# T 2: Neutrino Physics I

Time: Monday 16:15–18:15 Location: AudiMax

T 2.1 Mon 16:15 AudiMax

**Status Report on the ECHo Experiment** — •Raghav Pandey for the ECHo-Collaboration — Kirchhof Institute for Physics, INF 227, Heidelberg 69120

The analysis of the endpoint region of $\beta$-decay or electron capture decay spectra is a model independent method for the determination of the effective electron (anti-)neutrino mass. The ECHo collaboration aims to achieve this goal by preparing a high energy resolution and high statistics measurement of the electron capture spectrum in $^{163}$Ho. This experiment uses Metallic Magnetic Calorimeters enclosing samples of the $^{163}$Ho source. The first phase of the experiment — called ECHo-1k — has been completed with the publication of the best limit on the effective electron neutrino mass obtained from $^{163}$Ho, $m_{\nu_e} < 15$ eV(90%C.L.).

We present the results obtained in the ECHo-1k experiment and discuss the development of the next phase of ECHo, the ECHo-LE (Large Experiment). In ECHo-LE, 20000 MMC detectors will be read out using a microwave SQUID multiplexing scheme with the goal of acquiring $10^{13}$ events at a high energy resolution. The achievement of such a spectra allows for a sub-eV sensitivity on the effective electron neutrino mass.

T 2.2 Mon 16:30 AudiMax

**Fitting of the endpoint region of the Ho-163 spectrum in the ECHo–1k experiment** — •Lorenzo Calza — Kirchhoff Institute for Physics, Heidelberg University

The effective electron neutrino mass can be derived from the analysis of the endpoint region of electron capture spectra, since the finite mass distorts the spectral shape near the $Q$ value. In ECHo the shape of the Ho-163 EC spectrum is studied. During the first phase of the ECHo experiment, more than 200 million Ho-163 events were acquired using 2 arrays of metallic magnetic calorimeters enclosing Ho-163. For a reliable analysis of the endpoint region, a precise calibration of the spectrum was obtained by applying a tailored procedure determined in a dedicated calibration measurement. Since theoretical models fail to provide an accurate analytical description of the spectral shape, we have tested two different approaches for the determination of a phenomenological function. The obtained functions were tested for stability of fit in the endpoint region of the acquired Ho-163 spectrum. We present the analysis of the ECHo-1k data leading to the present best limit of $m(\nu_e) < 15$ eV 90% confidence interval ($m(\nu_e) < 18$ eV 95% C.I.) and discuss the study of the systematic uncertainties.

T 2.3 Mon 16:45 AudiMax

**Studies on general neutrino interactions with the KATRIN experiment** — •Hanna Henke for the KATRIN-Collaboration — Institute for Astroparticle Physics, Karlsruhe Institute of Technology, Karlsruhe, Germany

The Karlsruhe Tritium Neutrino (KATRIN) Experiment aims to determine the neutrino mass using precision spectroscopy of electrons from tritium $\beta$-decay. Recently, KATRIN published an improved upper bound of 0.45 eV at 90% C.L. [1] on the effective electron-neutrino mass. Beyond the neutrino mass measurement, KATRIN's high-precision spectroscopy enables searches for physics beyond the Standard Model, such as general neutrino interactions (GNI). These interactions can manifest as subtle shape deformations in the measured energy spectrum. The GNI framework provides a model-agnostic approach by combining all theoretically allowed interaction terms into an effective field theory, describing energy-dependent spectral contributions as indicators of novel weak processes. Recently, first constraints on GNI based on KATRIN data were released [2]. This talk will give an overview of the GNI framework and analysis, and present further studies using KATRIN data.
This work is supported by the Helmholtz Association and by the Ministry for Education and research BMFTR (grant numbers 05A23PMA, 05A23PX2, 05A23VK2 and 05A23WO6)
[1] DOI: 10.1126/science.adq9592,
[2] DOI: 10.1103/PhysRevLett.134.251801

T 2.4 Mon 17:00 AudiMax

**Insight into the Analysis of the KATRIN Neutrino Mass Data** — Chloé Goupy[1], Christoph Köhler[1], Susanne Mertens[1], •Jan Plößner[1], Richard Salomon[2], Alessandro Schwemmer[1], Jaroslav Štorek[3], Xaver Stribl[1,4], and Christoph Wiesinger[1] for the KATRIN-Collaboration — [1]Max-Planck-Institut für Kernphysik — [2]Universität Münster — [3]Karlsruher Institut für Technologie — [4]Technische Universität München

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 eV c$^{-2}$ (90 % C.L.) has been set, including the data of the first five measurement campaigns. With data collection now complete after a total of 19 measurement campaigns, the available statistics have increased by more than a factor of six compared to the initial dataset. In this presentation, I will provide an update on the current status of the KATRIN neutrino mass analysis, including the data from the first 17 measurement campaigns, and discuss the neural network approach utilized for this analysis.
This work is supported by the Helmholtz Association and by the Ministry for Education and Research BMFTR (grant numbers 05A23PMA, 05A23PX2, 05A23VK2, and 05A23WO6).

T 2.5 Mon 17:15 AudiMax

**Magnetic-field compatibility of TRISTAN detectors for the KATRIN keV sterile neutrino search** — •Simon Gentner — Karlsruhe Institute for Technology (KIT)

At the Karlsruhe Institute of Technology (KIT), a full-scale replica of the KATRIN experiment's detector system was developed to pretest the innovative TRISTAN detectors. This replica enables comprehensive testing and calibration of up to nine TRISTAN detector modules under controlled conditions, ensuring optimal performance before their integration into the KATRIN beamline in 2026. This upgrade will enhance KATRIN's sensitivity in the search for keV-scale sterile neutrinos. Preliminary results demonstrate that the TRISTAN modules deliver exceptional high-resolution for beta spectroscopy, which is essential for precise neutrino mass measurements and the exploration of potential new physics.

During operation in the KATRIN beamline, the detector modules will be exposed to a strong magnetic field. To investigate its influence on critical detector parameters, including energy resolution and signal rise time, dedicated measurements were performed using the replica system. This presentation will discuss these results and highlight the excellent properties of the TRISTAN detector modules.

This work is supported by the Helmholtz Association and by the Ministry for Education and Research BMFTR (grant numbers 05A23PMA, 05A23PX2, 05A23VK2 and 05A23WO6).

T 2.6 Mon 17:30 AudiMax

**Current status of the next-generation neutrino mass experiment Project 8** — •Rene Reimann for the Project 8-Collaboration — Johannes Gutenberg Universität Mainz

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). Future tritium beta decay experiments that aim for neutrino mass sensitivities below ∼200meV, must be operated with atomic tritium to avoid effects from rotational and vibrational final states of the daughter nucleus. The CRES technique has been demonstrated successfully with molecular tritium in a small cylindrical wave guide. For a competitive experiment, the CRES technique must be scaled up and be operated in combination with atomic tritium. Currently the CRES cavity apparatus is under commissioning, which will demonstrate the CRES technique with improved energy resolution within a cavity using an event-by-event reconstruction. The low-frequency apparatus is currently in its design phase and 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. In addition, atomic tritium sources at unprecedent fluxes are under development. In this contribution, I give a short overview of the current demonstrators, which pave the way to a full-scale neutrino mass experiment.

T 2.7 Mon 17:45 AudiMax

**Offline data validation framework for JUNO** — •Nurbakyt

Amanbek[1,2] and Livia Ludhova[1,2] — [1]GSI Helmholtzzentrum für Schwerionenforschung GmbH, Planckstr. 1, D-64291 Darmstadt, Germany — [2]Institute of Physics and EC PRISMA+, Johannes Gutenberg Universität Mainz, Mainz, Germany

The Jiangmen Underground Neutrino Observatory (JUNO) is a multi-purpose liquid-scintillator detector in China that aims to determine the neutrino mass ordering by measuring reactor antineutrinos at a 52.5 km baseline. The central detector contains 20 kton of liquid scintillator and is instrumented with 17,612 large (20") PMTs and 25,600 small (3") PMTs, providing high light yield and excellent energy resolution. After physics data taking began on August 26, 2025, JUNO reported the most precise measurements of $\Delta m^2_{12}$ and $\sin^2\theta_{12}$ from 59.1 days of data - a level of precision that requires stable detector performance and consistently low-background, high-quality data. To monitor data quality, JUNO operates a semi-automated data-validation framework that performs prompt (online) and offline monitoring. About 10% of the data are validated promptly online to allow us to quickly react in case of major problems, while more detailed offline validation is performed once the full dataset of each run becomes available. We monitor various properties at the level of single channels, events, and the whole run. We also monitor longer-term stability of the detector to identify potential slower changes. This contribution presents the offline validation workflow and highlights its essential role in securing the data quality required for JUNO's precision oscillation program.

T 2.8 Mon 18:00 AudiMax

**Measurement of Solar Neutrino Oscillation Parameters with the First JUNO Data** — •Cristobal Morales Reveco[1,2,3], Nurba Amanbek[1,3], Tim Charisse[1,3], Ze Chen[1,3], Livia Ludhova[1,3], Marco Malabarba[1,3], Mariam Rifai[1,2,3], Sahar Safari[1,3], Ujwal Santhosh[1,3], and Rosmarie Wirth[1,3] — [1]GSI Helmholtzzentrum für Schwerionenforschung, 64291 Darmstadt, Germany — [2]III. Physikalisches Institut B, RWTH Aachen University, 52062 Aachen, Germany — [3]Institute of Physics and EC PRISMA+, Johannes Gutenberg Universität Mainz, Mainz, Germany

The Jiangmen Underground Neutrino Observatory (JUNO) is a 20 kt liquid scintillator detector experiment located in the Jiangmen region, China. It is situated at an optimal distance of 52.5 km from multiple nuclear reactor cores and is designed for precision measurements of neutrino oscillation parameters and the determination of the neutrino mass ordering (NMO). In December 2024, construction was completed, and commissioning began by fully filling the detector with water. In February 2025, the water in the inner detector started to be replaced with liquid scintillator, a process that continued until the end of August of the same year. This talk presents results from 59.1 days of data, achieving a world-leading measurement of the solar oscillation parameters. It will focus on the analysis strategy: signal event and data-driven background selections, the estimation of residual backgrounds, uncertainties, and the fit strategy used to extract the solar oscillation parameters.