Muon Collider Symposium I (1+6 talks)

1 -- APR21-2021-001620 The Case for a Future Muon Collider 36'
Nathaniel Craig
In this talk I'll outline an aspirational theory case for the physics potential of a high-energy muon collider, emphasizing the unique advantages provided by energetic muon beams. I'll highlight the opportunities for a muon collider to probe a range of beyond-the-Standard Model phenomena including dark matter, naturalness, and the origins of electroweak symmetry breaking, focusing on the energy and luminosity goals that would position such a collider as a natural successor to the LHC and proposed electron-positron Higgs factories.

2 -- APR21-2021-000969 Simulation of Beam induced Background at Muon Collider and Study of its properties
Camilla Curatolo, Donatella Lucchesi, Francesco Collamati, Alessio Mereghetti, Paola Sala, Nikolai Mokhov, Nazar Bartosik, Massimo Casarsa, Sergo Jindariani, Mark Palmer, Simone Pagan Griso, Ron Lipton
Muon collider detector performance is critically related to the background produced by muon beam decay through the ring. It is therefore fundamental to contain the beam induced background and to carefully predict its characteristics. A novel simulation tool composed by LineBuilder and Fluka has been developed and the results obtained are benchmarked against the ones obtained by the MAP collaboration via MARS15. We report a detailed study of beam-induced background at few center-of-mass energies and comparison among some possible muon collider configurations

3 -- APR21-2021-000978 Physics Object reconstruction optimization at Muon Collider within the ILCSoftware
Nazar Bartosik, Paolo Andreetto, Alessio Gianelle, Lorenzo Sestini, Massimo Casarsa, Laura Buonincontri, Chiara Aime', Cristina Riccardi, Federica Legger, Tova Holmes, Paola Sala, Karri DiPetrillo, Christian Herwig, Lesya Anna Horyn, Stefan Spanier
The ILCSoft framework, developed for the International Linear Collider and later for CLIC, is now a backbone of the full-simulation studies at a Muon Collider. In contrast to electron-positron colliders, where this framework has been mostly used, a number of computational challenges have to be faced in the Muon Collider environment. The main reason for the increased simulation and reconstruction complexity is the presence of an unprecedented amount of beam-induced background particles arriving to the detector region in a single bunch crossing due to the unstable nature of muons. Performing a full simulation and reconstruction of all the particles is high CPU time consuming, but the distinct temporal and spatial distributions of this background allow to strongly reduce the amount of computation spent on irrelevant object reconstruction. This contribution presents a series of optimisations to the detector simulation workflow, tracker and calorimeter hits digitization as well as track and particle-flow reconstruction sequence taking into account the characteristic properties of the beam-induced background.

4 -- APR21-2021-000352 WIMPs at High Energy Muon Colliders
Zhen Liu, Tao Han, Xing Wang, Lian-Tao Wang
The Weakly Interacting Massive Particle (WIMP) paradigm is one of the most compelling scenarios for particle dark matter (DM). We show in this paper that a high energy muon collider can make decisive statements about the WIMP DM, and this should serve as one of its main physics driver cases. We demonstrate this by employing the DM as the lightest

member of an electroweak (EW) multiplet, which is simple, yet one of the most challenging WIMP scenarios given its minimal collider signature and high thermal target mass scale of 1 TeV-−23 TeV. We perform a first study of the reach of high energy muon colliders, focusing on the simple, inclusive, and conservative signals with large missing mass, through the mono-photon, VBF di-muon, and a novel mono-muon channel. Using these inclusive signals, it is possible to cover the thermal targets of doublet and triplet with a 10 TeV muon collider. Higher energies, 14 TeV-−75 TeV, would ensure a 5σ reach above the thermal targets for the higher EW multiplets. We also estimate the reach of a search for disappearing tracks, demonstrating the potential significant enhancement of the sensitivity.

5 -- APR21-2021-000972 Jet Reconstruction performance at Muon Collider with Beam-induced Background

Lorenzo Sestini, Donatella Lucchesi, Davide Zuliani, Alessio Gianelle, Paolo Andretto, Laura Buonincontri, Nazar Bartosik, Nadia Pastrone, Massimo Casarsa, Maximilian Swiatlowski, Marco Valente, Ivano Sarra

Muon collider is being proposed as next generation facilities, since clean events as in electron-positron colliders are possible, and high collision energy as in hadron colliders could be reached, due to negligible radiation losses. In a multi-TeV muon collider a considerable number of Higgs bosons events can be produced, including double and triple Higgs events, allowing an unprecedented precision for measurements in the Higgs sector. It is evident that the b-jet reconstruction will play an important role in these measurements. The main challenge for the detector is represented by the beam-induced-background produced by muon decays and subsequent interactions with the machine. In this contribution the possible calorimeter technologies that could be employed to face this background and to keep high performance in the jet reconstruction are discussed. Moreover results on the b-jets reconstruction and identification obtained by studying the full simulation of the experiment are presented.

6 -- APR21-2021-000727 Determination of the double Higgs cross section and trilinear Higgs coupling sensitivities at Muon Collider

Laura Buonincontri, Donatella Lucchesi, Camilla Curatolo, Lorenzo Sestini, Sergo Jindariani, Alessio Gianelle, Paolo Andreetto, Nazar Bartosik, Massimo Casarsa, Katherine Pachal, Hannsjoerg Weber, Lawrence Lee, Simone Pagan Griso, Karol Krizka, Maximilian Swiatlowski, Marco Valente

A multi-TeV center-of-mass energies muon collider is the ideal machine to study the Higgs boson properties. In fact, in the multi-TeV energies scale the double and triple Higgs boson production rate will be sufficiently high to directly measure the parameters of trilinear and eventually quadrilinear self-couplings, enabling the precise determination of the Higgs boson potential. In this contribution the expected sensitivity of an experiment at muon collider at □√ of 3 and 10 TeV on double Higgs production cross section and on the trilinear self-coupling is presented by using the full simulation of the detector and taking into account the effects of the beam-induced background. Signal (□□+□□−⟶□□□□□□¯, where H ⟶□□¯) and physics backgrounds processes are fully simulated and reconstructed. Multivariate analysis techniques are used to separate signal from background events and to determine the expected sensitivity on the double Higgs cross section measurement and the trilinear self-coupling confidence interval.

7 -- APR21-2021-001175 nuSTORM accelerator; challenges and opportunities

Jonathan Gall, Jaroslaw Pasternak, Chris Rogers

The nuSTORM facility uses a stored muon beam to generate a neutrino source. Muons are captured and stored in a storage ring using stochastic injection. The facility has aims to measure neutrino-nucleus scattering cross sections with uniquely well-characterised neutrino beams; to facilitate the search for sterile neutrino and other Beyond Standard Model processes with exquisite sensitivity; and to provide a muon source that makes an excellent technology test-bed required for the development of muon beams capable of serving as a multi-TeV collider. In this paper, we describe the latest status of the development of nuSTORM, the R&D needs, and the potential role of nuSTORM as a Muon Collider test facility.

Muon Collider Symposium II (1+6 talks)

1 -- APR21-2021-001057 The Muon Collider 36'
Daniel Schulte
A muon collider has a unique potential to achieve high-energy, high-luminosity lepton collisions that can provide discovery reach and precision measurements at the same time. Therefore the recent Update of the European Strategy for Particle Physics demands to form an international collaboration to study the potential of a muon collider. This collaboration is now forming. Furthermore, the ongoing Snowmass process points to a rapidly growing interest in a muon collider within the US particle physics community. The design is based on the results of the past Muon Accelerator Programme in the US and focuses on a 3 TeV and a 10+ TeV collider option. We will introduce the muon collider concept and challenges as well as the forming collaboration and its plans.

2 -- APR21-2021-001360 Muon Collider Lattice Design
Eliana Gianfelice-Wendt
High Energy Physics research is heavily based on particle colliders. There is only one collider operating at the energy frontier, namely the CERN LHC for which a luminosity upgrade is in preparation and is expected to operate until 2035. While many still unanswered questions call for more powerful tools for the post-LHC era, the costs for building and operating larger facilities is the main obstacle to their realization. Technological advancements and new ideas are key ingredients for overcoming the impasse. A Muon Collider could be a more affordable alternative to hadron and electron-positron colliders. First proposed by Budker in 1967, the idea of a MC has been revived in the US at the end of the 90s and many studies addressing the different aspects of such a facility have been published. In this talk I will give an overview of lattice designs which were proposed for the MC before such studies were put on hold in 2016.

3 -- APR21-2021-001181 Muon Cooling Channel Design Status
Diktys Stratakis
A Muon Collider requires a reduction of the six-dimensional emittance of the captured muon beam by several orders of magnitude. We present a complete cooling scheme that should meet this requirement. The scheme starts with the front end of a proposed Neutrino Factory that yields bunch trains of both muon signs. Subsequently, a 6-dimensional ionization cooling lattice reduces the longitudinal emittance until it becomes possible to merge the trains into single bunches, one of each sign. Further 6-dimensional ionization cooling is applied to the single bunches followed by final linear transverse cooling within multi-Tesla solenoids. We

review the main accelerator components involved in the above scheme as well detail the required beam and lattice parameters for successful cooling.

4 -- APR21-2021-001258 Magnet Needs for a Muon Collider
Soren Prestemon
A muon collider will require a variety of advanced magnet systems of various flavors, including radiation-tolerant solenoid configurations for beam capture at the target and high-field solenoids for the ionization cooling sections, various fast-ramp dipole magnets for the rapid acceleration sections and large-bore dipoles for the muon storage ring, and large-bore focusing optics for the interaction regions. We review the families of magnets needed for a muon collider, and in each case we summarize the current state of the art in magnet performance. The importance of evaluating the tradeoff in muon collider performance with magnet parameters is highlighted, so as to identify the most important magnet design elements that impact a muon collider facility. We summarize the primary technical challenges associated with each flavor of magnet in the context of a muon collider. We will also identify areas of particular interest for integrated design efforts to optimize muon collider performance, where magnet and optics design, together with accelerator physics considerations, are likely to provide unique opportunities for enhanced collider performance optimization.

5 -- APR21-2021-001355 Progress on Radio Frequency Cavities for Use in Muon Cooling Channels
Daniel Bowring, Alan Bross, Ben Freemire, Yagmur Torun, Katsuya Yonehara
An intense muon beam produced by the decay of pions coming from a high power proton beam hitting a target requires significant cooling before it can be useful in a Muon Collider or Neutrino Factory. The preferred method of accomplishing this is ionization cooling, recently demonstrated by the Muon Ionization Cooling Experiment. Efficient cooling requires radio frequency cavities to operate in multi-tesla magnetic fields. This has historically been problematic, as cavities operating under this condition exhibit increased susceptibility to RF breakdown. An experimental program carried out at the MuCool Test Area at Fermilab has experimentally verified two methods that allow normal conducting RF cavities to operate in external multi-tesla magnetic fields. Through the careful design and material selection using beryllium elements, stable high vacuum operation at gradients of 50 MV/m were achieved. Additionally, filling a cavity with high pressure hydrogen gas also allowed operation at 50 MV/m. These solutions eliminate a significant technical risk inherent to muon cooling channels.

6 -- APR21-2021-000507 Electroweak Couplings of the Higgs Boson at a Multi-TeV Muon Collider
Xing Wang, Tao Han, Ian Low, Da Liu
We estimate the expected precision at a multi-TeV muon collider for measuring the Higgs boson couplings with electroweak gauge bosons, □□□ and □□□□ (□=□±,□), as well as the trilinear Higgs self-coupling □□□. At very high energies both single and double Higgs productions rely on the vector-boson fusion (VBF) topology. The outgoing remnant particles have a strong tendency to stay in the very forward region, leading to the configuration of the ``inclusive process" and making it difficult to isolate □□ fusion events from the □□ fusion. In the single Higgs channel, we perform a maximum likelihood analysis on □□□ and □□□ couplings using two categories: the inclusive Higgs production and the 1-muon exclusive signal. In the double Higgs channel, we consider the

inclusive production and study the interplay of the trilinear □□□ and the quartic □□□□ couplings, by utilizing kinematic information in the invariant mass spectrum. We find that at a centre-of-mass energy of 10 TeV (30 TeV) with an integrated luminosity of 10 ab−1 (90 ab−1), one may reach a 95\% confidence level sensitivity of 0.073\% (0.023\%) for □□□ coupling, 0.61\% (0.21\%) for □□□ coupling, 0.6\% (0.20\%) for □□□□ coupling, and 5.6\% (2.0\%) for □□□ coupling.

7 -- APR21-2021-000768 Track Reconstruction at a Muon Collider in the Presence of Beam-induced Background
Massimo Casarsa, Alessandro Montella, Paolo Andreetto, Laura Buonincontri, Alessio Gianelle, Lorenzo Sestini, Donatella Lucchesi, Nazar Bartosik, Nadia Pastrone, Sergo Jindariani, Hannsjoerg Weber, Karol Krizka, Simone Pagan Griso, Elodie Resseguie, Lawrence Lee, Federico Meloni, Philip Chang, David Yu
Among the projects currently under study for the post-LHC generation of particle accelerators, the muon collider represents a unique machine, which has the capability to provide leptonic collisions at energies of several TeV and to open the path to a vast and mostly unexplored Physics programme. However, on the experimental side, such a great Physics potential is accompanied by unprecedented technological challenges, due to the fact that muons are unstable particles. Their decay products interact with the machine elements and produce an intense flux of background particles that eventually reach the detector and might degrade its performance. Being the closest detector to the beamline, the tracker is the most affected by the beam-induced background. This contribution will outline the measures adopted in order to mitigate the background effects on the track reconstruction and will present the tracking performance in the presence of the beam-induced background.

Muon Collider Symposium III (1+6 talks)

1 -- APR21-2021-000930 Design a detector for a Muon Collider experiment 36'
Simone Pagan Griso, Sergo Jindariani, Ron Lipton, Nadia Pastrone, Donatella Lucchesi, Umberto Dosselli, Massimo Casarsa, Lorenzo Sestini, Nazar Bartosik, Cristina Riccardi, Francesco Collamati, Hannsjoerg Weber, Maximilian Swiatlowski, Lawrence Lee, Federico Meloni, Paola Sala, Tova Holmes, Elizabeth Brost, Mia Liu, Katherine Pachal, Ivano Sarra, Isobel Ojalvo, Lian-Tao Wang
The Muon Collider is becoming more and more a realistic option for the next generation of high energy collider machines. Among the technological challenges in the realization of such a machine, the treatment of the beam-induced background is one of the most critical issues for the detector. Beams with intensity from 10^9 up to 10^{11} muons per bunch are necessary to obtain the desired luminosity, which entails a very high rate of muons decay. This contribution will present a first detector proposal based on strategies that have been studied to mitigate the beam-induced background by exploiting new detectors technologies and at the same time aims to meet the performance requirements needed for a vast physics program. An overview of the expected performance will be discussed, within the context of representative physics processes.

2 -- APR21-2021-001099 Advancing physics simulations at a Multi-TeV Muon Collider
Richard Ruiz, Antonio Costantini, Luca Mantani, Olivier Mattelaer, Fabio Maltoni, Xiaoran Zhao

Starting from collider energies of a few TeV, electroweak (EW) vector boson fusion/scattering becomes the dominant production mode at lepton colliders for Standard Model and new physics processes that are relevant to studying the EW sector. In this regime, a muon collider would effectively act as a ``high-luminosity weak boson collider," offering a wide range of opportunities to precisely measure EW and Higgs couplings as well as discover new particles. We present recent Monte Carlo developments in the context of the MadGraph5_aMC@NLO platform that allow for the precise exploration of arbitrary Standard Model and new physics processes.

3 -- APR21-2021-000933 Studies of Tracker Timing and Granularity for the Muon Collider Environment

Hannsjörg Weber, Sergo Jindariani, Ron Lipton, Simone Pagan Griso, Nazar Bartosik, Massimo Casarsa, Lawrence Lee

The particle physics community is currently studying collider projects for the post-LHC era. Among those, muon colliders are particularly interesting due to their ability to reach multi-TeV energies in the environment typical for lepton colliders where backgrounds due to other physics processes are significantly lower than at a hadron collider experiment. However, as muons are unstable particles such a machine will be accompanied with technological challenges for a collider experiment: an unprecedented amount of secondary and tertiary decay products will enter the detector volume. The tracker, being closest to the muon beam, is most affected by this ‘beam-induced background’ (BIB). Most reconstructed hits in the tracker are expected to come from the BIB. In this talk, we will discuss how the BIB can impact the occupancy of a tracker at a muon collider experiment and demonstrate how precision timing information and spatial granularity of such a tracker can be used to keep the occupancy at an acceptably low level that will allow proper reconstruction of the tracks.

4 -- APR21-2020-000112 Muon Ionization Cooling Experiment: Results & Prospects

Daniel Kaplan

A neutrino source based on decay of an intense muon beam would make an ideal source for measurement of neutrino oscillation parameters, and a high-energy muon collider could be the most powerful and cost-effective collider approach in the multi-TeV regime. Muon beams may be created through the decay of pions produced in the interaction of a proton beam with a target. The muons are subsequently accelerated and injected into a storage ring where they decay producing a beam of neutrinos, or collide with counter-rotating antimuons. Cooling of the muon beam would enable more muons to be accelerated resulting in a more intense neutrino source and higher collider luminosity. Ionization cooling is the novel technique by which it is proposed to cool the beam. The Muon Ionization Cooling Experiment collaboration has constructed a section of an ionization cooling cell and used it to provide the first demonstration of ionization cooling. Here the observation of ionization cooling is described. The cooling performance is studied for a variety of beam and magnetic field configurations. The future outlook for muon ionization cooling demonstrations is discussed.

5 -- APR21-2021-001046 Muon source from positron on target (LEMMA)

Mario Antonelli, Maria Enrica Biagini, Manuela Boscolo, Oscar Blanco-Garcia, Andrea Ciarma, Anna Giribono, Susanna Guiducci, Cristina Vaccarezza, Fabio Anulli, Matteo Bauce, Gian Mario Cesarini, Francesco Collamati, Alessandro Variola, Roberto Li Voti, Iryna Chaikovska, Robert Chehab, Alberto Bacci, Illya Drebot, Stefano Luizzo, Pantaleo Raimondi, Donatella Lucchesi, Peter Sievers, Lewis Keller, Nadia Pastrone

Recently alternative schemes to produce muon beams using positrons of about 45~GeV interacting on electrons in target have been studied. The production through the process $\square^+\square^- \longrightarrow \square^+\square^-$ allows very low emittance beams with no needs of cooling. A short review of the studies for a positron driven muon source, known as the Low EMittance Muon Accelerator (LEMMA) concept, will be presented and preliminary performances of the $\square^+\square^-$ source will be described.

6 -- APR21-2021-000531 Composite resonances at a multi-TeV muon collider
Ke-Pan Xie, Da Liu, Lian-Tao Wang
Multi-TeV vector and fermionic resonances generally exist in the composite Higgs models. In this work we investigate the phenomenology of the resonances at high-energy muon colliders, taking the minimal coset SO(5)/SO(4) as the benchmark model. Various possible production and decay processes are studied, and detailed collider simulations are further performed for the most promising channels. For the vector resonances, the projections are made via the radiative return production followed by di-boson and di-fermion decay channels; while for the fermionic resonances, projections are made for the single and pair productions and the exclusive decay of the charge-5/3 top partner $\square_{5/3}$. The interplay between vector and fermionic resonances are also considered.

7 -- APR21-2021-001321 No-Lose Theorem for Discovering the New Physics of $(g-2)_\mu$ at Muon Colliders
Rodolfo Capdevilla, David Curtin, Yoni Kahn, Gordan Krnjaic
The longstanding muon $g-2$ anomaly may indicate the existence of new particles that couple to muons, which could either be light (<~ GeV) and weakly coupled, or heavy (> 100 GeV) with large couplings. If light new states are responsible, upcoming intensity frontier experiments will discover further evidence of new physics. However, if heavy particles are responsible, many candidates are beyond the reach of existing colliders. Using a model-exhaustive approach we show that, if the $(g-2)_\mu$ anomaly is confirmed and no explanation is found at low-energy experiments, a high-energy muon collider program at the TeV - 10 TeV scale is guaranteed to make fundamental discoveries about our universe, either directly discovering new BSM states that account for g-2, or detecting indirect signatures of their existence while proving that their mass is close to the 100 TeV upper bound from perturbative unitarity. The latter is only theoretically consistent if the universe if fine-tuned and the flavour problem of the SM is solved non-minimally. In any scenario, a muon collider program is guaranteed to make fundamental discoveries about our universe. Based on 2006.16277 and ongoing investigations.

Muon Collider Symposium IV (9 talks – 12')

1 -- APR21-2021-001006 Presentation of the High Intensity Frontier Initiative (HIFI) to design a nuSTORM and~a Neutrino Factory based on the ESSnuSB facility
Jean-Pierre Delahaye, Marcos Dracos, Tord Ekelof

When the 5 MW, 2.5 GeV, 1.3 \ textmu s proton pulses hit the ESSnuSB neutrino target there will be a copious production of not only neutrinos but also of muons. These muons can be used to realize low energy versions of nuSTORM for neutrino cross-section measurements and sterile neutrino searches and of a Neutrino Factory for high precision PMNS parameter measurements. An overview will be given of the implementations of nuSTORM and Neutrino factory projects on the ESS site and the design work that will be required to evaluate their technical challenges and physics performances.

2 -- APR21-2021-001071 Target System for Collimated Muon Beam Production
Matteo Bauce, Roberto Li Voti, Gian Mario Cesarini, Gianluca Cavoto, Fabio Anulli, Francesco Collamati
Collimated beams for a Muon Collider can be produced with an intense positron beam stored in a large energy acceptance ring and directed to a multi-target system, producing muon pairs at threshold. To achieve significantly high muon beam intensities, each target of this system must be subject to a high power load and a large integrated Peak Energy Density Deposition (PEDD). Feasibility studies have been carried out investigating the properties of suitable targets: different low-Z materials, varying target thickness and configuration have been considered. A theoretical model has been developed to simulate the time evolution of the target heating, from energy deposition, to space-time temperature field calculation, and to thermal stress field derivation from temperature gradients. A targetry system with multiple elements has been simulated to evaluate the interference effect in each element's heat radiation. Results of the simulations for Be- and C-composites targets will be presented for a specific positron beam bunch pattern.

3 -- APR21-2021-001350 Complementary Probes of Lepton Flavor at a Muon Collider
Qianshu Lu, Samuel Homiller, Matthew Reece
Low energy probes of lepton flavor violation (LFV) are indirectly probing new physics beyond the TeV scale, with order of magnitude advances expected in the future. A high energy muon collider would have the reach to probe similar processes at higher energies, e.g., via □+□−⟶□±□∓, which can be compared to the low-energy flavor-violating decay bounds. Alternatively, in particular models of new physics, new particles with flavor-violating interactions can be produced directly, such as mixed slepton pair production in the MSSM. I'll present some first estimates of the physics reach of a muon collider for both of these scenarios, with an emphasis on the complementarity between low-energy precision experiments and high-energy muon collider searches.

4 -- APR21-2021-001234 Testing Positivity at Muon Colliders
Jiayin Gu, Liantao Wang, Cen Zhang
Certain dimension-eight operator coefficients of the Standard Model Effective Field Theory (SMEFT) are subject to positivity bounds, derived from fundamental principles of Quantum Field Theory, such as unitarity, locality, analyticity, and Lorentz invariance. We discuss the unique advantage of a multi-TeV muon collider in probing these positivity bounds. We point out a special channel, mu+mu- (e+ e-) -> gamma gamma, for which the leading new physics contribution comes only from dimension-8 operators. The positivity bounds are thus applicable to the most direct observable --- the diphoton cross-sections. This unique feature provides a clear, robust, and unambiguous test of the principles of Quantum Field Theory. We estimate the capability of various future lepton colliders and point out the importance of having a high center-of-mass energy in probing this channel. We also perform a combined analysis of the gamma gamma, Z gamma, and ZZ processes in the high energy limit and point out the important interplay among them.

5 -- APR21-2021-000982 A final word on electroweak Dark Matter models at future lepton colliders

Ludovico Vittorio, Salvatore Bottaro, Marco Costa, Dario Buttazzo, Roberto Franceschini, Paolo Panci, Diego Redigolo

Weakly Interacting Massive Particles (WIMPs) are theoretically appealing Dark Matter (DM) candidates. Generalizing the Minimal Dark Matter paradigm, we consider stable DM candidates within a single □□(2)□ □-plet, with odd □ in order to avoid strong constraints from direct detection and □≤7 to ensure calculability. WIMPs are perfect candidates for a high-energy lepton collider, given the electroweak nature of the signal, and since their thermal masses lie in the range 1−45 TeV \footnote{For previous work, see M. Cirelli et al, JHEP, 10 (2014) [Erratum: JHEP 01, 041 (2015)], M. Low et al, JHEP, 08 (2014), T. Han et al, arXiv:2009.11287}. \\ We consider the reach of the mono-□, the mono-W and the di-□ channels, for both scalar and fermion WIMPs. We compute the signal-to-noise ratio and the reaches for each □-plet and compare them with their respective thermal targets. Our key result is that a 30 TeV muon collider can probe the DM 5-plets at 95\% CL, while to produce the 7-plets a higher energy machine is required.

6 -- APR21-2021-001127 Constraining the Higgs potential at the Multi-TeV Muon Collider

Mauro Chiesa, Fabio Maltoni, Barbara Mele, Fulvio Piccinini, Luca Mantani, Mauro Moretti, Xiaoran Zhao

Multi Higgs production at a future high-energy muon collider provides a unique opportunity to gather information on the Higgs potential, ie. the determination of the triple and quartic self-couplings. We explore the potential of combining information from H,HH,HHH production to constrain possible coupling deformations induced by new physics at high scales, including the first matrix-element based evaluation of the irreducible backgrounds.

7 -- APR21-2021-000358 Electroweak parton distribution functions at a high-energy muon collider

Yang Ma, Tao Han, Keping Xie

After the triumph of discovering the Higgs boson at the CERN Large Hadron Collider, people are getting increasingly interested in studying the Higgs properties in detail and searching for the physics beyond the Standard Model (BSM). A multi-TeV muon collider provides a clean experimental environment for the Higgs precision measurements and for the discovery of new particles. However, in high-energy leptonic collisions well above the electroweak scale □□, the collinear factorization of the photon parton distribution function (PDF) based on the ``equivalent photon approximation (EPA)" is not well defined anymore. All the SM particles should be treated as partons that radiated off the beam particles, and the electroweak parton distribution functions (EW PDFs) should be adopted as a proper description for partonic collisions of the initial states. In our work, the Dokshitzer-Gribov-Lipatov-Altarelli-Parisi (DGLAP) formalism is employed to perturbatively resum the potential large logarithms emerging from the initial-state radiation (ISR). We present EW parton luminosities and semi-inclusive cross sections for several important SM processes at a future multi-TeV muon collider and show it is appropriate to adopt the EW PDFs for future high-energy leptonic colliders.

8 -- APR21-2021-000545 Sensitivity on Dark Sector through the Neutralino Production and Muon Pairs Decay at Muon Collider

Chiara Aime, Cristina Riccardi, Paola Salvini, Ilaria Vai
Muon colliders offer a great opportunity to discover and prove new physics beyond the Standard Model. Dark SUSY models, for instance, couple the supersymmetric particles with the dark sector, and long-lived dark matter particles are expected to decay with a clear signature, i.e. very collimated muon pairs. The study of decay channels with dark matter particles coming from neutralinos produced in muon collisions at 3 TeV centre-of-mass energy is presented for the time being without the effects of the machine Beam-Induced Background. Preliminary results of the muon reconstruction performances, obtained by analyzing the final state, characterized by muon pairs, are shown for a possible range of neutralino mass.

9 -- APR21-2021-000932 Tracking with ACTS for a Muon Collider detector
Karol Krizka, Simone Pagan Griso, Tomohiro Yamazaki, Heather Gray, Philip Chang, Donatella Lucchesi, Nazar Bartosik, Massimo Casarsa, Sergo Jindariani, Hannsjoerg Weber, Lawrence Lee, Federico Meloni
Charged particle trajectory reconstruction at a Muon Collider detector is more similar to the hadron collider environment than an electron collider. The presence of the beam-induced background leaves a large hit multiplicity in the tracking detector that complicates the pattern recognition stage of track reconstruction. The BIB hits increase the possible hit combinations that need to be filtered to create valid track candidates. This is analogous to the problem from pile-up hits in an hadron collider detector. The A Common Tracking Software (ACTS) is a library that implements the tracking algorithms developed by the collider tracking community, with a particular focus on hadronic environments. In addition to clever algorithms, it further tackles the tracking performance issue by heavily optimizing the code and exploring novel computing architectures. Due to the experiment-independent design, ACTS allows other experiments to leverage their complex tracking algorithms in different settings. This contribution will explore the usage of ACTS to perform the track reconstruction for simulated muon collider events with full beam-induced background.

POSTER

APR21-2021-000967 Muon Reconstruction Performance in Presence of Beam-Induced Background at Muon Collider

Chiara Aime', Cristina Riccardi, Paola Salvini, Ilaria Vai, Laura Buonincontri, Camilla Curatolo, Donatella Lucchesi, Paolo Andreetto, Alessio Gianelle, Lorenzo Sestini, Nazar

Bartosik, Nadia Pastrone, Massimo Casarsa, Francesco Collamati, Paola Sala, Sergo Jindariani, Simone Pagan Griso

In the context of the simulation and reconstruction forthe Muon Collider, based on CLIC's ILCSoft software, the performances of the muon detector have been studied for muon beams collisions at a centre-of-mass energy of 1.5 TeV. The CLIC muon system foresees to instrument the iron yoke plates with layers of track sensitive chambers in order to enhance the muon identification. The glass Resistive Plate Chambers technology has been adopted both for barrel and endcap region with readout cells of 30x30 mm^2. Alternative MicroPattern Gaseous Detector technologies are under investigation. Simulated data of the particles reaching the muon chambers have been analyzed both for a single muon and a background sample to study the detector layout and performance. The results of a first preliminary study investigating the muon reconstruction efficiency, Beam-induced Background sensitivity, and background mitigation are presented.