

# Early Career Researchers & Muon Colliders

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& Muon Colliders

Wed 28th August 2024 - Via Zoom  
14:00-18:00 (CEST) & 08:00-12:00 (EST)

Q&A  
Discussions  
Design Overview  
Call for External Speakers

Open to:

- Undergraduates
- Masters
- PhDs
- Postdocs
- Students etc.

Interested in:

- Physics
- Engineering
- Computing
- Mathematics
- Communication etc.

International Muon Collider Collaboration  
MuCol  
Funded by the European Union

## Report of Contributions

Contribution ID: 1

Type: **not specified**

# Welcome

*Wednesday 28 August 2024 14:00 (15 minutes)*

**Presenters:** SCHULTE, Daniel (CERN); TAYLOR, Rebecca (CERN)

Contribution ID: 2

Type: **not specified**

## Q&A with IMCC Representatives

*Wednesday 28 August 2024 16:20 (1 hour)*

**Presenters:** BOTTURA, Luca (CERN); LUCCHESI, Donatella (Universita e INFN, Padova (IT)); SCHULTE, Daniel (CERN)

Contribution ID: 3

Type: **not specified**

## Social Discussion

Contribution ID: 4

Type: **not specified**

## **Presentations from external young people - call for abstracts**

Contribution ID: 5

Type: **not specified**

## **Presentations by young IMCC people**

Contribution ID: 6

Type: **not specified**

## Particle Physics

*Wednesday 28 August 2024 14:15 (25 minutes)*

**Presenter:** CESAROTTI, Carissa Joyce (Massachusetts Inst. of Technology (US))

**Session Classification:** Invited Talks

Contribution ID: 7

Type: **not specified**

## Muon Production

*Wednesday 28 August 2024 14:40 (15 minutes)*

Proton Driver, Target & Front-End

**Presenter:** CALZOLARI, Daniele (Universita e INFN, Padova (IT))

**Session Classification:** Invited Talks



Contribution ID: 8

Type: **not specified**

## Muon Cooling

*Wednesday 28 August 2024 14:55 (15 minutes)*

6D and Final Cooling

**Presenter:** STECHAUNER, Bernd Michael (Vienna University of Technology (AT))

**Session Classification:** Invited Talks

Contribution ID: 9

Type: **not specified**

## Accelerator

*Wednesday 28 August 2024 15:10 (15 minutes)*

**Presenter:** AMORIM, David (CERN)

**Session Classification:** Invited Talks

Contribution ID: **10**

Type: **not specified**

## **Magnet Design**

*Wednesday 28 August 2024 15:40 (15 minutes)*

**Presenter:** SCARANTINO, Giuseppe (University of Rome "La Sapienza")

**Session Classification:** Invited Talks

Contribution ID: 11

Type: **not specified**

## Detector Design

*Wednesday 28 August 2024 15:55 (15 minutes)*

**Presenter:** KENNEDY, Kiley Elizabeth (Princeton University (US))

**Session Classification:** Invited Talks

Contribution ID: 12

Type: **not specified**

## Research Talk 1

**Session Classification:** Call for Abstracts:

Contribution ID: 13

Type: **not specified**

## Research Talk 2

**Session Classification:** Call for Abstracts:

Contribution ID: 14

Type: **not specified**

## Research Talk 3

**Session Classification:** Call for Abstracts:

Contribution ID: 15

Type: **not specified**

## Research Talk 4

**Session Classification:** Call for Abstracts:



Contribution ID: 16

Type: **not specified**

## Research Talk 5

**Session Classification:** Call for Abstracts:

Contribution ID: 17

Type: **not specified**

## Research Talk 6

**Session Classification:** Call for Abstracts:

Contribution ID: **18**

Type: **not specified**

## **Collider**

*Wednesday 28 August 2024 15:25 (15 minutes)*

**Presenter:** VANWELDE, Marion

**Session Classification:** Invited Talks

Contribution ID: 20

Type: **not specified**

## Design of pulsed synchrotrons for the high-energy acceleration chain of a muon collider

*Wednesday 28 August 2024 17:35 (10 minutes)*

Reaching collision energy in a matter of milliseconds is a key challenge for the high-energy acceleration chain. The baseline is to use a chain of pulsed synchrotrons including hybrid synchrotrons, a never-operated configuration, that allows working with a more compact machine. Because of the very fast acceleration, we have to distribute the radiofrequency cavities (the acceleration stations) along the machine instead of having one or two dedicated insertions. The lattice design (the way we organize the bending and focusing magnetic elements) has to be adapted to the fast acceleration and ensure good beam parameters.

**Primary author:** SOUBIROU, Lisa

**Presenter:** SOUBIROU, Lisa

**Session Classification:** Call for Abstracts:

Contribution ID: 21

Type: **not specified**

## Complementarity between muon colliders and precision experiments for discovering LFV within a SMEFT approach

*Wednesday 28 August 2024 17:45 (10 minutes)*

The strongest current bounds on lepton flavor violation (LFV) come primarily from low energy precision observables. While these experiments are expected to improve substantially in the next decade, there are cases where a muon collider could complement existing searches. In this talk, we utilize a SMEFT approach to explore the complementarity of muon colliders with low energy experiments for exploring LFV. We find a muon collider could probe regions of parameter space beyond what is explored with low energy experiments, including blind spots that low energy experiments are not sensitive to.

**Primary author:** FRASER, Katherine (Harvard University)

**Co-authors:** BAGHERIAN, Hengameh; ASADI, Pouya (University of Oregon); LU, Qianshu; HOMILLER, Samuel (Harvard University)

**Presenter:** FRASER, Katherine (Harvard University)

**Session Classification:** Call for Abstracts:

Contribution ID: 22

Type: **not specified**

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

*Wednesday 28 August 2024 18:05 (10 minutes)*

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 author:** RASTOGI, Angira (Lawrence Berkeley National Lab. (US))

**Co-author:** PAGAN GRISO, Simone (Lawrence Berkeley National Lab. (US))

**Presenter:** RASTOGI, Angira (Lawrence Berkeley National Lab. (US))

**Session Classification:** Call for Abstracts:

Contribution ID: 23

Type: **not specified**

## Z' boson mass reach and discrimination at muon colliders

*Wednesday 28 August 2024 18:15 (10 minutes)*

BSM theories extending the Standard Model gauge group are well motivated by grand unification, compositeness or flavor symmetries, and naturally introduce additional gauge bosons. Existing experimental bounds coming from LHC exclude the existence of an additional neutral gauge boson  $Z'$  with masses of up to about 5 TeV, depending on the model. The reach could be extended at future lepton colliders due to a cleaner collision environment. In our contribution, we show that a muon collider operating at 10 TeV could extend this reach by an order of magnitude for a vast set of BSM scenarios, far beyond the collider energy. We also present a framework to efficiently discriminate between different  $Z'$  models due to their vector and axial vector couplings using leptonic observables. We briefly discuss the impact of systematic uncertainties as well as beam polarization if available at a muon collider.

**Primary author:** LOESCHNER, Maximilian

**Presenter:** LOESCHNER, Maximilian

**Session Classification:** Call for Abstracts:

Contribution ID: 24

Type: **not specified**

## Electroweak radiation picture of the future multi-TeV muon collider

*Wednesday 28 August 2024 17:55 (10 minutes)*

As a potential energy frontier machine, a multi-TeV muon collider presents a vast array of physics opportunities, ranging from Higgs and top quark production to  $W/Z$  factories, jet studies, and neutrino sources. At energies far exceeding the electroweak scale, radiation effects become crucial and demand careful consideration. I will introduce the electroweak parton framework for high-energy lepton colliders, emphasizing the role of electroweak parton distribution functions (EW PDFs) in governing initial-state radiation (ISR). Utilizing this framework, I will outline the Standard Model (SM) predictions for prospective high-energy electron-positron and muon colliders, offering key insights for future analyses. Additionally, I will explore the rich physics landscape that a future muon collider could unlock, providing a comprehensive overview of the potential scientific advancements at high-energy lepton colliders.

**Primary author:** Dr MA, Yang (INFN Bologna)

**Co-authors:** XIE, Keping (Michigan State University); HAN, Tao

**Presenter:** Dr MA, Yang (INFN Bologna)

**Session Classification:** Call for Abstracts:



Contribution ID: 25

Type: **not specified**

## Towards the optimization of a Muon Collider Calorimeter

*Wednesday 28 August 2024 18:25 (10 minutes)*

In the context of design studies for a new experimental setup, automatic differentiation can play an important role in helping to find the optimal configuration which meets specified requirements. Setting up a differential pipeline that is able to condensate experimental information into a loss, which is subsequently minimized, allows a global approach to a configuration study, and can provide useful insights to improve performances and reduce costs. I will give a brief overview about an optimization of a Muon Collider Calorimeter. I will discuss the framework structure, analysis tools, as well as the reconstruction techniques applied to simulated data, the results obtained by our methods, and the latest efforts in setting up the full pipeline.

**Presenters:** NARDI, Federico (Universita e INFN, Padova (IT) - LPC Clermont); ABBAS, Shahzaib (University Of Karachi)

**Session Classification:** Call for Abstracts:

Contribution ID: 26

Type: **not specified**

## Lessons from the Fermilab Muon g-2 Experiment (E989)

*Wednesday 28 August 2024 18:35 (10 minutes)*

A summary of the beamline for the Fermilab Muon g-2 Experiment (E989) is presented. Particular focus is given to post-target elements such as the liquid lithium lens, along with momentum-cooling wedges in high-dispersion areas and a brief description of how the experiment storage ring has been optimised over multiple experiments since 1959.

**Presenter:** HERROD, Alexander (Ion Beam Applications)

**Session Classification:** Call for Abstracts:

Contribution ID: 27

Type: **not specified**

## Closing

*Wednesday 28 August 2024 18:50 (10 minutes)*

**Presenter:** TAYLOR, Rebecca (CERN)