Inaugural US Muon Collider Community Meeting

Inaugural
US Muon Collider
Meeting

Fermilab, August 7-9, 2024 indico.fnal.gov/e/usmc2024

Report of Contributions

Contribution ID: **1** Type: **not specified**

Welcome to Fermilab

Wednesday, 7 August 2024 09:00 (20 minutes)

Presenter: FLEMING, Bonnie (Fermilab)

Session Classification: Plenary

Contribution ID: **2** Type: **not specified**

Physics at the Muon Collider

Wednesday, 7 August 2024 10:00 (30 minutes)

Presenter: CRAIG, Nathaniel (UC Santa Barbara)

Session Classification: Plenary

Contribution ID: **3** Type: **not specified**

Muon Collider in the P5 Report

Wednesday, 7 August 2024 09:30 (30 minutes)

Presenter: MURAYAMA, Hitoshi (University of California, Berkeley & IPMU, University of Tokyo)

Session Classification: Plenary

Contribution ID: **4** Type: **not specified**

Overview of the Machine

Wednesday, 7 August 2024 11:00 (30 minutes)

Presenter: SHILTSEV, Vladimir (NIU)

Session Classification: Plenary

Contribution ID: **5** Type: **not specified**

Overview of the Experiment

Wednesday, 7 August 2024 11:30 (30 minutes)

Presenter: LEE, Lawrence (University of Tennessee, Knoxville)

Session Classification: Plenary

Contribution ID: **6** Type: **not specified**

Muon Collider in ITF Report

Wednesday, 7 August 2024 12:00 (30 minutes)

Presenter: RAUBENHEIMER, Tor (SLAC)

Session Classification: Plenary

Contribution ID: **8** Type: **not specified**

Meeting Logistics

Wednesday, 7 August 2024 09:20 (10 minutes)

Presenters: JINDARIANI, Sergo (Fermilab); HOLMES, Tova (University of Tennessee)

Session Classification: Plenary

Contribution ID: **9** Type: **not specified**

IMCC Status and Plans

Thursday, 8 August 2024 10:00 (30 minutes)

Presenter: SCHULTE, Daniel (CERN)

Session Classification: Plenary

Contribution ID: **10** Type: **not specified**

CPAD: Detector R&D coordination in the US

Wednesday, 7 August 2024 15:20 (30 minutes)

Presenter: ASAADI, Jonathan (University of Texas Arlington)

Session Classification: Plenary

Contribution ID: **11** Type: **not specified**

DOE/NSF Remarks

Session Classification: Plenary

Contribution ID: **12** Type: **not specified**

Towards a US Muon Collider Collaboration

Wednesday, 7 August 2024 17:30 (30 minutes)

Presenter: DASU, Sridhara (University of Wisconsin)

Session Classification: Plenary

Contribution ID: **13** Type: **not specified**

Overview of Accelerator R&D Needs

Friday, 9 August 2024 13:30 (30 minutes)

Presenter: STRATAKIS, Diktys (Fermi National Accelerator Laboratory)

Session Classification: Plenary

Contribution ID: **14** Type: **not specified**

Overview of Detector R&D Needs

Friday, 9 August 2024 13:00 (30 minutes)

Presenter: PASTRONE, Nadia (INFN-Torino)

Session Classification: Plenary

Contribution ID: **15** Type: **not specified**

Path Forward for Physics - the Big Picture

Friday, 9 August 2024 14:00 (40 minutes)

Presenter: ARKANI-HAMED, Nima (IAS)

Session Classification: Plenary

Contribution ID: **16** Type: **not specified**

Synergies with Neutrinos

Thursday, 8 August 2024 09:30 (30 minutes)

Presenter: HUBER, Patrick (Virginia Tech)

Session Classification: Plenary

Contribution ID: **17** Type: **not specified**

Closeout

Session Classification: Plenary

Contribution ID: **18** Type: **not specified**

America's path to a Muon Collider: A conversation with Congressman Bill Foster

Friday, 9 August 2024 16:00 (1 hour)

Presenter: CONGRESSMAN BILL FOSTER

Session Classification: Plenary

Contribution ID: **19** Type: **not specified**

Wrap up

Friday, 9 August 2024 14:40 (10 minutes)

Presenter: JINDARIANI, Sergo (Fermilab)

Session Classification: Plenary

Contribution ID: **20** Type: **not specified**

Searching for Heavy Leptophilic Z' at Future Muon Collider

We study the phenomenology of leptophilic Z' gauge bosons at the future muon collider. The leptophilic Z' model, although well-motivated, remains largely unconstrained from current low-energy and collider searches for Z' masses above $calO(100\ \mathrm{GeV})$, thus providing a unique opportunity for future lepton colliders. Taking $U(1)_{L_\mu - L_\tau}$ models as concrete examples, we show that future muon collider with multi-TeV center-of-mass energies provide unprecedented sensitivity to heavy leptophilic Z' bosons.

Primary authors: DASGUPTA, Arnab (Seoul National University of Science and Technology); DEV, Bhupal (Washington University in St. Louis); WANG, Si; XIE, Keping (University of Pittsburgh); PADHAN, ROJALIN (Institute of Physics, Bhubaneswar, India); HAN, Tao (University of Pittsburgh)

Presenter: WANG, Si

Session Classification: Poster Session and Reception

Contribution ID: **21** Type: **not specified**

Electron Cooling for a Muon Collider

Electron cooling of muons has the potential to enable an enormous increase in muon beam phase space density. At low energy and with a high electron current, evaluation of the cooling process indicates that the muon phase space can be reduced by a factor of about one hundred billion during several microseconds of cooling time. To achieve the needed high electron currents at low energy, we propose filamentation of the original muon beam into many smaller beams; each filamentary cooler will need only a small fraction of the total electron beam current. To mitigate against space charge induced instability in the electron beams, we further propose to neutralize the electron beam space charge in each filamentary cooler by trapping ions within the beam drift region. After cooling in one stage, the muon beam can be coalesced and focused (increasing its velocity spread) which allows further cooling in a subsequent cooling stage.

Primary author: LARSON, Delbert (Particle Beam Lasers, Inc.)

Presenter: LARSON, Delbert (Particle Beam Lasers, Inc.)

Session Classification: Poster Session and Reception

Contribution ID: **22** Type: **not specified**

Interplay between Theory and Experiment

Thursday, 8 August 2024 09:00 (30 minutes)

Presenter: CAPDEVILLA, Rodolfo (Perimeter Institute and University of Toronto)

Session Classification: Plenary

Contribution ID: **23** Type: **not specified**

Summary of the recent Detector+MDI workshop

Wednesday, 7 August 2024 14:30 (25 minutes)

Presenter: KENNEDY, Kiley (Princeton University)

Session Classification: Plenary

Contribution ID: **24** Type: **not specified**

Machine-Detector Interface

Wednesday, 7 August 2024 14:55 (25 minutes)

Presenter: CALZOLARI, Daniele (CERN)

Session Classification: Plenary

Contribution ID: **25** Type: **not specified**

Ionization Cooling

Wednesday, 7 August 2024 14:00 (30 minutes)

Presenter: SNOPOK, Pavel (Illinois Institute of Technology)

Session Classification: Plenary

Contribution ID: **26** Type: **not specified**

HTS-Based Rapid-Cycling Magnet for Muon Acceleration

The wide range of operational temperatures of the HTS (YBCO) conductor makes it suitable for the construction of rapid-cycling magnets required for the muon acceleration. The measured *) 0.06 W/m power loss of the 0.4 T magnet operating at 300 T/s suggests realistic possibility of the HTS-based accelerator magnet with much higher B-fields and ramp rates. The magnet core and power cable designs with projected HTS cable power loss for the +/- 1.7 T field in the 30 mm gap at the ramp rate of 1000 T/s are presented. The required supporting cryogenic power and the options of expanding B-field above 1.7 T are discussed.*) H. Piekarz, S. Hays, B. Claypool, M. Kufer, V. Shiltsev, MT-27- IEEE Trans. on Superconductivity. Vol: 32, Issue 6, Print ISSN: 1051-8223 (2022), https://arxiv.org/abs/211.06459

Primary author: Dr PIEKARZ, Henryk

Presenter: Dr PIEKARZ, Henryk

Session Classification: Poster Session and Reception

Contribution ID: **27** Type: **not specified**

Top Yukawa coupling determination at high energy muon collider

The Top Yukawa coupling profoundly influences several core mysteries linked to the electroweak scale and the Higgs boson. We study the feasibility of measuring the Top Yukawa coupling at high-energy muon colliders by examining the high-energy dynamics of the weak boson fusion to top quark pair processes. A deviation of the Top Yukawa coupling from the Standard Model would lead to a modified $VV \to t\bar{t}$ process, violating unitarity at high energy. Our analysis reveals that utilizing a muon collider with a center-of-mass energy of 10 TeV and an integrated luminosity of 10 ab^{-1} allows us to investigate the Top Yukawa coupling with a precision surpassing 1.5\%, more than one order of magnitude better than the precision from $t\bar{t}h$ channel at muon colliders. This precision represents a notable enhancement compared to the anticipated sensitivities of the High-Luminosity LHC (3.4\%) and those at muon colliders derived from the $t\bar{t}H$ process.

Primary authors: MAHBUB, Ishmam (University of Minnesota); LYU, Kunfeng; WANG, Liantao (University of Chicago); LIU, Zhen (University of Minnesota)

Presenter: MAHBUB, Ishmam (University of Minnesota)

Session Classification: Poster Session and Reception

Contribution ID: **28** Type: **not specified**

Muon Detector Visualization in Unreal Engine

This presentation will describe recent efforts to visualize muon collider detector geometries and collision events with modern 3D game development tools, particularly Unreal Engine 5. The workflow from HEP-specific tools to industry standard formats will be described, and an interactive demo will be available.

Primary authors: BELL, Charles (University of Michigan); LEE, Lawrence (University of Tennessee, Knoxville)

Presenter: LEE, Lawrence (University of Tennessee, Knoxville)

Session Classification: Poster Session and Reception

Contribution ID: **29** Type: **not specified**

Observations and theory of superconducting cable magnets

A recent re-analysis of data on the training in several designs, including the LHC, leads to a proposed theory of cable training and suggestions for experiments that could test the hypotheses.

Primary author: PALMER, Robert B (Brookhaven National lab)

Presenter: PALMER, Robert B (Brookhaven National lab)

Session Classification: Poster Session and Reception

Contribution ID: **30** Type: **not specified**

Advancements in ACTS: Speed and Adaptability for the Muon Collider

This poster presents two projects aimed at evaluating and adapting A Common Tracking Software (ACTS) for future collider experiments. In the first project, an evaluation of the latest version of ACTS (v32) has been conducted through various performance studies, both with and without Beam Induced Background events. The new ACTS version has demonstrated improvements over the previous version in both timing and efficiency.

The second project focused on transitioning ACTS processors from Marlin to Gaudi to address the need for scalable processing capabilities. This scalability is essential for the future high-luminosity Muon Collider. Unlike the current specialized ILC Software framework in which ACTS runs, Gaudi's design naturally supports parallelization. This parallelization will efficiently handle the abundance of Beam Induced Background (BIB) particles expected at the Muon Collider. Even amidst millions of BIB interactions per event, parallelization within Gaudi will allow for the accurate reconstruction of signal particles. With these changes, ACTS will be able to support future collider experiments at never before seen luminosity levels.

This work aims to address the need to adapt to evolving software frameworks. As Key4HEP continues to develop, transitioning older algorithms from ILCSoft becomes increasingly necessary. Key4HEP offers enhanced multithreading capabilities that optimize resource utilization and will allow advancements in speed and accuracy. By using these advancements, our work aims to facilitate reliable data analysis and pave the way for new discoveries in collider physics.

Primary authors: FERRARO, Samuel (Brown University); GARG, Rocky (Stanford University); PAGAN GRISO, Simone (Lawrence Berkeley National Laboratory); MELONI, Federico (Deutsches Elektronen-Synchrotron DESY); KRIZKA, Karol (Lawrence Berkeley National Laboratory); Mr ANDREETTO, Paolo (INFN PD); BURMASOV, Nazar

Presenters: FERRARO, Samuel (Brown University); GARG, Rocky (Stanford University)

Session Classification: Poster Session and Reception

Contribution ID: **31** Type: **not specified**

G4beamline tutorial

G4beamline is a user-friendly particle-simulation program based on the Geant4 toolkit. It describes the system to be simulated, and the simulation itself, in a user-friendly description language; it requires no C++ programming by the user. G4beamline has been used by over 1,500 people, including students and members of every muon experiment or proposal in the past 15-20 years. It is particularly adept at simulating muon cooling channels. This tutorial will describe how to install and use G4beamline at a basic level.

Primary author: ROBERTS, Thomas

Presenter: ROBERTS, Thomas

Session Classification: Poster Session and Reception

Contribution ID: **32** Type: **not specified**

Ultrafast Si detectors for timing/imaging layers in 5D calorimeters and particle identification at future high luminosity colliders

Achieving time stamping with resolution on the order of ten picoseconds will be vital to the success of future high luminosity collider experiments. Out-of-time effects such as pileup will drive down the efficiencies of current calorimeters, giving rise to the need for the addition of timing information to the energy measurements. Silicon-based sampling calorimeters may be ideal for this purpose. In some instances, a few timing/imaging layers may be sufficient to separate overlapping showers. A timing/imaging layer with picosecond accuracy also offers the opportunity of using time of flight measurements for hadron identification in a broader momentum range.

Low Gain Avalanche Diodes (LGADs) have been established as a viable option for four-dimensional tracking devices, as they can provide both position and timing information for incoming particle tracks. The introduction of LGADs to particle identification systems will improve time of flight measurements and calorimeter shower reconstruction, while suppressing the effects of pile-up and beam induced backgrounds. We outline the first steps in our efforts to study signal formation and timing resolution in LGADs of different areas, thicknesses, and gains, with the goal of optimizing cell sizes and fabrication parameters for shower detection and hadron identification while achieving the scalability and cost effectiveness needed for large scale applications.

Primary authors: MACK, Bridget (Syracuse University); ARTUSO, Marina (Syracuse University); RUDOLPH, Matthew (Syracuse University); MACKEY, Lauren (Syracuse University); DOWLING, Andrew (Syracuse University)

Presenter: MACK, Bridget (Syracuse University)

Session Classification: Poster Session and Reception

Contribution ID: **33** Type: **not specified**

ECAL Calibration and Energy Resolution for a 10TeV Detector Geometry

In the pursuit of a muon collider operating at ~10 TeV center-of-mass-energy, designing a highly accurate and sensitive detector is crucial. Calorimetry plays a key part in any detector setup, as we rely on our calorimeters for energy reconstruction and particle identification. Therefore, an effective calorimeter must be extremely well-calibrated and achieve excellent resolution. This poster will report on efforts to achieve a comprehensive energy calibration of the electromagnetic calorimeter (ECAL) for our 10 TeV detector design. This calibration is necessary in order to achieve desired energy resolution for reconstructed photons across a wide range of energies (0-1TeV). We report on the challenges introduced by the new location of the solenoid in our latest 10 TeV detector design, the necessity of a calibration strategy that is both energy-dependent and angularly dependent, and the resulting effects on photon energy resolution.

Primary author: POWERS, Rose (Yale University)

Presenter: POWERS, Rose (Yale University)

Session Classification: Poster Session and Reception

Contribution ID: **34** Type: **not specified**

Towards a Muon Collider: High-Powered Targetry in a High-Field Solenoid for Mu2e-II and AMF

Charged lepton flavor violation (CLFV) is expected in a diverse set of BSM scenarios. The proposed Mu2e-II and Advanced Muon Facility (AMF) experiments at Fermilab will make strong sensitivity improvements in the muon to electron conversion CLFV channel. There are a number of interesting synergies between R&D efforts for Mu2e-II/AMF and R&D needed for a US muon collider. One critical overlap is the need for high-powered targetry in a high-field solenoid. I will describe the targetry and magnetic field requirements of Mu2e-II and AMF and compare them to the requirements of the muon collider to highlight the possibility of using Mu2e-II and AMF as stepping stones on the path to a muon collider. The discussion will conclude with details of ongoing R&D efforts for Mu2e-II and AMF.

Primary author: KAMPA, Cole (Northwestern University)

Presenter: KAMPA, Cole (Northwestern University)

Session Classification: Poster Session and Reception

Contribution ID: **35** Type: **not specified**

Lattice Design of a Pulsed Synchrotron for a Muon Collider Fitting within the Fermilab Site Boundary

A muon collider allows one to have a high energy reach for physics studies while having a relatively compact footprint. Ideally such a machine would accelerate muon beams to about 5 TeV. We present a preliminary lattice design for a pulsed synchrotron that will accelerate muon beams to their maximum collision energy and having a circumference of 16.5 km, which would allow it to fit just within the Fermilab site boundary. We wish to estimate the maximum energy that muons can be accelerated to on the Fermilab site based on a realistic lattice layout. To achieve a high average bend field, superconducting fixed field dipoles are interleaved with iron-dominated dipoles whose field is rapidly ramped from negative to positive field. Multiple RF stations are required to ensure that the beam energy and the dipole fields are reasonably well synchronized and to avoid longitudinal losses due to the large synchrotron tune. We use FODO arc cells with dispersion suppressed into the RF straights. We will discuss tradeoffs between maximum energy, energy range, and muon decays. We will consider whether to mix superconducting and iron quadrupoles like the dipoles.

Primary authors: CAPOBIANCO-HOGAN, Kyle (Stony Brook University); BERG, J. Scott (Brookhaven National Laboratory)

Presenter: CAPOBIANCO-HOGAN, Kyle (Stony Brook University)

Session Classification: Poster Session and Reception

Contribution ID: **36** Type: **not specified**

Higgs Width and Couplings at Muon Colliders with Forward Muon Detection

We propose a novel method using the ZZ-fusion channel and forward muon detection at high-energy muon colliders to address the challenge of the Higgs coupling-width degeneracy. Our approach enables inclusive Higgs rate measurement to 0.75\% at 10~TeV muon collider, breaking the coupling-width degeneracy. Results indicate the potential to refine Higgs coupling to sub-percent levels and estimate its total width within (-0.41\%, +2.1\%). Key insights include the effectiveness of forward muon tagging in signal-background separation despite broad recoil mass distribution due to muon energy reconstruction and beam energy spread. The study emphasizes the significance of muon rapidity coverage up to $|\eta(\mu)| < 6$, enhancing measurement precision. Our findings highlight the unique capabilities of high-energy lepton colliders for model-independent Higgs coupling determination and lay the groundwork for future advancements in muon collider technology and Higgs physics research.

Primary authors: LYU, Kunfeng; LI, Peiran (University of Minnesota); LIU, Zhen (University of Minnesota)

Presenter: LI, Peiran (University of Minnesota)

Session Classification: Poster Session and Reception

Contribution ID: **37** Type: **not specified**

Beam Induced Background studies

Muon colliders offer a exciting new physics research avenue because of a variety of reasons including the muon's full energy being available in a collision, final states being much cleaner compared to a proton collider and being able to achieve much higher energies than electron colliders. There are certain challenges though, like the short lifetime of muons needing a variety of accelerator developments for this endeavour to be fruitful. In this poster, we would like to present our recent work on one of the challenges caused by this short muon lifetime namely the Beam Induced Background, which is the background caused by inflight decay of muons and their interactions with the accelerator. This is necessary in order to take advantage of the clean final state of muon collisions and to achieve the desired sensitivity to new physics.

Primary authors: MALLAMPALLI, Abhishikth; Prof. DASU, Sridhara (University of Wisconsin)

Presenter: MALLAMPALLI, Abhishikth

Session Classification: Poster Session and Reception

Contribution ID: **38** Type: **not specified**

Lepton Flavor Violation: From Muon Decays to Muon Colliders

We study dimension-6 lepton flavor-violating (LFV) operators within the Standard Model Effective Field Theory (SMEFT). We analyze their signals at a high-energy muon collider and compare them to constraints from lepton flavor-violating Higgs and Z decays, as well as precision measurements of τ and μ decays. Low-energy bounds are assessed by matching onto the low-energy effective theory. Our analysis shows the complementarity of low- and high-energy constraints by considering various operator combinations and assumptions about flavor structure.

Primary authors: BAGHERIAN, Hengameh; FRASER, Katherine (Harvard University); HOMILLER, Samuel (Harvard); Dr ASADI, Pouya (University of Oregon); Dr LU, Qianshu (Institute for Advanced Study)

Presenter: BAGHERIAN, Hengameh

Session Classification: Poster Session and Reception

Contribution ID: **39** Type: **not specified**

Proposal for a proton-bunch compression experiment at IOTA in the strong space-charge regime

The longitudinal compression of intense proton bunches with strong space-charge force is an essential component of a proton-based muon source for a muon collider. This paper discusses a proton-bunch compression experiment at the Integrable Optics Test Accelerator (IOTA) storage ring at Fermilab to explore optimal radio frequency (RF) cavity and lattice configurations. IOTA is a compact fixed-energy storage ring that can circulate a 2.5-MeV proton beam with varying beam parameters and lattice configurations. The study will aim to demonstrate a bunch-compression factor of at least 2 in the IOTA ring while examining the impact of intense space-charge effects on the compression process.

Primary author: SIMONS, Ben (Fermilab and Northern Illinois University)

Co-authors: BANERJEE, Nilanjan (Fermilab); ELDRED, Jeffrey (Fermilab); SHILTSEV, Vladimir (FNAL)

Presenter: SIMONS, Ben (Fermilab and Northern Illinois University)

Session Classification: Poster Session and Reception

Contribution ID: **40** Type: **not specified**

High Power Targetry R&D needed for Muon Collider

The Muon Collider (MuC) promises to be able to extend the lepton-collider energy reach to much higher energies. To produce an acceptable muon current, a 1- to 4-MW proton beam at 5 to 20 GeV is required, with an optimum at 2 MW. Development of a target system capable of reliably withstanding such an intense beam is a substantial challenge. The initial plan is to consider use of solid graphite instead of mercury as the target material. Other options, such as other liquid metals or fluidized targets, will be considered. A R&D Phase will be conducted during ~ 7 years to choose the most reliable and efficient concept for muon production and support R&D on target materials through the RaDIATE (Radiation Damage In Accelerator Target Environment) collaboration. This R&D phase will be extended during the ~10-years Demonstrator Phase to support any materials and performance studies on the MuC beam intercepting devices, including production target, beam dump, etc…

This talk will present the R&D needs for High Power Targetry related as well as the different synergies through the RaDIATE Collaboration to support the Muon Collider requirements.

Primary authors: PELLEMOINE, Frederique (Fermilab -AD - TSD - TRD); YONEHARA, Katsuya (Fermilab); AMMIGAN, Kavin (Fermi National Accelerator Laboratory); BIDHAR, Sujit (FNAL)

Presenter: PELLEMOINE, Frederique (Fermilab -AD - TSD - TRD)

Session Classification: Poster Session and Reception

Contribution ID: **41** Type: **not specified**

Direct detection of charged long-lived particles at a future 10 TeV Muon Collider

A future 10 TeV muon collider presents fantastic opportunities to search for new fundamental particles. This study focuses on the direct detection of charged long-lived particles (LLPs) by identifying tracks that are more slowly moving than those of Standard Model particles. However, beam-induced background (BIB) from muon decays presents a challenge for accurately reconstructing tracks and serves as a potential source of out-of-time background. Presented here is a study of long-lived staus in the context of a simplified GMSB model with the stau as the NLSP. Analysis of staus of varying mass and lifetime gives insight into which constraints may be imposed on timing windows for hit acceptance to reject BIB while maintaining high efficiency for LLPs.

Primary authors: DIPETRILLO, Karri (The University of Chicago); FLICKER, Tate (The University of Chicago); HUANG, Kane (The University of Chicago); ROSSER, Ben (The University of Chicago); ROZANOV, Leo (The University of Chicago); LARSON, Mark (The University of Chicago)

Presenter: FLICKER, Tate (The University of Chicago)

Session Classification: Poster Session and Reception

Contribution ID: **42** Type: **not specified**

Self-Consistent Modeling of Muon Cooling and Acceleration with Wakefields in WarpX/ImpactX

The modeling of collective effects in the muon beam during ionization cooling and acceleration pose important challenges for a Muon Collider design. Toward the end of the ionization cooling channel, the intense, short muon bunches are subject to significant space charge, and induce wakefields in the foil and the surrounding RF cooling cell that may result in the distortion of the RF waveform. We propose to use the code WarpX with ICOOL to evaluate such effects self-consistently using electromagnetic PIC. Likewise, in the downstream transport, it is important to evaluate the dynamical effects of long-range and short-range wakefields in the accelerating cavities. We propose to use the code ImpactX for efficient multibunch modeling of the muon acceleration transport. WarpX and ImpactX are parallel, GPU-capable codes that form part of the Beam, Plasma, and Accelerator Modeling (BLAST) toolkit.

Primary authors: MITCHELL, Chad (Lawrence Berkeley National Laboratory); STRATAKIS, Diktys (Fermi National Accelerator Laboratory); BERG, J. Scott (Brookhaven National Laboratory); VAY, Jean-Luc (Lawrence Berkeley National Laboratory); QIANG, Ji (Lawrence Berkeley National Laboratory); LEHE, Remi (Lawrence Berkeley National Laboratory)

Presenter: MITCHELL, Chad (Lawrence Berkeley National Laboratory)

Session Classification: Poster Session and Reception

Contribution ID: **43** Type: **not specified**

Displaced Tracking at a Muon Collider with Long-lived Staus

A future 10 TeV muon collider offers numerous opportunities to search for new fundamental particles. Long-lived particles (LLPs) are well-motivated by many open questions in physics and Beyond Standard Model theories. This study focuses on indirect detection of charged long-lived particles via displaced tracks. At a muon collider, beam-induced-background (BIB) can lead to background displaced tracks, making accurately reconstructing LLP displaced tracks challenging. In this study we consider a Supersymmetry benchmark model with long-lived staus, in which each stau decays to a tau and a Dark Matter particle. Displaced tracks from the stau decays are used to evaluate track reconstruction efficiency at varying levels of BIB rejection. This work gives insight into the tracking requirements and a possible analysis strategy to reject BIB background while maintaining sensitivity to LLPs.

Primary authors: LARSON, Mark (The University of Chicago); HUANG, Kane (The University of Chicago); FLICKER, Tate (The University of Chicago); ROZANOV, Leo (The University of Chicago); ROSSER, Benjamin (The University of Chicago); Prof. DIPETRILLO, Karri (The University of Chicago)

Presenter: LARSON, Mark (The University of Chicago)

Session Classification: Poster Session and Reception

Contribution ID: **44** Type: **not specified**

Full simulation studies of a segmented crystal ECAL for MuonC

A full detector simulation has been implemented from scratch in dd4hep. We present preliminary studies of EM pointing resolution and BIB response in such a detector with the goal of identifying the most appropriate performance benchmarks with respect to the physics case for MuonC detector development going forward.

Primary authors: TULLY, Christopher (Princeton University); CHUNG, Wonyong (Princeton University)

Presenter: CHUNG, Wonyong (Princeton University)

Session Classification: Poster Session and Reception

Contribution ID: **45** Type: **not specified**

Cluster shape analysis and impact on data readout of beam-induced background for 10 TeV Muon Collider

The muon collider stands as one of the most promising prospects for next-generation high-energy particle physics experiments. However, it presents significant challenges, particularly in managing the beam-induced background (BIB) resulting from various muon decay sources. Currently, several mitigation strategies are under investigation, such as leveraging timing information from the innermost tracker detector to improve the tracking performance. On top of that, we are also employing dedicated quality criteria on the tracks itself to filter out some of the in-time BIB from physics collision events.

In this poster, we will demonstrate further reductions in BIB by utilizing the properties of hit clusters produced through realistic event digitization. This will include not only the angular distribution of the clusters, but also the distribution of hits per cluster along with the possibility of overlap removal from multiple incident particles. Additionally, we will explore preliminary estimates of the data readout bandwidth requirements based on hit occupancy, assuming effective control over BIB events.

Primary authors: RASTOGI, Angira (Lawrence Berkeley National Laboratory (US)); SHINDE, Sara (University of Cincinnati); PAGAN GRISO, Simone (Lawrence Berkeley National Laboratory)

Presenter: RASTOGI, Angira (Lawrence Berkeley National Laboratory (US))

Session Classification: Poster Session and Reception

Contribution ID: **46** Type: **not specified**

Hadronic Calorimeter and Jet Reconstruction Performance for a 10 TeV Muon Collider Detector Design adapted from CLIC

Moving towards a 10 TeV pCM collider will require novel detector technologies, designs, and software. Previous studies have analyzed the performance of a muon collider detector design adapted from CERN's Compact Linear Collider (CLIC) detector for collision energies up to 3 TeV. The work outlined in this poster looks to expand these studies to 10 TeV collider energies as well as adapt the detector design for these higher energies. In particular, this poster quantifies the HCAL performance through neutron reconstruction efficiency, resolution, and response. Monte Carlo neutron gun samples were generated with and without Beam-Induced-Background (BIB) in batches from 1 GeV to 5 TeV. With these samples, the impact of the BIB on various neutron reconstruction methods can also be compared. Furthermore, the variation in neutron reconstruction, resolution, and response are calibrated across both eta and incident neutron energy. An initial resolution goal of 35%/\sqrt{E} for the HCAL resolution was set to be sufficient for jet reconstruction, but these studies have demonstrated neutron energy resolutions around 15%/\sqrt{E} for samples below 100 GeV and below 6%/\sqrt{E} for 100 GeV to 5 TeV samples. The neutron reconstruction efficiency is also greater than 90% for incident neutrons with energies above 30 GeV. These neutron studies demonstrate that the new 10 TeV detector design has improved neutron efficiency and resolution compared to previous 3 TeV designs.

Primary author: SLEDGE, Elise

Presenter: SLEDGE, Elise

Session Classification: Poster Session and Reception

Contribution ID: **47** Type: **not specified**

Machine-Learned Particle Flow for the Compact Linear Collider (CLIC)

Efficient and accurate algorithms are necessary to reconstruct particles in the highly granular detectors anticipated at future proton-proton, electron-positron, and muon colliders. We study scalable machine-learning models for event reconstruction in electron-positron collisions based on a full detector simulation. Particle-flow reconstruction can be formulated as a supervised learning task using tracks and calorimeter clusters. We compare a graph neural network and kernel-based transformer and demonstrate that we can avoid quadratic operations while achieving realistic reconstruction. We show that hyperparameter tuning significantly improves the performance of the models. The best graph neural network model shows improvement in the jet transverse momentum resolution by up to 50% compared to the rule-based algorithm. The resulting model is portable across Nvidia, AMD, and Habana hardware. Accurate and fast machine-learning-based reconstruction can significantly improve future measurements at colliders.

Primary author: Dr PATA, Joosep (National Institute of Chemical Physics and Biophysics)

Co-authors: Mr SOUTHWICK, David (European Center for Nuclear Research); Mr WULFF, Eric (European Center for Nuclear Research); Mr MOKHTAR, Farouk (University of California San Diego); Dr DUARTE, Javier (University of California San Diego); Dr GIRONE, Maria (European Center for Nuclear Research); Mr ZHANG, Mengke (University of California San Diego)

Presenter: Mr ZHANG, Mengke (University of California San Diego)

Session Classification: Poster Session and Reception

Contribution ID: **48** Type: **not specified**

Simulating Muon Beams using Fluka

Fluka is a simulation software used to simulate the interaction and travel of particles in any material. It has many applications in high energy physics, engineering, detector design, etc. One application that has been of interest lately was simulating muon colliders. A simulation of muon beams with several energies travelling down a 25m beampipe will be presented.

Primary authors: ALHARTHY, Ruaa (University of Wisconsin-Madison); PARELLA, Saketh (University of Wisconsin-Madison)

Presenter: ALHARTHY, Ruaa (University of Wisconsin-Madison)

Session Classification: Poster Session and Reception

Contribution ID: **49** Type: **not specified**

Progress on Conventional and Machine-Learning-Assisted Optimizations of a Rectilinear Cooling Channel

The design of a rectilinear cooling channel for a future muon collider poses an interesting multi-objective optimization problem: what are the lowest achievable longitudinal and transverse emittances while minimizing beam loss? In this work, we present our progress on computing these tradeoffs using a genetic algorithm. This algorithm can propose candidate solutions, evaluate their performance using a full-physics-included simulation tool, and then select the best performing individuals based on the objective functions we have selected. A second, more efficient algorithm that supplements the simulations with a machine-learning model is also considered. Our initial results demonstrate improved performance over literature values for the first stage of a proposed design [1] and continued effort in this direction may lead to shorter, higher performance cooling channels for the construction of a muon collider.

[1] Stratakis, D., Palmer, R. B. (2015). Physical Review Special Topics - Accelerators and Beams, 18(3), 031003

Primary authors: PIERCE, Christopher (University of Chicago); Mr DINN, Sophia (University of Chicago); Mr ZHANG, Aubrey (University of Chicago); Dr STRATAKIS, Diktys (Fermilab); KIM, Young-Kee (University of Chicago)

Presenter: PIERCE, Christopher (University of Chicago)

Session Classification: Poster Session and Reception

Contribution ID: **50** Type: **not specified**

Calculation of Longitudinal and Transverse Emittance Tradeoffs in a Rectilinear Cooling Channel

An important challenge in designing a muon collider is cooling the captured muon beam in an efficient and cost-effective manner. One approach to muon cooling consists of a multi-stage scheme in which the particle beam is passed through a rectilinear cooling channel made up of repeating cells each consisting of alternating radio frequency cavities and wedge absorbers. This scheme was studied in detail in [1]. However, analysis across multiple decision variables was outside of the work's scope. In this work, we combine multi-objective genetic optimization with realistic simulations of the rectilinear cooling channel in order to analyze the trade-off between transverse emittance, and longitudinal emittance, while constraining the percent of beam loss, of the muon beam during its first passage through the cooling lattice. We present the initial results of this optimization, which has achieved a balance between the two objectives that minimizes both beyond the results reported in [1].

[1] Stratakis, D., & Palmer, R. B. (2015). Physical Review Special Topics - Accelerators and Beams, 18(3), 031003

Primary authors: Mr DINN, Sophia (University of Chicago); Mr ZHANG, Aubrey (University of Chicago); PIERCE, Christopher (University of Chicago); Dr STRATAKIS, Diktys (Fermilab); Dr KIM, Young-Kee (University of Chicago)

Presenter: Mr DINN, Sophia (University of Chicago)

Session Classification: Poster Session and Reception

Contribution ID: **51** Type: **not specified**

Muon beam-induced background mitigation with neuromorphic AI

In any muon collider detector, abundant beam-induced backgrounds will challenge reconstruction algorithms. Cell-specific minimum-energy thresholds have shown some effectiveness in reducing diffuse, low-energy BIB contributions during digitization in a simulated 10TeV muon collider detector, but further research is needed to optimize these methods. This project aims to explore the use of timing-sensitive energy thresholding by neuromorphic computing algorithms to mitigate beam-induced backgrounds in electromagnetic calorimeter (ECAL) readout. The performance of several other thresholding methods will be examined for comparison.

Primary authors: TUNA, Alexander (Harvard University); LEE, Lawrence (University of Tennessee, Knoxville); HILLMAN, Micah (University of Tennessee, Knoxville); SCHUMAN, Catherine D. (University of Tennessee, Knoxville); HOLMES, Tova (University of Tennessee, Knoxville)

Presenter: HILLMAN, Micah (University of Tennessee, Knoxville)

Session Classification: Poster Session and Reception

Contribution ID: **52** Type: **not specified**

Using a cryogenic Li2MOO4 detector prototype to study qubit charge responses

We present a prototype Li2MoO4 calorimetric detector with a low-impedance TES readout designed and assembled to search for neutrinoless double beta decay. We analyze the results of the operation of the detector at the NEXUS underground facility located at the MINOS hall at Fermilab, which has a rock overburden of 107m. The prototype's fast rise time of ~0.5 ms improves its ability to resolve the background from so-called "pileup events": two independent neutrino decay events that may occur close enough in time to mimic a neutrinoless double beta decay in the energy window of interest. This same device was used to measure the ambient background in a study measuring the response of a four-qubit device to ambient radiation. With a baseline resolution of 1.95 FWHM and calibrated up to the MeV region, we characterize the radiation incident upon the detector, in two configurations: with and without the surrounding low radioactivity lead shield with coverage of 4π. The rates obtained are compared with the correlated jump rates of the superconducting qubits, and we observe the qubit jump rates don't scale with the incident ionizing radiation, indicating a new as-yet-unknown source of qubit jumps.

Primary author: SABHARI, Deeksha (Northwestern University)

Co-authors: CHOU, Aaron (Fermilab); Mr RODRIGUEZ, Alejandro (Northwestern University); COLON, Arianna (CosmiQ); SCHMIDT, Benjamin (Northwestern Univsersity); JAMES, Christopher; Mr CHANG, Clarence (Argonne National Laboratory); Mr BATHURST, Corey (University of Florida, Gainesville); BAXTER, Daniel; BOWRING, Daniel (Fermilab); TEMPLES, Dylan (Fermilab); Ms CUDMORE, Elspeth (University of Toronto); Ms OLIVIERI, Emiliano (Université Paris-Saclay, CNRS/IN2P3, IJCLab); FIGUEROA-FELICIANO, Enectali (Northwestern University); Mr SPAHN, Gabriel (University of Wisconsin-Madison); Mr WANG, Gensheng (Argonne National Laboratory); BRATRUD, Grace; WAGNER, Grace; CANCELO, Gustavo (fermilab); MAGOON, Hannah (Tufts University); HERNANDEZ, Israel (Illinois Institute of Technology); Ms YU, Jailin (Illinois Institute of Technology); Mr SCARPACI, Jean-Antoine (Université Paris-Saclay, CNRS/IN2P3, IJCLab); Mr ZHANG, Jianjie (Argonne National Laboratory); STIFTER, Kelly (Fermilab); ANYANG, Kester (Illinois Institute of Technology); KENNARD, Kyle (Northwestern University); HSU, Lauren (Fermilab); Ms MATEO, Lidabel Ovalle (Northwestern University); WINSLOW, Lindley (MIT); Ms LISOVENKO, Marharyta (Argonne National Laboratory); HOLLISTER, Matthew; RAHA, Nandita; KURINSKY, Noah; LUKENS, Patrick (FNAL); KHATIWADA, Rakshya; CHEN, Ran (Northwestern University); Mr GAULTIERI, Riccardo (Northwestern University); MCDERMOTT, Robert (University of Wisconsin, Madison); REN, Runze (Northwestern University); LINEHAN, Ryan (Fermi National Accelerator Laboratory); LEWIS, Samantha (Fermi National Accelerator Laboratory); SUSSMAN, Sara; RAY, Shilin; Mr UEMERA, Sho (Fermilab); DYSON, Taj (Stanford University); NOVATI, Valentina (Northwestern University); Mr NOVOSAD, Valentine (Argonna National Laboratory); YEFREMENKO, Vlad (Argonne National Laboratory); HONG, Ziqing (Northwestern University)

Presenter: SABHARI, Deeksha (Northwestern University)

Session Classification: Poster Session and Reception

Contribution ID: **53** Type: **not specified**

4D Tracking: 28nm sub-10ps TDC ASIC design and characterization

Muon collider detectors will require 4D trackers capable of determining the track time of arrival with tens of pico-second timing precision to reject beam induced backgrounds. As one of the critical components necessary to enable 4D tracking, we developed an innovative 4-channel sub-10ps Time-to-Digital Converter (TDC) ASIC in the 28nm CMOS technology node. The developed TDC is based on a novel 2D Vernier ring-oscillator structure with embedded sliding-scale technique for conversion linearity improvement that will simplify calibration of the TDCs, especially useful in high-channel count implementations such as 4D trackers. In this presentation we will discuss the TDC design and features, simulated results, and recent tests from a TDC prototype ASIC.

Primary authors: SCHWARTZMAN, Ariel (SLAC National Accelerator Laboratory); MARKOVIC, Bojan (SLAC National Accelerator Laboratory); RUCKMAN, Larry (SLAC); GUPTA, Aseem (SLAC National Accelerator Laboratory); MENDEZ, Julian (SLAC National Accelerator Laboratory); KENNEY, Chris (SLAC); SEGAL, Julie (SLAC); TURBINER, Victor (SLAC National Accelerator Laboratory); DONG, Su (SLAC National Accelerator Laboratory)

Presenter: SCHWARTZMAN, Ariel (SLAC National Accelerator Laboratory)

Session Classification: Poster Session and Reception

Contribution ID: **54** Type: **not specified**

Flavor

Thursday, 8 August 2024 11:00 (30 minutes)

Presenter: ZUPAN, Jure (U. Cincinnati)

Session Classification: Parallels

Contribution ID: **55** Type: **not specified**

Neutrinos

Thursday, 8 August 2024 11:30 (30 minutes)

Presenter: DE GOUVEA, Andre (Northwestern University)

Session Classification: Parallels

Contribution ID: **56** Type: **not specified**

Dark Sectors

Thursday, 8 August 2024 12:00 (30 minutes)

Presenter: YU, Tien-Tien (University of Oregon)

Session Classification: Parallels

Contribution ID: **57** Type: **not specified**

Targetry

Thursday, 8 August 2024 11:00 (20 minutes)

Presenter: PELLEMOINE, Frederique (Fermilab -AD - TSD - TRD)

Session Classification: Parallels

Contribution ID: **58** Type: **not specified**

Demonstrators at FNAL

Thursday, 8 August 2024 11:20 (20 minutes)

Presenter: YONEHARA, Katsuya (Fermilab)

Session Classification: Parallels

Contribution ID: **59** Type: **not specified**

Muon Acceleration

Thursday, 8 August 2024 11:40 (20 minutes)

Presenter: BERG, J. Scott (Brookhaven National Laboratory)

Session Classification: Parallels

Contribution ID: **60** Type: **not specified**

R&D at SNS

Thursday, 8 August 2024 12:00 (20 minutes)

Presenter: MOROZOV, Vasiliy (ORNL)

Session Classification: Parallels

Contribution ID: **61** Type: **not specified**

Timing detectors R&D directions

Thursday, 8 August 2024 11:10 (25 minutes)

Presenter: APRESYAN, Artur (Fermilab)

Session Classification: Parallels

Contribution ID: **62** Type: **not specified**

Pixel detectors in a muon collider environment

Thursday, 8 August 2024 11:35 (25 minutes)

Presenter: HEIM, Timon (Lawrence Berkeley National Lab)

Session Classification: Parallels

Contribution ID: **63** Type: **not specified**

Challenges for calorimeter design at a muon collider

Thursday, 8 August 2024 12:00 (25 minutes)

Presenter: CUMMINGS, Grace (Fermilab)

Session Classification: Parallels

Contribution ID: **64** Type: **not specified**

Celeritas: Bringing GPU capabilities to detector simulation R&D

The next generation of High Energy Physics experiments have set a new baseline of computational needs in all DOE frontiers. The energy frontier with the main experiments at the future High-Luminosity Large Hadron Collider, the intensity frontier with neutrino and dark matter experiments, and the cosmic frontier with unprecedented amounts of data from new observatories. The Snowmass community effort has defined that efficient use of accelerated hardware (GPUs) is paramount to enable the full potential of these experiments. It also acknowledges the challenges that come with it, as most codes require a full rewrite to be performant. This need was the main driver for the Celeritas Project, a new GPU-optimal particle transport code that has shown high performance gains on multiple High Performance Computing (HPC) systems. On Perlmutter, an example test problem simulating electromagnetic showers executed on an Nvidia A100 has the same performance as 166 AMD EPYC CPU cores, while using around 3 times less electricity. Celeritas is currently capable of simulating electromagnetic showers and is being expanded to incorporate electromagnetic and decay physics for muons, as well as optical photon physics. In order to be easily integrated with existing Geant4 workflows, Celeritas can be executed within a Geant4 application by offloading available particles and physics to GPU and returning hit information back to Geant4. The extensive R&D needed for a muon collider as proposed by the International Muon Collider Collaboration (IMCC) is a case where the use of current and future HPC systems is fundamental. In this scenario, Celeritas is the ideal avenue for leveraging HPC hardware for detector R&D. Therefore, we will present Celeritas' capabilities, performance results, and describe its usefulness in the context of the IMCC objectives.

Primary authors: LUND, Amanda (Argonne National Laboratory); Dr MORGAN, Benjamin (University of Warwick); Dr BIONDO, Elliott (Oak Ridge National Laboratory); LIMA, Guilherme (Fermilab); HOLLENBECK, Hayden (University of Virginia); Dr ESSEIVA, Julien (Lawrence Berkeley National Laboratory); CANAL, Philippe (FERMILAB); Dr JOHNSON, Seth (Oak Ridge National Laboratory); JUN, Soon Yung (Fermilab); TOGNINI, Stefano (Oak Ridge National Laboratory); EVANS, Thomas (Oak Ridge National Laboratory)

Presenter: TOGNINI, Stefano (Oak Ridge National Laboratory)

Session Classification: Poster Session and Reception

Contribution ID: **65** Type: **not specified**

Neutrino Tridents at Future Neutrino Factory : Synergy with Muon Collider

A precision measurement of rare processes such as Neutrino Tridents can be a powerful probe for physics beyond the standard model. While the near-future neutrino experiments are optimistically sensitive only to a handful of events in some channels, we will discuss how a future neutrino factory can be sensitive probe to these rare processes especially for tau-tridents. A future neutrino factory will be a great tie into the future high-energy muon collider program, where the neutrinos from energetic muon beam will increase the event yield for tridents.

Primary author: CHAUHAN, Garv (Virginia Tech)

Presenter: CHAUHAN, Garv (Virginia Tech)

Session Classification: Poster Session and Reception

Contribution ID: **66** Type: **not specified**

Testing Dynamical Inflection Point Inflation at Colliders

We introduce a minimal setup to achieve dynamical inflection point inflation, utilizing a minimal framework. Our approach examines collider constraints on inflationary parameters using the same field composition. Specifically, we incorporate a dark SU(2)D gauge sector featuring a dark scalar doublet as the inflaton, accompanied by particle content akin to the Standard Model but with degenerate masses. This configuration facilitates the realization of multiple inflection points in the inflaton potential. Notably, all vector-like particles in the exotic content possess identical Standard Model charges, enabling the inflaton's decay into the visible sector for reheating the universe. Our study establishes a vital link between collider constraints and their implications for inflationary parameters.

Primary author: BURK, Francis (University of Pittsburgh)

Co-authors: DASGUPTA, Arnab (Seoul National University of Science and Technology); BATELL, Brian (University of Pittsburgh); XIE, Keping (University of Pittsburgh); DUTTA, Swapnil (University of Pittsburgh); HAN, Tao (University of Pittsburgh)

Presenter: BURK, Francis (University of Pittsburgh)

Session Classification: Poster Session and Reception

Contribution ID: **67** Type: **not specified**

Beam Induced Background and MDI studies at $\sqrt(s) = 3\ TeV$

In order to minimize the Beam Induced Background contribution, shielding nozzles are placed inside the detector. This contribution aims to summarize the studies done on the shape of the nozzles and on the feasibility of detector installation inside them to detect forward muons for the $\sqrt(s) = 3\ TeV$ Muon Collider.

Primary authors: CALZOLARI, Daniele (CERN); LUCCHESI, Donatella (INFN-Padova); CASTELLI, Luca (Sapienza - Università di Roma); Mr COLLAMATI , Francesco (INFN - sezione di Roma)

Presenter: CASTELLI, Luca (Sapienza - Università di Roma)

Session Classification: Poster Session and Reception

Contribution ID: **68** Type: **not specified**

Reducing Computational Resources for Muon Collider Simulations Using a Custom Sub-Nozzle Volume

For all particle colliders, accurate and efficient simulations are necessary for the research and development required to build them. Current muon detector designs have a tungsten nozzle that block beam decays from reaching the detector. These tungsten nozzles produce a significant amount of initial showering (around 95% of the total number of particles) that will never interact with our active sensors. Due to these showers, the computation time to run these simulations can become very long, and sometimes even impossible to perform. A potential fix for this issue is to cut off particle tracking to the particles that will not hit our sensors. This study uses Geant4 to explore options for minimizing computational resources while maintaining high accuracy simulation.

Primary authors: Mr TUNA, Alexander; Mr JENKINS, Devlin (UTK); Mr DERVAN, John; Dr LEE, Lawrence (UTK); Dr HOLMES, Tova (UTK)

Presenter: Mr JENKINS, Devlin (UTK)

Session Classification: Poster Session and Reception

Contribution ID: **69** Type: **not specified**

Characterizing Neutrino Interactions In Proposed Muon Collider Detectors

This work investigates the beam-induced neutrino events in proposed muon collider detectors. Through MC simulations, we have computed the event rates within the detector interaction region for designs, considering both mu+mu+ and mu+mu- colliders. We calculate the physical distribution within the detector components as well as the resulting kinematic distributions of the neutrino-induced primary charged leptons. We also compare it to the other beam-induced backgrounds in scenarios discussed in the literature. We discuss possible applications of these events

Primary authors: BOJORQUEZ-LOPEZ, Luc (Harvard University); HOSTERT, Matheus (Harvard University)

Presenter: BOJORQUEZ-LOPEZ, Luc (Harvard University)

Session Classification: Poster Session and Reception

Contribution ID: **70** Type: **not specified**

Physics at the Muon Collider - the Big Picture

Presenter: ARKANI-HAMED, Nima (IAS)

Session Classification: Plenary

Contribution ID: **71** Type: **not specified**

What is our path to a Muon Collider?

Wednesday, 7 August 2024 16:20 (1h 10m)

Presenters: PATWA, Abid (U.S. Department of Energy); LUCCHESI, Donatella (INFN-Padova); OJALVO, Isobel (Princeton University (US)); MERMINGA, Lia (FNAL); PALMER, Mark (Brookhaven National Laboratory); SEIDEL, Sally (University of New Mexico); HAN, Tao (University of Pittsburgh)

Session Classification: Panel Discussion

Contribution ID: **72** Type: **not specified**

Mini-talks

Friday, 9 August 2024 11:00 (1 hour)

Presenters: LIU, Da (UC, Davis); LEWIS, Ian (University of Kansas); DUTTA, Juhi; XIE, Keping (University of Pittsburgh); HOSTERT, Matheus (Harvard University); LI, Peiran (University of Minnesota); WANG, Si; CHANG, Spencer (University of Oregon); FIGY, Terrance (Wichita State University)

Session Classification: Parallels

Contribution ID: **73** Type: **not specified**

Muon collider physics and simulation

Friday, 9 August 2024 09:00 (45 minutes)

Presenter: LIU, Zhen (University of Minnesota)

Session Classification: Parallels

Contribution ID: **74** Type: **not specified**

Theory group discussion

Friday, 9 August 2024 09:45 (45 minutes)

Presenter: MEADE, Patrick (Stony Brook University)

Session Classification: Parallels

Contribution ID: **75** Type: **not specified**

Introduction

Thursday, 8 August 2024 11:00 (10 minutes)

Presenters: DIPETRILLO, Karri (The University of Chicago); PAGAN GRISO, Simone (Lawrence Berkeley National Laboratory)

Session Classification: Parallels

Contribution ID: **76** Type: **not specified**

Tutorial Material

Friday, 9 August 2024 09:00 (1h 30m)

Presenters: TUNA, Alexander; PAGAN GRISO, Simone (Lawrence Berkeley National Laboratory)

Session Classification: Parallels