T 68: Neutrino physics without accelerators III

Time: Wednesday 16:00–18:20 Location: Tr

Group Report T 68.1 Wed 16:00 Tr

Search for Neutrinoless Double-Beta Decay with LEGEND-200 — •Michael Willers for the LEGEND-Collaboration — Max-Planck-Institut für Physik, Föhringer Ring 6, D-80805 München.

The **L**arge **E**nriched **G**ermanium **E**xperiment for **N**eutrinoless $\beta\beta$ **D**ecay (LEGEND) is a proposed ton-scale ^{76}Ge-based neutrinoless double-beta decay experimental program with discovery potential at a half-life greater than 10^{28} years.

The first 200-kg phase (LEGEND-200) is currently under construction at the Gran Sasso underground laboratory (Laboratori Nazionale del Gran Sasso, LNGS, Italy) and commissioning of the experiment is scheduled to start in 2021. With a background index in the signal region of interest around $Q_{\beta\beta} = 2039$ keV of $2 \cdot 10^{-4}$ cts/(kev kg yr) and a data-taking period of 5 years, LEGEND-200 is expected to achieve a half-life sensitivity of 10^{27} years. In this contribution, results from a first integration test (the so-called *Post-GERDA Test*) conducted in summer of 2020 as well as the current status of the experiment will be presented.

This work is supported in part by the Max-Planck Society, the German Federal Ministry for Education and Research (BMBF) and the German Research Foundation (DFG) via the *SFB1258* and the cluster of excellence *ORIGINS*.

T 68.2 Wed 16:20 Tr

Usage of PEN as self-vetoing structural material in the LEGEND-1000 experiment — •Luis Manzanillas Velez for the PEN-Collaboration — Max-Planck-Institut für Physik

PEN is an industrial polyester plastic interesting for the physics community as a new type of wavelength shifting plastic scintillator. Recently, PEN structures with good radiopurity and attenuation length have been successfully produced using the injection compression moulding technology. This opens the possibility for usage of PEN as optically active structural components in low-background experiments such as the LEGEND experiment. The ongoing R&D on PEN will be outlined with focus on the evaluation of the optical properties PEN. In addition, the ongoing efforts for application of PEN in the LEGEND-1000 experiment will be presented.

T 68.3 Wed 16:35 Tr

The cosmic muon induced background in LEGEND-1000 — •Moritz Neuberger, Luigi Pertoldi, Stefan Schönert, and Chrstoph Wiesinger — Physik-Department, Technische Universität München, Garching

In-situ production of long-lived isotopes by cosmic muon interactions may generate a non-negligible background for deep underground rare event searches. Depending on the depth, this might limit the sensitivity of next generation experiments, if no additional background identification techniques are implemented. One of those experiments is the LEGEND-1000 experiment (Large Enriched Germanium Experiment for Neutrinoless double beta Decay). Previous Monte Carlo studies identified the delayed decay of $^{77(m)}$Ge as dominant cosmogenic background in the search for neutrinoless double beta decay of ^{76}Ge [1]. Studies of this depth-dependent background, with special focus on the current LEGEND-200 site are carried out. Various background mitigation strategies, including different geometries, xenon doping and active rejection cuts are under study to increase the virtual depth.

[1] C. Wiesinger et al., Eur.Phys.J.C 78 (2018) 7, 597

T 68.4 Wed 16:50 Tr

The Large Enriched Germanium Experiment for Neutrinoless double beta Decay - LEGEND-1000 — •Christoph Wiesinger for the LEGEND-Collaboration — Physik-Department, Technische Universität München, Garching

Hidden by their tiny mass, neutrinos may carry a profound secret with far-reaching consequences for both particle physics and cosmology. Given zero electric charge and no color, they may be Majorana particles - fermions which are their own anti-particles. Double beta decay offers a unique probe for this hypothesis. Finding no neutrinos, but solely two electrons carrying the full decay energy, would prove lepton number non-conservation and reveal the Majorana character of neutrinos. The superb spectroscopic performance of high-purity germanium detectors provides exceptional discovery potential for the mono-energetic peak and separates it from the standard-model allowed continuum. Event topology information and outstanding intrinsic radiopurity allow for an ultra-low background level. Following the initial 200-kg phase, LEGEND-1000 will expand the reach of current neutrinoless double beta decay experiments by two orders of magnitude, beyond 10^{28} years of half-life, probing the full parameter space spanned by the inverted ordering scenario. The status of the LEGEND experimental program, as well as the requirements and challenges for the ton-scale phase will be covered in this talk. This work has been supported in part by the German Federal Ministry for Education and Research (BMBF), the German Research Foundation (DFG) via the SFB1258 and the Max Planck Society (MPG).

T 68.5 Wed 17:05 Tr

Pulse Shape Analysis in GERDA — •Vikas Bothe for the GERDA-Collaboration — MPIK Heidelberg

The GERDA experiment searches for the neutrinoless double- beta decay of ^{76}Ge using enriched high purity Germanium diodes as a source as well as a detector. For such a rare event search, the sensitivity of the experiment can be improved by employing active background suppression techniques. The time-profile analysis of the signals, called pulse shape analysis (PSA), generated by energy deposits within the detectors is employed to discriminate signal and background events. The PSA can highly reject background events like alpha particles and Compton scattered photons while preserving a high signal efficiency for $2\nu\beta\beta$-like events.

In Phase II, GERDA operated 44.2 kg HPGe detectors which included 6 semi-coaxial detectors, 5 inverted coaxial detectors, and 30 point-contact BEGe detectors. Different pulse shape analysis techniques were employed for these three types of detectors due to their different geometries. I will discuss the results from the pulse shape analysis of these detectors after the final data unblinding from May 2020.

T 68.6 Wed 17:20 Tr

Statistical methods for the final data analysis of GERDA — •Lolian Shtembari[1], Allen Caldwell[1], Matteo Agostini[2], and Oliver Schulz[1] for the GERDA-Collaboration — [1]Max Planck Institute for Physics, Munich, Germany — [2]Department of Physics and Astronomy, University College London, London, UK

The GERmanium Detector Array (GERDA) experiment investigated the Majorana nature of neutrinos by searching for the lepton-number-violating neutrinoless double-β ($0\nu\beta\beta$) decay of 76Ge. We present the statistical analysis of the data collected during all of GERDA's operational time. Through Bayesian Hierarchical modelling we investigated some challenging key aspects in the search for rare-processes: evaluating the discovery potential power, the limit setting power on the signal rate and the goodness of fit of the background for models with data sets consisting of a small number of events. The topics selected include the systematic variations in the results due to the choice of fit models. Order statistics and the Bayes factor are used as tools to study the background goodness of fit and the signal discovery potential.

T 68.7 Wed 17:35 Tr

Investigating the background of Ge neutrino experiments by ^{76}Ge(n,p)^{76}Ga reaction studies — •Hans Hoffmann[1], Marie Pichotta[1], Konrad Schmidt[2], Steffen Turkat[1], Birgit Zatschler[1], and Kai Zuber[1] — [1]TU Dresden IKTP, Dresden, Deutschland — [2]HZDR, Dresden, Deutschland

Several neutrino experiments, e.g. GERDA, are searching for the neutrinoless double beta decay of ^{76}Ge. The discovery of this extremely rare process with an expected Q-value of 2039 keV would prove the Majorana character of neutrinos and consequently physics beyond Standard Model. For an explicit identification of a signal caused by the neutrinoless double beta decay a precise understanding of the background components is crucial.

Previous work indicates gamma rays from the decay of ^{76}Ga in the region of interest (ROI) which can be produced by neutrons via (n,p)-reactions with ^{76}Ge and therefore contribute to the background in the ROI. For the investigation of this potential background an enriched Ge-sample is activated by neutrons from a DT generator located at the Helmholtz-Zentrum Dresden-Rossendorf (HZDR). Experimental procedure and preliminary works will be presented. This project is supported by BMBF (05A17OD1).

T 68.8 Wed 17:50 Tr

Simulation of the liquid argon veto system in Gerda and beyond — •Luigi Pertoldi[1,2] and Christoph Wiesinger[1] for the GERDA-Collaboration — [1]Physik-Department, Technische Universität München, Garching — [2]INFN Padova, 35131 Padua, Italy

Liquid argon (LAr) is widely employed in physics experiments as an active detector medium, thanks to its scintillation properties. In the Gerda experiment, LAr has served the three-fold role of cooling liquid for germanium detectors, passive and active shield against backgrounds. This technology choice has proven to be an effective background suppression strategy for Gerda to search for neutrinoless double-beta decay ($0\nu\beta\beta$) of ^{76}Ge in a background-free regime. In order to characterize the LAr veto system, a Monte Carlo framework has been developed to simulate the propagation of scintillation photons in the experimental setup and determine the expected veto condition for various event types. Data from special calibration runs is used to compensate for unknown optical parameters and effectively tune the simulation. Based on these expectations, a full background model of physics data has been obtained. This model provides insights on the background composition in the region of interest for the $0\nu\beta\beta$ search and is a fundamental input to exotic physics searches in the full energy range. In this talk, I will review the tools and the techniques developed to model the Gerda LAr veto system and present preliminary results. This work has been supported in part by the Italian Ministry of University and Research (MIUR), The Istituto Nazionale di Fisica Nucleare (INFN), BMBF and DFG via the SFB1258.

T 68.9 Wed 18:05 Tr

Search for 0νECEC of ^{36}Ar in GERDA Phase II — •Michele Korosec, Elisabetta Bossio, and Christoph Wiesinger for the GERDA-Collaboration — Physik-Department, Technische Universität München, Garching

The main objective of the GERmanium Detector Array (GERDA) experiment at the Laboratori Nazionali del Gran Sasso (LNGS, Italy) is to prove the Majorana nature of neutrinos through the discovery of the lepton-violating neutrinoless double-beta decay of ^{76}Ge. Similarly, an ^{36}Ar atom can capture two electrons in a process called neutrinoless double electron capture (0νECEC) which likewise can be studied in the GERDA experiment.
The GERDA Phase I analysis of 0νECEC in ^{36}Ar resulted in the current best lower limit for the half-life of $T_{1/2} > 3.6 \times 10^{21}$ years [1] for this process. The introduction of the liquid argon veto system in Phase II allowed for a significant background reduction compared to Phase I. Additionally, Phase II of the experiment offers more than four times the exposure.
According to a preliminary estimate, the Phase II sensitivity will double the Phase I result. The current status quo on the analysis of 0νECEC of ^{36}Ar in GERDA Phase II will be presented in this contribution. This work has been supported in part by the German Federal Ministry for Education and Research (BMBF) and the German Research Foundation (DFG) via the SFB1258.

[1] GERDA Collaboration, Eur.Phys.J.C 76 (2016) 12, 652