MDI: radiation damage in detectors update

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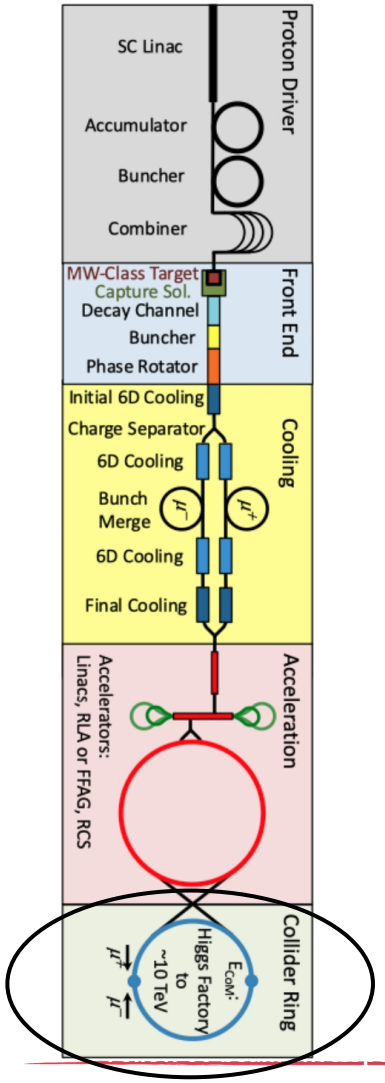
Outline



- Lattices for the study: from v0.4 to v0.8
- New/old nozzle
- MAIA/MUSIC detector implementations
- Radiation load: bugfix v 0.4 & new results

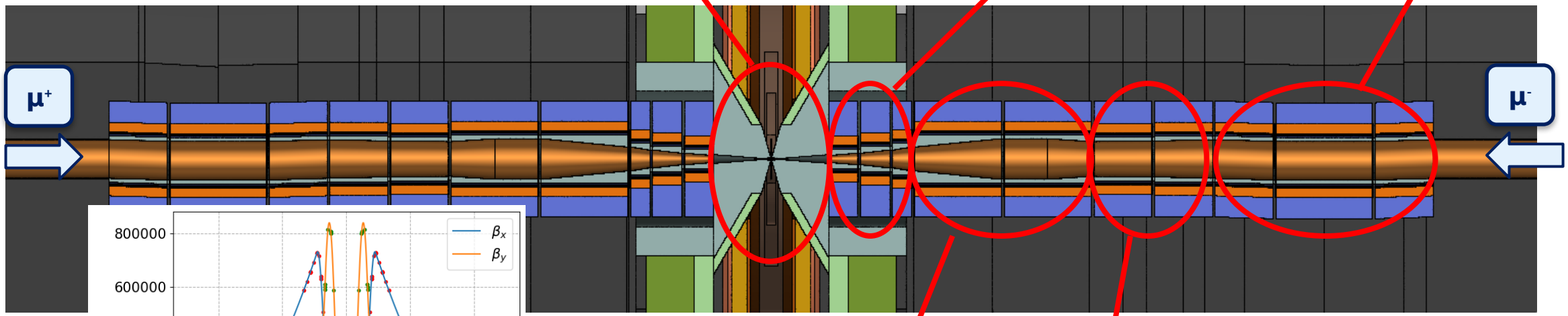
Final focus optics

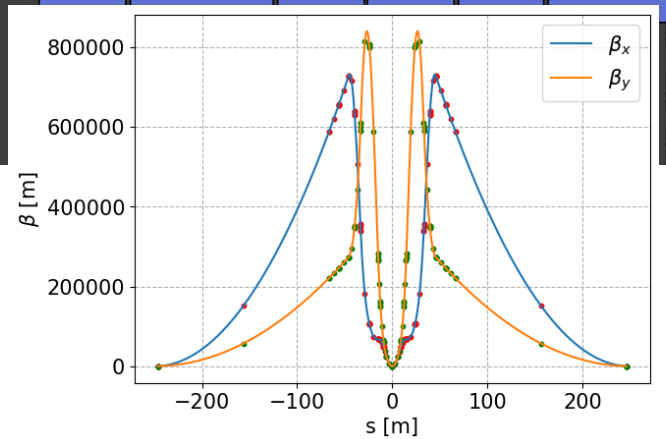
Overview of the lattice version 0.8. The novel approach does not leave a residual angle and does not require combined function magnets

Interaction point (IP) & nozzle
Reduce the amount of decay-induced background by several order of magnitude

Q1
Three focusing quadrupoles to control the beam size in the IP

Chicane
Three dipoles that remove the electrons coming from the line





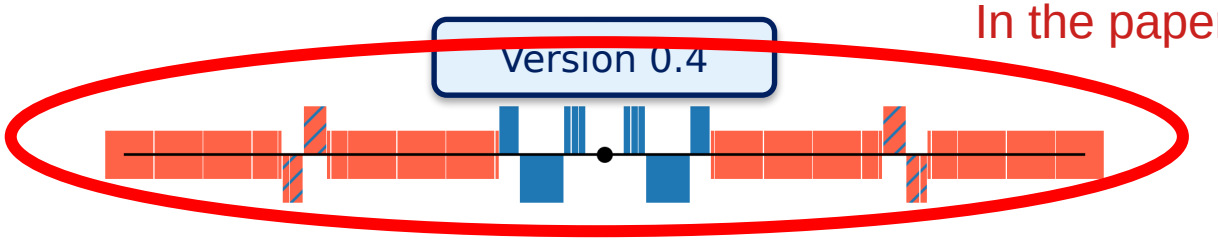
Q2
Two defocusing quadrupoles. Here the beam aperture reaches its maximum

Q3
Two focusing quadrupoles. Different options in the past to employ combined function to reduce BIB

Evolution of the optics

In the paper

Sep 2022

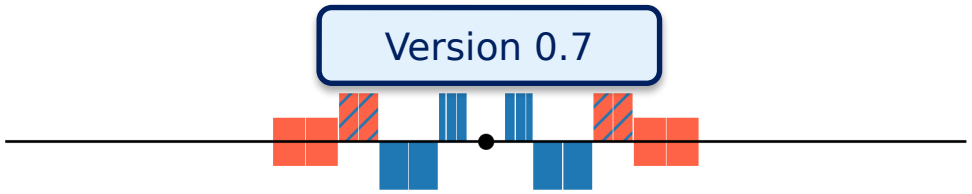


Dipolar components suppress BIB outside of the final focus. The BIB sample distributed (and considered baseline)

Jun 2023

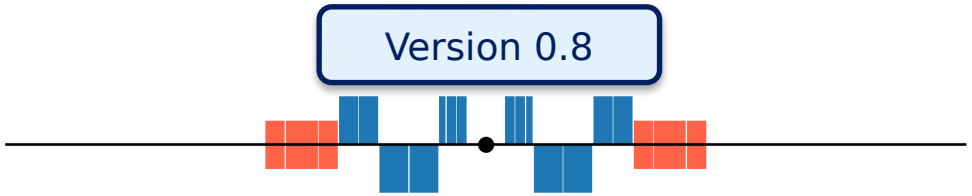
All the muon decays in ~200 meters from the IP give a non negligible contribution to the BIB

Feb 2024



A chicane is added to partially clean the line from the secondary electrons before they reach the nozzle

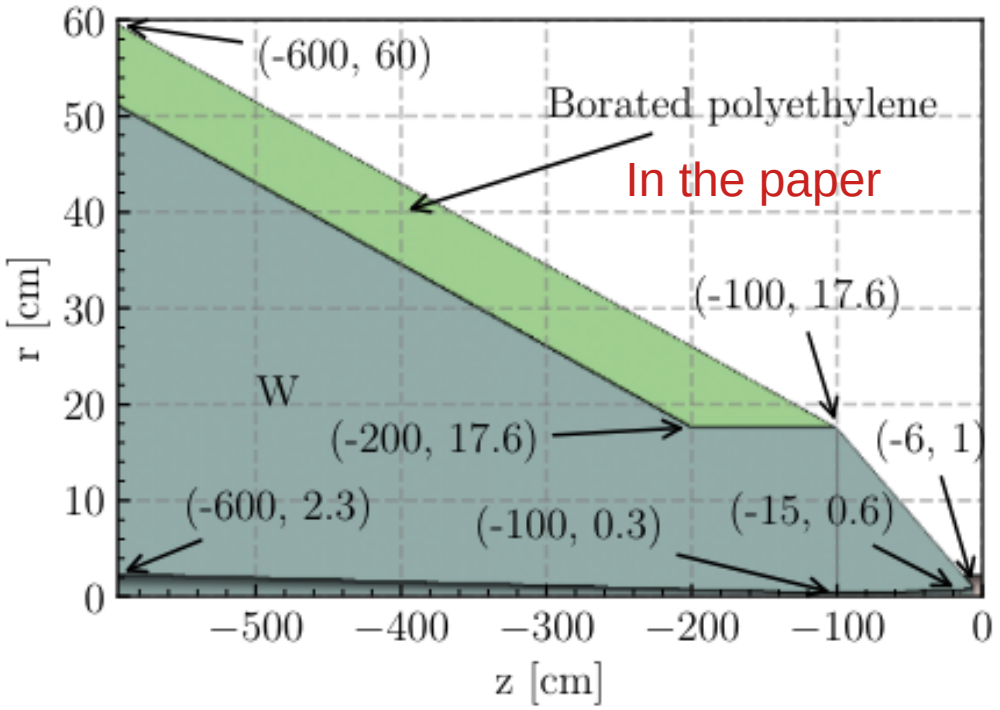
Jun 2024

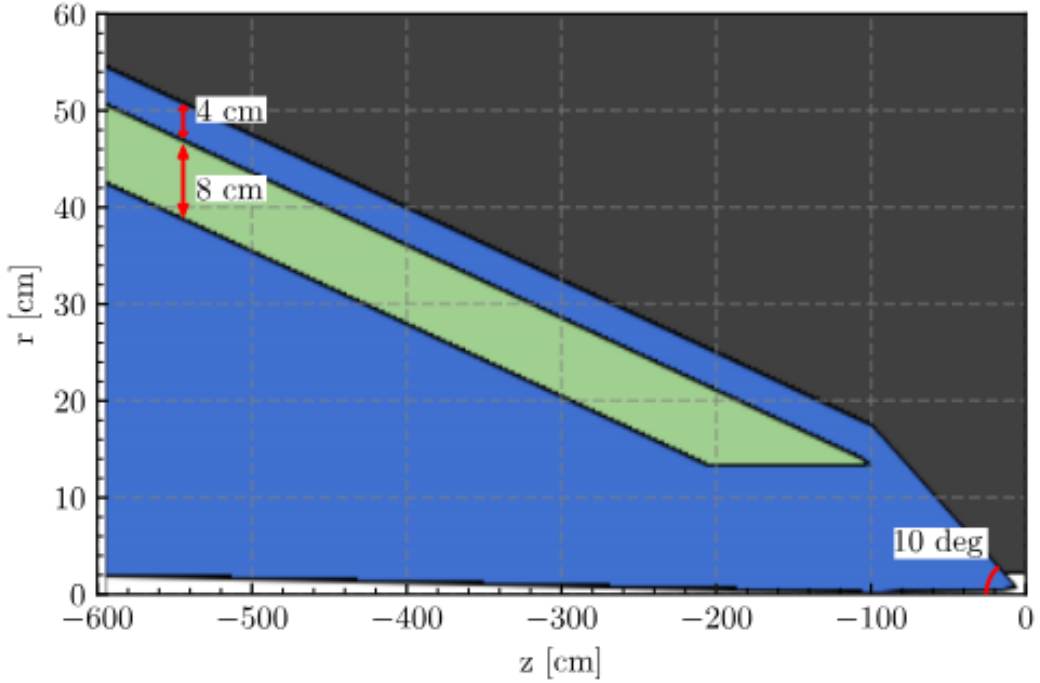


The chicane concludes with 0 angle, and the magnet aperture is increased in the dipoles

Nozzle from MAP to ESPPU

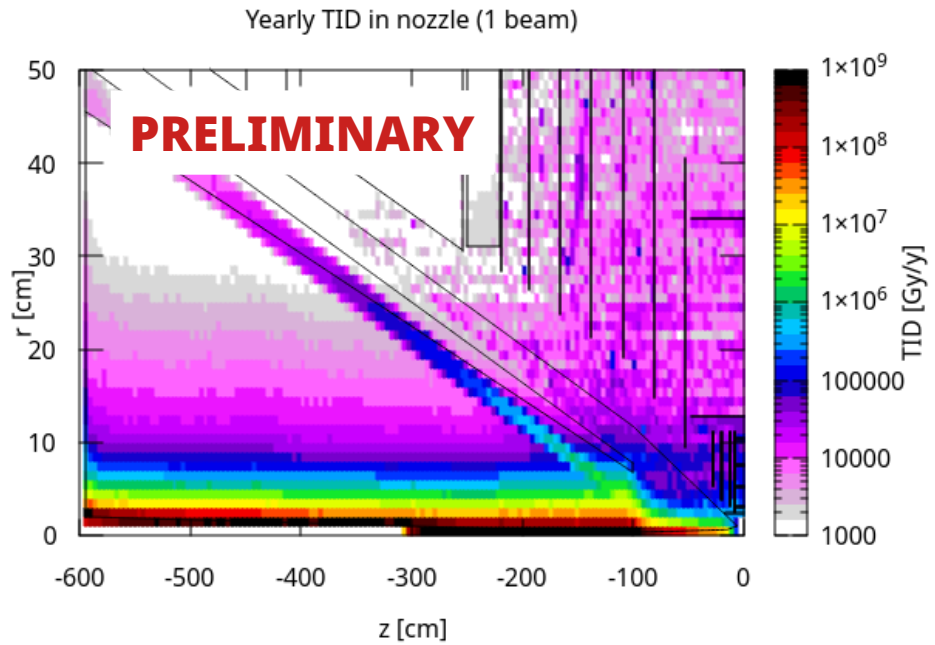
- Nozzle has changed for the ESPPU. I could reduce the lateral size of it and remove the low energy gamma from the neutron captures

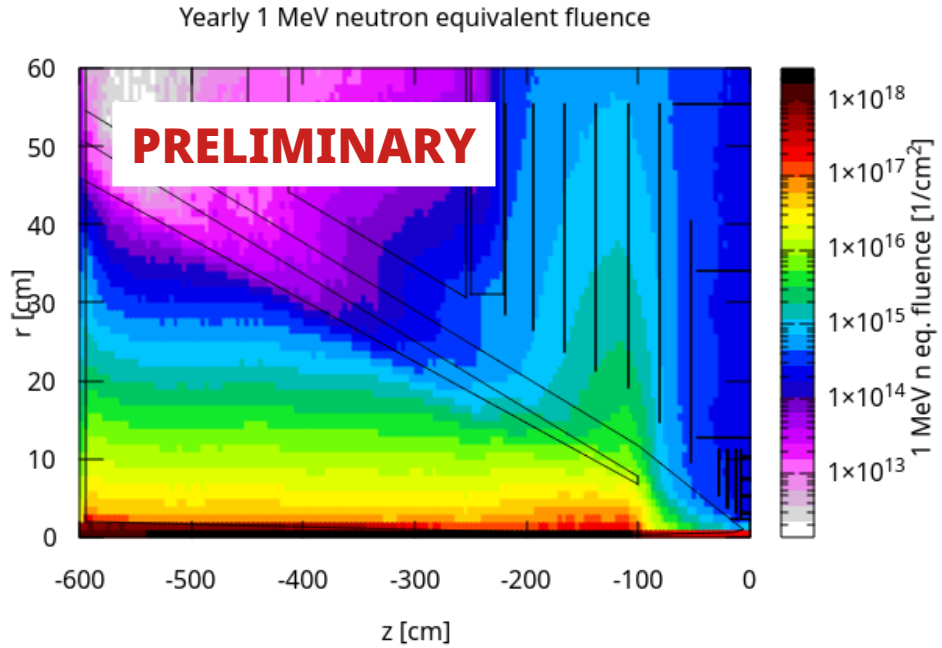




Radiation load inside of the nozzle

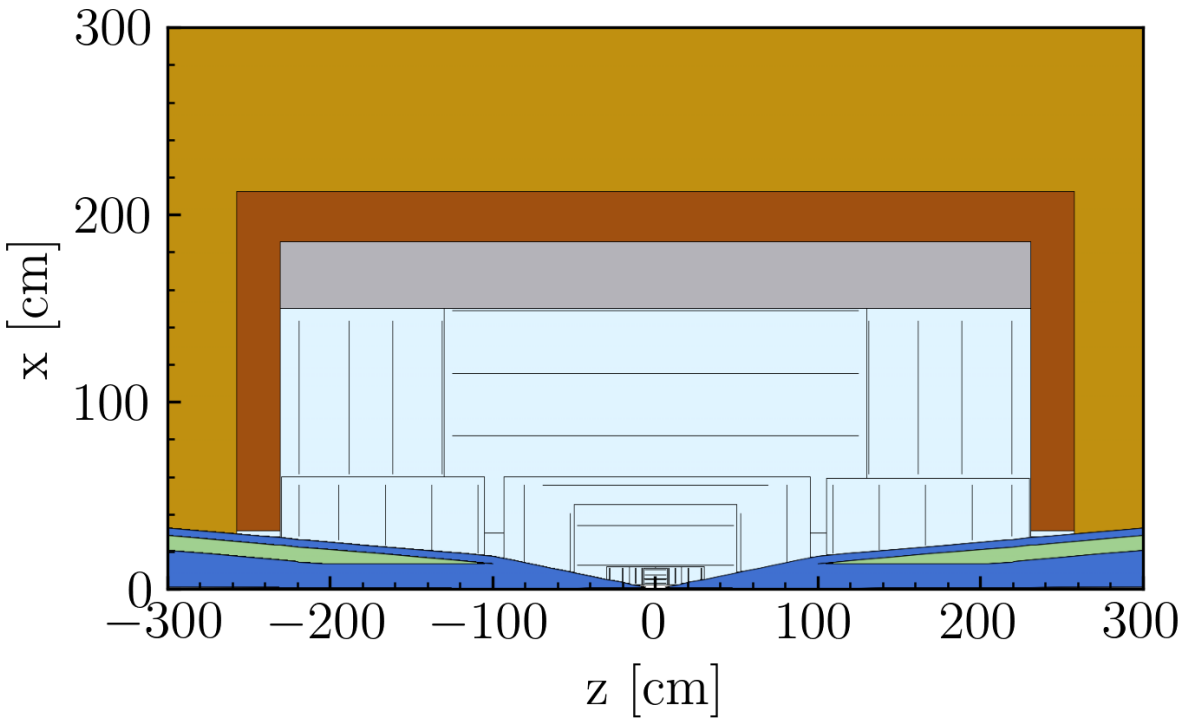
- The following plots have been produced for a preliminary evaluation of the possibility of instrumenting the nozzle. They have been produced with lattice version 0.7.

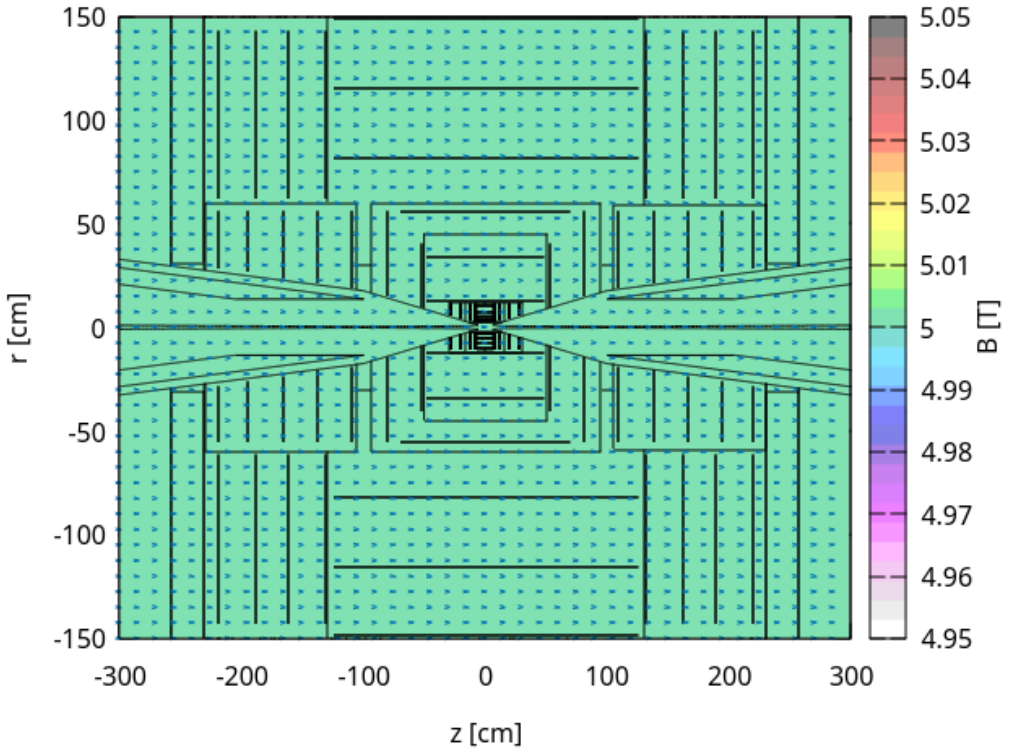




MAIA detector implementation

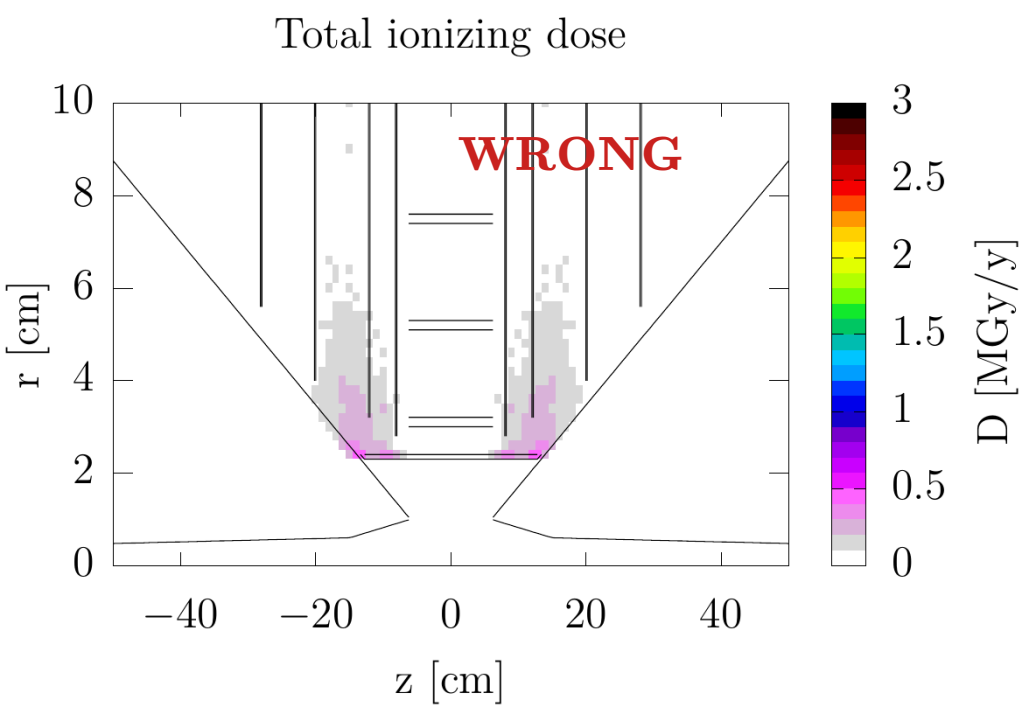
- New nozzle (not used in the simulation for the paper).
  The solenoid field is fixed at 5 T.

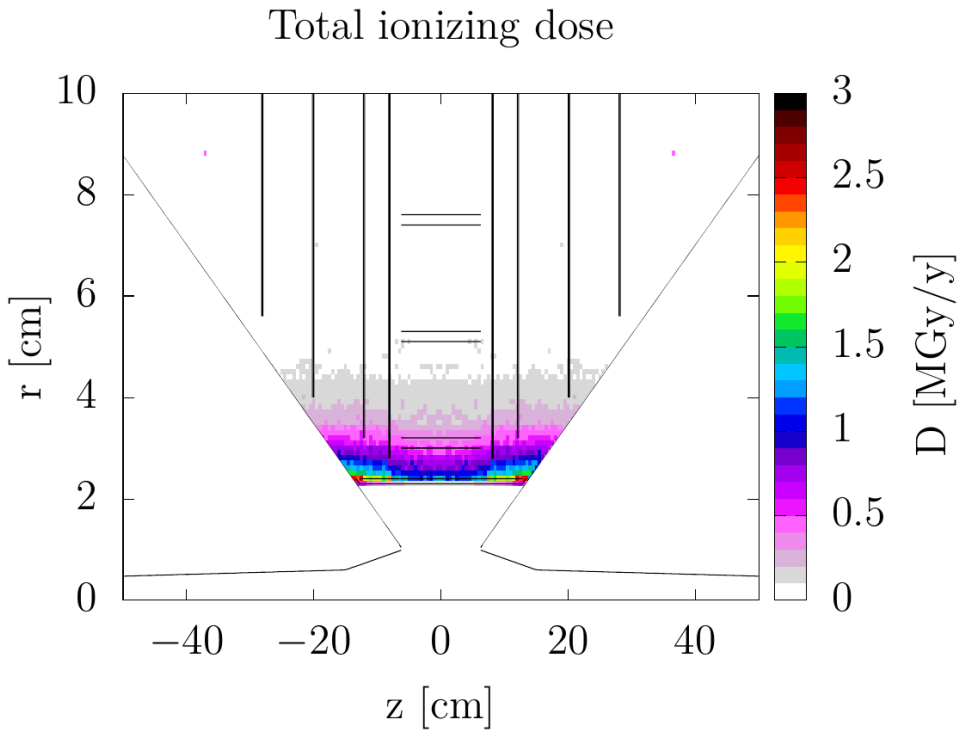




Bugfix (v 0.4)

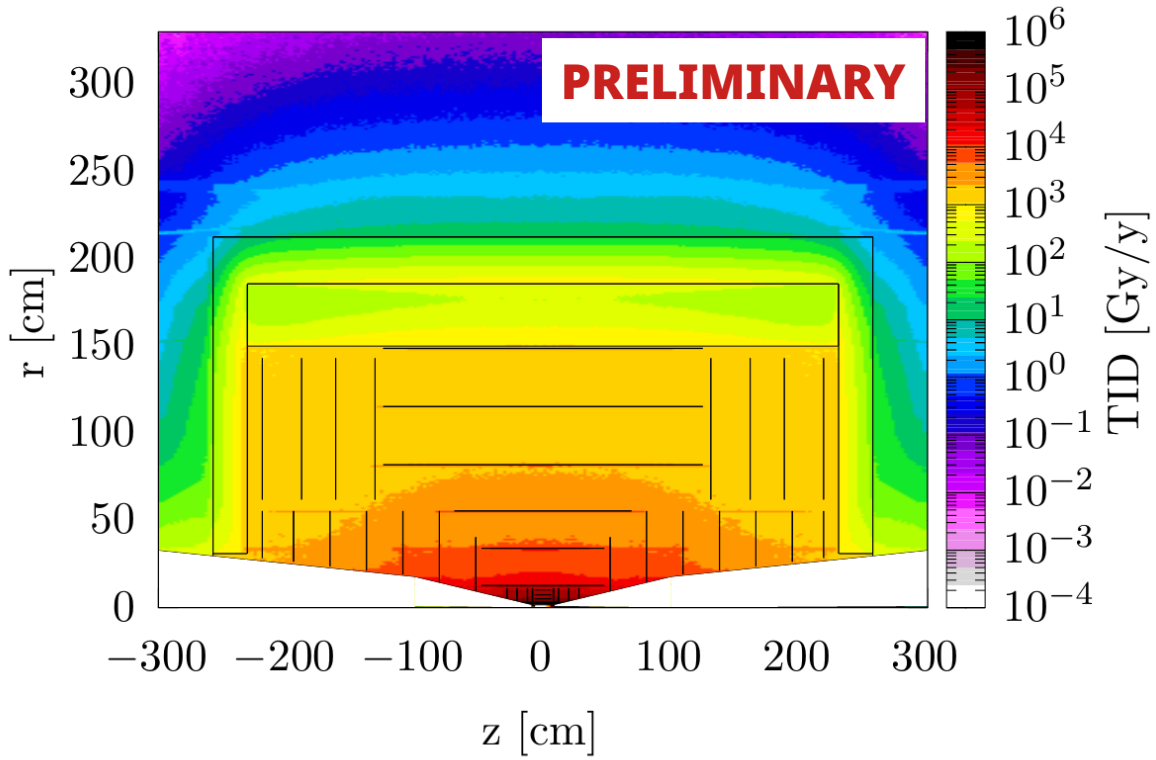
- In CLIC-like detector, a bug was affecting the geometry. The innermost region close to the beam pipe had experienced zero magnetic field
- This increases the TID in the innermost barrel layer of a factor ~3



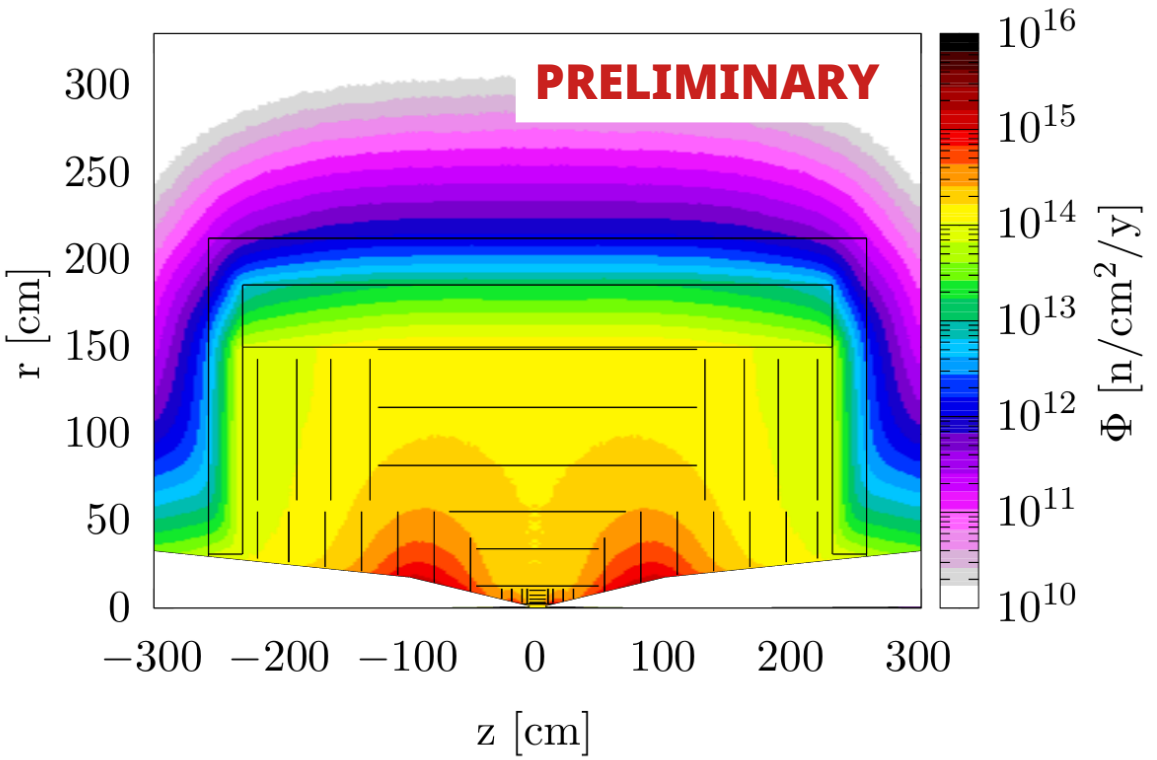


MAIA radiation load (v 0.8)

Yearly total ionizing dose in MAIA detector



Yearly 1 MeV n. eq. fluence in Si in MAIA detector



MAIA radiation load (v 0.8)

- This new results suggest higher TID than the ones expected in the past. The endcap position have a huge influence on the TID peak experienced.
- Having the solenoid in front of the ECAL reduces the TID of a factor 2
- The following table contains the latest results and it is part of the ESPPU muon collider document preparation.

PRELIMINARY

Component	Dose [kGy]		1 MeV neutron-equivalent fluence (Si) [10^{14} n/cm^2]	
	MAIA	MUSIC	MAIA	MUSIC
Vertex (barrel)	1000		2.3	
Vertex (endcaps)	2000		8	
Inner trackers (barrel)	70		4.5	4
Inner trackers (endcaps)	30		11.5	10
ECAL	580	1400	0.15	1

*difference mentioned only if higher than 10%

Thank you

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