LDG

LDG will also submit a document to the European Strategy

Chair of the LDG will change in January 2025:

- Mike Seidel will take over from Dave Newbold

Review of all five activities planned

- HFM, RF, plasma, energy recoveryy linacs and muon collider

Initially planned for end of Novembber but delayed

Exact scope of review is being defined

ESPPU

European Strategy Group
Represents member states, large laboratories, CERN management and invitees, e.g. Prof. Michael Tuts for the US

Preparatory Group
Prepares Briefing Book
To be appointed by CERN Council
Two members from the Americas

Strategy Secretariat
Karl Jakobs (Strategy Secretary)
Hugh Montgomery (SPC Chair)
Dave Newbold (LDG Chair)
Paris Sphicas (ECFA Chair)

Find more at: https://europeanstrategyupdate.web.cern.ch/welcome

Plan for ESPPU

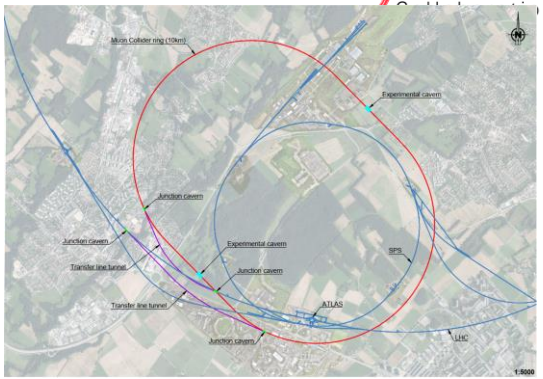
March 2025 deliver promised ESPPU reports
- **Evaluation report**, including tentative cost and power consumption scale
- **R&D plan**, including scenarios and timelines

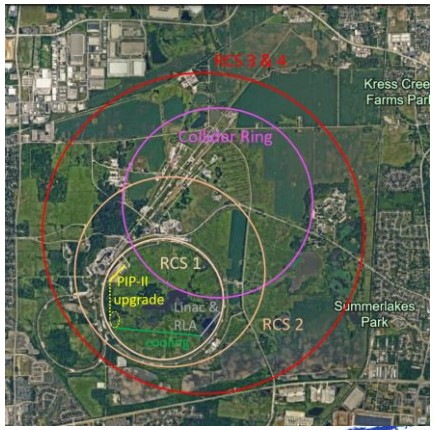
This requires to push as hard as possible with existing resources

Present **green field** designs and continue to work on them
- International collaboration
- Parameters, lattice designs, component designs, beam dynamics, cost, …

Perform example **civil engineering studies**
- CERN (collider and demonstrator)
- FNAL, the US started doing similar studies

Provide **dedicated parameter tables** for the implementation at **existing sites** (FNAL, CERN, …)
- Scaled from green field design using existing infrastructure
- Do not have the resources and time to make detailed designs for CERN and FNAL for ESPPU





Report Plan

Discussions with Karl Jakobs

Concise reports should have 10 pages
- Could be one ore two reports
- Maybe one overall report and one focused on the R&D plan and implementation

Need to coordinate with other reports
- E.g. one for the general magnet development
- But some overlap is probably fine
  - The same message more than once

Long supporting reports should also be available March 31rst 2025
- Evaluation report
- R&D Plan

Idea is to combine into one document with different sections

Tentative Timeline

Long report(s)

- April 2024: Parameter revision is starting
- End of June 2024: Parameters updated (to EU October)
- September 2024: Overleaf in place for authors to start
- End of October 2024: Report ready for content editing
- End of December 2024: Draft ready for collaboration and the IAC
- End of January 2025: Report ready for copy editing (language)
- End of February 2025: Start of signature process
- End of March 2025: Report ready

Concise report(s)

- End of September 2024: Overleaf in place
- End of October 2024: Start of editing to integrate long report
- End of December 2024: Draft ready for editing and IAC
- February 2025: Start of copy (language) editing
- End of March 2025: Report submission

US Progress

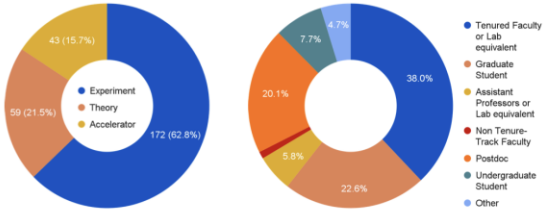
US Muon Collider Inauguration Meeting beginning of August at FNAL showed strong interest

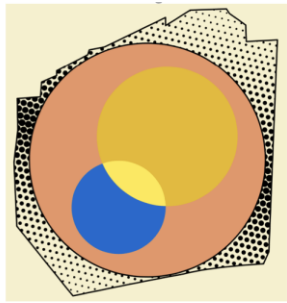
Full integration with US planned

Need to move forward while waiting for US to get organised

- In particular, R&D plan has to be common plan

- In early August, held an open meeting of the US community
  - 274 (+25 virtual) participants





Michael Begel (BNL)
Pushpa Bhat (Fermilab)
Philip Chang (University of Florida)
Sarah Cousineau (ORNL)
Nathaniel Craig (University of California, Santa Barbara)
Sridhara Dasu (University of Wisconsin)
Karri DiPetrillo (University of Chicago)
Spencer Gessner (SLAC)
Tova Holmes (University of Tennessee)
Walter Hopkins (ANL)
Sergo Jindariani (Fermilab)
Donatella Lucchesi (University of Padova/INFN)
Patrick Meade (Stony Brook University)
Isobel Ojalvo (Princeton University)
Simone Pagan Griso (LBNL)
Diktys Stratakis (Fermilab)

Used Organzation Committee of FNAL with some additional members as de facto US organisation

- Providing members for
  - Editorial Board
  - Authors of ESPPU report
  - Cost estimate
  - Next annual meeting programme committee

And Mark Plamer, Steve Gourley, Kevin Black, Lawrence Lee

Last years publications rules are now very important during the transition

Report Organisation

Editorial Board

Will drive the writing and editing

For Interim Report relied on authors to implement proposed changes

For ESPPU report, editors will at the end of the process write text directly and allow authors to comment

Will contain five experts chosen by the US partners

- Informal contacts in the US organization ongoing

Reviewers

A number of people can provide important overall input but might not have the time to edit the report

- Plan to invite them specifically to read the documents to give comments

Report Organisation

Evaluation Report

Will be based on the Interim Report

Reuse the same structure but

- Add some more detail, where beneficial
- Add progress over last year as appropriate
- Move unfunded R&D sections to R&D Plan

The same authors as for the Interim Report

US authors welcome to help

- Already helped during the Interim Report
- In some cases important activity in the US
  - E.g. physics, MAIA, …

Report Structure (Executive Summary)

Executive Summary

Overview

1.1 Motivation

1.2 The accelerator concept

1.3 Muon collider challenges

1.4 Developing the muon collider study

1.5 R&D programme

1.6 Timeline and staging

1.7 Site considerations

1.8 Synergies and outreach

Report Structure (Status and Progress)

1 **Physic opportunities**
(staging, synergies, …)

2 **Interface**
2.1 Phenomenology
2.2 MDI

3 **Detector**
3.1 Overview
3.2 MUSIC
3.3 MAIA
3.4 Performance
3.5 Technologies
3.6 Software and computing

4 **Accelerator complex concepts**
4.1 Proton driver
4.2 Target & front-end
4.3 Cooling
4.4 Acceleration
4.5 Collider
4.6 Collective effects and integration

5 **Technologies**
5.1 Magnets
5.2 Power converter
5.3 RF
5.4 Target
5.5 Radiation shielding
5.6 Muon cooling cell
5.7 Cryogenics
5.8 Vacuum
5.9 Instrumentation
5.10 Radiation protection
5.11 Movers
5.12 Infrastructure
5.13 General Safety

Note: Civil engineering moved to second part

Reminder: Interim Report Structure

Executive Summary

Implementation Considerations

Physics Potential

Physics, Detector and Accelerator Interface

Detector

Accelerator design

Accelerator technologies

Synergies

R&D programme development

Collaboration Development

Contents

Note: slightly older layout but authors are idenfied

R&D Programme

Do not need to again explain the challenges or the status

Strongly linked to timeline

Similar to LDG Roadmap exercise

- Did not get the resources planned, so have to still implement part of the last Roadmap

Relevant experts to submit proposals for workpackages

- Area leaders
- US experts
- Other authors and volunteers

Will then iterate to harmonise

- Defining priorities

Report Structure (R&D, Implementation)

1 R&D, Objectives, Timeline, Plan and Cost

Overview, introduction, focus 2025-2035

2 Physics R&D *()*

3 Detector R&D *()*

3.1 Detector concepts

3.2 Detector technologies

3.3 Software and computing for detectors

4 Magnet R&D *()*

Including integration with HFM

5 Accelerator R&D *()*

5.1 Accelerator design

5.2 Machine-detector interface

5.3 Neutrino flux mitigation system

5.4 RF Systems

5.5 Target system

5.6 Instrumentation

5.7 Radiation shielding

5.8 Cryogenics

5.9 Vacuum

5.10 Radiation protection

5.11 Infrastructure

5.12 General Safety

5.13 Other technologies

5.14 Software for the accelerator

Report Structure (R&D, Implementation)

6 Muon cooling technology development and demonstration *()*

6.1 Cooling demonstrator programme

Scope, test stands, cooling cells, magnets, …

6.2 Muon cooling test module

6.3 Demonstrator Implementation at CERN

6.3.1 Demonstrator system description

6.3.2 Civil engineering

6.3.3 Infrastructure

6.3.4 Cost and timeline

6.4 Implementation at FNAL

6.4.1 Demonstrator system description

6.4.2 Civil engineering

6.4.3 Infrastructure

6.4.4 Cost and timeline

7 Other Test Infrastructure *()*

Mention also existing infrastructure (e.g HiRadMat)

8 R&D Programme Synergies *()*

9 Sustainability *()*

9.4 Cost drivers and cost scale

9.5 Power driver and power scale

10 Collider Implementation (after 2035-2050) *()*

9.1 Overview

9.2 Implementation at CERN

9.3 Implementation at FNAL

9.6 Timeline

Template: Objectives, Deliverables and Resources

Name	Unique name, e.g. “Cool.P1”

Objectives
Short description of the workpackage
e.g. Engineering design of the protoype muon cooling cell for the demonstrator
High-level Deliverables
1) A set of functional specifications consistent with the beam dynamics needs
2) …

Resources	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Staff										
Postdoc										
Student										
Material										

Interested partners
Institutes that might be interested to contribute to the work

Resources are given in total number of FTE-years for the whole duration and in kEuro for material

Tasks and Resources

1	Task description	Resource estimate staff [FTEy]	postdoc [FTEy]	PhD [FTEy]	material [kEuro]
	Coordination, Scope and costing	0.6			400
	Civil Engineering, including freeing TT7 for RP survey and inspection	0.6	3		300
	Collimation Optics Design	0.1	0.5		
	Collimation magnet conceptual design	0.4	2		
	Cooling beam physics concept	0.1	0.5		
	RF concept (parameters, technology choice, power optimisation)	0.2	1		
	RF system design for the cooling cell (RF + mechanical)	0.4	2		
	magnet concept (technology choice, parameters, interfaces)	0.2	1		
	magnet system design for the cooling cell (magnet, cryo, power converter)	0.4	2		
	Engineering integration concept	0.2	1		150
	Engineering integration conceptual design	0.4	2		
	Engineering integration concept	0.2	1		150
	Engineering integration conceptual design	0.4	2		

Old example

Workpackage Description

Workpackage Description

The study will focus with high priority on two items:

1) Decision on the best possible site for a facility at CERN, with civil engineering studies to assess the feasibility.
2) Definition and conceptual design of a cooling cell for the purpose of testing hardware performance on deciding the baseline option, whether to implement a full facility in the vicinity of BA1 starting from TT10, and a reduced power facility in TT7.

In parallel, the workpackage will leverage on the work performed in other workpackages (muon production and cooling, RF, Magnets etc…), to select solutions ensuring a minimum performance to convince about the feasibility of the rectilinear FOFO scheme, using elements that could be built before the end of the decade. For instance, the muon capture solenoid might be replaced by a horn if its development would jeopardise a timeline allowing first beam around the end of the decade. The final deliverable is a conceptual design report including a cost estimate allowing a decision on its construction.

Comment: Design and Technologies

Do not have a full conceptual design at this moment
- Roadmap planned to justify investment into CDR
- The progress justifies to ramp up the programme

Progress in the different accelerator areas
- But did not yet address all areas
- Do not yet reach target performance in some areas

Progress with different technologies
- Magnets, power converter etc.
- But some need more work, e.g. RF beamloading compensation, cooling absorbers etc.

Plan is to stick with current target parameters and discuss on a case-by-case basis the impact of failure to further improve

Cost

Cost scale estimate has started (led by Carlo Rossi)

Some models exist
- Magnets, RF, power converter, …

Some areas are similar to known accelerators
- E.g. proton complex

However some areas need more work
- E.g. cooling module design

Did not have time to iterate to reduce cost
- More likely than in conventional designs

Need to understand scaling to large numbers

R&D Strategy

Assume that material budget will mainly be available in Europe in the next few years

While personnel is already ramping up in the US

- In particular on the detector and physics side

Will try to adjust some existing US programmes to make them more relevant for the muon collider

After 2030, the US can ramp up the material significantly

- Can share the cost

Need to work out the other regions

Demonstrator Strategy

Workshop at the end of October/early November at FNAL

Tentative strategy:

- RF test stand is urgent
- Cooling cell prototypes and test infrastructure
- Low-cost, fast-track infrastructure at CERN in TT7
- Longer-term, more substantial demonstrator infrastructure at FNAL, CERN or elsewhere

Outreach

Need your support

- National events
  - Attend to represent the muon collider
  - Help to convince organisors to invite IMCC experts
  - Inform us so that we can identify suitable experts

Early career events

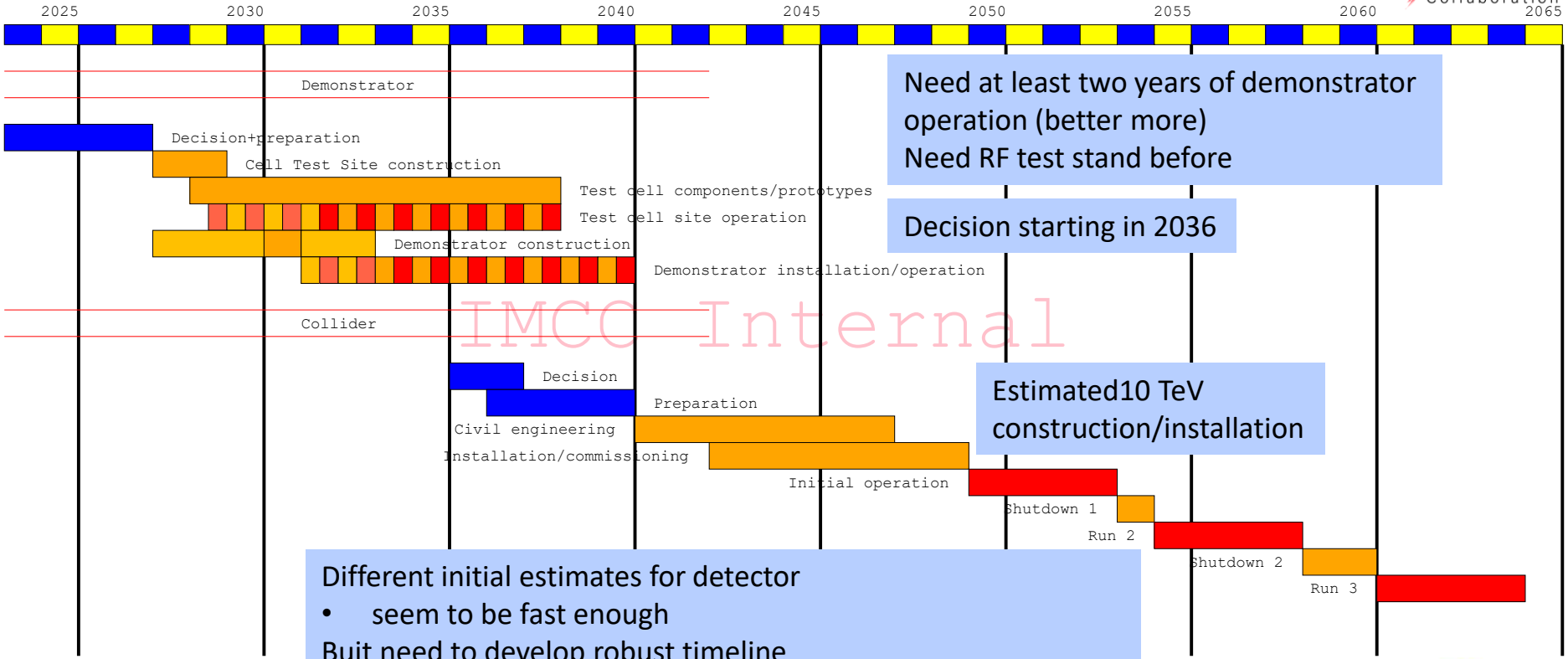
- First event has been successful (see Taylor)
- They will actually have to build and operate the machine

Please help

Reserve

Tentative Timeline (Fast-track 10 TeV)

Only a basis to start the discussion, will review this year



Need at least two years of demonstrator operation (better more)
Need RF test stand before

Decision starting in 2036

Estimated10 TeV construction/installation

Different initial estimates for detector
- seem to be fast enough

Buit need to develop robust timeline