T 50: Neutrinomasse II

Zeit: Dienstag 16:45–19:00 Raum: VMP5 SR 0079

T 50.1 Di 16:45 VMP5 SR 0079

Separation and Implantation of the Rare Isotope ^{163}Ho — •Tom Kieck[1], Katerina Chrysalidis[1], Holger Dorrer[1], Christoph Düllmann[1,2], Lisa Gamer[3], Loredana Gastaldo[3], Stefan Kormannshaus[1], Sebastian Schmidt[1], Fabian Schneider[1], and Klaus Wendt[1] for the ECHo-Collaboration — [1]JGU Mainz — [2]GSI Darmstadt — [3]Universität Heidelberg

The ECHo collaboration aims at measuring the electron neutrino mass by recording the spectrum following electron capture of ^{163}Ho. To reach a sub-eV sensitivity, a large number of individual microcalorimeters is needed, into which the isotope must be implanted in a well-controlled manner. The necessary amount of ^{163}Ho is produced by neutron irradiation of enriched ^{162}Er in the ILL high flux reactor. This introduces significant contaminations of other radioisotopes, which have to be quantitatively removed both, by chemical and mass spectrometric separation. The application of resonance ionization at the RISIKO mass separator guarantees the required isotope selectivity for purification and suitable energy for ion implantation. The efficiency and stability of the laser ion source was improved by Finite-Element Analysis of the thermal processes. For optimum implantation into the detector pixels (170×170 μm^2) with minimum losses a small ion beam spot at the implantation site is needed. For this purpose, post focusing ion optics were installed. Simulations were performed in order to optimize the homogeneous distribution of the implanted ions. The necessity to alternate implantation phases with deposition of a thin metallic layer for ^{163}Ho activities larger than 10 Bq is being discussed.

T 50.2 Di 17:00 VMP5 SR 0079

Status of the Cryogenic Pumping Section of the KATRIN Experiment — •Carsten Röttele for the KATRIN-Collaboration — Institut für Kernphysik (IKP), Karlsruhe Institute of Technology (KIT)

The **Ka**rlsruhe **Tri**tium **N**eutrino (KATRIN) experiment uses the kinematics of tritium β-decay to determine the electron antineutrino mass with a sensitivity of $m_\nu = 200\,\mathrm{meV/c^2}$ (90 % C.L.). In order to measure the decay electrons it is important to guide them adiabatically from the source to the spectrometer. In addition the diffusion of tritium into the spectrometers from the source has to be reduced by 14 magnitudes of order as tritium inside the spectrometers would induce additional background. For these two tasks the transport and pumping section were constructed. The last part of this section is the **C**ryogenic **P**umping **S**ection (CPS), which aims to reduce the residual gas flow by not less than seven orders of magnitude. For this a 3 K cold argon frost area (surface $\approx 2\,\mathrm{m^2}$) will be prepared to adsorb the incoming tritium molecules.
This talk will present the milestones which were reached since the CPS arrived on 30th July 2015 on KIT. Amongst others the calculations of the magnetic flux tube through the CPS based on as-built measurements of the coil geometries are presented.

T 50.3 Di 17:15 VMP5 SR 0079

Bestimmung der Stabilität von Elektronenstrahlen hoher Intensität bei Energien bis zu 20 keV mit einer Präzision von 0,1% mit Hilfe von pin-Dioden. — •Enrico Ellinger für die KATRIN-Kollaboration — Bergische Universtität Wuppertal

Der Forward Beam Monitor (FBM) soll im Karlsruher Tritium Neutrino Experiment (KATRIN) eingesetzt werden, um mit Hilfe einer pin-Diode die relative Intensität des von der Tritiumquelle erzeugten Elektronenstrahls mit einer Präzision von 0,1% zu überwachen. An der Messposition werden hohe Intensitäten von bis zu $10^6 \frac{e}{s \cdot mm^2}$ bei geringen Energien bis 20 keV erwartet. Dies stellt hohe Anforderungen an die Messelektronik, welche im wesentlichen aus einer pin-Diode, einem Transimpedanzverstärker und einem digitalen Pulsprozessor, besteht. Die Langzeitstabilität solcher Messungen wird durch Einflüsse wie Temperaturschwankungen sowie internen und externen Rauschquellen beeinträchtigt. Insbesondere die hohe Eventrate an der Nachweisschwelle führt bei Detektordrifts zu systematischen Fehlern.

Der Stand der Entwicklung und die aktuellen Ergebnisse werden präsentiert.

T 50.4 Di 17:30 VMP5 SR 0079

Influence of gas dynamics in the tritium source on the neutrino mass measurement of KATRIN — •Laura Kuckert for the KATRIN-Collaboration — Karlsruhe Institute of Technology

The Karlsruhe Tritium Neutrino Experiment (KATRIN) aims to measure the neutrino mass with a sensitivity of 200 meV/c^2 (90% C.L.) in a direct approach using the beta decay of molecular tritium. The neutrino mass is extracted from a fit of modelled beta decay spectra to the measured electron spectrum. Hence, it is important to include modifications from systematic effects in the simulated spectrum. Especially the gas dynamics, density and velocity distribution, in the windowless gaseous tritium source (WGTS) play a key role for accurate modelling. Since in most cases this can not be measured directly, the modelled beta spectrum relies on gas dynamics calculation as well as on monitoring of operation parameter changes. A comprehensive pseudo-3D model has been developed. The accuracy of the gas dynamics model in the spectrum simulation including the monitoring of operation parameters is reviewed and implications on the systematics budget for the neutrino mass measurement are described. Supported by the BMBF under grant no. 05A14VK2 and by the Helmholtz Association

T 50.5 Di 17:45 VMP5 SR 0079

Tritium ions in the Source and Transport Section (STS) of KATRIN — •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 with a magnetic field. Tritium ions, however, also leave the WGTS following the magnetic field lines.

For KATRIN measurements it is imperative to prevent tritium ions from reaching the detector or the spectrometers, where they could decay and cause an indistinguishable background. Ion blocking measures are implemented by electric blocking potentials and electric dipoles to drift out trapped ions. Their effective operation will be tested during KATRIN commissioning measurements: The ion flux between STS and spectrometers can be measured with the Forward Beam Monitor (FBM). It offers a manipulator arm to introduce a detector into the flux tube. For ion detection, a Faraday Cup for the FBM is being designed and constructed.

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T 50.6 Di 18:00 VMP5 SR 0079

Determination of the tritium flux in the pre-spectrometer of the KATRIN experiment — •Momin Ahmad for the KATRIN-Collaboration — Karlsruhe Institute of Technology (KIT), Institute for Experimental Nuclear Physics (IEKP)

The **Ka**rlsruhe **Tri**tium **N**eutrino experiment aims to probe the mass of the electron antineutrino in a model-independent way with an unsurpassed sensitivity of m_ν = 200 meV/c^2 (90% C.L.). The energy spectrum of electrons from tritium β-decay is analyzed by an electrostatic spectrometer which is based on the MAC-E filter principle.
The beamline of the KATRIN experiment starts with the rear section and the windowless gaseous tritium source. Different pumping systems (e.g. cryogenic pumps) follow until the pre-spectrometer, main-spectrometer and the detector finish the beamline. The tritium flux is reduced by many orders and only few molecules can migrate into the pre-spectrometer. The decay of tritium in the volume of the prespectrometer generates magnetically trapped electrons with typical energies on the order of a few keV. Via subsequent ionization of residual gas molecules, the primary trapped electrons produce several secondary electrons which can be detected at the detector system at the downstream end of KATRIN. Analysing these electrons using a Monte Carlo simulation allows a better understanding of the tritium activity. This talk is about the characteristic of the secondary electrons and the relating tritium activity in the pre-spectrometer. This work has been supported by the German BMBF (05A14VK2).

T 50.7 Di 18:15 VMP5 SR 0079

Die Suche nach sterilen Neutrinos auf der eV-Massenskala mit dem KATRIN-Experiment — •Marco Kleesiek — Karlsruher Institut für Technologie, Institut für Experimentelle Kernphysik

Das KArlsruher TRItium Neutrino Experiment wird nach seiner Inbetriebnahme über einen Zeitraum von fünf Kalenderjahren spektroskopisch den Endpunktsbereich des Tritium-Betazerfalls untersuchen. Hauptziel ist die modellunabhängige Bestimmung der effektiven Masse des Elektronantineutrinos mit einer bislang unerreichten Sensitivität von $0.2\,\mathrm{eV/c^2}$ (90 % C.L.).

Daneben ist KATRIN sensitiv für weitere Anomalien in der Form des Betazerfallsspektrums. Über Neutrinomischung werden hypothetische sterile Neutrinos kinematisch zugänglich und würden abhängig von ihrer Masse das beobachtete Spektrum in charakteristischer Weise modifizieren.

Dieser Beitrag untersucht den Effekt der Beimischung eines leichten sterilen Neutrinos im eV-Bereich bei kleinen Mischungswinkeln, motiviert durch die sogenannte ‚Reaktor-Antineutrino-Anomalie‘. Es wird gezeigt, dass das KATRIN-Experiment in der Lage sein wird, mit nur leichten Anpassungen der Messstrategie den in Frage stehenden Parameterraum in einer direkten Messung zu prüfen.

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T 50.8 Di 18:30 VMP5 SR 0079

KATRIN and sterile Neutrinos in the eV — •Marc Korzeczek[1], Thierry Lasserre[2], and Susanne Mertens[1,3] for the KATRIN-Collaboration — [1]Karlsruhe Institute of Technology, Germany — [2]Commissariat à l'énergie atomique, France — [3]Lawrence Berkeley National Laboratory, USA

Sterile neutrinos in the eV-mass range could resolve a number of longstanding anomalies in short baseline neutrino oscillation experiments. The KATRIN Experiment (KArlsruhe TRItium Neutrino) designed to measure the mass of the active neutrino, has the potential to search for a signature of light sterile neutrinos without any hardware modification.

In this talk we explore the combined sensitivity of KATRIN with CeSOX (CErium Short distance neutrino Oscillations with boreXino), an experiment dedicated to search for light sterile neutrinos via oscillations. In particular, we study the impact of sterile neutrinos on the KATRIN's active neutrino mass measurement.

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T 50.9 Di 18:45 VMP5 SR 0079

Requirements on read-out electronics for future keV-scale sterile neutrino search with KATRIN — •Kai Dolde — Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany

Recent publications show the great potential of the KATRIN (KArlsruhe TRItium Neutrino) experiment in the search for sterile neutrinos in the mass range of a few keV down to active-to-sterile mixing angles at least one order of magnitude smaller than current laboratory limits of $\sin^2\theta < 10^{-3}$. In order to be sensitive to the tiny kink-like signature of sterile neutrinos in tritium beta decay, KATRIN requires a novel sophisticated detector and read-out system. Several silicon prototype detectors are under construction at the moment to explore the most suitable detector design for this purpose. The selection of appropriate read-out electronics is strongly triggered by the requirements of allowing only very small systematic uncertainties due to ADC Non-Linearities to reach the expected sensitivity.

This talk investigates the impact of ADC Non-Linearities on the tritium beta decay spectrum, depending on the digitization method of analogue signals of a multi-pixel silicon detector, peak sensing or waveform digitization. The simulations show a higher achievable sensitivity using waveform digitizers and moreover strongly favor additional variable post-acceleration of the electrons to smear out the periodic structure of the ADC Non-Linearities.

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