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Understanding Dark Counts in Superconducting Transition-Edge Sensors

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Superconducting Transition-Edge Sensors (TESs) are promising detectors for experiments searching for rare signal events thanks to their high efficiency and extremely low dark count rates. To further enhance their sensitivity, it is essential to investigate the origins of these dark counts, a topic that has not been extensively studied. We found that the primary sources of dark counts in optical TESs are external in nature, with cosmic rays being the primary contributor.

We present various techniques for measuring the rates and characterizing the sources of dark counts. Additionally, we introduce new techniques for automated pulse shape discrimination using Principal Component Analysis (PCA). Through these methods, we categorize TES dark counts into three event types: photon-like events, high-energy events, and electrical noise events. By discriminating for photon-like events, we achieve an effective dark count rate around 360 μHz. This represents a reduction by a factor of 48 when compared to pre-discrimination levels.

We also investigate the sources of each type of event, attributing high-energy events to energy depositions in the substrate, photon-like events to photon absorption in the TES, and electrical noise events to the readout electronics. Our ability to discriminate high-energy events and attribute them to energy depositions in the substrate also opens the door for optical TESs to be used as sensitive radiation detectors for gamma rays and charged particles, broadening the range of applications for this type of sensor.

Collaboration

Role of Submitter

I am the presenter

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