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LANTERN: Characterizing low threshold cryogenic calorimeters

Abstract Recent advancements in low-energy rare-event searches rely on cryogenic calorimeters, which provide a low-noise environment crucial for the direct detection of dark matter and neutrinos. A key challenge in these detectors is accurately characterizing their response within the region of interest (ROI), typically spanning from O(10 eV) to O(1 keV). Conventional radioactive sources used for calibration primarily emit signals above this range, leading to non-linearities, saturation effects, and persistent background signals during data acquisition.

Abstract To address these limitations, we introduce LANTERN, an innovative optical calibration system specifically designed for highly segmented cryogenic calorimeters. LANTERN exploits the photostatistics generated by the absorption of monochromatic photons produced by a LED to study the detector response curve, without requiring prior knowledge of the total energy deposited. The system features a fast-switching LED matrix, operating at speeds faster than the typical response time of cryogenic detectors, and is capable of independently characterizing up to 64 calorimeters.

Abstract LANTERN can produce particle-like signals across a wide energy range, from a few eV to several hundreds of keV, allowing for a complete characterization of an array of detectors within the ROI, including the calibration, cross-talk evaluation and pixel identification. Furthermore, its minimal electronics and optics contribute to its reliability and ease of production, with the possibility of customization to meet specific requirements (wavelength, energy range, speed and number of channels). Importantly, because LANTERN is electronically activated, it can remain in place during data-taking, allowing for periodic performance validation without introducing unnecessary background.

Abstract In this contribution, we present the LANTERN project along with the latest results from the finalized system. We discuss the setup's characterization, detector calibration performance, thermalization, installation, and commissioning process.

Abstract With its features, LANTERN is a powerful tool for operating segmented calorimeters in low-background experiments, allowing for a full optimization of their response characterization. It is set to be deployed in the BULLKID-DM experiment, replacing the current calibration system, which faces significant scalability and customization constraints.

Title

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Topic

Solid state sensors

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