Introduction

D. Schulte for the international muon collider collaboration

Study Implementation

Objective:

In time for the next European Strategy for Particle Physics Update, the study aims to establish whether the investment into a full CDR and a demonstrator is justified. It will provide a baseline concept, well-supported performance expectations and assess the associated key risks as well as cost and power consumption drivers. It will also identify an R&D path to demonstrate the feasibility of the collider.

Deliverables:

Report assessing muon collider potential and describing R&D path to CDR

Scope:

- Focus on two energy ranges:
  - 3 TeV, if possible with technology ready for construction in 10-20 years
  - 10+ TeV, with more advanced technology
- Explore synergy with other options (neutrino/higgs factory)
- Define R&D path

Study Implementation

Objective:

In time for the next European Strategy for Particle Physics Update, the study aims to establish whether the investment into a full CDR and a demonstrator is justified. It will provide a baseline concept, well-supported performance expectations and assess the associated key risks as well as cost and power consumption drivers. It will also identify an R&D path to demonstrate the feasibility of the collider.

Deliverables:

Report assessing muon collider potentia

Scope:

- Focus on two energy ranges:
  - 3 TeV, if possible with technology re
  - 10+ TeV, with more advanced techn
- Explore synergy with other options (neutrino/higgs factory)
- Define R&D path

We need to make sure that this timescale is sufficient for other regions

An important milestone is set by the current Snowmass process

- What do we need to provide and how can we exploit this to the benefit of the muon collider?

Scope

The study aim is to develop a **baseline concept** for a muon collider at two centre-of-mass energy ranges.

- The first **around 3 TeV**, well above a higgs factory
- The second **at or above 10 TeV** extends the energy reach well beyond the capabilities of normal conducting linear colliders. This would likely require more advanced technologies that might not be ready within the next 10-20 years. Try to find the energy limit.
- The potential to use the technology for other purposes such as a Higgs or neutrino factory will be explored, provided this is found synergetic with the high-energy collider study.
- The collaboration will identify an **R&D path** toward a conceptual design
- The collaboration will design a **demonstrator**

Scope

The study aim is to develop a **baseline concept** for a muon collider at two centre-of-mass energy ranges.

- The first **around 3 TeV**, well above a higgs factory
- The second **at or above 10 TeV** extends the energy reach well beyond the capabilities of norma would likely require more advan ready within the next 10-20 yea
- The potential to use the technol Higgs or neutrino factory will be synergetic with the high-energy
- The collaboration will identify ar design
- The collaboration will design a **demonstrator**

We will need to understand the importance of the higgs factory and neutrino facility already for the Snowmass process

Also relevant for the integration into the ECFA efforts

Do we consider physics reach of ILC/CLIC + MC, FCC-ee/CEPC + MC, MC only?

Which information and studies would be required and how much effort is involved?

Tentative Target Parameters

Parameter	Unit	3 TeV	10 TeV	14 TeV
L	10^{34} cm^{-2}s^{-1}	1.8	20	40
N	10^{12}	2.2	1.8	1.8
f_r	Hz	5	5	5
P_{beam}	MW	5.3	14.4	20
C	km	4.5	10	14
<B>	T	7	10.5	10.5
ε_L	MeV m	7.5	7.5	7.5
σ_E / E	%	0.1	0.1	0.1
σ_z	mm	5	1.5	1.07
β	mm	5	1.5	1.07
ε	μm	25	25	25
$\sigma_{x,y}$	μm	3.0	0.9	0.63

Based on MAP source and concept

The same source for all energies

Should we better use integrated luminosities? Based on 5 years of running at full performance?

Achieves physics goal of $L \gtrsim \frac{5\,\text{years}}{\text{time}} \left(\frac{\sqrt{s}_\mu}{10\,\text{TeV}}\right)^2 2 \cdot 10^{35}\text{cm}^{-2}\text{s}^{-1}$

Proposed Plan

- A start-to-end collider design in particular in the view that this would be the first facility of its kind.
- A machine detector interface that protects the detector from collider background while allowing good machine performance.
- A physics and detector study to assess the physics reach of the collider.
- The design of a demonstrator to be built in the second half of the decade.

Short-term Goals

Continue to develop the physics justification

- benchmark points are key ingredient
- High-energy is the key
- should carefully consider low-energies
  - muon collider as stand-along approach
  - with lower energy higgs factory, most likely the best scenario
    - muon collider-based higgs factory vs. ILC/CLIC/FCC-ee/CEPC/…
  - complementary to hadron collider

Start to address the challenges to perform the actual measurements

- start to define the detector performance specifications
  - a Delphes card might allows to extend existing studies to muon collider
- identify and overcome technology bottlenecks in the detector
- start to understand the background and its impact
  - from the machine and the beam-beam

Short-term Goals, cont.

Simulation framework to include realistic detector and background

- will need time on the machine side to develop/optimise lattices
- start exercising the process even if high energy background will only come later

Identify what we can do for Snowmass and what comes afterwards

- **I think it is no problem if plenty of work is left for the future**

Need to prepare for ECFA

- **What is our higgs factory concept? High energies or more?**

Higgs factory task force

- **How does MC only compare to ILC/CLIC/FCC-ee/CEPC + MC ?**
- **Promises, status and efforts required to address low-energy MC higgs factory**
  - **is it worth the effort now?**

Reach out to other communities and involve more people

- **This will be the long-term key to success**

Short-term Goals, cont.

Simulation framework to include realistic detector and background

- will need time on the machine side to develop/optimise lattices
- start exercising the process even if high energy background will only come later

Identify what we can do for Snowmass and what comes afterwards

- **I think it is no problem if plenty of work is left for the future**

Need to prepare for ECFA

- **What is our higgs factory concept? High energies or more?**

Higgs factory task force

- **How does MC only compare to ILC/CLIC/FCC-ee/CEPC + MC ?**
- **Promises, status and efforts required to address low-energy MC higgs factory**
  - **is it worth the effort now?**

Reach out to other communities and involve mo

- **This will be the long-term key to success**

Note: The MoU is being prepared
Will go to the Laboratory Directors Group in September