MS 8: New Mass Spectrometric Methods and Technical Developments

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

Invited Talk MS 8.1 Thu 10:30 GÖR 229

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

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

MS 8.2 Thu 11:00 GÖR 229

Mobile High-Resolution Time-of-Flight Mass Spectrometer for in-situ Analytics — •Johannes Lang[1], Timo Dickel[1,2], Jens Ebert[1], Hans Geissel[1,2], Wolfgang Plass[1,2], and Christoph Scheidenberger[1,2] — [1]II. Physikalisches Institut, JLU Giessen — [2]GSI Darmstadt

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

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

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

MS 8.3 Thu 11:15 GÖR 229

Penning trap-assisted decay spectroscopy at SHIPTRAP — •C. Droese[1], D. Ackermann[2], L.-L. Andersson[3], K. Blaum[4,5], M. Block[2], M. Dworschak[2], M. Eibach[6], S. Eliseev[4], U. Forsberg[7], E. Haettner[2,8], F. Herfurth[2], F.P. Hessberger[2], S. Hofmann[2], J. Ketelaer[4], J. Ketter[4], G. Marx[1], M. Mazzocco[9], E. Minaya Ramirez[10], D. Nesterenko[11], Yu. Novikov[11], W.R. Plass[2,8], S. Rahaman[12], D. Rodríguez[13], D. Rudolph[7], C. Scheidenberger[2,8], L. Schweikhard[2], S. Stolze[12], P.G. Thirolf[14], G.K. Vorobjev[2,11] und C. Weber[14] — [1]Universität Greifswald — [2]GSI Helmholtzzentrum für Schwerionenforschung — [3]University of Liverpool — [4]Max-Planck-Institut für Kernphysik — [5]Ruprecht-Karls-Universität Heidelberg — [6]Johannes Gutenberg-Universitt Mainz — [7]Lund University Sweden — [8]Justus-Liebig-Universität Gießen — [9]Dipartimento di Fisica and INFN Sezione di Padova — [10]Helmholtz-Institut Mainz — [11]PNPI RAS Gatchina — [12]University of Jyväskylä — [13]Universidad de Granada — [14]Ludwig Maximilians-Universität Garching

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

MS 8.4 Thu 11:30 GÖR 229

Status Report for the FRS Ion Catcher — •Timo Dickel[1,2], Peter Dendooven[4], Jens Ebert[1], Hans Geissel[1,2], Christian Jesch[1], Wadim Kinsel[1], Wolfgang R. Plass[1,2], Sivaji Purushothaman[2], Manisha Ranjan[4], Moritz Pascal Reiter[1], Christoph Scheidenberger[1,2], and Mikhail I. Yavor[3] — [1]Justus-Liebig-Universität Gießen — [2]GSI, Darmstadt — [3]Inst. for Analytical Instrum., Russian Academy of Sci., St. Petersburg — [4]KVI, University of Groningen, Netherlands

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

MS 8.5 Thu 11:45 GÖR 229

A versatile Diagnosis Tool for Low Energy Radio Frequenzy Quadrupole Beam Lines — •Moritz Pascal Reiter[1], Timo Dickel[1,2], Wolfgang R. Plass[1,2], Christian Jesch[1], Christoph Scheidenberger[1,2], and Hans Geissel[1,2] — [1]Justus-Liebig-Universität Giessen — [2]GSI, Darmstadt

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

MS 8.6 Thu 12:00 GÖR 229

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

This work demonstrates the extremely favorable features of Proton

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

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

MS 8.7 Thu 12:15 GÖR 229

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

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