T 34: Neutrino physics 5

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

T 34.1 Tue 16:00 Geb. 30.22: Gaede-HS

Scintillation and Cherenkov Light Separation in Organic Liquid Scintillators for Large Scale Neutrino Detectors — •Meishu Lu[1], Hans Steiger[1,2], M. R. Stock[1], U. Fahrendholz[1], and L. Oberauer[1] — [1]Physik-Department, Technische Universität München, James-Franck-Str. 1, 85748 Garching — [2]Johannes Gutenberg University Mainz, Cluster of Excellence PRISMA+, Staudingerweg 9, 55128 Mainz

The separate observation of Cherenkov and scintillation light in liquid scintillation media and thus the extraction of a directional signal and excellent energy and vertex resolution is of great importance in current R&D projects for large scale neutrino detectors like JUNO or Theia. The expected progress in the field of background suppression is promising. To study this potential in novel liquid scintillators, a new setup exploiting the principle of time-correlated single photon counting with cutting-edge photomultiplier tubes is under commissioning at TUM. The experiment enables detailed studies of the probability density function of the photon emission from the scintillation medium including both Cherenkov, and scintillation light. A separation can be achieved either by direct timing or by chromatic filtering. In this talk the design of this novel table-top experiment is discussed as well as first test measurements with the used photosensors. This work has been supported by the Cluster of Excellence PRISMA+, the Cluster of Excellence ORIGINS as well as the Collaborative Research Center Neutrinos and Dark Matter in Astro- and Particle Physics (SFB1258) and the DFG Research Units 2319 and 5519.

T 34.2 Tue 16:15 Geb. 30.22: Gaede-HS

Measurement of the attenuation length and the group velocity of the JUNO liquid scintillators with the CELLPALS method — •Jessica Eck, Tanjina Anannya, Lukas Bieger, Marc Breisch, Tobias Heinz, Benedict Kaiser, Florian Kirsch, Tobias Lachenmaier, Dhanushka Bandara, and Tobias Sterr — Eberhard Karls Universität Tübingen, Physikalisches Institut

The Jiangmen Underground Neutrino Observatory (JUNO) is in the final stages of completion in southern China and data taking is scheduled to begin this year (2024). In the coming years, JUNO will investigate a broad field of neutrino physics. The main goal of JUNO is to determine the neutrino mass hierarchy, which requires a sufficiently good energy resolution in the detector. The JUNO detector consists of a large spherical vessel filled with 20ktons of highly transparent liquid scintillator based on the solvent linear alkyl-benzene (LAB) and the supplements PPO (fluor) and bis-MSB (wavelength shifter). The transparency of the scintillator is one of the most important factors in achieving a high energy resolution in the detector, thus it is important to quantify the attenuation length for the relevant wavelengths. Since conventional measurements of the attenuation length are affected by large uncertainties for very transparent liquids, the CELLPALS method was introduced, which provides significantly higher precision by using an optical resonator in combination with a modulated laser intensity. This talk will present results on the attenuation length and the group velocity of selected liquids including LAB samples after several stages of JUNOs liquid scintillator production chain.

T 34.3 Tue 16:30 Geb. 30.22: Gaede-HS

Event Reconstruction in OSIRIS — •Elisabeth Neuerburg, Achim Stahl, and Jochen Steinmann — RWTH Aachen

The Jiangmen Underground Neutrino Observatory (JUNO) is a 20kton liquid scintillator based neutrino observatory, which is currently under construction in southern China. To ensure the success of JUNO's physics program, stringent limits on the contamination of the scintillator with radioactive isotopes have been defined. OSIRIS (Online Scintillator Internal Radioactivity Investigation System) is a 20t liquid scintillator detector, which monitors the radiopurity during filling of JUNO. It consists of a cylindrical acrylic vessel surrounded by 64 PMTs detecting coincidence signals of the Bi-Po decay in the uranium and thorium series. Using the charge signals of the PMTs, the position and energy of such decay events is reconstructed based on a likelihood method. In this talk the method and performance of the reconstruction is presented.

T 34.4 Tue 16:45 Geb. 30.22: Gaede-HS

Liquid Handling System of the OSIRIS detector — Marcel Büchner[1], Arshak Jafar[1], Meishu Lu[2], •Oliver Pilarczyk[1], Hans Steiger[1,2], Tobias Sterr[1], and Michael Wurm[1] — [1]Johannes Gutenberg-University Mainz, Institute of Physics and EC PRISMA+ — [2]Technical University Munich

The Jiangmen Underground Neutrino Observatory (JUNO) is a 20 kt liquid scintillator experiment currently under construction in Jiangmen (China). To achieve its scientific goals the liquid scintillator has to go through several purification plants on site to make sure it meets the optical and radiopurity requirements. The 20m* OSIRIS pre-detector is the last device behind these purification plants. Its task is to monitor the radiopurity of the purified scintillator before it is filled in the JUNO detector and it will reach sensitivity levels of 10-16g/g on uranium and thorium. OSIRIS is expected to be operated in a continuous mode, which means that parts of the scintillator from the main filling line will be redirected into a bypass in which the OSIRIS detector is placed and then being returned to the main filling line. To make sure every batch of the scintillator stays about 24 h inside the OSIRIS detector a temperature gradient will be established in the detection volume to help stratification of the liquid scintillator inside. This talk covers the operation and function of the Liquid Handling System (LHS) and the included Level Measurement system (LM) which control and oversee the operation of OSIRIS as well as the construction and commissioning process. The development is funded by the DFG Research Unit *JUNO* (FOR5519) and the Cluster of Excellence PRISMA+.

T 34.5 Tue 17:00 Geb. 30.22: Gaede-HS

Track Reconstruction and Geometry Studies of Scintillators Bars for DUNE TMS — •Asa Nehm for the DUNE-Collaboration — Johannes Gutenberg-Universität Mainz

For the Deep Underground Neutrino Experiment (DUNE), that is currently under construction, a suite of near detectors is in development. DUNE is a long-baseline neutrino experiment that will use a high-intensity neutrino beam from Fermilab and observe the neutrinos in the far-detector complex located at SURF, USA. The primary focus will be on neutrino oscillations to test CP violation, but also neutrino mass ordering and supernova neutrinos will be investigated.

One of the near detectors is The Muon Spectrometer (TMS) that will primarily detect and measure properties of the muons resulting from neutrino interactions exiting the preceding near detector. TMS will consist of alternating layers of plastic scintillators, in form of bars, and steel. The scintillator bars will be read out by WLS fibers and SiPMs and detect the scintillation light created by through-going charged particles.

To extract the properties of the incoming muons a 3D track reconstruction was developed and implemented. This allowed to study different potential geometric layouts of the scintillator bars. In particular a stereo view of alternating 3° tilted layers and a layout that features full 90° rotated layers were studied. With these preceding studies the exiting muons that are reconstructed as stopping in the detector have been investigated and the results will be presented.

T 34.6 Tue 17:15 Geb. 30.22: Gaede-HS

DUNE-PRISM: An innovative technique for neutrino oscillation analysis — •Ioana Caracas — JGU Mainz, Mainz, Germany

The Deep Underground Neutrino Experiment (DUNE) will measure the neutrino and anti-neutrinto oscillation probabilities, using a high-intensity neutrino beam produced at Fermilab. With a baseline of 1300 km and large (kton) LArTPC detectors, DUNE will provide an unprecedented precision in measuring the oscillation parameters. The neutrino interaction cross sections represent the main systematic source entering the analysis. Constraining the oscillation parameters space is therefore limited by a good knowledge of the neutrino interaction modeling.

The DUNE Near Detector (ND) complex is designed to move to different positions along the neutrino beam axis. Several neutrino fluxes with different peak energies can thus be sampled as a function of the off-axis position. These ND off-axis results can then be linearly combined in order to match any target spectrum using a data-driven approach. This innovative technique, the Precision Reaction Independent Spectrum Measurement (PRISM), is able to predict the Far Detector (FD) neutrino oscillated spectrum with minimum modeling dependency. The PRISM prediction obtained and the impact of several systematics on the resultant oscillation parameters will be discussed. A case-study showing how PRISM can avoid potential biases resulting from the wrong interaction modeling will also be presented.

T 34.7 Tue 17:30 Geb. 30.22: Gaede-HS

Large-area MMC-based photon detector operated at mK temperatures — •Ashish Jadhav, Christian Enss, Andreas Fleishmann, Daniel Hengstler, Andreas Reifenberger, Daniel Unger, and Loredana Gastaldo — Kirchhoff Institute for Physics, Heidelberg, Germany

We present the development of a large area, high-energy resolution photon detector based on low temperature metallic magnetic calorimeters (MMCs). The detector is to be the photon detector in a combined Photon-Phonon (P2) detector to be coupled to molybdate scintillating crystals in the AMoRE experiment. The final P2 detector utilises a 3-inch Si wafer. A central area, weakly coupled to the rest of the wafer is defined to detect visible photons emitted by particle interactions in the scintillating crystal. The outer part of the wafer contains three double-meander MMC detectors as phonon detectors to monitor temperature changes in the crystal resting on gold spacers. The most challenging part is the photon detector based on a stripline pickup coil design. We present the R&D on a large area silicon photon detector with stripline MMC geometry. We discuss the results obtained and the implications of the photon detector for the AMoRE experiment.

T 34.8 Tue 17:45 Geb. 30.22: Gaede-HS

Search for Ge77(m) in LEGEND-200 — •Marie Pruckner, Moritz Neuberger, and Stefan Schönert for the LEGEND-Collaboration — Physik-Department E15 Technische Universität München James-Franck-Straße 85748 Garching

The delayed decay of $^{77(m)}$Ge ($Q_\beta = 2.7$ MeV), produced by muon-induced neutron capture on ^{76}Ge, has been identified as the dominant in-situ cosmogenic background contributor for the neutrinoless double-beta decay search with ^{76}Ge ($Q_{\beta\beta} = 2.039$ MeV) in the future LEGEND-1000 experiment at LNGS [1,2,3]. To verify its background contribution estimates, we search for for $^{77(m)}$Ge decays in the ongoing LEGEND-200 experiment and compare them with simulation estimates. In this talk, we will demonstrate how we attempt to identify the $^{77(m)}$Ge decays using delayed coincidence techniques that require new digital signal processing routines to reconstruct all relevant physics parameters.

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[3] M. Neuberger et al., 2021 J. Phys.: Conf. Ser. 2156 012216