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Status and Future Developments of Micro-pattern Gas Detectors for low-energy nuclear physics applications at FRIB

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Rare isotope (RI) beams facilities are now critical tools for nuclear physics. The Facility for Rare Isotope Beams (FRIB), located on the campus of Michigan State University, is a world-class facility for the study of RIs using the in-flight fragmentation method. The unprecedented potential discovery of a modern rare isotope beam facility, such as FRIB, can only be realized by implementing state-of-the-art experimental equipment capable of studying these isotopes at a high beam rate and high performance.
Originally developed for high-energy physics (HEP), implementation of MPGD technology as gas avalanche readouts has expanded to other fields, including nuclear physics, astrophysics, neutrino physics, material science, neutron detection, and medical imaging. MPGDs offer great flexibility and allow geometry and performance to be tailored to specific working conditions and requirements. The requirements of a typical low-energy nuclear physics experiment (LENP) with RI beam are generally very different from HEP fixed-target experiments, so that substantial efforts and resources are necessary to develop MPGD architectures optimized for LENP environments.
In this work, we will describe our latest results and progress obtained with novel gas avalanche concepts designed to target applications at the Facility for Rare Isotope Beam (FRIB). In particular, we will describe recent progress in the development of Multi-layer THGEM (M-THGEM) structures, for application in active-target TPC readout, as well as tracking at the focal-plane of high-rigidity spectrometers. This also includes a recent performance evaluation of the Multi-mesh THGEM in terms of gas gain and ion backflow suppression.
Further, we present a measurement of the secondary scintillation yield produced in multi-layer Thick Gas Electron Multipliers (M-THGEMs) in low-pressure (20-100 Torr) Tetrafluoropropane gas (CF4), which is of particular importance for the design of the next generation of optical-readout Time Projection Chamber (TPC) operated at low-pressure CF4. Potential applications include experimental nuclear physics with rare isotope beams or direct detection of dark matter based on the Migdal effect approach.

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Early Career

Yes

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