T 58: Neutrino physics 8

Time: Wednesday 16:00–18:00 Location: Geb. 30.22: Gaede-HS

T 58.1 Wed 16:00 Geb. 30.22: Gaede-HS

Synthesis and Applications of Low Background Modified Polyethylene Naphthalate (PEN-G) — •Brennan Hackett[1], Andreas Leonhardt[2], Maximilian Goldbrunner[2], Peter Bauer[4], Florian Puch[4], and Markus Stommel[3] for the LEGEND-Collaboration — [1]Max-Planck Institut für Physik, Garching, Germany — [2]Technische Universität München, Garching, Germany — [3]Leibniz-Institut für Polymerforschung, Dresden, Germany — [4]Thüringisches Institut für Textil- und Kunststoff-Forschung, Rudolstadt, Germany

Identification of background radiation is of utmost importance for enabling rare event experiments to attain the required sensitivities for probing new physics. Poly(ethylene-2,6-naphthalate) (PEN) has emerged as a highly promising material for such experiments due to its intrinsic scintillating properties and its adaptability as a structural material at both room and cryogenic temperatures. Notably, PEN has been successfully implemented in the LEGEND-200 experiment involving ∼200 kg of the target isotope ^{76}Ge for investigating neutrinoless double beta decay. In LEGEND-200, PEN serves as both an active material and a structural component within the detector assembly. Looking towards the next-generation experiment, LEGEND-1000 will further reduce background radiation by an order of magnitude. To achieve this goal, we are looking to expand more potential applications of PEN-G. To this end, we have successfully synthesized PEN in kilogram batches utilizing unique reagents. The radiopurity of the synthesized PEN has been measured, and we are exploring strategies to improve these values. In this presentation, we will outline the results.

T 58.2 Wed 16:15 Geb. 30.22: Gaede-HS

Charge Senstive Amplifier R&D for the LEGEND-1000 Experiment — •Andreas Gieb, Florian Henkes, Susanne Mertens, and Michael Willers for the LEGEND-Collaboration — Physik-Department, 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, experimental program searching for the neutrinoless double-beta ($0\nu\beta\beta$) decay.

The first 200 kg stage of the experiment, LEGEND-200, is currently taking data at Gran Sasso underground laboratory. The 1000 kg phase of the experiment, LEGEND-1000, aims to achieve discovery potential at half- lifes longer than 10^{28} years which covers the inverted-ordering neutrino mass scale. In order to achieve this, a significant reduction of background in the signal region of interest is necessary. An important role in this endeavor is a reduction in the background of the readout electronics due to its proximity to the detector, while ultimately improving noise performance and signal fidelity.

This contribution explores a novel approach to ASIC based frontend electronics, and present first results from measurements performed with a high-purity germanium detector.

We acknowledge support by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) under Germany's Excellence Strategy - EXC 2094 - 390783311 and through the Sonderforschungsbereich (Collaborative Research Center) SFB1258 Neutrinos and Dark Matter in Astro- and Particle Physics.

T 58.3 Wed 16:30 Geb. 30.22: Gaede-HS

First results of the MONUMENT Experiment; ^{76}Se partial capture rates — •Elizabeth Mondragon for the MONUMENT-Collaboration — Chair of Astroparticle Physics, Physics Department, Technical University of Munich, James Franck Str. 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's following the OMC process makes this a promising tool to validate NME calculations and test the quenching of the axial vector coupling g_A. MONUMENT performs OMC measurements at the Paul Scherrer Institute and is dedicated primarily to $0\nu\beta\beta$ decay searches. The first results will be presented on the $\beta\beta$ decay daughter isotope ^{76}Se, corresponding with the LEGEND experiment's isotope ^{76}Ge. This research was funded by RFBR and DFG, project number 21-52-12040, the DFG Grant 448829699, and by a Department of Energy Grant No DE-SC0019261.

T 58.4 Wed 16:45 Geb. 30.22: Gaede-HS

Neutron production in neutrino-nucleus interaction — •Asit Srivastava for the T2K-Collaboration — Johannes Gutenberg-Universität Mainz

T2K is a long-baseline experiment which measures parameters of neutrino oscillations. This can be done by analysing the interaction of neutrinos closer to the point of beam production and 295 km downstream. The detector located near the source of beam production, called ND280, primarily includes the interactions of neutrinos with carbon nuclei. The particles produced as a result of the interactions deposit energy in ND280 which is used to characterise the incoming neutrino flux and neutrino cross-sections before oscillations occur.

Out of all the particles produced in typical neutrino interactions, neutrons are by far the most challenging to detect since they are electrically neutral and do not leave a visible track in the detector. As a result, they provide uncertainties in identifying the interactions happening in the detector and measuring cross-sections. ND280 has a newly installed Super Fine-Grained Detector (SFGD) made of plastic scintillator cubes. The upgraded detector capable of better position resolution and 3D reconstruction opens up the possibilities of improving the efficiency of neutron detection. Analysing a neutron-rich sample and the interactions producing the neutrons can help in understanding nuclear effects better and reducing uncertainties in determining neutrino interaction cross-sections.

The interactions leading to neutron production and how nuclear effects can smear the neutron spectrum will be presented in this talk.

T 58.5 Wed 17:00 Geb. 30.22: Gaede-HS

Timing properties study in T2K ND280 Upgrade detector — •Gioele Reina for the T2K-Collaboration — Johannes Gutenberg-Universität Mainz

Detailed models of neutrino interactions with nuclei play a crucial role in long-baseline neutrino oscillation experiments. These models depend on neutron final state interactions (FSI) and, since neutrons are not easily detected and the cross section of these processes is not well-known, they constitute a relevant source of systematic uncertainties. The capabilities of the upgraded T2K ND280 near detector provide an opportunity to improve our knowledge on neutron FSI.

The newly installed Super Fine-Grained Detector (SFGD) consists of small plastic scintillator cubes read out by three wavelength shifting fibers in the three orthogonal directions. It ensures high granularity and 3D reconstruction, which can play a key role in improving the detection of low energy neutrons in neutrino interactions.

Before using real data, efficiency studies of neutron detection need to be performed with simulated events and control samples within the T2K software framework, where neutron reconstruction and selection have been developed. Evaluating how these may vary according to the actual detector performance is important since they will have an impact on the determination of systematic uncertainties in the experiment analysis and can be a source of systematic uncertainties themselves. Simulation-based determination of SFGD detector timing response will be presented along with the impact on efficiency studies for neutron detection.

T 58.6 Wed 17:15 Geb. 30.22: Gaede-HS

Neutrino-nucleus cross-section measurement strategies from the T2K experiment — •Liam O'Sullivan — JGU Mainz, Mainz, Germany

In both current and future neutrino oscillation experiments, an accurate understanding of neutrino-nucleus interactions is key to enabling precise determination of the parameters of interest. The physics underpinning the interactions of neutrinos on heavier elements is extremely complex, requiring an accurate description of the initial nuclear state, neutrino-nucleon interactions, and the propagation of particles through the dense nuclear medium.

T2K is a neutrino oscillation experiment with more than a decade's worth of neutrino interaction data with a peak neutrino energy of 0.6 GeV/c. Over this time, T2K's ND280 near detector — a magnetised tracker with hydrocarbon and water targets — has been measuring and characterising neutrino interactions with granular tracking. This allows precise study of the common neutrino interactions, and also enables constraints on less-understood kinematic regions and processes. This talk details the evolution of methods and analysis strategies used in T2K's cross-section analyses — past, present, and future — and how these data can be best used both to challenge current theory, and to motivate new model development.

T 58.7 Wed 17:30 Geb. 30.22: Gaede-HS

Development of novel water-based liquid scintillator with pulse-shape discrimination capabilities — •Manuel Böhles[1], Hans Theodor Josef Steiger[2,1], David Dörflinger[2], Ulrike Fahrendholz[2], Meishu Lu[2], Lothar Oberauer[2], Matthias Raphael Stock[2], and Michael Wurm[1] — [1]Johannes Gutenberg University Mainz, Institute of Physics, Staudingerweg 7, 55128 Mainz, Germany — [2]Technical University of Munich, Physics Department, James-Franck-Str. 1, 85748 Garching, Germany

Future hybrid detectors in the field of neutrino physics have to combine high-resolution energy determination down to low thresholds through 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 colloidally dissolved 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. Additionally, a study of its light yield as well as pulse-shape discrimination capabilities will be presented. This work is supported by the Clusters of Excellence PRISMA+ and ORIGINS and the Collaborative Research Center 1258.

T 58.8 Wed 17:45 Geb. 30.22: Gaede-HS

Precision Attenuation Length Measurement of Liquid Scintillators for Future Large Volume Neutrinos Experiments — •Vincent Rompel, Korbinian Stangler, Florian Kübelbäck, Hans Steiger, and Lothar Oberauer — Technische Universität München, Physik-Department, James-Franck-Straße 1

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 is supported by the Cluster of Excellence ORIGINS, the Collaborative Research Center 1258, and the DFG Research Units 2319 and 5519.