Mass Spectrometry Division
Fachverband Massenspektrometrie (MS)

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Overview of Invited Talks and Sessions

(Lecture room RW 2; Poster P OGs)

Invited Talks

MS 1.1	Mon	14:30–15:00	RW 2	**Mass Measurements at LEBIT** — •Martin Eibach, G. Bollen, K. Gulyuz, C. Izzo, M. Redshaw, R. Ringle, S. Schwarz
MS 1.2	Mon	15:00–15:30	RW 2	**Precision mass measurements in the context of neutrino-nuclear physics** — •Milad Alanssari, Dieter Frekers, Tommi Eronen
MS 2.1	Mon	17:00–17:30	RW 2	**Single-ion Penning-trap mass spectrometry using a single ion as detector** — •Daniel Rodriguez
MS 3.1	Tue	11:00–11:30	RW 2	**Resonant Laser-SNMS on actinides for spatially resolved ultra-trace analysis** — •Clemens Walther, Hauke Bosco, Linda Hamann, Michael Franzmann, Klaus Wendt
MS 3.2	Tue	11:30–12:00	RW 2	**Developments and applications of the Resonance Ionization Laser Ion Source at the CERN-ISOLDE facility** — •Bruce Marsh
MS 4.1	Tue	14:30–15:00	RW 2	**Secondary ion mass spectrometry using large gas cluster ion bombardment** — •Hubert Gnaser
MS 6.1	Wed	14:30–15:00	RW 2	**Laser Isobar suppression for cooled $^{26}AlO^-$ and $^{36}Cl^-$ ions** — •Johannes Lachner, Andreas Kalb, Christoph Marek, Martin Martschini, Alfred Priller, Peter Steier, Robin Golser

Invited talks of the joint symposium SYDD

See SYDD for the full program of the symposium.

SYDD 1.1	Mon	14:30–15:00	P 1	**Controlling (?) Quantum Dynamics with Open Systems** — •Dieter Meschede
SYDD 1.2	Mon	15:00–15:30	P 1	**Many-body physics of driven, open quantum systems: optically driven Rydberg gases** — •Michael Fleischhauer
SYDD 1.3	Mon	15:30–16:00	P 1	**Theorie getriebener dissipativer Quantensysteme / theory of driven dissipative quantum systems** — •Tobias Brandes
SYDD 1.4	Mon	16:00–16:30	P 1	**Calorimetry of a Bose-Einstein-condensed photon gas** — •Martin Weitz

Invited talks of the joint symposium SYAP

See SYAP for the full program of the symposium.

SYAP 1.1	Tue	11:00–11:30	P 1	**Electrons and ions meet ultracold atoms** — •Herwig Ott
SYAP 1.2	Tue	11:30–12:00	P 1	**Interrogating strongly bound electrons about fundamental physics** — •José R. Creso López-Urrutia
SYAP 1.3	Tue	12:00–12:30	P 1	**Strong-field effects in heavy-ion collisions** — •Andrey Surzhykov, Vladimir Yerokhin, Thomas Stöhlker, Stephan Fritzsche

SYAP 1.4	Tue	12:30–13:00	P 1	**Laser-based high photon flux XUV sources and applications in atomic physics** — •Jan Rothhardt, Robert Klas, Stefan Demmler, Maxim Tschernajew, Jens Limpert, Andreas Tünnermann

Invited talks of the joint symposium SYAD

See SYAD for the full program of the symposium.

SYAD 1.1	Wed	11:00–11:30	RW 1	**Exciton transport in disordered organic systems** — •Franziska Fennel
SYAD 1.2	Wed	11:30–12:00	RW 1	**Quantum dynamics in strongly correlated one-dimensional Bose gases** — •Florian Meinert
SYAD 1.3	Wed	12:00–12:30	RW 1	**Dynamics and correlations of a Bose-Einstein condensate of light** — •Julian Schmitt
SYAD 1.4	Wed	12:30–13:00	RW 1	**Circular dichroism and accumulative polarimetry of chiral femtochemistry** — •Andreas Steinbacher

Invited talks of the joint symposium SYAM

See SYAM for the full program of the symposium.

SYAM 1.1	Thu	11:00–11:30	P 1	**Buffer gas cooling of antiprotonic helium to T=1.5-1.7 K, and the antiproton to electron mass ratio** — •Masaki Hori
SYAM 1.2	Thu	11:30–12:00	P 1	**The BASE Experiment: High-precision comparisons of the fundamental properties of protons and antiprotons** — •C. Smorra, M. Besirli, K. Blaum, M. Bohman, M. J. Borchert, J. Harrington, T. Higuchi, H. Nagahama, Y. Matsuda, A. Mooser, C. Ospelkaus, W. Quint, S. Sellner, G. Schneider, N. Schoen, T. Tanaka, J. Walz, Y. Yamazaki, S. Ulmer
SYAM 1.3	Thu	12:00–12:30	P 1	**Antihydrogen physics at the ALPHA experiment** — •Niels Madsen
SYAM 2.1	Thu	14:30–15:00	P 1	**Muon g-2** — •Klaus Jungmann
SYAM 2.2	Thu	15:00–15:30	P 1	**Antihydrogen physics at ASACUSA and AEGIS** — •Chloé Malbrunot
SYAM 2.3	Thu	15:30–16:00	P 1	**An experiment to measure the anti-hydrogen Lamb shift** — •Paolo Crivelli

Sessions

MS 1.1–1.6	Mon	14:30–16:30	RW 2	**Precision Mass Spectrometry and Fundamental Applications I**
MS 2.1–2.7	Mon	17:00–19:00	RW 2	**Precision Mass Spectrometry and Fundamental Applications II**
MS 3.1–3.6	Tue	11:00–13:00	RW 2	**Resonance Ionization MS and others**
MS 4.1–4.3	Tue	14:30–15:30	RW 2	**New Methods and Technical Developments**
MS 5.1–5.3	Tue	15:30–16:15	RW 2	**Cluster**
MS 6.1–6.7	Wed	14:30–16:30	RW 2	**Accelerator Mass Spectrometry and Applications I**
MS 7.1–7.14	Wed	17:00–19:00	P OGs	**Poster**
MS 8	Thu	14:00–14:30	RW 2	**Annual General Meeting of the Mass Spectrometry Division, Election**
MS 9.1–9.10	Thu	14:30–17:00	RW 2	**Accelerator Mass Spectrometry and Applications II**

Annual General Meeting of the Mass Spectrometry Division

Thursday 14:00–14:30 RW 2

MS 1: Precision Mass Spectrometry and Fundamental Applications I

Time: Monday 14:30–16:30 Location: RW 2

Invited Talk MS 1.1 Mon 14:30 RW 2

Mass Measurements at LEBIT — •Martin Eibach[1,2], G. Bollen[1,3], K. Gulyuz[1], C. Izzo[1,3], M. Redshaw[4], R. Ringle[1], and S. Schwarz[1] — [1]Facility for Rare Isotope Beams, Michigan State University, East Lansing, Michigan 48824, USA — [2]Institut für Physik, Ernst-Moritz-Arndt-Universität, 17487 Greifswald, Germany — [3]Department of Physics and Astronomy, Michigan State University, East Lansing, Michigan 48824, USA — [4]Department of Physics, Central Michigan University, Mount Pleasant, Michigan 48859, USA

Reflecting the sum of all interactions inside a nucleus, its mass is an important characterizing property. Precisely known nuclear masses are an integral part in several different fields of fundamental science. Calculations of the astrophysical r-process, nuclear structure studies, and investigations of fundamental interactions require mass measurements of rare isotopes. Mass data of highest precision is obtained by Penning trap mass spectrometers such as LEBIT located at the National Superconducting Cyclotron Laboratory. The rare isotopes of interest are produced by heavy-ion fragmentation and subsequent in-flight separation and delivered to LEBIT which uses the destructive time-of-flight ion cyclotron resonance technique. As one moves further from the valley of stability, production rates of the exotic isotopes decline. In order to access rare isotopes being delivered at low rates, the Single Ion Penning trap is being developed using the FT-ICR technique.
We report on the present status of the SIPT development and also emphasize the impact of mass measurements with LEBIT on the topics of nuclear structure and fundamental interactions.

Invited Talk MS 1.2 Mon 15:00 RW 2

Precision mass measurements in the context of neutrino-nuclear physics — •Milad Alanssari[1], Dieter Frekers[2], and Tommi Eronen[3] — [1]University Muenster, Inst. f. Nucl. Phys., 48149 Muenster, Germany — [2]University Muenster, Inst. f. Nucl. Phys., 48149 Muenster, Germany — [3]University Jyvaskyla, Dept of Phys., Jyvaskyla FI-40014, Finland

High-precision mass measurements will be presented. The overall context is neutrino-nuclear physics. The measurements were performed at the IGISOL/JYFLTRAP facility of the University of Jyvaskyla, Finland.

After a brief and general introduction about precision mass measurements, double beta-decay and neutrino physics, emphasis will be on mass determinations for the A=96 triplet, i.e., 96Zr, 96Nb, and 96Mo. Of special importance is the 96Zr to 96Nb single beta-decay Q-value. The single beta-decay is an alternative decay to the 96Zr double beta-decay, and its observation could provide one of the most direct tests of theoretical models aimed at calculating the neutrinoless double beta-decay. The decay may also shed light onto the quenching of the axial-vector coupling constant gA.

The second part centers around a precision measurement of the 71Ga to 71Ge neutrino reaction Q-value. This Q-value had been discussed in the context of the "gallium anomaly" observed in the calibration of the SAGE and GALLEX neutrino detectors. The present precision value finally excludes the possibility of the observed "anomaly" being the result of wrongly assumed nuclear physics input.

MS 1.3 Mon 15:30 RW 2

A high-precision experiment for the determination of the atomic mass of the proton — •Fabian Heisse[1,2], Sven Junck[3], Florian Köhler-Langes[1], Andreas Mooser[4], Wolfgang Quint[2], Sascha Rau[1], Stefan Ulmer[4], Günter Werth[3], Klaus Blaum[1], and Sven Sturm[1] — [1]Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, D-69117 Heidelberg, Germany — [2]GSI-Helmholtzzentrum für Schwerionenforschung, D-64291 Darmstadt, Germany — [3]Institut für Physik, Johannes Gutenberg-Universität Mainz, D-55099 Mainz, Germany — [4]RIKEN Ulmer Initiative Research Unit, Saitama 351-0198, Japan

The proton, together with the electron and the neutron, form the central building blocks of the visible universe. The precise knowledge of its properties, among others its atomic mass, is of great interest for high-precision tests as well as for metrology.
We have started an experiment to determine the proton's atomic mass m_p to $\delta m_p/m_p = 10^{-11}$ or better. The measurement principle is based on a simultaneous phase-sensitive comparison of the proton's cyclotron frequency to that of a bare carbon nucleus ($^{12}C^{6+}$) in a Penning trap. A new cryogenic Penning-trap setup with a highly advanced magnetic shimming system has been built to achieve ultra stable measurement results.
The status of the experiment, such as the detection of single protons and carbon ions as well as the first results of the optimization of the seven-electrode cylindrical Penning trap, will be presented.

MS 1.4 Mon 15:45 RW 2

HF switches for high-precision experiments including ultra cold ions — •Sven Junck[1], Fabian Heisse[2,3], Florian Köhler - Langes[2], and Sven Sturm[2] — [1]Institut für Physik, Johannes Gutenberg-Universität Mainz, D - 55099 Mainz — [2]Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, D - 69117 Heidelberg — [3]GSI-Helmholtzzentrum für Schwerionenforschung, D-64291 Darmstadt

A new generation of Penning trap experiments, aiming for high-precision QED tests in extremely strong fields, a new approach to determine the fine-structure constant and most precise measurements of the atomic masses of the proton as well as the neutron, are currently commissioned. The central measurement routine will be based on the phase-sensitive measurement technique PnA [1]. Tapping its full potential by working at the lowest accessible temperatures, resonators for detection and cooling need to be tuned and detuned in a fast and reliable way. Such tuning requires cryogenic switches for various capacities that feature negligible noise in either open or closed state. Because this is not the fact for commonly used semiconductor switches a new kind of switch has been designed which is based on the principle of bistable relays. The design's status and its applicability to improve the phase-sensitive image charge detection technique will be discussed.
[1] Sturm, S., A. Wagner, B. Schabinger, and K. Blaum: 'Phase-Sensitive Cyclotron Frequency Measurements at Ultralow Energies'. Phys. Rev. Lett. (14 2011), vol. 107: p. 143003.

MS 1.5 Mon 16:00 RW 2

Implementation of the phase-imaging ion-cyclotron resonance detection technique at ISOLTRAP/CERN — •J. Karthein[1], P. Ascher[2], D. Atanasov[1], K. Blaum[1], T. E. Cocolios[3], F. Herfurth[4], M. Kowalska[5], D. Lunney[6], V. Manea[5], M. Mougeot[6], D. Neidherr[4], M. Rosenbusch[7], L. Schweikhard[7], A. Welker[5,8], F. Wienholtz[5,7], R. Wolf[1], and K. Zuber[8] — [1]MPIK, Heidelberg, Germany — [2]CENBG, France — [3]KU Leuven IKS, Belgium — [4]GSI, Darmstadt, Germany — [5]CERN, Geneva, Switzerland — [6]CSNSM-IN2P3-CNRS, Université Paris-Sud, Orsay, France — [7]Institut für Physik, Universität Greifswald, Germany — [8]TU Dresden, Germany

The Penning-trap mass spectrometer ISOLTRAP located at the radioactive ion beam facility ISOLDE at CERN performs high-precision mass measurements of short-lived nuclides. This gives access to the study of nuclear structure effects like the location of shell and subshell closures and beta-decay Q-values, providing tests of nuclear models and even the Standard Model of elementary particles. For three decades the measurement principle was based on a destructive time-of-flight ion cyclotron resonance detection method, which is reaching its limits now in accessible half-lives and relative uncertainties. With the new phase-imaging ion-cyclotron-resonance (PI-ICR) [PRL 110, 082501] detection technique, experiments can be performed with much less measurement time, providing access to new areas of the nuclear chart. This talk will report on the implementation of the PI-ICR technique as well as results from our first offline and online studies.

MS 1.6 Mon 16:15 RW 2

Status report on the on-line coupling of the TRIGA-TRAP experiment to the research reactor TRIGA Mainz — •Jessica Grund[1,2,3], Klaus Blaum[4], Michael Block[2,3,5], Stanislav Chenmarev[4], Christoph E. Düllmann[1,2,3,5], Klaus Eberhardt[1,2,3], Jacques J. W. van de Laar[1,2,3], Steffen Lohse[2,3], Szilard Nagy[4], Pascal Naubereit[6], Fabian Schneider[2,3], and Klaus Wendt[1,2] — [1]PRISMA Cluster of Excellence, Johannes Gutenberg-Universität, Mainz — [2]Institut für Kernchemie, Johannes Gutenberg-Universität, Mainz — [3]Helmholtz-Institut Mainz, Mainz — [4]Max-Planck-Institut für Kernphysik, Hei-

delberg — [5]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt — [6]Institut für Physik, Johannes Gutenberg-Universität, Mainz

Experimental data on ground-state properties of exotic nuclei are of interest for nuclear structure studies and allow testing the predictive power of nuclear mass models. Besides off-line measurements on long-lived transuranium isotopes, high-precision mass measurements on short lived nuclides can be performed at TRIGA-TRAP, thanks to the on-line coupling to the research reactor TRIGA Mainz. Neutron rich nuclides are produced by neutron-induced fission of U-235 inside the reactor, extracted by an aerosol-based gas-jet system and guided through a skimmer system to a high-temperature surface ion source. To improve the ionization efficiency, a new ion source has been successfully implemented in collaboration with JAEA/Tokai. An overview of the current status and latest results on the performance will be presented.

MS 2: Precision Mass Spectrometry and Fundamental Applications II

Time: Monday 17:00–19:00 Location: RW 2

Invited Talk MS 2.1 Mon 17:00 RW 2

Single-ion Penning-trap mass spectrometry using a single ion as detector — •Daniel Rodriguez — Departamento de Física Atómica, Molecular y Nuclear, Universidad de Granada, 18071, Granada, Spain

The eigenfrequencies of a charged-particle stored in a Penning trap (PT) are obtained from the current the oscillating particle induces in the trap electrodes, amplified e.g., by means of a tuned circuit operated at liquid-helium temperature. This detection method has been successfully implemented at several laboratories, yielding outstanding results, but with the highest sensitivity limited to particles with low or medium mass-to-charge ratios. With the primary goal of extending the applicability of PT mass spectrometry to any (single) ion, and make practicable for example PT measurements on SuperHeavy Elements produced in fusion-evaporation reactions, we are developing a method consisting in replacing the tuned circuit by a laser-cooled $^{40}Ca^{+}$ (sensor) ion stored in an adjacent trap. After probing an eigenfrequency of the ion of interest, this will be coupled to the sensor ion hold in vacuum at mK temperatures, the emitted photons will be collected, and the analysis of the distribution will allow determining the eigenfrequency. In this contribution, I will show the layout of the TRAPSENSOR facility built in Granada, and the outcomes from a series of developments and experiments, like the construction of the first micro-PT mass spectrometer, and the detailed characterization of the sensor ion used as high-sensitive detector. I will finish the talk discussing on-going experiments in Granada and the medium-term prospects.

MS 2.2 Mon 17:30 RW 2

A Cryogenic Single Nanoparticle Mass and IR Spectrometer — •Tim K. Esser and Knut R. Asmis — Wilhelm-Ostwald-Institut für Physikalische und Theoretische Chemie, Universität Leipzig, Linnestrasse 2, D-04103 Leipzig, Germany

Nanoparticles play an increasingly important role for the development of new materials e.g. for electrotechnology, catalysis and medicine. These particles exist in the atmosphere and participate in the formation of cloud condensation nuclei which directly impact the climate. Despite the environmental relevance, many of their properties are still not well understood. Here, we describe a cryogenic mass and infrared (IR) spectrometer to investigate the surface structure and chemistry of a single nanoparticle. The nanoparticle is confined in a quadrupole ion trap and oscillates with a frequency characteristic for its mass-to-charge (m/z) ratio. Optical detection of this frequency enables mass assignment with ppm resolution. The setup can monitor the mass variation of a single nanoparticle, as a function of temperature (10-350 K), background gas and interaction with light, over several days. IR spectra will be obtained and compared to data from solids and gas phase clusters.

MS 2.3 Mon 17:45 RW 2

Production of Highly Charged Ho-163 Ions in a Room Temperature Electron Beam Ion Trap — •Christoph Schweiger[1], Rima X. Schüssler[1], Alexander Rischka[1], Peter Micke[1,2], José R. Crespo López-Urrutia[1], Pavel Filianin[1], Sergey Eliseev[1], and Klaus Blaum[1] — [1]Max-Planck-Institut für Kernphysik, 69117 Heidelberg — [2]QUEST Institute for Experimental Quantum Metrology, 38116 Braunschweig

The ECHo experiment [1] aims to determine an upper limit of the electron neutrino mass in the sub-eV range by a calorimetric measurement of the de-excitation spectrum of Dy-163 following the electron capture process in Ho-163. As a consistency check the Q-value of this process will be measured as the mass difference of Ho-163 and Dy-163 with the high-precision Penning-trap mass spectrometer PENTATRAP [2] aiming for a relative mass uncertainty of 10^{-11}. At this level of precision highly charged ions have to be used and an efficient way for their production is the use of an electron beam ion trap (EBIT). Given an available Ho-163 sample size of less than 10^{13} atoms, the wire probe technique [3] will be applied for their precise injection into the trapping volume of a compact room temperature EBIT. In the talk the current status concerning setup, characterisation and measurements of the EBIT and the wire probe will be presented.

[1] Gastaldo, L. et al.. J. Low Temp. Phys. 176, 876 (2014)
[2] Repp, J. et al., Appl. Phys. B 107, 983 (2012)
[3] Elliott, S.R. et al., Nucl. Instr. and Meth. B 100, 523 (1995)

MS 2.4 Mon 18:00 RW 2

Recent upgrades of the SHIPTRAP setup — •Francesca Giacoppo[1,2], Klaus Blaum[3], Michael Block[1,2,4], Stanislav Chenmarev[3,5], Premaditya Chhetri[6], Christian Droese[7], Sergey Eliseev[3], Pavel Filianin[3,8], Stefan Götz[1,2,4], Yuri Gusev[5], Fritz-Peter Hessberger[1,2], Oliver Kaleja[4], Mustapha Laatiaoui[1,2], Felix Lautenschläger[6], Steffen Lohse[2,4], Enrique Minaya Ramirez[9], Andrew Mistry[1,2], Yuri Novikov[5,8], Sebastian Raeder[1,2], Daniel Rodriguez[10], Lutz Schweikhard[7], and Peter Thirolf[11] — [1]GSI Darmstadt — [2]Helmholtz Institut Mainz — [3]MPIK Heidelberg — [4]Universität Mainz — [5]PNPI KI Gatchina — [6]TU Darmstadt — [7]Universität Greifswald — [8]SPbSU St. Petersburg — [9]IPN Orsay — [10]Universidad de Granada — [11]LMU München

Recently, the SHIPTRAP double Penning-trap system was moved to a new location on axis with the recoil separator SHIP to integrate a cryogenic buffer-gas cell for a more efficient slowing down of the fusion-evaporation products of interest. This upgrade aims at extending the groundbreaking program of direct mass spectrometry towards the superheavy elements.

In addition, a second superconducting magnet was installed at a 90^{o} angle with the existing beam line. It will be connected to the surface and laser ablation ion sources to develop the single-ion mass spectrometry technique based on the image charge detection (FT-ICR). An overview of the technical developments and the latest off-line measurements with stable nuclides will be presented in this contribution.

MS 2.5 Mon 18:15 RW 2

Recent results from the FRS Ion Catcher — •Emma Haettner and the FRS Ion Catcher Collaboration — GSI Helmholtzzentrum für Schwerionenforschung GmbH

The accelerator complex at GSI and in the future, FAIR, gives access to the study of short-lived nuclei. The properties, such as the mass, are difficult to predict with sufficient accuracy to e.g. identify the limits of nuclear stability or fully understand the nucleosynthesis in stars. Thus mass measurements are mandatory to improve nuclear models.

Many nuclei far from stability can be produced in fragmentation or fission reactions. For precision experiments with the FRS Ion Catcher, the nuclei are produced and separated in-flight, momentum-compressed, and slowed-down in the fragment separator (FRS) and subsequently thermalized in a cryogenic stopping cell. The ions are extracted and guided through a multi-purpose RFQ beamline followed by a multiple-reflection time-of-flight mass spectrometer (MR-ToF-MS) for mass measurements or separation. A mass resolving power in excess of 600,000, its speed and single-ion sensitivity makes the method ideal for experiments with rare short-lived nuclei.

Recent measurements with the FRS Ion Catcher demonstrate the feasibility of the experimental scheme; the access to rare short-lived nu-

clei, operation as an isobar/isomer separator and high precision mass measurements. The latter method of operation used also as a complementary method for unambiguous particle identification of nuclei separated in the FRS. A highlight is the first direct mass measurements of 213-Rn, 218-Rn and 217-At, all with a half-life below 40 ms.

MS 2.6 Mon 18:30 RW 2

Peak shape analysis of high resolution Multiple-Reflection Time-of-Fight Mass Spectrometer (MR-TOF-MS) data — •Sivaji Purushothaman and The FRS ION Catcher Collaboration — GSI Helmholtzzentrum für Schwerionenforschung GmbH, 64291 Darmstadt, Germany

At the FRS Ion Cather setup, GSI, Darmstadt, the in-flight produced and separated radioactive isotopes are thermalized in a gas stopping cell and delivered to a Multiple-Reflection Time-of-Flight Mass Spectrometer (MR-TOF-MS). Due to the universal production in combination with the fast and high precision, high accuracy mass measurement capability, the FRS ion catcher setup is an ideal tool for studies of long-lived isomers (life times greater than a few milliseconds). However, the detected peak shape in MR-TOF-MS often shows symmetric and asymmetric deviations from a Gaussian form as a result of several processes, which cannot be disentangled. In the case of overlapping peaks, the peak position and the area will be influenced by the underlying tails from the neighboring peaks. This is critical for many high precision measurements, for example to deduce isomeric-to-ground state ratios and to determine the excitation energy of an isomer. A new probability distribution function called hyper-Exponentially Modified Gaussian (hyper-EMG), which can model a Gaussian distribution modified with multiple exponential tails at either one or both edges is presented. The application of the new peak shape model in MR-TOF-MS data analysis is demonstrated with the isomers observed from projectile (^{211}Po) and fissions (^{133}I) fragmentation of ^{238}U.

MS 2.7 Mon 18:45 RW 2

How does the isotopic enrichment in 28Si influences the measurement uncertainty of isotope ratio MC-ICP-mass spectrometry? — •Axel Pramann and Olaf Rienitz — Physikalisch-Technische Bundesanstalt (PTB), Bundesallee 100, 38116 Braunschweig, Germany

In the attempt for the re-defintion of the SI unit kilogram, the determination of the Avogadro constant N_A is one of the promising approaches using the X-ray-crystal-density XRCD method by counting silicon atoms in single-crystalline Si spheres, enriched in various degrees in 28Si [1]. One of the key parameters for the determination of N_A is the molar mass M of silicon of the spheres with lowest possible uncertainties u(M) accessible via high resolution multicollector ICP-mass spectrometry [2]. The evolution of u_rel(M) as a function of the enrichment of silicon crystals used is described (from x(28Si) = 0.922 mol/mol up to the latest extremely high enriched material with x(28Si) = 0.999 99 mol/mol). The uncertainty contributions are compared and discussed in the context of both methodological and experimental mass spectrometric improvements. In summary, the uncertainty contribution of M in N_A decreased from 60 % in 2003 down to 6 % in 2016, enabling u_rel(N_A) < 1.5 * 10-8, one of the preconditions of the refediniton of the kilogram and the mole.

[1] K. Fujii et al. Metrologia, 53, A19 (2016). [2] A. Pramann, K.-S. Lee, J. Noordmann, O. Rienitz. Metrologia, 52, 800 (2015).

MS 3: Resonance Ionization MS and others

Time: Tuesday 11:00–13:00 Location: RW 2

Invited Talk MS 3.1 Tue 11:00 RW 2

Resonant Laser-SNMS on actinides for spatially resolved ultra-trace analysis — •Clemens Walther[1], Hauke Bosco[1], Linda Hamann[1], Michael Franzmann[2], and Klaus Wendt[2] — [1]Institute for Radioecology and Radiation Protection, Leibniz-Universität Hannover, Herrenhäuser Straße 2, D-30419 Hannover, Germany — [2]Institute of Physics, Johannes Gutenberg-Universität Mainz, Staudingerweg 7, D-55128 Mainz, Germany

After accidental release of radionuclides into the environments, fast and highly sensitive detection methods are required. The new resonant Laser-SNMS system at the IRS Hannover was developed to cover those specifications by combining the high element selectivity of resonance ionization with the non-destructive analysis of a static TOF-SIMS with spatial resolution down to 70 nm. The laser-ionization of a neutral particle cloud above the sample required a simulation of the expanding particles and a simulation based optimization of the TOF analyzer due to different ionization behavior. First mass spectra of synthetical uranium and plutonium samples demonstrated the expected suppression of interfering elements and molecules, which was confirmed with environmental samples. In MOX fuel Pu-238 and U-238 were successfully discriminated. It was possible to create isotope selective images of environmental sample material. We present first resonant Laser SNMS Measurements on Pu, Sr and U containing samples. First results on particles from the Chernobyl exclusion zone and from the evacuated zone close to the Fukushima Daichii nuclear power plant are presented.

Invited Talk MS 3.2 Tue 11:30 RW 2

Developments and applications of the Resonance Ionization Laser Ion Source at the CERN-ISOLDE facility — •Bruce Marsh — CERN, Geneva, Switzerland

The CERN-ISOLDE Radioactive Ion Beam (RIB) Facility is at the forefront of fundamental and applied research related to the use of ion beams of artificially produced exotic isotopes.

Isotope purity - extracting a beam of ions with the desired combination of proton number (Z) and atomic mass (A) - is often an essential requirement. This is achieved by combining the element-selective process of multi-step laser resonance photo-ionization with mass-selective ion beam transmission using an electromagnetic dipole mass spectrometer. The ISOLDE Resonance Ionization Laser Ion Source (RILIS) comprises an array of industrial, scientific and custom made lasers (Nd:YAG, Ti:Sapphire and dye lasers) and is capable of selectively ionizing more than 35 different elements with efficiencies often exceeding 10%. In recent years state-of-the-art laser technologies and equipment monitoring and control systems have been implemented. These have increased the performance, reliability and capabilities of the RILIS, enabling its use for more than 75% of the ISOLDE experimental program.

In addition to its use as an efficient and selective ion source, the RILIS is itself a powerful spectroscopic tool for fundamental nuclear and atomic physics studies. Technical details and recent highlights of the various applications of the ISOLDE RILIS will be discussed.

MS 3.3 Tue 12:00 RW 2

Laser resonance photoionization spectroscopy on lutetium atoms within the MEDICIS project — •Vadim Gadelshin[1], Thomas Cocolios[2], Reinhard Heinke[1], Tom Kieck[1], Bruce Marsh[3], Pascal Naubereit[1], Sebastian Rothe[3], Thierry Stora[3], Dominik Studer[1], Piet Van Duppen[2], and Klaus Wendt[1] — [1]Institute of Physics, Mainz University, Germany — [2]Institute for Nuclear and Radiation Physics, KU Leuven, Belgium — [3]EN Department, CERN, Switzerland

Lutetium is one of the most relevant lanthanides for the MEDICIS Project, aimed at production of innovative radiopharmaceuticals for nuclear medicine, because of extraordinary properties of its medical radioisotope Lu-177. As a part of separation technology used in the project, laser resonance ionization requires an appropriate multi-step excitation scheme for the element of interest, which will ensure the most efficient ionization process. The current report presents the results of laser resonance photoionization spectroscopy on lutetium atoms with a tunable pulsed Titanium:Sapphire laser system. In several experimental periods, various two-step ionization schemes were investigated, suitable highly efficient excitation schemes were selected, which possess a combination of high transition strength of the first excitation step together with strong transition into an auto-ionizing state. The achieved level of the lutetium ionization efficiency in different laser excitation schemes will be presented. Further research is going to be undertaken for other relevant rare-earth elements: terbium and neodymium.

MS 3.4 Tue 12:15 RW 2

Towards High-resolution In-source Laser Spectroscopy On-

line: A Perpendicular Laser - Atom Beam Upgrade for the Laser Ion Source and Trap (LIST) at CERN/ISOLDE — •Reinhard Heinke[1], Valentin Fedosseev[2], Tom Kieck[1], Tobias Kron[1], Bruce Marsh[2], Sebastian Raeder[3], Sebastian Rothe[2], Marcel Trümper[1], Carsten Weichhold[1], and Klaus Wendt[1] — [1]Johannes Gutenberg-Universität, Mainz — [2]EN-STI Department, CERN — [3]Helmholtz-Institut Mainz

Highly selective and efficient laser ion sources are of fundamental importance to study atomic and nuclear properties along the nuclear chart. Upgrading the well-established, highly element-selective laser resonance ionization technique with additional suppression of isobaric contaminations immediately at the exit of the hot ion source cavity led to the development of the Laser Ion Source and Trap LIST, operated at the radioactive ion beam facility ISOLDE at CERN.

For high precision spectroscopic studies and isomer-selective ionization, a crossed atom - laser beam interaction geometry based on robust metal mirrors near the ionization region has been integrated into the LIST, reducing the experimentally realized spectral linewidth due to Doppler broadening in the atom vapor from a few GHz down to below 100 MHz. In the framework of the ECHo project, hyperfine structure studies on the radioactive isotopes ^{163,166m}Ho were performed at the RISIKO off-line mass separator at Mainz University, showing opportunities and constraints of a future implementation of this novel PI-LIST (Perpendicularly Illuminated) design at on-line facilities.

MS 3.5 Tue 12:30 RW 2

New insights into CD-REMPI-MS method — •Farinaz Mortaheb, Jörn Lepelmeier, Aras Kartouzian, Ulrich Boesl, and Ueli Heiz — Technical University of Munich, Chair of Physical Chemistry, Lichtenbergstraße 4, 85748 Garching, Germany

The importance of analytical methods, which give us the ability to have deeper, faster and more accurate information about the enantiomeric excess of mixtures of chiral molecules in different environments and conditions, is clear. CD-REMPI-MS is one such technique. Circular Dichroism (CD) effect is achieved by the different absorption of left and right circularly polarized light for chiral molecules. CD can be integrated into REMPI-MS, by circularly polarizing the excitation beam. Thus, CD-REMPI-MS becomes a sensitive method with the ability to give a mass- wavelength- and enantiomer selectivity in the analysis of chiral molecules, even in the mixture with achiral ones in the gas phase. Such a method can be employed to enantio-analyse the products of heterogeneous asymmetric catalytic processes. In the present work, 1-Phenylethanol is investigated. Using CD-REMPI-MS, anisotropy factors (g-value) of multiple vibronic transitions have been determined.

[1] C. Logé and U. Boesl, ChemPhysChem, 12 (2011) 1940-1947 [2] J.Lepelmeier, K. Titze, A. Kartouzian, U. Boesl, and U. Heiz, chemphyschem, 17 (2016)

MS 3.6 Tue 12:45 RW 2

Distinction of structural isomers by means of chirped femtosecond laser ionization — •Viola Krein, Nicola Reusch, Nikolaus Wollscheid, and Karl-Michael Weitzel — Philipps-Universität Marburg

Structural isomers of disubstituted benzenes are difficult to distinguish with most mass spectrometric methods, in particular when both substituents are identical. In those cases, a distinction is possible by coupling mass spectrometry with a chromatographic method. An alternative approach is the combination of femtosecond laser ionization with time-of-flight mass spectrometry (fs-LIMS). Here, the variation of several laser pulse characteristics opens access to a multidimensional analytical technique. In the current work we present a systematic chirped fs-LIMS investigation of two different ortho-, meta- and para-disubstituted benzenes, i. e. difluorobenzene and benzenediamine. In both cases the mass spectra for the three structural isomers look similar for transform limited laser pulses. By systematic variation of linear and quadratic chirp we are able to enhance small differences between the ortho-, meta- and para-isomers for specific fragments. Ultimately, we demonstrate, that we are able to distinguish the three structural isomers. In this context we will address i) differences in intensity-driven vs. non-intensity-driven fragmentation channels; ii) the mechanism for the formation of specific fragments; and iii) the relevance of a ring opening as start of the fragmentation process, as it is known for difluorobenzene [1]. [1] A.-M. Boulangera, D. M. P. Holland, D. A. Shaw, P. M. Mayer, J. Am. Soc. Mass Spectrom., 20, 20-24, (2009)

MS 4: New Methods and Technical Developments

Time: Tuesday 14:30–15:30 Location: RW 2

Invited Talk MS 4.1 Tue 14:30 RW 2

Secondary ion mass spectrometry using large gas cluster ion bombardment — •Hubert Gnaser — Department of Physics and Research Center OPTIMAS, University of Kaiserslautern, Germany

The characterization of organic and biological materials by secondary ion mass spectrometry (SIMS) has greatly benefited from the use of cluster ions as primary bombarding species. In particular, large gas cluster ions such as Ar_n^+ (with n > 1000 Ar atoms and an impact energy of about 10 keV) have led to a substantial improvement in those analyses. Using large cluster ions for sputtering, the emission of intact organic and biological molecules from surfaces is often observed. In addition, these "soft" ejection processes result in a pronounced reduction of molecular fragmentation. Thereby, depth profiling and 3D imaging of such specimens became feasible.

In this presentation, the basic processes of the interaction of large cluster ions with solid surfaces are discussed, emphasizing the influence of specific cluster parameters (cluster size, energy per cluster atom) on the emission yields and fragmentation. Furthermore, selective examples of the application of large gas cluster ions in SIMS of organic and biological systems are described.

MS 4.2 Tue 15:00 RW 2

Exploring MeV-SIMS with a capillary microprobe — •Klaus-Ulrich Miltenberger, Martina Schulte-Borchers, Arnold Milenko Müller, Matthias George, Max Döbeli, and Hans-Arno Synal — Laboratory of Ion Beam Physics, ETH Zürich, Switzerland

Over the course of the last two years, the new MeV-SIMS capillary microprobe setup CHIMP (Capillary Heavy Ion MeV-SIMS Probe) was developed and built at the ETH Zurich 6 MV TANDEM accelerator facility. The setup enables the use of a large variety of primary ions with energies of up to 80 MeV and even molecular or cluster ions (e.g. C_{60}) to enhance molecular secondary ion yields. The heavy and energetic MeV ion beams are collimated using a glass micro-capillary to diameters on the order of 1 to 10 μm, while molecular imaging with good spatial resolution is enabled by a piezo sample raster stage.

For mass spectrometry of the positive secondary ions a time-of-flight (ToF) spectrometer is used, which can be operated both in pulsed or continuous mode. While in pulsed mode the start time is derived from the pulsed primary ion beam, in continuous beam mode the start signal is either obtained from a transmission Bragg gas ionization detector (for thin samples) or from a channeltron detecting secondary electrons from the sample surface. This allows measurements with very high duty cycles and efficiencies.

The CHIMP setup as well as measurements characterizing its performance will be presented.

MS 4.3 Tue 15:15 RW 2

Design of a Beam Profile Monitor for measurements of the phase space — •Daniele De Maria, Hans-Arno Synal, Arnold Müller, and Sascha Maxeiner — Laboratory of Ion Beam Physics, ETH Zurich, Switzerland

In a typical AMS system, a beam of negative ions arises from the analyzed sample. The phase space of this beam, given by its width and divergence, is an interesting quantity, as it allows, for example, to optimize the beam transport through the system. To investigate the phase space generated by a MICADAS type ion source, a Beam Profile Monitor (BPM) based on two oscillating sensing wires located at two different positions along the beam axis has been developed. The versatile measurement board Red Pitaya implemented in the experimental set up has been programmed such that both the driving signal for the wires taking the intensity profile of the beam, as well as data acquisition of measured beam current are provided. Measurements of

the behaviour of the phase space after the first dipole magnet were performed as a function of the beam's energy in the range between 30 keV and 50 keV at the MyCadas facility at the Laboratory of Ion Beam Physics at ETH Zurich. The measurements allowed to identify the phase space in the horizontal plane and in the vertical plane, respectively. In the talk, the algorithms studied to calibrate the relative position of the BPM respect to a reference beam and to derive its width and divergence are presented. The results of the performed measurements are discussed too, as well as the sources of uncertainty and possible improvements.

MS 5: Cluster

Time: Tuesday 15:30–16:15 Location: RW 2

MS 5.1 Tue 15:30 RW 2

The Oxidation of Cationic Tantalum Clusters Under Multi-Collision Conditions — •Martin Tschurl, Jan Frederik Eckhard, Tsugunosuke Masubuchi, Daniel Neuwirth, and Ueli Heiz — Technical University of Munich, Chair of Physical Chemistry, Lichtenbergstraße 4, 85748 Garching, Germany

Tantalum clusters and their oxides represent prospective materials for catalysis. In particular, they offer great potential as oxidation catalysts, as e.g. in the electrochemical oxygen evolution reaction or the methane activation. In this talk it will be shown, how the oxidation properties of tantalum clusters are governed by their size. It is found that three different species are formed depending on the number of atoms and the oxidation state of the clusters. For smaller clusters fully oxidized tantalum oxides result, whereas the oxidation of larger clusters favors the formation of species with an intact metal core. For the latter a second oxidation mechanism occurs of higher oxidation states, which is assigned to species for which the O-O bond remains intact. Furthermore, it is show how these results will contribute to future studies of ion-molecule reactions.

MS 5.2 Tue 15:45 RW 2

Room-temperature methane activation by tantalum (oxide) clusters — •Jan Frederik Eckhard, Tsugunosuke Masubuchi, Daniel Neuwirth, Martin Tschurl, and Ueli Heiz — Technical University of Munich, Chair of Physical Chemistry, Lichtenbergstraße 4, 85748 Garching, Germany

The selective transformation of methane has received a lot of attention as it is one of the most important reactions that require C-H bond activation. Unraveling the mechanistics of such complex processes is facilitated in gas-phase studies. In our setup, the combination of a laser vaporization cluster source, a cryogenic ring electrode ion trap and a reflectron time-of-flight mass spectrometer is used to analyze reactions of size-selected metal clusters under multi-collision conditions. Doing so, reaction pathways as well as size-dependent apparent rate constants and activation energies are obtained. Additional information, e.g. about intrinsic cluster properties, may be revealed by employing ab-initio calculations. Tantalum was chosen as a clustering material as it is one of the few metals that, in its atomic cation form, brings about hydrogen elimination from methane. Cationic tantalum clusters and tantalum oxide clusters are also found to activate methane in consecutive dehydrogenation reactions. These new results will be presented in detail and surprising findings concerning cluster size, composition and activation energies will be discussed.

MS 5.3 Tue 16:00 RW 2

High-resolution cluster analysis by multi-reflection time-of-flight mass spectrometry — Paul Fischer[1], •Stefan Knauer[1], Gerrit Marx[1], Birgit Schabinger[1], Lutz Schweikhard[1], and Robert Wolf[2] — [1]Institut für Physik, Universität Greifswald, Felix-Hausdorff-Str. 6, 17489 Greifswald — [2]ARC Centre of Excellence for Engineered Quantum Systems, School of Physics, The University of Sydney, NSW 2006 Australia

Multi-reflection time-of-flight (MR-ToF) devices [1] have established themselves as mass separators and spectrometers with high resolving powers and fast processing times. A MR-ToF analyzer built at Greifswald was installed at ISOLTRAP for the investigation of exotic nuclei [2]. Based on this design a further setup combining MR-ToF analyzer with a laser ablation source was constructed for atomic cluster research. The developments aim to provide samples of selected clusters for further investigations, such as cluster-laser interactions or photoelectron spectroscopy. A characterization of the setup and first experimental results will be presented.

[1] H. Wollnik, M. Przewloka: Int. J. MassSpectrom. Ion Proc. 96 (1990) 267

[2] R. Wolf et. al, Phys. Rev. Lett. 110 (2013) 041101; F. Wienholtzet. al, Nature 498 (2013) 346;M. Rosenbusch et. al, Phys. Rev. Lett. 114 (2015) 202501; D. AtanasovPhys. Rev. Lett. 115 (2015) 232501

MS 6: Accelerator Mass Spectrometry and Applications I

Time: Wednesday 14:30–16:30 Location: RW 2

Invited Talk MS 6.1 Wed 14:30 RW 2

Laser Isobar suppression for cooled $^{26}AlO^-$ and $^{36}Cl^-$ ions — •Johannes Lachner, Andreas Kalb, Christoph Marek, Martin Martschini, Alfred Priller, Peter Steier, and Robin Golser — Faculty of Physics, University of Vienna, Austria

The newly developed Ion-Laser InterAction System (ILIAS) was connected to the Vienna Environmental Research Accelerator (VERA). ILIAS allows to slow down negatively charged ions to thermal velocities in a linear radiofrequency quadrupole (RFQ) filled with He gas. I will present our experiments on isobar suppression via collisions in the RFQ and via element selective photodetachment.

In the photodetachment experiments we used a 532 nm laser (18 W), which is coupled into the beamline and our RFQ via a viewport in a 90° magnet, the first filter after the negative ion source. The VERA mass spectrometer then allows identifying trace amounts of nuclides and molecules in the beam transmitted through the ion cooler. We studied the effects of collisions of the beam with He buffer gas and of laser photodetachment on the AMS-relevant ions $^{36}Cl^-$ and $^{26}AlO^-$: Suppression factors of the isobars ($^{26}MgO^-$ and $^{36}S^-$) of 10^3 and 10^7, respectively, are realized. Sufficient suppression of the isobars in the ion cooler will allow for the choice of lower charge states after the accelerator and improve the yields of detection. We therefore tested different charge states for the nuclides of interest and report on the separation of the isobars and of m/q interferences at beam energies between 10 and 25 MeV using a multi-anode gas-ionization chamber. The new isobar suppression method will widen the capabilities of smaller and middle-sized AMS facilities and open the future for novel AMS isotopes.

MS 6.2 Wed 15:00 RW 2

^{10}Be results from Trondheim 1 MV AMS — •Martin Seiler[1], Johanna Anjar[1], Einar Vaernes[1], Marie-Josée Nadeau[1], and Grazia Scognamiglio[2] — [1]National Laboratory for Age Determination, NTNU, Trondheim — [2]Centro Nacional de Aceleradores, Universidad de Sevilla, Sevilla

The 1 MV AMS system in Trondheim is regularly used for radiocarbon dating and provides stable measurement conditions for reliable results. The initial acceptance tests was conducted for ^{10}Be, ^{26}Al and ^{14}C. However, for many years only ^{14}C was measured. Recently the first tests with ^{10}Be were done. The 2^+2^+ measurement setup with a 150 nm thick degrader foil yielded a good efficiency as well as a low background level and was therefore chosen for further measurements. In order to determine the achievable performance under measurement conditions, several samples have been run in an ordinary measurement. This includes primary standards, which were used for normalization of the other samples. The precision for a single sample was 0.5 % at

a nominal ratio of ^{10}Be/Be 2.709·10^{-11}. Secondary standards with ^{10}Be/Be ratios between 5·10^{-13} and 9·10^{-12} were used to prove the accuracy of the measurement. As we aim to measure samples for cosmogenic exposure dating, the background level for rock samples was determined with process blanks of a Be extraction process from quartz were used. The average normalized blank level for these samples was 3·10^{-15}. A detailed analysis of the performance as well as an outlook to real sample applications will be given.

MS 6.3 Wed 15:15 RW 2

A dedicated AMS setup for medium mass isotopes at the Cologne FN-Tandem Accelerator — •Markus Schiffer, Richard Altenkirch, Gereon Hackenberg, Claus Müller-Gatermann, Claus Feuerstein, Susan Herb, Alexander Stolz, Marcel Marock, Gregor Zitzer, Stefan Heinze, Mario Cappellazzo, and Alfred Dewald — Institute for Nuclear Physics, University of Cologne, Germany

The new AMS system at the Cologne 10 MV FN accelerator has been finalized in its first stage. The system has been designed for the measurement of medium mass isotopes, especially for ^{53}Mn and ^{60}Fe.

In a first test period we have measured the suppression and separation capability of the system with ^{54}Cr and ^{54}Fe as well as ^{58}Fe and ^{58}Ni. The achieved suppression is mainly dominated by the energy loss and the energy loss straggling at stacked SiN degrader foils. Further we investigated the performance of the single components, the dispersion of the electrostatic analyzer as well as the resolution of the time of flight system and of the gas ionization detector. It will be shown, that energies of 100 MeV are sufficient for a suppression of ^{60}Ni from ^{60}Fe down to a ratio of 10^{-15} nearly without software gates and for the suppression of ^{53}Cr from ^{53}Mn down to a ratio of 10^{-8} with a 50% software gate. The final component of our AMS setup, a 135°-magnet, designed for gas-filled operation will be installed in spring 2017 and will increase the overall efficiency.

Supported by the DFG and the Excellence Initiative of the University Cologne, Emerging Group ULDETIS.

MS 6.4 Wed 15:30 RW 2

Modification of the 120° Bending Magnet at the CologneAMS as Gas-Filled-Magnet — •Richard Altenkirch, Claus Feuerstein, Markus Schiffer, Stefan Heinze, Claus Müller-Gatermann, and Alfred Dewald — Institute for Nuclear Physics, University of Cologne, Germany

Routine measurements of the last years at the 6 MV AMS system showed a good isobar suppression for all Isotopes, measured with the Degrader-Foil-Method, especially ^{36}Cl and ^{9}Be. However, the efficiency is reduced due to the charge state distribution by this technique.

For measurements with atomic ^{26}Al the efficiency is limited by the low beam output of the ion source. In the case of AlO the output is larger by the factor of 10. In this case the suppression of ^{26}Mg will become necessary.

In order to minimize efficiency losses for ^{9}Be, ^{26}Al and ^{36}Cl measurements the 120° magnet at the 6 MV AMS system was modified to enable a Gas-Filled-Operation, under the special condition to keep the equipment for the degrader-foil technique untouched.

Besides constructional steps, first results for ^{26}Al and ^{36}Cl beams will be presented. This includes beam broadening and isobar separation as a function of the gas pressure. The measured data will be compared to Monte Carlo simulations.

A new designed multi-wire chamber in combination with an ionisation chamber will be presented.

MS 6.5 Wed 15:45 RW 2

New data for cosmogenic ^{53}Mn and ^{60}Fe in iron meteorites — •Thomas Smith[1], Ingo Leya[1], Silke Merchel[2], Georg Rugel[2], Stefan Pavetich[3], Michaela Fröhlich[3], Anton Wallner[3], Keith Fifield[3], Stephen Tims[3], Gunther Korschinek[4], and Thomas Faestermann[4] — [1]University of Bern, Switzerland — [2]HZDR, Dresden, Germany — [3]ANU, Canberra, Australia — [4]TUM, Munich, Germany

Cosmogenic nuclides in meteorites can provide information on cosmic ray exposure (CRE) histories. In space, meteoroids are irradiated by galactic cosmic ray particles, inducing the production of cosmogenic nuclides (^{10}Be, ^{26}Al, ^{36}Cl, ^{41}Ca, ^{53}Mn, ^{60}Fe). Meteorites are routinely measured for ^{10}Be, ^{26}Al, and ^{36}Cl. However the database for ^{53}Mn and ^{60}Fe is scarce due to the low availability of high-MV accelerators and the debate over the half-lives of ^{53}Mn and ^{60}Fe. We report new ^{53}Mn and ^{60}Fe data for iron meteorites measured at Canberra (^{53}Mn, ^{60}Fe) and Munich (^{60}Fe). Among these radionuclides, ^{53}Mn has the longest half-life, thus is least influenced by terrestrial ages. The advantage of ^{53}Mn and ^{60}Fe isotopes is that only two (Fe, Ni) and one (Fe) target element(s), respectively, dominate production, overcoming the problem of inhomogeneous S and P distribution. Our new ^{60}Fe data almost doubles that present in the literature. We measured ^{53}Mn in seven subsamples of the iron meteorite Twannberg. The new ^{53}Mn and ^{60}Fe data, with ^{10}Be, ^{26}Al, ^{36}Cl, ^{41}Ca and the noble gases, will better constrain the CRE histories of meteorites and will also serve as benchmarks to validate and improve Monte-Carlo model calculations.

MS 6.6 Wed 16:00 RW 2

Analysis of ^{233}U/^{236}U in environmental samples — •Karin Hain[1], Peter Steier[1], Rosmarie Eigl[2], Robin Golser[1], Xiaolin Hou[3], Johannes Lachner[1], Jixin Qiao[3], Francesca Quinto[4], and Aya Sakaguchi[2] — [1]University of Vienna, Faculty of Physics, Austria — [2]Hiroshima University, Japan — [3]Technical University of Denmark, Denmark — [4]Karlsruhe Institute of Technology, Germany

For the tracing of environmental waters, long-lived radionuclides of soluble elements like U, which mainly behave conservatively in water, are demanded. Even though ^{236}U ($T_{1/2}$=2.342·10^7 a) in many cases is a suitable tracer for this application, the results on the concentration of ^{236}U can be difficult to interpret, e.g. for several contamination sources. The Accelerator Mass Spectrometry set-up at the Vienna Environmental Research Accelerator (VERA) has recently increased its detection efficiency for actinides such that it is now capable to detect also ^{233}U ($T_{1/2}$=1.592·10^5 a) in environmental samples. The detected average ^{233}U/^{236}U ratio in the environment is at a level of around 1%. First, preliminary results of ^{233}U/^{236}U in different types of sample material, e.g. corals, sediments, peat bog and sea water will be presented in this talk. These results indicate a predominant production of ^{233}U in a specific type of thermonuclear explosions which allows for source identification.

MS 6.7 Wed 16:15 RW 2

Quasi simultaneous measurements of ^{236}U/^{238}U ratios on the compact ETH Zurich Tandy AMS system — •Marcus Christl, Christof Vockenhuber, Sascha Maxeiner, Núria Casacuberta, Jürg Thut, and Hans-Arno Synal — Laboratory of Ion Beam Physics, ETH Zurich, Switzerland

Measurements of actinides with the compact 0.5 MV AMS system Tandy at ETH Zurich have become routine over the past years. With more than 200 samples analyzed per year (2012-2016), ^{236}U currently represents the most important actinide nuclide measured at ETHZ. Very recently new, small Faraday Cups (FC) with an opening of 8x12 mm^2 have been developed and installed at the HE side of the Tandy AMS system. With the new FCs it is now possible to perform quasi simultaneous measurements of ^{236}U/^{238}U ratios using the standard fast pulsing system. In this presentation the design of the FCs, the concept of the new AMS setup for ^{236}U/^{238}U and ^{236}U/^{233}U measurements, as well as the performance of the new FCs is presented. In addition to the technical part, new data from the ongoing oceanographic mapping program of ^{236}U (and ^{129}I) as well as the status of an intercalibration effort for ^{236}U will be presented.

MS 7: Poster

Time: Wednesday 17:00–19:00 Location: P OGs

MS 7.1 Wed 17:00 P OGs

Towards a Mass Measurement of Helium-3 at THe-Trap — •Tom Segal, Martin Höcker, Jochen Ketter, Marc Schuh, Sebastian Streubel, and Klaus Blaum — Max-Planck-Institut für Kernphysik

THe-Trap is a precision Penning-trap mass spectrometer[1] at the Max-Planck-Institute für Kernphysik (MPIK) in Heidelberg. It aims to settle the 4-sigma discrepancy in the mass measurements of helium-3[2,3] by measuring its mass with a relative uncertainty of about 100ppt. If left unresolved, the discrepancy will cause an increase in the uncertainties of the hydrogen and deuterium masses, as well as in the values of physical constants such as h, e, k and Avogadro's constant. In the talk the current status of the experiment will be presented as well as ideas for future developments.

[1] S.Streubel et al., Applied Physics B: Lasers and Optics (2014), 114(1-2), 137-145. [2] R.S.Van Dyck et al., Metrologia (2015), Volume 52, Number 2. [3] E.G. Meyers et al., Phys. Rev. Lett (2015), 144,013003.

MS 7.2 Wed 17:00 P OGs

An experiment for high-precision mass measurements of the proton and the neutron — •Sascha Rau[1], Fabian Heisse[1,2], Sven Junck[3], Florian Köhler-Langes[1], Andreas Mooser[4], Wolfgang Quint[2], Stefan Ulmer[4], Günter Werth[3], Klaus Blaum[1], and Sven Sturm[1] — [1]Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, D-69117 Heidelberg, Germany — [2]GSI-Helmholtzzentrum für Schwerionenforschung, D-64291 Darmstadt, Germany — [3]Institut für Physik, Johannes Gutenberg-Universität Mainz, D-55099 Mainz, Germany — [4]RIKEN Ulmer Initiative Research Unit, Saitama 351-0198, Japan

Protons and neutrons are the central building blocks of all nuclei. Measuring their properties, among others their atomic masses, is of continued interest for metrology and offers possibilities for precision tests.

We are presently setting up a new experiment consisting of a cryogenic Penning-trap system, which aims to measure m_p and m_n in atomic mass units with a relative uncertainty of $\delta m/m = 10^{-11}$ or better. This precision is achieved by comparing the simultaneously measured cyclotron frequencies of a proton or a deuteron, respectively, with a $^{12}C^{6+}$-ion utilizing a phase-sensitve measurement technique, thus cancelling magnetic field fluctuations. The current status of the experiment, experimental methods, as well as first results will be presented.

MS 7.3 Wed 17:00 P OGs

High-Precision Mass Measurements with PENTATRAP — •Rima X. Schüssler[1,2], José R. Crespo López-Urrutia[1], Sergey Eliseev[1], Pavel Filianin[1], Alexander Rischka[1,2], Christoph Schweiger[1,2], Sven Sturm[1], Stefan Ulmer[3], and Klaus Blaum[1] — [1]Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Germany — [2]Universität Heidelberg, Fakultät für Physik und Astronomie, Im Neuenheimer Feld 226, 69120 Heidelberg, Germany — [3]RIKEN, Ulmer Initiative Research Unit, Wako, Saitama 351-0198, Japan

The high-precision Penning-trap mass spectrometer PENTATRAP is currently being commissioned at the Max-Planck-Institut für Kernphysik, Heidelberg. PENTATRAP aims at mass-ratio measurements of single stable and long lived highly charged ions with a relative uncertainty of a few 10^{-12} through measurements of their respective cyclotron frequencies in the strong magnetic field of a Penning trap. At this precision level, PENTATRAP will, for instance, contribute to electron-neutrino mass related measurements within the ECHo collaboration, which investigates the de-excitation spectrum following the electron capture in ^{163}Ho.

The main features including the detection system, the traps and the ion creation part will be presented in the poster.

MS 7.4 Wed 17:00 P OGs

Kinetic and mechanistic reaction studies of metal clusters under multi-collision conditions — •Martin Tschurl, Jan Frederik Eckhard, Tsugunosuke Masubuchi, Daniel Neuwirth, and Ueli Heiz — Technical University of Munich, Chair of Physical Chemistry, Lichtenbergstraße 4, 85748 Garching, Germany

The reactions of metal and metal oxide clusters are studied in the gas-phase due to their nature as model catalysts. Important phenomena relevant for catalytic processes, e.g. C-C coupling and overcoming activation barriers, may be observed when these reactions are conducted under multi-collision conditions. We present a setup in which clusters are produced by a laser vaporization source, size-selected in a quadrupole mass filter and stored within a cryogenic ring electrode ion trap. Due to the buffer gas pressure, ions inside the trap are constantly thermalized. The reaction product intensities are analyzed by a reflectron time-of-flight mass spectrometer as a function of reaction time. Consequently, the kinetics and activation energy of each reaction step can be determined. Results concerning the cluster generation and analysis of their reaction properties will be presented.

MS 7.5 Wed 17:00 P OGs

Improvements of the resolving power at ClusterTrap — •Alexander Jankowski, Steffi Bandelow, Stephan König, Gerrit Marx, Lutz Schweikhard, and Markus Wolfram — Institut für Physik, Ernst-Moritz-Arndt-Universität Greifswald, 17487 Greifswald, Germany

The ClusterTrap experiment in Greifswald [1] is a versatile tool for the investigation of size- and charge-state dependent properties of metal cluster. For these investigations charged clusters are stored using Paul and Penning traps and are exposed to electrons, photons or other reactants. Interaction products are then analyzed by time-of-flight mass spectrometry. Its resolving power determines which reaction products can be distinguished. A particular difficulty poses the extraction from the Penning Trap, since it deviates from the two-stage acceleration section of a Wiley-McLaren arrangement [2]. The presentation describes simulations of the extraction from the Penning trap as well as the design and test of a reflectron [3] for the improvement of the resolving power.

References:
[1] F. Martinez et al., Int. J. Mass Spectrom. 365-366, 266 (2014)
[2] W.C. Wiley, I.H. McLaren, Rev. Sci. Instrum. 26, 1150 (1955)
[3] B.A. Mamyrin et al., Zh. Eksp. Teor. Fiz. 64, 82 (1973)

MS 7.6 Wed 17:00 P OGs

Operating a low-energy electron cooler at the Cryogenic Storage Ring CSR — •Marius Rimmler, Arno Becker, Claude Krantz, Jorrit Lion, Svenja Lohmann, Oldřich Novotný, Sunny Saurabh, Stephen Vogel, Patrick Wilhelm, and Andreas Wolf — Max-Planck-Institut für Kernphysik, Heidelberg, Germany

The Cryogenic Storage Ring CSR is an experimental platform for reaction studies on atomic, molecular and cluster ions stored for hours in a cryogenic enviroment and in a vacuum better than 10^{-14} mbar. Fundamental reaction dynamics can be probed, while the ions relax toward lower internal energy, in some cases reaching the ro-vibrational ground state. In these experimental studies well-defined overlaps in merged-beam experiments can be attained by minimizing the ion beam's emittance through phase-space cooling. This proceeds by Coulomb collisions when a low-energy-spread electron beam is merged with the ion beam. In CSR we have implemented such an electron beam device operating at cryogenic conditions.

The cold electrons are produced by a GaAs photocathode and merged with the stored ion beam via a magnetic guiding field using high-temperature superconduting coils. To perform velocity-matched electron cooling of slow heavy ions, the CSR electron cooler was designed to supply electron energies as low as 1eV. It is scheduled to operate during the upcoming cold CSR beam-time(spring 2017). The systematic studies on the performance of the electron cooler in terms of cooling times will be presented.

MS 7.7 Wed 17:00 P OGs

MOCCA: A 4k-pixel molecule camera for the position and energy resolving detection of neutral molecule fragments at the Cryogenic Storage Ring CSR — •S. Allgeier[1], C. Enss[1], A. Fleischmann[1], L. Gamer[1], L. Gastaldo[1], S. Kempf[1], C. Krantz[2], O. Novotný[2], D. Schulz[1], and A. Wolf[2] — [1]Heidelberg University — [2]MPIK Heidelberg

The Cryogenic Storage Ring CSR at the Max Planck Institute for Nuclear Physics in Heidelberg is designed to prepare and store molec-

ular ions in their rotational and vibrational ground states. A key requirement for the study of electron-ion interactions within CSR is the identification of reaction products. The use of metallic magnetic calorimeters (MMCs) allows for identifying all neutral products since the deposited kinetic energy of incident particles into MMC absorbers can be used as a measure of the particle mass. To actually resolve the full reaction kinematics, a position sensitive coincident detection of multiple reaction products is necessary.

For these measurements we designed MOCCA, a 4k-pixel molecule camera based on MMCs with a detection area of 45 mm×45 mm, which is segmented into 64×64 absorbers and read out using only 32 SQUIDs. We discuss the detector design and its microfabrication as well as its multi-hit capability, cross-talk and expected energy resolution for photons and massive particles. In addition, we outline our plans for integrating MOCCA and its ^{3}He/^{4}He dilution refrigerator into CSR.

MS 7.8 Wed 17:00 P OGs

Resonance ionization scheme development at ISOLDE RILIS — •Katerina Chrysalidis[1,2], Jochen Ballof[1,2], Thomas Day Goodacre[1,3], Valentin Fedosseev[1], Bruce Marsh[1], Sebastian Rothe[1], Christoph Seiffert[1], and Klaus Wendt[2] — [1]CERN, Geneva, Switzerland — [2]JGU, Mainz, Germany — [3]University of Manchester, Manchster, United Kingdom

The RILIS at the ISOLDE radioactive beam facility at CERN is the most intensively used ion source, providing more than $> 75\,\%$ of ion beams in 2016. Based on the stepwise laser resonance ionization, the RILIS offers an element selective process of ionization. Each element possesses a unique atomic configuration, requiring a specific laser ionization scheme. The stepwise ionization additionally offers the means to ionize the atom via high lying Rydberg states. This method allows for the determination of the ionization potential of an element.
An overview over the currently available laser ionization schemes and the latest scheme development will be given alongside the discussion of the measurement of the europium ionization potential. Furthermore, an outlook towards future developments and applications of the ISOLDE RILIS will be given.

MS 7.9 Wed 17:00 P OGs

Excitation scheme development for resonant Laser-SNMS on Strontium — •Hauke Bosco[1], Michael Franzmann[1,2], Tobias Kron[2], Dominik Studer[2], Martin Weiss[1], Klaus Wendt[2], and Clemens Walther[1] — [1]Institut für Radioökologie und Strahlenschutz Universität Hannover — [2]Institut für Physik Universität Mainz

Radionuclides were released into the environment in large amounts by nuclear weapons testing and by accidents in nuclear facilities. One of the most radiotoxic nuclides is Strontium 90, which is efficiently produced by fission of Uranium 235. Therefore, rapid detection techniques for trace and ultra-trace amounts of Strontium 90 are mandatory to be able to provide counter-measures for possible releases from nuclear facilities. Since radiometric methods with good detection limits (e.g. LSC) are time consuming, a rapid mass spectrometric ultra-trace analysis of environmental samples is developed based on an existing system for spatially resolved SIMS combined with a laser system for isobaric suppression by resonance ionization of elements. To find ionization steps with a high ion production yield, resonance ionization spectroscopy (RIS) on Strontium is performed starting from known electron transitions. Developed excitation schemes are applied to Strontium for resonance ionization to perform resonant Laser-SNMS. Different schemes are tested on artificial as well as natural samples containing stable and radioactive Strontium.

MS 7.10 Wed 17:00 P OGs

A Bragg curve detector for AMS purposes at Cologne AMS — •Gregor Zitzer, Alfred Dewald, Stefan Heinze, Claus Müller-Gatermann, Alexander Stolz, Gereon Hackenberg, Markus Schiffer, and Richard Altenkirch — Institut für Kernphysik, Universität zu Köln

A Bragg curve ionisation chamber has been designed and built for AMS studies at CologneAMS based on the ideas of the Brazilian Bragg curve detector [1], where a NEC accelerator tube module is used for housing the isobutane detector gas. Various detector gases, pressures and axial electrical fields have been tested with alpha particles emitted from a Pu-239, Am-241 and Cm-244 source. In contrast to the normally used analog electronics, with long and short shaping times, the preamplifier pulses are directly fed into a CAEN DT5724 digitizer which digitally processes and analyses the signals in respect of the two corresponding shaping times.

Also in-beam tests were performed with C-14, Al-26 and F-19 in the energy range of 25 - 45 MeV. For C-14 resolutions of 0.4 % fwhm and 2.5 % fwhm, for the total energy and Bragg peak signal, respectively, were obtained.

Finally we present a direct comparison of a standard multi-anode ionisation chamber with the Bragg detector for Cr-54, Fe-54 and Fe-58, Ni-58 beams, which are of special interest for our upcoming AMS program.

[1] G.M. Santos et al., Nucl. Instr. and Meth. in Phys. Res. B 172 (2000) 310-315

MS 7.11 Wed 17:00 P OGs

Control and automation of the AMS setup at the Cologne FN Tandem Accelerator — •Gereon Hackenberg, Alfred Dewald, Claus Feuerstein, Markus Schiffer, Richard Altenkirch, Claus Müller-Gatermann, and Susan Herb — Universität zu Köln, Institut für Kernphysik, Deutschland

For the new AMS setup at the Cologne FN Tandem Accelerator we designed a control and automation system, which allows a straightforward and easy operation of the currently more than 30 components. This includes the whole control of the ion source and many other components. All components are controlled by programmable logic controllers (PLC; Siemens SPS) and a few microcontrollers, which are driven by a LabVIEW program. The software can be operated via a graphical user interface or a linked control board mapping nearly all components. Additional features of the software enable to trace some indicators (e.g. beam current at cup) with respect to specific control elements. Correlations of parameters are also supported between control elements for automating them. They can be linked to other control elements using arbitrary functions, e.g. a lens can be operated in a linear dependency of an electrostatic analyzer. The control system supports batch-mode operation, which is commonly used in AMS measurements. This includes the automated handling of samples and data processing for online evaluation of measured signals.

MS 7.12 Wed 17:00 P OGs

Aktuelle Forschung und Upgrade der AMS am Münchener Tandembeschleuniger — •Dominik Koll, Christoph Busser, Thomas Faestermann, José Manuel Gómez Guzmán, Karin Hain, Gunther Korschinek, David Krieg, Manuel Lebert, Peter Ludwig und Boyana Deneva — Physik-Department der Technischen Universität München, 85748 Garching

Am Münchener Tandembeschleuniger wird seit vielen Jahren Beschleunigermassenspektrometrie (AMS) verwendet, um höchstempfindliche Messungen von Radionukliden in allen Massenbereichen durchzuführen.

Hierfür stehen zwei dedizierte Strahlrohre zur Verfügung, eines mit einem gasgefüllten Analysier-Magneten (GAMS) zur Isobarentrennung, das andere mit einer Flugzeitstrecke und einem Halbleiterzähler.

Aktuell werden verschiedene Radioisotope aus Umwelt, Technik und Astrophysik an dieser Anlage untersucht.

Im Moment findet ein Upgrade der Flugzeitstrecke mit einem neuen Detektorsystem für höhere Transmissionen, bestehend aus einem Array aus neun PIPS-Detektoren, statt.

Dieser Beitrag soll einen Überblick über die verschiedenen untersuchten Isotope und die verwendeten Nachweismethoden liefern.

MS 7.13 Wed 17:00 P OGs

The Heidelberg ArTTA: Expanding the ultimate limit of Trap Trace Analysis — •Zhongyi Feng[1], Sven Ebser[1], Lisa Ringena[1], Andreas Kamrad[1], Florian Nicolai[1], Werner Aeschbach[2], and Markus K. Oberthaler[1] — [1]Kirchhoff-Institut für Physik, Universität Heidelberg, Im Neuenheimer Feld 227, 69120 Heidelberg, Germany. — [2]Institut für Umweltphysik, Universität Heidelberg, Im Neuenheimer Feld 229, 69120 Heidelberg, Germany.

The high selectivity of many photon scattering processes in a Magneto-Optical Trap makes Trap Trace Analysis the state of the art detection technique for rare noble gas isotopes, where sample size is a limiting factor. Our Heidelberg Argon-39 Trap Trace Analysis (ArTTA) collaboration has improved this ultra-sensitive counting method below the 10^{-15} natural abundance level to fulfill the requirements for radiometric dating with Argon-39. With this poster, we will show the current status of the experiment and the prospects for measurements on a routine basis. The performance is mainly limited by the low count rate and further improvements require highly enriched Argon-39 samples with the drawback of contamination. This issue is addressed by a Optimizing Trap Trace Analysis (OpTTA) setup which can be operated

independently from the main apparatus. We will discuss the possible improvements of the metastable source, advanced cooling mechanism and trapping schemes that can be investigated with OpTTA.

MS 7.14 Wed 17:00 P OGs

A simple, low-cost radio-frequency ion deflector for mass separation — •Magnus Schlösser[1,2], Vitaly Rudnev[2], and Ángel González Ureña[2] — [1]Karlsruhe Institute of Technology, Institute of Technical Physics, Tritium Laboratory Karlsruhe, GER — [2]Universidad Complutense de Madrid, Instituto Pluridisciplinar, ES

Electrostatic cylindrical deflectors are routinely used as energy analyzer for ion beams. We present that by imposing of a radio-frequency modulation on the deflecting electric field, the ion transmission becomes mass dependent. By the choice of the appropriate frequency, amplitude, and phase, the deflector can be used as mass filter (without employing a magnetic field). The device has a very simple design, little cost and low machining requirements for mechanical workshops, and may therefore be of interest for certain applications.

We show the basic working principle of the instrument which is underlined by numerical simulations. This concept is demonstrated experimentally on a beam of molecular anions and it is shown how the different masses can be focussed in space and time by optimized settings of the radio-frequency parameters of the bender.

MS 8: Annual General Meeting of the Mass Spectrometry Division, Election

Time: Thursday 14:00–14:30 Location: RW 2

Annual General Meeting of the Mass Spectrometry Division

MS 9: Accelerator Mass Spectrometry and Applications II

Time: Thursday 14:30–17:00 Location: RW 2

MS 9.1 Thu 14:30 RW 2

AMS measurements of ^{26}Al at ETH Zurich — •Christof Vockenhuber[1], Marcus Christl[1], Klaus-Ulrich Miltenberger[1], Arnold Müller[1], Kristina Hippe[1], and Naki Akçar[2] — [1]Laboratory of Ion Beam Physics, ETH Zurich, Switzerland — [2]Institute of Geological Sciences, University of Bern, Switzerland

At ETH Zurich ^{26}Al has been measured for many decades at the 6 MV EN tandem accelerator. Compared to other cosmogenic rationuclides (e.g. ^{10}Be), the number of samples was always smaller because of the limited precision that could be achieved. A key challenge is the low ionization efficiency of $^{26}Al^-$ (from an Al-oxide matrix) required to suppress the isobar ^{26}Mg. Recent developments at low energies at the 500 kV TANDY promised significant improvements in overall efficiency due to higher transmission through the accelerator. Alternatively, the ionization efficiency can be increased by using $^{26}AlO^-$ from the ion source; however, then, high ion energies and the gas-filled magnet (GFM) are necessary to remove the majority of interfering ^{26}Mg before the final detector. In this talk we will give a comparison of the measurement methods at ETH Zurich, present their performance under routine measurement conditions and finally discuss the advantages and limitations of each setup.

MS 9.2 Thu 14:45 RW 2

Gas flow dynamics in an AMS stripper — •Sascha Maxeiner, Hans-Arno Synal, Marcus Christl, Lukas Wacker, and Andreas Herrmann — Laboratory for Ion Beam Physics (LIP), ETH Zurich, Switzerland

The stripper of an AMS system is required to strip off electrons from the incident negative ion beam and it is responsible for the dissociation of molecules. In low energy AMS gas strippers are widely applied. Besides their desired effects (charge exchange and molecule destruction) gas strippers can have a big influence on measurement sensitivity and background. For example, the interaction of incident ions with residual stripper gas outside of the stripper tube, e.g. during acceleration, is known to cause interferences which limit the abundance sensitivity.

In this presentation processes are discussed which can lead to increased leakage of stripper gas into the AMS beam line. Methods are presented to model these processes and an experimental setup is described to measure the gas leakage out of the stripper tube. The results of both, experiments and simulations are used to optimize the separation of stripper target and vacuum by designing new stripper geometries. As an example, the application of the optimization procedure to the TANDY AMS facility is presented and the potential of the new tool for optimization of existing systems is discussed.

MS 9.3 Thu 15:00 RW 2

Improvement of the Laser Ablation Interface for Direct ^{14}C -AMS analysis of carbonates — •Christiane Yeman[1], Caroline Welte[1], Bodo Hattendorf[2], Joachim Koch[2], Marcus Christl[1], Lukas Wacker[1], and Allen Andrews[3] — [1]Laboratory of Ion Beam Physics, ETH Zurich, 8093 Zurich, Switzerland — [2]Laboratory for Inorganic Chemistry, ETH Zurich, 8093 Zurich, Switzerland — [3]NOAA Fisheries, Pacific Islands Fisheries Science Center, HI 96818, USA

A novel method for direct and quasi continuous ^{14}C analysis of carbonates was developed, where a laser ablation (LA) system is coupled to the gas ion source of the MICADAS (MIniCArbonDAtingSystem) accelerator mass spectrometer (AMS) at the Laboratory of Ion Beam Physics, ETH Zurich. By focusing a pulsed laser beam (ArF excimer laser 193 nm, 200 - 250 Hz) on the sample surface, CO_2 is produced, which is directly and continuously introduced into the gas ion source and analyzed for radiocarbon. With the new design of the ablation cell and the modified optical setup the energy on the sample is doubled leading to higher CO_2 production. Moreover, the spatial resolution has improved from 100μm down to 75μm.

LA-AMS can be used for the analysis of terrestrial and marine carbonate samples, such as stalagmites, corals, shells and otoliths. Here, we present the analysis of the otolith of a red snapper (Lutjanus campechanus) - only a few hundred micrometers thick - by LA-AMS. The ^{14}C signature recorded for the lifespan of the fish shows pre-bomb and peak ^{14}C, indicating the fish was more than 50 years old.

MS 9.4 Thu 15:15 RW 2

$^{14}CO_2$ Radiocarbonmessungen am CologneAMS * — •Alexander Stolz[1], Alfred Dewald[1], Stefan Heinze[1], Richard Altenkirch[1], Markus Schiffer[1], Claus Müller-Gatermann[1] und Tibor Dunai[2] — [1]Institut für Kernphysik, Universität zu Köln — [2]Institut für Geologie, Universität zu Köln

Die zweite HVE-SO110 Sputterquelle am CologneAMS-Beschleuniger der Universität zu Köln wurde mit einem Gasinjektionssystem der Ionplus AG ausgestattet, um $^{14}CO_2$ Radiocarbonmessungen durchzuführen. Nach anfänglichen Instabilitäten der Quelle und vergleichsweise geringen Ionisierungseffizienzen von maximal 2% wurden nun Betriebsparameter gefunden, die einen stabilen Routinebetrieb bei Effizienzen über 5% gewährleisten. Um eine maximale Ausleuchtung der Ti-Inserts zu erreichen wurde eine modifizierte Immersionslinse verbaut und der Cs-Strahl vermessen. Die Targetposition und -geometrie wurden der neuen Optik angepasst. Zusätzlich wurde eine neue Steuerungssoftware für das Gasinjektionssystem entwickelt, die eine automatisierte Regelung des Gasflusses und optimierte Routinen für den Transfer und die Mischung sehr kleiner Proben bis 2 μg C mit dem Trägergas He bereitstellt. Testmessungen und Resultate zur Untersuchung der Abhängigkeiten von Probengröße, Mischungsverhältnis, Position und Targetspannung, sowie zur Reproduzierbarkeit der gemessenen $^{14}C/^{12}C$-Verhältnisse werden vorgestellt.

* Das Projekt wurde teilweise aus Mitteln des Deutschen GeoForschungsZentrums GFZ, Helmholtz-Zentrum Potsdam finanziert.

MS 9.5 Thu 15:30 RW 2

Current developments for AMS with medium mass isotopes in Garching — •Peter Ludwig[1], Christoph Busser[1], Thomas Faestermann[1], Jose Manuel Gomez Guzman[1], Karin Hain[2], Do-

MINIK KOLL[1], GUNTHER KORSCHINEK[1], DAVID KRIEG[1], and MANUEL LEBERT[1] — [1]Physik Department, Technische Universität München — [2]Isotopenforschung und Kernphysik, Universität Wien

The AMS setup at the Maier-Leibnitz-Laboratory (MLL) in Garching features a 14 MV tandem accelerator and two dedicated beam lines for high-sensitivity measurements of isotopes in all mass ranges. Especially in the medium mass range ($70 < A < 120$), AMS sensitivity is often limited by isobaric and isotopic background with only small relative difference in Z and/or A. Recent developments at the MLL are aimed at improved sensitivity for isotopes such as 79Se, 93Zr, and 99Tc. Possible applications include the measurement of astrophysical cross-sections and environmental studies. In this talk, I will present the employed measurement techniques, specifically isobaric suppression via either a gas-filled magnet or passive absorber foils, and show the status of the current upgrade of the facility with a new silicon detector array.

MS 9.6 Thu 15:45 RW 2

New and upgraded ionization chambers for AMS at HIAF — •MARTIN MARTSCHINI, KEITH FIFIELD, MICHAELA FROEHLICH, STEFAN PAVETICH, STEPHEN TIMS, and ANTON WALLNER — Department of Nuclear Physics, The Australian National University, ACT 2601, Australia

Radionuclides measured by Accelerator Mass Spectrometry at the Heavy Ion Accelerator Facility (HIAF) of the Australian National University include ^{10}Be, ^{26}Al, ^{36}Cl, ^{53}Mn, ^{60}Fe, ^{93}Zr, ^{129}I, ^{236}U and Pu. The 14UD pelletron accelerator provides ample energy for isobar separation using a gas-filled-magnet setup with an ENGE-split-pole spectrograph.

In order to fully exploit the isotopic and isobaric separation capabilities, three new ionization chambers are currently being designed and constructed: Two new compact ionization chambers based on similar designs to those at ETH Zurich and at VERA (Vienna) allow for measurements of actinides and other radioisotopes without atomic isobaric interferences. While one is optimized for high energy resolution, the other serves as the final energy detector in a time-of-flight setup. The third ionization chamber is a new multi-anode device optimized for the detection of ^{53}Mn after the gas-filled magnet. The design is based on simulations with Raytrace and SRIM. Last but not least, an existing ionization chamber used, e.g., for ^{93}Zr-measurements is undergoing an upgrade of detector electronics. Details of these projects and first experimental results will be discussed.

MS 9.7 Thu 16:00 RW 2

Erste Tests für ^{44}Ti-AMS an DREAMS — •ANDREAS SCHARF[1], DANIEL BEMMERER[1], TAMÁS DITRÓI[2], NASRIN B. KHOJASTEH[1], SILKE MERCHEL[1], GEORG RUGEL[1] und KAI ZUBER[3] — [1]HZDR, Dresden, Germany — [2]University of Debrecen, Hungary — [3]TU Dresden, Germany

Das Radionuklid ^{44}Ti ($T_{1/2}$ = 58,9 a) wird vor allem während Supernovaexplosionen gebildet und spielt eine wichtige Rolle für deren theoretische Modelle und die Nukleosynthese schwerer Elemente. In Supernovaüberresten kann ^{44}Ti mittels γ-Astronomie nachgewiesen werden, allerdings befinden sich die Beobachtungen nicht im Einklang mit den theoretischen Modellen. Problematisch dabei ist, dass der Wirkungsquerschnitt der Reaktion ^{40}Ca(α,γ)^{44}Ti bisher nur unzureichend bekannt ist [1]. Während bislang nur ^{44}Ti-AMS-Messungen an großen Beschleunigern (ab 10 MV Terminalspannung) durchgeführt wurden [2], sollte es prinzipiell auch möglich sein, an 6-MV-Anlagen dieses Radionuklid zuverlässig zu messen. Wir präsentieren erste Tests an der AMS-Anlage DREAMS des HZDR, die zeigen, dass mithilfe einer Degrader-Folie eine zuverlässige Abtrennung des stabilen Isobars ^{44}Ca und Messung des Radionuklids ^{44}Ti auch bei Beschleunigungsspannungen von 6 MV möglich ist. Diese ersten Tests dienen dazu, die Machbarkeit von AMS-basierten Messungen des Wirkungsquerschnitts der Reaktion ^{40}Ca(α,γ)^{44}Ti an DREAMS auszuloten. Das Projekt wurde unterstützt vom DAAD.

Ref.: [1] Schmidt et al., Phys. Rev. C 88, 025803 (2013) [2] Nassar et al., Phys. Rev. Let. 96, 041102 (2006)

MS 9.8 Thu 16:15 RW 2

Mass spectrometry and the evolution of the western Namibian drainage systems — •ANDREAS GÄRTNER[1], ULF LINNEMANN[1], SILKE MERCHEL[2], SAMUEL NIEDERMANN[3], AXEL GERDES[4], GEORG RUGEL[2], ANDREAS SCHARF[2], LOIC LE BRAS[2], MANDY HOFMANN[1], and JOHANNES ZIEGER[1] — [1]SNSD, Geochronologie, Dresden, Germany — [2]HZDR, Dresden, Germany — [3]GFZ, Potsdam, Germany — [4]JWG-Universität Frankfurt, Institut für Geowissenschaften, Frankfurt, Germany

Our multi-method MS study (AMS, noble gas MS, LA-(MC)-ICP-MS) aims to constrain the evolution of the western Namibian drainages since the last ca. 40 Ma. Therefore, fluvial sediments of several rivers and their precursors were sampled. In order to obtain precise surface exposure ages of the various terrace levels, the routinely used cosmogenic nuclides ^{10}Be, ^{21}Ne, ^{26}Al (quartz), and ^{36}Cl (calcite) were applied either on surface samples or on depth-profiles consisting of 3 to 5 samples each. U-Pb small scale isochrone (SSI) ages of calcareous matrices were also used for terrace dating. Sedimentary provenances were revealed by detrital zircon ($ZrSiO_4$) geochronology using U-Th-Pb and Lu-Hf isotope systematics. They indicate varying detrital zircon patterns through time. Our approach facilitates the recognition of changes in the fluvial sediment provenance at certain points in time. Such combined studies have a huge potential for revealing the palaeohydrological history, and to estimate amplitudes and processing speeds of past events or changing sizes of catchment areas, which is of particular interest for modelling the palaeoclimate and palaeogeography.

MS 9.9 Thu 16:30 RW 2

Tackling challenges in AMS sample preparation — •SILKE MERCHEL[1], LOIC LE BRAS[1], SABRINA GURLIT[1], GEORG RUGEL[1], ANDREAS SCHARF[1], THOMAS OPEL[2], and SEBASTIAN WETTERICH[2] — [1]HZDR, Dresden, Germany — [2]AWI, Potsdam, Germany

Since 2009 the DREAMS (DREsden Accelerator Mass Spectrometry) facility offers users to do their own sample preparation for AMS targets. A large number of samples from interdisciplinary research topics such as astronomy, climate, cosmochemistry and geology could be transformed into BeO, Al_2O_3, AgCl and CaF_2 showing reasonable to excellent performance [Rugel et al., this DPG.]. However, besides our constant approach to become a little better every day, sometimes very new challenges can arise due to the low availability of the sample material, low radionuclide concentration or a possible contamination of the sample with disturbing elements and nuclides. Two examples:

Ice samples are always in our focus. As we were facing problems with ^{10}Be contamination in "dirty" ground ice, we measured ^{36}Cl and ^{nat}Cl by isotope dilution in permafrost ice wedge samples as heavy as 1.6 kg. The chemical yield of AgCl was only 20-35% (and is a function of total ^{nat}Cl), which might be improved by preconcentration steps.

For the determination of in-situ or atmospheric ^{26}Al in marine and terrestrial sediments [e.g. Gärtner et al., this DPG.], we had sometimes unaccountable low chemical yields, which seems to be partially due to redissolving aluminium hydroxide in the last washings.

Thanks to A. Gärtner, P. Ludwig, D. Rodrigues and several students for providing/processing samples.

MS 9.10 Thu 16:45 RW 2

Avoiding pitfalls: Better performance of AMS at DREAMS — •GEORG RUGEL[1], DREAMS USERS[2], NASRIN B. KHOJASTEH[1], SILKE MERCHEL[1], ANDREAS SCHARF[1], and RENÉ ZIEGENRÜCKER[1] — [1]HZDR, Dresden, Germany — [2]all over the world

Since autumn 2011, the DREsden AMS-facility (DREAMS), is performing routine AMS at the 6 MV tandem accelerator of the ion beam centre (IBC) at the Helmholtz-Zentrum Dresden-Rossendorf [1,2]. In routine operation are measurements of ^{10}Be, ^{26}Al, ^{36}Cl, ^{41}Ca, and ^{129}I for a wide range of applications. Most of the samples are prepared at our own chemistry labs – or in close cooperation with the users – to allow best performance for diverse tasks [3]. Our performance to measure these routine isotopes improved considerably over the last years [2]. This successful approach needs a careful selection of measurement parameters like a propper measurement order, a specific tuning using low-level (traceable) standards and individual setting of detector parameters for each beam time. One example for an additional improvement is the low-background value of ^{26}Al/^{27}Al = 6×10^{-16} reached in blanks from commercial carriers. For ^{41}Ca measurements we get 30% more transmission, while having ten times less background from ^{41}K. Further promising developments include the upgrade to non-routine AMS-nuclides like ^{44}Ti [4] and to actinides [5].

Ref.: [1] S. Akhmadaliev et al., *NIMB* 294 (2013) 5. [2] G. Rugel et al., *NIMB* 370 (2016) 94. [3] S. Merchel, this conference. [4] A. Scharf, this conference. [5] Nasrin B. Khojasteh, this conference.