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Surface events pulse shape simulation for the LEGEND experiment

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The Large Enriched Germanium Experiment for Neutrinoless double-beta Decay (LEGEND) collaboration plans to search for neutrinoless double-beta ($0\nu\beta\beta$) decay in ^{76}Ge using modular arrays of germanium detectors enriched in the isotope. $0\nu\beta\beta$ candidate events happen at a single site in the germanium detector. Pulse shape simulations to model the movement of charge carriers in the detectors are key to cuts that can reject background from multi-site and surface events. Most events originating from the bulk of the detector, such as gamma-ray events, can be easily simulated by using established models of charge carriers inside the germanium. However, surface events such as those caused by alpha incidents on the detector are complex since they generate a large charge cloud, and thus their signal is influenced by effects such as diffusion and self-repulsion. Surface alpha events are also subjected to charge trapping and re-release. A minuscule amount of alpha contamination emerges from detector handling during detector fabrication, storage, and assembly. Thus, only the p+ contact and passivated surfaces of the detector are sensitive to them. While these events can be easily rejected using analysis cuts, their behavior before cuts, including their energy spectrum and their distribution on the detector surface, is difficult to model. In this poster, we describe a novel simulation of charge carriers in germanium that incorporates diffusion and self-repulsion to model surface alpha events. We show how such simulations can be sped up using parallel calculations on GPUs, and how they can be used to improve modeling of alpha backgrounds in ^{76}Ge-based $0\nu\beta\beta$ searches.

Primary author: BHIMANI, Kevin (University of North Carolina at Chapel Hill)

Presenter: BHIMANI, Kevin (University of North Carolina at Chapel Hill)

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