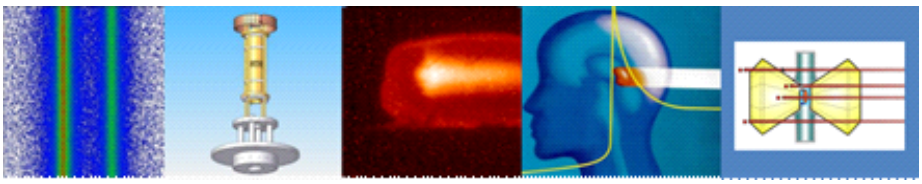
Annual Meeting of the ErUM-FSP APPA 2026



Book of Abstracts

https://indico.gsi.de/e/APPA_FSP_2026

Contribution ID: **1** Type: **Poster**

The SIS100 Laser Cooling Facility at FAIR

Thursday, January 22, 2026 7:10 PM (20 minutes)

The heavy-ion synchrotron SIS100 is (at) the heart of the Facility for Antiproton and Ion Research (FAIR) in Darmstadt, Germany. It is designed to accelerate intense beams of heavy highly charged ions up to relativistic velocities and to deliver them to unique physics experiments, such as those planned by the APPA/SPARC collaboration. In order to cool these extreme ion beams, "bunched beam laser cooling" will be applied using a dedicated facility at the SIS100. We will use a novel 3-beam concept, where laser beams from three complementary laser systems (1x cw and 2x pulsed) will be overlapped in space, time and energy to interact simultaneously with a very broad ion velocity range in order to maximize the cooling efficiency. We will present this project and give an update of its current status.

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Presenter: Dr WINTERS, Danyal (GSI Helmholtzzentrum für Schwerionenforschung GmbH(GSI))

Session Classification: Poster Session

Contribution ID: **2** Type: **Poster**

Commissioning of the Transverse Electron Target at the Heavy Ion Storage Ring CRYRING@ESR

Thursday, January 22, 2026 6:40 PM (20 minutes)

Electron-ion collision experiments in a
merged beams geometry (electron cooler) are
well established at ion storage rings. A complete
new range of experiments is possible if the geometry is changed to a crossed-beams setup in 90° angle between the electron and ion beams employing a dedicated free-electron target. The target bridges the gap between low-collision-energy experiments in electron coolers and those employing quasi-free electrons of gas-jet targets. Compared to the latter, the absence of a target nucleus enables unambiguous studies of processes,
which are otherwise masked by competing reactions with the target nucleus. As compared to an electron cooler, the interaction region of a transverse target is spatially well localized. This facilitates X-ray and electron spectroscopy with relatively large solid angles. Over the last years,
a specially tailored electron-target for heavy-ion
storage rings was developed and built at the
University of Giessen in cooperation with GSI.
Its scientific prospects have been outlined in the
CRYRING@ESR Physics Book [1]. The project benefits from decades-long experience of single-pass electron-ion-collision experiments [2–4].

Authors: BOROVIK, Alexander; BRANDAU, Carsten; DÖHRING, Michel (Justus-Liebig-Universität, FB07, AG für Atom- und Molekülphysik); SCHIPPERS, Stefan

Co-authors: GUMBERIDZE, Alexander; GLORIUS, Jan; LESTINSKY, Michael; LOOSHORN, Mirko; HILLENBRAND, Pierre-Michel; SPILLMANN, Uwe

Presenters: BRANDAU, Carsten; DÖHRING, Michel (Justus-Liebig-Universität, FB07, AG für Atom- und Molekülphysik); SCHIPPERS, Stefan

Session Classification: Poster Session

Contribution ID: **3** Type: **Poster**

Experimental and Theoretical Total Cross Sections for Single and Double Ionization of the Open-4d-Shell Ions Xe^{12+}, Xe^{13+}, Xe^{14+} by Electron Impact

Thursday, January 22, 2026 7:00 PM (20 minutes)

Using the electron-ion crossed-beams technique, we have measured absolute cross sections for electron impact single ionization of Xe^{12+} and Xe^{13+} ions, and double ionization of Xe^{12+}, Xe^{13+} and Xe^{14+} ions. In addition we have performed corresponding calculations using a hybrid level-to-level and subconfiguration-average distorted wave approach. We find excellent agreement between our experimental and theoretical data except near the double-ionization threshold.

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Co-authors: BOROVIK, Alexander; MÜLLER, Alfred

Presenters: DÖHRING, Michel (Justus-Liebig-Universität, FB07, AG für Atom- und Molekülphysik); SCHIPPERS, Stefan

Session Classification: Poster Session

Contribution ID: **4** Type: **Invited Talk**

High Resolution Dielectronic Recombination of Berylliumlike Heavy Ions at the CRYRING@ESR Storage Ring

Friday, January 23, 2026 3:00 PM (20 minutes)

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Electron–ion collision spectroscopy is a powerful tool for studying highly charged ions. The heavy-ion storage ring CRYRING@ESR offers excellent conditions for high-resolution dielectronic recombination (DR) measurements due to its ultra-cold electron cooler. Such high-precision DR spectroscopy enables sensitive tests of higher-order QED contributions in strong fields. We present recent DR studies of heavy berylliumlike systems, including fully evaluated results for Pb^{78+} [1] and measurements of Au^{75+}, which are currently under analysis. Comparisons with state-of-the-art theory highlight the potential of these systems to benchmark precision atomic-structure calculations in the high-Z regime.
[1] S. Schippers et al., Phys. Rev. Lett. **135**, 113001 (2025).

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Presenter: LOOSHORN, Mirko (Justus-Liebig-Universität Gießen(JULGi))

Session Classification: Session 5

Contribution ID: **5** Type: **Invited Talk**

CW and Pulsed UV Laser Systems for Laser Cooling Applications at the SIS100

Friday, January 23, 2026 2:20 PM (20 minutes)

Laser cooling, unlike established cooling methods such as electron cooling, promises to efficiently produce narrow longitudinal momentum distributions in relativistic bunched ion beams, even at large gamma factors. The concept was demonstrated (e.g. at the GSI in Darmstadt) using cw and pulsed laser systems separately, while the laser cooling facility in the upcoming heavy-ion synchrotron SIS100 at the FAIR facility will employ three laser systems simultaneously.

In this talk, two of these laser systems - the cw and a pulsed laser system - will be presented. Both operate at wavelengths of 514 nm and 257 nm, achieved via second-harmonic generation.
The cw laser system shows stable long-term operation with a high power output of 15 W in the green and 2 W in the UV region.
The pulsed laser system reaches average output powers of 34 W (green) and 5 W (UV), respectively. Its pulse duration and repetition rate can be adjusted within ranges of 46 - 734 ps and 1 - 10 MHz, with an additional frequency tuning range of 3.4 THz in the UV.

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Presenter: GRUNWITZ, Tamina (TU Darmstadt, HFHF Campus Darmstadt)

Session Classification: Session 5

Contribution ID: **6** Type: **Poster**

First Look at a New 14.5 GHz ECR Ion Source

Thursday, January 22, 2026 7:10 PM (20 minutes)

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Presenter: TATSCH, Maria (Justus-Liebig-Universität Gießen)

Session Classification: Poster Session

Contribution ID: **7** Type: **Poster**

High Power UV Laser Systems for Cooling Relativistic Bunched Ions

Thursday, January 22, 2026 7:10 PM (20 minutes)

Bunched relativistic ion beams with a narrow momentum distribution are essential for precision experiments at modern accelerator facilities. Laser cooling presents a promising approach to further reduce the relative momentum distribution of such ion beams.

This work presents the two high power UV laser systems, one pulsed and one cw, for laser cooling of relativistic bunched ion beams at the SIS100 at FAIR.
The cw system is optimized for high output powers with about 25 W in the green and 2.8 W in the UV even with long term operation due to an elliptical focus in the BBO crystal.
The pulsed laser is tunable over 3.4 THz in the UV with a dual BBO setup to improve conversion and beam displacement during frequency tuning.
Both laser systems ensure reliable and flexible operation for the laser cooling at the SIS100.

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Presenters: SCHWARZ, Denise (TU Darmstadt); LARA, Harri (TU Darmstadt)

Session Classification: Poster Session

Contribution ID: **8** Type: **Poster**

Rate Coefficients for Dielectronic Recombination of the Astrophysically Relevant N-Like Ne Ion at CRYRING@ESR

Thursday, January 22, 2026 6:20 PM (20 minutes)

Dielectronic recombination of N-like Ne was studied using a merged-beams setup at CRYRING@ESR for collision energies from 0 to 25 eV. The measured energy-dependent recombination rate coefficient includes all ΔN=0 DR resonances from 2s to 2p core excitations was compared with results from theoretical calculations. The ion beam contained roughly equal fractions of ions in the ground-state and in metastable states, therefore the theoretical rates were weighted accordingly. From the measurements we derived a DR plasma rate coefficient ⊠(T). The results agree well with previous theory for high temperatures where N-like Ne is abundant, but yield slightly higher rates at the lower temperatures typical of photoionized plasmas and collisionally ionized plasmas. Parametrized fits of the experimental DR plasma rates are provided for use in astrophysical models.

Authors: HANU, Elena-Oana (GSI Helmholtzzentrum für Schwerionenforschung GmbH(GSI)); LESTINSKY, M.; MENZ, E. B.; BRANDAU, C.; FOGLE, M.; HILLENBRAND, P.-M.; LOOSHORN, M.; SCHIPPERS, S.; SCHUCH, R.; TATSCH, M.; UEBERHOLTZ, K.; WANG, S.X.; STOEHLKER, T.

Presenter: HANU, Elena-Oana (GSI Helmholtzzentrum für Schwerionenforschung GmbH(GSI))

Session Classification: Poster Session

Contribution ID: **9** Type: **Invited Talk**

Site-Selective Fragmentation of Peptides Induced by Swift Heavy Ions

Friday, January 23, 2026 9:50 AM (20 minutes)

The interaction of swift heavy ions (SHI) with organic matter is of high relevance for applications such as cancer therapy as well as biomaterials'development based on SHI irradiation. Furthermore, the interaction of SHI with complex molecular systems such as biomolecules is interesting from a fundamental point of view in terms of the excitation mechanisms involved and how the energy deposited in the system is coupled into the molecular degrees of freedom relevant for bond breaking. SHI-induced fragmentation of peptides serves as an ideal model system to study these processes based on the variety of functional groups and bonds in the peptide molecules.
The study of molecular fragmentation by external stimuli, however, requires an analytical tool that does not introduce fragments itself. Therefore, we make use of Desorption/Ionization induced by Neutral SO_2 Clusters (DINeC), an extremely soft desorption method [1], in combination with mass spectrometry (MS). DINeC-MS has proven to be an ideal tool for analyzing fragmentation processes; in particular, it was employed to investigate peptide fragmentation by SHI impact [2].
Here we ask if the interaction of SHI with peptides can lead to bond-specific and/or selective fragmentation. We find, in addition to specific fragmentation, i.e, peptide bond cleavages restricted to the peptide backbone [2], a high site-selectivity of SHI-induced fragmentation. That means that only selected peptide bonds within the amino acid sequence are efficiently broken, whereas other ones remain intact. Influence of molecular structure and ion beam properties on this surprising observation will be discussed.

[1] C. Gebhardt, et al., Angw. Chem. Int. Ed. 48, 4162 (2009).
[2] P. Schneider, et al., Sci. Rep. 12, 17975 (2022).

Author: DÜRR, Michael (Justus-Liebig-Universität Gießen(JULGi))

Presenter: DÜRR, Michael (Justus-Liebig-Universität Gießen(JULGi))

Session Classification: Session 3

Contribution ID: **10** Type: **Poster**

Development of a Plasma Lens Operating at Hz-Frequencies for Laser-Driven Proton Acceleration

Thursday, January 22, 2026 7:10 PM (20 minutes)

An active plasma lens is a device used to focus charged particle beams by means of a gas discharge initiated in a capillary aligned with the beam axis. The high current carried by the discharge plasma generates a strong azimuthal magnetic field, causing the charged particles traversing the plasma to experience a focusing Lorentz force.

Plasma lenses are particularly suited for laser-accelerated ions, which exhibit high divergence and broad energy spectra. By adjusting the discharge current, the focal strength can be tuned to target specific particle energies. A key advantage of plasma lenses is their symmetric focusing in all transverse directions, in contrast to quadrupole magnets.

For technical implementation of the plasma lens a pulse forming network (PFN) is necessary, which can deliver discharge currents of several kiloamperes —depending on lens geometry, distance to the ion source, and ion energy. To ensure a homogeneous discharge and uniform current density, argon is used as the working gas due to its low thermal conductivity. Moreover, the operating frequency of the PFN must be synchronized with the repetition rate of the laser-driven ion source. Another challenge is the confinement of the working gas within the capillary without obstructing the ion beam. To address this, a pulsed gas injection system is proposed, eliminating the need for physical sealing.

Author: SCHMIDT, Gustav (Goethe Universität Frankfurt am Main, Institut für Angewandte Physik)

Presenter: SCHMIDT, Gustav (Goethe Universität Frankfurt am Main, Institut für Angewandte Physik)

Session Classification: Poster Session

Contribution ID: **11** Type: **Invited Talk**

Dielectronic Recombination of Highly Charged Ions: Experiment and Theory

Friday, January 23, 2026 3:20 PM (20 minutes)

Dielectronic recombination (DR) is widely recognized as the dominant electron–ion recombination mechanism in many astrophysical and laboratory plasmas, where it plays a crucial role in determining ionization balances and level populations over a broad temperature range. Moreover, DR experiments of highly charged ions (HCIs) at the storage rings have been developed as a precision spectroscopic tool to investigate the atomic structure as well as nuclear properties of stable and unstable nuclei.

In this talk, We will introduce our recent experimental progress on dielectronic recombination of astrophysically relevant ions performed at the CSRm storage ring in Lanzhou, China, together with the related state-of-the-art theoretical work. Furthermore, We will also present simulations of hyperfine-resolved DR spectra for several interesting highly charged ions, with a particular focus on bismuth ions. These studies provide useful theoretical guidance for future high-precision measurements of hyperfine splitting in HCIs using storage-ring merged-beam DR spectroscopy, especially at next-generation facilities such as HIAF in Huizhou, China, and FAIR in Darmstadt, Germany.

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Presenter: HUANG, Houke (Friedrich-Schiller-Universität Jena(FSU_Jena))

Session Classification: Session 5

Contribution ID: **12** Type: **Invited Talk**

CRYRING@ESR - Operational Performance and Limits of Electron Cooling

Thursday, January 22, 2026 5:00 PM (20 minutes)

Electron cooling is the only means of ion-beam cooling available at CRYRING@ESR. For precision experiments on stored ions, the range of available beam parameters is thus confined by technical and physical limits of the electron cooler in addition to those of the ring itself. Since recommissioning of the cooler at GSI/FAIR, its availability has steadily improved and new technical capabilities have been added, though some challenges remain. In my talk, I lay out the present limits of cooler operation and performance regarding experiments with low- and highly charged ions. I also give and outlook onto plans to further push those limits in the future.

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Presenter: KRANTZ, Claude (GSI Helmholtzzentrum für Schwerionenforschung GmbH(GSI))

Session Classification: Session 2

Contribution ID: **13** Type: **Poster**

Towards Testing Three-Loop QED and Nuclear Deformation Effects in Heliumlike Uranium

Thursday, January 22, 2026 7:10 PM (20 minutes)

Transition energy measurements in heavy, few-electron ions are unique tools to test bound-state quantum electrodynamics (QED) in extremely high Coulomb fields, where perturbative methods cannot be implemented. By accurately measuring the relative energies between $2p_{3/2} \rightarrow 2s_{1/2}$ transitions (of an energy of about 4.5 keV) in two-, three-, and four-electron uranium ions, we were able, for the first time in this regime, to disentangle and test separately high-order (two-loop) one-electron and two-electron QED effects and set a new important benchmark for this theory in the strong field domain [1]. The achieved accuracy of 37 parts per million allows us to discriminate between different theoretical approaches developed throughout the last decades for describing He-like systems. Such a precise measurement has been obtained by implementing a novel multi-reference method based on Doppler-tuned x-ray emission from fast ions stored in the ESR ring of the GSI/FAIR facility and using a pair of crystal diffractometers.
Experimental outlooks will also be presented, in which a new calibration scheme using a light reference ion and the implementation of a new time- and position-sensitive detector will be used. Together, these improvements are expected to reduce uncertainties to about 9 meV—ten times lower than current theoretical predictions and nuclear deformation effects. This approach opens a new pathway for probing the nuclear properties of heavy nuclei.

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Presenter: TRASSINELLI, Martino (Insitut des NanoSciences de Paris)

Session Classification: Poster Session

Contribution ID: **14** Type: **Invited Talk**

High-Pressure Platform for Swift Heavy Ion Irradiations: Probing Structural Transformations in Extreme Radiation Environments

Friday, January 23, 2026 10:30 AM (20 minutes)

Exploring the structural response and property transformations of materials under combined extreme conditions holds enormous importance across diverse multidisciplinary and fundamental research domains. The application of extreme pressures can induce novel phases and structures with distinctive properties. In this project, we explore the effects on exposing materials to radiation conditions provided by swift heavy ions, which locally deposit extreme high energy densities (~eV/atom) on time scales as short as sub-fs, an effect that cannot be reached by any other approach. This highly localized and fast energy deposition drives the local atomic structure far from equilibrium and produces specific defect configurations and complex structural modifications.
We present an innovative experimental platform designed to simultaneously apply high-energy ion irradiation and extreme static pressures while enabling in-situ sample characterization. This set-up is operated at the large-scale accelerator facility at the GSI Helmholtz Centre for Heavy Ion Research (Darmstadt, Germany). The ion accelerator provides beams of relativistic projectiles with ranges large enough to reach samples pressurized inside diamond anvil cells. Previous work has demonstrated that the combination of pressure and ion irradiation induces structural modifications, that are not observed if both extremes are applied separately [1-3]. For the irradiation experiment, the ion beam is collimated and injected through the gasket of the high-pressure cell enabling monitoring of structural changes with increasing irradiation dose by using in-situ Raman spectroscopy through the diamond anvil. All components are mounted on motorized high-precision stages operated by remote control to align the ion beam with the pressurized microscopic sample. This presentation details the technical aspects of the experimental setup along with future plans and showcases recent findings, including ion-induced phase transitions in rare earth sesquioxides (Gd2O3) and sodium azide (NaN_3). These examples highlight the unique opportunity of this approach to investigate materials far from equilibrium conditions and provide new routes for achieving and stabilizing unconventional structural transformations

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Session Classification: Session 3

Contribution ID: **15** Type: **Poster**

COLSPEC_MMC –a Setup of Magnetic Metallic Microcalorimeters for the CRYRING Transverse Electron Target

Thursday, January 22, 2026 7:10 PM (20 minutes)

The transverse electron target at the CRYRING has recently been commissioned successfully. It will allow investigating interactions between heavy ions and a collimated beam of monoenergetic electrons, including the emission of X-rays from radiative electron capture. For ions of low and medium nuclear charges, the X-ray transitions lie in the energy range of 1 –50 keV. To determine the transition energies with high precision, a detector array of magnetic metallic microcalorimeters (MMCs), which was developed at the Rupprecht-Karls-University Heidelberg, is prepared for the application at the transverse electron target. For this purpose, an existing $^3\mathrm{He}/^4\mathrm{He}$ dilution refrigerator is prepared at the TH University of Applied Sciences in cooperation with the Justus-Liebig-University Gießen in the framework of the APPA FSP. In addition, a special very small electron trap, a socalled MaMFIT, is set up at the TH Mittelhessen for complementary investigations which can be performed independently of the ion beams at CRYRING. The poster will present the status of the project and future perspectives.

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Presenter: KRAFT-BERMUTH, Saskia (TH Mittelhessen University of Applied Sciences)

Session Classification: Poster Session

Contribution ID: **16** Type: **Poster**

Experimental Validation of a Plasma Lens for Proton Beam Collimation at LIGHT, GSI

Thursday, January 22, 2026 7:10 PM (20 minutes)

Plasma lenses, created by gas discharges along the beam axis of charged particle beams, provide a compact and efficient approach to magnetic focusing. High currents initiated between ring electrodes generate azimuthal magnetic fields via Ampère's law, enabling symmetric focusing in both transverse planes. Compared to conventional solenoids and quadrupoles, plasma lenses achieve substantially stronger field gradients in minimal space, rendering them highly attractive for compact accelerator applications.

This work presents the design, construction, and initial experimental investigation of such a plasma lens at the LIGHT beamline of the GSI Helmholtz Centre for Heavy Ion Research in Darmstadt. The study specifically evaluates its capability to collimate ion beams from Target Normal Sheath Acceleration (TNSA), demonstrating the potential of plasma lenses as an alternative beam transport solution.

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Presenter: DEHMER, Marius (Goethe-Universität Frankfurt(UFfm-IAP))

Session Classification: Poster Session

Contribution ID: **17** Type: **Poster**

Oxygen Abundance in the Early Universe: A Storage Ring Experiment to Verify the Underlying Atomic Data

Thursday, January 22, 2026 7:10 PM (20 minutes)

The energy-resolved merged beams recombination rate coefficient α(E) for dielectronic recombination (DR) of O2+ has been measured on an absolute scale in the energy range from 0 to 45 eV. The experimental data comprises all ΔN=0 DR series associated with 2s ⟶ 2p core excitations and the lowest ΔN=1 DR series limits associated with 2p ⟶ 3s and 2p ⟶ 3d core excitations. In addition, we have performed corresponding quantum theoretical calculations using a freely available atomic code. From the combined experimental and theoretical data, we have derived a temperature-dependent plasma recombination rate coefficient α(T) for dielectronic recombination. In comparison to previously published theoretical data, we find excellent agreement for the temperature range, where O2+ is abundant in high-temperature plasmas dominated by collisional ionization. However, in the temperature range where O2+ exits in photoionized plasmas, our DR rate coefficient is a factor of two larger than the previously published ones. This should be relevant, e.g., for an accurate determination of the recently discovered surprisingly large oxygen abundances in early galaxies.

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Session Classification: Poster Session

Contribution ID: **19** Type: **Invited Talk**

Ionoacoustic Dose-Monitor for Laser Accelerated Ion-Bunches

Friday, January 23, 2026 11:30 AM (20 minutes)

State-of-the-art laser-driven plasma accelerators are entering the Hz repetition-rate regime, delivering ion beams with cut-off energies of multiple tens of MeV. For many applications, this creates an urgent need for a precise online dose monitor that can cope with the challenges of these sources and is capable of reconstructing the full dynamic range of the exponential dose distribution.
Ionoacoustic measurements provide a promising route to such a device. By detecting and reconstructing the acoustic wave emitted from the energy density deposited by the ions, the spatial dose distribution can be recovered for sub-nanosecond ion bunches. However, conventional ionoacoustic detection relies on the presence of a pronounced dose gradient, which limits its applicability to broad energy distributions.
To overcome this limitation, we introduce specially designed modulator foils into the ionoacoustic detector to artificially shape the dose deposition region. This forms the basis of the TIMBRE detector (Tracing Ionoacoustic Modulations of Broad Energy Distributions). Depending on the modulator material choice, the resulting acoustic wave is compressed in dynamic range and emitted at a characteristic resonance frequency, which strongly increases the signal-to-noise ratio. Consequently, single-shot measurements can recover the full energy density distribution, typically spanning more than four orders of magnitude in dose.
Here, we present experimental results from recent ATLAS and PHELIX campaigns benchmarked against simulation work, providing promising insights into the device performance. We demonstrate a robust, high-repetition-rate online readout, even under harsh electromagnetic pulse (EMP) conditions. This represents an important step toward meeting the diagnostic demands of next-generation laser-driven accelerators for future applications.

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Session Classification: Session 4

Contribution ID: **20** Type: **Poster**

Ionoacoustic Monitoring of Ion Bunches: Recent Developments and Applications

Thursday, January 22, 2026 7:10 PM (20 minutes)

The energy deposition of ions in water generates pressure waves, known as ionoacoustic signals. Ionoacoustic detection offers EMP-resilient diagnostics for (ultra-) short ion bunches over a broad dynamic range, enabling single-shot measurements of beam energy, dose, size, and position. We present recent developments of the I-BEAT detector as an online acoustic monitor for charged-particle beams and detector variants tailored to distinct measurement goals.
The I-BEAT 3D enables three-dimensional reconstruction of bunch position, size, and energy deposition in water. A solid-state variant of I-BEAT 3D enhances acoustic coupling and sensitivity, extending applicability to smaller signals and lower doses while maintaining spatial resolution. To measure broadband, quasi-exponential spectra from laser-accelerated ion beams, TIMBRE introduces specially designed modulator foils that shape the dose-deposition region, compress the dynamic range at the transducer, and imprint a characteristic resonance frequency, thereby improving the signal-to-noise ratio and enabling single-shot recovery of the spatial dose distribution. Ionoacoustic measurements, combined with interferometry, were performed in water near 4 ℃ with heavy-ion beams at SIS-18, revealing distinct axial versus lateral components of the acoustic signal consistent with a directional, non-thermal momentum-transfer contribution to wave generation. These advances support ionoacoustics as a versatile route to online three-dimensional characterisation and towards absolute single-shot dosimetry for conventional and laser-driven sources.

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Session Classification: Poster Session

Contribution ID: **21** Type: **Invited Talk**

Dielectronic Recombination - Assisted Laser Spectroscopy (DRALS): A New Tool to Investigate the Hyperfine Structure in Highly Charged Ions

Friday, January 23, 2026 2:40 PM (20 minutes)

We report on the first laser excitation of the ground-state hyperfine transition in lithium-like 208-Bi80+. The experiment was performed at the ESR, in May 2025. Detection of the transition was enabled through a new measurement scheme that combines laser excitation with dielectronic recombination (DR). In this approach, the electron cooler is set to a voltage that leads to the DR process predominantly from the upper hyperfine state. Resonant laser driving of the transition to the upper state thus leads to an enhancement of the DR recombination rate detected with particle detectors behind the electron cooler.
This technique has been successfully demonstrated for the first time using the radioactive isotope 208Bi in the lithium-like charge state, a species that is inherently difficult to produce, decelerate, and store at the required energies in the ESR. These results establish the feasibility of the method and pave the way for precision measurements during the next beam time, which has already been approved by the GPAC (Proposal G-24-00290). This research was funded by BMFTR, Contract numbers 05P24RD5, 05P21RGFA1 and 5P24RG2.

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Session Classification: Session 5

Contribution ID: **22** Type: **Poster**

Characterization of the FISIC Platform for Future Ion-Ion Collision Studies at CRYRING@ESR

Thursday, January 22, 2026 7:10 PM (20 minutes)

Study of electronic processes (ionization, excita-tion and capture) in ion-ion collisions is experimentally very challenging. So far, such collisions have been performed mainly in the low-energy regime (typically at center-of-mass energies ⊠ a few 100 keV) where the charge transfer is by far the dominant process. Specific experimental conditions are required to perform absolute cross section measurements such as crossed beam arrangements, ultra-high vacuum conditions, and ion beams of very good optical quality that must be able to be moved relative to each other to optimize their overlap.

Recently, a low-energy mobile platform capable of delivering keV/u ion beams, named FISIC, has been developed. As such ion beams constitute a rather dilute target (10^5 –10^6 particles.cm^{-3}), the use of an ion storage ring for an effective density increase offers most favorable conditions for ion-ion collision experiments. With the CRYRING@ESR facility at GSI/FAIR (Germany), we expect up to 10^7 ions stored at few MeV/u. Therefore, connecting the FISIC platform to CRYRING will enable collisions to be carried out between slow ion beams (a few keV/u) and fast ion beams (1-10 MeV/u) with high atomic numbers (from argon to uranium ions). This makes it possible to study the intermediate velocity regime, which is hitherto unexplored in atomic physics and where the cross-sections of elemantary electronic processes are unknown.

The FISIC platform consists of an electron cyclotron ion source and its beam line. As control of the charge state is mandatory when systematic measurements for different number of electrons are being considered, an omega-shaped system is installed prior to the collision chamber. Its role is to clean up unwanted charge states produced in the beam line by collisions with the residual gas. Just after this device, electrostatic deflectors enable the beam to be moved precisely into the collision chamber. Numerous ion beams (O^{q+}, Ne^{q+} and Ar^{q+}) have been produced and characterized in terms of currents, shapes and emittances.

In addition, the proportion of ions in metastable states that reach the collision zone is investigated. These data are of prime importance as the probability of a given electronic process in ion-ion colli-sions can be strongly affected if ions are initially in an excited electronic configuration. To determine the metastable states fraction produced in the source plasma, a x-ray detector having a good efficiency (> 0.2) for recording photons with energies ranging from 200 eV to a few keV was installed in the collision chamber located around 6 m from the ion source. There, the incident metastable ion (e.g. 1s2s O^{6+} with a lifetime of 900 µs) can excite directly via a M1 transition. Measurements have been carried out for O^{6+} and Ne^{8+} ions with differ-ent ion source parameters and will be presented at the conference.

This work is supported by the ANR (ANR-13-IS04-0007) and DFG (242466942) agencies.

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Session Classification: Poster Session

Contribution ID: **23** Type: **Poster**

Precision X-Ray Spectroscopy Using Metallic Magnetic Calorimeters

Thursday, January 22, 2026 7:10 PM (20 minutes)

In recent years, Metallic Magnetic Calorimeters (MMC) have emerged as excellent single photon detectors, exhibiting a broad spectral acceptance, ranging from a few to hundreds of keV, combined with a high energy resolution of $E/\Delta E(FWHM) \approx 6000$ [J. Geist. PhD thesis, 2020]. In combination with their fast rise time, they represent a superb tool for fundamental research in atomic physics.
Utilising these detectors, the Kα transitions in helium-like uranium were measured in a high precision X-ray spectroscopy experiment. The experiment was performed at the CRYRING@ESR to test bound state QED calculations in the strong field regime. For the first time, all four single-photon transitions forming the Kα peaks were identified and their energies determined in a heavy helium-like system [Ph. Pfäfflein *et al* 2022 Phys. Scr. **97** 114005]. The findings are in good agreement with theory. However, in order to distinguish between different theoretical approaches, it is imperative to achieve a higher accuracy in the measurement of the transition energies in helium-like uranium, which can be gained via enhanced statistics. To this end, a rerun experiment was performed in the summer months of 2025. The improvements made to the measurement process and preliminary results are presented.

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Session Classification: Poster Session

Contribution ID: **24** Type: **Invited Talk**

Laser Interaction with Near-Critical Density Structured Targets

Friday, January 23, 2026 11:50 AM (20 minutes)

Efficient DLA electron and proton acceleration from near-critical density is studied experimentally and in 3D PIC simulations. The 3D PIC simulations have shown that a smoothed density increase is favourable for DLA and leads to a higher effective temperature of accelerated electrons than in the case of a constant density plasma slab

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Session Classification: Session 4

Contribution ID: **25** Type: **Poster**

Setup and Characterization of a Plasma Window for Heavy Particle Beam Transmission to High Pressurized Target Areas

Thursday, January 22, 2026 6:00 PM (20 minutes)

As the upgrades of accelerator facilities are pushing the frontiers of high-intensity and high-energy particle beams, there is a demand for reliable beam extraction techniques into high-pressurized target areas with little impact on the beam properties. A promising technique that allows the extraction of such ion beams is the plasma window [1]. It is based on a cascaded arc discharge that enables active control of the pressure gradient depending on the selected working gas, flow rate and arc current.

At the Plasma Physics Group of Goethe University Frankfurt, a prototype of such a plasma window has been developed. As part of its characterization, it has been successfully used to demonstrate the transmission of heavy ion beams while simultaneously maintaining the pressure gradient well over 10h in a single run.

This contribution gives an insight into the plasma physical properties as well as the operating parameters of the developed plasma window and highlights its impact on the properties of the transmitted ion beam.

[1] Hershcovitch, A., J. Appl. Phys., AIP Publishing, 1995, 78, 5283

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Presenter: MICHEL, Andre (Goethe-Universität Frankfurt (IAP))

Session Classification: Poster Session

Contribution ID: **26** Type: **Invited Talk**

HED@FAIR Status Report

Thursday, January 22, 2026 3:20 PM (20 minutes)

The High Energy Density Science at FAIR (HED@FAIR) collaboration is continuing to prepare for the experimental program of First Science ++ in the APPA cave. Experiments at the existing GSI facilities play a vital role in preparing the experiments and in the commissioning and testing of experimental equipment. In my presentation I will give an overview of the recent experimental activities and outline the next steps in the preparation of the FAIR experiments.

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Session Classification: Session 1

Contribution ID: **27** Type: **Invited Talk**

Swift Heavy Ion Irradiation of Nanomaterials

Friday, January 23, 2026 10:10 AM (20 minutes)

Understanding how nanomaterials respond to radiation is essential for their reliable use in high-dose environments. At the nanoscale, size effects play a critical role, fundamentally altering energy dissipation mechanisms and influencing both intrinsic material properties and device performance. To deepen our understanding of ion–matter interactions in confined geometries, systematic studies are indispensable.
In this presentation, we will give an overview of our current activities on the study of swift heavy ion irradiation effects on nanowires. We have synthesized Bi nanowires with diameters ranging from 20 nm to 200 nm by electrodeposition into ion track-etched polymer templates. These wires were exposed to swift heavy ions (1–2 GeV) at the GSI UNILAC linear accelerator, with fluences from 5e10 to 1e12 ions/cm2 to study size-dependent structural changes under ion irradiation. Bismuth is particularly well-suited for such studies due to its long characteristic electronic length scales, such as the Fermi wavelength and electron mean free path, which make size effects prominent even at relatively large dimensions. Furthermore, its semi-metallic nature, low electrical conductivity, and low melting point contribute to formation of ion tracks of significant size. SEM and TEM analyses reveal distinct, diameter-dependent morphological changes, including crater formation, empty cavities, and perforations. Atomistic simulations using a thermal spike model support our experimental results.

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Presenter: SCHUBERT, Ina (GSI Helmholtzzentrum für Schwerionenforschung GmbH(GSI))

Session Classification: Session 3

Contribution ID: **28** Type: **Invited Talk**

ESR Machine Performance during Beam Time 2025

Thursday, January 22, 2026 4:40 PM (20 minutes)

During the user run 2025 essentially all operation modes of the ESR were used and highlights will be presented: electron cooling, stochastic cooling, stacking, internal experiments and extracted beam experiments with beam delivery to CryRing and HITRAP. The new LSA control system is consolidated in the sense that it offers practically all operation modes covered by the decommissioned legacy system, and in addition offers with its large flexibility many options to improve and optimize ESR operation in future machine development periods. During 2025 several machine studies were executed making use of the improved features of the control system and results will be presented. The main goal is to improve the understanding of the machine optics, which will allow a more efficient setup and operation of the ESR for the users in the coming years. The presentation will conclude with an outlook to the 2026 user beamtime.

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Presenter: LORENTZ, Bernd Alfred (GSI Helmholtzzentrum für Schwerionenforschung GmbH(GSI))

Session Classification: Session 2

Contribution ID: **29** Type: **Invited Talk**

Charged Particle Microscopy at GSI

Friday, January 23, 2026 12:10 PM (20 minutes)

Magnetic lens-based charged particle microscopy is a unique and powerful diagnostics technique capable of resolving ultra-fast processes on the ns-scale in dense matter with unprecedented micrometer spatial resolution. Recently, the PRIOR-II proton microscope facility has been designed, constructed and commissioned at the GSI Helmholtz Centre for Heavy Ion Research, pushing the technical boundaries of charged particle microscopy with normal conducting magnets to the limits. It is specifically designed for imaging ultra-fast processes in dense matter with up to 4.5 GeV protons from the SIS-18 synchrotron, its primary use case is the diagnostics of ultra-fast shock-wave experiments for HED fundamental physics applications or materials science.

PRIOR-II has the unique capability of imaging using heavier ions (tested with up to 975MeV/u 12C6+ and up to 1.5GeV/u 14N7+) which led to improvements of the underlying scattering theory used for radiographic density reconstruction. Furthermore, experiments can benefit from heavy ions due to an increased areal density contrast compared to proton imaging.

The PRIOR-II facility is currently undergoing a transition to enable HE driven HED physics and material science experiments on shock compressed matter at extreme densities above 100 GPa and to serve as a new user facility to the HED community. With the certification of key components completed, efforts are focusing on developing HE-driven planar shockwave generators to enable the first set of experiments in early 2027. These experiments will study shock compaction as an approach to large-scale,
high-pressure material synthesis, as well as planetary defense applications. The facility is also suited for characterizing new functional materials for use as first contact barriers in magnetic confinement fusion reactors, as well as for EOS measurements of inhomogeneous and porous matter under extreme conditions.

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Session Classification: Session 4

Contribution ID: **30** Type: **Invited Talk**

Status of the HITRAP Decelerator

Thursday, January 22, 2026 5:20 PM (20 minutes)

The HITRAP (Highly charged Ion TRAP) facility located at the GSI Helmholtzzentrum für Schwerionenforschung in Darmstadt provides the unique ability to decelerate heavy, accelerator-produced highly charged ions (HCI) down to 6 keV/nucleon and cool to eV equivalent temperature. A two-stage decelerator consisting of an interdigital H-type decelerator as well as a radio frequency quadrupole reduce the energy per nucleon from 4 MeV to 6 keV. After deceleration, the HCI are captured inside a Penning-Malmberg trap for sympathetic cooling using electrons.

We present the status of HITRAP. Results of the commissioning beamtime with $^{107}Ag^{45+}$ in 2025 are presented and difficulties are discussed. Lastly, the logistics of the recent experiment beamtime are discussed, during which HITRAP served an experiment with $^{197}Au^{79+}$ ions at 6 keV/nucleon.

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Session Classification: Session 2

Contribution ID: **31** Type: **Poster**

The ARTEMIS Experiment: G-Factor Measurement Through Precision Spectroscopy of Heavy Highly Charged Ions

Thursday, January 22, 2026 7:10 PM (20 minutes)

The ARTEMIS experiment at the HITRAP facility situated at GSI, Darmstadt, focuses on precision measurements of electron magnetic moments in highly charged ions as a benchmark QED test in extreme fields. The experiment utilises a homogeneous magnetic field of 7 T with a harmonic electrostatic field which enables ion densities of up to 10e6 cm−3 to be stored for several days. The trap is equipped for the in-situ production of ions thus acting as a mini-EBIT. Ions are currently produced within the cryogenic Penning trap [1] and are stored, prepared and cooled using electronic, non-destructive techniques [2].

The experimental setup is connected to the low energy HITRAP beamline [3], thereby facilitating online/offline beam delivery, dynamic capture and injection into the trap. Upgrades are ongoing to perform g-factor measurements on hydrogen-like heavy species such as bismuth Bi82+ and other lighter species such as sulfur S11+. Laser-microwave double-resonance spectroscopy enables microwave probing of the Larmor frequency through laser spectroscopy of fine/hyperfine structure of the ions. The induced Zeeman transition is determined through a difference in intensity of the fluorescence produced in a closed optical cycle. We present a general overview along with the current status of the experiment.

References:
[1] Kanika et al., J. Phys. B 56, 175001 (2023)
[2] Ebrahimi et al., Phys. Rev. A 98, 023423 (2018)
[3] Klimes et al., Rev. Sci. Instrum. 94, 113202 (2023)

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Session Classification: Poster Session

Contribution ID: **32** Type: **Poster**

A Novel Compton Telescope for Polarimetry in the MeV Range

Thursday, January 22, 2026 7:10 PM (20 minutes)

For photon energies from several tens of keV up to a few MeV, Compton polarimetry is an indispensable tool to gain insight into subtle details of fundamental radiative processes in atomic physics. Within the SPARC collaboration [1] several segmented semiconductor detectors have been developed that are well suited for application as efficient Compton polarimeters. For photon emission processes in the hard x-ray regime these kind of detectors enable revealing photon polarization effects in great detail [2]. In our presentation, a novel Compton telescope detector that will enable us to extend to photon energies up to the MeV range will be presented. In particular, we will discuss new experimental possibilities in the higher energy range.

[1] Th. Stöhlker et al. Nucl. Instrum. Methods Phys. Res. B 365 (2015) 680.
[2] K.H. Blumenhagen et al. New J. Phys. 18 (2016) 119601.

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Session Classification: Poster Session

Contribution ID: **33** Type: **Poster**

Testing Strong-Field QED to Second-Order in the Highly Correlated Atomic System Berylliumlike Pb78+ by Electron-Ion Collision Spectroscopy

Thursday, January 22, 2026 7:10 PM (20 minutes)

S. Schippers, C. Brandau, S. Fuchs, M. Lestinsky, S.-X. Wang, C. Y. Zhang, N. R. Badnell, A. Borovik Jr., M. Fogle, V. Hannen, Z. Harman, P.-M. Hillenbrand, E. B. Menz, Y. Zhang, Z. Andelkovic, F. Herfurth, R. Heß, A. Kalinin, C. Kozhuharov, C. Krantz, S. Litvinov, B. Lorentz, U. Spillmann, M. Steck, G. Vorobyev, D. Banas, S. Fritzsche, E. Lindroth, X. Ma, A. Müller, R. Schuch, A. Surzhykov, M. Trassinelli, K. Ueberholz, C. Weinheimer, Th. Stöhlker

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Presenter: SCHIPPERS, Stefan (JLU Giessen)

Session Classification: Poster Session

Contribution ID: **34** Type: **Invited Talk**

Current Status and Future Prospects of VUV-EUV VLS-Grating Photon Spectrometer at CRYRing

Friday, January 23, 2026 3:40 PM (20 minutes)

The vacuum-ultraviolet to extreme-ultraviolet (VUV–EUV) variable-line-spacing (VLS) grating spectrometer being installed at the gas-jet target of CRYRING is a new set-up for photon spectroscopy of ion-atom collisions. The setup enables detection of fluorescence (roughly 4–40 eV) from collision induced excitation, charge exchange, and multiple ionization of atoms and molecules by highly charged ions. Therefore, it provides state and charge resolved access to electron correlation effects in the target and projectile subsystems. The talk will first summarize the present status of the spectrometer, includ-ing lessons learnt from last beam time as well as new updates and and challenges to install it with new CARME interaction chamber. Finally, I shall discuss the prospects, such as coincidence measurements be-tween charged projectile ions and target photons, operation at other ring locations (e.g. the electron tar-get and laser ion nteraction setups), and the broader scientific opportunities this unique spectrometer opens for precision studies of electron correlation, relativistic, and QED effects in highly charged ions at FAIR.

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Presenter: TYAGI, Rohit (Universität Kassel(UNI-Kassel))

Session Classification: Session 5

Contribution ID: **35** Type: **Invited Talk**

Towards Frequency Metrology and a Quantum Logic Clock for Highly Charged Heavy Ions

Thursday, January 22, 2026 5:40 PM (20 minutes)

The accuracy of optical clocks is unprecedented and the study of highly charged heavy ions in these instruments promises an exceptional robustness against external perturbations in combination with an exceptional sensitivity to fundamental, nuclear, and beyond-Standard-Model physics. To pursue this goal, we are setting up a unique spectroscopy platform at the HITRAP ion trapping facility and as part of the APPA research pillar of FAIR. In this talk, I will outline the underlying scientific motivation, the measurement principle based on full quantum control of single ions, and our R&D activities which involve essential metrological infrastructure that still has to be established.

Author: MICKE, Peter (Helmholtz Institute Jena & GSI Helmholtz Center for Heavy Ion Research)

Presenter: MICKE, Peter (Helmholtz Institute Jena & GSI Helmholtz Center for Heavy Ion Research)

Session Classification: Session 2

Contribution ID: **36** Type: **Invited Talk**

ErUM: Exploration of the Universe and Matter

Thursday, January 22, 2026 2:30 PM (30 minutes)

This talk will give an overview on the federal ministry of research, technology and space and the project management agency PT.DESY. The relevant strategies and priorities, especially the funding framework ErUM and the high-tech agenda, and the current activities in the ErUM field "Particles" will be presented.

Author: KELLER, Denise (PT-DESY)

Presenter: KELLER, Denise (PT-DESY)

Session Classification: Session 1

Contribution ID: **37** Type: **Poster**

ESR: The Heavy Ion Storage Ring Facility

Thursday, January 22, 2026 7:10 PM (20 minutes)

Author: GUMBERIDZE, Alexandre (GSI Helmholtzzentrum für Schwerionenforschung GmbH(GSI))

Presenter: GUMBERIDZE, Alexandre (GSI Helmholtzzentrum für Schwerionenforschung GmbH(GSI))

Session Classification: Poster Session

Contribution ID: **38** Type: **Poster**

Experiments at the CRYRING@ESR Low-Energy Heavy-Ion Storage Ring

Thursday, January 22, 2026 7:10 PM (20 minutes)

As a first completed facility of the FAIR project, the heavy ion storage ring CRYRING@ESR is in operation since 2020 and is serving as experiment platform for the SPARC collaboration. The ring is optimized for low-energy storage and beam cooling, and with access to all ion species available from the GSI accelerator chain or from a local RFQ injector. This offers a unique access to study the dynamics of slow collisions and for precision spectroscopy in highly charged ions. To realize these experiments, CRYRING@ESR has four straight sections where experimental setups can be installed: for merged-beams electron-ion collisions spectroscopy at the electron cooler, in a collinear laser spectroscopy setup, in a 'free'experimental section for various setups provided from the collaboration, and an extracted beam for single pass experiments, such as surface modifications. Thus, in the recent years, researchers from atomic physics, nuclear reactions and materials science have been able to commence their experiment program. While the data analysis from these first experiments is largely still ongoing, we are finding that the very high expectations on achievable resolution have been fulfilled.
With this poster, we will be giving an overview of the CRYRING@ESR facility, discuss our presently available experimental installations, their performance, and the boundary conditions for beam operation. We present selected results from first experiments, preview our program for the next few years, and invite for a discussion of novel ideas.

Author: LESTINSKY, Michael (GSI Helmholtzzentrum für Schwerionenforschung GmbH(GSI))

Presenter: LESTINSKY, Michael (GSI Helmholtzzentrum für Schwerionenforschung GmbH(GSI))

Session Classification: Poster Session

Contribution ID: **39** Type: **Invited Talk**

Status and Future of GSI/FAIR

Thursday, January 22, 2026 2:00 PM (30 minutes)

Presenter: LEHMANN, Inti (FAIR/GSI)

Session Classification: Session 1

Contribution ID: **40** Type: **Invited Talk**

News from SPARC

Thursday, January 22, 2026 3:00 PM (20 minutes)

In my presentation, I report on the current status of SPARC, the Stored Particles Atomic physics Research Collaboration. First, I will give a brief overview of the FAIR facilities currently and in near future used in the SPARC experiments. Then, I will present some examples of scientific results from recent measurement campaigns at CRYRING, ESR, and HITRAP. I will also provide a brief outlook on some instrumental developments and upcoming measurement campaigns.

Presenter: SCHUCH, Reinhold (Stockholm university)

Session Classification: Session 1

Contribution ID: **41** Type: **not specified**

News from Materials Science

Thursday, January 22, 2026 3:40 PM (20 minutes)

Presenter: TOIMIL MOLARES, Maria Eugenia (GSI Helmholtzzentrum für Schwerionenforschung GmbH(GSI))

Session Classification: Session 1

Contribution ID: **42** Type: **Invited Talk**

In-Situ experiments on 2D-Materials

Friday, January 23, 2026 9:30 AM (20 minutes)

Presenter: BREUER, Lars (Universität Duisburg-Esseb)

Session Classification: Session 3

Contribution ID: **43** Type: **not specified**

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Friday, January 23, 2026 12:30 PM (20 minutes)

Presenter: MARTYNENKO, Artem (GSI Helmholtzzentrum für Schwerionenforschung GmbH)

Session Classification: Session 4

Contribution ID: **44** Type: **Invited Talk**

FSP APPA Business

Friday, January 23, 2026 4:00 PM (30 minutes)

Presenter: SCHIPPERS, Stefan (JLU Giessen)

Session Classification: Session 5