MS 8: Multi-Reflection Time-of-Flight Spectrometers

Time: Thursday 10:30–11:45 Location: MS-H9

Invited Talk MS 8.1 Thu 10:30 MS-H9

Present and future prospects for MRTOF-based mass spectroscopy at KEK and RIKEN — •Peter Schury[1], Michiharu Wada[1], Toshitaka Niwase[1], Marco Rosenbusch[1], Yoshikazu Hirayama[1], Hironobu Ishiyama[2], Daiya Kaji[2], Sota Kimura[2], Hiroari Miyatake[1], Kouji Morimoto[2], Momo Mukai[2], Hiroari Miyatake[1], Aiko Takamine[2], Yutaka Watanabe[1], and Hermann Wollnik[3] — [1]Wako Nuclear Science Center, Wako, Japan — [2]RIKEN Nishina Center for Accelerator-Based Science — [3]New Mexico State University

The KEK Wako Nuclear Science Center in collaboration with the RIKEN SLOWRI group presently operates three high-performance multi-reflection time-of-flight (MRTOF) mass spectrographs within the RIKEN accelerator complex – one for superheavy elements, one for in-flight fission and fragmentation products, and one for multi-nucleon transfer products – with more planned for the near future. With typical mass resolving power approaching $m/\Delta m{=}10^6$, we are able to achieve relative mass precision $\delta m/m{\sim}10^{-7}$ with 100 detected ions; in many cases isomeric states can be resolved. By embedding silicon detectors within the time-of-flight detector, we have initiated a new field of decay-correlated mass spectroscopy which greatly enhances the capabilities of the MRTOF. The results of recent measurement campaigns and plans for future MRTOF-based studies will be presented.

MS 8.2 Thu 11:00 MS-H9

A Multi-Reflection Time-of-Flight Mass Spectrometer (MR-ToF MS) for the Offline Ion Source of PUMA — •Moritz Schlaich, Alexandre Obertelli, Frank Wienholtz, and Clara Klink — TU Darmstadt, Darmstadt, Deutschland

Using low-energy antiprotons provided by the Extra Low Energy Antiproton ring (ELENA) at CERN, the antiProton Unstable Matter Annihilation experiment (PUMA) aims to probe the isospin composition of the density tail of radioactive nuclei. For this purpose, PUMA intends to trap one billion antiprotons at ELENA in a portable Penning trap and transport them to the Isotope mass Separator On-Line DEvice (ISOLDE) at CERN. There, the isotopes of interested are produced and will be brought together with the antiprotonic cloud. By analyzing the residuals of the subsequent annihilation reactions, the experiment plans to study neutron skin formation of multiple neutron-rich nuclei and possible halo nuclei.

In order to perform reference measurements and initially apply the experimental technique to stable nuclei, a versatile offline ion source is needed that must be able to generate isotopically pure ion bunches with sufficiently high particle intensity. Therefore, an MR-ToF MS will be used to analyze the constituents of the incoming beam and to selectively forwards only the ions of interest within milliseconds. The talk will cover an overview of the system and its capabilities with respect to mass separation.

MS 8.3 Thu 11:15 MS-H9

Improving a multi-reflection time-of-flight mass spectrometer with multiple active voltage-stabilization loops — •Paul Fischer[1], Paul Florian Giesel[1], Frank Wienholtz[2], and Lutz Schweikhard[1] — [1]Institut für Physik, Universität Greifswald, 17487 Greifswald, Germany — [2]Institut für Kernphysik, Technische Universität Darmstadt, 64289 Darmstadt, Germany

The principal observable in multi-reflection time-of-flight mass spectrometry (MR-ToF MS)—a stored ion species' lapping period between two electrostatic mirrors—is most stable over long measurement times when the MR-ToF analyzer's potential configuration is as constant as possible. By stabilizing the most sensitive mirror potential with an active feedback loop, long-term resolving powers can be significantly increased, as has been demonstrated recently [1].

Based on this concept, the Greifswald MR-ToF mass spectrometer is equipped with subsequent stabilization loops for multiple mirror potentials [2]. Isobaric species of atomic clusters are used to probe the subsequent gain in MR-ToF performance and characterize different-quality hardware for the implementation of the active voltage controller. The system shows improved long-term mass resolving power, settling behavior for different experimental cycles, and better conditions for the timing of pulsed in-trap photoexcitation of atomic clusters.

[1] Wienholtz et al., Nucl. Instrum. Meth. B 463:348 (2020)
[2] Fischer et al., Rev. Sci. Instrum. 92:063203 (2021)

MS 8.4 Thu 11:30 MS-H9

Study of a laser ablation carbon cluster ion source for MR-TOF MS — •Jiajun Yu[1,3] and FRS Ion Catcher Collaboration[1,2] — [1]GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt — [2]Justus-Liebig-Universität Giessen, Giessen — [3]Jinan University, Guangzhou, China

The MR-TOF-MS can be used for mass measurement with a resolving power of up to 1,000,000 (FWHM) and a relative accuracy down to a few 10^{-8}. To achieve high-precision mass measurement with a relative accuracy below 10^{-8}, calibrants over a broad mass range are needed for mass accuracy studies in the 10^{-9} level with the MR-TOF-MS. Furthermore, calibrants close to the ion of interest for a lowest uncertainty calibration are also needed. We have designed a laser ablation carbon cluster ion source (LACCI) capable of providing references in a mass range of 36 u to 240 u with a repetition rate up to 100 Hz in order to match the needs of the MR-TOF-MS.

Recently, the commission of LACCI has been carried out to study the capability of repetition rates, laser optics (laser spot size, laser energy), and ion optics (ion transfer efficiency). Especially, LACCI has been designed to be operated stably over a long time (several days) with a high frequency ($>$ 10 Hz), then stability for long term operation was also tested. The commissioning results of LACCI coupled with a quadrupole mass filter and the MR-TOF-MS will be reported in this contribution.