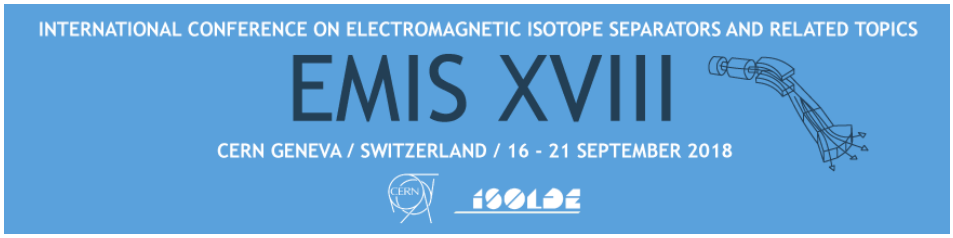

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Accurate High Voltage measurements based on laser spectroscopy

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Accurate High Voltage measurements based on laser spectroscopy

J. Krämer[1], K. König[1], Ch. Geppert[2], P. Imgram[1], B. Maaß[1], J. Meisner[3], E. W. Otten[4], S. Passon[3], T. Ratajczyk[1], J. Ullmann[1], 5 and W. Nörtershäuser[1]

[1] Institut für Kernphysik, TU Darmstadt
[2] Institut für Kernchemie, Johannes Gutenberg-Universität Mainz
[3] Physikalisch-Technische Bundesanstalt (PTB), Braunschweig
[4] Institut für Physik, Johannes Gutenberg-Universität Mainz
[5] Institut für Kernphysik, Westfälische Wilhelms-Universität Münster

Contact: kkoenig@ikp.tu-darmstadt.de, jkraemer@ikp.tu-darmstadt.de

The ALIVE experiment at the TU Darmstadt is a collinear laser spectroscopy setup that has been developed for the measurement of high voltages in the range of 10 to 100 kV with highest precision and accuracy. Here, ions with a well-known mass and transition frequency are accelerated with the voltage that has to be measured and their Doppler shift is examined precisely with laser spectroscopic methods. An accuracy of at least 1 ppm is targeted which is of interest for metrology as well as scientific applications like, e.g. the KATRIN experiment. Furthermore, this opens the opportunity to define a quantum standard for the absolute high voltage determination since only direct frequency measurements are involved.
Earlier attempts with this technique were limited by the uncertainty of the optical frequency measurement [1] or the uncertainty of the real starting potential of the ions in the ion source [2]. In the ALIVE (Accurate Laser Involved Voltage Evaluation) experiment a two-stage laser interaction for optical pumping and probing is combined with a highly accurate frequency determination with a frequency comb [3] to overcome these limitations.
We will present the results we achieved with 40Ca+ ions where the well-known 4s1/2 ⟶ 4p3/2 and the 3d3/2 ⟶ 4p3/2 transitions were used to identify the ion velocities before and after the acceleration. We have performed a measurement series with voltages between -5 kV and -19 kV in parallel to two high precision voltage dividers and were able to demonstrate a 20-fold improvement compared to the previous approaches to an accuracy almost comparable to the best state-of-art high voltage dividers. To further improve this, indium ions from a liquid metal ion source and an alternative pump-and-probe approach will be used in the next stage of the experiment. With these improvements we think that we will be able to reach a sub-ppm accuracy.

References

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Authors: Dr KRÄMER, Jörg (Institut für Kernphysik, TU Darmstadt); Mr KÖNIG, Kristian (Institut für Kernphysik, TU Darmstadt); Dr GEPPERT, Christopher (Institut für Kernchemie, Johannes Gutenberg-Universität Mainz); Mr IMGRAM, Phillip (Institut für Kernchemie, Johannes Gutenberg-Universität Mainz); Mr MAASS, Bernhard (Institut für Kernphysik, TU Darmstadt); Dr MEISNER, Johann (Physikalisch-Technische Bundesanstalt

(PTB), Braunschweig); Prof. OTTEN, Ernst (Institut für Physik, Johannes Gutenberg-Universität Mainz); Mr PASSON, Stephan (Physikalisch-Technische Bundesanstalt (PTB), Braunschweig); Mr RATAJCZYK, Tim (Institut für Kernphysik, TU Darmstadt); Dr ULLMANN, Johannes (Institut für Kernphysik, Westfälische Wilhelms-Universität Münster); Prof. NÖRTERSHÄUSER, Wilfried (Institut für Kernphysik, TU Darmstadt)

Presenter: Dr KRÄMER, Jörg (Institut für Kernphysik, TU Darmstadt)

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