

Advancing FriB's Science Program With A High-Voltage Mr-ToF Mass Spectrometer And Separator

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To further expand the science program at the Facility of Rare Isotope Beams (FRIB), we are developing a high-voltage Multi-Reflection Time-of-Flight (MR-ToF) device at FRIB. It is foreseen to increase the reach of FRIB's high-precision mass measurement program, to deliver isobaric and isomeric purified ion beams to experimental stations within FRIB's stopped and reaccelerated beam areas and to improve beam diagnostics and identification.

Uniquely, FRIB's MR-ToF device will store ions at an unprecedented beam energy of 30 keV. Simulations based on the work by the MIRACLS collaboration at ISOLDE/CERN [1,2] show that the ion throughput can be enhanced by 2 orders of magnitude when increasing the kinetic energy of the stored ions and when improving the MR-ToF design leading to a higher beam intensity of the purified ion beam. Furthermore, the raised beam energy also results in a larger energy spread tolerance enabling a higher mass resolving power in even shorter processing times [1,3] as required to access nuclei with extremely short half-lives.

This contribution presents the design concept, development status, and the planned first science cases of FRIB's MR-ToF system. The primary focus are high-precision mass measurements of the most exotic nuclei in close proximity to the driplines and the delivery of high-purity isomeric beams for decay spectroscopy studies critical to nuclear structure and astrophysics. Of particular interest is the study of astromers, nuclear isomeric states that can influence elemental abundances in astrophysical environments. Understanding the population and depopulation of these isomeric states is essential for modeling nucleosynthesis pathways.

[1] F.M.Maier et al, NIMA 1056, 168545 (2023)

[2] F.M.Maier et al, NIMA 1075, 170365 (2025)

[3] M.I. Yavor et al, IJMS 426, 1-11 (2018)

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