Contribution ID: **543** Type: **Contributed Oral Presentation**

Pushing the boundaries at FRIB: High-Precision Mass Measurements Near The Proton Dripline

Friday, 30 May 2025 12:40 (15 minutes)

With new radioactive-ion-beam facilities such as FRIB becoming operational, the properties of nuclei in close proximity to the driplines are coming within reach of high-precision measurements. Within the last year, at a fraction of FRIB's ultimate beam intensity, we used the LEBIT facility [1] to successfully perform Penning-trap mass measurements of 101Sn, 103Sn [2], 23Si, and 22Al [3]. These masses are critical for nuclear astrophysics and nuclear structure studies, providing insights into the smoothness of the mass surface, and determining the level ordering and isospin symmetry breaking effects. As FRIB ramps up its beam intensity, the production of many more nuclei will enable new and exceptional research opportunities. However, the short half-lives of many of these nuclei pose challenges for Penning-trap mass spectrometry. To overcome these limitations, we are developing a next-generation MR-ToF device at FRIB based on the work in [4].

In this contribution, I will discuss the mass measurements of 101,103Sn, and 23Si and their significance for nuclear physics, along with an overview of the ongoing development of a next-generation MR-ToF device that will expand the mass measurement and separation capabilities of FRIB.

[1] R. Ringle, S. Schwarz and G. Bollen, Penning trap mass spectrometry of rare isotopes produced via projectile fragmentation at the LEBIT facility, IJMS 349-350, 87 (2013).

[2] C.M. Ireland, F.M. Maier et al., High-Precision mass measurements of 103Sn restores smoothness of the mass surface, PRC 111, 014314 (2025).

[3] S.E. Campbell et al., Precision Mass Measurement of the Proton Dripline Halo Candidate 22Al, PRL 131, 152501 (2024).

[4] F.M. Maier et al., Increased beam energy as a pathway towards a highly selective and high-flux MR-ToF mass separator, NIMA 1056, 168545 (2023).

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Session Classification: Parallel Session

Track Classification: Nuclear Structure