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Spectroscopy of the first electrons from the KATRIN tritium source

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Neutrinos are by far the lightest particles in the Universe. According to the Standard Model of Particle Physics neutrinos should be massless. However, the existence of their mass has been proven experimentally by the observation of neutrino mass oscillations. The KArlsruhe TRitium Neutrino (KATRIN) experiment at the Karlsruhe Institute of Technology aims for a direct neutrino mass determination with a sensitivity of 200 meV/c^2 (90% C.L.).
The measurement will be performed by precise spectroscopy of the tritium-β-decay electrons near the kinematic endpoint of 18.6 keV. That is achieved by employing a high-resolution ($\Delta E < 1$ eV) MAC-E-type high-pass energy filter coupled to a high-luminosity (10^{11} Bq) windowless gaseous tritium source which is supplied by the closed gas processing loop of the Tritium Laboratory Karlsruhe (TLK) at throughput of 40 g of T_2 per day.

In autumn 2016, the First Light commissioning campaign took place, in which photoelectrons generated from KATRIN's rear wall were guided through the complete beamline (source and spectrometers) and were detected successfully on the detector. During the subsequent experimental stage in summer 2018, gaseous metastable Kr-83m was injected into the KATRIN source section. Furthermore, a condensed Kr-83m source was deployed in the transport section. By using both sources, first high-resolution spectroscopy of electrons from radioactive origin has been performed with KATRIN (arXiv:1802.04167). From this campaign, we could demonstrate many aspects of the high-resolution spectroscopy capability of the KATRIN setup and perform a highly accurate calibration of the energy scale of KATRIN from the mono-energetic conversion electrons from Kr-83m (arXiv:1802.05227).

After the demonstration of the high-resolution performance of the KATRIN spectrometers, in spring 2018, the first injection of tritium into the KATRIN source section is scheduled. The principal aim of this campaign is to demonstrate the stability of the tritium source at an activity of about 1% (˜10^9 Bq) of the nominal level, which is maintained by a complex tritium loop at the TLK. This stability investigation is crucial in order to operate the tritium source at high isotopic purity (>95%) and a stability of 0.1% during upcoming neutrino mass runs (with a total measurement time of three years).

This talk presents the ambitious goals of KATRIN and the complex setup designed to reach them. The fruitful achievements of the successful Krypton campaign will be summarized and an insight into the results from the first ever high-resolution spectroscopy with tritium beta-decay electrons by KATRIN is given.

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