AKBP 4: AKBP Posters

Time: Tuesday 16:30–18:00 Location: ZHG Foyer 1. OG

AKBP 4.1 Tue 16:30 ZHG Foyer 1. OG

A novel test cavity setup for surface conductivity measurements of additive manufacturing samples — •Julian Sonpar[1], Hendrik Hähnel[1], Guenther Dollinger[2], Michael Mayerhofer[2], and Ricardo Helm[2] — [1]Goethe University Frankfurt, 60438 Frankfurt am Main, Germany — [2]Bundeswehr University Munich, 85579 Neubiberg, Germany

Additive Manufacturing (AM) has the potential to increase the performance of radio frequency (rf) cavity resonators while cutting manufacturing costs. To investigate the surface conductivity of AM samples and postprocessing techniques, a compact rf cavity design has been introduced. The cylindrical cavity is made from Aluminum. The test body is held by a dielectric inside the cavity. A simulation assisted approach has been used to generate the dependence curve of surface conductivity to Quality factor. In order to calibrate this curve, to the rf cavity's experimentally measured Quality factor, an AOFC test body has been used which is assumed to have ideal conductivity. To further investigate the error that is made from said assumption and calibration, another method of generating the mentioned dependence curve is being investigated. This method uses simulations and Q-measurements to precisely evaluate the rf cavity's intrinsic (Aluminum) conductivity and loss tangent of the dielectric material. The aim is to generate the mentioned dependence curve without the need for AOFC test body calibration.

AKBP 4.2 Tue 16:30 ZHG Foyer 1. OG

Development of a 4:1 Guanella-type Impedance Transformer for the future SIS100 Broadband Cavity Systems — •Christoph Julien Wegmann[1] and Harald Klingbeil[1,2] — [1]Fachgebiet Beschleunigertechnik, Technische Universität Darmstadt, 64289 Darmstadt, Deutschland — [2]Abteilung Ring RF Systems, GSI Helmholtzzentrum für Schwerionenforschung, 64291 Darmstadt, Deutschland

Most particle accelerator cavity systems like e.g. the acceleration cavities focus on generating a harmonic voltage of a given frequency. The SIS100 heavy ion synchrotron under construction at GSI/FAIR will also contain broadband cavity systems generating signals with significant spectral components in a range from 100 kHz to 20 MHz.

Previous analyses have shown that designing a suitable transmission path leads to multiple serious challenges. One of these is that the input capacitance of the tetrode amplifier limits the upper cutoff frequency. To counteract this effect, the load impedance at the input of the tetrode amplifier can be reduced from 50 Ω to 12.5 Ω at the expense of more driver amplifier power. However, to achieve an impedance matching to the driver amplifier necessitates the inclusion of a transformer generating a broadband 4:1 impedance transformation over the entire relevant frequency range.

A Guanella-type 4:1 ferrite transmission line transformer meeting these requirements was developed, built and verified. The core operating principles, approaches and measurement results are presented.

AKBP 4.3 Tue 16:30 ZHG Foyer 1. OG

Towards three-dimensional confinement of the electron beam inside dielectric laser accelerators — •Manuel Konrad[1], Julian Freier[1], Stefanie Kraus[1], Leon Brückner[1], Julian Litzel[1], Tomas Chlouba[1,2], Roy Shiloh[1,3], and Peter Hommelhoff[1,4] — [1]Department Physik, Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), 91058 Erlangen — [2]Center for Nanophotonics, AMOLF, 1098 XG Amsterdam — [3]Institute of Applied Physics, Hebrew University of Jerusalem (HUJI), Jerusalem, Israel — [4]Department Physik, Ludwig-Maximilians-Universität München (LMU), 80799 München

Dielectric laser accelerators are the optical counterpart to classical RF-accelerators. Here, nanophotonic dielectric structures are illuminated by ultrashort laser pulses to create the accelerating modes. Alternating phase focusing (APF) is employed to confine the electron beam inside the acceleration channel [1]. After we successfully applied this concept to gain phase space control over the electrons in the longitudinal and one transverse direction [2], we have recently shown acceleration of electrons in combination with APF. By keeping the beam confined in a 500 μm long structure, we accelerated the electrons from 28.4 to 40.7 keV in a scanning electron microscope [3]. We will show how the APF scheme can be expanded to full 3D confinement and discuss how it is affected by illuminating the structure from the top.

[1] Niedermayer et al., PRL 121, 214801 (2018) [2] Shiloh et al., Nature 597, 498 (2021) [3] Chlouba et al., Nature, 622, 476 (2023)

AKBP 4.4 Tue 16:30 ZHG Foyer 1. OG

Optimisation of drift tube cooling and drift tube geometries of an additive manufacturing IH-type cavity — •Benjamin Dedic, Hendrik Hähnel, Adem Ateş, Jan Dominik Kaiser, and Ulrich Ratzinger — Institut für Angewandte Physik Goethe Universität Frankfurt am Main

Additive manufacturing is a now-powerful tool for the rapid prototyping and manufacturing of complex geometries. A proof-of-concept 433 MHz IH-DTL cavity was constructed for direct additive manufacturing of linear accelerator components. The CFD analysis of the initially designed cooling for the drift tube revealed a design with insufficient heat dissipation; this can lead to thermal deformations as well as problems in keeping the frequency stable during operation. In this respect, an optimization of the cooling system was done in detail with the help of advanced thermal simulation and iterative design improvements. Furthermore, the geometries of the drift tubes were refined to improve mechanical stability and thermal efficiency without compromising electromagnetic performance. The results illustrate that additive manufacturing can achieve significant design freedom, enabling new approaches toward the thermal management challenges faced by high-frequency linear accelerator components.

AKBP 4.5 Tue 16:30 ZHG Foyer 1. OG

Ultrafast electron diffraction at DELTA - commissioning and first results — •Linus Bölte[1], Xijie Wang[1,2], Arne Held[1], Peter Hartmann[1], Carsten Mai[1], Klaus Sokolowski-Tinten[2], and Marius Milnikel[2] — [1]Technische Universität Dortmund — [2]Universität Duisburg-Essen

Ultrafast electron diffraction (UED) enables the measurement of atomic-scale dynamics with femtosecond time resolution.

At DELTA, a new UED experiment has been commissioned, featuring a 100 kV direct current electron gun and a 3 GHz radiofrequency cavity. Here we present the commissioning process and initial results, demonstrating the potential for simultaneous bunch compression and acceleration.

AKBP 4.6 Tue 16:30 ZHG Foyer 1. OG

New aspects of laser polishing of niobium for the production of superconducting cavity resonators — •Florian Brockner and Dirk Lützenkirchen-Hecht — Bergische Universität Wuppertal, Germany

Superconducting cavity resonators require niobium surfaces with low roughness, high chemical purity and isotropic properties. Laser polishing is a more environmentally friendly alternative to established chemical and electrochemical polishing processes and avoids the formation of impurities through non-contact processing.

The melting of the surface during polishing not only smoothes the surface but also heats it. This allows niobium to be doped during the polishing process. Both polishing and doping are strongly influenced by process parameters such as laser power, nitrogen pressure and material parameters related to the crystal structure of the material.

The process parameters were varied to investigate the influence on nitrogen deposition and roughness. The surface properties were analysed using optical profilometry and electron microscopy. The changes in chemical composition and nitrogen incorporation were studied by electron microscopy combined with energy dispersive X-ray spectroscopy and extended X-ray absorption fine structure. X-ray diffraction was also carried out.

AKBP 4.7 Tue 16:30 ZHG Foyer 1. OG

Messung der dielektrischen Eigenschaften von 3D Druck Filamenten bei 500 MHz — •Philipp Müller und Hendrik Hähnel — Institut für Angewandte Physik, Goethe-Universität Frankfurt am Main, Frankfurt am Main, Deutschland

Zur Bestimmung der relativen Permittivität ϵ_r und des Verlustfaktors $\tan(\delta)$ von 3D-Druck Filamenten bei einer Frequenz von 500 MHz wurde ein Testresonator gebaut. Durch Einlegen von Testkörpern des jeweiligen Materials (Dielektrikums) ändern sich die Resonanzfrequenz, sowie die Güte der Kavität. Durch Vergleich mit Simulationen lassen sich dann ϵ_r und $\tan(\delta)$ bestimmen, was es ermöglicht 3D-Druck Filamente in HF Anwendungen, wie z.B. Kopplern einzusetzen. Die Ergebnisse der Untersuchung werden präsentiert.

AKBP 4.8 Tue 16:30 ZHG Foyer 1. OG

Utilizing Raspberry Pi Cameras for Multipacting Observations and Beam Characterization — •Leonie Bauer, Adem Ates, Hendrik Hähnel, and Ulrich Ratzinger — Institut für Angewandte Physik, Goethe Universität Frankfurt

Multipacting is a well-known phenomenon in accelerator cavities, typically appearing at lower RF power levels. To gain a better comprehension and characterization of these resonant discharges, the Institute for Applied Physics at Goethe University Frankfurt has implemented optical diagnostic techniques as part of the FRANZ project. By installing Raspberry Pi cameras both inside and outside the Radio Frequency Quadrupole (RFQ) cavity, we can directly visualize low power multipacting events and even observe the beam passing through the RFQ. As the conditioning power increases, additional optical phenomena become evident, starting at approximately 15 kW. Moreover, these camera systems enable the detection of beam-induced residual gas fluorescence, providing a direct method to determine the x-y position of the 700 keV proton beam at the RFQ exit.

AKBP 4.9 Tue 16:30 ZHG Foyer 1. OG

Generation of few-cycle laser pulses via HCF-based compression for pump probe experiments in plasma-based accelerators — •Onur Bilen, Marc Osenberg, Mirela Cerchez, Edgar Hartmann, Paula Sedlatschek, and Bernhard Hidding — Institute of laser- und plasmaphysics, Heinrich Heine University Düsseldorf

Generating ultrashort laser pulses is essential for resolving femtosecond-timescale dynamics in plasma-based particle accelerators. Here we present a hollow-core fiber setup designed to achieve sub-10 femtosecond pulses with a record-breaking pulse energy output of at least 2 millijoule. These ultrashort laser pulses will be utilized to visualize the acceleration process of electrons within a plasma wake via shadowgraphy. To create an ultrashort pulse, multiple light frequencies must overlap constructively, the more frequencies the shorter the pulse. To introduce more frequencies into a pulse, a nonlinearity known as self-phase modulation is employed. Self-phase modulation requires an intense, short laser pulse and a material with strong third-order nonlinearity. Noble gases such as neon and argon have shown sufficiently strong third-order nonlinear behaviour and are widely used for spectral broadening. The necessary intensity is achieved by focusing the light down to a smaller beam diameter. A hollow-core fiber is used to maintain a small beam diameter over a longer distance and to clean the spatial profile of the pulse. The spectrally broadened pulse can then be compressed to sub-10 femtoseconds using chirped mirrors and used for shadowgraphy.

AKBP 4.10 Tue 16:30 ZHG Foyer 1. OG

Extended phase space tomography for EOSD simulation considering crystal geometry effects — •Felipe Donoso, Stefan Funker, Erik Bründermann, Anke-Sussane Müller, and Martin Frank — KIT, Karlsruhe, Germany

This theoretical study presents an advanced method for longitudinal phase space tomography in electron storage rings, focusing on reconstructing phase space densities from electro-optical spectral decoding (EOSD) measurements that incorporate crystal geometry effects. The EOSD crystal geometry significantly impacts the measurement signal due to signal integration along its length and interference from wake fields and Cherenkov diffraction radiation (ChDR). These effects add challenges to reconstructing the original phase space density from experimental data.

To address these challenges, we integrate two theoretical frameworks. First, we employ the Vlasov-Fokker-Planck equation to model the turn-by-turn evolution of the charge density distribution. Second, CST simulations of the bunch profile characterize the electric field inside the crystal, enabling a tailored simulation for the EOSD system at the Karlsruhe Research Accelerator (KARA). By combining these approaches, we propose a refined tomography method that more accurately reconstructs the longitudinal phase space from sensor data, effectively capturing the interplay between bunch dynamics and the EOSD system configuration.

AKBP 4.11 Tue 16:30 ZHG Foyer 1. OG

Possibilities for performance enhancement of a compact TDS at FLUTE — •Sergei Glukhov[1], Matthias Nabinger[2], Michael Nasse[2], Anton Malygin[2], Erik Bründermann[2], Anke-Susanne Müller[2], and Oliver Boine-Frankenheim[1] — [1]Institute for Accelerator Science and Electromagnetic Fields (TEMF), Darmstadt, Germany — [2]Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany

A compact transverse-deflecting system (TDS) is being commissioned at the test facility FLUTE (Ferninfrarot Linac- und Test-Experiment) located at the Karlsruhe Institute of Technology (KIT). It has been proposed for diagnostics of short electron bunches. The idea of the technique is to use terahertz (THz) radiation, produced by the tilted-pulse front method using a part of the photoinjector laser, amplified by a sub-mm scale resonator for streaking of the electron bunch. Two types of resonators and their arrays have been studied: inverse splitting and tilted slit resonator.

Since the temporal resolution of this technique depends strongly on the electric field strength in the resonator gap, it would be desirable to increase this field strength. A horn-antenna-like device placed near the resonator has been proposed and simulated for this purpose. Simulations and geometrical parameter optimization have been performed using CST MICROWAVE STUDIO and will be presented in this contribution.

AKBP 4.12 Tue 16:30 ZHG Foyer 1. OG

Experimental strategy for diagnostic and parameters control of ARCTURUS high power laser system — •Kamill Naczynski, Mirela Cerchez, Koen Macken, Thomas Heinemann, Marius te Poel, and Bernhard Hidding — Institute of Laser- and Plasmaphysics, Heinrich-Heine-University Düsseldorf, Germany

Plasma-based Laser-Wakefield Accelerators (LWFAs) are a compact source of highly relativistic electron beams. However, fluctuations in the laser-plasma interaction affect the stability and reproducability compared to other acceleration methods. For this reason, the characterization and active control of laser parameters is vital to improve the LWFA performance.

Here, we present an integrated strategy to monitor, characterize and active control the ARCTURUS high power laser beam at the Heinrich Heine University Düsseldorf aiming towards the characterization of pulse duration, spatial and temporal intensity profile and spectrum. The beam pointing and wavefront are measured and actively corrected in a closed loop by an adaptive mirror, specifically including the possibility to employ this system at full-power operation. This setup aims for substantial improvements in reproducability and shot-to-shot stability, in turn enhancing the performance of future LFWA experiments.

AKBP 4.13 Tue 16:30 ZHG Foyer 1. OG

Advanced Diagnostic Setup Combining Few-Cycle Shadowgraphy, Schlieren Imaging, and Interferometry for Laser Wakefield Acceleration Experiments — •Marc Osenberg, Paula Sedlatschek, Onur Bilen, Edgar Hartmann, Georg Pretzler, and Bernhard Hidding — Institute of Laser- and Plasmaphysics, Heinrich Heine University Düsseldorf

We present a comprehensive diagnostic setup for laser wakefield acceleration (LWFA) experiments, combining few-cycle pulse shadowgraphy with quantitative Schlieren imaging and interferometric phase shift measurements. This integrated approach enables precise visualization and quantification of refractive index gradients induced by the electron distribution in plasma wakefields generated by high-power laser pulses. The quantitative Schlieren method provides detailed mapping of refractive index variations, while the interferometric capability allows for accurate phase shift measurements to reconstruct plasma density profiles and electric field distributions. By leveraging advanced optical setups and image processing algorithms, the system achieves high spatial and temporal resolution, facilitating in-depth analysis of wakefield dynamics, including amplitude, phase velocity, and electron distribution. The combined techniques provide significant insights into laser-plasma interactions, paving the way for enhanced performance in next-generation accelerator technologies.

AKBP 4.14 Tue 16:30 ZHG Foyer 1. OG

Self- and pre-ionized electron-driven wakefields in mixed gases at SLAC FACET-II — •Edgar Hartmann[1], Ahmad Fahim Habib[2,3], Mirela Cerchez[1], Marc Osenberg[1], Thomas Heinemann[1], Andrew Sutherland[1], Alexander Knetsch[4], and Bernhard Hidding[1,2,3] — [1]Institute for Laser- and Plasmaphysics, Heinrich Heine University, Düsseldorf — [2]University of Strathclyde, Glasgow, UK — [3]The Cockcroft Institute, Warrington, UK — [4]SLAC National Accelerator Laboratory, Menlo Park, California, USA

We present experimental results from the Facility for Advanced Accelerator Experimental Tests II (FACET-II) at SLAC National Accelerator Laboratory, marking the first exploratory experiments of the E310: Trojan Horse-II program. This work focuses on advancing a novel mechanism for generating high-brightness witness beams in electron beam-driven plasma wakefield accelerators. The mechanism, known as Trojan Horse injection, relies on selective ionization of a low-ionization-threshold (LIT) and high-ionization threshold (HIT) species, such as hydrogen and the first ionization level of helium. In this process, the LIT species provides the plasma sustaining the wakefield accelerator and is ionized either by the electron beam itself or by a pre-ionizing laser pulse. A secondary injector laser pulse ionizes the HIT species only within a small, defined region directly within the wakefield. The preliminary experiments investigated the ionization capabilities of the 10 GeV electron driver in a gas mixture. Selective ionization of only the LIT species is critical for enabling Trojan Horse injection.

AKBP 4.15 Tue 16:30 ZHG Foyer 1. OG

Extending aperture3d for Beam Dynamics Simulations of the High-Level Injector (HLI) at GSI — •Pascal Häckel[1,2], Winfried Barth[1,2], and Uwe Scheeler[1] — [1]GSI, Darmstadt — [2]Hi, Mainz

Beam dynamics simulations play a critical role in understanding and optimizing accelerator systems. In this work, we utilize and extend the capabilities of aperture3d, a versatile beam dynamics simulation framework, to model the High-Level Injector (HLI) at the GSI Helmholtzzentrum für Schwerionenforschung.

The study involves adapting aperture3d to accurately represent the unique components and operational parameters of the HLI, including the ion source, RFQ, and drift tube linac. Enhancements to the software were implemented to accommodate specific requirements, such as detailed beamline geometries, and custom diagnostics for analyzing transverse and longitudinal beam dynamics.

The extended functionality of aperture3d enabled precise simulations of the HLI's performance, highlighting emittance growth mechanisms, beam losses, and potential bottlenecks. These insights not only validate aperture3d as a robust tool for high-intensity accelerator studies but also pave the way for further software improvements tailored to complex accelerator systems.

This work underscores the value of extending modular simulation frameworks like aperture3d for advanced research in beam physics and accelerator optimization.

AKBP 4.16 Tue 16:30 ZHG Foyer 1. OG

Variation of the laser focus field geometry for direct electron acceleration — •Lars Torben Schwabe, Jan Riedlinger, Marc Osenberg, and Georg Pretzler — Institute of Laser- and Plasmaphysics, Heinrich Heine University Düsseldorf

The field geometry of a laser focus can be engineered by spatially resolved phase and polarization manipulations in the near field. In this work, focal structures with isolated longitudinal fields on axis, surrounded by a ring of transversal fields, are generated. Experimental results of these focal geometries, which match numerical simulations of the 3D field structures, are presented. Furthermore, PIC-simulations were performed to model the interaction of these fields with free electrons, for example in plasma. We discuss the possibilities and conditions for obtaining directed electron acceleration in the longitudinal fields of an ultrashort laser pulse and its properties.

AKBP 4.17 Tue 16:30 ZHG Foyer 1. OG

Thermal emittance measurements of photocathodes using single-shot techniques at the European XFEL — •Meng Cai — University of Hamburg, Mittelweg 177, 20148 Hamburg — DESY, Notkestraße 85, 22607 Hamburg

The operation of the European XFEL relies on the generation of high-quality electron beams at the photoinjector exit, with peak brightness limited by the photocathode's thermal emittance. Cathode characteristics evolve over time due to multiple cathode laser properties and actual gun conditions, making regular measurements essential for injector optimization. This work explores a single-shot measurement technique at the European XFEL to image and measure the transverse momentum distribution of photoemitted electrons. This method maps the momentum onto an observation screen, greatly enhancing time efficiency for thermal emittance measurements while preserving high spatial and momentum resolution.

AKBP 4.18 Tue 16:30 ZHG Foyer 1. OG

Adaptive automated activation of GaAs photocathodes at Photo-CATCH* — •Markus Engart, Joachim Enders, Maximilian Herbert, Maximilian Meier, Robin Petry, Julian Schulze, and Vincent Wende — Institut für Kernphysik - TU Darmstadt

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

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AKBP 4.19 Tue 16:30 ZHG Foyer 1. OG

Optical Emission Spectroscopy for the Characterization of a 2.45 GHz ECRIS Plasma — •Maria Molodtsova, Alexandra Philipp, and Erik Ritter — DREEBIT GmbH, Southwallstr. 5, 01900

ECR ion sources are widely used at many research institutions to provide ions for various experimental setups. DREEBIT GmbH aims to industrialize this type of ion source technology for efficient and reliable use in, e. g., hadron cancer therapy as well as ion implantation of semiconductors. Our goal is to build table-top sized ion sources which can easily be handled as part of a larger machine such as a particle accelerator or target irradiation facility, thereby fulfilling high requirements on beam current, quality, stability as well as reproducibility in serial production. To achieve this, we have already optimized the microwave injection system and magnetic plasma confinement by introducing a simple method to allow for injection of circularly polarized waves and adjusted the magnetic field distribution which led to an 80 % increase of beam current. In the present work, we show how optical emission spectroscopy was used to gain deeper information about the plasma of this specific type of ion source, independent from its ion extraction system. The plasma characterization includes studies of the electron energy distribution and the density of atomic and molecular hydrogen showing that the previous design changes of introducing circularly polarized microwaves and optimizing the magnetic field distribution have led to a well-optimized ECR ion source concerning plasma heating and proton production inside the plasma.