International Muon Collider Design Study

# Accelerator Design meeting

Monday 05/06/2023, 16:00 – 17:30

(https://indico.cern.ch/event/1283569/)

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| Chair | Daniel Schulte |
| Speakers | David Amorim |
| Participants (Zoom) | Andrea Wulzer, Bernd Stechauner, Carlo Carrelli, Christian Carli, Chris Densham, Chris Rogers, Daniel Schulte, David Amorim, David Neuffer, Elena Fol, F. Sosoho-Abasi Udongwo, Francisco J. Saura, Fulvio Boattini, Hamed Shaker, J. Scott Berg, Kyriacos Skoufaris, Marco Calviani, Massimo Casarsa, Nadia Pastrone, Natalia Milas, Paula Desire Valdor, Qiang Li, Simon Adrian, Ursula van Rienen |

## Meeting Actions

1. None

# 1. News (Daniel Schulte)

- A workshop on the Fermilab Accelerator Complex Evolution (ACE) will take place on 14-15 June. The accelerator evolution towards a muon collider and its physics case will be presented.
  - Daniel Schulte will present the IMCC on June 14
  - Link to the workshop page: https://indico.fnal.gov/event/59663
- Preparation for the LDG meeting planned in July in Frascati is ongoing. A general presentation of the Muon Collider collaboration and its synergies, the EU funding proposal for next year, and the physics drive, will be made.
  - Chris Rogers asked if the EU funding currently prepared only targets magnet or also covers other technology developments → Daniel Schulte said the scope is being discussed, and including developments such as RF cavities embedded in solenoids could be considered.
- The Muon for Future workshop took place in Venice on 29-31 May
  - Chris Rogers presented the demonstrator and test facilities plan, Daniel Schulte the muon collider status.
  - There was a proposal to have a discussion on proton beam targets for muon facilities. Marco Calviani suggested to integrate these discussions to an existing workshop on beam targets.
  - Both PSI and J-PARC are currently investigating low emittance muon sources, a collaboration with them could be fruitful. They will have a workshop at the end of the year.
  - Link to the event: https://agenda.infn.it/event/33270/
- On Tuesday 6 June a first discussion on publication process within the collaboration will take place. The goal is to have a rather light but coherent process for the publications made under the Muon Collider collaboration.

# 2. H- sources and high-power linacs (Alessandra Lombardi and Natalia Milas)

- The presentation has been postponed to a future meeting (tentative date: 4$^{th}$ September 2023).

# 3. Collective effects (David Amorim)

- David Amorim presented the work ongoing on collective effects studies for the 10 TeV Muon Collider
  - It is presently focused on including beam-beam effects for the collider ring.
  - For a given impedance model (10 km long chamber, copper coated tungsten) a scan in bunch intensity is performed. The transverse damper is not included, chromaticity is assumed to be corrected to 0. The muon beam decay is not included either.
  - Two different types of simulations are performed: tracking simulations using XSuite+PyHEADTAIL and Vlasov solver simulations using DELPHI as a cross-check.
    - Tracking simulations can include beam-beam effects. For now only 4D (horizontal and vertical planes) effects are included.

        - Vlasov solver simulations do not include beam-beam effects
    - At zero chromaticity and without beam-beam effect, the instability mechanism is a Transverse Mode Coupling instability. A strong instability appears at 1.8e12 muons per bunch. This instability is present in both tracking and Vlasov simulations.
    - When including beam-beam effects with two interaction points, the mode coupling instability appears to be suppressed in tracking simulations.
    - Next steps include cross-check with a Circulant Matrix Model code for beam-beam effects, inclusion of chromaticity effects, and inclusion of 6D (transverse + longitudinal plane) effects. The two beam impedance effects will also be investigated, in particular for the RCS rings and their numerous RF cavities.

- Discussion
    - Christian Carli remarked that simulations are not including the transverse damper, and once included the damper should help for stability → A transverse feedback is indeed a good mitigation measure for the mode coupling instability (if the coupling involves azimuthal modes 0 and 1). But a slow head-tail instability appears and should also be studied (more details are available in this reference: https://doi.org/10.1103/PhysRevAccelBeams.24.041003).
    - Christian Carli also pointed that an initial transverse offset to the bunch (created by systematic and random injection errors) could amplify a transverse instability → tracking simulations are ongoing to have a first estimate of this effect in the collider.
    - Daniel Schulte added that, in the longitudinal plane, the waist effect at the interaction point could have an important role (as was the case for example with LHeC) and its impact on stability and luminosity reduction should be checked as well.

# 4. AOB (Everybody)

- Reminder: the annual collaboration meeting will take place from 19th June to 22nd June in Orsay, France.
- There will be no meeting on 12th June, the next meeting will be announced in due time.

*Reported by D. Amorim, E. Métral and D. Schulte*