# T 81: Neutrinophysik 7 (Doppelbetazerfall, sterile Neutrinos)

Zeit: Mittwoch 16:45–19:10 Raum: VSH 118

**Gruppenbericht** T 81.1 Mi 16:45 VSH 118

**Background free search for neutrinoless double beta decay with GERDA Phase II** — •CHRISTOPH WIESINGER for the GERDA-Collaboration — Physik-Department and Excellence Cluster Universe, Technische Universität München, James-Franck-Straße, 85748 Garching

An observation of neutrinoless double beta decay would allow to shed light onto the nature of neutrinos. GERDA (GERmanium Detector Array) is operating isotopically enriched high purity germanium detectors bare in liquid argon and is aiming to perform a background-free search for this process in $^{76}$Ge. A signal would manifest in a monoenergetic peak in the summed electron spectrum. GERDA is located at the Laboratori Nazionali del Gran Sasso (LNGS) of INFN in Italy and follows a staged approach. In Phase II 35.6 kg of enriched germanium detectors are operated. The application of active background rejection methods, such as a liquid argon scintillation light read-out and pulse shape discrimination of germanium detector signals, allowed to reduce the background index to the intended level of $10^{-3}$ cts/(keV·kg·yr). In the first five month 10.8 kg·yr of exposure were accumulated. No signal has been found and together with data from Phase I a new limit for the neutrinoless double beta decay half-life of $^{76}$Ge of $5.3 \cdot 10^{25}$ yr at 90% C.L. was established in June 2016. Phase II data taking is ongoing and will allow the exploration of half-lifes in the $10^{26}$ yr regime. The current status of the blinded data taking and an update on the background index will be presented. This work was partly funded by BMBF.

T 81.2 Mi 17:05 VSH 118

**Monte Carlo Geometry of GERDA Phase II** — •JANINA HAKENMÜLLER for the GERDA-Collaboration — Max-Planck-Institut für Kernphysik (MPIK), Saupfercheckweg 1, 69117 Heidelberg, Germany

The GERDA experiment is looking for neutrinoless double beta decay in Germanium. GERDA Phase II consists of 40 germanium diodes enriched in $^{76}$Ge and operated in liquid argon. The setup is equipped with a liquid argon veto, meaning a light instrumentation registers energy depositions of background sources in liquid argon.

The geometry of the GERDA setup is implemented into a Monte Carlo (MC) simulation in MaGe, based on Geant4. It is used e.g. to simulate spectra of possible contaminations for the background model. For GERDA Phase II analysis this geometry has been updated to the current 7 string setup and will be shown in the talk. To check the accuracy of this implementation, a weekly calibration run with 3 $^{228}$Th sources has been simulated. After a necessary optimization of the source positions a good agreement between MC and data was found for the integral count rate as well as the spectral shape.

Moreover, in the MC output of the simulations of the background contributions also the energy depositions in liquid argon are registered. By doing a cut on these energy depositions it can be tried to approximate the effect of the veto suppression in the MC. This comparison as well as the MC to data comparison of the $^{228}$Th calibration will be presented in the talk.

T 81.3 Mi 17:20 VSH 118

**Charaterization of a segmented broad energy prototype Germanium detector** — ALLEN CALDWELL, IRIS ABT, BELA MAJOROVITS, •XIANG LIU, CHRIS GOOCH, MARTIN SCHUSTER, and JINGLU MA — Max Planck Institut fuer Physik, Muenchen

High purity Germanium detector (HPGe) has been playing an important role in fundamental research, especially in the searches for neutrinoless double beta decay in Ge76 (GERDA, Majorana) and WIMP dark matter candidate (CDEX, CoGeNT). In both cases, background identification and reduction is very important and extremely challenging. A four-fold segmented broad energy (BEGe) prototype HPGe detector, SegBEGe, was designed at the Max Planck Institut fuer Physik (MPI) in Munich and fabricated at Canberra Lingolsheim (now Mirion Technologies (Canberra) SAS). Results from the characterization of this prototype SegBEGe are presented. Similar to a standard BEGe detector, it provides the information to distinguish so-called single-site and multi-site events through a standard pulse shape analysis. In addition, the mirror pulses recorded in segments without energy deposition make it possible to locate the energy deposition in the segment in between with a precision of up to mm. This could contribute to background identification for the future ton-scale Germanium detector experiment.

**Gruppenbericht** T 81.4 Mi 17:35 VSH 118

**Search for keV mass sterile neutrinos with the KATRIN experiment** — •TOBIAS BODE for the KATRIN-Collaboration — Max-Planck-Institut für Physik, Munich, Germany

Sterile neutrino are a well-motivated extension of the Standard Model of Particle Physics. They are experimentally accessible via the mixing with the known active neutrinos.

A sterile neutrino with a mass of $\mathcal{O}$(keV) is a promising dark matter candidate possibly solving the too big to fail and the cusp vs core problem. In addition to astrophysical searches by X-ray telescopes, several laboratory measurement have been proposed. One is the TRISTAN project pursued in the framework of KATRIN. The KATRIN (KArsrluhe TRitium Neutrino) experiment investigates the energy endpoint of the tritium beta-decay to determine the effective mass of the electron anti-neutrino with a precision of 200 meV (90 % *C.L.*) after an effective data taking time of three years.

The signature of a sterile neutrino would be a kink-like structure in the tritium beta-decay spectrum originating from the mixing with the active neutrino states.

The TRISTAN project will proceed in two phases. Phase-0 will use the standard KATRIN setup. Whereas Phase-I will use a greatly improved detector system which will reduce systematics and allow a high count rate, increasing statistics. An overview of the two measurement phases and the respective experimental sensitivities will be given.

T 81.5 Mi 17:55 VSH 118

**Silicon drift detector prototypes for the keV-scale sterile neutrino search with TRISTAN** — •KONRAD ALTENMÜLLER[1,2], TOBIAS BODE[3], OLIVIER GEVIN[2], MARC KORZECZEK[4], THIERRY LASSERRE[2,5], OLIVIER LIMOUSIN[2], DANIEL MAIER[2], SUSANNE MERTENS[3], and MARTIN SLEZAK[3] — [1]Physik Department, Technische Universität München — [2]CEA Saclay / IRFU, France — [3]Max-Planck-Institut für Physik, München — [4]IEKP, Karlsruher Institut für Technologie — [5]IAS, Technische Universität München

The TRISTAN project is an upgrade of the KATRIN experiment to search for the signature of keV-scale sterile neutrinos in the electron spectrum of tritium. Since the detector in the KATRIN setup is designed to count electrons within a controlled energy range rather than to do electron spectroscopy, a new detector and read-out system are needed. An array of up to 10 000 silicon drift detectors could meet the requirements of a few hundreds eV energy resolution and ultra-low electronics noise while handling a high electron flux at the same time. Prototypes of 7-pixel arrays with 20-30 nm deadlayer were produced in different designs by MPG Halbleiterlabor. In this talk the results of the characterization with a proven multichannel ASIC (IDeF-X by CEA), originally developed for spaceborne applications, and with an ultra-low noise ASIC by XGLab are presented; the achieved energy resolution, noise performance, and charge sharing characteristics are reported. Also the analysis methods and consequences for the final TRISTAN setup are discussed.

T 81.6 Mi 18:10 VSH 118

**Characterization of the detector dead layer for a sterile neutrino search with KATRIN** — •TIM BRUNST for the KATRIN-Collaboration — Max-Planck-Institut für Physik, Munich, Germany

The KATRIN (Karlsruhe Tritium Neutrino) experiment investigates the energy endpoint of the tritium beta-decay to determine the effective mass of the electron anti-neutrino with a precision of 200 meV (@90CL) after an effective data taking time of three years.

The TRISTAN (Tritium Beta Decay to Search for Sterile Neutrinos) group aims to detect a sterile neutrino signature by measuring the entire tritium beta decay spectrum with an upgraded KATRIN system. One of the greatest challenges is to measure all electron energies in the decay spectrum up to the endpoint at 18.6 keV with a resolution $<$ 300 eV (FWHM). Since systematic effects (e.g. detector backscattering) lead to drastic modifications of the measured energy spectrum, a thin dead layer ($<$30nm) at the entrance window of the detector is crucial for achieving high sterile neutrino sensitivities. Several prototype detectors have been manufactured at the Halbleiterlabor of the

Max-Planck-Society in Munich. The dead layer thickness will be determined by a combined analysis of simulated and measured data with dedicated proton and electron sources.

This talk gives first simulation results and an overview of the planned experimental implementation of the dead layer characterization.

T 81.7 Mi 18:25 VSH 118

**Backscattering on the KATRIN rear wall as a systematic effect for a keV sterile neutrino search** — •Ellen Förstner for the KATRIN-Collaboration — KIT

The main goal of the KArlsruher TRitium Neutrino experiment (KATRIN) is the determination of the effective electron anti-neutrino mass. The TRISTAN project of KATRIN focuses on a possible upgrade of KATRIN that would allow the search for sterile neutrinos up to the keV mass range. A keV-scale sterile neutrino would imprint itself as a kink-like distortion of the tritium beta decay spectrum. This signature is extremely small and therefore a very precise understanding of the theoretical and experimental systematic effects is necessary.

One systematic effect is caused by backscattering of beta-decay electrons on the gold rear wall of the KATRIN-setup. Backscattering of electrons causes an energy and angle change and hence significantly distorts the tritium beta decay spectrum.

The effect can be mitigated by the following countermeasures: 1) reduced magnetic field at the rear wall, 2) low-Z rear wall materials, 3) reduced tritium source strength. Using Kassiopeia and Geant4 Monte-Carlo simulations the influence of the rear wall on a keV-scale sterile neutrino search with KATRIN has been investigated and an optimized rear wall design has been developed. In this talk, the systematic effects related to the rear wall and the new mitigation techniques will be presented.

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T 81.8 Mi 18:40 VSH 118

**Impacts of magnetic traps in the source section of KATRIN on a sterile neutrino search** — •Felix Knapp for the KATRIN-Collaboration — Karlsruhe Institute of Technology (KIT)

The main goal of the **Ka**rlsruhe **Tri**tium **N**eutrino Experiment is the determination of the effective electron neutrino mass by measuring the endpoint of the energy spectrum of tritium beta decay electrons. With the search for a sterile neutrino in the keV-mass regime, the physical reach of the experiment can be extended. A sterile keV-scale sterile neutrino would imprint itself as a kink-like distortion of the tritium beta decay spectrum. However, this signature is of a very small value and therefore a very precise understanding of systematic effects is necessary. One effect is the appearance of magnetic traps in the KATRIN source. The electrons start in the windowless gaseous tritium source at a magnetic field of 450 Gs. This field is however not completely homogeneous. Local field minima create magnetic traps for electrons starting with a large pitch angle. All trapped electrons will eventually escape via two mechanisms: 1) Due to the high gradient of the magnetic field in a trap the guidance of an electron along the field lines is not fully adiabatic, resulting in chaotic angle changes, allowing the electron to escape. 2) The electrons can scatter with tritium molecules. Hereby also their angle can be changed and the electron is able to escape. Escaped electrons, that reach the detector would distort the spectral shape and hence impact the sensitivity of a sterile neutrino search. This Talk gives an insight on this systematic effect and its impact on the sensitivity of KATRIN to a sterile neutrino in the keV-mass range.

T 81.9 Mi 18:55 VSH 118

**Search for sterile neutrinos with IceCube DeepCore** — •Andrii Terliuk for the IceCube-Collaboration — DESY, Platanenallee 6, 15738 Zeuthen, Germany

Sterile neutrinos are a hypothetical neutrino species that could explain the tension between some accelerator, reactor and radiochemical neutrino experiments. They have no standard weak interactions. However, they can mix with the three standard neutrinos, resulting in a modification of the characteristic pattern of atmospheric neutrino oscillations. DeepCore is a densely instrumented region in the center of the IceCube Neutrino Observatory that has an energy threshold for neutrino detection about 10 GeV. We present the results of a search for an eV-scale sterile neutrino signal in the atmospheric neutrino oscillation pattern using three years of low-energy DeepCore data taken between 2011 and 2014.