# T 33: Neutrino physics 4

Time: Tuesday 16:00–18:00 Location: Geb. 30.21: Gerthsen-HS

T 33.1 Tue 16:00 Geb. 30.21: Gerthsen-HS

**Use of micro-structured filters to explore the KATRIN background** — •Dominic Hinz for the KATRIN-Collaboration — Karlsruhe Institute of Technology (KIT)

The key goal of the KATRIN experiment is the measurement of the absolute mass scale of neutrinos with an unprecedented sensitivity of better than $0.3\,\mathrm{eV/c^2}$. Currently, the measured background level exceeds the design value, wherefore a detailed understanding of background processes in the large main spectrometer is required. According to our prior model, background events originate from Hydrogen Rydberg states, generated by the decay of surface-implanted $^{210}$Pb, on the main spectrometer vessel surface. Thermal radiation can ionise such long-lived, highly excited states, resulting in low-energy electrons on the meV-scale. These are then accelerated by the retarding potential, thus possess small transverse energy, which is in contrast to signal beta-electrons. We have performed measurements with a passive transverse energy filter (pTEF) implemented as a micro-structured honeycomb gold plate.
This talk discusses the observed transmission of background electrons through the pTEF at different magnetic field values and compares the initial and refined background model.
This work is supported by the Helmholtz Association and by the Ministry for Education and Research BMBF (grant numbers 05A23PMA, 05A23PX2, 05A23VK2, and 05A23WO6)

T 33.2 Tue 16:15 Geb. 30.21: Gerthsen-HS

**Reduction of Rydberg background in KATRIN by stimulated de-excitation using THz radiation** — •Shivani Ramachandran, Enrico Ellinger, and Klaus Helbing — Bergische Universität Wuppertal (BUW)

The key requirement for the KArlsruhe TRItium Neutrino experiment (KATRIN) to reach its goal sensitivity of 200 meV at 90% (C.L.) in measuring the effective electron anti-neutrino mass is minimising the background which currently exceeds the estimated design value. In order to achieve this and eliminate some known contributors, several background suppression methods have already been implemented. The dominant contribution to the background in the measured signal are electrons produced by thermal ionization of Rydberg atoms. These atoms originate from the walls of the main spectrometer vessel by radioactive decays of a $^{210}Pb$ contamination. THz radiation can be used for stimulated de-excitation inducing $\Delta n = 1$ transitions, which can lead to shorter lifetimes of Rydberg atoms. Different species of excited atoms are sputtered from the walls of the vessel which can lead to two-electron excited states. The influence of THz radiation on such states are investigated. The development and measurements from the test setup built in University of Wuppertal (BUW), as a proof of principle for THz-induced de-excitation is discussed.

T 33.3 Tue 16:30 Geb. 30.21: Gerthsen-HS

**Background investigations for keV sterile neutrino search at KATRIN** — •Moritz Puritscher for the KATRIN-Collaboration — Karlsruhe Institute of Technology (KIT)

Starting in 2026, the KATRIN experiment aims to measure the kink-like distortion of a keV-scale sterile neutrino in the tritium beta spectrum. In order to search for such a signal with the KATRIN setup several changes to the beamline are necessary. The integration of the modular TRISTAN detector into the KATRIN beamline can lead to deteriorated vacuum conditions at the main spectrometer. Together with changed electromagnetic settings at the main spectrometer, the amount of background electrons that are mapped onto the detector is expected to change. To study the effect of these changes on the overall background level, a set of background measurements at different retarding potentials and pressures was performed. Overall, only a slight increase of background at an elevated pressure of $10^{-9}$ mbar can be observed. However, changed trapping conditions for electrons at elevated pressure and low retarding potential can significantly increase the background rate.
This work is supported by the Helmholtz Association and by the Ministry for Education and Research BMBF (grant numbers 05A23PMA, 05A23PX2, 05A23VK2, and 05A23WO6)

T 33.4 Tue 16:45 Geb. 30.21: Gerthsen-HS

**Machine Learning for background discrimination in LEGEND200** — •Sean Sullivan — MPIK, Heidelberg, Germany

The development of Neural Networks has generated an array of powerful analysis techniques for modern scientific experiments. Particularly in areas of classification and background reduction. This talk will discuss the application of such techniques to the LEGEND200 experiment for neutrinoless double beta decay: an as yet unobserved process beyond the standard model for which background reduction is a keystone. LEGEND200 employs High Purity Germanium detectors enriched in Germanium-76 operated in a liquid argon cryostat. Important backgrounds that must be excluded include multi-site events and surface alphas. Established methods for dealing with these backgrounds can be compared with Machine Learning techniques.

T 33.5 Tue 17:00 Geb. 30.21: Gerthsen-HS

**Cosmogenic Background Suppression in LEGEND-1000** — •Moritz Neuberger and Stefan Schönert for the LEGEND-Collaboration — Physik-Department E15, Technische Universität München, James-Franck-Straße, 85748 Garching

The in-situ production of long-lived radioactive isotopes by cosmic muons can generate a non-negligible background for deep underground rare event searches. The delayed decay of $^{77(m)}$Ge is the primary in-situ cosmogenic contributor for a neutrinoless double-beta decay search with $^{76}$Ge [1]. The upcoming ton-scale LEGEND-1000 experiment requires a total background of $< 10^{-5}$ cts/(keV·kg·yr) [2]. A combination of passive and active background suppression techniques has been developed using Monte Carlso studies, which show a potential reduction of the background contribution approximately $2 \cdot 10^{-5}$ cts/(keV·kg·yr) to $4 \cdot 10^{-7}$ cts/(keV·kg·yr) without significantly decreasing the selection efficiency for neutrinoless double-beta decay [3]. We acknowledge support by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) under Germany's Excellence Strategy - EXC 2094 - 390783311 and through the Sonderforschungsbereich (Collaborative Research Center) SFB1258 'Neutrinos and Dark Matter in Astro- and Particle Physics'.

[1] C. Wiesinger et al., Eur. Phys. J. C (2018) 78: 597
[2] LEGEND-1000 pCDR, arXiv 2107.11462
[3] M. Neuberger et al., Constraining the 77(m)Ge Production with GERDA Data and Implications for LEGEND-1000, TAUP2023, poster presentation

T 33.6 Tue 17:15 Geb. 30.21: Gerthsen-HS

**Development of 3D-printable Plastic Scintillators** — •Tobias Woell[1] and Daniel Muenstermann[1,2] — [1]Hochschule RheinMain, FB ING, Wiesbaden — [2]Lancaster University, Physics Department, Lancaster, UK

3D-printing has many benefits and allows to create complex-shaped objects without the need for machining. In low-background experiments (e.g. LEGEND), radiopure scintillators are required, and machining potentially introduces additional contamination. SLA/DLP is a 3D-printing process that uses liquid reactants which could be (radio-)purified by various methods if necessary while classical plastic scintillators produced by casting or injection moulding usually require machining to match the required shapes. However, since the synthesis of polymers in SLA/DLP differs from the classical methods, the properties of the printed pieces may also be different and need to be assessed.

The presentation outlines the properties needed to create 3D-printable scintillators and features optical and mechanical characterisation results of initial samples in comparison to classical reference samples.

T 33.7 Tue 17:30 Geb. 30.21: Gerthsen-HS

**Search for the DSNB in JUNO: Development of new Methods for Background Event Identification** — •Matthias Mayer[1], Lothar Oberauer[1], Hans Steiger[1,2], Simon Basten[1], David Dörflinger[1], Ulrike Fahrendholz[1], Meishu Lu[1], Vincent Rompel[1], Konstantin Schweizer[1], Luca Schweizer[1], Korbinian Stangler[1], and Raphael Stock[1] — [1]Physik-Department, TU München, James-Frank-Str. 1, 85748 Garching b. München, Deutschland — [2]PRISMA+ Cluster of Excellence, Staudingerweg 9, 55128 Mainz, Deutschland

The diffuse supernova neutrino background (DSNB) describes the constant flux of neutrinos from past core-collapse supernovae over the visible universe. The Jiangmen Underground Neutrino Observatory (JUNO), a 20 kton liquid scintillator detector, plans to detect the DSNB in the inverse beta decay (IBD) detection channel. While other $\bar{\nu}_{\mathrm{e}}$ sources will cause irreducible IBD background, we plan to reduce non-IBD backgrounds such as neutron-induced events and NC interactions of atmospheric neutrinos by careful pulse-shape discrimination (PSD). In this talk, I compare the performance of different PSD techniques in the prospect of increasing the fiducial volume available for the DSNB search with an outlook into the energy dependence of the neutron flourescence time profile in the JUNO scintillator and a look into our recent publication regarding the DSNB detection potential. This work has been supported by the Clusters of Excellence PRISMA+ and ORIGINS as well as the DFG Collaborative Research Center "NDM" (SFB1258) and the DFG Research Units 2319 and 5519.

T 33.8 Tue 17:45 Geb. 30.21: Gerthsen-HS

**Detection of Cherenkov and Scintillation light in hybrid scintillators** — •Dorina Zundel and Michael Wurm — Johannes Gutenberg-Universität Mainz, Institute of Physics and Cluster of Excellence PRISMA+, Staudingerweg 7, 55128 Mainz

Hybrid scintillator detectors aim at the simultaneous detection of Cherenkov and scintillation light. SCHLYP (Scintillation Cherenkov Light Yield Prism) is a newly developed laboratory setup, used to distinguish Scintillation and Cherenkov light in scintillator samples. The setup uses the geometrical advantages of a hollow prism filled with scintillator as a detector, equipped with three ultra-fast photomultipliers, on each side. The photomultipliers have a rise time of a nanosecond and a transit time spread of 200ps. Photons from a close-by $^{137}$Cs source create a signal by Compton scattering in the scintillator. Using a secondary inorganic scintillator detector, recoil electrons are selected to be aligned with the prism geometry, so that two of the PMTs detect both Cherenkov and Scintillation light, while the third PMT is only able to detect scintillation light. In this talk the improved setup and the analysis of first data will be presented.