

Status of the AXEL: 180L Prototype Results and Developments for the 1000L Detector

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The AXEL (A Xenon ElectroLuminescence) experiment aims to search for neutrinoless double beta decay ($0\nu\beta\beta$) using a high-pressure xenon gas time projection chamber (TPC).

The detector features a unique ionization detection called the Electroluminescence Light Collection Cell (ELCC), which provides high energy resolution and topological information by converting ionization electrons into electroluminescence light within cellular structures.

We have successfully operated an 180 L prototype detector and demonstrate the performance of this technology.

One of the recent key achievements is the development and installation of a Cockcroft-Walton (CW) multiplier for in-situ high voltage generation, addressing the difficulty of feeding high voltage (> 100 kV) into a high-pressure vessel.

The prototype demonstrated stable operation at 6.8-bar with the CW multiplier, achieving an energy resolution of 0.67 ± 0.08 % (FWHM) at 2615 keV.

Furthermore, the capability to reconstruct three-dimensional tracks was confirmed, allowing for topological discrimination between signal and background events, such as distinguishing single-electron events from pair-creation events.

Building on these results, we are currently constructing a 1000 L-scale detector to realize the first physics run for the $0\nu\beta\beta$ search.

We are developing a high-voltage distribution system that supplies voltage to ELCC modules independently; this minimizes the risk of total detector failure caused by localized discharges and allows for finer voltage adjustment.

Additionally, to reduce radioactive background contamination, we are developing a low-mass field cage utilizing flexible printed circuits (FPC), designed to prevent inter-electrode discharges and surface charging.

We are also developing a low-radioactivity Cockcroft-Walton circuit utilizing FPC capacitors, and a scintillation detection mechanism utilizing wavelength-shifting coating to realize a large photosensitive area and high detection efficiency.

In this presentation, we will report on the performance of the 180 L prototype, including the CW multiplier operation and tracking capabilities, and discuss the status of the new technologies being developed for the 1000 L detector.

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