International MUON Collider Collaboration

Machine Detector Interface Report

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Working Group activities

- Meeting with people willing to contribute from CERN, INFN, Fermilab.
- Joint session with High Energy Complex
- Joint session with Radiation Protection on Neutrino Radiation Mitigation

Very fruitful discussion!

Proposed Workpackage Tasks

1. **Study of beam-induced background and identification of mitigation strategies at $\sqrt{s}$=3 TeV**
   - Study beam-induced background characteristics using the MAP $\sqrt{s}$=3 TeV interaction region design.
   - Define a metric for the determination of the shape and dimensions of the shielding inserted in the detector (nozzle) (e.g. electrons/photons fluxes on tracker, neutrons/photons on calorimeter).
   - Explore further shielding strategies (e.g. asymmetric nozzle, optimization of interaction region active elements together with detector modifications).
   - Provide estimates of the long-term radiation damage in the detector (Si-1 MeV neutron equivalent fluence, dose etc.)
   - "Adapt experiment design and propose new detector technologies"

2. **Quantification and mitigation of the beam-induced background for the $\sqrt{s}$=10+TeV collider**
   - In close collaboration with optics, magnet and detector experts, develop a first conceptual interaction region design, which integrates a detector shielding together with the detector envelope and the final focus system; incorporate also requirements from other Work Packages (e.g. neutrino emission (Radiation Protection), shielding of magnets etc.).
   - Quantify particle fluxes for different source terms (muon decay in the collider ring, incoherent electron-positron pair production at the IP, beam halo losses) and study the time dependence with respect to the bunch passage.
   - As a further step, optimize the shielding design with respect to different contributions (e.g. photons, electrons scattered from the nozzle, neutrons, Bethe-Heitler muons). Explore other possible background mitigation techniques (e.g. chicanes?). In collaboration with the Beam Dynamics Work Package, assess the need of a halo-collimation system for background reduction.
   - Provide estimates of the long-term radiation damage in the detector (Si-1 MeV neutron equivalent fluence, dose etc.)
   - "Adapt experiment design and propose new detector technologies"

Proposed Workpackage Timeline

1. **Study of beam-induced background and identification of mitigation strategies at $\sqrt{s}$=3 TeV**
   - Compare the beam-induced background characteristics at $\sqrt{s}$=3 TeV with the published results at $\sqrt{s}$=1.5 TeV. (**2021**)
   - Optimize the nozzle shape and dimensions by using the MAP interaction region design **in collaboration with detector community.** (**2022)**
   - Compare the nozzle shielding performance with the results of new beam induced-background mitigation strategies by using update interaction region design. (**2023 - 2025**) **Iterative process with the detector community and optics, beam dynamics and magnet experts.**

2. **Quantification and mitigation of the beam-induced background for the $\sqrt{s}$=10+TeV collider**
   - In collaboration with detector experts, define an approximate detector envelope and establish an indicative figure-of-merit for quantifying the detector background (2021-2022) – **input from detector community needed**
   - Develop a first detector shielding design and provide first estimates of the particle background and long-term radiation damage by means of FLUKA and MARS particle transport simulation (for different source terms); perform first optimization studies (2021-2022) – **iterative process with optics team, requires also input from magnet experts and beam dynamics experts (assessment of halo-induced background)**
   - Perform a more detailed optimization of the shielding design and other background reduction techniques, including a refinement of the detector envelope; provide input for event reconstruction studies by detector community (2023 -2025) – **iterative process with optics team, magnet and detector experts**

Requested Workpackage Resources

A table of the initial estimated required resources in FTE years, specifying staff, post-doc and student.

Task	Staff [pm]	postdoc [pm]	student [pm]	Cash [kEUR]	Comment
MDI 3 TeV	0.5 FTE	1 FTE			- INFN 0.3 FTE Staff + 0.5 FTE postdoc (1Y) - CERN - LBL* - Fermilab*
MDI 10+ TeV	0.5 FTE	1 FTE			- CERN 0.2 FTE Staff + 0.5 FTE postdoc - INFN - LBL* - Fermilab*

* assuming support by Snowmass/P5
FTE are requested for 5 years.