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Development of Position Sensitive Deep Transient Spectroscopy as a background mitigation tool for CCD-based dark matter searches

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The unparalleled sensitivity achieved with skipper CCDs, coupled with ultra-pure high-resistivity substrates (>22 kOhm×cm) and cryogenic operation, has rekindled interest in this technology for low-background experiments (DAMIC@SNOLAB, DAMIC-M, SENSEI, and OSCURA) Such devices offer sub-electron noise resolution, enabling the detection of extremely low-energy interactions critical for rare-event searches, including dark matter detection and neutrino studies. However, exposure to alpha particles and cosmic rays may induce lattice defects with extended annealing times, potentially degrading resolution and increasing background noise. We propose a novel method to mitigate these effects by integrating Laplace Deep-Level Transient Spectroscopy (DLTS) with electrical state pumping through the bias line, combined with the sequential readout of CCDs. Utilizing a lock-in amplifier synchronized to the shift register clock, we achieve pixel-by-pixel readout following charge injection. This approach addresses the inherent loss of timing information in charge-accumulating devices through a frequency scan at the pumping signal level. The method can be applied across various temperature points and injection levels, with an operational range typically spanning 120 K to 200 K. By conducting measurements at multiple injection and thermal conditions, we aim to characterize and mitigate background effects caused by lattice defects.

Type of presentation (in-person/online)

in-person presentation

Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

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