T 66: Neutrino Physics IV

Time: Thursday 16:15–18:00 Location: AudiMax

T 66.1 Thu 16:15 AudiMax

Tests of a full Monte Carlo simulation for keV-sterile neutrino searches with the KATRIN experiment in a mockup — •Tom Geigle for the KATRIN-Collaboration — Karlsruhe Institute of Technology (KIT), Karlsruhe

Sterile neutrinos in the keV mass range are a compelling dark matter candidate predicted by many extensions of the Standard Model. A distinctive signature would be a kink-like distortion in the tritium β-decay spectrum. While KATRIN currently probes the endpoint region to determine the effective neutrino mass, its next phase, TRISTAN, will extend the search across the full spectrum using a novel multi-pixel silicon drift detector and upgraded readout infrastructure, complemented by dedicated beamline modifications.

Sensitivity in this regime is strongly influenced by systematics such as electron scattering in the source and detector-response effects. To address these challenges, we have developed KAMELEON*a high-efficiency, Geant4-based Monte Carlo simulation of the entire KATRIN beamline. In this presentation, we outline its architecture and performance, compare simulation results with dedicated detector-mockup measurements, and present initial studies of systematic uncertainties relevant for the keV-scale sterile neutrino search.

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 66.2 Thu 16:30 AudiMax

Long-term evolution of the KATRIN background — •Florian Fränkle for the KATRIN-Collaboration — Institute for Astroparticle Physics (IAP), Karlsruhe Institute of Technology (KIT)

The KArlsruhe TRItium Neutrino (KATRIN) experiment is a large-scale effort with the objective to determine the effective electron antineutrino mass with an unprecedented sensitivity of better than 0.3 eV/c^2 (90% CL) in a model-independent way based on precision β-decay spectroscopy of molecular tritium. KATRIN completed its neutrino mass measurement campaigns at the end of 2025 and so far has improved the upper bound on the effective electron-neutrino mass to 0.45 eV/c^2 (90% CL) based on data collected before July 2021.

A major limiting factor for the KATRIN sensitivity is a background level which is an order of magnitude higher than the original design specification. This presentation will provide an overview of the long-term evolution of the background during the neutrino mass measurement campaigns and share insights on the underlying background mechanisms.

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 66.3 Thu 16:45 AudiMax

Status of Theia simulations — •Johann Martyn, Amala Augusthy, Noah Goehlke, Alfons Weber, and Michael Wurm — Johannes Gutenberg-University Mainz

Theia is a large-scale neutrino detector concept, designed to simultaneously exploit Cherenkov and scintillation light, potentially enabling a broad range of physics goals. The detector concept leverages recent advancments for the separation of Cherenkov and scintillation light, such as water-based liquid scintillator (WbLS), fast photo-detectors, dichroicons, and novel reconstruction techniques. This allows for the reconstruction of the particle direction, as well as particle identification via Cherenkov light while providing an enhanced energy resolution and low energy threshold from the scintillation. The proposed scientific program includes long-baseline neutrino oscillation measurements and CP violation searches, precision solar neutrino studies, search for the diffuse supernova neutrino background (DSNB), and ultimately neutrinoless double beta decay. This talk presents an overview of Theia and the current status of the Geant4 based Theia simulation framework, focusing on the ongoing efforts to optimize the detector configurations.

T 66.4 Thu 17:00 AudiMax

Sensitivity studies for neutron flux measurements in the LEGEND experiment — •Loris Steinhart for the LEGEND-Collaboration — University of Tuebingen

Achieving the ambitious background goals of the next phase of the Large Enriched Germanium Experiment for Neutrinoless Double-Beta Decay (LEGEND) requires a precise understanding of neutron-induced backgrounds within the detector array. In this contribution, sensitivity studies for measuring the neutron flux in LEGEND are presented using a dedicated Gadolinium-loaded polyethylene (GdPE) string introduced into the experimental setup. Neutron captures on gadolinium produce characteristic signatures that can be identified via coincident energy depositions in the surrounding germanium detectors. By exploiting these correlations, neutron capture rates in the GdPE can be reconstructed and used to infer the neutron flux at the center of the detector array. This talk will discuss the underlying analysis strategy, simulation-based sensitivity estimates, and first experimental considerations, and will outline the relevance of this measurement for constraining neutron-related backgrounds and improving the overall sensitivity of LEGEND to the $0\nu\beta\beta$ decay search.

We acknowledge support from the DFG under Germany's Excellence Strategy – EXC 2094 (ORIGINS) and through the Sonderforschungsbereich SFB 1258. We acknowledge support by the BMFTR Verbundprojekt 05A2023 (LEGEND).

T 66.5 Thu 17:15 AudiMax

DUNE-PRISM: An innovative technique for neutrino oscillation analysis — •Ioana Alexandra Caracas — JGU Mainz, Germany

As long baseline neutrino experiments are entering the high-precision era, an increased sensitivity towards constraining the oscillation parameters space is expected. A classical approach for the oscillation predictions is prone to systematic uncertainties, due to the incompleteness of neutrinos interaction cross section modelling. This would in turn limit the capability to obtain the physics goals for modern long baseline experiments, such as the Deep Underground Neutrino Experiment (DUNE). An innovative technique, the Precision Reaction Independent Spectrum Measurement (PRISM) has been proposed and studied within the DUNE collaboration. This novel method is designed to measure and predict neutrino oscillated spectra on a data-driven basis, thus avoiding many neutrino interaction uncertainties. In this regard, the Near Detector (ND) is designed to move off the neutrino beam axis at several locations up to a distance of 28.5 m. Different neutrino fluxes are thus sampled and these ND off-axis results are further used to predict the neutrino oscillated spectrum at the DUNE Far Detector. The prediction obtained with the DUNE-PRISM analysis framework and preliminary results regarding the systematics impact on the oscillation parameters will be presented. Ongoing studies to improve the overall sensitivity to the oscillation parameters and reduce their dependence on the interaction model will also be discussed. The importance of sampling the entire off-axis space will also be high-lighted.

T 66.6 Thu 17:30 AudiMax

JUNO detector response determination through calibration data — •Marco Malabarba[1,2] and Livia Ludhova[1,2] — [1]1GSI Helmholtzzentrum für Schwerionenforschung, 64291 Darmstadt, Germany — [2]2Institute of Physics and EC PRISMA+, Johannes Gutenberg Universität Mainz, Mainz, Germany

JUNO (Jiangmen Underground Neutrino Observatory) is a multipurpose neutrino physics experiment in China. Its construction ended in 2024 and it has been taking data since August 2025. The target consists of 20 kton of organic liquid scintillator. The optical photons are collected by photomultiplier tubes which provide a geometrical coverage of $\sim$ 78%. JUNO has already achieved world leading precision on the neutrino solar oscillation parameters with 59.1 days of data taking. To obtain this result, as well as to achieve its future goal of determining the neutrino mass ordering, an evaluation of the detector response, in terms of temporal stability, detector non-uniformity, energy resolution, and energy non-linearity, is needed. All these quantities can be determined both through calibration (^{137}Cs, ^{54}Mn, ^{68}Ge, ^{40}K, ^{60}Co, AmC, and laser) and natural sources (such as ^{214}Po, spallation neutrons, and some cosmogenic isotopes as ^{12}B and ^{11}C). In this talk, an analysis of the calibration sources will be presented. In particular, different fit models have been developed to take into account the different decay details of each individual nuclide. The results allow to infer the concentration of ^{14}C and, when combined with the spectra of ^{12}B and ^{11}C, also to determine the energy non-linearity for e^-, e^+, and γ, an essential building block for reactor neutrino analysis.

T 66.7 Thu 17:45 AudiMax

Liquid Handling System and radiopurity of the OSIRIS detector — Manuel Böhles[1], Marcel Büchner[1], Daniela Fetzer[1], Arshak Jafar[1], •Oliver Pilarczyk[1], Tobias Sterr[2], and Michael Wurm[1] — [1]Johannes Gutenberg-University Mainz — [2]Eberhard Karls Universität Tübingen

The Jiangmen Underground Neutrino Observatory (JUNO) is a 20 kt liquid scintillator experiment in Jiangmen (China). Its main scientific goal is to determine the neutrino mass ordering by measuring electron antineutrinos from two nearby nuclear power plants at a distance of ~53 km. To achieve this goal the liquid scintillator had to be thoroughly cleaned to make sure it meets the optical and radiopurity requirements.

The 20m* OSIRIS pre-detector is the last device behind these purification plants in an underground hall close to the main JUNO detector. Its task was to monitor the radiopurity of the purified scintillator before it was filled in the JUNO detector. OSIRIS was operated in batch-mode to qualify the purity of scintillator samples and its own experimental sensitivity before and during JUNO filling. To ensure every batch of the scintillator stays about 24h inside OSIRIS a temperature gradient can be established in the detection volume. This talk covers the operations and results from the commissioning phase of the OSIRIS detector as well as the background levels and sensitivity that were reached for U/Th.

The work is supported by the DFG Research Unit 'JUNO' (FOR5519) and the Cluster of Excellence PRISMA+.