Mass Spectrometry Division
Fachverband Massenspektrometrie (MS)

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Overview of Invited Talks and Sessions

(lecture room GÖR 229; Poster P1)

Invited Talks

MS 1.1	Mon	10:30–11:00	GÖR 229	**CologneAMS, ein neues Zentrum für Beschleuniger-Massenspektrometrie in Deutschland** — •Alfred Dewald, Tibor Dunai, Stefan Heinze, Jan Jolie, Martin Melles, Jürgen Richter, Ulrich Radtke, Janette Rethemeyer, Michael Staubwasser, Andreas Zilges, Friedhelm von Blanckenburg
MS 2.1	Mon	14:00–14:30	GÖR 229	**Setting-up an accelerator mass spectrometry (AMS) facility: The role of chemistry** — •Silke Merchel, Frans Munnik, Christoff Andermann, Didier Bourlès, Régis Braucher, Richard Gloaguen, Martin Martschini, Peter Steier
MS 4.1	Tue	10:30–11:00	GÖR 229	**On the interconversion of an ion's motional modes in a Penning trap by quadrupolar and octupolar rf-fields** — •Martin Kretzschmar
MS 4.2	Tue	11:00–11:30	GÖR 229	**High-precision Penning trap mass spectrometry for neutrino physics** — •sergey eliseev, christine böhm, klaus blaum, andreas dörr, mikhail goncharov, yuri novikov, julia repp, christian roux
MS 5.1	Wed	10:30–11:00	GÖR 229	**Searching for physics beyond the standard model using beta decay** — •Marcus Beck
MS 6.1	Wed	14:00–14:30	GÖR 229	**Hot water in space** — •Henrik Buhr
MS 7.1	Wed	16:00–16:30	GÖR 229	**Laser source of radioactive ion beams at the on-line isotope separation facility ISOLDE at CERN** — •Valentin Fedosseev
MS 8.1	Thu	10:30–11:00	GÖR 229	**First application of a multi-reflection time-of-flight mass separator to radioactive beams** — •Robert N. Wolf
MS 9.1	Fri	10:30–11:00	GÖR 229	**Power-law decays of excited aluminum cluster anions and their blackbody radiation dependence** — •Michael Froese, Felix Berg, Klaus Blaum, Michael Lange, Felix Laux, Sebastian Menk, Robert von Hahn, Andreas Wolf

Invited talks of the joint symposium SAMOP-DI

See SAMOP-DP for the full program of the symposium.

SAMOP-DP 1.1	Tue	10:30–11:00	MENSA Dül	**Rovibronic ground state molecules near quantum degeneracy** — •Johann Georg Danzl
SAMOP-DP 1.2	Tue	11:00–11:30	MENSA Dül	**Manipulation of Large Neutral Molecules with Electric Fields** — •Frank Filsinger
SAMOP-DP 1.3	Tue	11:30–12:00	MENSA Dül	**Entanglement in spinor Bose-Einstein condensates** — •Christian Gross, Tilman Zibold, Eike Nicklas, Helmut Strobel, Jiri Tomkovic, Markus K Oberthaler
SAMOP-DP 1.4	Tue	12:00–12:30	MENSA Dül	**State-selective transport of single neutral atoms** — •Michal Karski

Invited talks of the joint symposium SYCH

See SYCH for the full program of the symposium.

SYCH 1.1	Thu	14:00–14:30	HSZ 02	**Radiocarbon dating of cultural objects: Limit** — •Hans-Arno Synal
SYCH 1.2	Thu	14:30–15:00	HSZ 02	**From Lascaux to Rembrandt. Insights into invisible traces of paintings and drawings from physical methods** — •Ina Reiche
SYCH 1.3	Thu	15:00–15:30	HSZ 02	**IPANEMA, A European research platform for the study of ancient and historical materials** — •Loïc Bertrand
SYCH 1.4	Thu	15:30–16:00	HSZ 02	**3D X-ray view of treasures** — •Birgit Kanngiesser, Ioanna Mantouvalou, Wolfgang Malzer
SYCH 2.1	Thu	16:30–17:00	HSZ 02	**Looking below the surface of paintings by help of neutrons** — •Claudia Laurenze-Landsberg, Carl Otto Fischer
SYCH 2.2	Thu	17:00–17:30	HSZ 02	**X-ray fluorescence analysis using synchrotron radiation excitation** — •Martin Radtke, Günter Buzanich, Uwe Reinholz, Heinrich Riesemeier
SYCH 2.3	Thu	17:30–18:00	HSZ 02	**Metabolic tools to study wine body** — •Oliver Fiehn, Kirsten Skogerson, Gert Wohlgemuth
SYCH 2.4	Thu	18:00–18:30	HSZ 02	**Identification of Ancient Plant Textiles** — •Bodil Holst, Bridget Murphy

Sessions

MS 1.1–1.7	Mon	10:30–12:30	GÖR 229	**Accelerator Mass Spectrometry and Applications**
MS 2.1–2.5	Mon	14:00–15:30	GÖR 229	**Accelerator Mass Spectrometry and Applications**
MS 3.1–3.17	Mon	16:00–18:00	P1	**Poster**
MS 4.1–4.6	Tue	10:30–12:30	GÖR 229	**Precision Mass Spectrometry and Fundamental Applications**
MS 5.1–5.6	Wed	10:30–12:15	GÖR 229	**Precision Mass Spectrometry and Fundamental Applications**
MS 6.1–6.5	Wed	14:00–15:30	GÖR 229	**Ion Storage Rings**
MS 7.1–7.8	Wed	16:00–18:15	GÖR 229	**Resonance Ionization MS, REMPI, MALDI**
MS 8.1–8.7	Thu	10:30–12:30	GÖR 229	**New Mass Spectrometric Methods and Technical Developments**
MS 9.1–9.6	Fri	10:30–12:15	GÖR 229	**Ion Trap and FT-ICR-MS, Molecules, Clusters and Reactions**

Annual General Meeting of the Mass Spectrometry Division

Wednesday 12:15–12:45 GÖR 229

- Begrüßung
- Bericht des MS-Vorsitzenden
- Vorschläge für Symposien
- Verschiedenes

MS 1: Accelerator Mass Spectrometry and Applications

Time: Monday 10:30–12:30 Location: GÖR 229

Invited Talk MS 1.1 Mon 10:30 GÖR 229

CologneAMS, ein neues Zentrum für Beschleuniger-Massenspektrometrie in Deutschland — •Alfred Dewald[1], Tibor Dunai[2], Stefan Heinze[1], Jan Jolie[1], Martin Melles[2], Jürgen Richter[3], Ulrich Radtke[4], Janette Rethemeyer[2], Michael Staubwasser[2], Andreas Zilges[1] und Friedhelm von Blanckenburg[5] — [1]Kernphysik, Universität Köln — [2]Geologie und Mineralogie, Universität Köln — [3]Ur- und Frühgeschichte, Universität Köln — [4]Geographie, Universität Köln — [5]GFZ, Potsdam

CologneAMS ist ein neues Zentrum für Beschleuniger - Massenspektrometrie (AMS) an der Universität zu Köln, das von der Deutschen Forschungsgemeinschaft gefördert wurde, um die Messmöglichkeiten auf dem Gebiet der Beschleuniger-Massenspektrometrie in Deutschland zu verbessern. Die AMS-Anlage ist im Beschleunigerbereich der Kernphysik installiert. Probenlabore werden im Institut für Geologie und Mineralogie aufgebaut. In Zukunft soll ein vollständiger Probenservice für auswertige Kunden angeboten werden. Die AMS-Anlage selbst ist dazu ausgelegt, alle gängigen kosmogenen Nuklide 10Be,14C,26Al,36Cl, 41Ca,129I zu spektrometrieren sowie für den sensitiven Nachweis von schweren Ionen bis zu 239U und 244Pu. Das Herzstück der AMS-Anlage ist ein 6 MV TANDETRON Beschleuniger, der mit Folien und Gasstripper ausgerüstet ist. In diesem Beitrag wird über den momentanen Status des neuen AMS Zentrums mit seinen Einrichtungen sowie über die Ergebnisse der ersten Testmessungen berichtet. Darüber hinaus werden erste Projekte der lokalen Gruppen vorgestellt.

MS 1.2 Mon 11:00 GÖR 229

A new BPM-TOF system for CologneAMS — •Gheorghe Pascovici[1], Alfred Dewald[1], Stefan Heinze[1], Markus Schiffer[1], Mark Feuerstein[1], Michael Pfeiffer[2], Jan Jolie[2], Karl Oskar Zell[2], and Friedhelm von Blanckenburg[3] — [1]CologneAMS, Universität zu Köln — [2]IKP, Universität zu Köln — [3]GFZ, Potsdam

At the center for accelerator mass spectrometry (CologneAMS) a complex beam detector consisting of a high resolution Beam Profile Monitor (BPM) and a Time of Flight (TOF) spectrometer with tracking capabilities was designed especially for the needs of the Cologne AMS facility. The complex beam detector assembly is designed to match the beam specifications of the 6MV Tandetron AMS setup and its DAQ system, which is presently in the commissioning phase at the IKP of the University of Cologne. The BPM-TOF system will have a reconfigurable structure, namely: either a very fast TOF subsystem with a small active area or a more complex BPM -TOF detector with beam tracking capabilities and with a large active area. The systems aims for background suppression in case of the spectrometry of heavy ions, e.g. U, Cm, Pu, Am etc. and could also be used as an additional filter e.g., for the isobar 36S in case of the spectrometry of 36Cl.

MS 1.3 Mon 11:15 GÖR 229

Revival of the Utrecht AMS-components at the Cologne FN tandem accelerator — •Markus Schiffer[1], Alfred Dewald[1], Astrid Holler[1], Stefan Heinze[1], Claus Feuerstein[1], and Klaas van der Borg[2] — [1]CologneAMS, Universität zu Köln — [2]Universität Utrecht

After the complete dismantling of the AMS-facility at the institute of physics and astronomy of the Utrecht university in 2009, most of the AMS-components have been taken over by the institute of nuclear physics of the Cologne university (IKP). It is planned to setup a complete AMS-System at the Cologne FN tandem accelerator using the components from Utrecht. This setup can be used for developments and tests of future AMS-devices and techniques. In addition, higher energies available at the FN accelerator will improve the AMS performance especially for heavier isotopes, eg. 41Ca and 53Mn. The design of the injector is completed and the installation work has started. In parallel, the NEC multi-cathode ion-source will be installed first at an existing port of the FN tandem injector for test purposes.

MS 1.4 Mon 11:30 GÖR 229

Accelerator-SIMS for isotopic analysis of trace elements — •Dominik Güttler, Christof Vockenhuber, Max Döbeli, and Hans-Arno Synal — Laboratory of Ion Beam Physics, ETH Zurich, HPK G31, Schafmattstrasse 20, 8093 Zurich, Switzerland

Secondary ion mass spectrometry (SIMS) is one of the most extensively used methods to detect impurities and their isotopic signatures in materials. However, especially for heavier trace elements, the sensitivity of SIMS is severely limited by molecular and charge state interferences. This problem can be overcome using accelerator mass spectrometry (AMS).

Here negative ions are analyzed by an electromagnetic mass spectrometer and then injected into a 6 MV EN-Tandem accelerator. At the terminal the ions are stripped to high charge states, which guarantees the destruction of all molecular ions. At the high energy side of the accelerator, 40 MeV ions are selected by an electrostatic deflector and analyzed by a magnetic spectrometer. Final detection of the ions is done with a position-sensitive gas ionization chamber that also measures dE/dx and the residual energy for isobar separation. A fast beam bouncing system and a wide detector entrance window allow for quasi simultaneously detection of multiple isotopes.

Within the EuroGENESIS program we are planning to use Accelerator-SIMS to measure isotopic compositions of rare earth elements in pre-solar grains. The isotopic signatures in these grains carry the fingerprint of nucleosynthesis and provide valuable astrophysical information.

MS 1.5 Mon 11:45 GÖR 229

AMS measurement of the reaction ^{35}Cl(n,γ)^{36}Cl — •Stefan Pavetich[1], Tamás Belgya[2], Max Bichler[3], Iris Dillmann[4], Oliver Forstner[1], Robin Golser[1], Franz Käppeler[4], Zoltan Kis[2], Martin Martschini[1], Alfred Priller[1], Peter Steier[1], Georg Steinhauser[3], Laszlo Szentmiklosi[2], and Anton Wallner[1] — [1]VERA Laboratory, Faculty of Physics, Univ. of. Vienna, Austria — [2]Department of Nuclear Research, Institute of Isotopes, Hungarian Academy of Science, Budapest — [3]Atominstitut, TU Wien, Austria — [4]Karlsruhe Institute of Technology, Germany

^{36}Cl is a long-lived radionuclide ($t_{1/2}$ = 301000 a), which is dominantly produced via the reaction ^{35}Cl(n,γ)^{36}Cl. In the present work we focused on: First, the production of an independent ^{36}Cl/^{35}Cl reference material for AMS and second, the determination of the Maxwellian averaged cross section (MACS) of ^{35}Cl(n,γ)^{36}Cl at 25 keV neutron energy, i.e. the energy range which is important for astrophysical network calculations. Approaching the first goal, NaCl pellets were irradiated with thermal neutrons in Vienna and Budapest. The neutron fluence, used for the calculation of the ^{36}Cl/^{35}Cl ratio of the irradiated samples, was determined via gold fluence monitores. For the determination of the neutron capture cross section of ^{35}Cl at stellar energies, AMS measurements were performed on two samples, which were irradiated with neutrons of a Maxwell-Boltzmann energy distribution of 25 keV. Combining the AMS- and the neutron-fluence data, the MACS for ^{35}Cl at 25 keV was calculated. The neutron irradiations, the measuring procedure of ^{36}Cl at VERA and our new results will be presented.

MS 1.6 Mon 12:00 GÖR 229

Massenspektrometrischer Nachweis von Radiokarbon bei Strahlenergien von 45 keV — •Martin Seiler, Tim Schulze-König und Hans-Arno Synal — Ion Beam Physics, ETH Zürich, 8093 Zürich, Switzerland

Für biomedizinische Anwendungen von ^{14}C ist ein Nachweisverfahren mit kompakten Massenspektrometern wünschenswert. Messungen mit Kohlenstoffionen bei niedrigen Energien zeigten, dass unterhalb von 100 keV eine hohe Transmission erreicht werden kann indem Helium als Strippergas verwendet wird. Ergänzt wurden diese Messungen durch die Bestimmung von Wirkungsquerschnitten für die Molekülzerstörung von ^{13}CH und ^{12}CH$_2$. Diese zeigten im gemessenen Energiebereich keine Energieabhängigkeit. Darauf basierend wurde ein ^{14}C-Massenspektrometer entwickelt, welches bei einer Ionenenergie von 45 keV operiert. Der Aufbau des Beschleunigers und erste Messergebnisse werden vorgestellt.

MS 1.7 Mon 12:15 GÖR 229

First experiments at the new 6 MV-Tandetron at HZDR — •Shavkat Akhmadaliev, René Heller, Daniel Hanf, and Silke Merchel — Helmholtz-Zentrum Dresden-Rossendorf (HZDR), Institute of Ion Beam Physics and Materials Research, Dresden, Germany

The 6 MV tandem type accelerator replaces the old 5 MV machine in

the beginning of 2011. Besides ion beam analysis (IBA) and material modification via high-energy ion implantation, the system is equipped for accelerator mass spectrometry (AMS). The first interest is in the radioisotopes ^{10}Be, ^{26}Al, ^{36}Cl, ^{41}Ca, and ^{129}I [1].

An energy calibration of the machine and a test of ion beam energy stability have been carried out as a first experiment using the ^{1}H(^{15}N,$\alpha\gamma$)^{12}C nuclear reaction with a sharp resonance at an energy of 6385 keV. The total energy resolution for the system is about 12 keV.

First tests of the Dresden AMS system [2] have been performed and demonstrated background levels of $2{\cdot}10^{-16}$ for ^{10}Be/^{9}Be, $7{\cdot}10^{-16}$ for ^{26}Al/^{27}Al and $8{\cdot}10^{-15}$ for ^{41}Ca/^{40}Ca, respectively. The background of $2{\cdot}10^{-13}$ for ^{129}I/^{127}I originates from intrinsic ^{129}I (MERCK KI), whereas the reasons for high ^{36}Cl/^{35}Cl background of $3{\cdot}10^{-15}$ are under discussion.

References: [1] Sh. Akhmadaliev et al., MS6.2, DPG Frühjahrstagung der Sektion AMOP, Hannover 2010. [2] www.dresden-ams.de

MS 2: Accelerator Mass Spectrometry and Applications

Time: Monday 14:00–15:30 Location: GÖR 229

Invited Talk MS 2.1 Mon 14:00 GÖR 229

Setting-up an accelerator mass spectrometry (AMS) facility: The role of chemistry — •Silke Merchel[1], Frans Munnik[1], Christoff Andermann[2,3], Didier Bourlès[4], Régis Braucher[4], Richard Gloaguen[3], Martin Martschini[5], and Peter Steier[5] — [1]HZDR, Dresden, DE — [2]U Rennes, FR — [3]TUBA Freiberg, DE — [4]CEREGE, Aix-en-Provence, FR — [5]VERA, U Vienna, AT

Medium-energy AMS facilities such as the 5 MV British *SUERC* and French *ASTER* or the two 6 MV German *DREAMS* at Dresden [1] and *Cologne AMS* have recently been installed. These machines need physicists to get them running but also scientists to establish AMS chemistry on-site. As it is not advisable to change simultaneously two "things", i.e. machine and chemistry, a cooperation with the teams of *ASTER* and *VERA* helped to check the new sample preparation of DREAMS. A "good" AMS sample has two features: high stable isotope current and low isobar concentration. High chemical yields and low concentrations of other elements, from the matrix or chemical products used, are less important, but may play a role if e.g. a matrix contains Ti being introduced into BeO-targets as shown by μ-XRF [2] and recent μ-PIXE analyses of final AMS-targets at HZDR. A processing blank with low radionuclide/stable nuclide ratio is essential for projects near the detection limit. Finally, a fast, easy and cheap separation guarantees high sample throughput and reasonable costs. *Ref.:* [1] www.dresden-ams.de. [2] S. Merchel et al., *NIMB* 266 (2008) 4921. *Ackn.:* Thanks to T. Schildgen, C. Yildirim (Potsdam), K. Klemm, M. Fuchs (TUBA), M. Arnold, G. Aumaître (ASTER), A. Wallner (VERA).

MS 2.2 Mon 14:30 GÖR 229

Direkter Nachweis von Aktinidenmolekülen im Ladungszustand 3+ — •Johannes Lachner, Marcus Christl, Hans-Arno Synal und Christof Vockenhuber — Labor für Ionenstrahlphysik, ETH Zürich

Ein empfindlicher massenspektrometrischer Nachweis von Radionukliden erfordert die Unterdrückung von Isobaren und Molekülen gleicher Masse. In der AMS wird molekularer Untergrund beim Umladeprozess zerstört, indem nach dem Einschuss negativer Ionen oder Moleküle die Nuklide in positiven Ladungszuständen, üblicherweise 3+ und höher, aus dem Beschleuniger extrahiert werden. Am Zürcher Kleinbeschleuniger Tandy konnte im Rahmen von Sensitvitätsstudien für die Messung von ^{236}U nachgewiesen werden, dass eine Extraktion der Ionen im Ladungszustand 3+ nicht immer ausreicht, um molekularen Untergrund vollständig zu unterdrücken. Erstmals konnten Moleküle aus Aktiniden (^{232}Th, ^{235}U, ^{238}U) und Wasserstoff im Ladungszustand 3+ anhand einer typischen Stripperdruckabängigkeit der Zählrate auf der nächsthöheren Masse (233, 235 und 239) identifiziert werden. Ein direkter Nachweis gelang im Fall von ^{232}ThH^{3+} mittels Molekülaufbruch in einer dünnen Kohlenstofffolie und anschließender Analyse der Aufbruchprodukte.

MS 2.3 Mon 14:45 GÖR 229

Forschungen zur Siedlungsgeschichte in Tibet und im Himalaya mittels Wiggle-Matching von ^{14}C-AMS-Datierungen — •Andreas Scharf[1], Achim Bräuning[2], Stefanie Gierl[1], Katrin Leichmann[1], Karin Kritzler[1], Frederique Daragon[2], Bertram Wegner[1] und Wolfgang Kretschmer[1] — [1]AMS-Labor Erlangen, Physikalisches Institut, 91058 Erlangen — [2]Lehrstuhl für Physische Geographie, Geographisches Institut, 91054 Erlangen

In vier Regionen Hochasiens konnten in den vergangenen Jahren zahlreiche wertvolle Holzproben in Form von Holzbohrkernen aus historischen Profanbauten, Tempeln und Klöstern durch das geographische Institut der Universität Erlangen gesammelt und dendrochronologisch ausgewertet werden. In vielen Fällen war eine dendrochronologische Datierung nicht möglich, was darauf hindeutet, dass die Probenhölzer ein höheres Alter aufweisen als die derzeitige Länge der bestehenden Lokalchronologien.
Im Rahmen eines mehrjährigen DFG-Projekts konnte nun mit ^{14}C-AMS-Datierungen mit Hilfe der Wiggle-Matching Technik eine Datierung dieser Bohrkerne durchgeführt werden, wodurch teilweise erstmals wichtige Informationen über Entstehungsalter der kulturhistorisch sehr bedeutsamen Gebäude erzielt werden konnten. Darüber hinaus sollen mithilfe der datierten Holzbohrkerne bestehende Jahrringchronologien verlängert werden. Im Rahmen dieser Datierungen wurde auch eine auf die Möglichkeiten des Erlanger AMS-Labors abgestimmte Methode zur Zellulose-Extraktion entwickelt, die an modernen Baumringen aus der Bombenpeak-Periode getestet wurde.

MS 2.4 Mon 15:00 GÖR 229

Erste Messungen von ^{236}U im Ozean — •Marcus Christl, Johannes Lachner, Christof Vockenhuber und Hans-Arno Synal — Labor für Ionenstrahlphysik, ETH-Zürich, Schweiz

Am Kleinbeschleuniger TANDY der ETH-Zürich wurden erstmals ^{236}U-Messungen an Ozeanproben durchgeführt. Aufgrund technischer Weiterentwicklungen können nun ^{236}U/^{238}U Verhältnisse im Bereich von 10^{-12} gemessen werden, wobei die hohe Gesamteffizienz des Systems die Bestimmung von einigen Attogramm (10^{-18} g) ^{236}U erlaubt. Es ist daher nicht nur möglich anthropogenes ^{236}U zu erfassen, sondern auch die wesentlich geringeren natürlichen Verhältnisse von ^{236}U/^{238}U in der Umwelt zu detektieren. In einer ersten Studie soll eine Bilanz von ^{236}U im Atlantischen Ozean erstellt werden. Die Untersuchungsgebiete wurden dabei so gewählt, dass der Übergang vom rein anthropogen beeinflussten Ozean (Nordsee) zum prä-anthropogenen Ozean (westlicher äquatorialer Atlantik) deutlich wird. Erste Ergebnisse zeigen einen klaren Übergang von sehr hohen ^{236}U/^{238}U Verhältnissen (10^{-8} * 10^{-9}) in der Nordsee zu sehr niedrigen Werten im tiefen (4500 m) äquatorialen Atlantik (10^{-10} - 10^{-11}). Dennoch liegen die Werte im tiefen Ozean weit über den theoretischen Abschätzungen des natürlichen Hintergrunds (etwa 10^{-12} - 10^{-13}). Mögliche Erklärungen sind der partikuläre Transport von anthropogenem ^{236}U von der Oberfläche in die Tiefsee oder der Eintrag von ^{236}U durch eine deutlich erhöhte globale Verwitterungsrate der Kontinente über die letzten 500'000 Jahre. Weitere Implikationen für den globalen ^{236}U-Kreislauf werden anhand der ersten Daten diskutiert.

MS 2.5 Mon 15:15 GÖR 229

Untersuchung der Herkunft von Umweltschadstoffen mittels Beschleunigermassenspektrometrie — •Matthias Schindler, Wolfgang Kretschmer, Peter Leitherer, Andreas Scharf, Alexander Stuhl und Karin Kritzler — AMS-Labor des Physikalischen Instituts, Universität Erlangen

Die Erlanger AMS-Anlage wurde bzgl. der Messung von μg-Proben optimiert. Aus dem ^{14}C Gehalt von Schadstoffen lässt sich eine Unterscheidung zwischen Proben biogenen und anthropogenen Ursprungs treffen. Bisher wurden am Erlanger AMS-Labor die Proben direkt als Gastarget gemessen.Die Proben wurden mittels Gaschromatographie und anschließendem Ausfrieren in einem Fraktionssammler vorbereitet.
Um die Effektivität zu steigern und mögliche Kontamination durch mehrfaches Ausfrieren zu minimieren, wurde auf präperative HPLC (high performance liquid chromatography) umgestellt. Im Beitrag werden erste Ergebnisse bzgl. der ^{14}C Konzentration der in Raumluft gemessenen Aldehyde und Ketone vorgestellt.

MS 3: Poster

Time: Monday 16:00–18:00 Location: P1

MS 3.1 Mon 16:00 P1

Überblick über die höchstempfindlichen Messungen am Münchener Tandembeschleuniger — •Georg Rugel, Leticia Fimiani, Thomas Faestermann, Gunther Korschinek und Peter Ludwig — Physik Department E12 und E15, Technische Universität München, 85748 Garching

Mit den am Münchner MP Tandembeschleuniger erreichbaren hohen Energien werden seit vielen Jahren höchstempfindliche Messungen von Radionukliden im Massebereich von ^{26}Al bis zu den Aktiniden durchgeführt. Zu diesen Messungen werden zwei Strahlrohre verwendet, eines mit einem gasgefüllten Analysier-Magneten (GAMS), das andere mit einer Flugzeitstrecke. Im letzten Jahr wurden zusätzliche Wien-Filter in Betrieb genommen. In diesem Beitrag soll ein Überblick über die verschiedenen Isotope, ihre Nachweisgrenzen und ihre Anwendung gemacht werden.

MS 3.2 Mon 16:00 P1

Towards online coupling of TRIGA-SPEC to the research reactor TRIGA Mainz — •Szilard Nagy[1,2], Thomas Beyer[1,3], Klaus Blaum[1,3], Michael Block[2], Christoph E. Düllmann[2,4], Klaus Eberhardt[4], Martin Eibach[3,4], Nadja Frömmgen[4], Christopher Geppert[2,4], Alexej Gonschior[4], Michael Hammen[4], Frank Herfurth[2], Jens Ketelaer[1], Jörg Krämer[4], Andreas Krieger[4], Dennis Neidherr[2], Wilfried Nörtershäuser[2,4], Dennis Renisch[4], and Christian Smorra[3,4] — [1]Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg — [2]GSI Helmholtzzentrum für Schwerionenforschung GmbH, Planckstraße 1, 64291 Darmstadt — [3]Physikalisches Institut, Ruprecht-Karls-Universität Heidelberg, Philosophenweg 12, 69120 Heidelberg — [4]Institut für Kernchemie, Johannes Gutenberg-Universität Mainz, Fritz-Straßmann-Weg 2, 55128 Mainz

At the TRIGA research reactor in Mainz the TRIGA-SPEC setup is under construction. The aim is to perform Penning trap mass spectrometry and collinear laser spectroscopy on short-lived neutron-rich nuclides. The nuclides are produced by neutron-induced fission of an actinide target located in a target chamber close to the reactor core. A key issue is the extraction of these nuclides from the target chamber through the biological shield of the reactor, and ultimately the preparation of a mass-selected, cooled and bunched low energy ion sample for high-precision experiments on nuclides with half-lives in the order of 1 s. The current status of TRIGA-SPEC will be presented.

MS 3.3 Mon 16:00 P1

The control system and the automation of THe-TRAP — •Christoph Diehl[1], Martin Höcker[1], Jochen Ketter[1], David Pinegar[1], Sebastian Streubel[1], Marius Tremer[1], Robert S. Van Dyck Jr.[2], and Klaus Blaum[1] — [1]Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, D-69117 Heidelberg — [2]Department of Physics, University of Washington, Seattle, WA 98195-1560, USA

THe-TRAP is a double Penning trap mass spectrometer that aims at measuring the mass ratio of ^{3}H to ^{3}He at an uncertainty of 1 part in 10^{11}. This quantity is a relevant parameter in the determination of the neutrino mass by the Karlsruhe Tritium Neutrino Mass Experiment. The relevant quantities to be measured are the three eigenfrequencies of an ion in a Penning trap. This requires the computer-control of a variety of different components, such as synthesizers, power supplies, multimeters etc. Parts of these components are custom-made to meet the specifications of a high-precision mass measurement. Examples are a high-precision voltage source and the cryogenic amplifier for the detection of the ions. Combining the control of these diverse components was achieved in a program based on the programming language LabWindows/CVI. An existing version of the program and the experimental hardware were further developed to allow automation of experimental standard procedures such as loading the trap, cleaning the ion cloud from contaminations or the frequency measurements. Individual components of THe-TRAP setup as well as the basic structure of the control program will be presented.

MS 3.4 Mon 16:00 P1

New anchor points of the mass surface in the rare-earth region provided by TRIGA-TRAP — •J Ketelaer[1], T Beyer[1,2], K Blaum[1,2], M Eibach[2,3], Sz Nagy[1,4], D Neidherr[5], D Renisch[1,3], C Smorra[2,3], and the Triga-Trap collaboration[1,3,4] — [1]Max-Planck-Institut für Kernphysik, 69117 Heidelberg — [2]Ruprecht-Karls-Universität, 69117 Heidelberg — [3]Johannes Gutenberg-Universität, 55128 Mainz — [4]GSI Helmholtzzentrum für Schwerionenforschung GmbH, 64291 Darmstadt — [5]Helmholtz-Institut Mainz, 55128 Mainz

Nuclear structure effects, such as shell closures at magic nuclei as well as deformation, express themselves through certain characteristic shapes of the mass surface, which are usually studied using single and double differences of binding energies. Thus, precise and accurate experimental mass values, as measured, e.g., at the Penning-trap mass spectrometer TRIGA-TRAP, are highly required. The present recommended values of stable nuclides in the rare-earth region from the Atomic-Mass Evaluation (AME) 2003 are dominated by (n,γ) studies and only very few nuclides are part of a mass doublet. Recently, the masses of 15 stable isotopes of the elements europium, gadolinium, lutetium, and hafnium have been measured directly at TRIGA-TRAP using carbon cluster ions as references. Thus, these nuclides are now linked to the atomic-mass standard ^{12}C serving as new anchor points of the mass surface. Furthermore, for some of the nuclides under investigation deviations of the mass of 3-4 standard deviations from the latest AME values have been found. The results of the mass measurements and the comparison to the AME 2003 data will be presented.

MS 3.5 Mon 16:00 P1

Reinigung radioaktiver Ionenstrahlen und Q-Wert Messung von ^{110}Pd/^{110}Cd an Isoltrap — •Ch. Borgmann[1], G. Audi[2], D. Beck[3], K. Blaum[1], M. Breitenfeldt[4], D. Fink[1], F. Herfurth[3], A. Herlert[5], M. Kowalska[5], S. Kreim[1], D. Lunney[2], S. Naimi[2], D. Neidherr[1], M. Rosenbusch[6], S. Schwarz[7], L. Schweikhard[6], J. Stanja[8], R. Wolf[6] und K. Zuber[8] — [1]Mpi für Kernphysik, Heidelberg — [2]Csnsm, Orsay, Frankreich — [3]Gsi, Darmstadt — [4]Instituut voor Kern- en Stralingsfysica, Leuven, Belgien — [5]Cern, Genf, Schweiz — [6]Universität Greifswald — [7]Nscl Msu, East Lansing, Usa — [8]Universität Dresden

Mit dem Penningfallen-Massenspektrometer Isoltrap am Isotopen-Separator Isolde (Cern) werden die Massen von kurzlebigen Radionukliden mit relativen Genauigkeiten von 10^{-8} bestimmt.

Fernab der Stabilität nehmen üblicherweise Halbwertszeit sowie Produktionsrate der zu untersuchenden Ionen ab, womit sich zugleich der relative Anteil an isobarer Kontamination erhöht. Um sich diesen Herausforderungen zu stellen, wurde 2010 ein Multireflektions-Flugzeitmassenseparator (Mr-Tof) in Betrieb genommen und erfolgreich am radioaktiven Ionenstrahl getestet. Dabei wurde mit Hilfe des Mr-tof eine Unterdrückung von Kontamination um mehrere Größenordnungen erzielt.

Weiterhin wurden an Isoltrap Messungen für eine genauere Bestimmung der Neutrinomasse durchgeführt. Unter Verwendung einer Laser-Ablationsquelle konnte der Q-Wert des Zerfallspaares ^{110}Pd/^{110}Cd um mehr als einen Faktor 16 verbessert werden.

MS 3.6 Mon 16:00 P1

Detection System for a ^{3}H/^{3}He Mass-Ratio Measurement — •Jochen Ketter[1], Christoph Diehl[1], Martin Höcker[1], David B. Pinegar[1], Sebastian Streubel[1], Marius Tremer[1], Robert S. Van Dyck Jr.[2], and Klaus Blaum[1] — [1]Max-Planck-Institut für Kernphysik, Heidelberg — [2]Department of Physics, University of Washington, Seattle, WA 98195-1560, USA

The maximum energy release in the beta-decay of ^{3}H to ^{3}He is a crucial parameter in the determination of the electron antineutrino's mass by the Karlsruhe Tritium Neutrino Experiment (KATRIN) [1]. An independent measurement of this Q-value with an uncertainty of less than 100 meV would serve as an important systematic check, but an improvement of the presently accepted Q-value [2] by an order of magnitude is necessary. Even for Penning trap mass spectrometry, which derives the mass difference of the two nuclei from the measurement of their mass ratio, this represents an ambitious goal only to be accomplished by a dedicated experiment, such as THe-Trap. The double Penning trap mass spectrometer [3], originally developed and built at the University of Washington, has been commissioned in a customized laboratory at the MPIK in Heidelberg. The mass of the ion is related to its three eigenfrequencies in the trap. A frequency-locked loop in the

axial mode provides for continuous indirect monitoring of the radial modes. Details of the detection system will be given.

[1] E. W. Otten *et al.*, Int. J. Mass Spectrom. 251 (2006) 173–178
[2] Sz. Nagy *et al.*, Europhys. Lett., **74** (3), pp. 404–410 (2006)
[3] D. B. Pinegar *et al.*, Hyperfine Interactions (2007) 174:47–53

MS 3.7 Mon 16:00 P1

Untersuchung von Oktupolanregung in der Präparations-Penningfalle von ISOLTRAP — Marco Rosenbusch und •Robert N. Wolf für die ISOLTRAP-Kollaboration — Ernst-Moritz-Arndt-Universität Greifswald

In vielen Bereichen der Physik werden Penningfallen zum Speichern und Präparieren von Ionen genutzt. Für die Kernmassenspektroskopie bei ISOLTRAP [1] ist das massenselektive Kühlen von Ionen mit hohem Auflösungsvermögen ($m/\Delta m = 10^5$) eine wirksame Technik, um Ionen von isobaren Kontaminationen zu separieren. Dazu wird in einer mit Puffergas gefüllten Präparations-Penningfalle eine azimutale Quadrupolanregung auf der Zyklotronfrequenz $\nu_c = qB/m$ der zu zentrierenden Ionen eingestrahlt, was zu einem Energieübertrag zwischen den beiden radialen Eigemoden des Teilchens in der Falle führt. Die Magnetronbewegung der gespeicherten Ionen wird in die schnellere Zyklotronbewegung umgewandelt und im Puffergas gekühlt [2]. In diesem Beitrag werden Untersuchungen zur Oktupolanregung als alternative Anregungsform vorgestellt, mit dem Ziel das Auflösungsvermögen zu erhöhen.

[1] M. Mukherjee *et al.*, Eur. Phys. J. A **35**, 1 (2008)
[2] G. Savard *et al.*, Phys. Lett. A **158**, 247 (1991)

MS 3.8 Mon 16:00 P1

A new resonant Schottky pickup for nuclear physics measurements of highly charged ions in storage rings — •M. Shahab Sanjari[1,2], Peter Hülsmann[1,2], Fritz Nolden[2], Alwin Schempp[1], Dinko Atanasov[3], Klaus Blaum[3], Fritz Bosch[2], Violetta Ivanova[2], Christophor Kozhuharov[2], Yuri A. Litvinov[2,3], Peter Moritz[2], Claudius Peschke[2], Peter Petri[2], Daria Shubina[3], Markus Steck[2], Helmut Weick[2], Nicolas Winckler[3], Junxia Wu[4], Yongdong Zang[4], and Tiecheng Zhao[4] — [1]Goethe-Universität, Frankfurt am Main — [2]GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt — [3]Max-Planck-Institut für Kernphysik, Heidelberg — [4]Institute of Modern Physics, Lanzhou, China

An RF cavity was designed and used as a sensitive resonant pickup for Schottky noise of single or few particle beams in the ESR at GSI. The particle-induced energy builds up inside the resonator and is extracted with a matched loop antenna. A dedicated signal analysis system is then used for further processing. To allow high current experiments, the resonator can be disabled by taking apart its air-filled parts and shorting its gap. The design allows remote detuning of the resonance frequency. The resonator complements the existing capacitive Schottky noise pickup at the ESR. Nuclear experiments with highly charged ions such as time-resolved Schottky mass spectrometry and life time measurements were performed with much higher sensitivity. A similar cavity is currently being installed in the CSRe at IMP, Lanzhou. We will discuss the principles and recent results of these detectors.

MS 3.9 Mon 16:00 P1

Ultraspurennachweis von Uran-236 mittels HR-RIMS — •Raeder Sebastian[1], Amin Hakimi[1], Norbert Trautmann[2] und Klaus Wendt[1] — [1]WA LARISSA, Institut für Physik, Universität Mainz — [2]Institut für Kernphysik, Universität Mainz

Der sensitive Nachweis und die Quantifizierung der Isotopenhäufigkeit des Ultraspurenisotopes ^{236}U liefert einen Hinweis auf Herkunft und Geschichte der untersuchten Probe. Durch den niedrigen natürlichen Untergrund liefert diese Isotopensignatur bereits bei einem geringen Eintrag einer kontaminierten Probe in die Umwelt einen eindeutigen Nachweis.

Die in Mainz entwickelte hochauflösenden Resonanzionisations - Massenspektrometrie (HR-RIMS) kombiniert die selektive resonante Laserionisation mit der Massentrennung herkömmlicher Massenspektrometer. Die resonante Anregung und Ionisation durch schmalbandige Dauerstrich-Laserstrahlung transversal zu dem frei propagierenden Atomstrahl erlaubt eine isotopenselektive Anregung und Ionisation. Durch ein Quadrupol Massenfilter wird eine Selektion nach der individuellen Masse der Ionen und somit ein Abtrennen von Oberflächenionen erreicht. Diese Methode konnte mit synthetischen Proben bezüglich Untergrund, Selektivität und Effizienz charakterisiert werden und Messungen von Isotopenverhältnisse bis in den Bereich $^{236}U/^{238}U \approx 10^{-8}$ wurden demonstriert. Aktuell wird die Messung von ersten Umweltproben vorbereitet. Der aktuelle Status des Projekts sowie geplante Verbesserungen werden vorgestellt.

MS 3.10 Mon 16:00 P1

Multielementanalyse von Siliciumdioxid mittels LSMS — •Bernhard Wiedemann[1], Michael Deveaux[1], Michael Petri[1], Christoph Schrader[1], Tobias Tischler[1] und Karl-Heinz Wiedemann[2] — [1]Institut für Kernphysik, Max-von-Laue-Strasse 1, D-60438 Frankfurt am Main — [2]W. C. Heraeus GmbH, 63450 Hanau

Siliciumdioxid wird durch Oxidation von Siliciumtetrachlorid in Sauerstoff- und Wasserstoffathmosphäre synthetisiert. Für mikrolithographische Anwendungen sind hochreine Gläser aus diesem Material mit möglichst niedrigen Chlorkonzentrationen gefordert, da das Element Cl die Lebensdauer optischer Bauelemente verringert. Die Nachweisgrenze für Cl in Siliciumdioxid liegt für die Standardmethode ISE (Ion Selective Electrode) bei einer atomaren Konzentration von 80 ppm. Wesentlich niedrigere atomare Konzentrationen sind im synthetischen Siliciumdioxid für Cl und andere Fremdelemente von H bis U mittels Nd:YAG LSMS (Laser Source Mass Spectrometry) unter Verwendung eines modernisierten Massenspektrometers, Typ 21-110, mit ionenempfindlicher Q-Platte nachweisbar. Die atomaren Nachweisgrenzen für die Mulielementanalyse an Siliciumdioxid-Proben liegen im ppb($1 : 10^9$)-Bereich für Ladungsmengen von 100 nC. Für den Nachweis der meisten relevanten Elemente ist die Nd:YAG LSMS anderen Methoden der Elementanalyse überlegen und somit für die Qualitätssicherung im Herstellungsprozess besonders geeignet. Dies wird für Cl und andere herstellungbedingte Fremdelemente gezeigt.

MS 3.11 Mon 16:00 P1

H3O+, NO+ and O2+ as precursor ions in PTR-MS: isomeric VOC compounds and reactions with different chemical groups — Alfons Jordan[1], •Simone Jürschik[1,2], Bishu Agarwal[2], Gernot Hanel[1], Eugen Hartungen[1], Stefan Jaksch[1], Lukas Märk[1], Hans Seehauser[1], Philipp Sulzer[1], and Tilmann D. Märk[1,2] — [1]IONICON Analytik GmbH, Eduard-Bodem-Gasse 3, 6020 Innsbruck, Austria — [2]Institut für Ionenphysik und Angewandte Physik, Leopold-Franzens Universität Innsbruck, Technikerstr. 25, 6020 Innsbruck, Austria

Most PTR-MS instruments employed so far use an ion source consisting of a hollow cathode discharge in water vapour which provides an intense source of protonated water (H3O+). However, the use of other ions, e.g. NO+ and O2+, can be useful for the identification of VOCs, for separation of isomers and for the detection of VOCs with proton affinities below that of H2O.

In general the main advantage of O2+ is to see compounds which are not measureable with protonated water. For example nearly all halogenated hydrocarbons are detectable with O2+ whereas just the very large ones and the aromatic halogenated compounds are detectable with H3O+. By using NO+ as precursor ion in nearly all cases the product ions are different from the product ion by using protonated water. Very often also isomeric compounds show different product ions. For instance, isomers like aldehydes and ketones or acids and esters show in many cases different product ions in the reaction with NO+.

MS 3.12 Mon 16:00 P1

A Sub-nanosecond Microchannel-Plate Detector Development — •Samuel Ayet[1,2], Timo Dickel[1,2], Marcel Diwisch[1], Hans Geissel[1,2], Christian Jesch[1], Natalia Kuzminchuck[1,2], Wolfgang Plass[1,2], Christoph Scheidenberger[1,2], and Baohua Sun[1] — [1]Justus-Liebig-Universität, Gießen — [2]GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt

The timing performance, rise time, fall time and pulse width of microchannel-plate detectors (MCP) are often the main limitations of many physics experiments. For example in mass spectrometry the mass resolution of time-of-flight mass spectrometers is often influenced by the timing characteristics of the MCP detector.

A new MCP detector for Isochronous Mass Spectrometry in storage rings has been designed based on microwave simulations. The rise time, fall time and the pulse width of the detector have been optimized and measured. Compared to a previous design, improvements by up to a factor of two have been achieved.

MS 3.13 Mon 16:00 P1

Massenspektroskopische Untersuchung von Flüssigmetall-Ionenquellen — •Martin Wortmann, Dirk Reuter und Andreas

D. Wieck — Ruhr-Universität Bochum, Lehrstuhl für Angewandte Festkörperphysik, Universitätsstr. 150, 44780 Bochum, Deutschland

Die Flüssigmetall-Ionenquelle (LMIS) ist heutzutage der bei weitem am meisten verwendete Quelltyp zur Erzeugung von fokussierten Ionenstrahlen (focused ion beam, FIB). Allerdings entstehen bei der Verwendung von LMIS nicht nur Monomere, sondern auch elektrisch geladene Cluster unterschiedlicher Masse. Zu diesem Prozess gibt es jedoch bis heute nur wenige systematische Untersuchungen. Insbesondere für die Untersuchung größerer Cluster ($n > 10$) ist die Auflösung der in herkömmlichen FIB-Systemen verwendeten Massenfilter nicht mehr ausreichend. Allerdings ist zu erwarten, dass die Ausbeute an Clustern, die mit Hilfe von LMIS realisiert werden kann, in einer Größenordnung liegt, die derartige Quellen als vielversprechendes Hilfsmittel zur Erzeugung monodisperser Cluster mit hinreichend hohen Fluenzen erscheinen lässt. Derzeit befindet sich bei uns ein hochauflösendes Massenspektrometer im Aufbau, dessen Auflösung ausreichend ist, das Emissionsverhalten unterschiedlicher LMIS zu untersuchen. Die Massentrennung kann hierbei sowohl durch einen $E \times B$ – Massenfilter als auch durch Time-of-Flight-Spektroskopie erreicht werden. Die Ergebnisse erster Berechnungen zeigen, dass mit Hilfe dieses Systems eine relative Massenauflösung von $m/\Delta m > 100$ für Cluster mit Massen von mehr als 10000u (entsprechend etwa Ga_{140} oder Bi_{50}) erreicht werden kann.

MS 3.14 Mon 16:00 P1

Die elliptische Paulfalle — •Steffi Bandelow, Gerrit Marx und Lutz Schweikhard — Institut für Physik, Ernst-Moritz-Arndt Universität, D-17489 Greifswald

Paulfallen in Form von dreidimensionalen harmonisch oszillierenden elektrischen Feldern, sog. Führungsfeldern, erlauben die Speicherung geladener Teilchen, da bei geeigneten Fallenparametern die Ionen im zeitlichen Mittel eine zum Fallenzentrum rücktreibende lineare Kraft erfahren. Aufgrund der radialen Symmetrie hyperbolischer Paulfallen sind die radialen Bewegungen (x, y) gespeicherter Teilchen entartet. Die elliptische Paulfalle, d.h. die Überlagerung der Führungsfelder mit einem zusätzlichen, statischen radialen elektrischen Quadrupolfeld, ermöglicht die Aufhebung dieser Entartung. Realisiert wurde dies durch die Segmentierung der Ringelektrode der verwendeten Falle. Die radialen Bewegungsfrequenzen werden als Funktion der Elliptizität untersucht.

MS 3.15 Mon 16:00 P1

Cluster in Ionenfallen — •Franklin Martinez, Gerrit Marx, Lutz Schweikhard, Albert Vass, Frank Wienholtz und Falk Ziegler — Institut für Physik, Ernst-Moritz-Arndt Universität, 17487 Greifswald, Deutschland

Das ClusterTrap-Experiment wurde zur Untersuchung physikalischer Eigenschaften atomarer Cluster in der Gasphase entwickelt, wobei insbesondere die Abhängigkeit von der Größe und dem Ladungszustand der Cluster von Interesse ist. Die Kombination einer Clusterquelle mit Ionenfallen und einem Flugzeitmassenspektrometer erlaubt eine Vielzahl experimenteller Abläufe, zum Beispiel stoßinduzierte und Photo-Dissoziation, Elektronenstoßionisation und Elektronenanlagerung. Aufgrund der Speicherung von Clustern in Ionenfallen können ausgedehnte Zerfallsreaktionen beobachtet werden. Es werden Details des experimentellen Aufbaus vorgestellt, sowie ein Ausblick auf die weitere Entwicklung des ClusterTrap-Experiments gegeben.

MS 3.16 Mon 16:00 P1

Implementation of temperature and pressure stabilization systems at MLLTRAP* — Kevin Krug, Dietrich Habs, Jerzy Szerypo, Peter Thirolf, and •Christine Weber — Fakultät für Physik, Ludwig-Maximilians Universität München

MLLTRAP at the Maier-Leibnitz Tandem Accelerator Laboratory in Garching is a Penning trap setup, built to perform high-accuracy mass measurements on fusion-reaction products. During its commissioning phase, MLLTRAP is operated with an offline surface ionization source and characterization measurements are carried out to assess the inherent systematic uncertainties of the setup. For example, the magnetic-field-dependent variations of measured cyclotron frequencies show strong correlations to daily variations of ambient temperatures and pressures, which eventually limit the achievable precision in mass measurements. For this purpose, dedicated stabilization systems for the temperature of the trap environment and the helium exhaust of the magnet's cryostat were implemented. These stabilization systems result in a reduction of present fluctuations by about two orders of magnitude to about ±6 mK and ±0.2 hPa for the temperature and pressure, respectively. This contribution will describe the current status of the experiment.

[*]Supported by the DFG under contract HA 1101/14-1 and by the Maier-Leibnitz-Laboratory, Garching.

MS 3.17 Mon 16:00 P1

Detection electronics at the Penning trap mass spectrometer PENTATRAP — •Andreas Dörr[1,2], Christine Böhm[1,2], José Crespo López-Urrutia[2], Sergey Eliseev[2], Mikhail Goncharov[2], Yuri Novikov[4], Julia Repp[1,2], Christian Roux[1,2], Sven Sturm[3], Stefan Ulmer[1,3], and Klaus Blaum[1,2] — [1]Physikalisches Institut, Ruprecht-Karls-Universität, 69120 Heidelberg, Germany — [2]Max-Planck-Institut für Kernphysik, 69117 Heidelberg, Germany — [3]Johannes Gutenberg-Universität, Institut für Physik, 55099 Mainz, Germany — [4]St. Petersburg Nuclear Physics Institute, 188300 Gatchina, Russia

The "five Penning trap" mass spectrometer PENTATRAP is currently under construction at the Max-Planck-Institut für Kernphysik in Heidelberg. Measurements of masses of single stable and long lived highly charged ions with a relative uncertainty on the order of 10^{-11} are aimed at. The experiment is based on the non-destructive detection of image currents the ion induces in the trap electrodes. Essential part of each detection circuit is an inductance, configured either as a copper wire coil or as a superconducting toroid, in both cases mounted in a copper housing. Since signals are small (∼fA), low-noise detection electronics is needed to obtain a sufficient signal-to-noise ratio. Therefore the first amplification stage is a cryogenic GaAs amplifier. Currently, we evaluate the possible use of a SQUID based amplifier. Furthermore, an axial frequency down converter providing a high level of sideband rejection has been set up. Further details on the detection electronics mentioned above will be presented in the poster.

MS 4: Precision Mass Spectrometry and Fundamental Applications

Time: Tuesday 10:30–12:30 Location: GÖR 229

Invited Talk MS 4.1 Tue 10:30 GÖR 229

On the interconversion of an ion's motional modes in a Penning trap by quadrupolar and octupolar rf-fields — •Martin Kretzschmar — Institut für Physik, Johannes Gutenberg-Universität, 55099 Mainz, Germany

Penning trap mass spectrometry rests on the precise determination of an ion's cyclotron frequency. Part of the measurement procedure is the resonant conversion of magnetron motion into cyclotron motion by means of external quadrupolar or octupolar rf-fields.

I shall discuss the interconversion of the motional modes in a quantum mechanical formulation in conjunction with the rotating wave approximation. This permits the identification of the effective interactions responsible for the conversion process. The concept of the Bloch vector is introduced and applied to the conversion process to derive the excitation curve at the exact resonance frequency, and the conversion profile as a function of detuning.

The main emphasis shall be on novel results relating to the conversion by octupolar rf-fields with a frequency equal to twice the cyclotron frequency. Analytical solutions for the Bloch vector in terms of Jacobi elliptical functions shall be presented, the dependence of excitation curves and conversion profiles on the initial phases and amplitudes of the ion motional modes and of the octupolar field shall be discussed. The most remarkable feature of octupolar excitation is the extreme narrowness of the resonant conversion profiles, promising the possibility of very high mass resolution in future experiments. The theoretical results shall be compared to existent experimental data.

Invited Talk MS 4.2 Tue 11:00 GÖR 229

High-precision Penning trap mass spectrometry for neutrino physics — •sergey eliseev[1], christine böhm[1,2], klaus blaum[1,2], andreas dörr[2], mikhail goncharov[1], yuri novikov[3],

JULIA REPP[1,2], and CHRISTIAN ROUX[1,2] — [1]Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Germany — [2]Physikalisches Institut, Ruprecht-Karls-Universität, 69120 Heidelberg, Germany — [3]PNPI, Gatchina, 188300 St. Petersburg, Russia

The discovery of neutrino oscillations has proven neutrinos are massive particles. However, this does not provide information on the type of the neutrino and its mass. An answer to these questions lies in a study of beta transitions, i.e., β^-, double β^-, EC and double EC decays. A crucial parameter in this study is the Q-value of the beta transitions, which has to be measured with an accuracy of 100 eV in the case of the determination of the neutrino type to better than 1 eV if the neutrino mass is concerned.

Tremendous progress in Penning traps finally allowed such high precision Q-value measurements. JYFLTRAP/Finland and SHIPTRAP/Germany, e.g., contribute to the search for neutrinoless double β transitions. In the sector of experiments for a determination of the neutrino mass two Penning trap mass spectrometers are being developed at Max-Planck Institut für Kernphysik/Germany. *THe*-TRAP is devoted to a measurement of the Q-value of Tritium beta decay for the KATRIN experiment, whereas PENTATRAP aims for a measurement of the Q-values of EC in ^{163}Ho and of β^--decay of ^{187}Re with accuracies of much below 10^{-11}.

MS 4.3 Tue 11:30 GÖR 229

Ionenerzeugung und -transport von ^{3}H und ^{3}He zur präzisen Massenbestimmung in THe-Trap — •MARIUS TREMER[1], CHRISTOPH DIEHL[1], MARTIN HÖCKER[1], JOCHEN KETTER[1], DAVID B. PINEGAR[1], SEBASTIAN STREUBEL[1], ROBERT S. VAN DYCK JR.[2] und KLAUS BLAUM[1] — [1]Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Deutschland — [2]Department of Physics, University of Washington, Seattle, WA 98195-1560, USA

Das Massenspektrometer THe-Trap wurde zur Bestimmung des Q-Werts vom ^{3}H zu ^{3}He β-Zerfall mit einem Doppel-Penningfallensystem ausgestattet. Es ist gegenüber seinem Vorgängerexperiment unter anderem mit einer externen Ionenquelle, einer kompakten Penningionenquelle, ausgerüstet. Die Vorteile sind keine thermische Einflüsse und eine geringere Kontamination der Fallen mit Tritium. Zudem können weitere in der Ionenquelle ionisierbare Nuklide untersucht werden. Gefordert sind dabei ein fokussierter Ionenstrahl mit einstellbarer Energie und ein hoher Ionisationsgrad bei geringen Gasmengen, um die Gasdiffusion in die kryogenen Fallen zu minimieren. Diese Eigenschaften sollen in einem separaten Aufbau getestet und verbessert werden.

Zusätzlich zu den beiden Präzisions-Penningfallen von THe-Trap wurde eine weitere Penningfalle zum Ioneneinfang, bestehend aus einer Driftröhre als Ringelektrode und zwei Endkappen, in den Aufbau integriert. Die Ein- und Ausschusssequenz sowie eine Speicherung der in der Ionenquelle erzeugten Ionen soll mit Hilfe eines Nachbaus in einem 4,7 T starken Magnetfeld optimiert werden.

MS 4.4 Tue 11:45 GÖR 229

Minimization of environmental influences for precision mass measurements in THe-Trap — •SEBASTIAN STREUBEL[1], CHRISTOPH DIEHL[1], MARTIN HÖCKER[1], JOCHEN KETTER[1], DAVID B. PINEGAR[1], MARIUS TREMER[1], ROBERT S. VAN DYCK JR.[2], and KLAUS BLAUM[1] — [1]Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Germany — [2]Department of Physics, University of Washington, Seattle, WA 98195-1560, USA

THe-Trap is a double-Penning trap mass spectrometer dedicated to measure the mass ratio of ^{3}H to ^{3}He with an uncertainty of 10^{-11} and below. This would allow an independent measurement of the tritium Q-value, which is of relevance for the determination of the electron antineutrino mass by the KArlsruhe TRItium Neutrino Experiment (KATRIN). A control of the environmental influences is important to achieve the desired precision. Due to a temperature dependent magnetic susceptibility of the surrounding materials, the pressure and the level of the liquid helium around the traps are stabilized. With the same purpose the ambient temperature in the room is regulated. A pair of Helmholtz coils is used to minimize external fluctuations of the geomagnetic field. The remaining field fluctuation will be measured by a stored single C^{4+} Ion.

The stabilization systems as well as their performances will be presented.

MS 4.5 Tue 12:00 GÖR 229

A radiofrequency quadrupole system for mass separation and ion bunching at SHIPTRAP — •EMMA HAETTNER[1,2], WOLFGANG PLASS[1,2], SAMUEL AYET[1,2], ULRICH CZOK[1], TIMO DICKEL[1,2], HANS GEISSEL[1,2], WADIM KINSEL[1], FELIX LAUTENSCHLAEGER[1], MARTIN PETRICK[1], CHRISTOPH SCHEIDENBERGER[1,2], THORSTEN SCHAEFER[2], and JOSEPHINA WERNER[1] — [1]II. Physikalisches Institut, Gießen — [2]GSI, Darmstadt

At SHIPTRAP, very proton-rich exotic nuclei are produced and separated from the primary beam in the velocity filter SHIP, stopped in a gas cell, bunched and transferred to a double Penning trap system. A radio-frequency quadrupole (RFQ) system consisting of a RFQ cooler, RFQ mass filter and RFQ buncher has been developed in order to remove contaminant ions and abundant reaction products other than nuclei of interest, which so far limits the performance of SHIPTRAP. The newly developed system will also allow for quick identification of the ions produced.

Operation parameters of the system have been optimized and the performance has been investigated. The cooler mass filter combination shows full transmission up to a mass resolving power of about 200 (FWHM) and suppression of neigboring masses over at least four orders of magnitude. Studies of the RFQ buncher show that peak widths of the extracted ion bunches of about 50 ns can be reached while maintaining full energy acceptance of the Penning trap. Using the detectors installed at SHIPTRAP this would allow for broadband time-of-flight mass spectrometry with a resolution of about 300.

MS 4.6 Tue 12:15 GÖR 229

Online coupling and beam preparation for the TRIGA-SPEC experiment — •THOMAS BEYER[1,2], KLAUS BLAUM[1,2], MARTIN EIBACH[1,3], NADJA FRÖMMGEN[3], CHRISTOPHER GEPPERT[3,5], ALEXEY GONSCHIOR[3], JENS KETELAER[2], JÖRG KRÄMER[3], SZILARD NAGY[2,5], DENNIS NEIDHERR[2], WILFRIED NÖRTERSHÄUSER[3,5], DENNIS RENISCH[2,4], CHRISTIAN SMORRA[1,3], and THE TRIGA-SPEC COLLABORATION[2,4,5,6] — [1]Physikalisches Institut, Universität Heidelberg, 69120 Heidelberg — [2]Max-Planck-Institut für Kernphysik, 69117 Heidelberg — [3]Institut für Kernchemie, Universität Mainz, 55128 Mainz — [4]Institut für Physik, Universität Mainz, 55128 Mainz — [5]GSI Helmholtzzentrum für Schwerionenforschung GmbH, 64291 Darmstadt — [6]CSNSM, Université de Paris Sud, 91495 Orsay, France

Precise experimental data of the ground-state properties of short-lived nuclides are required to test the predictive power of nuclear mass models and to support nucleosythesis calculations of the astrophysical r-process. Besides the measurement of these properties with high precision, the creation and preparation of the nuclides of interest is one of the biggest challenges in this field of physics. For the TRIGA-SPEC experiment located at the TRIGA reactor in Mainz, nuclides of the neutron-rich side of the nuclear chart can be created by neutron-induced fission of an actinoide target inside the reactor. The online coupling is going to be realized with an aerosol-loaded gas-jet system, an ion source, a separator magnet, and an RFQ quadrupole for ion beam cooling and bunching. An overview of the online coupling and the ion beam preparation will be presented.

MS 5: Precision Mass Spectrometry and Fundamental Applications

Time: Wednesday 10:30–12:15 Location: GÖR 229

Invited Talk MS 5.1 Wed 10:30 GÖR 229

Searching for physics beyond the standard model using beta decay — •MARCUS BECK — Institut für Physik, Johannes Gutenberg-Universität Mainz

The standard model of particle physics is a well established theory. However, it is believed a more general theory with less free parameters exists. This should lead to experimental deviations from the predictions of the Standard Model at some level. One possibility to determine the free parameters of the Standard Model and to search for new physics are precision experiments with beta decay using modern technologies. This will be illustrated with several examples. These include the determination of the first element of the quark mixing ma-

trix, V_{ud}, the determination of the weak coupling constants g_A and g_V, searches for exotic interactions and the determination of the mass of the electron antineutrino. The latter will be discussed on the basis of the KATRIN experiment in greater detail.

MS 5.2 Wed 11:00 GÖR 229

First Mass Measurements with THe-Trap — •Martin Höcker[1], Christoph Diehl[1], Jochen Ketter[1], David B. Pinegar[1], Sebastian Streubel[1], Marius Tremer[1], Robert S. Van Dyck Jr.[2], and Klaus Blaum[1] — [1]Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Deutschland — [2]Department of Physics, University of Washington, Seattle, WA 98195-1560, USA

THe-Trap is a Penning trap mass spectrometer, specifically constructed to measure the mass ratio of tritium (^{3}H) and a light helium isotope (^{3}He) with a relative uncertainty of 10^{-11} or below. It was originally designed and built at the University of Washington, Seattle, and was moved to the MPIK in Heidelberg in 2008. Following modifications and improvements to the experimental setup as well as its environment, several mass measurements of light ion species have been conducted in its commissioning phase. Measuring the well known mass-ratios of different ion species gives a first estimate of the achievable accuracy and precision of our spectrometer.

Our first mass measurements will be presented and current limitations, as well as future upgrades, will be discussed.

MS 5.3 Wed 11:15 GÖR 229

The five-Penning trap mass spectrometer PENTATRAP — •Julia Repp[1,2], Christine Böhm[1,2], José Crespo López-Urrutia[1], Andreas Dörr[2], Sergey Eliseev[1], Mikhail Goncharov[1,2], Yuri Novikov[4], Christian Roux[1,2], Sven Sturm[3], Stefan Ulmer[2,3], and Klaus Blaum[1,2] — [1]Max-Planck-Institut für Kernphysik, 69117 Heidelberg, Germany — [2]Physikalisches Institut, Ruprecht-Karls-Universität, 69120 Heidelberg, Germany — [3]Johannes Gutenberg-Universität, Institut für Physik, 55099 Mainz, Germany — [4]St. Petersburg Nuclear Physics Institute, 188300 Gatchina, Russia

Currently the new mass spectrometer PENTATRAP is being developed at the Max-Planck-Institut für Kernphysik in Heidelberg. Ions of interest are stable and long-lived highly charged nuclides up to uranium. PENTATRAP aims for an accuracy of few parts in 10^{12} for mass ratios of mass doublets and a relative uncertainty of $\approx 10^{-11}$ for absolute mass ratios. The measured mass values will contribute among others to Q-value determinations of relevant β-processes for neutrino physics, stringent tests of quantum electrodynamics in the regime of extreme fields, and a test of special relativity. The five-trap setup allows to choose an optimal measurement scheme for each ionic species of interest. Main features of PENTATRAP are an access to highly charged ions, highly sensitive cryogenic non-destructive detection systems, a fast exchange between different ions and a continuous monitoring of magnetic field fluctuations. This talk will present the experimental setup and the present status of the PENTATRAP experiment.

MS 5.4 Wed 11:30 GÖR 229

Das Massenspektrometer ISOLTRAP auf dem Weg zu höherer Genauigkeit — •S. Kreim[1], D. Beck[2], K. Blaum[1], Ch. Böhm[1], Ch. Borgmann[1], M. Breitenfeldt[3], D. Fink[4], F. Herfurth[2], A. Herlert[4], M. Kowalska[4], D. Lunney[5], E. M. Ramirez[2], S. Naimi[5], D. Neidherr[1], M. Rosenbusch[6], S. Schwarz[7], L. Schweikhard[6], J. Stanja[8], R. Wolf[6] und K. Zuber[8] — [1]Max-Planck-Insitut für Kernphysik, Heidelberg — [2]GSI Darmstadt — [3]IKS Leuven — [4]CERN — [5]CSNSM-IN2P3-CNRS, Orsay — [6]Uni Greifswald — [7]NSCL MSU — [8]TU Dresden

Bei der Massenmessung von kurzlebigen Radionukliden erreicht das Penningfallen-Massenspektrometer ISOLTRAP routinemäßig eine relative Genauigkeit von $1 \cdot 10^{-8}$. Je nach Messung wird dabei die Genauigkeit durch unterschiedliche Faktoren bestimmt. Zum Beispiel ist bei der Auflösung von isomeren Gemischen nicht nur die Vermeidung isobarer Kontaminationen des vom Isotopenseparator ISOLDE gelieferten Ionenstrahel eine entscheidende Voraussetzung, sondern auch ein entsprechend gutes Vakuum. So ist vor kurzem die Bestimmung der Anregungsenergie des isomeren Zustands von ^{194}Tl gelungen. Ebenso kann in speziellen Fällen eine Wechselmessung mit kurzem Messablauf von Vorteil sein um systematische Fehler zu verringern, wie bei der Q-Wert Messung des Isotopenpaares ^{110}Pd/^{110}Cd. Zusätzlich benötigt man abseits der Stabilität aufgrund der geringen Statistik eine bessere Effizienz. Ausgehend von den 2010 durchgeführten Messungen werden Entwicklungen hin zu höheren Genauigkeiten vorgestellt.

MS 5.5 Wed 11:45 GÖR 229

Investigation of the accuracy limit at the Penning trap mass spectrometer TRIGA-TRAP — •Christian Smorra[1,2], Thomas Beyer[1,3], Klaus Blaum[1,3], Jens Ketelaer[3], Szilard Nagy[3,4], Dennis Neidherr[5], Dennis Renisch[2,3], and the TRIGA-TRAP Collaboration[2,3,4] — [1]Ruprecht-Karls-Universität, 69117 Heidelberg — [2]Johannes Gutenberg-Universität, 55128 Mainz — [3]Max-Planck-Institut für Kernphysik, 69117 Heidelberg — [4]GSI Helmholtzzentrum für Schwerionenforschung GmbH, 64291 Darmstadt — [5]Helmholtz-Institut Mainz, 55128 Mainz

Penning-trap mass spectrometry is a way to determine nuclear binding energies very accurately by measuring the cyclotron frequency of a trapped ion. The cyclotron frequency is then compared to a reference measurement of an ion with well-known mass. The double Penning-trap mass spectrometer TRIGA-TRAP, which is part of the TRIGA-SPEC facility, was installed at the research reactor TRIGA-Mainz. In order to investigate the uncertainty limit of the mass measurements, systematic studies have been performed using carbon clusters from $^{12}C_{10}^+$ to $^{12}C_{23}^+$, thus covering the whole mass range of the radionuclides available at the TRIGA reactor. Effects like magnetic field fluctuations and mass dependent frequency shifts have been studied and their amplitudes quantified. The well-known mass of ^{197}Au has been measured and used as a cosistency check at the level of $2.7 \cdot 10^{-8}$. The present status as well as the results of first mass measurements on stable rare-earth nuclides will be presented.

MS 5.6 Wed 12:00 GÖR 229

Massenspektrometrie in der Nuklearen Entsorgung — •Clemens Walther, Michael Steppert, Sebastian Büchner, Markus Fuss, Andreas Geist und Horst Geckeis — Karlsruher Institut für Technologie, Institut für Nukleare Entsorgung, PO 3640, 76021 Karlsruhe

Massenspektrometrie hat vielfältige Anwendung im nuklearen Umfeld. Neben der Spurenanalytik von Radioisotopen hilft die MS auch, viele Prozesse auf molekularer Ebene zu verstehen, die für den Brennstoffkreislauf interessant sind. Dieses Spektrum reicht von der Herstellung des Brennstoffs und Erforschung neuer Materialien bis zur sicheren tiefengeologischen Entsorgung. Mittels nano-Elektrospray Massenspektrometrie werden Polymerisierungsvorgänge in stark sauren Plutonium Lösungen untersucht, die relevant sind für Brennstoffherstellung oder Brennstoffauflösung. Die Kolloidbildung von Actiniden im Nahfeld eines Endlagers wird am Beispiel des Thorium betrachtet. Ein weiteres wichtiges Feld unserer Untersuchungen betrifft Reaktionen, die dazu beitragen, den Transport von Radionukliden aus dem Endlager zu verhindern, wie den Einbau von Actiniden in Aluminium-haltige Phasen. Weiterhin untersuchen wir chemische Liganden, die selektiv langlebige Actiniden von kurzlebigen Spaltprodukten abtrennen können.

MS 6: Ion Storage Rings

Time: Wednesday 14:00–15:30 Location: GÖR 229

Invited Talk MS 6.1 Wed 14:00 GÖR 229

Hot water in space — •Henrik Buhr — Weizmann Institute of Science, Rehovot, Israel — Max-Planck-Institut für Kernphysik, Heidelberg, Germany — Physikalisch-Technische Bundesanstalt, Braunschweig, Germany

Dissociative recombination (DR) of molecular ions with electrons plays an important role in many types of plasmas as destruction mechanism for ions and in the generation of neutral species, like water formation through DR of H_3O^+ in interstellar clouds. Information on the type and excitation of the DR products greatly helps understanding the chemistry in these environments and interpreting electro-magnetic

spectra from telescope observations.

A new, energy- and position-sensitive detector recently implemented at the merged-beams facility at the TSR storage ring of the MPI für Kernphysik in Heidelberg yields impact positions and fragment identification on a single-event basis. This setup was used to study the DR of D_3O^+, i. e. the branching ratios into the various fragmentation channels for a wide range of collision energies as well as the kinetic energy releases and fragment excitations for each channel. The water formed in DR is highly excited with more than 3 eV, close to the dissociation limit into OD+D. This excitation might be the source of microwave emissions observed e. g. in cometary comae and laboratory water plasmas. Furthermore, the three-body fragmentation into OD+D+D shows a strong dependence of the correlation of fragment kinetic energies on the total kinetic energy release in the DR process.

MS 6.2 Wed 14:30 GÖR 229

Study of the Rate Acceptance of a Time-of-Flight detector for IMS at FRS-ESR — •Natalia Kuzminchuk[1,2], Samuel Ayet[1,2], Marcel Diwisch[1], Benjamin Fabian[1], Hans Geissel[1,2], Ronja Knoebel[2], Yuri Litvinov[3], Wolfgang Plass[1,2], Christoph Scheidenberger[1,2], Baohua Sun[1,2], and Helmut Weick[2] — [1]Justus-Liebig-Universität Gießen — [2]GSI, Darmstadt — [3]MPI-K, Heidelberg

For Isochronous Mass Spectrometry at the FRS-ESR facility a TOF detector is used for the measurement of the revolution times of stored ions. In the detector, ions passing a thin carbon foil release secondary electrons, which are transported to microchannel plates (MCPs) by electric and magnetic fields. Because of the high revolution frequencies in the ESR, a high rate acceptance is required as well as good timing characteristics. Offline studies show that MCPs with 5 μm pore size can accept a higher count rate than MCPs with the same active diameter but with a commonly used pore size of 10 μm. To show the advantages of MCPs with 5 μm pore size, the saturation effects were investigated online in the ESR with Ne and Ni primary beam as well as with U fission fragments. Comparison of the experimental results with Monte Carlo simulations prove that MCPs with 5 μm channel diameter are at least 3 times more resistant to the higher rates than MCPs with 10 μm pore size. In addition, the number of revolutions of the stored ions could be increased significantly by using thinner carbon foils.

MS 6.3 Wed 14:45 GÖR 229

New Isochronous Mode of the ESR — •Sergey Litvinov[1], Alexei Dolinskii[1], Christina Dimopoulou[1], Hans Geissel[1], Bernhard Franczak[1], Yuri Litvinov[2], Fritz Nolden[1], Markus Steck[1], and Helmut Weick[1] — [1]GSI (Gesellschaft für Schwerionenforschung), Darmstadt, Germany — [2]Max-Plack Institut for Nuclear Physics, Heidelberg, Germany

Isochronous Mass Spectrometry (IMS) is an experimental technique for direct mass measurements of short-lived exotic nuclei which has been developed at the storage ring facility ESR of GSI. A bottleneck for the present IMS experiments is the low transmission from the fragment separator FRS to the ESR, which is mainly due to large negative dispersion in the straight sections of the ESR.

In order to facilitate the transmission and to improve the isochronicity of the ring, the present isochronous optics of the ESR has been recalculated. A new isochronous setting has been experimentally verified. The results of the first test run and the perspectives of further improvements will be presented. A sketch of the new isochronous storage ring CR within the future FAIR project will be outlined.

MS 6.4 Wed 15:00 GÖR 229

Status of the cryogenic heavy-ion storage ring CSR — •Michael Lange, Felix Berg, Klaus Blaum, Florian Fellenberger, Michael Froese, Manfred Grieser, Claude Krantz, Felix Laux, Sebastian Menk, Dmitry A. Orlov, Roland Repnow, Andrey Shornikov, Claus Dieter Schröter, Thomas Sieber, Joachim Ullrich, Robert von Hahn, and Andreas Wolf — Max-Planck-Institut für Kernphysik, Postfach 10 39 80, 69029 Heidelberg

At the MPI für Kernphysik the new cryogenic electrostatic heavy ion storage ring CSR is currently under construction. By applying liquid helium cooling, it will reach a residual gas pressure in the 10^{-14} mbar region, which will enable the storage of even highly charged atomic ions over extraordinarily long times. In addition the ring can be operated at any temperature between 10 K and room temperature. As an electrostatic device, it will allow storage of ions of masses up to and above 100 a.m.u. In two of its straight sections, an electron cooling device for beam cooling and low-energy electron collision experiments, and a reaction microscope with a gas jet for kinematically complete high energy investigations are foreseen. The ring will hence be a unique tool for future atomic, molecular and cluster physics experiments under very low densities of residual gas and blackbody radiation, and thus enable a new class of experiments especially in laboratory astrophysics.

In this presentation, we will give an introduction to the ring design and present the current status of its construction.

MS 6.5 Wed 15:15 GÖR 229

The injection beam lines of the Cryogenic Storage Ring (CSR) — •Felix Berg, Klaus Blaum, Florian Fellenberger, Michael Froese, Manfred Grieser, Claude Krantz, Michael Lange, Felix Laux, Sebastian Menk, Roland Repnow, Andrey Schornikov, Robert von Hahn, and Andreas Wolf — Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg

At the Max-Planck-Institute for Nuclear Physics in Heidelberg an electrostatic cryogenic storage ring (CSR) is under construction. The ions for the CSR will be provided by two ion sources with up to 60kV and 300kV potential, respectively. The layout of the beamlines connecting the ion sources with the CSR will be presented. They will be merged using an electrostatic deflector with an opening in the outer electrode, thereby allowing quick switching between the two ion sources. In order to determine the influence of the opening on the beam optics the deflector has been modeled and a modified transport matrix has been derived. An additional beamline element is a detachment region for the neutralization of a negative ion beam by photodetachment. The potential of the detachment region defines the precise energy of the neutral particles. Calculations of the ion beam optics using the MAD X code will be described.

MS 7: Resonance Ionization MS, REMPI, MALDI

Time: Wednesday 16:00–18:15 Location: GÖR 229

Invited Talk MS 7.1 Wed 16:00 GÖR 229

Laser source of radioactive ion beams at the on-line isotope separation facility ISOLDE at CERN — •Valentin Fedosseev — CERN, Geneva, Switzerland

The Resonance Ionization Laser Ion Source (RILIS) of the ISOLDE on-line isotope separation facility is based on the method of laser stepwise resonance ionization of atoms in a hot metal cavity. The atomic selectivity of the RILIS compliments the mass selection process of the ISOLDE separator magnets to provide beams of a chosen isotope with greatly reduced isobaric contamination. RILIS achieves efficient ionization for many elements through the selection of suitable atomic transitions which are excited by high average power dye lasers. Currently, a 10 kHz pulse rate Nd:YAG laser emitting 532 nm and 355 nm beams with total power of 100 W is being used for pumping the dye lasers. During 2010 a fully solid state laser system based on Ti:Sapphire lasers has been built at CERN to compliment the dye laser system. To date, ion beams of 27 different elements have been produced at ISOLDE with RILIS. Combining laser wavelength scanning over a resonance transition of RILIS excitation scheme with the detection of short-lived isotopes by methods of nuclear spectroscopy has enabled very sensitive atomic spectroscopy studies of isotopes far from stability. This new experimental technique called "In-source spectroscopy" has been applied for isotope shifts and hyperfine structure measurements of Cu, Tl, Pb, Bi, Po, as well as for first measurement of the ionization potential of the astatine atom.

MS 7.2 Wed 16:30 GÖR 229

Improving the Selectivity of the ISOLDE Resonance Ionization Laser Ion Source at CERN — •Daniel Fink[1,2], Klaus Blaum[2,3], Bernard Crepieux[1], Valentine Fedosseev[1], Bruce Marsh[1], Christoph Mattolat[4], Sebastian Raeder[4],

Sven Richter[4], Sebastian Rothe[1,4], Pekka Suominen[1], and Klaus Wendt[4] — [1]CERN, Genève, Switzerland — [2]Physikalisches Institut, Universität Heidelberg, Germany — [3]Max-Planck-Institut für Kernphysik, Heidelberg, Germany — [4]Institut für Physik, Universität Mainz, Germany

The on-line isotope mass separator ISOLDE at CERN provides radioactive beams for various experiments in many fields of physics. Here, a high ion production rate and isotope selectivity are of utmost importance for on-line experiments with short-lived radionuclides. The most extensively used ionization technique at ISOLDE is the element selective Resonance Ionization Laser Ion Source (RILIS). Nevertheless, even when the RILIS is used, many rare isotope beams produced at ISOLDE remain contaminated with surface ionized isobars. In order to suppress the surface ions, a radio-frequency quadrupole device known as the Laser Ion Source and Trap (LIST) has been developed at the University of Mainz and is now ready for implementation at ISOLDE. First tests of the LIST coupled with a real target unit have been performed at the ISOLDE off-line mass separator producing ion beams of stable isotopes. The results of the latest studies and the stages of the implementation of the LIST and its electronics into the present ISOLDE target unit and front end are given.

MS 7.3 Wed 16:45 GÖR 229

Entwicklung und Optimierung eines Niederenergie-Massenspektrometers zur resonanten Laserionisation — •Johannes Rossnagel, Tina Gottwald, Amin Hakimi, Sebastian Raeder und Klaus Wendt — Universität Mainz, Institut für Physik, Germany

Bei der Resonanzionisations-Massenspektrometrie (RIMS) werden Atome mittels Laserstrahlung elementselektiv ionisiert und anschließend in einem Massenfilter nach ihrem e/m Verhältnis analysiert. Die Methode wird zu relevanten atomphysikalischen Untersuchungen, z.B. der Suche nach atomaren Anregungszuständen in bisher unzureichend bekannten Atomspektren oder der Präzisionsbestimmung von Ionisationspotentialen (IP) eingesetzt; gleichermaßen dient sie auch der effizienten und selektiven Erzeugung von Ionenstrahlen kurzlebiger Nuklide an on-line Isotopentrennern oder aber dem Nachweis geringster Spurenelementgehalten in der Elementanalytik. Zur Optimierung des vorhandenen experimentellen Aufbaus der Mainzer Atomstrahlapparatur zur RIMS an einem Quadrupolmassenspektrometer, speziell zur Steigerung der Selektivität und Effizienz wurde eine neue an die RIMS angepasste Ionenoptik entwickelt und getestet. Ionenoptische Simulationen und systematische Tests im Vergleich mit dem 60 kV-RISIKO Massenseparator mit einem Sektorfeldmagneten werden vorgestellt.

MS 7.4 Wed 17:00 GÖR 229

Circular dichroism in ion yields employing femtosecond laser ionization — •Philipp Horsch[1], Gunter Urbasch[1], Dominik Kröner[2], and Karl-Michael Weitzel[1] — [1]Philipps-Universität Marburg, Chemistry Department — [2]Universität Potsdam, Chemistry Department

Recently, we have demonstrated the determination of circular dichroism (CD) in mass spectrometry using left- and right-circular polarized femtosecond laser pulses. [1] To adress the pivotal question, whether the CD depends on the laser pulse duration, we have investigated the CD in ion yield of 3-methyl-cyclopentanone by means of experiment and theory as a function of the laser pulse duration. [2] In the experiment the CD in ion yield is measured by femtosecond laser ionization *via* a one-photon resonant excited state. In the theoretical part the CD is calculated by solving laser driven quantum electron dynamics for the same resonant excitation based on *ab initio* electronic structure calculations. Both the experimentally measured CD in ion yields and the calculated CD in excited state populations exhibit a marked increase of the CD for pulse duration increasing from 50 fs to about 200 fs. Beyond 200 fs pulse duration the CD levels off. The combination of experimental and theoretical evidence indicates that the CD decreases with increasing laser intensity connected to the increased coupling between the excited state manifold. [1] H. G. Breunig, G. Urbasch, P. Horsch, J. Cordes, U. Koert, K. M. Weitzel, ChemPhysChem, 2009, 10, 1199-1202. [2] P. Horsch, G. Urbasch, K. M. Weitzel, D. Kröner, Phys. Chem. Chem. Phys., 2010, *in press*

MS 7.5 Wed 17:15 GÖR 229

Measurement of the hyperfine structure of ^{229g}Th — •Volker Sonnenschein[1], Sebastian Raeder[2], Tina Gottwald[2], Iain Moore[1], Sebastian Rothe[3], and Klaus Wendt[2] — [1]Department of Physics, FI-40014 University of Jyväskylä, Finland — [2]Institut für Physik, Johannes Gutenberg-Universität, D - 55099 Mainz — [3]CERN, Geneva, Switzerland

In preparation for an identification of the low-lying 7.6eV isomer ^{229m}Th, $I = 3/2^+$, through its respective hyperfine structure (HFS), the HFS of the ground state nucleus ^{229g}Th, $I = 5/2^+$, was measured using Resonance Ionization Spectroscopy.

Three transitions originating from the atomic ground state were probed with the help of a frequency doubled (tripled) narrow bandwidth (20 MHz) injection-seeded Ti:sapphire laser. Subsequent excitation into autoionizing states with broadband (5+ GHz) Ti:sapphire lasers was used for ionization. Though the HFS was not fully resolved in the resulting spectra of each transition, the combination of the data was used to give first estimates for the atomic ground state hyperfine coupling constants A_0 and B_0.

Preparations for further experiments related to the isomer search are in progress at the IGISOL facilty in Finland. These experiments will likely use an off-line ion-guide based quadrupole mass spectrometer setup with a ^{233}U recoil ion guide for ^{229g,m}Th production. Alternatively the collinear laser spectroscopy beam line will be available at the newly constructed IGISOL-4 site.

MS 7.6 Wed 17:30 GÖR 229

Resonante Laserionisation in einer Gaszelle: Erzeugung exotischer Isotope mit unterschiedlichen Lasersystemen — •Sven Richter[1], Piet van Duppen[2], Mark Huyse[2], Tobias Kron[1], Yuri Kudryavtsev[2], Christoph Mattolat[1], Sebastian Raeder[1], Johannes Rossnagel[1], Sebastian Rothe[4], Volker Sonnenschein[3] und Klaus Wendt[1] — [1]Institut für Physik, Johannes Gutenberg Universität, 55099 Mainz — [2]CRC, 1348 Louvain la Neuve, Belgien — [3]Department of Physics, University of Jyväskylä, 40014 Jyväskylä, Finnland — [4]ISOLDE, CERN, 1211 Genf, Schweiz

Resonante Laserionisationsquellen sind hocheffiziente und elementselektive Methoden zur Ionisation exotischer Nuklide an on-line Produktionsanlagen. Weit verbreitet ist der Einsatz an Hot-Cavity Ionenquellen. Am Centre de Recherches du Cyclotron (CRC) in Louvain la Neuve, Belgien werden kurzlebige Radionuklide durch den Beschuss von Target-Folien mit hochenergetischen geladenen Teilchen in einer Gaszelle erzeugt. Zweistufige-resonante Laserionisation erfolgt dort aktuell durch Laserstrahlung zweier 200 Hz Excimer/Dye-Lasersysteme. Mittels eines SextuPole Ion Guide SPIG in der Extraktionsöffnung zum Massenseparator werden die selektiv erzeugten Ionen vom Gasfluss abgetrennt. Während die Ionisation in der Gaszelle auch mit niedrig repetierenden Lasersystemen um 100 Hz erfolgen kann, ist eine deutliche Effizienzsteigerung bei Ionisation im SPIG durch Einsatz hochrepetierender Lasersysteme zu erwarten. Entsprechende Experimente mit dem 10 kHz Nd:YAG/Titan:Saphir-Lasersystem der Universität Mainz werden aktuell durchgeführt und sollen hierzu Aufschluss geben.

MS 7.7 Wed 17:45 GÖR 229

Systematische Untersuchungen zu Isotopenverhältnismessungen in Plutonium mittels RIMS — •Amin Hakimi[1], Sebastian Raeder[1], Nils Stöbener[2], Norbert Trautmann[2] und Klaus Wendt[1] — [1]Institut für Physik, JGU Mainz, Staudinger Weg 7, 55128 Mainz — [2]Institut für Kernchemie, JGU Mainz, Fritz-Strassmann-Weg 2, 55128 Mainz

Die quantitative Ultraspurenbestimmung von Aktiniden in Umweltproben ist für die Detektion von anthropogenen radioaktiven Kontaminationen von besonderer Bedeutung, wobei speziell die Isotopenzusammensetzung von Plutonium Aufschluss über Herkunft und Historie einer Probe geben. Für die Detektion kleinster Mengen ist eine hochselektive und empfindliche Nachweismethode erforderlich. Die Resonanzionisations-Massenspektrometrie (RIMS) kombiniert einen elementselektiven Ionisationsprozess mit der Isotopenselektion eines Massenspektrometers. In der vorgestellten Anwendung wurde ein gepulstes Titan:Saphir-Lasersystem zur hocheffizienten Resonanzionisation zusammen mit einer Massenselektion in einem Quadrupol-Massenspektrometer (QMS) genutzt. Nach der Charakterisierung des Systems an synthetischen Proben und erster Demonstration an Umweltproben wurde mit der Untersuchung systematischer Effekte bei der Isotopenverhältnismessung mittels RIMS begonnen. Die Ergebnisse dieser Untersuchungen sowie geplante Verbesserungen werden vorgestellt.

MS 7.8 Wed 18:00 GÖR 229

Entwicklung einer Referenzzelle für die resonante Laserionisation — •Tobias Kron, Sven Richter, Sebastian Raeder, Johannes Rossnagel, Amin Hakimi, Christoph Matto-

LAT und KLAUS WENDT — Institut für Physik, Johannes Gutenberg-Universität Mainz

Die elementselektive Ionisation über resonante Laserstrahlung ist eine effiziente Methode zur Produktion von Ionenstrahlen seltener Spezies wie auch zur Ultraspurenbestimmung. Dazu werden Atome in der Gasphase mittels Laserstrahlung schrittweise, über mehrere energetische Zwischenniveaus, angeregt und schlussendlich ionisiert. Die individuellen Lagen der atomaren Niveaus stellen dabei einen unverwechselbaren Fingerabdruck eines jeden Elements dar und gewährleisten eine absolute Elementselektion, die in beiden Anwendung von größter Bedeutung ist. Um die Energieniveaus schnell zu finden und die Abstimmung der Laser zu überprüfen, ist eine kompakte, robuste Referenzapparatur hilfreich. Diese beinhaltet einen Atomstrahlofen, in dem gleichzeitig die Verdampfung der Atome als auch deren Wechselwirkung mit dem Laser erfolgt, sowie einen Faraday-Cup und/oder Sekundärelektronenvervielfacher, die zusammen mit einer einfachen Ionenoptik den Nachweis der resonanten Ionisation ermöglichen. Die Konstruktion einer entsprechenden Zelle wird zusammen mit ersten Charakterisierungsmessungen vorgestellt.

MS 8: New Mass Spectrometric Methods and Technical Developments

Time: Thursday 10:30–12:30 Location: GÖR 229

Invited Talk MS 8.1 Thu 10:30 GÖR 229

First application of a multi-reflection time-of-flight mass separator to radioactive beams — •ROBERT N. WOLF for the ISOLTRAP-Collaboration — Ernst Moritz Arndt University of Greifswald, Germany

In most cases, radioactive ion beams are delivered only as a mixture of several isobaric species. This constitutes a major limitation for precision mass spectrometry of short-lived isotopes by use of Penning traps, since the simultaneous trapping of the nuclides of interest with contaminant ions leads to frequency shifts. The state-of-the-art procedure to remove unwanted ions – mass-dependent ion centering by resonant excitation while applying buffer-gas cooling – takes several 100 ms and works only for small ratios of "wanted" to "unwanted" ions. Thus, there is need for a cleaning method which not only conserves a high ion-of-interest throughput, in the case of strong contamination, but also works on short time scales. An auxiliary device for isobaric purification of rare-isotope ensembles, in the form of a multi-reflection time-of-flight mass separator (MR-ToF-MS), has recently been integrated into the Penning-trap mass spectrometer ISOLTRAP at the on-line isotope separator ISOLDE/CERN. The MR-ToF-MS device and the modifications of ISOLTRAP components required for its implementation will be described. In addition, the performance of the combined setup both in off-line tests as well as in first applications with radioactive beams will be presented.

MS 8.2 Thu 11:00 GÖR 229

Mobile High-Resolution Time-of-Flight Mass Spectrometer for in-situ Analytics — •JOHANNES LANG[1], TIMO DICKEL[1,2], JENS EBERT[1], HANS GEISSEL[1,2], WOLFGANG PLASS[1,2], and CHRISTOPH SCHEIDENBERGER[1,2] — [1]II. Physikalisches Institut, JLU Giessen — [2]GSI Darmstadt

A compact multiple-reflection time-of-flight mass spectrometer (MR-TOF-MS) has been developed. For the first time it allows for mass measurements with a resolving power exceeding 100000 and sub ppm accuracy in a mobile device. Thus it allows to resolve isobars and enables to accurately determine the composition and structure of biomolecules.

The MR-TOF-MS consists of an atmospheric pressure interface for DESI and REIMS, ion cooler, ion trap, time-of-flight analyzer, MCP detector and DAQ. Vacuum system components, power supplies as well as electronics are mounted together with the ion optical spectrometer parts on a single frame with a total volume of $0.8m^3$.

Applications of the device within the AmbiProbe research program include in-situ mass spectrometry such as realtime tissue recognition in electrosurgery, identification of mycotoxins and analysis of soil samples for environmental studies.

MS 8.3 Thu 11:15 GÖR 229

Penning trap-assisted decay spectroscopy at SHIPTRAP — •C. DROESE[1], D. ACKERMANN[2], L.-L. ANDERSSON[3], K. BLAUM[4,5], M. BLOCK[2], M. DWORSCHAK[2], M. EIBACH[6], S. ELISEEV[4], U. FORSBERG[7], E. HAETTNER[2,8], F. HERFURTH[2], F.P. HESSBERGER[2], S. HOFMANN[2], J. KETELAER[4], J. KETTER[4], G. MARX[1], M. MAZZOCCO[9], E. MINAYA RAMIREZ[10], D. NESTERENKO[11], YU. NOVIKOV[11], W.R. PLASS[2,8], S. RAHAMAN[12], D. RODRÍGUEZ[13], D. RUDOLPH[7], C. SCHEIDENBERGER[2,8], L. SCHWEIKHARD[2], S. STOLZE[12], P.G. THIROLF[14], G.K. VOROBJEV[2,11] und C. WEBER[14] — [1]Universität Greifswald — [2]GSI Helmholtzzentrum für Schwerionenforschung — [3]University of Liverpool — [4]Max-Planck-Institut für Kernphysik — [5]Ruprecht-Karls-Universität Heidelberg — [6]Johannes Gutenberg-Universitẗ Mainz — [7]Lund University Sweden — [8]Justus-Liebig-Universität Gießen — [9]Dipartimento di Fisica and INFN Sezione di Padova — [10]Helmholtz-Institut Mainz — [11]PNPI RAS Gatchina — [12]University of Jyväskylä — [13]Universidad de Granada — [14]Ludwig Maximilians-Universität Garching

Penning trap-assisted nuclear decay spectroscopy utilizes the high mass selectivity of a Penning trap to prepare an isotopically pure sample of a particular radionuclide for decay measurements. With the mass spectrometer SHIPTRAP at GSI Darmstadt a first experiment was performed to investigate ^{205}Rn and ^{213}Ra combining mass spectrometry and alpha-gamma spectroscopy by adding the new detector setup TRAPSPEC. The Penning trap served as a high-resolution mass separator to prepare a pure sample of ^{213}Ra or ^{205}Rn for implantation into the silicon detector array of TASISpec that was surrounded by three Ge detectors. For ^{213}Ra the well-known gamma lines, X-rays of Rn and gamma-gamma coincidences were observed. In addition, in the same experiment high-precision mass measurements of ^{213}Ra and the radon isotopes $^{203-207}$Rn were performed. Since the characteristic alpha lines of neighboring radon isotopes produced simultaneously in the same irradiation are very similar trap-assisted spectroscopy is crucial to select a particular isotope for an unambiguous interpretation of the observed decay spectrum. Here, the preparation of ^{205}Rn allowed the search for a so far unobserved isomeric state that is expected from the systematics in neighboring odd-A Rn isotopes. Supported by the German Federal Ministry for Education and Research (06GF9103I).

MS 8.4 Thu 11:30 GÖR 229

Status Report for the FRS Ion Catcher — •TIMO DICKEL[1,2], PETER DENDOOVEN[4], JENS EBERT[1], HANS GEISSEL[1,2], CHRISTIAN JESCH[1], WADIM KINSEL[1], WOLFGANG R. PLASS[1,2], SIVAJI PURUSHOTHAMAN[2], MANISHA RANJAN[4], MORITZ PASCAL REITER[1], CHRISTOPH SCHEIDENBERGER[1,2], and MIKHAIL I. YAVOR[3] — [1]Justus-Liebig-Universität Gießen — [2]GSI, Darmstadt — [3]Inst. for Analytical Instrum., Russian Academy of Sci., St. Petersburg — [4]KVI, University of Groningen, Netherlands

At the Fragment Separator (FRS) at GSI very exotic nuclei can be produced and separated. To facilitate experiments with the highest possible precision, the exotic nuclei have to be slowed down from relativistic energies to a few eV and thermalized. At the FRS Ion Catcher experiment, this is realized with a cryogenic gas-filled stopping cell. After the ions have been stopped and extracted from the cryogenic gas-filled stopping cell, they are guided through gas filled RFQ to a multiple-reflection time-of-flight mass spectrometer (MR-TOF-MS). The MR-TOF-MS will be used for highly accurate mass measurements ($\delta m/m \approx 10^{-7}$) and to remove isobaric contaminants from the ions of interest to facilitate other experiments. The first online test of the FRS Ion Catcher is scheduled for 2011. Besides the online commissioning of the gas cell and the MR-TOF-MS, which will also be part of the future LEB of the Super-FRS at FAIR, the masses of very neutron-rich r-process nuclei shall be measured with the FRS Ion Catcher.

MS 8.5 Thu 11:45 GÖR 229

A versatile Diagnosis Tool for Low Energy Radio Frequenzy Quadrupole Beam Lines — •MORITZ PASCAL REITER[1], TIMO DICKEL[1,2], WOLFGANG R. PLASS[1,2], CHRISTIAN JESCH[1], CHRISTOPH SCHEIDENBERGER[1,2], and HANS GEISSEL[1,2] — [1]Justus-Liebig-Universität Giessen — [2]GSI, Darmstadt

Conventional low energy beam lines use a structure of electrostatic or magnetic fields for transporting and guiding ions. A novel concept uses

continually RF fields for ion transmission. Such an RFQ transport system features a high transmission efficiency, can be compact, easy to optimize and is inexpensive compared to conventional beam lines. In order to facilitate a highly efficient transport, only gaps in the order of millimeters in the RFQ structure can be tolerated. Therefore, it is difficult to implement valves and beam diagnosis tools.
For the first time, a system of movable RFQs has been developed that allows to isolate parts of an RFQ transport system with a valve and to insert various detectors and test ion sources into such an RFQ beam line.
The setup has been built and will be employed in the FRS Ion Catcher experiment behind the new cryogenic stopping cell.

MS 8.6 Thu 12:00 GÖR 229

Analytical detection of explosives and illicit, prescribed and designer drugs using proton transfer reaction time-of-flight mass spectrometry (PTR-TOF-MS) — •Bishu Agarwal[1], Fredrik Petersson[1], Simone Jürschik[1], Philipp Sulzer[2], Alfons Jordan[2], Tilmann D. Märk[1,2], Peter Watts[3], and Chris A. Mayhew[3] — [1]Institut für Ionenphysik und Angewandte Physik, Universität Innsbruck, Technikerstr. 25, 6020 Innsbruck, Austria — [2]IONICON Analytik GmbH, Eduard-Bodem-Gasse 3, 6020 Innsbruck, Austria — [3]School of Physics and Astronomy, University of Birmingham, Edgbaston, Birmingham B15 4TT, UK

This work demonstrates the extremely favorable features of Proton Transfer Reaction Time-of-flight Mass Spectrometry (PTR-TOF-MS) for the detection and identification of solid explosives, chemical warfare agent simulants and illicit, prescribed and designer drugs in real time.

Here, we report the use of PTR-TOF, for the detection of explosives (e.g., trinitrotoluene, trinitrobenzene) and illicit, prescribed and designer drugs (e.g., ecstasy, morphine, heroin, ethcathinone, 2C-D). For all substances, the protonated parent ion (as we used H3O+ as a reagent ion) could be detected, providing a high level of confidence in their identification since the high mass resolution allows compounds having the same nominal mass to be separated. We varied the E/N from 90 to 220 Td (1 Td = 10-17 Vcm-1). This allowed us to study fragmentation pathways as a function of E/N (reduced electric field). For a few compounds rather unusual E/N dependencies were also discovered.

MS 8.7 Thu 12:15 GÖR 229

Instrumentelle Weiterentwicklungen und Anwendungen des kompakten, mobilen Flugzeitmassenspektrometers LAMPAS 3 zur Charakterisierung von Aerosolpartikeln — •Klaus-Peter Hinz, Elmar Gelhausen und Bernhard Spengler — Institut für Anorganische und Analytische Chemie, Universität Giessen

Die detaillierte physikalische und chemische Charakterisierung von Aerosolpartikeln der Umgebungsluft ist im Zusammenhang mit der Diskussion um Feinstaub und Klimawandel von zentraler Bedeutung. Derartige Partikel können mit der on-line Lasermassenspektrometrie schnell und ohne störende Beeinflussung analysiert werden. Dazu werden die Partikel durch ein Einlasssystem direkt in die Ionenquelle eines Flugzeitmassenspektrometers eingelassen. In einer Streulicht-Detektionszone erfolgt die Größenbestimmung der Partikel. Daran schließt sich die zeitlich abgestimmte Laserdesorption/Ionisation (LDI) der Partikel mittels eines UV-Laserpulses an. Die simultane Detektion der erzeugten positiv oder negativ geladenen Ionen ermöglicht die umfassende chemische Charakterisierung der Einzelpartikel. Die Realisierung des kompakten, on-line Lasermassenspektrometers LAMPAS 3 ermöglicht durch seine leichte Handhabbarkeit und Mobilität eine schnelle und aussagekräftige vor-Ort-Aerosolanalytik. Ergebnisse der instrumentellen Optimierung des Systems und seine Leistungsfähigkeit werden anhand verschiedener Messungen vorgestellt.

MS 9: Ion Trap and FT-ICR-MS, Molecules, Clusters and Reactions

Time: Friday 10:30–12:15 Location: GÖR 229

Invited Talk MS 9.1 Fri 10:30 GÖR 229

Power-law decays of excited aluminum cluster anions and their blackbody radiation dependence — •Michael Froese, Felix Berg, Klaus Blaum, Michael Lange, Felix Laux, Sebastian Menk, Robert von Hahn, and Andreas Wolf — Max Planck Institute for Nuclear Physics, Saupfercheckweg 1, 69117 Heidelberg

The decay of highly excited aluminum cluster anions has been investigated in the Cryogenic Trap for Fast ion beams (CTF). This electrostatic ion beam trap (EIBT) can be cooled with liquid helium and has demonstrated residual gas densities of 2000 particles/cm^3. A power-law is found to accurately reproduce the time dependence of the observed decay rates at early times, although the exponents significantly differ from the typically observed $1/t$ decay in other small metal clusters and bio-molecules. Quenching of the power-law decay was also observed at later times. A strong dependence of both the power-law exponent and the quenching time on the ambient temperature was observed when decays in the trap at room-temperature and cryogenic temperatures were compared. The effect of blackbody radiation on the $1/t$-type decay will be discussed based on these new observations.

MS 9.2 Fri 11:00 GÖR 229

Thermionic emission of highly excited cluster anions in a cryogenic electrostatic ion beam trap — •Sebastian Menk, Felix Berg, Klaus Blaum, Florian Fellenberger, Michael Froese, Michael Lange, Felix Laux, Robert von Hahn, and Andreas Wolf — Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg

In the Cryogenic Trap for Fast ion beams (CTF), ions are trapped between two electrostatic mirror electrodes allowing the storage of up to 20 keV ion beams in a cold environment (4 K - 300 K) for long times (minutes). After achieving the development goals of the Cryogenic Storage Ring (CSR), namely improving the cryogenic design and verifying an extremely low residual gas density of 2000 cm^{-3}, the CTF was moved to a new laboratory to make space for the CSR and for continued operation in molecular and cluster physics experiments.

Here, a new ion injection beam line has been taken into operation which includes a 90° dipole magnet for mass separation and an electrostatic quadrupole triplet for improved ion injection into the trap. In addition, a new 4 K helium supply line was installed, connecting the CTF again to the refrigeration system. A new MCP detection system equipped with a delay line anode has been placed inside the cryogenic vacuum chamber, providing enhanced solid angle detection and position sensitivity of the neutralized fragments.

We will report on room temperature thermionic emission measurements of Al_x^- (x=3-7) and SF_n^- (n=1-7) and include cold data down to 4 K from upcoming studies.

MS 9.3 Fri 11:15 GÖR 229

Broad-band detection for KATRIN and Ramsey excitation with FT-ICR MS — •Marta Ubieto Díaz[1], Klaus Blaum[1], R. Burcu Cakirli[1,2], Michael Heck[1], Martin Kretzschmar[3], Strahinja Lukic[4], Daniel Rodríguez[5], Lutz Schweikhard[6], and Stefan Stahl[7] — [1]Max-Planck-Institute for Nuclear Physics, Heidelberg, Germany — [2]Department of Physics, University of Istanbul, Istanbul, Turkey — [3]ohannes Gutenberg-Universität, Mainz, Germany — [4]Karlsruher Institut für Technologie, Karlsruhe, Germany — [5]Departamento de Física Atómica Molecular y Nuclear, Universidad de Granada,Granada, Spain — [6]Ernst-Moritz-Arndt-Universität-Greifswald, Greifswald, Germany — [7]Stahl Electronics. Kellerweg 23, 67528 Mettenheim, Germany

Penning traps are widely used as storage devices for charged particles. Based on these ion traps Fourier Transform Ion Cyclotron Resonance mass spectrometry (FT-ICR MS) has become a standard method for for both analytical and precision measurements. A broad-band FT-ICR detection system for monitoring the ion concentration at the KATRIN beamline has been developed and characterized at the Max-Planck-Institute for Nuclear Physics in Heidelberg. In addition, the on-line tests have been extended to fundamental studies on the ion motion, in particular by applying Ramsey excitation. In this contribution recent results of both studies, the off-line KATRIN tests and the Ramsey method, will be presented.

MS 9.4 Fri 11:30 GÖR 229

C-H bond activation at the surface of isolated homo- and heteronuclear transition metal clusters — Matthias Tombers,

Christine Merkert, •Lars Barzen, and Gereon Niedner-Schatteburg — Fachbereich Chemie & Forschungszentrum OPTIMAS, Kaiserslautern

We chose to investigate the C-H bond activation of small organic molecules by size selected transition metal clusters and under single collision conditions. Cluster ions of either charge states originate from a standard pulsed laser vaporization source, and they are made to react within the ion trap of a Fourier Transform Ion Cyclotron Resonance (FT-ICR) mass spectrometer.

In general, most of the investigated Cobalt, Platinum, Rhodium and Tantalum clusters are found to be highly reactive towards the chosen substrates (methane, ethane, benzene derivatives and alcohols) with several dependencies of the reaction rate on the sizes of the clusters and on their charges.

Among the cationic Co_n^+ clusters we find intact adsorption of benzene for all clusters sizes with only Co_{13}^+ being able to activate the benzene molecule. Anionic Co_n^- clusters show intact adsorption and activation for n larger than n=6 where for n=9 to 16 the activation is the dominant process.

Current experiments on the activation of alkanes by mixed metal clusters are underway. This project is part of the new Transregional Collaborative Research Center SFB / TRR 88 "3MET".

MS 9.5 Fri 11:45 GÖR 229

On-line detection of illicit substances in liquid phase with proton-transfer-reaction mass spectrometry (PTR-MS) — •Simone Jürschik[1,3], Philipp Sulzer[2], Bishu Argawal[1], Fredrik Petersson[1,3], Stefan Haidacher[2], Alfons Jordan[2], Ralf Schottkowsky[2], Eugen Hartungen[2], Gernot Hanel[2], Hans Seehauser[2], Lukas Märk[2], and Tilmann D. Märk[1,2] — [1]Institut für Ionenphysik und Angewandte Physik, Universität Innsbruck, Technikerstr. 25, 6020 Innsbruck, Austria — [2]IONICON Analytik GmbH, Eduard-Bodem-Gasse 3, 6020 Innsbruck, Austria — [3]on leave from IONICON (Marie Curie-IAPP project no 218065)

The direct aqueous injection (DAI) technique was recently utilized for the detection of illicit substances in liquid phase. DAI turns out to be an ideal solution for direct analysis of liquid samples, since we can make good use of the outstanding advantages, such as real-time analysis, no sample preparation, low detection limits and short response time. Differences in TNT concentration in the water could be seen dependent on time and original size of the pieces and we could demonstrate a linear correlation between the concentration in liquid and the PTR-MS signal [1]. Furthermore, we were also able to demonstrate that this method is capable of detecting minute traces of "rape drugs", i.e. γ-butyrolactone and 1,4-butanediol, in liquids. This new method achieving sensitivities in the around 100 pptw range appears therefore well suited for the fight against drug crime and terrorism and for the evaluation of contamination of ammunition dumping sites.

[1] S. Jürschik et al.; ABC (2010) in press.

MS 9.6 Fri 12:00 GÖR 229

Rapid screening of pesticides from fruit surfaces by means of laser desorption ion mobility spectrometry — •Sven Rötering[1], Helko Borsdorf[2], and Christian Weickhardt[1] — [1]Leipzig University of Applied Sciences, Leipzig, Germany — [2]Helmholtz Centre for Environmental Research - UFZ, Leipzig, Germany

Multi residue analysis of pesticides in fruits and vegetables is complicated because a large number of substances belonging to multiple groups of chemicals with different features are used. Standard analysis of pesticide residues is carried out by gas chromatography or HPLC coupled to mass spectrometry. These methods require time consuming pre-treatments. Consequently, at the time the analysis results are available, fruits or vegetables are either eaten or no longer suitable for consumption.

A promising approach for a rapid and inexpensive screening technique is a combination of laser desorption and ion mobility spectrometry.

Pesticides are desorbed from the fruit skin by interaction with a laser pulse. By means of a gas flow the desorbed molecules are transferred into an ion mobility spectrometer where they are identified and quantified. The results are available within seconds and the technique is applicable to many different pesticides representing insecticides and fungicides.

The report illustrates the set-up of the coupling and shows first results obtained for 26 pesticides detected on different fruit skins.