AKBP 9: Beam Dynamics / Simulation I

Zeit: Dienstag 16:45–18:45 Raum: BZ.08.04 (HS 2)

AKBP 9.1 Di 16:45 BZ.08.04 (HS 2)

Differences in tracking simulations of Insertion Devices — •Julian Gethmann[1], Axel Bernhard[1], Edmund Hertle[1], Steffen Hillenbrand[1], Anke-Susanne Müller[1], Nigel Smale[1], and Konstantin Zolotarev[2] — [1]Karlsruhe Institute of Technology (KIT) — [2]Budker Institute of Nuclear Physics

Simulations of the effects of insertion devices on beam dynamics are necessary to design and run a synchrotron. To that end, different approaches and codes are used. In some cases the results of the different codes and the measurements don't agree very well. Limitations of different simulation software—namely elegant, AT, Opera3D—are discussed and edge cases are presented in this talk. The edge cases were investigated by comparing multiple simulation approaches and codes among themselves. In addition experimental data is acquired and taken as a reference to compare against the models. These experiments were performed with a superconducting wiggler with known magnetic field component at the ANKA synchrotron light source.

AKBP 9.2 Di 17:00 BZ.08.04 (HS 2)

Computation of complex structures using the State Space Concatenation Scheme — •Johann Heller, Thomas Flisgen, and Ursula van Rienen — Institut für Allgemeine Elektrotechnik, Rostock, Germany

For the design and operation of radio frequency (RF) structures for high energy physics, the knowledge of the electromagnetic fields inside such structures is of crucial importance. These fields are computed numerically by solving the curl-curl equation, derived from Maxwells equations. For large and complex structures, due to the huge size of the problem the field patterns can not be computed on standard workstation computers in reasonable time. Actually, for such type of problems, sophisticated parallel codes are employed on high performance computers (HPC). Being very expensive, HPC platforms are rather rare and have a very limited access. Therefore, we recently proposed a concatenation scheme, denoted as State Space Concatenations (SSC), which is able to compute complex RF structures on standard workstations. In this contribution, we will present very promising results of performance studies related to FLASH and the European XFEL.

AKBP 9.3 Di 17:15 BZ.08.04 (HS 2)

Start-to-End Simulations for a 100 μm SASE FEL at PITZ — •Prach Boonpornprasert[1], Mahmoud Bakr[1,3], Mikhail Krasilnikov[1], Barbara Marchetti[2], and Frank Stephan[1] — [1]Deutsches Elektronen-Synchrotron (DESY), Zeuthen, Germany — [2]Deutsches Elektronen-Synchrotron (DESY), Hamburg, Germany — [3]Physics Department, Assiut University, Assiut, Egypt

High brightness electron sources for modern linac-based Free-Electron Lasers (FELs) have been characterized and optimized at the Photo Injector Test facility at DESY, Zeuthen site (PITZ). Since the time structure of the electron bunches at PITZ is identical to that at the European XFEL, the PITZ accelerator is being considered as a proper machine for the development of an IR/THz source prototype for pump and probe experiments planned at the European XFEL. Furthermore the development of such a THz radiation source at PITZ will allow also to test at this location new IR/THz radiation diagnostics devices and to develop an experimental setup for the characterization of the THz radiation, which can be used in parallel for the longitudinal diagnostic of the electron beam properties. For this reason simulation studies concerning the radiation generation using high gain FELs and Coherent Transition Radiation (CTR) have been started. In this work, start-to-end simulations for a Self Amplified Spontaneous Emission (SASE) FEL at a wavelength of 100 μm have been performed. The code ASTRA has been used to track the electron beams. The SASE FEL radiation is calculated by using the GENESIS1.3 code. The results of these studies will be presented and discussed in this contribution.

AKBP 9.4 Di 17:30 BZ.08.04 (HS 2)

Beam dynamics simulations for the S-DALINAC* — •Jonas Pforr, Michaela Arnold, Florian Hug, Lars Jürgensen, Thorsten Kürzeder, and Norbert Pietralla — Institut für Kernphysik, TU Darmstadt, Darmstadt, Germany

The superconducting electron accelerator S-DALINAC is a twofold recirculating linear accelerator located at TU Darmstadt. However, the design energy of 130 MeV could not be reached, yet, due to limitations in the cooling power.

It is planned to build a third recirculation in order to increase the possible beam energy and stability. In this process, simulations of the beam dynamics had to be done.

In general, in recirculating LINACs the beam current is limited by beam-breakup (BBU). BBU occurs when higher order modes (HOMs) in the cavities cause a transverse displacement of the beam, which can after the recirculation amplify the higher order modes. This can lead to a growth of the HOMs and the beam displacement until the beam is lost. In order to test different strategies to overcome BBU limits, we will integrate skew quadrupoles and sextupoles in the lattice.

In this talk we will present the beam dynamics simulations with these new magnets.

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AKBP 9.5 Di 17:45 BZ.08.04 (HS 2)

Space-charge matching of the transverse phase space at PITZ — •Georgios Kourkafas[1], Alexey V. Bondarenko[2], Mikhail Krasilnikov[1], Barbara Marchetti[1], and Aleksandr N. Matveenko[2] — [1]DESY, Zeuthen, Germany — [2]HZB, Berlin, Germany

Various diagnostics, applications and experiments at PITZ require specific transverse beam parameters at certain parts of the beamline. The standard matching techniques which do not include the effect of space charge are proven to be unsuccessful due to the moderate energy and high charge density of the generated bunches. On the other hand, codes which accurately simulate the self fields are too slow to provide results quick enough for on-line application.

A compromise is found when considering only the linear space-charge forces in the beam dynamics. For stationary beams in dense and periodic lattices, the smooth-approximation theory can be used to include the space-charge effect in matching codes like MAD. For the general case, codes like SC (developed in HZB) can be used to solve and iteratively optimize the beam envelope equation for each longitudinal slice of the bunch, taking into account the correlated emittance growth. The performance of both approaches is demonstrated and evaluated using the ASTRA software for the matching requirements of the phase space tomography at PITZ.

AKBP 9.6 Di 18:00 BZ.08.04 (HS 2)

Status of the FCC-ee lattice design and chromaticity correction scheme — •Bastian Härer[1,2], Bernhard J. Holzer[1], and Anke-Susanne Müller[2,3,4] — [1]CERN, Geneva — [2]LAS, KIT, Karlsruhe — [3]ANKE, KIT, Karlsruhe — [4]IPS, KIT, Karlsruhe

FCC-ee is a new large-scale electron positron collider with 100 km circumference designed within the Future Circular Collider Study (FCC) at CERN. It is supposed to run at four different beam energies in the range of 45-175 GeV imposing different boundary conditions on the design. At high energies operation is limited by beamstrahlung and at low energies by the beam-beam threshold. To limit the impact of the respective effect different beam emittances need to be obtained by modifying the arc lattice. Furthermore the very ambitious interaction region requirements create very high chromaticity that has to be corrected with a sophisticated sextupole scheme. This talk will present the status of the lattice design and the chromaticity correction scheme.

AKBP 9.7 Di 18:15 BZ.08.04 (HS 2)

Ion optical simulations of large-aperture separators including realistic magnet field models — •Erika Kazantseva — TEMF, Schlossgartenstr.8, Technische Universität Darmstadt

The main goal of this work is to develop an effective approach to fast and accurate ion optical simulations of an ensemble of large-aperture magnets such as in-flight fragment separators like the FRS at GSI and the future Super-FRS at FAIR. For accurate simulations capable of predicting the behavior of real particles it is necessary to have an ion-optical model in which a detailed and realistic description of the magnetic fields is implemented.

There are different approaches to make the ion-optical model more realistic, for example, the use of analytical functions to describe the fringe fields, for example, Enge-functions. One should also consider representing the effect of the fringe fields via effective fringe field maps or fringe field integrals. Large aperture magnetic elements and short distances between them could make simple models invalid. Thus the influence of the neighboring magnet yokes has to be taken into account.

We will also investigate the generation of transfer maps of arbitrary order from the magnetic fields of given elements. In this case, it is possible to relate computationally the final coordinates to the initial ones by the numerical integration of the equations of motion.

AKBP 9.8 Di 18:30 BZ.08.04 (HS 2)

Beam Extraction Dynamics at the Space-Charge-Limit of the High Brightness E-XFEL Electron Source at DESY-PITZ — •Ye Chen, Erion Gjonaj, and Thomas Weiland — TEMF, Technische Universitaet Darmstadt, Schlossgartenstrasse 8, 64289 Darmstadt, Germany

The physics of the photoemission, as one of the key issues for successful operation of linac based free-electron lasers like the European X-ray Free Electron Laser (E-XFEL) and the Free-electron Laser in Hamburg (FLASH), is playing an increasingly important role in the high brightness DESY-PITZ electron source.

We study photoemission physics and discuss full three-dimensional numerical modeling of the electron bunch emission. The beam extraction dynamics at the photocathode has been investigated through the 3D fully electromagnetic (EM) Particle-in-Cell (PIC) solver of CST Particle Studio under the assumption of the photoemission source operating at or close to its space charge limit. PIC simulation results have shown good agreements with measurements on total emitted bunch charge for distinct experimental parameters.

Further comparisons showed a general failure for the conventional Poisson solver based tracking algorithm to correctly predict the beam dynamics at the space charge limit. It is furthermore found, that fully EM PIC simulations are also consistent with a simple emission model based on the multidimensional Child-Langmuir law.