LNF – Italian Collaboration Meeting – November 13-14, 2023

International Muon Collider Collaboration Status and Plans

Nadia Pastrone
INFN TORINO

RD_MUCOL @ CSN1 – ESPP_MUCOL @ GE

BA BO FE GE MI MIB LNF LNL LNS NA PD PV RM1 RM3 TO TS

Physics, Detector R&D, MDI, Crystals/Targets, Accelerator Activities

HORIZON-INFRA-2022-DEV-01-01

Goals of the collaboration meeting

- ✓ Share our views and plan for next year and future in a nice environment
  - ➔ Thanks to LNF's group: Ivano + Cristina, Eleonora, Elisa…..
- ✓ News on organization and near future deadlines
- ✓ Cooling Cell design, integration and operation
  - ➔ Test facilities ➔ synergies
- ✓ Demonstrator: motivations, synergies
- ✓ Accelerator technology: activities and projects approved by INFN MAC
- ✓ Machine Detector Interface studies ➔ Lattice design

  ➔ Beam Induced background
- ✓ Physics: where we are and what is needed to further studies
  - ➔ identify benchmarks
- ✓ Full simulation (Delphes ?)

  ➔ design experiment @ 10 TeV and study different physics
- ✓ Detector magnet ➔ constraints
- ✓ Detector R&D ➔ Detector Roadmap implementation ➔ DRD collaborations

News on organization

- ✓ **Publication and Speaker Committee**

- ✓ **Parameters document**: MuCol milestone https://mucol.web.cern.ch/
  https://cernbox.cern.ch/s/NraNbczzBSXctQ9

- ✓ **Interim Report**

Publication and Speaker Committee

Members are in the e-group (8 initially):
IMCC-PSC@cern.ch

International MUON Collider Collaboration

- **Chair**: Elias Metral
- **Physics**: Andrea Wulzer + Federico Meloni
- **Detectors**: Donatella Lucchesi + Simone Pagan Griso
- **Accelerators**: Chris Rogers + Marica Biagini + Sergei Nagaitsev

+ Daniel Schulte + Steinar Stapnes + Nadia Pastrone (**Ex-officio**)

International MUON Collider Collaboration

3-page document "Procedures for presentations, conferences and publications" released on 10/10/2023 by Daniel Schulte (see also slides uploaded on the indico site)

Procedures for presentations, conferences and publications

Publication and Speakers Committee

The Publication and Speakers Committee (PSC) is responsible for implementing policy with regards to all types of publication from the International Muon Collider Collaboration (IMCC):

- The PSC consists of a Chair and at least five other members. The PSC chair is proposed by the Study Leader (SL) and approved by the International Collaboration Board (ICB);
- The other members of the publication committee are selected by the study leader in consultation with the chair of the PSC. While preserving continuation, a certain degree of rotation in the chair and membership roles of the Publication Committee is desirable, calling for a replacement of a fraction of the members each year. Normally, a mandate should last two years. Suggestions for new members are encouraged and should be made to the PSC chair. The SL will inform the ICB about new members;
- The PSC is responsible for both implementing the review procedure for papers/notes and maintaining the internal documentation/web pages;
- The PSC will define its internal process. For the reviews it will seek support from experts;
- The PSC regularly reports to the SL, ICB and other relevant governance bodies.

The PSC is also responsible for organising conference presentations on behalf of the IMCC:

- For plenary talks and other particularly important public presentations, the PSC in consultation with the SL, proposes the name of the speaker, taking into account the nature of the meeting;
- The PSC is responsible for maintaining a list of talks from the members of the IMCC;
- For major relevant workshops and conferences the PSC should propose a list of possible contributions to optimise the visibility of the study;
- Normally, slides should be made available for comments at least two days before the talk will be given;
- The PSC is responsible for ensuring that the collaboration is aware of significant conferences where results from the muon collider study could be presented. The PSC, together with the SL and supported by the ICB and SB chairs, is responsible for lobbying for talks at major meetings;
- For major HEP conferences, it is the responsibility of the PSC to submit abstracts on behalf of the IMCC;
- In the case where a specific person, has been asked to speak at a conference, they must inform the Chair of the PSC;
- Important project managerial reports must be approved by the SL. The SL will ensure appropriate consultation within the management team and that the Chair of the PSC is informed.

Publication Rules

Five types of publication are covered, each with specific rules:

- **Collaboration-wide papers**, journal papers such as reviews summarizing broad areas of the accelerator, technologies, detector or physics at the muon collider;
- **Single/multiple author papers**, journal papers based on a specific study, for example a paper summarizing the physics sensitivities from a physics analysis;
- **Notes** (which are not submitted to a journal) but are publicly available;
- **Conference proceedings**.
- **Community Papers,** they express the opinion and support of the community. For instance, papers submitted to the ESPPU or to the Snowmass process may fall under this category. In this case the PSC will manage the process to call for authorship and support to the paper.

In addition there will be categories of

- **Internal Notes** that will not be reviewed or made publicly available. Such notes are intended solely for internal use. These notes will provide reference material for the collaboration, for example, to document technical details of a study.
- **Theses** (PhD and Master) that have been submitted and defended at the home university / institute of the student. These are not reviewed by the collaboration.

Journal Publications

The IMCC will present its results in various types of paper, ranging from single/multiple author papers to collaboration-wide publications.

In all cases it is the responsibility of the PSC to organize the review of the publication and for the formal sign-off. The publication procedure is as follows:

- For all journal publications, there will be an open review process;
- Collaboration-wide publications will use the IMCC author list;
- The author list for other journal publications will be determined by the authors, but is subject to review by the PSC. Such papers should acknowledge the IMCC study;
- The PSC will assign two reviewers for publications.
- After the two-week review period the authors will produce a final draft paper based on the comments received;
- Where there are unresolved issues or disagreement, the PSC chair will adjudicate;
- It is the responsibility of the PSC to ensure that the comments have been addressed and to formally approve the paper for submission to the journal;

Once approved, it is the responsibility of the authors to submit the paper to the journal and place it in the archive.

Conference Proceedings

The rules for conference proceedings are as follows:

- Conference proceedings will be submitted under the name of the presenter and will include the words "endorsed by the IMCC" or "on behalf of IMCC", following the general rules below. The presenter can add additional names as authors;
- It is the responsibility of the PSC to initiate the one-week review process;
- At the end of the one-week review period, the author(s) should prepare the final document – no further iteration is necessary.

Notes

The rules for publicly visible publications are as follows:

- Notes appear under the names of the author(s);
- It is the responsibility of the PSC to initiate a two-week review process;
- At the end of the two-week review period, the author(s) should prepare the final document.

General Rules

Following the MoC the PSC will strive for open access. All publications that are approved by the PSC will include the words "endorsed by the IMCC" if the authors present their own work or "on behalf of IMCC" if the work of the collaboration is presented. The PSC proposes which report qualifies for the later and confirm this with the SL, supported by the CC. The reports will receive a muon collider note number and be made available on the server of the host organisation. Exceptions can be made provided they do not conflict with the MoC.

Collaboration Author List

The PSC will maintain the official collaboration author list and ensure that it is updated when needed.

- Authors should have made some contribution to the IMCC study over the course of the preceeding years;
- It is the responsibility of the ICB representatives to provide a list of authors from their institute to the PSC.
- The PSC will also seek author names from institutions that are not formally part of the IMCC but are contributing to the study. In particular, institutions that are part on another collaboration that is contributing to the muon collider study;
- It is the responsibility of the PSC to ensure that the lists are reasonable and to iterate with the ICB representatives;
- On their request, the PSC adds authors from other institutes provided they contributed to the study. In particular, if they are proposed by an area leader or if they are author of a paper published with agreement of the PSC. The PSC will strive to make potential authors aware of the opportunity and use all relevant contacts and mailing lists that may help with this;
- The complete author list is approved by the SL and distributed to the ICB and the collaboration for a final check.
- On collaboration wide publications, authors will be listed alphabetically;

The author list of community papers will include that of the collaboration wide papers and include additional authors that wish to express their support.

These rules will be updated as the collaboration develops.

Interim Report

Interim Report Key Messages

- Strong interest in the collaboration
  - E.g. US P5 ask
- Substantial increase in resources
  - Thanks to EU Design Study
  - More resources in institutes (e.g. CERN MTP)
- Good progress in studies
  - Many examples
- Still not at required level
  - Manage expectations for 2025/2026
- Synergies
  - Strong synergies exist, in particular for HTS magnet development, strong impact on society
- What will we need in the future?
  - RF test stand, demonstrator etc.
  - Technology developments

Interim Report

Interim Report Structure

Executive Summary (Daniel, Nadia Pastrone, Steinar Stapnes)

Implementation Considerations
- Staging
- Maturity
- Timeline considerations
- Reuse of existing infrastructure, Europe and US, site considerations

Physics Potential (Andrea Wulzer)
- Also synergy physics case

Physics, Detector and Accelerator Interface
- Physics and detector needs (Patrick Meade, Simone Pagan Griso, Federico Meloni)
- MDI (Anton Lechner)

Detector (Donatella Lucchesi)
- Concepts (Lorenzo Sestini)
- Technologies (Nazar Bartosik)
- Performance (Massimo Casarsa)

Accelerator design (Christian)
- Overview
- Proton complex (Natalia Milas)
- Muon production and cooling (Chris Rogers)
- Acceleration (Antoine Chance, Heiko Damerau)
- Collider ring (Christian Carli)
- Collective effects (Elias Metral)

Accelerator technologies (Luca)
- Magnets (Luca Bottura)
- Power converter (Fulvio Boattini)
- RF (Dario Giove, Alexej Grudiev)
- Target (Marco Calviani, Anton Lechner)
- Shielding and Absorbers (Anton Lechner, Rui, Jose)
- Muon cooling module (Lucio Rossi, Roberto Losito)
- Cryogenics (Rob, Patricia)
- Vacuum (Jose)
- Instrumentation (Thibaut?)
- Radiation and protection (Claudia)
- Civil engineering (Yuri, John)
- Movers (Antii, Carlotta)
- Other technologies, Electric supply, HVAC, … (Roberto)
- General safety considerations (Claudia to coordinate)

Synergies (Chris)
- Technologies (Luca Bottura, …)
- Facilities (Chris Rogers)

R&D programme development (Roberto)
- Demonstrator (Roberto Losito, Chris Rogers)
- RF test stand (Dario Giove, Alexej Grudiev)
- Magnet test facility (Lucio Rossi, Luca Bottura)
- Other test infrastructure required (HiRadMat, …) (Roberto Losito)

Collaboration Development (Steinar Stapnes, Nadia Pastrone, Daniel Schulte, also Mark Palmer, Sergo Jindariani, Diktys Stratakis)
- Members, contributions, MuCol, US plans

International MUON Collider Collaboration

Sommario persone/sedi coinvolte e attività

SEDE		FTE	MuCol	AIDA	PNRR	ATTIVITA'				
		*100		I.FAST	IRIS	FISICA/SIMUL	DETECTOR	ACCELERATOR	COMMENTO	PRIN
		RD_MUCOL		aMUSE						
BA		230				x	x		Fisica HCAL (DRD1/DRD6) HPTPC (DRD1)	Calo
BO	DTZ	125				x		x	Fisica teo e Fast ramping Magnets	
FE	DTZ	50					x		Cristalli manipolazione fasci mu e Calo	
GE	DTZ	95	45					x	Magneti	
LNF		300					x		CRILIN (DRD6)	Calo
LNL	DTZ	5	5					x	RF +(bersagni sottili)	
LNS	DTZ	0	20					x	RF	
MI		145	90		80			x	Magneti e RF (40 sj)	
MIB	DTZ	30					x		Test facility-dimostratore	
NA	DTZ	20						x	RF	
PD		325	20			x	x		Fisica Detector Calcolo MDI Dimostratore	
PV		185		30		x	x		Fisica e picosec+ generatori teo	gas
RM1		260	20	10		x			MDI fisica e bersagli/materiali	
RM3	DTZ	50				x			fisica - bersagli e finestre sottili	
TO		215	20	6		x	x	x	fisica R&D det (DRD3) MDI e cooling cell	gas - tracker
TS	DTZ	5	20	5		x	x		fisica e ricostruzione	

Sinergie su fondi esterni EU e MUR dedicati ➔ contribuiscono a definire sedi con **FTE ≥ 2**

TOT FTE	RD_MUCOL	MuCol	I_FAST	AIDAinnova	PNRR-IRIS	PRIN
24,11	20,40	2,40	0,15	0,30	0,80	inclusi RD_MUCOL

PERSONE	RD_MUCOL	MuCol	I_FAST	AIDAinnova	PNRR-IRIS	PRIN
116+2	106	4	-	1	5	inclusi RD_MUCOL

International Collaboration

International MUON Collider Collaboration

Project Leader: *Daniel Schulte*

Objective:
In time for the next European Strategy for Particle Physics Update, the Design Study based at CERN since 2020 aims to **establish whether the investment into a full CDR and a demonstrator is scientifically 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**.

Scope:

- Focus on the high-energy frontier and two energy ranges:

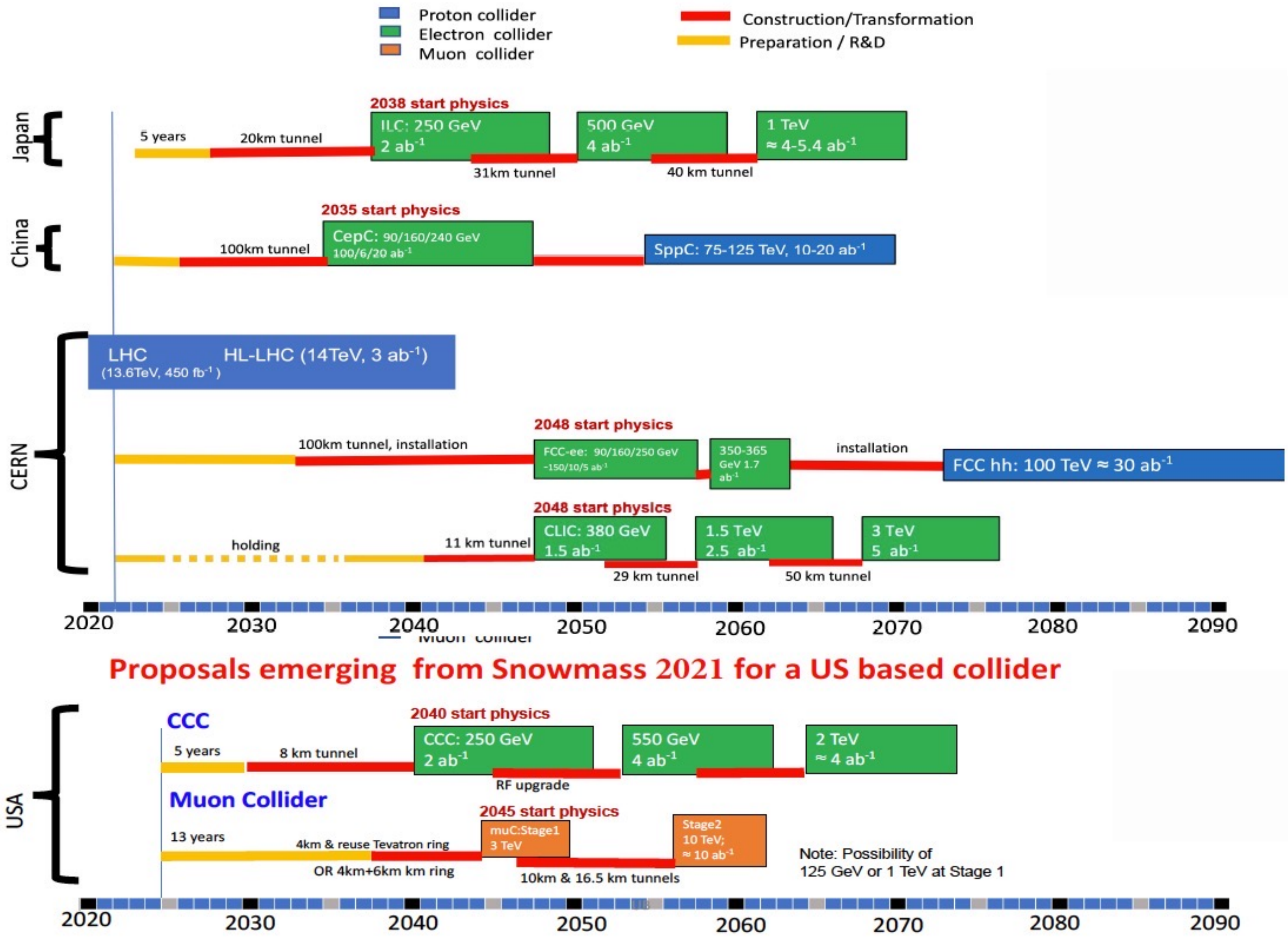
– **3 TeV** if possible with technology ready for construction in 10-20 years

– **10+ TeV** with more advanced technology, **the reason to choose muon colliders**

- Explore synergies with other options (neutrino/higgs factory)
- Define **R&D path**

Web page: http://muoncollider.web.cern.ch

Colliders timescale: Snowmass 2021



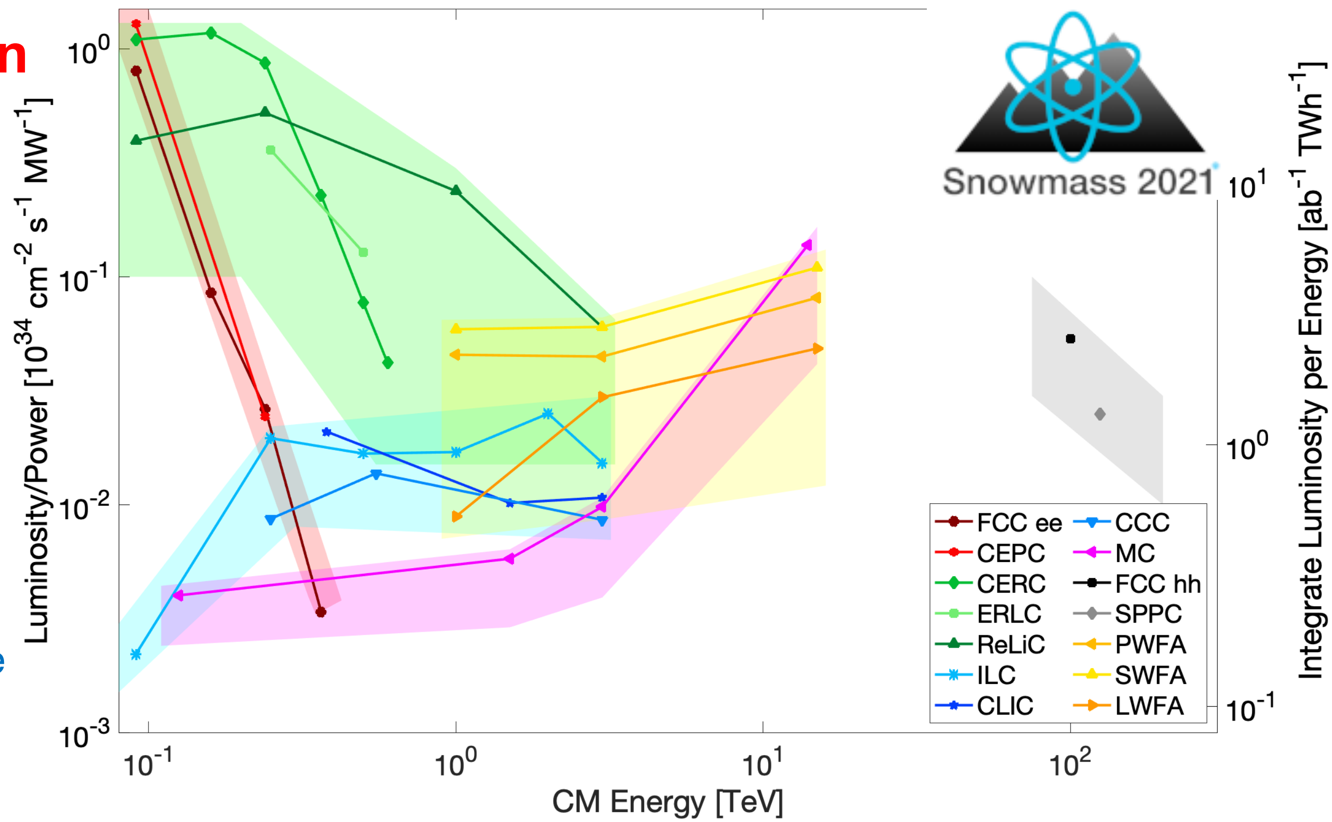
Energy efficiency of present and future colliders

Thomas Roser et al. **Aug 2022**

Report of the Snowmass 2021 Collider Implementation Task Force

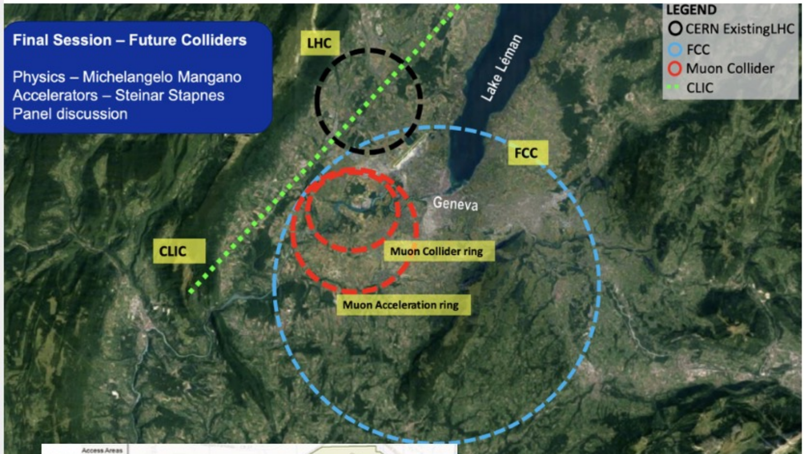
Luminosity per power consumption

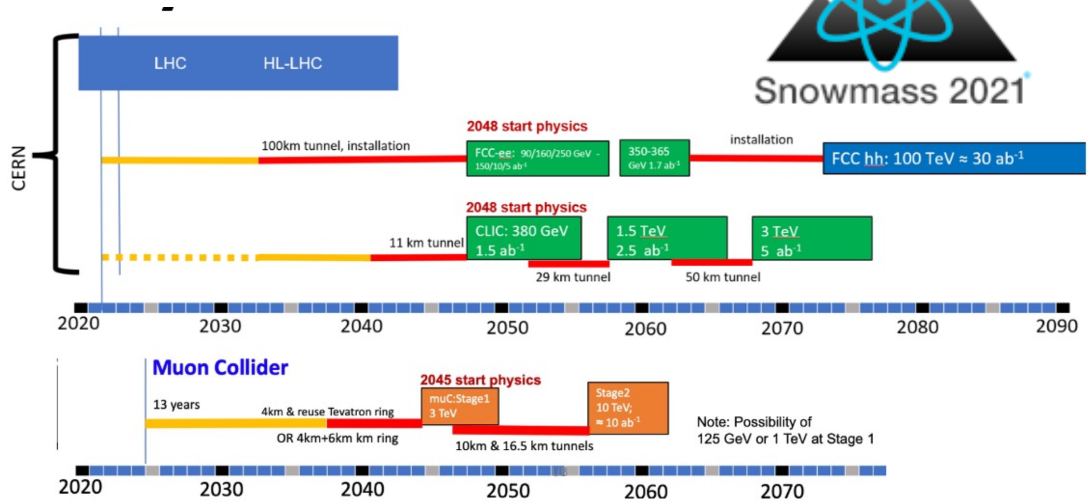
- Figure-of-merit Peak Luminosity (per IP) per Input Power and Integrated Luminosity per TWh.
- Luminosity is per IP and integrated luminosity assumes 10^7 sec/year
- Data points are provided to the ITF by proponents of the respective machine
- The bands around the data points reflect approximate power consumption uncertainty for the different collider concepts.

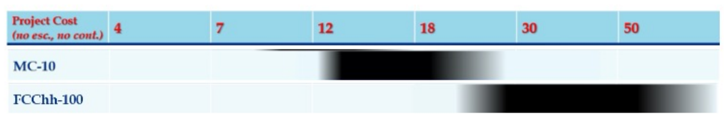


The effective energy reach of hadron colliders (LHC, HE-LHC and FCC-hh) is approximately a factor of seven lower than that of a lepton collider operating at the same energy per beam

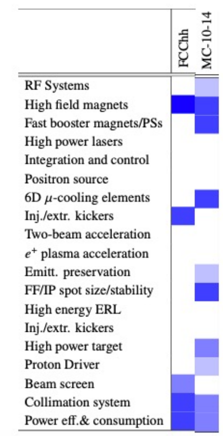
Options @ 10 TeV Scale







Proposal Name	Power Consumption	Size	Complexity	Radiation Mitigation
MC (14 TeV)	~300	27 km	III	III
FCC-hh (100 TeV)	~560	91 km	II	III



- 4 Town Hall Meetings ➔ physics & detector @ BNL
  ➔ accelerators @ SLAC
- P5 Report by October-November 2023
- Accelerator Complex Evolution (ACE) plan @ FNAL

International Design Study facility

- **Focus on two energy ranges:**

Proton driver production as baseline

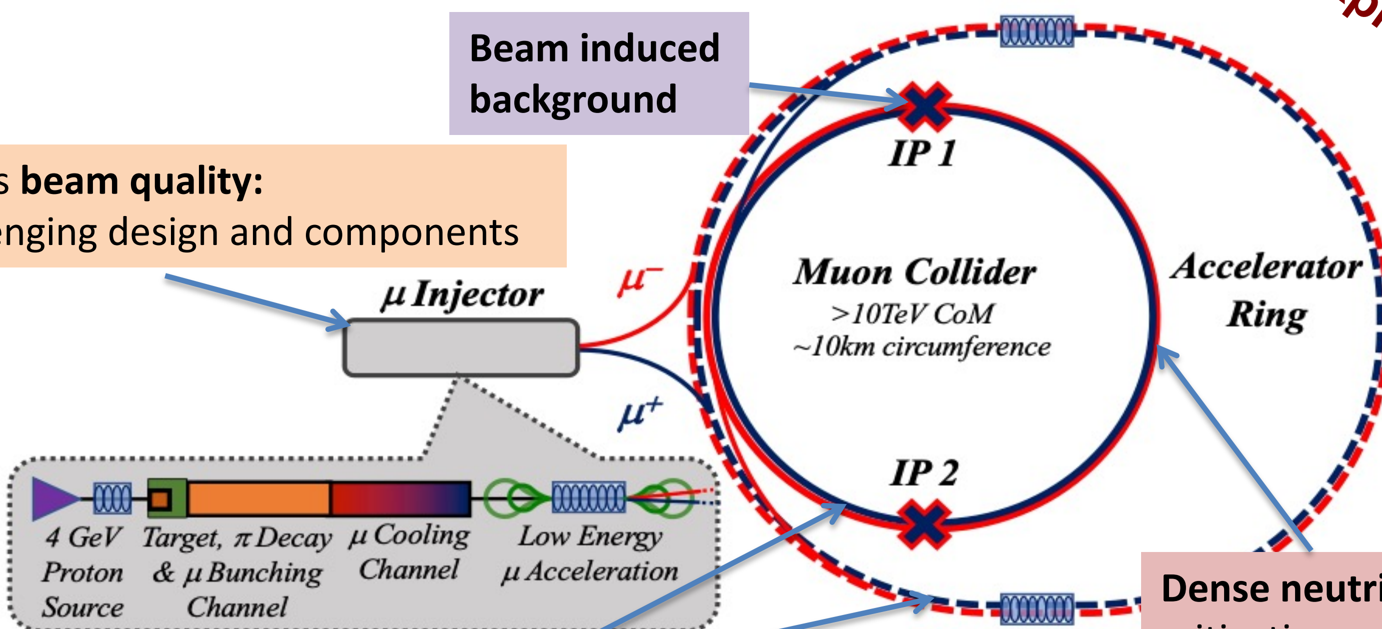
3 TeV technology ready for construction in 10-20 years

10+ TeV with more advanced technology

10+ TeV completely new regime to explore!

Beam induced background

Drives **beam quality:**
challenging design and components



Dense neutrino flux
mitigation and site

Cost and **power** consumption drivers, limit energy reach
e.g. 30 km accelerator for 10/14 TeV, 10/14 km collider ring

IMCC plans

MuCol

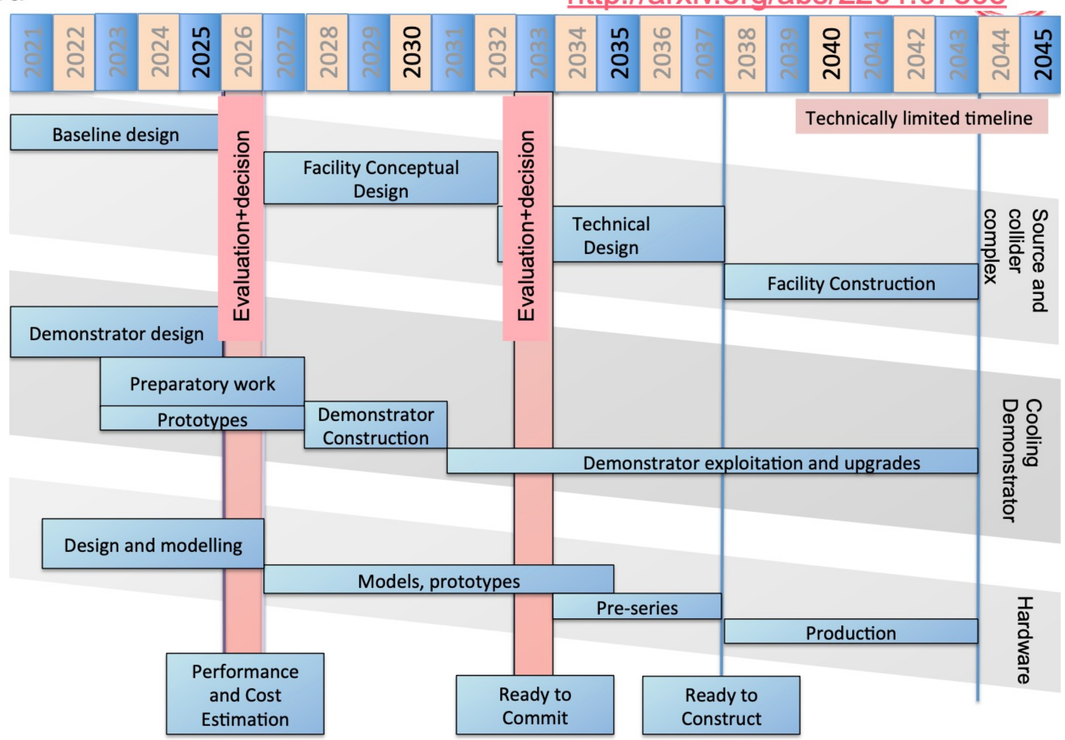
Accelerator R&D Roadmap

International MUON Collider Collaboration

Main goal is **10 TeV** collider
Potential initial stage **3 TeV**

- For **fast implementation**, e.g. directly after HL-LHC
- Compromises will be made as required
- Physics case already good

http://arxiv.org/abs/2201.07895



Deliverables by next ESPPU/other processes

- **Project Evaluation Report**
- **R&D Plan**

Allows to make **informed decisions**

Interim report by end of 2023

Currently resources start approaching minimal scenario

Scenario	FTEy	M MCHF
Full scenario	445.9	11.9
Reduced scenario	193	2.45

D. Schulte Muon Collider, LDG meeting, Frascati, July 2023

Plan

The panel has identified a development path that can address the major challenges and deliver a 3 TeV muon collider by 2045

[Accelerator R&D Roadmap]
[Detector R&D Roadmap]

Label	Begin	End	Description	Aspirational [FTEy]	Aspirational [kCHF]	Minimal [FTEy]	Minimal [kCHF]
MC.SITE	2021	2025	Site and layout	15.5	300	13.5	300
MC.NF	2022	2026	Neutrino flux mitigation system	22.5	250	0	0
MC.MDI	2021	2025	Machine-detector interface	15	0	15	0
MC.ACC.CR	2022	2025	Collider ring	10	0	10	0
MC.ACC.HE	2022	2025	High-energy complex	11	0	7.5	0
MC.ACC.MC	2021	2025	Muon cooling systems	47	0	22	0
MC.ACC.P	2022	2026	Proton complex	26	0	3.5	0
MC.ACC.COLL	2022	2025	Collective effects across complex	18.2	0	18.2	0
MC.ACC.ALT	2022	2025	High-energy alternatives	11.7	0	0	0
MC.HFM.HE	2022	2025	High-field magnets	6.5	0	6.5	0
MC.HFM.SOL	2022	2026	High-field solenoids	76	2700	29	0
MC.FR	2021	2026	Fast-ramping magnet system	27.5	1020	22.5	520
MC.RF.HE	2021	2026	High Energy complex RF	10.6	0	7.6	0
MC.RF.MC	2022	2026	Muon cooling RF	13.6	0	7	0
MC.RF.TS	2024	2026	RF test stand + test cavities	10	3300	0	0
MC.MOD	2022	2026	Muon cooling test module	17.7	400	4.9	100
MC.DEM	2022	2026	Cooling demonstrator design	34.1	1250	3.8	250
MC.TAR	2022	2026	Target system	60	1405	9	25
MC.INT	2022	2026	Coordination and integration	13	1250	13	1250
			Sum	445.9	11875	193	2445

Scenarios

Aspirational		Minimal	
[FTEy]	[kCHF]	[FTEy]	[kCHF]
445.9	11875	193	2445

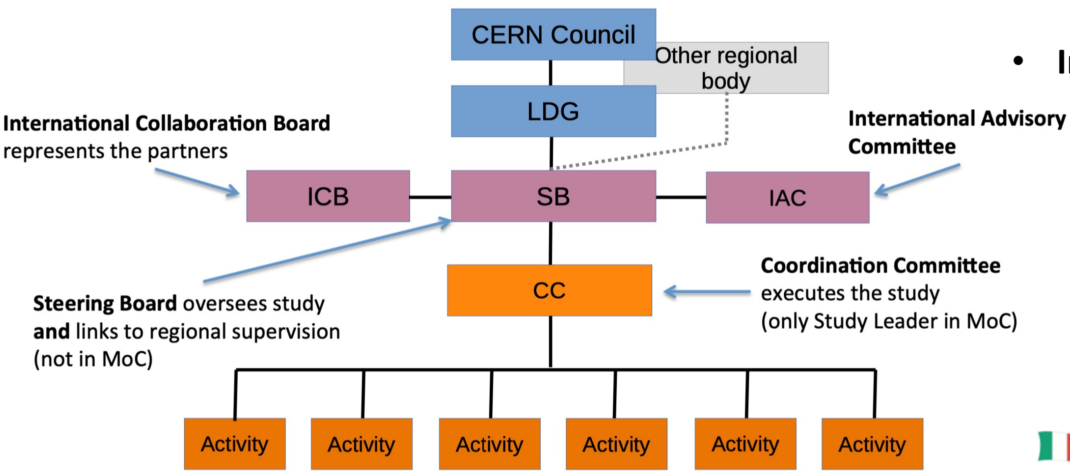
~70 Meu/5 years

Organization after the Roadmap

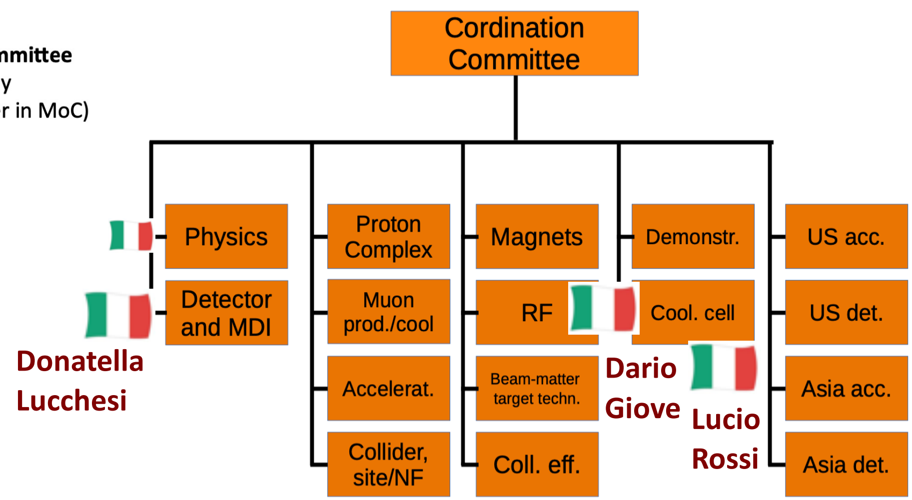
- Study Leader **Daniel Schulte**
  - Deputies: **Andrea Wulzer, Donatella Lucchesi, Chris Rogers**

- **Collaboration Board (ICB)**
  - Elected chair : **Nadia Pastrone**
- **Steering Board (SB)**
  - Chair **Steinar Stapnes**,
  - CERN members: Mike Lamont, Gianluigi Arduini, **Dave Newbold (STFC), Mats Lindroos (ESS), Pierre Vedrine (CEA)** , ICB chair and SL and deputies
- **International Advisory Committee (IAC)** *to be formed*

CERN is host organisation, can be transferred to other partner on request of CERN and with approval of ICB
Will review governance in 2024, US could join at that time



Coordination Committee



MoC signed by CERN CEA INFN STFC-RAL ESS IHEP and different universities in EU, US, China

Resources – Addenda – Grey Book @ CERN

Key Challenge Areas

- **Physics potential** evaluation, including **detector concept and technologies** 🇮🇹
- Impact on the environment
  - **Neutrino flux mitigation** and its impact on the site (first concept exists)
  - **Machine Induced Background** impact the detector, and might limit physics 🇮🇹
- **High-energy systems** after the cooling (acceleration, collision, ...)
  - Fast-ramping magnet systems 🇮🇹
  - High-field magnets (in particular for 10+ TeV) 🇮🇹
- **High-quality muon beam production**
  - Special RF and high peak power 🇮🇹
  - Superconducting solenoids 🇮🇹
  - Cooling string demonstration (cell engineering design, demonstrator design) 🇮🇹
- **Full accelerator chain**
  - e.g. proton complex with H- source, compressor ring ➔ test of target material

High energy complex requires known components
➔ synergies with other future colliders

Design Study activities: EU project

MuCol

Total EU budget: 3 Meu start March 1 '23 – 4 years
18(+14) beneficiaries (associated)

HORIZON-INFRA-2022-DEV-01-01:
Research infrastructure concept development

INFN 510 keu **UniMI** 300 keu **UniPD** 100 keu + associate partners: UniBO, UniPV

MuCol study will produce a coherent description of a novel particle accelerator complex that will collide muons of opposite charge at the energy frontier. The study will target a centre-of-mass energy (ECM) of 10 TeV with 3 TeV envisaged as a first stage.

The main outcome of MuCol will be a **report** documenting the facility design that should demonstrate that:

- the **physics case** of the muon collider is sound and **detector systems** can yield sufficient resolution and rejection of backgrounds;
- there are **no principle technology showstoppers** that will prevent the achievement of a satisfactory performance from the accelerator or from the detectors side;
- the muon collider provides **a highly sustainable energy frontier facility** as compared to other equivalent colliders;
- **exploiting synergies with other scientific and industrial R&D projects**, a valuable platform to provide Europe a leading edge not only in terms of discovery potential, but also for the development of associated technologies.

The final report will include a thorough assessment of benefits and risks of the accelerator and detector complex, including an evaluation of the scientific, industrial and societal return beyond high-energy physics, the cost scale and sustainability of the complex and the impact arising from an implementation on the CERN site.

EU project: WP

WP 2: Physics and Detector Requirements

Leader D. Lucchesi Univ. PD + INFN (M. Casarsa) + many + + Univ. PV associated

Link to the physics and detector studies, to provide a database with Beam-Induced Background (BIB) to the physics community and maintain a simplified model of the detector for physics studies. Based on feedback from the physics community, it will provide feedback and guidance to the accelerator design.

WP 3: The Proton Complex

Leader ESS-CERN-UU

key challenge of the proton complex design, the accumulation of the protons in very high-charge bunches and determine the required basic parameters of the complex.

WP 4: The Muon Production and Cooling

Leader STFC-CERN+ UK

Production of the muons by the proton beam hitting a target and the subsequent cooling

WP 5: The High-energy Complex

Leader CEA(Antoine Chance)-CERN-STFC-INFN (F. Collamati) only MDI

Acceleration and collision complex of the muons. Interaction Region and Machine Detector Interface.

EU project: WP

WP 6: Radio Frequency Systems

Leader INFN(D. Giove - MI – LNL – LNS - NA) CEA(Deputy) -CERN++++

Radio Frequency (RF) systems of the muon cooling and the acceleration complex.

WP 7: Magnet Systems

Leader CERN(L. Bottura)-CERN+++ INFN(GE, MI, BO) + Univ. BO associated

Most critical magnets of the muon collider. In particular focus on the solenoids of the muon production and cooling, which are specific to the muon collider. The fast-ramping magnet system, which has ambitious requirements on power flow and power efficiency and limits the energy reach of the collider,

WP 8: Cooling Cell Integration

Leader CERN(R. Losito)+Univ. MI (L. Rossi)-STFC-INFN(M. Statera – mag. e D. Giove – RF)

Design of the muon cooling cell, which is a unique and novel design and which faces integration challenges: interact to address the challenges of the muon collider concept.

Highlights 2023


infn
INFN Accelerator studies for the upcoming European Strategy for Particle Physics
Pierlugi Campana, Chiara Meroni, Aleandro Nisati
Istituto Nazionale di Fisica Nucleare
Future Circular Colliders – Expanding our Horizons
Lyon, 21-23 November 2022

- INFN at the 2025/6 ESPP: new resources March
- MuCol EU project launched – start April 1 – kick-off March 28
- Second Annual Meeting iFAST – April 17-21 @ Trieste
  https://indico.cern.ch/event/1204855/
- Muon4Future @ Venice May 29-31 https://agenda.infn.it/event/33270/
- IMCC Annual Meeting @ Orsay – June 19-22 + Synergy workshop ==> demonstrator
  https://indico.cern.ch/event/1250075/
- MuCol: training on detector design and physics performance tools – July 5-6 @ CERN
  https://indico.cern.ch/event/1277924/
- LDG Community Report on Accelerators Roadmap – meeting @ LNF July 12-13
  https://agenda.infn.it/event/35579/: facility, physics, magnets, demonstrator and RF
- EPS 2023 and TIPP 2023 - IPAC 2023 and EUCAS 2023
- Detector magnet workshop – October

- Start design new lattice @ 10 TeV ==> design new detector/magnet @ 10 TeV

Attività R&D Acceleratori

simulazioni – prototipi – misure di laboratorio

MI, GE, LNL, LNS, NA, TO, (FE, RM1, RM3)

- Magneti (MI-LASA, GE) ➔ progetto ESPP, EU-MuCol (WP7)
- Radiofrequenze SC (SC-RF) (MI-LASA) ➔ progetto ESPP , EU-MuCol (WP6)
- Radiofrequenze NC-RF (MI-LASA,LNL,LNS,NA) ➔ progetto ESPP , EU-MuCol (WP6)
- Integrazione cooling cell (MI-LASA,LNL,LNS,NA,TO) ➔ EU-MuCol (WP8)
- Machine Detector Interface ➔ progetto ESPP (personale), EU-MuCol (WP2-WP5)

⬇

CRUCIALE PER STUDI DI FISICA E DETECTOR – PERFORMANCE MACCHINA

- *Cristalli per i fasci, misure di laboratorio per finestre sottili in fase di definizione*

ESPP_MUCOL ➔ approvato dal MAC INFN

WP1 - Machine Detector Interface

WP2 - Ionizing Cooling Cell design and integration:

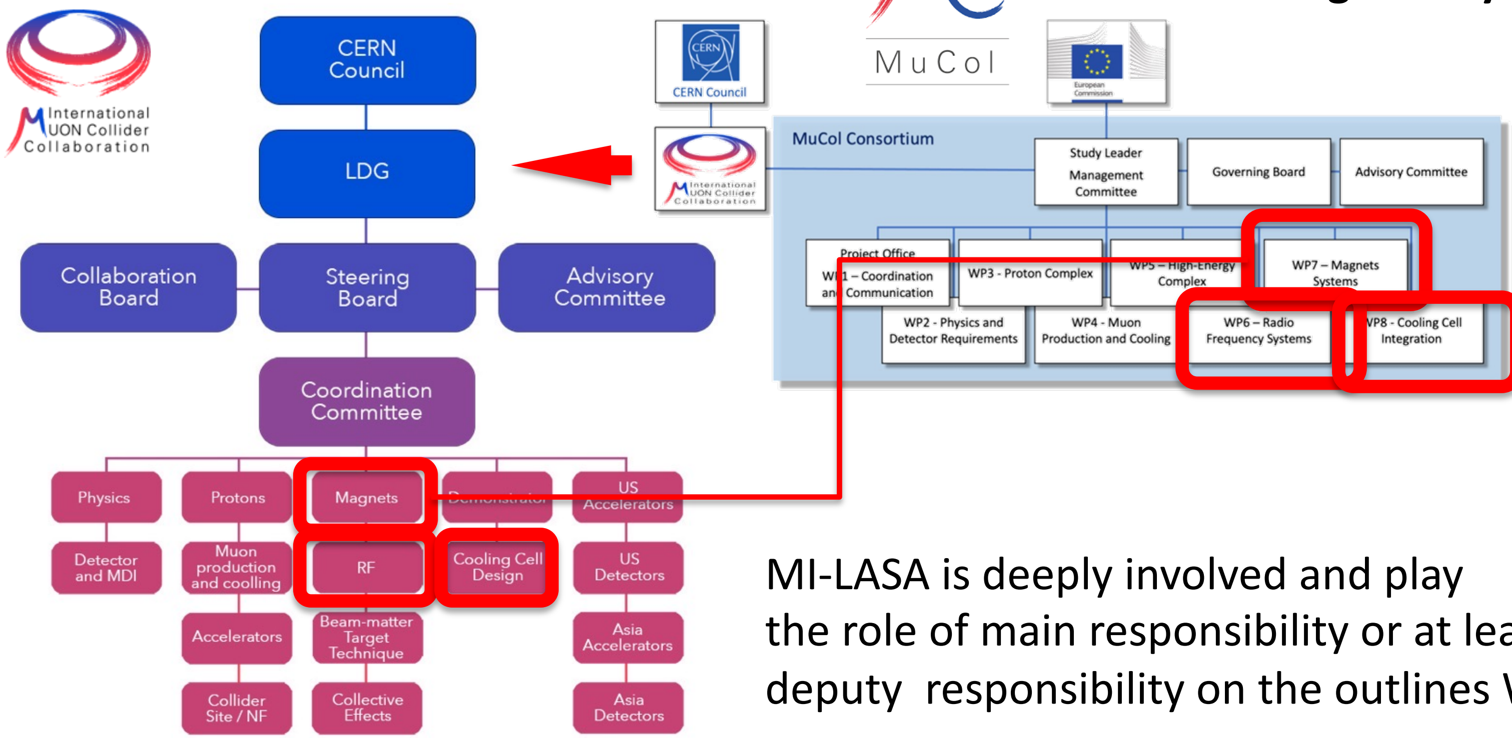
- normal-conducting RF cavities
- high field solenoidal magnets

WP3 - Superconducting RF cavities: fast frequency tuner system

WP4 - High Field dipole Magnets technologies

Project organization

International Muon Collider Collaboration **MuCol EU Design Study**



MI-LASA is deeply involved and play the role of main responsibility or at least deputy responsibility on the outlines WP:

- WP6 RadioFrequency Systems
- WP7 Magnets Systems
- WP8 Cooling cell Integration

Detector R&D

simulations – laboratories and beam tests

- Demonstrator detectors

  ➔ TPC – muon tracking

  ➔ HPTPC ν cross section measurements (synergy)
- Electromagnetic calorimeter ➔ CRILIN
- Hadronic calorimeter with MPGD
- Muon detectors ➔ picosec
- Resistive LGAD ➔ 4D tracking

Investigating synergies on physics and technologies

International MUON Collider Collaboration

29–31 May 2023 Venezia
Palazzo Franchetti
Istituto Veneto di Lettere, Scienze ed Arti

Muon4Future

Second Collaboration Meeting of the Muon Collider Study
Orsay – June 19-22
Synergies Workshop
Orsay – June 22-23

September 6, 2023 h 14:35-18:00
The Muon Collider: a superconducting technology driver for science and society

EUCAS2023

ICFA Seminar

	LHC and HL-LHC	08:30 - 08:50
09:00	SuperKEKB	08:50 - 09:10
	The Electron Ion Collider	09:10 - 09:30
	Research on high-field magnets	09:30 - 09:50
10:00	Super-conducting RF developments	09:50 - 10:10
	Energy-recovery linac research and facilities	10:10 - 10:30
	Coffee break	10:30 - 11:00
11:00	Linear collider proposals	11:00 - 11:25
	The CEPC and SppC proposals	11:25 - 11:45
12:00	The CERN Future Circular Collider study	11:45 - 12:05
	R&D on muon colliders	12:05 - 12:25
	Plasma wakefield acceleration	12:25 - 12:45

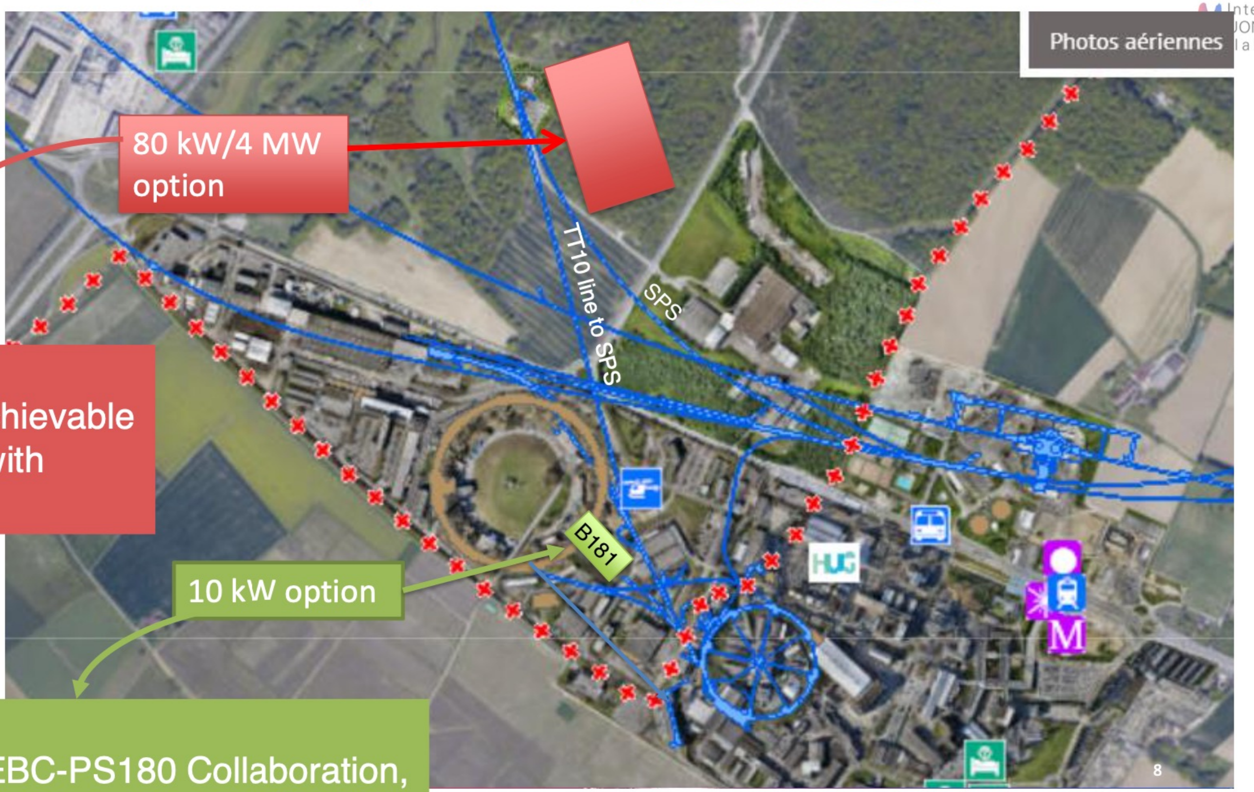
Demonstrator

CERN option, other solutions could be possible

R. Losito IMCC-2023

Both use maximum intensity per pulse ~10^{13} ppp (or more) in pulses of few ns at 20+ GeV.
Different repetition rate:

- 1 pulse/few second
- 1÷2 pulse/per minute



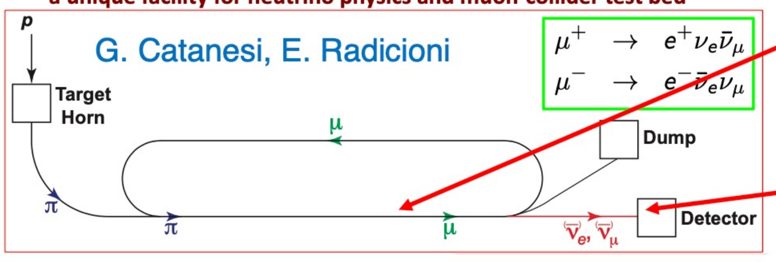
High power
O(80kW) on target easily achievable
No showstopper for 4 MW with beam at a depth of 40 m

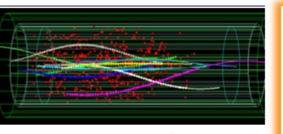
Low power:
Reuse line of BEBC-PS180 Collaboration, decommissioned, extending it towards B181 (now magnet factory)

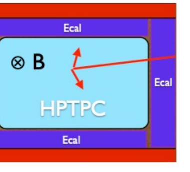
Demonstrator facility will allow:

- Test muon cooling cell and, later, muon cooling functionalities for 6D cooling principle at low emittance including re-acceleration.
- Study high gradients and relatively high-field solenoid magnets for the machine.
- Develop and test high-power production target.

- Identify and construct detectors to measure beam emittances.







Light atmospheric-pressure TPC: excellent tracker for precision emittance study.
High-pressure TPC: ideal active target for precise ν cross-section measurement on a range of target nuclei in a very much needed energy range.
In both cases, the optical readout is an enabling technology, (R&D in DRD1) to access low background and excellent energy resolution.

- Design physics experiment with the relative detectors:
  - nuSTORM and ENUBET could be branched.
  - Possible physics studies…

extras