T 89: Niederenergie-Neutrinophysik 4

Zeit: Mittwoch 16:45–18:35 Raum: P106

Gruppenbericht T 89.1 Mi 16:45 P106

Status of the KATRIN spectrometer and detector section — •Nancy Wandkowsky for the KATRIN-Collaboration — Karlsruhe Institute of Technology (KIT), Institute for Nuclear Physics (IKP)

The aim of the KArlsruhe TRItium Neutrino experiment is a model-independent determination of the effective mass of the electron antineutrino by a precise measurement of the Tritium β-spectrum with a sensitivity of 200 meV/c^2. KATRIN utilizes a windowless gaseous tritium source, a differential and a cryogenic pumping section, a system of two electrostatic spectrometers, which are based on the MAC-E filter technique, and a multi-pixel silicon semiconductor detector. The experiment is currently being constructed at the Karlsruhe Institute of Technology.

In summer 2013, the combined Spectrometer and Detector System (SDS) has been successfully commissioned. The electron transmission and background characteristics of the spectrometer have been determined experimentally and have been verified by simulations.

This talk summarizes the current status of the KATRIN experiment, focusing on the results of the SDS commissioning phase.

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T 89.2 Mi 17:05 P106

Markov Chain Monte Carlo basierte Optimierung der Messzeitverteilung des KATRIN Experiments — •Marco Haag für die KATRIN-Kollaboration — Karlsruher Institut für Technologie, IEKP

Das KArlsruher TRItium Neutrino Experiment wird über einen Zeitraum von mehreren Jahren spektroskopisch den Endpunktsbereich des Tritium-Betazerfalls untersuchen. Ziel ist die modellunabhängige Bestimmung der effektiven Masse des Elektronantineutrinos mit einer bislang unerreichten Sensitivität von 0.2 eV/c^2.

Die Bestimmung der Neutrinomasse aus den Messdaten erfordert einen aufwendigen Parameterfit, der allen relevanten systematischen Effekten und Unsicherheiten theoretischer Parameter Rechnung trägt. Der statistische Fehler dieser Analyse hängt darüber hinaus maßgeblich von der konkreten Aufteilung der Gesamtmesszeit von 5 Jahren ab.

Dieser Vortrag erläutert, wie sich durch den Einsatz von Markov Chain Monte Carlo Algorithmen die Messzeitverteilung und somit die Massensensitivität des KATRIN-Experiments optimieren lassen.

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T 89.3 Mi 17:20 P106

Untergrund durch gespeicherte Elektronen am KATRIN-Experiment - Simulation und Messung — •Nikolaus Trost für die KATRIN-Kollaboration — Karlsruher Institut für Technologie (KIT) — Institut für experimentelle Kernphysik (IEKP)

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 benötigt das Karlsruher Tritium Neutrino Experiment einen Untergrund von weniger als 10^{-2} cps. 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. Elektronen anderer Quellen, wie den radioaktiven Zerfällen von Radon (219, 220), können im Volumen der Spektrometer magnetisch gespeichert werden und durch kaskadierte Ionisation von Restgasatomen im Vakuum ($\sim 10^{-11}$ mbar) den Untergrund deutlich erhöhen. Um diese Untergrundkomponente zu minimieren sind Simulationen des Untergrundverhaltens und verschiedener aktiver Untergrundreduktionsmethoden am Hauptspektrometer nötig. Hierfür wird das von der KATRIN-Kollaboration entwickelte Simulationspaket KASSIOPEIA eingesetzt. In diesem Vortrag soll auf die hohen Anforderungen an die präzise Teilchenspurverfolgung über lange Zeiten eingegangen werden. Darüber hinaus werden die Ergebnisse von Monte Carlo Simulationen sowie den ersten Testmessungen vorgestellt.

Diese Arbeit wurde gefördert durch das BMBF-Projekt 05A11VK3 und die Helmholtz-Gemeinschaft.

T 89.4 Mi 17:35 P106

Removal of Stored Electrons in 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 the tritium beta decay near the endpoint. The goal is to reach a sensitivity of the neutrino mass of 200meV for which an ultra-low background level of 10^{-2} counts per second is mandatory. Electrons from single radioactive decays of radon and tritium in the KATRIN main spectrometer can be stored for hours. While cooling down via ionization of residual gas molecules, they produce hundreds of secondary electrons, which can reach the detector and contribute to the background signals. In order to suppress this background component, several methods are investigated to remove stored electrons, such as the application of an electric dipole field and the application of magnetic pulses. This talk introduces the theory of background production mechanisms due to stored electrons and the removal by active methods in the main spectrometer. In context of the spectrometer- and detector-commissioning phase in summer 2013, measurement results of the application of the electric dipole- and magnetic pulse-method are presented. This work was supported by the BMBF under grant no. 05A11VK3 and by the Helmholtz Association.

T 89.5 Mi 17:50 P106

The Electron Capture Ho-163 experiment ECHo: an overview — •Loredana Gastaldo for the ECHo-Collaboration — Kirchhoff Institute for Physics, Heidelberg University, Heidelberg, Germany

The Electron Capture Ho-163 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 Ho-163. In the ECHo experiment, arrays of low temperature metallic magnetic calorimeters with high energy resolution and fast response time, having the Ho-163 source embedded in the absorber, will be used to calorimetrically measure the EC spectrum. A precise description of the expected spectrum will be achieved by theoretical calculations based on Density Functional Theory (DFT) and Quasiparticle Random Phase Approximation (QRPA) supported also by experimental investigations. Moreover, independent measurements of the Q-value will be performed using high precision Penning traps. For the measurements of Q as well as for the calorimetric measurement of the Ho-163 spectrum, high purity Ho-163 sources will be produced. Detailed studies of the background and of methods to reduce it will be performed in order to increase the sensitivity of the calorimetric measurement.

T 89.6 Mi 18:05 P106

The Q-value of ^{163}Ho→^{163}Dy for the determination of the electron neutrino mass — •Andreas Dörr[1], Hendrik Bekker[1], Klaus Blaum[1], Michael Block[2], Christine Böhm[1,4], Christian Droese[3], Christoph Düllmann[2,5], Klaus Eberhardt[5], Sergey Eliseev[1], Mikhail Goncharov[1], Enrique Minaya Ramirez[2], Szilard Nagy[1], Yuri Novikov[6], Julia Repp[1], Alexander Rischka[1], Vanessa Simon[2], and Sven Sturm[1] for the ECHo-Collaboration — [1]Max-Planck-Institut für Kernphysik, 69117 Heidelberg, Germany — [2]GSI Helmholtzzentrum für Schwerionenforschung, 64291 Darmstadt, Germany — [3]Institut für Physik, Ernst-Moritz-Arndt-Universität, 17487 Greifswald, Germany — [4]ExtreMe Matter Institute EMMI, Helmholtz Gemeinschaft, 64291 Darmstadt, Germany — [5]Institut für Kernchemie, Johannes Gutenberg-Universität, 55128 Mainz, Germany — [6]Petersburg Nuclear Physics Institute, 188300 Gatchina, Russia

The ECHo-collaboration aims at measuring the energy spectrum of the electron capture (EC) in ^{163}Ho by means of microcalorimetry with sub-eV sensitivity to obtain information about the electron neutrino mass. Precise and accurate knowledge of the Q-value of the EC decay ^{163}Ho→^{163}Dy is crucial for this experiment. The high-precision mass spectrometers SHIPTRAP at GSI and PENTATRAP at MPIK will perform Q-value measurements with uncertainties of $\sim$30 eV and $<$1 eV, respectively. Preliminary tests of a ^{163}Ho-ion source will be performed at the TRIGA-TRAP experiment in Mainz.The status of measurements at SHIPTRAP as well as the status of PENTATRAP, which is currently in the commissioning phase, will be presented.

T 89.7 Mi 18:20 P106

Calorimetric measurement of the Ho-163 spectrum: from single pixels to arrays — •Philipp C.-O. Ranitzsch[1], Clemens Hassel[1], Mathias Wegner[1], Sebastian Kempf[1], Andreas Fleischmann[1], Christian Enss[1], Karl Johnston[2], Thierry Stora[2], Klaus Eberhardt[3], Christoph E. Duellmann[3], and Loredana Gastaldo[1] for the ECHo-Collaboration — [1]Kirchhoff Institute for Physics, Heidelberg University, Heidelberg, Germany — [2]CERN, Physics Department, 1211 Geneva 23, Switzerland — [3]Institute for Nuclear Chemistry, Mainz University, Mainz Germany

Low temperature metallic magnetic calorimeters (MMCs) are used within the Electron Capture Ho-163 experiment ECHo to perform the calorimetric measurement of the Ho-163 electron capture spectrum. With the first prototypes of MMCs, where the Ho-163 source was ion-implanted at ISOLDE-CERN, we were able to measure the presently most precise Ho-163 spectrum with an energy resolution of 7.6 eV (FWHM) and a signal rise-time of about 100 ns. We have recently produced a 64-pixels chip consisting of two 32-pixel arrays read-out using the microwave multiplexing technique. Two of these chips will be equipped with Ho-163 by ion-implantation at ISOLDE in 2014. We show the detector design, in particular the embedding of the Ho-163 source in the detector absorber. We present recent measurements of the Ho-163 spectrum where for the first time the OI-line was resolved and the results of the first tests performed on the 64-pixel chips. We discuss the achieved performance of single pixels and of the multiplexing technique in relation with the requirements for the ECHo experiment.