HK 20: Astroparticle Physics II

Time: Tuesday 15:45–17:15 Location: HBR 19: C 103

Group Report HK 20.1 Tue 15:45 HBR 19: C 103

LEGEND: Background-free hunt for the neutrinoless double-beta decay — •Luigi Pertoldi for the LEGEND-Collaboration — Department of Physics, TUM School of Natural Sciences, Technische Universität München, 85748 Garching b. München, Germany

The discovery that neutrinos are Majorana fermions would have profound implications for particle physics and cosmology. The Majorana character of neutrinos would make neutrinoless double-beta ($0\nu\beta\beta$) decay, a matter-creating process without the balancing emission of antimatter, possible. The LEGEND Collaboration pursues a phased, ^{76}Ge-based double-beta decay experimental program. The first phase, LEGEND-200, deploys up to 200 kg of germanium detectors enriched in ^{76}Ge. A background index of $2 \cdot 10^{-4}$ counts/(keV kg yr) will be achieved. With that background index, when integrated over the exposure, less than one background event in the region around the expected peak position of the $0\nu\beta\beta$ decay will be accumulated. It constitutes a quasi-background-free operation of LEGEND-200, enabling a potential discovery of the $0\nu\beta\beta$ decay at a half-life of at least 10^{27} years. The second phase, LEGEND-1000, will deploy 1000 kg of enriched germanium and reach a discovery potential above 10^{28} years. This talk will portray the LEGEND project and its goals. Furthermore, first results from the currently ongoing data-taking period of LEGEND-200 are presented. This research is supported by the DFG through the Excellence Cluster ORIGINS EXC 2094-390783311, the SFB1258, and by the BMBF Verbundprojekt 05A2023.

HK 20.2 Tue 16:15 HBR 19: C 103

Low-depolarizing Neutron Supermirrors — •Karina Bernert for the PERC-Collaboration — Physik-Department, Technische Universität München, Germany

Measurements of free neutron decay enable a variety of tests of the Standard Model of particle physics. Among the observables is the parity-violating beta asymmetry A, i.e. the angular distribution of the beta particles with respect to the neutron spin, with which one can test the unitarity of the quark-mixing Cabibbo-Kobayashi-Maskawa matrix.

The new PERC (Proton Electron Radiation Channel) facility is currently being set up at the research reactor FRM II of the Heinz Maier-Leibnitz Zentrum in Garching, with the aim to measure correlation coefficients one order of magnitude more precisely than previous experiments.

PERC crucially requires low-depolarizing neutron mirrors at the level of 10^{-4}, such that the polarized neutron beam stays sufficiently polarized inside the decay volume. I show preliminary results of a measurement campaign at the ILL PF1b beam line last summer, in which we used the Opaque Test Bench setup to determine the depolarizing effect of different supermirrors. With these measurements we prove that the supermirrors are suitable for the use in PERC and in other experiments that require low depolarization.

HK 20.3 Tue 16:30 HBR 19: C 103

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

The KATRIN experiment aims to measure the electron neutrino mass m_ν with 0.3 eV/c^2 (90% C.L.) sensitivity after 1000 measurement days in 2025, by measuring the Tr beta 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 Tr Q value. The latter is therefore valuable for cross checks of our experimental procedure. The KATRIN Q value can be determined by absolute calibration with $^{83\mathrm{m}}$Kr conversion electron lines. This is limited by knowledge of $^{83\mathrm{m}}$Kr nuclear transition energies, being known to 0.3 eV precision in literature. The excited nucleus of $^{83\mathrm{m}}$Kr decays via two-step cascade of 32.2 keV and 9.4 keV highly converted gamma transitions, and a suppressed direct transition. Using a gaseous Kr source at KATRIN, a new measurement of conversion electron lines from all three transitions was performed in 2023. 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 Tr Q value uncertainty to below 0.1 eV. In this talk the result of the new measurement is presented. This work is supported by Helmholtz Association and Ministry for Education and Research BMBF (grant numbers 05A23PMA, 05A23PX2, 05A23VK2, and 05A23WO6).

HK 20.4 Tue 16:45 HBR 19: C 103

Tracking of the spatial magnetic field distribution and equipment motion effects for the Fermilab Muon g-2 experiment — •Mohammad Ubaidullah Hassan Qureshi, René Reimann, and Martin Fertl for the Muon g–2-Collaboration — Institute of Physics and Cluster of Excellence PRISMA+, Johannes Gutenberg University Mainz, 55099 Mainz, Germany

The Fermilab Muon g-2 experiment, targets a precision of 140 ppb in measuring the muon's anomalous magnetic moment. Muons undergo cyclotron motion and spin precession in a ring-shaped quasi-Penning trap within a 1.45 T uniform magnetic field. The measurement determines a ratio of two frequencies: the anomalous spin precession frequency of muons (ω_a) and the muon-weighted spin precession frequency of protons ($\tilde{\omega}_p$), representing the magnetic field experienced by these muons. Magnetic field measurements are mainly based on nuclear magnetic resonance (NMR) systems.

This presentation will focus on two crucial sub-systems in the magnetic field measurement chain, the trolley probe and fixed probe systems, providing periodic and continuous magnetic field measurements, respectively. We will go through the procedure for synchronizing measurements from these sub-systems in time and discuss the removal of the trolley system's magnetic signature, due to its motion, in the fixed probes system.

HK 20.5 Tue 17:00 HBR 19: C 103

Development of a Neural-Network-Based Event Reconstruction for the RadMap Telescope — •Luise Meyer-Hetling[1], Liesa Eckert[1], Peter Hinderberger[1], Martin J. Losekamm[1], Stephan Paul[1], Thomas Pöschl[3], and Sebastian Rückerl[2] — [1]School of Natural Sciences, Technical University of Munich, Garching, Germany — [2]School of Engineering and Design, Technical University of Munich, Ottobrunn, Germany — [3]CERN, Geneva, Switzerland

The RadMap Telescope is a compact multi-purpose radiation detector developed to provide near real-time monitoring of the radiation aboard crewed un uncrewed spacecrafts. A first prototype is currently deployed on the International Space Station for an in-orbit demonstration of the instrument's capabilities. Its main sensor consists of a stack of scintillating-plastic fibers whose perpendicular configuration allows the three-dimensional tracking and identification of cosmic-ray ions by reconstruction of their energy-loss profiles. We trained a set of neural networks on simulated detector data and assembled them into an analysis framework to perform an event-by-event reconstruction of track parameters, ion type and energy. In addition to our current offline analysis, we plan to implement the framework on the instrument's flight computer to analyze measurements without requiring the transmission of raw data to Earth. In this contribution, we will describe our neural-network-based reconstruction methods and present first results. Our work is funded by the German Research Foundation (DFG, project number 414049180) and under Germany's Excellence Strategy - EXC2094 - 390783311.