AKBP 16: Posters

Time: Thursday 16:30–18:00 Location: P1C

AKBP 16.1 Thu 16:30 P1C

Activation Studies of GaAs Photo-Cathodes at TU Darmstadt* — •Vincent Wende, Joachim Enders, Markus Engart, Yuliya Fritzsche, and Maximilian Herbert — Institut für Kernphysik, Technische Universität Darmstadt, Germany

Spin-polarized electron sources based on GaAs photo-cathodes can be used to supply high-current electron beams for various applications. A thin layer covering the GaAs surface - typically consisting of Cs in combination with an oxidant - is required to achieve negative electron affinity (NEA). The aim of this process is to reach high quantum efficiency η and long surface layer lifetime τ to ensure smooth and sustained operation of a photo-gun in an accelerator. Both parameters strongly depend on the activation procedure. Hence, an optimization of this process is desired. For this purpose, a dedicated test stand for Photo-Cathode Activation, Test and Cleaning using atomic-Hydrogen Photo-CATCH has been set up at the Institut für Kernphysik at TU Darmstadt [1]. This setup consists of a vacuum system for photo-cathode activation and cleaning, as well as a DC photo-gun test chamber with adjacent 60 keV beamline. Results of ongoing experiments and options for automatizing the activation procedure will be discussed.

[1] N. Kurichiyanil et al., J. Instr. 14, P08025 (2019)

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AKBP 16.2 Thu 16:30 P1C

Mechanical and electromagnetic analysis of a quadrupole resonator under different loading conditions — •Shahnam Gorgi Zadeh, Pankajkumar Devganiya, Ursula van Rienen, and Piotr Putek — University of Rostock, Albert Einstein Str.2, 18059 Rostock, Germany

Most of the radio frequency (RF) cavities are nowadays made of superconducting materials, e.g. niobium. The surface resistance of superconductors at very low temperatures is typically in the range of tens of nano-ohms. Special dedicated devices are required to measure the extremely low surface resistance of superconductors. Quadrupole resonators (QPR) have been used since the 1990s for precise determination of the RF properties of superconducting materials. The QPR is typically composed of a pillbox-like niobium cavity containing four vertically placed niobium rods. By placing the superconducting samples under the rods and exciting a quadrupole-like magnetic field on the sample, the surface resistance could be investigated using calorimetric methods. The mechanical displacement of the rods can change the field distribution on the sample and thus affect the experiment setup. In this contribution the displacement of the rods under various mechanical loading conditions such as vacuum and helium pressure, as well as Lorentz force effects are studied. A sensitivity analysis is also carried out to find the sensitivity of the commonly used figures of merit of the QPR with respect to the shape of the rods.

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AKBP 16.3 Thu 16:30 P1C

Compact Neutron Sources Utilizing Laser Plasma Ion Acceleration — •Benedikt Schmitz[1], Oliver Boine-Frankenheim[1], and Markus Roth[2] — [1]TEMF, Technische Universität Darmstadt, Darmstadt — [2]IKP, Technische Universität Darmstadt, Darmstadt

The LOEWE NP goal is to develop compact accelerator based tabletop neutron sources, where the ion acceleration is induced by laser plasma interaction.

This setup can be split into two separate parts, first the laser plasma interaction causing the ion acceleration, second the ion to neutron conversion process.

Joining this different parts into one coherent model is difficult since the physics in both parts has different scales and therefore need different approaches. The goal is a unification of both parts to an effective model for the identification and optimization of all important parameters.

The present work focuses on the optimization and understanding of the laser plasma accelerated ion spectra via particle-in-cell (PIC) simulations and the development and understanding of neutron converter via Monte Carlo simulations. First results are presented.

AKBP 16.4 Thu 16:30 P1C

Automated optimization of synchrotrons for high intensity beams — •Dmitrii Rabusov — TU Darmstadt TEMF, Schloßgartenstr. 8, 64289 Darmstadt

Achieving high intensities is one of the main challenges during the exploitation of a synchrotron. The challenge can be complicated by various effects such as the space charge, wakefields, etc. Errors in the lattice of the synchrotron lead to additional obstacles during the operation: the orbit distortion, the beating of lattice functions: alpha, beta, dispersion, etc.

It's known that the aperiodic perturbation of the magnet structure breaks the symmetry of the synchrotron and particles cross undesired resonances driven by a nonlinear force, which is the space charge in the case of this work. Space charge with the linear perturbation of the lattice can be the reason for the increasing rate of particle losses. The high level of losses yields to damaging of the equipment. Finally, beta-beating at high intensities can cause the blow-up of the emittance.

Described effects and the compensation of them are essential for SIS100 project. Correction schemes for lattice optimization are studied. The goal of the correction is to restore the periodicity of the beta-function using an optimal set of correctors. Different optimization techniques are validated with simple FODO lattice first. A python library *cpymad* provided all required single-particle MADX computations for this project. Moreover, particle tracking with the space charge in PyORBIT is performed in order to investigate the benefits of different optimization functions.

AKBP 16.5 Thu 16:30 P1C

Simulation of ion motion and dynamics in particle accelerator ELSA — •Anthony Francis John Benedict, Shahnam Gorgi Zadeh, Dirk Hecht, and Ursula van Rienen — University of Rostock, Albert Einstein Str.2, 18109 Rostock, Germany

In particle accelerators, ions are generated by the interaction of the particle beam with the residual gas by direct collision or by synchrotron radiation. The generated particles get trapped by the attractive potential of the particle beam and cause negative effects such as tune shift and beam instabilities. If left unchecked, the ions can cause the beam quality to deteriorate and even lead to neutralization of the particle beam. To mitigate the negative effects of the accumulated ions, ion clearing methods such as clearing electrodes are employed. To optimize the use of adequate clearing methods, the ion motion and dynamics in various beamline elements must be investigated. Numerical methods such as Particle in Cell (PIC) simulations are employed to study the motion of ions in the presence of electromagnetic fields. In this contribution, the generation, accumulation, and clearance of ions in the beamline elements of the high energy storage ring (HESR) of particle accelerator ELSA (Elektronen Stretcher Anlage) are studied. The space-charges are studied using the finite element method (FEM). The effects of electromagnetic fields in radiofrequency (RF) cavities on ion motion are studied. An estimation of clearing current at the clearing electrodes is also carried out.

This research is funded by the Bundesministerium für Bildung und Forschung (BMBF) under contract 015K16HRA.

AKBP 16.6 Thu 16:30 P1C

Exploratory Analysis of Simulated Radiation from a Plasma Wakefield Accelerator — •Anton Lebedev[1], Alexander Debus[1], Richard Pausch[1], Ulrich Schramm[1,2], and Michael Bussmann[1,3] — [1]Helmholtz-Zentrum Dresden - Rossendorf, Bautzner Landstr. 400, Dresden — [2]Technische Universität Dresden, 01062 Dresden — [3]CASUS, Center for Advanced Systems Understanding, Görlitz, Germany

In this contribution, we present an exploratory study of the radiation expected to be produced during plasma wakefield acceleration (PWFA) of electrons.

Understanding radiation in the IR to UV range is key to diagnosing the responsible plasma processes in future PWFA accelerators. One goal of the study is to identify radiation signatures suitable for controlling beam quality, thereby enabling high-brightness electron beams for future applications.

The data for our analysis is obtained from PWFA simulations with the 3D3V particle-in-cell code PIConGPU. Emissions are computed using electromagnetic fields derived from Liénard-Wiechert potentials for the entirety of the simulated particles, thereby enabling analysis of the influence of collective plasma dynamics on the observed radiation and allowing quantitative predictions of signal-to-noise ratios. Furthermore, the capability of PIConGPU to select specific groups of radiating particles allows us to determine the origin of spectral signatures.

AKBP 16.7 Thu 16:30 P1C

RF Tuning of the 325 MHz Ladder-RFQ — •Maximilian Schuett, Marc Syha, and Ulrich Ratzinger — IAP, Goethe University Frankfurt, Germany

Based on the positive results of the unmodulated 325 MHz Ladder-RFQ prototype from 2013 to 2016, we developed and designed a modulated 3.4 m Ladder-RFQ*. The Ladder-RFQ features a very constant voltage along the axis, low dipole modes and easy field tuning opportunities. Furthermore, the Ladder-RFQ is completely maintainable and free of welding and soldering. The prototype accepted 3 times the operating power of which is needed in operation**. That level corresponds to a Kilpatrick factor of 3.1 with a pulse length of 200 μs.

The 325 MHz Ladder-RFQ is designed to accelerate protons from 95 keV to 3.0 MeV according to the design specifications of the proton linac within the FAIR project. This particular high frequency for a 4-ROD-RFQ creates difficulties, which triggered the development of a Ladder-RFQ with its high symmetry. The results of the unmodulated prototype have shown, that the Ladder-RFQ is very well suited for that frequency. The duty cycle is up to 5% for the applied cooling concept. Tuning and the final machining step have been completed in April 2019. We will show low level RF measurements as well as frequency and field tuning opportunities with solid movable plungers.

*Journal of Physics: Conf. Series 874 (2017) 012048 **Proceedings of LINAC2016, East Lansing, TUPLR053

AKBP 16.8 Thu 16:30 P1C

Advanced Landau Damping for high energy and high intensity machines — •Vadim Gubaidulin[1,2], Vladimir Kornilov[2], Elias Metral[3], and Oliver Boine-Frankenheim[1,2] — [1]TU Darmstadt, Darmstadt, Germany — [2]GSI, Darmstadt, Germany — [3]CERN, Geneva, Switzerland

Impedance driven transverse beam instabilities in hadron synchrotrons are damped by either an active feedback system or passive mitigation via Landau damping due to dedicated Landau octupole magnets.

For high energy machines, like the proposed Future Circular Collider (FCC-hh) or the Large Hadron Collider high luminosity upgrade (HL-LHC), this passive mitigation mechanism is weakened due to smaller transverse amplitudes. This study considers other sources of Landau damping (DC and pulsed electron lenses and RFQs) and their combination with octupole magnets for transverse beam instabilities mitigation in high energy and high-intensity machines.

DC and pulsed electron lens options are studied with stability diagram theory and particle tracking simulations with beam transfer function and simple impedance driven instability models. This study considers the effect of different electron beam profile shapes and sizes on Landau damping and an effect of combining octupoles with newer methods. An example of slow head-tail instability in HL-LHC is used to compare particle tracking results with stability diagram theory for advanced Landau damping sources and their combination with octupole magnets.

AKBP 16.9 Thu 16:30 P1C

Further Investigations on the Beam Dynamics Design of the FAIR p-Linac RFQ — •Marc Syha, Hendrik Hähnel, Ulrich Ratzinger, and Maximilian Schuett — Institute for Applied Physics, Frankfur, Gemrany

The construction of a 3.3 m Ladder-RFQ at IAP, Goethe University Frankfurt, has been finished successfully in 2018. This RFQ is designed to accelerate protons from 95 keV to 3.0 MeV according to the design parameters of the p-Linac [1, 2] at FAIR1 [3]. The development of an adequate beam dynamics design was done with the aid of the RFQGen-code and in close collaboration with the IAP resonator design team, whereby a design current of 100 mA was assumed. The RFQ beam dynamics design could be successfully reproduced with the TOUTATIS-routine of CEAs2 TraceWin-code in 2019. Furthermore, the effects of image-charge effects and bunch-bunch interactions on the RFQGen simulations were examined. The results of these studies were then compared to field map calculations in TraceWin [2]. [1] C. M. Kleffner et al., *Status of the FAIR Proton Linac*, in Proc. 10th Int. Particle Accelerator Conf. (IPAC*19), Melbourne, Australia, May 2019. [2] H. Hähnel et al., *End to End Simulations and Error Studies of the FAIR Proton Linac*, in Proc. 10th Int. Particle Accelerator Conf. (IPAC*19), Melbourne, Australia, May 2019. [3] FAIR, https://fair-center.eu/index.php?id=1 [4] M. Schuett, M. Syha and U. Ratzinger, *Compensation of longitudinal entrance and exit gap field effects in RFQ*s of the 4-ROD type*, Nuc. Inst. A, Volume 928, p. 58.

AKBP 16.10 Thu 16:30 P1C

Operation of copper cavities at cryogenic temperatures — •Huifang Wang and Ulrich Ratzinger — IAP, Frankfurt, Germany

The anomalous skin effect of copper will be studied in the experiment. The accurate quality factor Q and resonant frequency of three coaxial cavities will be measured over the temperature range from 300 to 22 K. The three coaxial cavities have the same structure, but different lengths, which correspond to resonant frequencies: around 100 MHz, 220 MHz and 340 MHz. The motivation is to check the feasibility of an effcient pulsed, liquid nitrogen cooled ion linac.

AKBP 16.11 Thu 16:30 P1C

Investigations On Algorithm Development For Non-Invasive Transverse Beam Emittance Measurements — •Ezgi Sunar[1], Adem Ates[2], Hendrik Hähnel[3], and Ulrich Ratzinger[4] — [1]IAP, Frankfurt, Germany — [2]IAP, Frankfurt, Germany — [3]IAP, Frankfurt, Germany — [4]IAP, Frankfurt, Germany

A non-invasive diagnostic concept has recently been developed for the Frankfurt Neutron Source Experiment (FRANZ) at the Institute for Applied Physics (IAP) at Goethe University Frankfurt. The aim of this improvement is to compute transverse emittances by monitoring the beam induced rest gas fluorescence along the diagnostic box at the LEBT section of the FRANZ experiment. Because the special cameras are inserted into the vacuum and observing the beam along a 480mm path it is expected to measure the angle of divergence in a more precise way. An algorithm has been developed for these imaging and computing processes. It is based on extracting the width of the transverse intensity distribution of the beam at three different positions or by setting the solenoid magnetic field strength at three different values. The reliability test of the algorithm has been done with various simulated data in TraceWin and further progress for improving the algorithm is assumed. The preliminary results measured by the simulation data are showing a decent outcome consistently.

AKBP 16.12 Thu 16:30 P1C

A Diagnostics Setup for Low-Energy Beam Characterization at the Injector of the S-DALINAC* — •Adrian Brauch, Michaela Arnold, Joachim Enders, Norbert Pietralla, and Simon Weih — Institut für Kernphysik, TU Darmstadt, Darmstadt, Germany

A new superconducting reduced-beta capture cavity 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 16.13 Thu 16:30 P1C

Modelling of thermal and elastic response of x-ray optics exposed to high peak power fel pulses — •Roman Shayduk, Alexey Zozulya, Ilia Petrov, and Markus Scholz — European XFEL GmbH Holzkoppel 4 22869 Schenefeld Germany

The European X-ray Free-Electron Laser delivers femtoseconds-long pulses in soft and hard X-ray wavelength range with up to 2 mJ pulse energy. The pulses are arranged into pulse trains containing from 1 to several hundreds of pulses spaced down to 220 ns apart. Trains arrive at 10 Hz rate. Stochastic nature of Self-Amplified Spontaneous Emission (SASE) defines rather short ~0.2 fs coherence time of pulses due to the broad spectral band width. Many experimental techniques require longer temporal coherence, so monochromators are currently used to reduce the spectral bandwidth. However, due to the combination of ultra high peak power and high repetition rate of X-ray pulses the impulsive heat load becomes a real challenge for preserving the performance parameters of monochromators as the number of pulses per train grows.

We propose a unified model for simulating thermoelastic response of solid targets to fs/ps/ns pulsed electromagnetic radiation in the visible and hard X-ray range and apply it for the case of impulsive X-ray excitation of monochromator crystals. Calculations show that the heat induced strain relaxation time exceeds by far the pulse repetition period of 220 ns and the amplitude of strain exceeds the Darwin width of a crystal reflection multiple times.