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Development of a Silicon Bolometer for Rare Event Detection with LED Self-Calibration

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This research introduces a novel silicon bolometer, designed to dramatically enhance sensitivity for detecting ultra-low radioactive contamination of material surfaces. Targeting a sensitivity of 1 nBq/cm², the project integrates meticulous surface contamination control with advanced bolometric techniques. A central advancement is the implementation of a self-calibrating system using LED pulses, which simplifies detector operations and enhances stability, and eliminates the need for radioactive alpha sources or heater-based stabilization techniques. In this work, such a self-calibration has been successfully performed for energies up to 10 MeV. The calibration process involves developing an energy resolution curve from LED events, providing foundational data. LED pulses of varying amplitudes are used to linearize and calibrate the energy scale by using the Poisson statistics of the light itself. The accuracy of this model is verified through simulations that assess background levels, enabling more reliable measurements. The successful development of this novel detector will enable future projects for rare events to perform high-precision screening measurements of all the components prior to the experiment construction.

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