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Gain and Ion Backflow Analysis in a Proposed Triple GEM Geometry Using ANSYS and Garfield^{++}

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The Gas Electron Multiplier (GEM) is a prominent class of Micro Pattern Gaseous Detectors (MPGDs), widely used in high-energy physics experiments, medical imaging, and radiation monitoring due to their excellent spatial resolution, high rate capability, and robustness against discharges. A GEM foil typically consists of a thin polyamide layer coated with copper on both sides, with a high density of microscopic holes. When a voltage is applied across the foil, strong electric fields inside the holes enable gas multiplication of electrons. To achieve higher gain, three GEM foils are often cascaded in series, forming a triple GEM configuration. However, performance is highly sensitive to hole geometry, foil structure, and applied voltages, motivating ongoing research into design optimizations.
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In this study, we explore the performance of a newly proposed GEM geometry aimed at improving gain and reducing ion backflow, two critical parameters in the optimization of gaseous detectors. Initially, a detailed simulation was carried out for a single GEM structure featuring a novel conical hole design, where a single conical hole replaces the conventional double-conical hole. Additionally, the thickness of the lower copper layer was increased to make the foil more stable to handle and to suppress the excess flow of ions to the drift region. The results from this single GEM configuration demonstrated a significant enhancement in effective gain along with a noticeable suppression in ion backflow compared to the standard geometry. Encouraged by these findings, we have extended the study to a full triple GEM detector setup, implementing the same proposed geometry across all three GEM layers. The results are very promising for the triple GEM configuration, demonstrating significant improvements in gain and ion backflow suppression. These findings are of valuable significance for future GEM upgrades.

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