Working Group on Accelerator Physics
Arbeitskreis Beschleunigerphysik (AKBP)

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Overview of Invited Talks and Sessions

(Lecture hall SCH/A117; Poster P4)

Topical Talks

AKBP 1.1	Mon	9:30–10:00	SCH/A117	**Recent Developments at S-DALINAC** — •D. Schneider, M. Arnold, J. Birkhan, U. Bonnes, A. Brauch, L. B. Dingeldein, J. Enders, R. Grewe, K. Ide, L. Jürgensen, M. Meier, C. M. Nickel, N. Pietralla, V. Pruy, F. Schliessmann, T. Zimmermann
AKBP 1.2	Mon	10:00–10:30	SCH/A117	**Status of Source and Delivery of Spin-Polarized Electron Beams at ELSA** — •Michael Switka, Klaus Desch, Dennis Proft, Axel Spreitzer
AKBP 2.1	Mon	11:00–11:30	SCH/A117	**From ELBE to DALI - Superconducting Electron Accelerators in Dresden** — •Andreas Wagner, Ulf Lehnert, Andre Arnold, Manfred Helm, Sebastian Mährlein, Raffael Niemczyk, Rong Xiang
AKBP 5.1	Tue	9:30–10:00	SCH/A117	**Generation and Acceleration of In-Target Gold Fission Fragments using the ATLAS-3000 Laser System** — •Laura D. Geulig, Veronika Kratzer, Erin Grace Fitzpatrick, Maximilian J. Weiser, Jörg Schreiber, Peter G. Thirolf
AKBP 6.1	Tue	11:00–11:30	SCH/A117	**Efficient high energy and high-repetition-rate proton acceleration from cryogenic hydrogen foil targets** — •Stefan Assenbaum, Martin Rehwald, Paweł Ordyna, Joshua Schilz, Maximilian Müller, Thomas Streil, Julian Garreis, Thomas Kluge, Sebastian Göde, Maxence Gauthier, Christopher Schönwälder, Ulrich Schramm, Karl Zeil
AKBP 10.1	Wed	15:00–15:30	SCH/A117	**Multiscale longitudinal electron bunch characteristics of LWFA bunches determined by single-shot CTR spectroscopy** — •Alexander Debus, Maxwell LaBerge, Omid Zarini, Susanne Schöbel, Jessica Tiebel, Finn-Ole Carstens, Nico Wrobel, Richard Pausch, Klaus Steiniger, Yen-Yu Chang, Jurjen Couperus Cabadağ, Alexander Köhler, Thomas Kurz, Rafal Zgadzaj, Michael Downer, Michael Bussmann, Ulrich Schramm, Arie Irman
AKBP 12.1	Thu	9:30–10:00	SCH/A117	**Cutting-edge research and technology at KIT's advanced accelerator facilities** — •Erik Bründermann

Sessions

AKBP 1.1–1.3	Mon	9:30–10:45	SCH/A117	**Electron Accelerators and Sources I**
AKBP 2.1–2.5	Mon	11:00–12:30	SCH/A117	**Electron Accelerators and Sources II**
AKBP 3.1–3.6	Mon	15:00–16:30	SCH/A117	**Diagnostics**
AKBP 4.1–4.5	Mon	16:45–18:00	SCH/A117	**Beam Dynamics**
AKBP 5.1–5.4	Tue	9:30–10:45	SCH/A117	**Plasma Accelerators, Ions I**
AKBP 6.1–6.5	Tue	11:00–12:30	SCH/A117	**Plasma Accelerators, Ions II**

AKBP 7.1–7.6	Tue	14:00–15:30	SCH/A117	**Ion and Medical Accelerators**
AKBP 8.1–8.10	Wed	9:30–11:00	P4	**Poster AKBP**
AKBP 9.1–9.6	Wed	11:00–12:30	SCH/A117	**RF Cavities I**
AKBP 10.1–10.4	Wed	15:00–16:15	SCH/A117	**Plasma Accelerators, Diagnostics I**
AKBP 11.1–11.4	Wed	16:30–17:30	SCH/A117	**Plasma Accelerators, Diagnostics II**
AKBP 12.1–12.5	Thu	9:30–11:00	SCH/A117	**Novel Accelerators I**
AKBP 13.1–13.4	Thu	11:30–12:30	SCH/A117	**Novel Accelerators II**
AKBP 14.1–14.3	Thu	15:00–15:45	SCH/A117	**RF Cavities II**
AKBP 15.1–15.3	Thu	16:00–17:30	SCH/A117	**AKBP Prize Talks**
AKBP 16	Thu	18:00–19:00	SCH/A117	**Members' Assembly**

Members' Assembly of the Working Group on Accelerator Physics

Thursday 18:00–19:00 SCH/A117

AKBP 1: Electron Accelerators and Sources I

Time: Monday 9:30–10:45 Location: SCH/A117

Topical Talk AKBP 1.1 Mon 9:30 SCH/A117

Recent Developments at S-DALINAC — •D. Schneider, M. Arnold, J. Birkhan, U. Bonnes, A. Brauch, L. B. Dingeldein, J. Enders, R. Grewe, K. Ide, L. Jürgensen, M. Meier, C. M. Nickel, N. Pietralla, V. Pruy, F. Schliessmann, and T. Zimmermann — Institut für Kernphysik, TU Darmstadt

The superconducting Darmstadt electron linear accelerator S-DALINAC is a thrice-recirculating accelerator [1] which can be operated as an energy recovery linac [2].

Two novel experimental set-ups are being implemented at the S-DALINAC: The study of electron-induced fission reactions of actinides and a demonstrator for Compton backscattering in ERL operation. We have further improved the overall beam quality and the diagnostic capabilities of the accelerator: A streak camera has been implemented for bunch length measurements. Monitoring the beam position with a system of high-speed cameras and a novel feedback-driven beam stabilization, the beam stability was increased significantly. A cavity for a double-chopper setup for the injector has been implemented. This contribution gives an overview on the activities at the S-DALINAC.

[1] N. Pietralla, Nucl. Phys. News, Vol. 28, No. 2, 4 (2018).
[2] F. Schliessmann et al., Nat. Phys. 19, 597-602 (2023).
[3] A. Brauch et al., Rev. Sci. Instrum. 96(11), 113303 (2025).
[4] D. Schneider et al., Nucl. Inst. Phys. A. 1077, 170540 (2025).

*Work supported by State of Hesse within GRK 2891 'Nuclear Photonics' (Project-ID 499256822).

Topical Talk AKBP 1.2 Mon 10:00 SCH/A117

Status of Source and Delivery of Spin-Polarized Electron Beams at ELSA — •Michael Switka, Klaus Desch, Dennis Proft, and Axel Spreitzer — University of Bonn, Physics Institute, Bonn, Germany

Operation of the 50 kV GaAs-based photoinjector source for spin-polarized electrons at the electron stretcher accelerator (ELSA) has been re-established and its usage for regular machine operation is being prepared. This includes the recommissioning of a Compton backscattering polarimeter located in the 3.2 GeV fast ramping storage ring to monitor the effects depolarizing resonances and their countermeasures during the energy increase. An overview of the latest achievements and upcoming improvements is presented.

AKBP 1.3 Mon 10:30 SCH/A117

Simultaneous Beam Extraction at ELSA — •Max Ammann, Klaus Desch, Dennis Proft, Michael Switka, and Leonardo Thome — Physikalisches Institut der Universität Bonn

At the electron accelerator facility ELSA, electrons with energies up to 3.2 GeV are extracted to multiple experimental stations at two distinct beamlines via slow resonant extraction, serving hadron-physics experiments, detector tests, and medical research. In the past, only one beamline could be served at a time. A new machine-operation mode has been developed that enables extraction to one of the hadron-physics experiments and, simultaneously, to the detector test beamline, where typically lower electron rates are required. This allows more efficient use of the available beam time. The properties and underlying beam dynamics of this machine mode are presented, along with sophisticated methods for rate control at the second beamline.

AKBP 2: Electron Accelerators and Sources II

Time: Monday 11:00–12:30 Location: SCH/A117

Topical Talk AKBP 2.1 Mon 11:00 SCH/A117

From ELBE to DALI - Superconducting Electron Accelerators in Dresden — •Andreas Wagner[1,2], Ulf Lehnert[1], Andre Arnold[1], Manfred Helm[3,4], Sebastian Mährlein[1,4], Raffael Niemczyk[1], and Rong Xiang[1] — [1]Institute of Radiation Physics, Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany — [2]Institute of Radiation Physics — [3]Institute of Ion Beam Physics and Materials Research, Helmholtz-Zentrum D — [4]Dresden University of Technology, Dresden, Germany

The Helmholtz-Zentrum Dresden-Rossendorf successfully operates the superconducting ELBE (Electron LINAC with High Brilliance and Low Emittance) accelerator to produce a variety of secondary photon and particle beams. ELBE serves an international user community involved in fundamental studies in nuclear physics, radiation biology, solid-state physics, chemistry, materials science, detector characterisation, positron interactions with matter, and materials control using high-field THz radiation. Based on the experience of the existing user facility and after more than 20 years of operations, the DALI (Dresden Advanced Light Infrastructure) concept for a successor facility with an enhanced frequency range for high-field THz radiation ranging from 0.1 to 30 THz, a high intensity positron source, and ultra-fast electron diffraction has been developed. In 2025, DALI was promoted to the national shortlist of research infrastructures. This contribution will cover the scientific motivations, the implementation of the machine, and the proposed auxiliary instruments and end stations.

AKBP 2.2 Mon 11:30 SCH/A117

CW e- beam from SRF gun for multifunctional accelerator facility ELBE — •Rong Xiang, André Arnold, Andreas wagner, Stefan Gatzmaga, Petr Murcek, Raffael Niemczyk, Anton Ryzhov, Jochen Teichert, and Gowrishankar Hallilingaiah — Helmholtz-Zentrum Dresden-Rossendorf (HZDR), Dresden, Germany

The ELBE center for high-power radiation sources is a compact, accelerator-based facility that provides a wide range of radiation types to its users, including gamma rays, IR- Free-Electron Lasers (FELs), THz radiation, positrons and electron beams, for various applications in materials science, medicine, and nuclear physics.

The development of new continuous-wave (CW) electron source with high bunch charges represents a significant advancement in enhancing the overall performance of ELBE. By combining the well-established radio-frequency (RF) with superconducting (SC) technology, it is able to realize CW operation at high gradient. The robust semiconductor photocathode Cs2Te shows a stably high quantum efficiency (QE) during the gun operation.

SRF Gun II has been routinely operated since 2018 for THz user experiments, delivering high bunch charges (200 pC at 100 kHz) with excellent stability and reliablity. In 2024, SRF Gun II achieved a record current of 0.6 mA in CW mode and drove the IR-FEL for a highly sensitive s-SNOM experiment. Recently the first ultrafast electron diffraction (UED) patterns of MoO3 sampple were obtained, demonstrating its outstanding stability and high beam quality.

AKBP 2.3 Mon 11:45 SCH/A117

Status and Perspectives of the Photo-CATCH Photocathode Test Stand* — •Maximilian Herbert, Joachim Enders, Markus Engart, Robin Petry, and Vincent Wende — Institut für Kernphysik, Technische Universität Darmstadt, Darmstadt, Germany

TU Darmstadt's test stand for Photo-Cathode Activation, Testing and Cleaning using atomic-Hydrogen Photo-CATCH faciliates dedicated research on GaAs photocathodes for electron-beam production at accelerators. Recent results include successful tests of automatized activation [1] and improved photocathode lifetime using an enhanced Cs-O-Li surface layer [2,3]. This contribution will present the current status of Photo-CATCH and work planned in the near future.

[1] M. Herbert et al., PoS(PSTP2022), Vol. 433, p. 003 (2023).
[2] N. Kurichiyanil et al., J. Instrum. 14 (8), P08025 (2019).
[3] M. Herbert et al., Phys. Rev. Accel. Beams 28, 013401 (2025).

*Work supported by DFG (Project-ID 264883531 - GRK 2128 “AccelencE”, and Project-ID 499256822 - GRK 2891 “Nuclear Photonics”)

AKBP 2.4 Mon 12:00 SCH/A117

Status of the Hybrid Electron Gun Development at ELSA — •Samuel Kronenberg, Klaus Desch, Ben Simon Gatzsche, Philipp Hänisch, Dennis Proft, Yannick Schober, and Michael

Switka — Physikalisches Institut, Universität Bonn

A redesign of the injector beamline for the S-band linac at ELSA is underway, including the replacement of the existing electron gun by a hybrid gun that combines thermionic emission and thermally assisted photoemission in a single setup. The goal is to offer a new single-bunch injection mode alongside the long pulse mode already provided by the current gun. Measurements have been conducted to verify this emission technique using caesium dispenser cathodes. The development of a dedicated test stand is currently being carried out to facilitate more detailed studies and serve as a prototype for the future injector section. Recent research has concentrated on the lattice and magnet design, as well as on evaluating suitable beam-diagnostic instrumentation.

AKBP 2.5 Mon 12:15 SCH/A117

First demonstration of MeV electron diffraction with the ELBE SRF Gun: towards an MeV-UED instrument — •Louis Stein[1,2], André Arnold[1], Michael Klopf[1], Raffael Niemczyk[1], Anton Ryzhov[1], Jochen Teichert[1], Ece Uykur[1], Andreas Wagner[1], Stephan Winnerl[1], Rong Xiang[1], and Sebastian Maehrlein[1,2] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Dresden — [2]TU Dresden

Ultrafast electron diffraction (UED) is a unique technique for measuring structural and electronic dynamics with sub-picosecond time resolution in a pump-probe arrangement. In most state-of-the-art UED setups, beams with keV electron energy are utilized. The project presented here aims to step up to MeV electron beams with the help of a superconducting radio frequency photo electron injector (SRF gun). The most promising argument for MeV-UED is its ability to access higher-order diffraction, which provides high sensitivity to small atomic displacements. Using the current HZDR ELBE SRF electron gun in continuous wave (CW) operation with megahertz repetition rates, a first demonstration of an MeV electron diffraction is presented. This presentation will summarize the SRF gun parameters and shows the current status of the electron diffraction setup at the ELBE SRF Gun. In future, the combination of MeV-UED with high-intensity tunable THz pump beams will open up exciting new possibilities for time-resolved studies of types of light-driven ultrafast structural dynamics in quantum matter, correlated systems, and other types of complex matter.

AKBP 3: Diagnostics

Time: Monday 15:00–16:30 Location: SCH/A117

AKBP 3.1 Mon 15:00 SCH/A117

Broadband Cavity BPM Design for MESA — •Robin Wolf — Institut für Kernphysik, Mainz, Germany

The MESA accelerator's Energy Recovery Linac (ERL) mode requires a fast and sensitive beam position monitor (BPM) capable of distinguishing between accelerated and decelerated electron bunches in diagnostic pulse mode. This talk will present the design of the proposed cavity BPM for the MESA requirements.

The proposed design is an adaptation of the SACLA BPM, optimised for operation at 2.6GHz (the 2nd harmonic of MESA's 1.3GHz RF frequency) for increased sensitivity and smaller physical size. The tailored cavity design integrates a monopole-mode cavity (for phase and intensity measurements) with an dipole-mode cavity (for position measurements). Key enhancements include the splitting of the X and Y planes with implementation of mode separators, which maximises orthogonal plane decoupling. Furthermore, integrated waveguides are employed in the dipole-part to suppress the monopole-mode, while offering increased freedom in antenna coupling to the dipole field.

AKBP 3.2 Mon 15:15 SCH/A117

Compact Beam Position Monitor using a Segmented Toroidal Coil — •Lars Festring — RWTH Aachen University, Germany

A compact beam position monitor based on a segmented toroidal coil surrounding a charged particle beam has been investigated (F. Abusaif et al., Rev. Sci. Instrum. 1 March 2025; 96 (3): 033302, https://doi.org/10.1063/5.0240076).

It uses the induced voltages in the windings. We theoretically investigate the response of the coils to a bunched particle beam based on a lumped-element model and a Gaussian beam model. Then, we compare the model to measurements taken in the laboratory and the storage ring COSY. In addition, we devise a way to measure the covariance of the transversal beam profile and test it via a simulation. The resonant behavior in the coils' frequency response may be exploited to further increase the sensitivity of the device.

The resolution of the position measurement presently achieved is about $5\,\mu$m in a 1 s time interval for a beam current of 0.5 mA.

AKBP 3.3 Mon 15:30 SCH/A117

Design, installation and commissioning of an optical real-time diagnostic system for the BESSY II Injection LINAC — •Pauline Ahmels — Helmholtz-Zentrum Berlin, Hahn-Meitner-Platz 1, 14109 Berlin — Technische Universität Berlin, Straße des 17. Juni 135, 10623 Berlin

In order to improve the present LINAC injection line diagnostic system at BESSY II, a non-destructive source point imaging system is being developed.

Until now, these source point imaging have primarily relied on retractable fluorescence screens (FOMs),which are inherently destructive due to the direct imaging of the electron beam. This talk presents the conceptual design, including technical requirements, simulation results, mechanical integration and commissioning of an optical diagnostic instrument for real-time monitoring at the injection line.

The design aims to ensure beam quality during operation using synchrotron radiation emitted from the dipole magnet. The primary components of this beamline are a CCD camera and a lens system designed to operate under high vacuum conditions. To enable precise positioning, the optical system is equipped with a motorized linear feed through. A basic, fixed focal length setup is initially employed to experimentally validate the simulation results, using the same CCD camera as in the final beamline setup. This new setup must be adapted to the spatial constraints, make use of existing materials as much as possible, and be simple to construct and install.

AKBP 3.4 Mon 15:45 SCH/A117

Error investigations of longitudinal phase space measurements using tomography — •Marc P. Kerstan, Christopher J. Richard, and Namra Aftab — Deutsches Elektronen-Synchrotron DESY, Zeuthen, Germany

The Longitudinal Phase Space (LPS) characterization is important in beam dynamics, especially in Free-Electron Lasers (FELs), where the slice energy spread is a key parameter to evaluate lasing performance and brightness.

The Photo Injector Test facility at DESY in Zeuthen (PITZ) is a test stand to condition and characterize electron sources for EuXFEL and FLASH. Measurement of the LPS directly after the electron source at PITZ is not possible due to unavailability of a dedicated diagnostics setup. Alternatively, the LPS can be measured 2.33 m from the cathode using tomography with the booster cavity as a rotating element. The aim of this project is to better understand the measured reconstructed LPS by refining the simulation model to better represent the measurement process. The current model is simplified. It only consists of a drift space with the correct length and does not include a dispersive element or many of the systematic error sources, that contribute to the real measurement.

Presented here are the results of an updated beamline model including a dipole and transverse focusing elements. This improved model allows for studies of the systematic errors on the reconstructed LPS including noise cuts and measurement camera resolution.

AKBP 3.5 Mon 16:00 SCH/A117

Compton Polarimetry with a Timepix3 ASIC at ELSA — •Tobias Schiffer, Michael Switka, Dennis Proft, and Klaus Desch — Physikalisches Institut der Universität Bonn, Bonn, Germany

The Electron Stretcher Facility (ELSA) in Bonn can provide spin polarized electrons to its users. During acceleration depolarising resonances have to be crossed reducing the achievable degree of polarization.

For a non-destructive in situ measurement of the beam polarization in the storage ring a Compton polarimeter is available. It utilizes a high intensity cw-laser beam scattering off the electron beam. The back scattered photon profile is measured with a detector. Depending on the polarization of the laser and the electron beam a vertical shift of the intensity profile can be observed. This is currently measured with a in-house custom-built silicon strip sensor.

However, to improve the detector setup and to obtain 2D information, a detector using a pixelized readout chip (Timepix3) with a 500 μm thick silicon sensor is in development.

The current status of the detector and first results of the performance are presented.

AKBP 3.6 Mon 16:15 SCH/A117

Automated In-Situ Ion Beam Characterization During Ion Implantation — •Ali Kosari Mehr, René Heller, Oliver Steuer, and Slawomir Prucnal — Institute of Ion Beam Physics and Materials Research, Helmholtz-Zentrum Dresden-Rossendorf, Bautzner Landstr 400, 01328 Dresden, Germany

Ion implantation is a key technique for materials modification, especially in semiconductor processing. However, high-current industrial implanters often struggle to distinguish ion species and energies when projectiles have similar mass-to-charge ratios, such as Al and N*. Because industrial implantation relies on fast throughput and simple mass-analysis stages, ambiguous beam composition can compromise process reliability. This motivates the development of an automated in-situ diagnostic tool. A compact apparatus combining Rutherford backscattering spectrometry and ionoluminescence was therefore developed. It is inserted into the beam path for only a few seconds before implantation and comprises a beam-entry aperture, a dummy target of known composition, an RBS detector, and an ionoluminescence module with mirrors, optical fibres, and a miniature spectrometer. The dual-modality concept enables cross-checked identification of ion species, energies, and molecular fractions. For automated beam-quality decisions, a machine-learning evaluation scheme based on an artificial neural network was implemented and trained on simulated RBS spectra. The optimised model reliably distinguishes target ions under realistic noise and intensity fluctuations, enabling real-time ion beam characterisation.

AKBP 4: Beam Dynamics

Time: Monday 16:45–18:00 Location: SCH/A117

AKBP 4.1 Mon 16:45 SCH/A117

Improving Energy spread of MESA beam in ERL operation — Esraa Khidr and •Florian Hug — Johannes Gutenberg university Mainz

Precise control of longitudinal beam dynamics is crucial at the Mainz Energy-Recovering Superconducting Accelerator (MESA), particularly in support of the MAGIX experiment, which operates in ERL mode. Comprehensive simulations were conducted using the elegant tracking code; starting with 4 ps bunch length, the full acceleration and deceleration process in ERL was modeled by optimizing the RF phase and the accelerating gradient field in off-crest operation, resulting in the desired energy gain in each linac section. At low energies, improved energy spread is required with a short bunch length; therefore, the injection arc was optimized for a 2 ps bunch by adjusting the arc momentum compaction R56 and introducing an energy*position correlation (chirp) downstream of MAMBO. The resulting optimization provides enhanced bunch compression and reduces the longitudinal phase-space width, while preserving longitudinal emittance and thereby enhancing overall beam quality not only at the lowest but also at all energies.

AKBP 4.2 Mon 17:00 SCH/A117

Determining the influence of transversal beam excitation on beam size and dynamics at KARA — •Simon Braner[1], Marvin-Dennis Noll[1], Johannes Steinmann[1], Erhard Huttel[1], Anke-Susanne Müller[1], Erik Bründermann[1], and Michele Caselle[2] — [1]IBPT, KIT, Karlsruhe — [2]IPE, KIT, Karlsruhe

Significant beam dynamics parameters, such as energy spread or transversal beam size, can be calculated from the transversal bunch profile. At the Karlsruhe Research Accelerator (KARA), located at the Karlsruhe Institute of Technology (KIT), the beam size in the storage ring is being investigated using the KArlsruhe Linear arraY detector for MHz rePetition rate SpectrOscopy (KALYPSO), a line array that examines the synchrotron radiation emitted at a five-degree port of a dipole magnet. Trench-Isolated Low-Gain Avalanche Diode (TI-LGAD) technology provides superior sensitivity compared to conventional silicon detectors, thereby facilitating the study of low-charge bunches. As the KALYPSO system can be triggered at several megahertz, turn-by-turn analysis can be performed at KARA, which has a revolution frequency of 2.7 MHz. In addition to the study of the energy spread, the analysis of beam size and position modulations can be performed. These can either occur naturally or be induced by a white noise signal on a strip line. In this contribution, the influence of transversal beam excitation on beam size and time-resolved dynamics at KARA is investigated.

AKBP 4.3 Mon 17:15 SCH/A117

Coulomb Crystallization in Free Electron Beams — •Valerio Di Giulio[1,2], Rudolf Haindl[1,2], and Claus Ropers[1,2] — [1]Max Planck Institute for Multidisciplinary Sciences, Göttingen, Germany — [2]University of Göttingen, Göttingen, Germany

In the context of electron beams, the Coulomb repulsion experienced by the constituents of high-current probes is usually regarded as a detrimental effect, leading to emittance growth. However, under suitable conditions, electron-electron interactions can be exploited to produce phase space distributions with well-defined energy-time correlations, as recently observed in few-electron pulses photoemitted from a metallic nanotip and imaged in a transmission electron microscope (R. Haindl et al., 2023). Such correlations can be leveraged to harness specific beam properties by selecting a portion of the probe. Extending this concept to higher currents and larger particle numbers, the beam can enter a crystalline state, forming an electron lattice defined by Coulomb repulsion, a Wigner crystal. In this work, we employ Monte Carlo simulations to examine the conditions under which Coulomb crystallization can emerge in both few-particle and continuous electron beams, exploring the interplay between beam temperature, current, and electromagnetic confinement. We compute properties associated with different structural phases, revealing a strong enhancement of beam brightness in the crystalline regime. We also present new measurements of electron-electron energy correlations in pulses containing from 4 to 8 particles, demonstrating the transient formation of an ordered electron chain during propagation in the microscope.

AKBP 4.4 Mon 17:30 SCH/A117

Status of the Compton Backscattering Source COBRA at the S-DALINAC* — •Lisa B. Dingeldein, Michaela Arnold, Ruben Grewe, Julian Hauf, Maximilian Herbert, Katharina E. Ide, Lars Jürgensen, Maximilian Meier, Clemens M. Nickel, Norbert Pietralla, and Dominic Schneider — Institut für Kernpysik, Technische Universität Darmstadt, Darmstadt, Germany

The COBRA source (Compton Backscattering at a Recirculating Accelerator) utilizes a 100 W Yb:YAG laser, which is synchronized with the electron beam of the superconducting Darmstadt linear accelerator S-DALINAC [1] for head-on collisions. The backscattered photons can be collimated into a quasi-monochromatic beam for electron beam diagnostics and as a technology demonstrator. This contribution highlights recent upgrades and developments of the detector setup, the laser beamline and the beam-stabilization systems of COBRA. The first collision of the electron and laser beam is planned in an upcoming beamtime with multi-turn recirculation. Later, COBRA is foreseen to be operated during energy-recovery mode [2] serving as a demonstrator for future Compton scattering light sources.

[1] N. Pietralla, Nucl. Phys. News **28**(2), 4 (2018)
[2] F. Schliessmann *et al.*, Nat. Phys. **19**, 597-602 (2023)

*This work is supported by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) - Project-ID 499256822 - GRK 2891 'Nuclear Photonics'.

AKBP 4.5 Mon 17:45 SCH/A117

Towards plasma-wakefield photon acceleration and its po-

tential applications — •Michael Quin[1], Tom Blackburn[1], and Mattias Marklund[2,1] — [1]Department of Physics, University of Gothenburg, SE-41296 Gothenburg, Sweden — [2]Department of Physics, Chalmers University of Technology, SE-41296 Gothenburg, Sweden

A laser pulse copropagating with a relativistic plasma wave (wakefield) can experience a continuous upshift in frequency known as "photon acceleration". Recent particle-in-cell (PIC) simulations have demonstrated how an optical laser pulse can be accelerated to extreme ultraviolet (XUV) frequencies in an electron-beam-driven plasma-wakefield using a tailored plasma density profile. Intense ($I_0 > 10^{17}$ W/cm^2) XUV laser light is highly sought after for collision experiments with multi-GeV electrons; the high photon and electron energy indicates the onset of effects in strong-field quantum electrodynamics, such as non-linear Compton scattering and Breit-Wheeler pair production. By combining PIC simulations of photon acceleration with Monte-Carlo simulations of the electron-photon collision, we show how the brilliance, yield, and polarization of the emitted γ-rays can be optimized for applications in nuclear and particle physics.

AKBP 5: Plasma Accelerators, Ions I

Time: Tuesday 9:30–10:45 Location: SCH/A117

Topical Talk AKBP 5.1 Tue 9:30 SCH/A117

Generation and Acceleration of In-Target Gold Fission Fragments using the ATLAS-3000 Laser System — •Laura D. Geulig, Veronika Kratzer, Erin Grace Fitzpatrick, Maximilian J. Weiser, Jörg Schreiber, and Peter G. Thirolf — Ludwig-Maximilians University Munich

In our experiment, the ATLAS-3000 laser system was used to accelerate ions from heated micrometer thing gold foils. A Thomson parabola spectrometer, optimized for high-resolution detection of heavy ions, was used to deflect ions with the same charge-to-mass (m/q) ratio on parabolic traces, which then can be matched to the ions with respective charge states. CR-39 track detectors were used to identify and characterize the accelerated ion species via their energy and charge states. In addition to remaining light contaminant species and highly-charged gold ions, an unexpected component of heavy (A 98) ions was observed in the m/q range below 2.5. We attributed those distinct pits to Au fission products. A similar in-target fission fragment component was observed in our previous experiment at the PHELIX laser. Details on our interpretation of the origin of these fragments will be presented.

AKBP 5.2 Tue 10:00 SCH/A117

Proton induced fission studies at CALA — •Maximilian J. Weiser, Erin G. Fitzpatrick, Laura D. Geulig, Runjia Guo, Jinbao Hong, and Syed A. Raza — Ludwig-Maximilians-Universität München

At the Centre for Advanced Laser Applications (CALA) we are investigating a novel fission-fusion reaction scheme [1] by employing the ATLAS-3000 laser with a central wavelength of 800 nm, energy per pulse < 60 J and a pulse duration of about 25 fs. This reaction scheme is in particularly interesting, as it could enable us to study extremely neutron-rich isotopes crucial for a quantitative understanding of the rapid neutron-capture, responsible for cosmic nucleosynthesis of heavy elements.

A necessary preparatory step for realizing this scheme is to gain a better understanding of the fission induced by laser accelerated protons in heavy elements. Therefore, we are improving a gas-flow transport system [2] and completed by aerosol-based transportation to transfer the fission products generated in laser-driven proton-induced fission of 238U to a shielded HPGe detector far from the EMP-contaminated experimental chamber. The status of fragment identification depending on laser and transport conditions will be presented.

Funded by the BMFTR under Grant No. 05P24WM2. We acknowledge the GSI target lab (Dr. Bettina Lommel) for providing the Uranium targets.

[1] D. Habs et al., Appl. Phys. B 103, 471-484 (2011)

[2] P. Boller et al., Sci. Rep. 10, 17183 (2020)

AKBP 5.3 Tue 10:15 SCH/A117

Pre-Expansion of Nano Rods in 2D PIC Simulations — •Franziska-Luise Paschke-Bruehl[1,2] and Thomas Kluge[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf — [2]Technische Universität Dresden

We present a computational study investigating the pre expansion of 10 um long, 100 nm thick nano rods under ultra-high intensity laser contrasts in 2D particle-in-cell simulations. We find that realistic contrasts, modelled by laser systems such as DRACO and ReLaX, lead to significant expansion, hindering the maximum intensities of the laser from seeing an intact rod structure. Based on that, we explore shorter pulse lengths and higher intensities of the laser pulse to ensure an intact rod structure at t_max.This shows that shorter pulse lenghts seem to be a promising alternatvie while higher intensities lead to more pre expansion, despite considering the relativistic critical density.

AKBP 5.4 Tue 10:30 SCH/A117

Characterization of Reflected Light Properties in PIC Simulations — •Vidisha Rana[1,2], Milenko Vescovi[1,2], Richard Pausch[1], Marvin E.P. Umlandt[1,2], Franziska Paschke-Brühl[1,2], Pengjie Wang[1], Tim Ziegler[1], Karl Zeil[1], Ulrich Schramm[1,2], and Thomas Kluge[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf — [2]Technische Universität Dresden

Laser-driven ion accelerators offer several advantages over the conventional ones due to their potential of achieving high accelerating gradients over small distances. Recent experiments have demonstrated that one can achieve significantly high proton energies by modifying the temporal profile and controlling the spectral phase of laser pulses, specifically using Group Delay Dispersion (GDD) and Third Order Dispersion (TOD).

Reflected light properties provide a powerful diagnostic tool for understanding these interactions and optimizing proton energies. Experiments involving ultrashort laser pulses interacting with glass targets reveal prominent spectral shifts across changing dispersion values. These shifts can offer valuable insights into plasma dynamics, relativistic surface motion, and laser contrast effects, which have a direct impact on proton energies but remain difficult to interpret solely through experiments. This challenge can be addressed by employing Particle-in-Cell codes to simulate these interactions to analyze the underlying mechanisms. By bridging the gap between experimental observations and theoretical predictions, this work aims to advance our understanding of laser-plasma interactions and optimize laser-driven ion acceleration.

AKBP 6: Plasma Accelerators, Ions II

Time: Tuesday 11:00–12:30 Location: SCH/A117

Topical Talk AKBP 6.1 Tue 11:00 SCH/A117

Efficient high energy and high-repetition-rate proton acceleration from cryogenic hydrogen foil targets — •Stefan Assenbaum[1,2], Martin Rehwald[1], Paweł Ordyna[1,2], Joshua Schilz[1,2], Maximilian Müller[1,2], Thomas Streil[1,2], Julian Garreis[1,2], Thomas Kluge[1], Sebastian Göde[3], Maxence Gauthier[4], Christopher Schönwälder[4], Ulrich Schramm[1,2], and Karl Zeil[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany — [2]TU Dresden, Dresden, Germany — [3]European XFEL, Schenefeld, Germany — [4]Stanford Linear Accelerator Center, Menlo Park, CA, USA

Laser plasma-based ion accelerators have not yet reached their full potential in producing high radiation doses at high particle energies, mainly due to the lack of a suitable high-repetition-rate targets that also provide adequate control of the plasma conditions. Cryogenic, solid hydrogen jet targets are being developed to fill this gap, as they combine many favourable properties for studying advanced laser ion acceleration regimes, such as low solid density, single ion species composition and ease of probing in experiments, with repetition-rated operation capability by being self-replenishing and debris-free. In a recent experiment, a new foil-like geometry of this cryogenic hydrogen target is used to accelerate proton bunches at 1 Hz repetition rate. Using the Draco PW laser at reduced laser energy, we report stable, continuous acceleration of ion beams over thousands of consecutive shots. Despite the low laser energy of only 1.6 J, we observe maximum proton energies of up to 50 MeV, indicating outstanding acceleration efficiency.

AKBP 6.2 Tue 11:30 SCH/A117

Hybrid study of the prepulse impact on cryogenic hydrogen target — •Arthur Hirsch Passicos[1], Stefan Assenbaum[1,2], Pawel Ordyna[1,2], Constantin Bernert[1], Thomas Kluge[1], and Martin Rehwald[1] — [1]Helmholtz-Zentrum Dresden - Rossendorf, 01328 Dresden, Germany — [2]Technical University Dresden, Dresden, Germany

Laser-driven ion accelerators have become more prominent in many fields of applications but are very sensititive to the target density profile in order to to determine the acceleration scheme of the main interaction. At HZDR, we demonstrated the use of cryogenic hydrogen jet targets shaped with controlled prepulse in order to optimise the proton acceleration.

Based on these results, we will present an hydrid study of the target shaping combining hydrodynamic and Particle-in-Cell simulations. By combining the two types of codes, we can correctly simulate and analyse the laser absorption processes, the target expansion as well as the acceleration schemes at play over a large range of pre-pulse intensities and delays.

AKBP 6.3 Tue 11:45 SCH/A117

PIC simulation study of highly efficient, high proton energy laser ion acceleration from cryogenic hydrogen jet targets — •Paweł Ordyna[1,2], Stefan Assenbaum[1,2], Thomas Kluge[1], Karl Zeil[1], and Ulrich Schramm[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf (HZDR), Dresden, Deutschland — [2]Technische Universität Dresden, Dresden, Deutschland

Recent experiments on laser ion acceleration using planar cryogenic hydrogen jet targets have demonstrated high laser to proton coupling efficiency and maximum proton energies that far exceed expected scaling (over 50 MeV at 1.6 J laser energy on target).

We present an accompanying particle-in-cell simulation study that incorporates an approximately 30 ps long laser pedestal and the resulting plasma pre-expansion. Our results reproduce both a highly directional fast proton-beam as well as a return current driven, low-energy, high-charge, nearly isotropic proton emission; both features are observed experimentally. Additionally, we discuss a surprisingly strong influence of small variations in jet orientation on the emission angle of the fast protons.

AKBP 6.4 Tue 12:00 SCH/A117

Investigation of the temporal laser contrast by optical probing of cryogenic hydrogen jet targets — •Thomas Streil — Helmholtz Zentrum Dresden Rossendorf — Technische Universität Dresden

Precise control of experimental parameters in laser-plasma-based ion accelerators is essential for improving acceleration performance. Temporal laser contrast is particularly critical, as it determines pre-plasma formation on the target before the main pulse. Understanding the onset of plasma pre-expansion is therefore vital for realistic simulations and insight into acceleration mechanisms. We investigated this onset by observing laser-induced breakdown, seen as a transition of the target to an opaque state once the electron density exceeds the critical density for the probe wavelength.

Using the DRACO petawatt laser, we scanned intrinsic contrast on a cryogenic hydrogen jet. The method provides a useful correction factor for autocorrelator-based contrast measurements, and additional target characterization and development are presented.

AKBP 6.5 Tue 12:15 SCH/A117

Human-Explainable, Compact, Clustering-based Latents for Fast Proton Energy Spectra Estimation — •Vedhas Pandit[1], Jeyhun Rustamov[1], Martin Rehwald[1], Stefan Assenbaum[1], Vidisha Rana[1], Hans-Peter Schlenvoigt[1], Michael Bussmann[1,2], Ulrich Schramm[1,3], Thomas Kluge[1], and Jeffrey Kelling[1,4] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany — [2]Center for Advance Systems Understanding (CASUS), Görlitz, Saxony, Germany — [3]Technische Universität Dresden, Faculty of Physics, Dresden, Saxony, Germany — [4]Technische Universität Chemnitz, Institute of Physics, Chemnitz, Saxony, Germany

A bottleneck in gaining a deeper understanding of the complex laser-plasma interaction that generates laser-accelerated protons is the lack of robust and near real-time information extraction from high frequency shot-data, due to human intervention required in the process. Here, we present an approach to employ deep learning methods to reduce the need for human input into the analysis of Thomson Parabola Spectrometer (TPS) measurements of proton energy spectra given relatively limited labelled data. Our approach builds on deep feature extraction using general pre-trained autoencoders, self organizing map-based clustering of global image features and the spectra that are available as labels, to effectively reduce the dimension of input and output modalities. Lower dimensional representations then enable a small model to be trained on limited data to estimate proton spectra and to help with spectrometer re-calibrations.

AKBP 7: Ion and Medical Accelerators

Time: Tuesday 14:00–15:30 Location: SCH/A117

AKBP 7.1 Tue 14:00 SCH/A117

Theoretical and Numerical Studies of the Effects of Ultra-High Dose Rate Pulses — •Athanasios Koutsostathis, Miriam Brosi, and Anke-Susanne Müller — Karlsruhe Institute of Technology, Karlsruhe, Germany

The understanding of the interaction of high-intensity particle beams with matter is an important aspect for the development of novel accelerator instrumentation. Recently, methods for delivery of ultra-high dose rate radiation have become an increasingly important area of accelerator technology, for example, in the context of FLASH radiotherapy, dosimetry, and particle detector development. In this paper, theoretical models and numerical simulations have been implemented to determine the thermal and subsequent mechanical response of materials subjected to sub-millisecond irradiation with high-intensity particle beams. Emphasis is placed on the identification of phenomena with the potential to drive the development of next-generation accelerator technologies.

AKBP 7.2 Tue 14:15 SCH/A117

Dosimetry for FLASH Radiotherapy with High-Energy Electrons at ELSA — •Anne Stähler, Klaus Desch, Dennis Proft, Michael Switka, and Leonardo Thome — Physikalisches Institut der Universität Bonn

At the electron accelerator facility ELSA, FLASH radiotherapy is being studied. This treatment concept utilises high dose rates in nanosecond to microsecond pulses, which may reduce damage to healthy tissue and improve treatment for deep-seated tumours. Experiments are performed with high-energy electrons between 1.2 GeV and 3.2 GeV, to investigate the underlying beam properties. By applying a newly implemented extraction mode, spill durations of around 330 ns can be achieved. The electromagnetic shower and beam profile throughout water are characterised with Gafchromic films and Cherenkov-light measurements. These results provide, for the first time at energies up to 3.2 GeV, an understanding of the beam properties under FLASH conditions for future radiation studies.

AKBP 7.3 Tue 14:30 SCH/A117

Laser cooling of bunched relativistic ion beams at the FAIR SIS100 — •Danyal Winters[1], Michael Bussmann[2,3], Tamina Grunwitz[4], Jens Gumm[4], Volker Hannen[5], Thomas Kühl[1,6], Sebastian Klammes[1], Benedikt Langfeld[4], Ulrich Schramm[2,7], Denise Schwarz[4], Mathias Siebold[2], Peter Spiller[1], Thomas Stöhlker[1,6,8], Ken Ueberholz[5], and Thomas Walther[4,9] — [1]GSI Darmstadt — [2]HZDR Dresden — [3]CASUS Görlitz — [4]TU-Darmstadt — [5]Uni Münster — [6]HI-Jena — [7]TU-Dresden — [8]Uni-Jena — [9]HFHF Campus Darmstadt

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 (cw and 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. We will also give an overview of the laser and detector systems that will be used.

AKBP 7.4 Tue 14:45 SCH/A117

Acceletor Physics at ESR — •Areso Sherjan[1], Aaron Heinz[2], Giuliano Franchetti[1,2,3], Bernd Lorentz[1], Sergey Litvinov[1], Regina Hess[1], Claude Krantz[1], Jon Rossbach[1], Claudius Peschke[1], Ronald Joseph[1], and Ulrich Popp[1] — [1]GSI Darmstadt — [2]Goethe Universität Frankfurt — [3]HFHF

The ESR (experimental storage ring) at GSI can store and decelerate heavy ion beams with different charge states covering a wide range of energy. Hence, the ESR facility provides suitable conditions for various atomic physics experiments, which requires a very precise control on the machine optics during operation. It is therefore of paramount importance the excellent optics control on the machine and the assessment of all the parameters to prevent beam degradation during the deceleration ramp. This talk reviews the accelerator physics activity of the ESR group for delivering high brightness beam to the low energy experiments.

AKBP 7.5 Tue 15:00 SCH/A117

Dosimetry and beam monitoring for laser-accelerated protons — •Joshua Schilz, Florian Kroll, Karl Zeil, Ulrich Schramm, and Josefine Metzkes-Ng — Helmholtz-Zentrum Dresden-Rossendorf, Germany

Laser-driven plasma accelerators (LPAs) provide multi-10 MeV proton bunches at extremely high instantaneous dose rates, offering unique opportunities for application-oriented studies such as radiobiology. To use these beams effectively, a dedicated experimental environment is required. The ALBUS-2S beamline at the Helmholtz-Zentrum Dresden–Rossendorf delivers such proton beams and is already qualified for irradiating millimeter-scale *in vivo* samples. Building on initial pilot work, we investigate improved methods for beam monitoring and dosimetry of single, ultra-short proton bunches delivering multi-Gy doses.

Two detector concepts were tested at ALBUS-2S. The miniSCIDOM scintillator tomograph enables online 3D dose reconstruction in volumes of about 1 cm^3 with sub-500 μm resolution and 100 mGy sensitivity, including characterization of scintillator quenching at LPA dose rates. A complementary time-of-flight detector records transmitted proton spectra, allowing Monte Carlo-based depth–dose predictions; recent studies have established an optimized detector configuration for routine use.

Together, these diagnostics enable precise characterization of laser-accelerated proton beams, supporting reliable radiobiological experiments under the extreme conditions produced by LPAs.

AKBP 7.6 Tue 15:15 SCH/A117

Advancements in Fast Extraction Methods of Short High Ity Pulses at ELSA for FLASH-RT Researchntensi — •Leonardo Thome, Klaus Desch, Dennis Proft, and Michael Switka — Physikalisches Institut der Universität Bonn

Studies investigating the FLASH effect for radiotherapy (FLASH-RT) are currently being carried out at the electron accelerator facility ELSA. In an initial operation mode, the booster synchrotron provides 1.2 GeV electron pulses of 250 ns duration for the irradiation of cell samples. To access higher beam energies up to 3.2 GeV and pulse lengths spanning from the nanosecond to the millisecond regime, this is complemented with a new developed fast extraction scheme from the stretcher ring. Current work focuses on repurposing the existing injection kickers to achieve single-turn or few-turn extraction. The extracted beam is characterized with charge and profile monitors. In parallel, the feasibility of faster resonant extraction techniques to provide spill durations up to several milliseconds is being investigated.

AKBP 8: Poster AKBP

Time: Wednesday 9:30–11:00 Location: P4

AKBP 8.1 Wed 9:30 P4

Status of the Automated Activation of GaAs Photocathodes at Photo-CATCH* — •Markus Engart, Joachim Enders, Maximilian Herbert, Robin Petry, Julian Schulze, and Vincent Wende — Institut für Kernphysik, TU Darmstadt, Germany

Photocathodes based on the III-V seminconductor GaAs are used as photo-electron sources to supply spin-polarized electron beams for accelerator applications. In order to achieve a sufficient electron yield, a thin surface layer of cesium combined with an oxidant is applied onto the cathode surface in a process called the cathode activation. It is typically done manually by an experienced operator. This contribution presents the current status in the development and testing of an adaptive algorithm for automated activation at the Photo-CATCH test stand.

*Work supported by DFG (GRK 2128 *AccelencE *, project number 264883531 and Project-ID 499256822 * GRK 2891 'Nuclear Photonics')

AKBP 8.2 Wed 9:30 P4

Status of the beam dynamics design of the bunch compressor for DALI — •Arthur Delan[1], Ulf Lehnert[1], Atoosa Meseck[2], Najmeh Mirian[1], Raffael Niemczyk[1], and Andreas Wagner[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany — [2]Helmholtz-Zentrum Berlin, Berlin, Germany

Dresden Advanced Light Infrastructure (DALI), a new 50 MeV superconducting linear accelerator at the Helmholtz-Zentrum Dresden-Rossendorf on the national shortlist of research infrastructures, is envisaged as the successor to ELBE, which has served users for over 20 years. Improving on the capabilities of ELBE, DALI contains a superradiant THz source designed to operate between 0.1 and 3 THz, driven by bunch charge increased up to 1 nC. Achieving the required form factor for superradiant emission demands sub-wavelength bunch lengths. The combination of high bunch charge and medium energy causes collective effects such as space charge forces and coherent synchrotron radiation emission to be significant contributions to the beam dynamics. Simulations of the compression and the status of the design for this bunch compressor are presented.

AKBP 8.3 Wed 9:30 P4

Gaussian Process Regression and Bayesian Optimization for a 90 MeV Laser-Plasma Injector for the cSTART Storage Ring — •David Squires, Elias Sailer, Joseph Natal, Alexander Saw, Nathan Ray, and Matthias Fuchs — Karlsruhe Institute of Technology, Kaiserstraße 12 76131 Karlsruhe

Laser-plasma accelerators (LPAs) generate ultrashort high intensity electron bunches from a compact source size. At the Karlsruhe Institute of Technology (KIT), we will use an LPA as one of the injectors for the compact, high-acceptance, non-equilibrium storage ring cSTART.

The LPA injector will be based on an ionization trapping scheme in combination with a tailored plasma density profile to produce an electron beam with small energy spread that maximizes the charge at our target energy, which is at (for LPAs) comparably low energies of 50-90 MeV. Moreover, the LPA injector must produce controlled electron beams with a high shot-to-shot stability and avoid high-energy runaway electrons. These goals can be achieved largely by the detailed design of the plasma density profile and the laser pulse parameters.

In an LPA, small changes across the high-dimensional parameter space can have an outsized influence on overall performance. To handle this challenge, we perform particle-in cell (PIC) simulations and use machine-learning driven approach using Gaussian Process Regression (GPR) and Bayesian Optimization (BO). This procedure allows us to both optimize our gas target design and characterize the effects of the interaction parameters, giving us a functional LPA with a simple tuning mechanism.

AKBP 8.4 Wed 9:30 P4

Programmable Focal Elongation and Shaping of High-Intensity Laser Pulses using Adaptive Optics — •Peter Blum[1], Anna Puchert[1], Emily Archer[1], Sören Jalas[1], Spencer W. Jolly[2], Jens Osterhoff[1,3], Wim P. Leemans[1], Manuel Kirchen[1], Andreas R. Maier[1], and Rob J. Shalloo[1] — [1]Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany — [2]Service OPERA-Photonique, Université libre de Bruxelles (ULB), Brussels, Belgium — [3]now at Lawrence Berkeley National Laboratory

Controlling the intensity distribution of laser pulses in the focal region is becoming increasingly important across many areas of high-intensity laser-matter interactions. Rather than focusing light to a single longitudinal point, like a parabolic mirror, it is often desirable to focus light to a line segment along the optical axis, allowing for the generation of extended regions of high laser intensity. Optics for generating such intensity structures, sometimes referred to as *axioptics*, include the axicon, the axilens, and the more recently proposed axiparabola.

In laser-plasma accelerators, *axioptics* are essential for forming optically-generated plasma waveguides and for enabling advanced plasma acceleration techniques, including dephasingless wakefield acceleration. Current solutions of tailoring the focal region rely on custom off-axis solutions or diffractive/refractive optics which can be expensive and senstive misalignment and/or aberrations. Here, we present an alternative approach for programmatically generating and shaping extended regions of high intensity, utilising common optical components; an adaptive optic and an off-axis parabolic mirror.

AKBP 8.5 Wed 9:30 P4

Towards spectroscopic characterization of in-target gold fission fragments — •Syed A. Raza[1,2], Maximilian J. Weiser[1], Erin G. Fitzpatrick[1], Laura D. Geulig[1], and Peter G. Thirolf[1] — [1]Ludwig-Maximilians-Universität München, Garching, Germany — [2]University of Bologna, Bologna, Italy

The fission fusion reaction mechanism aims to produce neutron-rich nuclei near the magic neutron number N = 126, which are important for understanding the r-process. A key prerequisite for enabling this mechanism is achieving high bunch densities of accelerated heavy ions, which is why laser-based acceleration is used [1].

In recent experiments at CALA on the acceleration of gold from 300-600 nm foils, using a Thomson parabola spectrometer and CR39 track detectors as diagnostics, we unexpectedly observed a heavy-ion component in the region of $m/q = 2 - 2.5$, where only light ions were expected. This component could be determined to be $A \approx 98$ and attributed to in-target fission fragments [2].

In our experiment in order to unambiguously identify these heavy ions as Au fission fragments, we will use gold target foils ($\approx 300nm - 2\,\mu$m) at CALA and implement a down-stream Mylar catcher foil in front of TPS with a central hole on the target-normal axis to allow accelerated ions to reach the TPS, while the rest will be implanted in the catcher foil and transported out of the vacuum to a well-shielded HPGe detector for characterization of (long-lived) species.

[1] D.Habs et al., Appl. Phys. B 103, 471–484 (2011).

[2] L. D. Geulig, Dissertation LMU, Munich 2025

AKBP 8.6 Wed 9:30 P4

MeV-UED: An instrument for experiments on the atomic scale in space and time — Jakob Krämer[1], Verena Kümper[1], Moritz Pfeiffer[1,2], •Christoph Quitmann[1], and Ariane Ufer[1,2] — [1]RI Research Instruments GmbH Friedrich-Ebert-Str. 75 51429 Bergisch Gladbach — [2]III. Physikalisches Institut B, RWTH Aachen, 52056 Aachen

Current research focuses on investigating promising materials that are potential candidates for applications as nano, quantum and energy technologies. For these kind of materials information about static atomic structures and how they change in time is of crucial importance. Such changes happen upon absorption of energy, during chemical reactions, or in phase transitions. In order to observe these changes, it is necessary to measure atomic positions with sub-Å spatial and sub-ps temporal resolution. RF-Photocathodes excited with ultra-short laser pulses allow generation of electron pulses with MeV energies. Such pulses can be used for diffraction experiments where they create Bragg peaks with ca. mrad angles.

We introduce a commercial robust MeV-UED instrument aimed at ultra-fast electron diffraction with 100fs temporal and sub Å spatial resolution based on a 2.5-cell warm RF-gun and a commercial Ti:Sa laser. This instrument is compatible with solid , liquid or gaseous samples (incl. cryogenic option). We present the main design considerations, electron beam dynamics simulations, and the engineering design of the RI-Bornite MeV-UED instrument.

AKBP 8.7 Wed 9:30 P4

Advancing Resolution in LWFA-Driven X-ray Probing of Laser-Nanostructure Interactions — •Maurice Zeuner[1], Moritz Foerster[1], Florian Haberstroh[1], Johannes Zirkelbach[1], Felipe Peña[1,3], Sonja Gerlach[1], Enes Travac[1], Sanchita Sharan[1], Mohamed Ayache[1], Marius S. Schollmeier[2], Gregor Schilling[1], Andreas Döpp[1], Daniel E. Rivas[2], and Stefan Karsch[1] — [1]Ludwig-Maximilians-Universität München, Fakultät für Physik, Am Coulombwall 1, Garching 85748, Germany. — [2]Marvel Fusion, Theresienhöhe 12, 80339 Munich, Germany — [3]Department of Physics, University of Oslo, Olso, Norway

A novel inertial fusion concept (by Marvel Fusion) proposes the use of nanostructured targets in the form of arrays of thin rods that are irradiated by high-intensity laser pulses. The resulting interaction potentially enables heating and compression of mixed solid fusion fuels. Experimental validation of this approach is crucial, but the underlying dynamics unfold on femtosecond time scales and nanometer length scales, posing significant diagnostic challenges. In the framework of the VANLIFE collaboration, this work investigates the feasibility of probing nanostructured targets during the laser-target interaction using laser-driven plasma-wakefield accelerators for X-ray generation, delivering ultrashort and high-brightness pulses via Betatron radiation. We want to explore possibilities to use these radiation sources to probe the interaction at such nano targets and gain a better understanding of diagnostic challenges in probing rapidly expanding, high-density laser-plasma interactions.

AKBP 8.8 Wed 9:30 P4

A Roadmap towards Direct Imaging of Plasma Targets during Laser Acceleration using Computation X-Ray Holography — •Ritz Ann Aguilar[1], Long Yang[1], Yangzhe Cui[1], Lingen Huang[1], Martin Rehwald[1], Toma Toncian[1], Karl Zeil[1], Michael Bussmann[1,2], Ulrich Schramm[1,3], Thomas Cowan[1,3], and Jeffrey Kelling[1,4] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany — [2]CASUS, Görlitz, Germany — [3]TU Dresden, Germany — [4]TU Chemnitz, Germany

Accurate density diagnostics of laser-driven targets are essential for optimizing high-intensity experiments in laser-plasma acceleration (LPA) and inertial-confinement fusion (ICF). We apply a computational X-ray imaging workflow based on single-shot, in-line coherent holography that records diffraction patterns with strong phase contrast and reconstructs spatial phase, and thus density, from intensity-only data. We use differentiable optical propagators and physics-informed machine-learning-assisted phase retrieval to recover fine-scale structures. As a proof of concept, we present reconstructions of laser-irradiated hydrogen gas jets, resolving features relevant to plasma tailoring and injection control. This is compatible with external light sources and compact plasma-based X-ray sources, supporting feedback-oriented operation on LPA platforms. We also outline an application to ICF: XFEL-based coherent diffraction imaging of shock-compressed solid hydrogen. At the European XFEL's HED-HIBEF instrument, the approach targets resolving fuel-compression dynamics down to sub-micron scales, addressing a central diagnostic need for high-gain implosion studies.

AKBP 8.9 Wed 9:30 P4

Preliminary Studies for a Colliding Beam Møller Polarimeter — •Philipp J. Kompa — JGU Mainz

The Colliding Beam Møller Polarimeter is a proposed setup for measuring the spin polarisation of electron beams with high precision. The proposed setup promises improved systematic uncertainties compared to existing polarimeters which have uncertainties around 0.5%. There are some experimental challenges, one of them being the low cross section of Møller scattering and the therefore low scattering rate even with the high average currents needed for experiments at MESA.

This work discusses the experimental challenges, focusing on background measurements and estimations of how far the background may be suppressed by using coincident measurement of the scattered electrons.

AKBP 8.10 Wed 9:30 P4

Development of a precision timing system for beam background characterization using plastic scintillators — •Florian Eisele[1], Fabian Hummer[1], and Luca Scomparin[2] — [1]Institute for Data Processing and Electronics, KIT — [2]SLAC National Accelerator Laboratory

Many facilities employ beam loss monitors that report time-averaged loss rates and do not support precise time-of-arrival measurements. We developed an FPGA-based read-out system that, in combination with plastic scintillator detectors, enables beam loss measurements with sub-nanosecond time resolution over multi-second acquisitions. After calibrating the system with cosmic particles, we commissioned this system at the (50 - 500 MeV) booster synchrotron of the Karlsruhe Research Accelerator (KARA). This measurement campaign demonstrated the potential of this new technique. First, we characterized the beam background with nanosecond-level timing precision. Second, we acquired the accelerator clock and injection triggers, in order to correlate the beam background with beam injection, storage and extraction. We prove that the revolution timing structure of the beam current is present in the beam loss. In addition, we showed versatility of the readout system to sample the signals of a stripline sensor at the KARA main ring. In this contibution, we present the FPGA based data acquisition system, first commissioning results and discuss future applications of this technique.

AKBP 9: RF Cavities I

Time: Wednesday 11:00–12:30 Location: SCH/A117

AKBP 9.1 Wed 11:00 SCH/A117

RF characterization of superconducting samples with the UHH QPR at DESY — •Carl Weiss[1], Ricardo Monroy-Villa[2], Manuela Schmökel[3], Marc Wenskat[1,3], and Wolfgang Hillert[1] — [1]Institut für Experimentalphysik, Universität Hamburg — [2]Institut für Kernphysik, Johannes Gutenberg-Universität Mainz — [3]Deutsches Elektronen-Synchrotron DESY

Superconducting materials are indispensable for modern accelerators, for example highest acceleration fields are achieved with superconducting radio-frequency cavities made out of niobium. To further advance the development of superconducting materials for accelerators, an RF testing of samples is essential. The quadrupole resonator (QPR) is such a testing system, which allows the RF characterization of samples in the range of typical operational parameters of accelerators, such as a temperature range of 2-20 K, magnetic fields up to 120mT and for three different frequencies: 425 MHz, 860 MHz and 1300 MHz. In this report, the very first measurement of a sample in two different QPRs will be reported, which will proof the reliability and accuracy of such a system. Furthermore, fully exploiting the fact that the very same surface is tested at three different frequencies, the slow vs. fast superconductor model and non-equilibrium superconductivity will be investigated. This is of significant importance to study the so-called mid-T recipe developed for 1.3 GHz and test its transferability to other frequencies.

AKBP 9.2 Wed 11:15 SCH/A117

Atomic layer deposition of silicon nitride as an insulator layer for use in multilayer coating of cavities — •Ana Katharina Steffens[1], Isabel Díaz-Palacio[1], Robert Zierold[1], Marc Wenskat[2], and Wolfgang Hillert[1] — [1]Universität Hamburg, Hamburg, Deutschland — [2]Deutsches Elektronen Synchrotron (DESY), Hamburg, Deutschland

Multilayer coatings of superconducting cavities provide a strategic route to superconducting radio frequency surfaces engineered to surpass the performance limits of conventional bulk Nb. Particular attention is paid to SIS structures consisting of thin superconducting (S) and insulating layers (I), as these can prevent global vortex penetration and allowing for higher surface magnetic fields before the loss of the Meissner state. However, previous SIS structures consisting of Nb bulk, AlN, and NbTiN show diffusion of aluminum into the NbTiN layer upon annealing at high temperatures, compromising the SIS-performance. Herein, SiN is investigated as an alternative due to its greater thermal stability. Plasma-enhanced atomic layer deposition (PEALD) is used to deposit thin SiN and NbTiN layers, enabling controlled growth of homogeneous, conformal layers at low process temperatures. This study focuses on the development of a PEALD process for SiN and the characterization of various layer configurations, with initial results being presented.

AKBP 9.3 Wed 11:30 SCH/A117

Comparison of co-sputtered Nb_3Sn thin films grown on copper, sapphire and fused silica — •Amir Farhood[1], Alexey Arzumanov[1], Márton Major[1], Mohammad Khodakarami[1], Amin Matin Javid[1], Michaela Arnold[2], Norbert Pietralla[2], and Lambert Alff[1] — [1]Institute of Materials Science, Technical University of Darmstadt, — [2]Institute of Nuclear Physics, Technical University of Darmstadt, Darmstadt, Germany

Pure Niobium is still the main choice for superconducting RF cavities; however, it must be operated at around 2 K, which significantly increases cooling requirements. Nb_3Sn with a much higher T_c of approximately 18.2 K enables operation at 4.2 K. Applying Nb_3Sn coatings onto copper cavities through co-sputtering is expected to enhance the quality factor and to suppress quenching at elevated accelerating fields. In this work, Nb_3Sn layers were co-sputtered onto different substrates to examine their critical temperature and lower critical field (H_{c1}). Film growth was carried out under controlled conditions, followed by characterization through X-ray diffraction, resistivity measurements, and SQUID magnetometer. On all substrates, Nb_3Sn exhibits a clear superconducting transition. For films deposited on r-cut sapphire, a T_c of 17.8 K was achieved, which is close to the value for bulk Nb_3Sn. On copper, the films showed a T_c of about 15 K. Importantly, H_{c1} exceeded not only that of bulk Nb_3Sn but also that of pure niobium.

AKBP 9.4 Wed 11:45 SCH/A117

Texture investigations of Nb_3Sn thin films grown for SRF cavity application — •Márton Major[1], Alexey Arzumanov[1], Amir Farhood[1], Michaela Arnold[2], Norbert Pietralla[2], and Lambert Alff[1] — [1]Institute of Materials Science, Technical University of Darmstadt, Darmstadt, Germany — [2]Institute of Nuclear Physics, Technical University of Darmstadt, Darmstadt, Germany

Superconducting (SC) RF cavity technology is dominated by bulk Nb due to its proven physical performance and mature production technology. Needs for reducing the energy consumption of particle accelerators, however, call for alternative SC materials, such as Nb_3Sn, to allow their operation at higher temperatures at lower cryogenic costs. The Nb_3Sn coating of carrier structures has the potential to reach high acceleration gradients even at 4.2 K. Utilising thin film technology enables to use copper, an excellent heat conductor, for the bulk of the cavity to which Nb_3Sn can be sputtered for high-quality SC coatings. At our group, based on a low-temperature magnetron co-sputtering process, the direct deposition of SC Nb_3Sn on Cu became possible. The grown films had high critical fields and critical temperatures. Films co-sputtered on different substrates (single crystalline sapphire, polycrystalline copper, amorphous glass) show different superconducting properties. In this contribution we present a detailed analysis of the texture and local order of the grown Nb_3Sn thin films based mainly on x-ray diffraction measurements and discuss possible causes of observed differences.

AKBP 9.5 Wed 12:00 SCH/A117

Successfull Refurbishment of TESLA Cavities for MESA — •Paul Plattner — JGU Mainz - Institut für Kernphysik, Mainz, Germany

Two TESLA cavities that were previously operated in the decommissioned ALICE project have been successfully refurbished in the clean room and tested at the AMTF. They now meet the requirements for the Mainz Energy-recovering Siperconducting Accelerator (MESA) and will be used to test Higher Order Mode (HOM) antenna upgrades for the MESA Energy Recovering (ER) mode.

AKBP 9.6 Wed 12:15 SCH/A117

V-Band Microwave Cavities for Pulse Compression in an Ultrafast Transmission Electron Microscope — •Johann Toyfl[1,2], Dennis Naraschkewitz-Epp[1,2], Armin Feist[1,2], and Claus Ropers[1,2] — [1]Department of Ultrafast Dynamics, Max Planck Institute for Multidisciplinary Sciences, Göttingen, Germany — [2]4th Physical Institute, University of Göttingen, Göttingen, Germany

Ultrashort electron bunches are a unique source of coherent radiation, but utilizing their short matter wavelength for nanoscale probing was only recently achieved in ultrafast electron microscopes (UEM). However, their temporal resolution is typically limited by electron pulse dispersion to a few hundred femtoseconds [1].

In this contribution, we explore high-frequency V-band microwave cavities to compress the longitudinal phase space of electron pulses generated by femtosecond photoemission, either in the temporal or energy domain [1, 2, 3]. We characterize the microwave reflection coefficient and use our ultrafast transmission electron microscope (UTEM) [1] to obtain electric-field maps by spectroscopic imaging.

The integration of cavity-based phase-space control will enhance the temporal and spectral resolution of UEM, enabling the study of ultrafast dynamics that are currently accessible only in large-scale free-electron laser facilities.

[1] A. Feist *et al.*, Ultramicroscopy **176**, 63 (2017) [2] T. van Oudheusden *et al.*, Phys. Rev. Lett. **105**, 264801 (2010) [3] R. P. Chatelain *et al.*, Appl. Phys. Lett. **101**, 081901 (2012) [4] J. Kuttruff *et al.*, Sci. Adv. **10**, eadl6543 (2024)

AKBP 10: Plasma Accelerators, Diagnostics I

Time: Wednesday 15:00–16:15 Location: SCH/A117

Topical Talk AKBP 10.1 Wed 15:00 SCH/A117

Multiscale longitudinal electron bunch characteristics of LWFA bunches determined by single-shot CTR spectroscopy — •Alexander Debus[1], Maxwell LaBerge[1], Omid Zarini[1,2], Susanne Schöbel[1], Jessica Tiebel[1,2], Finn-Ole Carstens[1,2], Nico Wrobel[1,2], Richard Pausch[1], Klaus Steiniger[1], Yen-Yu Chang[1], Jurjen Couperus Cabadağ[1], Alexander Köhler[1,2], Thomas Kurz[1,2], Rafal Zgadzaj[3], Michael Downer[3], Michael Bussmann[1], Ulrich Schramm[1], and Arie Irman[1] — [1]HZDR, Dresden, Germany — [2]TU Dresden, Germany — [3]UT Austin, USA

The longitudinal structure of ultra-short electron bunches produced in laser-wakefield accelerators (LWFAs) is strongly influenced by the rapid injection dynamics as well as by ongoing interactions between the driving laser and the accelerated beam. Gaining a detailed picture of these bunch structures is key for progressing toward compact FELs and other advanced secondary light sources.

We report experimental findings derived from single-shot broadband coherent transition radiation (CTR) spectroscopy (spanning UV to mid-IR, 250 nm - 11.35 μm) generated as LWFA electron bunches traverse a metal foil. Through analysis of the CTR spectra, we reconstruct the corresponding electron bunch profiles. Our results reveal that electron bunches originating from different injection processes exhibit intricate longitudinal structures spanning multiple temporal scales, from the overall envelope down to sub-micrometer features. These patterns vary systematically with the injection regime and align with signatures observed in the electron spectrometer.

AKBP 10.2 Wed 15:30 SCH/A117

Novel approaches of using transition radiation to diagnose driver dynamics in plasma wakefield accelerators — •Nico Wrobel[1,3], Finn-Ole Carstens[1,3], Alexander Debus[1], Arie Irman[1], Maxwell La Berge[1], Susanne Schöbel[1], Ulrich Schramm[1,3], Klaus Steiniger[1,2], Jessica Tiebel[1,3], Patrick Ufer[1], and Richard Pausch[1] — [1]Helmholtz-Zentrum Dresden - Rossendorf e.V., DE — [2]Center for Advanced Systems Understanding, Görlitz, DE — [3]TU Dresden, DE

LPWFA is a new hybrid accelerator concept which combines laser wakefield accelerators (LWFA) and plasma wakefield accelerators (PWFA), resulting in an ultra-compact form factor while promising improved beam quality, compared to LWFA. The dynamics of the PWFA driver are investigated due to their impact on the capabilities to accelerate particles in the plasma wake. Since the driver beam dynamics cannot be directly observed in experiment, new diagnostic methods had to be explored, which we will present here.

Coherent transition radiation (CTR) was investigated to diagnose longitudinal and transversal driver dynamics with the help of the open-source particle-in-cell code PIConGPU. We were able to detect the breakup of the driving bunch through the emitted CTR spectrum and developed a novel diagnostic approach, which may be able to reconstruct time-dependent driver dynamics, like driver oscillation, from CTR measurements.

AKBP 10.3 Wed 15:45 SCH/A117

From studying to controlling injection dynamics in laser wakefield accelerators — •Jessica Tiebel[1,2], Richard Pausch[1], Michael Bussmann[1], Finn-Ole Carstens[1,2], Alexander Debus[1], Klaus Steiniger[1], René Widera[1], and Ulrich Schramm[1,2] — [1]Helmholtz-Zentrum Dresden - Rossendorf — [2]Technische Universität Dresden

Laser Wakefield Accelerators (LWFAs) enable the generation of highly relativistic, high charge, low emittance electron beams within only a few millimeters of acceleration. Their compactness and favorable electron beam properties make them attractive for many applications, like compact plasma wakefield drivers, synchrotron sources or free electron lasers. Enabling application-ready operation requires precise control over the sensitive and non-linear acceleration process, and therefore a deep understanding of the injection process and bunch evolution.

We used the open-source, multi-GPU particle-in-cell code PIConGPU to perform a comprehensive investigation of the acceleration and injection process. This enabled us to explain discontinuities in the injection process of self-truncated ionization injection (STII) and their consequent impact of the spatial and spectral charge distribution of the electron bunch. Based on these findings, we provide a practical guide for controlling STII to achieve the targeted electron beam parameters.

AKBP 10.4 Wed 16:00 SCH/A117

Time-Resolved Interferometry Measurement of Ultrasound Pulses generated by Laser-Accelerated Ions in Water — •Hannah Forsthuber, Julia Liese, Florian Schweiger, Alexander Prasselsperger, Sonja Gerlach, Xiang Chen, Kumudini Pagare, and Jörg Schreiber — LMU München, Fakultät für Physik - Medizinische Physik, Am Coulombwall 1, 85748 Garching

Recent progress in laser-driven ion acceleration and its applications in radiation-therapy research demands sensitive techniques to probe processes like ionoacoustic pressure waves. Building on earlier work using optical detection of refractive-index changes caused by ion beams in water, this project investigates a Mach-Zehnder interferometric approach operated near destructive interference. By combining high optical intensities with a balanced-detection scheme, the setup aims to enhance sensitivity to the weak acoustic signatures generated by laser-accelerated ion bunches at LMU's Center for Advanced Laser Applications. The method targets temporally and spatially resolved measurements of the pressure-wave evolution within the interaction volume, providing complementary information to transducer-based diagnostics [1]. The performance of the interferometric system will be evaluated in forthcoming experiments, with initial results expected by the time of the conference. Ultimately, this optical technique aims to deepen the understanding of ion-induced acoustic phenomena and to advance diagnostic capabilities for laser-accelerated ion sources in radiation-research environments.[1] S. Gerlach et al., High Power Laser Science and Engineering 11, 38 (2023)

AKBP 11: Plasma Accelerators, Diagnostics II

Time: Wednesday 16:30–17:30 Location: SCH/A117

AKBP 11.1 Wed 16:30 SCH/A117

Time-Resolved Optical Probing of Water Vapor Effects in Laser-Driven Ion Acceleration — •Kumudini Devendra Pagare, Florian Schweiger, Julia Liese, Alexander Prasselsperger, Sonja Gerlach, Hannah Forsthuber, and Jörg Schreiber — LMU München, Fakultät für Physik-Medizinische Physik, Am Coulombwall 1, 85748 Garching

Applications in laser-driven ion acceleration demand stable and reproducible ion beams with well-controlled properties. The quality of these ion beams depends critically on the dynamics of laser-target interactions, which are determined by both laser and target parameters. Time-resolved optical probing provides insight into these rapid interaction dynamics, revealing the processes responsible for ion acceleration and the mechanisms involved. Here, we examine how water vapor emitted from a recently implemented liquid-leaf target at the Centre for Advanced Laser Applications (CALA) influences the acceleration process. We employ interferometric diagnostics to quantify spatiotemporal vapor density profiles in front of the target surface. This allows us to assess how the expanding vapor interacts with the main laser pulse and affects ion acceleration. These findings elucidate the complex dynamics of laser-target interactions and help optimize the resulting ion beam properties. This work was supported by the DFG under Grant Number 558546291 and CALA.

AKBP 11.2 Wed 16:45 SCH/A117

Active mirror cooling concept for high average power, high peak power Ti:Sapphire laser amplifiers — •Anneli Dick[1,2], Juan B. Gonzalez-Diaz[1], Thomas Hülsenbusch[1], Leonie Jaworski[1], Lutz Winkelmann[1], Andreas R. Maier[1], and Guido Palmer[1] — [1]Deutsches Elektronen Synchrotron DESY, Hamburg, Germany — [2]University of Hamburg, Hamburg, Germany

Advancing laser plasma accelerators from a few-hertz repetition rate to the kHz-regime is essential for unlocking next-generation applications, including free-electron lasers and direct synchrotron injection. Moreover, a high-repetition rate enables direct active stabilization of crucial laser parameters which will support sub-percent energy spread from the plasma accelerator. For efficient electron acceleration, 100 TW-level laser pulses are required, which are commonly generated by chirped pulse Ti:Sapphire amplifier systems. The Kaldera laser system at DESY is being developed to drive such a high-repetition-rate plasma accelerator. It is currently providing J-level energies at 100 Hz repetition rate. However, one major challenge of power scaling this material is the thermal load generated at high repetition rates and pump energies due to its high quantum defect. To control the resulting thermal effects more efficiently, new cooling concepts are required. Theoretical investigations on cryogenically cooled active mirror amplifiers have shown they can be a promising method to achieve this. The presented work evaluates this approach experimentally with respect to further power scaling of the Kaldera laser towards the multi-100 W range.

AKBP 11.3 Wed 17:00 SCH/A117

Patch-MLP-Based Predictive Control: Simulation with an Upstream Pointing Stabilization for PHELIX Laser System — •Jiaying Wang[1], Jonas Benjamin Ohland[3], Yen-Yu Chang[4], Vedhas Pandit[1], Stefan Bock[1], Andrew-Hiroaki Okukura[6], Udo Eisenbarth[3], Arie Irman[1], Michael Bussmann[1], Ulrich Schramm[1,2], and Jeffrey Kelling[1,5] — [1]HZDR, Dresden,Germany — [2]Technische Universität Dresden, Dresden, Germany — [3]GSI Helmholtzzentrum für Schwerionenforschung, Germany — [4]Amplitude laser group - Dresden operations, Germany — [5]Chemnitz University of Technology, Chemnitz, Germany — [6]Extreme Light Infrastructure - Nuclear Physics, National Institute for Physics and Nuclear Engineering, Ilfov, Romania

High-energy laser facilities such as PHELIX at GSI require excellent beam-pointing stability to ensure reproducibility and reliable operation. Conventional PID control mitigates slow drift but is fundamentally limited by diagnostic latency and mirror inertia. We introduce a predictive control scheme in which beam-pointing errors are forecast using a patch-based multilayer perceptron, and the predicted errors are converted into correction signals via a PID controller. This feedforward strategy compensates for system delay and is trained directly on diagnostic time-series data. Simulations with an upstream correction mirror at the PHELIX pre-amplifier bridge show reduced residual jitter compared with conventional PID control. Across a 10-hour dataset, the predictive controller remained drift-free and improved pointing metrics by approximately 10%-20%.

AKBP 11.4 Wed 17:15 SCH/A117

2D Measurements of Laser Angular Chirps for the DRACO CPA Laser system — •Mohamed Samir[1,2], Maxwell Laberge[1], Susanne Schöbel[1], Yen-Yu Chang[1], Patrick Ufer[1,2], Franziska Marie Herrmann[1,2], Stefan Bock[1], Ulrich Schramm[1,2], and Arie Irman[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf (HZDR) — [2]Technische Universität Dresden

Controlling spatio-temporal properties of ultrashort, high-power laser pulses is essential for laser-matter interactions, particularly Laser Wakefield Acceleration (LWFA). For such broadband pulses, angular dispersion (AD) becomes detrimental due to unavoidable transmissive optics or misalignment in the chirped-pulse amplification (CPA) chain. This dispersion induces wave-front tilt (WFT), degrading the focal spot, lowering the peak intensity on target, and introducing wakefield asymmetries that deflect the accelerated electron beam, thereby reducing the efficiency and stability of the acceleration process.

To quantify this for efficient LWFA and to support next-generation, dephasingless LWFA (DLWFA) concepts, we implemented a compact optical setup and conducted measurements at various positions along the 100-TW DRACO laser chain and inside the target chamber. The laser's AD and WFT were fully characterized in 2D and subsequently corrected at the target-chamber focal plane using the main TW compressor. The setup also enables precise spectral measurements, highly compact (~20 cm), lens configurable, and easily integrated.

These characterizations will support more stable, efficient laser wakefields, while serving as key diagnostics for DLWFA schemes.

AKBP 12: Novel Accelerators I

Time: Thursday 9:30–11:00 Location: SCH/A117

Topical Talk AKBP 12.1 Thu 9:30 SCH/A117

Cutting-edge research and technology at KIT's advanced accelerator facilities — •Erik Bründermann — IBPT Accelerator Team, KIT, Karlsruhe, Deutschland

The Institut für Beschleunigerphysik und Technologie (IBPT) at the Karlsruhe Institute of Technology (KIT) operates a unique suite of accelerator facilities. These include the Karlsruhe Research Accelerator (KARA) with its electron storage ring (0.5-2.5 GeV) and booster synchrotron (50-500 MeV), the short-pulse linear accelerator FLUTE (40-90 MeV), and the KITTEN test center for energy-efficient research infrastructures. In addition, IBPT is developing compact laser-plasma accelerators (LPAs). Together with its Magnet and Cryogenics Facilities of the Accelerator Technology Platform (ATP), KIT offers an outstanding environment for accelerator research and technology transfer. Looking ahead, the compact storage ring cSTART will be established to explore non-linear and non-equilibrium physics, with FLUTE and LPAs serving as injectors.

In this group report, we present the current and upcoming accelerator test facilities at KIT and highlight key results in accelerator physics and technology, including the first superconducting THz undulator, ultra-high-dose operation modes of FLUTE, and innovative diagnostic techniques.

AKBP 12.2 Thu 10:00 SCH/A117

Simulations of a Plasma Booster for the European XFEL — •Anna Krivkova[1], Tianyun Long[1], Alexander Sinn[1], Maxence Thevenet[1], Stephan Wesch[1], Matthew Wing[1,2], and Jonathan Wood[1] — [1]Deutsches Elektronen-Synchrotron DESY, 22607 Hamburg, Germany — [2]University College London, London WC1E 6BT, United Kingdom

Proposed upgrades of the European XFEL include continuous-wave operation, which requires lowering maximum beam energy from 17.5 GeV to about 8 GeV to facilitate a large increase in repetition rate. A beam-driven plasma accelerator offers a compact and efficient solution to compensate for this energy loss. By integrating a plasma booster into an existing beamline, the European XFEL could restore its nominal beam energy and potentially exceed the current 17.5 GeV limit. To evaluate the feasibility and performance of such a booster, we perform particle-in-cell simulations in HiPACE++ using several gas species over a range of plasma densities. The accelerating gradients consistently reach the multi-GV/m regime, with realistic peak values of about 8 GV/m. The simulations further show that the 5 kA, high-brightness XFEL bunches present challenges for plasma wakefield acceleration due to strong ion motion and beam-induced ionization, increasing the emittance and energy spread of the accelerated witness bunch. Mitigation strategies, including optimization of the initial driver and witness emittance, will be presented.

AKBP 12.3 Thu 10:15 SCH/A117

all-optical In-plasma multi-staging of Laser-Wakefield Accelerators using density tailoring — •Xingjian Hui, Alberto Martinez de la ossa, Alexander Sinn, Ángel Ferran pousa, Rob Shalloo, and Maxence Thévenet — DESY, Hamburg, Germany

The staging of laser-driven plasma accelerators (LPAs) could open up energy frontiers, but achieving in- and out-coupling of laser pulses while preserving beam quality remains a challenge. In this work, we present an all-optical, in-plasma staging scheme that uses refraction in a transverse plasma density gradient to couple the incoming laser into the next LPA stage, eliminating the need for mirrors and magnets. This design can in principle support significant ion motion without substantial emittance degradation, making it well-suited for a broad energy range. With realistic 3D simulations using the quasistatic particle-in-cell code HiPACE++ on GPU, we observe 98% capture efficiency and 15+3+3 GeV energy gain per within 3 stages with emittance preserved and proper bean loading, driven by a ~20J for first stage and ~10 J laser pulse for followings guided by a hydrodynamic optical-field-ionized (HOFI) channel of matched spot size 30 microns. These results represent a significant step toward practical multistage plasma acceleration, paving the way for the generation of ultra-high-energy electron beams for a wide range of scientific and technological applications.

AKBP 12.4 Thu 10:30 SCH/A117

Microsecond-timescale plasma density growth by electron beam energy deposition in plasma-wakefield accelerators — •Judita Beinortaite[1], Jonas Björklund Svensson[1], Lewis Boulton[1], Greg Boyle[2], Brian Foster[1,3], Pau González Caminal[1], Harry Jones[1], Advait Kanekar[1,4], Anna Křivková[1], Gregor Loisch[1], Jens Osterhoff[1], Felipe Peña[1,4], Sarah Schröder[1], Stephan Wesch[1], Matthew Wing[1,5], Jonathan Wood[1], and Richard D'Arcy[1,3] — [1]DESY, Germany — [2]James Cook University, Australia — [3]J.A.I, UK — [4]University of Hamburg, Germany — [5]University College London, UK

High-repetition-rate operation of plasma-wakefield accelerators is essential for their suitability in the design of particle colliders and Free-Electron Lasers (FELs). Energy remaining in the plasma after the wakefield acceleration event can limit the repetition rate of the plasma accelerator as the plasma takes time to relax to its initial state. This relaxation is dominated by two ion-driven effects: their redistribution after the wakefield event and potential further collisional ionisation caused by this motion. In this work, we investigated argon plasma at a variety of working points with two different diagnostics: the pump-probe electron-beam-based technique and optical-emission spectrometry. In some regimes, both diagnostics indicated additional ionisation occurring on the nanoseconds-to-microsecond timescale for specific initial plasma conditions, which increased the recovery time. This can inform the design of the highest-repetition-rate plasma sources for future colliders and FELs.

AKBP 12.5 Thu 10:45 SCH/A117

Radiation Signatures from Injection Lasers in Plasma Wakefield Accelerators — •Finn-Ole Carstens[1,2], Alexander Debus[1], Klaus Steiniger[1], Michael Bussmann[1], Fabia Dietrich[1,2], Maxwell LaBerge[1], Susanne Schoebel[1], Jessica Tiebel[1,2], Patrick Ufer[1,2], Nico Wrobel[1,2], Arie Irman[1], Ulrich Schramm[1,2], and Richard Pausch[1] — [1]Helmholtz-Zentrum Dresden - Rossendorf, Dresden, Germany — [2]Dresden University of Technology, Dresden, Rossendorf

Plasma-wakefield acceleration driven by electron beams from laser-wakefield accelerators enables compact, two-stage schemes of electron accelerators. The trojan horse injection method uses a transverse, femtosecond laser pulse to ionize electrons inside the first plasma cavity and promises high-brightness electron bunches. Unexpectedly, experiments showed a distinct radiation feature in shadowgraphy images whenever this injection laser interacted with the plasma wake. This effect that turned out to be crucial for timing calibration but was not understood.

We investigate this signal using particle-in-cell simulations equipped with an in-situ imaging plugin based on Fourier propagation, which models the shadowgraphy diagnostic directly during runtime. This approach allows tracing the formation of the observed feature and reveals that it originates from Thomson scattering of the injection laser of the sheath electrons of the PWFA cavity. In this contribution, we present the mechanism behind the signal and show how it can be used to infer structural properties of the plasma cavity.

AKBP 13: Novel Accelerators II

Time: Thursday 11:30–12:30 Location: SCH/A117

AKBP 13.1 Thu 11:30 SCH/A117

High-Repetition-Rate Electron Beams from a Multi-kHz LPA Driven by an Industrial Laser System — Bonaventura Farace[1], Kristijan Poder[1], •Taegyu Pak[1], Esmerando Escoto[1], Nikita Khodakovskiy[1], Christoph Heyl[1], and Wim Leemans[1,2] — [1]Deutsches Elektronen-Synchrotron DESY, Notkestr. 85, 22607 Hamburg, Germany — [2]University of Hamburg, Department of Physics, Jungiusstr. 9, 20355 Hamburg, Germany

Laser-plasma accelerators (LPAs) provide a compact platform for generating ultrashort, high-brightness electron beams and are gaining attention as next-generation electron sources. For practical use, the driving laser must operate stably at high repetition rates with high average power and scalability. Here, we report the first demonstration of electron acceleration using an industrial Yb-based laser compressed via a multi-pass cell (MPC) post-compression stage. The Yb:YAG laser was spectrally broadened in a 2-m long MPC and compressed from 1.3 ps to 49 fs, delivering 9 mJ on target at repetition rates up to 12.5 kHz. With these post-compressed pulses, we generated high-repetition-rate electron beams and characterised their charge, energy spectrum and transverse beam profile. The source produced 10 pC per shot with a thermal-like spectrum extending up to 5 MeV and operated robustly in the multi-kHz regime. These results demonstrate a new technological route for generating high-repetition-rate electron beams with industrial Yb lasers. They also open pathways toward applications that require high repetition rates and ultrashort pulses, including ultrafast electron diffraction and FLASH-type irradiation schemes.

AKBP 13.2 Thu 11:45 SCH/A117

Temperature diagnostics for MHz-repetition-rate plasma accelerator sources — •Juan Pablo Díaz[1,2], Judita Beinortaite[1], Maryam Huck[1], Harry Jones[1], Anna Křivková[1], Gregor Loisch[1], Gudrid Moortgat-Pick[1,2], Lukas Müller[1], Trupen Parikh[1], Stephan Wesch[1], Matthew Wing[3,1], and Jonathan Wood[1] — [1]DESY, Hamburg, Germany — [2]Universität Hamburg, Germany — [3]University College London, UK

Electron-bunch-driven plasma-wakefield accelerators promise to revolutionize particle acceleration by providing compact and cost-effective energy boosters for electron linacs which could, for example, significantly enhance the photon energies produced by free-electron lasers. The FLASHForward facility at DESY has made substantial progress, demonstrating that accelerated electron bunches can maintain their charge, energy spread, and emittance during plasma acceleration. A major challenge remains in achieving high-repetition-rate operation. Reaching MHz-level repetition rates, necessary to match superconducting RF linac bunch patterns, means generating reproducible plasma acceleration events at MHz frequencies. Doing so poses significant challenges: keeping the plasma density uniform over these rapid cycles and dealing with the high heat load placed on the plasma cell by the plasma formation process and the drive beam. In this contribution, we report on recent efforts to characterize the long-term heating effects arising in a discharge plasma source at repetition rates up to 1 kHz. We will present measurements of the time evolution of the discharge plasma source and discuss the implications of these results.

AKBP 13.3 Thu 12:00 SCH/A117

Statistical analysis of sources of instability in electron beam quality in laser plasma accelerators preparing for Bayesian optimization — •Franziska Marie Herrmann[1,2], Maxwell Laberge[1], Yen-Yu Chang[1], Amin Ghaith[1], Jeffrey Kelling[1], Susanne Schöbel[1], Patrick Ufer[1,2], Ulrich Schramm[1,2], and Arie Irman[1] — [1]HZDR, Dresden, Germany — [2]Technische Universität Dresden, Dresden, Germany

Laser-electron accelerators are emerging as novel, compact sources of high-quality relativistic electron beams for a wide range of applications. Each experimental application requires unique electron parameters. Additionally, all the input parameters are interconnected, resulting in a highly complex parameter space. To address this issue, we have developed a semi-automated Bayesian optimization loop that adjusts six input parameters simultaneously to achieve optimal electron beam parameters. However, the high nonlinearity of laser wakefield acceleration poses a challenge for automated optimization, as even minor fluctuations in input parameters can lead to significant changes in electron beam properties. To quantify and mitigate the effects of these statistical fluctuations, we have compiled an extensive dataset through systematic studies of their characteristics and influence on the electron beam quality. Alongside demonstrating an initial prototype for semi-automated Bayesian optimization, this work will enhance the understanding of the underlying sources of instability in laser-plasma acceleration experiments, which are essential for more complex machine learning experiments.

AKBP 13.4 Thu 12:15 SCH/A117

Characterization of kinetic instabilities in high-intensity, short-pulse, laser-driven solid-density plasmas — •Jannis Schulz — TU Dresden — HZDR

We present a study of instabilities in plasmas generated by the interaction of electron beams accelerated by intense femtosecond laser pulses with dense solid targets. At intensities exceeding 10^{18} W/cm^2, the beam-plasma system develops collective processes that strongly influence energy and particle transport. As an overarching framework, the analysis of linear stability properties is used to systematically describe the emergence and evolution of characteristic structures. The main emphasis lies on transverse filamentation instabilities, in particular the collisional-resistive regime, whose growth is strongly affected by electrical conductivity and current distribution. In addition, longitudinal processes such as the two-stream instability are examined, arising from counter-propagating electron populations. The classification relies on analytically derived dispersion relations, which allow the comparison of growth rates and wavelengths with numerical simulations and latest experiments performed at LCLS and EuropeanXFEL. The objective is to clarify the mechanisms that drive the development of these instabilities, connect them to the structures observed in the simulations, and ultimately connect them to the underlying plasma conditions (e.g. beam and background densities and effective temperatures).

AKBP 14: RF Cavities II

Time: Thursday 15:00–15:45 Location: SCH/A117

AKBP 14.1 Thu 15:00 SCH/A117

Development and Realization of a new Chopper Cavity for the S-DALINAC* — •Vincent Pruy, Arnold Michaela, Ruben Grewe, Katharina E. Ide, Lars Jürgensen, Lisa Dingeldein, Clemens M. Nickel, Norbert Pietralla, and Dominic Schneider — Institut für Kernphysik, Technische Universität Darmstadt, Darmstadt, Germany

The operation of the superconducting radio-frequency cavities of the S-DALINAC [1] relies on a bunched electron beam. Currently, the continuous beam generated by the thermionic gun is divided into bunches using a chopper system incorporating a single deflecting cavity. However, this system induces nonlinear curvatures in the beam trajectory. A second, identically constructed deflecting cavity can be employed to re-bend the beam thus counteracting the nonlinear distortions. Comprehensive electromagnetic and particle-tracking simulations aimed at optimizing the cavitiy's deflection behavior and quality factor have already been completed. This work further concluded the in-house fabrication of the cavity and its commissioning in the injector beamline of the S-DALINAC. In this contribution, we report on the manufacturing process and the measured properties of the cavity. In addition, we propose a viable concept realizing a double chopper system based on the existing components.

[1] N. Pietralla, Nucl. Phys. News, Vol. 28, No. 2, 4 (2018).

*This work is supported by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) * Project-ID 499256822 * GRK 2891 'Nuclear Photonics'.

AKBP 14.2 Thu 15:15 SCH/A117

Development of a New Prebuncher for the 26 MeV S-band Linac at ELSA — •Nicholas Treska, Klaus Desch, Jerome Orbons, Michael Switka, Dennis Proft, and Philipp Hänisch — Physikalisches Institut der Universität Bonn

A new prebuncher for the 26 MeV S-band linac at ELSA is being developed. A range of CST simulations and prototype measurements indicate the potential for improvements in transfer efficiency, vacuum performance, and electric field characteristics. A test stand for the characterization of prototypes is set up. The work focuses on assessing the feasibility and performance of the new design.

AKBP 14.3 Thu 15:30 SCH/A117

Design of a fast reactive tuner for 1.3 GHz TESLA cavities at MESA — •Ricardo Monroy-Villa[1], Ilan Ben-Zvi[2], Florian Hug[1], and Timo Stengler[1] — [1]Institute for Nuclear Physics, Johannes Gutenberg-Universität Mainz, Mainz, Germany — [2]Physics and Astronomy Department, Stony Brook University, New York, USA

We present a state-of-the-art design of a Ferroelectric Fast Reactive Tuner (FE-FRT), capable of modulating high reactive power in TESLA-type cavities on a microsecond time scale. The Mainz Energy-Recovering Superconducting Accelerator employs 1.3 GHz superconducting radio-frequency (SRF) cavities, achieving quality factors of the order of 10^10. However, detuning of 25 Hz induced by microphonics has led to the use of strong coupling for the fundamental power coupler, requiring high-power amplifiers, orders of magnitude above the intrinsic dissipation. Current solutions to mitigate microphonics rely on piezoelectric tuners, which are not fast enough for the spectral range of the microphonics. A novel alternative is the FE-FRT, a technology made possible by low-loss ferroelectric materials, which offer sub-microsecond response times. Analytical results are provided along with their validation through finite-element simulations. The FE-FRT can handle substantial reactive power while offering a tuning range of 50 Hz in SRF cavities, resulting in a reduction in peak forward RF power by about an order of magnitude.

AKBP 15: AKBP Prize Talks

Time: Thursday 16:00–17:30 Location: SCH/A117

AKBP 15.1 Thu 16:00 SCH/A117

Master course accelerator research - a joint effort of the Rhein Main Universities (RMU) — •Aulenbacher Kurt — Institut für Kernphysik Universität Mainz

Goethe-University Frankfurt, Johannes Gutenberg-University Mainz and TU-Darmstadt have developed a new educational concept in the field of accelerators. It is based on the unique situation in the Rhein-Main area where three universities are not only contributing to the GSI/FAIR project but also operate particle accelerators on their respective campus. This creates a unique opportunity to educate students coming from different areas, such as electric engineering or physics, towards a master degree in accelerator research. This qualification will address the needs for qualified accelerator personnel in industry and science. The talk will present the structure of the educational program and the specific possibilities of the contributing universities.

AKBP 15.2 Thu 16:30 SCH/A117

Young Investigator Prize AKBP — •N N — NN

Prize talk tbd

AKBP 15.3 Thu 17:00 SCH/A117

Horst Klein Prize Talk — •N N — NN

Prize Talk tbd

AKBP 16: Members' Assembly

Time: Thursday 18:00–19:00 Location: SCH/A117

All members of the Working Group on Accelerator Physics are invited to participate.