MuCol WP5
High energy complex

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Description of the Workpackage

- **Design of the acceleration complex**
  - Pulsed synchrotrons
  - Alternative based on FFA
- **Design of the collider** to get the target luminosity
  - Interaction region + shielding design
  - Limitations due to collective effects
  - Machine detector interface
  - Background to experiment
- **How to handle the radiation** due to muon decay and other beam losses

Description of the task 5.1
Coordination and Communication

- Overall coordination of the activity
- Communication of its results
- Monitoring of work progress
- Management of the WP budget and use of resources and prepare internal and deliverable reports
- Organization of and/or support to activity workshops or specialized working sessions, implying the attendance of invited participants from inside and outside the consortium

Description of the task 5.2
Collider design (CERN)

- **Feasibility and optimization of the muon collider**
  - **Consistent lattice** for a 3 TeV and 10 TeV com collider comprising:
    - Interaction region
    - Straights to house necessary equipment (RF, injection, possibly extraction…)
    - Arcs
  - **Cost estimate**
- **Particular challenges**:
  - **Chromatic effects** due to the small β* and large momentum spread and their correction
  - Control of linear and non-linear **momentum compaction** to keep small bunch length
  - Acceptable **beam induced background levels**
  - Control of the **neutrino radiation** issue
  - **Beam operation with moving beam lines** and, possibly, non-linear effects

Description of the task 5.3
Pulsed synchrotron and FFA design
(CEA, CERN, STFC, BNL)

- **Feasibility and optimization of the muon acceleration complex** with
  - Cost estimate
  - Upgrade path
  - Reasonable requirements on accelerator elements (RF cavities and magnets)
- **Very fast acceleration**. Power consumption and acceleration inefficiency
- **Two** explored **solutions**:
  - Pulsed synchrotrons
  - FFA
- **Objectives**:
  - Beamline in a **parameter table**
  - **Full set of lattices** with critical technologies identified
  - **Start-2-end tracking** to demonstrate luminosity performance and to validate the bunch compression and emittance preservation during the acceleration process

Description of the task 5.4
Beam dynamics (CERN)

- **Transverse collective effects** all along the muon accelerator chain
  - Impedance effects
  - To check the feasibility of the very quick acceleration phase due to high intensity
- **Detailed proposed work plan:**
  - Compute and store the r**esistive-wall impedance** and wakefield
  - Perform PyHEADTAIL simulations of **transverse beam stability** with single bunch
  - **Scan the relevant parameters** to set limits on the performance reach
  - Choose and include **RF cavity impedance models**
  - Extend the previous parameters scan to set new limits to RF impedances
  - Re-do the same analysis with the RF cavities distributed along the machines
  - Re-do the same analysis with the 2 counter-rotating bunches
  - **Propose possible mitigation measures** and study in particular if pulsed synchrotrons need sextupoles

Description of the task 5.5
MDI design and background to experiment
(CERN, INFN, STFC)

- **Goal**: **Develop a conceptual interaction region design** with:
  - A detector shielding together with the detector envelope
  - Final focus system
  - Other requirements (e.g. neutrino, shielding of magnets etc.)
- It will explore:
  - Quantification of **particle fluxes** and **time dependence w**ith respect to the bunch passage:
    - Muon decay in the collider ring
    - Incoherent electron-positron pair production at the IP
    - Beam halo losses
  - **Shielding design** with respect to different contributions
  - Other possible **background mitigation techniques** on the machine side
  - The need of a **halo-removal system** for background reduction
  - Close collaboration with WP2 to assess and mitigate the impact of background on the physics performance
  - The benefits of **asymmetric and smart nozzles** (instrumented nozzles)
  - Estimates of the **long-term radiation damage** in the detector

Description of the task 5.6
Radiation studies for the accelerators (CERN)

- **Simulation** and **mitigation of radiation-related effects** including the neutrino hazard
- To quantify the **heat load distribution** and **long-term radiation damage** in SC magnets due to muon decay and beam halo losses
- To develop a **shielding design for arc magnets** in order to:
  - Avoid quenches
  - Sustain the thermal load to the cryogenic system
  - Prevent magnet failures due to long-term radiation damage
- To quantify the **radiation environment** in the tunnel and caverns
  - To assess the need of machine protection systems to avoid beam induced-damage/quenches
  - Design of a beam extraction system (if needed)
  - Input for the design of a beam loss monitoring system
- Effect and optimization of the lattice design on the neutrino distribution
- **To refine the dose kernel** for assessing the surface dose arising from neutrino-induced particle showers, considering the different neutrino flavours

Table 3.1b

Work package number	5		**Lead beneficiary**			CEA
Work package title	High energy Complex					
Participant number	1	2	7	11		
Short name of participant	CERN	CEA	INFN	STFC		
Person months per participant:	216	34	34	128		
Start month	1			**End month**	48	

Table 3.1c: List of Deliverables

Deliverable (number)	Deliverable name	Work package number	Short name of lead participant	Type	Dissemination level	Delivery date (in months)
5.1	Report on the collider ring design	5.2, 5.4, 5.5, 5.6	CERN	R	PU	36
5.2	Report on the design of high energy acceleration complex	5.3, 5.4, 5.6	CEA	R	PU	36

Table 3.1d List of Milestones

Milestone number	Milestone name	Related work package(s)	Due date (in month)	Means of verification
5.1	Mini-Workshop with pulsed magnets	5.1, 5.3	12	Minutes of the workshop
5.2	Preliminary design of the interaction region	5.2	18	Optics files
5.3	Preliminary design of the collider	5.2	18	Optics files
5.4	Preliminary design of the pulsed synchrotrons	5.3	18	Optics files
5.5	Preliminary design of the FFA	5.3	24	Optics files
5.6	Impedance budget in the collider and pulsed synchrotron	5.4	24	Dataset

Table 3.1e: Critical risks for implementation

Description of risk (indicate level of (i) likelihood, and (ii) severity: Low/Medium/High)	Work package(s) involved	Proposed risk-mitigation measures
Hiring difficulty Likely/Medium	All	To promote the open positions on different professional networks to be the most attractive
Accelerator parameters are not feasible Likely/High severity	5	1) To discuss with WP6 and WP7 to find a set of more realistic parameters 2) To reduce a bit the target luminosity to get margins
Neutrino hazard is not manageable Likely/ High severity	5	1) Develop a strategy based on beam line movers, specific optics and civil engineering to reduce the impact.

Thank you
for attention