AKBP 4: Beam Dynamics I

Time: Monday 17:00–18:45 Location: E 020

AKBP 4.1 Mon 17:00 E 020

A 6-Dimensional Analytical Model for the SEALab SRF Gun and Solenoid — •Emily Jayne Brookes — HZB, Berlin, Germany

SEALab is home to an R&D superconducting radio-frequency photoinjector setup which aims to produce pulses of electrons at high brightness and low emittance to develop the technology for future high-brilliance electron beam purposes. Commissioning of the photoinjector will determine the characteristics of the achievable particle beam through the initial accelerating and magnetic components. In order to aid the commissioning of the setup, an analytical model of the machine is desired to provide fast insights into the beam dynamics for a simplified beamline. This will aid decision-making for commissioning and operation of the machine. For this purpose, a 6-dimensional, first-order, linear model of the photoinjector has been developed. This paper demonstrates the applicability of this toy-model for use in initial commissioning and its comparison to the corresponding ASTRA simulation.

AKBP 4.2 Mon 17:15 E 020

Phase space density tomography constrained by the Vlasov-Fokker-Planck equation — •Felipe Donoso, Stefan Funker, Erik Bründermann, Martin Frank, and Anke-Susanne Müller — KIT, Karlsruhe, Germany

Understanding the evolution of complex systems with numerous interacting particles requires advanced analytical tools capable of capturing the intricate dynamics of phase space. This study introduces a novel approach to phase space density tomography, leveraging constraints imposed by the Vlasov-Fokker-Planck equation. The Vlasov-Fokker-Planck equation offers a comprehensive description of the evolution of distribution functions in phase space, accounting for both deterministic and stochastic processes. The method proposed is designed to address the specific challenges associated with electron beam dynamics, providing enhanced accuracy in reconstructing phase space distributions.

In this work, we present a tomographic framework for reconstructing the phase space density of an electron bunch in the KARA synchrotron using simulated data and the Vlasov-Fokker-Planck equation.

AKBP 4.3 Mon 17:30 E 020

A Simulation of Ultrafast Electron Scattering Applications — •Simon Barg — Helmholtz-Zentrum Berlin für Materialen und Energie, Berlin, Germany

The superconducting radio-frequency (SRF) photoinjector is a photoelectron driven linear accelerator located at the SEALab facility at Helmholtz-Zentrum Berlin. With the injector, very flexible beam parameters can be achieved enabling many scientific applications like performing ultrafast electron scattering with diffraction and imaging modalities, which is this work's focus. Complex structures such as biological molecules, which are not suitable for conventional crystallographic methods, could be imaged and studied with this technique.

To assess the feasibility of ultrafast imaging, procedures and code libraries from electron microscopy (EM) are used and extended with the overall goal to provide a full numerical simulation for proposed liquid state experiments incorporating every step of the electrons' path: the emission from the gun, the deflection due to the interaction with a perpendicular stream of molecules and the aberrations created by the magnetic lens system.

A Python toolkit is build, which simplifies applying the simulation and thereby helps answering some of the experiment's key design questions: It allows the comparison of different modalities like dark and bright field imaging. It can also be used for optimizing the lens setup, or beam parameters. Additionally, it supports coherency studies and stroboscopic imaging to extensively and precisely explore different options for the future experiments at SEALab.

AKBP 4.4 Mon 17:45 E 020

Analytic formulation of the zero-crossing slope for a non-axial symmetric generalized Gaussian bunch. — •Stefano Mattiello, Bernhard Erich Jürgen Scheible, and Andreas Penirschke — Technische Hochschule Mittelhessen, Friedberg, Hessen

For future experiments with ultra-short X-ray free-electron lasers (XFEL) shots, fs precision is required for the synchronisation systems even with 1 pC bunches using one or more button-like pickups in the Bunch Arrival Time Monitors (BAM). The sensitivity of the BAM depends in particular on the slope of the bipolar signal at the zero crossing and thus also on the bunch charge. Consequently, a precise theoretical prediction of the slope is a challenging and fundamental task. Nevertheless, previous investigations assume a perfectly axial-symmetric gaussian bunch. In this contribution the theoretical foundations of the pickup signal are presented in a systematic way including a non-axial symmetric generalized Gaussian bunch a point-symmetric distorsion of the standard Gaussian charge distribution. We focus on a button-like pickup and present an exact estimation of the zero-crossing slope as well as systematic comparison to results for the axial symmetric gaussian bunch in order to to achieve a deeper understanding of the effects of the asymmetric contribution.

AKBP 4.5 Mon 18:00 E 020

Determining quadrupole magnetic length shortening in COSY using a Bmad model — •Michael Margos — Institut für Kernphysik, FZ Jülich, Germany — III. Physikalisches Institut B, RWTH Aachen University, Germany — GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany

Precision experiments, like the search for electric dipole moments (EDMs) in storage rings require very stable beam conditions and a very good understanding of the accelerator. The JEDI-Collaboration (Jülich Electric Dipole moment Investigations) in Jülich has modelled the storage ring COSY (COoler SYnchrotron) in the simulation software Bmad. A discrepancy between betatron tune measurements and computed betatron tune was found.

The primary suspect for this discrepancy is an inadequate description of quadrupole magnets, especially magnetic length shortening due to surrounding ferromagnetic material. Tune measurements with different quadrupole settings were measured and are compared to model tunes to determine actual quadrupole strength.

AKBP 4.6 Mon 18:15 E 020

Modelling of longitudinal phase space parameters of space charge dominated electron beams at PITZ — •Zarmina Shah[1,2], Namra Aftab[2], and Mohsen Kelisani[2] — [1]Brandenburgische Technische Universität-Cottbus — [2]Deutsches Elektronen-Synchrotron DESY, Platanenallee 6, 15738 Zeuthen, Germany

The Photo Injector Test facility at DESY in Zeuthen (PITZ) was established as a test stand of electron sources for the European X-ray Free Electron Laser (XFEL) and Free electron LASer in Hamburg (FLASH). PITZ utilizes tomography technique to reconstruct the LPS after the gun, which is based on an analytical model of the LPS parameters. This model does not include space charge forces and hence underestimates the energy spread for high charge beams, e.g., 250pC case, which is the working point for XFEL. The scope of this work was to include space charge forces into the analytical model. Astra simulations were carried out for electron beam including space charge forces and the calculated momentum and the momentum spread were compared to the results of the 6 dimensional envelope-based equations. The evaluation was done for different number of particles as well as under different energy chirp manipulation.

AKBP 4.7 Mon 18:30 E 020

Strategy towards deterministic lattice design — •Bettina Kuske and Paul Goslawski — HZB, Berlin, Germany

HZB is in the process of developing the lattice for BESSY III, the successor of the 1.7 GeV electron storage ring running in Berlin-Adlershof since 1998. Resource-intense generic optimization is often used to develop new lattices or modify existing lattices for new needs. Exploiting the intrinsic structure of modern MBA lattices, we elaborate on the benefits and limits of a deterministic approach that builds on principle considerations and short parameter scans.