MS 7: Poster

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

MS 7.1 Wed 17:00 P OGs

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

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

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

MS 7.2 Wed 17:00 P OGs

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

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

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

MS 7.3 Wed 17:00 P OGs

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

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

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

MS 7.4 Wed 17:00 P OGs

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

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

MS 7.5 Wed 17:00 P OGs

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

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

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

MS 7.6 Wed 17:00 P OGs

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

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

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

MS 7.7 Wed 17:00 P OGs

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

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

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

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

MS 7.8 Wed 17:00 P OGs

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

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

MS 7.9 Wed 17:00 P OGs

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

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

MS 7.10 Wed 17:00 P OGs

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

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

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

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

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

MS 7.11 Wed 17:00 P OGs

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

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

MS 7.12 Wed 17:00 P OGs

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

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

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

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

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

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

MS 7.13 Wed 17:00 P OGs

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

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

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

MS 7.14 Wed 17:00 P OGs

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

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

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