Introduction to Working Groups

C. Ahdida, L. Bottura, C. Carli, A. Chance, A. Grudiev, A. Lechner, R. Losito, D. Lucchesi, N. Milas, L. Quettier, C. Rogers, A. Wulzer,

Collaboration Meeting, CERN, 11-14 October 2022

Physics Studies Status

MuC is **established** in future colliders landscape

- 100+ pheno papers on MuC after 2019/2020 Strategy (0- papers previous years)
- Snowmass endorsement
- EPJC request for Review Article "Towards a Muon Collider"

Next step is to **consolidate** the physics case

- Develop **theoretical tools** we do not currently posses

  EW Radiation effects need **resummation**, definitely at 10 TeV. **Not a straightforward extension** of **QCD/EM** Radiation physics. **Our ability to make predictions needs to be demonstrated**
  Monte Carlo generators improvements needed (see Mauro's talk on Thursday)
- Ensure experimental feasibility of key measurements

  How do we see 5 TeV particles (top, W, H, etc)?
  Taking into account that they emit EW radiation (W, Z, H, etc), that we also need to measure?

And to **open new fronts**

- Forward physics

  Tagging forward muons could be unique MuC advantage (see Max's talk) to tag neutral VBF
  Physics with **high-energy neutrinos** from muon decay
- Physics potential along the way (at the facility before exploitation)

  Talks by Patrick and Robert on Thursday

11:00	**Machine-induced background studies for 1.5 TeV and 3 TeV**	*Dr Francesco Collamati*	
	40/S2-D01 - Salle Dirac, CERN	10:50 - 11:10	
	IR optics design for the 10 TeV Muon Collider	*Kyriacos Skoufaris*	
	40/S2-D01 - Salle Dirac, CERN	11:10 - 11:30	
	Machine-induced background studies for the 10 TeV Muon Collider	*Daniele Calzolari*	
	40/S2-D01 - Salle Dirac, CERN	11:30 - 11:50	
	How to use BIB data as input for the detector design	*Nazar Bartosik*	
12:00	*40/S2-D01 - Salle Dirac, CERN*	11:50 - 12:10	
	Magnetic field configurations for the detector	*John Hauptman*	
	40/S2-D01 - Salle Dirac, CERN	12:10 - 12:30	

Machine Detector Interface:

- IR absorbers shape and material optimization IR
- Detector magnetic field definition

14:00	**Tracks reconstruction algorithms performance**	*Karol Krizka*	
	40/S2-D01 - Salle Dirac, CERN	14:00 - 14:25	
	Muon detectors performance	*Chiara Aime'*	
	40/S2-D01 - Salle Dirac, CERN	14:25 - 14:50	
	Electrons and photons reconstruction	*Massimo Casarsa*	
15:00	*40/S2-D01 - Salle Dirac, CERN*	14:50 - 15:15	
	Jets reconstruction and b-tagging: leasson learned and new strategies	*Lorenzo Sestini*	
	40/S2-D01 - Salle Dirac, CERN	15:15 - 15:55	

Status of physics objects reconstruction

	Physics results with full sim and comparison with FastSim	*Luca Giambastiani*	
	40/S2-D01 - Salle Dirac, CERN	16:20 - 16:45	
	Future collider framework	*Andre Sailer*	
17:00	*40/S2-D01 - Salle Dirac, CERN*	16:45 - 17:10	
	Software status and future developments	*Alessio Gianelle et al.*	
	40/S2-D01 - Salle Dirac, CERN	17:10 - 17:35	
	Simulated sample, shared resources, FastSim update (TBA)		
	40/S2-D01 - Salle Dirac, CERN	17:35 - 17:55	
18:00	**BIB usage**	*Nazar Bartosik*	
	40/S2-D01 - Salle Dirac, CERN	17:55 - 18:15	
	Discussion		
	40/S2-D01 - Salle Dirac, CERN	18:15 - 18:30	

Software:

- Status
- New development

09:00	**R&D studies on tracking detector**	*Nicolo Cartiglia*	
	6/R-012 - conference room, CERN	09:00 - 09:15	
	R&D studies on calorimeter detector	*ivano sarra*	
	6/R-012 - conference room, CERN	09:20 - 09:35	
	R&D studies on muon detector	*Ilaria Vai*	
	6/R-012 - conference room, CERN	09:40 - 09:55	

Detector R&D:

- Outline specific needs to muon collider

14:00	**Monte Carlo challenges for the multi-TeV muon collider**	*Mauro Chiesa et al.*	
	6/R-012 - conference room, CERN	14:00 - 14:20	
	Questions and Discussion		
	6/R-012 - conference room, CERN	14:20 - 14:30	
	Toward 10 TeV detector studies	*Laura Buonincontri*	
	6/R-012 - conference room, CERN	14:30 - 14:50	
	Photon reconstruction	*Federico Nardi*	
15:00	*6/R-012 - conference room, CERN*	14:50 - 15:10	
	Discussion on physics objects reconstruction in the forward region		
	6/R-012 - conference room, CERN	15:10 - 15:25	
	Discussion on needs to go to high energy		
	6/R-012 - conference room, CERN	15:25 - 15:35	
	LFUV at muon collider	*Admir Greljo*	
	6/R-012 - conference room, CERN	15:35 - 16:00	

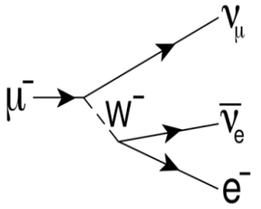
Toward 10+ TeV detector:

- Monte Carlo
- Physics requirements

Proton Driver, Target and Cooling

- Target (Wed 8-11)
  - Discussion on target materials (3 talks)
  - Novel muon production scheme using muon catalysed fusion
  - Discussion on pion yields
- Colling (Wed 11-12)
  - Cooling Rectilinear and Final (2 talks)
  - Colling experience, US views
- Proton Driver (Wed 16-18)
  - European and US views on the proton driver parameters and challenges. (2 talks)
  - LEMMA: positron driven Muon Collider
  - Proton Bunch Compression

High Energy Complex working group



- Acceleration to high energy (after rec. linacs)
  - Pulsed synchrotrons challenging
    - Very fast magnet ramping (power, eddy ..)
    - Orbit variations with fixed SC and cycled NC magnets
    - Circumference variations and longitudinal dynamics
  - FFAs (vertical) an alternative
- Collider ring
  - Very challenging conditions for lattice
    - Small β^*, short bunches, large energy spread..
    - High energy, neutrino radiation
    - Chromatic effects and compensation …..
  - Iterations with WGs on magnet design, beam loss, MDI, radiation protection ..

Parametric study for a rapid cycling ...
Dr Antoine Chance

RF parameter choices and longitudin...
Mr Fabian Batsch

Transverse impedance and stability ...
Dr David Amorim

Update on studies on vertical FFAs
Max Topp-Muggle...

3 TeV collider transverse impedance ...
Dr David Amorim

Wednesday 14:00
6/R-012

Magnet cycling considerations *Fulvio Boattini*
40/S2-D01 - Salle Dirac, CERN 14:00 - 14:20

RF cycling considerations *Mr Fabian Batsch*
40/S2-D01 - Salle Dirac, CERN 14:20 - 14:40

Collider ring lattice proposal *Kyriacos Skoufaris*
40/S2-D01 - Salle Dirac, CERN 14:40 - 15:00

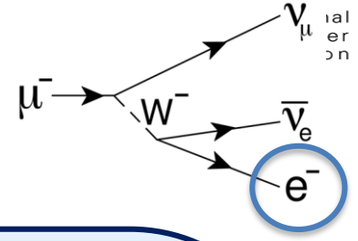
Neutrino radiation for a realistic collider *Christian Carli*
40/S2-D01 - Salle Dirac, CERN 15:00 - 15:20

Thursday 14:00
40/S2-D01

Dedicated sessions on Wednesday and Thursday afternoon

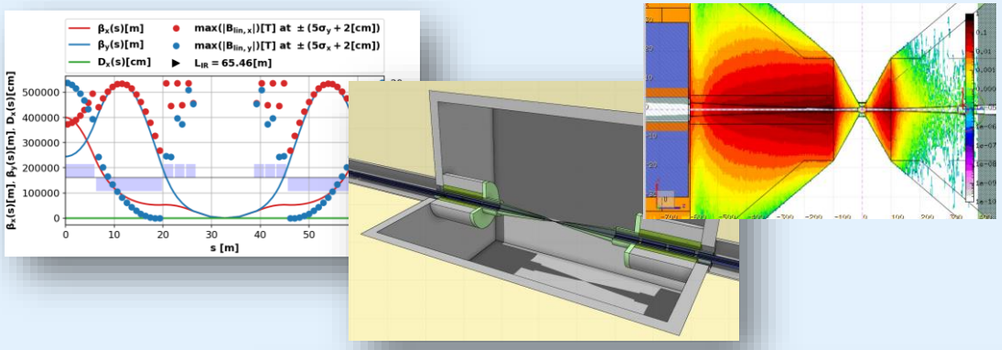
Contributions to and interaction with many WGs (MDI, magnets, beam loss, RP, RF ..)

Radiation challenges due to beam losses



Physics background and radiation damage in detector

Develop a credible **interaction region (IR) design** that yields background levels compatible with detector operation

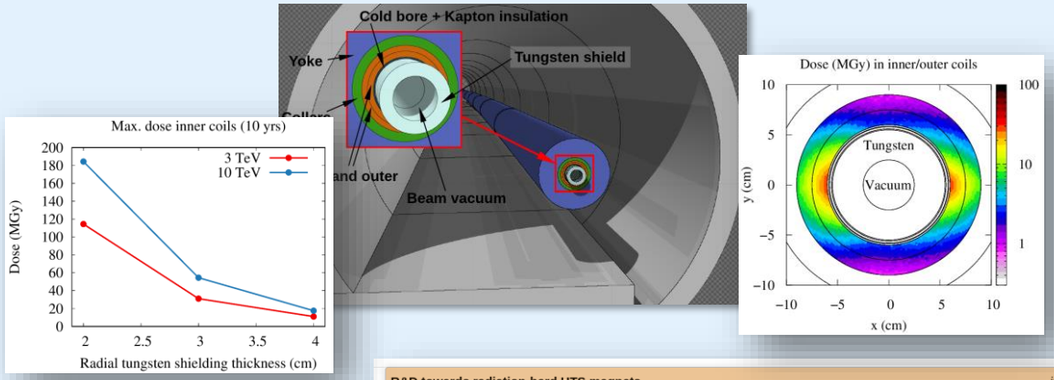


Machine-induced background studies for 1.5 TeV and 3 TeV	*Dr Francesco Collamati*	
40/S2-D01 - Salle Dirac, CERN	10:50 - 11:10	
	Kyriacos Skoufaris	
	11:10 - 11:30	
e 10 TeV Muon Collider	*Daniele Calzolari*	
	11:30 - 11:50	
How to use BIB data as input for the detector design	*Nazar Bartosik*	
40/S2-D01 - Salle Dirac, CERN	11:50 - 12:10	
Magnetic field configurations for the detector	*John Hauptman*	
40/S2-D01 - Salle Dirac, CERN	12:10 - 12:30	

MDI session, jointly between Physics & Detectors - High-Energy Complex (**Wed, 10h50**)

Heat load and radiation damage in accelerator systems (magnets)

Develop a **shielding design** to sustain the thermal load and to prevent system (magnet) failures due to cumulative radiation damage



R&D towards radiation-hard HTS magnets	*iio masami*	
30/7-010, CERN	14:00 - 14:20	
Effect of radiation on stabilizer - impact on stability and protection	*Makoto Yoshida*	
30/7-010, CERN	14:25 - 14:45	
rgy deposition at the muon collider	*Anton Lechner et al.*	
	14:50 - 15:10	
n superconductors summary	*Michael Eisterer*	
30/7-010, CERN	15:15 - 15:35	
Radiation effects in HTS compact fusion devices	*Zachary Hartwig*	
30/7-010, CERN	15:40 - 16:00	

Session on radiation damage in magnets (**Wed, 14h00**)

Radiation Protection Working Group

- One of the main challenges of the muon collider is the **neutrino radiation** and the related **dosimetric impact** on the **public**
- A **refined dose model** for an accurate estimation of neutrino-induced radiation is being developed and used for a **collider ring optimisation** to **minimise** the **effective dose** to members of the public

Neutrino radiation challenges

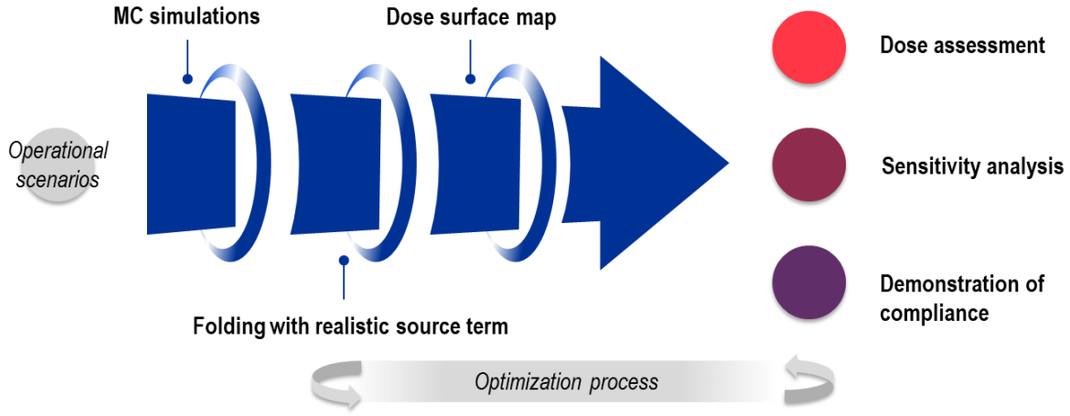
*The **aim** is to **optimize** the facility such as to keep the dose at **O(10) μSv/year** for members of the public*

Siting, dose, neutrinos
(Thu, 16h20)

Accelerator and Colliders
(Thu, 14h00)

14:00 → 16:00 **Plenary Session: Accelerator and Colliders**
Conveners: Dr Antoine Chance (CEA Irfu), Christian Carli (CERN)

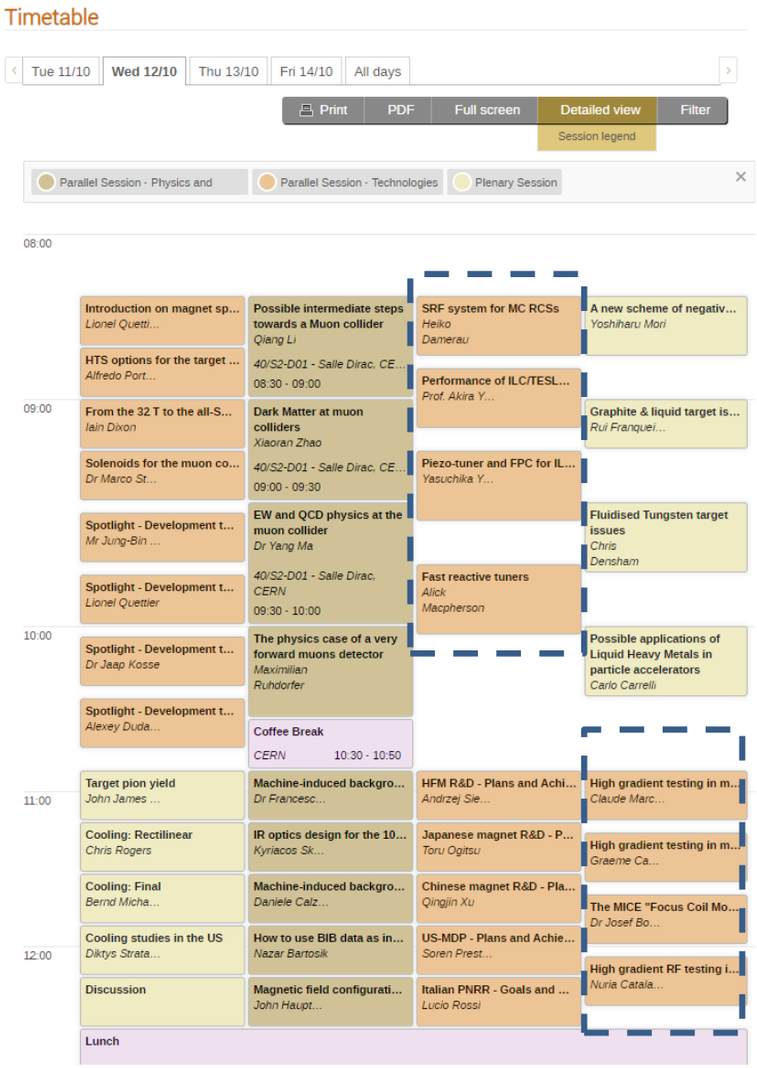
- 14:00 **Magnet cycling considerations** — Speaker: Fulvio Boattini (CERN)
- 14:20 **RF cycling considerations** — Speaker: Mr Fabian Batsch (CERN)
- 14:40 **Collider ring lattice proposal** — Speaker: Kyriacos Skoufaris (CERN)
- 15:00 **Neutrino radiation for a realistic collider** — Speaker: Christian Carli (CERN)



16:20 → 19:00 **Plenary Session: Siting, dose, neutrinos**

- 16:20 **Update on RP aspects** — Speaker: Claudia Ahdida
- 16:40 **FLUKA dose calculations for neutrinos** — Speaker: Dr Giuseppe Lerner (CERN)
- 17:00 **Dose tool development and Siting at CERN** — Speakers: Gil Lacerda (Universidade de Lisboa (PT)), John Andrew Osborne (CERN), Youri Robert (CERN)
- 17:20 **Siting a MC at FNAL** — Speakers: Diktys Stratakis, Pushpalatha Bhat (Fermi National Accelerator Lab. (US))
- 17:40 **Precision neutrino source** — Patrick Huber (remote); Speaker: Patrick Huber
- 18:10 **Charged Lepton Flavor Experiments at FNAL and the Muon Collider** — Speaker: Robert Bernstein

RF session: Wednesday morning, B30/7-010



Time	Title	Name	Affiliation	Participation
Wednesday, 12 October, 2022				
	RF session			
08:30	**SRF**			
20+5	**SRF system for MC RCSs**	**Heiko Damerau**	CERN	in person
20+5	**Performance of ILC/TESLA-type cavities for future MC RCS application**	**Akira Yamamoto**	KEK	remote
20+5	**Piezo-tuner and FPC for ILC/TESLA type cavities**	**Yasuchika Yamamoto**	KEK	remote
20+5	**Fast reactive tuners**	**Alick Macpherson**	CERN	in person
10:50	**NRF**			
20+5	**High gradient testing in magnetic field at CEA**	**Claude Marchand**	CEA	in person
20+5	**High gradient testing in magnetic field in UK**	**Graeme Burt**	U.Lancaster	remote
20+5	**The MICE "Focus Coil Module"**	**Josef Boehm**	STFC	remote
20+5	**High gradient RF testing infrastructure and MgB2 solenoid at CERN**	**Nuria Catalan**	CERN	in person

Objectives of “magnets” parallel session

- Define how to build the “magnetic reference configuration”, starting from US-MAP, and beyond:
  - Updated physics needs
  - Recent advances in magnet technology
- Agree on “representative challenges”, magnets that will provide focus for the specific R&D required to demonstrate feasibility:
  - Tentative performance specifications

- **Highlights of the session**: UHF solenoids technology, performance limits of accelerator magnets, radiation effects, relevant magnet R&D and workplan
- The main driver of the study is to produce a **credible and affordable accelerator complex design** (contain cost, energy efficient, sustainable operation), technology is a mean not the end
- Much work has already been done. **Grateful thanks to our colleagues from US-MAP**

Demonstrator and Test Facilities

- The aim of the session is to assess the status and relaunch studies for a muon cooling test facility at CERN, including possible synergies with nuSTORM.
- The study will be strongly linked to the development of the muon cooling cell to be performed through MuCol
- an overview of the needs for RF testing in strong magnetic fields will close the session.

11:00	**Layout of the facility** *40/S2-D01 - Salle Dirac, CERN*	*Chris Rogers* 10:50 - 11:10
	Possible implementation at CERN *40/S2-D01 - Salle Dirac, CERN*	*Dr Marco Calviani* 11:15 - 11:35
	Synergies with nuSTORM *40/S2-D01 - Salle Dirac, CERN*	*Kenneth Long* 11:40 - 12:00
12:00	**Demands for RF testing in strong magnetic fields** *40/S2-D01 - Salle Dirac, CERN*	*Claude Marchand* 12:05 - 12:25