



Forward detector and nozzle instrumentation

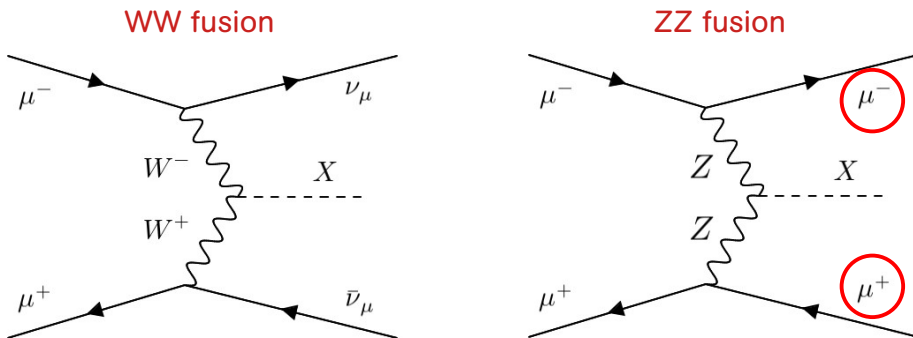
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- Detecting muons that are scattered at very low polar angles would allow distinguishing between the WW- and ZZ-fusion processes:

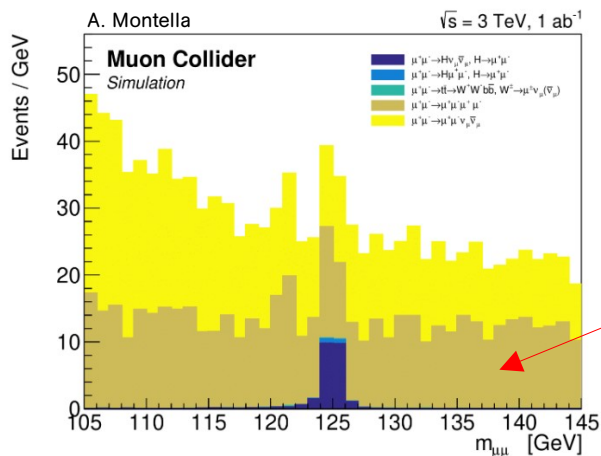
- ▶ to exploit the specific ZZ-fusion signature, like for example in:

P. Li, Z. Liu, K.-F. Lyu, arXiv:2401.08756;

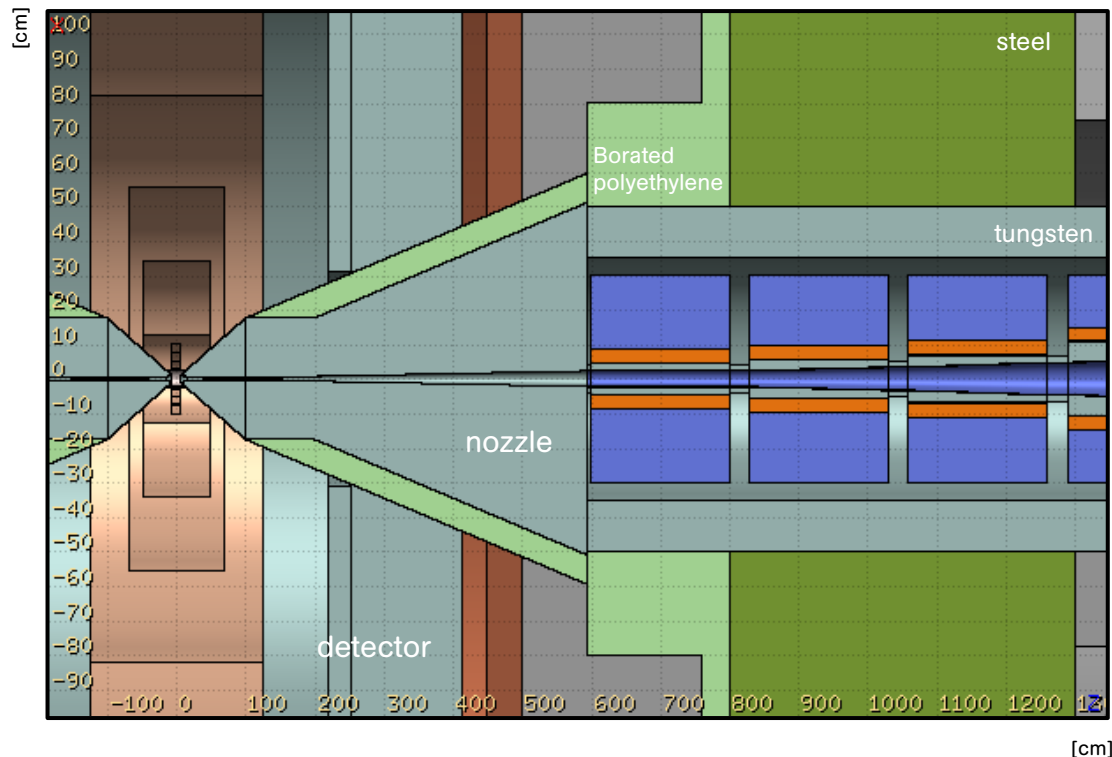
- ▶ to reduce physics backgrounds.

- Possibly help with the luminosity measurement.

H → μ⁻μ⁺ analysis



$\mu^- \mu^+ \rightarrow \mu^- \mu^+ \mu^- \mu^+$

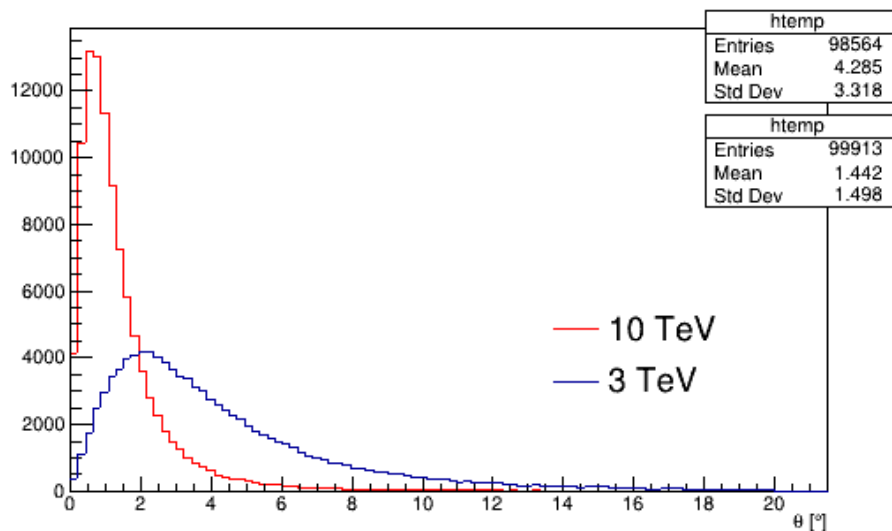


- At a more conventional machine, it would probably be a piece of cake.
- At a muon collider, the interaction region is densely packed with shielding.

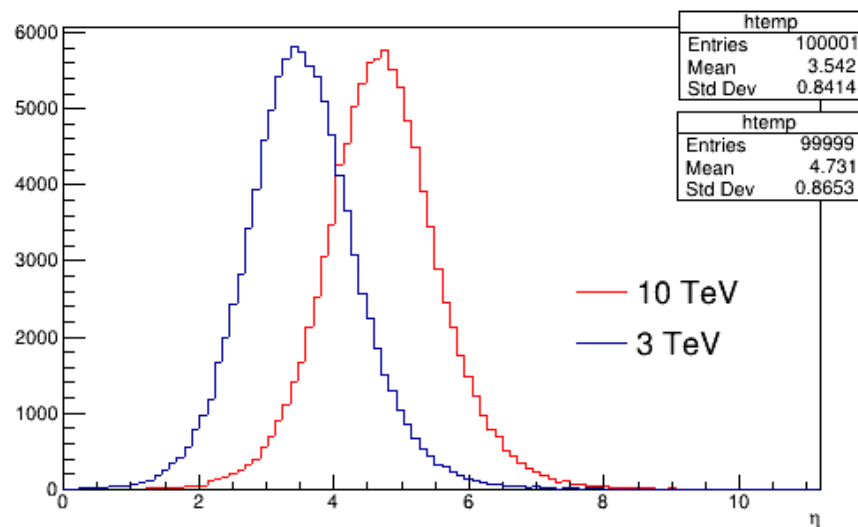
How forward are the forward muons?

- It depends on the collision energy and the specific physics channel being considered.
- Example: $\mu^- \mu^+ \rightarrow H \mu^- \mu^+$ at 3 and 10 TeV.

polar angle of forward muons



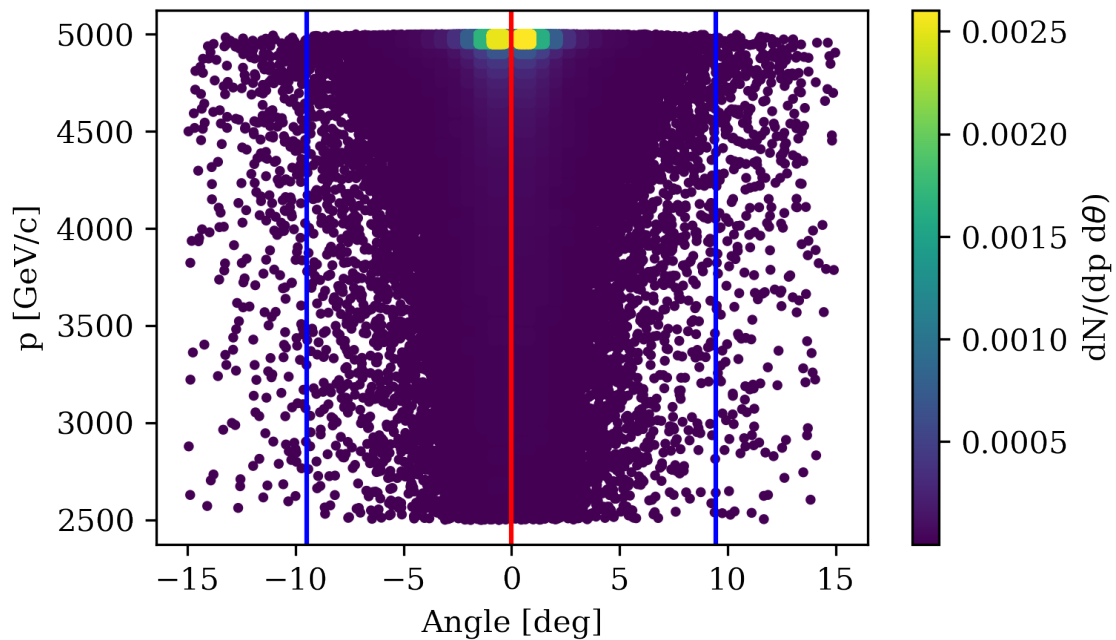
pseudorapidity of forward muons



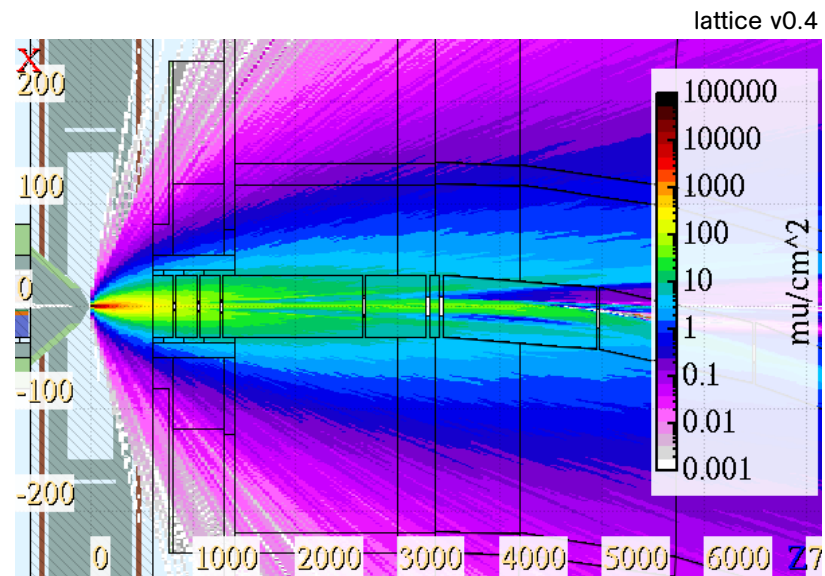
Samples provided by M. Forslund.

$\mu^- \mu^+ \rightarrow H \mu^- \mu^+$ at 10 TeV

muon momentum vs polar angle

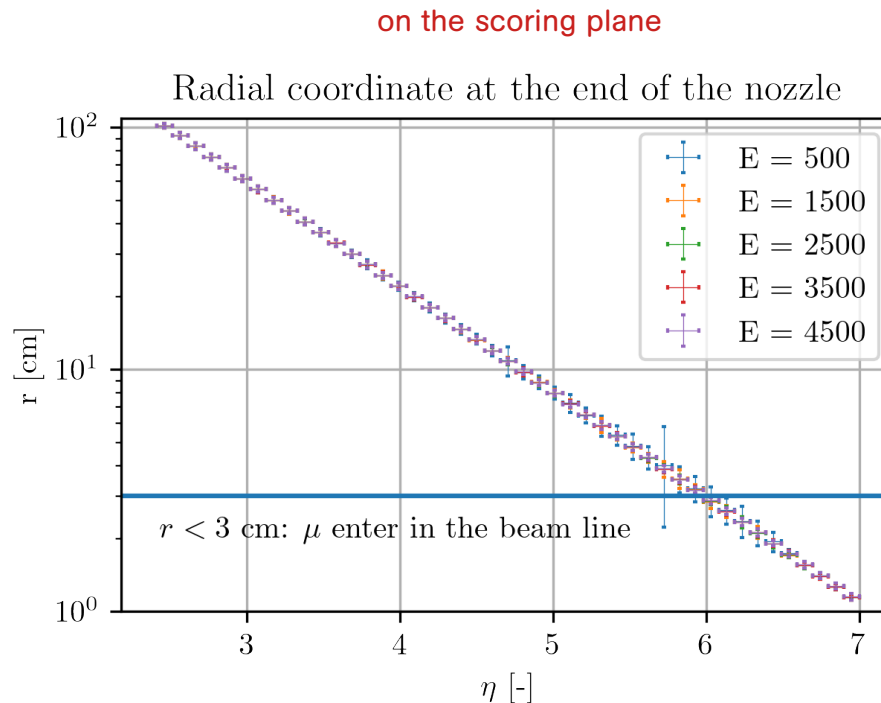
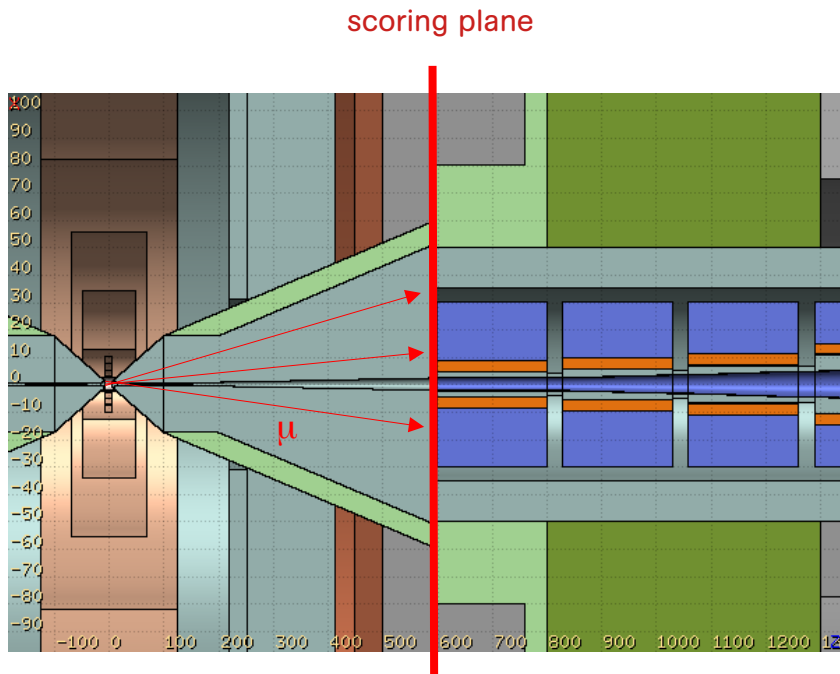


muon fluence in the machine

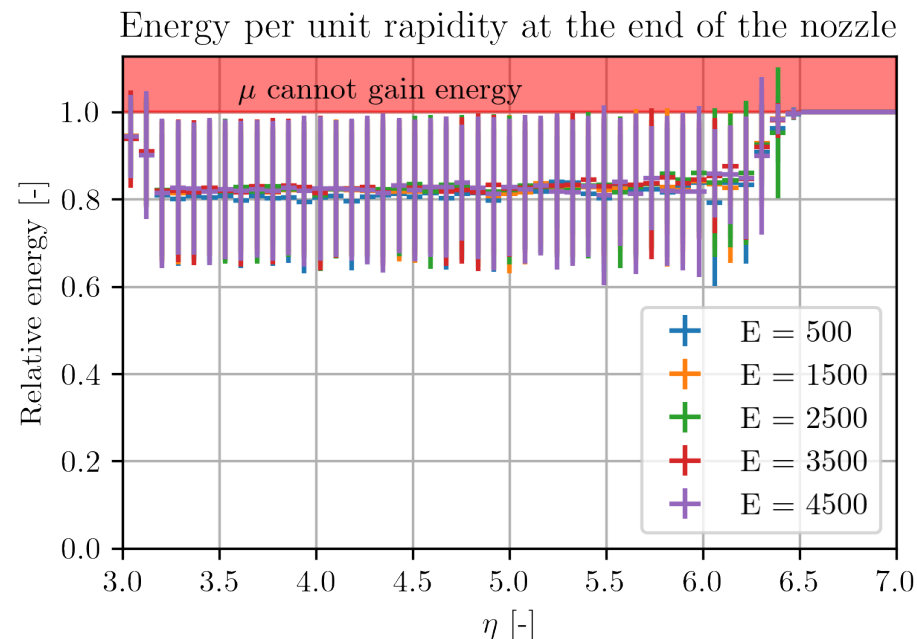
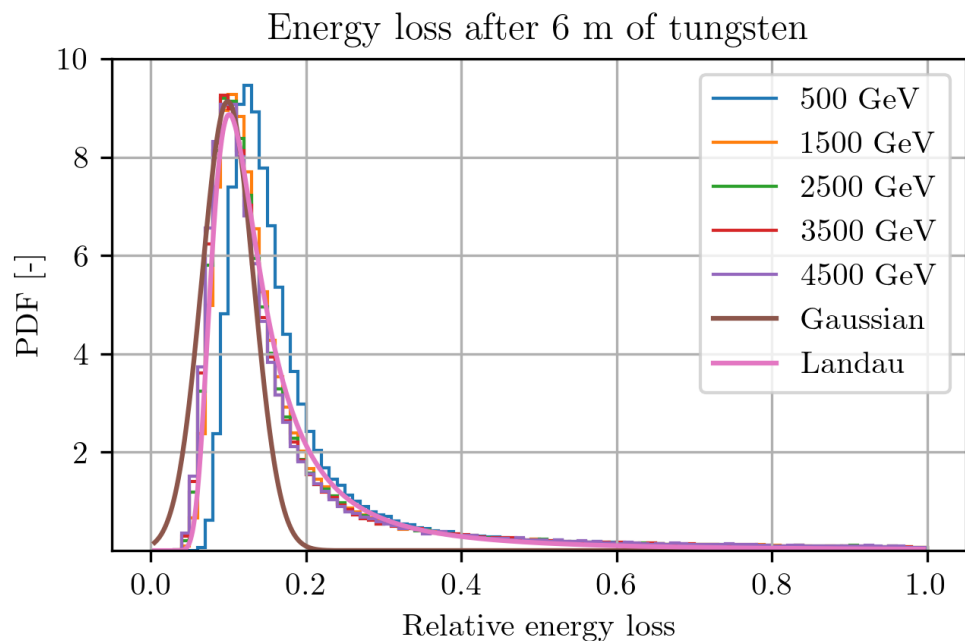


Muons passing through the nozzles (I)

- Muons of different energies shot through the nozzle at different angles and scored on a plane at the base of the nozzle.



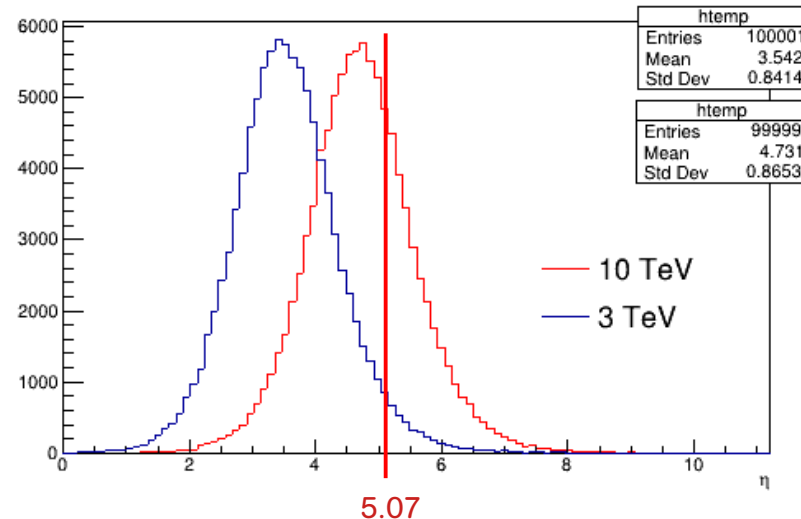
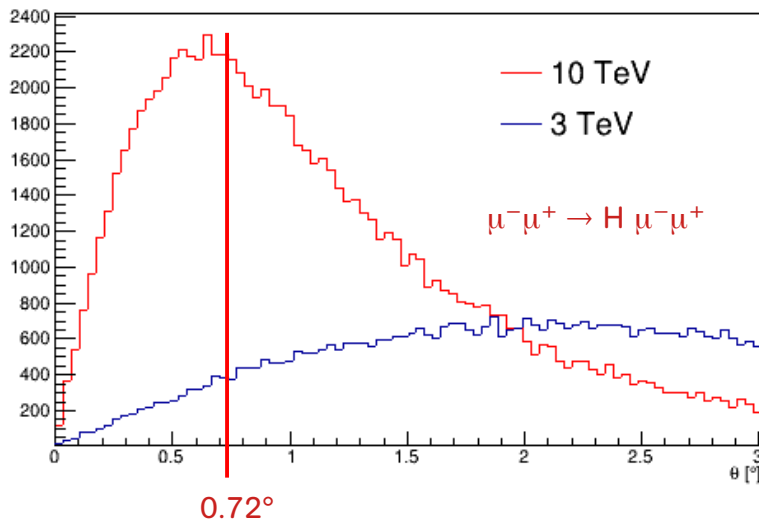
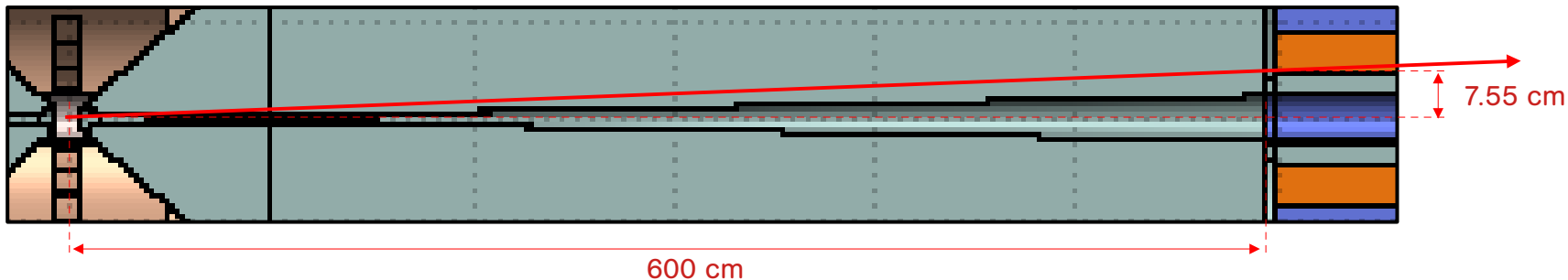
Muons passing through the nozzles (II)



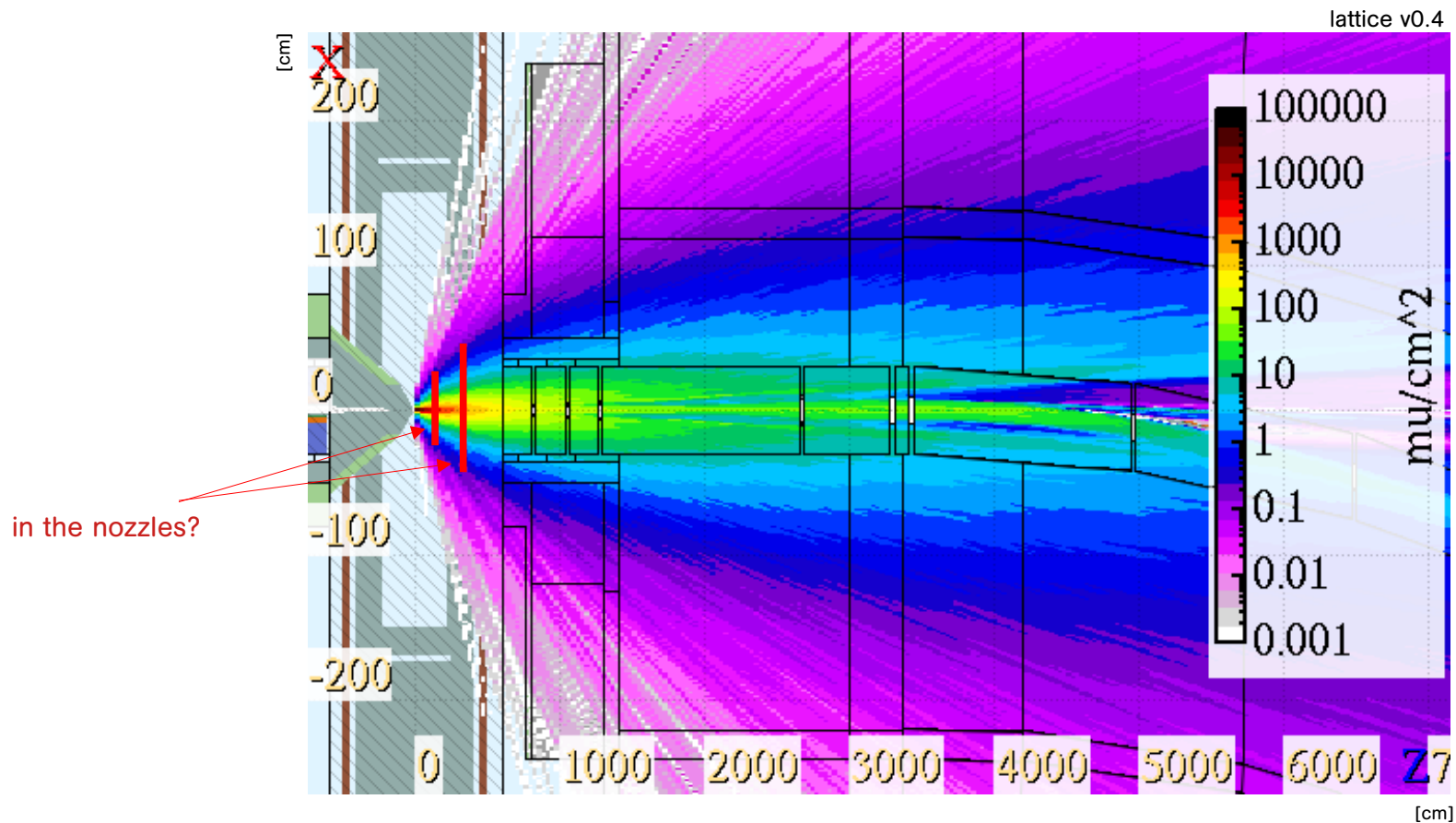
- Muons entering the nozzles pass through ~ 6 m of tungsten and lose on average $\sim 20\%$ of their energy.

Forward muons lost in the machine

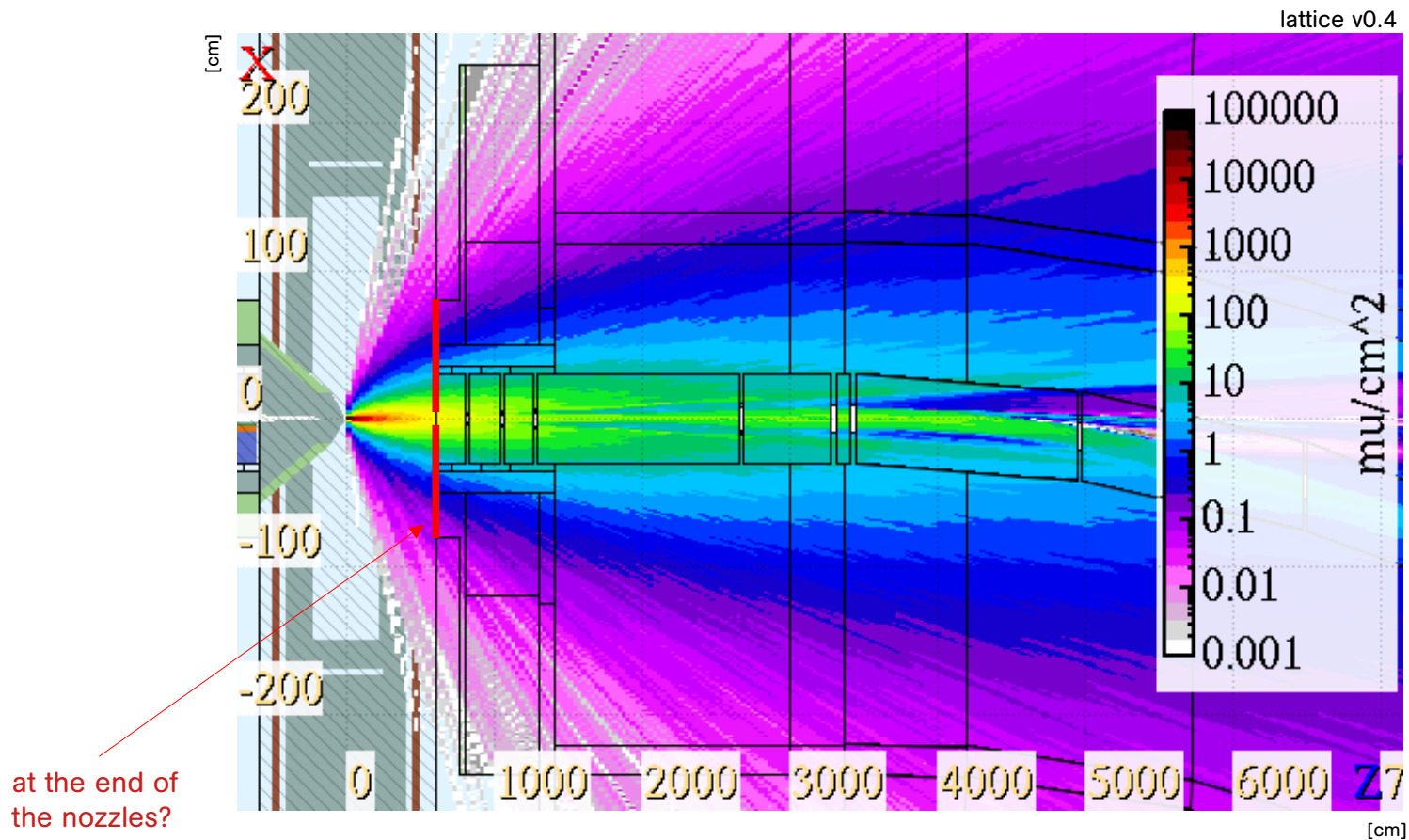
- Just from geometrical considerations at this point, to be confirmed with FLUKA simulation.



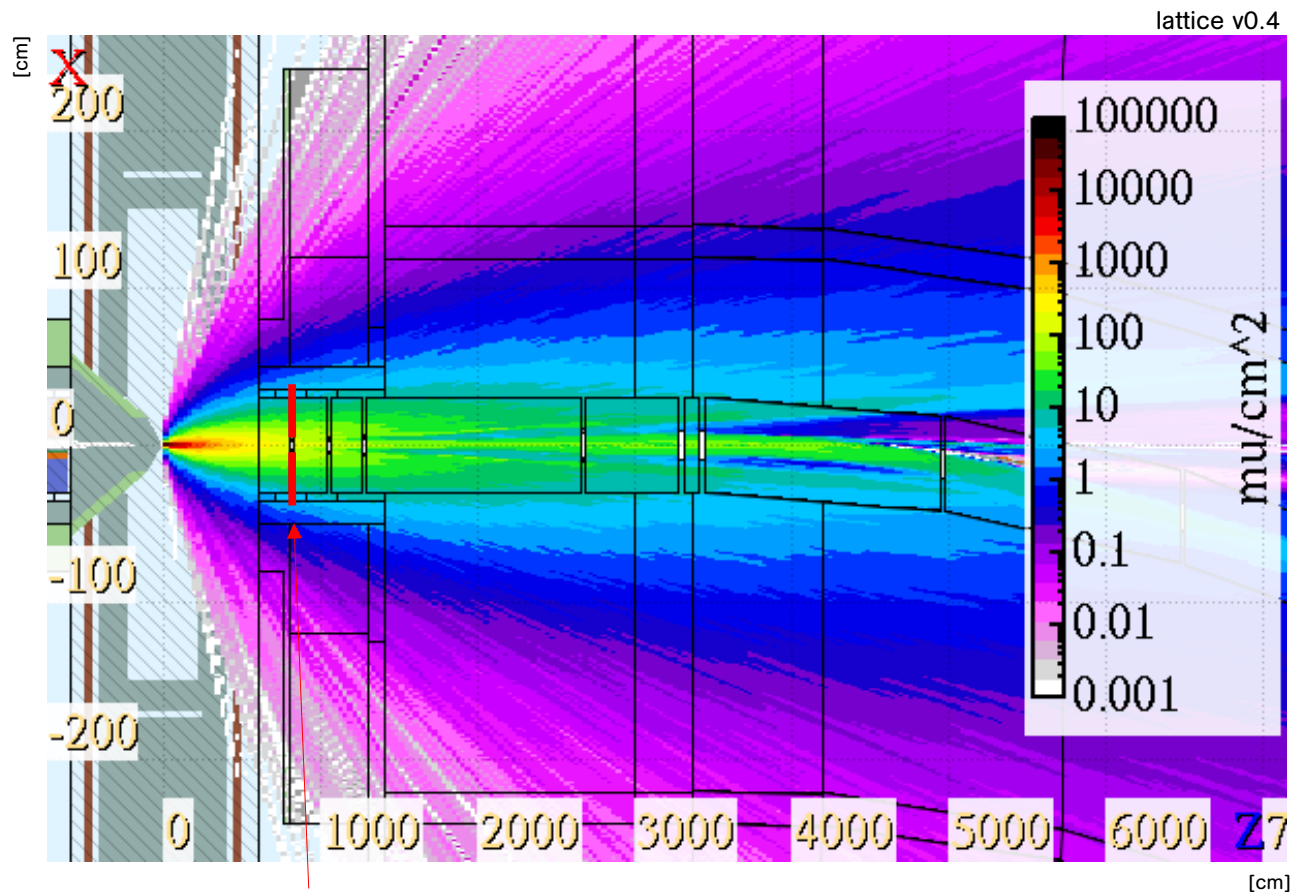
Where to place a muon detector?



Where to place a muon detector?

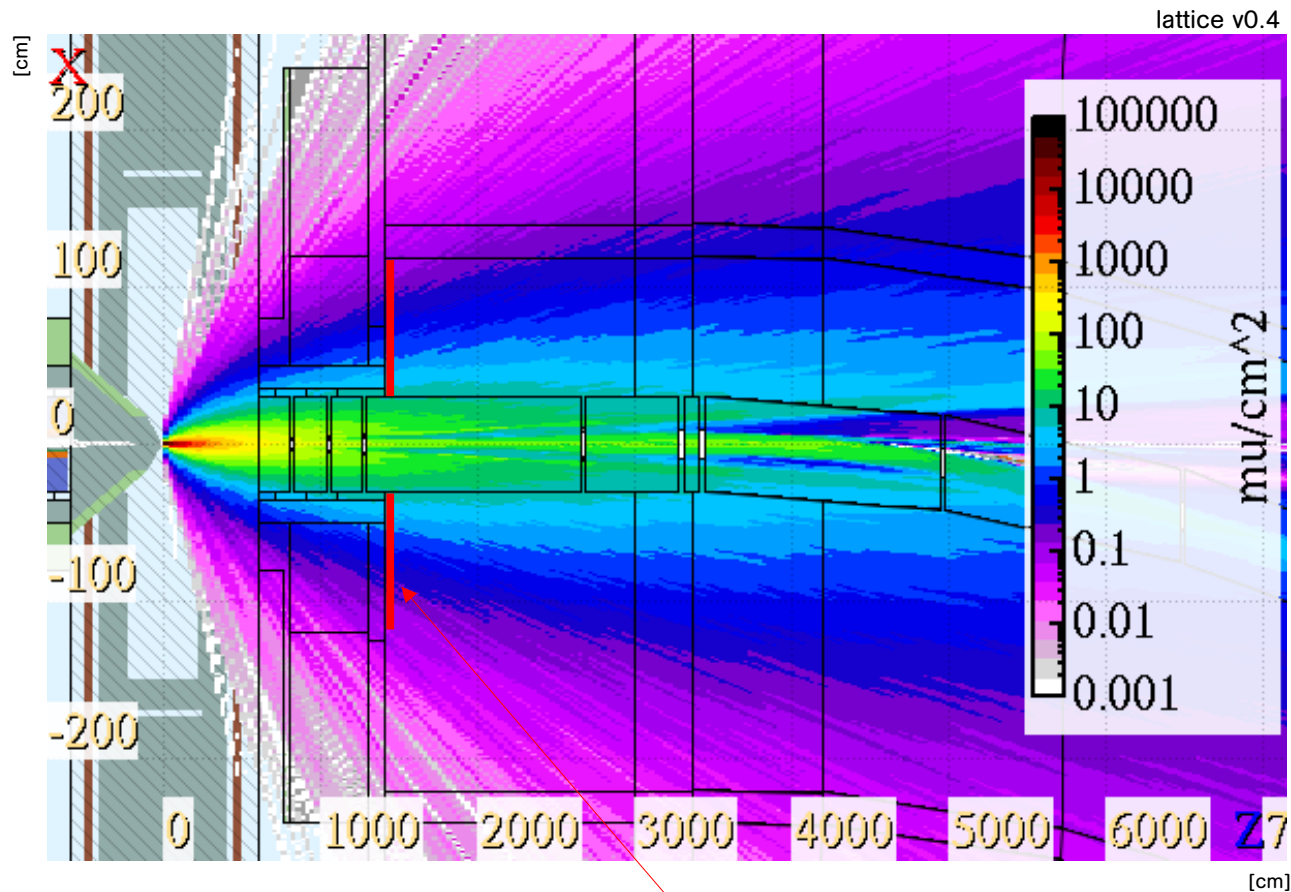


Where to place a muon detector?



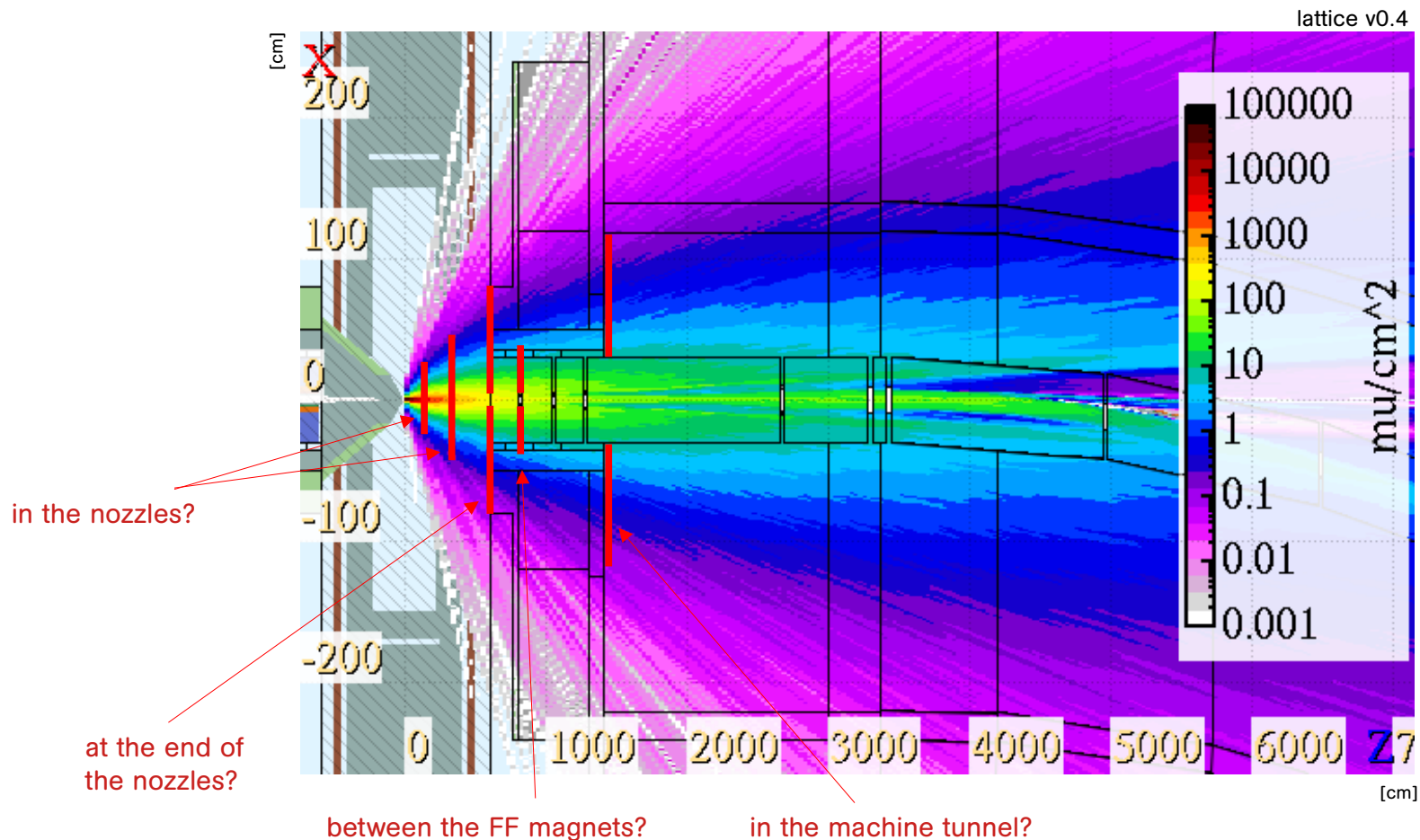
between the FF magnets?

Where to place a muon detector?



in the machine tunnel?

Where to place a muon detector?



- The possibility of detecting muons at very low polar angles would undoubtedly expand the physics potential of the muon collider and is highly anticipated by our theorist and experimentalist colleagues.
- A forward detector is going to add to the list of muon collider challenges:
 - ▶ a fraction of the forward muons are captured by the machine and lost;
 - ▶ the interaction region is densely packed with shields, and the optimal location for the forward detector may not be easily exploitable or accessible.
- Nonetheless, we should try to agree on a reasonably realistic concept for a forward detector and include it in the design of the 10 TeV detector.

Backup

