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Low Energy Muon Ionization Cooling Channel Fermilab

Let’s Collide Muons. Muon Ionisation Cooling Experiment What's the future for Muons? - Chris Rogers Muon Collider: prospects, challenges and the latest progress | Nazar Bartosik | WIN 2021 MICE: Creating a muon beam The Path to an Energy Frontier Muon Collider - Mark Palmer A journey to the future: “Our Muon Shot\" How To Live In The Hottest Place On Earth Using An Ancient AC System To Stay Cool! How to STAY COOL Living OFF GRID in the Desert (No A.C.) Radiant Cooling 101: What is Radiant Cooling? New Cold Fusion Device Successfully Generates Heat -- What does it mean? 3 cool Eurorack modules you might not know about How to Detect Muons! EARTH AIR TUNNEL || HOW IT WORKS || passive cooling technique 5 Mind-Bending New Wave Sci-Fi Books You Need To Read AIOs: The Do’s and Don’ts | Basics of Liquid Cooling What the media doesn't show you about BAGHDAD, IRAQ | S8, EP29 Physics Colloquium, \"Plasma-based Accelerators for Ultra High Energy Colliders\" Legitimate Cold Fusion Exists |

Muon-Catalyzed Fusion The Universe is Hostile to Computers Has Anomalous Beauty Muons Spinning Out of Control? A complete demonstrator of a muon cooled Higgs factory - C. Rubbia Muon Anomalies Shatter The Laws Of Physics? The Muon Collider: A Revolutionary New Particle Collider (w Prof Patrick Meade) Karri DiPetrillo: Towards a Multi-TeV Muon Collider, Today's R\u0026D for Tomorrow's Discoveries Energy Free Cooling through Physics Magnificent Muons - Johnny Wilkinson - QM Seminars Can You Really Hack Your Metabolism? | Good Energy by Casey Means | UsYouMe What is the Future of Particle Accelerators? Review Good Energy by Casey Means: A Must-Read for Holistic Health and Wellness

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RF ACCELERATING STRUCTURE FOR THE MUON COOLING EXPERIMENT.

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Physicist's Desk Reference
Introductory Muon Science
Pion Contamination in the MICE Muon Beam

Low Energy Muon Ionization Cooling Channel Fermilab *OMB No. 6034574898071* *edited by*

JIMENEZ BRADFORD

'98 Electroweak Interactions and Unified Theories

High Field - Low Energy Muon Ionization Cooling ChannelMuon beams are generated with large transverse and longitudinal emittances. In order to achieve the low emittances required by a muon collider, within the short lifetime of the muons, ionization cooling is required. Cooling schemes have been developed to reduce the muon beam 6D emittances to ≈ 300 [mu]m-rad in transverse and ≈ 1-1.5 mm in longitudinal dimensions. The transverse emittance has to be further reduced to ≈ 50-25 [mu]m-rad with an upper limit on the longitudinal emittance of ≈ 76 mm in order to meet the high-energy muon collider luminosity requirements. Earlier studies of the transverse cooling of low energy muon beams in high field magnets showed a promising performance, but did not include transverse or longitudinal matching between the stages. In this study we present the first complete design of the high field-low energy ionization cooling channel with transverse and longitudinal matching. The channel design was based on strong focusing solenoids with fields of 25-30 T and low momentum muon beam starting at 135 MeV/c and gradually decreasing. The cooling channel design presented here is the first to reach ≈ 50 micron scale emittance beam. As a result, we present the channel's optimized design parameters including the focusing solenoid fields, absorber parameters and the transverse and longitudinal matching.High Field {u2013} Low Energy Muon Ionization Cooling ChannelMuon beams are generated with large transverse and longitudinal emittances. In order to achieve the low emittances required by a muon collider, within the short lifetime of the muons, ionization cooling is required. Cooling schemes have been developed to reduce the muon beam 6D emittances to ≈ 300 ?m–rad in transverse and ≈ 1–1.5 mm in longitudinal dimensions. 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As a result, we present the channel's optimized design parameters including the focusing solenoid fields, absorber parameters and the transverse and longitudinal matching.Simulated Measurements of Cooling in Muon Ionization Cooling ExperimentCooled muon beams set the basis for the exploration of physics of flavour at a Neutrino Factory and for multi-TeV collisions at a Muon Collider. The international Muon Ionization Cooling Experiment (MICE) measures beam emittance before and after an ionization cooling cell and aims to demonstrate emittance reduction in muon beams. In the current MICE Step IV configuration, the MICE muon beam passes through low-Z absorber material for reducing its transverse emittance through ionization energy loss. Two scintillating fiber tracking detectors, housed in spectrometer solenoid modules upstream and downstream of the absorber are used for reconstructing position and momentum of individual muons for calculating transverse emittance reduction. However, due to existence of non-linear effects in beam optics, transverse emittance growth can be observed. Therefore, it is crucial to develop algorithms that are insensitive to this apparent emittance growth. We describe a different figure of merit for measuring muon cooling which is the direct measurement of the phase space density.The MICE Demonstration of Muon Ionization CoolingMuon beams of low emittance provide the basis for the intense, well-characterised neutrino beams necessary to elucidate the physics of flavour at the Neutrino Factory and to provide lepton-antilepton collisions up to several TeV at the Muon Collider. The international Muon Ionization Cooling Experiment (MICE) will demonstrate muon ionization cooling, the technique proposed to reduce the phase-space volume occupied by the muon beam at such facilities. In an ionization-cooling channel, the muon beam traverses a material (the absorber) loosing energy, which is replaced using RF cavities. The combined effect is to reduce the transverse emittance of the beam (transverse cooling). The configuration of MICE required to deliver the demonstration of ionization cooling is being prepared in parallel to the execution of a programme designed to measure the cooling properties of liquid-hydrogen and lithium hydride. The design of the cooling-demonstration experiment will be presented together with a summary of the performance of each of its components and the cooling performance of the experiment.Electromagnetic Design of RF Cavities for Accelerating Low-Energy MuonsA high-gradient linear accelerator for accelerating low-energy muons and pions in a strong solenoidal magnetic field has been proposed for homeland defense and industrial applications. The acceleration starts immediately after collection of pions from a target in a solenoidal magnetic field and brings decay muons, which initially have kinetic energies mostly around 15-20 MeV, to 200 MeV over a distance of ≈10 m. At this energy, both ionization cooling and further, more conventional acceleration of the muon beam become feasible. A normal-conducting linac with external-solenoid focusing can provide the required large beam acceptances. The linac consists of independently fed zero-mode (TM010) RF cavities with wide beam apertures closed by thin conducting edge-cooled windows. Electromagnetic design of the cavity, including its RF coupler, tuning and vacuum elements, and field probes, has been developed with the CST MicroWave Studio, and is presented.The MICE Demonstration of Ionization CoolingMuon beams of low emittance provide the basis for the intense, well-characterised neutrino beams necessary to elucidate the physics of flavour at the Neutrino Factory and to provide lepton-antilepton collisions at energies of up to several TeV at the Muon Collider. 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Agency Committee, will deliver a demonstration of ionization cooling by September 2017. In the revised configuration a central lithium-hydride absorber provides the cooling effect. The magnetic lattice is provided by the two superconducting focus coils and acceleration is provided by two 201 MHz single-cavity modules. The phase space of the muons entering and leaving the cooling cell will be measured by two solenoidal spectrometers. All the superconducting magnets for the ionization cooling demonstration are available at the Rutherford Appleton Laboratory and the first single-cavity prototype is under test in the MuCool Test Area at Fermilab. The design of the cooling demonstration experiment will be described together with a summary of the performance of each of its components. The cooling performance of the revised configuration will also be presented.A Study of Muon Ionization Cooling at MICE.A Neutrino Factory based on a high-energy muon storage-ring is proposed to study neutrino oscillation with high precision. An emittance reduction of muon beam by ionization cooling, which has never been demonstrated in practice, is one of the critical issues for Neutrino Factory. The international Muon Ionisation Cooling Experiment (MICE) is the first experiment to verify an effect of the ionization cooling with muons. MICE will measure a change in transverse emittance of approximately 10% with a precision of ±0.1%. In order to meet the requirements, muon trackers based on 350 [mu]m diameter scintillating fibers have been proposed. The construction of such trackers is a very challenging task and some innovative techniques are needed to realize, since there have been no trackers made with such a small diameter of scintillating fibers in the world. Upstream and downstream SciFi trackers have been successfully constructed with the international collaboration of UK, US and Japan by 2008. Both of the trackers have been tested with cosmic-rays at the RAL by 2009, at which high tracking efficiencies more than 90% are measured for both trackers. It is also confirmed that by collecting the misalignments found in both of the trackers, the requirements for the emittance measurement is met.Reviews Of Accelerator Science And

Technology - Volume 10: The Future Of Accelerators Muon beams are generated with large transverse and longitudinal emittances. In order to achieve the low emittances required by a muon collider, within the short lifetime of the muons, ionization cooling is required. Cooling schemes have been developed to reduce the muon beam 6D emittances to ≈ 300 ?m–rad in transverse and ≈ 1–1.5 mm in longitudinal dimensions. The transverse emittance has to be further reduced to ≈ 50–25 ?m–rad with an upper limit on the longitudinal emittance of ≈ 76 mm in order to meet the high-energy muon collider luminosity requirements. Earlier studies of the transverse cooling of low energy muon beams in high field magnets showed a promising performance, but did not include transverse or longitudinal matching between the stages. In this study we present the first complete design of the high field-low energy ionization cooling channel with transverse and longitudinal matching. The channel design was based on strong focusing solenoids with fields of 25–30 T and low momentum muon beam starting at 135 MeV/c and gradually decreasing. The cooling channel design presented here is the first to reach ≈ 50 micron scale emittance beam. As a result, we present the channel's optimized design parameters including the focusing solenoid fields, absorber parameters and the transverse and longitudinal matching.

RF ACCELERATING STRUCTURE FOR THE MUON COOLING EXPERIMENT. World Scientific Stanford University hosted the XIX International Symposium on Lepton and Photon Interactions at High Energies on August 9 – 14, 1999, at the Law School on the Stanford University Campus, the site of the previous Symposia. This volume constitutes the proceedings of the Symposium.

Contents:Reports from the B Factories:CESR and CLEO (K Honscheid)Status of KEKB Accelerator and Detector, BELLE (F Takasaki)Status of PEP-II and BaBar (J Dorfan)HERA-B Status (M Medinnis)Brief Report from the Tevatron (M Paulini)Heavy Flavor Physics and CP Violation:Heavy Quark Decays (R A Poling)Heavy Quark Lifetimes, Mixing, and CP Violation (G Blaylock)ε'/ε Results from KTeV (E

Blucher)Results on Direct CP Violation from NA48 (G Barr)A Status Report of KLOE at DAΦNE (S Bertolucci)Quark Mixing Matrix Studies and Lepton Flavor Violation Searches Using Rare Decays of Kaons (W Molzon)Tau Physics (A Pich)B Decays, the Unitarity Triangle, and the Universe (A F Falk)Neutrino Physics:Solar Neutrinos (Y Suzuki)Atmospheric Neutrinos and the Oscillations Bonanza (W A Mann)Accelerator and Reactor Neutrino Experiments (L DiLella)Neutrino Mass and Oscillations (R G H Robertson)Electroweak Interactions and Beyond:Precision Electroweak at the Z (M L Swartz)Electroweak Measurements from Hadron Machines (M Lancaster)Precise Electroweak Results from LEP2 (D G Charlton)R Values in Low Energy e+e- Annihilation (Z-G Zhao)Status of the Muon (g – 2) Experiment (B L Roberts)Ten Years of Precision Electroweak Physics (A Sirlin)New Particle Searches (V Ruhlmann-Kleider)Recent Developments in Physics Beyond the Standard Model (G F Giudice)Structure Within Particles:Structure Functions in Deep Inelastic Lepton-Nucleon Scattering (M Klein)Diffractio n and the Pomeron (H Abramowicz)The Spin Structure of the Nucleon (G K Mallot)Structure of the Photon (J M Butterworth)Rare Φ Decays and Exotic Hadrons (S I Serednyakov) QCD Phenomena and Theory:Fragmentation and Hadronization (B R Webber)Test of Perturbative QCD and Jet Physics (J Womersley)Applications of QCD (M Beneke) Lattice Calculations and Hadron Physics (S Aoki)Cosmology and Astrophysics: Dark Matter Searches (B Sadoulet)Supernovae, Dark Energy, and the Accelerating Universe: The Status of the Cosmological Parameters (S Perlmutter)High Energy Particles from the Universe (R A Ong)Cosmic Microwave Background: Past, Future, and Present (S Dodelson)Looking to the Future:Physics Needs for Future Accelerators (J D Lykken)R&D Progress Toward Future Linear Colliders (G-A Voss)Towards Very High Energy Accelerators (J S Wurtele)Gravity, Particle Physics and Their Unification (J M Maldacena)Assessment and Outlook (B Richter) Readership: High-energy, astro-, nuclear, experimental and theoretical physicists. Keywords:Lepton;Photon;High Energy

Physics;Astrophysics;Nuclear Physics

A Study of Muon Ionization Cooling at MICE.

World Scientific Cooled muon beams set the basis for the exploration of physics of flavour at a Neutrino Factory and for multi-TeV collisions at a Muon Collider. The international Muon Ionization Cooling Experiment (MICE) measures beam emittance before and after an ionization cooling cell and aims to demonstrate emittance reduction in muon beams. In the current MICE Step IV configuration, the MICE muon beam passes through low-Z absorber material for reducing its transverse emittance through ionization energy loss. Two scintillating fiber tracking detectors, housed in spectrometer solenoid modules upstream and downstream of the absorber are used for reconstructing position and momentum of individual muons for calculating transverse emittance reduction. However, due to existence of non-linear effects in beam optics, transverse emittance growth can be observed. Therefore, it is crucial to develop algorithms that are insensitive to this apparent emittance growth. We describe a different figure of merit for measuring muon cooling which is the direct measurement of the phase space density.

The MICE Demonstration of Muon Ionization Cooling

Atlantica Séguier Frontières

Particle-in-cell simulations involving the interaction of muon beam (peak density 1018 m3) with Li plasma (ionized medium) of density 1016-1022 m−3 have been performed. This study aimed to understand the effects of plasma on an incoming beam in order to explore scenario developed during the process of ionization cooling. The computer code takes into account the self-consistent electromagnetic effects of beam interacting with plasma. This study shows that the beam can pass through the plasma of densities four order of magnitude higher than its peak density. The low density plasmas are wiped out by the beam, however, the resonance is observed for densities of similar order. Study reveals the signature of plasma wakefield acceleration.

Large-acceptance Linac for Accelerating L9w-energy Muons

Springer Science & Business Media

Muon ionization cooling to the required

normalized rms emittance of 25 microns transverse, and 72 mm longitudinal, can be achieved with liquid hydrogen in high field solenoids, provided that the momenta are low enough. At low momenta, the longitudinal emittance rises from the negative slope of energy loss versus energy. Assuming initial emittances that have been achieved in six dimensional cooling simulations, optimized designs are given using solenoid fields limited to 30, 40, and 50 T. The required final emittances are achieved for the two higher field cases. Preliminary simulations of transverse cooling in hydrogen, at low energies, suggests that muon collider emittance requirements can be met using solenoid fields of 40 T or more. It might also be acceptable with 30 T. But these simulations did not include hydrogen windows, matching or reacceleration, whose performance, with one exception, was based on numerical estimates. Full simulations of more stages are planned. The design and simulation of hydrogen windows must be included, and space charge effects, and absorber heating, calculated. *Computational Accelerator Physics 2003* World Scientific

This volume presents the possibility of high intensity muon sources whose intensity would be at least 104 higher than that available now. Scientific opportunities anticipated with such sources are search for muon lepton flavor violation, measurement s of the muon anomalous magnetic moment and the electric dipole moment, neutrino factories based on a muon storage ring, muon collider and muon applied science such as muon catalyzed fusion and biology. In addition to physics opportunities, the necessary technology for such sources is discussed.

Final 6D Muon Ionization Colling Using Strong Focusing Quadrupoles

World Scientific The Muon Accelerator Program (MAP) collaboration is working to develop an ionization cooling channel for muon beams. An ionization cooling channel requires the operation of high-gradient, normal-conducting RF cavities in multi-Tesla solenoidal magnetic fields. However, experiments conducted at Fermilab?s MuCool Test Area (MTA) show that increasing the solenoidal field strength reduces the maximum achievable cavity gradient. This gradient limit is characterized by an RF breakdown process that has caused significant damage to copper cavity interiors. The damage may be caused by field-emitted electrons, focused by the solenoidal magnetic field onto small areas of the inner cavity surface. Local heating may then induce material fatigue and surface damage. Fabricating a cavity with beryllium walls would mitigate this damage due to beryllium?s low density, low thermal expansion, and high electrical and thermal conductivity. We address the design and fabrication of a pillbox RF cavity with beryllium walls, in order to evaluate the performance of high-gradient cavities in strong magnetic fields.

Lepton and Photon Interactions at High Energies

World Scientific Muon beams of low emittance provide the basis for the intense, well-characterised neutrino beams necessary to elucidate the physics of flavour at the Neutrino Factory and to provide lepton-antilepton collisions at energies of up to several TeV at the Muon Collider. The International

Muon Ionization Cooling Experiment (MICE) will demonstrate ionization cooling, the technique by which it is proposed to reduce the phase-space volume occupied by the muon beam at such facilities. In an ionization cooling channel, the muon beam passes through a material (the absorber) in which it loses energy. The energy lost is then replaced using RF cavities. The combined effect of energy loss and re-acceleration is to reduce the transverse emittance of the beam (transverse cooling). A major revision of the scope of the project was carried out over the summer of 2014. The revised project plan, which has received the formal endorsement of the international MICE Project Board and the international MICE Funding Agency Committee, will deliver a demonstration of ionization cooling by September 2017. In the revised configuration a central lithium-hydride absorber provides the cooling effect. The magnetic lattice is provided by the two superconducting focus coils and acceleration is provided by two 201 MHz single-cavity modules. The phase space of the muons entering and leaving the cooling cell will be measured by two solenoidal spectrometers. All the superconducting magnets for the ionization cooling demonstration are available at the Rutherford Appleton Laboratory and the first single-cavity prototype is under test in the MuCool Test Area at Fermilab. The design of the cooling demonstration experiment will be described together with a summary of the performance of each of its components. The cooling performance of the revised configuration will also be presented. Hydrogen-filled RF Cavities for Muon Beam Cooling World Scientific The ionization cooling of muons requires longitudinal acceleration of the muons after scattering in a hydrogen target. In order to maximize the accelerating voltage, we propose using linear accelerating structures with cells bounded by thin beryllium metal foils. This produces an on-axis field equivalent to the maximum surface field, whereas with beam-pipes the accelerating field is approximately half that of the peak surface field in the cavity. The muons interact only weakly with the thin foils. A [pi]/2 interleaved cavity structure has been chosen, with alternate cells coupled together externally, and the two groups of cells fed in quadrature. At present they are considering an operating temperature of 77K to gain a factor of at least two in Q-value over room temperature. The authors describe the design of the [pi]/2 interleaved cavity structure, design of an alternative [pi]-mode open structure, preliminary experimental results from a low-power test cavity, and plans for high-power testing. Progress on a Cavity with Beryllium Walls for Muon Ionization Cooling Channel R & D. Springer Science & Business Media

A conceptual design of a muon acceleration scheme based on recirculating superconducting linacs is proposed. In the presented scenario, acceleration starts after ionization cooling at 210 MeV/c and proceeds to 20 GeV, where the beam is injected into a neutrino factory storage ring. The key technical issues are addressed, such as the choice of acceleration technology (superconducting versus normal conducting) and the choice of RF frequency, and finally, implementation of the overall acceleration scheme: capture, acceleration, transport and preservation of large phase space of fast decaying species. Beam transport issues for large-momentum-spread beams are accommodated by appropriate lattice design choices. The proposed arc optics is further optimized with a sextupole correction to suppress chromatic effects contributing to emittance dilution. The presented proof-of-principle design of the arc optics with horizontal separation of multipass beams is extended for all passes. *High Energy Physics* Elsevier Development of two innovative linacs is discussed. (1) High-efficiency normal-conducting accelerating structures for ions with beam velocities in the range of a few percent of the speed of light. Two existing accelerator technologies - the H-mode resonator cavities and transverse beam focusing by permanent-magnet quadrupoles (PMQ) - are merged to create efficient structures for light-ion beams of considerable currents. The inter-digital H-mode accelerator with PMQ focusing (IH-PMQ) has the shunt impedance 10-20 times higher than the standard drift-tube linac. Results of the combined 3-D modeling for an IH-PMQ accelerator tank - electromagnetic computations, beam-dynamics simulations, and thermal-stress analysis - are presented. H-PMQ structures following a short RFQ accelerator can be used in the front end of ion linacs or in stand-alone applications like a compact mobile deuteron-beam accelerator up to a few MeV. (2) A large-acceptance high-gradient linac for accelerating low-energy muons in a strong solenoidal magnetic field. When a proton beam hits a target, many low-energy pions are produced almost isotropically, in addition to a small number of high-energy pions in the forward direction. We propose to collect and accelerate copious muons created as the low-energy pions decay. The acceleration should bring muons to a kinetic energy of ≈200 MeV in about 10 m, where both an ionization cooling of the muon beam and its further acceleration in a superconducting linac become feasible. One potential solution is a normal-conducting linac consisting of independently fed 0-mode RF cavities with wide apertures closed by thin metal windows or grids. The guiding magnetic field is provided by external superconducting solenoids. The cavity choice, overall linac design considerations, and simulation results of muon acceleration are presented. Potential applications range from basic research to homeland defense to industry and medicine.

Reviews of Accelerator Science and Technology

World Scientific

Ionization cooling requires low-Z energy absorbers immersed in a strong magnetic field and high-gradient, large-aperture RF cavities to be able to cool a muon beam as quickly as the short muon lifetime requires. RF cavities that operate in vacuum are vulnerable to dark-current-generated breakdown, which is exacerbated by strong magnetic fields, and they require extra safety windows that degrade cooling, to separate RF regions from hydrogen energy absorbers. RF cavities pressurized with dense hydrogen gas will be developed that use the same gas volume to provide the energy absorber and the RF acceleration needed for ionization cooling. The breakdown suppression by the dense gas will allow the cavities to operate in strong

magnetic fields. Measurements of the operation of such a cavity will be made as functions of external magnetic field and charged particle beam intensity and compared with models to understand the characteristics of this technology and to develop mitigating strategies if necessary.
The MICE Demonstration of Ionization Cooling World Scientific
We propose a high-gradient linear accelerator for accelerating low-energy muons and pions in a strong solenoidal magnetic field. The acceleration starts immediately after collection of pions from a target by solenoidal magnets and brings muons to a kinetic energy of about 200 MeV over a distance of the order of 10 m. At this energy, both an ionization cooling of the muon beam and its further acceleration in a superconducting linac become feasible. The project presents unique challenges - a very large energy spread in a highly divergent beam, as well as pion and muon decays - requiring large longitudinal and transverse acceptances. One potential solution incorporates a normal-conducting linac consisting of independently fed O-mode RF cavities

with wide apertures closed by thin metal windows or grids. The guiding magnetic field is provided by external superconducting solenoids. The cavity choice, overall linac design considerations, and simulation results of muon acceleration are presented. While the primary applications of such a linac are for homeland defense and industry, it can provide muon fluxes high enough to be of interest for physics experiments. Physicist's Desk Reference Cambridge University Press Edited by internationally recognized authorities in the field, this expanded and updated new edition of the bestselling Handbook, containing more than 100 new articles, is aimed at the design and operation of modern particle accelerators. It is intended as a vade mecum for professional engineers and physicists engaged in these subjects. With a collection of more than 2000 equations, 300 illustrations and 500 graphs and tables, here one will find, in addition to the common formulae of previous compilations, hard-to-find, specialized formulae, recipes and material data pooled from the lifetime experience of many of the world''s most able practitioners of the art and science of accelerators.The eight chapters include both theoretical and practical matters as well as an extensive glossary of accelerator types. Chapters on beam dynamics and electromagnetic and nuclear interactions deal with linear and nonlinear single particle and collective effects including spin motion, beam-environment, beam-beam, beam-electron, beam-ion and intrabeam interactions. The impedance concept and related calculations are dealt with at length as are the instabilities associated with the various interactions mentioned. A chapter on operational considerations includes discussions on the assessment and correction of orbit and optics errors, real-time feedbacks, generation of short photon pulses, bunch compression, tuning of normal and superconducting linacs, energy recovery linacs, free electron lasers, cooling, space-charge compensation, brightness of light sources, collider luminosity optimization and collision schemes. Chapters on mechanical and electrical considerations present material data and important aspects of component design including heat transfer and refrigeration. Hardware systems for particle sources, feedback systems, confinement and acceleration (both normal conducting and superconducting) receive detailed treatment in a subsystems chapter, beam measurement techniques and apparatus being treated therein as well. The closing chapter gives data and methods for radiation protection computations as well as much data on radiation damage to various materials and devices.A detailed name and subject index is provided together with reliable references to the literature where the most detailed information available on all subjects treated can be found.

Introductory Muon Science

Taylor & Francis

Muon beams of low emittance provide the basis for the intense, well-characterised neutrino beams necessary to elucidate the physics of flavour at the Neutrino Factory and to provide lepton-antilepton collisions up to several TeV at the Muon Collider. The international Muon Ionization Cooling Experiment (MICE) will demonstrate muon ionization cooling, the technique proposed to reduce the phase-space volume occupied by the muon beam at such facilities. In an ionization-cooling channel, the muon beam traverses a material (the absorber) loosing energy, which is replaced using RF cavities. The combined effect is to reduce the transverse emittance of the beam (transverse cooling). The configuration of MICE required to deliver the demonstration of ionization cooling is being prepared in parallel to the execution of a programme designed to measure the cooling properties of liquid-hydrogen and lithium hydride. The design of the cooling-demonstration experiment will be presented together with a summary of the performance of each of its components and the cooling performance of the experiment. **Pion Contamination in the MICE Muon Beam** World Scientific Abstract Low emittance muon beam lines and muon colliders are potentially a rich source of BSM physics for future exper-imenters. A muon beam normalized emittance of ax, y, z = (280, 280, 1570)æm has been achieved in simulation with short solenoids and a betatron function of 3 cm. Here we use ICOOL and MAD-X to explore using a 400 MeV/c muon beam and strong focusing quadrupoles to achieve a normalized transverse emittance of 100 æm and complete 6D cooling. The low beta regions, as low as 5 mm, produced by the quadrupoles are occupied by dense, low Z absorbers, such as lithium hydride or beryllium, that cool the beam transversely. Equilibrium transverse emittance is linearly proportional to the transverse betatron function. Reverse emittance exchange with septa and/or wedges is then used to decrease transverse emittance from 100 to 25 æm at the expense of longitudinal emittance for a high energy lepton collider. Cooling challenges include chromaticity correction, ssband overlap, quadrupole acceptance, and staying in phase with RF. *Reviews of Accelerator Science and Technology* World Scientific Muon beams are generated with large transverse and longitudinal emittances. In order to achieve the low emittances required by a muon collider, within the short lifetime of the muons, ionization cooling is required. Cooling schemes have been developed to reduce the muon beam 6D emittances to ≈ 300

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Desert 2003
World Scientific
The scientific program of these important proceedings was arranged to cover most of the field of neutrino physics. In light of the rapid growth of interest stimulated by new interesting results from the field, more than half of the papers presented here are related to the neutrino mass and oscillations, including atmospheric and solar neutrino studies. Neutrino mass and oscillations could imply the existence of a mass scale many orders of magnitudes higher than presented in current physics and will probably guide scientists beyond the standard model of particle physics.

Novel Linac Structures for Low-beta Ions and for Muons
World Scientific
The 32nd International Conference on High Energy Physics belongs to the Rochester Conference Series, and is the most important international conference in 2004 on high energy physics. The proceedings provide a comprehensive review on the recent developments in experimental and theoretical particle physics. The latest results on Top, Higgs search, CP violation, neutrino mixing, pentaquarks,

heavy quark mesons and baryons, search for new particles and new phenomena, String theory, Extra dimension, Black hole and Lattice calculation are discussed extensively. The topics covered include not only those of main interest to the high energy physics community, but also recent research and future plans. Contents: Neutrino Masses and MixingsQuark Matter and Heavy Ion CollisionsParticle Astrophysics and CosmologyElectroweak PhysicsQCD Hard InteractionsQCD Soft InteractionsComputational Quantum Field TheoryCP Violation, Rare Kaon Decay and CKMR&D for Future Accelerator and DetectorHadron Spectroscopy and ExoticsHeavy Quark Mesons and BaryonsBeyond the Standard ModelString Theory Readership: Experimental and theoretical physicists and graduate students in the fields of particle physics, nuclear physics, astrophysics and cosmology.Keywords:High Energy Physics;Particle Physics;Electroweak;QCD;Heavy Quark;Neutrino;Particle Astrophysics;Hadron Spectroscopy;CP Violation;Quark

Matter;Future Accelerator

Muon Collider Final Cooling in 30-50 T Solenoids

CRC Press

A high-gradient linear accelerator for accelerating low-energy muons and pions in a strong solenoidal magnetic field has been proposed for homeland defense and industrial applications. The acceleration starts immediately after collection of pions from a target in a solenoidal magnetic field and brings decay muons, which initially have kinetic energies mostly around 15-20 MeV, to 200 MeV over a distance of ≈10 m. At this energy, both ionization cooling and further, more conventional acceleration of the muon beam become feasible. A normal-conducting linac with external-solenoid focusing can provide the required large beam acceptances. The linac consists of independently fed zero-mode (TM010) RF cavities with wide beam apertures closed by thin conducting edge-cooled windows. Electromagnetic design of the cavity, including its RF coupler, tuning and vacuum elements, and field probes, has been developed with the CST MicroWave Studio, and is presented.

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