Latest results of the high-precision mass measurements with PENTATRAP

K. Kromer[a], J.R. Crespo López-Urrutia[a], M. Door[a], S. Eliseev[a], P. Filianin[a], W. Huang[a], Yu. N. Novikov[b], A. Rischka[a], R. X. Schüssler[a], Ch. Schweiger[a], K. Blaum[a]

[a] *Max-Planck-Institut für Kernphysik, 69117 Heidelberg, Germany*

[b] *Petersburg Nuclear Physics Institute, Gatchina, Russia*

The high-precision Penning-trap mass spectrometer PENTATRAP [1], located at the Max Planck Institute for Nuclear Physics in Heidelberg, features a stack of five Penning traps and determines mass-ratios with a relative uncertainty below 10^{-11}. Mass-ratio determinations of stable and long-lived highly charged ions at this level have numerous applications, among others, in bound-state QED, neutrino physics [2], tests of special relativity [3], and the search of possible clock transitions in highly charged ions (HCI) [4]. The features of the experiment necessary to achieve this precision include access to HCI provided by two external electron beam ion traps, a 7 T magnet stabilized against environmental parameters, and a cryogenic detection system with single ion phase sensitivity. This is achieved by Fourier Transform Ion Cyclotron Resonance (FT-ICR) detection of the image-current induced in the trap electrodes. These features combined with new measurement schemes based on the setup's five Penning traps led to our recent mass-ratio measurements with a relative uncertainty of below $1 \cdot 10^{-11}$ and the detection of a metastable state in highly charged rhenium.

---

[1] J. Repp, *et al.*, Appl. Phys. B **107** (2012) 983
[2] J. Gastaldo, *et al.*, Appl. Phys. B **226** (2017) 1623
[3] S. Rainville, *et al.*, Nature **438** (2005) 1096
[4] M.G. Kozlov, *et al.*, Rev. Mod. Phys. **90** (2018)