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LEGEND: Background-free hunt for the neutrinoless double-beta decay

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The discovery that neutrinos are Majorana fermions would have profound implications for particle physics and cosmology. The Majorana character of neutrinos would make neutrinoless double-beta ($0\nu\beta\beta$) decay, a matter-creating process without the balancing emission of antimatter, possible. The LEGEND Collaboration pursues a phased, ^{76}Ge -based double-beta decay experimental program. The first phase, LEGEND-200, deploys up to 200 kg of germanium detectors enriched in ^{76}Ge . A background index of $2 \cdot 10^{-4}$ counts/(keV kg yr) will be achieved. With that background index, when integrated over the exposure, less than one background event in the region around the expected peak position of the $0\nu\beta\beta$ decay will be accumulated. It constitutes a quasi-background-free operation of LEGEND-200, enabling a potential discovery of the $0\nu\beta\beta$ decay at a half-life of at least 10^{27} years. The second phase, LEGEND-1000, will deploy 1000 kg of enriched germanium and reach a discovery potential above 10^{28} years. This talk will portray how LEGEND utilizes high-purity materials, novel sub-detector systems, and sophisticated analysis tools to obtain a quasi-background-free energy spectrum. Furthermore, first results from the currently ongoing data-taking period of LEGEND-200 are presented.

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