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TRIGA-TRAP: High-precision mass measurements on heavy nuclides

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Nuclear masses are fundamental quantities in nature, reflecting the binding energy of the nucleons. In particular, experimentally determined masses of heavy nuclides provide new information on nuclear structure and test theoretical mass models in this region of the nuclear chart [1,2]. Masses of a few nobelium isotopes have been recently determined by SHIPTRAP (GSI, Darmstadt, Germany). However, none of the masses between uranium and californium has been directly measured yet, but most of them are linked to known species by alpha-decays [3].
We recently installed the double-Penning trap mass spectrometer TRIGA-TRAP at the nuclear research reactor TRIGA Mainz [4], which is dedicated in a first measurement period to off-line mass determinations of heavy nuclides between uranium and californium. For this purpose, a non-resonant laser ablation ion source has been developed, also providing carbon cluster ions for the calibration. The actual mass measurement can be carried out via the common Time-of-Flight-Ion-Cyclotron-Resonance (TOF-ICR) technique, where the mass value is determined by exciting and ejecting the ions from the trap and observing the minimum time of flight as a function of the excitation frequency. In a later stage, especially for nuclides with very low production rates of a few ions per minute but rather long half-lives above several tens of seconds, the non-destructive Fourier Transform-Ion Cyclotron Resonance (FT-ICR) technique will be employed for the first time for mass measurements on radionuclides. This method is based on the detection of image currents induced by the ions in the trap electrodes without the need for ion ejection, enabling repeated measurement cycles on the same stored charged particle. In future, this technique will be applied at the on-line facility SHIPTRAP for mass measurements on superheavy elements [5].
Besides mass measurements on heavy nuclides, TRIGA-TRAP will be connected to the research reactor TRIGA Mainz to exploit the field of neutron-rich nuclides produced by fission of 249Cf using the reactor. The status of the experiment as well as first mass measurements will be presented.

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