Working Group on Accelerator physics
Arbeitskreis Beschleunigerphysik (AKBP)

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Overview of Sessions

Sessions

AKBP 1.1–1.10	Mon	16:00–18:30	AKBPa	**Beam Dynamics**
AKBP 2.1–2.8	Tue	14:00–16:00	AKBPa	**New Accelerator Concepts**
AKBP 3.1–3.8	Tue	14:00–16:00	AKBPb	**Radiofrequency**
AKBP 4.1–4.8	Tue	16:30–18:30	AKBPa	**New Accelerator Concepts and Hadron Accelerators**
AKBP 5.1–5.6	Tue	16:30–18:00	AKBPb	**Radiofrequency and Miscellaneous**
AKBP 6.1–6.9	Wed	14:00–16:15	AKBPa	**Diagnostics, Control and Instrumentation I**
AKBP 7.1–7.9	Wed	14:00–16:15	AKBPb	**Electron Accelerators**
AKBP 8.1–8.8	Wed	16:30–18:30	AKBPa	**Diagnostics, Control and Instrumentation II**
AKBP 9.1–9.8	Wed	16:30–18:30	AKBPb	**Electron Accelerators and Particle Sources**
AKBP 10.1–10.9	Thu	14:00–16:15	AKBPa	**Synchrotron Radiation and FELs**
AKBP 11.1–11.8	Thu	16:30–18:30	AKBPa	**Diagnostics, Control and Instrumentation III**
AKBP 12	Thu	19:00–21:00	AKBPm	**General Assembly of the Working Group on Accelerator Physics**

Annual General Meeting of the Working Group on Accelerator physics

Thursday 19:00–21:00 AKBPm

AKBP 1: Beam Dynamics

Time: Monday 16:00–18:30 Location: AKBPa

AKBP 1.1 Mon 16:00 AKBPa

Beam Dynamics Simulations for the Multi-Turn Energy Recovery Mode at the S-DALINAC* — •Felix Schliessmann, Michaela Arnold, and Norbert Pietralla — Institut für Kernphysik, Technische Universität Darmstadt, Darmstadt, Germany

In August 2017, the electron accelerator S-DALINAC [1] at TU Darmstadt was initially operated in the so-called energy recovery mode using one recirculation beamline [2]. Here, once accelerated electrons are guided back to the cavities with an induced phase shift of approximately 180°. In this way, the electrons are decelerated and will restore energy to the cavities, which can then be used to accelerate subsequent electrons.

In the upcoming beam time, the S-DALINAC shall be operated in energy recovery mode using two recirculation beamlines, what involves further challenges: on the one hand, two beams are now superimposed in a recirculation beamline and four beams are superimposed in the linac, and on the other hand, the phase slippages during the linac passes reach such a critical level that they have to be determined in advance and compensated by suitable amplitude and phase settings.

This contribution addresses the necessary beam dynamics simulations in order to realize this multi-turn energy recovery mode.

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

[2] M. Arnold et al., Phys. Rev. Accel. Beams 23, 020101 (2020).

*Work supported by BMBF through grant No. 05H18RDRB2, DFG through GRK 2128 and by the state of Hesse through the LOEWE Research Cluster Nuclear Photonics.

AKBP 1.2 Mon 16:15 AKBPa

TRIB optics examined by Lie algebraic tools — •Jernej Frank[1,2], Michael Arlandoo[1], Paul Goslawski[1], Ji Li[1], Tom Mertens[1], and Markus Ries[1] — [1]Helmholtz-Zentrum Berlin für Materialien und Energie — [2]Freie Universität Berlin

At BESSY II in Berlin, a third-generation synchrotron light source facility, two orbits can be populated with different electron bunch fill patterns and provide to some extent two different radiation sources offering unique possibilities to its users. The second stable orbit in the machine was successfully produced by generating Transverse Resonance Island Buckets (TRIBs). In an ongoing effort to get a theoretical handle on the non-linear contributions that lead to TRIBs, we employ Lie algebraic theory to classify effects by order of non-linearity. In contrast to pure numerical particle tracking these tools allow us to enter the "black box" and examine qualitative behaviors such as the impact of symmetry breaking in the operator algebra context usually encountered in quantum field theory. As the whole machine is too complex, we present simple toy models (sections of the optical lattice) that demonstrate the non-linear behavior of the individual machine elements and their impact on lattice design. This contribution revisits Lie algebraic theory as a vital tool for the theoretical understanding of non-linear dynamics and gives a progress report about the importance of basic machine elements that are usually approximated to the linear regime, but produce rich non-linear effects that should not be neglected.

AKBP 1.3 Mon 16:30 AKBPa

The Metrology Light Source 2 — •Michael Arlandoo[1,2] and Paul Goslawski[1] — [1]Helmholtz-Zentrum Berlin für Materialien und Energie — [2]Humboldt-Universität zu Berlin

The Physikalisch-Technische Bundesanstalt (PTB), in cooperation with the Helmholtz-Zentrum Berlin (HZB), operates the Metrology Light Source (MLS), which is a low-energy electron storage ring. The MLS can be operated in a low-alpha mode to produce coherent synchrotron ration in the far-IR and THz spectral range. In the scope of the Conceptual Design process for a BESSY II successor, the PTB asked also for a MLS successor to cover their increasing demands on synchrotron radiation. A combination of two different machines, one optimized for low emittance (BESSY 3) and the other for flexible timing capabilities (MLS 2), will provide best radiation capabilities for our user community. In this paper, we discuss the demands on the MLS 2 and propose first lattice candidates which satisfy the needs of the PTB and HZB. Currently, we focus on linear lattices with first steps towards non-linear optimization. The lattice design has to include the option for a robust low-alpha operation mode and should be checked for the possibility of TRIBs (Transverse Resonance Island Buckets).

AKBP 1.4 Mon 16:45 AKBPa

Optics Studies at the DELTA Storage Ring — •Benedikt Büsing, Shaukat Khan, Stephan Kötter, Carsten Mai, Boris Sawadski, Detlev Schirmer, and Gerald Schmidt — Center for Synchrotron Radiation (DELTA), TU Dortmund University, Dortmund, Germany

DELTA is a 1.5-GeV synchrotron light source operated by the TU Dortmund University providing synchrotron radiation in a spectrum from hard X-rays to the VUV regime. A new 22-pole 7-T superconducting wiggler has been installed in 2020, optics studies and beta function measurements were performed to compensate the vertical focussing effect. Also studies on bunch shortening by reducing the momentum compaction factor will be presented.

AKBP 1.5 Mon 17:00 AKBPa

Split-ring-resonator experiment at FLUTE - Simulation results — •Jens Schäfer for the FLUTE-Collaboration — KIT, Karlsruhe, Deutschland

FLUTE (Ferninfrarot Linac- Und Test-Experiment) is a compact linac-based test facility for accelerator and diagnostics R&D. An example for a new accelerator diagnostics tool currently studied at FLUTE is the split-ring-resonator (SRR) experiment, which aims to measure the longitudinal bunch profile of fs-scale electron bunches. Laser-generated THz radiation is used to excite a high frequency oscillating electromagnetic field in the SRR. Particles passing through the SRR gap are time-dependently deflected in the vertical plane, which allows a vertical streaking of an electron bunch. This principle allows a diagnosis of the longitudinal bunch profile in the femtosecond time domain and will be tested at FLUTE. This contribution presents an overview of the SRR experiment and the results of various tracking simulations for different scenarios as a function of laser pulse length and bunch charge. Based on these results possible working points for the experiments at FLUTE will be proposed.

AKBP 1.6 Mon 17:15 AKBPa

Detailed studies of the effects of solenoid misalignment and development of beam-based alignment methods for FLUTE — •Micha Reissig for the FLUTE-Collaboration — KIT, Karlsruhe, DE

FLUTE (Ferninfrarot Linac- Und Test-Experiment) is a versatile linac-based test facility at the Karlsruhe Institute of Technology (KIT). It is designed to generate strong ultra-short THz pulses and to provide a platform for detailed accelerator studies and diagnostic development. The aim of wideband THz generation requires electron bunches with a length of a few femtoseconds, therefore a photoinjector is used as electron source. Shortly after the photoinjector, a solenoid is installed to focus the initially diverging beam. Accurate alignment of the magnet is required to avoid transverse deflection of the beam when adjusting operational parameters such as the beam energy or the focal length of the magnet. This presentation provides a detailed study on the effects of solenoid misalignment based on numerical tracking simulations for the FLUTE injector section. Based on this study, an iterative beam-based alignment procedure has been developed. In addition, this contribution provides a proof-of-concept for a software routine that fits the results of simulations to measurement data and, thereby, determines the misalignment of the solenoid.

AKBP 1.7 Mon 17:30 AKBPa

Single-shot spectral fingerprints for continuous observation of the microbunching instability at KARA — •Miriam Brosi[1], Erik Bründermann[1], Carsten Mai[3], Matthias Martin[2], Martin Laabs[4], Niels Neumann[4], Patrick Schreiber[2], Marcel Schuh[1], Johannes L. Steinmann[1], and Anke-Susanne Müller[1,2] — [1]IBPT, KIT, Karlsruhe — [2]LAS, KIT, Karlsruhe — [3]Technische Universität Dortmund — [4]Technische Universität Dresden

The micro-bunching instability occurring in an electron storage ring for short electron bunches leads to the emission of coherent synchrotron radiation (CSR) in the terahertz range. This collective instability can be studied by observing the resulting fluctuations in the emitted CSR power with fast THz detectors. The measurements presented in this

contribution were conducted at the KIT electron storage ring KARA (KArlsruhe Research Accelerator) in a dedicated short-bunch operation mode. For the measurements of these instability-induced CSR power fluctuations, an on-chip THz spectrometer providing a spectral fingerprint was used. The mm-sized chip contains eight antennas that are sensitive in different frequency ranges from 50 GHz up to 700 GHz, each connected to a Schottky-diode detector element. The on-chip spectrometer was read-out with the new version of the KArlsruhe Pulse Taking and Ultrafast Readout Electronics system, KAPTURE-2, providing continuous bunch-by-bunch data.

This work was supported by the BMBF projekt 05K16VKA NeoDyn (Federal Ministry of Education and Research).

AKBP 1.8 Mon 17:45 AKBPa

Electron beam studies from intensity modulated photocathode laser pulses for seeding a THz FEL — •Georgi Georgiev[1], Namra Aftab[1], Prach Boonpornprasert[1], Natthawut Chaisueb[1], James Good[1], Matthias Gross[1], Christian Koschitzki[1], Mikhail Krasilnikov[1], Xiangkun Li[1], Osip Lishilin[1], Anusorn Lueangaramwong[1], David Melkumyan[1], Sandeep Mohanty[1], Raffael Niemczyk[1], Anne Oppelt[1], Houjun Qian[1], Hamed Shaker[1], Guan Shu[1], Frank Stephan[1], Grygorii Vashchenko[1], Tobias Weilbach[1], and Wolfgang Hillert[2] — [1]Deutsches Elektronen-Synchrotron DESY, Platanenallee 6, 15738 Zeuthen, Germany — [2]University of Hamburg, 22761 Hamburg, Germany

A THz source is foreseen at the European XFEL for pump and probe experiments. As part of the efforts, a proof-of-principle experiment for an intense FEL-based THz source is under development at the Photo Injector Test Facility at DESY in Zeuthen (PITZ). Different FEL seeding schemes are considered, including temporal photocathode laser pulse modulation. A sub-THz modulated pulse is generated by introducing a Lyot filter into the laser system. The laser pulse is then converted into an electron bunch at the photocathode, which is transported downstream the accelerator until the location of a station for coherent transition radiation. Beam dynamics simulations and experimental results are presented.

AKBP 1.9 Mon 18:00 AKBPa

Effect of negative momentum compaction operation on the current-dependent bunch length at KARA — •Patrick Schreiber[1], Tobias Boltz[1], Miriam Brosi[2], Bastian Haerer[2], Akira Mochihashi[2], Alexander Papash[2], Robert Ruprecht[2], Marcel Schuh[2], and Anke-Susanne Müller[1,2] — [1]LAS, KIT, Karlsruhe — [2]IBPT, KIT, Karlsruhe

New operation modes are considered during the development of new synchrotron light sources. An understanding of the effects involved is inevitable for a successful operation of these schemes. At the KIT storage ring KARA (Karlsruhe Research Accelerator), new modes can be implemented and tested employing a variety of performant beam diagnostics devices. Negative momentum compaction optics at various energies have been established. Also the influence of a negative momentum compaction factor on different effects has been investigated. This contribution will show a short report on the status of the implementation of negative momentum compaction optics at KARA. Additionally, first measurements of the changes to the current-dependent bunch length will be presented.

Patrick Schreiber and Tobias Boltz acknowledge the support by the Doctoral School "Karlsruhe School of Elementary and Astroparticle Physics: Science and Technology"

AKBP 1.10 Mon 18:15 AKBPa

Excitation of micro-bunching in short electron bunches using RF amplitude modulation — •Tobias Boltz, Edmund Blomley, Miriam Brosi, Erik Bründermann, Bastian Härer, Akira Mochihashi, Patrick Schreiber, Marcel Schuh, Minjie Yan, and Anke-Susanne Müller — KIT, Karlsruhe, Deutschland

In its short-bunch operation mode, the KIT storage ring KARA provides picosecond-long electron bunches, which emit coherent synchrotron radiation (CSR) up to the terahertz frequency range. Due to the high spatial compression under these conditions, the self-interaction of the bunch with its own emitted CSR induces a wakefield, which significantly influences the longitudinal charge distribution. Above a given threshold current, this leads to the formation of dynamically evolving micro-structures within the bunch and is thus called micro-bunching instability. As CSR is emitted at wavelengths corresponding to the spatial dimension of the emitter, these small structures lead to an increased emission of CSR at higher frequencies. The instability is therefore deliberately induced at KARA to provide intense THz radiation to dedicated experiments. To further increase the emitted power in the desired frequency range, we consider the potential of RF amplitude modulations to intentionally excite this form of micro-bunching in short electron bunches.

This work is supported by the BMBF project 05K19VKC TiMo (Federal Ministry of Education and Research).

AKBP 2: New Accelerator Concepts

Time: Tuesday 14:00–16:00 Location: AKBPa

AKBP 2.1 Tue 14:00 AKBPa

Polarimeter Design for a LPA Electron Beam — •Jennifer Popp[1,2], Simon Bohlen[1], Jenny List[1], Gudrid Moortgat-Pick[2,1], Jens Osterhoff[1], Kristjan Põder[1], and Felix Stehr[1,2] — [1]Deutsches Elektronen-Synchrotron (DESY), Hamburg — [2]Universität Hamburg

Laser Plasma Acceleration (LPA) with its extremely high gradients promises compact accelerators and great progress has been made in that direction. However, many applications in material science, nuclear and high energy physics require polarized electron beams.

The motivation of the LEAP project at DESY is the first time demonstration of LPA with polarization. The electron polarization will be measured with photon transmission polarimetry. It makes use of the production of circularly polarized Bremsstrahlung during the passage of the electrons through a suitable target. The photon polarization is then measured with the aid of the transmission asymmetry related to the magnetization direction of an iron absorber.

In this contribution simulation studies and a design for the polarimeter for a future setup at DESY for the routine production of polarized electron beams are presented.

AKBP 2.2 Tue 14:15 AKBPa

The challenge and prospect of a plasma lens for the capture section of e+ sources in modern accelerator designs — •Manuel Formela[1], Gudrid Moortgat-Pick[1], Klaus Floettmann[2], and Niclas Hamann[1] — [1]Universität Hamburg — [2]DESY

The ILC is an ambitious international collaboration with its positron source especially being at the forefront of pushing technological boundaries. Part of this enterprise has to be the optical matching device responsible for catching positrons exiting a target and transforming them from a highly divergent beam with a small effective cross-section to a wide, parallel beam to be appropriate for the succeeding accelerator section. This problem has been approached by different types of sophisticated coils like the quarter wave transformer and flux concentrator for many years now. Today considerations exist to utilize a completely new principle based on an electric current passing a plasma. This so called plasma lens creates a magnetic field, which is potentially especially qualified for the usage as an optical matching device due to its pronounced azimuthal component in contrast to the radial component of conventional devices.

AKBP 2.3 Tue 14:30 AKBPa

Designing a matching device for positron sources — •Niclas Hamann[1], Manuel Formela[2], Gudrid Moortgat-Pick[3], and Klaus Flöttman[4] — [1]Uni Hamburg — [2]Uni Hamburg — [3]Uni Hamburg / DESY Hamburg — [4]DESY Hamburg

To realise a planned e+e- accelerators, as ILC, the accelerated particles have to be captured and matched according to the luminosity requirements. There exist several technical possibilities. In this talk a new promising alternative will be presented, the application of the plasma lense as an optical matching device. It will be compared with the current matching device namely the quarter wave transformer. An advantage of the plasma lense is a different magnetic field component

which focuses the divergent beam in a more effective manner. Therefore we will show in this talk that the yield requirements could be achieved more easily. The plasma lense can actually be a promising alternative for focussing beams as soon as the technical feasibility has been approved.

AKBP 2.4 Tue 14:45 AKBPa

LEAP: Polarized electrons from LPA — •Felix Stehr[1,2], Simon Bohlen[1], Jenny List[1], Gudrid Moortgat-Pick[1,2], Jens Osterhoff[1], Kristjan Põder[1], and Jennifer Popp[1,2] — [1]DESY — [2]Universität Hamburg

In recent years, laser plasma acceleration (LPA) has become a promising alternative to conventional RF accelerators. Polarized beams are indispensable for many experiments in particle, atomic and nuclear physics as well as in material science, where spin-dependent processes are to be studied. Theoretically, it has been shown that the interaction of multiple laser beams with a gas target can produce polarized electron beams through LPA. The LEAP (Laser Electron Acceleration with Polarization) project at DESY aims to demonstrate this experimentally for the first time. For this purpose, a LPA for the generation of polarized electron beams will be set up, as well as an electron polarimeter. The polarization of the electrons will be studied as a function of the laser and plasma parameters. The talk will give a general overview of the LEAP project and the generation of polarized beams.

AKBP 2.5 Tue 15:00 AKBPa

High stability OPCPA frontend for LPA Ti:Sapphire driver lasers — •Timo Eichner[1,3], Thomas Hülsenbusch[1,2,3], Julian Dirkwinkel[2], Tino Lang[2], Lutz Winkelmann[2], Guido Palmer[2], and Andreas R. Maier[1,2] — [1]Center for Free-Electron Laser Science and Department of Physics, University of Hamburg, Hamburg — [2]Deutsches Elektronen-Synchrotron (DESY), Hamburg — [3]These Authors contribute equally

Laser plasma acceleration (LPA) is a promising technology to drive the next generation of compact high brightness x-ray sources. Delivering the high electron beam quality, reproducibility and long-term stability required by applications is, however, still a major challenge. Here, we present a newly designed high-stability front-end for an LPA drive laser. The front-end consists of a white light seeded collinear OPCPA system, that is designed with the strict demands towards spatio-temporal beam quality and long-term stability in mind. We show first experimental results on the performance of the front-end that delivers highly stable >50uJ pulses with Fourier transform limit <25fs at a center wavelength of 800nm, suitable for seeding a high energy Ti:Sapphire laser system.

AKBP 2.6 Tue 15:15 AKBPa

Optimal beam loading in a laser-plasma accelerator — •Manuel Kirchen[1], Sören Jalas[1], Philipp Messner[2,1], Paul Winkler[3,1], Timo Eichner[1], Thomas Hülsenbusch[3,1], Laurids Jeppe[1], Trupen Parikh[3], Matthias Schnepp[1], and Andreas R. Maier[3,1] — [1]Center for Free-Electron Laser Science and Department of Physics Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg, Germany — [2]International Max Planck Research School for Ultrafast Imaging & Structural Dynamics, Luruper Chaussee 149, 22761 Hamburg, Germany — [3]Deutsches Elektronen Synchrotron (DESY), Notkestrasse 85, 22607 Hamburg, Germany

Applications of laser-plasma accelerators demand low energy spread beams and high-efficiency operation. Achieving both requires to flatten the accelerating fields by controlled beam loading of the plasma wave. Here, we tailor the current profile of an ionisation-injected electron bunch and optimize the laser-plasma dynamics to operate at such optimal beam loading conditions. This enables the reproducible production of 1.2% rms energy spread bunches with 282 MeV and 44 pC, at an estimated energy-transfer efficiency of 19%. We correlate shot-to-shot variations to reveal the phase space dynamics and train a neural network that predicts the beam quality as a function of the drive laser.

AKBP 2.7 Tue 15:30 AKBPa

Optimizing Particle-In-Cell simulations of laser-plasma accelerators — •Laurids Jeppe[1], Sören Jalas[1], Manuel Kirchen[1], and Andreas R. Maier[2] — [1]Center for Free-Electron Laser Science and Department of Physics, Universität Hamburg — [2]Deutsches Elektronen Synchrotron (DESY)

Designing experiments for laser-plasma acceleration via simulations is typically an expensive task due to the complexity of the physics involved. Here, we use the GPU-accelerated, quasi-3D Particle-In-Cell code FBPIC in a boosted frame to reduce the computational cost of such simulations and combine it with Bayesian Optimization to efficiently optimize LPA experiments. This approach is applied to different example cases to show its robustness and flexibility.

AKBP 2.8 Tue 15:45 AKBPa

A new transport line for transverse gradient undulator experiment at the JETI-200 plasma accelerator — •Maisui Ning[1], Samira Fatehi[1], Kantaphon Damminsek[1], Axel Bernhard[1], and Anke-Susanne Müller[1,2] — [1]LAS,KIT,Karlsruhe — [2]IBPT,KIT,Karlsruhe

The Karlsruhe Institute of Technology (KIT) and the University of Jena develop the generation of monochromatic undulator radiation with laser plasma-accelerated electron bunches by using a transverse-gradient undulator (TGU) designed to compensate the electron bunch energy spread. A proof-of-principle experiment with a superconducting TGU prototype, employing a specially designed beam transport line, is under preparation. A first experimental test of this transport line has been performed and evaluated. In this contribution, we describe the current status of the redesign of the beam transport line magnets and the beam optics, considering the results of this test as well as of the ongoing characterization experiments for both, the electron beam and the TGU, to prepare the experiment with the TGU at the laser-plasma accelerator setup at the JETI-200 laser facility in Jena.

This work is supported by the BMBF project 05K19VKA PlasmaFEL (Federal Ministry of Education and Research).

AKBP 3: Radiofrequency

Time: Tuesday 14:00–16:00 Location: AKBPb

AKBP 3.1 Tue 14:00 AKBPb

Investigation of RF-dependent charge production and electron energy at the FLUTE injector — •Tonia Windbichler for the FLUTE-Collaboration — KIT, Karlsruhe, Germany

FLUTE (Ferninfrarot Linac- und Test- Experiment) is a versatile and compact, linac-based test facility for accelerator R&D at the Karlsruhe Institute of Technology (KIT). The electron bunch is produced by a photoinjector in the injector section. The beam parameters, such as energy, energy spread and charge are highly dependent on the RF settings of the 3 GHz electron gun. Two adjustable RF parameters are the RF forward power and the accelerating phase at the time of electron production with the photoinjector laser system. In this study, the beam parameters' dependencies on the RF parameters have been scanned. Two examples are the points of highest energy transfer and highest charge production. In this contribution measurements of the influence of the RF phase and forward power on the beam parameters will be discussed.

AKBP 3.2 Tue 14:15 AKBPb

ALD-Based NbTiN studies for SIS R&D — •isabel gonzález díaz-palacio[1], marc wenskat[2], wolfgang hillert[2], robert zierold[1], and robert blick[1] — [1]Center for Hybrid Nanostructures, Hamburg — [2]Institute for Experimental Physics, Hamburg

Superconductor-Insulator-Superconductor multilayers (SIS structures) improve the performance of SRF cavities providing magnetic screening of the bulk cavity and lower surface resistance. In this framework NbTiN mixtures stand as a potential material of interest. One method which enables fine tuning of the stoichiometry and precise thickness control in sub-nm range is atomic layer deposition (ALD). ALD bases on a sequence of self-limiting gas-solid surface reactions and allows for uniform coating of complex geometries. In this talk, we report about NbTiN thin films deposited by plasma-enhanced ALD on insulating AlN buffer layer, which has been previously deposited in situ without vacuum break with the same technique. The deposition process has been optimized by studying the superconducting electrical properties

of the films. Post-deposition thermal annealing studies with varying temperatures, annealing times, and gas atmospheres have been performed to further improve the thin film quality and the superconducting properties. Our experimental studies show an increase in Tc by 87.5% after thermal annealing and a maximum Tc of 13.9 K has been achieved for NbTiN of 23 nm thickness. Future steps include lattice characterization, using XRR/XRD/EBSD/PALS, and SRF measurements to obtain Hc1 and the superconducting gap Δ.

AKBP 3.3 Tue 14:30 AKBPb

Nb3Sn thin film synthesis for SRF application by co-sputtering — •Nils Schäfer, Nail Karabas, Márton Major, and Lambert Alff — Institute of Material Science, Technische Universität Darmstadt (Germany)

Nowadays Nb is commonly used for superconducting radio frequency (SRF) cavities. Nb3Sn is a promising thin film material for SRF cavities as it can empower the cavity to operate at higher acceleration fields and higher temperatures. This is also achievable by a higher quality factor since the surface resistivity is lower with respect to Nb-only cavities at radiofrequency. Several approaches could be used for deposition of Nb3Sn thin films (e.g. sputtering, evaporation, and CVD). The applicability to successfully coat cavities was demonstrated for several processes with their respective disadvantages. Nb3Sn is either synthesized by a deposition of Sn on the Nb cavity or a stoichiometric deposition of Nb and Sn. Film Thickness, and especially stoichiometry are essential for the high potential of the Nb3Sn material properties. A new Co-Sputtering process is used in the Advanced Thin Film Technology group to form high performance layers at unprecedented process temperatures. This process is able to overcome the detrimental diffusion of Sn at elevated temperatures.

AKBP 3.4 Tue 14:45 AKBPb

Nitrogen-doping of niobium for SRF cavities — •Márton Major, Stefan Flege, Lambert Alff, Jens Conrad, Ruben Grewe, Michaela Arnold, and Norbert Pietralla — Technische Universität Darmstadt, Darmstadt, Germany

Niobium is the standard material for superconducting RF (SRF) cavities. Superconducting materials with higher critical temperature and higher critical magnetic field allow cavities to work at higher operating temperatures and higher accelerating fields. One direction of search for new materials with better properties is the modification of bulk niobium by nitrogen doping. In the Nb-N phase diagram the cubic δ-phase of NbN has the highest critical temperature (16 K).

For the investigation of the NbN phases niobium samples were doped at the refurbished UHV furnace at IKP Darmstadt. In this contribution we focus on the structural investigations (x-ray diffraction and pole figure, secondary ion mass spectroscopy, scanning electron microscopy) of the doped samples. We show results of the first samples with NbN surface phase.

Work supported by the German Federal Ministry for Education and Research (BMBF) through grant 05H18RDRB2 and the German Research Foundation (DFG) via the AccelencE Research Training Group (GRK 2128).

AKBP 3.5 Tue 15:00 AKBPb

beam coupling impedance minimization of the SPS cavities using the generalized coupled S-parameter method — •Shahnam Gorgi Zadeh[1], Erion Gjonaj[2], and Ursula van Rienen[1] — [1]Universität Rostock, Rostock, Germany — [2]Technische Universität Darmstadt, Darmstadt, Germany

The High Luminosity LHC (HL-LHC) project aims at increasing the luminosity in the LHC by up to a factor of ten. The longitudinal impedance of the Super Proton Synchrotron (SPS) poses a limitation on increasing the beam intensity in the injector chain. Beam dynamical studies have shown a large longitudinal impedance in the SPS cavities. Different types of higher order mode (HOM) couplers are used in the SPS cavities for the damping of different HOM passbands. The location of the HOM couplers in the cavities affects the damping of HOMs. Finding an efficient configuration requires solving a discrete optimization problem in which the cells that require a HOM coupler have to be identified to minimize the longitudinal impedance at the desired frequencies. The large size of the cavities, with a diameter of 0.75 m and a length which reaches up to 17 m, hinders the calculation of the beam coupling impedance by the conventional time-domain wakefield analysis methods. In this presentation, the Generalized Coupled S-parameter Calculation method, which is a domain decomposition scheme for the impedance calculation of large structures, is used to find an optimum HOM coupler configuration for the SPS cavities.

This research is funded by the Bundesministerium für Bildung und Forschung (BMBF) under Grant No. 05H18HRRB1.

AKBP 3.6 Tue 15:15 AKBPb

Status of the vertical bath cryostat at the S-DALINAC — •R. Grewe, M. Arnold, J. Conrad, S. Weih, and N. Pietralla — Institut für Kernphysik, TU Darmstadt

For sophisticated measurements of the intrinsic quality factor Q_0 of superconducting radio frequency (srf) cavities the vertical bath cryostat (vtc) of the S-DALINAC[1] is used. To reduce uncertainties of the measurements, the vtc was subject to detailed upgrades. Particular attention was given to the the radio frequency (rf) input and output couplers. To match the input coupler to the cavity it is now possible to change the input coupling strength, which leads to reduced uncertainties of the measured Q_0. The upgrade will be explained along with first measurement results of different srf cavities.

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

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AKBP 3.7 Tue 15:30 AKBPb

Design and fabrication of a new quadrupole resonator for SRF R&D — •ricardo monroy-villa[1,2], wolfgang hillert[1], detlef reschke[2], jan-hendrik thie[2], marc wenskat[1], piotr putek[3], and shahnam zadeh[3] — [1]Universität Hamburg, Hamburg, Germany — [2]Deutsches Elektronen-Synchrotron, Hamburg, Germany — [3]Universität Rostock, Rostock, Germany

Radio frequency cavities made from superconducting niobium have the advantage to achieve high accelerating gradients while operating at low losses. As superconducting RF (SRF) cavities are now approaching the theoretical limits of the material, a variety of different surface treatments have been developed to further improve their performance; although no fully understood theory is yet available. Small superconducting samples are studied to characterize their material properties and their evolution under different surface treatments. To study the RF properties of such samples under realistic SRF conditions at low temperatures, a test cavity called quadrupole resonator (QPR) is currently being fabricated. In this work we report the status of the QPR at Universität Hamburg in collaboration with DESY. Our device is based on the QPRs operated at CERN and at HZB and its design allows for testing samples under cavity-like conditions, *i.e.*, at temperatures between 2 K and 8 K, under magnetic fields up to 120 mT and with operating frequencies of 433 MHz, 866 MHz and 1300 MHz. Fabrication tolerance studies on the electromagnetic field distributions and simulations of the static detuning of the device, together with a status report on the current manufacturing process, will be presented.

AKBP 3.8 Tue 15:45 AKBPb

Refurbishment of a spare cryomodule for MESA* — •Paul Plattner, Florian Hug, and Timo Stengler — Institut für Kernphysik, Johannes Gutenberg-Universität Mainz

The Mainz Energy-Recovering Superconducting Accelerator (MESA) will be a new recirculating accelerator, which can operate in an external beam mode and an energy recovering mode. In the ERL-mode the electrons cross an internal gas-target at MAGIX and give their kinetic energy into the Superconducting Radio Frequency (SRF) system back after experimental use. The MESA cryomodules are based on ELBE-type cryomodules, which contain two 9-call TESLA/XFEL-type cavities. In the cryomodule the superconducting cavities are cooled down to 2 Kelvin with liquid helium. For any maintenance work at the cavities, it is necessary to disassemble the cryomodule. This includes to remove the cavities from the cold string. Smallest impurities can lead to big dercrease of the quality factor of the cavity, which reduces the achievable beam energy of the accelerator. That is why the disassembling and the later reassembling of the cryomodule must be done under very clean conditions which is provided in clean rooms. The plans of disassembling one cryomodule and cleaning the cavities are presented. For that project a spare module of the disassembled ALICE ERL at Daresbury, UK will be used.

* This work has been supported by DFG through the PRISMA$^+$ cluster of excellence EXC 2118/2019. The authors acknowledge the transfer of one cryomodule to Mainz by STFC Daresbury.

AKBP 4: New Accelerator Concepts and Hadron Accelerators

Time: Tuesday 16:30–18:30 Location: AKBPa

AKBP 4.1 Tue 16:30 AKBPa

Miniature transport-line design and experimental investigations of the superconducting transverse gradient undulator source for laser plasma accelerator-driven FELs — •Samira Fatehi[1], Maisui Ning[1], Kantaphon Damminsek[1], Axel Bernhard[1], and Anke-Susanne Müller[1,2] — [1]LAS, KIT, Karlsruhe — [2]IBPT, KIT, Karlsruhe

Laser-plasma acceleration is an outstanding candidate to drive the next-generation compact light sources and FELs. Having orders of magnitude larger electrical field gradients than RF cavities-based machines makes them more compact. To compensate large chromatic effects, beam divergence and energy spread, using novel compact beam optic elements in the beam transport line as well as a transverse-gradient undulator (TGU) has been considered. We aim to design miniaturized, high strength, normal conducting and superconducting magnets for the transport line planned to be experimentally tested and employed at the JETI laser facility in Jena, along with the experimental efforts for investigating and modifying the TGU as the final light source. In this contribution we present an overview over the project and its current status.

This work is supported by the BMBF project 05K19VKA PlasmaFEL (Federal Ministry of Education and Research).

AKBP 4.2 Tue 16:45 AKBPa

Bayesian optimization of a laser-plasma accelerator — •Soeren Jalas[1], Manuel Kirchen[1], Laurids Jeppe[1], and Andreas R. Maier[2] — [1]Center for Free-Electron Laser Science and Department of Physics Universität Hamburg — [2]Deutsches Elektronen Synchrotron (DESY)

Generating high-quality laser-plasma accelerated electron beams requires carefully balancing a plethora of physical effects and is therefore challenging * both conceptually and in experiments. Here, we use Bayesian optimization of key laser and plasma parameters to flatten the longitudinal phase space of an ionization-injected electron bunch via optimal beam loading. We first study the concept with particle-in-cell simulations and then demonstrate it in experiments. Starting from an arbitrary set-point the plasma accelerator autonomously tunes the beam energy spread to the sub-percent level at 254 MeV and 4.7 pC/MeV spectral density. Finally, we study a robust regime, which improves the stability of the laser-plasma accelerator and delivers sub-5-percent rms energy spread beams for 90% of all shots.

AKBP 4.3 Tue 17:00 AKBPa

FLASHForward X-1: Injection dynamics of high brightness beams from a plasma cathode — •Lewis Boulton[1,2,3] and Jonathan Wood[1] for the FLASHForward-Collaboration — [1]Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany — [2]SUPA, Department of Physics, University of Strathclyde, Glasgow, UK — [3]The Cockcroft Institute, Daresbury, UK

Plasma-wakefield accelerators promise to deliver high-energy particle beams over acceleration lengths orders of magnitude smaller than that of their conventional counterparts. However, some injection schemes also have the potential to act as beam-brightness transformers. The X-1 experiment at FLASHForward, DESY Hamburg, focuses on using density-downramp injection of electrons into a beam-driven plasma wake as a means of generating sub-μm emittance beams. Recent results have shown that the use of an optically-generated spike in the plasma-density profile results in the controlled, stable injection of witness beams with charges up to 105 pC, accelerated in an effective electric field of 2.5 GV/m. Further work explores via simulations the key parameters that influence the quality of the injected beams, shedding light on the underlying physics whilst also informing the next round of planned experiments.

AKBP 4.4 Tue 17:15 AKBPa

Beamline Design Studies for a Laser-Plasma Driven FEL — •Lars Hübner[1,2], Cora Braun[1,2], Julian Dirkwinkel[1], Timo Eichner[2], Thomas Hülsenbusch[1,2], Sören Jalas[2], Laurids Jeppe[2], Manuel Kirchen[2], Philipp Messner[1], Guido Palmer[1], Matthias Schnepp[2], Maximilian Trunk[2], P. Andreas Walker[1], Paul Winkler[1], Christian Werle[1], and Andreas R. Maier[1,2] — [1]Deutsches Elektronen Synchrotron (DESY) — [2]Center for Free-Electron Laser Science and Department of Physics, Universität Hamburg

Laser-plasma accelerators are promising candidates to drive compact, laboratory-scale free-electron lasers. However, the unique properties of plasma accelerated electron beams present a challenge to the beam transport and lasing concepts. Here, we present the upgrade of the LUX beamline with the goal of demonstrating FEL gain from a laser-plasma accelerator. The beamline features a chicane to decompress the electron beam and relax the conditions on the initial beam parameters from the plasma target. The concept shows a balancing between the decrease in beam peak current due to the decompression and the manipulation of the phase-space to optimize the slice properties of the beam. The transport to and the focusing scheme into the undulator are presented.

AKBP 4.5 Tue 17:30 AKBPa

Staging Laser and Plasma Wakefield Accelerators for low emittance electron generation — •Moritz Foerster for the Hybrid Collaboration-Collaboration — LMU München

Low emittance relativistic electron bunches are of crucial importance for the generation of high brilliance x-ray light. This light is needed in medical imaging to achieve the best trade-off between image quality, acceptable radiation dose, compactness and affordable coasts. However, there is little technology available to bridge the regime between conventional x-ray tubes and large-scale synchrotrons/free electron lasers.

Plasma Wakefield Acceleration (PWFA) can generate low emittance electrons. However, PWFA typically requires large scale particle accelerators like linacs or synchrotron machines to generate the particle driver. Laser Wakefield Acceleration (LWFA) on the other hand is widely available in many university scale labs but often suffers from higher emittance of the electron bunches created.

Here we describe a novel approach using a staged laser driven electron accelerator to produce the low emittance electrons needed. Nanocoulomb class electron bunches at a few hundred MeV energy are produced via LWFA. Thereafter those electrons drive a second PWFA stage a few millimetres downstream.

First experimental results show injection and acceleration in the second stage. These first proof of principle results pave the way to actual emittance optimisation necessary for making the source interesting for actual applications.

AKBP 4.6 Tue 17:45 AKBPa

Commissioning of the laser-driven ion acceleration beamline at the Centre for Advanced Laser Applications — •Jens Hartmann, Thomas Rösch, Luisa Tischendorf, Leonard Doyle, Lotta Flaig, Marc Berndl, Felix Balling, Sonja Gerlach, and Jörg Schreiber — Department of Medical Physics, Faculty of Physics at the Ludwig-Maximilians-Universtität München

The Centre for Advanced Laser Applications (CALA) in Garching near Munich features the ATLAS-3000 laser system, which can deliver up to 3 PW within a pulse duration of 20 fs. It is the driver for the Laser-driven ION (LION) beamline, which aims to accelerate protons and carbon ions for applications. A 20 degrees off-axis parabolic mirror with a focal length of 1.5 m focusses the 28 cm diameter laser-beam down to a micrometre-sized spot, where a vacuum-compatible wave-front sensor is used for a deformable mirror feedback loop focus optimization. Commissioning started mid 2019 with regular proton acceleration using nm-thin plastic foils as targets. The amount of light traveling backwards from the experiment into the laser is constantly monitored and currently limits safe operation to 5 J on target. Protons with a kinetic energy of 12 MeV are stably accelerated with the given laser parameters and are suitable for transport with permanent magnet quadrupoles towards our application platform 1.8 m downstream of the source. We have performed parameter scans varying target thicknesses and laser-pulse shape to optimize for highest and most stable proton numbers at 12 MeV kinetic energy, and investigated shot-to-shot particle number stability for the best parameters.

AKBP 4.7 Tue 18:00 AKBPa

Laser Wakefield Acceleration to GeV Energies — •Katinka v. Grafenstein for the Non-perturbative Pair Production-Collaboration

— Ludwig-Maximilians-Universität München, Am Coulombwall 1, 85748 Garching, Germany

For the creation of matter-antimatter pairs from the quantum vacuum via the Breit-Wheeler mechanism, energetic γ-rays and an intense laser need to interact with each other. The Breit-Wheeler experiment in the perturbative regime has been accomplished at the Stanford Linear Accelerator Center in 1997 but was never implemented in the non-perturbative regime. At the moment, this experiment is in preparation in a fully laser-driven set-up using Laser Wakefield Acceleration (LWFA) with the ATLAS3000 laser in Garching. In the experiment an initial high energy electron beam will be sent onto a Bremsstrahlung converter to generate γ-rays that are to interact with the intense laser. For this, an electron beam with multi-Gev energies is needed. Using LWFA, electron energies of the order of few hundred MeV are nowadays commonly reached. Reaching multi-GeV energies on the other hand still holds many challenges, even though it has been accomplished. Especially, the careful design of gas targets, such as gas jets and gas cells, is essential. These have to provide homogeneous gas densities over a distance of a few centimetres. In preparation for the Breit-Wheeler experiment in Garching, Computational Fluid Dynamic simulations were conducted to design and build such gas nozzles. Their gas flow was tested using a Mach-Zehnder interferometer and first LWFA experiments using these nozzles are to be conducted soon.

AKBP 4.8 Tue 18:15 AKBPa

Construction and first beam tests of a novel focalisation system for novel medical radioisotope production — •Philipp Daniel Häffner — Universität Bern, Sidlerstrasse 5, 3012 Bern

Radioisotopes are fundamental in modern medicine. A research program focused on the production of novel medical radionuclides is ongoing at the Laboratory for High Energy Physics of the University of Bern. Cross sections are measured and novel production routes explored using the 18 MeV PET proton cyclotron located at the Bern University Hospital. The production is carried out by irradiating a 6 mm diameter pellet embedded in a specific capsule developed by our group that can be inserted in a commercial solid target station. This talk reviews the development and first beam tests of a compact irradiation system consisting of a set of electromagnets, a beam profile detector and a specific feedback software. We proved that the system is able to focus a flat beam down to the size matching the pellet surface. The expected increase in the production yield was observed. The system is also able to detect and correct possible deviations in the beam position and shape that may occur during irradiation. This was tested by inducing external perturbations and by verifying that the system restores the good beam parameters. Being about 1 m long, this system can be installed and operated in any medical cyclotron facility.

AKBP 5: Radiofrequency and Miscellaneous

Time: Tuesday 16:30–18:00 Location: AKBPb

AKBP 5.1 Tue 16:30 AKBPb

FAIR phase 0 - laser cooling at the SIS100 — •Sebastian Klammes[1,2], Michael Bussmann[6], Volker Hannen[3], Daniel Kiefer[2], Thomas Kühl[1,5], Benedikt Langfeld[2], Xinwen Ma[4], Ulrich Schramm[6,7], Mathias Siebold[6], Peter Spiller[1], Thomas Stöhlker[1,5,8], Ken Ueberholz[3], Thomas Walther[2], and Danyal Winters[1] — [1]GSI Darmstadt — [2]TU Darmstadt — [3]Uni Münster — [4]IMP Lanzhou — [5]HI Jena — [6]HZDR Dresden — [7]TU Dresden — [8]Uni-Jena

The heavy-ion synchrotron SIS100 is the core element of the Facility for Antiproton and Ion Research (FAIR) and will store, accelerate, and deliver ion beams of highest intensity and energy to experiments. Especially for precision experiments, such as laser and X-ray spectroscopy, ion beams with a high brilliance are indispensable. To generate such ion beams, laser cooling has proven to be a powerful technique at relativistic energies. Furthermore, laser cooling will be the only cooling method to reduce the emittance and the relative longitudinal momentum spread of bunched heavy-ion beams at the SIS100 after acceleration at final energy. We will report on the status of the project and will present our plans for FAIR phase 0 - laser cooling at the SIS100.

AKBP 5.2 Tue 16:45 AKBPb

Multibunch spin manipulation for the deuteron EDM measurement in storage rings — •Jamal Slim for the JEDI-Collaboration — III. Phys. Inst. B., RWTH Aachen, Aachen, Germany

The JEDI collaboration aims to perform a direct measurement of the electric dipole moment (EDM) of deuterons at the Cooler Synchrotron (COSY).

Along with many milestones achieved so far, one of the first ever new devices, developed and commissioned at COSY, and to be used as a spin rotator in the EDM experiment, is an RF Wien filter. The rate of resonant rotation of the in plane precessing spin to the vertical one is a signal used to determine the EDM. In order to retain the resonance condition, one needs a continuous monitoring the of the precessing horizontal polarization which is impossible for polarizations close to the vertical one. We adopted an unconventional multibunch solution to this dilemma.

Two bunches that simultaneously orbit in COSY will be used in the experiment, where the RF Wien filter is gated out for one bunch. A spin of this gated-out bunch shall remain in the ring plane and its precession frequency will be measured by the JEDI technique. Consequently, it will serve as a co-magnetometer for the second bunch the spin of which will be subjected to the RF Wien filter driven rotation at exactly the parametric spin resonance frequency. We report the results of the first ever experimental test of this new approach to a continuous co-magnetometry for the RF resonance spin rotations in storage rings.

AKBP 5.3 Tue 17:00 AKBPb

Calibration Device for Second Sound Quench Detection — •Lukas Ebeling[1,2], Wolfgang Hillert[2], and Lea Steder[1] — [1]DESY, Hamburg, Germany — [2]Universität Hamburg, Germany

An important part of superconducting radio frequency cavity R&D is quench detection since the breakdown of the superconductivity limits the cavity performance. Although a detection based on second sound waves propagating in liquid helium is widely used, estimating its accuracy is difficult and only few studies dealing with systematic uncertainties exist. Particularly helpful for this task is the artificial generation of second sound signals using a calibration device. Therefore, the already existing second sound system at the cavity test facility of DESY is extended by calibration device prototypes.

This talk will show that ohmic resistors can play a crucial role in the construction of such a tool. Heated by means of short electrical pulses, these resistors generate a second sound wave, which can be detected even within larger cryostats using noise cancelling algorithms and the existing reconstruction software. With a calibration device at hand, the influences of sensor positioning and quench location are investigated. This presentation will also address the observed offset in second sound propagation time caused by the resistor's inertia.

AKBP 5.4 Tue 17:15 AKBPb

Goubau-Line Set Up for Measureing Impedance of Vacuum Chamber Components — •Paul Volz[1] and Atoosa Meseck[1,2] — [1]Helmholtz-Zentrum Berlin — [2]Johannes Gutenberg Universität Mainz

Currently, the worldwide first in-vacuum elliptical undulator, IVUE32, is being developed at Helmholtz Zentrum Berlin. The 2.5 m long insertion device with a period length of 3.2 cm and a minimum gap of about 7 mm is to be installed in the BESSY II storage ring. It will deliver radiation in the soft X-ray range for several beam lines. The proximity of the undulator structure to the particle beam makes the device susceptible to wake field effects which can in turn influence beam stability. Therefore, such a device requires a complete understanding of its impedance characteristics prior to installation and operations, as unforeseen heating of components could have catastrophic consequences. Since the complex structure of the device makes numerical calculations, such as CST simulations, at high frequency very resource intensive, bench testing the device may proof invaluable. A Goubau line is a single wire transmission line for high frequency surface waves. The transverse electric field of a Goubau line resembles that of a charged particle beam out to a certain radial distance. This can be used to mimic a particle beam and measure the impedance of

vacuum chamber components outside of the accelerator. This presentation will characterize and discuss such a testing set up optimized for bench testing IVUE32-components.

AKBP 5.5 Tue 17:30 AKBPb

Status of the deflecting cavity development as a beam separator for ELBE — •Gowrishankar Hallilingaiah[1], Andre Arnold[2], Peter Michel[1,2], and Ursula van Rienen[1,3] — [1]University of Rostock, Rostock — [2]Helmholtz-Zentrum Dresden-Rossendorf, Dresden — [3]Department of Life, Light and Matter, University of Rostock

The current beamline setup at ELBE tends to a single user experiment at any given time. Further, not all the user experiments utilize the full 13 MHz CW beam capacity. Therefore beam separator is being developed to maximize the beam usage which would distribute the beam simultaneously to different user experiments. A review of deflecting structure designs which can be adapted as a beam separator was carried out. Consequently, radiofrequency cavity was chosen, as they produce stable deflection at MHz range. Subsequently, a comparative study was carried out on the potential deflecting cavity designs, and in-turn, a new normal conducting double quarter wave cavity design was selected. Furthermore, fundamental power coupler and frequency tuners were designed. Finally, multiphysics simulations were carried out to aid in cavity fabrication, ascertain the adequacy of cooling, and to estimate the frequency drift during operation. Subsequently, the copper cavity parts were machined and the frequency pre-tuning was performed before the final vacuum brazing. To verify the field profile and figure of merit, bead-pull experiment was performed. Currently, high power testing is under progress. This research work is funded by Helmholtz-Zentrum Dresden-Rossendorf under the project TRACE.

AKBP 5.6 Tue 17:45 AKBPb

Development of a new B-Mapping System for SRF Cavity Vertical Tests — •Jonas Christian Wolff[1,2], Wolfgang Hillert[1,2], Detlef Reschke[1], and Lea Steder[1] — [1]Deutsches Elektronen-Synchrotron DESY, Notkestraße 85, 22607 Hamburg — [2]Universität Hamburg - Institut für Experimentalphysik, Luruper Chaussee 149, 22761 Hamburg

Magnetic flux trapped in the bulk material (Niobium) of superconducting radio frequency (SRF) cavities degrades their quality factor and the accelerating gradient. Here, the sensitivity of the surface resistance to trapped magnetic flux is mainly determined by the cavity geometry and the Niobium grain size. To potentially improve the flux expulsion characteristics and hence the efficiency of future accelerator facilities further studies of the trapping behavior are essential. For this purpose a so-called "B-Mapping System" to monitor the magnetic flux along the outer cavity surface of SRF 1.3 GHz TESLA-Type single-cell cavities is currently under development at DESY. Contrary to former approaches e.g. at Helmholtz-Zentrum Berlin (HZB), this system digitizes the sensor signals already inside of the cryostat to extensively reduce the number of required cable feedthroughs. Furthermore, the signal-to-noise ratio (SNR) and consequently the measuring sensitivity can be enhanced by shorter analog signal lines, less thermal noise and the Mu-metal shielding of the cryostat. In this contribution the design, the development process as well as first performance test results of the system are presented.

AKBP 6: Diagnostics, Control and Instrumentation I

Time: Wednesday 14:00–16:15 Location: AKBPa

AKBP 6.1 Wed 14:00 AKBPa

Development of a fast betatron tune and chromaticity measurement system — •Philipp Niedermayer, Bernd Breitkreutz, Andreas Lehrach, and Vsevolod Kamerdzhiev — Forschungszentrum Jülich, IKP-4, Jülich, Deutschland

A fast tune measurement is developed for the Cooler Synchrotron COSY at the Institut für Kernphysik of Forschungszentrum Jülich. Betatron oscillations of the beam are excited with an appropriate RF signal via a stripline kicker. Resonant transverse oscillations are then observed using capacitive beam position monitors. Based on the bunch-by-bunch beam position data the betatron tune is determined. The usage of bunch-by-bunch data is characteristic of the new system. It allows for a discrete tune measurement within a few milliseconds, as well as continuous tune monitoring during beam acceleration.

The high precision tune measurement also enables determination of the beam chromaticity. Therefore, the beam momentum is varied by means of the RF frequency and the subsequent tune change is determined. For routine use during beam operation and experiments, the developed method is integrated into the control system.

AKBP 6.2 Wed 14:15 AKBPa

Status of slice emittance measurements at PITZ — •Raffael Niemczyk[1], Prach Boonpornprasert[1], Maria-Elena Castro-Carballo[1], Georgi Georgiev[1], James Good[1], Matthias Gross[1], Christian Koschitzki[1], Mikhail Krasilnikov[1], Anusorn Lueangaramwong[1], Xiangkun Li[1], Osip Lishilin[1], David Melkumyan[1], Sandeep Mohanty[1], Anne Oppelt[1], Houjun Qian[1], Hamed Shaker[1], Guan Shu[1], Frank Stephan[1], Grygorii Vashchenko[1], Tobias Weilbach[1], and Wolfgang Hillert[2] — [1]Deutsches Elektronen Synchrotron DESY, Platanenallee 6, 15738 Zeuthen, Germany — [2]University of Hamburg, 22761 Hamburg, Germany

The Photo Injector Test facility at DESY in Zeuthen (PITZ) conditions and optimises high-brightness electron sources for X-ray free-electron lasers (FELs). Due to a relatively low energy beam at PITZ (∼20 MeV), the main tool to optimize electron source brightness was projected phase space measurement with a slit mask scan technique. Recently, a new procedure to measure the time-resolved phase space, i.e. slice emittance, was systematically commissioned at PITZ, which adds a transverse deflecting cavity to the slit mask scan. The slice emittance setup optimizations, e.g. time resolution and signal-to-noise ratio, and its applications for electron source optimizations will be presented.

AKBP 6.3 Wed 14:30 AKBPa

Concept of a Beam Diagnostics System for the Multi-Turn ERL Operation at the S-DALINAC* — •Manuel Dutine, Michaela Arnold, Ruben Grewe, Lars Jürgensen, Norbert Pietralla, Felix Schliessmann, and Manuel Steinhorst — Institut für Kernphysik, TU Darmstadt

The S-DALINAC [1] is a thrice-recirculating linear electron accelerator operating in cw-mode at a frequency of 3 GHz. Due to the implementation of a path-length adjustment system capable of a 360° phase shift, it is possible to operate the accelerator as an energy-recovery linac (ERL) [2]. While operating the accelerator in multi-turn ERL mode, there will be two beams in the same beamline. For this mode, a non-destructive beam diagnostics system is necessary in order to measure the beam position of both, the accelerated and the decelerated beam simultaneously in the same beamline. The conceptional study of a 6 GHz resonant cavity beam position monitor will be presented together with a wire scanner measurement and a test measurement of the currently existing 3 GHz monitors as alternative solutions.

[1] N. Pietralla, Nuclear Physics News, Vol. 28, No. 2, 4 (2018)
[2] M. Arnold et al., Phys. Rev. Accel. Beams 23, 020101 (2020)

*Work supported by DFG through GRK 2128, BMBF through grant No. 05H18RDRB2 and by the state of Hesse through the LOEWE Research Cluster Nuclear Photonics.

AKBP 6.4 Wed 14:45 AKBPa

Coherent Smith-Purcell radiation for minimally invasive bunch length measurement at the subpicosecond time scale — •Philipp Heil[1,2,3], Kurt Aulenbacher[1,2], Max Bruker[4], Frank Fichtner[1], Simon Friederich[2], and Christoph Matejcek[1] — [1]Institut für Kernphysik, Johannes Gutenberg-Universität Mainz — [2]Helmholtz Institut Mainz — [3]GSI Helmholtzzentrum für Schwerionenforschung Darmstadt — [4]Thomas Jefferson National Accelerator Facility, Newport News, Virginia 23606, USA

We have designed a tool to measure the bunch length of an electron beam in a minimally invasive way by means of coherent Smith-Purcell radiation (SPR). The technique has been employed successfully at a test apparatus for the Mainz Energy-recovery Superconducting Accelerator *MESA*, demonstrating it is possible to determine the bunch length while losing less than 0.6 % of the electron beam. The impact

of the space charge on the bunch length can be reduced while tuning the longitudinal bunch preparation system during a live measurement at beam currents up to 1 mA. Doing so, it is possible to achieve RMS bunch lengths of 70 μm in a typical operating mode of the low-energy beam transport system of MESA. In addition to the bunch length measurements, typical properties of the generated SPR are demonstrated.

AKBP 6.5 Wed 15:00 AKBPa

OTR diagnostic measurements for the High-Energy Scraper System of the S-DALINAC* — •M. Fischer, M. Arnold, M. Dutine, L. Jürgensen, and N. Pietralla — IKP, TU Darmstadt

The S-DALINAC is the thrice recirculating superconducting electron accelerator at the TU Darmstadt [1]. It delivers electron beams with energies up to 130 MeV which are used, among other things, for experiments in fundamental nuclear physics research. For the high-energy experiments at the S-DALINAC, a small momentum spread of the electron beam is of crucial importance. To reduce the momentum spread and improve the stability of the beam, a high-energy scraper system in the extraction beamline is used. In order to verify the impact of the scraper system, a new beam diagnostic setup was installed in a subsequent dispersive section. It is used to characterize the beam profile and quantify temporal fluctuations of the beam by optical transition radiation (OTR). In this talk, the beam diagnostic setup, its commissioning, and the results of the first measurements will be presented.

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

* Work supported by DFG through GRK 2128.

AKBP 6.6 Wed 15:15 AKBPa

A Diagnostics Setup for Low-Energy Beam Characterization at the Injector of the S-DALINAC* — •A. Brauch, M. Arnold, J. Enders, N. Pietralla, and S. Weih — Technische Universität Darmstadt, Darmstadt, Deutschland

A new superconducting cavity, which is optimized for capturing particles with non maximum velocity $\beta = 0.86$, will be installed at the injector of the superconducting Darmstadt electron linear accelerator (S-DALINAC [1]). For a successful operation of the upgraded injector, detailed knowledge of beam-parameters upstream the capture section is crucial. Therefore, a vertical diagnostics beamline is currently being installed. Capable of transverse and longitudinal beam parameter measurements, the setup will be used to characterize the beams from the thermionic and polarized electron guns. With the anticipated diagnostics data we aim at an acceleration in the superconducting injector linac optimized with respect to energy spread and both longitudinal and transverse beam quality. This contribution introduces the general layout of the diagnostics beamline, the current status, and the design of a transverse deflecting cavity which is planned to be installed for bunch length measurements.

[1] N. Pietralla, Nuclear Physics News, Vol. 28, No. 2, 4 (2018).
*Work supported by the DFG-funded GRK 2128 "AccelencE" and by the Hessian HMWK through the LOEWE research cluster "Nuclear Photonics"

AKBP 6.7 Wed 15:30 AKBPa

Extremum-Seeking-driven RF Control Optimization at the S-DALINAC* — •Manuel Steinhorst, Michaela Arnold, and Norbert Pietralla — IKP, TU Darmstadt

The radiofrequency (rf) control system of the S-DALINAC [1] allows for precise acceleration of the electron beam by keeping the amplitude and phase of the electric accelerating field constant. Residual fluctuations of amplitude and phase due to an unoptimized setting of the rf control parameters can increase the energy spread of the electron beam. In order to minimize corrsponding contributions to the energy spread, an algorithm based on extremum-seeking control was developed for optimized parameter settings. By minimizing a so-called costfunction, it adjusts the setting of the control, that its contribution to the energy spread is minimized. In this talk, the basic concept of the algorithm and data measured at the S-DALINAC are presented.

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

*Supported by the DFG through GRK 2128 and by the state of Hesse through the LOEWE Research Cluster Nuclear Photonics.

AKBP 6.8 Wed 15:45 AKBPa

Sensitivity Analysis of Beam-influencing Parameters at the S-DALINAC Using Surrogate Models* — •Dominic Schneider, Michaela Arnold, Jonny Birkhan, Norbert Pietralla, and Felix Schliessmann — Institut für Kernphysik, TU Darmstadt, Darmstadt

Machine learning methods provide a significant potential for the optimized operation of complex machinery, such as particle accelerators. In this contribution, the first application of so-called surrogate models to the electron accelerator S-DALINAC [1] will be discussed. This machine learning technique, based on polynomial fitting, gives not only access to predict future behavior based on training data, but also an extensive set of characteristics that can be extracted by analyzing the trained model. The talk will focus on a series of measurements that have been performed at the S-DALINAC in order to investigate the behavior and correlations of beam-influencing elements on the one hand and the performance of surrogate models on the other hand. Particularly, the global sensitivity analysis as well as Sobol indices will be discussed.

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

*Work supported by DFG through GRK 2128

AKBP 6.9 Wed 16:00 AKBPa

Investigation of the pickup signal for bunch arrival-time monitors with ultra-short electron bunches in free electron laser applications — •Bernhard Erich Jürgen Scheible[1,3], Marie Kristin Czwalinna[2], Wolfgang Ackermann[3], Holger Schlarb[2], Herbert De Gersem[3] und Andreas Penirschke[1] — [1]Technische Hochschule Mittelhessen, Friedberg, Germany — [2]DESY, Hamburg, Germany — [3]Technische Universität Darmstadt, Germany

X-ray free-electron lasers (XFEL) open up new frontiers across many areas of research and science. Numerous experiments require ultra-short pulse durations for measurements in fs-time-scales. Therefore, a reliable synchronization system with sub-10 fs precision is necessary, even for ultra-low bunch charges. The established all-optical synchronization systems depend on transient fields of passing electron bunches coupled into the pickups of the bunch arrival-time monitors (BAM). The extracted signal is imprinted on reference laser pulses by amplitude modulation in a Mach-Zehnder type electro-optical modulator. The sensitivity of the BAM depends in particular on the slope of the bipolar signal at the zero-crossing. In order to understand the limitations of the current pickups and to enable advances in design, it is crucial to examine the pickup signal by numerical and analytical methods. In this contribution, the theoretical foundations are reviewed with special attention to the less common case of ultra-short bunch lengths.

AKBP 7: Electron Accelerators

Time: Wednesday 14:00–16:15 Location: AKBPb

AKBP 7.1 Wed 14:00 AKBPb

Recent Developments at the S-DALINAC* — •M. Arnold, J. Birkhan, A. Brauch, M. Dutine, J. Enders, M. Fischer, R. Grewe, L. Jürgensen, M. Meier, J. Pforr, N. Pietralla, F. Schliessmann, D. Schneider, M. Steinhorst, L. Stobbe, and S. Weih — Institut für Kernphysik, Technische Universität Darmstadt

The superconducting Darmstadt linear accelerator S-DALINAC is a thrice-recirculating linac for electrons [1]. Besides the conventional acceleration scheme with corresponding nuclear physics experiments, the accelerator of TU Darmstadt can also be operated as an energy recovery linac (ERL) [2]. Since its establishment in 1991, the S-DALINAC was mainly developed and operated by students. Also during the past year, various projects have progressed and several measurements have been done. Among them, a new system for the measurement of beam emittance by optical transition radiation was set into operation. Additional diagnostics have been commissioned or are under construction. Further upgrades of the injector section are in preparation. Several projects are addressing the ERL operation of the S-DALINAC. Simulations and dedicated diagnostics for the twice-recirculating ERL mode

are under investigation. This contribution will give an overview of the status of those projects.

[1] N. Pietralla, Nuclear Physics News, Vol. 28, No. 2, 4 (2018).
[2] M. Arnold et al., Phys. Rev. Accel. Beams 23, 020101 (2020).

*Work supported by DFG (GRK 2128), BMBF (05H18RDRB2), State of Hesse (LOEWE Research Cluster Nuclear Photonics)

AKBP 7.2 Wed 14:15 AKBPb

A storage ring upgrade for MESA — •Christian Stoll — Institut für Kernphysik - JGU Mainz

MESA is an ERL facility currently under construction at the Johannes Gutenberg University in Mainz. With a maximum beam current of 1 mA it provides the opportunity for electron scattering experiments with a high density gas jet target at the MAGIX experiment. Increasing the beam current even further would also open up the investigation of thin polarized gas targets with sufficiently high interaction rates. Increasing the beam current to 100 mA would pose significant challenges to the existing ERL machine, thus the proposal is to use MESA in pulsed operation with a repetition rate of several kHz to fill a storage ring. The stored beam could nearly completely fill the ring, providing a quasi c.w. beam current to the thin gas target. Due to the repetition rate of several kHz the beam will not be stored for long so damping times and steady states are of no concern, rather we aim for peak brilliance at the experiment. Investigation of a suitable injection- and extraction scheme is crucial as well as understanding the beam target interaction and its effects on the beam. In the most favourable configuration the spent beam could be used for energy recovery.

AKBP 7.3 Wed 14:30 AKBPb

Investigations into MESA's Longitudinal Beam Dynamics with OPAL — •Sebastian Taubert — Institut für Kernphysik, JGU Mainz, Deutschland

The experiments at the future user facility MESA (Mainz Energy-Recovering Superconducting Accelerator) have very high demands regarding energy resolution and beam stability. Therefore, non-isochronous beam recirculation and off-crest acceleration will be used to reduce the energy spread. For the Energy Recovery (ER) mode of MESA this is not trivial and different operation schemes need to be investigated. In order to do that MESA's ER mode is being simulated using the OPAL accelerator library.

AKBP 7.4 Wed 14:45 AKBPb

Simulations and Measurements of the Emittance of the S-DALINAC's Electron Beam after its Injector Beamline* — •Lennart Stobbe, Michaela Arnold, Lars Jürgensen, Jonas Pforr, and Norbert Pietralla — IKP, TU Darmstadt, Germany

The injector section of the superconducting electron-linear-accelerator S-DALINAC has two different electron sources, a thermionic gun and a source of spin-polarized electrons [1]. The current chopper system consists of a 3 GHz normal-conducting pill-box cavity, a steering magnet and an aperture plate with a diameter of two millimeters. The injector beam-line was studied with respect to further optimizations of the resulting beam quality. Modifications of the current chopper system were investigated irrespective of constraints related to the source of polarized electrons. The results of simulations with the program Astra [2] will be presented. Also emittance measurements behind the injector beamline will be shown and compared to the simulations of the current setup.

[1] N. Pietralla, Nuclear Physics News, Vol. 28, No. 2, 4 (2018).
[2] A Space Charge Tracking Algorithm (ASTRA)
http://www.desy.de/ mpyflo/

*Work supported by DFG through GRK 2128 and by the state of Hesse through the LOEWE Research Cluster Nuclear Photonics

AKBP 7.5 Wed 15:00 AKBPb

Status and Advancements towards Commissioning of the S-DALINAC Injector Upgrade* — •Simon Weih, Michaela Arnold, Joachim Enders, and Norbert Pietralla — Institut für Kernphysik, TU Darmstadt, Darmstadt, Germany

A capture cavity for non-ultra relativistic electrons ($\beta = 0.86$) will be installed at the injector of the superconducting Darmstadt electron linear accelerator (S-DALINAC) [1] to achieve the beam quality required for the currently investigated multi-turn ERL mode and to re-enable an operation of the spin-polarized gun. After the finalization of the mechanical cavity processing, the latest completed work packages of the project include a hydrogen bake-out, field-flatness tuning, final RF surface preparation, and testing of the tuner components. In addition, a new diagnostics beamline upstream of the capture cavity was recently installed and commissioned. We will report on these latest advancements towards the commissioning of the upgraded injector.

[1] N. Pietralla, Nuclear Physics News, Vol. 28, No. 2, 4 (2018).
*Work supported by DFG through GRK 2128 and the state of Hesse through the LOEWE Research Cluster Nuclear Photonics

AKBP 7.6 Wed 15:15 AKBPb

LightHouse – A Superconducting Electron Accelerator for the Production of Medical Isotopes — Guido Blokesch, Marc Grewe, Björn Keune, Jakob Krämer, Michael Pekeler, Christian Piel, •Christoph Quitmann, Claudio Serpico, Peter vom Stein, and Thu Trang Trinh — RI Research Instruments GmbH, Friedrich-Ebert-Str. 75, 51429 Bergisch Gladbach, Germany

We are in designing the first industrial superconducting electron linear accelerator, which will be used for high-volume productionof ^{99}Mo. This isotope decays to the short-lived ^{99m}Tc, used in several ten-million diagnostic procedures worldwide, mostly with cancer patients. Customer is the Institute for Radioelements (IRE), Belgium, the world-leader in ^{99}Mo production. For decades ^{99}Mo has been produced by irradiating ^{235}U in high-flux reactors. The new LightHouse facility will be using a (γ, n) reaction driven by a high intensity 75 MeV electron beam stopped in the ^{100}Mo target. This eliminates the need for reactors and minimizes nuclear waste. The electron accelerator uses proven technology from the Cornell CBETA facility, a high brightness DC photoinjector and 1.3 GHz superconducting RF cavities. The challenges are the very high beam power of 3.0 MW (75 MeV, 40 mA) and the high uptime (23 h/day, 360 d/year) required for producing commercially relevant quantities of the short-lived ^{99}Mo ($t_{1/2}$ = 66 h). At present, a Beam Test Facility is being constructed to demonstrate the performance of the photoinjector for this linear accelerator. We describe the design challenges and strategies for solution. We also present opportunities for thesis projects for students in accelerator physics.

AKBP 7.7 Wed 15:30 AKBPb

Investigation of a Thomson scattering based gamma source at MESA — •Christoph Lorey — Johannes Gutenberg Universität, Mainz, Germany

At the Johannes Gutenberg University (JGU) in Mainz, the Mainz Energy-recovering Superconducting Accelerator (MESA), designed to deliver electron beams of up to 155 MeV, is currently under construction. As it can be operated in an energy-recovery (ER) mode with high repetition rate, it is a promising candidate for a Thomson scattering based gamma source of which a low interaction cross section is one of the key features. With MESA as the exemplary subject, this presentation will give a short summary of the challenges and benefits of a Thomson scattering based gamma source and a description of future tasks as well as potential realization concepts for the future beyond.

AKBP 7.8 Wed 15:45 AKBPb

Influence of collective effects on electron bunching — •Dmitrii Samoilenko[1,2], Lucas Schaper[2], Sven Ackermann[2], Wolfgang Hillert[1,2], and Enrico Allaria[2] — [1]University of Hamburg, Institut für Experimentalphysik, Hamburg, Germany — [2]DESY, Hamburg, Germany

FLASH is a free electron laser with high repetition rate in XUV and soft X-ray regime. Currently an upgrade for this facility is under development and it includes enabling an elaborated external seeding scheme: echo-enabled harmonic generation (EEHG). This scheme provides efficient electron bunching at high harmonics of the seeding laser, which will allow generation of seeded FEL radiation at wavelengths down to 4.16nm. To a considerable part the design implies sizable use of numerical simulations that predict performance of the future machine. Since these simulations are usually quite time- and resource-consuming, extensive parameter scans are expensive. The number of core-hours spent on the simulations can be reduced by educated guess for initial parameters. Here, an analytical study providing such a guess is performed on influence of collective effects on electron bunching for EEHG seeding scheme at FLASH. First, the study focuses on how different effects depend on beamline parameters separately to gain a clearer insight on each effect as compared to simulations. Then, combined contributions of the effects are considered together in order to determine an initial working point with promising performance.

AKBP 7.9 Wed 16:00 AKBPb

High brightness beam from a photoinjector for ultra-

fast scattering experiments. — •Beñat Alberdi Esuain[1,2], Axel Neumann[1], Jens Voelker[1], and Thorsten Kamps[1,2] — [1]Helmholtz-Zentrum Berlin — [2]Humboldt University of Berlin

Ultrafast Electron Diffraction (UED) is a pump-probe technique used to observe dynamical changes in the structure of materials. A laser pulse excites the target structure and a subsequent electron bunch scatters in the sample producing a diffraction pattern. The time resolution of UED experiments is governed by the bunch length, while the spatial resolving power is related to the transverse phase space. Hence, high brilliance electron beams are needed. The SRF Photoinjector test facility is a high current electron source at Helmholtz-Zentrum Berlin (HZB). It offers unique possibilities to perform UED experiments as the design is flexible enough to realize the strict electron beam requirements. Two phases are foreseen to achieve operational UED capabilities. The first phase is a proof of concept experiment with a static target to prove that it is possible to attain the required beam parameters. The second phase will have the objective of implementing the time-resolved pump-probe scheme. Phase 1 is currently being developed and is the main focus of this talk. In order to accomplish the high brilliance beam, the longitudinal phase space is linearized at the target by three booster cavities, while the desired transverse phase space is achieved by using an aperture and focusing elements. We discuss the requirements for such experiment, the work that has been carried out for the first phase and the outlook of the UED project in HZB.

AKBP 8: Diagnostics, Control and Instrumentation II

Time: Wednesday 16:30–18:30 Location: AKBPa

AKBP 8.1 Wed 16:30 AKBPa

The application of deep learn on slit scan image processing and emittance predict — •Shuai Ma, André Arnold, Anton Ryzhov, Jana Schaber, Jochen Teichert, and Rong Xiang — Institute of Radiation Physics, HZDR, 01328 Dresden, Germany

For slit scan method, how to decrease the noise of beam-let images directly influences the accuracy of the emittance results. There are two kind noise in the images, random noise and dark current. The traditional method is to capture two groups of images, one with beam and the other one without beam as background. The images with beam subtract the background image respectively. Then using filter algorithm, such as Median filter and Gaussian filter, to decrease the random noise. The total time of these is usually 5 to 10 minutes and sometimes the images with beam at the beginning and ending are not very clear because of low signal ratio, which will contribute emittance to the results. To compress the processing time and improve accuracy, one deep learning method, sparse auto-encoder network is used to pre-process the images. To train the network, the slit scan simulation program based on Astra is built to create the image cases. The sparse auto-encoder network is used to filter random noise. During the training, the noise from the real images, background images, is added to increase the stability of the network. After the network, the negative signals, meaningless signals, in the images are set to zero. The other model, point cloud network is used to filter the dark current and gives the emittance from phase space directly. The error is lower than 10%.

AKBP 8.2 Wed 16:45 AKBPa

Detection of Laser-Accelerated Ions using the Ionoacoustic Approach: the I-BEAT Detector — •Sonja Gerlach[1], Felix Balling[1], Anna-Katharina Schmidt[1], Vincent Bagnoud[2], Florian-Emanuel Brack[3], Johannes Hornung[2], Florian Kroll[3], Ulrich Schramm[3], Karl Zeil[3], Bernhard Zielbauer[2], Katia Parodi[1], and Jörg Schreiber[1] — [1]Department of medical physics at the LMU München, München, Germany — [2]GSI, Darmstadt, Germany — [3]HZDR, Dresden, Germany

Laser-driven ion sources represent a promising particle acceleration option for many interesting fields in physics, chemistry and biology. The properties of laser-accelerated ion bunches - especially the short and intense particle pulses with a broad energy spectrum emitted in conjunction with a strong electromagnetic pulse - demand the development of suitable beam diagnostics. The innovative approach of measuring the acoustic signals of particles depositing their energy in water, referred to as Ion-Bunch Energy Acoustic Tracing (I-BEAT), was already demonstrated to be capable of reconstructing also complex energy spectra at the ion focus while being radiation and EMP resistant. Here, an extension of the set-up for multidimensional dose reconstruction is presented. First experimental tests show promising results as e.g. the determination of the lateral beam position with sub-millimetre accuracy.

This work was supported by the German Research Foundation (DFG) within the Research Training Group GRK 2274. FB acknowledges financial support by the BMBF under project 05P18WMFA1.

AKBP 8.3 Wed 17:00 AKBPa

4D Transverse Phase Space characterization of high brightness electron beams at PITZ — •Namra Aftab[1] and Mikhail Krasilnikov[2] — [1]Deutsches Elektronen-Synchrotron, Platanenallee 6, 15738 Zeuthen, Germany — [2]Deutsches Elektronen-Synchrotron, Platanenallee 6, 15738 Zeuthen, Germany

Photo Injector Test facility at DESY in Zeuthen (PITZ) utilizes slit scan technique as a standard tool for reconstruction of horizontal and vertical phase spaces because of its space charge dominated electron beams. A novel method for 4-dimensional transverse beam phase space measurement is proposed at PITZ known as Virtual Pepper Pot that can give insight to transverse beam phase space coupling. It utilizes the 2D slit scans to form pepper-pot like beamlets by careful crossing and post processing of the slit scan data. All elements of the 4D transverse beam matrix are calculated and used to obtain the 4D transverse emittance, 4D kinematic beam invariant and coupling factors. The proposed technique has been applied to the ASTRA simulated beams as well as the experimental data from the PITZ facility and compared with the 2D slit scan technique.

AKBP 8.4 Wed 17:15 AKBPa

Design of a Laser Compton Backscattering Source for Beam Diagnostics at the S-DALINAC* — •Maximilian Meier[1], Michaela Arnold[1], Vincent Bagnoud[2], Joachim Enders[1], Norbert Pietralla[1] und Markus Roth[1] — [1]IKP, TU Darmstadt, Germany — [2]GSI, Darmstadt, Germany

Laser Compton Backscattering (LCB [1]) provides quasi-monochromatic highly polarized beams on the X-ray and gamma-ray regime for a variety of applications. A powerful stable and well synchronized laser with a high repetition rate is essential for a high-flux Compton light source. A project at TU Darmstadt foresees to synchronize a high-repetition high-power laser with electrons from the Superconducting DArmstadt electron LINear ACcelerator (S-DALINAC [2]) to realize a LCB photon beam with energy up to 180 keV. The main goal in the first years will be to use LCB as an additional diagnostic tool for determining the electron beam energy and the energy spread of the S-DALINAC, with respect to the energy-recovery linac (ERL [3]) operation as well as the optimizing design considerations for a Compton light source. An overview over the design concept of the LCB Source at the S-DALINAC will be given, simulations on the layout and the estimated output will be presented.
[1] C. Bemporad et al., Phys. Rev. 138, B1546 (1965)
[2] N. Pietralla, Nucl. Phys. News 28(2), 4 (2018)
[3] M. Arnold et al., Phys. Rev. Accel. Beams 23, 020101(2020)
*Supported through the state of Hesse (LOEWE research cluster Nuclear Photonics) and DFG through GRK 2128 *AccelencE*.

AKBP 8.5 Wed 17:30 AKBPa

Application of KALYPSO as a diagnostic tool for beam and spectral analysis — •Meghana M Patil, Michele Caselle, Erik Bründermann, Gudrun Niehues, Benjamin Kehrer, Andreas Ebersoldt, Michael J Nasse, Stefan Funkner, Anke-Susanne Müller, and Marc Weber — Karlsruhe Institute of Technology

KALYPSO is a novel detector operating at frame rates up to 10 MHz developed and tested at the KIT synchrotron light source and its storage ring KARA. This detector can consist of a Si, InGaAs, PbS or PbSe line array sensor with spectral sensitivity from 350 nm to 5000 nm. Such a wide spectral sensitivity for Si is obtained by applying an anti-reflection coating optimized for these wavelengths as well as the modular capability of the detector to employ sensors with different

spectral sensitivities. The unprecedented frame rate of this detector is achieved by a custom-designed ASIC readout. FPGA-readout architecture enables continuous data acquisition and real-time data processing. Such a detector has various applications in the fields of beam diagnostics and spectral analysis and is currently employed at various synchrotron facilities to study the longitudinal profile and energy spread of the electron beam, tuning of free-electron lasers, and in characterizing laser spectrum. This contribution will present an overview of results from the mentioned applications. This work is supported by BMBF project 05K19VKD STARTRAC (Federal Ministry of Education and Research) and by the DFG-funded Doctoral School Karlsruhe School of Elementary and Astroparticle Physics: Science and Technology (KSETA).

AKBP 8.6 Wed 17:45 AKBPa

Bayesian optimization of injection efficiency at KARA using Gaussian processes — •Chenran Xu[1], Tobias Boltz[2], Akira Mochihashi[1], Andrea Santamaria Garcia[2], and Anke-Susanne Müller[1,2] — [1]IBPT, KIT, Karlsruhe — [2]LAS, KIT, Karlsruhe

The injection at the KIT storage ring KARA (Karlsruhe Research Accelerator) is tuned by many parameters, such as the strength of various magnets and the RF frequency. The tuning process is currently performed manually by machine operators, which is time consuming and can get stuck in local optima. To address this, Bayesian optimisation is applied, i.e. a technique for optimising noisy black-box functions. Using Gaussian processes (GPs) for regression we obtain a probabilistic model, which allows the integration of prior knowledge about the physical process. The model can be queried during the optimization procedure to efficiently explore the given parameter space, leading to comparably fast convergence. In this contribution, we demonstrate the implementation of Bayesian optimization to automate and optimize the injection process.

Chenran Xu acknowledges the support by the DFG-funded Doctoral School "Karlsruhe School of Elementary and Astroparticle Physics: Science and Technology".

AKBP 8.7 Wed 18:00 AKBPa

Stability Investigation of long-term operations at FLUTE — •Thiemo Schmelzer for the FLUTE-Collaboration — LAS, KIT, Karlsruhe

At KIT the new compact and versatile linear-based test facility FLUTE (Ferninfrarot Linac- Und Test-Experiment) is operated. Its primary goal is to serve as a platform for a variety of accelerator R&D studies as well as to generate strong ultra-short THz pulses for photon science. For some studies, for example radiation exposure in material studies, the accelerator is best operated with a continuous and stable electron beam over several hours. In systematic measurements, several parameters of the electron beam were monitored to investigate their stability in different operation settings. The results as well as further optimization opportunities will be presented in this contribution.

Thiemo Schmelzer acknowledges the support by the Doctoral School Karlsruhe School of Elementary and Astroparticle Physics: Science and Technology.

AKBP 8.8 Wed 18:15 AKBPa

Impedance studies of a corrugated pipe for KARA — •Sebastian Maier[1], Miriam Brosi[2], Akira Mochihashi[2], Michael J. Nasse[2], Markus Schwarz[2], and Anke-Susanne Müller[1,2] — [1]LAS, KIT, Karlsruhe — [2]IBPT, KIT, Karlsruhe

At the KIT storage ring KARA (KArlsruhe Research Accelerator) it is planned to install an impedance manipulation structure in a versatile chamber to study and eventually control the influence of an additional impedance on the beam dynamics and the emitted coherent synchrotron radiation. For this purpose the impedance of a corrugated pipe is under investigation. In this contribution, we present first results of simulations showing the impact of different structure parameters on its impedance and wake potential. This work is supported by the DFG project 431704792 in the ANR-DFG collaboration project ULTRASYNC. Sebastian Maier acknowledges the support by the DFG-funded Doctoral School "Karlsruhe School of Elementary and Astroparticle Physics: Science and Technology"

AKBP 9: Electron Accelerators and Particle Sources

Time: Wednesday 16:30–18:30 Location: AKBPb

AKBP 9.1 Wed 16:30 AKBPb

Towards control of a photoinjector by using spatial light modulators at FLUTE — •Carl Sax[2], Michael Nasse[1], Chenran Xu[1], Andrea Santamaria Garcia[1], Erik Bründermann[1], and Anke-Susanne Müller[1] for the FLUTE-Collaboration — [1]IBPT, KIT, Karlsruhe — [2]LAS, KIT, Karlsruhe

The characteristics of an electron bunch created with a photoinjector are strongly influenced by the properties of the driving laser. Therefore, we plan to install spatial light modulators (SLMs) in the laser beam path to shape and manipulate the infrared laser pulses, which are converted to the ultraviolet spectrum, and eventually also the generated electron bunch in the transverse as well as the longitudinal plane. SLMs should also allow the flexible mitigation of aberrations in the beam profile. The SLMs are planned to be installed in FLUTE (Ferninfrarot Linac- und Test-Experiment) at KIT, a compact linac-based test facility for accelerator R&D and source of intense THz radiation. In this presentation, the first test-setup is shown.

AKBP 9.2 Wed 16:45 AKBPb

Status of the MESA ERL project* — •Florian Hug — Johannes Gutenberg-Universität Mainz

MESA is a recirculating superconducting accelerator under construction at Johannes Gutenberg-Universität Mainz, which will be operated in either external beam or ERL mode. After completion, it is planned to be used for high precision particle physics experiments. The operating cw beam current and energy in EB mode is 0.15 mA with polarized electrons at 155 MeV. In ERL mode a polarized beam of 1 mA at 105 MeV will be available. In a later construction stage of MESA the beam current in ERL-mode may be upgraded to 10 mA (unpolarized). Civil construction and commissioning of components like electron gun, LEBT and SRF modules have been progressed already. In this contribution we give a project overview including the accelerator layout, the current status and an outlook to the upcoming construction and commissioning steps.

* This work has been supported by DFG through the PRISMA+ cluster of excellence EXC 2118/2019

AKBP 9.3 Wed 17:00 AKBPb

Development of a GaAs-based photo-electron source with cryogenic components — •Tobias Eggert, Joachim Enders, and Yuliya Fritsche — Institut für Kernphysik, TU Darmstadt, Germany

Polarized electron beams can be generated using the internal photoeffect with GaAs as a photocathode. However, a negative-electron-affinity (NEA) coating consisting of a CsO layer, is necessary when using GaAs. This layer limits the operational lifetime as it gets corroded by oxygen and destroyed by ionized residual gas molecules hitting the surface. The latter is called ion back-bombardment (IBB) and one of the main lifetime limiting factors. Improving the vacuum conditions near the cathode surface is expected to reduce IBB and increase the lifetime. At the Photo-CATCH test facility in Darmstadt, an electron source is developed which uses cryocooling of a sub-volume around the cathode. In addition to the sub-volume, the cathode itself gets cooled.

This project is supported by DFG (GRK 2128) and BMBF (05H18RDRB1).

AKBP 9.4 Wed 17:15 AKBPb

QE and life time of Cs2Te photocathodes on copper for SRF gun-II at HZDR — •Rong Xiang[1], Andre Arnold[1], Shuai Ma[1,2], Petr Murcek[1], Anton Ryzhov[1], Jana Schaber[1,3], and Jochen Teichert[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf, 01328 Dresden, Germany — [2]Universität Rostock, 18051 Rostock, Germany — [3]Technische Universität Dresden, 01069 Dresden, Germany

The SRF gun-II at HZDR has been stably applied as the electron source for high power THz radiation since 2018, generating CW beams with bunch charges up to 300 pC at 100 kHz. It is an excellent demonstration that SRF guns can work reliably in a high power user facility.

In order to generate higher current beam with MHz repetition rate, Cs2Te photocathodes are required. However, in last two experiments with Cs2Te, the Mo substrate plugs were overheated in superconducting rf cavity. The reason is that different thermal expansion coefficient of Mo and Cu led to a bad thermal contact between the Mo plug and Cu holder. Thus we decided to use Cu as new substratum of Cs2Te cathodes. In last year we prepared several Cs2Te photocathodes on Cu plugs and improved the vacuum of cathode transfer system in order to achieve satisfied lifetime. In this contribution, we will present the study result of QE and life time of Cs2Te photocathodes with different thickness.

AKBP 9.5 Wed 17:30 AKBPb

Preparation of phothocathodes with nitrogen triflouride — •Jennifer Groth — Johannes Gutenberg-Universität Mainz, Institut für Kernphysik, Mainz, Deutschland

In the new, energy-recovering superconducting accelerator MESA in Mainz, spin-polarized electrons are required in the P2 experiment. Here the requirements increase considerably compared to the photocathode for the spin-polarized electrons for the microtron in Mainz.

A very sensitive part of the photocathodes concerns the specially prepared surface. The surface, which has a negative electron affinity, is particularly sensitive to residual gases in vacuum and suffers from ion back bombardment due to the radiation generated. The negative electron affinity of the surface is achieved through a preparation with alkali metals and an oxidizing agent, in the most common case with cesium and oxygen. One aspect of surface preparation that is being pursued takes up the idea of working oxygen-free with nitrogen trifluoride and cesium. It has already been shown in other studies that this method delivers results that are as good as a preparation with oxygen and cesium with regard to the quantum yield.

The aim is to examine the advantages of an oxygen-free preparation, especially with regard to the influence on the evolution of spin polarization during the experiment.

AKBP 9.6 Wed 17:45 AKBPb

Design of Photon Masks for the ILC Positron Helical Undulator — •Khaled Alharbi[1,2,4], Sabine Riemann[2], Gudrid Moortgat-Pick[1,3], Andriy Ushakov[1], and Peter Sievers[5] — [1]University of Hamburg — [2]Desy, Zeuthen — [3]Desy, Hamburg — [4]KACST, Saudi Arabia — [5]CERN

The positron source of the International Linear Collider (ILC) is based on a superconducting helical undulator passed by the high-energy electron beam to generate photons which hit a conversion target. Since the photons are circularly polarized the resulting positron beam is longitudinally polarized.

At a center-of-mass energy of 250 GeV (ILC-250), the undulator with 231 m magnet length is needed to produce the required number of positrons. The power deposition in the undulator walls should be below the acceptable limit of 1W/m since it is a superconducting undulator and also to fulfill the vacuum requirements. The power deposition of the photon beam in undulator walls was studied and shown that the peak power deposition in the undulator walls is above 20 W/m.

To keep the power deposition below the acceptable limit, 22 photon masks must be inserted in the undulator line.

In this paper the design of photon masks for an ideal and realistic helical undulator is presented.

AKBP 9.7 Wed 18:00 AKBPb

Automated activation procedures for GaAs-photocathodes — •Markus Engart, Joachim Enders, Yuliya Fritzsche, Maximilian Herbert, Manuel Steinhorst, and Vincent Wende — Institut für Kernphysik, Technische Universität Darmstadt, Schlossgartenstr. 9, 64289 Darmstadt

Gallium-arsenide-based photocathodes are used for a variety of applications. In particular, they serve in sources of polarized electrons. The source performance depends on the quantum efficiency and lifetimes of the photocathodes, usually activated to negative electron affinity using an alkali metal and an oxidant. Good reproducibility of the activation is desired in order to ensure stable and simple operation of such sources. Hence, an automation of this process is envisaged.

The Photo-CATCH (Photo-Cathode Activation, Test and Cleaning using Atomic Hydrogen) test stand at TU Darmstadt is used for experiments with un-/spinpolarized electrons with energies up to 60 keV. This contribution presents the results of experiments with automated activations following the co-deposition of caesium and oxygen using empirically determined values for the the different activation stages. Results show typical variations in the achieved quantum efficiency of about 20%.

Supported in part by BMBF (05H18RDRB1) and DFG (GRK 2128 AccelencE, project number 264883531).

AKBP 9.8 Wed 18:15 AKBPb

Corrections of high-order nonlinearities in the LHC and HL-LHC (An introduction to my PhD Thesis) — •Joschua Dilly — CERN and Humboldt Universität zu Berlin

Optics Measurements and Corrections have been of utmost importance for successful operation of the LHC and will continue to be so for the upcoming High-Luminosity upgrade HL-LHC. The optics in the insertion regions in particular are very sensitive to errors in their elements, due to the extremely high beta-functions present.

In this talk basic concepts of local and global corrections are presented and arguments made for the importance of extending these corrections to high-order magnetic field errors to improve beam stability and lifetime.

These procedures are presented in the framework of my PhD-Thesis, in which I am concerned with the mitigation of these errors by utilizing resonance driving terms and investigating the effects from feed-down emerging from the non-zero closed orbit in the insertion regions. Results of my studies of the first half of my PhD are shown and discussed here together with an outlook on the upcoming second half.

AKBP 10: Synchrotron Radiation and FELs

Time: Thursday 14:00–16:15 Location: AKBPa

AKBP 10.1 Thu 14:00 AKBPa

Computational Studies for the Future EEHG Upgrade at DELTA Short-pulse Facility — •Arjun Radha Krishnan, Benedikt Büsing, Arne Held, Shaukat Khan, Hubertus Kaiser, and Carsten Mai — Center for Synchrotron Radiation (DELTA), TU Dortmund University, Dortmund, Germany

The short-pulse facility at the 1.5-GeV synchrotron light source DELTA, operated by the TU Dortmund University, currently employs the Coherent Harmonic Generation (CHG) technique to generate ultrashort VUV pulses. This will be upgraded to Echo Enabled Harmonic Generation (EEHG) scheme to reach even shorter EUV wavelengths in the future. The two-stage energy modulations in combination with two dispersion sections allow more flexibility towards optimizing the parameters for the setup.

Results of the computational studies regarding the optimization of undulator, laser, and chicane parameters with an aim of producing coherent emission at 20 nm (40th harmonic of seed wavelength) will be presented.

This project is funded by BMBF under contract 05K19PEB.

AKBP 10.2 Thu 14:15 AKBPa

Status of the Short-Pulse Source at DELTA — •Hubertus Kaiser, Benedikt Büsing, Arne Held, Shaukat Khan, Daniel Krieg, Arjun Radha Krishnan, and Carsten Mai — Center for Synchrotron Radiation (DELTA),TU Dortmund University, Dortmund, Germany

The short-pulse source at the 1.5-GeV electron storage ring DELTA operated by the TU Dortmund University employs the coherent harmonic generation (CHG) technique to provide ultrashort pulses in the vacuum ultraviolet and terahertz regime. Here, a modulation of the electron energy induced by an interaction with an ultrashort laser within an undulator (modulator) tuned to the laser wavelength is transformed into a density modulation by a magnetic chicane. Recently, the influence of the Gouy phase shift in the laser pulse on the laser-electron interaction has been investigated. It causes a shift of the wavelength the undulator needs to be tuned to. Additionally, the magnetic setup of the short-pulse source allows to investigate the coherent emission

of edge radiation. Furthermore, a setup for Compton backscattering featuring a high-power continuous-wave CO2 laser and a gamma-ray spectrometer will be implemented at DELTA. It allows for precise measurements of the electron beam energy and energy spread. Funded by BMBF under contract 05K19PEB.

AKBP 10.3 Thu 14:30 AKBPa

Current status of the electro-optical electron bunch measurement setup at the DELTA short-pulse source — •Ihsan Mohammad, Shaukat Khan, and Carsten Mai — Center for Synchrotron Radiation (DELTA), TU Dortmund University, Dortmund, Germany

At the 1.5-GeV electron storage ring DELTA operated by the TU Dortmund University, the interaction with femtosecond pulses from a Ti:sapphire laser system in an undulator modulates the electron energy within a slice of the electron bunch and gives rise to the coherent emission of ultrashort pulses in the VUV range. Along the storage ring lattice, the off-energy electrons leave a dip in the longitudinal electron distribution causing the coherent emission of (sub-)THz radiation.

The talk reviews recent results obtained in the study and manipulation of coherently emitted THz radiation and presents the status of an electro-optical (EO) setup to measure the laser-induced temporal structure within the electron bunch. Using the EO effect, the temporal profile of THz radiation is mapped onto the spectrum of a chirped laser pulse. This can be done either in the far field with THz radiation passing through an EO crystal or with a near-field setup inside the storage ring with the electron bunches passing close to the crystal.

This project is supported by the BMBF under contract 05K19PEC.

AKBP 10.4 Thu 14:45 AKBPa

Progress of the development of a superconducting undulator as a THz source for FELs — •Julian Gethmann[1], Andreas Grau[2], David Saez de Jauregui[2], Nicole Glamann[2], Sara Casalbuoni[2,3], and Anke-Susanne Müller[1,2] — [1]LAS, KIT, Karlsruhe — [2]IBPT, KIT, Karlsruhe — [3]European XFEL GmbH, Schenefeld

To produce radiation in the THz wavelength range at X-ray free electron lasers, undulators with large period length, fields, and gaps can be used. These demands can be fulfilled by superconducting undulators. In this contribution the actual requirements on the main parameters of the superconducting undulator will be discussed. The progress of the design of one such undulator will be presented.

This work is supported by the BMBF project 05K19VK2 SCUXFEL (Federal Ministry of Education and Research) and by the DFG-funded Doctoral School "Karlsruhe School of Elementary and Astroparticle Physics: Science and Technology (KSETA)".

AKBP 10.5 Thu 15:00 AKBPa

Status of the CompactLight Design Study — Regina Rochow[1], Gerardo D'Auria[1], and •Andrea Latina[2] — [1]Elettra Sincrotrone Trieste — [2]CERN - European Organization for Nuclear Research

CompactLight (XLS) is a H2020 Design Study funded by the European Union under grant agreement 777431 and carried out by an International Collaboration of 26 partners and 5 third parties. The project started in January 2018 with a duration of 48 months and aims at designing an innovative, cost-effective and compact hard X-ray FEL facility beyond today's state of the art. This will be achieved using an advanced C-band photo-injector, high gradient X-band accelerating structures, and novel short period undulators. The hard X-ray FEL will be complemented by a soft X-ray source that can be operated up to 1 KHz pulse repetition rate. The presentation, held on behalf of the CompactLight Consortium, will give an overview of the state of the project, focusing in particular on the facility design and its potential regarding future user needs.

AKBP 10.6 Thu 15:15 AKBPa

Numerical simulation of a superradiant THz source at the PITZ facility — •natthawut chaisueb[1,2], prach boonpornprasert[3], mikhail krasilnikov[3], xiangkun li[3], anusorn lueangaramwong[3], and sakhorn rimjaem[1] — [1]Plasma and Beam Physics Research Facility (PBP), Department of Physics and Materials Science, Faculty of Science, Chiang Mai University, Chiang Mai, Thailand — [2]Doctor of Philosophy Program in Physics (International Program), Department of Physics and Materials Science, Faculty of Science, Chiang Mai University, Chiang Mai, Thailand — [3]DESY, Zeuthen, Germany

An accelerator-based THz source is under development at the Photo Injector Test Facility at DESY in Zeuthen (PITZ). The facility can produce high brightness electron beams with high charge and small emittance. Currently, study on development of a tunable high-power THz SASE FEL for supporting THz-pump, X-ray probe experiments at the European XFEL is underway. An LCLS-I undulator, a magnetic chicane bunch compressor, and THz pulse diagnostics will be installed downstream the current setup of the PITZ beamline. Additionally to the SASE FEL, a possibility to generate superradiant THz undulator radiation from short electron bunches is under investigation. Numerical simulations of the superradiant THz radiation by using sub-picosecond electron bunches with energy of 6 - 22 MeV and bunch charge up to 2 nC produced from the PITZ accelerator are presented and discussed in this contribution.

AKBP 10.7 Thu 15:30 AKBPa

HTS undulators: status of prototype coils for compact FELs — •Sebastian C. Richter[1,2], Daniel Schoerling[1], Axel Bernhard[2], Kantaphon Damminsek[2], Julian Gethmann[2], and Anke-Susanne Müller[2,3] — [1]CERN - 1211 Geneva 23 - Switzerland — [2]LAS, KIT, Karlsruhe, Germany — [3]IBPT, KIT, Karlsruhe, Germany

Compact free electron lasers (FELs) require short-period high field undulators in combination with shorter accelerator structures to produce coherent light up-to X-rays. Applying high-temperature superconductor (HTS) in form of coated REBCO tape conductors allows reaching higher magnetic fields and larger operating margins as compared to low-temperature superconductors (LTS). This contribution discusses and summarizes the potential of HTS for the major superconducting undulator geometries (horizontal, vertical racetrack and helical) as well as the status of prototype coils for each type, to be wound with coated REBCO tape conductor.

This work has been supported by the Wolfgang Gentner Programme of the German Federal Ministry of Education and Research (grant no. 05E15CHA).

AKBP 10.8 Thu 15:45 AKBPa

Operational experience and characterization of a superconducting transverse gradient undulator for compact laser wakefield accelerator-driven FELs — •Kantaphon Damminsek, Axel Bernhard, Julian Gethmann, Maisui Ning, Robert Rossmanith, Sebastian Richter, Yuancun Nie, Yimin Tong, and Anke-Susanne Müller — Karlsruhe Institute of Technology

A 40-period superconducting transverse gradient undulator (TGU) has been designed and fabricated at the Karlsruhe Institute of Technology (KIT). Combining a TGU with a laser wakefield accelerator (LWFA) is a potential key for realizing extremely compact free electron laser (FELs) radiation sources. The TGU scheme is a viable option to compensate the challenging properties of the LWFA electron beam in terms of beam divergence and energy spread. In this contribution, we report on the operational experience of this TGU inside its own cryostat and show first results of the characterization measurement, current status of the TGU and the further plan for experiments.

This work is supported by the BMBF project 05K19VKA PlasmaFEL (Federal Ministry of Education and Research).

AKBP 10.9 Thu 16:00 AKBPa

Divergence Study of an Echo-Enabled Harmonic Generation Free-Electron Laser — •Fabian Pannek[1], Sven Ackermann[2], Enrico Allaria[2], Pardis Niknejadi[2], Georgia Paraskaki[2], Lucas Schaper[2], and Wolfgang Hillert[1] — [1]Universität Hamburg, Hamburg, Deutschland — [2]Deutsches Elektronen-Synchrotron (DESY), Hamburg, Deutschland

At FLASH, the Free-Electron LASer in Hamburg, an upgrade of one of the existing beamlines towards echo-enabled harmonic generation (EEHG) is planned. With this upgrade, FLASH will be the first seeded FEL facility that provides high repetition rate radiation in the XUV and soft X-ray regime. A critical quantity characterizing the radiation is its divergence, which is crucial for the design of photon diagnostics and the transport of the radiation to the experiment. To investigate the impact of the electron beam and beamline parameters on the divergence, dedicated numerical simulations based on the FEL code GENESIS 1.3 version 4 have been carried out. We will present and discuss the first results of these studies.

AKBP 11: Diagnostics, Control and Instrumentation III

Time: Thursday 16:30–18:30 Location: AKBPa

AKBP 11.1 Thu 16:30 AKBPa

Experimental investigation of quadrupole-doublet alignment on the focus of laser-accelerated ions — •Luisa Tischendorf, Thomas Rösch, Felix Balling, Marc W. Berndl, Leonard Doyle, Lotta Flaig, Jens Hartmann, Sonja Kundel, and Jörg Schreiber — Ludwig-Maximilians-Universität München, Germany

Employing laser-accelerated ions in radiation related research requires control of ion bunch characteristics such as the energy spectrum and beam size. At the Centre for Advanced Laser Applications (CALA) we have investigated for this purpose a quadrupole doublet consisting of two permanent magnet quadrupoles (PMQs). The broad input energy distribution strongly determines the appearance of the proton focus at 1.8 m remote location, which we observe on a scintillating screen. Misalignments strongly affect the appearance of the downstream focus. We conducted a detailed experiment in which alignment parameters of the focusing system were varied to investigate their effect on the focal shape. We identified a smallest possible spot with dimension 1.2 mm by 0.8 mm. Buch profile calculations based on the matrix formalism provide a comparison to the experimental results and reveal that the source size of the proton emission in the laser-driven plasma is not negligible. This observation could provide an elegant way for determining the particle source emittance in future experiments.

AKBP 11.2 Thu 16:45 AKBPa

Efficient THz generation by tilted-pulse-front pumping in lithium niobate for the split-ring-resonator experiment at FLUTE — •Matthias Nabinger for the FLUTE-Collaboration — LAS, KIT, Karlsruhe

We develop a compact, longitudinal diagnostics for fs-scale electron bunches using a THz electric-field transient in a split-ring resonator (SRR) for streaking at the Ferninfrarot Linac- Und Test- Experiment (FLUTE). For this new streaking technique, intensive THz pulses are required, which will be generated by laser-based optical rectification. We present a setup for generating THz pulses using tilted-pulse-front pumping in lithium niobate at room temperature. Excited by an 800-nm Ti:Sa pump laser with 35-fs bandwidth-limited pulse length, conversion efficiencies up to 0.03% were achieved. Furthermore, the current status of the SRR experiment is shown.

AKBP 11.3 Thu 17:00 AKBPa

New bunch by bunch filling-pattern measuring system at ELSA — Klaus Desch, Dennis Proft, and •Alexandra Wald — Physikalischer Institut, Universität Bonn, Deutschland

The electron accelerator facility ELSA at the University of Bonn can accelerate and store electrons with a final energy from 0.8GeV up to 3.2GeV. To determine the filling pattern in the storage ring a new measuring system is developed. For hadron physics experiments the filling pattern, which is influenced by the injection from the pre-accelerator (the Booster-Synchrotron), should be as homogeneous as possible. The new measurement system should provide a real-time measurement of the filling pattern, so that a continuous optimisation of the injection becomes possible.

To measure the intensity and the position bunch by bunch for all 274 bunches, the signals of the existing BPMs will be digitised by fast 12-bit ADCs synchronous to the 500MHz ELSA radio frequency. The fast pre-processing and intermediate storage of the data is realised with a 500MHz clocked FPGA and transfers the data to a PC for further processing.

The measurement can be verified by a streak camera, which in this case is not suitable for the continuous measurement. The method and first measurements will be presented.

AKBP 11.4 Thu 17:15 AKBPa

Stabilisation der Strahlparameter für das P2 Experiment an MESA — •Ruth Kempf — Institut für Kernphysik, Becher-Weg 45, 55128 Mainz

Am neuen Elektronenbeschleuniger MESA am Institut für Kernphysik in Mainz soll das P2-Experiment den elektroschwachen Mischungswinkel $\sin^2\Theta_W$ mit einer bisher unerreichten Genauigkeit von 0,15 % bestimmen. Dafür wird die Asymmetrie, die durch die Elektron-Proton-Streuung der longitudinal spinpolarisierten Elektronen an unpolarisierten Protonen verursacht wird, gemessen. Wegen der vergleichsweise geringen Strahlenergie von 155 MeV beläuft sich die zu messende paritätsverletzende Asymmetrie auf ca. 30 ppb. Daher ist die systematische Unsicherheit auf 0,1 ppb am Ende der Strahlzeit von 10000 Stunden bei einem Strahlstrom von 150 μA begrenzt. Für eine solch hohe Präzision müssen die Strahlparameter Energie, Strom, Winkel und Position extrem stabil sein und mit einem entsprechend leistungsfähigen Regelungssystem kontrolliert werden. Das erstellte Konzept zur Regelung von Strahlwinkel und -position basiert auf einem digitalen System unter Verwendung von FPGAs und ist damit nicht nur extrem schnell, sondern auch äußerst flexibel an veränderliche Anforderungen anpassbar. Die hohe Genauigkeit der Strahllagemessung wird erreicht durch die Verwendung von Hohlraumresonatoren als Strahllagemonitore. Tests des Regelungssystems, das in diesem Vortrag vorgestellt wird, wurden am Mainzer Mikrotron MAMI durchgeführt und ergaben, dass die Anforderungen des P2-Experiments erfüllt werden und der MESA-Strahl ausreichend stabilisiert werden kann.

AKBP 11.5 Thu 17:30 AKBPa

A transmission ionization chamber for online monitoring of ion-bunch fluence and trajectory of laser-driven ions — •Lotta Flaig[1], Jona Bortfeldt[1,2], Jens Hartmann[1], Thomas Rösch[1], Martin Speicher[1], Johannes Gebhard[1], Leonard Doyle[1], Luisa Tischendorf[1], Marc Berndl[1], Felix Balling[1], Sonja Gerlach[1], and Jörg Schreiber[1] — [1]Ludwig-Maximilians-Universität München, Germany, Department of Medical Physics — [2]European Organization for Nuclear Research (CERN), Meyrin, Switzerland

Since laser-driven ion bunches have unique properties such as large particle numbers and a broad energy spectrum with comparably large shot-to-shot fluctuations, a fundamental requirement is the improvement of online-diagnostics. The Foil Electrode Ionization Chamber with Red Light Emission for Laser-Driven Ions (FIREFLI) is a minimal invasive transmission monitor aiming to detect fluctuations at 1 Hz laser repetition rate. The ionization charge produced by traversing ions can be measured by a gated integrator as a measure for the overall bunch charge. The entrance and exit windows as well as the electrodes of the ionization chamber consist of μm-thin aluminized foils that ensure a minimal material budget for transmitted ions. Simultaneously, locally produced scintillation light from the detector gas can be observed via a camera looking perpendicularly on the beam axis providing additionally a measure for the bunch trajectory inside FIREFLI. First experimental tests with laser-induced ionization as well as at a laser-driven ion beamline show promising results.

AKBP 11.6 Thu 17:45 AKBPa

Non-Destructive Bunch-Resolved 2D Beam Diagnostics at BESSY II — •Marten Koopmans, Ji-Gwang Hwang, Andreas Jankowiak, Markus Ries, Andreas Schälicke, and Gregor Schiwietz — Helmholtz-Zentrum Berlin

Due to the complexity of the filling pattern in the BESSY II electron-storage ring, bunch resolved diagnostics are required for machine commissioning and to ensure the long-term quality and stability of operation. Low-α operation and a possible BESSY VSR upgrade, in addition, demand bunch-length measurements with picosecond resolution. Therefore a dedicated beamline equipped with a fast streak camera was set up and successfully commissioned. Couplings between time- and space-coordinates do also call for bunch-selective and correlated multi-parameter detection methods. Thus, the same beamline and the streak camera have been made capable of direct beam-profile imaging and interferometry of the vertical beam size using the X-ray blocker bar method. Dependent on the polarization choice of visible light one may switch between these diagnostic methods. With an additional transverse dimension in the streak-camera image, bunch-resolved 2D measurements are possible. In the vertical direction the characteristic dip in the center of the image of the π-polarized synchrotron radiation can be observed at the streak camera. We also present a new method to study the properties of the PPRE bunch. Applying a statistical analysis of single-shot images enables one to distinguish between horizontal orbital motion and the broadening of the bunch due to the excitation. The results are compared with data from the BPM system.

AKBP 11.7 Thu 18:00 AKBPa

Laser development for L(P)WFA experiments and driver

laser pulse diagnostics and stability — •Florian Haberstroh — LMU Munich, Germany

The Center for Advances Laser Applications (CALA) combines powerful lasers and experimental areas with a focus on electron and ion acceleration. For such experiments the solid-state laser Atlas-3000 is developed. The lasers backbone, a chain of Ti:Sa based chirped pulse amplifiers (CPA) delivers an energy of up to 90J per pulse at a repetition rate of 1Hz and a central wavelength of 800nm. Compressing these pulses to 28fs (FWHM) yields a peak power of 2PW. Such a system can be used to drive a laser wakefield accelerator (LWFA) to generate electron bunches in the energy regime of GeV and with a charge of multiple nC. The accelerated electron's energy spectrum and charge is determined by the pulse parameters of the driving laser. But how sensitive is the acceleration process to temporal, spatial and spectral pulse properties? With the aim to eliminate pre-pulses and generate cleaner pulses, we evaluate the laser pulse's temporal contrast. It was just as important to ensure a flat wave front for amplification, compression and interaction with the target. Spectral and temporal pulse profiles are recorded during the experiments and are correlated to the accelerated electrons. We show measures to reduce breathing and to stabilize pointing of the focus in the gas target. Recorded HDR images build a 2D intensity map in and near the focus which helps evaluate the focus quality, for instance to optimizing the Strehl ratio.

AKBP 11.8 Thu 18:15 AKBPa

Optimization of laser wakefield accelerators using machine-learning methods — •Faran Irshad, Andreas Döpp, and Stefan Karsch — Ludwig-Maximilians-Universität München, Am Coulombwall 1, 85748 Garching, Germany

With advances in both laser technology and data-acquisition software, the number of parameters that can be tuned to directly influence the behavior of the Laser Wakefield accelerators (LWFA) have increased. One concern with LWFA has been one of stable operation and time spent in optimizing the electron beams. While the former is an engineering challenge, the latter can be improved using techniques from machine learning. Conventionally, optimizing LWFA parameters have been done by human operators on the run. We propose a more systematic approach to optimizing these parameters using sequential optimization on a Gaussian process (GP) model commonly referred to as Bayesian Optimization. Bayesian optimization treats the LWFA as a black-box function and uses GP to model it. The important features of the LWFA such as electron beam energy or peak charge are captured in an objective function defined by the user. This method was applied to FBPIC simulations to optimize plasma parameters such as plasma electron density and laser parameters such as focus position and spectral phase. We show a faster convergence of the laser-plasma interaction to the optimal settings in a computational experiment. In conclusion, the Bayesian optimization can significantly reduce optimization times of a LWFA and help achieve subtle tuning of parameters that otherwise are missed in single-variable scans.

AKBP 12: General Assembly of the Working Group on Accelerator Physics

Time: Thursday 19:00–21:00 Location: AKBPm

120 min. break.