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Development of novel PID detector concepts for nuclear physics with rare isotope beams at FRIB

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Since their introduction in the 1930s, particle accelerator science has led to major discoveries and advancements in high-energy physics, nuclear physics, and other fields. In this context, Rare Isotope (RI) beam facilities represent a crucial resource for modern nuclear physics. The Facility for Rare Isotope Beams (FRIB), located on the campus of Michigan State University, is one of the world-leading user facilities for the study of RIs, produced by 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. In this talk, I report on the development of a few innovative detector concepts for tracking and particle identification (PID) of heavy ions for applications in modern spectrographs. I will describe the development of new micro-pattern gaseous detector (MPGD) structures capable of stable, high-gain operation at low pressure, applied as either a position-sensitive readout for Time-Projection-Chamber in active-target mode (AT-TPC), or for drift chambers at the focal plane of a large-acceptance spectrometer. In addition, I will present progress on the design and construction of advanced, innovative instrumentation for highly accurate and efficient identification of the atomic number (Z) of nuclei transmitted to the focal plane of high-resolution spectrographs. This includes a novel detector concept based on event-by-event energy-loss measurement in a multi-segmented optical scintillator system (ELOSS), by recording the scintillation light released by a charged particle along its track. We discuss the optimization of the optical readout configuration based on DUV-sensitive Photo-Multiplier Tubes (PMTs), the expected performance of the novel detector concept, and the overall impact on radiation detection physics and technology applied to experimental nuclear physics with rare-isotope beams. Acknowledgment: This material is based upon work supported by the U.S. Department of Energy, Office of Science, Office of Nuclear Physics and user resources of the Facility for Rare Isotope Beams (FRIB) Operations, which is a DOE Office of Science User Facility under Award Number DE-SC0023633.

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