# T 39: Neutrino Physics IV

Time: Tuesday 16:15–17:45 Location: VG 3.104

T 39.1 Tue 16:15 VG 3.104

**Insight into the Analysis of the KATRIN Neutrino Mass Data**
— Christoph Köhler[1,2], Susanne Mertens[1,2], •Jan Plößner[1,2], Richard Salomon[3], Alessandro Schwemmer[1,2], Jaroslav Štorek[4], Xaver Stribl[1,2], and Christoph Wiesinger[1,2] for the KATRIN-Collaboration — [1]Max Planck Institute for Nuclear Physics — [2]Technical University of Munich — [3]University of Münster — [4]Karlsruhe Institute of Technology

The KArlsruhe TRItium Neutrino (KATRIN) experiment probes the effective electron anti-neutrino mass by a precision measurement of the tritium beta-decay spectrum near the endpoint. A world-leading upper limit of $0.45\,\mathrm{eV\,c^{-2}}$ (90 % C.L.) has been set, including the data of the first five measurement campaigns, corresponding to approximately 15 % of the final statistics. Since then, the collected data has increased by a factor of five.

In this presentation, I will provide an update on the current status of the KATRIN neutrino mass analysis beyond the fifth measurement campaign and discuss the neural network approach utilized for this analysis.

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T 39.2 Tue 16:30 VG 3.104

**Unbinned analysis of $^{163}$Ho-spectrum endpoint region**
— •Frederic Böhm — Kirchhoff Institute for Physics, Heidelberg University — ECHo Collaboration

The aim of the Electron Capture in $^{163}$Ho (ECHo) collaboration is to determine the effective electron neutrino mass by analysing the endpoint region of the $^{163}$Ho electron capture spectrum. The spectrum is measured using metallic magnetic calorimeters (MMC) enclosing $^{163}$Ho and subsequently the data is reduced to avoid the presence of artifacts before further analysis can take place. Previously, a histogram-based approach already proved to be a suitable choice for the analysis of the spectrum and, in particular, of the endpoint region. To further improve the sensitivity of the fitting algorithms to quantify the effect of tiny neutrino masses, we are testing methods of unbinned analysis like a Kernel Density Estimation (KDE) to mitigate potential artifacts of binning the continuous event energies of the low-intensity endpoint region close to the Q-value of the $^{163}$Ho decay. We present the implementation of these algorithms in the analysis of the $^{163}$Ho spectrum acquired within the ECHo-1k experiment and compare the results with the ones obtained with binned spectra.

T 39.3 Tue 16:45 VG 3.104

**Integrated magnetic field design for next-generation neutrino mass experiment with CRES**
— •René Reimann and Martin Fertl for the Project 8-Collaboration — Institute of Physics and Excellence Cluster PRISMA+, Johannes Gutenberg University Mainz, 55099 Mainz, Germany

The Project 8 experiment aims to probe the absolute neutrino mass through direct kinematic measurements of the tritium beta decay spectrum using cyclotron radiation emission spectroscopy (CRES). The low-frequency apparatus (LFA) should demonstrate the coexistence of CRES electron detection and an atomic trap while increasing the effective volume and lowering the background magnetic field compared to previous CRES experiments. To achieve the required energy resolution, the magnetic field experienced by the electrons must be known to very high precision. The magnetic field consists of a carefully tuned uniform background field with a super-imposed magnetic bottle trap to confine the CRES electrons within the detection region. In addition, a high-order multipole magnet adds a strong field only near the wall to confine the cold tritium atoms whose decay provides the electrons for CRES. This contribution describes how, individually and in concert, the three elements of Project 8's magnetic field impact key performance parameters of the detector.

T 39.4 Tue 17:00 VG 3.104

**Simulating the atomic beam source for Project 8 experiment : from dissociation to cooling**
— •Aya El Boustani[1] and Sebastian Böser[2] for the Project 8-Collaboration — [1]Institute of Physics, Johannes Gutenberg University of Mainz, Germany — [2]Institute of Physics, Johannes Gutenberg University of Mainz, Germany

The Project 8 experiment aims to determine the absolute neutrino mass using Cyclotron Radiation Emission Spectroscopy (CRES) to measure the radiation emitted by tritium beta-decay electrons near the spectrum's endpoint, where the neutrino mass effect is most significant. Achieving the desired sensitivity requires an atomic tritium source with well-characterized beam properties. In the test setup at JGU Mainz, molecular hydrogen serves as a non-radioactive tritium analog and is dissociated using a tungsten capillary heated to approximately 2300 K. The dissociated gas undergoes a multi-stage cooling process to bring the atomic beam's temperature down to 8 K. This process is critical to allow the trapping of atoms at later stages of the experiment while minimizing recombination. For this study, simulations were carried out to investigate the atomic source and the accommodator, which serves as the first cooling stage. Using the SPARTA framework, gas flow within the heated tungsten capillary was modeled to characterize atomic beam formation, quantify dissociation efficiency, and evaluate the resulting beam properties. Additional analyses of the accommodator are conducted to assess the effects of surface geometry and gas-surface dynamics on cooling efficiency and overall beam characteristics.

T 39.5 Tue 17:15 VG 3.104

**MMC Design and Microfabrication for the ECHo Experiment**
— •Lorenzo Calza — Kirchhoff Institute for Physics, Heidelberg University, Heidelberg, Germany — ECHo Collaboration

The ECHo experiment is conceived to determine the electron neutrino mass through the analysis of the endpoint region of a high statistics and high energy resolution $^{163}$Ho spectrum. During the ECHo-100k phase more than $10^{12}$ $^{163}$Ho decays will be detected by large metallic magnetic calorimeter arrays in which single pixels contain up to 10 Bq of $^{163}$Ho. To achieve this goal, about $10^4$ MMC pixels will be operated simultaneously. A dedicated chip composed of 60 pixels and 2 temperature channels for gain correction has been designed. 40 chips are microfabricated on a 3" silicon wafer. The design and fabrication steps have been optimised for $^{163}$Ho implantation on wafer-scale. We describe the single pixel optimisation for minimal heat capacity and close to 100% quantum efficiency for all decay products besides the electron neutrino, as well as the final chip design. We also present the lithographic microfabrication process and the quality control procedures. We discuss the fabrication yield and the reproducibility of detector parameters. To meet the required pixel count for ECHo-100k, 6 wafers are currently being produced.

T 39.6 Tue 17:30 VG 3.104

**ECHo-100k Chip characterization**
— •Neltje Sophie Buermann — Kirchhoff Institute for Physics, Heidelberg University, Germany — ECHo Collaboration

The ECHo experiment is designed to search for the signature of the finite neutrino mass in the endpoint region of the $^{163}$Ho electron capture spectrum. The first stage of the experiment ECHo-1k has been completed, and now the second stage ECHo-100k is under construction. This stage includes a new metallic magnetic calorimeter array with improved pixel design and thermalization. The foreseen resolution of 4 eV FWHM will be more than a factor two better than the one achieved with the ECHo-1k arrays. In this contribution, we present the results for the newly developed chips and discuss their performance in terms of the ECHo-100k requirements.