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In-situ Cosmogenic Background for LEGEND

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The Large Enriched Germanium Experiment for Neutrinoless double beta Decay (LEGEND) Collaboration aims to develop an experimental program to search for neutrinoless double-beta decay in ^{76}Ge, with a half-life sensitivity of up to 10^{28} years in the second phase. Assuming a light neutrino exchange model, the sensitivity would cover the entire parameter space for neutrinos in the inverted hierarchy, as well as a portion of the normal hierarchy parameter space. Discovery of this decay mode, or exclusion of this decay mode in the case of inverted hierarchy, would have far-reaching consequences for multiple areas of particle physics and cosmology.
The first phase of the project, LEGEND-200, will utilize 200 kg of isotopically enriched Ge detectors and is under construction at the Laboratori Nazionali del Gran Sasso (LNGS). The second phase of the project, LEGEND-1000, will use one tonne of enriched Ge in its search, and aims to operate at an unprecedented background goal of 10^{-5} (keV kg yr)$^{-1}$ around the Q value. Improvements in all areas of background modeling and analysis are being investigated in the pursuit of this goal. One area of active study is the background induced in-situ by atmospheric muons and their secondary particles. Towards this end, a standalone GEANT4 simulation module has been developed for exploring both the prompt and delayed signals generated by the passage of the muons. The two sites primarily investigated in these simulations are LNGS, with a rock overburden of 3400 m.w.e., and SNOLAB, with a rock overburden of 6000 m.w.e. An estimate of the impact of the muon-induced signals over the lifetime of the experiment has been produced, along with the effectiveness of a variety of analysis cuts. Presented here are the results of the baseline simulations to date, as well as the implications for a number of alternative design options which have been considered while planning LEGEND-1000.

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