Contribution ID: **108** Type: **Talk**

The TRISTAN Detector Upgrade for the Search of Sterile Neutrino Dark Matter at KATRIN

Thursday 27 March 2025 11:35 (15 minutes)

The TRISTAN detector is an upgrade to the KATRIN experiment designed to optimize sensitivity to the spectral distortion caused by keV sterile states. The KATRIN experiment has produced the world leading limits from direct kinematic studies for the neutrino mass and eV scale sterile neutrinos through the precision measurement of the endpoint region of the tritium β decay spectrum. After 1000 days of neutrino mass measurement, and the transition to a systematics dominated measurement, the KATRIN detector will be replaced by 9 TRISTAN detector modules to enable an efficient differential measurement of the full tritium spectrum. A statistical uncertainty of $\sin(\theta) < 10^{-6}$ is shown to be reachable in just 1 month of data taking in the new experimental configuration.

The production and characterization of the TRISTAN detectors, as well as the first tests of a partially populated TRISTAN tower with 3 detector modules in a KATRIN-like environment will be presented. The treatment of systematic effects to the spectral measurement, through response matrices and full Monte-Carlo approaches, is shown with the related impact to sensitivity to sterile mixing. Additionally, the changes in operating conditions within KATRIN and detector integration timeline to enable first TRISTAN data taking in 2026 is outlined.

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Session Classification: SESSION 16- Directional Direct Detection & Direct Detection Recent Developments I