MS 4: Resonance Ionization MS and others

Time: Tuesday 14:30–16:30 Location: f128

Invited Talk MS 4.1 Tue 14:30 f128

Applications of ISOLTRAPs multi-reflection time-of-flight mass spectrometer — •Frank Wienholtz — Ernst-Moritz-Arndt-Universität, Institut für Physik, Greifswald, Germany

For the ISOLTRAP collaboration https://isoltrap.web.cern.ch/isoltrap/

Mass spectrometers (MS) and more specific high-resolving multi-reflection time-of-flight (MR-ToF) devices have provided a fast way to separate the different components of ion beams. Thus, they are applicable to many fields of physics and beyond. This contribution will give an overview on how ISOLTRAPs MR-ToF MS at ISOLDE/CERN was already used, not only to support Penning-trap mass spectrometry and for mass measurements on its own, but also as a highly-selective detector for target and ion-source developments as well as for in-source laser spectroscopy. Furthermore, it has been a valuable tool as a highly sensitive and selective ion-beam monitor supporting gamma spectroscopy measurements, isotope accumulations for solid state physics and collections for medical applications. With their advantageous combination of high measurement speed and high resolving power it can be expected that further fields of application for MR-ToF devices are just around the corner. The development of the ISOLTRAP MR-ToF MS is supported by the BMBF (contract numbers 05P12HGCI1 and 05P15HGCIA).

MS 4.2 Tue 15:00 f128

Integration of the compact Photoionization Spectroscopy Apparatus (PISA) to ISOLDE-RILIS — •K. Chrysalidis[1,2], B. Crepieux[1], T. Day Goodacre[1,3], V. Fedosseev[1], P. Gach[1,4], T. Kron[2], B.A. Marsh[1], R.E. Rossel[5], S. Rothe[1,3], C. Seiffert[1], and K. Wendt[2] — [1]CERN, Geneva, Switzerland — [2]Johannes-Gutenberg Universität, Mainz, Germany — [3]The University of Manchester, UK — [4]Cracow University of Technology, Poland — [5]Hochschule RheinMain, Wiesbaden, Germany

The Resonance Ionization Laser Ion Source (RILIS) is the principal ionization technique for radioactive ion beam production at the CERN-ISOLDE on-line isotope separator facility. We introduce the photoionization spectroscopy apparatus (PISA), a compact atomic beam unit for RILIS ionization scheme development. Samples of the element to be investigated can be evaporated from an oven and ionized using the RILIS lasers. Other additional applications of PISA are envisaged: During setup it provides the means to optimize some laser parameters prior to the availability of an ion beam from the target; During operation it could serve as an additional observable for the RILIS performance monitoring; PISA can be used as a reference while performing in-source laser spectroscopy.

We will present the current status of integration into the RILIS setup and results from first applications of PISA to scheme development and in-source laser spectroscopy. We conclude with an outlook on future upgrades of PISA towards mass selectivity and faster sample switching.

MS 4.3 Tue 15:15 f128

Separation and Implantation of the Rare Isotope ^{163}Ho for the ECHo Project — •Tom Kieck[1], Katerina Chrysalidis[1], Holger Dorrer[1], Christoph Düllmann[1,2], Lisa Gamer[3], Loredana Gastaldo[3], Stefan Kormannshaus[1], Sebastian Schmidt[1], Fabian Schneider[1], and Klaus Wendt[1] — [1]JGU Mainz — [2]GSI Darmstadt — [3]Universität Heidelberg

The ECHo collaboration aims at measuring the electron neutrino mass by recording the spectrum following electron capture of ^{163}Ho. To reach a sub-eV sensitivity, a large number of individual microcalorimeters is needed, into which the isotope must be implanted in a well-controlled manner. The necessary amount of ^{163}Ho is produced by neutron irradiation of enriched ^{162}Er in the ILL high flux reactor. This introduces significant contaminations of other radioisotopes, which have to be quantitatively removed both, by chemical and mass spectrometric separation. The application of resonance ionization at the RISIKO mass separator guarantees the required isotope selectivity for purification and suitable energy for ion implantation. The efficiency and stability of the laser ion source was improved by Finite-Element Analysis of the thermal processes. For optimum implantation into the detector pixels ($170 \times 170\ \mu m^2$) with minimum losses a small ion beam spot at the implantation site is needed. For this purpose, post focusing ion optics were installed. Simulations were performed in order to optimize the homogeneous distribution of the implanted ions. The necessity to alternate implantation phases with deposition of a thin metallic layer for ^{163}Ho activities larger than 10 Bq is being discussed.

MS 4.4 Tue 15:30 f128

Enhanced Isobaric Suppression in the Laser Ion Source & Trap (LIST) — •Marcel Trümper[1], Valentin Fedosseev[4], Reinhard Heinke[1], Tobias Kron[1], Bruce Marsh[4], Sebastian Raeder[2], Tobias Reich[3], Sven Richter[1], Sebastian Rothe[4], Pascal Schönberg[3], Carsten Weichhold[1], and Klaus Wendt[1] — [1]Institute of Physics, Mainz University — [2]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt — [3]Institute of Nuclear Chemistry, Mainz University — [4]CERN, Switzerland

Highly selective and efficient ion sources using laser resonance ionization are needed in order to provide isotopically pure ion beams of rare exotic nuclei at on-line facilities like ISOLDE/CERN. To gain access to isotopes with vanishingly low production rates, for which isobaric contaminations may completely overwhelm the isotope of interest, even more advanced isotope selective approaches are required. The laser ion source and trap LIST combines the high elemental selectivity of laser resonance ionization with electrostatic ion manipulation to suppress any remaining isobaric contaminations from surface ionization.

During final characterization of the LIST in recent off-line studies at the Mainz RISIKO mass separator, electron impact ionization was identified as another interfering ionization process generating isobaric contaminants. In order to adress this aspect, the LIST was enhanced by adding an additional electron-repelling electrode. Performance, advantages and constraints of this enhancement of the LIST will be discussed in this talk.

MS 4.5 Tue 15:45 f128

Laser Ionization of Lanthanides in Preparation of the CERN MEDICIS-PROMED project — •Vadim Gadelshin[1,2], Thomas Cocolios[3], Piet Van Duppen[3], Bruce Marsh[4], Yisel Martinez Palenzuela[3,4], Sebastian Rothe[4], Thierry Stora[4], Dominik Studer[1], and Klaus Wendt[1] — [1]Institut für Physik, University of Mainz — [2]Ural Federal University, Yekaterinburg — [3]IKS, KU Leuven — [4]EN Department, CERN

The MEDICIS-PROMED Project is an Innovative Training Network (ITN) under the EU Marie Sklodowska-Curie Actions within EU H2020. In the framework of the CERN knowledge transfer program "Physics for Health Initiatives" it aims to develop a scientific network, exchange and active cooperation between physicists and physicians from European universities and medical institutions with CERN in the field of personalized cancer treatments by providing and testing novel radioisotopes for diagnostics and treatment. The project will apply a dedicated off-line mass separator at CERN's ISOLDE facility for selection of the innovative radiopharmaceuticals, and aims to involve a resonance ionization laser ion source (RILIS) for ensuring highest efficiency and purity of the radioactive ion beams. At Johannes Gutenberg-Universität Mainz the optical ionization processes for the primarily envisaged lanthanide elements are investigated and preparations for the development of a specialized, highly automated laser system are ongoing. A future transfer towards application at compact hospital-based medical cyclotrons and accelerators for enhancement of specific radioisotope production efficiency and purity is envisaged.

MS 4.6 Tue 16:00 f128

Resonant Laser-SNMS on actinides for spatially resolved ultra-trace analysis — •Michael Franzmann[1,2], Hauke Bosco[1], Linda Hamann[1], Clemens Walther[1], and Klaus Wendt[2] — [1]Institut für Radioökologie und Strahlenschutz, Leibniz Universität Hannover — [2]Institut für Physik, Johannes Gutenberg Universität Mainz

The transport mechanisms and geochemical behavior of actinides in natural systems is of major importance to evaluate their distribution in geological formations at contaminated areas and storage sites. The composition analysis of hot particles, sorption on mineral surfaces and migration of trace concentrations of radionuclides requires an excellent suppression of organic background and isobaric contamination in combination with high spatial resolution while maintaining the natural structure of the sample. The new resonant Laser-SNMS system at

the IRS Hannover was developed to cover those specifications by combining the high element selectivity of resonance ionization with the non-destructive spatially resolved analysis of a static TOF-SIMS. After the setup of a Ti:Sa laser system and the adaption of an IONTOF TOF.SIMS 5 for laser post-ionization we achieved a platform for a broad range of radioecological measurements. This talk presents the results of characterization and simulation based optimization of the system as well as latest measurements on artificial and environmental samples containing uranium, plutonium and other radionuclides.

MS 4.7 Tue 16:15 f128

ToF-SIMS and Laser-SNMS Investigations of Different Polymer Systems — •Andreas Pelster[1], Martin Körsgen[1], Rainer Kassenböhmer[1], Hiromi Morita[2], and Heinrich F. Arlinghaus[1] — [1]University of Münster, Physikalisches Institut, Wilhelm-Klemm-Str. 10, 48149 Münster, Germany — [2]Panasonic Corporation, Device Research Laboratory, Advanced Research Division, 3-1-1 Yagumonaka-machi, Moriguchi City, Osaka 570-8501, Japan

Polymer systems become more and more important for the technical or medical industries. For characterizing and improving of thin organic film systems, it is very important to determine the 3D chemical composition of such systems. For this, two powerful methods are time-of-flight secondary ion mass spectrometry (ToF-SIMS) and laser post-ionization secondary neutral mass spectrometry (Laser-SNMS). Both techniques are based on the detection of sputtered particles from the surface produced by ion bombardment. In the case of ToF-SIMS the sputtered secondary ions can be directly detected while in the case of Laser-SNMS the sputtered neutrals have to be post-ionized with a pulsed laser beam prior detection. In this study we investigated the yields of different polymer systems and films using both ToF-SIMS and Laser-SNMS. It was found that with 157 nm laser post-ionization the molecular yield for several polymer signals could be enhanced by more than one order of magnitude compared to the corresponding molecular yields obtained with ToF-SIMS. High-resolution sub-micrometer images showed that for some polymer samples only Laser-SNMS could distinguish between specific polymers in a structured mixture.