Mass Spectrometry Division (MS)

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Overview of Invited Talks and Sessions

(lecture room F 428; poster Lichthof)

Invited Talks

MS 1.1	Mo	14:00–14:30	F 428	**Resonanzionisationsmassenspektrometrie (RIMS) zur isotopenselektiven Ultraspurenanalyse von langlebigen Radionukliden** — •Nicole Erdmann
MS 1.2	Mo	14:30–15:00	F 428	**ESI-MS for nuclear safety assessment: Polymerization of plutonium** — •Clemens Walther
MS 2.1	Mo	16:30–17:00	F 428	**Cold electron collisions at ion storage rings** — •Andreas Wolf
MS 2.2	Mo	17:00–17:30	F 428	**Photodissociation of dipeptide cations in an electrostatic ion storage ring** — •Steen Brøndsted Nielsen
MS 3.1	Tu	14:00–14:30	F 428	**TOF-Bρ mass measurements of neutron rich nuclei at the NSCL** — •Sebastian George, Alfredo Estrade, Milan Matoš, Mathew A. Amthor, Daniel Bazin, Ana D. Becerril, Thom J. Elliot, Alexandra Gade, Daniel Galaviz, Giuseppe Lorusso, Jorge Pereira, Mauricio Portillo, Andrew Rogers, Hendrik Schatz, Dan Shapira, Edward Smith, Andreas Stolz, Mark S. Wallace
MS 4.1	We	10:30–11:00	F 428	**Retrospektive Dosimetrie der I-131 Exposition nach dem Reaktorunfall von Tschernobyl mittels AMS-Messung von I-129 in Böden** — •Rolf Michel, Abdelouahed Daraoui, Jens Korntheuer, Monika Gorny, Dieter Jakob, Rüdiger Sachse, Vasily Alfimov, Hans-Arno Synal
MS 5.1	We	14:00–14:30	F 428	**Progress in Mass Spectrometry of Exotic Nuclei at the FRS-ESR Facility at GSI** — •Wolfgang Plass
MS 5.2	We	14:30–15:00	F 428	**Mass measurements on neutron-rich fission products and actinoids at Triga-Trap** — •J. Ketelaer, T. Beyer, M. Block, K. Eberhardt, M. Eibach, F. Herfurth, Sz. Nagy, C. Smorra, W. Nörtershäuser, K. Blaum

Invited talks of the symposium S-AMOP Dissertationspreis (SYDP)

See SYDP for the full program of the Symposium.

SYDP 1.1	Mo	16:30–17:00	F 107	**Experimental all-optical one-way quantum computing** — •Robert Prevedel
SYDP 1.2	Mo	17:00–17:30	F 107	**Benchmarks and statistics of entanglement dynamics** — •Markus Tiersch
SYDP 1.3	Mo	17:30–18:00	F 107	**Squeezed Light For Gravitational Wave Astronomy** — •Henning Vahlbruch
SYDP 1.4	Mo	18:00–18:30	F 107	**High-precision mass measurements with Penning traps** — •Sebastian George

Invited talks of the joint symposium 50 Years of Lasers (SYLA)

See SYLA for the full program of the Symposium.

SYLA 1.1	We	14:00–14:30	E 415	**How the laser happend** — •Herbert Welling
SYLA 1.2	We	14:30–15:00	E 415	**The origin of the quantum theory of lasing** — •Fritz Haake

SYLA 1.3	We	15:00–15:30	E 415	**Lasers for precision measurements** — •Thomas Udem
SYLA 1.4	We	15:30–16:00	E 415	**Short, Ultra Short, Atto Short** — •Dietrich von der Linde
SYLA 2.1	We	16:30–17:00	E 415	**Our Daily Life with Semiconductor Lasers** — •Dieter Bimberg
SYLA 2.2	We	17:00–17:30	E 415	**Power to the Industry - the story of Laser upscaling** — •Reinhart Poprawe
SYLA 2.3	We	17:30–18:00	E 415	**The Outstanding Qualities of Fiber Lasers and Thin Disk Lasers** — •Adolf Giesen
SYLA 2.4	We	18:00–18:30	E 415	**Solid State Lasers:meeting the challenges of the 21st Century** — •Robert L. Byer

Invited talks of the joint symposium New Methods of Mass Spectroscopy and their Application in the Environmental Science (SYMS)

See SYMS for the full program of the Symposium.

SYMS 1.1	Th	10:30–11:00	A 001	**Mass spectrometric measurements of atmospheric trace gases and ions** — •Frank Arnold
SYMS 1.2	Th	11:00–11:30	A 001	**What do cosmogenic radionuclides in polar ice cores tell us?** — •Juerg Beer
SYMS 1.3	Th	11:30–12:00	A 001	**Aerosol-Massenspektrometrie: Techniken, Möglichkeiten, Grenzen** — •Frank Drewnick
SYMS 1.4	Th	12:00–12:30	A 001	**Organic compounds in the atmosphere: insights from Isotope Mass Spectrometry** — •Astrid Kiendler-Scharr, Iulia Gensch, Thorsten Hohaus, Beatrix Kammer, Werner Laumer
SYMS 2.1	Th	14:00–14:30	A 001	**Cosmogenic and anthropogenic radionuclides in the Earth Surface Sciences** — •Tibor Dunai
SYMS 2.2	Th	14:30–15:00	A 001	**Pushing the limits of high-precision radiocarbon measurements** — •Lukas Wacker, Georges Bonani, Irena Hajdas, Bernd Kromer, Hans-Arno Synal
SYMS 2.3	Th	15:00–15:30	A 001	**Precise and accurate analysis of U-series isotopes by MC-ICPMS** — •Denis Scholz
SYMS 2.4	Th	15:30–16:00	A 001	**Progress of inorganic mass spectrometry in environmental and life sciences** — •J. Sabine Becker

Invited talks of the joint symposium Precision Spectroscopy of Highly Ionized Matter (SYPS)

See SYPS for the full program of the Symposium.

SYPS 1.1	Fr	11:00–11:30	A 001	**Status of QED tests in heavy highly charged ions** — •Paul Indelicato
SYPS 1.2	Fr	11:30–12:00	A 001	**Penning trap mass spectrometry with highly charged ions** — •Szilard Nagy
SYPS 1.3	Fr	12:00–12:30	A 001	**Diagnostic of Hot Dense Plasmas by Advanced XUV and X-ray Spectroscopy** — •Ingo Uschmann
SYPS 1.4	Fr	12:30–13:00	A 001	**Measurements of masses and beta-lifetimes of stored exotic highly charged ions** — •Fritz Bosch
SYPS 2.1	Fr	14:00–14:30	A 001	**Exciting and ionizing trapped highly charged ions with electrons and photons in an EBIT** — •José R. Crespo Lopéz-Urrutia
SYPS 2.2	Fr	14:30–15:00	A 001	**Precision x-ray spectroscopy of intense laser-plasma interaction experiments** — •Nigel Woolsey

Sessions

MS 1.1–1.6	Mo	14:00–16:00	F 428	**Laser-Resonanzionisation, REMPI und MALDI**
MS 2.1–2.8	Mo	16:30–19:00	F 428	**Speicherringe und neue Entwicklungen**
MS 3.1–3.7	Tu	14:00–16:00	F 428	**Neue massenspektrometrische Methoden und Entwicklungen**
MS 4.1–4.9	We	10:30–13:00	F 428	**Beschleunigermassenspektrometrie und Anwendungen I**
MS 5.1–5.6	We	14:00–16:00	F 428	**Präzisionsmassenspektrometrie und Anwendungen I**
MS 6.1–6.9	We	16:30–18:45	F 428	**Beschleunigermassenspektrometrie und Anwendungen II**
MS 7.1–7.7	Th	10:30–12:30	F 428	**Präzisionsmassenspektrometrie und Anwendungen II**
MS 8.1–8.18	Th	16:00–18:00	Lichthof	**Poster**

MS 9.1–9.9 Fr 10:30–13:00 F 428 **Ionenfallen und FT-IZR-MS, Moleküle, Cluster und Reaktionen**

Mitgliederversammlung Fachverband Massenspektrometrie

Dienstag 16:00–16:30 F 428

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

MS 1: Laser-Resonanzionisation, REMPI und MALDI

Time: Monday 14:00–16:00 Location: F 428

Invited Talk MS 1.1 Mo 14:00 F 428

Resonanzionisationsmassenspektrometrie (RIMS) zur isotopenselektiven Ultraspurenanalyse von langlebigen Radionukliden — •Nicole Erdmann — European Commission Joint Research Center, Institute for Transuranium Elements, P.O. Box 2340, D-76125 Karlsruhe

Die Resonanzionisationsmassenspektrometrie (RIMS) ist aufgrund ihrer ausgezeichneten Element- und Isotopenselektivität und ihrer hohen Empfindlichkeit sehr gut für die Ultraspurenanalyse langlebiger Radionuklide geeignet. Für die Analyse von Plutonium und anderen Aktiniden wurde ein gepulstes, Nd:YAG-Laser gepumptes Titan-Saphir-Lasersystem entwickelt und mit einem Flugzeit-Massenspektrometer gekoppelt. Für das jeweils untersuchte Element erhält man durch Spektroskopie effektive Anregungs- und Ionisationsschemata sowie Informationen über die Isotopieverschiebungen in dem jeweiligen Schema. Für Plutonium wird eine Nachweisgrenze von 2 x 1E6 Atomen für ein einzelnes Isotop erreicht. Die Anwendung der RIMS für die Ultraspurenanalyse und die Messung von Plutonium-Isotopenverhältnissen in verschiedenartigen Umweltproben wird beschrieben. Die Bestimmung der Isotopenzusammensetzung von Plutonium ermöglicht Aussagen über dessen Herkunft. Erste Ergebnisse der Weiterentwicklung des Systems zur Analyse von aktinidenhaltigen Mikropartikeln werden vorgestellt, wo durch Kopplung von Ionenstrahlsputtern mit resonanter Nachionisation der erzeugten Neutralteilchen das Problem isobarer Interferenzen, wie es bei SIMS auftritt, elegant überwunden wird.

Invited Talk MS 1.2 Mo 14:30 F 428

ESI-MS for nuclear safety assessment: Polymerization of plutonium — •Clemens Walther — Institut für Nukleare Entsorgung, Karlsruher Institut für Technologie, Postfach 3640 D-76021 Karlsruhe, Germany

The safety assessment of prospective deep geological nuclear waste disposal sites such as Gorleben (or the research salt mine Asse) requires detailed knowledge of aqueous chemistry of radionuclides. Water intrusion into the repository may lead to leaching processes and migration of radionuclides. Among these the long lived actinides 241 americium and 239 plutonium (half lifes 430y and 24000y, respectively) are of particular relevance. Since man made containers cannot be expected to stand $>$ 250000 y (10 half lifes) immobilizing processes (such as sorption or incorporation into the host matrix) and mobilizing processes (volatility or colloid mediated transport) must be understood on a molecular level. Repository conditions must be chosen such as to favor immobilizing conditions over geological timescales. In the present work polymerization processes of tetravalent actinides (the most prominent example being 239Pu) are investigated by high resolution nano-electrospray mass spectrometry. Polymerization may lead to formation of colloids and subsequent efficient transport as recently demonstrated in the case of former Nevada nuclear weapons test sites and a Russian reprocessing plant. Hence, conditions must be chosen to inhibit these reaction path ways.

MS 1.3 Mo 15:00 F 428

Ultraspurenanalyse von Uranisotopen mittels hochauflösender Resonanzionisations-Massenspektrometrie — •Amin Hakimi[1], Sebastian Raeder[1], Klaus Wendt[1] und Norbert Trautmann[2] — [1]Institut für Physik, Universität Mainz — [2]Institut für Kernchemie, Universität Mainz

Die Isotopenzusammensetzung einer uranhaltigen Probe, insbesondere die Häufigkeit des Uranisotops U-236, liefert wichtige Informationen über ihre Historie und Herkunft. Natururan weist einen Gehalt von $<$10 ppb an U-236 auf. Da das extrem seltene Isotop U-236 durch Neutroneneinfang aus U-236 gebildet wird, korreliert die Isotopenhäufigkeit von U-236 mit der integralen Neutronenflussdichte, der das Material ausgesetzt war. Mit diesem Indikator kann man anthropogene Uraneinträge in die Umwelt, z.B. aus Kernbrennstoff, nachweisen.

Mit der hochauflösenden Resonazionisations-Massenspektrometrie (HR-RIMS) steht ein hochselektives Verfahren zum Ultraspurennachweis zur Verfügung. In einem Prototypsystem konnte die Leistungsfähigkeit der Methode zum Ultraspurennachweis von 236U prinzipiell demonstriert werden. Ziel ist nun, die Methode weiter zu optimieren, zu charakterisieren und zur Einsatzreife zu bringen. Zu diesem Zweck ist eine Umstellung auf ein Resonanzionisationsschema geplant, das mit kommerziellen Diodenlasern angeregt werden kann. Durch Weiterentwicklung des Atomisierungsofens sollen die Probeneinbringung und damit die Effizienz verbessert werden. Mit diesen Voraussetzungen ist der Übergang zu quantitativer Analytik, wie z.B. Messungen der Isotopenzusammensetzung in randomisierten Umweltproben, möglich.

MS 1.4 Mo 15:15 F 428

Bestimmung von Isotopenverhältnissen in U und Pu durch RIMS — •Raeder Sebastian[1], Amin Hakimi[1], Nils Stöbener[2], Norbert Trautmann[2], Tobias Reich[2] und Klaus Wendt[1] — [1]WA LARISSA, Institut für Physik, Universität Mainz — [2]Institut für Kernphysik, Universität Mainz

Für die Überwachung von Kontaminationen mit radioaktiven Material aus dem Kernbrennstoffkreislauf in der Umwelt ist die quantative Analyse von Aktiniden evon besonderer Bedeutung. Insbesondere die Bestimmung von Plutonium- und Urangehalten, sowie die genaue Kenntnis der Isotopenzusammensetzung liefern einen wichtigen Aufschluss über Herkunft und Geschichte der untersuchten Probe. Für die Bestimmung geringster Spuren dieser Aktinide ist eine hohe Nachweiseffizienz der Bestimmungsmethode und eine gute Selektivität gegenüber isobaren Kontaminationen unerlässlich. Die Methode der Resonanzionisations - Massenspektrometrie (RIMS) kombiniert eine selektive Ionisation durch Laserstrahlung mit der Massenauflösung herkömmlicher Massenspektrometer. Unter Verwendung gepulster, spektral breitbandiger gepulster Lasersysteme für die resonante Ionisation in einer heissen Laserionenquelle erreicht man hohe Ionisationseffizienzen und durch die Kombination mit einem Quadrupol-Massenspektrometer eine adäquate Massenauflösung. Das System wurde mit synthetischen Proben charakterisiert während erste Messungen von Umweltproben in Vorbereitung sind. Der aktuelle Status des Projekts sowie geplante Verbesserungen werden vorgestellt.

MS 1.5 Mo 15:30 F 428

Two-photon spectroscopy inside a hot cavity — •Christoph Mattolat[1], Hideki Tomita[2], Tina Gottwald[1], Sebastian Raeder[1], Sebastian Rothe[3], Fabio Schwellnus[1], and Klaus Wendt[1] — [1]Johannes Gutenberg-Universität, Mainz — [2]Nagoya University, Nagoya, Japan — [3]Cern, Genf, Schweiz

At on-line isotope separators like ISOLDE/Cern access to the study of exotic radioisotopes is given. A severe limitation for any spectroscopic investigations is the life time of the isotope of interest. Therefore, in-source resonance ionization spectroscopy is performed to access extremly short lived isotopes. Nevertheless, this method suffers from the large Doppler broadening of the observed resonance lines due to the hot environment in the source necessary for a fast release of the atoms. One approach to overcome this limitation is found in two-photon spectroscopy in combination with resonance ionization by which ions can be created directly inside the hot ionizer cavity without Doppler broadening. Resonance ionization usually makes use of pulsed lasers with high power and a spectral line width of a few GHz, while for two-photon spectroscopy it is essential to use a well adapted laser with narrow line width. An injection seeded Ti:sapphire laser which operates at high repetition rate and offers an average output power of about 2.5 W at a line width of 20 MHz fulfills these needs. The general feasibility of Doppler free two-photon resonance ionization spectroscopy inside a hot cavity and the suitability of this laser has been demonstrated in investigations of the hyperfine structures of the $3s^2\ 3p^2\ {}^3P \rightarrow 3s^2\ 3p4p\ {}^3P$ multiplet in ^{29}Si, which could be well resolved.

MS 1.6 Mo 15:45 F 428

Die Laserionenquelle und -falle LIST - Eine hochselektive Quelle für radioaktive Ionenstrahlen — •Fabio Schwellnus[1], Klaus Blaum[2], Richard Catherall[3], Bernard Crepieux[3], Valentin Fedosseev[3], Tina Gottwald[1], Klaus-Peter Höldtke[1], Hans-Jürgen Kluge[4], Thierry Stora[3] und Klaus Wendt[1] — [1]Institut für Physik, Johannes Gutenberg-Universität Mainz, 55099 Mainz — [2]Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg — [3]CERN, CH-1211 Meyrin — [4]GSI, Planckstrasse 1, 64291 Darmstadt

Die Laserionenquelle und -falle (Laser Ion Source and Trap - LIST) wurde zur hochselektiven Erzeugung isobarenfreier, radioaktiver Ionenstrahlen an Großforschungsanlagen, beispielsweise ISOLDE, entwi-

ckelt. Dieser Beitrag faßt die mehrjährige off-line Entwicklungsphase der LIST in Mainz und bei ISOLDE zusammen. Im gegenwärtigen Entwicklungsstand erreicht die LIST eine Unterdrückung von Oberflächenionen über mehr als fünf Größenordnungen, Ionisationseffizienzen von über 0,1 % und liefert nahezu untergrundfreie, gepulste Ionenstrahlen mit Pulsbreiten unter 10 μs. Die off-line Charakterisierung und Entwicklung einer Version der LIST zum on-line Einsatz bei ISOLDE kann damit zunächst als abgeschlossen betrachtet werden. Ein Ausblick auf den ersten on-line Einsatz, der sich zurzeit in Vorbereitung befindet, sowie auf mögliche zukünftige Entwicklungen wird gegeben.

MS 2: Speicherringe und neue Entwicklungen

Time: Monday 16:30–19:00 Location: F 428

Invited Talk MS 2.1 Mo 16:30 F 428

Cold electron collisions at ion storage rings — •Andreas Wolf — Max-Planck-Institut für Kernphysik, Heidelberg

Cold electron collisions, often driven by Feshbach resonances, are important in a wide range of ionized media and also open efficient pathways for electrons to destroy molecular compounds. Highest precision in their study is reached using merged beams inside ion storage rings. Intense cold electron beams, velocity-matched to the stored ion beams, can realize collision energies as low as a few Kelvin (near 1 meV). The electrons not only initiate reactive collisions, but also cool the internal quantum states of the stored ions and lead to their phase-space compression (beam cooling). Ion beams, moreover, offer powerful tools for coincidence momentum spectroscopy on the products of individual reactions. – Recent beam cooling results and high-resolution atomic and molecular collision studies at the magnetic ion storage ring TSR will be presented, with particular emphasis on the lately introduced intense electron beams from cryogenic semiconductor photocathodes. These sources open the door towards very low electron beam energies (down to a few eV) and offered efficient phase-space cooling already for compounds such as water ions. Few-Kelvin electron collisions will also become available at electrostatic ion storage rings, where the ion energies lie in the range of only a few keV per nucleon. Here, phase-space compression and low-energy merged beams collisions will be applicable to a wide range of heavy molecular ions, heavy singly charged atoms, and slow highly charged ion beams.

Invited Talk MS 2.2 Mo 17:00 F 428

Photodissociation of dipeptide cations in an electrostatic ion storage ring — •Steen Brøndsted Nielsen — Department of Physics and Astronomy, Aarhus University

In photobiology, the aromatic amino acids phenylalanine, tyrosine, and tryptophan are highly important spectroscopic probes for protein conformations and dynamics. They act as markers because of the fact that their photophysics is highly dependent on the chemical environment. To have a proper reference for the intrinsic properties, it is necessary to establish the electronic properties of amino acids without any perturbations from solvent molecules, counter ions, or other amino acids. This requires gas phase experiments on individual molecules. In Aarhus we have developed a setup to record gas-phase absorption spectra of biomolecular ions. It combines an electrospray ion source, a multipole ion trap for pre-storage, an electrostatic ion storage ring, and pulsed tuneable lasers. The technique relies on the measurement of delayed dissociation of photoexcited ions (action spectroscopy). In this talk I will present some of our recent results on dipeptide cations and demonstrate how the electronic structure is linked to peptide conformation. Tagging the positively charged ammonium group with crown ether prevents internal ionic hydrogen bonding and leads to open structures. This influences dissociation lifetimes and channels.

MS 2.3 Mo 17:30 F 428

A mass sensitive imaging detector for storage-ring molecular fragmentation studies — •Christian Nordhorn[1], Henrik Buhr[2,1], Dennis Bing[1], Manfred Grieser[1], Oded Heber[2], Claude Krantz[1], Michael Lestinsky[1], Mario B. Mendes[1], Oldřich Novotný[1], Michael L. Rappaport[2], Roland Repnow[1], Andrey Shornikov[1], Julia Stützel[1], Dirk Schwalm[2,1], Daniel Zajfman[2], and Andreas Wolf[1] — [1]Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg — [2]Weizmann Institut of Science, Rehovot, 76100, Israel

In astrophysically relevant plasmas dissociative recombination is considered the principal destruction mechanism for molecular ions. Consequently remote probes of interstellar media require extensive comprehension of essential process characteristics, which are investigated in molecular fragmentation studies.

To enhance these studies an energy-sensitive multi-strip surface-barrier detector (EMU) has been developed, which introduces mass identification of individual recombination products and a simultaneous determination of the fragment positions in the detector plane by coincidence imaging. This enables advanced investigations of the final state branching ratios into the different fragmentation channels, the excitation of the molecular fragments and the dissociation kinematics.

Utilizing the capability of the EMU detector a storage-ring experiment on the dissociative recombination of DCO^+ has been performed applying the merged beam technique provided by the Test Storage Ring (TSR) at the Max Planck Institute for Nuclear Physics.

MS 2.4 Mo 17:45 F 428

Exploring superconducting detectors for neutral nanoparticles — •Michele Sclafani[1], Markus Marksteiner[1], Philipp Haslinger[1], Hendrik Hulbricht[1], Markus Arndt[1], Alexander Divochiy[2], Alexander Korneev[2], and Gregory Gol'tsman[2] — [1]Faculty of Physics, University of Vienna, Boltzmanngasse 5, 1090 Vienna, Austria — [2]Department of Physics, Moscow State Pedagogical University, M. Pirogovskaya Street 1, Moscow 119992, Russia

We present the first experimental evidence for the successful detection of neutral nanoparticle beams using Superconducting Single Photon Detectors (SSPD). The detection process relies on the formation of an impact-induced hot spot on a nanostructured superconducting NbN film. When the critical current density is exceeded a measurable resistance builds up across the film and a short voltage peak (20 ns) can be measured. We test the detector with a beam of laser-desorbed and jet-cooled biomolecules. For tryptophan (204 Da) and gramicidin (1884 Da) the arrival time distributions are in agreement with those observed with in VUV-postionization/time-of-flight mass spectrometry. We also observe signals for larger biological molecules such as insulin (ca. 6 kDa), myoglobin (ca. 17 kDa) and hemoglobin (ca. 64 kDa), which still have to be confirmed by independent methods, as photo-ionization does not succeed for these species. We suggest that further developments can turn SSPD chips into devices that may help us overcome current mass limitations in a variety of beam experiments with neutral molecules. We also discuss the options for matter wave interferometry to characterize and finally use SSPD detectors.

MS 2.5 Mo 18:00 F 428

Marker bands for four-coordinate Fe(III)-heme proteins from absorption spectra of isolated chromophore ions in vacuo — •Jean Wyer — Department of Physics and Astronomy, Aarhus University

Heme proteins are ubiquitous in nature and are responsible for key biological. They are reddish-brown due to the presence of a heme group that is a porphyrin with an iron atom located in the centre. Electronic spectroscopy is used extensively to obtain detailed information on heme proteins such as conformation and dynamics. Importantly, spectral features depend on e.g. the iron oxidation state, axial ligands, and nearby amino acid residues. Often heme is located in hydrophobic protein pockets or crevices with minimal access to water. These pockets are in certain cases well simulated by a vacuum. It requires gas-phase experiments to establish the influence of a nearby environment, determined by the protein folding state. Conventional spectroscopic characterisations of Fe(III)-heme are hampered by the strong affinity of Fe(III) for water and anions. In this talk I will present the first unequivocal spectroscopic characterisation of isolated Fe(III)-heme ions and Fe(III)-heme-histidine complexes. Ions were generated by electrospray ionisation, stored in a pretrap, accelerated to keV energies and injected into the electrostatic ion storage ring in Aarhus, ELISA. Here they were irradiated by visible light. Based on the yield of photoproducts and the lifetimes with respect to dissociation, absorption spectra were obtained. The data are useful in bioanalytical chemistry and for benchmarking quantum mechanical calculations.

MS 2.6 Mo 18:15 F 428

Probing the exotic metastable states of D_2^- at ELISA — •Lutz Lammich, Lars H. Andersen, Aravind Gopalan, and Henrik B. Pedersen — Department of Physics and Astronomy, Aarhus University, Denmark

The rovibrational states of the metastable anionic hydrogen molecule D_2^- were studied in photofragmentation experiments at 532 nm employing a fast (keV) ion beam [1]. By a 3D fragment momentum imaging technique, the photodetachment and the dissociation of the system into neutral atoms was investigated. Employing the electrostatic ion storage ring Aarhus (ELISA) these studies could be performed at different times after production of the molecular ions and thus for different relative populations of their metastable states. The present data are sensitive to both the rotational states and the vibrational wave functions of the anions, and suggest that the level of rotational excitation, while still exceptionally high, is somewhat lower than estimated in recent theoretical predictions.

[1] L. Lammich, L.H. Andersen, G. Aravind and H.B. Pedersen, *Phys. Rev. A* **80**, 023413 (2009)

MS 2.7 Mo 18:30 F 428

Mass Selective Acceleration at the Test Storage Ring — •Felix Laux[1], Robin Bastert[1], Henrik Buhr[2], Manfred Grieser[1], Claude Krantz[1], Mario Mendes[1], Andreas Wolf[1], and Klaus Blaum[1] — [1]Max-Planck-Institut für Kernphysik, Heidelberg — [2]Weizmann Institute of Science, Rehovot, Israel

The Test Storage Ring (TSR) at the Max-Planck-Institut für Kernphysik in Heidelberg has recently been successfully used for mass selective acceleration. This newly developed method renders the possibility of effective separation of ion species with small relative mass differences. We report on an experiment in which we were able to separate the desired $DCND^+$ from nearly isobaric N_2D^+ and DCO^+ with mass selective acceleration, although the relative mass differences of the two neighbouring species are as small as $\Delta m/m \sim 4 \cdot 10^{-4}$. The composition of the accelerated beam was analyzed by collisional fragmentation measurements.

MS 2.8 Mo 18:45 F 428

Das CSR Projekt — •Florian Fellenberger, Klaus Blaum, Michael Froese, Manfred Grieser, Robert von Hahn, Dirk Kaiser, Michael Lange, Felix Laux, Sebastian Menk, Roland Repnow, Andrey Schornikov und Andreas Wolf — Max-Planck-Institut für Kernphysik

Am Max-Planck-Institut für Kernphysik in Heidelberg wird derzeit ein kryogener elektrostatischer Speicherring (CSR) aufgebaut, mit dem Experimente mit niederenergetischen Ionen (20-300keV pro Ladungszustand) geplant sind. Der Ring besitzt eine große Akzeptanz (±40mm) und ermöglicht die Elektronenkühlung niederenergetischer Ionenstrahlen. Die Vakuumkammern werden auf Temperaturen von unter 10K gekühlt, was es ermöglicht, ein Vakuum unter 10^{-13}mbar und damit lange Speicherzeiten für langsame Ionenstrahlen zu erreichen. Die Kühlung ermöglicht es auch, die Anregung innerer Schwingungs- und Rotationszustände durch Wärmestrahlung zu unterdrücken. Erste Tests mit einem Prototypen (CTF) haben gezeigt, dass die geplanten Anforderungen an Kammertemperaturen und Vakuum zu erreichen sind, so dass mit dem Aufbau des CSR begonnen werden konnte.

MS 3: Neue massenspektrometrische Methoden und Entwicklungen

Time: Tuesday 14:00–16:00 Location: F 428

Invited Talk MS 3.1 Tu 14:00 F 428

TOF-Bρ mass measurements of neutron rich nuclei at the NSCL — •Sebastian George[1,2], Alfredo Estrade[1,2,3], Milan Matoš[4], Mathew A. Amthor[5], Daniel Bazin[1], Ana D. Becerril[1,2,3], Thom J. Elliot[1,2,3], Alexandra Gade[1], Daniel Galaviz[1,2], Giuseppe Lorusso[1,2,3], Jorge Pereira[1,2], Mauricio Portillo[1], Andrew Rogers[1,2,3], Hendrik Schatz[1,2,3], Dan Shapira[6], Edward Smith[7], Andreas Stolz[1], and Mark S. Wallace[8] — [1]National Superconducting Cyclotron Laboratory, Michigan State University, East Lansing, MI, USA — [2]Joint Institute for Nuclear Astrophysics (JINA) — [3]Department of Physics and Astronomy, Michigan State University, East Lansing, MI, USA — [4]Louisiana State University, Baton Rouge, LA, USA — [5]Grand Accelerateur National d'Ions Lourds, Bd Henri Becquerel, BP 55027, F-14076 Caen Cedex 5, France — [6]Oak Ridge National Laboratory, Oak Ridge, TN, USA — [7]The Ohio State University, Columbus, OH, USA — [8]Los Alamos National Laboratory, Los Alamos, NM, USA

Nuclear masses of exotic nuclei far from stability are important key parameters for the understanding of the nuclear structure and several questions in nuclear astrophysics. Particularly the description of astrophysical processes, such as nucleosynthesis during the r-process or the evolution of matter in the crust of accreting neutron stars, is limited by the use of theoretical mass models. The experimental access to the mass of atoms is based on different techniques. Beside the measurements of nuclear decays and nuclear reaction studies, Penning trap facilities and time-of-flight (TOF) experiments allow the determination of masses. The latter two are somewhat complementary methods in respect of precision and accessibility of exotic nuclei. The time-of-flight-Bρ (TOF-Bρ) method has shown the potential to access nuclides very far from stability at several radioactive beam facilities. Here the setup of the TOF-Bρ experiment at the National Superconducting Cyclotron Laboratory (NSCL) at the Michigan State University is presented. The results of the first experiment in the region of neutron-rich isotopes as well as upcoming measurements will be discussed.

MS 3.2 Tu 14:30 F 428

Thermal ionization mass spectrometry (TIMS) of actinides: Pushing the limits of accuracy and detection — •Stefan Bürger[1], Sergei Boulyga[1], Alan Cunningham[1], Dilani Klose[1], Andreas Koepf[1], Jane Poths[1], and Stephan Richter[2] — [1]Safeguards Analytical Laboratory, International Atomic Energy Agency, Vienna, Austria — [2]Institute for Reference Materials and Measurements, JRC-EU, Retieseweg 111, 2440 Geel, Belgium

New method developments in multi-collector thermal ionization mass spectrometry (MC-TIMS) for actinide isotope ratio analysis to improve accuracy and limits of detection will be presented. With respect to limits of detection, results on improving work function using various carbon additives will be reviewed and presented as well as developments in cavity ion source (as compared to standard flat ribbon filament ion source) for femto- and attogram levels of uranium, plutonium, and americium. With respect to accuracy, results on isotope ratio measurements of isotopes of uranium (relative accuracy of 0.3 % to 0.01 %) will be presented with an example being U-234-Th-230 age-dating (NBL CRM 112-A). In this context, the importance of traceability (to the S.I. units) and the use of (certified) reference materials will be emphasized. The focus of this presentation will be on applications to nuclear safeguards / forensics.

MS 3.3 Tu 14:45 F 428

Isotope dilution mass spectrometry at the limit: a novel concept

— •Axel Pramann, Olaf Rienitz, and Detlef Schiel — Physikalisch-Technische Bundesanstalt, Bundesallee 100, 38116 Braunschweig

The experimental measurement of the molar mass M of silicon crystals has been performed for the first time applying a modification of the powerful isotope dilution mass spectrometry (IDMS) technique. This method has been successfully applied in combination with a multicollector-ICP-mass spectrometer (MC-ICP-MS).[1] The background of this work is linked to an international project for the redetermination of the Avogadro constant with an associated relative measurement uncertainty in the range of 10^{-8}.[2] M is measured by isotope ratio measurements. Isotope ratios near unity can be measured after separating the element under investigation (silicon) into a virtual element consisting of all isotopes of the element (^{29}Si and ^{30}Si) except the isotope of highest abundance (^{28}Si). Then, IDMS is applied on this virtual element resulting in the isotopic pattern and thus molar mass of the complete element (all isotopes). The novel IDMS-method is explained and first results of silicon crystal material are presented and discussed on a metrological level with the aid of a comprehensive uncertainty budget.

[1]O. Rienitz, A. Pramann, D. Schiel, Int. J. Mass Spectrom., **289**, 47 (2010).
[2]P. Becker, Metrologia **40**, 366 (2003).

MS 3.4 Tu 15:00 F 428

Explosives and chemical warfare agents - detection and analysis with PTR-MS — •Philipp Sulzer[1], Fredrik Petersson[2], Simone Jürschik[1], Stefan Jaksch[1], Alfons Jordan[1], Gernot Hanel[1], Eugen Hartungen[1], Hans Seehauser[1], Lukas Märk[1], Stefan Haidacher[1], Ralf Schottkowsky[1], and Tilmann Märk[1,2] — [1]IONICON Analytik GmbH, Technikerstr. 21a, 6020 Innsbruck, Austria — [2]Institut für Ionenphysik und Angewandte Physik, Leopold-Franzens Universität Innsbruck, 6020 Innsbruck, Austria

We utilized a recently developed high sensitivity PTR-MS instrument equipped with a high resolution time-of-flight mass analyzer for detailed investigations on explosives and chemical warfare agents (CWAs). We show that with this so called PTR-TOF 8000 it is possible to identify solid explosives (RDX, TNT, HMX, PETN and Semtex A) by analyzing the headspace above small quantities of samples at room temperature and from trace quantities not visible to the naked eye placed on surfaces. As the mentioned solid explosives possess very low vapor pressures, the main challenge for detecting them in the gas phase is to provide an instrument with a sufficient sensitivity. CWAs on the other side have very high vapor pressures but are difficult to identify unambiguously as their nominal molecular masses are usually comparably small and therefore hard to distinguish from harmless everyday-compounds (e.g. mustard gas: 159 g/mol). In the present work we demonstrate that we can detect a broad range of dangerous substances, ranging from the CWA mustard gas to the explosive HMX.

MS 3.5 Tu 15:15 F 428

On-line Charakterisierung von Aerosolpartikeln mit einem neuen, kompakten, mobilen Flugzeitmassenspektrometer LAMPAS 3 — •Klaus-Peter Hinz, Elmar Gelhausen und Bernhard Spengler — Institut für Anorganische und Analytische Chemie, Universität Giessen

Die bipolare on-line Lasermassenspektrometrie ermöglicht die Bestimmung von Größe und chemischer Zusammensetzung einzelner Mikro- und Nanopartikel uns umgebender Aerosole. Die Partikel werden dazu ohne weitere Beeinflussung direkt in die Ionenquelle des Flugzeitmassenspektrometers eingelassen. Nach Detektion des Streulichts an zwei kontinuierlichen Laserstrahlen erfolgt die Verdampfung und Ionisation der Partikel mittels zeitlich abgestimmter Laserdesorption durch einen UV-Laserpuls. Die chemische Charakterisierung der Einzelpartikel erfolgt anhand der simultan detektierten positiv und negativ geladenen Ionen. Die umfassende Weiterentwicklung der vorhandenen Methodik (LAMPAS 2 [1]) ermöglichte die Realisierung eines verbesserten, kompakten Gerätes für die schnelle und aussagekräftige vor-Ort-Aerosolanalytik. Das System und seine Leistungsfähigkeit werden anhand erster Messungen vorgestellt.

[1] A. Trimborn, K.-P. Hinz, B. Spengler. Aerosol Sci. Technol. 33 (2000) 191-201.

MS 3.6 Tu 15:30 F 428

Simulations of a stopping cell for the LEB of the Super-FRS at FAIR — •Daniel Schäfer[1], Wolfgang R. Plass[1,2], Peter Dendooven[3], Hans Geissel[1,2], Sivaji Purushothaman[3], Maneesha Ranjan[3], and Christoph Scheidenberger[1,2] — [1]II.Physikalisches Institut, Justus-Liebig-Universität, Gießen, Germany — [2]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany — [3]KVI, University of Groningen, Netherlands

The low energy branch of the Super-FRS at the Facility for Antiprotons and Ions Research will be equipped with a cryogenic cell for stopping and extracting exotic nuclei produced by projectile fragmentation or fission, thus making them available for further experiments. This stopping cell has been developed and constructed at KVI, University of Groningen, Netherlands. Several computer models have been developed utilizing the ion trajectory simulation program. The design and basic features of the cell have been determined using these simulations, and optimal operating parameters have been found. Furthermore, simulations confirmed (semi-)analytical descriptions of ion collecting devices. Comparisons with first experimental results will be presented as well.

MS 3.7 Tu 15:45 F 428

Implementation of a MR-ToF isobar separator at the online mass spectrometer ISOLTRAP — •Robert Wolf[1], Klaus Blaum[2], Christopher Borgmann[2], Martin Breitenfeldt[1], Daniel Fink[2], Alexander Herlert[3], Magdalena Kowalska[3], Susanne Kreim[2], Dave Lunney[4], Gerrit Marx[1], Sarah Naimi[4], Marco Rosenbusch[1], and Lutz Schweikhard[1] — [1]University Greifswald — [2]Mpi for Nuclear Physics, Heidelberg — [3]Cern, Geneva, Switzerland — [4]Csnsm, Orsay, France

A multi-reflection time-of-flight mass separator (MR-ToF-MS) was installed at the ISOLTRAP/CERN mass spectrometer for isobaric purification of rare isotope ensembles as a preparation for precision mass determinations. The MR-ToF-MS consists of two ion optical 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. Previous 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^+. In combination with a Bradbury-Nielsen beamgate, the MR-ToF-MS will support the existing purification methods of the setup to gain access to nuclides produced with high isobaric contamination yields at the ISOLDE facility. The modified ISOLTRAP setup and its performance will be presented.

MS 4: Beschleunigermassenspektrometrie und Anwendungen I

Time: Wednesday 10:30–13:00 Location: F 428

Invited Talk MS 4.1 We 10:30 F 428

Retrospektive Dosimetrie der I-131 Exposition nach dem Reaktorunfall von Tschernobyl mittels AMS-Messung von I-129 in Böden — •Rolf Michel[1], Abdelouahed Daraoui[1], Jens Korntheuer[1], Monika Gorny[1], Dieter Jakob[1], Rüdiger Sachse[1], Vasily Alfimov[2] und Hans-Arno Synal[2] — [1]Zentrum für Strahlenschutz und Radioökologie, Leibniz Universität Hannover, Deutschland — [2]Ion Beam Physics, Paul Scherrer Institut und ETH Zürich, Schweiz

Nach dem Reaktorunfall von Tschernobyl stiegen in der Ukraine, Weißrussland und Russland die Fälle von Schilddrüsenkrebs bei Jugendlichen aufgrund der I-131 Strahlenexpositionen dramatisch an. Aufgrund von zu wenigen direkten Messungen der Schilddrüsenaktivitäten ist die Dosimetrie der I-131 Expositionen nicht befriedigend. Mit Hilfe des langlebigen I-129 kann in hoch- und mittelkontaminierten Gebieten der Fallout von I-131 nach dem Unfall bestimmt und damit die Strahlenexposition modelliert werden. In dieser Arbeit wurden 62 Siedlungen der nördlichen Ukraine, für die auch Direktmes-sungen der Schilddrüsenaktivitäten vorliegen, untersucht. Pro Siedlung wurden je 5 Bodenproben bis zu einer Tiefe von 40 cm bzgl. Cs-137 und I-129 analysiert. Da mehr als 90 % der I-129-Konzentration noch immer in den obersten 40 cm lokalisiert ist, können die I-129-Inventare in den Profilen als Näherungen für die gesamten anthropogenen I-129-Iventare betrachtet werden. Aus den I-129 Inventaren wurden über aggregierte Dosisfaktoren die I-131 Schilddrüsendosen berechnet. Die Ergebnisse werden mit direkten Messungen der Schilddrüsenaktivität verglichen.

MS 4.2 We 11:00 F 428

The potential of Accelerator Secondary Ion Mass Spectrometry for astrophysical applications — •Christof Vockenhuber[1], Max Döbeli[1], and Anton Wallner[2] — [1]ETH Zurich, Zurich, Switzerland — [2]University of Vienna, Vienna, Austria

The understanding of the nuclear processes which formed the elements is based on the elemental abundances and their isotopic pattern. Astronomical observation allows to determine the elemental abundances; information of the isotopic pattern is obtained by mass spectrometry of meteoritic material. In particular, specific pre-solar grains, which preserved the isotopic composition of the early stage of our solar system, show strong deviations from the terrestrial isotopic pattern which can be attributed to different nucleosynthesis processes.

Since about 20 years pre-solar material has been analyzed using sta-

ble mass spectrometers, like SIMS, TIMS or ICPMS. However, especially elements in the rare earth region are difficult to measure due to the low concentrations and molecular interferences. The combination of a SIMS ion source with an AMS system allows for interference-free measurements. The potential and the challenges of this combination with prospects for future measurements will be discussed.

MS 4.3 We 11:15 F 428

New approaches investigating production rates of in-situ produced terrestrial cosmogenic nuclides — •Silke Merchel[1,2], Régis Braucher[1], Lucilla Benedetti[1], and Didier Bourlès[1] — [1]CEREGE, CNRS-IRD-Université Aix-Marseille, F-13545 Aix-en-Provence, France — [2]FZD, D-01314 Dresden, Germany

In-situ produced cosmogenic nuclides have proved to be valuable tools for environmental and Earth sciences. However, accurate application of this method is only possible, if terrestrial production rates in a certain environment over a certain time period and their depth-dependence within the exposed material are exactly known. Unfortunately, the existing data and models differ up to several tens of percent. Thus, one of the European project *CRONUS-EU* goals is the high quality calibration of the ^{36}Cl production rate by spallation at independently dated surfaces. As part of fulfilling this task we have investigated calcite-rich samples from four medieval landslide areas in the Alps: *Mont Granier*, *Le Claps*, *Dobratsch*, and *Veliki Vrh* (330-1620 m, 1248-1442 AD). For investigating the depth-dependence of the different nuclear reactions, especially, the muon- and thermal neutron-induced contributions, we have analysed mixtures of carbonates and siliceous conglomerate samples - for ^{10}Be, ^{26}Al, and ^{36}Cl - exposed at different shielding depths and taken from a core drilled in 2005 at *La Ciotat*, France (from surface to 11 m shielding). AMS of ^{36}Cl was performed at LLNL and ETH, ^{10}Be and ^{26}Al at ASTER.

Acknowledgments: Thanks to V. Alfimov, M. Arnold, G. Aumaître, J. Borgomano, R. Finkel, I. Mrak, and J.M. Reitner.

MS 4.4 We 11:30 F 428

The measured and modeled ^{36}Cl concentration in 100-m long limestone core from Vue des Alpes, Switzerland — •Vasily Alfimov[1], Susan Ivy-Ochs[1], Peter W. Kubik[1], Jürg Beer[2], and Hans-Arno Synal[1] — [1]Laboratory of Ion Beam Physics, ETH Zurich, Switzerland — [2]EAWAG, Duebendorf, Switzerland

A 100-m long limestone core was sampled in Vue des Alpes (1256.86m, 47°4'46.8"N, 6°52'14.70E), Switzerland, and analysed for ^{36}Cl with Accelerator Mass Spectrometry at the Laboratory of Ion Beam Physics, ETH Zürich. The measurements were compared with the theoretical calculation of ^{36}Cl content in the core. The long-lived radionuclide ^{36}Cl ($T_{1/2}$=301kyr) is produced in limestone by cosmic rays. There are several pathways of ^{36}Cl production in the limestone, and they have different attenuation lengths. At the surface the dominant production pathway is the spallation of Ca by fast neutrons. Under one meter of rock, the slow muon capture on ^{40}Ca starts to take over the lead, while after 10 m depth the fast-muon-induced processes in Ca starts to play a significant role. Three mentioned processes plus U-Th content of the rock also produce thermal neutrons, and these neutrons activate stable ^{35}Cl into ^{36}Cl. These are also important pathways, because concentration of stable chlorine in the sampled core is non-negligible (65 ppm on average). All pathways were combined in a model of ^{36}Cl production and applied to the calculation of ^{36}Cl content of the core. The talk will contain the comparison of the measured and calculated ^{36}Cl profiles, and our conclusions on the parameters included into the model.

MS 4.5 We 11:45 F 428

Production of a ^{55}Fe-AMS standard and Neutron Capture on ^{54}Fe — •Kathrin Buczak[1], Tamás Belgya[2], Max Bichler[3], Oliver Forstner[1], Robin Golser[1], Walter Kutschera[1], Claudia Lederer[1], Alfred Priller[1], Peter Steier[1], and Anton Wallner[1] — [1]VERA Laboratory, Faculty of Physics - Isotope Research, Univ. of Vienna, Austria — [2]Institute of Isotopes HAS, Dept. of Nuclear Research, Hungary — [3]Atominstitut, TU Wien, Austria

The interest in neutron capture on ^{54}Fe is linked to: studies of nucleo-synthesis in stellar environments, radioactive waste generation in fusion reactors and the half-life value of the long-lived ^{59}Ni. For the measurement of the thermal neutron capture cross section $\sigma(^{54}\text{Fe(n,}\gamma)^{55}\text{Fe})$, irradiations have been performed at the TRIGA reactor in Vienna, and with cold neutrons at the Budapest Research Reactor. The radionuclide ^{55}Fe ($t_{1/2}$ = 2.7 yr) produced in these activations, was measured at VERA (Vienna Environmental Research Accelerator) via accelerator mass spectrometry (AMS). Such isotope-ratio measurements, however, require an accurate ^{55}Fe-AMS standard as reference material: (1) At VERA, iron samples, highly enriched in ^{54}Fe, were bombarded with 5.5 MeV protons to produce ^{55}Co ($t_{1/2}$ = 17.53 h), which decays to ^{55}Fe. The total number of daughter-nuclides ^{55}Fe was determined from the measured ^{55}Co-activity. (2) Another, independent standard was produced by a dilution series of a certified ^{55}Fe-standard-solution. The cross section value is expected to be accurate at a level of ± 3% and is directly coupled to a previous ^{59}Ni half-life value. The measurement procedure and the latest results will be presented.

MS 4.6 We 12:00 F 428

^{53}Mn - a long-lived activation product in a nuclear fusion environment — •Claudia Lederer[1], Iris Dillmann[2], Thomas Faestermann[2], Axel Klix[3], Gunther Korschinek[2], Johannes Lachner[2], Mikhail Poutivtsev[2], Georg Rugel[2], Klaus Seidel[3], Herbert Vonach[1], and Anton Wallner[1] — [1]VERA-Labor, Fakultät für Physik, Universität Wien, Österreich — [2]Physik Department, Technische Universität München, Deutschland — [3]Inst. f. Kern- und Teilchenphysik, TU und FZ Dresden, Deutschland

Since nuclear fusion devices as a potential energy source seem feasible, there is a strong need for accurate cross-section data to estimate production of long-lived radioisotopes. ^{53}Mn ($T_{1/2}$=3.7 Myr) is considered to contribute significantly for long-term waste disposal. It is mainly produced via interaction of 14-MeV (fusion) neutrons with Fe- and Ni-containing structure materials (predominantly via reactions on ^{54}Fe). Fe samples, enriched in ^{54}Fe, were irradiated with quasi-monoenergetic neutrons of energies from 13.4 to 14.9 MeV at the 14 MeV neutron generator of the TU Dresden. The number of produced ^{53}Mn nuclei was quantified via AMS, utilizing the 14-MV tandem at the MLL of TU and LMU Munich. Previous measurements indicate nearly constant cross-section values of about 200 mb around 14 MeV, whereas evaluations show an increasing excitation function between 400 and 600 mb. Our results, which are the first ones based on AMS, suggest even higher cross-sections. These new experimental data will allow to forecast ^{53}Mn activation for an ITER-like device with a significant reduction of present uncertainties.

MS 4.7 We 12:15 F 428

Improved measurements of gaseous ^{14}C samples at Micadas — •Simon Fahrni[1,2,3], Lukas Wacker[4], Matthias Ruff[1,2,4], Sönke Szidat[1,3], and Hans-Arno Synal[4] — [1]Department of Chemistry and Biochemistry, University of Bern, Bern, Switzerland — [2]Laboratory for Radiochemistry and Environmental Chemistry, Paul Scherrer Institute, Villigen, Switzerland — [3]Oeschger Centre for Climate Change Research, University of Bern, Bern, Switzerland — [4]Ion Beam Physics, ETH Hönggerberg, Zurich, Switzerland

Samples of 1 to 40 μg carbon are measured as CO_2 in the gas ion source of the small AMS facility MICADAS at ETH Zurich. This measurement technique offers a simple and fast way of ^{14}C measurements without the need of sample graphitization. Low negative ion currents, however, are a drawback of gaseous measurements as they result in a reduced precision. To overcome this problem, we optimized several parameters of the new ion source at MICADAS. The performance now achieved allows to measure samples faster, more efficiently and with a higher precision. Therefore, the gas ion source at MICADAS even becomes feasible for dating in the 5 per mil range. A report on the state of our gas ion source is presented.

MS 4.8 We 12:30 F 428

^{14}C AMS measurement and sample preparation methods of μg-sized carbon samples — •Jakob Liebl[1], Simon Fahrni[2], Robin Golser[1], Walter Kutschera[1], Klaus Mair[1], Alfred Priller[1], Peter Steier[1], Iris Vonderhaid[1], Lukas Wacker[3], and Eva Maria Wild[1] — [1]Vienna Environmental Research Accelerator (VERA), Faculty of Physics - Isotope Research, University of Vienna, Austria — [2]Department of Chemistry and Biochemistry, University of Bern, Switzerland — [3]Ion Beam Physics, Physics Department, ETH Zurich, Switzerland

^{14}C AMS measurement and sample preparation methods for μg-sized samples have been developed at VERA. Overall measurement uncertainties do not primarily originate from the uncertainty of the AMS measurement itself, but are strongly affected by carbon contamination introduced during sample preparation. In contrast to contamination levels at graphitization, contamination introduced at earlier steps of sample preparation is sparsely investigated. At VERA, procedures

with no detectable (<0.2 μg C) carbon contamination during graphitization, and contamination below 0.4 μg C during sample combustion and pretreatment were developed. Sample preparation procedures and graphitization protocols currently applied for small samples are presented. We will also discuss results of comparative AMS measurements of CO_2 samples (10 μg C), either graphitized and measured at VERA or introduced as CO_2 into a gas ion source installed at a MICADAS facility of the ETH Zurich. With both methods, we have reached a precision level of about 1% for ^{14}C measurements of 10 μg C samples.

MS 4.9 We 12:45 F 428

Direct Radiocarbon Analysis of CO_2 samples — •Tim Schulze-König, Lukas Wacker, and Hans-Arno Synal — Ion Beam Physics, ETH Zurich, 8093 Zurich

Sample preparation of radiocarbon samples for analysis with Accelerator Mass Spectrometry is a time consuming process. A kit has been developed, which circumvents this process and allows direct analysis after sample taking. The kit uses a CO_2 trap and requires a small gas interface, which is connected to the gas ion source of the mass spectrometer. Initially developed for breath air analysis, it might be useful for analysis of exhaust air of industry plants, as well. An example of use will be given and potential applications will be discussed.

MS 5: Präzisionsmassenspektrometrie und Anwendungen I

Time: Wednesday 14:00–16:00 Location: F 428

Invited Talk MS 5.1 We 14:00 F 428

Progress in Mass Spectrometry of Exotic Nuclei at the FRS-ESR Facility at GSI — •Wolfgang Plass — GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt — Justus-Liebig-Universität Gießen

Storage ring mass spectrometry at the FRS-ESR facility at GSI offers unique capabilities for the research with exotic nuclei. Schottky Mass Spectrometry (SMS) allows for broadband mass measurements with mass accuracies on the level of 0.2 ppm, whereas Isochronous Mass Spectrometry (IMS) gives access to nuclei with lifetimes as short as a few tens of microseconds. Both methods are sensitive to single ions and can be used to investigate the decay and the lifetime of exotic nuclei.

Using SMS, mass measurements of uranium projectile fragments in the element range Pt to U have been performed. Five isotopes and six isomers have been observed for the first time, the masses of 35 nuclides have been measured for the first time, and the proton-neutron interaction strength at the doubly magic shell closure of lead has been determined. Methodical improvements have enabled a first broadband IMS experiment on uranium fission fragments, addressing nuclei in the vicinity of the r process path. The 4.6 MeV isomeric state in ^{133}Sb has been measured directly for the first time, whose neutral-atom lifetime is 17 μs only.

For storage ring mass spectrometry at the international accelerator facility FAIR a detection system for IMS is being developed, which offers significantly improved accuracy, detection efficiency and rate capability compared to the system available at GSI currently.

Invited Talk MS 5.2 We 14:30 F 428

Mass measurements on neutron-rich fission products and actinoids at Triga-Trap — •J. Ketelaer[1], T. Beyer[2,3], M. Block[4], K. Eberhardt[1], M. Eibach[1,3], F. Herfurth[4], Sz. Nagy[2,4], C. Smorra[1,3], W. Nörtershäuser[1,4], and K. Blaum[2,3] — [1]Johannes Gutenberg-Universität, 55128 Mainz — [2]Max-Planck-Institut für Kernphysik, 69117 Heidelberg — [3]Ruprecht-Karls-Universität, 69117 Heidelberg — [4]GSI Helmholtzzentrum für Schwerionenforschung GmbH, 64291 Darmstadt

The double Penning trap mass spectrometer Triga-Trap has been installed at the research reactor Triga Mainz to perform high-precision mass measurements on neutron-rich fission products and actinoids. Masses of these nuclides are important for nuclear structure studies of heavy elements, tests of mass models, and nucleosynthesis calculations of the astrophysical r-process. Ions of many stable isotopes as well as carbon clusters for calibration purposes can be produced by a non-resonant laser ablation ion source, allowing off-line mass measurements independently from the research reactor. Besides the physics program, Triga-Trap serves as a test bench for the development of new ion detection techniques, which will enable mass measurements on single stored singly-charged ions with a half-life in the order of one second. To this end, a unique combination of the commonly used destructive time-of-flight technique and the non-destructive image current detection method is employed here in an on-line mass spectrometer for short-lived nuclides. First time-of-flight mass measurements on rare earth elements and actinoids will be reported.

MS 5.3 We 15:00 F 428

Setup of a separator magnet and an RFQ-buncher for the TRIGA-SPEC experiment — •T Beyer[1,2], M Block[5], K Eberhardt[3], M Eibach[1,3], F Herfurth[5], J Ketelaer[4], K Knuth[4], D Lunney[6], Sz Nagy[2,5], W Nörtershäuser[3,5], C Smorra[1,3], and K Blaum[1,2] — [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 heavy nuclides are required to test the predictive power of nuclear mass models and to support nucleosythesis calculations of the astrophysical r-process. The TRIGA-TRAP mass spectrometer and the TRIGA-LASER laser spectroscopy setup, forming the TRIGA-SPEC experiment, were recently installed at the research reactor TRIGA Mainz in order to perform high-precision measurements of the ground state properties of short-lived neutron-rich radionuclides. The radionuclides are produced by thermal neutron-induced fission in an actinoide target inside the reactor, extracted by a gas-jet system, and ionized by an ECR ion source. The ions of interest will then be mass-separated in a 90° dipole magnet. An RFQ buncher is being installed to accumulate, cool and bunch the ion beam. The status of the implementation of the dipole magnet and the RFQ buncher will be presented.

MS 5.4 We 15:15 F 428

Status of the ^{3}H/^{3}He mass ratio measurement — •Christoph Diehl[1], Jochen Ketter[1], Martin Höcker[1], David B. Pinegar[1], Sebastian Streubel[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

A precise determination of the ^{3}H/^{3}He mass ratio, and hence of the tritium Q-value, is of relevance for the determination of the electron antineutrino mass by the Karlsruhe Tritium Neutrino Experiment (KATRIN). In our double Penning trap mass spectrometer we aim to measure the mass ratio of ^{3}H to its β-decay product ^{3}He with an precision of 10^{-11} and below. The spectrometer, originally built at the University of Washington, is setup now in a new laboratory in Heidelberg, and first test measurements have been performed. Tests have focused on $^{12}C^{4+}$ because it has the same mass-to-charge ratio as ^{3}H and ^{3}He. The new axial frequency lock loop performed well and first cyclotron resonances have been recorded with the new traps. Work continues towards the elimination of contaminations and the isolation of single ions.

MS 5.5 We 15:30 F 428

Ion Transport in the ^{3}H/^{3}He Penning trap mass spectrometry experiment — •Martin Höcker[1], Christoph Diehl[1], Jochen Ketter[1], David B. Pinegar[1], Sebastian Streubel[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 ^{3}H/^{3}He mass spectrometry experiment features two hyperbolical Penning traps and an external ion source in order to measure the Q-value of the ^{3}H to ^{3}He beta decay. The setup is designed to allow fast switching between ^{3}H and ^{3}He ions. This will enable us to decrease the dead time between cyclotron frequency measurements on the different ion species, which will in turn decrease the influence of magnetic

field drift and other time dependent perturbations on the measured Q-value. This talk will focus on the challenges of single ion transport in a precision trap with high impedance electrodes.

MS 5.6 We 15:45 F 428

PENTATRAP: A high-precision Penning trap mass spectrometer for highly-charged ions — •Christian Roux[1,2], Christine Böhm[1,2], Jose Crespo Lopez-Urrutia[1], Sergey Eliseev[1], Yuri Novikov[5], David Pinegar[1], Wolfgang Quint[2,4], Julia Repp[1,2], Andreas Rosa[1,2], Sven Sturm[3], Stefan Ulmer[1,2,3], and Klaus Blaum[1,2] — [1]Max-Planck Institut für Kernphysik, D-69117 Heidelberg — [2]Ruprecht-Karls-Universität Heidelberg, D-69120 Heidelberg — [3]Institut für Physik, Johannes Gutenberg-Universität Mainz, D-55099 Mainz — [4]GSI Helmholtzzentrum für Schwerionenforschung, D-64291 Darmstadt — [5]St. Petersburg Nuclear Physics Institute, 188300 Gatchina, Russia

A novel cryogenic Penning trap setup called PENTATRAP is presently under construction at the Max-Planck-Institut für Kernphysik, Heidelberg. The project aims for high-precision mass measurements on single highly-charged and stable ions related to e.g. tests of non-perturbative QED in strong electric fields as well as neutrino oriented mass determinations. In order to achieve the needed accuracy of $\delta m/m = 10^{-11}$, non-destructive cryogenic detection methods will be used at a stack of five Penning traps. Thereby, two traps will be used for real time monitoring of the magnetic field whereas the relative mass measurements will be performed in the central three traps. The apparatus is planned to be coupled to the EBIT at MPI-K and later to the HITRAP facility at GSI Darmstadt. The design studies of the project as well as the present status of the experimental setup will be presented.

MS 6: Beschleunigermassenspektrometrie und Anwendungen II

Time: Wednesday 16:30–18:45 Location: F 428

MS 6.1 We 16:30 F 428

Statusbericht zum Aufbau des Kölner Zentrums für Beschleuniger-Massenspektrometrie, CologneAMS — •Alfred Dewald[1], Martin Melles[2], Stefan Heinze[1], Jan Jolie[1], Andreas Zilges[1], Michael Staubwasser[2], Janet Rethemeyer[2], Jürgen Richter[4], Ulrich Radtke[3] und Friedhelm von Blanckenburg[5] — [1]Institut für Kernphysik, Universität zu Köln — [2]Institut für Geologie und Mineralogie, Universität zu Köln — [3]Geographisches Institut, Universität zu Köln — [4]Institut für Ur- und Frühgeschichte, Universität zu Köln — [5]Deutsches GeoForschungszentrum, Potsdam

Die Deutsche Forschungsgemeinschaft (DFG) fördert im Rahmen einer Großgeräte-Initiative ein 6 MV Beschleuniger-Massenspektrometer, das im Beschleunigerbereich des Instituts für Kernphysik (IKP) der Universität zu Köln aufgebaut und von der Universität zu Köln betrieben werden soll. Die Fertigung der 6 MV Beschleunigeranlage durch die Firma HVEE in Amersfoort/Niederlande ist nahezu abgeschlossen und der Testbetrieb wird in Kürze aufgenommen werden. Die parallel ablaufenden Umbauarbeiten des Beschleunigerbereichs des IKP werden voraussichtlich bis Anfang 2010 abgeschlossen werden. Die Betriebsgenehmigung für die neue AMS Anlage wurde beantragt und die Erteilung wird auch für Anfang 2010 erwartet. Im Rahmen dieses Beitrags sollen Einzelheiten zum Projektstatus vorgetragen und ein Ausblick über die noch anstehenden Arbeiten sowie über zukünftige Projekte gegeben werden.

MS 6.2 We 16:45 F 428

DREAMS - a universal AMS facility based on the 6 MV-Tandetron^{TM} at FZD in Dresden — •Shavkat Akhmadaliev, Andreas Kolitsch, Silke Merchel, and Wolfhard Möller — Forschungszentrum Dresden-Rossendorf e. V., Institute of Ion Beam Physics and Materials Research, P. O. Box 510119, D-01314, Dresden, Germany

A new accelerator mass spectrometry (AMS) system has been installed at the Forschungszentrum Dresden-Rossendorf (FZD). The system is based on a 6 MV-Tandetron ^{TM} accelerator produced by High Voltage Engineering Europe (HVEE). The AMS facility is specified for measurements of ^{10}Be, ^{14}C, ^{26}Al, ^{36}Cl, ^{41}Ca and ^{129}I with isotopic ratios of 10^{-10} - 10^{-16} and precision better than 0.3% for $^{14}C/^{12}C$.

The system uses a bouncer sequential injector with two Cs-sputter ion sources and a 54° electrostatic analyser (ESA). On the high-energy site it has a 90°-analysing magnet, Faraday-Cups for stable nuclides, a 35°-ESA, a post-stripper foil, and a 30°-vertical magnet for suppression of interfering species, and gas ionisation chamber for detection of radionuclides [1].

The Cockroft-Walton type high voltage generator provides a terminal voltage of up to 6 MV. The system is additionally equipped with a multipurpose ion injector containing a third Cs-sputter ion source and a duoplasmatron for high-energy ion implantation and ion-beam materials analysis.

[1] M. Arnold et al., accepted for Nucl. Instr. and Meth. B (Proceedings of IBA-2009).

MS 6.3 We 17:00 F 428

Status Report of the Aarhus AMS facility — •Klaus Bahner and Jan Heinemeier — AMS 14C Dating Centre, University of Aarhus, Ny Munkegade 120, 8000 Aarhus C, Denmark

The AMS 14C Dating Centre at Aarhus University is portrayed in this status report. The facility is based on an HVEC EN tandem accelerator and the system is briefly described. Technical developments during the past years were the transition to a replacement charging belt and, more recently, the installation of a high-intensity sputter source, which is used in routine operations since December 2009. Technical details of using the new charging belt type and a first performance evaluation of the new ion source are presented.

MS 6.4 We 17:15 F 428

Höchstempfindliche Messungen von mittelschweren Radionukliden am Münchener Tandembeschleuniger — •Georg Rugel, Iris Dillmann, Thomas Faestermann, Gunther Korschinek und Mikhail Poutivtsev — Physik Department E12 und E15, Technische Universität München, 85748 Garching

Am Münchner MP Tandembeschleuniger werden seit vielen Jahren höchstempfindliche Messungen von Radionukliden im Massebereich von ^{26}Al bis ^{244}Pu durchgeführt. Die hohe Energie der Ionen nach dem Tandembeschleuniger in Kombination mit einem gasgefüllten Analysier-Magneten (GAMS) erlaubt die Isobarentrennung in einer ortsempfindlichen Frischgitter-Ionisationskammer. Die erzielten Empfindlichkeiten bis etwa 10^{-16} ^{60}Fe/Fe ermöglichen es in vielen Gebieten einzigartige Resultate zu erzielen. Ein weiterer Aufbau dient dem Nachweis von Actiniden, wie ^{244}Pu, über eine Flugzeitstrecke. Ergebnisse unserer Gruppe in Zusammenarbeit mit anderen Gruppen mit einem Schwerpunkt auf astrophysikalische Fragestellungen werden vorgestellt.

MS 6.5 We 17:30 F 428

Direkte Bestimmung von natürlichen ^{10}Be/^{9}Be-Verhältnissen am Tandy — •Johannes Lachner, Marcus Christl und Hans-Arno Synal — Labor für Ionenstrahlphysik, ETH Zürich

Am Kleinbeschleuniger Tandy (600 kV) wurde das ^{10}Be/^{9}Be-Verhältnis in Tiefseesedimenten ohne Zugabe von Trägermaterial bestimmt. Diese Methode bietet die Möglichkeit einer einfacheren und präziseren Bestimmung des ^{10}Be/^{9}Be-Verhältnisses in natürlichen Proben mittels einer einzigen Messung, während konventionell die natürliche ^{9}Be-Konzentration einer Probe mit einer zusätzlichen Messung (z.B. per ICP-MS) ermittelt werden muss.

Eine Herausforderung bei der trägerfreien AMS-Messmethode ist die Vermeidung von Probenkontamination mit stabilem ^{9}Be während der chemischen Aufbereitung und der Herstellung der Targets. Erste Daten von Sedimentproben aus dem Zeitraum der letzten Umkehr des Erdmagnetfelds werden gezeigt.

MS 6.6 We 17:45 F 428

Recent advances in AMS of ^{36}Cl with a 3-MV-tandem — •Martin Martschini, Oliver Forstner, Robin Golser, Walter Kutschera, Tobias Orlowski, Stefan Pavetich, Alfred Priller, Peter Steier, and Anton Wallner — VERA Laboratory, Universität Wien - Fakultät für Physik - Isotopenforschung, Austria

Accelerator mass spectrometry (AMS) of ^{36}Cl ($t_{1/2}$ = 0.30 Ma) at natural isotopic concentrations requires high particle energies for the separation from the stable isobar ^{36}S and so far was exclusively the domain of machines with at least 5 MV terminal voltage.

At VERA (Vienna Environmental Research Accelerator) we had performed the first ^{36}Cl exposure dating measurement with a 3-MV tandem accelerator, operating our machine up to 20% above the nominal value, using foil stripping and a split-anode ionization chamber. We evaluated the performance of various detector setups for ^{36}Cl. With the ionization chamber and an additional energy signal from a silicon strip detector, we now achieved an equally good ^{36}S-suppression at 3 MV terminal voltage compared to 3.5 MV in our previous measurements. In addition, we improved ion source conditions and target backing materials with respect to sulfur output and cross contamination. We believe that ^{36}Cl measurements, which are competitive to larger tandems, are now possible.

Recently we started investigations on energy straggling in different counting gases. Comparison of first experimental data with simulations and published data yielded interesting insight into the physics underlying the detectors.

MS 6.7 We 18:00 F 428

Zerstörungswirkungsquerschnitte von Kohlenstoffmolekülen in Stickstoff — •Martin Seiler, Tim Schulze-König und Hans-Arno Synal — Ion Beam Physics, ETH Zürich, 8093 Zürich, Switzerland

Für die Entwicklung von kompakten Beschleunigermassenspektrometern ist die Kenntnis der Wirkungsquerschnitte für die Molekülzerstörung nötig. Diese Wirkungsquerschnitte wurden für die Kohlenstoffmoleküle $^{12}CH_2$ und ^{13}CH im Energiebereich zwischen 80 und 240 keV gemessen. Das Hauptproblem, die Flächendichte im Stripperrohr, wurde sowohl experimentell mittels Energieverlustmessungen sowie theoretisch durch Leitwertrechnung untersucht. Die Ergebnisse werden vorgestellt und mit bestehenden Literaturwerten verglichen.

MS 6.8 We 18:15 F 428

Upgrade der ETH 600 kV TANDY AMS Anlage durch einen zusätzlichen 130° Ablenkmagneten — •Arnold Müller, Marcus Christl, Johannes Lachner, Martin Suter, Hans-Arno Synal und Christof Vockenhuber — Labor für Ionenstrahlphysik, ETH Zürich, 8093 Zürich, Schweiz

Seit einigen Jahren steigt das Interesse an kompakten Multiisotopen AMS-Anlagen stetig an. Die mit kleinen Strahlenergien verbundenen hohen Streu- und Umladungsquerschnitte können jedoch zu einem erhöhten Untergrund führen. So gelangten an der ETH 600 kV TANDY Anlage durch Umladungs- und Streuprozesse ^{9}Be Projektile in den Detektor mit der gleichen Energie wie das Radionuklid ^{10}Be. Der ^{10}Be/^{9}Be Untergrund für die Abschwächer-Methode war dadurch auf ein Level von 10^{-13} begrenzt. Dank dem Einsatz eines zusätzlichen 130° Ablenkmagneten konnten diese ^{9}Be Projektile effizient unterdrückt werden. Es wird nun ein ^{10}Be/^{9}Be Untergrundverhältniss von unter $1{\cdot}10^{-15}$ erreicht. Um die Transmission durch das System zu optimieren, wurde der Aufbau wurde so konzipiert, dass der ^{10}Be-Strahl nach Passieren der SiN-Abschwächerfolie achromatisch in den Detektor abgebildet wird. Die Performance der erweiterten TANDY Anlage und erste Resultate sollen diskutiert werden.

MS 6.9 We 18:30 F 428

Aktinide-Messungen am "upgraded" Tandy — •Marcus Christl, Johannes Lachner, Christof Vockenhuber und Hans-Arno Synal — ETH-Zürich, Labor für Ionenstrahlphysik

Die Installation eines zusätzlichen Hochenergiemagneten am Kleinbeschleuniger "Tandy" der ETH-Zürich und der Umbau der Ionenquelle haben zu einer deutlichen Verbesserung der Performance des AMS-Systems geführt. In diesem Beitrag wird der aktuelle Messaufbau für Aktinide vorgestellt und es wird auf die Performance bezüglich Effizienz, Transmission, Unterdrückung der Nachbarmassen und Untergrund eingegangen. Zudem werden erste Messungen von U-236 und Pu-244 präsentiert.

MS 7: Präzisionsmassenspektrometrie und Anwendungen II

Time: Thursday 10:30–12:30 Location: F 428

Group Report MS 7.1 Th 10:30 F 428

Fortschritte bei WITCH — •Marcus Beck[1], Peter Friedag[1], Jonas Mader[1], Christian Weinheimer[1], Martin Breitenfeld[2], Sam Coeck[2], Nathal Severijns[2], Emil Traykov[2], Michael Tandecki[2], Simon van Gorp[2], Frederick Wauters[2], Alexander Herlert[3], Fredrik Wenander[3], Dalibor Zákoucký[4] und Valentin Yu. Kozlov[5] — [1]Westfälische Wilhelms-Universität Münster — [2]K.U.Leuven, Belgien — [3]CERN, Schweiz — [4]NPI Rez/Prag, Tschechien — [5]KIT, Karlsruhe

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 exotischen Wechselwirkungen jenseits des Standardmodelles.

In 2008 und 2009 wurden zahlreiche Verbesserungen am experimentellen Aufbau vorgenommen, die Ende 2009 mit einer Strahlzeit mit ^{35}Ar erfolgreich getestet wurden. Sowohl das Problem der starken Entladungen im Spektrometer wie auch der des Ladungsaustauschs in den Penningfallen wurden gelöst und die Kühlung in und Transfer zwischen den Penningfallen verbessert. Es wurden Rückstoßionen aus dem Zerfall des ^{35}Ar mit niedriger Statistik gemessen und verschiedenen systematische Effekte untersucht. Der Status des Experimentes und erste Ergebnisse der Messung werden dargestellt.

Dieses Projekt wird vom BMBF unter der Nummer 06MS270 unterstützt.

MS 7.2 Th 11:00 F 428

Massenmessungen zur Untersuchung der Kernstruktur von Kr und Ag an Isoltrap — •Ch. Borgmann[1], G. Audi[2], D. Beck[3], K. Blaum[1], Ch. Böhm[1], M. Breitenfeldt[4], D. Fink[1], S. George[1], F. Herfurth[3], A. Herlert[5], M. Kowalska[5], S. Kreim[1], D. Lunney[2], S. Naimi[2], D. Neidherr[6], M. Rosenbusch[4], S. Schwarz[7] und L. Schweikhard[4] — [1]Mpi für Kernphysik, Heidelberg — [2]Csnsm, Orsay, Frankreich — [3]Gsi, Darmstadt — [4]Universität Greifswald — [5]Cern, Genf, Schweiz — [6]Universität Mainz — [7]Nscl Msu, East Lansing, Usa

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

2009 wurden unter anderem die Massen und damit die Kernbindungsenergien von ^{96,97}Kr und $^{122-124}$Ag bestimmt. Ziel dieser Messungen war die Untersuchungen der Kernstruktur, außerdem ermöglichen sie Tests der Genauigkeit von Massenmodellen. Durch die neuen Massenwerte für neutronenreiche Silbernuklide wurden zuvor beobachtete Auffälligkeiten in den Zweineutronenseparationsenergien der Silber–Isotopenkette korrigiert. Ihr Verhalten entspricht nun wie erwartet dem für sphärische Kerne. Die erstmals gemessenen Krypton–Massen liefern einen wichtigen Beitrag in der Diskussion um den plötzlichen Wechsel von sphärischen zu deformierten Kernen in der Region um $A = 100$.

Im Rahmen dieses Beitrags werden die oben erwähnten Messungen vorgestellt.

MS 7.3 Th 11:15 F 428

A new route for neutrino mass determination using the electron capture of ^{194}Hg — Dietrich Beck[1], Klaus Blaum[2,3], •Christine Böhm[2,3], Martin Breitenfeldt[4], Sergey Eliseev[2], Valentin Fedoseev[5], Sebastian George[2], Frank Herfurth[1], Alexander Herlert[5], Magdalena Kowalska[5], David Lunney[6], Sarah Naimi[6], Dennis Neidherr[7], Yuri Novikov[8], Stefan Schwarz[9], Lutz Schweikhard[4], Maxim Seliverstov[5], and Kai Zuber[10] — [1]GSI, Darmstadt — [2]MPI für Kernphysik, Heidelberg — [3]Ruprecht-Karls-Universität, Heidelberg — [4]Ernst-Moritz-Arndt-Universität, Greifswald — [5]CERN, Genève — [6]Université de Paris Sud, Orsay — [7]Johannes Gutenberg-Universität, Mainz — [8]PNPI, Gatchina, St. Petersburg — [9]NSCL, MSU, East Lansing, Michigan — [10]Technische Universität, Dresden

The electron neutrino mass is of highest importance for many fields of physics. To measure the neutrino mass, beta-decay spectra are typi-

cally used. Here an alternative way to determine the neutrino mass, using an electron capture in ^{194}Hg will be presented. Direct mass measurements of ^{194}Hg and its daughter nucleus ^{194}Au were performed at the high-precision Penning trap mass spectrometer ISOLTRAP at the ISOLDE facility (CERN). The Q_{EC}-value obtained by the mass difference of these nuclei leads to the conclusion that the K-capture is forbidden, thus an L-capture is assumed. For further investigations a measurement using a cryogenic micro-calorimeter is suggested. From this, a de-excitation spectrum is obtained which can be compared to the Q_{EC}-value in order to determine the neutrino mass.

MS 7.4 Th 11:30 F 428

First direct Penning trap mass measurements on nobelium and lawrencium — •Michael Dworschak[1], Michael Block[1], Dieter Ackermann[1], Klaus Blaum[2], Christian Droese[3], Sergey Eliseev[2], Timo Fleckenstein[4], Emma Haettner[4], Frank Herfurth[1], Fritz-Peter Hessberger[1], Sigurd Hofmann[1], Jens Ketelaer[5], Jochen Ketter[5], Heinz-Jürgen Kluge[1], Gerrit Marx[3], Marco Mazzocco[6], Dmitriy Nesterenko[7], Yuri Novikov[1,7], Wolfgang Plass[1,4], Andrey Popeko[8], Saidur Rahaman[9], Daniel Rodríguez[10], Christoph Scheidenberger[1,4], Lutz Schweikhard[3], Peter Thirolf[11], Gleb Vorobyev[1], and Christine Weber[9] — [1]GSI Helmholtzzentrum, Darmstadt — [2]MPI für Kernphysik, Heidelberg — [3]Universität Greifswald — [4]Universität Gießen — [5]Universität Mainz — [6]INFN Sezione, Padova — [7]PNPI RAS, Gatchina — [8]JINR, Dubna — [9]University of Jyväskylä — [10]Universidad de Granada — [11]LMU, München

The mass measurements of the three nobelium isotopes $^{252-254}$No and the lawrencium isotope ^{255}Lr measured with the Penning trap mass spectrometer SHIPTRAP/GSI have been evaluated. These were the first direct mass measurements of transfermium elements ever performed. The results mark the first step in the exploration of masses of even heavier nuclides which is planned at SHIPTRAP. The main objective is to measure the endpoints of α-decay chains starting from superheavy nuclei in the region of the predicted island of stability. The SHIPTRAP results were compared with previous measurements based on α-decay chains and new literature values were obtained.

MS 7.5 Th 11:45 F 428

A Gas-Jet ECR Ion Source at TRIGA-SPEC — •Christian Smorra[1,2], Thomas Beyer[2,3], Klaus Blaum[2,3], Michael Block[4], Martin Eibach[1,2], Klaus Eberhardt[1], Frank Herfurth[4], Jens Ketelaer[5], Konstantin Knuth[5], Szilard Nagy[3,4], and Wilfried Nörtershäuser[1,4] — [1]Institut für Kernchemie, Johannes Gutenberg-Universität, Fritz-Strassmann-Weg 2, 55128 Mainz — [2]Physikalisches Institut, Ruprecht Karls-Universität, Philosophenweg 12, 69120 Heidelberg — [3]Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg — [4]GSI Helmholzzentrum für Schwerionenforschung GmbH, Planckstrasse 1, 64291 Darmstadt — [5]Institut für Physik, Johannes Gutenberg-Universität, Staudingerweg 7, 55128 Mainz

The TRIGA-SPEC experiment has been installed recently at the research reactor TRIGA Mainz. Ground state properties like masses, charge radii, spins, and moments of short-lived nuclides can be determined with very-high precision using the Penning trap mass spectrometer TRIGA-TRAP, and the collinear laser spectroscopy setup TRIGA-LASER. Short-lived neutron-rich radionuclides in the mass range 80 $<$ A $<$ 140 are produced by thermal neutron induced fission of e.g. U-235, Pu-239 or Cf-249, respectively. For the extraction and ionization of the fission products a gas-jet system is coupled to a 2.45-GHz ECR ion source for the production of singly charged ions. The gas-jet has been tested on-line and fission products have been extracted. First off-line tests of the ion source have been performed successfully with argon gas. The results of the commissioning test of the ion source and the on-line coupling of the experiments will be presented.

MS 7.6 Th 12:00 F 428

MR-TOF-MS: A Time-of-Flight-Based System with sub-ppm Mass Measurement Accuracy and Large Isobar Separation Ion Capacity ($>$ 10^6 ions/s) — •Timo Dickel[1], Wolfgang R. Plass[1,2], Arno Becker[1], Ulrich Czok[1], Hans Geissel[1,2], Emma Haettner[1,2], Christian Jesch[1], Wadim Kinsel[1,2], Martin Petrick[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, Russia

At low-energy radioactive ion beam facilities, mass measurements and spectroscopy for a broad range of nuclei can be performed. For these experiments, the nuclei have to be stopped, cooled, separated and measured as fast and efficiently as possible. A multiple-reflection time-of-flight mass spectrometer (MR-TOF-MS) has been developed that will be essential for these experiments. It is a multi-purpose, non-scanning mass spectrometer with single-ion sensitivity. The MR-TOF-MS has been tested at the tandem accelerator of the Maier-Leibnitz-Laboratory Garching (Germany). Systematic studies on the mass resolving power ($>$300.000), transmission efficiency ($\sim$70%), separation power and dynamic range of the MR-TOF-MS will be presented. Mass measurements of an isobaric triplet indicate that the systematic errors of the device are as low as 10^{-7}.

MS 7.7 Th 12:15 F 428

The ion circus — •Enrique Minaya Ramirez[1] and David Lunney[2] — [1]GSI Helmholtzzentrum, Darmstadt, Germany — [2]CSNSM- IN2P3/CNRS, Université de Paris-Sud, Orsay, France

The ability to prepare radioactive beams for experiments in nuclear structure has seen important developments in recent years. The use of ion traps and buffer-gas cooling now enables the accumulation and purification of even short-lived nuclides. This is a key point for future installations since higher intensity also brings increased isobaric contamination which can be disastrous for background. Until now, the development of beam cooler/bunchers has relied on linear (radiofrequency quadrupole) Paul traps. In this contribution we describe the progress in developing a novel circular Paul trap. The ion circus, so named for its ability to trap ions at different positions along the ring circumference and to eject them in either perpendicular or tangential direction, has also been designed to cool and mass separate the ions over a longer flight path. The resolving power is increased as the ions orbit in the ring and are cooled with buffer gas at a much lower pressure. The first prototype is now under test in Orsay. We report results of the first tests and the future program.

MS 8: Poster

Time: Thursday 16:00–18:00 Location: Lichthof

MS 8.1 Th 16:00 Lichthof

An optimized ion-optical setup for AMS of ^{10}Be with a degrader foil — •Martin Martschini, Oliver Forstner, Robin Golser, Walter Kutschera, Leonard Michlmayr, Alfred Priller, Peter Steier, and Anton Wallner — VERA Laboratory, Universität Wien - Fakultät für Physik - Isotopenforschung, Austria

The challenge in accelerator mass spectrometry (AMS) of ^{10}Be ($t_{1/2}$=1.4 Ma) is the suppression of the stable isobar ^{10}B. One method established in recent years at VERA (Vienna Environmental Research Accelerator), is the use of a thin degrader foil to introduce an energy difference between ^{10}Be and ^{10}B, followed by an additional energy-sensitive bending element and a split-anode ionization chamber. While this setup has considerably reduced our background (^{10}Be/^{9}Be $<$ 10^{-15}), it initially suffered from a poor transmission after the degrader foil.

In order to optimize our setup, we have measured the phase space of a ^{9}Be^{2+}-beam and determined the transverse emittance and energy distribution of the beam. These results were used in ion-optical simulations of our high energy beamline. They allowed to identify the beamline elements responsible for transmission losses and helped to plan modifications of our quadrupole doublet and the switcher magnet chamber. Thereby, the transmission increased by a factor of 3. At VERA, the degrader foil method now clearly outperforms other established methods for samples with ^{10}Be/^{9}Be ratios lower than 10^{-13}.

MS 8.2 Th 16:00 Lichthof

TRIGA-TRAP: High-precision mass measurements on neutron-rich fission products and actinoids — •J. Ketelaer[1], T. Beyer[2,3], M. Block[4], K. Eberhardt[1], M. Eibach[1,3], F. Herfurth[4], Sz. Nagy[2,4], C. Smorra[1,3], W. Nörtershäuser[1,4], and K. Blaum[2,3] — [1]Johannes Gutenberg-Universität, 55128

Mainz — [2]Max-Planck-Institut für Kernphysik, 69117 Heidelberg — [3]Ruprecht-Karls-Universität, 69117 Heidelberg — [4]GSI Helmholtzzentrum für Schwerionenforschung GmbH, 64291 Darmstadt

Triga-Trap is currently the only Penning trap mass spectrometer installed at a nuclear reactor. High-precision mass measurements on neutron-rich fission products and actinoids will be performed here to provide valuable input data for tests of nuclear structure models as well as for astrophysical calculations of the r-process. The setup also serves as a test bench for the development of new detection techniques which will be implemented at other experiments at the future GSI facility FAIR. As an example, a non-destructive image current detection system will allow mass measurements on single stored singly-charged ions whereas a few hundred to thousands are typically needed with the traditionally used time-of-flight resonance method. Triga-Trap is presently the only on-line Penning trap mass spectrometer where simultaneously the destructive and non-destructive detection techniques are implemented. The poster will show the technical developments and give an overview on first time-of-flight mass measurements already performed on rare earth elements and actinoids.

MS 8.3 Th 16:00 Lichthof

Minimization of environmental influences for precision mass measurements — •Sebastian Streubel[1], Christoph Diehl[1], Jochen Ketter[1], Martin Höcker[1], David B. Pinegar[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

In an experiment with a double-Penning trap mass spectrometer, we aim to measure the mass ratio of ^{3}H to ^{3}He with a precision of 10^{-11} and below. This mass ratio gives an independent measurement of the tritium Q-value and is thus of relevance for the determination of the electron antineutrino mass by the Karlsruhe Tritium Neutrino Experiment (KATRIN). To obtain the desired precision, it is important to control the environmental influences. For the best B-field control possible, we stabilize the pressure and the height of the liquid He surrounding the traps and the temperature of the room in which the magnet stands. We actively compensate the drift of the geomagnetic field, and reduce the coupling of vibrations to the magnet from the movement of the building.

MS 8.4 Th 16:00 Lichthof

Ion cyclotron resonance detection techniques at TRIGA-TRAP — •K. Knuth[1], T. Beyer[2,3], K. Blaum[2,3], M. Block[4], K. Eberhardt[1], M. Eibach[1,3], F. Herfurth[4], J. Ketelaer[1], C. Smorra[1,3], and Sz. Nagy[2,4] — [1]Johannes Gutenberg-Universität, 55128 Mainz — [2]Max-Planck-Institut für Kernphysik, 69117 Heidelberg — [3]Ruprecht-Karls-Universität, 69120 Heidelberg — [4]GSI Helmholtzzentrum für Schwerionenforschung GmbH, 64291 Darmstadt

In Penning trap mass spectrometry the mass of stored ions is obtained via a determination of the cyclotron frequency $\nu_c = qB/(2\pi m)$, for which two different techniques are available. The destructive time-of-flight ion cyclotron resonance (TOF-ICR) technique, based on the measurement of the flight time of excited ions, is the established method for measurements on short-lived radionuclides. It is not ideally suited for rarely produced ion species, since typically some hundred ions are required for a single resonance spectrum. At the Penning trap mass spectrometer TRIGA-TRAP therefore a non-destructive narrow-band Fourier transform ion cyclotron resonance (FT-ICR) detection system is being developed. It is based on the detection of the image currents induced by the stored ions in the trap electrodes and will ultimately reach single ion sensitivity. TRIGA-TRAP also features broad-band FT-ICR detection for the coarse identification of the trap content. Additionally, the TOF-ICR detection system has been recently improved to utilize the Ramsey excitation technique to gain in precision, and the position information of the ion impact to further suppress background events in the final time-of-flight spectrum.

MS 8.5 Th 16:00 Lichthof

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], 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

More precise knowledge of the Q-value of the β-decay of ^{3}H to ^{3}He will complement the determination of the electron antineutrino's mass by the Karlsruhe Tritium Neutrino Experiment (KATRIN) [1]. In order to improve the presently accepted Q-value [2] by a factor of 25 to an uncertainty of 50 meV, the mass ratio of ^{3}H to ^{3}He has to be measured with an uncertainty of less than 10^{-11}. Penning trap mass spectrometry has the prospect of doing so. To this end, a double Penning trap mass spectrometer [3], originally developed and built at the University of Washington, has been commissioned in a dedicated laboratory in Heidelberg. The mass measurement relies on the determination of the ion's three eigenfrequencies in the trap. While a frequency-locked loop keeps the ion's axial frequency in resonance with a tuned circuit, the other two frequencies are determined via shifts induced in the axial frequency due to higher-order couplings when sweeping through resonances. 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 8.6 Th 16:00 Lichthof

PENTATRAP: A cryogenic multi-Penning trap experiment for high-precision mass measurements on highly charged ions. — •Julia Repp[1,2], Christine Böhm[1,2], José Crespo López-Urrutia[1], Sergey Eliseev[1], Yuri Novikov[5], David Pinegar[1], Wolfgang Quint[2,4], Andreas Rosa[1,2], Christian Roux[1,2], Sven Sturm[3], Stefan Ulmer[1,2,3], and Klaus Blaum[1,2] — [1]Max-Planck-Institut für Kernphysik, D-69117 Heidelberg — [2]Ruprecht-Karls-Universität Heidelberg, D-69120 Heidelberg — [3]Institut für Physik, Johannes Gutenberg-Universität Mainz, D-55099 Mainz — [4]GSI Helmholtzzentrum für Schwerionenforschung, D-64291 Darmstadt — [5]St. Petersburg Nuclear Physics Institute, Gatchina Russia

The PENTATRAP experiment is under construction at the Max-Planck-Institut für Kernphysik Heidelberg. It aims for high-precision mass measurements of stable, highly charged nuclides up to uranium with an accuracy of $\delta m/m \approx 10^{-11}$. Primary goals are for example tests of quantum electrodynamics and of electron correlations in the regime of extreme fields as well as neutrino oriented mass measurements on *e.g.* ^{163}Ho. In order to achieve the desired accuracy, a setup of five cryogenic Penning traps including a dedicated detection system is designed. This setup will guarantee a fast ion exchange between a reference ion and an ion of interest as well as an observation of the magnetic field over the measurement time. The planned experimental setup as well as its present status will be presented.

MS 8.7 Th 16:00 Lichthof

A multi-passage spectrometer for charge-state separation at MLLTRAP [*] — •Christine Weber[1], Eva Gartzke[1], Dietrich Habs[1], Veli Kolhinen[2], Kevin Krug[1], Jerzy Szerypo[1], and Peter Thirolf[1] — [1]Fakultät für Physik, LMU - München — [2]Department of Physics, University of Jyväskylä

MLLTRAP is a Penning trap mass spectrometer facility which is currently being commissioned at the Maier-Leibnitz Tandem Accelerator Laboratory in Garching. Here, atomic mass values are determined by comparison of cyclotron frequencies, $\omega_c = qB/m$, of stored ions with mass m and charge q in a strong magnetic field B, relative to those of well-known ion species. One of the future goals of MLLTRAP is to utilize highly-charged ions for an improvement in the achievable mass accuracy $\delta m/m$. For this purpose, singly-charged ions will have to be injected into a charge-breeding device, such as an EBIT, and transferred back towards the Penning traps, while being q/A selected. A multi-passage-spectrometer (MPS) is being built to fulfill these tasks. It consists of a fast-ramping, round-pole dipole magnet with a four-way electrostatic mirror system [2]. In this presentation, the planned MLLTRAP setup focussing on the q/A-selection with the MPS system will be presented.

[1] V.S. Kolhinen *et al.*, Nucl. Instr. and Meth. A **600** (2009) 391.
[2] A. Lakatos, Diploma Thesis, University of Frankfurt (1992).
[*] Supported by the DFG under contract HA 1101/14-1 and MLL.

MS 8.8 Th 16:00 Lichthof

Commissioning of the double Penning trap system MLLTRAP and first studies on mass-dependent systematic uncertainties* — •Kevin Krug[1], Christine Weber[1], Peter G. Thirolf[1], Jerzy Szerypo[1], Veli Kolhinen[1,2], Eva Gartzke[1], and Dietrich Habs[1] — [1]Fakultät für Physik, LMU München — [2]Department of Physics, University of Jyväskylä

The cylindrical double Penning trap system MLLTRAP in its commis-

sioning phase at the Maier-Leibnitz-Laboratory (MLL) Tandem accelerator in Garching is designed to perform high-accuracy mass measurements on fusion-reaction products. As the mass uncertainty is inversely proportional to the ionic charge state, the ions of interest will be charge bred prior to injection into the Penning trap system. In the future setup, both traps are foreseen to be operated as measurement traps with a relative homogeneity of the magnetic field at the trapping sites of $\Delta B/B \leq 0.3$ ppm. In the commissioning phase, an offline surface ionization source is used for iterative optimization of the apparatus and studies on mass-dependent systematic uncertainties. Mass measurements via the time-of-flight ion cyclotron resonance method (TOF-ICR) of reference ions with well-known masses (^{85}Rb, ^{87}Rb, ^{39}K, ^{133}Cs) were carried out to analyze mass-dependent systematic effects. Together with previous studies on the uncertainty due to magnetic-field fluctuations the current status with respect to the limits of mass accuracy of the apparatus will be presented.

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

MS 8.9 Th 16:00 Lichthof

A complementary laser system for ISOLDE-RILIS — •Sebastian Rothe[1,2], Christoph Mattolat[2], Bruce Marsh[1], Klaus Wendt[2], and Valentin Fedosseev[1] — [1]CERN, Geneva, Switzerland — [2]Institut für Physik, Universität Mainz

The resonant laser ion source (RILIS) is a well-established tool for efficient and selective production of radioactive ion beams (RIBs) at ISOL facilities. Element selectivity is achieved by applying stepwise resonant ionization using up to three different laser wavelengths. Due to their advantages in terms of stability and reliability, an all solid-state titanium:sapphire (ti:sa) system is used or is planned to be installed at the majority of on-line facilities worldwide. Ti:sa lasers are pumped by frequency doubled Nd:YAG lasers at a repetition rate of typically 10 kHz and generate radiation in the near infrared between 690 nm and 960 nm at output powers of 3 W and a typical spectral line width of 3 GHz.

Such an all solid-state ti:sa laser system is going to be installed at the ISOLDE-RILIS, CERN alongside the well-established dye laser system. Primary objective of this complementary laser system is a reduction in the RILIS downtime during laser configuration changes for ionization of different elements requested by ISOLDE users. Secondary benefits such as better beam quality and power stability, and therefore lower maintenance during operation, are expected.

The progress of these activities at CERN will be discussed and future projects such as in-source spectroscopy and refined on-line laser surveillance will be covered.

MS 8.10 Th 16:00 Lichthof

Novel techniques for laser ionization at the IGISOL facility - an inductively-heated RF hot cavity and the gas jet method — •Volker Sonnenschein, Iain Moore, Mikael Reponen, and Juha Äystö — University of Jyväskylä, Finland

Experiments have revealed a (21^+) isomeric state in ^{94}Ag. Recently the observed decay modes, including a two proton decay, have been brought into question. For further investigation an inductively-heated hot cavity designed to operate at temperatures of up to 2300 K has been developed at JYFL for the production of radioactive silver ion beams. An efficient laser ionization scheme for silver has already been tested, though a further search for autoionizing states using a grating-based Ti:Sapphire laser is planned.

The SPIG (Sextupole Ion Guide) allows for element selective ionization of the on-line produced radioactive species at IGISOL by using resonant laser ionization of atoms in an expanding gas jet and trapping the produced ions by RF fields. Visualization of the jet by a DC discharge showed a large angular spread of the gas jet, which would result in a poor overlap geometry between the atoms and the counter-propagating laser beams. Offline studies of the gas flow as a function of nozzle design, gas cell pressure and background extraction chamber pressure have been carried out. The velocity of the jet has been probed using resonance ionization spectroscopy of nickel atoms evaporated from a filament. A clear shift in the resonance centroid compared to ionization in the gas cell indicates a supersonic jet expansion.

MS 8.11 Th 16:00 Lichthof

Zweiphotonen- und Einphotonen-Circulardichroismus — •Christoph Logé und Ulrich Boesl — Technische Universität München, Deutschland

Nichtlineare Photonen-Prozesse sind aufgrund ihrer besonderen und oftmals zu linearen Prozessen unterschiedlichen Charakteristika interessant. Die Verknüpfung von Zweiphotonenabsorption mit Circulardichroismus lässt eine Reihe neuer Effekte erwarten. Ein großer Vorteil ist, dass nun spektrale Bereiche im VUV mit sichtbarem und nahem UV-Licht erreichbar sind. Erste Hinweise auf die Besonderheiten des Zweiphotonen-Circulardichroismus sind aus theoretischen Betrachtungen abzuleiten. Aktuelle detaillierte quantenmechanische Berechnungen der Effekte zeigen, dass bei Zweiphotonen-Circulardichroismus teilweise wesentlich höhere Effekte als bei Einphotonen-Circulardichroismus zu erwarten sind. Die vorliegenden Untersuchungen mittels enantiosensitiver Lasermassenspektrometrie wurden an verschiedenen elektronischen Übergängen des Moleküls 3-Methylcycopentatnon durchgeführt. Die resonante Multiphotonenionisation über die ersten angeregten Zustände konnte sowohl im Ein- als auch im Zweiphotonenprozess durchgeführt werden. Höher angeregte Zustände wurden ebenfalls untersucht. Es konnte gezeigt werden, dass der Zweiphotonen-Circulardichroismus teilweise um Größenordnungen über dem Einphotonen-Circulardichroismus liegt. Der Effekt ist besonders interessant für die Untersuchung elektronisch erlaubter Übergänge, deren lineare optische Aktivität normalerweise gering ist.

MS 8.12 Th 16:00 Lichthof

Festkörper-Massenspektrometrie an SiO_2-Proben durch Nd:YAG-Laserpuls-induzierte Si-O-Plasmaerzeugung — •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-Str. 1, D-60438 Frankfurt am Main — [2]Heraeus Quarzglas, D-63450 Hanau

Mit einem grünen Q-switch Nd:YAG-Laser hoher Leistungsdichte werden unter Ultrahochvakuum-Bedingungen Silicium-Sauerstoff-Plasmen erzeugt. Es werden transparente und hochreine Siliciumdioxid-Scheiben verwendet und derart bewegt, dass im Laserfokus und im Takt der Laserpulse an der Oberfläche Krater (Durchmesser < 40 μm) gebildet und aneinander gereiht werden. Es entstehen Atom-, Molekül- und Cluster-Ionen, die simultan mit einem Massenspektrometer, Typ 21-110, nachgewiesen und für Elemente von Wasserstoff bis Uran qualitativ und quantitativ analysiert werden.

MS 8.13 Th 16:00 Lichthof

An RFQ beam preparation system for SHIPTRAP — •Thorsten Schäfer[1], Emma Haettner[1,2], Wolfgang Plass[1,2], Arno Becker[1], Ulrich Czok[2], Timo Dickel[1], Hans Geissel[1,2], Wadim Kinsel[2], Felix Lautenschläger[1], Martin Petrick[1], Christoph Scheidenberger[1,2], Richard Thöt[1], and Josephina Werner[1] — [1]Justus Liebig Universität, Gießen — [2]GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt

A radio frequency quadropole (RFQ) system for beam preparation, reduction and matching of the phase-space has been developed for the Penning trap facility SHIPTRAP. The system consists of an RFQ cooler, an RFQ mass filter and an RFQ buncher and will allow to cool, mass seperate and bunch the nuclei of interest from unwanted species, which contaminate the ion sample and often deteiorate the quality of the measurement, sometimes even obscure the measured data.

The targeted performance of the mass filter are highest possible transmission at unit mass resolution. For this purpose the RFQ cooler, mass filter and buncher have been developed and built in a matched combination. High quality RF coils have been built, which enable RF voltages with amplitudes up to 2 kV, and the RF voltage has been stabilized to the level of 0.1%.

For highest quality of the extracted ion bunches RF-free, dipolar extraction from the RF buncher has been implemented. The RF-free extraction of the buncher has been realised using a special damping circuit. In order to increase its efficiency, the RFQ buncher is designed as a two stage trap system.

MS 8.14 Th 16:00 Lichthof

Extremely high mass resolution and sensitivity - comparison of two novel proton transfer reaction time-of-flight mass spectrometers (PTR-TOFMS) — Alfons Jordan[1], •Philipp Sulzer[1], Simone Jürschik[1], Stefan Jaksch[1], Gernot Hanel[1], Eugen Hartungen[1], Hans Seehauser[1], Lukas Märk[1], Stefan Haidacher[1], Ralf Schottkowsky[1], and Tilmann Märk[1,2] — [1]IONICON Analytik GmbH, Technikerstr. 21a, 6020 Innsbruck, Austria — [2]Institut für Ionenphysik und Angewandte Physik, Universität Innsbruck, Technikerstr. 25, 6020 Innsbruck, Austria

Since many years PTR-MS is a well established technique in trace gas analysis with its major advantages of having very short response times

of below 100ms and outstanding detection limits in the single digit pptv region. However, the quadrupole mass filter based instruments used so far cannot separate isobaric compounds due to lack of mass resolution. To overcome this problem Ionicon developed the so called PTR-TOF 8000 instrument, which couples the well established PTR ionization technique with a high resolution time-of-flight (TOF) mass analyzer. In contrast to a quadrupole based PTR-MS where only one nominal mass at a time can be monitored, the PTR-TOF acquires whole mass spectra in split-seconds at a resolution of up to 8.000 m/Δm (FWHM). As there might be applications where an enormous mass resolution is not necessarily needed, but the sensitivity has to be as high as possible, we now developed an instrument (called PTR-TOF 2000) that performs with an enhanced sensitivity at the expense of a somewhat lower mass resolution.

MS 8.15 Th 16:00 Lichthof

Distinguishing isomers and entering the ppqv detection limit region - latest developments in PTR-MS instruments — Alfons Jordan[1], Philipp Sulzer[1], Simone Jürschik[1], Stefan Jaksch[1], Gernot Hanel[1], Eugen Hartungen[1], Hans Seehauser[1], •Lukas Märk[1], Stefan Haidacher[1], Ralf Schottkowsky[1], and Tilmann Märk[1,2] — [1]IONICON Analytik GmbH, Technikerstr. 21a, 6020 Innsbruck, Austria — [2]Institut für Ionenphysik und Angewandte Physik, Universität Innsbruck, Technikerstr. 25, 6020 Innsbruck, Austria

We report on the latest instrumental developments, namely i) the improvement of the detection limit that now allows for measuring trace gas compounds in a concentration range from several ppmv down to the ppqv (parts-per-quadrillion) region with a typical response time well below 100ms and, in case a TOF mass analyzer is used, a mass resolution better than 5.000 m/Δm and ii) the possibility to switch between H3O+, NO+ and O2+ as reagent ions. We show, that the sensitivities obtained with NO+ and O2+ are comparable or even better to the outstanding sensitivity of the established PTR-MS instruments and therefore well above those from e.g. SIFT-MS instruments. To demonstrate the advantages of the new setup we e.g. measured acetone and propanal (isomeric molecules at nominal mass 58amu) utilizing NO+ as the precursor ion. We see the isomeric compounds on different nominal masses and can identify them unambiguously. Furthermore, by using O2+ precursor ions we are able to ionize molecules that cannot be measured via hydronium proton transfer reaction.

MS 8.16 Th 16:00 Lichthof

Direct aqueous injection analysis of trace compounds in water with proton-transfer-reaction mass spectrometry (PTR-MS) — Simone Jürschik[1], Philipp Sulzer[1], Stefan Jaksch[1], Stefan Haidacher[1], Alfons Jordan[1], Ralf Schottkowsky[1], Eugen Hartungen[1], Gernot Hanel[1], Hans Seehauser[1], •Lukas Märk[1], and Tilmann Märk[1,2] — [1]IONICON Analytik GmbH, Technikerstr. 21a, 6020 Innsbruck, Austria — [2]Institut für Ionenphysik und Angewandte Physik, Universität Innsbruck, Technikerstr. 25, 6020 Innsbruck, Austria

Here we report on a new instrumental development that allows for direct analysis of liquid samples. The direct aqueous injection (DAI) technique which we will present here turns out to be an ideal solution for direct analysis of liquid samples with PTR-MS. Water solutions were prepared with 1 to 1000 ppbw (part per billion weight) concentrations of methanol, acetonitrile, pyridine (in this case additional mixtures down to 125 pptw were prepared) and cyclohexanol in distilled water. We found that the detection of trace compounds in water is possible over several orders of magnitude down to a concentration level of about 100 pptw (for pyridine at protonated mass m/z = 80 and for about 5 min integration time) with great linearity, while only consuming about 100 ul of the sample. The response time of the setup is between 20 and 25 seconds. This method is applicable to the analysis of all substances and not limited by the permeability of a membrane. Therefore it will open completely new fields of application for the PTR-MS technique.

MS 8.17 Th 16:00 Lichthof

Design and Construction of an Energy Buncer for a Multiple-Reflection Time-of-Flight Isobar Separator — •Felix Lautenschläger[1], Timo Dickel[1], Hans Geissel[1,2], Christian Jesch[1], Wolfgang R. Plass[1,2], 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

A high resolution, multiple-reflection time-of-flight mass spectrometer (MR-TOF-MS) has been developed. It can be used as an isobar separator delivering an isobarically clean beam of short-lived nuclei to connected experiments. The ions are injected into the MR-TOF-MS analyser by an ion trap system with a kinetic energy of 1.5 keV. The longitudinal spatial distribution of the ions inside the ion trap causes an energy spread of the injected ion population. In order to efficiently recapture these ions after mass separation, it is necessary to reduce the energy spread.This is achieved by employing a homogenous electric field, in which the ions are retarded until they have almost the same kinetic energy. Then, the field is pulsed down and the almost monenergetic ions are injected into an accumulation trap. The energy buncher consists of two systems of ring electrodes. The first system reduces the energy spread, while the second decelerates and focuses the ions into the accumulation trap.
In the simulation, the average energy spread of the ions has been reduced by a factor of 13. The design of the energy buncher, simulations and first experimental results will be shown.

MS 8.18 Th 16:00 Lichthof

Untersuchung von Oktupolanregung in der Präparationspenningfalle von ISOLTRAP — Marco Rosenbusch[1], Klaus Blaum[2], Christopher Borgmann[2], Martin Breitenfeldt[1], Daniel Fink[2], Alexander Herlert[3], Magdalena Kowalska[3], Susanne Kreim[2], Dave Lunney[4], Gerrit Marx[1], Sarah Naimi[4], Lutz Schweikhard[1] und •Robert Wolf[1] — [1]Universität Greifswald — [2]Mpi für Kernphysik, Heidelberg — [3]Cern, Genf, Schweiz — [4]Csnsm, Orsay, Frankreich

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 ($R = \frac{m}{\delta m} = 10^5$) eine wirksame Technik, um Ionen von isobaren Kontaminationen zu separieren. Dazu wird in einer puffergasgefüllten Präparationspenningfalle 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 zur Oktupolanregung als alternative Anregungsform vorgestellt, mit dem Ziel 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 9: Ionenfallen und FT-IZR-MS, Moleküle, Cluster und Reaktionen

Time: Friday 10:30–13:00 Location: F 428

Group Report MS 9.1 Fr 10:30 F 428

Röntgenabsorptionsspektroskopie isolierter Übergangsmetallcluster in einer Penningfalle: Das neue GAMBIT Experiment bei BESSY — Sergey Peredkov[1], Ali Savci[1], Matthias Neeb[1], Wolfgang Eberhardt[1], Heinrich Kampschulte[2], Jennifer Meyer[2], Fabian Menges[2] und •Gereon Niedner-Schatteburg[2] — [1]Helmholtz-Zentrum Berlin, Campus Adlershof, BESSY II, Albert-Einstein-Straße 15, 12489 Berlin — [2]Fachbereich Chemie und Forschungszentrum OPTIMAS, TU Kaiserslautern, Erwin-Schrödinger-Straße 52, 67663 Kaiserslautern

Bei BESSY wurde ein neue Penning Ionenfalle mit externer Clusterionenquelle an der UE52-PGM beamline aufgebaut. Erste Röntgenabsorptionsspektren von größenselektierten Übergangsmetallclustern zeigen die volle Funktionsfähigkeit dieses neuen GAMBIT-Experiments. Über die weiteren Fortschritte bei der Integration einer Fallenkühlung (Designtemperatur 20 Kelvin) wird berichtet. Unter Ausnutzung der umschaltbar zirkularen Polarisation des Röntgenlichts soll letztlich ein röntgeninduzierter Zirkulardichroismus (XMCD) benutzt werden, um die Spin- und Bahnbeiträge zu den magnetischen Momenten der isolierten Cluster zu bestimmen. Für diese Messungen ist die Thermali-

sierung der gespeicherten Ionen auf wohldefinierte, niedrige Temperaturen erforderlich.

MS 9.2 Fr 11:00 F 428

Erste Ergebnisse nach dem Umbau der ClusterTrap-Apparatur — •Albert Vass, Franklin Martinez, Falk Ziegler, Gerrit Marx und Lutz Schweikhard — Institut für Physik, Ernst-Moritz-Arndt Universität, 17487 Greifswald, Deutschland

Die ClusterTrap-Apparatur dient der Untersuchung atomarer Cluster. Hierbei erlaubt die Kombination von Clusterquelle, Penning-Falle und Flugzeitmassenspektrometer (ToF-MS) eine breite Palette an Experimenten mit gespeicherten Clustern, unter anderem stoßinduzierte Dissoziation (CID), Photodissoziation und Elektronenanlagerung. Nach dem Umbau dient ein linearer Radiofrequenz-Quadrupol als Präparationsfalle zur Akkumulation und axialen Kompression der Clusterwolke. Das Clusterpaket wird über einen neu installierten Quadrupolumlenker in die Penning-Falle transferiert, in der die eigentlichen Clusterexperimente durchgeführt werden. Diese Schritte erlauben den beidseitigen Zugang zur Penning-Falle, eine effizientere Clusterpräparation und die Verbesserung des ToF-MS. Den Umbauten vorausgehende und diese begleitende ionenoptische Simulationen, sowie erste Ergebnisse zu Untersuchungen an Aluminiumclustern werden vorgestellt.

MS 9.3 Fr 11:15 F 428

CTF: a new tool for molecular and cluster physics — •Sebastian Menk[1], Klaus Blaum[1], Florian Fellenberger[1], Michael Froese[1], Manfred Grieser[1], Oded Heber[2], Michael Lange[1], Felix Laux[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

One major goal of constructing the electrostatic Cryogenic Trap for Fast ion beams (CTF) was the development of technology and methods for the construction of the Cryogenic Storage Ring (CSR) which is currently being built. Ions are trapped between two electrostatic mirror electrodes allowing the storage of up to 20 keV ion beams for over 5 minutes. The ability of reaching extremely low vacuum conditions with this kind of assembly has been verified by measuring storage lifetimes and neutral particle count rates of a trapped 7.1 keV N_2^+ ion beam. A residual gas density of about 2000 cm^{-3} ($8 \cdot 10^{-14}$ mbar for same density at room temperature) and the low temperatures below 15 K also gave the opportunity to perform various measurements under previously unavailable conditions. A few highlights of the performed measurements including, for instance, radiative cooling measurements of hot aluminum cluster anions Al_n^- will be presented.

MS 9.4 Fr 11:30 F 428

Ion bunching properties at extremely high vacuum in the Cryogenic Trap for Fast ion beams (CTF) — •Michael Froese[1], Klaus Blaum[1], Florian Fellenberger[1], Manfred Grieser[1], Oded Heber[2], Michael Lange[1], Felix Laux[1], Sebastian Menk[1], Dmitry A. Orlov[1], Roland Repnow[1], Thomas Sieber[1], Yoni Toker[2], Robert von Hahn[1], and Andreas Wolf[1] — [1]Max-Planck-Institut für Kernphysik, 69117 Heidelberg, Germany — [2]Weizman Institute of Science, Rehovot, 76100, Israel

The electrostatic Cryogenic Trap for Fast ion beams (CTF) employed the already demonstrated extremely high vacuum (room temperature equivalent pressure of $8 \cdot 10^{-14}$ mbar or a residual gas density around 2000 cm^{-3}) to investigate ion bunching properties. Since the main ion loss processes are dramatically reduced at these residual gas pressures, beam lifetimes of over 5 minutes were measured. Coherent ion bunches were observed for tens of seconds, demonstrating a dramatic increase from previous measurements using room-temperature electrostatic ion beam traps (EIBTs) with durations of around 100 ms. The observed decays demonstrate that a minimum charge density is required to sustain the bunch. Both N_2^+ and Al_2^- ion bunches stored at energies between 6.0 and 7.1 keV demonstrate qualitatively similar decays. These ion bunch decays in addition to a determination of the initial bunch shape using a laser probing technique will be presented. The implications of these bunch decays for using EIBTs as mass spectrometers will also be discussed.

MS 9.5 Fr 11:45 F 428

Status of a non-destructive broad-band FT-ICR detection system for the KATRIN experiment — •Marta Ubieto Díaz[1], R. Burcu Cakirli[1,2], Michael Heck[1], Daniel Rodríguez[3], Stefan Stahl[4], and Klaus Blaum[1] — [1]Max-Planck-Institute for Nuclear Physics, Heidelberg, Germany — [2]Department of Physics, University of Istanbul, Istanbul, Turkey — [3]Departamento de Física Atómica Molecular y Nuclear, Universidad de Granada, 18071 Granada, Spain — [4]Stahl Electronics. Kellerweg 23, 67528 Mettenheim, Germany

The KArlsruhe TRItium Neutrino experiment KATRIN aims at improving the upper limit of the mass of the electron antineutrino to about 0.2 eV (90% c.l.) by investigating the β-decay of tritium gas molecules $T_2 \rightarrow (^3HeT)^+ + e^- + \bar{\nu}_e$. The experiment is currently under construction to start first data taking in 2012. One source of systematic uncertainties in the KATRIN experiment is the formation of ion clusters when tritium decays and decay products interact with residual tritium molecules. It is essential to monitor the abundances of these clusters since they have different final state energies than tritium ions. For this purpose, a prototype of a cylindrical Penning trap has been constructed and tested at the Max-Planck-Institute for Nuclear Physics in Heidelberg (MPIK), which will be installed in the KATRIN beam line. This system employs the technique of Fourier-Transform Ion-Cyclotron-Resonance in order to measure the abundances of the different stored ion species. The status and results will be presented.

MS 9.6 Fr 12:00 F 428

Experimental and theoretical studies of FT-ICR Measurements — •Michael Heck[1], Marta Ubieto-Diaz[1], Daniel Rodriguez[2], R. Burcu Cakirli[1,3], Stefan Stahl[1], Lutz Schweikhard[4], and Klaus Blaum[1] — [1]Max-Planck-Institut for Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Germany — [2]Universidad de Granada, 18071, Granada, Spain — [3]Department of Physics, University of Istanbul, Istanbul, Turkey — [4]Institut of Physics, Ernst-Moritz-Arndt-University Greifswald, 17487 Greifswald, Germany

Fourier-Transform Ion-Cyclotron-Resonance Mass Spectrometry (FT-ICR MS) is a standard technique in Chemistry for ion identification with very high resolution. It makes use of ion confinement in a Penning trap and, in contrast to methods applied to short-lived nuclides for precision mass determination, FT-ICR MS is a non-destructive detection technique, where the ions are still trapped after mass measurement and thus available for further studies. This property is of high interest for rare nuclides which are difficult to produce. The technique has not been used for high precision mass measurement on radionuclides at the level required for fundamental physics studies, but we are currently working on modifications to serve this purpose. Recent results from these studies at the Max-Planck-Institute for Nuclear Physics in Heidelberg, in particular the performance of a broad-band FT-ICR Penning trap system tested with $^7Li^+$ ions in comparison with simulation and theoretical investigations, will be presented.

MS 9.7 Fr 12:15 F 428

Non-destructive ion detection at TRIGA-TRAP — •Martin Eibach[1,2], Thomas Beyer[2,3], Michael Block[4], Klaus Eberhardt[1], Frank Herfurth[4], Jens Ketelaer[5], Jochen Ketter[2,3], Konstantin Knuth[5], Szilard Nagy[3,4], Christian Smorra[1,2], and Klaus Blaum[2,3] — [1]Institut für Kernchemie, Universität Mainz, D-55128 Mainz — [2]Physikalisches Institut, Universität Heidelberg, D-69120 Heidelberg — [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

Tests of nuclear mass models, studies of the nuclear structure of heavy elements and calculations of the astrophysical r-process require high precision atomic mass data. For this purpose the double Penning trap mass spectrometer TRIGA-TRAP has recently been set up in order to explore the less-known neutron-rich area of the nuclide chart. Certain nuclides of interest are produced by thermal neutron-induced fission of an actinoide target with low rates, in the order of a few nuclides per second or less. Thus, the implementation of very efficient means of detection are necessary, such as the non-destructive Fourier transform ion cyclotron resonance (FT-ICR) technique where ultimately a single trapped ion, with a half-life of longer than one second is sufficient for the entire mass measurement. The present status of the implementation of the FT-ICR detection at TRIGA-TRAP will be presented. The potential benefit for other experiments will be discussed.

MS 9.8 Fr 12:30 F 428

Weiterentwicklung der Kohlenstoffclusterquelle zur Erzeugung von Referenzionen für Massenmessungen an ISOL-

TRAP — •D. Fink[1], K. Blaum[1], Ch. Böhm[1], Ch. Borgmann[1], M. Breitenfeld[4], F. Herfurth[3], A. Herlert[5], M. Kowalska[5], S. Kreim[1], D. Lunney[2], S. Naimi[2], D. Neidherr[6], M. Rosenbusch[4], L. Schweikhard[4] und K. Zuber[7] — [1]MPI für Kernphysik, Heidelberg — [2]CSNSM, Orsey, Frankreich — [3]GSI, Darmstadt — [4]Universität Greifswald — [5]CERN, Genf, Schweiz — [6]Universität Mainz — [7]TU Dresden

Am ISOLTRAP-Experiment an ISOLDE/CERN werden Präzisionsmassenmessungen in einer Penningfalle durchgeführt. Ein Limit für die erreichbare Genauigkeit stellt der Massenabstand zum Referenzion dar, welcher zur Kalibrierung des Magnetfelds benötigt wird; dafür sind Kohlenstoffcluster mit einem Abstand von 12u ideal. Zudem sind mit Kohlenstoff als Massenreferenz auch absolute Massenmessungen gegen den mikroskopischen Massenstandard möglich. An ISOLTRAP wird ein Kohlenstofftarget mit einem frequenzverdoppelten Nd:Yag-Laser beschossen, wodurch Kohlenstoffcluster 12C_n bis 12C_20 leicht produziert werden können. Die Schwierigkeit liegt darin, Cluster über einen langen Zeitraum mit gleichbleibender Zählrate sowie einer hochwertigen Strahlemittanz zu erzeugen. Hierzu wurden Untersuchungen zur Laserenergie, an der Laseroptik und Modifikationen am Extraktionsbereich durchgeführt. In Kürze soll die Quelle zusätzlich als Laserablationsquelle genutzt werden, um Massen- und Q-Wertmessungen durchzuführen.

MS 9.9 Fr 12:45 F 428

Entwicklung eines Experiments zur Analyse von flüssigen Wasserstoff-Isotopologen via Infrarot-Strahlung für die ISS von ITER — •Andreas Kosmider — Karlsruhe Institute für Technologie, Institut für experimentelle Kernphysik, Karlsruhe, Germany

Die technische Nutzung der Kernfusion zur Gewinnung elektrischer Energie wird auf dem Fusionsprozess zwischen Deuterium und Tritium basieren und wird im Rahmen des internationalen ITER Projekts demonstriert und weiterentwickelt. Ein zentraler Schritt hin zu einem funktionalen Fusions-Kraftwerk ist die Entwicklung eines stabilen und zuverlässigen Brennstoffkreislaufs. Wichtige Entwicklungen zu diesem Ziel wurden und werden am Tritium Labor Karlsruhe (TLK) vorangetrieben. In diesem Vortrag wird das Design und die Inbetriebnahme eines Prototypen zur quantitativen Analyse von kryogenen Wasserstoff-Isotopologen durch Infrarot-Strahlung zum Einsatz im Isotope-Separation-System (ISS) von ITER vorgestellt. Die Messungen wurden an Wasserstoff und Deuterium in der flüssigen Phase bei 20 K durchgeführt. Neben den technische Anforderungen und physikalische Randbedingungen werden experimentelle Lösungen und vorläufige Ergebnisse vorgestellt. Die technische Realisierbarkeit wird bewiesen und Vorschläge zur weiteren Entwicklung hin zu einer ITER-kompatiblen Anlage werden präsentiert.