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K-42 mitigation studies in Ar-42-spiked liquid argon for LEGEND

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The LEGEND experiment aims to detect neutrinoless double beta decay (0νββ) of Ge-76 using high-purity germanium (HPGe) detectors immersed in liquid argon (LAr). The LAr serves both as a coolant and as an active shield against background radiation. In the current phase (LEGEND-200), HPGe detectors are operated in conventional atmospheric LAr, which contains the cosmogenically activated radioactive isotope Ar-42. K-42, the beta-decaying progeny of Ar-42 (Qβ = 3.5 MeV), is a major background component of LEGEND-200.
LEGEND-1000 aims to use underground LAr (UGLAr) depleted in Ar-42 to eliminate this background. In case UGLAr is unavailable, K-42 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 analyzing event topologies in HPGe detectors and using 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, and present preliminary results. This research is funded by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) - Excellence Cluster ORIGINS EXC 2094-39078331; SFB1258-283604770.

Collaboration you are representing

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