Particle Physics Division
Fachverband Teilchenphysik (T)

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Overview of Invited Talks and Sessions

(Lecture halls HSZ/AUDI, HSZ/0003, HSZ/0004, HSZ/0101, HSZ/0103, HSZ/0105, HSZ/0201, HSZ/0204, HSZ/0301, HSZ/0304, HSZ/0401, HSZ/0403, HSZ/0405, POT/0051, POT/0151, POT/0251, POT/0361, POT/0006, POT/0112, POT/0013, POT/0351, POT/0106, WIL/A317, WIL/A124, WIL/C133, WIL/A120, and WIL/C129)

Invited Talks

T 1.1	Mon	11:00–11:30	HSZ/AUDI	**What we learned about the Higgs Boson from the LHC so far** — •Duc Bao Ta
T 1.2	Mon	11:30–12:00	HSZ/AUDI	**QCD at the LHC – Precision for Discoveries** — •Malgorzata Worek
T 1.3	Mon	12:00–12:30	HSZ/AUDI	**The charm and beauty of flavour physics** — •Marco Gersabeck
T 24.1	Tue	11:00–11:30	HSZ/AUDI	**Searching for Long-Lived Particles at the LHC and Beyond** — •Juliette Alimena
T 24.2	Tue	11:30–12:00	HSZ/AUDI	**The Neutrino-Dawn of Galaxies** — •Wolfgang Rhode
T 24.3	Tue	12:00–12:30	HSZ/AUDI	**Galactic cosmic rays: What have we learned and what's next?** — •Philipp Mertsch
T 100.1	Thu	11:00–11:30	HSZ/AUDI	**AI Techniques for Event Reconstruction** — •Ivan Kisel
T 100.2	Thu	11:30–12:00	HSZ/AUDI	**Accelerator operation optimisation using machine learning** — •Pierre Schnizer
T 100.3	Thu	12:00–12:30	HSZ/AUDI	**Is this even physics? – Progress on AI in particle physics** — •Gregor Kasieczka
T 153.1	Fri	11:00–11:30	HSZ/AUDI	**The Standard Model on the test bench: What bosons and the top quark (will) tell us** — •Valerie Lang
T 153.2	Fri	11:30–12:00	HSZ/AUDI	**Gravitational wave observations: Current results & future expectations** — •Harald Pfeiffer
T 153.3	Fri	12:00–12:30	HSZ/AUDI	**Precise muon detection: novel technologies for the luminosity frontier** — •Kerstin Hoepfner
T 154.1	Fri	13:30–14:00	HSZ/AUDI	**ECN3: Experimental Opportunities at a Future High-Intensity Proton Facility at the CERN SPS (BDF/SHiP and HIKE+SHADOWS)** — •Annika Hollnagel

Invited Topical Talks

T 50.1	Wed	11:00–11:20	HSZ/AUDI	**Search for leptoquarks at the ATLAS experiment** — •Mahsana Haleem
T 50.2	Wed	11:20–11:40	HSZ/AUDI	**Making the most of Yukawa couplings: searching for Dark Matter accompanied by heavy quarks** — •Danyer Perez Adan
T 50.3	Wed	11:40–12:00	HSZ/AUDI	**Precision predictions for transverse momentum distributions of Higgs and vector bosons at the LHC** — •Maximilian Stahlhofen
T 50.4	Wed	12:00–12:20	HSZ/AUDI	**Axion fragmentation** — •Enrico Morgante
T 51.1	Wed	11:00–11:20	HSZ/0003	**LUXE – A new experiment to study non-perturbative QED in electron-laser and photon-laser collisions** — •Ruth Jacobs
T 51.2	Wed	11:20–11:40	HSZ/0003	**Precision timing with silicon sensors** — •Annika Vauth

T 51.3	Wed	11:40–12:00	HSZ/0003	**Recent advancements in Micro-Pattern Gaseous Detectors: Exciting research ahead towards future experiments** — •Michael Lupberger
T 51.4	Wed	12:00–12:20	HSZ/0003	**Recent Liquid Scintillator Developments for Astroparticle Physics** — •Stefan Schoppmann
T 52.1	Wed	14:00–14:20	HSZ/AUDI	**Commissioning of the new LHCb trigger system** — •Marian Stahl
T 52.2	Wed	14:20–14:40	HSZ/AUDI	**Alignment of the CMS Tracker: Automation is Key** — •Marius Teroerde
T 52.3	Wed	14:40–15:00	HSZ/AUDI	**ITk – ATLAS tracker upgrade** — •Dennis Sperlich
T 52.4	Wed	15:00–15:20	HSZ/AUDI	**Role of simulation in silicon tracker sensors R&D** — •Anastasiia Velyka
T 53.1	Wed	14:00–14:20	HSZ/0003	**LST-1: Initial scientific results from the first CTA telescope** — •Dominik Elsaesser
T 53.2	Wed	14:20–14:40	HSZ/0003	**Multimessenger astronomy with the Pierre Auger Obser- vatory** — •Marcus Niechciol
T 53.3	Wed	14:40–15:00	HSZ/0003	**Positron annihilation as an astrophysical messenger** — •Thomas Siegert
T 53.4	Wed	15:00–15:20	HSZ/0003	**The first results of the XENONnT experiment and an outlook to the future DARWIN observatory** — •Andrii Terliuk
T 101.1	Thu	14:00–14:20	HSZ/0003	**How to Study the Higgs Boson in its Bosonic Decays** — •Benedict Winter
T 101.2	Thu	14:20–14:40	HSZ/0003	**Measuring $H \to WW$ with the ATLAS Experiment** — •Carsten Burgard
T 101.3	Thu	14:40–15:00	HSZ/0003	**Belle II opportunities in B-decays with invisible signatures** — •Slavomira Stefkova
T 101.4	Thu	15:00–15:20	HSZ/0003	**Two Pieces of a Puzzle: Inclusive and Exclusive $\|\mathbf{V_{cb}}\|$** — •Markus Prim
T 102.1	Thu	14:00–14:20	HSZ/0004	**Expanding the Frontiers of Galactic Neutrino Astronomy via Machine Learning*** — •Mirco Hünnefeld
T 102.2	Thu	14:20–14:40	HSZ/0004	**Enhancing the CMS Level-1 Trigger with real-time Machine Learning** — •Artur Lobanov
T 102.3	Thu	14:40–15:00	HSZ/0004	**Higgsino Hunting at ATLAS** — •Michael Holzbock
T 102.4	Thu	15:00–15:20	HSZ/0004	**New Ideas for Baryo- and Leptogenesis** — •Kai Schmitz

Sessions

T 1.1–1.3	Mon	11:00–12:30	HSZ/AUDI	**Invited Overview Talks I**
T 2.1–2.6	Mon	16:30–18:00	HSZ/0004	**Flavor I**
T 3.1–3.6	Mon	16:30–18:00	HSZ/0401	**Top I**
T 4.1–4.6	Mon	16:30–18:00	HSZ/0403	**Searches I**
T 5.1–5.6	Mon	16:30–18:00	HSZ/0101	**Higgs Searches**
T 6.1–6.6	Mon	16:30–18:00	HSZ/0103	**Other Exp., EW**
T 7.1–7.6	Mon	16:30–18:00	HSZ/0105	**Higgs, Di-Higgs I**
T 8.1–8.6	Mon	16:30–18:00	HSZ/0204	**Outreach Public/Teilchenwelt (joint session T/HK)**
T 9.1–9.6	Mon	16:30–18:00	HSZ/0301	**DAQ NN/ML – HW**
T 10.1–10.6	Mon	16:30–18:00	HSZ/0405	**ML Methods I**
T 11.1–11.6	Mon	16:30–18:00	POT/0051	**Neutrinos, Dark Matter I**
T 12.1–12.6	Mon	16:30–18:00	POT/0151	**Gamma Astronomy I**
T 13.1–13.6	Mon	16:30–18:00	POT/0251	**Neutrinos I**
T 14.1–14.6	Mon	16:30–18:00	POT/0361	**Neutrinos, Dark Matter II**
T 15.1–15.6	Mon	16:30–18:00	POT/0006	**Neutrinos, Dark Matter III**
T 16.1–16.6	Mon	16:30–18:00	POT/0112	**Neutrino Astronomy I**
T 17.1–17.6	Mon	16:30–18:00	POT/0013	**Cosmic Ray I**
T 18.1–18.6	Mon	16:30–18:00	POT/0351	**Exp. Methods, CTA, others**
T 19.1–19.5	Mon	16:30–17:45	POT/0106	**Detector Systems, Electronics**
T 20.1–20.5	Mon	16:30–17:45	WIL/A317	**Pixel ITk, Si-Strips/Other**
T 21.1–21.6	Mon	16:30–18:00	WIL/A124	**Si-Strips/CMS, Pixel/Sensor**
T 22.1–22.6	Mon	16:30–18:00	WIL/C133	**Calorimeter / Detector Systems I**
T 23.1–23.6	Mon	16:30–18:00	WIL/A120	**Gas-Detectors / Muon MDT**

T 24.1–24.3	Tue	11:00–12:30	HSZ/AUDI	**Invited Overview Talks II**
T 25.1–25.6	Tue	17:00–18:30	HSZ/0304	**Flavor II**
T 26.1–26.6	Tue	17:00–18:30	HSZ/0401	**Flavor III**
T 27.1–27.6	Tue	17:00–18:30	HSZ/0403	**Searches II**
T 28.1–28.6	Tue	17:00–18:30	HSZ/0101	**Forward Physics**
T 29.1–29.6	Tue	17:00–18:30	HSZ/0103	**Other Exp., EW**
T 30.1–30.6	Tue	17:00–18:30	HSZ/0105	**Higgs Charm, Di-Higgs**
T 31.1–31.5	Tue	17:00–18:15	HSZ/0201	**Theory Higgs, BMS**
T 32.1–32.6	Tue	17:00–18:30	HSZ/0204	**Di-Higgs, Higgs BSM**
T 33.1–33.6	Tue	17:00–18:30	HSZ/0301	**DAQ NN/ML – GRID I**
T 34.1–34.6	Tue	17:00–18:30	HSZ/0405	**ML Methods II**
T 35.1–35.6	Tue	17:00–18:30	POT/0051	**Neutrino Astronomy II**
T 36.1–36.6	Tue	17:00–18:30	POT/0151	**Gamma Astronomy II**
T 37.1–37.6	Tue	17:00–18:30	POT/0251	**Neutrinos, Dark Matter IV**
T 38.1–38.6	Tue	17:00–18:30	POT/0361	**Neutrinos, Dark Matter V**
T 39.1–39.6	Tue	17:00–18:30	POT/0006	**Neutrinos, Dark Matter VI**
T 40.1–40.4	Tue	17:00–18:00	POT/0112	**Astro Particle Theory**
T 41.1–41.6	Tue	17:00–18:30	POT/0013	**Cosmic Ray II**
T 42.1–42.6	Tue	17:00–18:30	POT/0351	**Exp. Methods, IceAct, Auger, RNO-G**
T 43.1–43.6	Tue	17:00–18:30	POT/0106	**Electronics, DAQ, Exp. Methods**
T 44.1–44.6	Tue	17:00–18:30	WIL/A317	**Pixel/LHCb, Si-Strips/CMS**
T 45.1–45.6	Tue	17:00–18:30	WIL/A124	**Si-Strips, Pixel**
T 46.1–46.6	Tue	17:00–18:30	WIL/C133	**Calorimeter / Detector Systems II**
T 47.1–47.6	Tue	17:00–18:30	WIL/A120	**Gas-Detecors, Detector Systems**
T 48.1–48.5	Tue	17:00–18:15	WIL/C129	**Exp. Methods I**
T 49.1–49.7	Tue	17:00–18:45	SCH/A252	**Outreach (joint session HK/T)**
T 50.1–50.4	Wed	11:00–12:20	HSZ/AUDI	**Invited Topical Talks I-A**
T 51.1–51.4	Wed	11:00–12:20	HSZ/0003	**Invited Topical Talks I-B**
T 52.1–52.4	Wed	14:00–15:20	HSZ/AUDI	**Invited Topical Talks II-A**
T 53.1–53.4	Wed	14:00–15:20	HSZ/0003	**Invited Topical Talks II-B**
T 54.1–54.6	Wed	15:50–17:20	HSZ/0304	**Flavor IV**
T 55.1–55.6	Wed	15:50–17:20	HSZ/0401	**Flavor V, Top-BSM**
T 56.1–56.6	Wed	15:50–17:20	HSZ/0403	**Searches EW I**
T 57.1–57.6	Wed	15:50–17:20	HSZ/0101	**Single Top – Higgs Top**
T 58.1–58.6	Wed	15:50–17:20	HSZ/0103	**Other Exp., $t\bar{t}$**
T 59.1–59.6	Wed	15:50–17:20	HSZ/0105	**QCD Theory and Experiment I**
T 60.1–60.5	Wed	15:50–17:05	HSZ/0201	**Theory BMS**
T 61.1–61.6	Wed	15:50–17:20	HSZ/0204	**Higgs I**
T 62.1–62.6	Wed	15:50–17:20	HSZ/0301	**DAQ NN/ML – GRID II**
T 63.1–63.6	Wed	15:50–17:20	HSZ/0405	**ML Methods III**
T 64.1–64.6	Wed	15:50–17:20	POT/0051	**Neutrino Astronomy III**
T 65.1–65.4	Wed	15:50–16:50	POT/0151	**Gamma Astronomy III**
T 66.1–66.6	Wed	15:50–17:20	POT/0251	**Neutrinos II**
T 67.1–67.4	Wed	15:50–16:50	POT/0361	**Neutrinos, Dark Matter VII**
T 68.1–68.4	Wed	15:50–16:50	POT/0006	**Neutrinos, Dark Matter VIII**
T 69.1–69.5	Wed	15:50–17:05	POT/0112	**Neutrinos, Dark Matter IX**
T 70.1–70.6	Wed	15:50–17:20	POT/0013	**Cosmic Ray III**
T 71.1–71.6	Wed	15:50–17:20	POT/0351	**Exp. Methods AP, PMTs**
T 72.1–72.5	Wed	15:50–17:05	POT/0106	**Exp. Methods II**
T 73.1–73.4	Wed	15:50–16:50	WIL/A317	**Pixel/CMS**
T 74.1–74.4	Wed	15:50–16:50	WIL/A124	**DetSys MAGIX, DetSys KATRIN**
T 75.1–75.3	Wed	15:50–16:35	WIL/C133	**Calorimeter / Detector Systems III**
T 76.1–76.4	Wed	15:50–16:50	WIL/A120	**Gas-Detectors**
T 77.1–77.6	Wed	17:20–18:50	HSZ/0401	**Flavor VI**
T 78.1–78.6	Wed	17:30–19:00	HSZ/0304	**Flavor VII**
T 79.1–79.5	Wed	17:30–18:45	HSZ/0403	**Searches III**
T 80.1–80.6	Wed	17:30–19:00	HSZ/0101	**Searches EW II**
T 81.1–81.6	Wed	17:30–19:00	HSZ/0103	**Single Top, Top Properties**
T 82.1–82.6	Wed	17:30–19:00	HSZ/0105	**Higgs, Di-Higgs II**
T 83.1–83.4	Wed	17:30–18:30	HSZ/0201	**Theory BSM**
T 84.1–84.6	Wed	17:30–19:00	HSZ/0204	**Theory EW**

T 85.1–85.5	Wed	17:30–18:45	HSZ/0301	**DAQ, Data Techniques**
T 86.1–86.6	Wed	17:30–19:00	HSZ/0405	**ML Methods IV**
T 87.1–87.6	Wed	17:30–19:00	POT/0051	**Neutrinos III**
T 88.1–88.6	Wed	17:30–19:00	POT/0151	**Gamma Astronomy IV**
T 89.1–89.6	Wed	17:30–19:00	POT/0251	**DM, Neutrino Theory**
T 90.1–90.6	Wed	17:30–19:00	POT/0361	**Neutrinos, Dark Matter X**
T 91.1–91.6	Wed	17:30–19:00	POT/0006	**Neutrinos IV**
T 92.1–92.6	Wed	17:30–19:00	POT/0013	**Cosmic Ray IV**
T 93.1–93.6	Wed	17:30–19:00	POT/0351	**Exp. Methods – Scint., HESS, Auger**
T 94.1–94.6	Wed	17:30–19:00	POT/0106	**DAQ, Exp. Methods**
T 95.1–95.6	Wed	17:30–19:00	WIL/A317	**Pixel, Det/Sys LHCb, HGT**
T 96.1–96.6	Wed	17:30–19:00	WIL/A124	**TestBeam, RadHard for Si and Pixel**
T 97.1–97.6	Wed	17:30–19:00	WIL/C133	**Calorimeter / Detector Systems IV**
T 98.1–98.6	Wed	17:30–19:00	WIL/A120	**Gas-Detecors, Detector Systems**
T 99	Wed	19:00–20:00	HSZ/0101	**Annual Meeting of Young Scientists in High Energy Physics (yHEP)**
T 100.1–100.3	Thu	11:00–12:30	HSZ/AUDI	**AI Topical Day – Invited Talks (joint session AKPIK/HK/ST/T/AKBP)**
T 101.1–101.4	Thu	14:00–15:20	HSZ/0003	**Invited Topical Talks III-A**
T 102.1–102.4	Thu	14:00–15:20	HSZ/0004	**Invited Topical Talks III-B**
T 103.1–103.6	Thu	15:45–17:15	HSZ/0004	**AI Topical Day – Simulation, Inverse Problems and Algorithmic Development (joint session AKPIK/T)**
T 104.1–104.6	Thu	15:50–17:20	HSZ/0304	**Flavor VIII**
T 105.1–105.6	Thu	15:50–17:20	HSZ/0401	**Flavor IX**
T 106.1–106.5	Thu	15:50–17:05	HSZ/0403	**Searches IV**
T 107.1–107.6	Thu	15:50–17:20	HSZ/0101	**Searches – Neutrino at accelerators**
T 108.1–108.6	Thu	15:50–17:20	HSZ/0103	**Top, EW I**
T 109.1–109.6	Thu	15:50–17:20	HSZ/0105	**Higgs, Di-Higgs III**
T 110.1–110.6	Thu	15:50–17:20	HSZ/0201	**Other Theory**
T 111.1–111.6	Thu	15:50–17:20	HSZ/0204	**Outreach Diverse (joint session T/HK)**
T 112.1–112.6	Thu	15:50–17:20	HSZ/0301	**DAQ Test/RO – GRID I**
T 113.1–113.6	Thu	15:50–17:20	HSZ/0405	**QCD Theory and Experiment II**
T 114.1–114.6	Thu	15:50–17:20	POT/0051	**Neutrinos V**
T 115.1–115.6	Thu	15:50–17:20	POT/0151	**Gamma Astronomy V**
T 116.1–116.6	Thu	15:50–17:20	POT/0251	**Neutrinos Legend, Neutrino Theory**
T 117.1–117.6	Thu	15:50–17:20	POT/0361	**Dark Matter I**
T 118.1–118.6	Thu	15:50–17:20	POT/0006	**Dark Matter II**
T 119.1–119.5	Thu	15:50–17:05	POT/0112	**Neutrino Astronomy IV**
T 120.1–120.6	Thu	15:50–17:20	POT/0013	**Cosmic Ray V**
T 121.1–121.6	Thu	15:50–17:20	POT/0351	**Cosmic Ray VI**
T 122.1–122.4	Thu	15:50–16:50	POT/0106	**DAQ Systems**
T 123.1–123.6	Thu	15:50–17:20	WIL/A317	**Pixel/Belle II, Si/Other**
T 124.1–124.6	Thu	15:50–17:20	WIL/A124	**Si-Strip/CMS, Pixel/DMAPS**
T 125.1–125.6	Thu	15:50–17:20	WIL/C133	**Calorimeter / Detector Systems V**
T 126.1–126.6	Thu	15:50–17:20	WIL/A120	**Gas-Detecors, Detector Systems**
T 127.1–127.5	Thu	15:50–17:05	WIL/C129	**Exp. Methods III**
T 128.1–128.6	Thu	17:30–19:00	HSZ/0004	**AI Topical Day – New Methods (joint session AKPIK/T)**
T 129.1–129.6	Thu	17:30–19:00	HSZ/0304	**Flavor X**
T 130.1–130.5	Thu	17:30–18:45	HSZ/0401	**Top II**
T 131.1–131.5	Thu	17:30–18:45	HSZ/0403	**Searches V**
T 132.1–132.6	Thu	17:30–19:00	HSZ/0101	**Searches VI**
T 133.1–133.6	Thu	17:30–19:00	HSZ/0103	**Top, EW II**
T 134.1–134.6	Thu	17:30–19:00	HSZ/0105	**Higgs, Di-Higgs IV**
T 135.1–135.6	Thu	17:30–19:00	HSZ/0201	**Top Mass, Top BSM**
T 136.1–136.6	Thu	17:30–19:00	HSZ/0204	**Higgs TH, VH**
T 137.1–137.6	Thu	17:30–19:00	HSZ/0301	**DAQ Test/RO – GRID II**
T 138.1–138.5	Thu	17:30–18:45	HSZ/0405	**QCD Experiment III**
T 139.1–139.6	Thu	17:30–19:00	POT/0051	**Neutrinos VI**
T 140.1–140.6	Thu	17:30–19:00	POT/0151	**Gamma Astronomy VI**
T 141.1–141.6	Thu	17:30–19:00	POT/0251	**Neutrino Astronomy V**
T 142.1–142.6	Thu	17:30–19:00	POT/0361	**Neutrinos, Dark Matter XI**

T 143.1–143.6	Thu	17:30–19:00	POT/0006	**Neutrinos VII**
T 144.1–144.6	Thu	17:30–19:00	POT/0013	**Cosmic Ray VII**
T 145.1–145.6	Thu	17:30–19:00	POT/0351	**Cosmic Ray VIII**
T 146.1–146.6	Thu	17:30–19:00	POT/0106	**DAQ Systems, Exp. Methods**
T 147.1–147.6	Thu	17:30–19:00	WIL/A317	**Pixel/HV-Maps, Si/Diamond**
T 148.1–148.6	Thu	17:30–19:00	WIL/A124	**Si/SiPM, Pixel/Other**
T 149.1–149.6	Thu	17:30–19:00	WIL/C133	**Detector Systems / Muon**
T 150.1–150.6	Thu	17:30–19:00	WIL/A120	**Gas-Detecors, Pixel/TANGERINE**
T 151.1–151.6	Thu	17:30–19:00	WIL/C129	**Exp. Methods IV**
T 152	Thu	20:00–22:00	HSZ/0003	**Members' Assembly**
T 153.1–153.3	Fri	11:00–12:30	HSZ/AUDI	**Invited Overview Talks III**
T 154.1–154.1	Fri	13:30–14:00	HSZ/AUDI	**Invited Overview Talks IV**

Members' Assembly of the Particle Physics Division

Thursday 20:00–22:00 HSZ/0003

T 1: Invited Overview Talks I

Time: Monday 11:00–12:30 Location: HSZ/AUDI

Invited Talk T 1.1 Mon 11:00 HSZ/AUDI

What we learned about the Higgs Boson from the LHC so far — •Duc Bao Ta — Johannes Gutenberg-Universität Mainz

The Higgs boson in the Standard Modell of particle physics has a unique role as it is related to the mechanism that gives elementary particles their mass. Last year the large LHC experiments, ATLAS and CMS, released the most comprehensive overview of their results on the Higgs boson for the 10th year after its discovery. These results are based on the LHC run 2 dataset from 2015-2018, which constitutes only 5% of the ultimate dataset. However, it has already enabled us to study the Higgs boson properties in unprecedented detail. The two collaborations continue to study the dataset and explore more corners of the Higgs sector that might connect it to the open questions in particle physics, like the origin of CP violation or the nature of dark matter. In this presentation, I will review the current results of the Higgs boson from the LHC and give an outlook on what is planned and can be achieved with the data from the currently ongoing Run 3 or when the remaining 90-95% of the full dataset will have been collected and analysed in the future.

Invited Talk T 1.2 Mon 11:30 HSZ/AUDI

QCD at the LHC – Precision for Discoveries — •Malgorzata Worek — RWTH Aachen University

In this presentation, I will summarise the relevance of higher-order QCD effects to Standard Model processes at the Large Hadron Collider (LHC). Special emphasis will be placed on the physics of the top quark and QCD jets. Many models look at the production of top quarks as well as QCD jets as interesting channels to evidentiate signals of new physics. A good theoretical control of Standard Model backgrounds is, thus, a fundamental prerequisite for a correct interpretation of the possible signals of new physics that may arise in these channels. Since the top quark and QCD jets play an important role in virtually every LHC analysis, proper modeling of their production is essential both for SM measurements and for beyond the Standard Model searches. Such modelling will become even more important for high luminosity measurements and at future colliders.

Invited Talk T 1.3 Mon 12:00 HSZ/AUDI

The charm and beauty of flavour physics — •Marco Gersabeck — The University of Manchester, Manchester, UK

Precision flavour physics measurements have a long track record of providing some of the most powerful tests of the Standard Model, with sensitivity to scales of physics beyond the Standard Model well in excess of those directly accessible at colliders. This talk will review highlights among the latest set of results and report on the status of ongoing experiments. The recent discovery of CP violation in charm decays necessitates a range of further measurements to identify its origin and the latest analyses will be discussed. The talk will also include the most recent results on tests of lepton universality. The talk will further include an outlook on the next generation of flavour physics experiments.

T 2: Flavor I

Time: Monday 16:30–18:00 Location: HSZ/0004

T 2.1 Mon 16:30 HSZ/0004

Search for $^3\overline{\mathrm{He}}$ and $^3_{\Lambda}\overline{\mathrm{H}}$ at LHCb — •Hendrik Jage[1], Razvan-Daniel Moise[1], Gediminas Sarpis[2], Valery Zhukov[1], and Stefan Schael[1] — [1]I. Physikalisches Institut B, RWTH Aachen University — [2]University of Edinburgh

In recent presentations, AMS-02 has reported the observation of several anti-helium candidates in cosmic rays. In 2020, it has been suggested by M. Winkler and T. Linden that dark matter annihilation into b-quarks could produce a detectable $^3\overline{\mathrm{He}}$ flux in cosmic rays via $\overline{\Lambda}_b^0$ decays.

The LHCb detector at CERN is an experiment dedicated to the study of b-hadrons, which are abundantly produced in the proton-proton collisions at the Large Hadron Collider (LHC). Therefore, the large sample of Λ_b^0 decays, collected by LHCb until 2018, provides a unique opportunity to study the potential displaced production of ^{3}He via Λ_b^0 decays.

While prompt ^{3}He from proton-proton collisions as well as from $^3_{\Lambda}\mathrm{H} \to {}^3\mathrm{He}\pi^-$ decays has already been observed at the LHC by the ALICE Collaboration in the central region ($|y| < 0.5$), prompt and displaced ^{3}He has not previously been searched for at LHCb ($2 < \eta < 5$). In this talk, the possibility of identifying ^{3}He with the LHCb tracking system is discussed and the status of the on-going analysis is presented.

T 2.2 Mon 16:45 HSZ/0004

Taming New Physics in $b \to c\bar{u}d(s)$ with $\tau(B^+)/\tau(B_d)$ and a_{sl}^d — Alexander Lenz, •Jakob Müller, Maria Laura Piscopo, and Aleksey V. Rusov — Center for Particle Physics Siegen, Theoretische Teilchenphysik, Universität Siegen

Inspired by the recently observed tensions between the experimental data and the theoretical predictions, based on QCD factorisation, for several colour-allowed non-leptonic B-meson decays, we study the potential size of new physics (NP) effects in the decay channels $b \to c\bar{u}d(s)$. Starting from the most general effective Hamiltonian describing the $b \to c\bar{u}d(s)$ transitions, we compute NP contributions to the theoretical predictions of B-meson lifetime and of B-mixing observables. The well-known lifetime ratio $\tau(B^+)/\tau(B_d)$ and the experimental bound on the semi-leptonic CP asymmetry a_{sl}^d, provide strong, complementary constraints on some of the NP Wilson coefficients.

T 2.3 Mon 17:00 HSZ/0004

Flavour tagging, $B_s \to D_sK$, and $B^0 \to J/\psi K_S$ — Quentin Führing, Vukan Jevtic, Gerwin Meier, •Sophie Hollitt, and Johannes Albrecht — TU Dortmund University, Dortmund, Germany

The amount of CP violation in the Standard Model is insufficient to explain the universe's matter-antimatter asymmetry. Precision measurements of CP violation in decays–including measurements of the angles of the 'CKM triangle' to test for unitarity–are crucial to further understand CP violation in the Standard Model and reveal any possible hints of new physics. Determining the flavour of the B meson at the time of production with flavour tagging is a key part of this process.

In this talk we consider analyses for two of the three CKM angles: the angle γ using the decay $B_s^0 \to D_sK$, and the angle β using the channel $B^0 \to J/\psi K_S$. The LHCb experiment provides a large number of B_s meson decays with an excellent decay time resolution, that can be used to measure $B_s \to D_sK$ and provide an additional constraint on γ. For $\sin(2\beta)$, the statistical significance of previous measurements of $B^0 \to J/\psi K_S$ can be improved by including additional track reconstruction types and more decay channels in this updated analysis.

T 2.4 Mon 17:15 HSZ/0004

***CP* violation measurement in $B^0 \to D^+D^-$ and $B_s^0 \to D_s^+D_s^-$ decays at the LHCb experiment** — Johannes Albrecht, •Louis Gerken, Philipp Ibis, and Antje Mödden — TU Dortmund University, Dortmund, Germany

Time dependent measurements of *CP* violation are a major part of the research at the LHCb experiment. They provide access to important Standard Model parameters such as the *CP*-violating mixing phases $\sin 2\beta$ and ϕ_s. These can be measured in $B^0 \to D^+D^-$ and $B_s^0 \to D_s^+D_s^-$ decays, respectively. The *CP* violation in these decays arises in the interference between the direct decay and the decay after mixing. Due to the similarities of these decays, the two measurements are performed in parallel.

In this talk, the current status of the analysis is presented. The analysis uses data collected by the LHCb detector during 2015 to 2018 at a centre-of-mass energy of 13 TeV corresponding to an integrated luminosity of $6\,\mathrm{fb}^{-1}$.

T 2.5 Mon 17:30 HSZ/0004

CP violation in $\tau \to K_S\pi\nu_\tau$ decays at Belle* — •Katarina Dugic, Daniel Greenwald, and Stephan Paul for the Belle II-Collaboration — Technical University Munich

In 2012, BaBar measured a CP-violating decay-rate asymmetry in $\tau \to \pi K^0_S(\geq 0\pi^0)\nu_\tau$ that deviates from the standard-model prediction by 2.8σ. We present initial studies for measuring the same asymmetry using data from the Belle experiment, which is twice as large.

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T 2.6 Mon 17:45 HSZ/0004

Minimal Models for Radiative Fermion Masses — •Zachary Wüthrich[1,2] and Andreas Crivellin[3,4] — [1]Universität Siegen — [2]ETH, Zürich — [3]PSI — [4]UZH

There has been a long history of attempts to generate fermion masses from loops of heavier particles. This would be an elegant theory, as it provides a simple and natural explanation of the observed fermion mass hierarchy through the loop hierarchy.

This work investigates a class of minimal renormalizable models using scalar leptoquarks and other new scalar particles to generate the fermion masses at the loop level. We provide for the first time a classification of the different representations of a scalar field that allows for a chirally enhanced radiative generation of fermion masses. Constraints from observables give bounds on the scalar particle masses and their couplings, with special emphasis given to the effect of the new models on the anomalous magnetic moment of the muon.

T 3: Top I

Time: Monday 16:30–18:00 Location: HSZ/0401

T 3.1 Mon 16:30 HSZ/0401

Top-beauty couplings at FCC-ee and synergies in global SMEFT interpretations — Kevin Kröninger[1], Romain Madar[2], Stéphane Monteil[2], and •Lars Röhrig[1,2] — [1]TU Dortmund University, Department of Physics — [2]Université Clermont-Auvergne, Laboratoire de Physique de Clermont

Experiments for the post-LHC era as proposed nowadays are aimed at precision measurements in the electroweak, flavor, Higgs and top-quark sector. The FCC-ee among other proposals offers unrivaled precision in these fields and allows to combine measurements within the Standard Model Effective Field Theory at energy scales ranging from 91 GeV up to 365 GeV.

This talk motivates the combination of the top- and the $Z \to b\bar{b}$ energy scale and possible synergies through a common set of dimension-six operators. The estimation of several top-quark observable sensitivites is highlighted, as well as challenges and prospects of a full reconstruction in an FCC-ee environment. Systematically limited measurements of EWPO at the Z-pole at FCC-ee are discussed and novel hemisphere tagging techniques are presented to reduce these uncertainties.

T 3.2 Mon 16:45 HSZ/0401

Search for same-sign top pair production with the Standard Model Effective Field Theory at the ATLAS experiment — Noemi Cavalli[1,2], Merve Nazlim Agaras[4], Maximiliano Sioli[2], Matteo Negrini[2], Kevin Alexander Kroeninger[1], Shalini Epari[4], Aurelio Juste Rozas Rozas[4], Stergios Kazakos[4], Javier Montejo Berlingen[3], Nicola Orlando[4], Tamara Vazquez Schroeder[3], and •Aaron van der Graaf[1,2] — [1]TU Dortmund — [2]Bologna — [3]CERN — [4]IFAE

Model-independent searches for new physics at high energies by using the Standard Model (SM) Effective Field Theory (SMEFT) are an important part of todays physics program. Same-sign top-quark pair production is highly suppressed in the SM while several models beyond the SM enhance the production. SMEFT is used obtain model-independent predictions for the production of the same-sign top pairs beyond the SM. Three EFT operators are considered to simulate the searched signal. The full Run 2 dataset collected by the ATLAS detector from proton-proton collisions is used for this search for same-sign top-quark pairs, in the dilepton final state. A Neural Network (NN) is employed to build separate signal regions (SR) enriched in same-sign top events resulting from different EFT operators. Within the defined SRs, a second NN is applied to perform a signal-background discrimination. In order to attain an accurate estimation of background contributions in the SRs, several Control Regions (CRs) are defined. The background estimation and the signal search are performed by using a maximum likelihood fit over all analysis regions.

T 3.3 Mon 17:00 HSZ/0401

Measurement of SMEFT parameters in $t\bar{t} + \gamma$ using Run 2 data with the ATLAS experiment — •Jan Joachim Hahn[1], Binish Batool[1], Beatrice Cervato[1], Markus Cristinziani[1], Carmen Diez Pardos[1], Ivor Fleck[1], Arpan Ghosal[1], Gabriel Gomes[1], Vadim Kostyukhin[1], Buddhadeb Mondal[1], Amartya Rej[1], Katharina Voss[1], Wolfgang Walkowiak[1], and Tongbin Zhao[1,2] — [1]Center for Particle Physics Siegen, Experimentelle Teilchenphysik, Universität Siegen — [2]Shandong University, China

In the Standard Model Effective Field Theory (SMEFT), the effects of physics phenomena beyond the Standard Model (SM) are modelled via higher dimension operators. Measurements of sensitive processes can be used to constrain the coefficients of operators that contribute to a process. The top quark is the heaviest known particle and the only quark that decays before hadronisation. It is expected to play a relevant role in many models of physics beyond the SM given its large mass. Final states including photons are sensitive to modifications in the electroweak sector, changing the photon energy spectrum. This talk will focus on a interpretation of the ongoing $t\bar{t}\gamma$ cross section measurement in terms of SMEFT. To constrain several EFT operators, $t\bar{t}\gamma$ events decaying semileptonically are studied. The study is performed using the full Run 2 data set collected by the ATLAS experiment corresponding to 139 fb^{-1} at $\sqrt{s} = 13\ TeV$.

T 3.4 Mon 17:15 HSZ/0401

Kinematic Fit for Top-Antitop Production at LHC — •Constant Peeters, Patrick Connor, Johannes Lange, Hartmut Stadie, and Peter Schleper — Institut für Experimentalphysik, Universität Hamburg

The decay products of top quark pairs in proton-proton collisions at the LHC can be reconstructed independently of one another using the particle flow algorithm. A fit utilising physical properties of the event topology may be used in addition to further constrain their kinematics. This may be beneficial to measure fundamental quantities of the top quark, such as its mass. In this work, we present the general technique and investigate the impact of the jet energy resolution on the fit results. The kinematic fitting package KinFitter, commonly used within the CMS software framework, is utilized with the aim of ensuring usability independent of the CMS software stack.

T 3.5 Mon 17:30 HSZ/0401

Messung der Energieasymmetrie bei der Top-Antitop-Jet Produktion in der resolved Topologie am ATLAS — •Jessica Höfner, Alexander Basan, Asma Hadef, Lucia Masetti, Eftychia Tzovara und Doga Elitez für die ATLAS-Kollaboration — Universität Mainz

Das Top-Quark ist das schwerste Teilchen im Standardmodell der Elementarteilchen und das einzige Quark das zerfällt bevor es hadronisieren kann. Es eignet sich sehr gut dafür Physik jenseits des Standardmodells zu suchen, denn es könnten noch unentdeckte schwerere Teilchen mit dem Top-Quark wechselwirken.

Bei der Produktion eines Top-Antitop-Paares mit zusätzlichem Jet kann die Energieasymmetrie, eine Observable, die auf der Ladungsasymmetrie beruht, bestimmt werden, die besonders sensitiv auf Physik jenseits des Standardmodells sein kann. Daher ist es vom großem Interesse diese Observable zu messen. Nach einer ersten veröffentlichten Messung der Energieasymmetrie mit dem ATLAS Experiment in der Topologie mit einem kollimierten hadronischen Top-Quark Zerfall und einem semileptonischen Zerfall, ist es ebenfalls das Ziel die Observable in einem erweiterten Phasenraum zu bestimmen. Dazu wird zunächst die Eventrekonstruktion in der "resolved" Topologie, in der der hardonische Zerfall durch mehrere small-R Jets rekonstruiert wird,

optimiert. In diesem Vortrag werden die bisher erzielten Fortschritte dieser Optimierung vorgestellt.

T 3.6 Mon 17:45 HSZ/0401

Machine learning approaches for parameter reweighting in MC samples of top quark production — •Valentina Guglielmi, Katerina Lipka, and Simone Amoroso — Deutsches Elektronen-Synchrotron DESY, Notkestraße 85, D-22607 Hamburg, Germany

In particle physics, complex Monte Carlo (MC) simulations are needed to compare theoretical predictions to observables. Further MC samples have to be generated to account for all the systematic uncertainties. Therefore, the MC statistic becomes a limiting factor for most measurements. Moreover, the significant computational cost of these programs is a bottleneck in most physics analyses. Therefore, finding a way to reduce the number of MC samples is important to decrease the MC statistical uncertainties and lower the computational cost. In this contribution, an approach called Deep neural network using Classification for Tuning and Reweighting (DCTR) is evaluated. DCTR is a method, based on a Deep Neural Network (DNN) technique, to reweight simulations to different models by using the full kinematic information in the event. This methodology avoids the need for simulating the detector response multiple times by incorporating the relevant variations in a single sample. This way, the MC statistical uncertainties and the computational cost are reduced. Unlike the standard reweighting, in which the ratio in bins of two histograms at truth level is performed, multidimensional and unbinned information can be used as inputs to the DNN. This method is tested on MC simulations of top quark pair production within the CMS experiment.

T 4: Searches I

Time: Monday 16:30–18:00 Location: HSZ/0403

T 4.1 Mon 16:30 HSZ/0403

Search for long-lived particles decaying into displaced jets using a trackless and delayed jet tagger — •Lisa Benato and Gregor Kasieczka — Institute of Experimental Physics, Hamburg University

A search for long-lived particles decaying in the outer regions of the CMS silicon tracker or in the calorimeters is presented. A novel technique, using trackless and delayed jet information combined in a deep neural network discriminator, is employed to identify decays of long-lived particles. The results are interpreted in a simplified model of chargino-neutralino production, where the neutralino is the next-to-lightest supersymmetric particle, is long-lived, and decays to a gravitino and either a Higgs or Z boson. This search is most sensitive to neutralino proper decay lengths of ∼1 m, for which neutralino masses from up to 1180 GeV are excluded at 95% confidence level.

T 4.2 Mon 16:45 HSZ/0403

Search for resonant lepton+jet production with the ATLAS experiment — •Jiyoung Kim, Adrian Fernandez, and Stefan Tapprogge — Institute for Physics, Johannes Gutenberg University, Mainz

The leptoquark (LQ) is a hypothetical particle, which carries both lepton and quark quantum numbers. Its existence could point to extended theories beyond the Standard Model. If such particles were to exist, their decays might be observable in high-energy pp collisions using the ATLAS detector at the LHC. In this contribution, the specific interest is single LQ production leading to a resonant structure in the lepton-jet invariant mass. The search strategy about the existence of the LQs will be presented, including optimization of the selection cuts and comparison with the run 2 data set from ATLAS (with an integrated luminosity of 139fb^{-1}at$\sqrt{s} = 13$TeV).

T 4.3 Mon 17:00 HSZ/0403

Search for Dark Matter in association with a single top quark at the CMS experiment - leptonic analysis and combination — •Sebastian Wieland, Ulrich Husemann, and Michael Wassmer — Institute of Experimental Particle Physics (ETP), Karlsruhe Institute of Technology (KIT)

A promising production mechanism of Dark Matter at the Large Hadron Collider (LHC) is the associated production with a single top quark. Since the Dark Matter particles are not directly detected by the CMS detector the final state consists of a single top quark and missing transverse momentum, referred to as mono-top signature. The focus of this talk is the leptonic decay channel of the top quark, where the transverse W boson mass is utilized to discriminate between the mono-top signal and the standard-model backgrounds. In addition, the combination with the analysis targeting the hadronic decay of the top quark is presented. The analysis utilizes the full Run-2 dataset collected by the CMS experiment at the LHC. All results of this search are interpreted in the context of a simplified model introducing a flavor-changing neutral current at tree level by a spin-1 mediator and a Dirac Dark Matter particle.

T 4.4 Mon 17:15 HSZ/0403

Search for long-lived particles in the CMS muon system — •Joerg Schindler, Lisa Benato, Karim El Morabit, and Gregor Kasieczka — Universität Hamburg

Traditionally, searches for new physics at the LHC focused on already established objects, like photons, leptons, jets or missing energy. A different approach is to look for signatures in the detector which up until now were not considered. One example are long-lived particles, which can have a long lifetime leading to macroscopic flight distances ranging from a few micrometers up to several kilometers. In this talk, a search for long lived particles decaying in the CMS muon system is presented. The resulting signature is a large hadronic shower in the muon system with no inner detector activity, which can be observed with close to no background, but requires the development of new reconstruction and analysis tools. The status of the current searches for LLPs with decays in the muon system is shown, using data collected by the CMS detector in Run 2.

T 4.5 Mon 17:30 HSZ/0403

Substructure tagging with mass and p_T dependent variable-R jet clustering and a soft drop veto — •Anna Benecke[1], Anna Albrecht[2], and Roman Kogler[3] — [1]UCLouvain, Belgium — [2]Universität Hamburg, Germany — [3]DESY, Germany

The Heavy Object Tagger with Variable R (HOTVR) is an algorithm for the clustering and identification of boosted, hadronically decaying, heavy particles. The central feature of the HOTVR algorithm is a vetoed jet clustering with variable distance parameter R, that decreases with increasing transverse momentum of the jet. In this talk, we present improvements to the HOTVR algorithm, replacing the mass jump with a soft drop veto in the clustering. We study the performance of jet substructure tagging with HOTVR and ungroomed variable R jets, where we use machine learning techniques and energy flow polynomials to analyse the information loss from the soft drop veto. In addition, we show preliminary results of a distance parameter that changes with the jet mass and the transverse momentum, allowing to achieve an optimal value of R for W, Z, H bosons and top quarks simultaneously.

T 4.6 Mon 17:45 HSZ/0403

Search for Heavy Majorana Neutrinos in same-sign W Boson Scattering with the ATLAS experiment — •Jonas Neundorf for the ATLAS-Collaboration — Deutsches Elektronen-Synchrotron DESY, Notkestraße 85, 22607 Hamburg

Among the open question of particle physics is the origin of neutrino masses. While they are predicted to be zero by the Standard Model, oscillation measurements have shown that at least two of the three neutrino flavours observed in nature are massive. These masses can be explained by the "Seesaw Mechanism", which introduces Majorana neutrinos with a mass on the TeV scale. This talk will discuss the design and statistical evaluation of an ATLAS search for Heavy Majorana Neutrinos produced via same-sign W boson scattering.

T 5: Higgs Searches

Time: Monday 16:30–18:00 Location: HSZ/0101

T 5.1 Mon 16:30 HSZ/0101

An interference search for heavy Higgs bosons decaying to a top-antitop-quark pair with the ATLAS detector — •Nicola de Biase, Katharina Behr, and Eleanor Jones — Deutsches Elektronen-Synchrotron

New pseudoscalar (A) and scalar (H) states coupling strongly with $t\bar{t}$ states are predicted by many models with an extended Higgs sector, such as two-Higgs Doublet Models (2HDMs), which add a second Higgs doublet to the SM. In 2HDMs with fermion coupling structure of type II, these states decay predominantly to $t\bar{t}$, provided that they are massive enough (m>500 GeV) and that the ratio between the vacuum-expectation-values of the two Higgs doublets ($\tan\beta$) is small ($\tan\beta \lesssim 3$). To date, this parameter region is only little constrained by direct searches, as any search in the $t\bar{t}$ final state is complicated by the interference between the signal process (gluon-gluon initiated A/H production) and the dominant and irreducible background, which is the Standard Model production of $t\bar{t}$ pairs. This interference produces a characteristic peak-dip structure in the $t\bar{t}$ mass spectrum. In this talk, a search for pseudoscalar and scalar states decaying to a pair of top-quarks will be presented, using the full Run-II ATLAS dataset. Special attention will be given to the conceptual and technical challenges regarding the treatment of interference effects in the statistical analysis of the data.

T 5.2 Mon 16:45 HSZ/0101

Search for charged Higgs bosons in $H^+ \to W^+h$ decays with the ATLAS detector — Dominik Duda, •Simon Grewe, Sandra Kortner, and Hubert Kroha — Max Planck Institut für Physik

Many theories beyond the Standard Model predict the existence of charged Higgs bosons. The main production mode of these new particles depends on their mass. For large masses ($m(H^+) > m(t) + m(b)$), the dominant mode of production is in association with a top quark and a bottom quark (tbH^+). In the alignment limit of the Two-Higgs-Doublet Model (2HDM), heavy charged Higgs bosons with $m(H^+) > m(t) + m(b)$ decay almost exclusively via $H^+ \to tb$. In other models such as the Georgi-Machacek model, however, significant branching ratios for $H^+ \to W^+h$ are possible. This decay has so far not been studied by ATLAS or CMS.
A search for $H^+ \to W^+h$ decays in association with a top and bottom quark is presented, based on the full Run-2 dataset of the ATLAS experiment. The analysis targets final states with resolved $h \to b\bar{b}$ decays containing five or more jets, one charged lepton and missing transverse momentum. The reconstruction of the charged Higgs boson decay, as well as the definition of the signal and control regions is based on boosted decision trees (BDTs). Limits on $\sigma(pp \to tbH^+) \times BR(H^+ \to W^+h)$ are obtained by a maximum likelihood fit of the reconstructed H^+ mass spectrum.
This talk presents an overview of the analysis with special emphasis on the signal reconstruction and the development of the signal and control regions.

T 5.3 Mon 17:00 HSZ/0101

Search for inelastic Dark Matter with a Dark Higgs at Belle II — •Patrick Ecker, Giacomo De Pietro, Jonas Eppelt, Torben Ferber, and Pablo Goldenzweig — Institute of Experimental Particle Physics (ETP), Karlsruhe Institute of Technology (KIT)

Belle II has a unique reach for a broad class of models that postulate the existence of Dark Matter particles in the MeV-GeV mass range. One highly motivated scenario is a model which involves inelastic Dark Matter, consisting of two Dark Matter states with a mass splitting between them and the presence of a Dark Higgs boson. This model has a signature of up to two displaced vertices, one from the resonant decay of the Dark Higgs and another non-resonant one emerging from the decay of the involved Dark Matter particles. This talk will present a way to search for such signatures, which is not only challenging due to the presence of displaced vertices but also because of the seven-dimensional parameter space of the model.

T 5.4 Mon 17:15 HSZ/0101

Search for non-resonant light axion-like particles with heavy vector bosons in the final state. — •Anna Albrecht[1], Steffen Albrecht[1], Andreas Hinzmann[2], and Ankita Mehta[1] — [1]Institut für Experimentalphysik, Universität Hamburg — [2]DESY, Hamburg, previously Universität Hamburg

Many extensions of the Standard Model (SM) propose axion-like particles (ALPs) that could solve the strong CP problem and are proposed as dark matter candidates. A non-resonant search for light off-shell ALPs as mediators between gluons and heavy bosons (ZZ, ZH) is presented. Only the hadronic decays of two vector bosons are considered. For the high invariant mass of the diboson system, the differential cross section via ALPs as mediator decreases slower than the SM production. To extract the signal a three dimensional maximum likelihood fit of the jet masses and the invariant mass of the diboson system is performed. The analysis is performed using pp collision data collected by the CMS experiment at $\sqrt{s} = 13\,\text{TeV}$ in the years 2016 - 2018.

T 5.5 Mon 17:30 HSZ/0101

Low Temperature MMC-based Muon Veto for IAXO — •Daniel Unger, Christian Enss, Andreas Fleischmann, Daniel Hengstler, Ashish Jadhav, and Loredana Gastaldo — Kirchhoff Institute for Physics, Heidelberg University, Im Neuenheimer Feld 227, 69120 Heidelberg, Germany.

An array of Metallic Magnetic Calorimeter (MMC) operated at a few mK in a dilution refrigerator is considered as a possible focal plane detector for the IAXO helioscope. For such an experiment, the background rate must be smaller than $10^{-6}\,\text{keV}^{-1}\text{cm}^{-2}\text{s}^{-1}$. However, we expect the rate of events related to cosmic muons to be two orders of magnitude larger. A traditional muon veto composed by scintillating panels would have to cover the full cryostat, a volume of about $3\,\text{m}^3$. A cryogenic muon veto surrounding the $150\,\text{cm}^3$ volume of the detector module could veto muon related events more efficiently. We present the development of a large-area MMC-based muon veto. Muons will be detected through their energy deposition while traversing a silicon wafer with thickness of 0.4 mm and an area of $30\,\text{cm}^2$. We discuss the design and the fabrication challenges of the muon veto in addition to the prototype setup for testing purposes. We aim to characterize the performance of the large silicon detector and at the same time study the spectrum of muon related events detected by the MMC array as well as of the residual background due to natural radioactivity. Finally, we evaluate the suitability of MMC arrays for low background measurements.

T 5.6 Mon 17:45 HSZ/0101

Recent Updates on the ALPS II Experiment — •Gulden Othman for the ALPS-Collaboration — Institut für Experimental Physik, Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg

The Any Light Particle Search II (ALPS II) experiment searches for axions and axion-like particles (ALPs) in an important parameter space that is relevant in understanding anomalous astrophysical phenomena, including stellar evolution. ALPS II takes advantage of the axion coupling to photons using a Light-Shining-through-a-Wall technique. Photons created using a strong laser may convert into ALPs in the presence of a strong magnetic field, traverse a light-tight barrier, reconvert into photons in another strong magnetic field, and be subsequently detected. By using two mode-matched optical resonators before and after the barrier, ALPS II aims to surpass the sensitivity of previous experiments by three orders of magnitude. In this talk, we will discuss the exciting recent progress and current status of ALPS II as we continue with our science program at DESY.

T 6: Other Exp., EW

Time: Monday 16:30–18:00 Location: HSZ/0103

T 6.1 Mon 16:30 HSZ/0103

High-p_T electron performance in proton-lead collisions in the ATLAS experiment at the LHC — •Patrycja Potepa for the ATLAS-Collaboration — Johannes Gutenberg-Universität Mainz, Germany

Electrons constitute an essential ingredient of final states from the leptonic decay channels of W and Z bosons. Their reconstruction and identification are especially challenging in heavy-ion collisions due to high detector occupancy. Therefore, the evaluation of electron performance is crucial for precision measurements of properties of quark-gluon plasma produced in heavy-ion collisions at the LHC energies. The presented measurement focuses on electron reconstruction, identification, isolation, and trigger efficiencies in proton-lead collisions collected at 8.16 TeV in 2016. The tag-and-probe method allows to derive electron efficiencies in data and MC simulation independently, and compare the results.

T 6.2 Mon 16:45 HSZ/0103

Towards a new test of lepton flavor universality using $B^0 \to K^{*0}e^+e^-$ decays in the high di-lepton invariant mass region — Martino Borsato and •Miguel Ruiz Díaz — Physikalisches Institut, Universität Heidelberg

Lepton Flavor Universality (LFU) tests using rare B-meson decays are amongst the most sensitive probes of the Standard Model (SM) flavor structure. They are mediated by a $b \to sl^+l^-$ transition which is loop suppressed in the SM. However, new physics (NP) processes involving new particles and interactions could lead to a measurable contribution.

Many NP models predict a sizable violation of LFU in $b \to sl^+l^-$ decays. A commonly used observable is the ratio $R_{K^{*0}} \equiv B(B^0 \to K^{*0}\mu^+\mu^-)/B(B^0 \to K^{*0}e^+e^-)$, defined within a given interval of the di-lepton invariant mass, q^2. This observable benefits from a clean theoretical prediction since most theoretical uncertainties cancel in the ratio in the SM.

This talk presents the current state of the analysis towards a new measurement of $R_{K^{*0}}$ in the experimentally more challenging high-q^2 region, using data from LHCb recorded between 2011 and 2018. It is the first measurement performed by the LHCb collaboration in this kinematic region. Being a relatively independent measurement it will serve to validate and cross-check the results obtained in lower-q^2 regions as NP effects are expected to be roughly q^2 independent.

T 6.3 Mon 17:00 HSZ/0103

Muon Momentum Calibration in ATLAS experiment — •Dionysios Fakoudis[1] and Stefan Tapprogge[2] for the ATLAS-Collaboration — [1]Johannes Gutenberg University, Mainz, Germany — [2]Johannes Gutenberg University, Mainz, Germany

In this contribution the momentum calibration of (anti-)muons for the ATLAS detector will be discussed. Precise measurements of the W and Z boson mass using the data from the full Run2 of LHC provide new challengeS for an even more accurate muon calibration. Firstly the overall method with the constraints, the systematics and the limits of the current calibration will be presented. The muon calibration scheme provides tools for reconstructed muons using information from the Inner Detector or the Muon Spectrometer and also using the so called combined muons, by comparing Monte Carlo generated events with ATLAS data using the well known 'standard candles' J/Psi and Z. Some of the major issues are going to be discussed (for example the extrapolation from the kinematic region of the J/Psi to the Z region) as well as their possible impact on precision measurements. Current solutions and further challenges will be presented.

T 6.4 Mon 17:15 HSZ/0103

Study of polarization fractions in same-sign W boson scattering — •Prasham Jain, Beate Heinemann, and Oleg Kuprash — Albert-Ludwigs-Universität Freiburg, Freiburg, Germany

Polarized same-sign W boson pair production is a crucial process to examine the electroweak symmetry breaking mechanism. A measurement of the fraction of longitudinally polarized W bosons, $W_L^\pm W_L^\pm$, directly probes the unitarization mechanism of the vector boson scattering amplitude through Higgs boson contributions, and is sensitive to potential new physics effects. This talk presents machine learning (ML) methods for classification of $W^\pm W^\pm$ polarization modes. Results are shown of applying the ML for the extraction of longitudinal polarization fraction.

T 6.5 Mon 17:30 HSZ/0103

Machine Learning Application for Single Boson Polarization Measurement in Same-Charged WW Scattering Within the Atlas Experiment — •Max Vincent Stange for the ATLAS-Collaboration — Institut für Kern- und Teilchenphysik, Technische Universität Dresden

In 2019, the scattering of same-charged W bosons was measured for the first time in the ATLAS experiment. This process provides a strong dependence on the exact mechanism of electroweak symmetry breaking. Since the W bosons obtain their mass and thus their longitudinal polarization directly from the Higgs mechanism, the longitudinal parts of the W boson scattering are particularly promising for studying the Higgs mechanism and finding physics beyond the Standard Model. Since the scattered W bosons decay into one charged lepton and one neutrino each, the original polarizations of the W bosons can no longer be reconstructed directly from the measurement. To be able to measure the contribution of WW scattering with at least one longitudinal boson, multi-variable analysis techniques are applied in the analysis. In this regard, this talk will demonstrate the application of neural networks trained to distinguish signal from background and polarizations. The focus is on comparing different methods to maximize the expected significance.

T 6.6 Mon 17:45 HSZ/0103

Same-sign WW scattering in the semi-leptonic channel at the CMS experiment — Thorsten Chwalek[1], Nils Faltermann[1], Abideh Jafari[2], Thomas Müller[1], and •Komal Tauqeer[1] — [1]Institut für Experimentelle Teilchenphysik (ETP), Karlsruher Institut für Technologie (KIT) — [2]Deutsches Elektronen-Synchrotron (DESY), Hamburg

Vector boson scattering (VBS) provides an opportunity for testing the Higgs mechanism in the electroweak sector of the standard model. At the LHC, the scattering of the weak gauge bosons can reveal the actual process by which they get their masses.

The most promising VBS channel for this type of study is same-sign WW scattering, which has a good balance between signal and backgrounds. In particular, the semi-leptonic decay channel provides a larger cross section than the fully leptonic decay channel; however, this channel faces large background contributions from V + jets and $t\bar{t}$ processes. Also, to study same-sign WW process, one needs to seperate it from processes like WZ, ZZ, and opposite-sign WW scattering. To do this in the semi-leptonic channel is very challenging because of very small W/Z reconstructed mass seperation.

To extract our signal, we have developed a ParticleNet based jet charge tagger to identify boosted W-jet charge. In this talk, I will discuss about the features and performance of this jet charge tagger and its implementation in this analysis. I will also discuss the overall analysis strategy and some important kinematic distributions for signal vs. background discrimination.

T 7: Higgs, Di-Higgs I

Time: Monday 16:30–18:00 Location: HSZ/0105

T 7.1 Mon 16:30 HSZ/0105

Strong first-order EWPTs in a Type-II 2HDM-EFT and their implications on Higgs pair production — Anisha[1,3], •Lisa Biermann[2], Milada Margarete Mühlleitner[2], and Christoph Englert[3] — [1]Indian Inst. Tech., Kanpur, India — [2]ITP, KIT, Karlsruhe, Germany — [3]Glasgow U., Glasgow, United Kingdom

We study the scalar dimension six effective field theory (EFT) extended 2HDM-Type-II in its possibility to promote the strength of the electroweak phase transition to a strong first-order electroweak phase transition (SFOEWPT). Therefore, a global minimization of the one-loop daisy-resummed effective potential at finite temperature is performed with the C++ code BSMPT. Our special focus lies on investigating the connection between Wilson coefficient constellations that enable an SFOEWPT and their phenomenological implications on Higgs pair production (resonant and non-resonant) in top final states.

T 7.2 Mon 16:45 HSZ/0105

Higgs Pair Production in a Composite 2HDM — Stefania De Curtis[1], Luigi Delle Rose[2], •Felix Egle[3], Stefano Moretti[4], Margarete Mühlleitner[3], and Kodai Sakurai[5] — [1]INFN sezione di Firenze and Dipartimento di Fisica e Astronomia, Università di Firenze, Via G. Sansone 1, I-50019, Sesto Fiorentino, Italy — [2]Dipartimento di Fisica, Università della Calabria, I-8703 Arcavacata di Rende, Cosenza, Italy — [3]Institute for Theoretical Physics, Karlsruhe Institute of Technology, 76131 Karlsruhe, Germany — [4]School of Physics and Astronomy, University of Southampton, Southampton, SO17 1BJ, United Kingdom — [5]Department of Physics, Tohoku University, Sendai, Miyagi 980-8578, Japan

In composite Higgs models the scalar particles in the Higgs sector are not elementary particles, but of composite nature, arising as pseudo Nambu-Goldstone bosons from higher broken symmetries. In a composite 2-Higgs-Doublet Model thus a 2HDM-like structure is generated but with couplings already predetermined by the composite nature of the model. In this talk we present Higgs Pair production in this model via gluon fusion. We give a brief introduction into the model and an overview over the calculation, highlighting the contributing couplings and diagrams. We apply current experimental limits for Di-Higgs production on our results and study differential distributions for specific benchmark scenarios.

T 7.3 Mon 17:00 HSZ/0105

The reconstruction of the $\tau\tau$ invariant mass in $H \to \tau\tau$ decays as a machine learning task — •Moritz Molch, Ulrich Husemann, Nikita Shadskiy, Lars Sowa, Michael Wassmer, and Roger Wolf — Institute of Experimental Particle Physics (ETP), Karlsruhe Institute of Technology

Analyses that deal with Higgs boson decays into a pair of τ leptons often rely on a good reconstruction of the $\tau\tau$ invariant mass. As the decay of two τ leptons involves at least two neutrinos, the reconstruction of $m_{\tau\tau}$ is a challenging part of such analyses.

In many analyses at the CMS experiment the SVfit algorithm, which is a likelihood method on an event-by-event basis, is utilized for that task. First studies have shown that $m_{\tau\tau}$ can also be reconstructed using a deep neural network.

In this talk the applicability of deep neural networks to reconstruct $m_{\tau\tau}$ is further investigated and a comparison to current methods is made.

T 7.4 Mon 17:15 HSZ/0105

Probing high p_{T} Higgs boson production in the di-τ decay channel — •Steffen Ludwig, Christopher Young, Karsten Köneke, and Karl Jakobs for the ATLAS-Collaboration — University of Freiburg, Institute of Physics, Freiburg im Breisgau, Germany

The Higgs boson was observed first in 2012 by the ATLAS and CMS experiments at the Large Hadron Collider at CERN. Even more than 10 years after its discovery, more precise measurements of the Higgs boson decay are desired to search for physics beyond the Standard Model.
One particularly interesting measurement is the transverse momentum (p_{T}) spectrum of the Higgs boson where deviations at high values could be a sign of new physics. I will discuss the prospects for selecting such events in the channel where the Higgs boson decays to τ leptons. At high p_{T} the two τ leptons are close to each other in $\eta - \phi$, making this a uniquely interesting final state.

T 7.5 Mon 17:30 HSZ/0105

Test of CP invariance in Higgs boson production via vector boson fusion exploiting the $H \to \tau_{\mathrm{had}}\tau_{\mathrm{had}}$ decay mode — •Daniel Bahner, Ö. Oğul Öncel, and Markus Schumacher — Albert-Ludwigs-Universität, Freiburg, Deutschland

In the universe, an asymmetry exists between the number of baryons and the anti-baryons. Three Sakharov conditions need to be fulfilled in order to explain this observed baryon asymmetry. One of those is the violation of the CP invariance. Its amount in the Standard Model is not enough to explain the asymmetry. The discovery of the Higgs boson has opened a new window to search for additional sources of CP violation. The vector-boson fusion (VBF) production of the Higgs boson is one of them. In the VBF production topology, it is possible to probe CP-violating contributions to the HVV coupling vertex.

In this talk the fully hadronic decay channel, where VBF-produced Higgs boson decays into two hadronically decaying tau leptons, is presented. The dominant background process in this decay channel is the irreducible $Z \to \tau\tau$ process. A data-driven Fake Factor method is used to estimate the sizeable contribution from events in which jets are misidentified as hadronically decaying tau leptons. A neural network is exploited to discriminate signal from background processes.

CP-odd observables are used in a profile-likelihood fit to perform a test of CP invariance and to constrain the strength of new CP-violating interactions. The talk will discuss the analysis strategy, CP-odd observables, and first results based on $\sqrt{s} = 13\,\mathrm{TeV}$ proton-proton collision data collected by the ATLAS detector with $\mathcal{L}_{\mathrm{int}} = 139\,\mathrm{fb}^{-1}$.

T 7.6 Mon 17:45 HSZ/0105

Precision measurements of the τ-identification efficiency of CMS — •Olha Lavoryk, Sebastian Brommer, Maximilian Burkart, Roger Wolf, Markus Klute, and Günter Quast — Karlsruhe Institute of Technology(ETP), Karlsruhe, Germany

τ-leptons play an important role in Higgs physics because the scalar coupling to the fermions is proportional to their mass. Standard model (SM) as well as Beyond the SM (BSM) analyses require precise reconstruction of the hadronic τ-lepton decays. Discriminators based on Deep Neural Networks (DNN) provide a fast and efficient solution to this task.

In this talk, precision measurements of the τ-identification efficiency on the ultra-legacy Run-2 data taken from 2016–2018 are presented, and an appropriate uncertainty model for future Run-2+Run-3 measurements with τ-leptons in the final state is presented.

T 8: Outreach Public/Teilchenwelt (joint session T/HK)

Time: Monday 16:30–18:00 Location: HSZ/0204

T 8.1 Mon 16:30 HSZ/0204

The german LHC-Office for outreach, transfer and promotion of young talents — •Marius Hoffmann[1], Marie-Lena Dieckmann[2], Harald Appelshäuser[3], Johannes Haller[2], Stephanie Hansmann-Menzemer[4], and Arnulf Quadt[1] — [1]Georg-August-Universität Göttingen — [2]Universität Hamburg — [3]Goethe-Universität Frankfurt — [4]Universität Heidelberg

Communicating the scientific results to the public, fostering cooperation with partners in industry and the promotion of young talents are key tasks of the german LHC research groups. For this reason in 2020, the research focuses ("Forschungsschwerpunkte" short ErUM-FSPs) of the four LHC experiments have initiated a joint "LHC-Office" which is

funded by the Federal Ministry for Education and Research(BMBF). Since then, the LHC-office has been active in a multitude of areas, including a common broschure, a new joint website, the participation at major industry fairs as well as several workshops and events to promote young researchers. This talk will give an overview of the work of the LHC-office's work of the last two years and present an outlook into future activities.

T 8.2 Mon 16:45 HSZ/0204

KCETA event summer — •Katrin Link — Karlsruhe Institute of Technologie, KIT Center Elementary Particle and Astroparticle Physics KCETA, Karlsruhe, Germany

In the summer of 2022, the traveling exhibition "Code of the Universe" (codeoftheuniverse.eu) designed by CERN, was displayed for four weeks in the center of Karlsruhe. Accompanying this, the KIT Center for Elementary Particle and Astroparticle Physics (KCETA) organized a colorful program of events for a broad audience. The series of events included a vernissage, a lecture evening as part of the Karlsruhe EFFEKTE series and a panel discussion on the topic "Kommen große Forschungsinfrastrukturen an ihre Grenzen? Neue Energiekonzepte für die Forschung der Zukunft". The main focus was on "Science Afternoons", during which the individual working groups of KCETA presented their research with a small exhibition, hands-on experiments and short lectures. Additionally a special programm for pupils was offered, including masterclasses and "Physik am Samstag". In this talk we want to present the different formats we used to interact with a broad audience and report from our experiences.

T 8.3 Mon 17:00 HSZ/0204

Belle II - The Beauty goes public — •Johanna Häusler and Thomas Kuhr — LMU, München, Deutschland

Public outreach is an element feature of modern science. In particular, the large and internationally organized particle physics experiments have great potential to raise public awareness of physics - both in terms of the physics questions themselves and the technological developments associated with fundamental research. The Belle II experiment is a rather novel experiment based in Japan and involving worldwide collaboration. The German Belle II institutes - in close cooperation with partner organizations and supported by a BMBF *Forschungsschwerpunkt* - are in the process of building a network and developing a strategy to present Belle II particle physics research to the German public. This is particularly interesting in view of the important scientific results that are expected from Belle II in the coming years. The outreach strategy includes a corporate design, a strategy to present the Belle II institutes, scientific results and staff both on Twitter and on the Belle II homepage, basic outreach activities in education (such as Belle II Masterclasses, a Belle II coursework for students and the design of a Belle II model) and industry transfer to promote technological development and human potential in the broad field of industry.

T 8.4 Mon 17:15 HSZ/0204

Urknall unterwegs: eine mobile Ausstellung zur Teilchenphysik — Uta Bilow, •Sarah Kästner, Michael Kobel und Philipp Lindenau für die Netzwerk Teilchenwelt-Kollaboration — TU Dresden, Institut für Kern- und Teilchenphysik

Urknall unterwegs ist eine mobile Ausstellung, die von Weltmaschine bei DESY in Hamburg in Zusammenarbeit mit Netzwerk Teilchenwelt und Expert:innen aus der Teilchenphysik und Didaktik der TU Dresden entwickelt wurde. Besucher:innen erfahren bei einer kurzen Zeitreise in fünf Schritten, wie das Universum sich seit dem Urknall entwickelt hat. Außerdem können sie etwas über die Menschen erfahren, die in der Teilchenphysik wissenschaftlich tätig sind: Wie und warum geforscht wird und vor allem wie sich das auf ihren Alltag und die Gesellschaft auswirkt. Interaktive Elemente wie der Teilchen-Twister vervollständigen die Ausstellung. Studierende und Physiker:innen vermitteln als Urknall-Guides wissenschaftliche Inhalte. Im Juli 2022 wurde die Ausstellung zum 10jährigen Jubiläum der Higgs-Entdeckung gezeigt. Es folgten weitere Stationen bei der Langen Nacht der Wissenschaften in Dresden, der Mainzer Science Week und Stadtteilfesten in Hamburg. Für das Wissenschaftsjahr 2023 Unser Universum gibt es bereits Planungen für bundesweite Stationen. Die Ausstellung wird auch an die MS Wissenschaft andocken und in einigen Häfen vor dem schwimmenden Science-Center zu sehen sein. Der Vortrag zeigt Beispiele der bisherigen Ausstellungstour, stellt Erweiterungen vor und gibt eine Aussicht auf Entwicklungen. Urknall unterwegs kann während der Tagung vor dem Hörsaalzentrum angeschaut werden.

T 8.5 Mon 17:30 HSZ/0204

Nachwuchs für die Forschung gewinnen: Das Fellow-Programm von Netzwerk Teilchenwelt — •Andrea Mayer-Houdelet, Uta Bilow und Michael Kobel für die Netzwerk Teilchenwelt-Kollaboration — TU Dresden, Institut für Kern- und Teilchenphysik

Jedes Jahr kommen etwa 3.500 Jugendliche an den 30 Standorten von Netzwerk Teilchenwelt mit der Physik der kleinsten Teilchen in Kontakt. Die besonders Interessierten besuchen dann einen CERN-Workshop oder die Teilchenphysik-Akademie Mainz. Viele dieser Jugendlichen studieren danach Physik. Für diese vorgebildeten jungen Leute hat das Netzwerk Teilchenwelt das Fellow-Programm ins Leben gerufen. Ziel ist es sie möglichst früh mit den Forschungsgruppen zu vernetzen, sie fachlich weiter zu qualifizieren und so langfristig Nachwuchs für die Forschungsgruppen zu gewinnen. Wir stellen das Fellow-Programm vor, berichten von unseren bisherigen Erfahrungen und präsentieren die Ergebnisse einer Evaluation zu den vielfältigen Online- und Präsenz-Angeboten für Fellows.

T 8.6 Mon 17:45 HSZ/0204

Die Netzwerk Teilchenwelt Projektwochen: aktive Teilhabe an der aktuellen Forschung für Jugendliche am CERN — •Uta Bilow[1], Niklas Herff[1,2], Michael Kobel[1], Franziska Rauscher[3] und Sascha Schmeling[2] für die Netzwerk Teilchenwelt-Kollaboration — [1]TU Dresden, Institut für Kern- und Teilchenphysik — [2]CERN — [3]Gymnasium Olbernhau

Im Stufenprogramm von Netzwerk Teilchenwelt bilden die Projektwochen am CERN eine außergewöhnliche Möglichkeit für motivierte Jugendliche. Bis zu zehn Jugendliche, die durch ihr vorheriges Engagement bereits ein umfassendes Wissen und eine große Begeisterung für die "Physik der kleinsten Teilchen" mitbringen, bekommen die Chance, selbst einmal richtig in die Forschung einzutauchen. Im Rahmen einer umfangreichen Forschungsarbeit, die von schulischer Seite und mit Unterstützung vom Netzwerk Teilchenwelt betreut wird, finden individuelle Projekte in verschiedenen Bereichen am CERN statt. Betreut von Wissenschaftler:innen arbeiten die Jugendlichen zwei Wochen in einem Team am CERN, in dem sie beispielsweise Daten analysieren oder Detektorkomponenten vermessen und auswerten.

In einem gemeinsamen Vortrag von Niklas Herff (der verantwortlichen Person am CERN) und Franziska Rauscher (einer Teilnehmerin der Projektwochen 2022) werden die besonderen Chancen dieses Programms genauer vorgestellt.

T 9: DAQ NN/ML – HW

Time: Monday 16:30–18:00 Location: HSZ/0301

T 9.1 Mon 16:30 HSZ/0301

Implementation of an improved Neural Network for identification of hadronically decaying τ leptons in the ATLAS trigger system for the LHC Run 3 — •Naman Kumar Bhalla, Ö. Oğul Öncel, and Markus Schumacher — Albert-Ludwigs-Universität Freiburg

The ATLAS detector employs a trigger system to reduce the large event rate by saving only interesting events on mass storage for further analyses. This is done via dedicated triggers for each observable physics object. Being the heaviest lepton in the Standard Model of particle physics, the τ lepton is highly unstable, allowing only its decay products to be directly observed. While the electron and muon triggers can be used for the leptonic decays of the τ lepton, separate triggers are necessary to differentiate between hadronically decaying τ leptons (τ_{had}) and jets, which are produced with significantly higher abundance. ATLAS uses a recurrent neural network (RNN) for τ_{had} identification, which exploits various track, cluster and high-level variables as inputs, and returns a single classifier as output. However, it needed to be retuned for operations in the ongoing Run 3 phase of

the Large Hadron Collider (LHC) due to upgrades in the detector and the accelerator. Furthermore, new input variables were added to improve the performance of the RNN. An alternative architecture based on Deep Sets was tested in order to have a more efficient usage of computing resources. This talk presents the results of performance studies of the retuned RNN, and a comparison between the two network architectures in terms of efficacy and resource consumption.

T 9.2 Mon 16:45 HSZ/0301

Machine learning based triggers for VBF H → inv at the Level-1 trigger system of CMS — •Shahin Sepanlou, Johannes Haller, Gregor Kasieczka, Finn Labe, Artur Lobanov, and Matthias Schröder — Institut für Experimentalphysik, Universität Hamburg

At the CMS experiment, a two-level trigger system is used to decide which collision events to store for later analysis. The Level-1 trigger is subject to strict latency, resource and rate constraints. To handle the even more challenging High Luminosity-LHC environment, novel strategies in the trigger system are necessary. Therefore, in this talk studies towards a topological trigger algorithm using fast machine learning on FPGAs are presented. The vector boson fusion production of a Higgs boson decaying to invisible particles is used as an example process that is difficult to select with classical trigger strategies and would benefit from machine learning based approaches.

T 9.3 Mon 17:00 HSZ/0301

FPGA-based fast Machine Learning Triggers for Neutrino Telescopes — •Francesca Capel[1,3], Christian Haack[2,3], Lukas Heinrich[2,3], and Christian Spannfellner[2,3] — [1]Max-Planck-Institut für Physik — [2]Technische Universität München — [3]ORIGINS Excellence Cluster

Neutrinos provide valuable insight into the origin and acceleration mechanisms of cosmic particles. They are able to traverse vast distances and dense environments on their way to Earth unimpeded, but are also challenging to detect due to their weakly interacting nature. Earth itself is used as detector, where large volumes are equipped with photosensors to detect the Cherenkov light induced by astrophysical neutrino interactions. Neutrino telescopes are located deep underwater or in the Antarctic ice to reduce the background rate, inducing often strict limits on power and bandwidth available for the detector. Trigger algorithms are inevitable to reject background signals and reduce the data stream to manageable rates. In this contribution we will present the potential of fast, intelligent machine learning triggers implemented on low power FPGAs for the usage as online trigger in neutrino telescopes. Our main objectives are an improved signal to background discrimination and improved sensitivity for low energy events.

T 9.4 Mon 17:15 HSZ/0301

The MDT Trigger Processor for the ATLAS HL-LHC Upgrade of the Level-0 Muon Trigger — •Davide Cieri, Markus Fras, Oliver Kortner, and Sandra Kortner — Max-Planck-Institut für Physik, Munich, Germany

The novel MDT Trigger Processor (MDTTP) system is a fundamental part of the upgrade of the first-level (L0) muon trigger of the ATLAS experiment at the HL-LHC. The new system will be responsible for improving the muon momentum resolution and thus refining the muon selectivity, using for the first time at L0 the precision tracking information from Monitored Drift Tube (MDT) chambers in addition to the trigger chamber information. The system will also transmit the MDT hit data to the data acquisition (DAQ) system in the event of a trigger accept. Sixty-four MDTTP boards will be installed in ATLAS, one for each MDT trigger sector. The design of the MDTTP is highly challenging, requiring a high number of optical links and high-performance processing units.

We present here the recently fabricated MDTTP prototype and its testing plans. Based on an ATCA design, it is composed by two modules: the Service Module responsible for the powering and the infrastructure; and the Command Module, performing the trigger and DAQ processing and communicating with the other components of the ATLAS muon trigger. The Command Module mounts a powerful Xilinx Virtex Ultrascale+ FPGA XCVU13P, and ten 12-channel bidirectional optical transceiver modules with a link speed of up to 14 Gbps.

T 9.5 Mon 17:30 HSZ/0301

The ATLAS Forward Feature Extractor for the HL-LHC — •Adrian Alvarez Fernandez, Stefan Tapprogge, Ulrich Schaefer, Bruno Bauss, Julian Blumenthal, Marcel Weirich, and Dennis Layh — Johannes Gutenberg University (Mainz)

The ATLAS detector will undergo many upgrades to account for the more challenging running conditions of the High Luminosity LHC (HL-LHC). Some of these Phase-II upgrades will be focused on improving the trigger system, a crucial part to deal with the higher data rates and increased pile-up. Phase-I upgrades for Run 3 introduced the Feature EXtractors for a more refined processing of the calorimeter information and to better discriminate between jets, photons, electrons and taus. A Forward Feature EXtractor (fFEX) is being developed for the HL-LHC that will provide more flexible algorithms for the objects in the forward region (|eta|>2.5 for electrons/photons and |eta|>3.2 for jets). In contrast to the first level calorimeter trigger before HL-LHC, this system will have access to the full detailed calorimeter granularity in that region. The preliminary design of the fFEX has been recently reviewed and will be discussed in this presentation.

T 9.6 Mon 17:45 HSZ/0301

High-Speed Link Tests for the fFEX L1Trigger Module — •Dennis Layh, Stefan Tapprogge, Ulrich Schäfer, and Bruno Bauss — Johannes Gutenberg Universität

For the planned High Luminosity LHC upgrade the forward Feature EXtractor (fFEX), which will be a new component of the ATLAS first level trigger, will have an estimated input data rate of 2.2Tb/s. To achieve a data rate of this magnitude it is necessary to move to a higher line rate than previous modules, which were running at about 12Gb/s per link. The planned line rate of 25.7Gb/s per link will require thorough testing to make sure that signal integrity and quality needs are met. One part along the path from the LAr calorimeters to the fFEX FPGAs are opto-electrical modules, which translate the data from incoming optical fibers to electrical signals and vice versa. For this purpose a PCB was designed, produced and utilized to test a new 12-channel unidirectional firefly module from Samtec which runs at line rates of up to 28Gb/s.

T 10: ML Methods I

Time: Monday 16:30–18:00 Location: HSZ/0405

T 10.1 Mon 16:30 HSZ/0405

Fooling IceCube's Deep Neural Networks — •Oliver Janik, Markus Bachlechner, Thilo Birkenfeld, Philipp Soldin, Christopher Wiebusch, and Katharina Winkler for the IceCube-Collaboration — III. Physikalisches Institut B, RWTH Aachen University

Deep neural networks (DNNs) find more and more use in the data analysis of physics experiments. In IceCube, such networks are used as classifiers for particle identification or as regressors to reconstruct the direction and energy of particles. In the context of adverserial attacks, it has been observed that imperceptible changes to the input of DNNs can alter the output drastically. Algorithms like DeepFool can calculate minimal changes of the input in order to obtain a wrong output, thus fooling the network. This talk will focus on testing the robustness of IceCube's DNNs to such minimal changes.

T 10.2 Mon 16:45 HSZ/0405

Generating Calorimeter Showers as Point Clouds — •Simon Schnake[1,2], Kerstin Borras[1,2], and Dirk Krücker[1] — [1]Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany — [2]RWTH Aachen, Aachen, Germany

In particle physics, precise simulations are necessary to enable scientific progress. However, accurate simulations of the interaction processes in calorimeters are complex and computationally very expensive, demanding a large fraction of the available computing resources in particle physics at present. Various generative models have been proposed to reduce this computational cost. Usually, these models interpret calorimeter showers as 3D images in which each active cell of the de-

tector is represented as a voxel. This approach becomes difficult for high-granularity calorimeters due to the larger sparsity of the data. In this study, we use this sparseness to our advantage and interpret the calorimeter showers as point clouds. More precisely, we consider each hit as part of a hit distribution depending on a global latent calorimeter shower distribution. A first model to learn calorimeter showers as point clouds is presented. The model is evaluated on a high granular calorimeter dataset.

T 10.3 Mon 17:00 HSZ/0405

DeepTreeGAN: Fast Generation of High Dimensional Point Clouds for Calorimeter Simulation — •Moritz Scham[1,2,3], Dirk Krücker[1], and Kerstin Borras[1,2] — [1]Deutsches Elektronen-Synchrotron, Hamburg, Germany — [2]RWTH Aachen University - III. Physikalisches Institut A, Aachen, Germany — [3]Institute for Advanced Simulation - Jülich Supercomputing Centre, Juelich, Germany

In high energy physics, detailed and time-consuming simulations are used for particle interactions with detectors. To bypass these simulations with a generative model, the generation of large point clouds in a short time is required, while the complex dependencies between the particles must be correctly modeled. Particle showers are inherently tree-based processes, as each particle is produced by decays or detector interaction of a particle of the previous generation.

In this work, we present a novel GNN model that is able to generate such point clouds in a tree-based manner. We show that this model is able to reproduce complex distributions, and we evaluate its performance on the public JetNet Dataset.

T 10.4 Mon 17:15 HSZ/0405

Particle identification at Belle II using Neural Networks — •xavier simo[1,2], daniel greenwald[1], stefan wallner[2], and stephan paul[1,2] — [1]Techincal University Munich (TUM) — [2]Max Planck Institute for Physics (MPP)

We will present improvements to the charged-particle identification algorithms used by the Belle II experiment located at KEK, Japan. So far, different approaches have been used to tackle the challenge of combining the information from each subdetector into a single variable for particle identification in an optimal way. We will present evaluations of the performance of a Neural Network based approach that combines information such as the likelihood values from each subdetector and the measured momentum of the particle track.

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T 10.5 Mon 17:30 HSZ/0405

Reconstruction of Full Decays using Transformers and Hyperbolic Embedding at Belle II — •Boyang Yu, Hosein Hashemi, Nikolai Hartmann, and Thomas Kuhr — Ludwig-Maximilians-Universität München

In analyses at Belle II, it is often helpful to reconstruct the whole decay process of each electron-positron collision event using the information collected from detectors. The reconstruction is composed of several steps which require manual configurations and suffers from high uncertainty as well as low efficiency.

In this project, we are developing a software with the aim to reconstruct B decays at Belle II automatically with both high efficiency and high accuracy. The well trained models should be tolerant to rare decays that have very small branching ratio or are even unseen during the training.

To ensure high performance, the project is separated into several stages: particle level embedding, event level embedding and decay reconstruction. Inspired by the recent achievements in computer science, transformers and hyperbolic embedding are employed as building blocks with pre-training-fine-tuning framework, contrastive metric learning and knowledge transfer serving as training tools.

T 10.6 Mon 17:45 HSZ/0405

The Federation - A novel machine learning technique applied on data from the Higgs Boson Machine Learning Challenge — •Maximilian Mucha and Eckhard von Törne — Universität Bonn, Physikalisches Institut, Bonn, Germany

The Federation is a new machine learning technique for handling large amounts of data in a typical high-energy physics analysis. It utilizes Uniform Manifold Approximation and Projection (UMAP) to create an initial low-dimensional representation of a given data set, which is clustered by using Hierarchical Density-Based Spatial Clustering of Applications with Noise (HDBSCAN). These clusters can then be used for a federated learning approach, in which we separately train a classifier on the high-dimensional data of each individual cluster. By doing so, the computational resource demands for the learning process is reduced. We additionally apply an imbalanced learning method to the data in the found clusters before the training to handle high class imbalances. By using a Dynamic Classifier Selection method, the Federation can then make predictions for the whole data set.

As a proof of concept for this novel technique, open data from the Higgs Boson Machine Learning Challenge is used and comparisons to results from established methods will be presented.

T 11: Neutrinos, Dark Matter I

Time: Monday 16:30–18:00 Location: POT/0051

T 11.1 Mon 16:30 POT/0051

Status and Prospects of the COBRA experiment — •Juliane Volkmer — Technische Universität Dresden, Deutschland

As many Beyond-Standard-Model theories predict the existence of the neutrinoless double beta decay ($0\nu\beta\beta$), this lepton-number-violating nuclear reaction is one of today's most examined processes in fundamental physics. Its observation could help to solve important questions as for the neutrino's mass or whether it is a Majorana particle, and thus shed light on physics beyond the Standard Model.

In 2011 the COBRA demonstrator was built with the objective of investigating the practicability of using CdZnTe semiconductor crystals for the decay's investigation. The CdZnTe crystals contain nine isotopes capable of different $0\nu\beta\beta$ decay modes, can be operated at room temperature and are commercially available. Additionally, the versatile detector material offers the possibility of investigating physics besides the $0\nu\beta\beta$ decay, like a potential quenching of g_A in nuclear processes – by measuring the spectrum shape of the strongly forbidden ^{113}Cd β decay – and exotic $\beta^+\beta^+$ decay modes.

Four years ago the demonstrator setup of $4 \times 4 \times 4$ 1 cm^3 CdZnTe crystals was upgraded based on the knowledge gained from the many years of operation. With nine additional larger detector crystals higher exposure rates as well as strongly reduced background levels can be achieved.

This talk shall give an overview of the status, plans and most recent experimental results of the COBRA collaboration.

T 11.2 Mon 16:45 POT/0051

Pulse shape analysis with quad coplanar grid CdZnTe detectors of the COBRA experiment — •Yingjie Chu — Institute of Nuclear and Particle Physics, TU Dresden

The COBRA experiment searches for double beta decays using CdZnTe room temperature semiconductor detectors operating at the Gran Sasso underground laboratory. The setup was upgraded in 2018 using nine large CdZnTe detectors with the novel electrode layout, a quad coplanar grid surrounded by a guard ring, which can veto surface contaminations intrinsically. Although the prominent surface α backgrounds identified in the previous setup are reduced with the new CdZnTe detector, nonphysical events and other background events are present in the $\beta\beta$ region of interest. Therefore, pulse shape discriminations are evaluated to identify the noise, distorted pulses, and multi-hit events, which enables further background suppression. After applying those discrimination cuts, significantly reduced background levels are observed. Furthermore, the pulse shape of the detector is simulated and used to investigate the efficiency of the cuts.

T 11.3 Mon 17:00 POT/0051

Status of the MONUMENT Experiment; ordinary muon capture as a benchmark for $0\nu\beta\beta$ decay nuclear structure calculations — •Elizabeth Mondragon for the MONUMENT-Collaboration — Technical University of Munich, 85748 Garching, Germany

Extracting particle physics properties from neutrinoless double-beta

($0\nu\beta\beta$) decay requires a detailed understanding of the involved nuclear structures. Still, modern calculations of the corresponding nuclear matrix elements (NMEs) differ by factors 2-3. The high momentum transfer of Ordinary Muon Capture (OMC) provides insight into highly excited states similar to those that contribute virtually to $0\nu\beta\beta$ transitions. The precise study of the γ-radiation following the OMC process makes this a promising tool to validate NME calculations and test the quenching of the axial vector coupling g_A. The MONUMENT collaboration is performing a series of explorative OMC measurements involving typical $\beta\beta$ decay daughter isotopes such as ^{76}Se and ^{136}Ba, as well as other benchmark isotopes. The experiment carried out at the Paul Scherrer Institute and the first results from the beam-time in 2021 will be presented.

This research is supported by the DFG Grant: 448829699 and RFBR-DFG with project number: 21-52-12040.

T 11.4 Mon 17:15 POT/0051

COSINUS: Cryogenic Search for Dark Matter With Scintillating NaI Calorimeters — •Martin Stahlberg for the COSINUS-Collaboration — Max-Planck-Institut für Physik, Föhringer Ring 6, 80805 München

COSINUS (Cryogenic Observatory for SIgnatures seen in Next-generation Underground Searches) is a cryogenic dark matter direct detection experiment that aims for a model-independent cross-check of the DAMA/LIBRA claim for dark matter. Since 1995, the DAMA/LIBRA experiment is measuring a yearly modulated signal with properties that fit well to a local dark matter halo in the Milky Way. The DAMA/LIBRA target mass consists of 250 kg of sodium iodide, and the experiment reaches a significance of 13.7 sigma for its claim of a modulation. COSINUS detectors will read out both the scinitllation light signal and the heat signal caused by particle interactions. Each detector will consist of a NaI absober crystal equipped with a transition edge sensor using the remoTES design and a silicon beaker surrounding the absorber. With the dual-channel readout, which is unique for NaI , different types of interacting particles can be discriminated on an event-by-event basis. This contribution will present the status of the COSINUS experiment and its detectors.

T 11.5 Mon 17:30 POT/0051

Magnetic shielding tests for the COSINUS experiment — •Maximilian Hughes for the COSINUS-Collaboration — Max Planck Institute for Physics Föhringer Ring 6, 80805 München

The COSINUS experiment is a dark matter search using cryogenic detectors . The readout of these detectors is sensitive to environmental parameters such as magnetic fields. Active and passive shielding are being investigated to counteract the fluctuations of these fields. Superconducting materials enclosing the detectors and employed inside the dilution refrigerator can be used to keep magnetic field values constant after cooling. The operating conditions of the detectors with an applied magnetic field and a superconducting shield has been investigated. This talk will be a description of the efforts for the optimization of passive and active shielding for cryogenic detectors.

T 11.6 Mon 17:45 POT/0051

Vibration decoupling in the COSINUS underground facility — •Moritz Kellermann for the COSINUS-Collaboration — Max-Planck-Institut für Physik, Föhringer Ring 6, 80805 München

COSINUS is a direct dark matter detection experiment that will utilize cryogenic calorimeters based on sodium iodide (NaI) to resolve the tension between the positive dark matter signal measured by DAMA/LIBRA and the null-result by other experiments. Currently, a modern cryogenic facility is set up at the Laboratori Nazionali del Gran Sasso (LNGS) and is expected to begin operation within 2023. The facility includes a large clean room area on top of a 270 cubic meter water tank equipped with ~30 Photo Multiplier Tubes (PMTs) acting as an active muon veto. Detectors will be mounted in a custom-made dry dilution refrigerator with a base temperature of 9 mK. A lifting system will lower the refrigerator into a passive copper shielding within the water tank. To reach the thermal stability necessary for operating cryogenic calorimeters in a dry dilution refrigerator, a multi-stage passive vibration-decoupling system is currently being tested. This contribution will present the COSINUS facility and the planned vibration decoupling system.

T 12: Gamma Astronomy I

Time: Monday 16:30–18:00 Location: POT/0151

T 12.1 Mon 16:30 POT/0151

Generation of IACT images using generative models — •Christian Elflein, Jonas Glombitza, and Stefan Funk for the H.E.S.S.-Collaboration — Erlangen Centre for Astroparticle Physics, Erlangen, Germany

The development of precise, fast, and computationally efficient simulations is a central challenge of modern physics. With the advent of deep learning, new methods are emerging from the field of generative models. Recent applications to the generation of calorimeter images showed promising results, which motivates the application in astroparticle physics. In this contribution, we introduce a deep-learning-based model for the generation of camera images of Imaging Air Cherenkov Telescopes (IACTs).

In our case study, we use simulations of the High Energy Stereoscopic System (H.E.S.S.) to train a Wasserstein generative adversarial network (WGAN) for the generation of IACT images. We examine basic image properties of the generated samples, discuss their physical properties, and outline possibilities for stereoscopic image generation.

T 12.2 Mon 16:45 POT/0151

A template-based air shower reconstruction method for SWGO — •Franziska Leitl, Vikas Joshi, and Stefan Funk for the SWGO-Collaboration — Friedrich-Alexander-Universität Erlangen-Nürnberg, Erlangen Centre for Astroparticle Physics, Nikolaus-Fiebiger-Str. 2, D-91058 Erlangen, Germany

The Southern Wide-field Gamma-ray Observatory (SWGO) is a future ground-based gamma-ray detector that will be built in South America, extending current generation instruments to the Southern Hemisphere. Primarily, water Cherenkov detectors will be utilized to detect particles in an energy range from 100s of GeV to 100s of TeV. The instrument will possess a close to 100% duty cycle and an order steradian field-of-view. The detection area will consist mainly of a densely packed inner array of water Cherenkov detectors for detecting low energy events, while a large, sparse outer array of detectors is used mainly for higher energy showers. In this contribution, the current status of air shower reconstruction for SWGO with a template-based reconstruction method will be presented.

T 12.3 Mon 17:00 POT/0151

Event classification in Compton-Pair telescopes using Convolutional Neural Networks — •Jan Lommler and Uwe Oberlack — Institut für Physik und Exzellenzcluster Prisma$^+$ Johannes Gutenberg-Universität Mainz

Low to medium energy gamma rays are shielded by the Earth's atmosphere and cannot be measured with on-ground facilities. Satellite based gamma-ray astronomy relies on photo absorption, Compton scatter and Pair creation as measurement channels. Among the biggest challenges are the poor signal to background ratio due to low signal fluxes from cosmic sources and the high background rates even in the comparatively moderate environment of Low Earth Orbits. An efficient event tagging reduces signal losses by preventing type-mismatching applications of reconstruction algorithms (e.g. performing a Compton reconstruction on a Pair event) and signal pollution (distinguishing events originating from background sources). We explore the feasibility of Deep Convolutional Neural Networks in the context of event classification for Compton-Pair telescopes on the example of the e-ASTROGAM design proposal and show improvements possible when using publicly available analysis tools.

T 12.4 Mon 17:15 POT/0151

eep-learning-based gamma/hadron separation for IACTs — •Jonas Glombitza, Vikas Joshi, Benedetta Bruno, and Stefan Funk for the H.E.S.S.-Collaboration — Erlangen Centre for Astroparticle Physics, Erlangen, Germany

Ground-based gamma-ray observatories have opened in the last

decades a new window to the non-thermal universe by studying air showers initiated by cosmic particles. Imaging Air Cherenkov Telescopes (IACTs), like the High Energy Stereoscopic System (H.E.S.S.), are utilized to image the distribution of Cherenkov light emitted during the development of air showers. For the rejection of the hadronic background, many algorithms rely on a high-level parameterization of these IACT images and exploit their correlation. Recently, deep-learning-based approaches showed promising results by explolting the full images, which overcomes the limitation of the elliptical modeling.

In this contribution, we present a new approach to reconstruct IACT images using deep learning. We model the images as a collection of triggered sensors that can be described by a graph and analyzed using graph convolutional neural networks. We describe our new algorithm, trained using H.E.S.S. simulations, examine its performance, and compare it to various classification algorithms.

T 12.5 Mon 17:30 POT/0151

Characterization of the Response of large-area PMTs for SWGO. — •Frederik Wohlleben, Fabian Haist, Hazal Göksu, and Felix Werner for the SWGO-Collaboration — Max-Planck-Institut für Kernphysik, P.O. Box 103980, D 69029 Heidelberg, Germany

The SWGO collaboration aims at building a ground-based gamma-ray detector in the southern hemisphere. A promising approach to build a low-cost water Cherenkov detector with muon-tagging abilities is to deploy a two-chamber bladder containing two PMTs into an open body of water. This talk will give a short overview over the research done on large-area PMTs operated with a custom electronics chain which will be used in prototype SWGO detectors.

T 12.6 Mon 17:45 POT/0151

Actuators for the Medium-Sized Telescopes of the Cherenkov Telescope Array — •Heiko Salzmann for the CTA MST-Collaboration — Sand 1, 72076 Tübingen, Germany

The Cherenkov Telescope Array (CTA) is a future ground-based observatory for gamma-ray astronomy offering unparalleled sensitivity in the energy range from 20 GeV up to 300 TeV. One array will be located in the northern hemisphere (La Palma, Canary Islands), one in the southern hemisphere (Atacama, Chile). Three different telescope types are foreseen. The Medium-Sized Telescope (MST) is covering the core energy range from 100 GeV up to 10 TeV and is currently the only type foreseen for both CTA sites in the Alpha configuration. It has a reflector with a diameter of 12 m and a tessellated mirror design of 86 mirror facets. Each mirror facet is mounted on the mirror support structure with two actuators that are adjustable in length to align the mirrors, and a freely rotating fixpoint. Image resolution and pointing accuracy constraints impose limits on the backlash and deformation of the actuators and the fixpoint under various weight and wind loads. After a short introduction into the MST mirror alignment procedure, this contribution will cover the mechanical design of the actuators, the limits on the positioning accuracy of the actuators and fixpoints as well as the verification thereof.

T 13: Neutrinos I

Time: Monday 16:30–18:00 Location: POT/0251

T 13.1 Mon 16:30 POT/0251

Core-Collapse Supernova detection with JUNO — •Alexei Coretzki, Thilo Birkenfeld, Markus Braun, and Achim Stahl for the JUNO-Collaboration — III. Physikalisches Institut B, RWTH Aachen University

The Jiangmen Underground Neutrino Observatory (JUNO) is a liquid scintillator (LS) detector currently under construction in China. In addition to determining the neutrino mass ordering, JUNO is highly efficient for detecting neutrinos from Core-Collapse Supernovae. In particular, JUNO features the detection of inverse beta decay interactions. Due to its delayed coincidence signature this interaction is unique within the LS. We estimate the maximum distance of detectable supernovae using this interaction. For this we take into account backgrounds, elastic scattering, and other charged current interactions like neutrino-carbon interactions.

T 13.2 Mon 16:45 POT/0251

External Background in JUNO for Solar Neutrinos and DSNB Detection — •Simon Csakli[1], Lothar Oberauer[1], Simon Appel[1], Matthias Mayer[1], and Sebastian Zwickel[2] — [1]Technische Universität München, München, Germany — [2]Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany

The Jiangmen Underground Neutrino Observatory (JUNO) is an upcoming 20 kt liquid scintillator detector. In this work, the impact of external backgrounds is studied with the goal of increasing the fiducial volume available for two specific neutrino measurements with JUNO. First, the periodic modulations in the solar neutrino flux are analysed. For this, the sensitivity for the detection of these modulations is determined for several fiducial volume cuts, taking the background caused by radioactive decays in various materials in and around the detector volume into account. The second part focuses on the diffuse supernova neutrino background (DSNB), the constant flux of neutrinos emitted by past core-collapse supernova in the entire visible universe. A crucial background for this signal are fast neutrons induced by spallation processes, which are simulated in this work. The fiducial volume is then determined from the obtained fast neutron data. This work is supported by the DFG research unit "JUNO", the DFG collaborative research centre 1258 "NDM", and the DFG Cluster of Excellence "Origins".

T 13.3 Mon 17:00 POT/0251

JUNO's sensitivity to 7Be, pep and CNO solar neutrinos and strategy for directional analysis of CNO solar neutrinos in JUNO — •Apeksha Singhal[1,3], Runxuan Liu[1,3], Livia Ludhova[1,3], Anita Meraviglia[2,3], Nikhil Mohan[2,3], Luca Pelicci[1,3], Mariam Rifai[1,3], and Cornelius Vollbrecht[1,3] for the JUNO-Collaboration — [1]Forschungszentrum Jülich GmbH, Institut für Kernphysik IKP-2, Jülich, Germany — [2]GSI Helmholtz Centre for Heavy Ion Research, Darmstadt, Germany — [3]III. Physikalisches Institut B, RWTH Aachen University, Aachen, Germany

JUNO Experiment is 20 kt multipurpose LS detector, under construction in China, with planned completion in 2023. Its main goal is Neutrino Mass Ordering determination, exploiting its large target mass and excellent energy resolution (3% at 1 MeV). Due to its unique properties, JUNO will have potential of real-time solar neutrino measurement with unprecedented levels of precision using multivariate (MV) fit. Sensitivity study is performed by considering all possible sources of background, including their various concentration level and full simulation of detector response. Performing directional analysis of CNO solar neutrinos via Correlated and Integrated Directionality method (developed by Borexino collaboration) in JUNO and using it as additional constraint in MV fit has potential to further improve precision of CNO solar neutrino measurement. This talk will summarize methods for sensitivity studies using MV fit and the final results. Investigation of Cherenkov and scintillation light properties using JUNO MC software and strategies of preliminary directional analysis will be shown.

T 13.4 Mon 17:15 POT/0251

Combined analysis of the first five KATRIN measurement campaigns with KaFit — •Stephanie Hickford[1], Leonard Köllenberger[1], and Weiran Xu[2] for the KATRIN-Collaboration — [1]Institute for Astroparticle Physics, Karlsruhe Institute of Technology — [2]Massachusetts Institute of Technology

The KATRIN collaboration aims to determine the neutrino mass with a sensitivity of 0.2 eV/c^2 (90 % CL). This will be achieved by measuring the endpoint region of the tritium β-electron spectrum. Combined analysis of the first two KATRIN measurement campaigns yielded a neutrino mass limit of $m_\nu \leq 0.8$ eV (90 % CL).

Analyses of data from the first five measurements campaigns are currently underway. One of the combined analyses is performed using the `KaFit/SSC` model within the `KASPER` software framework. In this analysis systematic uncertainties are propagated as additional fit parameters with constraints (the "pull term" method). An overview of the collected data and the expected combined sensitivity on the neutrino mass from these five measurement campaigns will be presented in this talk.

This work is supported by the Helmholtz Association, the Ministry for Education and Research BMBF (05A17PM3, 05A17PX3, 05A17VK2, and 05A17WO3), the Helmholtz Alliance for Astroparticle Physics (HAP), and the Helmholtz Initiative and Networking Fund (W2/W3-118).

T 13.5 Mon 17:30 POT/0251

A Look at General Neutrino Interactions with KATRIN — •Caroline Fengler for the KATRIN-Collaboration — Institute of Experimental Particle Physics, Karlsruhe Institute of Technology

The KATRIN experiment aims to measure the neutrino mass by precision spectroscopy of tritium β-decay with a target sensitivity of 0.2 eV. Recently, KATRIN has improved the direct upper bound on the effective electron-neutrino mass to 0.8 eV at 90 % CL [1]. However, the scientific potential of KATRIN extends well beyond the neutrino mass analysis. In particular, General Neutrino Interactions (GNI) [2] can be investigated through a search for potential shape variations of the β-spectrum. For this purpose, all theoretically allowed interaction terms for neutrinos are combined in one Effective Field Theory. This enables a model-independent description of novel interactions. Such potential modifications can then be identified in the β-spectrum measured with KATRIN by means of energy-dependent contributions to the rate. The talk will introduce the theory of GNI and present recent sensitivity studies on first year KATRIN data.

[1] The KATRIN Collab. *Nat. Phys.* 18, 160-166, 2022.
[2] I. Bischer and W. Rodejohann. *Nucl. Phys. B*, 947, 2019.

This work is supported by the Helmholtz Association, the Ministry for Education and Research BMBF (05A17PM3, 05A17PX3, 05A17VK2, and 05A17WO3), the Helmholtz Alliance for Astroparticle Physics (HAP), and the Helmholtz Initiative and Networking Fund (W2/W3-118).

T 13.6 Mon 17:45 POT/0251

Sensitivity of eV-scale sterile neutrino search with KATRIN using KaFit — •Shailaja Mohanty for the KATRIN-Collaboration — Institute for Astroparticle Physics, Karlsruhe Institute of Technology

KATRIN has recently reported a direct sub-eV upper bound on the neutrino mass from tritium beta-decay spectrum measurements. Along with the neutrino mass search, KATRIN has published recent results on searching for a fourth neutrino with a mass in the eV-range using the precision beta-decay spectra.

The fourth neutrino mass-eigenstate introduces an additional branch into the tritium β-spectrum which manifests as a kink in the differential spectrum. The position and amplitude of this kink correspond to the sterile neutrino mass m_4 and effective mixing angle $\sin^2(\theta) = |U_{e4}|^2$, respectively. In this work sensitivity studies to light sterile neutrinos based on new science runs and the effect of systematic uncertainties are presented. A grid scan is performed in the $[m_4^2, \sin^2(\theta)]$ 2-D plane using the fitting tool "KaFit" and sensitivity contours are calculated within this parameter space. Approach for a combined analysis of successive measurement campaigns are discussed.

This work is supported by the Ministry for Education and Research BMBF (05A17PM3, 05A17PX3, 05A17VK2, and 05A17WO3) and the Doctoral School "Karlsruhe School of Elementary and Astroparticle Physics: Science and Technology (KSETA)" through the GSSP program of the German Academic Exchange Service (DAAD).

T 14: Neutrinos, Dark Matter II

Time: Monday 16:30–18:00 Location: POT/0361

T 14.1 Mon 16:30 POT/0361

Nuclear Recoil modelling in XENONnT — •Luisa Hötzsch for the XENON-Collaboration — Max-Planck-Institut für Kernphysik, Heidelberg

The XENONnT detector is among the most sensitive dark matter experiments, aiming for the direct detection of WIMP dark matter with a multi-tonne xenon target in a dual-phase time projection chamber (TPC). WIMPs are expected to scatter elastically off the xenon nuclei in the target, resulting in a physical recoil of the nucleus. The energy that the recoiling nucleus imparts on neighboring xenon atoms leads to the creation of scintillation light and ionisation electrons, which are the two observables in the detector. A detailed understanding of the processes that govern the translation from deposited nuclear recoil (NR) energy into these two signal channels is therefore of utmost importance for the prediction of the signal shape of a potential WIMP interaction, as well as of NR background sources such as radiogenic neutrons.

In order to calibrate the detector response to NRs for the WIMP search, XENONnT uses neutrons from an external Americium-Beryllium source. In this talk, I will present the modelling and fitting of the liquid xenon response to the NR calibration data for the first WIMP search of the XENONnT detector.

T 14.2 Mon 16:45 POT/0361

Radon removal in the XENONnT experiment via cryogenic distillation — •Henning Schulze Eissing[1], Lutz Althüser[1], Christian Huhmann[1], David Koke[1], Andria Michael[1], Michael Murra[2,1], Philipp Schulte[1], and Christian Weinheimer[1] for the XENON-Collaboration — [1]Institut für Kernphysik, Universität Münster — [2]Columbia University, New York, USA

In order to reduce the dominant component of the electronic recoil background, Rn-222 and its progenies, in the XENONnT experiment a high flux radon removal system has been build by our group (Eur. Phys. J. C 82 (2022) 1104). Rn-222 continuously emanates from detector components and distributes homogeneously within the liquid xenon target due to the half-life of 3.8 days.

Our active radon removal system utilizes the vapor pressure difference between radon and xenon in the form of a cryogenic distillation column. With a xenon flow of 200 slpm the full 8.6 t of xenon are passed through the column within one mean lifetime of Rn-222 resulting in a radon concentration reduction by a factor two. An additional extraction flow of 25 slpm from the xenon gas phase provides a further reduction factor of about two. Combining both methods we achieved a radon activity concentration as low as 1 muBq/kg, the lowest value to date with a xenon-based Dark Matter experiment.

This talk will outline the working principle of the radon removal system and the performance within the XENONnT experiment.

This work is supported by BMBF under contract 05A20PM1 and by DFG within the Research Training Group GRK 2149.

T 14.3 Mon 17:00 POT/0361

Search for Sub-Relativistic Magnetic Monopoles in IceCube — •Silvia Latseva, Annika Wolf, Jakob Böttcher, Christian Dappen, and Christopher Wiebusch for the IceCube-Collaboration — III. Physikalisches Institut B, RWTH Aachen University

The IceCube Neutrino Observatory at the South Pole is designed to detect high-energy neutrinos. It is also used for searches for exotic particles such as magnetic monopoles, which are predicted by Grand Unified Theories as relics from the very early Universe. A sub-relativistic magnetic monopole could catalyze nucleon decays in matter via the Rubakov-Callan effect. These decays result in small particle showers along the monopole's track with a spacing ranging from centimeters to tens of meters. IceCube detects the Cherenkov light produced in these processes and records potential monopole events by the so-called SLOw Particle (SLOP) trigger. For the separation of signal from background, we have developed an event selection algorithm based on Boosted Decision Trees (BDTs), which are trained on simulated monopole signals and data-driven backgrounds. This talk will give an update on the search for sub-relativistic monopoles in IceCube.

T 14.4 Mon 17:15 POT/0361

Paleo-detectors for Dark Matter — •Alexey Elykov — Karlsruhe Institute of Technology, Institute for Astroparticle Physics

Despite the recent advances in physics, Dark Matter (DM) still eludes detection by modern large-scale experiments and puzzles the minds of physicists. Paleo-detectors represent a drastically different approach to DM detection, which uses ancient samples of natural minerals to search for nm-sized damage tracks produced by DM-induced nuclear recoils, that will accumulate in the minerals for ~ 1 Gyr, while they reside in the depths of the Earth. Modern, state-of-the-art microscopy techniques can be used to read out these minute tracks with nm reso-

lution, differentiating them from those produced by more energetic radioactive contaminants. Despite their small size the Gyr-scale lifetime of paleo-detectors provides them with enormous exposure, allowing them to probe DM-nucleon cross sections below current limits for DM masses greater than 30 GeV/c^2. For lighter DM particles, with masses $< 10\,\mathrm{GeV/c^2}$, the sensitivity of paleo-detectors reaches many orders of magnitude below the current upper limits. In this talk, the latest research and developments towards the use of mineral-based paleo-detectors will be presented.

T 14.5 Mon 17:30 POT/0361

Construction of the JUNO pre-detector OSIRIS — •Tobias Sterr[1], Cornelius Vollbrecht[2], Oliver Pilarczyk[3], Jessica Eck[1], Tobias Heinz[1], Lukas Bieger[1], Marc Breisch[1], Benedict Kaiser[1], and Tobias Lachenmaier[1] — [1]Eberhard Karls Universität Tübingen, Tübingen, Physikalisches Institut — [2]Nuclear Physics Institute IKP-2 Forschungzentrum Jülich, Jülich, Germany — [3]Institute of Physics and EC PRISMA+, Johannes-Gutenberg University Mainz, Mainz, Germany

The Online Scintillator Internal Radioactivity Investigation System (OSIRIS) is a 20-ton liquid scintillator detector currently under construction at the Jiangmen Underground Neutrino Observatory (JUNO) in Kaiping, China. OSIRIS* main goal is the monitoring of the purity of the liquid scintillator during the filling phase of the JUNO main detector. The construction of OSIRIS was performed between September *22 to January *23 and involved both, Chinese and German personnel. During that time all auxiliary systems (e.g., liquid handling), (digital) infrastructure (e.g., network devices) as well as scientific equipment was installed. This talk will report on the procedures, systems, challenges, and results of this installation work. This work is supported by the Deutsche Forschungsgemeinschaft.

T 14.6 Mon 17:45 POT/0361

Optimisation of Light Concentrators in the OSIRIS Upgrade — •Marcel Büchner — Johannes Gutenberg-University Mainz

OSIRIS as the pre-detector of the JUNO reactor neutrino measurement, is meant to monitor the radio-purity of the scintillator used. When upgraded in the future, it is supposed to either be used as solar neutrino detector or to search for neutrino-less double-Beta decay. To provide a better energy resolution, the photon detection efficiency of OSIRIS needs to be increased. This is achieved by increasing the number of PMTs used along with adding Winston cones as light concentrators in front of them. Previous optimisations have shown that the optimal shape of these light concentrators depends heavily on the exact detector geometry. So the ideal arrangement for the PMTs needs to be found. This talk presents the on going work to optimise the light collection of the OSIRIS upgrade. During first tests an arrangement of 132 PMTs with light concentrators, on an almost equidistant triangular grid has been found, with an optical coverage that is at least 9 times higher then the current OSIRIS detector.

T 15: Neutrinos, Dark Matter III

Time: Monday 16:30–18:00 Location: POT/0006

T 15.1 Mon 16:30 POT/0006

The SNO+ Experiment: Current Status and future Prospects — •Johann Dittmer and Kai Zuber — IKTP, TU Dresden, Deutschland

Located at 2 km underground in a mine near Sudbury, Ontario, Canada, the SNO+ experiment has an excellent shielding against cosmic rays. Due to this fact, it is nicely suitable for low background measurements. SNO+ consists of a 12 m diameter acrylic sphere filled with 780 t of a liquid scintillator. The sphere is observed by 9400 photomultipliertubes mounted on support structure with 18 m diameter. The main goal is to search for the neutrinoless double beta decay ($0\nu\beta\beta$) of ^{130}Te. For this, the scintillator will be doped with 3.9 t of natural Tellurium. Owing to it's design as a general purpose neutrino detector, it is also possible to measure neutrinos from different sources (geo, reactor, solar, Supernova, etc). After a commissioning water phase ended in 2019, a phase with pure scintillator started in 2022 is currently running. During this phase, reactor neutrino oscillations, low energy ^{8}B solar neutrinos and geo neutrinos are studied. In addition, background components of the $0\nu\beta\beta$ deacay are investigated. The double beta phase is forseen to run for 5 years starting in 2025.

In this talk, the recent results and the broad physics program will be presented.

SNO+ is funded by the German Research Foundation (DFG).

T 15.2 Mon 16:45 POT/0006

Improved detector response modelling for single-charge sensitive SuperCDMS detectors — •Matthew Wilson and Alexander Zaytsev for the SuperCDMS-Collaboration — Karlsruhe Institute of Technology, Institute for Astroparticle Physics

Recently, R&D facilities within the SuperCDMS collaboration have developed and employed cryogenic, high-voltage, eV-scale (HVeV) detectors with single-charge sensitivity. For a typical event observed by one of these gram-sized, silicon crystal detectors, the total amount of phonon energy measured is proportional to the number of electron-hole pairs created by the interaction. However, crystal imperfections and surface effects can cause propagating charges to either trap inside the crystal or ionize additional charges, producing non-quantized measured energy as a result. Modelling these detector-response effects continues to be important for the HVeV R&D program in order to understand calibration data and apply these effects on potential signals for dark matter searches. This presentation showcases an improved, more robust model of these detector-response effects that has fewer limitations and is capable of modelling more effects compared to previous models. This model allows for more accurate characterization of HVeV detectors and may facilitate discrimination between potential dark matter signals and background sources.

T 15.3 Mon 17:00 POT/0006

Low-frequency noise classification for the SuperCDMS experiment using Machine Learning — •Sukeerthi Dharani for the SuperCDMS-Collaboration — Karlsruhe Institute of Technology, Institute for Astroparticle Physics — University of Hamburg, Institute for Experimental Physics

The SuperCDMS Soudan experiment was a direct dark matter search experiment that was operated from 2012 to 2015 at the Soudan Underground Laboratory in Minnesota, USA. It used germanium crystal detectors at cryogenic temperatures to search for dark matter-nucleon scattering events. The experiment was affected by broadband low-frequency (LF) noise due to vibrations from the cryocooler, which deteriorated the detector baseline resolution and increased the noise trigger rate. The LF noise events can have a similar pulse shape as the low-energy signal events, making it difficult to remove them at low energies. In the final low ionization threshold analysis, this has led to stronger event selection criteria to remove LF noise events which set a higher analysis threshold and thus reduced the sensitivity of the experiment to low-mass dark matter. Currently, an LF noise selection criterion using machine learning is being studied. Under investigation is a convolutional neural network that yields better signal purity while also retaining signal efficiency. This talk discusses the machine learning-based classification of LF noise and its preliminary results.

T 15.4 Mon 17:15 POT/0006

The LEGEND Experiment - Status of commissioning and outlook — •Simon Sailer for the LEGEND-Collaboration — Max-Planck-Institut für Kernphysik, Heidelberg, Germany

The LEGEND experiment searches for the neutrino-less double beta ($0\nu\beta\beta$) decay of the germanium isotope 76Ge which would reveal the Majorana nature of neutrinos and prove lepton number non-conservation. The first stage of experiment (LEGEND-200) is built at the underground facility of LNGS in Italy. Here close to 200 kg of enriched high-purity germanium detectors ($\sim$88% 76Ge) are being deployed providing a discovery sensitivity for the half-life of the $0\nu\beta\beta$ decay of $> 10^{27}$ yr. within 5 years of measurement. The detectors are emerged in a liquid argon cryostat which simultaneously provides the coolant, a gamma-radiation shield and active veto system. The cryostat itself is surround by a large water tank acting as an additional neutron shield and muon-veto. LEGEND-200 is ending it's commissioning phase and switches to standard operations. Meanwhile the preparations for the second stage (LEGEND-1000) increasing the de-

tector mass to 1 tonne are making great strides which will increase the sensitivity to $> 10^{28}$ yr. A non-observation would probe the effective Majorana neutrino mass $m_{\beta\beta}$ in the range of 10-20 meV and allow the exclusion of the inverted mass ordering.

T 15.5 Mon 17:30 POT/0006

Commissioning of the Liquid Argon Instrumentation of LEGEND-200 — •Rosanna Deckert, Patrick Krause, Laszlo Papp, Luigi Pertoldi, and Stefan Schönert — Technische Universität München

LEGEND (Large Enriched Germanium Experiment for Neutrinoless $\beta\beta$ Decay) is a ton-scale experiment to search for neutrinoless double beta ($0\nu\beta\beta$) decay using high-purity germanium detectors enriched in ^{76}Ge. An observation of $0\nu\beta\beta$ decay would prove the existence of lepton number violation and provide insight into the nature of neutrino masses. The first phase of the experiment LEGEND-200 will deploy 200 kg of enriched material and aims for a sensitivity of 10^{27} years on the $0\nu\beta\beta$ decay half-life. To achieve this, the germanium detectors are operated in liquid argon instrumented as an active detector to detect the scintillation light produced by backgrounds from trace radioactive contaminants. Commissioning of the liquid argon instrumentation, consisting of wavelength-shifting fibers, a wavelength-shifting reflector and silicon photomultipliers, took place during 2022 at the Laboratori Nazionali del Gran Sasso. In this talk, some of the main outcomes of the commissioning are presented.
This research is supported by the BMBF through the Verbundforschung 05A20WO2 and by the DFG through the Excellence Cluster ORIGINS and the SFB1258.

T 15.6 Mon 17:45 POT/0006

BSM physics searches beyond $0\nu\beta\beta$ decay with GERDA and LEGEND — •Elisabetta Bossio for the GERDA-Collaboration — Physik-Department E15, Technische Universität München, Garching, Germany

While searching for neutrinoless double-β ($0\nu\beta\beta$) decay, experiments collect huge statistics of the Standard Model (SM) two neutrino double-β ($2\nu\beta\beta$) decays. This is amongst the rarest nuclear processes ever observed. Beyond the Standard Model (BSM) physics, like the existence of new particles, Majorons, or light exotic fermions, or the violation of Lorentz symmetry, would affect the shape of the measured two-electron spectrum, originating detectable and characteristic signatures. The GERDA experiment, with its ultra-low background and excellent understanding of the experiment's response, set the best limits on the mentioned BSM double-β decays with ^{76}Ge [1]. In this contribution, the results of the GERDA experiment will be presented, and the sensitivity of the LEGEND experiment [2] to improve the current limits and to search for more exotic double-β decays involving non-standard interactions, like right-handed leptons currents or neutrino self-interactions, will be discussed. This research is supported by the BMBF through the Verbundforschung 05A20WO2 and by the DFG through the Excellence Cluster ORIGINS and the SFB1258.

[1] GERDA Collaboration, M. Agostini et al JCAP12(2022)012
[2] LEGEND-1000 pCDR, arXiv 2107.11462

T 16: Neutrino Astronomy I

Time: Monday 16:30–18:00 Location: POT/0112

T 16.1 Mon 16:30 POT/0112

Quasi-periodic oscillations in J1048.4+714 - comparison of hadronic and leptonic signatures* — •Tom Mianecki[1,2], Julia Becker Tjus[1,2], and Leander Schlegel[1,2] — [1]Theoretische Physik IV, Ruhr Universität Bochum, Bochum, Germany — [2]RAPP-Center at Ruhr Universität Bochum, Bochum, Germany

Active Galactic Nuclei belong to the most luminous known astrophysical sources of high energy radiation. They are assumed to produce charged particles as well as uncharged messengers as photons and neutrinos via leptonic as well as hadronic processes and show a strong time-variability in their corresponding light curves. The quasi-periodic behaviour of the recently analyzed light curve of the source J1048.4+714 especially raises the question of the creation of such temporal structures. One explanation is that the shape of the light curve stems from a precessing jet. In this work, we compare the photon flux produced via the $pp \to \pi^0 \to \gamma\gamma$ channel and the photon flux produced from synchrotron self-compton scattering in dependence of parameters of the emitting region. Furthermore, we investigate the differences of the flaring durations of the source defined by two methods, i.e. full-width at half-maximum method and the centroid method. Finally we evaluate the results with respect to the curvature parameter of the SEDs in the flaring phase. With these investigations we aim to reach a better understanding of the quasi-periodic oscillations in AGN and the interpretation of high-energy radiation signatures.
*Supported by DFG (SFB 1491)

T 16.2 Mon 16:45 POT/0112

Search for periodic low energy neutrino sources — •Maximilian Eff for the ANTARES-KM3NET-ERLANGEN-Collaboration — ECAP, Friedrich-Alexander Universität Erlangen-Nürnberg (FAU), Erlangen, Germany

Pulsars are rotating neutron stars that emit beams of electromagnetic radiation. Neutrino emission from pulsars has been the subject of phenomenological models during the last decades. So far, experimental data has not shown any neutrino emission at high energies. This contribution reports about the development of a novel search approach that aims at identifying low-energy (below 10 GeV) neutrinos from periodic sources with a neutrino telescope. This is done by applying a Fast Fourier Transformation to the PMT counting rate time series.

T 16.3 Mon 17:00 POT/0112

Study of high-energetic muon deflections * — •Pascal Gutjahr — TU Dortmund University, Dortmund, Germany

The analysis of incoming muon-neutrinos and muons relies on the reconstruction of the detected muons. In general, the energy and the direction of an incoming particle are estimated via likelihood methods. With new reconstruction algorithms and hardware optimizations, the direction of an incoming muon can be measured with an angular resolution lower than 1 degree.

However, high-energetic muons are able to travel many kilometers through dense media like ice and water. In these media, the muons interact very frequently with energy losses of up to 90% of the muon energy and even larger energy losses are possible. In each interaction, there is a momentum transfer which leads to a small deflection of the initial muon direction.

In this presentation, the lepton simulation framework PROPOSAL is used to estimate the accumulated muon deflection. Muons with different energies are propagated through ice and water over several distances. Data-Monte-Carlo comparisons as well as comparisons with the simulation tools MUSIC and Geant4 are shown. Finally, the impact of muon deflections for large scale neutrino telescopes is discussed.
*Supported by DFG (SFB 876 and 1491) and BMBF

T 16.4 Mon 17:15 POT/0112

Image Recognition Algorithm for Deep Sea Bioluminescence — •Sophie Loipolder and Kilian Holzapfel for the P-ONE-Collaboration — Technical University of Munich, Munich, Germany

The Pacific Ocean Neutrino Experiment (P-ONE) is a planned, cubic-kilometer-scale neutrino telescope in the Pacific Ocean off the coast of Vancouver, Canada. Two pathfinder experiments have already been deployed: STRAW (STRings for Absorption length in Water) in 2018 and STRAW-b in 2020. Both pathfinder experiments are connected to the NEPTUNE deep-sea observatory, an initiative of Ocean Networks Canada (ONC). In the deep sea, light produced by bioluminescent organisms presents a particular background for neutrino detection, although the bioluminescence data obtained are valuable for interdisciplinary research. The cameras installed in STRAW-b allow a visual detection of the bioluminescence. In this contribution, we present an image recognition algorithm including a deep neural network to analyze the bioluminescence on the pictures.

T 16.5 Mon 17:30 POT/0112

Applications of an improved track reconstruction algorithm in IceCube — •Sofia Athanasiadou for the IceCube-Collaboration — DESY, Zeuthen, Germany

The IceCube Neutrino Observatory, the world's largest neutrino telescope, has detected neutrinos in spatial and time coincidence with AGN, providing strong evidence that these astrophysical objects can in fact be neutrino sources. Neutrinos of astrophysical origin can be discerned from the atmospheric background at energies above 100 TeV, and for point-source studies in particular, high-energy track-like events are preferred. In this energy regime, the stochastic energy losses of the neutrino-induced muons are the dominant source of Cherenkov light measured by the detector, thus it is essential to include them in our reconstruction methods. The SegmentedSpline reconstruction algorithm incorporates stochastic losses into the energy loss pattern while performing an energy fit as a first step, which significantly improves on the subsequent track reconstruction step and the angular resolution achieved. In this work we present our results when the algorithm is run on a subsample of simulated events for validation purposes, and our plans for implementation on IceCube data for a point-source search study.

T 16.6 Mon 17:45 POT/0112

Flavor differentiation for in-ice radio neutrino detectors — •Janna Vischer for the RNO-G-Collaboration — Erlangen Centre for Astroparticle Physics, Erlangen, Germany

Cosmogenic neutrinos (> PeV) can be detected via the Askaryan effect when they interact and induce particle showers in ice. The thereby created radio signals can be observed using large scale antenna arrays. This is currently done at the Radio Neutrino Observatory Greenland (RNO-G) and planned for the radio component of IceCube-Gen2. The capability to differentiate neutrino flavors would be an asset for such experiments. In the event of deep-inelastic scattering, neutrino interactions produce either an undetectable neutrino (neutral-current interaction) or an electron, muon, or tau lepton (charged-current interaction), both occasionally accompanied by measurable hadronic showers. In the second case extremely high energetic muons and taus themselves radiate secondary showers along their tracks. Particle showers with an energy above PeV can be detected. In this contribution we investigate how the signatures of these secondary showers can be used to deduce the flavor of the original neutrino in radio neutrino detectors.

T 17: Cosmic Ray I

Time: Monday 16:30–18:00 Location: POT/0013

T 17.1 Mon 16:30 POT/0013

Radio emission-mechanism of horizontal air showers measured with AERA at the Pierre Auger Observatory* — •Rukije Uzeiroska for the Pierre Auger-Collaboration — Bergische Universität Wuppertal, Gaußstr. 20, 42119 Wuppertal, Germany

The Pierre Auger Observatory is the world's largest detector measuring ultra high energy cosmic rays. The Auger Engineering Radio Array (AERA) is an ensemble of 153 antennas each with two polarization directions covering an area of 17 km^2 in order to detect the radio signal of the extensive air showers. These radio emissions consists of two components: the geomagnetic and the charge-excess emission. They can be disentangled by measuring the direction of the electric field vector. This talk presents current efforts to determine the relative contributions of these two processes using the polarisation pattern of the antenna stations for events measured with AERA, which helps to understand the development of air showers.

**Gefördert durch die BMBF Verbundforschung Astroteilchenphysik (Vorhaben 05A20PX1)*

T 17.2 Mon 16:45 POT/0013

Directional Calibration of radio antennas by using a drone emitter and information field theory for interpolating measured data at the Pierre Auger Observatory — Matthias Boddenberg, Martin Erdmann, •Alex Reuzki, and Maximilian Straub — III. Physikalisches Institut A, RWTH Aachen University

Ultra-high-energy cosmic rays in the Earth's atmosphere induce extensive air showers. At the Pierre Auger Observatory those air showers are measured using various detection techniques including the type of Short Aperiodic Loaded Loop Antennas (SALLA) as part of the AugerPrime upgrade.

SALLA antennas have been calibrated in a limited solid angle using the galactic background together with simulations. Here we introduce a recently started drone campaign to enable the relative directional calibration over the full sphere. Following pilot measurements with a small drone, we use a well defined biconical antenna mounted to a sizable drone. With that we will be able extract the antenna pattern from any direction and distance. Furthermore we will use an additional GPS unit to measure the drone's position to cm accuracy such that the positional uncertainty is strongly reduced.

Finally we will interpolate the discrete measurements using information field theory (IFT) to obtain the full antenna pattern for all directions and frequencies.

T 17.3 Mon 17:00 POT/0013

Development of a Signal Model for the Radio Emission of Inclined Air Showers for GRAND — •Lukas Gülzow, Jelena Petereit, Tim Huege, and Markus Roth — Karlsruhe Institute of Technology (KIT), Institute for Experimental Particle Physics, Karlsruhe, Germany

Ultra-high energy (UHE) neutrinos induce particle cascades in the atmosphere after interacting with the Earth's crust. With its unprecedented sensitivity, the Giant Radio Array for Neutrino Detection (GRAND) will be able to consistently detect the radio signals emitted by extensive air showers caused by UHE neutrinos and UHE cosmic rays. GRAND plans to cover a detection area of 200 000 km^2 with a spacing of one radio antenna per square kilometre. The radio array will be optimised for the detection of inclined air showers and cover a wide frequency band from 50 to 200 MHz. In contrast to existing arrays, GRAND will operate autonomously, i.e. on radio events alone, hence efficient radio triggering techniques need to be developed.

We use CORSIKA air-shower simulations to develop a more advanced signal model of the radio emission with an emphasis on the high frequencies GRAND will utilise. The model will be instrumental for the development of the novel autonomous trigger* as well event reconstruction for large-scale detector systems.

This talk gives an overview on the radio emission of extensive air showers, the details of the signal model, and how it can be used for trigger development and event reconstruction.

* *NUTRIG project, ANR-DFG Funding Programme (HU 1830/6-1)*

T 17.4 Mon 17:15 POT/0013

Cosmic ray radio detection with the IceCube Surface Array Enhancement — •Megha Venugopal for the IceCube-Collaboration — Institute of Astroparticle Physics (IAP), Karlsruhe Institute of Technology, Germany

The IceCube Neutrino Observatory has been recording neutrino events and cosmic rays at the South Pole for more than a decade. The cosmic ray observatory of this experiment, IceTop with 162 Cherenkov tanks, has played an important part in understanding the high-energy universe. A Surface Array Enhancement(SAE), made up of scintillators and radio antennas, is planned to address the rising uncertainties from IceTop measurements due to snow accumulation and to improve measurement capabilities. A prototype station was deployed in January 2020 and has taken measurements which have been correlated with reconstructed events from IceTop. This contribution focuses on the current status of radio detection of cosmic rays at the SAE. The calibration and characterization of hardware components were performed and prepared for deployment. Reconstruction of Xmax, the atmospheric depth of the shower maximum, was done with initial measurements and with data from IceTop. The main goal is to characterize uncertainties and to prepare the experiment to do physics.

T 17.5 Mon 17:30 POT/0013

A new approach to efficiency estimation of radio arrays — •Vladimir Lenok — Bielefeld University, Germany

The progress of in the field of radio detection of air showers in the last decades paved the way for the large-scale radio observatories of cosmic rays and neutrinos. One of the remaining challenges regarding this kind of instrumentation is estimation of their efficiency, which is a complicated problem due to high computational complexity of the required large Monte-Carlo libraries. We developed a new approach to this problem that is based on explicit probabilistic treat-

ment or each of the components of the detection process. With this approach we built an efficiency model for the Tunka-Rex radio array as for example. The model uses a parametrization of the air-shower radio footprint and probability densities for signal detection on the antenna level and shower detection on the array level. The model was validated against full-fledged Monte-Carlo simulations and against the observational data that showed that it is suitable for selection of the full-efficiency regions usually used in all cosmic-ray studies. In the talk we will present the details of the approach and the results of its application to the Tunka-Rex array.

T 17.6 Mon 17:45 POT/0013

First Radio Measurements of an IceCube Surface Enhancement Station at the Pierre Auger Observatory — •Carmen Merx for the Pierre Auger and IceCube-Collaboration — Institute for Astroparticle Physics, Karlsruhe Institute of Technology

Radio detection of air showers has become a powerful method to measure cosmic rays at energies of several 10 PeV and above. IceTop, the surface array of the IceCube Neutrino Observatory at the South Pole as well as the Pierre Auger Observatory in Argentina are being upgraded with antenna stations to improve the accuracy of air-shower measurements.

A prototype station of the surface enhancement of IceCube has recently been installed at the Pierre Auger Observatory. This station comprises eight scintillation panels and three SKALA antennas. The frequency band of the SKALA antennas reaches up to 350 MHz, which is significantly higher than the 30-80 MHz currently used at Auger.

During my presentation, I will discuss first measurements of this prototype station at the Auger site.

T 18: Exp. Methods, CTA, others

Time: Monday 16:30–18:00 Location: POT/0351

T 18.1 Mon 16:30 POT/0351

Characterization of PMTs for the FlashCam project — •Oleg Kalekin for the CTA FlashCam-Collaboration — Erlangen Centre for Astroparticle Physics, FAU Erlangen-Nürnberg, Nikolaus-Fiebiger-Str. 2, 91058 Erlangen, Germany

High quantum efficiency PMTs of type R12199-100-5 from Hamamatsu have been selected for the cameras of telescopes of the Cherenkov Telescope Array (CTA). The FlashCam group has developed a camera design suitable for installation in Medium-Sized Telescopes of CTA.

Using PMTs delivered in 2017, an advanced FlashCam prototype was produced and installed in the central CT5 telescope of the H.E.S.S. experiment in Namibia in fall 2019. Since then the PMTs are in field operation for more than 2 years already, and provide very stable performance. To control the quality of the PMTs, sub-samples delivered in 2017 and 2021-2022 have been characterized in laboratory for timing parameters, gain, afterpulsing and Quantum Efficiency (QE). The results on spectral shape of QE and homogeneity of QE over photocathode area as well as an evolution of these parameters with time will be presented.

T 18.2 Mon 16:45 POT/0351

Performance of SiPM test pixel operation in the MAGIC IACT PMT camera — •Alexander Hahn[1], Razmik Mirzoyan[1], Antonios Dettlaff[1], David Fink[1], Daniel Mazin[1,2], and Masahiro Teshima[1,2] — [1]Max Planck Institute for Physics, Munich, Germany — [2]Institute for Cosmic Ray Research, The University of Tokyo, Kashiwa City, Japan

All currently operating large Imaging Atmospheric Cherenkov Telescopes (IACTs), such as MAGIC, H.E.S.S., or VERITAS, or such as CTA's LST presently being commissioned, use photomultiplier tubes (PMTs) as primary light detectors. It has been shown that smaller IACTs such as FACT and ASTRI can operate with Silicon photomultipliers (SiPMs) instead. However, it is an open research question whether SiPMs may also be suitable as light detectors for large-scale IACTs. To address this question, we have built several SiPM-based prototype detector modules at the Max Planck Institute for Physics. The first module, based on SiPMs from Excelitas, was installed in the PMT-based MAGIC-I imaging camera in May 2015, while two more modules, one using SiPMs from Hamamatsu and another one from SensL, were installed in 2017. Since then, all these modules have been operated in parallel with the PMT camera. Here we present a multi-year in situ study of SiPMs and PMTs in an operational IACT and present a direct performance comparison between the two detector types.

T 18.3 Mon 17:00 POT/0351

nsb2: an open source tool for simulating Imaging Atmospheric Cherenkov Telescope Night Sky Background — •Gerrit Roellinghoff[1], Samuel Spencer[2,1], and Stefan Funk[1] for the H.E.S.S.-Collaboration — [1]Friedrich-Alexander-Universität Erlangen-Nürnberg, Erlangen Centre for Astroparticle Physics, Nikolaus-Fiebiger-Str. 2, 91058 Erlangen, Germany — [2]Department of Physics, University of Oxford, Keble Rd, Oxford OX1 3RH, United Kingdom

As a result of being exposed to the night sky, Imaging Atmospheric Cherenkov Telescopes (IACTs) are sensitive to background illumination; all sources of illumination that are not Cherenkov light. This Night Sky Background (NSB) limits the operational time of IACTs, introduces systematic uncertainty and is a source of Data/Monte-Carlo mismatch. Building on software previously developed for H.E.S.S., we present an open source tool for the pixel-wise prediction of NSB in IACTs, simulating contributions from a variety of sources, such as starlight, moonlight and atmospheric glow. It allows for the computationally efficient prediction of NSB rates for a variety of IACT types, thus improving on Data/Simulation mismatch and enabling users to plan observations for IACTs during partial moonlight observations.

T 18.4 Mon 17:15 POT/0351

IceCube-Gen2: Optical module prototyping and performance studies — •Markus Dittmer and Alexander Kappes for the IceCube-Collaboration — Westfälische Wilhelms-Universität Münster

As the progression of IceCube continues, a novel optical module (OM) for IceCube-Gen2 is being developed, that incorporates lessons learned from the development of modules for IceCube Upgrade while adapting to the reduced borehole diameter. The presentation will provide a brief introduction to four (of many) aspects involved in the development of the Gen2OM prototype: The gel pad concept, which is key for performance and integrity, and related prototyping; photomultiplier studies; simulation studies for OM performance; and a method for estimating the module background caused by radioactive scintillation in the pressure vessel.

T 18.5 Mon 17:30 POT/0351

Acceptance Tests of 10,200 Photomultiplier Tubes for the mDOMs of the IceCube Upgrade — •Lasse Halve[1], Philipp Behrens[1], Erik Büchau[1], Maja Freienhofer[2], Tara Haji Azim[1], Joëlle Savelberg[1], Lars Schmidt[1], Lydia von der Weiden[2], Johannes Werthebach[2], and Christopher Wiebusch[1] for the IceCube-Collaboration — [1]RWTH Aachen University - Physics Institute III B, Aachen, Germany — [2]Astroparticle Physics WG Rhode, TU Dortmund University, Germany

More than 10,000 3-inch Photomultiplier Tubes (PMT) will be deployed in multi-PMT Digital Optical Modules (mDOM) of the IceCube Upgrade. Prior to integration of the PMTs into the modules, they need to be tested for compliance with specifications agreed upon with the manufacturer. For this purpose, two dedicated testing facilities have been constructed at RWTH Aachen University and TU Dortmund University. These facilities have been optimized for a large throughput of PMTs using highly automized and parallelized testing routines. All PMTs have undergone extensive acceptance tests including single-photon response and detection efficiency, time-resolution, background rates, high-voltage dependence and more. During testing, several deviations from the specifications were identified and could be mitigated prior to the mDOM production. We describe the design of the facilities, testing procedures, and results of the acceptance tests.

T 18.6 Mon 17:45 POT/0351

Validation Tests of 10,200 Photomultiplier Tubes for the IceCube Upgrade — •Tara Haji Azim, Philipp Behrens,

Erik Büchau, Lasse Halve, Joëlle Savelberg, Lars Schmidt, and Christopher Wiebusch for the IceCube-Collaboration — III. Physikalisches Institut B, RWTH Aachen University

The Upgrade of the IceCube Neutrino Observatory incorporates the installation of Photomultiplier Tubes (PMTs) as parts of advanced multi-PMT Digital Optical Modules (mDOMs). For this purpose, 10,200 of 3-inch PMTs were quality controlled prior to the commissioning phase at two facility sites, one at RWTH Aachen University and the other one at TU Dortmund University. All PMTs have undergone extensive acceptance tests including single-photon response, detection efficiency, time-resolution, background rates, high-voltage dependence, and more. In this talk, we will review selected results of the survey.

T 19: Detector Systems, Electronics

Time: Monday 16:30–17:45 Location: POT/0106

T 19.1 Mon 16:30 POT/0106

Development of a high temperature superconducting magnet for applications in space. — •Christian von Byern[1], Laurenz Klein[1], Daniel Louis[1], Tim Mulder[1,2], Irfan Özen[1], Stefan Schael[1], Thorsten Siedenburg[1], and Michael Wlochal[1] — [1]Physics Institute 1B, RWTH Aachen University — [2]CERN

While AMS-02 is currently operated on board of the International Space Station, the next generation of cosmic particle detector is already planned. AMS-100 will be operated at Lagrange Point 2 and will feature a geometric acceptance of 100m*sr. With this large acceptance and improved momentum resolution a measurement of cosmic rays up to the PeV scale will be possible and an improvement of factor 1000 regarding the sensitivity of anti-matter measurements is expected.

The magnetic field of the spectrometer will be generated by a High Temperature Superconducting (HTS) solenoid. This coil will include several layers of individual HTS tapes. The coil is operated at 55K, and it will produce a field of 0.5T at 10kA current. To reduce the material budget in terms of mass and interaction length the HTS tapes will be stabilized using few millimetres of aluminium. As an intermediate step a small demonstrator coil is in preparation. In this R&D phase multiple samples, including straight cable samples, meteoroid impacts samples as well as coil samples with a few windings are prepared and teste. In this talk measurement results of the different samples will be presented and discussed.

T 19.2 Mon 16:45 POT/0106

Development of a quench detection system based on optical fibres for the AMS-100 high temperature superconducting solenoid. — •Clemens Dittmar[1], Markus Gastens[2], Caroline Girmen[3], Stefan Schael[1], Thorsten Siedenburg[1], and Michael Wlochal[1] — [1]Physics Institute I B, RWTH Aachen, Germany — [2]Institute of Structural Mechanics and Lightweight Design SLA, RWTH Aachen, Germany — [3]Fraunhofer Institute for Production Technology IPT, Aachen, Germany

The magnetic spectrometer AMS-100, which includes a high temperature superconducting coil, is being designed to measure cosmic rays and detect cosmic antimatter in space. This extreme environment requires a suitable sensing solution to monitor critical changes in the solenoid structure, for example the beginning of a quench in the superconducting coil. Rayleigh scattering-based distributed optical fibre sensors (DOFS) fulfil the high requirements for these extreme conditions, as they are small and lightweight, can be used under cryogenic temperatures, are immune to electromagnetic interference and have sub-millimetre spatial resolution over long distances. The established application of using this system only allows a coupled measurement of mechanical and thermal signals, based on knowledge of the thermomechanical behaviour of the structure being measured. A precise calibration of the temperature and strain response of the optical fibre in the range of 77K to 350K was achieved and a measurement principle was developed to decouple the mechanical and thermal signals.

T 19.3 Mon 17:00 POT/0106

Development of a High-Current, Low-Voltage Remote Power Supply for the P2 Tracking Detector — •Lars Steffen Weinstock for the P2-Collaboration — PRISMA+ Cluster of Excellence and Institute of Nuclear Physics, Johannes Gutenberg University Mainz

The P2 experiment is planned for the Mainz Energy recovering Superconducting Accelerator (MESA), which is currently under construction. The goal of P2 is to determine the electroweak mixing angle with an unprecedented precision at low energy scales with by measuring the parity violating asymmetry in proton-electron scattering at low momentum transfer. A key parameter for the analysis, the electron momentum transfer during scattering, is measured by the P2 tracker, which is placed inside the 0.6 T solenoid spectrometer. The tracker utilises over 4000 High-Voltage Monolithic Active Pixel Sensors (HV-MAPS) each drawing about 500 mA at a supply voltage of 2 V. Due to the high amount of radiation as well as thermal and noise constraints, the power conversion was shifted from the front-end to the counting room at a distance of 30 meters to the detector using a remote-sense technique.

This talk gives an overview of the P2 experiment and the powering scheme of its tracking detector, as well as the current state of development of the remote power supply using a combination of physics (COMSOL) and electronics simulation (SPICE) to estimate the performance and stability of the supplied power.

T 19.4 Mon 17:15 POT/0106

DC-DC Converter Development for the Mu3e Experiment — •Sophie Gagneur for the Mu3e-Collaboration — Institut für Kernphysik , JGU Mainz

The Mu3e experiment under construction at the Paul Scherrer Institute, Switzerland, aims to search for the lepton flavour violating decay of a muon into one electron and two positrons with an ultimate sensitivity of one in 10^{16} muon decays. The Mu3e detector consists of High-Voltage Monolithic Active Pixel Sensors (HV-MAPS) for an accurate track and vertex reconstruction combined with scintillating tiles and fibres for precise timing measurements. The entire detector and front-end electronics are located in the 1m diameter bore of a 1T superconducting magnet. A compact power distribution system based on custom DC-DC converters provide the detector ASICs and readout FPGAs with supply voltages of 1.1V to 3.3V with currents up to 30A per channel. 126 converters are placed as close as possible to the detector and provide 9kW of power in total. The talk presents the development process of the Mu3e DCDC converters and the results of recent prototype tests.

T 19.5 Mon 17:30 POT/0106

FPC prototype tests and results for the ATLAS High Granularity Timing Detector Demonstrator — •Maria Soledad Robles Manzano[1], Andrea Brogna[2], Jan Ehrecke[1], Atila Kurt[2], Lucia Masetti[1], Jigar Patel[1], Binh Pham[2], Fabian Piermaier[2], Steffen Schoenfelder[2], Quirin Weitzel[2], and Patricia Theobald[2] — [1]Institut für Physik, Johannes Gutenberg-Universität Mainz — [2]PRISMA Detektorlabor, Johannes Gutenberg-Universität Mainz

The ATLAS detector requires upgrades to face the challenges of the new High Luminosity LHC, in particular the increase of pile-up interactions. The High-Granularity Timing Detector (HGTD) will be built in order to mitigate the effects of pile-up in the ATLAS forward region, providing time information with a resolution of about 30 ps per track. The active area consists of 2-double-sided disks per end-cap. The HGTD basic unit, so-called module, is made up of two 2x2 cm^2 Low Gain Avalanche Detectors bump-bonded to two ASICs and glued to a flexible PCB. The modules are connected to the Peripheral Electronics Boards, surrounding the active area, via a Flexible Printed Circuit (Flex tail) that serves as interconnection for power, communication signals and HV bias. A prototype of different lengths of the flex tail for a small scale, but full chain HGTD demonstrator has been produced and tested. The tests results of both electrical and mechanical performance of the prototype are presented.

T 20: Pixel ITk, Si-Strips/Other

Time: Monday 16:30–17:45 Location: WIL/A317

T 20.1 Mon 16:30 WIL/A317

ITk-Pixel Pre-production Sensor QA Measurements Including Testbeam — Jörn Grosse-Knetter, Arnulf Quadt, •Yusong Tian, and Hua Ye — II. Physikalisches Institut, Georg-August-Universität Göttingen

In the ATLAS detector upgrade for the High-Luminosity LHC (HL-LHC), the current Inner Detector will be upgraded to an all-silicon Inner Tracker (ITk), to operate under higher occupancy (instantaneous luminosity $7.5 \times 10^{34}\,\mathrm{cm}^{-2}\,\mathrm{s}^{-1}$, corresponding to approximately 200 inelastic pp collisions per bunch crossing) and radiation damage (fluence 2×10^{16} $\mathrm{n_{eq}/cm^2}$). The data taking is planned to start in 2029 and last for 10 years. The pixel detector is the inner-most layer of the ITk, it consists of modules equipped with planar or 3D sensors, and is currently in the pre-production stage. To be assured that specifications will be met during production, sensors from different vendors were sent to different ITk sites for testing, and some modules were assembled for beam test. This talk shows ITkPix pre-production planar sensor quality assurance (QA) measurements and testbeam.

T 20.2 Mon 16:45 WIL/A317

ATLAS ITk Module Testing Quality Control — •Yannick Dieter, Fabian Hügging, Florian Hinterkeuser, Hans Krüger, Maximilian Mucha, Matthias Schüssler, Thomas Senger, and Jochen Dingfelder — Physikalisches Institut der Universität Bonn

With the upgrade of the Large Hadron Collider (LHC) to the High-Luminosity LHC (HL-LHC), the instantaneous luminosity will increase by a factor of 5 with respect to its design value from 2029 onward. The resulting unprecedented hit rates and radiation levels require major upgrades of the detectors located at the HL-LHC to meet the new challenging requirements.

For the upgrade of the ATLAS detector, a new all-silicon inner tracking detector (ITk detector) consisting of silicon strip and pixel modules will be installed to replace the currently operated Inner Detector. In total, approximately 10 000 new pixel detector modules have to be built and tested carefully to ensure that only fully functional detector modules are installed. Approximately 1000 pixel detector modules will be built and tested at the Forschungs- und Technologiezentrum Detektorphysik (FTD) in Bonn during the production of the ATLAS ITk pixel detector. For testing the electrical functionality of the detector modules an intensive quality control (QC) with dedicated testing setups was developed.

This talk gives an overview of the electrical QC for ATLAS ITk pixel detector modules in Bonn, with a focus on the newly developed test setup and first testing results.

T 20.3 Mon 17:00 WIL/A317

Status update of the Cell Integration Site for ATLAS ITk Pixel Detector in Bonn — •Alexandra Wald, Klaus Desch, Matthias Hamer, Florian Hinterkeuser, Fabian Hügging, and Hans Krüger for the ATLAS-Collaboration — Physikalisches Institut, University of Bonn, Germany

In conjunction with the high luminosity upgrade of the Large Hadron Collider (HL-LHC) at CERN, the current tracking system of the ATLAS experiment will be replaced by the Inner Tracker (ITk), an all-silicon detector consisting of 5 layers of pixel detectors and 4 layers of strip detectors. More than 8000 modules are installed in the pixel layers, which together have an active area of approx. $13\mathrm{m}^2$ and cover a pseudorapidity of up to 4. In order to built such a large detector in time, the integration of the ITk Pixel modules on their local support structures, as well as the quality control of individual loaded local supports will be distributed over many institutes. One of the assembly lines for loaded local supports will be setup at the University of Bonn. Due to the powering scheme of the ITk Pixel Detector, the quality control of a loaded local support is challenging in several aspects: loaded modules cannot be tested standalone, as the implemented serial powering scheme only allows for the simultaneous operation of a significant fraction of all modules on a loaded local support. In this presentation, the current status of the cell integration line in Bonn is presented, with a particular focus on the data acquisition infrastructure required for the QC setup, which is based on a FELIX server (Front-End LInk eXchange).

T 20.4 Mon 17:15 WIL/A317

Commissioning and Testing of a QC-Setup for the ATLAS ITK-Pixel Outer Barrel Bare Cell — •Nico Klein[1], Matthias Hamer[1], Klaus Desch[1], Florian Hinterkeuser[1], Diego Alvarez Feito[2], Alexandre Lacroix[2], and Nicola Pacifico[2] — [1]Universität Bonn — [2]CERN

The high-luminosity upgrade of the Large Hadron Collider at CERN requires a complete redesign of the current tracking detector of the ATLAS experiment. The new Inner Tracker, the ITk Detector, will consist of a silicon pixel detector and a silicon strip detector. The ITk Pixel Detector is divided into three subsystems, the Outer Barrel (OB), Outer Endcaps and Inner System. In the OB, modules are loaded on cells (pyrolytic graphic tiles that are glued to an aluminum-graphite cooling block) before they are mounted on the local supports. These cells play a crucial role in the thermal performance of the modules, as they provide the connection between the modules and the cooling system. In order to meet the demanding requirements that are placed on the cooling system of the ITk Pixel Detector, bare cells must be tested for their thermal conductivity before silicon modules are loaded onto them. In this contribution, a setup for the thermal quality control of the bare cells is presented, as well as measurements of the thermal performance of prototype cells with this setup.

T 20.5 Mon 17:30 WIL/A317

Humidity Studies on Silicon Strip Sensors — •Ilona-Stefana Ninca — Deutsches Elektronen-Synchrotron (DESY), Zeuthen, Germany

Silicon strip sensors for the ATLAS Upgrade showed a strong dependence of the breakdown voltage on varying levels of relative humidity. This study aims to investigate the same behavior on test structures that are produced on "half moons" of the same wafers as the sensors. The test structures are first imaged in breakdown conditions: high bias voltage and 20% - 50% relative humidity. Using an infrared camera the location of the avalanche breakdown on the surface of the test structures was captured. Afterwards, the test structures are investigated using the transient current technique (TCT). The region of the avalanche breakdown is investigated in the TCT setup by scanning a focused, pulsed 660 nm laser beam along the surface of the test structure and recording the resulting current transients. Using the TCT data, the electric field at the breakdown point can be estimated. In the future, hopefully with a better understanding of the origin of the humidity sensitivity we wish to be able to propose changes for new sensors reducing the humidity impact.

T 21: Si-Strips/CMS, Pixel/Sensor

Time: Monday 16:30–18:00 Location: WIL/A124

T 21.1 Mon 16:30 WIL/A124

Stress testing optical readout components for CMS 2S modules — Max Beckers[2], •Christian Dziwok[2], Lutz Feld[1], Katja Klein[1], Alexander Pauls[1], Oliver Pooth[2], Nicolas Röwert[1], Martin Lipinski[1], Vanessa Oppenländer[1], Felix Thurn[1], and Tim Ziemons[2] — [1]I. Physikalisches Institut B, RWTH Aachen University, D-52056 Aachen — [2]III. Physikalisches Institut B, RWTH Aachen University

New detector modules will be installed for the upcoming CMS Phase-2 Outer Tracker upgrade. There are two general types of modules, one consisting of two co-planar silicon strip sensors (2S) and one of a macro pixel and a strip sensor (PS). The communication and the auxiliary support are supplied by a so-called SErvice Hybrid (SEH) in the case of a 2S module. It houses a two-stage DC-DC converter

and a Low-Power Gigabit Transceiver (lpGBT). At the RWTH Aachen University, the SEHs are qualified regarding power and communication stability in a so-called test board setup, where the SEHs will undergo additional thermal cycling while being tested. A Field-Programmable Gate Array (FPGA) firmware was developed for the integrated testing routines, like a Bit Error Rate Testing (BERT) of the lpGBT's connections. This talk will focus on the data tests of this setup.

T 21.2 Mon 16:45 WIL/A124

Thermal Measurements of 2S Modules with an evaporative CO_2 Cooling System for the CMS Phase-2 Outer Tracker Upgrade — Christian Dziwok[2], Lutz Feld[1], Katja Klein[1], Martin Lipinski[1], •Vanessa Oppenländer[1], Alexander Pauls[1], Oliver Pooth[2], Nicolas Röwert[1], Michael Wlochal[1], and Tim Ziemons[2] — [1]1. Physikalisches Institut B, RWTH Aachen — [2]3. Physikalisches Institut B, RWTH Aachen

The new operating conditions of the future HL-LHC require a replacement of the complete silicon tracking system of the CMS experiment as part of the CMS Phase-2 Upgrade. For the Phase-2 Outer Tracker new silicon strip modules, so-called 2S modules, are being developed that consist of two silicon sensors stacked on top of each other. The high radiation conditions of the HL-LHC lead to a higher leakage current in the silicon sensors, which is exponentially dependent on the sensor temperature. An evaporative CO_2 cooling system will be used to cool the modules and ensure a successful operation. In an unstable cooling scenario it is possible that the module enters an uncontrolled self-heating loop called thermal runaway. Therefore it is crucial that the thermal properties and performance of the 2S modules and the cooling structure are tested and characterized. In this talk measurements with a test setup of 2S modules on a cooling structure using a custom CO_2 cooling system will be presented.

T 21.3 Mon 17:00 WIL/A124

Integration Tests with 2S Module Prototypes for the Phase-2 Upgrade of the CMS Outer Tracker — •Lea Stockmeier, Bernd Berger, Alexander Dierlamm, Ulrich Husemann, Markus Klute, Roland Koppenhöfer, Stefan Maier, Hans Jürgen Simonis, and Pia Steck — Institute of Experimental Particle Physics (ETP), Karlsruhe Institute of Technology (KIT)

To deal with the increased luminosity of the HL-LHC, the CMS experiment will be upgraded until 2028. During this Phase-2 Upgrade, the CMS Outer Tracker will be equipped with modules each assembled with two silicon sensors. Depending on the position in the tracker, these silicon sensors are pixel or strip sensors. The modules with two strip sensors are called 2S modules. In the barrel region, they are placed on mechanical structures called ladders. A fully equipped ladder contains twelve modules.

During the prototyping phase of the modules, integration tests are performed with the purpose to test the module functionality on the final detector structures. Investigations focus on the cooling performance as well as on electrical performance of the modules on the supporting structures.

This talk summarizes integration tests with 2S modules on ladders performed at CERN and Institut Pluridisciplinaire Hubert Curien (Strasbourg) in cooperation with other CMS working groups.

T 21.4 Mon 17:15 WIL/A124

Investigations of a BiCOMS Pixel Sensor — André Schöning[1], Heiko Augustin[1], Ivan Peric[2], and •Benjamin Weinläder[1] — [1]Physikalisches Institut, Universität Heidelberg — [2]IPE, Karlsruher Institut für Technologie

In the field of particle physics, High Voltage Monolithic Active Pixel Sensors (HV-MAPS) are promising candidates to fulfil the high demands on spatial and time resolution of modern detectors. A new generation of sensors, which combines the HV-MAPS architecture with a BiCMOS technology, opens new possibilities for faster timing in the sub-nanosecond regime.

The BeBiPix is a small test chip to investigate the aforementioned potentials. It is a fully analog sensor featuring two 3×3 pixel matrices with pixel sizes of $41 \times 41\,\mu\mathrm{m}^2$ and $81 \times 81\,\mu\mathrm{m}^2$. During the ongoing testing phase several problems occurred, making an in-depth characterisation difficult. Identified problems such as an early break down at $\sim 10\,\mathrm{V}$ and a weak amplifier feedback are isolated and reproduced in simulations.

T 21.5 Mon 17:30 WIL/A124

Study of diffusion in small pixel sensors — •Amala Augusthy[1], Daniel Pitzl[2], Erika Garutti[1], Jörn Schwandt[1], and Tilman Rohe[3] — [1]Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg, Deutschland — [2]Deutsches Elektronen-Synchrotron, Notkestraße 85, 22607 Hamburg, Deutschland — [3]Paul Scherrer Institute, 5232 Villigen PSI, Switzerland

Pixel sensors are widely used in the CMS experiment for tracking. From 2025 to 2027, the LHC will undergo the high luminosity upgrade where the beam luminosity will be increased to about 7.5 x $10^{34} cm^{-2} s^{-1}$. To maintain high tracking efficiencies under such an extreme radiation environment, pixel sensors of smaller pitches will be used for tracking. However, as the pixel pitch is reduced, charge sharing effects like diffusion start to play an important role in determining the resolution of these sensors.

To investigate the effects of diffusion, measurements were performed on non-irradiated pixel sensors of sizes 50 x 50 μm^2 , 25 x 100 μm^2 and 17 x 150 μm^2 using 5.2 GeV electron beam at the DESY test beam facility. These sensors have a thickness of 285 μm and are bump bonded to low noise read-out chip ROC4SENS. From these measurements, the spatial resolution, cluster size and efficiency as a function of sensor bias and incidence angle of the beam were extracted. These results are then compared to simulation. The simulations were performed using PIXELAV and Synopsys TCAD. In this talk, the results of these measurements will be presented.

T 21.6 Mon 17:45 WIL/A124

guard ring optimisation for passive-CMOS pixel sensors — •Sinuo Zhang[1], Tomasz Hemperek[2], and Jochen Dingfelder[1] — [1]Physikalisches Institut, Universität Bonn, Germany — [2]Dectris, Switzerland

In high energy physics, the silicon pixel sensors manufactured in commercial CMOS chip fabrication lines have been proven to have good radiation hardness and spatial resolution. Along with the mature manufacturing techniques and the potential of large throughput provided by the foundries, the so-called "passive CMOS" sensor has become an interesting alternative to standard planer sensors.

High and predictable breakdown behaviour is a major design goal for sensors and the guard-ring structure is one factor to optimise. This is especially important for applications that require higher voltages.

In this talk we discuss the influence of the guard ring design on the breakdown voltage based on measurements and TCAD simulations. Results has shown that a more uniform potential distribution across the guard rings can be achieved by implementing deep n-well for guard ring structures, and reveals a higher breakdown voltage. Simulations has provided a potential way to reduce the size of the guard ring structures without limiting the breakdown performance.

T 22: Calorimeter / Detector Systems I

Time: Monday 16:30–18:00 Location: WIL/C133

T 22.1 Mon 16:30 WIL/C133

Bitwise Optimization of Artificial Neural Networks for the Energy Reconstruction of ATLAS Liquid-Argon Calorimeter Signals — •Alexander Lettau, Anne-Sophie Berthold, Nick Fritzsche, Christian Gutsche, Arno Straessner, and Johann Christoph Voigt — Institut für Kern- und Teilchenphysik, Dresden, Deutschland

The LHC will be upgraded to become the High-Luminosity-LHC, with significantly increased numbers of simultaneous particle collisions. With this upgrade, up to 200 pile-up events are expected within one bunch crossing. To cope with that, processing of the signals of the Liquid-Argon Calorimeter will need to be improved, because conventional algorithms are expected to lose performance. Artifical neural networks provide one way to deal with this. It has been shown, that convolutional neural networks are able to detect signals and reconstruct their energy with good performance. These networks are planned to be executed on Field Programmable Gate Arrays (FPGA)

which have limited resources in signal, processing units, logic and memory. This talk will deal with the quantization of neural networks, a technique to reduce the resources needed for neural networks, by reducing the precision of the weights, biases and activations, while keeping the performance.

T 22.2 Mon 16:45 WIL/C133

Artificial Neural Networks for the Energy Reconstruction of ATLAS Liquid-Argon Calorimeter Signals — •Anne-Sophie Berthold, Nick Fritzsche, Christian Gutsche, Alexander Lettau, Arno Straessner, Johann Christoph Voigt, and Philipp Welle — Institut für Kern- und Teilchenphysik, Dresden, Deutschland

From 2029 on, the enhanced performance of the High-Luminosity LHC will increase the number of simultaneous proton-proton collisions at the ATLAS detector considerably. In order to cope with that, the so-called Phase-II upgrade is planned. Up to 200 pile-up events will emerge within one bunch crossing, which is why one important part of this upgrade will be the processing of the Liquid-Argon Calorimeter signals. It has been shown that the conventional, optimal filtering signal processing will loose its performance due to the increase of overlapping signals and a trigger scheme with trigger accept signals in each LHC bunch crossing. That is why more sophisticated algorithms such as neural networks come into focus. This talk deals with the application of convolutional neural networks, which on the one hand need to perform well under varying signal conditions and on the other hand need to satisfy tight resource restrictions. Different network architectures are compared. A scoring, which is visualized in a spider diagram, is introduced to evaluate the network performance with respect to different scenarios.

T 22.3 Mon 17:00 WIL/C133

Automated Photon Energy Resolution Calibration at Belle II — •Alexander Heidelbach and Torben Ferber — Institute of Experimental Particle Physics (ETP), Karlsruhe Institute of Technology (KIT)

At the Belle II experiment in Tsukuba, Japan, the electromagnetic calorimeter is used to measure the energy of photons in e^+e^- collisions. The utilization of physical observables, like the invariant mass, from measured quantities, requires precise knowledge of the uncertainties on the components of the four-momentum. To account for uncertainties of these components, the determination of the full covariance matrix is crucial. This matrix stores the variances and covariances of the differences between reconstructed and generated four-momentum vector components for data, respectively MC. At Belle II, in the case of photons, the entries of the photon covariance matrix are determined with the help of radiative dimuon decays $e^+e^- \to \mu^+\mu^-\gamma$. This talk presents the studies on the radiative dimuon decay which are used to extract the photon energy resolution from data. Additionally, it discusses the current efforts to automatize the extraction procedure for run-dependent data and the implementation into the Belle II Analysis Software Framework.

T 22.4 Mon 17:15 WIL/C133

Testbeam Performance and Light Yields of Prototype Cell for the SHiP SBT — •Fairhurst Lyons for the SHiP-SBT-Collaboration — University of Freiburg

We present R&D towards a large-area detector for energy reconstruction and tracking, which consists of many individual cells filled with liquid scintillator. Each cell is equipped with two wavelength-shifting optical modules (WOMs) that capture scintillation light and transfer it to silicon photomultipliers. This design could serve as the surrounding background tagger (SBT) of the proposed Search for Hidden Particles (SHiP) experiment, a general-purpose detector housed at the CERN SPS accelerator to search for light, feebly interacting particles. One such cell was tested at the DESY e^- testbeam in October 2022; analysis of performance and light yields will be presented here. This work is funded by the Federal Ministry of Education and Research.

T 22.5 Mon 17:30 WIL/C133

Spatial information on particles crossing through a WOM-SiPM based liquid scintillator — •Constantin Eckardt for the SHiP-SBT-Collaboration — Humboldt Universität zu Berlin, Berlin, Germany

The proposed option of the SHiP surround background tagger is based on detector cells filled with liquid scintillator that are equipped with two wavelength-shifting optical modules (WOMs). A WOM is a light-guiding tube coated with a UV light-absorbing paint that emits secondary photons in the visible spectrum. By total internal reflection inside the tube walls, these photons are guided to the actual photon detector, which in this case is made of a ring array of silicon photomultipliers coupled to one end of the tube. We study the light yield distribution over the SiPMs in this ring array in a test detector equipped with one WOM as a function of the track position of cosmic muons. The possibility to obtain spatial information about this track position from the light yield distribution on the SiPM array with different optical coupling schemes between the WOM tube and the SiPM ring array is investigated.

T 22.6 Mon 17:45 WIL/C133

position reconstruction in a protoype cell of the SHiP surround background tagger — •Mahyar Jadidi for the SHiP-SBT-Collaboration — Albert Ludwigs Universität Freiburg, Freiburg im Breisgau, Germany

The future SHiP experiment at CERN aims for the discovery of long lived heavy neutral particles in a zero background experiment. To reach this challenging goal, its decay volume is surrounded by an active layer of the liquid scintillator (LAB), consisting of cells of about 1 square meter surface area. Each cell is equipped with two wavelength-shifting optical modules (WOMs) to collect the scintillation light. At each WOM, the collected light is detected by 40 silicon photomultipliers (SiPMs) arranged in a circle. With the help of a neural network, the time and the amplitude information from the SiPMs are used to reconstruct the position and possibly the direction of the particles passing the cell. First results on the position resolution measured in the test beam campaign at DESY in Fall 2022 and a comparison to Monte Carlo simulations will be presented.

T 23: Gas-Detectors / Muon MDT

Time: Monday 16:30–18:00 Location: WIL/A120

T 23.1 Mon 16:30 WIL/A120

Production and testing of Resistive Plate Chambers (RPCs) — •Timur Turkovic, Oliver Kortner, Daniel Soyk, and Hubert Kroha — Max Planck Institut für Physik

Resistive plate chambers (RPCs) with electrodes of high-pressure phenolic laminate (HPL) and small gas gap widths down to 1 mm provide a relatively low cost detector for large area tracking in ATLAS, that still grants high rate capability and fast response with an excellent time resolution of better than 500 ps. They can be operated up to γ background count rates of 10 kHz/cm2, which is five times the maximum rate these RPCs will encounter in the innermost layer of the barrel muon spectrometer of the ATLAS detector, where they will be installed in the phase-II upgrade for the HL-LHC operation. Production procedures that were previously developed in the lab have been transferred to several companies of which each produced first test samples. The quality of these samples was tested by measuring the voltage-current curves and the muon detection efficiency with cosmic muons.

T 23.2 Mon 16:45 WIL/A120

Study of the muon detection efficiency of thin-gap RPCs — •Nayana Bangaru, Oliver Kortner, Hubert Kroha, and Timur Turkovic — MPI für Physik, München, Deutschland

Resistive plate chambers (RPC) with small gaps between electrodes of high-pressure phenolic laminate offer excellent time resolution of better than 500 ps and cm position resolution . Thin-gap RPCs with a gas gap of 1 mm will be used for the phase II upgrade of the ATLAS muon spectrometer. The muon hit positions will computed from he signals induced on 30 mm wide pick-up strips. In order to obtain a muon detection efficiency >99%, very sensitvie amplifiers have to be used. We studied the dependence of the muon detection efficiency of thin-gap RPCs on the applied operating voltage with two different amplifier options: the ATLAS thin-gap RPCs and an alternative circuit using

commercial high-performance transimpedance amplifiers from Texas Instruments. In this contribution we will introduce the two amplifiers and present the results of our efficiency measurements

T 23.3 Mon 17:00 WIL/A120

Finding eco-friendly alternatives for highly potent greenhouse gases in drift chambers — •Ines Hannen, Thomas Radermacher, Stefan Roth, David Smyczek, and Nick Thamm — RWTH Aachen University - Physics Institute III B, Aachen, Germany

Climate change poses an immense challenge to mankind. Drift chambers used in high-energy physics are often filled with highly potent greenhouse gases. To find an alternative to these, simulations on drift gas properties and energy deposition are performed. Important drift gas parameters, simulations and criteria to find eco-friendly alternatives are presented. The focus lies on Argon based drift gases as used for example in the time projection chambers of the T2K experiment.

T 23.4 Mon 17:15 WIL/A120

Quality Control in the Construction of new small-diameter Muon Drift Tube (sMDT) Chambers for the ATLAS Muon Spectrometer at the HL-LHC — •Daniel Buchin, Alice Reed, Marian Rendel, Patrick Rieck, Elena Voevodina, Oliver Kortner, and Hubert Kroha — Max-Planck-Institut für Physik (Werner-Heisenberg-Institut), München

In order to improve the muon trigger efficiency and the rate capability of the ATLAS muon detectors for operation at the high luminosity upgrade of the Large Hadron Collider (HL-LHC), the Monitored Drift Tube (MDT) tracking chambers in the inner barrel layer of the ATLAS Muon Spectrometer will be replaced by small-diameter Muon Drift Tube (sMDT) chambers integrated with new thin-gap RPC trigger chambers.

The sMDT chambers are in serial production since January 2021. The serial production involves a stringent quality control program to assure the reliability and high mechanical precision of the chambers. In the talk, this program will be presented. It includes tests of the individual drift tubes and several mechanical measurements on the sMDT chambers. Also, the dedicated quality control database and monitoring web interface will be discussed.

T 23.5 Mon 17:30 WIL/A120

Construction of new small-diameter Monitored Drift Tube (sMDT) chambers for the HL-LHC upgrade of the ATLAS Muonspectrometer — •Alice Reed, Daniel Buchin, Marian Rendel, Patrick Rieck, Elena Voevodina, Oliver Kortner, and Hubert Kroha — Max Planck Institut für Physik (Werner-Heisenberg-Institut), München

In order to improve the muon trigger efficiency and the rate capability of the ATLAS muon detectors for operation at the high-luminosity upgrade of the Large Hadron Collider (HL-LHC), the Monitored Drift Tube (MDT) chambers in the inner barrel layer of the ATLAS Muon Spectrometer will be replaced by small-diameter Muon Drift Tube (sMDT) chambers integrated with new thin-gap RPC trigger chambers. The sMDT chambers fit, together with the RPCs, into the very tight available space and provide an order of magnitude higher background rate capability compared to the current detectors.

The sMDT chambers have been in serial production since January 2021. In this talk, the steps for the drift tube production and chamber construction will be presented, followed by a discussion of the cosmic muon tests used for the final chamber certification.

T 23.6 Mon 17:45 WIL/A120

Impact of environmental pressure and temperature variations on triple-GEM detector gas gain — •Francesco Ivone, Thomas Hebbeker, Kerstin Hoepfner, Giovanni Mocellin, and Shawn Zaleski — III. Physikalisches Institut A, RWTH Aachen University

The GEM (Gas Electron Multiplier) technology has been widely adopted for muon detection in high energy physics experiments, for both tracking and triggering, as well as in other application areas.

The GEM gas electron amplification factor depends on the gas properties: mainly the mixture, the temperature and the pressure. While the gas mixture is finely controllable, the gas temperature and pressure are influenced by the fluctuations of the environmental parameters. Correcting for such variations is therefore crucial to maintain stable operating conditions or to compare performance measured in different conditions. In this contribution we describe the dependence of triple-GEM gas gain on temperature and pressure for three different gas mixtures. The study is based on experimental data, supported by simulations.

T 24: Invited Overview Talks II

Time: Tuesday 11:00–12:30 Location: HSZ/AUDI

Invited Talk T 24.1 Tue 11:00 HSZ/AUDI

Searching for Long-Lived Particles at the LHC and Beyond — •Juliette Alimena — DESY, Hamburg

Particles beyond the standard model (SM) can generically have lifetimes that are long compared to SM particles at the weak scale. When produced at experiments such as the Large Hadron Collider (LHC) at CERN, these long-lived particles (LLPs) can decay far from the interaction vertex of the primary proton-proton collision. Such LLP signatures are distinct from those of promptly decaying particles that are targeted by the majority of searches for new physics at the LHC, often requiring customized techniques to identify, for example, significantly displaced decay vertices, tracks with atypical properties, and short track segments. In this talk, I will present the latest searches for LLPs at the LHC and other experiments and then give my view of where the field will go in the future.

Invited Talk T 24.2 Tue 11:30 HSZ/AUDI

The Neutrino-Dawn of Galaxies — •Wolfgang Rhode — Fakultät Physik, TU Dortmund

For decades, generations of underground detectors have been opening more and more the window to the neutrino sky. Quickly, the background shine of atmospheric neutrinos could be separated from the bright light of atmospheric muons. Ten years ago, astrophysical neutrinos' first faint isotropic glow was detected. After a brief gamma-flare of TXS 0506+056 in 2017, which coincided with a matching high-energy neutrino, it now appears that a time-independent neutrino signal from galaxies is finally arising: NGC 1068 in muon neutrinos and our Galaxy in cascading neutrino events of all flavors. The potential of neutrino telescopes is simultaneously being exploited to investigate several other important physical or methodological questions. The status of these questions will be reported. In addition, it is discussed what steps one needs to take in the future to look at the neutrino sky in detail - and to answer the fundamental physics questions involved.

Invited Talk T 24.3 Tue 12:00 HSZ/AUDI

Galactic cosmic rays: What have we learned and what's next? — •Philipp Mertsch — Institute for Theoretical Particle Physics and Cosmology (TTK), RWTH Aachen University, Sommerfeldstr. 16, 52074 Aachen, Germany

Cosmic rays constitute an important ingredient in the galactic ecosystem and hold lessons beyond the Milky Way, for instance in regulating galaxy formation and evolution. In addition, cosmic rays lend themselves to searches for new physics, like dark matter or primordial antimatter. All of these studies, however, require answering the century-old question of cosmic ray origin. Over the last ten years, there has been an abundance of new data from space-based experiments like AMS-02, CALET and DAMPE. Modelling of these data allow inferences on the various types of cosmic ray sources and the conditions determining their transport, for instance galactic magnetic fields. What emerges is a rather complex picture and thus existing models need to be revised, if not completely overhauled. I will highlight the lessons learned and discuss the open questions and what kind of instrumentation is required for answering them.

T 25: Flavor II

Time: Tuesday 17:00–18:30 Location: HSZ/0304

T 25.1 Tue 17:00 HSZ/0304

Observation of $B_s^0 \to D^{*+}D^{*-}$ and *CP* violation studies in $B^0 \to D^{*+}D^{*-}$ with the LHCb experiment — Johannes Albrecht, Sophie Hollitt, and •Jan Langer — TU Dortmund University, Dortmund, Germany

At the LHCb experiment, precision measurements are performed to search for physics beyond the Standard Model. One important area of interest is the field of CP violation. This includes direct measurements of CP violation in decays of neutral B mesons as well as the determination of branching fractions to constrain higher order effects in such measurements.

The $B_s^0 \to D^{*+}D^{*-}$ decay was observed with a high significance and its branching fraction was measured relative to the $B^0 \to D^{*+}D^{*-}$ decay. Further, the *CP* violation parameter $\sin(2\beta)$ can be measured by exploiting $b \to c\bar{c}d$ transitions in $B^0 \to D^{*+}D^{*-}$ decays, where the phases arise through the interference between the direct decay of the B^0 meson and the decay after mixing. Due to the topology of the decay, an angular analysis is required.

In this talk, the observation of the $B_s^0 \to D^{*+}D^{*-}$ decay and the current status of the *CP* violation measurement in $B^0 \to D^{*+}D^{*-}$ are presented.

T 25.2 Tue 17:15 HSZ/0304

Search for the $B^0 \to D^0\bar{D}^0$ decay with the LHCb experiment. — Johannes Albrecht, Sophie Hollitt, and •Jonah Blank — TU Dortmund University, Dortmund, Germany

With precise measurements of B-meson decays the LHCb experiment can test the integrity of the Standard Model. In particular $B \to DD$ decays are interesting to examine CP violation. While decays to charged $D^{\pm}$ mesons have already been well measured, the $B^0 \to D^0\bar{D}^0$ decay channel has not yet been observed by any experiment. The branching ratio of this decay mode is a key input to the theoretical prediction of its CP-asymmetry as well as the properties of other doubly charmed decays.
In the analysis presented in this talk, data collected by the LHCb experiment at $\sqrt{s} = 7, 8\,\text{TeV}$ and $13\,\text{TeV}$, corresponding to an integrated luminosity of $9\,fb^{-1}$ is used to search for the $B^0 \to D^0\bar{D}^0$ decay. The $B^0 \to \bar{D}^0\pi^+\pi^-$ decay channel is used as a normalisation mode to cancel systematic uncertainties. The current status of the analysis will be presented.

T 25.3 Tue 17:30 HSZ/0304

Belle II measurement of $B^+ \to K^+\pi^0$ and $B^+ \to \pi^+\pi^0$ decays — •Justin Skorupa, Thibaud Humair, Hans-Günther Moser, Markus Reif, Oskar Tittel, and Benedikt Wach — Max Planck Institute for Physics, Munich, Germany

Charmless hadronic B-meson decays provide sensitive probes for physics beyond the Standard Model, since the contribution of penguin decay amplitudes to their decay is non-negligible. Exploiting isospin symmetry between charmless hadronic B-meson decays allows the construction of null tests of the Standard Model with an accuracy of better than 1%. Moreover, they allow to determine the angle α of the unitary triangle associated with B-meson decays. The Belle II experiment at the SuperKEKB e+ e- accelerator in Tsukuba, Japan, has the unique capability to measure all relevant final states to determine the angle α and to study all isospin-related decays necessary to set stringent limits on null tests. In this talk, a measurement of the decays $B^+ \to K^+\pi^0$ and $B^+ \to \pi^+\pi^0$ using Belle II data is presented.

T 25.4 Tue 17:45 HSZ/0304

On the contribution of the electromagnetic dipole operator to the $B_s \to \mu^+\mu^-$ decay amplitude — Thorsten Feldmann, Nico Gubernari, Tobias Huber, and •Nicolas Seitz — Center for Particle Physics Siegen, Theoretische Teilchenphysik, Universität Siegen

We report on the construction of a factorization theorem that allows to systematically include QCD corrections to the contribution of the electromagnetic dipole operator O_7 to the $\bar{B}_s \to \mu^+\mu^-$ decay amplitude. We elaborate on how the occurring endpoint divergences appearing in individual momentum regions cancel, and show how the resulting rapidity logarithms can be isolated by suitable subtractions applied to the corresponding bare factorization theorem. This allows to include in a straightforward manner the QCD corrections arising from the renormalization-group running of the hard matching coefficient, the hard-collinear scattering kernel, and the B_s-meson distribution amplitude. We estimate the effect numerically using a recently advocated parameterization of the B_s-meson light-cone distribution amplitude.

T 25.5 Tue 18:00 HSZ/0304

enhancing Bs to e+e- to an observable level — •Gilberto Tetlalmatzi-Xolocotzi — Siegen University, Siegen, Germany

As a result of the helicity suppression effect, within the Standard Model the rare decay channel $B_s\rightarrow e^+e^-$ has a decay probability which is extremely suppressed, being five orders of magnitude below current experimental limits. Thus, any observation of this channel within the current or forthcoming experiments will give unambiguous evidence of Physics Beyond the Standard Model. In this work, we present for the first time a New Physics scenario in which the branching fraction $\mathcal{B}r(B_s\rightarrow e^+ e^-)$ is enhanced up to values which saturate the current experimental bounds. More concretely, we study the general Two-Higgs-Doublet Model (2HDM) with a pseudoscalar coupling to electrons unsuppressed by the electron mass. Furthermore, we demonstrate how this scenario can arise from a UV-complete theory of quark-lepton unification that can live at a low scale.

T 25.6 Tue 18:15 HSZ/0304

Analysis of $B \to \mu\nu$ with inclusive tagging at Belle II — Florian Bernlochner, Jochen Dingfelder, •Daniel Jacobi, Peter Lewis, and Markus Prim for the Belle II-Collaboration — Physikalisches Institut der Rheinischen Friedrich-Wilhelms-Universität Bonn

$B\overline{B}$ meson pairs are the dominant decay products of the $\Upsilon(4S)$ resonance, which is produced in large amounts in e^+e^- collisions at the SuperKEKB collider in Japan, and their decays are measured by the Belle II experiment. Leptonic B meson decays such as $B \to \mu\nu$ are highly CKM- and helicity-suppressed. In a two-body decay like $B \to \mu\nu$, the muon momentum is exactly known in the rest frame of the signal-side B meson. By boosting the signal-side muon into that frame, a better signal resolution and improved sensitivity can thus be achieved compared to the center-of-mass frame. This requires a high-precision for the boost vector, which can be determined from the rest of the event that contains the decay products of the second B meson. At the same time, this information can be used to reconstruct the kinematics of the signal-side B meson. Boosted decision trees are trained to deal with model discrepancies, suppress background and increase signal purity. The hadronic $B^- \to D^0[\to K^-\pi^+]\pi^-$ decay can be used to validate different steps in the analysis of the $B \to \mu\nu$ decay. This talk will discuss the current status of the analysis for the measurement of the $B \to \mu\nu$ branching fraction with an integrated luminosity of 364 fb^{-1} at the Belle II experiment.

T 26: Flavor III

Time: Tuesday 17:00–18:30 Location: HSZ/0401

T 26.1 Tue 17:00 HSZ/0401

Multi-lepton B decays within the Standard Model and their impact on LHCb analysis — Johannes Albrecht, Emmanuel Stamou, Vitalii Lisovskyi, and •Jan Peter Herdieckerhoff — TU Dortmund University, Dortmund, Germany

Rare flavour-changing neutral current decays of hadrons to multi-lepton final states are sensitive probes of the Standard Model and thus among the target measurements at LHCb. A reliable Standard Model prediction of their rates is an essential input for the realistic simulation within the LHCb analyses and even more so when analysing

decays with non-trivial angular and q^2 dependence.
One such analysis is the most recent search of $B^0_{(s)} \to \mu^+\mu^-\mu^+\mu^-$ performed by the LHCb experiment and published in 2022. The main systematic uncertainty in this search comes from the missing Standard Model prediction. So far, only a simplified phase-space approach was used to simulate signal candidates in the LHCb analysis.
In this talk, we present the computation and results of the Standard Model prediction of the decay $B^0_s \to \mu^+\mu^-\mu^+\mu^-$, and its implementation in the simulation framework `EvtGen`. The impact of this calculation on the LHCb analysis is also evaluated.

T 26.2 Tue 17:15 HSZ/0401

Tests of muon-electron universality at the LHCb experiment — •Alex Seuthe and Johannes Albrecht — TU Dortmund University, Dortmund, Germany

The LHCb experiment at the Large Hadron Collider (LHC) specialised in high-precision measurements of flavour physics with hadrons containing b and c quarks. Tests of lepton flavour universality are a sensitive and clean way to probe the Standard Model of particle physics. Any deviations from this universality would be a clear sign of new physics. In this talk, I will present the first simultaneous test of muon-electron universality using the full LHCb Run 1 and Run 2 dataset with the observables R_{K^*} and R_K. These observables are defined as ratios of the branching fractions of the decays $B^0 \to K^{*0}\mu^+\mu^-$ and $B^0 \to K^{*0}e^+e^-$, and $B^+ \to K^+\mu^+\mu^-$ and $B^+ \to K^+e^+e^-$, respectively. This result is the most sensitive test of lepton flavour universality with rare b decays to date.

T 26.3 Tue 17:30 HSZ/0401

Angular analysis of the decay $B^0 \to K^{*0}\mu^+\mu^-$ with LHCb — •Leon Carus[1], Thomas Oeser[1], Eluned Smith[2], and Christoph Langenbruch[1] — [1]I Physikalisches Institut B RWTH Aachen — [2]Massachusetts Institute of Technology

Flavor Changing Neutral Currents, such as $b \to s\ell^+\ell^-$ transitions, are forbidden in the Standard Model of Particle Physics (SM) at tree-level and may only occur at the loop-level. Angular analyses of $b \to s\ell^+\ell^-$ decays are thus very sensitive to New Physics contributions. A previous measurement of angular observables of $B^0 \to K^{*0}(\to K^+\pi^-)\mu^+\mu^-$ decays, performed by the LHCb collaboration using data collected during Run 1 and 2016, found tensions with SM predictions at the level of 3 standard deviations.

The analysis of the full Run 2 data sample of LHCb, along with improvements of the analysis strategy, is expected to increase the precision of this measurement significantly. This talk will present the status of an update of this analysis, including LHCb data collected in 2017 and 2018.

T 26.4 Tue 17:45 HSZ/0401

Isospin asymmetry in $B \to K\mu^+\mu^-$ decays — Johannes Albrecht, •Fabio De Vellis, Vitalii Lisovskyi, and Biljana Mitreska — TU Dortmund University, Dortmund, Germany

Isospin symmetry is a fundamental property of the Standard Model. It predicts a branching fraction that is almost the same for decays which differ only by one spectator quark, like $B^0 \to K^0\mu^+\mu^-$ and $B^+ \to K^+\mu^+\mu^-$. For these decays a quantity which describes differences in branching fraction, namely the asymmetry, can be defined. This is particularly convenient since it is theoretically clean and it allows to cancel some experimental uncertainties.

Previous measurements on these decays from LHCb and Belle, despite being compatible with expectations, suggested coherent deviations that could be interpreted as statistical fluctuations, or unaccounted theoretical uncertainties, or as a sign of New Physics. In this talk an update of the asymmetry measurement with the full LHCb dataset is presented. This means that data corresponding to an integrated luminosity of 6 fb^{-1} are added to the dataset used in the previous Run 1 analysis. Particular attention is given to the new strategy adopted to calibrate simulation samples to data.

T 26.5 Tue 18:00 HSZ/0401

Neutrino Cross-Section Measurements with the T2K Near Detector — •Liam O'Sullivan for the DUNE-Collaboration — Johannes-Gutenberg Universität Mainz

T2K is a long baseline neutrino oscillation experiment in Japan, measuring electron (anti-)neutrino appearance in a muon (anti-)neutrino beam. As a good understanding of neutrino-nucleus interactions is essential to enable precise oscillation measurements, the T2K near detector complex has been designed to measure neutrino interactions on a variety of nuclear targets for the T2K neutrino beam at a distance of 280m from the beam target. This talk presents an overview of the T2K cross-section measurement strategy in the context of both present and future neutrino oscillation measurements, together with select recent cross-section results.

T 26.6 Tue 18:15 HSZ/0401

Čerenkov ring counting using ensembles of CNNs in ANNIE — •Daniel Tobias Schmid, David Maksimović, Michael Nieslony, and Michael Wurm for the ANNIE-Collaboration — Johannes Gutenberg-Universität Mainz, Germany

The Accelerator Neutrino Neutron Interaction Experiment (ANNIE) is a 26-ton Gadolinium-doped water Čerenkov detector located at the Booster Neutrino Beam (BNB) at Fermilab. The scientific aim of ANNIE is the study of the cross-section and the neutron multiplicity of GeV neutrinos in the BNB.

These measurements will benefit next generation neutrino experiments through the reduction of systematics and understanding the underlying interactions.

This talk focuses on using ensembles of Convolutional Neural Networks (CNNs) to perform Čerenkov ring counting to discriminate single- and multi-ring events. The identification of single-ring events will be used in the ANNIE neutron multiplicity analysis to select an exclusive sample of CC-0π events which are predominantly composed of CC-quasielastic interactions, while simultaneously rejecting more inelastic pion-producing interaction types.

T 27: Searches II

Time: Tuesday 17:00–18:30 Location: HSZ/0403

T 27.1 Tue 17:00 HSZ/0403

CMS Dijet Anomaly Search with Substructure — Gregor Kasieczka, •Louis Moureaux, Tobias Quadfasel, and Manuel Sommerhalder — Institut für Experimentalphysik, Universität Hamburg

The extensive searches for physics beyond the Standard Model carried out at the LHC have so far yielded no positive result, despite the very large number of models that have been tested. This motivates the use of techniques based on machine learning that, unlike common search strategies, are capable of dynamically adjusting the event selection to the observed data. These "anomaly detection" methods are expected to feature broad coverage of potential new physics signatures and can thus fill the gaps between searches dedicated to specific models.

We present the application of such an anomaly detection method, CATHODE, in a search for resonant dijet events using substructure observables with the CMS experiment. CATHODE combines density estimation and weak supervision techniques to detect anomalous events in a signal region, interpolating the background from sidebands to achieve nearly optimal classification performance.

T 27.2 Tue 17:15 HSZ/0403

The LHC as Lepton–Proton Collider: Searches for Resonant Production of Leptoquarks — •Daniel Buchin, Michael Holzbock, and Hubert Kroha — Max-Planck-Institut für Physik (Werner-Heisenberg-Institut), München

Searches for leptoquarks constitute an essential part of the physics programme at the ATLAS detector. These hypothetical particles couple to a lepton and a quark and are predicted by many extensions of the Standard Model such as Grand Unified Theories. The existing leptoquark searches at the LHC currently only consider production modes via quark and/or gluon interactions. The small but non-zero lepton content of the proton, however, allows also for the so far unexplored resonant leptoquark production.

This production mode gives rise to lepton-plus-jet signatures. Thus,

leptoquarks would emerge as peaks over the smoothly falling Standard Model background in the invariant mass spectrum of the lepton-plus-jet system. The talk will introduce the search strategy and present the current status of the analysis, focusing on final states with fermions of the first and second generation.

T 27.3 Tue 17:30 HSZ/0403

Development of a new trigger for exotic particle searches with IceCube — •Timo Stürwald for the IceCube-Collaboration — Bergische Universität, Wuppertal, Deutschland

The IceCube Neutrino Observatory is a cubic kilometer scale Cherenkov light detector that also searches for signatures of particles beyond the standard model. The upcoming IceCube Upgrade and IceCube-Gen2 extension will improve the sensitivity for these searches due to an increased and partly denser instrumented sensitive volume. The better sensitivity allows for the detection of signatures of exotic particles including fractionally charged particles, which directly and indirectly produce light.
The development of a new trigger for faint signatures of exotic particles with the focus on fractionally charged particles is presented. The new trigger includes the analysis of isolated single hits that so far are not included in any IceCube trigger, because a large fraction of them originates from well understood noise sources. For simulated faint exotic signatures the isolated single hits become the dominant hit type. The improvement in signal efficiency and the estimated trigger rate for different trigger configurations will be presented. Furthermore, the results of running the new trigger at the IceCube test DAQ will be presented.
* Funded by BMBF-Verbundforschung Astroteilchenphysik

T 27.4 Tue 17:45 HSZ/0403

Axion-Like-Particle (ALP) search using ATLAS central and ATLAS Forward Proton (AFP) detectors — •Ondrej Matousek and Andre Sopczak — CTU in Prague

The latest results of the ALP search with the AFP detector are presented.

T 27.5 Tue 18:00 HSZ/0403

A TES for ALPS II - Status and Prospects — •José Alejandro Rubiera Gimeno for the ALPS-Collaboration — Deutsches Elektronen-Synchrotron DESY, Notkestr. 85, 22607 Hamburg, Germany

The Any Light Particle Search II (ALPS II) is a Light-Shining-through-a-Wall experiment operating at DESY, Hamburg. Its goal is to probe the existence of Axions and Axion Like Particles (ALPs), possible candidates for dark matter. In the ALPS II region of interest, a rate of photons reconverting from Axions/ALPs on the order of 10^{-5} cps is expected. This requires a sensor capable of measuring low-energy photons (1.165 eV) with high efficiency and a low dark count rate. We investigate a tungsten Transition Edge Sensor (TES) system as a photon-counting detector that promises to meet these requirements and is foreseen for a later science run of ALPS II. This detector exploits the drastic change in its resistance caused by the absorption of a single photon when operated in its superconducting transition region at millikelvin temperatures. In order to achieve the required sensitivity, the implementation of the TES into the ALPS II experiment needs to be carefully optimized. In this work, we present the progress on measurements for the characterization of dark noise, energy resolution, background rejection, efficiency and linearity of our sensor.

T 27.6 Tue 18:15 HSZ/0403

LUXE-NPOD background estimation — Torben Ferber, Alexander Heidelbach, Markus Klute, •Raquel Quishpe, and Nicolo Trevisani — Karlsruhe Institute of Technology, Karlsruhe, Germany

The proposed LUXE experiment at the European XFEL at DESY will produce high-intensity electron-laser interactions to study QED in the non-perturbative regime. These interactions have as a secondary product a large flux of photons with energy up to a few GeV. The photons are then directed onto a physical dump allowing the production of axion-like particles (ALPs) in a region of parameters never probed before. The ALPs produced will decay into pairs of photons detected by an electromagnetic calorimeter. One of the challenges for ALPs searches at LUXE is to reduce the background of neutrons and non-resonant photons reaching the calorimeter. We present a systematic simulation study with different dump materials and depths we carried out in the quest of the best balance between signal acceptance and background suppression.

T 28: Forward Physics

Time: Tuesday 17:00–18:30 Location: HSZ/0101

T 28.1 Tue 17:00 HSZ/0101

QCD cross-section measurements for astroparticle physics with the LHCb experiment — Johannes Albrecht, Hans Dembinski, and •Lars Kolk — TU Dortmund University, Dortmund, Germany

A long-standing issue in the field of cosmic-ray research is the discrepancy between the observed and simulated numbers of muons in cosmic-ray-induced hadronic showers in Earth's atmosphere, which are called air showers. This discrepancy is referred to as the Muon Puzzle, as the required changes to existing models in simulation would violate either data constraints or the consistency between air shower simulations and other air shower features.
One explanation for this inconsistency lies in universal strangeness enhancement. Measurements from the ALICE and LHCb experiments show first evidence that this enhancement could truly be universal and thus potentially solve the Muon Puzzle.
To further study the impact on forward produced hadrons and to test this universality, proton-ion data from the LHCb fixed target mode are analysed. Of particular interest are proton-oxygen collisions, as they are a good proxy for air showers. Since proton-oxygen data are not yet available, the first step is to bracket oxygen with helium and neon. The current status of this analysis is presented.

Supported by DFG (SFB 1491)

T 28.2 Tue 17:15 HSZ/0101

LHCb for astroparticle physics: Prompt production of identified charged hadrons — Johannes Albrecht[1], •Julian Boelhauve[1], Hans Dembinski[1], and Michael Schmelling[2] — [1]TU Dortmund University, Dortmund, Germany — [2]Max Planck Institute for Nuclear Physics, Heidelberg, Germany

A long-standing issue in the field of cosmic-ray research is the discrepancy in the number of muons produced in high-energy air showers between observations and simulation, referred to as the Muon Puzzle. Precision measurements of hadron production in the forward region are needed to validate and improve the hadronic-interaction models used in the simulation of air showers, with the aim of solving the Muon Puzzle. In this context, measuring the differential cross-section of prompt production of identified long-lived charged hadrons as a function of transverse momentum and pseudorapidity is of great importance.

An analysis in which this differential cross-section is determined for proton–proton and proton–lead collisions is presented in this talk. The corresponding data samples were recorded with the LHCb experiment at centre-of-mass energies of 13 TeV and 8.16 TeV in the nucleon–nucleon system, respectively. The focus of the talk is placed on the calibration of the particle-identification response of the detector, which is essential to an accurate measurement of the fractions of the three most commonly produced hadrons, i.e. pions, kaons and protons, present in the data.

Supported by DFG (SFB 1491).

T 28.3 Tue 17:30 HSZ/0101

Obtaining the Total Cross-Section and ϱ-Parameter from Elastic Proton-Proton Scattering at $\sqrt{s} = 900$ GeV with the ATLAS Subdetector ALFA — Wolfgang Friebel[2], Karlheinz Hiller[2], •Mustafa Schmidt[1], and Hasko Stenzel[3] for the ATLAS-Collaboration — [1]Bergische Universität Wuppertal — [2]Deutsches Elektronen-Synchrotron DESY — [3]Justus-Liebig-Universität Gießen

ALFA (Absolute Luminosity for ATLAS) is a Roman Pot (RP) detector system in the LHC tunnel, located around 240 m away from the

Interaction Point (IP) downstream in the forward region of ATLAS. The ALFA subdetector contains several layers of scintillating fibers for tracking elastically scattered protons in the outgoing beams. The RPs are used as a housing for the fiber trackers and can be moved in small steps close to the beam to ensure proton tracking at small scattering angles. In 2018, 12 runs were recorded at a center-of-mass energy of $\sqrt{s} = 900\,\text{GeV}$ during several fills using special LHC beam optics with $\beta^\star = 100/50\,\text{m}$ parallel-to-point focusing.

This combination makes it possible to probe various important physics parameters of pp interactions in the Coulomb-nuclear interference region, providing a unique evaluation of the underlying model predictions within the non-perturbative QCD regime. A fit describing the physics models to the elastic cross-section distribution, which is obtained from the calculation of the four-vector momentum transfer, allows the extraction of the nuclear slope parameter B, the total cross-section σ, and the ϱ-parameter, defined as $\varrho = \Re[f(0)]/\Im[f(0)]$. This talk covers the current status of the ongoing analysis and future steps.

T 28.4 Tue 17:45 HSZ/0101

Physics potential of a combined data-taking of the LHCf and ATLAS roman pot detectors — •Yusuf Can Cekmecelioglu[1], Clara Elisabeth Leitgeb[1], and Cigdem Issever[2] — [1]DESY, Zeuthen, Germany — [2]Humboldt University, Berlin, Germany

The study determines a common geometrical acceptance for the LHCf and ATLAS roman pot (ARP) detectors located in the forward regions of the ATLAS interaction point. In order to better understand the soft QCD processes and to improve pileup modelling for hadron accelerators and cosmic ray air shower modelling, a simultaneous analysis of central tracks (ATLAS), forward proton (ARP) and neutral particles (LHCf) could be beneficial. Analyses of single diffraction processes especially take advantage of these kind of setup, since the final state intact proton can be detected using ARPs and the neutral particles from the dissociated proton can be detected using LHCf and ATLAS Zero Degree Calorimeter (ZDC). Delta baryons produced in a pomeron exchange can lead to a similar signature with one neutral pion and one proton in the final state. This process, which effectively represents very low mass diffraction, is also taken into account in these studies.

In the end, a good common geometrical acceptance is found, yielding an acceptable event rate with the proposed joint data-taking between the detectors. Based on these studies, the ATLAS Forward Proton detector (AFP) joined the special run for LHCf in 2022, which results the very first combined data of LHCf, ZDC, ATLAS and AFP so far, with a recorded data of about 300 millions events.

T 28.5 Tue 18:00 HSZ/0101

Prospect studies for Proton-Oxygen Collisions at ATLAS, LHCf and AFP — Yusuf Can Çekmecelioğlu[2], •Erik Dieckow[1], Cigdem Issever[1,2], and Clara Elisabeth Leitgeb[2] — [1]Humboldt Universität zu Berlin, Germany — [2]DESY, Zeuthen, Germany

In astroparticle physics, ground based analysis is done by studying cosmic ray induced showers in the Earth's atmosphere. The phenomenological models used to simulate the interaction of cosmic ray particles with the atmospheric nuclei cause large systematic uncertainties and thus need improvement. In the past, LHC has conducted proton-proton and proton-heavy nucleus (lead) collisions. In LHC run 3 there will be the opportunity to study proton-Oxygen collisions. The cross-sections and particle energy spectra in the forward regions that will be measured with this data can provide invaluable and complementary input to the aforementioned models. The main focus of these studies is on the feasibility of a combined data taking of LHCf, ATLAS and AFP detectors during the proton-Oxygen collision run. This would allow for a better reconstruction of the event kinematics, as well as a purer selection of low mass single diffraction events than would be possible with LHCf data only.

T 28.6 Tue 18:15 HSZ/0101

Measurement of Fragmentation Cross Sections of Intermediate-Mass Nuclei with NA61/SHINE at CERN — •Neeraj Amin for the NA61/SHINE-Collaboration — Institute for Astroparticle Physics, Karlsruhe Institute of Technology, Karlsruhe, Germany

Cosmic-ray propagation in the galaxy can be constrained by modeling the secondary-to-primary cosmic-ray flux ratios, like the boron-to-carbon flux ratio that reaches Earth. While these fluxes are currently measured with higher precision(<5%) by space-based detectors like AMS, CALET, and DAMPE, insufficient knowledge of nuclear fragmentation cross sections hinders our inference of propagation parameters. Therefore, laboratory measurements of fragmentation cross section above 10 A GeV/c are essential. We remediate this situation by utilizing the NA61/SHINE experimental facility at CERN.

Pilot data on fragmentation was taken in 2018 with the main aim of probing the feasibility of performing fragmentation studies at SPS energies. Two fixed targets, polyethylene(C_2H_4) and graphite were employed to study C+p interactions at 13.5 A GeV/c beam momentum. In this contribution, we will present the isotopic production of boron including direct production of ^{10}B & ^{11}B as well as via indirect channels originating from the decay of ^{10}C and ^{11}C fragments. We also report on the feasibility of measuring light and intermediate-mass nuclei from Li to F relevant for cosmic ray propagation studies. A dedicated high statistics data-taking is scheduled in late 2023 to study the fragmentation of various primary nuclei like C, N, O & Si.

T 29: Other Exp., EW

Time: Tuesday 17:00–18:30 Location: HSZ/0103

T 29.1 Tue 17:00 HSZ/0103

Search for new physics in top quark production with an associated boson in the framework of the SMEFT — Arnulf Quadt, Baptiste Ravina, Elizaveta Shabalina, and •Sreelakshmi Sindhu for the ATLAS-Collaboration — II. Physikalisches Institut, Georg-August-Universität Göttingen, Germany

The Standard Model Effective Field Theory (SMEFT) provides a model independent approach to study beyond the Standard Model effects. A search for new physics using the framework of the SMEFT is performed using events with one or two top quarks in association with a boson ($t\bar{t}W$, $t\bar{t}Z$, tZ, $t\bar{t}H$, tH). The simultaneous analysis of these processes gives the opportunity to constrain a large number of dimension six SMEFT operators.

In this analysis, final states with two same sign or three isolated leptons are selected and classified into various regions based on the number of leptons, jets, b-jets and the total charge of the leptons. Using the event yields in these regions, limits are extracted on the SMEFT operators. This measurement is performed using the proton-proton collision data at $\sqrt{s} = 13$ TeV with an integrated luminosity of 139 fb^{-1}, recorded from 2015 to 2018 with the ATLAS experiment at the Large Hadron Collider at CERN.

T 29.2 Tue 17:15 HSZ/0103

A neural network for beam background decomposition in Belle II at SuperKEKB — •Yannik Buch, Ariane Frey, Lukas Herzberg, and Benjamin Schwenker — II. Physikalisches Institut, Georg-August-Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Deutschland

The Belle II detector investigates the b-sector by measuring the decays of the $\Upsilon(4S)$ resonance. These $\Upsilon(4S)$ decays are produced by the SuperKEKB accelerator at KEK in Tsukuba, Japan. The goal of SuperKEKB is to achieve an instantaneous luminosity of $6.5 \times 10^{35}\,\text{cm}^{-2}\text{s}^{-1}$, of which $4.7 \times 10^{34}\,\text{cm}^{-2}\text{s}^{-1}$ has recently been reached.

The beam backgrounds at Belle II are mostly composed of storage and luminosity-induced backgrounds. Due to short beam lifetimes continuous top-up injections into both rings are necessary, resulting in injection-induced background spikes. BGNet is a neural network based diagnostic tool for real-time background decomposition and analysis. The training data for BGNet are 1 Hz time series of diagnostic variables describing the state of the SuperKEKB collider subsystems. Using feature attribution to explain the predictions, provides clues to identify the most relevant causes of changes in background levels.

T 29.3 Tue 17:30 HSZ/0103

Studies of ATLAS Forward Proton (AFP) ToF performance

with Run-3 data — •Viktoriia Lysenko and Andre Sopczak — CTU in Prague

Performance studies of ATLAS Forward Proton (AFP) ToF with Run-3 data are presented.

T 29.4 Tue 17:45 HSZ/0103

Search for $\gamma\gamma$jj final states from Vector Boson Scattering at the ATLAS experiment — •Orcun Kolay — Technische Universität Dresden, Germany

Vector boson scattering (VBS) is a suitable process to observe triple and quartic gauge couplings. This rare processes provide us an avenue to examine electroweak (EW) symmetry breaking mechanism and to search for possible new physics effects. In this study, two photons along with two jets ($\gamma\gamma$jj) are taken into account as the final state. The measurement of the VBS $\gamma\gamma$jj process comes along with two main challenges as the background coming from QCD induced $\gamma\gamma$jj and misidentified jets as photon. In this talk, it will be presented an ongoing work which mainly covers the separation of EW $\gamma\gamma$jj from QCD $\gamma\gamma$jj, the signal-control region strategy for misidentified jets and the comparison of the different Monte Carlo event generators for the signal phase space.

T 29.5 Tue 18:00 HSZ/0103

Electroweak production of two jets in association with a Z boson in proton-proton collisions — •Keila Moral Figueroa — Deutsches Elektronen-Synchrotron DESY, Notkestraße 85, D-22607 Hamburg

In recent years, the Large Hadron Collider (LHC) has played an important role in constraining extensions of the Standard Model (SM). One of the measurements which can contribute to it, is the electroweak production of the Z boson in association with two jets (EW Zjj). This process limits the anomalous weak-boson self-interactions, due to its sensitivity to the weak vector-boson scattering (VBS), an increasingly relevant process at the LHC.

So far, the theoretical predictions of the EW Zjj process diverge slightly among different Monte Carlo event generators. As a consequence, further studies are needed in order to obtain reliable model-independent measurements. The EW Zjj process is identified by imposing large invariant dijet mass and dijet pseudaripidty separation. First distributions are shown using the full Run 2 dataset.

T 29.6 Tue 18:15 HSZ/0103

A data-driven multijet background estimation method for the measurement of the electroweak Wjj production with the ATLAS experiment — •Lisa Marie Baltes — Kirchhoff-Institute for Physics, University Heidelberg, Germany

The observation and measurement of self-interactions of weak gauge bosons provide an indirect search for physics beyond the Standard Model. The electroweak production of a W boson in association with two jets includes the vector-boson-fusion (VBF) production of a W boson and is thus sensitive to the triple gauge boson vertices WWγ and WWZ. In proton-proton collisions, the characteristic signature of VBF includes two high-momentum jets at small angles with respect to the incoming beams and a centrally produced lepton-neutrino pair originating from the W boson decay. A significant background for this analysis is multijet production via the strong interaction where a jet is misidentified as a lepton. Monte-Carlo simulation generally do not provide a proper description of QCD backgrounds. Therefore, data-driven techniques are used to estimate this background. In this talk, the current status of the analysis including the multijet background estimation using the matrix method is presented.

T 30: Higgs Charm, Di-Higgs

Time: Tuesday 17:00–18:30 Location: HSZ/0105

T 30.1 Tue 17:00 HSZ/0105

Introduction of a new framework in the analysis of the Higgs boson decay to a charm-anticharm pair in the vector boson associated production mode at CMS — •Valentyn Vaulin[1], Annika Stein[1], Xavier Coubez[1,2], Alena Dodonova[1], Ming-Yan Lee[1], Spandan Mondal[1], Andrzej Novak[1], Andrey Pozdnyakov[1], Manuella Guirgues[1], and Alexander Schmidt[1] — [1]Physics Institute III A, RWTH Aachen University, Germany — [2]Brown University, USA

During the last years the analysis techniques to measure the Higgs boson coupling to charm quarks using the full Run-2 data of the CMS experiment have been established. The Higgs boson decay into charm-anticharm pair, where the Higgs boson is produced in association with the W or Z boson, has been analysed in a resolved topology with individually reconstructed jets and in a boosted topology with merged jets. In this talk a concept of a new analysis framework is presented with the intention to reproduce the known results of the VH search from Run-2 analysis by CMS. The $Z \to 2l$ decay channel of the associate vector boson and resolved jet topology of the $H \to c\bar{c}$ decay are considered for this study. Furthermore, the results of the current state of ML-supported analysis in the new framework will be discussed.

T 30.2 Tue 17:15 HSZ/0105

Direct search for Higgs boson decay to a pair of charm quarks in the vector boson associated production mode at CMS — •Annika Stein[1], Bjorn Burkle[2], Xavier Coubez[1,2], Alena Dodonova[1], Manuella Guirgues[1], Luca Mastrolorenzo[1], Ming-Yan Lee[1], Spandan Mondal[1], Andrzej Novak[1], Andrey Pozdnyakov[1], Alexander Schmidt[1], and Valentyn Vaulin[1] — [1]III. Physikalisches Institut A, RWTH Aachen University, Aachen, Germany — [2]Brown University, Providence, USA

The search targets Higgs bosons produced in association with a vector boson (W, Z) and probes the coupling of the Higgs boson to charm quarks via the $H \to c\bar{c}$ decay, using full Run-2 data of the CMS experiment. Two topologies contribute to the full analysis, the "boosted" topology, where the two jets from a Higgs boson candidate are merged into one large-radius jet, and a "resolved" topology which utilizes two reconstructed small-radius jets. Compared to a previous search, the analysis techniques have been improved by exploiting a DNN-based charm jet tagging algorithm along with a new calibration method, improved jet-energy regression, and a "kinematic fit" to constrain momenta of the jets using leptons. The most stringent constraint on the Higgs-charm Yukawa coupling modifier, κ_c, at the observed (expected) 95% CL interval is set to $1.1 < |\kappa_c| < 5.5$ ($|\kappa_c| < 3.4$). A validation of the analysis is carried out with a search for $Z \to c\bar{c}$ in VZ events, which leads to its first observation at a hadron collider with a significance of 5.7 standard deviations. Further developments that feature novel machine learning methods will be discussed.

T 30.3 Tue 17:30 HSZ/0105

Search for boosted Higgs boson decays to a charm quark pairs — •Andrzej Novak, Xavier Coubez, Ming-Yan Lee, Luca Mastrolorenzo, Andrey Pozdnyakov, Annika Stein, and Alexander Schmidt — Physics Institute III A, RWTH Aachen

The Higgs boson decay to charm quarks ($H \to c\bar{c}$) has the highest branching fraction of the yet unobserved decays. Moreover, it is predicted to be the strongest coupling to the second generation of fermions, which as of now remains unconfirmed. This talk presents a recent search by the CMS experiment for $H \to c\bar{c}$ at high transverse momentum, primarily targeting the gluon fusion production mode. The method is validated with the $Z \to c\bar{c}$ decay, which is observed for the first time in this channel and provides the strongest constraint yet at the LHC. The observed (expected) upper limit on $H \to c\bar{c}$ process is set at 47 (39) times the SM prediction. The analysis was enabled by recent developments in deep learning tools for jet identification in such topologies.

T 30.4 Tue 17:45 HSZ/0105

Discrimination of Di-Higgs and Higgs-Z Boson Final States Using Neural Networks — •Lars Linden, Otmar Biebel, Christoph Ames, and Celine Stauch — Ludwig-Maximilians-Universität, München

Precise measurements of Higgs boson pair production are of significant importance for new physics searches and determining the Higgs potential's exact shape. These processes have small cross-section however, making them exceptionally rare. As a result, neural networks

are used to improve the experimental sensitivity for these processes. The employed network uses general event jet information and specific variables sensitive to di-Higgs production for event classification. This talk presents a network structure for distinguishing $gg \to HH$ from the important background process $gg \to HZ$ and its respective sensitive variables.

T 30.5 Tue 18:00 HSZ/0105

Separation of HH and HZ processes in LHC events — •Celine Stauch, Otmar Biebel, Christoph Ames, and Lars Linden — LMU München

LHC Processes with HH final states and HZ final states are kinematically very similar due to H and Z boson being close in mass and both final states having similar cross sections in proton-proton collisons. While the H boson is a scalar particle, the Z boson has a spin of 1. The spin of the Z boson transfers to the jets in the final state leading to a correlation of the angles of these jets.

For HH or HZ final states resulting in at least 4 jets all possible combinations of the four energetically highest jets are calculated in order to find the combination closest in mass to a H or Z boson. A variable sensitive to the correlation of the angles of the final state jets is introduced, which is a modification of the Ellis-Karliner angle. This variable is investigated using generator simulation data for the best combination of jets in HH final states ans HZ final states.

T 30.6 Tue 18:15 HSZ/0105

A neural network based regression of the neutrinos in H→ $\tau\tau$ decays for a resonant HH→bb$\tau\tau$ analysis — Philip Keicher, •Tobias Kramer, Nathan Prouvost, Marcel Rieger, Peter Schleper, Jan Voss, and Bogdan Wiederspan — Universität Hamburg

The CMS resonant HH→bb$\tau\tau$ analysis searches for heavy spin 0/2 resonances decaying into two Higgs bosons which subsequently decay into bottom quarks and tau leptons. It uses the Run 2 data collected from 2016-2018 at a center of mass energy of $\sqrt{s} = 13\,\text{TeV}$ corresponding to an integrated luminosity of 138 fb^{-1}. As a wide range of resonance masses is covered, reconstructing the invariant mass of the HH system and therefore the individual Higgs bosons is crucial. Especially for the Higgs boson decaying into tau leptons a significant amount of information is lost in the form of neutrinos not being measured by the detector. This talk presents a study on how to regress the full HH system using deep neural networks in order to improve the mass resolution of a potential new heavy particle.

T 31: Theory Higgs, BMS

Time: Tuesday 17:00–18:15 Location: HSZ/0201

T 31.1 Tue 17:00 HSZ/0201

Higgs pair production in SMEFT at full NLO QCD: an investigation of truncation effects — •Jannis Lang — Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany

We present results for Higgs boson pair production in gluon fusion at NLO (2-loop) QCD including operators in the Standard Model Effective Field Theory (SMEFT) framework. Contributions from subsets of higher order terms in $\frac{1}{\Lambda^2}$, such as squared dimension-6 operators at cross section level and double operator insertions at amplitude level, are used as a proxy for the study of truncation effects of the SMEFT expansion. The different truncation options are contrasted to the non-linear Higgs Effective Field Theory (HEFT) framework for selected phenomenological examples.

T 31.2 Tue 17:15 HSZ/0201

Precision test of the muon-Higgs coupling at a high-energy muon collider — •Nils Kreher[1], Tao Han[2], Wolfgang Kilian[1], Yang Ma[2], Jürgen Reuter[3], Tobias Striegl[1], and Keping Xi[2] — [1]Department of Physics, University of Siegen, Walter-Flex-Straße 3, 57068 Siegen, Germany — [2]Pittsburgh Particle Physics, Astrophysics, and Cosmology Center, Department of Physics and Astronomy, University of Pittsburgh, Pittsburgh, PA 15206, U.S.A. — [3]Deutsches Elektronen-Synchrotron DESY, Notkestraße 85, 22607 Hamburg, Germany

I will present a sensitivity test of the muon-Yukawa sector at a high-energy muon collider. While in the Standard Model this sector is described by a single parameter, effects of new physics that is not aligned with the Standard Model Yukawa interactions may introduce a more sophisticated parameter dependence, which can be understood either in SMEFT or a HEFT frameworks. With the accidentally small value of the muon Yukawa coupling and its subtle role in the high-energy production of multiple (vector and Higgs) bosons, I will show that it is possible to measure the muon-Higgs coupling to an accuracy of ten percent for a 10 TeV muon collider and a few percent for a 30 TeV machine by utilizing the three boson production, potentially sensitive to a new physics scale about $\lambda = 10 \sim 30$ TeV. In addition I will discuss effects of an extended Higgs sector to the same processes in both frameworks.

T 31.3 Tue 17:30 HSZ/0201

Projecting composite operators onto a unique basis — Robert V. Harlander, •Jakob W. Linder, and Magnus C. Schaaf — 1Institute for Theoretical Particle Physics and Cosmology, RWTH Aachen, Aachen

The Standard Model effective field theory (SMEFT) describes the low-energy effects of possible high-energy theories in terms of Standard Model fields. In a top-down approach, the effective Lagrangian can be obtained by constructing the effective action using a functional matching procedure, for example. However, this yields a non-unique action in general.

To restore the desired uniqueness, an algorithm is developed to decompose any operator with arbitrary mass dimension into operators free of redundancies due to equations of motion, integration-by-part identities or internal symmetries. For this purpose, the operators are converted into a redundancy-free basis, which can be constructed automatically for arbitrary mass dimensions. In this talk, I will report on such a basis and ProSMEFTion, our implementation of the algorithm.

T 31.4 Tue 17:45 HSZ/0201

Debye mass effects in the Dark Sector in the Early Universe — Simone Biondini[1], Nora Brambilla[2], •Andrii Dashko[3], Gramos Qerimi[2], and Antonio Vairo[2] — [1]Department of Physics, University of Basel, Klingelbergstr. 82, CH-4056 Basel, Switzerland — [2]Physik-Department, Technical University Munich, James-Franck-Str. 1, 85748 Garching, Germany — [3]Deutsches Elektronen-Synchrotron DESY, Notkestr. 85, 22607 Hamburg, Germany

We address the impact of the thermal Debye mass m_D scale on the bound-state formation and ionization (dissociation) in the dark sector in the Early Universe. We focus on heavy dark fermions (with mass m) charged under a $U(1)_d$ group coupling dark matter to dark photons and dark light fermions with the coupling constant $\alpha = g^2/4\pi$. We determine the effect of the HTL resummation on the bound state formation and dissociation rates of heavy dark fermions in presence of a hot (with temperature T), weakly coupled ($T \gg gT$) dark plasma, under the assumption that $m \gg m\alpha \gg T$. Our analysis is based on Non-Relativistic Effective Field Theory (NREFT) to address the dark matter threshold dynamics and on Thermal Field Theory to address the thermal scales. We obtain and solve coupled Boltzmann equations and show how our results affect the evolution of the dark matter density in the Early Universe. Working with this simplified model of the dark sector, we show that the effect of HTL resummation on the bound-state formation and thermal relic abundance is non-negligible (and of the same order as the NLO fixed order correction), which indicates the importance of further studies in more realistic scenarios.

T 31.5 Tue 18:00 HSZ/0201

Trilinear Higgs Self-Couplings at $\mathcal{O}(\alpha_t^2)$ in the CP-Violating NMSSM — •Christoph Borschensky[1], Thi Nhung Dao[2], Martin Gabelmann[3], Margarete Mühlleitner[1], and Heidi Rzehak[4] — [1]Karlsruhe Institute of Technology, Germany — [2]PHENIKAA University, Hanoi, Vietnam — [3]DESY, Hamburg, Germany — [4]Eberhard Karls Universität Tübingen, Germany

In supersymmetric theories the Higgs boson masses are derived quantities where higher-order corrections have to be included in order to match the measured Higgs mass value at the precision of current ex-

periments. Closely related through the Higgs potential are the Higgs self-interactions. In addition, the measurement of the trilinear Higgs self-coupling provides the first step towards the reconstruction of the Higgs potential and the experimental verification of the Higgs mechanism sui generis.

In this talk, I will present the $\mathcal{O}(\alpha_t^2)$ corrections to the trilinear Higgs self-couplings in the CP-violating Next-to-Minimal Supersymmetric extension of the SM (NMSSM), calculated in the gaugeless limit at vanishing external momenta. The higher-order corrections turn out to be larger than the corresponding mass corrections, but show the expected perturbative convergence. The inclusion of the loop-corrected effective trilinear Higgs self-coupling in gluon fusion into Higgs pairs and the estimate of the theoretical uncertainty due to missing higher-order corrections indicate that the missing electroweak higher-order corrections may be significant.

T 32: Di-Higgs, Higgs BSM

Time: Tuesday 17:00–18:30 Location: HSZ/0204

T 32.1 Tue 17:00 HSZ/0204

Employing Matrix Elements with Neural Networks to Search for Higgs Self-coupling — •Christoph Ames, Otmar Biebel, Lars Linden, and Celine Stauch — Ludwigs-Maximilians-Universität, München

The Higgs boson was discovered in 2012 as predicted by the Standard Model (SM), however, not all of its predicted couplings have been measured yet. One such coupling is the Higgs self-coupling, in which a Higgs boson decays into two further Higgs bosons. By integrating over all possible initial states and by using the details of the end state, the matrix element method evaluates the weight of an event for the specific production cross section. In this work, machine learning is combined with the matrix element method to search for $HH \to b\bar{b}\,W^+W^-$ using simulated data. A neural network is trained to calculate the matrix element weight of an event and to use this to determine whether the event contains a signal or a background decay.

T 32.2 Tue 17:15 HSZ/0204

Prospects for measuring di-Higgs production at the ILC — •Julie Torndal[1,2], Jenny List[1], and Yasser Radkhorrami[1,2] — [1]Deutsches Elektronen-Synchrotron DESY, Hamburg — [2]Universität Hamburg, Hamburg, Germany

The Higgs mechanism is a central part of the Standard Model (SM). However, at this point in time, it has not been established experimentally which can only be done by reconstructing the Higgs potential. In the SM, the shape of the potential is determined by the Higgs self-coupling, which can be measured directly and model-independently at future linear e+e- colliders through di-Higgs production.

The Interntional Linear Collider (ILC) offers a clean experimental environment and a physics programme with sufficient energies to produce di-Higgs events. The measurement suffers from small production cross sections and large jet multiplicity, imposing high standards on the reconstruction tools. Modern reconstruction tools have seen a large improvement since the di-Higgs analysis was last visited almost 10 years ago. These improvements are foreseen to improve the precision, and an analysis strategy is presented focusing on an accurate event reconstruction and Z/H separation. Other aspects such as the the centre-of-mass energy and BSM effects might also influence the reachable precision and will be considered.

T 32.3 Tue 17:30 HSZ/0204

Prospects for constraints on light-quark Yukawa couplings from differential distributions of Higgs boson production in the diphoton decay channel — Johannes Erdmann and •Jan Lukas Späh — III. Physikalisches Institut A, RWTH Aachen University

More than ten years after the discovery of the Higgs boson, various production and decay channels have been explored experimentally. However, the constraints on couplings to the light quarks up, down, and strange are comparatively weak as they are challenging to probe experimentally.

In this talk, studies to constrain these couplings based on the production mode of quark-antiquark annihilation in the diphoton decay channel are presented. The focus lies on the discrimination of this $q\bar{q} \to H + X$ component against the dominant Standard Model contribution from gluon-gluon fusion. For this, the transverse momentum and the rapidity of the Higgs boson play an important role.

Expected upper limits on the Yukawa couplings to the three light quark species are presented. The potential for this interpretation in light of the large statistical power of the datasets collected with the High-Luminosity Large Hadron Collider is highlighted.

T 32.4 Tue 17:45 HSZ/0204

Search for heavy Higgs bosons in the $t\bar{t}Z$ final state at CMS — Matteo Bonanomi, Yannick Fischer, Johannes Haller, •Daniel Hundhausen, and Matthias Schröder — Institut für Experimentalphysik, Universität Hamburg

All measurements of the properties of the Higgs boson at 125 GeV are compatible with a standard model-like behaviour. However, the observed resonance might well be part of an extended Higgs sector, which is predicted in various scenarios of new physics beyond the standard model. Two Higgs Doublet Models (2HDM) provide a generic description of the phenomenology arising in models with a second Higgs doublet. In this talk, we will present a search for a hypothetical CP odd heavy Higgs boson A decaying into a CP even heavy Higgs boson H and a Z boson, with the H decaying further into a pair of top quarks. This decay channel is particularly relevant in the high mass and low $\tan(\beta)$ regime. We will present the strategy and status of the analysis of data collected with the CMS experiment at a centre of mass energy of 13 TeV, targeting the fully hadronic $t\bar{t}$ decay.

T 32.5 Tue 18:00 HSZ/0204

Exotic Higgs Decays: ATLAS Search for Higgs Decays to Two Light Scalars — •Judith Höfer, Claudia Seitz, and Beate Heinemann — DESY, Hamburg, Germany

Extensions of the SM Higgs sector featuring one or several singlet scalar fields are realised in many BMS models. While several searches have been performed targeting decays of the SM Higgs boson to two light spin-zero particles of the same mass, the decay to two new scalars of different mass is largely unexplored. The successive decays of these particles can give rise to spectacular high-multiplicity collider signatures, including so-called cascade decays, where the heavier of the scalars decays into the lighter one. The talk discusses an analysis searching for scalar decays to multi-b final states with the ATLAS experiment at the Large Hadron Collider, CERN. The analysis focuses on the ZH production mode and the channel where the scalars decay to b-quarks, resulting in a challenging low-pT jet final state. Particular focus is put on the cascade decays that result in a 6b final state. The signatures motivate the use of novel reconstruction techniques, such as a newly developed low-pT X→bb tagger or the reconstruction of soft secondary vertices.

T 32.6 Tue 18:15 HSZ/0204

Domain walls in the N2HDM — Gudrid Moortgat-Pick, Mohamed Younes Sassi, and •Muriel Kaya Blenck — II. Institut für Theoretische Physik Luruper Chaussee 149 22761 Hamburg

In the next-to-two Higgs doublet model, the Higgs sector is extended by a second doublet as well as a singlet real scalar. These extra degress of freedom lead to the possibility of extending the symmetry group of the theory with additional discrete symmetries. In this talk, I will discuss the domain walls arising in this model due to the breaking of a discrete symmetry imposed on the singlet scalar and also discuss how to avoid the domain wall problem in such a model by allowing for soft breaking of this discrete symmetry.

T 33: DAQ NN/ML – GRID I

Time: Tuesday 17:00–18:30 Location: HSZ/0301

T 33.1 Tue 17:00 HSZ/0301

Track reconstruction with Graph Neural Networks on FPGAs for the ATLAS Event Filter at the HL-LHC — Sebastian Dittmeier and •Sachin Gupta — Physikalisches Institut, Universität Heidelberg

The High-Luminosity LHC (HL-LHC) will enhance the potential to discover new physics with the ATLAS experiment beyond its reach at the LHC. To cope with the increased pile-up foreseen during the HL-LHC, major upgrades to the ATLAS detector and trigger system are required. The trigger system will consist of a hardware-based trigger and an online server farm, called the Event Filter (EF), with track reconstruction capabilities. For the EF, a heterogeneous computing farm consisting of CPUs and potentially GPUs and/or FPGAs is under study, together with the use of modern machine learning algorithms such as Graph Neural Networks (GNNs).

GNNs are a powerful class of geometric deep learning methods for modelling spatial dependencies via message passing over graphs. They are well-suited for track reconstruction tasks by learning on an expressive structured graph representation of hit data. A considerable speed-up over CPU-based execution is possible on FPGAs.

In this talk, a study of track reconstruction for the ATLAS EF system at HL-LHC using GNNs on FPGAs is presented. The main focus is set on model size minimization using quantization aware training, as resource utilization is a key aspect in the application of GNNs on FPGAs.

T 33.2 Tue 17:15 HSZ/0301

Convolutional Neural Networks on FPGAs for Processing of ATLAS Liquid Argon Calorimeter Signals — •Johann Christoph Voigt, Anne-Sophie Berthold, Nick Fritzsche, Rainer Hentges, Christian Gutsche, and Arno Straessner — Institut für Kern- und Teilchenphysik, TU Dresden, Germany

The Phase-II upgrade of the ATLAS Liquid Argon Calorimeter allows for the energy reconstruction of all ~180000 readout channels at the LHC bunch crossing frequency of 40 MHz. Further challenges arise from the increased pile-up due to the planned higher number of simultaneous proton-proton collisions.

For the digital energy reconstruction, we propose the use of Convolutional Neural Networks (CNNs) instead of the previous Optimal Filter. The networks need be able to run on an FPGA with limited resources and are therefore limited in complexity to approximately 100 weight parameters.

This talk focuses on the firmware implementation of these networks in VHDL. The implementation is optimized for DSP usage and latency. To be able to process all readout channels on the available FPGAs, time domain multiplexing is used to process multiple channels per CNN instance. This reduces the number of required instances and increases the frequency the design needs to run at. A multiplexing factor of 12 at a frequency of 480 Mhz is demonstrated for a design processing 384 detector cells. The latest FPGA resource usage estimates are presented.

T 33.3 Tue 17:30 HSZ/0301

Implementation of neural networks for live reconstruction using AI processors — Klaus Desch[1], Jochen Kaminski[1], Michael Lupberger[1,2], and •Patrick Schwäbig[1] — [1]Physikalisches Institut, Universität Bonn, Deutschland — [2]Helmholtz-Institut für Strahlen- und Kernphysik, Universität Bonn, Deutschland

For years, data rates generated by modern detectors and the corresponding readout electronics exceeded by far the limits of data storage space and bandwidth available in many experiments. The solution of using fast triggers to discard uninteresting and irrelevant data is a solution used to this day. Using FPGAs, ASICs or directly the readout chip, a fixed set of rules based on low level parameters is applied as a pre-selection. Only a few years ago, live track reconstruction for triggering was rarely possible but with the emergence of fast and highly parallelized processors for AI inference attempts to sufficiently accelerate tracking algorithms become viable. The Xilinx Versal AI Adaptive Compute Acceleration Platform (ACAP) is one such technology and combines FPGA and CPU resources with dedicated AI cores. Our approach is to utilize the unique combination of FPGA and AI cores to leverage neural networks for live triggering which will be relevant for future experiments and upgrades of already existing setups.

In this talk AI algorithms for track reconstruction, especially their quantized and non-quantized implementation on the Xilinx VC1902, will be shown. They will be used in an envisioned mid-size ultra-high rate fixed-target dark matter experiment (Lohengrin) at the ELSA accelerator at the University of Bonn.

T 33.4 Tue 17:45 HSZ/0301

Profiling of GPU-based neural network trainings — •Tim Voigtländer, Manuel Giffels, Artur Gottmann, Günter Quast, Matthias Schnepf, and Roger Wolf — Karlsruhe Institute of Technology, Karlsruhe, Germany

The training of neural networks has become a significant workload of particle physics analyses. To speed up these trainings and reduce their turnaround cycle, one or more accelerators, e.g. GPUs, are typically utilized. While the increase in computational capacity is greatly beneficial, the heterogeneous hardware also adds layers of complexity to an already opaque process. In order to improve the efficiency in the usage of the available hardware, suitable profiling to identify possible bottlenecks. In this talk, solutions to a number of commonly occurring challenges found in single- and multi-GPU neural network trainings are presented, using the DeepTau neural network training as a case-study.

T 33.5 Tue 18:00 HSZ/0301

Open Science in KM3NeT — •Rodrigo Gracia-Ruiz for the ANTARES-KM3NET-ERLANGEN-Collaboration — FAU-ECAP, Erlangen, Germany

The KM3NeT neutrino detectors are currently under construction at two locations in the Mediterranean Sea, with a first data taking of high-energy neutrino interactions already under way. This scientific data is valuable both for the astrophysics and neutrino physics communities as well as for marine biologists. In order to facilitate FAIR data sharing of the research results, the KM3NeT collaboration is actively working towards an open science infrastructure to provide high-level scientific data, software, and analysis pipelines in an interoperable research environment suited both for research and education. This contribution introduces the open science program of KM3NeT and gives an overview of its current architecture and implementation.

T 33.6 Tue 18:15 HSZ/0301

Towards JupyterHub as one point of entry for the PUNCH4NFDI computing infrastructure — •Luka Vomberg, Philip Bechtle, Oliver Freyermuth, and Peter Wienemann for the PUNCH4NFDI Consortium-Collaboration — Physikalisches Institut Bonn

PUNCH (Particles, Universe, NuClei and Hadrons) is a consortium of the NFDI (Nationale ForschungsDaten Infrastruktur) representing about 9000 physicists in Germany at the Ph.D. level. The goals of PUNCH are the setup of infrastructure that enables physicists to easily manage and publish their data and corresponding analyses in accordance to the FAIR principles. These are Findability, Accessibility, Interoperability and Reproducibility, which are desirable properties that publications and their underlying data should adhere to as much as possible. The infrastructure supplied by PUNCH is meant to make this as easy as possible for individual researchers and collaborations alike. This talk will describe the vision of accessing the PUNCH infrastructure with FAIRness in mind through a JupyterHub infrastructure built on the PUNCH AAI (Authorisation and Authentication Infrastructure).

T 34: ML Methods II

Time: Tuesday 17:00–18:30 Location: HSZ/0405

T 34.1 Tue 17:00 HSZ/0405

Equivariant Normalising Flows for Particle Jets — •Cedric Ewen — Institut für Experimentalphysik, Universität Hamburg

In high energy physics, current Monte Carlo simulations are time-consuming and the demand for fast computationally efficient simulations is rising. Therefore, generative machine learning models have become a major research interest due to their ability to speed up data generation. A data structure capable of describing collider events such as jets are variable-size point clouds. However, due to complex correlations between the points, a powerful architecture is needed for high generative fidelity. Continuously normalising flows (CNFs) can model these complex point processes while having traceable likelihood and straightforward sampling. We show an implementation of an architecture using CNFs with equivariant functions and compare its performance to multiple GAN approaches on benchmark datasets.

T 34.2 Tue 17:15 HSZ/0405

Identification of $b\bar{b}$-Jets Using a Deep-Sets-Based Flavour-Tagging Algorithm with the ATLAS Experiment — •Joschka Birk[1,2], A. Froch[1], M. Guth[3], and A. Knue[1] — [1]University of Freiburg — [2]University of Hamburg — [3]University of Geneva

Jets that contain two b-hadrons ($b\bar{b}$-jets) are usually not considered as an individual target class in flavour-tagging algorithms. Instead, these jets are included in an inclusive b-jet category which consists of single-b jets and $b\bar{b}$-jets, making these two types of jets indistinguishable when they are processed with such an algorithm.

While this is sufficient for most physics analyses, an explicit identification of $b\bar{b}$-jets could be promising for analyses like the search for the $t\bar{t}H(\rightarrow b\bar{b})$ signal, which suffers from the large irreducible $t\bar{t}+b\bar{b}$ background. This irreducible background contains the same final-state particles as the signal, including four b-quarks. In the background process, a radiated gluon can split into a b-quark pair, which might be contained in one single jet. In order to improve the rejection of these particular background events, the ATLAS DL1d algorithm, which is the b-tagging algorithm designed for ATLAS Run 3 analyses, is extended with an additional output class dedicated to $b\bar{b}$-jets ($b\bar{b}$-DL1d).

By applying a cut in a two-dimensional discriminant plane, $b\bar{b}$-DL1d provides a proof-of-concept for a flavour-tagging algorithm that is capable of both inclusive b-tagging and $b\bar{b}$-jet identification. The design of the $b\bar{b}$-DL1d algorithm and its most important, Deep-Sets-based, low-level tagger $b\bar{b}$-DIPS are discussed in this talk. Futhermore, performance studies for both algorithms are shown.

T 34.3 Tue 17:30 HSZ/0405

Improving the robustness of jet tagging algorithms with adversarial training — •Hendrik Schönen[1], Annika Stein[1], Judith Bennertz[1], Xavier Coubez[1,2], Alexander Jung[1], Summer Kassem[1], Ming-Yan Lee[1], Spandan Mondal[1], Alexandre de Moor[3], Andrzej Novak[1], and Alexander Schmidt[1] — [1]III. Physikalisches Institut A, RWTH Aachen University, Germany — [2]Brown University, USA — [3]Vrije Universiteit Brussel, Belgium

Neural network architectures have advanced over the last decade and are an important part of current jet flavour tagging algorithms. Since these algorithms rely on training the network with simulated events as input, they might have a worse performance on detector data due to data/MC deviations. A possible approach to address this issue is adversarial training, which uses distorted inputs for training. One possibility to distort the inputs is applying a FGSM attack, which shifts the inputs in a way that maximizes the loss with a fixed magnitude. This talk is about the impact of adversarial training on the model performance and robustness.

T 34.4 Tue 17:45 HSZ/0405

Binning high-dimensional classifier output for HEP analyses through a clustering algorithm — •Svenja Diekmann, Niclas Eich, and Martin Erdmann — III. Physikalisches Institut A, RWTH Aachen University

The usage of Deep Neural Networks (DNNs) as multi-classifiers is widespread in modern HEP analyses. In standard categorisation methods, the high-dimensional output of the DNN is often reduced to a one-dimensional distribution by exclusively passing the information about the highest class score to the statistical inference method. Correlations to other classes are hereby omitted. Moreover, in common statistical inference tools, the classification values need to be binned, which relies on the researcher's expertise and is often non-trivial. To overcome the challenge of binning multiple dimensions and preserving the correlations of the event-related classification information, we perform K-means clustering on the high-dimensional DNN output to create bins without marginalising any axes. We evaluate our method in the context of a simulated cross section measurement at the CMS experiment, showing an increased expected sensitivity over the standard binning approach.

T 34.5 Tue 18:00 HSZ/0405

Resonant anomaly detection without background sculpting — •Manuel Sommerhalder[1], Gregor Kasieczka[1,2], Tobias Quadfasel[1], Anna Hallin[3], and David Shih[3] — [1]Institut für Experimentalphysik, Universität Hamburg, 22761 Hamburg, Germany — [2]Center for Data and Computing in Natural Sciences (CDCS), 22607 Hamburg, Germany — [3]NHETC, Dept. of Physics and Astronomy, Rutgers University, Piscataway, NJ 08854, USA

Anomaly searches are a class of machine learning–based methods to search for new phenomena without relying on specific signal and background models. They provide a promising complement to the typically model-dependent searches for physics beyond the standard model at the LHC. Resonant anomaly detection methods, such as CATHODE, make use of the assumptions of a signal being localized in one feature and have demonstrated great performance in terms of classifying new physics signals on simulation-based studies. However, they are prone to background sculpting in the case of input features being correlated with the resonant one and thus can ultimately impair a background estimation via the bump hunt. We thus propose Latent CATHODE (LaCATHODE), a new technique for resonant anomaly detection, which moves the features into a decorrelated latent space. Using the LHC Olympics R&D dataset, we observe that LaCATHODE leaves the background unsculpted while retaining much of the signal extraction performance of the original CATHODE approach.

T 34.6 Tue 18:15 HSZ/0405

ANN for Pulse Shape Analysis in GERDA — •Vikas Bothe for the GERDA-Collaboration — Max-Planck-Institute for Nuclear physics, Heidelberg

The GERDA experiment searches for the neutrinoless double-beta decay of 76Ge using enriched high-purity Germanium diodes as a source as well as a detector. For such a rare event search, the sensitivity of the experiment can be improved by employing active background suppression techniques. The time-profile analysis of the signals, called pulse shape analysis (PSA), generated by energy deposits within the detectors is employed to discriminate signal and background events. An effective PSA with artificial neural networks can reject the background events like alpha particles and Compton scattered photons while preserving a high signal efficiency for double beta decay-like events.

Coaxial detectors due to their geometry have significantly homogenous weighting potential adding a spatial dependence to pulse shapes. This makes the signal-background differentiation difficult with the use of simple mono-parametric cuts and to overcome this, we employ a multi-variate analysis with artificial neural networks which are capable of modeling complex relationships.

I will give a review of the methodology in building these ANN and their performance for PSA in GERDA.

T 35: Neutrino Astronomy II

Time: Tuesday 17:00–18:30 Location: POT/0051

T 35.1 Tue 17:00 POT/0051

Simulation of Bioluminescence for the Pacific Ocean Neutrino Experiment — •Moritz Brandenburg and Christian Haack for the P-ONE-Collaboration — Technical University Munich, Germany

The Pacific Ocean Neutrino Experiment (P-ONE) is a planned cubic kilometer-scale neutrino telescope in the Pacific Ocean. The first prototype detector line, P-ONE-1, is currently under construction. It consists of multi-PMT optical modules that will measure Cherenkov light produced by high-energy charged particles that stem from neutrino interactions in water. The optical modules are very sensitive to photons in the optical range, thus studying the impact of luminescent bio-organisms in the deep sea is crucial to forecasting expected trigger rates and the impact on neutrino searches. In this contribution we present a simulation that models the expected water currents around the optical modules which lead to stress-induced light emission of bioluminescent organisms. In the next step, the simulation propagates individual photons from expected emission positions to a simulated optical module. Analyzing the photon hits and PMT coincidences helps in designing the trigger algorithm that filters noise and reduces the background data rate.

T 35.2 Tue 17:15 POT/0051

Optical Timing and Synchronization for the Pacific Ocean Neutrino Experiment — •Lea Ginzkey, Christian Spannfellner, Michael Böhmer, and Elisa Resconi for the P-ONE-Collaboration — Technical University of Munich, Garching bei München, Germany

The Pacific Ocean Neutrino Experiment (P-ONE) aims to instrument more than one cubic kilometer of the Northeast Pacific Ocean off Vancouver Island (Canada) as a non-invasive next-generation neutrino telescope. P-ONE will measure high-energy astrophysical neutrinos and characterize the nature of astrophysical accelerators. A sub-ns timing synchronization within the photosensors in the detector volume is necessary to reconstruct the direction and energy of such highly energetic particles. Between the individual components of the P-ONE detector point-to-point fiber connections are used. A special implementation of ethernet allows to proliferate a central clock and synchronization signals to all modules in the system in real time, while offering a high bandwidth data connection by established protocols. This approach reduces the complexity of the system and cable design and optimizes the power consumption within the detector. First results of on- and offline delay measurements will be presented.

T 35.3 Tue 17:30 POT/0051

Neutrino detection with new triggers at the Pierre Auger Observatory* — Srijan Sehgal and •Michael Schimp for the Pierre Auger-Collaboration — Bergische Universität Wuppertal, Wuppertal, Germany

The Pierre Auger Observatory apart from detecting ultra-high energy comic rays is also an excellent instrument to look for highly inclined neutrino-induced air showers using its Surface Detector (SD) array. To improve the detection efficiency and to decrease the energy threshold of the array, two new SD triggers, time-over-threshold-deconvolved (ToTd) and multiplicity of positive steps (MoPS) were added in 2014.

This talk presents the work done to evaluate the effect of new triggers on the neutrino search. Events with energies below 10^{19} eV and in the zenith angle range of $60° < \theta < 75°$ are selected for both data and simulated neutrino-induced showers. The particular focus is on the improvements with the new triggers, MoPS and ToTd, to the neutrino sensitivity in comparison to previous neutrino searches at the Pierre Auger Observatory.

Gefördert durch die BMBF Verbundforschung Astroteilchenphysik (Vorhaben 05A20PX1)

T 35.4 Tue 17:45 POT/0051

Novel approaches in multimessenger observation of core-collapse supernovae — •David Maksimović and Michael Wurm — Johannes Gutenberg University, Mainz, Germany

In the case of a nearby galactic core collapse supernovae (CCSN), large-scale neutrino observatories and gravitational wave interferometers are expected to provide a wealth of experimental data.

This contribution presents a novel machine learning approach in the field of multi-messenger astronomy by investigating possible correlation between features in gravitational waves (GW) and neutrino signals originating from such galactic CCSN. Overarching phenomena during the explosion process can be so better understood, such as the suspected standing accretion shock instability (SASI) or oscillation modes of the newly formed proto-neutron star. Applying machine learning on combined GW- and neutrino-detector outputs from simulated CCSN can enable us a potential reconstruction of these crucial moments and parameters such as the shock radius during the explosion.

T 35.5 Tue 18:00 POT/0051

Event selection and spectrum unfolding for Supernova burst neutrinos in JUNO — •Thilo Birkenfeld, Achim Stahl, Jochen Steinmann, and Christopher Wiebusch — RWTH Aachen University

No core-collapse supernova (CC-SN) exploded close enough to be observed by terrestrial neutrino telescopes since the first detection of neutrinos from SN 1987A. The Jiangmen Underground Neutrino Observatory (JUNO) is a next-generation liquid scintillator detector with a large target mass of 20 kt. It will provide valuable insight into the details of the SN mechanism by observing the neutrino burst of a galactic CC-SN with high statistics and an unpreceded energy resolution of 3 % @ 1 MeV. JUNO will be sensitive to signals from all neutrino flavors via different detection channels. The reconstruction of their respective energy spectra requires an effective event classification. In this talk, we will present the results of an event classification and a subsequent Bayesian-based energy spectrum unfolding.

T 35.6 Tue 18:15 POT/0051

Hunting Supernova neutrinos with dark matter detectors — •Melih Kara — Karlsruhe Institute of Technology, Institute for Astroparticle Physics

During a massive star's death, 99% of its energy is released in the form of neutrinos. Neutrinos of all flavors escape the core well before any light. If detected, they can provide crucial information on stellar core collapse and its mechanisms. Detection of the next galactic supernova will provide the first multimessenger signal from electromagnetic waves, gravitational waves, and neutrinos. While existing neutrino observatories mostly probe neutrinos of a single flavor, ton-scale dark matter detectors can provide information from all flavors through coherent elastic neutrino-nucleus scattering, CEνNs, in the low-energy (few keV) range.

In this talk, we will discuss the challenges and opportunities of using two-phase xenon dark matter detectors for supernovae neutrino detection, and we will review some of the recent results and future prospects in this exciting field of research. I am also going to introduce the supernova early warning system, SNEWS, and the integration of the XENONnT experiment to SNEWS.

T 36: Gamma Astronomy II

Time: Tuesday 17:00–18:30 Location: POT/0151

T 36.1 Tue 17:00 POT/0151

Status of the Medium-Sized Telescopes of the Cherenkov Telescope Array — •Florian Leitgeb for the CTA MST-Collaboration — Deutsches Elektronen-Synchrotron DESY, Platanenallee 6, D-15738 Zeuthen, Germany

The Cherenkov Telescope Array (CTA) is the next-generation ground-based observatory for gamma-ray astronomy at very high energies. In its initial Alpha Configuration, it will consist of 64 imaging atmospheric Cherenkov telescopes of different sizes and designs, which will be deployed in the form of two large arrays in the northern hemisphere

at the Roque de Los Muchachos Observatory on La Palma (Canary Islands, Spain) and in the southern hemisphere at the Paranal Observatory in the Atacama Desert (Chile), respectively.

The core energy range (100 GeV to 10 TeV) will be covered by the Medium-Sized Telescopes (MSTs), which are planned to be deployed at both sites. An international collaboration of institutes and universities from various countries is responsible for the design, construction and commissioning of the MSTs. The MST effort is grouped into three subprojects: one for the telescope structure, and two for the Cherenkov cameras which differ in their camera design.

In this contribution, an overview of the MST telescope and the status of the MST project will be presented, including the plans for building one pre-production telescope, a so-called pathfinder, per site ahead of the bulk production.

T 36.2 Tue 17:15 POT/0151

Status of the Large-Sized Telescopes of the Cherenkov Telescope Array — •Martin Will for the CTA-Collaboration — Max-Planck-Institut für Physik, München

The Cherenkov Telescope Array (CTA), the next-generation ground based observatory for gamma-ray astronomy at very high energies, will consist of Imaging Atmospheric Cherenkov Telescopes of different sizes and designs. Two arrays are foreseen, one in the northern hemisphere at the Roque de Los Muchachos Observatory on La Palma (Canary Islands, Spain) and one in the southern hemisphere at the Paranal Observatory in the Atacama Desert (Chile).

The Large-Sized Telescope (LST) will be part of both arrays. With its reflective surface of 23 meter diameter, the LSTs are optimized to detect gamma-rays in the low energy range (20 GeV to 3 TeV). LST-1 in La Palma is close to finishing its commissioning phase and scientific data taking has started.

In this presentation, the status and plans for the LSTs in La Palma and Chile will be shown.

T 36.3 Tue 17:30 POT/0151

LST-1 observations of BL Lacertae flare in 2021 — •seiya nozaki[1], katsuaki asano[2], gabriel emery[3], juan escudero pedrosa[4], and chaitanya priyadarshi[5] for the CTA-Collaboration — [1]Max Planck Institute for Physics, Munich, Germany — [2]Institute for Cosmic Ray Research, Chiba, Japan — [3]University of Geneva - DPNC, Geneva, Switzerland — [4]Institute of Astrophysics of Andalusia - CSIC, Granada, Spain — [5]Institute for High Energy Physics, Barcelona, Spain

The Cherenkov Telescope Array (CTA) will be the next-generation very-high-energy gamma-ray observatory. Three different sizes of telescopes are planned to be built to cover a wide energy range. The Large-Sized Telescope (LST), with a 23-m diameter mirror dish, is designed to detect low-energy gamma-ray signals upwards from a few tens of GeV. This energy range plays a crucial role in the exploration of the extragalactic objects, especially transient sources. The first prototype of LST (LST-1) located at La Palma (Canary Islands, Spain) has been in a commissioning phase since 2018 and already started to observe gamma-ray sources. In 2021, LST-1 observed BL Lacertae and detected enormous gamma-ray flares with a large flux variability. In this contribution, we will report the results of LST-1 observations of BL Lacertae in 2021, including the energy spectrum down to around the energy threshold of LST-1 and sub-hour-scale fast flux variability.

T 36.4 Tue 17:45 POT/0151

Status and results of TAIGA — Michael Blank[1], Martin Brückner[3,4], Alaa Kuotb Awad[1], Razmik Mirzoyan[2], Andrea Porelli[3], •Martin Tluczykont[1], and Ralf Wischnewski[3] — [1]Institut für Experimentalphysik, Universität Hamburg, Deutschland — [2]Max Planck Institut für Physik, München, Deutschland — [3]Deutsches Elektronen Synchrotron, Zeuthen, Deutschland — [4]PSI, Zürich, Schweiz

TAIGA (Tunka Advanced Instrument for Gamma-ray and cosmic ray Astrophysics) is implementing a new, hybrid air Cherenkov observation technique to access the TeV to PeV gamma-ray regime, particularly important to spectrally resolve the cutoff regime of cosmic-ray pevatrons. The TAIGA complex consists of a distributed array of 120 wide angle (0.6 sr) air Cherenkov timing stations (TAIGA-HiSCORE) covering 1.1 square-km, three 4.2m imaging air Cherenkov telescopes (TAIGA-IACTs) with a field of view of 9.6deg, and a surface and underground scintillator-based muon detector array. For a proof-of-principle of the hybrid method, combining IACTs with a non imaging timing array, first the individual components were tested. Both the HiSCORE array and the IACTs were found to operate within expectations using simulations and comparisons to real data. Measurements of a light source onboard the international space station were used to verify the pointing of HiSCORE and IACTs. Recently, the Crab Nebula was detected using data from the first TAIGA-IACT in stand alone mode. In the beginning of March 2022, we froze the collaboration work, but the German team is continuing to work with the available data.

T 36.5 Tue 18:00 POT/0151

FACT - Ten Years of Operation — •Daniela Dorner[1], Bernd Schleicher[1], and FACT Collaboration[2] — [1]Universität Würzburg, Germany — [2]ww.fact-project.org

The First G-APD Cherenkov Telescope (FACT) started operation in October 2011. Designed for remote and automatic operation and using semiconductor photosensors, the duty cycle of the instrument is maximized and the gaps in the light curves minimized. Thanks to the unbiased observing strategy, a unique and unprecedented data sample has been collected. The physics program consists of monitoring of bright TeV blazars combined with follow-up observations of multi-wavelength and multi-messenger alerts. The presentation summarizes the lessons learned from ten years of operation and the results of this legacy data sample.

T 36.6 Tue 18:15 POT/0151

The MAGIC of VHE gamma-ray astronomy: 20 years, 200 peer-reviewed publications and beyond — •David Paneque for the MAGIC-Collaboration — Max Planck Institute fuer Physik, Muenchen, Deutschland

The MAGIC telescope system consists of two 17-m diameter mirror dish telescopes located at 2200m a.s.l. on the Canary Island of La Palma, in Spain. The year 2023 is the 20th anniversary of MAGIC, reaching the milestone of 200 peer-reviewed publications over a wide range of research areas, covering astrophysics with Galactic and extragalactic objects, dark matter searches, and studies of cosmology via the propagation of gamma rays from distant sources. MAGIC has become a world-wide leading instrument for gamma-ray astronomy in the energy range from 20 GeV to beyond 100 TeV, and an active participant in various multiwavelength and multimessenger observational campaigns. In the conference I will give a status report of this instrument, including the discussion of a few recent highlight results.

T 37: Neutrinos, Dark Matter IV

Time: Tuesday 17:00–18:30 Location: POT/0251

T 37.1 Tue 17:00 POT/0251

Characterisation of the first 166-pixel TRISTAN detector module in a MAC-E filter environment — •Christina Bruch — Technical University Munich, James-Franck-Straße 1, 85748 Garching bei München

One possible Dark Matter candidate is the keV-scale sterile neutrino, that would only interact via the mixing of sterile and active eigenstates. In a tritium beta decay spectrum, this mixing would lead to a characteristic, kink-like signature for sterile neutrinos with masses up to 18.6 keV. The KATRIN experiment will be upgraded with a novel TRISTAN multi-pixel silicon drift detector and readout system to search for this signature.

The final TRISTAN detector will consist of multiple 166 pixel detector modules. This presentation will give an overview of the first characterisation with electrons of one of this 166 pixel detector modules in the KATRIN Monitor Spectrometer, which is a KATRIN-like MAC-E filter environment.

This project has received funding from the European Research Council (ERC) under the European Union Horizon 2020 research and innovation program (grant agreement No. 852845). In addition, this work is supported by BMBF (05A17PM3, 05A17PX3, 05A17VK2, 05A17WO3), KSETA, the Max Planck society, and the Helmholtz As-

sociation.

T 37.2 Tue 17:15 POT/0251

Search for Light Sterile Neutrinos with the KATRIN Experiment — •Xaver Stribl for the KATRIN-Collaboration — Chair for Dark Matter E47, Technical University of Munich

Light sterile neutrinos with a mass on the eV-scale could explain several anomalies observed in short-baseline oscillation experiments. The Karlsruhe Tritium Neutrino (KATRIN) experiment is designed to directly determine the effective electron anti-neutrino mass by measuring the tritium beta decay spectrum. The measured spectrum can also be investigated for the signature of light sterile neutrinos.
In this talk we present the status of the light sterile neutrino analysis of the KATRIN experiment. To handle the increasing computational challenge, a neural network is adapted for the analysis and its applicability is validated. This neural network is then used on Monte Carlo data sets to study the sensitivity of the first five measurement campaigns as well as the impact of individual systematic uncertainties. The obtained sensitivity is compared to current results and anomalies in the field of light sterile neutrinos.

T 37.3 Tue 17:30 POT/0251

Penning trap induced background in the KATRIN experiment — •Florian Fraenkle for the KATRIN-Collaboration — Institute for Astroparticle Physics (IAP), Karlsruhe Institute of Technology (KIT)

The KArlsruhe TRItium Neutrino (KATRIN) experiment is a largescale experiment with the objective to determine the effective electron anti-neutrino mass with an unprecedented sensitivity of 0.2 eV/c^2 at 90% CL in a model-independent way based on precision β-decay spectroscopy of molecular tritium. KATRIN is currently in the middle of several physics measurement campaigns and so far has improved the upper bound on the effective electron-neutrino mass to 0.8 eV at a 90% confidence level.

A Penning trap located between the KATRIN spectrometers, in combination with a large flux of β-decay electrons in this area, produces a scan-step-duration-dependent background which is one of the leading systematic uncertainties of KATRIN. This background was successfully mitigated with an optimized configuration of the voltages in the KATRIN beamline and is not present anymore in recent measurement campaigns. This talk will present measurements and a background model to describe the Penning trap induced background.

This work is supported by the Helmholtz Association, the Ministry for Education and Research BMBF (05A17PM3, 05A17PX3, 05A17VK2, and 05A17WO3), the Helmholtz Alliance for Astroparticle Physics (HAP), and the Helmholtz Initiative and Networking Fund (W2/W3-118).

T 37.4 Tue 17:45 POT/0251

WISPLC: Search for Dark Matter with LC Circuit — •Zhongyue Zhang[1], Oindrila Gosh[2], and Dieter Horns[1] — [1]Institut für Experimentalphysik, Universität Hamburg, Luruper Chausseee 149, 22761 Hamburg — [2]I. Institute of Theoretical Physics, Universität Hamburg, Notkestraße 9-11, 22607 Hamburg

The focus on dark matter search has expanded to include low-mass particles such as axions or axion-like particles (ALPs). Assuming dark matter is composed of axions, in presence of a strong magnetic field, they induce a displacement current that generates a magnetic field detectable by state-of-art superconducting quantum interference devices (SQUIDs). The Weakly Interacting Slender Particle detection with LC circuit (WISPLC) is a precision direct detection experiment that will search for light dark matter candidates such as ALPs in part of the parameter space previously unexplored. The key facility is a large cryogen-free magnetic system that can produce a maximum solenoidal magnetic field of 14 Tesla at the center of the bore, inducing an axion-sourced toroidal magnetic field which can be captured by a superconducting pickup loop. We present two detection scheme: a broadband detection with up to 2 MHz bandwidth, and a resonant scheme where a LC circuit is used to enhance the signal with an expected Q factor $\sim 10^4$. Taking into account the irreducible flux noise of SQUIDs, we estimate the sensitivity of the experiment in the axion mass range between 10^{-11} eV and 10^{-6} eV to reach a detectable axion-photon coupling of $g_{a\gamma\gamma} \approx 10^{-15}$ GeV^{-1}, making it possible to probe mass ranges corresponding to ultralight axions motivated by string theory.

T 37.5 Tue 18:00 POT/0251

Towards direct neutrino mass measurement with the Project 8 experiment — •Larisa Thorne for the Project 8-Collaboration — Johannes Gutenberg University Mainz

There have been significant gains in characterizing neutrino properties in recent years, however the absolute neutrino mass scale continues to be elusive. The Project 8 collaboration seeks to probe this quantity directly via kinematic analysis of tritium beta decay, using the novel cyclotron radiation emission spectroscopy (CRES) technique with an atomic tritium source. CRES employs a frequency-based approach to measure tritium beta decay spectra in the endpoint region, where the spectral shape is most sensitive to distortions from the neutrino mass. Here we present a roadmap of Project 8 towards neutrino mass, with a design sensitivity of 40 meV. This includes recent results from our successful demonstrator experiment with tritium, as well as status updates on the components comprising the experiment's future full-scale version.

T 37.6 Tue 18:15 POT/0251

Precise Temperature Characterization of an Atomic Hydrogen Source — •Brunilda Muçogllava and Martin Fertl for the Project 8-Collaboration — Johannes Gutenberg Universität Mainz

In order to achieve a neutrino mass sensitivity of 40 meV, Project 8 aims to use the Cyclotron Radiation Emission Spectroscopy technique to analyze the tritium beta decay spectrum. To that end, a tritium atomic beam must be constructed and employed. Due to tritium's radioactive nature, initial measurements have been carried out using a Hydrogen Atom Beam Source (HABS) at the Mainz atomic test stand. The HABS produces hydrogen atoms via a 1 mm diameter tungsten capillary radiatively heated to ˜ 2300 K by a filament. Precise capillary temperature measurements with low uncertainty at this high temperature are required for accurate characterization of the source. This is particularly important to understand the dissociation efficiency from molecular into atomic hydrogen, the key performance parameter for the atomic source. In this talk, the results of several temperature measuring devices will be discussed: a thermocouple inside the HABS, an optical spectrometer operated from outside the vacuum system, and a camera looking into the interior of the capillary.

T 38: Neutrinos, Dark Matter V

Time: Tuesday 17:00–18:30 Location: POT/0361

T 38.1 Tue 17:00 POT/0361

Understanding the RF response of the MADMAX experiment — •Juan Pablo Arcila Maldonado for the MADMAX-Collaboration — Max Planck Institute for Physics/ University of Bonn

The MADMAX collaboration aims to probe the parameter space of the QCD axion around the well-motivated range of 40-400 μeV, which is out of reach for conventional cavities, using a novel technique referred to as dielectric haloscope. This concept relies on the power enhancement by constructive interference of axion-induced microwave signals from multiple dielectric boundaries. A prototype to verify the sensitivity of this approach was built, which helped to understand the underlying physics and the dependency from parameters on the axion-generated signal power. This talk presents the first results and discusses the next steps toward a possible final MADMAX setup.

T 38.2 Tue 17:15 POT/0361

Fitting the reflectivity of the MADMAX booster — •David Leppla-Weber for the MADMAX-Collaboration — Institut für Experimentalphysik, Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg — Now at Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany

The **MA**gnetized **D**isk and **M**irror **A**xion e**X**periment is a dielectric haloscope aiming to detect axions from the galactic halo by resonant conversion to photons in a strong magnetic field. It uses a stack of

dielectric disks, called booster, to amplify the axion-photon conversion probability over a significant mass range dependent on the position of the adjustable disks. In the planned prototype, depending on the axion mass, amplifications of a factor of $\sim 10^4$ can be achieved. To calibrate the system, an optimization fitting measurements to simulation is needed. The main physical quantity of the booster that can be measured is its complex reflectivity. It is shown how the simulation parameters are optimized in a way to reproduce the measured reflectivity. Previously, instead of the reflectivity, the group delay was used. The new method improves the match between simulation and measurement by one order of magnitude.

T 38.3 Tue 17:30 POT/0361

In-place optimization of a dielectric haloscope for axion dark matter detection, MADMAX — •Dominik Bergermann for the MADMAX-Collaboration — RWTH Aachen University, Physics Institute III A

The axion is a promising candidate to explain cold dark matter and the absence of CP violation in strong interaction. The **MA**gnetized **D**isc and **M**irror **A**xion e**X**periment is a planned experiment which intends to probe axion dark matter in a mass range of 40 to 400 μeV. It is a dielectric microwave haloscope utilizing the axion photon conversion, consisting of multiple, consecutive and movable dielectric discs.

Covering this range with a single experimental setup, while simultaneously being able to finetune the resonance on potential signals, necessitates repositioning the experimental hardware continuously and automatically. In simulations the parameter-space (disc positions) can be optimized to produce desired signals. Prominent optimizers are Nelder-Mead or Quasi-Newtonian algorithms.

This talk focuses on the attempt of optimizing a physical, scaled-down MADMAX-like setup in-place based on it's electrical microwave responses. Challenges are the reduced set of information, the time requirement of the motor movement and the reliability of the algorithm.

T 38.4 Tue 17:45 POT/0361

Axion-Photon Coupling Distributions for Non-Minimal DFSZ-type Axion Models — •Johannes Diehl and Emmanouil Koutsangelas — Max Planck Institute for Physics, Munich, Germany

We systematically calculate anomaly ratios and thus axion-photon couplings for non-minimal DFSZ models. This allows us to classify every model and study the resulting distributions to make predictions for axion experiments like haloscopes, helioscopes or light-shining-through-a-wall experiments. Doing so we confirm the experimental importance of the values dictated by the minimal DFSZ models, while also extending the viable axion parameter space. We map this space by introducing a theoretical prior probability distribution for DFSZ-type axions under the assumption of equally probable numbers of Higgs doublets $n_D \leq 9$ and give 68% and 95% lower bounds on the axion-photon coupling. In contrast to the minimal DFSZ models, there is a large number of non-minimal DFSZ models with domain wall number of unity, thus avoiding the domain wall problem. We find a significantly enhanced axion-photon coupling compared to the minimal DFSZ models, adding to the experimental relevance of this subset.

T 38.5 Tue 18:00 POT/0361

Search for the DSNB in JUNO: Development of new Methods for Background Event Identification — •Matthias Mayer[1], Lothar Oberauer[1], Raphael Stock[1], Hans Steiger[2], Konstantin Schweizer[1], Ulrike Fahrendholz[1], David Dörflinger[1], Simon Appel[1], Carsten Dittrich[1], Korbinian Stangler[1], Simon Csakli[1], and Florian Kübelbäck[1] — [1]Technische Universität München, München, Germany — [2]Institute of Physics and EC PRISMA$^+$, Johannes Gutenberg Universität Mainz, Mainz, Germany

The diffuse supernova neutrino background (DSNB) describes the constant flux of neutrinos from past core-collapse supernovae over the entire visible universe. The Jiangmen Underground Neutrino Observatory (JUNO), a 20 kton liquid scintillator detector, plans to detect the DSNB in the inverse beta decay (IBD) detection channel. While other electron anti-neutrino sources will cause irreducible IBD background, non-IBD backgrounds such as neutron-induced events and NC interactions of atmospheric neutrinos can be reduced by careful pulse-shape discrimination (PSD). In this talk, I compare the performance of different PSD techniques with the prospect of increasing the fiducial volume available for the DSNB search. Additionally, I discuss the influence of possible quenching of non-IBD pulseshapes on the available discrimination performance in the DSNB energy region of interest. This work is supported by the DFG research unit "JUNO", the DFG collaborative research centre 1258 "NDM", and the DFG Cluster of Excellence "Origins".

T 38.6 Tue 18:15 POT/0361

Characterisation measurements of LAPPDs for ν-detectors — •Benedict Kaiser, Lukas Bieger, Marc Breisch, Jessica Eck, Tobias Heinz, Tobias Lachenmaier, and Tobias Sterr — Universität Tübingen, Physikalisches Institut, Auf der Morgenstelle 14, 72076 Tübingen

Designed for use in future neutrino experiments, Large Area Picosecond Photodetectors (LAPPDs) are novel Microchannel Plate (MCP) based photodetectors. With a uniform gain of 10^6 to 10^7 over a large active area of more than 370 cm, an LAPPD is capable of single photon detection. It features a position resolution of better than 3 mm and an unprecedented time resolution of better than 70 ps. This performance is achieved by using a compact, evacuated glass case containing a multi-alkali photocathode, a chevron pair of MCPs for electron multiplication, and 28 individual anode strips for signal detection. Currently, we are analysing the performance of an LAPPD using a self-developed test setup. This talk will outline the working principle and characteristics of an LAPPD and the first measurement results will be discussed.

T 39: Neutrinos, Dark Matter VI

Time: Tuesday 17:00–18:30 Location: POT/0006

T 39.1 Tue 17:00 POT/0006

Constraining the $^{77(m)}$Ge Production with GERDA Data and Implications for LEGEND-1000 — •Moritz Neuberger[1], Luigi Pertoldi[1], Stefan Schönert[1], and Christoph Wiesinger[2] for the GERDA-Collaboration — [1]Physik-Department E15, Technische Universität München — [2]Physik-Department E47, Technische Universität München

The delayed decay of $^{77(m)}$Ge, produced by neutron capture on ^{76}Ge, is a potential background for the next-generation neutrinoless double-beta decay experiment LEGEND-1000 at the LNGS site. Based on Monte Carlo simulations, various mitigation strategies and suppression techniques have been proposed to identify and suppress this background [1,2,3]. In this talk, we will present the results to search for $^{77(m)}$Ge by exploiting the isomeric state in ^{77}As. Given the very similar configuration - bare germanium detectors in liquid argon - it serves as a benchmark for our LEGEND-1000 predictions. This research was supported by the BMBF through the Verbundforschung 05A20WO2 and by the DFG through the SFB1258 and Excellence Cluster ORIGINS.

[1] C. Wiesinger et al., Eur. Phys. J. C (2018) 78: 597 [2] LEGEND-1000 pCDR, arXiv 2107.11462 [3] M. Neuberger et al., 2021 J. Phys.: Conf. Ser. 2156 012216

T 39.2 Tue 17:15 POT/0006

Plans for the Muon Veto of LEGEND-1000 — •Gina Grünauer for the LEGEND-Collaboration — Physikalisches Institut, Eberhard Karls Universität Tübingen

The **L**arge **E**nriched **G**ermanium **E**xperiment for **N**eutrinoless $\beta\beta$ **D**ecay (LEGEND) is a ton-scale experimental program searching for the neutrinoless $\beta\beta$ ($0\nu\beta\beta$) decay of ^{76}Ge. LEGEND-1000 will have a total active mass of the detector of about 1000 kg, with the goal of a discovery sensitivity at half-life of more than 10^{28} years. To reach such a sensitivity, the background rate must be reduced to less than 10^{-5} cts/(keV·kg·yr). A Cherenkov Muon Veto is currently being developed for this purpose. The new Veto will further optimize the detection efficiency and the noise. The number and positions of the photomultiplier tubes (PMTs) are adapted to the requirements of the LEGEND-1000 Muon Veto.

T 39.3 Tue 17:30 POT/0006

ASIC-based front-end electronics for LEGEND-1000 — •Florian Henkes, Michael Willers, and Susanne Mertens for the LEGEND-Collaboration — Physik-Department, E47, Technische Universität, München, Germany

The **L**arge **E**nriched **G**ermanium **E**xperiment for **N**eutrinoless $\beta\beta$ **D**ecay (LEGEND) is a ton-scale, ^{76}Ge-based, neutrinoless double-beta ($0\nu\beta\beta$) decay experimental program with discovery potential at half-lifes greater than 10^{28} years.

Low-background and low-noise signal readout electronics in close vicinity to the HPGe-detectors are crucial in order to achieve the experiment's sensitivity on $0\nu\beta\beta$-decay. The close proximity to the detectors poses unique challenges to balance electronic performance with radiopurity requirements. In LEGEND-1000, the use of **A**pplication-**S**pecific **I**ntegrated **C**ircuit (ASIC) technology would allow to implement the entire charge sensitive amplifier into a single low-mass chip with ultimate electronic noise performance and signal fidelity while ideally further reducing backgrounds.

In this contribution, the current status of the LEGEND-1000 ASIC based readout development will be presented. It will focus on the design challenges of the CSA implementation and present first results of simulations and measurements of the chip.

T 39.4 Tue 17:45 POT/0006

Double weak decays of ^{124}Xe and ^{136}Xe in XENON1T and XENONnT — •Christian Wittweg for the XENON-Collaboration — Physik-Institut, Universität Zürich

The current generation of xenon-based dark matter direct detection experiments has reached large enough target masses and low enough background levels to probe rare double weak decays. Among these decays are the two-neutrino double electron capture (2νECEC) of ^{124}Xe as well as the neutrinoless double beta decay ($0\nu\beta\beta$) of ^{136}Xe. Observation of the hypothetical neutrinoless decay would provide definite proof of the neutrino's Majorana nature and indicate lepton number violation. The measurement of the Standard Model 2νECEC – first detected by XENON1T in 2018 – provides nuclear structure information that is a crucial input for the nuclear models used to interpret $0\nu\beta\beta$ experiments. This contribution will present the ^{124}Xe 2νECEC results and search for $0\nu\beta\beta$ of ^{136}Xe in XENON1T. Moreover, the sensitivity projection for a ^{136}Xe $0\nu\beta\beta$ search in XENONnT will be outlined.

T 39.5 Tue 18:00 POT/0006

Fast track simulations in XENONnT — •Jaron Grigat for the XENON-Collaboration — Albert-Ludwigs-Universität, Freiburg, Deutschland

We present the work on a fast, effective simulator for the XENONnT dark matter experiment, which bypasses the sophisticated - but resource-intensive - full simulation of waveforms, while remaining as accurate as possible. This talk focuses on the aspect of predicting the multi-scatter resolution in this 'fast track' simulation framework using machine learning techniques.

T 39.6 Tue 18:15 POT/0006

Light signal correction for the XENONnT experiment — •Johanna Jakob for the XENON-Collaboration — Institut für Kernphysik, WWU Münster

XENONnT, the latest stage of the XENON dark matter project, is currently taking science data with the science goals to detect WIMP-nucleus scattering and to search for other rare events. The detector is a dual-phase time projection chamber (TPC) filled with 8.5 tonnes of liquid xenon. The detector side walls reflect the scintillation light caused by energy deposition in the detector, which is registered at the top and bottom by photomultiplier arrays. Free electrons, additionally created by the energy deposition, are drifted to the gaseous phase at the top of the detector where they create a secondary scintillation light pulse by electroluminescence. The combination of light and charge signal allows for a 3-dimensional position reconstruction of the recorded events and a differentiation between electron and nuclear recoil events. This talk focuses on the light signal reconstruction, which requires a correction of the position dependent light collection efficiency. Based on calibration data from internal radioactive sources, light collection efficiency maps are derived and applied to the light signals.

This work is supported by BMBF under contract 05A20PM1 und by DFG within the Research Training Group GRK 2149.

T 40: Astro Particle Theory

Time: Tuesday 17:00–18:00 Location: POT/0112

T 40.1 Tue 17:00 POT/0112

Inferring the properties of the Solar magnetic field via the temporal evolution of Sun shadow and the produced secondaries — •Alex Kääpä — Ruhr-Universitaet Bochum D-44780 BOCHUM

The Sun shadow of cosmic rays (CRs) constitutes an unlikely intersection between Solar and CR physics. Previous work based on Monte-Carlo-based propagation studies has shown that properties of the Solar magnetic field (SMF) can be inferred from the temporal evolution of the size of the shadow. One main observation is the tempral correlation with the 11-year Solar cycle. During low activity, the SMF can be described as a dipole, whereas the structure of the field becomes exceedingly complex during high activity.

In this talk, we discuss follow-up and expansive simulation studies, based on these previous findings. Particular focus is put on the production of secondaries, i.e. photons and neutrinos. Our aim is to constrain the properties of the SMF during high activity and confirm or improve upon the dipolar description during low activity. We further discuss the prospects of experimentally testing said studies.

T 40.2 Tue 17:15 POT/0112

The radial field in the axion kinetic misalignment mechanisms — •Vera Butz — Institut für Astroteilchenphysik, Karlsruher Institut für Technologie (KIT), Germany

The axion kinetic misalignment mechanism introduces an initial velocity for the phase of a complex scalar field thereby creating axion dark matter with a lower decay constant. The introduction of a velocity in angular direction however gives rise to the question of what would happen if we also introduced a velocity in radial direction and allowed the radial field to change its value away from the PQ symmetry breaking scale f_a. In this work we study the behaviour of the radial field by solving the coupled equations of motion for the radial and angular fields at different times. We allow the radial field to decay into Standard Model particles, which damps the velocity in radial direction.

T 40.3 Tue 17:30 POT/0112

Neutrino fluxes from Z'-mediated Dark Matter annihilation in the Sun — •Miriam Neumann[1], Amin Aboubrahim[2], Luca Wiggering[2], Michael Klasen[2], and Alexander Kappes[1] — [1]Institut für Kernphysik, Westfälische Wilhelms-Universität Münster, Germany — [2]Institut für Theoretische Physik, Westfälische Wilhelms-Universität Münster, Germany

While there is various experimental evidence for the existence of dark matter (DM), its nature remains unclear. If DM scatters from conventional matter, it can be gravitationally captured in the Sun, leading to a local overdensity and enhanced annihilation of DM into Standard Model particles. When the unstable particles from this interaction decay further this leads to a neutrino flux that can be searched for with the IceCube neutrino observatory. Thus, IceCube can be used for an indirect DM search, complementing direct DM searches. To describe the DM and its interactions, we use a minimal model that extends the Standard Model by only a few fields. We specifically investigate a Z'-mediated leptophobic model featuring Majorana DM. Due to the Majorana character, the DM nucleon scattering is completely spin-dependent, making this model particularly interesting for the search of neutrinos from the Sun with IceCube. We perform a scan of the model parameter space taking into account the recent constraints from DM direct and indirect detection experiments as well as LHC searches of a heavy Z' resonance. In this talk, we present some first results showing the parts of the parameter space that have evaded all constraints to date and can potentially be probed by IceCube.

T 40.4 Tue 17:45 POT/0112

Looking for massive ALPs from SN1987A with Cherenkov detectors — •Tim Kretz — KIT TTP, Karlsruhe, Deutschland

In this talk I will discuss the production of massive axion-like-particles (ALP) via nucleon Bremsstrahlung in supernova 1987A, and review the resulting exclusion limits for the nucleon-nucleon-ALP coupling in the large coupling regime. Following an earlier suggestion by Engel et al. for QCD axions, such ALPs may be absorbed by oxygen nuclei and lead to photon signals in the MeV regime induced by de-excitation. For massive ALPS the flux at Earth is essentially mono-energetic, due to the long time of flight from SN1987A that stretches out their spectral distribution. This allows to estimate the number of detectable events in water Cherenkov detectors like Super-Kamiokande or SNO+, which I will use to derive novel exclusion limits and motivate new dedicated searches for this signal.

T 41: Cosmic Ray II

Time: Tuesday 17:00–18:30 Location: POT/0013

T 41.1 Tue 17:00 POT/0013

Determination of the Energy Spectrum of UHECRs using Air Showers Detected by the Fluorescence and Surface Detector of the Pierre Auger Observatory — •Kathrin Bismark for the Pierre Auger-Collaboration — Karlsruher Institut für Technologie (KIT)

The origin, propagation and mass composition of ultrahigh-energy cosmic-rays (UHECRs) are still open questions. A precise measurement of the spectral features of the UHECR energy spectrum provides important clues to answer these questions.

In this contribution, we present an analysis of air shower data using a hybrid technique, i.e. the combination of surface (SD) and fluorescence detector (FD) measurements from the Pierre Auger Observatory. The high statistics of hybrid data available after more than 15 years of UHECR observations enable us to evaluate environmental influences on detection capabilities as well as to optimize selection criteria using measured rather than simulated data. We will show how previous estimates of the hybrid spectrum can be improved and present a preliminary calorimetric measurement of the energy spectrum of UHECRs.

T 41.2 Tue 17:15 POT/0013

Depth of Maximum of Air-Shower Profiles at the Pierre Auger Observatory — •Thomas Thomas for the Pierre Auger-Collaboration — Karlsruhe Institute of Technology, Institute for Astroparticle Physics, Karlsruhe, Germany

The Pierre Auger Observatory is the largest ultra-high energy cosmic ray observatory in the world. Using a hybrid technique (fluorescence telescopes and surface detectors) it is possible to estimate the mass composition of cosmic rays. The main mass-sensitive observable measured with fluorescence telescopes is the depth of maximum of air-shower profiles called $X_{\max}$.

In this presentation, we will present the analysis of the most recent datasets for the standard eyes and also for the low energy measurements performed with the High Elevation Auger Telescope (HEAT). This low energy measurements allow to study the energy region where the transition between Galactic and extragalactic cosmic rays is expected.

T 41.3 Tue 17:30 POT/0013

A machine learning approach to mass composition studies of ultra-high energy cosmic rays with the AugerPrime upgrade of the Pierre Auger Observatory. — •Akash Parmar, Paulo Ferreira, and Thomas Hebbeker — RWTH Aachen University, Aachen, Germany

The Pierre Auger Observatory is the world's largest experiment to observe the extensive air showers produced by ultra-high energy cosmic rays. The observatory uses a hybrid detection method that combines 1600 ground-based water Cherenkov detectors covering an area of more than 3000 km^2 and 27 fluorescence detectors at four sites. The efficiency and measurement techniques of the Pierre Auger observatory are improved by the ongoing upgrade called AugerPrime. A part of the upgrade consists of deploying a scintillator detector on top of each water Cherenkov detector which provides additional information about the composition of the extensive air showers.

Currently, the understanding of cosmic rays at ultra-high energy is limited by low incoming flux and the available theoretical models for hadronic interactions. Precise measurement of the composition can help us understand the sources of cosmic rays and improve the current models.

The additional information provided by the combination of water Cherenkov detectors and scintillator surface detectors has been explored with a machine learning algorithm called random forest, to analyze the measurable properties of the shower and infer the mass composition of the primary particle.

T 41.4 Tue 17:45 POT/0013

Inferring Properties of Ultra-High-Energy Cosmic Ray Sources from Surface Detector Data of the Pierre Auger Observatory — Teresa Bister, Martin Erdmann, Merlin Klein, •Frederik Krieger, and Josina Schulte — III. Physikalisches Institut A, RWTH Aachen University

With the Pierre Auger Observatory, the energy spectrum and the distributions of the depths of the shower maximum $X_{\max}$ of ultra-high-energy cosmic rays (UHECRs) can be measured. The latter is correlated to the mass of the primary cosmic ray and can be directly measured by the fluorescence detector (FD). Using deep learning, $X_{\max}$ can also be extracted from the surface detector (SD) data which has the benefit of high event statistics. With these observables, characteristics of the sources of UHECRs can be inferred. Owing to the stochastic nature of interactions during propagation, simple inversion of the process from source to Earth is not possible. To this end, different inference methods can be used.

We present and compare two different inference methods and apply them to actual astrophysical scenarios: the Markov Chain Monte Carlo (MCMC) method and conditional invertible neural networks (cINNs). It has already been shown that cINNs perform similarly well to the frequently used MCMC method. We show the results of both methods on SD data of $X_{\max}$ and the energy spectrum.

T 41.5 Tue 18:00 POT/0013

Studying the properties of bursting UHECR sources in a multi-messenger approach* — •Leonel Morejon — Bergische Universität Wuppertal, Gaußstr. 20, 42119 Wuppertal

The study of Ultra-High Energy Cosmic Rays (UHECRs) via the multi-messenger approach is reaching a level that requires going beyond steady state sources. The exploration of bursting sources and the implications for multi-messenger detection is the goal of the French-German research project MICRO. Meeting this challenge requires improvements of the existing tools and defining new methods to accelerate the computations related to the propagation of UHECRs in extragalactic space and within the sources. The progress of MICRO in these aspects will be presented by discussing: a) a module to compute hadronic interactions within CRPropa, b) tools to fit the UHECR spectrum and composition with precomputed propagation tensors and corresponding propagation matrices, and c) the estimation of the impact that uncertainties of the latest models of Extragalactic Background Light (EBL) have on the precision in UHECR propagation.

** Supported by the DFG through project number 445990517.*

T 41.6 Tue 18:15 POT/0013

Numerical investigation of bursting sources as potential accelerators of ultra-high-energy cosmic rays — •Leander Schlegel[1,2], Julia Becker Tjus[1,2], and Marcel Schroller[1,2] — [1]Theoretische Physik IV, Ruhr Universität Bochum, Bochum, Germany — [2]RAPP-Center at Ruhr Universität Bochum, Bochum, Germany

Since their discovery over a century ago, the origin of cosmic rays of the highest energies is still widely uncertain. While the observed constant flux suggests at first sight to analyze primarily steady state source models, the needed magnetic luminosities for potential sources seem to favor bursting sources, that appear in quiescent and flaring states, like the class of Active Galactic Nuclei (AGN). The goal of

this work is trying to understand the detailed behaviour of bursting sources and their possible contribution to the UHECR flux, by simulating the time resolved propagation of a plasma blob inside the jet of an AGN and accounting for a temporal variability of the source. For this purpose, a tool for cosmic-ray propagation in relativistic plasmoids of AGN jets implemented into the open-source code CRPropa 3.1, is further improved. With this framework, we will predict the multimessenger signatures of flaring sources that are active for certain intervals in time, representing a flaring behaviour. With this investigation we aim to help providing a numerical AGN model, that can finally be tested against other source models by fitting to observed UHECR data.

T 42: Exp. Methods, IceAct, Auger, RNO-G

Time: Tuesday 17:00–18:30 Location: POT/0351

T 42.1 Tue 17:00 POT/0351

Construction of IceAct Telescopes — •Lea Schlickmann[1], Thomas Bretz[2], Lars Heuermann[1], Andreas Nöll[1], Merlin Schaufel[1], and Christopher Wiebusch[1] for the IceCube-Collaboration — [1]III. Physikalisches Institut B, RWTH Aachen University — [2]GSI Helmholtzzentrum für Schwerionenforschung

IceAct is an array of Imaging Air Cherenkov Telescopes at the ice surface as part of the IceCube Neutrino Observatory. Each telescope features a 55cm diameter Fresnel lens and a camera with 61 Silicon Photomultiplier pixels resulting in a 12° field of view. The design is optimized for harsh environmental conditions, as in Antarctica. Since 2019, the first two telescopes are operating at the South Pole in a stereoscopic configuration. Seven telescopes can be combined in a fly's eye configuration, forming a so-called station which has a field of view of 36°. In the future, for IceCube-Gen2, an array of four stations is planned. The commissioning of a first full station is scheduled for the next years within the current surface upgrade. For this, six telescopes are being constructed. This talk will report on the construction and calibration of these telescopes.

T 42.2 Tue 17:15 POT/0351

Characterization and Optimization of the Readout Electronics for IceAct Telescopes — •Andreas Nöll[1], Thomas Bretz[2], Lars Heuermann[1], Merlin Schaufel[1], Lea Schlickmann[1], and Christopher Wiebusch[1] for the IceCube-Collaboration — [1]III. Physikalisches Institut B, RWTH Aachen University — [2]GSI Helmholtzzentrum für Schwerionenforschung

IceAct is an Imaging Air Cherenkov Telescope array located at the South Pole as part of the IceCube Neutrino Observatory. The telescopes feature a 61 pixel camera based on Silicon Photomultipliers (SiPM). The camera signals are processed and digitized by the TARGET module, developed for the Cherenkov Telescope Array (CTA). The inherent high rate of ambient photons caused e.g. by stars, the Moon, and auroras combined with the high decay time of the SiPM signal results in a signal pile-up. The TARGET system provides an analog front-end for pulse shaping combined with a high sampling rate of 1GSa/s to accommodate the pile-up. Extensive tests are necessary to understand the complete signal chain from the SiPM to digitization. In this talk a characterization of the current system is presented. In addition design improvements, based on electronics simulations and tests with prototypes, will be proposed.

T 42.3 Tue 17:30 POT/0351

Three Years Performance of IceAct — •Lars Heuermann[1], Thomas Bretz[2], Oliver Janik[1], Silvia Latseva[1], Andreas Nöll[1], Merlin Schaufel[1], Lea Schlickmann[1], and Christopher Wiebusch[1] — [1]RWTH Aachen University - Physics Institute III B, Aachen, Germany — [2]GSI Helmholtzzentrum für Schwerionenforschung

IceAct is an array of Imaging Air Cherenkov Telescopes at the ice surface as part of the IceCube Neutrino Observatory. The telescopes, featuring a camera of 61 Silicon Photomultipliers and a fresnel lens based optic, are optimised to be operated in harsh environmental conditions, such as the South Pole. Since 2019, the first two telescopes operate in a stereoscopic configuration in the centre of IceCube's surface detector IceTop. The telescopes enable improved cosmic ray studies and cross calibrations of IceCube and IceTop by a hybrid measurement of air showers. This talk will review the performance and detector operations of the past 3 years of the telescopes as well as give an outlook for the future of IceAct.

T 42.4 Tue 17:45 POT/0351

A new network of electric field mills at the Pierre Auger Observatory — •Max Büsken for the Pierre Auger-Collaboration — Institute for Experimental Particle Physics, Karlsruhe Institute of Technology (KIT) — Instituto de Tecnologías en Detección y Astropartículas, Universidad Nacional de San Martín (UNSAM)

The Pierre Auger Observatory is the largest ground-based instrument for the detection of ultra-high energy cosmic rays via extensive air showers. As part of the current detector upgrade, called AugerPrime, the new Radio Detector (RD) is being deployed, which will finally consist of 1661 radio antennas covering an area of more than 3000 km^2. A crucial ingredient for the interpretation of data taken with the RD is monitoring the atmospheric electric field over the observatory. Large atmospheric electric fields, typically in the presence of thunderstorms, can significantly alter the radio emission from air showers. Therefore, these kinds of conditions have to be flagged.

We present a new network of five electric field mills (EFM) that was installed at the Pierre Auger Observatory to tackle this task. The network is designed such that each EFM measures the electric field with an absolute calibration. The setup of the network and the deployment process are shown. First data are presented.

T 42.5 Tue 18:00 POT/0351

Nanosecond time synchronization of distributed detectors — •Yan Seyffert and Tim Huege — Karlsruhe Institute of Technology (KIT), Institute for Experimental Particle Physics, Karlsruhe, Germany

At the Pierre Auger Observatory, the surface detectors used to detect and measure cosmic-ray air showers are placed in a triangular ground pattern with a 1500 m spacing, covering a total area of about 3000 km^2. Time synchronization of such distributed detectors to very high accuracy on the nanosecond scale is challenging. Currently, ordinary GPS receivers are used, which simply and independently report the GPS-time/UTC-time at their current position. Achieving 1 ns relative time accuracy between detectors would prove very useful, for example in the context of the measurement of radio emissions from extensive air showers. Accurate timing information of an event recorded by an array of radio antennas would enable intriguing possibilities for radio-interferometric analyses of cosmic-ray air showers.

This talk will report on recent findings regarding wirelessly communicating GPS modules with currently non-standard capabilities, promising 3 cm accurate relative positioning and thus potentially 1 ns relative timing accuracy.

T 42.6 Tue 18:15 POT/0351

Study of the antenna response for the Radio Neutrino Observatory Greenland (RNO-G) — •Anna Eimer for the RNO-G-Collaboration — Erlangen Centre for Astroparticle Physics (ECAP), Erwin-Rommel-Str. 1, D-91058 Erlangen

Ultra high energy neutrinos can be detected via radio emission following a neutrino interaction in ice. The long attenuation length of radio signals in ice allows for a much sparser instrumentation than required for optical Cherenkov neutrino telescopes, hence making it possible to survey large volumes. The Radio Neutrino Observatory Greenland (RNO-G) is a project that will eventually consist of 35 stations (7 already deployed) with distances of about 1.25 km between neighbouring stations. Each station consists of 9 log-periodic dipole array (LPDA) antennas about 1.5 m below the ice surface and with up to 100 m deep in-ice strings, equipped with vertically and horizontally polarized dipole antennas.

Understanding the antenna properties and potential interferences between nearby antennas is important to operate the experiment to evaluate the recorded data and reconstruct neutrino properties. In this contribution, first results of lab studies with the RNO-G antennas with emphasis on interferences will be presented.

T 43: Electronics, DAQ, Exp. Methods

Time: Tuesday 17:00–18:30 Location: POT/0106

T 43.1 Tue 17:00 POT/0106

Turning an FPGA into a fast multi-channel ADC — •Dmitry Eliseev, Thomas Hebbeker, Markus Merschmeyer, Carsten Presser, and Erik Ehlert — III. Physikalisches Institut A, RWTH Aachen University, Germany

Electronics for particle detectors nowadays typically deal with a huge number of channels. In a typical detector read-out electronics, the front-end signals are passed through a multi-channel conditioning circuit and meet an FPGA chip at the other end. Modern FPGAs enable good time resolution for such multi-channel acquisition. However, the common solution remains to acquire information on the energy or amplitude of particular events using high-speed multi-channel ADCs. Using ADCs often results in more complex schematics and much higher costs of the electronics for signal acquisition. The presented method makes it possible to waive the ADCs and, to some extent, replace the ADC's functionality with FPGA's internal resources. The method requires a minimal number of additional low-cost external components and can be potentially interesting for many detector applications.

The talk provides a general overview of how to turn a commercially available FPGA device into a multi-channel high-speed ADC. Characterization measurements and calibration methods for the resulting FPGA-based ADC are also given. Possible technical difficulties and ways to overcome them are discussed in an example application: an 8-channel mezzanine PCB for signal acquisition from multiple SiPMs.

T 43.2 Tue 17:15 POT/0106

A Software-Scalable ADC in 28nm CMOS for Detector Readout — •Lukas Krystofiak — Forschungszentrum Jülich

Particle detector experiments rely more and more on advanced integrated circuits to achieve new discoveries. Their development is a lengthy and costly process, that poses a high threat to the overall success of a project. Using a pre-developed software-scalable ADC, adjustable in resolution and sample rate and ultimately in power consumption, catering to many different areas of applications, can decrease this risk substantially. While a generic approach will never reach the same performance as a dedicated development, it facilitates rapid prototyping and verification of readout methods prior to the building of the complete systems without the need to develop a dedicated chip. It also opens up possibilities for projects with smaller budgets. The key driver for this concept is the use of a bulk CMOS 28nm process technology, which allows incorporation of a powerful digital signal processor while analog performance and design is not too restricted. Here, the first iteration of a software-scalable ADC is shown. It features a high-precison mode with 11 Bit resolution and a maximum sample rate of 400 Megasample per second, and a low-power mode with 8 Bit resolution and 800 Megasample per second.

T 43.3 Tue 17:30 POT/0106

High-rate On-Board Drift Tube electronics testing — •Matej Repik, Dmitry Eliseev, Thomas Hebbeker, and Markus Merschmeyer — III. Physikalisches Institut A, Aachen, Germany

A general-purpose detector at the Large Hadron Collider (LHC), the Compact Muon Solenoid (CMS), undergoes changes that are summed up under the Phase 2 Upgrade. As one of the CMS muon-detecting subsystems, the drift tube chambers (DT) also require an upgrade. Among others, the plans foresee new On-Board Drift Tube (OBDT) electronics to replace the previous electronics. OBDTs congregate front-end signals from the DT chambers and stream the acquired data to the CMS back-end. Each OBDT also implements certain slow control routines. As for every complex device, quality assurance is essential for the new OBDT electronics. Consequently, a test system for OBDT is being developed by the DT collaboration with the following requirements: emulate drift tube front-end signals at the expected high hit rates and record the response of OBDT. This talk focuses on the aforementioned test system and its implementation at RWTH Aachen University.

T 43.4 Tue 17:45 POT/0106

Absolute luminosity calibration through van der Meer scans in ATLAS — •Cédrine Hügli for the ATLAS-Collaboration — DESY Zeuthen

Luminosity is a very important quantity for many physics analyses. Its precise knowledge is required for example in cross section measurements. In ATLAS, luminosity is measured by several detectors: the main luminometer is LUCID, located in the forward region and based on Cherenkov radiation. All luminosity detectors need to be absolutely calibrated through so-called van der Meer scans. These are scans where the two beams are scanned through each other, first in the horizontal and then in the vertical plane. In this work, the preliminary analysis of the run 3 13.6 TeV van der Meer scan from 2022 is presented. The analysis precisely measures the part of the inelastic proton-proton interaction cross section visible in the luminosity detectors, which is the absolute luminosity calibration constant. Its value is obtained by fitting the scan curves. During the van der Meer scan analysis several effects need to be corrected to get a precise calibration constant, for example the impact of the electromagnetic interaction of the beams on their separation. The obtained absolute calibration of luminosity is then transferred to physics conditions and used in the early run 3 ATLAS measurements.

T 43.5 Tue 18:00 POT/0106

Emittance Scans at the LHCb Detector in Run 3 — Johannes Albrecht, Elena Dall'Occo, Hans Dembinski, and •Jan Ellbracht — TU Dortmund University, Dortmund, Germany

Precise determination of the luminosity at the LHCb detector is needed for accurate measurements of cross-sections as well as in daily operations. The instantaneous luminosity at LHCb is levelled throughout the fill to optimise the detector performance, which is achieved by tuning the distance between the two colliding beams based on a real-time measurement of the luminosity. The luminosity calibration is performed once per year and per centre-of-mass energy in dedicated van-der-Meer scans. Here, particular beam conditions are used, leading to a maximum number of visible proton-proton interactions $\mu \sim 1$ when the beams are colliding head-on.

In Run 3 the LHCb detector operates at a five times higher instantaneous luminosity compared to the previous runs, with a μ of about 5.5. Therefore, it is planned to perform additional per-fill emittance scans in order to verify linearity from calibration to data taking conditions. This talk will focus on the emittance scan analysis, procedure and first results of Run 3 data.

Supported by DFG (SFB 1491)

T 43.6 Tue 18:15 POT/0106

Estimation of the van-der-Meer factorization bias using the Beam Imaging Method — •Konstantin Sharko and Andreas Meyer — Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany

At the CMS Experiment at the LHC, van-der-Meer (vdM) scans are used to calibrate the luminosity measurement. The beam imaging (BI) data, a special type of vdM-scan data, are used to estimate and correct biases coming from the assumption of transverse factorization of the proton-bunch densities. In BI scans one of the beams is kept at rest while the other one moves along the x- or y-axis.

In this analysis, the four scans, one for each of the two transverse orientations and two beams, are fit using combinations of Gaussian functions to extract the van-der-Meer factorization bias for LHC Run-2 and Run-3 data.

T 44: Pixel/LHCb, Si-Strips/CMS

Time: Tuesday 17:00–18:30 Location: WIL/A317

T 44.1 Tue 17:00 WIL/A317

LHCb MightyPix - First measurements and ongoing developments — •Hannah Schmitz, Can-Deniz Arslan, Klaas Padeken, Niclas Sommerfeld, and Sebastian Neubert — Rheinische Friedrich-Wilhelms Universität Bonn

With the upgrade of the LHC to the HL-LHC in LS4, the instantaneous luminosity at the LHCb detector will be increased from $2 \times 10^{33}\text{cm}^{-2}\text{s}^{-1}$ to $1.5 \times 10^{34}\text{cm}^{-2}\text{s}^{-1}$. In order to enable fast and precise tracking in this environment, it is planned to upgrade the entire LHCb tracking system. The downstream tracking system, known as the Mighty Tracker, has to withstand the increased radiation and occupancy at a similar or lower material budget than the current detector. Thus, a hybrid solution consisting of silicon pixels, called MightyPix, with a size of 55x165μm in the inner and scintillating fibres in the outer region is under development. In order to fulfill the conditions beyond Run4, the pixels are based on the technology of HV-CMOS MAPS.
To characterize the MightyPix, a new readout system is currently developed in Bonn. Further, first characterization studies are ongoing and development chips as the ATLASPix3.1 have been characterized at testbeams.
This presentation covers an introduction into the newly developed readout system for the MightyPix, latest testbeam results and an overview of the current developments regarding the Mighty Tracker with focus on the MightyPix.

T 44.2 Tue 17:15 WIL/A317

Characterization of HV-CMOS sensors for the Mighty Tracker at LHCb — •Can-Deniz Arslan, Klaas Padeken, Hannah Schmitz, Niclas Sommerfeld, and Sebastian Neubert — Helmholtz-Institut für Strahlen- und Kernphysik, Bonn, Germany

From Run 5 of the HL-LHC onwards the LHCb detector expects an instantaneous luminosity of $1.5 \cdot 10^{-34}\text{cm}^{-2}\text{s}^{-1}$.
The upgraded downstream tracker will be called the Mighty Tracker and it will be equipped with HV-CMOS sensors around the beamline and scintillating fibres in the outer regions. A development version of the MightyPix is currently characterized. For this purpose a newly developed readout system is used and commissioned.
A first characterization of the development chip will be shown. The status of further plans including an irradiation campaign at the isochronous cyclotron in Bonn will be reported.

T 44.3 Tue 17:30 WIL/A317

Development of a setup to measure the timing resolution of the upcoming Mighty Tracker — •Niclas Sommerfeld, Can-Deniz Arslan, Klaas Padeken, Hannah Schmitz, and Sebastian Neubert — Helmholtz-Institut für Strahlen- und Kernphysik Bonn

With the upgrade during LS4, the instantaneous luminosity at the LHCb experiment will increase by almost one order of magnitude to $1.5 \times 10^{34}\,\text{cm}^{-2}\text{s}^{-1}$. With this increased data rate the untriggered readout of the LHCb detector provides changeless for the tracking detectors. The downsteam tracker (Mighty Tracker) will be instrumented with HV-CMOS pixel sensors in the central part. To assign each hit to the correct bunchcrossing, a timing resolution of 3 ns is needed to contain 3 sigma of the hits in a 25 ns window.

To measure the timing resolution of the MightyPix in the lab, a timing setup is required. This ongoing development of a generalized timing layer will be presented within this talk. The setup will consist of fast plastic scintillators with SIPM readouts and configurable, standardized outputs. The modular design allows to use this setup in a variety of applications.

T 44.4 Tue 17:45 WIL/A317

High rate measurements of HV-MAPS for a future main tracker — Sebastian Bachmann, •Lucas Dittmann, Maja Lecher, and Ulrich Uwer — Physikalisches Institut, Heidelberg, Germany

The LHCb experiment plans to upgrade its detector during the long shutdown 4 of the LHC to cope with a further luminosity increase at LHCb's interaction point during Run 5. For this upgrade, the currently installed scintillating fiber tracker will be replaced by the MightyTracker. The MightyTracker consists of an inner part made from silicon pixels sensors and an outer part made from scintillating fibers.

For the silicon sensor part of the MightyTracker, dedicated High-Voltage Monolithic Active Pixels Sensors (HV-MAPS), which are called MightyPix, are proposed. HV-MAPS are produced in commercial High-Voltage CMOS technology, which allows the design of low cost, thin and radiation hard sensors.

The MightyPix sensors in the hottest regions of the MightyTracker will experience a mean particle rate of 125 kHz/mm^2. To determine possible hit rate limitations of existing HV-MAPS experimentally, rate measurements with ATLASPix3.1 sensors have been performed. The results are compared to theoretical expectations. The ATLASPix3.1 sensor is used as a proxy for the MightyPix sensor, since the pixel readout of both sensors will be structured similarly.

T 44.5 Tue 18:00 WIL/A317

Series Production of 2S Modules for the Phase-2 Upgrade of the CMS Detector in Aachen — Max Beckers[1], Christian Dziwok[1], Lutz Feld[2], Katja Klein[2], Martin Lipinski[2], Vanessa Oppenländer[2], Alexander Pauls[2], Oliver Pooth[1], Nicolas Röwert[2], Felix Thurn[2], and •Tim Ziemons[1] — [1]III. Physikalisches Institut B, RWTH Aachen University — [2]I. Physikalisches Institut B, RWTH Aachen University, D-52056 Aachen

The CMS detector will be upgraded in the Phase-2 Upgrade for the operation at the HL-LHC. Among others, the silicon tracking system will be completely replaced by a new system providing an extended acceptance, an improved granularity and the feature to include tracking information into the first level hardware trigger. The new Outer Tracker will consist of 2S modules with two strip sensors and PS modules with a macro-pixel sensor and a strip sensor, specialized detector modules with onboard p_T discrimination.

Up to 1000 2S modules will be assembled and tested at RWTH Aachen University. In this talk, the module assembly process is summarized and the preparation of the series production is presented.

T 44.6 Tue 18:15 WIL/A317

Development of a database and web applications for the production of CMS 2S modules — •Max Beckers[2], Christian Dziwok[2], Lutz Feld[1], Katja Klein[1], Alexander Pauls[1], Oliver Pooth[2], Nicolas Röwert[1], Martin Lipinski[1], Vanessa Oppenländer[1], Felix Thurn[1], and Tim Ziemons[2] — [1]I. Physikalisches Institut B, RWTH Aachen University, D-52056 Aachen — [2]III. Physikalisches Institut B, RWTH Aachen University

For the CMS Phase-2 Outer Tracker upgrade, new silicon strip detector modules consisting of two silicon strip sensors, so-called 2S modules, are developed and produced. This process is distributed along multiple assembly centers worldwide. To ensure consistent module quality, many specifications need to be respected. This includes different kinds of tests and measurement results.

RWTH Aachen University will build around 1000 2S modules. The production requires well-organized procedures. To guarantee the transparency and traceability of the production conditions and module quality many data are recorded and analyzed.

This talk presents how production and testing are organized in Aachen with a focus on the processing of the acquired data during module assembly. This includes multiple web applications based on a central database. This database is compatible with the central CMS construction database. Exemplary measurements are shown.

T 45: Si-Strips, Pixel

Time: Tuesday 17:00–18:30 Location: WIL/A124

T 45.1 Tue 17:00 WIL/A124

Strip sensor characterization for the ATLAS ITk tracker — •Elizaveta Sitnikova — DESY, Hamburg, Germany

Before the start of High Luminosity LHC the Inner Detector of the ATLAS detector will reach the end of its operating life. It will be replaced by a new Inner Tracker (ITk), more suitable for high luminosity. Building the ITk requires a lot of effort from many institutes in the collaboration, and DESY is one of the main contributing institutes. One of the two strip ITk endcaps will be assembled at DESY. During production, the main sensing units of the tracker, the silicon microstrip sensors, have to pass a number of tests to ensure that they are suitable for becoming part of the detector. One of these tests is measuring the IV sensor characteristic. In this talk the importance and the procedure of measuring strip sensor IV curves at DESY Hamburg will be discussed, as well as a detailed study of whether the number of required IV testing can be reduced, done using high statistics provided by the current data stored in the ITk production database.

T 45.2 Tue 17:15 WIL/A124

Producing high quality and long-lasting modules for the ATLAS ITk strip detector — •Ben Brüers — Deutsches Elektronen-Synchrotron DESY, Zeuthen, Germany

For the high luminosity phase of the LHC, the ATLAS collaboration plans to upgrade its current tracking detector with a new, all silicon pixel and strip detector, referred to as Inner Tracker (ITk). Core components of the ITk strip detector are modules that consist of sensors and printed circuit flex boards carrying the read-out and powering chips. To ensure reliable operation of the ITk strip detector, all module components are extensively tested and characterised before module building. After and during module assembly, the quality of the modules is additionally assessed to verify that they fulfil the high standards determined to lead to the required quality by the ATLAS collaboration. This talk will give an overview of the means of ensuring this level of quality for the modules and their components. Special focus will be on stress-tests of ASIC stuffed printed circuit boards and on temperature cycling of modules. During the quality assessment of a module and its components it is paramount to not damage the wire-bonds connecting the ASICs and the printed circuit boards, e.g. through resonances induced by the cooling or vibrations. A new approach to determine the resonance frequency of the wire-bonds is presented in this talk. Knowledge of this frequency is also relevant to prevent damages due to wire-bond oscillations excited by currents through the wires in the 2 T magnetic field of the ATLAS detector.

T 45.3 Tue 17:30 WIL/A124

Characterisation and test beam data analysis of passive CMOS strip sensors — •Naomi Davis for the CMOS Strip Detectors-Collaboration — Deutsches Elektronen Synchrotron DESY, Hamburg, Germany

In high-energy physics, upgrades for particle detectors, as well as studies on future particle detectors are largely based on silicon sensors as tracking devices. The surface that needs to be covered by silicon sensors is constantly increasing so that they become an immense cost driver in particle physics experiments. Consequently, there is a need to investigate new silicon sensor concepts that can realise large-area coverage and cost-efficiency. A promising technology is found in passive CMOS sensors, based on CMOS imaging technology. They provide a lowered sensor cost by being produced in commercial chip processing lines. Since passive CMOS sensors do not contain any active elements they also allow for a large choice of possible vendors and easy portation from one CMOS process to another.

The passive CMOS project at DESY is investigating passive CMOS strip sensors fabricated at LFoundry in a 150nm technology. Two different strip formats of the n-in-p sensor are achieved by the process of stitching. An electrical sensor characterisation is realised by measuring the change in the sensor current and capacitance with the applied bias voltage. In addition, the sensor performance is evaluated based on test beam measurements conducted at the DESY II test beam facility. This presentation will provide a characterisation of passive CMOS strip sensors and results of the test beam data analysis.

T 45.4 Tue 17:45 WIL/A124

Test beam analysis of irradiated, passive CMOS strip sensors — •Fabian Lex for the CMOS Strip Detectors-Collaboration — Albert-Ludwigs Universität, Freiburg, Germany

Nearly all envisioned future high-energy particle detectors will employ silicon sensors as their main tracking devices. Due to the increased demand in performance, large areas of the detectors will have to be covered with radiation hard silicon, facilitating the need for silicon sensors produced in large quantities, reliably and cost-efficiently.

A possible solution to these challenges has been found in the utilization of the CMOS process, which is an industrial standard, offering the advantage of a large choice of vendors and reduced production costs. To create the larger sensor structures typical for silicon strip trackers, the stitching process has to be used.

Currently three variations of passive CMOS strip sensors, produced by LFoundry in a 150 nm process, are being investigated. In order to examine the radiation hardness of the design and any possible effect of the stitching on position resolution, detection efficiency or charge collection efficiency, a test beam measurement at the Test Beam Facility at DESY Hamburg has been conducted, using the ALiBaVa (Analogue Liverpool, Barcelona, Valencia) system for DUT (Device under test) readout. In the course of the analysis, a new module to process the ALiBaVa data in the Corryvreckan Test Beam Data Reconstruction Framework has been developed. A summary of the results of this test beam analysis will be presented in this talk.

T 45.5 Tue 18:00 WIL/A124

Tests of the first TRISTAN 166 pixel detector modules in a MAC-E filter environment — •Daniel Siegmann — Technical University Munich, James-Franck-Straße 1, 85748 Garching bei München

Sterile neutrinos are a natural extension of the Standard Model of particle physics. If their mass is in the keV range, they are a viable dark matter candidate. One way to search for sterile neutrinos in a laboratory-based experiment is via tritium beta decay. A sterile neutrino with a mass up to 18.6 keV would manifest itself in the decay spectrum as a kink-like distortion. The objective of the TRISTAN project is to extend the KATRIN experiment measurement range with a novel multi-pixel silicon drift detector and readout system to search for a keV-scale sterile neutrino signal. In this presentation will an overview of the first measurements of a 166 pixel TRISTAN detector module inside a KATRIN-like MAC-E filter environment at the Monitor Spectrometer using an implanted ^{83m}Kr source will be shown.

This project has received funding from the European Research Council (ERC) under the European Union Horizon 2020 research and innovation program (grant agreement No. 852845). This work is also supported by BMBF (05A17PM3, 05A17PX3, 05A17VK2, 05A17WO3), KSETA, the Max Planck society, and the Helmholtz Association.

T 45.6 Tue 18:15 WIL/A124

A hot cathode electron gun to test and characterize silicon drift detector arrays for the KATRIN experiment — •Korbinian Urban for the KATRIN-Collaboration — Technical University Munich, James-Franck-Straße 1, 85748 Garching bei München

The KATRIN (Karlsruhe Tritium Neutrino) experiment investigates the kinematic endpoint of the tritium beta-decay spectrum to determine the effective mass of the electron anti-neutrino. Its unprecedented tritium source luminosity and spectroscopic quality make it a unique instrument to also search for physics beyond the standard model such as sterile neutrinos. For these searches a new silicon drift detector array is being developed to replace the current silicon detector in KATRIN. Key features of the new detector are the high rate capability and good energy resolution for electrons. This talk presents a setup where these properties of the new detector modules can be tested with electrons of up to 20 keV kinetic energy from a hot cathode electron gun.

This project has received funding from the European Research Council (ERC) under the European Union Horizon 2020 research and innovation program (grant agreement No. 852845). This work is also supported by BMBF (05A17PM3, 05A17PX3, 05A17VK2, 05A17WO3), KSETA, the Max Planck society, and the Helmholtz Association.

T 46: Calorimeter / Detector Systems II

Time: Tuesday 17:00–18:30 Location: WIL/C133

T 46.1 Tue 17:00 WIL/C133

Fast Hadron Shower Simulation Methods with the CALICE AHCAL Prototype — •André Wilhahn, Julian Utehs, and Stan Lai for the CALICE-D-Collaboration — II. Physikalisches Institut, D-37077, Göttingen

Extensive simulations of particle showers are crucial for high energy physics experiments, since they allow for a sensible interpretation of recorded calorimeter data. As many calorimeters are designed with increasing granularity, while having to cope with higher energy deposits and higher luminosity conditions, the accurate simulation of particle showers in a computationally efficient manner is of utmost importance. This talk describes preliminary investigations into a data-driven fast calorimeter simulation that is meant to describe particle showers accurately, without simulating every individual particle interaction with the calorimeter material.

We start by investigating pion showers in the CALICE AHCAL (Analog Hadron Calorimeter) prototype, which is a highly granular hadronic calorimeter comprising a total of 38 active layers embedded in a stainless-steel absorber structure. Each active layer contains a grid of 24×24 scintillator tiles that are read out individually via silicon photomultipliers. Longitudinal energy distributions and correlation factors between these detector layers have been simulated with the help of kernel density estimators and compared with data. The results of this procedure are presented in this talk. In particular, current developments will be discussed and future plans for improving and expanding the fast calorimeter simulation will be outlined.

T 46.2 Tue 17:15 WIL/C133

Data-driven Fast Calorimeter Simulation with the CALICE AHCAL Prototype — •Julian Utehs, André Wilhahn, and Stan Lai for the CALICE-D-Collaboration — II. Physikalisches Institut, Georg-August-Universität Göttingen

High granularity calorimeters are foreseen to be an integral part of future particle physics detectors, for instance in detectors at a future e^+e^- collider. Therefore, there is an extensive research program dedicated to understanding how high granularity calorimeters can be exploited. For this purpose, the CALICE collaboration has developed a prototype, the Analog Hadron Calorimeter, which uses SiPM technology to read out highly granular scintillator tiles. The combination of highly granular calorimetry with a foreseeable higher luminosity will significantly increase the calculation time for MC simulations that simulate all particle interactions with the calorimeter material (as in GEANT4). Therefore fast simulation methods are also important, allowing the reduction of computational resources, while accurately describing the shape and correlations of the showers.

The aim is to parameterize showers in order to describe them via a probability density function, that can be used for the simulation of particle showers. This talk will focus on the description of radial and angular distributions of pion showers, based on test beam data taken with the AHCAL Prototype. The combined description of longitudinal, radial, and angular distributions is also discussed.

T 46.3 Tue 17:30 WIL/C133

Shower Separation in Five Dimensions using Machine Learning — •Jack Rolph and Erika Garutti — University of Hamburg, 22761, Luruper Chaussee 149, Hamburg, Germany

To fulfil the requirements for BSM physics searches and Higgs precision measurements at future linear colliders, a final state jet-energy resolution of 3-4 % for jet energies in the range 150-350 GeV is mandatory. Particle Flow Calorimetry (PFC) is a method expected to provide this resolution, which relies upon highly granular sampling calorimeters and sophisticated clustering techniques. In addition, the PFC technique requires excellent separation of single particles. This study presents the performance of three published neural network models to separate the energy deposited by a single charged and single pseudo-neutral hadron estimated from a charged shower, observed with the highly granular CALICE Analogue Hadronic Calorimeter (AHCAL). The neural networks use spatial and temporal event information from the AHCAL and energy information, which is expected to improve sensitivity to shower development and differences in the time development of the hadron shower. Neutral hadron showers with energy 5-120 GeV were separated from charged showers at a variable distance of 0.2-658 mm by the neural networks. It is found that the best-performing network reconstructed events with a Mean90 energy in agreement within 5% of the known shower energy and with an average RMS90 of 1.6 and 1.4 GeV without and with 100 ps timing information from AHCAL, respectively. The improvement due to timing information is attributed to the superior clustering of the hadron shower core.

T 46.4 Tue 17:45 WIL/C133

Track reconstruction of charged particles using a 4D quantum algorithm — Arianna Crippa[1,2], Lena Funcke[3,4], Tobias Hartung[5], Beate Heinemann[1,6], Karl Jansen[1], Annabel Kropf[1,6], Stefan Kühn[1], Federico Meloni[1], •David Spataro[1,6], Cenk Tüysüz[1,2], and Yee Chinn Yap[1] — [1]Deutsches Elektronen-Synchrotron DESY — [2]Humboldt-Universität zu Berlin — [3]Universität Bonn — [4]Massachusetts Institute of Technology — [5]Northeastern University, London — [6]Albert-Ludwigs-Universität Freiburg

Reconstructing tracks in future colliders can be challenging for several reasons. For example, there may be a large number of particle tracks or a high background rate. Therefore, new reconstruction techniques need to be developed and existing ones refined. Quantum algorithms are believed to offer an advantage in computation time in combinatorial tasks such as track reconstruction. By formulating the tracking task as Quadratic Unconstrained Binary Optimization (QUBO), the task can be solved with quantum computers. For the first time, a time component is integrated into QUBO to enable 4D tracking, reducing background rates effectively. Results of an initial implementation are presented for a setup similar to the positron tracking system of LUXE, an experiment planned at DESY and Eu.XFEL. Peak occupancies of up to 100 hits/mm^2 are expected in the initial phase of LUXE. To demonstrate the transferability of this approach, results are also presented for a barrel-shaped muon collider detector geometry, where lower peak occupancy but large background is expected.

T 46.5 Tue 18:00 WIL/C133

QUBO partitioning and choice of quantum device for charged particle track reconstruction at LUXE — •Annabel Kropf[1,2], Arianna Crippa[1,3], Lena Funcke[4,5], Tobias Hartung[6], Beate Heinemann[1,2], Karl Jansen[1,3], Stefan Kuehn[1], Federico Meloni[1], David Spataro[1,2], Cenk Tüysüz[1,3], and Yee Chinn Yap[1] — [1]DESY — [2]Albert-Ludwigs-Universität Freiburg — [3]Humboldt-Universität zu Berlin — [4]Universität Bonn — [5]MIT — [6]Northeastern University, London

LUXE (Laser Und XFEL Experiment) is a proposed experiment at DESY using the electron beam of the European XFEL and a high-intensity laser. The experiment's primary aim is to investigate the transition from the well-probed perturbative to the non-perturbative Quantum Electrodynamics regime. In LUXE's initial phase, positrons are produced that impinge on a four-layered pixel detector with occupancies of up to 100 hits/mm^2. Reconstructing positron trajectories is a combinatorial problem challenging for a classical computer to solve. Our group explores the novel approach of expressing the track pattern recognition problem as a quadratic unconstrained binary optimization (QUBO), allowing the algorithm to be mapped onto a quantum computer. Splitting the QUBO term into mappable subQUBOS is required because the size of the QUBO exceeds the number of qubits of state-of-the-art quantum computers. This talk investigates the influence of the QUBO splitting algorithm on the final track reconstruction efficiency. Additionally, the effectiveness of a gate-based quantum computer and a quantum annealer for applying the QUBO approach will be compared.

T 46.6 Tue 18:15 WIL/C133

Beam induced background identification in ATLAS by tracking system — •Marzieh Bahmani for the ATLAS-Collaboration — Humboldt-Universität, Berlin, Germany

It is important to study Beam Induced Background (BIB) since the BIB can significantly affect the data from ATLAS detector. Events with a large BIB component can produce a large hit occupancy in the sub-detectors and can affect the track reconstruction in the Inner Detector. The hits pattern in the Inner detector has been studied which allows to distinguish electronic noise hits form those generated by BIB and provides information on BIB characteristics at different locations

in barrel and end-caps. For this study unpaired isolated bunches are exploited using BCM unpaired triggers. The ATLAS Run-II dataset has been used for this study.

T 47: Gas-Detecors, Detector Systems

Time: Tuesday 17:00–18:30 Location: WIL/A120

T 47.1 Tue 17:00 WIL/A120

First measurements with a gas monitoring chamber at subatmospheric pressures — Rebecca Fischer, Thomas Radermacher, Stefan Roth, David Smyczek, and •Nick Thamm — RWTH Aachen University - Physics Institute III B, Aachen, Germany

Time projection chambers (TPCs) are gaseous ionization detectors, which can instrument large volumes for particle tracking applications. By adjusting the internal gas-mixture and the operating pressure it is possible to fine-tune these detectors to have increased target mass for neutrino interactions or improved track resolution for low energies. For the precise operation of TPCs various electron swarm parameters are usually measured during runtime with a gas monitoring chamber (GMC), a small specialized TPC. These monitoring chambers can also be used for the verification of drift parameter simulations, which help predict the physics behavior of larger detectors. In this talk the hardware modification of a high pressure GMC (HPGMC) towards low pressure operation is addressed, the associated challenges are explained and first measurement results are shown.

T 47.2 Tue 17:15 WIL/A120

Development and Commissioning of Gas Flow Meters — Thomas Radermacher, Stefan Roth, David Smyczek, Jochen Steinmann, Nick Thamm, and •Hanja Wehrle — RWTH Aachen University - Physics Institute III B, Aachen, Germany

Gas flow meters will be installed in the new Gas Monitoring Chambers (GMCs) of the T2K time projection chambers. The flow meters measure the heat transfer caused by the gas flow using platinum resistors. This offers an efficient solution for monitoring the gas flow through the GMCs. The construction, calibration and performance of the flow meters are presented.

T 47.3 Tue 17:30 WIL/A120

Gas Monitoring Chambers for the T2K Near Detector Upgrade — Ines Hannen, Thomas Radermacher, Stefan Roth, •David Smyczek, and Nick Thamm — RWTH Aachen University - Physics Institute III B, Aachen, Germany

A new pair of Time Projection Chambers for high angle measurements (HATs) will be installed during the upgrade of the T2K near detector ND280. For their calibration the gas parameters will be continuously monitored using newly developed Gas Monitoring Chambers (GMCs). Systematic measurements of drift velocity and gas gain have been performed for different gas mixtures. These measurements are compared to simulations and previous measurements. The test setup and measurement results are presented.

T 47.4 Tue 17:45 WIL/A120

Commissioning of the large-scale LXe detector test platform PANCAKE — •Tiffany Luce — Physikalisches Institut, Universität Freiburg, 79104 Freiburg, Germany

As liquid xenon (LXe) detectors grow in size with each experiment, larger components have to be developed and tested. PANCAKE is a cryogenic detector test platform for components up to 2.6 m diameter as required for the future dark matter project DARWIN. PANCAKE's primary goal is to test the behavior of large scale detector components, such as TPC electrodes, in cryogenic conditions. A first commissioning run has been performed for two months at liquid argon temperature. The talk will present the results and discuss the strategy for future runs with cryogenic liquid xenon.

T 47.5 Tue 18:00 WIL/A120

Preparations for TPC Electrode Tests in a large LXe R&D-Platform — •Julia Müller — Albert-Ludwigs Universität, Freiburg

PANCAKE is a large-scale cryogenic platform to develop and test components for future LXe TPCs such as DARWIN. Over the past decades LXe TPCs continuously grew in size and became more sensitive, however, also the technical realization of its large TPCs got more and more challenging. Among the most crucial and also most complex detector components are the TPC electrodes, which need to feature a high optical transparency and high voltage resilience. PANCAKE allows testing the full-scale electrodes in an LXe-environment before they are installed into a final TPC. We here present preparations towards such an electrode test.

T 47.6 Tue 18:15 WIL/A120

Detector system and simulation of the 155 MeV Hydro-Møller polarimeter at MESA — •Michail Kravchenko for the P2-Collaboration — PRISMA+ Cluster of Excellence and Institute of Nuclear Physics, Johannes Gutenberg University Mainz

The Mainz Energy-recovering Superconducting Accelerator (MESA) is an electron accelerator, which is currently under construction at the Johannes Gutenberg University Mainz. One aim for the MESA is the precise measurement of the weak mixing angle $sin^2\theta_w$, an important parameter of the Standard Model, with a relative uncertainty of 0.14%. The measurement will be performed by the P2 experiment by measuring the parity-violating asymmetry in elastic electron-proton scattering at low momentum transfer Q^2. MESA will provide a 150 μA beam of alternatingly polarized 150 MeV electrons with excellent beam stability. In order to achieve the goal of the P2 experiment, the beam polarization must be measured online with a very low systematic error ($< 0.5\%$ relative). The 155 MeV Møller polarimeter using a polarized atomic hydrogen target, known as the Hydro-Møller polarimeter, as proposed by V. Luppov and E. Chudakov opens the opportunity for achieving these requirements. The current design of the detector system for the Hydro-Møller polarimeter and the results of the simulation with Geant4 are presented.

T 48: Exp. Methods I

Time: Tuesday 17:00–18:15 Location: WIL/C129

T 48.1 Tue 17:00 WIL/C129

Tau-lepton decay mode classification using machine learning in ATLAS — •Jonathan Pampel[1], Duc Bao Ta[2], Christina Dimitriadi[1], Jochen Dingfelder[1], Tatjana Lenz[1], and Eckhard von Törne[1] — [1]University of Bonn, Germany — [2]University of Mainz, Germany

The tau-lepton is the heaviest charged lepton with a mass of about twice the mass of the proton. It can decay leptonically into a neutrino and other leptons or hadronically into a neutrino and hadrons, the latter being mostly pions. In the ATLAS collaboration at CERN, there are already several algorithms for the decay mode classification of hadronically decaying tau-leptons (tau-jets).

This talk presents a novel technique based on convolutional neural networks to classify the hadronic tau-lepton decay modes. The goal is to count the number of neutral and charged pions in a tau-jet using calorimeter information. To do this, for each calorimeter layer, a 'picture' of the tau-jet is generated. These 'pictures' are used as input for a neural network built from several 2D convolution and pooling layers and flattening layer followed by a number of dense layers.

The preliminary results of this study will be presented based on ATLAS Run 2 Monte Carlo samples, i.e. pp-collisions at a center of mass energy of 13TeV. This includes an introduction into the problem as well as a visualization of the preprocessed data which is fed into the neural network. Finally, the best performing neural network's architecture

and its performance will be presented.

T 48.2 Tue 17:15 WIL/C129

Photon identification efficiency measurement with the Matrix Method using 139 fb^{-1} of data collected by the ATLAS experiment at $\sqrt{s} = 13$ TeV — •Nils Julius Abicht and Tomas Dado — Technische Universität Dortmund, Fakultät Physik

Photon identification (ID) is an integral part of many analyses, for example, measurements of Higgs boson properties or hypothetical pro cesses involving isolated photons in the final state. As the photon ID efficiency is not necessarily modeled well in Monte Carlo simulations, data-driven approaches are employed. One of these approaches is the Matrix Method, which estimates the efficiencies between a loose and a tight selection. For this selection, two sets of variables are used. The first set describes the longitudinal and lateral shape of the calorimeter shower and the second the topology of the center of the calorimeter shower. For calculating the photon ID efficiency, track isolation criteria that are weakly correlated with with the second set of variables are used. A description of the Matrix Method, the systematic uncertainties of the measurement as well as the resulting photon ID efficiencies and corrections to simulated efficiencies, calculated on full Run-2 samples, corresponding to 139 fb^{-1}, are presented.

T 48.3 Tue 17:30 WIL/C129

Improvement of Electron identification with the ATLAS detector and performance with first Run3 data — Asma Hadef and •Lucia Masetti for the ATLAS-Collaboration — Johannes Gutenberg Universität, Mainz, Germany

Electrons are important objects both for the search for new physics and for precision measurements. An algorithm to identify electrons in the ATLAS experiment based on a deep neural network was recently developed. Inputs to the network are high-level discriminating variables derived from the reconstructed electron track and cluster of energy depositions in the calorimeter system. The performance is estimated in simulated proton-proton (pp) collisions at $\sqrt{s}$=13 TeV and compared to the current identification algorithm which is based on a likelihood approach. Depending on the kinematics of the electron candidate, an increase in background rejection between 1.7 and 5.5 at the same signal efficiency can be observed. The performance of the electron identification algorithms is evaluated by measuring efficiencies using tag-and-probe techniques with large statistics samples of isolated electrons from $Z \to ee$ resonance decay. The first results of Run3 data recorded in 2022 from pp collisions at $\sqrt{s}$=13.6 TeV, corresponding to an integrated luminosity of 3.4 fb^{-1}, will also be presented.

T 48.4 Tue 17:45 WIL/C129

A Particle Identification Framework for Future Higgs Factories — •Ulrich Einhaus — Deutsches Elektronen-Synchrotron DESY, Notkestr. 85, 22607 Hamburg

The particle physics community has concluded that the next collider should be an e^+e^- Higgs factory. Such a collider would also enable many other precision measurements, e.g. of the top quark and in the electroweak sector, as well as searches for exotic particles. In the ongoing discussions it has become increasingly clear that particle identification including charged hadron ID is a key feature that enables a number of analyses and improves many. A number of different PID systems - from the simple muon ID to gaseous dE/dx and dN/dx to calorimeter shower shapes and time of flight (and more) - are being envisioned for the proposed future Higgs factory detector concepts. It is desirable to assess their impact and the effect of combining them in a common tool to enable fair comparisons.

This talk presents a new modular approach to a generic PID framework for the different possible future Higgs factories, embedded in the Key4HEP framework. It discusses implementation questions, performance measures and possible physics applications, exampling the International Large Detector (ILD) concept for the International Linear Collider (ILC).

T 48.5 Tue 18:00 WIL/C129

Time-of-flight particle identification at future Higgs factories — •Bohdan Dudar[1,2], Jenny List[1], Annika Vauth[2], and Ulrich Einhaus[1] — [1]Deutsches Elektronen-Synchrotron DESY, Notkestr. 85, 22607 Hamburg, Germany — [2]Universität Hamburg, Hamburg, Germany

It is established that particle identification of charged hadrons with $\gtrsim$ 5 GeV momentum plays an important role at future e^+e^- Higgs factories to achieve outstanding precision in Higgs and electroweak physics, which can be covered by dE/dx (or dN/dx) in a gaseous tracker or RICH. However, at low momentum these methods become inefficient, while also some detectors don't have a gaseous tracker or RICH in their designs at all. Modern Si sensors technologies that can achieve time resolutions of 10 – 30 ps, such as LGADs, allow us to use the time-of-flight technique to identify $\pi^{\pm}$, $K^{\pm}$ and p at low momentum by placing fast timing layers in the ECAL or as an outer tracker. This should enhance the particle identification at the future Higgs factory. Thus, achievable time resolutions of the LGADs together with time-of-flight particle identification technique are interesting points to investigate for the future detector R&D.

In this talk, we present test beam measurements of time resolution of LGAD samples with an electron beam at the DESY II test beam facility, the latest developments of the time-of-flight technique as well as its realistic momentum reach and limitations of integrating it into the detector at a future e^+e^- Higgs factory, using the International Large Detector at the International Linear Collider as an example case.

T 49: Outreach (joint session HK/T)

Time: Tuesday 17:00–18:45 Location: SCH/A252

T 49.1 Tue 17:00 SCH/A252

Förderung des kritischen Denkens durch Teilchenphysikunterricht: Chancen und Herausforderungen — •Farahnaz Sadi-di und Gesche Popsiech für die Netzwerk Teilchenwelt-Kollaboration — Professur für Didaktik der Physik, TU Dresden

Kritisches Denken (KD) ist eine der wünschenswerten Fähigkeiten, die in der Schule vermittelt werden sollten. Das Fehlen einer klaren, durch empirische Befunde gestützten Theorie für die Entwicklung eines fachspezifischen Unterrichts zur Förderung des kritischen Denkens der SchülerInnen stellt die Lehrkräfte jedoch vor große Herausforderungen. Um diese Lücke zu schließen, wurden im Rahmen eines Promotionsprojekts die Gestaltungsprinzipien für einen Teilchenphysikunterricht zume Thema Antimaterie für SchülerInnen der Klassen 10, 11 und 12 nach dem Ansatz der Design-Based Research (DBR) entwickelt, um KD zur fördern. In der Hauptstudie wurde der Antimateriekurs in 3 Klassen in verschiedenen Bundesländern Deutschlands durchgeführt. Die Daten wurden induktiv ausgewertet, um die Lernprozesse der SchülerInnen zu identifizieren. Die Ergebnisse zeigten die Effektivität des Antimateriekurses bei der Förderung der KD-Fähigkeiten der SchülerInnen und offenbarten auch die Herausforderungen, denen die SchülerInnen beim kritischen Denken gegenüberstehen. Die in dieser Studie angewandten und empirisch getesteten Gestaltungsprinzipien können für die Entwicklung anderer fachspezifischer Unterrichtseinheiten zur Förderung des KD verwendet werden.

T 49.2 Tue 17:15 SCH/A252

Vorstellung einer Netzwerk Teilchenwelt Masterclass über das MuonPi-Projekt — •Lara Dippel, Hans-Georg Zaunick und Kai-Thomas Brinkmann für die Netzwerk Teilchenwelt-Kollaboration — II. Physikalisches Institut, Justus-Liebig-Universität, Giessen

Das MuonPi-Projekt ist ein verteiltes Netzwerk von Raspberry-Pi basierten Detektorstationen zur Messung von Myonenschauern, die bei der Wechselwirkung ultrahochenergetischer, kosmischer Primärstrahlung mit der Erdatmosphäre ausgelöst werden. Die Detektoren werden mit geringen Anschaffungskosten angeboten, sodass interessierte Laien einen Einblick in das Forschungsgebiet der Astroteilchenphysik gewinnen können. Für interessierte Schüler:innen wird im Rahmen des *Netzwerks Teilchenwelt* eine Masterclass angeboten, die durch verschiedene Experimente mit MuonPi-Detektoren die Grundlagen der hochenergetischen Teilchenphysik einführen soll. Dabei können sowohl Themen aus der theoretischen Physik, wie z.B. Konzepte der speziellen Relativitätstheorie und Teilchenzerfälle, als auch experimentelle Messtechniken vermittelt werden. Dazu stehen sowohl betreute Kurz-

zeitexperimente an Schulen als auch die angeleitete Durchführung von Langzeitversuche mit einer eigenen Station zur Verfügung.

T 49.3 Tue 17:30 SCH/A252

A new Nuclear Astrophysics Masterclass - A Journey through the Elements — •Hannes Nitsche[1], Uta Bilow[1], Lana Ivanjek[1], Kai Zuber[1], and Daniel Bemmerer[2] for the Netzwerk Teilchenwelt-Collaboration — [1]Technische Universität Dresden — [2]Helmholtz-Zentrum Dresden-Rossendorf

Masterclasses are one-day outreach events for high school students, introducing them to topics of current research. Within the framework of the EU project ChETEC-INFRA, a new Masterclass on Nuclear Astrophysics has been developed. This interdisciplinary field of science provides a new didactic perspective on nuclear and astrophysical processes by addressing the link between these two subjects.

The Nuclear Astrophysics Masterclass picks up this didactic potential. It includes the analysis of measurement data from a nuclear reaction studied at the Felsenkeller Laboratory in Dresden. Furthermore, the processes behind nucleosynthesis are reconstructed with the help of various gamification elements. The talk will present the teaching materials, the didactic concept as well as the experiences made so far in the implementation of the Masterclass.

T 49.4 Tue 17:45 SCH/A252

The Particle Therapy Masterclass for targeted education and outreach on real-world application of fundamental physics — •Niklas Wahl for the Netzwerk Teilchenwelt-Collaboration — Deutsches Krebsforschungszentrum (DKFZ), Heidelberg, Germany

The Particle Therapy Masterclass (PTMC) was established in 2019 by the piloting institutes CERN, DKFZ and GSI to showcase how fundamental physics can translate to applications with directly visible societal benefit. Over a day the PTMC introduces how fundamental physics research on accelerators as well as particle, hadron and detector physics enable cancer treatments utilizing the Bragg-peak. A hands-on session with the open source toolkit "matRad" facilitates interactive treatment planning for participants using open, virtual patient data.

In the following, the PTMC was integrated into the International Physics Masterclasses by IPPOG targeting high school students with more than 40 international course sessions during spring 2022. With Netzwerk Teilchenwelt, customized Masterclasses were held in fellowship meetings of senior grade students, intermediate level school project days or as interactive outreach events to the general public. Integration into university level courses at DKFZ was also successful.

Held over the last years in Germany, these sessions showed that the PTMC can be adapted to different educational levels from the general public to undergraduate students and is especially suited for online courses. The PTMC thus proved to be a flexible and interactive tool in education and outreach for different target groups to show directly visible "real-world" impact of fundamental physics research.

T 49.5 Tue 18:00 SCH/A252

Machine Learning Masterclass - Physik trifft Daten — •Maike Hansen[1], Johanna Rätz[2] und Barbara Valeriani-Kaminski[1] — [1]Physikalisches Insitut, Universität Bonn — [2]Argelander-Institut für Astronomie, Universität Bonn

"Wieso sollen wir jetzt was programmieren? Ist doch Physik und kein Informatik..." - Schüler:innen ist kaum bewusst, welche zentrale Bedeutung Datenauswertung und Maschinelles Lernen in der modernen Physik sowie in anderen Naturwissenschaften haben. Die Machine Learning (ML) Masterclass vom Netzwerk Teilchenwelt, der Universität Münster und PUNCH4NFDI fördert das fächerübergreifende Denken und macht moderne Datenverarbeitung in der Teilchenphysik erlebbar. Neben dem Standardmodell der Teilchenphysik und der Funktionsweise eines Teilchendetektors geht es bei der ML Masterclass um den Einsatz Neuronaler Netze bei der Datenauswertung. Angeleitet durch junge Wissenschaftler:innen programmieren die Schüler:innen nach interaktiven Einführungsvorträgen und Übungen in einer Browser-basierten Programmierumgebung das Neuronale Netz, um so einen authentischen Datensatz aus der Teilchenphysik auszuwerten. Einzelne Schulpraktikant:innen und zwei Lerngruppen haben die Masterclass bereits getestet und Feedback zur Weiterentwicklung gegeben. In diesem Vortrag werden der aktuelle Entwicklungsstand und die bisherigen Erfahrungen mit der ML Masterclass vorgestellt.

T 49.6 Tue 18:15 SCH/A252

Belle II Masterclass - Teilchenidentifikation und Dunkle Materie mit interaktiven Jupyter Notebooks — •Jonas Eppelt, Torben Ferber, Filipp Gostner, Isabel Haide, Alexander Heidelbach und Lea Reuter — Institute of Experimental Particle Physics (ETP), Karlsruhe Institute of Technology (KIT)

Eine Masterclass im Rahmen des Netzwerk Teilchenwelt Projektes soll Schüler:innen physikalische Konzepte näher bringen und das Interesse an der Physik wecken. Dafür wurde am Karlsruher Institut für Technologie in der Belle II Gruppe eine Masterclass entwickelt, in welcher die Interaktionen der Teilchen mit Detektorkomponenten simuliert werden. Die Teilnehmer:innen können mithilfe interaktiver Jupyter Notebooks Spuren in einem vereinfachten Spurdetektor rekonstruieren, Energiedepositionen im elektromagnetischen Kalorimeter von Belle II zu einem Cluster zusammenfassen und durch zusätzliche Informationen aus dem Belle II-Myonendetektor Teilchen identifizieren. Die Ausnutzung von Energie- und Impulserhaltungssätze ermöglicht den Schüler:innen zudem, fehlender Energie Teilchenhypothesen zuzuordnen. Wir präsentieren das Konzept und die technische Umsetzung unserer Masterclass.

T 49.7 Tue 18:30 SCH/A252

Higgs Entdeckung als ein Masterkurs für Fortgeschrittene — •Artur Monsch und Günter Quast — Institute of Experimental Particle Physics (ETP), Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany

Im Rahmen des Vortrags wird ein Konzept einer fortgeschrittenen Masterclass vorgestellt, welche an die bestehende CMS Masterclass anknüpft und diese um zusätzliche Themen erweitert. Im Fokus stehen dabei interessierte Schülerinnen und Schüler der Oberstufe, welche Interesse daran haben, Ideen und Methoden der experimentellen Teilchenphysik anhand tatsächlicher Messdaten kennenzulernen. Hierzu werden die vom CERN Open Data Portal bereitgestellten Mess- und Simulationsdaten verwendet, welche auch zur Entdeckung des Higgs-Bosons ausgewertet wurden. Diese Entdeckung können die Schülerinnen und Schüler dann durch die Bearbeitung eines interaktiven, auf der Programmiersprache Python basierendem, Jupyter-Notebook selbst erleben. Ausgehend von aufbereiteten Originaldaten aus dem 'goldenen Zerfallskanal' $H \to ZZ \to 4\ell$ lernen Schülerinnen und Schülern grundlegende Konzepte aus der Physik und der Datenauswertung kennen, wie die Bedeutung der invarianten Masse oder die Notwendigkeit einer Datensatz-Bereinigung. Die anschließende Frage, inwieweit der beobachtete Überschuss in der Verteilung der invarianten Masse dem vorhergesagtem Higgs Boson der Masse $125\,\mathrm{GeV}/c^2$ entspricht und ob die gewonnene Beobachtung signifikant ist, lässt sich mit den kennengelernten Methoden auch auf Themengebiete außerhalb der Teilchenphysik anwenden.

T 50: Invited Topical Talks I-A

Time: Wednesday 11:00–12:20 Location: HSZ/AUDI

Invited Topical Talk T 50.1 Wed 11:00 HSZ/AUDI

Search for leptoquarks at the ATLAS experiment — •Mahsana Haleem for the ATLAS-Collaboration — Julius-Maximillian-Universität Würzburg, Germany

The leptoquarks predicted in the extensions of physics beyond the Standard Model can describe the similarities between the lepton and quark generations. In the past years, these particles have been the most popular explanations for the B-anomalies reported in low-energy data, and the searches for leptoquarks have been among the important goals of the ATLAS program. Recent results from the LHCb collaboration reporting the disappearance of lepton flavour anomalies in the B-meson decays into kaon and charged-lepton pairs do not affect the search program. They probe unique signatures at the LHC, as they provide direct transitions between leptons and quarks. I will review some of these searches with ATLAS Run-2 dataset and their prospects in Run-3, particularly focusing on the final states with third-generation quarks, which offer great potential to the SM background reductions

but are also challenging in terms of the remaining background modeling.

Invited Topical Talk T 50.2 Wed 11:20 HSZ/AUDI
Making the most of Yukawa couplings: searching for Dark Matter accompanied by heavy quarks — •Danyer Perez Adan — Deutsches Elektronen Synchrotron (DESY), Hamburg, Germany

Among the foremost alternatives to unravel the mysteries of Dark Matter (DM) is the search for invisible particles at colliders. The main experiments at the Large Hadron Collider (LHC) are engaged in an intense search program to identify any evidence of non-standard unbalanced transverse momentum. Should this DM hunt be successful and the manifestation consistent with any of the various theoretical scenarios, it could be a first indication of the particle-like nature of this unknown matter. A large number of these models propose that the coupling between the DM mediators and the Standard Model (SM) fermions is of Yukawa type, thus favoring at the LHC the associated production of DM with top-quarks or b-quarks. Such consideration turns out to be one of the leading motivations for many of the analyses that have a particular focus on heavy flavour fermions accompanying the DM particles in the final state. The most recent experimental efforts and some of the prospects in this direction will be the primary topic of this talk.

Invited Topical Talk T 50.3 Wed 11:40 HSZ/AUDI
Precision predictions for transverse momentum distributions of Higgs and vector bosons at the LHC — •Maximilian Stahlhofen — University of Freiburg

The transverse momentum (p_T) spectra of Higgs and electroweak gauge bosons are among the most prominent observables measured at the LHC. The expected quality of their experimental data requires high precision theoretical predictions to enable maximally accurate physics analyses like Standard Model tests, new physics searches, or PDF fits. I will discuss recent developments and future prospects in the theoretical description of p_T spectra at small and large transverse momenta, which are largely based on effective field theory techniques. I will put a focus on bottom mass effects in the peak region of the Higgs transverse momentum distribution and third-order QCD calculations for direct photon production at large p_T.

Invited Topical Talk T 50.4 Wed 12:00 HSZ/AUDI
Axion fragmentation — •Enrico Morgante — Johannes Gutemberg Universität, Mainz, Deutschland

Axion-like particles are a key ingredient of many new physics scenarios, well motivated both from the theoretical and phenomenological point of view. In a number of recent proposals, the non-trivial dynamical evolution of an axion field in the early universe is used to solve many open problems of particle physics and cosmology, such as the hierarchy problem, Dark Matter, and others. An effect which was previously overlooked is the growth of quantum fluctuations when the axion rolls down a potential with multiple minima. This effect is particularly relevant for the relaxion mechanism and for the kinetic misalignment scenario. I will introduce this effect presenting analytic and lattice results, and then discuss the cosmological aspects of the scenario.

T 51: Invited Topical Talks I-B

Time: Wednesday 11:00–12:20 Location: HSZ/0003

Invited Topical Talk T 51.1 Wed 11:00 HSZ/0003
LUXE – A new experiment to study non-perturbative QED in electron-laser and photon-laser collisions — •Ruth Jacobs — Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany

The LUXE experiment (Laser Und XFEL Experiment) is a new experiment in planning at DESY Hamburg using the electron beam of the European XFEL. At LUXE, the aim is to study collisions between a high-intensity optical laser and up to 16.5GeV electrons from the Eu.XFEL electron beam, or, alternatively, high-energy secondary photons. The physics objectives of LUXE are to measure processes of Quantum Electrodynamics (QED) at the strong-field frontier, where QED is non-perturbative. This manifests itself in the creation of physical electron-positron pairs from the QED vacuum. LUXE intends to measure the positron production rate in a new physics regime at an unprecedented laser intensity. Additionally, the high-intensity Compton photon beam of LUXE can be used to search for physics beyond the Standard Model.

Invited Topical Talk T 51.2 Wed 11:20 HSZ/0003
Precision timing with silicon sensors — •Annika Vauth — Institut für Experimentalphysik, Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg, Deutschland

Precision timing with silicon is an important tool in many areas of particle physics, either by adding a dedicated timing layer for track timing to a detector, or full "4D-tracking" where precise space and time coordinates are assigned to each hit.

Intense R&D is taking place in the design and optimisation of different types of silicon sensors to achieve excellent timing performance. Two examples for promising technologies are Low Gain Avalanche Diodes, which have been shown to achieve time resolutions of 30 ps or better, as well as 3D sensors, which display excellent radiation hardness. In this contribution, the currently existing technological solutions and ongoing research addressing the remaining challenges are reviewed. Future applications for precision timing will be presented.

Invited Topical Talk T 51.3 Wed 11:40 HSZ/0003
Recent advancements in Micro-Pattern Gaseous Detectors: Exciting research ahead towards future experiments — •Michael Lupberger — Helmholtz-Institut für Strahlen- und Kernphysik — Physikalisches Institut — Forschungs- und Technologiezentrum Detektorphysik, Bonn, Germany

The invention of Micro-Pattern Gaseous Detectors (MPGDs), overcoming the limitation of wire-based devices, marked a new epoch in the field of gaseous detectors. MPGDs, as 2nd generation gaseous detectors, were installed with large sizes in LHC experiments within the Long Shutdown 2 upgrades - more than 20 years after their invention.

The RD51 collaboration supported this path from prototypes to large area detectors, and promotes further MPGD R&D.

Major advancements have been achieved recently, opening up novel opportunities for exciting research and future experiments: The long-standing timing limitation of planar detectors was overcome with the PICOSEC concept, achieving 17 ps time resolution. With the implementation of the VMM chip into RD51's general Scalable Readout System, R&D support for the next decade is secured as well as new high-rate mid-size experiments are enabled. The GridPix technology with its single electron detection capability allows imaging of the fundamental particle-gas interaction and its features at a microscopic level.

These highlights will be presented, taking the prospects of the ECFA Detector R&D Roadmap and the transition from RD51 to DRDC1 into account.

Invited Topical Talk T 51.4 Wed 12:00 HSZ/0003
Recent Liquid Scintillator Developments for Astroparticle Physics — •Stefan Schoppmann — Johannes Gutenberg-Universität Mainz, Exzellenzcluster PRISMA+, PRISMA Detektorlabor, Staudingerweg 9, 55128 Mainz, Germany

Liquid scintillators have been used for decades in many experiments. They are particularly suited for the detection of low-energy particles where energy and timing information is required. Liquid scintillators exhibit advantages such as high light yield, cost effectiveness, radiopurity, and more.

In recent years, various developments aim for improving the vertex and directional resolution as well as particle identification of liquid scintillators. These ideas include advanced detector instrumentations, fine-grained vertex reconstruction, hybrid scintillators, and more. These novel approaches open a rich physics programme reaching from reactor neutrinos and searches for Majorana particles to solar and astrophysical neutrinos and beyond.

In this presentation, the status of novel approaches to liquid scintillators is reviewed and their prospects and applications compared.

T 52: Invited Topical Talks II-A

Time: Wednesday 14:00–15:20 Location: HSZ/AUDI

Invited Topical Talk T 52.1 Wed 14:00 HSZ/AUDI
Commissioning of the new LHCb trigger system — •Marian Stahl — European Organization for Nuclear Research (CERN), Geneva, Switzerland

Since 2022 the upgraded LHCb experiment uses a triggerless readout system collecting data at an event rate of 30 MHz and a data rate of 4 Terabytes/second. A software-only heterogeneous High Level Trigger (HLT) enables unprecedented flexibility for reconstruction and selections. Compared to Run2 (2015-18), the amount of data to be processed by the HLT increased by a factor 60 due to operating at five times higher luminosity and the removal of the hardware trigger. The GPU-based first stage (HLT1) reduces the event rate to 1 MHz by selections based on charged particle tracking, vertexing, photon reconstruction and lepton identification. At the CPU-based second stage (HLT2), full offline quality event reconstruction and user-friendly configuration provides the flexibility that has allowed analysts to implement more than 1500 inclusive and exclusive selection algorithms. Real-time alignment and calibration directly after HLT1 ensures best detector performance in HLT2's full event reconstruction. I will describe how LHCb's Real-Time-Analysis project addresses performance and code portability challenges associated with heterogeneous computing at this scale and how the new trigger, alongside with the upgraded detector, have been commissioned in 2022.

Invited Topical Talk T 52.2 Wed 14:20 HSZ/AUDI
Alignment of the CMS Tracker: Automation is Key — •Marius Teroerde — 1. Physikalisches Institut B, RWTH Aachen, Germany

The inner tracker is the central part of the Compact Muon Solenoid (CMS) detector at the Large Hadron Collider (LHC). In order to ensure excellent physics performance, it is necessary to have precise knowledge of the tracker geometry, so that tracks and vertices can be accurately reconstructed.

The measurement of the tracker geometry using particle tracks, called 'alignment', is a very complex task. It involves tracking the time dependent position of about 15000 detector modules. Radiation damage to the modules influences the position measurements. The best data quality is therefore achieved if the tracker geometry is frequently updated based on recent data and if the granularity of the alignment is fine enough to account for biases in individual modules. An automated procedure, including automated quality control, is key to meet these requirements. In this talk, an introduction to tracker alignment strategies at CMS is given and recent developments of automatic alignment are discussed. Future prospects for the era of the High-Luminosity LHC are also touched upon.

Invited Topical Talk T 52.3 Wed 14:40 HSZ/AUDI
ITk – ATLAS tracker upgrade — •Dennis Sperlich — Albert-Ludwigs-Universität Freiburg

For the LHC Phase-II upgrade, the ATLAS Experiment needs to upgrade the new whole tracking system. ITk will be able to cope with the higher pileup up to 200 and integrated luminosities up to 4000 fb^{-1}. It will replace the current Pixel, SCT and TRT detector with an all silicon detector comprised of Pixel and Strip subdetectors. The Pixel detector will consist of five barrel layers and a number of endcap-region rings to provide hermetic coverate and tracking up to $|\eta| < 4$. The Strip detector will consist of four barrel layers and six discs per endcap. With the R&D concluding in the system tests of bigger Pixel and Strip structures and the production starting, this talk will show the current state of the two subprojects and gives and outlook towards production and integration.

Invited Topical Talk T 52.4 Wed 15:00 HSZ/AUDI
Role of simulation in silicon tracker sensors R&D — •Anastasiia Velyka — DESY Hamburg

Experiments at possible future colliders require, among others, lightweight detectors with a single-point resolution of a few micrometers. These requirements are addressed with various silicon tracker sensor R&D projects. Optimisation of the sensor design requires precise simulations, which can be achieved by combining computer-aided design (TCAD) and Monte Carlo methods. TCAD is used to simulate an accurate electric field of a sensor via static simulations. The response of the sensor is simulated using the Monte Carlo software.

The examples of sensor optimisation are shown for the hybrid Enchanted Lateral Drift (ELAD) sensor and the monolithic small collection electrode CMOS sensor.

T 53: Invited Topical Talks II-B

Time: Wednesday 14:00–15:20 Location: HSZ/0003

Invited Topical Talk T 53.1 Wed 14:00 HSZ/0003
LST-1: Initial scientific results from the first CTA telescope — •Dominik Elsaesser for the CTA-Collaboration — Fakultät Physik, TU Dortmund

The Cherenkov Telescope Array (CTA) will lead the frontier of ground-based gamma-ray astronomy with its unprecedented sensitivity in the energy range between 20 GeV to 300 TeV. CTA will be composed of two telescope sites, in the northern hemisphere on the Roque de Los Muchachos Observatory in La Palma, Spain and in the southern hemisphere at the Paranal Observatory in the Atacama Desert in Chile, and of three telescope types: Large, Medium, and Small sized telescopes. The Large-Sized Telescopes (LSTs) are specially designed for low-energy and transient phenomena and will dominate CTA's sensitivity in the energy range from 20 GeV to 150 GeV. The northern CTA site at Roque de Los Muchachos, La Palma, will host an array of four LSTs, each with a mirror diameter of 23m. The prototype, LST-1, was inaugurated in October 2018 and has since been in its commissioning phase. In this talk, we report on the first results from scientific observations using LST-1. Finally, we will discuss prospects for LST 2-4.

Invited Topical Talk T 53.2 Wed 14:20 HSZ/0003
Multimessenger astronomy with the Pierre Auger Observatory — •Marcus Niechciol for the Pierre Auger-Collaboration — Center for Particle Physics Siegen, Experimentelle Astroteilchenphysik, Universität Siegen

The Pierre Auger Observatory is the largest air-shower experiment in the world, offering an unprecedented exposure not only to charged cosmic rays, but also to neutral particles at the highest energies. The Observatory can therefore contribute significantly to current efforts in multimessenger astronomy. For example, the upper limits on the incoming flux of ultra-high-energy (UHE) photons and neutrinos determined from Auger data are the most stringent to date, severely constraining current models for the origin of UHE cosmic rays. Follow-up searches for neutral particles in association with gravitational wave events and other transient events, such as the anomalous blazar TXS 0506+056, complement those performed by specialized instruments at lower energies, extending the energy range of current multimessenger studies to the UHE regime.

In the contribution, the various activities concerning multimessenger astronomy at the Pierre Auger Observatory are presented and the current results are summarized. In addition, future perspectives in the scope of the ongoing AugerPrime upgrade will be discussed.

Invited Topical Talk T 53.3 Wed 14:40 HSZ/0003
Positron annihilation as an astrophysical messenger — •Thomas Siegert — Institut für Theoretische Physik und Astrophysik, Julius Maximilians Universität, Würzburg, Germany

One of the major tasks of astrophysics is to understand the emission mechanisms of observed sources and regions in the sky. Only by pinpointing down these mechanisms, it is possible to derive physical parameters and learn about the evolution of astrophysical objects. Alas, many observations of high-energy phenomena are ambiguous, requiring more and orthogonal information. The nature of several sources,

among others accreting X-ray binary systems, core-collapse and thermonuclear supernovae, cosmic-rays, stellar flares and potentially dark matter, all show signatures of positron production and annihilation. Utilising this underrated emission mechanism can shed light on unsolved problems in astrophysics and cosmology.

In this talk, I will show examples of how we can learn from these gamma-ray signatures already now, and what might be possible in the context of new gamma-ray satellite missions, such as the accepted NASA mission COSI.

Invited Topical Talk T 53.4 Wed 15:00 HSZ/0003
The first results of the XENONnT experiment and an outlook to the future DARWIN observatory — •Andrii Terliuk for the XENON-Collaboration — Universität Heidelberg, Heidelberg, Germany — Max-Planck-Institut für Kernphysik, Heidelberg, Germany

The nature of Dark Matter is one of the most important open questions in today's particle physics and cosmology. The XENONnT experiment at the Gran Sasso Laboratory in Italy aims to discover it using a dual-phase time projection chamber filled with 6 tonnes of liquid xenon. It was commissioned in 2021 and shows an excellent performance in terms of background and purity levels. In this talk we will present the status and results obtained with the first XENONnT science run. Furthermore, we will introduce the future DARWIN observatory that will have the mass of at least 50 tonnes of liquid xenon, while further improving background levels and purity.

T 54: Flavor IV

Time: Wednesday 15:50–17:20 Location: HSZ/0304

T 54.1 Wed 15:50 HSZ/0304
Systematic Parametrization of the B-meson Light-Cone Distribution Amplitude — Thorsten Feldmann[1], •Philip Lüghausen[1], and Danny van Dyk[2] — [1]Theoretische Physik 1, Universität Siegen, Walter-Flex-Straße 3, D-57068 Siegen, Germany — [2]Institute for Particle Physics Phenomenology, Durham University, Durham DH1 3LE, UK

The light-cone distribution amplitude (LCDA) of the B meson provides the essential non-perturbative input in the QCD factorization approach to calculate, for example, the $B \to \gamma\ell\nu$ decay amplitude.
While previous phenomenological analyses were based on specific model assumptions for the LCDA, we propose a systematic parametrization with suitable properties: (1) to extract information about the LCDA from experimental data, (2) to perform analytical calculations in QCD-based approaches, and (3) to obtain numerical estimates for observables with controlled theoretical uncertainties.

T 54.2 Wed 16:05 HSZ/0304
New Physics Studies in $B_q^0 - \bar{B}_q^0$ Mixing — Kristof De Bruyn[1,5], Robert Fleischer[1,2], •Eleftheria Malami[3,1], and Philine van Vliet[4] — [1]Nikhef, Science Park 105, 1098 XG Amsterdam, Netherlands — [2]Vrije Universiteit Amsterdam, 1081 HV Amsterdam, Netherlands — [3]Center for Particle Physics Siegn (CPPS), Theoretische Physik 1, Universität Siegen, D-57068 Siegen, Germamy — [4]Deutsches Elektronen-Synchrotron DESY, Notkestr. 85, 22607 Hamburg, Germany — [5]Van Swinderen Institute for Particle Physics and Gravity, University of Groningen, 9747 Groningen, Netherlands

Neutral $B_q - \bar{B}_q$ mixing (where $q = d, s$) is a powerful probe for testing the Standard Model and searching for New Physics. Focusing on the analyses of the different determinations of the Unitarity Triangle apex, we explore how much room for New Physics is left through the available experimental data. We discuss the discrepancies between inclusive and exclusive $|V_{ub}|$ and $|V_{cb}|$ CKM matrix elements and the determination of the angle γ. Presenting future scenarios, we discuss the application of our findings to leptonic rare B decays, allowing us to minimise the CKM parameters impact in the New Physics searches. We explore the impact of increased precision on key input measurements, performing future projections. It will be exciting to see how the data will evolve in the high-precision era of flavour physics.

T 54.3 Wed 16:20 HSZ/0304
Flavour Tagging in Run 3 at LHCb — •Micol Olocco[1], Claire Prouve[2], Biljana Mitreska[1], and Johannes Albrecht[1] — [1]TU Dortmund University, Dortmund, Germany — [2]University of Santiago de Compostela, Santiago, Spain

The knowledge of the B meson flavour at time of production is crucial for measurements of time-dependent CP violation and flavour oscillations. Flavour tagging algorithms exploit correlations between the B meson flavour and features of the global event in order to tag the candidate as B or $\overline{B}$ with a corresponding efficiency and mistag probability. Beside the information that is saved in real time, it is fundamental to optimize the tagging power of the algorithm since it heavily affects the uncertainty on the CP asymmetry factor.

In the Run 3 of the LHC, the LHCb experiment will operate at the average non-empty bunch crossing rate of 30 MHz with an upgraded detector and a solely software-based trigger. The current status and challenges in flavour tagging algorithms for Run 3 are presented, together with their estimated performance at trigger level.

T 54.4 Wed 16:35 HSZ/0304
Automation of the Flavor tagging calibration software in the ATLAS experiment — •Marawan Barakat for the ATLAS-Collaboration — Platanenallee 6, 15738 Zeuthen

Particle cascades originating from quarks and gluons decays (jets) are omnipresent in proton-proton collisions at the LHC. The identification of jet flavors is essential for many physics searches at the ATLAS experiment. This is achieved using machine learning algorithms (taggers) trained with simulated Monte Carlo events. Due to simulations imperfections, the taggers performance need to be measured in data in order to extract correction factors for the simulation predictions. ATLAS is using a set of calibration software for different jets flavors, which are complicated to use, specially for non-experts. In order to make the software easier, more flexible and more time efficient, automation workflows are defined. This study shows the framework used to automate the calibration of the flavor tagging software using REANA platform. The results are compared to the official results from ATLAS calibration with 139 fb^-1 of 13 TeV collisions data from ATLAS. Same technique can be extended to RUN III of ATLAS and other analyses beyond Flavor Tagging.

T 54.5 Wed 16:50 HSZ/0304
Light Separation with the Topological Track Reconstruction in an idealised water-based liquid scintillator detector as study for Theia — Daniel Bick, Caren Hagner, and •Malte Stender — Universität Hamburg, Institut für Experimentalphysik

In neutrino physics, large unsegmented liquid scintillator or water Cherenkov detectors are often the tool of choice. Where the scintillation type excels in energy reconstruction, shower identification via the $\mathrm{d}E/\mathrm{d}x$ and a low detection threshold, the water Cherenkov detectors perform very well in direction reconstruction, particle identification via the fuzziness of the Cherenkov rings and background reduction with the number of rings. Experiments like the proposed Theia plan to combine the detection capabilities of both detector types and use water-based liquid scintillator (WbLS) as active volume. In order to unlock the full potential of these new detectors, a successful separation of Cherenkov and scintillation photons is of vital importance.
The Cherenkov scintillation photon separation is the focus of this work. Different light separation algorithms are implemented and studied in the context of a simulated idealised WbLS detector, which has a maximum optical coverage of Large Area Picosecond Photodetectors. These photodetectors feature a good spatial resolution of $\sim 1\,\mathrm{mm}$ and an excellent time resolution of $\sim 0.1\,\mathrm{ns}$ compared to the few nanoseconds PMTs typically achieve.
This contribution introduces the detector simulation, discusses the used light separation algorithms including the Topological Track Reconstruction and shows first results.

T 54.6 Wed 17:05 HSZ/0304
Sensitivity Studies for the Theia Experiment at LBNF — •Wei-Chieh Lee, Caren Hagner, and Daniel Bick — Institut für Experimentalphysik, Universität Hamburg, Hamburg, Germany

Theia is a next-generation neutrino detector, which can achieve great

precision in neutrino event reconstruction and background rejection by exploiting both Cherenkov radiation and scintillation light. With this type of detectors, the nature of neutrinos may be further investigated to provide answers to unsolved questions in physics, especially those considering the mass ordering and the possible CP violation of neutrinos. For this purpose, the detector is proposed to be constructed at the Long-Baseline Neutrino Facility (LBNF) in the United States, alongside the Deep Underground Neutrino Experiment (DUNE) far detectors. The General Long Baseline Experiment Simulator (GLoBES) software package is utilized for the detector performance simulation. In this talk, studies of Theia's ability to discover CP violation will be presented with details, including effects from variations in oscillation parameters and systematic uncertainties. With conservative assumptions and 7 years of data, Theia can ultimately have $> 3\sigma$ ($> 5\sigma$) sensitivity to CP violation for 60% (20%) of δ_{CP} parameter space in the case of normal (inverted) mass ordering.

T 55: Flavor V, Top-BSM

Time: Wednesday 15:50–17:20 Location: HSZ/0401

T 55.1 Wed 15:50 HSZ/0401

Measurement of the isospin asymmetry in $B \to K^*\mu^+\mu^-$ decays with LHCb — Christoph Langenbruch, •Thomas Oeser, and Stefan Schael — I. Physikalisches Institut B, RWTH Aachen

In the Standard Model (SM), $b \to s\ell^+\ell^-$ transitions are forbidden at tree level and can only occur via loop-level and higher-order processes. Precision measurements of these processes therefore constitute powerful tests of the SM, sensitive to various potential New Physics contributions.

The isospin asymmetry $\mathcal{A}_I$ between $B^0 \to K^{*0}\mu^+\mu^-$ and $B^+ \to K^{*+}\mu^+\mu^-$ has a clean SM prediction as many hadronic uncertainties cancel in the calculation. Previous measurements are consistent with SM expectations, within still large uncertainties.

This talk presents an overview of the analysis of the isospin asymmetry in $B \to K^*\mu^+\mu^-$ using the full LHCb dataset, recorded between 2011 and 2018 and corresponding to an integrated luminosity of approximately 9fb^{-1}.

T 55.2 Wed 16:05 HSZ/0401

Inclusive analysis of untagged $B \to Xl^+l^-$ decays at Belle II — •Arul Prakash Sivagurunathan, Sviatoslav Bilokin, and Thomas Kuhr — Ludwig-Maximilians-Universität München

Precision measurements of inclusive $B \to Xl^+l^-$ decays can provide invaluable complementary information to scrutinize anomalies observed in their exclusive $b \to sl^+l^-$ counterparts. However, limited tagging efficiency, small Standard Model signal and very high background rate make these measurements very challenging, with no results being published so far. In our work, we will assess the chances of a 5σ result with data from the Belle and Belle II experiments. We will apply machine learning algorithms to tackle background rejection. We will finally compute the lepton flavour universality ratio $R(X) = B(B \to X\mu^+\mu^-)/B(B \to Xe^+e^-)$ which, together with $R(K)$ and $R(K^*)$, will be key to constrain potential New Physics contributions.

T 55.3 Wed 16:20 HSZ/0401

Testing Lepton Flavour Universality with $B_s^0 \to \phi\ell^+\ell^-$ decays using LHCb data — Christoph Langenbruch, Stefan Schael, and •Sebastian Schmitt — I. Phys. Inst. B RWTH Aachen

In the Standard Model of Particle Physics (SM), $b \to s\ell^+\ell^-$ transitions are forbidden at tree-level and may only occur at the loop-level. The branching fractions of these so-called Flavour Changing Neutral Currents (FCNCs) can thus be significantly affected by New Physics (NP) beyond the SM. While in the SM, the coupling of the electro-weak gauge-bosons is Lepton Flavour Universal (LFU), this universality can be broken in NP scenarios. Ratios of branching fractions of semileptonic rare decays with muons and electrons in the final state constitute clean SM tests.

The LHCb detector is located at the Large Hadron Collider (LHC) at CERN and is optimised to study rare b-hadron decays. For this purpose LHCb features high trigger efficiencies, excellent track reconstruction, and particle identification.

This talk gives an overview of the measurement of lepton universality $R_\phi = \mathcal{B}(B_s^0 \to \phi\mu^+\mu^-)/\mathcal{B}(B_s^0 \to \phi e^+e^-)$, which benefits from the experimentally clean $B_s^0 \to \phi\ell^+\ell^-$ environment. The analysis uses the full Run 1 and Run 2 dataset collected by LHCb which corresponds to $9\,\text{fb}^{-1}$ of integrated luminosity.

T 55.4 Wed 16:35 HSZ/0401

Measurement of the branching fractions and differential kinematic distributions of $B^{+/0} \to XJ/\psi$ with hadronic tagging — Florian Bernlochner[1], Jochen Dingfelder[1], Thomas Kuhr[2], •Martin Angelsmark[1], William Sutcliffe[1], and Sviat Bilokin[2] for the Belle II-Collaboration — [1]Physikalisches Institut der Rheinischen Friedrich-Wilhelms-Universität Bonn — [2]Fakultät für Physik der Ludwig-Maximilians-Universität München

Using data from the Belle II experiment we perform the first measurements of the individual branching fractions $B(B^0 \to XJ/\psi)$ and $B(B^+ \to XJ/\psi)$. The Belle II experiment is located at the superKEKB e^+e^- collider in Japan. The collisions are performed at the $\Upsilon(4S)$ resonance leading to a large amount of produced $B\bar{B}$ pairs. One of the B mesons (tag B meson) is fully reconstructed using the Full Event Interpreter (FEI) algorithm, which then gives full kinematic information about the opposite B (signal candidate). Previous analyses measured the admixture of B^0 and B^+, but using the B tag we can separate B^0 and B^+ candidates. A tagged approach also makes it possible to measure the shape distributions of the kinematic variables X mass, J/ψ momentum and absolute helicity angle. This measurement is also an important background study for a future inclusive $B \to X\ell\ell$ analysis, where XJ/ψ is one of the major backgrounds. This talk will present the current status of the analysis and predicted systematics with 364 fb^{-1} integrated luminosity.

T 55.5 Wed 16:50 HSZ/0401

Search for flavour-changing neutral current couplings between the top-quark and the Higgs boson in the $H \to WW/ZZ$ decay channel with the ATLAS detector at the LHC. — Marvin Geyik, •Oliver Thielmann, and Wolfgang Wagner — Bergische Universität Wuppertal, Germany

A search for flavour-changing neutral current (FCNC) couplings between the top-quark and the Higgs boson in the $H \to WW/ZZ$ decay channel in the tri-lepton final state is presented. The search for FCNC couplings in the top-quark-Higgs-boson sector is a promising search for a theory beyond the SM. Proton-proton collision data produced by the LHC at a centre-of-mass energy of $\sqrt{s} = 13$ TeV and collected by the ATLAS experiment during the years 2015 - 2018, and corresponding to an integrated luminosity of $139fb^{-1}$, are used. Data is analysed in different final states, characterised by three isolated electrons or muons, missing transverse energy and the number of jets where exactly one of them is identified as a b-jets. A machine learning analysis based on neural networks is conducted to improve the discrimination between the signal and the backgrounds. Preliminary results, interpreted in the context of an effective field theory for FCNC, are presented, where additional exclusion limits on the qtH effective coupling are derived.

T 55.6 Wed 17:05 HSZ/0401

Search for FCNC couplings between the top quark and the Higgs boson in dilepton same-charge final states — •Marvin Geyik, Oliver Thielmann, and Wolfgang Wagner — University of Wuppertal, Germany

Flavour-changing neutral current interactions are strongly suppressed in the Standard Model. Still, some extensions of the Standard Model predict tree-level FCNC couplings between the top quark, other up-type quarks and neutral bosons, including the Higgs boson. These anomalous couplings can be parametrised in the framework of effective field theories (EFT). The presented analysis searches for the production of a single top-quark in association with a Higgs boson and for top-quark-antiquark production with one of the top quarks decaying to an up quark or a charm quark and a Higgs boson. Higgs decays to WW*, ZZ* and two taus leading to leptonic final states are considered in the event selection. Two analysis channels are defined: one with two leptons (electrons or muons) of the same electric charge and a second

channel with three leptons. This talk focuses on advancements in the dilepton final state and the combination with the trilepton channel. The sensitivity of the analysis in setting limits to relevant coefficients of EFT operators will be presented.

T 56: Searches EW I

Time: Wednesday 15:50–17:20 Location: HSZ/0403

T 56.1 Wed 15:50 HSZ/0403

Search for charged Higgs bosons in $H^+ \to Wh$ decays with the ATLAS detector — •Shubham Bansal, Jochen Dingfelder, and Tatjana Lenz — Physikalisches Institut, University of Bonn, Germany

After the discovery of the Higgs boson at a mass of 125 GeV, the last missing piece of the Standard Model (SM) was presumably found. However, various theories beyond the SM predict additional Higgs bosons, one of which could be the observed Higgs boson at 125 GeV. One such example is the Two-Higgs-Doublet Model (2HDM) that features an extended scalar sector including the existence of charged Higgs bosons (H^+). The H^+ production mechanism depends on its mass (m_{H^+}) and for $m_{H^+} > m_t + m_b$, the leading H^+ production mode is the associated production with a top and a bottom quark via $gg \to tbH^+$. In the alignment limit for 2HDM, the dominant decay mode is $H^+ \to tb$. However, in models like N2HDM and the Georgi-Machacek (GM) model, it is possible to obtain a sizable branching ratio for $H^+ \to Wh$.

This talk presents a search for charged Higgs bosons in $H^+ \to Wh(\to b\bar{b})$ decays. The analysis strategy is presented and a focus is put on the data-driven improvements of the modelling of the main background from $t\bar{t}$ production, the event classification technique to separate the leptonic and hadronic decay modes of the W boson from the H^+ decay. Finally, the fit model is discussed to derive the first estimate of the expected sensitivity for the full Run-2 ATLAS dataset.

T 56.2 Wed 16:05 HSZ/0403

Constraints on spin-0 dark matter mediators and invisible Higgs decays using ATLAS 13 TeV *pp* collision data with two top quarks and missing transverse momentum in the final state. — •Marco Rimoldi for the ATLAS-Collaboration — DESY, Hamburg, Germany

Results of a statistical combination of searches targeting final states with two top quarks and invisible particles, characterised by the presence of zero, one or two leptons, at least one jet originating from a b-quark and missing transverse momentum are presented.

The analyses are searches for phenomena beyond the Standard Model consistent with the direct production of dark matter in pp collisions at the LHC, using 139 fb^{-1} of data collected with the ATLAS detector at a centre-of-mass energy of 13 TeV.

The results are interpreted in terms of simplified dark matter models with a spin-0 scalar or pseudoscalar mediator particle. In addition, the results are interpreted in terms of upper limits on the Higgs boson invisible branching ratio, where the Higgs boson is produced according to the Standard Model in association with a pair of top quarks.

T 56.3 Wed 16:20 HSZ/0403

Search for a charged Higgs boson decaying to cs in the low mass region with the ATLAS detector at $\sqrt{s} = 13$ TeV — Jochen Dingfelder, Tatjana Lenz, and •Christian Nass — Physikalisches Institut, Universität Bonn, Deutschland

In the Standard Model (SM) electroweak symmetry breaking (EWSB) is introduced by a single complex scalar field. The consequence is the prediction of a scalar, neutrally charged particle, the Higgs boson, which was discovered at the LHC in 2012 at the LHC. A simple extension of the SM is to introduce EWSB through two complex scalar fields. Such two-Higgs doublet models (2HDM) are attractive because they offer the opportunity to include additional CP violation in the SM, which is needed for explaining baryogenesis. 2HDMs feature 3 neutral and 2 charged Higgs bosons. An observation of such a charged scalar particle would be a striking signal of physics beyond the SM.

In the low mass region, $m_H^{\pm} < m_t$, the dominant production mode is by a $t\bar{t}$ pair with one t-quark decaying to $H^{\pm}b$. At low masses, the search for $H^{\pm} \to cs$ decays is promising, as suggested in several theory papers. This talk presents the analysis strategy to define signal-enriched and -depleted regions as well as the expected sensitivity for the $H^{\pm} \to cs$ search, including a complete set of systematics uncertainties, with the full Run-2 ATLAS dataset.

T 56.4 Wed 16:35 HSZ/0403

Search for $A \to ZH \to \ell\ell t\bar{t}$ at $\sqrt{s} = 13$ TeV with the ATLAS detector — •Roman Kuesters, Tetiana Moskalets, and Spyros Argyropoulos for the ATLAS-Collaboration — University of Freiburg, Freiburg im Breisgau, Germany

The generation of the existing matter-antimatter asymmetry in the observable universe is one of the biggest open questions that cannot be explained with the standard model and therefore requires physics beyond the standard model.

Many models suggest that electroweak symmetry breaking can generate the matter-antimatter asymmetry, however an extended Higgs sector is needed to satisfy the conditions for baryogenesis.One of the simplest extensions are models with two Higgs doublets, which give rise to 5 Higgs bosons. In these models a large mass splitting between the heavy CP-odd boson A and the CP-even boson H is required for successful baryogenesis.

The analysis, which will be presented, searches for the decay of the A boson into a heavy H boson and a Z boson. The heavy H boson subsequently decays into two top quarks, while the Z boson decays leptonically. This final state will allow us to probe the the parameter space with $m_H > 350\,\text{GeV}$, which remains so far unexplored. In the presentation the analysis optimisation and the setup for the statistical analysis will be shown. Finally the expected exclusion limits will be presented.

T 56.5 Wed 16:50 HSZ/0403

Search for photon-induced semileptonic WW production at the ATLAS Experiment — •Varsiha Sothilingam for the ATLAS-Collaboration — Kirchhoff-Institut für Physik, Universität Heidelberg

Due to the non-abelien nature of the electroweak sector of the Standard Model of Particle Physics (SM), direct interactions between gauge couplings are possible. Measurements of the cross sections of these interactions allow for validation of the SM and potential deviations from it opens possibilities for physics beyond the SM. This talk will focus on the coupling between W bosons and photons where the W bosons decay semileptonically. They interact via the triple ($\gamma \to WW$) and quartic ($\gamma\gamma \to WW$) gauge couplings of the SM. This process can be produced via Centrally Exclusive Production at the LHC, where non-colliding protons produce a non-linear electromagnetic field which creates a photon pair. The photons couple to the W bosons, providing the signal of interest while the protons remain intact. These protons can be detected using the ATLAS Forward Proton (AFP) spectrometers, which are located around 200m away from the ATLAS detector, on both sides. This talk will provide insight to the measurement of this rare process and the methods used to optimise its signal. It will provide an insight to the different models of the final state which take advantage of the boosted topology of such events.

T 56.6 Wed 17:05 HSZ/0403

Probing the use of advanced observables for measuring the electromagnetic dipole moments of the tau lepton — •Kartik Bhide, Valerie Lang, and Markus Schumacher — Albert-Ludwigs-Universität Freiburg

Precise measurements of the anomalous magnetic moments (a_ℓ) and the electric dipole moments (d_ℓ) of leptons are strong tests of the predictions of the Standard Model (SM), and can be used to constrain theories beyond the SM. Recent measurements of a_τ by the ATLAS and CMS Collaborations demonstrate the ability to perform such measurements in ultra-peripheral lead-lead collisions, via the $\gamma\gamma \to \tau\bar{\tau}$ process. Improving future measurements of a_τ and d_τ can be done by exploiting advanced observables instead of simple kinematic distributions. In this work, the use of observables inspired by matrix element methods is explored for measuring the electromagnetic moments of the tau lepton, in Monte Carlo events produced by the gamma-UPC event generator integrated with MadGraph5. Studies of the performance of these advanced observables at particle level, in particular regarding the extraction of a_τ will be presented.

T 57: Single Top – Higgs Top

Time: Wednesday 15:50–17:20 Location: HSZ/0101

T 57.1 Wed 15:50 HSZ/0101

EFT interpretation of a t-channel single top-quark production cross-section measurement in proton-proton collisions at a centre-of-mass energy of 13 TeV with the ATLAS detector — Benedikt Gocke[2], Dominic Hirschbühl[1], Joshua Reidelstürz[1], •Maren Stratmann[1], and Wolfgang Wagner[1] — [1]Bergische Universität Wuppertal, Wuppertal, Deutschland — [2]Technische Universität Dortmund, Dortmund, Deutschland

Effective field theories (EFTs) provide a model-independent approach for searches for physics beyond the Standard Model (SM). The impact of new physics at high energy scales is parameterized by higher-dimension operators extending the SM Lagrangian.

In this talk, an EFT interpretation of a t-channel single top-quark production cross-section measurement is presented. Constraints on the four-fermion operator $O_{qQ}^{(1,3)}$ are set. The impact of a non-zero contribution of $O_{qQ}^{(1,3)}$ is studied from dedicated samples with simulated events. Constraints on the operator strength are set from a fit to data collected by the ATLAS detector from 2015 to 2018 at a centre-of-mass energy of 13 TeV.

T 57.2 Wed 16:05 HSZ/0101

Constraining effective field theory coefficients with machine learning in top quark pair production at CMS — •andre zimermmane-santos, gilson correia, afiq anuar, alexander grohsjean, and christian schwanenberger — Deutsches Elektronen-Synchrotron DESY, Notkestraße 85, D-22607 Hamburg

Effective Field Theories (EFT) provide a systematic way to look for physics beyond the Standard Model (SM) via indirect searches. Nevertheless even the most restrictive scenarios contain dozens of operators predicting subtle deviations from the SM. Such small effects could only be significantly measured over a high-dimensional space of observables. While this complex problem does not scale well with traditional analysis approaches, *likelihood-free inference* methods based on machine learning (ML) techniques can be combined with the knowledge of the EFT structure to perform test statistics efficiently using several EFT parameters as well as a high number of observables. In this study, we aim at applying recent developments in ML-based inference on the measurement of all QCD-like dimension-six EFT operators in the top quark pair production process at the LHC.

T 57.3 Wed 16:20 HSZ/0101

Search for the tWZ process in the boosted region with the CMS experiment — •Michele Mormile[1], Abideh Jafari[2,3], and Alessia Saggio[2] — [1]Institute of Experimental Particle Physics (ETP), Karlsruhe Institute of Technology (KIT) — [2]Deutsches Elektronen-Synchrotron (DESY) — [3]Isfahan University of Technology

Searching for rare processes is a fundamental instrument in testing our understanding of the universe. The high luminosity of proton-proton collisions delivered by the LHC in the 2016-2018 period (Run 2) allows us to search for processes with cross sections in the order of magnitude of 100 fb, such as the associated production of a single top quark with a W and a Z boson (tWZ). The tWZ process has never been observed and has been shown to be promisingly sensitive to new physics in the context of SM Effective Field Theory (SMEFT), especially in the high-p_T spectrum of the final state products. An ongoing search for tWZ in the boosted top quark regime is presented. The data has been collected by the CMS experiment during LHC Run 2 and amounts to 138 fb^{-1}. Final states with three leptons are explored, where the Z boson decays to two oppositely charged leptons, either the W boson or the top quark decays leptonically, the remaining one decays hadronically. A boosted leptonic top tagger was developed using a deep neural network to identify leptons and b-jets arising from the decay of a top quark. The tagger was validated in a phase space pure in events of top quark-antiquark pair production, with both tops decaying into leptons. The results are included in an inclusive tWZ search.

T 57.4 Wed 16:35 HSZ/0101

Search for *tWZ* production at CMS and its interpretation in the SMEFT — •Alberto Belvedere, Roman Kogler, and Katerina Lipka — DESY, Hamburg, Germany

The production of a single top quark t in association with a W and a Z boson in proton-proton collisions has not been observed so far. Its small predicted cross section of 115 fb^{-1} at $\sqrt{s} = 13$ TeV and a large background from ttZ production make this process very challenging to study. However, tWZ production receives large contributions from beyond-the-standard-model (BSM) theories through the electroweak interaction of the top quark, making this process an important probe of BSM physics. In the context of the Standard Model Effective Field Theory (SMEFT), tWZ is sensitive to unitarity violating effects, leading to an anomalous growth of the cross section as a function of the energy.

A search using Run 2 and 3 data collected by the CMS experiment at $\sqrt{s} = 13$ and 13.6 TeV offers the possibility to study tWZ with high significance. A status of the ongoing efforts is presented, including studies of the discriminating power of selected variables between tWZ and ttZ. Additionally, the sensitivity to different SMEFT dimension-6 operators is shown.

T 57.5 Wed 16:50 HSZ/0101

tbH$^+$ analysis with multileptons with Run-2 ATLAS data — •Martin Rames and Andre Sopczak — CTU in Prague

The latest results with Run-2 ATLAS data are presented for the search tbH$^+$ in the multilepton channel.

T 57.6 Wed 17:05 HSZ/0101

CP-violation, Asymmetries and Interferences in ttphi — •Duarte Azevedo[1,2], Rodrigo Capucha[3], António Onofre[4], and Rui Santos[3,5] — [1]Institute for Theoretical Physics, Karlsruhe Institute of Technology, 76128 Karlsruhe, Germany — [2]Institute for Astroparticle Physics, Karlsruhe Institute of Technology, 76344 Karlsruhe, Germany — [3]Centro de Fisica Teórica e Computacional, Faculdade de Ciências, Universidade de Lisboa, Campo Grande, Edificio C8 1749-016 Lisboa, Portugal — [4]Departamento de Fisica , Universidade do Minho, 4710-057 Braga, Portugal — [5]ISEL - Instituto Superior de Engenharia de Lisboa, Instituto Politécnico de Lisboa 1959-007 Lisboa, Portugal

We present the results of our paper, where we use the associated production of top-quark pairs (t\bar{t}\phi) with a generic scalar boson (\phi) at the LHC (pp \to t\bar{t}\phi) to explore the sensitivity of a large set of observables to the sign of the CP mixing angle (\alpha), present in the coupling between the scalar boson and the top quarks.

The mass of the scalar boson is set to m_\phi = 125 GeV (the Standard Model Higgs boson mass) and its coupling to top-quarks is varied such that \alpha = 0, 22.5, 45.0, 67.5, 90.0, 135.0 and 180.0. Dileptonic final states of the t\bar{t}\phi system are used, where the scalar boson is set to decay as \phi \to b\bar{b}.

The most sensitive CP-observables are selected to compute Confidence Level (CL) limits as a function of the sign of the top quark Yukawa couplings to the \phi boson.

T 58: Other Exp., $t\bar{t}$

Time: Wednesday 15:50–17:20 Location: HSZ/0103

T 58.1 Wed 15:50 HSZ/0103

Charge detection via proportional scintillation in a single-phase liquid xenon TPC — •Florian Tönnies — Albert-Ludwigs-Universität Freiburg

Dual-phase liquid/gas xenon TPCs are a well-established detector technology to search for WIMP Dark Matter. Nevertheless, the spatially uniform detection of the charge signal in the standard way, i.e., via proportional scintillation in the gaseous xenon, will be challenging at the scale of the next-generation detectors due to the size of the TPCs. The detection of the charge signal in the liquid phase of a single-

phase TPC is a promising option to circumvent this issue. In Freiburg we successfully operated a single-phase TPC demonstrator which exploits proportional scintillation in the strong electric field around very thin wires. Some of the most recent results will be presented in this talk.

T 58.2 Wed 16:05 HSZ/0103

Luminosity measurements using the ATLAS Forward Proton (AFP) detector — •Petr Fiedler and Andre Sopczak — CTU in Prague

The latest results of luminosity measurements using the AFP detector are presented.

T 58.3 Wed 16:20 HSZ/0103

Measurement of the top-quark pair to Z-boson production cross-section ratio at a centre-of-mass energy of 13.6 TeV with the ATLAS detector — •Donna Maria Mattern, Tomáš Dado, and Kevin Kröninger — TU Dortmund, Fakultät Physik

The ratio of the top-quark-pair production cross-section to the Z-boson production cross-section is sensitive to the gluon-to-quark ratio of parton distribution functions and other parameters that allow to study the Standard Model, such as the strong coupling constant and the top-quark mass.

A measurement of the top-quark-pair and Z-boson production cross-section, as well as the cross-section ratio, using data collected in proton-proton collisions in 2022 during the early Run 3 of the Large Hadron Collider (LHC) at a center-of-mass energy of 13.6 TeV with the ATLAS experiment, corresponding to an integrated luminosity of 1.2 fb^{-1}, is presented.

Events with an oppositely charged electron-muon pair, as well as b-tagged jets, are used for the top-quark-pair production, while same-flavor dileptonic events are used for the Z-boson production cross-section measurement.

The probability to reconstruct and tag a b-jet is measured in-situ. A large cancellation of the luminosity uncertainty is achieved in the ratio, while this uncertainty is otherwise dominant in cross-section measurements in the early stages of the Run 3 of the LHC. This early result at the new center-of-mass energy at the LHC also serves to validate data quality, hardware and software updates.

T 58.4 Wed 16:35 HSZ/0103

top-Yukawa coupling extraction from $t\bar{t}$ cross-section using ATLAS data — •Supriya Sinha for the ATLAS-Collaboration — DESY Zeuthen

The aim of this analysis is to extract the top-Yukawa coupling (Y_t) from the $t\bar{t}$ cross-section close to the threshold. The presence of a virtual Higgs boson in the loop for the $t\bar{t}$ production process affects several kinematic distributions. This boson exchange mainly modifies the differential distributions near the $t\bar{t}$ production threshold energy. It becomes highly sensitive to Y_t, and hence, is used to extract its value.

This talk introduces the involved physics processes and gives an insight to the analysis strategy. It also highlights a method to reconstruct the $t\bar{t}$ mass efficiently with a minimal bias. The decay channel considered for this analysis is the lepton+jets final state. Full Run-II data with an integrated luminosity of 139 fb^{-1} taken by the ATLAS experiment at 13 TeV, is used.

T 58.5 Wed 16:50 HSZ/0103

First measurement of the top quark pair production cross section at $\sqrt{s} = 13.6$ TeV at the CMS experiment — Maria Aldaya, Alexander Grohsjean, •Laurids Jeppe, Andreas Meyer, Evan Ranken, and Christian Schwanenberger — Deutsches Elektronen-Synchrotron DESY, Notkestraße 85, D-22607 Hamburg

Recently, the Large Hadron Collider (LHC) at CERN reached a new, unprecedented center-of-mass energy of $\sqrt{s} = 13.6$ TeV, starting LHC Run 3. This presents the opportunity to measure relevant physical quantities at the new energy frontier, thereby checking the predictions of the standard model.

In this talk, we present the first measurement of the top quark pair production cross section at $\sqrt{s} = 13.6$ TeV, using data recorded at the CMS detector. The analysis uses a new method combining dilepton and lepton+jets decay channels, constraining several experimental uncertainties such as lepton selection and b jet identification efficiencies in situ. This result also constitutes a first validation of the new data taken by CMS in LHC Run 3.

T 58.6 Wed 17:05 HSZ/0103

Measurement of the dileptonic $t\bar{t}$ differential cross section in a BSM phase space at CMS — Lutz Feld, •Danilo Meuser, Philipp Nattland, and Marius Teroerde — I. Physikalisches Insitut B, RWTH Aachen University

Measurements of the $t\bar{t}$ production cross section yield important precision tests of the Standard Model (SM), while also probing scenarios for physics beyond the SM (BSM).

This analysis aims to measure the $t\bar{t}$ cross section in a phase space where additional contributions from BSM scenarios could be present. It is based on the data set recorded by CMS in the years 2016 to 2018 at a center-of-mass energy of 13 TeV, corresponding to an integrated luminosity of 138 fb^{-1}. The BSM scenarios considered include supersymmetric and dark matter models, where, similarly to the dileptonic $t\bar{t}$ channel, two leptons, b jets and undetected particles are produced.

Unlike previous measurements, where the differential cross sections were mainly measured as a function of kinematic variables of the leptons or top quarks, this analysis focuses on observables related to the neutrinos, like the missing transverse momentum and the angular distance between the missing transverse momentum and the nearest lepton, to separate BSM from SM $t\bar{t}$ events. In order to increase the sensitivity of the analysis multivariant techniques are used which improve the resolution of the missing transverse momentum in SM $t\bar{t}$ events. In this talk the analysis strategy will be presented and preliminary results on the improved missing transverse momentum resolution and on systematic uncertainties will be shown.

T 59: QCD Theory and Experiment I

Time: Wednesday 15:50–17:20 Location: HSZ/0105

T 59.1 Wed 15:50 HSZ/0105

Measurement and QCD analysis of inclusive jet production in deep inelastic scattering at ZEUS — •Florian Lorkowski — DESY, Hamburg, Germany

The measurement of cross sections of deep inelastic scattering processes at the electron-proton collider HERA is a well established tool to test perturbative QCD predictions. Additionally, they can be used to determine the non-perturbative parton distribution functions of the proton. Measurements of jet production cross sections are particularly well suited to also constrain the strong coupling constant.

In this talk, a new measurement of inclusive jet cross sections in neutral current deep inelastic scattering using the ZEUS detector at the HERA collider is presented. The data were taken during the HERA 2 period at a center of mass energy of 318 GeV and correspond to an integrated luminosity of 347 pb^{-1}. Massless jets, reconstructed using the $k_\perp$-algorithm in the Breit reference frame, are measured as a function of the squared momentum transfer Q^2 and the transverse momentum of the jets in the Breit frame $p_{\perp,\mathrm{Breit}}$.

The measured jet cross sections are compared to previous measurements as well as NNLO QCD theory predictions. The measurement is used in a QCD analysis at NNLO accuracy to perform a simultaneous determination of parton distribution functions of the proton and the strong coupling constant. A significantly improved accuracy is observed compared to similar measurements of the strong coupling constant.

T 59.2 Wed 16:05 HSZ/0105

Measurement of the 1-jettiness event shape observable in DIS — Daniel Britzger[1], Sook Hyun Lee[2], and •Johannes Hessler[1] — [1]Max Planck Institute for Physics — [2]University of Michigan

A first measurement of the 1-jettiness event shape observable τ_1^b in neutral-current deep inelastic scattering is presented. The data were taken by the H1 experiment at HERA from 2003 to 2007 at a centre of mass energy of $\sqrt{s} = 319$ GeV. The triple-differential cross sections are

presented as a function of the 1-jettiness τ_1^b, the virtuality of the exchanged boson Q^2 and the inelasticity of the event y. The data exhibit a sensitivity to the strong coupling constant and to resummation and hadronisation effects. The data are compared to selected predictions.

T 59.3 Wed 16:20 HSZ/0105

Fast simulations with NNLO QCD accuracy - new developments in the APPLfast project — •Lucas Kunz — Karlsruhe Institute of Technology, Karlsruhe, Germany

The calculation of theoretical predictions for hadron colliders at higher orders in perturbation theory involves computing time expensive iterative procedures. The same is true for the extraction of parton distribution functions (PDFs) from measured data. Hence, to produce results in reasonable time, a very efficient and flexible setup is needed. The APPLfast project fulfills these requirements by linking the parton-level Monte Carlo program NNLOJET with both the APPLgrid and fastNLO grid libraries, thereby allowing for an a posteriori choice of a set of PDFs or value of the strong coupling constant. This talk will give an overview of the project, focusing on an explanation of the general logic and on possible applications rather than technical details. We will further present some first results for NNLO dijet production at the LHC, both at leading and full color.

T 59.4 Wed 16:35 HSZ/0105

The NNLO beam function for jet-veto resummation — Guido Bell[1], •Kevin Brune[1], Goutam Das[2], Marcel Wald[1], and Ding Yu Shao[3,4] — [1]Theoretische Physik 1, Center for Particle Physics Siegen, Universität Siegen, Germany — [2]Institut für Theoretische Teilchenphysik und Kosmologie, RWTH Aachen University, D-52056 Aachen, Germany — [3]Department of Physics and Center for Field Theory and Particle Physics, Fudan University, Shanghai, China — [4]ey Laboratory of Nuclear Physics and Ion-beam Application (MOE), Fudan University, Shanghai, China

The jet-veto beam function describes collinear initial-state radiation that is constrained by a veto on reconstructed jets. As the veto is imposed on the transverse momenta of the jets, the beam function is subject to rapidity divergences, and we use the collinear-anomaly framework to extract the perturbative matching kernels to next-to-next-to-leading order (NNLO) in the strong-coupling expansion. Our calculation is based on a novel framework that automates the computation of beam functions and provides the ingredients to extend jet-veto resummations to NNLL′ accuracy.

T 59.5 Wed 16:50 HSZ/0105

Numerical multi-loop calculations with pySecDec — •Anton Olsson — Karlsruhe Institute of Technology

We present new features of the program pySecDec, which can serve to calculate loop amplitudes numerically. Examples for 2-loop multi-scale integrals needed for LHC precision physics as well as 3-loop integrals relevant at a future lepton collider will be given.

T 59.6 Wed 17:05 HSZ/0105

The determination of r_0 on the CLS 2+1 ensembles — •Tom Asmussen, Roman Höllwieser, Francesco Knechtli, and Tomasz Korzec — University of Wuppertal, Wuppertal, Germany

We determine the scale r_0 for $2 + 1$ flavour QCD ensembles generated by CLS. This scale is determined from an improved definition of the static force which we measure using Wilson loops. Reweighting factors from the simulations are included in the analysis and mass derivatives have been calculated to correct for mistunings. In the end we present an analysis for r_0/a at several values of the lattice gauge coupling and perform chiral extrapolations. We also compare with the scale t_0.

T 60: Theory BMS

Time: Wednesday 15:50–17:05 Location: HSZ/0201

T 60.1 Wed 15:50 HSZ/0201

Domain walls in the 2HDM and their interactions with standard model fermions — •Mohamed Younes Sassi and Gudrid Moortgat-Pick — II. Institut für Theoretische Physik, Hamburg, Germany

Extended Higgs models such as the 2HDM can induce topological defects after spontaneous symmetry breaking. In this talk, I will discuss the formation of domain walls arising after the breaking of the discrete Z2 symmetry present in the 2HDM. I will, in particular, discuss the property of localized CP and charge violation inside the domain walls and finish with describing how standard model fermions interact with such types of domain walls.

T 60.2 Wed 16:05 HSZ/0201

Dark Matter Phenomenology in Z'2 broken Two Higgs Doublet Model with Complex Singlet Extension — •Julia Ziegler, Juhi Dutta, Cheng Li, Gudrid Moortgat-Pick, and Tabira Farah Sheikh — Universitaet Hamburg, Germany

Although the Standard Model is very successful, there are still open problems which it cannot explain, one of it being dark matter (DM). This has led to various Beyond Standard Model theories, of which Two Higgs Doublet models are very popular, as they are one of the simplest extensions and lead to a rich phenomenology. Further extensions with a complex singlet lead to a natural DM candidate.

The aim of this work is the exploration of the dark sector in a Two Higgs Doublet Model extended by a complex scalar singlet, where the imaginary component of the singlet gives rise to a pseudo-scalar DM candidate. Both, the doublets, and the singlet, obtain a vacuum expectation value (vev), where the singlet vev leads to additional mixing of the doublet and the singlet scalar sector. We examine the influence of the Higgs sector parameters on DM relic density and direct detection scattering cross sections. The results are then compared with constraints from experiments.

T 60.3 Wed 16:20 HSZ/0201

Leading Logarithmic 3-loop Corrections to $(g-2)_\mu$ in the Two-Higgs-Doublet Model — •Kilian Möhling — TU Dresden, Germany

The persistent deviation of the measured value of the anomalous magnetic moment of the muon $(g-2)_\mu$ from the prediction in the Standard Model provides us with one of the currently most tantalizing hints at physics beyond the Standard Model. In the near future, increased statistics and improved theoretical calculations will further reduce the uncertainty of this result which in turn puts stronger constraints on new physics models and motivates more precise calculations of the additional corrections.

In this talk I will focus on the Two-Higgs-Doublet Model as one of the promising explanations of the deviation. Here, the dominant contribution to the magnetic moment arises through two-loop Barr-Zee diagrams with large Yukawa couplings to heavy fermion loops. These diagrams bring with them a large uncertainty from QCD corrections at 3-loop order. I will discuss how this uncertainty can be reduced by including large logarithmic 3-loop contributions resummed in the renormalization group equation of an appropriate effective field theory.

T 60.4 Wed 16:35 HSZ/0201

Scalar Potential in SU(6) Gauge-Higgs Grand Unification — Andreas Bally, Florian Goertz, •Maya Hager, and Aika Marie Tada — Max-Planck-Institut für Kernphysik, Heidelberg, Germany

Composite Grand Unified Theories unify the Standard-Model gauge symmetries and their breaking in a single structure while at the same time offering a solution to the hierarchy problem. In these scenarios, the corrections to the Higgs mass are expected to be at the order of the compositeness scale around a few TeV, significantly decreasing the necessary level of fine-tuning. In the recently proposed SU(6) Gauge-Higgs GUT (GHGUT) by Angelescu et al., the Higgs emerges as a pseudo Nambu-Goldstone boson of the coset SU(6)/SU(5) along with a scalar leptoquark and a scalar singlet. The scalar potential is generated radiatively through explicit symmetry breaking induced by the coupling to elementary fields. To describe the dynamics of the SU(6) GHGUT we work in a 4-dimensional framework using the AdS/CFT correspondence and we employ the Callan-Coleman-Wess-Zumino (CCWZ) mechanism to find the zero temperature potential. The 4D method enables a better analytical understanding of the scalar potential than the numerical study in five dimensions done previously. In addition, it can shed light on open problems such as baryogenesis,

for which we include the finite temperature potential. A small hierarchy remains between the scales and we look at the fine tuning needed to achieve a realistic Higgs mass and vev. Furthermore, phenomenological aspects are investigated, such as the modification of couplings with respect to the SM, or the bounds on the lightest composite resonances.

T 60.5 Wed 16:50 HSZ/0201

Constraining BSM scalars with neural networks — Thomas Flacke[1], Jeong Han Kim[2], •Manuel Kunkel[3], Jun Seung Pi[2], Werner Porod[3], and Leonard Schwarze[3] — [1]Center for AI and Natural Sciences, KIAS, Seoul, Republic of Korea — [2]Department of Physics, Chungbuk National University, Chungbuk, Republic of Korea — [3]Institut für Theoretische Physik und Astrophysik, Julius-Maximilians-Universität Würzburg, Germany

We study a simple extension of the Standard Model motivated by composite Higgs models, in which a doubly charged scalar decays to $W^+t\bar{b}$, resulting in a $4t$-like signature from pair production. We train a neural network to differentiate this BSM signal from the dominant SM backgrounds using jet images and kinematic data. We derive the discovery reach and expected exclusion limit at the LHC. A comparison with recasts of Run-2 analyses shows a significant improvement over cut-based analyses.

T 61: Higgs I

Time: Wednesday 15:50–17:20 Location: HSZ/0204

T 61.1 Wed 15:50 HSZ/0204

ttH analysis with two light leptons and one hadronically decaying tau lepton with Run-2 ATLAS data — •Vladyslav Yazykov and Andre Sopczak — CTU in Prague

The latest results on the analysis with Run-2 ATLAS data are reported on the ttH 2lSS1tau channel.

T 61.2 Wed 16:05 HSZ/0204

Measurement of the inclusive $t\bar{t}H$ Cross-Section in the 4ℓ Final State — •Stephen Eggebrecht, Steffen Korn, Arnulf Quadt, Baptiste Ravina, and Elizaveta Shabalina for the ATLAS-Collaboration — II Physikalisches Institut, Göttingen

The Higgs boson production in association with a top quark pair plays a key role for studying the Yukawa coupling between the Higgs boson and the top quark. The coupling can be determined by measuring the cross-section of the $t\bar{t}H$ production to various finial states. Multilepton final states are quite but pure since most backgrounds are significantly suppressed. The non-resonant $t\bar{t}H \to 4\ell$ process has low rate and is sensitive to various Higgs decay modes like $H \to WW$, $H \to \tau\tau$, and $H \to ZZ$. The dominant background arises from $t\bar{t}Z$ and ZZ events. A multiclass dense neural network (DNN) is trained to separate signal events from these backgrounds and to define analysis regions. Input features such as kinematic information of all final state particles, missing transverse energy, and other high level variables like invariant masses of lepton pairs and their distances are used. An Asimov fit is then performed to evaluate the signal sensitivity.

T 61.3 Wed 16:20 HSZ/0204

Multivariate techniques for measurements of Higgs boson production cross-sections in $H \to WW^* \to e\nu\mu\nu$ decays with the ATLAS experiment — •Ahmed Markhoos, Karl Jakobs, Karsten Köneke, and Benedict Winter — University of Freiburg, Germany

The $H \to WW^* \to e\nu\mu\nu$ channel provides a sizeable signal and moderate background yields, allowing for accurate measurements of the total and differential cross-sections. The measurements for gluon-fusion production are generally dominated by systematic uncertainties, except in the sparsely populated regions of the phase space, such as at large transverse momenta.

In this talk, Deep Neural Network models (DNN) are showcased as powerful tools in tackling this complex but highly sensitive channel. Enhancing the signal purity with respect to the current cut-based selection method, reduces systematic uncertainties from backgrounds and statistical uncertainties, as well as enables measurements of simplified template cross-sections with finer granularity. Additionally, DNNs facilitate the difficult measurement of vector boson fusion in the single jet channel.

T 61.4 Wed 16:35 HSZ/0204

Search for the Higgs plus charm quark production mode in the H→WW→2ℓ2ν channel — •Ming-Yan Lee[1], Spandan Mondal[1], Alena Dodonova[1], Alexander Schmidt[1], Annika Stein[1], Luca Mastrolorenzo[1], Andrzej Novak[1], Xavier Coubez[1,2], Andrey Pozdnyakov[1], Manuella Guirgues[1], and Valentyn Vaulin[1] — [1]RWTH III. Physikalisches Institut A, Aachen, Germany — [2]Brown University, Providence, USA

The Higgs plus charm production mode is another topology to probe Higgs-charm Yukawa coupling complementary to H→cc channels. This topology provides the possibility to access the Higgs-charm coupling via cleaner final states. In this analysis, we aim to consider the Higgs decay into W boson to dileptonic final states with additional charm-tagged jets. The expected upper limit to extract H-c coupling is demonstrated using the data-taking period 2017 of the CMS experiment at the LHC at $\sqrt{s}$ =13 TeV.

T 61.5 Wed 16:50 HSZ/0204

Higgs Boson Cross Section Measurement in the $H \to ZZ \to 4\ell$ Channel with Early Run 3 ATLAS Data — •Alice Reed and Sandra Kortner — Max Planck Institut für Physik, München

Run 3 of the LHC began in July 2022, starting a new period of data taking at a higher centre of mass energy of 13.6 TeV, compared to 13.0 TeV during Run 2. At this higher center of mass energy, the Higgs boson cross section is expected to increase by $\sim 7\%$ compared to Run 2.

An important process for the measurement of the Higgs boson properties is the Higgs boson decay into two Z bosons, which subsequently decay into a $\mu^+\mu_-$ or e^+e^- pair, $H \to ZZ \to 4\ell$. Due to its clear signature, this decay channel can already be studied with early Run 3 data. The precision of the fiducial and differential $H \to 4\ell$ cross section measurements was studied and optimized in preparation for the measurements with early Run 3 data from the ATLAS experiment.

T 61.6 Wed 17:05 HSZ/0204

Measurement of $pp \to WH \to WWW$ with the ATLAS Experiment — •Moritz Hesping, Volker Büscher, Ralf Gugel, and Christian Schmitt — Johannes Gutenberg Universität Mainz

The measurement of the couplings of the Higgs boson is of great scientific interest, since it has the potential of testing possible extensions to the Standard Model. The decay of a Higgs boson into a pair of W bosons after production in association with a W boson is especially useful, since in this process the Higgs boson exclusively couples to W bosons.

In this talk, the analysis of the $pp \to WH \to WWW$ using the full run 2 dataset of the ATLAS experiment will be presented, focusing on the three lepton Z-depleted channel. First preliminary results for this analysis will be shown. Finally, the extension of the analysis to the Simplified Template Cross Sections (STXS) scheme will be discussed. In the STXS scheme, the measurement is performed as a function of the momentum of the associated W boson, which gives improved sensitivity to possible contributions from physics beyond the standard model.

T 62: DAQ NN/ML – GRID II

Time: Wednesday 15:50–17:20 Location: HSZ/0301

T 62.1 Wed 15:50 HSZ/0301

Development of machine-learning based topological algorithms for the CMS level-1 trigger — •Finn Labe, Johannes Haller, Gregor Kasieczka, Artur Lobanov, and Matthias Schröder — Institut für Experimentalphysik, Universität Hamburg

At the CMS experiment, a two-level trigger system is used to decide which collision events to store for later analysis. Due to the large fraction of non-interesting, low-energy collisions, currently used triggers often rely on momentum thresholds, only selecting events containing at least one highly-energetic object. In many cases, such as searches for di-Higgs production, this can substantially reduce the signal efficiency of the trigger selection. Targeting the upgraded CMS detector for the High Luminosity LHC, novel techniques are presented that utilize machine learning inside the first hardware layer of the trigger, which is based on FPGAs. Instead of individual objects, these triggers rely on the full event topology to select previously inaccessible events. The usage of these algorithmns in the context of the second trigger layer and offline analysis is studied.

T 62.2 Wed 16:05 HSZ/0301

LHCb's Topological Trigger in Run 3 — Johannes Albrecht[1], Gregory Max Ciezarek[2], Blaise Delaney[3], Niklas Nolte[3], and •Nicole Schulte[1] — [1]TU Dortmund University, Dortmund, Germany — [2]CERN, Switzerland — [3]Massachusetts Institute of Technology, Massachusetts, USA

The data-taking conditions expected in Run 3 of the LHCb experiment present unprecedented challenges for the software and computing systems. Consequently, the LHCb collaboration is pioneering an entirely software-based trigger system to efficiently manage the increased event rate. The beauty physics programme of LHCb is heavily dependent on topological triggers. These are dedicated to the inclusive selection of b-hadron candidates based on the characteristic beauty decay topology and their expected kinematic properties.

We present the Run 3 implementation of the topological triggers using Lipschitz monotonic neural networks. This architecture offers robustness under varying detector conditions and sensitivity to long-lived candidates, opening the possibility of discovering New Physics at LHCb.

T 62.3 Wed 16:20 HSZ/0301

APEL accounting with AUDITOR — Michael Böhler, Stefan Kroboth, •Dirk Sammel, and Markus Schumacher — Albert-Ludwigs-Universität Freiburg

Institutions that are part of the Worldwide LHC Computing Grid (WLCG) offer computing resources to analyse the data recorded by experiments at the Large Hadron Collider (LHC), and to produce simulated samples. An important task is the accounting of the utilized resources. For this, the used CPU time among other information is reported to the APEL (Accounting Processor for Event Logs) server, which publishes it on the Accounting Portal of the European Grid Infrastructure (EGI).
In Freiburg, for example, the accounting to APEL is performed by ARC CE (Advanced Resource Connector Compute Element). The compute element accepts compute jobs from WLCG and submits them to the local batch system. In addition it can also report the utilized resources. An alternative approach, independent from ARC CE, is the use of AUDITOR (Accounting Data Handling Toolbox For Opportunistic Resources). AUDITOR uses a "collector" to gather job information from the local batch system. These "job records" are stored in a PostgreSQL database, which can be accessed by plug-ins.
This talk first gives a short overview of the accounting system of the ARC software, and then presents an AUDITOR plug-in for accounting to APEL. The plug-in receives job records from the AUDITOR database, formats them according to APEL specifications, and submits them to the APEL server.

T 62.4 Wed 16:35 HSZ/0301

Accounting opportunistic resources with AUDITOR — •Stefan Kroboth, Michael Boehler, Dirk Sammel, and Markus Schumacher — Albert-Ludwigs-Universität Freiburg

The increasing computational demand and concerns about energy efficiency in high performance/throughput computing are driving forces in the search for more efficient ways to utilize available resources. A measure for achieving high efficiency is the sharing of idle resources of under-utilized sites with fully occupied sites. The software COBalD/TARDIS can automatically, transparently, dynamically and opportunistically integrate and disintegrate such resources. However, sharing resources also requires accounting. In this work we present AUDITOR (AccoUnting DatahandlIng Toolbox for Opportunistic Resources), a flexible and extensible accounting system that is able to cover a wide range of use cases and infrastructure. AUDITOR gathers accounting data via so-called collectors which are designed to monitor batch systems, COBalD/TARDIS, cloud schedulers or other sources of information. The data is stored in a database and provided to so-called plugins, which take an action based on accounting records. Actions can range from creating a bill, computing the CO_2 footprint, adjusting parameters of a service (i.e. priorities in a batch system) to forwarding accounting information to other accounting systems. Depending on the use case, one simply selects a suitable collector and plugin from a growing ecosystem of collectors and plugins. To facilitate the development of collectors and plugins for yet uncovered use cases by the community, libraries for interacting with AUDITOR are provided.

T 62.5 Wed 16:50 HSZ/0301

Containerization of the ATLAS HammerCloud setup — •Benjamin Rottler, Michael Böhler, and Markus Schumacher — Universität Freiburg

HammerCloud (HC) is a testing service and framework for continuous functional tests, on-demand large-scale stress tests, and performance benchmarks. It checks the computing resources and various components of distributed systems with realistic full-chain experiment workflows.

The current deployment setup based on RPMs allowed a stable deployment and secure maintenance over several years of operations for the ATLAS and CMS experiments. However, the current model is not flexible enough to support an agile and rapid development process. Furthermore, we wanted to be more independent of software versions that are provided by the package manager of the host system.

Therefore, we have decided to use a solution based on containerization, and switched to industry-standard technologies and processes. Having an "easy to spawn" instance of HC enables a more agile development cycle and easier deployment. With the help of such a containerized setup, CI/CD pipelines can be integrated easily into the automation process as an extra layer of verification. Furthermore, the container-based setup allows for quick onboarding of new team members, as developers can now work locally with a quick turnaround without the need to set up a production-like environment first.

In this talk we present the container-based setup for HammerCloud and discuss the process that led to our containerized solution.

T 62.6 Wed 17:05 HSZ/0301

Sapphire - Small-file aggregation for the dCache tape interface — •Svenja Meyer[1], Krishnaveni Chitrapu[3], Dmitry Litvintsev[2], Paul Millar[1], Tigran Mkrtchyan[1], Lea Morschel[1], Albert Rossi[2], and Marina Sahakyan[1] — [1]Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany — [2]Fermi National Accelerator Laboratory, Batavia, USA — [3]National Supercomputer Center, Linköping University, Sweden

dCache is an open source distributed storage system used to manage and store scientific data in the scale of hundreds of petabyte. Archiving data on tertiary storage, for example tape, is a main feature of this software. Unfortunately the performance of writing data to tape decreases for small sized files, which are produced more and more by experiments.

To circumvent this problem, *Sapphire*, an advancement of *SmallFiles* for *dCache*, was developed. Working as a plugin for *dCache*, these small files are bundled into bigger archives without needed intervention by the user. Flushing files to tape as well as staging them back works transparently to the user.

T 63: ML Methods III

Time: Wednesday 15:50–17:20 Location: HSZ/0405

T 63.1 Wed 15:50 HSZ/0405

Automated Hyperparameter Optimization of Neural Networks for ATLAS analyses — •Erik Bachmann — Institute of Nuclear and Particle Physics, Technische Universität Dresden, Germany

In recent years, artificial neural networks have become a standard tool in many analyses to increase the sensitivity of measurements and largely replaced other multivariate techniques. The hyperparameters of the neural network, e. g. the number of hidden layers in a multilayer perceptron, are however usually chosen based on intuition and experience without any optimization. Additionally, the absence of overtraining is often only verified by visually inspecting the network's output distributions.

In this talk, a framework to perform automated hyperparameter optimization with a special focus on directly including objective overtraining conditions as part of the optimization is presented. Furthermore, its first application in the ATLAS vector boson polarization analysis of $W^{\pm}W^{\pm}$ scattering is discussed.

T 63.2 Wed 16:05 HSZ/0405

Optimising inference with binning — Phillip Keicher, Marcel Rieger, Peter Schleper, and •Jan Voss — Institut für Experimentalphysik Universität Hamburg, Hamburg, Deutschland

In order to increase the sensitivity of searches for rare processes, neural networks are nowadays a widely-spread tool to construct powerful discriminators. These discriminators are usually optimized to separate physics-motivated classes, but not necessarily on an optimal statistical inference. Consequently, the results can depend on auxiliary effects such as the exact binning choice for the distributions of the final discriminants.

This study aims to construct a setup for optimising the sensitivity with respect to the binning choice in the context of a Di-Higgs in the $b\bar{b}\tau^{+}\tau^{-}$ final state. This setup is based on the python packages pyhf and JAX, which are used for the statistical modeling and the derivation of the inference with respect to the bin edges. This talk presents the current status of this on-going project and will highlight the challenges and possible applications of this novel technique.

T 63.3 Wed 16:20 HSZ/0405

Uncertainty aware training — Markus Klute, •Artur Monsch, Günter Quast, Lars Sowa, and Roger Wolf — Institute of Experimental Particle Physics (ETP), Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany

As physics experiments continue their measurements, with the LHC Run-3 and the future High-Luminosity LHC as notable examples, the amount of data is steadily increasing. These continued measurements will lead to reduced statistical uncertianties of many analyses, emphasizing the importance of systematic uncertainties in analysis results. This talk presents a machine-learning (ML)-based data analysis strategy to obtain an optimal test statistic minimizing analysis-specific statistical and systematic uncertainties. To achieve this the training objective for the neural network is modified to take systematic variations into account, leading to an overall uncertainty reduction on the analysis objective. The method will be demonstrated on a simple example using pseudo data and on a reduced CMS dataset used for an ML-based analysis of the observed Higgs boson in the di-τ final state with the goal of differential measurements of Higgs boson production, with the CMS experiment.

T 63.4 Wed 16:35 HSZ/0405

Interpolating Antenna Calibration Data from Sparse Measurements with Information Field Theory — •Maximilian Straub, Martin Erdmann, and Alex Reuzki for the Pierre Auger-Collaboration — Physics Institute III A RWTH Aachen University

Extensive air showers are induced in the Earth's atmosphere by ultra-high-energy cosmic rays. These air showers are measured at the Pierre Auger Observatory using various detection techniques, including radio antennas. As part of the Pierre Auger Observatory's AugerPrime upgrade, so-called Short Aperiodic Loaded Loop Antennas (SALLAs) are currently being deployed. These antennas will be calibrated with a remotely-piloted aircraft that carries a known signal source to characterize the direction- and frequency dependent gain, the so-called antenna pattern. With this method, only a finite number of directions and frequencies is probed, limited by i.a. battery life of the aircraft. Information Field Theory (IFT) is a framework for reconstructing field-like structures using Bayesian statistics. With IFT it is possible to leverage local correlation structures to interpolate on the domain product $S^2 \times \mathbb{R}$, that is direction dependence and frequency dependence at the same time. The multidimensional interpolation is informed by physics and therefore performs better than e.g. a linear interpolation. Using Information Field Theory provides calibration uncertainties resulting from the calibration measurements. Furthermore, by operating directly on the sphere it avoids projection-related distortions and edge effects that stem from the angular periodicity.

T 63.5 Wed 16:50 HSZ/0405

Tau neutrino identification with Graph Neural Networks in KM3NeT/ORCA — •Lukas Hennig for the ANTARES-KM3NET-ERLANGEN-Collaboration — Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), Erlangen Centre for Astroparticle Physics, Nikolaus-Fiebiger-Straße 2, 91058 Erlangen, Germany

One of the goals of the KM3NeT collaboration is to constrain the PMNS matrix elements associated with the tau neutrino flavour. The data needed to perform this task is taken with KM3NeT/ORCA, a neutrino detector currently under construction in the Mediterranean deep sea. To constrain the matrix elements, one needs to measure the tau neutrino flux produced by atmospheric muon and electron neutrinos oscillating into tau neutrinos. Selecting the tau neutrino events from the full neutrino event dataset is a notoriously difficult task because the final states of tau neutrino interactions look very similar to the final states of muon or electron neutrino events. This classification problem was tackled in my Master's thesis using Graph Neural Networks (GNNs), a type of neural network architecture that showed promising results, e.g., on the related task of jet tagging. This talk will discuss the different methods used to optimise the GNN's performance on this classification task, including a computation-intensive automated hyperparameter search, and present the performance gains achieved by each of these steps and the final performance of the tau event classifier.

T 63.6 Wed 17:05 HSZ/0405

Negative event weights in Machine Learning and search for heavy Higgs bosons in top quark pair events at CMS — •Jörn Bach[1,2,3], Christian Schwanenberger[1,2], Peer Stelldinger[3], and Alexander Grohsjean[1] — [1]Deutsches Elektronen Synchrotron DESY, Hamburg — [2]Universität Hamburg, Hamburg — [3]Hochschule für angewandte Wissenschaften (HAW) Hamburg

Sophisticated Monte-Carlo event generators are key to the LHC research program. When involving higher order predictions or interference effects, simulated events can be negatively weighted. To achieve correct results with maximum sensitivity, negative weights cannot simply be ignored when working with Machine Learning methods. In this talk, I will discuss the issues that arise in trainings of Deep Neural Networks through negatively weighted events and propose a solution on how to efficiently handle them. Additionally, I will discuss the application of these techniques in a search for heavy Higgs bosons and its potential for LHC data analyses in general.

T 64: Neutrino Astronomy III

Time: Wednesday 15:50–17:20 Location: POT/0051

T 64.1 Wed 15:50 POT/0051

KM3NeT status — •Alba Domi for the ANTARES-KM3NET-ERLANGEN-Collaboration — ECAP, Erlangen, Germany

KM3NeT is an underwater neutrino telescope under construction in the Mediterranean Sea. It is divided into two subdetectors: ORCA, whose main goal is the determination of the neutrino mass ordering, is optimised for neutrino oscillation studies in the GeV energy range and it is located 40 km off-shore Toulon (France), and ARCA, located 100 km off-shore Portopalo di Capopassero (Italy), is optimised for cosmic neutrino studies up to the PeV energy range. The construction and deployment of the telescope is modular and, to date, a fraction of the planned detection units is already taking data. This talk reviews the status of the KM3NeT neutrino telescope, and it presents the first analyses performed with collected data.

T 64.2 Wed 16:05 POT/0051

Exploring Prospects for Multi-Messenger Observations of Short Gamma-Ray Bursts with IceCube-Gen2 and the Einstein Telescope — •Sharif El Mentawi[1], Jakob Böttcher[1], Anna Franckowiak[2], Philipp Fürst[1], Erik Ganster[1], Lasse Halve[1], Xavier Rodrigues[2], Matthias Thiesmeyer[1], and Christopher Wiebusch[1] for the IceCube-Collaboration — [1]III. Physikalisches Institut B, RWTH Aachen University — [2]Astronomisches Institut (AIRUB), Ruhr-Universität Bochum

After the coincident observation of a short gamma-ray burst (sGRB) in gamma rays and a neutron star binary merger in gravitational waves in 2017, sGRBs have become one of the most prominent sources for multi-messenger astronomy. Whereas photons provide insight into some of the radiative processes taking place in sGRBs and gravitational waves reproduce kinematics of progenitor neutron stars, neutrinos can traverse dense material and thus might probe the source environment or the merger process itself. With the new generation of multi-messenger experiments, such as IceCube-Gen2 for high-energy neutrinos and the Einstein Telescope for gravitational waves on our doorsteps, the sensitivity to both messengers will be greatly improved. We discuss a data-motivated simulation of sGRBs in neutrinos and gravitational waves, with the goal of estimating joint detection prospects with IceCube-Gen2 and the Einstein Telescope.

T 64.3 Wed 16:20 POT/0051

Investigations of hadronic vs electromagnetic cascade identification at the PeV energy scale. — •Yara Darras for the ANTARES-KM3NET-ERLANGEN-Collaboration — Nikolaus-Fiebiger-Str. 2 91058 Erlangen, Germany

KM3NeT/ARCA is an underwater Cherenkov detector located 100 km off-shore Portopalo di Capo Passero on the south-eastern coast of Sicily. Its main goal is the detection of high energy neutrinos from astrophysical sources such as gamma ray bursts or active galactic nuclei. Neutrino interactions with matter are detected as events of different topologies depending on the neutrino flavour and interaction type. The Glashow resonance is a particular type of neutrino interaction in which an electron antineutrino with an energy of about 6.3 PeV interacts with an electron producing a W-boson which can decay through different channels. In this contribution, the use of deep learning techniques to distinguish between hadronic and leptonic decay modes of the W boson produced in the Glashow resonance is described.

T 64.4 Wed 16:35 POT/0051

Optimization of the Forward-Folding Likelihood Fit for the Astrophysical Muon Neutrino Analysis with IceCube — •Matthias Thiesmeyer[1], Jakob Böttcher[1], Shuyang Deng[1], Philipp Fürst[1], Erik Ganster[1], Jonas Hellrung[1], Sharif El Mentawi[1], Richard Naab[2], and Christopher Wiebusch[1] for the IceCube-Collaboration — [1]III. Physikalisches Institut B, RWTH Aachen University — [2]DESY, Zeuthen, Germany

One important detection channel for astrophysical neutrinos in IceCube is neutrino-induced muon tracks. The astrophysical flux parameters are estimated using a explicit forward-folding likelihood fit of the measured neutrino data. Here, the binned distribution of reconstructed zenith and energy is compared to the number of expected events from atmospheric and astrophysical neutrino fluxes by means of a profile likelihood. To maximize the sensitivity to the astrophysical neutrino flux properties we optimize and generalize the choice of binning. A particular challenge is limited Monte-Carlo statistics for the estimation of precise templates over the full parameter space. As an optimization metric we extend the simple Poissonian likelihood to an effective likelihood that includes the uncertainties of the bin predictions caused by limited Monte-Carlo statistics. By this we can balance between a limited measurement resolution in cases where the binning is too coarse, and a higher statistical uncertainty of the bin predictions in cases where the binning is too fine.

T 64.5 Wed 16:50 POT/0051

Search for collider neutrinos with FASER — Florian Bernlochner, Tobias Blesgen, •Tobias Böckh, Jochen Dingfelder, and Markus Prim — Physikalisches Institut der Rheinischen Friedrich-Wilhelms-Universität Bonn

Although neutrinos are produced in large numbers at the LHC, such collider neutrinos have not been discovered yet since they interact weakly and neutrinos with high energies are dominantly produced along the beamline. Therefore FASER, the forward search experiment, is located on the beam collision axis line-of-sight 480m downstream from the ATLAS interaction point. In this talk, we will present the search for such collider neutrinos using the electronic detectors of the FASER detector.

T 64.6 Wed 17:05 POT/0051

ANNIE: The Accelerator Neutrino Neutron Interaction Experiment — •Marc Breisch for the ANNIE-Collaboration — Physikalisches Institut, Eberhard Karls Universität Tübingen

The Accelerator Neutrino Neutron Interaction Experiment (ANNIE) is a 26-ton gadolinium doped water Cherenkov detector on-axis of the Booster Neutrino Beam (BNB) at FermiLab. Its primary goal is to measure the final state neutron multiplicity of neutrino-nucleus interactions to improve the systematic uncertainties of next-generation long baseline neutrino experiments. An additional milestone will be the deployment of multiple Large Area Picosecond Photodetectors (LAPPD), of which the first one is already commissioned and deployed. These novel detectors feature a timing resolution less than 100 picoseconds and a sub-centimeter spatial resolution, thus improving the track reconstruction capabilities of the detector. This talk will give a general overview of ANNIE in general and the status of the LAPPD deployment.

T 65: Gamma Astronomy III

Time: Wednesday 15:50–16:50 Location: POT/0151

T 65.1 Wed 15:50 POT/0151

Towards searching for ultra-high energy photons from galactic PeVatrons — •Chiara Papior, Marcus Niechciol, Markus Risse, and Philip Ruehl — Center for Particle Physics Siegen, Experimentelle Astroteilchenphsik, Universität Siegen

Recently, photons from galactic sources with maximum energies in the PeV range have been discovered. Sources which are able to accelerate particles to these energies are referred to as PeVatrons. They do not only emit photons, but are also candidate sources of galactic cosmic rays. The only firmly identified PeVatron is the Crab nebula. However, through theoretical considerations and directional observations of PeV photon signals, several other potential PeVatron candidates have been proposed, including pulsars, supernova remnants and massive stars. In this contribution, the energy spectra of such source candidates are modelled and extrapolated to even higher energies reaching up to EeV scales. Photons of these energies are referred to as ultra-high-energy

(UHE) photons. The results of the extrapolation can then be used to obtain information on the required sensitivity for the measurement of UHE photons from specific source candidates. The work presented in this contribution aims to evaluate the potential at present and future observatories to detect UHE photons from certain sources.
This work is supported by the Deutsche Forschungsgemeinschaft (DFG).

T 65.2 Wed 16:05 POT/0151

Indirect Search for scotogenic WIMP Dark Matter — •Laura Eisenberger — University of Würzburg

Weakly interacting massive particles (WIMPs) are one of the most promising candidates for dark matter. They are predicted for example by scotogenic models which implement an additional Z_2 symmetry under which all Standard Model particles are even while new particles, among them a stable dark matter candidate, are odd.

In our study, we use a scotogenic model (T1-2-A′) which can explain neutrino masses and the muon anomalous magnetic moment while fulfilling the current limits for charged lepton flavour violating processes simultaneously. In addition, it also incorporates a new WIMP dark matter type (m=1.1 TeV) consistent with limits from direct dark matter detection experiments.

We focus on the indirect search for this promising dark matter candidate via the detection of annihilation signals. For this, we predict multiwavelength spectral energy distributions (SEDs) reaching from very-high-energy photons from pion decay to secondary Inverse Compton and synchrotron emission. The results are compared to observational limits.

T 65.3 Wed 16:20 POT/0151

Machine Learning Methods for an Increased Understanding of AGN Flares* — •Yannick Hartych[1,2], Julia Becker Tjus[1,2], Wolfgang Rhode[2,3], and Marcel Schroller[1,2] — [1]Theoretische Physik IV, Ruhr Universität Bochum, Bochum, Germany — [2]RAPP-Center at Ruhr Universität Bochum, Bochum, Germany — [3]Experimentelle Physik 5, Technische Universität Dortmund, Dortmund, Germany

Blazars are some of the brightest known sources in the Universe and are considered possible sources of the highest energy cosmic rays (CRs). Hence they are of high interest to astronomers to understand the processes accelerating those CR. One of those blazars is TXS 0506+056, from which a gamma-ray flare arrived in temporal and spatial coincidence with a high-energy neutrino of high probability to be of astrophysical origin. For this reason, the source was brought into focus for further investigation to understand the underlying processes leading to this observation. It is crucial to physically model blazars thoroughly. In order to find the related parameters responsible for this behaviour, we set up simulations in CRPropa3 and develop theoretical flare templates that can be compared to observational signatures. With those templates, the next step would be to train a machine learner to search the galactic catalogues for other blazars with a high probability of showing behaviour similar to TXS 0506+056. In this talk, we will present first preliminary results of such simulations and evaluate their significance in the context of the parameter study.
* Financial support by the DFG (SFB 1941) is gratefully acknowledged

T 65.4 Wed 16:35 POT/0151

Unfolding the Crab Nebula Flux with Gammapy* — •Noah Biederbeck and Maximilian Linhoff — TU Dortmund University, WG Elsässer

In spectral analyses of astrophysical gamma-ray sources, a flux model is typically fitted. Unfolding has the advantage over fitting that it is model independent and correctly includes all known detector effects. Gammapy is a widely used open-source Python package for gamma-ray astronomy, but is lacking unfolding functionality. In this talk, we present the implementation of unfolding in Gammapy and its application to joint flux unfolding of the Crab Nebula using public data of multiple Imaging Atmospheric Cherenkov Telescopes.
*Supported by DFG (SFB 1491) and BMBF (ErUM).

T 66: Neutrinos II

Time: Wednesday 15:50–17:20 Location: POT/0251

T 66.1 Wed 15:50 POT/0251

Detection of solar pp-neutrinos with CID in SERAPPIS — •Tim Charissé, Marcel Büchner, Arshak Jafar, Kai Loo, George Parker, Oliver Pilarczyk, and Michael Wurm — Institute of Physics and EC PRISMA+, Johannes-Gutenberg University Mainz, Mainz, Germany

The OSIRIS detector, a pre-detector that monitors the radiopurity of the scintillator for the JUNO experiment, is planned to be used for the measurement of the solar pp-neutrino flux after fulfilling it's initial purpose. This upgrade is called SEarch for RAre PP-neutrinos In Scintillator (SERAPPIS). As these pp-neutrinos originate from the sun it is crucial to obtain the directional information to get a high sensitivity. This directional information is contained in the Cherenkov light which is hard to distinguish from the scintillation signal. While there are experimental efforts like slow scintillators to enhance the sensitivity for Cherenkov light in SERAPPIS, there is also a data-analytical method called Correlated and Integrated Directionality (CID) to obtain the directional information from the data. It uses the angular distribution between the direction of the neutrino and the detected light for the whole data set to gain information over the pp-neutrino flux.

This talk will present the status of the ongoing sensitivity study for CID in SERAPPIS based on Monte Carlo simulations. It is investigated if CID can have a valuable impact on the measurement of the solar pp-neutrino flux.

T 66.2 Wed 16:05 POT/0251

Column Density Determination for the KATRIN Neutrino Mass Measurement — Fabian Block[1], •Christoph Köhler[2], and Sonja Schneidewind[3] for the KATRIN-Collaboration — [1]Karlsruhe Institute of Technology — [2]Technical University of Munich — [3]Westfälische Wilhelms-Universität Münster

The KATRIN experiment aims to model-independently probe the effective electron anti-neutrino mass with a sensitivity of 0.2 eV (90 % CL) by investigating the endpoint region of the tritium beta decay spectrum. To achieve this goal the gas quantity of the windowless gaseous tritium source, characterized by the column density, has to be known with great accuracy.

We present in this talk the principle of measuring the column density with an angular resolved photoelectron source and describe the method to ensure continuous monitoring of the column density during measurement campaigns of KATRIN. The influence of the recent hardware upgrade of the photoelectron source is discussed in light of the column density determination accuracy.
This work is supported by the Technical University of Munich, the Helmholtz Association, the Ministry for Education and Research BMBF (05A17PM3, 05A17PX3, 05A17VK2, 05A17WO3, 05A20PMA), the Helmholtz Alliance for Astroparticle Physics (HAP), the Helmholtz Initiative and Networking Fund (W2/W3-118) and Deutsche Forschungsgemeinschaft DFG (Research Training Group GRK 2149).

T 66.3 Wed 16:20 POT/0251

Calorimetric methods for monitoring Atomic hydrogen beam for Project 8 — •Christian Matthé, Felix Wünsch, and Sebastian Böser for the Project 8-Collaboration — Johannes Gutenberg Universität Mainz

The Project 8 collaboration aims to determine the absolute neutrino mass with a sensitivity of 40 meV by measuring the tritium decay spectrum around the endpoint energy. For this level of precision it is necessary to use atomic tritium, since molecular tritium sensitivity is limited by the molecular final state distribution to about 100 meV.

A flux of $\approx 10^{19}$atoms/s from the source will be required to inject a beam with $\approx 10^{15}$atoms/s into the detection volume after cooling and state selection inefficiencies. For monitoring this beam, we have built a detector that uses a wire with a micrometer-scale diameter intersecting the beam on which a small fraction of the beam's hydrogen atoms recombine into molecules. The energy released heats the wire and produces a measurable change in its resistance. Such a detector is suitable for both development work and for minimally disruptive

online monitoring in the final experiment.

Additionally, we are working on a calorimetrically estimating the fraction of molecules being split by measuring the surplus power our thermal atom source draws when dissociating hydrogen.

In this talk I will present results from tests of both methods.

T 66.4 Wed 16:35 POT/0251

Modeling of RF signals in large-volume antenna-array CRES detectors — •Florian Thomas and Sebastian Böser for the Project 8-Collaboration — Institut für Physik, Johannes Gutenberg-Universität Mainz

The Project 8 collaboration has established Cyclotron Radiation Emission Spectroscopy (CRES) as a novel frequency-based approach of measuring the tritium beta decay spectrum and determining neutrino mass with the endpoint method. To gather sufficient statistics for its design sensitivity of $m_\beta < 40$ meV the Project 8 experiment needs to be scaled up to a $\mathcal{O}(m^3)$ source volume.

In the large-volume case a possible detection scheme for the radio frequency radiation emitted by the decay electrons is an antenna array with $\mathcal{O}(100)$ independent readout channels. In order to reconstruct the electron tracks comprehensive simulations are required. For this large number of channels, numerical solutions of the electron trajectory, the electromagnetic fields and the antenna response are computationally challenging. In this contribution we present an alternative simulation approach which is based on analytic knowledge about cyclotron radiation and $\mathcal{O}(1000)$ faster than our full numeric baseline approach with a negligible impact on the simulation results.

T 66.5 Wed 16:50 POT/0251

Test setup for de-excitation of Rydberg atoms in KATRIN using THz radiation — •Enrico Ellinger — Bergische Universität Wuppertal

The majority of the background in the neutrino mass experiment KATRIN probably originates from the ionization of Rydberg atoms in the main spectrometer volume. The Rydbergs are formed by natural radioactive decay, followed by sputtering processes on the inner walls of the spectrometer vessel. The neutral Rydberg atoms can migrate through the spectrometer before they are ionized by thermal radiation. The resulting free electrons are eventually accelerated towards the main detector producing the background.

Terahertz radiation can stimulate $\Delta n = \pm 1$ transitions in Rydberg atoms to states from which spontaneous decay to the ground state is faster, significantly reducing the ionization probability. A set of 8 high intense THz sources, targeting subsequent transitions in the vicinity of $n = 30$ can reduce the background by up to 50 %, as shown by earlier simulations.

We developed an experimental test setup that serves as a proof of principle for this new method. The setup mimics the processes in the main spectrometer. The main components are an implanted ^{212}Pb source producing the Rydberg atoms and a 40 mW tuneable Thz source able to target two transitions (256.3 & 284.3 GHz) in Rydberg atoms.

The development of the test setup and first experimental results are presented.

T 66.6 Wed 17:05 POT/0251

Recent developments for an automated krypton assay in xenon at the ppq level — Steffen Form, •Matteo Guida, Robert Hammann, Ying-Ting Lin, Hardy Simgen, and Jonas Westermann — Max-Planck Institut für Kernphysik, Heidelberg, Germany

The beta-decaying isotope ^{85}Kr is one of the main intrinsic background components in liquid xenon (LXe) dark matter detectors. Via purification techniques, a krypton-in-xenon concentration below 100 ppq (parts per quadrillion) can routinely be achieved. The rare gas mass spectrometer (RGMS), at Max-Planck Institut für Kernphysik, provides a measurement of the krypton concentration of an extracted xenon gaseous sample taken directly from the experiment. First, krypton is separated from xenon using a cryogenic gas-solid chromatography system. Then, the amount of krypton is quantified using a mass spectrometer. The system has achieved a detection limit of 8 ppq. A fully automatic rare gas mass spectrometer (Auto-RGMS) is under construction for the krypton assay of future low-background LXe detectors. Without human effort, the automatic operation is going to enable more frequent krypton monitoring and provide more robust results. The plan is to introduce a novel adsorbent for the chromatography system to increase the xenon sample size and further push down the krypton detection limit. The new solutions show a large enhancement in the separation power at a given temperature and in the linearity of the adsorption isotherms. The progress to select a new adsorbent and optimize the working point of Auto-RGMS will be discussed.

T 67: Neutrinos, Dark Matter VII

Time: Wednesday 15:50–16:50 Location: POT/0361

T 67.1 Wed 15:50 POT/0361

Optimization of the remoTES design using silicon absorbers — •Kumrie Shera, Gode Angloher, Mukund Bharadwaj, Trosten Frank, Moritz Kellermann, Michele Mancuso, Federica Petricca, Franz Pröbst, Karoline Schäffner, Martin Stahlberg, Vanessa Zema, Antonio Bento, Lucia Canonica, and Abhijit Garai — Max-Planck-Institut für Physik, 80805 München, Germany

Transition Edge Sensors (TES) are sensors that can measure tiny increases of temperature of order μK and are widely used to read out cryogenic calorimeters. However, delicate materials (e.g. with low melting point and/or hygroscopicity) can not undergo the process of fabricating such a sensor on their surface. To deal with this, the COSINUS-experiment developed the remoTES readout design, where the TES itself is placed on a separate wafer and the coupling of the absorber crystal to the TES consists of a gold bonding wire connected to a gold pad on the absorber. In this talk studies done for the optimization of the remoTES design using silicon crystals as a benchmark are shown.

T 67.2 Wed 16:05 POT/0361

Particle Dependent Parameter Determination of Liquid Scintillators for Neutrino Experiments — •David Dörflinger[1], Lothar Oberauer[1], Hans Th. J. Steiger[1,2], Raphael Stock[1], Ulrike Fahrendholz[1], Lennard Kayser[1], Florian Kübelbeck[1], Korbinian Stangler[1], Michael Wurm[2], Dorina Zundel[2], and Manuel Böhles[2] — [1]Technische Universität München (TUM), Physik-Department, James-Franck-Straße 1, 85748 Garching bei München — [2]Institute of Physics and Excellence Cluster PRISMA+, Johannes Gutenberg-Universität (JGU) Mainz, Staudingerweg 9, 55099 Mainz

The Jiangmen Underground Neutrino Observatory (JUNO) aims to detect neutrinos using 20 kton of organic liquid scintillator based on LAB (Linear AlkylBenzene). In order to understand the detector response, a precise determination of particle dependent scintillation parameters is crucial. Compared to gamma radiation, neutrons have a different energy dissipation method in the detector material, which leads to a quenched light output. The quenching factors of the JUNO scintillator and other organic, as well as water based liquid scintillator samples have been studied using a particle accelerator driven neutron source at the INFN-LNL in Legnaro, Italy. The neutrons are produced quasi-monoenergetically by ^{7}Li(p,n) reaction with energies between 3.5 MeV and 5.5 MeV. This work is supported by the DFG Research Unit JUNO (FOR2319) and the clusters of excellence ORIGINS and PRISMA+.

T 67.3 Wed 16:20 POT/0361

Quenching Factor measurements with COSINUS NaI crystals — •Mukund Raghunath Bharadwaj for the COSINUS-Collaboration — Max-Planck-Institut für Physik, Föhringer Ring 6, 80805 München

NaI (Tl) based scintillation detectors have become a staple in the field of direct dark matter searches, with the DAMA-LIBRA experiment being the stand out for its reported dark matter observation which is in direct contrast with numerous other results. In order to accurately calibrate the energies of WIMP induced nuclear recoil signals and conclusively rule out the parameter space covered by DAMA/LIBRA, precise measurements of the quenching factor of the NaI crystals is

essential for each of these experiments as it is well established that electron recoils and nuclear recoils have dis-similar scintillation light yields. In this study, we present first preliminary results of a systematic study that has been carried out by the COSINUS collaboration to measure the quenching factor values primarily in the low recoil energies of 1-30keV$_{nr}$ in order to better understand the discrepancies/uncertainities reported by various experiments. Five ultra-pure NaI crystals manufactured by the Shanghai Institute for Ceramics, each of which have varying Tl dopant concentration, were irradiated with a mono-energetic neutron beam to study its impact on the quenching factor values in the desired recoil energy range.

T 67.4 Wed 16:35 POT/0361

Precision Attenuation Length Measurement of Liquid Scintillators for Future Large Volume Neutrinos Experiments — •Korbinian Stangler[1], Florian Kübelbäck[1], Hans Steiger[2], and Lothar Oberauer[1] — [1]TUM, Physik-Department, James-Franck-Straße 1, 85748 Garching — [2]Cluster of Excellence PRISMA+, Detector Laboratory, Staudingerweg 9, 55128 Mainz

Upcoming large volume neutrino experiments (like JUNO or THEIA) place high demands on the purity of their scintillators. The optical properties are important to ensure that a large number of photons reach the light detectors. Therefore, scintillators require attenuation lengths >20m for the wavelengths of interest. Measurements of these optical properties have so far been carried out with UV/Vis spectrometers and cuvette lengths of 10cm which leads to overall uncertainties of the same order of magnitude as the attenuation length. In order to obtain precise measurements, the Precision Attenuation Length Measurement (PALM) was developed with light path lengths of up to 2.8m. The setup aims to determine the attenuation length for a wavelength range between 350 and 1000nm with an uncertainty of less than ten percent. So far, initial calibration and test measurements have been performed on linear alkylbenzene (LAB) to ensure and optimize the performance of the setup.

This work was supported by the DFG Forschergruppe JUNO.

T 68: Neutrinos, Dark Matter VIII

Time: Wednesday 15:50–16:50 Location: POT/0006

T 68.1 Wed 15:50 POT/0006

Determination of electromagnetic fields in the shifted analyzing plane of the KATRIN main spectrometer — •Fabian Block and Alexey Lokhov for the KATRIN-Collaboration — Karlsruhe Institute of Technology

The KATRIN experiment aims to determine the effective electron antineutrino mass with a sensitivity of 0.2 eV (90 % C.L.) by high-resolution spectroscopy of the endpoint region of the tritium β decay spectrum. To reach the sensitivity goal, the experimental setup of KATRIN combines a windowless gaseous tritium source with a high-resolution MAC-E filter, called main spectrometer. The energy analysis of the β-decay electrons in the main spectrometer takes place via a complex interplay of electric and magnetic fields.

To improve the signal-to-background ratio in neutrino mass measurements, the electromagnetic field configuration in the main spectrometer is adapted to the so-called Shifted Analyzing Plane (SAP). The SAP fields need to be known with high precision in order for them to be taken accurately into account in the β-spectrum model applied in the fit of the data. We present in this talk the results of high-statistics SAP characterization measurements employing conversion electrons of Kr-83m as sensitive probes for electromagnetic fields.

This work is supported by the Helmholtz Association, the Ministry for Education and Research BMBF (05A17PM3, 05A17PX3, 05A17VK2, and 05A17WO3), the Helmholtz Alliance for Astroparticle Physics (HAP), and the Helmholtz Initiative and Networking Fund (W2/W3-118).

T 68.2 Wed 16:05 POT/0006

Observables of the Electrical Potential of the KATRIN Tritium Source from Calibration with a High-Intensity Krypton-83m Source — •Moritz Machatschek for the KATRIN-Collaboration — Institute for Astroparticle Physics, Karlsruhe Institute of Technology

The KArlsruhe TRItium Neutrino experiment currently provides the best neutrino-mass upper limit of 0.8 eV/c^2 (90 % C. L.) in the field of direct neutrino-mass measurements. Reaching the target sensitivity of 0.2 eV/c^2 at 90 % C. L. not only relies on the ongoing data taking, but also the detailed study of systematic measurement uncertainties.

One major uncertainty is linked to the electric potential inside the tritium source. Inhomogeneities of the potential lead to a distortion of the β-spectrum, which needs to be characterized in order to reduce the systematic bias in the neutrino-mass measurement.

To this end we use conversion electrons from ^{83m}Kr as nuclear standard. Traces of gaseous ^{83m}Kr are circulated alongside tritium in the 10 m long source, such that inhomogeneities of the potential are observable as a broadening of the selected mono-energetic ^{83m}Kr lines. In this talk we describe the result of a three-week long ^{83m}Kr campaign carried out in 2021 and its impact on the neutrino-mass determination.

This work is supported by the Helmholtz Association, the Ministry for Education and Research BMBF (05A17PM3, 05A17PX3, 05A17VK2, and 05A17WO3), the Helmholtz Alliance for Astroparticle Physics (HAP), and the Helmholtz Initiative and Networking Fund (W2/W3-118).

T 68.3 Wed 16:20 POT/0006

The XENONnT Gd-loaded water n-veto detector and purification system — •francesco Lombardi for the XENON-Collaboration — flombard@uni-mainz.de

The nuclear recoil scattering by Neutrons is the most dangerous background for the XENONnT experiment because they can mimic the expected Dark Matter signal: the single nuclear recoil scattering. To increase the Neutron tagging efficiency, the Muon Veto Water tank has been modified by introducing an additional neutron veto detector surrounding the XENON time projection chamber (TPC) and, in the next phase of the experiment, the 700 ton of water of the Cherenkov detector will be loaded with a solution at 0.48% of Gadolinium Sulfate Octahydrate salt ($Gd_2(SO_4)_3 \cdot 8H_2O$), corresponding to a percentage of 0.2% of Gadolinium of the total mass. In the next phase, the addiction of Gadolinium at 0.2%, will increase the neutron capture efficiency from the 74% of pure water to the 90% of the new solution. Together with the infrastructure of the neutron veto detector, we will also present the filtration plant for purification system and the relative automatic control.

T 68.4 Wed 16:35 POT/0006

Results and updates of the XENONnT neutron-veto — •Daniel Wenz for the XENON-Collaboration — Johannes Gutenberg-Universität Mainz

Nobel liquid time projection chambers (TPC) are playing a key role in the search for WIMP dark matter in the mass range of a few to a few hundred GeV/c^2. Neutrons, emitted by the detector material, pose a great danger for this type of experiments as they can mimic WIMP signals, by undergoing single-scatter nuclear recoils before leaving the sensitive region of the TPC. To mitigate this detector intrinsic background, the XENONnT TPC is enclosed by a water Cherenkov neutron-veto which tags these dangerous signals by measuring in a delayed coincidence the 2.22 MeV gamma-ray released from the neutron-capture on hydrogen. To get a precise calibration of the neutron-veto tagging efficiency, a novel coincidence technique, based on coincidentally emitted neutrons and gammas of an AmBe source, is used. The very same technique is also applied to conduct a very clean calibration of the XENONnT TPC nuclear recoils response.

In this talk, we are going to present the latest results of the XENONnT neutron-veto, including its tagging efficiency calibration as well as the calibration of the NR response of the XENONnT TPC.

T 69: Neutrinos, Dark Matter IX

Time: Wednesday 15:50–17:05 Location: POT/0112

T 69.1 Wed 15:50 POT/0112

Reconstruction of atmospheric neutrino events in JUNO using GCNs — •Rosmarie Wirth, Caren Hagner, Daniel Bick, and Vidhya Thara Hariharan — Universitaet Hamburg, Hamburg, Germany

The Jiangmen Underground Neutrino Observatory (JUNO) is a 20 kt liquid scintillation detector, which will be completed in 2023 as the largest of its kind. JUNO aims to determine the neutrino mass ordering with $3\,\sigma$ significance in about 6 years by observing the energy dependent oscillation probabilities of reactor anti-neutrinos.

Due to JUNO's large volume, it provides the opportunity to detect atmospheric neutrino events with lower energies than today's large Cherenkov experiments. This channel could deliver further measurements on the mass ordering, by observing the energy and direction dependent oscillation probabilities.

This talk presents reconstruction methods based on Graph Convolutional Networks (GCNs) to analyze these atmospheric neutrino events in JUNO.

T 69.2 Wed 16:05 POT/0112

Atmospheric neutrino reconstruction for the neutrino mass ordering measurement of JUNO — •Mariam Rifai[1,3], Runxuan Liu[1,3], Livia Ludhova[1,3], Anita Meraviglia[2,3], Nikhil Mohan[2,3], Luca Pelicci[1,3], Apeksha Singhal[1,3], and Cornelius Vollbrecht[1,3] — [1]Forschungszentrum Jülich GmbH, Institut für Kernphysik IKP-2, Jülich, Germany — [2]GSI Helmholtz Centre for Heavy Ion Research, Darmstadt, Germany — [3]III. Physikalisches Institut B, RWTH Aachen University, Aachen, Germany

The Jiangmen Underground Neutrino Observatory (JUNO) is a multipurpose liquid scintillator-based neutrino experiment with a target mass of 20 kt. The detector is currently under construction and expected to be completed by the end of 2023. Its main goal is the determination of the neutrino mass ordering (MO), through a measurement of the oscillation pattern of reactor anti-neutrinos over a 53 km baseline. As the largest liquid-scintillator detector, JUNO will also be able to observe atmospheric neutrinos events in the GeV region and down to sub-GeV. Therefore, the sensitivity of JUNO to the neutrino mass ordering can be enhanced from 3 to at least 4 sigma in 6 years via a combined analysis of reactor anti-neutrinos with atmospheric neutrinos. Such an analysis requires a precise knowledge on the track of atmospheric neutrinos, which is challenging in terms of reconstruction of the isotropic scintillation light emitted in JUNO. To achieve this target performance, a novel track reconstruction technique based on the voxelized distribution of optical photon emissions is being developed. The current status of this method will be presented in this talk.

T 69.3 Wed 16:20 POT/0112

Development of the first Detector Line for the Pacific Ocean Neutrino Experiment — Christian Spannfellner, •Niklas Retza, Elisa Resconi, Chiara Bellenghi, Mariia Sharshunova, and Lea Ginzkey for the P-ONE-Collaboration — Technical University Munich, Physics Department, James-Franck-Str. 1, Garching, Germany

The Pacific Ocean Neutrino Experiment (P-ONE) is a proposed multi-cubic-kilometre neutrino observatory off the coast of Vancouver Island, Canada. P-ONE will be connected to the NEPTUNE observatory, a deep-sea infrastructure in the Northeast Pacific Ocean hosted by Ocean Networks Canada (ONC). The NEPTUNE node at the Cascadia Basin, roughly 200 km offshore of Vancouver Island at a depth of 2660 m, has been probed for its optical properties by two pathfinder experiments, STRAW and STRAW-b, deployed in 2018 and 2020 respectively and was found to be suitable for a neutrino telescope. A first mooring line, called P-ONE-1, is planned to be deployed in 2024. P-ONE-1, consisting of 20 optical and calibration instruments distributed over a total vertical length of around one kilometre, shall serve as a prototype line for the detector, and ultimately be the blueprint for the following detector lines. In this contribution, we will present the design of P-ONE-1 and its optical instruments. The multi-PMT design of the latter allows to cope with the high background rates in the depths of the Northeast Pacific Ocean, while their modular and minimal mechanical design makes them easily scalable in vision of the construction of the full P-ONE detector.

T 69.4 Wed 16:35 POT/0112

DELight: Direct Search Experiment for Light Dark Matter with Superfluid Helium — •Francesco Toschi[1], Klaus Eitel[1], Christian Enss[1,2], Torben Ferber[1], Loredana Gastaldo[2], Felix Kahlhoefer[1], Sebastian Kempf[1], Greta Heine[1], Markus Klute[1], Sebastian Lindemann[3], Marc Schumann[3], Kathrin Valerius[1], and Belina von Krosigk[1] — [1]Karlsruhe Institute of Technology — [2]Heidelberg University — [3]University of Freiburg

The DM-nucleon scattering parameter space of Light Dark Matter (LDM) has been barely experimentally probed, as it requires an energy detection threshold down to a few tens of eV. The "Direct search Experiment for Light dark matter" (DELight) aims at using superfluid helium-4 as target, particularly suited because of its low nuclear mass and radiopurity, while providing both photon and quasiparticle signal channels valuable for event classification. DELight will deploy Magnetic Micro-Calorimeters (MMCs) operating at a temperature of 20 mK, promising high resolution and a threshold of a few eV. With an exposure of only 1 kg×d and an energy threshold of 20 eV, in its first phase DELight will be able to probe unexplored regions of the parameter space for LDM masses below 100 MeV with an expected sensitivity lower than $10^{-39}\,\mathrm{cm}^2$ at 20 MeV.

In this talk we will present the working principle of the detector technologies as well as an overview of the ongoing R&D towards the realization of DELight.

T 69.5 Wed 16:50 POT/0112

Design and Commissioning of the MainzTPC2 — •Constantin Szyszka, Christopher Hils, Jan Lommler, Uwe Oberlack, Daniel Wenz, and Alexander Deisting — Institut für Physik & Exzellenzcluster PRISMA$^+$, Johannes Gutenberg-Universität Mainz

The MainzTPC is an experimental dual-phase xenon time projection chamber (TPC) dedicated to the study of scintillation and ionization processes of liquid xenon for low-energy electronic and nuclear recoils. It features a signal readout with two PMTs and eight APDs, enabling 3D position reconstruction. The TPC also allows to study the influence of the drift field's strength on the scintillation process. Its design has been optimized for the use as primary target in Compton scattering experiments to measure recoil energies in liquid xenon down to 1 keV.

The MainzTPC is being redesigned to accommodate a SiPM array instead of the top PMT and APDs to improve position resolution in x and y. To address known instabilities in the liquid level of the MainzTPC, we aim to improve the level meters and level control by observing the liquid gas interface with commercially available cameras. We report on the status of this work.

T 70: Cosmic Ray III

Time: Wednesday 15:50–17:20 Location: POT/0013

T 70.1 Wed 15:50 POT/0013

measurment of the cosmic ray electron flux with AMS02 — •Yasaman Najafijozani — RWTH Acchen University, Sammelbau Physik, Sommerfeldstr. 14, Turm 28, 52074 Aachen, Germany

The Alpha Magnetic Spectrometer (AMS-02) on the International Space Station has been performing precision measurements of cosmic rays in the GeV to TeV energy range since 2011. The fluxes of electrons and positrons are potential probes of dark matter or new astrophysical phenomena. With AMS-02, electrons and positrons are identified by two independent subdetectors, a transition radiation detector, and an

electromagnetic calorimeter. I will present my analysis of the cosmic-ray electron flux from 0.5 to 1000 GeV.

T 70.2 Wed 16:05 POT/0013

3D modelling of the Galactic Center region — •Julien Dörner[1,2], Julia Becker Tjus[1,2], Paul-Simon Blomenkamp[1,2], Horst Fichtner[1,2], Anna Franckowiak[1,2], Mario Hoerbe[1,2], and Memo Zaninger[1,2] — [1]Ruhr-Universität Bochum, 44801 Bochum, Deutschland — [2]RAPP-Center at Ruhr University Bochum, Bochum, Germany

The Galactic Center (GC) region is a unique astrophysical environment, which has been intensively studied in the past decades. In the HE and UHE gamma-ray regime several point like sources and a diffuse emission have been discovered. In addition, observation in the emission with FermiLAT show an excess, which may hint to a population of unresolved sources. The detection of the first *PeVatron* by H.E.S.S. indicates that cosmic-rays (CRs) can be accelerated up to PeV energies in the GC. While 3-D transport models for the entire Galaxy do exist in well-advanced states, the GC region in these global models is not well-represented and dedicated 3-D models of this region are missing. We present the first model using a realistic 3D distribution of the gas and the magnetic field for the Central Molecular Zone. The magnetic field is composed by a large-scale structure, as well as a contribution from several molecular clouds and non-thermal filaments. We use an anisotropic diffusion tensor defined by the ratio of the perpendicular and the parallel diffusion coefficient with respect to the local magnetic field direction. In the end, we compare our model with the observation by H.E.S.S. and calculate synthetic 2D count maps with predictions for the observability by CTA and for the expected neutrino flux.

T 70.3 Wed 16:20 POT/0013

Modeling of the Galactic Cosmic-Ray Antiproton Flux — •Thomas Pöschl[1], Laura Fabbietti[1], Maximilian Horst[1], Laura Serksnyte[1], and Andrew Strong[2] — [1]Technische Universität München, Garching, Deutschland — [2]Max-Planck-Institut für extraterrestrische Physik, Garching, Deutschland

Cosmic-ray particles are an excellent probe to study processes in our galaxy and can hint at exotic sources of energetic particles, such as dark-matter annihilation. In particular, cosmic-ray antinuclei are informative since these particles are expected to be only rarely produced in conventional reactions. However, the interpretation of cosmic antinuclei measurements requires a good understanding of all involved processes of the creation and propagation of the antiparticles and a realistic estimate of the involved modeling uncertainties to distinguish potential exotic contributions from ordinary production.

In this contribution, we review the current understanding of the production and propagation of charged cosmic rays in our galaxy and the thereon-based modeling of galactic cosmic-ray fluxes, with a special focus on cosmic-ray antiprotons. We quantify systematic deviations of the modeled flux that arise due to inaccuracies of the numerical solution of the propagation equation, different models of propagation processes, and different models of the antiproton-production cross section. Based on the found systematic uncertainties, we comment on the agreement between the modeled fluxes and recent measurements.

This research is funded by the DFG under Germany's Excellence Strategy - EXC2094 - 390783311.

T 70.4 Wed 16:35 POT/0013

Charge sign dependent modulation of protons and electrons during solar cycle 22 and 23 — Johannes Marquardt, •Bernd Heber, Carlotta Jöhnk, Marlon Köberle, and Lisa Romaneehsen — Christian-Albrechts-Universität Kiel, D

The cosmic ray electron and proton flux observed with the Kiel Electron Telescope (KET) onboard the Ulysses space probe varies with solar activity as well as with heliospheric position. Ulysses' launched in 1990 completed its mission in 2009. The KET measured the electron, proton and helium flux during the declining phase of solar cycle 22 and during the full solar cycle 23 during an $A > 0$ and $A < 0$-solar magnetic epoch. In this contribution we discuss the flux variation of protons/anti protons and electrons/positrons at an averaged rigidity of 2.5 GV that were corrected for spatial gradients and compare our measurements with the ones from AMS 02 showing clear signatures of charge sign dependent modulation.

T 70.5 Wed 16:50 POT/0013

Measurement of the p-p cross section at $\sqrt{s} \geq 50$ TeV using cosmic-ray induced air showers detected with the Pierre Auger Observatory — •Olena Tkachenko for the Pierre Auger-Collaboration — Karlsruhe Institute of Technology, Karlsruhe, Germany

In this talk, we present a measurement of the proton-proton interaction cross sections from the distribution of the depth of air shower maximum, $X_{\max}$, measured by the fluorescence detector of the Pierre Auger Observatory. In previous analyses, the interaction cross section was obtained assuming the predominance of protons in the tail of the $X_{\max}$ distribution. Similarly, assumptions on hadronic interactions in air showers were needed to estimate the mass composition of cosmic rays. To get a self-consistent estimation of the interaction cross sections and cosmic-ray primary composition, we implement an algorithm for the combined measurement of the interaction cross sections and composition fractions. For this, we perform a standard binned maximum-likelihood mass composition fit with the varied proton-proton interaction cross sections. The conversion from the modified proton-proton to the corresponding nucleus-nucleus cross sections is done via the Glauber formalism. We include a shift in the $X_{\max}$ scale to account for systematic uncertainties of the data and theoretical uncertainties of the properties of particle production in air showers. The preliminary cross sections and composition fractions obtained using this novel self-consistent approach will be compared to the previous measurements and future improvements to the method will be discussed.

T 70.6 Wed 17:05 POT/0013

A new bound on Lorentz violation based on the absence of vacuum Cherenkov radiation in ultra-high energy air showers — •Fabian Duenkel, Marcus Niechciol, and Markus Risse — Center for Particle Physics Siegen, Experimentelle Astroteilchenphysik, Universität Siegen

In extensive air showers induced by ultra-high energy (UHE) cosmic rays, secondary particles are produced with energies far above those accessible by other means. These extreme energies can be used to search for new physics. We study the effects of isotropic, nonbirefringent Lorentz violation in the photon sector. In case of a photon velocity smaller than the maximum attainable velocity of standard Dirac fermions, vacuum Cherenkov radiation becomes possible. Implementing this Lorentz-violating effect in air shower simulations, a significant reduction of the calculated average atmospheric depth of the shower maximum $\langle X_{\max} \rangle$ is obtained. Based on $\langle X_{\max} \rangle$ and its shower-to-shower fluctuations $\sigma(X_{\max})$, we present a new bound on Lorentz violation sensitive to vacuum Cherenkov radiation from fundamental particles (electrons and positrons) in air showers.

This work is supported by the Deutsche Forschungsgemeinschaft (DFG).

T 71: Exp. Methods AP, PMTs

Time: Wednesday 15:50–17:20 Location: POT/0351

T 71.1 Wed 15:50 POT/0351

Performance Tests of the Acoustic Module for the IceCube Upgrade — •Charlotte Benning, Jan Audehm, Jürgen Borowka, Mia Giang Do, Oliver Gries, Christoph Günther, Dirk Heinen, Adam Rifaie, Joëlle Savelberg, Christopher Wiebusch, and Simon Zierke for the IceCube-Collaboration — III. Physikalisches Institut B, RWTH Aachen University

The IceCube Neutrino Observatory is a one cubic kilometer particle detector consisting of 5160 Digital Optical Modules located in the ice at the geographic South Pole. During the IceCube Upgrade more than 700 additional modules will be deployed at the center of the existing detector with the purpose of calibrating and enhancing the detectors capabilities. Part of this upgrade will be ten specialized Acoustic Modules which are capable of receiving and transmitting acoustic signals from 5 to 40 kHz. Based on the principle of trilateration, the positions of acoustic and optical modules will be determined from the propa-

gation times of these signals. With this system we aim to achieve an accuracy of a few 10 cm for the geometrical precision of the detector. In this talk the results of performance tests of the acoustic modules in the laboratory and at a local swimming pool are presented.

T 71.2 Wed 16:05 POT/0351

The Design of the Acoustic Module for the IceCube Upgrade — •Adam Rifaie, Jan Audehm, Charlotte Benning, Jürgen Borowka, Mia Giang Do, Oliver Gries, Christoph Günther, Lasse Halve, Dirk Heinen, Joëlle Savelberg, Christopher Wiebusch, and Simon Zierke for the IceCube-Collaboration — III. Physikalisches Institut B, RWTH Aachen University

The IceCube Neutrino Observatory at the South Pole detects high energy neutrinos from astrophysical sources. With the upcoming IceCube Upgrade, more than 700 detector modules along with calibration devices will be deployed at the central core of IceCube, 2 km deep into the Antarctic ice. Ten Acoustic Modules (AM) will transmit and receive acoustic signals from 5 to 40 kHz. By means of trilateration of the propagation times of these acoustic signals, we determine the positions of the AMs with an accuracy of about 10 cm and thus calibrate the geometry of the detector. The AM consists of acoustic transducer, communication and signal generation power electronics, and receiver electronics, all embedded in a housing, withstanding the pressure in the ice. For the proper measurement of transit times between different modules a dedicated synchronization and timing protocol has to be implemented. This talk presents an overview of the functionality and technical design of the main components and describes the development of appropriate firmware.

T 71.3 Wed 16:20 POT/0351

Status of the implementation of "Event-Generator" in IceCube-Gen2 — •Francisco Javier Vara Carbonell and Alexander Kappes for the IceCube-Collaboration — Institut für Kernphysik WWU Münster, Münster, Germany

The success of large observatories such as the IceCube neutrino telescope is highly dependent on the accuracy of their reconstruction algorithms. In IceCube, traditional likelihood-based methods are limited by the lookup tables used for calculating the event hypotheses, since their complexity requires them to be simplified. Promising results have recently been obtained with "Event Generator", a generative neural network that can replace such tables and lead to an improvement in reconstruction performance since it does not require simplification. The success of this neural network lies in its design, which, unlike most machine learning applications, is able to explicitly exploit the information domain of IceCube event generation, such as symmetries and detector properties. In this talk, "Event Generator" will be introduced and the current status and future plans for its implementation in IceCube-Gen2 will be presented.

T 71.4 Wed 16:35 POT/0351

Photomultiplier simulation in COMSOL Multiphysics — •Willem Achtermann, Alexander Kappes, and Markus Dittmer for the IceCube-Collaboration — Institut für Kernphysik, Westfälische Wilhelms-Universität Münster, Münster, Germany

Photomultiplier tubes (PMTs) are used in water Cherenkov neutrino detectors such as IceCube and KM3NeT. They play a central role in the performance of the detector and therefore a deep understanding of their properties is crucial for the operation and improvement of the experiment. In this talk, I discuss some of the timing parameters, e.g., the transit time (spread) for a PMT, which I investigate using a COMSOL multiphysics simulation. The current state of simulation will be shown and some insights into the working principle of PMTs and simulation results will be given.

T 71.5 Wed 16:50 POT/0351

Characterizing Light Attenuation inside the Wavelength-Shifting Optical Module from Timing Distributions — •Yuriy Popovych, John Rack-Helleis, Martin Rongen, and Sebastian Böser — Johannes Gutenberg-Universität Mainz

The Wavelength Shifting Optical Module (WOM) makes use of wavelength-shifting paint to absorb UV-photons and re-emit them as visible light. These photons are captured via Total Internal Reflection inside a quartz tube and propagate to Photomultipliers at both ends. Due to its design the timing resolution of the WOM does not result not from the sensors, but from the photon propagation inside the tube. Further, one can measure the timing distribution to differentiate between scattering and absorption processes in the light propagation. Characterizing the timing lets us explore new use cases for the WOM-technology.

This talk will describe the modeling and measurement of the timing characteristics of the WOM and a method to deduce absorption and scattering properties of the wavelength-shifter coated WOM tube from it.

T 71.6 Wed 17:05 POT/0351

Investigation of photomultiplier photocathodes with an ellipsometer — •Berit Schlüter and Alexander Kappes — Institut für Kernphysik, Westfälische Wilhelms-Universität Münster, Münster, Germany

Photomultiplier tubes (PMTs) are a central component of today's neutrino telescopes such as IceCube and KM3NeT, and an accurate understanding and measurement of their properties is indispensable for further improvement of the detectors. In my talk I focus on the optical properties of the photocathode, which is only a few 10 nanometers thick and will be investigated using an ellipsometer. As part of my master's thesis, I set up the ellipsometer and used it to characterize flat samples. Currently, the setup is being extended for the measurement of curved photocathodes as part of my PhD thesis. This talk presents the idea of the measurement as well as the current status of the work.

T 72: Exp. Methods II

Time: Wednesday 15:50–17:05 Location: POT/0106

T 72.1 Wed 15:50 POT/0106

Soft b-hadron vertex reconstruction tool — •Beatrice Cervato[1], Binish Batool[1], Markus Cristinziani[1], Carmen Diez Pardos[1], Ivor Fleck[1], Arpan Ghosal[1], Gabriel Gomes[1], Jan Joachim Hahn[1], Vadim Kostyukhin[1], Buddhadeb Mondal[1], Amartya Rej[1], Katharina Voss[1], Wolfgang Walkowiak[1], and Tongbin Zhao[1,2] — [1]Center for Particle Physics Siegen, Experimentelle Teilchenphysik, Universität Siegen — [2]Shandong University, China

Several interesting physical processes lead to the production of low-energy (soft) b-quarks in the final state, that may fragment into a b-hadron without the creation of a reconstructable jet. Moreover, sometimes b-hadrons in jets are so soft that their decay products are distributed over a wider angular range than the standard jet cone (the typical cone size is 0.4). The tool described in this contribution is targeting b-hadrons without jets and soft-b-hadrons inside jets, which are not detectable by standard Flavour Tagging Algorithms. For this reason, it is very important to develop and optimize such a b-tagging tool, as will be described in the presentation. After defining the efficiency and the fake rate, we estimate the tool performance using a $t\bar{t}$ reference sample, and define three working points. Subsequently, we check the tool performance at those working points using a sample with soft b-hadrons and a b-hadron-free sample. We demonstrate that the efficiency (fake rate) varies in a range that goes from 27% (0.5%) to 44% (7.1%).

T 72.2 Wed 16:05 POT/0106

Graph Neural Network based Track Finding in the Central Drift Chamber at Belle II — •Lea Reuter, Philipp Dorwath, Torben Ferber, and Slavomira Stefkova — Institute of Experimental Particle Physics (ETP), Karlsruhe Institute of Technology (KIT)

In many new physics extensions of the Standard Model, new mediator particles may decay into charged particles leaving a unique signature of a displaced vertex and charged tracks. These displaced decay products are an important signature in searches for dark sector candidates in collider experiments. The current Belle II trigger algorithm is not designed for events with displaced vertices and therefore insufficient to

detect these events. Traditional tracking algorithms scale poorly with the high beam-background, which is expected to increase significantly in the upcoming data-taking of the Belle II experiment.

Therefore, we develop a Graph Neural Network (GNN) based approach to find particle tracks and displaced vertices in the Central Drift Chamber of Belle II, where we realize track measurements using a graph representation of detector hits. We use GNN-based object condensation for track finding to identify the varying number of tracks per event. The goal of this project is to improve the track finding for Belle II. Furthermore, we also implement track fitting simultaneously to the track finding, to investigate if this GNN approach can also be used in real-time application in the level 1 trigger system.

T 72.3 Wed 16:20 POT/0106

Graph building and input feature analysis for edge classification in the Central Drift Chamber at Belle II — •Philipp Dorwarth, Torben Ferber, Lea Reuter, and Slavomira Stefkova — Institute of Experimental Particle Physics (ETP), Karlsruhe Institute of Technology (KIT)

Many extensions of the Standard Model, such as inelastic dark matter models, predict long-lived particles. They can manifest with two charged tracks originating from a vertex with a large displacement from the interaction point in collider experiments. Conventional tracking algorithms are insufficient to respond to those highly displaced vertices, and they also scale poorly with an increased beam background, as expected from SuperKEKB's increased luminosity.

Graphs are an intuitive representation of hits in a tracking detector as they provide high flexibility regarding input features and the length of input vectors. Therefore, we develop a Graph Neural Network (GNN) approach for hit and edge classification in the Central Drift Chamber (CDC) at Belle II. Eventually, the output will be used for GNN-based displaced vertex and tracking algorithms. We examine different methods of graph building and analyze their performance for the classification task. In addition, we study the feasibility of using detector-level information, such as digitized signal hits, as GNN input features in both data and simulation. We find that this information provides very good discriminatory power and should therefore be used as an additional input feature for the GNN to improve the efficiency of the edge classification.

T 72.4 Wed 16:35 POT/0106

Development of a Classifier for Simulated Secondary Decay Vertices in the CMS Experiment — •Tim Graulich[1], Xavier Coubez[1,2], Wahid Redjeb[1], and Alexander Schmidt[1] — [1]III. Physikalisches Institut A, RWTH Aachen University, Aachen, Germany — [2]Brown University, USA

Secondary decay vertices are important signatures which can indicate the presence of a long-lived particle such as a b hadron. These vertices provide important information to be used in higher level algorithms, most importantly b-tagging algorithms. In order to study the performance of secondary vertex reconstruction algorithms, the investigation of simulated vertices is necessary. A classifier to find and classify secondary decay vertices in simulated events is presented, with a focus on b and c hadron decays. Furthermore, the final state decay products of the vertex are associated with it to provide reliable training information to neural networks. This talk will showcase how event generator and detector simulation data can be combined to extract the secondary vertex information from simulated data.

T 72.5 Wed 16:50 POT/0106

Introduction to columnflow — Mathis Frahm, Philip Daniel Keicher, Tobias Kramer, •Nathan Prouvost, Marcel Rieger, Daniel Savoiu, Peter Schleper, Matthias Schröder, and Bogdan Wiederspan — Institut für Experimentalphysik, Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg

In order to observe and measure rare processes in nature, a staggering amount of data needs to be produced and processed at particle colliders. With the advancement of the LHC towards Run 3 and HL-LHC, the flow of data as well as the complexity of the analyses will increase even more. In light of these challenges and the limited resources available, an efficient usage of computing power and disc usage is critical for future analyses.

In order to analyze data in an efficient way, a new columnar analysis tool, columnflow, has been developed. In this presentation, an introduction to columnflow is given, including an overview of the workflow and some examples of use cases.

T 73: Pixel/CMS

Time: Wednesday 15:50–16:50 Location: WIL/A317

T 73.1 Wed 15:50 WIL/A317

Measurements of the CMS Inner Tracker pixel assemblies for the Phase-2 upgrade — •Bianca Raciti, Massimiliano Antonello, Erika Garutti, Jörn Schwandt, and Georg Steinbrück — University of Hamburg, 22761, Luruper Chaussee 149, Hamburg, Germany

During Long Shutdown 3, the entire CMS Tracking System will be replaced to operate during the High Luminosity LHC running phase with considerably increased luminosity. The new pixel sensors will have to fulfill stringent requirements to operate in an extremely harsh radiation environment and cope with the high data readout rate.

An extensive campaign has taken place to characterize the first half-size pixel chip demonstrator (RD53A), which led to the submission and production of the first full-size prototype chip (RD53B-CMS).

The new sensor-readout chip modules have been extensively tested both in the laboratory and at the CERN and DESY testbeam facilities.

This study presents results on the performances of the two subsequent iterations of pixel assemblies with different irradiation levels, sensor designs and experimental conditions.

T 73.2 Wed 16:05 WIL/A317

Commissioning of a Burn-In Setup for PS and 2S Detector Modules for the Upgrade of the CMS Outer Tracker — •Ana Ventura Barroso, Paul Schütze, and Katerina Lipka — Deutsches Elektronen-Synchrotron DESY, Notkestraße 85, D-22607 Hamburg

The high luminosity LHC Upgrade will increase the instantaneous luminosity by a factor of five. The CMS detector will be upgraded in the so called Phase-2 Upgrade in order to meet the new requirements, among others the level of radiation tolerance and coping with larger pileup and thus higher data rates, as well as to add triggering capabilities. The entire silicon tracker will be replaced. The Outer Tracker (OT), consisting of macro-pixel and strip detectors, will be based on silicon modules that must operate at low temperatures (−35°C) due to the exposition at high radiation levels. The probability for defective electronic components to fail is higher after few hours of operation. Moreover, temperature cycles can induce mechanical stress. Therefore a burn-in procedure as well as thorough quality control is needed to ensure the correct operation of each of the OT modules before installation.

For this, a burn-in system is being commissioned at DESY. This setup will perform thermal cycles from room to operation temperature and key measurements to ensure the good performance of the modules. In this talk, the status of the DESY burn-in setup as well as noise measurements and temperature test on a PS module will be presented.

T 73.3 Wed 16:20 WIL/A317

Optical Metrology for the PS module production — •Leonie Sommer[1,2] and Paul Schütze[1] — [1]DESY, Hamburg, Germany — [2]University of Wuppertal, Wuppertal, Germany

The High Luminosity LHC upgrade aims at increasing the instantaneous luminosity leading to various challenges for the detectors. The CMS detector will undergo an upgrade to cope with larger pileup, higher data rates and higher radiation dose. As the new Outer Tracker will contribute to the first trigger stage at 40MHz bunch crossing rate, on-module pT-discrimination is needed for data reduction. This is achieved by building dual-sensor modules, where the efficiency of the momentum discrimination depends on the alignment precision of the sensors which needs to be checked thoroughly during module assembly. Metrology systems are used by the assembly centers to monitor that the modules used in the final detector meet the required align-

ment precision. In this talk the optical metrology setup at DESY is introduced and measurement procedures are described. Measurement results of various prototype PS modules built and tested at DESY are summarized and the stability of the system is assessed.

T 73.4 Wed 16:35 WIL/A317

Position reconstruction of shallow angle tracks in irradiated pixel sensors for the CMS Inner Tracker Upgrade — •Lukas Eikelmann, Massimiliano Antonello, Erika Garutti, Bianca Raciti, Jörn Schwandt, Georg Steinbrück und Annika Vauth — Institut für Experimentalphysik Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg, Germany

The position reconstruction of shallow angle tracks in the CMS Phase-II inner barrel layers is studied for its planned pixel pitch of 25 μm by 100 μm. These tracks have incident angles on the sensor of up to 84° with respect to vertical incidence. At such incident angles, the deposited charge is shared between over 13 pixels of 100 μm length. An algorithm attempts to cluster these pixels. It assigns the cluster position as the track hit position in this layer. Hits in the four layers are used to reconstruct the track. One of the effects of radiation damage in silicon is charge trapping. This leads to a reduction in the recorded signal of a pixel. If it is below the threshold of the readout chip, no signal is recorded. A missing pixel affects the proper cluster reconstruction resulting in a wrong hit position. In this study, irradiated and non-irradiated pixel sensors bump-bonded to the RD53A prototype chip are tested with shallow angle tracks in the DESY-II electron beam. The cluster breakage and the impact on the position reconstruction of different cluster algorithms are analyzed.

T 74: DetSys MAGIX, DetSys KATRIN

Time: Wednesday 15:50–16:50 Location: WIL/A124

T 74.1 Wed 15:50 WIL/A124

A sophisticated trigger veto system for the MAGIX experiment — •Sebastian Stengel for the MAGIX-Collaboration — Institute for Nuclear Physics, Johannes Gutenberg University Mainz

At the new electron accelerator MESA, the MAGIX setup will be used for high- precision scattering experiments including dark sector searches, the study of hadron structure and few-body systems, and investigations of reactions relevant to nuclear astrophysics.

Together with the MAGIX time projection chamber (MX-TPC), the MAGIX trigger veto system builds the sophisticated detector system inside the two high-resolution magnetic spectrometers. It will provide the fast and reliable signals essential for DAQ, coincidence time measurements, and PID, as well as the basic hit and position information for the triggered readout of the MX-TPC.

The MAGIX trigger veto system consists of one segmented trigger layer made of plastic scintillation detectors and a flexible veto system of additional scintillation detectors and lead absorbers mounted below the trigger layer.

The data readout uses the ultrafast preamplifier-discriminator NINO chip which encodes the signal amplitudes using the time-over-threshold method, followed by FPGAs programmed as TDCs.

T 74.2 Wed 16:05 WIL/A124

Scintillating active Transverse Energy Filter: a novel detector concept for low-energy electron background discrimination — •Joscha Lauer for the KATRIN-Collaboration — Karlsruhe Institute of Technology (KIT)

One of the leading sensitivity limiting factors in the Karlsruhe Tritium Neutrino (KATRIN) experiment are background electrons from the main spectrometer. These electrons, presumably low in energy at their creation point, are currently indistinguishable from the tritium beta electrons. Since they arrive at the detector with predominantly small angles relative to the guiding magnetic field lines in contrast to the signal electrons, an angular selective detector has great potential in increasing the sensitivity of the KATRIN experiment by enhancing the signal-to-background ratio.

Micro-structured detector configurations which exhibit angular selectivity due to their 3D structure, so-called active Transverse Energy Filters (aTEF), have been proposed by Eur. Phys. J. C 82 (2022) 922. One approach is a scintillator-based aTEF (scint-aTEF). This presentation gives an overview of the aTEF principle and in particular the scint-aTEF detector, including *GEANT4* simulation-based studies and prototype micro-structures 3D printed via two-photon lithography.

This work is supported by the Helmholtz Association, the Ministry for Education and Research BMBF (05A17PM3, 05A17PX3, 05A17VK2 and 05A17WO3), the Helmholtz Alliance for Astroparticle Physics (HAP) and the Helmholtz Initiative and Networking Fund (W2/W3-118).

T 74.3 Wed 16:20 WIL/A124

Design of a scintillating active Transverse Energy Filter for Background Suppression at the KATRIN Experiment — •Nathanael Gutknecht for the KATRIN-Collaboration — Karlsruhe Institute of Technology (KIT)

The **Ka**rlsruhe **Tri**tium **N**eutrino (KATRIN) experiment aims to determine the mass of the electron antineutrino with an unprecedented sensitivity of $0.2\,\mathrm{eV/c^2}$ (90 % C. L.) by precise measurement of the energy spectrum of tritium β-electrons. The energy of the signal electrons are spectrometrically determined in a MAC-E-Filter setup. At the moment, one sensitivity limiting factor is the spectrometer background which consists of electrons that are generated in the mainspectrometer volume. Due to their small initial energy the background electrons have a different angular distribution than the signal electrons at the point of detection.

A scintillating structure acting as an angular selective detector (scint-aTEF) has potential to discriminate between β- and background electrons. This talk will discuss the geometrical concept of the scint-aTEF and its expected impact on the background reduction, based on simulations with *Geant4*.

This work is supported by the Helmholtz Association, the Ministry for Education and Research BMBF (05A17PM3, 05A17PX3, 05A17VK2, and 05A17WO3), the Helmholtz Alliance for Astroparticle Physics (HAP), and the Helmholtz Initiative and Networking Fund (W2/W3-118).

T 74.4 Wed 16:35 WIL/A124

PMT test stand simulations of first scintillator prototypes towards active Transverse Energy Filter — •Tom Geigle for the KATRIN-Collaboration — Karlsruhe Institute of Technology (KIT)

The **Ka**rlsruhe **Tri**tium **N**eutrino (KATRIN) experiment has the goal of determining the neutrino mass scale with a sensitivity of $0.2\,\mathrm{eV/c^2}$ (90%C.L.). One of the most important factors limiting the measurement is the background, originating from the main spectrometer which consists of mostly low energy electrons. These electrons are accelerated by the retarding potential and thus possess low transverse energy, resulting primarily in small angles relative to the guiding magnetic field. Therefore, a detector that allows angular sensitivity could greatly improve the sensitivity of the KATRIN experiment.

The concept of an **a**ctive **T**ransverse **E**nergy **F**ilter (aTEF) has been proposed (Eur. Phys. J. C 82 (2022) 922) which could use microstructures to develop such an angular sensitive detector. For this purpose, one of two designs being considered consists of a plastic scintillator that is read out via CMOS **s**ingle-**p**hoton **a**valanche **d**iodes (SPADs). In this presentation, we discuss our first investigation of scintillator prototypes for 2-photon lithography using *Geant4* based simulations and measurements with a photomultiplier setup.

This work is supported by the Helmholtz Association, the Ministry for Education and Research BMBF (05A17PM3, 05A17PX3, 05A17VK2, and 05A17WO3), the Helmholtz Alliance for Astroparticle Physics (HAP), and the Helmholtz Initiative and Networking Fund (W2/W3-118).

T 75: Calorimeter / Detector Systems III

Time: Wednesday 15:50–16:35 Location: WIL/C133

T 75.1 Wed 15:50 WIL/C133

Neutron and Photon Tagging in Plastic Scintillators — Asma Hadef, Antoine Laudrain, •Asa Nehm, and Sebastian Ritter — JGU Mainz, ETAP

While neutron-photon separation using pulse shape discrimination with liquid scintillators and PMTs is a well-known technique, it represents a major challenge using plastic scintillators with SiPM readout. A setup using an AmBe source has been built in order to study the ability of the EJ-276G plastic scintillator optimized for pulse shape discrimination to distinguish between neutrons and photons. The design also includes a cosmic tagging which allows for the identification and rejection of the cosmic background.

The main approach for the discrimination method is to use the more frequent delayed scintillation photons for neutrons compared to the gammas for the events. Different analysis methods using the amount of delayed photon-electron peaks per event as well as their timing information are implemented and studied in detail.

This method could be used in the electromagnetic calorimeter that is part of the DUNE near detector complex, to provide neutron tagging capabilities and enable neutron energy reconstruction.

T 75.2 Wed 16:05 WIL/C133

Development of PEN as an Optically Active Structural Material for Low Background Experiments — •Brennan Hackett[1], Iris Abt[1], Felix Fischer[1], Béla Majorovits[1], Luis Manzanillas[1,2], and Oliver Schulz[1] — [1]Max Planck Institute for Physcis, Munich, Germany — [2]Synchrotron Soleil, Saint-Aubin, France

Neutrino physics and experiments searching for dark matter are pursuing novel low background and self-vetoing materials for components in order to improve their sensitivity. One material of interest is poly(ethylene-2, 6-naphatalate) (PEN) for its inherent scintillating and wavelength shifting properties, as well as its commercial availability and structural stability. Commercially available PEN films are limited in their applications and occasionally do not fulfill the stringent radiopurity and optical requirements of these experiments. As such, the PEN working group has developed a method to produce PEN components with excellent optical properties of thicknesses up to 5 mm, and with a specific activity of less than mBq/kg. PEN detector holders have been successfully installed in the LEGEND experiment and additional PEN structures are being evaluated to further expand the use of structural scintillators. Details of this R&D effort with commercial PEN and the progress on development of custom synthesized radio-pure PEN will be presented.

T 75.3 Wed 16:20 WIL/C133

Light yields and spatial resolution of a wavelength-shifting fibre structured plastic scintillator detector — Alessia Brignoli[1], Heiko Markus Lacker[1], Christian Scharf[1], •Ben Skodda[1], Valery Dormenev[2], Hans Georg Zaunick[2], and Martin J. Losekamm[3] — [1]Humboldt-Universität zu Berlin — [2]Justus-Liebig-Universität Gießen — [3]Technische Universität München

The "CheapCal" project aims to develop a low-cost and easy-to-build detector for charged particle detection with spatial resolution of about a centimeter. The detector principle is based on an extruded plastic scintillator material with a short light attenuation length, which is structured with parallel oriented wavelength-shifting fibres and a fibre-to-fibre distance of 1.5 cm. The fibres are read-out at each end by a SiPM. Using a Sr-90 beta source, we study the light yield of each fibre as a function of the beta-source position on the scintillator plate from which the particle's intersection point at the plastic scintillator plate is determined. We acknowledge the support from BMBF via the High-D consortium.

T 76: Gas-Detectors

Time: Wednesday 15:50–16:50 Location: WIL/A120

T 76.1 Wed 15:50 WIL/A120

Material Optimization for Photon Detection by Structured Converter Layers using Micro-Pattern Gaseous GEM Detectors — •Nick Schneider, Otmar Biebel, Valerio D'Amico, Florian Egli, Stefanie Götz, Ralf Hertenberger, Christoph Jagfeld, Eshita Kumar, Katrin Penski, Maximilian Rinnagel, Chrysostomos Valderanis, and Fabian Vogel — LMU München

Micro-Pattern Gaseous Detectors are heavily used for the detection of charged particles with excellent temporal and spatial resolution. Electrically neutral particles are detected with poor efficiency due to the low density in the active gas volume. By inserting solid converter layers of high-Z material this disadvantage can be mitigated. In our design multiple converter layers are placed perpendicular to the first GEM foil. Proper electric fields guide the electrons to the amplification region. In order to further increase the photon detection efficiency the material and structure of the converter layers need to be optimized to find the perfect balance between creation and extraction rate. For photon conversion copper plated layers are used with relatively thin FR4 as carrier material. Different thick combinations of FR4 and copper are tested in order to achieve high photon detection efficiencies. These results are compared to simulations for better understanding of the physical processes. This method increases the photon detection efficiency by a factor of about 2 and provides interdisciplinary possibilities in material research, medical physics or astrophysics.

T 76.2 Wed 16:05 WIL/A120

Photon Position Reconstruction using Structured Converter Layers in Micro-Pattern Gaseous Detectors — •Katrin Penski, Otmar Biebel, Valerio D'Amico, Florian Egli, Stefanie Götz, Ralf Hertenberger, Christoph Jagfeld, Eshita Kumar, Maximilian Rinnagel, Nick Schneider, Chrysostomos Valderanis, and Fabian Vogel — LMU München

Micro-Pattern Gaseous Detectors are high-rate capable with excellent spatial and temporal resolution. Developed for the detection of charged particles, the low density in the active gas volume of these detectors exhibit only a poor detection efficiency for electrically neutral particles. For photons the detection via the photoelectric effect can be increased using a solid converter cathode, which is made of high-Z materials. With our novel approach, the detection efficiency can be optimized by incorporating multiple converter plates quasi perpendicularly on top of the first GEM foil. Moreover, this technique aims to provide a full two-dimensional position reconstruction of the particle with a resolution of less than 100 μm within a converter plate. Using the two coordinates of the readout anode of the GEM detector enables this by mounting the converter layers at a specific angle that allows geometric position reconstruction. An optimized electric field, where the electric field lines are parallel to the amplification field, guides the electrons from the converter layers to the GEM foils. Detailed simulations on the influence of different parameters, such as the tilting angle or the drift gas, were performed to optimize the design. Simulation and measurement results are presented.

T 76.3 Wed 16:20 WIL/A120

Setup of a 5 m long Straw Tube prototype for the SHiP experiment — •Rishabh Moolya, Caren Hagner, and Daniel Bick — Hamburg University

The Search for Hidden Particles (SHiP) experiment is a proposed, general purpose fixed target beam-dump experiment utilising the 400 GeV Super Proton Synchrotron (SPS) proton beam at CERN. It is specifically designed to search for hidden particles, at the intensity frontier and to also study tau neutrino physics extensively for the first time. The SHiP hidden sector (HS) detector is designed to detect the decay products of hidden particles decaying inside its ∼50 m long vacuum decay vessel. An essential role is to reconstruct the tracks and determine the momentum of the charged particles produced in these decays. This is the purpose of the Spectrometer Straw Tracker (SST), consisting of

roughly 16000 straw tubes, each 4 m long and 2 cm in diameter.

A prototype consisting of four straw tubes has recently been set up at Hamburg University. The status of the commissioning and the first results will be presented.

T 76.4 Wed 16:35 WIL/A120

The Influence of Water defects and Mesh Geometry on Measurements with a MicroMegas Detector filled with an Ar-CO_2 Gas Mixture — •Burkhard Böhm, Anno Strobel, and Raimund Ströhmer — Universität Würzburg

In particle physics, Micro-Pattern Gaseous Detectors (MPGD) find high usage in different experiments like ATLAS, CMS or ALICE. In this study MicroMegas Detectors (MM) - a special type of MPGDs - are researched in terms of H_2O contamination. They are well known for their simple single-stage amplification, high and stable gain and excellent spatial and temporal resolutions. These detectors can be contaminated by H_2O from air which can have an effect on detector stability. H_2O can also act as a quenching gas similar to CO_2. The effect on the gas-gain and the amplification of the number of primary electrons are studied by precisely controlled inflowing of H_2O inside a resistive MM chamber. Even a small change in concentration of H_2O is expected to have an impact on the detector performance.

Also the influence of different mesh geometries like gap size and wire diameter in terms of contamination is researched. The geometry can have an influence on the electric field and therefore on the detector gain as well as on the transparency of the mesh. Studied mesh types are 70/30, 50/30 and 45/18 (pitch size/wire diameter in μm).

T 77: Flavor VI

Time: Wednesday 17:20–18:50 Location: HSZ/0401

T 77.1 Wed 17:20 HSZ/0401

Studies of lepton universality with $\Lambda_b \to pKl^+l^-$ decays at LHCb — Johannes Albrecht, Vitalii Lisovskyi, and •Jannis Speer — TU Dortmund University, Dortmund, Germany

In recent measurements of b-hadron decays, a pattern of consistent tensions with the Standard Model predictions is observed. This includes rare decays with $b \to s\ell^+\ell^-$ transitions, which play an important role in lepton flavor universality tests. Complementary to b-meson decays, lepton flavor universality can also be tested in b-baryon decays, which come with partly orthogonal experimental uncertainties. The first measurement of the ratio of branching fractions of the decays $\Lambda_b \to pKe^+e^-$ and $\Lambda_b \to pK\mu^+\mu^-$, R_{pK}^{-1}, was published by the LHCb Collaboration using proton-proton collision data corresponding to an integrated luminosity of $4.7\,\mathrm{fb}^{-1}$. The ratio was measured to be $R_{pK}^{-1} = 1.17^{+0.18}_{-0.16} \pm 0.07$ in the dilepton mass-squared range $0.1 < q^2 < 6.0\,\mathrm{GeV}^2/\mathrm{c}^4$ and the pK mass range $m(pK) < 2600\,\mathrm{MeV/c}^2$. The legacy measurement of R_{pK}^{-1} aims to reduce the uncertainties by analyzing the full $9\,\mathrm{fb}^{-1}$ dataset of LHCb experiment and implementing new selection techniques. In this talk, the recent developments of the ongoing measurement are presented.

T 77.2 Wed 17:35 HSZ/0401

Updated Search for Rare Electroweak Decay $B \to K^{(*)}\nu\overline{\nu}$ to Constrain New Physics Models — •Caspar Schmitt, Sviatoslav Bilokin, and Thomas Kuhr — LMU München, Am Coulombwall 1, 85748 Garching, Germany

Precision measurements of rare decays serve as indirect searches for new physics up to scales well beyond the collider energy, since Standard Model contributions are strongly suppressed. Multiple anomalies are seen in rare decays of B mesons, in particular of the type $B \to K^{(*)}l^+l^-$. We search hints for new physics in the neutral lepton channel $B \to K^{(*)}\nu\overline{\nu}$, which is closely related assuming an unbroken SU(2) Standard Model symmetry. This channel allows particularly precise theoretical predictions and can help reducing hadronic uncertainties in the charged lepton channel.

Experimentally the decay has not yet been detected and is challenging due to the two neutrinos in its final state. Belle II currently is the only experiment in operation that can infer the decay from missing energy and momentum searches. Current experimental limits are model-dependent and a factor 3 to 5 above the Standard Model expectations.

In subsets of new physics models, Wilson coefficients map onto observables and make clear experimental signatures for different new physics scenarios accessible. We explore possibilities for model-independent q^2-binned searches for new physics contributions in $B \to K^{(*)}\nu\overline{\nu}$ by employing novel untagged methods using machine learning.

T 77.3 Wed 17:50 HSZ/0401

Enhancing data exploitation with public likelihoods — •Lorenz Gaertner[1], Thomas Kuhr[1], Danny van Dyk[2], Lukas Heinrich[3], Méril Reboud[2], and Slavomira Stefkova[4] — [1]Ludwig-Maximilians-Universität, München, DE — [2]IPPP, Durham University, Durham, UK — [3]Technical University Munich, München, DE — [4]Karlsruhe Institute of Technology, Karlsruhe, DE

The results published using data from high-energy experiments have large scientific potential beyond initial publication. To maximize the scientific impact of the data and the corresponding likelihood of the results, facilitating reuse for combination, reinterpretation, and the generation of pseudo data should be made standard practice.

A channel with a potentially high benefit from reinterpretation in terms of new physics models is the rare $B^+ \to K^+\nu\bar{\nu}$ decay, for which a search is conducted by the Belle II collaboration. The observables arising from such decays are very sensitive to many new physics models. Due to the experimental challenge arising from two final state neutrinos, the analysis of this decay requires assumptions on the kinematic distribution. Consequently, the results feature a model dependency arising from both (beyond) standard model assumptions and from the description of the pertinent hadronic matrix element. This dependency makes reinterpretation complicated without reanalysing the underlying data. By exploring methods to perform result-level reweighting of published likelihoods according to new theoretical models, we want to study the effect on the likelihoods and interpret the physical significance.

T 77.4 Wed 18:05 HSZ/0401

Studies of angular and CP asymmetries in $D_{(s)}^+ \to h^+l^-l^+$ decays at LHCb — Serena Maccolini, Dominik Mitzel, and •Luca Toscano — TU Dortmund University, Dortmund, Germany

LHCb has recorded the world's largest sample of charm hadron decays and takes a leading role in measurements of rare decays and searches for CP violation.

Rare semi-leptonic charm decays such as $D^+ \to \pi^+l^-l^+$ and $D_s^+ \to K^+l^-l^+$ are sensitive to beyond-standard-model effects in flavour-changing neutral current $c \to u\ell^+\ell^-$ transitions, where $\ell^+\ell^-$ is a pair of oppositely charged electrons or muons. Null test observables can be defined to test the Standard Model in angular or CP asymmetries, where new physics signals can be enhanced in the vicinity of intermediate hadronic resonances.

In this talk, an overview of the tentative analysis strategy to perform a first study of angular distributions and CP asymmetries in $D_{(s)}^+ \to h^+l^-l^+$ decays is presented. The analysis uses data collected by the LHCb detector from 2016 to 2018 at a centre-of-mass energy of 13 TeV, corresponding to an integrated luminosity of $6\mathrm{fb}^{-1}$.

T 77.5 Wed 18:20 HSZ/0401

Measurement of the branching fraction of the rare decay $D^0 \to K^-\pi^+e^-e^+$ with the LHCb experiment — Daniel Unverzagt and •Stefan Blenkle — Physikalisches Institut, Heidelberg, Germany

The LHCb experiment at the Large Hadron Collider (LHC) is particularly suitable for studying decays of charm hadrons. This talk presents the branching fraction measurement of the four-body decay $D^0 \to K^-\pi^+e^-e^+$ using LHCb data collected in 2017 and 2018, corresponding to an integrated luminosity of $3.8fb^{-1}$. The analysis aims to measure the most precise value for the decay branching fraction using the world's largest data sample of charm decays.

T 77.6 Wed 18:35 HSZ/0401

New Physics at the $K \to \pi\nu\nu$ kinematic distributions — •Kai Sieja[1], Emmanuel Stamou[1], Mustafa Tabet[1], and Martin

Gorbahn[2] — [1]TU Dortmund, Germany — [2]University of Liverpool, United Kingdom

The rare decays $K^+ \to \pi^+\nu\nu$ and $K_L \to \pi^0\nu\nu$ are among the strongest probes of Beyond-the-Standard-Model dynamics with new sources of quark-flavour violation. These decays are thus the main target for the dedicated experiments NA62 and KOTO. Working within the LEFT framework, we analyze the impact of dimension-six operators including lepton-number violating ones on the experimentally accessible distributions. Concrete New Physics models can induce operators with different chirality, i.e., vector-, scalar, tensor-type operators, and different neutrino flavour structure. Using published data from NA62, we assess the impact of a combined binned likelihood in constraining the New Physics parameter space and how this varies for different operator types.

T 78: Flavor VII

Time: Wednesday 17:30–19:00 Location: HSZ/0304

T 78.1 Wed 17:30 HSZ/0304

Completing the Heavy Quark Expansion — •Ilija Sibin Milutin[1], Thomas Mannel[1], and Keri Vos[2] — [1]Siegen University, Siegen, Germany — [2]Maastricht University, Maastricht, The Netherlands

The Heavy Quark Expansion (HQE) has become the major tool to perform precision calculations for inclusive rates and spectra of heavy hadron decays. The HQE is an expansion in powers of the inverse mass of the heavy quark $1/m_b$ and introduces HQE matrix elements which need to be extracted from data. Recently, moments of the dilepton spectrum of inclusive semileptonic $B \to X_c\ell\bar{\nu}$ have been used to extract the CKM matrix element V_{cb} with incredible percent-level precision and in agreement with the world's best determination of V_{cb}.

The HQE for the inclusive semileptonic $B \to X_c\ell\bar{\nu}$ decay is usually set up in such a way that one assumes that the charm quark is also a heavy quark. Therefore, one will also have contributions of order $\Lambda^n_{\rm QCD}/m^n_c$.

At dimension six, i.e. at $1/m^3_b$, a coefficient function behaving as $\ln m^2_c$ appears and at dimension eight, terms with $1/m^2_c$ appear. A consistent power counting therefore needs to be set up. Numerically, we find that $m^2_c \sim m_b\Lambda_{\rm QCD}$ and therefore two powers of m_c should be counted as one power of m_b. Consequently, in order to complete the existing calculation at order $1/m^4_b$, we need to include contributions of order $1/m^3_b \cdot 1/m^2_c$ that may be numerically relevant.

In this talk, we present how we determine these contributions and the results for the moments of the leptonic invariant mass spectrum.

T 78.2 Wed 17:45 HSZ/0304

Studies of hadronic tag reconstruction and muon identification efficiency for $B \to X_u\ell\nu$ decays at the Belle II experiment — •Merle Graf-Schreiber[1], Florian Bernlochner[2], Lu Cao[1], Marcel Hohmann[3], Munira Khan[2], Tommy Martinov[1], and Kerstin Tackmann[1] — [1]DESY, Hamburg — [2]Universität Bonn — [3]University of Melbourne

The Belle II experiment is located at the SuperKEKB e^+e^- collider where it collects collision data around the $\Upsilon(4S)$ resonance, which primarily decays into $B\bar{B}$ pairs. The clean experimental environment of e^+e^- collisions enables us to study the inclusive $B \to X_u\ell\nu$ decay with good resolution, where X_u can be any charmless hadronic final state. The measurement of the partial branching fractions of this decay can be used to extract the Cabibbo-Kobayashi-Maskawa matrix element $|V_{ub}|$, which is important for constraining the unitary triangle. In addition insights about the discrepancy between the $|V_{ub}|$ value measured in inclusive versus exclusive decays can be gained.

The lepton of the signal B decay and the second (tag) B meson of the $\Upsilon(4S)$ decay are crucial ingredients for reconstructing the kinematics of the X_u system and the undetected neutrino. The muon identification efficiency and its calibration to account for possible differences between data and simulation using the $ee \to \mu\mu\gamma$ process are going to be discussed in this talk. The tag B meson is reconstructed using a multivariate based tagging algorithm, the full event interpretation. The second part of this talk is going to focus on studying the tagging performance using variables related to the $B_{\rm tag}$ meson.

T 78.3 Wed 18:00 HSZ/0304

Fitting procedure for the inclusive measurement of $\mathrm{B} \to \mathrm{X_u}\ell\nu$ at Belle II — Martin Angelsmark[1], Florian Bernlochner[1], Lu Cao[2], Jochen Dingfelder[1], Merle Graf-Schreiber[2], Marcel Hohmann[3], •Munira Khan[1], Tommy Martinov[2], and Kerstin Tackmann[2] — [1]Physikalisches Institut der Rheinischen Friedrich-Wilhelms-Universität Bonn — [2]DESY, Hamburg — [3]University of Melbourne

The discrepancy between the results of exclusive and inclusive measurements of the Cabibbo-Kobayashi-Maskawa matrix element $|\mathrm{V_{ub}}|$ remains an open question in flavor physics. The precise determination of $|\mathrm{V_{ub}}|$ proves to be difficult since it is CKM suppressed and therefore suffers from a high physics backgrounds originating from the CKM favored $\mathrm{b} \to \mathrm{c}$ transition. Phase space regions that allow clear separation of these two processes are heavily dominated by modeling uncertainties. We are preparing a new determination using data from the Belle II experiment. Belle II is a next-generation flavor factory with an anticipated data set of 50 ab^{-1} of collision events. In this talk we present the current status of the analysis and focus on a new fitting procedure for the signal extraction.

T 78.4 Wed 18:15 HSZ/0304

Measurement of the ratio of partial branching fractions of hadronicly tagged inclusive $B \to X_u\ell\nu$ to $B \to X_c\ell\nu$ decays at the Belle experiment. — •Marcel Hohmann[1], Phillip Urquijo[1], and Kerstin Tackmann[2] — [1]The University of Melbourne, Melbourne — [2]DESY, Hamburg

We present a measurement of the ratio of partial branching fractions of the semi-leptonic inclusive decays, $B \to X_u\ell\nu$ to $B \to X_c\ell\nu$, where $\ell = e, \mu$. The measurement is performed on the world leading sample of 772×10^6 $B\overline{B}$ pairs collected at the $\Upsilon(4S)$ resonance by the Belle experiment using the state-of-the-art Full Event Interpretation algorithm developed for the Belle II experiment to fully reconstruct the companion B-meson. Identifying inclusive $B \to X_u\ell\nu$ decays is difficult due to the abundance of Cabibbo–Kobayashi–Maskawa (CKM) favored $B \to X_c\ell\nu$ events which share a similar single lepton signature and whose composition are not fully understood. To minimize dependence on modeling of these channels a data-driven $B \to X_c\ell\nu$ description is employed. The ratio is measured via a two-dimensional fit to the lepton momentum, $p_\ell^{B_{sig}}$, and four-momentum transfer squared, q^2, in the regime $p_\ell^{B_{sig}} > 1.0\,\mathrm{GeV}$, covering approximately 86% and 79% of the $B \to X_u\ell\nu$ and $B \to X_c\ell\nu$ phase-space respectively. The determination of this ratio allows for direct extraction of $|V_{ub}|/|V_{cb}|$, corresponding to the length of one of the sides of the Unitarity Triangle. Precise knowledge of this side-length allows for powerful tests of the flavor sector of the standard model and to constrain beyond standard model physics.

T 78.5 Wed 18:30 HSZ/0304

Machine learning applications to the measurement of $|V_{ub}|$ at Belle II — •Tommy Martinov[1], Florian Bernlochner[2], Lu Cao[1], Merle Graf-Schreiber[1], Marcel Hohmann[1,3], Munira Khan[2], and Kerstin Tackmann[1] — [1]DESY, Hamburg — [2]University of Bonn — [3]University of Melbourne

The Belle II detector is located at the SuperKEKB collider in Japan and performs high-precision flavour physics studies through e^+e^- collisions at a center-of-mass energy of approximately 10.58 GeV. Using data collected by the Belle II experiment, new precision measurements of $|V_{ub}|$ will be performed using inclusive semi-leptonic decays to a hadronic system, a lepton and a neutrino ($B \to X_u\ell\nu$). This is particularly important for constraining the unitarity triangle, including potential insights in the long-standing discrepancy between $|V_{ub}|$ measurements from inclusive and exclusive semi-leptonic decays. However, this process is overwhelmed by the much more likely decay to a hadronic system containing a charm quark ($B \to X_c\ell\nu$). A multivariate classifier can be used to improve the signal-to-background separation compared to simple kinematic selections. However, the signal acceptance of such a classifier is usually not uniform as a function of the main parameters of interest (leptonic system invariant mass q^2, hadronic mass M_X...). Different methods exist to constrain the clas-

sifier and obtain more uniform signal efficiency. Two examples are the uBoost method for Boosted Decision Trees and the DisCo method for Neural Networks. In this presentation the applications of these methods on simulated $B \to X_{u/c}\ell\nu$ data will be discussed.

T 78.6 Wed 18:45 HSZ/0304

Semileptonic Charged Kaon Decays in NA62 — •Atakan Tugberk Akmete — Johannes Gutenberg University Mainz

The NA62 experiment at the CERN SPS was proposed and designed to measure the branching ratio of the ultra-rare $K^+ \to \pi^+\nu\bar{\nu}$ using a decay-in-flight technique. NA62 took data of $K_{\pi\nu\nu}$ in 2016, 2017, 2018, 2021 and 2022.

In such Kaon experiments, it is also possible to measure the branching ratios of the semileptonic decays $K \to \pi^0\ell\nu(\gamma)$ ($K_{\ell 3}$) with high precision. $K_{\ell 3}$ provides a very clean way to test the lepton universality and probe the first row of the unitary of the CKM quark mixing matrix $|V_{ud}|^2 + |V_{us}|^2 + |V_{ub}|^2 = 1$. The measurement is done by analyzing the charged single tracks to measure the six main decay modes at once without any specific PID. This strategy reduces the systematics and allows to measure of the branching fractions by using binned maximum-likelihood fit of each MC component to the data. In this talk, I will present my preliminary results using this method.

T 79: Searches III

Time: Wednesday 17:30–18:45 Location: HSZ/0403

T 79.1 Wed 17:30 HSZ/0403

A new algorithm for the identification of boosted $Z \to e^+e^-$ decays for heavy resonance searches with the ATLAS detector at the LHC — Duda Dominik, •Kiwit Florian, Kortner Sandra, and Kroha Hubert — Max-Planck-Insitut für Physik

The identification of W, Z and Higgs bosons with large transverse momenta is crucial in many searches for new heavy resonances. Thus far, the development of algorithms for the tagging of boosted bosons focuses on the reconstruction and identification of hadronic boson decays, while no dedicated algorithm to identify boosted $Z \to e^+e^-$ decays exists. The performance of the standard electron reconstruction and identification algorithms degrades with decreasing angular separation between the e^+e^- pairs and will eventually vanish once the angular separation between the e^+e^- pairs is too small to construct individual clusters in the calorimeter. To improve the reconstruction and identification of such highly boosted $Z \to e^+e^-$ decays, a dedicated algorithm for $Z \to e^+e^-$ tagging is being developed using a deep neural network.

Finally, the $Z \to e^+e^-$ identification and reconstruction approach is tested in the search for a Z' boson based on Monte Carlo simulations of the data taken with the ATLAS detector during the LHC Run 2. Expected exclusion limits on the production cross section times branching ratio at 95% confidence level are presented.

T 79.2 Wed 17:45 HSZ/0403

Exploring extentions of MUSiC with Machine Learning techniques — •Ana Rita Alves Andrade, Thomas Hebbeker, Yannik Kaiser, Arnd Meyer, and Felipe Torres da Silva de Araujo — III. Physikalisches Institut A, RWTH Aachen University

MUSiC - Model Unspecific Search in CMS - is a model-independent search used in the CMS experiment, serving as a complementary approach to model-specific searches. Unlike the latter approach, MUSiC neither constrains the search phase-space nor is restricted to a specific final state. To this end, MUSiC employs, per set of final state multiplicity, an automated search for the most discrepant phase-space region, considering a defined p-value. We report results on exploring the implementation of the New Physics Learning from a Machine (NPLM) algorithm, a machine learning (ML) approach for new physics searches, applied to simulated MUSiC-like data as well as CMS data pre-processed by MUSiC. Sensitivities for the nominal MUSiC and the ML modified approach are discussed. Challenges to incorporate this or similar ML methods to the standard MUSiC procedure, are also considered.

T 79.3 Wed 18:00 HSZ/0403

Search for excited leptons in the contact interaction and Z decay channels with CMS — •Fabian Nowotny, Thomas Hebbeker, and Kerstin Hoepfner — III. Physikalisches Institut A, RWTH Aachen University

The Standard Model of particle physics does not provide a comprehensive explanation for the observed hierarchy of three generations of fermions, for both leptons and quarks. A possible explanation is delivered by models postulating that quarks and leptons themselves are composite objects. Their constituents are bound by an asymptotically free gauge interaction below a characteristic scale Λ. Such models of compositeness predict the existence of excited lepton ($l^\star$) and excited quark ($q^\star$) states at the characteristic scale Λ of the new binding interaction. The theory allows the production of excited leptons via contact interactions in conjunction with a Standard Model lepton. Furthermore, the leptons can decay into several final states. This talk focuses on the contact interaction and Z-boson decay channels, both resulting in $l^\star \to lq\bar{q}$ transitions where l represents e and μ. Preliminary results are presented on the Run 2 proton-proton dataset of CMS corresponding to a luminosity of 137.6 fb^{-1} at a center of mass energy of $\sqrt{s} = 13$ TeV.

T 79.4 Wed 18:15 HSZ/0403

Search for high-mass resonances in dilepton final states with associated b-jets at the ATLAS experiment — Frank Ellinghaus and •Anna Vorländer for the ATLAS-Collaboration — Bergische Universität Wuppertal

A search for the Z' boson in high-mass dilepton (e,μ) final states in association with b-jets is presented. The considered Z' model is a candidate explanation for potential anomalies in B hadron decays and couples to b and s quarks in the production. The search is carried out using the dataset collected by the ATLAS detector in Run-2 of the LHC corresponding to an integrated luminosity of 139 fb^{-1}. Control, signal and validation regions are defined, and these regions are fitted in a profile-likelihood fit. Expected exclusion limits on the Z' mass are obtained based on the results of the fit.

T 79.5 Wed 18:30 HSZ/0403

Search for Dark Matter in association with a hadronically decaying top quark at the CMS experiment — •Michael Wassmer, Ulrich Husemann, and Sebastian Wieland — Institute of Experimental Particle Physics (ETP), Karlsruhe Institute of Technology (KIT)

In this talk a search for the production of Dark Matter in association with a single highly-energetic top quark is presented. In the standard model such a final state can only be generated at loop level and is, in addition, CKM suppressed, making it a prime candidate to search for new physics. The search is based on the total Run-2 dataset collected by the CMS collaboration. The mono-top signature is characterized by large missing transverse momentum and the well-known top quark decay. This talk is focused on the hadronic decay of the top quark. Large-radius jets are used to reconstruct the decay products and multivariate methods are employed to distinguish these jets from purely QCD-initiated jets. The results of the search are interpreted in the context of a simplified model introducing a flavor-changing neutral current at tree level by a spin-1 mediator and a Dirac Dark Matter particle.

T 80: Searches EW II

Time: Wednesday 17:30–19:00 Location: HSZ/0101

T 80.1 Wed 17:30 HSZ/0101

Constraints on Supersymmetry from Collider Searches and Other Experiments — Samuel Bein Bein, •Malte Mrowietz, and Peter Schleper — Universität Hamburg, Institut für Experimentalphysik

Constraints from searches at the LHC and from other experiments on the minimal supersymmetric standard model (MSSM) are evaluated in the context of the 19-parameter phenomenological MSSM (pMSSM). For this purpose a large scan of the pMSSM parameter scan is performed. Complementarity and possible tension between the LHC data, the recent g-2 result, and direct detection experiments are examined.

T 80.2 Wed 17:45 HSZ/0101

Kaon Quenching Measurements for Proton Decay Search with JUNO — •Ulrike Fahrendholz[1], Carsten Dittrich[1], Meishu Lu[1], Sarah Braun[1], Lothar Oberauer[1], Hans Steiger[2], and Matthias Raphael Stock[1] — [1]E15, Physik-Dep., Technische Universität München, James-Franck-Str. 1, 85748 Garching — [2]Cluster of Excellence PRISMA$^+$, Staudingerweg 9, 55128 Mainz

Proton Decay is a main consequence of Baryon Number Violation and is predicted in several Grand Unified Theories (GUTs). It is one of the conditions to explain the asymmetry of matter and anti-matter in our universe. One of the main proton decay channels favored by supersymmetric GUTs is $p \to K^+ + \bar{\nu}$. By now, Super-Kamiokande has set a lower lifetime limit of $5.9 \cdot 10^{33}$ years for this channel. The Jiangmen Underground Neutrino Observatory (JUNO) is a 20 kton liquid scintillator detector currently under construction in China and is expected to reach the order of 10^{34} years after ten years of data taking. In this talk, I present a general strategy of JUNO for the search of the proton decay as well as an experimental setup to identify the still unknown quenching behavior of the K^+ in the scintillator of JUNO.

This work is supported by the Clusters of Excellence Origins and PRISMA$^+$.

T 80.3 Wed 18:00 HSZ/0101

Search for supersymmetry in final states with disappearing tracks in proton-proton collisions at 13 TeV — •Samuel Bein, Viktor Kutzner, Malte Mrowietz, Peter Schleper, Alexandra Tews, and Moritz Wolf — Universität Hamburg, Hamburg, Germany

We report the results of a search for charged, semi-stable, supersymmetric particles in final states with one or more disappearing tracks embedded within a range of final states characterized by varying numbers of jets, b-tagged jets, electrons, and muons. The transverse length of signal candidate tracks is used to target various lifetimes associated with wino-like and Higgsino-like charginos in the MSSM, as well as semi-stable charged particles with longer lifetimes. The hit-averaged deposited energy associated with signal candidates traversing the pixel tracker is used to increase sensitivity to particles with large mass or small boost. The search uses a sample of proton-proton collisions at sqrt(s)=13 TeV collected between 2016 and 2018, corresponding to an integrated luminosity of 136 fb^{-1}. Limits on the pair production of gluinos and squarks are obtained in the framework of simplified and full-spectrum SUSY models.

T 80.4 Wed 18:15 HSZ/0101

Diboson polarization measurement in a region enhanced in longitudinal-longitudinal $W^{\pm}Z$ events — •Jan-Eric Nitschke — Institute of Nuclear and Particle physics

In the Standard Model (SM), fundamental particles acquire their masses through the Higgs mechanism. These resulting Goldstone bosons are absorbed into the W and Z bosons and become their longitudinal components, consequently making these gauge bosons massive. Thus, studying the longitudinal components of the W and Z bosons allows the probing of one of the cornerstones of the SM theory.

Vector boson scattering (VBS) events are often used to study longitudinal-longitudinal vector boson interactions. However, VBS processes have low production cross sections and only in recent years all VBS processes were observed for the first time.

Instead, this talk focuses on a study of longitudinal-longitudinal WZ interactions using diboson $WZ \to \ell\nu\ell\ell$ events. Additionally the considered events are constrained to have $p_{\mathrm{T}}^{Z} > 200$ GeV to enhance the contribution of the s-channel production where the bosons directly interact as well as $p_{\mathrm{T}}^{WZ} < 70$ GeV to isolate leading-order like events that exhibit a radiation amplitude zero effect, reducing the contribution from doubly-transversely polarized events.

This phase space has a significantly increased fraction of direct longitudinal-longitudinal vector boson interactions, allowing for an important and unique test of the standard model and electroweak symmetry breaking.

T 80.5 Wed 18:30 HSZ/0101

A precision measurement of fiducial and differential cross sections of WW production with the ATLAS detector — •José Antonio Fernández Pretel, Beate Heinemann, and Oleg Kuprash for the ATLAS-Collaboration — Albert-Ludwigs Universität Freiburg

Measuring production of W boson pairs at particle colliders gives an important way to test the predictions of Standard Model (SM) of particle physics in both perturbative Quantum Chromodynamics and Electroweak domains. Production of WW is also a significant background source for Higgs measurements (especially $H \to WW$) and beyond SM searches. In this measurement, fiducial and differential cross sections are obtained using the full Run 2 dataset collected in proton-proton collisions at the LHC at center-of-mass energy of $\sqrt{s}$ =13 TeV with the ATLAS detector, corresponding to an integrated luminosity of 139 fb^{-1}. Multiple background contributions such as fake and non-prompt leptons are estimated using data-driven techniques. In contrast to most previous measurements that enhance the WW signal purity by vetoing hadronic jets in the final state, the first measurement of WW cross sections using a fully jet-inclusive selection is presented in this work, providing the most precise cross sections of WW production achieved in hadron-hadron collisions to date. The measurements are also performed in a dynamic jet-veto phase space. Additionally, detector level distributions are used to extract constraints on dimension-6 Wilson coefficients in the Standard Model Effective Field Theory. No deviations with respect to the SM are observed.

T 80.6 Wed 18:45 HSZ/0101

Measurement of $ZZ\gamma$ final states with the ATLAS detector at the LHC — •Anke Ackermann for the ATLAS-Collaboration — Kirchhoff-Institute for Physics, Heidelberg University

The Standard Model of Particle Physics (SM) predicts the rare production of triboson final states. Although suffering from small cross sections and hence a limited amount of signal events, such triboson states can be studied with the vast amount of data collected by the ATLAS detector in Run 2. In addition to validating the predictions of the SM for rare processes, sensitivity to New Physics is given via anomalous quartic couplings of e.g. four neutral gauge bosons. This talk will focus on the analysis of the simultaneous production of $ZZ\gamma$. In order to determine the cross sections of this process, it is crucial to separate signal events from events arising through background processes mimicking the signal topology. The most dominant background process contains fake photons, which are non-prompt photons within jets. Due to the limited statistics no conventional data-driven method can be used. Instead a new approach with jet ratios is applied to estimate the amount of fake photons in the signal region. After giving a general introduction about the triboson production of the $ZZ\gamma$ process, a short summary of the analysis, including the event selection and the background estimation, is presented.

T 81: Single Top, Top Properties

Time: Wednesday 17:30–19:00 Location: HSZ/0103

T 81.1 Wed 17:30 HSZ/0103

Measurement of the t-channel single top-quark production cross-section in proton-proton collisions at a centre-of-mass energy of 13 TeV with the ATLAS detector — Olga Bessidskaia Bylund[1], Dominic Hirschbühl[1], •Joshua Reidelstürz[1], Mohsen Rezaei Estabragh[1], Wolfgang Wagner[1], Johannes Erdmann[2], Benedikt Gocke[2], Lukas Kretschmann[1], Olaf Nackenhorst[2], and Maren Stratmann[1] — [1]Bergische Universität Wuppertal, Wuppertal, Deutschland — [2]Technische Universitaet Dortmund, Dortmund, Deutschland

The measurement of the single top-quark t-channel production cross sections σ_{tq} and $\sigma_{\bar{t}q}$ and their fraction R_t as well as the total cross section $\sigma_{tq,\bar{t}q}$ is presented. These measurements provide a precise test of the standard model and are sensitive to new-physics phenomena by probing the properties of the Wtb vertex and placing limits on the CKM matrix element $|V_{tb}|$. Data taken with the ATLAS detector from 2015 to 2018 corresponding to an integrated luminosity of $\mathcal{L} = 139\,\mathrm{fb}^{-1}$ at a center-of-mass energy of 13 TeV is analyzed using corresponding samples of simulated events. Requirements are applied to the data selecting events with the signature expected for the signal process. To further enhance the separation between signal and background events a neural network is trained using the Monte Carlo simulated data combining several kinematic variables. The neural network output distribution is then used in a binned profile maximum likelihood fit including all systematic uncertainties to determine the cross sections.

T 81.2 Wed 17:45 HSZ/0103

Differential cross-section measurement of the tZq process with the ATLAS detector — •Nilima Akolkar[1], Ian Brock[1], Lidia Dell'Asta[2], and Thomas Stevenson[3] for the ATLAS-Collaboration — [1]Physikalisches Institut, Universität Bonn — [2]University of Milano — [3]University of Sussex

The associated production of a single top-quark with a Z-boson (tZq) is a rare process that has been discovered by the CMS and ATLAS Collaborations. This process is of special interest, as it allows one to probe the couplings of the Z-boson to the quark sector and to the W-boson simultaneously.

This talk will focus on the differential cross-section measurement of the tZq process, analyzed in the trilepton decay channel. The data used was collected with the ATLAS detector during Run 2 of the LHC. The tZq differ- ential cross-section is measured using profile likelihood unfolding and the preliminary results will be presented in the talk.

T 81.3 Wed 18:00 HSZ/0103

first simultaneous differential measurement of tZq and ttZ with the CMS detector — •Federica Cecilia Colombina — Deutsches Elektronen-Synchrotron (DESY), Notkestraße 85, 22607 Hamburg

With the large dataset of proton-proton collisions recorded during LHC Run-2, several precise and differential measurements of both ttZ and tZq processes have been produced with the CMS experiment. These two processes are mutual backgrounds to one another. In previous measurements, background processes were assumed to follow the expectations of the standard model. In this measurement, for the first time, both processes ttZ and tZq are measured simultaneously and differentially. The measurement will therefore be more sensitive to new physics, and particularly suitable for effective field theory interpretations.

T 81.4 Wed 18:15 HSZ/0103

Measurements of observables sensitive to colour reconnection in $t\bar{t}$ events with the ATLAS detector at $\sqrt{s} = 13$ TeV — •Shayma Wahdan, Dominic Hirschbühl, and Wolfgang Wagner — Bergische Universität Wuppertal, Wuppertal, Germany

A measurement of observables sensitive to effects of colour reconnection in top-quark pair-production events is presented using 139 fb^{-1} of 13 TeV proton–proton collision data collected by the ATLAS detector at the LHC. Events are selected by requiring exactly one isolated electron and one isolated muon with opposite charge and two or three jets, where exactly two jets are required to be b-tagged. For the selected events, measurements are presented for the charged-particle multiplicity, the scalar sum of the transverse momenta of the charged particles, and the same scalar sum in bins of charged-particle multiplicity. These observables are unfolded to the stable-particle level, thereby correcting for migration effects due to finite detector resolution, acceptance and efficiency effects. The particle-level measurements are compared with different colour reconnection models in Monte Carlo generators. These measurements disfavour some of the colour reconnection models and provide inputs to future optimisation of the parameters in Monte Carlo generators.

T 81.5 Wed 18:30 HSZ/0103

Measurements of top-quark pair spin correlation in the ℓ + jets channel using the ATLAS experiment — •Oleksandr Burlayenko, A. Knue, and Z. Rurikova for the ATLAS-Collaboration — University of Freiburg

The top quark is the heaviest known fundamental particle and has a lifetime of $\mathcal{O}(10^{-25}s)$. This lifetime is shorter than the quantum chromodynamic (QCD) hadronization time scale $1/\Lambda_{QCD} \approx 10^{-24}$s, and much shorter than the spin decorrelation time scale $m_t/\Lambda^2_{QCD} \approx 10^{-21}$s. This gives an opportunity to study the spin properties of a bare quark, as top-quark spin information is preserved in the angular distribution of its decay products.

The Standard Model predicts the $t\bar{t}$ pairs to have correlated spins. The degree of this correlation is sensitive to the production mechanism. The most recent measurement performed by ATLAS uses 13 TeV data in the dilepton channel.

This work presents ongoing studies of the $t\bar{t}$ spin correlation in the ℓ + jet channel at $\sqrt{s} = 13$ TeV. While this channel provides a larger dataset to study, the analyzing power is reduced compared to the dilepton channel.

To improve the event reconstruction, machine learning techniques are employed and non-reconstructable events are removed. Studies of various observables on particle- and detector-level measured inclusively and as a function of mass of the $t\bar{t}$ system will be presented. In addition the impact of systematic uncertainties on these observables will be studied.

T 81.6 Wed 18:45 HSZ/0103

Measurement of top quark involved CKM matrix elements in single top-quark t-channel processes — •Benedikt Gocke[1], Dominc Hirschbuel[2], Kevin Kröninger[1], Olaf Nackenhorst[1], Joshua Reidelstürz[2], Maren Stratmann[2], and Wolfgang Wagner[2] — [1]TU Dortmund, AG Kröninger — [2]Bergische Universität Wuppertal

Measuring top quark properties is one of the main purposes of the ATLAS experiment at the LHC. Since the top quark is the heaviest quark and thus decays before it hadronises, it can be seen as a quasi free quark. Therefore, its properties and especially its couplings are crucial to test the Standard model.

In general, all flavour-changing quark couplings are described by the Cabbibo-Kobayashi-Maskawa (CKM) matrix. Furthermore, all CKM matrix elements are free parameters of the Standard model and thus need to be measured. For the three CKM matrix elements involved in top quark processes - V_{tb}, V_{ts} and V_{td} - this is especially challenging due to the very small magnitudes for the two latter ones.

The CKM interpretation of the single top-quark t-channel cross section measurement at $\sqrt{s} = 13$ TeV with the ATLAS experiment is presented, in which all possible top quark production and decay processes are considered. The aim is to set limits on each involved CKM element individually for the first time. For this purpose, a profile-likelihood scan is used for the interpretation.

T 82: Higgs, Di-Higgs II

Time: Wednesday 17:30–19:00 Location: HSZ/0105

T 82.1 Wed 17:30 HSZ/0105

Constraints on the Higgs boson self-coupling, κ_λ, and the di-vector boson di-Higgs boson coupling, κ_{2V}, via Higgs boson pair production with the ATLAS detector — Jochen Dingfelder[1], Tatjana Lenz[1], Christopher Deutsch[1], and •Fiona Ann Jolly[2] — [1]Physikalisches Institut, Universitat Bonn, Germany — [2]Deutsches Elektronen-Synchrotron DESY, Notkestraße 85, 22607 Hamburg

After the discovery of the Higgs boson in 2012, searches for Higgs boson pair production have become valuable in probing the Higgs boson self-coupling, κ_λ. The dominant mode for Higgs boson pair production is gluon-gluon fusion (ggF) followed by vector boson fusion (VBF), which produces two additional jets in the final state. Both production modes provide access to κ_λ. In addition, the VBF mode provides access to two other couplings: the quartic $HHVV$ coupling (κ_{2V}) and the Higgs boson-vector boson coupling (κ_V) with $V = W, Z$.

In this talk, a search for Higgs boson pair production via ggF and VBF in the $bb\tau\tau$ final state (both τ leptons decay hadronically) using 139 fb^{-1} of proton-proton collisions at 13 TeV recorded with the ATLAS detector, is presented. Expected constraints on κ_λ and κ_{2V} are obtained after employing a categorisation strategy that separates the VBF and ggF modes in the statistical analysis. In addition, extrapolated results for an integrated luminosity of 3000 fb^{-1} are given.

T 82.2 Wed 17:45 HSZ/0105

Search for non-resonant Higgs boson pair production in the lepton+jets final state of the bbWW decay mode at CMS — •Mathis Frahm, Johannes Haller, Alexander Paasch, and Matthias Schröder — Institut für Experimentalphysik, Universität Hamburg

The Higgs boson self-coupling is an important parameter of the Standard Model (SM), since it is related to the shape of the Higgs potential. At the LHC, this parameter can be probed by measuring the Higgs boson pair production (HH) cross section. The sensitivity of current HH searches is limited by the small SM production cross-section of only 33 fb at 13 TeV. The analysis of data from Run 3 of the LHC promises a further leap in sensitivity.

In this talk, preparation studies towards a search for non-resonant HH production in the lepton+jets final states of the bbWW decay mode with Run 3 data of the CMS experiment are presented. They benefit from a new analysis framework that relies on the novel 'columnar analysis' paradigm.

T 82.3 Wed 18:00 HSZ/0105

NMSSM di-Higgs search in bb$\tau\tau$ final states — •Nikita Shadskiy, Ulrich Husemann, Moritz Molch, Michael Wassmer, and Roger Wolf — Institute of Experimental Particle Physics (ETP), Karlsruhe Institute of Technology (KIT)

The Next-to-Minimal Supersymmetric Standard Model (NMSSM) introduces additional Higgs bosons with different masses next to the already known SM-like Higgs boson. A full CMS run II data analysis (JHEP 11 (2021) 057), which focuses on such a beyond Standard Model search, was previously performed for the decay of a heavy Higgs boson into two lighter Higgs bosons i.e. $H \to h_S(bb)h_{SM}(\tau\tau)$, with h_{SM} being the SM-like Higgs boson with a mass of 125 GeV.
The new analysis presented in this talk introduces some changes to the previous analysis to improve the results. One of the improvements is to consider both possible Higgs boson decay channels $h_S(bb)h_{SM}(\tau\tau)$ and $h_S(\tau\tau)h_{SM}(bb)$, another is to improve the sensitivity of the measurement, especially in high mass regions of H, by considering boosted topologies. Besides that, the newest CMS reconstruction of run II data will be used, which also includes updates of the data-driven background estimation methods.

T 82.4 Wed 18:15 HSZ/0105

Search for a light CP-odd Higgs boson with ATLAS — •Tom Kresse, Arno Straessner, Manuel Gutsche, Hannah Jacobi, and Christian Schmidt — IKTP, Dresden, Germany

Even though theoretical predictions of the SM are corresponding to experimental results to an incredible degree, there are still some phenomena unexplained, for example the deviation of the measured anomalous magnetic moment, g-2, of the muon from SM calculations. This deviation could be explained by the flavor-aligned two-Higgs-doublet model. The introduction of a second Higgs doublet leads to four additional Higgs bosons, one of which being CP-odd and electrically neutral. The muon g-2 deviation is best explained with a light CP-odd Higgs boson which couples nearly exclusively to top quarks and tau leptons.

This talk presents the search of such a light CP-odd Higgs boson produced via gluon fusion. The decay into two tau leptons is analyzed by requiring one electron and one muon in the final state. The search is carried out in the mass range between 20 GeV and 110 GeV. It is based on 139 fb-1 of data collected by the ATLAS experiment at 13 TeV center-of-mass energy.

The analysis strategy as well as the various validation regions to check the background estimation are presented. An overview over the most relevant systematic uncertainties is given. Even though the analysis is still blinded, expected limits for the production cross-section and model-dependent coupling parameters can be calculated and the fits can be checked for consistency. An outline for the further steps towards the unblinding and the publication of the analysis is given.

T 82.5 Wed 18:30 HSZ/0105

Optimisation and systematic uncertainties in the search for a light CP-odd Higgs boson with ATLAS — •Hannah Jacobi, Tom Kresse, Manuel Gutsche, Christian Schmidt, and Arno Straessner — IKTP, Dresden, Germany

The Standard Model of particle physics is a very successful theory as its predictions are in most cases compatible with experimental results. One example for deviations between the Standard Model and experimental measurements is the value of the anomalous magnetic moment g-2 of the muon. To resolve this problem expansions to the Standard Model, like the 2HDM, are proposed. This theory predicts two Higgs doublets and therefore a total of five Higgs bosons, including the CP-odd and neutral A boson. Assuming the A boson has a light mass and couples strongly to leptons and top quarks it is possible to predict a value for the g-2 that is compatible with the measured one.

This talk focuses on the experimental search for such a light CP-odd Higgs boson with a mass between 20 GeV and 110 GeV produced via gluon fusion. It is examined by looking at final states that contain one electron and one muon, which originated from the decay of the A boson to two τ leptons. The analysis uses 139 fb^{-1} of data recorded by the ATLAS detector at a centre of mass energy of 13 TeV. Before being able to unblind the data in the signal region it is important to ensure the correct modelling of the relevant background processes, like Z bosons decaying into two τ leptons. This talk presents the investigation and correction of mismodelling between measured data and Monte Carlo predictions in dedicated validation regions.

T 82.6 Wed 18:45 HSZ/0105

Top background estimation in the search for a light CP-odd Higgs boson with ATLAS — •Christian Schmidt, Tom Kresse, Manuel Gutsche, Hannah Jacobi, and Arno Straessner — IKTP, Dresden, Germany

Even though predictions of the Standard Model correspond to experimental results to an incredible degree, there are some deviations, for example between the measured anomalous magnetic moment g-2 of the muon and SM calculations.

To resolve this problem expansions to the Standard Model, like the 2HDM, are proposed. This theory predicts two Higgs doublets and therefore a total of five Higgs bosons with one of them being the CP-odd and neutral A boson. Assuming the A boson has a light mass and couples strongly to leptons and top-quarks, the model can predict a value for g-2 compatible with the measured one.

This talk describes the experimental search for such a light CP-odd Higgs boson with a mass of 20 to 110 GeV. The analysis aims to detect this A-boson by its production from gluon fusion and its decay via two tau-leptons into a final state containing one electron and one muon.

To be able to spot the extra events caused by A-boson decay, it is necessary to know the rate of background events very precisely. Background events have the same detector signature as signal events, but are caused by Standard Model processes. Their rate can be estimated by the Monte Carlo method. The talk focuses on the background caused by the decay of top quark-antiquark pairs, and the associated uncertainties due to approximations in the Monte Carlo generator.

T 83: Theory BSM

Time: Wednesday 17:30–18:30 Location: HSZ/0201

T 83.1 Wed 17:30 HSZ/0201

Charge-Parity Asymmetries of Charmed Meson Decays to Pseudoscalar Mesons — •Emil Overduin and Maurice Schüssler — Institut für Theoretische Teilchenphysik, Karlsruher Institut für Technologie, 76131 Karlsruhe, Germany

Measurements at the Large Hadron Collider beauty experiment (LHCb) have seen larger than expected direct charge-parity (CP) asymmetries in the charmed meson decays $D^0 \to K^-K^+$ and $D^0 \to \pi^-\pi^+$, violating the Standard Model U-spin symmetry predictions at around 2σ. An attempt to explain the discrepancy will be made by postulating new physics in the decay amplitudes. The measured CP asymmetries hint at a stronger coupling to d quarks than s quarks motivating an interpretation in terms of $\Delta U = 1$ new physics, where U denotes the U-spin. New sum rules based on $SU(3)_F$ for CP asymmetries of D meson decays to pseudoscalar mesons to test the $\Delta U = 1$ model are shown, one of which holds in both the $\Delta U = 0$ and $\Delta U = 1$ cases. We propose new experimental tests for the new-physics sum rules.

T 83.2 Wed 17:45 HSZ/0201

Charge-Parity-Asymmetrien von Charmed Meson-Zerfällen in pseudoskalare Mesonen und Vektormesonen — •Maurice Schüssler und Emil Overduin — Institut für Theoretische Teilchenphysik, Karlsruher Institut für Technologie, 76131 Karlsruhe, Germany

Neuste Messungen der Charge-Parity-Asymmetrie (CP-Asymmetrie) in $D^0 \to K^+K^-$ und $D^0 \to \pi^+\pi^-$ Zerfällen stimmen nicht gut mit den Vorhersagen des etablierten Standardmodells der Teilchenphysik überein. Wir untersuchen die Hypothese, dass diese Spannung von Beiträgen jenseits des Standardmodells stammt, die den U-Spin um eine Einheit ändern. Zur Überprüfung dieser Hypothese mit künftigen Daten betrachten wir Zerfälle von D^0, D^+, D_s^+-Mesonen in Endzuständen aus einem pseudoskalaren Meson und einem Vektormeson. Im Vortrag werden Summenregeln zwischen CP-Asymmetrien vorgestellt, die die neuen $\Delta U = 1$-Beiträge erfüllen und somit Konsistenzchecks künftiger Messungen erlauben.

T 83.3 Wed 18:00 HSZ/0201

Corrections of the B meson baryogengesis model to lifetimes of B mesons. — •Ali Mohamed, Alexander Lenz, Maria Laura Piscopo, Aleksey Rusov, and Zachary Wüthrich — Siegen university

The framework of B meson Baryogenesis by Alonso-Álvarez, Elor, and Escudero aims at describing the matter-antimatter asymmetry and the existence of dark matter in the Universe by introducing new decay channels of the b quark. These new decay channels could also modify other observables, e.g. the lifetime ratio of B^+ and B_d mesons. We perform a study of the possible size of these new contributions to $\tau(B^+)/\tau(B_d)$ within the framework of the Heavy Quark Expansion.

T 83.4 Wed 18:15 HSZ/0201

Holographic Non-Abelian Flavour Symmetry Breaking — •Yang Liu[1], Werner Porod[1], Johanna Erdmenger[1], and Nicholas Evans[2] — [1]Universität Würzburg — [2]University of Southampton

Multiple AdS/QCD models have been constructed to explain the lowest QCD meson and baryon spectra. Albeit the action is formulated in a non-abelian way, the spectra are essentially abelian. To produce the non-abelian spectra as observed in QCD, our work starts with the non-abelian DBI action taken from a top-down model in string theory. In constructing a bottom-up version, we keep the spirit of the top-down model, i.e. extending the action to matrices in flavour space, which describes coincident N_f D-branes. The explicitly breaking of the flavour symmetry is realised by separating the branes. The fact that the metric and coupling constants are matrices in the flavour space marks the main difference from the other models. We computed the two- and three-flavour QCD spectra and show the validity of our model.

T 84: Theory EW

Time: Wednesday 17:30–19:00 Location: HSZ/0204

T 84.1 Wed 17:30 HSZ/0204

Polarized cross sections for vector boson production with Sherpa — •Mareen Hoppe[1], Frank Siegert[1], and Marek Schönherr[2] — [1]Institute of Nuclear and Particle Physics, Technische Universität Dresden — [2]Institute for Particle Physics Phenomenology, Durham University

Polarization of vector bosons started to become an extensively investigated topic in recent years due to its sensitivity to the concrete mechanism of electroweak symmetry breaking and to beyond standard model physics. The general-purpose Monte-Carlo event generator Sherpa is used for event simulation of various processes in the analysis of LHC data. In this talk, an implementation is presented which will enable the simulation of polarized cross sections for vector bosons in future releases of Sherpa. Special features like the simulation of all polarized contributions in a single run - including the bulk of their NLO QCD behavior - and the direct calculation of the interference between them are discussed. Validation data comparing the new implementation with literature studies and results from its first applications in phenomenological analyses will be shown for several processes.

T 84.2 Wed 17:45 HSZ/0204

Soft photon emission at the LHC and the LBK theorem — •Roger Balsach[1], Domenico Bonocore[2], and Anna Kulesza[1] — [1]Institute of Theoretical Physics, WWU Münster, D-48149 Münster, Germany — [2]Physik Department T31, Technische Universität München, D-85748, Garching, Germany

The emission of low energetic (soft) photons plays a fundamental role in the understanding of Quantum Field Theories. However, there appears to be a discrepancy between the experimental measurements and the calculations for one-photon emission observables. Furthermore, future improvements to the ALICE detector will result in better measurement of soft photon emission, necessitating increasing precision of theoretical predictions.

For those reasons, we compute the cross-section for processes with a single photon emission including NLP and one-loop QCD corrections.

T 84.3 Wed 18:00 HSZ/0204

Detection schemes for light-by-light scattering — Naser Ahmadiniaz, Thomas Cowan, •Sebastian Franchino-Viñas, Jörg Grenzer, Alejandro Laso-Garcia, Michal Smid, Toma Toncian, María Anabel Trejo, and Ralf Schützhold — Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany

In the theory of Quantum Electrodynamics loop corrections induce nonlinear interactions for the electromagnetic fields, allowing for effects such as light-by-light scattering. One of the most promising scenarios for its experimental detection regards the quantum vacuum diffraction and birefringence of x-rays at the combined field of two optical lasers. In this talk, we will theoretically compare various scenarios; as a way to deal with experimental constraints, we analyze cases in which the initial and final x-ray photons differ not just in polarization, but also in propagation direction or energy.

T 84.4 Wed 18:15 HSZ/0204

NLO QCD predictions for polarised WZ production — •Christoph Haitz — Institut für Theoretische Physik 2, Julius-Maximilians Univerität Würzburg

The double-pole approximation allows the calculation of observables with polarised virtual particles in a gauge-independent way. One class of processes where this is particularly useful are gauge-boson pair-production processes. This method has been very successful for the study of vector bosons decaying into leptons. The natural step forward from this is the investigation of hadronically decaying bosons. In my talk I will discuss the NLO QCD predictions to the production of a polarised WZ pair where the W boson decays hadronically and the

Z boson leptonically. In particular it will be explained what physical observables are best suited to discriminate between the different polarisation states of the resonant bosons. Furthermore the effects of the NLO QCD corrections on the differential cross-sections will be elaborated, as the corrections can become very large and fundamentally change the features of the distributions.

T 84.5 Wed 18:30 HSZ/0204

Two-loop Symmetry Restoration in a Chiral Abelian Gauge Theory in DReg with Non-Anticommuting γ_5 — •Paul Kühler — Institut für Kern- und Teilchenphysik, TU Dresden

Dimensional Regularization is a popular and powerful method for renormalizing gauge theories at the multiloop level. This is due not least of all to the fact that DReg preserves BRST symmetry for vector-like theories such as QCD and QED, which not only guarantees that the renormalized theories make sense as a quantum theory, but it also tremendously simplifies calculations.

This feature is unavoidably lost in the case of chiral theories like the electroweak sector of the SM. Technically, this manifests in inconsistencies arising from insisting on retaining certain relations valid for γ_5 in 4-dimensions in the formal D-dimensional space of DReg. One way out is the BMHV scheme which gives up anti-commutativity and recommends itself by its consistent treatment generalizable to the multiloop setting. BRST symmetry is intermediately broken but may be restored by adding finite, non-invariant counterterms.

In this talk we exemplify our approach to renormalizing chiral gauge theories in the BMHV scheme with the aim of applying it to the SM. Here we present a concrete two-loop calculation of a simple, chiral Abelian model (based on Belusca-Maito et al., JHEP, Vol. 11, 2021; 2109.11042) with its necessary counterterm structure, and we discuss the explicit restoration of well-known Ward identities like transversality of the photon self-energy. In this setting, they are an immediate test of the restoration (or lack thereof) of the classical symmetry.

T 84.6 Wed 18:45 HSZ/0204

Algebraic Renormalization of abelian chiral Gauge Theories with non-anticommuting γ_5 at the Multi-Loop Level — •Matthias Weisswange — Institut für Kern- und Teilchenphysik, TU Dresden, Dresden, Deutschland

Divergences emerging in quantum corrections need to be handled via regularization and renormalization. However, treating manifestly 4-dimensional quantities such as γ_5 and $\varepsilon^{\mu\nu\rho\sigma}$ naively within dimensional regularization (DReg) may lead to inconsistencies. This constitutes a problem in chiral gauge theories, such as the electroweak Standard Model. In order to avoid such inconsistencies, γ_5 needs to be treated rigorously as a non-anticommuting object using the Breitenlohner-Maison/'t Hooft-Veltman (BMHV) scheme within DReg. Employing the BMHV scheme, however, violates gauge invariance, which subsequently needs to be restored using symmetry-restoring counterterms guaranteed to exist by the methods of algebraic renormalization. These counterterms may be calculated via special Feynman diagrams with an insertion of the $\widehat{\Delta}$-operator, which reflects the breaking of chiral gauge invariance, using the regularized quantum action principle of DReg. In the case of an abelian chiral gauge theory this is consistently done at the multi-loop level, showing that the counterterm structure in the BMHV scheme may be written in a very compact form, suitable for computer implementations. Ultimately, this renormalization procedure will be needed for high-precision calculations of e.g. electroweak observables.

T 85: DAQ, Data Techniques

Time: Wednesday 17:30–18:45 Location: HSZ/0301

T 85.1 Wed 17:30 HSZ/0301

Simulation and Optimization of Particle Detector Signal Processing using Matlab and Simulink — •Florian Rössing[1], André Zambanini[1], Christian Grewing[1], and Stefan van Waasen[1,2] — [1]ZEA-2, Forschungszentrum Jülich — [2]NTS, Universität Duisburg-Essen

Matlab and Simulink are tools that are widely used in the field of engineering because they provide a flexible tool chain for mixed signal simulation that can be tailored to the specific needs of the user. With these, we model the sensors used in particle detectors and the attached read-out systems, creating a full system view on the electronics component in the chain. This enables studies on the influence of various parameters to obtain a better understanding of relevant factors and optimization potential, for instance for power efficient information extraction.

With this contribution, we will present our modeling approaches, split into three stages: The per channel event modelling, the sensor response to the incident energy, and the analog receiver chain with a front-end and corresponding pre-processing. We will demonstrate how we can model different characteristics in all three stages of the systems, including statistical fluctuations, bandwidth limitations, non-linearity and noise. These models are also used to develop approaches for the digital processing of the signals. The Simulink HDL Coder Toolbox allows us to directly convert the digital domain of our models into HDL, implementable into either an FPGA or an integrated circuit.

T 85.2 Wed 17:45 HSZ/0301

A Simulink Hardware-in-the-Loop Demonstrator Setup for Detector System Analysis — •Aravinda Lasya Indukuri[1], Florian Rössing[1], Christian Grewing[1], André Zambanini[1], and Stefan van Waasen[1,2] — [1]ZEA-2, Forschungszentrum Jülich — [2]NTS, Universität Duisburg- Essen

In our work, we study the influence of different parameters in read-out chains of particle detectors, alongside with studying digital processing methods for feature extraction. As described in our adjacent contribution, we are using Matlab and Simulink to model different aspects of the read-out chain. In order to verify the developed processing methods and setup a demonstrator , we are implementing the digital domain of the models on an FPGA in an FPGA-in-the-loop workflow. Matlab and Simulink provide tools like HDL Coder and HDL Verifier to automatically generate HDL code, select an external simulator to simulate the generated HDL code, implement it on an FPGA, and compare the results with the Simulink reference model. To verify the whole read-out chain model, we are setting up a hardware-in-the-loop model with an arbitrary waveform generator and an ADC along with an FPGA that will be stimulated and verified over Matlab and Simulink. We will also be working on automating the workflow for different event models and signal processing methods. In this contribution, we will present an automated Matlab-Simulink workflow for an FPGA-in-the-Loop demonstrator setup to verify simulink models in hardware, efficiency of HDL coder in comparison to a handwritten HDL code, and our progress on the Hardware-in-the-Loop demonstrator setup.

T 85.3 Wed 18:00 HSZ/0301

Firmware for the Mu3e Filter Farm — •Marius Köppel for the Mu3e-Collaboration — Institute for Nuclear Physics, Johannes Gutenberg University, Mainz Germany

The Mu3e experiment at the Paul Scherrer Institute searches for the decay $\mu^+ \to e^+e^+e^-$. This decay violates charged lepton flavour conservation - any observation would be a clear indication for Physics Beyond the Standard Model. The Mu3e experiment aims for an ultimate sensitivity of one in 10^{16} μ decays. The first phase of the experiment, currently under construction, will reach a branching ratio sensitivity of $2 \cdot 10^{-15}$ by observing 10^8 μ decays per second over a year of data taking. The highly granular detector based on thin high-voltage monolithic active pixel sensors (HV-MAPS) and scintillating timing detectors will produce about 100 Gbit/s of data at these particle rates.

Since the corresponding data cannot be saved to disk, a triggerless online readout system is required which is able to sort, align and analyze the data while running. A farm with PCs equipped with powerful graphics processing units (GPUs) will perform the data reduction. The talk presents the developed firmware used to provide the detector data for the GPU reconstruction. The firmware runs on Field Programmable Gate Arrays (FPGAs), which hold Double Data Rate Synchronous Dynamic Random-Access Memory (DDR SDRAM) to buffer the data. It will also show insides of the online analyzer used to perform data quality checks and other system checks.

T 85.4 Wed 18:15 HSZ/0301

Handling systematic uncertainties with the new ATLAS analysis formats — Nikolai Hartmann, Günter Duckeck, Otmar Biebel, and •Alexander Mario Lory — Ludwig-Maximilians-Universität München

Evaluating systematic uncertainties is one of the main elements contributing to CPU usage and processing time of a physics analysis in ATLAS. Frequently, these uncertainties are variations applied during the calibration of physics objects. During Run 2 of the LHC, although a common infrastructure and set of tools were used, the calibration was performed by each analysis group individually. For Run 3, two new small-sized formats have been introduced in order to cope with the increasing amount of data that is expected to be recorded. In one of these formats, the stored physics objects are already calibrated, which allows for a fast processing downstream and potentially new workflows. However, systematic uncertainties need to be revisited in that context, as they can no longer be applied as variations during the calibration step, but need to alter the already-calibrated objects. Can correctionlib, a tool which was developed within CMS to handle the typical correction factors encountered in particle physics, be used for this purpose within ATLAS?

T 85.5 Wed 18:30 HSZ/0301

HS3 - A serialization standard for statistical models in high energy physics — Carsten Burgard[1], Cornelius Grunwald[1], •Robin Pelkner[1], and Oliver Schulz[2] — [1]TU Dortmund University, Department of Physics — [2]Max Planck Institute for Physics, Munich

An important aspect of experimental particle physics, and science in general, is to perform analyses in a reproducible way. In addition to providing the observational data, this also means that the statistical models, which are usually formulated in terms of likelihood functions, must be provided in an accessible form as well. Currently, sharing statistical models between different programs and communities can be cumbersome because there is no standardized exchange format. Different software packages and toolkits usually use fundamentally different ways for representing data and models. We present the "high energy physics serialization standard" (HS3), a proposed standard, which is a language-agnostic and software-independent format for saving statistical models in exchangeable files. HS3 makes it possible to share entire analyses and to use them across software frameworks and methods so results can be cross-checked and models can be reused in new contexts. We give a general introduction to the HS3 standard, its design philosophy and semantics. In addition, we focus on the ongoing implementation of HS3 in ROOT, in Python, and the Julia programming language for use in packages like BAT.jl.

T 86: ML Methods IV

Time: Wednesday 17:30–19:00 Location: HSZ/0405

T 86.1 Wed 17:30 HSZ/0405

EPiC-GAN: Equivariant Point Cloud Generation for Particle Jets — •Erik Buhmann — Institut für Experimentalphysik, Universität Hamburg

With current and future high-energy collider experiments' vast data-collecting capabilities comes an increasing demand for computationally efficient simulations. Generative machine learning models allow fast event generation, yet so far are largely constrained to fixed data and detector geometries. We introduce the Deep Sets-based equivariant point cloud generative adversarial network (EPiC-GAN) for the generation of point clouds with variable cardinality – a flexible data structure optimal for collider events such as jets. The generator and discriminator utilize multiple EPiC layers with an interpretable global latent vector and do not rely on pairwise information sharing between particles, leading to a significant speed-up over graph- and transformer-based approaches. We show that our GAN scales well to large particle multiplicities and achieves high generation fidelity for gluon, light quark, and top jets.

T 86.2 Wed 17:45 HSZ/0405

Development of novel machine learning algorithms for robust jet flavour classification for Run3 at CMS — •Annika Stein[1], Judith Bennertz[1], Xavier Coubez[1,2], Alexander Jung[1], Summer Kassem[1], Ming-Yan Lee[1], Spandan Mondal[1], Alexandre de Moor[3], Andrzej Novak[1], Alexander Schmidt[1], and Hendrik Schönen[1] — [1]III. Physikalisches Institut A, RWTH Aachen University, Aachen, Germany — [2]Brown University, Providence, USA — [3]Vrije Universiteit Brussel, Brussels, Belgium

Complex neural network architectures have been developed for jet tagging and play a crucial role for numerous analyses relying on this classification task. Recent advances exploit low-level information with convolutional layers, graph neural networks, or transformer models with attention mechanisms. While improving performance is one of the key components in tagger development, the capability to generalize to detector data imposes new challenges and can be probed through comparisons between the two domains, simulation and data, in different phase spaces. This talk will showcase how strategies like adversarial training can be used to improve robustness and data/MC agreement for state-of-the-art tagging algorithms. An overview of the upcoming generation of flavour tagging algorithms for Run3 will be given.

T 86.3 Wed 18:00 HSZ/0405

Deep Neural Networks for jet-flavor tagging based on different hadronization models — •Aritra Bal, Markus Klute, and Roger Wolf — Institute for Experimental Particle Physics (ETP), Karlsruhe Institute of Technology (KIT)

Differences between the samples of either quark- or gluon-initiated jets produced by the two Monte-Carlo event generators Pythia and Herwig have been reported in the literature. A neural network can be trained to perform jet-flavor tagging on samples from either MC generator, but the performance of the network is observed to depend on the sample to which it is applied, and a network applied to a Herwig sample performs better than when applied to a Pythia sample, irrespective of the sample it was originally trained on.

We train a neural network using simple kinematic, and high-level constructed variables for better discrimination, to tag jets based on their flavor (as quark or gluon). A thorough analysis of the dependence on the input space is performed, to examine how the network responds to samples generated using different hadronization models. We also identify the critical regions of the input space where the two generators differ in the neural network response, using a Taylor Series expansion of the output function (up to 2nd order) in terms of the input variables, which we then use to find one possible answer for the generator dependence observed in the neural network application.

T 86.4 Wed 18:15 HSZ/0405

Multi-parameter Conditioning of Generative Models for Fast Simulation of Highly Granular Calorimeter Showers — •Peter McKeown — Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany

High fidelity detector simulation is crucial for modern high energy physics experiments. While traditional simulation tools based on Monte Carlo methods are powerful, they consume significant computational resources. For this reason at the upcoming high luminosity stage of the LHC and for future colliders, simulation is expected to produce a major computational bottleneck. Particle showers in calorimeters are particularly computationally intensive due to the many interactions that occur with the detector material. Given the vast increases in the granularity of these detectors for future experiments, a high degree of fidelity is required of a surrogate simulator.

Deep generative models hold promise to provide significantly faster, yet accurate, simulation tools. Significant progress has been made in the simulation of both electromagnetic and hadronic showers in highly granular calorimeters. However challenges remain when broadening the scope of these simulators. In particular, these tools must be able to accept multiple conditioning parameters, for example to be able to handle particles incident at arbitrary angles. This talk will review the development of such a simulation tool, with a particular focus on the high degree of physical fidelity achieved, as well as the performance after interfacing with reconstruction algorithms.

T 86.5 Wed 18:30 HSZ/0405

Super-resolution of photon calorimeter images using genera-

tive adversarial networks — Johannes Erdmann[1], Aaron van der Graaf[2], •Florian Mausolf[1], and Olaf Nackenhorst[2] — [1]III. Physikalisches Institut A, RWTH Aachen University — [2]TU Dortmund University, Department of Physics

Photons are important objects at collider experiments as, for example, the Higgs boson can be studied with high precision in the diphoton decay channel. For this purpose, it is crucial to achieve the best possible spatial resolution for photons and to discriminate against other particles which can mimic the photon signature.

In this talk, a method to generate photon calorimeter images at increased resolution is presented. The energy depositions of single photons and photon pairs from neutral pion decays are simulated in a lead tungstate crystal calorimeter. Each shower is obtained pairwise, for a calorimeter with a crystal width of 2.2 cm and for a calorimeter with higher resolution, where the number of crystals is increased by a factor of 16. Wasserstein generative adversarial networks are trained to estimate the high-resolution images from their low-resolution counterparts, with a deep residual convolutional neural network used as generator. The properties of the super-resolved calorimeter images are analysed and it is shown that their barycentres can be significantly better localised in the calorimeter. Moreover, classifiers are trained on either super-resolution or low-resolution images to separate single photons from neutral pion decays and their performances are compared.

T 86.6 Wed 18:45 HSZ/0405

Generative Modeling with Diffusion Neural Networks for Fast Simulation of Electromagnetic Showers in the International Large Detector — •Anatolii Korol — Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany

In high energy physics, detailed and time-consuming simulations are used for particle interactions with detectors. For future experiments and the upcoming High-Luminosity phase of the Large Hadron Collider (HL-LHC), the computational costs of conventional simulation tools are expected to exceed the projected computational resources.

Generative neural networks (GNNs) have the potential to provide a fast and accurate alternative. So far most of the studies of GNNs for fast simulations have used data represented in the form of a regular grid since it is possible to apply modern machine learning algorithms from image processing that are well optimized and developed.

In fast simulations with GNNs, it is crucial to be able to place GNNs into the simulation pipeline, and since many of today*s detector systems are not regular in terms of the positions of the active cells, it*s very hard to represent the data in a form suitable for training the GNN.

This work focuses on the development of a GNN for speeding up the simulation of electromagnetic showers in the electromagnetic calorimeter of the International Large Detector (ILD). In particular, a Diffusion Model is trained on Geant4 steps, where the electromagnetic shower is presented as a 3D point cloud to avoid the irregularities of the detector geometry and thereby generate showers anywhere in the calorimeter.

T 87: Neutrinos III

Time: Wednesday 17:30–19:00 Location: POT/0051

T 87.1 Wed 17:30 POT/0051

The Taishan Antineutrino Observatory — •Hans Theodor Josef Steiger — Cluster of Excellence PRISMA+, Detector Laboratory, Mainz, Germany — Experimental Particle and Astroparticle Physics, Johannes Gutenberg University, Mainz, Germany

The TAO (Taishan Antineutrino Observatory) detector is aiming for a measurement of the reactor neutrino spectrum at very low distances (<30m) to the core with a groundbreaking resolution better than 2 % at 1 MeV. The TAO experiment will realize the unprecedented neutrino detection rate of about 2000 per day, which is approximately 30 times the rate in the JUNO main detector. In order to achieve its goals, TAO is relying on yet to be developed, cutting-edge technology, both in photosensor and liquid scintillator (LS) development which is expected to have an impact on future neutrino and Dark Matter detectors. In this talk TAO's design, physics prospects as well as the status of its construction will be presented, together with a short excursion into its rich R&D program with a special focus on the German contribution to the development of the novel gadolinium-loaded liquid scintillator. This work is supported by the Cluster of Excellence PRISMA+ at the Johannes Gutenberg University in Mainz and the DFG research unit JUNO.

T 87.2 Wed 17:45 POT/0051

Event Reconstruction in JUNO-TAO using Deep Learning — •Vidhya Thara Hariharan, Daniel Bick, Caren Hagner, and Rosmarie Wirth for the University of Hamburg-Collaboration — University of Hamburg

he primary goal of JUNO is to resolve the neutrino mass hierarchy using precision spectral measurements of reactor antineutrino oscillations. To achieve this goal a precise knowledge of the unoscillated reactor spectrum is required in order to constrain its fine structure. To account for this, Taishan Antineutrino Observatory (TAO), a ton-level, high energy resolution liquid scintillator detector with a baseline of about 30 m, is set up as a reference detector to JUNO. The 20% increase in the coverage of photosensors, the replacement of Photomultiplier Tubes (PMTs) with Silicon Photomultiplier (SiPM) tiles, the smaller dimension and the operating temperature at -50°C, would enable TAO to achieve a yield of 4,500p.e./MeV. Consequently TAO will achieve an energy resolution better than 2% @ 1 MeV.

The ability to accurately reconstruct reactor antineutrino events in TAO is of great importance for providing a model-independent reference spectrum for JUNO. This work aims to demonstrate the general applicability of Graph Neural Network (GNN) for event reconstruction in TAO. The dataset for model training and validation are Monte Carlo samples generated from the official TAO offline software. The network is trained on the features that are obtained from the information collected by SiPMs to predict the vertices and energy. The resolutions obtained from the model are presented in the talk.

T 87.3 Wed 18:00 POT/0051

Calibration of the JUNO pre-detector OSIRIS — •Moritz Cornelius Vollbrecht[1,2], Livia Ludhova[1,2], Runxuan Liu[1,2], Anita Meraviglia[2,3], Nikhil Mohan[2,3], Luca Pelicci[1,2], Mariam Rifai[1,2], Apeksha Singhal[2,3], and Tobias Richard Sterr[4] — [1]Forschungszentrum Jülich GmbH, Institut für Kernphysik IKP-2, Jülich, Germany — [2]III. Physikalisches Institut B, RWTH Aachen University, Aachen, Germany — [3]GSI Helmholtz Centre for Heavy Ion Research, Darmstadt, Germany — [4]Physikalisches Institut, Eberhard Karls Universität Tübingen, Tübingen, Germany

The 20-kton liquid scintillator detector (LS) of the Jiangmen Underground Neutrino Observatory (JUNO) experiment, currently under construction in southern China, has a huge potential for insights in several fields of particle physics. To achieve its many goals, stringent radiopurity requirements have to be fulfilled. In order to ensure these limits, the Online Scintillator Internal Radioactivity Investigation System (OSIRIS) was designed as a pre-detector for JUNO. During the months-long filling of JUNO, OSIRIS will closely assess the radiopurity of purified LS batches to allow fast countermeasures in case of contaminations. In OSIRIS, an array of 76 Large Photomultiplier Tubes (LPMTs) instruments a water-shielded 20-ton LS target. An Automatic Calibration Unit (ACU) from the Daya Bay experiment is used for the calibration of event and vertex reconstruction as well as LPMT timing and charge responses. A separate laser system is used for redundant LPMT timing and charge calibration. This presentation will summarize the current status of the calibration strategy of OSIRIS.

T 87.4 Wed 18:15 POT/0051

Tau appearance with KM3NeT/ORCA — •Nicole Geisselbrecht for the ANTARES-KM3NET-ERLANGEN-Collaboration — Friedrich-Alexander-Universität Erlangen-Nürnberg, ECAP

KM3NeT/ORCA is a water Cherenkov detector currently under construction in the Mediterranean Sea. It is optimised for the detection of atmospheric neutrinos with the main goal of determining the neutrino mass ordering.
Even though atmospheric neutrinos are produced as electron or muon neutrinos and thus initially do not contain tau neutrinos, these are expected to appear at Earth due to neutrino oscillations. In KM3NeT/ORCA, tau neutrinos can't be identified on an event-by-

event basis but rather as a statistical excess of shower-like events. This measurement will allow KM3NeT/ORCA to measure the tau neutrino flux normalisation factor and provide insights into the unitarity of the PMNS matrix and hence the validity of the standard three-flavour neutrino oscillation model. This talk will cover the status of the tau appearance analysis with an early sub-array of KM3NeT/ORCA.

T 87.5 Wed 18:30 POT/0051

Search for quantum gravity effects with neutrino telescopes — •Alba Domi for the ANTARES-KM3NET-ERLANGEN-Collaboration — ECAP, Erlangen, Germany

The Standard Model of particle physics and General Relativity are expected to merge into a new theory of Quantum Gravity (QG) at energies approaching the Planck scale. However, none of the proposed QG approaches has been validated to date. In this context, several signatures of QG effects in accessible energy regimes, known as "Windows on Quantum Gravity", have been postulated. In particular, quantum decoherence (QD) or QG-induced violation of Lorentz invariance (LIV), could cause modifications in neutrino oscillation patterns accessible to observation with neutrino telescopes. Moreover, the phenomenon of QD will provide new possibilities to investigate the neutrino nature as a Dirac or Majorana particle, as well as to trace possible violations of CPT symmetry in neutrino oscillations. Such a phenomenon represents a totally new scenario where to test the real nature of neutrinos. This talk reviews the efforts made in neutrino physics to search for QD and LIV effects and their implications in terms of QG models.

T 87.6 Wed 18:45 POT/0051

Neutrino Generator Comparisons GiBUU/GENIE in KM3NeT — •Johannes Schumann for the ANTARES-KM3NET-ERLANGEN-Collaboration — Friedrich-Alexander-Universität Erlangen-Nürnberg

The KM3NeT neutrino telescope is currently being deployed in the Mediterranean Sea. The detector comprises a three-dimensional array of digital optical modules, which detect faint Cherenkov light signals from secondary particles of neutrino interactions. Simulations of the neutrino interactions play an important role for the interpretation of the measurements and are performed by so-called neutrino generators, which employ different approximations in order to achieve a numerical solution with reasonable computing resources. This contribution describes the comparison between GENIE, the neutrino generator used by KM3NeT and the GiBUU generator. The comparisons are performed at the level of systematic uncertainties and their impact on sensitivity estimates.

T 88: Gamma Astronomy IV

Time: Wednesday 17:30–19:00 Location: POT/0151

T 88.1 Wed 17:30 POT/0151

Simulated galactic SNR populations compared to experimental data — •Rowan Batzofin[1], Kathrin Egberts[1], Constantin Steppa[1], and Pierre Cristofari[2] — [1]University of Potsdam, Potsdam, Germany — [2]Observatoire de Paris, PSL Research University, LUTH, France

For a long time it has been believed that supernova remnants are the primary source of galactic cosmic rays up to the knee although it has not been conclusively proven yet. Supernova remnants are expected to produce VHE gamma rays via hadronic interactions between the cosmic rays accelerated at the shock and the ambient gas in the interstellar medium. There are many supernova remnants detected in the radio energy range but very few of them have been identified at VHE.

To study the VHE emission of galactic supernova remnants we create a model for supernova remnant populations. The supernova remnant population model ingredients are: The acceleration physics of the supernova remnants, the matter distribution of the interstellar medium in the Milky Way and the source distribution for the supernova remnants in the Milky Way. We utilise population synthesis to optimise some of the parameters for the model to best fit the experimental data. We compare our simulated populations to experimental data by looking at the source distribution and the detectability of the simulated sources.

We test the simulated populations of galactic supernova remnants against the experimental observations to show whether supernova remnants could be the primary accelerators of cosmic rays.

T 88.2 Wed 17:45 POT/0151

What we can learn from blazar light curves — •Lea Heckmann, David Paneque, and Axel Arbet-Engels — Max-Planck-Institut für Physik, D-80805 München, Germany

Blazars are among the most energetic sources in our Universe. However, even though they have been studied for decades over a wide range of the electromagnetic spectrum, they are far from being understood.

In this contribution, we would like to give some insights into what we can learn from studying the multi-wavelength light curves of blazars. It includes on the one hand the features in each single waveband, such as the degree of variability or signs of potential periodicity. On the other hand, the the connection between different wavebands can also be investigated by studying the correlations between them. In addition to introducing the theory behind these characteristics, we will use a long-term data set of the archetypal blazar Mrk 501 to demonstrate their capabilities when applied to real data.

T 88.3 Wed 18:00 POT/0151

Intergalactic magnetic fields and Mkn 421 gamma-ray observations — •Matias Sotomayor Webar and Dieter Horns — Institut für Experimentalphysik, Universität Hamburg, Luruper Chausseee 149, D-22761 Hamburg

The existence of intergalactic magnetic fields as a relic of a phase transition in the early universe has so far not been confirmed through observations. While Faraday rotation measure provide an upper bound ($\lesssim 10^{-9}$ G), lower bounds have been proposed via the non-detection of gamma-ray emission produced in inverse Compton/pair production cascades. Sufficiently large magnetic fields ($\gtrsim 10^{-16}$ G are required to deflect the secondary electrons out of the line of sight and suppress the visible inverse Compton emission. The interpretation of these limits is however debatable, as oblique pair instabilities could be a dominating energy-loss mechanism, providing the long sought additional heating of the intergalactic medium to explain Ly$-\alpha$ forest data. In this contribution, we present the results for a search for a strongly suppressed cascade emission from the direction of the prominent nearby blazar Mkn 421 ($z = 0.031$) using *Fermi* LAT data. Preliminary results will be presented at the conference.

T 88.4 Wed 18:15 POT/0151

3D Shower Reconstruction with the Cherenkov Telescope Array* — •Stefan Fröse and Lukas Nickel for the CTA-Collaboration — TU Dortmund University, Dortmund, Germany

The Cherenkov Telescope Array (CTA) is the next-generation telescope array for high-energy gamma-ray astronomy. The Imaging Atmospheric Cherenkov Telescopes (IACTs) will be able to make precise measurements of the Cherenkov light induced by incident primary particles, such as photons or ions. To determine the direction and energy of these particles, the characteristics of the atmospheric shower have to be reconstructed.

One possible method is the reconstruction using a three-dimensional rotationally invariant Gaussian shower model, as introduced by the H.E.S.S. collaboration. This model is fitted directly to the images of the shower in the triggered cameras using a maximum likelihood approach. This talk will summarize the current implementation as part of the ctapipe analysis package and the initial results.

* Supported by DFG (SFB 1491)

T 88.5 Wed 18:30 POT/0151

MAGIC Event Reconstruction with Deep Learning — •Jarred Gershon Green for the MAGIC-Collaboration — Max Planck Institute for Physics, Munich, Germany

The Major Atmospheric Gamma Imaging Cherenkov (MAGIC) telescope is a stereoscopic system used for detecting gamma rays in the GeV to TeV range. When gamma rays and cosmic rays interact with the atmosphere, an air shower is initiated which itself emits Cherenkov photons detectable by MAGIC. After parametrizing the images of each shower, machine learning algorithms like random forests are used to re-

construct the properties of each primary particle, including their type, energy, and arrival direction. Convolutional Neural Networks offer a promising way to perform this reconstruction directly on pixelated camera images. In this contribution, we explore how deep learning algorithms like convolutional and graph neural networks can be used to reconstruct events, first by introducing architectures and then showing their performance as applied to real MAGIC data.

T 88.6 Wed 18:45 POT/0151

ctapipe – Prototype Open Event Reconstruction Pipeline for the Cherenkov Telescope Array — •Maximilian Linhoff, Lukas Nickel, and Noah Biederbeck for the CTA-Collaboration — Astroparticle Physics, TU Dortmund University, Germany

The Cherenkov Telescope Array (CTA) is the next-generation ground-based, very high energy gamma-ray observatory currently under construction. It will improve over the current generation of imaging atmospheric Cherenkov telescopes (IACTs) by a factor of five to ten in sensitivity and it will be able to observe the whole sky from its two sites: La Palma, Spain, and Paranal, Chile.

CTA will also be the first open ground-based gamma-ray observatory. Accordingly, the data analysis pipeline is developed as open-source software. The event reconstruction pipeline accepts raw data from the telescopes and processes it to produce suitable input for the high-level science tools. Its primary tasks include reconstructing the physical properties of each recorded shower and providing the corresponding instrument response functions.

ctapipe is a python framework to facilitate calibration of the raw data, image extraction, image parameterization and event reconstruction. Though the current focus has been the analysis of simulated data, the software has also been successfully applied to the data obtained with the first CTA prototype telescopes, such as Large-Sized Telescope (LST-1). A plugin system also allows processing of comparable data from other IACT facilities. Recent updates, new features and the planned roadmap towards a 1.0 release will be discussed.

T 89: DM, Neutrino Theory

Time: Wednesday 17:30–19:00 Location: POT/0251

T 89.1 Wed 17:30 POT/0251

A mobile neutron spectrometer for the LNGS underground laboratory — •Melih Solmaz[1], Klaus Eitel[2], Kathrin Valerius[2], and Uwe Oberlack[3] — [1]Karlsruhe Institute of Technology, Institute of Experimental Particle Physics — [2]Karlsruhe Institute of Technology, Institute for Astroparticle Physics — [3]Johannes Gutenberg University Mainz, Institute for Physics

Environmental neutrons are a source of background for various rare event searches (e.g., dark matter direct detection and neutrinoless double beta decay experiments) taking place in deep underground laboratories. Both the neutron flux and spectrum depend on location. Precise knowledge of this background is necessary to devise shielding and veto mechanisms, improving the sensitivity of the neutron-susceptible underground experiments.

Ambient neutrons have been measured previously at different locations of the underground laboratory LNGS in Italy. However, flux numbers vary considerably across the measurements and direct comparison between them is difficult owing to the use of different detector technologies and setups, each of which possesses characteristic systematics and energy windows. A project was launched to solve these issues and enhance the scientific infrastructure of LNGS.

In this talk, we present the design and the expected performance of a portable neutron detector based on capture-gated spectroscopy as well as first test measurements and give an outlook towards the deployment at LNGS. This project is funded by the German Federal Ministry of Education and Research (BMBF) under the grant number 05A21VK1.

T 89.2 Wed 17:45 POT/0251

Background characterisation of GeMPI detectors and shield design for improved GeMPI-neo detectors — •Nicola Ackermann[1], Matthias sLaubenstein[2], Jochen Schreiner[1], Christian Buck[1], Manfred Lindner[1], Gerd Heusser[1], Herbert Strecker[1], Werner Maneschg[1], Janina Hakenmüller[1], and Hannes Bonet[1] — [1]Max-Planck-Institut für Kernphysik, Heidelberg, Germany — [2]Laboratori Nazionali del Gran Sasso, L'Aquila, Italy

This talk presents Monte Carlo simulations of the background spectra of the 4 screening detectors GeMPI 1 - 4 at the Gran Sasso Underground Laboratory (LNGS) using the Geant4 based framework MaGe. The GeMPI detectors are low background Ge spectrometers located at a depth of 3500 m.w.e. and achieve extremely high sensitivites in material screening at a level of muBq/kg. They are used to test material samples on their suitability to use in rare event experiments.

In the simulations muons, neutrons and tiny radioactive contaminations of the detector and shielding materials are investigated as possible sources of background radiation. It was found that the Pb210 contaminations in the detector shield and the neutrons coming from radioactive decays in the surrounding rock have the highest impact on the background spectra. With this new found understanding, a possible shield design for a next generation GeMPI-like detector is proposed.

T 89.3 Wed 18:00 POT/0251

Towards a low-background SDD for IAXO — Joanna Bilicki, Frank Edzards, Susanne Mertens, Lucinda Schönfeld, Juan Pablo Ulloa Beteta, •Christoph Wiesinger, and Michael Willers — Physik-Department, Technische Universität München, Garching

The International Axion Observatory (IAXO) aims to detect solar axions as they are back-converted into X-rays along a strong magnet pointed towards the sun Excellent spectroscopic performance, high X-ray absorption efficiency at and below 10 keV and great potential for ultra-low background operations are features of silicon drift detectors (SSDs) that could facilitate this endeavour. Dedicated low-background detector designs, following a consequent passive shielding strategy and a novel all-semiconductor active shield approach, are under development. A background demonstrator has been installed at the Canfranc underground laboratory in Spain. In this talk, we will report on the latest achievement towards a low-background SDD for IAXO. This work has been supported by the DFG through the Excellence Cluster ORIGINS.

T 89.4 Wed 18:15 POT/0251

Some Cosmological Constraints on Many Species Theories — •Alan Zander[1], Philipp Eller[1], and Manuel Ettengruber[2] — [1]TUM, Garching, Deutschland — [2]Max-Planck-Institut für Physik, München, Deutschland

We consider the so-called Many Species Model introduced by Dvali and Redi, which postulates the existence of $N \sim 10^{32}$ particle species yielding a new mechanism to solve the well-known hierarchy problem. We study some possible extensions of the model allowing the electroweak vacuum expectation values of the Higgs bosons of the different Standard Model (SM) copies to break the permutation symmetry in the species space and we show how this renders the theory testable in the context of neutrino physics. These scenarios make also possible to address some of the other biggest questions in modern physics that remain open like the smallness of the active neutrino masses and the nature of dark matter, yielding a viable explanation for these two mysteries. That being said, we also analyze some of the cosmological implications of these extensions, obtaining the first constraints available in the literature for this sort of theories on the number of species that interact to some extent with the SM.

T 89.5 Wed 18:30 POT/0251

Phenomenological implications of neutrinos and axions in Many Species Theories — •Manuel Ettengruber[1], Philipp Eller[2], Emmanouil Koutsangelas[1], and Alan Zander[2] — [1]Max-Planck-Institut für Physik, München, Deutschland — [2]TUM, Garching, Deutschland

The framework of TeV scale gravity theories was originally invented to solve the hierarchy problem. One specific BSM model is the Many Species Theory in which the scale of quantum gravity gets lowered by the existence of many additional light states. In this talk we want to present how small neutrino masses can be generated in this infrared approach and how this modifies the oscillation pattern. Then we present

how current neutrino data can be used to give a lower bound on the number of additional species. Moreover, we show how to get an upper bound from axion physics. These results give the first time a theoretically restricted parameter space which can be tested by current and future experiments.

T 89.6 Wed 18:45 POT/0251

Influence of a gravitationally induced phase on neutrino oscillation and Baryogenesis — •Sara Krieg — TU Dortmund, 44227 Dortmund, Germany

In view of the fact that there is still no uncontroversial theory of quantum gravity nor an experimental evidence for its existence it is well motivated to look for the latter in neutrino oscillations.

For this a general transition probability is derived for a neutrino interacting gravitationally with background neutrinos. Entanglement of the neutrinos and a garvitational quantum field induces a phase modifying the oscillation behavior which may be experimentally detectable. Therefore this could be a direct evidence for the quantum character of gravity.

Since there are theories that explain baryon asymmetry via neutrino oscillations the effect of the phase shift may also have an impact on the predictions of these models.

Extra dimensions are introduced to consider even larger effects.

T 90: Neutrinos, Dark Matter X

Time: Wednesday 17:30–19:00 Location: POT/0361

T 90.1 Wed 17:30 POT/0361

Estimate of the electronic and nuclear recoil background in DARWIN: — •Antoine Chauvin, Maike Doerenkamp, Andrii Terliuk, and Stephanie Hansmann-Menzemer — Universität Heidelberg

The DARWIN experiment is a proposed future Direct Dark Matter observatory that aims to detect WIMPs through WIMP-nucleus interactions, in a multi-ton liquid xenon TPC. Its goal is to become the most sensitive experiment to WIMP-nucleus interaction. To estimate this sensitivity, good models for signal and background generation, and of the detection processes are fundamental. In this talk, we will report on the simulation of the response of the DARWIN detector to different background sources, interacting both through Electronic Recoil and Nuclear Recoil. We compare these to the response of a WIMP signal and derive according estimates for the WIMP sensitivity of the DARWIN experiment.

T 90.2 Wed 17:45 POT/0361

Properties of the radiogenic neutron background in DARWIN — •Maike Doerenkamp, Antoine Chauvin, Andrii Terliuk, and Stephanie Hansmann-Menzemer — Universität Heidelberg

DARWIN is a proposed multi-ton liquid xenon experiment that aims to explore new parameter-space in the direct detection of WIMPs through nuclear recoil. A major source of background for this experiment are radiogenic neutrons, originating from detector materials. A good understanding and modelling of their properties is therefore necessary for sensitivity studies. This talk will discuss characteristics of this background and methods to reduce it, to ultimately improve the sensitivity.

T 90.3 Wed 18:00 POT/0361

Radon mitigation in current and future liquid xenon detectors — •Florian Jörg for the XENON-Collaboration — Max-Planck-Institut für Kernphysik Heidelberg, Germany

Dual-phase liquid xenon time projection chambers have become a leading technology for rare-event searches such as the direct detection of particle dark matter. The sensitivity of current experiments is limited by the xenon-internal background from ^{222}Rn. Therefore, techniques for radon mitigation are applied during all stages of the experiment.

The XENONnT detector belongs to the latest generation of liquid xenon detectors and has reached an unprecedented low radon concentration of $< 1\,\mu$Bq/kg. This achievement was driven by a thorough material pre-selection in combination with a novel radon removal system. In-situ measurements of its radon concentration during scientific data taking will be presented. Furthermore, recent results from a novel radon mitigation method using surface coatings will be discussed.

T 90.4 Wed 18:15 POT/0361

Liquid Handling System (LHS) of the OSIRIS Detector — Michael Wurm, Kai Loo, •Oliver Pilarczyk, Arshak Jafar, George Parker, Tim Charisse, and Marcel Büchner for the JUNO-Collaboration — Johannes Gutenberg-University Mainz

The Jiangmen Underground Neutrino Observatory (JUNO) is a 20kt liquid scintillator (LS) detector currently being built in southern China. It will use the neutrino flux from 2 nuclear power plants in a distance of 53km to achieve its main goal of determining the neutrino mass hierarchy. During the filling of the main JUNO detector the LS will undergo several cleaning steps as well as a final monitoring by the Online Scintillator Internal Radioactivity Investigation System (OSIRIS) to ensure it meets the needed radiopurity requirements. This talk will present the Liquid Handling System (LHS) of the OSIRIS detector.

T 90.5 Wed 18:30 POT/0361

Towards an Online Radiopurity Analysis with BiPo coincidences in the JUNO Pre-Detector OSIRIS — •Konstantin Schweizer[1], Lothar Oberauer[1], Michael Wurm[2,3], and Kai Loo[3] — [1]Technische Universität München, Physik Department, James-Franck-Str., 85748 Garching, Germany — [2]Institute of Physics, Johannes Gutenberg University Mainz Staudingerweg 7, 55128 Mainz, Germany — [3]Institute of Physics and Excellence Cluster PRISMA+, Johannes-Gutenberg Universität Mainz, Mainz, Germany

The organic liquid scintillator based JUNO experiment (Jiangmen Underground Neutrino Observatory) is aiming to determine the neutrino mass hierarchy. This goal imposes strict requirements on the radiopurity of the scintillator.

The 20m^3 OSIRIS pre-detector is expected to monitor the level of radioactive contaminations in the purified scintillator as the last device after the purification plants. This way the scintillator's radiopurity will be checked just before it is filled into the JUNO main detector. The level of U/Th contaminations can be determined by exploiting the coincidence structure of a Bi β-decay to Po immediately followed by an α-decay to Pb. This talk presents the status of the development of an in-situ analysis of this method using pulse shape discrimination.

This work is supported by the DFG Research Unit "JUNO" (FOR2319).

T 90.6 Wed 18:45 POT/0361

Machine learning based event reconstruction for the OSIRIS detector — •Lukas Bieger, Marc Breisch, Jessica Eck, Tobias Heinz, Benedict Kaiser, Tobias Lachenmaier, and Tobias Sterr — Eberhard Karls Universität Tübingen, Physikalisches Institut

The Jiangmen Underground Neutrino Observatory (JUNO) is a multi-purpose neutrino experiment with a 20 kt liquid scintillator detector that is currently set up in southern China. The main goal of JUNO is determining the neutrino mass hierarchy, which is to be achieved by a precise measurement of the oscillated energy spectrum of electron antineutrinos from nearby nuclear power plants. The Online Scintillator Internal Radioactivity Investigation System (OSIRIS) will monitor the radio-purity of the liquid scintillator during the filling of JUNO, to ensure that the required contamination levels are met. OSIRIS itself is a 18 t liquid scintillator detector, which is instrumented with 64 20-inch PMTs to collect the light produced by events in the detector's sensitive volume. This talk will present an event reconstruction method based on machine learning which was developed for the application in the OSIRIS detector.

T 91: Neutrinos IV

Time: Wednesday 17:30–19:00 Location: POT/0006

T 91.1 Wed 17:30 POT/0006

Sensitivity studies of the KATRIN experiment with a differential detector — •Svenja Heyns for the KATRIN-Collaboration — Institute for Astroparticle Physics, Karlsruhe Institute of Technology

The Karlsruhe Tritium Neutrino Experiment (KATRIN) is designed to probe the neutrino mass with a sensitivity of 0.2 eV/c^2 (90% C.L.). The measurement principle relies on an integral measurement of the tritium beta spectrum at the kinematic endpoint of T_2 by a high-pass MAC-E-type filter. Switching to a differential measurement of the beta-electron spectrum with eV-scale resolution would increase statistics and allow improved discrimination of background events. This presentation outlines the potential modification to the setup with possible detector concepts and discusses their impact in first studies on neutrino mass sensitivity.

This work is supported by the Helmholtz Association (HGF), the Ministry for Education and Research BMBF (05A17PM3, 05A17PX3, 05A17VK2, and 05A17WO3), the Helmholtz Alliance for Astroparticle Physics (HAP), and the Helmholtz Young Investigator Group (VH-NG-1055).

T 91.2 Wed 17:45 POT/0006

Characterization of a TRISTAN detector with a laser system — •Christian Forstner for the KATRIN-Collaboration — Technical University Munich, James-Franck-Straße 1, 85748 Garching bei München

Sterile neutrinos are a minimal extension of the Standard Model of particle physics. These neutrinos are a dark matter candidate if their mass is in the keV range. They can be accessed experimentally in the tritium beta decay, if they have a mass of up to 18.6 keV and would manifest themselves as a kink-like distortion in the electron energy spectrum. For the KATRIN experiment, a novel silicon drift detector and read-out system is developed to search for this signal. In this presentation, the results of the characterization of a 7 pixel TRISTAN detector with a laser system will be presented and compared to simulations.

This work is supported by BMBF (05A17PM3, 05A17PX3, 05A17VK2, 05A17WO3), KSETA, the Max Planck society, and the Helmholtz Association. This project has received funding from the European Research Council (ERC) under the European Union Horizon 2020 research and innovation program (grant agreement No. 852845).

T 91.3 Wed 18:00 POT/0006

The other end of KATRIN – systematic effects by the rear wall — •Leonard Hasselmann, Max Aker, and Rudolf Sack — IAP, Karlsruher Institut für Technologie

In order to determine the neutrino mass with a sensitivity of 0.2 eV/c^2 (90% C.L.) the Karlsruhe Tritium Neutrino (KATRIN) experiment measures the β-decay endpoint spectrum of tritium using a MAC-E filter type spectrometer. In KATRIN's source 10^{11} β-decay electronss are emitted per second. They are magnetically guided to the spectrometer in one direction and to a gold coated stainless steel plate, named rear wall, to the other.

A comprehensive understanding of various background contributions, e.g. accumulated tritium on the rear wall, is paramount. Decays of absorbed tritium create an additional spectrum which superimposes that of the source. This results in a systematic uncertainty, which is mitigated either by modelling the additional spectrum or by removing the tritium from the rear wall and surrounding surfaces.

The talk presents an overview on a cleaning method using UV/ozone which has been performed three times so far in the KATRIN setup. Besides a good cleaning performance, an influence on the source potential was found. Additionally, results from a test setup further investigating the cleaning effect are discussed.

This work is supported by the Helmholtz Association (HGF), the Ministry for Education and Research BMBF (05A17PM3, 05A17PX3, 05A17VK2, and 05A17WO3).

T 91.4 Wed 18:15 POT/0006

OSIRIS Upgrade: Solar PP Neutrinos and Neutrinoless Double Beta Decay — •Arshak Jafar[1], Kai Loo[1,2], Michael Wurm[1], Marcel Büchner[1], Tim Charisse[1], George Parker[1], Oliver Pilarczyk[1], and Timo Enqvist[2] — [1]Johannes Gutenberg University Mainz, Germany — [2]University of Jyvaskyla, Finland

The Jiangmen Underground Neutrino Observatory (JUNO), under construction in southern China, will determine the neutrino mass hierarchy (MH) by observing neutrinos from nuclear reactors at a distance of 53 km. To reach the desired sensitivity ($> 3\sigma$) for MH, the radiopurity of the different detector components plays a crucial role. To ensure the purity of the 20 kt liquid scintillator (LS) target of JUNO, the Online Scintillator Internal Radioactivity Investigation System (OSIRIS) is being constructed. It will monitor the radiopurity of the LS during its production and the filling phase of the central detector of JUNO.

After the filling phase, a plan to repurpose OSIRIS as a standalone detector for studying physics has been put forward, as OSIRIS along with the existing JUNO infrastructure provides a unique chance for low-budget high precision measurements. The OSIRIS upgrade project aims at a precision measurement of the flux of solar pp neutrinos on the few-percent level as well as to test the Majorana nature of neutrinos through neutrinoless double beta decay. The upgrade relies on the use of 20 tons of slow scintillator, either low ^{14}C or loaded with $0\nu\beta\beta$ isotope, with excellent energy resolution (∼2.5% at 1 MeV), low internal background and sufficient shielding from surrounding radioactivity.

T 91.5 Wed 18:30 POT/0006

JUNO's sensitivity to geoneutrinos using full Monte Carlo simulation — •Nikhil Mohan[1,3], Runxuan Liu[2,3], Livia Ludhova[2,3], Anita Meraviglia[1,3], Luca Pelicci[2,3], Mariam Rifai[2,3], Apeksha Singhal[2,3], and Cornelius Vollbrecht[2,3] — [1]GSI Helmholtz Centre for Heavy Ion Research, Darmstadt, Germany — [2]Forschungszentrum Jülich GmbH, Institut für Kernphysik IKP-2, Jülich, Germany — [3]III. Physikalisches Institut B, RWTH Aachen University, Aachen, Germany

JUNO is a multipurpose 20 kton liquid scintillator detector located in China, with planned completion in 2023. Its main physics goal is the determination of the Neutrino Mass Ordering via the measurement of the vacuum oscillation pattern of the reactor antineutrinos coming from two nuclear power plants, each at a 53 km baseline. JUNO is also an excellent candidate to investigate geoneutrinos thanks to its sizable active mass and unprecedented effective energy resolution (3% at 1 MeV). The sensitivity study is performed by producing all the energy reference shapes - signal and backgrounds - using the JUNO official Monte Carlo simulation with a full detector response as well as the reconstruction software. The reference shapes generated from the massive pseudo-experiments are then fitted with JUST (Juelich nUsol Sensitivity Tool), a software tool developed in our group. This study reveals the important role JUNO can have in detecting geoneutrinos. Even only after one year of data-taking, JUNO will be able to reach a 14% precision, thus improving the best current result given by the Borexino and KamLAND experiment.

T 91.6 Wed 18:45 POT/0006

Neutrino directionality: aims, methods and the reaction of inverse beta decay — •Yaroslav Nikitenko, Philipp Soldin, Achim Stahl, and Christopher Wiebusch — III. Physikalisches Institut B, RWTH Aachen University

Reconstructing the direction of neutrinos is of high interest for supernovae and geoneutrinos. We discuss existing experimental methods and focus on neutrino directionality using the reaction of inverse beta decay.

While the reaction of neutrino-electron scattering provides a better per-event angular resolution for supernova neutrinos, inverse beta decay usually has many more events. Its detection threshold for existing large detectors is lower than that for electron scattering, which is important for geoneutrinos.

The Double Chooz reactor neutrino experiment provides a good scientific basis to study neutrino directionality with the reaction of inverse beta decay. Its advantage is the neutrino source of a known direction and almost point-like structure.

T 92: Cosmic Ray IV

Time: Wednesday 17:30–19:00 Location: POT/0013

T 92.1 Wed 17:30 POT/0013

Modeling Diffusive Shock Acceleration with CRPropa* — •Sophie Aerdker[1,2], Lukas Merten[1,2], Julia Becker Tjus[1,2], Dominik Walter[1,2], Frederic Effenberger[1,2], and Horst Fichtner[1,2] — [1]Ruhr-Universität Bochum — [2]RAPP Center Bochum

Ultra high energy cosmic rays are most likely accelerated stochastically in time-dependent, turbulent magnetic field structures present in astrophysical sources and the interstellar medium. One of such processes is Diffusive Shock Acceleration: Diffusive particles gain energy by repeatedly crossing a shock front. The stochastic nature of this process leads to the characteristic power-law spectrum. We study Diffusive Shock Acceleration using a stochastic differential equation solver (DiffusionSDE) of the cosmic-ray propagation framework CRPropa3.2. We show that the expected spectra are reproduced for various configurations, from one-dimensional planar shocks to three-dimensional spherical shocks. The effect of anisotropic diffusion is discussed and how different injection spectra change the resulting spectrum. We clarify constraints for modeling Diffusive Shock Acceleration using stochastic differential equations.

*Supported by DFG (SFB 1491)

T 92.2 Wed 17:45 POT/0013

Untersuchung des Einflusses magnetischer Spiegel auf den Transport kosmischer Strahlung — •Seeliger Ines[1,2], Schlegel Leander[1,2] und Tjus Julia Becker[1,2] — [1]Theoretische Physik IV, Ruhr-Universität Bochum, Bochum, Germany — [2]RAPP-Center at Ruhr-Universität Bochum, Bochum, Germany

Seit den ersten Messungen der kosmischen Strahlungen bei den Ballonfahrten von Victor Hess im Jahre 1912, sind die Forschungen zu der Frage der Quellen der hochenergetischen Strahlung noch immer nicht abgeschlossen und Gegenstand laufender Untersuchungen. Numerische Betrachtungen des Transports ergeben, dass Teilchen des beobachteten Energiespektrums der kosmischen Strahlung in unterschiedlichen Transportregimen mit dafür charakteristischem Transportverhalten betrachtet werden können. Ziel dieser Arbeit ist es, insbesondere das Spiegelregime genauer zu untersuchen, indem der Einfluss von magnetischen Spiegeln hinsichtlich des Transportverhaltens relevant wird. Dazu wird numerisch das Verhalten der Teilchen an magnetischen Spiegeln durch analytisch implementierte magnetische Flaschen analysiert und es gilt den Einfluss der Spiegel bei der Simulation der Propagation von Testteilchen mit Hilfe der Software CRPropa zu bestimmen.

T 92.3 Wed 18:00 POT/0013

Unstable cosmic-ray nuclei constrain low-diffusion zones in the disk — •Hanno Jacobs, Philipp Mertsch, and Vo Hong Minh Phan — TTK RWTH Aachen

Gamma ray halos around pulsars indicate a locally suppressed diffusion coefficient. In the past the impact of those zones on galactic cosmic ray transport has been neglected due to their supposedly small filling fraction. Here we show that the determining factor is not the volume of the low diffusion zones, but the effective time spent in pockets of low diffusivity. We derive an averaged diffusion coefficient in the disc and implement it in a semi-analytical model of cosmic ray transport. Upcoming Beryllium data from the AMS-02 and HELIX experiments will be able to constrain the filling fraction of low diffusion zones at the percent level.

T 92.4 Wed 18:15 POT/0013

The CORSIKA 8 air shower simulation framework — •Alexander Sandrock for the CORSIKA 8-Collaboration — Bergische Universität Wuppertal, Gaußstr. 20, 42119 Wuppertal

Originally developed for the KASCADE experiment, the air shower simulation code CORSIKA is now used in the simulation chain of numerous experiments in astroparticle physics. The monolithic hand-optimized Fortran code, that has served the community for the last decades, becomes increasingly difficult to maintain and to expand. For this reason, a community effort has been started in 2018 to rewrite CORSIKA as a flexible air shower simulation framework, making use of the possibilities of modern C++ standards.

By now, CORSIKA 8 is capable of simulating both hadronic and electromagnetic components of an air shower, calculate the radio and Cherenkov emission, and offers a considerably increased flexibility in defining properties and geometries of the media, in which the shower is to take place. Several abilities already go beyond what is possible in earlier versions of CORSIKA, such as cross-media showers or full genealogy of particles.

This presentation discusses the status of the implementation and validation of this new air shower simulation framework.

T 92.5 Wed 18:30 POT/0013

High-energy lepton, photon and air shower simulations using PROPOSAL — •Jean-Marco Alameddine[1], Pascal Gutjahr[1], and Alexander Sandrock[2] — [1]Astroparticle Physics WG Rhode, TU Dortmund University, Germany — [2]Faculty of Mathematics and Natural Sciences, University of Wuppertal

In modern physics experiments, simulations are crucial to apply modern analysis methods to the obtained data. One prime example in astroparticle physics is the simulation of extensive air showers, whose signatures can either be signal or background for experiments that needs to be separated.

PROPOSAL is a customizable C++ and Python library, providing three-dimensional simulations of charged leptons and high-energy photons. One of many applications of PROPOSAL is within the currently developed shower simulation framework CORSIKA 8, the successor of the well-established software CORSIKA 7. For CORSIKA 8, PROPOSAL is used as a library to describe the electromagnetic and muonic shower component.

In this contribution, the basic concepts of PROPOSAL are introduced. Furthermore, validations of electromagnetic showers simulated with CORSIKA 8 are presented, which are obtained by comparing relevant shower parameters such as longitudinal and lateral profiles with CORSIKA 7 simulations.

Supported by the BMBF (ErUM) and by the DFG (SFB 1491, SFB 876).

T 92.6 Wed 18:45 POT/0013

Air shower genealogy — •Maximilian Reininghaus and Ralph Engel — Karlsruher Institut für Technologie (KIT), Karlsruhe, Deutschland

Experiments detecting ultra-high energy cosmic rays rely heavily on air shower simulations and models governing the hadronic interactions. These have to cover a vast phase-space (several combinations of projectile species and target nuclei, interaction energies ranging over many orders of magnitude, final-state kinematic distributions), but not all regions of it share the same relevance for air shower observables.

Using the air shower simulation framework CORSIKA 8 and its *particle history* feature, we investigate the relation between kinematic distributions of pseudorapidity, Feynman-x, and transverse momentum in hadronic interactions and muon distributions from air showers at ground. Additionally, we quantitatively study the energy transfer from the hadronic into the electromagnetic (EM) cascade and the impact of early hadronic interactions on the EM profile and its maximum $X_{\max}$.

T 93: Exp. Methods – Scint., HESS, Auger

Time: Wednesday 17:30–19:00 Location: POT/0351

T 93.1 Wed 17:30 POT/0351

Design of a detector irradiation facility in Mainz — •Daniela Fetzer, Michael Wurm, Kai Loo, and Arshak Jafar — Johannes Gutenberg-University Mainz

Detectors for low-energy particles (MeV) are often calibrated using gamma rays to induce electron-like signals. This contribution describes Monte Carlo simulation for a new experimental array to be set up at the Detector Irradiation Facility in the Center for Fundamental Physics in Mainz. It will use a DD-neutron generator, PE moderator and a nickel (neutron,gamma) converter to produce fairly high-energy gamma rays of 9 MeV. This allows a calibration for a far wider energy range than is accessible with standard radioactive sources.

In the planned experiment, different scintillator targets will be irradiated with neutrons and gammas. In a secondary detector array, the scattered particles will then be detected and their scattering angle and energy will be compared to the incident particles and their energy deposition in the target. This talk gives an overview of the proposed experiment and its current status.

T 93.2 Wed 17:45 POT/0351

Development of a spatial resolving scintillator readout system - "MIP-Cube" — •Philippe Bruder[2], Thomas Huber[1], and Andreas Haungs[1] — [1]Karlsruhe Institute of Technology, Institute for Astroparticle Physics, Karlsruhe, Germany — [2]Karlsruhe Institute of Technology, Institute for Particle Physics, Karlsruhe, Germany

High-energy muons from extensive air-showers, originated in the interaction between cosmic rays and the Earth's atmosphere, can propagate to Earth or even into low-noise facilities, like underground research laboratories and contribute to the noise level of experiments. By measuring the flux and spatial distribution of these muons, systematic background effects can be studied. For this purpose, a monitoring system based on a net of crossed 20 cm long and 5 cm wide plastic scintillator bars is in development. The foreseen scintillator system presented here will be readout by Hamamatsu 64-channel Silicon Photomultiplier (SiPM) arrays and are based on detectors developed for the surface instrumentation of the IceCube Neutrino Observatory. The baseline design provides a highly mobile detector system, with an adequate power supply and signal where focus will be given on a plug-and-play setup for variable measuring locations. The CAEN Co. Ltd Front-End units DT5202 or DT5203 as SiPM array readout and trigger electronic unit is one of the candidates. This contribution includes R&D efforts towards an appropriate data acquisition (DAQ) system, the foreseen detector design and the concept for front-end readout electronics.

T 93.3 Wed 18:00 POT/0351

Intensity Interferometry at H.E.S.S. - Introduction and first Results — •Andreas Zmija[1], Naomi Vogel[1], Gisela Anton[1], Stefan Funk[1], Alison Mitchell[1], Frederik Wohlleben[2], and Adrian Zink[1] — [1]Friedrich-Alexander-Universität Erlangen-Nürnberg, ECAP — [2]MPG Heidelberg

It has been less than a decade since astronomers rediscovered the concept of intensity interferometry, originally developed by Hanbury Brown & Twiss in the late 1950s, but state-of-the-art electronics have led to tremendous progress in recent years. The technique of correlating photon streams rather than interfering electromagnetic waves between telescopes is almost insensitive to atmospheric effects, and thus promises an increase in angular resolution in the optical regime by an order of magnitude. Since large light collection areas are preferred to optical quality mirrors, Imaging Atmospheric Cherenkov Telescopes are optimally suited for being equipped as intensity interferometer. In April 2022 we performed first photon correlation measurements with two of the H.E.S.S. Phase I telescopes during the moonlight break. We give a brief introduction into the method intensity interferometry, and present the first results of angular diameter measurements of the two stars Lambda Scorpii and Sigma Sagittarii.

T 93.4 Wed 18:15 POT/0351

Intensity Interferometry at H.E.S.S. - Technical Setup — •Naomi Vogel[1], Andreas Zmija[1], Gisela Anton[1], Stefan Funk[1], Alison Mitchell[1], Frederik Wohlleben[2], and Adrian Zink[1] — [1]Friedrich-Alexander-Universität Erlangen-Nürnberg, ECAP — [2]MPG Heidelberg

Intensity Interferometers are used to determine the angular diameter of stars. Imaging Atmospheric Cherenkov Telescopes are provided with technical setups to perform intensity interferometry (II) measurements. Our developed II setup was designed to be mounted to the lid of the Phase I H.E.S.S. telescopes in Namibia. It includes a 45 degree angled mirror and an optical path with a 2 nm interference filter leading to two photomultipliers whose photo currents are measured and then correlated. This enables us to handle high photon count rates. The data is then transferred via optical fibres to our workstation where the analysis is done after the measurements. The setup is equipped with motors in order to move each element individually which enables us to have a live pointing correction. In this contribution we will present the structure of our technical setup, how to include it between gamma ray observations and our future plans.

T 93.5 Wed 18:30 POT/0351

Trigger Concept for the Detection of Photon Air Showers with the AugerPrime Radio Detector* — •Jannis Pawlowsky for the Pierre Auger-Collaboration — Bergische Universität Wuppertal, Gaußstr. 20, 42119, Wuppertal, Germany

The Pierre Auger Observatory is the largest Cosmic Ray (CR) observatory with a size of $\approx 3000\,\mathrm{km}^2$. Its size makes it feasible to not only look for CRs but also for presumably rare primaries like photons at energies larger than 1 EeV. Strong upper limits on the diffuse photon flux have been set in the past using the Water Cherenkov Detector (WCD). Additionally, air showers with photon-like properties were detected. For these photon candidate events, however, an uncertainty remains regarding whether they are of photon origin or possibly misinterpreted hadrons. With the AugerPrime upgrade, the WCD is complemented by the Radio Detector (RD). The combination of both detectors yields new information about air showers and will improve primary identification. Here, inclined photon showers are of special interest. We will present a stand-alone RD trigger concept to detect photon air showers with negligible particle footprints. It will be shown that the trigger is compatible with given hardware limitations and the noise level at the Pierre Auger Observatory. The status and results of a first hardware implementation is discussed. We will quantify the trigger efficiency of photon air showers for different configurations of the trigger.

Gefördert durch die BMBF Verbundforschung Astroteilchenphysik (Vorhaben 05A20PX1)

T 93.6 Wed 18:45 POT/0351

Segmented scintillation tracking detector for space applications — •Roman Bergert, Hans-Georg Zaunick, and Kai-Thomas Brinkmann — II. Physics Institute Justus-Liebig-University Giessen

A 3D-resolving detector concept as a payload for an upcoming satellite mission, which is foreseen to reach a final medium earth orbit (MEO) and high radiation levels, is discussed. A precise measurement of fluences and dose rates of relativistic charged particles with energies above 100 MeV is targeted as the main goal of the concept. The determination of the momentum vector of charged particles combined with a precise timing of the events will be used to demonstrate the feasibility of the unprecedented experimental correlation between the primary particles events and triggered secondary particles in air showers on earth by a citizen science project (MuonPi muonpi.org). The steps to reach these goals and first concept results will be presented with a focus on the mechanical and electrical construction of the detector payload for deployment in space.

T 94: DAQ, Exp. Methods

Time: Wednesday 17:30–19:00 Location: POT/0106

T 94.1 Wed 17:30 POT/0106

Development of a Detector Response Model and an Autonomous Trigger for the Detection of Air-Shower Radio Emission — •Jelena Petereit, Tim Huege, Markus Roth, and Lukas Gülzow — Karlsruhe Institute of Technology, Germany

Radio detection of air-showers has proven to be very advantageous for the measurement of ultra-high energy cosmic rays. As a consequence, a new generation of radio detectors is now evolving at much larger scales. The Giant Radio Array for Neutrino Detection (GRAND) is planned as an array of wide-band radio antennas, which will cover a total area of 200 000 km^2. In order to reliably distinguish air-shower events from noise for such large arrays, an efficient and autonomous multi-level radio trigger is developed*. The first-level trigger selects an antenna signal according to expected signal shapes, whereas the second-level trigger refines this selection according to information of all antennas triggered during the same event.

While the deployment of GRAND is in progress, a digital detector model is being developed. It will include a sufficiently accurate instrument response and signal processing methods. It will then make it possible to analyze the detector response and determine significant parameters that are needed for building this novel trigger method. This talk will cover the approaches to build a realistic response model and the multi-level radio trigger needed for large-scale experiments like GRAND. * *NUTRIG project, supported by the ANR-DFG Funding Programme (RO 4165/2-1)*

T 94.2 Wed 17:45 POT/0106

Event builder and online monitoring of OSIRIS pre-detector of JUNO — •Runxuan Liu[1,2], Kai Loo[4], Livia Ludhova[1,2], Cornelius Vollbrecht[1,2], Anita Meraviglia[2,3], Nikhil Mohan[2,3], Luca Pelicci[1,2], Mariam Rifai[1,2], and Apeksha Singhal[1,2] — [1]Forschungszentrum Jülich GmbH, Institut für Kernphysik IKP-2, Jülich, Germany — [2]III. Physikalisches Institut B, RWTH Aachen University, Aachen, Germany — [3]GSI Helmholtz Centre for Heavy Ion Research, Darmstadt, Germany — [4]Cluster of Excellence PRISMA+, Johannes Gutenberg University Mainz, Mainz, Germany

JUNO is a 20 kt liquid scintillator detector under construction in Jiangmen, China. The installation is expected to be completed in 2023. Its main goal is to determine the neutrino mass hierarchy with the measurement of reactor anti-neutrinos from the two nuclear power plants in the proximity. This requires stringent limits on the radiopurity of the liquid scintillator. The OSIRIS (Online Scintillator Internal Radioactivity Investigation System) pre-detector is designed to monitor the liquid scintillator during the several months of filling the large volume of JUNO. OSIRIS will contain 18 tons of scintillator and will be equipped with 76 20-inch PMTs. It will be sensitive for the $^{238}U/^{232}Th$ decay rates via tagging of the Bi-Po coincidence decays in the $^{238}U/^{232}Th$ decay chain. This talk will present the trigger strategies of OSIRIS and its updated event builder software. The online monitoring software for OSIRIS is needed for a live measurement of scintillator radiopurity during filling and it will also be presented in this talk.

T 94.3 Wed 18:00 POT/0106

Writing photons to disk - The triggerless DAQ-System of XENONnT — •Robin Glade-Beucke for the XENON-Collaboration — Physikalisches Institut, Universität Freiburg, 79104 Freiburg, Germany

The XENONnT experiment is an ultra low-background liquid xenon TPC for WIMP direct detection which is taking data at LNGS (Italy). Its triggerless data acquisition (DAQ) system allows for fast and storage-efficient recording with a very low threshold, accepting signals as small as from individual photons. Custom-developed FPGA firmware on the read-out digitizers and on auxiliary logic boards, e.g., a high energy veto to remove high-energy events during detector calibration, makes the data-taking in the triggerless paradigm possible. In this talk, I will present the system and its performance.

T 94.4 Wed 18:15 POT/0106

Improving Particle Flow Reconstruction in the CMS HGCAL — •Abhirikshma Nandi[1], Wahid Redjeb[1,2], Felice Pantaleo[2], Marco Rovere[2], and Alexander Schmidt[1] — [1]III. Physikalisches Institut A, RWTH Aachen University, Aachen, Germany — [2]CERN, Geneva, Switzerland

The CMS calorimeter endcaps will be completely replaced by the High Granularity Calorimeter (HGCAL) as part of the Phase-2 upgrades. The large number of simultaneous collisions (pile-up) and the novelty of the detector makes physics object reconstruction a challenging task. A new, modular framework, called The Iterative Clustering (TICL), is under development for reconstruction in HGCAL. Its granularity and the capability to obtain 5D (x,y,z,t,E) measurements, make HGCAL an ideal candidate for particle flow reconstruction - where information from different parts of the detector are matched to improve the global event description. Moreover, accumulating separate objects reconstructed inside the calorimeter, from the secondary components of a particle shower, is also necessary. This talk discusses a linking algorithm that was introduced in TICL as a first attempt to solve these problems. A complementary approach of learning functions on a graph of clustered energy deposits and detecting communities in it, will also be presented.

T 94.5 Wed 18:30 POT/0106

The Heterogeneous TICL Framework — •Wahid Redjeb[1,2], Abhirikshma Nandi[1], Alexander Schmidt[1], Felice Pantaleo[2], Marco Rovere[2], and Antonio Di Pilato[3] — [1]III. Physikalisches Institut A, RWTH Aachen University, Aachen, Germany — [2]CERN, Geneva, Switzerland — [3]University of Geneva, Geneva, Switzerland

The High-Granularity Calorimeter (HGCAL) is a sampling calorimeter with both lateral and longitudinal fine granularity designed for the High-Luminosity LHC. The calorimeter will use silicon sensors, in the high radiation regions, providing high pile-up mitigation, and scintillators in the low radiations regions. For the physics object reconstruction a dedicated framework for HGCAL is currently under development: The Iterative Clustering (TICL), which utilizes the 5D (x,y,z,t,E) information from the reconstructed hits and returns particle properties and probabilities. Heterogeneous computing will play a fundamental role in the physics object reconstruction software to fully exploit the reach of the HL-LHC. Performance Portability libraries allow performance portability across different hardware architectures with a single code basis. In this talk we present and overview of the TICL framework and we show how heterogeneous computing has been integrated in the framework, exploiting the Alpaka library to achieve Performance Portability and being able to run core parts of the Framework on GPU and on CPU with a single source code.

T 94.6 Wed 18:45 POT/0106

Updated jet energy scale calibration using Monte Carlo samples for ATLAS — •Gediminas Glemža and Christian Sander — DESY, Notkestr. 85, 22607 Hamburg, Germany

An updated simulation-based jet energy scale calibration utilising the newest ATLAS software release version and updated Run-2 Monte Carlo samples is presented. The calibration restores the jet energy scale back to particle level jets. The jets are reconstructed using particle-flow objects and clustered using the anti-k_t jet algorithm with a radius parameter of 0.4. The presented calibration accounts for in-time and out-of-time residual pile-up effects, calibrates the absolute jet energy scale and pseudorapidity, as well as provides additional corrections based on global jet observables. The presented procedure is based on similar simulation-based calibrations carried out during the period of Run-2 and their performance comparison is discussed.

T 95: Pixel, Det/Sys LHCb, HGT

Time: Wednesday 17:30–19:00 Location: WIL/A317

T 95.1 Wed 17:30 WIL/A317

Providing YARR Software Support to Operate ATLAS-ITk Read-out Chips with BDAQ53 Hardware — •Wael Alkakhi, Joern Grosse-knetter, Arnulf Quadt, and Ali Skaf — II. Physikalisches Institut, Georg-August-Universität Göttingen

During the ATLAS HL-LHC upgrade, the current inner detector is going to be replaced by an all-silicon Inner Tracker (ITk), using prototype and pre-production read-out chips, referred to as RD53A and RD53B respectively.

YARR is a DAQ system developed for the ITk detector. It is composed of a software communicating originally with several PCI-e FPGA hardware (HW) platforms. It was developed to read out different front-end (FE) chips with, recently, an extended support to other HW platforms. This work reports on providing the support for BDAQ53 FPGA platform, which was developed as a part of the BDAQ DAQ system, with its Ethernet connectivity. This enables YARR to read out both RD53A and RD53B (ITkPix-V1) FE chips, while preserving the original existing BDAQ53 firmware. In particular, this would be most helpful for several institutions of the ATLAS collaboration, having already a purchased BDAQ DAQ system. The work required to develop specific Hardware Abstraction Library (HAL) controller software blocs. Different RD53A and RD53B scans were successfully performed, validating the added BDAQ53 support.

T 95.2 Wed 17:45 WIL/A317

Developments in the ITk Pixel OB Demonstrator DCS — •Anne Gaa, Stan Lai, and Hans Joos — II. Physikalisches Institut, Georg-August-Universität Göttingen

The ATLAS experiment is developing the new Inner Tracker (ITk) in preparation for the High-Luminosity LHC Upgrade. The ITk pixel Outer Barrel demonstrator, as a system prototype, is in its final design review phase in preparation of the construction of the finished detector. The Detector Control System (DCS) is responsible for monitoring and controlling the detector and its sub-systems. The DCS uses WinCC OA, a SCADA software by Siemens, in a distributed system.

This talk discusses various improvements to the ITk pixel OB demonstrator DCS in the scope of its system tests. These include new monitoring panels for the modules mounted on the loaded local supports, the implementation of an archiving system for monitored data points, and the calibration of temperature and voltage monitoring.

T 95.3 Wed 18:00 WIL/A317

Electrical Tests with the ITk Pixel Outer-Barrel Demonstrator — •Hans Joos[1,2], Benedikt Vormwald[1], Leyre Flores Sanz De Acedo[1], Brian Moser[1], Stan Lai[2], and Anne Gaa[2] — [1]CERN — [2]II. Physikalisches Institut, Georg-August-Universität Göttingen

For the upgrade of the LHC to the High-Luminosity LHC (HL-LHC), the ATLAS tracking detector will be replaced with an all-silicon detector, the Inner Tracker (ITk), as the higher luminosity requires radiation hard components that can deal with higher occupancies and radiation. Given the close proximity to the interaction point, the environment is especially challenging for the pixel detector. The Outer-Barrel layers of the pixel detector will comprise quad chip modules that are combined into serially powered (SP) chains and loaded on ring and stave shaped low mass carbon-fibre local supports to reduce the material budget of the detector.

The integration from individual detector components to a final detector is one of the big challenges of the HL-LHC detector upgrades. In order to test the loading procedure and performance of the modules after loading, prototype modules were mounted on a stave local support and connected with realistic services to form a smallest "feature-complete" functional building block and demonstrator of the ITk Pixel Outer-Barrel detector.

This talk will explain the demonstrator setup and present the results of electrical performance tests of the demonstrator modules after loading and their behavior in SP chains.

T 95.4 Wed 18:15 WIL/A317

Measurements with a serial powering prototype for the ATLAS ITk Pixel Detector — •Thomas Senger, Florian Hinterkeuser, Matthias Hamer, Fabian Huegging, Jochen Dingfelder, Klaus Desch, and Hans Krüger for the ATLAS-Collaboration — Physikalisches Institut Bonn Germany

The high-luminosity upgrade of the LHC at CERN requires completely new inner detectors for ATLAS and CMS experiments. A serial powering scheme has been chosen to cope with the constraints of the new pixel detectors. A prototype consisting of up to 8 quad modules, based on the new readout chips (ITkPixV1.1) developed by the RD53 collaboration in 65 nm CMOS technology has been set up in Bonn. This talk presents the results of measurements with a full ITkPixV1.1 serial powering chain to better understand and validate the requirements for all active components in the ITk Pixel System.

T 95.5 Wed 18:30 WIL/A317

First data from the LHCb Beam Conditions Monitor in Run III of the LHC — Johannes Albrecht[1], Elena Dall'Occo[1], •Martin Bieker[1], David Rolf[2,1], Holger Stevens[1], and Dirk Wiedner[1] — [1]TU Dortmund University, Dortmund, Germany — [2]CERN, Geneva, Switzerland

The LHCb experiment is a single-arm forward spectrometer at the LHC that focuses on measurements in the b and c quark sector. Due to its unique geometry, featuring a sensitive tracking system located as close as 3 mm to the LHC beams, the detector is at risk of damage from adverse beam conditions. For this reason, the particle flux near the beam pipe is monitored by eight diamond sensors in a circular arrangement on either side of and close to the interaction point.

In preparation for the ongoing Run III of the LHC this so-called Beam Conditions Monitor (BCM) has been overhauled as part of a comprehensive upgrade of the LHCb detector. Besides the safety-related functions, measurements of the particle flux near the interaction point can serve as an estimate for the instantaneous luminosity.

The talk will present the first data acquired during the initial months of LHC operation in Run III with the upgraded BCM readout system. In order to evaluate performance metrics, such as the linearity of the sensor response, the BCM output is compared to data from other LHCb subdetectors.

T 95.6 Wed 18:45 WIL/A317

Module assembly for the ATLAS High Granularity timing detector — •Hendrik Smitmanns[1], Andrea Brogna[2], Doğa Elitez[1], Theodorus Manoussos[1], Lucia Masetti[1], Fabian Piermaier[2], Maria Soledad Robles Manzano[1], Steffen Schoenfelder[2], and Quirin Weitzel[2] — [1]Institut für Physik, Johannes Gutenberg-Universität Mainz — [2]PRISMA Detektorlabor, Johannes Gutenberg-Universität Mainz

To meet the challenges of the High Luminosity-LHC, especially the increase of pile-up interactions, the ATLAS detector needs to be upgraded. One of the foreseen upgrades consists of the installation of the High-Granularity Timing Detector (HGTD). The HGTD will mitigate the effects of pile-up in the ATLAS forward region, providing time information with a resolution of about 30 ps per track. The active area consists of 2-double-sided disks per end-cap. Two 2x2 cm^2 Low Gain Avalanche Detectors bump-bonded to two ASICs and wire bonded to a flexible PCB form the HGTD basic unit, the so-called module. 8032 modules have to be built in total. During the HGTD R&D phase, module prototypes are assembled and tested in order to optimize the procedures and be integrated for system level tests in the HGTD demonstrator. The module assembly procedure in Mainz and the results of the very first assemblies are presented.

T 96: TestBeam, RadHard for Si and Pixel

Time: Wednesday 17:30–19:00 Location: WIL/A124

T 96.1 Wed 17:30 WIL/A124

Characterisation of a novel trigger and timing plane for the EUDET Telescopes — •Arianna Wintle[1], Lennart Huth[1], Francesca Maria Pofi[1], Felix Sefkow[1], Marcel Stanitzki[1], and Ivan Peric[2] — [1]DESY, Notkestraße 85, 22607 Hamburg — [2]Karlsruhe Institute of Technology (KIT)

The DESY Test Beam facility provides GeV beams for users and precise reference tracking systems, the EUDET telescopes. The telescope readout is triggered externally and multiple particles are recorded in one readout cycle, causing ambiguities as no time-stamping is provided.

TelePix is a 180 nm HV-CMOS sensor foreseen to be used in upgrades of the EUDET-style pixel beam telescopes allowing for fast timing and triggering on a region of interest. Here, characterisation results of TelePix are presented using the latest test beam results.

T 96.2 Wed 17:45 WIL/A124

Irradiation Studies on Silicon Sensors for the CMS Outer Tracker Sensor Production — •Umut Elicabuk, Tobias Barvich, Bernd Berger, Alexander Dierlamm, Ulrich Husemann, Markus Klute, Roland Koppenhöfer, Thomas Müller, Marius Neufeld, Hans Jürgen Simonis, and Pia Steck — Institute of Experimental Particle Physics (ETP), Karlsruhe Institute of Technology (KIT)

With the upcoming Phase-2 Upgrade of the CMS Outer Tracker, silicon sensors will be used to reconstruct the tracks of charged particles. The detector material continuously accumulates radiation damage at the level of the crystal lattice during operation. Due to the increased demands on radiation hardness with the HL-LHC upgrade, a sufficiently radiation hard sensor material is necessary.

Both during and before ongoing sensor production, it is therefore necessary to monitor the efficiency of the detectors under radiation exposure and to draw conclusions about subsequent performance in the detector.

Among other things, the ETP is investigating the sensor characteristics of these silicon sensors as part of the Phase-2 Upgrade. The talk will give an insight into the used measurement setups, investigated sensor characteristics and give an overview of the concept of irradiation studies in general.

T 96.3 Wed 18:00 WIL/A124

A High-Precision Irradiation Site for Silicon Pixel Detectors — •Pascal Wolf[1], Reinhard Beck[2], Jochen Dingfelder[1], and Dennis Sauerland[2] — [1]Physikalisches Institut, University of Bonn, Germany — [2]Helmholtz-Institut für Strahlen- und Kernphysik, University of Bonn, Germany

An irradiation site for radiation hardness studies of silicon pixel detectors is in operation at the isochronous cyclotron at the University of Bonn. The accelerator provides protons as well as other light ions with energies ranging from 7 to 14 MeV per nucleon and beam currents of up to 1 μA to the setup. Devices Under Test (DUTs) are irradiated in a temperature-controlled box, minimizing annealing, while being moved through the beam in a well-defined pattern, ensuring homogeneity. On-site beam diagnostics facilitate online monitoring of the beam parameters and enable a beam-driven irradiation procedure resulting in highly uniform damage profiles with relative uncertainties of typically 2%. The setup provides extensive data acquisition, visualization and control of all components allowing for flexible irradiation plans (DUT powering & R/O, pausing, etc.), post-irradiation corrections and precise damage analysis. In this talk, the irradiation site and its operational parameters are introduced in detail. Energy simulations for light ions are presented, showing the total ionizing dose (TID) as well as non-ionizing energy loss (NIEL) damage capabilities. Measurements of the applied particle fluence, using different techniques, are presented and their precisions are compared. Furthermore, an overview of the recently performed irradiation campaigns is given.

T 96.4 Wed 18:15 WIL/A124

Radiation hardness studies of the ULTRASAT space mission — •Vlad Dumitru Berlea — DESY, Zeuthen, Germany

ULTRASAT (ULtraviolet TRansient Astronomy SATellite) is a wide-angle space telescope that will perform deep time- resolved surveys in the near ultraviolet spectrum. ULTRASAT is led by the Weizmann Institute of Science (WIS) in Israel and the Israel Space Agency (ISA) and is planned for launch in 2026. The telescope implements a backside-illuminated, stitched pixel detector. The pixel has a dual-gain 4T architecture with a pitch of 9.5 μm and is produced in the 180 nm process by Tower Semiconductor. As part of the space qualification for the sensors, radiation tests are to be performed on both test sensors provided by Tower and the final flight design of the sensor. One of the main contributions to sensor degradation due to radiation for the ULTRASAT mission is Total Ionizing Dose (TID). TID measurements on the test sensors have been performed with Co-60 gamma source at Helmholz Zentrum Berlin (HZB) and CC-60 facilities at CERN, and preliminary results are presented in this talk.

T 96.5 Wed 18:30 WIL/A124

Test-Beam Performance Results of the FASTPIX Sub-Nanosecond CMOS Pixel Sensor Demonstrator — •Justus Braach[1,2], Eric Buschmann[1], Dominik Dannheim[1], Katharina Dort[1,3], Thanushan Kugathasan[4], Magdalena Munker[1], Walter Snoeys[1], Peter Švihra[1], and Mateus Vicente Barreto Pinto[4] — [1]CERN (CH) — [2]Universität Hamburg (DE) — [3]Justus-Liebig-Universität Giessen (DE) — [4]Université de Genève (CH)

Within the ATTRACT FASTPIX project, a monolithic pixel sensor demonstrator chip has been developed in a modified 180 nm CMOS imaging process technology, targeting sub-nanosecond timing precision for single ionising particles. It features a small collection electrode design on a 25 μm-thick epitaxial layer and contains 32 mini matrices of 68 hexagonal pixels each, with pixel pitches ranging from 8.66 μm to 20 μm. Four pixels are transmitting an analog output signal and 64 are transmitting binary hit information. Various design variations are explored, aiming at accelerating the charge collection and making the timing of the charge collection more uniform over the pixel area. Signal treatment of the analog waveforms, as well as reconstruction of time and charge information, is carried out off-chip.
This contribution introduces the design of the sensor and readout system and presents performance results for various pixel designs achieved in recent test-beam measurements with external tracking and timing reference detectors. A time resolution below 150 ps is obtained at full efficiency for all pixel pitches.

T 96.6 Wed 18:45 WIL/A124

Reconstruction of high track density beams in beam tests — •Christopher Krause, Jens Weingarten, and Kevin Kröninger — TU Dortmund, Dortmund, Deutschland

The Inner Tracker of the ATLAS experiment requires the optimal performance of its pixel sensors. To test their efficiency, a reliable track reconstruction and analysis for testbeam data is necessary to ensure the precise detection of particles. The quality of data from testbeam campaigns are influenced by many factors, including high beam densities, which can impair the track reconstruction.

To analyse and evaluate the data taken at beam tests, the track reconstruction software Corryvreckan is used. It is now the predominant reconstruction framework for beam tests and was developed with the intention to reduce external dependencies without reducing the quality and versatility of track reconstruction in complex environments.

In beam tests, high density beams lead to many hits on the sensors in short periods of time. The reconstruction of particle tracks with too many hits becomes increasingly difficult due to the ambiguity of track fits. In order to differentiate between false and true reconstructed tracks, a machine learner is implemented, which is trained on simulated testbeam data, generated by the Allpix2 software.

This talk presents results of the track reconstruction of high track density using Corryvreckan and the performance of a machine learner for true track tagging. Both simulated data and real testbeam data is investigated.

T 97: Calorimeter / Detector Systems IV

Time: Wednesday 17:30–19:00 Location: WIL/C133

T 97.1 Wed 17:30 WIL/C133

Evaluation of the Performance of SiPM-on-Tiles at the End of Life of the CMS HGCAL Upgrade — •Malinda de Silva — Deutsches Elektronen-Synchrotron (DESY), Hamburg

For the HL-LHC phase, the calorimeter endcap of the CMS detector will be upgraded with a High Granularity Calorimeter (HGCAL), a sampling calorimeter that will use silicon sensors as well as scintillator tiles read out by silicon photomultipliers (SiPMs) as active material (SiPM-on-tile). The design of the SiPM-on-tile section was inspired by the CALICE AHCAL. The complete HGCAL will be operated at $-30°C$.

The basic detector unit in the SiPM-on-tile section is the tile module, consisting of a PCB with one or two HGCROC ASICs, reading out up to 96 SiPM-on-tiles. Signals from MIPs passing through the SiPM-on-tiles are used to quantify the performance of SiPM-on-tiles. With irradiation, their performance degrades while increasing the noise. The ratio between the MIP signal and noise is known as the signal-to-noise ratio (SNR). In order to maintain an SNR>3 at end of the detector lifetime, SiPMs will be used in areas where the expected radiation dose during the lifetime of the detector is less than $5 \times 10^{13} n_{eq}/cm^2$.

A series of tests were conducted to quantify the performance of SiPM-on-tiles mounted on tile modules including beam tests and cold tests at $-30°C$. These tests were also repeated using irradiated SiPMs mounted on the tile modules. These tests were then used to extrapolate the performance expectations at the detector's end of life.

T 97.2 Wed 17:45 WIL/C133

Quality control for SiPM-on-tile section of the CMS HGCAL at DESY — •Daria Selivanova — Deutsches Elektronen-Synchrotron (DESY), Hamburg

The new High-Luminosity era of the LHC challenges the detector development field to implement technology in a new way. A detector under construction, the High Granularity Calorimeter (HGCAL) for CMS, is based on two detection technologies: silicon sensors and SiPM-on-tile boards. The highly segmented structure of the two will allow both electromagnetic and hadronic showers to be utilised in the energy reconstruction and the identification of particles.

The SiPM-on-tile component of the HGCAL consists of scintillator tiles wrapped in a reflective foil and photodetectors (SiPMs), mounted on a board with HGCROC readout electronics. The ability of each individual scintillator component (a tile) to fulfil the performance requirements stands on a choice of methods of production, wrapping and placement. That is why quality control (QC) measures have been implemented in the Tile Assembly Center (TAC) at DESY to monitor parameters at every stage. Two test stands have been developed to measure the size of the wrapped tile and to measure its light yield. Several tests have been performed using the setups with a variety of tiles to ensure consistency of measurements and to measure tile-to-tile wrapping variation and light output.

T 97.3 Wed 18:00 WIL/C133

Results of the Megatile prototype for the CALICE AHCAL — •Anna Rosmanitz for the CALICE-D-Collaboration — Johannes Gutenberg-Universität Mainz

The CALICE collaboration develops several highly granular calorimeter concepts for a future e^+e^- collider, that are designed for Particle Flow Algorithms. The current design for the Analog Hadronic Calorimeter (AHCAL) consists of 3x3 cm^2 scintillator tiles read out by silicon photomultipliers (SiPM). Each tile is individually wrapped in reflective foil and glued to the boards. The final AHCAL detector would countain 8 million channels.

To facilitate the assembly process, the Megatile design is developed at the University of Mainz. It is made from a large scintillator plate which houses 12x12 channels at once. The channels are separated by tilted trenches filled with a mixture of glue and TiO_2 for reflectivity and optical insulation. Optical tightness is achieved by gluing reflective foil on both faces and varnishing the edges. Until now, ten prototypes have successfully been built, continuously monitored in a cosmic test-stand in Mainz and tested in several test beam campaigns at DESY and CERN.

This talk presents the latest technical developments, the results from long-term monitoring and measurements with cosmic rays and with beam, focusing in particular on light yield and cross talk performance of the Megatiles.

T 97.4 Wed 18:15 WIL/C133

Characterization of a wavelength-shifter coated polystyrene plastic scintillator detector — Alessia Brignoli, Constantin Eckardt, Heiko Lacker, •Christophe Mullesch, Christian Scharf, and Ben Skodda — Humboldt-Universität zu Berlin, Berlin, Germany

Plastic scintillator detectors are widely used in particle physics for detecting charged particles crossing the scintillating material, converting the excitation energy into fluorescence radiation. It has been recently shown that a pure polystyrene plate that is coated with a wavelength-shifting dye can be used as an easy-to-build cheap scintillator with a decent light output. In this work, we further studied the light-yield response of a rectangular polystyrene tile coated with a wavelength-shifting dye. It was coupled to a photomultiplier at each end of the strip and exposed to beta particles from a Sr-90 source. By analyzing the light-yield and signal arrival times as a function of the beta source position along the tile, we determined the time and spatial resolution of the detector, as well as the light signal speed and the effective attenuation length in the scintillator.

T 97.5 Wed 18:30 WIL/C133

Simulation studies for tomography with fast neutrons and gammas with a multi-pixel detector — •Aenne Abel, Nina Höflich, and Oliver Pooth — III. Physikalisches Institut B, RWTH Aachen University

Combined neutron and gamma tomography enables a new, non-destructive imaging procedure showing further material properties than a common CT scan.

At the RWTH Aachen University a portable measuring setup for fast neutrons is developed, which uses an Americium Beryllium source and 16 stilbene crystals coupled to an SiPM for detection. The organic scintillator stilbene allows the simultaneous detection and separation of neutrons and gammas. The detector pixels are arranged in a 4 x 4 grid with a pixel size of 6.2 x 6.2 mm.

In this talk the simulation procedure of the experimental setup using GEANT4 along with methods to determine the quality of the tomographic images is presented.

T 97.6 Wed 18:45 WIL/C133

Simultaneous fast neutron and gamma tomography with a stilbene-based multi-pixel detector — Aenne Abel, •Nina Höflich, and Oliver Pooth — III. Physikalisches Institut B, RWTH Aachen University

The neutron detectors group at the Physics Institute III B, RWTH Aachen University, develops a multi-pixel detector for a compact fast neutron imaging setup. Since the interactions of fast neutrons in matter differ from those of X-rays and gamma rays, imaging with fast neutrons in addition to X- or gamma ray imaging can provide complementary information about the object of interest.

Our current detector prototype uses cuboids of the organic scintillator stilbene as active material, coupled to a SiPM array. The pixel size is 6.2×6.2 mm^2 . The usage of stilbene allows to distinguish neutron- and gamma-induced signals in the detector. An Americium-Beryllium neutron source delivers fast neutrons of up to 11 MeV and gamma rays of 4.44 MeV for our measurements.

In this talk, tomographic measurements of different test objects will be discussed, combining information from neutron and gamma attenuation. The main focus will be on the spatial resolution and the material distinction capability of our setup. Furthermore, possible improvements of our setup and the tomographic reconstructions will be briefly discussed.

T 98: Gas-Detecors, Detector Systems

Time: Wednesday 17:30–19:00 Location: WIL/A120

T 98.1 Wed 17:30 WIL/A120

X-ray Polarimetry with GridPixes — Klaus Desch, •Markus Gruber, and Jochen Kaminski — Physikalisches Institut, Universität Bonn

In astrophysics and material science on synchrotron light sources the measurement of X-ray polarisation can be an useful instrument. Therefore, a direct measurement would be beneficial. It can be directly measured by tracking photoelectrons created in photoelectric interactions. This is possible because their emission angle depends on the direction of the electric field vector of the photons. Within a gaseous detector these electrons have a sufficiently long mean free path such that tracking is possible - if the granularity of the readout is high enough. For this a GridPix - a combination of a Timepix(3) ASIC with 55 μm pixel pitch and a photolithographically postprocessed amplification stage (integrated grid) can be used. Within the GridPix the holes of the grid are perfectly aligned with the pixels. Thus, it is possible to detect the avalanches of individual primary electrons.

The talk will focus on the working principle and the design of a GridPix based X-ray polarimeter. Based on testbeam data taken at PETRA III and simulations the performance of the detector at different X-ray energies as well as the dependence on different detector parameters like gas choice and geometry will be discussed. Additionally challenges and possible improvements of such a detector will be presented.

T 98.2 Wed 17:45 WIL/A120

Development of a GridPix detector for IAXO — •Johanna von Oy, Klaus Desch, Jochen Kaminski, Tobias Schiffer, Sebastian Schmidt, and Markus Gruber — Physikalisches Institut der Universität Bonn

To search for the yet undiscovered particle axion, the helioscope experiment International AXion Observatory (IAXO) and its intermediate experimental stage BabyIAXO have been proposed. In these experiments, axions coming from the sun are converted into X-rays in a magnet utilizing the inverse Primakoff effect.

The then focused X-rays can be detected with a gas-filled GridPix detector. The base of this detector is a pixelated readout chip with a perfectly aligned mash on top that acts as a gas amplificication stage. This allows individual electrons, produced by the X-rays in the gas volume to be detected.

Due to the low probability of axions converting into X-rays thanks to their small interaction strength, the detector background has to be very low. For that purpose, the materials used have to be as radiopure as possible. A first prototype, using the materials in their non-radiopure form has been build and is being tested.

This talk explains the detector in detail and discusses first test results.

T 98.3 Wed 18:00 WIL/A120

Prototype of a Cherenkov position sensitive Micromegas — •Maximilian Rinnagel, Otmar Biebel, Valerio D'Amico, Florian Egli, Stefanie Goetz, Christoph Jagfeld, Eshita Kumar, Katrin Penski, Nick Schneider, Chrysostomos Valderanis, Fabian Vogel, and Ralf Hertenberger — LMU München

Detectors utilizing the Cherenkov effect are well established for particle identification of charged particles in detector systems such as LHCb. In reverse it is possible to determine the momentum of a known particle by measuring the opening angle of the Cherenkov cone in Cherenkov media.Our goal with this D =100 mm prototype is a proof of principle using cosmic muons. A traversing muon creates around 1500 Cherenkov photons in our 19 mm thick ultra-violet transparent Lithium Fluoride crystal (diameter 50 mm; UV optical refractive index 1.5). The conversion to electrons happens in transmission in a photosensitive CsI layer evaporated onto a 5 nm Cr layer, both applied to the bottom of the radiator. High voltage of -300 V, at the Cr layer, guides the ionization and photoelectrons into the drift region of a Micromegas gaseous micro pattern detector with two dimensional position readout, spatial resolution below 100 μm and good timing resolution. This will allow to distinguish between muon and photon signals.

T 98.4 Wed 18:15 WIL/A120

Prototype of a Cherenkov detector for the LUXE Experiment — •Antonios Athanassiadis[1,2], Louis Helary[1], Ruth Magdalena Jacobs[1], Jenny List[1], Gudrid Moortgat-Pick[2,1], Evan Ranken[1], and Stefan Schmitt[1] — [1]Deutsches Elektronen-Synchrotron (DESY), Hamburg, Germany — [2]Universität Hamburg, Germany

The aim of LUXE (Laser Und XFEL Experiment based at DESY, Hamburg) is to measure strong-field QED effects with high precision. In order to create electric fields stronger than the so-called Schwinger limit, it is planned to collide a high-intensity laser pulse with either high-energy electrons up to 16.5 GeV or high-energy photons.
These two configurations either result in non-linear Compton scattering or Breit-Wheeler interactions which can be studied by measuring rates and kinematics of secondary particles created at the interaction point like high-energy electrons, positrons and photons.

For the detection of electrons, with expected fluxes of the order of 10^4 to 10^9 particles in an area of 15 cm × 1 mm per event, a Cherenkov detector in combination with magnetic deflection for high-precision spectrometry will be used.
This contribution will present the simulation-based design of the Cherenkov detector, as well as first operation experience obtained with a prototype. Further optimisation of the various components as well as reconstruction algorithms will be discussed.

T 98.5 Wed 18:30 WIL/A120

Monte Carlo simulation studies of background contributions in the Mu2e experiment — •Reuven Rachamin[1], Stefano Di Falco[2], Anna Ferrari[1], Valerio Giusti[3], Stefan Müller[1], and Vitaly Pronskikh[4] for the Mu2e-Collaboration — [1]Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany — [2]INFN Pisa, Pisa, Italy — [3]University of Pisa, Pisa, Italy — [4]Fermi National Accelerator Laboratory, Batavia, IL, USA

The Mu2e experiment is currently being constructed at Fermilab to search for the direct conversion of muons into electrons in the field of a nucleus without the emission of neutrinos. The experiment aims at a sensitivity of four orders of magnitude higher than previous related experiments, which implies highly demanding accuracy requirements both in the design and during the operation. Hence, it is essential to estimate precisely the backgrounds that could mimic the monoenergetic conversion electron signal and the particle yields relevant to the experiment sensitivity. In that regard, Monte Carlo simulations were performed to investigate key yields and beam-related and cosmic rays-related backgrounds. The investigation includes: (I) an evaluation of the antiproton and charged pion yields from an 8 GeV proton pencil beam impinging on a tungsten cylindrical target, (II) an evaluation of the transmission of cosmic neutrons and neutral kaons in a block of concrete. The simulations were performed using the FLUKA2021, MCNP6, GEANT4, PHITS, and MARS15 codes. The presentation will show the simulation results with a focus on the prediction obtained from each code and their impact on the experiment.

T 98.6 Wed 18:45 WIL/A120

The Stopping Target Monitor of the Mu2e experiment — •Stefan E. Müller, Anna Ferrari, Oliver Knodel, and Reuven Rachamin for the Mu2e-Collaboration — Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany

The Mu2e experiment, currently under construction at the Fermi National Accelerator Laboratory near Chicago, will search for the neutrinoless direct conversion of a muon to an electron in the field of an aluminum nucleus, aiming for a sensitivity four orders of magnitude better than previous experiments. The observation of a clear signal would imply Charged Lepton Flavor Violation, and hint at physics beyond the Standard Model.

The normalization of the signal events will be done by monitoring the rate of muons stopping on aluminum target discs. This will be accomplished with a detector system made of an HPGe detector and a Lanthanum Bromide detector, which detect the characteristic X- and γ-rays of energies up to 1809 keV produced when the muons are stopped or captured on the aluminum.

At the Helmholtz-Zentrum Dresden-Rossendorf, we have used a pulsed Bremsstrahlung photon beam at the ELBE radiation facility to study the performance of the detectors under conditions very simi-

lar to the ones expected at Mu2e.

In the presentation, a short overview of design and status of the Mu2e experiment and its detectors will be given, and results of the ELBE beamtime campaigns will be presented.

T 99: Annual Meeting of Young Scientists in High Energy Physics (yHEP)

Time: Wednesday 19:00–20:00 Location: HSZ/0101

Annual Meeting of Young Scientists in High Energy Physics (yHEP) Hosts: Afzal, Peña, Morejon, Lupberger, Niknejadi, Krönert, Sehgal, Lang

T 100: AI Topical Day – Invited Talks (joint session AKPIK/HK/ST/T/AKBP)

Time: Thursday 11:00–12:30 Location: HSZ/AUDI

Invited Talk T 100.1 Thu 11:00 HSZ/AUDI
AI Techniques for Event Reconstruction — •Ivan Kisel — Goethe University, Frankfurt, Germany

Why can we relatively easily recognize the trajectory of a particle in a detector visually, and why does it become so difficult when it comes to developing a computer algorithm for the same task? Physicists and computer scientists have been puzzling over the answer to this question for more than 30 years, since the days of bubble chambers. And it seems that we are steadily approaching the answer in our attempts to develop and apply artificial neural networks both for finding particle trajectories and for physics analysis of events in general.

This talk will present the basics of artificial neural networks in a simple form, and provide illustrations of their successful application in event reconstruction in high energy physics and heavy ion physics experiments. You will get an insight into the application of traditional neural network models, such as deep neural network, convolutional neural network, graph neural network, as well as those standing a little aside from traditional approaches, but close in idea of elastic network and even cellular automata.

Invited Talk T 100.2 Thu 11:30 HSZ/AUDI
Accelerator operation optimisation using machine learning — •Pierre Schnizer — Helmholtz-Zentrum Berlin für Materialien und Energie GmbH, Berlin, Germany

Accelerators are complex machines whose many components need to be accurately tuned to achive design performance. Reliable operation requires frequent recalibration and tuning. Especially for large machines tools have been developed that facilitating this task.

Machine learning allows building such tools using simulations, archiver data or interaction with the real machine, thus making many tools now also available for smaller machines.

This talk will give an overview of different machine learning projects targeted to accelerators, which simplifies accelerator operation or even enable applications not been possible before.

Invited Talk T 100.3 Thu 12:00 HSZ/AUDI
Is this even physics? – Progress on AI in particle physics — •Gregor Kasieczka — Universität Hamburg

Motivated by the large volume and high complexity of experimental data and mathematical structures, particle physics has a long tradition of employing state of the art computing and analysis techniques. Recent progress in machine learning and artificial intelligence have further pushed this trend, and these approaches are now ubiquitous in our field. This overview attempts to capture key developments such as the rise of unsupervised approaches and the quest for suitable neural network architectures for physics tasks; challenges like ultra-low latency inference and robust predictions; as well as promising new ideas looking forward.

T 101: Invited Topical Talks III-A

Time: Thursday 14:00–15:20 Location: HSZ/0003

Invited Topical Talk T 101.1 Thu 14:00 HSZ/0003
How to Study the Higgs Boson in its Bosonic Decays — •Benedict Winter — Physikalisches Institut, Universität Freiburg

Measurements of the Higgs boson are means to probe electroweak symmetry breaking and the generation of the elementary particles' masses. Studies of Higgs boson decays to pairs of W and Z bosons and photons are cornerstones of the investigations by the ATLAS and CMS experiments at the LHC. This presentation illuminates how the Higgs boson's couplings as well as its mass and width are measured. It demonstrates how physics beyond the Standard Model is searched for in Higgs boson production and what opportunities will be provided by future LHC datasets.

Invited Topical Talk T 101.2 Thu 14:20 HSZ/0003
Measuring $H \to WW$ with the ATLAS Experiment — •Carsten Burgard for the ATLAS-Collaboration — TU Dortmund

The past year saw the 10th anniversary of the discovery of the Higgs boson - an excellent time to reflect on past achievements and look into the future. The decay of the Higgs boson to a pair of W bosons is one of the most sensitive channels to measure the total Higgs boson production rate, mostly due to the relatively large rate of leptonic W decays. This leptonic signature comes with some unique challenges and opportunities: it exposes a high rate of gluon-fusion produced Higgs bosons on top of the backgrounds, providing an opportunity for a powerful differential measurement, while the rarer VBF and VH decays allow direct experimental access to the coupling of the Higgs to vector bosons. Also for possible high-mass particles decaying to a pair of W bosons, this channel is a sensitive probe. While the reconstruction of the properties of the Higgs boson itself can be challenging due to the evanescent neutrinos, precise measurements are still enabled by the sheer statistical power of the channel. Finally, even the neutrinos can be exploited: the parity-violation-induced spin-entanglement of the leptons does not only provide a distinctive feature to reject continuum WW background, but could also allow to measure violation of Bell inequalities in Higgs physics in the future. Run 2 of the LHC has provided the ATLAS experiment with a powerful dataset to tackle these measurements, and the ongoing Run 3 will only add to this.

Invited Topical Talk T 101.3 Thu 14:40 HSZ/0003
Belle II opportunities in B-decays with invisible signatures — •Slavomira Stefkova for the Belle II-Collaboration — KIT, Karlsruhe, Germany

$B \to K\nu\bar{\nu}$ decays are excellent probes for finding new physics for two reasons. Firstly, many extensions to the Standard Model are expected to manifest themselves in these very decays. Secondly, they belong to the family of $b \to sll$ transitions, where tensions with SM have been measured. They are, however, experimentally challenging as not only are they rare but they contain two neutrinos leaving no signature in the detector. In this talk I will present the latest status of the measurements of observables in $B \to K\nu\bar{\nu}$ decays with the data collected by the Belle II experiment. I will also outline the prospects for future measurements of $B \to K\nu\bar{\nu}$ decays and similar processes using the growing Belle II dataset.

Invited Topical Talk T 101.4 Thu 15:00 HSZ/0003
Two Pieces of a Puzzle: Inclusive and Exclusive $|\mathbf{V_{cb}}|$ — •Markus Prim — Physikalisches Institut, Bonn, Germany

Over the last decade, the CKM matrix element $|V_{cb}|$ has been measured by various experiments, and the tension between the two experimental methods - the inclusive and the exclusive reconstruction of the final-state hadron system - persists to this day, despite the increasing precision of the experimental measurements and the higher-order corrections in the theoretical calculations. In this talk, we will review the current status of measurements and the implications of the ever-increasing Belle II data on the precision that can be achieved in the coming years.

T 102: Invited Topical Talks III-B

Time: Thursday 14:00–15:20 Location: HSZ/0004

Invited Topical Talk T 102.1 Thu 14:00 HSZ/0004
Expanding the Frontiers of Galactic Neutrino Astronomy via Machine Learning* — •Mirco Hünnefeld for the IceCube-Collaboration — TU Dortmund, Dortmund, Germany

IceCube has discovered a flux of astrophysical neutrinos and presented evidence for the first neutrino sources, a flaring blazar known as TXS 0506+056 and the active galaxy NGC 1068. However, the sources responsible for the majority of the astrophysical neutrino flux remain elusive. Within our Galaxy, high energy neutrinos can be produced when cosmic rays interact at their acceleration sites and during propagation through the interstellar medium. The Galactic plane has therefore long been hypothesized as a potential neutrino source.

In this contribution, results are presented for a new search of neutrino emission utilizing an improved dataset of cascade-like events that builds upon recent advances in deep learning based reconstruction methods. Enabled by these novel methods, the resulting dataset improves IceCube's sensitivity in the southern neutrino sky and is thus particularly promising for the identification of neutrino production from the Galactic plane.

*Financial support by the BMBF and DFG (SFB 876, SFB 1491) is gratefully acknowledged.

Invited Topical Talk T 102.2 Thu 14:20 HSZ/0004
Enhancing the CMS Level-1 Trigger with real-time Machine Learning — •Artur Lobanov — Institut für Experimentalphysik, Universität Hamburg, Hamburg, Germany

The Level-1 Trigger (L1) is the first stage of the online event filter system of the CMS Experiment at the LHC. It reduces the event rate from 40 MHz to $\mathcal{O}(100)$ kHz by reconstructing, identifying and filtering collision events in real-time using dedicated processing hardware based on field-programmable gate arrays (FPGAs).

Following the success of machine learning (ML) in enhancing event selections in the offline analysis of recorded data, ML algorithms are finding their way into the real-time processing of the CMS L1 Trigger system. Contrary to current filters that rely on simple rule-based selection algorithms using the detected physics objects, ML allows to capture deeper correlations between and within the objects, improving the identification of the event.

In addition to the tight constraints on the processing latency of several microseconds, trigger algorithms also have to fit into the restricted processing resource budget of the FPGAs. This requires a dedicated optimisation of ML models for their use in hardware in these challenging conditions.

In this talk I will outline the basics of the CMS L1 Trigger system, the principles of ML inference in FPGAs, and present the current state-of-the-art developments of novel ML algorithms enhancing the trigger performance at the LHC and beyond.

Invited Topical Talk T 102.3 Thu 14:40 HSZ/0004
Higgsino Hunting at ATLAS — •Michael Holzbock — Max Planck Institut für Physik, München, Germany

Supersymmetry (SUSY) remains one of the best motivated candidates for physics beyond the Standard Model (SM) and predicts a new partner for each SM particle. The higgsino, the SUSY partner of the Higgs SM boson, has always been of particular interest due to its connection with the hierarchy problem and as a promising Dark Matter candidate when realized with masses near the weak scale. Intriguingly, (nearly) pure higgsino states can still escape the current constraints from colliders and direct Dark Matter searches, and hence they remain a prime target for new physics searches at the LHC.

In this talk the motivation and experimental challenges for higgsino searches at the LHC are reviewed, and the current results from ATLAS discussed. Finally, new techniques developed for accessing so far unprobed phase space in the search for higgsinos at the LHC are introduced.

Invited Topical Talk T 102.4 Thu 15:00 HSZ/0004
New Ideas for Baryo- and Leptogenesis — •Kai Schmitz — Institut für Theoretische Physik, WWW Münster

The baryon asymmetry of the Universe (BAU) cannot be explained by the Standard Model and hence represents important evidence for new physics. In this talk, I will review recent new ideas for the generation of the BAU in the early Universe that generalize or are complementary to conventional scenarios of baryo- and leptogenesis. Specifically, I will discuss the interplay between lepton number/flavor violation and the chemical transport in the Standard Model plasma at high temperatures, which provides the basis for new scenarios known as "wash-in leptogenesis" and "leptoflavorgenesis". I will highlight possible UV completions of these scenarios, notably cosmic inflation driven by an axion-like field, and outline their rich phenomenological implications for particle physics and cosmology. This will include the possibility that the generation of the BAU is in fact closely related to the generation of primordial magnetic fields, which in turn would have important consequence for the electroweak phase transition and the properties of intergalactic magnetic fields in the present Universe.

T 103: AI Topical Day – Simulation, Inverse Problems and Algorithmic Development (joint session AKPIK/T)

Time: Thursday 15:45–17:15 Location: HSZ/0004

T 103.1 Thu 15:45 HSZ/0004
Efficient Sampling from Differentiable Matrix Elements with Normalizing Flows — •Annalena Kofler[1,2], Vincent Stimper[2,3], Mikhail Mikhasenko[4], Michael Kagan[5], and Lukas Heinrich[1] — [1]Technical University Munich — [2]Max Planck Institute for Intelligent Systems, Tübingen — [3]University of Cambridge, UK — [4]ORIGINS Excellence Cluster, Munich — [5]SLAC National Accelerator Laboratory, Menlo Park, USA

The large amount of data that will be produced by the high-luminosity LHC imposes a great challenge to current data analysis and sampling techniques. As a result, new approaches that allow for faster and more efficient sampling have to be developed. Machine Learning methods such as normalizing flows, have shown great promise in related fields. There, access to not only the density function but also its gradient has proven to be helpful for training. Recently, software for accessing differentiable amplitudes, which serve as densities in particle scattering, have become available that allow us to obtain the gradients and benchmark these new methods. The described approach is demonstrated by training rational-quadratic spline flows with differentiable matrix elements of the hadronic three-body decays, $\pi(1800) \to 3\pi$ and $\Lambda_c^+ \to pK^-\pi^+$. To boost the ability to accurately learn and sample from complex densities whilst also reducing the number of training samples, we explore the use of the newly proposed method Flow Annealed Importance Sampling Bootstrap. Building on prior work, we plan to extend the approach to examples with more particles in the final state via the differentiable matrix elements provided by MadJax.

T 103.2 Thu 16:00 HSZ/0004

Generating Accurate Showers in Highly Granular Calorimeters Using Normalizing Flows — •Thorsten Buss — Institut für Experimentalphysik, Universität Hamburg, Germany

The full simulation of particle colliders incurs a significant computational cost. Among the most resource-intensive steps are detector simulations. It is expected that future developments, such as higher collider luminosities and highly granular calorimeters, will increase the computational resource requirement for simulation beyond availability. One possible solution is generative neural networks that can accelerate simulations. Normalizing flows are a promising approach in this pursuit. It has been previously demonstrated, that such flows can generate showers in low-complexity calorimeters with high accuracy. We show how normalizing flows can be improved and adapted for precise shower simulation in significantly more complex calorimeter geometries.

T 103.3 Thu 16:15 HSZ/0004

Introspection for a normalizing-flow-based recoil calibration — •Lars Sowa, Jost von den Driesch, Roger Wolf, Markus Klute, and Günter Quast — Institute of Experimental Particle Physics (ETP), Karlsruhe Institute of Technology (KIT)

Normalizing flows (NFs) are neural networks, that preserve the probability between their input and output distributions. NFs can be promising candidates either as surrogates for the fast generation of new samples or as universal approximators of arbitrary probability density functions, based on which confidence intervals may be determined, both of which are interesting properties in high-energy physics (HEP). This work presents the case study of recoil calibration on LHC Run- 3 data and Monte Carlo simulation with the goal to better understand the behavior of NFs. The result of the NF is compared to a deep ensem- ble of feed-forward neural networks created to compare the calibration results and the different coverage in the value space.

T 103.4 Thu 16:30 HSZ/0004

Normalising Flows for Parameter Estimation from Gravitational Wave Signals — Johannes Erdmann[1], •Jon Hoxha[1], and Shichao Wu[2,3] — [1]III. Physikalisches Institut A, RWTH Aachen University — [2]Max-Planck-Institut für Gravitationsphysik (Albert-Einstein-Institut) — [3]Leibniz Universität Hannover

The Einstein Telescope (ET) is a proposal for a next generation ground-based gravitational wave detector. Due to higher sensitivity, ET is expected to receive orders of magnitude more gravitational wave signals than the current 2nd generation detectors LIGO, Virgo and KAGRA. Additionally, these signals will also be in the frequency band of the detector for a longer time, which would cause overlaps of signals. The analysis methods currently in use, which are based on Markov Chain Monte Carlo (MCMC) nested sampling methods, are unsuitable for handling such data and would take up significant computing resources. Therefore, new efficient analysis methods are required. Deep learning methods form a promising approach for this task. Specifically, normalizing flows promise to provide a more efficient means for signal parameter estimation. We use mock data to estimate signal parameters through normalizing flows and compare them to the current standard approach.

T 103.5 Thu 16:45 HSZ/0004

A method for inferring signal strength modifiers by conditional invertible neural networks — •Mate Zoltan Farkas, Svenja Diekmann, Niclas Eich, and Martin Erdmann — III. Physics Institute A, RWTH Aachen

The continuous growth in model complexity in high-energy physics collider experiments demands increasingly time-consuming model fits. We show first results on the application of conditional invertible networks (cINNs) to this challenge. Specifically, we construct and train a cINN to learn the mapping from signal strength modifiers to observables and its inverse. The resulting network infers the posterior distribution of the signal strength modifiers rapidly and for low computational cost. We present performance indicators of such a setup including the treatment of systematic uncertainties. Additionally, we highlight the features of cINNs estimating the signal strength for a vector boson associated Higgs production analysis carried out at an LHC experiment on simulated data samples.

T 103.6 Thu 17:00 HSZ/0004

Reconstruction of SAXS Data using Invertible Neural Networks — •Erik Thiessenhusen[1], Melanie Rödel[1], Thomas Kluge[1], Michael Bussmann[2], Thomas Cowan[1], and Nico Hoffmann[1] — [1]HZDR, FWKT, Dresden, Germany — [2]CASUS, Görlitz, Germany

The understanding of laser-solid interactions is important to the development of future laser-driven particle and photon sources, e.g., for tumor therapy, astrophysics or fusion. Currently, these interactions can only be modeled by simulations which need verification within the scope of pump-probe experiments. This experimental setup allows us to study the laser-plasma interaction that occurs when an ultrahigh-intensity laser hits a solid density target. We employ Small-Angle X-Ray Scattering (SAXS) to image the nanometer-scale spatial- and femtosecond temporal resolution of the laser-plasma interactions. However, the analysis of the SAXS pattern is an ill-posed inverse problem meaning that multiple configurations of our target might explain the same measurement due to the loss of the phase information. We approach the ambiguities of the inverse problem by a conditional Invertible Neural Network (cINN) that is returning a probability density distribution over target parameters explaining a single SAXS pattern. We will show that the domain gap between generated training and experimental data can be approached by integrating perturbations of experimental data into the training workflow. We assess the applicability of our approach to a selected set of grating targets in terms of a comprehensive evaluation on simulation and experimental data.

T 104: Flavor VIII

Time: Thursday 15:50–17:20 Location: HSZ/0304

T 104.1 Thu 15:50 HSZ/0304

b->c decays at NNLO — •Manuel Egner[1], Matteo Fael[2], Kay Schoenwald[3], and Matthias Steinhauser[1] — [1]Karlsruhe Institute of Technology, TTP — [2]CERN, Department of Theoretical Physics — [3]University of Zurich, Physik-Institut

The decay of B mesons can be described in the heavy quark expansion as the decay of a free bottom quark plus corrections which are suppressed by powers of 1/m_b. In this talk I will present our NNLO calculations to the decay of free bottom quarks b->c with full charm mass dependence. For the semileptonic decay channel b->clv, we obtain analytic results which can be compared to previous known results obtained via expansions in the mass ratio m_c/m_b. I will also give an outlook on the ongoing calculation of the hadronic decay channels b->cud and b->ccs, where similar calculation techniques as in the semileptonic case are used.

T 104.2 Thu 16:05 HSZ/0304

Measurement of the branching fraction and q^2-spectrum of $B \to D^{**}\ell\nu$ decays at Belle II — •Eylül Ünlü, Thomas Lück, and Thomas Kuhr — Ludwig-Maximilians-Universität München

There is currently some tension between the measured value of $R(D^*) = \mathcal{B}(B \to D^*\tau\nu_\tau)/\mathcal{B}(B \to D^*\ell\nu_\ell)$ and the Standard Model prediction, hinting at lepton universality violation. Semileptonic B meson decays to D^{**} mesons are background to the $R(D^*)$ measurement, where D^{**} denotes the orbitally excited P-wave charm mesons: $D_1(2420)$, $D_2^*(2460)$, $D_0^*(2300)$, and $D_1^{'}(2430)$. These decays are not well understood, and there have been discrepancies between past measurements of their yields made by BaBar and Belle. Hence, improved understanding of these decays would reduce an important systematic uncertainty of $R(D^*)$ measurements.

The aim of the present study is to use simulation and data from the Belle II experiment to study these decays, in particular to determine the distribution of $q^2 = (p_B - p_{D^{**}})^2$ which is key to understanding these decays and an important input for theory.

We reconstruct one of the B mesons from the $\Upsilon(4S) \to BB$ decay in the signal channel, $B \to D^{**}(D^*\pi)\ell\nu$. The other B meson is reconstructed in various hadronic modes using the Full Event Interpretation algorithm, which provides a high purity tag B sample with

well known kinematics. We identify signal decays by a peak at zero in the $M^2_{missing}$ (missing mass squared) distribution, and do a fit to the mass difference $M(D^*\pi) - M(D^*)$ to extract the D^{**} signal yield.

The current status of the analysis will be presented.

T 104.3 Thu 16:20 HSZ/0304

Studies of $B \to D^{**}\ell\nu$ at Belle II — Gerald Eigen[1,2], Ariane Frey[2], and •Noreen Rauls[2] — [1]Institutt for fysikk og teknologi, Bergen, Norway — [2]II. Physikalisches Institut, Georg-August-Universität Göttingen, Deutschland

To probe the Standard Model, various different measurements can be conducted. One test that can be performed is the determination of the ratio $R(D^{(*)}) = \frac{\mathcal{B}(B\to D^{(*)}\tau\overline{\nu})}{\mathcal{B}(B\to D^{(*)}\ell\overline{\nu})}$, where one limiting factor is the background arising from semileptonic $B \to D^{**}\ell\nu$ decays. Therefore, this analysis attempts to acquire a better understanding of the decay $B \to D^{**}\ell\nu$ as well as measure its branching ratio.
This measurement is based on data collected at the Belle II experiment, which is situated at the asymmetric e^+e^- collider SuperKEKB in Japan, which operates at the $\Upsilon(4S)$ resonance. Thus, the B mesons are always produced in pairs. One of these B mesons is reconstructed employing the hadronic Full Event Interpretation (FEI), which reconstructs exclusive hadronic B decays. To reconstruct the other B meson, a charged, light lepton is combined with a D^{**}, where multiple hadronic decay modes are considered.
This talk will outline the selection procedure as well as explain a binned maximum likelihood fit to extract the branching ratio. Besides, a brief outlook on future plans will be given.

T 104.4 Thu 16:35 HSZ/0304

Untagged analysis of $B \to \pi\ell\bar{\nu}_\ell$ and $B \to \rho\ell\bar{\nu}_\ell$ and extraction of $|V_{ub}|$ at Belle II — Florian Bernlochner, Jochen Dingfelder, •Svenja Granderath, and Peter Lewis for the Belle II-Collaboration — Physikalisches Institut der Rheinischen Friedrich-Wilhelms-Universität Bonn

One of the puzzles of current research in flavor physics is the persisting discrepancy between the results of exclusive and inclusive measurements of the CKM matrix element $|V_{ub}|$. The charmless semileptonic decays $B \to \pi\ell\bar{\nu}_\ell$ and $B \to \rho\ell\bar{\nu}_\ell$ belong to the most accessible and powerful channels for determining $|V_{ub}|$ in exclusive modes. Using data from the Belle II experiment, new precision measurements of $|V_{ub}|$ can be performed. In preparation for this, an untagged measurement method for simultaneously extracting $B \to \pi\ell\bar{\nu}_\ell$ and $B \to \rho\ell\bar{\nu}_\ell$ events is developed. An untagged measurement allows for sufficiently large samples of these rare decays already with the current Belle II dataset. In order to increase the signal purity, boosted decision trees are employed to suppress continuum and $B\overline{B}$ backgrounds. Once the signal events are extracted, $|V_{ub}|$ is determined using the measured partial branching fractions in combination with theory predictions of hadronic form factors. This talk will present the current status of the analysis and $|V_{ub}|$ extraction.

T 104.5 Thu 16:50 HSZ/0304

$B \to \rho\ell\nu_\ell$ Decays with Hadronic Tagging in Belle II Data — •Moritz Bauer, Torben Ferber, and Pablo Goldenzweig — Karlsruhe Institute of Technology (KIT)

Over the last 10 years, a 3σ tension between inclusive and exclusive measurements of the magnitude of the CKM matrix element $|V_{ub}|$ has become apparent in multiple experiments. Semileptonic decays involving $b \to u$ quark transitions present a unique opportunity to measure $|V_{ub}|$ with the current Belle II dataset due to their comparatively high branching fraction.

We present analyses of $B \to \rho\ell\nu_\ell$ decays in Belle II data as steps towards the extraction of this matrix element from exclusive decays. These analyses are conducted with hadronic tagging, an approach in which the second B meson in $\Upsilon(4S)$ decays is reconstructed in a wide variety of hadronic decay chains to increase the selection purity and obtain the recoil of the B-meson decay of interest. This is achieved using a multivariate analysis method, the Full Event Interpretation.

T 104.6 Thu 17:05 HSZ/0304

Leptoquarks at high and low energies — •Felix Wüst, Marco Fedele, and Ulrich Nierste — Institut für Theoretische Teilchenphysik (TTP), Karlsruher Institut für Technologie (KIT)

I consider the case that quarks and leptons are unified at some high scale. The so-called flavour anomalies, which have built up in the data of recent years, are usually interpreted in terms of leptoquarks (LQ) with masses in the multiple-TeV range. I present the renormalisation group equations which connect the LQ couplings at the fundamental high scale with those at the low scale probed in the flavour experiments and discuss phenomenological implications.

T 105: Flavor IX

Time: Thursday 15:50–17:20 Location: HSZ/0401

T 105.1 Thu 15:50 HSZ/0401

Search for the lepton flavour violating decay $B^0 \to \tau^\pm\ell^\mp$ — •Nathalie Eberlein, Thomas Kuhr, and Thomas Lück — Ludwig-Maximilians-Universität, München

Lepton flavour is conserved in the Standard Model, but violated in many new physics models. An observation of the $B^0 \to \tau^\pm\ell^\mp$ decay, where $\ell = e/\mu$, would be a clear sign for new physics. While an upper limit on the expected branching ratio would help constrain new physics models.

At B factories one can determine the kinematics of the signal B meson by fully reconstructing the accompanying B meson in $e^+e^- \to \Upsilon(4S) \to B\overline{B}$ events. In the rest frame of the signal B meson the monoenergetic lepton provides a clean signature to identify the signal decay. This talk presents the current status of the search for $B^0 \to \tau^\pm\ell^\mp$ decays with the full Belle data set using the Full Event Interpretation algorithm for the reconstruction of the accompanying B meson in hadronic decay modes.

T 105.2 Thu 16:05 HSZ/0401

Search for the lepton flavour violating decay $\tau^+ \to \mu^+\mu^-\mu^+$ with the LHCb experiment — •Giulia Frau[1], Flavio Archilli[2], and Rowina Caspary[1] — [1]Physikalisches Institut, Heidelberg University,Germany — [2]Università di Roma Tor Vergata, Rome, Italy

As lepton flavour violating, the $\tau^+ \to \mu^+\mu^-\mu^+$ decay is forbidden in the Standard Model (SM) at the tree level. The combination of the SM with neutrino oscillations predicts for this decay a branching ratio (BR) of the order of 10^{-55}, well below our current and foreseen experimental sensitivity. Improving the existing limit on the BR of this decay would allow to constrain theories of Physics beyond the SM. Especially lepto-quark models which are often discussed in the context of the recently observed flavor anomalies predict $\tau \to \mu\mu\mu$ BR which are testable with the current available data set. In this talk, I will show the different steps of the analysis performed to evaluate the limit on the BR using data collected by LHCb during Run 2, by focusing on the improvements introduced with respect to the previous LHCb analysis, which was conducted by analyzing Run 1 data. With the increasing luminosity and cross section of Run 2 and a more sophisticated analysis, we expect the LHCb limit to improve by at least a factor of two, making our results competitive with the current best experimental limit.

T 105.3 Thu 16:20 HSZ/0401

Restrictions on scalar leptoquark couplings from charged lepton flavor violation processes — •Uladzimir Khasianevich, Dominik Stöckinger, Hyejung Stöckinger-Kim, and Johannes Wünsche — Institut für Kern- und Teilchenphysik, TU Dresden, Zellescher Weg 19, 01069 Dresden, Germany

We derived the most conservative limits on the S_1 leptoquark model that comes from charged lepton flavour violation observables and magnetic moment of the muon, as they involve a similar diagrammatic structure. We apply the case study, where top-induced, charm-induced or mixed scenarios lead to an explanation of the $(g-2)_\mu$ and then further apply additional two- and three- body decay observables to restrict relevant couplings and their products. The $\mu - e$ conversion process in Au and Al is used to restrict the first row of couplings. As there are known restrictions from K- and D-meson decays, we incorporate them to further improve the bounds on the relevant coupling entries. The FlexibleSUSY program was used in this work to perform scans

over various leptoquark coupling scenarios. We designed appropriate model files incorporating the parameterization of the couplings in the up-type mass diagonal basis. The expressions for the leptonic observables were generated with the help of the NPointFunctions extension of the FlexibleSUSY program.

T 105.4 Thu 16:35 HSZ/0401

Probing light New Physics in invisible rare charm decays — •Dominik Suelmann and Gudrun Hiller — TU Dortmund University, Department of Physics, Otto-Hahn-Str.4, D-44221 Dortmund, Germany

We analyze rare $|\Delta c| = |\Delta u| = 1$ charm decays with missing energy in the final state and study their potential to probe different scenarios of light New Physics (NP). We study three-body and two-body decays of baryons and mesons and probe the sensitivities of different observables for the various light NP models. We find that the $\Lambda_c \to p\,\nu\bar{\nu}$ missing energy distribution can distinguish between the scenario of only left-handed neutrinos and the scenario with additional light right-handed neutrinos. We also work out constrains from available experimental data for the two body decays $\Lambda_c \to p + nothing$ and $D \to \pi + nothing$ and point out the benefits of baryonic modes in rare decays.

T 105.5 Thu 16:50 HSZ/0401

Estimate of material effects on neutral charm mixing at the LHCb experiment — •Lennart Uecker[1], Adam Davis[2], Evelina Mihova Gersabeck[2], and Marco Gersabeck[2] — [1]Physikalisches Institut, Universität Heidelberg, Germany — [2]Department of Physics and Astronomy, The University of Manchester, United Kingdom

The LHCb experiment at the LHC is leading the precision measurements in the charm sector. The large charm production cross section and the unique vertex detector, with first detector compoments as close as 6mm to the interaction point, enable the LHCb experiment to measure a larger number of D^0 mesons passing through material

In this talk, we present a data-driven approach to estimate material effects on the mixing of neutral charm mesons using $D^0 \to K\pi$ decays recorded during Run 2 of the LHC, corresponding to an integrated luminosity of 5.6 fb^{-1}. Further, we explore the sensitivity of the upgraded LHCb detector for Run 3+4 to material effects on the charm mixing.

T 105.6 Thu 17:05 HSZ/0401

Constraining flavorful SMEFT operators with missing energy plus jet — Gudrun Hiller and •Daniel Wendler — TU Dortmund University, Department of Physics, Otto-Hahn-Str.4, D-44221 Dortmund, Germany

We consider the Drell-Yan process with final state neutrinos, where the experimental signature is given by "missing energy + jet", as a probe for new physics. The process $pp \to \nu\bar{\nu} + \text{jet}$ is analyzed, to constrain flavorful semileptonic four-fermion operators based on present LHC data ($\mathcal{L}_{int} = 139\,\text{fb}^{-1}$). Projections are derived for the High Luminosity Large Hadron Collider (HL-LHC). New physics scales probed are $\Lambda_{NP} \sim 3.5\,\text{TeV}, 3.0\,\text{TeV}, 2.6\,\text{TeV}$ and $1.6\,\text{TeV}$ for uc, ds, db and sb, respectively for four-fermion operators. The limits are complementary and competitive or better to those from Drell-Yan involving taus, and with low energy observables, such as from rare decays of kaons, charm and beauty hadrons.

T 106: Searches IV

Time: Thursday 15:50–17:05 Location: HSZ/0403

T 106.1 Thu 15:50 HSZ/0403

Using Density Estimation for Resonance Searches at the LHC — Thorben Finke, •Marie Hein, Michael Krämer, and Alexander Mück — Institute for Theoretical Particle Physics and Cosmology (TTK), RWTH Aachen University, Germany

We demonstrate an end-to-end application of model-agnostic weakly supervised machine learning methods improving a traditional resonant anomaly search. In particular we focus on the Cathode method and show its superior performance and its limitation at the example of the LHC Olympics R&D data set. For our specific search strategy, we discuss the treatment of systematic errors, however, the potential issue of background sculpting is absent. The method is powerful at present and will benefit substantially from increased statistics to be collected at the LHC.

T 106.2 Thu 16:05 HSZ/0403

Searches for new physics with MUSiC in pp collisions at $\sqrt{s}$ = 13 TeV — •Yannik Kaiser, Thomas Hebbeker, Arnd Meyer, Ana Rita Alves Andrade, and Felipe Torres da Silva de Araujo — III. Physikalisches Institut A, RWTH Aachen University

Besides the large effort of the LHC collaborations, no direct evidence for physics beyond the standard model (BSM) has been found. Considering several theory models available, which adress the inadequacies of the standard model (SM), many model-specific searches have been employed. Complementary to this approach is MUSiC - Model Unspecific Search in CMS - a model-independent search procedure in which data collected by the CMS experiment, with at least one identified lepton, is classified according to its final state multiplicities of well-reconstructed objects. For each class a search algorithm is used to determine the most stringent phase-space region, according to a defined p-value, with respect to an SM statistical model. The procedure also takes into account systematic and statistical effects. As an extension of the already published result using 2016 data, we report preliminary results of the MUSiC search on data collected by CMS during 2018, corresponding to 58.83 fb^{-1} of integrated luminosity.

T 106.3 Thu 16:20 HSZ/0403

Search for new physics in the final state with a lepton and $\overrightarrow{p}_{\mathrm{T}}^{\mathrm{miss}}$ — •Valentina Sarkisovi, Thomas Hebbeker, Kerstin Hoepfner, Sebastian Wiedenbeck, and Christoph Schuler — III. Physikalisches Institut A, RWTH Aachen University

Various Beyond the Standard Model (BSM) theories anticipate the existence of new particles that could decay into final states characterized by the presence of a charged lepton and missing transverse momentum ($\overrightarrow{p}_{\mathrm{T}}^{\mathrm{miss}}$) as their most distinctive experimental signature. The CMS detector at the CERN LHC is used to hunt for novel physics in the high mass region of final states containing a lepton (electron, muon, tau) and $\overrightarrow{p}_{\mathrm{T}}^{\mathrm{miss}}$. Achievement of a high mass resolution, rejection of the standard model backgrounds, and efficient identification and reconstruction of TeV leptons are crucial in a search for such phenomena. One of the main challenges of this search is represented by the high rate of QCD multi-jet background produced in the LHC proton-proton collisions, leading to the possible misidentification of a jet as a lepton. Data driven methods as well as advanced machine learning technologies are used to model the QCD contamination and to properly identify leptons. The latest CMS data, recorded in 2022 at unprecedented center-of-mass energy of 13.6 TeV, have been analysed. The key concepts of the analysis techniques employed in the search for new physics in the final state with a lepton and $\overrightarrow{p}_{\mathrm{T}}^{\mathrm{miss}}$ are addressed.

T 106.4 Thu 16:35 HSZ/0403

Leptoquark production in a single τ charm/bottom and met final state at the ATLAS detector — •Patrick Bauer, Philip Bechtle, and Klaus Desch for the ATLAS-Collaboration — Physikalisches Institut Bonn

At B-factories, anomalies were observed in decays of the B-hadrons into $\mathrm{D}^{(*)}$ and $\mathrm{K}^{(*)}$ plus leptons, which are consistent with the hypothesis of contributions from Leptoquarks in the high GeV to low TeV range.

Therefore, the direct search for leptoquarks (LQ) is a focus at high energy collider experiments. A very recent result, where CMS observes an excess of 3.4 sigma consistent with non-resonant LQ contributions, potentially provides an even stronger case.

This observation emphasizes the importance of exploiting all possible LQ production modes. For for LQ masses well above 1 TeV the single- and non-resonant production modes become an key ingredient for ongoing an future searches. With the single production into final states with one τ, bottom or charm jet with large missing transverse momentum, one can directly probe the couplings expected to be involved in the $\mathrm{B} \to \mathrm{D}^{(*)}\tau\nu$ anomaly. Furthermore the non resonant contributions to the same final state could give sizable sensitivity to higher masses

for large coupling strengths from the LQ. For the inclusion of a non-resonant interpretation it is crucial to study the interference behaviour of LQ signal with the SM.

This talk will provide an overview over the ongoing search for singly produced LQ in the given final states, covering resonant, non-resonant and interference aspects.

T 106.5 Thu 16:50 HSZ/0403

Search for Beyond Standard Model particles with exclusive coupling to top quarks in four-top-quark final states — •Gabriele Milella[1], Freya Blekman[1], Matthias Komm[1], and Denise Müller[2] — [1]DESY, Hamburg, Germany — [2]VUB, Brussel, Belgium

Many Beyond Standard Model (BSM) theories predict new top-philic particles that couple exclusively with the top quark, as this coupling is the most favorable for new physics with respect to any other lighter quark.

This search is therefore focused on a heavy resonance decaying to a pair of top quarks. The resonance is produced in association with a top quark pair resulting in four top quarks in the final state.

The two top quarks from the resonance are expected to be highly boosted and their decay products can be found within large-radius jets. The signal region is constructed from events that contain also opposite-sign leptons and b-tagged jets.

The invariant mass distribution of the reconstructed pair of large-radius jets is studied. Various signal scenarios with different resonance masses and decay widths are tested by searching for local excesses in the reconstructed mass spectrum of the large-radius jets. Preliminary results are presented using the LHC Run 2 data taken with the CMS experiment.

T 107: Searches – Neutrino at accelerators

Time: Thursday 15:50–17:20 Location: HSZ/0101

T 107.1 Thu 15:50 HSZ/0101

Identification of displaced τ leptons for long-lived τ slepton searches at CMS — •Mykyta Shchedrolosiev — Deutsches Elektronen-Synchrotron DESY

Searches for the supersymmetric (SUSY) partner of the tau lepton are of high interest, since scenarios in which the tau slepton ($\widetilde{\tau}$) is the next-to-lightest supersymmetric particle can lead to the observed relic density. In gauge mediated symmetry breaking scenarios, $\widetilde{\tau}$ can have macroscopic lifetime. Direct searches of $\widetilde{\tau} \rightarrow \tau\widetilde{\chi}_0^1$, where $\widetilde{\chi}_0^1$ is the lightest SUSY particle are limited by the reconstruction efficiency of displaced tau leptons at CMS, which are produced up to 50 cm away from the IP. In addition, the small cross-section of slepton production at the LHC makes such searches challenging. In our study, we explore a new displaced τ lepton tagger using a deep neural network.

T 107.2 Thu 16:05 HSZ/0101

Search for new physics in $t\bar{t}$+$\mathbf{E}_T^{miss}$ final states in pp collisions at 13 TeV with the ATLAS experiment — •Simran Gurdasani, Daniele Zanzi, and Christian Weiser for the ATLAS-Collaboration — Albert-Ludwigs-Universität Freiburg

This talk will present the recent developments of an ongoing search for Beyond Standard Model (BSM) signatures that can be probed using the $t\bar{t}$+E_T^{miss} final state at the Large Hadron Collider (LHC). The search is performed on proton-proton collision data at $\sqrt{s} = 13$ TeV collected by the ATLAS experiment during the LHC Run 2, corresponding to a luminosity of 139 fb^{-1}. Targeted signatures include Dark Matter production via scalar or pseudo-scalar mediators and SUSY stop pair production. A machine learning approach via Neural Networks (NN) is used in two stages of the search (i) to reconstruct the hadronic decays of top quarks and (ii) to discriminate signal events from background events exploiting information on the full event kinematics. The presence of signal events is inferred via a template fit to the distributions of the NN output values in samples of events at different kinematic phase spaces. This talk will give an overview of the machine learning strategy developed, background modeling techniques and the expected sensitivity estimates.

T 107.3 Thu 16:20 HSZ/0101

Search for Compressed Elektroweakinos in Events with Two Soft and Displaced Leptons at the CMS Experiment — •Alexandra Tews — University of Hamburg, Hamburg, Germany

A variety of supersymmetric (SUSY) extensions of the Standard Model lead to light elektroweakinos with small differences in mass between the eigenstates.

One example is that of Higgsino-like electroweakinos, where the four states $\chi_1^{\pm}, \chi_2^0$, and χ_1^0 are nearly mass degenerate. The production of two elecroweakinos followed by the decay of the semi-stable second neutralino through an off-shell Z boson can lead to a pair of same-flavor opposite-sign leptons. The leptons can have very low momentum if the mass spectrum of the SUSY particles is sufficiently compressed and be displaced from the primary interaction vertex.

Searches for new physics in events with two low-momentum opposite-sign leptons are particularly sensitive to such SUSY models. Scenarios with compressed Higgsinos with a mass splitting below 2 GeV with the CMS experiment are studied. We exploit new reconstruction and vertexing techniques for oppositely charged displaced lepton tracks with very low momentum of order of a few hundred MeV to extend the sensitivity of current searches to unexplored phase-space.

T 107.4 Thu 16:35 HSZ/0101

DUNE-PRISM: An innovative technique for neutrino oscillation predictions — •Ioana Caracas for the DUNE-Collaboration — JGU Mainz

As long baseline experiments are approaching the high precision era, an increased sensitivity towards constraining the oscillation parameter space is expected. Since the oscillation predictions are based on neutrino interaction cross sections, a classical approach is prone to systematic uncertainties, due to the incompleteness in the physical description of such models. This would in turn limit the capability to obtain the physics goals set for modern long baseline neutrino experiments, such as the Deep Underground Neutrino Experiment (DUNE).

An innovative technique, the Precision Reaction-Independent Spectrum Measurement (PRISM), has been proposed and investigated within the DUNE collaboration. This novel method is designed to measure neutrino oscillations based on a data-driven approach, eluding most theoretical modeling uncertainties. In this regard, the Near Detector (ND) is designed to move off the neutrino beam axis at several locations up to a distance of 33m, sampling thus several neutrino energy spectra. These ND off-axis results are used as a basis to predict the oscillated neutrino spectrum at the DUNE Far Detector, located at a baseline of 1300 km. The prediction obtained with the DUNE-PRISM analysis framework and the systematics impact on the oscillation parameters are presented. Additional studies needed to improve the overall sensitivity to the oscillation parameters and reduce their dependence on the interaction model uncertainties are also discussed.

T 107.5 Thu 16:50 HSZ/0101

Monoenergetic neutrino cross-section measurements with DUNE PRISM — •Lukas Koch for the DUNE-Collaboration — Johannes Gutenberg Universität Mainz

Next generation neutrino oscillation experiments like DUNE and Hyper-Kamiokande will require a precise understanding of systematic uncertainties to realise their physics goals. This includes a better understanding of neutrino-energy dependent cross sections of neutrino interactions with the target material. The DUNE near detector complex presents an opportunity to measure these cross sections using the PRISM approach. After recording interaction rates at different off-axis angles, and thus different neutrino energy spectra, we can make linear combinations of these measurements to create "virtual neutrino fluxes". These can be much narrower than the real fluxes, allowing for more precise cross-section measurements. This talk will explore the potential of the PRISM approach at the DUNE near detector complex and its potential implications for our understanding of neutrino cross sections.

T 107.6 Thu 17:05 HSZ/0101

The ESSνSB(+) design study: Achievements and Prospects

— •Tamer Tolba — Institut für Experimentalphysik, Universität Hamburg, Hamburg, Germany

The European Spallation Source neutrino Super Beam (ESSνSB) is a long-baseline neutrino project that will be able to measure the CP-violation (CPV) in the leptonic sector at the second oscillation maximum, where the sensitivity of the experiment is close to three times compared to that at the first oscillation maximum. As shown in the recently published ESSνSB conceptual design report (CDR), the initially foreseen physics performance of the ESSνSB project has surpassed earlier expectations by covering, after 10 years of data collection, more than 70% of the range of possible CP-violating phase, δ_{CP}, values with a confidence level of more than 5σ to reject the no-CP-violation hypothesis. The expected measurement precision of the value of δ_{CP} is smaller than 8◦ for all δ_{CP} values, making it the most precise proposed experiment in the field by a large margin. The extension project, ESSνSB+ to be performed between 2023 and 2026, aims in addressing the challenging task of measuring the neutrino-nucleon cross-section, which is the dominant term of the systematic uncertainty, in the energy range from 0.2 to 0.6 GeV, using a Low Energy nuSTORM (LEnuSTORM) and an ENUBET-like Low Energy Monitored Neutrino Beam (LEMNB) facilities. With the successful end of the previous design-study program and the publication of the ESSνSB CDR, an overall status of the project, as well as the recently accepted, by the Horizon-Europe program, extension project, the ESSνSB+, will be presented.

T 108: Top, EW I

Time: Thursday 15:50–17:20 Location: HSZ/0103

T 108.1 Thu 15:50 HSZ/0103

Towards a WbWb differential cross-section measurement — •Eleonora Loiacono for the ATLAS-Collaboration — DESY Campus Zeuthen

The production of a top quark pair is extensively studied at the Large Hadron Collider (LHC). It constitutes a significant background in many searches for physics Beyond the Standard Model (BSM). The final state of this process, WWbb, interferes with the production of a single top quark in association with a W boson at Next Leading Order (tWb). In this contribution, I will focus on presenting different techniques that are used to correct the data for inefficiencies and limited geometric acceptance for the WWbb single lepton channel, with the goal of improving the modelling of Standard Model (SM) processes for BSM searches. First differential cross-section measurements in variables that are maximally sensitive to the interference, using data from second run of the LHC, will be presented.

T 108.2 Thu 16:05 HSZ/0103

Towards a WbWb differential cross-section measurement in a search-like phase space — •Thomas Mclachlan for the ATLAS-Collaboration — DESY

Top quark pair production is a widely studied process at the Large Hadron Collider (LHC) and is a significant background in many searches beyond the Standard Model (BSM). The WbWb final states of this process interfere with the production of a single top quark in association with a W boson and a b-quark (tWb). Inspired by searches for supersymmetry and dark matter, I will measure the WbWb production cross-section in a search-like phase space that is maximally sensitive to the interference effects. Performing such a measurement can allow for new constraints on new physics and improve the sensitivity of future searches through improved background modelling. An event selection using single lepton events has been developed and will be used on the entire Run 2 dataset. In this context, I will present a range of quantities and theoretical parameters that will be used in the differential cross-section measurement.

T 108.3 Thu 16:20 HSZ/0103

Measurement of differential cross sections in the process $pp \to W^+W^-b\bar{b}$ — Stefan Kluth, Daniel Britzger, and •Johannes Hessler — Max-Planck-Institut für Physik

Precise measurements of differential cross sections in the process $pp \to W^+W^-b\bar{b}$ offer an outstandingly rich physics potential at highest precision. Although the process is theoretically and experimentally well defined, dedicated measurements of $W^+W^-b\bar{b}$ production cross sections were not (extensively) performed in the past at the LHC. We will report on ongoing measurements in the single-lepton channel with Run-II data taken by the ATLAS experiment. Due to the high jet multiplicity of the final state the event reconstruction can be challenging. This talk will focus on the kinematic reconstruction of the hadronically decaying W-boson.

T 108.4 Thu 16:35 HSZ/0103

Measurement of the differential $W \to e\nu$ cross section at high transverse masses with the ATLAS detector and its combination with the $W \to \mu\nu$ channel — Frank Ellinghaus, Johanna Wanda Kraus, and •Tim Frederik Beumker — Bergische Universität Wuppertal

A measurement of the differential cross section of the process $W \to e\nu$ is shown. The data set used is based on pp-collision data corresponding to an integrated luminosity of $\mathcal{L} = 139$ fb^{-1} at a center-of-mass energy of $\sqrt{s} = 13$ TeV. It was recorded with the ATLAS detector during LHC Run-2. The measurement is done double-differentially in the transverse mass of the W boson and the absolute of the pseudorapidity of the electron. It focuses on the region of high transverse masses above 200 GeV. The results will allow constraints on effective field theories and parton distribution functions of the proton. An overview of the analysis with a focus on the determination of the multijet background will be given. In addition, a combination with the associated $W \to \mu\nu$ measurement using the HAverager tool will be presented.

T 108.5 Thu 16:50 HSZ/0103

Measurement of the differential $W \to \mu\nu$ cross section at high transverse masses at $\sqrt{s} = 13$ TeV with the ATLAS detector — Frank Ellinghaus and •Johanna Wanda Kraus — Bergische Universität Wuppertal

The measurement of the differential cross section of the charged-current Drell-Yan process in the decay $W \to \mu\nu$ is presented. It is based on pp-collision data taken with the ATLAS detector during the LHC Run-2 at a center-of-mass energy of $\sqrt{s} = 13$ TeV, corresponding to an integrated luminosity of $\mathcal{L} = 139\,\text{fb}^{-1}$. The cross section is measured double-differentially as a function of the transverse mass m_T^W and the pseudorapidity of the muon with a focus on the high transverse mass region above 200 GeV. This is done for the first time and will allow for constraints on the parton distribution functions of the proton and on effective field theories. A short overview of the complete analysis will be given with a focus on studies of the unfolding procedure via Iterative Bayesian Unfolding.

T 108.6 Thu 17:05 HSZ/0103

Measurement of the inclusive W and Z boson production cross sections in pp collisions at 13.6 TeV — •Jost von den Driesch, Markus Klute, Minseok Oh, and Xunwu Zuo — Karlsruhe Institute of Technology (KIT)

The measurement of the W and Z boson production cross sections and their ratios provides an important test of quantum chromodynamics and electroweak processes in the Standard Model. Such measurements have been previously performed by the ATLAS and CMS collaborations at LHC collision energies of $\sqrt{s} = 7$ TeV, 8 TeV and 13 TeV.
This talk will provide an overview on the results of the W and Z production cross section measurement at CMS using Early Run3 data at the new collision energy of $\sqrt{s} = 13.6$ TeV.

T 109: Higgs, Di-Higgs III

Time: Thursday 15:50–17:20 Location: HSZ/0105

T 109.1 Thu 15:50 HSZ/0105

Higgs-associated Top Quark Pair Production in the Bottom-Antibottom Higgs Decay Channel with ATLAS at 13 TeV — Arnulf Quadt, •Chris Scheulen, and Elizaveta Shabalina — II. Physikalisches Institut, Georg-August Universität Göttingen

The bottom anti-bottom Higgs decay channel of Higgs-associated top quark pair production offers direct access to measurements of the top Yukawa coupling and Higgs-p_{T} differential cross-section, which are sensitive to potential new physics. To incorporate improvements such as developments in b-tagging and Monte Carlo simulation of the dominant $t\bar{t}+b\bar{b}$ background, a legacy analysis of the $t\bar{t}H(H\to b\bar{b})$ process with the full ATLAS Run 2 dataset of $\mathcal{L}=139\,\mathrm{fb}^{-1}$ is currently ongoing.

This talk will outline the general analysis strategy and provide an insight into the expected sensitivity of the analysis. Additionally, a focus will be placed on specific aspects of this round of analysis, such as the application of a muon-in-jet correction technique utilised to improve the Higgs mass and Higgs-p_{T} resolution.

T 109.2 Thu 16:05 HSZ/0105

Fake Estimation for the Search of the $t\bar{t}H(H\to b\bar{b})$ Process in the Single Lepton Channel — •Alexander Froch, Andrea Knue, and Ksenia Solovieva — Albert-Ludwigs-Universität Freiburg

The coupling of the Higgs boson to the standard model (SM) fermions, called Yukawa coupling, is one of the most basic but also most interesting properties in Higgs physics. In the standard model the top quark, with the largest mass of all SM fermions, should have the largest Yukawa coupling to the Higgs boson of approximately 1. To measure this property, the production of a top-antitop quark pair in association with a Higgs boson is studied. Due to its small production rate at the LHC, the most dominant decay of the Higgs boson (into a pair of b-quarks) is used. One of the top quarks is required to decay hadronically while the other one decays leptonically. This results in a final state with at least 4 b-quarks, a lepton and 2 additional non-b-quarks. The selected sample of events are split into signal- and background-dominated sub-samples called regions. While the signal region is not strongly affected by fake leptons, in dedicated control regions where additional correction are derived, the fake lepton contribution is not negligible.

In this talk, the current status of the fake estimation of the analysis in the single lepton channel will be discussed.

T 109.3 Thu 16:20 HSZ/0105

Measurement of the $ttH(b\bar{b})$ Cross Section in Events with High Higgs Boson Momentum at the ATLAS Experiment — •Doga Elitez, Lucia Masetti, Eftychia Tzovara, Asma Hadef, Alexander Basan, and Jessica Höfner for the ATLAS-Collaboration — Johannes Gutenberg Universität Mainz

The coupling of the Higgs boson to the top quark is very sensitive to effects of the physics beyond the Standard Model (BSM) and the most favorable production mode for direct measurement of the top Yukawa coupling is the Higgs production in association with a pair of top quarks, $t\bar{t}H$. The decay to two bottom quarks ($H\to b\bar{b}$) has the largest branching fraction of about 58%. This analysis aims at events where one of the top quarks decays semi-leptonically and produces an electron or a muon. The so-called boosted topology targets events containing a Higgs boson produced at high transverse momentum, whose decay products are contained in a large radius jet. In this talk, methods to improve background rejection, event reconstruction, and increase the sensitivity above the current p_T range are presented.

T 109.4 Thu 16:35 HSZ/0105

Search for Higgs boson pair production via vector-boson fusion in final states with four b-quarks in the boosted regime using data collected by the ATLAS detector at $\sqrt{s}=13$ TeV — •Marcus Vinicius Gonzalez Rodrigues, Janna Katharina Behr, and Kunlin Ran for the ATLAS-Collaboration — DESY, Hamburg, Germany

Searches targeting Higgs boson pair production via vector-boson fusion (VBF) provide unique access to the coupling of a Higgs boson pair to a vector boson pair (HHVV), and allow to set constraints on theories that predict resonant production of heavy particles that interact directly with the Higgs boson. The ultimate goal of this analysis is to improve the constraints on the HHVV coupling and search for heavy particles produced via VBF. For this purpose we consider the VBF di-Higgs pair production with final states containing four b-quarks in the boosted regime, where a pair of particle showers initiated by b-quarks from the decay of a high transverse momentum Higgs boson produces one single merged large-radius jet.

This analysis relies on data collected by the ATLAS detector at $\sqrt{s}=13$ TeV with an integrated luminosity of 139fb^{-1}. To improve the signal vs. background discrimination a Boosted Decision Tree (BDT) is used to define signal regions sensitive to the HHVV coupling, whereas a Parametric BDT is employed to define signal regions targeting resonant production in a wide range of masses. In this presentation the BDT performance will be shown with regard to the HHVV coupling constraints and to the limits on the resonant production.

T 109.5 Thu 16:50 HSZ/0105

Search for non-resonant Higgs Boson pair production in the decay channel bbWW at the CMS experiment — Martin Erdmann, •Peter Fackeldey, Benjamin Fischer, and Dennis Noll — III. Physikalisches Institut A, RWTH Aachen University

A measurement of the Higgs boson pair production can directly determine the trilinear Higgs coupling and probe the structure of the Higgs potential.

We present a search for Higgs boson pair production with one Higgs boson decaying into b quarks and the other Higgs boson decaying into W bosons. It includes final states with one or two leptons and resolved or boosted event topologies. The central challenge of this analysis is a tiny signal among a large amount of different backgrounds. To address this, we use physics process multiclass classification that is driven by a deep neural network.

We present results corresponding to the data recorded at the CMS experiment during Run 2.

T 109.6 Thu 17:05 HSZ/0105

Search for Higgs Boson Pair Production in Multi-Lepton Final States with the ATLAS Detector — Anamika Aggarwal, Janek Both, Volker Büscher, Antoine Laudrain, Christian Schmitt, •Niklas Schmitt, and Duc Bao Ta — Johannes Gutenberg-University, Mainz

After the discovery of the Higgs boson in 2012 at the LHC, many of its properties have already been determined precisely using 139 fb^{-1} of proton-proton collisions at $\sqrt{s}=13$ TeV. However, one of the biggest challenges in this field remains the measurement of the coupling of the Higgs boson to itself. It allows for a deep insight into the real shape of the Higgs potential and hence has a big impact on the understanding of fundamental interactions not only at the electroweak scale. In order to constrain the trilinear self-coupling, the Di-Higgs production cross section is measured. While decay modes including b-quarks typically have larger branching fractions, leptonic final states are generally much cleaner and have less SM background. Accordingly, probing this channel as a complement to $b\bar{b}$ analyses will be very promising.

Dedicated neural networks in the 2,3 and 4 lepton final states have been trained to distinguish all relevant signal processes against the sum of all SM backgrounds. This talk will highlight the performance of these multi-lepton channels compared to other HH decay modes and also introduces a regression network used for probing the sensitivity to the Higgs boson self-coupling. In addition, a first look into Run 3 data, as well as projections for the full Run 3 dataset, are presented.

T 110: Other Theory

Time: Thursday 15:50–17:20 Location: HSZ/0201

T 110.1 Thu 15:50 HSZ/0201

The use of Fierz identities beyond one loop — •Sophie Kollatzsch[1,2], Adrian Signer[1,2], Dominik Stöckinger[3], and Yannick Ulrich[4] — [1]Paul Scherrer Institut, CH-5232 Villigen PSI, Switzerland — [2]Physik-Institut, Universität Zürich, Winterthurerstrasse 190, CH-8057 Zürich, Switzerland — [3]Institut für Kern- und Teilchenphysik, TU Dresden, DE-01069 Dresden, Germany — [4]Institute for Particle Physics Phenomenology, University of Durham, South Road, Durham DH1 3LE, United Kingdom

EFTs typically contain dimension-six four-fermion operators. Different basis choices of such operators are possible by applying Fierz identities to rearrange four-fermion expressions. In d dimensions, such Fierz identities are not strictly valid; hence the question arises how such a basis change has to be treated at the (multi-)loop level. We discuss the treatment of so-called Fierz-evanescent operators, resulting in (finite) shifts of Wilson coefficients. Motivated by an abelian toy model, we show how the two-loop QED effects of specific Fierz-evanescent operators are absorbed into the renormalisation. As an example, we demonstrate how those basis changes affect the calculation of $\mu \to e\gamma$ at next-to-leading order.

T 110.2 Thu 16:05 HSZ/0201

Two-loop Treatment of a Simple Chiral Yang–Mills Model using Non-Anticommuting γ_5 — •Baibhab Ray — Deutsches Elektronen-Synchrotron DESY, Platanenallee 6, 15738 Zeuthen — TU Dresden, Institut für Kern- und Teilchenphysik, Zellescher Weg 19, 01069 Dresden

For practical calculations of loop diagrams in perturbative quantum field theory, Dimensional Regularization (DREG) is the most commonly applied regularization scheme. In this context, fields and integrals are transformed to D dimensions and one invariably needs to decide how intrinsically four-dimensional quantities like γ_5 should be treated in $D \neq 4$ dimensions. The original and to date most rigorous and universal HVBM scheme ('t Hooft–Veltman/Breitenlohner–Maison) forfeits anticommutativity of γ_5 with all other γ^μ and breaks BRST symmetry in intermediate steps. The latter can be restored by means of finite, symmetry-restoring counterterms.

In this talk, I shall discuss a simple chiral Yang–Mills model with only one SU(N) gauge group and without scalar fields, and present two-loop results in the HVBM scheme. Besides acquiring the two-loop counterterm structure (involving both singular and finite counterterms), I shall demonstrate methods of cross-checking by considering the Abelian special case (which can be compared with literature), as well as comparing with Ward identities (which are derived from the relevant Slavnov–Taylor identities encoding BRST symmetry). Time permitting, I shall provide insights into the implementation in `Mathematica`.

T 110.3 Thu 16:20 HSZ/0201

The phase structure of neutral three flavor quark matter — •Marco Hofmann, Gholami Hosein, and Buballa Michael — Institut für Kernphysik, Technische Universität Darmstadt, Schlossgartenstr. 2, 64289 Darmstadt

This talk explores the phase structure and equation of state of dense neutral quark matter at zero and finite temperature. As the equation of state and the speed of sound of neutron stars become more and more constrained by observations from gravitational waves and mass-radius measurements, the phenomenology of the quark matter phase structure is pivotal to understand the composition of stars with a quark matter core. We calculate the phase diagram from a three flavor Nambu Jona-Lasinio (NJL)-type model in the mean field approximation. Color superconductivity is included through the attractive scalar diquark channel. A repulsive vector interaction increases the stiffness of the matter. Furthermore, we address the systematic removal of cutoff artefacts within an renormalization group consistent approach.

T 110.4 Thu 16:35 HSZ/0201

Hybrid equation of state and mass radius relation — •Hosein Gholami, Marco Hofmann, and Michael Buballa — Institut für Kernphysik,Technische Universität Darmstadt, Schlossgartenstraße 2, 64289 Darmstadt

With the discovery of gravitational waves from neutron star mergers, investigating the structure of these objects using theoretical models has gained more importance. Matter at the highest densities reached in neutron star remnants is expected to be in a color superconducting state. To constrain the quark matter equation of state at these densities, we compare with constraints on hybrid star equations of state for isolated neutron stars at zero temperature. Here we explore the speed of sound and mass-radius relation for such hybrid equations of state. We also study these properties within a renormalization group consistent approach. Our calculation is based on a mean field approximation of three flavor Nambu Jona-Lasinio (NJL)-type models. A repulsive vector interaction is included to satisfy the 2 solar mass neutron star observations. Color superconducting phases are included through the attractive scalar diquark channel.

T 110.5 Thu 16:50 HSZ/0201

Notational Invariance of the standard model — •Lello Boscoverde — Istituto della Fava Pazza, Garching

We present current investigations into the notational invariance of the standard model as well as an introduction to the principles of notational invariance with pedagogical examples, a history of its study, and algorithms for implementing changes of notation.

T 110.6 Thu 17:05 HSZ/0201

Particle knowledge enhanced by a classical model — •Albrecht Giese — Taxusweg 15, 22605 Hamburg

According to today's understanding, the properties of elementary particles must be treated quantum mechanically - preferably according to the "Copenhagen Interpretation". In contrast, we present a particle model that classically provides the usual parameters; and what is more, it derives parameters that are only postulated by today's quantum mechanics.

This classic model initially refers to Louis de Broglie's approach and takes into account the relativistic behavior of particles. With these ingredients, not only standard properties such as spin and magnetic moment can be derived. In complete contrast to the Higgs model, it is possible to determine the particle mass very precisely; in the case of the electron by 1:300 000 without any adaption of parameters. It also allows the physical quantities h (Planck) and alpha not only to be postulated, but also to be derived from more fundamental elements. The additional understanding gained in this way leads to further properties such as the Pauli principle and the color codes of quarks, which are also only postulated to this day.

Further info: www.ag-physics.org/rmass

T 111: Outreach Diverse (joint session T/HK)

Time: Thursday 15:50–17:20 Location: HSZ/0204

T 111.1 Thu 15:50 HSZ/0204

Z0-Versuch im Jupyter notebook — •Gianni Di Paoli, Guenter Duckeck und Nikolai Hartmann — LMU München

Der 'Z0-Versuch' mit OPAL/LEP Daten ist an der LMU München seit vielen Jahren ein klassischer Versuch im Fortgeschrittenen Praktikum und wird in verschiedenen Varianten auch an anderen Universitäten verwendet. Er illustriert exemplarisch Analysemethoden in der Teilchenphysik und erlaubt die Bestimmung fundamentaler Parameter wie Z0-Masse, -Breite und Zahl der Neutrino-Generationen. Im Rahmen einer Bachelor Arbeit wurde die bisherige Root-basierte Analyse auf die Python data-science Umgebung und jupyter notebooks umgestellt. Das erleichtert zum einen den Studierenden die Versuchsdurchführung, weil die meisten schon mit der Python/Jupyter Umgebung vertraut sind. Zum anderen lernen sie anspruchsvolle Filter-techniken, komple-

xe Visualisierungen und Fit-Verfahren kennen, die über die Standard-Beispiele in den einschlägigen Kursen und Tutorials hinausgehen.

T 111.2 Thu 16:05 HSZ/0204

Forschung trifft Schule @home - Digitale Teilchenphysik-Fortbildungen für Lehrkräfte — •Philipp Lindenau[1], Carolin Gnebner[2], Niklas Herff[1], Michael Kobel[1], Frank Siegert[1] und Steffen Turkat[1] für die Netzwerk Teilchenwelt-Kollaboration — [1]Technische Universität Dresden — [2]DESY Zeuthen

Häufig unter den Herausforderungen der Covid-19-Pandemie entstanden, haben digitale Angebote mittlerweile einen festen Platz in der Bildungslandschaft. Auch die von Netzwerk Teilchenwelt dank der Förderung durch die Dr. Hans Riegel-Stiftung durchgeführte Fortbildungsreihe "Forschung trifft Schule" wurde um in der Regel halbtägige digitale Formate erweiterte, die nun unter dem Titel "Forschung trifft Schule @home" zum permanenten Veranstaltungsportfolio gehören. Das digitale Angebot beinhaltet insbesondere Fortbildungen zur Forschungsmethodik in der Teilchenphysik unter dem Motto "Von der Kollision zur Entdeckung" sowie Veranstaltungen zur Astroteilchenphysik und deren Behandlung im Schulunterricht unter Nutzung des Online-Tools Cosmic@Web. Die Veranstaltungen wurden bundesweit beworben und von Lehrkräften aus fast dem gesamten Bundesgebiet sowie von deutschen Schulen im Ausland besucht. Im Vortrag werden sowohl die bisher umgesetzten als auch geplante Formate sowie das Feedback der teilnehmenden Lehrkräfte vorgestellt und diskutiert.

T 111.3 Thu 16:20 HSZ/0204

Physik der kleinsten Teilchen in der Schule - Eine multiperspektivische Tagungsreihe zur kohärenten Vermittlung — Stefan Heusler[1], Christian Klein-Bösing[1], Michael Kobel[2], •Philipp Lindenau[2], Oliver Passon[3] und Thomas Zügge[4] — [1]Westfälische Wilhelms-Universität Münster — [2]Technische Universität Dresden — [3]Bergische Universität Wuppertal — [4]Universität Greifswald

Es existiert eine Vielzahl von Unterrichtsentwürfen für die Vermittlung der Teilchenphysik, Hadronen- und Kernphysik sowie Astroteilchenphysik. Engagierte Physiker:innen aus Outreach, Schulpraxis, Fachwissenschaft und Fachdidaktik, aber auch populärwissenschaftliche und Schulbuchverlage konzipierten Vermittlungskonzepte – häufig unabhängig voneinander. Mit zunehmender Aufnahme der Themen in die Lehrpläne stieg das Bedürfnis nach Austausch der Akteur:innen. Einige für die kohärente Vermittlung zentrale Fragen erwiesen sich als nur gemeinsam bearbeitbar, etwa jene nach der verwendeten Nomenklatur, den bildenden Inhalten, Bezügen zur aktuellen Forschungspraxis und Verknüpfung mit den in den Lehrplänen ausgedrückten Kompetenzerwartungen. So fand 2018 ein interdisziplinäres Symposium in Wuppertal statt. Weitere Tagungen folgten in Münster und Dresden. Sukzessive trug der kollegiale Austausch dazu bei, Unschärfen in unseren Vermittlungspraxen zu erkennen und bildende Gelegenheiten der Themen zu identifizieren. Die nächste Tagung ist 2023 in Greifswald mit dem Schwerpunkt "Nature of Science" geplant. Im Vortrag werden die Tagungsreihe sowie einige ihrer bisherigen Ergebnisse vorgestellt.

T 111.4 Thu 16:35 HSZ/0204

Bausteine der Materie – ein Mitmachexperiment für Schüler:innen — •Luisa Faber für die Netzwerk Teilchenwelt-Kollaboration — Institut für Kernphysik, WWU Münster

Das Projekt „Bausteine der Materie – Ein Mitmachexperiment für Schüler:innen“ soll Schüler:innen durch die Vermittlung von Inhalten der Kern- und Teilchenphysik für Natur und Technik begeistern. Als Kernelement wurden die weitverbreiteten Klemmbausteine gewählt, um eine aktive Beteiligung und selbstständiges Arbeiten der Schüler:innen zu ermöglichen.

Inhalte des Buchs „Particle Physics Brick by Brick“ von Dr. Ben Still dienen als erster Kontakt der Schüler:innen mit den Elementarteilchen des Standardmodells – den Bausteinen der Materie. Der Nachbau des ALICE-Detektors aus LEGO® in verschiedenen Maßstäben ist ein zentraler Bestandteil des Projekts. Dabei soll der gemeinschaftliche Charakter der wissenschaftlichen Arbeit vermittelt werden.

Ziel der Arbeit ist die Einbindung der beschriebenen Komponenten in einen Workshop. Dieser soll in unterschiedlichem Umfang in Schulklassen und bei verschiedenen Events durchgeführt werden können. Beim Bau eines ALICE-Modells aus 18.000 LEGO®-Teilen in einer AG an einem Gymnasium in Münster werden bereits erste Elemente des Workshops angewendet.

In dem Vortrag wird über den aktuellen Stand des Projekts und bereits erfolgte Events, die in Zusammenarbeit mit dem Netzwerk Teilchenwelt durchgeführt wurden, berichtet. Gefördert durch die Joachim Herz Stiftung.

T 111.5 Thu 16:50 HSZ/0204

Cosmic Watch - Bau eines Myonendetektors für Schulkinder — •Sebastian Laudage — Argelander-Institut für Astronomie, Universität Bonn

Sekundäre Teilchen der kosmischen Strahlung, insbesondere Myonen, erreichen zu hoher Zahl jede Sekunde unsere Erdoberfläche und sind ohne dass wir es merken, Teil unseres alltäglichen Lebens. Sie sind ein unsichtbares, aber höchst interessantes Phänomen astronomischen Ursprungs. Im privaten Kontext oder an Schulen war die Untersuchung dieses Bereichs der Physik bislang nur rudimentär möglich, da zuverlässige Detektoren komplex und teuer in der Herstellung sind. 2017 wurde das Projekt Cosmic Watch durch einen PhD-Studenten am MIT (Spencer N. Axani) entwickelt, welches den Bau eines bezahlbaren (≈ 120 Euro), zuverlässigen und mobilen Myonendetektors beschreibt. Der fertige Detektor ist nur etwa 8x7x4cm groß, ist leicht zu bedienen und kann autark die lokale Rate, Energie und Richtung von passierenden Myonen messen. Damit ist er sehr gut geeignet um Schüler:innen oder Fachfremden einen Einblick in die Welt der Astroteilchenphysik zu geben. Neben spannenden experiementellen Möglichkeiten bietet der Detektor die Möglichkeit Erfahrungen im löten und mit elektrischen Schaltungen zu sammeln, da er nach Anleitung selber zusammengebaut werden kann. Der Vortrag beschreibt den Aufbau des Detektors, die Umsetzbarkeit des Baus als Projekt für Schüler:innen oder Hobbybastler:innen und gibt Ausblick auf Anwendungmöglichkeiten in der Lehre.

T 111.6 Thu 17:05 HSZ/0204

Die Selbstbau-Nebelkammer als Hands-On Exponat für Events und Ausstellungen — •David Borgelt und Christian Klein-Bösing für die Netzwerk Teilchenwelt-Kollaboration — Wilhelm-Klemm-Str. 9 48149 Münster

Diffusions-Nebelkammern sind ein beliebtes Exponat für physikbezogene Ausstellungen. Beispielsweise verfügen sowohl die Dauerausstellung des FB Physik der WWU, das ExperiMINTum, als auch das Universum in Bremen über solche Nebelkammern. Allerdings sind diese wie klassische Exponate in Museen zu bestaunen und besitzen keine Hands-On Charakteristika.

In zahlreichen Workshops für Schulen sowie in Masterclasses (siehe Netzwerk-Teilchenwelt) erweist sich das Konzept der Hands-On Exponate in Form von Selbstbau-Nebelkammern des Netzwerk Teilchenwelt als überaus beliebt. Auch für Ausstellungen oder Events mit naturwissenschaftlichem Schwerpunkt können diese von Bedeutung sein. Die Selbstbau-Nebelkammern sind wie die Diffusions-Nebelkammern hervorragend dazu geeignet, die Relevanz von Teilchenphysik im Alltag zu zeigen. Darüber hinaus kann mit der Selbstbau-Nebelkammer zusätzlich das Experimentieren als Bestandteil der Physik vorgestellt und Aspekte von Nature of Science diskutiert werden.

In diesem Vortrag werden die Hands-On Charakteristika der Selbstbau-Nebelkammer vorgestellt und Erfahrungsberichte über ihren Nutzen in Ausstellungen und auf Events präsentiert.

T 112: DAQ Test/RO – GRID I

Time: Thursday 15:50–17:20 Location: HSZ/0301

T 112.1 Thu 15:50 HSZ/0301

Modular and Scalable Multi-Timepix3 Readout System — •Thomas Block, Klaus Desch, Markus Gruber, Jochen Kaminski, and Tobias Schiffer — Universität Bonn

The Timepix3 chip of the Medipix3 collaboration is a highly granular pixel chip. It can be used in combination with different detector components, e.g. with a bump bonded silicon pixel sensor, with a photolithographically postprocessed MicroMegas gas amplification stage (InGrid), or with a micro-channel plate (MCP). Therefore different

detectors can be built, which can be used for various applications like beam telescopes, X-Ray detectors for axion search and polarimetry and neutron detectors. For these different detectors we are developing a fully open source solution: the Timepix3 readout system. It enables us to adapt to the different requirements (low- to high-rate events and single- to multi-chip design) efficiently. The system, which already has been used in test runs, supports different FPGA boards, which cover the different requirements. The Scalable Readout System (SRS), being one of them, together with of our own PCB designs, supports low- to medium-rate applications. Based on the basil framework, developed at SILAB Bonn, the firmware is written in Verilog and the software is written in Python. For the control system both a graphical user interface and a command-line interface have been developed.

In this talk I will present the readout and control system and the recent development from single-chip to multi-chip support. Also I will show the needed functionality like calibration, equalisation, readout and monitoring.

T 112.2 Thu 16:05 HSZ/0301

Scan Automated Testing for the ATLAS Pixel Detector — Marcello Bindi, Arnulf Quadt, and •Chris Scheulen — II. Physikalisches Institut, Georg-August Universität Göttingen

The ATLAS Pixel detector data acquisition system (DAQ) is distributed over several different physical components, such as front-end detector modules, read-out drivers, and PCs for operating and calibrating the detector. As a result, time-consuming manual tests are currently required to ensure the correct operation of the entire system after software or firmware changes in any one component. After the first year of detector operation during Run 3, this represents a bottleneck to the development work carried out during the end-of-year shutdown on the basis of the experience collected, such as observed dead-time desynchronisation instabilities.

To simplify software validation and free up manpower, a suite of automated tests is being developed for deployment in the DAQ software's continuous integration system on GitLab. Fully automated testing is only possible without involvement of the detector modules, whose operation requires some degree of manual supervision. Therefore, emulated detector responses are used for tests of read-out chain components under exclusion of the detector modules themselves.

This talk will provide a brief overview of required improvements to the Pixel detector's DAQ system based on the operational experience collected during the first data-taking year of Run 3. A special focus will be placed on the development of the automated testing framework being used to validate this firmware and software development.

T 112.3 Thu 16:20 HSZ/0301

Tests of the Mu3e DAQ in the Cosmic run 2022 — •Martin Müller for the Mu3e-Collaboration — Institute for Nuclear Physics, JGU Mainz

The Mu3e experiment will search for the lepton flavour violating decay $\mu^+ \to e^+e^-e^+$ and is aiming for a sensitivity of one in 10^{16} muon decays. Since this decay is highly suppressed in the Standard Model to a branching ratio of below $\mathcal{O}(10^{-54})$, an observation would be a clear sign for new physics.

In the Mu3e detector, four layers of silicon pixel sensors will be used to track electrons and positrons and a time resolution of $\mathcal{O}(100\ ps)$ will be provided by scintillating tile and fibre detectors. The overall detector is expected to produce a data rate from 80 Gbit/s (Phase I) to 1 Tbit/s (Phase II), which will be processed in a three-layer, triggerless DAQ system using FPGAs and a GPU filter farm for online event selection.

A prototype of the detector was operated in summer 2022 in the first Mu3e cosmic run with the intent to test and validate a variety of systems. The operated prototype included two cylindrical layers of pixel sensors, a scintillating fibre module and a vertical slice of the final data acquisition (DAQ) system. The talk will focus on the commissioning and validation of the DAQ in this run.

T 112.4 Thu 16:35 HSZ/0301

Integration of the Goettingen HPC resources to the WLCG Tier- 2 grid computing environment of GoeGrid — •Uday Saidev Polisetty, Arnulf Quadt, Daniel Schindler, and Sebastian Wozniewski — II. Physikalisches Institut, Georg-August-Universität Göttingen

The amount of data produced will significantly increase with the upcoming Run 4 of the LHC. To handle the incoming data there is a necessity to increase the computing resources for simulation, reconstruction and analysis in terms of storage and computing power. The important aspect of the solution is the integration of the High Performance Computing (HPC) resources. At Goettingen campus, there is both WLCG (Worldwide LHC Computing Grid) Tier-2 site (GoeGrid) and a large HPC cluster by National High Performance Computing (NHR) and North German Supercomputing Alliance (HLRN) supercomputer resources. In context of the FIDIUM project, the aim is to increase the computing resources by integrating the local HPC cluster to the GoeGrid. The unused quota from the external sources can be used to fill the shortage of computing resources required for the ATLAS experiment. This integration would lead to a solution to run all the job types provided by the ATLAS experiment.

T 112.5 Thu 16:50 HSZ/0301

Analysis benchmarking tests on selected sites — •David Koch[1], Thomas Kuhr[1], Günter Duckeck[1], Dennis Noll[2], and Benjamin Fischer[2] — [1]LMU München, Germany — [2]RWTH Aachen, Germany

A fast turn-around time and ease of use are important factors for systems supporting the analysis of large HEP data samples. We study and compare multiple technical approaches. This presentation will be about setting up and benchmarking the Analysis Grand Challenge (AGC) using CMS Open Data. The AGC is an effort to provide a realistic physics analysis with the intent of showcasing the functionality, scalability and feature-completeness of the Scikit-HEP Python ecosystem.

I will present the results of setting up the necessary software environment for the AGC and benchmarking the analysis' runtime on various computing clusters: the institute SLURM cluster at my home institute, LMU Munich, a SLURM cluster at LRZ (WLCG Tier-2 site) and the analysis facility Vispa, operated by RWTH Aachen. Each site provides slightly different software environments and modes of operation which poses interesting challenges on the flexibility of a setup like that intended for the AGC. Comparing these benchmarks to each other also provides insights about different storage and caching systems. At LRZ and LMU we have regular Grid storage (HDD) as well as and SSD-based XCache server and on Vispa a sophisticated per-node caching system is used.

T 112.6 Thu 17:05 HSZ/0301

Transparent extension of the Worldwide LHC Computing Grid to non-HEP resources — Manuel Giffels[1], •Alexander Jung[2], Thomas Kress[3], Thomas Madlener[4], Andreas Nowack[3], Alexander Schmidt[2], and Christoph Wissing[4] — [1]Institut für Experimentelle Teilchenphysik, Karlsruher Institut für Technologie, Deutschland — [2]III. Physikalisches Institut A, RWTH Aachen, Deutschland — [3]III. Physikalisches Institut B, RWTH Aachen, Deutschland — [4]Deutsches Elektronen-Synchrotron DESY, Deutschland

With the recently started Run 3 of the LHC, enormous amounts of data are expected. It is already foreseeable that the resources provided by the Worldwide LHC Computing Grid (WLCG) will be put under a lot of stress in the coming years, especially at the start of HL-LHC in Run 4. HEP computing is therefore increasingly developing in the direction of using external non-HEP dedicated resources and thus becoming more heterogeneous. This contribution reports on the work carried out as part of the BMBF (Bundesministerium für Bildung und Forschung) funded FIDIUM (Föderierte digitale Infrastrukturen für die Erforschung von Universum und Materie) project on the dynamic and transparent integration of non-HEP resources into the existing infrastructure of the WLCG and what challenges arise in the process. The currently ongoing integration of the high performance computing (HPC) resources at Jülich Supercomputing Centre (JSC) using the resource manager COBalD/TARDIS serves as an example.

T 113: QCD Theory and Experiment II

Time: Thursday 15:50–17:20 Location: HSZ/0405

T 113.1 Thu 15:50 HSZ/0405

Quark Masses in the Heavy Quark Expansion — •Anastasia Boushmelev[1], Thomas Mannel[1], and K. Keri Voss[2] — [1]Theoretische Physik 1, Center for Particle Physics Siegen Universität Siegen, D-57068 Siegen, Germany — [2]Gravitational Waves and Fundamental Physics (GWFP), Maastricht University, Duboisdomein 30, NL-6229 GT Maastricht, the Netherlands and Nikhef, Science Park 105, NL-1098 XG Amsterdam, the Netherlands

Many observables can be written in terms of an operator product expansion (OPE) which factorizes the expression in perturbative and non-perturbative parts. The examples to be studied in this talk are the Heavy Quark Expansion (HQE) for inclusive semi-leptonic $b \to u$ decays and the inverse moments of the cross section $e^+e^- \to$ hadrons.

In both cases the leading term of the OPE is given by the perturbatively calculated, partonic expression, which depends on the mass of the heavy quark. Calculating this using the pole mass one encounters the problem that this mass scheme suffers from so called renormalon induced ambiguities which spoil the convergence of the perturbative expansion.

However, we propose the following strategy: Since observables should be free of such ambiguities, we use an observable such as an inverse moment of the $e^+e^- \to$ hadrons cross section to eliminate the pole mass from the expression for the semi-leptonic $b \to u$ rate, obtaining a perturbative relation between two observables valid to leading order in the OPE.

T 113.2 Thu 16:05 HSZ/0405

Measurement of D^* meson cross sections in the full phase space for charm in CMS — •Yewon Yang[1], Achim Geiser[1], Nur Zulaiha Jomhari[1], Valentina Mariani[2], Josry Metwally[1], and Max Uetrecht[3] — [1]Deutsches Elektronen-Synchrotron DESY, Notkestraße 85, D-22607 Hamburg — [2]Università degli Studi di Perugia, Piazza Università, 106123 Perugia — [3]Technische Universität Dortmund, August-Schmidt-Straße 1, 44227 Dortmund

This is a summary talk about total, single- and double-differential cross sections for charm which are measured from the reconstruction of charm hadronic states in the CMS detector. Among all the hadronic states of charm, for this talk especially the reconstruction of D^* which decays into D^0 and a slow pion is introduced at proton-proton center-of-mass energies of 0.9, 5, 7, and 13 TeV. The measured cross sections for this final state show consistency compared to QCD theory and also to other LHC experiments. Then the D^* meson cross sections measured in the full phase space accessible with the CMS detector are extrapolated to extract the total charm cross section. For the first time, this extrapolation applies the p_T-dependent cross-section ratios between meson and baryon of charm, which are recently measured from LHC experiments.

T 113.3 Thu 16:20 HSZ/0405

Study of the X(3915) at Belle — •Yaroslav Kulii[1], Thomas Kuhr[1], and Boris Grube[2] — [1]Ludwig-Maximilians-Universität München — [2]Thomas Jefferson National Accelerator Facility

Many of the charmonium states, which consist of a charm and anticharm quark, have been found and studied experimentally. Detailed theoretical predictions of the charmonium excitation spectrum agree well with the experimental data.

However, in recent years experiments discovered a growing number of charmonium-like states that do not fit into the predicted charm-anticharm excitation spectrum. One such state is $X(3915)$. It has been discovered by the BaBar and Belle collaborations in the two-photon reaction $e^+e^- \to e^+e^-X(3915) \to e^+e^-J/\psi\omega$, where the final-state electron and positron were not detected. The analysis of projections of angular distributions preferred the $J^{PC} = 0^{++}$ hypothesis, but other quantum numbers, in particular $J^{PC} = 2^{++}$, could not be excluded.

Because of this the $X(3915)$ was initially identified as the $\chi_{c0}(2P)$ charmonium state, although its mass and decay width were not in good agreement with the theory predictions. Following the Belle discovery of the $X^*(3860)$, which agrees much better with the $\chi_{c0}(2P)$ hypothesis, opinions shifted towards interpreting the $X(3915)$ as an exotic state. It could be, for example, a meson molecule or a so-called hybrid meson.

We will present research prospects and the status of the angular analysis to measure the quantum numbers of the $X(3915)$ in its $J/\psi\omega$ decay using Belle data.

T 113.4 Thu 16:35 HSZ/0405

Measuring the Drell-Yan Cross Section using Forward Electrons with the ATLAS Detector — •Craig Wells for the ATLAS-Collaboration — Deutsches Elektronen-Synchrotron (DESY), Hamburg, Germany

The full LHC Run-2 dataset offers an unparalleled opportunity to measure the complete decomposition of the Drell-Yan cross section in terms of the lepton decay angles in the rest frame of the incident quarks, rapidity of the dilepton system, and the transverse momentum of the vector boson. For this purpose, forward electrons ($|\text{eta}| > 2.5$) in the ATLAS detector present a unique opportunity to probe Z decays in extreme regions of phase space, which are sensitive to fundamental parameters of the Standard Model.

Forward electrons are, however, experimentally challenging objects to work with, due to large amounts of passive material in this region of ATLAS. This talk will present an overview of the analysis and calibration process for forward electrons, so that they are ready to be used for physics purposes.

T 113.5 Thu 16:50 HSZ/0405

Machine-learning off-shell effects in top quark production at the LHC — •Mathias Kuschick — Institut für Theoretische Physik, Münster

Measuring top quark processes at the LHC is an important test of the Standard Model of particle physics. As the heaviest of all quarks the investigation into its properties allows for tests of QCD and the electroweak interaction as well as tests of the Higgs mechanism, but also provides a window to new physics. Therefore, a precise determination of the top quark's fundamental properties is compulsory. Such determinations heavily rely on precise theoretical calculations. The most sophisticated of such calculations include improvements such as radiative corrections or off-shell effects, which make them extremely computational costly to evaluate. In my talk I will explore the use of modern machine learning techniques such as neural networks to learn how top pair production predictions change when finite width and interference effects are included in an effort to bypass the undesirable computational complexity of such calculations.

T 113.6 Thu 17:05 HSZ/0405

Automated NLO electroweak corrections to processes at hadron and lepton colliders — •Pia Bredt — U. Siegen, Siegen, Germany

The aim of this project was the completion of an automated framework calculating NLO corrections in the full SM for arbitrary processes at hadron and lepton colliders. This framework is an element of the Monte-Carlo program WHIZARD simulating cross sections and differential distributions. Specifically, it builds on the implemented FKS subtraction scheme for NLO QCD calculations, and extends it to automated NLO EW and QCD-EW mixed corrections. To that end, the implemented FKS scheme is generalised to systematically subtract QED and QCD infrared divergences in mixed coupling expansions. The automated computation of NLO contributions is validated for a set of benchmark processes at the LHC, including e. g. $t\bar{t}$ $(+H/W/Z)$ production. Cross-checks for e^+e^- processes likewise show that WHIZARD can be used for predictions at lepton colliders including fixed $\mathcal{O}(\alpha)$ corrections. This framework is applied to the study of multi-boson processes at a future multi-TeV muon collider.

T 114: Neutrinos V

Time: Thursday 15:50–17:20 Location: POT/0051

T 114.1 Thu 15:50 POT/0051

Characterization of the ECHo-100k detector response — •Raghav Pandey[1], Arnulf Barth[1], Sebastian Berndt[2], Holger Dorrer[2], Christoph E. Düllmann[2], Christian Enss[1], Andreas Fleischmann[1], Nina Kneip[3], Federica Mantegazzini[1], Klaus Wendt[3], and Loredana Gastaldo[1] — [1]Kirchhoff Institute for Physics, Heidelberg University — [2]Department of Chemistry - TRIGA Site, Johannes Gutenberg-Universität Mainz — [3]Institute of Physics, Johannes Gutenberg-Universität Mainz

In the ECHo-100 experiment high energy resolution and high statistics Ho-163 electron capture spectra will be acquired with more than 10000 single detector pixels that fully enclose implanted Ho-163. A well-understood and reliable detector response is at the basis for a precise analysis of the spectral shape in the endpoint region around 2.8 keV. We present the results obtained with ECHo-100k detectors containing Ho-163. We discuss the shape of the acquired spectrum with respect to the spectrum acquired with ECHo-1k detectors and with the spectrum acquired with the same ECHo-100k detectors but consisting only of the lower half of the absorber, meaning without complete Ho-163 enclosure.

T 114.2 Thu 16:05 POT/0051

First ^{7}Be Electron Capture Spectrum measured with MMCs — •Arnulf Barth[1], Karl Johnston[2], Federica Mantegazzini[1], Peter Rubovič[3], and Loredana Gastaldo[1] — [1]Kirchhoff-Institute for Physics, Heidelberg University — [2]ISOLDE, CERN — [3]Institute of Experimental and Applied Physics, Czech Technical University in Prague

^{7}Be, with a half-life of about 53 days and a Q-value of about 862 keV is the lightest nuclide to undergo electron capture. In nature, electron capture processes typically occur in atoms within a medium. ^{7}Be electrons provide very low screening from environment effects from the host material, causing a change in half-life and other atomic properties. This makes ^{7}Be an optimal candidate to study the effect of different host materials on the electron capture process and on the energy transferred to the nuclear recoil. We present the first measurement of the ^{7}Be spectrum using low temperature metallic magnetic calorimeters where ^{7}Be has been ion-implanted into gold. We achieved a baseline resolution of 4 eV FWHM and could observe the peak corresponding to the capture of the 1s electron, which includes the atomic de-excitation energy and the nuclear recoil energy. These very promising results demonstrate the possibility to perform a detailed study of the effect of the environment on the electron capture process by implanting ^{7}Be in different host materials.

T 114.3 Thu 16:20 POT/0051

Reducing temperature drifts and their effect on MMC detector response for the ECHo experiment — •Cicek Cihan, Arnulf Barth, Daniel Unger, Daniel Hengstler, Andreas Fleischmann, and Loredana Gastaldo — Kirchhoff Institute for Physics, Heidelberg University

In the ECHo experiment, large arrays of metallic magnetic calorimeters are mounted at the mixing chamber plate of a dilution refrigerator kept at a temperature below 20 mK. The temperature of the mixing chamber is regulated and shows average drifts at the level of 1 μK. Methods to improve the stability are presently under study.
Even if very small, these temperature fluctuations degrade the energy resolution of detectors optimized for the ECHo experiment. To cure this effect, each ECHo chip hosts two temperature sensors. For each triggered event in pixels on a chip, the signal of the temperature channels are also acquired and will be used for an off-line correction. We discuss methods which allow for identification and correction of temperature instabilities and present the effect of this correction on energy resolution.

T 114.4 Thu 16:35 POT/0051

Analysing KATRIN neutrino mass data using a neural network — Christian Karl[1,2], Susanne Mertens[1,2], •Alessandro Schwemmer[1,2], and Christoph Wiesinger[1,2] for the KATRIN-Collaboration — [1]Physik Department, Technische Universität München, Garching — [2]Max-Planck-Institut für Physik, München

The Karlsruhe Tritium Neutrino (KATRIN) experiment probes the effective electron anti-neutrino mass by a precision measurement of the tritium beta-decay spectrum near the endpoint. A world-leading upper limit of 0.8 eV c^{-2} (90 % CL) has been set with the first two measurement campaigns. Improvements w.r.t. the measurement configuration allowed for an enhanced signal-to-background ratio as well as a reduction of systematic uncertainties and a substantial increase in statistics. Subsequently the combined sensitivity of the first five datasets is estimated to be below 0.5 eV c^{-2} (90 % CL). In this talk we will present a novel approach for the analysis of these datasets using a neural network.

T 114.5 Thu 16:50 POT/0051

High voltage preparation and first measurement of a new ^{83m}Kr conversion line with the KATRIN experiment — •Benedikt Bieringer and Matthias Böttcher for the KATRIN-Collaboration — Institute for Nuclear Physics, University of Münster

The Karlsruhe Tritium Neutrino Experiment (KATRIN) is targeted to measure the neutrino mass with a design sensitivity of 0.2 eV at 90 % confidence level through electron spectroscopy of β^- decay electrons from a windowless gaseous tritium source. To determine the spectrometer properties and to calibrate the beamline work function, a Condensed Krypton Source (CKrS) can be inserted into the beamline, providing conversion electrons from ^{83m}Kr. For precision spectroscopy, the KATRIN experiment features a stabilized high voltage system up to −35 kV with ppm level precision. This talk presents the extention of the KATRIN high voltage system to support retarding potentials of up to −40 kV and a consecutive first measurement of a new ^{83m}Kr conversion line using the CKrS following the idea of EPJ C 82 (2022) 700.

The work shown in this talk is funded via BMBF contract number 05A20PMA.

T 114.6 Thu 17:05 POT/0051

Optimization-based Bayesian sensitivity on neutrino mass and constraints on cosmology with the KATRIN experiment — Stephanie Hickford[1], Leonard Köllenberger[1], and •Weiran Xu[2] — [1]Institute for Astroparticle Physics, Karlsruhe Institute of Technology — [2]Laboratory for Nuclear Science, Massachusetts Institute of Technology

The Karlsruhe Tritium Neutrino (KATRIN) experiment has pushed the direct bound of the neutrino mass down to sub-eV level in their first two scientific campaigns. The upcoming data release using a frequentist approach which includes the most recent three measurement campaigns is currently in preparation.

A comprehensive Bayesian analysis provides an alternative interpretation for the prior information and the neutrino mass results. Performing Bayesian sampling is computationally intensive and challenging when including all the systematic uncertainties, e.g. for the shifted analyzing plane configuration of the main spectrometer. New methods to optimize the model calculation will be presented, together with the Bayesian sensitivity for KATRIN's first five measurement campaigns. Constraints on cosmological models with the released data will also be presented within the Bayesian framework.

T 115: Gamma Astronomy V

Time: Thursday 15:50–17:20 Location: POT/0151

T 115.1 Thu 15:50 POT/0151

Quasi-periodic behavior of J1048+7143* — •Armin Ghorbanietemad[1], Ilja Jaroschewski[1], Emma Kun[1,2,3], and Julia Becker Tjus[1] — [1]Theoretical Physics IV, Ruhr University Bochum — [2]CSFK, MTA Centre of Excellence, Hungary — [3]Konkoly Observatory, ELKH, Hungary

Most blazars show short- and long-term variability in their electromagnetic emissions. Some of these have a gamma-ray light curve with a periodic pattern with a declining periodicity called quasi-periodic behavior, which is evident in observations using Fermi-LAT. Jet precession is a possible explanation for such a behavior. Supermassive binary back holes (SMBBHs) are characterized by the change in jet direction accompanied by jet precession close to an imminent merger, which makes them interesting candidates as the origin of quasi-periodic emission. A recent study on the multi-messenger behavior of the blazar J1048+7143 indicates a quasi-periodic behavior in the gamma-ray emissions from 2009 until now. The detected gamma-ray light curve is composed of three double-peak structures, each different in shape and symmetry, which makes conventional ways of signal assessment unsuitable.

In this talk, we analyze the gamma-ray light curve of J1048+7143 and use the centroid approach to find its characterizations, meaning duration and period. Furthermore, we apply our developed jet precession model on this blazar. Our findings show that its gamma-ray flares are compatible with an SMBBH at its center. Then, we use this model to predict its next gamma-ray flares and the time of merger based on its mass ratio. *Supported by DFG (SFB 1491)

T 115.2 Thu 16:05 POT/0151

Potential for detection of M31-like gamma-ray halos with CTA and Fermi-LAT — •Mario Engelmann, Alison Mitchell, and Katrin Streil — Erlangen Centre for Astroparticle Physics Nikolaus-Fiebiger-Str. 2 D-91058 Erlangen Germany

Recent evidence from the Fermi LAT satellite suggests that a gamma-ray halo exits around the Andromeda Galaxy. One explanation for the gamma-ray emission is, that in the inner region of the galaxy, buoyant bubbles of gas are created. These bubbles are pushed outwards and create a cosmic ray Halo around the galaxy. Consequently, the gamma rays are produced via proton-proton interaction of cosmic rays or inverse Compton scattering of cosmic ray electrons with the microwave background photons.

The sensitivity of the Fermi LAT satellite isn't sufficient to observe the whole spectrum in the GeV range. For this reason, observations with CTA can be used to search for emission at higher energies. With this information, the parameters for the spectrum can be fine-tuned. After this, potential candidate galaxies for similar halos will be chosen from the nearby galactic catalogue (maximum distance at 25 Mpc). In this contribution I will compare the sensitivity of CTA and Fermi-LAT to the gamma-ray emission from galaxies similar to the Andromeda galaxy.

T 115.3 Thu 16:20 POT/0151

Satellite trails in H.E.S.S. data — •Thomas Lang, Alison Mitchell, and Samuel Spencer for the H.E.S.S.-Collaboration — Erlangen Centre for Astroparticle Physics

The commercialization of space by private companies such as SpaceX and OneWeb has caused the number of satellites launched in low earth orbit to almost triple to over 4000 in the last three years. 17 constellations with over 400,000 total satellites are planned/proposed, which causes major concerns for ground based astronomy. The impact on Imaging Air Cherenkov Telescopes (IACTs) has been assumed to be low and apart from the brightest trails has not been considered as a significant problem.

This work aims to find and quantify satellite trails in data taken by the High Energy Stereoscopic System (H.E.S.S.), determine which observation times and directions are affected the most, giving a prediction for these effects depending on the satellite numbers and determine whether trails have an impact on the Hillas parameters used to reconstruct high energy particle events.

Trails are found in night sky background (NSB) maps of FlashCam data, the latest camera of the largest telescope (CT5) with a 0.1 s NSB mapping rate, and from this inferred for the other smaller telescopes (CT1-4). Comparisons of the distributions of Hillas parameters will be made of during and around satellite trail passing times.

T 115.4 Thu 16:35 POT/0151

Simultaneous TeV and X-Ray Observations of Markarian 421 in 2020 — •Bernd Schleicher for the MAGIC-Collaboration — University of Würzburg, Institute for Theoretical Physics and Astrophysics, Germany

The blazar Mrk 421 is one of the brightest and most studied sources in very-high-energy (VHE) gamma rays. As the underlying processes of the production of these gamma rays are still under debate and different models predict correlations between X-rays and gamma rays and some hadronic models for example predict specific features in the hard X-ray regime. Therefore, regular multi-wavelength (MWL) campaigns have been carried out since 2009. In late 2020, simultaneous observations were performed with the X-ray satellites XMM-Newton, the International Gamma-Ray Astrophysics Laboratory (INTEGRAL), and the Major Atmospheric Gamma Imaging Cherenkov Telescopes (MAGIC) to check if these hadronic signatures can be found. Two INTEGRAL observations with an long exposure of 165 ks were performed during the time range of 21. November to 24. November and the time range of 12. December to 15. December and data were taken simultaneously with XMM-Newton and MAGIC. The results of this MWL campaign will be presented.

T 115.5 Thu 16:50 POT/0151

Evidence of hadronic origin of the gamma-ray emission from the nova RS Oph by the MAGIC telescopes — •David Green[1], Vandad Fallah Ramazani[2], Francesco Leone[3], Rubén López-Coto[4], Alicia López-Oramas[5], and Julian Sitarek[6] for the MAGIC-Collaboration — [1]Max Planck Institute for Physics, Munich, Germany — [2]Astronomisches Institut (AIRUB) Ruhr-Universität Bochum, Bochum, Germany — [3]National Institute for Astrophysics, Rome, Italy — [4]IAA-CSIC, Granada, Spain — [5]Instituto de Astrofísica de Canarias, Tenerife, Spain — [6]University of Lodz, Faculty of Physics and Applied Informatics, Department of Astrophysics, Lodz, Poland

RS Ophiuchi (RS Oph) is a symbiotic recurrent nova that shows eruptive events roughly every 15 years. On August 8th, 2021, RS Oph erupted with its latest outburst. This event was detected by a wide range of multi-wavelength (MWL) instruments from radio up to very-high-energy (VHE) gamma rays. The MAGIC telescopes followed up on optical and high-energy triggers and initiated an observation campaign from August 9th till September 1st. RS Oph is the first nova detected in the VHE gamma-ray energy range. We report on the detection of VHE gamma rays at a significant level of 13.2σ during the first 4 days of RS Oph with the MAGIC telescopes. We combine the VHE emission detected by MAGIC with optical and high-energy observations and conclude RS Oph accelerated hadrons during its eruption. We will present the MWL modeling revealing this hadronic emission, and its further implications for Galactic cosmic-rays.

T 115.6 Thu 17:05 POT/0151

Performance of joint observations with LST-1 and MAGIC — •Alessio Berti[1], Yoshiki Ohtani[2], Julian Sitarek[3], Federico Di Pierro[4], Yusuke Suda[5], and Elli Jobst[1] for the MAGIC-Collaboration — [1]Max Planck Institute for Physics, Munich, Germany — [2]Institute for Cosmic Ray Research, Tokyo, Japan — [3]University of Lodz, Lodz, Poland — [4]INFN Torino, Torino, Italy — [5]Hiroshima University, Hiroshima, Japan

The next generation ground-based instrument for very high energy gamma rays observations will be the Cherenkov Telescope Array (CTA). In one of the two planned sites, La Palma (Canary Islands, Spain), the first prototype of a Large Sized Telescope, LST-1, is already operational and is currently under commissioning. The proximity of the two MAGIC telescopes offers a unique opportunity to perform joint observations with LST-1. This three-telescope system provides a better reconstruction of the events, both in angular and energy resolution, and discrimination between showers initiated by gamma rays and cosmic rays, which turns into an improvement in sensitivity with respect to LST-1 or the two MAGIC telescopes separately. In this contribution, we will report on results from Crab Nebula data with a pipeline developed for the analysis of joint LST-1 and MAGIC observations, and show the performance estimated both from real and simulated data.

T 116: Neutrinos Legend, Neutrino Theory

Time: Thursday 15:50–17:20 Location: POT/0251

T 116.1 Thu 15:50 POT/0251

Polyethylene-Naphthalate-Based Wavelength Shifting Reflectors for LEGEND-1000 — •Andreas Leonhardt, Maximilian Goldbrunner, and Stefan Schönert for the LEGEND-Collaboration — Physik Department, Technische Universität München, Garching, Germany

The next-generation experiment LEGEND-1000 will search for the neutrinoless double-beta decay (0νbb) of Ge-76 with unprecedented discovery potential covering the inverted neutrino mass ordering. To this end, 1000 kg of enriched germanium is employed bare in a segmented liquid Argon (LAr) volume. Particle interactions in LAr produce vacuum-ultraviolet (VUV) light flashes peaking at 128 nm, which are converted to longer wavelengths by wavelength shifters (WLSs). To efficiently instrument the LAr volume in LEGEND-1000, a large-scale wavelength shifting reflector (WLSR) based on polyethylene naphthalate (PEN) will be lined on the inner cryostat wall. In this talk, we describe the custom VUV spectrofluorometer used for the optical characterization of PEN-based WLSRs at VUV excitation and cryogenic temperatures. We present the first measurement of the wavelength-resolved photoluminescence yield of PEN for VUV excitation at cryogenic temperatures and compare it to the commonly used wavelength shifter tetraphenyl butadiene (TPB). This research is supported by the DFG through the Excellence Cluster ORIGINS and the SFB1258.

T 116.2 Thu 16:05 POT/0251

Trace gas analysis of unpurified and purified liquid argon by mass spectrometry for LEGEND — •Christoph Vogl, Martin Guevara, Alice Ortmann, and Stefan Schönert — Physics Department, TU-Munich

Liquid argon is commonly used as a medium for particle detection in rare event searches and particle physics experiments. Its performance is heavily impaired in the presence of electronegative impurities, typically oxygen, nitrogen, and water. The chemical purity of liquid argon can be assessed indirectly by measuring its scintillation properties. A complementary and direct way of determining purity is through mass spectrometry. In this talk, we will present our new quadrupole mass spectrometer setup (IDEFIX) and discuss the main challenges and solutions. Results are shown regarding the assessment of the chemical composition of commercial and in-house purified liquid and gaseous argon. This research is supported by the BMBF through the Verbundforschung 05A20WO2 and by the DFG through the Excellence Cluster ORIGINS.

T 116.3 Thu 16:20 POT/0251

Set Up and Run of a Cherenkov Test Detector — •Ivana Nikolac — Physikalische Institut, Eberhard Karls Universität Tübingen, Tübingen, Germany

High-energy particles, like muons, can cross many kilometres of rock and penetrate even the deepest underground laboratories, causing a non-negligible background in rare-event experiments. Muons can also produce neutrons, which mimic dark matter signals. This makes the muon veto an integral part of any rare-event underground experiment. To test the properties of a muon veto system, at the University of Tübingen a small volume water Cherenkov veto is being set up. The instrument (DODI) is a dodecahedron-shaped steel tank with a capacity of 700 litres, lined inside with highly reflective foil, and equipped with eleven photomultiplier tubes (PMTs). Due to its relatively small size and easy access to both its exterior and interior parts, DODI offers the opportunity to probe the muon veto system and its efficiency in real-time. This can be achieved, for example, by introducing different reflective materials in the tank or changing the PMT types. For future experiments, DODI will be further tested as a neutron tagger, first with water and then by introducing different Gadolinium arrangements into the water to improve the efficiency.

T 116.4 Thu 16:35 POT/0251

Neutrino Decay in JUNO — •George Parker, Marcel Büchner, Tim Charisse, Arshak Jafar, Joachim Kopp, Kai Loo, Oliver Pilarczyk, and Michael Wurm — Johannes Gutenberg Universität Mainz, Mainz, Germany

The decay of the neutrino mass eigenstates are well-constrained using astrophysical neutrinos, with the exception of neutrino mass eigenstate $\nu 3$, which has a much less stringent lifetime bound. In this work, we explore the sensitivity of the Jiangmen Underground Neutrino Experiment (JUNO) to $\nu 3$-decay. JUNO is a next-generation reactor neutrino liquid-scintillator detector with enhanced flavour sensitivity, exceptional energy resolution and high statistics, which operates on a medium-baseline and could be uniquely tuned to uncover evidence of neutrino decay. We consider the signature of $\nu 3$-decay on the neutrino oscillation spectrum in the case of (1) invisible decay, where the daughter states are not observable; and (2) visible decay, where the daughter states are active neutrinos. We comment on how neutrino decay models can be embedded into larger consistent theories.

T 116.5 Thu 16:50 POT/0251

Decoherence Effects of Reactor Neutrinos — •Raphael Krüger — Theoretical Astroparticle Physics at IAP, Karlsruhe Institute of Technology, Karlsruhe, Germany

In the most common theoretical formulation of Neutrino Oscillations neutrinos are described by plane waves. Although this formulation gives the correct oscillation formula verified by experiments it must be considered physically wrong. Several conceptual problems of the plane wave treatment, i.e. violated Lorentz invariance, can be avoided if one uses the QFT with external wave packets approach. There decoherence effects automatically emerge from the formalism. These decoherence effects depend on the localizations of the external particles and are negligible for the standard mass splittings.

This work focuses on reactor neutrino experiments and whether decoherence effects may play a role for the mixing with a potential light sterile neutrino. First, the localizations of the external particles are estimated on physical grounds. Using these results, the decoherence effects on the spectrum of the measured positron in the detector are analysed. Here this work makes use of a consistent treatment of the problem starting from basics feynman rules and without the use of normalizations introduced by hand. The results give no observable decoherence effects.

T 116.6 Thu 17:05 POT/0251

Light new particles in tritium beta decay — •Philipp Goller, Syuhei Iguro, and Ulrich Nierste — Institut für Theoretische Teilchenphysik (TTP), Karlsruhe Institute of Technology (KIT)

A hypothetical new light particle S interacting with neutrinos can be produced in the tritium beta decay studied in the KATRIN experiment. Near the kinematic endpoint the presence of various small energy scales (neutrino mass and energy, mass of S) require a careful treatment of the phase space integral. I present the prediction for the differential decay rate in the region probed by KATRIN and discuss the shape of the electron energy spectrum for different mass scenarios.

T 117: Dark Matter I

Time: Thursday 15:50–17:20 Location: POT/0361

T 117.1 Thu 15:50 POT/0361

Investigating Dielectric Loss in Travelling Wave Parametric Amplifiers for MADMAX — •Georg Monninger[1], Gwenael Le-Gal[2], Giulio Cappelli[2], Béla Majorovits[1], and Nicolas Roch[2] for the MADMAX-Collaboration — [1]Max-Planck-Institut für Physik, Munich, Germany — [2]Institut Néel, 38000 Grenoble, France

MADMAX is an experiment for the search of dark matter axions. In order to have the required senstivity, preamplifiers are required that operate at or close to the quantum limit. To reach standard quantum limit, a major open challenge is to improve the added noise in TWPA. One of the main phenomena, which could contribute to the noise, is capacitive dielectric loss. Losses become especially large when going to

higher frequencies, as we are looking for when probing the axion mass in the range of $40-400\,\mu$eV at MADMAX. To investigate their origin, $\lambda/2$-Josephson resonators were built to measure $\tan(\delta)$ via extraction of quality factors. Two geometries were compared. This talk shows the measurement procedure and the obtained results.

T 117.2 Thu 16:05 POT/0361

Bead pull method on an open dielectric haloscope — •Jacob Egge for the MADMAX-Collaboration — Institut für Experimentalphysik, Universität Hamburg, Luruper Chaussee149, 22761 Hamburg

The **MA**gnetized **D**isk and **M**irror **A**xion e**X**periment is a dielectric haloscope that aims to search for axionic dark matter. It uses a stack of movable dielectric disks, called a booster, to enhance the weak axion signal. In order to calibrate the setup, the electromagnetic field inside the booster needs to be known. This is a difficult challenge as the complex design and open nature of the booster do not permit a simple mode analysis as in the traditional, closed cavity haloscopes. However, having an open and tunable setup also provides unique opportunities for additional measurements of the electromagnetic field of the booster. In this talk, I will present the first results of so-called bead pull measurements on a minimal dielectric haloscope and how they can be used to calibrate the setup.

T 117.3 Thu 16:20 POT/0361

Measurements of dielectric properties of single crystal sapphire (Al2O3) for the axion dark matter search experiment, MADMAX — •Haotian Wang, Alexander Schmidt, and Erdem Oez for the MADMAX-Collaboration — III. Physikalisches Institut A ,RWTH, Aachen, Germany

Axions are one of the candidates for cold dark matter and will be searched in the range of microwave frequencies from 10 to 100 GHz in the magnetized disk and mirror axion (MADMAX) experiment. Multiple dielectric disks will be used to amplify the axion signal. The dielectric properties, dielectric constant and loss tangent, of the disk materials affect the boost factor, so precise knowledge of them is crucial for the detection of axion. Here we present measurement results of dielectric properties of sapphire (Al2O3), a candidate material for the dielectric disks, at room temperature (295-297 K) and at 18 K. The measurements are done in the 10 to 40 GHz range using a microwave resonator.

T 117.4 Thu 16:35 POT/0361

Further dark matter searches using ALPS II's TES detector — •Christina Schwemmbauer for the ALPS-Collaboration — Deutsches Elektronen-Synchrotron, Hamburg, Germany

The elusive **D**ark **M**atter (DM), proposed due to its gravitational interaction with ordinary matter, supposedly makes up $\sim 25\%$ of our universe. Various models aim to explain the origin and properties of DM, many of these proposing beyond standard model particles to make up most of the DM in our universe. The ALPS II (**A**ny **L**ight **P**article **S**earch II) light-shining-through-walls experiment will use **T**ransition **E**dge **S**ensors (TESs) to detect low-energy single-photons originating from axion(ALP)-photon conversion with rates as low as 10^{-5} cps.

Even beyond ALPS II, these superconducting microcalorimeters, operated at cryogenic temperatures, could help search for further particle-DM candidates. Much of the work to ensure the viability of the TES detector for use in ALPS II, such as calibrating the detector and mitigating external sources of backgrounds, also leads to the ability to utilize the TES for an independent direct-DM search. For this purpose, the superconducting sensor, sensitive to sub-eV energy depositions, can be used as a simultaneous target and sensor for DM-electron scattering for sub-MeV DM. Hence, direct DM searches with TES could explore parameter space as-of-yet inaccessible by nucleon-scattering experiments.

T 117.5 Thu 16:50 POT/0361

Heterodyne detection of weak fields in ALPS II — •Isabella Oceano for the ALPS-Collaboration — Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany

The Any Light Particle Search II (ALPS II) is a Light Shining through a Wall experiment at DESY in Hamburg, which will hunt for axions and axion-like particles in the sub-meV mass range with an axion-photon-photon coupling $g_{\alpha\gamma\gamma} > 2\times10^{-11}$ GeV^{-1}. To do this, a high-power laser will be directed through a strong magnetic field where some of the photons can convert into a beam of axion-like particles. After this, the beam will cross a light-tight barrier and another strong magnetic field where some of the axion-like particles can convert back into photons and be detected. During the first data acquisition, planned for early 2023, a HETerodyne (HET) interferometer will be used to detect the reconverted photons. This very sensitive interferometer can detect very weak signals at the exact signal frequency.

The HET principle and its implementation in ALPS II will be discussed in this talk.

T 117.6 Thu 17:05 POT/0361

Impact of axion decay on the extragalactic background light — •Sara Porras Bedmar, Manuel Meyer, and Dieter Horns — Institut für Experimentalphysik, Universität Hamburg, Luruper Chaussee 149, D-22761 Hamburg

The Extragalactic Background Light (EBL) is an isotropic diffuse radiation field of extragalactic origin. Assuming that dark matter consists of axions with masses on the order of electron volts, we expect an additional contribution to the EBL due to their decay into two photons.

Here, we model the main light-emitting processes that constitute the EBL: stellar populations, intra-halo light, and dust. Utilizing the Starburst99 and SWIRE code libraries we create synthetic spectra to characterize the stellar components. Our model critically depends on structure formation and evolution, encoded in the star formation rate history, as well as star metallicity, and the distribution and composition of dust. We explore the dependencies of our model on these parameters, as measurements of these quantities are highly uncertain. In addition to these astrophysical EBL components, we include the contribution of decaying dark matter axions. Through a comparison of our model with the most recent direct and indirect EBL measurements, we are able to constrain the photon-axion coupling in the mass range from $\sim 0.1-10$ eV.

T 118: Dark Matter II

Time: Thursday 15:50–17:20 Location: POT/0006

T 118.1 Thu 15:50 POT/0006

R&D of large-scale electrodes for future generation TPCs — •Vera Hiu-Sze Wu, Alexey Elykov, and Francesco Toschi — Karlsruhe Institute of Technology, Institute for Astroparticle Physics

The DARk matter Wimp search with liquid xenoN (DARWIN) observatory is a future dark matter detector aiming at reaching the sensitivity for WIMPs at the neutrino floor and covering the mass range from 5 GeV/c2 to above 10 TeV/c2 [1]. The observatory uses the technology of a dual-phase time projection chamber (TPC) with a 40 t active volume of liquid xenon (LXe) [1].

The electrodes of the TPC are the vital components for 3D position reconstruction of the signal, benefiting the event selection processes. When designing the electrodes, we have to calculate and optimize the electrostatic. At the same time, the mechanical stability, the feasibility of manufacturing and treatment, as well as to minimization of spark and electron emission has to be ensured. Here we present our investigations of hexagonal mesh electrodes, including mechanical stability and handling as well as the first test of local high-voltage field emission.

[1] J. Aalbers et al., J. Cosmol. Astropart. Phys., 11, 017 (2016)

T 118.2 Thu 16:05 POT/0006

A high resolution scanning set-up for defect detection on electrodes — •Alexander Deisting[1], Jan Lommler[1], Shumit Mitra[1], Uwe Oberlack[1,2], Fabian Piermaier[2], Quirin Weitzel[2], and Daniel Wenz[1] — [1]Institut für Physik & Exzellenzcluster PRISMA+, Universität Mainz — [2]PRISMA Detector Laboratory, Universität Mainz

Achieving as low backgrounds as possible is key when operating time projection chambers (TPCs) for dark matter searches. One source of background signals is the (field) emission of electrons from the electrodes inside the detector. For dual phase TPCs, similar to

XENONnT, these electrodes are meshes or grids with wire diameters of $200 - 300\,\mu$m, operated at a high voltage (HV) $\gg 1\,$kV.

The scanning set-up at the PRISMA Detector Laboratory features a high resolution camera mounted to a gantry robot system. The camera's resolution of $1.4 \times 1.4\,\mu\text{m}^2$ provides detailed images of electrode wires. A 3D confocal microscope with a resolution better than $1\,\mu$m is used for studies on the μm scale. We will present results of mesh-scans.

The high resolution images uncover an abundance of microscopic "defects" but they do not show whether a found spot will enhance electron emission and thus the background signals in the TPC or not. To asses the defects' nature we extended the set-up with an overview camera and a HV supply. An electrode wire in a gas may emit electrons, resulting in a corona discharge, which the overview camera records. We present the set-up and report on our progress of matching regions of corona discharges with defects uncovered in the high resolution scan.

T 118.3 Thu 16:20 POT/0006

Understanding xenon scintillation properties — •Robert Hammann, Dominick Cichon, Luisa Hötzsch, Florian Jörg, Teresa Marrodán Undagoitia, and Mona Piotter — Max-Planck-Institut für Kernphysik

Xenon in gaseous and liquid form is a commonly used detector target material for rare-event searches like the direct detection of dark matter. The material has a number of beneficial properties for this application, one being that it is an excellent scintillator. Most xenon-based detectors rely on measuring the scintillation light component emitted in the vacuum ultraviolet range, however, light is also emitted in a wide spectrum of longer wavelengths. Exploring this parameter space could enable the construction of even more sensitive detectors in the future.

In this contribution, we present first measurements with a dedicated setup to extend our knowledge of the scintillation response in gaseous xenon to infrared light, which is so far not exploited in the field. In order to assess the usefulness of this wavelength range for rare-event searches, it is essential to characterize its response. We report measurements of the scintillation light yield for varying levels of electromagnetic impurities and as a function of the xenon gas pressure.

T 118.4 Thu 16:35 POT/0006

The CRESST-III Dark Matter Search: Status and Outlook — •Christian Strandhagen for the CRESST-Collaboration — Eberhard-Karls-Universität Tübingen, D-72076 Tübingen

The CRESST experiment (Cryogenic Rare Event Search with Superconducting Thermometers) operates an array of cryogenic detectors using different target materials in a well-shielded setup at the LNGS (Laboratori Nazionali del Gran Sasso) underground laboratory in Italy to search for nuclear recoils induced by scattering of dark matter particles in the detectors. With detection thresholds for nuclear recoils as low as 10 eV, CRESST is among the leading experiments in the search for low mass dark matter particles. The most recent measurement campaign, which started in summer 2020, was focused on investigating the origin of an unexplained event population at very low energies ("low energy excess") which is limiting the sensitivity of the experiment in the low mass region. We present the status of CRESST-III and report on observations of the low energy excess and dark matter results. Finally we show our plans for the coming years including the upgrade of the readout electronics.

T 118.5 Thu 16:50 POT/0006

A low-threshold diamond cryogenic detector for sub-GeV Dark Matter searches — •Anna Bertolini[1], Gode Angloher[1], Antonio Bento[1,2], Lucia Canonica[1], Nahuel Ferreiro Iachellini[1], Dominik Fuchs[1], Abhijit Garai[1], Dieter Hauff[1], Athoy Nilima[1], Michele Mancuso[1], Federica Petricca[1], Franz Probst[1], Francesca Pucci[1], Ahmed Abdelhameed[1], Elia Bertoldo[1,3], and Johannes Rothe[1,4] — [1]Max-Planck-Institut für Physik, München, Germany — [2]LIBPhys-UC, Departamento de Fisica, Universidade de Coimbra, Coimbra, Portuga — [3]Institut de Física d'Altes Energies (IFAE), Barcelona Institute of Science and Technology (BIST), Bellaterra (Barcelona) — [4]Physik-Department and Excellence Cluster Universe, Technische Universität München, D-85748 Garching, Germany

Recently the sub-GeV dark matter (DM) mass region has started to be probed. To explore this region, detectors with a low energy threshold are required. Recent developments in the production of diamond crystals allow for high-quality large-mass diamonds that can be used as DM detectors. Thanks to their superior cryogenic properties, diamond detectors can reach an energy threshold in the eV range. In this contribution the realization of the first low-threshold cryogenic detector that uses diamond as absorber for astroparticle physics applications will be reported. Two diamond samples instrumented with a W-TES have been tested, showing transitions at about 25 mK. The performance of the diamond detectors will be presented highlighting the best performing one, reaching an energy threshold of 16.8 eV.

T 118.6 Thu 17:05 POT/0006

ELOISE - Reliable Background Simulation at Sub-keV Energies — •Holger Kluck — Institut für Hochenergiephysik der Österreichischen Akademie der Wissenschaften, 1050 Wien, Österreich

$CaWO_4$ is a well-known target material for experiments searching for rare events like coherent elastic neutrino-nucleus scattering (CEνNS) with NUCLEUS or hypothetical dark matter-nucleus scattering with CRESST. Pushing the detection threshold down to sub-keV energies, experiments encounter new phenomena like an exponential rise of observed events towards lowest energies of yet unknown origin. This highlights the need for verified and reliable simulations of radioactive background components at sub-keV energies, e.g. based on the widely used Geant4 toolkit.

The ELOISE project aims to tackle this issue for electromagnetic particle interactions in $CaWO_4$ in a two-stage approach: First by a systematic evaluation of the current accuracy by comparing benchmark simulations with data from extended literature research and dedicated measurements. Second, if needed, ELOISE intend to develop bespoken simulation code for $CaWO_4$ to improve the accuracy at the sub-keV energy regime. Currently, ELOISE conduct a dedicated measurement of electronic energy loss in $CaWO_4$ via ionization.

In this contribution, I will first motivate the problem and outline the scope of ELOISE. Afterwards, I will report first results of ELOISE's reference measurements. Finally, I will discuss our preliminary findings and its implication for rare event searches with $CaWO_4$.

T 119: Neutrino Astronomy IV

Time: Thursday 15:50–17:05 Location: POT/0112

T 119.1 Thu 15:50 POT/0112

Search for neutrinos from AGN using a machine-learning-based source selection — •Sebastian Schindler for the IceCube-Collaboration — ECAP, University Erlangen-Nürnberg, Germany

The IceCube Neutrino Observatory is currently the world's largest high-energy neutrino detector. After the detection of a diffuse astrophysical neutrino flux in 2013, one of the main goals has been to associate parts of this flux with specific source classes. A few "hot spots" at or above the three-sigma level have been found and associated with certain classes of Active Galactic Nuclei (AGN). Most recently, the Seyfert II galaxy NGC 1068 was associated with a neutrino flux at a significance of $4.2\,\sigma$, and there is growing evidence for a neutrino flux from blazars. However, the underlying physical processes of neutrino production remain poorly understood. One problem for neutrino-source searches comes from the use of historically-driven class definitions of AGN, which are based on specific spectral properties that are not necessarily optimal for the selection of potential neutrino sources.

This talk will motivate a study that aims to address this problem in two stages. The first stage will use multi-wavelength data to define a source selection using modern machine-learning approaches in a way that emphasizes intrinsic physical properties and mostly disregards the general AGN classification. This will allow to identify potential neutrino sources similar in physical properties to those associated with the currently detected "hot spots". The second part will perform a statistical analysis in the form of a correlation analysis, for example a stacking search, using these previously defined source selections.

T 119.2 Thu 16:05 POT/0112

Searching for neutrino point-sources in the northern hemi-

sphere with IceCube: recent results and outlook — •Elena Manao, Chiara Bellenghi, Martin Ha Minh, Tomas Kontrimas, and Martin Wolf for the IceCube-Collaboration — Technische Universität München

The IceCube Neutrino Observatory is a one cubic kilometer neutrino telescope deployed deep in the Antarctic ice at the South Pole. One of its main goals is to identify sources of the diffuse astrophysical neutrino flux, discovered by IceCube in 2013. In this talk we present the results of the search for neutrino point-sources in the northern hemisphere, which found evidence of astrophysical neutrino emission from the active galaxy NGC 1068 with a global significance of 4.2σ, and the prospects of an extension of this analysis with several additional years of data.

T 119.3 Thu 16:20 POT/0112

Solving the multi-messenger puzzle of the AGN-starburst composite galaxy NGC 1068 * — Bjoern Eichmann[1,2], Foteini Oikonomou[2], •Silvia Salvatore[1], Ralf Juergen Dettmar[1], and Julia Becker Tjus[1] — [1]Theoretical Physics IV, Ruhr University Bochum, Bochum, Germany — [2]Institutt for fysikk, Norwegian University for Science and Technology (NTNU), Trondheim, Norway

Multi-wavelength observations indicate that some starburst galaxies show a dominant non-thermal contribution from their central region. These active galactic nuclei (AGN)-starburst composites are of special interest, as both phenomena on their own are potential sources of highly-energetic cosmic rays and associated gamma-ray and neutrino emission. In our work, a homogeneous, steady-state two-zone multi-messenger model of the non-thermal emission from the AGN corona as well as the circumnuclear starburst region is developed and subsequently applied to the case of NGC 1068, which has recently shown some first indications of high-energy neutrino emission. We show that the entire spectrum of multi-messenger data - from radio to gamma-rays including the neutrino constraint - can be described very well if both, starburst and AGN corona, are taken into account. Using only a single emission region is not sufficient.

Supported by DFG (SFB|,1491)

T 119.4 Thu 16:35 POT/0112

Estimate of Galactic Neutrino emission — •Mohadeseh Ozlati Moghadam[1], Kathrin Egberts[1], Constantin Steppa[1], Rowan Batzofin[1], and Elisa Bernardini[2] — [1]University of Potsdam, Potsdam, Germany — [2]University of Padova, Padova, Italy

The origin of high-energy cosmic rays is an enduring mystery in science. As cosmic rays propagate through the universe, they interact with the environment, which eventually produces high-energy neutrinos as well as gamma rays.

High-energy Neutrinos are an unambiguous signal of hadronic interaction and, thus, provide valuable information about particle acceleration mechanisms and the origin of cosmic rays. On the other hand, identifying neutrino sources is a longstanding challenge. Exploiting the simultaneous production of neutrinos and gamma rays, neutrino sources are typically identified based on the tempo-spatial coincidence of variable emission of point-like objects. This has resulted in the detection of TXS 0506+056 as one extragalactic source for Neutrinos.

However, from VHE gamma-ray observation, we know there is a population of Galactic sources, some of which are expected to produce neutrinos as well. In this contribution, we use simulations of the*Galactic*population of*steady*VHE gamma-ray sources to estimate the Galactic neutrino flux. For this, a parametrization of the neutrino production for a given gamma-ray signal is used. We will present a galactic map of expected neutrino fluxes and will make a comparison with data.

T 119.5 Thu 16:50 POT/0112

Integration of the KM3NeT instrument response function with gammapy software — •Mikhail Smirnov for the ANTARES-KM3NET-ERLANGEN-Collaboration — Friedrich-Alexander-Universitat Erlangen-Nurnberg (FAU), Erlangen Centre for Astroparticle Physics, Erwin-Rommel-Straße 1, 91058 Erlangen, Germany

The instrument response function (IRF) contains all the necessary information about the physical properties of a neutrino telescope. It is an ideal tool for quick estimation of the sensitivity of the detector to an incoming neutrino flux from distant sources. Since a similar approach is used in gamma ray astronomy, both communities can benefit from using the same software tools and standards. Nowadays the gammapy python package is a standard tool used in the gamma ray community. Synergy between the KM3NeT IRF and gammapy will allow us to use the power of this package and at the same time to push forward the developments of combined analyses in the context of open science. In gammapy, the IRF consists of four main data domains and it is a part of the DL3 format along with the event list. In order to make KM3NeT data compatible with gammapy, the km3irf python package is being developed. This contribution covers in detail the km3irf package and the compatibility of the km3net data with gammapy.

T 120: Cosmic Ray V

Time: Thursday 15:50–17:20 Location: POT/0013

T 120.1 Thu 15:50 POT/0013

Unfolding the Atmospheric Muon Spectrum Using Stopping Muons in IceCube* — •Lucas Witthaus for the IceCube-Collaboration — TU Dortmund University

The IceCube Neutrino Observatory is a cubic kilometer neutrino detector located in the ice sheet close to the geographical South Pole. Its primary goal is the observation of neutrinos. However, the majority of detected events is caused by atmospheric muons produced in cosmic ray induced air showers in the upper layers of the atmosphere. Upon entering the antarctic ice, the muons are subject to significant energy losses due to interactions with the surrounding matter, resulting in a limitation of their propagation length. This talk presents the unfolding of the stopping muons depth intensity, providing information about the abundance of atmospheric muons in the South Pole ice. It is conducted on a subset of events, comprising single muons, which stop inside the IceCube detector. Deep neural networks are used to perform the event classification and reconstruction tasks.

* Supported by the BMBF and the DFG (SFB 1491)

T 120.2 Thu 16:05 POT/0013

Improved Measurements of Seasonal Variations of the Atmospheric Neutrino Flux with IceCube — •Shuyang Deng, Jakob Bötter, Hannah Erpenbeck, Philipp Fürst, Erik Ganster, Matthias Thiesmeyer, and Christopher Wiebusch for the IceCube-Collaboration — III. Physikalisches Institut B RWTH Aachen University

The IceCube Neutrino Observatory is proven to be highly efficient in detecting atmospheric neutrinos that originate from cosmic-ray induced air showers. The high statistics allow measuring the correlation between the atmospheric neutrino flux and atmospheric properties such as temperature. This correlation depends particularly on the early hadronic development of air showers in the upper atmosphere. In this talk we present the extension of a previous analysis from six years to about ten years of observations. Furthermore, we investigate improved descriptions of atmospheric temperature profiles, and test the prediction of different hadronic interaction models.

T 120.3 Thu 16:20 POT/0013

Searching for the Prompt Component of the Atmospheric Muon Flux — Pascal Gutjahr, Jean-Marco Alameddine, Mirco Hünnefeld, and •Ludwig Neste for the IceCube-Collaboration — Astroparticle Physics WG Rhode, TU Dortmund University, Germany

The muon is connected to many challenges in current physics, such as the muon puzzle in cosmic-ray induced air showers. The prompt component of the atmospheric muon flux has not been measured with high significance, yet. Understanding and measuring the prompt muon flux could help to better understand these challenges and help to test hadronic interaction models.

Atmospheric muons stem from the decay of particles created in hadronic interactions and their flux can be divided into a conventional

and a prompt component. In the conventional part, muons originate from the decay of long-lived particles, mainly pions and kaons. In the prompt part, muons are produced by the decay of short-lived mesons. They consist of charmed mesons, strange mesons and unflavored ones.

In this talk, the current state of the analysis, which aims to confirm the existence of the prompt muon flux with the IceCube detector, is presented. Previous analyses suffered from statistical and systematic uncertainties in Monte Carlo simulations. Thus, we evaluate and create a new set of Monte Carlo simulations specialized to measure the prompt component.

Supported by BMBF (ErUM) and DFG (SFB 1491).

T 120.4 Thu 16:35 POT/0013

Sensitivity of IceCube-Gen2 for Cosmic-Ray Anisotropy Studie — •Wenjie Hou for the IceCube-Gen2-Collaboration — Institute for Astroparticle Physics, Karlsruhe Institute of Technology (KIT)

At which energy the transition from Galactic to extra-galactic cosmic rays (CRs) takes place is one of the major unresolved issues of cosmic ray physics. One expects to get strong constraints by studying the anisotropy in the cosmic-ray arrival directions. Recently, the cosmic ray anisotropy measurements in the TeV to PeV energy range were updated from IceCube using its 11 years of data. Moreover, IceCube-Gen2 is designed to achieve an exposure about 8 times larger than the IceCube area, as well as more statistics and capability to investigate the cosmic-ray anisotropy with higher sensitivity. The sensitivity of IceCube-Gen2 to anisotropy is in particular a matter of statistics. Taking into account the detector exposure of IceCube-Gen2 and the dipole input, we build a Monte Carlo toy model for IceCube-Gen2 and randomly generate the arrival directions for 10 years of measurements. In this case, the relative intensity maps, significance maps and angular power spectrum can be investigated. More importantly, by scanning the dipole declination and zenith threshold, we can determine under what conditions IceCube-Gen2 could achieve the highest sensitivity to observe the cosmic-ray anisotropy. In general, the current studies on the sensitivity of IceCube-Gen2 for CR anisotropy will also be discussed.

T 120.5 Thu 16:50 POT/0013

Studies on Monte Carlo generator tuning for cosmic-ray induced air shower simulations * — Kevin Kröninger, Salvatore La Cagnina, and •Michael Windau — TU Dortmund, Fakultät Physik

Monte Carlo (MC) generators are a fundamental tool in particle and astroparticle physics. To achieve a high-quality simulation of physical processes involving hadrons, the hadronic interaction model of the generator must be tuned efficiently. The free parameters of MC generators are optimized with the help of experimental data and Bayesian methods.

One area of application for MC generators is the simulation of cosmic-ray induced air showers in the Earth's atmosphere. Since hadronic interactions have a direct influence on the composition of secondary particles in the shower formations, tuning the parameters of these hadronic models has an impact on crucial observables such as the muon number.

In this talk, studies on the tuning of Monte Carlo generators for cosmic-ray induced air showers are presented.

* Supported by the DFG (SFB 1491)

T 120.6 Thu 17:05 POT/0013

Fixed-target $\pi^{\pm}$ C interactions at GeV energies simulated with PYTHIA8* — •Chloé Gaudu — Bergische Universität Wuppertal, Gaußstraße 20, 42119 Wuppertal, Germany

Understanding the properties of extensive air showers (EAS) is of prime importance for extracting the properties of ultra high-energy cosmic rays from data, such as collected by the Pierre Auger Observatory. Inferring their primary energy and, most importantly, their primary mass relies on detailed comparisons of EAS measurements with corresponding air shower simulations. The largest uncertainties in such simulations are caused by limited knowledge of hadronic interactions at high energies. To assess the effect of such uncertainties, different hadronic interactions are applied in EAS simulations, each of them being tuned to accelerator data. PYTHIA8 is a hadronic interaction model that is frequently used in the context of LHC experiments and is well suited to be tuned to accelerator data, but up to now has only rarely been used in EAS simulations. This contribution focuses on studying the production cross-sections and p_T-integrated particle spectra from charged pion-carbon fixed-target collisions at momenta between 3 and 350 GeV/c and comparing them against the newest version of the hadronic interaction model PYTHIA8. Three distinct datasets from the HARP, HARP-CDP, and NA61/SHINE collaborations are used for this purpose. The validity of the model to describe the experimental datasets is investigated using the RIVET interface. We discuss the results of this comparison as well as the effects to the uncertainties of EAS simulations. **Supported by DFG (SFB 1491).*

T 121: Cosmic Ray VI

Time: Thursday 15:50–17:20 Location: POT/0351

T 121.1 Thu 15:50 POT/0351

Detector Design Update for the AFIS Sattelite Mission — •Liesa Eckert[1], Peter Hinderberger[1], Martin J. Losekamm[1], Stephan Paul[1], Thomas Pöschl[1], and Sebastian Rückerl[2] — [1]Technical University of Munich, Department of Physics, Garching, Germany — [2]Technical University of Munich, Department of Aerospace and Geodesy, Garching, Germany

Radiation in space consists of charged particles, photons, and neutrons. We aim to measure the charged nuclear component of the radiation environment with CubeSat-sized detectors composed of scintillating-plastic fibers read out by silicon photomultipliers (SiPMs). With different detector versions, we study the radiation's composition for dosimetry with the RadMap Telescope and aim to measure the flux of antiprotons trapped in the Earth's magnetic field with the upcoming AFIS mission.

For the latter, we are currently improving the detector design and plan to verify the updated version as part of the In-Orbit Verification Experiment 1 (IOV-1) on the International Space Station.

In this talk, I will present the current detector design as used in the RadMap Telescope, as well as the opportunities for improvement we identified during production and calibration. Furthermore, I will show which changes we plan to apply to the current design to achieve a better performance and simplify production for future missions.

Our work is funded by the German Research Foundation (DFG, project number 414049180) and under Germany's Excellence Strategy - EXC2094 - 390783311.

T 121.2 Thu 16:05 POT/0351

Onboard Data Processing for the AFIS Satellite Mission — •Peter Hinderberger[1], Martin J. Losekamm[1], Stephan Paul[1], Thomas Pöschl[1], and Sebastian Rückerl[2] — [1]Technical University of Munich, Department of Physics, Garching, Germany — [2]Technical University of Munich, Department of Aerospace and Geodesy, Garching, Germany

The Antiproton Flux in Space (AFIS) satellite mission aims to measure the flux of antiprotons trapped in Earth's Van Allen radiation belts at energies of 20 to 100 MeV. The mission's central instrument is a charged-particle detector comprised of scintillating-plastic fibers and silicon photomultipliers. We are testing a range of processing approaches and hardware options to filter and analyze the recorded data in real time in order to reduce the amount of data that needs to be sent to ground. In this contribution, we present the technical motivation of these approaches, as well as early test implementations and simulations. Our work is funded by the German Research Foundation (DFG, project number 414049180) and under Germany's Excellence Strategy - EXC2094 - 390783311.

T 121.3 Thu 16:20 POT/0351

The RadMap Telescope — Ready for Flight — •Martin J. Losekamm[1], Liesa Eckert[1], Peter Hinderberger[1], Stephan Paul[1], Thomas Pöschl[1], and Sebastian Rückerl[2] — [1]Technical University of Munich, Department of Physics, Garching, Germany — [2]Technical University of Munich, Department of Aerospace and Geodesy, Garching, Germany

The RadMap Telescope will demonstrate new technologies for the characterization of the nuclear component of cosmic rays by measuring the radiation environment aboard the International Space Station (ISS). At the heart of the instrument is a tracking calorimeter made from scintillating-plastic fibers and silicon photomultipliers capable of recording particle-dependent energy spectra; several silicon-based dosimeters provide additional dosimetry information. RadMap will be deployed to the ISS in March 2023, with operations expected to begin a few weeks later. In this contribution, we present the instrument design, its capabilities, and our plans for on-orbit operations that shall lead to a full validation of the central detector and its read-out electronics. Our work is funded by the German Research Foundation (DFG, project number 414049180) and under Germany's Excellence Strategy - EXC2094 - 390783311.

T 121.4 Thu 16:35 POT/0351

Resolution limits in low-energy neutrino event reconstruction with IceCube — •Kaustav Dutta, Sebastian Böser, Martin Rongen, and Elisa Lohfink — Johannes Gutenberg Universität Mainz, Germany

The IceCube Observatory is a cubic-kilometer neutrino telescope built into the deep glacial ice at the South Pole. Low energy extensions to the detector include the existing DeepCore subarray and the upcoming IceCube Upgrade. These focus on neutrino oscillation physics using atmospheric neutrinos and are characterized by a denser instrumentation. These elusive particles are indirectly detected by collecting Cherenkov photons emitted by secondary charged particles produced as a result of neutrino-nucleon interactions inside the detector. The reconstruction of event information, in particular direction and energy of an incoming neutrino, is a crucial ingredient to the oscillation analyses. The accuracy of reconstruction is therefore affected by statistical fluctuations in the particle shower development as well as by photon propagation and detection efficiencies of sensors. Here we present first steps to identify the theoretically achievable resolution in the absence of modeling inaccuracies and computational limitations.

T 121.5 Thu 16:50 POT/0351

SkyLLH: A tool for using the public 10-year IceCube point-source data — •Martin Wolf and Chiara Bellenghi — TU-Munich, James-Franck-Straße 1, 85748 Garching, Germany

The IceCube collaboration has released 10 years of recorded data suitable for point-like neutrino source searches. In addition, the instrument response function is provided as well, making this data set usable for neutrino source searches by the public. In this contribution we highlight the tool "SkyLLH", a software framework for performing log-likelihood-ratio-based analyses on celestial data, and its interface to the public 10-year IceCube point-source data. Within the accuracy of the released binned instrument response function, the public data interface of SkyLLH allows to reproduce IceCube's results published in Phys. Rev. Lett. 124, 051103 (2020).

T 121.6 Thu 17:05 POT/0351

Reconstruction of proton showers using H.E.S.S. — •Benedetta Bruno, Jonas Glombitza, and Stefan Funk for the H.E.S.S.-Collaboration — Friedrich-Alexander-Universität Erlangen-Nürnberg, Erlangen Centre for Astroparticle Physics, Nikolaus-Fiebiger-Str. 2, 91058 Erlangen, Germany

Imaging Atmospheric Cherenkov Telescopes (IACTs) - like the High Energy Stereoscopic System (H.E.S.S.) - observe extensive air showers initiated by gamma rays and cosmic rays (CRs) when interacting with the Earth's atmosphere. IACTs image the distribution of Cherenkov light emitted by air shower particles as they propagate toward the Earth's surface. The traditional reconstructions of the properties of the gamma rays rely on the Hillas parameterization, which reduces the measurement to a few characteristics using elliptical modelling of the image.

For the analysis of cosmic rays, which are usually considered background in gamma-ray astronomy, the reconstruction is more challenging. Since the development of hadronic-induced shower is subject to larger fluctuations, the detected IACT images feature deviations from the typical elliptical shape, making modifications necessary.

In this contribution, we utilize H.E.S.S. simulations to investigate the reconstruction of protons using the Hillas parametrization. In addition, we discuss the potential to use deep-learning-based reconstruction techniques to overcome the limits of the Hillas approach and outline the potential of H.E.S.S. data to measure the CR spectrum.

T 122: DAQ Systems

Time: Thursday 15:50–16:50 Location: POT/0106

T 122.1 Thu 15:50 POT/0106

Performance of the ATLAS Level-1 Calorimeter Trigger in Run 3 — •Thomas Junkermann — Kirchhoff-Institut für Physik, Heidelberg

The Phase-I Upgrade of the ATLAS Level-1 Calorimeter Trigger adapts the finer granularity of the spatial information of energy, provided by the upgraded front-end electronics of the Liquid-Argon calorimeter. To process the higher amounts of data a new digital trigger is installed. The new trigger has three feature extractors which each specialize on different calorimeter objects. They identify electrons, photons, taus, jets and missing energy.
The upgraded front-end components for the new digital trigger effect the old trigger system and re-calibration of it is needed as it will be run in Run 3 (started in July 2022) parallel to the new system.
The re-calibrated legacy trigger is the natural candidate to compare the new system to and offers many possibilities to compare and ultimately optimize the new system. Different calibrations are performed and eventually efficiencies and rates will give a deep insight into whether the re-calibration of the old system worked as expected and commissioning and calibration of the new system was succesful.
The new trigger is being comissioned during Run 3 and took part in first data taking. With stable running making comparisons possible, the calibration as well as efficiency studies are presented.

T 122.2 Thu 16:05 POT/0106

Anomaly detection for the level 1 trigger system of the CMS experiment — •Sven Bollweg, Karim El Morabit, Lars Emmrich, Gregor Kasieczka, and Artur Lobanov — University of Hamburg, Germany

There exist strong hints for the existence of physics beyond the standard model (BSM). At the CMS experiment, the first event selection step is the Level 1 (L1) trigger system, which decides whether an event is stored for further analysis. Assuming that BSM events differ from standard model (SM) events, a trigger decision could then utilize this difference to detect anomalous event properties instead of being fully based on model specific criteria.

This talk discusses such an anomaly detection trigger based on neural networks. An autoencoder (AE) network is trained to reproduce typical collision events. It is found that the reconstuction quality of anomalous events, such as BSM events or rare SM events, is decreased. This decrease in reproduction quality can then be used as a basis for the trigger decision. Since the L1 trigger has a very limited time for the decision, the AE needs to be deployed on dedicated hardware in the form of field programmable gate arrays which presents additional challenges.

T 122.3 Thu 16:20 POT/0106

Online Track Reconstruction for the Mu3e Experiment — •Haris Avudaiyappan Murugan for the Mu3e-Collaboration — Institute of Nuclear Physics, Johannes Gutenberg University of Mainz, Germany

The Mu3e experiment aims to observe or exclude the rare decay of a positive muon into two positrons and an electron. Such an observation would be a violation of charged lepton flavour conservation and thus a clear signal of new physics. In the first phase, it will observe 10^8 muon decays per second using a thin pixel detector complemented by scintillating timing detectors. The data rate from the detector subsystems is estimated at about 100 Gb/s and is mostly comprised of background processes from other decay channels of the muon. To store the data for physics analysis, it needs to be reduced by a factor of 100. This can be achieved by selecting the potential signal events through online track and vertex reconstruction on graphics processing units (GPUs). The

talk discusses the algorithm employed on the GPUs and the achieved performance.

T 122.4 Thu 16:35 POT/0106

Dilepton trigger selections for Run 3 at the LHCb Experiment — Johannes Albrecht, •James Gooding, and Biljana Mitreska — TU Dortmund University, Dortmund, Germany

Lepton flavour-violating processes in B decays are amongst the key curiosities studied at the LHCb Experiment. Measurements of such processes rely on high-quality selection of leptons, in particular of lepton pairs arising from B decays. These selections typically rely on cuts to essential kinematic and topological variables.

During the LHC Run 3 data-taking period, the LHCb Experiment will receive collisions at a rate of 30 MHz. The full detector readout at this rate produces 5 TB/s of data, though only 10 GB/s can be recorded. To reduce the amount of data recorded, LHCb will employ an entirely software-based trigger system to select events in real time. Within this framework, an inclusive cut-based trigger is being developed to select dilepton events (i.e. events containing a lepton pair).

In this talk, the status of the inclusive cut-based dilepton trigger is presented, and its performance is evaluated within the context of the Run 3 LHCb trigger system.

T 123: Pixel/Belle II, Si/Other

Time: Thursday 15:50–17:20 Location: WIL/A317

T 123.1 Thu 15:50 WIL/A317

Investigation of high backside currents in DEPFET pixel sensors for the Belle II experiment using dedicated test structures — Florian Bernlochner, Jochen Dingfelder, •Georgios Giakoustidis, and Botho Paschen — University of Bonn, Germany

For the Belle II experiment at KEK (Tsukuba, Japan) the KEKB accelerator was upgraded to deliver e^+e^- collisions at a center-of-mass energy of $E_{CM} = 10.58\ GeV$ with an instantaneous luminosity of up to $8 \cdot 10^{35}\ cm^{-2}s^{-1}$. As the innermost part of the Belle II detector, the PiXel Detector (PXD), based on DEpleted P-channel Field Effect Transistor (DEPFET) technology, is most exposed to radiation from the accelerator. An unexpected steady increase of backside current with time and thus accumulated irradiation dose was observed in several modules during detector operation. Doping profile measurements and electric field simulations show that this is a consequence of (partially) shorted guard rings at the backside leading to high electric fields and avalanche current multiplication. Irradiation results of dedicated test structures to further investigate the mechanism will be presented.

T 123.2 Thu 16:05 WIL/A317

Development of the BDAQ-PXD laboratory readout system for the characterization of DEPFET pixel detector modules — Patrick Ahlburg, Florian Bernlochner, Jochen Dingfelder, Tomasz Hemperek, Hans Krüger, Botho Paschen, and •Jannes Schmitz for the Belle II-Collaboration — University of Bonn, Germany

The DEPFET PiXel Detector (PXD) is successfully operated in the innermost layers of the Belle II experiment at the SuperKEKB e^+e^-collider in Japan. The PXD data acquisition is optimized for the requirements of the full-scale pixel detector in Belle II. In this talk, the development of a laboratory readout system (BDAQ-PXD) for single PXD modules is presented. BDAQ-PXD provides a simple, flexible and expandable readout for measurements in laboratory, irradiation and test-beam environments. It thus facilitates studies to gain further insights into the behavior of the pixel detector modules and the DEPFET technology. The setup of the system and measurements for the characterization of PXD modules under laboratory conditions are presented in this talk.

T 123.3 Thu 16:20 WIL/A317

Simulation of power lines for the Investigation of the Emergency Shutdown system of the DEPFET pixel detector — •Paula Scholz[1], Florian Bernlochner[1], Jochen Dingfelder[1], Hans Krüger[1], Botho Paschen[1], Matthias Hoek[2], Jannes Schmitz[1], and Patrick Ahlburg[1] for the Belle II-Collaboration — [1]University of Bonn, Germany — [2]Institut für Kernphysik JGU Mainz, Germany

The Belle II Pixel Detector (PXD) is based on DEpleted P-channel Field Effect Transistor (DEPFET) matrices. To control the sensors, voltage levels have to be switched by 20 V within a few nanoseconds per readout cycle (50 kHz). The voltage switching is implemented in Application Specific Integrated Circuits (ASICs), the so-called switchers, on the detector modules. These switchers have been observed to be vulnerable to sudden irradiation bursts, which can occur during beam loss events in the SuperKEKB accelerator. To safeguard the modules from damage caused by beam loss events, the modules have to be switched off as fast as possible when a loss of beam control is imminent. Several beam monitoring systems are employed in the experiment to detect these situations. On PXD hardware side it is investigated how the vulnerable channels can be switched off fast and securely. Therefore, an electronics circuit simulation of the complex PXD power system is being set up to understand the limitations and conduct studies of possible hardware modifications. This talk will concentrate on the necessary steps for creating such a simulation.

T 123.4 Thu 16:35 WIL/A317

Investigation of high resistivity p-type FZ silicon diodes after ^{60}Co - γ irradiation — •Chuan Liao[1], Eckhart Fretwurst[1], Erika Garutti[1], Joern Schwandt[1], Anja Himmerlich[2], Yana Gurimskaya[2], Michael Moll[2], and Ioana Pintilie[3] — [1]Institute of Experimental Physics University of Hamburg, Hamburg, Germany — [2]European Organization for Nuclear Research (CERN), Geneva, Switzerland — [3]National Institute of Materials Physics, Bucharest, Romania

In this work, the macroscopic (I-V, C-V) and microscopic Thermally Stimulated Current (TSC) measurements were used to investigate the radiation effects in high resistivity p-type FZ silicon diodes induced by ^{60}Co γ-rays with dose values between 1×10^5 and 2×10^6 Gy. Two different types of diodes were manufactured using either p-stop or p-spray isolation between the pad and the guard-ring. The leakage current density development with dose was investigated and compared to standard float zone (FZ) n-type diodes. Frequency dependence of capacitance-voltage characteristics was only observed for p-stop diodes and showed a strong dose dependence. In the microscopic measurements, the development of radiation-induced defects (B_iO_i, C_iO_i, VO, I_P) with dose will be presented. To understand the thermal stability of these defects, isochronal annealing experiments from 80 ^{o}C up to 300 ^{o}C for 15 min were performed. The corresponding macroscopic and microscopic measurements will be presented and discussed.

T 123.5 Thu 16:50 WIL/A317

Compton imaging of undepleted regions of germanium detectors — •Felix Hagemann, Iris Abt, Chris Gooch, Lukas Hauertmann, David Hervas Aguilar, Xiang Liu, Oliver Schulz, and Martin Schuster — Max-Planck-Institut für Physik, München

Over the past three years, a novel experimental setup has been built, commissioned and operated at the Max-Planck-Institute for Physics in Munich to characterize the bulk of germanium detectors: the Compton Scanner. In this fully automated setup, a detector is irradiated with a collimated beam of 661.66 keV gammas from a ^{137}Cs source. A part of these gammas Compton scatter in the germanium detector and are detected by pixelated cameras placed nearby, allowing to reconstruct their interaction point in the detector.

If the germanium detector is operated below the depletion voltage, the undepleted volume of the detector cannot be used to register the energy left behind by the Compton scattered photon. By comparing regions with almost no reconstructed events, i.e. measured undepleted volumes for different bias voltages, to predictions based on different assumed impurity density profiles, an estimate of the real impurity density profile of the detector becomes possible.

In this talk, the Compton Scanner setup and its working principle will be presented. Images of the undepleted regions of a germanium detector will be shown and compared to predictions obtained with the open-source julià software package *SolidStateDetectors.jl*.

T 123.6 Thu 17:05 WIL/A317

Angle-selective electron detection with a silicon-based active

Transverse Energy Filter (aTEF) — •Kevin Gauda[1,4], Sonja Schneidewind[1,4], Kyrill Blümer[1,4], Christian Gönner[1,4], Volker Hannen[1,4], Hans-Werner Ortjohann[1,4], Wolfram Pernice[2,3], Lukas Pöllitsch[1,4], Richard Wilhelm Julius Salomon[1,4], Maik Stappers[2], and Christian Weinheimer[1,4] — [1]Institute for Nuclear Physics, University of Münster — [2]CeNTech and Physics Institute, University of Münster — [3]Kirchhoff-Institute for Physics, University of Heidelberg — [4]KATRIN Collaboration

The active Transverse Energy Filter (aTEF) is a concept to discriminate electrons in a large magnetic field based on their pitch angle (EPJ-C 82, 922 (2022)). It is investigated as a background reduction measure in the KATRIN experiment, where low-energy electrons from ionisation of atoms in highly excited (Rydberg or autionising) states within the spectrometer impede the design sensitivity of $0.2\,\mathrm{eV\,c^{-2}}$ (90% C.L.). These electrons are practically indistinguishable from desired tritium beta electrons via kinetic energy, while their pitch angle distribution differs significantly. The aTEF for KATRIN may be realized as a microstructured detector – e.g., based on Si-PIN diodes – tailored to exclusively detect electrons with large pitch angles. Fabrication of prototypes is carried out via semiconductor processing technologies, for instance deep inductively coupled plasma etch (ICP-RIE). Production and performance of aTEF prototypes will be presented.

The work of the speaker for KATRIN is supported by BMBF under contract number 05A20PMA.

T 124: Si-Strip/CMS, Pixel/DMAPS

Time: Thursday 15:50–17:20 Location: WIL/A124

T 124.1 Thu 15:50 WIL/A124

Performance of the latest Service Hybrid prototypes for CMS silicon strip modules — Christian Dziwok[2], Lutz Feld[1], Katja Klein[1], Martin Lipinski[1], Daniel Louis[1], •Alexander Pauls[1], Oliver Pooth[2], Nicolas Röwert[1], Felix Thurn[1], Michael Wlochal[1], and Tim Ziemons[2] — [1]1. Physikalisches Institut B, RWTH Aachen — [2]3. Physikalisches Institut B, RWTH Aachen

The CMS Collaboration is developing silicon strip modules for the second phase of the CMS tracker upgrade. This upgrade will enable the CMS experiment to utilize the high luminosity provided by the future HL-LHC. The modules' Service Hybrids are responsible for the sensor bias voltage and low voltage distribution on the module and the data transmission via optical links to the back-end electronics. For the first time, final versions of the required ASICs were assembled and tested on Service Hybrid prototypes with materials and geometries as foreseen in the detector. The measurements were performed with setups similar to the foreseen production test system. The gained experience is crucial for the design validation and in taking the final choices in the design process before series production.

T 124.2 Thu 16:05 WIL/A124

Influence of High-Frequency Magnetic Fields on the Noise Behavior of CMS 2S Module Prototypes — Christian Dziwok[2], Lutz Feld[1], Katja Klein[1], Martin Lipinski[1], Alexander Pauls[1], Oliver Pooth[2], and •Nicolas Röwert[1] — [1]I. Physikalisches Institut B, RWTH Aachen University, Germany — [2]RWTH Aachen University - Physics Institute III B, Aachen, Germany

For the CMS tracker Phase-2 upgrade new modules with silicon strip sensors are being developed. Each module features a Service Hybrid (SEH), which is responsible for the distribution of low voltages to the module components using a two-stage DC-DC conversion scheme. For modules equipped with the latest generation of SEHs an increase in module noise has been observed. A setup for inducing radiative noise with external magnetic fields that are frequency- and location-dependent is presented. Measurements carried out on modules from different prototyping phases show that the sensitivity is similar across generations, which indicates that radiative coupling into the sensor or readout electronics is not responsible for the observed noise increase.

T 124.3 Thu 16:20 WIL/A124

Systematic tests of the testing infrastructure for CMS Outer Tracker Service Hybrids — Christian Dziwok[2], Lutz Feld[1], Katja Klein[1], Martin Lipinski[1], Daniel Louis[1], Alexander Pauls[1], Oliver Pooth[2], Nicolas Röwert[1], •Felix Thurn[1], Michael Wlochal[1], and Tim Ziemons[2] — [1]1. Physikalisches Institut B, RWTH Aachen — [2]3. Physikalisches Institut B, RWTH Aachen

The CMS Collaboration is developing so-called 2S modules for the Phase-2 upgrade of the CMS tracker. This upgrade will enable the CMS experiment to utilize the high luminosity provided by the future HL-LHC. A 2S module consists of two silicon strip sensors, two support bridges and three electronics hybrids. One of these hybrids is the Service Hybrid (SEH), which supplies the power to all other parts of the module, aggregates the data lines from both sides of the module and is responsible for the data transmission via optical links to the back-end of the detector. During the production roughly 20,000 SEHs will undergo a vigorous quality control procedure. The test card for testing the functionality of the SEH is developed by RWTH Aachen and around 100 test cards were manufactured. These will be distributed to the manufacturer and collaborating institutes of the SEHs. Before that they have been tested and the statistical fluctuations of the measurements have been analyzed. A crate with several test cards was set up in a climatic chamber and the whole testing procedure including thermal cycling was exercised. Selected results from the commissioning and quality control of the test cards are presented.

T 124.4 Thu 16:35 WIL/A124

Characterization of TJ-Monopix2 - A depleted monolithic active pixel sensor with column drain readout architecture — •Christian Bespin[1], Ivan Caicedo[1], Jochen Dingfelder[1], Toko Hirono[2], Hans Krüger[1], Konstantinos Moustakas[3], and Norbert Wermes[1] — [1]Universität Bonn, Bonn, Deutschland — [2]DESY, Hamburg, Deutschland — [3]Paul Scherrer Institut, Villingen, Schweiz

The increasing availability of commercial CMOS processes with high-resistivity wafers has fueled the R&D of depleted monolithic active pixel sensors (DMAPS) for usage in high energy physics experiments. One of these developments is a series of monolithic pixel detectors with column-drain readout architecture and small collection electrode facilitating low-power designs: the TJ-Monopix series.

The latest iteration TJ-Monopix2 is designed in a 180 nm TowerJazz CMOS process and features a pixel size of 33 um x 33 um. Results from laboratory measurements and test beam campaigns demonstrating threshold and noise performance as well as hit efficiency measurements will be presented to discuss the suitability of TJ-Monopix2 for use in high-radiation environments.

T 124.5 Thu 16:50 WIL/A124

Characterisation of a DMAPS prototype for BELLE II a proposed Vertex Detector Upgrade — •Marike Schwickardi[1], Benjamin Schwenker[1], Ariane Frey[1], Yannik Buch[1], Maximilian Babeluk[2], Bernhard Pilsl[2], Patrick Sieberer[2], Christian Irmler[2], and Jérôme Baudot[3] — [1]Georg-August-Universität Göttingen, Deutschland — [2]HEPHY, Wien, Österreich — [3]IPHC, Straßburg, France

The SuperKEKB collider in Japan is an asymmetric electron-positron collider at a center-of-mass energy of 10.58 GeV. A world record peak luminosity of $4.7 \cdot 10^{34}\ \mathrm{cm^{-2}s^{-1}}$ was achieved during the last run period in June 2022. The peak luminosity is planned to be ramped up incrementally to the design value of $6.5 \cdot 10^{35}\ \mathrm{cm^{-2}s^{-1}}$. During the long shutdown tentatively scheduled for 2026/2027 an upgrade for the vertex detector is planned, to improve the detectors performance, robustness against beam-induced backgrounds and simplify servicing the system. Proposed is a fully pixelated 5 layer vertex detector (VXD) concept, based on the CMOS-DMAPS technology. The proposed chip is named OBELIX and is a further development based of the TJ-MONOPIX2 produced in the Tower 180 nm process, as a replacement of the current pixel-and-strip vertex detector concept.

To ensure the design specification for the OBELIX chip are met, the predecessor TJ-MONOPIX2, was characterised in laboratory measurements and during a beam test at DESY in June 2022. The results obtained from these measurements are implemented in simulations in the Belle II Analysis Framework for more realistic performance studies.

T 124.6 Thu 17:05 WIL/A124

Test-beam campaign and characterization of irradiated depleted monolithic active pixel sensors (DMAPS) designed in 150nm CMOS technology — •Lars Schall[1], Christian Bespin[1], Ivan Caicedo[1], Jochen Dingfelder[1], Tomasz Hemperek[2], Toko Hirono[1], Fabian Hügging[1], Hans Krüger[1], Piotr Rymaszewski[2], Tianyang Wang[3], and Norbert Wermes[1] — [1]University of Bonn, Germany — [2]Dectris, Switzerland — [3]Zhangjiang National Lab, China

Monolithic active pixel sensors with depleted substrates are a promising option for pixel tracking detectors in high-radiation environments. The use of a highly resistive silicon substrate and short drift paths enhance the radiation tolerance, while a careful guard ring design facilitates high biasing voltages to deplete the sensor.

LF-Monopix2 is the latest prototype of a DMAPS development in 150 nm CMOS technology. It features a fully functional column-drain readout architecture in a 2x1 cm^2 matrix. A reduced pixel pitch of 50x150 μm^2 compared to its predecessor results in a smaller detector capacitance and an improved spatial resolution. Each pixel's digital electronics are integrated within the large collection electrode.

LF-Monopix2 chips thinned down to 100 μm have been tested and found to work successfully after being irradiated to 1e15 neq/cm^2. In this talk, results from recent characterization measurements and test-beam campaigns are shown. Focus is put on measurements with irradiated sensors and the comparison to unirradiated sensors.

T 125: Calorimeter / Detector Systems V

Time: Thursday 15:50–17:20 Location: WIL/C133

T 125.1 Thu 15:50 WIL/C133

Developement of a SplitCAL Prototype — •Matei Climescu and Rainer Wanke — Johannes Gutenberg Universität Mainz

The SplitCAL is a mixed electromagnetic calorimeter designed to provide both energy reconstruction through layers of scintillating stripes read out by wavelength shifting fibres and shower direc tion information through high-precision layers. This can be used for fixed target experiments which require high geometrical precision (such as SHiP@ECN3 or SHADOWS@ECN3). The development needs to account for low rates but a large dynamic range. The status of the detector prototype as well as the readout electronics will be presented.

T 125.2 Thu 16:05 WIL/C133

A pointing Calorimeter for the SHADOWS Experiment — •Sebastian Ritter for the SHADOWS-Collaboration — Universität Mainz

The SHADOWS experiment is a proposed off-axis beam dump experiment on the 400 GeV/c proton beam from the CERN SPS aiming to measure the decay of Hidden Sector particles. To reconstruct particles that only decay into photons, the photon energies, and directions need to be measured. In this talk, a highly granular plastic scintillator-based electromagnetic calorimeter is presented, which aims to provide the necessary energy and pointing resolution to achieve this task in SHADOWS.

T 125.3 Thu 16:20 WIL/C133

Multi-layer tile modules test system using cosmic ray for the CMS HGCAL upgrade — •Jia-Hao Li — Deutsches Elektronen-Synchrotron DESY, Notkestr. 85, 22607 Hamburg, Germany

The CMS experiment plans to upgrade its calorimeter endcap for the high luminosity phase of the LHC with the High Granularity Calorimeter (HGCAL). The hadronic calorimeter (CE-H) part of the HGCAL in the lower radiation dose region is composed of scintillator-base tile modules using the SiPM-on-tile technology for particle detection. The tile module is equipped with HGCROC ASIC for data readout. The fast command and slow control signals from the counting room are also received by the HGCROC. To test and calibrate the tile modules, a cosmic ray measuring test with multi-layer tile modules parallel to each other is set up for quality control and a better understanding of the property and capability of the tile module. The presentation will discuss the idea and current status of the cosmic test setup at DESY.

T 125.4 Thu 16:35 WIL/C133

Testbeam Measurements with a Liquid Scintillator Detector Prototype for the SHiP Surrounding Background Tagger — •Annika Hollnagel for the SHiP-SBT-Collaboration — JGU Mainz

By introducing a segmented geometry, Liquid Scintillator [LS] detectors are able to offer a combination of large geometrical coverage and good spatial resolution. This approach can be employed to create a new generation of high-resolution particle detectors or to improve the performance of large-volume detectors commonly used in neutrino and low-background experiments.

As a frontrunner proposal of the CERN Physics Beyond Colliders initiative, SHiP aims to exploit the full potential of a future SPS Beam-Dump Facility and combine the Search for Hidden Particles [SHiP] with tau neutrino physics. The Hidden Sector detector of SHiP will consist of a large evacuated volume followed by magnetic spectrometer and Particle Identification system. To enable studying the decays of Feebly-Interacting Particles, the reduction of beam-induced background heavily relies on the Surrounding Background Tagger [SBT] enveloping the 50m-long decay vessel. Current baseline for the SBT is a segmented LS detector that is instrumented with Wavelength-shifting Optical Modules [WOM] and read out via SiPMs.

Supported by laboratory measurements and simulations, several testbeam measurements have already been conducted at CERN and DESY, proving the principle and allowing to improve detector design and performance. This talk will give an overview of the latest 2022 test exposure of a full-size detector cell to the DESY II electron beams.

T 125.5 Thu 16:50 WIL/C133

Development of the experiment control system for the Timepix4 telescope — Johannes Albrecht[1], Elena Dall'Occo[1], and •David Rolf[1,2] — [1]TU Dortmund University, Dortmund, Germany — [2]CERN, Geneve, Switzerland

Future high-energy physics experiments will require a very precise timing measurement, on top of a good spatial resolution. A precise timing will allow to not only reconstruct tracks in space, but also to separate them in time; this in turn allows for densely packed, almost simultaneous collisions to be reconstructed with high precision.

The Timepix4 telescope is designed to be a first demonstrator of track reconstruction in four dimensions, as well as a system to probe and characterise next generation devices in terms of space and time capabilities. The final version of the telescope aims to have a pointing resolution below 2 μm in space and around 30 ps in time. To achieve this, the telescope is built up from eight silicon sensors of 100 μm and 300 μm thickness, bump bonded to the newest generation of Timepix4 ASICs.

This talk will give a brief overview of the Timepix4 telescopes design, and then focus on its experiment control system. The control system is used to remotely operate the motion stages and power supplies of the telescope, and to monitor the environmental conditions. The focus of the talk will be on the development of the controlling software implemented in WinCCOA and its communication to the hardware.

T 125.6 Thu 17:05 WIL/C133

Upgrading the Cosmic Ray Facility for Tests Regarding the Phase-II Upgrade of the ATLAS Muon Spectrometer — •Florian Egli[1], Otmar Biebel[1], Henk Boterenbrood[2], Valerio D'Amico[1], Stefanie Götz[1], Ralf Hertenberger[1], Christoph Jagfeld[1], Eshita Kumar[1], Katrin Penski[1], Maximilian Rinnagel[1], Nick Schneider[1], Chrysostomos Valderanis[1], and Fabian Vogel[1] — [1]LMU München — [2]Nikhef, Amsterdam

The Phase-II Upgrade of the ATLAS Muon Spectrometer for the High Luminosity LHC (HL-LHC) includes the installation of a new and more efficient trigger and readout system for the Monitored Drift Tube (MDT) chambers. It is crucial that the Phase-II Upgrade can be tested on an MDT chamber outside of ATLAS, to detect errors and verify possible solutions, independent of the upgrade operations at CERN. The Cosmic Ray Facility in Garching could provide an ideal testsite, as it consists of two fully functional MDT chambers. However, its readout electronics and infrastracture are not compatible with the Phase-II Upgrade. As a first step, the infrastructure and electronics in the Cosmic Ray Facility are upgraded to the Phase-I standard of the ATLAS Muon Spectrometer. This includes the setup of a FELIX based

readout system, which is compatible with both the Phase-I and the Phase-II electronics. Furthermore, new scintillators are installed on the top and on the bottom of the setup, in parallel to the MDTs, to allow preliminary tests of a path-based trigger. In this talk the current status of the project and first results are presented.

T 126: Gas-Detecors, Detector Systems

Time: Thursday 15:50–17:20 Location: WIL/A120

T 126.1 Thu 15:50 WIL/A120

Measurement Analysis of Micromegas detectors — •Eshita Kumar, Otmar Biebel, Valerio D'Amico, Florian Egli, Stefanie Götz, Ralf Hertenberger, Christoph Jagfeld, Katrin Penski, Maximilian Rinnagel, Nick Schneider, Chrysostomos Valderanis, and Fabian Vogel — LMU München

MICRO MEsh GAseous Structure (Micromegas) detectors are micro patterned gaseous detectors that have high rate capability due to the fast evacuation of positive ions and excellent spatial resolution due to a small scale readout strip pitch. These detectors are used for the track reconstruction of ionizing particles. To test the performance and resilience of such detectors under high background, multiple detectors are irradiated by a 10 GBq Americium-Beryllium neutron source: measurements with different shielding materials of varying thicknesses placed in front of the source are used to disentangle the detector response for gamma and neutron radiation. A Geant4 simulation to determine the interaction probability from the background radiation is carried out. Comparison of the analysis of the detector output to the simulation results for the final charge obtained from the gammas and the neutrons will be shown.

T 126.2 Thu 16:05 WIL/A120

Development of a Segmented GEM Readout (SGR) Detector — •Christoph Jagfeld, Otmar Biebel, Valerio D'Amico, Stefanie Götz, Ralf Hertenberger, Katrin Penski, Maximilian Rinnagel, Chrysostomos Valderanis, and Fabian Vogel — LMU, München

In Micromegas detectors the primary charges are amplified by electron avalanches between a planar anode and a mesh in 120 μm distance. For resistive Micromegas detectors the signal is read out via readout strips below the anode. A 2D position is reconstructed using two perpendicular readout strip layers below the resistive anode structure.
Using a standard 2D resistive Micromegas readout structure, a unique 2D particle position reconstruction is possible if the detector is hit by one particle at the same time. Ambiguities occur if multiple particles arrive at the same time. A unique X-Y assignment is not possible.
This issue can be solved by replacing the mesh with a GEM foil, which is segmented into 0.5 mm wide strips on both sides. The GEM strips must be turned by 45° with respect to the Micromegas readout strips. Thus the detector has four readout strip directions (X, Y, U, V).
A prototype of such a Segmented GEM Readout detector is built with GEM strips and readout strips perpendicular to each other. Test beam measurements with this detector were performed using 120 GeV muons. The GEM and Micromegas strips show a similar pulse height. For perpendicular incident particles a position reconstruction efficiency better than 90% is reached on both the GEM - and the readout strips. A resolution better than 80 μm for the GEM and readout strips is achieved.

T 126.3 Thu 16:20 WIL/A120

Efficiency and time resolution of a large-size WOM-SiPM-based liquid-scintillator detector — •Alessia Brignoli for the SHiP-SBT-Collaboration — Humboldt Universität zu Berlin

Within the BMBF-funded generic R&D consortium High-D, a multi-cell large area liquid-scintillator detector, where each cell is equipped with two wavelength-shifting optical modules (WOMs) viewed by a ring-array of silicon photomultipliers (SiPMs) is being developed. The aim is to reconstruct particles crossing the detector using the time and light-yield response. Such a detector type has been proposed for the Surround Background Tagger for the SHiP experiment proposal at the CERN SPS. In a first step, we are studying the characteristics of a one-cell detector using data taken during a testbeam campaign in October 2022 with a positron beam at the DESY testbeam facility in Hamburg. We will present results on the detector cell efficiency as well as on the time resolution of the detector as function of particle beam position at the detector cell.

We acknowledge the support from BMBF via the High-D consortium.

T 126.4 Thu 16:35 WIL/A120

Readout of Wavelength-shifting Optical Modules — •Johannes Alt for the SHiP-SBT-Collaboration — Albert-Ludwigs-Universität Freiburg

Wavelength-shifting optical modules (WOMs) are a low-cost way to capture the scintillation light produced in a liquid scintillator volume. These WOM tubes connected to Silicon Photomultipliers are proposed to be used in the large-area Surrounding Background Tagger (SBT) of the proposed general-purpose Search for Hidden Particles (SHiP) experiment. In this talk, the current status of the research and development on the WOM readout will be presented. This work is funded by BMBF.

T 126.5 Thu 16:50 WIL/A120

Photon exit angles of Wavelength-Shifting Optical Modules for the SHiP-SBT — •Florian Rehbein for the SHiP-SBT-Collaboration — RWTH Aachen University

This contribution will present simulations of the photon exit angle distributions of a Wavelength-Shifting Optical Module (WOM) for the SHiP experiment. These simulations are compared to first measurements taken with a DSLR camera on a laboratory test stand.

WOMs present a novel optical sensor for numerous applications, combining a well-designed light guide with a wavelength-shifting coating. They will be used as an integral part of the Surrounding Background Tagger (SBT) in SHiP (Search for Hidden Particles), a proposed general-purpose fixed target experiment at the SPS accelerator of the CERN facility. The SBT acts as a discriminator against external particle interactions and is composed of many cells utilizing liquid scintillator and tube-shaped WOMs made of PMMA to detect traversing particles. The coating of the WOMs absorbs the scintillation photons and re-emits wavelength-shifted photons, which are then detected by an array of SiPMs coupled to one end of the WOM.

T 126.6 Thu 17:05 WIL/A120

Reflective Coating for the SHiP Surround Background Tagger — •Patrick Deucher for the SHiP-SBT-Collaboration — Johannes Gutenberg Universität Mainz

The Surrounding Background Tagger (SBT) is a liquid scintillator-based detector in the SHiP Experiment. Divided into segments and embedded into the Corten steel structure of the Hidden Sector decay vessel, the SBT's main task will be the discrimination against beam-induced backgrounds. The efficiency of such a detector type can be increased by optimizing the light detection equipment, lowering the attennuation length of the scintillator (purification and addition of different fluorophores) and increasing the reflectivity of the inner detector walls. Following results of Photon Transport Simulations the application of a diffuse and highly reflective Bariumsulfate-based (OPRC by Berghof*Fluoroplastic*Technology*GmbH) coating to the inner detector walls is studied. After extensive reflectivity-, stability- and compatibility tests the reflective coating was applied to the SBT test cell for the test beam 2022 at the DESY facilities. This talk will discuss results of a first large scale application of the reflective coating in a liquid-scintillator detector cell.

T 127: Exp. Methods III

Time: Thursday 15:50–17:05 Location: WIL/C129

T 127.1 Thu 15:50 WIL/C129

A General Track Fit based on Hit Triplets — •Mohd Talha and André Schöning for the ATLAS-Collaboration — Physikalische Institute, Universität Heidelberg

Modern particle physics experiments often deal with high particle rates and therefore use silicon detectors for particle tracking. High hit occupancies, together with a relatively large amount of material in the tracking layers, pose a big challenge for track reconstruction.

For the High Luminosity ATLAS upgrade, it is planned to perform a full reconstruction of ∼5000 tracks per event at the ATLAS Event Filter with a rate of about 100 kHz. The tracking algorithm has to run on commercial hardware. One option considered by our group is the implementation of a parallelizable track reconstruction algorithm on a farm of GPUs. The algorithm of choice is a general broken line fit based on hit triplets that was originally developed for applications with dominating multiple scattering uncertainties [N. Berger et al., JINST 9 P07007 (2014)] and has also been extended to include hit uncertainties. The latter is crucial for the reconstruction of high momentum tracks.

After motivating hit triplets as basic tracking elements for a general broken line fit, the general solution for a track fit of three hits (triplet) in a solenoidal magnetic field will be presented and discussed.

T 127.2 Thu 16:05 WIL/C129

Matrix inversion in the context of a novel track reconstruction algorithm for the ATLAS Event Filter — •Antara Paul[1] and Andre Schöning[2] for the ATLAS-Collaboration — [1]Physikalisches Institut, Universität Heidelberg, Germany — [2]Physikalisches Institut, Universität Heidelberg, Germany

The High Luminosity LHC project is expected to provide a tenfold increase of the integrated luminosity compared to the LHC. To cope with the resulting high pile-up from proton-proton collisions, the ATLAS detector, and its trigger and DAQ systems are undergoing major upgrades. As a part of the upgrade of the online event filter, a fast triplet track reconstruction algorithm is being developed based on a broken line fit. The track parameters are estimated by minimizing a χ^2 function, which includes the multiple scattering and spatial hit uncertainties at each layer. This minimization involves the inversion of a matrix.
In this context, the talk focuses on different algorithms of matrix inversion, including but not limited to LDL^T decomposition and the partition method. The speed and accuracy of each method will be presented and compared, in view of their implementation in the track reconstruction algorithm.

T 127.3 Thu 16:20 WIL/C129

Navigation and track parameter transport using a heterogeneous code design for CPUs and GPUs within the ACTS R&D project — Andreas Salzburger[1], •Joana Niermann[1,2], Beomki Yeo[3,4], Stephen Swatman[1,5], Attila Krasznahorkay[1], and Stan Lai[2] — [1]CERN — [2]II. Physikalisches Institut, Georg-August-Universität Göttingen — [3]Department of Physics, University of California — [4]Lawrence Berkeley National Laboratory — [5]University of Amsterdam

With the upcoming high luminosity era of the LHC, track reconstruction, in particular, will suffer from drastically increasing combinatorics. A promising perspective to meet these rising computing demands is the deployment of hardware accelerators which offer massive parallelism, like GPGPUs. Current state-of-the-art implementations of pattern recognition algorithms in track reconstruction are problematic to adapt to accelerator hardware architectures in several ways. For example, runtime-polymorphic geometry classes and pointer based data structures are commonly difficult to move to an accelerator device.

Within the ACTS parallelization R&D project, research is on-going to adapt a complete track reconstruction chain, from clusterization to track fitting, to run efficiently on GPUs. We show the implementation and performance of a core component of this chain: the propagation of track parameters and their associated covariances through an inhomogeneous magnetic field (*covfie* library), together with the application of material effects. The implementation is part of the *detray* library and makes use of its geometry description and navigation.

T 127.4 Thu 16:35 WIL/C129

Tracking efficiency studies for LHCb in Run 3 — Flavio Archilli[1], •Rowina Caspary[2], Giulia Frau[2], and Peilian Li[3] — [1]Università di Roma Tor Vergata, Rome, Italy — [2]Physikalisches Institut, Heidelberg University, Germany — [3]CERN

The LHCb detector is dedicated to the measurement of particles containing b- and c-quarks and has recently been upgraded, aiming to take data with an instantaneous luminosity of $2 \times 10^{33} cm^{-1} s^{-1}$ at $\sqrt{s} = 14$ TeV . The tracking system is completely renewed and a new reconstruction and trigger framework is implemented, in which all the tracking reconstruction algorithms are redesigned.

The correct evaluation of the tracking reconstruction efficiency is essential for many measurements of the LHCb experiment. However the precision of the simulation is limited, thus a data-driven approach is developed exploiting a tag-and-probe method on a sample of $J\psi \to \mu\mu$ events to cross-check the track reconstruction efficiency in data. The difference of track reconstruction efficiency between simulation and data is then evaluated and exploited as calibration parameters. In addition, the effect of hadronic interactions on the track reconstruction efficiency is estimated using $D^0 \to K\pi$ and $D^0 \to K\pi\pi\pi$ decays.

T 127.5 Thu 16:50 WIL/C129

Track reconstruction for the *Mu3e* experiment — •Alexandr Kozlinskiy — Institut für Kernphysik, JGU Mainz, Germany

The *Mu3e* experiment is designed to search for the lepton flavor violating decay $\mu^+ \to e^+e^-e^+$. The aim of the experiment is to reach a branching ratio sensitivity of 10^{-16}. The experiment is located at the Paul Scherrer Institute (Switzerland) and an existing beam line providing 10^8 muons per second will allow to reach a sensitivity of a few 10^{-15} in the first phase of the experiment. The muons with a momentum of about 28 MeV/c are stopped and decay at rest on a target. The decay products (positrons and electrons) with energies below 53 MeV are measured by a tracking detector consisting of two double layers of 50 μm thin high-voltage monolithic active pixel sensors. The high granularity of pixel detector with a pixel size of 80×80 μm together with the small material budget allows for a precise track reconstruction. The track reconstruction is optimized for low noise and high efficiency of tracking detector. This environment allows to efficiently remove incorrectly reconstructed tracks with minimal effect on tracks produced by real particles. This talk will present the details of the track reconstruction, the methods to reduce the number of fake tracks and suppress clones produced due to high hit densities.

T 128: AI Topical Day – New Methods (joint session AKPIK/T)

Time: Thursday 17:30–19:00 Location: HSZ/0004

T 128.1 Thu 17:30 HSZ/0004

Neural networks for cosmic ray simulations — •Pranav Sampathkumar[1], Tanguy Pierog[1], and Antonio Augusto Alves Junior[2] — [1]Institute for Astroparticle Physics (IAP), KIT, Germany — [2]Brazilian Synchrotron Light Laboratory (LNLS), CNPEM, Brazil

Simulating cosmic ray showers at high energies is memory and time intensive. Apart from the traditional methods such as thinning and cascade equations, novel methods are needed for the modern needs in astroparticle physics.

A hybrid model of generating cosmic ray showers based on neural networks is presented. We show that the neural network learns the solution to the governing cascade equation in one dimension. We then use the neural network to generate the energy spectra at every height slice. Pitfalls of training to generate a single height slice is discussed, and we present a sequential model which can generate the entire shower from an initial spectrum. Errors associated with the model and the po-

tential to generate the full three dimensional distribution of the shower and detector footprints are discussed.

T 128.2 Thu 17:45 HSZ/0004

Transformer-Based Eventwise Reconstruction of Cosmic-Ray Masses at the Pierre Auger Observatory — Martin Erdmann, •Niklas Langner, and Dominik Steinberg — III. Physikalisches Institut A, RWTH Aachen University

As one aspect of the AugerPrime upgrade, scintillators (SSDs) will be added to the water Cherenkov detectors (WCDs) that form the surface detector of the Pierre Auger Observatory. This combined measurement offers the possibility to distinguish individual components of extensive air showers, potentially increasing the mass sensitivity. To efficiently exploit this new potential, novel methods are needed.

We introduce a Transformer-based neural network to reconstruct cosmic-ray masses from joint WCD and SSD measurements that outperforms both recurrent and convolutional networks. Efficient Transformers are employed to analyze and relate the two different sets of time traces on station level while ensuring a reasonable degree of computational demands. A Vision Transformer is then applied to the hexagonal grid of detector stations to process the whole shower footprint.

The Transformer network is trained to simultaneously reconstruct the depth of the shower maximum $X_{\max}$ as well as the shower's number of muons on ground R_μ. Both observables can be combined to estimate the primary cosmic-ray mass with an accuracy higher than what can be achieved individually.

T 128.3 Thu 18:00 HSZ/0004

Quantum Angle Generator for Image Generation — •Florian Rehm[1,2], Sofia Vallecorsa[1], Michele Grossi[1], Kerstin Borras[2,3], Dirk Krücker[2], Simon Schnake[2,3], Alexis-Harilao Verney-Provatas[2,3], and Valle Varo[3] — [1]CERN, Switzerland — [2]RWTH Aachen University, Germany — [3]DESY, Germany

The Quantum Angle Generator (QAG) is a new generative model for quantum computers. It consists of a parameterized quantum circuit trained with an objective function. The QAG model utilizes angle encoding for the conversion between the generated quantum data and classical data. Therefore, it requires one qubit per feature or pixel, while the output resolution is adjusted by the number of shots performing the image generation. This approach allows the generation of highly precise images on recent quantum computers. In this paper, the model is optimised for a High Energy Physics (HEP) use case generating simplified one-dimensional images measured by a specific particle detector, a calorimeter. With a reasonable number of shots, the QAG model achieves an elevated level of accuracy. The advantages of the QAG model are lined out - such as simple and stable training, a reasonable amount of qubits, circuit calls, circuit size and computation time compared to other quantum generative models, e.g. quantum GANs (qGANs) and Quantum Circuit Born Machines.

T 128.4 Thu 18:15 HSZ/0004

Photon identification at hadron colliders using graph neural networks — •Ali Malyali Choban[1], Johannes Erdmann[1], Florian Mausolf[1], and Christopher Morris[2] — [1]III. Physikalisches Institut A, RWTH Aachen University — [2]Fachgruppe Informatik, RWTH Aachen University

At hadron colliders like the LHC, photons are essential physics objects in a wide range of analyses. For example, they allow the study of the Higgs boson using the diphoton decay channel. At a typical particle detector, the main signatures of photons are energy depositions in the electromagnetic calorimeter. However, other objects can leave similar signatures in the electromagnetic calorimeter, leading to misidentification as photons. Jets are abundant at the LHC and they include a high number of light hadrons, most notably neutral pions decaying into two photons. The decay of pions produces photons that are often close to each other and they are likely to be reconstructed as a single photon. However, photon candidates from jets have different attributes that can help to discriminate them from real photons. Specifically, they tend to produce wider signatures in the calorimeter, and to be accompanied by more additional particles.

Graph neural networks (GNNs) are flexible neural architectures well suited for dealing with input data of irregular structure and variable shape. Hence, they are particularly suited for classifying photon candidates as often a variable number of particles surrounds them. In this talk, our study of the applicability of GNNs for photon identification and comparisons with convolutional neural networks are presented.

T 128.5 Thu 18:30 HSZ/0004

Data-driven Simulation of Target Normal Sheath Acceleration by Fourier Neural Operator — Jeyhun Rustamov[1,2], Thomas Miethlinger[1], Thomas Kluge[1], Michael Bussmann[1,3], and •Nico Hoffmann[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany — [2]TU Dresden, Dresden, Germany — [3]CASUS, Görlitz, Germany

Particle-in-Cell simulations are a ubiquitous tool for linking theory and experimen- tal data in plasma physics rendering the comprehension of non-linear processes such as Laser Plasma Acceleration (LPA) feasible. These numerical codes can be considered as state-of-the-art approach for studying the underlying physical processes in high temporal and spatial resolution. The analysis of experiments is performed by optimising simulation parameters so that the simulated system is able to explain experimental results. However, a high spatio-temporal resolution comes at the cost of elevated simulation times which makes the inversion nearly impossible. We tackle that challenge by introducing and studying a reduced order model based on Fourier neural operator that is evolving the ion density function of Laser-driven Ion acceleration via 1D Target Normal Sheath acceleration (TNSA). The ion density function can be dynamically generated over time with respect to the thickness of the target. We show that this approach yields a significant speed-up compared to numerical code Smilei while retaining physical properties to a certain degree promising applicability for inversion of experimental data by simulation-based inference.

T 128.6 Thu 18:45 HSZ/0004

RootInteractive tool for multidimensional statistical analysis, machine learning and analytical model validation — •Marian Ivanov[1] and Marian Ivanov jr.[2] for the ALICE Germany-Collaboration — [1]GSI Darmstadt — [2]UK Bratislava

ALICE, one of the four large experiments at CERN LHC, is a detector for the physics of heavy ions. In a high interaction rate environment, the pile-up of multiple events leads to an environment that requires advanced multidimensional data analysis methods.

Our goal was to provide a tool for dealing with multidimensional problems, to fit and visualize multidimensional functions including their uncertainties and biases, to validate assumptions and approximations, to easy define the functional composition of analytical parametric and non-parametric machine learning functions, to use symmetries and to define multidimensional "invariant" functions/alarms.

RootInteractive is a general-purpose tool for multidimensional statistical analysis. Its declarative programming paradigm makes it easy to use for professionals, students, and educators. RootInteractive provides functions for interactive, easily configurable visualization of unbinned and binned data and extraction of derived aggregate information on the server (Python/C++) and client (Javascript). We support client/server applications using Jupyter, or a stand-alone client-side interactive application/dashboard.

T 129: Flavor X

Time: Thursday 17:30–19:00 Location: HSZ/0304

T 129.1 Thu 17:30 HSZ/0304

New physics in $b \to c\tau\nu$ — Marco Fedele[1], Monika Blanke[1,2], Andreas Crivellin[3,4], Syuhei Iguro[1,2], Teppei Kitahara[5,6,7], •Ulrich Nierste[1], and Ryoutaro Watanabe[8] — [1]Institut für Theoretische Teilchenphysik (TTP), Karlsruhe Institute of Technology (KIT) — [2]Institut für Astroteilchenphysik (IAP), Karlsruhe Institute of Technology (KIT) — [3]Paul Scherrer Institut — [4]Physik-Institut, Universität Zürich — [5]Institute for Advanced Research & Kobayashi-Maskawa Institute for the Origin of Particles and the Universe, Nagoya University — [6]KEK Theory Center, IPNS, Tsukuba — [7]CAS Key Laboratory of Theoretical Physics, Institute of Theoretical Physics, Chinese Academy of Sciences, Beijing — [8]INFN, Sezione di Pisa

The branching fractions of the decays $B \to D\tau\nu$ and $B \to D^*\tau\nu$ have been measured by BaBar, Belle, and LHCb. The combination of these measurements indicates an enhancement of the $b \to c\tau\nu$ amplitude w.r.t. the Standard-Model prediction by 3.2σ. This finding is in in tension with the measurement of $B(\Lambda_b \to \Lambda_c\tau\nu)$, which is related to the former two branching ratios by a sum rule. I discuss the implications of this sum rule for future measurements and assess popular scenarios of new physics postulating either a charged Higgs boson or leptoquarks.

T 129.2 Thu 17:45 HSZ/0304

Measurement of $R(D^*)$ with inclusive B meson tagging at Belle II — •Stephanie Steinmetz, Thomas Lück, and Thomas Kuhr — Ludwig-Maximilians-Universität München

The measured ratio $R(D^*) = \mathcal{B}(B \to D^*\tau\nu)/\mathcal{B}(B \to D^*\ell\nu)$ of branching fractions, where $\ell = e, \mu$, has consistently shown an excess of $B \to D^*\tau\nu$ events. The deviation between Standard Model predictions and the current world average lies at 2.8σ, made even more interesting by the fact that many systematic uncertainties cancel in the ratio. In combination with the analogous $R(D)$, the discrepancy exceeds 3σ and has therefore attracted much attention as a possible hint towards new physics phenomena such as leptoquarks or a charged Higgs.

In this analysis at Belle II, we investigate the decay chains $B \to D^*\tau(\ell\nu\nu)\nu$ as the signal channel, and $B \to D^*\ell\nu$ as normalisation. As both provide the same final state (up to neutrinos), a D^* and a lepton are reconstructed in both cases. The other B meson ("tag B") in the $\Upsilon(4S) \to BB$ event is reconstructed ("tagged") inclusively, i.e. by assuming all particles not assigned to the signal B belong to the tag B without reconstructing intermediate particles. The resulting higher event yields are especially useful when only limited data is available, but come at the cost of higher background levels compared to previous approaches where specific tag B decay trees are reconstructed. The goal of this analysis is to determine the feasibility of applying the inclusive tagging approach to early Belle II data in order to gain competitive results w.r.t. other approaches. The current status of the analysis will be presented in this talk.

T 129.3 Thu 18:00 HSZ/0304

Measuring R(D*) in hadronic one-prong τ decays at Belle II. — Florian Bernlochner, Jochen Dingfelder, Peter Lewis, and •Ilias Tsaklidis for the Belle II-Collaboration — Physikalisches Institut der Rheinischen Friedrich-Wilhelms-Universität Bonn, Nußallee 12, 53115 Bonn, Germany

Over the last years many experiments have hinted at the existence of lepton universality violating processes. In this work we probe these processes by measuring the R(D*) ratio with hadronically decaying τ leptons. The Belle II experiment produces $B\bar{B}$ pairs and it greatly benefits from the clean experimental environment of e^+ e^- collisions. In this study we tag one of the two B mesons using the Full Event Interpretation algorithm in fully hadronic modes, in order to kinematically constrain the second B meson. We further reconstruct $B \to D^*\tau\nu$ decays with a single charged hadron originating from the τ decay and two missing neutrinos in the event. This gives us a unique access to other quantities sensitive to New Physics, such as the polarization of the τ lepton in B-meson decays. In this talk the current status of the analysis and the expected sensitivity using 364 fb^{-1} of Belle II data will be presented.

T 129.4 Thu 18:15 HSZ/0304

Measurement of $R(D^{(*)})$ using $B \to D^{(*)}\tau\nu$ events with semileptonic tagging and leptonic τ decays — Florian Bernlochner, Jochen Dingfelder, Peter Lewis, and •Alina Manthei for the Belle II-Collaboration — Physikalisches Institut der Rheinischen Friedrich-Wilhelms-Universität Bonn

The Belle II experiment at the SuperKEKB asymmetric-energy collider, where electrons and positrons are collided at the $\Upsilon(4S)$ resonance, collects a large number of events with $B\overline{B}$ pairs. The analysis of semitauonic decays of these B mesons allows for tests of lepton flavour universality. Existing experimental results on the ratios of the branching fractions $\mathcal{R}(D) = \mathcal{B}(\overline{B} \to D\tau^-\overline{\nu})/\mathcal{B}(\overline{B} \to D\ell^-\overline{\nu})$ and $\mathcal{R}(D^*) = \mathcal{B}(\overline{B} \to D^*\tau^-\overline{\nu})/\mathcal{B}(B^* \to D\ell^-\nu^-)$, where ℓ denotes an electron or muon, are in tension with the Standard Model (SM) predictions, which might hint at physics beyond the SM, such as the presence of charged Higgs bosons or leptoquarks. A combined analysis of $\mathcal{R}(D)$ and $\mathcal{R}(D^*)$ with measurements from Belle, BaBar and LHCb yields a divergence from the SM prediction of $> 3\sigma$. Thus, further investigations of these decays with the recently collected Belle II data are necessary. In order to exploit kinematic constraints in the $B\bar{B}$ decay, the second B meson in the event is reconstructed in semileptonic decay modes, a technique denoted as semileptonic tagging. In this talk, a signal extraction strategy for such a measurement will be presented and the current status and plans for the analysis will be outlined.

T 129.5 Thu 18:30 HSZ/0304

Probing lepton universality in inclusive semileptonic B-meson decays at Belle II — Florian Bernlochner, Jochen Dingfelder, •Henrik Junkerkalefeld, and Peter Lewis for the Belle II-Collaboration — Physikalisches Institut der Rheinischen Friedrich-Wilhelms-Universität Bonn

Excesses in the ratios $R(D^{(*)}) = \mathcal{B}(B \to D^{(*)}\tau\nu)/\mathcal{B}(B \to D^{(*)}\ell\nu)$ measured by BaBar, Belle and LHCb have created large interest in recent years. Together with other measurements in the flavor sector they may hint at non-universality of lepton couplings. The Belle II experiment in Japan enables a complementary test of these measurements. Due to the precise knowledge of the initial state of the collision and the controlled production of $B\bar{B}$ pairs, an inclusive measurement of $R(X_{\tau/\ell}) = \mathcal{B}(B \to X\tau\nu)/\mathcal{B}(B \to X\ell\nu)$ as well as the light-lepton ratio $R(X_{e/\mu}) = \mathcal{B}(B \to Xe\nu)/\mathcal{B}(B \to X\mu\nu)$ becomes possible. Here, the hadronic system X is not constrained to specific final states, i.e., all possible B-meson decay modes contribute. In this talk, the results of the $R(X_{e/\mu})$ measurement based on a Belle II dataset of $189\,\text{fb}^{-1}$ are presented and the current status of the $R(X_{\tau/\ell})$ measurement is discussed.

T 129.6 Thu 18:45 HSZ/0304

Flavour of the dark photon — •jordi folch eguren[1], emmanuel stamou[1], mustafa tabet[1], and robert ziegler[2] — [1]Fakultät für Physik, TU Dortmund, D-44221 Dortmund, Germany — [2]Physikhochhaus (Gebäude 30.23, 9. Stock) Wolfgang-Gaede-Str. 1 D-76131 Karlsruhe

In this work we analyse a BSM model in which an additional U(1) symmetry is added to the SM. We study how FCNCs might arise in this setup due to the new gauge field, the Dark Photon. We constrain the model by considering 2-body meson and baryon decays with different quark transitions, in which form factors play a crucial role.

Jordi Folch Eguren (TU Dortmund), Emmanuel Stamou (TU Dortmund), Mustafa Tabet (TU Dortmund) and Robert Ziegler (KIT).

T 130: Top II

Time: Thursday 17:30–18:45 Location: HSZ/0401

T 130.1 Thu 17:30 HSZ/0401

Measurement of the production cross-section of a W boson in association with $t\bar{t}$ — •Marcel Niemeyer, Arnulf Quadt, and Elizaveta Shabalina — Georg-August-Universität Göttingen

The top-quark pair production in association with a W boson is an important background to processes like $t\bar{t}H$ or 4-tops production. Due to higher order electroweak corrections, the process is difficult to model. In consequence, a tension of the predicted and observed rate of $t\bar{t}W$ surpassing 2σ has been observed in previous analyses. Thus, it is of high importance to increase our understanding of it.

This talk will give an overview of the measurement of the $t\bar{t}W$ cross-section in the multi-lepton channel with two same sign or three leptons (electrons or muons), using the full Atlas Run 2 dataset. In addition to a measurement in the inclusive phase space, the extraction of the cross-section in a fiducial phase space, as well as the measurement of the ratio $\sigma(t\bar{t}W^+)/\sigma(t\bar{t}W^-)$ will be discussed. The fit to extract the cross-section is performed simultaneously to a template fit estimating the main background contributions.

T 130.2 Thu 17:45 HSZ/0401

Measurement of the inclusive production cross section of a top quark pair with a Z boson in the trileptonic channel —

•Steffen Korn, Arnulf Quadt, Baptiste Ravina, and Elizaveta Shabalina — II. Physikalisches Institut - Georg-August-Universität Göttingen

The strength and structure of the coupling of the top quark and the Z boson can be measured through the associated production of a top quark pair and a Z boson. It provides sensitivity to the top quark's weak isospin in the Standard Model (SM) framework. The measurement of this parameter also serves as a probe of the SM. The process was measured by ATLAS and CMS at $\sqrt{s} = 13$ TeV with the full Run 2 dataset and a partial Run 2 dataset, respectively. In a new, refined analysis, multivariate techniques are used to improve the sensitivity of the measurement. The impact of using a multi-class deep neural network for event classification on the inclusive cross-section of $t\bar{t}Z$ final states with three charged leptons is presented.

T 130.3 Thu 18:00 HSZ/0401

Measurements of differential cross-sections of the $t\bar{t}\gamma$ production in the semileptonic and dileptonic channels in pp collisions at $\sqrt{s}$ = 13 TeV with the ATLAS detector — •Buddhadeb Mondal[1], Binish Batool[1], Beatrice Cervato[1], Markus Cristinziani[1], Carmen Diez Pardos[1], Ivor Fleck[1], Arpan Ghosal[1], Gabriel Gomes[1], Jan Joachim Hahn[1], Vadim Kostyukhin[1], Amartya Rej[1], Katharina Voss[1], Wolfgang Walkowiak[1], and Tongbin Zhao[1,2] — [1]Center for Particle Physics Siegen, Experimentelle Teilchenphysik, Universität Siegen — [2]Shandong University, China

The top quark being the heaviest fundamental particle in the Standard Model (SM) plays a very important role in the study of fundamental interactions. It has a very short lifetime and it decays before it hadronizes, passing its properties to its decay products. Top quark pair production in association with a photon ($t\bar{t}\gamma$) is a very important process for measuring the coupling between top quark and photon. A precise measurement of this coupling is necessary for testing the SM and is also a probe for new physics effects at very high energy scale. In this talk, measurements of $t\bar{t}\gamma$ differential cross-sections using 139 fb^{-1} of data collected by the ATLAS detector in proton-proton collisions at $\sqrt{s} = 13$ TeV will be presented. They are performed in the semileptonic and dileptonic $t\bar{t}$ decay channels.

T 130.4 Thu 18:15 HSZ/0401

Measurement of $t\bar{t}+\gamma$ production with the full Run 2 ATLAS dataset — •Andreas Kirchhoff, Arnulf Quadt, Baptiste Ravina, and Elizaveta Shabalina — II. Physikalisches Institut, Georg-August-Universität Göttingen

The optimal way to measure the top-photon coupling would be an e^+e^- collider with sufficient energy. As such a collider does not exist, another possibility to measure it is the production of $t\bar{t}$ pairs in association with a photon. Unfortunately, such photons will mostly originate from the decay products of the top quarks and hence do not convey any information about the top-photon coupling. However, photons radiated from the top quarks themselves (and to some extent, from the initial state quarks) can be differentiated based on their kinematics and the topology of the event. The separation between 'production' and 'decay' modes is achieved for the first time in this ATLAS analysis, thanks to a dedicated MVA approach. In this talk, the measurement of the inclusive fiducial cross section of the $t\bar{t}\gamma$ process with photons originating from production and decay in single- and dilepton channels will be presented.

T 130.5 Thu 18:30 HSZ/0401

Search for $t\bar{t}\gamma\gamma$ production in pp collisions at $\sqrt{s}$=13 TeV with the ATLAS detector — •Arpan Ghosal[1], Binish Batool[1], Beatrice Cervato[1], Markus Cristinziani[1], Carmen Diez Pardos[1], Ivor Fleck[1], Gabriel Gomes[1], Jan Joachim Hahn[1], Vadim Kostyukhin[1], Buddhadeb Mondal[1], Amartya Rej[1], Katharina Voss[1], Wolfgang Walkowiak[1], and Tongbin Zhao[1,2] — [1]Center for Particle Physics Siegen, Experimentelle Teilchenphysik, Universität Siegen — [2]Shandong University, China

The top-quark pair production in association with one or more photons are important Standard Model processes that allow us to measure the strength of the electroweak coupling of the top quark with photon. While the production of $t\bar{t}\gamma$ is well-studied, the $t\bar{t}\gamma\gamma$ process has not been observed yet. The rare $t\bar{t}\gamma\gamma$ process is not only a good candidate for probing the top electroweak coupling but is also significant as an irreducible background process to the $t\bar{t}$ production with a Higgs boson decaying to two photons ($H \to \gamma\gamma$). New sources of CP-violation can appear as electric dipole moment terms in top-quark interactions, and their precise measurement is essential to determine the effects of new physics. Understanding the $t\bar{t}\gamma\gamma$ process can help set better bounds on these anomalous moments. The presentation will discuss the ongoing efforts in the search for the $t\bar{t}\gamma\gamma$ process in the semileptonic $t\bar{t}$ decay channel with a cut-and-count approach using the full Run 2 dataset collected by the ATLAS detector at $\sqrt{s} = 13$ TeV.

T 131: Searches V

Time: Thursday 17:30–18:45 Location: HSZ/0403

T 131.1 Thu 17:30 HSZ/0403

Gamma-gamma collider with Energy < 12 GeV based on European XFEL — •Marten Berger — Universität Hamburg

The possibility of a Gamma-gamma collider extension to the Beam dump 17.5 GeV European XFEL has been discussed. This collider would be without competition in the region 5−12 GeV. In this range $b\bar{b}$ resonances, tetraquarks as well as mesonic molecules can be observed. Apart from these there are also BSM and dark matter processes that can be observed. In this talk we want to focus on possible BSM and dark matter observations with dark photon and ALPs.

T 131.2 Thu 17:45 HSZ/0403

SUPAX - A Superconducting Axion Search Experiment — •Tim Schneemann, Kristof Schmieden, and Matthias Schott — Johannes Gutenberg-Universität, Mainz

Supax is one of the first RF cavity based experiments in Germany to search for axions. Axions are hypothetical particles that could solve the well known strong CP problem in the standard model of particle physics. Furthermore axions could explain the dark matter content of the universe. Axions are expected to convert to photons in the presence of a strong magnetic field, where the photon frequency depends on the axions mass. For wavelengths in the microwave regime resonators are typically used to enhance the axion signal. We propose to use a superconducting radio frequency cavity with high quality factor. A Copper RF cavity has already been successfully tested probing for Dark Photons in the absence of a magnetic field whilst tune-able and superconducting RF cavities are currently being developed. With this innovative approach and by using an existing 14T magnet at the Institute of Physics at the Johannes Gutenberg University in Mainz, the largely unexplored mass region between 20 μeV to 50 μeV could be tested.

In this talk I will cover the experimental setup, data acquisition, analysis and current results of the experiment as well as future ideas of the experiment beside the search for axions.

T 131.3 Thu 18:00 HSZ/0403

BabyIAXO: prospects and status of a new generation axion helioscope — •Daniel Heuchel[1] and the IAXO-Collaboration[2] — [1]Deutsches Elektronen-Synchrotron (DESY) — [2]https://iaxo.desy.de

In order to search for solar axions and axion-like particles (ALPs) with unprecedented sensitivities, the International Axion Observatory (IAXO) aims to convert those particles via the interaction with virtual photons into X-rays in a strong magnet pointing towards the sun followed by high-precision focusing and ultra-low background and high-efficiency X-ray detectors.

The intermediate experimental stage, BabyIAXO, proposed to be sited at DESY Hamburg, will not only serve as a prototype-stage for all IAXO subsystems, but it will be a fully fledged helioscope with potential for discovery. Along with a 10 m long and about 2 T strong superconducting magnet hosting two 70 cm diameter bores, optics and detector systems very similar to the ones foreseen for IAXO will complete the two detection lines. Based on this setup, BabyIAXO will be able probe axion-photon couplings down to 1.5×10^{-11} GeV^{-1} for axion masses of up to 0.25 eV.

In this contribution, the general prospects of BabyIAXO, the current status of the different BabyIAXO subsystems including the different X-ray detector technologies and the ongoing background simulation campaigns are presented and discussed.

T 131.4 Thu 18:15 HSZ/0403

Results from First Simulation Studies for a Dark Photon Search Experiment at the ELSA Electron Accelerator — Philip Bechtle, Klaus Desch, Oliver Freyermuth, Matthias Hamer, •Jan-Eric Heinrichs, and Martin Schürmann — Rheinische Friedrich-Wilhelms-Universität Bonn

The true nature of Dark Matter (DM) has long been of interest for scientists worldwide. Previous searches have so far been unsuccessful in finding proposed DM particles. A promising and not well explored family of DM models contains dark matter particles and a portal to the SM with masses below ≈ 1 GeV. Mainly two approaches are investigated by the community, namely beam dump and fixed targets experiments.

Lohengrin is a proposed experiment to search for a dark sector that couples to the SM through a dark photon at the ELSA accelerator in Bonn. In this presentation, the underlying theory and the proposed experiment strategy will be explained. The challenges for the proposed experiment are presented, as well as first steps towards the reconstruction of high level physics objects using a Geant 4 simulation.

T 131.5 Thu 18:30 HSZ/0403

QCD Generative Model Without Machine Learning — •Samuel Bein — Universität Hamburg, Hamburg, Germany

The Rebalance and Smear technique for the modeling of QCD backgrounds to searches for dark matter at the LHC is presented as a publicly available toolkit. Bayesian inference is carried out on real data events to estimate a latent space of the true jet energy values within each event. The latent space is sampled multiple times per event according to a known PDF of the detector response to the jet energy, and the resulting collection represents a high-statistics proxy for the true QCD background. This method, previously carried out at CMS and ATLAS for background estimation, can be further employed in the training of multivariate classifiers to optimally extend the sensitivity of searches to BSM scenarios with compressed mass spectra. An example future search probing pure Higgsino dark matter in gluino and squark simplified models, is a suitable application of this method in Run 3.

T 132: Searches VI

Time: Thursday 17:30–19:00 Location: HSZ/0101

T 132.1 Thu 17:30 HSZ/0101

Search for high mass lepton flavour violating processes with CMS — •Sebastian Wiedenbeck, Thomas Hebbeker, Arnd Meyer, and Swagata Mukherjee — III. Physikalisches Institut A, RWTH Aachen University

Lepton flavour is a conserved quantity in the standard model of particle physics, but it does not follow from an underlying symmetry. Neutrino oscillations imply that lepton flavour is not conserved in the neutral sector. Lepton flavour violating processes are common in several models of physics beyond the standard model (e.g. supersymmetry with R-parity violation, black hole production, and leptoquarks). Some models predict objects at the TeV mass scale that can decay into two standard model leptons of different flavours: electron + muon, muon + tau, or electron + tau. The challenges in a search for such phenomena are to achieve a high mass resolution, good rejection of standard model backgrounds, and efficient lepton identification at the same time. The status of the analysis, based on the CMS data taken in Run 2, and plans for Run 3 are presented.

T 132.2 Thu 17:45 HSZ/0101

Search for Leptoquarks in the multilepton channel with ATLAS Run-2 data — •Janik Böhm and Andre Sopczak — CTU in Prague

The latest results in the search for leptoquarks in the multilepton channel are presented using ATLAS Run-2 data.

T 132.3 Thu 18:00 HSZ/0101

Search for new particles decaying to top quark-antiquark pairs at CMS — •Henrik Jabusch[1], Ksenia de Leo[1], Johannes Haller[1], and Roman Kogler[2] — [1]Institut für Experimentalphysik, Universität Hamburg — [2]DESY, Hamburg

We present a model-independent search for new particles decaying to top quark-antiquark pairs ($\mathrm{t\bar{t}}$) using 138 fb^{-1} of pp collision data at $\sqrt{s} = 13$ TeV recorded with the CMS detector during LHC Run 2. The search targets both resonant and non-resonant signatures in the spectrum of the invariant mass $m_{\mathrm{t\bar{t}}}$.

Focusing on lepton+jets final states, we use novel top-tagging techniques to identify the hadronic decay of highly Lorentz-boosted top quarks. We further employ a deep neural network for event classification. Reconstructed $m_{\mathrm{t\bar{t}}}$-distributions are used to derive constraints on various physics models predicting new particles decaying to $\mathrm{t\bar{t}}$, such as heavy resonances, Kaluza-Klein gluons, heavy Higgs bosons (including interference with the SM process), as well as non-resonant axion-like particles, extending the reach of earlier searches significantly.

T 132.4 Thu 18:15 HSZ/0101

Search for supersymmetry in single lepton events using angular correlations and heavy-object identification — Kerstin Borras[4,5], •Frederic Engelke[4,5], Kimmo Kallonen[3], Henning Kirschenmann[3], Pantelis Kontaxakis[1], Dirk Krücker[4], Isabell Melzer-Pellmann[4], Ashraf Mohammed[4,5], Paris Sphicas[1,2], Costas Vellidis[1], and Lucas Wiens[4] — [1]University of Athens — [2]CERN — [3]Helsinki Institute of Physics — [4]DESY — [5]RWTH Aachen IIIA

Results are presented from a search for supersymmetry in events with a single electron or muon, and multiple hadronic jets. The data corresponds to a sample of proton-proton collisions at $\sqrt{s} = 13$ TeV with an integrated luminosity of 138 fb^{-1}, recorded by the CMS experiment at the LHC.

The search targets gluino pair production, where the gluinos decay into the lightest supersymmetric particle (LSP) and either a top quark-antiquark pair or a pair of light quarks in the final state.

We use the angular correlation between the lepton and the W boson's transverse momenta for a strong separation between the signal and the background region. The investigation of the two different signal models benefits from improved top and W tagging methods.

Furthermore, we also present current endeavors to prepare this analysis for the Run3 period using modern analysis tools.

T 132.5 Thu 18:30 HSZ/0101

Investigation of background processes for proton decay search in the JUNO experiment — •Carsten Dittrich[1], Ulrike Fahrendholz[1], Meishu Lu[1], Sarah Braun[1], Lothar Oberauer[1], Hans Steiger[2], and Matthias Raphael Stock[1] — [1]E15, Physik-Dep., Technische Universität München, James-Franck-Str. 1, 85748 Garching — [2]Cluster of Excellence PRISMA$^+$, Staudingerweg 9, 55128 Mainz

The Jiangmen Underground Neutrino Observatory (JUNO) is a large liquid scintillator detector, capable to search for the hypothetical proton decay $\mathrm{p} \to \mathrm{K}^+ + \bar{\nu}$, which is predicted by supersymmetric Grand Unified Theories (GUTs). As the momentum of the daughter kaon is below the Cherenkov threshold in water, JUNO will quickly be able to provide competitive results in comparison to the current lifetime limit of $\tau > 5.9 \cdot 10^{33}$ years by the Super-Kamiokande collaboration. The three-fold coincidence signature generated by the kaon and its daughter particles will be crucial to discriminate proton decay events from possible backgrounds produced by atmospheric neutrinos. This talk will present a brief overview on the proton decay search in JUNO, the different background processes and possible identification criteria to discriminate between the two.

This work is supported by the Clusters of Excellence Origins and PRISMA$^+$.

T 132.6 Thu 18:45 HSZ/0101

Search for Higgsinos in final states with a low-momentum, displaced track at the CMS experiment — Samuel Bein, Yuval

Nissan, Peter Schleper, Alexandra Tews, and •Moritz Wolf — Universität Hamburg

Many supersymmetric extensions to the Standard Model predict the three lightest electroweakinos, χ_2^0, $\chi_1^\pm$, and χ_1^0, to be Higgsino-like with nearly degenerate masses around the electroweak scale. The lightest chargino can be produced alongside another electroweakino and then decay to the lightest neutralino. To search for these particles, the best strategy depends on the differences between the various masses. For $\Delta m(\chi_2^0, \chi_1^0) > \mathcal{O}(1\,\mathrm{GeV})$ lepton pairs from the decay of the second-lightest neutralino leave an experimentally distinct signature, whereas $\Delta m(\chi_1^\pm, \chi_1^0) \lesssim 0.3\,\mathrm{GeV}$ can lead to the chargino giving rise to a disappearing track. For mass splittings in the range of $\Delta m(\chi_1^\pm, \chi_1^0) = 0.3 - 1.0\,\mathrm{GeV}$, searches carried out so far at the LHC are lacking in sensitivity.

In this analysis, a slightly displaced track with small transverse momentum, corresponding to a pion originating from the chargino decay, is used to gain sensitivity to this challenging range of mass splittings.

T 133: Top, EW II

Time: Thursday 17:30–19:00 Location: HSZ/0103

T 133.1 Thu 17:30 HSZ/0103

Measuring mass and width of the W-boson with the ATLAS detector — Philip Bechtle[1], Klaus Desch[1], Oleh Kyvernyik[1], Jakub Kremer[2], •Philipp König[1], and Matthias Schott[2] — [1]Rheinische-Friedrich-Wilhelms-Universität Bonn — [2]2Johannes Gutenberg-Universität Mainz

In 2017, the ATLAS collaboration measured the W-boson mass using *pp*-collision data taken at $\sqrt{s} = 7$ TeV in 2011, resulting in a precision of 19 MeV. We present a revised analysis of the same dataset, improving the fit methods and including a measurement of the width of the W-boson. A precise measurement of these quantities in the decay of the W-boson represent an excellent precision test of the Standard Model (SM). The recently released measurement of the W-boson mass using the full dataset recorded by the CDF collaboration is in significant tension with all previous measurements.

We will present the revised analysis of the ATLAS data including extensive cross-checks of the new profile likelihood fit approach. Detailed stability and consistency checks of the measurements will be discussed. Finally, a novel approach to validate fit models will be presented.

T 133.2 Thu 17:45 HSZ/0103

A direct measurement of the invisible width of the Z-boson with the ATLAS detector — •Martin Klassen — Kirchhoff-Institut für Physik, Heidelberg

The invisible width of the Z-boson, $\Gamma_Z(inv)$, is a fundamental parameter of the Standard Model. It is related to the number of light neutrinos that couple to the Z-boson, and its precise measurement allows for tests of the Standard Model. $\Gamma_Z(inv)$ has been indirectly measured at LEP with a precision of 0.3% and was in addition also directly determined using events with a photon and missing transverse energy to a precision of 3.2%.

At the ATLAS experiment, $\Gamma_Z(inv)$ can be obtained by measuring the ratio of $Z \to \nu\nu + jets$ to $Z \to ll + jets$ events (R^{miss}) as function of the Z boson's transverse momentum p_T. This approach is sufficient because the production cross section and the branching ratios can be decoupled leading to the relation $R^{miss} = \Gamma_Z(inv)/\Gamma_Z(ll)$ and the leptonic widths of the Z are already precisely measured. The ratio measurement benefits form a large degree of cancelation of many of the experimental and theoretical uncertainties. For this to work the phase spaces of selected $Z \to \nu\nu$ and $Z \to ll$ events need to be as similar as possible, and residual differences are corrected for using simulations.

In this talk the analysis strategy will be presented and it will be shown that the experiments at the Large Hadron Collider can obtain competitive results 30 years after the first direct measurement of $\Gamma_Z(inv)$ at LEP.

T 133.3 Thu 18:00 HSZ/0103

Measuring the Weinberg Angle at the Belle II Experiment * — •Lukas Grussbach, Daniel Greenwald, and Stephan Paul for the Belle II-Collaboration — Technical University Munich

The Weinberg angle is known precisely only at high energies around the Z^0 mass. At Belle II, we have the opportunity to measure it at a lower energy via $e^+e^- \to \mu^+\mu^-$, near to the energy where the NuTeV experiment has measured a discrepant value. We present preliminary studies of event selection criteria, muon identification performance and potential precision of such a measurement at Belle II.

*Funded by the DFG under Germany's Excellence Strategy - EXC2094 - 390783311 and BMBF Verbundforschung (05H21WOKBA BELLE2).

T 133.4 Thu 18:15 HSZ/0103

$t\bar{t}$+heavy flavor classification at the CMS experiment — •Emanuel Pfeffer, Ulrich Husemann, Rufa Rafeek, Jan van der Linden, and Michael Wassmer — Institute of Experimental Particle Physics (ETP), Karlsruhe Institute of Technology (KIT)

Processes in which a bottom quark-antiquark pair is produced in addition to the decay products of a top quark-antiquark pair are difficult to separate from each other. These processes include $t\bar{t}$+$b\bar{b}$, where the additional bottom quark-antiquark pair stems from a gluon splitting, as well as $t\bar{t}$+H with H $\to$ $b\bar{b}$ and $t\bar{t}$+Z with Z $\to$ $b\bar{b}$. New analysis techniques based on Graph neural networks are promising to improve the classification of these events. This talk sheds light on the current status of a simultaneous measurement of the production cross section of a top quark-antiquark pair in association with heavy flavor jets in the dileptonic channel at the CMS experiment. In this analysis, classification methods based on Graph neural networks are applied to separate processes in the $t\bar{t}$+heavy flavor phase space.

T 133.5 Thu 18:30 HSZ/0103

Differential cross-section measurements of an hadronically decaying top-quark-antitop-quark pair produced in association with two b-jets with the ATLAS detector at $\sqrt{s} = 13$ TeV — •Nina Wenke and Teresa Barillari — Max-Planck-Institut für Physik, München

The production of a top-quark-antitop-quark ($t\bar{t}$) pair in association with two b-jets ($t\bar{t}b\bar{b}$) is an important and insightful Standard-Model (SM) process to study at the LHC. It is the perfect playground to study the dynamics of multiple heavy quark production which is difficult to model precisely. It is also a major background in important SM measurements. In addition, precise $t\bar{t}b\bar{b}$ measurements could allow to catch glimpses of New Physics.
In this talk, preliminary results of the first ATLAS analysis targeting the hadronic decay channel of $t\bar{t}b\bar{b}$ production will be presented. It uses proton-proton collision-data recorded with the ATLAS detector at the LHC at a center-of-mass energy of 13 TeV, corresponding to an integrated luminosity of 139 fb^{-1}. The analysis uses a cut-based event selection with at least four b-jets. A likelihood-based algorithm is then used to reconstruct the hadronic decay of the $t\bar{t}$ pair in the event. The challenging large multijet background is modelled using a data-driven method. The final aim of the analysis is to perform fiducial differential cross-section measurements as a function of several variables and compare them to next-to-leading-order matrix-element calculations matched to a parton shower.

T 133.6 Thu 18:45 HSZ/0103

Simultaneous measurement of $t\bar{t}$+$\mathbf{X}(b\bar{b})$ **processes in the semileptonic channel at the CMS experiment** — •Rufa Kunnilan Muhammed Rafeek, Ulrich Husemann, Jan van der Linden, Emanuel Pfeffer, and Michael Wassmer — Institute of Experimental Particle Physics (ETP), Karlsruhe Institute of Technology (KIT)

Top quark anti-quark pairs ($t\bar{t}$) are produced in association with other particles (X) where X can be the Higgs boson, Z/W boson or QCD-initiated heavy flavour jets ($b\bar{b}/c\bar{c}$). The measurement of $t\bar{t} + X$ is a direct probe of the coupling of standard model particles like the Higgs and Z boson to the top quark and may reveal new physics effects in modifications of these couplings.
The analysis is challenging as these processes, particularly when the bosons decay into heavy flavour quarks, like for example, $t\bar{t} + H(H \to b\bar{b})$ and $t\bar{t} + b\bar{b}$ or $t\bar{t} + Z(Z \to b\bar{b})$, share the same signature and kine-

matic features. These high jet multiplicity final states create ambiguities in the reconstruction and identification of these processes and thus, it is hard to differentiate them from each other. Due to this challenge, an attempt to simultaneously measure these $t\bar{t}+X$ processes is made by exploring multivariate analysis strategies.
In this talk, an overview of the ongoing analysis, designed with the full Run-2 data of the LHC using the single lepton channel, is given.

T 134: Higgs, Di-Higgs IV

Time: Thursday 17:30–19:00 Location: HSZ/0105

T 134.1 Thu 17:30 HSZ/0105

Differential measurement of the $H \to \tau\tau$ cross-section in the VBF production mode — •Lena Herrmann, Christian Grefe, Philip Bechtle, and Klaus Desch — Physikalisches Institut, Universität Bonn

Precision measurements of the Higgs boson properties are promising to show evidence of BSM physics. One aspect of interest is the Yukawa-interaction which can be directly investigated by the cross-section measurement of the di-τ final state. Detailed studies are performed in a combined maximum-likelihood fit of the di-τ mass in different p_T^H bins using the *"Simplified Template Cross Section"* framework (STXS). Orthogonal control regions are used to determine and to validate the contribution of important background processes. Multi-jet events which are misidentified as visible τ's (fakes), play an important role apart from the dominant $Z \to \tau\tau$ events. The fraction of fake events depends on the decay-mode of the hadronically decaying τ and has a less prominent contribution if no neutral pions are involved in the final state. In past analysis efforts, the estimated fake background events were only differentiated by 1- and 3-prong events which is why a more accurate, now decay-mode dependent fake background estimation is developed. It enables a loosened event selection for decay-modes without neutral pions and thus, an increased selection efficiency of signal events.

The method as well as the influence of the improved background estimation on the sensitivity of the measurement in different STXS bins will be discussed.

T 134.2 Thu 17:45 HSZ/0105

Charge-asymmetry measurement in WH($\tau\tau$) events — •Ralf Schmieder, Nicolo Trevisani, Nils Faltermann, Markus Klute, Roger Wolf, Xunwu Zuo, Sebastian Brommer, Maximilian Burkart, and Günter Quast — Karlsruher Institut für Technologie, Karlsruhe, Deutschland

At the LHC, an asymmetry in W^+H and W^-H production is expected as the parton distribution functions (PDFs) favour the production of positively-charged W bosons in proton-proton collisions. The measurement of the WH charge asymmetry provides a consistency test for the Standard Model (SM), as it is sensitive to enhanced Yukawa couplings to the first and more so to second generation quarks like the c quark. The production of an H in association with a W boson can happen through the exchange of a c quark in the t channel. Experimentally, the WH charge asymmetry measurement is independent of any challenging c jet tagging algorithms. This talk reports the status of this measurement in the channel where the Higgs boson decays into a pair of τ leptons.

T 134.3 Thu 18:00 HSZ/0105

Improved event cleaning for the τ-embedding method of CMS — •Christian Winter, Sebastian Brommer, Artur Gottmann, Roger Wolf, and Günter Quast — ETP, Karlsruhe Institute of Technology, Karlsruhe, Germany

In $H \to \tau\tau$ analyses a major source of background are genuine tau leptons, mostly originating from $Z \to \tau\tau$ decays. The τ-embedding method is a method to estimate this background from data, by replacing muons in an selected-event in data with simulated τ-decays. For this purpose, the muon signatures have to be removed from the original event record. This talk will focus on an improved cleaning, which takes electromagnetic muon showering in the muon detectors into account.

T 134.4 Thu 18:15 HSZ/0105

Measuring Higgs boson production cross sections in its decays into two tau leptons with the ATLAS detector — •baktash amini, christopher young, karsten köneke, and karl jakobs for the ATLAS-Collaboration — Albert-Ludwigs-Universität Freiburg, Freiburg, Germany

Since the Higgs boson discovery, probing the properties of it is an important physics program of the LHC. The significance of these studies originates from the fact that the Higgs boson is the only fundamental, point-like scalar which has been observed, and the precision measurement of the couplings of the Higgs boson through the production mechanisms and the decay modes might lead us to new physics. In this talk, the latest advances in Higgs boson measurements in its decays into two tau leptons, using data collected by the ATLAS detector, will be discussed.

T 134.5 Thu 18:30 HSZ/0105

Sensitivity to Triple Higgs Couplings via Di-Higgs Production in the 2HDM at the (HL-)LHC — Francisco Arco[1,2], Sven Heinemeyer[2], Margarete Muhlleitner[3], and •Kateryna Radchenko[4] — [1]UAM, Spain — [2]IFT (UAM-CSIC), Spain — [3]KIT, Germany — [4]DESY, Germany

The reconstruction of the Higgs potential is a major goal for experimental particle physics. This can be accomplished via the precise measurement of the Higgs mass and its self interactions. The first process that provides access to the trilinear self-coupling is Higgs pair production, which at the LHC happens dominantly trough gluon fusion. In this context, models with extended Higgs sectors are theoretically and experimentally allowed and can accommodate large deviations of the trilinear Higgs couplings while providing explanations to some of the shortcomings of the Standard Model.

We study the sensitivity to the triple Higgs couplings involved in Higgs pair production via gluon fusion in the framework of the Two Higgs Doublet Model. In particular, we focus on the contribution of the resonant diagram involving a heavy CP-even Higgs boson exchange to the total production cross section as well as the invariant mass distribution of two Higgses in the final state. We show that for the benchmark scenarios where the resonant production is dominant, there is significant sensitivity to the parameters of the extra scalar. Finally, we discuss the effects of experimental uncertainties by applying smearing and binning to our results.

T 134.6 Thu 18:45 HSZ/0105

A model-independent analysis of interference effects in the $t\bar{t}$ final state at the LHC involving two $\mathcal{CP}$-mixed Higgs bosons — Henning Bahl[1], •Romal Kumar[2], and Georg Weiglein[2,3] — [1]University of Chicago, Department of Physics and Enrico Fermi Institute, 5720 South Ellis Avenue, Chicago, IL 60637 USA — [2]Deutsches Elektronen-Synchrotron DESY, Notkestr. 85, 22607 Hamburg, Germany — [3]II. Institut für Theoretische Physik, Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg, Germany

Various extensions of the Standard Model predict the existence of additional Higgs bosons. If these additional Higgs bosons are sufficiently heavy, an important search channel is the di-top final state. In this channel interference contributions between the signal and the corresponding QCD background process are expected to be important. If more than one heavy Higgs boson is present, besides the signal-background interference effects associated with each Higgs boson also important signal-signal interference effects are possible. We perform a comprehensive model-independent analysis of the various interference contributions within a simplified model framework considering two heavy Higgs bosons that can mix with each other, taking into account large resonance-type effects arising from loop-level mixing between the scalars. The interference effects are studied both in an analytic way at the parton level and with Monte Carlo simulations for proton-proton collisions at the LHC. The mapping of the general approach to a specific model is demonstrated for the case of a complex Two-Higgs Doublet Model.

T 135: Top Mass, Top BSM

Time: Thursday 17:30–19:00 Location: HSZ/0201

T 135.1 Thu 17:30 HSZ/0201

Measurement of the top-quark mass in the $t\bar{t} \to$ lepton + jets channel with a template method, using the full Run 2 dataset in ATLAS — •Dimbiniaina Rafanoharana and Andrea Knue for the ATLAS-Collaboration — Albert-Ludwigs-Universität Freiburg

The top-quark mass is a free parameter of the Standard Model (SM) and is playing a key role in the test of the consistency of the SM. Its precise determination is therefore of paramount importance. Several measurements of the top-quark mass in different final states using various methods were performed at the Tevatron and the Large Hadron Collider.

The combined measurement of the top-quark mass using different ATLAS Run 1 measurements achieved a relative overall uncertainty of 0.28%. The combination is limited by the systematic uncertainty as the relative statistical and systematic uncertainties are 0.14% and 0.23%, respectively.

The measurement of the top-quark mass with the template method in the $t\bar{t} \to$ lepton + jets channel using the full Run 2 dataset in ATLAS will be shown. Given the large amount of data collected during Run 2, the measurement is mainly limited by systematic effects. The presentation will discuss the dominating systematic uncertainties and studies aimed at reducing those uncertainties in the top-quark mass.

T 135.2 Thu 17:45 HSZ/0201

Messung der Masse des Topquark mit einer Likelihood-Anpassung mit Störparametern im vollhadronischen Kanal — •Yannek Gruel, Johannes Lange, Patrick Connor, Hartmut Stadie und Peter Schleper — Institut für Experimentalphysik, Universität Hamburg

Die Genauigkeit der Messung von der Masse des Topquarks hängt vor allem von unterschiedlichen systematischen Unsicherheiten ab. Um den Einfluss dieser Unsicherheiten auf die Masse zu verringern wird eine Likelihood-Anpassung angewendet, in der diese als freie Störparameter behandelt werden. Bisher wurde die Methode für die Messung im semileptonischen Zerfallskanal angewendet. Die hier präsentierten Ergebnisse zeigen die potentiellen Verbesserungen im vollhadronischen Kanal im Vergleich zur klassischen Messung ohne Störparameter.

T 135.3 Thu 18:00 HSZ/0201

Measurement of the jet mass distribution of boosted top quarks and the top quark mass with CMS — •Alexander Paasch[1], Johannes Haller[1], Roman Kogler[2], and Dennis Schwarz[3] — [1]Institut für Experimentalphysik, Universität Hamburg — [2]DESY, Hamburg — [3]Austrian Academy of Sciences, Wien

We present a measurement of the jet mass distribution in fully hadronic decays of boosted top quarks in pp collisions recorded by the CMS experiment in Run-2 of the LHC. The measurement is performed in the lepton+jets channel of top quark pair production. The top quark decay products of the all-hadronic decay cascade are reconstructed with a single large-radius jet with transverse momentum greater than 400 GeV. The top quark mass is extracted from the normalised differential top quark pair production cross section at particle level. The uncertainties arising from the calibration of the jet mass scale and modelling of the final state radiation in simulation are improved by dedicated studies of the jet substructure. This results in a significant increase in precision in the top quark mass with respect to an earlier measurement, now reaching a precision below 1 GeV.

T 135.4 Thu 18:15 HSZ/0201

Measurement of the top quark pole mass using $t\bar{t}$ +1 jet events with the CMS experiment — •Ana Ventura Barroso, Sebastian Wuchterl, Roman Kogler, and Katerina Lipka — Deutsches Elektronen-Synchrotron DESY, Notkestraße 85, D-22607 Hamburg

The top quark is the most massive elementary particle known. Its mass,m_t, is a fundamental parameter of the Standard Model, and its value needs to be determined experimentally. However, direct top quark mass measurements suffer from ambiguities in their interpretation because of nonperturbative effects.

In this work, the pole mass of the top quark is extracted from a precise measurement of the distribution in ρ, in events where the $t\bar{t}$ system is produced in association with at least one additional jet. The variable ρ is defined as the inverse of the invariant mass of the $t\bar{t}$+jet system. This observable has been chosen due to strongest sensitivity to m_t at the threshold of the $t\bar{t}$+jet production. The analysis is performed using proton-proton collision data collected by the CMS experiment in 2016-2018 with $\sqrt{s}$=13 TeV, corresponding to a total integrated luminosity of 138 fb^{-1}. Events with two opposite-sign leptons in the final state are analyzed and the cross section is measured at the parton level using a likelihood unfolding method.

T 135.5 Thu 18:30 HSZ/0201

Prospects for a Measurement of Quantum Entanglement in Top Quark Pair Production in the Lepton+Jets Final State — Marcel Niemeyer, Arnulf Quadt, Baptiste Ravina, •Theresa Reisch, and Elizaveta Shabalina — II. Physikalisches Institut, Georg-August-Universität Göttingen

Quantum entanglement is a fundamental prediction of quantum mechanics. Experimental achievements with electrons and photons were recognised by the Nobel Prize in Physics 2022. At the LHC, quantum entanglement could be observed for the first time in quarks, testing quantum mechanics at high energies. Therefore, a sensitivity study for a possible measurement of quantum entanglement in the top quark pair production in the lepton+jets final state is presented. The angular separation between the decay products of the top quarks can act as a marker of quantum entanglement, when the two top quarks are produced near threshold. To take advantage of the presence of c-quarks in W decays in l+jets channel, c-tagging is used based on the working points of the current b-tagging algorithm. The result is then unfolded using Profile Likelihood Unfolding to remove detector effects. The study is performed with ATLAS Monte Carlo simulations under Run 2 conditions.

T 135.6 Thu 18:45 HSZ/0201

Search for heavy right-handed Majorana neutrinos in $t\bar{t}$ decays — •Tongbin Zhao[1,2], Binish Batool[1], Beatrice Cervato[1], Markus Cristinziani[1], Carmen Diez Pardos[1], Ivor Fleck[1], Arpan Ghosal[1], Gabriel Gomes[1], Jan Joachim Hahn[1], Vadim Kostyukhin[1], Buddhadeb Mondal[1], Amartya Rej[1], Katharina Voss[1], and Wolfgang Walkowiak[1] — [1]Center for Particle Physics Siegen, Experimentelle Teilchenphysik, Universität Siegen — [2]Shandong University, China

A search for heavy right-handed Majorana neutrinos is performed with the Run-2 dataset recorded from 2015 to 2018 with the ATLAS detector at the CERN Large Hadron Collider and is based on $\sqrt{s} = 13$ TeV proton–proton collision data with an integrated luminosity of 139 fb^{-1}. The targeted process is $t\bar{t}$: one of the top quarks decays into a pair of same-sign same-flavour leptons (electrons or muons), a b-quark and two light quarks, while the other decays into a b-quark and two light quarks. The final states feature same-sign dilepton signatures. This analysis is the first search for heavy neutrinos using $t\bar{t}$ events.

A multivariate analysis is employed in order to improve the sensitivity. Several control regions are defined to estimate the main backgrounds. With profile likelihood fits using the ee and $\mu\mu$ channels, we expect to reach good sensitivities for the mixing parameters in the mass region 15–80 GeV.

T 136: Higgs TH, VH

Time: Thursday 17:30–19:00 Location: HSZ/0204

T 136.1 Thu 17:30 HSZ/0204

Associated production of a Higgs boson and a single top quark from t-channel production (tHq) in channels with hadronically decaying tau leptons at ATLAS — •Christian Kirfel, Ian C. Brock, Tanja Holm, and Oleh Kivernyk — Physikalisches Institut Bonn

A measurement of the single top-quark production in association with a Higgs boson and a spectator light-quark (tHq) gives insight into the properties of not only the top quark but also the Higgs boson. The associated production is uniquely sensitive to the relative sign of the top quark-Higgs boson Yukawa coupling. Additionally, the ditau decay of the Higgs boson, which successively decay hadronically, allows for precise reconstruction of the Higgs mass. The desired precision is limited by the plethora of background processes with higher cross sections.

This talk will discuss the search for this channel in the Run 2 LHC dataset by ATLAS.

T 136.2 Thu 17:45 HSZ/0204

Correlation studies on particle kinematics to improve mass reconstruction in single top quark associated H boson production (tHq) in the $H \to \tau\tau$ channel at ATLAS — •Mathias Weiss, Tanja Holm, and Ian Brock for the ATLAS-Collaboration — Universität Bonn

The associated production of a top quark and a H boson (called tHq) allows experimental tests of the relative phase between g_{HWW} and y_t, the coupling constants of the H boson to the W boson and to the top quark.

In the decay channel $H \to \tau\tau$ and $t \to l$ with one hadronic τ and two light leptons, l, in the final state, missing neutrinos are the main challenge to mass reconstruction. This talk approaches this challenge by exploiting correlations derived from Monte Carlo samples with truth information, which simulate events taken by the ATLAS detector during Run 2 of the LHC.

T 136.3 Thu 18:00 HSZ/0204

Associated production of a Higgs boson and a single top quark from t-channel production (tHq) in channels with hadronically decaying tau leptons at ATLAS — •Florian Kirfel, Tanja Holm, Christian Kirfel, and Oleh Kivernyk for the ATLAS-Collaboration — Physikalisches Institut der Universität Bonn, Deutschland

A measurement of the single top-quark production in association with a Higgs boson and a spectator light-quark (tHq) gives insight into the properties of not only the top quark but also the Higgs boson. The associated production is uniquely sensitive to the relative sign of the top quark-Higgs boson Yukawa coupling. In this talk the ditau decay of the Higgs boson, with one hadronically and one leptonically decaying tau, is investigated. The channel where the lepton from the top quark and the one from the Higgs boson have the same sign reduces the number of background events substantially. Techniques to treat the tau fakes as well as charge flip events present in this channel will be discussed in combination with applied TMVA methods and the fitting procedure.

T 136.4 Thu 18:15 HSZ/0204

Analysis of tH(bb) production with ATLAS Run-2 data — •Martin Vatrt and Andre Sopczak — CTU in Prague

The latest results on the analysis tH(bb) are presented with focus on machine learning optimization using ATLAS Run-2 data.

T 136.5 Thu 18:30 HSZ/0204

Comparison of different monte carlo generators for the simulation of ZH events in the gluon fusion production mode — •Manuella Guirgues[1], Xavier Coubez[1,2], Svenja Diekmann[1], Alena Dodonova[1], Ming-Yan Lee[1], Luca Mastrolorenzo[1], Spandan Mondal[1], Andrej Novak[1], Andrey Pozdnyakov[1], Alexander Schmidt[1], Annika Stein[1], and Valentyn Vaulin[1] — [1]III. Physikalisches Institut A, RWTH Aachen, Aachen, Germany — [2]Brown University, Providence, USA

The associated Higgs production via Higgsstrahlung from a Z boson originating from gluon fusion is a loop-induced process with destructive interference between the triangle and box contributions at leading order. This makes the process a sensitive candidate to probe new beyond the standard model pyhsics (BSM). Therefore, comparing different Monte Carlo generators and investigating their differences is important for the development of physics analyses to access the gg→ZH process in data. This talk will present the comparison of 4 generators for the process gg→ZH with the Higgs boson decaying via the H→b$\bar{\text{b}}$ channel. The comparison is done using simulated CMS Run 2 datasets at $\sqrt{s} = 13$ TeV.

T 136.6 Thu 18:45 HSZ/0204

Extraction of the gluon-initiated component of the associated production of the Higgs boson and a vector boson with the CMS experiment — •Alena Dodonova[1], Alexander Schmidt[1], Xavier Coubez[1,2], Luca Mastrolorenzo[1], Andrey Pozdnyakov[1], Andrzej Novak[1], Spandan Mondal[1], Ming-Yan Lee[1], Annika Stein[1], Svenja Diekmann[1], Niclas Eich[1], and Martin Erdmann[1] — [1]III. Physikalisches Institut A, RWTH Aachen University, Aachen, Germany — [2]Brown University, Providence, USA

Associated Higgs boson production with a Z boson (ZH) contains quark- and gluon-initiated components. The gluon-initiated component ($gg \to ZH$) could be a good probe for the physics beyond the Standard Model (SM) since the effects of the new physics for the loop-induced processes would be of the same order as the SM process. Due to destructive interference between box and triangle contributions at the leading order, this component is suppressed with respect to the dominant quark-initiated contribution to ZH production.

In this talk, I will present the prospects to set an upper limit on the $gg \to ZH$ component in the $H \to b\bar{b}$ decay channel using DNN classifier. The study is performed with the full Run 2 dataset collected with the CMS detector at the LHC at $\sqrt{s} = 13\ TeV$.

T 137: DAQ Test/RO – GRID II

Time: Thursday 17:30–19:00 Location: HSZ/0301

T 137.1 Thu 17:30 HSZ/0301

Introducing Constellation - Development of a flexible DAQ Infrastructure Framework — •Stephan Lachnit — DESY, Hamburg, Germany

Test beam qualifications of new detectors are very volatile environments which require stable operation and synchronization of multiple devices while allowing for fast integration of new prototypes. For this purpose, a centralized run control software is usually used to distribute commands and to manage data recording and logging.

Constellation is an upcoming open-source DAQ infrastructure framework with the goal to implement such a run control software. The main aspect is the orchestration of different data acquisition "satellites" with the run control and other satellites for data storage.

In this talk several design concepts of Constellation will be presented, including for the Final State Machine, Messaging via ZeroMQ, zero-configuration networking, dynamic loading of DAQ modules and support for EUDAQ2 modules.

T 137.2 Thu 17:45 HSZ/0301

GUI framework and database for ATLAS ITk system tests — •Jonas Schmeing, Gerhard Brandt, Wolfgang Wagner, Marvin Geyik, and Maren Stratmann — Bergische Universtität Wuppertal

For the LHC Phase-2 upgrade, a new inner tracker (ITk) will be installed in the ATLAS experiment. It will allow for even higher data rates and will be thoroughly tested in the ATLAS ITk system tests. To operate these tests and later the final detector, a GUI and configuration system is needed. For this a flexible and scalable GUI framework based

on distributed microservices has been introduced. Each microservice consists of a frontend GUI, a server running the python application, and a system-level backend.

The frontend GUI is a single-page application built with the React JavaScript library. The API for RESTful HTTP communication between the frontend and the Python app is defined via an OpenAPI specification. The Python app is the central part of each microservice. It connects to the microservices backend, such as a database or various DAQ applications. The OpenAPI and Python interfaces facilitate the maintainability and long-term upgradability of the system.

With this microservice framework, it is possible to serve specialized applications for different purposes: e.g., an API to access the data acquisition software or services to configure and monitor different hardware components. The system additionally includes multiple interfaces to a database used for storing configuration and connectivity data, data about the executed runs and their results.

T 137.3 Thu 18:00 HSZ/0301

ITk-Pixel FELIX read-out chain stress test preparations — •Matthias Drescher, Jörn Grosse-Knetter, Arnulf Quadt, and Ali Skaf — II. Physikalisches Institut, Georg-August-Universität Göttingen, Germany

The current ATLAS Inner Detector will be upgraded to an all-silicon Inner Tracker (ITk) for the experiment's phase 2 upgrade. The ATLAS ITk read-out system employs the FELIX hardware/software system for interfacing the optical fiber cables of the on-detector components to the higher level infrastructure. Each FELIX board has 24 high-speed fiber links. In the Pixel subdetector configuration, each uplink fiber is connected to an lpGBT aggregator chip, which itself bundles 7 Aurora 64b/66b data lanes at 1.28 Gbps. In our case, the Aurora data is the output of the RD53A prototype front-end chip. To ensure stable operation under full load before moving to the final large-scale read-out system, a stress test populating all 24 of these fibers is being prepared.

Due to limited hardware availability, we aim for carrying out stress tests with lpGBT and RD53A emulators implemented on several Xilinx FPGA development boards instead of the respective ASICs. The hit maps sent by the RD53A emulators are stored in fast local memory, which would be written from a central controller PC connecting to the FPGA boards via Gigabit Ethernet. In order to prepare our stress test, we had to develop a set of helping tools and procedures that might also be used independently. For example, a dedicated programmer GUI software was developed to be used with the existing CERN USB-I2C dongle.

T 137.4 Thu 18:15 HSZ/0301

Modelling Distributed Computing Infrastructures for High Energy Physics — •Maximilian Horzela[1], Henri Casanova[2], Robin Hofsaess[1], Manuel Giffels[1], Artur Gottmann[1], Günter Quast[1], Achim Streit[1], and Frederic Suter[3] — [1]Karlsruhe Institute of Technology, Karlsruhe, Germany — [2]University of Hawai'i at Manoa, Honolulu, USA — [3]Oak Ridge National Laboratory, Oak Ridge, USA

Designing distributed, heterogeneous computing-infrastructures is a challenging task. Since, due to their complexity and size, only a single design candidate can be feasibly deployed, building different prototypes is no option.

We therefore propose to simulate the behaviours of infrastructure candidates based on realistic simulation models as an accessible approach. This ansatz already proved to be successful, utilizing the MONARC simulator for the design of the original structure of the WLCG. In this spirit, a modern tool for simulation of high energy physics workloads executing on distributed computing infrastructures is presented. It is based on the SimGrid/WRENCH simulation framework, allowing to simulate complex infrastructures enhanced with models to simulate relevant data access and caching patterns.

T 137.5 Thu 18:30 HSZ/0301

Caching in Distributed Computing Infrastructures — •Robin Hofsaess, Maximilian Horzela, Manuel Giffels, Artur Gottman, and Matthias Schnepf — Karlsruher Institut für Technologie

With the steadily growing amount of data collected in several high energy physics experiments, new challenges occur when it comes to an efficient processing of the data. Besides storage, data transfers are becoming more and more limiting for the increasingly distributed computing infrastructure used by the HEP community. An efficient usage of the resources therefore make higher bandwidths necessary. However, it is often not possible to simply improve the connectivity of a resource provider leading to the necessity of other approaches. A first step here could be to reduce unnecessary data transfers by (local) caching. The talk will address the general ideas on coordinated caching within a distributed computing infrastructure - as given at KIT/GridKa - and briefly discuss its challenges. Furthermore, our future plans at KIT will be presented.

T 137.6 Thu 18:45 HSZ/0301

Belle II Grid Computing Developments in Germany — •Matthias Schnepf[1], Moritz Bauer[1], Günter Duckeck[2], Torben Ferber[1], Oliver Freyermuth[3], Andreas Gellrich[4], Manuel Giffels[1], Günter Quast[1], Michel Hernandez Villanueva[4], and Peter Wienemann[3] — [1]Karlsruhe Institute of Technology (KIT) — [2]LMU Munich — [3]Univertity of Bonn — [4]DESY Hamburg

The Belle II experiment studies B-meson decays with high precision and plans to record 50ab^{-1}, which corresponds to 50PB of recorded data. For reconstruction, simulation, and analysis, the Belle II collaboration uses several data centers around the world as a Grid, similar to the worldwide LHC Computing Grid.

To improve the global job throughput and support the local groups, several developments in Belle II Grid computing are being worked on and are applied in Germany or by German groups. In this presentation, we describe the challenges and the current development projects. These involve the Grid storage for local groups, caching techniques to increase dataset accessibility, GPU, and multicore support in the Grid for Belle II.

T 138: QCD Experiment III

Time: Thursday 17:30–18:45 Location: HSZ/0405

T 138.1 Thu 17:30 HSZ/0405

Triple differential cross-section measurement of Z($\mu\mu$)+jet events at 13 TeV — •Cedric Verstege, Robin Hofsaess, Maximilian Horzela, Günter Quast, and Klaus Rabbertz — Karlsruhe Institute of Technology, Karlsruhe, Germany

The differential cross-sections of Z($\mu\mu$)+jet events is presented using the data recorded at 13 TeV center-of-mass energy by the CMS experiment in the years 2016, 2017, and 2018. The cross-sections are measured as a function of the Z boson transverse momentum p_T^Z, the rapidity separation y^* of the Z boson and the leading jet, and the boost in rapidity y_b of their center-of-mass system in the lab frame. The observables y^* and y_b enhance the sensitivity to different parton initial-state and momentum contributions, and thus to the PDFs.

The measured cross-sections are unfolded for detector effects in all three dimensions simultaneously. The resulting cross-sections at stable particle level are compared to precise theory predictions calculated at next-to-next-to-leading order in perturbative QCD corrected for electroweak and non-perturbative effects.

T 138.2 Thu 17:45 HSZ/0405

Measurement of jet mass distribution of hadronic W and Z bosons — •Steffen Albrecht[1] and Andreas Hinzmann[2] — [1]Universität Hamburg — [2]DESY, Hamburg, previously Universität Hamburg

In this talk we introduce a new effort towards measuring the jet mass distribution of hadronically decaying W and Z bosons.
We study events in which the bosons have a large transverse momentum and thus produce strongly collimated decay products reconstructed as single fat jets. The substructure of such jets proves to be a useful handle in various procedures (e.g. jet calibration, jet tagging), but has room for improvement in its modelling. We aim to gain an in-depth understanding of the substructure by studying the unfolded jet mass distribution in dependence of the jet p_T and substructure

tagger discriminants. While previous measurements of jet mass have been carried out for gluon, quark and top jets in dijet, Z(ll)+jet and $t\bar{t}$ samples, this is the first study of W and Z jet masses in the processes with $W(qq)$+jets, $Z(qq)$+jets as well as hadronic $t\bar{t}$ systems in the final states.
In addition the measurement of the difference $m_Z - m_W$ will be pursued, setting a first step towards a potential measurement of the W mass with jet substructure.

T 138.3 Thu 18:00 HSZ/0405

First results from inclusive jet measurement with Run2 data at CMS — •Valentina Guglielmi[1], Katerina Lipka[1], Simone Amoroso[1], Patrick Connor[2], and Roman Kogler[1] — [1]Deutsches Elektronen-Synchrotron DESY, Notkestraße 85, D-22607 Hamburg — [2]University Hamburg, Hamburg, Germany

We present preliminary results of the measurement and QCD analysis of double-differential inclusive jet cross sections in proton-proton collisions by using the full Run2 data collected by CMS experiment at a center of mass energy of s = 13 TeV. The higher accumulated luminosity, compared with the previous result, of full Run2 allows for an improved precision and opens up new corners of the phase space. This permits further testing of the Standard Model (SM) and facilitates indirect searches for physics beyond the SM. Our study addresses the high transverse momentum region, where possible contributions of new physics, e.g. different models of 4-quark contact interactions, are most significant. Furthermore, the precision of the parton distribution functions can be significantly improved and the strong coupling constant can be extracted. An overview of the current status of the measurement will be given, together with preliminary results of a simultaneous determination of alpha-s and PDFs at NNLO in QCD.

T 138.4 Thu 18:15 HSZ/0405

A novel method to measure the jet energy resolution from dijet events at CMS — •Yannick Fischer[1], Johannes Haller[1], Andrea Malara[2], Alexander Paasch[1], and Matthias Schröder[1] — [1]Universität Hamburg — [2]Université Libre de Bruxelles

The jet energy is a key observable for almost all analyses at the CMS experiment at the CERN LHC. A precise knowledge of the jet energy resolution (JER) is crucial for both measurements and searches. This talk will give a brief overview over JER measurements at CMS. A novel method based on the missing transverse momentum fraction (MPF) technique is introduced. The new approach provides a JER measurement complementary to existing methods and aims at avoiding several of their dominant uncertainties. In this talk, we will introduce the new method and show first results with the recent CMS data.

T 138.5 Thu 18:30 HSZ/0405

Production of interpolation grids for inclusive jet cross sections at ALICE — •Hector Pillot[1,2], Rachid Guernane[3], and Klaus Rabbertz[2] — [1]Grenoble Alpes University (UGA) — [2]Karlsruhe Institut of Technology (KIT) — [3]Laboratory of Subatomic Physics & Cosmology (LPSC)

The APPLfast project interfaces APPLgrid and fastNLO with the fixed-order cross section integrator NNLOJet. This produces interpolation grids that allow fast and accurate iterative computation of observables up to NNLO with different PDF sets or renormalization and factorization scales. This interface is employed in a workflow using the LAW and LUIGI packages for workflow management. As an example, differential cross sections of inclusive jet production from pp collisions at a center-of-mass energy of 5.02 TeV are computed within this workflow and are compared to experimental data from the ALICE collaboration. The cross sections are measured as a function of the jet p_T and jet size parameter R. The cross sections are also compared using different PDF sets including PDF uncertainties and renormalization and factorization scale variations.

T 139: Neutrinos VI

Time: Thursday 17:30–19:00 Location: POT/0051

T 139.1 Thu 17:30 POT/0051

Status of the NUCLEUS experiment — •Sebastian Dorer — Technische Universität Wien, Vienna, Austria

Coherent elastic neutrino nucleus scattering (CEvNS) is a well-predicted Standard Model process only recently observed for the first time. Its precise study could reveal non-standard neutrino properties and open a window to search for physics beyond the Standard Model.

NUCLEUS is a CEvNS experiment conceived for the detection of neutrinos from nuclear reactors with unprecedented precision at recoil energies below 100 eV. Thanks to the large cross-section of CEvNS, an extremely sensitive cryogenic target of 10g of CaWO4 and Al2O3 crystals is sufficient to provide a detectable neutrino interaction rate.

NUCLEUS will be installed between the two 4.25 GW reactor cores of the Chooz-B nuclear power plant in the French Ardennes, which provide an anti-neutrino flux of 1.7×10^{12} ν/(s cm^2). At present, the experiment is under construction. The commissioning of the full apparatus is scheduled for 2023, in preparation for the move to the reactor site. In this talk we will discuss the NUCLEUS goals and sensitivity, as well as present the recent activities and progresses of the experiment.

T 139.2 Thu 17:45 POT/0051

Design and fabrication of MMC-based P2 detectors to be coupled to scintillating crystals at mK temperatures — •Ashish Jadhav, Christian Enss, Andreas Fleischmann, Daniel Hengstler, Daniel Unger, and Loredana Gastaldo — Kirchhoff Institute for Physics, Heidelberg University, Im Neuenheimer Feld 227, 69120 Heidelberg, Germany.

We present the development of high-energy resolution integrated photon and phonon detectors (P2), based on low-temperature Metallic Magnetic Calorimeters (MMC) to be coupled to a scintillating crystal operated at 20 mK. The present design of P2 is based on a 3 inch wafer. The central part, of area 15 cm^2 is connected to the rest of the wafer through 7 legs fabricated using deep silicon etching and is used for the detection of visible photons emitted after the interaction of a particle in the crystal. On the outer part of the wafer, three double meander MMC detectors are fabricated as phonon detectors. They will be connected to the crystal for monitoring the increase in temperature upon the interaction of a particle. We aim at demonstrating an energy resolution better than 1 keV for the phonon detectors and a time resolution better than 1 μs for the photon detector. This detector development is part of the R&D for the AMoRE experiment searching for $0\nu\beta\beta$ decay in ^{100}Mo. Demonstrating the expected performance for P2 will have a substantial impact on background reduction and influence the design of detector modules for the next stage of the AMoRE experiment.

T 139.3 Thu 18:00 POT/0051

CEvNS and searches for new physics with the CONUS experiment — •Sophie Armbruster for the CONUS-Collaboration — Max-Planck-Institut für Kernphysik, Heidelberg

The CONUS experiment (COherent elastic NeUtrino nucleus Scattering) aims to detect coherent elastic neutrino-nucleus scattering (CEvNS) of reactor antineutrinos on germanium nuclei in the fully coherent regime. The CONUS experiment - operated in the Brokdorf nuclear power plant (Germany) between April 2018 and December 2022- was located at 17m from the 3.9 GWth core. The possible CEvNS signature was studied with four 1 kg point-contact high-purity germanium (HPGe) detectors, which provided a sub keV energy threshold with background rates in the order of 10 events per kg, day and keV. The analysis of the final CONUS data set allows us to establish competitive limits on CEvNS from a nuclear reactor with a germanium target. The most recent results including constraints on beyond the Standard Model parameters will be presented together with future plans of the project.

T 139.4 Thu 18:15 POT/0051

CNO solar neutrinos measurement with Borexino detector: updated combined analysis with directionality constraint — •Luca Pelicci — Forschungszentrum Jülich GmbH, Institut für Kernphysik IKP-2, Jülich, Germany — Johanniterstrasse 22

Borexino was a large liquid scintillator experiment with an unprecedented level of radiopurity, designed for real-time detection of low-energy solar neutrinos. It was located at the underground INFN Lab-

oratori Nazionali del Gran Sasso, in Italy. During more than ten years of data taking, it has measured the neutrino flux from each individual within the proton-proton-chain, i.e. the main fusion process accounting for 99 % of the energy production of the Sun, and in the CNO cycle, responsible for the remaining 1%. To disentangle neutrino-induced signals from residual background, a multivariate analysis was adopted, based on the fitting of the spectrum of Borexino events with Monte-Carlo simulated reference shapes. In recent years, through the method called "Correlated and Integrated Directionality" (CID) Borexino has also provided a proof of principle for the exploitation of the sub-dominant Cherenkov information produced by sub-MeV solar neutrinos in a liquid scintillator detector. In this talk, the improvements and upgrades performed in recent years will be discussed. Furthermore, the combination of the two analysis approaches was recently exploited for a measurement of the CNO solar neutrinos with improved precision. The most recent results will be presented.

T 139.5 Thu 18:30 POT/0051

Looking for sterile neutrinos using the solar ^{8}B neutrino spectrum — •Simon Appel and Lothar Oberauer — Technische Universität München, München, Germany

Solar ^{8}B neutrinos are detected via elastic scattering on electrons in large radiopure detectors. The expected upturn in the survival probability of solar ^{8}B neutrinos is still not detected. Current generation detectors struggle with several challenges. Cosmic muons produce radiogenic isotopes that mimic the ^{8}B neutrino shape. Especially the long lived ^{10}C and ^{11}Be isotopes are problematic. External gamma background limits the fiducial volume.The expected upturn in the survival probability of solar ^{8}B neutrinos is still not detected. Current Besides the MSW effect there is more physics beyond the standard model that could affect the neutrino survival probability. Light sterile neutrinos $\Delta m^2_{01} \simeq (0.7 - 2) \cdot 10^{-7}\text{eV}^2$ and flavor changing ν_e-ν_τ interactions affect the survival probability in the same energy region as the MSW effect. This talks focuses on the ability of future detector generations exploring this parameter space. This work is supported by the DFG collaborative research centre 1258 "NDM", and the DFG Cluster of Excellence "Origins".

T 139.6 Thu 18:45 POT/0051

Directionality measurement of CNO neutrinos in the Borexino detector — •Johann Martyn[1] and Apeksha Singhal[2,3] — [1]Johannes Gutenberg - Universtät Mainz — [2]Forschungszentrum Jülich GmbH, Nuclear Physics Institute IKP-2 — [3]III. Physikalisches Institut B, RWTH Aachen

Borexino has been a 280 t liquid scintillator detector situated at the INFN Laboratori Nazionali del Gran Sasso in Italy. With an unprecedetened level of radiopurity and a 3800 m.w.e. of rock shielding its main goal is the measurement of solar neutrinos. Previously the Borexino collaboration has provided the first directional measurment of sub-MeV ^{7}Be neutrinos using the so called "Correlated and Integrated Directionality" (CID). Here the known position of the Sun is correlated to the reconstructed photon direction, given by the hit PMT position and the reconstructed event position. Cherenkov hits from the neutrino recoil electrons show a correlation to the position of the Sun, while the isotropic scintillation and background events are not. The integrated angular distribution of the hits for a large number of events then allows for the statistical inference on the number of neutrino events. This talk presents the CID measurement of CNO neutrinos, using the full Borexino detector live time from May 2007 to October 2021.

T 140: Gamma Astronomy VI

Time: Thursday 17:30–19:00 Location: POT/0151

T 140.1 Thu 17:30 POT/0151

Signal extraction of raw simulated and laboratory data with the FlashCam camera for Medium Sized Telescopes in CTA. — •Clara Escanuela, Felix Werner, and Jim Hinton — Max-Planck Institut fuer Kernphysik, Saupfercheckweg 1, 69117 Heidelberg

The Cherenkov Telescope Array (CTA) is the next generation observatory for very high energy (VHE) gamma rays. The southern CTA site will consist of large, medium (MST), and small size telescopes to cover a wide range of photon energies. The FlashCam will be used for the southern site MSTs, and is a photomultiplier-tube based camera with a fully digital readout system. A FlashCam MST is expected to start taking data in Chile in 2024. This requires deep laboratory testing which includes the reproduction of shower-like illumination patterns and time profiles with an LED array, laser calibration, and night sky background simulation. We present first results from testing the signal extraction algorithm and performance verification in the laboratory.

T 140.2 Thu 17:45 POT/0151

Influence of varying pulse shapes on the response of FlashCam — •Fabian Leuschner for the CTA FlashCam-Collaboration — IAAT, 72076 Tübingen, Germany

FlashCam is a fully digital camera for Imaging Air Cherenkov Telescopes (IACTs) and is foreseen to be used for the Medium-Sized Telescopes (MSTs) at the southern site of the upcoming CTA Observatory. Since 2019, a fully functional advanced prototype is installed to CT5, the world's largest IACT that is part of the H.E.S.S. array in Namibia. Accurate reconstruction of the input light intensity in each individual pixel is key for correctly reconstructing air showers and consecutively for observations of very high energetic gamma rays. Extensive measurements with tuneable light-pulses from two pulsed lasers have been used to assess the performance of the reconstruction algorithms. The setup provides dual pulses, each with less than a nanosecond duration. Pulses are emitted either synchronously or with an adjustable time delay of multiples of 0.5 ns between each pulse.

After a short introduction into the FlashCam concept, I will discuss the influence of such pulses with varying length, shape, and intensity on the camera response. The results show that FlashCam is able to reconstruct the intensity of incoming light pulses over the required dynamic range with accuracies on the percent scale and meets the requirements for use in the CTA Observatory.

T 140.3 Thu 18:00 POT/0151

Muon Calibration of Dual-Mirror-Telescopes — •Henning Ptaszyk, Rune M. Dominik, and Maximilian Linhoff for the CTA-Collaboration — Astroparticle Physics, TU Dortmund University, D-44227 Dortmund, Germany

The Cherenkov Telescope Array (CTA) is being built at two sites on the northern and southern hemisphere respectively and will be the next generation ground- based very-high-energy gamma-ray observatory. Both arrays will consist of multiple Imaging Atmospheric Cherenkov Telescopes (IACT) in different sizes, built for the observation of gamma-ray induced air showers within different energy ranges. The southern array, currently being constructed in Chile, will include Small-Sized Telescopes (SSTs) utilizing a Schwarzschild-Couder design, that feature two reflectors instead of one. This optical design, which is also proposed for some of the MSTs, not only allows for a more compact construction, but also counteracts optical aberration.

To ensure precise reconstruction of the incoming gamma-ray's properties, calibra- tion methods are required. As for previous IACT experiments, ringlike images, generated by atmospheric muons, present an important calibration source for CTA. Since the aforementioned dual-mirror telescopes pose a novel introduction to IACT observatories, it is necessary to study the muon calibration process for Schwarzschild-Couder telescopes. The status and further proceeding of this research are the subject of this talk.

T 140.4 Thu 18:15 POT/0151

Reproducible Analysis of MAGIC Data with the Database-Driven Framework AutoMAGIC and the Open-Source Python Package Gammapy — •Simone Mender and Jan Lukas Schubert for the MAGIC-Collaboration — TU Dortmund University

The open-source Python package Gammapy is mainly developed for the high-level analysis of gamma-ray data of the future Cherenkov Telescope Array Observatory. It can also be used to analyze data from existing imaging air Cherenkov telescopes like MAGIC. Gammapy requires event-based data combined with the corresponding instrument response functions. In order to process this science-ready data (so-called DL3) for MAGIC, the new database-driven framework AutoMAGIC is developed. With AutoMAGIC it is possible to create DL3

data in an automated and reproducible way. It enables the possibility to perform very cumbersome analyses automatically, e.g. the low-level data reprocessing that is needed for observations with moderate to strong moonlight. In this talk, we present the analysis chain and its validation. For this, we analyzed Crab Nebula data, which was taken under different observational conditions.

T 140.5 Thu 18:30 POT/0151

Automatized Analysis of MAGIC Sum-Trigger-II Pulsar Data — •Jan Lukas Schubert and Simone Mender for the MAGIC-Collaboration — TU Dortmund University, Dortmund, Germany

The MAGIC telescopes are a stereoscopic system of Imaging Air Cherenkov Telescopes which is used for gamma-ray detection in the GeV to TeV range. Thanks to an analogue trigger system, dubbed Sum-Trigger-II, low-energy data with a threshold as low as ˜25 GeV can be recorded, enabling the MAGIC telescopes to perform comparably low energetic analyses such as pulsar analyses.

This data requires a dedicated treatment adapted to the low energies. Since the analysis structure is complex, it is reasonable to automatize the analysis to save time for an analyzer and to deliver entirely reproducible results. The automatization of the analysis of Sum-Trigger-II data was implemented in the autoMAGIC project which aims to automatize the entire MAGIC analysis chain.

A workflow for the pulsar timing and the pulsar analysis based on the autoMAGIC output is currently designed and implemented. It delivers results comparable to manual pulsar analyses.

In the future, the automatization of the analysis of Sum-Trigger-II data could be used for further optimizations of the low-energy analysis as well as for comparisons of low-energy data from MAGIC and the LST. In combination with the automatic pulsar analysis, this will enable the possibility to perform long-term pulsar analyses with a comparably small amount of work.

T 140.6 Thu 18:45 POT/0151

Towards an automatic mode of operation of the MAM subsystem of MAGIC — •Angela Bautista for the MAGIC-Collaboration — Max Planck Institute for Physics, Munich, Germany

The MAGIC telescope system is sensitive to gamma rays in the very high energy range 20 GeV-100 TeV. Cherenkov light produced in extensive air showers is collected and used to estimate the primary gamma-ray energy. The atmosphere absorbs part of the Cherenkov light and the MAGIC LIDAR system is used to correct observations with zenith angles up to 60°. MAGIC observes sources above 60° using the Very Large Zenith Angle (VLZA) observation technique. The increased collection area during VLZA observations enables the study of PeVatron candidates with steep spectra extending to 100 TeV and beyond. At such large zenith angles, the column density of air exceeds the range covered by the LIDAR and a different atmospheric calibration technique is needed. The MAGIC Atmospheric Minion (MAM) was installed at the MAGIC site to correct for the atmospheric effects during VLZA observations. The task of MAM is to measure the atmospheric transmission in real-time either by using aperture photometry or spectroscopy of stars within the same sky region as the gamma-ray source of interest. Currently, a manual procedure for photometric calibration is already in place. This talk presents recent progress along with the next steps to advance towards an automatic mode of operation of the MAM subsystem.

T 141: Neutrino Astronomy V

Time: Thursday 17:30–19:00 Location: POT/0251

T 141.1 Thu 17:30 POT/0251

Study of the transport behaviour in blazars under the influence of hadronic and photohadronic interactions * — •Vladimir Kiselev[1,2], Marcel Schroller[1,2], Julia Becker Tjus[1,2], and Patrick Reichherzer[1,2] — [1]Theoretische Physik IV, Ruhr-Universität Bochum — [2]RAPP Center, Ruhr-Universität Bochum

Active Galactic Nuclei (AGN) are considered among the few possible sources of high-energy neutrino emission. Therefore, it is important to describe the temporal behaviour and their signal correctly in the multimessenger picture. The most commonly used approach to describe a blazar flare in the present work has been applied, where a population of high-energy primary protons enters a plasmoid, travelling along the jet axis. One such realisation is the modified version of the publicly available propagation framework CRPropa 3.2, which modular structure offers two different propagation approaches, i.e. the equation of motion (EoM) and the solution of the transport equation, under consideration of a broad network of interactions. Previously, it has been shown how, in the considered high-energy range of primary protons, a transition between ballistic and diffusive behaviour takes place, which influences the spectral energy distribution, as well as the light curve of flares. The present work is an extension of the aforementioned work, where the same energy range is considered. In this talk we investigate how the introduction of hadronic interaction modules influences the diffusive behaviour of protons and the transition between both propagation regimes. * Supported by DFG (SFB 1491).

T 141.2 Thu 17:45 POT/0251

Neutrino Cadence of TXS 0506+056 Consistent with Supermassive Binary Origin* — Julia Becker Tjus[1], •Ilja Jaroschewski[1], Armin Ghorbanietemad[1], Imre Bartos[2], Emma Kun[1,3,4], and Peter L. Biermann[5,6] — [1]Theoretical Physics IV, Ruhr University Bochum — [2]Dept. of Phys., Univ. of Florida, USA — [3]CSFK, MTA Centre of Excellence, Hungary — [4]Konkoly Observatory, ELKH Research Centre for Astr. and Earth Sciences, Hungary — [5]MPI for Radioastronomy, Bonn — [6]Dept. of Phys. & Astr., Bonn

In the past, two distinct flares of high-energy neutrinos have been detected by the IceCube neutrino observatory from the direction of the blazar TXS 0506+056. In de Bruijn et al. 2020, it was shown that these two neutrino emission episodes could be due to an ongoing supermassive binary black hole (SMBBH) merger where jet precession close to final coalescence leads to periodic emission. This model made predictions on when the next neutrino emission episode must occur. On September 18, 2022, a new alert by IceCube indicated that a high-energy neutrino arrived from the direction of TXS 0506+056, consistent with the model prediction.

In this work, we show that these three distinct flares of neutrino emission from TXS 0506+056 are consistent with a SMBBH origin and constrain the total mass as well as mass ratio for the binary. We make predictions on when the next neutrino flares should happen and, for the first time, calculate the characteristic strain of its gravitational wave emission. *Supported by DFG (SFB 1491)

T 141.3 Thu 18:00 POT/0251

Time and Density Dependent Modelling of Hadronic and Leptonic Processes in Blazar Jets* — •Marcel Schroller, Julia Becker Tjus, and Lukas Merten — Theoretical Physics IV, Ruhr University Bochum, Germany

Active galactic nuclei (AGN), and the accompanied jets, are some of the most luminous objects in the observable Universe. Both the active cores and their jets are candidates for the engine of ultra high-energy cosmic rays, gamma rays, and neutrinos with the highest energies measured on Earth. In 2017, IceCube recorded an extragalactic high-energy neutrino event with a strong hint of a directional coincidence with the position of a known jetted AGN TXS0506+056. A deep understanding of the processes related to jets will fuel the field of high-energy cosmic rays, fundamental plasma, astro, and particle physics. However, an AGN jet's physical and mathematical modelling is challenging, with ambiguous signatures that need to be understood by numerical simulations of cosmic ray transport and interactions. In this talk, we present a simulation framework for hadronic constituents and their interactions inside of a plasmoid propagating along the AGN jet axis, which is utilised to investigate the time- and density dependence of hadronic interactions in blazar jets and their effects on multimessenger spectra. Furthermore, we will provide deeper insights into the results of such simulations and discuss how to include non-linear leptonic radiation processes into our test particle simulation framework for a more complete, physical description of processes in AGN jets. *Supported by DFG (SFB 1491).

T 141.4 Thu 18:15 POT/0251

Seasonal Variations of the Atmospheric Neutrino Flux measured in IceCube — •Karolin Hymon and Tim Ruhe for the IceCube-Collaboration — Technische Universität Dortmund, Germany

The IceCube Neutrino Observatory measures high energy atmospheric neutrinos with high statistics. These atmospheric neutrinos are produced in cosmic ray interactions in the atmosphere, mainly by the decay of pions and kaons. The rate of the measured neutrinos is affected by seasonal temperature variations in the Stratosphere, which are expected to increase with the particle's energy. In this contribution, seasonal energy spectra are obtained using a novel spectrum unfolding approach, the Dortmund Spectrum Estimation Algorithm (DSEA+), in which the energy distribution is estimated from measured quantities with machine learning algorithms. The seasonal spectral difference to the annual average flux will be discussed based on preliminary results from IceCube's atmospheric muon neutrino data.

T 141.5 Thu 18:30 POT/0251

Search for the Prompt Neutrino Flux with IceCube — •Jakob Böttcher, Philipp Fürst, Erik Ganster, Matthias Thiesmeyer, and Christopher Wiebusch for the IceCube-Collaboration — III. Physikalisches Insitut b, RWTH Aachen University

For about a decade the IceCube Neutrino Observatory has been measuring a high-energy diffuse astrophysical neutrino flux. At these energies, an important source of background is prompt atmospheric neutrinos produced in decays of charmed mesons that are part of cosmic-ray-induced air showers. The production yield of charmed mesons in hadronic interactions, and thus the flux of prompt neutrinos, is not well known and has not yet been observed by IceCube. The analysis of up-going muon neutrino-induced tracks in IceCube provides a large sample of atmospheric neutrinos which likely includes prompt neutrinos. However, the measurement of a subdominant prompt neutrino flux strongly depends on the hypothesis for the dominating astrophysical neutrino flux. This makes the estimation of upper limits on the prompt neutrino flux challenging. We discuss the extent of this model dependency on the astrophysical flux and propose a method to calculate robust upper limits. Furthermore, a possible dedicated search of the prompt neutrino flux using multiple IceCube detection channels is outlined.

T 141.6 Thu 18:45 POT/0251

Search for up-going air showers and constraints of BSM particles with the Pierre Auger Observatory* — •Baobiao Yue for the Pierre Auger-Collaboration — Bergische Universität Wuppertal, Gaußstr. 20, 42119, Wuppertal, Germany

We report on the search for up-going air showers using data from the Pierre Auger Observatory. The observation of such kind of showers with energies above 10^{17} eV has been reported by the ANITA experiment but waits explanation. Using 14 years of available Auger data, the exposure to up-going showers after accounting for all cuts exceeds the one of ANITA by a large factor. Defining a data-blinded search strategy, only one event was found in the zenith angle range $[110°, 180°]$ to pass all cuts, which is consistent with a background expectation of 0.4 ± 0.2 events. The non-observation is used to derive stringent bounds on BSM particles that were discussed in the literature to explain the anomalous ANITA observation. These particles could be produced by high energy interactions within the atmosphere or the Earth and penetrate the Earth with only little absorption to eventually produce tau-particles initiating observable up-going air showers. We discuss the derived upper fluxes of such BSM particles as a function of their unknown cross section with matter and find the strongest bounds when it is at the level of 1% of the neutrino nucleon cross section at the same energy.

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T 142: Neutrinos, Dark Matter XI

Time: Thursday 17:30–19:00 Location: POT/0361

T 142.1 Thu 17:30 POT/0361

The finestructure in the reactor antineutrino spectrum and its implications on the JUNO NMO sensitivity — •Tobias Heinz, Lukas Bieger, Marc Breisch, Jessica Eck, Benedict Kaiser, Tobias Lachenmaier, and Tobias Sterr — Eberhard Karls Universität Tübingen, Physikalisches Institut

To determine the neutrino mass ordering (NMO) with the Jiangmen Underground Neutrino Observatory (JUNO) a precise knowledge of the antineutrino spectrum emitted by nuclear reactors is crucial. New model predictions of the reactor antineutrino spectra show the possible existence of a finestructure in the spectrum that has not been measured yet which can have an impact on the sensitivity of the NMO determination using a detector of unprecedented energy resolution of 3% @ 1 MeV like JUNO. This talk will focus on the study of those implications on the NMO sensitivity of JUNO as well as on the possibility to reduce this impact by measuring an unoscillated reactor antineutrino spectrum with high energy resolution by JUNO's satellite detector TAO as a reference.

This work is supported by the Deutsche Forschungsgemeinschaft.

T 142.2 Thu 17:45 POT/0361

Investigating atmospheric neutrino-antineutrino separation in JUNO — •Achilleas Patsias[1,2], Aachim Stahl[1], and Thilo Birkenfeld[1] for the JUNO-Collaboration — [1]III. Physikalisches Institut B, RWTH Aachen University — [2]Physikalisches Institut, University of Bonn

The CP-violating nature of neutrinos has drawn a lot of attention after the discovery of neutrino oscillations. Atmospheric neutrinos appear in a broad energy range and with high flux of neutrinos and anti-neutrinos which makes them suitable candidates for the study of their CP properties. The Jiangmen Underground Neutrino Observatory (JUNO) will provide atmospheric neutrino data with high statistics and excellent energy resolution. In this study we investigate the required separation accuracy for neutrinos and anti-neutrinos to measure CP-violation with the JUNO detector.

T 142.3 Thu 18:00 POT/0361

UV-complete Dark-Matter models and the ATLAS missing-energy-plus-jets measurement — •Martin Habedank and Priscilla Pani — Deutsches Elektronensynchrotron (DESY) Zeuthen

In the Standard Model, the final state of missing energy and at least one jet (MET+jets) at colliders can be mostly attributed to the production of vector bosons in association with jets. Events with Dark Matter in the final state would however also contribute to this channel. It offers therefore a powerful handle in observing or constraining Dark-Matter models.

Traditionally, mostly simplified Dark-Matter models have been used to interpret the MET+jets final state at the LHC. UV-complete models like the two-Higgs-doublet-model with a pseudoscalar mediator to Dark Matter (2HDM+a) provide however a more complex phenomenology, offering many processes that can contribute to the MET+jets final state.

In this talk, insights into the ATLAS measurement of the MET+jets final state in $139\,\mathrm{fb}^{-1}$ of proton–proton collision at 13 TeV are given. Unfolding the measurement allows for direct comparisons to predictions of Standard-Model and beyond without having to take into account detector effects. This is demonstrated in interpreting the measurement with respect to the 2HDM+a and setting stringent parameter constraints on the latter.

T 142.4 Thu 18:15 POT/0361

Constraining the dark matter distribution of galaxy clusters — •Lukas Nickel — TU Dortmund University

Dark matter remains one of the unsolved mysteries of modern astrophysics. Many phenomena can only be explained under the assumption of an additional matter component, yet - despite searches in all channels - no clear detection was made so far.

One way dark matter could be found, is to look for an excess in gamma-rays from regions with high concentrations of dark matter. Assuming that the unknown particle(s) decay/annihilate into standard-model particles, they would produce gamma-rays even without direct electromagnetic interaction.

To estimate the expected signal, the distribution of dark-matter in an astrophysical object needs to be determined first. This talk will fo-

cus on constraining the dark-matter content of nearby galaxy clusters using the CLUMPY software package, presenting current results and discussing implications for gamma-ray observations.

T 142.5 Thu 18:30 POT/0361

Dark Matter Annihilation in NGC 1068 — •Alexandra Scholz and Li Ruohan — TU München

If Dark Matter (DM) is of particle nature, the Weakly Interacting Massive Particle (WIMP), with an expected mass in the range of some GeV to TeV, detectable by the IceCube telescope, would be a possible candidate. For the barred spiral galaxy NGC 1068 we calculated the neutrino flux from the spike of the super massive black hole (SMBH), and the disk, induced from DM self-annihilation into Standard Model (SM) particles. The calculation was performed for the DM masses 100 GeV, 1 TeV, and 10 TeV, and different Navarro-Frenk-White (NFW) density profile parameters. The annihilation branch ratios and neutrino energy spectra were simulated with the softwares Pythia and MadDM. Comparing IceCube data from NGC 1068 with the results for those three masses, the TeV Dark Matter annihilation scenario has no conflict with the spectrum shape from NGC 1068. Therefore, DM can be a potential explanation for the neutrino flux from NGC 1068.

T 142.6 Thu 18:45 POT/0361

multi-particle dark matter: how to get the hint — subhaditya bhattacharya[1], purusottam ghosh[2], •jayita lahiri[3], and biswarup mukhopadhyaya[4] — [1]Indian Institute of Technology, Guwahati, India — [2]Indian Association for the Cultivation of Science, Kolkata, India — [3]II. Institut für Theoretische Physik, Universität Hamburg, 22761 Hamburg, Germany — [4]Indian Institute of Science Education and Research Kolkata, Mohanpur, India

We investigate ways of identifying two kinds of dark matter component particles at high-energy colliders. The strategy is to notice and distinguish double-peaks(humps) in some final state observable. We carried out our analysis in various popular event topologies for dark matter search, such as mono-X and n-leptons+n-jets final state along with missing energy/transverse momenta. It turns out that an e^+e^- collider is suitable for such analyses. The observables which are best-suited for this purpose have been identified, based on the event topology. The implication of beam-polarization is also explored in detail. Lastly, a quantitative measure of the distinguishability of the two peaks has been established in terms of a few newly-constructed interesting variables.

T 143: Neutrinos VII

Time: Thursday 17:30–19:00 Location: POT/0006

T 143.1 Thu 17:30 POT/0006

Development of novel water-based liquid scintillator with pulse-shape discrimination capabilities — •Hans Theodor Josef Steiger[1,2], Matthias Raphael Stock[3], Manuel Böhles[2], David Dörflinger[3], Ulrike Fahrendholz[3], Daniele Guffanti[4], Meishu Lu[3], Lothar Oberauer[3], Andreas Steiger[3], Michael Wurm[1,2], and Dorina Zundel[2] — [1]Cluster of Excellence PRISMA+ — [2]Johannes Gutenberg-Universität Mainz — [3]Technische Universität München — [4]Università degli Studi di Milano-Bicocca

Future hybrid detectors in the field of neutrino physics have to combine high-resolution energy determination down to low thresholds by scintillation light detection and directional reconstruction with the help of Cherenkov radiation. The spectrum of potential applications is broad, ranging from long-baseline oscillation experiments to the measurement of low-energy solar neutrinos. One possible detector medium for these next-generation detectors is Water-based Liquid Scintillator (WbLS). Here, organic scintillators are dissolved colloidally in small quantities in highly pure water with the aid of surfactants. In this talk, a novel WbLS (based on Triton X-100) will be presented. Particular attention will be paid to its key properties, such as micelle size, scattering length and transparency. In addition, a study of its light yield as well as pulse-shape discrimination capabilities will be presented. This work has been supported by the Clusters of Excellence PRISMA+ and ORIGINS, the DFG Sonderforschungsbereich 1258 as well as the Bundesministerium für Bildung und Forschung (Verbundprojekt 05H2018: R&D Detectors and Scintillators).

T 143.2 Thu 17:45 POT/0006

Development of novel organic liquid scintillators with slow light emission — •Manuel Böhles[1], Hans Theodor Josef Steiger[1,2], David Dörflinger[3], Lothar Oberauer[3], Matthias Raphael Stock[3], and Michael Wurm[1,2] — [1]Johannes Gutenberg-Universität Mainz — [2]Cluster of Excellence PRISMA+ — [3]Technische Universität München

One of the most promising approaches for the next generation of neutrino experiments is the realization of large hybrid Cherenkov/scintillation detectors made possible by recent innovations in photodetection technology and liquid scintillator chemistry.

This talk will focus on the development of such detector liquids with particularly slow light emission. Various attempts are currently underway, such as the use of special wavelength shifters or the use of blended multi-solvent cocktails. Several of these mixtures are compared with respect to their fundamental characteristics (scintillation efficiency, transparency, and time profile of light emission). In addition, the optimization of the admixture of wavelength shifters for a scintillator with particularly high light emission and pulse shape discrimination capability is presented. Newly developed purification methods based on column chromatography and fractional vacuum distillation for several candidate solvents are also discussed.

The work is supported by the Cluster of Excellence PRISMA+, the DFG Sonderforschungsbereich 1258 and the Bundesministerium für Bildung und Forschung (BMBF Verbundprojekt 05H2018: R&D Detectors and Scintillators).

T 143.3 Thu 18:00 POT/0006

Fluorescence Time Profiles of Slow Organic and Water-Based Liquid Scintillators using a Pulsed Neutron Beam — •Matthias Raphael Stock[1], Hans Steiger[2], Lothar Oberauer[1], David Dörflinger[1], Ulrike Fahrendholz[1], Manuel Böhles[2], Stefan Schoppmann[2,3], Luca Schweizer[1], Korbinian Stangler[1], and Dorina Zundel[2] — [1]Physik-Department, Technische Universität München — [2]Johannes Gutenberg University Mainz, Institute of Physics and Cluster of Excellence PRISMA+ — [3]University of California, Department of Physics, Berkeley, CA 94720-7300, USA

We performed two liquid scintillator (LS) characterization experiments using a pulsed neutron beam at the CN accelerator of INFN Laboratori Nazionali di Legnaro. At different energies ranging from 3.5 MeV to 5.5 MeV, one experiment measures the quenching factor of recoil protons while the other one measures the fluorescence time profile of recoil protons. This talk is about the time profile experiment, where we show studies of slow organic and water-based LS mixtures, which will be relevant for future neutrino detectors, e.g., Theia. Differences in the time profiles after gamma and neutron excitation would open the window to perform pulse shape discrimination and therefore advances the ability to distinguish the neutrino signal from background. This work is supported by the BMBF Verbundforschung 05H2018 "R&D Detektoren (Szintillatoren)", the DFG CRC 1258 "NDM", the DFG Clusters of Excellence "PRISMA+" and "Origins".

T 143.4 Thu 18:15 POT/0006

Background investigations with passive transverse energy filters at KATRIN — •Dominic Hinz for the KATRIN-Collaboration — Karlsruhe Institute of Technology (KIT)

The measurement of the absolute mass scale of neutrinos with an unprecedented sensitivity of $0.2\,\mathrm{eV/c^2}$ is the key goal of the KATRIN experiment. This requires a detailed understanding of background processes in the large main spectrometer. Currently, the measured background level exceeds the design value by more than one order. An initial model assigned background events to originate from Rydberg H-states generated by the decay of traces of surface-implanted Pb-210. Highly-excited Rydberg states from the inner spectrometer surface are long-lived and can be ionised by thermal radiation. The resulting low-energy electrons on the meV-scale are then accelerated by the retarding potential, thus they only possess a very small transverse energy, which is in contrast to signal electrons. In a first step we have performed measurements with a passive transverse energy filter (pTEF) imple-

mented as a micro-structured honeycomb gold plate. In this talk we present the measured transmission of background electrons through the pTEF and compare results at different magnetic field values with the initial and refined background models.

This work is supported by the Helmholtz Association (HGF), the Ministry for Education and Research BMBF (05A17PM3, 05A17PX3, 05A17VK2, and 05A17WO3), the Helmholtz Alliance for Astroparticle Physics (HAP), and the Helmholtz Young Investigator Group (VH-NG-1055).

T 143.5 Thu 18:30 POT/0006

Background reduction at the KATRIN experiment with an active transverse energy filter (aTEF) — •Sonja Schneidewind[1,4], Kevin Gauda[1,4], Kyrill Blümer[1,4], Christian Gönner[1,4], Volker Hannen[1,4], Hans-Werner Ortjohann[1,4], Wolfram Pernice[2,3], Lukas Pöllitsch[1,4], Richard Salomon[1,4], Maik Stappers[2], and Christian Weinheimer[1,4] — [1]Institute for Nuclear Physics, University of Münster — [2]CeNTech and Physics Institute, University of Münster — [3]Kirchhoff-Institute for Physics, University of Heidelberg — [4]KATRIN Collaboration

The KATRIN experiment aims at the direct measurement of the incoherent sum of neutrino masses via precision endpoint spectroscopy of the tritium β-decay. Despite advances in background reduction, the elevated background level prohibits to achieve the target sensitivity of 0.2 eV/c^2 (90% C.L.).

One option to reduce the background is the implementation of an active Transverse Energy Filter (aTEF, Eur. Phys. J. C 82, 922 (2022)), which makes use of the specific angular distribution of the background and discriminates electrons at the detector based on their pitch angle. The contribution presents studies concerning the potential background reduction and related sensitivity improvement from an implementation of an aTEF at KATRIN.

This work is supported by BMBF under contract number 05A20PMA and Deutsche Forschungsgemeinschaft DFG (Research Training Group GRK 2149) in Germany.

T 143.6 Thu 18:45 POT/0006

Investigation of electron backscattering for the TRISTAN project — •Daniela Spreng — Technical University Munich, James-Franck-Straße 1, 85748 Garching bei München

One open question in the field of neutrino physics is the existence of keV-sterile neutrinos, which would be a possible Dark Matter candidate. They are experimentally accessible through their mixing with the active neutrino flavours and would therefore lead to a kink-like distortion in the beta-decay spectrum. The KATRIN experiment aims to search for this kink-like structure in the tritium beta-decay spectrum by installing a new multi-pixel silicon drift detector named TRISTAN. To resolve the kink, the detector electron response has to be very well understood. In this talk the effect of the backscattering on the detected electron spectrum for different initial electron energies and incident angles will be presented. To analyse these effects, a dedicated test stand was build and measurements were compared to Geant4 simulations.

This project has received funding from the European Research Council (ERC) under the European Union Horizon 2020 research and innovation program (grant agreement No. 852845). This work is supported by BMBF (05A17PM3, 05A17PX3, 05A17VK2, 05A17WO3), KSETA, the Max Planck society, and the Helmholtz Association.

T 144: Cosmic Ray VII

Time: Thursday 17:30–19:00 Location: POT/0013

T 144.1 Thu 17:30 POT/0013

Effects of magnetic fields on anisotropies in a catalog based research — •Luca Deval, Ralph Engel, Thomas Fitoussi, and Michael Unger — Karlsruhe Institute of Technology, Karlsruhe, Germany

Ultra high energy cosmic rays (UHECRs) are charged particles which origins is still an open question in modern astrophysics. For the identification of valid sources, a key role is played by the Galactic magnetic field (GMF) which influences the arrival direction of charged particles.

Recent studies, by the Pierre Auger Collaboration, on the arrival direction of UHECRs showed the presence of anistropies above 40 EeV which indicates the contribution from nearby sources such as starburst galaxied (SBG) and active galactic nuclei (AGN). The likelihood analysis revealed a significance of 4.2σ for the starburst sample although the coherent deflections related to the GMF have not been considered.

In this work we focus our attention on the SBG catalog and we conduct the likelihood analysis on simulated datasets. The mock datasets are constructed by employing CRPropa3 for the extragalactic propagation and by adding an isotropic background. A lensing technique, considering the JF12 model for the GMF, is then applied to the simulated particles.

Our results show that the parameters as reported by the Pierre Auger Collaboration occur for 20% of all data sets. However, due to the neglected coherent deflections, the inferred anisotropy fraction is a biased estimator and the true anisotropic fraction is always larger than the one derived from the likelihood fit.

T 144.2 Thu 17:45 POT/0013

An all-sky search method for coherent magnetic field deflections of ultra-high-energy cosmic rays — •Josina Schulte[1], Teresa Bister[2], and Martin Erdmann[1] — [1]III. Physikalisches Institut A, RWTH Aachen University — [2]Institute for Mathematics, Astrophysics and Particle Physics, Radboud Universiteit Nijmegen

We present a method of searching for coherent deflection patterns in ultra-high-energy cosmic ray arrival directions induced by the Galactic magnetic field. These patterns are described by a variable magnetic field strength in combination with adaptable coefficients of a spherical harmonics expansion in our approach. The reconstruction of the free model parameters from the arrival directions is performed with a likelihood-free method in a Bayesian approach based on normalizing flows. This allows for a straightforward assessment of the uncertainty on the model prediction. We evaluate the sensitivity of the method to identify the presence of coherent magnetic field deflections on a realistic simulated astrophysical scenario.

T 144.3 Thu 18:00 POT/0013

The effects of a ΛCDM extension on the propagation of UHECRs — •Janning Meinert — Bergische Universität Wuppertal, Gaußstraße 20, 42119 Wuppertal, Germany

Current tensions in the cosmological parameters of ΛCDM (such as H_0, Ω_m, σ_8) motivate a possible extension. Treating the photon propagation in thermal equilibrium with an SU(2) gauge group instead of a U(1) gauge group gives the photon more degrees of freedom and thus changes the temperature redshift relation. This pushes the emergence of the CMB, recombination, to higher redshifts and dilutes the photon density. Since CMB photons interact with ultra-high energy cosmic rays (UHECRs), I will examine the effects of this particular ΛCDM extension on the interaction with UHECRs. In particular, the spectral shape of the cosmogenic neutrino flux is distorted and the GZK cutoff might be shifted to slightly higher energies.

*Supported by DFG (SFB 1491) and the Vector Foundation under grant number P2021-0102

T 144.4 Thu 18:15 POT/0013

Cosmic-ray signatures in dwarf galaxies: astrophysical foreground and dark-matter background* — •Athithya Aravinthan[1,2], Lukas Merten[1,2], Julia Becker Tjus[1,2], and Jurek Völp[1,2] — [1]Theoretische Physik IV, Ruhr-Universität Bochum, Bochum, Germany — [2]RAPP-Center, Ruhr-Universität Bochum, Bochum, Germany

Dwarf galaxies are a convenient testing ground in the search for Dark Matter (DM), owing to their low, astrophysical background in the radio and gamma-ray energies. Studying the multimessenger signatures of dwarf galaxies can lead to a more precise astrophysical background for DM searches, thereby improving the current limits on indirect DM detection. This motivates the study of nearby starburst galaxies like IC10, which produces non-thermal radio emission coupled to complex Cosmic Ray (CR) propagation.

The goal of this work is to understand the role of CRs in low-mass dwarf galaxies by modelling their propagation using the open-source

tool CRPropa 3.2. First test results, starting with a general propagation environment in CRPropa, are pursued in a generic starforming-type magnetic field for IC10, and will later be modified for other low-mass galaxies. For the first time, the modelling is done in combination with astrophysical data on magnetic field structure and gas densities with the goal of pursuing a coherent understanding of the outflow produced in dwarf galaxies. *Supported by DFG (SFB 1491).

T 144.5 Thu 18:30 POT/0013

Stochastic modelling of cosmic ray sources for diffuse high-energy neutrinos — •Anton Stall and Philipp Mertsch — Institute for Theoretical Particle Physics and Cosmology (TTK), RWTH Aachen University, Aachen, Germany

Cosmic rays of energies up to a few PeV are believed to be of Galactic origin, yet individual sources have still not been firmly identified. Due to inelastic collisions with the interstellar gas, cosmic-ray nuclei produce a diffuse flux of high-energy gamma-rays and neutrinos. Fermi-LAT has provided maps of galactic gamma-rays at GeV energies which can be produced by both hadronic and leptonic processes. Neutrinos, on the other hand, are exclusively produced by the sought-after hadronic processes, yet they can be detected above backgrounds only at hundreds of TeV. To predict diffuse emission at these high energies, one can extrapolate from the GeV maps, but it is an open question to what extend this is justified. It can be expected that the consideration of individual cosmic-ray sources instead of a smooth density limits the correlation of the maps at TeV energies compared to the ones at GeV energies. Such a modelling of sources should be done stochastically. In a first step, we investigate the modelling of multiple point sources and the extension to a stochastic model.

T 144.6 Thu 18:45 POT/0013

Diffuse Emission of Galactic High-Energy Neutrinos from a Global Fit of Cosmic Rays — •Georg Schwefer[1,2,3], Philipp Mertsch[2], and Christopher Wiebusch[3] — [1]Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Deutschland — [2]Institute for Theoretical Particle Physics and Cosmology (TTK), RWTH Aachen University, 52056 Aachen, Deutschland — [3]III. Physikalisches Institut B, RWTH Aachen University, 52056 Aachen, Deutschland

In the standard picture of galactic cosmic rays, a diffuse flux of high-energy gamma-rays and neutrinos is produced from inelastic collisions of cosmic ray nuclei with the interstellar gas. The neutrino flux is a guaranteed signal for high-energy neutrino observatories such as IceCube, but has not been found yet. Experimental searches for this flux constitute an important test of the standard picture of galactic cosmic rays. Both the observation and non-observation would allow important implications for the physics of cosmic ray acceleration and transport. In this talk, we present `CRINGE`, a new model of galactic diffuse high-energy gamma-rays and neutrinos, fitted to recent cosmic ray data from AMS-02, DAMPE, IceTop as well as KASCADE. We also discuss the uncertainties for the predicted emission from the cosmic ray model as well as from the choice of source distribution, gas maps and cross-sections and consider the possibility of a contribution from unresolved sources.

T 145: Cosmic Ray VIII

Time: Thursday 17:30–19:00 Location: POT/0351

T 145.1 Thu 17:30 POT/0351

Status of the production and calibration of the scintillation detectors for the IceCube Surface Array Enhancement — •Shefali Shefali for the IceCube-Collaboration — Institut für Astroteilchenphysik, Karlsruher Institut für Technologie (KIT), Karlsruhe, Germany

The surface array of IceCube, IceTop, operates as a veto for the astrophysical neutrino searches, as a calibration detector for the IceCube in-ice instrumentation, as well as a cosmic ray detector. However, the snow accumulation on top of these detectors results in an increased uncertainty in the number of detected particles and consequently, the air shower reconstruction. Enhancing IceTop with a hybrid array of scintillation detectors and radio antennas will lower the energy threshold for air-shower measurements, provide more efficient veto capabilities, enable the separation of the electromagnetic and muonic shower components and improve the detector calibration by compensating for snow accumulation. After the initial commissioning period, a prototype station at the South Pole has been recording air shower data and has successfully observed coincident events with the IceTop array. The production and calibration of the scintillation detectors for the full array has been ongoing. Additionally, one station each at Pierre Auger Observatory and Telescope Array have been installed for R&D of these detectors in different environmental conditions. This contribution will present the status of the scintillation detectors for the IceCube Surface Array Enhancement.

T 145.2 Thu 17:45 POT/0351

A new approach for the reconstruction of low-energy air showers at the IceCube Neutrino Observatory — •Federico Bontempo for the IceCube-Collaboration — Karlsruhe Institute of Technology, Institute for Astroparticle Physics, 76021 Karlsruhe, Germany

The IceCube Neutrino Observatory is an experiment located at the geographic South Pole. It is composed of two detectors: an array of ice-Cherenkov tanks at the surface called IceTop and an optical array deep in the ice. The combination of the two detectors can be exploited for the study of cosmic rays. This work will primarily focus on the IceTop response, mainly dominated by the electromagnetic component of cosmic-ray air showers, with the goal of developing a new reconstruction technique for low energy air-showers. Some preliminary plots of the reconstructed quantities will be shown, like the energy proxy, zenith and azimuth angle or core position.

T 145.3 Thu 18:00 POT/0351

A Two Component Lateral Distribution Function for the Reconstruction of Air-Shower Events with IceCube — •Mark Weyrauch for the IceCube-Collaboration — Karlsruhe Institute of Technology

The IceCube Neutrino Observatory, located at the geographic South Pole, consists of a surface detector comprised of ice-Cherenkov tanks, IceTop, and an optical in-ice array. With this combination, IceCube provides the unique possibility to perform coincident measurements of the low-energy ($\sim$ GeV) and high-energy ($\gtrsim 400\,\mathrm{GeV}$) muon component in cosmic-ray air shower events. Since IceTop does not feature dedicated muon detectors, an estimation of the GeV muon component on basis of individual air showers is challenging. However, an event-by-event GeV muon estimator can constitute a useful tool for, amongst others, cosmic ray composition analyses and, in combination with the TeV muon component, strongly constrain hadronic interaction models. One possibility for an event-by-event estimation of low-energy muons is given by the Two Component Lateral Distribution Function (Two Component LDF), combining an analytical description for the electromagnetic and muon lateral distribution of the full detector signal. In this talk, I will discuss the main principle of the Two Component LDF and present first results of the reconstruction of simulated air-shower events.

T 145.4 Thu 18:15 POT/0351

Measurement and reconstruction of laser shots of the Aeolus satellite in the Pierre Auger Observatory — •Felix Knapp for the Pierre Auger-Collaboration — Karlsruher Institut für Technologie

The Pierre Auger Observatory is a large-scale experiment for the detection of ultra-high-energy cosmic rays. To this end, a combination of surface detectors as well as fluorescence telescopes is used to measure extensive air showers initiated by cosmic-ray particles in the atmosphere. Aeolus is a satellite, operated by the ESA, with the purpose of measuring global wind profiles. To achieve this, it uses a UV-lidar which emits laser beams towards the surface of the Earth. When the satellite passes over the Pierre Auger Observatory, light scatters off the laser beam in the atmosphere which can be detected by the Fluorescence Detector. The laser data taken by the Observatory allowed for a reconstruction of the laser tracks for several overpasses each year since its first appearance in 2019. The reconstructed laser tracks provide an interesting approach to study the aerosol content of the atmosphere above the Observatory, as well as a novel way to perform ground-

truthing for space-based lidards.

In this presentation, we will explain the methods used to reconstruct laser tracks from the Fluorescence Detector data, show some results of this reconstruction and introduce a possible application of the data for the measurement of aerosols.

T 145.5 Thu 18:30 POT/0351

Radio Interferometry for extensive air showers using Information Field Theory — •Matthias Boddenberg, Martin Erdmann, Maximilian Straub, and Alex Reuzki for the Pierre Auger-Collaboration — III. Physikalisches Institut A, RWTH Aachen University

Ultra-high-energy cosmic rays induce extensive air showers (EAS) in the Earth's atmosphere. During its propagation through the atmosphere, radio waves are emitted by to the geomagnetic effect and the Askaryan effect, which can be observed by the ground based antenna array at the Pierre Auger Observatory.

In this contribution we apply an interferometry method for extensive air showers and and show its potential use in deriving the depth of shower maximum and the arrival direction of the cosmic ray. We will present a method to reconstruct the location of a point source in the atmosphere. Furthermore we discuss the impact of antenna positions and noise on the radio traces on the location reconstruction.

Finally, we will show an alternative interferometry method for the reconstruction using information field theory (IFT) and discuss its potential uses.

T 145.6 Thu 18:45 POT/0351

Nanosecond time synchronisation with GNNS antennas for application in autonomous astroparticle physics detectors. — •Qader Dorosti[1], Markus Cristinziani[1], Stefan Heidbrink[2], Noah Siegemund[1], Jens Winter[2], and Michael Ziolkowski[2] — [1]Center for Particle Physics Siegen, Experimentelle Astroteilchenphysik, Universität Siegen — [2]Elektronikentwicklungslabor des Departments Physik, Universität Siegen

The new generation of commercially available navigation satellite receivers, known as highly accurate multi-band GNSS timing modules, are designed to meet the requirements of the 5G mobile standard. They can achieve local time synchronisation with an accuracy of 5 ns (1 sigma) with respect to the Universal Time Clock. This accuracy is obtained by exploiting a dual-frequency technique that effectively compensates for the dominant source of error in signal propagation through the ionosphere without the need for additional correction data. The stricter requirements for the future mobile radio standard 6G will lead to a further significant improvement in time synchronisation with an expected accuracy of less than 1 ns. This is relevant for the instrumentation of future astrophysical experiments and is being pursued by our group through the testing and evaluation of novel GNSS products in the field. Here we present our investigations on the latest multi-band GNSS receivers, where we achieved time synchronisation of clock signals of 3.5 ns from two GNSS receivers operating 40 m apart for several hours. Strategies for improving performance will be discussed.

T 146: DAQ Systems, Exp. Methods

Time: Thursday 17:30–19:00 Location: POT/0106

T 146.1 Thu 17:30 POT/0106

Real-time alignment and calibration for Run 3 at the LHCb experiment — •Biljana Mitreska and Johannes Albrecht — TU Dortmund University, Dortmund, Germany

The real-time alignment and calibration procedure is a fully automatic procedure at LHCb that is executed at the beginning of each fill of the LHC. The alignment estimates the position of detector elements and the correct alignment contributes to improving the data for offline analysis. Its importance in Run 3 is even more enhanced due to having a fully software trigger at LHCb. The procedure is implemented for the full tracking system at LHCb with the event reconstruction run as a multithreaded process. The operational and technical point of view of this procedure during the Run 3 data-taking is discussed with the focus on performance and optimisations done regarding the new computing framework and the new detectors.

T 146.2 Thu 17:45 POT/0106

Online data reduction with the FPGA-based DATCON track reconstruction system at the Belle II Detector — Florian Bernlochner, Bruno Deschamps, Jochen Dingfelder, •Ralf Farkas, and Botho Paschen for the Belle II-Collaboration — Physikalisches Institut der Rheinischen Friedrich-Wilhelms-Universität Bonn

The DATCON system is a set of 15 FPGAs, deployed at the Belle II detector at the KEK facility in Tsukuba, Japan. Its purpose is the real-time reduction of the data stream of the two innermost PXD detector layers, by defining regions of interest (ROI) on them. Only the hit information of the pixels located inside these ROIs are to be further processed and saved. DATCON uses the information of the SVD layers of the detector, finds tracks using a Hough Transformation-based track reconstruction algorithm and extrapolates them towards the center of the detector, to the PXD layers. While the track reconstruction algorithm itself has already been validated both on Hardware and Software, further work is required to improve the stability and reliability of the system. This talk will highlight the recent changes and improvements of DATCON.

T 146.3 Thu 18:00 POT/0106

Techniques for the investigation of segmented sensors using the Two Photon Absorption – Transient Current Technique — •Sebastian Pape[1,2], Michael Moll[1], Esteban Curras[1], and Marcos Fernandez Garcia[1,3] — [1]CERN — [2]TU Dortmund University — [3]Instituto de Física de Cantabria

The Two Photon Absorption - Transient Current Technique (TPA-TCT) is a technique for the characterisation of radiation detectors with three dimensional resolution. The TPA-TCT setup at CERN is designed for the investigation of silicon based detectors and uses a 430 fs pulse fiber lasers, with a wavelength of 1550 nm, which is in the quadratic absorption regime of silicon. Highly focusing optics are used to only generate excess charge carriers in a small volume (approximately $1\mu m \times 1\mu m \times 20\mu m$) around the focal point of the laser beam, which enables a resolution in all three spatial directions. This three dimensional resolution is particular useful for the investigation and characterisation of segmented detectors. This talk introduces to the TPA-TCT and the setup at CERN. Further, the weighted prompt current method is presented, which allows to investigate the electric field of segmented sensors. The method is demonstrated on various segmented sensors: a HV-CMOS CCPDv3, a Micron strip detector, and a passive CMOS strip detector. Further, the mirror technique is presented, which exploits a reflection of the rear side, to probe below front surface metallisations.

T 146.4 Thu 18:15 POT/0106

Prototype studies of a liquid organic TPC for the detection of low energy antineutrinos — Malte Göttsche, •Niklas Herrmann, Thomas Radermacher, Stefan Roth, and Yan-Jie Schnellbach — RWTH Aachen University - Physics Institute III B, Aachen, Germany

Liquid organic time projection chambers, LOr-TPCs, can potentially be used to detect and measure low energy antineutrinos. One application would be monitoring antineutrinos from nuclear waste via inverse beta decay. Using an organic liquid as drift medium has the advantage of room temperature operation, but the measurement is very sensitive to impurities. Therefore, we set up a prototype including a purification system, which contains a turbomolecular pump, a boiler, a condenser and filters. The status of the prototype setup is presented.

T 146.5 Thu 18:30 POT/0106

Detection of Low-Energy Antineutrinos with Liquid-organic Time Projection Chambers — Marike Ellerbroek[1], Malte Göttsche[1,2], Niklas Herrmann[1], •Thomas Radermacher[1,2], Stefan Roth[1], and Yan-Jie Schnellbach[1,2] — [1]RWTH Aachen University - Physics Institute III B, Aachen, Germany — [2]RWTH Aachen University - Nuclear Verification and Disarmament, Aachen, Germany

The region of antineutrino energy of a few MeV is of special interest for physics research and for the application of antineutrino-monitoring

in the nuclear safeguards regime. Typically, scintillation detectors are used to detect these low-energy antineutrinos via the inverse beta decay (IBD) by reconstructing the time-correlated light signals of the positron annihilation and the neutron capture. A novel detection concept utilizing a time projection chamber (TPC) filled with an organic liquid (LOr) could enable a background-minimized detection of the antineutrino since it allows the reconstruction of all final state particles in the IBD event. From the positron track the antineutrino's initial energy and its vertex can be determined. If the energy deposition of the neutron-induced proton recoils can be detected it offers the possibility to reconstruct the antineutrino direction on an event-by-event basis. We are investigating the IBD signature with a Geant4-based simulation together with a subsequent modelling of the electron drift. Additionally, we are working on prototype measurements and simulations to study the feasibility of such a LOr-TPC. This talk presents the status of our studies.

T 146.6 Thu 18:45 POT/0106

Stimulated de-excitation of Rydberg atoms in KATRIN using THz radiation* — •Shivani Ramachandran, Enrico Ellinger, and Klaus Helbing for the KATRIN-Collaboration — Bergische Universität Wuppertal (BUW)

The key requirement for the KArlsruhe TRItium Neutrino experiment (KATRIN) to reach its goal sensitivity of 200 meV at 90 % (C.L.) in measuring the effective electron anti-neutrino mass is minimal background. Several background suppression methods have already been implemented to achieve that and eliminate some known contributors. The most dominant contribution to the background in the measured signal is electrons produced by the thermal ionization of Rydberg atoms. They originate due to the sputtering of ^{210}Pb from inherent radioactivity from the walls of the KATRIN main spectrometer. A plausible method is using THz and microwave radiation (method developed by ASACUSA CERN) for dedicated stimulated de-excitation which can lead to a shorter lifetime of Rydberg atoms. The influence of THz light source in the main spectrometer along with the state and spatial evolution of the Rydberg atoms is presented via simulations. The effect of the properties of the ionization electrons on the de-excitation method is discussed.

*Gefördert durch die BMBF-Verbundforschung Astroteilchenphysik

T 147: Pixel/HV-Maps, Si/Diamond

Time: Thursday 17:30–19:00 Location: WIL/A317

T 147.1 Thu 17:30 WIL/A317

Measuring Large Energy deposition with HV-MAPS — •Danish Alam for the HD-HVMAPS-Collaboration — Physikalisches Institut, Heidelberg University

In high-energy physics experiments, the increasingly challenging physics demands high-rate detectors with excellent spatial and time resolution. High Voltage - Monolithic Active Pixel Sensor (HV-MAPS) fabricated in HV-CMOS processes provides fast charge collection via drift and enables the implementation of readout and the sensitive volume on the same die. Currently, the first tracking detector utilizing ultra-thin HV-MAPS chips is under construction for the Mu3e experiment.

At present, typical HV-MAPS detectors can measure energy depositions of the order of several 10 keV before the in-pixel charge-sensitive amplifier suffers saturation effects. The primary goal of the test chip Run2021V3 is to extend the measurable range and improve the precision of the measurements, which will allow detailed studies of the energy deposition of traversing particles, e.g., for particle identification. In the scope of this talk, the first characterization results of the Run2021V3 prototype will be presented.

T 147.2 Thu 17:45 WIL/A317

Charge Deposition and Charge Collection in HV-MAPS — •Ruben Kolb for the HD-HVMAPS-Collaboration — Physikalisches Institut Universität Heidelberg

Modern particle physics experiments have an ever growing demand on high rate detectors which combine precise spatial and time resolution. These requirements are met by the High Voltage - Monolithic Active Pixel Sensor (HV-MAPS). It combines active detector volume and readout on one chip. Currently, the first tracking detector using ultra thin HV-MAPS is under construction for the Mu3e experiment. The Run2021V2 chip is an HV-MAPS test chip which includes in-pixel electronics such as an amplifier and comparator. It is the most advanced HV-MAPS chip presently available.

The charge deposition and charge collection process in this sensor is investigated to improve the further design of HV-MAPS. The signal was studied in dependency of high voltage for a 4 GeV electron beam, 5.9 keV photons from a ^{55}Fe and electrons from a ^{90}Sr source. A complementary study using a test circuit to inject charge directly into the amplifier was performed.

T 147.3 Thu 18:00 WIL/A317

Charge collection study of thin HV-MAPS — •David Maximilian Immig for the HD-HVMAPS-Collaboration — Physikalisches Institut Universität Heidelberg

High-voltage monolithic active pixel sensors (HV-MAPS) combine the advantages of MAPS with fast charge collection via drift in a reversely biased diode. The amount of collected signal charge is influenced by two factors, the applied bias voltage and a dependent unknown fraction due to diffusion from the undepleted region. The former, determines the depleted volume intended for charge collection, as well as the detector capacitance. In the case of ultra thin sensors (e.g. 50 um), the depletion depth is limited by the sensor thickness and a contribution by diffusion is no longer applicable at full depletion.
An measurement campaign with sensors of various thickness was performed to investigate and determine the size of these contributions. In this talk, first results extracted from this extensive data set are presented.

T 147.4 Thu 18:15 WIL/A317

Radiation damage studies of a HV-MAPS detector — •Maja Lecher, Lucas Dittmann, Sebastian Bachmann, and Ulrich Uwer — Physikalisches Institut, Heidelberg, Germany

As one cornerstone of the prospective LHCb upgrade during Long Shutdown 4 in 2033, the current Scintillating Fibre tracker is set to be replaced by the MightyTracker, which combines scintillating fibres with radiation-hard silicon pixel detectors. The MightyPix sensor proposed as pixel detector employs the relatively new HV-MAPS technology. In preparation for the LHCb upgrade, the AtlasPix 3.1, a detector of similar build as the MightyPix, was studied with an emphasis on radiation damage.

While a number of studies investigating the damage sustained by HV-MAPS from radiation exist, irradiation campaigns to date were carried out using unpowered sensors. In a first proof-of-principle measurement, we irradiated a powered AtlasPix 3.1 with 14 MeV protons at the Bonn Isochronous Cyclotron. Specific sensor characteristics, most notably the leakage current, power consumption, and signal response, were tested before, during, and after the irradiation in an effort to evaluate the performance and viability of HV-MAPS in the radiation environment expected for the MightyPix. Results from these studies are presented and discussed.

T 147.5 Thu 18:30 WIL/A317

Diamond detector research — •Holger Stevens, Patrick Hoelken, and Johannes Albrecht — TU Dortmund University, Dortmund, Germany

The need for radiation-hard detectors is growing steadily. Compared to other semiconductor materials, diamond has a low leakage current, due to it's large bandgap and is very radiation-hard. This talk will present the experimental setups, which are developed for characterisation of diamond sensors. The radiation source used in these setups is Strontium (Sr90). In addition, the process to create gold contact surfaces in variable dimensions is described. The possible usage of diamond sensors for the precise dose profile measurement of large radiation fields is discussed and the option for spectrometric energy measurements is presented.

T 147.6 Thu 18:45 WIL/A317

implementation of diamond as detector material in AllPix

Squared — •Faiz Ur Rahman Is-haqzai — TU Dortmund, Germany. Kabul University, Afghanistan

Monte-Carlo-based simulation of particle interactions with matter is a very important tool for detector development in high-energy physics and related fields since it allows testing of detector concepts in-silico before investing money and time in building the detectors. A widely used software framework in the high-energy physics community is Allpix Squared, based on GEANT4. It was started to simulate testbeam setups with silicon detectors but has garnered interest from a wider community by now. To extend the Allpix Squared framework and make it useful for further detector development, different sensor materials need to be implemented. My work is intended to implement the Diamond material. Diamond sensors are considered superior to others because of their faster signal generation, better radiation hardness, thermal properties, and ability to operate in harsh conditions. To test the implementation, given sensors are used in real test beam measurements where hits on the device under test (DUT) are extrapolated against a row of well-known detectors, called Beam Telescope. Implementation of Diamond sensor material will significantly contribute to the task of R&D of Diamond sensors by making the simulated prototype simply possible. I will present the status of the implementation of the diamond as detector material in Allpix Squared.

T 148: Si/SiPM, Pixel/Other

Time: Thursday 17:30–19:00 Location: WIL/A124

T 148.1 Thu 17:30 WIL/A124

Study of the self-heating in SiPMs — •Carmen Victoria Villalba Petro, Erika Garutti, Robert Klanner, Stephan Martens, and Jörn Schwandt — Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg, Deutschland.

The main effect of radiation damage in a Silicon-Photomultiplier (SiPM) is a significant increase in the dark current. For SiPMs irradiated at $\Phi_{eq} = 10^{13}$ cm^{-2} and operated at 2 V above breakdown voltage, V_{bd}, the leakage current leads to a power of 50 mW. Such power produces an instantaneous increase in the SIPM temperature, which needs to be cooled down by proper thermal contact to a cooling system. The performance of the SiPM changes with temperature (T). The V_{bd} increases with T. For a fixed bias voltage, this leads to a decrease in gain and PDE. A method has been developed to determine the SiPM temperature increase induced by the power dissipated in the SiPM multiplication layer. Heating studies were performed with a KETEK SiPM, glued on an Al_2O_3 substrate, which is either directly connected to the T-controlled chuck of a probe station, or through layers of material with well-known thermal resistance. The SiPM is illuminated by a LED operated in DC-mode. The SiPM current is measured and used to determine the steady-state temperature as a function of power dissipated in its multiplication region and of the thermal resistance, as well as the time constants for heating and cooling. The method is applied to MPPC samples before and after irradiation. The knowledge of the multiplication region temperature can be used to properly determine the working parameters of irradiated SiPMs.

T 148.2 Thu 17:45 WIL/A124

Integration time dependence of sipm performance parameters — •Katjana Neumann, Erika Garutti, Jörn Schwandt, and Jack Rolph — Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg, Deutschland

The research on Silicon Photomultipliers (SiPMs) and their characteristic parameters has increased strongly due to their advantages as photon detectors. The standard way to obtain these parameters from the charge spectra of SiPMs is to fit a model based on (generalized) Poisson distributed Gaussian functions to the low light intensity response spectra. However, this method has the disadvantage that it only describes the photo-electron peaks but not the regions between them, which means that a large amount of information is lost, for example about the dark-count rate (DCR) or after-pulsing. Thus a description of the whole spectrum in a single model is practical. The Python program PeakOTron is based on a model, that describes the entire spectrum. This program has been tested on the low light intensity spectra obtained by integrating the charge at various gate lengths, for two SiPM types operated at various overvoltage. The parameters and fitted spectra determined with this method are discussed and compared to those obtained with standard methods.

T 148.3 Thu 18:00 WIL/A124

Design and Production of Pixel Strips for the P2 Tracking Detector Modules — •Lucas Sebastian Binn for the P2-Collaboration — Institute of Nuclear Physics, Johannes Gutenberg-University Mainz, Germany

The P2 Experiment will make use of the new Mainz Energy-Recovering Superconducting Accelerator (MESA), currently under construction in Mainz, to measure the weak mixing angle in electron-proton scattering at low momentum transfer with unprecedented precision.

A key parameter for the analysis, the momentum transfer Q^2, is measured by a tracking detector consisting of 8 identical modules. Each module consists of two sensor planes, with pixel sensors glued and wire-bonded on rigid-flex strips. Commercially available and custom solutions for the production of the strip module design are currently being evaluated. With a total production of 260 strips, processes are semi-automated, with dedicated glue and bonding machines.

An overview of the P2 experiment with focus on the tracking detector will be given in this talk, as well as the current state of the development of the strip modules.

T 148.4 Thu 18:15 WIL/A124

Characterization of a Digital Silicon Photomultiplier — •Gianpiero Vignola[1,2], Inge Diehl[1], Doris Eckstein[1], Finn Feindt[1], Ingrid-Maria Gregor[1,2], Karsten Hansen[1], Stephan Lachnit[1], Frauke Poblotzki[1], Simon Spannagel[1], and Tomas Vanat[1] — [1]DESY, Hamburg, Germany — [2]Universität Bonn, Bonn, Germany

Silicon photomultipliers (SiPM) are increasingly used in high-energy physics, medical and commercial applications. Until now, most SiPMs are implemented as large arrays of Single Photon Avalanche Diodes (SPAD) in a parallel circuit, serving as photon counters. Recently, the possibility of using SPADs produced in commercial Complementary Metal-Oxide Semiconductor (CMOS) processes has opened up the possibility of combining their excellent performance in single photon detection and timing, with the possibilities offered by monolithic circuitry at a relatively low cost. The digital SiPMs, thanks to the per-pixel CMOS circuitry, extend the properties of standard SiPMs with features such as detailed event hit map, masking of noisy SPADs and in-chip trigger logic and digitalisation.

A prototype of a SPAD array with per-pixel CMOS circuitry was fully developed at DESY in a 150 nm CMOS technology offered by LFoundry. This talk will report the results of characterisations performed on the prototype in the laboratory and in the DESY II Test Beam facility. Studies on Dark Count Rate, MIPs detection efficiency and time resolution will be presented; along with an overview of planned future studies with a laser setup and scintillator coupling.

T 148.5 Thu 18:30 WIL/A124

Simulation of laser-TCT experiments with Allpix^2 — •Daniil Rastorguev for the Tangerine-Collaboration — Deutsches Elektronen-Synchrotron, Hamburg, Germany — Bergische Universität Wuppertal, Wuppertal, Germany

The Transient Current Technique (TCT) is a powerful yet flexible laboratory characterization technique for silicon sensors. By precisely injecting charges with laser pulses and analyzing waveforms, produced as deposited charge drifts in the sensor bulk, one may experimentally study different charge collection features of the sensor under test.

With the development of novel types of silicon sensors with complex internal structures, experimental results can be challenging to interpret. To investigate possible outcomes of such experiments and understand these in detail, computer simulations are often used.

This work focuses on Monte-Carlo simulations of TCT experiments, performed with the Allpix^2 framework. A dedicated Allpix^2 module, modeling absorption of laser light in silicon sensors, was developed to build a full pipeline that simulates processes occurring in a real experiment. An overview of the simulation technique is presented, as well as first simulation results and its comparison to experimental data.

T 148.6 Thu 18:45 WIL/A124

Simulations for High-Granularity LGAD Sensors using Commercial CMOS Technologies — •Saqlain Khan[1], Sinuo Zhang[1], Tomasz Hemperek[2], and Jochen Dingfelder[1] — [1]Physikalisches Institut, Universität Bonn — [2]Dectris, Switzerland

Low-Gain Avalanche Diode (LGAD) detectors can provide a time resolution an order of magnitude better than traditional silicon detectors. This enhancement is enabled by the implementation of controlled low gain in the detector response. One of the challenges in LGAD design is to achieve a high granularity. The granularity is constrained due to the design of an inter-channel protection structure referred to as "Junction Termination Extension" (JTE). This structure avoids breakdown between channels but also creates regions where charge collection is severely limited. An approach in the direction of improving the granularity is to have the gain layer of LGAD buried deep inside and below the readout surface. In this way, inter-channel breakdown is avoided and a high granularity could be achieved.

CMOS pixel sensors utilizing commercial processes are promising methods to be used in high energy particle physics experiments for high-precision charged particle tracking. In this talk, TCAD simulations to investigate the feasibility of the aforementioned approach using a commercial CMOS process will be presented.

T 149: Detector Systems / Muon

Time: Thursday 17:30–19:00 Location: WIL/C133

T 149.1 Thu 17:30 WIL/C133

The commissioning of the new SciFi tracking detector for LHCb — Johannes Heuel and •Jan-Marc Basels — I. Physikalisches Institut B, RWTH Aachen University

The LHCb Upgrade I detector at the Large Hadron Collider (LHC) at CERN includes a new and unique scintillating fibre tracker (SciFi) with a silicon photo-multiplier (SiPM) readout system. The SciFi tracker is organised in 12 detector planes. Each, with an area of 30 m^2 and a radiation length of only 1 %, provides spatial measurements with a resolution of 0.07 mm and an efficiency of more than 98 %.

A real-time and offline monitoring system enables the optimisation of the detector performance and early detection of potential issues during operation. The signal detection efficiency is dominated by the time-alignments and the definition of the signal thresholds for the 4096 SiPM arrays, each with 128 channels. For long term operation, the expected degradation of the performance of the SiPMs due to radiation damages is of particular importance.

The detector assembly has been completed in 2022 and its commissioning is still ongoing. We present the status of the commissioning work.

T 149.2 Thu 17:45 WIL/C133

Understanding the alignment of LHCb's SciFi Tracker — •Nils Breer, Sophie Hollitt, and Johannes Albrecht — TU Dortmund, Germany

As part of the LHCb upgrade, the Scintillating Fibre Tracker (SciFi) replaces the previous Outer and Inner Tracker detectors. A well-aligned detector is crucial in order to measure the physics performance as precisely as possible. Understanding which constraints and which parts of the SciFi have the most impact on the overall alignment will be important for monitoring the reconstruction quality of each fill.

With the commissioning of the SciFi in 2022 we are able to perform misalignment tests on simulated samples and compare the results to the real misaligned detector. As part of the initial alignment of the SciFi, configuration tests on the best estimate for the detector position were performed. In particular, performance tests are used to compare alignments of the full length modules compared to half modules. An overview of the current preparation for further SciFi alignment commissioning in 2023 is presented in this talk.

T 149.3 Thu 18:00 WIL/C133

LHCb Upgrade II - Mighty Tracker Sci-Fi Readout — Thomas Kirn, Thomas Oeser, Stefan Schael, and •Sebastian Schmitt — I. Phys. Inst. B RWTH Aachen

The LHCb experiment at the Large Hadron Collider (LHC) at CERN is an experiment designed to perform precise measurements of CP-Violation and rare decays of b-hadrons. With its configuration during Run I and Run II of the LHC, many measurements are statistically limited, hence more data are required to improve their sensitivity.

The LHCb Upgrade II detector will operate with increased instantaneous luminosity, $\mathcal{L}_{\text{int}}$, in order to collect more data in a shorter time interval. This increases pile-up and the occupancy of the detector subsystems with respect to the current setup. As a result, the current detector needs to be upgraded in order to withstand the higher radiation damage and track multiplicity.

The downstream tracking stations will therefore be replaced by the Mighty Tracker, a tracker that comprises an inner silicon tracker and an outer Scintillating-Fibre (Sci-Fi) tracker. A design for the readout system of the Sci-Fi tracker is proposed that relies on coupling the Sci-Fi mats to a cryogenous chamber that houses Silicon Photomultipliers (SiPMs). This talk focuses on how to perform the coupling of the Sci-Fi mats to the cryogenous cooling chamber readout system.

T 149.4 Thu 18:15 WIL/C133

Impact of residual misalignment of the ATLAS' New Small Wheel on muon reconstruction performance — •Stefanie Götz[1], Otmar Biebel[1], Valerio D'Amico[1], Florian Egli[1], Ralf Hertenberger[1], Christoph Jagfeld[1], Eshita Kumar[1], Katrin Penski[1], Maximilian Rinnagel[1], Nick Schneider[1], Patrick Scholer[2], Chrysostomos Valderanis[1], and Fabian Vogel[1] — [1]LMU München — [2]Uni Freiburg

Highly accurate alignment of the ATLAS detector's New Small Wheel (NSW) is crucial to fully exploit the wheels precision tracking capability as required for the high luminosity upgrade of the Large Hadron Collider (LHC) at CERN. Therefore, precise information on the true NSW chamber positionings and shapes is included in the muon reconstruction software, but only with a certain degree of accuracy as caused by measurement uncertainties of the optical alignment sensors. This study investigates the impact of the NSW residual misalignment on the muon reconstruction performance in comparison to the ideal detector geometry. Translations, rotations and deformations described by specific alignment parameters are studied on Monte Carlo samples generated by the simulation software of the ATLAS experiment both at native detector geometry and with misaligned NSW detector components. Their effect is evaluated isolated for each alignment parameter and in a realistic scenario for which the residual chamber misalignment is determined using specific information on the alignment uncertainties. The final goal is to estimate the order of magnitude of the residual misalignment and its impact on the muon reconstruction performance.

T 149.5 Thu 18:30 WIL/C133

Reconstruction Performance of the ATLAS New Small Wheel — •Patrick Scholer — University of Freiburg

Before the start of the 2022 data-taking period, the innermost end cap of the ATLAS muon spectrometer was replaced by the so-called New Small Wheel (NSW). Micromegas and small-strip Thin Gap Chambers (sTGCs) detectors are used to maintain the precise particle tracking capabilities of the ATLAS muon spectrometer and to improve the rejection of false trigger signals at the rates expected after the high luminosity LHC upgrade.

This talk will discuss the tracking performance of the NSW for its first year of data-taking in ATLAS. First studies on the reconstruction of clusters and their properties on the individual detector layers will be presented for different settings of the detector working point and the readout system. This will be followed by a discussion of the track reconstruction performance using the 16 NSW detector layers and the combination of those tracks with the rest of ATLAS.

T 149.6 Thu 18:45 WIL/C133

Certification of sMDT chambers for the phase II upgrade of the ATLAS muon spectrometer — Oliver Kortner, Hubert Kroha, and •Nick Meier — MPI für Physik, München, Deutschland

For operation at the HL-LHC, the ATLAS experiments will upgrade the inner muon spectromater barrel layer with stations of thin-gap resistive plate chambers (RPCs) and small diameter muon drift-tube

(sMDT) chambers in order to increase the acceptance of the first level muon trigger from current 80% to 95%. The MPI for Physics in Munich produced 49 sMDT chambers for this upgrade. The performance of all 49 chambers was measured with cosmic-ray muons: dark currents, electronics noise, muon detection efficiency, and the spatial resolution of all chambers were determined. The methods used for this certification and the results of the tests will be explained and shown in this presentation.

T 150: Gas-Detecors, Pixel/TANGERINE

Time: Thursday 17:30–19:00 Location: WIL/A120

T 150.1 Thu 17:30 WIL/A120

Cosmic test stand gas studies with a small-strip Thin Gap Chamber quadruplet — •Ksenia Solovieva, Jose Antonio Fernandez Pretel, Patrick Scholer, Vladislavs Plesanovs, and Ulrich Landgraf — Albert-Ludwigs University, Freiburg

The small-strip Thin Gap Chamber (sTGC) technology has been implemented in the New Small Wheel upgrade of ATLAS for improved triggering and tracking in a higher particle rate environment. For the purpose of investigating readout, trigger and gas parameters, a quadruplet was set up in a cosmic muon test stand in Freiburg and read out with the final ATLAS NSW readout system and the final gas mixture. With the unique opportunity of this setup to study analog signals before digitisation and to closely monitor various properties of the gas and HV, it lends itself to studies of the properties of the sTGC gas mixture. This presentation discusses the goals and challenges of the dedicated setup, as well as presenting the results of investigations into the behaviour of signals with varying gas mixtures. Some technical details of the mixing procedure to obtain the gas mixture (45:55 n-pentane: CO2) will be included as part of the results.

T 150.2 Thu 17:45 WIL/A120

Test of ATLAS Micromegas detectors with a ternary gas mixture at the CERN GIF++ facility — •Fabian Vogel, Otmar Biebel, Valerio D'Amico, Florian Egli, Stefanie Götz, Ralf Hertenberger, Christoph Jagfeld, Eshita Kumar, Katrin Penski, Maximilian Rinnagel, Nick Schneider, and Chrysostomos Valderanis — LMU München

The ATLAS collaboration at LHC has chosen the resistive Micromegas technology, along with the small-strip Thin Gap Chambers (sTGC), for the high luminosity upgrade of the first muon station in the high-rapidity region, the New Small Wheel (NSW) project. Achieving the requirements for these Micromegas detectors revealed to be even more challenging than expected. One of the main features being studied is the HV stability of the detectors. Several approaches have been tested in order to enhance the stability, among them the use of different gas mixtures. A ternary Argon-CO_2-iC_4H_{10} mixture has shown to be effective in dumping discharges and dark currents. It allows the operation of the Micromegas detectors at safe working points with high cosmic muon detection efficiency. The presence of Isobutane in the mixture required a set of aging studies, ongoing at the GIF++ radiation facility at CERN, where the expected HL-LHC background rate is created by a ^{137}Cs 14 TBq source of 662 keV photons. Preliminary aging results and muon reconstruction efficiencies under photon background of the ternary mixture will be shown.

T 150.3 Thu 18:00 WIL/A120

Measurement of the first Townsend coefficient using UV light — •Paolina Noll, Thomas Radermacher, Stefan Roth, David Smyczek, and Nick Thamm — RWTH Aachen University - Physics Institute III B, Aachen, Germany

In gaseous ionization detectors primary electrons are accelerated in high electric fields and hence generate secondary ion pairs. These electron avalanches are described by the first Townsend coefficient which is the number of electrons produced per unit path length per primary electron. In a test setup a UV LED produces primary electrons via the photoelectric effect. The Townsend coefficient is extracted from the anode current measured in relation to the voltage applied. The experimental setup and first results are presented.

T 150.4 Thu 18:15 WIL/A120

TANGERINE Project: Transient Simulation Studies — •Manuel Alejandro Del Rio Viera for the Tangerine-Collaboration — Deutsches Elektronen-Synchrotron (DESY)

The goal of the TANGERINE project is to develop the next generation of monolithic silicon pixel detectors using a 65 nm CMOS imaging process, which offers a higher logic density and overall lower power consumption compared to previously used processes. In order to understand the processes and parameters that are involved in the development in the new 65 nm technology, a combination of Technology Computer-Aided Design (TCAD) and Monte Carlo (MC) simulations are used. Transient simulations allow to study the response of the sensor over time, such as the signal produced after a charged particle passes through the sensor. The study of these signals is important to understand the magnitude and timing of the response from the sensors and improve upon them.

While TCAD simulations are accurate, the time required to produce a single pulse is large compared to a MC and TCAD combination approach, which reduces the simulation time and allows for high statistics studies. Electrostatic fields from TCAD are imported into the Allpix Squared framework, a simulation framework for semiconductor radiation detectors, and through the use of the Shockley-Ramo Theorem, the pulses induced from charges moving in the sensor are calculated.

In this talk, the advantages of this approach, the resulting pulses and the integrated charge obtained from the MC and TCAD simulations used as validation between the two methods will be presented.

T 150.5 Thu 18:30 WIL/A120

Monte Carlo Simulations of Detector Prototypes Designed in a 65 nm CMOS Imaging Process — •Sara Ruiz Daza for the Tangerine-Collaboration — DESY, Hamburg, Germany

Monolithic CMOS sensors enable the development of detectors with a low material budget and a low fabrication cost. Moreover, using a small collection electrode results in a small sensor capacitance, a low analogue power consumption, and a large signal-to-noise ratio. These characteristics have become very attractive in the development of new silicon sensors for charged particle tracking at future experiments. One of the goals of the Tangerine Project (Towards Next Generation Silicon Detectors) is to develop a telescope setup consisting of detector prototypes designed in a 65 nm CMOS imaging process. This contribution presents the Monte Carlo simulations of such detector prototypes using the Allpix Squared framework.

T 150.6 Thu 18:45 WIL/A120

Simulations and Test Beam Results of a MAPS in a 65 nm CMOS Imaging Technology — •Adriana Simancas for the Tangerine-Collaboration — Deutsches Elektronen-Synchrotron, Hamburg, Deutschland — Universität Bonn, Bonn, Deutschland

Monolithic CMOS sensors produced in a 65 nm imaging technology are being investigated for an application in particle physics for the first time. Their main characteristic is the integration of an active sensor and readout circuit in the same silicon wafer, which provides a reduction in material budget. Compared to the previously investigated 180 nm process, the 65 nm technology offers a significant improvement in the logic density of the pixels. The small collection electrode sensor is characterized by a low input capacitance, granting a high signal to noise ratio and a low power consumption. The Tangerine Project aims to use this technology for vertex detectors at future lepton colliders. TCAD Device and Monte Carlo simulations are used to develop an understanding of the sensor technology and provide important insight into performance parameters of the sensor. Testing prototypes in laboratory and test beam facilities allows to study their charge collection, spatial resolution and efficiency. Combining results from all these studies it is possible to optimize the sensor layout. This contribution will present the first comparison of simulation results to test beam data of a 65 nm CMOS sensor with a small collection electrode.

T 151: Exp. Methods IV

Time: Thursday 17:30–19:00 Location: WIL/C129

T 151.1 Thu 17:30 WIL/C129

Evaluating new triggers for ATLAS HH(4b) analysis in LHC Run 3 data — •Abdullah Nayaz[1], Teng Jian Khoo[2], and Cigdem Issever[3] — [1]Humboldt University, Berlin, Germany — [2]Humboldt University, Berlin, Germany — [3]Humboldt University, Berlin, Germany

The diHiggs (HH) study plays a central role in probing both the Standard Model and new Physics. The dominant higgs decay to a pair of b quarks (h->bb) makes the 4b final state one of the most significant signatures to look for a di-Higgs system.The small cross section of the process plus the existence of a huge QCD background make the trigger (selecting signature-relevant events) extremely challenging.

For Run 3, ATLAS has designed new triggers that use better reconstruction and selection, in order to improve the efficiency at which we record HH4b events. In this study, the efficiency of these triggers as well as the existing run-2 triggers are studied and compared using the hh4b MC samples and LHC run-3 data. Several factors such as improvement in jet calibration, b-tagging and optimized selection for hardware and software triggers are expected to boost the efficiency of over all run-3 triggers. The study, in particular, quantifies these improvements which is crucial for understanding the effectiveness of each trigger. In addition, since simulation is not a perfect reflection of real data, the measured detailed trigger performance in data and simulation will then help us to determine the parameterized correction factors needed to make simulation match the data.

T 151.2 Thu 17:45 WIL/C129

Prospects for machine-learning based unfolding techniques with a focus on the measurement of differential Higgs boson production cross sections — Johannes Erdmann, •David Kavtaradze, and Jan Lukas Späh — III. Physikalisches Institut A, RWTH Aachen University

In high-energy physics experiments, measured distributions are the result of Poissonian fluctuations around expectation values that are obtained from folding the underlying distribution with detector effects. The inference of the underlying distribution from the measurement in cases where no parametric form is available is known as "unfolding".

Traditional unfolding methods rely on a categorisation of events in a certain binning scheme. This limits the flexibility of the unfolding and does not allow for a simultaneous deconvolution of multiple observables.

An alternative approach, termed "Omnifold" in the literature, does not have these restrictions and benefits from machine-learning to take into account the whole information from each event. This approach is contrasted with the traditional approaches using a physically motivated example from a measurement of differential Higgs boson production cross sections in the diphoton decay channel.

T 151.3 Thu 18:00 WIL/C129

Studies on Monte Carlo tuning using Bayesian Analysis — •Salvatore La Cagnina[1], Andrii Verbytski[2], Kevin Kröninger[1], and Stefan Kluth[2] — [1]TU Dortmund, Fakultät Physik — [2]Max-Plank-Institut für Physik, München

Monte Carlo (MC) simulations are an essential aspect of data analysis at the LHC. One aspect of MC event generation involves hadronisation and parton shower models. Since these models are based on approximations, they introduce a number of parameters. These parameters cannot be inferred from first principles. Therefore, their values have to be optimized using numerical tools and experimental data (MC tuning). Generally, MC tuning is performed by choosing observables that are sensitive to the parameters. Afterwards, a fit of the parameters to data using a simplified MC response function derived from fits to MC events is performed. Though state-of-the-art methods for MC tuning exist, uncertainties are usually treated as uncorrelated. In this talk, MC tuning using a Bayesian approach will be discussed. The EFTfitter tool is used for fitting, which enables the implementation of correlations for different sources of uncertainties. In addition, the propagation of uncertainties with respect to the tune are discussed.

T 151.4 Thu 18:15 WIL/C129

Tuning Pythia8 for future e^+e^- colliders — •Zhijie Zhao[1,2], Mikael Berggren[1], and Jenny List[1] — [1]DESY, Hamburg, Germany — [2]Center for Future High Energy Physics, Institute of High Energy Physics, Chinese Academy of Sciences, Beijing, China

The majority of Monte-Carlo (MC) simulation campaigns for future e^+e^- colliders has so far been based on the leading-order (LO) matrix elements provided by Whizard 1.95, followed by parton shower and hadronization in Pythia6, using the tune of the OPAL experiment at LEP. In this contribution, we test and develop the interface between Whizard3 and Pythia8. As a first step, we simulate the $e^+e^- \to q\bar{q}$ process with LO matrix elements, and compare three tunes in Pythia8: the standard Pythia8 tune, the OPAL tune and the ALEPH tune. At stable-hadron level, predictions of charged and neutral hadron multiplicities of these tunes are compared to LEP data, since they are strongly relevant to the performance of ParticleFlow algorithms.

Then events are used to perform a full detector simulation and reconstruction of the International Large Detector concept (ILD), as an example for a ParticleFlow-optimised detector. At reconstruction level, a comparison of the jet energy resolution in these tunes is presented. We found good agreement with previous results that were simulated by Whizard1+Pythia6. This modern MC simulation chain, probably with matched NLO matrix elements in the future, should be introduced to ILC or other future e^+e^- colliders.

T 151.5 Thu 18:30 WIL/C129

Geant4 Optimizations in ATLAS — •Mustafa Schmidt for the ATLAS-Collaboration — Bergische Universität Wuppertal

Production of Monte-Carlo simulations for ATLAS usually require large amount of computation time and result in huge memory consumption. In order to minimize the required resources, a dedicated Geant4 optimization task force works on optimizing the performance of the integrated Geant4 version in the ATLAS offline software framework Athena. After being founded in 2020, many optimizations have been implemented, mainly related to improvements of various physics lists, stepping parameters, and detector descriptions.

Recent developments cover a Woodcock tracking algorithm for improving the CPU time for photons in the calorimeter, and a proposal for a particle killer that stops propagating unimportant secondary particles in ATLAS. In addition, a Geant4 toolkit called FullSimLight has been developed which can run with various geometries including the most recent ATLAS detector geometry description. It contains many useful tools, such as a clash detection or a generator for geantino maps of the imported geometry. This talk covers the current status of the ongoing projects as well as an overview of future work packages.

T 151.6 Thu 18:45 WIL/C129

Monte-Carlo Generator Validation in ATLAS with JEM/PAVER — Frank Ellinghaus, Dominic Hirschbühl, Johanna Kraus, Joshua Reidelstürz, Jens Roggel, and •Mustafa Schmidt for the ATLAS-Collaboration — Bergische Universität Wuppertal

Periodic validation of available Monte-Carlo (MC) generators is crucial for obtaining reliable physics simulations, especially for the ATLAS experiment. Its main idea is to spot the origin of possible problems and unwanted features in generated MC events by comparing the shapes of various observables between the generated samples and their references. For that purpose, the existing job execution monitor (JEM), originally designed for monitoring grid jobs, has initially been used. However, due to many missing features, a new validation system, PMG Architecture for Validating Evgen with Rivet (PAVER), was recently developed based on the JEM infrastructure. It uses the ATLAS official Rivet analysis routines for validating specific physics processes, providing an automated and central MC event generator validation procedure that allows a regular evaluation of new revisions and updates for commonly used MC generators in ATLAS. The result is a robust, flexible, and highly functional MC validation setup, that is constantly developed further, for efficiently detecting issues in generated samples within a restricted timescale. It turned out to be a very useful tool for determining several unexpected features related to MC generator behaviors that are regularly reported to the generator authors, which resulted in various bug-fix releases of external MC tools.

T 152: Members' Assembly

Time: Thursday 20:00–22:00 Location: HSZ/0003

All members of the Particle Physics Division are invited to participate.

T 153: Invited Overview Talks III

Time: Friday 11:00–12:30 Location: HSZ/AUDI

Invited Talk T 153.1 Fri 11:00 HSZ/AUDI

The Standard Model on the test bench: What bosons and the top quark (will) tell us — •Valerie Lang — Albert-Ludwigs-Universität Freiburg

The Standard Model of particle physics has been very successful at predicting the properties and interaction rates of particles since its formulation. The currently largest test bench for the Standard Model are the experiments at the Large Hadron Collider (LHC) at CERN. The supreme performance of both accelerator and detectors has allowed us to drive both, precision of measured properties and rarity of observed processes, into unprecendented areas. Particularly fascinating probes are the bosons of the Standard Model, which act as force carriers and can be produced directly at the LHC, as well as the top quark, the heaviest particle in the Standard Model and the only quark which we can observe as free particle. In this presentation, I will provide a glimpse at the insights we have gained so far, and at the possibilities that are still awaiting us with the current third running period of the LHC, and its upgrade - the high-luminosity LHC.

Invited Talk T 153.2 Fri 11:30 HSZ/AUDI

Gravitational wave observations: Current results & future expectations — •Harald Pfeiffer for the LIGO Scientific-Virgo-KAGRA-Collaboration — Max Planck Institute for Gravitational Physics, Am Mühlenberg 1, 14476 Potsdam

Gravitational Wave (GW) Astronomy has blossomed since the groundbreaking discovery in 2015 of a GW emitted by two merging black holes. The third observing run of the LIGO and Virgo observatories has increased the number of GW signals to nearly 100. Three types of compact object binaries have now been discovered: binary black holes, binary neutron stars and mixed systems with one neutron star and one black hole. This large set of GW signals enables ever more diverse conclusions about fundamental physics and astrophysics, with results including the equation of state at supernuclear densities, the mass-distribution of black holes, properties of gamma ray bursts, the nature of gravity and cosmology. This talk gives an overview of the observations and the wide variety of scientific results enabled by them. We close with an outlook to future observing runs and GW detectors.

Invited Talk T 153.3 Fri 12:00 HSZ/AUDI

Precise muon detection: novel technologies for the luminosity frontier — •Kerstin Hoepfner — RWTH Aachen, Phys. Inst. 3A, Aachen, Germany

Muons play an essential role in the discovery of new particles because of their potential to warrant a clean signature and low background. Outstanding examples from the past include the finding of the bottom quark as well as the tau lepton, and more recently the discovery of the Higgs boson. At present another type of signature is gaining importance: displaced muons as a probe for potential new BSM particles.

At the upcoming High-Luminosity LHC, muon detection as well as muon triggering face big challenges in terms of rate and precision. Consequently, modern muon systems evolve beyond being pure particle identification devices and rather turn into complex and high granularity trackers. High particle rates and densities also imply the requirement of increased radiation tolerance.

In anticipation of these challenges, new detection technologies were developed, largely based on micro-pattern gas detectors. These detectors provide a high spatial and time resolution. For the upcoming High-Luminosity LHC, the high-rate experiments ATLAS and CMS install large-scale systems of such detectors for muon detection. Their superior performance makes these detectors also good candidates for other applications in particle physics.

T 154: Invited Overview Talks IV

Time: Friday 13:30–14:00 Location: HSZ/AUDI

Invited Talk T 154.1 Fri 13:30 HSZ/AUDI

ECN3: Experimental Opportunities at a Future High-Intensity Proton Facility at the CERN SPS (BDF/SHiP and HIKE+SHADOWS) — •Annika Hollnagel — JGU Mainz

Within the framework of the CERN Physics Beyond Colliders (PBC) initiative and as an essential part of the European Strategy for Particle Physics, an upgrade of the existing ECN3 experimental hall will enable a diverse physics program at the CERN SPS and complement research at the energy frontier.

Competitive Letters of Intent have been submitted for experiments at the facility, focusing on either Kaon physics or the Hidden Sector:

BDF/SHiP aims to exploit the full potential of a dedicated Beam Dump Facility (BDF) in the Search for Hidden Particles (SHiP), covering a wide range of the Hidden Sector while also offering a rich neutrino physics program.

The combined approach of HIKE+SHADOWS - runnning part-time in beam dump or Kaon mode - on the other hand would allow to further pursue Kaon research by NA62-successor HIKE (High-Intensity Kaon Experiment), while also providing Hidden Sector sensitivity with off-axis experiment SHADOWS (Search for Hidden And Dark Objects With the SPS).

This talk will give an overview of the physics capabilities of the proposed experiments - all offering excellent options for research at a future high-intensity proton facility at ECN3. With significant German contribution and extensive efforts in R&D, further insight can be gained from the various talks at this conference.