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A Minidrift GEM Tracking Detector and its Potential Use for Large Angle Tracking at an Electron Ion Collider

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At large angles (typically greater than ~ 20 degrees), the resolution of conventional GEM tracking detectors deteriorates rapidly due to the increased charge spread along the track direction in the collection gap. In order to circumvent this problem, a minidrift GEM tracking detector has been developed that measures both the position and arrival time of the charge deposited in the drift gap, which allows the reconstruction of a vector for the track traversing the chamber. The resulting position and angle information from the vector is then used to improve the position resolution for larger angle tracks.

The detector consists of a triple GEM stack with a 1.6 cm drift gap that is operated in a mini TPC mode. Charge is collected on a readout plane which is used to determine the position information, and the arrival time of the charge is measured by sampling the analog pulse in 25 ns bins using the CERN SRS readout system. Two types of readout planes were studied. One was a COMPASS style readout plane with 400 micron pitch XY strips and the other consisted of 2x10 mm2 chevron pads with a 0.5 micron zigzag pitch. The detector was studied in a test beam at Fermilab, along with additional measurements in the lab, in order to determine its position and angular resolution for incident track angles up to 45 degrees. Several algorithms were studied for reconstructing the vector using the position and timing information in order to optimize the position and angular resolution of the detector for the different readout planes. A position resolution of ~ 125 microns and an angular resolution less than 20 mrad was obtained for angles up to 45 degrees for the measurements obtained in these tests. However, we believe this resolution was limited by the time resolution of the readout system and could be improved significantly (well below 100 microns, even at large angles) with more precise timing information and the use of more sophisticated tracking algorithms.

This study was part of the Detector R&D Program for a future Electron Ion Collider that is being planned to be built at either Brookhaven National Lab or Thomas Jefferson National Lab. EIC would collide beams of electrons with protons and heavy ions at high energies in order to study nucleon structure and QCD over a broad range of x and Q2. A large multipurpose spectrometer would be used to measure deep inelastic electron scattering over a wide range of rapidity and solid angle and would include a large aperture forward spectrometer in the hadron going direction. This spectrometer would use large area GEM detectors for particle tracking and would benefit from the improved resolution that could be achieved with the minidrift detector developed here. A description of the envisioned EIC spectrometer and how this type of detector could be used to improve its physics capabilities will also be described in this presentation.

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