Homework: Muon Collider Machine-Detector Interface

Accelerator School

(a) General question

1. What is the role of the Machine Detector Interface in a collider experiment?
2. Why is machine-induced background more severe in muon colliders compared to electron or proton colliders?

(b) Machine induced background at MuC

1. Which are the main physics processes that contribute to the machine-induced background at $\sqrt{s} = 3$ TeV and $\sqrt{s} = 10$ TeV?
2. For muon beams with energy $E_\mu = 1.5$ and $E_\mu = 5$ TeV and other useful parameters reported in table on slide 9, estimate the number of muon decays per meter of lattice per bunch.

(c) Shielding Design Tradeoffs

1. Why is the shielding nozzle designed with a conical shape, and what tradeoff does the opening angle impose?
2. What strategies can be used to reduce the machine-induced background particles arriving in the detector while maintaining its acceptance?

(d) Design Exercises

Imagine you are tasked with designing an MDI for a hypothetical new collider operating at $\sqrt{s} = 30$ TeV:

1. What considerations would guide your design of the final focus system, shielding, and detector?
2. How would you address background contributions mitigation?