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Design and Construction of a Spark Chamber

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The spark chamber is a particle detector for visualizing the paths of electrically charged particles through the Townsend avalanche effect. At TDLI, we are developing a spark chamber prototype with dimensions of 525 mm × 370 mm × 130 mm using aluminum plates, designed for both demonstration and educational purposes. Our design process has encountered challenges in three main areas: sealing, the gas system, and the electronic trigger mechanism. We have successfully constructed a prototype that integrates a sealing and gas system with an electronic trigger system. Helium was selected as the working gas due to its relatively lower breakdown voltage. Additionally, a box-type acrylic chamber was chosen to minimize gas leakage and enhance operability. To further improve performance, we have rounded the edges of the aluminum plates and minimized circuit connections within the gas environment, which helps to reduce unwanted edge sparking and prevent corona discharge in the electronic components. The prototype allows for adjustable gap widths, ranging from 5 mm to 10 mm in 1 mm increments, using spacers to find the optimal setting. Gas leakage rates have been rigorously tested in a negative pressure atmosphere of -0.047 MPa, showing similar rates of approximately 0.002 MPa/min for both helium and air. Looking ahead, we plan to expand the spark chamber prototype to include 21 layers of aluminum plates. This enhancement aims to enable the clear detection of muon decay events, further extending the research and educational utility of the spark chamber.

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