T 56: Neutrinophysik 4 (Doppelbetazerfall und Massen)

Zeit: Dienstag 16:45–19:05 Raum: VSH 118

Gruppenbericht T 56.1 Di 16:45 VSH 118

Status and Perspectives of the COBRA Experiment — •Jan Tebrügge for the COBRA-Collaboration — Experimentelle Physik IV, TU Dortmund

The COBRA collaboration searches for neutrinoless double beta-decay. The detection of this decay would be a proof of lepton number violation and could answer several questions in neutrino physics. The collaboration operates a demonstrator setup at the Gran Sasso underground laboratory consisting of about 400g of CdZnTe detectors. This detector material is a commercially available room-temperature semiconductor. It contains nine double beta-decay isotopes, of which Cd-116 is the most promising one due to its high Q-value of 2813 keV. This talk gives an overview of the demonstrator and discusses the measurement of the fourfold-forbidden non-unique beta-decay of Cd-113. Its measurement allows the precise determination of the quenching of the g_A factor of this weak process. This dedicated investigation is being done at the moment. Furthermore, recent developments for the installation of the extended demonstrator (XDEM) are shown. XDEM will use larger detectors which have six times the volume of the current detectors. A new powerful tool for background reduction will be discussed which improves the veto capabilities of surface events by up to two orders of magnitude.

T 56.2 Di 17:05 VSH 118

Discrimination of single-site and multi-site events in CZT-CPG detectors for the COBRA experiment — •Stefan Zatschler for the COBRA-Collaboration — TU Dresden, Institut für Kern- und Teilchenphysik, Germany

The COBRA experiment is aiming to search for the rare neutrinoless double beta-decay ($0\nu\beta\beta$-decay) with CdZnTe detectors. Currently, a demonstrator setup is operated at the underground facility LNGS in Italy. Each monolithic detector of the 4×4×4 array is 1 cm^3 in size and equipped with a coplanar grid (CPG) readout. This demonstrator is used to characterize potential background components and to prove that stable operation over several years can be achieved. One key requirement for a high sensitivity is the ability to differentiate between signal and background events. In this context, pulse-shape analysis has been found to show excellent capabilities while maintaining a high signal efficiency. The $0\nu\beta\beta$-decay signal is expected to be almost always a single-site event (SSE) within only one detector. Hence, all multi-detector and multi-site events (MSEs), which are likely induced by multiply scattered photons in the same crystal, can be vetoed as background. The imprints on the recorded pulse-shapes caused by the drift of multiple, separated charge clouds can be used to discriminate those MSEs from signal-like SSEs. In this talk, an overview of the developed technique to discriminate between both event types will be presented. Additionally, the results of a dedicated laboratory experiment, which makes use of coincident Compton scattering to create a library of SSEs, as well as an efficiency estimate will be shown.

T 56.3 Di 17:20 VSH 118

The KATRIN Forward Beam Monitor Phase II commissioning — •Stephanie Hickford and Simon Schbotz for the KATRIN-Collaboration — Bergische Universität Wuppertal

The KATRIN collaboration aims to measure the neutrino mass with a sensitivity of 200 meV. This will be done by observing the β-electron spectrum from the decay of tritium. The tritium source properties need to be stable, and known to a high precision, in order to accurately measure the neutrino mass. For this reason the source will undergo extensive measurements from several monitoring systems.

The *Forward Beam Monitor* (FBM) is one such monitoring system. The Phase II commissioning of the FBM was recently carried out onsite at the KATRIN experiment. This commissioning phase was the first operation of the FBM in conjunction with the *Cryogenic Pumping Section* (CPS) of the KATRIN experiment, and covered three main measurement topics: Temperature influences, magnetic field scan, and absolute positioning. The data-taking procedure and results of these measurements will be presented.

T 56.4 Di 17:35 VSH 118

Optimization of detector arrays and the cryogenic platform for the ECHo experiment — •Clemens Hassel for the ECHo-Collaboration — Kirchhoff-Institute for Physics, Heidelberg University, Germany.

The Electron Capture in ^{163}Ho experiment ECHo aims to probe the electron neutrino mass on a sub-eV level via the analysis of the calorimetrically measured high statistics electron capture spectrum of ^{163}Ho. For this, metallic magnetic calorimeter arrays (MMC) will be used, which are operated at millikelvin temperatures. The performance achieved by first prototypes of MMC detectors show that an energy resolution of $\Delta E_{\rm FWHM} < 5$ eV and a signal rise time of $\tau < 1\ \mu s$ can be reached. These values, obtained with single channel read out, fulfill the requirements for the first phase of ECHo, ECHo-1k. The challenge is to keep the same performance using the multiplexed read out. We present the current status of the new design for the detector arrays to be used in ECHo-1k. This array design allows for parallel read out as well as for multiplexed read out. We discuss results obtained during the first characterization of these detectors. The first phase of ECHo will be performed in a new dedicated cryostat. The future plans for mounting read out cables and the the design for the installation of the array on the experimental platform will be shown. Finally we discuss the present status of the ECHo-1k experimental set-up and present first results obtained with the new arrays operated in the new cryostat.

T 56.5 Di 17:50 VSH 118

Background Studies for the ECHo Experiment — •Stephan Scholl for the ECHo-Collaboration — Kepler Center for Astro and Particle Physics, Eberhard-Karls-Universität Tübingen

The ECHo experiment is going to measure the the endpoint of the spectrum of the ^{163}Ho electron capture at 2.833 keV, which offers great potential to reach sub-eV sensitivity on the absolute neutrino mass m_{ν_e}. In order to achieve this sensitivity, the low energy background below 3 keV has to be thoroughly understood and reduced as much as possible. The background spectra of radioactive contaminants ^{40}K, ^{166m}Ho and ^{210}Pb in the surrounding structures of the detectors have been investigated via GEANT4 Monte-Carlo simulations. The results of our studies with respect to the tolerable contamination levels and the necessary improvements in the simulation software are presented in this contribution.

T 56.6 Di 18:05 VSH 118

Untergrund durch Radioaktive Zerfälle am KATRIN Experiment — •Nikolaus Trost für die KATRIN-Kollaboration — Karlsruher Institut für Technolgie, Hermann-von-Helmoltzplatz-1, 76344 Eggenstein-Leopoldshafen

Für die modellunabhängige Messung der effektiven Neutrinomasse mit einer Sensitivität von 200 meV/c^2 (90% C.L) durch Untersuchung des Betaspektrums von Tritium am Endpunkt werden am **Ka**rlsruher **Tri**tium **N**eutrino Experiment die Elektronen einer fensterlosen, gasförmigen Tritiumquelle, werden adiabatisch zu Vor- und Hauptspektrometer geführt, welche die Elektronenenergie nach dem MAC-E Filter Prinzip analysieren, und von einem Siliziumdetektor gezählt. Für das Erreichen der vollen Sensitivität werden weniger als $10^{-2}\,\mathrm{s}^{-1}$ Untergrundereignisse benötigt.

Radioaktive Zerfälle von $^{219/220}$**Rn** im Volumen und ^{210}**Pb** an der Wand der Spektrometer können aufgrund verschiedener Speicher- und Transportmechanismen durch Ionisation von Restgas im Vakuum (10^{-11} mbar) den Untergrund deutlich erhöhen. Für die somit sehr wichtige Simulation von Untergrund und Transmission wurde die modulare Particle Tracking Software KASSIOPEIA entwickelt und Veröffentlicht [arXiv 1612.00262]. Dieser Beitrag stellt Ergebnisse von Messungen und Simulationen des Untergrunds am KATRIN Hauptspektrometer vor.

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T 56.7 Di 18:20 VSH 118

Ion-induced background processes in the KATRIN main spectrometer — •Woo-Jeong Baek for the KATRIN-Collaboration — Karlsruhe Institute of Technology (KIT), Institut für Experimentelle Kernphysik (IEKP)

The aim of the KArlsruhe TRItium Neutrino (KATRIN) Experiment is to determine the effective mass of the electron antineutrino with a sensitivity of 200 meV/c^2 in a model-independent way by investi-

gating the energy spectrum of tritium β-electrons near the endpoint. The experimental setup of KATRIN consists of a windowless gaseous tritium source (WGTS), a transport section for the signal electrons split in differential and cryogenic pumping sections for the extraction of gaseous tritium, a high-resolution electrostatic spectrometer system (pre- and main spectrometer) based on the MAC-E filter principle and a focal-plane detector system, that detects the transmitted electrons. The flux of positive ions, which originate in the decay of tritium, is reduced by several subsystems (e.g. blocking electrodes) in the pumping sections. In order to investigate the possibility to use the KATRIN spectrometers as sensitive ion detectors, a series of dedicated measurements were performed as part of the first commissioning measurement phase of the KATRIN beam line in November 2016.
This talk will present the results of these measurements focusing on the characteristics of ion-induced background processes in the main spectrometer. This work is supported by KSETA, BMBF (05A14VK2), HAP and the Helmholtz association.

T 56.8 Di 18:35 VSH 118

Ion detection, blocking and removal in the KATRIN experiment — •Manuel Klein for the KATRIN-Collaboration — Karlsruhe Institute of Technology

The KArlsruhe TRItium Neutrino (KATRIN) experiment aims at the model independent measurement of the electron neutrino mass. It is designed for a neutrino mass sensitivity of 0.2 eV (90% CL) after three years of measurement time. KATRIN measures the end point of the tritium beta-decay spectrum using a MAC-E filter and a Windowless Gaseous Tritium Source (WGTS). While neutral tritium gas molecules are pumped through the WGTS, the decay electrons are guided to the detector by a magnetic field. Tritium ions, however, would also follow the magnetic field lines to the Pre- and Main Spectrometer (PS and MS), where they could cause background by ionisation and contamination. Preventing this is imperative for KATRIN measurements.

Concepts of ion detection, blocking and removal were tested successfully during KATRIN First Light measurements in November 2016. Deuterium ions were detected with either the MS or PS at high voltage via secondary electrons, produced when the ions ionised residual gas. The ions were blocked in the beamtube by applying a positive potential with ring electrodes. Also, the ions were removed with dipole electrodes via $E \times B$-drift or with the PS at negative potential, moving the ions non-adiabatically into the PS walls. These results show that the methods of ion detection, blocking and removal work as intended.

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T 56.9 Di 18:50 VSH 118

Einfluss des Magnetfelds auf die Transmissionseigenschaften und Systematik des KATRIN Experiments — •Moritz Erhard für die KATRIN-Kollaboration — KIT, Karlsruhe, Deutschland

Ziel des Karlsruher Tritium Neutrino Experiments ist es, durch eine Endpunktsuntersuchung des β-Zerfallsspektrums von Tritium die effektive Masse des Elektronantineutrinos direkt und modellunabhängig mit einer Sensitivität von 200 meV/c^2 (90 % CL) zu bestimmen. Um diese hohe Sensitivität zu erreichen wird das KATRIN Hauptspektrometer mit dem MAC-E-Filter (Magnetic Adiabatic Collimation with Electrostatic Filter) Prinzip betrieben. Der genaue Magnetfeldverlauf innerhalb des Hauptspektrometers wird zur Bestimmung der Transmissionseigenschafte sowie der zu erwartenden Untergrundrate benötigt und ist damit von zentraler Bedeutung für die spätere Interpretation der Tritiumdaten und der Extraktion der Neutrinomasse. Basierend auf Messungen mit einer Elektronenkanone und hoch präzisen Magnetometer wurden die Magnetfeldunsicherheit und die Transmissionseigenschaften bestimmend um in Ensembletest deren Einfluss auf die Systematische Unsicherheit zu ermitteln, die in diesem Vortrag vorgestellt werden. Gefördert durch KSETA, BMBF (05A14VK2), HAP und der Helmholtz Gemeinschaft.