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Design and construction of a novel energy-loss optical scintillation system (ELOSS) for heavy-ion particle identification

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A novel heavy-ion particle-identification (PID) device based on optical-readout energy-loss measurement (ELOSS) is presented. The device is designed to identify the atomic number of the reaction fragments that reach the focal–plane detector system of the S800 spectrograph at the Facility for Rare Isotope Beams (FRIB). The new instrument consists of a large volume filled with xenon gas at pressures ranging from 400 to 800 Torr, surrounded by arrays of PhotoMultiplier Tubes (PMTs) for recording the prompt scintillation light emitted along the track of ions that traverse the detector. The number of scintillation photons captured by the optical readout is proportional to the energy deposited by the impinging particle, allowing identification of its atomic number (Z).
The ELOSS technology is expected to provide high-resolution ΔE measurements (≤0.6% σ) at a high counting rate (>50 kHz). In addition, it provides timing information (with a resolution < 150 ps σ) and a moderate localization capability (with a resolution <1 mm σ), compared to the lack of usable timing and space information of the conventional ionization chamber relying on drifting charges.
The development of fast, accurate ΔE measurement techniques for present and future nuclear science facilities will have a high impact on the design and implementation of rare-isotope beam experiments at FRIB and their scientific outcome. As such, ELOSS also represents a prototype for the development of PID detector systems of other planned and future spectrometers, such as the High Rigidity Spectrometer (HRS) at FRIB.

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