T 17: Neutrino Physics II

Time: Monday 16:45–18:15 Location: VG 3.104

T 17.1 Mon 16:45 VG 3.104

Novel constraints on neutrino physics beyond the standard model of elementary particles from the CONUS and CONUS+ experiments — •Dario Piani, Nicola Ackermann, Hannes Bonet, Christian Buck, Janina Hakenmüller, Janine Hempfling, Gerd Heusser, Manfred Lindner, Werner Maneschg, Kaixiang Ni, Thomas Rink, Edgar Sánchez García, and Herbert Strecker — MPIK, Heidelberg, Germany

The detection of coherent elastic neutrino-nucleus scattering (CEνNS) opens up new opportunities for neutrino physics within and beyond the standard model of elementary particles. Constantly refining the setup, the experiments CONUS (until 2022) and CONUS+ (since 2023) provide valuable data towards the detection of such events from reactor (anti)neutrinos emitted by the powerful (3.9 GW and 3.6 GW) reactors of the nuclear power plants in Brokdorf (Germany) and Leibstadt (Switzerland). The acquired and future CONUS/CONUS+ data sets enable further investigations on neutrino physics beyond the standard model, such as yet undetected neutrino channels and electromagnetic properties. This talk will explore constraints on beyond the standard model neutrino phenomenology from not yet analyzed data. Bounds on non-standard neutrino-quark interactions of vector and tensor type from CEνNS are presented. Furthermore, the parameter space of simplified scalar and vector mediators probed by CEνNS and elastic neutrino-electron scattering is discussed. Finally, limits on an effective neutrino magnetic moment and effective neutrino millicharge are given.

T 17.2 Mon 17:00 VG 3.104

First result of the CONUS+ experiment — •Nicola Ackermann for the CONUS-Collaboration — Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg

With the CONUS+ reactor antineutrino experiment, the coherent elastic neutrino nucleus scattering (CEνNS) on germanium nuclei is currently studied at the nuclear power plant in Leibstadt, Switzerland. Very low energy thresholds down to 160 eV were achieved in four 1 kg point contact germanium detectors equipped with electric cryocooling. The setup is positioned at a distance of about 20 m from the center of the reactor core. The detector performances and first CONUS+ results after few months of data taking will be presented. In November 2024 three detectors were replaced by newer models with higher Ge crystal masses of 2.4 kg each to further improve the sensitivity of the experiment.

T 17.3 Mon 17:15 VG 3.104

Precise Determination of the Background in Electronic Recoil Channel from XENONnT — •Ying-Ting Lin for the XENON-Collaboration — Saupfercheckweg 1, 69117 Heidelberg, Germany

The XENONnT experiment, utilizing a 5.9-tonne liquid xenon dual-phase time projection chamber (TPC), is searching for dark matter and other rare physical phenomena. Having achieved an unprecedentedly low background level in the electron-recoil (ER) channel, the detector will be capable of detecting proton-proton (pp) chain solar neutrinos via elastic neutrino-electron scattering, while at the same time setting new limits to search of Beyond the Standard Model (BSM) physics such as solar axions, neutrino magnetic moments, axion-like particles (ALPs), and dark photons. To achieve such sensitivity, it is critical to determine the precise levels of the two major background sources, ^{222}Rn and ^{85}Kr. For ^{222}Rn, a dedicated ^{222}Rn calibration was performed. Together with an analysis framework that tracks the ^{222}Rn alpha decay, this background contribution can be constrained to an order of 10% precision. For krypton, the Rare Gas Mass Spectrometer (RGMS) at the Max Planck Institute for Nuclear Physics (MPIK) has demonstrated the world-leading detection limit of 8 parts per quadrillion (ppq) to the krypton concentration in our xenon TPC, providing a stringent constraint to ^{85}Kr. The highlight will cover the analysis results for both background estimates.

T 17.4 Mon 17:30 VG 3.104

Prospects of Solar Neutrino Detection via Delayed Coincidence Signatures in ^{136}Xe Charged Current Interactions with XENONnT — •Henning Schulze Eissing for the XENON-Collaboration — Institut für Kernphysik, Universität Münster

The XENONnT experiment, located at the INFN Laboratori Nazionali del Gran Sasso, is a dual-phase time projection chamber containing a target mass of 5.9 tonnes of liquid xenon designed for direct dark matter detection. Its unprecedented low background level in the electronic recoil channel enable searches for rare processes beyond its primary science goal.

A search strategy for solar neutrino charged current interactions with ^{136}Xe into an excited state of ^{136}Cs is being developed, exploiting the unique de-excitation signature of ^{136}Cs* caused by low-lying isomeric states with lifetimes on the order of 100 nanoseconds. This characteristic delayed coincidence signature provides powerful background discrimination in XENONnT's already low-background environment. The analysis methodology employs two complementary machine learning approaches: a classifier trained to identify the characteristic multi-peak events in the scintillation waveforms, and a reconstruction algorithm capable of resolving individual scintillation signals within merged waveforms. The development of these ML models, their validation, and initial studies of the detection efficiency are presented along with a overview of the search strategy, demonstrating the potential of this approach for solar neutrino measurements with XENONnT.

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T 17.5 Mon 17:45 VG 3.104

Neutron Detection with SANDI II in ANNIE — •Amala Augusthy, Noah Goehlke, Philipp Kern, David Maksimovic, Johann Martyn, Daniel Schmid, Michael Wurm, and Dorina Zundel for the ANNIE-Collaboration — Institut für Physik and EC PRISMA+, JGU Mainz, Mainz 55128, Germany

ANNIE is an accelerator neutrino experiment at the Booster Neutrino Beam at Fermilab. It is a 26-ton Gadolinium-loaded water Cherenkov detector designed to measure CC interaction cross-sections and neutron multiplicity. In addition, ANNIE serves as a testbed for novel detector technologies amongst which is Water-based Liquid Scintillator (WbLS). WbLS is a novel detection medium that allows the simultaneous detection of scintillation and Cherenkov light. To test the detection capabilities with WbLS, a 366 L cylindrical vessel, filled with Gadolinium (Gd) loaded WbLS, dubbed SANDI II was deployed in ANNIE, in fall 2024. Neutrons are a major source of systematic uncertainty in long baseline neutrino oscillation experiments, hence it is very important to tag neutrons efficiently. To investigate the enhanced neutron detection capabilities of Gd loaded WbLS, an AmBe neutron calibration source was deployed in ANNIE. This talk gives an overview of the preliminary results of the analysis of AmBe data with Gd loaded WbLS. This project is supported by DFG ANNIE and DFG Graduate School GRK 2796: Particle Detectors.

T 17.6 Mon 18:00 VG 3.104

First Water-based Liquid Scintillator (WbLS) measurement with DISCO — •Noah Goehlke[1], Amala Augusthy[1], Manuel Böhles[1], Daniele Guffanti[3], Benedict Kaiser[4], Tobias Lachenmaier[4], Hans Steiger[2], and Michael Wurm[1] — [1]Johannes Gutenberg-Universität Mainz — [2]Technical University of Munich — [3]University of Milano-Bicocca — [4]Eberhard Karls Universität Tübingen

Water based liquid scintillator (WbLS) is a novel detection medium, consisting of liquid scintillator dissolved in water with the help of a surfactant. It allows for the simultaneous measurement of Cherenkov and scintillation light. This hybrid event topology can be used for event reconstruction including sub-Cherenkov particles but also enhanced background rejection, for example for measuring the DSNB. Thus, WbLS is being considered as detection medium for future neutrino detectors like Theia. DISCO is a lab-scale experiment, designed to investigate the Cherenkov-scintillation separation and to characterize WbLS, using cosmic muons. The detector has a cylindrical 15 l test-cell which can be filled with water, WbLS or liquid scintillator. The light is detected by 16 fast 1" PMTs with the option to install in addition an LAPPD (Large Area Picosecond PhotoDetector). The fast photon detectors allow DISCO to investigate a time-based separation of the fast Cherenkov and slower scintillation light. Above the test-cell is a muon tracker, used as a trigger and to reconstruct the muon tracks. This talk presents results of the first WbLS run with DISCO. This work is supported by the Research Training Group "Particle Detectors".