Mass Spectrometry Division
Fachverband Massenspektrometrie (MS)

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Overview of Invited Talks and Sessions

(Lecture halls f128; Poster Empore Lichthof)

Invited Talks

MS 1.1	Mon	11:00–11:30	f128	**Precision Mass Measurements on light Nuclei: The Deuteron's Atomic Mass** — •Sascha Rau
MS 2.1	Mon	14:00–14:30	f128	**Reaction studies with internally cold molecular ions in a storage ring** — •Oldrich Novotny
MS 4.1	Tue	14:00–14:30	f128	**Multi-reflection time-of-flight mass spectrometry for cluster research** — •Paul Fischer, Gerrit Marx, Lutz Schweikhard
MS 5.1	Tue	15:15–15:45	f128	**Experiments with multiple-reflection time-of-flight mass spectrometers (MR-TOF-MS) at TRIUMF and GSI/FAIR** — •Christine Hornung, the FRS Ion Catcher Collaboration, the TITAN Collaboration
MS 7.1	Wed	14:00–14:30	f128	**Spatially resolved ultra-trace analysis of actinides on hot particles by resonant laser-SNMS** — •Hauke Bosco, Martin Weiss, Manuel Raiwa, Nina Kneip, Klaus Wendt, Clemens Walther
MS 8.1	Wed	14:30–15:00	f128	**The new compact, multi isotope AMS system (MILEA) at ETH Zurich - performance and applications** — •Marcus Christl, Sascha Maxeiner, Arnold Milenko Müller, Philip Gautschi, Christof Vockenhuber, Maxi Castrillejo, Nuria Casacuberta, Hans-Arno Synal
MS 13.1	Thu	15:00–15:30	f128	**The Multi Ion Reflection Apparatus for Collinear Laser Spectroscopy and its potential for fast and highly selective mass separation** — •Stephan Malbrunot-Ettenauer for the MIRACLS collaboration

Invited talks of the joint symposium SYAI

See SYAI for the full program of the symposium.

SYAI 1.1	Mon	14:00–14:30	e415	**Atom interferometry and its applications for gravity sensing** — •Franck Pereira dos Santos, Luc Absil, Romain Caldani, Xiaobing Deng, Romain Karcher, Sébastien Merlet, Raphaël Piccon, Sumit Sarkar
SYAI 1.2	Mon	14:30–15:00	e415	**Atom interferometry for advanced geodesy and gravitational wave observation** — •Philippe Bouyer
SYAI 1.3	Mon	15:00–15:30	e415	**Fundamental physics with atom interferometry** — •Paul Hamilton
SYAI 1.4	Mon	15:30–16:00	e415	**Atoms and molecules interacting with light** — •Lucia Hackermüller

Invited talks of the joint symposium SYAD

See SYAD for the full program of the symposium.

SYAD 1.1	Tue	11:00–11:30	e415	**Electron Pulse Control with Terahertz Fields** — •Dominik Ehberger
SYAD 1.2	Tue	11:30–12:00	e415	**Laser-Based High-Voltage Metrology with ppm Accuracy** — •Kristian König, Christopher Geppert, Phillip Imgram, Jörg Krämer, Bernhard Maass, Johann Meisner, Ernst Otten, Stephan Passon, Tim Ratajczyk, Johannes Ullmann, Wilfried Nörtershäuser

SYAD 1.3	Tue	12:00–12:30	e415	**Structured singular light fields** — •Eileen Otte
SYAD 1.4	Tue	12:30–13:00	e415	**Coherent Coupling of a Single Molecule to a Fabry-Perot Microcavity** — •Daqing Wang

Invited talks of the joint symposium SYAR

See SYAR for the full program of the symposium.

SYAR 1.1	Wed	11:00–11:30	e415	**Use of actinides in medical research** — •Thomas Elias Cocolios
SYAR 1.2	Wed	11:30–12:00	e415	**Pushing the Limits: Detection of Long-Lived Actinides at VERA** — •Karin Hain, Michael Kern, Francesca Quinto, Aya Sakaguchi, Peter Steier, Gabriele Wallner, Andreas Wiederin, Masatoshi Yamada, Robin Golser
SYAR 1.3	Wed	12:00–12:30	e415	**Application of Inorganic Mass Spectrometry in Nuclear Forensics** — •Klaus Mayer, Maria Walllenius, Zsolt Varga, Magnus Hedberg, Michael Krachler
SYAR 1.4	Wed	12:30–13:00	e415	**Actinide elements and fundamental nuclear structure studies** — •Iain Moore

Sessions

MS 1.1–1.7	Mon	11:00–13:00	f128	**Precision Mass Spectrometry I**
MS 2.1–2.4	Mon	14:00–15:15	f128	**Storage Rings**
MS 3.1–3.3	Mon	15:15–16:00	f128	**New Developments and Techniques**
MS 4.1–4.4	Tue	14:00–15:15	f128	**Clusters and Molecules**
MS 5.1–5.2	Tue	15:15–16:00	f128	**Precision Mass Spectrometry II**
MS 6.1–6.1	Wed	13:10–13:55	f303	**Lunch talk: German Research Foundation (DFG) (joint session A/K/P/MO/MS/Q)**
MS 7.1–7.1	Wed	14:00–14:30	f128	**Laser-SNMS**
MS 8.1–8.5	Wed	14:30–16:00	f128	**Accelerator Mass Spectrometry and Applications I**
MS 9.1–9.7	Wed	16:30–18:30	Empore Lichthof	**Mass Spectrometry Posters**
MS 10.1–10.8	Thu	11:00–13:00	f128	**Accelerator Mass Spectrometry and Applications II**
MS 11	Thu	13:00–13:30	f128	**Annual General Meeting of the Mass Spectrometry Division**
MS 12.1–12.4	Thu	14:00–15:00	f128	**Accelerator Mass Spectrometry and Applications III**
MS 13.1–13.4	Thu	15:00–16:15	f128	**New Developments and Techniques**

Annual General Meeting of the Mass Spectrometry Division

Thursday 13:00–13:30 f128

- Bericht
- Verschiedenes

MS 1: Precision Mass Spectrometry I

Time: Monday 11:00–13:00 Location: f128

Invited Talk MS 1.1 Mon 11:00 f128

Precision Mass Measurements on light Nuclei: The Deuteron's Atomic Mass — •Sascha Rau — Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Germany

The rest masses of many light nuclei, e.g. the proton, deuteron, triton and helion are of great importance for testing our current understanding of physics as well as in metrology. One example is the mass difference of triton and helion [1], which is used for systematic studies in the determination of $m(\bar{\nu}_e)$ in the KATRIN experiment. However, the relatively large ratio of kinetic energies compared to the low rest masses makes measuring light ions especially challenging. Recently discussed discrepancies in light ion mass measurements, carried out at different mass spectrometers and sometimes termed "light ion mass puzzle", give further motivation for independent measurements.

In the contribution the present progress and results of LIONTRAP (Light ION TRAP) [2] will be presented, an ion trap setup dedicated to high-precision mass measurements of light ions. We recently measured the proton's atomic mass by comparing the cyclotron frequencies of a single proton and a bare carbon nucleus, achieving a relative mass uncertainty of 3.2×10^{-11}. Compared to the CODATA-2014 value our result is a factor of three more precise and reveals a 3σ deviation.

After upgrading the experiment we are currently measuring the deuteron's atomic mass. These upgrades and the current status of the deuteron measurement campaign will be presented.

[1] E.G. Myers *et al.* Phys. Rev. Lett. **114**, 013003 (2015)
[2] F. Heiße *et al.* Phys. Rev. A **100**, 022518 (2019)

MS 1.2 Mon 11:30 f128

Systematic effects of high-precision mass measurements at Pentatrap — •Kathrin Kromer, Menno Door, Sergey Eliseev, Pavel Filianin, Wenjia Huang, Charlotte M. König, Alexander Rischka, Rima X. Schüssler, Christoph Schweiger, and Klaus Blaum — Max-Planck-Institut für Kernphysik, 69117 Heidelberg, Germany

Pentatrap [1] is a high-precision Penning-trap mass spectrometer featuring a stack of five Penning traps and determining mass-ratios with a relative uncertainty of below 10^{-11}. Mass-ratio determinations of stable and long-lived highly charged ions at this level have numerous applications, among others, in neutrino physics [2] and tests of special relativity [3]. Systematic uncertainties include electric and magnetic field anharmonicities and missalignments as well as fluctuating environmental parameters like external magnetic fields, pressure, and temperature. The systematic uncertainties stemming from environmental influences are measured in order to find possible correlations to fluctuations in the cyclotron frequency of the trapped highly charged ions. Stabilization systems have been tested and have shown improvements, e.g. the active stabilization of the liquid-helium level and the pressure in the magnet's cold bore, resulting in Pentatrap's first mass-ratio measurement with a relative uncertainty of $1 \cdot 10^{-11}$.

[1] Repp, J. et al., Appl. Phys. B 107, 983 (2012)
[2] Gastaldo, L. et al., Eur. Phys. J. ST 226, 1623 (2017)
[3] Rainville, S. et al., Nature 438, 1096 (2005)

MS 1.3 Mon 11:45 f128

Towards an improved measurement of the antiproton *g*-factor — •Stefan Erlewein[1,2,3], Matthias Borchert[1,4], Jack Devlin[1,3], Markus Fleck[1,3], James Harrington[1,2], Motoki Sato[1,5], Jan Warncke[1,4], Elise Wursten[1,3], Matthew Bohman[1,2], Christian Smorra[1], Markus Wiesinger[1,2], Christian Will[1,2], Klaus Blaum[2], Yasuyuki Matsuda[5], Christian Ospelkaus[4,7], Wolfgang Quint[6], Jochen Walz[8,9], Yasunori Yamazaki[1], and Stefan Ulmer[1] — [1]RIKEN, Ulmer Fundamental Symmetries Laboratory, 2-1 Hirosawa, Wako, Saitama, 351-0198, Japan — [2]Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, D-69117, Heidelberg, Germany — [3]CERN, Esplanade des Particules 1, 1217 Meyrin, Switzerland — [4]Institut für Quantenoptik, Leibniz Universität, Welfengarten 1, D-30167 Hannover, Germany — [5]Graduate School of Arts and Sciences, University of Tokyo, 3-8-1 Komaba, Meguro, Tokyo 153-0041, Japan — [6]GSI-Helmholtzzentrum für Schwerionenforschung GmbH, Planckstraße 1, D-64291 Darmstadt, Germany — [7]Physikalisch-Technische Bundesanstalt, Bundesallee 100, D-38116 Braunschweig, Germany — [8]Helmholtz-Institut Mainz, Johannes Gutenberg-Universität, Staudingerweg 18, D-55128 Mainz, Germany — [9]Institut für Physik, Johannes Gutenberg-Universität, Staudinger Weg 7, D-55128 Mainz, Germany

The BASE experiment, located at CERN's Antiproton Decelerator (AD) facility, measures the fundamental properties of protons and antiprotons in order to test CPT symmetry with high precision. In 2015, the first ever non-destructive observation of spin flips with a single trapped antiproton was demonstrated, allowing the measurement of the antiproton's magnetic moment to a fractional precision of 1.5 parts-per-billion (p.p.b.), which improved previous results by about a factor of 3000.

In my talk, I will give an overview of the BASE experiment and discuss limitations of the 1.5 p.p.b. measurement of the antiproton's magnetic moment. I will present a new technique for the detection of a single trapped antiproton's spinstate, which will allow for measurements at increased sampling rate. The application of this scheme and the introduction of additional experiment upgrades will enable an antiproton *g*-factor measurement with a fractional uncertainty of 100 p.p.t. on the short term.

MS 1.4 Mon 12:00 f128

Reduction of Measurement Uncertainty in MC-ICP-MS: A Precondition for the Dissemination of the SI Units Kilogram and Mole — •Axel Pramann and Olaf Rienitz — Physikalisch-Technische Bundesanstalt (PTB), Braunschweig, Germany

After the revision of the SI units in 2019, one of the two main methods to realize and disseminate the kilogram and mole is the the X-ray-crystal-density (XRCD) method [1-3]. Here, silicon atoms in a silicon sphere are counted combining the measurements of the volume, the lattice parameter, the surface condition, and the isotopic composition using the fixed Avogadro constant. A key experiment uses high resolution multicollector inductively coupled plasma mass spectrometry (HR-MC-ICP-MS) to measure isotope ratios in natural and in 28Si enriched silicon to determine the respective molar mass (M) [4]. It is shown how the measurement uncertainty of the isotope ratios according to the *Guide to the Expression of Uncertainty in Measurement* influences the results and how this has been, is, and will be treated in the near future combining established and new experimental techniques with special emphasis on the mass resolution of the mass spectrometer. The target uncertainty is u(M) < 5 x 10-9 in case of enriched silicon and u(M) < 5 x 10-6 for natural silicon.

[1] K. Fujii et al., Metrologia, 53, A19 (2016). [2] D. Knopf et al., Metrologia, 56, 024003 (2019). [3] B. Güttler, O. Rienitz, A. Pramann, Annalen der Physik, 1800292 (2018). [4] A. Pramann, T. Narukawa, O. Rienitz, Metrologia, 54, 738 (2017).

MS 1.5 Mon 12:15 f128

Development of an electronic detectionmethod for FT-ICR-MS — •Sven Böhland[1], Steffen Lohse[1,2], Michael Block[1,2,3], Joaquín Berrocal[4], Gabriel Ramirez[5], and Daniel Rodríguez[4] — [1]JGU, Mainz — [2]HI Mainz — [3]GSI, Darmstadt — [4]Universidad de Granada — [5]Seven Solutions S.L., Granada

The existance of superheavy elements ($Z \geq 104$) stems from an enhanced stability as a result of nuclear shell effects. High-precision Penning trap mass spectrometry provides the nuclear binding energies of these elements. This will help constraining theoretical predictions of nuclear models, and in particular for the so-called Island of Stability, a region of relatively long-lived nuclides expected around $Z = 114 - 126$ and $N = 184$. Production rates for superheavy elements are exceptionally low, which requires the highest level of efficency and sensitivity. In recent years the cutting edge technique for mass spectrometry on single ions is the Fourier-Transform Ion-Cyclotron-Resonance method (FT-ICR). The outstanding performance has been shown in several experiments, pushing the border of precision beyond 10^{-10} for single ions of select stable nuclides. All these experiments have relied on a LC tank circuit formed by the capacity of the Penning trap electrode connected to a superconducting coil and only very recently, a novel quartz amplifier has been built and used for the first time with stored $^{40}Ca^{+}$-ions. Following the first tests, the amplifier has been characterized using the heavier $^{207}Pb^{+}$-ions. The results pave the way to measurements on super heavy elements.

MS 1.6 Mon 12:30 f128

Development of a Helium-3 source for the LIONTRAP experiment — •Sangeetha Sasidharan[1], Sascha Rau[1], Fabian Heisse[1], Florian Köhler-Langes[1], Wolfgang Quint[2], Sven Sturm[1], and Klaus Blaum[1] — [1]Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Germany — [2]GSI Helmholtzzentrum für Schwerionenforschung GmbH, Planckstraße 1, 64291 Darmstadt, Germany

High-precision mass measurements of light atomic nuclei enable sensitive tests of fundamental physics. An ultra-precise measurement of the mass difference of ^{3}He and ^{3}T [1] will provide an important input parameter for the determination of the electron anti-neutrino mass with the KATRIN experiment [2]. At the LIONTRAP Penning-trap experiment we have measured the atomic mass of the proton with a relative uncertainty of 3×10^{-11} [3]. With the deuteron mass being measured at present to even higher precision, the next step will be a measurement of the ^{3}He mass. The LIONTRAP has a hermetically sealed trap chamber, which together with cryopumping results in a vacuum better than 10^{-16} mbar. However, this creates the necessity of an in-situ ion production method. Creating an in-situ ^{3}He source is a challenge due to the weak bonding capability of helium. The method being investigated for this is the use of activated charcoal as an adsorption agent. In this talk the current status will be discussed.

[1] E.G. Myers *et al.* Phys. Rev. Lett. **114**, 013003 (2015)
[2] M. Aker *et al.* Phys. Rev. Lett. **123**, 221802 (2019)
[3] F. Heiße *et al.* Phys. Rev. A **100**, 022518 (2019)

MS 1.7 Mon 12:45 f128

Optimizations of the laser ablation ion source at the SHIPTRAP setup — •Brankica Andelić[1,2], Michael Block[2,3,4], Pierre Chauveau[2,3], Premaditya Chhetri[2,3], Julia Even[1], Francesca Giacoppo[2,3], Nasser Kalantar-Nayestanaki[1], Oliver Kaleja[2,3,5], Sebastian Raeder[2,3], and Fabian Schneider[2,3] — [1]University of Groningen — [2]HI Mainz — [3]GSI Darmstadt — [4]JG University Mainz — [5]MPIK Heidelberg

The SHIPTRAP mass spectrometer allows direct high-precision ion-mass measurements that reveal detailed information on the evolution of the nuclear shell structure of heavy exotic nuclei as well as the decay probability of nuclides relevant in stellar nucleosynthesis and neutrino physics. In addition to online experiments, mass measurements that involve the offline production of ions using a laser ablation ion source are being performed.

To study long-lived rare and radioactive isotopes we have to cope with small sample sizes. Therefore, an efficient ion production and injection into the double Penning-trap system as narrow bunches of few ions are crucial. A gas-filled miniature Radio-Frequency Quadrupole (mini-RFQ) was recently implemented into the SHIPTRAP ion source to thermalize the laser-ablated ions and thus improve the production efficiency as well as the sample preparation. In addition, the laser ablation ion source is important also for the online measurements since it provides reference ions of suitable mass-over-charge ratio for magnetic field calibration. In this contribution, the performance of the recently improved laser ablation ion source will be presented.

MS 2: Storage Rings

Time: Monday 14:00–15:15 Location: f128

Invited Talk MS 2.1 Mon 14:00 f128

Reaction studies with internally cold molecular ions in a storage ring — •Oldrich Novotny — Max-Planck-Institut für Kernphysik, Heidelberg, Germany

In last decades room-temperature ion storage rings have proven to be unique tools for investigating properties and reaction dynamics of molecular ions, in particular the low-energy electron-ion collisions in merged beams. This is mainly due to 1) the long storage of the ions allowing relaxation of the internal ion states and 2) the ion beam target preparation for experiments at high collision-energy resolution by e.g., electron cooling. The recently built Cryogenic Storage Ring (CSR) [1] in Heidelberg, Germany, with its < 6 K vacuum wall temperature brings these advantages to a new level: the low radiation field allows the molecules to relax down to their ro-vibrational ground-state. Studying collisions of cold molecular ions with electrons, photons, and atoms give access to unprecedented details on the respective reaction dynamics. Also, the CSR environment mimics well the conditions in the cold interstellar medium, which makes CSR an outstanding experimental set-up for laboratory astrochemistry.

In the talk the measurements from the first four years of CSR operation will be reviewed, with an emphasis on the recent rotational-state resolved dissociative recombination studies [2].

[1] R. von Hahn et al. Rev. Sci. Instr. 87 063115 (2016)
[2] O. Novotny et al., Science 365, 676 (2019)

MS 2.2 Mon 14:30 f128

Electron-impact rotational de-excitation of CH^+ molecules — •Á Kálosi[1], K. Blaum[1], S. George[1,2], J. Göck[1], M. Grieser[1], F. Grussie[1], R. von Hahn[1], N. Jain[1], C. Krantz[1], H. Kreckel[1], C. Meyer[1], D. Müll[1], O. Novotný[1], F. Nuesslein[1], D. Paul[1], S. Saurabh[1], D. W. Savin[3], V. C. Schmidt[1], P. Wilhelm[1], and A. Wolf[1] — [1]Max Planck Institute for Nuclear Physics, Heidelberg, Germany — [2]University of Greifswald, Germany — [3]Columbia University, New York, NY, USA

Hydrides are the first molecules to form in the interstellar medium due to the abundance of hydrogen. The CH^+ ion was the first molecular cation identified in the interstellar medium. Interpretation of the observed spectrum relies, in part on radiative transfer models built on a knowledge of all the relevant excitation and de-excitation processes, such as inelastic collisions with electrons. Here we present merged beams experiments of CH^+ ions with the recently implemented electron cooler at the Cryogenic Storage Ring (CSR) in Heidelberg. This experimental setup facilitates low (meV) collision energy measurements to study inelastic electron-ion collisions. We combined the collision measurements with near-threshold photodissociation to directly probe the populations of the lowest rotational states of the stored CH^+ beam. Using a velocity-matched or slightly detuned electron beam, we can for the first time experimentally determine electron-impact rotational excitation and de-excitation rates for CH^+. Here we will present preliminary results.

MS 2.3 Mon 14:45 f128

Metastable states of the silicon anion observed in a cryogenic storage ring — •D. Müll[1], K. Blaum[1], S. George[1,2], M. Grieser[1], F. Grussie[1], E.A. Guerin[1], J. Göck[1], R. von Hahn[1], N. Jain[1], Á. Kálosi[1], C. Krantz[1], H. Kreckel[1], O. Novotný[1], F. Nuesslein[1], D. Paul[1], S. Saurabh[1], C. Schumacher[1], V. Schmidt[1], S. Sunil Kumar[1], X. Urbain[3], P. Wilhelm[1], A. Wolf[1], and A. Znotins[1] — [1]Max-Planck-Institut für Kernphysik, Heidelberg, Germany — [2]Institut für Physik, Ernst-Moritz-Arndt Universität Greifswald, Germany — [3]Institute of Condensed Matter and Nanosciences, Université Catholique de Louvain, Louvain-la-Neuve B-1348, Belgium

We have used the Cryogenic Storage Ring (CSR) at the Max Planck Institute for Nuclear Physics to study the metastable states of the silicon anion. We stored fast Si^- ions (58 keV kinetic energy) in the ultra-high cryogenic vacuum of the CSR, using only electrostatic deflection elements. We used several continuous wave laser systems at 633 nm, 980 nm, 1064 nm, 1390 nm and 2700 nm as well as a tunable pulsed optical parametric oscillator to obtain information about the decay of the metastable anionic states by selective photodetachment. Our data shows evidence for the existence of an extremely long-lived metastable state with a lifetime of several hours and of another very weakly-bound metastable state with a lifetime of around 20 s. We compare our results to state-of-the-art calculations of Si^- metastable lifetimes, which show considerable differences in the predicted time constants.

MS 2.4 Mon 15:00 f128

MOCCA: operating a full 4k-pixel molecule camera for the position and energy resolved detection of neutral molecular fragments — •Lisa Gamer[1], Steffen Allgeier[1], Christian Enss[1], Andreas Fleischmann[1], Loredana Gastaldo[1], Julia Hauer[1], Sebastian Kempf[1], Oldřich Novotný[2], Dennis Schulz[1], Sebastian Spaniol[2], and Andreas Wolf[2] — [1]Kirchhoff-

Institute for Physics, Heidelberg University — [2]Max-Planck-Institute for Nuclear Physics, Heidelberg

The MOCCA detector is a high-resolution, large-area molecule camera based on metallic magnetic calorimeters and read out with SQUIDs that has the ability to detect neutral molecule fragments with keV kinetic energies. MOCCA is an array of 64 × 64 quadratic pixels with a side length of 700 μm and covers a total detection area of 4.5 cm × 4.5 cm with a filling factor of 99.5 %. It will be deployed at the Cryogenic Storage Ring CSR at the Max Planck Institute for Nuclear Physics in Heidelberg, a storage ring built to prepare and store molecular ions in their rotational and vibrational ground states, enabling studies on electron-ion interactions. To reconstruct the reaction kinematics, MOCCA is able to measure the energy and position of multiple incident particles hitting the detector simultaneously.

We present the fabrication of Through-Wafer Vias together with new measurements of a full-scale MOCCA detector, demonstrating the readout principle, multi-hit capability, and energy resolution of less than 200 eV, combined with a very low cross-talk between pixels.

MS 3: New Developments and Techniques

Time: Monday 15:15–16:00 Location: f128

MS 3.1 Mon 15:15 f128

Generation and detection of mass-selected neutral polypeptide beams — Jonas Schätti[2], Moritz Kriegleder[1], Maxime Debiossac[1], Michael Kerschbaum[1], •Marcel Strauss[1], Philipp Geyer[1], Marcel Mayor[2,3], Valentin Köhler[2], and Markus Arndt[1] — [1]Faculty of Physics, University Vienna — [2]Department of Chemistry, University Basel — [3]Institute of Nanotechnology, Karlsruhe Institute of Technology

Studies of biomolecules in the gas phase have attracted increasing interest because they allow elucidating the relative influence of the solvent shell or the determination of molecular polarizabilities, which are challenging to measure on ionic species. Here we report on novel concepts for the generation and detection of neutral polypeptide beams. For the preparation of neutral biomolecular beams we have designed and synthesized photocleavable subunits that can be generically labelled to peptides and proteins and allow us to gain control over the molecular charge state in high vacuum, using intense laser light. We demonstrate site-specific photo-activated cleavage neutralization in the gas phase, with high spatial control and precise timing for polypeptides even up to insulin [1]. While neutral biomolecules may be detected by a second photocleavage stage for post-ionization, we discuss new realizations of superconducting nanowire devices (SNWD) as detectors for slow ions and even neutral particles.

[1] Schätti et al., Chem. Commun. 55, 12507(2019)

MS 3.2 Mon 15:30 f128

Towards Ion Mobility Measurements of Actinides — •Elisabeth Rickert[1,2], Hartmut Backe[2], Michael Block[1,2,3], Christoph E. Düllmann[1,2,3], Mustapha Laatiaoui[1,2], Werner Lauth[2], Sebastian Raeder[1,3], Fabian Schneider[1,2], and Jonas Schneider[1,2] — [1]Helmholtz-Institut Mainz — [2]Johannes Gutenberg-Universität Mainz — [3]GSI Helmholtzzentrum für Schwerionenforschung GmbH

Relativistic effects strongly influence the chemical and physical properties of the heaviest elements, which can significantly differ from the periodicity displayed by the periodic table of elements. Previous systematic mobility measurements on monoatomic lanthanide ions revealed the dependence of ion-atom interactions on the underlying electronic configuration and helped to investigate the aforementioned effects. Presently, the measurements are being extended to the actinides, where larger deviations from periodicity are expected. In this contribution, experimental approach, first results, and future plans are presented.

MS 3.3 Mon 15:45 f128

A cryogenic drift cell setup for ion mobility measurements in the actinides — •Jonas Schneider[1,2], Hartmut Backe[1], Michael Block[1,2,3], Christoph E. Düllmann[1,2,3], Mustapha Laatiaoui[1,2], Werner Lauth[1], Steffen Lohse[2], Sebastian Raeder[2,3], Elisabeth Rickert[2,3], and Fabian Schneider[1,2] — [1]Johannes Gutenberg-Universität, Mainz — [2]Helmholtz-Institut, Mainz — [3]GSI Helmholtzzentrum für Schwerionenforschung mbH, Darmstadt

Ion mobility spectrometry is a powerful tool to get insights on the ion-atom interaction potential by measuring the drift time of ions through a gas atmosphere. The potential is highly influenced by the atom's electronic configuration and subject to increasingly stronger relativistic effects with increasing atomic number Z. A cryogenic drift cell is currently under development to improve the capabilities of the existing ion mobility spectrometer [Laatiaoui et al. EPJD 66 (2012) 232] and to enable measurements over a large temperature and pressure range of the buffer gas in the region of the transuranium elements ($Z > 92$). To achieve optimal transmission rates for the design, extensive ion trajectory simulations for the cell and surrounding radiofrequency quadrupole structures were carried out using the SIMION software package. Results from these simulations as well as the current status will be discussed.

MS 4: Clusters and Molecules

Time: Tuesday 14:00–15:15 Location: f128

Invited Talk MS 4.1 Tue 14:00 f128

Multi-reflection time-of-flight mass spectrometry for cluster research — •Paul Fischer, Gerrit Marx, and Lutz Schweikhard — Institut für Physik, Universität Greifswald, 17487 Greifswald, Germany

Multi-reflection time-of-flight mass spectrometry (MR-ToF MS) is known as a powerful tool for precision mass measurements [1] and high-resolution isobar separation [2] in nuclear physics. In atomic and molecular physics, MR-ToF devices are appreciated for their characteristics as electrostatic ion traps [3], however, they are often operated in non-bunching mode, abandoning high resolving powers in favor of easier interaction prerequisites.

At the University of Greifswald, MR-ToF MS is applied for high-resolution investigations of atomic clusters. To this end, a series of techniques for the work with ion bunches exhibiting large mass differences is developed. This includes in-trap photodissociation [4] and the introduction of a novel tandem MR-ToF MS scheme [5]. As a first case of interest, the dissociation behavior of bismuth clusters and the change thereof resulting from doping with a single lead atom is investigated.

[1] F. Wienholtz et al., Nature 498:346 (2013)
[2] R.N. Wolf at al., Phys. Rev. Lett. 110:041101 (2013)
[3] D. Zajfman et al., Phys. Rev. A 55:R1577 (1997)
[3] P. Fischer at al., Eur. Phys. J. D 73:105 (2019)
[5] P. Fischer at al., Phys. Rev. Research 1:033050 (2019)

MS 4.2 Tue 14:30 f128

Nitrophobia of size selected iron clusters under cryo conditions — •Annika Steiner[1], Christopher Wiehn[1], Matthias P. Klein[1], Daniela V. Fries[1], Peter B. Armentrout[2], and Gereon Niedner-Schatteburg[1] — [1]Fachbereich Chemie and Forschungszentrum OPTIMAS, Technische Universität Kaiserslautern, 67663 Kaiserslautern, Germany — [2]Department of Chemistry, University of Utah, Salt Lake City, Utah 84112, USA

We utilize a modified FT-ICR MS to characterize the interaction of N_2 with transition metal surfaces and clusters in detail. With this tandem cryo trap (T<11 K) instrument we have investigated the N_2 adsorption on Co, Ni, Rh and N_2 and H_2 co-adsorption on Ru_8^+.

In continuation of these studies, we conduct investigations of N_2 adsorption on Fe_n^+ clusters. We investigate kinetic studies of N_2 adsorption and found size and pressure dependent effects. Thereby, we unravel otherwise unpredictable cluster size effects as e.g. very slow N_2 adsorption on Fe_{17}^+, and an isomerism of the Fe_{18}^+ cluster.

Furthermore, we present gas phase IR spectra of N_2 adsorption on isolated Fe_n^+ clusters at cryo temperatures. The complex variations in terms of single or multiple IR active N_2 stretching bands are significantly red shifted with respect to the IR inactive stretching mode of free N_2 (2330 cm^{-1}). Based on this we compare the IR spectra of the "normal" Fe_{13}^+ cluster with those of the nitrophobic Fe_{17}^+ cluster. In combination with DFT studies, we try to interpret these size effects in terms of size dependent spin repulsion and to unravel cluster morphologies in more detail.

MS 4.3 Tue 14:45 f128

A gas-phase soft X-ray study on the metal active site of metalloporphyrins and metalloproteins — •Kaja Schubert[1], Kaan Atak[1], Lucas Schwob[1], Simon Dörner[1], Martin Timm[2], Christine Bülow[2], Vicente Zamudio-Bayer[2], Xin Wang[3], Tobias Lau[2], Thomas Schlathölter[3], and Sadia Bari[1] — [1]Deutsches Elektronen-Synchrotron, Hamburg — [2]Institut für Methoden und Instrumentierung der Forschung mit Synchrotronstrahlung, Helmholtz Zentrum Berlin für Materialien und Energie, Berlin — [3]Zernike Institute for Advanced Materials, University of Groningen, Groningen

Metalloporphyrins (MPs) are organometallic molecules widely found in nature and composed of a porphyrin ring coordinating a metal ion in the ring's cavity center. Their particular electronic structure makes MPs ideally suited for a number of applications, from biological functions to the usage in electronic devices. Electronic structure and functional activity of MPs are determined by the type of the metal, its oxidation and spin state as well as axial ligands around the metal center. For understanding the properties of MPs, it is hence of great importance to probe the local electronic sturcture of the metal ion. In this study electrospray ionization (ESI) tandem mass-spectrometry and synchrotron-based light were combined and site-selective excitation at the metal L-absorption edges was used for probing the metal site of several MPs. Similar measurements were performed for the MP-containing protein cytochrome c (12.4 kDa).

MS 4.4 Tue 15:00 f128

Dissociative Electron Attachment Studies with 2-Nitrofuran — •Muhammad Saqib, Eugene Arthur-Baidoo, Milan Oncak, and Stephan Denifl — University of Innsbruck ,6020 Innsbruck, Austria

Nitrofurans belong to the class of drugs typically used as antibiotics or antimicrobials. The defining structural component is a furan ring with a nitro group attached. In the present investigation, dissociative electron attachment (DEA) to 2-Nitrofuran (C4H3NO3), which is considered as a potential radiosensitizer candidate for application in radiotherapy, has been studied in a crossed electron*molecular beams experiment. The present results indicate that low-energy electrons with kinetic energies from about 0 - 14 eV effectively decompose the molecule by DEA. In total, fifteen fragment anions were detected within the detection limit of the apparatus, as well as the parent anion of 2-Nitrofuran. Two major resonance regions, at which the anions are formed, are observed, one between ~0 eV and 5 eV and a second one in the range from 7 eV to 10 eV. (NO2)-, (C4H3O)-, and (C4H3NO3)- is the most abundant fragment anion observed. The experimental results are compared with calculations of the thermochemical thresholds of the anions observed. The current study shows that low-energy electrons very effectively decompose the 2-Nitrofuran molecule upon attachment of low energy electrons, producing a large variety of charged fragments and radicals. This work was supported by the FWF, Vienna (P30332).

MS 5: Precision Mass Spectrometry II

Time: Tuesday 15:15–16:00 Location: f128

Invited Talk MS 5.1 Tue 15:15 f128

Experiments with multiple-reflection time-of-flight mass spectrometers (MR-TOF-MS) at TRIUMF and GSI/FAIR — •Christine Hornung[1], the FRS Ion Catcher Collaboration[1,2], and the TITAN Collaboration[3] — [1]II. Physikalisches Institut, Justus-Liebig-Universität Gießen, Gießen, Germany — [2]GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany — [3]TRIUMF, Vancouver, Canada

At the JLU Giessen, MR-TOF-MS have been developed for the TITAN experiment at TRIUMF and for the FRS/Super-FRS at GSI/FAIR. 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 $6 \cdot 10^{-8}$ and a background suppression of grater than 7 orders of magnitude. Mass measurements of neutron-deficient Yb and Tm isotopes have been performed across the $N = 82$ shell closure using TITAN's MR-TOF-MS. With the MR-TOF-MS of the FRS Ion Catcher at the FRS the masses of neutron-deficient ^{124}Xe projectile fragments in the vicinity of ^{100}Sn have been measured, including the ^{101}In ground state. Two new isomeric states have been discovered in ^{97}Ag and ^{101}In. A novel method for the measurement of half-lives and decay branching ratios with the FRS Ion Catcher has been developed and experimentally applied.

MS 5.2 Tue 15:45 f128

High-precision mass spectrometry of superheavy elements at SHIPTRAP: latest experiments, status and performances of the setup. — •Pierre Chauveau for the SHIPTRAP collaboration[1,2], Brankica Andelić[1,3], Olesya Bezrodnova[4,5], Klaus Blaum[6], Michael Block[1,2,7], Stanislav Chenmarev[5,7], Premaditya Chhetri[1,2], Christoph E. Düllmann[1,2,7], Martin Eibach[2,8], Julia Even[3], Sergey Eliseev[6], Pavel Filianin[6], Francesca Giacoppo[1,2], Stefan Götz[1,2,7], Manuel Gutiérrez[9], Frank Herfurth[2], Fritz-Peter Hessberger[1,2], Nasser Kalantar-Nayestanaki[3], Oliver Kaleja[2,6,7], Jadambaa Khuyagbaatar[1,2], Jacques J.W. van de Laar[1,7], Mustapha Laatiaoui[1], Steffen Lohse[1,7], Natalia Martynova[4,5], Enrique Minaya Ramirez[10], Andrew Mistry[1,2], Tobias Murböck[2], Yuri Novikov[4,5], Sebastian Raeder[2], Daniel Rodriguez[9], Fabian Schneider[1,7], Lutz Schweikhard[8], Peter Thirolf[11], and Alexander Yakushev[1,2] — [1]HI Mainz — [2]GSI Darmstadt — [3]Univ. Groningen — [4]SPbSU St. Petersburg — [5]PNPI KI Gatchina — [6]MPIK Heidelberg — [7]JGU Mainz — [8]Univ. Greifswald — [9]Univ. de Granada — [10]IPN Orsay — [11]LMU München

Mass measurements in the very heavy and superheavy regions of the nuclear chart are crucial to understand the increased stability of certain superheavy elements and can be used as anchor points for nuclear models attempting to pinpoint the position of the island of stability. In the latest experimental campaigns with the SHIPTRAP setup, ground states masses and excitation energies of low-lying isomers in nobelium ($Z = 102$), lawrencium ($Z = 103$) and rutherfordium ($Z = 104$) isotopes have been measured with very high accuracy. The Phase-Imaging Ion-Cyclotron-Resonance technique has been successfully applied for such challenging measurements characterized by the very low ion production rate and number of collected events. These results have been accomplished thanks to careful investigations and improvements of the efficiency of the SHIPTRAP setup, paving the way for the first direct high-precision mass spectrometry of even heavier and more exotic nuclides, including dubnium ($Z = 105$) isotopes. In this contribution, an overview on the efficiency of the setup as well as a summary of recent experimental campaigns will be given.

MS 6: Lunch talk: German Research Foundation (DFG) (joint session A/K/P/MO/MS/Q)

Time: Wednesday 13:10–13:55 Location: f303

Lunch Talk MS 6.1 Wed 13:10 f303

Funding by the German Research Foundation (DFG) – a brief overview — •Andreas Deschner — Deutsche Forschungsgemeinschaft (DFG), Kennedyallee 40, 53175 Bonn, Germany

During the last 100 years, the German Research Foundation (DFG) and its predecessors have been funding research in Germany. Today, the DFG is the central third party funding organization for basic research in Germany. It offers a broad spectrum of funding opportunities from individual grants to larger coordinated programs.

This talk will give a brief outline of the financial framework, the decision-making processes and the funding portfolio of the DFG. I will mostly focus on the different programs that offer support to early career scientists, e.g. the new Walter Benjamin for postdoctoral positions and the Emmy Noether program for junior research groups.

MS 7: Laser-SNMS

Time: Wednesday 14:00–14:30 Location: f128

Invited Talk MS 7.1 Wed 14:00 f128

Spatially resolved ultra-trace analysis of actinides on hot particles by resonant laser-SNMS — •Hauke Bosco[1], Martin Weiss[1], Manuel Raiwa[1], Nina Kneip[2], Klaus Wendt[2], and Clemens Walther[1] — [1]Institute of Radioecology and Radiation Protection, Leibniz University Hannover — [2]Institute of Physics, Johannes Gutenberg-University Mainz

A titanium:sapphire resonance excitation laser system for element selective ionization of sputtered neutrals has been linked to a commercial TOF-SIMS for spatially resolved ultra-trace isotope detection [1]. The system allows analysis of stable and radioactive isotope ratios with 70nm spatial resolution. Synthetic as well as environmental samples are measured on either conducting or non-conducting samples. As an example, investigations of hot particles from the Chernobyl exclusion zone will be presented and discussed with respect to isotopic ratios of uranium, plutonium, americium and strontium. By suppression of isobaric interferences minor acitinide isotopes on the scale of a few fg were detected within the analyzed fuel matrix. Additionally, Pu-238 was unambiguously identified despite five orders of magnitude of U-238 isobaric contamination. Ongoing excitation scheme development, influences of the plutonium hyperfine structure on the resulting isotope signal and single particle analysis will be presented as a part of the BMBF funded project SIRIUS.

[1] Franzmann et al., Resonant laser-SNMS for spatially resolved and element selective ultra-trace analysis of radionuclides, JAAS 2018

MS 8: Accelerator Mass Spectrometry and Applications I

Time: Wednesday 14:30–16:00 Location: f128

Invited Talk MS 8.1 Wed 14:30 f128

The new compact, multi isotope AMS system (MILEA) at ETH Zurich - performance and applications — •Marcus Christl[1], Sascha Maxeiner[2], Arnold Milenko Müller[2], Philip Gautschi[1], Christof Vockenhuber[1], Maxi Castrillejo[1], Nuria Casacuberta[1], and Hans-Arno Synal[1] — [1]Laboratory of Ion Beam Physics, ETH Zurich, Switzerland — [2]Ionplus AG, Dietikon, Switzerland

The prototype version of a new, compact, multi-isotope, low energy accelerator mass spectrometry system (MILEA) was built in collaboration with Ionplus AG and set into operation at ETH Zurich in 2018. The system is based on a 300 kV power supply and was optimized for small footprint (3.5 x 7 m^2) and to reach optimal performance for ^{10}Be, ^{14}C, ^{26}Al, ^{129}I, and actinide measurements at low energies. During the past year the system was thoroughly tested and is now starting to be used for routine AMS operations. In the first part of the presentation, the layout of the system, its ion optical properties and the setup for the different nuclides will be presented. The performance of the system with respect to ion currents, over-all transmission and background will be discussed for the different nuclides. In the second part of the talk most recent results of our actinide and heavy ion program will be presented. The results include some new data measured on MILEA which shows superior performance compared to our 500 kV Tandy system. In the application part new data from the distribution of ^{236}U and ^{129}I in the ocean as well as a ^{236}U/^{238}U record from sea shells from the Northeast Atlantic Ocean will be presented.

MS 8.2 Wed 15:00 f128

Increased ionization efficiency for the detection of ^{236}U and ^{233}U by AMS — •Michael Kern, Karin Hain, Maki Honda, Peter Steier, Andreas Wiederin, and Robin Golser — University of Vienna, Faculty of Physics - Isotope Physics, Austria

The ^{233}U/^{236}U ratio is a promising method for contamination source assessment. The detection of ^{233}U is most critical due to its abundance ranging below 10^{-12}, where the Vienna Environmental Research Accelerator (VERA) is to date the only instrument delivering sufficient detection efficiency for routine measurements of environmental samples. The ionization efficiency is the main limiting factor ($\approx 10^{-4}$). Introduction of a new preparation method for samples containing $\approx 5\,\mu$g U extracted as UF_5^- within PbF_2 + Fe_2O_3 matrix instead of UO^- sputtered from Fe_2O_3 yields a strong improvement in detection efficiency by up to a factor 10. Thus substantially shortened measurement duration could be obtained, while maintaining the same statistical uncertainty. We also succeeded in further cutting down hydrides of highly abundant adjacent masses ($^{232}ThH^{3+}$, $^{235}UH^{3+}$) at lower He stripper gas pressure, which results in a further improvement of efficiency. This presentation will give detailed insights on the new sample preparation as well as ion current characteristics and method verification.

MS 8.3 Wed 15:15 f128

The difficulty to measure the neutron capture cross section of ^{235}U at thermal energies — Anton Wallner[1,2], Peter Schillebeeckx[3], Stefaan Pomme[4], Jan Wagemans[4], Jan Heyse[3], Roberto Capote[5], Michaela Froehlich[2], Peter Steier[6], Zsolt Revay[7], Christian Stieghorst[7], Ulli Koester[8], Thorsten Soldner[8], and •Tobias Jenke[8] — [1]Helmholtz-Zentrum Dresden-Rossendorf, 01328 Dresden, Germany — [2]The Australian National University, Canberra, Australia — [3]JRC-Geel, Retieseweg 111 B-2440 Geel, Belgium — [4]SCK CEN, Mol, Belgium — [5]Nuclear Data Section, IAEA, Vienna — [6]VERA laboratory, Univ. of Vienna, Austria — [7]FRM II, TU Munich, Germany — [8]Institut Laue-Langevin, Grenoble, France

The recommended *highly precise* cross-section value for ^{235}U neutron-capture at thermal energies is largely based on the difference from total and competing cross-sections of ^{235}U. Despite its importance and high value (100 barn), direct measurements of (n,γ) are rare (only two exist for thermal energies) and exhibit large uncertainties. The reason is the difficulty to measure the characteristic radiation of the reaction product ^{236}U within a dominant fission background (^{236}U has a long half-life of 23.4 Myr).

For this reasons, we started a project with a new method utilizing different neutron fields to evaluate its energy dependence in the low energy region. We use a combination of neutron activation and subsequent accelerator-mass-spectrometry (AMS) for direct atom counting of the reaction product ^{236}U.

MS 8.4 Wed 15:30 f128

Application of AMS to the research on nuclear waste disposal safety — •Francesca Quinto[1], Ingo Blechschmidt[2], Thomas Faestermann[3], Karin Hain[4], Dominik Koll[3], Gunther Korschinek[3], Stephanie Kraft[1], Johanna Pitters[4], Markus Plaschke[1], Georg Rugel[5], Thorsten Schäfer[6], Peter Steier[4], and Horst Geckeis[1] — [1]Karlsruhe Institute of Technology, Germany — [2]National Cooperative for the Disposal of Radioactive Waste, Switzerland — [3]Technical University of Munich, Germany — [4]University of Vienna, Austria — [5]Helmholtz-Zentrum Dresden-Rossendorf, Germany — [6]Friedrich-Schiller-University, Jena, Germany

At the Grimsel Test Site (Switzerland), several in situ tracer tests aim at studying the possible radionuclide release from the bentonite engineered barrier system and the processes which may lead to their subsequent migration though the granodiorite host rock. We investigate the diffusion of Tc-99 and actinides (AN) through the bentonite and the remobilization over a time period of several years of the AN tracers employed in previous in situ tests. AMS is the ultra-trace analysis method of choice for studying the behaviour of Tc-99 and AN with concentration at and below fg/g levels in such dedicated long-term in situ tests, providing results that contribute to the safety evaluation of future nuclear waste repositories.

MS 8.5 Wed 15:45 f128

Ultra-trace Detection of ^{99}Tc in Environmental Samples by Accelerator Mass Spectrometry — •Johanna Pitters[1,2], Thomas Faestermann[3], Fadime Gülce[1], Karin Hain[1], Dominik Koll[3,4], Gunther Korschinek[3], Martin Martschini[1], Francesca Quinto[5], Georg Rugel[6], and Robin Golser[1] — [1]University of Vienna, Isotope Physics, Austria — [2]Vienna Doctoral School in Physics, Austria — [3]Technical University of Munich, Germany — [4]The Australian National University, Australia — [5]Karlsruhe Institute of Technology, Germany — [6]Helmholtz-Zentrum Dresden-Rossendorf, Germany

In our project we are developing methods for the detection of the anthropogenic radionuclide 99-Technetium by Accelerator Mass Spectrometry (AMS). For environmental samples, a highly effective chemical sample preparation method was developed, that removes a large fraction of the interfering elements Ruthenium and Molybdenum and embeds the Tc in a Niobium matrix. The samples were measured at the AMS setup of the Maier-Leibnitz-Laboratory in Munich by extraction of $^{99}TcO^-$ from the ion source, stripping to $^{99}Tc^{12+}$ and normalizing to the $^{93}Nb^{11+}$ current. A particle energy of 150 MeV in combination with the detection via a Time-of-Flight path and the Gas-filled Analyzing Magnet System (GAMS) allows for a sensitivity of $5{\cdot}10^6$ atoms per sample. The method is discussed together with results from environmental samples. In particular, ^{99}Tc concentrations along a water column from the Pacific Ocean, as well as in porewater from an Austrian peat-bog are presented.

MS 9: Mass Spectrometry Posters

Time: Wednesday 16:30–18:30 Location: Empore Lichthof

MS 9.1 Wed 16:30 Empore Lichthof

LIONTRAP - A High-Precision Mass Spectrometer — Sascha Rau[1], Sangeetha Sasidharan[1], Fabian Heisse[1], •Florian Köhler-Langes[1], Wolfgang Quint[2], Sven Sturm[1], and Klaus Blaum[1] — [1]Max-Planck-Institut für Kernphysik, Heidelberg, Germany — [2]GSI-Helmholtzzentrum für Schwerionenforschung Darmstadt, Germany

The precise knowledge of the atomic masses of various light nuclei, e.g. of the proton, deuteron, helion and triton, is of great importance for several tests of fundamental physics. For example, the mass of the proton is an important input parameter for hydrogen spectroscopy. Furthermore, an essential consistency check of the KATRIN experiment will require an ultra-precise measurement of the mass difference of triton and helion on a so far unrivalled level of precision of 30 meV/c^2. However, five sigma discrepancies between high-precision measurements of these light nuclear masses question their current literature values. They give strong motivation for a new and independent experiment, the LIONTRAP (Light ION TRAP) apparatus [1], aiming for relative uncertainties of a few parts per trillion. Several setup highlights like the doubly compensated Penning trap, an in-situ B_2 shim coil, various precisely tuned detection systems and an online-tunable trap tilt are presented on the poster. Furthermore, the proton mass campaign ($\delta m_p/m_p = 3 \cdot 10^{-11}$) [2], the current measurement campaign on deuteron and future plans on the helion and triton masses are explained. [1] F. Heiße et al., Phys. Rev. A 100, 022518 (2019) [2] F. Heiße et al., Phys. Rev. Lett. 119, 033001 (2017)

MS 9.2 Wed 16:30 Empore Lichthof

Latest results of the high-precision Penning-trap mass spectrometer Pentatrap — •M. Door[1], J. R. Crespo López-Urrutia[1], P. Filianin[1], W. Huang[1], C. M. König[1], K. Kromer[1], Y. Novikov[2], A. Rischka[1], R. X. Schüssler[1], Ch. Schweiger[1], S. Sturm[1], S. Ulmer[3], S. Eliseev[1], and K. Blaum[1] — [1]Max-Planck-Institut für Kernphysik, Heidelberg, Germany — [2]Peterburg Nuclear Physics Institute, Gatchina, Russia — [3]RIKEN, Fundamental Symmetries Laboratory, Saitama, Japan

The Penning-trap mass spectrometer Pentatrap [1] located at the Max-Planck-Institut für Kernphysik in Heidelberg recently proved its capabilities performing first mass-ratio measurements with a relative uncertainty in the 10^{-11} regime using highly charged ions of stable xenon isotopes [2]. Pentatrap will continue with mass measurements of dedicated nuclides which will allow, among others, to contribute to tests of special relativity, bound-state QED and neutrino-physics research. Achieving this level of precision requires using a cryogenic detection system with single ion sensitivity and phase sensitive image-current detection methods in combination with highly charged ions provided by external ion sources. A unique feature of Pentatrap is the suppression of systematic uncertainties by performing simultaneous measurements in two adjacent traps, which, according to our latest tests, are subject to equal fluctuations of the magnetic field.

[1] Repp, J. et al., Appl. Phys. B 107, 983 (2012)
[2] Rischka, A. et al., Phys. Rev. Lett., submitted (2020).

MS 9.3 Wed 16:30 Empore Lichthof

High-current caesium sputter ion source with planar ionizer for accelerator mass spectrometry — •Dimitar Yordanov[1], Hans Hofsäss[1], Georg Rugel[2], Shavkat Akhmadaliev[2], Johannes von Borany[2], Stefan Facsko[2], and Jenny Feige[3] — [1]University of Göttingen, Göttingen, Germany — [2]Institute of Ion Beam Physics and Material Research, Helmholz-Zentrum Dresden Rossendorf, Germany — [3]Technical University of Berlin, Berlin, Germany

A new caesium sputter negative ion source with planar ionizer for Accelerator Mass Spectrometry (AMS) is being built, regarding quantifying the ratios of long-lived cosmogenic radionuclides in micrometeorites. The focus of the ion source is on an optimal ion-optics design, together with a realization of new concepts for the construction and function of the ionizer, with the possibility of the precise in-situ adjustment of the ion-optical components, and optimization of the caesium ion beam and ion transport. In addition, the source is designed for operation with higher cathode voltage (up to 20 kV), which aims to increase the sputter rate of the sample, and in turn to increase the extracted negative current. Higher ion currents and better ion yields mean shorter measuring times, higher precision due to higher counting statistics and/or higher throughput of samples in an AMS runs.

The authors would like to thank the Federal Ministry of Education and Research of Germany for its financial support (project 05K2016), and the HZDR's Ion Beam Center for its essential contribution to the realization of this project.

MS 9.4 Wed 16:30 Empore Lichthof

Gas filled magnet for isobar separation for use with a 5.0 MV Tandetron AMS system — •Matthias Klein, Dirk Mous, Nicolae Podaru, and Guillermo Dominguez — High Voltage Engineering Europa B.V., Amersfoort, The Netherlands

AMS Measurements of 26Al are presently done using Al- extraction from the ion source at the 5.0 MV Tandetron AMS system at CEREGE, France. Extraction of AlO- increases the usable source out-

put by about an order of magnitude, allowing a higher measurement throughput. However, isobaric 26Mg from MgO- injection forms an interference that must be reduced for avoiding overload of the final detector. For this purpose, a gas-filled magnet (GFM) will be connected to the existing high-energy spectrometer. It separates Al and Mg ions based on their different characteristics regarding average charge state and energy loss. The mass-energy product of the GFM is sufficiently high for supporting measurements of 36Cl and reduction of 36S as well. The magnet is followed directly by a multi-anode gas ionization chamber with a large entrance window, allowing as much as possible of the Al beam which has increased in size due to angular straggling by passage through the gas. In this contribution we will present the design and the specification details of this GFM detection system.

MS 9.5 Wed 16:30 Empore Lichthof

Design of an isotope separator for target production — •Dominik Studer[1], Rugard Dressler[2], Ulli Köster[3], Dorothea Schumann[2], and Klaus Wendt[1] — [1]JGU Mainz — [2]PSI Villigen — [3]ILL Grenoble

With the rising demand for isotopically pure targets for the study of specific nuclear reactions, the construction of a high-throughput isotope separator is foreseen within the SANDA project. Specifically the handling and purification of radioisotopes is mandatory and will be enabled by installation of the whole setup within a radiologically supervised working area in close contact to a hot lab. In the current project phase the design of the apparatus and establishment of a suitable commissioning site, located at PSI, is planned. The design will be derived from experiences with the RISIKO isotope separator at Mainz University, which has been successfully used for radioisotope purification and implantation, e.g. within the ECHo project. It features a hot-cavity laser ion source. The laser system is based upon tunable pulsed Ti:sapphire lasers with high repetition-rate. Ion extraction from the source region with about 30 to 50 kV, electrostatic beam focussing and separation with a conventional double focussing sector field magnet seem most suitable for the task. After passing the separation slit, the ion beam can be re-focused to well below mm size for implantation into detectors, collectors or targets with sub mm control and resolution. In this contribution we present the principles, capabilities and limitations of the RISIKO separator with regard to improvements which can be implemented in the new SANDA isotope separator.

MS 9.6 Wed 16:30 Empore Lichthof

Studies of lanthanide desorption for laser spectroscopic investigations of the heaviest actinides — •Sebastian Raeder[1,2], Michael Block[1,2,3], Premaditya Chhetri[1,2], Katherine Diaz[1], Francesca Giacoppo[1,2], Mustapha Laatiaoui[1,3], and Tobias Murböck[1,4] — [1]HI Mainz — [2]GSI, Darmstadt — [3]JGU Mainz — [4]TRIUMF, Vancouver

Laser spectroscopic investigations on the heaviest elements allow for a deeper understanding of fundamental atomic and nuclear properties. Due to relativistic effects on the atomic electron shell, the configuration of the atomic ground state , for instance, may differ for an element with respect to its lighter homologue, like in element 103, lawrencium. Only precise determination of the first ionization potential or a hyperfine structure measurement will help to unambiguously characterize the atomic ground state.
The sensitive RAdiation Detected Resonance Ionization Spectroscopy (RADRIS) technique allowed studying the element nobelium (No, Z=102), the only element with Z>100 for which atomic spectroscopy was performed to date. Crucially, the RADRIS technique relies on a fast and complete desorption of collected atoms from a catcher filament. Therefore an off-line mass spectrometry setup was developed to study the desorption behaviour of lutetium, the isolectronic homologue of Lr, from different filament materials as well as the competing process of surface ionization. In this contribution, first results of theses desorption studies will be presented along with the prospects of laser-spectroscopic investigations on lawrencium.

MS 9.7 Wed 16:30 Empore Lichthof

Mapping of elements in various environmental matrices with LA-ICP-QQQ-MS — •Dorian Zok, Anica Weller, and Georg Steinhauser — Leibniz University Hannover - Institute of Radioecology and Radiation Protection

We coupled our triple quadrupole ICP-mass spectrometer with a nanosecond laser ablation unit for the mapping of various elements. This coupling has the offers spatial resolution of the concentrations over the entire sample area. In this study, natural inorganic stromatolites as well as organic sample matrices such as carrot plants and shitake mushrooms were investigated. Stromatolites as biogenic rocks can be used as monitor for marine changes in a long time history. We analysed the deposition of nearly 20 main and rare earth elements in the thin layer structure of this rocks. We observed a correlation between some collectively deposited elements within the different layers. Mass ratios were semi-quantified by the NIST 610 glass standard and in the range of ppm for the rare earth elements. The carrot plants and shitake mushrooms were selected due to their importance in the human diet. Carrots were spiked with high activities of long-lived Tc-99, and mushrooms with Cs-137 and Ag-108m. Both matrices have effectively incooperated the anthropogenic radionuclides into their compartments due to the signals inside of the cross section. We successfully coupled both laser ablation and MS units and measured various kinds of matrices. In the future, we want to extend this to the build-in reaction cell of the mass spectrometer to improve the system for more difficult-to-measure elements/radionuclides.

MS 10: Accelerator Mass Spectrometry and Applications II

Time: Thursday 11:00–13:00 Location: f128

MS 10.1 Thu 11:00 f128

14C Datierungen im Zusammenhang mit einer Sarkophagöffnung in der Johanniskirche von Mainz — •Alfred Dewald[1], Alexander Stolz[1], Stefan Heinze[1], Janet Rethemeyer[1], Daniela Warock[2], Svetlana John[2], Ulrike Patt[2], Guido Faccani[3], Rüdiger Gogräfe[4], Carola Berszin[5], Anja Bayer[6] und Jutta Göpfrich[7] — [1]Inst. für Kernphysik, UzK — [2]Inst. für Gologie und Mineralogie, UzK — [3]arch. fab. et sculp. medial., Basel — [4]IBD Marburg/Lahn — [5]Anthr. Dienstl. Konstanz — [6]Abegg-Stiftung, Riggisberg — [7]Deut. Ledermuseum, Offenbach

Bei Grabungen in der Kirche St. Johannis in Mainz zog ein Sarkophag die Aufmerksamkeit der Archäologen auf sich, da vermutet wurde, dass hier der Erzbischof Erkanbald von Mainz bestattet sein könnte, dessen Grabstätte nicht bekannt war. Im Sarkophag fand man die Überreste eines in liturgischer Kleidung beigesetzten Mannes. Da der Leichnam mit Ätzkalk bedeckt worden war, waren die Knochen des Skeletts für eine Datierung unbrauchbar. Reste der textilen Bekleidung und der Lederschuhe des Toten konnten jedoch mit der 14C Methode datiert werden. Diese Messungen wurden am CologneAMS durchgeführt. Zusammen mit den Textilanalysen und anderen archäologischen Befunden, konnte der Schluss gezogen werden, dass es sich bei dem Bestatteten tatsächlich um Erzbischof Erkanbald gehandelt hat. In diesem Beitrag werden wir Einzelheiten der durchgeführten Untersuchungen vorstellen. Darüber hinaus werden wir die Datierung der Proben aus dem Sarkophag mit Datierungen von Proben aus der Umgebung des Sarkophags vergleichen.

MS 10.2 Thu 11:15 f128

Developments in the measurements of $^{14}CO_2$ samples at CologneAMS — •Alexander Stolz[1], Alfred Dewald[1], Stefan Heinze[1], Markus Schiffer[1], Susan Herb[1], Claus Müller-Gatermann[1], Gereon Hackenberg[1], Janet Rethemeyer[2], and Tibor Dunai[2] — [1]Institut für Kernphysik, Universität zu Köln — [2]Institut für Geologie und Mineralogie, Universität zu Köln

In this contribution we report on the status of the actual $^{14}CO_2$ system at CologneAMS, which consists of a second HVE SO-110 B ion source, a gas injection system from Ionplus AG and a EuroVector EA3000 elemental analyzer (EA). Recently a new isoprime precisION IRMS and a second EA from elementar were installed for the study of fractionation effects of our AMS system. Additionally, a second gas system for CO_2 EA measurements was developed and built. The new development was aimed for the measurements of samples with high ^{14}C concentrations (> 1e-11) by diluting the sample CO2 material with blank gas, in order to avoid contaminations of the equipment. We will report on the

routine performance of gas measurements and discuss first results of test runs with the new system.

MS 10.3 Thu 11:30 f128

On the behavior of ^{14}C in a radioactive waste repository — •Sönke Szidat[1], Gary Salazar[1], Typhaine L. M. Guillemot[2], Benjamin Z. Cvetković[2], Dominik Kunz[2], and Erich Wieland[2] — [1]University of Bern, Bern, Switzerland — [2]Paul Scherrer Institut (PSI), Villigen-PSI, Swizerland

Current strategies of the disposal of radioactive waste involve multi-barrier retaining in geological repositories in order to prevent the mobilization of long-lived radionuclides. ^{14}C has not been considered explicitly for a long time, as the risk emerging from its total activity, radiotoxicity and half-live is rather moderate compared to other components of the radioactive waste. However, the diversity of inorganic and organic carbon chemistry may challenge the effectiveness of state-of-the-art multi-barrier systems.

Most of the ^{14}C in low- and intermediate-level (L/ILW) radioactive waste from Switzerland originates from ^{14}C-containing irradiated steel. During anoxic corrosion of the steel, ^{14}C will be released in the near field of a cement-based L/ILW repository. In this work, we simulate these conditions in a corrosion experiment using irradiated steel from a nuclear power plant and trace ^{14}C-containing products with compound-specific radiocarbon analysis (CSRA). Dissolved carboxylic acids such as formic and acetic acid are separated with ion chromatography, whereas alkanes such as methane are isolated using gas chromatography. We report on the development of the analytical setup and the outcome of the first three years of the corrosion experiment.

MS 10.4 Thu 11:45 f128

Measurements of volatile radioactive isotopes in reactor graphite — •Timm-Florian Pabst, Gereon Hackenberg, Stefan Heinze, Susan Herb, Yannik Jakobi, Claus Müller-Gatermann, Markus Schiffer, Alexander Stolz, and Alfred Dewald — Institute for Nuclear Physics, University of Cologne, Germany

In order to determine the tritium concentration in reactor graphite samples, we expanded our ion source test bench. We added a 100 kV accelerator stage along with a 90° analyzing magnet and a silicon detector, with the aim to suppress the molecular background for tritium measurements.

Activated graphite from graphite moderated reactors contains volatile radioactive isotopes like ^{14}C, ^{36}Cl, or ^{3}H. For a final disposal of reactor graphite a quantitative characterization is needed.

We are aiming for a system which allows fully automated measurements of ^{14}C, ^{36}Cl and ^{3}H with a high sample throughput by using AMS techniques with gaseous samples. This will allow for an optimal handling of the nuclear waste, which has to be stored in disposal sites like e.g. Zeche Konrad.

In this contribution we will present the layout of our system as well as preliminary results of first test runs.

MS 10.5 Thu 12:00 f128

The status of the AMS device for medium mass isotopes at the Cologne University — •Susan Herb, Stefan Heinze, Markus Schiffer, Gereon Hackenberg, Claus Müller-Gatermann, Alexander Stolz, and Alfred Dewald — Institute of Nuclear Physics, University of Cologne, Cologne, Germany

In order to improve the features of the new mass spectrometer at the Cologne 10 MV FN accelerator we started a detailed investigation of the actual beam optics by installing beam profile monitors at four locations along the beamline. The beam path inside the gas-filled 135° bending magnet is inspected by use of multiple array of solar cells which were mounted at different angles of the magnet and moved along the focal plane. In addition it is intended to measure the flight time through the magnet by a MCP start detector in front and a Silicon detector after the magnet.

In this contribution we will report on the actual performance of the system and the results of the beam profile measurements.

MS 10.6 Thu 12:15 f128

Ion Laser Interaction Mass Spectrometry - status and prospects — •Martin Martschini[1], Johannes Lachner[1,2], Karin Hain[1], Oscar Marchhart[1], Johanna Pitters[1], Alfred Priller[1], Peter Steier[1], Alexander Wieser[1], and Robin Golser[1] — [1]University of Vienna, Faculty of Physics - Isotope Physics, Austria — [2]HZDR Dresden, Germany

The Ion Laser InterAction Mass Spectrometry (ILIAMS) technique at the Vienna Environmental Research Accelerator (VERA) tackles the problem of elemental selectivity in AMS. It achieves near-complete suppression of isobar contaminants via selective laser photodetachment of decelerated anion beams in a gas-filled radio frequency quadrupole cooler. The technique exploits differences in electron affinities (EA) within elemental or molecular isobaric systems neutralizing anions with EAs smaller than the photon energy. Collisional detachment or chemical reactions with the buffer gas can further enhance anion separation.

In AMS of ^{36}Cl and ^{26}Al, ILIAMS reliably provides isobar suppression of more than 10 orders of magnitude. Furthermore it already enables measurements of ^{90}Sr, ^{135,137}Cs and ^{182}Hf with unprecedented sensitivity at VERA and allows to study anion chemistry at eV energies. Current research focusses on extending this technique to ^{41}Ca, ^{53}Mn, ^{59}Ni, ^{99}Tc and ^{107}Pd. Exotic species such as double-negatively charged carbon clusters complete the cooler 'guestbook'. This contribution will give an overview over these achievements and prospects of the ILIAMS-technique for the near future.

MS 10.7 Thu 12:30 f128

Developments towards the detection of ^{135}Cs and ^{137}Cs by AMS — •Alexander Wieser[1], Johannes Lachner[1,2], Martin Martschini[1], Peter Steier[1], Alfred Priller[1], Maki Honda[1], Oscar Marchhart[1], and Robin Golser[1] — [1]University of Vienna, Faculty of Physics - Isotope Physics, Austria — [2]HZDR, Dresden

The isotopic ratio ^{135}Cs/^{137}Cs can be used to assign sources of anthropogenic cesium, as a geochemical tracer, or for modifying dispersion models. Due to its long half-life, ^{135}Cs is hard to detect via decay counting.

Mass Spectrometry has to deal with isobaric interferences of the stable ^{135}Ba and ^{137}Ba for Cs detection. The new method of Ion Laser InterAction Mass Spectrometry (ILIAMS) at the Vienna Environmental Research Accelerator (VERA) overcomes this problem by exploiting differences in the electron affinites of CsF_2^- and BaF_2^- molecules.

A $^{133}CsF_2^-$ current on the order of 100 nA from a mixed Cs_2SO_4 and PbF_2 - matrix is extracted from the ion source. The sample material is mobilized by heating the ionizer only, so no external sputtering material is needed. First results show reproducible detection of ^{135}Cs and ^{137}Cs in in-house reference materials. With 1 mg stable Cs carrier, we reach a blank level of ^{137}Cs/^{133}Cs $= 6 \cdot 10^{-12}$, which corresponds to $\approx$ 30 mBq. We aim to further improve this value by at least two orders of magnitude for measuring environmental samples.

MS 10.8 Thu 12:45 f128

AMS of ^{90}Sr at the sub-fg-level using laser photodetachment at VERA — •Oscar Marchhart[1], Martin Martschini[1], Maki Honda[1], Dag Hanstorp[2], Johannes Lachner[1,3], Haimei Liang[2], Alfred Priller[1], Peter Steier[1], Alexander Wieser[1], and Robin Golser[1] — [1]University of Vienna, Faculty of Physics-Isotope Physics, Austia — [2]University of Gothenburg, Department of Physics, Sweden — [3]HZDR, Dresden

The fission product ^{90}Sr ($T_{1/2} = 28.9$ a) is of interest in environmental sciences for its radiotoxicity as well as a potential tracer. Limits of detection (LoD) of mass spectrometric methods such as ICP-MS, RIMS or conventional AMS are close to the radiometric limit of 3 mBq.

The main problem in AMS of ^{90}Sr is the strong interference of the stable isobar ^{90}Zr. This problem can be overcome with the new Ion Laser InterAction Mass Spectrometry (ILIAMS) setup at the Vienna Environmental Research Accelerator (VERA). It provides near complete suppression of elemental or molecular isobars via selective laser photodetachment inside a gas-filled radiofrequency quadrupole (RFQ). With 10 W of laser power from a 532 nm cw-laser and a $He + O_2$ mixture as buffer gas, ILIAMS achieves a suppression factor for ^{90}Zr of 10^7. Extracting SrF_3^- out of the ion source and elemental separation inside an ionization chamber gives an additional Zr suppression of 10^5. Measurements with dilution series of reference materials were successfully conducted. The overall Sr detection efficiency is 0.4 ‰ and the blank level ^{90}Sr/Sr $= (4.5 \pm 3.2) \times 10^{-15}$. This corresponds to a more than tenfold improved LoD of 0.1 mBq.

MS 11: Annual General Meeting of the Mass Spectrometry Division

Time: Thursday 13:00–13:30 Location: f128

Duration: 30 min.

MS 12: Accelerator Mass Spectrometry and Applications III

Time: Thursday 14:00–15:00 Location: f128

MS 12.1 Thu 14:00 f128

Production of calcium and strontium hydride for negative ion beams — •Gereon Hackenberg, Alfred Dewald, Claus Müller-Gatermann, Markus Schiffer, Susan Herb, Karl-Oskar Zell, and Andrey Blazhev — Institut für Kernphysik, Universität zu Köln

There is a growing interest in AMS measurements of ^{41}Ca and ^{90}Sr isotopes. Whereas CaF_2 and SrF_2 are common sample materials for these isotopes, alternative cathode materials like CaH_2 or SrH_2 are of interest because of a potentially higher transmission through the accelerator.
The protocol for the sample preparation is well established and has been shown to yield high efficiencies for quantities in the 10 mg range of sample material. We tested these protocols also for sample quantities in the 1 mg range.
In this contribution we report on the results and the total yield of negative Ca and Sr beams and compare these values with fluoride samples.

MS 12.2 Thu 14:15 f128

Highly sensitive ^{26}Al measurements assisted by ILIAMS — •Johannes Lachner[1,2], Michael Kern[1], Oscar Marchhart[1], Martin Martschini[1], Alfred Priller[1], Peter Steier[1], Anton Wallner[2,3], Alexander Wieser[1], and Robin Golser[1] — [1]University of Vienna, Faculty of Physics, Austria — [2]HZDR, Dresden — [3]ANU, Canberra, Australia

The higher ion source output from Al_2O_3 for AlO^- compared to Al^- can improve the sensitivity of ^{26}Al AMS measurements. One obstacle is the more complicated isobar suppression after AlO^- extraction: For the metallic Al anion the ^{26}Mg background is suppressed in the ion scource. With ion-laser interaction mass spectrometry (ILIAMS), however, the ^{26}Mg isobar can also be completely suppressed for extracted AlO^- ions. This now allows the use of the more prolific AlO^- beam at facilities with terminal voltages < 10 MV.

At the 3 MV Vienna Environmental Research Accelerator (VERA) routine ILIAMS assisted AMS measurements of ^{26}Al are performed utilizing AlO^- and charge states 2^+ and 3^+ on the high-energy (HE) side of the spectrometer. Tests of Al_2O_3 mixtures with different metals were conducted to achieve the most efficient generation of AlO^- currents. Admixtures of Cu or Ag powder showed good results but were surpassed by mixing Al_2O_3 with Fe powder. In addition, results of first experiments will be presented regarding the utilization of ILIAMS assisted ^{26}Al measurements with lower terminal voltages and using the 1^+ charge state on the HE side.

MS 12.3 Thu 14:30 f128

Towards the redetermination of the halflife of ^{32}Si - Equilibrium charge distributions of ^{28}Si in Ar — •Matthias Schlomberg, Christof Vockenhuber, and Hans-Arno Synal — Laboratory of Ion Beam Physics, ETH Zurich

The long-lived radionuclide ^{32}Si is a cosmogenic nuclide with potentially interesting applications for dating the recent past. However, its half-life of about 150 years is still not known with sufficient precision despite several independent measurements over the four decades. The SINCHRON collaboration with partners from PSI, CHUV, PTB and ETH aims at a comprehensive redetermination of the half-life of ^{32}Si. Laboratory of Ion Beam Physics at ETH Zurich will perform the AMS measurements for the determination of the number of ^{32}Si atoms in the samples used for the activity measurement. In addition to the challenge of the separation of ^{32}Si from the isobar ^{32}S, the absolute measurement is challenging, because no ^{32}Si standards are available.

Therefore, the equilibrium charge state distribution of ^{28}Si in Ar was measured in the energy range of 1-40 MeV using the external stripper at the TANDEM AMS facility. This information is necessary to find the optimal terminal voltage and for correction of mass fractionation in the stripping process.

In the first part of the presentation, the SINCHRON project will be introduced and motivated. Subsequently, our setup to measure the equilibrium charge distribution will be shown and the obtained data will be presented and discussed.

MS 12.4 Thu 14:45 f128

Supernova-produced ^{53}Mn on Earth — •Gunther Korschinek[1], Thomas Faestermann[1], Mikhail Poutivtsev[2], Andres Arazi[3], Klaus Knie[4], Georg Rugel[5], and Anton Wallner[5] — [1]Physik-Department, Technische Universität München, 857 Garching, Germany — [2]DAW SE, 64372 Ober-Ramstadt, Germany — [3]Laboratorio TANDAR, Comision Nacional de Atomica, Av. Gral. Paz 1499, B1650KNA San Martin, Argentina — [4]GSI Helmholtz-Zentrum für Schwerionenforschung GmbH, 64291 Darmstadt, Germany — [5]Helmholtz-Zentrum Dresden-Rossendorf, 01328 Dresden, Germany

For the age range from 1.5 to 4 Myr ago we found in deep ocean ferromanganese crusts an excess concentration in terms of ^{53}Mn/Mn of about $4 \cdot 10^{-14}$ over that expected for cosmogenic production. We conclude that this ^{53}Mn is of supernova origin because it is detected in the same time window, about 2.5 Myr ago, where ^{60}Fe has been found earlier. This overabundance confirms unambiguously the supernova (SN) origin of that ^{60}Fe. For the first time supernova-formed ^{53}Mn has been detected and it is the second positively verified radioisotope from the same supernovae. The ratio ^{53}Mn/^{60}Fe of about 12 is consistent with that expected for a SN with a 11 - 25 $M_\odot$ progenitor mass and solar metallicity. A fit over the whole range until 10 Myr shows also a second increase of ^{53}Mn/Mn in the range around 6 Myr matching recent ^{60}Fe detection in sediments at ANU.

MS 13: New Developments and Techniques

Time: Thursday 15:00–16:15 Location: f128

Invited Talk MS 13.1 Thu 15:00 f128

The Multi Ion Reflection Apparatus for Collinear Laser Spectroscopy and its potential for fast and highly selective mass separation — •Stephan Malbrunot-Ettenauer for the MIRACLS collaboration — CERN, ISOLDE, Experimental Physics Department, CH-1211 Geneva 23, Switzerland

Collinear laser spectroscopy (CLS) is a powerful tool to access nuclear ground state properties of short-lived radionuclides such as spin, charge radius, and electromagnetic moments. Conventional CLS is based on the detection of fluorescence from laser-excited ions or atoms. It is limited to radioactive ion beams with yields of more than 100 to 10,000 ions/s, depending on the specific case and spectroscopic transition. To reach radionuclides with lower production yields, we are developing the Multi Ion Reflection Apparatus for Collinear Laser Spectroscopy (MIRACLS) [1]. It is based on a Multi Reflection Time of Flight (MR-ToF) device in which ions bounce back and forth between electrostatic mirrors. The trapped ions are probed by the laser during each revolution inside the MR-ToF device which largely enhances the sensitivity of CLS. In order to preserve the high resolution of CLS, MIRACLS's MR-ToF device will operate at unprecedented ion beam energies of 30 keV. This also opens new possibilities for fast and highly selective mass separation beneficial for a wide range of applications. This talk will present the MIRACLS concept and its first experimental highlights.

[1] S. Sels et al., Nucl. Instr. Meth. Phys. Res. B, in press (2019)

MS 13.2 Thu 15:30 f128

A new gas-jet setup for laser spectroscopy of transfermium elements — •Steven Nothhelfer[1,2,3], Michael Block[1,2,3], Premaditya Chhetri[1,5], Rafael Ferrer[4], Sandro Kraemer[4], Mustapha Laatiaoui[2,3], Sebastian Raeder[1,2], Fabian Schneider[2,3], Piet Van Duppen[4], Matthias Verlinde[4], Elise Verstraelen[4], and Thomas Walther[5] — [1]GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, DE — [2]Helmholtz-Institut Mainz, DE — [3]Universität Mainz, DE — [4]Instituut voor Kern- en Stralingsfysica, KU Leuven, BEL — [5]TU Darmstadt, DE

Experimental data on the hyperfine structure splittings of spectral lines in transfermium elements reveal valuable information about their nuclear structure. In addition, the atomic properties of transfermium elements are of special interest due to strong relativistic effects. Therefore, a new experimental online setup is under development aiming at precise investigations of atomic states in transfermium elements by laser spectroscopy in a supersonic gas-jet. During the experiment the fusion evaporation residues are stopped in a buffer gas cell after their production and separation at SHIP at GSI, Darmstadt. Subsequently, the fusion products are extracted in a supersonic gas-jet created by a de Laval-nozzle. Laser spectroscopy in this jet enables a higher spectral resolution compared to the previous RADRIS setup, granting access to nuclear moments and spins which are derived from the hyperfine structure and isotope shifts. This talk will summarize the current status of the experiment together with first results.

MS 13.3 Thu 15:45 f128

MELISSA: First Laser Ions and Recent Achievements — •Vadim Gadelshin[1,2], Thomas E. Cocolios[3], Kristof Dockx[3], Charlotte Duchemin[3,4], Valentin Fedosseev[4], Roberto Formento Cavaier[5], Ferid Haddad[6,7], Laura Lambert[4], Bruce Marsh[4], Joao Pedro Ramos[3,4], Annie Ringvall Moberg[4,8], Thierry Stora[4], Dominik Studer[1], Felix Weber[1], Shane Wilkins[4], and Klaus Wendt[1] — [1]Johannes Gutenberg University Mainz — [2]Ural Federal University, Russia — [3]KU Leuven, Belgium — [4]CERN, Switzerland — [5]Advanced Accelerator Applications, A Novartis Company, Italy — [6]GIP ARRONAX, France — [7]SUBATECH, Nantes University, France — [8]Gothenburg University, Sweden

In April 2019 the MEDICIS Laser Ion Source for Separator Assembly (MELISSA) was launched. It was designed and constructed to provide the highly purified isotope yield and to boost it at the CERN-MEDICIS facility, aimed for routine operation with regular collection of typically 500 MBq batches of non-conventional medical radionuclides. Meanwhile MELISSA became the major ion source in use for all collections in this operational year. Several production cycles of different rare-earth radioisotopes with high specific activity were accomplished, demonstrating their yield enhancement, improved isotopic purity, and opening an access to them for users.

In the talk, a report on the first MELISSA operation period is presented. Recent achievements and difficulties, discovered during the period, are considered. Results on Er, Tb, and Yb collections, foreseen refinements and future upgrades of the laser ion source are discussed.

MS 13.4 Thu 16:00 f128

A diode pumped single frequency continuous wave Titanium:sapphire laser — •Volker Sonnenschein[1], Kato Kotaro[1], Hattori Koya[1], Hideki Tomita[1], Dominik Studer[2], Ryohei Terabayashi[1], Felix Weber[2], and Klaus Wendt[2] — [1]Nagoya University, Japan — [2]Mainz University, Germany

Pumping of Ti:sapphire using InGaN diode lasers promises a drastic reduction in cost and system size compared to traditionally employed frequency doubled Nd:YAG pump lasers. Several research groups have demonstrated diode-pumped femtosecond Ti:sapphire systems. Here we show a proof of principle for a single-frequency continuous wave (cw) Ti:sapphire system for use in high resolution spectroscopy.

The laser is pumped by three diodes providing a combined pump power of up to 8 W. A wide tuning range from 725-890 nm was realized. Frequency control and stabilization uses piezo actuators and an external reference cavity fixed on a low thermal expansion Zerodur spacer. A short-term spectral width of 500 kHz was observed using beat-note measurements with respect to a reference laser. A measurement of the hyperfine structure in the D_2 line of Rubidium yielded accurate parameters of the hyperfine coupling parameters and isotope shift, with deviations from the literature values well below 1 MHz. The full system promises a cw Ti:sapphire system at a significantly lower price point. Compared to widely utilized external cavity diode lasers a higher total output power and wider tuning range can be expected. Optimization of the pump-beam shaping and cavity geometry should further enhance these benefits.