Mass Spectrometry Division
Fachverband Massenspektrometrie (MS)

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Overview of Invited Talks and Sessions

(Lecture halls MS-H9; Poster P)

Invited Talks

MS 1.1	Mon	14:00–14:30	MS-H9	**Direct high-precision measurement of the electron capture Q-value in ^{163}Ho for the determination of the effective electron neutrino mass** — •Christoph Schweiger, Martin Brass, Vincent Debierre, Menno Door, Holger Dorrer, Christoph E. Düllmann, Sergey Eliseev, Christian Enss, Pavel Filianin, Loredana Gastaldo, Zoltan Harman, Maurits W. Haverkort, Jost Herkenhoff, Paul Indelicato, Christoph H. Keitel, Kathrin Kromer, Daniel Lange, Yuri N. Novikov, Dennis Renisch, Alexander Rischka, Rima X. Schüssler, Klaus Blaum
MS 2.1	Mon	16:30–17:00	MS-H9	**Ion Laser InterAction Mass Spectrometry with fluoride molecular anions** — •Martin Martschini, Karin Hain, Maki Honda, Johannes Lachner, Oscar Marchhart, Silke Merchel, Carlos Vivo-Vilches, Robin Golser
MS 3.1	Tue	10:30–11:00	MS-H9	**Two-photon decay of nuclear isomers** — •Wolfram Korten
MS 4.1	Wed	10:30–11:00	MS-H9	**Isobar separation with cooled ions and laser light for compact AMS facilities** — •Johannes Lachner, Stefan Findeisen, Robin Golser, Michael Kern, Oscar Marchhart, Martin Martschini, Anton Wallner, Alexander Wieser
MS 6.1	Wed	14:00–14:30	MS-H9	**PUMA: nuclear structure with low-energy antiprotons** — •Alexandre Obertelli
MS 8.1	Thu	10:30–11:00	MS-H9	**Present and future prospects for MRTOF-based mass spectroscopy at KEK and RIKEN** — •Peter Schury, Michiharu Wada, Toshitaka Niwase, Marco Rosenbusch, Yoshikazu Hirayama, Hironobu Ishiyama, Daiya Kaji, Sota Kimura, Hiroari Miyatake, Kouji Morimoto, Momo Mukai, Hiroari Miyatake, Aiko Takamine, Yutaka Watanabe, Hermann Wollnik
MS 9.1	Thu	14:00–14:30	MS-H9	**Isochronous mass spectrometry and beam purification in an electrostatic storage ring** — •Viviane C. Schmidt

Invited talks of the joint symposium Laboratory Astrophysics (SYLA)

See SYLA for the full program of the symposium.

SYLA 1.1	Mon	14:00–14:30	Audimax	**Probing chemistry inside giant planets with laboratory experiments** — •Dominik Kraus
SYLA 1.2	Mon	14:30–15:00	Audimax	**Inner-shell photoabsorption of atomic and molecular ions** — •Stefan Schippers
SYLA 1.3	Mon	15:00–15:30	Audimax	**Molecular Astrophysics at the Cryogenic Storage Ring** — •Holger Kreckel
SYLA 1.4	Mon	15:30–16:00	Audimax	**Observing small molecules in stellar giants - High spectral resolution infrared studies in the laboratory, on a mountain, and high up in the air** — •Guido W. Fuchs

SYLA 2.1	Mon	16:30–17:00	Audimax	**State-to-State Rate Coefficients for NH_3-NH_3 Collisions obtained from Pump-Probe Chirped-Pulse Experiments** — •Christian P. Endres, Paola Caselli, Stephan Schlemmer
SYLA 2.4	Mon	17:30–18:00	Audimax	**A multifaceted approach to investigate the reactivity of PAHs under electrical discharge conditions** — •Donatella Loru, Amanda L. Steber, Johannes M. M. Thunnissen, Daniël B. Rap, Alexander K. Lemmens, Anouk M. Rijs, Melanie Schnell
SYLA 2.5	Mon	18:00–18:30	Audimax	**Exploring the Femtosecond Dynamics of Polycyclic Aromatic Hydrocarbons Using XUV FEL Pulses** — •Jason Lee, Denis Tikhonov, Bastian Manschwetus, Melanie Schnell

Invited talks of the joint PhD symposium Solid-state Quantum Emitters Coupled to Optical Microcavities (SYPD)

See SYPD for the full program of the symposium.

SYPD 1.1	Mon	16:30–17:00	AKjDPG-H17	**Fiber-based microcavities for efficient spin-photon interfaces** — •David Hunger
SYPD 1.2	Mon	17:00–17:30	AKjDPG-H17	**A fast and bright source of coherent single-photons using a quantum dot in an open microcavity** — •Richard J. Warburton
SYPD 1.3	Mon	17:30–18:00	AKjDPG-H17	**New host materials for individually addressed rare-earth ions** — •Sebastian Horvath, Salim Ourari, Lukasz Dusanowski, Christopher Phenicie, Isaiah Gray, Paul Stevenson, Nathalie de Leon, Jeff Thompson
SYPD 1.4	Mon	18:00–18:30	AKjDPG-H17	**A multi-node quantum network of remote solid-state qubits** — •Ronald Hanson

Invited talks of the joint symposium SAMOP Dissertation Prize 2022 (SYAD)

See SYAD for the full program of the symposium.

SYAD 1.1	Tue	14:00–14:30	Audimax	**New insights into the Fermi-Hubbard model in and out-of equilibrium** — •Annabelle Bohrdt
SYAD 1.2	Tue	14:30–15:00	Audimax	**Searches for New Physics with Yb^+ Optical Clocks** — •Richard Lange
SYAD 1.3	Tue	15:00–15:30	Audimax	**Machine Learning Methodologies for Quantum Information** — •Hendrik Poulsen Nautrup
SYAD 1.4	Tue	15:30–16:00	Audimax	**Precision Mass Measurement of the Deuteron's Atomic Mass** — •Sascha Rau

Sessions

MS 1.1–1.7	Mon	14:00–16:00	MS-H9	**Penning-Trap Mass Spectrometry**
MS 2.1–2.6	Mon	16:30–18:15	MS-H9	**Mass Spectrometry Methods**
MS 3.1–3.5	Tue	10:30–12:05	MS-H9	**Studies of Nuclear Metastable States**
MS 4.1–4.7	Wed	10:30–12:30	MS-H9	**Accelerator Mass Spectrometry**
MS 5	Wed	13:00–14:00	MS-MV	**Annual general meeting**
MS 6.1–6.6	Wed	14:00–15:45	MS-H9	**New Developments**
MS 7.1–7.4	Wed	16:30–18:15	P	**MS Poster Session**
MS 8.1–8.4	Thu	10:30–11:45	MS-H9	**Multi-Reflection Time-of-Flight Spectrometers**
MS 9.1–9.4	Thu	14:00–15:15	MS-H9	**Ion Storage Rings**

Annual General Meeting of the Mass Spectrometry Division

Wednesday 18:00–19:00 MS-MV

- Bericht
- Verschiedenes

MS 1: Penning-Trap Mass Spectrometry

Time: Monday 14:00–16:00 Location: MS-H9

Invited Talk MS 1.1 Mon 14:00 MS-H9

Direct high-precision measurement of the electron capture Q-value in ^{163}Ho for the determination of the effective electron neutrino mass — •Christoph Schweiger[1], Martin Brass[2], Vincent Debierre[1], Menno Door[1], Holger Dorrer[3], Christoph E. Düllmann[3,4,5], Sergey Eliseev[1], Christian Enss[6], Pavel Filianin[1], Loredana Gastaldo[6], Zoltan Harman[1], Maurits W. Haverkort[2], Jost Herkenhoff[1], Paul Indelicato[7], Christoph H. Keitel[1], Kathrin Kromer[1], Daniel Lange[1], Yuri N. Novikov[8,9], Dennis Renisch[3,4], Alexander Rischka[1], Rima X. Schüssler[1], and Klaus Blaum[1] — [1]Max-Planck-Institut für Kernphysik, Heidelberg, Germany — [2]Institute for Theoretical Physics, Heidelberg University, Germany — [3]Department Chemie - Standort TRIGA, Mainz University, Germany — [4]Helmholtz-Institut Mainz, Germany — [5]GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany — [6]Kirchhoff-Institute for Physics, Heidelberg University, Germany — [7]Laboratoire Kastler Brossel, Sorbonne Université, Paris, France — [8]NRC "Kurchatov Institute"-Petersburg Nuclear Physics Institute, Gatchina, Russia — [9]St. Petersburg State University, Petersburg, Russia

Among the most important quantities for fundamental physics is the effective mass of the electron neutrino m_ν, which has far-ranging consequences for cosmology and theories beyond the Standard Model. At present, the most precise indirect upper limit on m_ν is <120 meV/c^2 resulting from astrophysical observations while the most precise direct limit is set by the KATRIN collaboration with <0.8 meV/c^2, based on the kinematic study of the tritium β-decay. Complementary, the ECHo and HOLMES collaborations investigate the electron capture decay in ^{163}Ho using microcalorimeters. In order to reach the anticipated sub-eV limits on m_ν with calorimetric measurements, the exclusion of possible systematic uncertainties is crucial and is achieved by a comparison of the calorimetrically determined Q-value of the decay to an independently measured one with the same uncertainty level. Within this talk, an independent, direct, ultra-precise measurement of this Q-value using the Penning-trap mass spectrometer Pentatrap is presented with a sub-eV uncertainty. Using this technique, the Q-value is determined by measuring the ratio of the free cyclotron frequencies of highly charged ions of the mother and daughter nuclides, the synthetic radioisotope ^{163}Ho and ^{163}Dy, respectively. The Q-value is finally determined from the measured ratio of cyclotron frequencies by including precise atomic physics calculations of the electronic binding energies of the missing electrons in the measured highly charged ions. This more than 40-fold improved Q-value compared to the previous best direct measurement paves the way for a sub-eV upper limit on m_ν within the ECHo and HOLMES collaborations.

MS 1.2 Mon 14:30 MS-H9

Plans and development of the gas-jet apparatus for laser spectroscopy of the heavy actinides at GSI/HIM — •Danny Münzberg[1,2,3], Michael Block[1,2,3], Premaditya Chhetri[4], Arno Claessens[4], Piet Van Duppen[4], Rafael Ferrer[4], Jekabs Romans[4], Sandro Kraemer[4], Jeremy Lantis[3], Mustapha Laatiaoui[3], Steven Nothhelfer[1,2,3], Sebastian Raeder[1,2], Moritz Schlaich[5], Lutz Schweikhard[6], Simon Sels[4], Thomas Walther[5], and Frank Wienholtz[5] — [1]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, DE — [2]Helmholtz-Institut, Mainz, DE — [3]Department Chemie, Johannes Gutenberg-Universität, Mainz, DE — [4]Institut voo Kern- en Stralingsfysica, KU Leuven, Leuven, Belgium — [5]Technische Universität Darmstadt, DE — [6]Universität Greifswald, DE

At GSI-Darmstadt we use the Radiation-Detected Resonance-Ionization Spectroscopy (RADRIS) technique, to study elements in the heavy actinide region to determine their basic nuclear and atomic properties. A setup combining the features of RADRIS with laser spectroscopy in a gas-jet is currently under development to minimize broadening mechanisms occuring in the gas environment of RADRIS, improving the spectral resolution by about an order of magnitude. Due to low production rates in these experiments it is important to minimize the background from other reaction or decay products. In addition, for long-lived nuclides a decay-based detection will not be feasible. With a multi-reflection time-of-flight mass seperator (MR-ToF MS) a separation of ions with different mass to charge ratio can be achieved with a high mass resolving power, suppressing background from unwanted species. For this reason an MR-ToF MS will be added to the gas-jet apparatus. A technical overview oft the MR-ToF MS will be given and its integration into the system will be discussed.

MS 1.3 Mon 14:45 MS-H9

Precision mass measurements of actinides at SHIPTRAP — •Manuel J. Gutiérrez[1,2], Michael Block[1,2,3], Christoph E. Düllmann[1,2,3], Francesca Giacoppo[1,2], Oliver Kaleja[1,4], Kanika Kanika[1,5], Jacques J. W. van de Laar[2,3], Yury Nechiporenko[6,7], Yuri Novikov[6,7], Wolfgang Quint[1,5], and Dennis Renisch[2,3] — [1]GSI Darmstadt, Germany — [2]HIM Mainz, Germany — [3]JGU Mainz, Germany — [4]University of Greifswald, Germany — [5]University of Heidelberg, Germany — [6]PNPI Gatchina, Russia — [7]Saint Petersburg State University, Russia

The existence of superheavy nuclides is possible due to quantum-mechanical shell effects. A region of enhanced stability, dubbed *island of stability*, was long ago predicted at the next spherical shell closure above the doubly magic ^{208}Pb. Although not yet experimentally found, its location has been pinned down to around Z=114–126 and N=184. More information can be retrieved from the study of the actinides, linked to heavier nuclides by decay chains.

Penning-trap mass spectrometry provides precise measurements of atomic masses, which directly translate into binding energies. Their high-resolution measurement provides a powerful indicator of nuclear structure effects. An offline campaign for direct mass measurements of selected U and Pu isotopes was recently carried out at the SHIPTRAP mass spectrometer at GSI, usually devoted to the investigation of superheavy elements. The campaign complements the more extensive program carried out at the TRIGA-TRAP setup in Mainz. This contribution presents the first results of the SHIPTRAP campaign.

MS 1.4 Mon 15:00 MS-H9

Status report on the TRIGA-Trap experiment — •Stanislav Chenmarev[1,2], Klaus Blaum[1], Michael Block[3,4,5], Christoph E. Düllmann[3,4,5], Steffen Lohse[3,4], Szilard Nagy[1], and Jacques J. W. van de Laar[3,4] — [1]Max-Planck-Institut für Kernphysik, Heidelberg, DE — [2]Petersburg Nuclear Physics Insitute, Gatchina, RU — [3]Department Chemie - Standort TRIGA, Johannes Gutenberg-Universität Mainz, DE — [4]Helmholtz-Institut Mainz, DE — [5]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, DE

The TRIGA-Trap setup [1] is a double Penning-trap mass spectrometer at the research reactor TRIGA Mainz. Currently we are performing high-precision mass measurements of long-lived transuranium isotopes. A new cylindrical measurement trap made possible the implementation of the phase-imaging ion cyclotron resonance (PI-ICR) technique [2], originally developed at SHIPTRAP. The current status including results for several long-lived actinide isotopes will be presented. Our results find application in nuclear structure studies and provide reliable atomic mass anchor points in the transuranium region.

1. J. Ketelaer *et al.*, Nucl. Instrum. Meth. A **594**, 162-177 (2008).
2. S. Eliseev *et al.*, Phys. Rev. Lett. **110**, 082501, (2013).

MS 1.5 Mon 15:15 MS-H9

Status of precision mass measurements at the LIONTRAP experiment — •Sangeetha Sasidharan[1,2], Olesia Bezrodnova[1], Sascha Rau[1], Wolfgang Quint[2], Sven Sturm[1], and Klaus Blaum[1] — [1]MPIK, Heidelberg, Germany — [2]GSI Helmholtzzentrum, Darmstadt, Germany

The LIONTRAP experiment is a high-precision mass spectrometer dedicated to light ions. The results at LIONTRAP include the atomic mass measurements of the proton [1], the deuteron and the HD^+ molecular ion [2]. The deuteron mass was measured to a relative precision of 8.5 ppt [2]. Our results show an excellent agreement with values extracted from laser spectroscopy of HD^+ [3] and the comparison is limited by the precision of the electron's atomic mass. The electron mass in atomic mass units (amu) is currently extracted from the bound electron g-factor measurement of $^{12}C^{5+}$ [4]. This could be improved in the future via a better measurement of the magnetic moment of the bound electron. ^{4}He ion is a prime candidate for the same as it has smaller theoretical uncertainties for the g-factor due to its lower

Z than $^{12}C^{5+}$ and also has a simpler nuclear structure. Currently, we are measuring the atomic mass of ^{4}He to support such a determination of the electron mass in amu. In this contribution, the present status of the experiment will be discussed.

[1] F. Heiße *et al.*, Phys. Rev. A **100**, 022518 (2019).
[2] S. Rau *et al.*, Nature **585**, (2020) pp. 43-47.
[3] I. V. Kortunov *et al.*, Nature Physics, **17**, (2021) pp. 569-573.
[4] S. Sturm *et al.*, Nature **506**, (2014) pp. 467-470.

MS 1.6 Mon 15:30 MS-H9

Latest results of the high-precision Penning-trap mass spectrometer PENTATRAP — •M. Door[1], J. R. Crespo López-Urrutia[1], P. Filianin[1], J. Herkenhoff[1], K. Kromer[1], D. Lange[1], Y. Novikov[2], A. Rischka[1], F. Herzog[1], Ch. Schweiger[1], S. Sturm[1], S. Ulmer[3], S. Eliseev[1], and K. Blaum[1] — [1]Max-Planck-Institut für Kernphysik, Heidelberg, Germany — [2]Peterburg Nuclear Physics Institute, Gatchina, Russia — [3]RIKEN, Fundamental Symmetries Laboratory, Saitama, Japan

Measurements with the Penning-trap mass spectrometer PENTATRAP [1], located at the Max-Planck-Institut für Kernphysik in Heidelberg, allow to determine mass ratios with a relative uncertainty in the few parts per trillion regime using highly charged ions [2]. PENTATRAP's mass measurements of selected nuclides allow, among others, to contribute to tests of special relativity, bound-state quantum electrodynamics and neutrino-physics research. Achieving this level of precision requires using a cryogenic image-current detection system with single-ion sensitivity and phase-sensitive detection methods in combination with highly charged ions provided by external ion sources. The talk will present recent measurement results on neon for tests of bound-state quantum electrodynamics as well as medium heavy isotopes of ytterbium for dark matter search [3].

[1] Repp, J. et al., Appl. Phys. B 107, 983 (2012).
[2] Filianin, P. et al. Phys. Rev. Lett. 127, 072502 (2021).
[3] Counts, I. et al. Phys. Rev. Lett. 125, 123002 (2020).

MS 1.7 Mon 15:45 MS-H9

Towards a High-Precision Atomic Mass Measurement of the ^{3}He and T Nuclei — •Olesia Bezrodnova[1], Sangeetha Sasidharan[1,2], Sascha Rau[1], Wolfgang Quint[2], Sven Sturm[1], and Klaus Blaum[1] — [1]Max-Planck-Institut für Kernphysik, Heidelberg, Germany — [2]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany

The mass difference of T and ^{3}He nuclei, measured with the highest precision, will allow an important consistency check for the systematic uncertainty of an upper limit of the $m(\bar{\nu}_e)$ by the KATRIN project [1]. The most precise mass measurements of the lightest nuclei, including ^{3}He nucleus, revealed considerable inconsistencies between the values reported by different experiments [2]. In order to provide an independent cross-check, LIONTRAP, a multi-Penning trap mass spectrometer, has carried out mass measurements on the proton [3], the deuteron and the HD^+ molecular ion [4].
The present activities of the LIONTRAP group aim at ultra-precise mass measurements of the ^{3}He and T nuclei with a relative uncertainty better than 5 ppt. In this contribution, I present the current status of the experiment, which includes the ^{3}He source preparation for the upcoming mass measurement campaign and modifications of the experimental setup for the radioactive T source placement.

[1] M. Aker *et al.* Phys. Rev. Lett. **123**, 221802 (2019)
[2] S. Hamzeloui *et al.* Phys. Rev. A **96**, 060501(R) (2017)
[3] F. Heiße *et al.* Phys. Rev. A **100**, 022518 (2019)
[4] S. Rau *et al.* Nature **585**, 43-47 (2020)

MS 2: Mass Spectrometry Methods

Time: Monday 16:30–18:15 Location: MS-H9

Invited Talk MS 2.1 Mon 16:30 MS-H9

Ion Laser InterAction Mass Spectrometry with fluoride molecular anions — •Martin Martschini[1], Karin Hain[1], Maki Honda[1,3], Johannes Lachner[2], Oscar Marchhart[1], Silke Merchel[1], Carlos Vivo-Vilches[2], and Robin Golser[1] — [1]University of Vienna, Faculty of Physics, Austria — [2]HZDR, Dresden, Germany — [3]NSRC, JAEA, Japan

AMS generally has the best abundance sensitivity for long-lived radionuclides, but the detection of ^{41}Ca, ^{90}Sr, ^{99}Tc, ^{135}Cs and ^{182}Hf in the general environment has been limited or even hampered by strong isobaric interferences. Using molecular fluoride anions, the novel technique of Ion Laser-InterAction Mass Spectrometry (ILIAMS) provides unprecedented isobar suppression for these nuclides of 10^4-10^8 inside an RFQ ion guide. Therein, isobaric molecules are efficiently eliminated via laser photodetachment. In addition, molecular interactions with the buffer gas further enhance isobar suppression, e.g. via breakup of KF_3^- into $KF_2^- + F$ or via O-pickup of WF_5^-. Thereby, the VERA-facility has recently achieved the most sensitive detection of ^{182}Hf and ^{90}Sr, the latter at the 15 attogram level. For ^{41}Ca, the blank level with CaF_3^- and ILIAMS is $^{41}Ca/^{40}Ca = (1.5^{+1.7}_{-1.5})\times10^{-15}$. Recent tests also demonstrated that ^{41}Ca can now be measured directly in stony meteorites with sample sizes down to 1-2 mg without performing any chemical preparation, i.e. in the presence of ∼1000 ppm K. This talk will review these benefits of fluoride anions with ILIAMS but also discuss the challenges involved like the strong parasitic ion current and the influence of excited molecules coming from a sputter ion source.

MS 2.2 Mon 17:00 MS-H9

A digital RF ion filter and trap combination for the MS SPIDOC prototype — •Florian Simke, Paul Fischer, and Lutz Schweikhard — Universität Greifswald, Institut für Physik, Felix-Hausdorff-Str. 6, 17489 Greifswald

The MS SPIDOC (Mass Spectrometry for Single Particle Imaging of Dipole Oriented protein Complexes) prototype [1] will deliver mass- and conformation separated samples of protein-based biomolecules for single-particle imaging analysis at the European X-Ray Free-Electron Laser Facility (XFEL)[2]. The design, simulation, and construction of one of its key modules is presented along with first offline results. The module consists of a linear-quadrupole filter assembly and a linear-quadrupole ion trap, both operated with digital radio frequencies. The restriction to keep investigated biomolecules as native as possible leads to a design that separates ion filtering and accumulation/trapping. The module is able to filter ions of interest with mass-to-charge ratios of up to $m/z \approx 12000$ Th. The ion trap is utilized to collect and bunch incoming ions from a continuous source and eject them with a narrow temporal width for downstream analysis and X-ray interaction.

[1] C. Uetrecht et al., Native mass spectrometry provides sufficient ion flux for XFEL single-particle imaging, Journal of Synchrotron Radiation 26 (3) (2019) 653-659. doi:10.1107/S1600577519002686
[2] Europe turns on bright x-ray source, Nature Photon; 11 (2017) 609-609, doi:https://doi.org/10.1038/s41566-017-0025-z

MS 2.3 Mon 17:15 MS-H9

Production and characterization of standard particles for rL-SNMS calibration — Stefan Bister, •Paul Hanemann, Manuel Raiwa, Sandra Reinhard, Darcy van Eerten, and Clemens Walther — Institute of Radioecology and Radiation Protection, Leibniz University Hannover

Resonant laser secondary neutral mass spectrometry (rL-SNMS) is a non-destructive method that combines high sensitivity and resolution of ToF-SIMS with high element selectivity of resonant laser ionisation. One main application is the determination of isotope ratios on individual micro particles of spent nuclear fuel from the Chernobyl exclusion zone (CEZ). Standard materials are needed for dealing with isobaric interferences such as 238U and 238Pu as well as differences in the laser ionisation and sputter efficiencies for different elements and isotopes. This work produced particles via Fe-coprecipitation to achieve homogeneous U and Pu bearing particles. Isotopes with different mass numbers were used to determine relative ionisation efficiencies without isobaric interferences. The homogeneity of U and Pu in the particles was confirmed by ToF-SIMS and EDX measurements. On several particles Pu-resonant measurement were performed to investigate the suppression of non-resonant U. It was shown that the suppression is high enough to be able to detect 238Pu in a particle with a 1E5 higher 238U content, as found in "hot particles" from the CEZ. RL-SNMS measurements of produced particles containing only different U iso-

topes allowed the investigation of isotope effects in the resonant laser ionisation.

MS 2.4 Mon 17:30 MS-H9

Dissociative electron attachment studies with nitro-heterocyclic aromatic compounds — •Muhammad Saqib, Eugene Arthur-Baidoo, Milan Ončák, and Stephan Denifl — Institute of Ion Physics and Applied Physics, University of Innsbruck, Technikerstraße 25, 6020 Innsbruck, Austria

Nitro-heterocyclic aromatic compounds have a wide range of applications in medicine. Due to their specific toxicity, which is defined by their reduction to the biologically active form in the lack of oxygen, these compounds play a crucial role in targeting the hypoxic tumor cell during cancer treatment. We have studied the formation of anions following electron attachment to nitro-heterocyclic compounds in the gas phase. By using a crossed electron/molecular beams experiments with mass spectrometric detection of the anions, we studied electron attachment to 2-nitrofuran, 3-nitro-1,2,4-triazole, and 1H-1,2,4-triazole molecules. Dissociative electron attachment and non-dissociative electron attachment were observed. The obtained results of electron attachment to 2-nitrofuran indicate that low-energy electrons, with kinetic energies from 0 eV to 12 eV, effectively decompose the molecule and lead to a large variety of charged fragments and radicals with the nitrogen dioxide anion as the most abundant fragment anion. The experimental study was supported by thermochemical threshold calculations. This work was supported by the FWF, Vienna (P30332).

MS 2.5 Mon 17:45 MS-H9

Investigation of mass-scale drift effects in the milli-mass range using MC-ICP-MS — •Axel Pramann, Janine Noordmann, and Olaf Rienitz — Physikalisch-Technische Bundesanstalt; Braunschweig, Germany

During the application of an MC-ICP magnetic sector field mass spectrometer, severe mass drift effects in the milli-mass range in the high resolution mode (M/ΔM = 8000) have been observed [1]. Their potential origins, experimental prevention, and the consequences are outlined. Additional simulations were performed using silicon enriched in 28Si as the main element in this investigation. One background is the fact that a drift of the mass scale influences the determination of isotope ratios strongly. For example, the signal-plateau width of 29Si+ in Si highly enriched in 28Si exhibits an extremely narrow mass plateau width of ΔM = 4 * 10-3 u, one of the smallest plateaus routinely investigated in isotope ratio measurements. A change of the magnetic field B, the acceleration voltage Uacc or the ESA voltage UESA by 0.01% induces respective changes of the mass scale of 6 * 10-3 u, 3 * 10-3 u, and 1 * 10-3 u, respectively. Electrical charging/discharging effects in the MS were observed and suggested to be affecting the mass scale stability. Therefore, the instrument was completely dismantled, grounded, and carefully reinstalled. Subsequent stability tests yielded a negligible mass drift of ΔM/Δt = 0.001 u/8 h, allowing for the measurement of isotope ratios with lowest uncertainty.

[1] A. Pramann, J. Noordmann, O. Rienitz, J. Mass Spectrom. 56:e4732 (2021)

MS 2.6 Mon 18:00 MS-H9

The PUMA offline ion source for high-intensity, purified ion bunches — •Clara Klink, Alexandre Obertelli, Frank Wienholtz, and Moritz Schlaich — TU Darmstadt, IKP, Darmstadt, Deutschland

The antiProton Unstable Matter Annihilation (PUMA) experiment aims at investigating the nucleonic composition in the tail of the nuclear density distribution of stable and exotic nuclei using antiprotons. The combined charge of the reaction products, which originate from the annihilation of the antiproton with the nucleons on the nucleus' surface, will allow for a determination of neutron and proton densities. Inter alia, PUMA plans on performing experiments with low-energy antiprotons from the ELENA facility of CERN with a broad range of stable isotopes from an offline ion source to observe their behaviour during antiprotonic annihilation. The beamline, which transports the stable ions to the experimental site of PUMA, must meet several requirements to reliably forward the beam and shape it according to our needs. The ions are mass-separated with a multi-reflection time-of-flight mass spectrometer and then accumulated, bunched and cooled with a buffer gas in a linear Paul trap. Strict vacuum requirements due to the attached antiproton beamline (p < 10e-11 mbar) must be considered. This talk will give an introduction to the setup and operation of the offline ion source beamline, which will be essential for achieving the first physics results of PUMA.

MS 3: Studies of Nuclear Metastable States

Time: Tuesday 10:30–12:05 Location: MS-H9

Invited Talk MS 3.1 Tue 10:30 MS-H9

Two-photon decay of nuclear isomers — •Wolfram Korten — IRFU, CEA, Université Paris-Saclay

The nuclear two-photon decay is a rare decay mode in atomic nuclei whereby a nucleus in an excited state emits two gamma rays simultaneously. First order processes usually dominate the decay by many orders of magnitude, but two-photon emission may become significant when first order processes are forbidden or strongly retarded. This is the case for nuclei with a first excited 0+ state, since the emission of a single gamma ray is strictly forbidden for the resulting electric monopole transition to the 0+ ground by angular momentum conservation. Such a configuration occurs when the potential energy of the nucleus is characterized by local minima for different shapes. If the potential barrier separating the secondary minimum from the ground-state minimum is sufficient strong the excited 0+ state will become a long-lived state, a so-called shape isomer.

The first successful observation of a nuclear two-photon decay was achieved in the 1980s by a direct detection of the simultaneously emitted gamma-rays. However, the very small branching ratio with respect to other decay paths, such as internal conversion, becomes minuscule when searching for low-lying 0+ states below ˜1 MeV. In this talk I will present an alternative method to directly search for such isomers by using time-resolved mass spectrometry at relativistic energies, where the atomic nucleus is completely stripped of its atomic electrons and report on the first successful experiment to directly observe the decay from an isomer in 72Ge at the GSI Experimental Storage Ring (ESR).

Group Report MS 3.2 Tue 11:00 MS-H9

Towards the Lifetime Measurement of the $^{229m}Th^{3+}$ Nuclear Clock Isomer — •Kevin Scharl[1], Benedict Seiferle[1], Shiqian Ding[1,2], Daniel Moritz[1,2], Florian Zacherl[1], and Peter G. Thirolf[1] — [1]LMU Munich — [2]Tsinghua University Beijing, China

The elusive Thorium Isomer (^{229m}Th) with its unusually low-lying first excited state (8.19 ± 0.12 eV or λ = 150.4 ± 2.2 nm) represents the so far only candidate for the realization of an optical nuclear clock, potentially capable to outperform even state-of-the-art optical atomic clocks. Moreover, possible applications of a nuclear clock are not limited to time keeping, but reach into many other fields from geodesy to dark matter research. Considerable progress was achieved in recent years on the characterization of the thorium isomer, from its first identification, the determination of its lifetime in neutral charge state and of the isomeric hyperfine structure to recent direct decay measurements. While the identification of the nuclear resonance with laser spectroscopic precision is still awaited, a measurement of the ionic lifetime of the isomer (theory prediction: 10^3-10^4 s) is being prepared by our group. A cryogenic Paul trap is the core of this setup, providing long enough storage time for the ^{229m}Th ions. Prior to targeting the ionic lifetime by hyperfine spectroscopy, sympathetic laser cooling using $^{88}Sr^+$ ions will be applied to the stored ions. The talk will present the status of the commissioning of the setup for $^{229m}Th^{3+}$ ion generation, cryogenic storage, laser cooling and spectroscopic studies.

This work was supported by the European Research Council (ERC): Grant agreement No. 856415.

MS 3.3 Tue 11:20 MS-H9

Shedding light on low-lying metastable states in the heaviest elements with SHIPTRAP at GSI — •Francesca Giacoppo[1,2], Brankica Anđelić[1,2,3], Luisa Arcila Gonzalez[3], Joaquín Berrocal[4], Lennart Blaauw[3], Klaus Blaum[5], Michael Block[1,2,6], Pierre Chauveau[1,2], Stanislav Chenmarev[2,5,7], Christoph E. Düllmann[1,2,6], Julia Even[3], Manuel J.

Gutiérrez[1,2,4], Fritz P. Hessberger[1,2], Nasser Kalantar-Nayestanaki[3], Oliver Kaleja[1,8], Steffen Lohse[2,6], Enrique Minaya Ramirez[9], Andrew Mistry[1], Elodie Morin[9], Yury Nechiporenko[7,10], Dennis Neidherr[1], Steven Nothhelfer[2,6], Yuri Novikov[7,10], Sebastian Raeder[1,2], Elisabeth Rickert[2,6], Daniel Rodríguez[4], Lutz Schweikhard[8], Peter G. Thirolf[11], Jessica Warbinek[1,2,6], and Alexander Yakushev[1,2] — [1]GSI Darmstadt, Germany — [2]HIM Mainz, Germany — [3]University of Groningen, the Nederlands — [4]University of Granada, Spain — [5]MPIK Heidelberg, Germany — [6]JGU Mainz, Germany — [7]PNPI Gatchina, Russia — [8]Universiy of Greifswald, Germany — [9]IJCLab Orsay, France — [10]Saint Petersburg State University, Russia — [11]LMU Munich, Germany

Probing the limit of existance at the uppermost corner of the nuclear chart requires a deep understanding of the nuclear properties of very heavy nuclides and their evolution in the superheavy region.

In the framework of the FAIR phase-0 program, the goal of directly investigating the mass of superheavy nuclei (Z⩾104) is pursued at the Penning-trap mass spectrometer SHIPTRAP at GSI. In the latest campaign the masses of the ground states as well as of low-lying metastable states of ^{257}Rf (Z=104) and ^{258}Db (Z=105) have been precisely measured. In addition, several heavy nuclides above the Z=82 magic shell closure have been investigated. Many of these nuclei display shape deformation and complex shell configurations with often more than one competing level at low energies. Such states have traditionally been studied by decay and laser spectroscopy, as for instance the ^{206}Fr-^{202}At-^{198}Bi chain. In our last campaign the excitation energies of the metastable states in some of the key nuclei in this region have been finally directly measured, allowing to benchmark the proposed level and decay schemes.

MS 3.4 Tue 11:35 MS-H9

Fission isomer studies with the FRS Ion Catcher — •Nazarena Tortorelli[1], Timo Dickel[2,3], Ilkka Pohjalainen[2,4], Peter G. Thirolf[1], Michiharu Wada[5], and Jianwei Zhao[2,6] — [1]Ludwig-Maximilian-University, Munich, Germany — [2]GSI Helmholtzentrum für Schwerionenforschung Darmstadt, Germany — [3]JLU Gießen, Germany — [4]University of Jyväskylä, Finland — [5]KEK Wako Nuclear Science Center, Japan — [6]Peking University, Beijing, China

The potential energy landscape in actinide nuclei (Z = 92-97, N = 141-151) shows a "super-deformed" second minimum. The ground state in this minimum is called a fission isomer, as it will preferably decay via isomeric (delayed) fission with known half-lives between 5 ps and 14 ms. The fragmentation mechanism (i.e. the collision of a heavy relativistic beam with a light target) offers rapid production, hence access to isomers with short half-lives, and most importantly, a clean beam and event-by-event identification.

In this contribution, we will present fission isomer studies (e.g. on ^{235}mU) with the FRS Ion Catcher at GSI where a 1 GeV/u ^{238}U beam fragments on a Be target. The projectile fragments are filtered by the FRS magnetic fragment separator and then slowed down and thermalized in the Cryogenic Stopping Cell (CSC) before being extracted into the diagnostic section for time-of-flight mass spectrometry (MR-TOF-MS).

MS 3.5 Tue 11:50 MS-H9

A cryogenic Paul trap setup for the determination of the ionic radiative lifetime of ^{229m}Th^{3+} — •Daniel Moritz[1], K. Scharl[1], B. Seiferle[1], F. Zacherl[1], T. Dickel[2,3], F. Greiner[2,3], W. Plass[2,3], L. von der Wense[1,4], T. Leopold[5,6], P. Micke[5,7], J. Crespo López-Urrutia[5], P.O. Schmidt[6], and P.G. Thirolf[1] — [1]Ludwig Maximilians Universität München — [2]Justus Liebig Universität Gießen — [3]GSI Darmstadt — [4]JILA, University of Colorado, USA — [5]Max-Planck-Institut für Kernphysik, Heidelberg — [6]PTB Braunschweig — [7]CERN, Genf, Schweiz

The exceptionally low energy of the isomeric first excited nuclear state of ^{229}Th, which has recently been constrained to 8.28±0.17 eV (i.e. λ=149.7±3.1 nm)[1], allows for direct laser excitation with current technology. This offers the unique opportunity to develop a nuclear clock capable of competing or even outperforming existing atomic clocks. One of the next steps towards the realization of such a clock is the determination of the ^{229}Th isomer's ionic lifetime (theoretically expected to range between $10^3 - 10^4$ seconds) via hyperfine spectroscopy. In order to achieve the required long ion storage time, a cryogenic Paul-trap with a corresponding mass-selective ion guide system has been set up at LMU Munich. The talk will present this new experimental platform. This work was supported by DFG (Th956/3-2) as well as by the European Union's Horizon 2020 research and innovation program under grant agreement 6674732 "nuClock" and the ERC Synergy Grant "ThoriumNuclearClock".

[1] B. Seiferle et al., Nature 573, 243 (2019).

MS 4: Accelerator Mass Spectrometry

Time: Wednesday 10:30–12:30 Location: MS-H9

Invited Talk MS 4.1 Wed 10:30 MS-H9

Isobar separation with cooled ions and laser light for compact AMS facilities — •Johannes Lachner[1,2], Stefan Findeisen[1], Robin Golser[2], Michael Kern[2], Oscar Marchhart[2], Martin Martschini[2], Anton Wallner[1], and Alexander Wieser[2] — [1]HZDR, Dresden — [2]University of Vienna, Faculty of Physics, Austria

Ion-Laser InterAction Mass Spectrometry (ILIAMS) slows down anions to thermal kinetic energies in a radiofrequency quadrupole (RFQ) filled with He buffer gas. Laser light (e.g. 532 nm) is overlapped with the decelerated anions to separate isobars via photodetachment.

Here, we present two applications of ILIAMS at the 3 MV Vienna Environmental Research Accelerator (VERA): ^{26}Al is an established AMS nuclide but its detection can be improved using AlO^-, which is formed more likely than the customarily applied Al^-. ILIAMS suppresses the isobar ^{26}Mg by neutralization of MgO^- and overcomes the disadvantage of AlO^- compared to Al^-, where Mg^- is not extracted from the ion source. This enhances the sensitivity of ^{26}Al detection and the prolific AlO^- beam can be used at facilities with terminal voltages < 10 MV. ^{135,137}Cs measurements are presented as an example of highly sensitive detection of novel AMS nuclides. In this case, we use $^{135,137}CsF_2^-$ anions and ILIAMS suppresses the isobaric $^{135,137}BaF_2^-$.

We furthermore present a new design of a modular ion cooler with multiple RFQ sections. With more control of the ion energy during their passage through the RFQ we want to improve the transport efficiency for molecular anions. This ion cooler will be integrated in a new 1 MV AMS facility at Dresden in 2023.

MS 4.2 Wed 11:00 MS-H9

Why and how producing an isotopic spike for the analysis of environmental ^{237}Np — •Karin Hain[1], Martin Martschini[1], Aya Sakaguchi[2], Peter Steier[1], Andreas Wiederin[1], Akahiko Yokoyama[3], and Robin Golser[1] — [1]University of Vienna, Faculty of Physics, Austria — [2]University of Tsukuba, Faculty of Pure and Applied Science, Japan — [3]Kanazawa University, Institute of Science and Engineering, Japan

The quantitative analysis of the potential oceanographic tracer ^{237}Np by mass spectrometric techniques such as Accelerator Mass Spectrometry (AMS) still suffers from the lack of an isotopic spike. Measurements using non-isotopic spikes for normalisation, such as ^{242}Pu, have achieved acceptable results for selected environmental materials, but require careful control of the oxidation states during chemical separation and monitoring of the relative ion source output. In our joint project with the University of Tsukuba we successfully produced mass 236 by the irradiation of Th foils with a ^{7}Li beam in the 30-40 MeV range at the RIKEN Nishina Center. First AMS measurements using fluoride molecules indicate that the observed surplus of mass 236 above background is indeed ^{236}Np. The by-production of mass 237, however, is higher than expected from model calculations with the EMPIRE code and needs further investigation. This contribution will discuss environmental levels of ^{237}Np obtained with AMS using non-isotopic normalisation and the present status of the ^{236}Np spike production.

MS 4.3 Wed 11:15 MS-H9

Separation of U and Np Isobars by ILIAMS — •Andreas Wiederin[1], Karin Hain[1], Martin Martschini[1], Aya Sakaguchi[2], Peter Steier[1], and Robin Golser[1] — [1]University of Vienna, Fac-

ulty of Physics - Isotope Physics, Austria — [2]University of Tsukuba, Faculty of Pure and Applied Science, Japan

^{237}Np ($T_{1/2}$=2.1 Ma) is the second most abundant anthropogenic actinide in the environment, but a reliable quantification by AMS independent of the environmental matrix would require an isotopic spike for normalization. We currently consider ^{236}Np the most suitable candidate to serve this purpose. Such a spike material is currently under development and needs a careful characterization regarding interfering by-products. Possible isobaric background from ^{236}U necessitates the separation of U and Np by chemical means and/or during the AMS measurement. Ion Laser InterAction Mass Spectrometry (ILIAMS) uses selective laser photodetachment inside an RFQ ion cooler to neutralize anions of the interfering isobar. By applying a 2.33 eV laser, UF_4^- has been suppressed by at least four orders of magnitude in recent experiments, while NpF_4^- passed unaffected. The comparatively low formation rate and high sensitivity to interactions with the buffer gas of UF_4^- further increased the suppression relative to NpF_4^-. This result represents the first isobar separation in the mass range of the actinides in AMS. The U suppression achieved is already sufficient for the application of ^{236}Np to quantitatively determine ^{237}Np by isotope ratio measurements.

MS 4.4 Wed 11:30 MS-H9

Study of Actinide Signatures as Potential Markers for the Anthropocene — •Janis Wolf[1], Karin Hain[1], Maria Meszar[2], Michael Strasser[3], Michael Wagreich[2], and Robin Golser[1] — [1]University of Vienna, Faculty of Physics, Währinger Str. 17, 1090 Vienna, Austria — [2]University of Vienna, Department of Geology, Althanstraße 14, 1090 Vienna, Austria — [3]University of Innsbruck, Department of Geology, Innrain 52f, 6020 Innsbruck, Austria

The Anthropocene is the proposed geological epoch that follows the Holocene and is defined by the predominance of human impact on the Earth System. An epoch-defining impact must produce stratigraphic signals that are unique, distributed globally, and well preserved for a long time. Long-lived radionuclides released in atmospheric nuclear weapon testings may have produced a suitable signal. The proposed markers for the Anthropocene, Pu-239 and Am-241, and additionally U-233, U-236, Np-237 and Pu-241 were analyzed in the different reservoirs, urban strata and Austrian lake sediments, using the AMS facility VERA. The anthropogenic radionuclides have been successfully detected in layers corresponding to the active phase of nuclear weapons testing. In the urban strata, the isotopic ratio U-233/U-236, a new signature for nuclear weapons fallout, marks the onset of the Anthropocene whereas the concentrations of the other radionuclides in general gradually increase towards younger ages.

MS 4.5 Wed 11:45 MS-H9

Towards the Redetermination of the Half-life of ^{32}Si - Isobar Separation of ^{32}Si from the Isobar ^{32}S — •Matthias Schlomberg, Dr. Christof Vockenhuber, and Prof. Dr. Hans-Arno Synal — Laboratory of Ion Beam Physics, ETH Zürich

The ^{32}Si is a cosmogenic, long-lived radionuclide with potentially interesting applications for dating the recent past. However, its half-life of about 150 years is still not known with sufficient precision despite several independent measurements over the past four decades. The SINCHRON collaboration with partners from PSI, CHUV, PTB and ETH aims at a comprehensive redetermination of the half-life of ^{32}Si. The Laboratory of Ion Beam Physics (LIP) at ETH Zurich will perform the AMS measurements using the 6 MV-Tandem facility for the determination of the number of ^{32}Si atoms in the samples used for the activity measurement. In addition to the challenge of performing an absolute measurement without having standards available, ^{32}Si must be separated from its intense isobar ^{32}S.
We developed a method based on a passive gas absorber in front of a gas ionization detector that allows us detection of ^{32}Si by stopping the isobar ^{32}S at 30 MeV. However, background from light recoils from the absorber material and deviations of the stopping power at low energies still pose challenges.
An overview of the SINCHRON project will be presented. The setup and the obtained data will be discussed with respect to an absolute measurement.

MS 4.6 Wed 12:00 MS-H9

Improved ^{41}Ca AMS measurements at DREAMS — •Carlos Vivo-Vilches, Georg Rugel, Johannes Lachner, Anton Wallner, Dominik Koll, Konstanze Stuebner, Sebastian Fichter, and Stephan Winkler — Helmholtz-Zentrum Dresden-Rossendorf, AcceleratorMass Spectrometry and Isotope Research, Dresden, Germany

Sensitivity of ^{41}Ca measurements at the 6 MV AMS system at HZDR, DREAMS, using calcium fluoride (CaF_2) targets, is mainly limited by 2 factors: the total efficiency of the measurements; and the fraction of ions of its isobar ^{41}K which mimic the signal of ^{41}Ca in the gas ionization chamber detector.

The addition of lead fluoride (PbF_2) to the target mixture has been proven to boost the production of different $(MF_n)^-$ ions. At DREAMS, changing the previously used mixture of CaF_2+Ag (1:4 w/w) by CaF_2+Ag+PbF_2 (1:4:4 w/w), ionization efficiency is increased from ∼0.15% to ∼0.45%.

The ^{41}K suppression by the detector can also be improved, even without changes in the instrumentation itself. With an optimized analysis of the 4-dimensional signals from the gas ionization chamber detector, the suppression factor can be increased, at least, a factor 2: from 2×10^4 to 4×10^4.

The reported changes improve the total efficiency of ^{41}Ca detection as well as the suppression of the ^{41}K isobar and lead to a ^{41}Ca/^{40}Ca sensitivity of 2-3 $\times$ 10^{-15} with an overall efficiency of ∼0.03%.

MS 4.7 Wed 12:15 MS-H9

Normalization methods for the analysis of environmental ^{99}Tc — •Stephanie Adler, Karin Hain, Martin Martschini, Fadime Gülce, and Robin Golser — University of Vienna, Faculty of Physics

Quantification of the anthropogenic radionuclide ^{99}Tc ($t_{1/2} = 2.1 \cdot 10^5$ yr) in the general environment by AMS requires suppression of the stable isobaric background of ^{99}Ru and a reliable normalization method to overcome the lack of a stable Tc isotope.

At VERA, previous research has shown that extracting TcF_5^- from the ion source is suitable for Ion Laser InterAction Mass Spectrometry (ILIAMS) as RuF_5^- can be suppressed by a laser by up to 10^5.

Experiments at other AMS-facilities using TcO^- normalized the ^{99}Tc to the ^{93}Nb-current of the matrix material with a precision of 30%. Using this approach, our experiments showed Tc-deficits of $> 40\%$, indicating major loss of Tc during sample preparation. This lead to thorough investigations of the final target preparation steps utilizing ^{95}Tc and γ-Spectrometry. The chemical recovery was improved to reliable yields >92%, by lowering the calcination temperature.

When extracting $^{99}TcF_5^-$ from the source as required for ILIAMS, the Nb-normalization scatters by a factor of 10 and seems less reliable. Thus research on using an alternative spike material ^{103}Rh for normalization is currently ongoing.

MS 5: Annual general meeting

Time: Wednesday 13:00–14:00 Location: MS-MV

Annual general meeting

MS 6: New Developments

Time: Wednesday 14:00–15:45 Location: MS-H9

Invited Talk MS 6.1 Wed 14:00 MS-H9

PUMA: nuclear structure with low-energy antiprotons — •Alexandre Obertelli — Technische Universität Darmstadt

Nuclear halos are a fascinating manifestation of quantum physics. They belong to a subset of low-density clustering for which most of the probability to find the halo nucleon extends to a region of space that is classically forbidden. Their properties show universal aspects of few-body systems such as scaling laws. Advances in the production of radioactive isotope beams give access to loosely-bound neutron-rich systems at the nuclear driplines, where halos are found.

Low-energy antiprotons offer a very unique sensitivity to the neutron and proton densities in the tail of the nuclear density. Such studies with stable nuclei at ELENA, CERN, and with short-lived nuclei at ISOLDE, CERN, are the motivation of the recently-accepted experiment PUMA (antiProton Unstable Matter Annihilation). The concept, sensitivity and status of the experiment will be introduced.

MS 6.2 Wed 14:30 MS-H9

A novel transportable PI-ICR Penning-trap mass spectrometer — •D. Lange[1,2], M. Door[1], S. Eliseev[1], P. Filianin[1], J. Herkenhoff[1], K. Kromer[1], A. Rischka[1], Ch. Schweiger[1], and K. Blaum[1] — [1]Max-Planck-Institut for Nuclear Physics, Heidelberg, Germany — [2]Heidelberg University, Heidelberg, Germany

The new, transportable PILOT-trap (Phase-Imaging Located in One Transportable-trap) experiment aims to measure masses of short-lived nuclides with low production rates and half-lives down to 100 ms with relative uncertainties of about 10^{-8}. This should be realised with a Penning-trap based modified buffergas cooling and PI-ICR technique [1]. In order to deal with the low production rates of some isotopes a modified dynamic buffer gas cooling technique is used in only a single measurement trap. Therefore a fast piezo valve is being developed, which enables a fast and precisely timed helium injection into the Penning-trap, followed by a fast helium release to be directly able to measure in the same trap. This increases the overall efficiency by also avoiding the transport. The setup is situated in the warm bore of a 6T superconducting cryocooled magnet which ensures transportability to different radioactive beam facilities. Here, mass measurements of e.g. rare superheavy nuclides become possible contributing to nuclear physics and the search for the island of stability, see e.g. [2]. The current status as well as the developed dynamic cooling method of this experiment are presented.

[1] Eliseev, S. et al., Phys. Rev. Lett. 110, 082501 (2013).
[2] Block, M. et al., Nature 463, 785-788 (2010).

MS 6.3 Wed 14:45 MS-H9

New developments in radiation-detected resonance ionization towards the heaviest actinides — •Jessica Warbinek[1,2], Brankica Andelić[1,3], Michael Block[1,2,4], Premaditya Chhetri[1,4], Arno Claessens[5], Rafael Ferrer[5], Francesca Giacoppo[1,4], Oliver Kaleja[1,6], Tom Kieck[1,4], EunKang Kim[2], Mustapha Laatiaoui[2], Jeremy Lantis[2], Andrew Mistry[1,7], Danny Münzberg[1,2,4], Steven Nothhelfer[1,2,4], Sebastian Raeder[1,4], Emmanuel Rey-Herme[8], Elisabeth Rickert[1,2,4], Jekabs Romans[5], Elisa Romero-Romero[2], Marine Vandebrouck[8], and Piet Van Duppen[5] — [1]GSI Helmholtzzentrum für Schwerionenforschung, Germany — [2]Johannes Gutenberg-Universität, Mainz, Germany — [3]KVI-CART, Groningen, The Netherlands — [4]Helmholtz Institut Mainz, Germany — [5]KU Leuven, IKS, Belgium — [6]Universität Greifswald, Germany — [7]TU Darmstadt, Germany — [8]CEA Saclay, France

Laser spectroscopy can be a powerful tool to get insight into atomic and nuclear structures of exotic elements such as the heavy actinides. However, commonly applied techniques often lack the required sensitivity as most of these nuclides are very short-lived and can only be produced in atom-at-a-time quantities. The efficient and sensitive RAdiation-Detected Resonance Ionization Spectroscopy (RADRIS) method enabled the first laser spectroscopy of nobelium and it was recently applied to study a chain of fermium isotopes. To expand this technique for the search of atomic levels in the heaviest actinide, lawrencium (Z=103), the sensitivity of the setup needs to be further improved. Therefore, a new movable double-detector setup was developed, which allows an enhancement in the overall efficiency by about 60 % compared to the single-detector design. Further development work was performed to enable the study of shorter-lived (<1 s) and longer-lived (>1 h) nuclides with the RADRIS method. The most recent results on the commissioning of the new setup will be presented.

MS 6.4 Wed 15:00 MS-H9

Commissioning and status of a gas-jet apparatus for laser spectroscopy of the heaviest elements — •Jeremy Lantis[1,2], Julian Auler[1], Michael Block[1,2,3], Premaditya Chhetri[4], Arno Claessens[4], Christoph E. Düllmann[1,2,3], Rafael Ferrer[4], Francesca Giacoppo[2,3], Magdalena Kaja[1], Oliver Kaleja[1,3,5], Tom Kieck[3], Nina Kneip[1], Sandro Kraemer[4], Mustapha Laatiaoui[2,3], Nathalie Lecesne[6], Vladimir Manea[6,7], Danny Münzberg[1,2,3], Steven Nothhelfer[1,2,3], Jekabs Romans[4], Herve Savajols[6], Simon Sels[4], Matou Stemmler[1], Dominik Studer[1], Barbara Sulignano[8], Piet Van Duppen[4], Marine Vandebrouck[8], Thomas Walter[9], Jessica Warbinek[1,3], Felix Weber[1], and Klaus Wendt[1] — [1]Johannes Gutenberg University Mainz, 55099 Mainz, Deutschland — [2]Helmholtz Institute Mainz, 55099 Mainz, Germany — [3]GSI Helmholtzzentrum für Schwerionenforschung GmbH, 64291 Darmstadt, Germany — [4]KU Leuven, Instituut voor Kern- en Stralingsfysica, B-3001 Leuven, Belgium — [5]Max-Planck-Institut für Kernphysik, 69117 Heidelberg, Germany — [6]Grand Accélérateur National d'Ions Lourds, 14000 Caen, France — [7]Laboratoire de Physique des 2 Infinis Irène Joliot Curie, 91400 Orsay, France — [8]CEA Saclay, 91190 Saclay, France — [9]TU Darmstadt, 64289 Darmstadt, Germany

Laser spectroscopy measurements can provide information about fundamental properties of both atomic and nuclear structure. These techniques are of particular importance for the heaviest actinides and superheavy elements, where atomic data are sparse. Recent resonance ionization spectroscopy experiments at GSI, Darmstadt have focused on in-gas-cell measurements using the RADRIS technique, with success measuring several nobelium and fermium isotopes. However, the resolution of these measurements is limited by collisional and Doppler broadening and cannot be applied to isotopes with half-lives shorter than one second. Simultaneously, work has been performed at KU Leuven performing laser spectroscopy on atoms in a hypersonic jet, allowing for high resolution measurements in an almost collision-free and reduced Doppler broadening environment. A new gas- jet apparatus has been constructed combining the sensitivity of the RADRIS technique with the resolution of in-gas jet spectroscopy to overcome these limitations. Commissioning experiments have been performed using thulium and dysprosium to optimize the experimental conditions, ensuring that the achievable resolution is sufficient for planned online experiments with nobelium. The most recent results will be presented.

MS 6.5 Wed 15:15 MS-H9

Efficiency measurements of in-gas-jet resonance ionization spectroscopy — •Julian Auler[1], Michael Block[1,2,3], Premaditya Chhetri[4], Arno Claessens[4], Rafael Ferrer[4], Magdalena Kaja[1], Tom Kieck[3], Nina Kneip[1], Jeremy Lantis[1,2], Vladimir Manea[5,6], Danny Münzberg[1,2,3], Steven Nothhelfer[1,2,3], Sebastian Raeder[2,3], Jekabs Romans[4], Simon Sels[4], Matou Stemmler[1], Dominik Studer[1], Piet Van Duppen[4], Jessica Warbinek[1,3], Felix Weber[1], and Klaus Wendt[1] — [1]Johannes Gutenberg-Universität Mainz, 55099 Mainz, Germany — [2]Helmholtz Institute Mainz, 55099 Mainz, Germany — [3]GSI Helmholtzzentrum für Schwerionenforschung GmbH, 64291 Darmstadt, Germany — [4]KU Leuven, Institutuut voor Kern- en Stralingsfysica, B-3001 Leuven, Belgium — [5]Laboratoire de Physique des 2 Infinis Irène Joliot Curie, 91400 Orsay, France — [6]Grand Accélérateur National d'Ions Lourds, 14000 Caen, France

We present a new gas-jet experiment intended to study optical transitions of the heaviest elements at the Separator for Heavy Ion reaction Products (SHIP) at GSI, Darmstadt. The novel aspect of the gas-jet experiment is the extraction of previously stopped and neutralized heavy ions in a well-defined, low-temperature, homogeneous, hypersonic gas-jet. Laser resonance ionization spectroscopy is performed in the gas jet, yielding high spectral resolution due to reduced Doppler broadening. Considering the limited production rate of heavy ions at on-line facilities, such as GSI, a high total efficiency is a crucial require-

ment for the gas-jet experiment. The overall efficiency can be factorized into different contributions, like the injection of heavy ions into the setup, the ion transport efficiency, the re-evaporation efficiency, the efficiency of resonance ionisation and the detector efficiency. Additionally, for radioactive elements the losses due to decay have to be taken into account. Efficiency measurements are performed with both stable and radioactive samples. The results of the efficiency measurements will be presented.

MS 6.6 Wed 15:30 MS-H9

Sympathetic cooling of single ions in a Penning trap using a self-cooled electron plasma — •Jost Herkenhoff, Menno Door, Sergey Eliseev, Pavel Filianin, Kathrin Kromer, Daniel Lange, Alexander Rischka, Christoph Schweiger, Sven Sturm, and Klaus Blaum — Max-Planck-Institut für Kernphysik, 69117 Heidelberg, Germany

The amazing evolution of precision in recent Penning-trap experiments is driving the need for ever-improving cooling techniques. In this talk, the prospect of a new sympathetic cooling technique using an electron-plasma coupled to a single ion is presented. Utilizing the synchrotron-radiation of electrons in a strong magnetic field enables cooling to very low motional quantum numbers, almost to their ground state. Using a common-resonator, the motion of this self-cooled electron plasma can be coupled to a single ion stored in a spatially separated Penning trap, allowing sympathetic cooling of all modes of the ion. The extremely low expected temperatures in the milllikelvin range open up an exciting new frontier of measurements in Penning traps.

MS 7: MS Poster Session

Time: Wednesday 16:30–18:15 Location: P

MS 7.1 Wed 16:30 P

Direct high-precision measurement of the Q-value of the electron capture in ^{163}Ho — •K. Kromer[1], M. Brass[2], V. Debierre[2], M. Door[1], H. Dorrer[3], Ch.E. Düllmann[3,4,5], S. Eliseev[1], C. Enss[6], P. Filianin[1], L. Gastaldo[5], Z. Harman[1], M.W. Haverkort[2], J. Herkenhoff[1], P. Indelicato[7], C.H. Keitel[1], D. Lange[1], Yu.N. Novikov[8], D. Renisch[4,5], A. Rischka[1], Ch. Schweiger[1], and K. Blaum[1] — [1]Max-Planck-Institut für Kernphysik, 69117 Heidelberg, Germany — [2]Institute for Theoretical Physics, Heidelberg University, 69120 Heidelberg, Germany — [3]Institut für Kernchemie, Johannes-Gutenberg-Universität Mainz, 55128 Mainz, Germany — [4]Helmholtz-Institut Mainz, 55128 Mainz, Germany — [5]GSI Helmholtzzentrum für Schwerionenforschung GmbH, 64291 Darmstadt, Germany — [6]Kirchhoff-Institute for Physics, Heidelberg University, 69120 Heidelberg, Germany — [7]Laboratoire Kastler Brossel, Sorbonne Université, CNRS, ENS-PSL Research University, Collège de France, 75005 Paris, France — [8]NRC "Kurchatov Institute"-Petersburg Nuclear Physics Institute, Gatchina 188300, Russia

Pentatrap [1] is a high-precision Penning-trap mass spectrometer featuring a stack of five Penning traps and determining mass-ratios with a relative uncertainty of below 10^{-11}. Mass-ratio determinations of stable and long-lived highly charged ions at this level have numerous applications, among others, in neutrino physics. The ECHo collaboration [2] plans to set an upper limit on the mass of the electron neutrino by measuring the sprectrum of the electron capture decay of ^{163}Ho with metallic magnetic calorimeters. In order to exclude systematic errors and have an independent value of the endpoint of the electron capture spectrum, Pentatrap measured the Q-value by means of Penning-trap mass spectometry, comparing the mass of highly charged ions of the mother and daughter nuclides ^{163}Ho and ^{163}Dy. The uncertainty of the final Q-value including binging energy calculations of the missing electrons is as low as 1.1 eV.

[1] Repp, J. et al., Appl. Phys. B 107, 983, (2012)
[2] Gastaldo, L. et al., Eur. Phys. J. ST 226, 1623 (2017)

MS 7.2 Wed 16:30 P

Schottky detectors for high resolution and fast Schottky spectroscopy of short-lived fragments in heavy ion storage rings — •Shahab Sanjari[1,2], Dmytro Dmytriiev[1,3], George Hudson-Chang[4,5], Yuri A. Litvinov[1,3], and Mariia Selina[2] — [1]GSI Helmholtz Center, D-64291 Darmstadt, Germany — [2]Aachen University of Applied Sciences, D-52005 Aachen, Germany — [3]Heidelberg University, D-69117 Heidelberg, Germany — [4]University of Surrey, GU2 7XH, Surrey, UK — [5]RIKEN Nishina Center, 351-0198, Wako, Saitama, Japan

Using non-destructive Schottky detectors, precise determination of masses and lifetimes of exotic nuclear species and their isomeric states can be performed in heavy ion storage rings. Single ion sensitivity has regularly been achieved in the past using resonant cavity pick-ups. New designs are targeting an increase in measurement accuracy by additionally measuring particle position in the dispersive section of the storage ring. In this work, we report on the latest progress on the development of new position sensitive cavity pickup detectors.

MS 7.3 Wed 16:30 P

Implementation of a software defined radio (SDR) based beam current monitor for Schottky detectors in heavy ion storage rings — •Mariia Selina[1], Shahab Sanjari[1,2], Dmytro Dmytriiev[2,3], and Yuri A. Litvinov[2,3] — [1]Aachen University of Applied Sciences, D-52005 Aachen, Germany — [2]GSI Helmholtz Center, D-64291 Darmstadt, Germany — [3]Heidelberg University, D-69117 Heidelberg, Germany

With the increasing sensitivity and precision of resonant Schottky detectors, this technology becomes more valuable in the determination of masses and lifetimes of the yet unstudied nuclei inside heavy ion storage rings but also in general storage ring physics. At present, information from these detectors is gained by high-end units with software and hardware interface that are not versatile and / or not suitable for applications where scalability is indispensable. Here, software-defined radio (SDR) based data acquisition systems come in handy, mainly due to their low cost and relatively simple hardware but also due to the fact that their functionality is almost entirely software-defined/programmable. If calibrated, Schottky detectors can facilitate beam current measurements that are orders of magnitude more sensitive compared to existing DC current transformers (DDCT). In this work, we report on the implementation of an SDR-based online beam current monitor for use with Schottky detectors in heavy ion storage rings such as ESR in GSI/FAIR.

MS 7.4 Wed 16:30 P

LISEL@DREAMS progress report — •Oliver Forstner[1,2,3], Thomas Weber[1], Vadim Gadelshin[4], and Klaus Wendt[4] — [1]Friedrich-Schiller-Universität Jena, Jena — [2]Helmholtz-Institut Jena, Jena — [3]GSI Holmholtzzentrum, Darmstadt — [4]Johannes Gutenberg-Universität Mainz, Mainz

The LISEL setup (Low-energy Isobar SEparation by Lasers) is currently being built at the University of Jena in the framework of a BMBF funded project. It comprises a gas-filled radio frequency quadrupole cooler where negative ions will be slowed down to thermal energies and overlapped with a laser beam. This allows an elemental selective suppression of isobars by laser photodetachment by careful selection of the photon energy. The tunable laser system is currently being developed at the University of Mainz. After commissioning the LISEL setup will be transferred to the DREAMS (DREsden AMS) facility at the Helmholtz Center Dresden Rossendorf (HZDR).

In this presentation I will give a status report of the construction of the LISEL cooler and present an outlook of the future activities.

MS 8: Multi-Reflection Time-of-Flight Spectrometers

Time: Thursday 10:30–11:45 Location: MS-H9

Invited Talk MS 8.1 Thu 10:30 MS-H9

Present and future prospects for MRTOF-based mass spectroscopy at KEK and RIKEN — •Peter Schury[1], Michiharu Wada[1], Toshitaka Niwase[1], Marco Rosenbusch[1], Yoshikazu Hirayama[1], Hironobu Ishiyama[2], Daiya Kaji[2], Sota Kimura[2], Hiroari Miyatake[1], Kouji Morimoto[2], Momo Mukai[2], Hiroari Miyatake[1], Aiko Takamine[2], Yutaka Watanabe[1], and Hermann Wollnik[3] — [1]Wako Nuclear Science Center, Wako, Japan — [2]RIKEN Nishina Center for Accelerator-Based Science — [3]New Mexico State University

The KEK Wako Nuclear Science Center in collaboration with the RIKEN SLOWRI group presently operates three high-performance multi-reflection time-of-flight (MRTOF) mass spectrographs within the RIKEN accelerator complex – one for superheavy elements, one for in-flight fission and fragmentation products, and one for multi-nucleon transfer products – with more planned for the near future. With typical mass resolving power approaching $m/\Delta m{=}10^6$, we are able to achieve relative mass precision $\delta m/m{\sim}10^{-7}$ with 100 detected ions; in many cases isomeric states can be resolved. By embedding silicon detectors within the time-of-flight detector, we have initiated a new field of decay-correlated mass spectroscopy which greatly enhances the capabilities of the MRTOF. The results of recent measurement campaigns and plans for future MRTOF-based studies will be presented.

MS 8.2 Thu 11:00 MS-H9

A Multi-Reflection Time-of-Flight Mass Spectrometer (MR-ToF MS) for the Offline Ion Source of PUMA — •Moritz Schlaich, Alexandre Obertelli, Frank Wienholtz, and Clara Klink — TU Darmstadt, Darmstadt, Deutschland

Using low-energy antiprotons provided by the Extra Low Energy Antiproton ring (ELENA) at CERN, the antiProton Unstable Matter Annihilation experiment (PUMA) aims to probe the isospin composition of the density tail of radioactive nuclei. For this purpose, PUMA intends to trap one billion antiprotons at ELENA in a portable Penning trap and transport them to the Isotope mass Separator On-Line DEvice (ISOLDE) at CERN. There, the isotopes of interested are produced and will be brought together with the antiprotonic cloud. By analyzing the residuals of the subsequent annihilation reactions, the experiment plans to study neutron skin formation of multiple neutron-rich nuclei and possible halo nuclei.

In order to perform reference measurements and initially apply the experimental technique to stable nuclei, a versatile offline ion source is needed that must be able to generate isotopically pure ion bunches with sufficiently high particle intensity. Therefore, an MR-ToF MS will be used to analyze the constituents of the incoming beam and to selectively forwards only the ions of interest within milliseconds. The talk will cover an overview of the system and its capabilities with respect to mass separation.

MS 8.3 Thu 11:15 MS-H9

Improving a multi-reflection time-of-flight mass spectrometer with multiple active voltage-stabilization loops — •Paul Fischer[1], Paul Florian Giesel[1], Frank Wienholtz[2], and Lutz Schweikhard[1] — [1]Institut für Physik, Universität Greifswald, 17487 Greifswald, Germany — [2]Institut für Kernphysik, Technische Universität Darmstadt, 64289 Darmstadt, Germany

The principal observable in multi-reflection time-of-flight mass spectrometry (MR-ToF MS)—a stored ion species' lapping period between two electrostatic mirrors—is most stable over long measurement times when the MR-ToF analyzer's potential configuration is as constant as possible. By stabilizing the most sensitive mirror potential with an active feedback loop, long-term resolving powers can be significantly increased, as has been demonstrated recently [1].

Based on this concept, the Greifswald MR-ToF mass spectrometer is equipped with subsequent stabilization loops for multiple mirror potentials [2]. Isobaric species of atomic clusters are used to probe the subsequent gain in MR-ToF performance and characterize different-quality hardware for the implementation of the active voltage controller. The system shows improved long-term mass resolving power, settling behavior for different experimental cycles, and better conditions for the timing of pulsed in-trap photoexcitation of atomic clusters.

[1] Wienholtz et al., Nucl. Instrum. Meth. B 463:348 (2020)
[2] Fischer et al., Rev. Sci. Instrum. 92:063203 (2021)

MS 8.4 Thu 11:30 MS-H9

Study of a laser ablation carbon cluster ion source for MR-TOF MS — •Jiajun Yu[1,3] and FRS Ion Catcher Collaboration[1,2] — [1]GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt — [2]Justus-Liebig-Universität Giessen, Giessen — [3]Jinan University, Guangzhou, China

The MR-TOF-MS can be used for mass measurement with a resolving power of up to 1,000,000 (FWHM) and a relative accuracy down to a few 10^{-8}. To achieve high-precision mass measurement with a relative accuracy below 10^{-8}, calibrants over a broad mass range are needed for mass accuracy studies in the 10^{-9} level with the MR-TOF-MS. Furthermore, calibrants close to the ion of interest for a lowest uncertainty calibration are also needed. We have designed a laser ablation carbon cluster ion source (LACCI) capable of providing references in a mass range of 36 u to 240 u with a repetition rate up to 100 Hz in order to match the needs of the MR-TOF-MS.

Recently, the commission of LACCI has been carried out to study the capability of repetition rates, laser optics (laser spot size, laser energy), and ion optics (ion transfer efficiency). Especially, LACCI has been designed to be operated stably over a long time (several days) with a high frequency ($>$ 10 Hz), then stability for long term operation was also tested. The commissioning results of LACCI coupled with a quadrupole mass filter and the MR-TOF-MS will be reported in this contribution.

MS 9: Ion Storage Rings

Time: Thursday 14:00–15:15 Location: MS-H9

Invited Talk MS 9.1 Thu 14:00 MS-H9

Isochronous mass spectrometry and beam purification in an electrostatic storage ring — •Viviane C. Schmidt — Max-Planck-Institut für Kernphysik, 69117 Heidelberg, Germany

Electrostatic storage rings have been primarily used for collision studies of charged atoms or molecules with photons, atoms, and electrons until now. Due to the electrostatic nature and therefore mass-independent storage of the devices, multiple ion species can be stored simultaneously. The identification and removal of these predominantly isobaric contaminations from the beam is not obvious. So far, electrostatic storage rings mostly rely on identification and purification methods prior to injection for contaminant-free measurements. Here, we report the first successful isochronous operation of an electrostatic storage ring achieved at the Cryogenic Storage Ring (CSR) facility at the Max-Planck-Institut für Kernphysik in Heidelberg (*von Hahn et al., Rev. Sci. Instrum. 87, 2016*). The isochronous operation enables a sensitive, mass based identification of the stored beam components, information vital for all experiments conducted at CSR. Uncooled beams with typical momentum spreads of 10^{-3} and emittance of a few mm·mrad were investigated at non-relativistic beam energies of a few hundred keV. Mass resolutions of $\frac{\Delta m}{m} < 10^{-5}$ could be reached and isobaric contaminations below relative beam fractions of 10^{-4} could be identified. The proof-of-principle measurements presented here open up a new field of application in the form of ion mass measurements for these devices. Furthermore, beam purification methods to remove the identified contaminations inside the ring have been developed.

MS 9.2 Thu 14:30 MS-H9

4k-pixel microcalorimeter detector for the Cryogenic Storage Ring CSR - standalone experimental setup and new readout possibilities — •Christopher Jakob[1], Lisa Gamer[1],

Klaus Blaum[1], Christian Enss[2], Andreas Fleischmann[2], Ansgar Lowack[2], Michael Rappaport[3], Dennis Schulz[2], Yoni Toker[4], Andreas Wolf[1], and Oldřich Novotný[1] — [1]MPIK Heidelberg — [2]KIP Heidelberg University — [3]Weizmann Institute of Science, Rehovot, Israel — [4]Bar-Ilan University, Ramat Gan, Israel

The Cryogenic Storage Ring CSR at the Max Planck Institute for Nuclear Physics, Heidelberg, can store heavy molecular ions in their rotational and vibrational ground states, enabling the investigation of electron-ion interactions such as the dissociative recombination in laboratory environment under conditions close to those in cold interstellar plasmas. To reconstruct the full kinematics of these processes, position- and energy-sensitive coincident detection of multiple reaction products is necessary. For this purpose, MOCCA, a 4k-pixel molecule camera based on magnetic calorimeters with a detection area of 45 mm×45 mm, was developed at the Kirchhoff-Institute for Physics in Heidelberg. We introduce a new readout scheme and present the plans for the integration of MOCCA and its ^{3}He/^{4}He dilution refrigerator into CSR, as well as a CSR-independent experimental setup where MOCCA will be used to study collision- and photon-induced ion fragmentation processes.

MS 9.3 Thu 14:45 MS-H9

Measurement of the bound-state beta decay of bare 205-Thallium and its nuclear astrophysical implications — •Ragandeep Singh Sidhu, Rui-Jiu Chen, Yu. A. Litvinov, and and the E121 collaboration — GSI Helmholtzzentrum für Schwerionenforschung, Planckstraße 1, 64291 Darmstadt, Germany

We report on the first direct measurement of the bound-state beta decay [1] of ^{205}Tl^{81+} ions, an exotic decay mode, in which an electron is directly created in one of the empty atomic orbitals instead of being emitted into the continuum. One of the most awaited and pioneering experiments was realized in the spring beamtime at GSI, Darmstadt in 2020, wherein the entire accelerator chain was employed. ^{205}Tl^{81+} ions (with no electron) were produced with the projectile fragmentation of ^{206}Pb primary beam on ^{9}Be target, separated in the fragment separator (FRS), accumulated, cooled, and stored for different storage times (up to 10 hours) in the experimental storage ring (ESR). The experimentally measured half-life value [2] draws a 2.7σ [3] and 4.2σ [4] tension with the theoretically predicted values, which could influence our understanding of the abundance of chemical elements in the early universe. In this contribution, the authors aim to present the s-process motivation and a preliminary value of the ^{205}Tl^{81+} half-life.

[1] R. Daudel *et al.*, J. Phys. Radium, **8**, 238, 1947.
[2] Ragandeep Singh Sidhu, Ph.D. Thesis, Ruprecht-Karls-Universität, 2021.
[3] K. Takahashi *et al.*, Phys. Rev. C, **36**, 1522, 1987.
[4] S. Liu *et al.*, Phys. Rev. C, **104**, 024304, 2021.

MS 9.4 Thu 15:00 MS-H9

Search of the exotic nuclear two-photon emission decay in isochronous heavy ion storage rings — •David Freire[1,2,3,4], F. Çağla Akinci[5], Klaus Blaum[1,2], Wolfram Korten[3], Yuri A. Litvinov[2,4], Shahab Sanjari[4,6], and the E143 Collaboration[4] — [1]Max Planck Institute for Nuclear Physics, D-69117 Heidelberg, Germany — [2]Heidelberg University, D-69117 Heidelberg, Germany — [3]IRFU, CEA, Université Paris-Saclay, F-91191 Gif-sur-Yvette, France — [4]GSI Helmholtz Center, D-64291 Darmstadt, Germany — [5]Istanbul University, T-34452 Istanbul, Turkey — [6]Aachen University of Applied Sciences, D-52005 Aachen, Germany

The nuclear two-photon (2γ) decay is a rare decay mode in atomic nuclei whereby a nucleus in an excited state emits two gamma rays simultaneously. First order processes usually dominate the decay, however two-photon emission may become significant when first order processes are forbidden or strongly retarded, which can be achieved at the experimental storage ring ESR (GSI/FAIR). Within this work we will present the implemented methodology and the obtained results of two beam times performed in 2021, when for the first time the isochronous mode of ESR alongside non-destructive Schottky detectors were operated for the study of short-lived isomer production yields and lifetimes. We investigated specifically the isotope ^{72}Ge, as it is the most easily accessible nucleus having a first excited 0^+ state below the pair creation threshold paramount for the study of 2γ decay without competition of first order decays. In addition, the nuclei ^{70}Se and ^{72}Br were studied, as their isomeric states play a major role in nuclear astrophysics.