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Mitigation studies of K-42 in liquid argon for LEGEND

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The Large Enriched Germanium Experiment for Neutrinoless ββ Decay (LEGEND) aims to detect neutrinoless double beta decay (0νββ) of Ge-76 using high-purity germanium detectors (HPGe) immersed in liquid argon (LAr). The LAr serves both as a coolant and as an active shield against background radiation. In LEGEND-200, HPGe detectors are operated in atmospheric LAr, which contains the cosmogenically activated radioactive isotope Ar-42. LEGEND-1000, however, plans to use underground LAr (UGLAr) depleted in Ar-42 to mitigate this background. In case UGLAr is unavailable, K-42, the beta-decaying progeny of Ar-42 (Qβ = 3.5 MeV), would be the dominant background at the 0νββ Q-value (2.039 MeV) due to beta-decay-induced events occurring on the surface of the HPGe detectors. These surface events must be suppressed and efficiently discriminated from 0νββ candidate events. We present K-42 suppression measurements conducted at the SCARF LAr test facility at TU-Munich using Ar-42-enriched LAr. Our study evaluates background discrimination methods, including the analysis of event topologies in HPGe detectors and the use of scintillation light readout from LAr for suppression. Additionally, we explore enhancing suppression by surrounding the detectors with optically active barriers, such as polyethylene naphthalate (PEN) enclosures and tetraphenyl butadiene (TPB) coated nylon mini-shrouds. This research is funded by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) - Excellence Cluster ORIGINS EXC 2094-39078331; SFB1258-283604770.

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