

# SMI-2023: 14th International Conference on Stopping and Manipulation of Ions and Related Topics



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## Recent results from the SHIPTRAP mass spectrometer on heavy and superheavy nuclei

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Investigating the boundaries of the nuclear chart and understanding the structure of the heaviest elements are at the forefront of nuclear physics. The existence of the superheavy nuclei is intimately linked to nuclear shell effects which counteract Coulomb repulsion and therefore hinder spontaneous fission. Moreover, heavy and superheavy nuclides feature often metastable excited states with half-lives that can exceed that of the ground state.

Long-lived isomeric states can have excitation energies of only few tens of keV or below, therefore their identification is challenging, especially in decay-based measurements. On the other hand, Penning trap mass spectrometry can provide sufficient resolving power to allow the separation of isomeric states when they are populated in the same reaction as the ground state. Direct high-precision mass measurements provide also indispensable knowledge on binding energies, shell strength and yield important anchor-points on  $\alpha$ -decay chains, constraining absolute mass values of the more exotic heaviest nuclei.

The SHIPTRAP spectrometer at GSI Darmstadt, Germany has shown that direct high-precision mass measurements of  $^{102}\text{No}$  and  $^{103}\text{Lr}$  isotopes around the deformed shell closure  $N = 152$  are feasible. Thanks to several improvements in the ion preparation with the implementation of a second-generation gas-stopping cell operating at cryogenic temperatures and the development of the Phase-Imaging Ion-Cyclotron-Resonance (PI-ICR) technique which boosts the sensitivity of mass measurements, the investigation of  $^{251}\text{No}$ ,  $^{254}\text{Lr}$  and the superheavy nuclides  $^{257}\text{Rf}$  and  $^{258}\text{Db}$  were performed in the latest experimental campaigns with rates down to one detected ion per day.

Despite lowest rates, the PI-ICR technique allowed operating with a mass resolving powers of up to  $10^7$  and accurately determining the excitation energies of the  $^{251m}, ^{254m}\text{No}$ ,  $^{254m}, ^{255m}\text{Lr}$ , and  $^{257m}\text{Rf}$  isomeric states which had previously been derived only indirectly via decay spectroscopy. The overall efficiency of the setup has been improved and its stability over extended measurement times tested.

In this contribution an overview of the technical developments and the recent experimental campaigns will be presented.

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