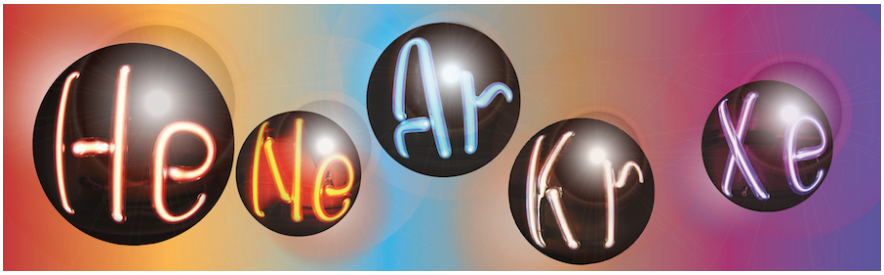

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Filling of the LEGEND cryostat - Liquid argon optical properties study

Friday, 23 September 2022 10:00 (15 minutes)

In the LEGEND experiment, approximately 90 tons (65 m^3) of liquid argon (LAr) serve as a cooling medium for the germanium detectors and as an instrumented shielding. To achieve optimal performance of the liquid argon detector system, the LAr was purified by a dedicated system during the cryostat's initial filling. The LEGEND LAr purification System (LLArS) performance was studied and monitored during cool down and filling of the cryostat by three systems: A scintillation analyzer for probing the argon scintillation properties by triplet state lifetime measurements; simultaneously, a direct measurement of the concentrations of impurities, such as water, oxygen, and nitrogen was performed with a sensitivity of 0.1 ppm. Additionally, the optical properties of argon filled inside the cryostat are constantly monitored by the LEGEND Liquid Argon Monitoring Apparatus (LLAMA). Thanks to the employment of LLArS, the achieved argon triplet lifetime ($_3$) measured inside the 70%-filled LEGEND-200 cryostat was 1.3 µs. It dropped to 1.1 µs after adding LAr of poor quality. The delivered LAr had a too high nitrogen content, which could not fully be removed by LLArS. However, this accidental nitrogen doping gave an opportunity to study optical properties of liquid argon at low nitrogen concentrations. The nitrogen content increased by 0.9 ppm in the course of several hours. Thanks to the argon monitoring system good quality data was collected and analyzed. The liquid argon purity in the cryostat can be recovered by implementing LLArS into an argon circulation system.
We will present the design, construction, and performance of the LLArS system capable of efficiently purifying 65 m^3 of liquid argon to a sub-ppm level for the LEGEND-200 experiment. Additionally, we show the evolution of the measured light yield and effective triplet lifetime during the filling and at low nitrogen concentrations.

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