T 109: Neutrino physics 12

Time: Friday 9:00–10:30 Location: Geb. 30.21: Gerthsen-HS

T 109.1 Fri 9:00 Geb. 30.21: Gerthsen-HS

Characteristics of electron gun to investigate the energy loss function in KATRIN — •Rudolf Sack[1], Sonja Schneidewind[2], Volker Hannen[2], and Sascha Wüstling[1] for the KATRIN-Collaboration — [1]Karlsruhe Institute of Technology — [2]University of Münster

The KATRIN experiment aims to determine the mass of the neutrino by scanning the electron energy spectrum near the endpoint. Electrons can however scatter with tritium molecules in the source of the experiment and lose energy in the process. This energy loss function needs to be measured with high precision. At the back end of the KATRIN beam line a mono energetic and mono angular photo-electron source, the so called e-gun, is in place to perform this measurement in situ with high precision. This talk will focus on our new beam pulsing method for measurements using time of flight information in addition to energy scanning with the KATRIN main spectrometer. The combination of time of flight analysis with beam pulsing greatly reduces the background contribution in the measurement. With the much improved signal to noise ratio we performed a direct measurement of the function at 18.6 keV for energy losses of up to 200 eV.

This work is supported by the Helmholtz Association and by the Ministry for Education and Research BMBF (grant numbers 05A23PMA, 05A23PX2, 05A23VK2, and 05A23WO6)

T 109.2 Fri 9:15 Geb. 30.21: Gerthsen-HS

Improved analysis methods for the determination of the energy-loss function of electrons in high-purity tritium gas at KATRIN — •Sonja Schneidewind[1], Volker Hannen[1], Rudolf Sack[2], Richard Salomon[1], and Christian Weinheimer[1] for the KATRIN-Collaboration — [1]Institute for Nuclear Physics, University of Münster — [2]Karlsruhe Institute of Technology (KIT)

The Karlsruhe Tritium Neutrino Experiment (KATRIN) aims to directly assess the absolute neutrino-mass scale via precision spectroscopy of the tritium beta-decay spectrum in its endpoint region. Energy-losses of electrons scattering with gas molecules while travelling through the high-density gaseous tritium source lead to distortions of the measured energy spectrum and therefore need to be known with high precision. In 2022 and 2023, new measurements of the energy-loss of electrons in tritium gas at different electron energies have been performed with a newly installed high-rate photoelectron source with narrow energy and angular distribution. Those measurements extend earlier measurements at KATRIN which were published in EPJC 81, 579 (2021). In this talk, improved analysis methods developed for the analysis of the new energy-loss data will be presented. This work is supported by the Helmholtz Association, by the Ministry for Education and Research BMBF, by Deutsche Forschungsgemeinschaft DFG (Research Training Group GRK 2149) and other agencies (grant numbers 05A23PMA, 05A23PX2, 05A23VK2, and 05A23WO6).

T 109.3 Fri 9:30 Geb. 30.21: Gerthsen-HS

Preliminary Results from the LAPPD Integration in the ANNIE Experiment — •Marc Breisch, Tanjina Anannya, Lukas Bieger, Jessica Eck, Tobias Heinz, Benedict Kaiser, Florian Kirsch, Tobias Lachenmaier, Dhanushka Bandara, and Tobias Sterr — 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. The main physics goal is to measure the final state neutron multiplicity of neutrino-nucleus interactions as well as the neutrino cross-section in water which will improve the systematic uncertainties of next-generation long-baseline neutrino experiments. ANNIE is also the first large scale neutrino experiment to deploy multiple Large Area Picosecond Photodetectors (LAPPD), a novel photo sensor with a timing resolution of <100 ps and a sub-centimeter spatial resolution. Three LAPPDs have been successfully commissioned in ANNIE and neutrino induced events were detected. This talk will give an update on the status of the LAPPD beam data analysis as well as the first results from neutrino induced events recorded by the LAPPD.

T 109.4 Fri 9:45 Geb. 30.21: Gerthsen-HS

Particle Identification with the Cherenkov to Scintillation Ratio in an idealised Water-based Liquid Scintillator Detector — Daniel Bick, Caren Hagner, and •Malte Stender — Universität Hamburg, Institut für Experimentalphysik

The Diffuse Supernova Neutrino Background (DSNB) is of great interest for the star formation rate and understanding of supernovae. However, DSNB neutrinos were not detected yet due to the presence of strong backgrounds. For water Cherenkov detectors, a relevant background are muons below Cherenkov threshold. Mixing liquid scintillator into the water gives the opportunity to suppress invisible muons via the Cherenkov to scintillation ratio (C/S ratio). Such a Water-based Liquid Scintillator (WbLS) detector has also access to advantages like direction and enhanced energy reconstruction, if a light separation algorithm is in place. This algorithm uses the difference between Cherenkov and scintillation photons - the first is emitted instantenous in a cone, the latter isotropic and delayed - to sort the hits.
For this sorting the photodetector of choice has to be able to resolve the difference in time and space from the hits of both light types. The Large Area Picosecond Detector (LAPPD) is a novel photosensor reaching a spatial resolution of about 1 mm and a time resolution of ~ 0.1 ns and is therefore well-suited to do exactly that.
At the example of a simulated and idealised WbLS detector completely covered with LAPPDs, a feasibility study is conducted.
This contribution presents the simulation and a light separation algorithm showing the suppression of invisible muons in a WbLS detector.

T 109.5 Fri 10:00 Geb. 30.21: Gerthsen-HS

Simulating LiquidO detectors for prototype research and development — •Ben Cattermole for the CLOUD-Collaboration — University of Sussex, Brighton, United Kingdom

LiquidO is a novel detector technology that makes use of the stochastic confinement of scintillator light around its origin in an opaque medium. To collect this light a lattice of wavelength-shifting fibers runs through the medium, with each fiber end leading to a SiPM. By analysing event topology LiquidO style detectors have strong particle identification down to the MeV scale. Subsequent background rejection capabilities of the LiquidO technology make it ideal for neutrino detection. LiquidO will be used in the Chooz LiquidO Ultra near Detector, CLOUD, planned to be a 5 to 10 ton above ground detector for reactor anti neutrinos.

I will report on my work which involves simulations of LiquidO based detectors for research and development purposes. These simulations are built in Geant4 and include the geometries of prototypes, the scintillator material itself, the reflectivity of the vessel, fiber position and simulations of light in the fibers themselves. Alongside prototyping, these simulations are used to generate machine learning datasets. The main machine-learning technique being considered is a convolutional neural network due to the lattice of fibers used by LiquidO detectors being easily mapped to a pixel grid image format.

T 109.6 Fri 10:15 Geb. 30.21: Gerthsen-HS

LiquidO: Simulations for Cloud Inner Detector — •Susanna Wakely for the CLOUD-Collaboration — Johannes Gutenberg Universität Mainz

LiquidO is an innovative technology that uses opaque liquid scintillators for particle detection. A LiquidO scintillator combines a short scattering length and a long absorption length to confine optical photons close to their creation point. A fine array of wavelength-shifting fibres is used to collect and transport the scintillation light for readout. A LiquidO detector will have unprecedented position resolution compared to current transparent scintillators and be capable of particle identification via event topology. Proof of principle has been demonstrated by two prototypes with a third currently under construction.

The Cloud collaboration is designing a 5-10 ton LiquidO anti-neutrino detector. This will be an above-ground ultra-near reactor anti-neutrino detector located in the Chooz nuclear power plant, France.

This talk will discuss simulations of the inner detector including particle identification via event topology and fibre array design. Two broad fibre array designs are considered: parallel and stereo shells. A parallel array achieves mm resolution in x and y, with z-position obtained at lower resolution from signal timing differences. A stereo shell array would improve the resolution in z but presents challenges for the design and construction of the detector.