AKBP 9: Diagnostics, Control, Modeling, Modern IT Applications

Time: Wednesday 14:00–15:30 Location: AKBP-H13

AKBP 9.1 Wed 14:00 AKBP-H13

Sensitivity Analysis of Beam-influencing Parameters at the S-DALINAC Using Surrogate Models* — •Dominic Schneider, Michaela Arnold, Jonny Birkhan, Norbert Pietralla, and Felix Schliessmann — Institut für Kernphysik, TU Darmstadt, Germany

Particle accelerates are complex systems that coincide with their ideal design within the tolerances of its large number of technical components, only. Quantitative understanding of the beam dynamics and the analysis of their sensitivity to various components are challenging tasks. Machine learning methods provide a significant potential for the optimized operation of particle accelerators. In this contribution, the first application of so-called surrogate models to the electron accelerator S-DALINAC will be discussed. This machine learning technique gives access to predict future behavior and an extensive set of characteristics that can be extracted by analyzing the trained model. The talk will focus on a series of measurements performed in the injector section of the accelerator to study the behavior of beam-influencing elements. Surrogate models, constructed and based on the acquired data, are being evaluated to reveal the behavior of these elements. Based on the information obtained, optimizations of the alignment of magnets as well as the beam dynamics simulations at the S-DALINAC will be discussed.

*Work supported by DFG (GRK 2128) and the State of Hesse within the Research Cluster ELEMENTS (Project ID 500/10.006).

AKBP 9.2 Wed 14:15 AKBP-H13

Optimization of spin-coherence time in a prototype storage ring for electric dipole moment measurements — •Rahul Shankar[1], Maximillian Vitz[2], and Paolo Lenisa[1] for the JEDI-Collaboration — [1]Università degli studi di Ferrara and INFN, Italy — [2]Institute of Nuclear Physics, Forshungszentrum Jülich, Germany

The JEDI experiment is dedicated to the search for the electric dipole moment (EDM) of charged particles using storage rings, which can be a very sensitive probe of physics beyond the Standard Model. In order to reach the highest possible sensitivity, a fundamental parameter to be optimized is the particles' Spin Coherence Time (SCT), i.e., the time interval within which the particles of the stored beam maintain a net polarization greater than 1/e. To identify the working conditions that maximize SCT, accurate spin-dynamics simulations with the code BMAD have been performed on the lattice of a "prototype" storage ring which uses a combination of electric and magnetic fields for bending. This talk will present the results of these simulations addressing the impact on the SCT of different factors like horizontal tune, and the electric bending field, as well as suggestions on lattice modifications to further improve its value.

AKBP 9.3 Wed 14:30 AKBP-H13

Parasitic Optimization of the Transfer Beamline Efficiency at ELSA — •Sebastian Witt, Klaus Desch, Daniel Elsner, and Dennis Proft — Elektronen-Stretcher-Anlage ELSA, Physikalisches Institut, Universität Bonn

The 3.2 GeV electron accelerator ELSA consists of three acceleration stages each interconnected by tunable transfer beamlines. The steering of the electron beam through the transfer line from linear accelerator to the booster synchrotron is currently adjusted by hand, which limits a systematic optimization of the transfer efficiency.

To improve the situation, an automated optimization using the "simulated annealing" technique has been developed and integrated into the accelerator's control system. It allows for a continuous optimization without interfering with usual beamtime for experiments by utilizing the 6s off-time in between injections into the storage ring. In a simulation using the actual accelerator's settings as starting parameters, transmission rates have been increased significantly, while testing with the accelerator is still ongoing.

AKBP 9.4 Wed 14:45 AKBP-H13

Magnetic Field Characterization with Circular Scan and Multipole Moment Analysis — •Yimin Tong[1], Yuancun Nie[2], Axel Bernhard[1], and Anke-Suanne Müller[1] — [1]KIT, Karlsruhe, Germany — [2]Wuhan China

For the optimisation of an accelerator like FLUTE which aims at producing femtosecond bunches by means of a specially designed compressor chicane, it is important to take into account the detailed properties of the real and magnets in the beam dynamics simulations. A typical approach to do so is to use particle tracking through flux density maps, measured e.g. by a 3D Hall probe on a sufficiently dense 3D grid and interpolated by an appropriate integration procedure. This approach yields accurate results but can be very time consuming both, regarding the measurement and the simulation. For the FLUTE quadrupole and chicane dipole magnets, we have in addition to this method investigated the alternative approach of measuring the radial flux density component on a cylinder surface concentric with the beam axis and representing the field in the beam dynamics simulations by a set of magnet slices with the multipole components deduced from the measurement. In this contribution the calibration and measurement procedure is described and the two measurement and representation approaches are compared to each other.

This work is supported by the BMBF under grant No. 05H18VKRB1

AKBP 9.5 Wed 15:00 AKBP-H13

Injection optimization using machine learning at the Cooler Synchrotron COSY — •Awal Awal for the JEDI-Collaboration — RWTH Aachen University — GSI Helmholtzzentrum für Schwerionenforschung

In accelerators it is usually desired to have a particle beam with high intensity and small emittance. A key factor that limits the beam intensity in storage rings are injection losses. The setup of the Injection Beam Line (IBL) depends on a large number of configurations in a complex, non-linear, and time-dependent way. Machine learning methods exhibit promising algorithms to effectively tackle the challenge of optimize the IBL setup. In this research, Reinforcement Learning (RL) techniques are planned to be utilized to optimize the IBL for the Cooler Synchrotron (COSY) at Forschungszentrum Jülich (FZJ). Both simulation environment and actual data from COSY are to be used in the process of training the RL agent. The goal is to increase the beam intensity inside COSY while decreasing the setup time required. This method has the potential to be applied in future accelerators like the FAIR facility.

AKBP 9.6 Wed 15:15 AKBP-H13

Microbunching Studies for FLASH2020+ Using Efficient Semi-Lagrangian Vlasov-Simulation — •Philipp Amstutz and Mathias Vogt — DESY, Hamburg, Germany

In semi-Lagrangian approaches a solution to the Vlasov-Equation is obtained by back-tracking its characteristics and subsequently evaluating the initial condition. These methods yield a smooth numerical approximation to the phase-space density (PSD), which can put them at an advantage over particle-based methods. For instance, when studying small-scale effects where the inherent stochastic noise of particle-tracking methods becomes burdensome, semi-Lagrangian schemes are a promising alternative.

In free-electron lasers the electron bunches typically exhibit an "exotic" structure in the longitudinal phase-space resembling a fine, wiggling hair-like band. Such PSDs are not efficiently captured by a regular grid, as large parts of the minimum bounding rectangle of the PSD are void and do not contribute to the dynamics of the system. We present studies of the microbunching instability for FLASH2020+ using SelaV – a semi-Lagrangian Vlasov code we developed, which employs tree-based domain decomposition to efficiently handle exotic PSDs.