Beam Dynamics In High Energy Particle Accelerators

Beam Dynamics
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Beam Dynamics Problems in a Muon Collider
Beam Dynamics in an Electron Lens with the Warp Particle-in-cell Code
Longitudinal Beam Dynamics and LLRF Requirements for Project X Pulsed Linac
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Quantum Aspects of Beam Physics
Proceedings of the 39th ICFA Advanced Beam Dynamics Woorkshop High Intensity, High Brightness Hadron Beams Tsukuba, Japan, May 29-June 2, 2006
A Modern View
Particle Accelerator Physics
High Energy Polarized Proton Beams
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Volume I and II (study edition)
Control of Beam Dynamics in High Energy Induction Linacs
Analysis and Measurement of Beam Dynamics in H- Charge-exchange Injection
Beam Dynamics Issues of Muon Acceleration in RLA.
An Introduction
New Beam-dynamics Design Procedure for RFQs
The Physics of High Brightness Beams
Introduction to Beam Dynamics in High-Energy Electron Storage Rings
Particle Accelerator Physics: Nonlinear and higher-order beam dynamics
A Contemporary Guide to Beam Dynamics
Particle Accelerator Physics

CANTRELL SILAS

Beam Dynamics World Scientific
This book is devoted to the quickly developing area of high intensity particle beam physics. Beam emittance growth, halo formation and chaotic particle motion are the main areas of research in the new intense particle accelerators. Knowledge of those phenomena is crucial for the design of particle accelerators with space-charge dominated beams. This important book provides a new, self-consistent description of high brightness particle beams with essentially nonlinear space-charge forces. The emphasis is on the proper matching of the beam with focusing and accelerating structures to suppress beam emittance growth and halo formation.The book will be useful for researchers and engineers dealing with space-charge dominated beams and for graduate and undergraduate students who are starting to work in this field.
Quantum Aspects Of Beam Physics - Advanced Icfa Beam Dynamics Workshop World Scientific
This book of proceedings is an up-to-date review of the advances made in the past two decades on the production, control and exploitation of bright electron and light beams for science — in particular, innovative manipulation and control, in linear and circular accelerators, of high brightness charged particle beams. In the conceptual, theoretical and experimental framework of nonlinear beam dynamics and collective cooperative effects, the book provides an update of the state-of-the-art theoretical formulations, techniques and technologies, innovative concepts and scientific results obtained at existing accelerator facilities. Challenges and solutions, proposed or implemented, for the operation of third and fourth generation storage rings as synchrotron radiation sources and circular colliders for high energy particle physics, as well as radiofrequency linear accelerators for Compton/Thomson scattering-based light sources and free electron lasers, are reviewed and discussed. The complementarity between single-pass and recirculating light sources in energy, timing and spectral operational modes also emerges.
Beam Dynamics Problems in a Muon Collider Springer Science & Business Media
This book by Helmut Wiedemann is a well-established, classic text, providing an in-depth and comprehensive introduction to the field of high-energy particle acceleration and beam dynamics. The present 4th edition has been significantly revised, updated and expanded. The newly conceived Part I is an elementary introduction to the subject matter for undergraduate students. Part II gathers the basic tools in preparation of a more advanced treatment, summarizing the essentials of electrostatics and electrodynamics as well as of particle dynamics in electromagnetic fields. Part III is an extensive primer in beam dynamics, followed, in Part IV, by an introduction and description of the main beam parameters and including a new chapter on beam emittance and lattice design. Part V is devoted to the treatment of perturbations in beam dynamics. Part VI then discusses the details of charged particle acceleration. Parts VII and VIII introduce the more advanced topics of coupled beam dynamics and describe very intense beams – a number of additional beam instabilities are introduced and reviewed in this new edition. Part IX is an exhaustive treatment of radiation from accelerated charges and introduces important sources of coherent radiation such as synchrotrons and free-electron lasers. The appendices at the end of the book gather useful mathematical and physical formulae, parameters and units. Solutions to many end-of-chapter problems are given. This textbook is suitable for an intensive two-semester course starting at the senior undergraduate level.
Beam Dynamics in an Electron Lens with the Warp Particle-in-cell Code World Scientific

An electron lens is planned for the Fermilab Integrable Optics Test Accelerator as a nonlinear element for integrable dynamics, as an electron cooler, and as an electron trap to study space-charge compensation in rings. We present the main design principles and constraints for nonlinear integrable optics. A magnetic configuration of the solenoids and of the toroidal section is laid out. Singleparticle tracking is used to optimize the electron path. Electron beam dynamics at high intensity is calculated with a particle-in-cell code to estimate current limits, profile distortions, and the effects on the circulating beam. In the conclusions, we summarize the main findings and list directions for further work.

Longitudinal Beam Dynamics and LLRF Requirements for Project X Pulsed Linac World Scientific

Superconducting linacs are capable of producing intense, ultra-stable, high-quality electron beams that have widespread applications in Science and Industry. Many project are based on the 1.3-GHz TESLA-type superconducting cavity. In this paper we provide an update on a recent experiment aimed at measuring the transfer matrix of a TESLA cavity at the Fermilab Accelerator Science and Technology (FAST) facility. The results are discussed and compared with analytical and numerical simulations.

Introduction to Beam Dynamics in High-Energy Electron Storage Rings World Scientific

The frontiers of beam research point to increasingly high energy, greater brightness and lower emittance beams with ever-increasing particle species. These demands in turn have triggered a rapidly growing number of beam phenomena that involve quantum effects. Concurrently, the violent accelerations which are becoming available through novel accelerator research may, perhaps, help to investigate fundamental physics associated with general relativity. In view of these exciting developments and the important role they may play in the next century, the world's first conference on the "Quantum Aspects of Beam Physics", held at Monterey, California, in January 1998, attracted a broad spectrum of experts from beam physics, particle physics, laser science, astrophysics, condensed matter physics, nuclear and atomic physics. At the end of the meeting, a new term "quantum beam physics" was coined. This book collects together the excellent reviews and papers on new advances in the field which were presented during the workshop. It should be a valuable reference to all physicists interested in the frontiers of quantum beam physics. Contents: Quantum Fluctuations in Beam DynamicsPhoton-Electron Interaction in Beam Production, Cooling, and Monitoring, and Physics of Condensed BeamsBeam Phenomena Under Strong Fields and Fundamental Physics Under Violent AccelerationQuantum Methodology in Beam Physics Readership: Beam physicists and, high energy, nuclear and laser physicists with an interest in the frontiers of beam physics.

Physics Of Intense Charged Particle Beams In High Energy Accelerators Morgan & Claypool Publishers

We had carried out a design of an ultimate storage ring with beam emittance less than 10 picometer for the feasibility of coherent light source at X-ray wavelength. The accelerator has an inherent small dynamic aperture. We study method to improve the dynamic aperture and collective instability for an ultimate storage ring. Beam measurement and accelerator modeling are an integral part of accelerator physics. We develop the independent component analysis (ICA) and the orbit response matrix method for improving accelerator reliability and performance. In collaboration with scientists in National Laboratories, we also carry out experimental and theoretical studies on beam dynamics. Our proposed research topics are relevant to nuclear and particle physics using high brightness particle and photon beams.

Future Perspectives In High Energy Physics - Proceedings Of The 1990 Icfa Seminars Springer Science & Business Media

Electron storage rings play a crucial role in many areas of modern scientific research. Introduction to Beam Dynamics in High-Energy Electron Storage Rings describes the physics of particle behaviour in these machines. Starting with an outline of the history, uses and structure of electron storage rings, the book develops the foundations of beam dynamics, covering particle motion in the components used to guide and focus the beams, the effects of synchrotron radiation, and the impact of interactions between the particles in the beams.

The Joint 28th ICFA Advanced Beam Dynamics and Advanced & Novel Accelerators Workshop, Hiroshima, Japan, 7-11 January 2003 World Scientific

The application horizon of particle accelerators has been widening significantly in recent decades. Where large accelerators have traditionally been the tools of the trade for high-energy nuclear and particle physics, applications in the last decade have grown to include large-scale accelerators like synchrotron light sources and spallation neutron sources. Applications like generation of rare isotopes, transmutation of nuclear reactor waste, sub-critical nuclear power, generation of neutrino beams etc. are next area of investigation for accelerator scientific community all over the world. Such applications require high beam power in the range of few mega-watts (MW). One such high intensity proton beam facility is proposed at Fermilab, Batavia, US, named as Project-X. Project-X facility is based on H- linear accelerator (linac), which will operate in continuous wave (CW) mode and accelerate H- ion beam with average current of 1 mA from kinetic energy of 2.5 MeV to 3 GeV to deliver 3MW beam power. One of the most challenging tasks of the Project-X facility is to have a robust design of the CW linac which can provide high quality beam to several experiments simultaneously. Hence a careful design of linac is important to achieve this objective.

Design and Beam Dynamics Issues of the JHF Synchrotrons Morgan & Claypool Publishers

The Advent of laser-ion-guiding in the Advanced test Accelerator along with the development of accelerator cavities optimized with respect to beam breakup coupling impedence now make it possible to consider a new class of high current, high emergy linear induction accelerators. The control of the beam breakup and other instabilities by laser guiding and by various magnetic focusing schemes will be discussed along with the scaling laws for the design of such machines to minimize the growth of the beam breakup instability. Many linacs, particularly induction linacs are limited in performance by the beam breakup (BBU) instability. The instability is found in two forms. In the first form the accelerating cavities communicate with one another through interaction with the beam and through propagation of cavity fields through the accelerator structure. In the second form which is the more virulent of the two, the cavities couple to each other only through their interactions with the beam. It is this second form of PPU that will be discussed in this paper.

SciDAC Advances in Beam Dynamics Simulation World Scientific Publishing Company

Electron storage rings play a crucial role in many areas of modern scientific research. In light sources, they provide intense beams of x-rays that can be used to understand the structure and behavior of materials at the atomic scale, with applications to medicine, the life sciences, condensed matter physics, engineering, and technology. In particle colliders, electron storage rings allow experiments that probe the laws of nature at the most fundamental level. Understanding and controlling the behavior of the beams of particles in storage rings is essential for the design, construction, and operation of light sources and colliders aimed at reaching increasingly demanding performance specifications. Introduction to Beam Dynamics in High-Energy Electron Storage Rings describes the physics of particle behavior in these machines. Starting with an outline of the history, uses, and structure of electron storage rings, the book develops the foundations of beam dynamics, covering particle motion in the components used to guide and focus the beams, the effects of synchrotron radiation, and the impact of interactions between the particles in the beams. The aim is to emphasize the physics behind key phenomena, keeping mathematical derivations to a minimum: numerous references are provided for those interested in learning more. The text includes discussion of issues relevant to machine design and operation and concludes with a brief discussion of some more advanced topics, relevant in some special situations, and a glimpse of current research aiming to develop the "ultimate" storage rings.

Basic Principles and Linear Beam Dynamics Springer

Particle Accelerator Physics is designed to serve as an introduction to the field of high-energy particle accelerator physics and particle-beam dynamics. It covers the dynamics of relativistic particle beams, basics of particle guidance and focusing, lattice design, characteristics of beam transport systems and circular accelerators. Particle-beam optics is treated in the linear approximation including sextupoles to correct for chromatic aberrations. Perturbations to linear beam dynamics are analyzed in detail and correction measures are discussed. Basic lattice design features and building blocks leading to the design of more complicated beam transport systems and circular accelerators are studied. Characteristics of synchrotron radiation and quantum effects due to the statistical emission of photons on particle trajectories are derived and applied to determine particle-beam parameters. The discussions specifically concentrate on relativistic particle beams and the physics of beam optics in beam transport systems and circular accelerators such as synchrotrons and storage rings. This book is aimed at students and scientists who are interested in an introduction to particle-beam optics and accelerator physics. It provides a general understanding of particle-beam physics and forms a broad basis for further, more detailed studies of nonlinear beam dynamics and associated accelerator physics problems to be discussed in a subsequent volume.

Beam Dynamics in Heavy Ion Fusion CRC Press

Research and development of high energy accelerators began in 1911. Since then, milestones achieved are: (1) development of high gradient dc and rf accelerators,(2) achievement of high field magnets with excellent field quality,(3) discovery of transverse and longitudinal beam focusing principles,(4) invention of high power rf sources,(5) improvement of ultra-high vacuum technology,(6) attainment of high brightness (polarized/unpolarized) electron/ionsources,(7) advancement of beam dynamics and beam manipulation schemes, such as beam injection, accumulation, slow and fast extraction, beam damping and beam cooling, instability feedback, laser-beam interaction and harvesting instability for high brilliance coherent photon source. The impacts of the accelerator development are evidenced by the many ground-breaking discoveries in particle and nuclear physics, atomic and molecular physics, condensed matter physics, biology, biomedical physics, nuclear medicine, medical therapy, and industrial processing. This book is intended to be used as a graduate or senior undergraduate textbook in accelerator physics and science. It can be used as preparatory course material in graduate accelerator physics thesis research. The text covers historical accelerator development, transverse betatron motion, synchrotron motion, an introduction to linear accelerators, and synchrotron radiation phenomena in low emittance electron storage rings, introduction to special topics such as the free electron laser and the beam-beam interaction. Attention is paid to derivation of the action-angle variables of the phase space, because the transformation is important for understanding advanced topics such as the collective instability and nonlinear beam dynamics. Each section is followed by exercises, which are designed to reinforce concepts and to solve realistic accelerator design problems. Contents:Introduction:Historical DevelopmentsLayout and Components of AcceleratorsAccelerator ApplicationsTransverse Motion:Hamiltonian for Particle Motion in AcceleratorsLinear Betatron MotionEffect of Linear Magnet ImperfectionsOff-Momentum OrbitChromatic AberrationLinear CouplingNonlinear ResonancesCollective Instability and Landau DampingSynchro-Betatron HamiltonianSynchrotron Motion:Longitudinal Equation of MotionAdiabatic Synchrotron MotionRF Phase and Voltage ModulationsNonadiabatic and Nonlinear Synchrotron MotionBeam Manipulation in Synchrotron Phase SpaceFundamentals of RF SystemsLongitudinal Collective InstabilitiesIntroduction to Linear AcceleratorsPhysics of Electron Storage Rings:Fields of a Moving Charged ParticleRadiation Damping and ExcitationEmittance in Electron Storage RingsSpecial Topics in Beam Physics:Free Electron Laser (FEL)Beam-Beam InteractionClassical Mechanics and Analysis:Hamiltonian DynamicsStochastic Beam DynamicsModel Independent AnalysisNumerical Methods and Physical Constants:Fourier TransformCauchy Theorem and the Dispersion RelationUseful Handy FormulasMaxwell's EquationsPhysical Properties and Constants Readership: Accelerator, high-energy, nuclear, plasma and applied physicists.

Beam-dynamics Calculations Including Magnetic Field Measurements for the High-energy Storage Ring (HESR) at FAIR Springer Science & Business Media

Electron lenses are a mature technique for beam manipulation in colliders and storage rings. In an electron lens, a pulsed, magnetically confined electron beam with a given current-density profile interacts with the circulating beam to obtain the desired effect. Electron lenses were used in the Fermilab Tevatron collider for beam-beam compensation, for abort-gap clearing, and for halo scraping. They will be used in RHIC at BNL for head-on beam-beam compensation, and their application to the Large Hadron Collider for halo control is under development. At Fermilab, electron lenses will be implemented as lattice elements for nonlinear integrable optics. The design of electron lenses requires tools to calculate the kicks and wakefields experienced by the circulating beam. We use the Warp particle-in-cell code to study generation, transport, and evolution of the electron beam. For the first time, a fully 3-dimensional code is used for this purpose.

Accelerator Physics Morgan & Claypool

Particle accelerators are essential tools for scientific research in fields as diverse as high energy physics, materials science and structural biology. They are also widely used in industry and medicine. Producing the optimum design and achieving the best performance for an accelerator depends on a detailed understanding of many (often complex and sometimes subtle) effects that determine the properties and behavior of the particle beam. Beam Dynamics in High Energy Particle Accelerators provides an introduction to the concepts underlying accelerator beam line design and analysis, taking an approach that emphasizes the elegance of the subject and leads into the development of a range of powerful techniques for understanding and modeling charged particle beams. Contents:Electromagnetism and Classical Mechanics:Electromagnetic Fields in Accelerator ComponentsHamiltonian for a Particle in an Accelerator Beam LineSingle-Particle

Linear Dynamics:Linear Transfer Maps for Common ComponentsLinear Optics in Uncoupled Beam LinesCoupled OpticsLinear Imperfections in Storage RingsEffects of Synchrotron RadiationSingle-Particle Nonlinear Dynamics:Examples of Nonlinear Effects in Accelerator Beam LinesRepresentations of Transfer MapsSymplectic IntegratorsMethods for Analysis of Single-Particle DynamicsCollective Effects:Space ChargeScattering EffectsWake Fields, Wake Functions and ImpedanceCoherent Instabilities Readership: Undergraduate students who are looking for an introduction to beam dynamics, and graduate students and researchers in the field. Key Features:Basic ideas are introduced from the start using an approach that leads logically into the development of more advanced concepts and techniques. In particular, linear dynamics is treated consistently using a Hamiltonian formalism, which provides a suitable foundation not only for perturbation theory, but also for more modern techniques based on Lie operators. The use of a consistent approach makes the progress from introductory to advanced material as straightforward as possibleThe treatment of nonlinear dynamics using Lie operators provides a number of powerful techniques for the analysis of accelerator beam lines. Lie operators are generally found only in more advanced and specialized treatments of nonlinear dynamics. Beam Dynamics in High Energy Particle Accelerators provides an accessible introduction to the subject, and illustrates the use of techniques such as Lie transforms and normal form analysis through examples of particular relevance for beam dynamicsAs well as providing a clear description of the important topics in beam dynamics and an explanation of the physical principles, attention is given to techniques of particular importance for computer modeling of beam dynamics. For example, there is a chapter on symplectic integration that gives explicit formulae for methods that are of some importance in accelerator modeling codes, but have not previously been presented in a book of this kindKeywords:Accelerator Physics;Beam Dynamics;Particle AcceleratorsReviews: “This is a recommendable addition to the literature, covering its topics clearly and thoroughly.” CERN Courier

Field Calculations, Single-particle Tracking, and Beam Dynamics with Space Charge in the Electron Lens for the Fermilab Integrable Optics Test Accelerator Beam Dynamics in High Energy Particle Accelerators

In this second edition of Particle Accelerator Physics, Vol. 1, is mainly a reprint of the first edition without significant changes in content. The bibliography has been updated to include more recent progress in the field of particle accelerators. With the help of many observant readers a number of misprints and errors could be eliminated. The author would like to express his sincere appreciation to all those who have pointed out such shortcomings and wel comes such information and any other relevant information in the future. The author would also like to express his special thanks to the editor Dr. Helmut Lotsch and his staff for editorial as well as technical advice and support which contributed greatly to the broad acceptance of this text and made a second edition of both volumes necessary. Palo Alto, California Helmut Wiedemann November 1998 VII Preface to the First Edition The purpose of this textbook is to provide a comprehensive introduction into the physics of particle accelerators and particle beam dynamics. Parti cle accelerators have become important research tools in high energy physics as well as sources of incoherent and coherent radiation from the far infra red to hard x-rays for basic and applied research. During years of teaching accelerator physics it became clear that the single most annoying obstacle to get introduced into the field is the absence of a suitable textbook.

Beam Dynamics in High Energy Particle Accelerators Springer

This book provides an in-depth and comprehensive introduction to the field of high-energy particle acceleration and beam dynamics. This is the first modern and comprehensive textbook in the field. It begins by gathering the basic tools, recalling the essentials of electrostatics and electrodynamics as well as of particle dynamics in electromagnetic fields. It includes coverage of advanced topics of coupled beam dynamics. There is an exhaustive treatment of radiation from accelerated charges. Appendices gather useful mathematical and physical formulae, parameters and units, and solutions to the many end-of-chapter problems are given.

Particle Accelerator Physics I World Scientific

This two-volume book serves as a thorough introduction to the field of high-energy particle accelerator physics and beam dynamics. Volume 1 provides a general understanding of the field and a firm basis for the study of the more elaborate topic, mainly nonlinear and higher-order beam dynamics, which is the subject of Volume 2.

Collective Effects in Short Bunches

Physics of Intense Charged Particle Beams in High Energy Accelerators is a graduate-level text — complete with 75 assigned problems — which covers a broad range of topics related to the fundamental properties of collective processes and nonlinear dynamics of intense charged particle beams in periodic focusing accelerators and transport systems. The subject matter is treated systematically from first principles, using a unified theoretical approach, and the emphasis is on the development of basic concepts that illustrate the underlying physical processes in circumstances where intense self fields play a major role in determining the evolution of the system. The theoretical analysis includes the full influence of dc space charge and intense self-field effects on detailed equilibrium, stability and transport properties, and is valid over a wide range of system parameters ranging from moderate-intensity, moderate-emittance beams to very-high-intensity, low-emittance beams. This is particularly important at the high beam intensities envisioned for present and next generation accelerators, colliders and transport systems for high energy and nuclear physics applications and for heavy ion fusion. The statistical models used to describe the properties of intense charged particle beams are based on the Vlasov-Maxwell equations, the macroscopic fluid-Maxwell equations, or the Klimontovich-Maxwell equations, as appropriate, and extensive use is made of theoretical techniques developed in the description of one-component nonneutral plasmas, and multispecies electrically-neutral plasmas, as well as established techniques in accelerator physics, classical mechanics, electrodynamics and statistical physics.Physics of Intense Charged Particle Beams in High Energy Accelerators emphasizes basic physics principles, and the thorough presentation style is intended to have a lasting appeal to graduate students and researchers alike. Because of the advanced theoretical techniques developed for describing one-component charged particle systems, a useful companion volume to this book is Physics of Nonneutral Plasmas by Ronald C Davidson./a

Beam Dynamics Studies and the Design, Fabrication and Testing of Superconducting Radiofrequency Cavity for High Intensity Proton Accelerator

A standard design for heavy ion fusion drivers under study in the US is an induction linac with electrostatic focusing at low energy and magnetic focusing at higher energy. The need to focus the intense beam to a few-millimeter size spot at the deuterium-tritium target establishes the emittance budget for the accelerator. Economic and technological considerations favor a larger number of beams in the low-energy, electrostatic-focusing section than in the high-energy, magnetic-focusing section. Combining four beams into a single focusing channel is a viable option, depending on the growth in emittance due to the combining process. Several significant beam dynamics issues that are, or have been, under active study are discussed: large space charge and image forces, beam wall clearances, halos, alignment, longitudinal instability, and bunch length control.