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

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Since their invention in the 1930s, particle accelerator science has led to major discoveries and advancements in high-energy physics, nuclear physics, and other fields. Progress in accelerator-based experimental physics has always been linked to improvement of detector technology. Rare isotope (RI) beam facilities are now important tools for nuclear physics. The Facility for Rare Isotope Beams (FRIB), located on the campus of the Michigan State University, is a new world-leading user 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.
In this work, I report the development of a few innovative detector concepts for tracking and particle identification (PID) of heavy-ions. In particular, 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 position-sensitive readout for Time-Projection-Chamber in active-target mode (AT-TPC), or for drift chambers at the focal-plane of large-acceptance spectrometer.
In addition, I will present the progress on 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. The detector concept is 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 PhotoMultiplier Tubes (PMTs), the expected performance of the novel detector concept, and the overall impact on radiation-detection physics and technology applied to the field of experimental nuclear physics with rare-isotope beams.

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