BE 13: Beam Dynamics and Fields II

Time: Thursday 9:30–12:30 Location: ZEU 255

BE 13.1 Thu 9:30 ZEU 255

Progress in Eigenmode Computation Using Perturbative Methods — •Korinna Brackebusch and Ursula van Rienen — Institute of General Electrical Engineering,University of Rostock

Parametric studies of geometric variations are an essential part of the performance optimization and error estimation in the design of accelerator cavities. Using common eigenmode solvers the analysis of intentional and undesired geometric perturbations tend to be very extensive since any geometric variation involves an entire recomputation. Perturbative methods constitute an efficient alternative for the computation of a multitude of moderately varying geometries. Their practicability was proven by means of simple cavity geometries.

We present the progress in eigenmode computation using perturbative methods, showing improvements of the algorithm and latest results for single and multi cell cavities subject to cylindrically symmetric and nonuniform perturbations.

BE 13.2 Thu 9:45 ZEU 255

Numerical Modeling of Superconducting Radio Frequency Cavities — •Tomasz Galek and Ursula van Rienen — Universität Rostock, Institut für Allgemeine Elektrotechnik, Albert-Einstein-Str. 2, 18051 Rostock

Design of modern superconducting radio frequency cavities for acceleration of charged particle bunches require intensive numerical simulations. Wide variety of parameters vital to the proper operation of accelerating cavities must be optimized. The aim of this talk is to present currently existing simulation and modeling methods applied in the field of accelerator physics. General considerations and more specific problems of B*ERL*inPro and BESSY$^{\mathrm{VSR}}$ cavity design and optimization will be discussed.

BE 13.3 Thu 10:00 ZEU 255

Parameter Studies and Geometry Optimization on Superconducting Multicell RF-Cavity-Resonators* — •Benjamin Isbarn, Bernard Riemann, and Thomas Weis — Center for Synchrotron Radiation (DELTA) TU Dortmund University, 44227 Dortmund, Germany

Modern accelerator concepts for high intensity electron beams often require superconducting multicell RF-cavity-resonators in circular accelerators (e.g. storage rings). Various numerical studies were performed to numerically calculate the dependence of different figures of merit with respect to the geometry parameters of the RF-structure. To ease the numerical effort an optimization routine has been developed which automatically optimizes the geometry based on goal functions. In this context it turned out that cell geometries defined by spline functions have advantages compared to the standard elliptical parametrization regularly used. The number of free parameters is substantially reduced which facilitates the search for optimum solutions.

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BE 13.4 Thu 10:15 ZEU 255

Simulation of electron beam - ion interactions — •Aleksandar Markovik and Ursula van Rienen — Universität Rostock, Institut für Allgemeine Elektrotechnik, Albert-Einstein-Str. 2, D-18059 Rostock

Parasitic ions generated by synchrotron radiation and collisions of the electron beam and the rest gas in the vacuum chamber of a particle accelerators could harm the quality of the beam. Therefore numerical simulations of their behavior in the field of the electron beam and/or beam guiding magnets are indispensable to achieve an understanding of the phenomena and to possibly model their influence on the beam. Here we present results of a tracking simulation of the ion distribution over a relatively long period of time. During that time the ions interact up to thousand times with the passing bunches.

BE 13.5 Thu 10:30 ZEU 255

Prediction of severe electron loading of high-gradient accelerating structures based on field emission sample measurements — •Stefan Lagotzky and Günter Müller — University of Wuppertal, D-42097 Wuppertal, Germany

Enhanced field emission (EFE) limits the performance of both superconducting and normal conducting high-gradient accelerating structures. Systematic field emission scanning microscopy and correlated SEM/EDX measurements of relevant Nb and Cu samples have revealed particulates and surface irregularities with field enhancement factors β = 10 - 90 as origin of EFE. Based on sufficient emitter statistics, an exponential increase of the emitter number density N with increasing surface field (E) was found. This allows a prediction of the EFE loading of future ILC and CLIC accelerating structures by scaling of N to relevant E and using a weighted integration over the high-field cavity surface. Accordingly, an electropolished (Ra < 300 nm) and dry-ice cleaned (DIC) TESLA-shape 9-cell 1.3 GHz Nb cavity [1] will still suffer from EFE at E_{acc} = 35 MV/m (N = 0.3 cm^{-2} at E_{peak} = 70 MV/m). Moreover, a diamond-turned, chemically etched and DIC 11.2 GHz Cu structure [2] will breakdown at E_{acc} = 100 MV/m (N = 20 cm^{-2} at E_{peak} = 243 MV/m). Possible improvements, i.e. by emitter processing will be discussed.

The work is funded by BMBF project 05H12PX6.

[1] ILC Technical Design Report (2013)
[2] A. Grudiev and W. Wuensch, LINAC2010, pp. 211 - 213
Gruppenbericht

BE 13.6 Thu 10:45 ZEU 255

Optimierung des Förstersondenprinzips für die Anwendung im SRF-Bereich — •Matthias Wegen — Helmholtz-Zentrum Berlin, Berlin, Deutschland

Die Güte supraleitender Kavitäten ist umgekehrt proportional zum Hochfrequenz-Oberflächenwiderstand des supraleitenden Materials, welcher aus dem BSC-Widerstand und dem Restwiderstand besteht. Für SRF Kavitäten mit hohen Güten kann eingefrorener magnetischer Fluss letzteren leicht dominieren. Messungen am Helmholtz-Zentrum Berlin ergaben, dass bis zu 100 % des angelegten Magnetfeldes während des Phasenüberganges eingefroren werden, was den Restwiderstand und die Güte der Kavitäten deutlich verschlechtert.

Um die Magnetfeldverteilung an der Kavität im Betrieb vermessen zu können, wurde eine Sonde entwickelt, die eine hochauflösende Messung der DC-Magnetfelder im sub-μT-Bereich ermöglicht und somit die genaue Bestimmung des Magnetfeldes während des Phasenüberganges und auch des eingefrorenen Flusses zulässt. Dazu wurde das bestehende Prinzip der Förster-Sonde auf kleinere Raumabmessungen von ca. 20mm übertragen und dabei Kryotauglichkeit gewährleistet. In diesem Beitrag werden die Messungen der selbstgefertigten Sonde präsentiert und mit denen von kommerziell erhältlichen Produkten verglichen und anschließend diskutiert.

Eine Anordnung mehrere Sonden könnte helfen, eine 3-Dimensionale Aufnahme magnetischer Felder zu erstellen und somit die genaue Abhängigkeit zwischen Temperatur-Gradient und eingefrorenen Fluss zu erforschen, um signifikant höhere Kavitäten-Güten zu ermöglichen.

15 min. break

BE 13.7 Thu 11:15 ZEU 255

Recalculation of the dispersion tracks of the recirculations at the S-DALINAC* — •Jonas Pforr, Michaela Arnold, Florian Hug, and Norbert Pietralla — Institut für Kernphysik, TU Darmstadt, Darmstadt, Germany

The S-DALINAC is a twofold recirculating superconducting electron linear accelerator operated at Darmstadt. The design-energy of 130 MeV could however not be reached in cw operation so far due to a lower quality factor of the superconducting cavities than originally expected.

In order to increase the possible beam energy in future the construction of a third recirculation is planned. Since this modification slightly changes the layout of the excisting recirculations as well, the beam dynamics in all recirculations had to be revised by simulations. In this context, the relation between the longitudinal disperison and the quadrupole gradients was studied, which is important for the non-isochronous operation of the S-DALINAC.

We present the latest simulations of the beam dynamics, where the results of the new recirculation are of particular interest.

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BE 13.8 Thu 11:30 ZEU 255

Future experiments on beam break up at the S-DALINAC* — •Thorsten Kürzeder, Florian Hug, Lars Jürgensen, and Norbert Pietralla — Institut für Kernphysik, TU Darmstadt, Darmstadt, Germany

The superconducting accelerator S-DALINAC provides electron beams of up to 130 MeV for nuclear physics experiments at the Technische Universität Darmstadt. It consists of a 10 MeV injector and a 40 MeV main linac cryostat, where 20-cell SRF cavities are operated at 3 GHz in 2 K liquid helium. Two recirculation paths provide the possibility to use the main linac up to three times. Due to transverse beam break up (BBU) the design beam current of 20 μA could not be reached in recirculating operation mode yet, the highest stable beam current obtained so far accounts for 5 μA, which is sufficient for the nuclear physics experiments carried out at Darmstadt. On the other hand the very low threshold current for the occurance of beam break up gives a unique opportunity for testing different strategies of avoiding BBU in a recirculating linear SRF accelerator. We report on upcoming experiments which will be carried out at the S-DALINAC for that purpose. *Work suported by BMBF through 05K13RDA.

BE 13.9 Thu 11:45 ZEU 255

Sextupole magnets for beam break up measurements at the S-DALINAC* — •Marcel Schilling, Michaela Arnold, Mirco Gros, Florian Hug, Lars Jürgensen, Thorsten Kürzeder, and Norbert Pietralla — TU Darmstadt, Darmstadt, Germany

Energy recovery linacs (ERLs) are an emerging type of electron accelerators which can provide very high beam currents at low investment and running costs compared to conventional linacs. The high current densities generate strong fields that on the one hand act back on the beam (space charge forces) and on the other hand excite higher order modes (HOM) inside the accelerator structures. Those HOMs interact with the beam and excite beam oscillations that deteriorate beam quality and can lead to beam break up (BBU) in the worst case limiting the maximum achievable beam current in cw operation .

Avoiding BBU is investigated theoretically within simulations by several groups world-wide resulting in different strategies. In this talk we will focus on the idea of using the natural chromaticity in the beam transport system to delete the correlation of HOMs and electrons within the bunch in order to increase BBU threshold currents [1]. For that purpose test experiments at the superconducting recirculating electron accelerator S-DALINAC will be performed. As the natural chromaticity of the S-DALINAC beam transport system is rather low, new sextupoles had to be designed for this project. We will report on the properties of these sextupoles and the upcoming experiment.

[1] V. Litvinenko, Proc. LINAC'12, Tel Aviv, Israel (2012) 249.

*Work supported by BMBF through 05K13RDA

BE 13.10 Thu 12:00 ZEU 255

Kompakte Combined-Function-Quadrupol-Sextupol-Magnete für die Elektronstrahlführung an einem Laser-Wakefield-Beschleuniger — •Walter Werner, Veronica Afonso Rodriguez, Tilo Baumbach, Robert Rossmanith und Christina Widmann — Karlsruher Institut für Technologie (KIT)

Ein Laser-Wakefield-Beschleuniger (LWFA) erzeugt kurze Elektronenpakete mit einer relativ großen Energiebandbreite und Divergenz. Der Transport von Elektronenpaketen mit diesen Eigenschaften erfordert stark fokussierende Magnete mit chromatischer Korrektur. Für die Realisierung einer kompakten Strahlführung am LWFA in Jena sind Combined-Function-Magnete (CF-Magnete) mit Quadrupol- und Sextupolkomponenten vorgesehen.

Die Realisierung der hohen Quadrupol- und Sextupol-Stärken erfordert kleine magnetische Aperturen. Deshalb werden die Magnete im Vakuum aufgebaut, woraus sich besondere Anforderungen an die Kühlung der Spulen ergeben.

In diesem Vortrag werden Ergebnisse der magnetischen und thermischen Modellierung und Optimierung der CF-Magnete vorgestellt. Zusätzlich werden Tracking-Simulationen zur Untersuchung der Randfeldeffekte sowie der aktuelle Status der Realisierung der Magnete präsentiert.

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BE 13.11 Thu 12:15 ZEU 255

Test und Feldmessung eines vollständigen Kurzmodells eines Transversal-Gradient-Undulators — •Andreas Will, Peter Peiffer, Veronica Afonso Rodriguez, Axel Bernhard, Andreas Grau, Robert Rossmanith, Christina Widmann und Anke-Susanne Müller — Karlsruher Institut für Technologie (KIT)

Mit einem Transversalgradient-Undulator (TGU) ist es möglich, auch mit Elektronenpaketen mit einer relativ breiten Energieverteilung monochromatische Strahlung zu erzeugen. Dabei müssen die Elektronen entlang einer Magnetfeld-Gradientenachse nach ihrer Energie aufgefächert in den Undulator eintreten. Ein zylindrischer Undulator liefert entlang der Symmetrieachse einen passenden Feldgradienten.

Derzeit wird am KIT für den Laser-Wakefield-Beschleuniger am Jenaer Ti:Sa-Laser (JETI) ein zylindrischer TGU entwickelt. Dieser Beitrag zeigt die Ergebnisse der magnetischen Charakterisierung eines vollständigen Kurzmodells (2 Perioden) des zylindrischen, supraleitenden TGU.

Das Projekt wurde teilgefördert durch das BMBF unter Förderkennz. 05K10VK2.