Particle Accelerators Colliders And The Story Of High Energy Physics Charming The Cosmic Snake

The Proceedings contains 1261 papers presented at PAC'97, held in Vancouver in May, 1997. With one third of the 1221 delegates coming from 23 countries outside North America, these papers present a comprehensive picture of accelerator science, technology and applications worldwide. Highlights include the initial operation of the SPring-8 light source, the PEP-II B-factory high-energy ring, the CERN LEP2 collider, and one sextant of RHIC. Construction reports range from the CERN Large Hadron Collider and the Fermilab Main Injector and Recycler, to the BESSY-II light source and the TRIUMF-ISAC radioactive beam facility. Upcoming projects described include the US Spallation Neutron Source, the Japanese Hadron Facility and the RIKEN Beam Factory. Important progress is reported on advanced accelerators - linear colliders, muon colliders and laser accelerators - and on pulsed-power and high-intensity beams. There are also details. of interesting advances on superconducting rf and magnets, ion sources and electron guns, controls, instrumentation, and other technology. Free-electron lasers now offer novel photon beams for users, while the standard industrial and medical applications have been joined by new schemes for contraband detection and proton radiography.

Awarded one of BookAuthority's best new Particle Physics books in 2019! Hands-On Accelerator Physics Using MATLAB® provides an introduction into the design and operational issues of a wide range of particle accelerators, from ion-implanters to the Large Hadron Collider at CERN. Many aspects from the design of beam optical systems and magnets, to the subsystems for acceleration, beam diagnostics, and vacuum are covered. Beam dynamics topics ranging from the beam-beam interaction to free-electron lasers are discussed. Theoretical concepts and the design of key components are explained with the help of MATLAB® code. Practical topics, such as beam size measurements, magnet construction and measurements, and radio-frequency measurements are explored in student labs without requiring access to an accelerator. This unique approach provides a look at what goes on 'under the hood' inside modern accelerators and presents readers with the tools to perform their independent investigations on the computer or in student labs. This book will be of interest to graduate students, postgraduate researchers studying accelerator physics, as well as engineers entering the field. Features: Provides insights into both synchrotron light sources and colliders Discusses technical subsystems, including magnets, radio-frequency engineering, instrumentation and diagnostics, correction of imperfections, control, and cryogenics Accompanied by MATLAB® code, including a 3D-modeler to visualize the accelerators, and additional appendices which are available on the CRC Press website

How does a particle accelerator work? The most direct and intuitive answer focuses on the dynamics of single particles as they travel through an accelerator. Particle accelerators are becoming ever more sophisticated and diverse, from the Large Hadron Collider (LHC) at CERN to multi-MW linear accelerators and small medical synchrotrons. This self-contained book presents a pedagogical account of the important field of accelerator physics, which has grown rapidly since its inception in the latter half of the last century. Key topics covered include the physics of particle acceleration, collision and beam dynamics, and the engineering considerations intrinsic to the effective construction and operation of particle accelerators. By drawing direct connections between accelerator technology and the parallel development of computational capability, this book offers an accessible introduction to this exciting field at a level appropriate for advanced undergraduate and graduate students, accelerator scientists, and engineers.

Particle Accelerator Physics 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, while 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 forms a broad basis for further, more detailed studies of nonlinear beam dynamics and associated accelerator physics problems, discussed in the subsequent volume.

This book takes the readers through the science behind particle accelerators, colliders and detectors: the physics principles that each stage of the development of particle accelerators helped to reveal, and the particles they helped to discover. The book culminates with a description of the Large Hadron Collider, one of the world’s largest and most complex machines operating in a 27-km circumference tunnel near Geneva. The book provides the material honestly without misrepresenting the science for the sake of excitement or glossing over difficult notions. The principles behind each type of accelerator is made accessible to the undergraduate student and even to a lay reader with cartoons, illustrations and metaphors. Simultaneously, the book also caters to different levels of reader’s background and provides additional materials for the more interested or diligent reader.

Modern particle accelerators and storage rings, whether used for high-energy physics, synchrotron light sources, or other purposes, require particle beams with the highest possible intensity. In order to achieve this maximum performance, a good understanding of the interaction of the charged particle beams with the surrounding vacuum chamber and other accelerator components is necessary. In the frequency domain, this interaction can be described by impedances, and equivalently by wake fields in the time domain. These need to be known to estimate the thresholds of coherent instabilities, or other collective effects, which limit the achievable beam current. Such considerations have to be taken into account already during the design of such machines, as they limit the choice of materials and the shapes of components required for their operations. The book explains the basic concepts, and the methods which have been used to calculate impedances and wakes. The emphasis is on circular particle accelerators and storage rings, with which the authors are more familiar, but many of these concepts are equally useful in linear accelerators or colliders. Without any pretense of completeness, the most important accelerator components, such as vacuum chambers with bellows and pumping ports, RF and other cavities, single steps, irises and collimators, etc. are described in specialised chapters. Also limitations and restrictions of the impedance and wake field descriptions are discussed. The book is mainly written for physicists working with or on particle accelerators or storage rings, and who want to understand the methods which have been used for such calculations.

This Seminar has been organized in Erice, in the frame of the Eloisatron project activities, with the special purpose of bringing together an interdisciplinary group of distinguished physicists with prominent interest in the development of the accelerators. Listening to the invited lectures, examining the new topics and reviewing ideas for the acceleration of particles to energies beyond those attainable in machines whose construction is under way or is now contemplated are all important moments of this Seminar that will offer to the Italian Physicists a very important opening over the scenario of the accelerators. In connection with the Eloisatron project developments future Workshop-

Seminars are now envisioned, each one aimed to a very specific topic in the field of the particle accelerators. The Editors v CONTENTS Overview of Linear Collider Studies ... -. ... K. Johnsen Principles of Beat-Wave Accelerators ... ... 15 U. de Angelis, R. Fedele and V.G. Vaccaro Wake Field Acceleration. ... ... 29 W. Bialowons, H.D. Bremer, F. -J. Decker, M. v. Hartrott, H.C. Lewin, G. -A. Voss, T. Weiland, P. Wilhelm, Xiao Chengde and K. Yokoya Energy Efficiency and Choice of Parameters for Linear Colliders ... 45 J. Clauss A Two-Stage RF Linear Colliders using a Superconducting Drive Linac ... -. ... -. ... . . -. ... -- 67 \~. Schne 11 The Micro Lasertron. An Efficient Switched-Power Source of mm Wave 1 ength Radi at ion --. -. . -. ... . -. -. . . -. . . -. 89 R.B. Palmer Collider Scaling and Cost Estimation ... ... -- 105 R.B.
The first edition of Engines of Discovery celebrated in words, images and anecdotes the accelerators and their constructors that culminated in the discovery of the Higgs boson. But even before the Higgs was discovered, before the champagne corks popped and while the television producers brushed up their quantum mechanics, a new wave of enthusiasm for accelerators to be applied for more practical purposes was gaining momentum. Almost all fields of human endeavour will be enhanced by this trend: energy conservation, medical diagnostics and treatment, national security, as well as industrial processing. Accelerators have been used most spectacularly to reveal the structure of the complex molecules that determine our metabolism and life. For every accelerator chasing the Higgs, there are now ten thousand serving other purposes. It is high time to move from abstract mathematics and philosophy to the practical needs of humankind. It is the aim of this revised and expanded edition to describe this revolution in a manner which will attract the young, not only to apply their curiosity to the building blocks of matter but to help them contribute to the improvement of the quality of life itself on this planet. As always, the authors have tried to avoid lengthy mathematical description. In describing a field which reaches out to almost all of today's cutting edge technology, some detailed explanation cannot be avoided but this has been confined to sidebars. References guide experts to move on to the journal Reviews of Accelerator Science and Technology and other publications for more information. But first we would urge every young physicist, teacher, journalist and politician to read this book. Contents: Electrostatic Accelerators; Cyclotrons; Linear Accelerators; Betatrons; Synchrotrons; Colliders; Neutrino Super Beams, Neutrino Factories and Muon Colliders; Detectors; High-Energy and Nuclear Physics; Synchrotron Radiation Sources; Isotope Production and Cancer Therapy Accelerators; Spallation Neutron Sources; Accelerators in Industry and Elsewhere; National Security; Energy and the Environment; A Final Word OCo Mainly to the Young. Readership: Scientists, research physicists, engineers and administrators at accelerator laboratories; general readers; undergraduates and graduates in physics, electrical engineering and the history of science."
There has been a great progress in development of high power laser technology. Harnessing their potential for particle accelerators is a challenge and of great interest for development of future high energy colliders. The author discusses some of the advances and new methods of acceleration including plasma-based accelerators. The exponential increase in sophistication and power of all aspects of accelerator development and operation that has been demonstrated has been remarkable. This success has been driven by the inherent interest to gain new and deeper understanding of the universe around us. With the limitations of the conventional technology it may not be possible to meet the requirements of the future accelerators with demands for higher and higher energies and luminosities. It is believed that using the existing technology one can build a linear collider with about 1 TeV center of mass energy. However, it would be very difficult (or impossible) to build linear colliders with energies much above one or two TeV without a new method of acceleration. Laser driven high gradient accelerators are becoming more realistic and is expected to provide an alternative, (more compact, and more economical), to conventional accelerators in the future. The author discusses some of the new methods of particle acceleration, including laser and particle beam driven plasma based

accelerators, near and far field accelerators. He also discusses the enhanced IFEL (Inverse Free Electron Laser) and NAIBEA (Nonlinear Amplification of Inverse-Beamstrahlung Electron Acceleration) schemes, laser driven photo-injector and the high energy physics requirements.

An accessible look at the hottest topic in physics and the experiments that will transform our understanding of the universe The biggest news in science today is the Large Hadron Collider, the world's largest and most powerful particle-smasher, and the anticipation of finally discovering the Higgs boson particle. But what is the Higgs boson and why is it often referred to as the God Particle? Why are the Higgs and the LHC so important? Getting a handle on the science behind the LHC can be difficult for anyone without an advanced degree in particle physics, but you don't need to go back to school to learn about it. In Collider, award-winning physicist Paul Halpern provides you with the tools you need to understand what the LHC is and what it hopes to discover. Comprehensive, accessible guide to the theory, history, and science behind experimental high-energy physics Explains why particle physics could well be on the verge of some of its greatest breakthroughs, changing what we think we know about quarks, string theory, dark matter, dark energy, and the fundamentals of modern physics Tells you why the theoretical Higgs boson is often referred to as the God particle and how its discovery could change our understanding of the universe Clearly explains why fears that the LHC could create a miniature black hole that could swallow up the Earth amount to a tempest in a very tiny teapot "Best of 2009 Sci-Tech Books (Physics)"-Library Journal "Halpern makes the search for mysterious particles pertinent and exciting by explaining clearly what we don't know about the universe, and offering a hopeful outlook for future research."-Publishers Weekly Includes a new author preface, "The Fate of the Large Hadron Collider and the Future of High-Energy Physics" The world will not come to an end any time soon, but we may learn a lot more about it in the blink of an eye. Read Collider and find out what, when, and how.

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

Accelerator technology has advanced tremendously since the introduction of accelerators in the 1930s, and particle accelerators have become indispensable instruments in high energy physics (HEP) research to probe Nature at smaller and smaller distances. At present, accelerator facilities can be classified into Energy Frontier colliders that enable direct discoveries and studies of high mass scale particles and Intensity Frontier accelerators for exploration of extremely rare processes, usually at relatively low energies. The near term strategies of the global energy frontier particle physics community are centered on fully exploiting the physics potential of the Large Hadron Collider (LHC) at CERN through its high-luminosity upgrade (HL-LHC), while the intensity frontier HEP research is focused on studies of neutrinos at the MW-scale beam power accelerator facilities, such as Fermilab Main Injector with the planned PIP-II SRF linac project. A number of next generation accelerator facilities have been proposed and are currently under consideration for the medium- and long-term future programs of accelerator-based HEP research. In this paper, we briefly review the post-LHC energy frontier options, both for lepton and hadron colliders in various regions of the world, as well as possible future intensity frontier accelerator facilities.

This third open access volume of the handbook series deals with accelerator physics, design, technology and operations, as well as with beam optics, dynamics and diagnostics. A joint CERN-Springer initiative, the "Particle Physics Reference Library" provides revised and updated contributions based on previously published material in the well-known Landolt-Boernstein series on particle physics, accelerators and detectors (volumes 21A,B1,B2,C), which took stock of the field approximately one decade ago. Central to this new initiative is publication under full open access.

Since the mid-twentieth century, accelerators and colliders have been at the forefront of science and technology in the fields of space, medicine, energy, and others. This book presents sophisticated knowledge about accelerators and colliders and their crucial technological applications. With six chapters, the book presents information about currently available accelerators and colliders as well as novel schemes for future systems. Other topics covered include vacuum systems, elementary particles, and quantum chromodynamics.

From the linear accelerators used for cancer therapy in hospitals, to the giant atom smashers at international laboratories, this book provides a simple introduction to particle accelerators.

The Science and Technology of Particle Accelerators provides an accessible introduction to the field, and is suitable for advanced undergraduates, graduate students, and academics, as well as professionals in national laboratories and facilities, industry, and medicine who are designing or using particle accelerators. Providing integrated coverage of accelerator science and technology, this book presents the fundamental concepts alongside detailed engineering discussions and extensive practical guidance, including many numerical examples. For each topic, the authors provide a description of the physical principles, a guide to the practical application of those principles, and a discussion of how to design the components that allow the application to be realised. Features: Written by an interdisciplinary and highly respected team of physicists and engineers from the Cockcroft Institute of Accelerator Science and Technology in the UK Accessible style, with many numerical examples Contains an extensive set of problems, with fully worked solutions available Rob Appleby is an academic member of staff at the University of Manchester, and Chief Examiner in the Department of Physics and Astronomy. Graeme Burt is an academic member of staff at the University of Lancaster, and previous Director of Education at the Cockcroft Institute. James Clarke is head of Science Division in the

Accelerator Science and Technology Centre at STFC Daresbury Laboratory. Hywel Owen is an academic member of staff at the University of Manchester, and Director of Education at the Cockcroft Institute. All authors are researchers within the Cockcroft Institute of Accelerator Science and Technology and have extensive experience in the design and construction of particle accelerators, including particle colliders, synchrotron radiation sources, free electron lasers, and medical and industrial accelerator systems.

The purpose of the proceedings of the Accelerator Schools is to introduce CERN- and US-students to advanced ideas and concepts from the frontiers of the rapidly developing field of accelerator physics and technology. Considerable emphasis is put on understanding the rich variety of mechanisms at work in a charged particle beam determining its behaviour. The subjects range from the very topical problem of dynamic aperture, which is of interest for predicting the stability of particles in the new machines such as SSC and LEP, through some better known subjects such as coherent and incoherent radiation, which is of increasing importance as a tool for industry and basic research in other disciplines, to the very latest and most exotic discovery of crystal beams, which is as yet in the totally academic phase of its development. This central theme of the internal physics of beams has been supplemented by lectures on the coming generation of linear colliders, the status of the superconducting project CEBAF, and on other topics.

This book is an introductory course to accelerator physics at the level of graduate students. It has been written for a large audience which includes users of accelerator facilities, accelerator physicists and engineers, and undergraduates aiming to learn the basic principles of construction, operation and applications of accelerators.The new concepts of dynamical systems developed in the last twenty years give the theoretical setting to analyse the stability of particle beams in accelerator. In this book a common language to both accelerator physics and dynamical systems is integrated and developed, aiming to eliminate the difficulties faced by accelerator physicists, engineers and applied mathematicians when they try to join efforts in the attempt to control the nonlinearities disturbing particle beams.

Modern particle accelerators and storage rings, whether used for high-energy physics, synchrotron light sources, or other purposes, require particle beams with the highest possible intensity. In order to achieve this maximum performance, a good understanding of the interaction of the charged particle beams with the surrounding vacuum chamber and other accelerator components is necessary. In the frequency domain, this interaction can be described by impedances, and equivalently by wake fields in the time domain. These need to be known to estimate the thresholds of coherent instabilities, or other collective effects, which limit the achievable beam current. Such considerations have to be taken into account already during the design of such machines, as they limit the choice of materials and the shapes of components required for their operations. The book explains the basic concepts, and the methods which have been used to calculate impedances and wakes. The emphasis is on circular particle accelerators and storage rings, with which the authors are more familiar, but many of these concepts are equally useful in linear accelerators or colliders. Without any pretense of completeness, the most important accelerator components, such as vacuum chambers with bellows and pumping ports, RF and other cavities, single steps, irises and collimators, etc. are described in specialised chapters. Also limitations and restrictions of the impedance and wake field descriptions are discussed. The book is mainly written for physicists working with or on particle accelerators or storage rings, and who want to understand the methods which have been used for such calculations. Contents:Calculation of EM FieldsWake Functions and Wake PotentialsCoupling ImpedancesLoss Factors and Effective ImpedancesUniform Cylindrical PipesPerturbation MethodsField Matching TechniquesIntegral Equation Methods and Diffraction TheoryRadiation Impedance and Curvature EffectsModels and Measurements of ImpedanceAccelerator Structures Readership: High energy physicists. keywords:Particle Accelerators;High-Energy Storage Rings;Charged Particle Beams;Coupling Impedances;Effective Impedances;Wake Functions;Effective Impedances;(Beam) Loss Factors;(Beam) Kick Factors;Broad-Band Resonator Model;Resistive Wall Effect

Historically, progress in particle physics has largely beendetermined by development of more capable particle accelerators. Thistrend continues today with the recent advent of high-luminosityelectron-positron colliders at KEK and SLAC operating as "B factories, "the imminent commissioning of the Large Hadron Collider at CERN, and theworldwide development effort toward the International Linear Collider. Looking to the future, one of the most promising approaches is thedevelopment of muon-beam accelerators. Such machines have very highscientific potential, and would substantially advance thestate-of-the-art in accelerator design. A 20-50 GeV muon storage ringcould serve as a copious source of well-characterized electron neutrinosor antineutrinos (a Neutrino Factory), providing beams aimed at detectorslocated 3000-7500 km from the ring. Such long baseline experiments areexpected to be able to observe and characterize the phenomenon ofcharge-conjugation-parity (CP) violation in the lepton sector, and thusprovide an answer to one of the most fundamental questions in science, namely, why the matter-dominated universe in which we reside exists atall. By accelerating muons to even higher energies of several TeV, we canenvision a Muon Collider. In contrast with composite particles likeprotons, muons are point particles. This means that the full collisionenergy is available to create new particles. A Muon Collider has roughlyten times the energy reach of a proton collider at the same collisionenergy, and has a much smaller footprint. Indeed, an energy frontier MuonCollider could fit on the site of an existing laboratory, such asFermilab or BNL. The challenges of muon-beam accelerators are related tothe facts that i) muons are produced as a tertiary beam, with very large6D phase space, and ii) muons are unstable, with a lifetime at rest ofonly 2 microseconds. How these challenges are accommodated in theaccelerator design will be described. Both a Neutrino Factory and a MuonCollider require large numbers of challenging superconducting magnets, including large aperture solenoids, closely spaced solenoids withopposing fields, shielded solenoids, very high field (~;40-50 T)solenoids, and storage ring magnets with a room-temperature midplanesection. Uses for the various magnets will be outlined, along withR & D plans to develop these and other required components of suchmachines.

The purpose of these lectures is to convey an understanding of how particle accelerators work and why they look the way they do. The approach taken is physically intuitive rather than mathematically rigorous. The emphasis is on the description of proton circular accelerators and colliders. Linear accelerators are mentioned only in passing as sources of protons for higher energy rings. Electron accelerators/storage rings and antiproton sources are discussed only by way of brief descriptions of the features which distinguish them from proton accelerators. The basics of how generic accelerators work are discussed, focusing on descriptions of what sets the overall scale, single particle dynamics and stability, and descriptions of the phase space of the particle beam, the information thus presented is then used to go through the exercise of designing a Superconducting Super Collider. (LEW).

After a historical consideration of the types and evolution of accelerators the physics of particle beams is provided in detail. Topics dealt with comprise linear and nonlinear beam dynamics, collective phenomena in beams, and interactions of beams with the surroundings. The design and principles of synchrotrons, circular and linear colliders, and of linear accelerators are discussed next. Also technological aspects of accelerators (magnets, RF cavities, cryogenics, power supply, vacuum, beam instrumentation, injection and extraction) are reviewed, as well as accelerator operation (parameter control, beam feedback system, orbit correction, luminosity optimization). After introducing the largest accelerators and colliders of their times the application of accelerators and storage rings in industry, medicine, basic science, and energy research is discussed, including also synchrotron radiation sources and spallation sources. Finally, cosmic accelerators and an outlook for the future are given.

High energy physics, perhaps more than any other branch of science, is driven by technology. It is not the development of theory, or consideration of what measurements to make, which are the driving elements in our science. Rather it is the development of new technology which is the pacing item. Thus it is the development of new techniques, new computers, and new materials which allows one to develop new detectors and new particle-handling devices. It is the latter, the accelerators, which are at the heart of the science. Without particle accelerators there would be, essentially, no high energy physics. In fact. the advances in high energy physics can be directly tied to the advances in particle accelerators. Looking terribly briefly, and restricting one's self to recent history, the Bevatron made possible the discovery of the anti-proton and many of the resonances, on the AGS was found the [mu]-neutrino, the J-particle and time reversal non-invariance, on Spear was found the [psi]-particle, and, within the last year the Z0 and W{sup {+-}} were seen on the CERN SPS p-{bar p} collider. Of course one could, and should, go on in much more detail with this survey, but I think there is no need. It is clear that as better acceleration techniques were developed more and more powerful machines were built which, as a result, allowed high energy physics to advance. What are these techniques? They are very sophisticated and ever-developing. The science is very extensive and many individuals devote their whole lives to accelerator physics. As high energy experimental physicists your professional lives will be dominated by the performance

of 'the machine'; i.e. the accelerator. Primarily you will be frustrated by the fact that it doesn't perform better. Why not? In these lectures, six in all, you should receive some appreciation of accelerator physics. We cannot, nor do we attempt, to make you into accelerator physicists, but we do hope to give you some insight into the machines with which you will be involved in the years to come. Perhaps, we can even turn your frustration with the inadequacy of these machines into marvel at the performance of the accelerators. At the least, we hope to convince you that the accelerators are central, not peripheral, to our science and that the physics of such machines is both fascinating and sophisticated. The plan is the following: First I will give two lectures on basic accelerator physics; then you will hear two lectures on the state of the art, present limitations, the specific parameters of LEP, HERA, TEV2 and SLC, and some extrapolation to the next generation of machines such as the Large Hadron Collider (LHC), Superconducting Super Collider (SSC), and Large Linear Colliders; finally, I will give two lectures on new acceleration methods.
This book presents the developments in accelerator physics and technology implemented at the Tevatron proton-antiproton collider, the world's most powerful accelerator for almost twenty years prior to the completion of the Large Hadron Collider. The book covers the history of collider operation and upgrades, novel arrangements of beam optics and methods of orbit control, antiproton production and cooling, beam instabilities and feedback systems, halo collimation, and advanced beam instrumentation. The topics discussed show the complexity and breadth of the issues associated with modern hadron accelerators, while providing a systematic approach needed in the design and construction of next generation colliders. This book is a valuable resource for researchers in high energy physics and can serve as an introduction for students studying the beam physics of colliders.
Particle accelerators have attracted much interest and expectation from the international scientific community, and these show no sign of diminishing. Major world research laboratories have either planned or are envisaging the construction of new accelerators in order to foster the progress of science in many fields, from high energy physics to cultural heritage and the environment. This book presents 13 papers from the workshop "Future Research Infrastructures; Challenges and Opportunities", held as part of the series of the Enrico Fermi International School of Physics in Varenna, Italy, in July 2015. The workshop combined presentations on the science of particle accelerators and their applications with talks on the development of future accelerators, and the papers included here cover a diverse range of topics including: the European Spallation Source; the Swiss Light Source; accelerator projects in Korea; future circular colliders; synchrotron-based techniques for cultural heritage; and the new research horizon in hadron therapy. The book also includes a summary of the panel discussion on the need for international world infrastructures.
Accelerators have been devised and built for two reasons: In the first place, by physicists who needed high energy

particles in order to have a means to explore the interactions between particles that probe the fundamental elementary forces of nature. And conversely, sometimes accelerator builders produce new machines for higher energy than ever before just because it can be done, and then challenge potential users to make new discoveries with the new means at hand. These two approaches or motivations have gone hand in hand. This lecture traces how high energy particle accelerators have grown from tools used for esoteric small-scale experiments to the gigantic projects of today. So far all the really high-energy machines built and planned in the world--except the SLC--have been ring accelerators and storage rings using the strong-focusing method. But this method has not removed the energy limit, it has only pushed it higher. It would seem unlikely that one can go beyond the Large Hadron Collider (LHC)--but in fact a workshop was held in Sicily in November 1991, concerned with the question of extrapolating to 100 TeV. Other acceleration and beam-forming methods are now being discussed--collective fields, laser acceleration, wake-field accelerators etc., all aimed primarily at making linear colliders possible and more attractive than with present radiofrequency methods. So far it is not entirely clear which of these schemes will dominate particle physics in the future--maybe something that has not been thought of as yet.

Particle Accelerators, Colliders, and the Story of High Energy PhysicsCharming the Cosmic SnakeSpringer Science & Business Media

This book provides a comprehensive overview of the operating principles and technology of electron lenses in supercolliders. Electron lenses are a novel instrument for high energy particle accelerators, particularly for the energy-frontier superconducting hadron colliders, including the Tevatron, RHIC, LHC and future very large hadron colliders. After reviewing the issues surrounding beam dynamics in supercolliders, the book offers an introduction to the electron lens method and its application. Further chapters describe the technology behind the electron lenses which have recently been proposed, built and employed for compensation of beam-beam effects and for collimation of high-energy high-intensity beams, for compensation of space-charge effects and several other applications in accelerators. The book will be an invaluable resource for those involved in the design, construction and operation of the next generation of hadron colliders.

The high energy physics community is continually looking to push the limits with respect to the energy and luminosity of particle accelerators. In the realm of leptons, only electron colliders have been built to date. Compared to hadrons, electrons lose a large amount of energy when accelerated in a ring through synchrotron radiation. A solution to this problem is to build long, straight accelerators for electrons, which has been done with great success. With a new generation of lepton colliders being conceived, building longer, more powerful accelerators is not the most enticing option. Muons have been proposed as an alternative particle to electrons. Muons lose less energy to synchrotron radiation and a Muon Collider can provide luminosity within a much smaller energy range than a comparable electron collider. This allows a circular collider to be built with higher attainable energy than any present electron collider. As part of the accelerator, but separate from the collider, it would also be possible to allow the muons to decay to study neutrinos. The possibility of a high energy, high luminosity muon collider and an abundant, precise source of neutrinos is an attractive one. The technological challenges of building a muon accelerator are many and diverse. Because the muon is an unstable particle, a muon beam must be cooled and accelerated to the desired energy within a short amount of time. This requirement places strict requisites on the type of acceleration and focusing that can be used. Muons are generated as tertiary beams with a huge phase space, so strong magnetic fields are required to capture and focus them. Radio frequency (RF) cavities are needed to capture, bunch and accelerate the muons. Unfortunately, traditional vacuum RF cavities have been shown to break down in the magnetic fields necessary for capture and focusing.

The rapid growth in the power of large-scale computers has had a revolutionary effect on the study of charged-particle accelerators that is similar to the impact of smaller computers on everyday life. Before an accelerator is built, it is now the absolute rule to simulate every component and subsystem by computer to establish modes of operation and tolerances. We will bypass the important and fruitful areas of control and operation and consider only application to design and diagnostic interpretation. Applications of computers can be divided into separate categories including: component design, system design, stability studies, cost optimization, and operating condition simulation. For the purposes of this report, we will choose a few examples taken from the above categories to illustrate the methods and we will discuss the significance of the work to the project, and also briefly discuss the accelerator project itself. The examples that will be discussed are: (1) the tracking analysis done for the main ring of the Superconducting Supercollider, which contributed to the analysis which ultimately resulted in changing the dipole coil diameter to 5 cm from the earlier design for a 4-cm coil-diameter dipole magnet; (2) the design of accelerator structures for electron-positron linear colliders and circular colliding beam systems (B-factories); (3) simulation of the wake fields from multibunch electron beams for linear colliders; and (4) particle-in-cell simulation of space-charge dominated beams for an experimental liner induction accelerator for Heavy Ion Fusion. 8 refs., 9 figs.

A highly efficient, fully parallelized, six-dimensional tracking model for simulating interactions of colliding hadron beams in high energy ring colliders and simulating schemes for mitigating their effects is described. The model uses the weak-strong approximation for calculating the head-on interactions when the test beam has lower intensity than the other beam, a look-up table for the efficient calculation of long-range beam-beam forces, and a self-consistent Poisson solver when both beams have comparable intensities. A performance test of the model in a parallel environment is presented. The code is used to calculate beam emittance and beam loss in the Tevatron at Fermilab and compared with measurements. They also present results from the studies of stwo schemes proposed to compensate the beam-beam interactions: (a) the compensation of long-range interactions in the Relativistic Heavy Ion Collider (RHIC) at Brookhaven and the Large Hadron Collider (LHC) at CERN with a current carrying wire, (b) the use of a low energy electron beam to compensate the head-on interactions in RHIC.

The twentieth biennial Particle Accelerator Conference on Accelerator Science and Technology was held May 12 - 16, 2003 at the Hilton Hotel in Portland, Oregon. The Stanford Linear Accelerator Center and the Lawrence Berkeley National Laboratory organized PAC 2003, and it was held under the auspices of the Nuclear and Plasma Sciences Society of the Institute of Electrical and Electronics Engineers and the Division of Physics of Beams of the American Physical Society. The attendance was 1025 registrants from 21 countries. The Program Committee was co-chaired by Alan Jackson and Ed Lee. The program they arranged had opening and closing plenary sessions that covered the most important accomplishments, opportunities, and applications of accelerators. During the remainder of the conference there were parallel sessions with oral and poster presentations. In addition, there was an industrial exhibit during the first three days. The Proceedings present a total of 1154 papers from the invited, contributed orals, and poster sessions. Particle Accelerators and Colliders, Beam Dynamics. Magnets, RF Systems, Synchrotron radiation sources, Free Electron Lasers, Energy Recovery Linacs, Instabilities, Feedback Instrumentation, Pulsed Power, High Intensity Beams, Accelerator Applications, Advanced Accelerators.

Market: Physicists, engineers, and advanced graduate students working with particle accelerators, storage rings, and colliders. This cogent, contemporary work by two preeminent Russian accelerator physicists details the physical processes limiting or assisting the performance of intense beams in particle accelerators. The authors apply statistical methods to the physics of stored beams and describe in rigorous detail a wide range of beam physics problems. These range from single particle dynamics, through the theory of linear coherent oscillations and cooling techniques, to the kinetic effects in intense beams and nonlinear collective phenomena.