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Estimating the Energy Threshold of Qubit-based Detectors in a Relaxation Sensing Scheme

Over the last decade, several low-energy physics searches, including the hunt for particle dark matter, have driven interest in developing increasingly sensitive particle detectors. Superconducting quantum sensors based on Cooper Pairs provide a possible channel for sensing O(meV) energy depositions, and therefore could represent a significant step in developing such low-threshold detectors. In this poster we present a bottom-up estimate of the energy threshold of a superconducting qubit operated in an energy-relaxation sensing scheme. We model the in-substrate phonon response with the G4CMP low-energy physics simulation package and model the evolution of phonon-created quasiparticles and qubit state with a custom package called QDR (Quantum Device Response). Using a novel energy reconstruction technique for qubits operated in this sensing scheme, we estimate an in-qubit energy threshold for near-term devices of approximately 0.4 eV. Moreover, we confirm the validity of this technique by applying it to recently published data in which cosmic rays were observed to pass through a qubit chip.

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