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Technologies for a Future Neutrino Mass Experiment with Tritium

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Currently, the best limits on the neutrino mass from the direct measurements are obtained by the KATRIN (KArlsruhe TRItium Neutrino) experiment, giving an upper limit on the mass of electron anti-neutrino of 0.45 eV (KATRIN Collaboration, Science 388, 180 (2025)). Towards the end of this year, KATRIN will reach its desired goal of 1000 days of measurement, allowing the electron anti-neutrino mass to be constrained to a value in the vicinity of 0.3 eV. Going beyond this limit, and eventually excluding the inverted mass ordering, will be the task of future neutrino mass experiments.

Achieving these ambitious goals will require a paradigm shift in the experimental approach, necessitating development of new and scalable technologies. In particular, a combination of an ultra-high resolution differential detection method together with a high-luminosity atomic tritium source shows a promising path forward.

Building upon the success of the KATRIN experiment, in the following years we plan to develop a quantum sensor array and atomic tritium demonstrators, making use of the existing KATRIN and TLK (Tritium Laboratory Karlsruhe) infrastructure.

In this talk, we present the status of our R&D efforts towards development of these new technologies as a basis for the next generation neutrino mass experiment with tritium, the so called KATRIN++. We will show the results of our first measurement campaigns with the $^{83}\mathrm{Rb}/^{83\mathrm{m}}\mathrm{Kr}$ radioactive source, and discuss our plans for the proof-of-principle measurements of the tritium β-spectrum with an ultra-high resolution cryogenic microcalorimeters.

Collaboration you are representing

KATRIN

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