T 69: Neutrinomasse III

Zeit: Mittwoch 16:45–19:05 Raum: VMP5 SR 0079

Gruppenbericht T 69.1 Mi 16:45 VMP5 SR 0079

The Electron Capture in ^{163}Ho experiment — •Clemens Hassel for the ECHo-Collaboration — Kirchhoff-Institute of Physics, Heidelberg University, Germany.

The **E**lectron **C**apture **^{163}Ho** experiment, **ECHo**, has the goal to probe the electron neutrino mass on a sub-eV level via the analysis of the calorimetrically measured **e**lectron **c**apture spectrum (**EC**) of ^{163}Ho.

For this metallic magnetic calorimeters will be used. The performance achieved by a first prototype of MMC with embedded ^{163}Ho already shows that the desired values of an energy resolution of $\Delta E_{FWHM} <$ 3 eV and a signal risetime of $\tau < 1$ μs for ECHo can be reached.

Recently the energy available for the decay $Q_{EC} = 2833(30_{stat})(15_{sys})$ eV/c^2 has been precisely determind by ECHo. Given this Q_{EC}-value we expect a sensitivity on the electron neutrino mass below 10 eV in the first phase of the ECHo experiment, ECHo-1k. In this phase a high purity ^{163}Ho source with a total activity of 1 kBq will be measured by about 100 detectors operated in a dedicated cryogenic platform in a reduced background environment. The results from this experiment will define parameters to scale the experiment to the next phase of ECHo-1M. There the total activity of the source will be 1 MBq and it will be measured by using 10^5 detectors. We present the current status of the ECHo experiment.

T 69.2 Mi 17:05 VMP5 SR 0079

The thermal properties of the windowless gaseous tritium source of the KATRIN experiment. — •Moritz Hackenjos for the KATRIN-Collaboration — Institut für Technische Physik KIT

The Karlsruhe Tritium Neutrino (KATRIN) Experiment aims to determine the neutrino mass with an unreached sensitivity of 200 meV/c^2 (90% C.L.) by the investigation of the endpoint energy-region of the tritium β-spectrum in a direct and model-independent way. Molecular Tritium gas with purity 95% is injected continuously in the center of the Windowless Gaseous Tritium Source (WGTS) of KATRIN and pumped off at both ends. The beta electrons are guided by a strong magnetic field to the spectrometers and are analyzed there energetically.

The statistical and systematic uncertainties of the $m_{\overline{\nu}_e}$ measurement are closely related to the thermal and gas dynamic performance and stability of this source. In order to keep the source pressure profile stable at 0.1% level, injection pressure and temperature of the beam tube need to be stabilized. The beam tube itself will be operated at 30 K to reduce systematic uncertainties like Doppler Effect.

To restrict systematic effects the thermal homogeneity and stability fluctuations therefore have to be lower than 30 mK. This talk will provide an insight of the thermal and gas dynamic properties of the WGTS with a construction overview and planed commissioning measurements.

T 69.3 Mi 17:20 VMP5 SR 0079

Simulation of differential electron spectra in the KATRIN WGTS — •Norman Haussmann for the KATRIN-Collaboration — Bergische Universität Wuppertal

The KArlsruhe TRItium Neutrino (KATRIN) experiment aims to measure the effective electron antineutrino mass in a model-indepedent way with a sensitivity of 200 meV/c^2 (90 % C.L.).

In order to extract the neutrino mass the Windowless Gaseous Tritium Source (WGTS) properties of KATRIN need to be known to a high precision. For this reason several monitoring systems are installed. One of them, situated in the transport section, is the Forward Beam Monitor (FBM). The FBM is capable of recording the electron rate (10^6 e/s $\cdot$ mm^2) and the differential electron spectra with a high energy resolution and precision.

The electrons in the WGTS are emitted isotropically and guided magnetically. Thereby, the electrons undergo different effects changing their kinetic energy and angle to the guiding field. The major influence herein is elastic and inelastic scattering.

Changes in the column density are expected to have a great influence on lower energetic electrons and thereby change the spectrum and count rate at the FBM-detector. Monte-Carlo simulations have been performed to understand the influences of varying column densities and temperature fluctuations on the expected count rate and spectra by tracking the emitted electrons. The results will be shown in this talk.

T 69.4 Mi 17:35 VMP5 SR 0079

Tritium source-related systematic uncertainties of the KATRIN experiment — •Hendrik Seitz-Moskaliuk for the KATRIN-Collaboration — Karlsruher Institut für Technologie, Institut für experimentelle Kernphysik, Hermann-von-Helmholtz-Platz 1, 76344 Eggenstein-Leopoldshafen

KATRIN will perform a direct, kinematics-based measurement of the neutrino mass with a sensitivity of 200 meV (90 % C. L.) reached after 3 years of measurement time. The neutrino mass is obtained by determining the shape of the spectrum of tritium β decay electrons close to the endpoint of 18.6 keV with a spectrometer of MAC-E filter type. To achieve the planned sensitivity, the systematic measurement uncertainties have to be carefully controlled and evaluated. Main sources of systematics are the MAC-E filter on the one hand and the source and transport section (STS) on the other hand. Most of the operational parameters of KATRIN have to be stable at or even below the per mille level and have to meet further strict requirements.

This talk will review the KATRIN systematics with a special focus on the STS. Early commissioning measurements to determine the main systematics will be introduced.

This work is supported by BMBF (05A14VK2) and the Helmholtz Association.

T 69.5 Mi 17:50 VMP5 SR 0079

Stability measurements of the electron gun for the KATRIN Rear Section — •Sylvia Ebenhöch for the KATRIN-Collaboration — Karlsruhe Institute of Technology (KIT), Institute for Technical Physics (ITEP), Tritium Laboratory Karlsruhe (TLK)

The aim of the KArlsruhe TRItium Neutrino (KATRIN) experiment is to determine the antineutrino mass with a sensitivity of 0.2 eV (90 % C.L.) by high-precision spectroscopy close to the tritium beta decay endpoint at 18.6 keV. To achieve the sensitivity aim both statistical and systematic uncertainties must be minimized. One contribution to the systematic error are uncertainties in the column density of the tritium source or in the source activity. In order to detect and monitor changes in the tritium source the Rear Section, which is integrated at the rear end of the KATRIN setup, is used. The Rear Section includes an angular selective electron gun (e-gun) based on the photoelectric effect. With the e-gun it will be possible e.g. to achieve a precise calibration of the column source density. To achieve the requirements on the e-gun a stable UV light source is essential to produce photoelectrons. The presentation will focus on the setup of the e-gun and intensity stability measurements of the UV light source setup.

T 69.6 Mi 18:05 VMP5 SR 0079

Krypton mode of the Windowless Gaseous Tritium Source of the KATRIN Experiment — •Moritz Machatschek for the KATRIN-Collaboration — KIT-IEKP, Hermann-von-Helmholtz-Platz 1, 76344 Eggenstein-Leopoldshafen, Deutschland

The KArlsruhe TRItium Neutrino experiment, currently in its final construction & commissioning phase will perform a kinematic measurement of the neutrino mass, by precision spectroscopy of tritium beta decay at the endpoint of 18.6 keV. To reach the planned sensitivity of 200 meV (90 % C. L.) a precise knowledge of the systematic measurement uncertainties of the experiment is crucial.

Several important systematics arise in the 10 m long source containing the gaseous tritium, for instance related to the low density plasma generated by the beta decay. Together with the rear wall closing off the beam tube this defines an inhomogeneous potential, which has to be known to a level of 10 mV. One way to analyze it is gaseous, excited krypton ^{83m}Kr. The krypton will be added to the tritium with a low concentration of $<10^{-4}$, which will not affect the normal tritium gas profile. ^{83m}Kr deexcites by internal conversion, exhibiting several lines with mono energetic electrons at 18 keV and around 31 keV. When measured by the KATRIN main spectrometer, the shape and position of these lines will carry information on the plasma potential distribution. In this talk an overview of the simulation and modelling of the krypton mode as well as the experimental implications for KATRIN will be given.

Supported by BMBF (05A14VK2) and by the Helmholtz Association

T 69.7 Mi 18:20 VMP5 SR 0079

Work function studies of gold surfaces with a Kelvin Probe for the Rear Section of the KATRIN experiment — •Kerstin Schönung for the KATRIN-Collaboration — Karlsruhe Institute of Technology

The KArlsruhe TRItium Neutrino-Experiment KATRIN will perform a model-independent measurement of the antineutrino mass by the examination of the beta electron energy spectrum of a gaseous molecular tritium source. To achieve the desired sensitivity of $0.2\,\mathrm{eV/c^2}$ (90 % CL) the plasma potential of the tritium gas must be temporally and spatially stable within 20 meV. Therefore, the work function of the so called Rear Wall which probably defines the plasma potential must be known even more precisely and the temporal changes must be investigated.

A common instrument to measure the work function of a surface with a precision of a few meV is a Kelvin Probe. Such a system was built up at the Tritium Laboratory Karlsruhe. In the talk the working principle of a Kelvin Probe and the setup will be presented. In addition first work function measurements of Rear Wall candidates will be discussed.

T 69.8 Mi 18:35 VMP5 SR 0079

Ions in the KATRIN experiment — •Ferenc Glück for the KATRIN-Collaboration — Karlsruhe, KIT, Campus Nord

The aim of the KATRIN experiment is to determine the absolute neutrino mass scale in a model independent way, by measuring the electron energy spectrum shape near the endpoint of tritium beta decay. Beta decays and ionizations produce about $2 \cdot 10^{12}$ s^{-1} tritium ion rate in the KATRIN source. About 10 % and 1 % of that rate is the expected flux of positive tritium ions and T^{-} ions leaving the source in detector direction. The positive tritium ions are not affected by the pumping system, and, when unhindered, they would cause an extremely large background and tritium contamination in the spectrometers. They will be blocked in the transport system by positive potential electrodes and will be removed from the flux tube by dipole electrodes. The ion composition and the ion blocking and removal efficiency will be tested by an FT-ICR trap, a Faraday cup and the KATRIN pre- and main spectrometers and FPD, using both a photoelectron induced deuterium plasma and the tritium beta decay plasma.

This work has been supported by the German BMBF (05A14VK2).

T 69.9 Mi 18:50 VMP5 SR 0079

A Pre-KATRIN search for keV-scale sterile neutrinos — •Anton Huber[1], Susanne Mertens[2,1], and Thierry Lasserre[3] for the KATRIN-Collaboration — [1]Karlsruher Institut für Technologie, Karlsruhe — [2]Lawrence Berkeley National Laboratory, USA — [3]Commissariat à l'énergie atomique, France

Sterile neutrinos in the keV-mass range are a viable dark matter candidate. A sterile neutrino with a mass up to 18.6 keV would be visible in the beta-decay spectrum of tritium as a kink-like signature and distortion. The KATRIN experiment, which is commissioned at the moment, is designed to determine the absolute neutrinos mass by measuring the beta-decay spectrum of gaseous tritium close to its endpoint. Beyond that, the many outstanding features of the experiment could be used to measure the entire beta-spectrum to search for a kink-like signature of a sterile neutrino.

The idea discussed in this talk is a so-called Pre-KATRIN measurement, where the first light data of KATRIN would be used to scan the entire tritium beta-decay spectrum to search for sterile neutrinos. A measurement of only one week with KATRIN has the potential to set a new world best limit on laboratory search for keV-scale sterile neutrinos. This work presents the expected sensitivity, important systematic effects and the experimental realization of this experiment.

We like to remark, that this work has been supported by the German BMBF (05A14VK2), by the Ministry of Science, Research and the Arts, Baden- Wuerttemberg (MWK), by the CEA and the Deutschlandstipendium (BMBF and SAP SE).