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Multiplexed TES Based Light Detectors using transition edge sensors for CUPID and beyond

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Low-temperature calorimeters have demonstrated significant efficacy in probing rare phenomena such as neutrinoless double beta decay and dark matter. Despite the impressive energy resolution these massive calorimeters achieve, the physics sensitivity reach is constrained by background radioactivity in these experiments. One approach to address this limitation involves implementing event-by-event background rejection through simultaneous readout of phonon and photon signals from scintillating crystals. Our current efforts focus on developing sensitive optical-photon detectors capable of capturing faint scintillation light in low-temperature calorimeters. We employ a pioneering Iridium/Platinum bilayer superconducting transition-edge-sensor (TES) technology, operating at temperatures below 40 mK, deposited on a large-area dielectric wafer (Si) serving as a photon absorber. These light detectors are ideal candidates for the next generation of calorimetric experiments involving thousands of channels. A multiplexed readout system is essential for this configuration to mitigate heat load into the cryostat and minimize surrounding radioactive materials. We are currently developing a frequency-domain multiplexing readout using TES bolometers, including designing a new resonator chip tailored to meet the bandwidth, size, and noise requirements of projects like CUPID (CUORE Upgrade with Particle IDentification). This resonator chip consists of ten superconducting resonators with characteristic frequencies in the MHz range and incorporates a SQUID (superconducting quantum interference device). Superconducting aluminum traces on Kapton backing transmit signals from the TESs and resonators at the 10 mK stage to the SQUID at a few hundred mK. Our ongoing work includes the characterization of optical photon detectors in terms of energy and timing resolution and the implementation of multiplexing readout in a ten-channel demonstrator.

Poster prize

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