Fachverband Massenspektrometrie (MS)

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Übersicht der Hauptvorträge und Fachsitzungen

(Die Vorträge finden im Gebäude VMP8, Hörsaal R05 statt. Die Postersession ist im Gebäude VMP9.)

Hauptvorträge

MS 1.1	Mo	10:45–11:15	VMP 8 R05	**First direct mass measurements of nobelium isotopes** — •Michael Block
MS 1.2	Mo	11:15–11:45	VMP 8 R05	**Recent activities and results at the Penning-trap mass spectrometer ISOLTRAP** — •M. Kowalska, G. Audi, D. Beck, Klaus Blaum, M. Breitenfeldt, Ch. Böhm, Ch. Borgmann, S. George, Frank Herfurth, A. Herlert, A. Kellerbauer, D. Lunney, E. Minaya-Ramirez, S. Naimi, D. Neidherr, M. Rosenbusch, S. Schwarz, Lutz Schweikhard, U. Warring
MS 2.1	Mo	14:00–14:30	VMP 8 R05	**PENTATRAP: A precision Penning trap mass spectrometer for highly-charged ions** — •Sergey Eliseev, Jose Crespo López-Urrutia, Christoph Diehl, Sebastian George, Jens Ketelaer, Szilard Nagy, Yuri Novikov, David Pinegar, Wolfgang Quint, Julia Repp, Christian Roux, Andreas Rosa, Stefan Ulmer, Klaus Blaum
MS 3.1	Mo	16:00–16:30	VMP 8 R05	**Penning trap mass measurements on stable isotopes** — •David Pinegar
MS 4.1	Di	10:30–11:00	VMP 8 R05	**Nuclear Astrophysics and AMS** — •Anton Wallner

Hauptvorträge des Symposiums S-AMOP Dissertationspreis (SYDI)

Siehe SYDI für das komplette Programm des Symposiums.

SYDI 1.1	Di	10:30–11:00	VMP 8 HS	**Experimental manipulation of atoms and photons: the application in quantum information processing** — •Yu-Ao Chen
SYDI 1.2	Di	11:00–11:30	VMP 8 HS	**Cavity QED with a Bose-Einstein Condensate** — •Tobias Donner, Stephan Ritter, Ferdinand Brennecke, Anton Oettl, Thomas Bourdel, Michael Koehl, Tilman Esslinger
SYDI 1.3	Di	11:30–12:00	VMP 8 HS	**Poking and probing strongly correlated gases in optical lattices** — •Simon Fölling, Artur Widera, Stefan Trotzky, Olaf Mandel, Tatjana Gericke, Torben Müller, Fabrice Gerbier, Patrick Cheinet, Immanuel Bloch
SYDI 1.4	Di	12:00–12:30	VMP 8 HS	**Discrete optics in femtosecond-laser written photonic structures** — •Alexander Szameit

Fachsitzungen

MS 1.1–1.6	Mo	10:45–12:45	VMP 8 R05	**Präzisionsmassenspektrometrie, Ionenfallen, FT-IZR-MS, Moleküle, Cluster I**
MS 2.1–2.7	Mo	14:00–16:00	VMP 8 R05	**Präzisionsmassenspektrometrie, Ionenfallen, FT-IZR-MS, Moleküle, Cluster II**
MS 3.1–3.8	Mo	16:00–18:15	VMP 8 R05	**Präzisionsmassenspektrometrie, Ionenfallen, FT-IZR-MS, Moleküle, Cluster III**

MS 4.1–4.9	Di	10:30–13:00	VMP 8 R05	**AMS-Applications**
MS 5.1–5.8	Di	14:00–16:00	VMP 8 R05	**AMS-Developments**
MS 6.1–6.3	Di	16:00–16:45	VMP 8 R05	**Laser-Resonanzionsation und REMPI**
MS 7.1–7.8	Di	16:00–18:00	VMP 9 Poster	**Poster**
MS 8.1–8.8	Mi	14:00–16:00	VMP 8 R05	**Speicherringe, ICP-MS, Neue Entwicklungen**

Mitgliederversammlung Fachverband Massenspektrometrie

Dienstag 13:00–13:30 VMP 8 R05

- Bericht
- Wahl
- Verschiedenes

MS 1: Präzisionsmassenspektrometrie, Ionenfallen, FT-IZR-MS, Moleküle, Cluster I

Zeit: Montag 10:45–12:45 Raum: VMP 8 R05

Hauptvortrag MS 1.1 Mo 10:45 VMP 8 R05

First direct mass measurements of nobelium isotopes — •Michael Block — GSI Helmholtzzentrum für Schwerionenforschung

The region of superheavy elements with their very high proton and neutron number is of particular interest to study the nuclear strucutre evolution at the extremes. The stability of these elements despite their large Coulomb repulsion is due to shell effects. The next spherical shell closures have been predicted by different theoretical models at proton numbers $Z = 114 - 126$ and neutron number $N = 184$. In recent years many new elements have been synthesized but the shell closure has not been reached. Thus, accurate experimental data such as masses of nuclei with $Z > 100$ are important to benchmark the theoretical models. The Penning trap mass spectrometer SHIPTRAP at GSI is presently the only device of its kind that can access trans-fermium elements for which no direct mass measurements have been performed so far. Recently, a major breakthrough has been achieved with the direct mass measurements of the nobelium isotopes $^{252-254}$No ($Z = 102$). Their production rates of less than one ion per second in the case of ^{252}No make these studies very challenging. The investigated isotopes are connected by α decay chains up to Ds (Z=110) and can be used for an accurate mass determination of these heavier nuclides that are not accesible for a direct mass measurement yet. Moreover, direct mass measurments can be used to pin down endpoints of decay chains that are not connected to the known territory and can contribute to the identification of superheavy elements.

Hauptvortrag MS 1.2 Mo 11:15 VMP 8 R05

Recent activities and results at the Penning-trap mass spectrometer ISOLTRAP — •M. Kowalska[1], G. Audi[2], D. Beck[3], Klaus Blaum[4], M. Breitenfeldt[5], Ch. Böhm[6], Ch. Borgmann[4], S. George[4], Frank Herfurth[3], A. Herlert[1], A. Kellerbauer[4], D. Lunney[2], E. Minaya-Ramirez[2], S. Naimi[2], D. Neidherr[6], M. Rosenbusch[5], S. Schwarz[7], Lutz Schweikhard[5], and U. Warring[4] — [1]CERN, Geneva, Switzerland — [2]Université de Paris Sud, Orsay, France — [3]GSI Darmstadt, Germany — [4]MPI für Kernphysik Heidelberg, Germany — [5]Ernst-Moritz-Arndt-Universität Greifswald, Germany — [6]Johannes Gutenberg-Universität Mainz, Germany — [7]NSCL MSU, East Lansing, USA

The Penning-trap mass spectrometer ISOLTRAP located at ISOLDE/CERN, with its high performance and ability to address nuclides with production yields of a few 100 ions/s and half-lives below 100 ms, is a powerful tool to investigate the nuclear binding energies. To its recent scientific highlights belong the masses of the proton halo candidate ^{17}Ne, ^{132,134}Sn relevant for the r process in nucleosynthesis and magicity of $N = 82$, and $^{223-229}$Rn revealing a unique behaviour of the double-mass differences proportional to the interaction of the last proton and neutron. 2008 gave also the first discovery of a nuclide in a Penning trap, namely ^{229}Rn. Technical activities included the C-cluster ion source, new excitation schemes in the purifying trap - to increase mass selectivity, studies of systematic effects - to lower the present residual systematic uncertainty, and tests of tape-station system for decay-spectroscopy studies on isobarically-purified samples.

MS 1.3 Mo 11:45 VMP 8 R05

Untersuchung alternativer Anregungsmethoden in der Präparationspenningfalle von ISOLTRAP — •M. Rosenbusch[1], Klaus Blaum[2], Ch. Böhm[3], Ch. Borgmann[2], M. Breitenfeldt[1], A. Herlert[4], M. Kowalska[4], S. Naimi[5], D. Neidherr[3] und Lutz Schweikhard[1] — [1]Ernst-Moritz-Arndt-Universität, Greifswald, Deutschland — [2]MPI für Kernphysik, Heidelberg, Deutschland — [3]Johannes Gutenberg-Universität, Mainz, Deutschland — [4]CERN, Genf, Schweiz — [5]Université Paris-Sud, Orsay, Frankreich

In vielen Bereichen der Physik werden Penningfallen zum Speichern und Präparieren von Ionen genutzt. Insbesondere ist das massenselektive Kühlen von Ionen mit hohem Auflösungsvermögen ($R = \frac{m}{\Delta m} = 10^5$) bei ISOLTRAP [1] eine wirksame Technik, um Ionen von isobaren Kontaminationen zu separieren. Dazu wird in der puffergasgefüllten Präparationsfalle eine azimutale Quadrupolanregung auf der Zyklotronfrequenz $\nu_c = q/m \cdot B$ der zu zentrierenden Ionen eingestrahlt, um die Magnetronbewegung der Ionen in die schnellere Zyklotronbewegung umzuwandeln und diese im Puffergas zu kühlen [2]. In diesem Beitrag werden Untersuchungen zu alternativen Anregungsformen vorgestellt, mit dem Ziel der Verkürzung der Kühlzeit und der Erhöhung des Auflösungsvermögens.

[1] M. Mukherjee *et al.*, Eur. Phys. J. A 35, 1-29(2008)
[2] G. Savard *et al.*, Phys. Lett. A 158, 247-252(1991)

MS 1.4 Mo 12:00 VMP 8 R05

Systematic studies at ISOLTRAP using the invariance theorem — •Christine Boehm[1], Klaus Blaum[2], Ch. Borgmann[2], M. Breitenfeldt[3], A. Herlert[4], M. Kowalska[4], D. Lunney[5], S. Naimi[5], Dennis Neidherr[1], M. Rosenbusch[3], and Lutz Schweikhard[3] — [1]Johannes Gutenberg University, Mainz, Germany — [2]MPI for Nuclear Physics, Heidelberg, Germany — [3]Ernst-Moritz-Arndt University, Greifswald, Germany — [4]CERN, Geneva, Switzerland — [5]University Paris-Sud 11, Orsay, France

ISOLTRAP is a Penning-trap mass spectrometer at the ISOLDE facility (CERN) where high-precision mass measurements on exotic nuclides are performed by determining their cyclotron frequency relative to that of a reference ion. For the obtained frequency ratios the present relative systematic uncertainty limit is $\delta m/m = 8 \cdot 10^{-9}$ based on systematic studies using carbon cluster ions [1]. To further investigate the origin of the systematic uncertainty, and hopefully to decrease the magnitude, the invariance theorem by Brown and Gabrielse [2] was used. All three motional ion eigenfrequencies, as well as the conversion frequency were measured and compared. The difference $\Delta\omega_c$ between the conversion frequency and the cyclotron frequency calculated from the invariance theorem was found to be mass independent and about 240 mHz. The knowledge of $\Delta\omega_c$ in turn allows to estimate trap imperfections. The results of this study will be presented. [1] A. Kellerbauer *et al.*, Eur. J. Phys. D 22, 53 (2003) [2] L. S. Brown, G. Gabrielse, Phys. Rev. A 25, 2423 (1982)

MS 1.5 Mo 12:15 VMP 8 R05

TRIGA-TRAP: A Penning trap mass spectrometer at the research reactor TRIGA Mainz — •Christian Smorra[1,2], Klaus Blaum[1,3], Michael Block[4], Klaus Eberhardt[2], Martin Eibach[5], Frank Herfurth[4], Jens Ketelaer[5], Jochen Ketter[5], Konstantin Knuth[5], Szilard Nagy[3], and Julia Repp[5] — [1]Physikalisches Institut, Universität Heidelberg, D-69120 Heidelberg — [2]Institut für Kernchemie, Universität Mainz, D-55128 Mainz — [3]Max-Planck-Institut für Kernphysik, D-69117 Heidelberg — [4]GSI Helmholtzzentrum für Schwerionenforschung GmbH, D-64291 Darmstadt — [5]Institut für Physik, Universität Mainz, D-55128 Mainz

Nuclear masses represent the binding energies and, therefore, the sum of all interactions in the nucleus. They provide an important input parameter to nuclear structure models. Presently, a tremendous interest in masses of very exotic neutron-rich nuclides exists to support theoretical models for the nucleosynthesis via the rapid neutron capture process. The research reactor TRIGA Mainz provides access to a large variety of neutron-rich nuclides produced by thermal-neutron induced fission of an actinide target. The double-Penning trap mass spectrometer TRIGA-TRAP will perform high-precision mass measurements in this region of the nuclear chart as well as on actinides from uranium to californium [1]. It also serves as a test facility for the development of new techniques that will be implemented in future facilities like MATS at FAIR (GSI, Darmstadt). The layout of TRIGA-TRAP as well as recent mass measurements will be presented.

[1] J. Ketelaer et al., Nucl. Instr. Meth. A 594 (2008) 162.

MS 1.6 Mo 12:30 VMP 8 R05

Penning trap mass measurements and laser spectroscopy on neutron-rich fission products extracted from the research reactor TRIGA-Mainz — •Martin Eibach[1], Klaus Blaum[2], Klaus Eberhardt[5], Frank Herfurth[4], Jens Ketelaer[1], Jochen Ketter[1], Konstantin Knuth[1], Szilard Nagy[2], Wilfried Nörtershäuser[5], and Christian Smorra[3,5] — [1]Institut für Physik, Universität Mainz, D-55128 Mainz — [2]Max-Planck-Institut für Kernphysik, D-69117 Heidelberg — [3]Physikalisches Institut, Universität Heidelberg, D-69120 Heidelberg — [4]GSI Helmholtzzentrum für Schwerionenforschung GmbH, D-64291 Darmstadt — [5]Institut für Kernchemie, Universität Mainz, D-55128 Mainz

TRIGA-SPEC is a setup for Penning trap mass spectrometry and

collinear laser spectroscopy on short-lived neutron-rich nuclides located at the research reactor TRIGA-Mainz. It is dedicated to the determination of nuclear ground-state properties like masses and charge-radii[1]. The nuclides are produced by neutron-induced fission of an actinide target located in a target chamber near the reactor core. It is required to extract the nuclides fast and with high efficiency from the target chamber in order to make precision experiments on short-living species with half-lives in the order of 1s. To this end, they are flushed out with a helium gas jet containing carbon aerosols and transported through a skimmer region to an ECR ion source. The characterisation of the carbon aerosol generator and the verification of transported fission products will be presented.

[1] J. Ketelaer et al., Nucl. Instr. Meth. A 594 (2008) 162

MS 2: Präzisionsmassenspektrometrie, Ionenfallen, FT-IZR-MS, Moleküle, Cluster II

Zeit: Montag 14:00–16:00 Raum: VMP 8 R05

Hauptvortrag MS 2.1 Mo 14:00 VMP 8 R05

PENTATRAP: A precision Penning trap mass spectrometer for highly-charged ions — •Sergey Eliseev[1], Jose Crespo López-Urrutia[1], Christoph Diehl[1], Sebastian George[1,2], Jens Ketelaer[3], Szilard Nagy[3], Yuri Novikov[4], David Pinegar[1], Wolfgang Quint[5], Julia Repp[1,2], Christian Roux[1,2], Andreas Rosa[2], Stefan Ulmer[3,5], and Klaus Blaum[1] — [1]Max-Planck-Institut für Kernphysik, D-69117 Heidelberg — [2]Ruprecht Karls Universität Heidelberg, D-69120 Heidelberg — [3]Johannes Gutenberg-Universität, Institut für Physik, D-55128 Mainz — [4]St. Petersburg Nucl. Phys. Inst., 188300 Gatchina, Russia — [5]Helmholtzzentrum für Schwerionenforschung GmbH, D-64291 Darmstadt

A novel cryogenic Penning trap setup called PENTATRAP is under construction at the Max-Planck-Institut für Kernphysik, Heidelberg. It aims for high-precision mass measurements on highly-charged stable and long-lived single ions related to tests of fundamental symmetries and constants. In order to reach the needed accuracy of 10^{-11} for medium-heavy nuclides a monitoring of the magnetic field in real time in combination with the dip detection technique performed on highly-charged ions will be implemented. The apparatus is planned to be coupled to the EBIT at MPI-K and later to the HITRAP facility at GSI. The design studies of the project will be presented.

MS 2.2 Mo 14:30 VMP 8 R05

Penning trap setup and detection principle at the PENTATRAP project. — •Julia Repp, Sergey Eliseev, Sebastian George, Andreas Rosa, Christian Roux, and Klaus Blaum — Max-Planck-Institut für Kernphysik, D-69117 Heidelberg

PENTATRAP constructed at the Max-Planck-Institute of nuclear physics in Heidelberg is a unique Penning trap experiment, since a stack of five cylindrical Penning traps will be used for high-precision mass measurements. The ions of interest will be highly charged ions delivered either from an EBIT in Heidelberg or from the HITRAP facility at GSI. In the on-line apparatus the Penning traps will be located in an ultra high vacuum inside a copper chamber. This chamber will be situated in liquid helium inside a superconducting cryogenic magnet. The trap setup itself consists of two monitor traps for a continuous B-field investigation, two preparation traps enabling a fast ion exchange and a precision trap where the actual mass measurement is carried out via a non-destructive image current detection technique. To perform the individual measurements, some trap electrodes will be connected to tank circuits which consist of a high-Q inductor followed by a low-noise amplifier with high input impedance.

In this talk, the importance of the five Penning taps to gain highest precision will be discussed. Moreover, further design developments of the electronics as well as the trap and trap chamber manufactoring progress will be presented.

MS 2.3 Mo 14:45 VMP 8 R05

Preparation of a tritium Q-value measurement in a double Penning trap — •Christoph Diehl[1,2], David Pinegar[1], Robert Van Dyck Jr.[3], Christoph Orth[1,2], and Klaus Blaum[1,2] — [1]Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Germany — [2]Physikalisches Institut, Ruprecht-Karls-Universität, 69120 Heidelberg, Germany — [3]Department of Physics, University of Washington, Seattle, WA 98195-1560, USA

A precise determination of the Q-value of tritium (^{3}H) is of relevance for the determination of the electron anti-neutrino mass as aspired by the Karlsruhe Tritium Neutrino Experiment (KATRIN). In our double Penning trap mass spectrometer we aim to measure the mass ratio of ^{3}H and its β-decay product ^{3}He to an accuracy of 10^{-11}, which would determine the Q-value to an accuracy of 30 meV. The spectrometer we utilize is an enhanced version of the University of Washington Penning trap mass spectrometer (UW-PTMS)[1] and was recently transfered from Seattle to Heidelberg, where it is set up at the moment as the MPIK/UW-PTMS. We will present the necessary preparation work at the Max-Planck-Institut für Kernphysik. This includes major reconstructions of the building as well as studies and control of environmental parameters in the laboratory, like temperature and magnetic field.

[1] D. B. Pinegar, S. L. Zafonte, R. S. Van Dyck Jr., Hyperf. Int. 174, 47 (2007)

MS 2.4 Mo 15:00 VMP 8 R05

Broad-band FT-ICR detection at the Penning trap mass spectrometer TRIGA-TRAP — •Konstantin Knuth[1], Klaus Blaum[2,3], Michael Block[4], Klaus Eberhardt[5], Martin Eibach[1], Frank Herfurth[4], Jens Ketelaer[1], Jochen Ketter[1], Szilard Nagy[2], Julia Repp[1,2], Christian Smorra[3,5], Sven Sturm[1], and Stefan Ulmer[1,3] — [1]Institut für Physik, Universität Mainz, D-55128 Mainz — [2]Max-Planck-Institut für Kernphysik, D-69117 Heidelberg — [3]Physikalisches Institut, Universität Heidelberg, D-69120 Heidelberg — [4]GSI Helmholtzzentrum für Schwerionenforschung, D-64291 Darmstadt — [5]Institut für Kernchemie, Universität Mainz, D-55128 Mainz

The double Penning trap mass spectrometer TRIGA-TRAP will perform high-precision mass measurements on exotic neutron-rich nuclides, which are produced via neutron-induced fission of actinide targets at the research reactor TRIGA Mainz. In order to determine which ion species are present in the ion bunch delivered to the Penning trap system, a non-destructive ion detection technique will be implemented in the cylindrical purification trap. This so called broad-band Fourier transform ion cyclotron resonance (FT-ICR) detection technique is based on the detection of image currents, induced by the ions in the trap electrodes. To this end, a new cryogenic low-noise broad-band amplifier is being designed and tested. With this system the identification of contaminations will be possible without the need to eject ions from the trap as usually done at other facilities. The setup as well as its present status will be presented.

MS 2.5 Mo 15:15 VMP 8 R05

Status der MATS Facility — •Gerrit Marx[1], Lutz Schweikhard[1], Klaus Blaum[2], Michael Block[3], Christopher Geppert[4], Frank Herfurth[3], A. Herlert[5], Wilfried Noerteshaeuser[4], W. Plass[6], Lutz Schweikhard[1], Peter Thirolf[7] und die MATS collaboration[3] — [1]Institut für Physik, Ernst-Moritz-Arndt-Universität, 17487 Greifswald — [2]MPI für Kernphysik, 69117 Heidelberg — [3]GSI, 64291 Darmstadt — [4]Johannes-Guthenberg-Universität, 55099 Mainz — [5]CERN, CH-1211 Geneva 23 — [6]Justus-Liebig-Universität, 35390 Giessen — [7]Ludwig-Maximilians-Universität, 80539 München

Die Masse, bzw. die Kernbindungsenergie, ist eindeutig und charakteristisch für jeden einzelnen Kern und ist das Resultat der starken und der elektromagnetischen Kraft im Kern. Präzise Massenmessungen und der damit mögliche präzise Vergleich mit kerntheoretischen Modellen erlaubt die Verfeinerung dieser Modelle. Die Untersuchung lokaler Eigenschaften wie Deformationen oder die Bindungsenergie der letzten Nukleonen fordern Massenmessungen mit einer relativen Genauigkeit von bis zu 10^{-8}. Die entscheidenden Tests sind nur an besonders exotischen Kernen möglich, wie sie am geplanten Super FRS zur Verfügung stehen werden. Die MATS Facility (Precision Measurement of very short-lived nuclei using an Advanced Trapping System for highly charged Ions) an FAIR besteht aus der Kombination eines RFQ Bunchers, einer EBIT, eines MR-ToF und verschiedenen Pennigfallen. In diesem Beitrag wird der Status des Experiments vorgestellt.

MS 2.6 Mo 15:30 VMP 8 R05

Status des WITCH Experimentes — •Marcus Beck[1], Peter Friedag[1], Jonas Mader[1], Christian Weinheimer[1], Nausikaa Geeraert[2], Nathal Severijns[2], Michael Tandecki[2], Emil Traykov[2], Simon van Gorp[2], Frederik Wauters[2], Alexander Herlert[3] und die ISOLDE Kollaboration[3] — [1]Institut für Kernphysik, WWU Münster, Wilhelm-Klemm Str. 9, 48149 Münster, Deutschland — [2]Instituut voor Kern- en Stralingsfysica, K.U.Leuven, Celestijnenlaan 200D, B-3001 Leuven, Belgien — [3]CERN, CH-1211 Geneve 23, Schweiz

Das WITCH Experiment misst das Rückstoßspektrum der Tochterionen nach Kern-Betazerfall unter Verwendung von Penningfallen als Quelle und eines Retardierungsspektrometers zur Energieanalyse. Aus dem Rückstoßspektrum soll die Beta-Neutrino Winkelkorrelation mit hoher Genauigkeit (¡0,5%) bestimmt werden. Ziel ist dabei die Suche nach exotische Wechselwirkungen jenseits des Standardmodelles.

In 2008 und 2009 wurden zahlreiche Verbesserungen am experimentelle Aufbau vorgenommen sowie Simulationen zu Transmission und systematischen Effekten durchgeführt. In diesem Vortrag werden wir den Stand des Experimentes, der Simulationen und der Auswertung bestehender Meßdaten vorstellen, sowie einen Überblick der Planung für 2009 und 2010 geben. Diese soll zu einer präzisen Messung des Rückstoßspektrums und der Bestimmung wesentlicher systematischer Effekte führen.

Dieses Projekt wird durch das BMBF unter dem Kennzeichen 06MS270 gefördert.

MS 2.7 Mo 15:45 VMP 8 R05

Recent results from the Penning trap mass spectrometer JYFLTRAP — •Christine Weber, Viki-Veikko Elomaa, Tommi Eronen, Jani Hakala, Ari Jokinen, Anu Kankainen, Saidur Rahaman, Juho Rissanen, and Juha Äystö — Department of Physics, P.O. Box 35 (YFL), FI-40014 University of Jyväskylä, Finland

Accurate mass determination employing Penning ion traps has gained increasing importance after the installation of several new on-line facilities at accelerator labs. These setups combine unique production possibilities for rare isotopes with elaborate ion-capture and manipulation techniques. Since the final commissioning of the JYFLTRAP setup at the IGISOL facility in Jyväskylä, the masses of more than 200 short-lived nuclides have been measured. Their knowledge applies to studies on nuclear structure, the modeling of nucleosynthesis processes, tests of the conserved vector current (CVC) hypothesis and the unitarity of the CKM matrix, and furthermore, can help to assist in ongoing searches of neutrinoless double-beta decays. This presentation will focus on recent highlights studied at JYFLTRAP.

MS 3: Präzisionsmassenspektrometrie, Ionenfallen, FT-IZR-MS, Moleküle, Cluster III

Zeit: Montag 16:00–18:15 Raum: VMP 8 R05

Hauptvortrag MS 3.1 Mo 16:00 VMP 8 R05

Penning trap mass measurements on stable isotopes — •David Pinegar — Max-Planck Institut für Kernphysik, Heidelberg

Because single ions of long-lived nuclides can be observed indefinitely in Penning traps, there is no fundamental limit on the resolving power of Penning trap mass spectrometers. Instead, practical limitations observed on the accuracy of these experiments have included instabilities of the trap's magnetic field strength, the voltage source used to bias the ring electrode, and the frequency standard used for reference. This talk will review several different techniques used by several research groups to minimize these sources of uncertainty, allowing atomic mass ratios to be measured with uncertainties approaching, and sometimes even exceeding 1 part in 10^{11}. This precision is useful for mass measurements related to neutrino physics, such as neutrinoless double-beta decay. But due to the speaker's involvement, special emphasis will be given to work on the tritium/helium-3 mass ratio and its application to beta-spectrometer direct neutrino mass measurements.

MS 3.2 Mo 16:30 VMP 8 R05

Results from the commissioning of the double Penning trap system MLLTRAP[*] — •Veli Kolhinen, Eva Gartzke, Dietrich Habs, Jürgen Neumayr, Christian Schürmann, Jerzy Szerypo, and Peter Thirolf — Fakultät für Physik, LMU München and Maier-Leibnitz Laboratory, Am Coulombwall 1, 85748 Garching, Germany

A cylindrical double Penning trap [1] has been installed and successfully commissioned at the Maier-Leibnitz Laboratory (MLL) in Garching. This trap system has been designed to isobarically purify low energy ion beams and perform highly accurate mass measurements. Test measurements were performed by using an offline Rb surface ion source producing singly charged ^{85}Rb and ^{87}Rb ions. A mass resolving power of $139(2) \cdot 10^3$ has been reached with the purification trap for ^{85}Rb ions and a relative mass uncertainty of the order of $\delta m/m = 2.9 \cdot 10^{-8}$ with the measurement trap for ^{85}Rb ions by using ^{87}Rb as reference ions. This value does not yet include systematic uncertainties. Detailed studies of systematic uncertainties arising from magnetic field changes caused by short term temperature and pressure fluctuations in the experimental area and from the long term decay of the magnetic field strength have been performed and the result of the analysis will be presented. Mass measurements with offline actinide alpha recoil ion sources providing heavy radioactive species (e.g. ^{240}U) are in preparation.

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

MS 3.3 Mo 16:45 VMP 8 R05

Parametrische Anregung von Ionen in einer ICR-Falle durch Axialisierung mit 2 Elektroden — •Franklin Martinez[1], Alexander Herlert[2], Gerrit Marx[1], Lutz Schweikhard[1] und Noelle Walsh[1] — [1]Institut für Physik, Ernst-Moritz-Arndt Universität, 17487 Greifswald, Deutschland — [2]Physics Department, CERN, 1211 Geneva 23, Switzerland

Die azimuthale Quadrupolanregung wird in der ICR-Massenspektrometrie vor allem in Kombination mit Puffergaskühlung verwendet, um eine Axialisierung der gespeicherten Ionen zu erreichen. Die herkömmliche Quadrupolanregung wird an 2 Paaren jeweils gegenüberliegender Ringsegmente mit entgegengesetzter Phase angelegt. Verwendet man aber zur Anregung nur ein Elektrodenpaar, so führen parametrische Resonanzeffekte bei den Frequenzen $2\nu_z$ und $\nu_p = \nu_+ - \nu_-$ unter bestimmten Umständen zu einem unbeabsichtigten Ionenverlust aus der Falle. Diese parametrischen Resonanzeffekte wurden theoretisch und experimentell untersucht. Durch eine einfache Vektordarstellung können die Multipol-Komponenten verschiedener radialer Anregungsschemata abgeleitet und somit parametrische Anteile schnell erkannt werden. Der Einfluß der Quadrupolanregung mit einer Phase konnte im Experiment am Beispiel der Axialisierung gespeicherter Clusterionen gezeigt werden.

MS 3.4 Mo 17:00 VMP 8 R05

The influence of magnetic field fluctuations on the mass uncertainty of SHIPTRAP — •Christian Droese[3], Dieter Ackermann[2], Michael Block[1], Michael Dworschak[1], Sergey Eliseev[2], E. Haettner[4], Frank Herfurth[1], Fritz-Peter Hessberger[1], Sigurd Hofmann[1], Heinz-Jürgen Kluge[1,5], Gerrit Marx[3], M. Mazzocco[6], Yuri Novikov[1,7], W. Plass[4], Saidur Rahaman[8], Daniel Rodriguez[9], C. Scheidenberger[1,4], Lutz Schweikhard[3], Peter Thirolf[10], Gleb Vobrobyew[1,7], Christine Weber[8], Jens Ketelaer[11] und Jochen Ketter[11] — [1]GSI Helmholtzzentrum für Schwerionenforschung mbH, 64291 Darmstadt, Germany — [2]Max-Planck-Institut für Kernphysik, 69117 Heidelberg, Germany — [3]Institut für Physik, 17487 Greifswald, Germany — [4]II. Physikalisches Institut,Justus-Liebig-Universität, 35392 Gießen, Germany — [5]Ruprecht-Karls-Universität, 69120 Heidelberg, Germany — [6]University of Padova, 35122 Padova, Italy — [7]Petersburg Nuclear Physics Institute, 188300 Gatchina, St. Petersburg, Russia — [8]Department of Physics, University of Jyväskyä, 40014 Jyväskylä, Finland — [9]Universidad de Huelva, 21071 Huelva, Spain — [10]Fakultät für Physik, Ludwig-Maximilians-Universität München, 85748 Garching, Germany — [11]Institut für Physik, Johannes-Gutenberg-Universität, 55099 Mainz, Germany

Precise atomic mass measurements are essential for obtaining conclusive answers in several disciplines in physics. Particularly important are

the values of masses of nuclides close to the limits of nuclear existence, commonly referred to as exotic nuclides. The masses contribute, for example, to a better understanding of astrophysical nucleosynthesis. SHIPTRAP is a high-precission mass measurement facility for heavy and superheavy ions produced in fusion-evaporation reactions at the velocity filter SHIP at GSI. The system consists of a buffer-gas cell to thermalise the incoming ions, an extraction system to separate the ions from the buffer gas, an RFQ buncher to cool and accumulate the ions and a tandem Penning-trap system for isobaric purification and high-precision mass measurements. With this setup absolut mass measurements with an uncertainty of about 10^{-8} are possible. For the detection of superheavy ions with low production rates in a penning trap system a magnetic field with lowest possible fluctuations is essential to minimize the systematical error of the results. These fluctuations can be effectively reduced by stabilizing the temperature and the pressure in the superconducting magnet. The implementation of such a system and its impact on the uncertainty for long term measurements will be presented.

MS 3.5 Mo 17:15 VMP 8 R05

Status of a non-destructive FT-ICR detection system for KATRIN — •Marta Ubieto Diaz[1], Klaus Blaum[1], Daniel Rodriguez[2], and Stefan Stahl[3] — [1]Max-Planck-Institute for Nuclear Physics, Heidelberg — [2]Universidad de Huelva - Avda. de las Fuerzas Armadas s/n 21071 Huelva — [3]Stahl Electronics. Kellerweg 23, 67528 Mettenheim

The KATRIN experiment has been designed to measure the mass of the electron antineutrino directly with a sensitivity of 0.2 eV, one order of magnitude better than the present upper limit. The intended sensitivity will be obtained by analyzing the end-point of the β spectrum from the decay of tritium gas molecules $T_2 \rightarrow (^3HeT)^+ + e^- + \bar{\nu}_e$. The KATRIN setup comprises a gaseous tritium source, a transport section, a pre-spectrometer, the main spectrometer and the detector. In the main spectrometer the electrons from the decay are guided by a strong magnetic field and analyzed using electrostatic fields. The tritium gas is removed from the system by differential pumping and cryogenic trapping. The formation of ion clusters $(T_{2n+1})^+$ which decay with different end-points than T_2, will prevent unambiguous analysis of the end-point of the tritium decay. Therefore, the knowledge of the concentrations of these ions is essential to evaluate the β spectrum. The best way for a precise determination of these concentrations is the use of Penning traps with FT-ICR detection systems. These Penning trap systems will be located in the transport section. A prototype is currently under commissioning at the Max-Planck Institute for Nuclear Physics in Heidelberg. The status and results will be presented.

MS 3.6 Mo 17:30 VMP 8 R05

Cryogenic trapping of keV ion beams at the CSR prototype — •Sebastian Menk[1], Klaus Blaum[1], Michael Froese[1], Manfred Grieser[1], Oded Heber[2], Michael Lange[1], Dimitry Orlov[1], Thomas Sieber[1], Michael Rappaport[2], Robert von Hahn[1], Jozef Varju[1], Andreas Wolf[1], and Daniel Zajfman[2] — [1]Max-Planck-Institut für Kernphysik, Saupfercheckweg 1,69117 Heidelberg — [2]Weizmann Institut of Science, Rehovot, 76100, Israel

A Cryogenic Trap for Fast ion beams (CTF) was built to explore cooling techniques and test thermal decoupling of ion optics for the development of the electrostatic Cryogenic Storage Ring (CSR). These challenging projects will lead to a new experimental field of atomic and molecular physics with keV ion beams. The cold conditions of 2-10 K minimize the blackbody radiation field and are expected to lead to extremely low restgas densities (equivalent pressure at room temperature $\approx 10^{-13}$ mbar) which result in long storage lifetimes and for molecular ions to radiative cooling to their ro-vibrational ground states.
The CTF consists of two stacks of electrostatic mirror electrodes allowing the storage of up to 20 keV ion beams. Cryogenic ion beam storage has been realized with this device using a liquid helium refrigeration system to cool down the experimental trapping area to few-Kelvin cryogenic temperatures and experiments with cryogenically trapped molecular nitrogen ions have been performed to verify the low vacuum conditions by measuring their storage lifetimes.

MS 3.7 Mo 17:45 VMP 8 R05

Intense electron pulses for HITRAP from a robust GaAs photocathode using UV pulse irradiation — •Claude Krantz[1], Dmitry A. Orlov[1], Andreas Wolf[1], Giancarlo Maero[2], Frank Herfurth[2], and Wolfgang Quint[2] — [1]Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg — [2]Gesellschaft für Schwerionenforschung, Planckstraße 1, 64291 Darmstadt

The HITRAP facility includes a multiring Penning trap to store decelerated highly charged ions (HCI) from the GSI accelerator complex at temperatures of 4 K. The trap will simultaneously store 10^5 HCI of initial kinetic energies of 6 keV/u and 10^9 cold electrons of temperature $k_BT = 10$ eV, achieving electron cooling of the ions through Coulomb scattering with the electrons and subsequent synchrotron radiation of the latter. Electrons need to be produced in pulses of around 100 ns in order to efficiently fill the cooler trap. For this purpose a photoelectron gun has been developed at the Max-Planck-Institute of Nuclear Physics (MPIK) based on a GaAs-photocathode. Following experience gathered at the MPIK in the operation of such photocathodes, the electron gun will be operated in reflection mode using a pulsed UV light source. Test measurements performed at the MPIK show that in this regime the quantum efficiency of the photocathode can be expected to be stable and robust against many vacuum degradations at a value $> 10^{-3}$, which, by itself, would permit single-shot filling of the cooler trap. Commissionning will allow to determine an optimal trap-filling procedure.

MS 3.8 Mo 18:00 VMP 8 R05

Cryogenic hydrogen ions and chemical probing spectroscopy in rf ion cages — •Max H. Berg[1], Annemieke Petrignani[1], Dennis Bing[1], Holger Kreckel[2], and Andreas Wolf[1] — [1]Max-Planck Institut fuer Kernphysik, Heidelberg D-69117 — [2]Columbia University, New York, NY 10027, USA

Radio frequency ion cages in the 22-pole geometry are well established tools for confining molecular ions in an almost field-free space, providing distinctly lower ion micromotion than standard Paul traps. We are applying these devices for the cryogenic cooling of H_3^+ ions by He buffer gas down to the lowest rotational levels. H_3^+ plays an important role in astrophysical and technical hydrogen plasmas, and is also a benchmark for quantum mechanical calculations of rovibrational energy levels of polyatomic molecules. For rovibrational spectroscopy, the conventional absorption method is a cumbersome approach as densities are low and H_3^+ rovibrational transitions are weak. A much more efficient detection method adapted to the cold multipole traps is to probe photon absorption by laser induced chemical reactions. The reaction products are detected via a mass spectrometer with near unity efficiency. This method revealed in the latest measurements the weakest H_3^+ rovibrational transitions observed to date, accessing vibrational levels more than 1.6 eV above the ground state.

MS 4: AMS-Applications

Zeit: Dienstag 10:30–13:00 Raum: VMP 8 R05

Hauptvortrag MS 4.1 Di 10:30 VMP 8 R05

Nuclear Astrophysics and AMS — •Anton Wallner — VERA Labor, Fakultät für Physik, Univ. Wien, Währinger Strasse 17, 1090 Wien, Austria

Nuclear astrophysics aims at describing nuclear processes relevant to nucleosynthesis. Except for the very light elements, the abundance pattern of our solar system is the product of nucleosynthesis within many generations of stars. Isotopic abundances can be studied in the laboratory via nuclear cross-section measurements at the relevant energy regimes. In cases of longer-lived nuclides or nuclides with an unfavorable decay scheme, counting atoms directly via Accelerator Mass Spectrometry (AMS) rather than their decay rates, is the far more sensitive method.

The general isotopic pattern for elements heavier than Fe can be understood as the result of a few distinct processes, like s-, r- or p-process. Interestingly, recent observations of very old, so-called ultra-metal-poor (UMP) stars indicate that our knowledge of nucleosynthesis is still limited. New precise AMS measurements will help to clarify this recently found discrepancy in UMP stars. In addition, the search

for certain supernova-produced, long-lived radionuclides on Earth, like ^{60}Fe, ^{182}Hf, ^{244}Pu and possibly super-heavy elements, will give an improved insight into explosive nucleosynthesis scenarios.

An overview on recent activities of the AMS technique in nuclear astrophysics will be given, including measurements relevant for Big-Bang nucleosynthesis and the search for SN-produced radionuclides on Earth.

MS 4.2 Di 11:00 VMP 8 R05

Suche nach schwersten primordialen Radionukliden — •Johannes Lachner[1], Iris Dillmann[1], Thomas Faestermann[1], Udo Gerstmann[2], Gunther Korschinek[1], Christoph Lierse[3], Mikhail Poutivtsev[1], Georg Rugel[1] und Andreas Türler[3] — [1]Physik Department, Technische Universität München — [2]Helmholtz-Zentrum München — [3]Institut für Radiochemie, Technische Universität München

Langlebige Radioisotope ermöglichen unter anderem Untersuchungen von Vorgängen während des Frühstadiums des Sonnensystems. Am Münchner Beschleunigerlabor können mithilfe einer Flugzeitmessung hochempfindliche und untergrundfreie Messungen von solchen Nukliden durchgeführt werden.

Dieser Aufbau wurde auch für die Suche nach natürlichem ^{244}Pu ($T_{1/2}$=81 Ma) benutzt, von dem man annimmt, dass es sowohl das kurzlebigste als auch das schwerste primordiale Nuklid auf der Erde ist. Nach mehreren indirekten Nachweisen von zerfallenem ^{244}Pu über die Messung fissiogener Xenon-Isotope gelang einmalig (Hoffman et al., Nature, 234:132-134, 1971) die direkte Bestimmung des natürlichen Vorkommens von ^{244}Pu in dem Seltenerdmineral Bastnaesit. Unsere Messungen des gleichen Minerals zeigen jedoch kein ^{244}Pu und schließen insgesamt ein natürliches Vorkommen dieses Nuklids in der bei Hoffman et al. angegebenen Häufigkeit aus.

MS 4.3 Di 11:15 VMP 8 R05

Über die Halbwertszeiten von Be-10 und Fe-60 — •Georg Rugel[1], Andreas Bergmaier[2], Iris Dillmann[1], Thomas Faestermann[1], Udo Gerstmann[3], Ines Günther-Leopold[4], Niko Kivel[4], Klaus Knie[1], Gunther Korschinek[1], Johannes Lachner[1], Christoph Lierse von Gostomski[5], Moumita Maiti[1], Mikhail Poutivtsev[1], Ariane Remmert[5], Dorothea Schumann[4], Anton Wallner[6], Regin Weinreich[4] und Michael Wohlmuther[4] — [1]Fachbereich Physik, Technische Universität München — [2]Universität der Bundeswehr München — [3]Helmholtz Zentrum München — [4]Paul Scherrer Institut, 5232 Villigen, Schweiz — [5]Institut für Radiochemie, Technische Universität München — [6]VERA Wien, Österreich

Die genaue Kenntnis sehr langer Halbwertszeiten (im Bereich von Millionen Jahre) von Radionukliden ist von großer Wichtigkeit in oft sehr verschiedenen wissenschaftlichen Disziplinen, die von der Astrophysik (^{60}Fe, Nukleosynthese in unserer galaktischen Umgebung) bis zur Geologie (^{10}Be, Expositionsdatierung) reichen. Die Bestimmungen erfordern dedizierte Methoden, da die Zerfallskurven außerhalb des Beobachtungszeitraumes liegen. Aus der Messung der Anzahl der Nuklide sowie der jeweiligen Aktivität, wird dann auf die jeweilige Halbwertszeit geschlossen. Die Anzahl wird durch unterschiedlichste massenspezifische Techniken bestimmt, die Aktivität entweder direkt oder durch die Beobachtung des Aufbaus sekundärer Zerfälle. Im Vortrag wird detailliert auf unsere neuesten Messungen zu den Halbwertszeiten von ^{10}Be und ^{60}Fe eingegangen.

Diese Arbeit wurde von der DFG durch EXC 153 gefördert.

MS 4.4 Di 11:30 VMP 8 R05

Carrier-free Be-10/Be-9 measurements at low energies — •Marcus Christl[1], Colin Maden[2], Peter W. Kubik[1], Arnold Müller[1], and Hans-Arno Synal[1] — [1]Laboratory of Ion Beam Physics, ETH-Zurich, Switzerland — [2]Institute of Isotope Geochemistry and Mineral Resources, ETH Zurich, Switzerland

A new method to directly measure the natural Be-10/Be-9 ratio of environmental samples with a compact low energy AMS system (0.6 MV) has been developed recently. This method allows us to use standard sample preparation methods and AMS techniques. In some cases, when the only the relative variation of the natural Be-10/Be-9 ratio is needed, the direct measurement of Be-10/Be-9 significantly reduces sample preparation time, enables higher sample throughput in the lab, provides more precise data, and avoids all problems related to possible systematic offsets between both AMS and ICP-MS.

Applications of carrier free Be-10/Be-9 measurements like dating of manganese crusts or the reconstruction of the solar- or the geomagnetic field are discussed. First results of the newly developed method applied to marine samples will be presented and systematic ion source efficiency studies with artificial samples will be discussed.

MS 4.5 Di 11:45 VMP 8 R05

Iod-129 und andere anthropogene Radionuklide in der Nordsee — •Lübbert Tosch[1], Rolf Michel[1], Hartmut Nies[2], Hans-Arno Synal[3] und Vasily Alfimov[3] — [1]Zentrum für Strahlenschutz und Radioökologie, Leibniz Universität Hannover, Deutschland — [2]Bundesamt für Seeschiffahrt und Hydrographie, Hamburg, Deutschland — [3]Institut für Teilchenphysik, ETH Zürich, Schweiz

Durch anthropogene Freisetzungen wurde das Vorkommen des langlebigen Radionuklids Iod-129 ($T_{1/2}$=15,7Ma) nachhaltig verändert. Natürliches ^{129}I entsteht durch Spontanspaltung von ^{238}U und durch Spallationsreaktionen von Xenon mit kosmischer Strahlung. Künstliches ^{129}I wird bei der neutroneninduzierten Spaltung von ^{235}U und ^{239}Pu gebildet. Anthropogenes ^{129}I wird in erster Linie durch die Wiederaufarbeitungsanlagen in La Hague und Sellafield in die Umwelt freigesetzt, weitere Quellen sind Kernwaffentests und Unfälle in kerntechnischen Anlagen. Es wird über eine systematische Beprobung der Nordsee und des Englischen Kanals in Hinblick auf ^{129}I im Meerwasser berichtet. Durch anthropogene Beimengungen werden ^{129}I/^{127}I-Isotopenverhältnisse von mehr als 10^{-6} angetroffen, das natürliche Isotopenverhältnis liegt bei 10^{-12}. Die Emissionen aus La Hague lassen sich innerhalb der Nordsee verfolgen. Es zeigt sich, dass sich die Kompartimente in Europa in Ungleichgewicht befinden. Die Ergebnisse werden auch in Hinblick auf die Radionuklide ^{90}Sr, ^{99}Tc und ^{137}Cs in Nordseewasser diskutiert. Die ^{129}I/^{127}I-Isotopenverhältnisse wurden mit AMS an der ETH Zürich bestimmt und die ^{127}I-Gehalte wurden mit ICP-MS ermittelt.

MS 4.6 Di 12:00 VMP 8 R05

The systematics of the ^{36}Cl production rate calculations in limestone — •Vasily Alfimov and Susan Ivy-Ochs — Ion Beam Physics, ETH Zurich, 8093 Zurich, Switzerland

One of the major radionuclides that are measured by Accelerator Mass Spectrometry (AMS) is chlorine-36 ($T_{1/2}$ = 301 kyr). It is produced by cosmic rays in the atmosphere and the upper meters of the lithosphere. Since limestone contains no or very little quartz, and hence ^{10}Be cannot be used, surface exposure dating of this rock type has to be done with ^{36}Cl. There are several production pathways of ^{36}Cl in calcite: spallation of Ca by fast neutrons, capture of slow negative muons on ^{40}Ca, fast-muon induced reactions on Ca, capture of thermal and epithermal neutrons on ^{35}Cl, where these neutrons are also produced by several pathways. The complexity of ^{36}Cl production makes it difficult to calibrate each separate pathway and ultimately to use this radionuclide in surface exposure dating. Here we summarize our investigation into the ^{36}Cl production systematics and draw an outline for the recommended calibration constants and calculation procedure.

MS 4.7 Di 12:15 VMP 8 R05

Be-10 and Cl-36 interlaboratory comparisons — •Silke Merchel[1,2], Wolfram Bremser[3], Vasily Alfimov[4], Maurice Arnold[1], Georges Aumaître[1], Lucilla Benedetti[1], Didier L. Bourlès[1], Régis Braucher[1], Marc Caffee[5], Marcus Christl[4], L. Keith Fifield[6], Robert C. Finkel[1,7], Stewart P.H.T. Freeman[8], Aarón Ruiz-Gomez[9], Peter W. Kubik[4], Dylan H. Rood[7], Kimikazu Sasa[10], Peter Steier[11], Stephen G. Tims[6], Anton Wallner[11], Klaus M. Wilcken[8], and Sheng Xu[8] — [1]CEREGE, Aix-en-Provence, France — [2]FZD, Dresden, Germany — [3]BAM, Berlin, Germany — [4]PSI/ETH Zurich, Switzerland — [5]PRIME Lab, Purdue, IN, USA — [6]ANU, Canberra, Australia — [7]LLNL, Livermore, CA, USA — [8]SUERC, East Kilbride, UK — [9]CNA, Sevilla, Spain — [10]University of Tsukuba, Japan — [11]VERA, Wien, Austria

Driven by the progress in AMS and its spreading application within geosciences, measurements of increasing numbers of samples with low isotopic ratios will be required in the future. Therefore, we have examined the linearity of ^{10}Be/^{9}Be as a function of isotope ratio by distributing 3 secondary standards (dilutions of NIST4325: 10^{-12}-10^{-14}) to 9 AMS labs. The problem of low ratio samples is even more crucial for ^{36}Cl mainly due to the high volatility of chlorine. Thus, we have prepared large quantities of 3 ^{36}Cl/Cl solutions from a certified ^{36}Cl activity (NIST4943) by dilution with NaCl. AgCl precipitated from these solutions (10^{-11}-10^{-13}) has been distributed to 9 AMS labs. Some measurements are still ongoing. First results from 6 labs for each nuclide show that these interlaboratory exercises are very valuable.

MS 4.8 Di 12:30 VMP 8 R05

Bestimmung von Plutonium-Isotopen mittels AMS — •Tanja Bisinger[1], Rolf Michel[1], Lukas Wacker[2] und Hans-Arno Synal[2] — [1]Zentrum für Strahlenschutz und Radioökologie, Leibniz Universität Hannover, Deutschland — [2]Institut für Teilchenphysik, ETH Zürich, Schweiz

Die Bestimmung von Aktivitätskonzentrationen sowie Isotopenverhältnissen der verschiedenen Plutonium-Isotope ist von besonderem Interesse in der Radioökologie. Plutonium wurde durch Kernwaffentests, Wiederaufarbeitungsanlagen, Kernreaktoren oder Unfälle in die Umwelt eingebracht. Die Kombination aus Beschleunigermassenspektrometrie (AMS) und Alphaspektrometrie ermöglicht die Untersuchung aller dosis-relevanter Plutonium-Isotope. Der große Vorteil der AMS liegt darüber hinaus in der Messung der $^{240}Pu/^{239}Pu$-Isotopenverhältnisse, der Bestimmung von ^{241}Pu, den kurzen Messzeiten sowie der geringen Nachweisgrenze (10^6 Atome). Proben aus den hoch kontaminierten Gebieten um Tschernobyl, der Nordsee und der Irischen See wurden per Alphaspektrometrie untersucht, um das der AMS nicht zugängliche Isotop ^{238}Pu zu bestimmen. Anschliessend erfolgte die Messungen der Proben am 500 kV Tandem-Beschleuniger der ETH Zürich. Die gemessenen $^{240}Pu/^{239}Pu$-Isotopenverhältnisse ermöglichen Rückschlüsse auf den Ursprung der Kontamination. Dadurch kann Plutonium, welches während des Reaktorunglücks von Tschernobyl emittiert wurde, von dem Plutonium unterschieden werden, welches aus dem globalen Fallout oder anderen Quellen stammt.

MS 4.9 Di 12:45 VMP 8 R05

AGE: Optimization of the Graphitization Procedure — •Mojmír Němec[1] and Lukas Wacker[2] — [1]Department of Chemistry and Biochemistry, University of Bern, Switzerland — [2]Ion Beam Physics, ETH Zurich, Switzerland

The Automated Graphitization Equipment (AGE) was developed at ETH Zurich for fast and efficient sample preparations for radiocarbon measurement by accelerator mass spectrometry. Samples are combusted in an elemental analyzer and the resulting CO_2 is absorbed on a single column filled with zeolite absorber. The CO_2 is then released by heating the zeolite trap and transferred by gas expansion to the reactor, where it is reduced by H_2 to graphite on the iron catalyst.

AGE was optimized to find conditions for the fastest graphitization reaction completion and the smallest isotopic fractionation with minimum formation of molecular fragments. The tuning was focused on the preconditioning of iron catalyst, reaction temperature (540-620°C), H_2/CO_2 ratio (1.8-2.5) and also the suitable timing for each step of the whole procedure.

The results of the optimization experiments and the final graphitization procedure will be presented.

MS 5: AMS-Developments

Zeit: Dienstag 14:00–16:00 Raum: VMP 8 R05

MS 5.1 Di 14:00 VMP 8 R05

Aufbau eines 6MV Beschleuniger-Massenspektrometers an der Universität zu Köln — Alfred Dewald[1], •Stefan Heinze[1], Martin Melles[2], Jan Jolie[1], Andreas Zilges[1], Michael Staubwasser[2], Ulrich Radtke[3,4], Jürgen Richter[5] und Friedhelm von Blankenburg[6] — [1]Institut für Kernphysik, Universität zu Köln — [2]Institut für Geologie und Mineralogie, Universität zu Köln — [3]Geographisches Institut, Universität zu Köln — [4]Universität Duisburg-Essen — [5]Institut für Ur- und Frühgeschichte, Universität zu Köln — [6]Deutsches GeoForschungsZentrum (GFZ), Potsdam

Am Institut für Kernphysik der Universität zu Köln wird ein durch die DFG gefördertes 6MV Beschleuniger-Massenspektrometer aufgebaut. Die Anlage ist ausgelegt zum Messen der kosmogenen Nuklide ^{10}Be, ^{14}C, ^{26}Al und ^{36}Cl und basiert auf einem 6MV Tandetron der Firma High Voltage Engeneering. Die Anlage ermöglicht es auch, schwere Isotope bis hin zu ^{244}Pu zu vermessen. Die Montage der Anlage im Institut für Kernphysik ist für Anfang 2010 geplant. Für den neuen Beschleuniger, sowie für den existierenden FN-Tandem wird ein neues SF6-Gassystem installiert, das den verschärftten EU-Richtlinien entspricht. Im Vortrag soll über den Status des AMS-Projekts der Universität zu Köln und über Pläne für zukünftige Erweiterungen berichtet werden.

MS 5.2 Di 14:15 VMP 8 R05

Additional Isobar suppression in AMS using selective laser photodetachment — •Oliver Forstner[1], Pontus Andersson[2], Christoph Diehl[3], Robin Golser[1], Dag Hanstorp[2], Walter Kutschera[1], Anton Lindahl[2], Christof Vockenhuber[4], and Klaus Wendt[3] — [1]Universität Wien, Wien, Austria — [2]Göteborg University, Gothenburg, Sweden — [3]Johannes Gutenberg Universität, Mainz, Germany — [4]ETH Zurich, Switzerland

We are investigating the possibility to use laser photodetachment of negative ions as an isobar-selective filter in accelerator mass spectrometry (AMS). The aim of this study is to find a possibility to further improve the detection limit for long-lived heavy radionuclides at 3-MV AMS facilities.

The present detection limit for measuring the isotope ratio $^{182}Hf/Hf$ at VERA is $1x10^{-11}$. The limiting factor is the strong background of the stable isobar ^{182}W. Currently this background is reduced using suitable molecular ions in the injection stage of VERA. Test experiments have been carried out in a low-energy, negative-ion-beam setup at Göteborg University, where a pulsed tunable laser beam is used to measure the absolute photodetachment cross section of negative fluoride ions from W and Hf. The most promising of the investigated molecular ions is HfF_5^-, which shows a high production yield from the ion source and a negligible photodetachment cross section at the tripled fundamental wavelength of a Nd:YAG laser. At this wavelength an electron detachment of WF_5^- ions is clearly observed and the detachment cross section rises with increasing photon energy.

MS 5.3 Di 14:30 VMP 8 R05

Leistungssteigerung der Erlanger Hybrid-Ionenquelle — •Alexander Stuhl, Katrin Leichmann, Andreas Rottenbach, Andreas Scharf, Michael Wiedenhofer und Wolfgang Kretschmer — AMS-Labor Erlangen, Uni Erlangen, 91058 Erlangen

An der AMS-Anlage der Universität Erlangen wird eine Hybrid-Ionenquelle verwendet, die es erlaubt, 14C-AMS-Datierungen an festen und gasförmigen Proben vorzunehmen. Der Fokus bei der Messung gasförmiger Proben liegt dabei bei besonders kleinen Probenmengen und der Online-Messung gezielter organischer Komponenten von Proben mittels eines an die Ionenquelle gekoppelten Gaschromatographen und Massenspektrometers. Ein kritischer Punkt ist dabei die Ausbeute an erzeugten und für die AMS-Messung verwendbaren negativen Ionen. Die Erlanger Hybrid-Ionenquelle wurde deshalb mit dem Ziel einer erheblichen Leistungssteigerung umgebaut. Die Auswirkungen auf die AMS-Messung fester und gasförmiger Proben werden im Beitrag vorgestellt.

MS 5.4 Di 14:45 VMP 8 R05

Design eines zusätzlichen Ablenkmagneten für das 600kV PSI/ETH AMS System — •Arnold Müller, Marcus Christl, Max Döbeli, Peter W. Kubik, Martin Suter und Hans-Arno Synal — Labor für Ionenstrahlphysik, ETH Zürich, 8093 Zürich, Schweiz

Vor kurzem wurde gezeigt, dass das Radioisotop ^{10}Be kompetitiv bezüglich Untergrund und Transmission an der 600kV PSI/ETH AMS Anlage (TANDY) gemessen werden kann. Das Isobar ^{10}B wird nach der Passage einer 67-90nm dicken SiN Folie durch einen elektrostatischen Analysator (ESA) um vier Grössenordnungen reduziert. Ein hoch auflösender ΔE-E_{res} Gasionisationsdetektor unterdrückt daraufhin das im Strahl verbleibende Bor um weitere 4-6 Grössenordnungen. Das $^{10}Be/^9Be$ Untergrundniveau des Systems ist jedoch auf 10^{-13} limitiert durch ^9Be Ionen, welche durch Umladungs- und Streueffekte in den Detektor gelangen. Testmessungen mit einem zusätzlich zwischen ESA und Detektor montierten 90° Ablenkmagneten zeigten, dass der von ^9Be Ionen hervorgerufene Untergrund entfernt und ein $^{10}Be/^9Be$ Untergrundverhältnis von $<5{\cdot}10^{-15}$ realisiert werden kann. Aufgrund der energiefokussierenden Wirkung konnte zudem eine totale Transmission von 7 - 8% erreicht werden.
Daher wurde ein magnetisches Spektrometer mit 130° Ablenkwinkel konzipiert, welches eine achromatische Abbildung des Strahl von der SiN Abschwächer-Folie zum Detektor ermöglichen soll und auch für schwere Massen angewendet werden kann. Die ionenoptische Konzepte

und allfällige erste Messungen des erweiterten TANDY Systems sollen in diesem Beitrag präsentiert werden.

MS 5.5 Di 15:00 VMP 8 R05

Increasing the dynamic range of radiocarbon AMS — •Tim Schulze-König[1], Jason Giacomo[2], John Vogel[2], and Hans-Arno Synal[1] — [1]Ion Beam Physics, ETH Zurich, 8093 Zurich, Switzerland — [2]Vitalea Science, 95618 Davis, CA, USA

Whereas in radiocarbon dating efforts are done to minimize the background of an accelerator mass spectrometry (AMS) measurement, biomedical applications rather ask for an extension of the dynamic range on the upper end of the scale. Especially in the beginning of a ^{14}C-tracer study, samples may have $^{14}C/^{12}C$ ratios of up to 1000 fraction Modern Carbon (fMC). In a routine measurement procedure, those high ratios typically cause count rates of up to 100 kHz. Thus a detailed study of the detection system and its dead times becomes necessary. General considerations on dead times in detection systems as well as an analysis of the BioMICADAS detection system will be presented.

MS 5.6 Di 15:15 VMP 8 R05

Improvement of a 846 ion source — •Axel Steinhof — MPI für Biogeochemie, Hans-Knöll-Str. 10, 07745 Jena

At the Jena AMS system the 846 ion source was modified; e.g. the capacity of the target wheel was increased to 79 targets, and the Cs oven was redesigned to improve the temperature control. The modifications and the performance of the ion source will be reported.

MS 5.7 Di 15:30 VMP 8 R05

Micadas: A versatile radiocarbon dating system in routine operation — •Lukas Wacker[1], Irena Hajdas[1], Bernd Kromer[2], Mojmir Nemec[3], Matthias Ruff[3], and Hans-Arno Synal[1] — [1]Ion Beam Physics, ETH Zurich, Switzerland — [2]Heidelberg Academy of Sciences, Germany — [3]Department of Chemistry and Biochemistry, University of Bern, Switzerland

The mini carbon dating system (Micadas) at ETH Zürich was built 4 years ago. While it was mainly used for experimental development the first 3 years, we will now present our first experiences in routine operation for gaseous and solid radiocarbon samples.

We will show the prospects of the direct measurement of carbon dioxide with the gas ion source for either small samples or samples where low precision is required. Beyond that, we will demonstrate the excelled stability and reproducibility of the Micadas system on high-precision measurements of solid samples. This will end in a discussion about the perspectives of our mini radiocarbon dating system.

MS 5.8 Di 15:45 VMP 8 R05

Energy loss and straggling measurements for AMS — •Christof Vockenhuber, Vasily Alfimov, Arnold Müller, Martin Suter, and Hans-Arno Synal — ETH Zurich, Zurich, Switzerland

Energy loss in matter is important for particle identification in Accelerator Mass Spectrometry (AMS). Isobaric contamination can be identified by their different specific energy loss as it is usually done with ionization chambers at energies above 1 MeV/u, but other methods (e.g. passive absorption) are also used. At lower energies the energy-loss straggling increases relative to the difference in energy loss, thus becoming the limiting factor for particle identification.

While energy loss in matter is relatively well understood and predictions can be made with often sufficient precision, energy-loss straggling is more difficult to predict. In addition, measurements of energy-loss straggling in foils are often hampered by inhomogeneities leading to additional broadening of the energy distribution. At energies relevant for the small AMS systems TANDY and MICADAS energy loss and energy-loss straggling of heavy ions in highly homogeneous silicon nitride foils were measured previously [1].

We are extending these measurements to other materials and energies at and below the stopping power maximum. An improved data set should eventually lead to a better understanding of the physical processes and to improved predictions of energy-loss straggling.

[1] G. Sun *et al.*, Nucl. Instr. Meth. B 256 (2007) 586

MS 6: Laser-Resonanzionsation und REMPI

Zeit: Dienstag 16:00–16:45 Raum: VMP 8 R05

MS 6.1 Di 16:00 VMP 8 R05

RIMS of thorium isotopes - Towards a laser spectroscopic identification of the low-lying 7eV isomer of ^{229}Th — Juha Äystö[1], Iain Moore[1], Tina Gottwald[2], Thomas Kessler[1], Sebastian Raeder[2], •Volker Sonnenschein[1], and Klaus Wendt[2] — [1]University of Jyväskylä, Finland — [2]Johannes Gutenberg Universität, Mainz

High resolution gamma-spectroscopic experiments indicate a isomeric state ^{229m}Th, I= $\frac{3}{2}^+$ lying very closely above the ground state ^{229g}Th, I= $\frac{5}{2}^+$ with an excitation energy of only about 3.5-7 eV. These measurements used a differencing technique of the gamma-ray decay paths, while, however, direct observation of the decay of the isomer or its decay to the ground state was unsuccessful so far.
An alternative approach to gamma-spectroscopy would be identification of the isomer through a measurement of its corresponding hyperfine structure relative to the structure of the ground state. As a first step to achieve a highly sensitive detection of the isomer, an efficient laser ionization scheme of thorium was developed using stable ^{232}Th. A solid state titanium sapphire (Ti:Sa) laser system, including a wide-tunable grating-based Ti:Sa laser, was used to analyze a large energy region above the ionization potential in the search for transitions to autoionizing states.
As a next step, a suitable efficient scheme will be used for a study of the hyperfine structure of the ^{229}Th ground state. This investigation will utilize a seeded Ti:Sa laser for high-resolution resonance ionization spectroscopy measurements.

MS 6.2 Di 16:15 VMP 8 R05

Resonanzionisations-Massenspektrometrie zur Ultraspurenbestimmung von Neptunium — •Nils Stöbener[1], Tina Gottwald[2], Sebastian Raeder[2], Razvan Buda[1], Gerd Passler[2], Tobias Reich[1], Norbert Trautmann[1] und Klaus Wendt[2] — [1]Johannes Gutenberg-Universität Mainz, Institut für Kernchemie — [2]Johannes Gutenberg-Universität Mainz, Institut für Physik

Nach dem Zerfall der Spaltprodukte wird die Radiotoxizität abgebrannter Brennelemente primär durch minore Actiniden wie Plutonium und Neptunium bestimmt. Zur Sicherheitsbewertung eines Endlagers für hochradioaktive Abfälle ist deshalb eine genaue Kenntnis des geochemischen Verhaltens von Neptunium unter umweltrelevanten Bedingungen unabdingbar. Um das Ausbreitungsverhalten kleinster Mengen von Neptunium untersuchen zu können, werden entsprechend nachweisstarke und elementselektive Bestimmungsmethoden benötigt. Es wurde eine Methode entwickelt, die die Bestimmung geringster Mengen von Neptunium mit Resonanzionisations-Massenspektrometrie ermöglicht. Hierzu erfolgten zunächst umfangreiche spektroskopische Untersuchungen an Np-237, die zur Identifikation verschiedener dreistufig-resonanter Ionisationsschemata führten. In allen Anregungsleitern wird ein angeregter Zustand mit dem Licht eines frequenzverdoppelten Titan-Saphir-Lasers populiert, von dem ausgehend die Ionisation des Neptuniums (IP: 6,2655 eV) durch zweifache Anregung mit rotem bzw. infrarotem Laserlicht zweier weiterer Ti:Sa-Laser erfolgt. Die so erzeugten Laserionen werden in einem Flugzeitmassenspektrometer mit einem Kanalplattendetektor nachgewiesen.

MS 6.3 Di 16:30 VMP 8 R05

Selektiver Nachweis des Spurenisotops Uran-236 mittels HR-RIMS — •Sebastian Raeder[1], Silke Fies[1], Norbert Trautmann[2] und Klaus Wendt[1] — [1]Institut für Physik - Universität Mainz — [2]Institut für Kernchemie- Universität Mainz

Die Bestimmung des Ultraspurenisotopes ^{236}U in einer uranhaltigen Probe liefert einen wichtigen Hinweis auf Herkunft und Geschichte der untersuchten Probe. Diese anthropogene Signatur lässt sich, bedingt durch den niedrigen natürlichen Untergrund, auch bei einer geringen Kontamination nachweisen.

Die Methode der hochauflösenden Resonanzionisations - Massenspektrometrie (HR-RIMS) kombiniert eine selektive Laserionisati-

on mit der Massenauflösung herkömmlicher Massenspektrometer. Die Verwendung schmalbandiger Dauerstrich-Laser senkrecht zu dem Atomstrahl der evaporierten Probe erlaubt durch die Struktur der Atomhülle eine isotopenselektive Anregung und Ionisation. Durch ein Quadrupol-Massenspektrometer wird eine weitere Selektion der Masse und ein Abtrennen von Oberflächenionen erreicht. Diese Methode konnte mit synthetischen Proben bezüglich Untergrund, Selektivität und Effizienz charakterisiert werden. Die Bestimmung von Isotopenverhältnissen wurde bis in den Bereich $^{236}U/^{238}U < 5 \cdot 10^{-8}$ demonstriert. Aktuell werden Messungen von ersten Umweltproben vorbereitet.

MS 7: Poster

Zeit: Dienstag 16:00–18:00 Raum: VMP 9 Poster

MS 7.1 Di 16:00 VMP 9 Poster

The MPIK/UW-PTMS: a tool for a precision measurement of the ^{3}H/^{3}He mass ratio — •Christoph Diehl[1,2], David Pinegar[1], Robert Van Dyck Jr.[3], and Klaus Blaum[1,2] — [1]Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Germany — [2]Physikalisches Institut, Ruprecht-Karls-Universität, 69120 Heidelberg, Germany — [3]Department of Physics, University of Washington, Seattle, WA 98195-1560, USA

The MPIK/UW-PTMS (Max-Planck-Institut für Kernphysik/University of Washington-Penning trap mass spectrometer) is a high precision tool for the measurement of the ^{3}H/^{3}He mass ratio. A determination of this ratio to a precision of 1 part in 10^{11} would help the data analysis of the KATRIN (Karlsruhe tritium neutrino) experiment. The spectrometer was developed at the University of Washington, Seattle and is set up again at the Max-Planck-Institut für Kernphysik in Heidelberg. We present our measurement principle together with newly developed techniques. To minimize contaminations an external Penning ion source is utilized. The mass measurements are performed in a double Penning trap sitting in an ultrastable (field drift of only 17 ppt/h) 6-T magnet, where both a single ion of ^{3}H and ^{3}He will be stored and their masses are alternately measured. This will help to suppress long-term drift effects in the electric and magnetic fields of the spectrometer. The experiment is completely installed in Heidelberg and starts measurements in 2009.

MS 7.2 Di 16:00 VMP 9 Poster

Measurement principle and setup of detection electronics at the PENTATRAP project — •Christian Roux[1], Jose Crespo Lopez-Urrutia[1], Christoph Diehl[1], Sebastian George[1], Jens Ketelaer[2], Szilard Nagy[2], Yuri Novikov[3], David Pinegar[1], Wolfgang Quint[4], Julia Repp[1], Andreas Rosa[1], Stefan Ulmer[2], and Klaus Blaum[1] — [1]Max-Planck-Institut für Kernphysik, 69117 Heidelberg, Germany — [2]Institut für Physik, Johannes Gutenberg-Universität, 55128 Mainz, Germany — [3]St. Petersburg Nucl. Phys. Inst., 188300 Gatchina, Russia — [4]Helmholtzzentrum für Schwerionenforschung GmbH, 64291 Darmstadt

The PENTATRAP project is a new cryogenic Penning trap setup currently under construction at the MPI-K in Heidelberg. It is dedicated to mass measurements of single highly-charged ions. To achieve high precision, a stack of five cylindrical Penning traps will be utilized. Mass measurements will take place in the central precision trap. Additionally, there are two preparation traps, which enable a fast exchange of the ion of interest and the reference ion. On each end of the trap tower a monitor trap will be placed, where permanent storage of single ions and continuous observation of their cyclotron frequency is possible. For detection of the ions the non destructive image current technique will be applied for each trap. Therefore, the trap electrodes are connected to tuned circuits consisting of high-Q inductors followed by very low-noise cryogenic amplifiers or a SQUID.

On this poster the measurement process as well as the individual detection circuits and their present design status will be presented.

MS 7.3 Di 16:00 VMP 9 Poster

Quadrupole deflector of the double Penning trap system MLLTRAP [*] — •Eva Gartzke, Veli Kolhinen, Dietrich Habs, Jürgen Neumayr, Christian Schürmann, Jerzy Szerypo, and Peter Thirolf — Fakultät für Physik, LMU München and Maier-Leibnitz Laboratory, Am Coulombwall 1, 85748 Garching, Germany

A cylindrical double Penning trap has been installed and successfully commissioned at the Maier-Leibnitz Laboratory in Garching. This trap system has been designed to isobarically purify low energy ion beams and perform highly accurate mass measurements [1].

An electrostatic quadrupole deflector has been designed and installed at the injection line of the Penning trap system enabling a simultaneous use of an online ion beam with reference ions from an offline ion source. Alternatively two offline sources can be used concurrently e.g. an α recoil sources providing heavy radioactive species (e.g ^{240}U) together with reference mass ions (which in the future will be e.g. a carbon cluster ion source).

The bender has been designed for beam energies up to 1 keV with q/A ratios 1/1-1/250.

This presentation will show the technical design and the operating parameters of the quadrupole beam bender and its implementation at the MLLTRAP system.

[*] Supported by DFG under contract HA 1101/14-1.

[1] V.S. Kolhinen et al., Nucl. Instr. Meth B 266 (2008) 4547.

MS 7.4 Di 16:00 VMP 9 Poster

Carbon cluster mass calibration at the double Penning trap mass spectrometer TRIGA-TRAP — •Christian Smorra[1,2], Klaus Blaum[1,3], Klaus Eberhardt[2], Martin Eibach[5], Frank Herfurth[4], Jens Ketelaer[5], Jochen Ketter[5], Konstantin Knuth[5], and Szilard Nagy[3] — [1]Physikalisches Institut, Universität Heidelberg, D-69120 Heidelberg — [2]Institut für Kernchemie, Universität Mainz, D-55128 Mainz — [3]Max-Planck Institut für Kernphysik, D-69117 Heidelberg — [4]GSI Helmholtzzentrum für Schwerionenforschung GmbH, D-64291 Darmstadt — [5]Institut für Physik, Universität Mainz, D-55128 Mainz

TRIGA-TRAP is a facility which aims for mass measurements on neutron-rich short-lived fission products and actinides with relative mass uncertainties of 10^{-7} and below [Ket08]. To this end the cyclotron frequency of a stored ion in a Penning trap is determined. In high-precision mass spectrometry the investigation of systematic errors is of utmost importance. In order to demonstrate the accuracy of the measured values, various carbon cluster ions have been used in cross reference measurements. The results will be presented and the accuracy limit of TRIGA-TRAP is going to be discussed.

[Ket08] J. Ketelaer et al., Nucl. Instr. Meth. A 594 (2008) 162-177.

MS 7.5 Di 16:00 VMP 9 Poster

Manipulation der Ionenbewegung in einer 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. Bei geeigneten Fallenparametern erfahren die Ionen im zeitlichen Mittel eine zum Fallenzentrum rücktreibende lineare Kraft. Mittels Einstrahlung weiterer Hochfrequenzfelder können die Ionenbewegungen beeinflusst werden. Zusätzlich zum Studium axialer Anregungsmoden wurden Untersuchungen zu radialen Anregungstypen sowohl in Simulationen als auch im Experiment durchgeführt.

MS 7.6 Di 16:00 VMP 9 Poster

Design of a switchable low-noise power supply — •Jochen Ketter[1], Klaus Blaum[2], Jens Ketelaer[1], Szilard Nagy[2], and Sven Sturm[1] — [1]Institut für Physik, Johannes Gutenberg-Universität, 55099 Mainz, Germany — [2]Max-Planck-Institut für Kernphysik, 69117 Heidelberg, Germany

Triga-Trap [1] aims at mass measurements of heavy ions and neutron-rich fission products. Such on-line mass measurements using small-band and broad-band Ft-Icr in this setup, also allowing for the traditional Tof-Icr method, are particularly challenging. The voltages applied to the trap's electrodes must be switched within the order of 100 ns for capture and optional ejection, while remaining stable with low noise during the detection of image currents. Switching requires a supply with high power output, but comparatively long idle time with

constant trapping voltage does not warrant a fully-featured amplifier. The double-headed approach to the problem capitalizes on these peculiarities to design a power supply specially tailored to the needs of on-line FT-ICR detection. An electronic switch is at the heart of the power supply. The precision output voltage in the range of ±200 V is set by a regulator operating a push-pull stage with its own high-voltage supply. The principle of each component and first results will be presented.

[1] J. Ketelaer *et al.*, Nucl. Instr. Meth. A, 594 (2008) 162–177

MS 7.7 Di 16:00 VMP 9 Poster

Entwicklung einer direkten Online-Einbringung für die Resonazionisations - Massenspektrometrie — •SILKE FIES[1], SEBASTIAN RAEDER[1], NORBERT TRAUTMANN[2] und KLAUS WENDT[1] — [1]Institut für Physik - Universität Mainz — [2]Institut für Kernchemie- Universität Mainz

Die Methode der hochauflösenden Resonanzionisations-Massenspektrometrie (HR-RIMS) erlaubt durch die gezielte Nutzung der atomaren Hüllenstruktur eine element- und isotopenselektive Ionisation mittels schmalbandiger frequenzstabilisierter cw-Laser. Für die Ultraspurenanalyse am ^{236}U wurden Selektivitäten von $> 10^9$ erreicht und ^{236}U / ^{238}U-Isotopenverhältnisse bis in den Bereich von $< 10^{-8}$ mit ausreichender Präzision bestimmt.

Um den Zeitaufwand des Probenwechsels im Hinblick auf Routinemessungen zu reduzieren, wurde eine direkte Einbringung für flüssige Proben über eine Kapillare in die HR-RIMS entwickelt und für erste spektrometrische Untersuchungen genutzt. Eine solche direkte Einbringung erlaubt zusätzlich eine Kopplung der isotopenselektiven HR-RIMS mit speziesselektiven chromatographischen Trennmethoden wie der High Performance Liquid Chromatography (HPLC) oder der Kapillarelektrophorese (CE).

MS 7.8 Di 16:00 VMP 9 Poster

An electrostatic mass separator for ISOLTRAP — •ROBERT WOLF[1], M. BREITENFELDT[1], ALEXANDER HERLERT[2], GERRIT MARX[1], and LUTZ SCHWEIKHARD[1] — [1]Inst. f. Physik, Ernst-Moritz-Arndt-Universität, D-17489 Greifswald — [2]Physics Department, CERN, 1211 Geneva 23, Switzerland

An electrostatic ion beam trap was built as a test device for future separation and removal of isobaric ions at ISOLTRAP. Electrostatic ion beam traps consist of two ion mirrors between which ions are oscillating and are separated by their mass-over-charge ratio m/q. Flight paths of several hundreds of meters are folded to an apparatus length of less than one meter. It is planned to install the device at the ISOLTRAP experiment at CERN/Geneva to support the contamination removal of isobaric masses caused by the production of short-lived nuclides at the ISOLDE facility. First tests resulted in a mass resolving power of up to $m/\Delta m \approx 10^5$ and the separation was demonstrated for the isobaric ions CO and N_2. Further improvements concerning trapping techniques will be presented, in particular with respect to the injection and ejection of ions without switching the mirror potentials.

MS 8: Speicherringe, ICP-MS, Neue Entwicklungen

Zeit: Mittwoch 14:00–16:00 Raum: VMP 8 R05

MS 8.1 Mi 14:00 VMP 8 R05

Time dependence of two-body weak decays of highly-charged single ions in the ESR Storage Ring of GSI Darmstadt — •N. WINCKLER[1,2], K. BECKERT[1], F. BOSCH[1], D. BOUTIN[1,2], C. BRANDAU[1], L. CHEN[1,2], C. DIMOPOULOU[1], H.G. ESSEL[1], B. FABIAN[2], THOMAS FAESTERMANN[3], H. GEISSEL[1,2], E. HAETTNER[2], S. HESS[1], P. KIENLE[3,4], RONJA KNOEBEL[1,2], C. KOZHUHAROV[1], J. KURCEWICZ[1], N. KUZMINCHUK[2], S.A. LITVINOV[1,2], Y.A. LITVINOV[1,2], L. MAIER[3], M. MAZZOCCO[1], F. MONTES[1], P. MORITZ[1], A. MUSUMARRA[5], C. NOCIFORO[1], F. NOLDEN[1], T. OHTSUBO[6], W. PLASS[2], A. PROCHAZKA[1], R. REDA[4], R. REUSCHL[1], C. SCHEIDENBERGER[1,2], U. SPILLMANN[1], M. STECK[1], T. STOEHLKER[1], B. SUN[1,7], T. SUZUKI[8], S. TORILOV[9], M. TRASSINELLI[10], H. WEICK[1], M. WINKLER[1], D. WINTERS[1], and T. YAMAGUCHI[8] — [1]Gesellschaft für Schwerionenforschung GSI, Darmstadt, Germany — [2]Justus-Liebig-Universität Gießen, Gießen, Germany — [3]Technische Universität München, Garching, germany — [4]Stefan Meyer Institut für subatomare Physik, Vienna, Austria — [5]INFN-LNS Catania, Italy — [6]Department of Physics, Niigata university, Niigata, Japan — [7]Peking University, Beijing, China — [8]Department of Physics, Saitama university, Saitama, Japan — [9]St. Petersburg State University, St. Petersburg, — [10]Institut des NanoSciences de Paris, CNRS-UPMC, Paris, France

Nuclear decay properties have been well established from the studies of neutral atoms. However, the decay modes of highly-charged ions can be dramatically modified. Experimental studies can be performed in ion-storage rings or ion traps where the high-vacuum conditions are the prerequisite to preserve high charge states.

In this contribution we discuss experiments on orbital electron capture (EC) decay of hydrogen-like ions. These experiments have been performed at the FRS-ESR facility of GSI. Hydrogen-like ^{140}Pr, ^{142}Pm, and ^{122}I ions have been separated in-flight by the FRagment Separator FRS and injected, stored and cooled in the Experimental Storage Ring ESR. Using time-resolved Schottky Mass Spectrometry, a non-destructive and highly sensitive technique, the fate of each stored ion can be investigated.

Decay events accounting for nuclear electron capture processes have been unambiguously identified and the time between production and decay has been measured. The obtained results show a significant deviation from the expected exponential decay. The interpretation of this effect is widely disputed in literature and will be discussed.

MS 8.2 Mi 14:15 VMP 8 R05

Investigation of the Isochronous Mode of the ESR — •SERGEY LITVINOV, ALEKSEY DOLINSKII, H. GEISSEL, F. NOLDEN, M. STECK, and H. WEICK — GSI, 64291, Darmstadt, Germany

The isochronous mode of a storage ring is a special ion-optical setting in which the revolution time of circulating ions of one species does not depend of their velocity spread. In this mode the ring can be used as a Time-Of-Flight (TOF) mass spectrometer.

Isochronous Mass Spectrometry (IMS) is an experimental technique for direct measurements of short-lived exotic nuclei which has been developed at the FRS-ESR facility at GSI.

A bottleneck for the present IMS experiments is the low transmission from the FRS to the ESR due to ion-optical mismatch between both systems. Besides transmission, dispersion mismatch negatively influences the isochronicity. For the first time, the ion-optical matching of the FRS-ESR in the isochronous mode has been calculated and experimentally verified. The experimental results and perspectives of further improvements will be presented.

Additionally, the influence of the transverse motion on the isochronicity has been studied and the corresponding calculation results will be shown. Possible improvements of the isochronous mode of the ESR will be outlined.

MS 8.3 Mi 14:30 VMP 8 R05

Isochronous Mass Measurements of Neutron-Rich Fission Fragments at the FRS-ESR Facility — •RONJA KNÖBEL[1,2], K. BECKERT[1], F. BOSCH[1], D. BOUTIN[1,2], C. BRANDAU[1], L. CHEN[1,2], I. J. CULLEN[3], C. DIMOPOULOU[1], ALEKSEY DOLINSKII[1], B. FABIAN[1,2], H. GEISSEL[1,2], M. HAUSMANN[4], O. KLEPPER[1], C. KOZHUHAROV[1], J. KURCEWICZ[1], S. A. LITVINOV[1,2], Y. A. LITVINOV[1,2], Z. LIU[3], M. MAZZOCCO[1], F. MONTES[4], G. MÜNZENBERG[1], A. MUSUMARRA[5], S. NAKAJIMA[6], C. NOCIFORO[1], F. NOLDEN[1], T. OHTSUBO[7], A. OZAWA[8], Z. PATYK[9], W. PLASS[1,2], C. SCHEIDENBERGER[1,2], M. STECK[1], B. SUN[1,10], T. SUZUKI[6], P. M. WALKER[3], H. WEICK[1], N. WINCKLER[1,2], M. WINKLER[1], and T. YAMAGUCHI[6] — [1]GSI Helmholtzzentrum für Schwerionenforschung GmbH, 64291 Darmstadt, Germany — [2]Justus-Liebig-Universität Gießen, 35392 Gießen, Germany — [3]University of Surrey, Guildford, GU2 7XH, U. K. — [4]Michigan State University, East Lansing, Mi 48824, U.S.A. — [5]Laboratori Nazionali del Sud, INFN Catania, Italy — [6]Saitama University, 338-8570 Saitama, Japan — [7]Niigata University, Niigata 950-2181, Japan — [8]University of Tsukuba, Tsukuba 305-8577, Japan — [9]Soltan Institute for Nuclear Studies, 00-681 Warszawa, Poland — [10]School of Physics, Peking University, Beijing 100871, China

Accurate mass measurements of exotic nuclei give insight into basic nuclear properties important for the understanding of nuclear structure and astrophysics. The unique combination of the fragment separator

FRS and the cooler-storage ring ESR has been used for the investigations of short-lived neutron-rich masses of ^{238}U-fission fragments via Isochronous Mass Spectrometry (IMS). The method has been extended with an additional magnetic rigidity determination. Masses for 14 nuclides have been obtained for the first time. The experimental setup, the data analysis, and the results will be presented.

MS 8.4 Mi 14:45 VMP 8 R05

The electron target for the CSR — •Andrey Shornikov[1], Alexandr S. Jaroshevich[2], Claude Krantz[1], Klaus Blaum[1], Andreas Wolf[1], and Dmitry A. Orlov[1] — [1]Max-Planck-Institut für Kernphysik, Heidelberg, Germany — [2]Institute of Semiconductor physics, Novosibirsk, Russia

An ultralow energy photoelectron cooler for the novel cryogenic electrostatic storage ring CSR is under development. The electron device will serve as a major tool for electron-ion collision studies and for phase space cooling of 20-300 keV (E/Q, charge number Q) ions in velocity matched electron and ion beams. Electrons in energy range from 165 eV (matched to 20 keV protons) down to a fraction of eV (matched to heavy molecules of mass up to 160 A/Q) will be confined by 30-150 Gauss guiding magnetic field in a newly developed configuration[1]. The key points related to ultralow energy cooling operation [2] (maximal gun current at the low energies, minimal longitudinal temperature) have been taken into account and were recently studied by experiments at the TSR e-target. Adiabatic beam transport has been simulated by the TOSCA code. In this talk we present experimental and simulation results as well as the mechanical and cryogenic concept of the CSR electron target.

[1] H. Fadil et al Proc. EPAC2006 pp 1630-1632
[2] D. Orlov et al. Proc COOL05 (2005) pp 478-487

MS 8.5 Mi 15:00 VMP 8 R05

Electron-capture decay probability for highly-charged single ions — •Nicolas Winckler for the GSI-oscillations collaboration — Gesellschaft für Schwerionenforschung GSI, 64291 Darmstadt, Germany — Justus-Liebig-Universität Gießen, 35392 Gießen, Germany

Nuclear decay properties have been well established from the studies of neutral atoms. However, the decay modes of highly-charged ions can be dramatically modified. Experimental studies can be performed in ion-storage rings or ion traps where the high-vacuum conditions are the prerequisite to preserve high charge states.

In this contribution we discuss experiments on orbital electron capture (EC) decay of hydrogen-like ions. These experiments have been performed at the FRS-ESR facility of GSI. Hydrogen-like ^{140}Pr, ^{142}Pm, and ^{122}I ions have been separated in-flight by the FRagment Separator FRS and injected, stored and cooled in the Experimental Storage Ring ESR. Using time-resolved Schottky Mass Spectrometry, a non-destructive and highly sensitive technique, the fate of each stored ion can be investigated.

Decay events accounting for nuclear electron capture processes have been unambiguously identified and the time between production and decay has been measured. The obtained results show a significant deviation from the expected exponential decay. The interpretation of this effect is widely disputed in literature and will be discussed.

MS 8.6 Mi 15:15 VMP 8 R05

CSR: a new tool for storage and cooling of keV ion beams — •Michael Froese[1], Klaus Blaum[1], Jose Crespo López-Urrutia[1], Florian Fellenberger[1], Manfred Grieser[1], Oded Heber[2], Dirk Kaiser[1], Michael Lange[1], Felix Laux[1], Sebastian Menk[1], Dmitry A. Orlov[1], Michael Rappaport[2], Roland Repnow[1], Claus D. Schröter[1], Dirk Schwalm[1], Thomas Sieber[1], Jonathan Toker[2], Joachim Ullrich[1], Jozef Varju[1], Robert von Hahn[1], Andreas Wolf[1], and Daniel Zajfman[2] — [1]Max-Planck-Institut für Kernphysik, 69117 Heidelberg, Germany — [2]Weizman Institute of Science, Rehovot, 76100, Israel

An electrostatic Cryogenic Storage Ring (CSR) is currently being built in Heidelberg, Germany. The current status and final design of this ring, with a focus on the optimized 2 K chamber cooling, precision chamber suspension, and pumping down to extremely low pressures via cryogenic vacuum chambers will be presented. This ring will allow long storage times of highly charged ion and polyatomic molecular beams with energies in the range of keV per charge-state. Combining the long storage times with vacuum chamber temperatures approaching 2 K, infrared-active molecular ions will be radiatively cooled to their rotational ground states. Many aspects of this concept were experimentally tested with a cryogenic trap for fast ion beams (CTF), which has already demonstrated the storage of fast ion beams in a large cryogenic device. An upcoming test will investigate the effect of pre-baking the cryogenic vacuum chambers to 600K on the cryogenic vacuum and the ion beam storage.

MS 8.7 Mi 15:30 VMP 8 R05

Multicollector-ICP-Mass Spectrometry for Trace Analysis of Silicon Crystals — •Axel Pramann, Olaf Rienitz, and Detlef Schiel — Physikalisch-Technische Bundesanstalt, Braunschweig, Germany

The measurement of the molar mass of highly pure silicon is a challenging task of an international project for the re-determination of the Avogadro constant[1] on a relative uncertainty level of 10^{-8}. At PTB a MC-ICP-Mass Spectrometer (*Neptune*$^{\mathrm{TM}}$, ThermoFinnigan) is used to measure isotope ratios ^{28}Si/^{29}Si and ^{30}Si/^{29}Si of the silicon WASO17 crystal. This experiment is used to validate and optimize the current data received by gas mass spectrometry at IRMM.[1] Based on a new method for the analytical determination of calibration (K) factors which will be described elsewhere, both the principal proof of the ability of this method as well as a new chemical preparation route in combination with MC-ICP-MS has been demonstrated for the first time. The reported method shows the ability of the determination of molar masses traceable to the SI units. Details of the experiment and the way of sample preparation are described. First measurements show a repeatability of the K factors in the range of $s_{\mathrm{rel}} = 0.1 \ldots 0.4$ %. The abundance of Si isotopes ^{28}Si, ^{29}Si, and ^{28}Si in various Si crystal samples is determined by applying the K factors. Isotope ratios show standard uncertainties $u_{\mathrm{rel}}(^{30}\mathrm{Si}/^{29}\mathrm{Si}) = 0.13$ % and $u_{\mathrm{rel}}(^{28}\mathrm{Si}/^{29}\mathrm{Si}) = 0.6$ %. The study is completed with an uncertainty budget according to the guide to the expression of uncertainty in measurement (GUM).

[1]P. Becker, Metrologia **40**, 366 (2003).

MS 8.8 Mi 15:45 VMP 8 R05

Eine puffergasgefüllte Quadropolfalle zu selektiven Unterdrückung angeregter Zustände des Si$^-$ — •Tina Gottwald[1], Oliver Forstner[2], Dag Hanstorp[3], Anton Lindahl[3], Yuan Liu[4] und Klaus Wendt[1] — [1]Universität Mainz, Institut für Physik, Staudinger Weg 7, 55128 Mainz — [2]VERA Laboratory, Faculty of Physics, Universität Wien, Vienna, Austria — [3]Department of Physics, Göteborg University, SE-412 96 Göteborg, Sweden — [4]Physics Division, Oak Ridge National Laboratory, Oak Ridge TN, USA

Eine selektive Kühlung angeregter Zustände ist in Präzisionsexperimenten mit negativen Ionen oder Molekülen wünschenswert, z.B. zur genauen Bestimmung der Elektronenaffinität oder in Kollisionsexperimenten, in denen ein zustandsreiner Strahl im Grundzustand eingesetzt werden soll. Am Oak Ridge National Laboratory (ORNL) wurden Studien zur Kühlung angeregter Zustände des negativen Silizium Ions in einer puffergasgefüllten Quadrupolfalle durchgeführt. Ergänzend wurde die selektive Laserphotoneutralisation angeregter Energiezustände untersucht. Hierzu wurde der in einer Sputterionenquelle erzeugte Si$^-$ Ionenstrahl zunächst massenselektiert; hiernach enthält dieser ein Gemisch des Grundzustands sowie angeregter Zustände des negativen Ions. Zur Photoneutralisation der angeregten Zustände des Si$^-$ standen zwei Nd:YAG Laser, kontinuierlich bzw. mit 20 Hz gepulst, zur Verfügung. Angeregte Zustände des Si$^-$ wurden in der Kühlerfalle in Kombination mit selektiver Laserphotoneutralisation effizient unterdrückt.