

International
UON Collider
Collaboration



MuCol



EU Project MuCol Status and Plans

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CERN

Funded by the European Union (EU). Views and opinions expressed are however those of the author only and do not necessarily reflect those of the EU or European Research Executive Agency (REA). Neither the EU nor the REA can be held responsible for them.



Summary



- History of MuCol
- MuCol Organisation
- WorkPackages
- Milestones & Deliverables

History of MuCol



- MuCol has been submitted in April '22 with an outstanding collective commitment from all participating institutes
- WP leaders, task leaders and the coordinators from each institute have invested a lot of effort to shape a coherent programme and to write a very well organised proposal.
- The proposal has been approved with an excellent evaluation

Evaluation from the reviewers

- **An excellent 14.5/15!**
 - “The scientific goals of the project are clear and important”
 - “A muon Collider offers a way (..) that is **novel** and **complementary** to existing approaches”
 - “The proposed work is timely, important and strategically positioned to influence the next European Strategy Exercise (....) and global decision making”
 - “The project objectives are realistically achievable”
 - “The potential impact of the proposed work is very high”
 - “The workplan has been developed with pathways to impact in mind”
 - “Environmental aspects are well covered in the proposal”
 - “The make-up of the consortium is of high quality”

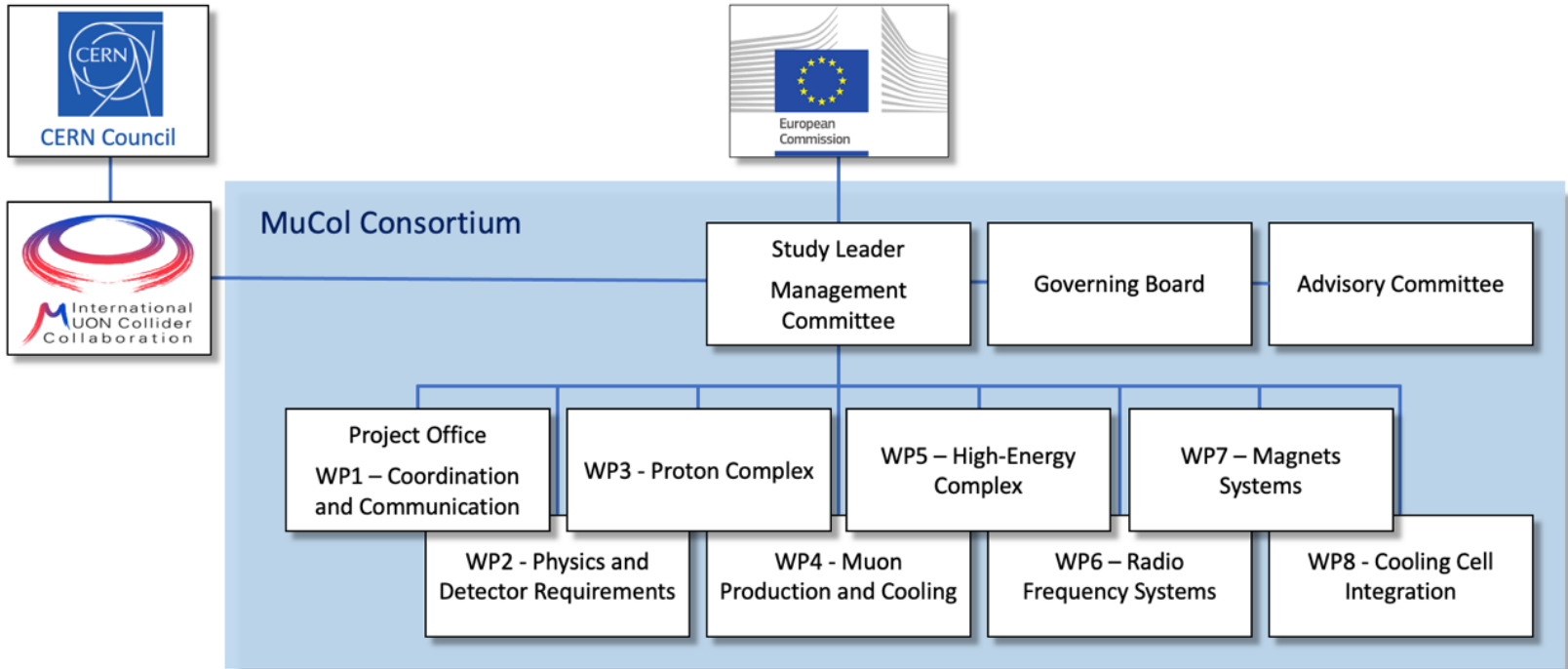
MuCol Organisation



- The consortium includes ~~32~~ 31 Institutes:
 - CERN as coordinator and beneficiary
 - 11 more Beneficiaries (no UK Institutes)
 - 19 Associated Partners

- **Study Leader** : *Daniel Schulte (CERN)*
- **Technical Coordinator** (WP1 leader) : *Roberto Losito (CERN)*
- **Deputy Study Leader**: *Chris Rogers (UKRI)*
- Transversal Roles :
 - **Gender Adviser Officer** :
E.J. Bahng (Iowa State University)
 - **Communication and dissemination Officer**: Elias Metral (CERN)
- **WP Coordinators:**
 - **WP1**: Roberto Losito (CERN)
 - **WP2**: Donatella Lucchesi (UNIPD)
 - **WP3**: Natalia Milas (ESS)
 - **WP4**: Chris Rogers (UKRI)
 - **WP5**: Antoine Chance (CEA)
 - **WP6**: Claude Marchand (CEA)
 - **WP7**: Luca Bottura (CERN)
 - **WP8**: Lucio Rossi (UNIMI)

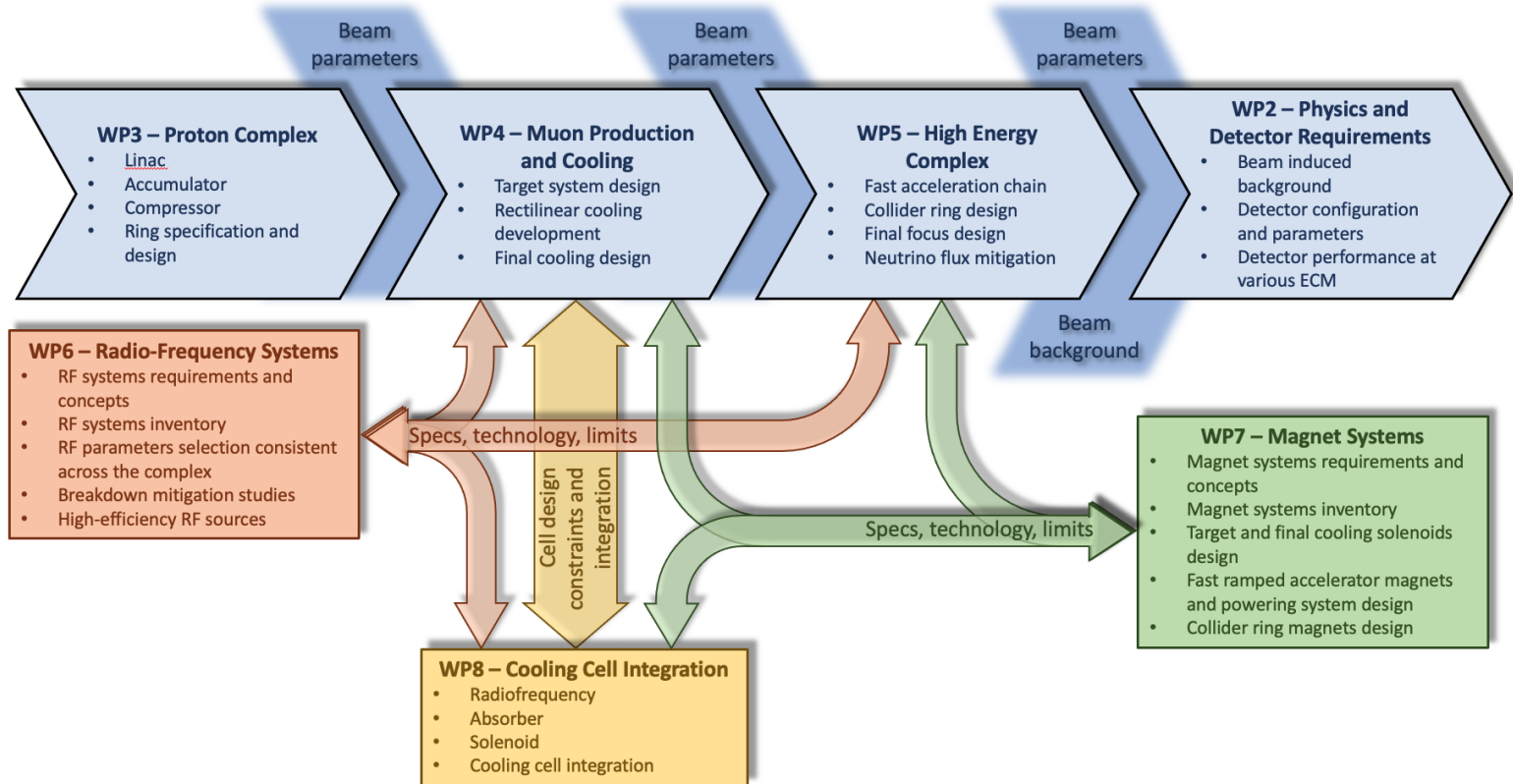
MuCol Organisation



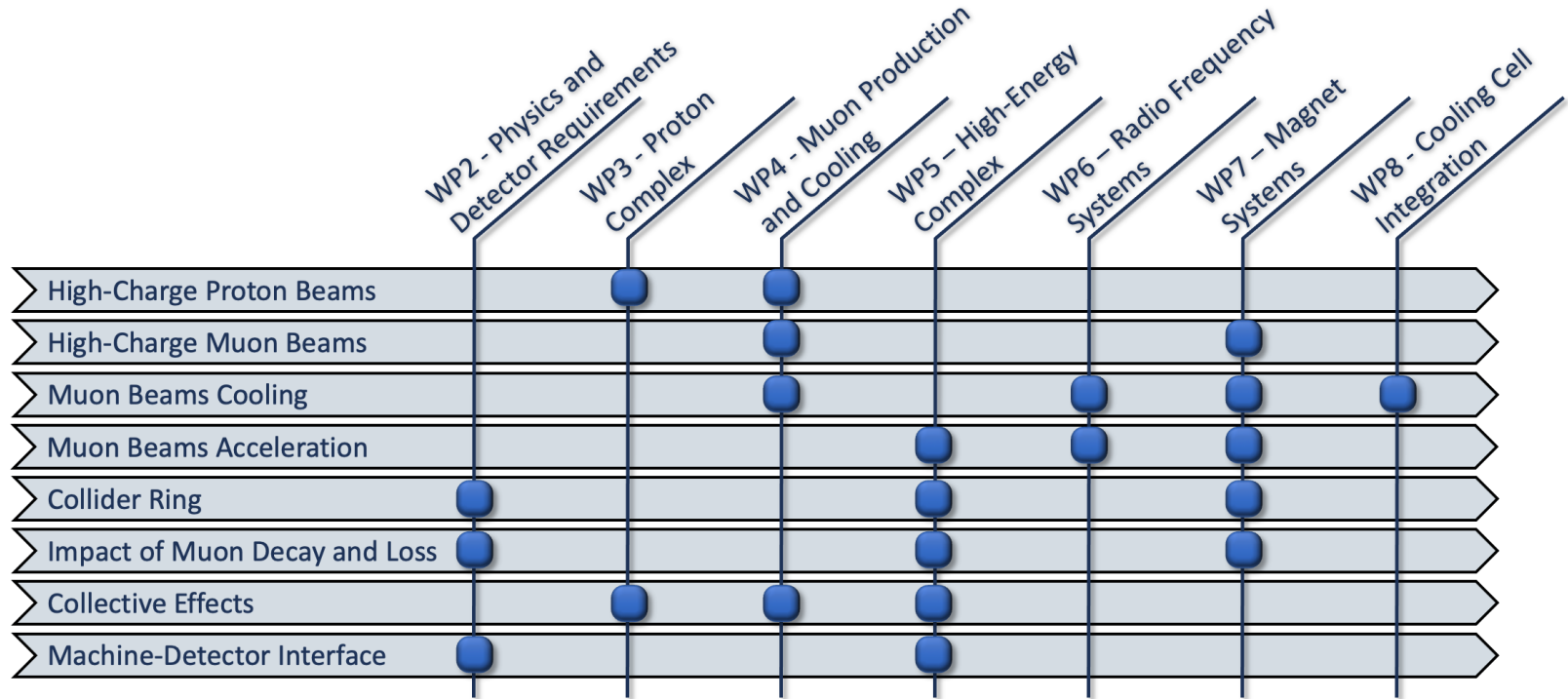
Goals of the project

- MuCol has been shaped to coordinate the effort of the International Muon Collider Collaboration towards the specific goal of providing a comprehensive input for the next European Strategy for Particle Physics Update
- The main deliverables will be yearly progress reports, that will be used to edit the report that will be submitted to the ESPPU in 2025/26 as input from the Collaboration.
- The same material can be used by the collaboration to provide input to other prioritization processes/funding agencies (e.g. P5 in US).

Scientific and technical organization of the project



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- All along the duration of the project we will animate a table of parameters, covering both the accelerator layout and the main technologies (magnets, RF, beam diagnostics...)
- Overleaf document being edited, during the project we will publish
 - M6: Tentative Parameters
 - M18: Preliminary Parameters
 - M30: Consolidated Parameters



WP1: Coordination and Integration



- **Task 1.1: Study coordination (Daniel)**
 - Focus on Overall design and table of parameters
- **Task 1.2: Technical Coordination (Roberto)**
 - Ensures timely delivery of milestones and Deliverables
 - Ensures the application of the Data Management Plan
 - Monitors Gender Dimension Issue with the help of the Gender Dimension Officer.
- **Task 1.3 & 1.4: Elias**
 - Peer review process with an editorial board
 - Communication and Dissemination together with Other institutes...
- **Task 1.5: Daniel**
 - Implementation Scenarios, in particular implementation at CERN

WP2: Physics and Detector Requirements

- **Task 2.1: Design of detector configurations at $\sqrt{s}=3$ TeV and $\sqrt{s}=10$ TeV with the optimised interaction regions (*D. Zuliani*)**
 - Focus on BIB with a strong interaction with WP5 (High Energy)
- **Task 2.2: Design and implementation of event reconstruction algorithms in 5D at $\sqrt{s}=3$ TeV and $\sqrt{s}=10$ TeV (*F. Meloni*)**
 - developing reconstruction algorithms exploiting 3D position, energy, and timing measurements to mitigate beam-induced background and perform tracking and calorimetry clustering
 - this task will explore machine learning solutions and parallel computing.
- **Task 2.3: Evaluate detector performance at different collision energies by using major physics processes: (*M. Casarsa*)**
 - This task will explore the detector performance of a muon collider operating at different collision energies.
 - Will evaluate the reach of major physics processes for Standard Model measurements, and for searches for physics beyond the

WP3: Proton Complex

- This work package aims to define the most promising scheme for the linac, accumulator and compressor rings and prepare a comprehensive summary of the current technology and possible R&D topics of importance for the proton complex
- **Task 3.1: High Power Linac (*A. Lombardi, CERN*)**
 - Collection of parameters based on ESS and LINAC4/SPL designs
- **Task 3.2 – Compressor ring design (*E. Laface, ESS*)**
 - The ring will create the high intensity short bunches that will be delivered to the target for muon production

- **Task 4.1 Cooling system development (UKRI)**
 - Need to design a system that will compress the phase space of the muon beams by 5 orders of magnitude
 - Will liaise with WP6, WP7 and WP8 in order to provide a design based on a realistic assessment of the main technological aspects.
- **Task 4.2 – Target system development (R. Franqueira Ximenes, CERN)**
 - Has to deal with high power (2÷4 MW) and short pulse (1 nsec).
 - Will investigate possible technology but also consequences for infrastructure, shielding, materials etc...
- **Task 4.3 Code development (Imperial)**
 - Will develop specific modules of BDSIM to reach and go beyond the performance of G4Beamline

- **Task 5.1 Collider Design (C. Carli, CERN)**
 - Will interface closely with WP2 for the optimization of the interaction regions and minimization of BIB
- **Task 5.2 Pulsed synchrotron and FFA design (A. Chance, CEA)**
 - Will provide start 2 end simulations of the two alternatives based on reasonable assumptions on the development of associated technologies.
- **Task 5.3 Beam dynamics (E. Metral, CERN).**
 - This task focuses on the transverse collective effects all along the muon accelerator chain
- **Task 5.4 MDI design and background to experiment (A. Lechner, CERN)**
 - Will implement in FLUKA, based on input from task 5.1, a detailed model of the interaction regions and will provide the map of BIB to WP2.
- **Task 5.5 Radiation studies for the accelerators (C. Ahdida, CERN)**
 - Mitigation of radiation effects to personnel and public, including evaluation of neutrino radiation hazard.

WP6: RadioFrequency

- **Task 6.1 High Energy Complex RF (U. Van Rienen, UROS)**
 - Main focus on the design of cavities for acceleration in a Rapid Cycling Synchrotron.
- **Task 6.2 Muon Cooling Complex RF (D. Giove, INFN)**
 - Will address high gradients in high magnetic fields, limited space for integration.
- **Task 6.3 Breakdown mitigation studies (G. Ferrand, CEA).**
 - This task will study and enhance the present comprehension of the intrinsic concepts that influence the break down rate of RF cavities submitted to strong magnetic fields
- **Task 6.4 High efficiency RF sources (G. Burt, ULA)**
 - Will provide confidence that present assumptions for high efficiency klystrons (24 MW @ 700 MHz with efficiency of 80%) is reasonable.

- **Task 7.1 Integration and Magnet Catalog (L. Bottura, CERN)**
 - Will provide coordination of the other tasks and aim at “standardization” of magnets, maintaining a complete catalog of magnets being used on each WP.
 - Will also provide interface fro radiation tolerance, magnet cooling, radiation protection studies etc..
- **Task 7.2 Target, Capture and Cooling Solenoids (M. Statera, INFN)**
 - Will address large bore solenoids, for fields up to 40÷60T.
- **Task 7.3 Fast Ramped Accelerator magnet systems (F. Boattin, CERN).**
 - Will provide performance targets for fast ramping accelerator systems, with the aim of limiting to realistic values the power consumption.
- **Task 7.4 Collider ring magnets (S. Mariotto, UMIL)**
 - Will study realistic performance targets for large bore (150 mm) magnets at 16 T (and above?).

WP8: Cooling cell integration

- Will perform the detailed study of a representative cooling cell, with the goal of integrating the single components in a complete 3D model
- **Task 8.1 Absorbers and Windows (J. A. Ferreira Somoza, CERN)**
- **Task 8.2 Solenoids (S. Sorti, UMIL)**
- **Task 8.3 RadioFrequency (D. Giove, INFN).**
- **Task 8.4 Cooling Cell Performance (C. Rogers, UKRI)**
- **Task 8.5 Cooling Cell Integration (L. Rossi, UMIL)**

Milestones & Deliverables

- **Deliverables for year 1:**

- *Data Management Plan*, M5: **WP1 (CERN) + all**
 - CERN is working on a “standard” data management plan, that can be customized for our needs
- *Preliminary ESPPU report No. 1* : **WP1 (CERN) + all**

- **Milestones for year 1:**
 - *Website online, M2: **WP1 (CERN)***
 - *Kick-off meeting, by M3: M2*
 - *Tentative Parameters available, M6: **WP1 (SL) + all***
 - *Training on detector design and physics performance tools, M6, **WP2***

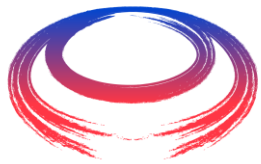
Deliverables

Deliverable No	Deliverable Name	Work Package No	Lead Beneficiary	Date
D1.1	Data-management plan	WPI	1 -CERN	5
D1.2	Preliminary ESPPU report No. 1	WPI	1 - CERN	12
D1.3	Preliminary ESPPU report No. 2	WPI	1 -CERN	24
D1.4	Intermediate ESPPU report	WPI	1- CERN	36
D1.5	Consolidated ESPPU report	WPI	1 - CERN	48
D2.1	Beam-induced background and detector configuration	WP2	8 - UNIPD	30
D2.2	Detector performance by using physics processes	WP2	2 - DESY	36
D3.1	Final report on parameters and initial study for the Proton Complex	WP3	11 -ESS	45
D4.1	Development of BDSIM simulation	WP4	16 -UKRI	24
D4.2	Preliminary Report on key subsystems for ESPPU input	WP4	16 -UKRI	33
D4.3	Consolidated Report on key subsystems	WP4	16 -UKRI	45
D5.1	Report on the collider ring design	WP5	5 - CEA	44
D5.2	Report on the design of the HEC	WP5	5 - CEA	45
D6.1	Report on design of high power and high efficiency RF power sources	WP6	5 - CEA	42
D6.2	Report on RF for MCC and HEC	WP6	5 - CEA	45
D7.1	Preliminary report on muon collider magnets	WP7	1 - CERN	33
D7.2	Consolidated report on muon collider magnets	WP7	1 - CERN	45
D8.1	Presentation of cooling cell conceptual design	WP8	7 - UMIL	15
D8.2	Final report on cooling cell design	WP8	7 - UMIL	42

Milestone No	Milestone Name	Work Package No	Lead Beneficiary	Due Date (month)
1	Website Available	WP1	1 -CERN	2
2	Kick-off meeting	WP1	1-CERN	3
3	Tentative parameters available	WP1	1-CERN	6
4	First annual meeting	WP1	1 -CERN	15
5	Preliminary parameters	WP1	1-CERN	18
6	Second annual meeting	WP1	1-CERN	27
7	Consolidated parameters	WP1	1-CERN	30
8	Third annual meeting	WP1	1-CERN	39
9	Training on detector design and physics performance tools	WP2	8-UNIPD	6
10	Workshop on MDI and IR design	WP2, WP5	8-UNIPD	13
11	Release of simplified detector performance model (DELPHES card or/and similar format)	WP2	8-UNIPD	18
12	Workshop on detector design and physics performance with a public lecture on Muon Collider	WP2	8-UNIPD	25
13	Publication of report of detector performance with major physics process at several ECM	WP2	8-UNIPD	48
14	Mini-Workshop on pulsed magnets	WP7, WP5	5-CEA	15
15	Tentative design of the interaction region	WP2, WP5	1-CERN	18
16	Tentative optics of the collider ring and pulsed synchrotrons	WP5	5-CEA	19
17	Tentative design of the FFA	WP5	5-CEA	25
18	Tentative impedance budget in the collider and pulsed synchrotron	WP5	5-CEA	26
19	Workshop on ultra-high-field solenoids	WP7	1 -CERN	30
20	Workshop on high-field collider magnets	WP7, WP5	1-CERN	42
21	Cooling cell design 3D model	WP8	7-UMIL	33

Achievements

- We have a website:
 - <https://mucol.web.cern.ch/>
- Well on schedule with milestones
- Working on DMP and table of Parameters
- Hiring of PHD and postdocs started
 - Please let us know about openings, we will advertise on our website and socials...



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*Thank you
for your attention*

- **Transveral roles**
 - ***Gender Adviser:***
 - responsible for the enforcement of gender equality in the Project
 - ***Dissemination and Communication Officer***
 - Will monitor the effective implementation of the dissemination and communication plan