AKBP 12: AKBP Poster Session

Time: Thursday 11:00–14:00 Location: Poster A

AKBP 12.1 Thu 11:00 Poster A

Design of Dual-Core Cryogenic Current Comparators for Beamlines — •Volker Tympel[1,2], Frank Machalett[1,2,3], Thomas Stöhlker[1,2,3], Lorenzo Crescimbeni[2,3], David Haider[2], Thomas Sieber[2], Marcus Schwickert[2], Frank Schmidl[3], Paul Seidel[3], Matthias Schmelz[4], Ronny Stolz[4], and Vyacheslav Zakosarenko[4,5] — [1]Helmholtz Institut Jena, Jena — [2]Fröbelstieg 3 — [3]Friedrich-Schiller-University Jena — [4]Leibniz Institute of Photonic Technology, Jena — [5]Supracon AG, Jena

Bunched (AC) and un-bunched (DC) beam of charged particle leads to a magnetic field, like an electrical current in a wire. Cryogenic Current Comparators (CCC) for beamlines are able to measure that AC or DC beam current non-destructive, highly sensitive, and absolute in the nA range. Niobium based single core CCCs are running at CERN-Antiproton Decelerator (100 mm beamline diameter, BLD) and tested at GSI-CRYRING@ESR for the new Facility for Antiproton and Ion Research (FAIR) in Darmstadt with 150 mm BLD. In this work, smaller CCCs (BLD 63 mm) were created to investigate the limits of this measuring principle. For this purpose, dual-core CCCs (DCCCs) with total inductances of 200 uH or 300 uH @4.2 K were developed and measured. The fluctuation dissipation theorem (FDT) proved to be an effective tool for making a prediction about the expected current noise right at the beginning of the CCC creation. For the first time a white noise below 1 pArms/sqrt(Hz) could be achieved. Finely, it was possible to measure current impulses below 1 nApp in the laboratory. First results were presented at the EUCAS 2023 in Bologna.

AKBP 12.2 Thu 11:00 Poster A

PID-based beam current stabilisation system for Photo-CATCH* — •Victor Winter, Joachim Enders, Markus Engart, Maximilian Herbert, Maximilian Meier, and Julian Schulze — Institut für Kernphysik, Fachbereich Physik, Technische Universität Darmstadt, Darmstadt, Germany

Photo-CATCH is a test stand for research on GaAs photocathodes that can be used to generate spin-polarized electrons. It features a -60 kV DC photo-electron source with adjacent beamline. A stable current is required for operation of a particle accelerator. For a photo-electron source, this can be provided by altering the incident laser power on the photocathode surface. A PID controller can be used for this purpose, controlling a $\lambda/2$-plate to regulate the power of the laser beam and hence the emitted beam current. This contribution will present development and testing of a PID controller for beam current stabilisation at Photo-CATCH.

*Work supported by DFG (GRK 2128 „AccelencE“, project number 264883531)

AKBP 12.3 Thu 11:00 Poster A

Adaptive automated GaAs photocathode activation procedure for Photo-CATCH* — •Markus Engart, Joachim Enders, Maximilian Herbert, Maximilian Meier, Julian Schulze, and Victor Winter — Institut für Kernphysik, Fachbereich Physik, Technische Universität Darmstadt, Darmstadt, Germany

Photocathodes based on GaAs are a common source of spin-polarized electrons for particle accelerators. To achieve a sufficient yield of electrons with a GaAs semiconductor, the cathodes are activated to negative electron affinity by applying a thin layer of cesium and an oxidant, in our case O_2.The activation process is generally done manually, following an established scheme such as Co-Deposition (Co-De), i.e., the simultaneous application of Cs and O_2. This Contribution presents the development of an adaptive algorithm for the automation of Co-De activations and its implementation at the Photo-CATCH test stand.

*Work supported by DFG (GRK 2128 „AccelencE“, project number 264883531)

AKBP 12.4 Thu 11:00 Poster A

Investigation of annealed NbTiN thin films with field emission scanning microscopy — •Frederic Braun[1], Isabel Díaz-Palacio[2], Florian Brockner[1], Robert Zierold[2], Wolfgang Hillert[2], and Dirk Lützenkirchen-Hecht[1] — [1]Bergische Universtiät Wuppertal — [2]Universität Hamburg

Superconducting radio-frequency (SRF) cavities, primarily constructed from Niobium, are currently operating at or near their theoretical limits, leaving little room for significant improvements. Consequently, the exploration of alternative materials becomes imperative to push the boundaries of SRF cavity performance. A promising approach for achieving enhanced performance involves the deposition of superconducting thin films, such as NbTiN or Nb*Sn on the inner walls of the cavities. This study focuses on the analysis of NbTiN-coated samples using a Field Emission Scanning Microscope (FESM) to get critical insights into the field emission properties within an accelerating field. The measurement of current-voltage curves on the surface allows for the determination of the onset-field, where a sufficiently large current of, e.g., 1 nA is measured. Surface mapping reveals variations in onset-fields, attributed to film properties like surface roughness, impurities, and contamination from small particles and adsorbates. Moreover, conducting constant current measurements over an extended period provides valuable information regarding the long-term stability of the thin film surface. These analyses assess NbTiN-coated surfaces in SRF cavities, aiming to enhance efficiency in superconducting applications.

AKBP 12.5 Thu 11:00 Poster A

Investigation of laser macro- and micropolishing on fine-grained niobium for use in Superconducting radio frequency cavities — •Florian Brockner[1], Laura Kreinest[2], Patrick Schwoche[1], and Dirk Lützenkirchen-Hecht[1] — [1]Bergische Universität Wuppertal — [2]Fraunhofer-Institut für Lasertechnik ILT

We carried out a feasibility study on laser macro and micro polishing of polycrystalline fine-grained planar niobium sheets, which fulfil the specification for a use in SRF cavities. Due to the high initial roughness of the untreated, non-polished sheets, macropolishing was first carried out under an inert Ar-gas atmosphere using a diode-pumped fiber laser, and the laser polishing parameters (laser power, feed rate, beam diameter, number of cycles) were systematically varied. The optimal parameters are adjusted and selected after analysing the surface using white light interferometry. The test areas prepared in this way (approx. (5x5)mm^2) were then subjected to micropolishing by varying the average laser power and pulse duration of the ns laser used. The prepared surfaces were characterised using optical profilometry, electron microscopy, energy dispersive X-ray spectroscopy and measurements of the parasitic field emission.

AKBP 12.6 Thu 11:00 Poster A

Beam dynamics simulation of the high bunch charge in the second injection beamline of MESA — •Anatolii Kalamaiko[1], Kurt Aulenbacher[1,2,3], Monika Dehn[1], and Simon Friederich[1] — [1]Institute of Nuclear Physics, Mainz, Germany — [2]Helmholtz Institute Mainz, Germany — [3]GSI Helmholtzzentrum fur Schwerionenforschung, Darmstadt, Germany

MESA (Mainz Energy-recovering Superconducting Accelerator) is an electron accelerator with the beam energy up to 155 MeV, which is under construction at the Johannes Gutenberg University in Mainz. The accelerator has two laser-driven 100 KeV electron sources (polarized and unpolarized). The unpolarized electron source MIST (MESA Injector Source Two) allows producing highly charged electron bunches (up to 7.7 pC in a bunch). This electron source will be arranged above the main injector beamline of MESA. A special parallel shifting beamline was developed for transporting and compress with a buncher of electron beam from the electron source MIST to the main MESA beamline. This report presents the last results of the beam dynamics simulation and status of the second separation beamline of MESA.

AKBP 12.7 Thu 11:00 Poster A

Co-sputtering of Nb_3Sn thin films for prospective SRF applications — •Amir Farhood, Nils Schäfer, Alexey Arzumanov, Márton Major, and Lambert Alff — Institute of Materials Science, TU Darmstadt, 64287 Darmstadt, Germany

Nb_3Sn thin films are excellent candidates for superconducting radio frequency (SRF) applications due to their low surface resistivity and high superheating field in comparison to pure bulk Nb. Magnetron co-sputtering is shown to grow Nb_3Sn thin films with excellent homogeneity and microstructure at low temperature. In this work, the deposition of Nb_3Sn thin films using the mentioned magnetron co-sputtering process with substrate temperature of 400 °C to 600 °C on fused silica substrates was done. Based on earlier works, the presence

of phase pure Nb_3Sn was shown by X-ray diffraction (XRD) scans. The stoichiometry of the thin films was verified by energy dispersive spectroscopy (EDS) measurements. Finally, critical temperature up to 16.5 K were measured for the applied thin films.

This work was supported by the German Federal Ministry for Education and Research (BMBF) through grant 05H21RDRB1 and the German Research Foundation (DFG) via AccelencE research training Group (GRK2128).

AKBP 12.8 Thu 11:00 Poster A

Multi-physics simulation of Quadrupole Resonators under geometric uncertainties — •Piotr Putek[1], Gowrishankar T. Hallilingaiah[2], Marc Wenskat[3], Simon B. Adrian[1], and Ursula van Rienen[1] — [1]Universität Rostock, Rostock, Germany — [2]HZDR, Dresden, Germany — [3]Universität Hamburg, Hamburg, Germany

Exploring the fundamental properties of materials, including niobium, NbTiN, multilayers or Nb3Sn, in high-precision surface resistance measurements is highly relevant to superconducting radio-frequency (RF) technology. Typically, the calorimetric measurement is carried out with a quadrupole resonator (QPR) to precisely characterize the RF properties of superconducting samples. Still, one of the main challenges in the QPR design and operations is to mitigate the influence of microphonics and Lorentz force (LF) detuning, on the one hand, and the RF losses on the adapter flange with the fabrication tolerances, on the other hand, into QPR functioning. For this reason, a multi-physics problem with random input parameters is addressed to study a significant measurement bias of the surface resistance, observed mainly for the third operating mode of the given QPR. Finally, the preliminary optimization results and their implication for the operational conditions of the QPR are discussed.

AKBP 12.9 Thu 11:00 Poster A

Studies on a Three-Turn Energy-Recovery Mode at the S-DALINAC — •Felix Schliessmann, Michaela Arnold, Adrian Brauch, Manuel Dutine, Marco Fischer, Ruben Grewe, Lars Juergensen, Maximilian Meier, Norbert Pietralla, and Dominic Schneider — Institut für Kernphysik, Technische Universität Darmstadt, Schloßgartenstraße 9, 64289 Darmstadt, Darmstadt, Germany

The electron accelerator S-DALINAC at Technische Universität Darmstadt was successfully operated in one-turn and two-turn energy-recovery mode. Due to its existing third recirculation beamline, the S-DALINAC has the potential to be operated in three-turn energy-recovery mode. In this mode, an accelerated and a decelerated beam are superimposed in both the first and the second recirculation beamline. Due to this shared beam-transport, this mode is particularly challenging since the number of degrees of freedom is reduced compared to an individual beam-transport. Therefore, beam-dynamics simulations are necessary to determine a suitable setup in advance. In this contribution, results of these beam-dynamics simulations will be presented.

AKBP 12.10 Thu 11:00 Poster A

Assembly and test of the first cryo-module for the HELIAC-project at GSI — •Thorsten Kürzeder[1,2], Winfried Barth[1,2,3], Christoph Burandt[1], Florian Dziuba[1,2], Viktor Gettmann[1,2], Robin Kalleicher[2,3], Szymon Kowina[1], Simon Lauber[1], Julian List[1,3], Maksym Miski-Oglu[1,2], and Stepan Yaramyshev[1] — [1]GSI, Darmstadt, Germany — [2]HIM, Mainz, Germany — [3]JGU, Mainz, Germany

The Helmholtz Linear Accelerator HELIAC is a superconducting (sc) continuous wave linear accelerator for heavy ions currently in development at GSI, the Helmholtz Centre for Heavy Ion Research in Darmstadt. The HELIAC offers variable output energies in between 3.5 MeV/u and 7.3 MeV/u and its main acceleration will be done in three cryo-modules. The assembly of the first cryo-module has just been finished in June 2023. The module houses three sc multi gap Cross bar H-mode (CH) acceleration cavities and a sc rebuncher cavity, as well as two sc solenoid lenses. The cavities are operated at 4 K at an accelerating gradient of up to 7 MV/m. The cold-string assembly took place in an ISO-class 4 cleanroom, which was finished in March, subsequently it was integrated into the cryo-module in a dedicated area in front of the cleanroom. Afterwards the module with a total weight of about 7 tons and a length of 5.5 m was shipped to GSI where it was integrated in a test area with connection to a 700 W cryo-plant and a beamline for tests with heavy ion beams. We will report on the assembly and the setup at GSI. First results of the tests, which started in November 2023, will be presented.

AKBP 12.11 Thu 11:00 Poster A

Implementation of a Transmission Diagnostic for High-Power Laser Plasma Interactions during Laser Ion Acceleration — •Runjia Guo, Maximilian J. Weiser, Erin G. Fitzpatrick, Laura D. Geulig, Ming-Yang Hsu, Veronika Kratzer, Vitus Magin, and Peter G. Thirolf — Ludwig-Maximilians-Universität München, Munich, Germany

Laser-driven acceleration of heavy ions is actively studied due to its ability to deliver ion bunches with high densities and ultra-short duration. These are needed for the novel fission-fusion nuclear reaction mechanism to investigate nuclear properties related to the rapid neutron capture process [1]. The process of ion acceleration begins when the focused laser pulse interacts with the plasma it generates from thin foil targets. To put ion beams into applications, diagnostics of the laser-plasma interaction quality is significant. For this, in High Field (HF) experiments of the Centre for Advanced Laser Applications (CALA), we are currently developing a diagnostic method to measure the amount of transmitted light through the targets, which is a key indicator of the efficiency of the conversion of laser pulse to ion energy [2]. A sandblasted glass screen is placed at 33 cm downstream of the laser focus. Two cameras with varied filters image the laser pulse profile transmitted through targets, measuring empty and target shot brightness, respectively, to quantitatively assess laser-light transmission and its dependency on target thickness. [1] D. Habs et al., Appl. Phys. B 103, 471-484 (2011) [2] Nicholas P.Dover., et al. Light Sci Appl 12, 71 (2023).

AKBP 12.12 Thu 11:00 Poster A

Realizing the cSTART Compact Storage Ring at KIT — •Jakob Krämer[1], Guido Blokesch[1], Erik Bründermann[2], Kai Dunkel[1], Verena Kümper[1], Anke-Susanne Müller[2], Christoph Quitmann[1], Robert Ruprecht[2], and Markus Schwarz[2] — [1]RI Research Instruments GmbH, Bergisch Gladbach, Germany — [2]Karlsruhe Institute of Technology, Karlsruhe, Germany

Karlsruhe Institute of Technology has designed a compact STorage ring for Accelerator Research and Technology (cSTART). This storage ring will operate with ultra-short electron bunches and wide momentum spread from either the FLUTE injector or a Laser Plasma Accelerator. RI Research Instruments (RI) won the contract in a competitive tendering process and is currently working on the Technical Design Report (TDR) together with subcontractors. In this contribution, we present the status of the design and its main challenges. Due to the pre-existing building the circumference of cSTART is limited to 44 m and will be installed at about 5 m height, above the existing FLUTE injector. Together with strict tolerances on the relative alignment of the magnets, this requires an innovative support structure and alignment concept. On-axis injection is mandatory to study the non-equilibrium beam dynamics of the stored bunches. The short revolution period of 144 ps sets the boundary conditions for the pulsed kickers and septa. The compact design also leads to tight packing of magnets that are designed to minimize cross-talk. Upon successful completion of the TDR, RI will also realize cSTART, targeting a start of operation in 2027.

AKBP 12.13 Thu 11:00 Poster A

Data-driven Simulation of Target Normal Sheath Acceleration by Fourier Neural Operator — •Jeyhun Rustamov, Thomas Miethlinger, Thomas Kluge, Nico Hoffmann, Michael Bussmann, and Jeffrey Kelling — Helmholtz-Zentrum Dresden Rossendorf, Dresden, Germany

Particle-in-Cell simulations are a ubiquitous tool for linking theory and experimental data in plasma physics, rendering the comprehension of non-linear processes such as Laser-Plasma Acceleration (LPA) feasible. These numerical codes can be considered as state-of-the-art approach for studying the underlying physical processes in high temporal and spatial resolution. The analysis of experiments is performed by optimizing simulation parameters so that the simulated system is able to explain experimental results. However, a high spatio-temporal resolution comes at the cost of elevated simulation times which makes the inversion nearly impossible. We tackle this challenge by introducing and studying a reduced order model based on a Fourier neural operator that is evolving the ion density function of Laser-driven ion acceleration via 1D Target Normal Sheath acceleration (TNSA). The ion density function can be dynamically generated over time with respect to the thickness of the target. We demonstrate that, for achieving physical

fidelity, our method requires a large number of Fourier modes, on top of a logarithmically scaled real-space density. Finally, this approach yields a significant speed-up compared to numerical code Smilei while retaining physical properties to a certain degree promising applicability for inversion of experimental data by simulation-based inference.

AKBP 12.14 Thu 11:00 Poster A

Resonator design optimization for a compact transverse-deflecting system — •Sergei Glukhov[1], Oliver Boine-Frankenheim[1], Uwe Niedermayer[1], Matthias Nabinger[2], Jens Schäfer[2], Michael J. Nasse[2], Erik Bründermann[2], and Anke-Susanne Müller[2] — [1]Institute for Accelerator Science and Electromagnetic Fields (TEMF), Darmstadt, Germany — [2]Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany

Various design options have been studied and simulated using CST MICROWAVE STUDIO for a compact transverse-deflecting system proposed for diagnostics of extremely short electron bunches. The idea of the method is to use terahertz radiation, produced from optical rectification of the facility's electron gun laser pulse. The proposed system is to be checked experimentally at the test facility FLUTE (Ferninfrarot Linac- und Test-Experiment) at Karlsruhe Institute of Technology (KIT).

The present paper is focused on the simulations of the resonator providing interaction between the electron bunch and the terahertz pulse. Two types of resonators and their arrays have been studied for this purpose: inverse split-ring resonator and tilted slit resonator. Different types of terahertz pulse structure have been studied, including plane wave and transversally focused (Gaussian) beam. Useful analytical models have been proposed to systematize the results of the simulations.

AKBP 12.15 Thu 11:00 Poster A

Coupled S-parameter modelling of the beam impedance of elliptical undulators — •Alistair Muir[1], Paul Volz[3], Frederik Quetscher[2], Atoosa Meseck[3], Erion Gjonaj[2], and Ursula van Rienen[1] — [1]Universität Rostock, Rostock, Germany — [2]TU Darmstadt, Darmstadt, Germany — [3]Helmholtz-Zentrum Berlin, Berlin, Germany

Undulators are long and complex structures used in electron accelerators to generate X-rays. They are central components of a free electron laser. Such structures can generate strong wakefields that affect the beam impedance and create heat loads. Current software cannot efficiently model the beam impedance for long, complex structures on modest computing resources. We use the CSC_Beam method, based on Coupled S-Parameter Calculation (CSC), to model the beam impedance of arbitrarily long structures efficiently. It involves dividing the beam path into sections, forming a matrix containing the S-parameters and the direct beam impedance for each section, and concatenating the matrices of all the sections using CSC. We apply this method to model the beam impedance through the entrance section of an elliptical undulator. We compare with direct simulation results and evaluate the relative computational efficiency of the method.

AKBP 12.16 Thu 11:00 Poster A

Algorithmic Quantification of Laser-Plasma Accelerated Electron Bunches for Campaign Bayesian Steering — Tobias Hänel[1], Franziska Herrmann[1], Susanne Schöbel[1], Anna Willmann[1], Richard Pausch[1], Amin Ghaith[2,1], Maxwell Laberge[1,3], Ye-Yu Chang[1], Patrick Ufer[1,4], Paula Twellenkamp[1], Teresa D'Orsi Barreto[1], Michael Bussmann[5,1], Ulrich Schramm[1,4], Arie Irman[1], and •Jeffrey Kelling[1,6] — [1]Helmholtz-Zentrum Dresden - Rossendorf, Dresden, Germany — [2]Synchrotron SOLEIL, Saint-Aubin, France — [3]The University of Texas at Austin, Austin, TX, USA — [4]Technische Universität Dresden, Dresden, Germany — [5]CASUS, Görlitz, Germany — [6]Institut für Physik, TU Chemnitz, Chemnitz, Germany

Laser-plasma accelerators (LPA) are much smaller than conventional systems and can generate electron bunches with uniquely high current and small length, making them ideally suited to seed free electron lasers (FEL). UV lasing in such a setup has recently been demonstrated at the COXINEL experiment. Characteristics of the emitted radiation are sensitive to the shape of the seeding electron bunches, which in turn is determined by the pulse-properties of the driving laser. In order to enable the use of multi-objective Bayesian optimization to efficiently find pareto-optimal laser parameters given electron-bunch energies and spreads, we require a consistent and automatic way of extracting these properties measured energy spectra. Here, we present our approach, based on classical computer-vision methodology and evaluate the efficacy for Bayesian optimization runs.