MS 2: Precision Mass Measurements II

**Invited Talk**

**Experiment with multiple-reflection time-of-flight mass spectrometers (MR-TOF-MS) at TRIUMF and GSI**

*Christine Horning*, the FRS Ion Catcher Collaboration, and the TITAN Collaboration

*GSI Helmholtzcentrum für Schwerionenforschung GmbH, Darmstadt, Germany — II. Physikalisches Institut, Justus-Liebig-Universität Gießen, Gießen, Germany — TRIUMF, Vancouver, Canada*

MR-TOF-MS have been developed for the TITAN experiment at TRIUMF and for the FRS-TOF at GSI Darmstadt, respectively. The systems incorporate several novel and unique concepts. The design enables world class performance, including a mass resolving power up to 1,000,000, mass accuracies down to 1.8 · 10⁻¹⁸ and a background suppression of greater than 7 orders of magnitude.

Experiments contributing to different fields from nuclear astrophysics and structure were performed at the FRS Ion Catcher experiment at the in-flight fragment separator FRS at GSI and the TITAN experiment at the ISOL facility ISAC at TRIUMF, Canada.

In addition, the use of these MR-TOF-MS goes beyond even precision mass measurements, e.g., they can be employed to identify and analyze ions independent of their decay properties unambiguously. This enables novel and universal approaches to measure reaction cross sections, fission yields, half-lives, and branching ratios. Recent highlights and perspectives from both experiments at GSI and TITAN will be presented focusing on different regions of the chart of nuclei.

**Latest improvements on TITAN’s Multiple-Reflection Time-Of-Flight Mass-Spectrometer — Ali Mollaebrahimi, Timo Dickel, Andrew Jacobs, Tobias Mürbök, Moritz Pascal Reiter, and Coulter Walls — University of Gießen, Gießen, Germany — TRIUMF, Vancouver, Canada — GSI, Darmstadt, Germany — University of British Columbia, Vancouver, Canada — University of Victoria, Victoria, Canada — University of Edinburgh, Edinburgh, United Kingdom*

TRIUMF’s Ion Trap for Atomic and Nuclear science (TITAN) is specialized in high-precision mass measurement and isobaric separation of exotic nuclei by using different electromagnetic and electrostatic traps. A precision Penning trap for the highest-precision mass measurements, EBIT (Electron Beam Ion Trap) for charge breeding and gamma spectroscopy measurements of radioactive nuclei and MR-TOF-MS (Multiple-Reflection Time-Of-Flight Mass Spectrometer) for high-precision mass measurement as well as for monitoring and identification of ISAC beam. MR-TOF-MS can also be used as an isobar separator for beam purification with a high separation power and send the isobarically-purified beam toward the penning trap or other downstream detectors. MR-TOF-MS allows to measure masses of radioactive nuclei and enables the studies of short-lived and exotic nuclei far away from the valley of stability. Mass measurements of these isotopes are demanded for studies of nuclear structure and nuclear astrophysics processes. In this work, the performance, the capabilities and the latest technical improvements of MR-TOF-MS is going to be presented.

**High-Precision Mass Spectrometry of Superheavy Elements — Oliver Kaleja, Branika Andelic, Luisa Arcila Gonzalez, Joaquín Berrocal, Lennart Blauw, Klaus Blauw, Michael Block, Pierre Chauveau, Stanislav Chemorevan, Premaditya Chetri, Christoph E. Dullman, Martin Eibach, Julia Everts, Pavel Filiann, Francesca Giacoppi, Man J. Gutiérrez Torres, Fritz P. Hessberger, Nasser Kallantar-Nayestanaki, Oliver Kallai, Jacques W. de Laar, Mustapha Laatiaoui, Peter Chauveau, Enrico Minaya Ramirez, Andrew Mistry, Elodie Morin, Yury Nechiporenko, Dennis Neidhard, Steven Nothefield, Yuri Novikov, Daniel Rodrigues, Lutz Schweikhard, Peter Thirillo, Jessica Warbinek, and Alexander Yakushev — GSI Darmstadt, Germany — HIM Mainz, Germany — University of Groningen, the Netherlands — University of Granada, Spain — IMP Heidelberg, Germany — JGU University Mainz, Germany — University of Greifswald, Germany — JICLab Orsay, France — PNPI Gatchina, Russia — Saint Petersburg State University, Russia — LMU Munich, Germany**

Investigation of ground and metastable states in the heaviest nuclei at SHIPTRAP

One of the keys in understanding the existence of superheavy elements with proton numbers \( Z \geq 104 \) is the study of phenomena like nuclear shell effects far from stability. For these studies, one has to measure atomic masses at the borders of the nuclear chart very accurately. In 2021, the performance of the mass spectrometer SHIPTRAP at the GSI in Darmstadt was significantly improved. As a result, the atomic masses of several heavy At, Bi, Fr, Rn, Th, Po and Pb isotopes were measured and a background suppression of greater than 7 orders of magnitude was observed allowing us to determine their excitation energy. In this contribution, an overview of the experimental improvements and results will be given.

**Status report on the TRIGA-TRAP experiment — Jacques J. W. van de Laar, Klaus Blauw, Michael Block, Stanislav Chemorevan, Christoph E. Dullman, Steffen Losee, and Szilard Nagy — Department Chemie - Standort TRIGA, Johannes Gutenberg-Universität Mainz, DE — Helmholtz-Institut Mainz, DE — Max-Planck-Institut für Kernphysik, Heidelberg, DE — GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, DE — Petersburg Nuclear Physics Insitute, Gatchina, RU**

Experimental data of ground-state properties of exotic nuclei are important for nuclear structure studies and can test the reliability of nuclear models. The TRIGA-TRAP experiment is a double Penning trap mass spectrometer used to perform high-precision measurements on long-lived transuranium isotopes and fission produced neutron-rich radionuclides at the research reactor TRIGA Mainz. Recently, a new cylindrical measurement trap was installed and characterized. After recombination, a mass measurement campaign started with several long-lived actinide isotopes. The new trap is expected to extend the mass range of the exotic states and reduce the uncertainties of the masses of heavier nuclei which are crucial for nuclear models attempting to pinpoint the position of the predicted island of stability.

In this contribution an overview of the results will be given.