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Transition-edge sensors to detect low-energy electrons: chasing the CvB and the neutrino mass

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The PTOLEMY collaboration aims to detect the Cosmic Neutrino Background (CνB) and measuring the neutrino mass. To do so, PTOLEMY plans to reconstruct the tritium beta decay and the cosmic neutrino capture on tritium: the electrons near the endpoint of the spectrum will be decelerated and then detected using an array of Transition-Edge Sensors (TES). To be sensitive to neutrino mass effects in the tritium spectrum and to cosmic neutrino captures, the energy resolution goal of PTOLEMY is a standard deviation of 50 meV on 10 eV electrons.
TES devices are superconductive detectors with high sensitivity, high energy resolution and low dark count rates, which have to be operated at cryogenic temperatures. They have been traditionally used as photon-number resolving detectors but they have recently accomplished electron detection. This research is carried out at INRiM (Istituto Nazionale di Ricerca Metrologica), in Italy, where the TESs are also fabricated.
To produce electrons directly inside the cryostat, vertically-aligned carbon nanotubes (CNTs) were chosen as cold electron source. In fact, applying a strong enough external electric field, they emit electrons through the quantum process of field emission, favored by their nanoscale tips which provide a high local field enhancement factor.
Applying a bias voltage to a CNT sample placed in front of a TES, electrons with a kinetic energy E_e ⊠ 100 eV were directed towards the TES to test its performance, focusing on the energy resolution.

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