T 6: Neutrino physics without accelerators I

Time: Monday 16:30–18:00 Location: H-HS IV

T 6.1 Mon 16:30 H-HS IV

Characterization of the TRISTAN prototype detectors with electrons — •Daniel Siegmann for the KATRIN-Collaboration — Max Planck Institut for Physics

The TRISTAN (TRitium Invetigations of STerile to Active Neutrino mixing) project aims to search for the signature of a keV sterile neutrino in the tritium beta decay spectra. Therefore, the detector system of the KATRIN experiment will be upgraded after its neutrino mass survey.

To reach a high sensitivity to the sterile neutrino mixing angle the strong activity of the KATRIN tritium source is required. The resulting high electron rate is one of the greatest challenges for the TRISTAN project. It will be approached by distributing the rate among 3500 pixels, resulting in count rates of 100 kcps per pixel. To resolve the kink-like signature of the keV sterile neutrino signal the detector needs to maintain an excellent energy resolution of 300 eV (FWHM) at 20 keV and a low energy threshold.

To fulfill these requirements the first two generations of the TRISTAN silicon drift detector prototypes have been characterized with photons and electrons. The overall performance with regard to energy resolution, detection threshold and the thickness of the entrance window are presented in this talk. Additionally the detector response for electrons is modeled and discussed.

This work is supported by the Max Planck society and the TU Munich ("Chair for Dark Matter, Susanne Mertens").

T 6.2 Mon 16:45 H-HS IV

Analysis based on the covariance matrix approach of the first neutrino mass measurement data with KATRIN — •Lisa Schlüter for the KATRIN-Collaboration — Max Planck Institute for Physics, Munich, Germany

The KArlsruhe TRItium Neutrino (KATRIN) experiment is designed to determine the effective mass of the electron-antineutrino with an sensitivity of 200 meV/c^2 (90% C.L.) in a direct and model-independent way. The neutrino mass can be inferred from the shape of the endpoint region of the tritium β-decay spectrum, which is measured using a MAC-E filter and a Windowless Gaseous Tritium Source (WGTS).

KATRIN started its first neutrino mass measurement campaign in March 2019. Considering statistical and systematic uncertainties, we find a central value of the effective electron anti-neutrino mass of $m_\nu^2 = \left(-1.0\,^{+0.9}_{-1.0}\right)$ eV^2. Following the method of Lokhov and Tkachov, we derive an upper limit of $m_\nu < 1.1$ eV at 90 % C.L..

This talk presents an analysis of the first neutrino mass measurement data with KATRIN, including systematic effects based on the covariance matrix approach, using the Samak simulation analysis package.

T 6.3 Mon 17:00 H-HS IV

Calibrating the KATRIN main spectrometer with condensed $^{83\mathrm{m}}$Kr films — •Alexander Fulst for the KATRIN-Collaboration — Institut für Kernphysik, WWU Münster

The *Karlsruhe Tritium Neutrino* (KATRIN) experiment is a direct measurement of the neutrino mass from the kinematics of the tritium β-decay aiming for a sensitivity of 0.2 eV/c^2 (90% C.L.) after five years of operation. It uses an electrostatic spectrometer working in MAC-E-filter mode to analyze energies of beta-electrons generated in the *windowless gaseous tritium source* (WGTS). The experiment recently published the results of its first science run, establishing a new upper limit of $m_\nu < 1.1$ eV/c^2 (90% C.L.). Several sources are used for absolute energy calibration, monitoring and precise determination of the spectrometer's transmission function. One of them is the *Condensed Krypton Source* (CKrS) developed in Münster, which utilizes nearly monoenergetic conversion electrons from a $^{83\mathrm{m}}$Kr film. Measuring the transmission properties is especially necessary in the *shifted analysis plane* (SAP) configuration which reduces the volume between the detector and the analysis plane in the spectrometer. The SAP setting presents a new way to reduce the volume dependent Rydberg background of the spectrometer but can lead to less homogeneous electric potentials and magnetic fields, requiring a precise calibration in order to perform an accurate neutrino mass analysis.

A short overview over the system is given and calibration measurements of the SAP are presented and compared to simulations. This work is supported under BMBF contract number 05A17PM3.

T 6.4 Mon 17:15 H-HS IV

Determination of the tritium Q-value with KATRIN — •Rudolf Sack for the KATRIN-Collaboration — WWU Münster

The **Ka**rlsruhe **Tri**tium **N**eutrino experiment (KATRIN) is a next generation tritium beta decay experiment. It allows a model independent investigation of the absolute neutrino mass scale with an estimated sensitivity of 0.2 eV/c^2 (90% C.L.).

The KATRIN experiment is sensitive to the absolute energy scale of the T_2 beta-decay and can determine the Q-value of tritium beta-decay with sub eV precision. This measured value can be compared to the mass difference of ^{3}He- and T-atoms in Penning traps. This comparison is very important to check the systematic effects of the KATRIN experiment. For the first KATRIN neutrino mass measurement the Q-value determination is still limited by experimental uncertainties, such as work functions and the plasma potential of the source. The talk presents the Q-value of tritium beta decay which was obtained from a measurement phase in 2019, and discusses the dominant systematic effects and uncertainties in detail.

This work is funded by BMBF (05A17PM3) and by DFG (GRK-2149).

T 6.5 Mon 17:30 H-HS IV

Column Density Determination in KATRIN with the Photo-Electron Source — •Christoph Köhler[1], Fabian Block[2], and Alexander Marsteller[2] for the KATRIN-Collaboration — [1]Technical University of Munich/Max Planck Institue for Physics — [2]Karlsruhe Institute of Technology

The Karlsruhe Tritium Neutrino (KATRIN) experiment is designed to measure the effective electron antineutrino mass with a sensitivity of 200 meV (90 % C.L.) using the direct method of investigating the spectral shape of the tritium beta spectrum near the endpoint. To achieve this goal the column density of the windowless gaseous tritium source (WGTS) has to be known with a precision of 0.2 %.

The experimental setup of KATRIN includes an angular resolved electron gun in the rear-end of the beamline. Electrons produced by this source traverse the full length of the WGTS before they are selected according to their energy in the spectrometer and counted by the detector. Analyzing the measured e-gun data with a model of the KATRIN response function for the e-gun electrons allows the determination of the column density with high precision. The implementation of the model reponse function in the analysis software Fitrium and the successful application of this method in the first neutrino mass science run of KATRIN is presented in this talk.

This work is supported by the Technical University of Munich and the Max Planck Society.

T 6.6 Mon 17:45 H-HS IV

Monitoring High Voltage fluctuations in KATRIN using an independent MAC-E filter. — •Vikas Gupta for the KATRIN-Collaboration — Max-Planck Institute for Physics, Munich

KATRIN (Karlsruhe Tritium Neutrino) experiment is measuring electron energy near the endpoint of tritium beta decay (about 18.6 keV) in order to measure the neutrino mass. The final sensitivity goal on the effective mass of the electron anti-neutrino is 0.2 eV at 90% CL. To achieve such a stringent limit, the high voltage of the main spectrometer, which acts as an electrostatic filter, has to be stable at the ppm-level.

The HV in KATRIN is measured using a voltmeter associated with a voltage divider. The Monitor Spectrometer is a stand-alone MAC-E filter coupled to the Main Spectrometer and built to independently assess the HV stability. To do so, a radioactive source of ^{83}Rb is used as a calibration standard. In this talk, the results of the Monitor Spectrometer during the first neutrino mass campaign will be presented. Further, detector upgrades in the Monitor Spectrometer using a novel Silicon Drift detector will be discussed.