T 94: Niederenergie Neutrinophysik VI

Zeit: Donnerstag 16:45–18:30 Raum: I.13.71 (HS 28)

T 94.1 Do 16:45 I.13.71 (HS 28)

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

The Electron Capture ^{163}Ho experiment, ECHo, aims to investigate the electron neutrino mass in the sub-eV range by means of the analysis of the calorimetrically measured energy spectrum following the electron capture process of ^{163}Ho. The ^{163}Ho spectrum will be measured with array of low temperature metallic magnetic calorimeters (MMCs). With a first prototype of MMC having the ^{163}Ho source embedded in the absorber, we performed the first high energy resolution measurement of the EC spectrum. The achieved energy resolution was $\Delta E_{FWHM} = 7.6$ eV and the signal rise-time was $\tau = 130$ ns. We aim to improve the performance of the detector to reach an energy resolution $\Delta E_{FWHM} < 5$ eV and a signal rise-time $\tau < 100$ ns. We present the plan for a medium scale experiment, ECHo-1k, in which about 1000 Bq of high purity ^{163}Ho will be implanted in the optimized detectors. With about one year of measuring time and with a better knowledge of the EC spectral shape, which will be reached thanks to dedicated experiments, we will be able to achieve a sensitivity on the electron neutrino mass below 10 eV/c^2, improving the present limit of about one order of magnitude.

T 94.2 Do 17:00 I.13.71 (HS 28)

Production and Purification of ^{163}Ho Sources for the ECHo Project — •Fabian Schneider for the ECHo-Collaboration — Institute für Physik und Kernchemie, Johannes Gutenberg-Universität Mainz

The ECHo collaboration uses the electron capture of ^{163}Ho for determing the mass of the electron neutrino. The calorimetric spectrum is recorded by metallic magnetic calorimeters and the neutrino mass is deduced by the analysis of the endpoint region of the spectrum in comparison to the decay Q-value. The required ^{163}Ho sample is produced by reactor activation of enriched ^{162}Er and is strongly contaminated by other radioactive isotopes which would produce unacceptable levels of background.

The most efficient way to produce isotopic pure sources in the detectors is a three step process of a chemical purification, electromagnetic mass separation and subsequent ion beam implantation. The RISIKO mass separator of the working group LARISSA is the ideal tool to perform the separation and implantation because it offers the advantage of a resonant ionization laser ion source. With this highly element-selective method and a dipole mass separation at 30 keV ion energy, a purity in the detectors can be reached with no coimplants beyond a fraction of 10^{-5} while maintaining a high efficiency in the process.

T 94.3 Do 17:15 I.13.71 (HS 28)

Optimization of metallic magnetic calorimeters for high resolution measurement of the ^{163}Ho electron capture spectrum — •Sebastian Hähnle for the ECHo-Collaboration — Kirchhoff-Institute for Physics, Heidelberg University, Germany

The absolute scale of the neutrino mass eigenstates is one of the puzzles in modern particle physics. One method to investigate the value of the electron neutrino mass is to analyse the high energy region of the ^{163}Ho electron capture spectrum. In the ECHo experiment low temperature metallic magnetic calorimeters (MMCs) are used for the calorimetric measurements of the EC spectrum of 163Ho. To ensure 100% quantum efficiency, the ^{163}Ho ions are implanted into the gold absorber. Experiments carried out with a first detector prototype have demonstrated that MMC-based detectors fulfill the requirements in terms of energy resolution, rise-time and energy calibration. We discuss methods to further optimize the performance of MMCs with implanted ^{163}Ho. Our aim is to achieve an energy resolution $\Delta E_{FWHM} < 5$ eV and a signal rise-time $\tau < 100$ ns. An important aspect of this optimization is to define the maximum activity per pixel. This will result from a compromise between allowed unresolved pile-up fraction, additional heat capacity in the absorber due to Ho ions in the absorber material and minimization of the pixel number. We discuss experimental approaches for the determination of the optimal activity per pixel.

T 94.4 Do 17:30 I.13.71 (HS 28)

Entwicklung einer Feldemissions-Elektronenkanone zum Testen von pin-Dioden — •Enrico Ellinger für die KATRIN-Kollaboration — Universität Wuppertal

Der Forward Beam Monitor Detektor (FBMD) soll im Karlsruher Tritium Neutrino Experiment (KATRIN) eingesetzt werden, um mit Hilfe einer pin-Diode den von der Tritiumquelle erzeugten Elektronenstrahl zu überwachen. An der Messposition werden hohe Intensitäten von bis zu 10 e/s mm^2 bei geringen Energien bis 20 keV erwartet. Um eine geeignete pin-Diode für diesen Zweck zu finden, soll eine Elektronenkanone entwickelt werden, welche einen scharfen Elektronenstrahl mit den zuvor genannten Spezifikationen liefert. Da pin-Dioden i.d.R. stark lichtempfindlich sind, müssen Lichtquellen im Vakuumrezipienten vermieden werden.

Elektronenkanonen, welche die Feldemission nutzen, emittieren kein Licht, um freie Elektronen zu erzeugen, da das Filament nicht erhitzt wird. Vielmehr besteht das Filament aus einer scharfer Wolframspitze (100 nm Spitzenradius), an welcher elektrische Feldstärken im Bereich von 10 V/m erzeugt werden können. Dies begünstigt das Tunneln von Elektronen aus der Spitze. Solche Spitzen wurden mit der Methode des elektrochemischen Ätzens gewonnen und danach mit einem SEM vermessen.

Der aktuelle Stand der Entwicklung und die Ergebnisse erster Testmessungen werden präsentiert.

T 94.5 Do 17:45 I.13.71 (HS 28)

The KATRIN Forward Beam Monitor Detector — •Stephanie Hickford for the KATRIN-Collaboration — Universität Wuppertal

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

The Forward Beam Monitor Detector (FBMD) is one such monitoring system. This detector is being constructed at the University of Wuppertal and will be transported on-site to the KATRIN detector within the next few months. The working principle and the performance of the FBMD will be presented, including a comparison between vacuum simulations and vacuum measurements, software details of the slow control systems, and the resulting spectra of low-energetic electrons.

T 94.6 Do 18:00 I.13.71 (HS 28)

Simulation of realistic electromagnetic fields for the KATRIN Main Spectrometer — •Daniel Hilk for the KATRIN-Collaboration — Institut für Experimentelle Kernphysik, KIT, Karlsruhe

The goal of the KATRIN experiment is to determine the effective mass of the electron anti neutrino by measuring the electron energy spectrum of tritium beta decay near the endpoint with a sensitivity of 200 meV (90 % C.L.). KATRIN consists of a molecular tritium source, a transport section and a spectrometer section for a precise energy measurement. The main spectrometer is based on the MAC-E (magnetic adiabatic collimation with electrostatic filtering) principle: Electrons are guided adiabatically on magnetic field lines, and a precise electric retarding potential within the main spectrometer filters the electrons by their energy.

The simulation of the electro-magnetic fields is crucial to optimize the transmission properties and to study various background processes. These fields have been simulated with the software KEMField, which has been developed within the KATRIN collaboration. The tool can compute precise three-dimensional electro-magnetic fields for complex geometries. In context of this talk, field simulations for the KATRIN main spectrometer are presented in comparison to latest measurement results from the second commissioning phase. Furthermore, technical improvements of the KEMField software are discussed. This work was supported by the BMBF under grant no. 05A11VK3 and by the Helmholtz Association.

T 94.7 Do 18:15 I.13.71 (HS 28)

Numerical integration in BEM — •Ferenc Glück for the KATRIN-Collaboration — Karlsruhe Institute of Technology, IKP

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. Precise axisymmetric and 3 dimensional electric field computation is an important task for the KATRIN experiment. For this purpose the boundary element method (BEM) is used, which has several advantages compared to the finite difference and finite element method. One and two dimensional integration is necessary to compute the potential and field of the various elements (e.g. triangles, rectangles, conical sections) of the discretized electrode system. Analytical integration has round-off errors for field points far away from the element, and these errors can cause serious problems for the potential and field calculations. Instead, one can use numerical integration like Gauss quadrature and cubature, and this can have higher accuracy and also higher speed than the corresponding analytical integration.