

Mass Spectrometry Division Fachverband Massenspektrometrie (MS)

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Overview of Invited Talks and Sessions

(Lecture room: PH/HS2; Poster: C/Foyer)

Invited Talks

MS 1.1	Mon	11:30–12:00	PH/HS2	Nuclear Masses and Neutron Stars — ●JÜRGEN SCHAFFNER-BIELICH
MS 2.1	Mon	14:30–15:00	PH/HS2	Precision Penning trap mass measurements of short-lived exotic isotopes — ●JENS DILLING
MS 4.1	Tue	11:00–11:30	PH/HS2	Direct search for the neutrino mass: the KATRIN experiment — ●CHRISTIAN WEINHEIMER
MS 5.1	Tue	14:30–15:00	PH/HS2	Resonance laser ionization for RIB production and spectroscopy in gas cells and jets — ●IAIN MOORE
MS 8.1	Wed	14:30–15:00	PH/HS2	Entwicklung eines multi-Isotopen nieder-Energie AMS Systems — ●SASCHA MAXEINER, HANS-ARNO SYNAL, MARCUS CHRISTL, MARTIN SUTER, ARNOLD MÜLLER, CHRISTOF VOCKENHUBER
MS 10.1	Wed	17:00–17:30	PH/HS2	Betrieb und Performance des CologneAMS Systems — ●STEFAN HEINZE, CLAUS FEUERSTEIN, BJÖRN DITTMANN, STEVE BINNIE, SILKE MECHERNICH, ALFRED DEWALD, TIBOR DUNAI, JANET RETHEMEYER
MS 13.1	Thu	17:00–17:30	PH/HS2	From the Earth to the Stars: AMS a versatile technique in different fields of Science. — ●GUNTHER KORSCHINEK
MS 14.1	Fri	11:00–11:30	PH/HS2	AMS detection of actinides at high mass separation — ●PETER STEIER, ROSMARIE EIGL, JOHANNES LACHNER, ALFRED PRILLER, FRANCESCA QUINTO, AYA SAKAGUCHI, STEPHAN WINKLER, ROBIN GOLSER

Invited talks of the joint symposium SYNG

See SYNG for the full program of the symposium.

SYNG 1.1	Thu	11:00–11:30	C/gHS	Development of a new facility for measuring 81Kr and 85Kr at ultra-trace level in environmental samples. — ●BERNARD LAVIELLE, ERIC GILABERT, BERTRAND THOMAS, ROMAIN REBEIX, GRÉGORIE CANCHEL, CHRISTOPHE MOULIN, SYLVAIN TOPIN, FABIEN POINTURIER
SYNG 1.2	Thu	11:30–12:00	C/gHS	Atom counting system to measure trace krypton contamination in ultra-pure xenon — ●ANDRE LOOSE, TANYA ZELEVINSKY, ELENA APRILE
SYNG 1.3	Thu	12:00–12:30	C/gHS	Krypton-85 and Radioxenon: Environmental Tracers and Indicators for Nuclear Activities — ●CLEMENS SCHLOSSER, VERENA HEIDMANN, MARTINA KONRAD, SABINE SCHMID
SYNG 2.1	Thu	14:30–15:00	C/gHS	Using Noble Gases to Understand the History of Terrestrial Volatiles — ●DON PORCELLI
SYNG 2.2	Thu	15:00–15:30	C/gHS	Noble gas analysis in water: from temperature reconstruction over excess formation to oxygen turnover on environmentally relevant time scales — ●ROLF KIPFER, MATTHIAS BRENNWALD
SYNG 2.3	Thu	15:30–16:00	C/gHS	Applications of Noble Gases in Oceanography — ●PETER SCHLOSSER, ROBERT NEWTON, GISELA WINCKLER, ANGELICA PASQUALINI

Sessions

MS 1.1–1.5	Mon	11:30–13:00	PH/HS2	Precision Mass Spectrometry 1
MS 2.1–2.7	Mon	14:30–16:30	PH/HS2	Precision Mass Spectrometry 2
MS 3.1–3.8	Mon	17:00–19:00	PH/HS2	New Mass Spectrometric Methods and Technical Developments
MS 4.1–4.7	Tue	11:00–13:00	PH/HS2	Ion Traps, Molecules, Clusters, Decay and Reactions
MS 5.1–5.6	Tue	14:30–16:15	PH/HS2	Resonance Ionization
MS 6.1–6.15	Tue	17:00–17:00	C/Foyer	Posters
MS 7.1–7.5	Wed	11:00–12:15	PH/HS2	Ion Storage Rings
MS 8.1–8.7	Wed	14:30–16:30	PH/HS2	Accelerator Mass Spectrometry and Applications 1
MS 9.1–9.7	Wed	14:30–16:30	PH/SR106	Clusters in Molecular Physics (with A & MS)
MS 10.1–10.7	Wed	17:00–19:00	PH/HS2	Accelerator Mass Spectrometry and Applications 2
MS 11.1–11.5	Thu	11:00–13:00	C/gHS	Applied Noble Gas Physics Part 1
MS 12.1–12.5	Thu	14:30–16:30	C/gHS	Applied Noble Gas Physics Part 2
MS 13.1–13.5	Thu	17:00–18:30	PH/HS2	Accelerator Mass Spectrometry and Applications 3
MS 14.1–14.7	Fri	11:00–13:00	PH/HS2	Accelerator Mass Spectrometry and Applications 4

Annual General Meeting of the Mass Spectrometry Division

Wed 12:30–13:00 PH/HS2

- Bericht
- Amtseinführung des neuen Sprecher
- Vorschläge für Symposien
- Verschiedenes

MS 1: Precision Mass Spectrometry 1

Time: Monday 11:30–13:00

Location: PH/HS2

Invited Talk

MS 1.1 Mon 11:30 PH/HS2

Nuclear Masses and Neutron Stars — ●JÜRGEN SCHAFFNER-BIELICH — Goethe Universität, Frankfurt am Main

Neutron stars are born in the aftermath of the explosion of massive stars in core-collapse supernovae. Stabilized by nuclear forces these compact stars can withstand the gravitational pull. During cool-down a crust forms at the outer layer of the neutron star consisting of a lattice of nuclei immersed in a surrounding bath of electrons thereby ensuring overall charge neutrality. The high electron degeneracy pressure enables neutron-rich nuclei to be stabilized in the neutron star crust which would be short-lived exotic isotopes in a terrestrial laboratory. In beta-equilibrium, it can be shown that the sequence of nuclei in the outer crust of neutron stars is solely determined by their masses. We report on the recent advances of measuring masses of neutron-rich isotopes and on determining their impact on the composition of the outer crust of neutron stars. A brief glimpse on the possible composition of the core of neutron stars and their relation to nuclear physics experiments are given as well as an outlook for future astrophysical observations of neutron stars.

MS 1.2 Mon 12:00 PH/HS2

TOF-B ρ mass measurements of neutron-rich nuclei at the NSCL — ●SEBASTIAN GEORGE for the TOF-BRho-Collaboration — Max-Planck-Institut für Kernphysik, Heidelberg, Germany

Nuclear masses of exotic nuclei towards the driplines are important key parameters for the understanding of nuclear structure of very exotic nuclei and the description of astrophysical processes. Particularly the evolution of matter in the crust of accreting neutron stars incorporates nuclei far away from stability and is limited by the use of theoretical mass models. Time-of-flight-B ρ (TOF-B ρ) mass spectrometry allows the mass determination of such exotic species. The method has shown the potential to access short-lived and rarely produced nuclides at several radioactive beam facilities. Here the setup of the TOF-B ρ experiment at the National Superconducting Cyclotron Laboratory (NSCL) at the Michigan State University is presented. Results of mass measurements in the region of neutron-rich argon to iron are discussed in the context of their impacts on nuclear astrophysics and nuclear structure.

MS 1.3 Mon 12:15 PH/HS2

Probing the $N = 32$ shell closure below the magic proton number $Z = 20$: Mass measurements of the exotic isotopes $^{52,53}\text{K}$ — ●M. ROSENBUSCH¹, P. ASCHER², D. ATANASOV², C. BARBIERI³, D. BECK⁴, K. BLAUM², CH. BORGMANN², M. BREITENFELDT⁵, R. B. ÇAKIRLI^{2,6}, S. GEORGE², F. HERFURTH⁴, M. KOWALSKA⁷, S. KREIM^{2,7}, D. LUNNEY⁸, V. MANEA⁸, P. NAVRÁTIL⁹, D. NEIDHERR⁴, L. SCHWEIKHARD¹, V. SOMÀ^{10,11,12}, J. STANJA¹³, F. WIENHOLTZ¹, N. R. WOLF^{1,2}, and K. ZUBER¹³ — ¹Institut für Physik, Ernst-Moritz-Arndt-Universität, 17487 Greifswald — ²Max-Planck-Institut für Kernphysik, 69117 Heidelberg — ³Department of Physics, University of Surrey, Guildford GU2 7XH, UK — ⁴GSI Helmholtzzentrum für Schwerionenforschung GmbH, 64291 Darmstadt — ⁵Katholieke Universiteit, 3000 Leuven, Belgium — ⁶University of Istanbul, 334452 Istanbul, Turkey — ⁷CERN, CH-1211 Geneva, Switzerland — ⁸CSNSM-IN2P3-CNRS, Université Paris-Sud, 91406 Orsay, France — ⁹TRIUMF, V6T 2A3 Vancouver, BC, Canada — ¹⁰ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH, 64291 Darmstadt — ¹¹Institut für Kernphysik, Technische Universität Darmstadt, 64289 Darmstadt, Germany — ¹²CEA-Saclay, IRFU/Service de Physique Nucléaire, 91191 Gif-sur-Yvette, France — ¹³Institut für Kern- und Teilchenphysik, Technische Universität Dresden, 01069 Dresden

The Penning-trap mass spectrometer ISOLTRAP at the on-line isotope separator ISOLDE/CERN has been set up for precision mass measurements of short-lived nuclides and has been continuously improved for

accessing more exotic species. A crucial step forward has been made with the installation of a multi-reflection time-of-flight mass separator/spectrometer (MR-ToF MS), which enables fast mass separation and a direct mass determination of the involved species. With new mass measurements of the exotic isotopes $^{52,53}\text{K}$, the recent investigations of the neutron-shell closure at $N = 32$ for calcium [1] could be extended for an element below the magic proton number $Z = 20$ for the first time. The resulting two-neutron separation energies reveal a 3 MeV shell gap at $N = 32$, which is slightly lower than for ^{52}Ca , highlighting the doubly-magic nature of this nuclide. While Hartree-Fock-Bogoliubov calculations have difficulties to reproduce these findings, fully *ab initio* calculations in the framework of Gorkov-Green function theory performed for the first time beyond $N = 32$ agree with the measured shell effect.

[1] F. Wienholtz *et al.*, Nature 498, 346-349 (2013)

MS 1.4 Mon 12:30 PH/HS2

Präzisionsmassenmessungen mit Penning-Fallen unterstützter Zerfallsspektroskopie, für fundamentale Fragestellungen — ●ANDREE WELKER für die ISOLTRAP-Kollaboration — Technische Universität Dresden, Deutschland

Atomkerne sind einzigartige Vielteilchensysteme, welche mit den ersten Experimenten von J. J. Thomson im vorherigen Jahrhundert erste tiefere Beachtung erlangten. Im Allgemeinen sind Massenmessungen heutzutage eine der größten Forschungsschwerpunkte der Physik, wodurch die Interesse stets nach tieferen Hintergründen verlangt, um das Zusammenspiel der starken, schwachen und elektromagnetischen Wechselwirkung, welche zur Bindungsenergie resultieren, in den Nukleonen besser verstehen zu können. Mit Hilfe von Penning-Fallen werden Massen mit Unsicherheiten von $\frac{\delta m}{m} = 10^{-9} - 10^{-11}$ erreicht, um diese Unsicherheiten weiter zu verbessern und Nuklidmessungen von exotischeren Kernen zu ermöglichen, bedarf es in einigen Isotopen die Unterscheidung einzelner Isomere sowie Bestimmung der Halbwertszeiten zwischen Mutter- und Tochternukliden. Das Konzept des geplanten Aufbaues der Alpha-, Beta- und Gammaspektroskopieeinheit an ISOLTRAP/CERN sowie erste Simulationen der Strahlführung, sind Gegenstand dieses Vortrags. Die durch ISOLTRAP gewonnenen physikalischen und technischen Erkenntnisse werden Richtungsweisend für bestehende als auch zukünftige Experimente dieser Art wie MATS@FAIR (Precision Measurements of Very Short-Lived Nuclei using an Advanced Trapping System for Highly-Charged Ions) sein.

MS 1.5 Mon 12:45 PH/HS2

Image charge shift simulations for Penning traps and current status of THE-Trap — ●MARC SCHUH, TOMMI ERONEN, MARTIN HÖCKER, JOCHEN KETTER, TOM SEGAL, SEBASTIAN STREUBEL, and KLAUS BLAUM — Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg

THE-Trap is a precision Penning-trap mass spectrometer [1] at the Max-Planck-Institut für Kernphysik in Heidelberg. While the main goal is to measure the tritium/helium-3 mass ratio with a relative uncertainty of 10 parts per trillion (ppt), the experiment is not limited to the measurement of mass doublets. In 2014 we reported a measurement of the mass ratio of carbon-12 to oxygen-16 with an uncertainty of 120 ppt, limited by systematic uncertainties [2]. Within the last year we were able to reduce the systematic uncertainties down to a few ten ppt through increased ion lifetimes and lower motional amplitudes. Further, the electrostatic properties of THE-Trap were investigated by extensive finite element simulations performed with Comsol Multiphysics. One limiting effect for the mass measurements of non mass doublets are the image charges on the electrodes created by the ion present in the trap. It is possible to simulate this effect reliably. The result is in excellent agreement with experimental values [1].

[1] R.S. Van Dyck Jr., International journal of mass spectrometry (2006), doi:10.1016/j.ijms.2006.01.038

[2] S. Streubel *et al.*, Appl. Phys. B, doi:10.1007/s00340-013-5669-x

MS 2: Precision Mass Spectrometry 2

Time: Monday 14:30–16:30

Location: PH/HS2

Invited Talk

MS 2.1 Mon 14:30 PH/HS2

Precision Penning trap mass measurements of short-lived exotic isotopes — ●JENS DILLING — TRIUMF & University of British Columbia — Max-Planck Institute for Nuclear Physics

Exotic isotopes offer unique research and science opportunities, for example related to the fundamental understanding of the strong force, or the generation of the chemical elements in the universe. However, since exotic or often-called rare isotopes have to be generated at accelerator facilities, and usually only in minuscule quantities, with half-lives as short as few milliseconds, the mass measurement methods have to be adjusted. For this, we have developed very sensitive and fast methods using ion trap techniques. Ion traps are employed to measure atomic masses, using one single ion in as short as a 1/100 of a second with 10 parts per billion precision, breaking a world-record for precision mass spectroscopy. We were able to do such experiments using a unique combination of traps, including a Paul trap, an electron beam ion trap (to generate highly charged ions), and a set of Penning traps. In this talk I will report on measurements, the novel techniques we have developed, in particular when using highly charged ions, and plans for the future.

MS 2.2 Mon 15:00 PH/HS2

Status of the high-precision Penning-trap mass spectrometer Pentatrap — ●ALEXANDER RISCHKA¹, HENDRIK BEKKER¹, KLAUS BLAUM¹, CHRISTINE BÖHM^{1,2}, JOSÉ R. LÓPEZ-URRUTIA¹, ANDREAS DÖRR¹, SERGEY ELISEEV¹, MIKHAIL GONCHAROV¹, YURI N. NOVIKOV³, RIMA SCHÜSSLER^{1,4}, SVEN STURM¹, and STEFAN ULMER⁵ — ¹Max-Planck-Institut für Kernphysik, 69117 Heidelberg, Germany — ²ExtreMe Matter Institute EMMI, Helmholtz Gemeinschaft, 64291 Darmstadt, Germany — ³Petersburg Nuclear Physics Institute, 188300 Gatchina, Russia — ⁴Universität Heidelberg, Fakultät für Physik und Astronomie, 69120 Heidelberg, Germany — ⁵RIKEN, Ulmer Initiative Research Unit, Japan

The Penning-trap mass spectrometer PENTATRAP is currently in the commissioning phase at the Max-Planck-Institute for Nuclear Physics in Heidelberg. We are aiming at measurements of mass ratios of highly charged ions with a relative uncertainty of 10^{-11} and better, e.g. to probe, with the measurement of the Q -value of $^{163}\text{Ho}/^{163}\text{Dy}$, the electron neutrino mass. In the first commissioning campaign we demonstrated the transport of the ions from the electron beam ion source to the trap. We succeeded as well in trapping a single $^{40}\text{Ar}^{8+}$ ion where trapping times up to 30 min were achieved. To improve the trapping time even further and thus, to achieve a full characterization of the trap and start first precision measurements, a major revision of the cryogenic setup is presently prepared. This includes a new detection and trap alignment system.

MS 2.3 Mon 15:15 PH/HS2

The detection systems of the Penning-trap mass spectrometer PENTATRAP — ●RIMA SCHÜSSLER^{1,2}, HENDRIK BEKKER¹, KLAUS BLAUM¹, CHRISTINE BÖHM^{1,3}, JOSÉ CRESPO LÓPEZ-URRUTIA¹, ANDREAS DÖRR¹, SERGEY ELISEEV¹, MIKHAIL GONCHAROV¹, YURI N. NOVIKOV⁴, ALEXANDER RISCHKA¹, SVEN STURM¹, and STEFAN ULMER⁵ — ¹Max-Planck-Institut für Kernphysik, Heidelberg, Germany — ²Universität Heidelberg, Fakultät für Physik und Astronomie, Heidelberg, Germany — ³ExtreMe Matter Institute EMMI, Helmholtz Gemeinschaft, Darmstadt, Germany — ⁴Petersburg Nuclear Physics Institute, Gatchina, Russia — ⁵Ulmer Initiative Research Unit, RIKEN, Wako, Saitama, Japan

The Penning-trap mass spectrometer PENTATRAP is currently in the commissioning phase at the Max-Planck-Institut für Kernphysik in Heidelberg. Measurements of mass ratios of single stable and long lived highly charged ions with a relative uncertainty below 10^{-11} are aimed for. The mass-ratio measurement is carried out by determining simultaneously the cyclotron frequencies of two ions in the magnetic fields of the Penning traps. For this purpose the ions' eigenfrequencies are measured by means of a non-destructive detection of image currents induced in the trap electrodes by the oscillating ions. Essential part of each detection circuit is a cryogenic high-quality resonator, realised as a superconducting or copper coil in a copper housing. Together with cryogenic GaAs FET amplifiers, the small image currents ($\sim\text{fA}$) induced by a single ion become detectable. The design of a new

detection system as well as first tests will be presented in the talk.

MS 2.4 Mon 15:30 PH/HS2

On-line coupling of the TRIGA-SPEC facility at the research reactor TRIGA Mainz — ●JESSICA GRUND for the TRIGA-SPEC-Collaboration — Institut für Kernchemie, Johannes Gutenberg-Universität, Mainz — PRISMA Cluster of Excellence, Johannes Gutenberg-Universität, Mainz

Experimental data of ground-state properties of exotic nuclei are important to test current nuclear models. The double Penning-trap mass spectrometer TRIGA-TRAP allows precise mass measurements on neutron-rich radionuclides and long-lived transuranium isotopes.

The on-line coupling to the research reactor TRIGA Mainz offers the possibility to measure short-lived nuclides produced by neutron-induced fission of U-235, Pu-239 or Cf-249, respectively. Fission products are extracted by an aerosol-based gas-jet system and are guided through a skimmer system to a high-temperature surface ion source. By means of an aerodynamic lens the aerosols containing the activity are collimated and introduced into the ion source with high efficiency. The low-energy ion beam from the ion source is mass separated with a 90° dipole magnet, followed by a radio-frequency quadrupole cooler/buncher and a pulsed drift tube.

Here we report recent efficiency measurements and performance tests of different parts of the beamline.

MS 2.5 Mon 15:45 PH/HS2

Recent high-precision mass measurements of transuranium nuclides at TRIGA-TRAP — ●DENNIS RENISCH for the TRIGA-SPEC-Collaboration — Institut für Kernchemie, Johannes Gutenberg-Universität Mainz

The heaviest nuclei owe their existence to shell effects, without which they would immediately decay. The strength of shell effects is directly accessible through high-precision mass measurements, using Penning-trap mass spectrometers. TRIGA-TRAP is such an experiment, installed at the research reactor TRIGA Mainz. It is optimized for measurements of long-lived transuranium isotopes and of neutron-rich nuclides produced by neutron-induced fission inside the research reactor. Recent results of high-precision mass measurements of transuranium nuclides, including Pu-242, Bk-249, Cm-245/246/248 and Cf-249/250/251, will be presented. Direct mass measurements in this region of the chart of nuclei are important for mapping the evolution of the deformed shell closure at $N=152$ over several units in Z and as anchor points of α -decay chains for superheavy element (SHE) research.

MS 2.6 Mon 16:00 PH/HS2

Performance of the Cryogenic Buffer-Gas Stopping Cell at SHIPTRAP — CHRISTIAN DROESE¹, KLAUS BLAUM², MICHAEL BLOCK^{3,4}, PREMADITYA CHHETRI⁵, SERGEY ELISEEV², FRANK HERFURTH⁴, ●MUSTAFA LAATIAOUI³, FELIX LAUTENSCHLÄGER⁵, ENRIQUE MINAYA RAMIREZ², LUTZ SCHWEIKHARD¹, and PETER THIROLF⁶ — ¹Ernst-Moritz-Arndt-Universität Greifswald — ²Max-Planck-Institut für Kernphysik Heidelberg — ³Helmholtz-Institut Mainz — ⁴GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt — ⁵Technische Universität Darmstadt — ⁶Ludwig-Maximilians-Universität München

The Penning-trap mass spectrometer SHIPTRAP is employed for high-precision mass measurements of exotic nuclides, in particular in the region above fermium. In recent experiments, the masses of $^{252-254}\text{No}$ and $^{255,256}\text{Lr}$ were measured directly for the first time in a Penning trap. These achievements paved the way for the development of a new-generation gas-stopping cell aiming for mass measurements in the superheavy element region. As the expected production rates are below one per hour, the stopping and extraction of the evaporation residues becomes a bottleneck for the entire setup's performance. With the new gas cell operated at cryogenic temperatures an extraction efficiency of 74(3)% was obtained, an increase by a factor of 2.5 compared to the old setup. In this talk, results from the off-line commissioning of the new cell will be presented.

MS 2.7 Mon 16:15 PH/HS2

PIPERADE: A large Penning trap isobar separator for the

future low-energy facility DESIR of SPIRAL2 — ●ANTOINE DE ROUBIN^{1,2}, MEHDI AOUDI², PAULINE ASCHER², BERTRAM BLANK², KLAUS BLAUM¹, PIERRE DUPRÉ³, MATHIAS GERBAUX², STÉPHANE GRÉVY², HUGO GUÉRIN², DAVID LUNNEY³, and ENRIQUE MINAYA RAMIREZ¹ — ¹MPIK, Heidelberg, Germany — ²CENBG, Gradignan, France — ³CSNSM, Orsay, France

Exotic nuclei currently not accessible will be delivered to the future DESIR facility for nuclear structure and astrophysics studies using beta decay spectroscopy, laser spectroscopy and trap-based experiments. For most of them, a high precision is needed and can be reached only if highly pure samples of exotic nuclei are available. Some particular physics cases will be presented.

In addition of the HRS, located upstream, PIPERADE will be a system placed at the DESIR hall entrance to purify the radioactive ion beam from undesired contaminants. It will consist of an RFQ for bunching and cooling and of a double Penning trap to separate the isobaric species and accumulate the ions of interest. The purified beam will then be sent to the various experiments of the low-energy DESIR facility.

The challenge for the present double-Penning trap system consists of being able to separate very large amounts of short-lived nuclei ($< 10^5$ ions per bunch) while maintaining the resolving power necessary for isobar selection of 10^5 . For this purpose, research about space charge effects and new excitation schemes are ongoing and will be presented.

MS 3: New Mass Spectrometric Methods and Technical Developments

Time: Monday 17:00–19:00

Location: PH/HS2

MS 3.1 Mon 17:00 PH/HS2

Anreicherung und Implantation von ^{163}Ho im RISIKO Massenseparator für das ECHO Projekt — ●TOM KIECK für die ECHO-Kollaboration — Institut für Physik, Johannes-Gutenberg-Universität Mainz

Die ECHO-Kollaboration nutzt zur Untersuchung der Masse des Elektron-Neutrinos den Elektroneneinfangsprozess von ^{163}Ho . Dabei wird das Zerfallsspektrum in einem metallisch-magnetischen Kalorimeter bestimmt. Die Produktion dieses Isotops bringt eine möglicherweise signifikante Verunreinigung mit anderen Radio- wie auch stabilen Isotopen mit sich, welche nur begrenzt chemisch abgetrennt werden können.

Der RISIKO Massenseparator der LARISSA Arbeitsgruppe bietet über den Einsatz vollständig elementselektiver und effizienter resonanter Laserionisation und nachfolgender Isotopenselektion in einem Sektorfeld-Magneten optimale Voraussetzungen für die Auswahl und Anreicherung des Isotops. Die Beschleunigung der Ionen auf 30 keV ermöglicht eine optimale Strahlformung zur direkten Implantation des reinen ^{163}Ho Strahls in die kleinflächigen Kalorimeter mit Kantenlängen von 160 μm .

Die entsprechenden Modifikationen des RISIKO Massenseparators für diesen Einsatzzweck sowie Messungen zu Effizienz, Strahlfleckgröße und Isotopenverhältnissen der ^{163}Ho Produktionen werden vorgestellt.

MS 3.2 Mon 17:15 PH/HS2

Multi-purpose RFQ Beamline for ion cooling, transport, identification, separation, beam mixing and bunching at the FRS Ion Catcher — ●ANN-KATHRIN RINK for the FRS Ion Catcher Collaboration — Justus-Liebig Universität Gießen

Conventional low-energy beam lines use a structures of electrostatic or magnetic fields for transporting and guiding ions. However, those beam lines require low vacuum pressures for efficient transport; in the vicinity of buffer gas stopping cells low vacuum pressures cannot be provided. At pressures of about 10^{-2} mbar radio-frequency quadrupoles (RFQ) can provide an efficient, reliable ion transport. Such a transport system based on RFQs also enables identification, mass separation (RFQ operated as mass filter), cooling, bunching and beam mixing (merging ions of interest with calibration ions) in a compact setup. It is coupled easily to identification detectors using alpha or beta spectroscopy and accurate mass spectrometers. For these reasons the low-energy beam line of the FRS Ion Catcher is designed as RFQ beam line.

A novel component in the RFQ beam line of the FRS Ion Catcher is an RFQ switch yard that allows to guide or split a beam into five directions, as well as to merge five beams. The RFQ beam line was commissioned offline and online and was essential for performing efficient experiments at the FRS Ion Catcher.

MS 3.3 Mon 17:30 PH/HS2

Multiple-Reflection Time-of-Flight Mass Spectrometer as Isomer Separator — ●JENS EBERT for the FRS Ion Catcher Collaboration — Justus-Liebig-Universität Gießen

Recently multiple-reflection time-of-flight mass spectrometer (MR-TOF-MS) have been established as important tools for isobar separation at several facilities for research on exotic nuclei. They combine short measurement cycles with high efficiencies and very high mass resolving power.

Through technical improvements of mass resolving power and stability, the MR-TOF-MS for the FRS Ion Catcher at GSI and the Low-Energy Branch of the Super-FRS at FAIR is now also capable to separate isomers in time and space. The spatial separation can provide isomeric clean beams for further experiments. This has been successfully demonstrated in a beamtime of the FRS Ion Catcher in October 2014. Isomers have been produced via projectile fragmentation and fission, thermalized in a cryogenic stopping cell and transported to the MR-TOF-MS, where mass measurements and spatial separation with a Bradbury-Nielsen-Gate have been performed on them. After the separation the decay of α -emitting isomers was measured with a silicon detector to verify the identity of the separated nuclides.

MS 3.4 Mon 17:45 PH/HS2

Status of the MR-TOF-MS for the TITAN facility —

●TIMO DICKEL^{1,2}, CHRISTIAN JESCH¹, WOLFGANG R. PLASS^{1,2}, DEVIN SHORT³, SAMUEL AYET SAN ANDRÉS^{1,2}, JENS DILLING⁴, HANS GEISSEL^{1,2}, FLORIAN GREINER¹, JOHANNES LANG¹, KYLE G. LEACH^{3,4}, WAYNE LIPPERT¹, CHRISTOPH SCHEIDENBERGER^{1,2}, and MIKHAIL I. YAVOR⁵ — ¹JLU, Giessen — ²GSi, Darmstadt — ³Simon Fraser University, Vancouver, Canada — ⁴TRIUMF, Vancouver, Canada — ⁵Inst. for anal. instr. RAS, St. Petersburg, Russia

At TRIUMF's Ion Trap for Atomic and Nuclear Science (TITAN) the MR-TOF will extend TITAN's capabilities and facilitate mass measurements and in-trap decay spectroscopy of exotic nuclei that so far have not been possible due to strong isobaric contaminations. The MR-TOF-MS will also enable mass measurements of very short-lived nuclei ($T_{1/2} > 5$ ms) that are produced in very low quantities (a few detected ions overall).

In order to allow the installation of an MR-TOF-MS in the restricted space on the TITAN platform, novel mass spectrometric methods have been developed. Ion transport into and out of the device is performed using an RFQ-based switchyard. In addition the exotic ions can be merged with ions from several offline ion sources. Mass selection is performed using a dynamic retrapping technique after time-of-flight analysis. The isobarically clean beam can be provided for the EBIT, Penning trap or in the future to the laser spectroscopy setup.

We report on the commissioning of the system in Giessen and carried out tests and plans for TRIUMF.

MS 3.5 Mon 18:00 PH/HS2

Delayed bunching of ions in multi-reflection time-of-flight mass separators — ●M. ROSENBUSCH¹, S. KEMNITZ², P. LUKSCH²,

G. MARX¹, R. SCHNEIDER¹, L. SCHWEIKHARD¹, and N. R. WOLF¹ — ¹Institut für Physik, Ernst-Moritz-Arndt-Universität, 17487 Greifswald — ²Institut für Informatik, Universität Rostock, 18095 Rostock

Multi-reflection time-of-flight mass separators (MR-ToF MS) consist of two electrostatic mirrors facing one another, which enable back-and-forth reflections of ions and thus provide a long flight path. In that way, mass resolving powers $m/\delta m$ exceeding 10^5 can be reached in only tens of milliseconds [1]. However, in case of contaminating ions in large quantities from the ion source, the mass separation is often hindered due to the dominance of coulomb interactions [2]. In this contribution a technique is discussed, that allows to decrease the ion density during the major part of the trapping period in the MR-ToF MS, while later on still enabling a high-resolution mass separation. To this end, an ion bunch with a purposely broad time-of-flight (ToF) dis-

tribution is injected into the MR ToF MS and trapped isochronously (no ToF energy dispersion) for a duration of choice. Then, the ToF-energy dispersion of the system is modified by a fast switching of the electrostatic-mirror voltages for strong focusing during the next few reflections. Proof-of-principle experiments with isobaric ions will be reported.

- [1] R. N. Wolf *et al.*, *Int. J. Mass Spectrom.* 349-350, 123-133 (2013)
 [2] M. Rosenbusch *et al.*, *AIP Conf. Proc.* 1521, 53 (2013)

MS 3.6 Mon 18:15 PH/HS2

Improvements on the MR-TOF-MS for the LEB of the Super-FRS and its application for high-accuracy mass measurements — ●SAMUEL AYET SAN ANDRÉS for the FRS Ion Catcher-Collaboration — GSI Darmstadt — JLU Gießen

At the FRS Ion Catcher facility, in-flight separated exotic nuclei produced by Uranium beam fragmentation and fission in a Beryllium target are thermalized through gas collisions in a cryogenic stopping cell (CSC), transported through a diagnostic unit (DU) to a multiple-reflection time-of-flight mass spectrometer (MR-TOF-MS) where mass measurements of the stopped ions are performed. The FRS Ion Catcher is a test bench for the low energy branch (LEB) at the Super-FRS at FAIR. Recently several improvements of the MR-TOF-MS were developed and tested online during a beam time in October 2014. The increase of kinetic energy from 750 eV to 1300 eV and improved stability of the system and power supplies in the MR-TOF-MS lead to a mass resolving power exceeding 400.000 FWHM in less than 16ms of total time-of-flight. With these performance characteristics, direct mass measurements of uranium projectile and fission fragments were performed.

MS 3.7 Mon 18:30 PH/HS2

Ultra-High Resolution Tandem Mass Spectrometry in a Mobile MR-TOF Mass Spectrometer — ●WAYNE LIPPERT¹, JOHANNES LANG¹, SAMUEL AYET SAN ANDRÉS², JULIAN BERGMANN¹, TIMO DICKEL^{1,2}, HANS GEISSEL^{1,2}, CHRISTIAN JESCH¹, ALEXANDER PIKHELEV³, WOLFGANG PLASS^{1,2}, CHRISTOPH SCHEIDENBERGER^{1,2}, and MIKHAIL YAVOR⁴ — ¹Justus-Liebig-Universität Gießen — ²GSI Darmstadt — ³RAS Moscow — ⁴RAS St. Petersburg

The mobile multiple-reflection time-of-flight mass spectrometer (MR-

TOF-MS) provides a mass resolving power exceeding 400,000 and sub-ppm mass accuracy in a transportable format. It comprises an atmospheric pressure interface (API) that enables coupling with various atmospheric ion sources, an RFQ beam preparation system and a high resolution time-of-flight mass analyzer with MCP detector.

In addition to highly resolved and accurate mass measurements, the device offers unique MS/MS capability via selective ion re-trapping with ultra-high mass separation power ($R \approx 50,000$) and collisional-induced dissociation (CID) as intermediate fragmentation method. By analyzing the molecule fragments in the time-of-flight analyzer after ion re-trapping and CID, structural information and unambiguous identification are provided.

The instrument is ideally suited for the identification of species in biological or environmental samples and can be applied for in-situ operation at various measurement sites.

MS 3.8 Mon 18:45 PH/HS2

Determination of krypton concentration in xenon gas with a quadrupole mass spectrometer following a cold-trap at a temporarily reduced pumping speed — ●ALEXANDER FIEGUTH, ETHAN BROWN, GIANMARCO BRUNO, MICHAEL MURRA, SERGEJ SCHNEIDER, and CHRISTIAN WEINHEIMER — Institut für Kernphysik, WWU, Münster

The removal of trace impurities in xenon gas, as for example the radioactive isotope ⁸⁵Kr, is of viable importance for achieving new sensitivities in particle physics experiments, especially in the field of dark matter search. While the removal of this isotope can be performed by cryogenic distillation down to the sub-ppb level, the detection at this low concentrations is not trivial. A recently improved method (E. Brown *et al.* JINST 8 (2013) P02011) uses a commercial quadrupole mass spectrometer supported by an auxiliary structure based on a cold trap to achieve sub-ppb sensitivity in measurements on the minute scale and with consumption of only a few milliliters of expensive xenon gas. Additional sensitivity gain is provided by a self-made butterfly valve in front of the pumping system to allow for dynamically manipulate the pumping speed. This method can be used for the characterization of the working performance of the cryogenic distillation column build for the upcoming XENON1T experiment. This work is funded by DFG.

MS 4: Ion Traps, Molecules, Clusters, Decay and Reactions

Time: Tuesday 11:00–13:00

Location: PH/HS2

Invited Talk

MS 4.1 Tue 11:00 PH/HS2

Direct search for the neutrino mass: the KATRIN experiment — ●CHRISTIAN WEINHEIMER for the KATRIN-Collaboration — Westfälische Wilhelms-Universität Münster

Since the discovery of neutrino oscillations we know that neutrinos have non-zero masses, but the absolute neutrino mass scale is still unknown. The knowledge of the neutrino masses is very important for astrophysics and cosmology as well as for nuclear and particle physics.

With the Karlsruhe Tritium Neutrino experiment KATRIN we directly search for the neutrino mass by investigating the endpoint region of the tritium beta decay spectrum at 18.6 keV with ultra-high precision and sensitivity. This method is complementary to the search for neutrinoless double beta-decay and analyses of cosmological data.

The KATRIN experiment, which is being set up at Karlsruhe Institute for Technology, will improve the sensitivity of direct neutrino mass experiments by one order of magnitude down to 200 meV/c². The apparatus consists of a windowless gaseous tritium source, a beta electron transport and tritium elimination system based on differential and cryogenic pumping, and a doublet of electron spectrometers of MAC-E-Filter type followed by an electron detector. Its high sensitivity requires KATRIN to be technically very demanding and to drive several technologies to the extreme.

Currently the KATRIN spectrometer and detector system (SDS) is being commissioned. In this talk the status of the KATRIN experiment and the recent SDS commissioning measurements will be presented.

The work of the author is supported by BMBF Verbundforschung.

MS 4.2 Tue 11:30 PH/HS2

Auf dem Weg zum FT-ICR Nachweis mehrfach negativ geladener Clusterionen — STEFFI BANDELOW¹, FRANKLIN MARTINEZ²,

GERRIT MARX¹, LUTZ SCHWEIKHARD¹ und ●ALBERT VASS¹ — ¹Institut für Physik, Ernst-Moritz-Arndt Universität, 17487 Greifswald, Deutschland — ²Institut für Physik, Universität Rostock, 18055 Rostock, Deutschland

Durch die gleichzeitige Speicherung von Elektronen und Monoanionen in einer Penningfalle werden bis zu 10fach negativ geladene Metallcluster erzeugt, wobei der erreichbare Ladungszustand mit der Clustergröße steigt [1]. Die in den bisherigen Experimenten verwendete Flugzeit (ToF)-Methode ermöglicht zwar die Detektion sehr weniger Ionen, ist aber ein destruktiver Nachweis. Außerdem begrenzt das ToF-Massenaufklärungsvermögen die Identifikation der größeren Clusterpolyanionen.

In einem alternativen Ansatz soll ein Fouriertransformation-Ionenzyklotronresonanz-Nachweis (FT-ICR) implementiert werden. Hierbei werden die m/q -abhängigen Bewegungsfrequenzen der gespeicherten Ionen genutzt, deren Bildladungssignale auf den Elektroden der Penningfalle detektiert werden. Diese nichtdestruktive Methode besitzt eine größere Massenaufklärung, wenn auch bei geringerer Nachweisempfindlichkeit. Im Beitrag wird auf die Implementierung der FT-ICR-Detektion zum Nachweis mehrfach negativ geladener Cluster eingegangen und es werden erste Messergebnisse präsentiert.

- [1] F. Martinez *et al.*, *Int. J. Mass Spectrom.* 365-366 (2014) 266.

MS 4.3 Tue 11:45 PH/HS2

New setup to study the reactivity of metal clusters in the gas phase — ●DANIEL NEUWIRTH¹, JAN ECKHARD¹, KATHRIN LANGE¹, BRADLEY VISSER², MARTIN TSCHURL¹, and UELI HEIZ¹ — ¹Lehrstuhl für Physikalische Chemie & Catalysis Research Center, Chemistry Department, Technische Universität München, Lichtenbergstraße 4, 85748 Garching bei München, Germany — ²Paul-Scherrer Institute, 5232 Villigen PSI, Switzerland

Many properties of metal clusters differ significantly from the properties of the bulk material. For example the reactivity of such clusters depends often on charge and size. Within our group we want to investigate reactions of metal clusters with various molecules in the gas phase. Therefore clusters are produced with a laser-vaporization-cluster-source, size-selected with a quadrupole mass filter and stored within a ring electrode ion trap. The trap is filled with a buffer gas, consequently clusters and reaction products are constantly thermalized. The special geometry of the trap allows the controlled ejection of the reaction products into a reflectron mass spectrometer. As reaction time, temperature and concentration of the reactive gas can be varied, the kinetics of the reaction can be determined. First results of this experimental setup will be presented.

MS 4.4 Tue 12:00 PH/HS2

Polyanionische Metallcluster — ●STEFFI BANDELOW¹, FRANKLIN MARTINEZ², GERRIT MARX¹, LUTZ SCHWEIKHARD¹ und ALBERT VASS¹ — ¹Institut für Physik, Ernst-Moritz-Arndt Universität, 17487 Greifswald, Deutschland — ²Institut für Physik, Universität Rostock, 18055 Rostock, Deutschland

Ionenfallen haben sich als vielfältiges Instrument zur Untersuchung gespeicherter atomarer Cluster etabliert. Sie ermöglichen die Beobachtung zeitlich ausgedehnter Wechselwirkungen größenselektierter Cluster mit Elektronen, Laserstrahlung, Neutralgas oder anderen Ionen. Insbesondere eignen sie sich zur Erzeugung mehrfach negativ geladener Cluster durch Elektronenanlagerung an niedrigere Ladungszustände (z.B. Monoanionen). Die Techniken zur Polyanionenproduktion in Penningfallen und in digital betriebenen Paulfallen werden erläutert [1,2]. Für Gold- und Aluminiumcluster werden Messungen zur Auftrittshäufigkeit höherer Ladungszustände als Funktion der Clustergröße und Cluster-Elektronen-Interaktionszeit diskutiert. Darüber hinaus werden Ansätze zur theoretischen Beschreibung der Stabilität polyanionischer Metallcluster bezüglich Elektronenemission vorgestellt.

[1] F. Martinez et al., *Int. J. Mass Spectrom.* 365-366 (2014) 266.

[2] S. Bandelow et al., *Int. J. Mass Spectrom.* 353 (2013) 49.

MS 4.5 Tue 12:15 PH/HS2

Cryo kinetics of size selected cobalt clusters — ●JENNIFER MOHRBACH, SEBASTIAN DILLINGER, and GEREON NIEDNER-SCHATTEBURG — Fachbereich Chemie and Forschungszentrum OPTIMAS, Technische Universität Kaiserslautern, 67663 Kaiserslautern, Germany

A customized Fourier Transform Ion Cyclotron Resonance (FT-ICR) mass spectrometer served to investigate the kinetics of nitrogen adsorption on size selected cobalt cluster cations (Co_n^+ , $9 < n < 29$) at well-defined cryo temperatures. Our setup combines a hexapole ion trap for kinetic studies with a FT-ICR cell for Infrared Multiple Photon Dissociation (IRMPD) studies and mass analysis. Both ion traps are cryogenically cooled to temperatures below 30 K. We have conducted kinetic studies to determine the rates and numbers of the N_2 adsorption to the respective cobalt clusters. Furthermore we have performed IR(M)PD spectroscopy in the N-N stretching frequency range of the adsorbed nitrogen to gain insight into its binding motifs on the cluster and the structure of the cobalt clusters themselves.

MS 4.6 Tue 12:30 PH/HS2

Size-dependent gas phase reactivity of tantalum cluster cations with small alcohols — ●JAN ECKHARD¹, DANIEL NEUWIRTH¹, KATHRIN LANGE¹, BRADLEY VISSER², MARTIN TSCHURL¹, and UELI HEIZ¹ — ¹Lehrstuhl für Physikalische Chemie & Catalysis Research Center, Chemistry Department, Technische Universität München, Lichtenbergstraße 4, 85748 Garching bei München, Germany — ²Paul-Scherrer Institute, 5232 Villigen PSI, Switzerland

As the properties of metal clusters may change vastly as a function of cluster size, their study is a model approach to find and tune catalysts for use in specific reactions. The detailed investigation of metal clusters is facilitated in the gas phase. As a result, we found a strong size dependence for the reactivity of tantalum cluster cations with small alcohol molecules. The clusters were produced in the gas phase by laser vaporization; various alcohols (methanol, ethanol, n-propanol and 2-propanol) were consecutively added to the cluster beam in a pulsed jet and allowed to react to an extent of conversion of approximately 50 %. The charged reaction products were subsequently measured using time-of-flight mass spectrometry. Two distinct reaction pathways were observed, involving complete dehydrogenation or OH abstraction from the alcohol molecule. The relative total reaction yield was found to not vary significantly within the cluster size regime studied. The branching ratios for the reaction demonstrated a cluster-size dependence, with a minimum of OH abstraction occurring for a cluster size of 7 atoms.

MS 4.7 Tue 12:45 PH/HS2

Slow molecular beams of biochromophores via laser induced acoustic desorption — ●UGUR SEZER¹, LISA WÖRNER¹, CHRISTOPH GÖTZ², ALIPASHA VAZIRI², and MARKUS ARNDT¹ — ¹University of Vienna, Faculty of Physics, VCQ and QuNaBioS, Boltzmanngasse 5, 1090 Vienna, Austria — ²University of Vienna, Max F. Perutz Laboratories; Research Institute of Molecular Pathology; QuNaBioS, Doktor-Bohr-Gasse 7, 1030 Vienna, Austria.

A beam of intact, neutral, and slow molecules is an essential criterion for experiments in physical chemistry and quantum optics, such as deflectometry and matter-wave interferometry[1]. Different molecular beam methods have been developed over recent years, among them thermal beams of functionalized molecules[2], free laser desorption[3] or supersonic expansion of laser desorbed molecules[4].

In this work we show that beams of intact, neutral, biologically relevant chromophores, such as chlorophyll a and hemin can be launched in high vacuum with mean velocities as low as 45 m/s with minimal fragmentation. The molecules are volatilized via laser-induced acoustic desorption[5], photoionized with lasers light at 157 nm or 266 nm, and detected in time-of-flight mass spectrometry. We present mass spectra, desorption and photoionization efficiencies as well as velocity distributions and discuss possible applications.

[1] K. Hornberger et al. *Rev. Mod. Phys.* 2012, 84. [2] S. Eibenberger et al. *Phys. Chem. Chem. Phys.* 2013, 15. [3] P. Schmid et al. *J. Am. Soc. Mass. Spectrom.* 2013, 24. [4] M.-H. Ha-Thi et al. *Phys. Chem. Chem. Phys.* 2010, 12. [5] A.V. Zinovev et al. *Anal. Chem.* 2007, 79.

MS 5: Resonance Ionization

Time: Tuesday 14:30–16:15

Location: PH/HS2

Invited Talk

MS 5.1 Tue 14:30 PH/HS2

Resonance laser ionization for RIB production and spectroscopy in gas cells and jets — ●IAIN MOORE — University of Jyväskylä, Jyväskylä, Finland

In recent years, resonant laser ionization has become a mature technique, playing a key role in the selective production of radioactive nuclides at on-line isotope separator (ISOL) and ion guide isotope separator (IGISOL) facilities. A further increase in selectivity has been successfully demonstrated whereby laser ionization is performed immediately downstream from the ion source. In connection with gas cell-based approaches, neutral radioactive atoms are selectively ionized upon exit from the cell within the expanding gas jet. By combining gas jet laser ionization with a mass separator, ultra-high purification of low-energy beams becomes a reality.

More recently, laser spectroscopy has been performed in-source to

obtain fundamental and model-independent data on the structure of ground and isomeric nuclear states. In order to increase the sensitivity of such methods, the gas jet offers an attractive environment with reduced temperature and density. High power, high repetition rate laser systems with narrow bandwidths can exploit the unique opportunities offered by the gas jet.

This contribution will review the progress at existing facilities as well as presenting an outlook for the future.

MS 5.2 Tue 15:00 PH/HS2

Einsatz und weitere Optimierung der hochselektiven Laserionenquellenfalle LIST bei ISOLDE/CERN — ●REINHARD HEINKE¹, VALENTIN FEDOSSEEV², DANIEL FINK², TOBIAS KRON¹, BRUCE MARSH², SVEN RICHTER¹, SEBASTIAN ROTHE² und KLAUS WENDT¹ — ¹Institut für Physik, Johannes Gutenberg-Universität Mainz — ²EN Department, CERN, Geneva

Hochselektive Ionenquellen sind eine Grundvoraussetzung zur Untersuchung kurzlebiger radioaktiver und exotischer Nuklide, wie sie nur an modernen Isotopengeneratoren wie z.B. ISOLDE am CERN durchgeführt werden können. Die Laserresonanzionisation hat sich hierbei als weltweiter Standard mit besonderen Vorzügen in der Elementselektion etabliert. Für Anwendungen, in denen die Unterdrückung isobarer Kontaminationen durch die Resonanzionisation nicht ausreichend gewährleistet wird, wurde die hochselektive Laserionenquellenfalle Laser Ion Source & Trap (LIST) entwickelt. Diese wurde inzwischen erfolgreich in den Routineeinsatz bei ISOLDE integriert und hat Messungen an einer Reihe bisher nicht zugänglicher Isotope ermöglicht.

Der Vortrag gibt einen Überblick über aktuelle Ergebnisse des online Betriebs der LIST. Betriebsmodi und dabei erzielte Erkenntnisse sowie unerwartete Effekte, z.B. eine stark eingeschränkte Isobarenunterdrückung bei einigen wenigen Isotopen, werden diskutiert. Geeignete Weiterentwicklungen des Designs zur weiteren Steigerung von Selektivität und Effizienz werden abgeleitet und vorgestellt.

MS 5.3 Tue 15:15 PH/HS2

Resonant Laser-SNMS for spatially resolved ultra-trace analysis of radionuclides — ●MICHAEL FRANZMANN^{1,2}, LINDA HAMANN¹, KLAUS WENDT², and CLEMENS WALTHER¹ — ¹Institut für Radioökologie und Strahlenschutz, Leibniz Universität Hannover — ²Institut für Physik, Johannes Gutenberg Universität Mainz

The understanding of chemical behavior of most radionuclides in different natural compartments and anthropogenic systems, i.e. the investigation on speciation and transport mechanisms, requires more than just the determination of amount and isotope ratios of the contamination in a sample. Information about microscopic structural formation, e.g. onto nanoparticles, or sorption processes on different particle or surface materials is of primary relevance for the assessment of contamination threats. This is particularly valid in case of accidents or undeclared releases from nuclear power reactors, reprocessing plants or nuclear waste repositories. The system for resonant Laser-SNMS at the IRS Hannover is setup to combine the excellent element selectivity and efficiency of resonant laser ionization with the submicron spatial resolution and high mass resolution of a commercial TOF-SIMS. Sputtering by primary ions in combination with element selective ionisation allows to prevent chemical preparation, which most likely destroys the structural information in conventional radiometric or mass spectrometric approaches. The applied Ti:Sa laser system was developed at University of Mainz for radioecological bulk sample analysis. The ability of this Laser-SNMS system to analyze and map ultra-trace amounts of radionuclides is currently tested on environmental samples.

MS 5.4 Tue 15:30 PH/HS2

Resonance Ionization Mass Spectrometry (RIMS) for ultra-trace analysis of Technetium — ●PASCAL SCHOENBERG¹, DANIELA SCHOENENBACH¹, SEBASTIAN ZEISEL¹, NORBERT TRAUTMANN¹, PETRA THOERLE-POSPIECH¹, JOERG RUNKE¹, TOBIAS KRON², KLAUS WENDT², and TOBIAS REICH¹ — ¹Institute of Nuclear Chemistry, Johannes Gutenberg-University, Mainz, Germany — ²Institute of Physics, Johannes Gutenberg-University, Mainz, Germany

The determination of ultratrace amounts of the long-lived β -emitter ^{99g}Tc is difficult with radiometric methods. Common mass spectrometric techniques such as ICP-MS might be hampered by isobaric interferences. RIMS provides high sensitivity and selectivity for ultra-trace analysis and isotope ratio measurements of Tc due to multi-step

laser excitation and ionization in combination with a time-of-flight mass measurement.

The aim of this study was to apply RIMS for the analysis of ^{99g}Tc in environmental samples. For the determination of ^{99g}Tc in such samples, a known amount of ⁹⁷Tc is added as a tracer. The isotope shift between ⁹⁹Tc and ⁹⁷Tc is known and both isotopes can be ionized simultaneously using a three-step ionization scheme. The application of the RIMS technique to a contaminated soil sample will be illustrated. Furthermore, isotope ratio measurements of ^{97/98/99}Tc with RIMS and ICP-MS are presented.

MS 5.5 Tue 15:45 PH/HS2

Characterization of mixed Mo-Zr solution species by nano-Electrospray Ionization Mass Spectrometry — ●MEIJIE CHENG^{1,2}, MICHAEL STEPERT¹, and CLEMENS WALTHER¹ — ¹Institut für Radioökologie und Strahlenschutz, Leibniz Universität Hannover, Herrenhäuser Str. 2, D-30419 Hannover. — ²Karlsruher Institut für Technologie, Institut für Nukleare Entsorgung (INE), Hermann-von-Helmholtz-Platz 1, 76344 Eggenstein-Leopoldshafen

Nano-electrospray ionization mass spectrometry is a useful tool to characterize not only stoichiometry of solution species, but also redox state. This technique is able to transfer charged species present in solution into the vacuum under soft conditions that keep the molecules intact during the whole measurement process. Mass spectrometric methods find increasingly more applications within questions arising from the nuclear fuel cycle. Both Molybdenum and Zirconium are present in spent fuel in significant amounts as high yield fission products. These two elements tend to form poorly soluble solid phases, which can disturb reprocessing steps of spent fuel as well as the immobilization of radionuclides in matrices for final disposal. By applying ESI MS to solutions of Mo and Zr at high acidic strengths we were able to detect mixed Mo-Zr precursors to the precipitates in solution and probe their abundance depending on acidic strength.

MS 5.6 Tue 16:00 PH/HS2

Isomer-selective detection of reaction products in heterogeneous catalysis in the UHV by REMPLI-ToF — ●SEBASTIAN KOLLMANNBERGER, ANDREAS WINBAUER, CONSTANTIN WALENTA, JOSEF KIERMAIER, PATRICK SCHREIBER, MARTIN TSCHURL, and UELI HEIZ — Lehrstuhl für Physikalische Chemie & Catalysis Research Center, Chemistry Department, Technische Universität München, Lichtenbergstraße 4, 85748 Garching bei München, Germany

Selective hydrogenation mechanisms in heterogeneous catalysis are of major importance for the development of new catalysts. One system of particular interest is the selective hydrogenation of unsaturated aldehydes and ketones. Many studies in this field are performed under low pressure or in vacuum and even on single crystals to ensure well defined conditions. Usually, product molecule detection in such studies is performed by EI ionization in a Q-MS due to the high sensitivity of this method. However, this technique allows only a limited discrimination between isobars, because of the unselective properties of EI ionization. In this work we present a TOF-MS in combination with laser ionization. Due to the setup, this system allows a very sensitive detection of isobaric species by different ionization wavelengths. The sensitivity is compared to a commercial EI-QMS. Furthermore, the ability of isomer-selective detection is demonstrated by the desorption of ethylbenzene and p-xylene (both C₈H₁₀) as well as of their mixtures on a Pt (111) crystal.

MS 6: Posters

Time: Tuesday 17:00–17:00

Location: C/Foyer

MS 6.1 Tue 17:00 C/Foyer

Bestimmung der stereochemischen Absolutkonfiguration mittels Koinzidenzspektroskopie — ●MARTIN PITZER¹, MAKSYM KUNITSKI¹, GREGOR KASTIRKE¹, REINHARD DÖRNER¹, JÜRGEN STÖHNER², ROBERT BERGER³ und MARKUS SCHÖFFLER¹ — ¹Institut für Kernphysik, Goethe-Universität Frankfurt am Main — ²Fachbereich Chemie, Philipps-Universität Marburg — ³Zürcher Hochschule für Angewandte Wissenschaften

Zahlreiche pharmazeutische Wirkstoffe besitzen eine definierte Händigkeit, d.h. nur eines der beiden möglichen molekularen Spiegelbilder (Enantiomere) besitzt den erwünschten therapeutischen Nutzen. Aus

diesem Grund besteht ein großes Interesse, den Enantiomerenüberschuss in einer Probe zu bestimmen. Bisherigen Methoden gelingt dies jedoch meist nur über den Umweg chemischer Reaktionen oder makroskopischer Effekte. Kürzlich wurde am Beispiel des Halogenmethans CHBrClF gezeigt, dass sich Koinzidenzspektroskopie dazu eignet, die absolute Händigkeit einzelner Moleküle zu bestimmen [1]. Dabei wurden die Moleküle vielfach ionisiert und die dreidimensionalen Impulsvektoren der Fragmente mittels COLTRIMS (Cold Target Recoil Ion Momentum Spectroscopy) [2] gemessen. Dieser Beitrag zeigt, dass die Effizienz der Methode deutlich gesteigert werden kann, wenn geeignete molekulare Aufbrüche zur Bestimmung der Händigkeit gefunden werden. Dies eröffnet neue Möglichkeiten für Grundlagenforschung und

diagnostische Anwendung.

- [1] M. Pitzer et al., Science Vol. 341, 1096-1100 (2013)
 [2] J. Ullrich et al., Rep. Prog. Phys. Vol. 66, 1463-1545 (2003)

MS 6.2 Tue 17:00 C/Foyer

Room-temperature ultrasensitive mass spectrometer via dynamical decoupling — ●NAN ZHAO¹ and ZHANG-QI YIN² — ¹Beijing Computational Science Research Center — ²The Center for Quantum Information, Institute for Interdisciplinary Information Sciences, Tsinghua University

We propose an ultrasensitive mass spectrometer based on a coupled quantum-bit-oscillator system. Under dynamical decoupling control of the quantum bit (qubit), the qubit coherence exhibits a comb structure in the time domain. The time-comb structure enables high-precision measurements of oscillator frequency, which can be used as an ultra sensitive mass spectrometer. We show that, in the ideal case, the sensitivity of the proposed mass spectrometer has better performance at higher temperature and scales with the temperature T as $\eta \sim T^{1/2}$. While taking into account qubit and oscillator decay, the optimal sensitivity reaches a universal value independent of environmental temperature T . The measurement sensitivity also shows an improved dependence on the control-pulse number N as $\eta \sim N^{3/2}$, in comparison with the $N^{1/2}$ scaling in previous magnetometry studies. With the present technology on solid-state spin qubit and high-quality optomechanical system, our proposal is feasible to realize an ultrasensitive room-temperature mass spectrometer.

MS 6.3 Tue 17:00 C/Foyer

MAC, Software for data acquisition and hardware control of time-of-flight mass-spectrometers — ●JULIAN BERGMANN¹, ALEXANDER PIKHTELEV², SAMUEL AYET SAN ANDRES³, TIMO DICKEL^{1,3}, JENS EBERT^{1,4}, HANS GEISSEL^{1,3}, CHRISTINE HORNUNG¹, JOHANNES LANG¹, WAYNE LIPPERT¹, CHRISTIAN LOTZE¹, WOLFGANG PLASS^{1,3}, ANN-KATHRIN RINK¹, and CHRISTOPH SCHEIDENBERGER^{1,3} — ¹JLU Gießen, Deutschland — ²Institute of Energy Problems of Chemical Physics, Russian Academy of Sciences, Moscow, Russia — ³GSI Darmstadt, Deutschland — ⁴TU Darmstadt, Deutschland

MAC, short for Mass Analyzer control, is a software written in C++ for reading and controlling ADCs and TDCs as well as implemented analyzing methods in connection to multiple-reflection time of flight mass spectrometers (MR-TOF-MS).

As it supports multiple hardware (currently 3 TDCs and 2 ADCs), it is very versatile and can be adapted to specific applications.

It supports long-term measurement, online peak detection and data auto-saving, online multi-turn calibration (as used in our MR-TOF-MS), synchronous multi-channel readout and integrated hardware control (e.g. timing and voltage control) for automation procedures. MAC is able to import and export into different common file formats used by external software, which allows easy and flexible postprocessing of the data.

In the near future there will be automatic optimization of the MR-TOF-MS and online draft correction available.

MS 6.4 Tue 17:00 C/Foyer

An experimental setup for spectroscopic and reactivity studies of metal clusters with adsorbates in the gas phase — ●MARTIN TSCHURL¹, KATHRIN LANGE¹, DANIEL NEUWIRTH¹, JAN ECKHARD¹, BRADLEY VISSER², and UELI HEIZ¹ — ¹Lehrstuhl für Physikalische Chemie & Catalysis Research Center, Chemistry Department, Technische Universität München, Lichtenbergstraße 4, 85748 Garching bei München, Germany — ²Paul-Scherrer Institute, 5232 Villigen PSI, Switzerland

The elucidation of the properties of small metal clusters is inspired by their potential applicability in chemistry as powerful heterogeneous catalysts. Studies in the gas phase enable very well-defined experimental condition, which allow for the easy modelling of the systems. The combination of reactivity studies and spectroscopy is particularly powerful for obtaining a complete picture of the system. While the latter enables the elucidation of the cluster geometries and their electronic state, the first allows for a determination of all reaction pathways as well as kinetic and thermodynamic properties of the reaction. In this work we present our apparatus, which enable the investigation of bare metal clusters and their adsorbate complexes by laser spectroscopic methods. In a second part of the apparatus these species are stored in a ring-electrode ion trap for the study of reaction kinetics under isothermal conditions. The abilities of our setup is demonstrated by the reactivity of small Ta-cluster cations.

MS 6.5 Tue 17:00 C/Foyer

Discharge ion source for systematic studies of a cryogenic stopping cell — ●FLORIAN GREINER¹, TIMO DICKEL^{1,2}, HANS GEISSEL^{1,2}, IVAN MISKUN³, WOLFGANG PLASS^{1,2}, MORITZ PASCAL REITER¹, ANN-KATHRIN RINK¹, and CHRISTOPH SCHEIDENBERGER^{1,2} — ¹JLU Giessen, Germany — ²GSI, Darmstadt, Germany — ³Tomsk Polytechnic University, Russia

At the FRS Ion Catcher facility ions are produced, selected and range-bunched in the FRS. In a gas-filled cryogenic stopping cell (CSC) the ions will be thermalized and extracted via a RF carped into an RF quadrupole and guided to further detectors.

An electrical discharge source was installed inside the CSC. The advantages of this source are a high current and a broad spectrum of ion masses (~ 4 u to 250 u). Due to the high current it is possible to investigate space charge effects and the wide range of masses are necessary to proof the mass-dependent operation of the RF carpet.

Systematic studies for different mass-over-charge ratios can be done by filtering the mass of interest with the RFQ mass filter. In this case one mass region or one mass line was cut with the extraction RFQ in a mass-selectiv mode. Even in the high-pressure region of the RFQ, good mass filter performance was achieved. It was shown that the RF carpet can transport ions with masses down to 60 u and that doubly-charged ions can be extracted.

Systematic studies of the mass and intensity dependence of the RF carpet will be presented.

MS 6.6 Tue 17:00 C/Foyer

Aufrüstung der Ionenoptik des RISIKO-Massenseparators zur präzisen Ionenstrahlimplantation — ●SVEN JUNCK, REINHARD HEINKE, TOM KIECK, PASCAL NAUBEREIT, FABIAN SCHNEIDER und KLAUS WENDT — Institut für Physik, Johannes Gutenberg-Universität Mainz

Das ECHO-Projekt exploriert ein neuartiges Verfahren zur Bestimmung der oberen Grenze der Masse des Elektroneneutrinos. Hierzu ist die kalorimetrische Charakterisierung des Elektroneneinfangs von Holmium-163 in einem metallischen, magnetischen Kalorimeter vorgesehen. Die isotonenreine und möglichst isobarenfreie Implantation der Ho-163-Atome soll am RISIKO-Massenseparator der Arbeitsgruppe LARISSA der JGU Mainz über Resonanzionisation und direkte Ionenstrahlimplantation durchgeführt werden. Über autoradiographische Untersuchungen lässt sich bestimmen, dass mit den aktuellen Strahlparametern des RISIKO-Massenseparators die geometrische Implantationseffizienz in den kleinflächigen Detektor nur sehr gering ist. Aufgrund der stark eingeschränkten Verfügbarkeit des Ho-163 ist dies nicht tragbar und soll mittels einer speziellen Ionenoptikanordnung verbessert werden. Eine kurzbrennweitige Einzellinsenordnung dient der Fokussierung des Ionenstrahls, ein Ablenker der Korrektur und gezielter Steuerung der Ionenstrahlblage. Dadurch ist eine Steigerung der geometrischen Effizienz von etwa 1% bis auf 50% zu erwarten.

MS 6.7 Tue 17:00 C/Foyer

Absolute mass measurement of oxygen-16 at THE-Trap — ●TOM SEGAL¹, TOMMI ERONEN^{1,2}, MARTIN HÖCKER¹, JOCHEN KETTER¹, MARC SCHUH¹, SEBASTIAN STREUBEL¹, ROBERT S. VAN DYCK JR.³, and KLAUS BLAUM¹ — ¹Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg — ²Department of Physics, University of Jyväskylä, P.O. Box 35, FI-40014 University of Jyväskylä, Finland — ³Department of Physics, University of Washington, Seattle, WA 98195-1560

THE-Trap is a Penning-trap mass spectrometer that aims to measure the atomic mass ratio of tritium to helium-3 with a relative uncertainty of $1 \cdot 10^{-11}$. To test the experiment's accuracy and precision, we measured the mass ratio of carbon-12 to oxygen-16, which is one of the most precisely determined mass ratios [1].

In 2014 we reported a measurement of this mass ratio with a relative uncertainty of $6.3 \cdot 10^{-11}$ [2], which was limited by systematic effects. Since then we upgraded the experiment, including the ion source, the vacuum system, and the amplifier for the detection of the induced image current. Due to the improved ion storage times we were able to characterize the amplitude dependent systematic shifts [3] and reach a significantly lower uncertainty that approaches the uncertainty of the literature value.

[1] R. S. Van Dyck Jr. *et al.*, Int. J. Mass Spectrom. (2006) 251:231–242

[2] S. Streubel *et al.*, Appl. Phys. B (2014) 114: 137–145

[3] J. Ketter *et al.*, Int. J. Mass Spectrom. (2014) 358: 1–16

MS 6.8 Tue 17:00 C/Foyer

Laser-Resonanzionisation und Spurennachweis von Dysprosium und Erbium für das ECHO-Projekt — ●DOMINIK STUDER, PATRICK DYRAUF, MICHAEL FRANZMANN, TINA GOTTFELD, TOM KIECK, TOBIAS KRON, FABIAN SCHNEIDER und KLAUS WENDT — Institut für Physik, Johannes Gutenberg-Universität Mainz

Zur Untersuchung optischer Spektren von Dysprosium und Erbium wie auch zum elementselektiven Nachweis in ausgewählten Proben wird in der LARISSA Arbeitsgruppe die Methode der Laserresonanzionisation eingesetzt. Die mehrstufige Anregung optischer Übergänge erfolgt durch die in der Arbeitsgruppe entwickelten hoch-repetierenden Titan:Saphir-Laser und bedient sich zusätzlich einer nachfolgenden Massenseparation im Quadrupol-Massenspektrometer MABU (Mainzer Atomic Beam Unit). Die Kenntnis der Spektren der Holmium-Nachbarelemente Dysprosium und Erbium ist insbesondere im Rahmen des ECHO-Projekts wünschenswert, bei dem die Masse des Elektron-Neutrinos durch Untersuchung des Elektroneneinfangprozesses am Radioisotop Ho-163 bestimmt werden soll. Da bei der dort verwendeten Holmiumprobe bereits geringfügige Verunreinigungen durch die Nachbarelemente Dysprosium und Erbium die Messung signifikant beeinträchtigen können, ist die Bereitstellung hocheffizienter elementselektiver Selektions- und Nachweisverfahren mittels Resonanzionisation zur Reinheitsprüfung der Ausgangsproben unabdingbar. Hierzu werden spektroskopische Untersuchungen und Effizienzmessungen vorgestellt.

MS 6.9 Tue 17:00 C/Foyer

An ion trap for in-trap nuclear decay-spectroscopy experiments* — ●CHRISTINE WEBER and PETER G. THIROLF — Fakultät für Physik, LMU - München, 85748 Garching

A novel type of ion-trap setup, dedicated for decay-spectroscopy experiments on stored ions, is presently being built at the MLLTRAP Penning trap system in Garching [1]. Being free from any background or scattering effects, a trapped ion resembles the ideal source, and hence will facilitate a direct, in-situ observation of its decay products. For this purpose, a customized 'detector trap' made from Si-strip detectors will provide the ion storage potential and allow for the detection of alpha particles, whereas emitted electrons can be very efficiently guided by the magnetic field of the trap's solenoid to an auxiliary detector.

Possible experiments are in-trap alpha-decay experiments of heavy actinides and conversion-electron spectroscopy. Moreover, a coincident detection of an alpha decay with electron detection allows for a reconstruction of the original positions of electron clouds initiated by shake-off as well as from subsequent conversion decay. Via this decay length, the half-lives of states, *e.g.*, 2^+ , populated by alpha decay can be derived in a unique type of recoil-distance method. In this presentation, the design and characterization results of the detector systems are presented and possible physics experiments are highlighted.

[1] C. Weber *et al.*, Int. J. of Mass Spectrometry 349-350, 270 (2013).

* Supported by BMBF (06ML9148, 05P12WMFNE), DFG (HA 1101/14-1).

MS 6.10 Tue 17:00 C/Foyer

A setup for studying correlation effects in poly-anionic metal clusters by photoelectron spectroscopy — ●MADLEN MÜLLER¹, FRANKLIN MARTINEZ², GERRIT MARX¹, PATRICE OELSSNER², JOSEF TIGGESBÄUMKER², ROBERT WOLF³, KARL-HEINZ MEIWESE-BROER², and LUTZ SCHWEIKHARD¹ — ¹Ernst-Moritz-Arndt-Universität, Greifswald, Deutschland — ²Universität Rostock, Rostock, Deutschland — ³Max-Planck-Institut für Kernphysik, Heidelberg, Deutschland

Photoelectron spectroscopy (PES) experiments open insight into the electronic structure of atomic clusters. In the case of multiply negatively charged clusters, electron affinities and Coulomb barriers of these species can be probed by varying the wavelength of the photo-detachment laser. In addition, poly-anionic metal clusters serve as model systems for electron-correlation phenomena. A setup is presented, which combines a Paul trap, used for cluster-size selection and poly-anion production by electron attachment, with a magnetic-bottle time-of-flight electron spectrometer. As a first test PES on mono-anionic fullerenes with ultraviolet nanosecond laser pulses has been performed. In the future, the measurements will be extended to poly-anionic metal clusters in order to explore their electronic properties. As the appearance size of an anionic cluster increases with higher charge state, the resulting need of an increased mass resolving power will be satisfied by the implementation of a multi-reflection time-of-flight mass-separator/spectrometer. The project is funded by the Collaborative

Research Center (SFB) 652.

MS 6.11 Tue 17:00 C/Foyer

A large-area 4k-pixel detector for position and energy resolving detection of neutral molecular fragments — ●D. SCHULZ¹, L. GAMER¹, A. FLEISCHMANN¹, L. GASTALDO¹, S. KEMPF¹, C. KRANTZ², O. NOVOTNY³, A. WOLF², and C. ENSS¹ — ¹KIP Heidelberg University. — ²MPI-K Heidelberg. — ³Columbia Astrophysics Laboratory, New York, USA.

To investigate reactions like dissociative recombination in a laboratory environment, the Max Planck Institute for Nuclear Physics in Heidelberg is commissioning the Cryogenic Storage Ring to prepare molecular ions in their rotational and vibrational ground state. The full kinematics of these processes can be resolved by a position and energy sensitive detection of the produced neutral molecular fragments.

We present the design of a new large-area multi-pixel detector using metallic magnetic calorimeters for position and energy sensitive detection of massive particles with kinetic energies of up to a few hundred keV. The detector encompasses an array of 4096 quadratic absorbers, each with a side length of 700 μm , amounting to a total detection area of about 20 cm^2 . Groups of four absorbers are thermally connected to one paramagnetic sensor, using different thermal links for pixel discrimination. A temperature change in the paramagnetic sensor leads to a change of magnetization in the sensor. Thanks to a novel readout scheme, all 4096 sensors can be read out using at total of 32 SQUIDS only.

MS 6.12 Tue 17:00 C/Foyer

Electron Capture Decay Studies of $^{142}\text{Pm}60+$ Ions at GSI — ●FATMA CAGLA OZTURK^{1,2}, YURI A. LITVINOV¹, FRITZ BOSCH¹, and YESIM OKTEM² for the Two-Body Weak-Decay-Collaboration — ¹GSI, Darmstadt, Germany — ²Istanbul University, Istanbul, Turkey

GSI accelerator facility leads the scientific innovations on highly charged, heavy ions and search for the structure of atomic nucleus and the universe. Experimental Storage Ring (ESR) gives a great opportunity to study the periodic time modulations, claimed recently in the two-body orbital electron capture (EC) decay of $^{142}\text{Pm}60+$ ion, with period near to 6 seconds by using a 245 MHz resonator cavity with a high sensitivity and time resolution.

This study presents the results obtained from the latest experiment on EC decays of $^{142}\text{Pm}60+$ ions which are produced in FRS (FRagment Separator).

MS 6.13 Tue 17:00 C/Foyer

Measurement of the $^{144}\text{Sm}(\alpha,\gamma)^{148}\text{Gd}$ reaction cross section using Accelerator Mass Spectrometry — ●P. SCHOLZ, A. DEWALD, S. HEINZE, C. MÜLLER-GATTERMANN, L. NETTERDON, and A. ZILGES — Institute for Nuclear Physics, University of Cologne

The extinct *p* process nuclide ^{146}Sm serves as an astrophysical and geochemical chronometer through measurements of isotopic anomalies of its α -decay daughter ^{142}Nd . Hence, it serves as a clock for determining the chronology of solar-system formation and planetary differentiation. For this, the half-life of ^{146}Sm as well as the initial ratio of ($^{144}\text{Sm}/^{146}\text{Sm}$) has to be known very precisely. The initial isotopic ratio after *p*-process nucleosynthesis is still very unclear. Determining cross sections of reactions producing ^{144}Sm or ^{146}Sm would put predictions leading to *p*-process abundances on a more reliable basis. Although the very challenging $^{144}\text{Sm}(\alpha,\gamma)^{148}\text{Gd}$ reaction was measured before [1], the results are heavily debated for methodical reasons. In a new approach, enriched ^{144}Sm -targets activated by high-intense α -particle beam will be analyzed for their content of ^{148}Gd via Accelerator Mass Spectrometry at CologneAMS. General ideas for isobaric suppression and normalization procedures as well as the different experimental setups will be presented.

Supported by the ULDETIS project within the UoC Excellence Initiative institutional strategy.

[1] E. Somorjai *et al.* Astron. Astrophys. **333**, 1112-1116, 1998.

MS 6.14 Tue 17:00 C/Foyer

Heavy ions at the DREAMS facility — ●STEFAN PAVETICH¹, KEITH FIFIELD², MICHAELA FRÖHLICH², MICHAEL HOTCHKIS³, SILKE MERCHEL¹, GEORG RUGEL¹, ANTON WALLNER², and RENÉ ZIEGENRÜCKER¹ — ¹Helmholtz-Zentrum Dresden-Rossendorf, Germany — ²Australian National University, Australia — ³Australian Nuclear Science and Technology Organisation, Australia

The Dresden Accelerator Mass Spectrometry (DREAMS) facility is designed for the measurement of ^{10}Be , ^{26}Al , ^{36}Cl , ^{41}Ca and ^{129}I [1]. The actual goal is to extend the measurement capabilities to actinides. For this purpose, a time-of-flight system was designed and is currently under construction. The system is based on a 1.5 m long flight path and thin carbon foils with Micro Channel Plates as start and stop detectors. For an optimal tuning of the system with low currents, special beam diagnostic elements are planned. In order to characterize the existing system, first measurements of actinide samples have been performed in collaboration with the ANU and ANSTO, using an ionization chamber as detector. Measurements of Pu-isotopes in the 3+ and the 5+ charge state have been conducted.

[1] S. Akhmadaliev et al., NIMB 294 (2013) 5.

MS 6.15 Tue 17:00 C/Foyer

Physical and chemical testing of graphite targets — ●MATTHIAS SCHINDLER, WOLFGANG KRETSCHMER, ALEXANDER STUHL, ALEXANDER TSCHKEKALINSKIJ und ANDREAS SCHARF — Uni Erlangen-Nürnberg, Physikalisches Inst. Abt. IV, 91058 Erlangen

One way to reduce the background in radiocarbon AMS is to reduce the content of hydrocarbons in the target material. Therefore we did physical tests like thermogravimetric analysis and molecular spectroscopy to determine the composition of graphite targets. Based on this results the reduction parameters were adjusted and cross checked.

MS 7: Ion Storage Rings

Time: Wednesday 11:00–12:15

Location: PH/HS2

MS 7.1 Wed 11:00 PH/HS2

The Cryogenic Storage Ring CSR — ●ROBERT VON HAHN¹, ARNO BECKER¹, KLAUS BLAUM¹, CHRISTIAN BREITENFELDT¹, AODH O'CONNOR¹, SEBASTIAN GEORGE¹, JÜRGEN GÖCK¹, MANFRED GRIESER¹, FLORIAN GRUSSIE¹, PHILIPP HERWIG¹, CLAUDE KRANTZ¹, HOLGER KRECKEL¹, CHRISTIAN MEYER¹, OLDA NOVOTNY^{1,2}, ROLAND REPNOW¹, CLAU-DIETER SCHRÖTER¹, KAIJA SPRÜCK³, STEPHEN VOGEL¹, and ANDREAS WOLF¹ — ¹Max-Planck-Institut für Kernphysik, Heidelberg, Germany — ²Columbia Astrophysics Laboratory, Columbia University, New York, USA — ³Institut für Atom- und Molekülphysik, Justus-Liebig-Universität Giessen, Germany

At the CSR, a cryogenic electrostatic storage ring, first experiments studying low-energy ion reactions with atoms, photons or electrons are upcoming in near future. At beam energies of 20 keV to 300 keV per charge unit and 35 m circumference the CSR is designed to allow experiments in a cryogenic environment providing conditions of extremely low vacuum (1×10^{-13} mbar) and temperature (10K). Moreover, phase space cooling by electrons is under construction to be installed as the next step.

In spring 2014 a 50 keV Ar⁺-beam could be successfully stored in the CSR still operating at room temperature. Additionally beam diagnostics as well as particle detectors for neutral and charged fragments have been successfully tested.

Presently preparations are finalized for the first complete cryogenic cool down of the CSR, in order to start first exploratory experiments with stored atomic and molecular anions and cations in spring 2015.

MS 7.2 Wed 11:15 PH/HS2

The low-energy electron cooler for the Cryogenic Storage Ring — ●STEPHEN VOGEL, KLAUS BLAUM, CLAUDE KRANTZ, SVENJA LOHMANN, and ANDREAS WOLF — Max-Planck-Institut für Kernphysik, 69117 Heidelberg, Germany

The Cryogenic Storage Ring (CSR) at the Max Planck Institute for Nuclear Physics in Heidelberg, Germany, is being commissioned. CSR will be an ideal tool for preparing and studying cold atomic and molecular ions using ion beams of 20 – 300 keV kinetic energy (per ion charge unit). As a first important upgrade CSR will be equipped with an electron cooler. The latter is designed for cooling beams with a charge-to-mass ratio q/m of 1 to $1/160$ e/amu. This corresponds to an electron beam energy range of 1 to 163 eV. The beam will be produced by a cryogenic photocathode and electron temperatures in the co-moving frame reach down to 10 K. The cooler can also be used as an electron target by detuning the electrons' kinetic energy. The cooler is currently under construction and first tests on the already finished warm beam line parts are ongoing. The current status of the CSR electron cooler will be presented.

MS 7.3 Wed 11:30 PH/HS2

Large-area detectors for position and energy resolving detection of neutral molecular fragments at CSR — ●L. GAMER¹, D. SCHULZ¹, A. FLEISCHMANN¹, L. GASTALDO¹, S. KEMPF¹, C. KRANTZ², O. NOVOTNY³, A. WOLF², and C. ENSS¹ — ¹Heidelberg Univ. — ²MPI-K Heidelberg — ³Columbia Astrophysics Laboratory

We present a detector with a circular detection area of 10 cm^2 based on metallic magnetic calorimeters that is suited for position and energy sensitive measurements of neutral particle hits from fragmentation of molecular ion beams at the Cryogenic Storage Ring at MPI-K. It con-

sists of 16 large area particle absorbers, arranged like the 16 slices of a pizza of radius 36 mm, where the temperature of each is monitored by a paramagnetic temperature sensor positioned along the outer absorber edges. Due to the finite thermal diffusivity in the absorbers, the signal rise-time is a measure of the radial event position while the integrated signal amplitude is proportional to the particle energy. We show very successful prove-of-principle experiments of this detector using x-ray photons. We discuss measurements where fragments of 150 keV molecules where stopped in massive gold absorbers showing that the production of lattice defects can cause a major contribution to linewidth in this energy and mass range. As an outlook we move on to a 4096 pixels detector covering a detection area of 20 cm^2 . It consists of 1024 temperature sensors that are read out by only 32 SQUID channels. Each temperature sensor is coupled to 4 absorbers using different thermal links, thus allowing to locate the event position within a set of absorbers again by measuring the rise-time of the detector signal.

MS 7.4 Wed 11:45 PH/HS2

Neutral-atom molecular-ion merged beams experiments at the cryogenic storage ring — ●AODH O'CONNOR, MANFRED GRIESER, FLORIAN GRUSSIE, and HOLGER KRECKEL — Max-Planck-Institut für Kernphysik, Heidelberg

Gas phase interstellar chemistry is dominated by reactions between neutrals and ions. Thus far, there remain large uncertainties on many reaction rate coefficients, which determine formation pathways. Experimental determination of ion-neutral reaction rates relevant to cosmic chemistry have been inhibited by technical challenges. The greatest obstructions are: generation of a well-defined, pure, ground-term neutral beam, and preparation of molecular ion beams with sufficiently low internal energies. To address these challenges, we have developed a beamline capable of producing atomic beams of hydrogen, deuterium, carbon and oxygen. The neutrals are created by photodetachment from a parent anionic beam using a direct diode laser. The neutral beams are coupled to the Cryogenic Storage Ring (CSR) at the Max Planck Institute for Nuclear Physics. They are merged with a cold, stored molecular ion beam in one of the straight sections of the CSR. The co-propagating beams can be matched in velocity, allowing center-of-mass collisional energies as low as a few meV. Measurement of beam fluxes, velocities, and overlap length will permit absolute determination of the reaction thermal rate coefficients.

MS 7.5 Wed 12:00 PH/HS2

Development of a Transversely Sensitive Resonant Schottky Pickup for the CR@FAIR — ●XIANGCHENG CHEN^{1,2}, SHAHAB SANJARI¹, JEREMI PIOTROWSKI^{2,3}, PETER HÜLSMANN¹, YURI LITVINOV^{1,4}, FRITZ NOLDEN¹, MARKUS STECK¹, and THOMAS STÖHLKER^{1,5} — ¹GSI, Darmstadt — ²Uni. HD, Heidelberg — ³AGH University of Science and Technology, Krakow, Poland — ⁴MPI-K, Heidelberg — ⁵HIJ, Jena

The prospective FAIR facility will offer unprecedented opportunities to extend atomic and nuclear physics research programs with its high-energy and high-intensity heavy ion beams. For instance, the Collector Ring (CR) will be best suitable for addressing mass and lifetime measurements of rare isotopes when it is operating in the isochronous ion-optical mode. However due to the large acceptance of the CR the non-isochronicity effect still exists, which limits the measurement precision. The determination of particle positions in addition to their rev-

olution frequencies is required to enhance the mass resolving power. In this contribution, we present a novel design of a transversely sensitive resonant Schottky pickup for the CR. It is an elliptical pillbox-cavity with an off-centred beam pipe, and works in the monopolar eigenmode.

Based on the simulations and offline tests, its feasibility of coping with different beam parameters of the CR is also discussed.

MS 8: Accelerator Mass Spectrometry and Applications 1

Time: Wednesday 14:30–16:30

Location: PH/HS2

Invited Talk MS 8.1 Wed 14:30 PH/HS2

Entwicklung eines multi-Isotopen nieder-Energie AMS Systems — ●SASCHA MAXEINER, HANS-ARNO SYNAL, MARCUS CHRISTL, MARTIN SUTER, ARNOLD MÜLLER und CHRISTOF VOCKENHUBER — Labor für Ionenstrahlphysik, ETH Zürich, Schweiz

Auf dem Weg zu einem niederenergetischen und kompakten multi-Isotopen AMS System wurden mehrere systemkritische Punkte wie der Stripper, die Beschleunigung und die Ionoptik eines bestehenden 0.6 MV AMS Systems der ETH Zürich anhand von Messungen und bekannter Theorie modelliert. Die Modelle wurden in Simulationen verwendet, um relevante physikalische Prozesse wie Streuung und Verlust von Ionen im Stripper, elektrische Feldverteilungen der Beschleunigung und die Strahlführung im System zu analysieren. Die Nutzung im Rahmen der Entwicklung eines vakuumisolierten 250 kV Tandem-Beschleunigers und kritische Designüberlegungen werden in diesem Vortrag diskutiert.

Im zweiten Teil werden erste Messungen mit dem neuen Beschleuniger im bestehenden Spektrometer präsentiert. Die Performance-Parameter und der Untergrund von AMS Messungen von Aktiniden, ^{129}I , ^{41}Ca und ^{26}Al werden besprochen und mit bestehenden Systemen verglichen. Eine vergleichbare oder erhöhte Performance wurde erreicht und ermutigt zu weitergehenden Entwicklungen. Als Abschluss werden mögliche Messungen des Isotops ^{10}Be und die dazu notwendigen Schritte kurz diskutiert.

MS 8.2 Wed 15:00 PH/HS2

Isobar suppression of MgO^- vs. AlO^- by laser photodetachment — ●MARTIN MARTSCHINI¹, PONTUS ANDERSSON², OLIVER FORSTNER³, DAG HANSTORP⁴, YUAN LIU⁵, TOBIAS MOREAU¹, JOHANNA PITTERS¹, ALFRED PRILLER¹, PETER STEIER¹, and ROBIN GOLSER¹ — ¹VERA Laboratory, University of Vienna, Faculty of Physics, Austria — ²Earth and Space Sciences Department, Chalmers University of Technology, Gothenburg, Sweden — ³Institut für Optik und Quantenelektronik, Friedrich-Schiller-Universität, Jena, Germany — ⁴Department of Physics, University of Gothenburg, Sweden — ⁵ORNL Oak Ridge National Laboratory, Tennessee, USA

The Ion Laser Interaction Setup ILIAS at the VERA Laboratory of the University of Vienna is fully operational since November 2014. A gas-filled radio frequency quadrupole is used to decelerate negative ions from a cesium sputter source and to study isobar suppression by selective laser photodetachment for future AMS purpose.

With a 532nm laser, we recently achieved a suppression of MgO^- ions by more than 4 orders of magnitude at only 15% reduction in AlO^- . This may pave the way for the use of the much more intense oxide beams for Al injection during ^{26}Al AMS, which currently suffers from the poor ion yield of Al^- . Following the discussion of these experimental results, we will also present the layout of the new injector at VERA that will allow to couple the ion cooler to a state-of-the-art AMS facility.

MS 8.3 Wed 15:15 PH/HS2

Isobar-separation of intense beams at 6 MV Tandem accelerators — ●CHRISTOF VOCKENHUBER — Laboratory of Ion Beam Physics, ETH Zurich, Switzerland

I will review the isobar-separation techniques that are available at 6 MV tandem accelerators and show with some examples (^{26}Al , ^{32}Si , ^{36}Cl) from the 6 MV EN Tandem accelerator at ETH Zurich what are the physical limits of these techniques.

MS 8.4 Wed 15:30 PH/HS2

Offline and online radiocarbon measurements of carbonaceous aerosols — ●SÖNKE SZIDAT, KONSTANTINOS AGRIOS, and GARY A. SALAZAR — Universität Bern, Departement für Chemie und Biochemie & Oeschger-Zentrum für Klima- und Klimafolgenforschung, Bern, Schweiz

Atmospheric aerosols are of concern due to their impacts on human health and the global climate. Legislative measures of air quality improvement require a detailed knowledge of emission sources of the aerosols, which is still lacking. Radiocarbon analyses provide a large potential in this context, as they distinguish between fossil and non-fossil sources of carbonaceous aerosols. To fully exploit this potential, the aerosol fractions organic carbon (OC) and elemental carbon (EC) should be separated and measured with AMS individually, preferably from numerous aerosol filters. In order to fulfil this goal, we have investigated the separation of OC and EC with a commercial thermo-optical aerosol analyzer and offline radiocarbon determinations. Furthermore, we coupled this instrument to the gas ion source of the MICADAS in Bern with two different online approaches a) by trapping portions of the carbon dioxide that evolves from aerosol analyzer with a zeolite molecular sieve and b) by direct transfer of the gas into the ion source using a flow separator for real-time analysis. Here, we present the technical setups, strategies for semi-automated measurements and the validation of the methods with standards and ambient aerosol samples.

MS 8.5 Wed 15:45 PH/HS2

Erkenntnisse über die Geschichte eines Alpengletschers durch Kombination von kosmogenem Be-10, in-situ C-14 und Cl-36 — ●CHRISTIAN WIRSIG¹, SUSAN IVY-OCHS¹, NAKI AKCAR², CHRISTIAN SCHLÜCHTER², MAARTEN LUPKER³, KRISTINA HIPPE¹, LUKAS WACKER¹, CHRISTOF VOCKENHUBER¹ und HANS-ARNO SYNAL¹ — ¹Labor für Ionenstrahlphysik, ETH Zürich, Schweiz — ²Institut für Geologie, Universität Bern, Schweiz — ³Institut für Geochemie und Petrologie, ETH Zürich, Schweiz

Kosmogene Nuklide werden an der Oberfläche von Fels gebildet, der kosmischer Strahlung ausgesetzt ist. Sie werden vorrangig genutzt um die Expositionsdauer einer Oberfläche zu bestimmen und somit die Evolution einer Landschaft zu verstehen. Die Kombination von Messergebnissen unterschiedlicher kosmogener Nuklide ermöglicht zusätzlich den Nachweis von komplexen Expositionsgeschichten, d.h. insbesondere zwischenzeitliche Episoden von Bedeckung durch Sedimente oder Eis.

Wir präsentieren Ergebnisse einer Studie, in der zum ersten Mal AMS-Messungen von Be-10, in-situ C-14 und Cl-36 in denselben Gesteinsproben durchgeführt wurden. Die Proben stammen von einem proglazialen Felsbetrieel am Gruebengletscher in den Schweizer Alpen. Durch die Kombination der drei kosmogener Nuklide erlangen wir Erkenntnisse über Expositions- und Bedeckungsdauer der vier Probenstandorte. Daraus ziehen wir Rückschlüsse über die Ausdehnung des Gruebengletschers im Holozän und quantifizieren subglaziale Erosionsraten auf dem Felsbetrieel.

MS 8.6 Wed 16:00 PH/HS2

^{14}C Analysen von karbonatischen Klimaarchiven mittels LA-AMS — ●CAROLINE WELTE^{1,2}, LUKAS WACKER¹, BO DO HATTENDORF², MARCUS CHRISTL¹, JOACHIM KOCH², DETLEF GÜNTHER² und HANS-ARNO SYNAL¹ — ¹Laboratory of Ion Beam Physics, ETHZ, Otto Stern Weg 5, HPK, 8093 Zurich, Switzerland — ²Laboratory of Inorganic Chemistry, D-CHAB, ETHZ, Vladimir-Prelog-Weg 1, 8093 Zurich, Switzerland

Die Analyse von Festkörpern mittels Laser Ablation (LA) erlaubt eine rasche Bestimmung der stofflichen Zusammensetzung der Probe, bei der eine hohe Ortsauflösung ($< 100 \mu\text{m}$) erreicht werden kann. Diese Methode kann nun auch zur Untersuchung des ^{14}C -Gehalts von Karbonaten mittels AMS eingesetzt werden. Hierbei wird ein fokussierter Laser zur Erzeugung von CO_2 verwendet und das Gas direkt in die Gasionenquelle des AMS geleitet. Diese neue Methode (LA-AMS) [1] ist besonders interessant für die ^{14}C -Analyse von karbonatischen Klimaarchiven wie z.B. Korallen oder Speleothemen, da die konventionelle Probennahme der einzelnen Wachstumslagen zeitaufwendig und die örtliche Auflösung limitiert ist. Die LA-AMS Apparatur besteht aus einem Excimer Laser (193 nm) und einer Ablationszelle mit ei-

nem Positionier- sowie einem Gastransportsystem. Ortsauflösung und Messpräzision für unterschiedliche Abrastermethoden werden anhand eines Stalagmiten mit einem deutlich ausgeprägten ^{14}C -Bombenpeak verglichen. Es werden weitere Beispiele gezeigt, deren Analyse von der hohen Ortsauflösung des neuen LA-AMS Verfahrens profitiert.

[1] Wacker, L. et al., NIM B 2013, 294, 287.

MS 8.7 Wed 16:15 PH/HS2

A molecular sieve cartridge (MSC) to collect soil CO₂ for radiocarbon dating - first tests and applications — ●ANJA CORDING¹, PATRICK DIETRICH², LUKAS WACKER³, AXEL DON², and JANET RETHEMEYER¹ — ¹Institut für Geologie und Mineralogie, Universität zu Köln, Cologne, Germany — ²Johann Heinrich von Thünen-Institut, Institut für Agrarclimatschutz, Braunschweig, Germany — ³Labor für Ionenstrahlphysik, ETH Zürich, Zurich, Switzerland

The aim of this study is to trap low concentrations of CO₂ respired

from soils. The subsequent AMS-radiocarbon analysis of the CO₂ can give valuable information about the microbial decomposition of different soil organic carbon pools. A great advantage of the MSC trapping technique is the collection of CO₂ from large air volumes on a small amount of adsorbent without the need of using liquid nitrogen or caustic NaOH, which makes it suitable for sampling in remote areas. Difficulties of this approach arise from the incomplete removal of atmospheric CO₂, which results in memory effects, and the absorption of soil water, which can lead to isotopic fractionation. In this study, a stainless steel MSC was constructed and tested to assess the methodological difficulties given above. Different active (under He-flow) and passive (under vacuum) methods of loading CO₂ onto the trap, of CO₂ desorption as well as different regeneration methods of the zeolite were performed using blank gas. Additionally, different amounts of molecular sieve were tested to obtain enough CO₂ for the AMS analysis but trap as little water as possible. We will also present the first results of CO₂ released from soils with very low organic carbon contents.

MS 9: Clusters in Molecular Physics (with A & MS)

Time: Wednesday 14:30–16:30

Location: PH/SR106

Invited Talk MS 9.1 Wed 14:30 PH/SR106
Vibrational Spectroscopy of Cluster Complexes with Free Electron Lasers: Surface Science en Miniature — ●ANDRÉ FIELICKE — Institut für Optik und Atomare Physik, Technische Universität Berlin, Germany

Transition metal clusters are frequently used as model systems for low coordinated sites of extended surfaces and their study can provide valuable insights into the mechanisms of surface reactions. In many cases, however, there is still a lack of information on their structures and the relationship between structure and chemical behavior. Using vibrational spectroscopy of gas-phase clusters one can obtain information about the clusters' structure or the behavior of adsorbed species. The latter provides valuable insights into the binding geometry, the activation of bonds within the ligands or reactions occurring on the clusters' surface. Cluster size specific data can be obtained using infrared multiple photon dissociation spectroscopy. To cover the required spectral range from the far to the mid-IR our experiments make use of IR free electron lasers. The talk will discuss exemplary studies about reactions on platinum clusters [1] and the activation of molecular oxygen by small gold clusters [2].

[1] D.J. Harding, A. Fielicke, Chem. Eur. J. 20 (2014) 3258

[2] A.P. Woodham, A. Fielicke, Struct. Bond. 161 (2014) 243

MS 9.2 Wed 15:00 PH/SR106

Vibrational spectra and structures of C, B, and N-doped silicon clusters — ●NGUYEN XUAN TRUONG, BERTRAM JAEGER, PHILIP JÄGER, MARCO SAVOCA, ANDRÉ FIELICKE, and OTTO DÖPFER — IOAP, TU-Berlin, Germany

Doping Si clusters changes their physical and chemical properties in a way that might be promising for the miniaturization trend towards nanoelectronics. Here, we investigated Si clusters doped with C, B and N with resonant infrared-ultraviolet two-color ionization (IR-UV2CI) and global optimization coupled with electronic structure methods. Doped Si clusters are irradiated with tunable IR light from a Free Electron Laser before being ionized with UV photons from an F₂ laser. Resonant absorption of IR photons leads to an enhanced ionization efficiency for the neutral clusters and provides the size-specific IR-UV2CI spectra. Structural assignment of the clusters is achieved by comparing the experimental IR-UV2CI spectrum with the calculated linear absorption spectra of the most stable isomers. Low-energy isomers are found with the help of genetic and basin-hopping algorithms. For Si_mC_n (with $m + n = 6$), we observed the systematic transition from chain like geometries for C₆ to 3D structures for Si₆. We showed for the first row doped Si₆X (with X = Be, B, C, N, O) clusters that different structures, vibrational and electronic properties can be achieved depending on the nature of the dopant atom. All dopant atoms in Si₆X have a negative net charge suggesting that Si atoms act as electron donors within the clusters. Finally, vibrational spectra and structural assignments for B and N-doped Si clusters are discussed in detail.

MS 9.3 Wed 15:15 PH/SR106

(N)IR spectroscopy on two- and three-centered isolated cationic cobalt-, nickel- and cobalt/nickel - ethanol clusters

— ●MARKUS BECHERER¹, DANIEL BELLAIRE¹, WEI JIN², GEORGIOS LEFKIDIS², WOLFGANG HÜBNER², and MARKUS GERHARDS¹ — ¹TU Kaiserslautern, Fachbereich Chemie, Erwin-Schrödinger-Straße 52, 67663 Kaiserslautern — ²TU Kaiserslautern, Fachbereich Physik, Erwin-Schrödinger-Straße 47, 67663 Kaiserslautern

Clusters containing transition metals and aliphatic ligands provide model systems regarding e.g. catalytical properties, magnetism, reactivity and structure. Thus, the successive variation of size and composition of the metal clusters can give a fundamental insight on possible cooperative effects. The investigated two- and three-centered pure and combined cationic cobalt, nickel clusters are produced by applying laser ablation to a rotating metal rod and by attaching the ethanol ligand in a supersonic beam. The frequencies and frequency shifts of OH and CH stretching vibrations (between different clusters) are probed by means of IR-photofragmentation spectroscopy. A structural assignment is performed by comparing the experimental data with calculated frequencies obtained from DFT calculations. In case of the isolated cationic (cobalt)₃(ethanol)₁ and (cobalt)₃(ethanol)₁(water)₁ clusters both IR and electronic spectra (in the NIR region) are investigated through photodissociation spectroscopy. The experimentally observed spectra serve, among other aspects, as reference for theoretical calculations especially on the electronic transitions localized on the triangular Co trimer metal centre.

MS 9.4 Wed 15:30 PH/SR106

First experiments with cooled clusters at the Cryogenic Trap for Fast ion beams — ●CHRISTIAN MEYER¹, KLAUS BLAUM¹, CHRISTIAN BREITENFELD^{1,2}, SEBASTIAN GEORGE¹, JUERGEN GOECK¹, JONAS KARTHEIN¹, THOMAS KOLLING³, JENNIFER MOHRBACH³, GEREON NIEDNER-SCHATTEBURG³, LUTZ SCHWEIKHARD², and ANDREAS WOLF¹ — ¹Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Germany — ²Institut für Physik, Ernst-Moritz-Arndt Universität, 17487 Greifswald, Germany — ³Fachbereich Chemie, TU Kaiserslautern, Germany

The Cryogenic Trap for Fast ion beams (CTF) is an electrostatic ion beam trap for the investigation of charged particles in the gas phase located at the "Max-Planck-Institut für Kernphysik" in Heidelberg. It is suited to study thermionic and laser-induced electron emission of anions with complex multi-body structure such as clusters and molecules. They can be stored up to several minutes due to the low restgas pressure of 10⁻¹³ mbar [1] in an ambient temperature down to 15 K. The experiments were so far hampered by the ion production in a sputter source leading to excited particles with high rovibrational states. In order to be able to investigate the ground state properties of such systems a new supersonic expansion source [2] has been implemented. A laser-induced plasma is expanded into vacuum by short pulses (50 μs) of a helium carrier gas and thereby rovibrationally cooled. First tests with metal cluster will be presented and discussed.

[1] M. Lange et al., Rev. Sci. Instr., 81,055105 (2010)

[2] C. Berg et al., J. Chem. Phys. 102, 4870 (1995)

MS 9.5 Wed 15:45 PH/SR106

Optical spectra and structures of C, N, and O-doped silicon clusters — ●BERTRAM K.A. JAEGER, JANINA LEBENDIG, NGUYEN X. TRUONG, ANDRE FIELICKE, and OTTO DOPFER — IOAP, TU Berlin, Germany

Controlled changes in physical and chemical properties of doped Si clusters provide promising candidates of nanostructures for optoelectronics, sensors or medicine. We study Si clusters doped with C, N and O via their photodissociation spectra and compare them with theoretical quantum chemical calculations. Ionic clusters are produced in a laser vaporization source, then irradiated with tunable visible light from an OPO laser in the range from 410 to 580 nm and characterized by a reflectron time-of-flight mass spectrometer. Absorption of photons leads to dissociation of the clusters, which is detected in the mass spectrum. Calculated absorption spectra are compared to experimental data for assignment of geometries and electronic parameters of the observed clusters. The most stable and low-energy isomers are found with the help of genetic and basin-hopping algorithms. All results will be compared to existing studies about IR-UV two color ionization of neutral and doped Si clusters.

Pristine and tagged Au clusters show absorption bands in the visible range and are used as a test system to verify the experimental principle.

MS 9.6 Wed 16:00 PH/SR106

Angular distribution of electron and photon emission from isolated SiO₂ nanoparticles excited by femtosecond laser pulses — ●EGILL ANTONSSON, INA HALFPAP, CHRISTOPHER RASCHPICHLE, VALERIE MONDES, JÜRGEN PLENKE, BURKHARD LANGER, and ECKART RÜHL — Physical Chemistry, Freie Universität Berlin, Takustr. 3, 14195 Berlin

We excite isolated spherical SiO₂ nanoparticles (diameter: 90 nm, size distribution: 8%) with intense femtosecond laser pulses ($\lambda=800$ nm, $\tau=80$ fs, Intensity: $1\text{-}3\cdot 10^{13}$ W/cm²) and study the angular distribution of emitted electrons and UV photons ($h\nu>8$ eV). The nanoparticles are prepared in an aerodynamically focused beam which propagates into a high vacuum system where excitation and photoionization occurs. This ensures that fresh sample is available to each laser pulse

MS 10: Accelerator Mass Spectrometry and Applications 2

Time: Wednesday 17:00–19:00

Location: PH/HS2

Invited Talk MS 10.1 Wed 17:00 PH/HS2
Betrieb und Performance des CologneAMS Systems — ●STEFAN HEINZE¹, CLAUD FEUERSTEIN¹, BJÖRN DITTMANN², STEVE BINNIE², SILKE MECHERNICH², ALFRED DEWALD¹, TIBOR DUNAI² und JANET RETHMEYER² — ¹Institut für Kernphysik der Universität zu Köln — ²Institut für Geologie und Mineralogie, Universität zu Köln

Die Liste der von CologneAMS im Routinebetrieb gemessenen Isotope wird kontinuierlich erweitert. Diese umfasst zur Zeit Beryllium, Kohlenstoff, Aluminium, Plutonium und Chlor. Es wird ein Überblick bzgl. Qualität der Messungen und Performance des CologneAMS Systems gegeben. Hierbei wird insbesondere auf die ersten Chlor Analysen, welche Ende 2014 durchgeführt wurden, eingegangen.

Für zukünftige Plutonium AMS Messungen wurde ein neuer Pu Hausstandard aus vier Referenzmaterialien erzeugt. Er enthält die Isotope ²⁹³Pu, ²⁴⁰Pu, ²⁴²Pu und ²⁴⁴Pu und wurde von mehreren AMS Laboren am bekannten UK Pu 5/92138 zertifizierten Referenzmaterial kalibriert. Diese Daten dienen auch als Inter-Labor-Vergleich. Die zusammengefassten Ergebnisse werden präsentiert.

MS 10.2 Wed 17:30 PH/HS2

Aufbau einer neuen Ionenquelle für ¹⁴CO₂ Gasproben am AMS-System der Universität zu Köln — ●ALEXANDER STOLZ¹, STEFAN HEINZE¹, RICHARD ALTENKIRCH¹, MARKUS SCHIFFER¹, CLAUD FEUERSTEIN¹, CLAUD MÜLLER-GATERMANN¹, PACHANDAR BANDARI¹, JANET RETHMEYER², TIBOR DUNAI² und ALFRED DEWALD¹ — ¹Institut für Kernphysik, Universität zu Köln — ²Institut für Geologie, Universität zu Köln

Um komponentenspezifische ¹⁴C AMS-Analysen durchführen zu können, soll eine neue Sputterquelle vom Typ HVE-SO110 mit Gaszuführung am CologneAMS-Beschleuniger der Universität zu Köln aufge-

and rules out effects due to particle-particle interactions, sample charging, and radiation damage. For electron emission, a distinct angular dependence with respect to the polarization vector of the laser pulses is observed, which varies for different photoelectron energies. High-energy photoelectrons are found to be emitted preferentially parallel to the polarization vector of the exciting laser photons, which is discussed in terms of an elastic scattering of continuum electrons at or near the surface of the nanoparticles. For low-energy photoelectrons, on the other hand, the angular dependence is quenched due to multiple inelastic scattering events of the photoelectrons in the nanoparticles which smears out angular effects.

MS 9.7 Wed 16:15 PH/SR106

Vibrationally resolved UV fluorescence of diamondoids — ●TORBJÖRN RANDE¹, ROBERT RICHTER¹, TOBIAS ZIMMERMANN¹, ANDRE KNECHT¹, ANDREA MERLI¹, CHRISTOPH HEIDRICH¹, RAMON RAHNER¹, THOMAS MÖLLER¹, MERLE I. S. RÖHR², JENS PETERSEN², ROLAND MITRIC², JEREMY E. DAHL³, and ROBERT M. K. CARLSON³ — ¹Institut für Optik und Atomare Physik, Technische Universität Berlin, Berlin, Deutschland — ²Institut für Physikalische und Theoretische Chemie, Universität Würzburg, Würzburg, Deutschland — ³Stanford Institute of Materials and Energy Sciences, Stanford University

Diamondoids are a class of perfectly size- and shape selectable carbon nanoparticles, with a wide range of interesting properties. Due to the size-selectivity afforded by the diamondoids, they are ideal model systems for studying the photo-physics of hydrocarbon molecules of different sizes. We present a study of the size- and shape dependent energy resolved UV fluorescence of diamondoids, ranging from adamantane to pentamantane, using narrow band laser light as excitation source.

We conclude that previous, relatively straightforward interpretations of the fluorescence spectra recorded using synchrotron light are incomplete, and that the additional fine-structure observed in the laser excited spectra can only be properly assigned by performing computations, in our case DFT and TD-DFT was deemed sufficient to accurately describe and understand the spectral envelopes of the different sized diamondoids. The approach employed is thought to generally be applicable also for other hydrocarbon molecules.

baut werden. Die Quelle wird am noch freien -54° Eingang des elektrostatischen Analysators des Injektors installiert. Die Gasinjektion erfolgt durch ein an die Sputterquelle angepasstes Gassystem der Ionplus AG. Parallel dazu wurden Messungen mit einem selbst entwickelten Gasführungssystem durchgeführt, das die kontrollierte Mischung mit einem Trägergas und die Regelung des Volumenstroms in die Quelle ermöglicht. Die Messungen hierzu fanden an einer bis zu diesem Zeitpunkt nur für feste Targets verwendeten Quelle (modifizierter Nachbau (Bochum) der Middleton Quelle von 1982) statt. Es wurden verschiedene geometrische Veränderungen an der Quelle vorgenommen, mit dem Ziel, die Sputtereffizienz zu maximieren. Zudem wurden verschiedene Mischungsverhältnisse des Trägergases He mit CO₂ untersucht. In diesem Beitrag sollen Aufbau und erste Ergebnisse vorgestellt werden.

Das Projekt wird gefördert durch das Deutsche GeoForschungsZentrum GFZ, Helmholtz-Zentrum Potsdam.

MS 10.3 Wed 17:45 PH/HS2

A new Time of Flight system at the Cologne FN-Tandem accelerator — ●P. BHANDARI, A. DEWALD, C. MÜLLER-GATERMANN, S. HEINZE, C. FEUERSTEIN, M. SCHIFFER, A. STOLZ, and R. ALTENKIRCH — Institute for Nuclear Physics, University of Cologne

A new time of flight (TOF) system has been set up and will be installed at the FN-Tandem accelerator facility at Institute for Nuclear Physics, University of Cologne. It is compatible with the existing TOF system at CologneAMS. The new system is optimized for timing resolution. We selected the chevron microchannel plate detector (F4655-13), from Hamamatsu with a rise time of around 290 ps, small channel diameter (4 μ m) and the active area diameter of 14.5 mm. The detector system is based upon the triangular foil-mirror-MCP design[1]. In this geometry, secondary electrons emitted from the carbon foil ($20\mu\text{g}/\text{cm}^2$) are deflected by 90° with respect to the beam direction towards the MCP by an electrostatic mirror consisting of the two tungsten meshes

of 0.001" diameter 92% open area ratio). The signals of two identical detectors were used as start and stop for timing measurements. The preliminary results will be presented.

[1] S. Heinze *et al.*, A new beam profile monitor and time of flight system for CologneAMS, Nucl. Inst. Meth. B 294 (2013) 410.

MS 10.4 Wed 18:00 PH/HS2

An ion beam cooler for negatively charged atomic and molecular ions — ●JOHANNA PITTERS¹, OLIVER FORSTNER², YUAN LIU³, MARTIN MARTSCHINI¹, TOBIAS MOREAU¹, ALFRED PRILLER¹, PETER STEIER¹, and ROBIN GOLSER¹ — ¹VERA Laboratory, University of Vienna, Faculty of Physics, Austria — ²Friedrich-Schiller-Universität, Jena, Germany — ³ORNL Oak Ridge National Laboratory, Tennessee, USA

A major challenge in AMS (Accelerator Mass Spectrometry) is the suppression of stable isobars that interfere with the radioisotope of interest. Laser photodetachment of negative atomic or molecular ions can be used for suppression of these isobars, provided that the detachment energy of the radioisotope of interest is higher than that of the unwanted isobar. By overlapping the negative ion beam with a high intensity laser beam of appropriate wavelength, the unwanted isobar can be neutralized. To extend the laser-ion interaction time, the ions are decelerated in a gas-filled radiofrequency quadrupole where the beam is cooled down to thermal energies by collisions with He buffer gas.

Such a cooler system for 30 keV negative ion beams is being realized as an extension to the AMS facility VERA (Vienna Environmental Research Accelerator) at the University of Vienna.

In this talk, we will give a detailed description of the cooler and present the latest experimental results concerning the transmission of the ion beam through the cooler system and the efficiencies of buffer gas cooling and laser photodetachment.

MS 10.5 Wed 18:15 PH/HS2

Nachweis einzelner Ionen bei tiefsten Energien (< 50 keV) mit einem Gas-Ionisationsdetektor — ●ARNOLD MILENKO MÜLLER, MAX DÖBELI, MARTIN SEILER and HANS-ARNO SYNAL — Labor für Ionenstrahlphysik, ETH Zurich, CH-8093 Zurich

Die Detektion einzelner Radionuklid Ionen an kleinen AMS Systemen stellt eine spezielle Herausforderung dar. Die myCADAS Anlage beispielsweise, welche für Radiocarbon Messungen konzipiert wurde, verfügt über keine zusätzliche Beschleunigerstufe. Somit wird die Ionenenergie einzig über die Quellenspannung von max. 45 kV definiert. In einer Gas-Ionisations-Kammer erzeugt ein Radiocarbon Ion mit 45 keV Energie weniger als 2'000 Elektron-Ion Paare durch die Abbremsung in Isobutan. Das resultierende Signal kann nur schwer oder gar nicht vom Rauschband der Verstärkerelektronik unterschieden werden. Falls die Anzahl primärer Elektronen im Gas jedoch mittels einer Elektro-

nenlawine (im sog. Proportionalbereich) vervielfacht wird, kann das Detektorsignal auch bei tiefsten Energien deutlich über den Pegel des elektronischen Rauschens verstärkt werden. Erste Experimente zeigen, dass auf diese Weise mit einem vereinfachten Aufbau eines Bragg-Detektors im Energiebereich zwischen 30 - 45 keV eine Energieauflösung von 7 - 11 keV und eine Effizienz von mehr als 80 % erreicht werden kann.

MS 10.6 Wed 18:30 PH/HS2

¹³⁵Cs at VERA - developments for a new AMS isotope — ●JOHANNES LACHNER, MAGDALENA KASBERGER, MARTIN MARTSCHINI, ALFRED PRILLER, PETER STEIER, and ROBIN GOLSER — VERA Laboratory, University of Vienna, Faculty of Physics, Austria
Decreasing activities of ¹³⁷Cs (T_{1/2}=30.2yr) in environmental samples complicate the decay counting measurements of this important isotope for radioecological assessment. This raises the interest in mass spectrometric methods for the measurement of radioactive Cs isotopes. Due to its longer half-life (T_{1/2}=2.3Myr), the sister isotope ¹³⁵Cs is even more suited for MS techniques. The combined measurement of the two isotopes would allow identification and tracing sources of contamination. At the current stage, the isobars ^{135,137}Ba prohibit measurements in samples from the general environment.

We present results for AMS measurements of Cs concerning negative ion formation, transmission through the accelerator and detection obtained at the 3 MV VERA facility. In addition to its use for the production of negative Cs beams, Rb sputtering was tested during these measurements for various AMS elements. In the present setup and in chemically pure samples of Cs₂SO₄, ¹³⁵Ba can be suppressed to ¹³⁵Ba/¹³³Cs ratios of ≈10⁻⁹. Further potential for isobar suppression is expectable after the future installation of the Ion-Laser-Interaction system (ILIAS) at VERA.

MS 10.7 Wed 18:45 PH/HS2

Interaktive Programme für die Modellierung von Beschleunigermassenspektrometrie — ●MARTIN SUTER, SASCHA MAXEINER and HANS-ARNO SYNAL — Labor für Ionenstrahlphysik, ETH Zürich, Schweiz

Um die bestehende Instrumente für Beschleunigermassenspektrometrie (AMS) zu verbessern oder neue optimierte Anlagen zu entwickeln, ist es wichtig geeignete Modelle zu haben, um die Eigenschaften der Anlagen wie Strahltransmission und Untergrund im Voraus abschätzen zu können. Dazu sind an der ETH experimentelle Daten zusammengestellt und mit Modellen kombiniert worden. Daraus sind interaktive Programme entstanden, die es ermöglichen die Strahltransmission und Ladungshäufigkeiten für die verschiedensten Isotope und für verschiedenste Konfigurationen vorauszusagen. Die Funktion der Programme wird anhand von Beispielen erklärt und illustriert.

MS 11: Applied Noble Gas Physics Part 1

Time: Thursday 11:00–13:00

Location: C/gHS

Invited Talk MS 11.1 Thu 11:00 C/gHS
Development of a new facility for measuring ⁸¹Kr and ⁸⁵Kr at ultratrace level in environmental samples. — ●BERNARD LAVIELLE¹, ERIC GILABERT¹, BERTRAND THOMAS¹, ROMAIN REBEIX¹, GRÉGORIE CANCHEL¹, CHRISTOPHE MOULIN², SYLVAIN TOPIN², and FABIEN POINTURIER² — ¹CENBG, University of Bordeaux, BP 120, F-33175 Gradignan Cedex, France — ²CEA-DASE, F-91297 Arpajon, France

Mainly produced on Earth by nuclear reactions induced by cosmic rays in the atmosphere, the radionuclide ⁸¹Kr (t_{1/2}=229,000yr) is considered as the best tracer for absolute dating of old groundwaters or ice cores in the range of 50,000 yr to 1,000,000 yr. Krypton-85 (t_{1/2}=10.76yr) is mainly released into the atmosphere by the reprocessing facilities for nuclear fuel. This isotope is of great interest as a tracer for nuclear activities but also for dating young groundwater (<50 yr). Several instruments and lines are being developed at CENBG in order to measure both ⁸¹Kr and ⁸⁵Kr in groundwater using small volume of water (20 l). It includes: 1) a line for gas extraction from water, Kr separation and purification; 2) A double-focusing mass spectrometer operating a ⁸¹Kr and ⁸⁵Kr enrichment process based on implantation of separated Kr isotope in Al foils; 3) An instrument based on RIS-TOF technique capable to perform Kr isotopic abun-

dance measurements from samples containing only a few thousands of atoms. The extremely high sensitivity of this instrument also allows measurements of cosmogenic Kr at very low concentration to determine cosmic ray exposure of small meteorite samples.

Invited Talk MS 11.2 Thu 11:30 C/gHS
Atom counting system to measure trace krypton contamination in ultra-pure xenon — ●ANDRE LOOSE, TANYA ZELEVINSKY, and ELENA APRILE — Columbia University, 550 W 120th Street, New York, NY 10027, USA

The Atom Trap Trace Analysis (ATTA) Project at Columbia University is an experiment designed to measure the abundance of Kr in a Xe sample to the parts per trillion (ppt) level. Setting an upper limit on the amount of Kr-85 present in natural Xe is critical for knowing the sensitivity of dark matter searches based on LXe as target and detector medium. In particular, the ATTA will be an essential assaying tool for the XENON program. We completed the full ATTA setup and it's characterization for metastable Ar-40* in Ar and Kr-84* in Xe. The abundance of Kr-85 will then be inferred using previously measured relative isotopic abundances. We designed and tested custom pipettes to avoid air contamination of samples during the transport from the XENON1T detector to our ATTA setup. We verified the system calibration by comparing ATTA and rare gas spectrometer measurements

for the same sample, and conducted first ATTA measurements of ultra-pure Xe.

Invited Talk MS 11.3 Thu 12:00 C/gHS
Krypton-85 and Radioxenon: Environmental Tracers and Indicators for Nuclear Activities — ●CLEMENS SCHLOSSER, VERENA HEIDMANN, MARTINA KONRAD, and SABINE SCHMID — Bundesamt für Strahlenschutz, Rosastraße 9, 79098 Freiburg

Already in the 1940s scientists recognized the usefulness of radioactive noble gases as for monitoring nuclear activities. Krypton-85 is a very good indicator for the reprocessing of nuclear fuel and Xe-133 can be used for the detection of clandestine nuclear weapon tests and nuclear reactor operation. Additionally, Kr-85 can be used as tracer in environmental sciences. The German Federal Office for Radiation Protection (BfS) operates a noble gas laboratory and a global network which continuously monitors the Kr-85 and Xe-133 activity concentrations in ground level air since the 1970s. The laboratory of the BfS and the techniques used will be presented. Currently, the mean activity concentrations at German sampling sites are approx. 1.5 Bq/m³ for Kr-85 and in the order of 1 mBq/m³ for Xe-133. Based on the long time series of the BfS the global atmospheric distribution and the influence of different sources on the atmospheric activity concentrations over the last decades are discussed. Since 2004, radioactive Xenon isotopes are continuously measured at Schauinsland by an automated system *SPALAX* as part of the International Monitoring System of the Comprehensive Nuclear-Test-Ban Treaty (CTBT). The network capacity of this global monitoring network is demonstrated on the basis of particular events, like the Fukushima nuclear power plant accident and the Nuclear Weapon Tests in North Korea.

MS 11.4 Thu 12:30 C/gHS
Miniature High Sensitive Time-of-Flight Noble gas Mass spectrometer for very low gas measurements — ●RAMAKRISHNA RAMISSETY and INGO LEYA — University of Bern, Space Research and Planetary Sciences, Bern, Switzerland

Noble gas analysis in early solar system materials, which can provide valuable information about early solar system processes and timescales, are very challenging because of extremely low noble gas concentrations

(ppt). We therefore developed a new, high sensitive, compact sized (33 cm length, 7.2cm diameter, 1.3 L internal volume) Time-of-Flight (TOF) noble gas mass spectrometer. The instrument uses electron impact ionization coupled to an ion trap, which allows us to ionize and measure all noble gas isotopes with high efficiency. Using a reflectron set-up we reach a mass resolution of >1000amu. In addition, the reflectron set-up also enables some extra focusing. The detection is via MCPs and the signals are processed either via ADC or TDC systems. The instrument can be tuned automatically and under normal operational conditions the electronics and valves are fully computer controlled. Noble gas calibrations showed a detection limit in the range 10-14 cm³STP and about 7 orders of dynamic range.

MS 11.5 Thu 12:45 C/gHS
Studying the constancy of galactic cosmic rays using cosmogenic noble gases and radionuclides in iron meteorites — ●THOMAS SMITH¹, INGO LEYA¹, SILKE MERCHEL², GEORG RUGEL², STEFAN PAVETICH², ANTON WALLNER³, KEITH FIFIELD³, STEPHEN TIMS³, and GUNTER KORSCHINEK⁴ — ¹University of Bern, Switzerland — ²Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany — ³The Australian National University, Canberra, Australia. — ⁴TU Munich, Germany.

Cosmogenic noble gases and radionuclides in meteorites are the only tools that provide information about the cosmic ray exposure (CRE) history of meteorites. In space, meteoroids are irradiated by galactic cosmic ray (GCR), which produces, among others, stable and radioactive cosmogenic nuclides. It has been demonstrated that periodic variations in the GCR intensity induce periodic peaks in the CRE age histograms. Therefore, searching for periodic peaks in CRE histograms enables one to obtain information about GCR fluency variations. Since expected GCR fluency variations have periodicities of a few hundred million years, one needs meteorites irradiated for at least that long. Iron meteorites, which have CRE ages ranging from a few million to a few billion years, are the best candidates. So far we measured noble gases and radionuclides in 28 iron meteorites by noble gas mass spectrometry and accelerator mass spectrometry. First CRE age histograms have been established and will be presented. Further analyses are ongoing and will improve the statistical interpretation, providing new information on the temporal variability of the GCR fluency.

MS 12: Applied Noble Gas Physics Part 2

Time: Thursday 14:30–16:30

Location: C/gHS

Invited Talk MS 12.1 Thu 14:30 C/gHS
Using Noble Gases to Understand the History of Terrestrial Volatiles — ●DON PORCELLI — Oxford University, Dept Earth Sciences, Oxford, UK

Noble gas isotopes provide essential information on the origin and distribution of terrestrial volatiles. The ³He/⁴He ratios measured in mantle-derived volcanics indicate that the noble gases initially incorporated into the Earth remains heterogeneously distributed, although it is not yet clear how this relates to mantle structure. Xe isotopes indicate that separate noble gas reservoirs were established during Earth formation, with variations that must have been created before complete decay of short-lived ¹²⁹I and ²⁴⁴Pu. Further, Ne isotopes suggest that there have been several different solar system sources of noble gases. Also, Xe isotopes indicate that substantial quantities of noble gases were incorporated into the Earth and lost soon after. A number of key questions remain, as data are limited due to the subtle variations and low concentrations involved, and the presence of atmospheric contamination. More precise measurements of all noble gases, and with greater sensitivity, are essential to better identify how many sources of noble gases there have been; the extent of isotope variability within the Earth and so the history of early losses and subsequent reservoir isolation; the role of the core in storing noble gases; and the relationship between variations of the different noble gases and so the history of each separate reservoir. With such data, the history of terrestrial volatiles can be understood within the context of evolving theories of planetary accretion.

Invited Talk MS 12.2 Thu 15:00 C/gHS
Noble gas analysis in water: from temperature reconstruction over excess formation to oxygen turnover on environmentally relevant time scales — ●ROLF KIPFER and MATTHIAS BRENNWALD

— Eawag, Swiss Federal Institute of Aquatic Science and Technology, 8600 Dübendorf, Switzerland

Noble gases (and other quasi-conservative transient trace gases) in aquatic systems have commonly been used to determine water residence times and to reconstruct past environmental and climatic conditions.

However, these analyses were hampered by the occurrence of a surplus of atmospheric gases in natural ground water, e.g. the presence of excess air (EA) which in former days was only considered as contamination.

Recent developments in understanding the physics of air (gas) / water partitioning in porous media as well as revisiting noble gas diffusion in water now allows EA formation to be understood in mechanistic terms and facilitates the robust interpretation of EA as a proxy for the hydraulic conditions during groundwater recharge.

Furthermore, portable membrane-inlet mass spectrometers enable continuous and real-time analysis of dissolved (noble) gases directly in the field, allowing, for instance, quantification of O₂ turnover rates on time scales as small as minutes.

This presentation will touch some of these recent achievements with the intention of stimulating a broader discussion on the future applications of gases in conventional and unconventional aquatic systems.

Invited Talk MS 12.3 Thu 15:30 C/gHS
Applications of Noble Gases in Oceanography — ●PETER SCHLOSSER^{1,2,3}, ROBERT NEWTON³, GISELA WINCKLER³, and ANGELICA PASQUALINI^{2,3} — ¹Dept of Earth and environmental Sciences, Columbia University — ²Dept of Earth and Environmental Engineering, Columbia University — ³Lamont-Doherty Earth Observatory, Columbia University

Over the past decades, methods for detection and routine measurement of noble gases and their isotopes at ultra-low levels have been developed. They enabled application of these trace substances to many problems of ocean circulation, dynamics, and air/sea exchange. In principle, noble gases are used in studies such as (1) radioactive clocks (Tritium/He-3; Ar-39), (2) natural or anthropogenic injections into specific water masses (He isotopes), and (3) global dyes (Kr-85 or the quasi noble gas sulfurhexafluoride). To illustrate these applications three oceanographic noble gas studies are presented and discussed. Determination of the major circulation pathways and mean residence times of the waters in the Arctic Ocean (tritium/He-3; Ar-39): knowledge of the Arctic Ocean circulation pattern is needed to understand the implications of rapid Arctic Environmental Change. Large-scale mixing at mid-depth in the Pacific Ocean: the turbulent mixing coefficients derived from these studies are used to quantify redistribution of water and dissolved substances (He-3). Air/sea exchange, especially in the high-wind regimes of the Southern Ocean: air/sea gas exchange rates, together with measurements of the partial pressure of carbon dioxide, are applied to calculate the uptake of carbon by the oceans.

MS 12.4 Thu 16:00 C/gHS

Basal ice-shelf melting in the Weddell Sea inferred from oceanic noble-gas observations — ●OLIVER HUHN¹, MONIKA RHEIN¹, and MICHAEL SCHRÖDER² — ¹Institute of Environmental Physics, University of Bremen, Germany — ²Alfred-Wegener-Institute, Bremerhaven, Germany

We use oceanic noble-gas observations from the Weddell Sea from the period 1990 to 2013 to infer basal ice-shelf melting and the spatial distribution and temporal variability of the melt water input into the ocean. Helium and neon data were used to compute the glacial melt water contributing to the formation of Antarctic Bottom Water, a substantial water mass in the global ocean and important driver of the Meridional Overturning Circulation.

Oceanic measurement of low-solubility and stable noble-gases helium and neon provide a useful tool to quantify glacial melt water. Atmospheric air with a constant composition of these noble gases is trapped in the ice matrix during formation of the meteoric ice. Due to

the enhanced hydrostatic pressure at the base of the floating ice, these gases are completely dissolved, when the ice is melting from below. This leads to a substantial excess of helium and neon in pure glacial melt water.

We find an increasing trend in helium, neon, and, hence, in the glacial melt water content in the deep Weddell Sea. Melt water fractions along a repeated section in the north-western Weddell Sea are almost doubling from 1990 to 2013, indicating increasing melting in the Weddell Sea.

MS 12.5 Thu 16:15 C/gHS

Environmental Tracer and helium measurements in the context of Coal Seam Gas exploration. — ●AXEL SUCKOW and STANLEY D. SMITH — CSIRO Land and Water Flagship, Gate 5, Waite Road, Urrbrae, SA 5064, Australia

The Surat Basin in Northeast Queensland, Australia is subject to massive exploration and development for coal-seam gas extraction. To extract the gases, reduction of hydrostatic pressure in the Walloon Coal Measures by up to 70bar is necessary. The impact of this groundwater de-pressurization on adjacent aquifers is unknown. Also the flow regime of the underlying Hutton Sandstone and Precipice Sandstone aquifers is not well understood. Environmental tracers (SF₆, CFCs, tritium, helium, ⁸⁷Sr/⁸⁶Sr, ¹⁴C, ³⁶Cl) were measured along two north-south transects in the Hutton Sandstone aquifer. Also helium pore water profiles were obtained in vertical profiles through two aquitards isolating the Walloon Coal measures from the underlying Hutton Sandstone and this from the underlying Precipice Sandstone. Results indicate that groundwater in the Hutton has very low flow velocities and ³⁶Cl decreases to background values along a flow distance of less than 150km. Vertical profiles of terrigenous helium through the aquitard formations indicate very low vertical flow in these formations and the aquifer system seems to be dominated by diffusion processes. However, it remains an open question to what extent the ³⁶Cl/Cl decrease can be attributed to aging or is dominated by diffusive inflow of dead Cl from adjacent aquitards. To further elucidate this flow system, samples for ⁸¹Kr are planned along these transects.

MS 13: Accelerator Mass Spectrometry and Applications 3

Time: Thursday 17:00–18:30

Location: PH/HS2

Invited Talk MS 13.1 Thu 17:00 PH/HS2
From the Earth to the Stars: AMS a versatile technique in different fields of Science. — ●GUNTHER KORSCHINEK — Physik-Department Technische Universität München, 85748 Garching

Modern AMS (Accelerator Mass Spectrometry) has developed since around 35 years. It started with ¹⁴C but soon spread out to long-lived radioactive isotopes of different elements. Most of the AMS facilities at present are dedicated to specific isotopes and their applications. The unique sensitivity of AMS offers applications in rather different scientific fields; from chemistry, physics, and medical science, until geo-science, extra-terrestrial-physics, and astrophysics.

After a historical remark on AMS I will introduce the method with emphasis on AMS at the Munich Tandem facility. Examples that will be discussed:

- i. Measurements of ²³²Th and ²³⁸U in ultra clean Cu for low background detectors.
- ii. ⁵³Mn (T_{1/2} = 3.7My) determined in deep ocean ferromanganese crusts reveal an almost constant interplanetary dust flow (originating from the Asteroid-belt and the Kuiper-belt) on Earth during about the last 10My.
- iii. ⁶⁰Fe (T_{1/2} = 2.62My) measured in ferromanganese crusts suggested a close supernova around 2 to 3My ago. This is now supported by ⁶⁰Fe determinations in ocean sediments, and in lunar samples.

MS 13.2 Thu 17:30 PH/HS2

Supernova-Produced ²⁶Al and ⁶⁰Fe in Deep-Sea Sediments — ●JENNY FEIGE¹, ANTON WALLNER², L. KEITH FIFIELD², SILKE MERCHERL³, GEORG RUGEL³, PETER STEIER¹, STEVE TIMS², STEPHAN R. WINKLER¹, and ROBIN GOLSER¹ — ¹University of Vienna, Austria — ²ANU Canberra, Australia — ³HZDR, Germany

Massive stars, which end their lives in a supernova (SN) explosion, eject freshly produced nuclides into the surrounding interstellar medium.

Among them long-lived radionuclides, that can be deposited into terrestrial archives, if such an event occurs close to the Solar System.

About 100 samples of four deep-sea sediment cores originating from the Indian Ocean were analyzed for their content in the isotopes ²⁶Al and ⁶⁰Fe for the time range of 2-3 Myr. These nuclides are produced in SNe and the time range corresponds to an ⁶⁰Fe enhancement observed in a deep-ocean crust sample (Knie et al., 2004). The method used for analysis is accelerator mass spectrometry (AMS), a very sensitive technique for the detection of long-lived radionuclides.

A clear signal of ⁶⁰Fe throughout the whole measured time period was observed. This observation is in contrast to a narrow peak if originating from a direct input from a single SN. Further, no ⁶⁰Fe was detected in much older or younger sediment samples. A concurring SN-signal of ²⁶Al is, however, hidden underneath a dominant terrestrial background from continuous atmospheric and in-situ production. The resulting limits on the ratios of ⁶⁰Fe/²⁶Al were compared to nucleosynthesis models.

MS 13.3 Thu 17:45 PH/HS2

Search for supernova-⁶⁰Fe in Earth's microfossil record — ●PETER LUDWIG¹, SHAWN BISHOP¹, RAMON EGLI², VALENTYNA CHERNENKO¹, BOYANA DENEVA¹, THOMAS FAESTERMANN¹, NICOLAI FAMULOK¹, LETICIA FIMIANI¹, JOSE MANUEL GOMEZ GUZMAN¹, KARIN HAIN¹, GUNTHER KORSCHINEK¹, THOMAS FREDERICH³, MARIANNE HANZLIK⁴, GEORG RUGEL⁵, and SILKE MERCHERL⁵ — ¹Physik Department, TU München — ²ZAMG, Wien — ³Fachbereich Geowissenschaften, Univ. Bremen — ⁴Fakultät für Chemie, TU München — ⁵HZDR Dresden

Supernova (SN) explosions eject copious amounts of material into the interstellar medium. It is possible that supernova ejecta are incorporated into solar system reservoirs. ⁶⁰Fe is an ideal isotope to search for such a signature, since it is produced in massive stars and can be ejected in their subsequent SN explosions, and has almost no terres-

trial background. For this study, the ratio of $^{60}\text{Fe}/\text{Fe}$ was determined with AMS using the GAMS setup in Garching, Germany, in a set of samples extracted from two Pacific Ocean sediment cores of 0 to 7 Ma of age. The Fe samples were obtained using a novel chemical extraction technique targeting specifically magnetofossils, chains of magnetite crystals produced by magnetotactic bacteria, and other small-grained Fe-bearing minerals, to prevent signal dilution. Our findings reveal a ^{60}Fe signature in the age range of 1.8-2.5 Ma, which is attributed to input of SN ejecta.

MS 13.4 Thu 18:00 PH/HS2

Interstellar radionuclides in lunar samples — ●LETICIA FIMIANI¹, DAVID COOK², THOMAS FAESTERMANN¹, JOSE MANUEL GOMEZ GUZMAN¹, KARIN HAIN¹, GREGORY HERZOG³, KLAUS KNIE^{1,4}, GUNTHER KORSCHINEK¹, BRET LIGON³, PETER LUDWIG¹, JISUN PARK³, ROBERT REEDY⁵, and GEORG RUGEL^{1,6} — ¹Technische Universität München, Garching, Germany — ²Institut für Geochemie und Petrologie ETH, Zurich, Switzerland — ³Dept. Chem. & Chem. Biol, Rutgers U., Piscataway NJ, United States of America — ⁴GSI, Darmstadt, Germany — ⁵Planetary Science Institute, Los Alamos NM, United States of America — ⁶Forschungszentrum Dresden-Rosendorf, Dresden, Germany

The enhanced activity of ^{60}Fe found in several lunar samples is a confirmation of the deposition of supernova debris in the solar system. The concentrations of ^{53}Mn and ^{60}Fe were determined in samples originating from three different Apollo missions, by means of accelerator mass spectrometry (AMS).

A local interstellar fluence of ^{60}Fe between 2×10^7 – 4×10^8 at/cm² is consistent with the findings in a ferromanganese crust from the Pacific Ocean reported by Knie et al [PRL 93, 171103, 2004]. In this talk the

results of this work will be summarized, with emphasis on the possible background sources and details on how these were estimated.

MS 13.5 Thu 18:15 PH/HS2

Determination of the Maxwellian averaged cross-section of the reaction $^{35}\text{Cl}(n,\gamma)^{36}\text{Cl}$ — ●STEFAN PAVETICH¹, SHAVKAT AKHMADALIEV¹, IRIS DILLMANN², SHLOMI HALFON³, TANJA HEFTRICH⁴, FRANZ KÄPELER⁵, CLAUDIA LEDERER⁶, MARTIN MARTSCHINI⁷, SILKE MERCHEL¹, MICHAEL PAUL⁸, RENE REIFARTH⁴, GEORG RUGEL¹, PETER STEIER⁷, MOSHE TESSLER⁸, ANTON WALLNER⁹, MARIO WEIGAND⁴, and LEO WEISSMAN³ — ¹Helmholtz-Zentrum Dresden-Rosendorf, Germany — ²TRIUMF, Canada — ³Soreq Nuclear Research Center, Israel — ⁴Goethe Universität Frankfurt am Main, Germany — ⁵Karlsruhe Institut of Technology, Germany — ⁶University of Edinburgh, Scotland — ⁷Vienna Environmental Research Accelerator (VERA), Austria — ⁸Hebrew University of Jerusalem, Israel — ⁹Australian National University, Australia

Routine measurements of ^{36}Cl at the Dresden Accelerator Mass Spectrometry (DREAMS) facility have resulted in an astrophysical application: the determination of the Maxwellian averaged cross-section (MACS) of the reaction $^{35}\text{Cl}(n,\gamma)^{36}\text{Cl}$. As ^{35}Cl acts as a neutron poison in the nucleosynthesis processes during later burning phases of stars, the reaction is important for astrophysical calculations of elemental abundances. The neutron irradiations with a quasi Maxwell Boltzmann spectrum for the production of ^{36}Cl were performed at the Karlsruhe Institute of Technology and the Soreq Applied Research Accelerator Facility. AMS measurements were performed at VERA and DREAMS and are planned at the Australian National University in 2015. Acknowledgement: Alberto Mengoni, CERN.

MS 14: Accelerator Mass Spectrometry and Applications 4

Time: Friday 11:00–13:00

Location: PH/HS2

Invited Talk

MS 14.1 Fri 11:00 PH/HS2

AMS detection of actinides at high mass separation — ●PETER STEIER¹, ROSMARIE EIGL², JOHANNES LACHNER¹, ALFRED PRILLER¹, FRANCESCA QUINTO³, AYA SAKAGUCHI⁴, STEPHAN WINKLER¹, and ROBIN GOLSER¹ — ¹University of Vienna, Faculty of Physics, Vienna, Austria — ²Hiroshima University, Earth and Planetary Systems Science, Hiroshima, Japan — ³Institut für Nukleare Entsorgung, KIT, Eggenstein-Leopoldshafen, Germany — ⁴University of Tsukuba, Center for Research in Isotopes and Environmental Dynamics, Tsukuba, Japan

AMS is the mass spectrometric method with the highest abundance sensitivity, which is a prerequisite for measurement of the long-lived radioisotope ^{236}U ($t_{1/2}=23.4$ million years). The most successful application so far is oceanography, since anthropogenic ^{236}U is present in the world oceans at $^{236}\text{U}/^{238}\text{U}$ from 10^{-11} to 10^{-8} . We have explored methods to increase the sensitivity and thus to reduce the water volume required to 1 L or less, which significantly reduces the sampling effort. High sensitivity is also necessary to address the expected typical natural isotopic ratios on the order $^{236}\text{U}/^{238}\text{U} = 10^{-13}$, with potential applications in geology.

With a second 90° analyzer magnet and a new Time-of-Flight beam line, VERA is robust against chemical impurities in the background, which e.g. allows measuring Pu isotopes directly in a uranium matrix. This simplifies chemical sample preparation for actinide detection, and may illustrate why AMS reaches lower detection limits than other mass spectrometric methods with nominally higher detection efficiency.

MS 14.2 Fri 11:30 PH/HS2

Determination of Actinides in Pacific Ocean Water by AMS with Respect to the Fukushima Accident — ●KARIN HAIN¹, BOYANA DENEVA¹, THOMAS FAESTERMANN¹, NICOLAI FAMULOK¹, LETICIA FIMIANI¹, JOSÉ M. GÓMEZ-GUZMÁN¹, GUNTHER KORSCHINEK¹, FLORIAN KORTMANN², CHRISTOPH LIERSE V. GOSTOMSKI², and PETER LUDWIG¹ — ¹Physics Department, Technische Universität München, James-Frank-Str.1, 85748 Garching — ²Radiochemie München, Technische Universität München, Walther-Meißner-Str.3, 85748 Garching

A chemical separation procedure for plutonium (Pu) and neptunium (Np) was developed using extraction chromatography to determine

their amounts and isotopic ratios in sea water. ^{241}Am , which causes isobaric background on ^{241}Pu in mass-spectrometric measurements, was successfully separated from the Pu fraction by this method. Water samples which were spiked with ^{242}Pu and ^{237}Np or ^{239}Np , respectively, were used for chemical yield determination. Chemical yields of Pu and Np, which were determined by alpha and gamma spectrometry at the Radiochemie München, of more than 85% were obtained. The developed method was applied to analyze the amount of Pu and Np in the certified reference material, IAEA-443, by accelerator mass spectrometry (AMS) at the Maier-Leibnitz-Laboratory to check the applicability of the method. The amounts of ^{240}Pu , ^{241}Pu and ^{237}Np obtained in this study are in agreement with the literature values within the uncertainties. This method can be used for the analysis of Pu and Np in Pacific Ocean water samples collected after the Fukushima accident.

MS 14.3 Fri 11:45 PH/HS2

Determination of plutonium and uranium in environmental samples from Fukushima — ●STEPHANIE SCHNEIDER¹, MARCUS CHRISTL², GEORG STEINHAUSER³, and CLEMENS WALTHER¹ — ¹Institut für Radioökologie und Strahlenschutz, Leibniz Universität Hannover, Hannover — ²Laboratory of Ion Beam Physics, ETH Zürich, Switzerland — ³Department of Environmental and Radiological Health Sciences, Colorado State University, United States of America

During the Fukushima accident significant amounts of radioactive nuclides were released into the atmosphere, including small amounts of actinides. Previous investigations showed a strong localization of plutonium, which indicates a particulate release of this element from the NPP. As plutonium is of a high radiological relevance if incorporated, further investigations on vegetation, litter and soil samples taken at 8 different sampling sites in the vicinity of the damaged reactor were conducted. Accelerator mass spectrometry is a powerful tool to determine even lowest concentrations. For these measurements the samples were first leached and then uranium and plutonium were chemically separated using extraction chromatography. Here we use the $^{236}\text{U}/^{238}\text{U}$ and the $^{240}\text{Pu}/^{239}\text{Pu}$ isotopic ratios as indicators to distinguish between global fallout and releases from a nuclear reactor.

MS 14.4 Fri 12:00 PH/HS2

I-129 in der Atmosphäre auf der Zugspitze — ●ABDELOUAHED DARAOU¹, CLEMENS WALTHER¹, CHRISTOF VOCKENHUBER² und HANS-ARNO SYNAL² — ¹Institut für Radioökologie und Strahlenschutz (Uni Hannover), Hannover, Deutschland — ²Labor für Ionenstrahlphysik (ETH), Zürich, Schweiz

Der Transport von Radionukliden über die Luft und das Meer kennt keine Grenzen. So kann das Iod-129 aus den Wiederaufbereitungsanlagen Sellafield in England und La Hague in Frankreich in der Atmosphäre bei der Zugspitze bestimmt werden. In der Umweltforschungsstation Schneefernerhaus (2650 m ü. NN) und auf der Zugspitze Gipfel (2962 m ü. NN) werden Iod-127 und Iod-129 in der Atmosphäre gemessen. Es wurden die Schnee Proben zwischen 2012 und 2014 und eine wöchentliche Aerosolproben zwischen August und Oktober 2014 gesammelt. Nach der Iod-Extraktion durch eine Anionenaustausch-Methode für Schnee Proben und Lösungsmittel-extraktion für Aerosolfilter wurde I-127 durch ICP-MS und I-129 durch Beschleuniger-massenspektrometrie (AMS) untersucht. Die ersten Ergebnisse der Einträge von I-129 im Vergleich zu I-127 zeigen eine erhebliche Variationsbreite. Der Vergleich der Messwerte von Iod-129 mit den meteorologischen Daten zeigt die Möglichkeit auf, dass die höchste Konzentration von I-129 mit Luftmassen aus Nordwesteuropa kommt, also aus Richtung der Wiederaufbereitungsanlagen. Hier wird das aktuelle Ergebnis zu überraschend hohen I-129-, und I-127-Gehalten sowie zu I-129/I-127-Isotopenverhältnissen bewertet und diskutiert.

MS 14.5 Fri 12:15 PH/HS2

Die Verteilung von $^{236}\text{U}/^{238}\text{U}$ im Nordatlantik und den angrenzenden Ozeanen — ●MARCUS CHRISTL¹, NURIA CASACUBERTA¹, JOHANNES LACHNER¹, SASCHA MAXEINER¹, CHRISTOF VOCKENHUBER¹, JÜRGEN HERRMANN², MAXI CASTRILLEJO³, PERE MASQUE³, MICHIEL RUTGERS VAN DER LOEFF⁴ und HANS-ARNO SYNAL¹ — ¹Labor für Ionenstrahlphysik, ETH Zürich, Schweiz — ²Bundesamt für Seeschifffahrt und Hydrographie, Hamburg, Deutschland — ³Universitat Autònoma de Barcelona, Spanien — ⁴Alfred-Wegener-Institut, Bremerhaven, Deutschland

Die technischen Entwicklungen der letzten Jahre, wie zum Beispiel die Einführung von Helium als stripper Gas, machen kompakte AMS Systeme wahrscheinlich zu den sensitivsten verfügbaren Analysegeräten für Ultra-Spurenstoffanalysen von Aktiniden in der Umwelt. Solche Systeme eignen sich im Besonderen zur Spurenanalyse von ^{236}U , da konventionelle Massenspektrometrie hier nicht die erforderliche Unterdrückung des durch Moleküle oder Nachbarmassen verursachten Untergrundes bietet.

Am AMS System *Tandy* der ETH Zürich wurden während der letzten Jahre einzigartige Datensätze von $^{236}\text{U}/^{238}\text{U}$ im Atlantischen und Arktischen Ozean, sowie im Mittelmeer und der Nordsee produziert.

In diesem Vortrag soll zunächst ein kurzer Überblick über die neuesten technischen Entwicklungen im Bezug auf Schwerionen Analysen an kompakten AMS Anlagen der ETH Zürich gegeben werden. Im zweiten Teil werden dann die produzierten Datensätze zusammengefügt und das gegenwärtige Verständnis dieses neuen Ozean-Tracers diskutiert.

MS 14.6 Fri 12:30 PH/HS2

AMS with ^{93}Zr — ●BOYANA DENEVA, THOMAS FAESTERMANN, LETICIA FIMIANI, JOSÉ GÓMEZ GUZMAN, KARIN HAIN, PETER LUDWIG, and GUNTHER KORSCHINEK — Technische Universität München, Physik Department, Garching

The isotope ^{93}Zr with its long half life of 1.6×10^6 years is produced in a nuclear reactor as a fission product or by neutron capture from the stable ^{92}Zr in the reactor cladding. It is thus the most important zirconium isotope considering spent nuclear fuel storage and disposal assessment on long terms. The quantitative detection of ^{93}Zr allows also a measurement of $^{92}\text{Zr}(n,\gamma)^{93}\text{Zr}$ reaction cross section relevant for the nucleosynthesis s-process, and to search for traces of ^{93}Zr from interstellar material in exclusive deposits or for hydrological and radioactive waste tracing. One of the difficulties in identifying ^{93}Zr by AMS is the isobaric interference of the stable ^{93}Nb . The adequate separation of these isobars is our goal in the ongoing measurements. In order to investigate the possibility of using the energy loss in a passive absorber we carried out stopping power measurements of ^{92}Zr and ^{94}Zr to estimate that of ^{93}Zr . An experimental determination of the stopping power of ^{93}Nb is performed by using silicon nitride passive absorbers of different thicknesses. The results are compared with SRIM simulations and the estimations for ^{93}Zr to understand the behavior of ^{93}Zr ions in a Si_3N_4 passive absorber. This is crucial for the developments and optimizations of an AMS set up for the detection of ^{93}Zr .

MS 14.7 Fri 12:45 PH/HS2

AMS of actinides in ground- and seawater: a new procedure for simultaneous analysis of U, Np, Pu, Am and Cm isotopes below ppq levels — ●FRANCESCA QUINTO¹, MARKUS LAGOS¹, MARKUS PLASCHKE¹, THORSTEN SCHÄFER¹, PETER STEIER², and HORST GECKEIS¹ — ¹Institut für Nukleare Entsorgung, KIT, Eggenstein-Leopoldshafen, Germany — ²VERA Laboratory, University of Vienna, Vienna, Austria

U-236, Np-237, Pu isotopes and Am-243 were determined in ground- and seawater samples at levels below ppq with a maximum sample size of 0.250 l. Such high sensitivity measurement was possible by using accelerator mass spectrometry (AMS) with an improved gas stripping and an additional high resolving magnet. The use of non-isotopic tracers was investigated in order to allow the determination of those nuclides, namely Np-237 and Am-243, for which isotopic tracers for mass spectrometry are rarely available. The actinides were concentrated from the sample matrix via iron hydroxide co-precipitation and measured sequentially without previous chemical separation from each other. The analytical method was validated with the analysis of IAEA 443 seawater Reference Material and applied to background samples from the Colloid Formation and Migration project at the Grimsel Test Site and to sea- and freshwater samples affected solely by global fallout. The sensitivity of the presented analytical method provides the capability to study the long-term release of actinide tracers in field experiments as well as the transport of actinides in a variety of environmental systems.