Low Energy Muon Ionization Cooling Channel Fermilab

Feasibility Study
Hydrogen-filled RF Cavities for Muon Beam Cooling
Electromagnetic Design of RF Cavities for Accelerating Low-Energy Muons
The Proceedings of the International Symposium on Nuclear Electro-Weak Spectroscopy for Symmetries in Electro-Weak Nuclear-Processes
Tsukuba, Japan, 1-4 December 1999
Beyond the Desert 2003
Physics Potential and Development of [mu]+ [mu]− Colliders, Second Workshop
KEK International Workshop on High Intensity Muon Sources
Progress on a Cavity with Beryllium Walls for Muon Ionization Cooling Channel R & D.
Physics Potential and Development of U + U - Colliders
Muon Collider Final Cooling in 30-50 T Solenoids
'98 Electroweak Interactions and Unified Theories
High Field {u2013} Low Energy Muon Ionization Cooling Channel
Proceedings of the Fourth Tegernsee International Conference on Particle Physics

Beyond the Standard BEYOND 2003, Castle Ringberg, Tegernsee, Germany, 9–14 June 2003
Neutrino Factory and Muon Collider Fellow
The MICE Collaboration
Computational Accelerator Physics 2003
Physicist's Desk Reference
Lampf Users Group Inc. (Lugi) Symposium: 20 Years Of Meson Factory Physics: Accomplishments And Prosp
Muon Muon Collider
Accelerator, Non-accelerator, and Space Approaches Into the Next Millennium ; Proceedings of the Second International Conference on Particle Physics Beyond the Standard Model, Castle Ringberg, Germany, 6-12 June 1999
News 99
Physics and Technology of Linear Accelerator Systems
Proceedings of the Seventh International Conference on Computational Accelerator Physics, Michigan, USA, 15-18 October 2003
Handbook Of Accelerator Physics And Engineering (2nd Edition)
Introductory Muon Science
Osaka, Japan, 9-12 March, 1999
Reviews of Accelerator Science and Technology
Lepton and Photon Interactions at High Energies
INTERACTION OF MUON BEAM WITH PLASMA DEVELOPED DURING IONIZATION COOLING.
The MICE Demonstration of Muon Ionization Cooling

Particle Physics: Perspectives And Opportunities - Report Of The Dpf Committee On Long-term Planning
Physics Beyond the Standard Models of Particles, Cosmology and Astrophysics
Proceedings of the 2002 Joint USPAS-CAS-Japan-Russian Accelerator School, Long Beach, California 6-14 November 2002
Challenges And Goals For Accelerators In The Xxi Century
The MICE Demonstration of Ionization Cooling
Reviews of Accelerator Science and Technology
Large-acceptance Linac for Accelerating L9w-energy Muons
Neutrino Physics and Astrophysics

CAREY SINGH

Feasibility Study World Scientific
High Field - Low Energy Muon Ionization Cooling Channel
Hydrogen-filled RF Cavities for Muon Beam Cooling World Scientific
Muons are fundamental particles like electrons but much more massive. Muon accelerators can provide physics opportunities similar to those of electron accelerators, but because of the larger mass muons lose less energy to radiation, allowing more compact facilities with lower operating costs. The way muon beams are produced makes them

too large to fit into the vacuum chamber of a cost-effective accelerator, and the short muon lifetime means that the beams must be reduced in size rather quickly, without losing too many of the muons. This reduction in size is called "cooling." Ionization cooling is a new technique that can accomplish such cooling. Intense muon beams can then be accelerated and injected into a storage ring, where they can be used to produce neutrino beams through their decays or collided with muons of the opposite charge to produce a muon collider, similar to an electron-positron collider. We report on the research carried out at the University of California, Riverside, towards producing such muon accelerators, as part of the Muon Accelerator Program based at Fermilab. Since this research was carried out in a university environment, we were able to involve both undergraduate and graduate students.

Electromagnetic Design of RF Cavities for Accelerating Low-Energy Muons World Scientific

This book is useful to people working or planning to work in the field of linear accelerators. It is a good reference, presenting the most recent advances in the field. The intended audience are researchers, practitioners, academics and graduate students.The proceedings have been selected for coverage in: ? Index to Scientific & Technical Proceedings (ISTP CDROM version / ISI Proceedings)? CC Proceedings ? Engineering & Physical Sciences

The Proceedings of the International Symposium on Nuclear Electro-Weak Spectroscopy for Symmetries in Electro-Weak Nuclear-Processes 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 [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.

Tsukuba, Japan, 1-4 December 1999

Taylor & Francis

The past 100 years of accelerator-based research have led the field from first insights into the structure of atoms to the development and confirmation of the Standard Model of physics. Accelerators have been a key tool in developing our understanding of the elementary particles and the forces that govern their interactions. This book describes the past 100 years of accelerator development with a special focus on the technological advancements in the field, the connection of the various accelerator projects to key developments and discoveries in the Standard Model, how accelerator technologies open the door to other applications in medicine and industry, and finally presents an outlook of future accelerator projects for

the coming decades.
Beyond the Desert 2003 CRC Press 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 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. Potential applications range from basic research to homeland defense to industry and medicine.

Physics Potential and Development of [mu]+ [mu]− Colliders, Second Workshop
Springer Science & Business Media
Addressing the need for an up-to-date reference on silicon devices and heterostructures, Beyond the Desert 99 reviews the technology used to grow and characterize Goup IV alloy films. It covers the theory, device design, and simulation of heterojunction transistors, emphasizing their relevance in developing the technologies involving strained layers; device

design and simulation of conventional silicon bipolar transistors and SiGe HBTs at room and low temperatures; and device design and simulation for MOSFETs, including SiGe and strained-Si channel MOSFETs. The book concludes with simulations and examples of different applications. It provides a unified reference for scientists and engineers investigating the use of SiGe and strained silicon in a new generation of high-speed circuit applications.

KEK International Workshop on High Intensity Muon Sources 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 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.
Progress on a Cavity with Beryllium Walls for Muon Ionization Cooling Channel R & D.
Springer Science & Business Media
The well-known Casimir effect has a direct analogue in systems near critical or multicritical points. Critical fluctuations in systems confined to finite geometries lead to attractive or repulsive forces between system boundaries. These forces influence the formation of wetting layers of liquid 4He or binary liquid mixtures near critical points in these fluids. With the aid of recently developed versions of the atomic force microscope, these forces appear to be directly measurable. The book contains an introduction to the physics of critical phenomena and reviews the most recent developments in the theory of finite-size scaling. A detailed discussion of the Casimir effect and related questions follows. The analysis of quantitative effects on the specific heat of critical films, the

formation of wetting layers, and force measurements finish the presentation. This is perhaps the first book on the critical Casimir effect.

Physics Potential and Development of U + U - Colliders

World Scientific

This book reviews the major physics results from the meson factories, surveys the status of the relevant fields (including pion physics, hadron physics, and electroweak physics), and explores prospects for further progress.

Muon Collider Final Cooling in 30-50 T Solenoids World Scientific

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.
'*98 Electroweak Interactions and Unified Theories* World Scientific
The international Muon Ionization Cooling Experiment (MICE) will perform a systematic investigation of ionization cooling with muon beams of momentum between 140 and 240\, MeV/c at the Rutherford Appleton Laboratory ISIS facility. The measurement of ionization cooling in MICE relies on the selection of a pure sample of muons that traverse the experiment. To make this selection, the MICE Muon Beam is designed to deliver a beam of muons with less than $\sim$1\% contamination. To make the final muon selection, MICE employs a particle-identification (PID) system upstream and downstream of the cooling cell. The PID system includes time-of-flight hodoscopes, threshold-Cherenkov counters and calorimetry. The upper limit for the pion contamination measured in this paper is $f_\pi

High Field {u2013} Low Energy Muon Ionization Cooling Channel AIP Conference Proceedings (Nu

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.

Proceedings of the Fourth Tegernsee International Conference on Particle Physics Beyond the Standard BEYOND 2003, Castle Ringberg, Tegernsee, Germany,

9–14 June 2003 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.
Neutrino Factory and Muon Collider Fellow
Elsevier
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 Collaboration

Cambridge University Press

The NEWS 99 international symposium discusses symmetries in electroweak processes in nuclei. Many phenomena in nuclear and particle physics are related to symmetry. It is known that we are living in a left-handed world as far as the Weak interaction is concerned, but neutrino physics suggests that a right-handed world may also be relevant. Chiral symmetry and its breaking plays an essential role in generating hadron masses. Symmetries related to flavor in the strong interaction like isospin, SU(3) and so on are known to be violated although they play a crucial role for the understanding of phenomena in nuclear and particle physics. The treatment of tiny breaking is of particular importance. Weak and electromagnetic interactions are well established at the fundamental level and can be used to probe the structure of nuclei and hadrons. A wide variety of phenomena in nuclear and particle physics were discussed in NEWS 99 with an emphasis on symmetry. Topics ranged from nuclear structure to neutrino properties, covering highly phenomenological to fundamental fields. Contents:Symmetries in Electro Weak Interactions in Nuclei:Double Beta Decay in Gauge Theories (J D Vergados)Flavor Changing Lepton Processes (Y Kuno)Neutrinos and Symmetries in Nuclei:Double Gamow-Teller Excitation by Second-Order Born Approximation (K Muto)Axion Search Experiment in Kyoto (S Matsuki et al.)Dynamical Symmetry Breaking and QCD Physics:Physics with LEPS at SPring-8 (T Nakano)Partial Chiral

Restoration at Finite Baryon Density (T Hatsuda)Quarks and Hadrons by Electro Weak Probes:Physics of SU(3) Baryons (A Hosaka et al.)Photons Probing Dynamics in Few-Body Systems (O Scholten & A Yu Korchin)Symmetries in Flavor Nuclear Physics:Chiral Symmetry and Weak Decay of Hypernuclei (M Oka)Flavor Changing Baryon–Baryon Collision (T Kishimoto)Symmetries in Nuclear Structures by Electromagnetic Spectroscopy:Isospin and Spin-Isospin Modes in Nuclei (M N Harakeh et al.)Mixed-Symmetry Quadropole States in Nuclei (P von Brentano et al.)Hadrons and Nuclei:Nucleon Spin Asymmetry and Nucleon and Meson Effective Masses (T Noro et al.)Role of Isobar Components in the Low-Lying Levels in Light Nuclei (C Rangacharyulu)Astronuclear Physics by Electro Weak Nuclear Processes:Neutrinos in Explosive Nucleosynthesis: Big-Bang and Supernovae (T Kajino)Hadrons and Nuclei:Electromagnetic Production of Hyperons (K Maeda)New Facilities and Future Plans:Electron Accumulator Ring for the PEARL Project (K Hatanaka)and other papers Readership: Graduate students, researchers and professionals in nuclear and particle physics. Keywords:
Computational Accelerator Physics 2003 Atlantica Séguier Frontières
Annotation Even before

the US government's defunding of the Superconducting Super Collider, a few physicists had been talking about building a muon+ muon- collider, which entails a much lower energy loss and can still use circular machines up to the multi-TeV range, and so might be practical to use more often. Here scientists present 25 papers on the early concepts for colliders and high- energy storage rings, a muon collider scenario based on stochastic cooking, the progress toward a high-energy and high luminosity collider, targets and magnetic elements for pion collection in muon collider drivers, measurements of dynamic aperture in LEP, and other topics. Five are from a 1992 workshop in Napa, California. No subject index. Reproduced from typescripts. Annotation c. by Book News, Inc., Portland, Or.

Physicist's Desk Reference 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. 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.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.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.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. 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.Large-acceptance Linac for Accelerating L9w-energy MuonsWe 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.Reviews Of Accelerator Science

And Technology - Volume 10: The Future Of Accelerators
This is a major revision of a classic, best selling reference book. Originally published by the American Institute of Physics under the title "Physics Vade Mecum" in 1981, and then the second edition in 1989 with the new title "A Physicist's Desk Reference", this third edition has been completely updated and modernized to reflect current modern physics. The book is a concise compilation of the most frequently used physics data and formulae with their derivations. This revision has six more chapters than the second edition, outdated chapters dropped, and new chapters added on atmospheric physics, electricity and magnetism, elementary particle physics, fluid dynamics, geophysics, nonlinear physics, particle accelerators, polymer physics, and quantum theory. There is a new last chapter on practical laboratory data. The references and bibliographies have been updated.This book is an indispensable tool for the researcher, professional and student in physics as well as other scientists who use physics data. The editors of this volume are Richard Cohen, author of the first two chapters of PDR and the "Physics Quick Reference Guide"; David Lide, one of the editors of the previous two editions and the editor of the "CRC Handbook of

Physics and Chemistry"; and George Trigg, editor of the "Encyclopedia of Physics" and the "Encyclopedia of Applied Physics" (VCH). The market for this classic reference book includes the practicing scientist, including engineers, chemists, and biologists; and students.

Lampf Users Group Inc. (Lugi) Symposium: 20 Years Of Meson Factory Physics: Accomplishments And Prosp World Scientific

A feasibility study is presented of a 2 + 2 TeV muon collider with a luminosity of L = 1035 cm−2s−1. The resulting design is not optimized for performance, and certainly not for cost; however, it does suffice - we believe - to allow us to make a credible case, that a muon collider is a serious possibility for particle physics and, therefore, worthy of R and D support so that the reality of, and interest in, a muon collider can be better assayed. The goal of this support would be to completely assess the physics potential and to evaluate the cost and development of the necessary technology. The muon collider complex consists of components which first produce copious pions, then capture the pions and the resulting muons from their decay; this is followed by an ionization cooling channel to reduce the longitudinal and transverse emittance of the muon beam. The next stage is to accelerate the muons and, finally, inject them into a collider ring wich has a small beta function at the colliding point. This is the first attempt at a point design and it will require further study and optimization. Experimental work will be needed to verify the validity of diverse crucial elements in the design. Muons because of their large mass compared to an electron, do not produce significant synchrotron radiation. As a result there is negligible beamstrahlung and high energy collisions are not limited by this phenomena. In addition, muons can be accelerated in circular devices which will be considerably smaller than two full-energy linacs as required in an e - e− collider. A hadron collider would require a CM energy 5 to 10 times higher than 4 TeV to have an equivalent energy reach. Since the accelerator size is limited by the strength of bending magnets, the hadron collider for the same physics reach would have to be much larger than the muon collider. In addition, muon collisions should be cleaner than hadron collisions. There are many detailed particle reactions which are open to a muon collider and the physics of such reactions - what one learns and the necessary luminosity to see interesting events - are described in detail. Most of the physics accesible to an e+ - e− collider could be studied in a muon collider. In addition the production of Higgs bosons in the s-channel will allow the measurement of Higgs masses and total widths to high precision; likewise, t{bar t} and W+W− threshold studies would yield m{sub t} and m{sub w} to great accuracy. These reactions are at low center of mass energy (if the MSSM is correct) and the luminosity and?p/p of the beams required for these measurements is detailed in the Physics Chapter. On the other hand, at 2 + 2 TeV, a luminosity of L ≈ 1035 cm−2s−1 is desirable for studies such as, the scattering of longitudinal W bosons or the production of heavy scalar particles. Not explored in this work, but worth noting, are the opportunities for muon-proton and muon-heavy ion collisions as well as the enormous richness of such a facility for fixed target physics provided by the intense beams of neutrinos, muons, pions, kaons, antiprotons and spallation neutrons. To see all the interesting physics described herein requires a careful study of the operation of a detector in the very large background. Three sources of background have been identified. The first is from any halo accompanying the muon beams in the collider ring. Very carefully prepared beams will have to be injected and maintained. The second is due to the fact that on average

35% of the muon energy appears in its decay electron. The energy of the electron subsequently is converted into EM showers either from the synchrotron radiation they emit in the collider magnetic field or from direct collision with the surrounding material. The decays that occur as the beams traverse the low beta insert are of particular concern for detector backgrounds. A third source of background is e+ - e− pair creation from?+ -?− interaction. Studies of how to shield t ...

Muon Muon Collider

World Scientific

This book contains the Proceedings of the Fourth International Conference on Particle Physics Beyond the Standard Model - BEYOND THE DESERT 2003. Emphasis at BEYOND03 was put on supergravity, which had its twentieth birthday that year, on neutrino physics and dark matter search, and on gravitation and cosmology, and some other very important fields. The book resents a timely and valuable overview of the status and future potential and trends in theoretical and experimental particle physics, in the complementary sectors of accelerator, non-accelerator and space physics.