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Cherenkov and scintillation light detection in large array bolometers, and potential synergy with QIS

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CUPID (CUORE Upgrade with Particle ID) is a next-generation tonne-scale experiment that will use arrays of low-temperature calorimeters to search for rare processes like neutrinoless double beta decay. While CUORE (Cryogenic Underground Observatory for Rare Events) has already demonstrated the concept of operating a tonne-scale array at low temperatures (~10 mK), CUPID aims to significantly improve on the search sensitivity by using novel methods for background rejection. One technique is to enable event-by-event background rejection by reading out phonon and photon signals simultaneously from a scintillating crystal or a Cherenkov light-emitting crystal. We have an ongoing R&D effort at ANL, LBNL, and UCB towards developing sensitive optical-photon detectors that can measure tiny amounts of scintillation/Cherenkov light from low-temperature calorimeters. The detectors use a novel Iridium/Platinum bilayer superconducting transition-edge-sensor (TES) that can be operated at temperatures below ~ 40 mK, and have shown promising results in terms of energy and timing resolution. There is significant synergy between this detector R&D and QIS: from our experience in deploying customized large-scale millikelvin infrastructure, to the development of low-noise SQUIDs and their multiplexing electronics, to cryogenic high quantum efficiency detectors with single-photon resolution.

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