Summary of the RP Working Group

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3rd Muon Community Meeting

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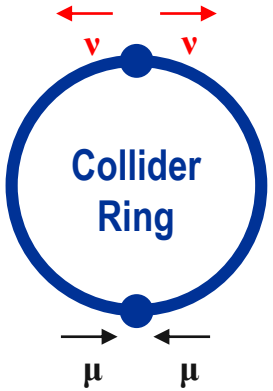
Recap – Main challenges identified by RP WG

Neutrino radiation challenges



Unprecedented: Substantial neutrino induced radiation hazard at very far distance from the source

‚Conventional' RP challenges

PROMPT AND RESIDUAL RADIATION

AIR AND HE ACTIVATION

WATER AND SOIL ACTIVATION

RADIOACTIVE WASTE

‚Conventional' radiation challenges are principally well understood and can mitigated to levels as low as reasonably possible, but to be addressed at an early design stage

→ At given stage mainly relevant for Test Facility

Description

- One of the main challenges of the muon collider is the **neutrino radiation** and the related **dosimetric impact** on the **public**
- A **refined dose model** for an accurate estimation of neutrino-induced radiation hazard outside the accelerator complex shall therefore be developed and used for a **collider ring optimisation** to **minimise** the **effective dose** to members of the public
- The dose model shall include a more **detailed topographical model** to evaluate the spatial dose distribution
- **Mitigation strategies** shall be investigated and developed, such as the **concept** for the technology of **large-stroke, high-resolution movers**

Objectives and Deliverables

Objectives
Basic: Assess whether the neutrino flux can in principle be mitigated sufficiently to allow implementation of the collider in the Geneva area or elsewhere.
Develop a concept of the neutrino flux mitigation technology and assess its maturity.

High-level Deliverables
1) Assessment of the dose and a plan to demonstrate compliance
1) Verification that the proposed mitigation method does not compromise beam operation
2) A basic concept for the mechanical system including the cryogenics.
2) A basic concept of accurate large-stroke, high-resolution mover and alignment system

Tasks and Resources (1/2)

Task description (2021-2025)	Resource estimate staff [FTEy]	postdoc [FTEy]	PhD [FTEy]	material [kEuro]
Further verification of the neutrino induced dose model	0.5	1		
Intercomparison of FLUKA+MARS predictions of ν induced dose	0.5*			

To build on extensive accomplish-ments with MARS15!

*FNAL + assuming support by DOE and Snowmass/P5

Resources in black identified

Resources in red not yet identified

Neutrino Radiation Work Package

Tasks and Resources (1/2)

Task description (2021-2025)	Resource estimate staff [FTEy]	postdoc [FTEy]	PhD [FTEy]	material [kEuro]
Further verification of the neutrino induced dose model	0.5 0.5*	1		
Intercomparison of FLUKA+MARS predictions of ν induced dose				
Develop tool to link the collider to the surface map and optimise position	0.3 0.2	1	1 (2021-2022)	

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Use tool with realistic source term from beam	0.25 0.25	0.25 (2021-2023) 0.25 (2024-2025)		

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Use tool with realistic source term from beam	0.25 0.25	0.25 (2021-2023) 0.25 (2024-2025)		
Assess dose and develop possible methods to demonstrate compliance	0.4 1.1			

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Neutrino Radiation Work Package

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Use tool with realistic source term from beam	0.25 0.25	0.25 (2021-2023) 0.25 (2024-2025)		
Assess dose and develop possible methods to demonstrate compliance	0.4 1.1			
Study impact of lattice deformation on beam and assess tolerances and time needed to recover from movements	In HE-Acceleration package			

To build on extensive accomplish-ments with MARS15!

Several resources already identified

Work has started!

Aim to obtain first results on IR asap

*FNAL + assuming support by DOE and Snowmass/P5

Resources in black identified

Resources in red not yet identified

Dose model – milestone plan

Preliminary

Task	2021	2022	2023	2024	2025
MC simulations		Dose distribution for equilibrium nu_mu case		Sensitivity studies	Final documentation
MC inter-comparison		Intercomparison of preliminary results			Final documentation
Surface map		First version of tool			Final documentation
Realistic source term		First results on dose predictions for IR			Final documentation
Dose assessment + compliance		First dose assessment for IR			Final documentation

Tasks and Resources (2/2)

(2022-2026)

Task description	Resource estimate staff [FTEy]	postdoc [FTEy]	PhD [FTEy]	material [kEuro]
Assess impact of movements on mechanical, cryogenics, RF and other systems	1.0	6		

Resources not yet identified

Tasks and Resources (2/2)

	Task description	Resource estimate staff [FTEy]	postdoc [FTEy]	PhD [FTEy]	material [kEuro]
(2022-2026)	Assess impact of movements on mechanical, cryogenics, RF and other systems	1.0	6		
(2022-2025)	Develop concept of large-stroke, high-resolution movers	0.5		4	50

Resources not yet identified

First prototype of mover including 3D models + detailed design office drawings + prototype itself by an external company (hardware and control/ command software)

Tasks and Resources (2/2)

	Task description	Resource estimate staff [FTEy]	postdoc [FTEy]	PhD [FTEy]	material [kEuro]
(2022-2026)	Assess impact of movements on mechanical, cryogenics, RF and other systems	1.0	6		
(2022-2025)	Develop concept of large-stroke, high-resolution movers	0.5		4	50
(2022-2026)	Develop solution to remotely control positions over a large range	0.5	3	3	50

Resources not yet identified

First prototype of alignment sensor (with a large range of measurement and a high resolution), including 3D models + detail design office drawings of the sensor + prototype itself by an external company

Tasks and Resources (2/2)

	Task description	Resource estimate staff [FTEy]	postdoc [FTEy]	PhD [FTEy]	material [kEuro]
(2022-2026)	Assess impact of movements on mechanical, cryogenics, RF and other systems	1.0	6		
(2022-2025)	Develop concept of large-stroke, high-resolution movers	0.5		4	50
(2022-2026)	Develop solution to remotely control positions over a large range	0.5	3	3	50
(2023-2026)	Develop concept of accurate reference system with respect to the surface	0.5		4	50

Resources not yet identified

Prototype of permanent system to transfer the position of the surface in the tunnel within a very good accuracy. In that case, prototype would be rather different proposals of measurement concepts (3D models + detailed drawings) + simulations and qualification studies

Neutrino Radiation Work Package

Summary

Objectives
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High-level Deliverables
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Resources	1	2	3		1	2	3
Staff	1.45, 2.05	2.5		Student	1	11	
Postdoc	0.25, 2.25	9		Material		150	

Interested partners
CERN, resources partly in place, FNAL with support by DOE and Snowmass/P5

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

‘Conventional’ RP Work Package

Description

- According to the radiation protection principles, the **exposure of persons** to **radiation** and the **radiological impact** on the environment must be **optimised**
- Based on the experience from past design studies the RP and radiological environmental impact of a MW facility should be **manageable** at the **present state of technology**
- The past studies have however also shown that the **RP considerations strongly determine** the **design** of high power facilities and should be taken into account from the design phase onwards
- The design of the **test facility** and **key areas** of the **muon collider complex** will have to be optimised w.r.t. prompt and residual radiation, air/He/N activation, water and soil activation, and radioactive waste production

‘Conventional’ RP Work Package

Objectives and deliverables

Objectives							
Basic: Optimize the design of the test facility as well as key areas of the complex for the exposure of persons to radiation and the radiological impact on the environment							
High-level Deliverables							
1) RP assessment of the test facility (2022-2025)							
3) First RP assessment of the key areas of the complex*							
Resources	1	2	3		1	2	3
Staff	1		(0.4)*	Student			
Postdoc	4			Material			
Interested partners							
CERN							

*In case of first studies for a MW facility until the next ESPPU


International
MUON Collider
Collaboration
CERN
Thank you
for your attention!