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The first neutrino mass limit of HOLMES

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Measuring the absolute mass of neutrinos remains a significant challenge in particle physics and astrophysics. The only theory-unrelated method to assess its value is through direct measurements, which involve a kinematic analysis of electrons emitted in beta decays. The experiments aiming to perform such a measurement fall into two categories: spectrometers and calorimeters. Spectrometers like KATRIN set stringent limits, yet face limitations due to the fact that the source is external to the detectors with possibility of systematics. Calorimeters, on the other hand, embed sources within low-temperature detectors, measuring the entire energy released by the decay except the fraction carried by the neutrino. Balancing statistical sensitivity and unresolved pile-up fraction, crucial for calorimeters, involves distributing the total activity across numerous detectors, necessitating multiplexing readout.
HOLMES is an experiment seeking to assess the feasibility of measuring the neutrino mass with a sub-eV sensitivity by measuring the electron capture of 163Ho calorimetrically. The nuclei of 163Ho are embedded in the detectors with a custom ion-implanter. The detectors are readout using the microwave multiplexing technique developed by NIST, which is based on the use of rf-SQUIDs as input devices with ramp modulation. The modulated signals are readout by coupling the rf-SQUIDs to superconducting lambda/4 resonators: by tuning resonators at different frequencies it is possible to achieve a large multiplexing factor, while providing a relatively large bandwidth per channel.
HOLMES has completed a thorough optimization of the detectors and multiplexing, achieving results that meet the requirement of the experiment. Following an extensive commissioning and testing phase, the custom ion implanter has been able to perform implantations at low dose (around 1 Hz) successfully. This milestone has represented a major progress for HOLMES, from which will plan to increase the specific activity in the detectors, to assess the contribution to the TESs total heat capacity due to the concentration of 163Ho.
In this contribution the collaboration presents the initial results following the first high-statistics data tacking campaign, discussing the status and the overall outlook of the experiment.

Poster prize

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