Contribution ID: **6** Type: **not specified**

LANTERN: A novel characterization technology for cryogenic detectors

Current advancements in low-energy rare-event searches rely on cryogenic calorimeters, commonly used for the direct detection of dark matter or neutrinos. These detectors provide a low-noise environment but face challenges in characterizing responses within the region of interest (ROI). Developed for probing energies from O(10eV) to O(1keV), these detectors encounter issues when calibrating with commonly available radioactive sources since these produce signals at energies above the ROI, affected by non-linearities and saturations, and cannot be removed during data-taking.

To overcome these limitations, a novel calibration procedure is required to better understand detector characteristics. LANTERN is an innovative optical calibration system designed for the characterization of an array of cryogenic calorimiteres. LANTERN exploits the photostatistics generated by the absorption of monochromatic photons produced by a LED, without requiring to know of the total energy deposited. This system is composed by a LED matrix, designed for fast switching times (faster than the typical response of cryogenic detectors), capable of characterizing up to 64 calorimeters independently.

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 and studies like cross-talk and pixel identification. Furthermore, its minimal electronics and optics contribute to cost-effectiveness and ease of production, with the possibility of customization to meet specific requirements (wavelength, energy range, speed and number of channels). Moreover LANTERN, being electronically activated, can remain present during data-taking, allowing periodic validation of detector performance without introducing unnecessary background.

These features make LANTERN an ideal system to be used with segmented calorimeters operated in low background setups to fully understand their response, thus exploiting their full potential. LANTERN aims to replace the systems employed by the BULLKID and NUCLEUS experiments, that present severe scalability and customization limitations.

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