BEAM EXTRACTION SIMULATION AND MAGNETIC CHANNELS' DESIGN FOR MSC230 CYCLOTRON

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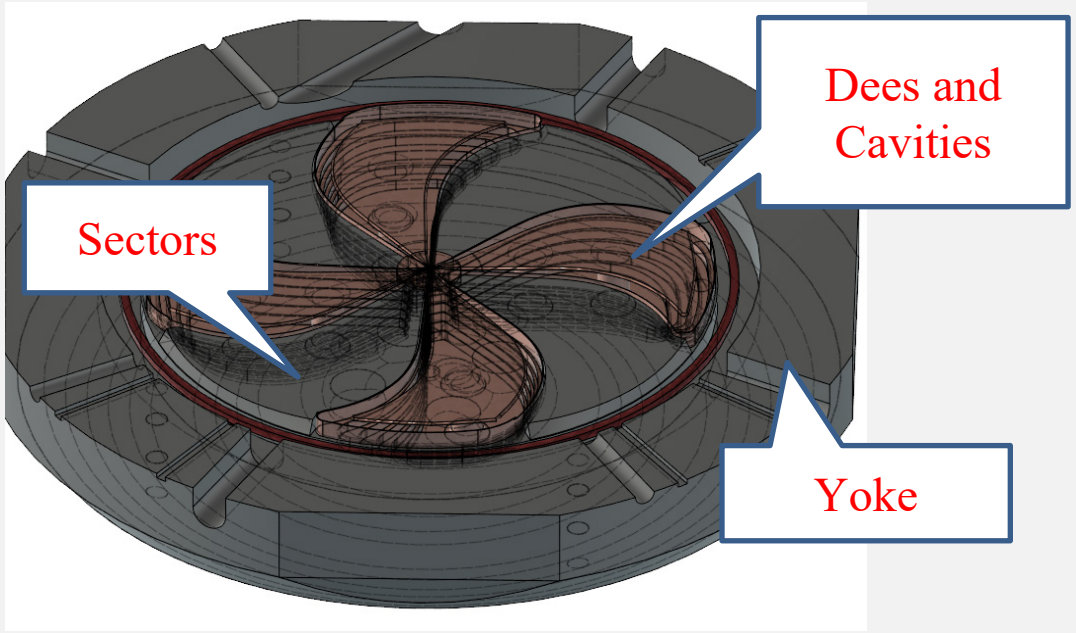
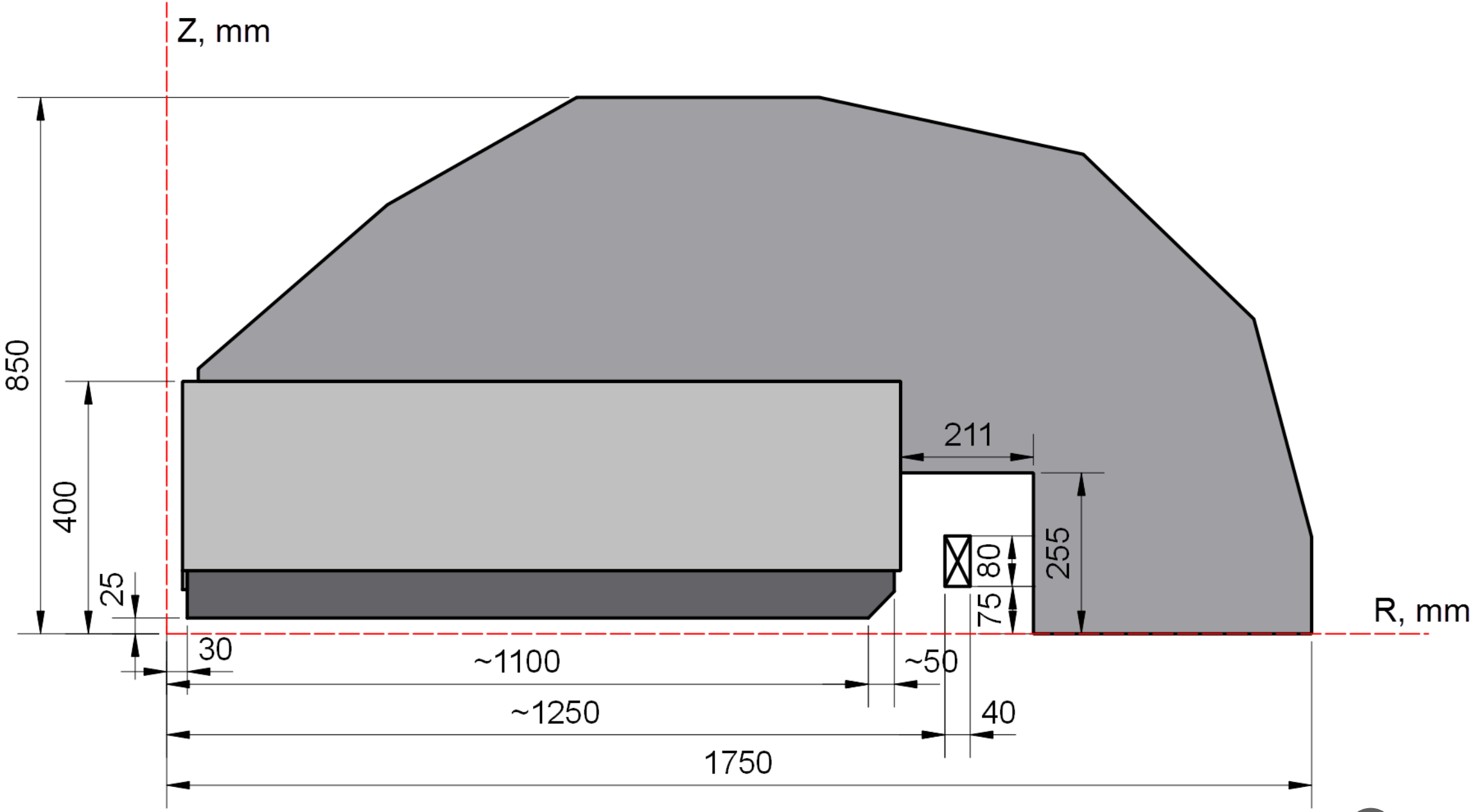
MSC230 PROJECT

MSC230 design reasoning and specifications



Inside the MSC230

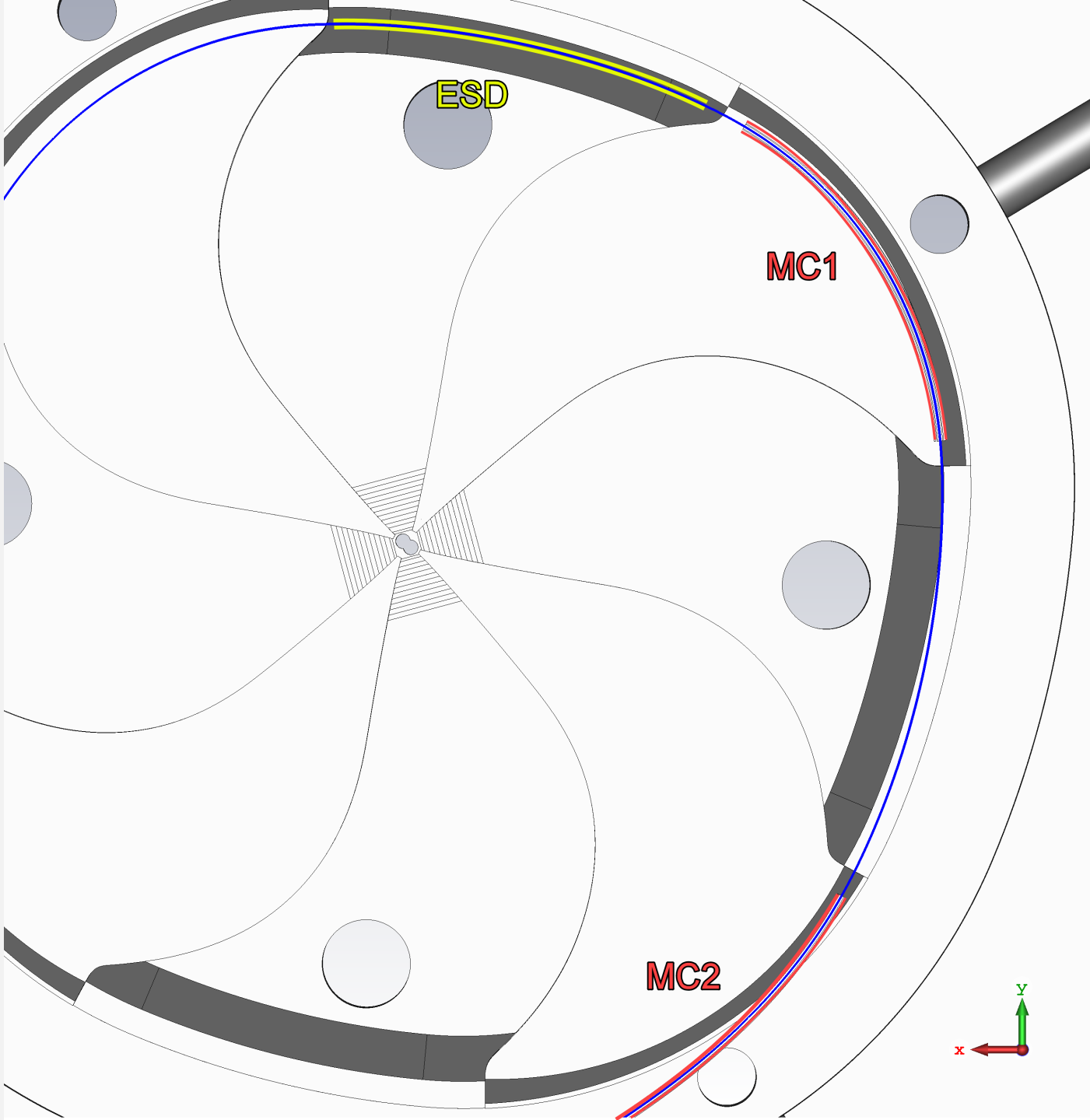
Accelerated Particles	Protons
Magnet Type	Compact, SC coil, warm yoke, B≈1.5 T
Number of Sectors	4
Number of RF Cavities	4
Ion Source	Internal, PIG
Final Energy	230 MeV
Number of Turns	600



MSC230 magnet quarter cross section.

EXTRACTION SYSTEM

Extraction system positioning



The extraction beam trajectory (marked blue) with segment zones to deploy magnetic channels (marked red) and electrostatic deflector (marked yellow).

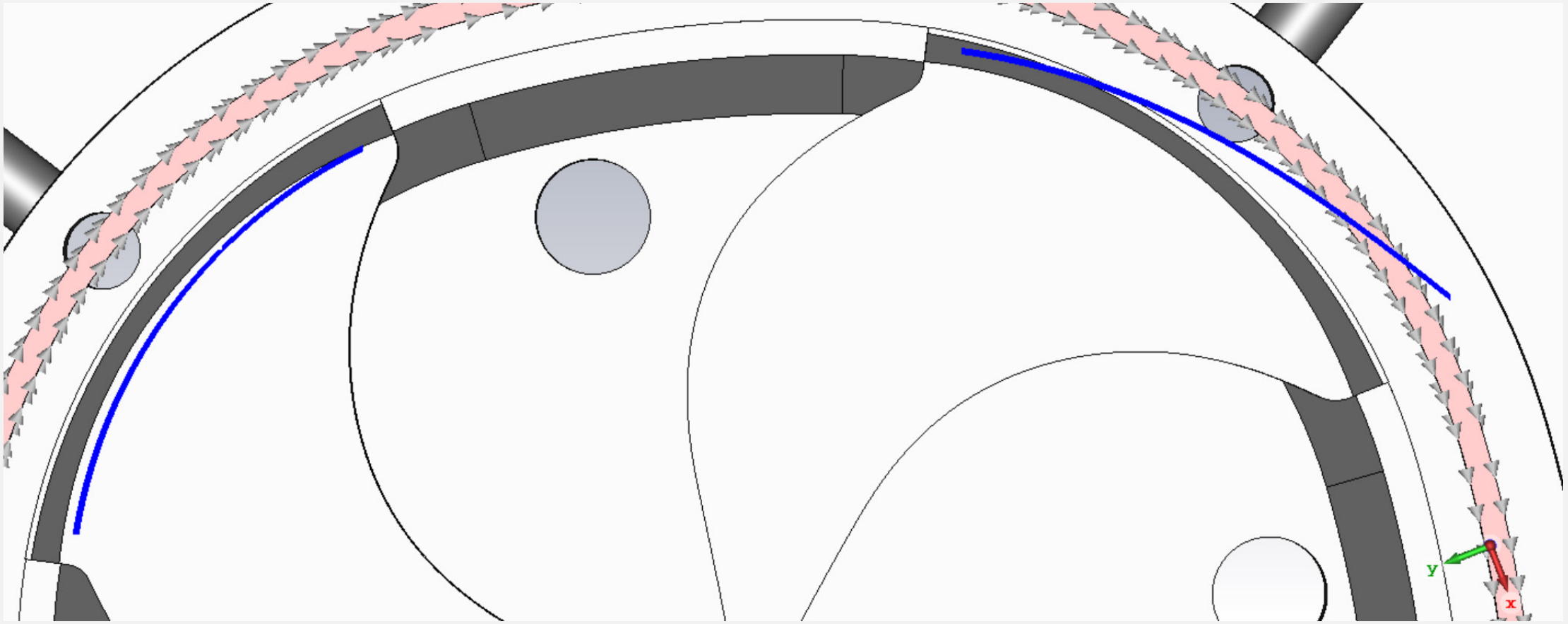
ELECTROSTATIC DEFLECTOR

ESD's specifications

Azimuthal extent, °	40°
Azimuthal extent, m	0.58 m
The nominal gap	5 mm
The septum's thickness	0.1 mm
The voltage of the high-voltage electrode	50 kV
The nominal electric field strength	90 kV/cm
Maximal electric field strength	100 kV/cm

MAGNETIC CHANNELS

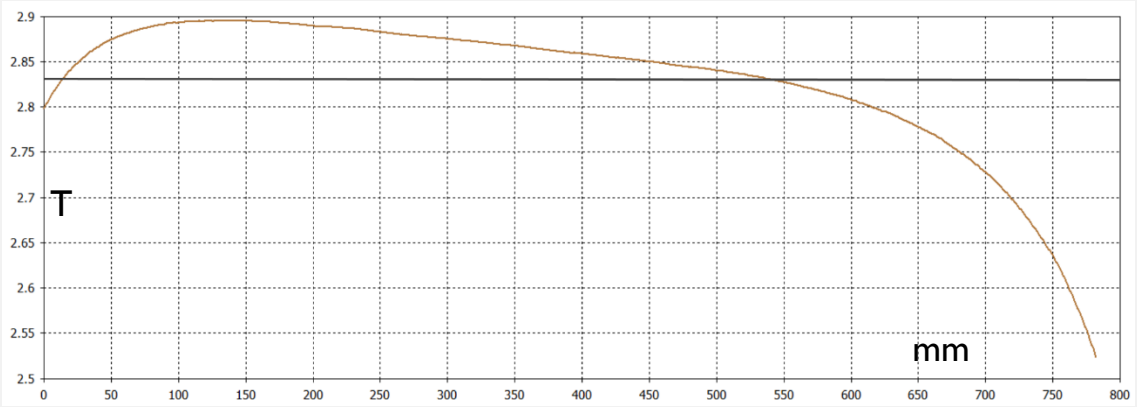
Placement



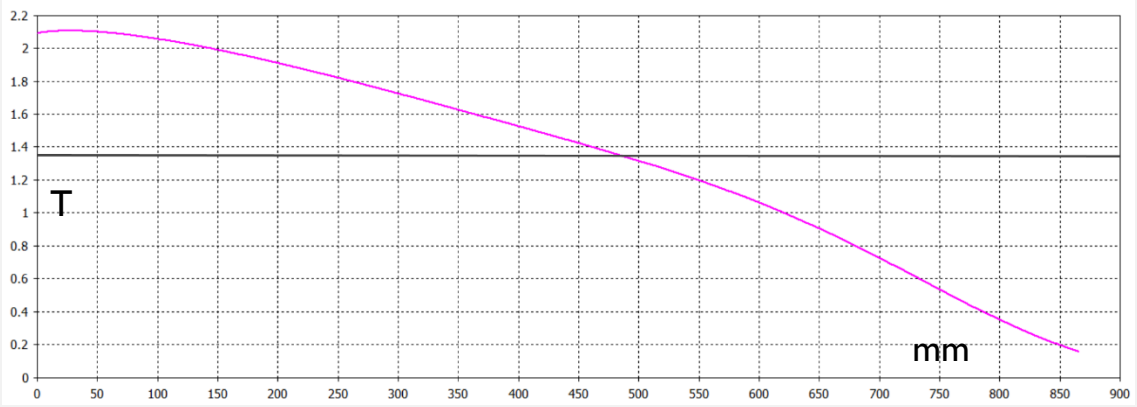
The location of MCs along beam trajectory with relation to the rest of the magnet.

Field distribution & Requirements

	MC1	MC2
Aperture	10 mm	10 mm
Gradient	100 Gs/mm	170 Gs/mm
Bz shift	-600 Gs	0 Gs



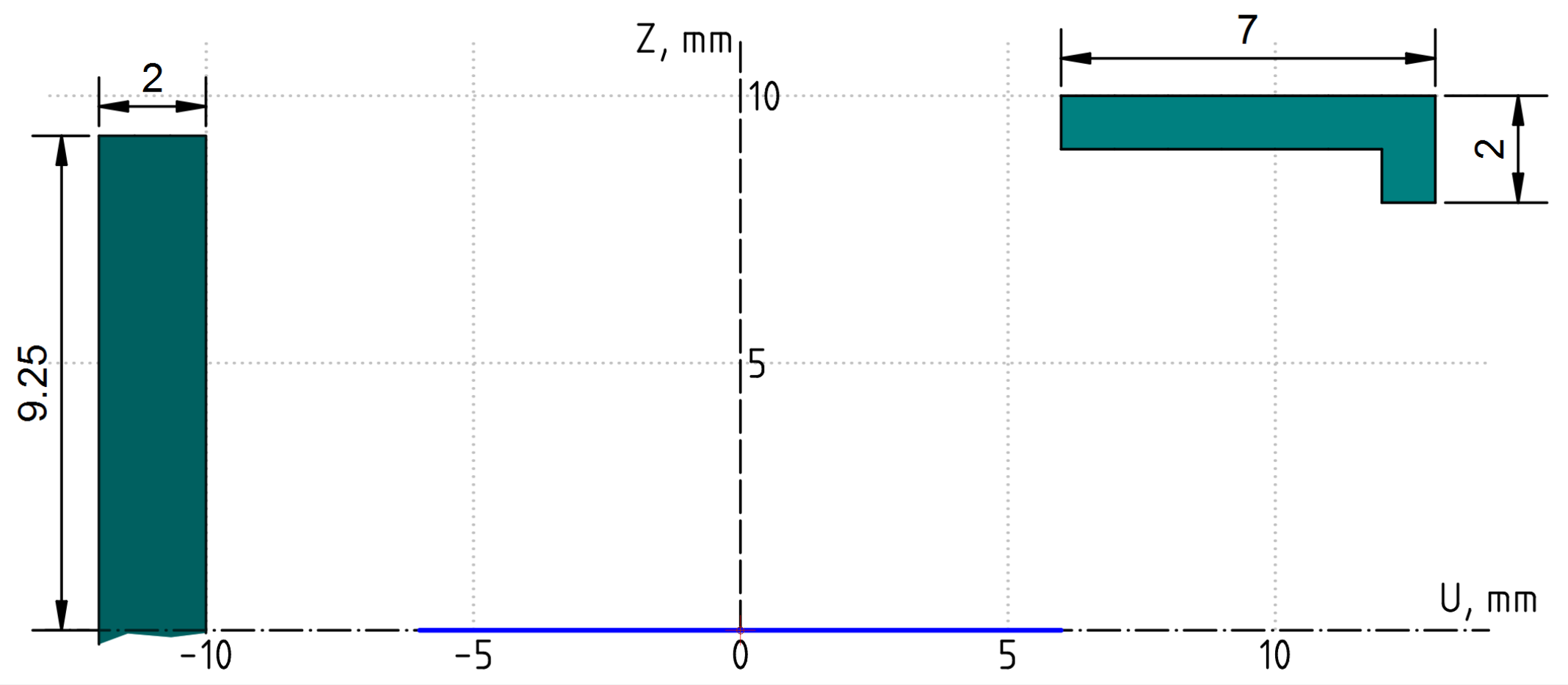
Vertical field on MC1 trajectory.



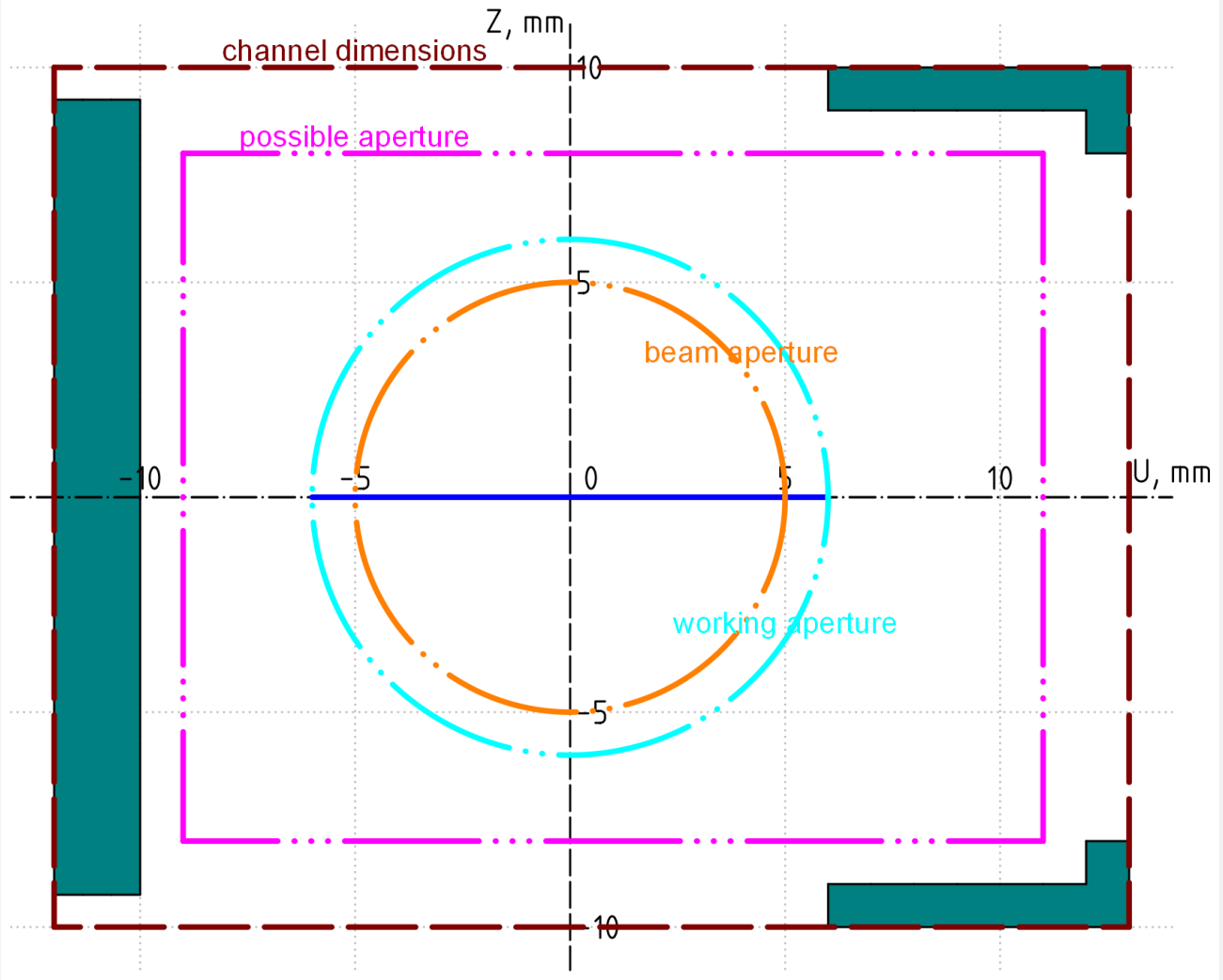
Vertical field on MC2 trajectory.

CHANNELS DESIGN

MC1

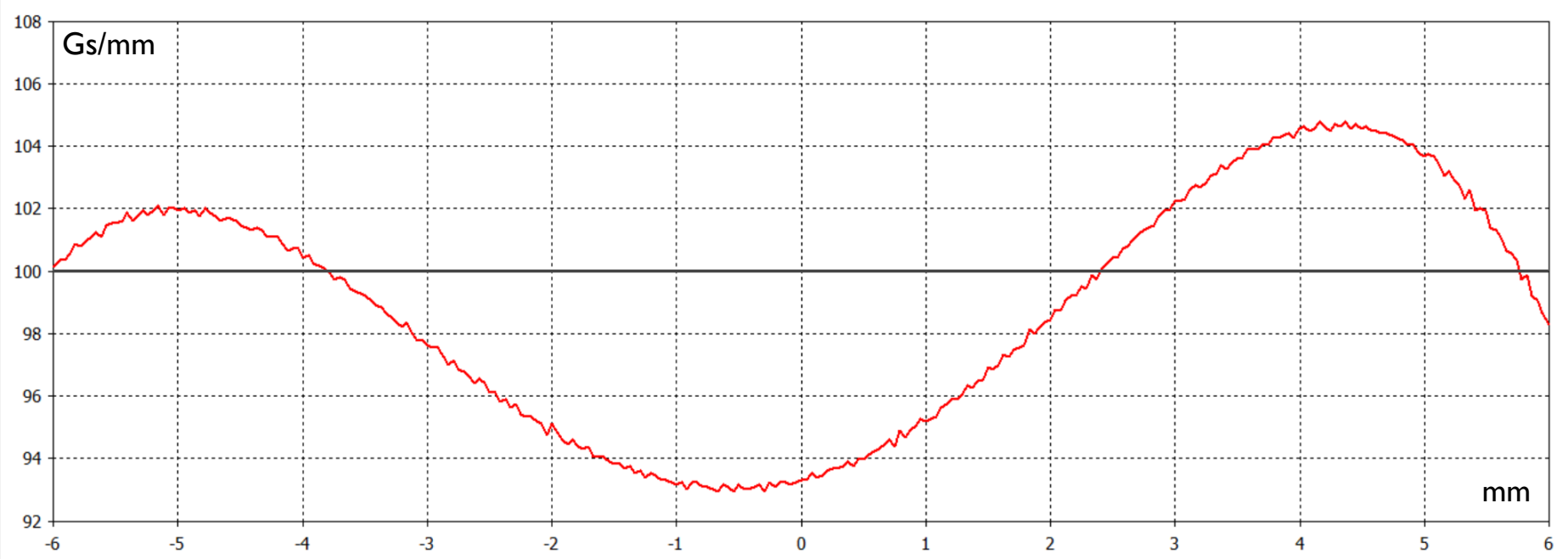


Half cross section of MC1 centered around the main particle.

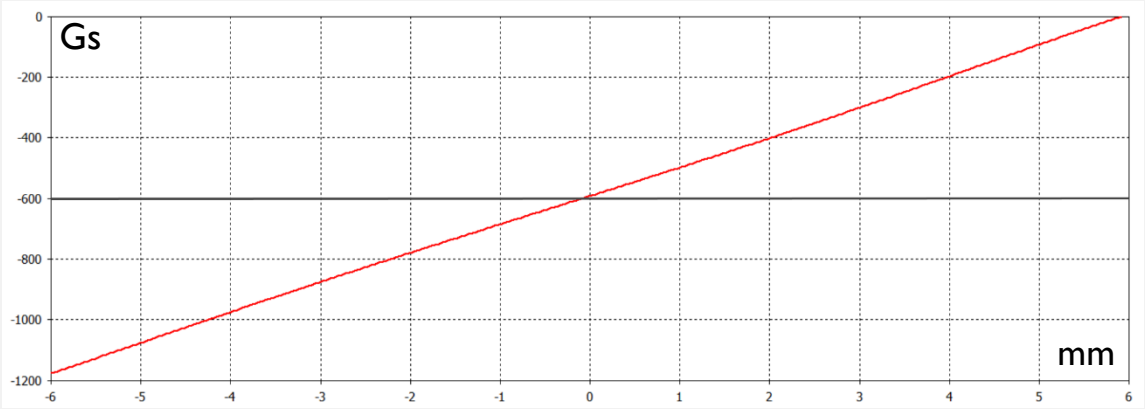


The cross section of MC1 with beam aperture.

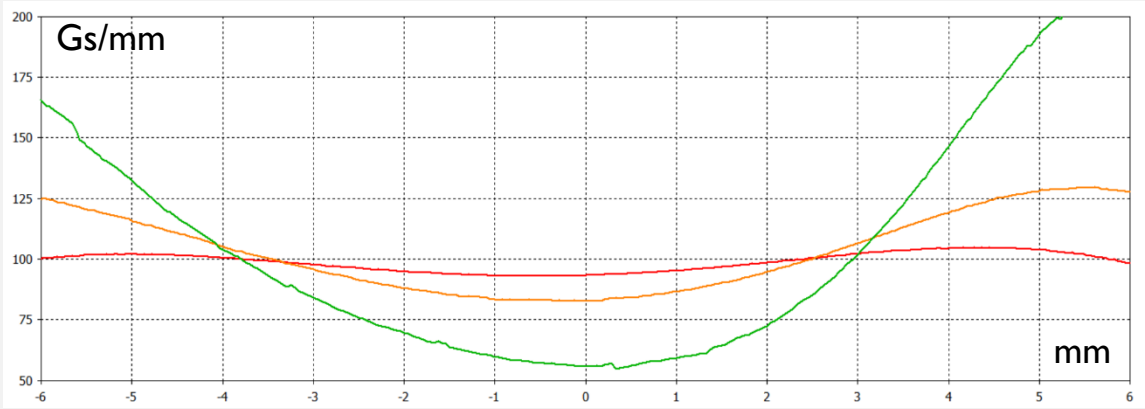
MC1



MC1 gradient.

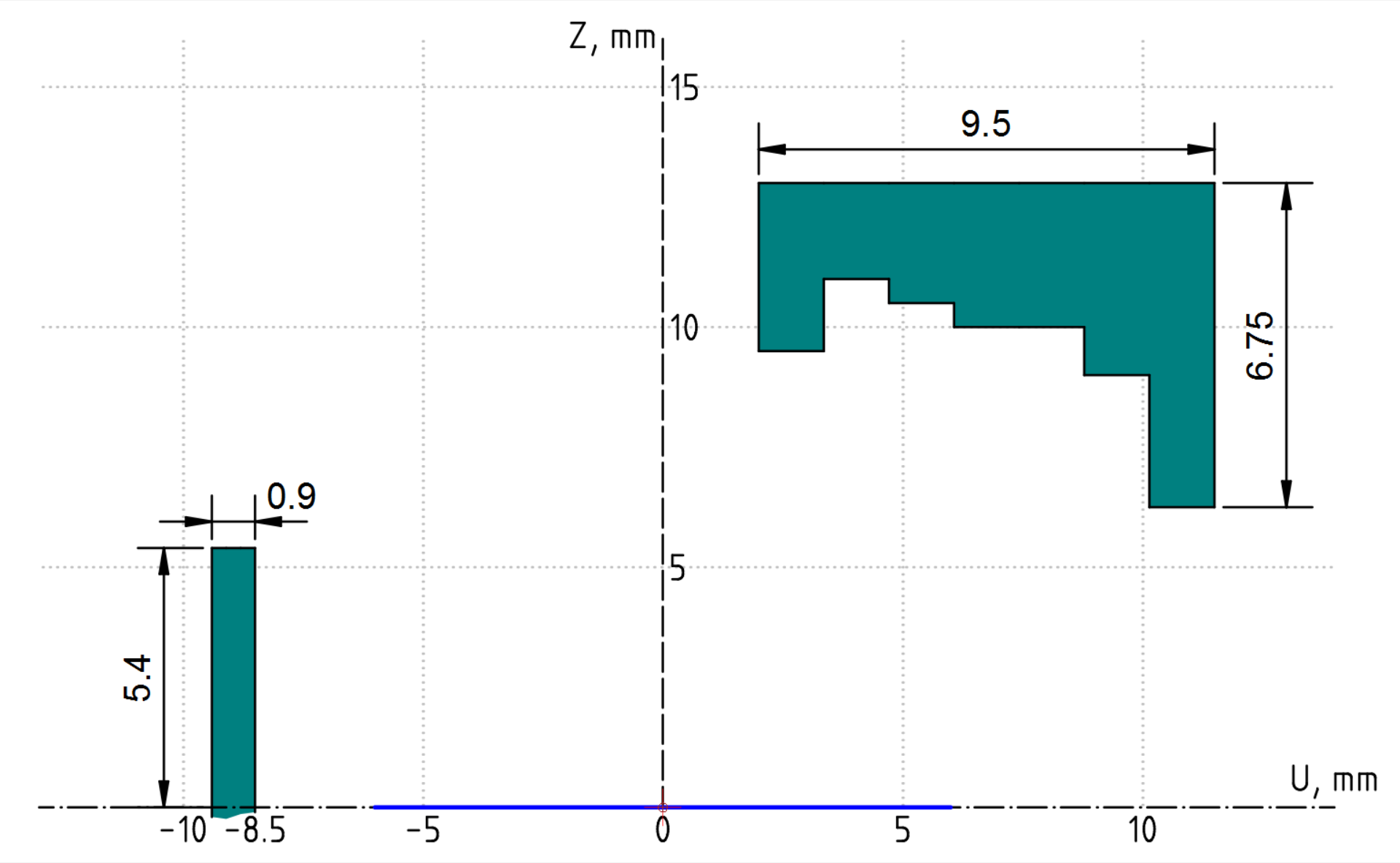


MC1 Bz impact.



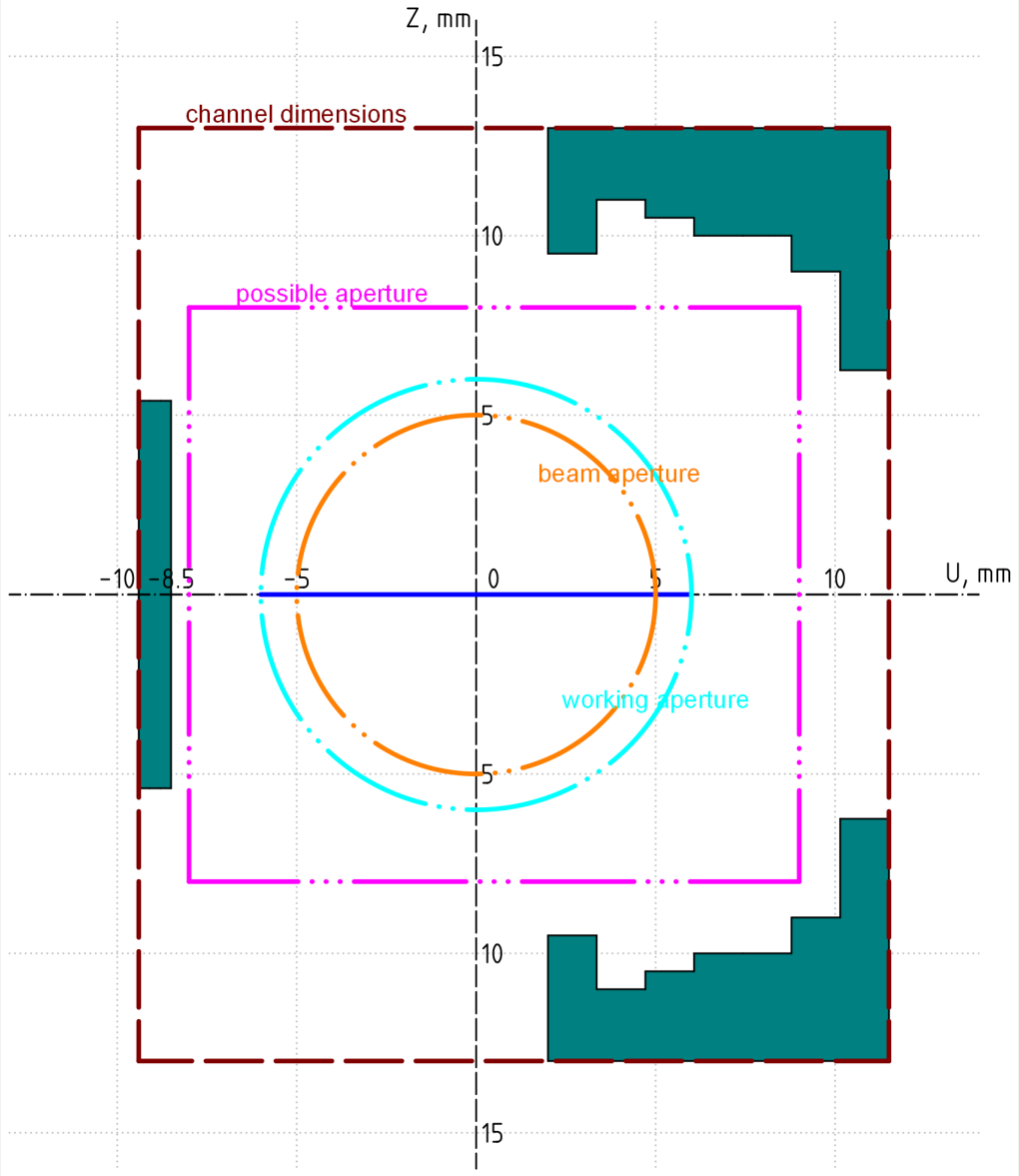
MC1 gradient degradation in vertical direction.

MC2



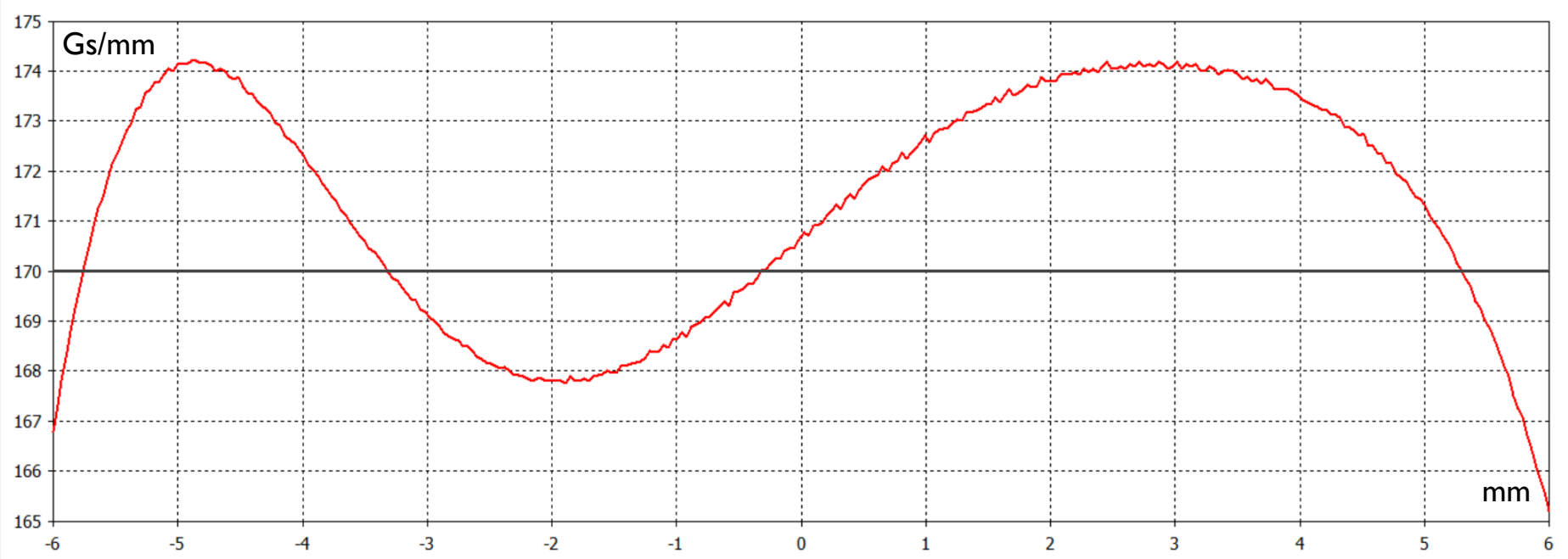
Half cross section of MC2 centered around the main particle.

MC2

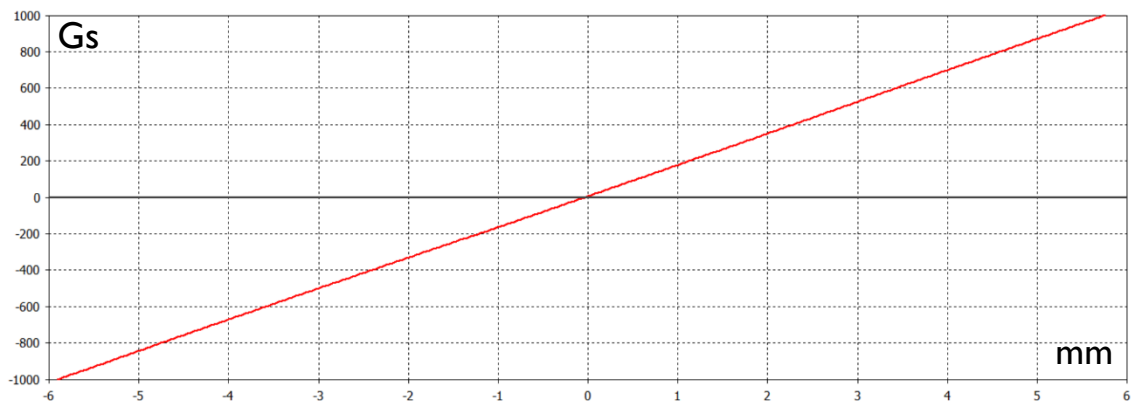


The cross section of MC2 with beam aperture.

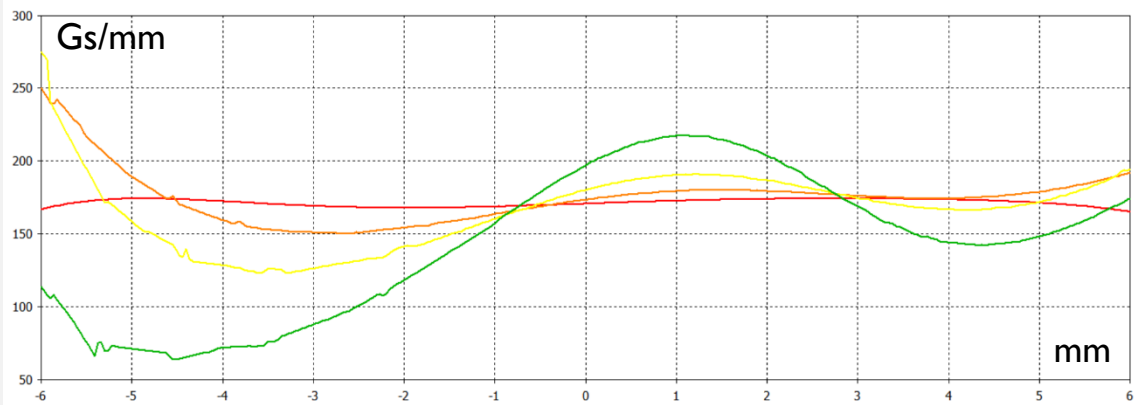
MC2



MC2 gradient.



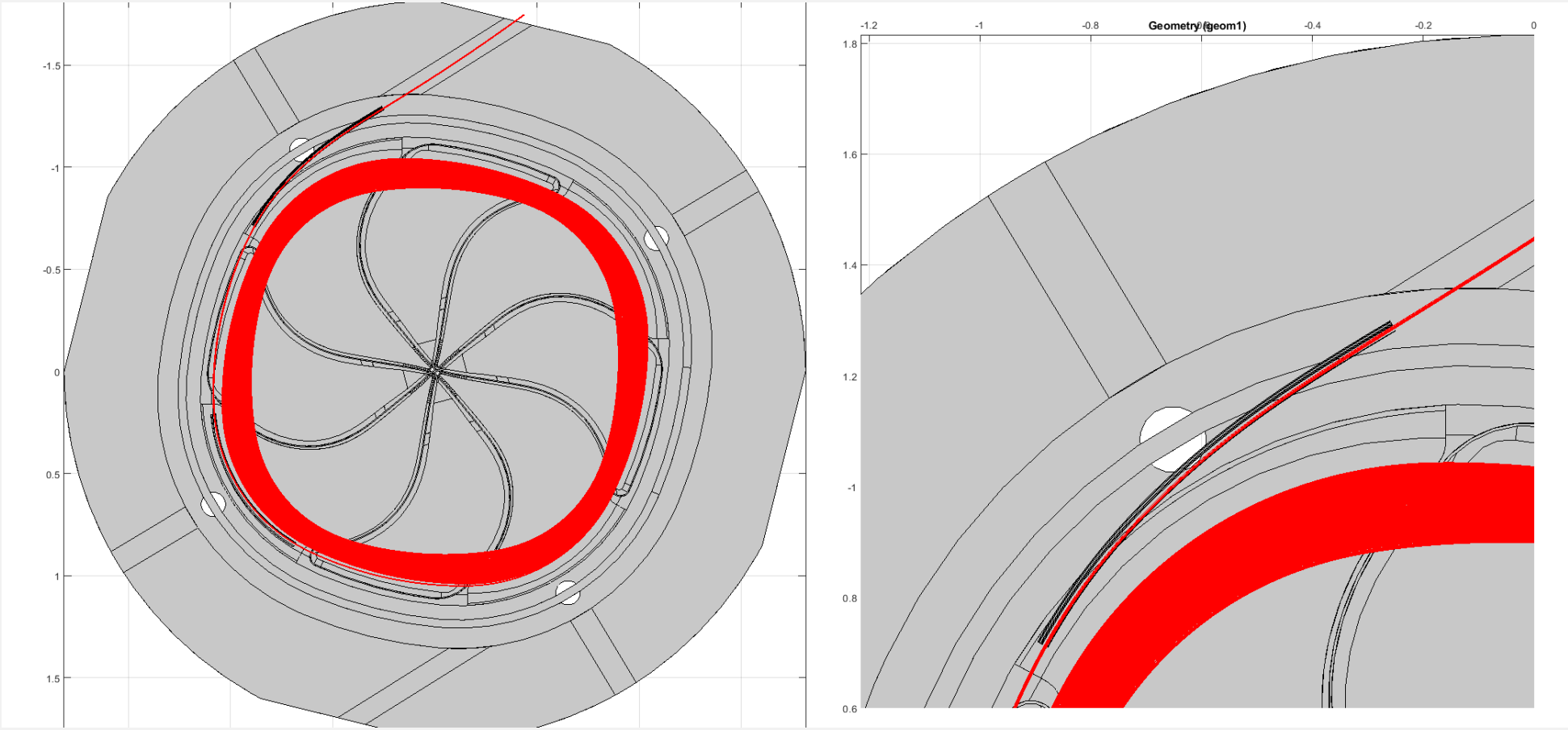
MC2 Bz impact.



MC2 gradient degradation in vertical direction.

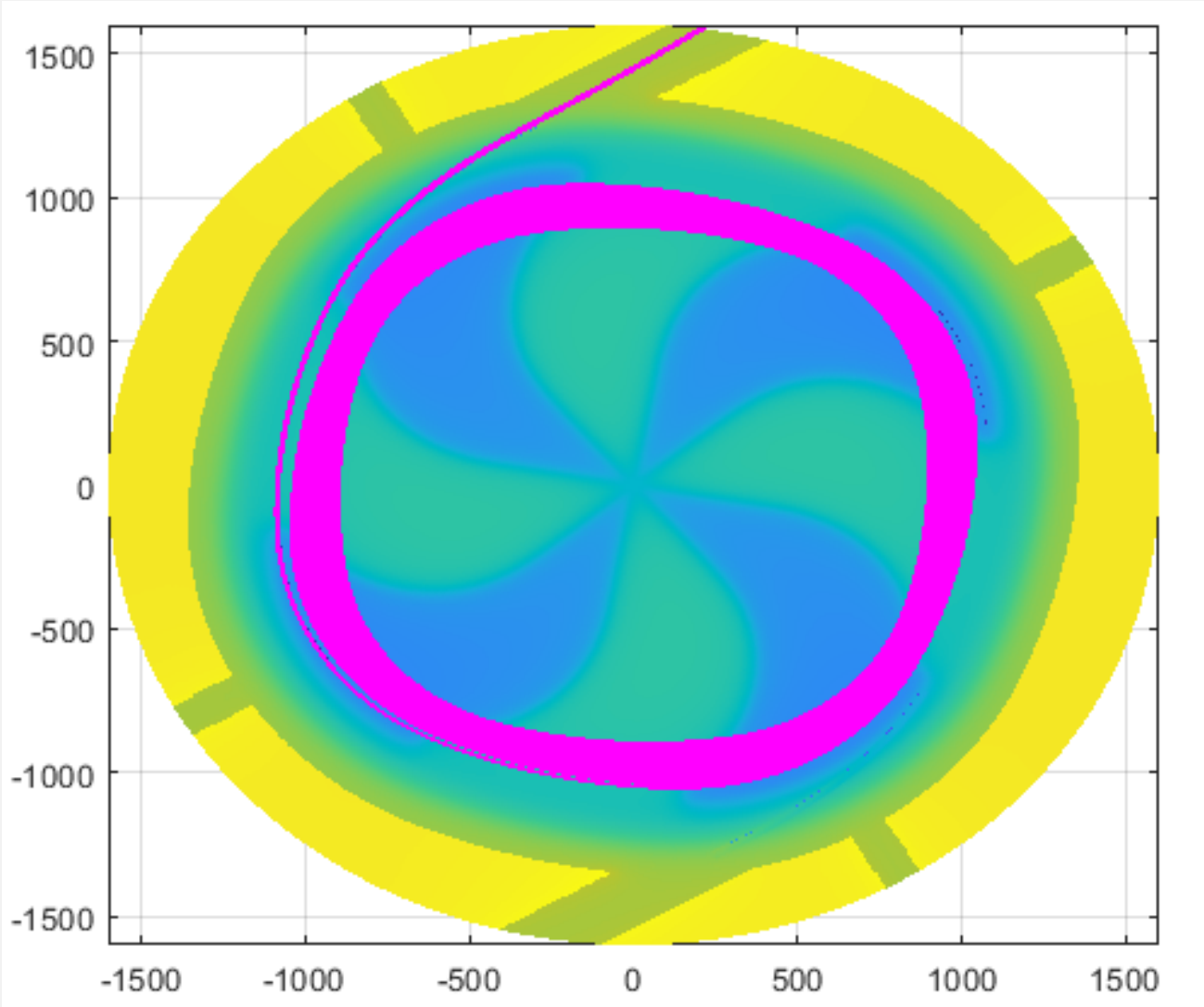
BEAM DYNAMICS SIMULATION

In cyclotron structure



The beam tracing and extraction in the cyclotron structure.

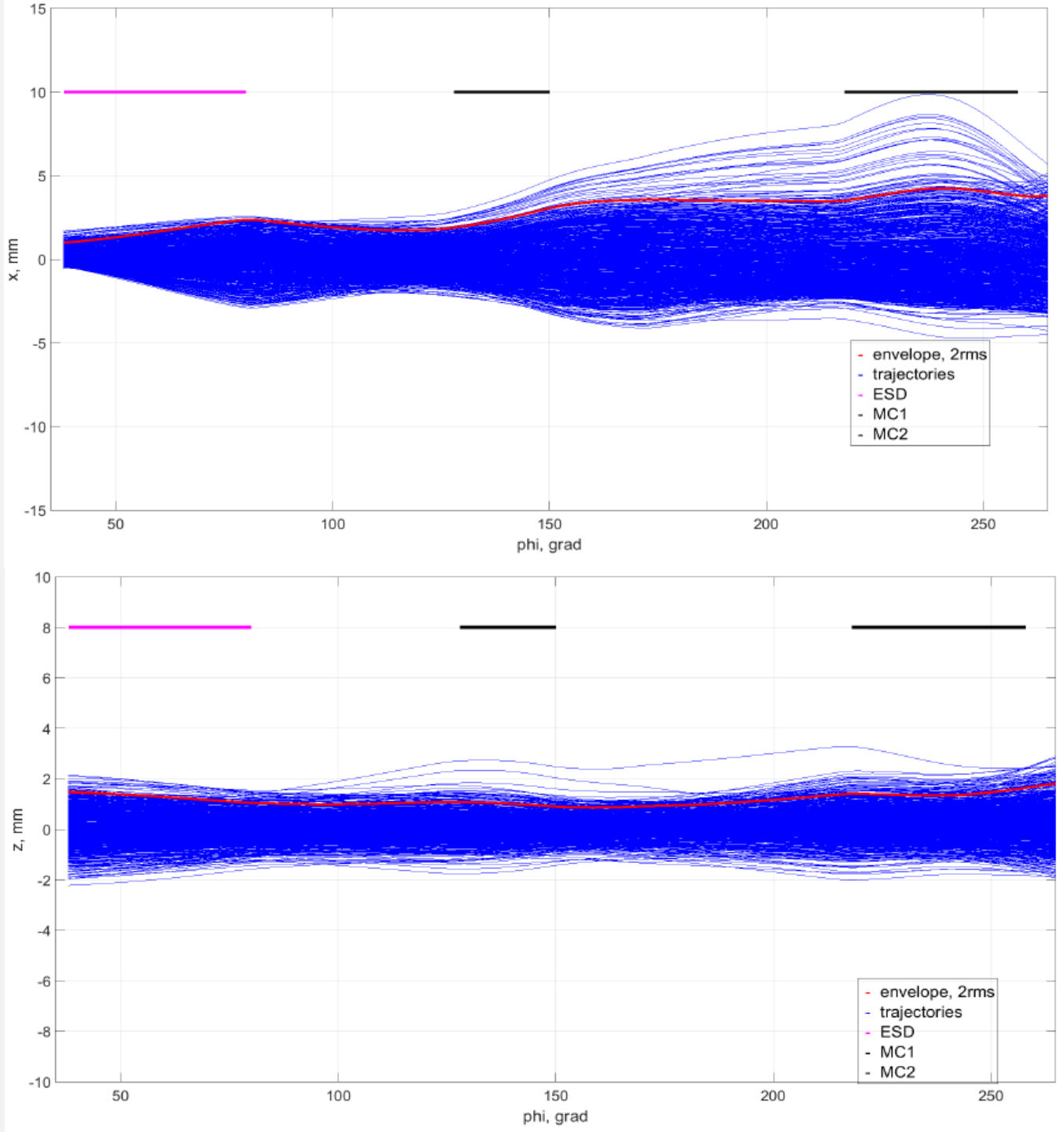
In magnetic field



Particle tracing

horizontal emittance ~ 8π [mm·mrad]

vertical emittance ~ 2π [mm·mrad]



Radial motion (top) and vertical motion (bottom) of the particles through the extraction system.

CONCLUSION

- ✓ The MCs alter the field with more than sufficient accuracy.
- ✓ The channels were inserted into working 3D magnet model. This allowed to perform beam dynamics simulation. The beam were conducted perfectly through the channels.
- ✓ The channels geometry won't be hard to alter to meet the requirements of the new version of MSC230.
- ✓ The design procedure could be automated, if there is demand.

THANK YOU FOR YOUR ATTENTION