AKBP 10: Beam Dynamics / Simulation II

Zeit: Mittwoch 16:30–18:30 Raum: S1/05 122

AKBP 10.1 Mi 16:30 S1/05 122

Improvements in the Beam Dynamics Simulations for the HESR — •Jan Henry Hetzel, Andreas Lehrach, Ulf Bechstedt, Jürgen Böker, Bernd Lorentz, and Raimund Tölle — FZ Jülich, Jülich, Deutschland

The High-Energy Storage Ring HESR is a part of the emerging accelerator complex FAIR (Facility for Antiproton and Ion Research) at the GSI in Darmstadt. The HESR will accelerate and store antiprotons with a momentum range from 1.5 to 15 GeV/c. It will also be suitable for heavy ions with an approximate momentum range from 0.6 GeV/c to 5.8 GeV/c.

In this talk beam-dynamics simulations for the HESR will be presented. The first focusing magnets and the first bending magnets have been delivered and the magnetic field measured recently. These measurements include the estimation of the mulipole components. From these measurement the average harmonic content and its standard deviation throughout the series is estimated. In beam tracking studies for the HESR the multipole errors are diced accordingly. The results of these tracking studies are then used to estimate the dynamic aperture.

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Simulation Studies on Measures to Mitigate Ion Clouds — Prasanth Babu Ganta[1], Ahmed Masood[1], Dennis Sauerland[2], Wolfgang Hillert[2], Atoosa Meseck[3], and •Ursula van Rienen[1] — [1]Universität Rostock, Institut für Allgemeine Elektrotechnik, Albert-Einstein-Str. 2, 18059 Rostock — [2]Physikalisches Institut der Universität Bonn, ELSA, Nussallee 12, 53115 Bonn — [3]HZB, Institut Beschleunigerphysik, Albert-Einstein-Str. 15, 12489 Berlin

For future Energy Recovery Linacs (ERL), parasitic ions, which are generated by collisions of the beam and the rest gas in the vacuum chamber, present a limiting factor for the high current-low emittance electron beams. Clearing gaps, clearing electrodes and appropriate filling patterns are a remedy to keep the ion density in the accelerator at a level that allows for a minimum stability of the beam parameters. The MOEVE PIC Tracking code, which employs a 2D wake matrix, enables tracking simulations of the ion distribution over a relatively long period of up to thousands of interactions with the passing bunches. It enables to develop a deeper understanding of the ion-cloud behavior in order to design appropriate measures for their mitigation. For certain cases, it is sufficient to study the problem in 2D. Therefore, an additional 2D solver shall be implemented into MOEVE PIC Tracking in order to reduce the computation times. Numerical studies of ion cloud dynamics in beam guiding magnets and drift sections of electron machines will be shown and compared with experimental results obtained at the ELSA facility. Work supported by Federal Ministry for Research and Education BMBF under contract 05K13HRC.

AKBP 10.3 Mi 17:00 S1/05 122

Experimentelle Studien zur Ionendynamik in Kreisbeschleunigern* — •Dennis Sauerland[1], Wolfgang Hillert[1], Ursula van Rienen[2] und Atoosa Meseck[3] — [1]Elektronen-Stretcher-Anlage, Physikal. Institut, Universität Bonn — [2]Institut für Allgemeine Elektrotechnik, Universität Rostock — [3]Helmholtz-Zentrum Berlin

Im ELSA Stretcherring der Universität Bonn werden Elektronen auf eine Energie von bis zu 3,2 GeV beschleunigt. Hierbei akkumulieren Ionen, welche durch Stoßionisation kontinuierlich produziert werden, im Strahlpotential und sind Ursache für inkohärente Arbeitspunktverschiebungen und Strahlinstabilitäten. Da die Arbeitspunktverschiebung linear mit der Neutralisation anwächst, bietet sie einen Zugang um angewendete Ionensäuberungsmaßnahmen zu evaluieren:
Durch eine breitbandige Anregung des Strahls um seinen transversalen Arbeitspunkt mittels eines Stripline-Kickers ist es möglich, die Transferfunktion des Strahls zu bestimmen. Die Verschiebung und Verbreiterung des Arbeitspunktes kann durch eine Größe parametrisiert werden, welche mit der inkohärenten Arbeitspunktverschiebung korreliert. Der Einfluss von inkohärenten Effekten auf das kohärente Antwortverhalten des Elektronenstrahls bei dieser Methode ist zur Zeit noch nicht ausreichend untersucht worden, wodurch aus der gemessene Größe nicht direkt eine Neutralisation extrahiert werden kann. Deshalb werden in diesem Vortrag neue numerische Berechnungen und experimentelle Nachweise vorgestellt, die die Ergebnisse der vorangegangenen Messung untermauern.
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UFOs in the LHC — •Laura Grob — CERN, Geneva, Switzerland — Technische Universität Darmstadt

In the Large Hadron Collider (LHC) localized and recurring beam losses have been observed, which usually persist for several hundred microseconds. With increasing beam energy these losses were found to pose a serious risk to the machine availability, as some of these events can cause quenches in the superconducting magnets. The current understanding is that these losses are caused by falling microparticles that interact with the proton beam. To describe these so-called UFOs (unidentified falling objects) and their dynamics, a model was developed starting from the approach that only gravitational and electrostatic forces act on a neutrally charged particle. However, the model's results cannot reproduce the actual data from the LHC's beam loss monitors (BLMs), which indicates a more complex UFO dynamic. Experimental studies and further analysis of the BLM data are planned to investigate the UFO dynamics in greater detail and to understand origins and release mechanisms for microparticles in the LHC beam pipe.

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Zeitersparnis durch den "Multi-Energie-Betrieb" — •Mohammad Hossein Ravasani, Christian Schömers und Andreas Peters — Heidelberger Ionenstrahl-Therapiezentrum

Das Heidelberger Ionenstrahl Therapiezentrum (HIT) wurde im Jahr 2009 eröffnet.Die Tumorbestrahlung erfolgt mit dem Rasterscan-Verfahren.Ein Ionenstrahl, der auf die zur Eindringtiefe passenden Energien beschleunigt wurde, wird über die Iso Energie Schichten(IES)im Tumor geführt. In einem Synchrotron werden die Teilchen auf das vorgegebene Energieniveau beschleunigt. Die benötigten Teilchen werden anschließend in einem RF-K.O Extraktionsprozess vom Strahl getrennt und weitergeleitet. Die restlichen Teilchen,werden an einem Scraper gezielt gestoppt. In diesem Bestrahlungsmodus muss für jedes Energieniveau ein neuer Synchrotronzyklus gestartet werden. Dadurch erhöht sich die Behandlungsdauer. Um dem entgegen zu wirken, soll am HIT ein multipler Energiebetrieb (MEB) eingeführt werden. Dieser soll es ermöglichen, mit einer Synchrotronfüllung mehrere Zyklen zu durchlaufen,um so eine Zeitersparnis zu erreichen. Im Rahmen einer Bachelor-Arbeit werden die Bestrahlungspläne aller am HIT behandelten Patienten analysiert. In einer Simulation des MEB wird abgeschätzt wie viel Zeit eingespart werden kann. Dazu werden mit einem Pythonprogramm, Energieniveaus,und die mittlere Zeitdauer der IES, aus den Bestrahlungsplänen extrahiert. Das Modell wird dann um Annahmen in Bezug auf die Strahldynamik erweitert, die eine Vorhersage der Bestrahlungsdauer im MEB-Modus ermöglichen. Das signifikante Zeitersparnis wird hier präsentiert.

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Simulation studies of gas and plasma-based charge strippers — •Oliver Sebastian Haas[1] and Oliver Boine-Frankenheim[1,2] — [1]Institut für Theorie Elektromagnetischer Felder, Darmstadt, Germany — [2]GSI Helmholtz Centre for Heavy Ion Research, Darmstadt, Germany

Charge stripping of heavy ion beams at high intensities is a major challenge in current and future facilities with high intensity heavy ion beams. Conventional stripping techniques are limited in their applicability, e.g. solid carbon foils suffer from short lifetimes at high intensities and gas strippers usually achieve only low charge states. One possible alternative is the use of a plasma as a stripping medium. The presented work focuses on theoretical studies of the interaction of an heavy ion beam with a plasma and accompanying effects in possible charge strippers.

The main interest in the presented studies is the final charge state distribution of the ion beam. Different models for solving the corresponding rate equations were developed, taking into account ionization, recombination, energy loss and straggling processes. Sophisticated models, e.g. for ionization cross sections, as well as limits and applicability of simplified models are discussed. Quantitative results are presented in form an overview of the charge state distributions of

different - conventional and novel - charge stripping media. Furthermore comparisons are done with charge state distributions of available experimental data. Typical practically relevant target conditions are discussed as well as deterioration of beam quality.

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Realistic ion optical transfer maps for Super-FRS magnets from numerical field data — •Erika Kazantseva and Oliver Boine-Frankenheim — Schlossgartenstr.8, Technische Universität Darmstadt

In large aperture accelerators such as Super-FRS, the non-linearity of the magnetic field in bending elements leads to the non-linear beam dynamics, which cannot be described by means of linear ion optics. Existing non-linear approach is based on the Fourier harmonics formalism and is not working if horizontal aperture is bigger as vertical or vice versa. In Super-FRS dipole the horizontal aperture is much bigger than the vertical. Hence, it is necessary to find a way to create the higher order transfer map for this dipole to accurately predict the particle dynamics in the realistic magnetic fields in the whole aperture.

The aim of this work is to generate an accurate high order transfer map of magnetic elements from measured or simulated 3D magnetic field data. Using differential algebraic formalism allows generating transfer maps automatically via numerical integration of ODEs of motion in beam physics coordinates along the reference path. To make the transfer map accurate for all particles in the beam, the magnetic field along the integration path should be represented by analytical function, matching with the real field distribution in the volume of interest. Within this work the steps of high order realistic transfer map production starting from the field values on closed box, covering the volume of interest, will be analyzed in detail.

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Transverse decoherence with space charge — •Ivan Karpov[1], Vladimir Kornilov[2], and Oliver Boine-Frankenheim[1,2] — [1]TEMF, TU Darmstadt, Schloßgartenstraße 8, 64289 Darmstadt, Germany — [2]GSI, Planckstr. 1, 64291 Darmstadt, Germany

After a transverse offset the amplitude of beam centroid oscillations decays due to the spread of individual particle frequencies. Decoherence of low intensity coasting beams can be described as the pulse response. However in heavy ion and proton beams, like in SIS100 synchrotron of the FAIR project, transverse space charge strongly modify this process. We present a model that explains the first stage of decoherence process in high intensity bunched beams. It uses the modified beam transfer function with space charge and image charges to calculate the pulse response. The model agrees with particle tracking simulations and measurements at the SIS18 synchrotron at GSI Darmstadt. The applicability region of the model was obtained.