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Exploring exotic nuclei by high-precision MRTOF mass measurements: The new ion catcher and mass spectrograph at RIKEN's RIBF facility

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Exploiting closed-path ion trajectories in an electrostatic ion trap, the multi-reflection time-of-flight mass spectrograph (MRTOF-MS) [1] is one of the most promising techniques for precise mass measurements of short-lived isotopes. Exotic ions produced at radioisotope facilities are stored in an electrostatic trap at kinetic energies on the order of a few keV, reflected back and forth between two electrostatic ion mirrors, and ultimately ejected to a detector for time-of-flight (TOF) determination. By comparison of precise TOF data obtained from ions of well-known mass, the mass of an unknown ion can be calculated with relative uncertainties reaching $\Delta m/m < 5 \cdot 10^{-8}$ using state-of-the-art technology.
At the RIBF/BigRIPS facility of RIKEN (Wako, Japan) the new ZD-MRTOF system [2,3] located downstream of RIBF's ZeroDegree (ZD) spectrometer has been put into operation. The precision mass spectrometer is coupled to a cryogenic helium-gas filled ion catcher [4], where the initially relativistic reaction products are stopped, thermalized, and extracted as ions to be forwarded to the MRTOF-MS.
Since autumn 2020 exotic ion beams are provided to our new setup, and previously unknown radioactive isotope masses, or those with high mass uncertainty, have been determined with high precision and accuracy. This contribution will focus on the success of this setup and the recent achievements for nuclear mass measurements. The physics results and an outlook for the near future program will be presented.
Furthermore, new efforts have been made to improve the wideband mass accuracy of the system, and I will discuss about the presently known causes of uncertainties for wideband mass measurements in MRTOF-MS and our present state of knowledge for possible solutions and technical challenges.

[1] H. Wollnik and M. Przewloka, Int. J. Mass Spectrom. Ion Proc. 96, 267 (1990)
[2] M. Rosenbusch et al., Nucl. Instr. Meth A (under review), arXiv:2110.11507
[3] M. Rosenbusch et al., Nucl. Instr. Meth B 463, 184 (2019)
[4] A. Takamine et al., Acc. Prog. Rep. 52, 139 (2019)

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