Study of a Large-Area GEM Detector Read Out with Radial Zigzag Strips for Forward Tracking in Experiments at a Future Electron-Ion Collider

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Abstract:

Experiments at a future Electron-Ion Collider will improve our understanding of QCD, e.g. by addressing the spin problem of the nucleon and the role played by the angular momenta of partons. The RD6-FLYSUB Consortium† is performing R&D on tracking and particle ID with Gas Electron Multipliers (GEM) for such experiments. A 1m-long trapezoidal triple-GEM detector read out by 1024 radial zigzag strips in eight η-sectors is an option under study for tracking in the forward region. The zigzag structure of the readout strips improves the position-sensitivity of charge sharing among strips. Consequently, it allows a threefold reduction in the required number of strips and electronic channels over a conventional straight-strip readout while preserving good spatial resolution. In an era of flat NP and HEP research budgets, the resulting significant reduction in electronics cost for a forward tracking system in an EIC detector would be of high value to the field. The construction of a detector prototype with such a zigzag strip readout is briefly discussed. We report results from a beam test of this prototype with 20-120 GeV hadrons at the Fermilab Test Beam Facility. The readout design shows a typical cross-talk of not more than ~5%. The charged-particle detection efficiency of this detector is measured to be ~98%. With hit positions based on the barycenters of zigzag-strip clusters, the overall measured spatial resolution of the detector is ~240μrad given a 1.37mrad azimuthal pitch of the radial zigzag strips. Clusters with exactly two strips give a resolution of ~180μrad. Spatial resolution and efficiency are studied as a function of high voltage and for different positions on the detector. We discuss how a correction for the non-linearity of the strip response and a new readout board with more closely interleaved zigzag strips can each further enhance the spatial resolution of this detector type.

† RD6-FLYSUB is a collaboration of researchers from Brookhaven National Laboratory, Florida Institute of Technology, Lawrence Livermore National Laboratory, Stony Brook University, University of Virginia, Weizmann Institute of Science and Yale University formed to carry out R&D for tracking and particle identification for detectors for a future electron-ion collider.