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Performance of the SHIPTRAP mass spectrometer

Within the recent FAIR phase-0 program, the Penning-trap mass spectrometer SHIPTRAP at GSI in Darmstadt, Germany, was used to extend direct high-precision mass spectrometry to superheavy nuclides (Z≥ 104) in the vicinity of the N=152 shell closure [1].
In spite of challenging experimental conditions as long measurement times due to low production rates down to few atoms per hour, the improved efficiency, ion sensitivity and mass-resolving power allowed resolving metastable states with half-lives >200 ms from their respective ground state in No (Z=102), Lr (Z=103) and Rf (Z=104) isotopes. For the first time, isomer excitation energies in the range of ≈ 30 keV to 1.3 MeV were determined directly for these heavy nuclides. In addition, multiple metastable states in a variety of heavy isotopes, many of which are close to the Z=82, N=126 shell closures, have been measured, e.g., for isotopes of Pb, Bi, Po, At, Fr (Z=82–87), and Cf (Z=98). This allowed the direct determination of the excitation energies of long-lived isomeric states and therefore to contribute to the understanding of the level and decay schemes of these heavy nuclei, complementing the findings from decay and laser spectroscopy investigations.
This contribution focuses on the experimental challenges, the efficiency of the setup and the systematic uncertainties of the measurements.

[1] O. Kaleja et al, Phys. Rev. C 106 054325 (2022)

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