<u>Two GEM Applications:</u> Forward EIC Tracker with Zigzag-Strip Readout & Muon Tomography for Homeland Security

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Work on two applications of Gas Electron Multiplier technology is presented. The first application is a tracker for the forward region of an experiment at a future Electron Ion Collider (EIC) in the U.S. Specifically, the development of a cost-effective readout structure with zigzag strips for large-area GEM detectors is discussed. The zigzag structure allows a significant reduction in the number of strips and electronic readout channels for 1D detectors while preserving good spatial resolution. Recent results on efficiency, cross-talk, and angular resolution obtained from a beam test of a 1-m long trapezoidal prototype detector with radial zigzag strips are presented. Corrections for the non-linear strip response improve the angular resolution from 240μrad to 170μrad, which corresponds to just 12% of the angular pitch of the zigzag strips. The second application is GEM-based muon tomography that aims at 3D-imaging of well-shielded high-Z material, e.g. nuclear contraband in cargo for homeland security. This technique exploits multiple scattering of atmospheric cosmic ray muons, which is stronger in dense, high-Z nuclear materials than in low-Z and medium-Z shielding materials. The imaging performance of a compact Muon Tomography Station that tracks muons using 30cm×30cm Triple-GEM detectors with 2D readout placed on four sides of a 27-liter cubic imaging volume is presented. Using the observed scattering signatures, shielded objects can be distinguished from each other according to their radiation lengths. A 75cc depleted uranium cube is successfully imaged through 2-3cm thick medium-Z bronze shielding material.