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Energy calibration of the BULLKID-DM experiment

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BULLKID is a monolithic array of dice of 5.4 x 5.4 x 5.0 mm3 carved in a silicon crystal and sensed by phonon-mediated cryogenic Kinetic Inductance Detectors (KIDs). It is designed for the detection of sub-keV energy depositions from particle interactions within the crystal, making it suitable for direct Dark-Matter (DM) searches and coherent elastic neutrino-nucleus scattering (CE□NS) experiments.

One of the main challenges in this low-energy regime is the energy calibration, which is typically performed through the emission lines of radioactive sources in the O(keV) range followed by the linear extrapolation of the detector response down to threshold.

To overcome this limitation, the BULLKID-DM collaboration employs a method based on bursts of UV-Vis photons, that allows the individual calibration of the dice. This technique enables individual calibration of the KIDs in the array and allows for controlled signal generation across an energy range from a few eV up to tens of keV enabling a wide range detector characterization. However, photons produce electron recoils near the surface of the crystal, unlike DM or CE□NS interactions, which produce nuclear recoils uniformly distributed throughout the crystal volume (bulk events).

Validating this optical calibration method, using particle interactions, is thus of critical importance. We performed two measurements: one of the 59.5 keV gamma rays of a 241Am radioactive source and another using X-rays from lead facing the detector. The optical calibration is validated within a 10% deficit with respect to the true energy and we find no hint of different detector response with the depth of the interaction in the crystal.

Finally we present an ongoing study of a calibration method based on the response function of the detector which may be employed in absence of external sources during the data taking.

Collaboration you are representing

BULLKID-DM

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