MS 3: Precision Mass Spectrometry 2

Time: Monday 16:30–17:45 Location: DO24 1.205

Invited Talk MS 3.1 Mon 16:30 DO24 1.205

Precision Measurements with the Multi-Reflection Time-of-Flight Mass Spectrometer of ISOLTRAP at ISOLDE/CERN — Dinko Atanasov[1], Pauline Ascher[1], Dietrich Beck[2], Christopher Borgmann[1], Martin Breitenfeldt[3], Christine Böhm[1], Burcu Cakirli[4], Thomas Elias Cocolios[5], Sergey Eliseev[1], Tommi Eronen[1], Sebastian George[1], Frank Herfurth[2], Alexander Josef Herlert[6], Dmitry Kisler[1], Magdalena Kowalska[7], Susanne Kreim[1,7], Yuri Litvinov[2], David Lunney[8], Vladimir Manea[8], Enrique Minaya Ramirez[2], Sarah Naimi[1], Dennis Neidherr[2], Marco Rosenbusch[9], Lutz Schweikhard[9], Juliane Stanja[10], •Frank Wienholtz[9], Robert Wolf[9], and Kai Zuber[10] — [1]Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Germany — [2]GSI Helmholtzzentrum für Schwerionenforschung GmbH, Planckstr. 1, 64291 Darmstadt, Germany — [3]Instituut voor Kern- en Stralingsfysica, Celestijnenlaan 200d - bus 2418, 3001 Heverlee, Belgium — [4]University of Istanbul, Department of Physics, 34134 Istanbul, Turkey — [5]University of Manchester, Manchester, United Kingdom — [6]FAIR GmbH, Planckstr. 1 , D-64291 Darmstadt, Germany — [7]CERN, Geneva 23, 1211 Geneva Switzerland; — [8]CSNSM-IN2P3-CNRS, 91405 Orsay Campus, bât. 104, 108, France — [9]Ernst-Moritz-Arndt-Universität, Institut für Physik, Felix-Hausdorff-Str. 6, 17487 Greifswald, Germany — [10]Institut für Kern- und Teilchenphysik, Technische Universität Dresden, Zellescher Weg 19, 01069 Dresden, Germany

The masses of exotic nuclides are among the most important input parameters for modern nuclear theory and astrophysical models. At the high-precision Penning-trap mass spectrometer ISOLTRAP at ISOLDE/CERN, a multi-reflection time-of-flight mass spectrometer (MR-ToF-MS) in combination with a Bradbury-Nielsen gate (BNG) can be used to achieve high-resolution isobar purification with mass-resolving powers of 105 in a few tens of milliseconds [1, 2]. Furthermore, the MR-ToF device can be used as a spectrometer to determine the masses of nuclides with very low yields and short half-lives, where a Penning-trap mass measurement becomes impractical due to the lower transport efficiency and decay losses during the purification and measurement cycles. Recent cross-check experiments show that the MR-ToF MS allows mass measurements with uncertainties in the sub-ppm range. In a first application the mass measurements of the nuclides 53,54Ca was performed [3], delivered with production rates as low as 10/s and half-lives of only 90(6) ms [4]. The nuclides serve as important benchmarks for testing modern chiral effective theory with realistic 3-body forces.

The contribution will present the on-line mass spectrometer ISOLTRAP focusing on the new applications, which became possible after the implementation of the MR-ToF MS into the current setup. In particular, the mass measurements of the neutron-rich calcium isotopes up to A=54 will be discussed. In addition, measurements of the isotonic potassium isotopes will be reported.

MS 3.2 Mon 17:00 DO24 1.205

Recent Developments of the MR-TOF-MS for the LEB of the Super-FRS — •Samuel Ayet San Andres[1], Julian Bergmann[2], Timo Dickel[1,2], Jens Ebert[2], Hans Geissel[1,2], Christine Hornung[2], Christian Jesch[2], Johannes Lang[2], Christian Lotze[2], Wolfgang Plass[1,2], Pascal Reiter[2], Ann-Katrin Rink[2], Christoph Scheidenberger[1,2], Johan Siebring[3], Alexander Pikhtelev[4], Matti Werner[1], and Mikhail Yavor[5] — [1]GSI Darmstadt — [2]JLU Gießen — [3]KVI - University of Groningen — [4]IPCP RAS Chernogolovka — [5]IAI RAS St. Petersburg

A multiple-reflection time-of-flight mass spectrometer (MR-TOF-MS) is being currently tested and improved at the FRS Ion Catcher facility. This MR-TOF-MS will be used at the LEB of the Super-FRS facility to provide a low energy isobarically clean beam to other experiments, as a diagnostic tool for the cryogenic stopping cell of the Low-Energy Branch (LEB) and as a mass spectrometer for the most short-lived nuclides. Understanding the influence of many parameters in such a complex system, as well as getting new instrumental developments in order to maximize the performance of the system is an important and continuous task. Most recent improvements of the system are: increase of the kinetic energy of the ions in the analysis path, optimization of ion optics and an upgrade in the electronics. Also, a dedicated data acquisition software for high quality online analysis and a full remote control software of the system were developed. The current status of the system, the latest developments of the system and a systematic characterization of the device will be presented.

MS 3.3 Mon 17:15 DO24 1.205

Status Report of the FRS Ion Catcher — •Timo Dickel[1,2] and the FRS Ion Catcher Collaboration[1] — [1]GSI Darmstadt — [2]Justus-Liebig-Universität

The FRS Ion Catcher facility is a prototype for the LEB of the Super-FRS. It is used to thermalize relativistic exotic nuclides in a cryogenic helium-filled stopping cell (CSC) and provides, with the help of a multi-reflection time-of-flight mass spectrometer (MR-TOF-MS), an isobarically clean beam to experiments further downstream. The MR-TOF-MS can also be used for mass measurements of short-lived nuclei with half-lives down to 10ms. The MR-TOF-MS is also an indispensable diagnostic device for operation of the stopping cell.

The CSC and MR-TOF-MS are central elements of the LEB and were successfully commissioned on-line in recent beamtimes at the FRS Ion Catcher at GSI. For the first time, a stopping cell for exotic nuclei was operated on-line at cryogenic temperatures. Various projectile fragments were thermalized and extracted with high efficiencies and short extraction times. Moreover, direct mass measurements of short-lived nuclei were performed with an MR-TOF-MS, among them the nuclide ^{213}Rn with a half-life of only 19.5 ms. Current status and upgrades of the facility will be presented.

MS 3.4 Mon 17:30 DO24 1.205

Progress at THe-Trap — •Martin Höcker[1], Tommi Eronen[1], Jochen Ketter[1], Marc Schuh[1], Sebastian Streubel[1], Robert S. Van Dyck Jr.[2], and Klaus Blaum[1] — [1]Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg — [2]Department of Physics, University of Washington, Seattle, WA 98195-1560

THe-Trap is a Penning-trap mass spectrometry experiment that is currently being set up to measure the atomic mass ratio of tritium and helium-3 with a relative uncertainty of 10^{-11}. In 2013, the experiment's first high-precision mass ratio measurement was performed on the ions $^{12}C^{4+}$ and $^{16}O^{5+}$. The carbon-12/oxygen-16 mass ratio is one of the most precisely determined mass ratios [1] and serves as a benchmark for the experiment. This measurement reached a statistical uncertainty of $6.3 \cdot 10^{-11}$ [2] and was limited by systematic frequency shifts [3] due to too high motional amplitudes.

In the following service cycle, the experiment was modified to address the shortcomings that were discovered in the 2013 ratio measurements. This talk summarizes the results of the 2013 measurements and introduces the upgrades to the experiment, including a new amplifier, a modified ion source, and an improved vacuum system.

[1] R. S. Van Dyck Jr. *et al.*, Int. J. Mass Spectrom. (2006) 251:231–242

[2] S. Streubel *et al.*, Appl. Phys. B, doi:10.1007/s00340-013-5669-x

[3] J. Ketter *et al.*, Int. J. Mass Spectrom., doi:10.1016/j.ijms.2013.10.005