AKBP 8: Beam Dynamics II

Time: Wednesday 11:30–13:30 Location: E 020

AKBP 8.1 Wed 11:30 E 020

Hydrodynamic Simulations of an Argon-filled Tapered Plasma Lens for Optical Matching at the ILC e^+ Source — •Manuel Formela[1], Niclas Hamann[1], Gudrid Moortgat-Pick[1,2], Gregor Loisch[2], Mathis Mewes[2], Maxence Thévenet[2], Jens Osterhoff[2], and Greg Boyle[3] — [1]II. Institute of Theoretical Physics, University of Hamburg, Luruper Chaussee 149, 22761 Hamburg, Germany — [2]Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany — [3]James Cook University, Townsville, Australia

The positron beam produced in the target of the ILC positron source is highly divergent and therefore requires immediate optical matching conventionally performed by some kind of solenoid arrangement. More recently, the usage of a plasma lens is considered as an alternative with the expectation of enhanced performance. Previous simulations have indicated that a plasma lens design with linear tapering is optimal for the ILC positron source.

The latest hydrodynamic simulations are meant to investigate argon as a plasma medium for the aforementioned linear design. Argon*s various reaction paths are systematically studied to understand their impact on the discharge process. The obtained results are then compared with hydrogen.

AKBP 8.2 Wed 11:45 E 020

Beam dynamic investigations for heavy ion beams with high duty cycle — •Pascal Häckel[2,3], Winfried Barth[1,2,3], and Simon Lauber[1,2] — [1]GSI, Damstadt, Germany — [2]HIM, Mainz, Germany — [3]JGU, Mainz, Germany

Research on Super Heavy Elements (SHE) is a fundamental component of scientific inquiry. The GSI Helmholtz Centre for Heavy Ion Research is an institution engaged in the discovery of new elements. It has successfully identified elements 108 to 112, made possible through the utilization of the UNILAC (Universal Linear Accelerator), which delivers 11.4 MeV/u heavy ion beams. For further synthesis of new elements, HELIAC (Helmholtz Linear ACcelerator) is currently constructed at GSI. In addition a new transfer channel from HELIAC to UNILAC for integration of HELIAC into existing beamlines, using bending- and focusing magnets, is being designed, transferring particles from HELIAC into experimental halls or further accelerators. To build this channel, the beamline is investigated using beam dynamics simulations for applicability for several energies and collimation. Through a parameter study, the optimal magnetic strengths of the magnets are determined. The HELIAC will provide variable energies between 3.5 and 7.3 MeV/u. Therefore, it is crucial to use the simulation to identify the parameters for various energies. The parameter study cannot be carried out for each energy individually. Accordingly, relationships between the parameters and energy are investigated. This allows the magnets to be adjusted for each energy, ensuring high transmission and beam quality for delivered heavy ion beams.

AKBP 8.3 Wed 12:00 E 020

Beam Dynamics Investigations for the HELIAC advanced demonstrator — •Simon Lauber[1], Robin Kalleicher[1,2,3], Maksym Miski-Oglu[1], Stepan Yaramyshev[1], and Winfried Barth[1,2,3] — [1]GSI, Darmstadt, Deutschland — [2]HIM, Mainz, Deutschland — [3]JGU, Mainz, Deutschland

The Helmholtz Linear Accelerator (HELIAC) is under construction at GSI Helmholtz Center for Heavy Ion Research. The superconducting linac will provide for continuous wave heavy ion beams to conduct super heavy element research, as well as material science. A special feature of this machine is the variable output energy of 3.5 to 7.3 MeV/u within an energy spread of ±3 keV/u. Following the beam test of the crossbar H-Mode cavity, in fall 2023 the first cryomodule, consisting of three cavities and two solenoids, is foreseen to be operated with beam. Preparations and measurements for the commissioning of the mentioned first of four cryomodules are presented.

AKBP 8.4 Wed 12:15 E 020

Coping non-linear dynamics in the BESSY III MBA lattice — •Paul Goslawski, Michael Abo-Bakr, Michael Arlandoo, Johan Bengtsson, Bettina Kuske, and Malte Titze — Helmholtz-Zentrum Berlin für Materialien und Energie

The main strategy to cope with non-linear beam dynamics at BESSY III is avoiding it. The main drivers of non-linear dynamics in the transverse and longitudinal plane and techniques to control and suppress it will be discussed.

AKBP 8.5 Wed 12:30 E 020

Modes Investigation for a Coupled Cross-bar H-type Cavity — •Ali Almomani[1] and Ulrich Ratzinger[2] — [1]Physics Department, Faculty of Science, Yarmouk University, 211-63 Irbid, Jordan — [2]Institute for Applied Physics, University of Frankfurt, Max-von-Laue Str. 1, 60438 Frankfurt am Main, Germany

The development of Cross-bar H-type cavities (CH-DTL) lasts since more than 20 years at IAP - Frankfurt and GSI - Darmstadt. In comparison with the conventional DTL, the H-type cavities show advantages with respect to the effective field gradient and to the shunt impedance at an energy range up to 100 A MeV. Efficient H - mode DTL's can be designed when applying the KONUS beam dynamics. Up to around 35 MeV, it is attractive to integrate one triplet lens into each cavity, as one KONUS section is relatively short and would not exploit the full RF power of 3 MW klystrons. Such a cavity is denoted as Coupled CH - cavity CCH. It can be seen as a coupled resonator connecting of two accelerating drift tube sections and one coupling cell containing of the triplet housing drift tube. In a second step, the second accelerator section of the CCH - cavity is rotated by 90°. In a third step, the coupling cell in the original CCH - cavity is rotated by 90°. In a fourth step, the coupling cell in the original CCH - cavity is exchanged by an ordinary accelerating drift tube section. As a result, it is shown that the RF behaviour for the first three modes is nearly identical. This means, that the tuning behaviour of the CCH - cavity can be simply deduced from the ordinary CH - cavity by replacing the coupling cell by an ordinary drift tube structure.

AKBP 8.6 Wed 12:45 E 020

Towards experimental-tailored laser wakefield acceleration aided by Bayesian methods — •Franziska Marie Herrmann[1,2], Tobias Hänel[1,2], Susanne Schöbel[1,2], Amin Ghaith[1], Maxwell Laberge[1], Yen-Yu Chang[1], Patrick Ufer[1,2], Paula Twellenkamp[1,2], Teresa D'Orsi Barreto[1,2], Jeffrey Kelling[1], Arie Irman[1], and Ulrich Schramm[1,2] — [1]Institut für Strahlenphysik, Helmholtz-Zentrum Dresden-Rossendorf, Deutschland — [2]Technische Universität Dresden, Deutschland

In recent years, the demand for relativistic electrons is increasing emerging from various applications in material science, particle physics and medicine. This fuels the development of compact electron accelerators. One promising approach is laser wakefield acceleration, which harnesses the capability of plasma to sustain very high electric fields. As laser wakefield acceleration is driven by high-intensity lasers, it relies on a complex, non-linear interplay between drive lasers and plasma parameters, resulting in a broad parameter space for an optimum acceleration for the generation of high quality electron beams. For tailoring the electron beam to match the requirements of each application case, independent control of all the interconnected parameters is imperative. Because optimization relying solely on experimental data is expensive in both time and resources, we utilize Bayesian methods to optimise the acceleration process parameters and determine the Pareto front for each experiment, ensuring reproducible conditions on each operation day. This project will be a crucial step toward a stable laser-plasma accelerator with experiment-adapted electron beam properties.

AKBP 8.7 Wed 13:00 E 020

HELIAC Beam Dynamics Simulations — •Robin Kalleicher[2,3], Winfried Barth[1,2,3], and Simon Lauber[1,2] — [1]GSI, Darmstadt, Germany — [2]HIM, Mainz, Germany — [3]JGU, Mainz, Germany

The synthesis of **S**uper **H**eavy **E**lements (**SHE**) is an active field in nuclear physics. Thereby, research in accelerator technology, contributing to synthesis of SHEs, is strongly motivated. At **GSI** Helmholtz Centre for Heavy Ion Research, where the elements 107 to 112 were discovered, the new **HE**lmholtz **LI**near **AC**celerator (**HELIAC**) is currently under construction. As a state-of-the-art continuous-wave (**CW**) superconducting accelerator for stable heavy ion beams, the HELIAC offers output energies in between 3.5 MeV/u and 7.3 MeV/u with outstanding precision for the SHE research community.

Still, for superconducting accelerators, cost substantially increases with the size of their cryo cooling system, limiting space for beam diagnotics elements. In this contribution a real-time, live simulation tool - the **Advanced Demonstrator Simulator** -, which was operated in parallel to beam tests in Q4 2023, will be presented. The main goal of this Advanced Demonstrator Simulator is the precise modelling and prediction of heavy ion beams inside the first HELIAC cryomodule conducting multi-particle simulations by implementing a digital twin of the actual machine. Beneficially, operators obtain massive gains in information, potentially resulting in faster tuning of the accelerator with increased precision. Furthermore, the interactive design of the tool enables calibration processes to be practised and post-processing of data in a well-organized manner.

AKBP 8.8 Wed 13:15 E 020

Chaotic Dynamics of Near-Critical Density Plasmas for Laser-Ion Acceleration — •Thomas Miethlinger[1], Sergei Bastrakov[1], Michael Bussmann[1], Alexander Debus[1], Marco Garten[3], Ilja Göthel[1,2], Axel Huebl[3], Brian Marre[1,2], Richard Pausch[1], Martin Rehwald[1,2], Klaus Steininger[1], Rene Widera[1], Karl Zeil[1], Thomas Cowan[1,2], Ulrich Schramm[1,2], and Thomas Kluge[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf — [2]Technische Universität Dresden — [3]Lawrence Berkeley National Laboratory

We investigate the emergence and consequences of chaotic dynamics in the interaction of near-critical density plasmas with ultra-intense laser pulses, leading to highly sensitive dependencies on initial conditions even for important macroscopic quantities such as the absorbed laser energy and the spectrum of ions accelerated in the process. The interplay of laser- and induced fields continuously accelerates electrons in both forward and backward directions, leading to the formation of spiral-like vortex structures in phase space that exhibit varying degrees of mixedness. We identify a stretching and folding process in the electron dynamics, which is a prerequisite for deterministic chaos and also responsible for the creation of additional electron streams. Based on the results of particle-in-cell simulations, we present the intimate connection between the degree of mixing and chaotic dynamics, and we show a pathway to enhance the stability of the laser-plasma dynamics and thus secondary particle generation and acceleration.