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Design and Optimization of SuperCDMS SNOLAB Low-Mass Detectors

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CDMSlite, the low-mass SuperCDMS Soudan Dark Matter search, operated detectors at high crystal voltages to exploit the large Luke-Neganov phonon energy gain, allowing for higher statistics due to lower energy thresholds. The first runs of this search were able to push cross-section limits to sub 10 GeV masses, leading the field in this regime. To push to even lower masses and cross section limits for SuperCDMS SNOLAB, we are developing specialized high voltage detectors with further improved phonon energy resolution by exploiting lower Tc TES sensors and improving "ballistic" Luke-Neganov phonon collection. These high voltage detectors aim to achieve 10 eV phonon energy resolution, translating to sub electron-volt nuclear recoil energy resolution, and reach within an order of magnitude of the coherent neutrino scattering floor. These design improvements have come through an R&D program that has shed light on aspects of the phonon sensor design that limit energy transport efficiency, and experience with CDMSlite, which highlighted the need for highly uniform fields in Luke-Neganov gain enhanced devices. I will discuss the design and optimization of these detectors, focusing on the requirements to understand nuclear recoil energy scale, separate surface and bulk events, and maximize energy collection efficiency both at the crystal surfaces and in our phonon sensors.

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