# T 116: Neutrinos Legend, Neutrino Theory

Time: Thursday 15:50–17:20 Location: POT/0251

T 116.1 Thu 15:50 POT/0251

**Polyethylene-Naphthalate-Based Wavelength Shifting Reflectors for LEGEND-1000** — •Andreas Leonhardt, Maximilian Goldbrunner, and Stefan Schönert for the LEGEND-Collaboration — Physik Department, Technische Universität München, Garching, Germany

The next-generation experiment LEGEND-1000 will search for the neutrinoless double-beta decay ($0\nu$bb) of Ge-76 with unprecedented discovery potential covering the inverted neutrino mass ordering. To this end, 1000 kg of enriched germanium is employed bare in a segmented liquid Argon (LAr) volume. Particle interactions in LAr produce vacuum-ultraviolet (VUV) light flashes peaking at 128 nm, which are converted to longer wavelengths by wavelength shifters (WLSs). To efficiently instrument the LAr volume in LEGEND-1000, a large-scale wavelength shifting reflector (WLSR) based on polyethylene naphthalate (PEN) will be lined on the inner cryostat wall. In this talk, we describe the custom VUV spectrofluorometer used for the optical characterization of PEN-based WLSRs at VUV excitation and cryogenic temperatures. We present the first measurement of the wavelength-resolved photoluminescence yield of PEN for VUV excitation at cryogenic temperatures and compare it to the commonly used wavelength shifter tetraphenyl butadiene (TPB). This research is supported by the DFG through the Excellence Cluster ORIGINS and the SFB1258.

T 116.2 Thu 16:05 POT/0251

**Trace gas analysis of unpurified and purified liquid argon by mass spectrometry for LEGEND** — •Christoph Vogl, Martin Guevara, Alice Ortmann, and Stefan Schönert — Physics Department, TU-Munich

Liquid argon is commonly used as a medium for particle detection in rare event searches and particle physics experiments. Its performance is heavily impaired in the presence of electronegative impurities, typically oxygen, nitrogen, and water. The chemical purity of liquid argon can be assessed indirectly by measuring its scintillation properties. A complementary and direct way of determining purity is through mass spectrometry. In this talk, we will present our new quadrupole mass spectrometer setup (IDEFIX) and discuss the main challenges and solutions. Results are shown regarding the assessment of the chemical composition of commercial and in-house purified liquid and gaseous argon. This research is supported by the BMBF through the Verbundforschung 05A20WO2 and by the DFG through the Excellence Cluster ORIGINS.

T 116.3 Thu 16:20 POT/0251

**Set Up and Run of a Cherenkov Test Detector** — •Ivana Nikolac — Physikalische Institut, Eberhard Karls Universität Tübingen, Tübingen, Germany

High-energy particles, like muons, can cross many kilometres of rock and penetrate even the deepest underground laboratories, causing a non-negligible background in rare-event experiments. Muons can also produce neutrons, which mimic dark matter signals. This makes the muon veto an integral part of any rare-event underground experiment. To test the properties of a muon veto system, at the University of Tübingen a small volume water Cherenkov veto is being set up. The instrument (DODI) is a dodecahedron-shaped steel tank with a capacity of 700 litres, lined inside with highly reflective foil, and equipped with eleven photomultiplier tubes (PMTs). Due to its relatively small size and easy access to both its exterior and interior parts, DODI offers the opportunity to probe the muon veto system and its efficiency in real-time. This can be achieved, for example, by introducing different reflective materials in the tank or changing the PMT types. For future experiments, DODI will be further tested as a neutron tagger, first with water and then by introducing different Gadolinium arrangements into the water to improve the efficiency.

T 116.4 Thu 16:35 POT/0251

**Neutrino Decay in JUNO** — •George Parker, Marcel Büchner, Tim Charisse, Arshak Jafar, Joachim Kopp, Kai Loo, Oliver Pilarczyk, and Michael Wurm — Johannes Gutenberg Universität Mainz, Mainz, Germany

The decay of the neutrino mass eigenstates are well-constrained using astrophysical neutrinos, with the exception of neutrino mass eigenstate $\nu 3$, which has a much less stringent lifetime bound. In this work, we explore the sensitivity of the Jiangmen Underground Neutrino Experiment (JUNO) to $\nu 3$-decay. JUNO is a next-generation reactor neutrino liquid-scintillator detector with enhanced flavour sensitivity, exceptional energy resolution and high statistics, which operates on a medium-baseline and could be uniquely tuned to uncover evidence of neutrino decay. We consider the signature of $\nu 3$-decay on the neutrino oscillation spectrum in the case of (1) invisible decay, where the daughter states are not observable; and (2) visible decay, where the daughter states are active neutrinos. We comment on how neutrino decay models can be embedded into larger consistent theories.

T 116.5 Thu 16:50 POT/0251

**Decoherence Effects of Reactor Neutrinos** — •Raphael Krüger — Theoretical Astroparticle Physics at IAP, Karlsruhe Institute of Technology, Karlsruhe, Germany

In the most common theoretical formulation of Neutrino Oscillations neutrinos are described by plane waves. Although this formulation gives the correct oscillation formula verified by experiments it must be considered physically wrong. Several conceptual problems of the plane wave treatment, i.e. violated Lorentz invariance, can be avoided if one uses the QFT with external wave packets approach. There decoherence effects automatically emerge from the formalism. These decoherence effects depend on the localizations of the external particles and are negligible for the standard mass splittings.

This work focuses on reactor neutrino experiments and whether decoherence effects may play a role for the mixing with a potential light sterile neutrino. First, the localizations of the external particles are estimated on physical grounds. Using these results, the decoherence effects on the spectrum of the measured positron in the detector are analysed. Here this work makes use of a consistent treatment of the problem starting from basics feynman rules and without the use of normalizations introduced by hand. The results give no observable decoherence effects.

T 116.6 Thu 17:05 POT/0251

**Light new particles in tritium beta decay** — •Philipp Goller, Syuhei Iguro, and Ulrich Nierste — Institut für Theoretische Teilchenphysik (TTP), Karlsruhe Institute of Technology (KIT)

A hypothetical new light particle $S$ interacting with neutrinos can be produced in the tritium beta decay studied in the KATRIN experiment. Near the kinematic endpoint the presence of various small energy scales (neutrino mass and energy, mass of $S$) require a careful treatment of the phase space integral. I present the prediction for the differential decay rate in the region probed by KATRIN and discuss the shape of the electron energy spectrum for different mass scenarios.