T 102: Neutrino Physics IX

Time: Friday 9:00–10:30 Location: VG 3.104

T 102.1 Fri 9:00 VG 3.104

Sensitivity determination for neutron flux measurements in the LEGEND experiment — •Loris Steinhart — University Tübingen, Tübingen Germany

The next phase of the Large Enriched Germanium Experiment for Neutrinoless Double-Beta Decay (LEGEND) aims to achieve unprecedented background suppression, making accurate neutron flux measurements within the detector array critical. This contribution focuses on sensitivity studies for determining the neutron flux using a Gadolinium-loaded polyethylene (GdPE) string integrated into the detector setup. This talk will present the methodology, simulation results, and initial experimental efforts, highlighting the impact of this measurement on understanding neutron-induced backgrounds and optimizing the LEGEND setup for maximum sensitivity to search for the $0\nu\beta\beta$ decay signal.

T 102.2 Fri 9:15 VG 3.104

Implementation of the Pulse Shape Discrimination Classifier within the JuLeAna Software Stack for LEGEND-200 — •Verena Aures[1], Florian Henkes[1], Felix Hagemann[2], and Susanne Mertens[1] — [1]Technische Universität München, Deutschland — [2]Max Planck Institut für Physik, Garching bei München, Deutschland

The Large Enriched Germanium Experiment for Neutrinoless $\beta\beta$ Decay (LEGEND) searches for neutrinoless double-beta decay using high-purity germanium detectors enriched in ^{76}Ge, which serve as both the source and detector. The project's final phase, LEGEND-1000, aims to set a new limit on the half-life of ^{76}Ge exceeding 10^{28} years. The first phase, LEGEND-200, is currently running at the Laboratori Nazionali del Gran Sasso in Italy with its first results presented in 2024. The experimental sensitivity is enhanced by using pulse shape discrimination (PSD) techniques to distinguish signal-like from background-like events. This work focuses on the development and optimization of the A/E classifier, a PSD tool to efficiently reject multi-site events. The implementation was performed within the Julia-based software stack JuLeAna (Julia LEGEND Analysis), focusing on the classifier's performance and the evaluation of a charge trapping correction.

T 102.3 Fri 9:30 VG 3.104

The Liquid Argon Instrumentation of LEGEND-200: Background Rejection Performance — •Rosanna Deckert for the LEGEND-Collaboration — Technical University of Munich, Garching, Germany

LEGEND-200 is an experiment designed to search for neutrinoless double beta decay of Ge-76. Located deep underground at LNGS, it operates up to 200 kg of enriched high-purity germanium detectors in a liquid argon (LAr) cryostat. To achieve ultra-low backgrounds, the LAr is instrumented as an active volume to detect scintillation light emitted upon interactions with ionizing radiation, thus tagging and rejecting backgrounds. To provide insight into the rejection capability at different origins of scintillation light generation, we require proper modeling of light propagation throughout the experimental setup, from any origin in the LAr volume to its eventual detection by the light read-out system. The optical model must be tuned on special calibration data to match the observed photo electron yield. In this contribution, I will present a first analysis of special calibration runs that were performed to benchmark the optical simulations. Additionally, I will discuss the rejection performance of the LAr instrumentation in physics data.

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T 102.4 Fri 9:45 VG 3.104

KATRIN++ - Development of New Detector Technologies for a Future Neutrino Mass Experiment with Tritium — •Neven Kovac[1], Fabienne Adam[1], Beate Bornschein[1], Woosik Gil[1], Ferenc Glück[1], Svenja Heyns[1], Sebastian Kempf[2,3], Andreas Kopmann[3], Michael Müller[2], Rudolf Sack[1], Magnus Schlösser[1], Frank Simon[3], Markus Steidl[1], and Kathrin Valerius[1] — [1]Institute for Astroparticle Physics (IAP), Karlsruhe Institute of Technology (KIT) — [2]Institute of Micro- and Nanoelectronic Systems (IMS), Karlsruhe Institute of Technology (KIT) — [3]Institute for Data Processing and Electronics (IPE), Karlsruhe Institute of Technology (KIT)

Currently, the tightest constraints on the absolute scale of neutrino mass from a direct, model-independent approach, are obtained by the KATRIN experiment, giving an upper limit on the mass of the electron anti-neutrino of 0.45 eV (https://doi.org/10.48550/arXiv.2406.13516), with final projected sensitivity below 0.3 eV. Going beyond this limit, and probing the inverted mass ordering (and beyond), will be the task for future neutrino mass experiments. In this regard, development of new detector technologies is of utmost importance, with quantum sensor arrays currently being the front runners due to their exceptional performance and excellent energy resolution. We report on our R&D efforts aiming to demonstrate the feasibility of developing and operating large quantum sensor arrays for detection of external electrons in a KATRIN-like setup, as a basis for the next generation neutrino mass experiments with tritium.

T 102.5 Fri 10:00 VG 3.104

Determination of the absolute nuclear transition energies of ^{83m}Kr using the gaseous krypton source of KATRIN — •Benedikt Bieringer and Matthias Böttcher for the KATRIN-Collaboration — Institut für Kernphysik, Universität Münster

The KATRIN experiment aims to measure the electron neutrino mass m_ν with $0.3\,\mathrm{eV}/c^2$ (90% C.L.) sensitivity after 1000 measurement days in 2025, by measuring the T_2 β spectrum near its endpoint E_0 and performing a fit including parameters E_0 and m_ν^2. Since these are highly correlated, systematic effects influencing the obtained m_ν will also manifest in E_0 and the derived T_2 Q value. Comparing this with the $T-{}^3$He mass difference from Penning-trap measurements is therefore a valuable for cross checks of our experimental procedure. Determining the KATRIN Q value with high precision requires calibration of the experimental energy scale with ^{83m}Kr conversion electrons. This is limited by knowledge of ^{83m}Kr nuclear transition energies, being known to 0.3 eV precision in the literature. The excited nucleus of ^{83m}Kr decays via a two-step cascade of 32.2 keV and 9.4 keV highly converted γ transitions, and a weak direct transition. With a gaseous Kr source, a measurement of conversion electrons from all three transitions was performed in 2023 at KATRIN. Following the method described in ref. EPJ C 82 (2022) 700 the nuclear transition energies can be determined, which can allow for a reduction of the T_2 Q value uncertainty to 0.1 eV. In this talk, we present the analysis of the measurement. This work is supported by the Helmholtz Association and BMBF (grant numbers ErUM-Pro 05A23PMA, 05A23PX2, 05A23VK2 and 05A23WO6).

T 102.6 Fri 10:15 VG 3.104

^{83m}Kr N-line spectrum measurement at KATRIN — •Jaroslav Storek[1] and Matthias Böttcher[2] for the KATRIN-Collaboration — [1]Institute for Astroparticle Physics, Karlsruhe Institute of Technology — [2]Institute of Nuclear Physics, University of Münster

Conversion electrons from ^{83m}Kr are used as a versatile calibration tool in a range of different (astro-)particle physics experiments. Favourable properties are the short half-life and narrow line spectrum of 83m-Kr as a nuclear standard. In the KArlsruhe TRItium Neutrino experiment (KATRIN) which currently provides the best direct neutrino mass upper limit of 0.45 eV/c^2 (90% C. L.), several systematic uncertainties are studied by a shape distortion of the quasi monoenergetic ^{83m}Kr spectrum. This creates high demands on precise knowledge of the undistorted spectrum.

In KATRIN we use the 32 keV N-lines lying in the high energy region of the spectrum including the weaker N_1 line. Results of a dedicated measurement of the ^{83m}Kr electron N-spectrum with emphasis on N_1 line and adjacent shake lines will be presented in this talk.

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