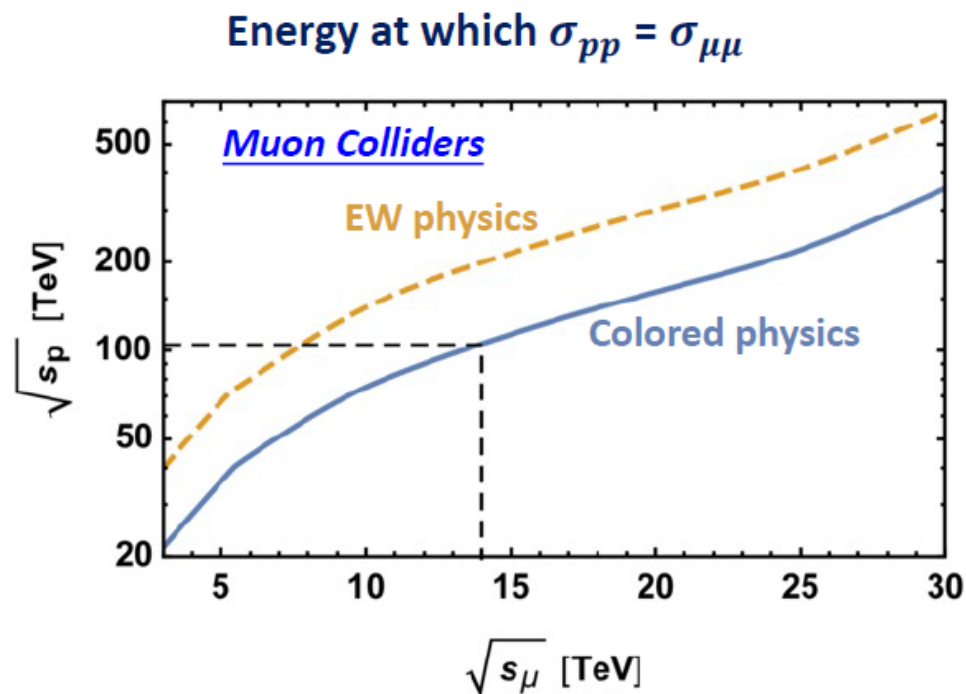
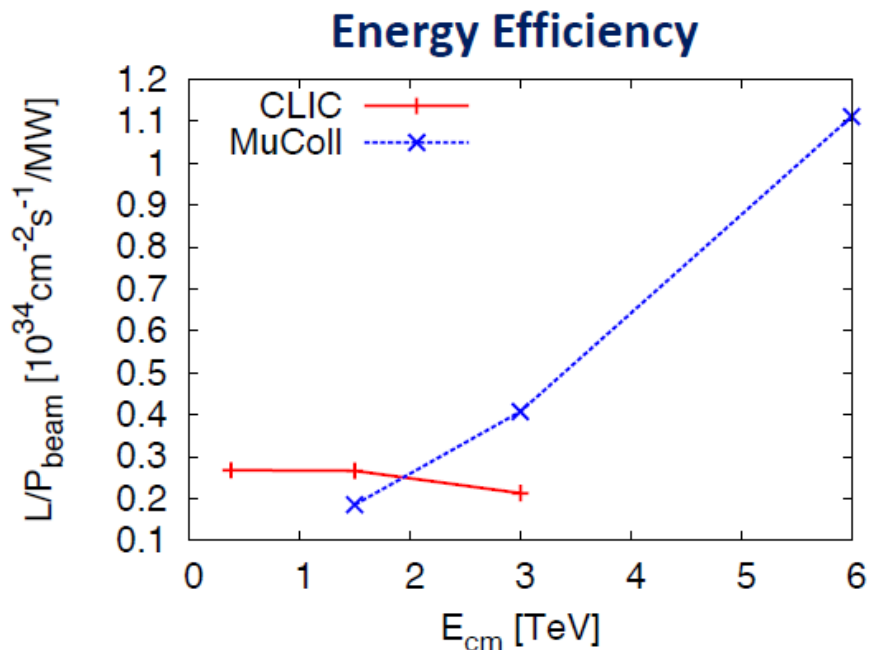


Why a multi-TeV Muon Collider?

cost-effective and unique opportunity

for lepton colliders @ $E_{cm} > 3$ TeV



sufficient luminosity required

Strong interest to reuse existing facilities and infrastructure (i.e. LHC tunnel) in Europe

Energy efficiency of present and future colliders

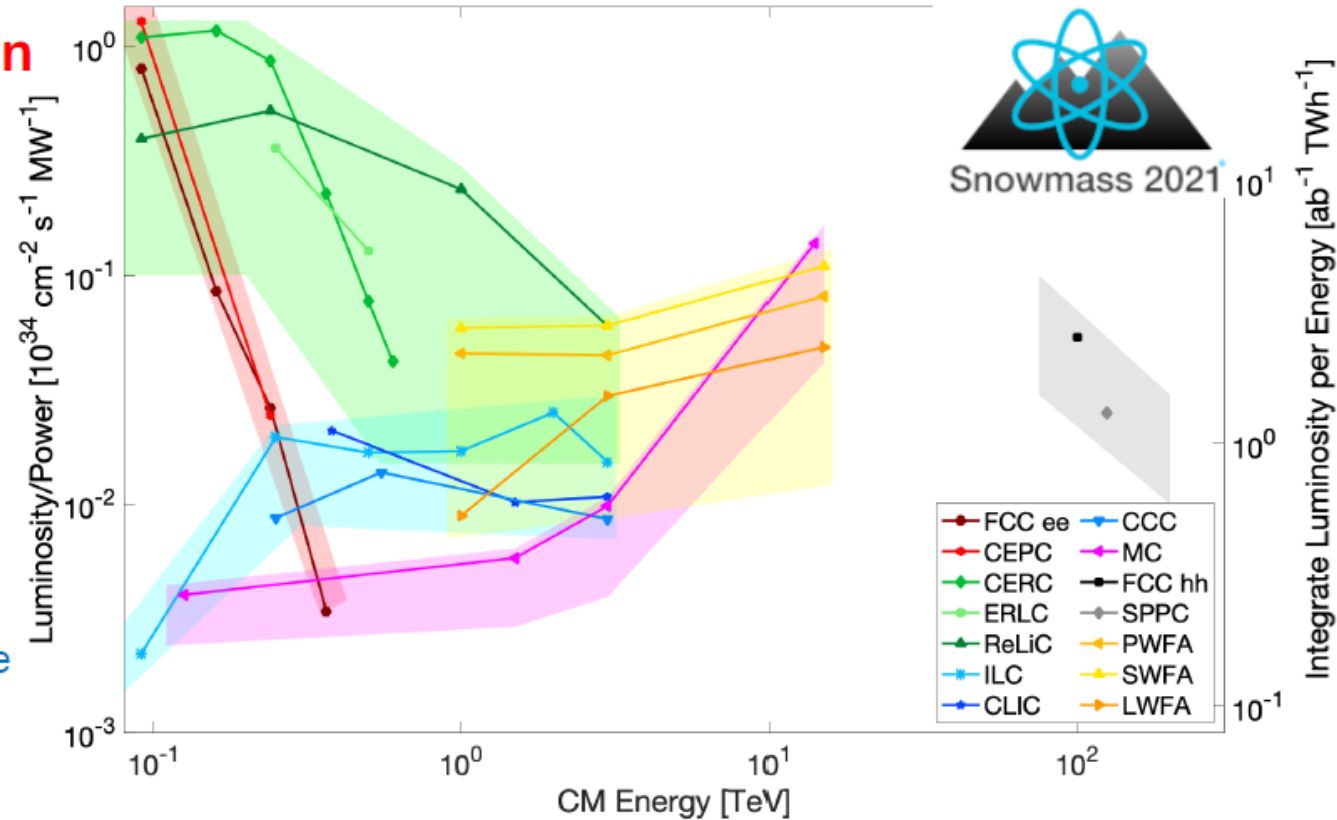
Thomas Roser et al.

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.

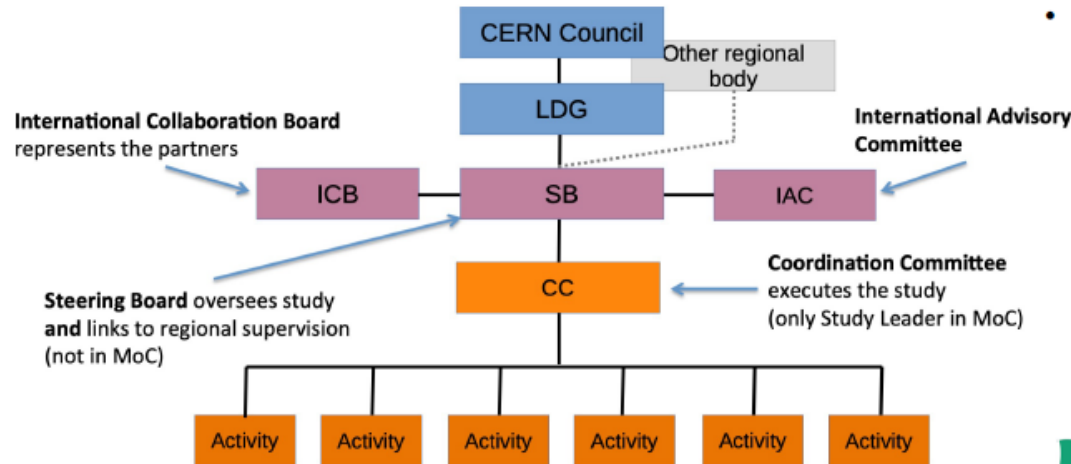


The effective energy reach of hadron colliders (LHC, HE-LHC and FCC-hh) is approximately a factor of seven lower than that of a lepton collider operating at the same energy per beam

Organization after the Roadmap

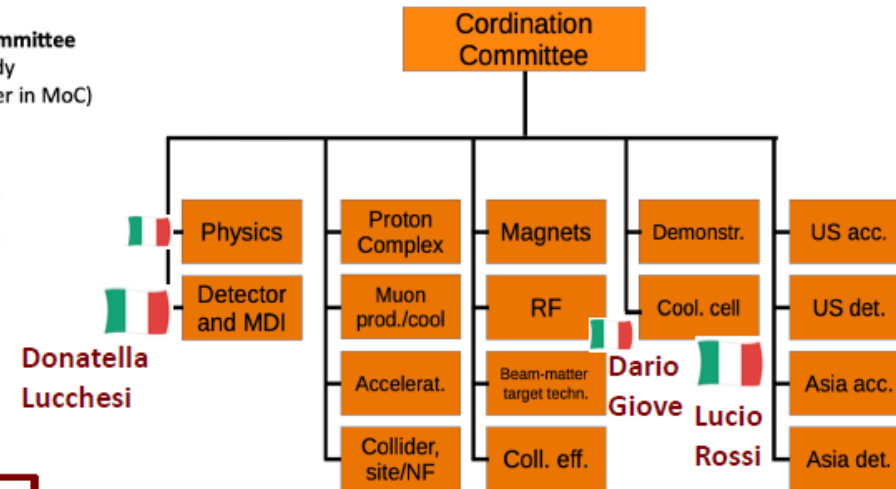
- Study Leader **Daniel Schulte**
 - Deputies: **Andrea Wolzer**, **Donatella Lucchesi**, **Chris Rogers**

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



- **Collaboration Board (ICB)**
 - Elected chair : **Nadia Pastrone**
- **Steering Board (SB)**
 - Chair **Steinar Stapnes**,
 - CERN members: Mike Lamont, Gianluigi Arduini, + ICB representatives, ICB chair and SL and deputies
- **International Advisory Committee (IAC)** *still to be formed*

Coordination Committee

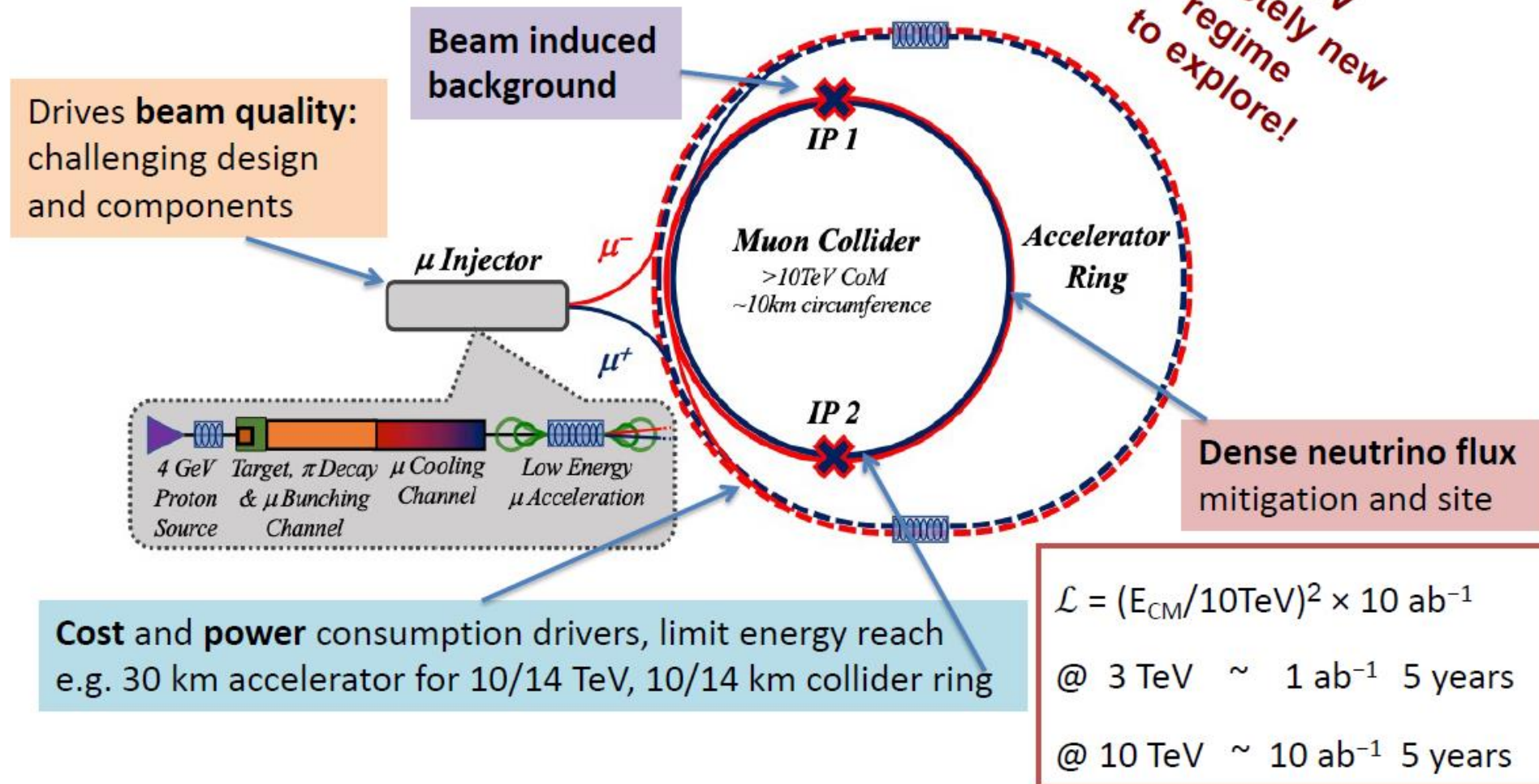


MoC signed by CERN CEA INFN STFC-RAL ESS IHEP and different universities in EU, US, China

International Design Study facility

Proton driver production as baseline

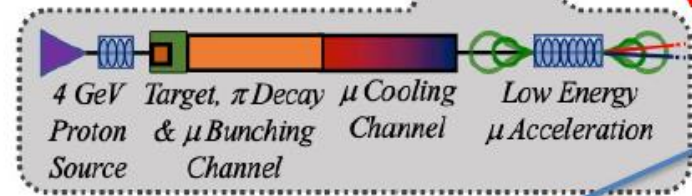
- Focus on two energy ranges:
 - 3 TeV technology ready for construction in 10-20 years
 - 10+ TeV with more advanced technology



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

Beam induced
background

10+ TeV
completely new
regime
to explore!



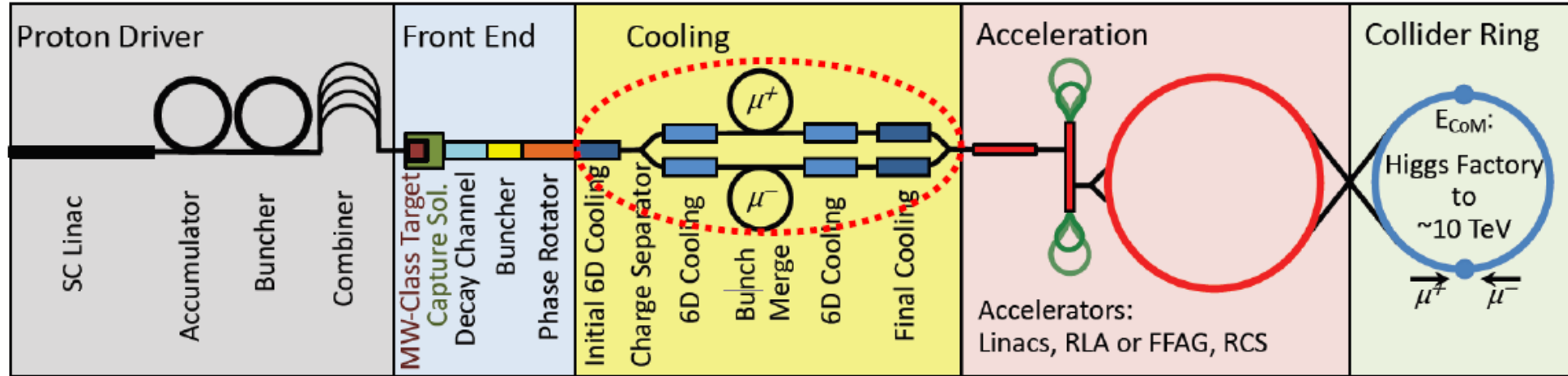
Dense neutrino flux
mitigation and site

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

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

@ 3 TeV $\sim 1 \text{ ab}^{-1}$ 5 years
@ 10 TeV $\sim 10 \text{ ab}^{-1}$ 5 years

Proton-driven Muon Collider Concept



Short, intense proton bunches to produce hadronic showers

Muon are captured, bunched and then cooled

Acceleration to collision energy

Collision

Pions decay into muons that can be captured

MICE 4D ionization cooling experiment

1-4 MW proton beam @ 5-20 GeV, compressed to 1-3 ns bunches at a 5-10 Hz frequency



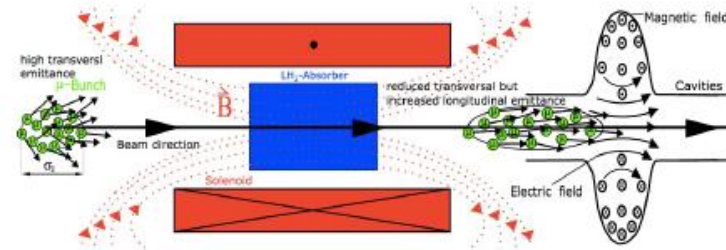
U.S. Muon Accelerator Program (MAP)

<http://map.fnal.gov/>

[MUON JINST collection](#)

Muon ionizing cooling

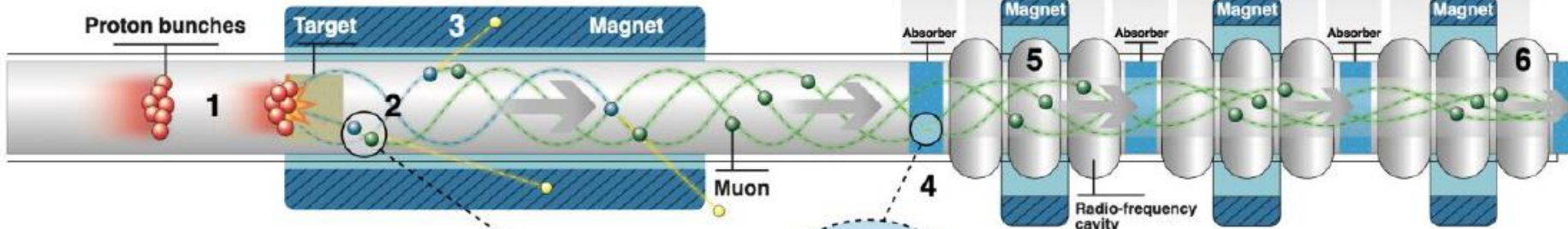
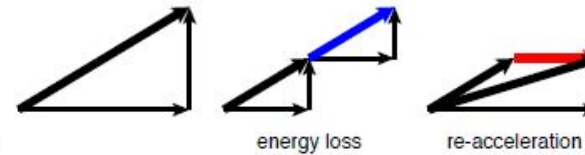
Integration of magnets, RF, absorbers, vacuum is an engineering challenge



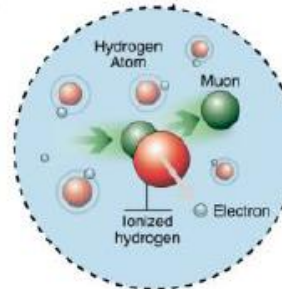
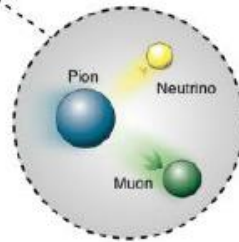
1. Bunches of protons are accelerated into a target of dense material. The atoms within the target emit a pion.
2. Pions are unstable and they quickly decay into a muon and a neutrino.

3. The neutrinos, virtually massless and without charge, pass out of the experiment. Solenoid magnets capture and direct the large cloud of charged muons towards a sequence of cooling stations.

4. In each cooling station the muons pass first through an absorber made of light material, such as liquid hydrogen. The muons collide with the atoms of the absorber, knocking off electrons, and losing energy in the ionization process. This causes the muons to slow down...



The goal is to turn a "cloud" of muons travelling in all directions... into a tight beam travelling in one direction.



5. ...strong magnetic fields then guide the muons into radio-frequency cavities. The electric field in the cavities gives the lost energy back to the muons by replacing the momentum lost in the direction of the beam. In this way, muons lose energy and momentum in all directions, and are accelerated in only one direction.

6. This process is repeated until the muon beam is pencil-like, ready for injection into the accelerator.

Fig. 3: Principle of the Muon Ionisation Cooling

RD_MUCOL: che fa Roma Tre?

- Studi di fenomenologia (R.Franceschini)
- Nel 2021-22 il laboratorio di fisica delle superfici ha fatto studi di danneggiamento dei target (articolo non ancora pubblicato ma non disperiamo)
- Ci sarebbe ampio spazio contribuire con studi dei materiali da utilizzare per le finestre del canale del muon cooling, ma al momento manca una persona che possa lavorarci.....
- Si potrebbe aprire la possibilità di collaborare allo sviluppo di detector di beam monitor nel muon cooling.
- Nel 2024 capire se riusciamo a contribuire o non ha senso continuare....

RD_MUCOL Roma Tre 2023

Anagrafica:

Biagio Di Micco	0.1
Roberto Franceschini	0.1
Domizia Orestano	0.1
Antonio Passeri	0.1
Ludovico Tortora	0
Totale FTE	0.4

Richieste finanziarie:

Missioni:	3 k€	meeting ed eventuale partecipazione test beam
	3 k€	Conferenze fenomenologia Franceschini
Consumo:	3 k€	Metabolismo