T 59: Neutrino Physics V

Time: Wednesday 16:15–18:30 Location: VG 3.103

T 59.1 Wed 16:15 VG 3.103

The Taishan Antineutrino Observatory — •Hans Theodor Josef Steiger — Physik-Department, Technische Universität München, James-Franck-Str. 1, 85748 Garching, Germany

The Taishan Antineutrino Observatory (TAO or JUNO-TAO) is a satellite detector for the Jiangmen Underground Neutrino Observatory (JUNO). JUNO will use reactor antineutrinos at a baseline of about 53 km to probe the interference effects between the two atmospheric mass-squared differences, which are sensitive to the sign of the mass ordering. Located near the Taishan-1 reactor, TAO independently measures the antineutrino energy spectrum of the reactor with unprecedented energy resolution and by that uncovering its fine structure for the first time. Beyond that, TAO is expected to make world-leading time-resolved measurements of the yield and energy spectra of the main isotopes involved in the antineutrino emission of nuclear reactors. By that TAO will provide a unique reference for other experiments and nuclear databases. In order to achieve its goals, TAO is relying on 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, the design of the TAO detector with special focus on its new detection technologies will be introduced. In addition, an overview of the progress currently being made in the R&D for photosensor and LS technology in the frame of the TAO project will be presented.

T 59.2 Wed 16:30 VG 3.103

JUNOs sensitivity to the annihilation of sub-GeV dark matter in the galactic halo — •Jessica Eck, Dhanushka Bandara, Lukas Bieger, Silvia Cengia, Adrian Keiderling, Florian Kirsch, Tobias Lachenmaier, Anurag Sharma, and Tobias Sterr — Eberhard Karls Universität Tübingen, Physikalisches Institut

The Jiangmen Underground Neutrino Observatory (JUNO) is in the final construction stage in southern China with the main goal to determine the neutrino mass hierarchy with reactor antineutrinos. Due to the large volume of 20 kt, indirect search for self-annihilating light dark matter (DM) in the mass range from 10 MeV to 1 GeV is an additional physics goal of JUNO. In this talk, the expected signal from a monoenergetic neutrino flux on Earth, originating from direct annihilation of DM particles into neutrinos, will be discussed. Furthermore, different methods to suppress background contributions in the respective energy range are presented to estimate the expected sensitivity of JUNO to DM self-annihilation in the Milky Way.

T 59.3 Wed 16:45 VG 3.103

Particle identification in JUNO with a Graph Convolutional Network — Thilo Birkenfeld, •Elisabeth Neuerburg, Philipp Soldin, and Achim Stahl — RWTH Aachen

The Jiangmen Underground Neutrino Observatory (JUNO) is a 20 kton liquid scintillator-based neutrino observatory. Identifying the secondary particles gives a handle on the primary neutrino type. In this talk, a method of particle identification using a Graph Convolutional Network (GCN) is presented. A fixed Graph is fed into the network, which uses partition pooling for dimensionality reduction. This method is applied to the discrimination of electrons and positrons. Their discrimination aids in distinguishing atmospheric neutrinos and antineutrinos, as well as backgrounds from the IBD signal of reactor antineutrinos.

T 59.4 Wed 17:00 VG 3.103

A novel view at using the topological track reconstruction in JUNO — •Mikhail Smirnov, Daniel Bick, Milo Charavet, Caren Hagner, and Rosmarie Wirth — Institute of Experimental Physics, University of Hamburg, Hamburg, Germany

The Jiangmen Underground Neutrino Observatory (JUNO) represents a new generation of kiloton-scale neutrino detectors based on liquid scintillator (LSc). With a target mass of 20 kilotons, it will be the largest LSc detector in the world. Utilizing the antineutrino flux from two nuclear power plants at a baseline of approximately 53 km, JUNO aims to determine the neutrino mass ordering with at least 3σ significance and to make precise measurements of oscillation parameters. Initially, the topological track reconstruction (TTR) was developed to reconstruct muon events in unsegmented LSc detectors for particles with energies up to 10 GeV. This reconstruction algorithm uses time and spatial information from PMT hits to iteratively determine the origin and trajectory of particles inside the detection medium. This talk reviews the TTR method and its potential applications in the JUNO experiment and is supported by the DFG.

T 59.5 Wed 17:15 VG 3.103

Application of the Topological Track Reconstruction to ANNIE — Daniel Bick, Caren Hagner, and •Malte Stender for the ANNIE-Collaboration — Universität Hamburg, Institut für Experimentalphysik

The Topological Track Reconstruction (TTR) is an algorithm originally developed for reconstructing the energy depostion of muons in liquid scintillator detectors like LENA for improving veto strategies. In its development history, the TTR was successfully used for electron/positron discrimination in JUNO and for separating Cherenkov and scintillation photons in an simulated idealised Water-based liquid scintillator (WbLS) detector. The latter application can be tested on real data in the near future with the help of the Accelerator Neutrino Neutron Interaction Experiment (ANNIE).

ANNIE is a 26-ton water-Cherenkov beam-neutrino detector that - besides neutrino-nucleus cross section and neutron multiplicity measurements - aims to be a test-bed for new detector technologies like WbLS and Large Area Picosecond Photodetectors (LAPPDs). For that, the ANNIE collaboration deployed an acrylic vessel filled with WbLS for several months and intends to use a greater volume of the liquid in the future.

A necessary step for the Cherenkov/scintillation light separation algorithm is the modification and application of the TTR to ANNIE data. This is the focus of this talk together with an introduction to the ANNIE experiment and the TTR algorithm. The presented work is supported by the DFG.

T 59.6 Wed 17:30 VG 3.103

Topological reconstruction of neutrino interactions with the SHiP detector — •James Webb, Christian Weiser, and Karl Jakobs — Albert-Ludwigs-Universität Freiburg, Physikalisches Institut, 79104 Freiburg, Germany

The SHiP (Search for Hidden Particles) experiment, to be installed within ECN3 at CERN, aims to utilise a 400 GeV/c proton beam on target to probe a broad physics regime. The high energy, high intensity proton beam dump will produce a high flux of all neutrino flavours, making this environment ideally suited for performing neutrino physics studies.

A proposed detector to exploit the neutrino flux comprises a passive tungsten plane, followed by pairs of rotated silicon strip detectors; many such layers are envisioned to be stacked up along the beam axis.

This talk will discuss the potential of such a detector in terms of track and vertex reconstruction, with an emphasis on studying tau neutrino interactions.

T 59.7 Wed 17:45 VG 3.103

Tau-neutrino signal in AdvSND@LHC — Heiko Lacker and •Eduard Ursov — Humboldt University of Berlin, Berlin, Germany

The SND@LHC (Scattering and Neutrino Detector at the LHC) is a compact, stand-alone, emulsion-based experiment designed to measure neutrinos produced in proton-proton collisions at the LHC. It operates in the previously unexplored pseudo-rapidity range of $7.2 < \eta < 8.4$. In July 2023, the SND@LHC collaboration reported the observation of eight muon neutrino charged-current candidates with a significance of 6.8σ. AdvSND@LHC, a proposed fully electronic upgrade of SND@LHC, is planned to collect data during the High-Luminosity LHC era. The upgraded detector will feature two primary subsystems: a tungsten target and a hadronic calorimeter with magnetized iron as passive material. Both subsystems will be interleaved by sensitive planes composed of silicon strips. This work presents the development of a full simulation pipeline for neutrino studies at AdvSND@LHC. The pipeline encompasses the generation of proton-proton collisions at the interaction point, production of the neutrino flux, propagation of neutrinos to the detector vicinity, neutrino interactions within the detector, and digitization of the resulting signals. To study the tau-neutrino signal, a machine learning classifier based on the Boosted Decision Trees (BDT) algorithm has been developed. This classifier achieves effective separation between charged-current muon neutrino events and charged-current tau-neutrino events with subsequent leptonic decays of the tau-leptons.

T 59.8 Wed 18:00 VG 3.103

Simulation Studies on Muon Neutrino DIS Analysis at the SND@LHC Detector — Andrew Conaboy, Heiko Lacker, •Tilly Smith, and Eduard Ursov — Humboldt University Berlin

The SND@LHC experiment, located 480m downstream from the ATLAS interaction point at the LHC, aims to detect high-energy neutrinos originating from proton-proton collisions at the LHC. This standalone experiment targets the otherwise inaccessible pseudo-rapidity region of $7.2 < \eta < 8.4$ and with the data taken during the first year of running in 2022 has successfully identified 8 $\nu\mu$ CC candidates with a significance of seven standard deviations. An in-depth simulation of the detector environment as well as the muon neutrino deep inelastic scattering (DIS) interaction is being developed to further enhance this significance level.

This talk gives an overview of the developed simulation as well as its performance on MC simulated data for both signal and background processes. Details on the applied selection cuts, tracking algorithm and analysis methods are given as well as a comparison to previous performance studies. To improve the background rejection, we study the distributions of the interaction point, shower width and position, and muon angle after interaction for simulated signal and background samples.

T 59.9 Wed 18:15 VG 3.103

Detecting Collider Neutrinos at the LHC: the FASER Experiment — •Wissal Filali, Florian Bernlochner, Tobias Boeckh, and Markus Prim — Physikalisches Institut der Universität Bonn

The neutrinos produced at the Large Hadron Collider (LHC) proton-proton collision provide an opportunity to explore the TeV regime which has remained largely uncharted. The FASER experiment, located 480 meters downstream from the ATLAS interaction point and aligned with the beam collision axis, aims to measure the interaction cross section and flux of neutrinos ν_{mu} in the energy range from 400GeV to 6TeV. Using FASER's active electronic detector, charged current interactions of muon neutrinos and anti-neutrinos are identified, the neutrino flux is measured in six momentum bins and five pseudorapidity bins, with correlations between these measurements providing improved precision in the flux determination. In this presentation, we present the current status of the analysis.