MS 2: Laser Assisted Mass Spectrometry

Time: Monday 14:00–15:30 Location: R 1.020

Invited Talk MS 2.1 Mon 14:00 R 1.020

Production, Separation and Implantation of ^{163}Ho for Neutrino Mass Measurements — •Tom Kieck[1], Holger Dorrer[1], Christoph E. Düllmann[1,2], Klaus Eberhardt[1], Lisa Gamer[3], Christian Enss[3], Loredana Gastaldo[3], Clemens Hassel[3], Ulli Köster[4], Christoph Mokry[1], Jörg Runke[1,2], Andreas Türler[5], and Klaus Wendt[1] — [1]JGU, Mainz, Germany — [2]GSI, Darmstadt, Germany — [3]Heidelberg University, Heidelberg, Germany — [4]ILL, Grenoble, France — [5]PSI, Villigen and University of Bern, Bern, Switzerland

The ECHo collaboration aims at measuring the electron neutrino mass by recording the spectrum following electron capture of ^{163}Ho using metallic magnetic calorimeters (MMCs). The radioisotope ^{163}Ho is produced from enriched ^{162}Er in the ILL high flux nuclear reactor, chemically and mass spectrometrically separated and purified and is fully embedded into the 180x180 μm^2 Au-absorber of the ECHo MMCs. Resonance ionization at the RISIKO mass separator guarantees elemental and isotopic selectivity for ultra-pure ^{163}Ho ion implantation with a sub millimeter beam spot size. The performance of the laser ion source and the implantation process was improved to minimize sample losses. On-line in-situ deposition of Au using pulsed laser deposition (PLD) ensures homogeneous ^{163}Ho/Au layer formation in the implantation area. To verify the purity of the ECHo source material from production up to implantation and data taking a varity of different analytical techniques is applied, including γ-ray spectrometry, NAA, ICP-MS and RIMS.

MS 2.2 Mon 14:30 R 1.020

Single-ion Penning-trap mass measurements using a laser-cooled ^{40}Ca$^+$ ion as sensor — •Manuel J. Gutiérrez[1], Jesús J. Del Pozo[1], Francisco Domínguez[1], Raúl A. Rica[1,2], Michael Block[3,4,5], and Daniel Rodríguez[1,2] — [1]Departamento de Física Atómica, Molecular y Nuclear, Universidad de Granada, 18071 Granada, Spain — [2]Centro de Investigación en Tecnologías de la Información y las Comunicaciones, Universidad de Granada, 18071 Granada, Spain — [3]Institut für Kernchemie, Johannes Gutenberg-Universität, 55128 Mainz, Germany — [4]GSI Helmholtzzentrum für Schwerionenforschung GmbH, 64291 Darmstadt, Germany — [5]Helmholtz-Institut Mainz, 55099 Mainz, Germany

Mass measurements on superheavy elements demand a technique that is single-ion capable and fast, while maintaining the level of precision required for nuclear physics studies. Our proposed technique arises from an existing Paul-trap experiment, where a laser-cooled ^{40}Ca$^+$ (sensor) ion is used as motional energy detector, but now implemented in a Penning-traps beamline. First, the axial motion of the sensor ion is characterized. The target ion is then loaded into the trap, where it forms a two ion crystal, together with the sensor ion, along the axial direction. By measuring the modified axial frequencies through the fluorescence photons emitted by the sensor ion, the target mass is calculated. This contribution will focus on the cooling of the target and sensor ions in 7 Tesla and the analysis method, presenting also the developments carried out for the implementation of the technique.

MS 2.3 Mon 14:45 R 1.020

Progress in spatially resolved ultra-trace analysis on plutonium containing particles by rL-SNMS — •Hauke Bosco[1], Martin Weiss[1], Manuel Raiwa[1], Klaus Wendt[2], and Clemens Walther[1] — [1]Institute for Radioecology and Radiation Protection, Leibniz Universität Hannover, Germany — [2]Institute of Physics, Johannes-Gutenberg Universität Mainz, Germany

The resonant laser secondary neutral mass spectrometry (rL-SNMS) system at the IRS in Hanover has been previously tested for its sensitivity to plutonium, uranium and other elements on synthetic and mineral samples. After these first test measurements, hot particles from the Chernobyl exclusion zone have been measured and influences of insulating sample materials instead of conductive bulk samples have been investigated. As a result, the omnipresent background of the measurement process could be lowered to a minimum, so that the signal to noise ratio has been increased. Furthermore, significant progress in suppression of isobars could be achieved, for example non-resonantly ionized uranium 238 as interfering signal for plutonium 238. In addition, further elements like fission products and transuranium elements have been tested. Results of the progression and improvements will be presented.

MS 2.4 Mon 15:00 R 1.020

ISOLDE's Highly Selective Laser Ion Source LIST - Upgrades and Development — •Reinhard Heinke[1], Katerina Chrysalidis[2], Dominik Studer[1], Valentin Fedosseev[2], Tom Kieck[1], Bruce Marsh[2], Sebastian Raeder[3], Sebastian Rothe[2], Marcel Trümper[1], and Klaus Wendt[1] — [1]Institut für Physik, JGU Mainz — [2]EN Department, CERN — [3]Helmholtz-Institut Mainz

Laser ion sources based on resonance ionization techniques today are well-established core techniques at all leading radioactive ion beam facilities worldwide. Ensuring both, highly efficient and element-selective ion beam production for on-line experiments on low-yield isotopes, these devices in addition allow for direct laser spectroscopic investigations on exotic nuclides. The Laser Ion Source and Trap (LIST) approach comprises preeminent suppression of contaminations from competing non-selective ionization mechanisms by spatially separating the hot atomization cavity from a clean laser - atom interaction volume, permitting access to nuclides previously inaccessible.

For this year's measurement campaign, a "next generation" LIST has been derived from operation experience and systematic studies: Revised repelling electrode and geometrical design yield further improvements in selectivity and efficiency.

On top, recent developments comprise a fast and robust cavity heating current switch to allow for both laser repetition rate synchronized heating and quick in-situ polarity switching to select between additional suppression and ion guiding operation.

MS 2.5 Mon 15:15 R 1.020

Isotopentrennung von Mangan mittels Resonanzionisations-Massenspektrometrie - Charakterisierung von Effizienz und Selektivität — •Nina Kneip, Reinhard Heinke, Tom Kieck, Pascal Naubereit, Dominik Studer und Klaus Wendt — Institut für Physik, Johannes Gutenberg-Universität Mainz

Das Paul Scherrer Institut in der Schweiz beschäftigt sich im Rahmen des MeaNCoRN-Projekts mit Nachweismethoden zur zeitlichen Einordnung von Supernovae im näheren Umfeld unseres Sonnensystems. Für die Experimente werden isotopenreine Targets mit $5 \cdot 10^{17}$ implantierten ^{53}Mn-Atomen benötigt. Bei der Implantation von ^{53}Mn in das Target am RISIKO-Massenseparator in Mainz müssen die im Probenmaterial im hohen Überschuss vorliegende Isotope ^{54}Mn und ^{55}Mn separiert werden und gleichzeitig das wertvolle ^{53}Mn mit hoher Effizienz transmittiert werden. Dazu wird eine hocheffiziente und selektive Resonanzionisations-Laserionenquelle verwendet. Für Mangan wurde mittels zweier frequenzverdoppelter konventioneller Ti:Saphir-Laser und eines weitabstimmbaren gittergestützten Ti:Saphir-Lasers dezidiertes Anregungsschema am stabilen Isotop ^{55}Mn entwickelt. Durchgeführt wurden damit Effizienzmessungen an unterschiedlichen Probengrößen und mit Ionenströmen bis zu 1 μA, um das neue Verfahren zu charakterisieren. Dabei konnten in Proben mit 10^{14} Atomen durchschnittliche Effizienzen von 23 % erreicht werden, die bei sehr hohen Ionenströmen deutlich abfallen.