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Title: Prospects of Reactor Monitoring with a Germanium Antineutrino Detection System

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Abstract:

An operating 3GW nuclear reactor emits about 10^{22} antineutrinos per second in all directions that cannot be shielded, and thus, exploiting this antineutrino signature has the advantage of providing a verification tool independent of the declaration of the reactor operator. An antineutrino detector has the potential to monitor in real-time the operational status, power and fissile content of the reactor core.

The focus of this work is the development of a High-Purity Germanium (HPGe) detector system that will enable us to be sensitive to an as-yet undetected antineutrino interaction: coherent neutrino-nucleus scattering (CNNS). The detection of this interaction requires an unprecedented low electronic-noise threshold not available in commercial detectors with the desired target mass (1kg-scale). In recent years, there has been a qualitative advance in the field of large-mass HPGe detector fabrication, with low noise achieved by reducing the center electrode to a point contact. Using electrical contact preparation and surface passivation methods developed at LBNL, a new ~1-kg detector has been fabricated with a point contact diameter of ~1 mm, targeting a significant reduction in capacitance-driven electronic noise and leakage current. The detector element has been inserted in an optimized low-noise electronic readout, based on a similar prototype already developed by LBNL.

Controlling background signals is another imperative target, which is addressed by building a robust shield and eventually, using low-background materials in the proximity of the detector element. We have built a plastic scintillator veto to act as an anticoincidence detector surrounding the target Germanium detector, and present preliminary tests of its detection efficiency and light collection. We also present Geant4 simulation results evaluating the effectiveness of this detector as a neutron and gamma veto in the reactor tendon gallery (30mwe), compared to a similar NaI(Tl) veto detector.