multi-TeV Muon Collider @ INFN

European Strategy Update – June 19, 2020:

High-priority future initiatives [..]
In addition to the high field magnets the **accelerator R&D roadmap** could contain:
[..] an **international design study** for a **muon collider**, as it represents a unique opportunity to achieve a *multi-TeV energy domain beyond the reach of e^+e^-colliders*, and potentially within a *more compact circular tunnel* than for a hadron collider. The biggest challenge remains to produce an intense beam of cooled muons, but *novel ideas are being explored.*

International MUON Collider Collaboration

2016-2020: LEMMA studies – RD_FA @ CSN1
2021-ongoing: RD_MUCOL @ CSN1
RN: Nadia Pastrone – ~18 FTE / 90 phys/eng in 13 sections
EU projects**:**
RISE (US) aMUSE, I.FAST, AIDAinnova + more to come

The International Community

CONTEXT:

- **Laboratory Directors' Group (LDG) initiated a muon collider collaboration July 2, 2020**
- CERN Medium Term Plan 2021-2025 - dedicated budget line – 2MCHF/year

mainly to cover machine up to MDI activities and test facilities

- International Design Study based at CERN

➔ **MoC signed by INFN, CERN, CEA …**

the project encompasses physics, machine, detector and Machine Detector Interface

- European LDG Accelerator R&D Roadmap by fall 2021

➔ **INTENSE REVIEW & PLANNING ON-GOING**

dedicated Muon Beams Panel - but also High field magnets, RF and ERL

- European ECFA Detector R&D Roadmap by fall 2021

Muon collider @ 10 TeV is considered as one of the targeted facilities emerging from the EPPSU

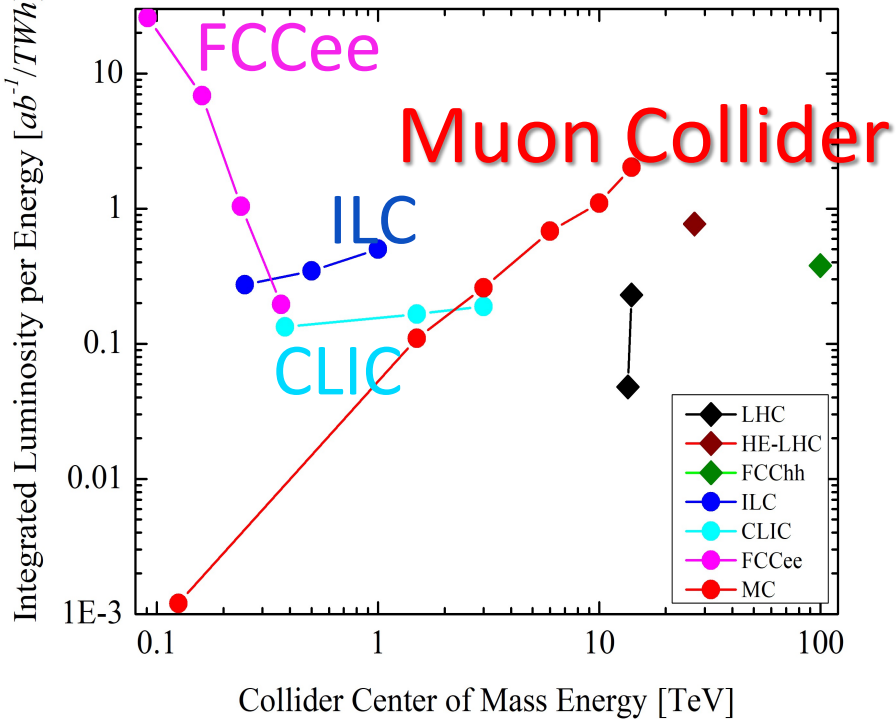
- US SnowMass Muon Collider Forum since 2021

share ideas and studies across frontiers

- Snowmass/P5 process in the US by spring 2023

RESTARTED ➔ Documents by 15 March '22

Energy Efficiency of Future Colliders



nature physics

Muon colliders to expand frontiers of particle physics

Overwhelming physics potential:
- Precision measures
- Discovery searches

Challenging Machine Design:
- Key issues/risks
- R&D plan - synergies

Proton driver production
Baseline @ International Design Study

ASSUMPTION/IP

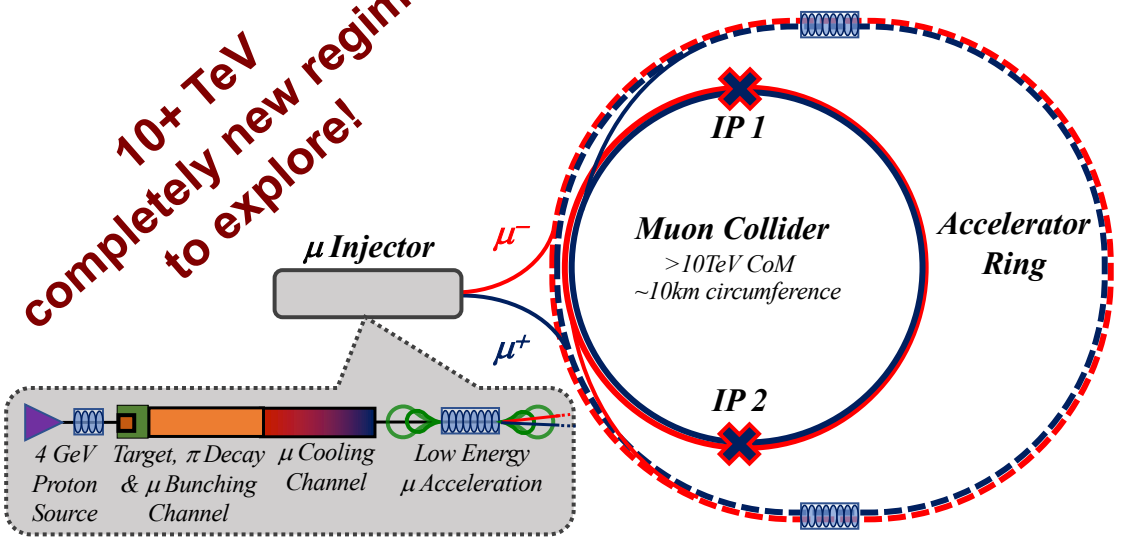
$\mathcal{L} = (E_{CM}/10TeV)^2 \times 10\ ab^{-1}$

@ 3 TeV ~ 1 ab^{-1} 5 years

@ 10 TeV ~ 10 ab^{-1} 5 years

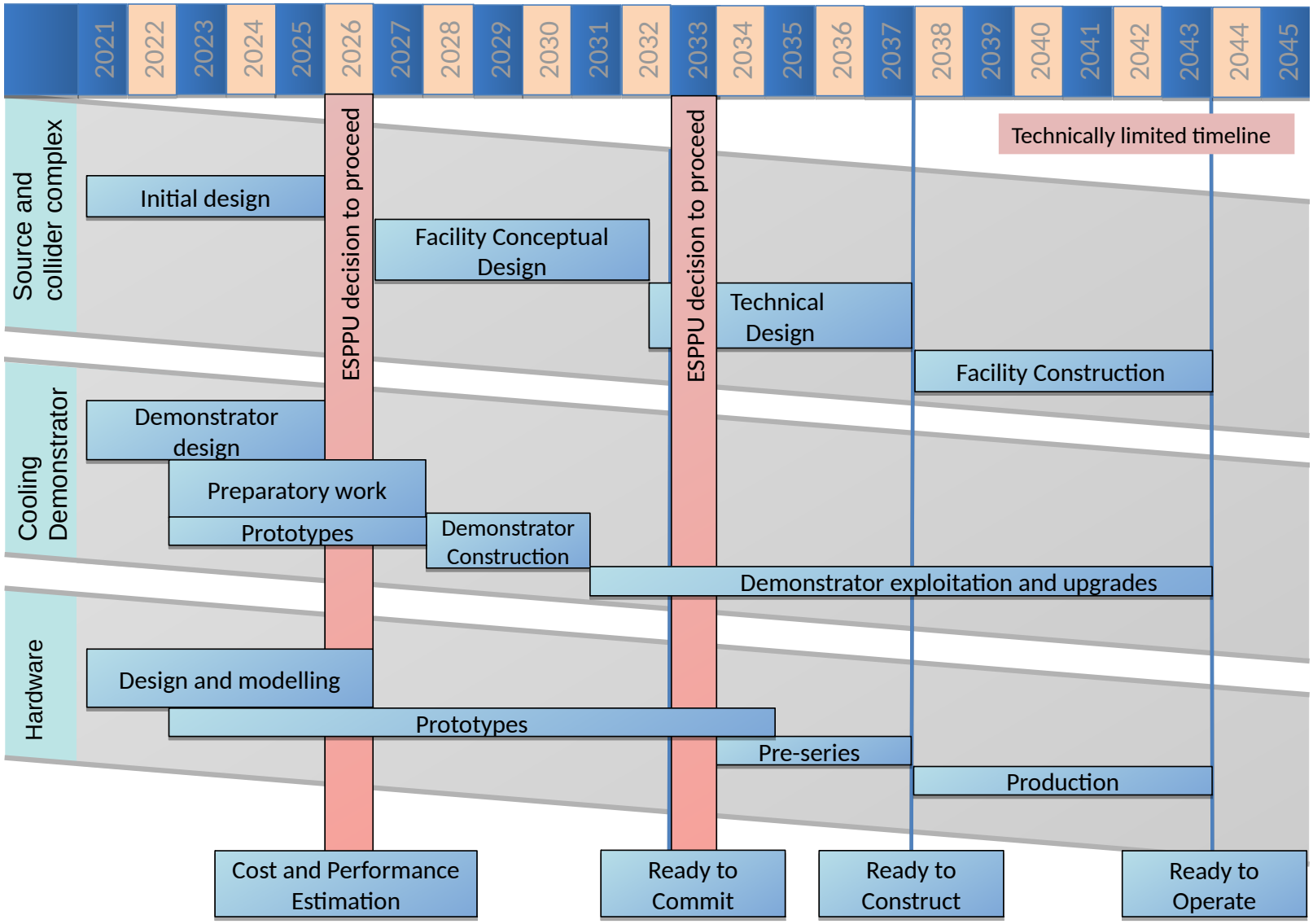
@ 14 TeV ~ 20 ab^{-1} 5 years

10+ TeV completely new regime to explore!



➔ **Need to have a muon collider option ready for operation before 2045!**

Proposed Timeline for a 3 TeV MC



INFN Activities

- LEMMA activities to be integrated completing target materials studies (simulations, lab and test beams) **RM1-RM3-LNL-PoliTO-LNF**
  ➔ could eveolve towards absorber materials for 6D cooling
- Crystals for intense positron sources (Synergy with FCCee and IJCL) and for beam manipulation **FE**
- Test Beam: measure $e^+e^- \rightarrow \mu^+\mu^-$ cross section at the threshold and emittances
- Machine Detector Interface studies **MI-PD-RM1-LNF-TO-TS**
- Detector Full Simulation Studies lead by **Donatella Lucchesi PD-TS-TO-MI-PV-BA**
- Detector R&D **LNF-PD-TO-BA-PV-TS**
- Theory-phenomenology studies: physics potential **RM1-RM3-PV-BO**

NEW

- Test facility **PD-MIB-RM3….**
- Magnet tecnologies for collider **GE-LASA**
- Radio-Frequency ?? Still investigating

Prossimi passi – scadenze – da fare/quando

- Roadmap Accelerator R&D Report to be closed by Nov 12 ➔ Dec Council
- AF4 SnowMass meeting Nov 11, 2021
- SnowMass whitepapers deadline Mar 15, 2022
- CSN1 Feb 17-18, 2022 – Detector R&D for Muon Collider
- EU design study project by March 2022 ➔ which contributions?

- Pros & Cons of next steps…

- PJAS CERN – deadline 8/11 https://jobs.dsi.infn.it/dettagli_job.php?id=3150