MS 5: Poster

Time: Wednesday 17:00–19:00 Location: Philo 1. OG

MS 5.1 Wed 17:00 Philo 1. OG

^{41}Ca measurements using a Bragg detector at CologneAMS — •Jonathan Leven, Timm-Florian Pabst, Stefan Heinze, and Dennis Mücher — Institute of Nuclear Physics, University of Cologne

Depending on the A/Z ratio of the target isotope and its isobar, it can be helpful to use a Bragg type gas ionization chamber, instead of a multi-anode gas ionization chamber in AMS measurements. One contribution is the different scattering behavior in the detectors, with impact on the separation of the isotope of interest and its isobar(s). To exploit this, a Bragg type gas ionization chamber has been installed at the CologneAMS 6MV accelerator, with the hope of improving the separation when compared to the currently used four-anode gas ionization chamber for selected isotopes. We implemented a new, fully digital DAQ approach with the advantage of offline analysis of the pulse shape of the Bragg detector. We will present the status and first results for ^{41}Ca AMS measurements.

MS 5.2 Wed 17:00 Philo 1. OG

AMS measurements of ^{93}Mo for nuclear fusion research — •Kyra Altindag[1], Esad Hrnjic[1], Carlos Vivo-Vilches[1], Silke Merchel[1], Martin Martschini[1], Lee W. Packer[2], Johannes H. Sterba[3], Matic Dokl[4], Jixin Qiao[4], Erik Strub[5], and Karin Hain[1] — [1]University of Vienna, Faculty of Physics, Vienna, Austria — [2]UKAEA, Culham Campus, Abingdon, United Kingdom — [3]Center for Labelling and Isotope Production, TRIGA Center Atominstitut, TU Wien, Vienna, Austria — [4]Department of Environmental and Resource Engineering, Technical University of Denmark, Roskilde, Denmark — [5]Division of Nuclear Chemistry, University of Cologne, Cologne, Germany

In fusion environments, ^{93}Mo ($T_{1/2} = 4839$ a) will be produced via nuclear reactions of neutrons from the deuterium-tritium fusion with Mo-containing materials, e.g. stainless steel. At the Vienna Environmental Research Accelerator (VERA), accelerator mass spectrometry (AMS) is under development for ^{93}Mo. The selection of MoO_2^- allows the suppression of the respective stable isobar ^{93}Nb via laser photodetachment within the Ion-Laser InterAction Mass Spectrometry (ILIAMS) setup using a 637 nm laser. A Mo foil was irradiated at the TRIGA Mark II reactor at TU Wien to yield ^{93}Mo/^{nat}Mo ratios of 10^{-9}, and further diluted with stable ^{nat}Mo to produce MoO_2 with ratios down to 10^{-12}. First AMS measurements showed a blank level of ^{93}Mo/^{nat}Mo = (1-5)×10^{-13}. The ^{93}Mo/^{nat}Mo ratio expected in foil samples of future fusion reactor component materials irradiated during the DTE2 deuterium-tritium campaign at the JET reactor is ≈10^{-10}.

MS 5.3 Wed 17:00 Philo 1. OG

Sample preparation and AMS measurements of ^{90}Sr in soil — •Leonie Ebenberger[1], Oscar Marchhart[1], Robin Golser[1], Martin Martschini[1], Silke Merchel[1], Joel Mohren[2], Dennis Mücher[3], Markus Schiffer[3], and Erik Strub[3] — [1]University of Vienna, Austria — [2]RWTH Aachen, Germany — [3]University of Cologne, Germany

^{90}Sr ($T_{1/2}$ = 28.91 a) is a radionuclide produced almost exclusively anthropogenically in nuclear fission reactors, as well as by nuclear weapons. It is of radiological concern due to its high radiotoxicity and mobility in the environment. Our dedicated sample preparation procedure for ^{90}Sr Accelerator Mass Spectrometry (AMS) was applied to a larger number of soil samples. The investigated soil samples consist of two soil cores taken near the Rur river, within the vicinity of the Arbeitsgemeinschaft Versuchsreaktor (AVR) Jülich. The AVR Jülich is a quite unique nuclear facility because of a specific incidental release of ^{90}Sr. The measurements were performed at the Vienna Environmental Research Accelerator (VERA) utilizing the Ion-Laser InterAction Mass Spectrometry (ILIAMS) setup, which achieves an overall ^{90}Zr isobar suppression of $> 10^{12}$. Preliminary measurement results will be shown.

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MS 5.4 Wed 17:00 Philo 1. OG

Towards ^{53}Mn measurements with ALIS at CologneAMS — •Timm-Florian Pabst[1], Markus Schiffer[1,2], Derin Schmidt[1], Natasha Kalanke[3], Stefan Heinze[1], and Dennis Mücher[1] — [1]University of Cologne, Institute of Nuclear Physics, Cologne, Germany — [2]University of Cologne, Department of Prehistoric Archaeology, Laboratory of Isotope Archaeology — [3]Department of Physics and Astronomy, Botswana International University of Science and Technology

The mesaurement of ^{53}Mn contents has a variety of applications. Ranging from astrophysics and meteorites to geosince where ^{53}Mn could extend the look in the past in burrial and exposure dating. For a long time, ^{53}Mn measurements were restricted to AMS facilities powered by rather large tandem accelerators of at least 10 MV terminal voltage. But as it is the case for a range of other radioisotopes the high isobaric suppression by laser photo detachement might improve the chalenging Suppression of ^{53}Cr.

We will be reporting on recent updates on the ALIS setup at CologneAMS regarding the development of ^{53}Mn measurements. This includes putting into service a new 940 nm, 20 W CW laser and optimizations for manganese ion beams as well as the new lasers transport through the ion cooler. Additionally we will show first insights on the reduction of ^{53}Cr in our setup as well as the seperation of ^{53}Mn and its isobar using the ALIS setup in combination with the 6 MV tandetron.

MS 5.5 Wed 17:00 Philo 1. OG

Recent progress in the search of live ^{182}Hf in geological archives — •Sebastian Fichter[1], Laurenz Widermann[1,2], Alexander Lorenz[1], Dominik Koll[1], Martin Martschini[2], Silke Merchel[2], Robin Golser[2], and Anton Wallner[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf (HZDR), Accelerator Mass Spectrometry and Isotope Research, Dresden, Germany — [2]University of Vienna, Faculty of Physics, Isotope Physics, Vienna, Austria

The detection and quantification of the astrophysically relevant radionuclide ^{182}Hf ($t_{1/2} = 8.9 \times 10^6$ yr) in diverse geological archives would greatly enhance our understanding of potential *r*-process production sites, particularly when its temporal abundance is compared with other nucleosynthesis radionuclides such as ^{60}Fe and ^{244}Pu. In this study, we report recent progress in developing an optimized chemical protocol for extracting ^{182}Hf from a variety of sample matrices, including deep-sea ferromanganese crusts and nodules. Our primary goal is to achieve high chemical yields while maximizing the separation from interfering elements. A key focus is the suppression of the stable isobar ^{182}W, which remains one of the main factors limiting the direct detection of live ^{182}Hf via Accelerator Mass Spectrometry. In the future, also the newly established Helmholtz Accelerator Mass Spectrometer Tracing Environmental Radionuclides (HAMSTER) at HZDR will participate in this endeavour using its ion cooler setup Ion Linear Trap for Isobar Suppression (ILTIS).

MS 5.6 Wed 17:00 Philo 1. OG

High-precision Penning trap mass spectrometry of heavy, highly charged ions — •Rima X. Schüssler[1,2,3] and Thomas Stöhlker[1,2,3] — [1]GSI Helmholtz Center for Heavy Ion Research, Darmstadt — [2]Helmholtzinstitut Jena — [3]Institute of Optics and Quantum Electronics, Friedrich Schiller University Jena

The theory of quantum electrodynamics (QED) has been extensively tested in light or medium heavy atoms, but stringent tests in the heaviest atoms in the highest charge states, where QED effects are largest, still lack high precision. So far, such measurements have been performed in storage rings at high ion energies.

To this end, we are setting up a high-precision Penning trap mass spectrometer to perform measurements of the binding energy of the innermost electron by determining the mass difference with a relative precision of 10^{-12} of ions in different charge states. The experiment will be situated at the Hitrap facility at the GSI Helmholtz Center for Heavy Ion Research in Darmstadt. Here, heavy, highly charged ions are produced in the accelerator facility and then decelerated such that they can be captured in the Penning trap. The experiment itself will consist of a strong magnetic field, feature several cryogenic Penning traps, and a cryogenic detection system with single-ion efficiency.

Furthermore, due to the nature of a Penning trap, the experiment will extend the application of mass measurements to the region of the heaviest ions in the highest charge states for a vast range of applications.

MS 5.7 Wed 17:00 Philo 1. OG

Mass Measurements near N=126 with the FRS Ion Catcher — •Kriti Mahajan[1,2] and Daler Amanbayev[3,1] for the Super-FRS Experiment-Collaboration — [1]Justus-Liebig-Universität Gießen, Germany — [2]Helmholtz Research Academy Hesse for FAIR (HFHF), Campus Gießen, Germany — [3]GSI Darmstadt, Germany

Studying the r-process requires nuclear data of very neutron-rich nuclei. This data is still scarce and modern r-process network calculations rely on theoretical models that give divergent predictions as one moves away from the valley of stability. Nuclear masses help to determine the r-process path and shed light on the nucleosynthesis environment.

The use of high-energy heavy-ion beams with the Fragment Separator (FRS) at GSI facilitates the study of neutron-rich nuclei in the r-process region. An experiment was performed within FAIR Phase-0, where these nuclei were produced at the FRS using fragmentation of 1 GeV/u ^{208}Pb beam on a 4 g/cm^2 thick ^{9}Be target and precise mass measurements were performed using the multiple-reflection time-of-flight mass spectrometer (MR-TOF-MS). The MR-TOF-MS features a high resolving power of up to 1,000,000, short cycle times of a few tens of milliseconds, and mass accuracy down to 2×10^{-8}.

During the experiment, masses of sixteen nuclides around $N = 126$ were measured, of which four masses were measured for the first time. The results of this experiment will be presented, including the first mass measurements of ^{204}Au and ^{205}Au, where significant deviations from the AME2020 extrapolations indicate a change in nuclear structure around the N = 126 shell closure.

MS 5.8 Wed 17:00 Philo 1. OG

Isotope shift and hyperfine structure measurements in curium — •R. Hasse[1,3,4], T. E. Albrecht[2], S. Berndt[1], M. Block[1,3,4], Ch. E. Düllmann[1,3,4], J. G. Ezold[5], U. Köster[6], A. T. Loria Basto[1,4], Ch. Mokry[1,4], K. Myhre[5], S. Raeder[3,4], D. Renisch[1,4], J. Runke[1,3], S. K. Schrell[5], M. Stemmler[1,7], and K. Wendt[1] — [1]JGU, Mainz, Germany — [2]CSM, Golden, CO, United States — [3]GSI, Darmstadt, Germany — [4]HIM, Mainz, Germany — [5]ORNL, Oak Ridge, TN, United States — [6]ILL, Grenoble, France — [7]LU, Hannover, Germany

Curium ($Z = 96$) is a minor actinide that is produced in nuclear reactors and therefore present in spent nuclear fuel. We report on high resolution resonance ionization mass spectrometry at RISIKO employing a narrowband Ti:Sa laser on the isotopes $^{242-248,250}$Cm to determine isotope shifts and the hyperfine structures of the odd-A isotopes ^{243,245,247}Cm. For these measurements two ground state transitions from $5f^76d7s^9D_2^o$ to the excited states $5f^76d7s7p^9D_3$ and $5f^86d7s^9D_3$ were used in two-step ionization schemes. The sample sizes ranged from 10^7 atoms of the isotope ^{250}Cm to 10^{13} atoms of the more abundant isotopes ^{246,248}Cm. In a King-plot analysis these results are analyzed to derive so far missing nuclear mean square charge radii differences of the isotopes ^{242,247,250}Cm. Additional analysis of the hyperfine structure using the SATLAS package yields the hyperfine parameters A and B.

MS 5.9 Wed 17:00 Philo 1. OG

Status Report of the Projects LISEL@DREAMS and ELISE@IBC — •Oliver Forstner[1], Shiva Prasad Pulipati[1], Thorben Niemeyer[2], and Klaus Wendt[2] — [1]Friedrich-Schiller-Universität Jena — [2]Johannes-Gutenberg-Universität Mainz

The German Ministry of Science and Education has granted funding for the two consecutive research projects LISEL@DREAMS and ELISE@IBC to advance laser photodetachment as an additional element selective filter in AMS. At Jena an ion beam apparatus and an ion beam cooler has been built allowing to study and improve the capture of negative atomic and molecular ions with the goal of increasing the photodetachment efficiency. In Mainz two types of tuneable laser systems have been built. One system based on a Ti:sapphire and a second based on a OPO from Hübner Photonics. Both systems operate in different wavelength ranges allowing to study a broad range of isotopes.

In this status report we will present what has been achieved so far covering the activities at the setup in Jena and the Mainz laser systems as well as connected activities at the FLSR storage ring in Frankfurt. An outlook will be given into the future applications of the developed systems.

MS 5.10 Wed 17:00 Philo 1. OG

Advancing (A)MS-based techniques for ultra-trace detection of Tc-99 — •Stephanie Adler[1,2], Martin Martschini[1], Dennis Mücher[3], Erik Strub[3], Thomas C. Meisel[4], and Karin Hain[1] — [1]University of Vienna, Faculty of Physics, Austria — [2]University of Vienna, Vienna Doctoral School in Physics, Austria — [3]University of Cologne, Institute for Nuclear Physics, Germany — [4]Montanuniversität Leoben, Austria

Determination of absolute concentrations of the anthropogenic radionuclide ^{99}Tc ($t_{1/2}$=2.1×10^5 yr) in environmental samples by accelerator mass spectrometry (AMS) requires the suppression of the stable isobaric background of ^{99}Ru and a reliable normalisation method. Ion-Laser InterAction Mass Spectrometry (ILIAMS) has demonstrated $^{99}RuF_5^-$ suppression factors of up to 10^5, while leaving $^{99}TcF_5^-$ unaffected. However, a variability in this suppression factor has been observed in recent measurements, and the possible reasons for this variability are being investigated. Using a negative thermal ionisation source (N-TIMS), isobar suppression and the feasibility of normalisation with a ^{97}Tc spike is being investigated at the Technical University of Leoben. An ionization efficiency of 2-10% and a ^{99}Ru suppression factor of 10^6 were achieved when extracting $^{99}TcO_4^-$ from the ion source. When investigating the possibility of applying the same approach to AMS, the same anion was extracted from the Cs-sputter ion source. However, for similar concentrations, a higher output of $^{99}RuO_4^-$ than of $^{99}TcO_4^-$ was observed in this case, which makes the N-TIMS approach more feasible.

MS 5.11 Wed 17:00 Philo 1. OG

Targets for precision spectroscopy with multiply-charged actinide molecules — •Lennard Marek Arndt[1], Jonas Stricker[1,2], Dennis Renisch[1,2], and Christoph Emanuel Düllmann[1,2,3] — [1]JGU Mainz Germany — [2]HI Mainz, Germany — [3]GSI Darmstadt, Germany

Multiply-charged actinide molecules offer promising new opportunities for tests of fundamental symmetries by precision spectroscopy. The production of multiply-charged ions was reported via laser ablation of chemically tailored targets that contain all elements desired in the molecular ion. We demonstrate target production via electroplating and direct synthesis. We also present ToF spectra from laser ablation of actinide molecular ions. Ablation of a ThF_4 target and an uranium foil yielded ThF^{2+} and UO^{3+} respectively, both isoelectronic to RaF and thus, sensitive to nuclear Schiff moments.

MS 5.12 Wed 17:00 Philo 1. OG

Determination of the size of the neutral particle cloud in rL-SNMS — •Jonah Böttger, Paul Hanemann, Manuel Raiwa, Aaron Lehnert, and Clemens Walther — Leibniz University Hannover, IRS, Hannover, Germany

After the installation of resonant Laser Secondary Neutral Mass Spectrometry (rL-SNMS), a combination of TOF-SIMS and laser system, the size of the neutral particle cloud was only estimated through simulations. [1]

Using two different methods we were able to measure the size of the cloud. First, by scanning it with a resonant laser, producing a two-dimensional map of the number of neutral particles. Second, by measuring saturation curves for uranium, plutonium and americium with different laser beam diameters to determine an upper limit for the size of the neutral particle cloud. Possible differences in the size of the cloud for different elements and isotopes were also investigated.

The cloud was determined to be spherical with a diameter of around 300 - 400 μm with only minimal differences between elements and isotopes. Both methods came to similar results, experimentally confirming the earlier simulations. Using this, we were able to optimize the overlap of the laser beams and the neutral particle cloud, increasing the sensitivity of the system by a factor of 4.

[1] DOI: 10.1016/j.ijms.2017.10.003

MS 5.13 Wed 17:00 Philo 1. OG

Surprises 60 years after the Thule plane crash: More nuclear weapons material involved than previously assumed? — •Jan Schimansky[1], Tobias Weissenborn[1], Paul Hanemann[1], Jixin Qiao[2], Sven Nielsen[2], and Clemens Walther[1] — [1]Leibniz Universität Hannover, IRS, Hannover, Germany — [2]Technical University of Denmark, Roskilde, Denmark

In 1968, the crash of a US B-52 bomber near Thule Airbase released mixed uranium-plutonium particles into the environment. Although existing literature provides values for their general isotopic composition [1], the full extent of their heterogeneity and complex morphology remains to be explored. Using isolated hot particles, we apply tradi-

tional Time-of-Flight Secondary Ion Mass Spectrometry (ToF-SIMS) and resonant Laser Secondary Neutral Mass Spectrometry (rL-SNMS) to analyze $^{235}U/^{238}U$ isotopic ratios. Combined with Gamma Spectrometry and Scanning Electron Microscopy (SEM), this approach allows for a comprehensive characterization of the particles. We identified particles with isotopic fingerprints similar to values found by previous works [1,2] containing weapons grade plutonium ($^{240}Pu/^{239}Pu > 0.055$) and enriched uranium ($^{235}U/^{238}U > 1.2$), as well as surprising variations from these values, containing purer weapons grade Pu ($240Pu/239Pu < 0.025$) and higher enriched uranium ($^{235}U/^{238}U > 2.5$). In this work we present and discuss the measured isotope ratios and compare the ToF-SIMS and rL-SNMS measurements highlighting the advantages of isobar free mass spectrometry. References: 1: DOI:10.1021/es800203f; 2: DOI:10.1016/j.jenvrad.2004.10.013