THE EXTRACTION SYSTEM ADAPTATION FOR MSC230 CYCLOTRON FINAL ENGINEERING DESIGN

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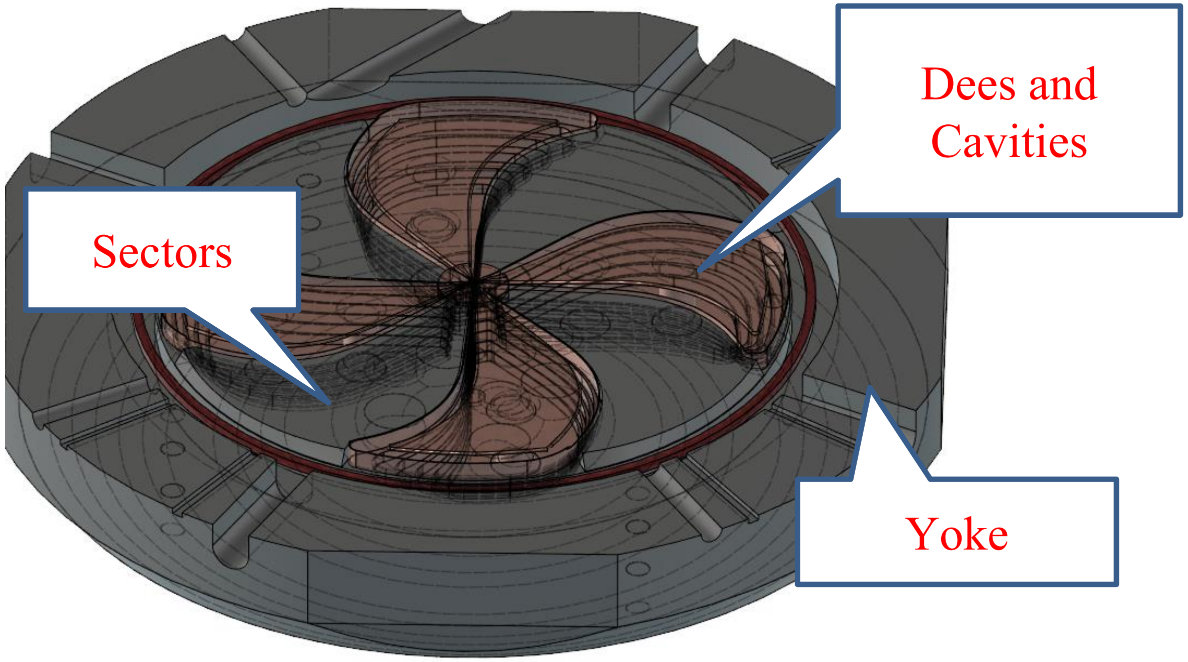
STRUCTURE OF MY TALK

1. A few words about the MSC230 project
2. Overview of the beam extraction system
   - Electrostatic deflector
   - Magnetic channels MC1 and MC2
3. Conclusion and further plans

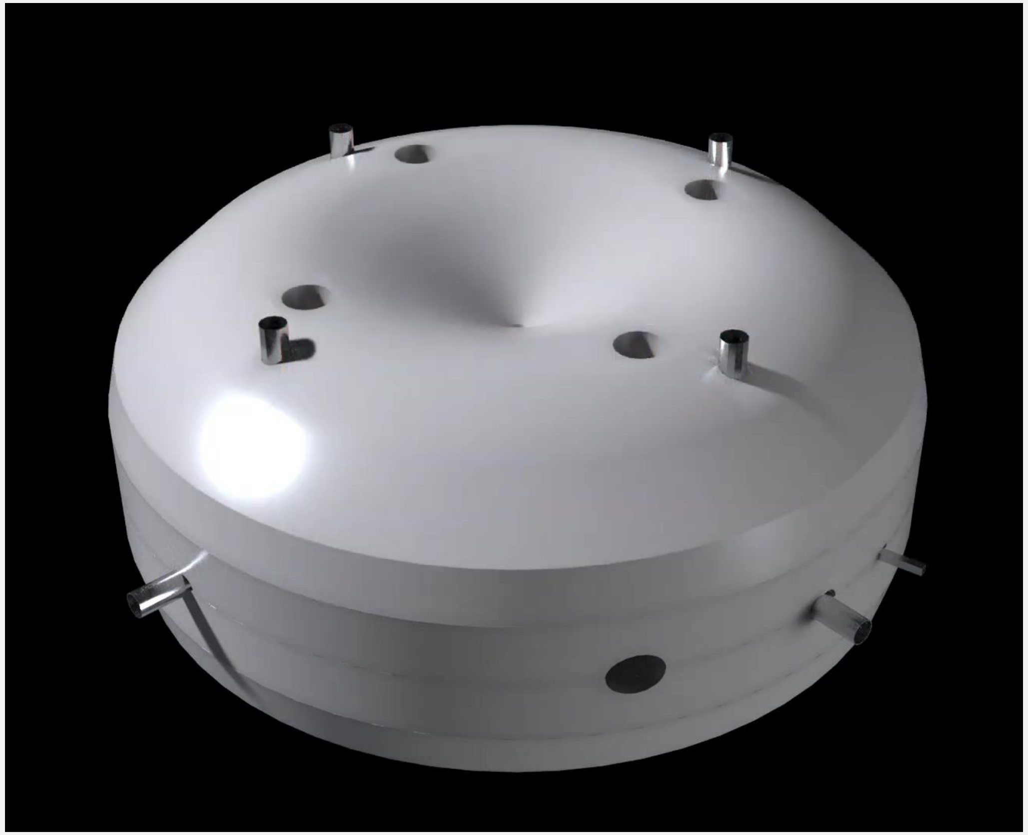
MSC230 PROJECT

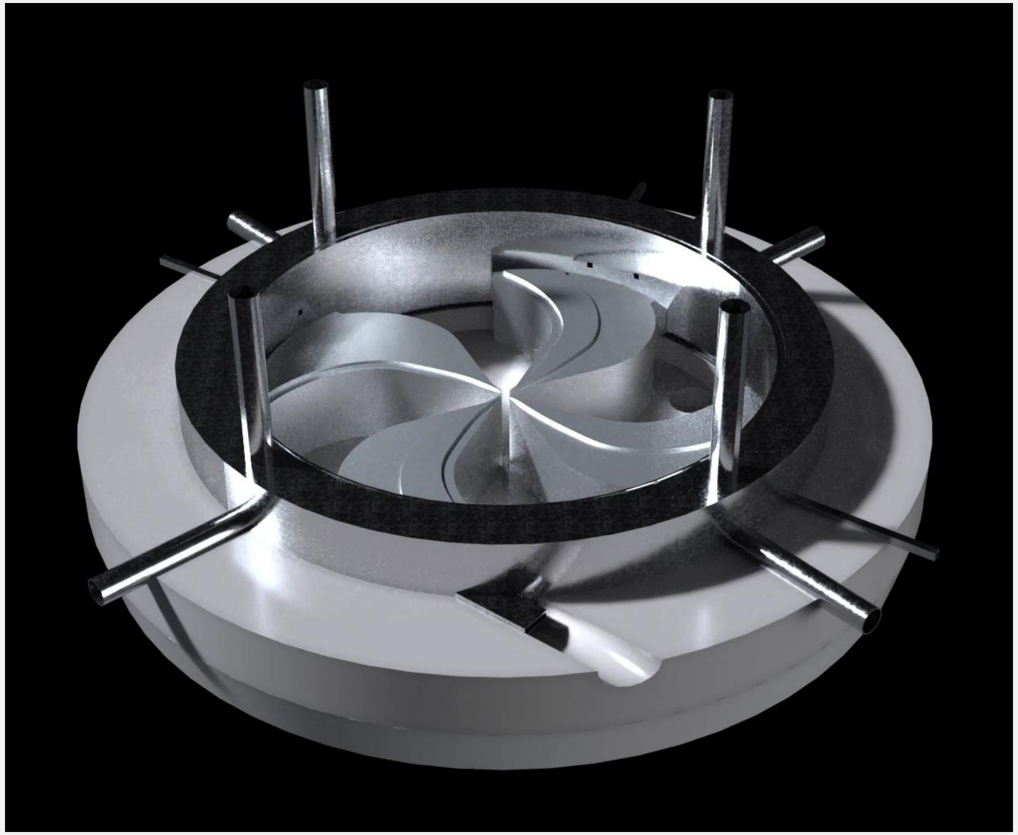
Accelerated Particles	Protons
Magnet Type	Compact, SC coil, warm yoke, B≈1.5 T
Number of Sectors	4
Number of RF Cavities	4
Ion Source	Internal, PIG
Final Energy	230 MeV
Number of Turns	600



Cyclotron's interiors

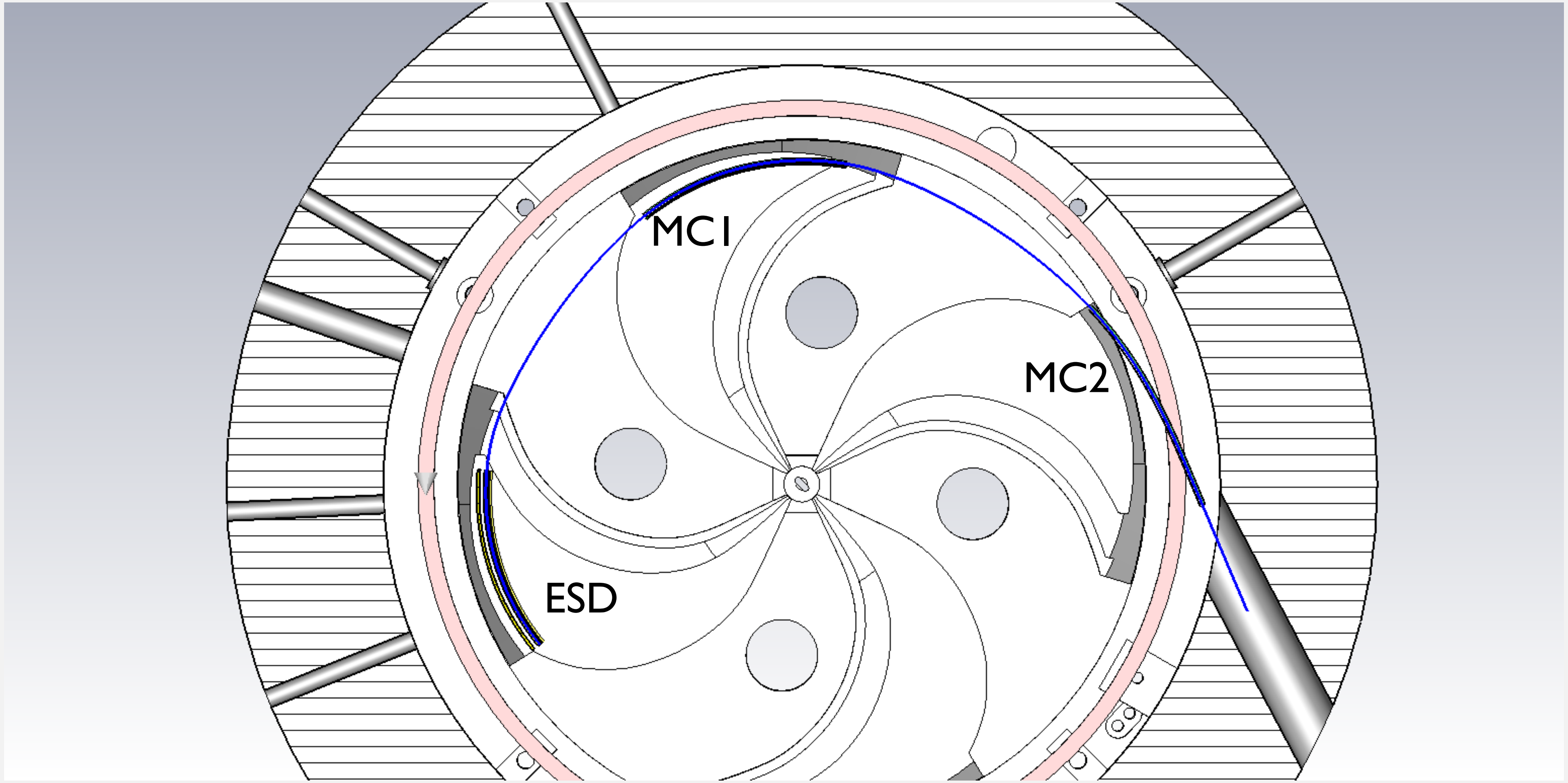
MSC230 PROJECT



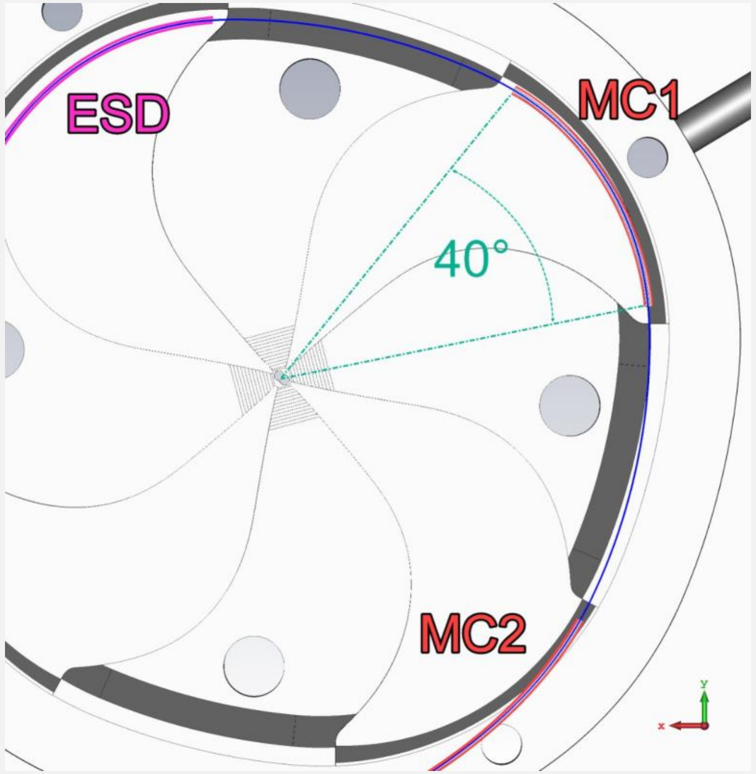


Cyclotron's VFX-modelled appearance

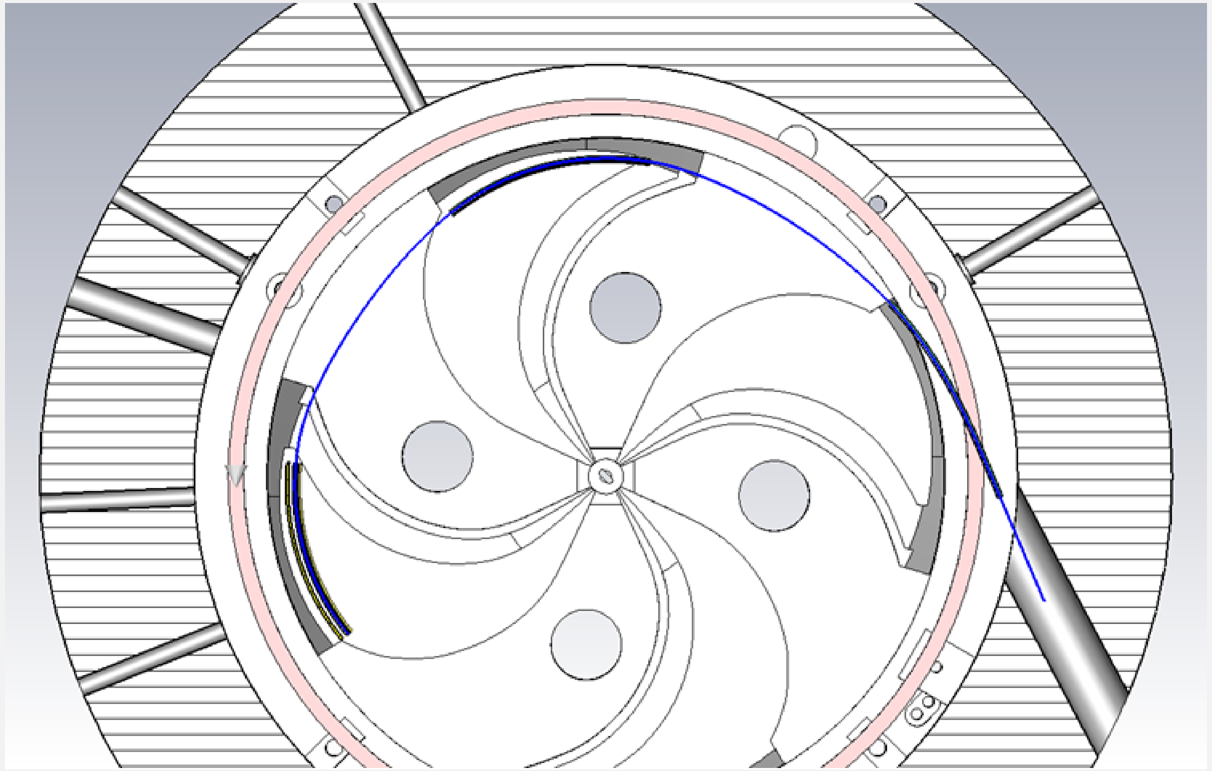
MAIN ELEMENTS OF THE EXTRACTION SYSTEM



NEW MAGNET VS OLD MAGNET



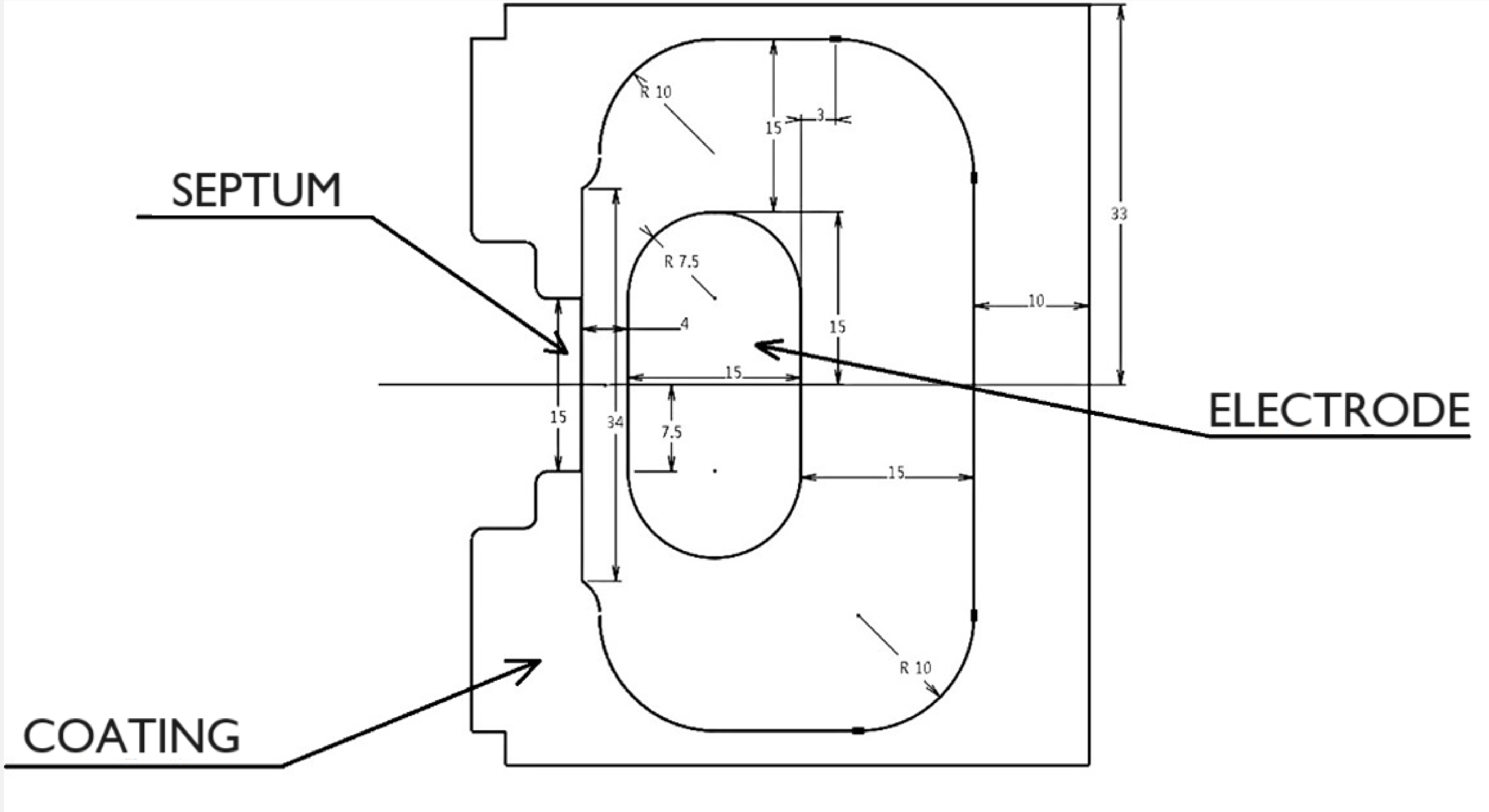
Before



After

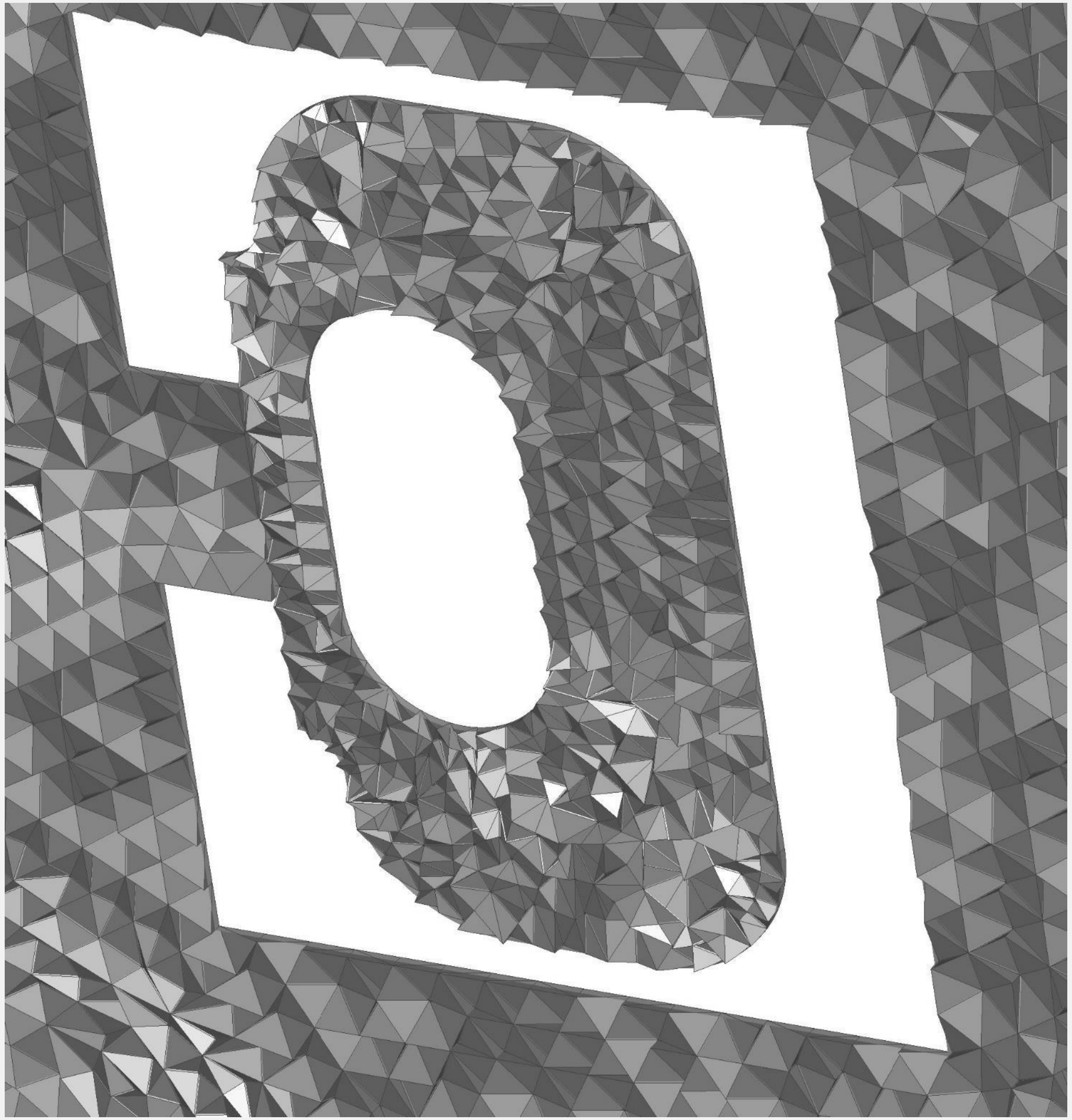
ELECTROSTATIC DEFLECTOR

INITIAL MODEL



CALCULATION METHODS

The modelling and testing was perfomed via CST Studio Suite functions. Mesh cells number for “flat” models is about 14000 each with doubled accuracy inside the device.

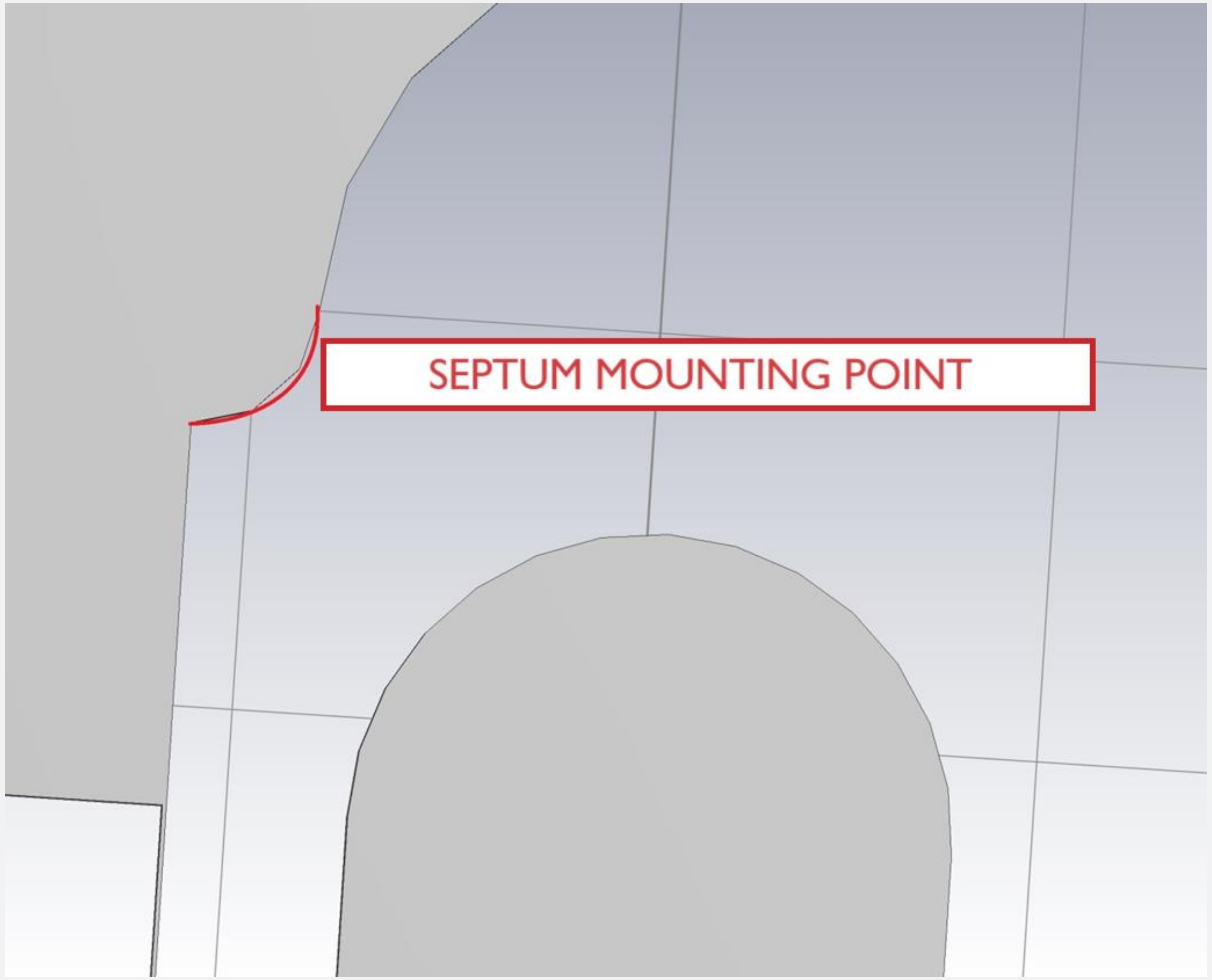


Initial model mesh view

CALCULATION METHODS

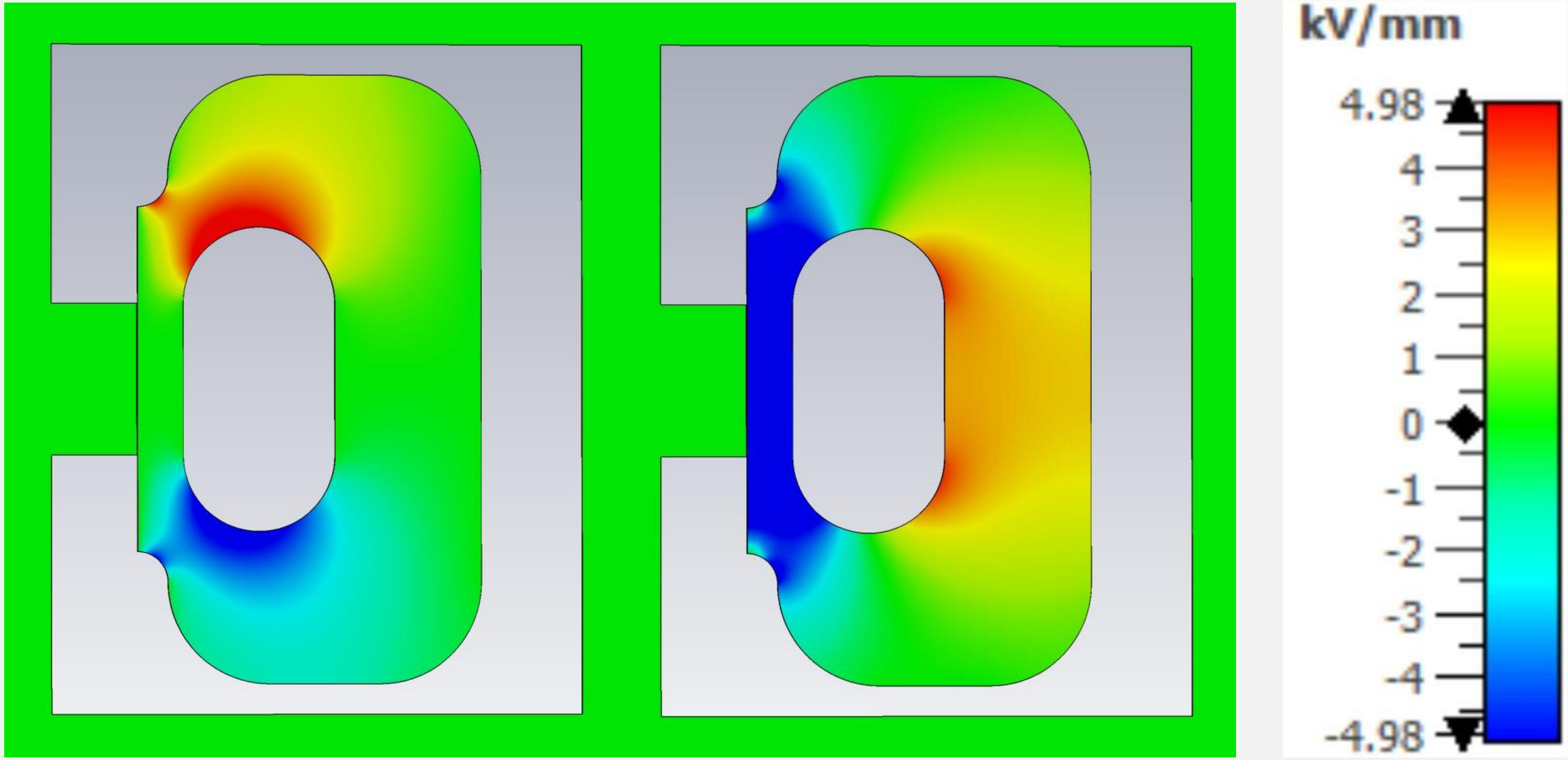
Three options of field values were calculated:

1. E1: Mean/ext value at the septum-to-coating mounting point;
2. E2: Mean/ext value at the length between electrode and low-radius septum mounting surface;
3. W: Mean value of energy density in the space of deflector.



The tricky low-radius surface

INITIAL MODEL



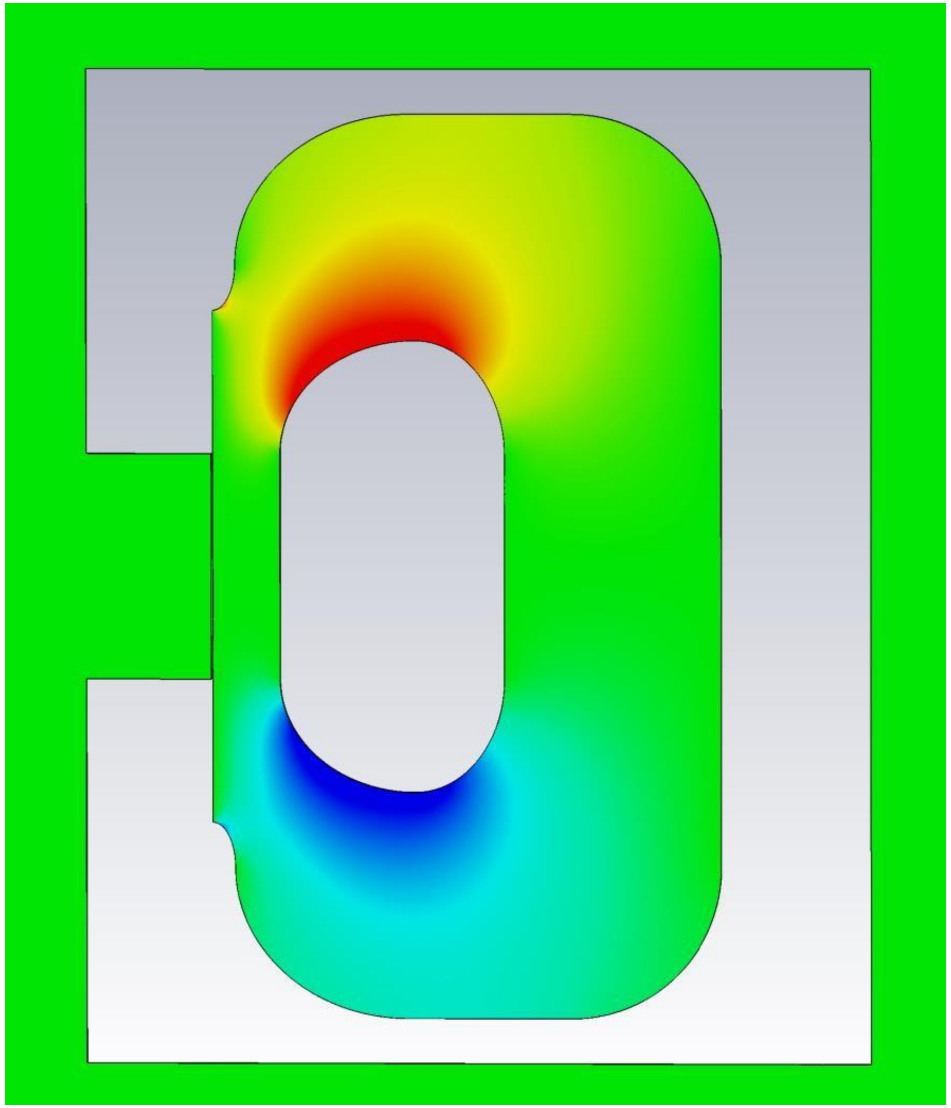
Electric field values' graphic interpretation in the initial model, both on Y and X axes.

MODIFIED MODEL

Changes made:

1. Asymmetrical electrode shape with bigger radii in the working side of the deflector
2. Narrower septum mounting surface with still larger radius.

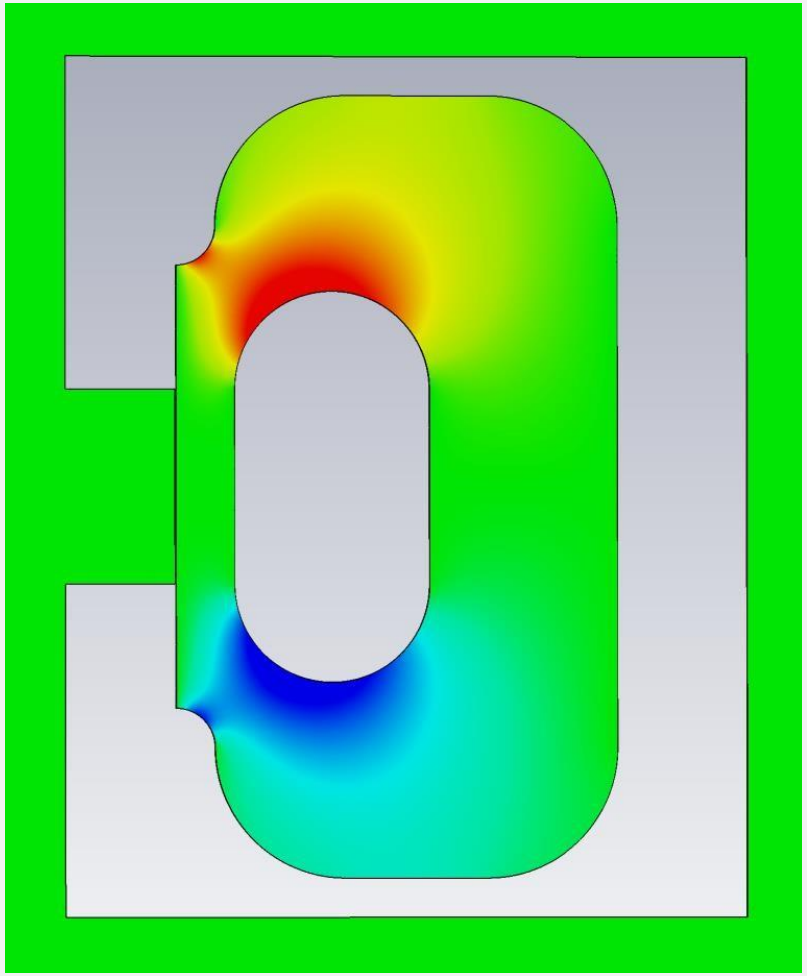
	Initial model	Modified model
E1max, kV/mm	6,79	4,16
E1mean, kV/mm	5,37	3,75
E2max, kV/mm	9,36	8,54
E2mean, kV/mm	7,11	5,82
W, J/m^3	72,733	69,767



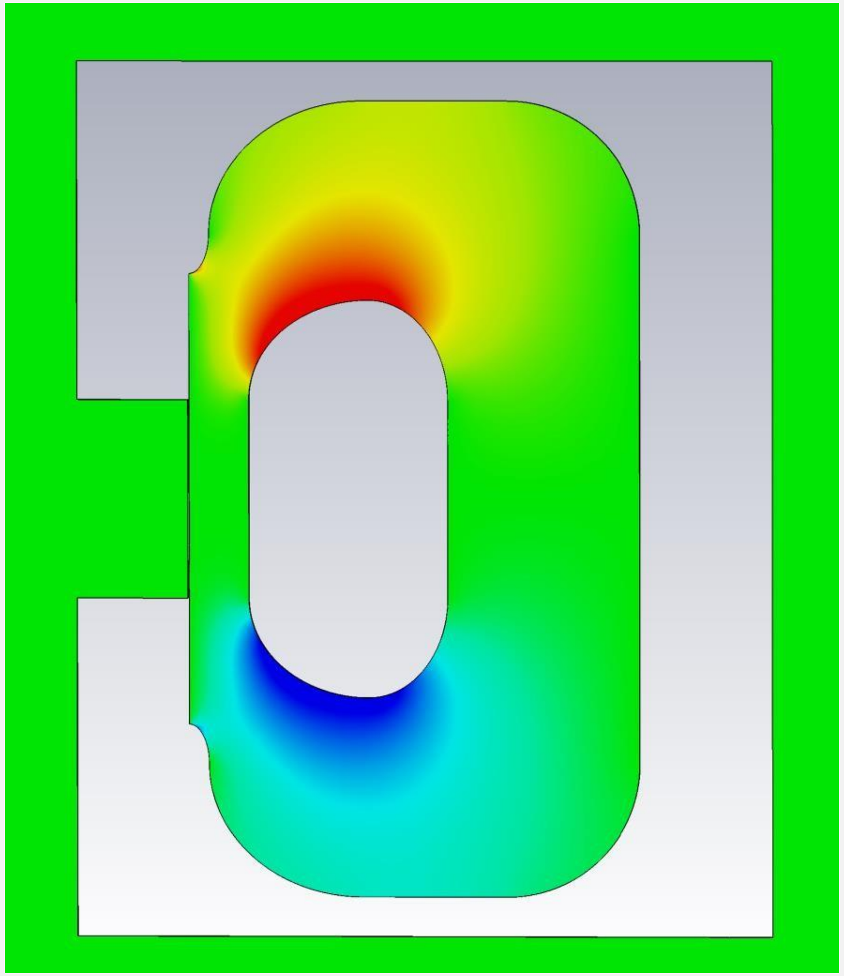
Electric field value on the vertical axis in the modified model

MODELS' COMPARISON: Y AXIS

INITIAL

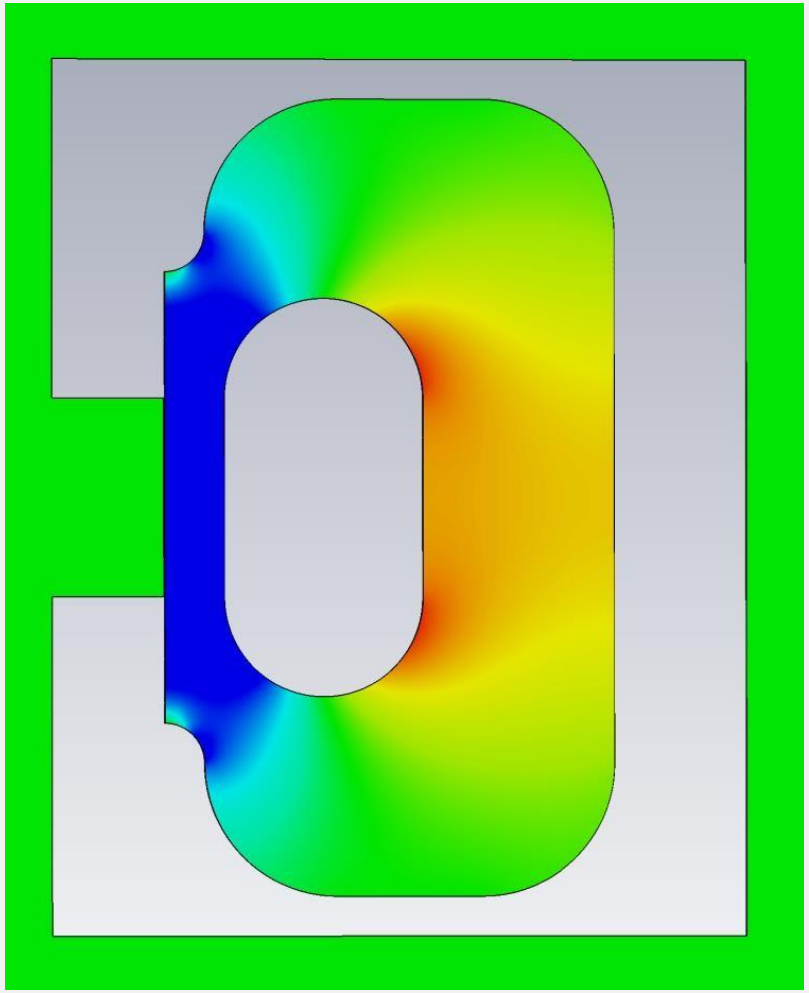


MODIFIED

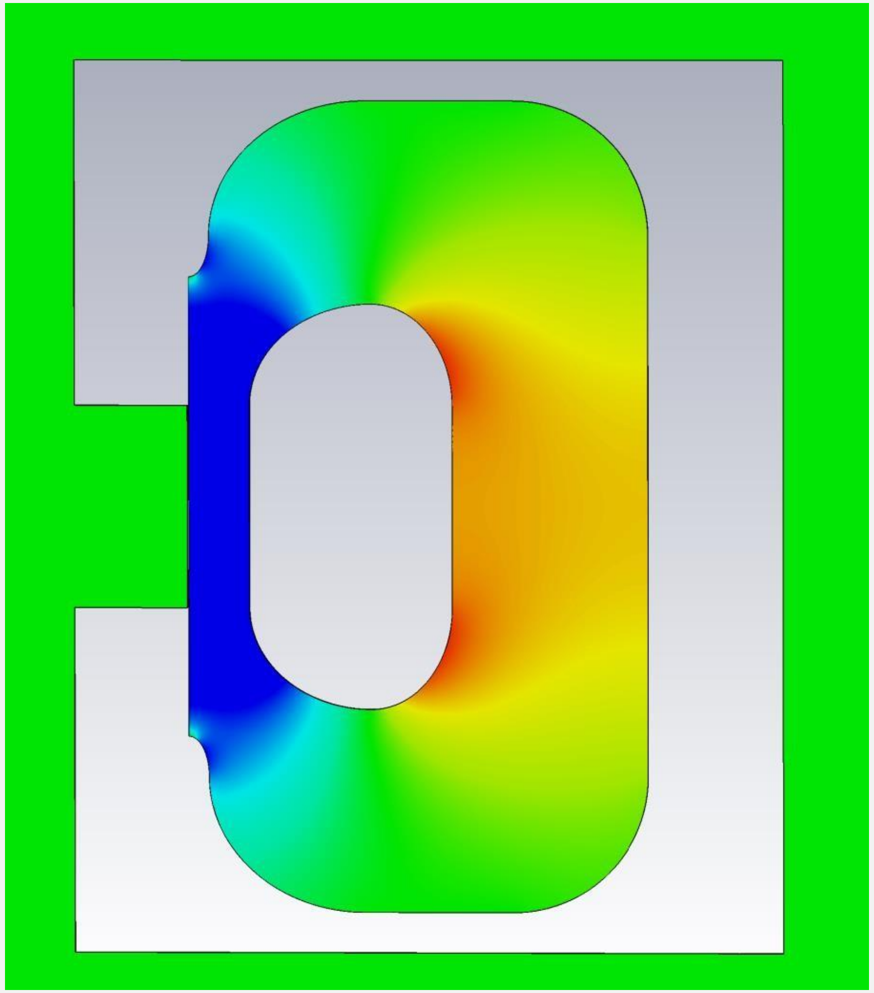


MODELS' COMPARISON: X AXIS

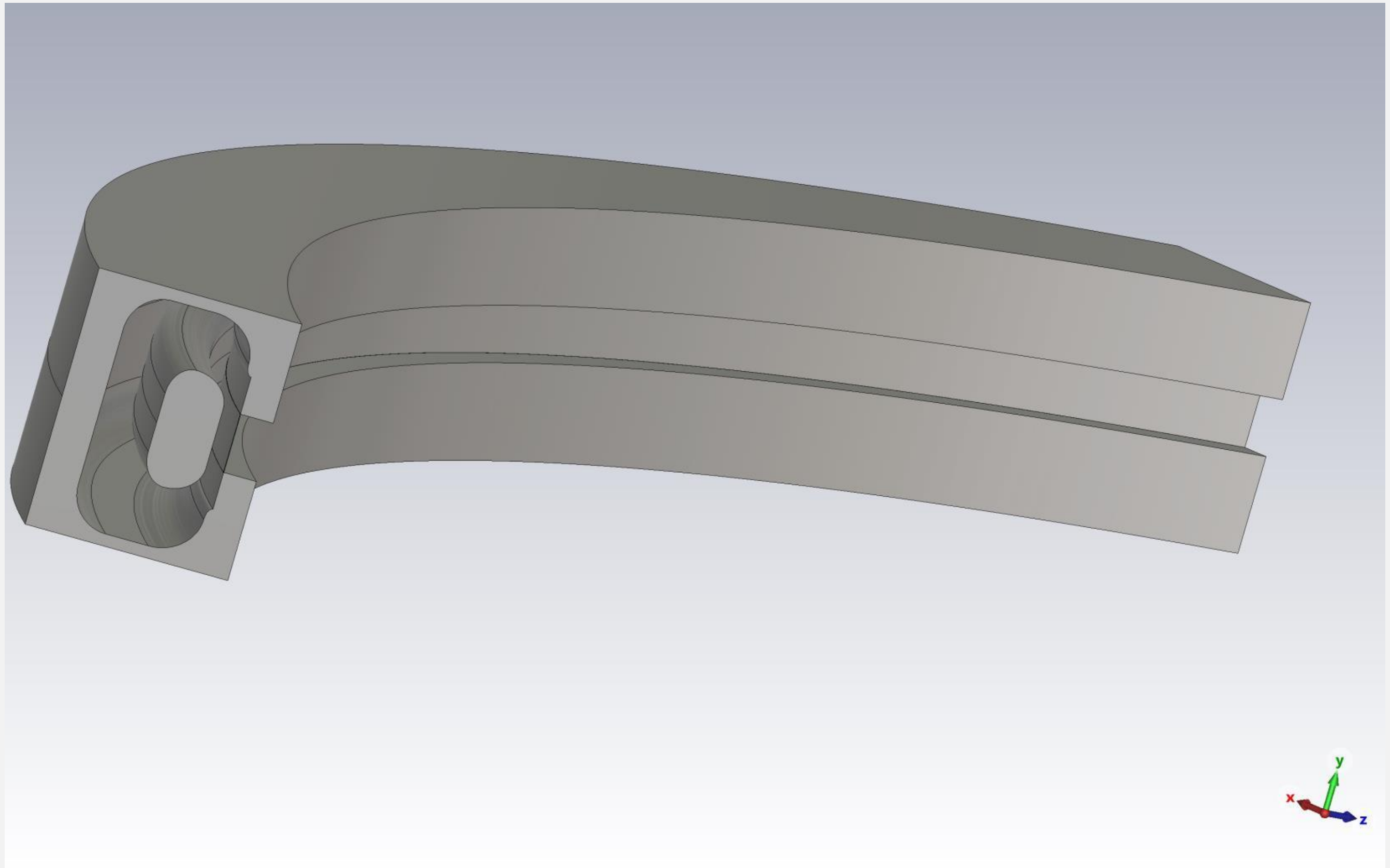
INITIAL



MODIFIED



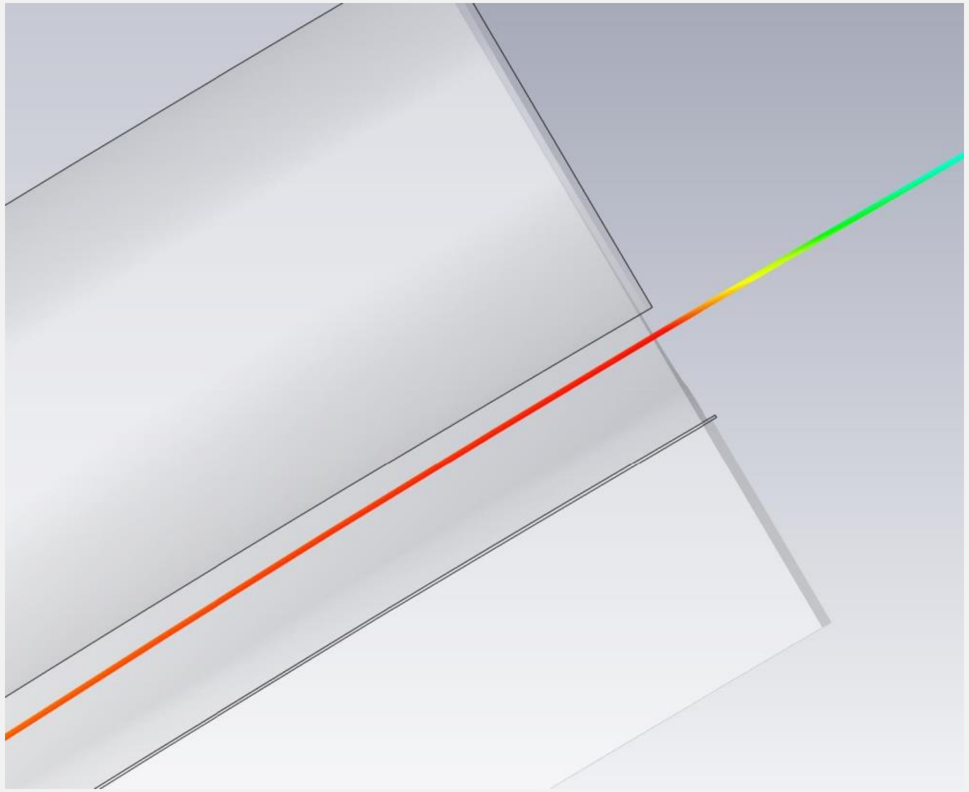
3D MODELLING

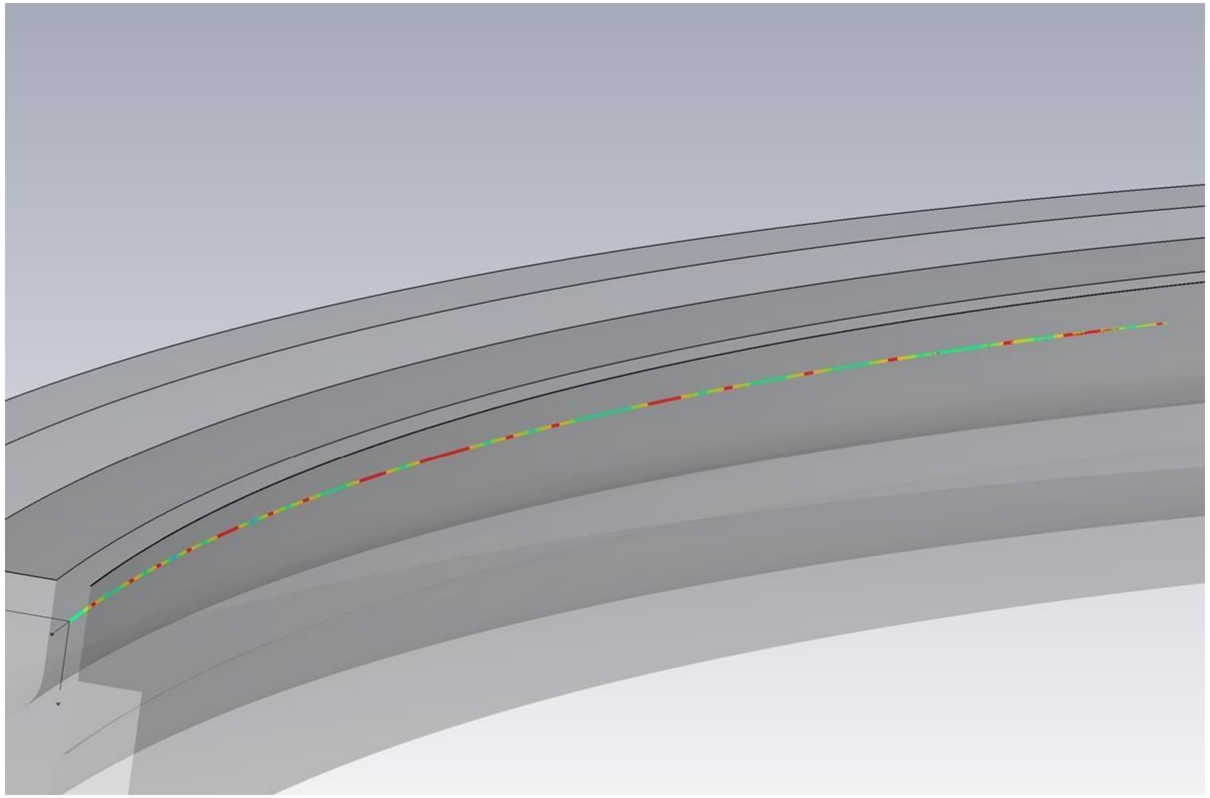


Expected trajectory – based 3D model overview

BEAM SIMULATION

Picture 1 (below). Beam at the exit of the deflector. Device is turned on with 35 kV potential.

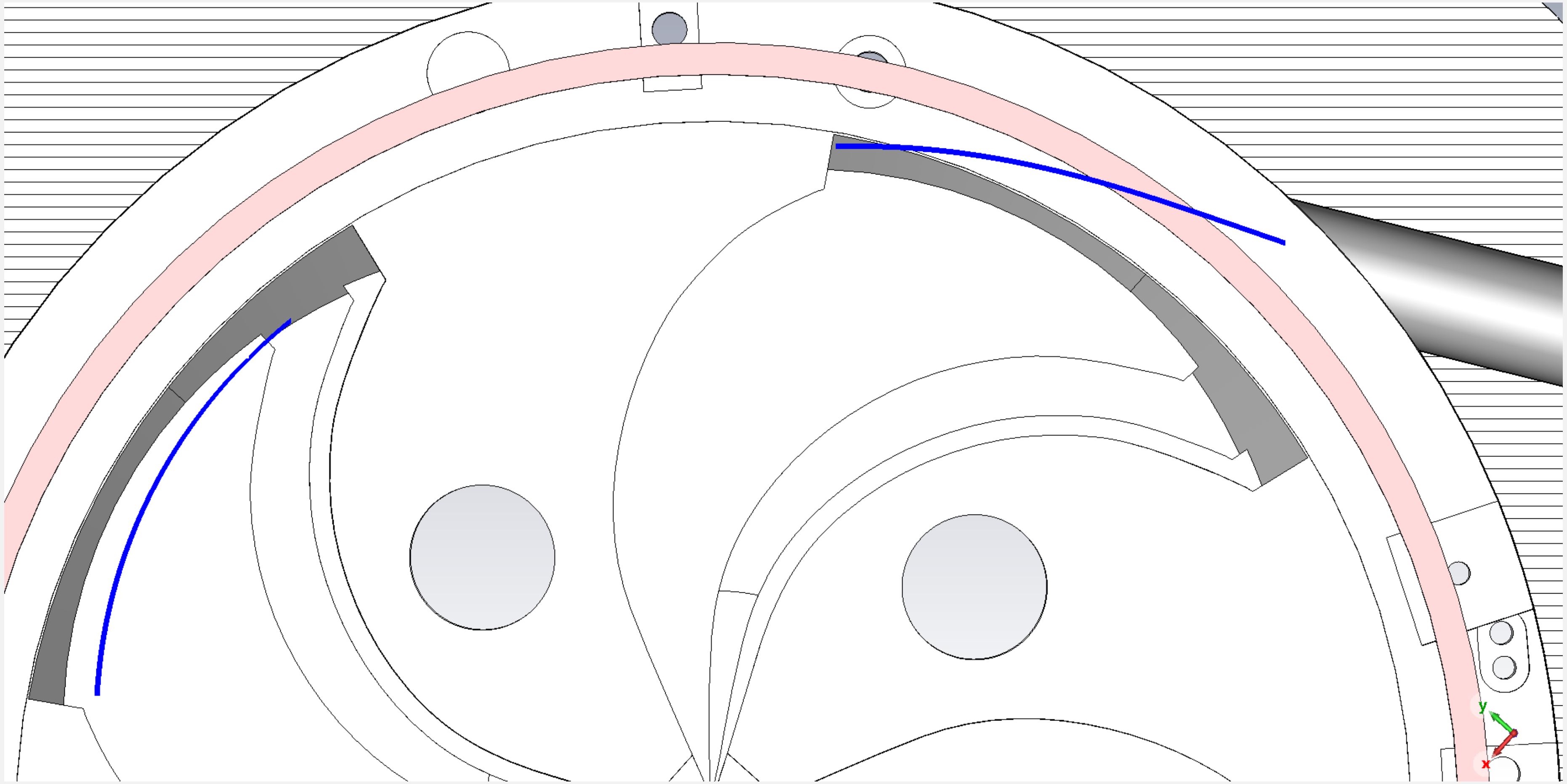




Picture 2 (above). Full beam absorption at less than ½ device length when turned off.

MAGNETIC CHANNELS

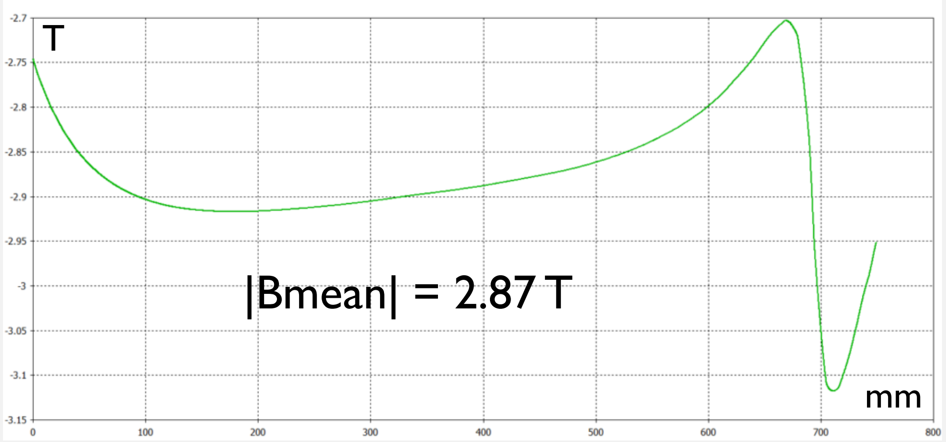
THE LOCATION OF MCS ALONG BEAM TRAJECTORY WITH RELATION TO THE REST OF THE MAGNET.



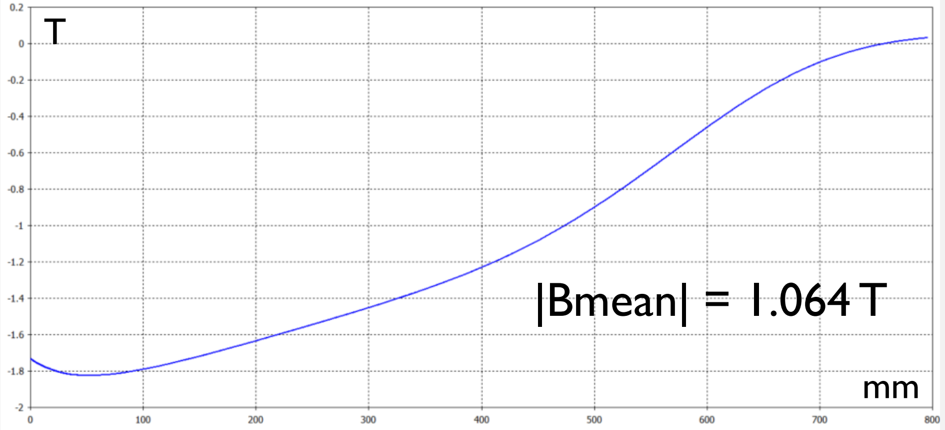
The trajectory intervals to deploy MCs around

FIELD DISTRIBUTION & REQUIREMENTS.

	MC1	MC2
Aperture	10 mm	10 mm
Gradient	180 Gs/mm	120 Gs/mm
Bz shift	-1900 Gs	0 Gs
Bz mean	2.87 T	1.064 T



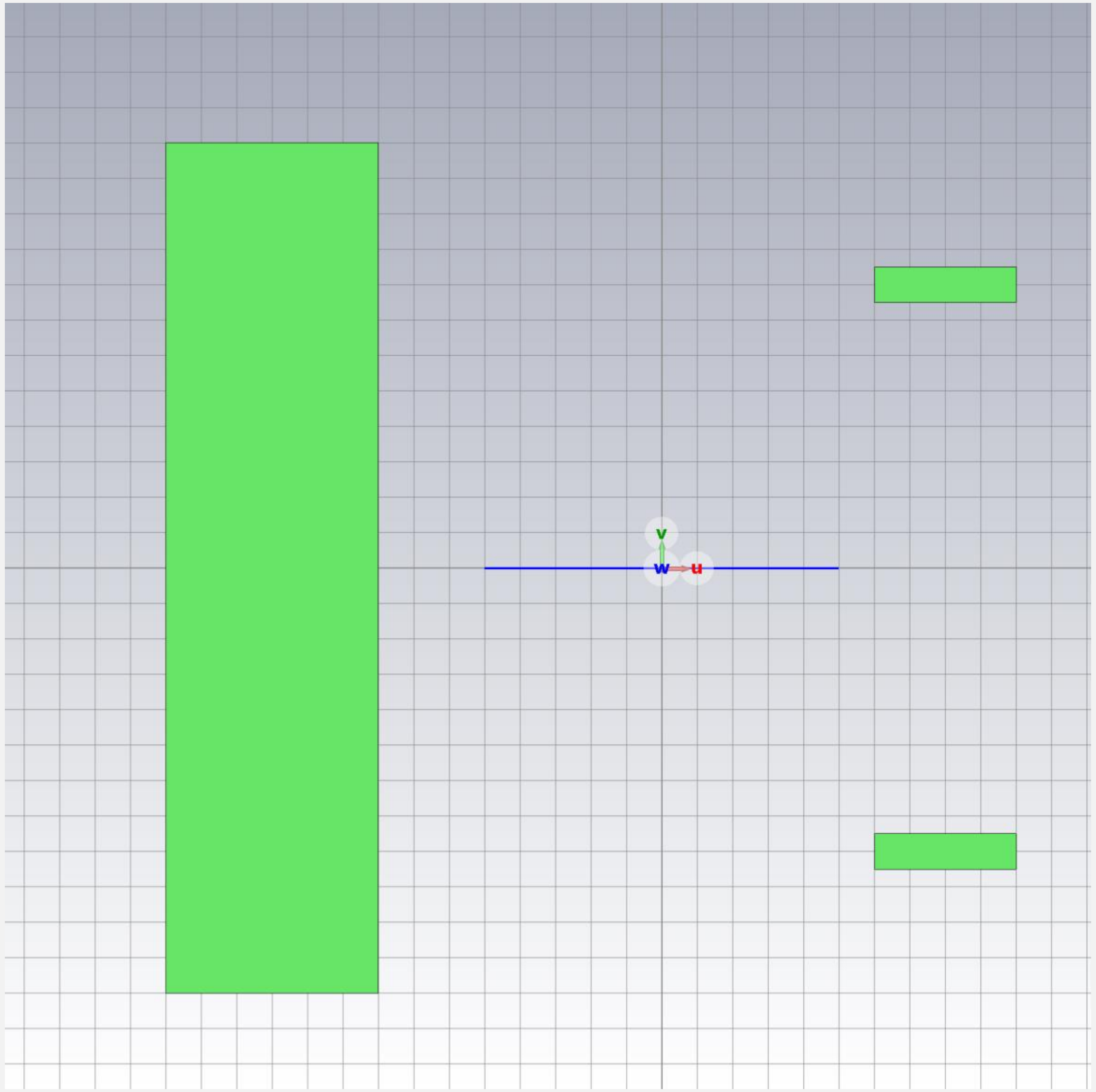
Vertical field on MC1 trajectory



Vertical field on MC2 trajectory

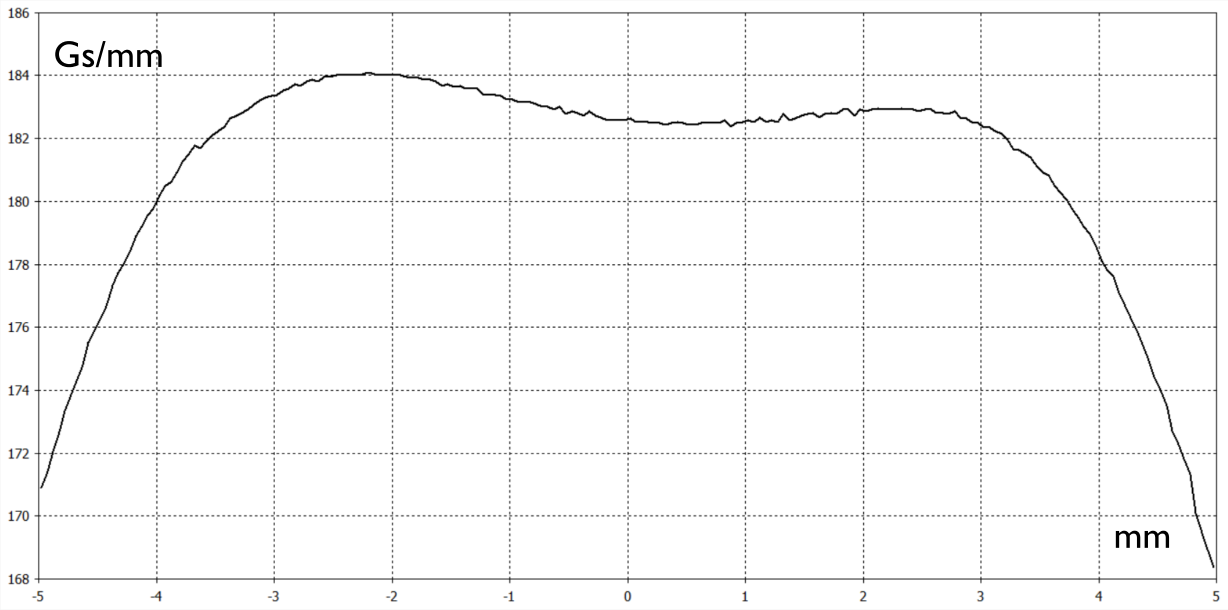
MC DESIGN

MC1

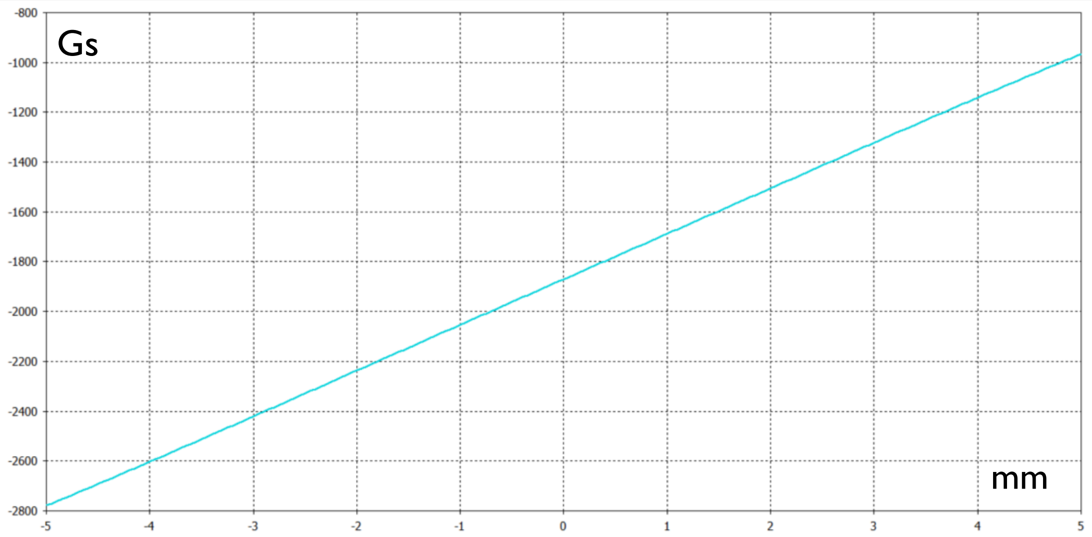


The cross section of the MC1 centered around main particle.

MC1



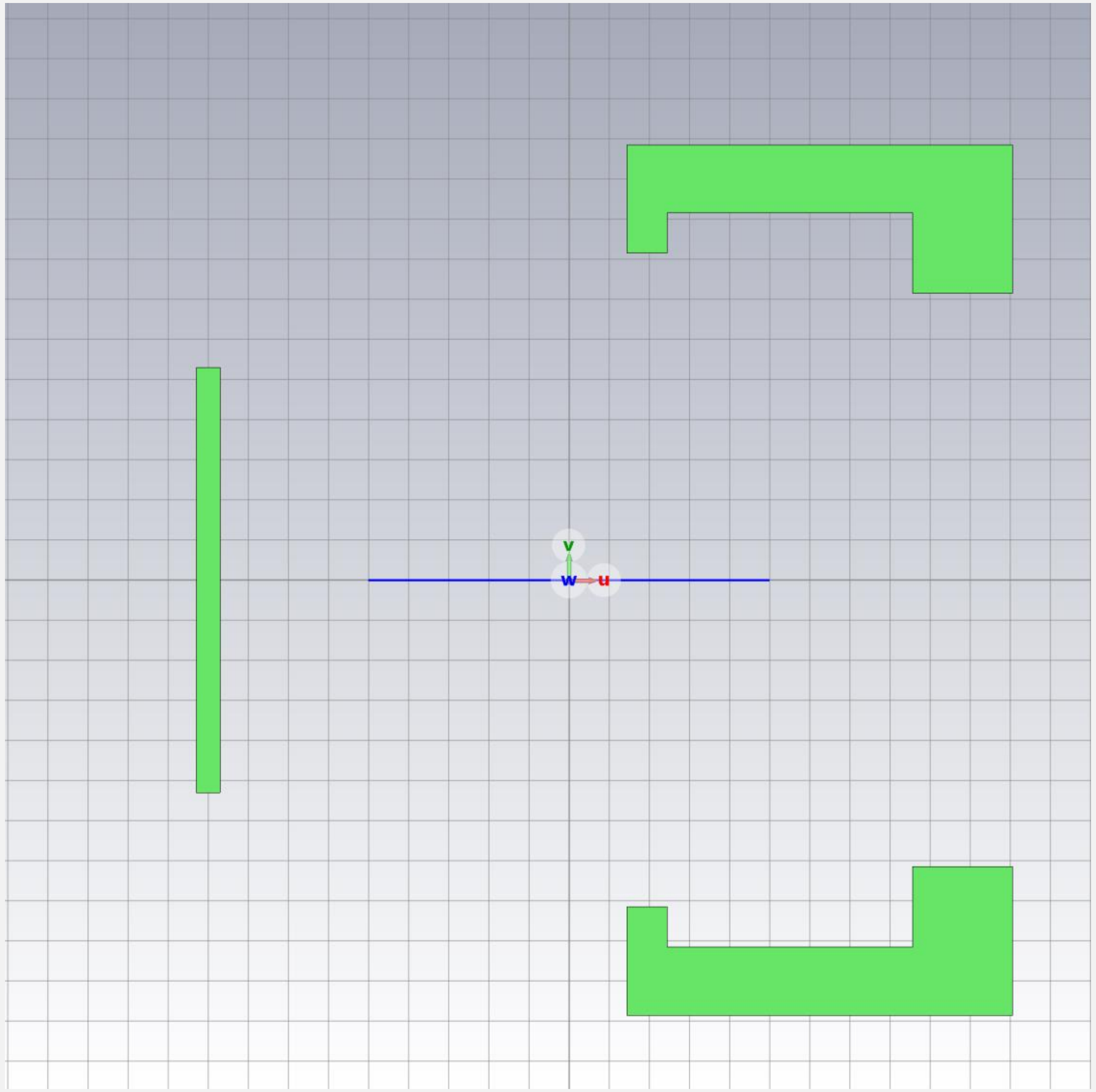
MC1 gradient.



MC1 Bz impact.

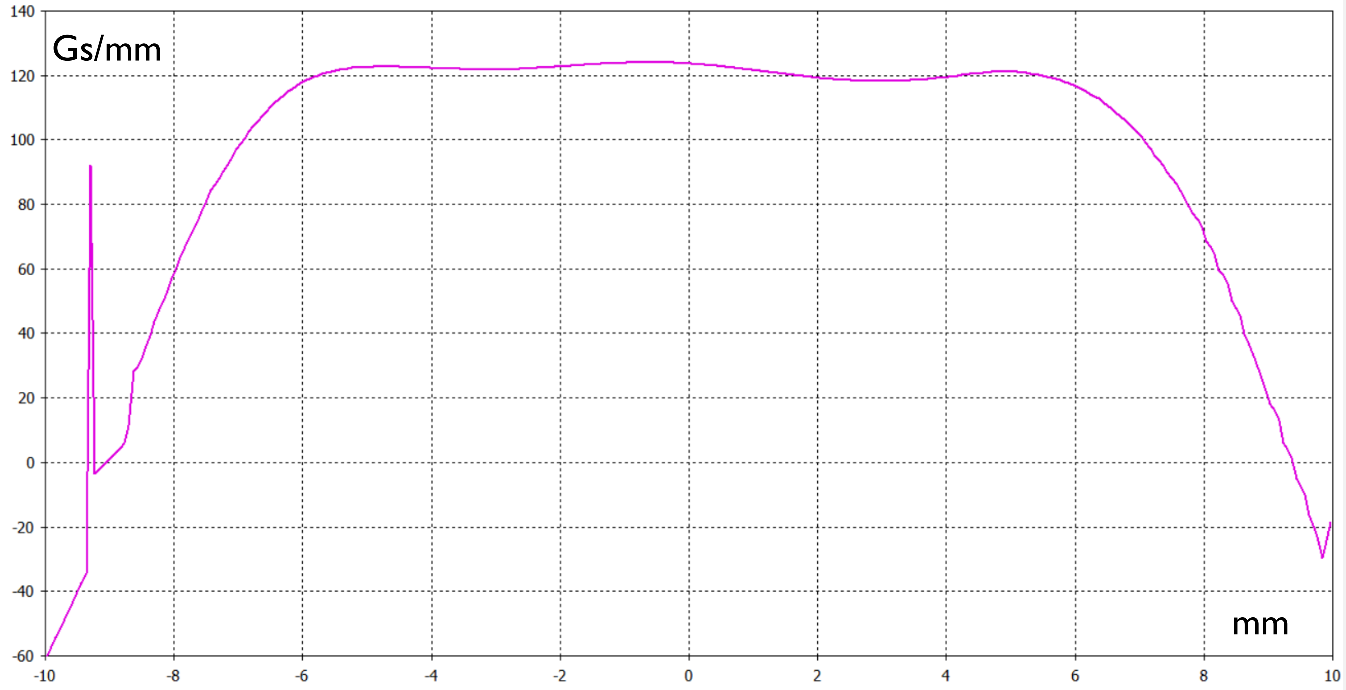
Gradient	Gs/mm
min	168
max	184
mean	181

MC2

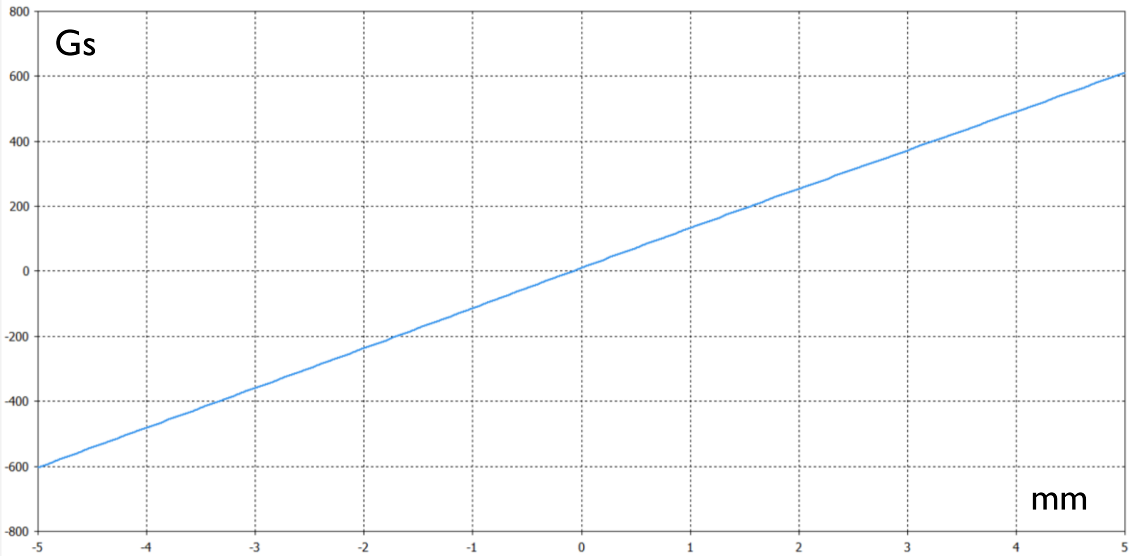


The cross section of the MC2 centered around main particle.

MC2

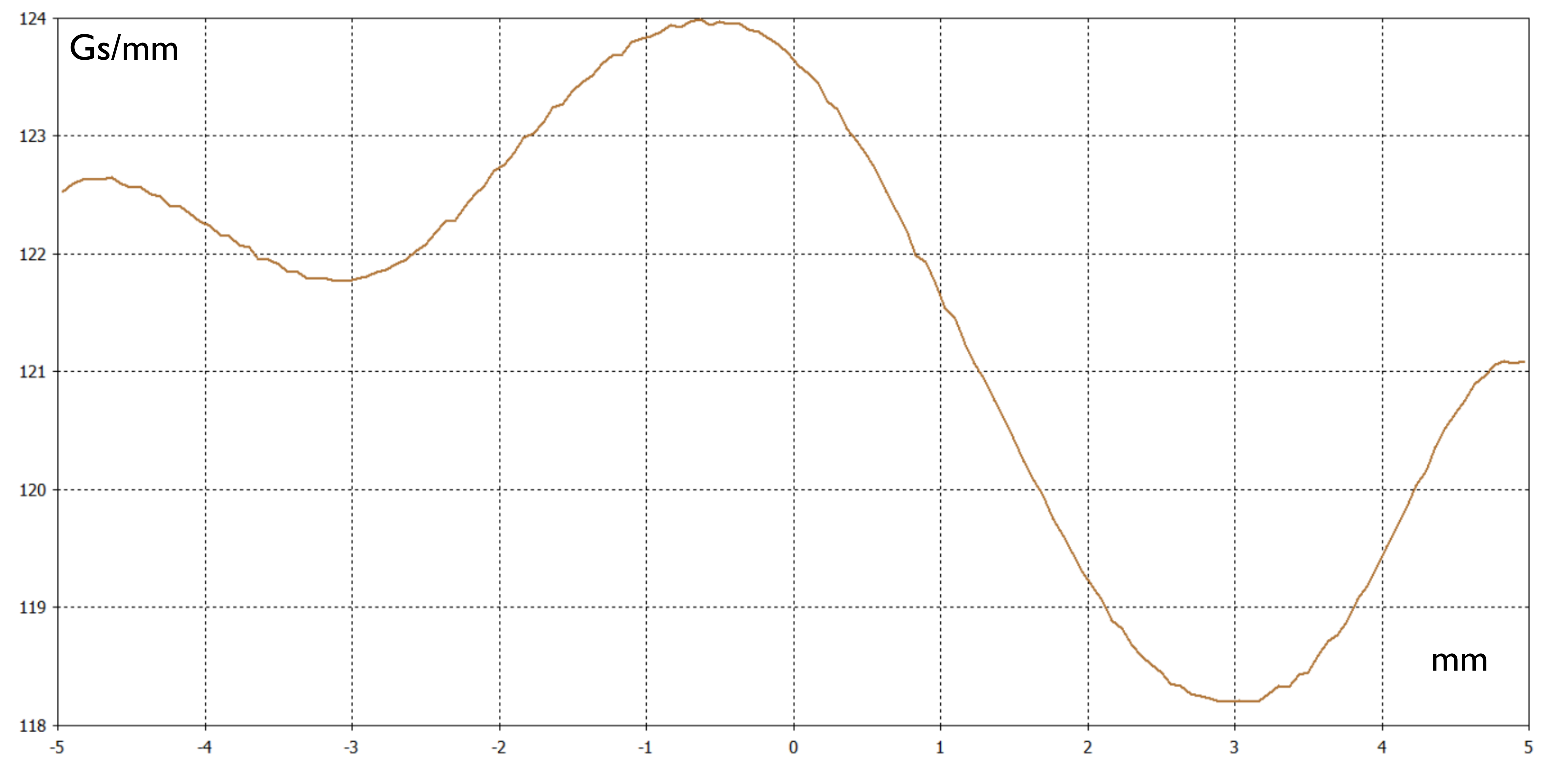


MC2 gradient 20 mm aperture



MC2 Bz impact

MC2



MC2 gradient 10 mm aperture.

Gradient	Gs/mm
min	118
max	124
mean	121.5

CONCLUSION AND FURTHER PLANS

- The deflector construction was optimized to fit the cyclotron geometry and minimize voltage breakdowns while maintaining the same efficiency;
- The magnetic channel designs were adjusted to reach the target field decrease and harmonics suppression values;
- It is planned to imply mentioned changes during the stand-testing and, if successful, production stage.

THANK YOU FOR YOUR ATTENTION!