Status report on the electrostatic simulations for the 6x6x6

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Goal

Whole electrostatic simulation of the field cage including the cathode and the high voltage feedthrough

Outline

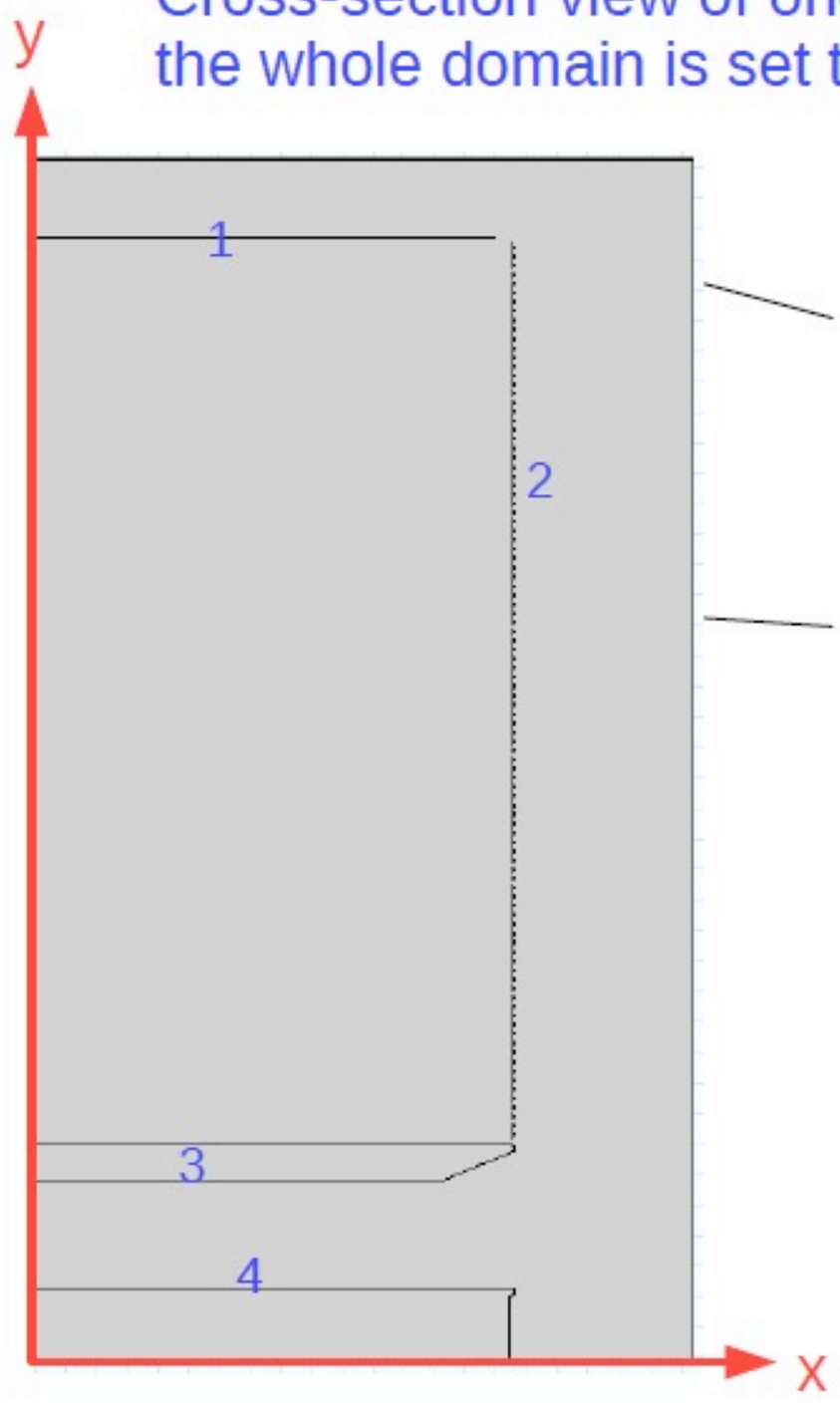
- **Field cage simulations**
  - 2D-cross section
  - Influence of the clip
- **Cathode simulations**
- **High voltage feedthrough (HVFT) simulations**
  - Field along the HVFT
  - Connection to the cathode

Outline

- **Field cage simulations**
  - 2D-cross section
  - Influence of the clip

2D Simulation of the Field Cage

Cross-section view of one corner of the field cage; in this simulation, the whole domain is set to **liquid Ar** only.



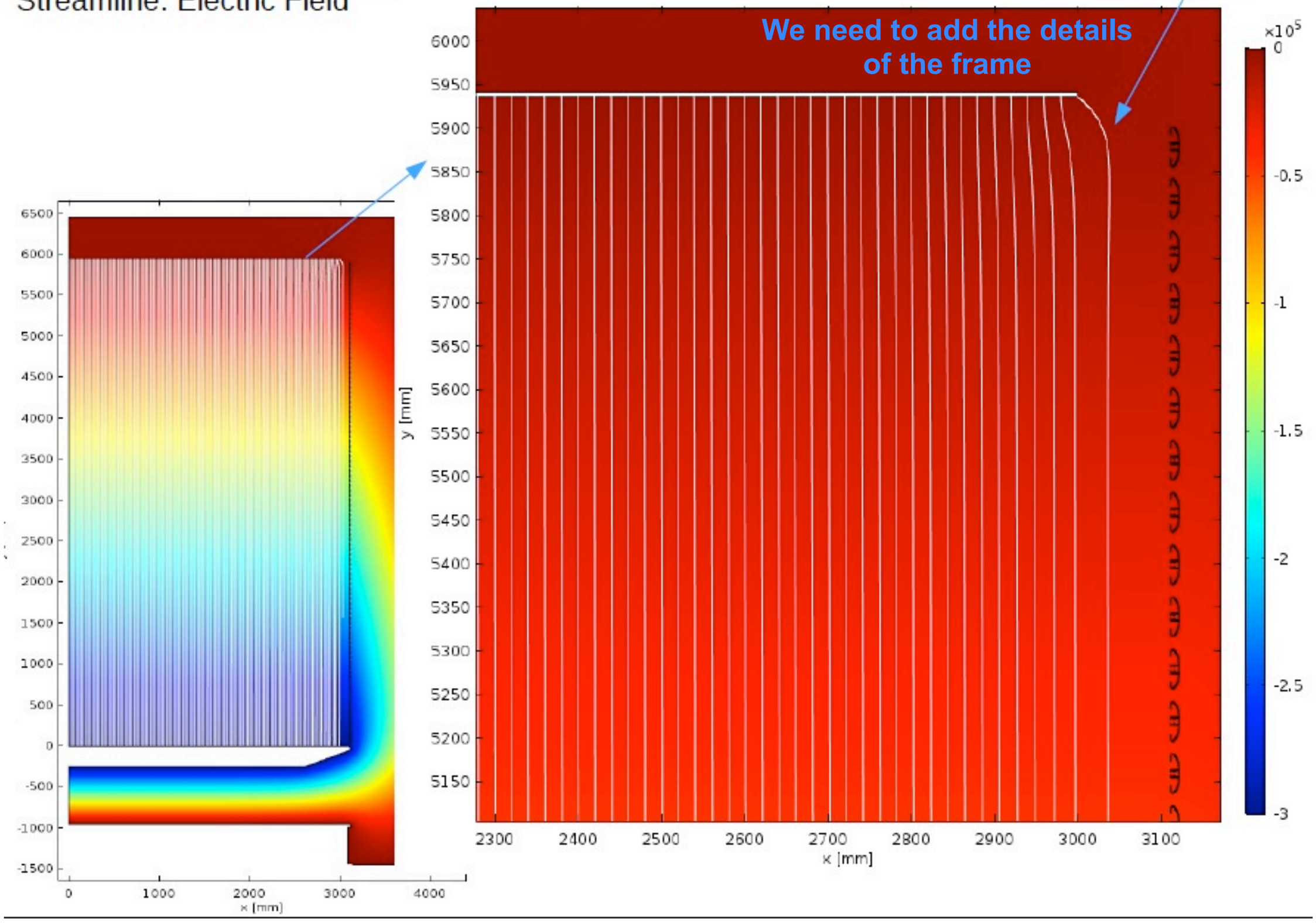
The vertical distance and potential difference between the CRP and the first field shaper is kept identical to those between two field shapers.

98 field shapers with the potential difference in between being 3kV and the distance 60mm.

	Geometry
1	CRP
2	Field Shapers
3	Cathode
4	Ground Grid

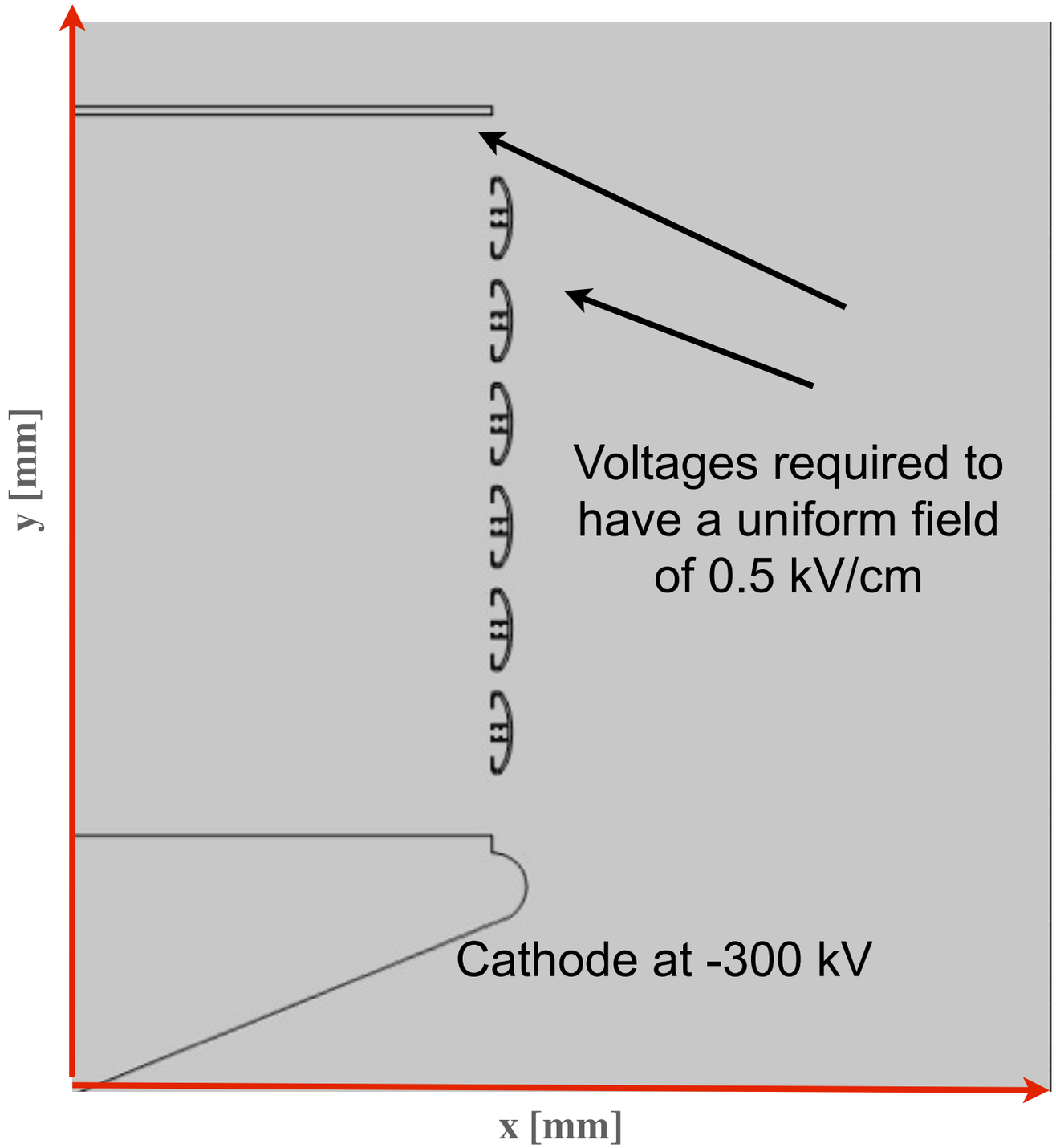
Surface: Electric Potential (V)
Streamline: Electric Field

Streamline deviates in the vicinity of the boundary

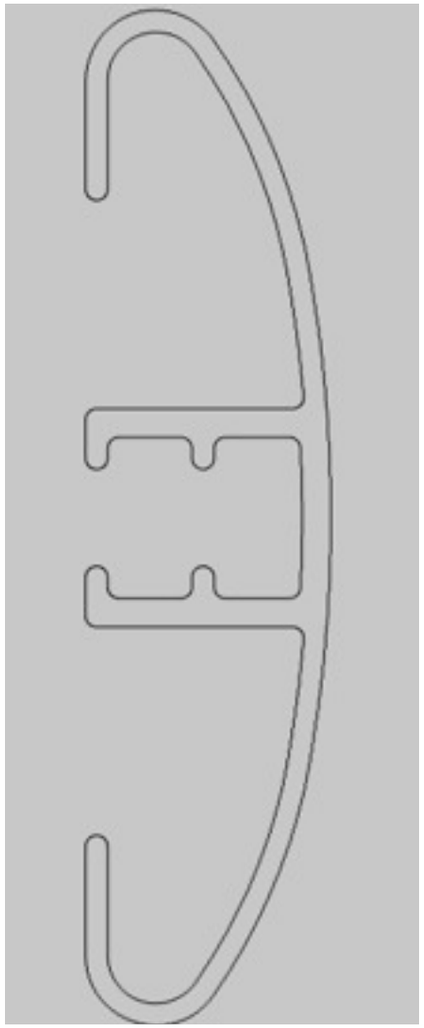


2D-simplified simulation

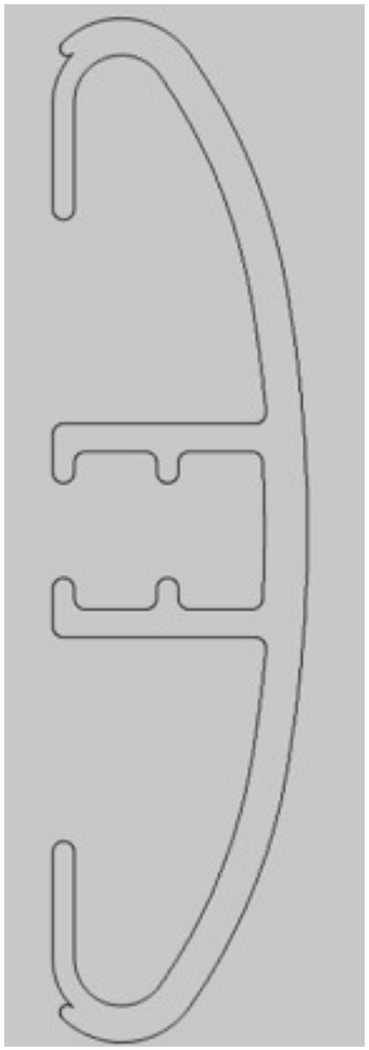
Cross-section view of 6 profiles considering a potential difference between them of 3 kV, as in the 6x6x6. We just add on the top the anode at a certain voltage to keep the field of 0.5 kV/cm uniform inside the volume

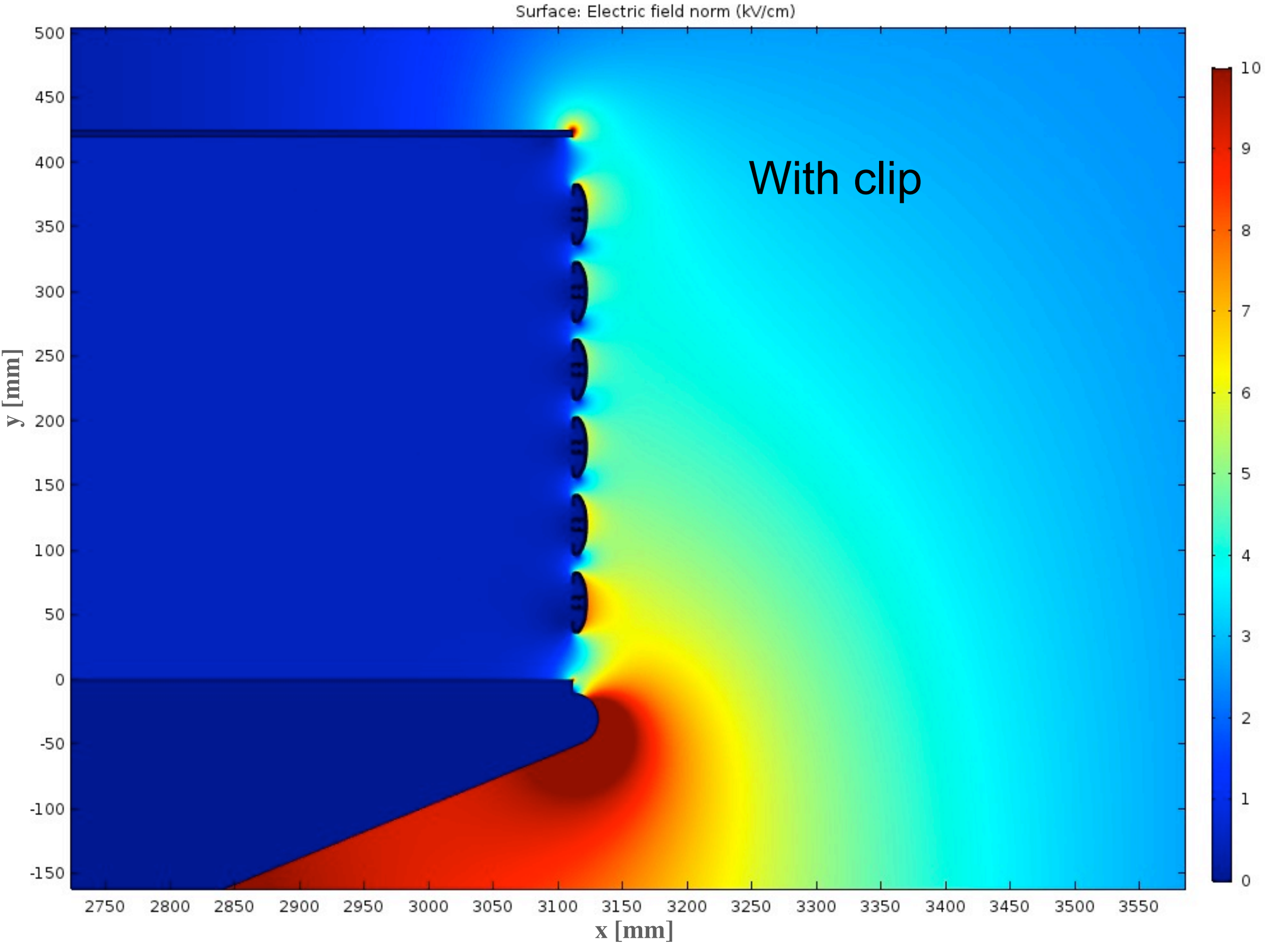


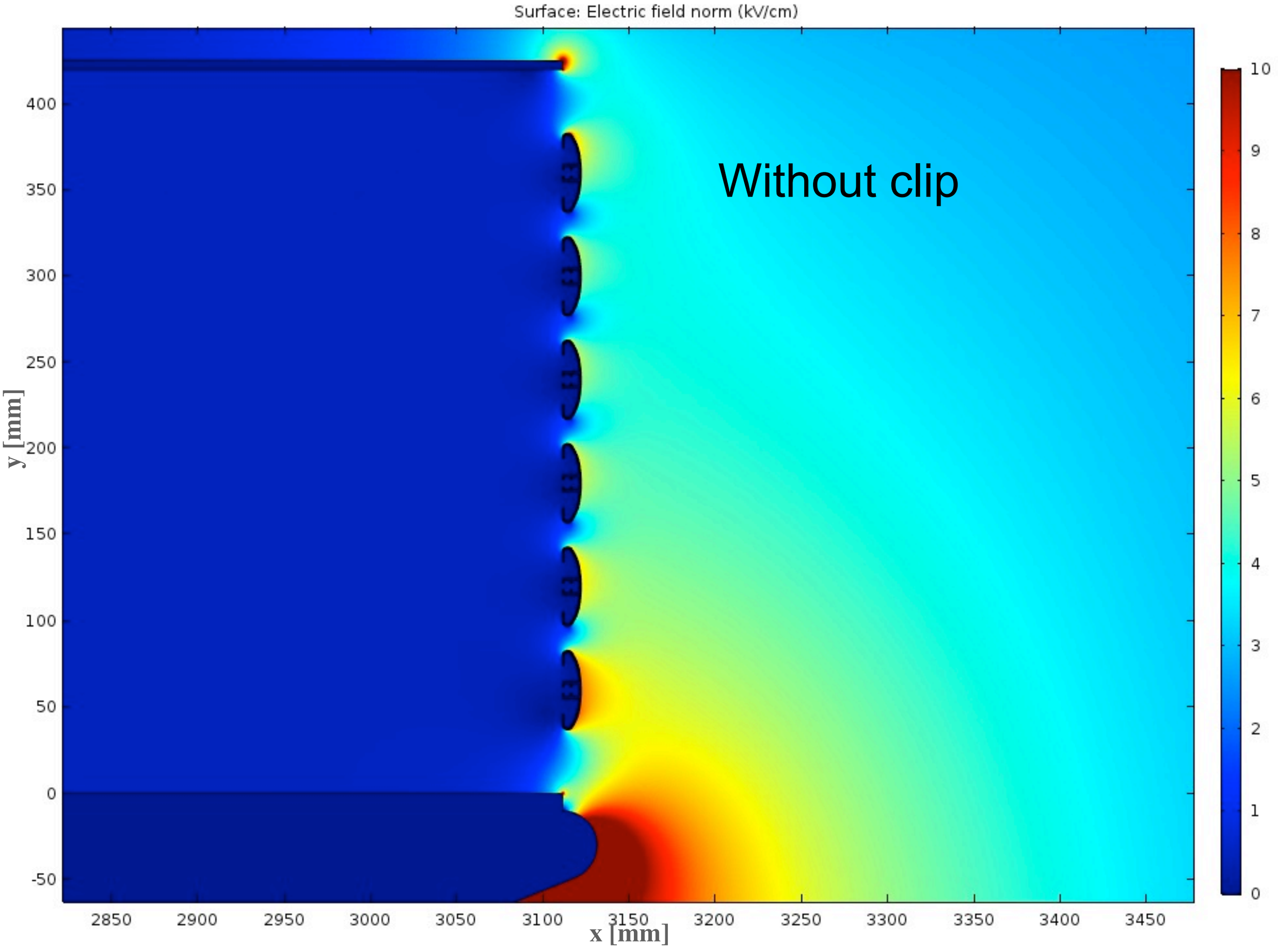
Without clip



With clip



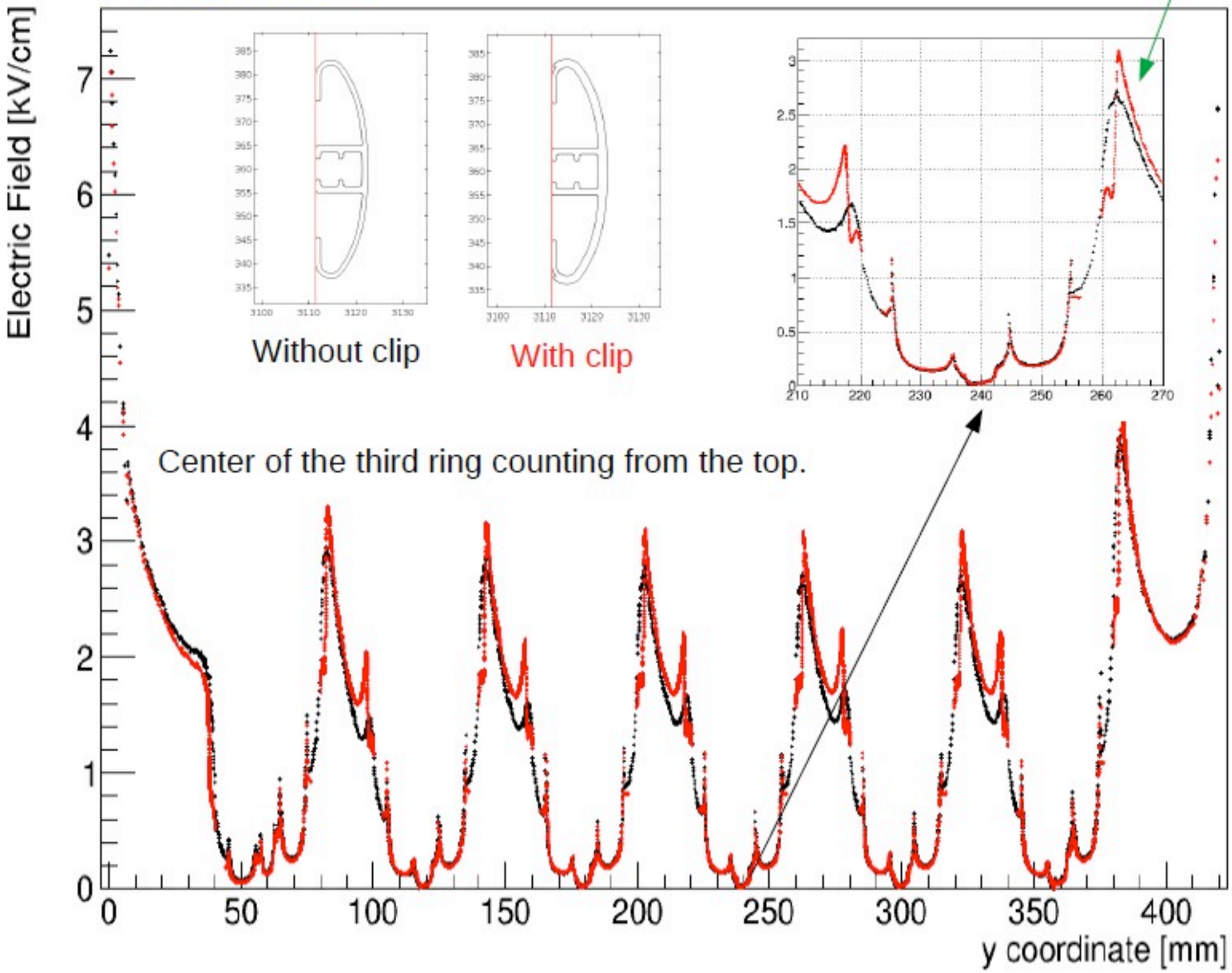

Surface: Electric field norm (kV/cm)
With clip
y [mm]
x [mm]
500
450
400
350
300
250
200
150
100
50
0
-50
-100
-150
2750
2800
2850
2900
2950
3000
3050
3100
3150
3200
3250
3300
3350
3400
3450
3500
3550
10
9
8
7
6
5
4
3
2
1
0


Surface: Electric field norm (kV/cm)
Without clip
y [mm]
400
350
300
250
200
150
100
50
0
-50
2850
2900
2950
3000
3050
3100
3150
3200
3250
3300
3350
3400
3450
x [mm]
10
9
8
7
6
5
4
3
2
1
0

Electric Field on the Surface of the Profile

X = 3111.499 mm

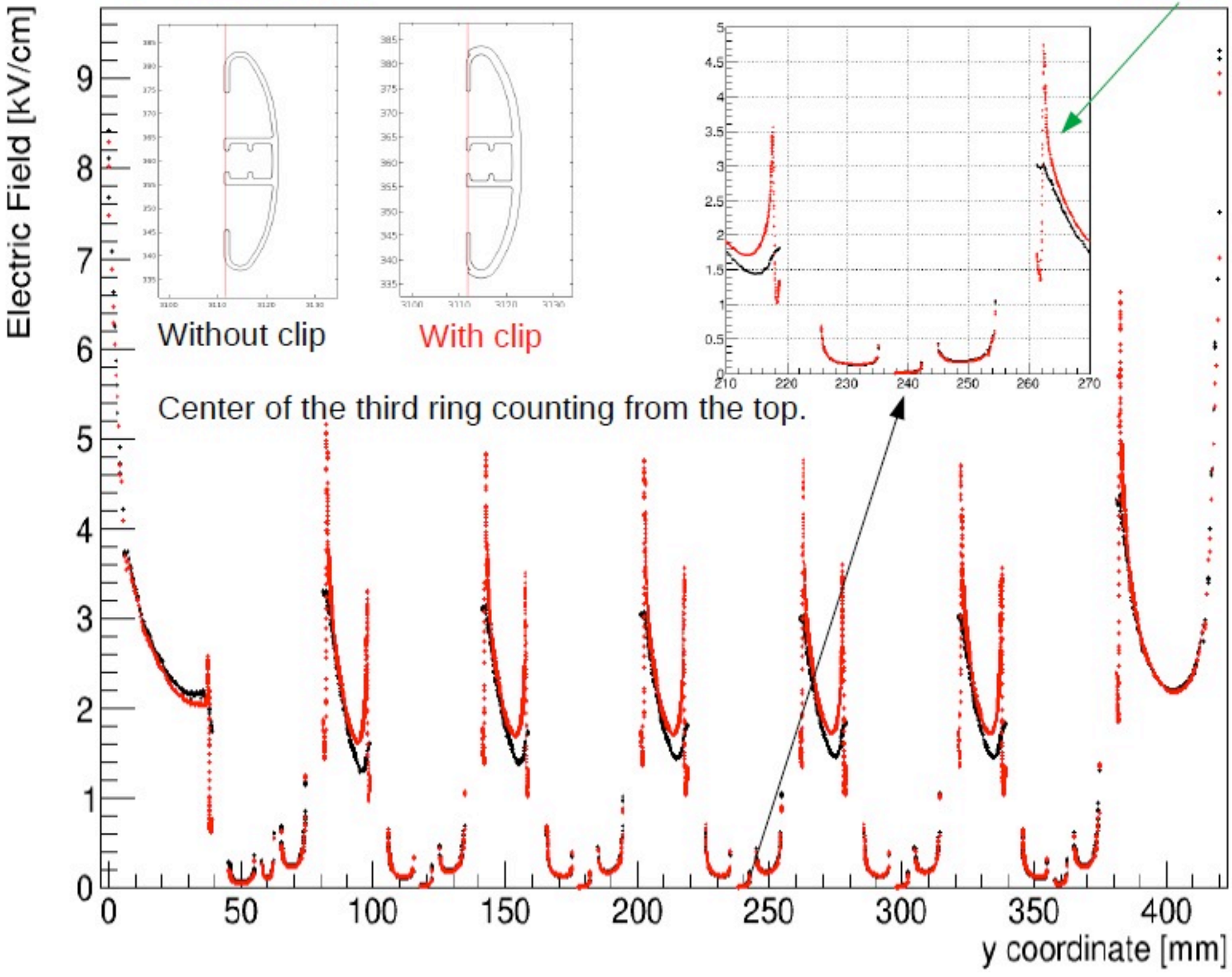
electric field increases from 2.7 to 3.1 kV/cm



Electric Field on the Tangent Line of the Clip

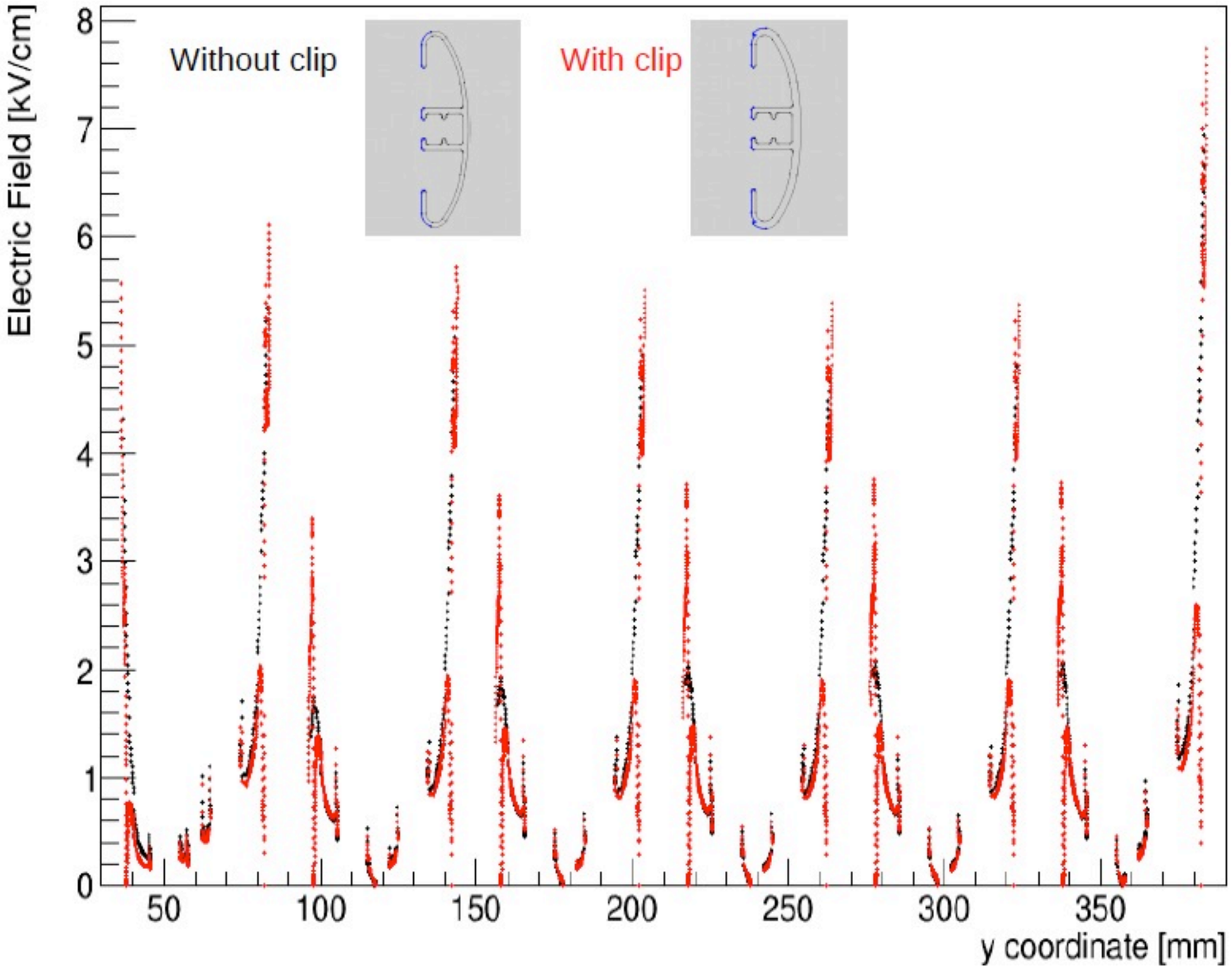
X = 3111.833 mm

electric field increases from 3.1 to 4.8 kV/cm.



Electric Field on the Surface of the Profile

in adjacent to the detecting volume

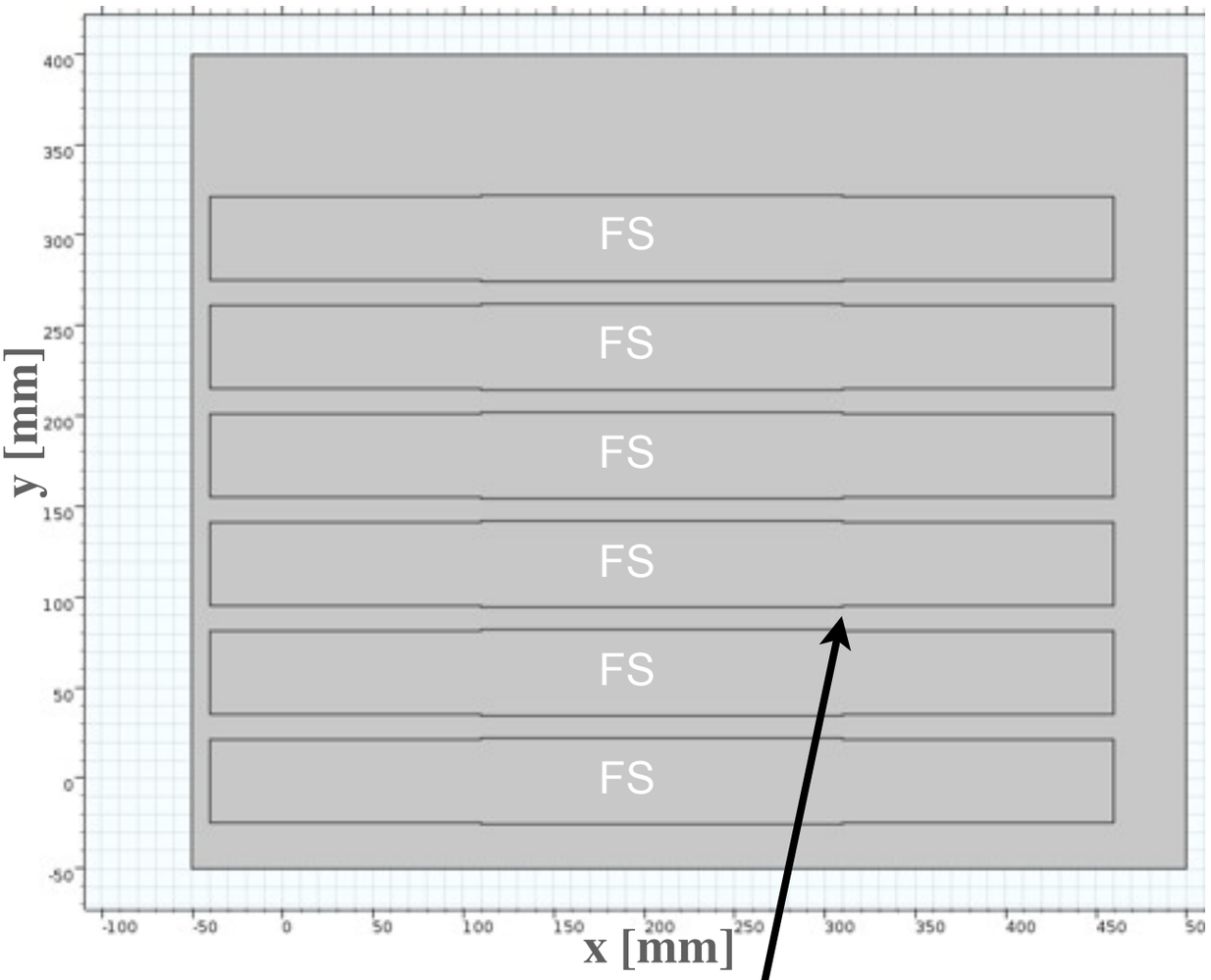


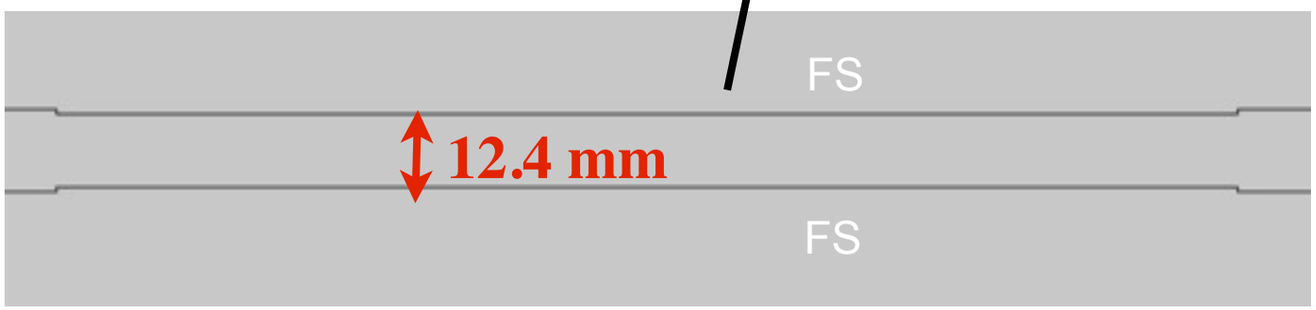
2D-simplified simulation

Front-view

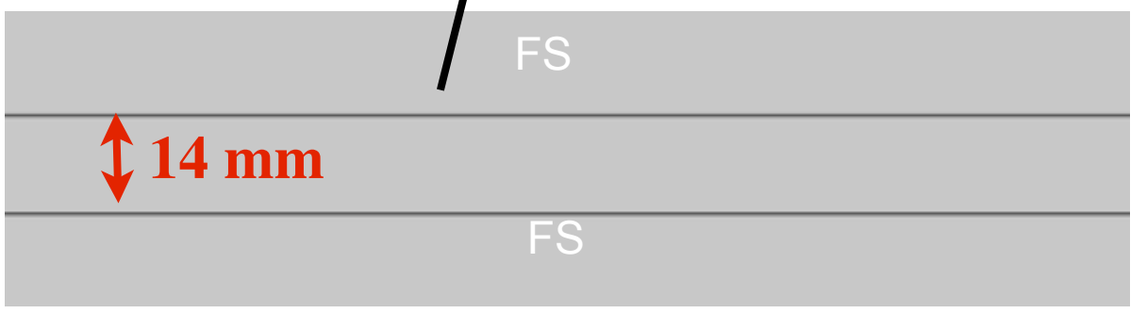
Front-view of 6 profiles considering a potential difference between them of 3 kV, as in the 6x6x6 field cage

With clip





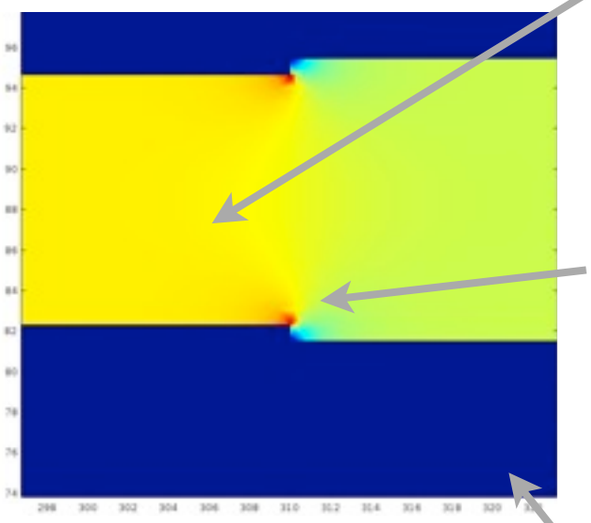
Without clip



2D-simplified simulation

Front-view

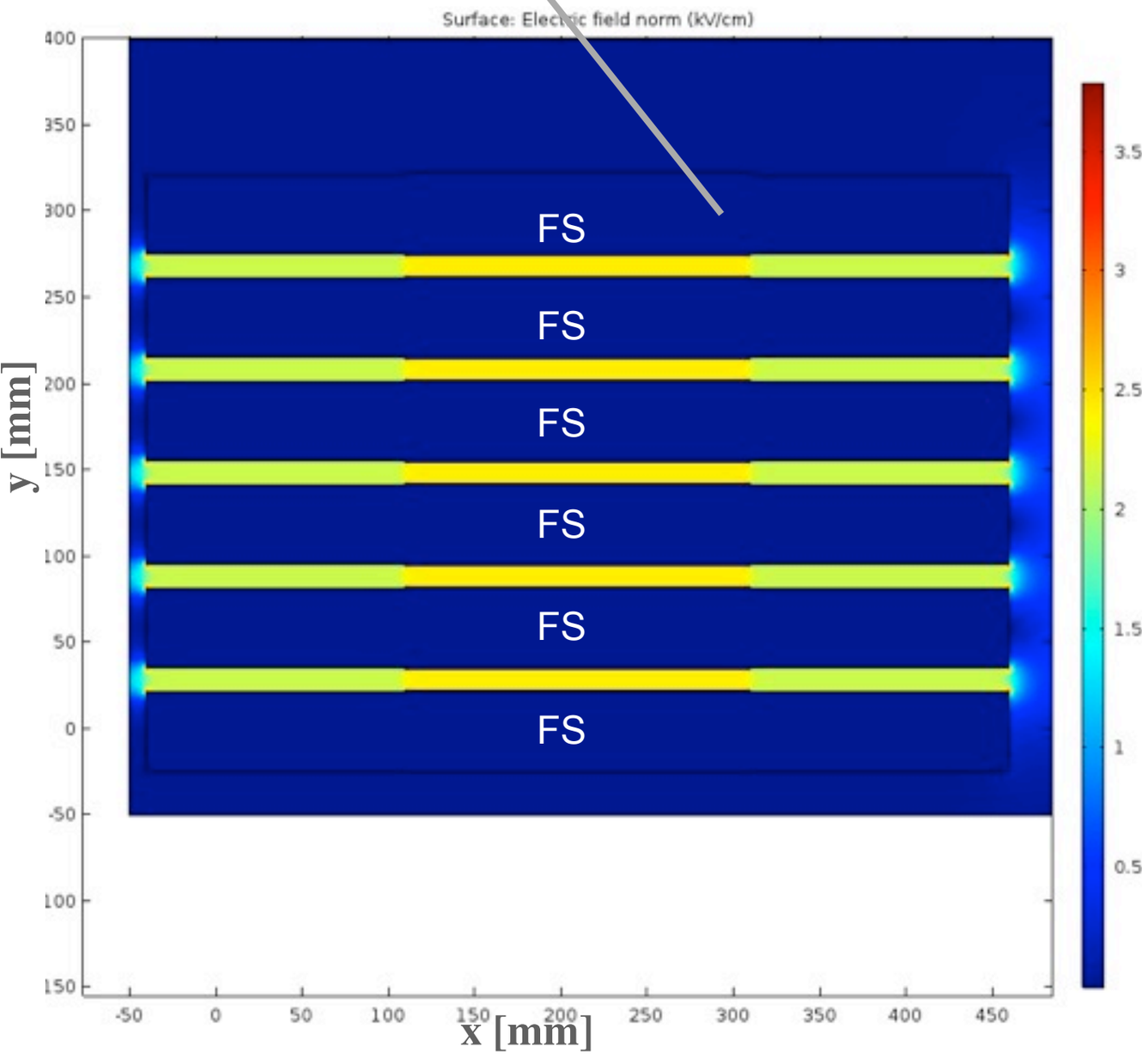
Surface: Electric Field [kV/cm]



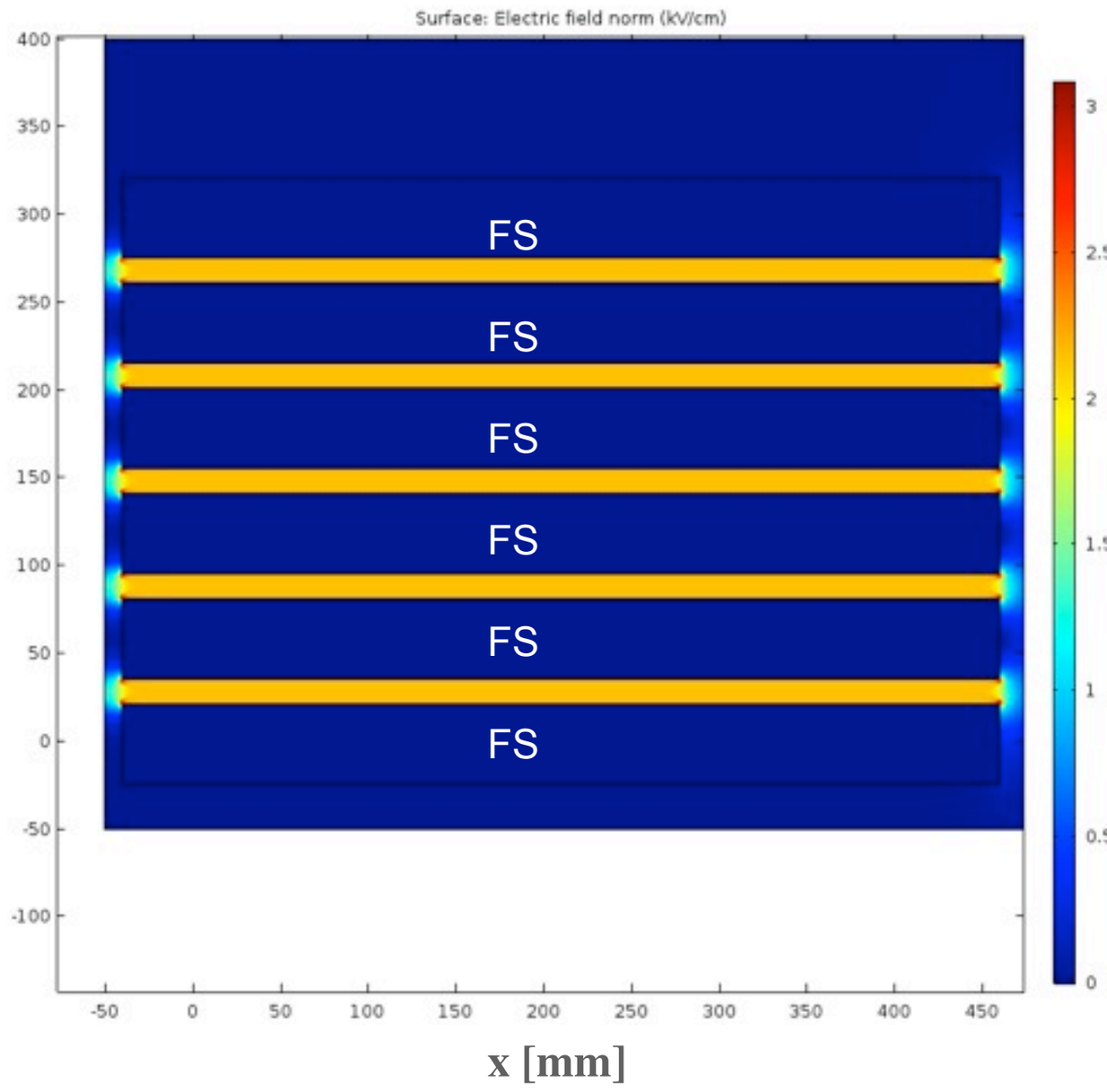
The fieldis larger in the region in between the clip, as the distance between the profiles is smaller

Edge effect in the end of the clip. Is it possible to round it?

With clip



Without clip

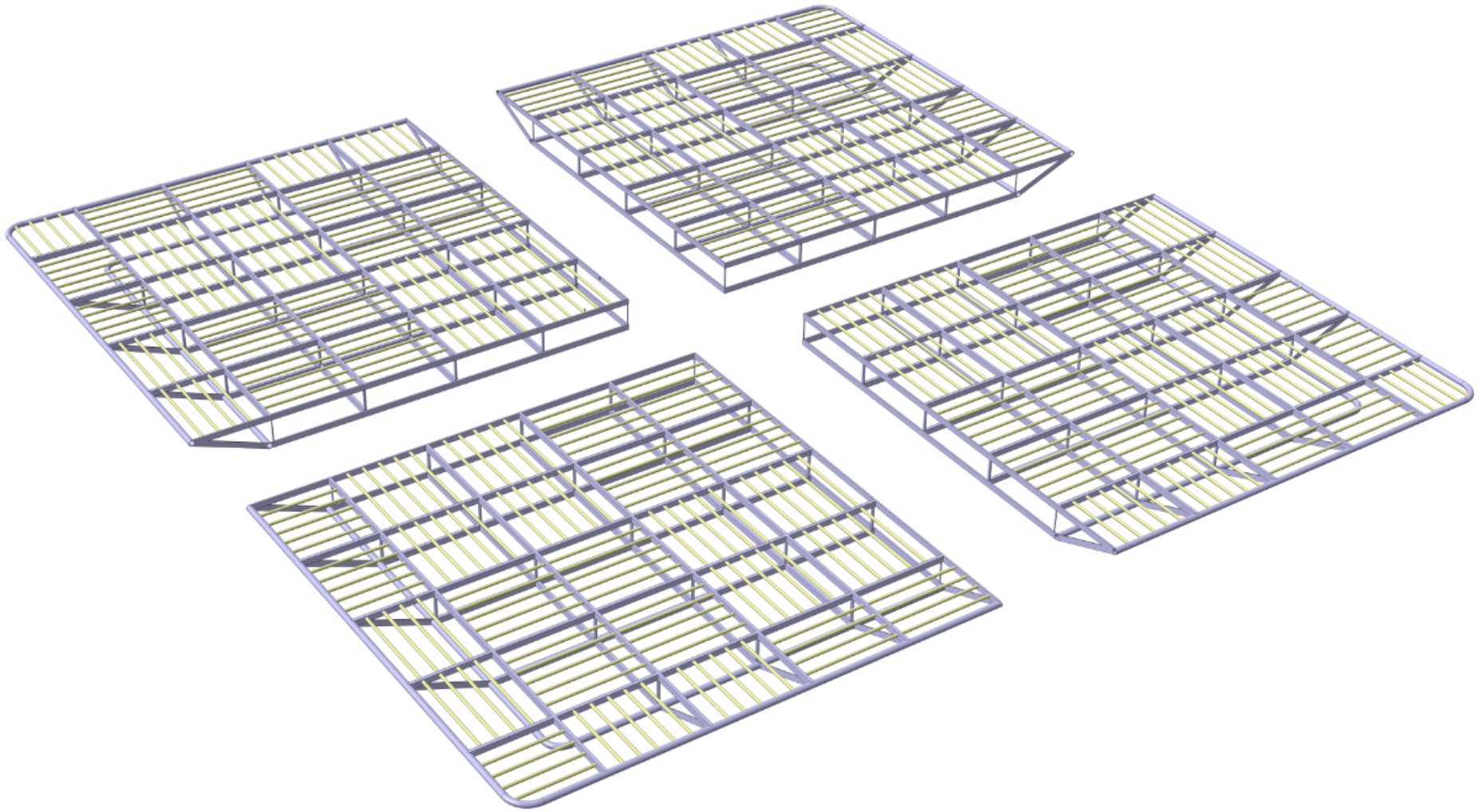


Outline

- **Cathode simulations**

Cathode simulations

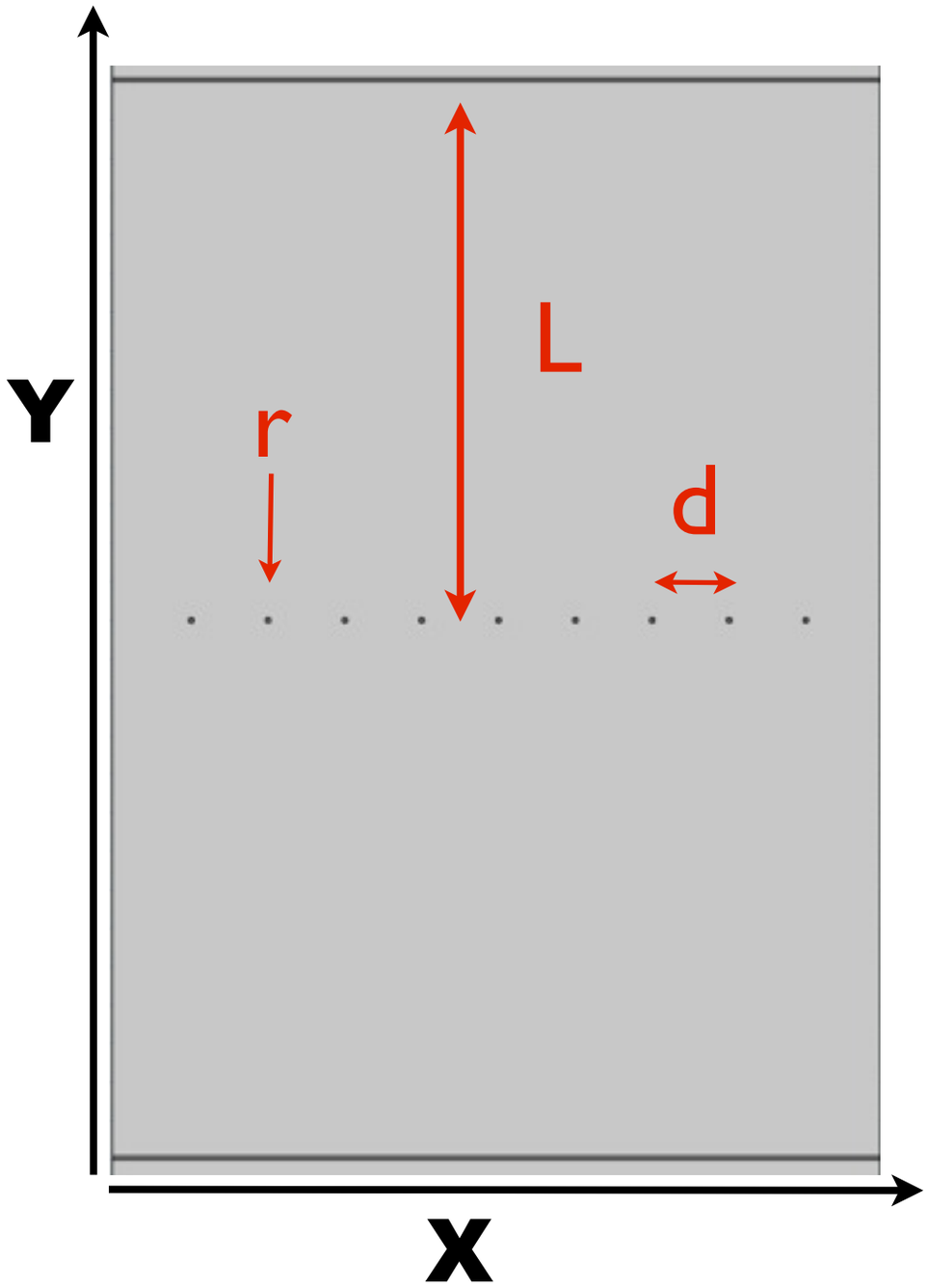
Current cathode design on the plone



Cathode simulations

Sauli formula

$$E(x,y)=\frac{CV}{2\varepsilon d}\sqrt{\left(1+\tan^2\left(\frac{\pi x}{d}\right)\tanh^2\left(\frac{\pi y}{d}\right)\right)}\Bigg/\sqrt{\left(\tan^2\left(\frac{\pi x}{d}\right)\tanh^2\left(\frac{\pi y}{d}\right)\right)}$$



$$C=\frac{2\pi\varepsilon}{\pi L/d-\ln\left(2\pi r/d\right)}$$

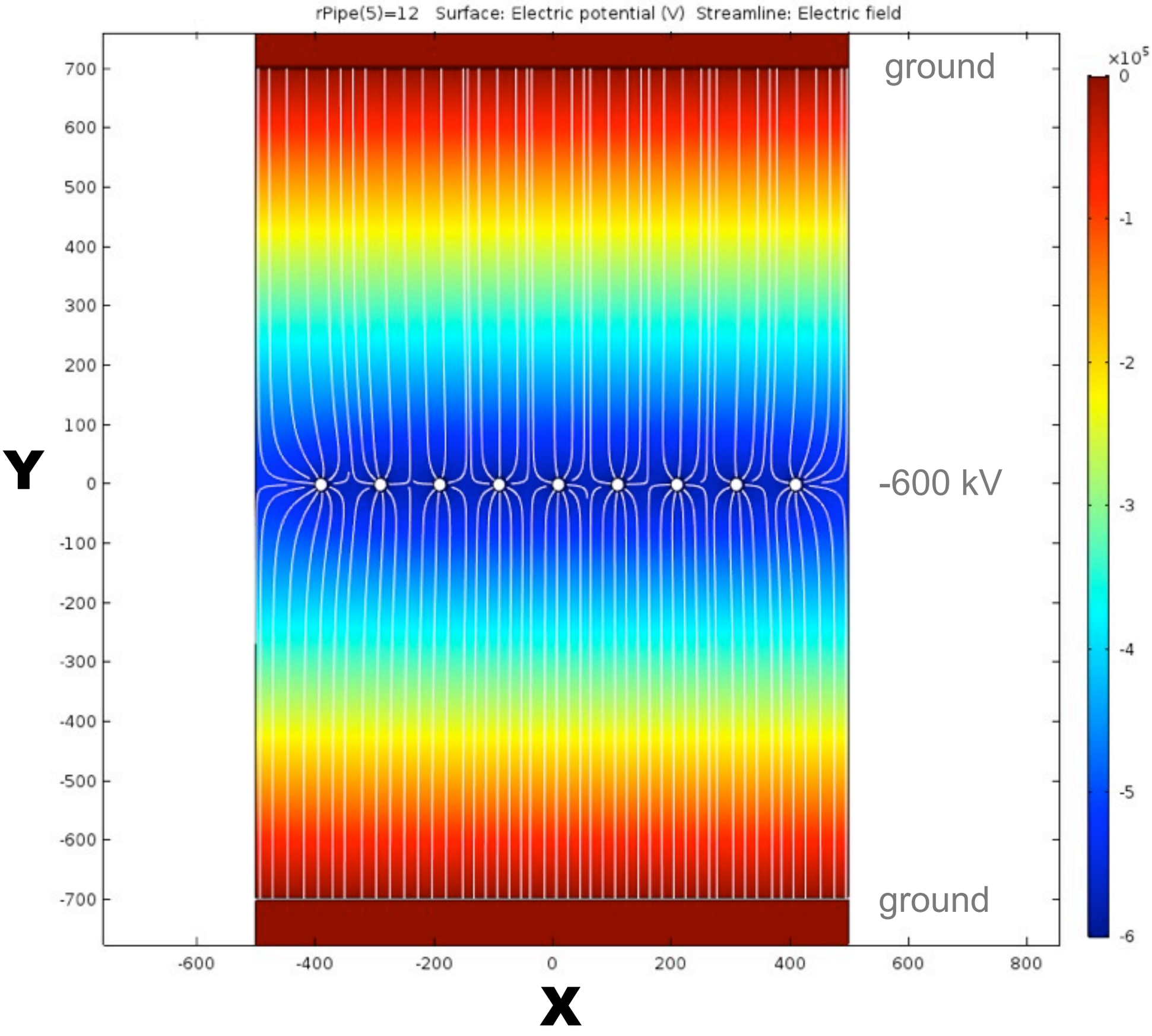
$$\varepsilon=1.5$$
$$d=10cm$$
$$L=70cm$$
$$V=-600kV$$

Results from analytical calculation

Radius [mm]	Field [kV/cm]
3	84,8
6	44,1
8	33,8
10	27,6

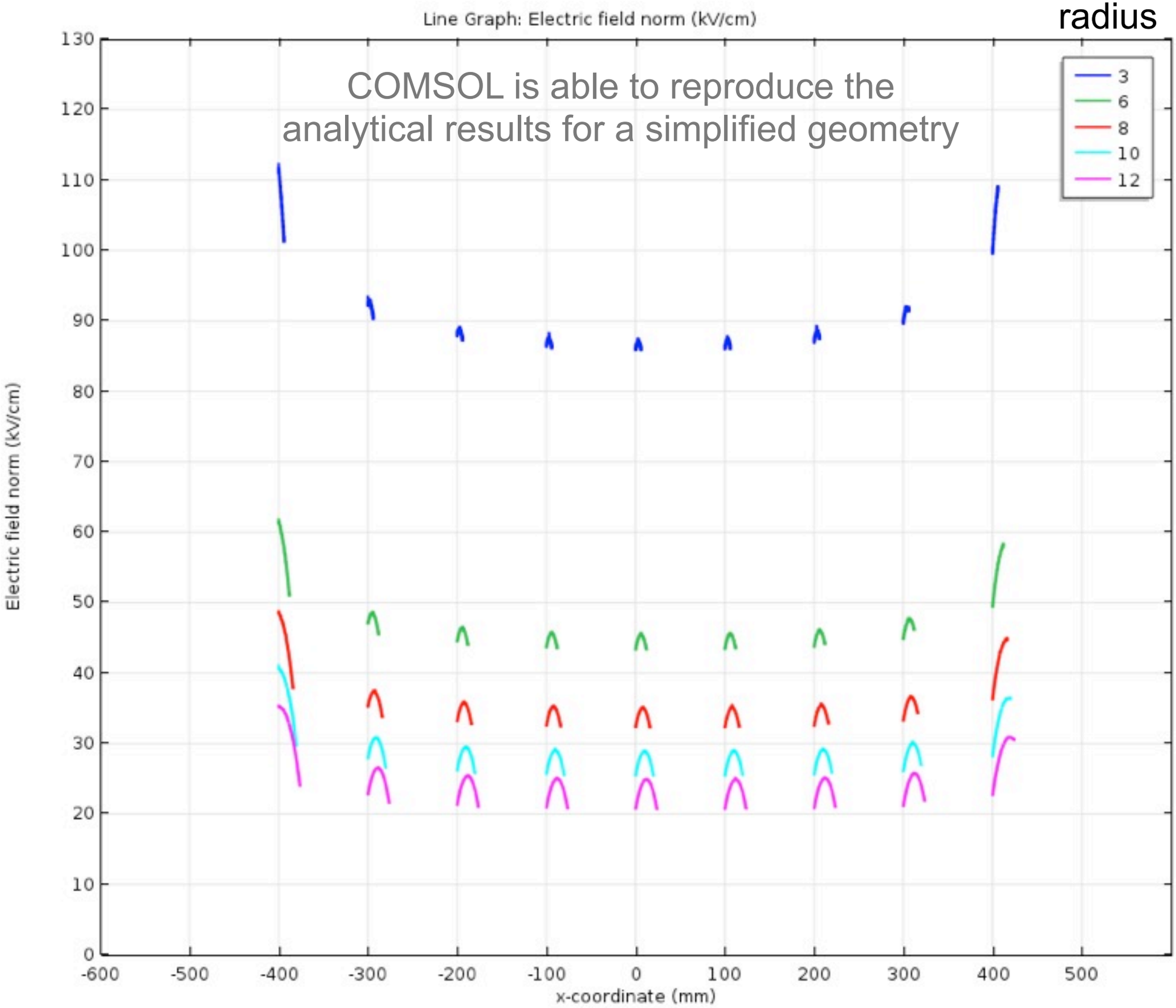
Cathode simulations

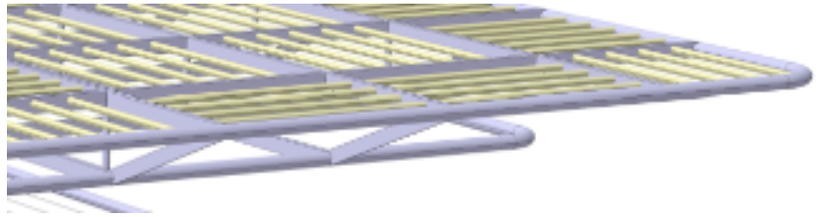
Results from COMSOL simulations



Cathode simulations

Results from COMSOL simulations

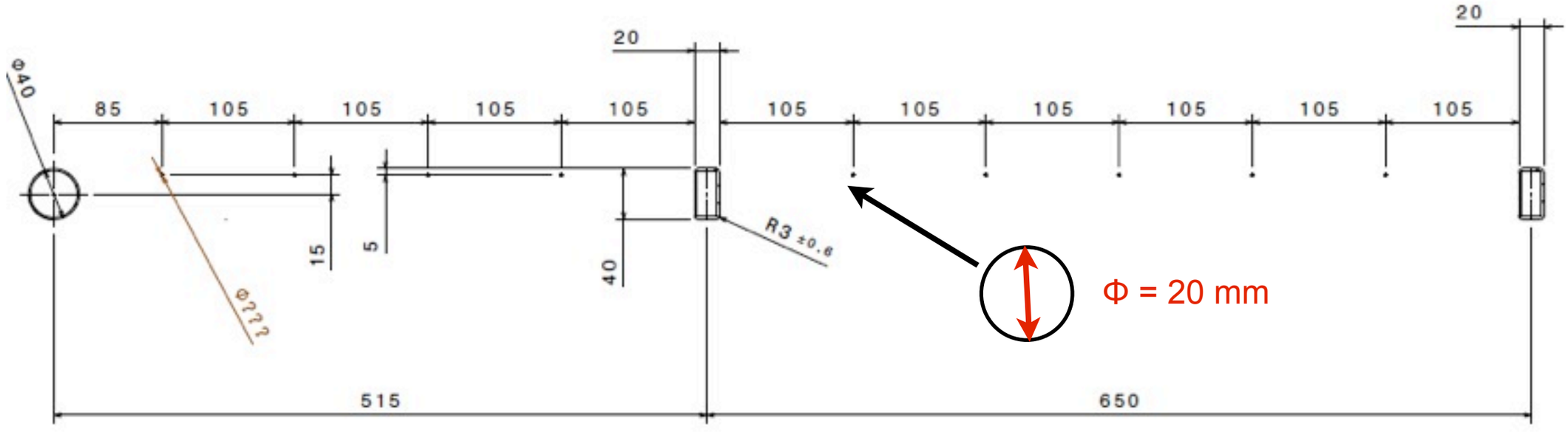


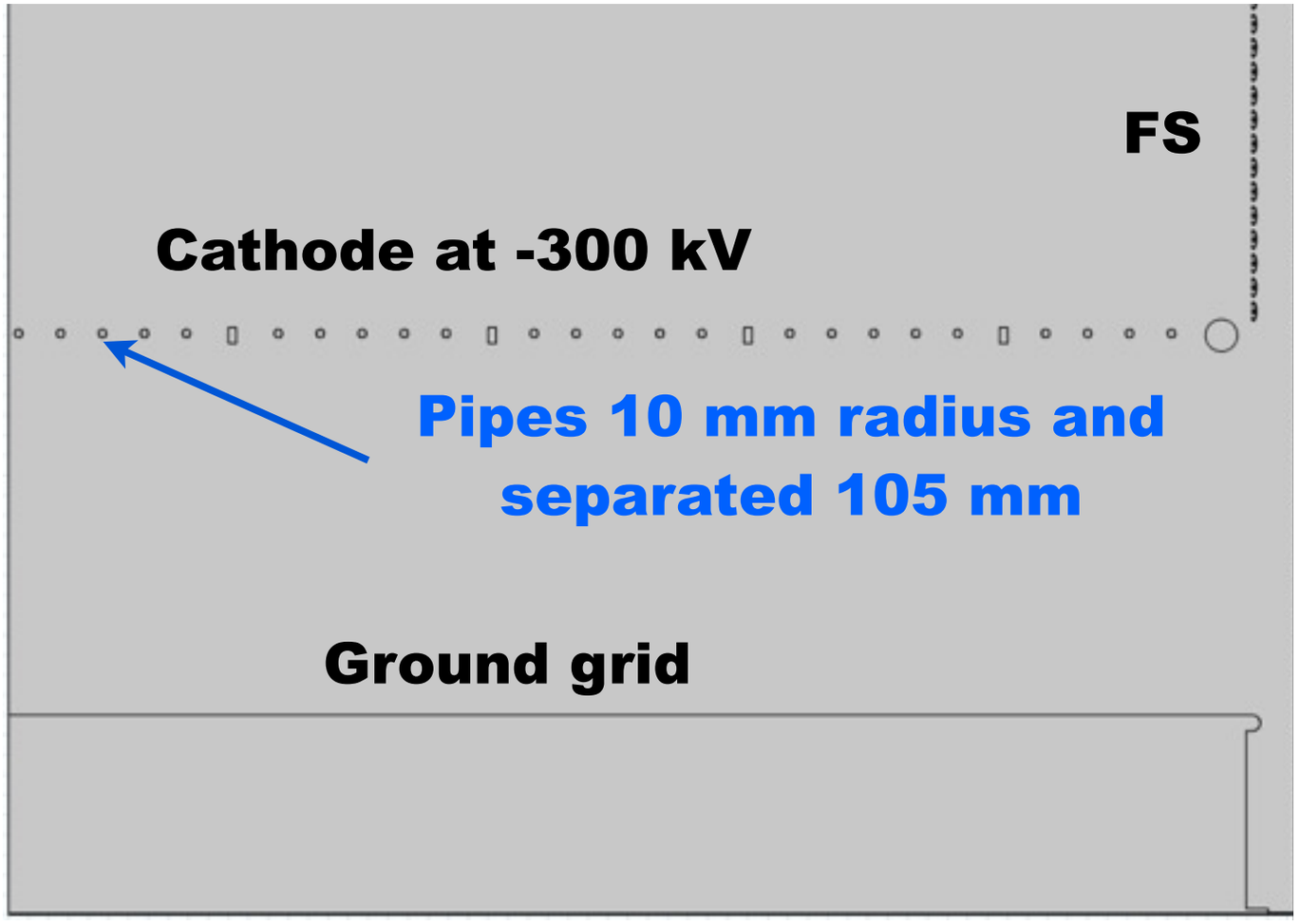


Cathode simulations

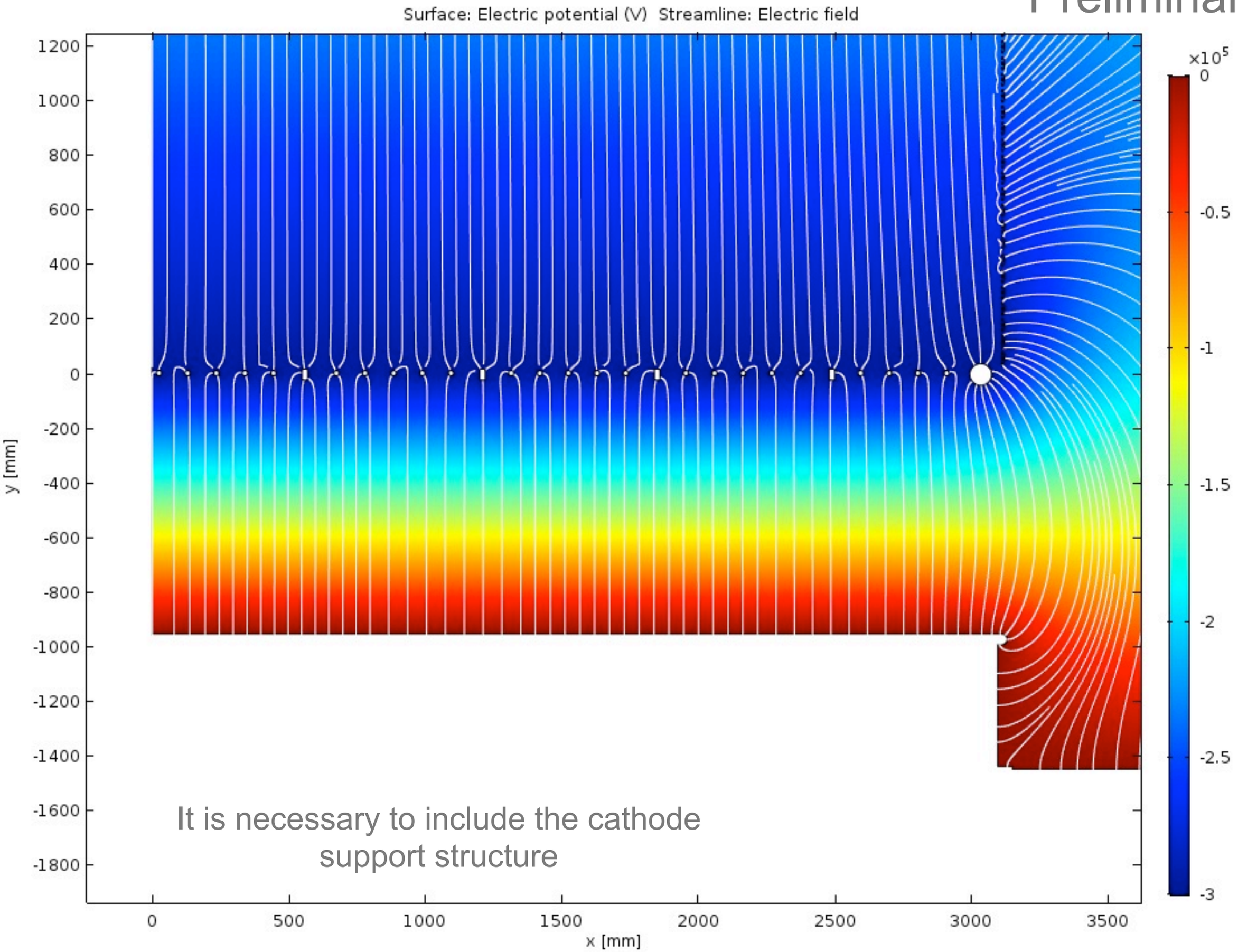
Preliminary

2D Cross-section of the corner of the cathode

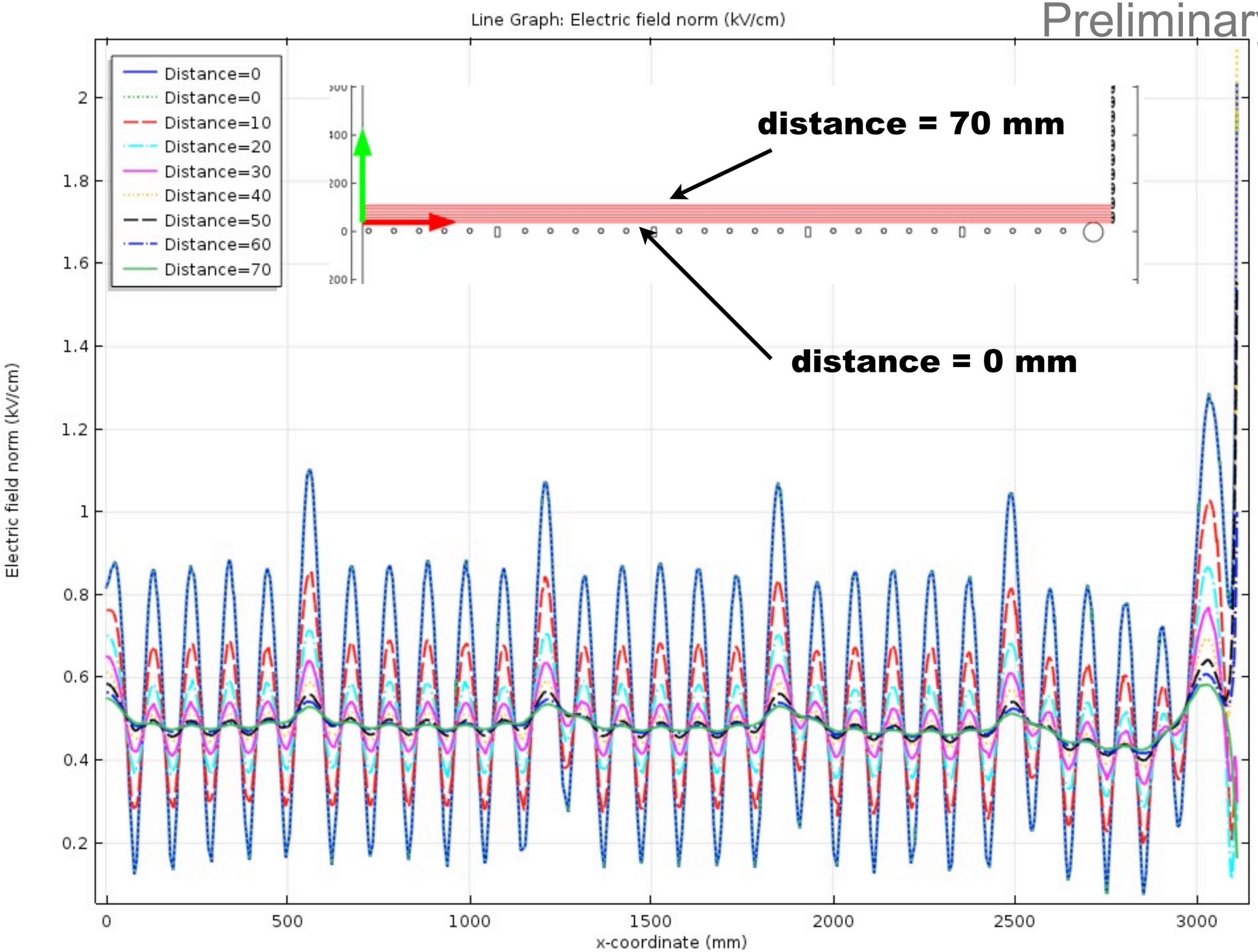




Preliminary



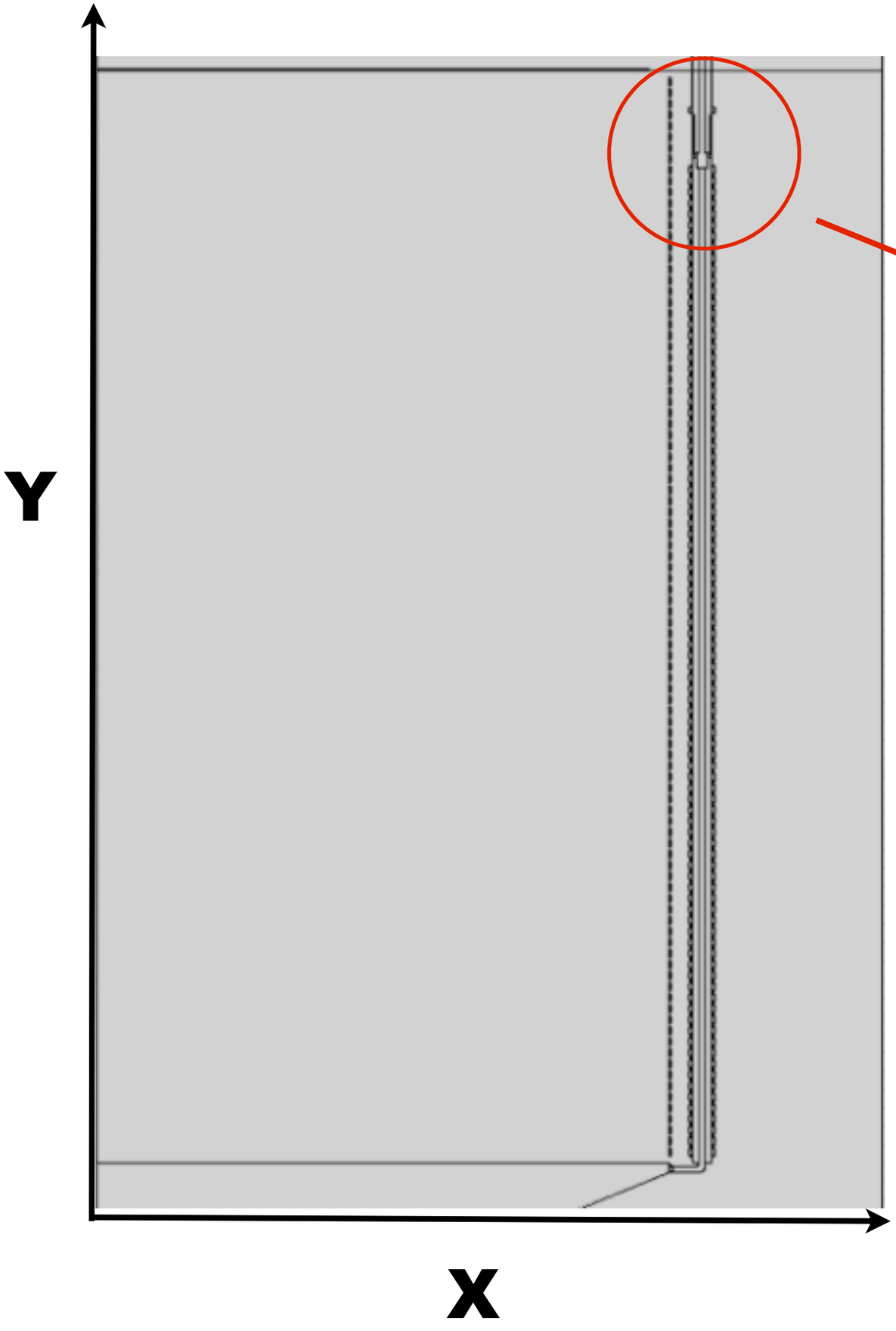
Preliminary

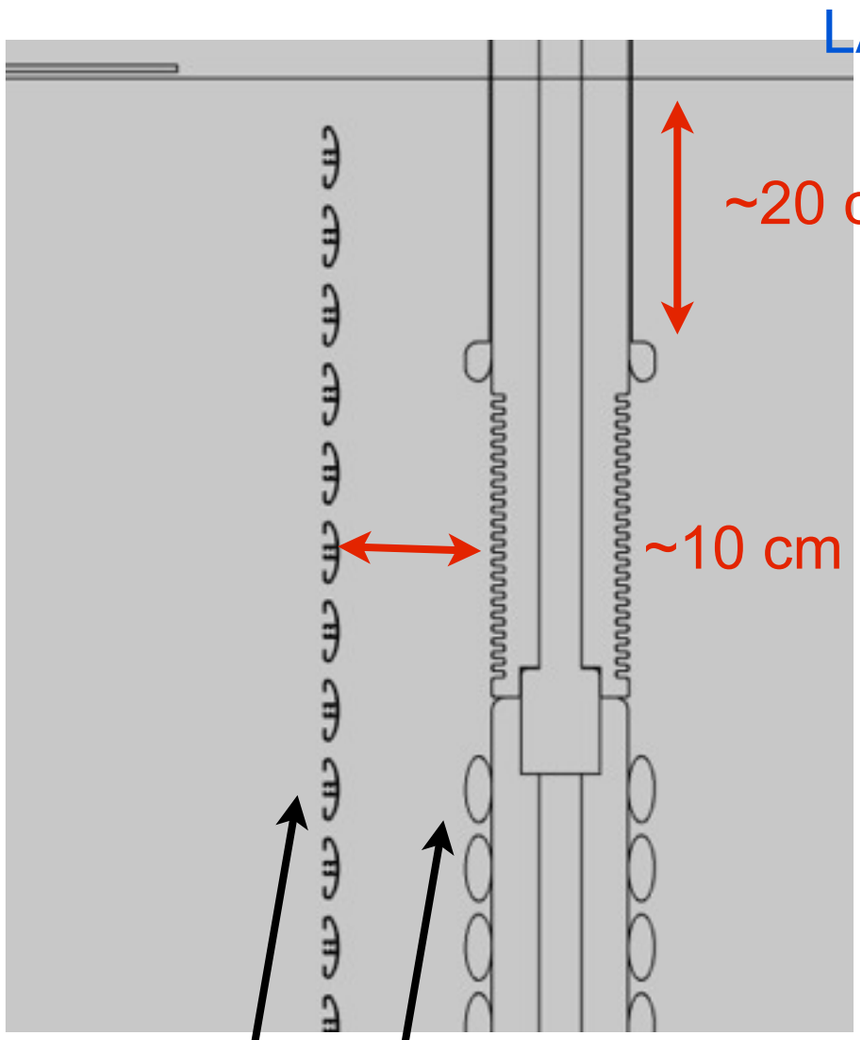


Outline

- **High voltage feedthrough(HVFT) simulations**
  - Field along the HVFT
  - Connection to the cathode

2D simulation field cage + HVFT





Degraders at the same potential as the corresponding field shaper

Surface: Electric potential (V)

[V]

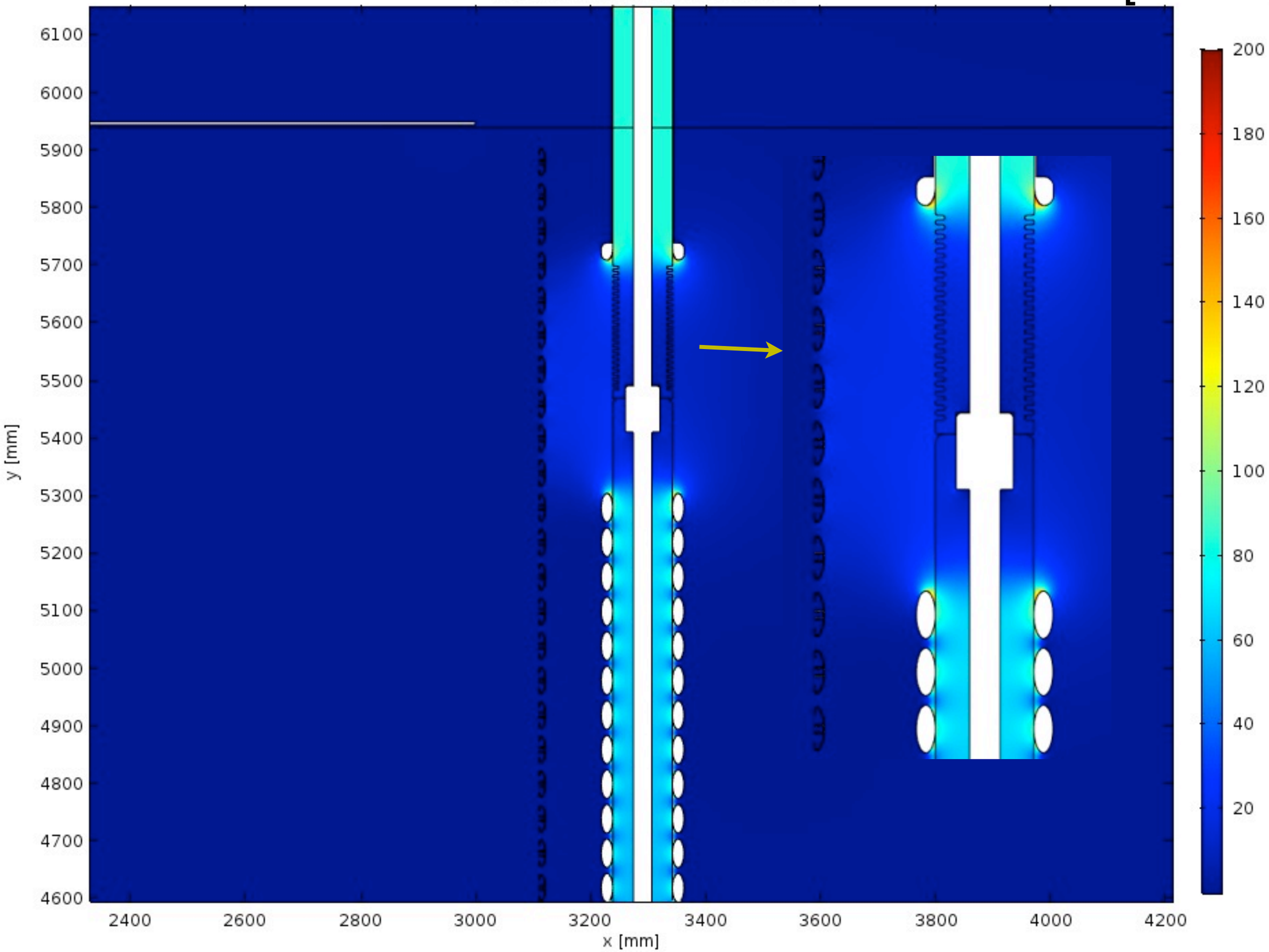
×10^5
0
-0.5
-1
-1.5
-2
-2.5
-3

y [mm]
6100
6000
5900
5800
5700
5600
5500
5400
5300
5200
5100
5000
4900
4800
4700
4600

2400
2600
2800
3000
3200
3400
3600
3800
4000
4200
x [mm]

Surface: Electric field norm (kV/cm)

[kV/cm]



Conclusions

➡**Field cage:** 2D simulations performed. In order to finalise the results the CRP-frame needs to be included.

➡**Clips:** Based on 2D simulations, the proposed clips do not represent a problem.

➡**Cathode:** Pipes with r > 8mm for field below 40 kV/cm at 600 kV. Drift field uniformity acceptable above 7 cm from the cathode.
Cathode support structure to be included in the simulations.

➡**HVFT:** Work in progress to include field shapers to avoid regions with high electric field.

➡**Work in progress:**
- finalise 2D simulations
- Attempt to get 3D simulations of part of the field cage