LEM Field simulations

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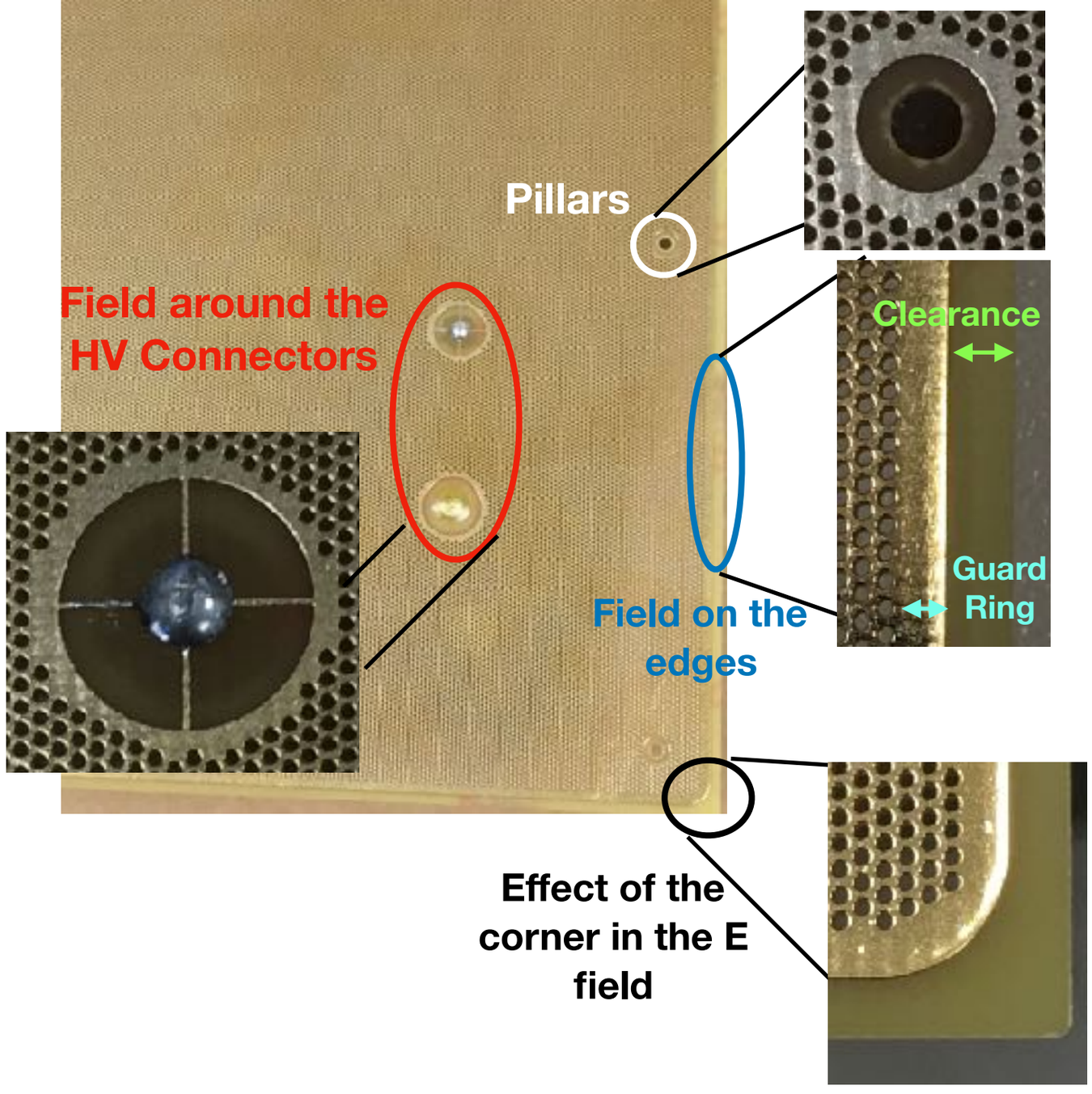


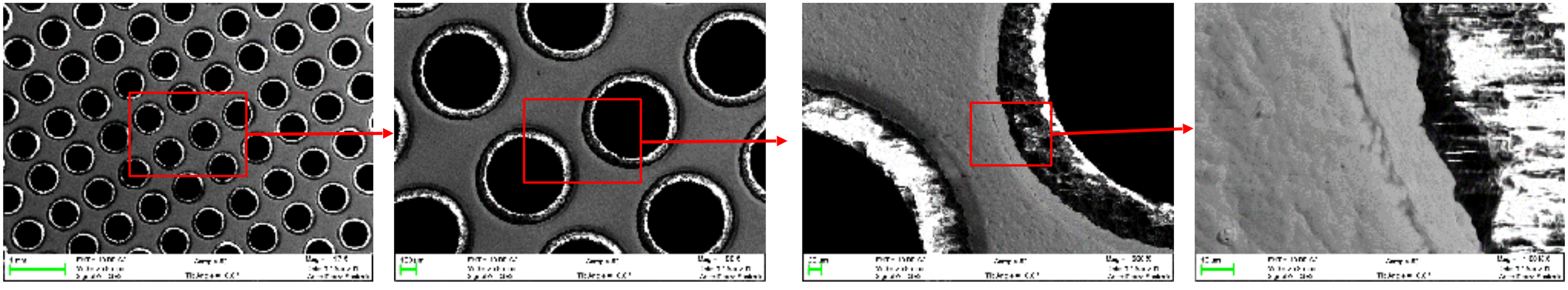
GOAL

- **LEM electrostatic simulation:** identify the most potentially sensitive areas and understand the effect of the different design parameters on the electric field configuration.

- In this first attempt, we have studied the impact on electric field configuration of the variation of the **Guard Ring (GR)** and **the Clearance (Cl).**

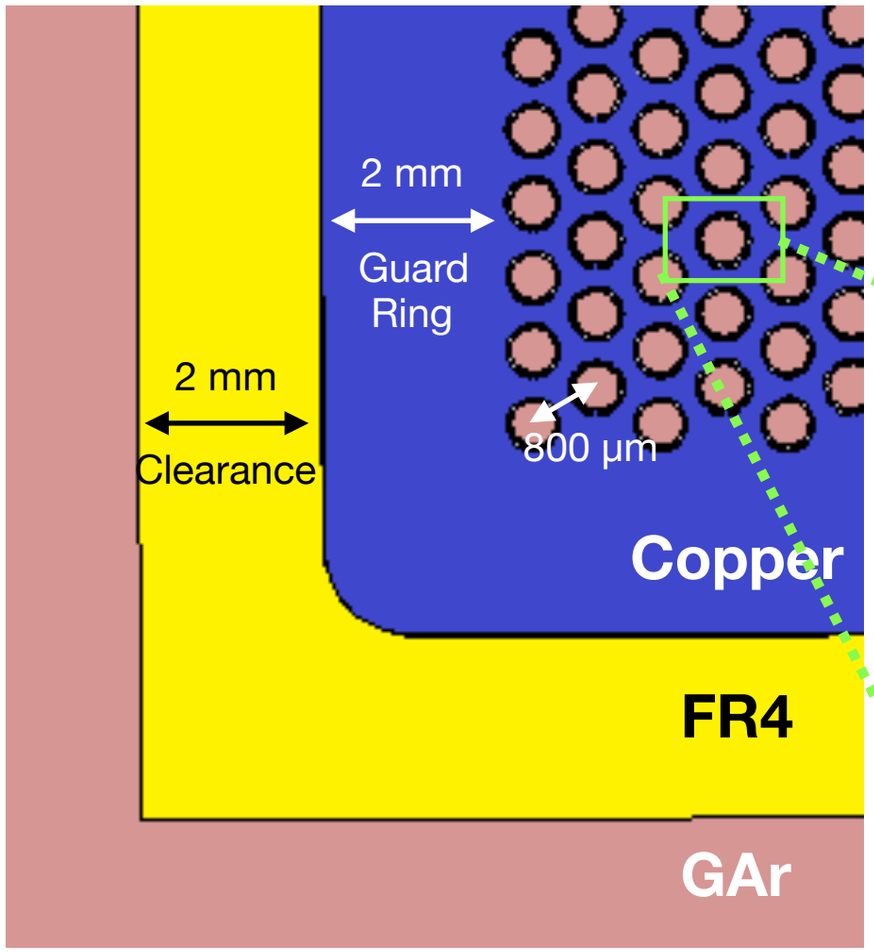
- **Next steps:** Simulations of the HV connectors and the pillars

SEM Images

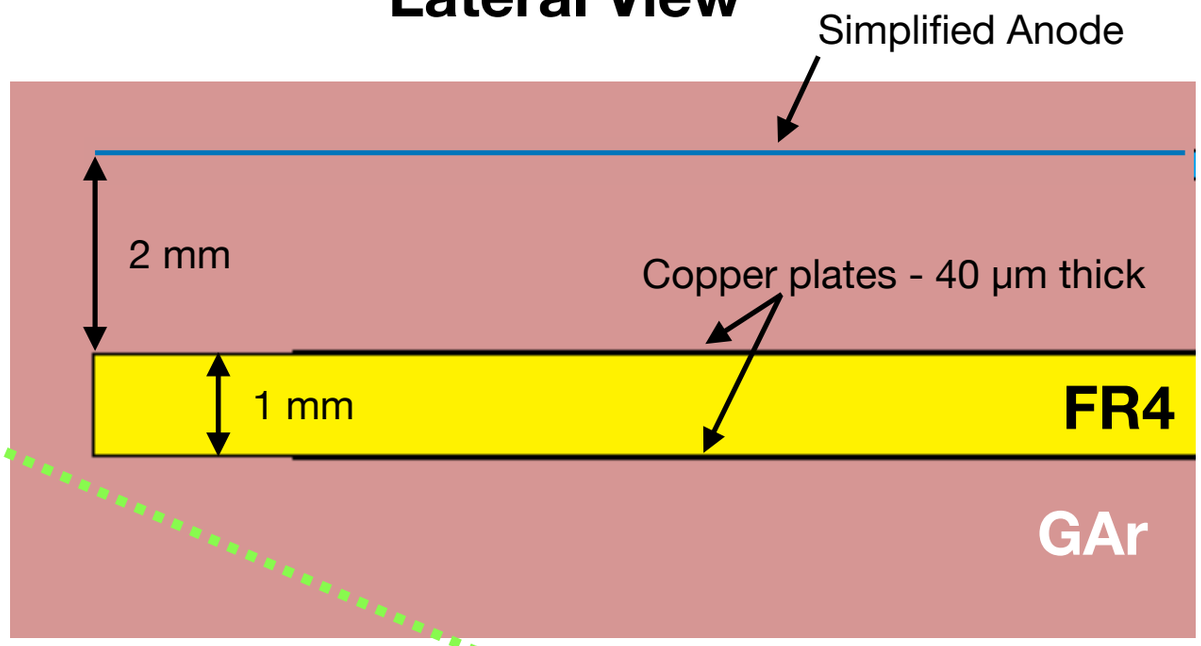


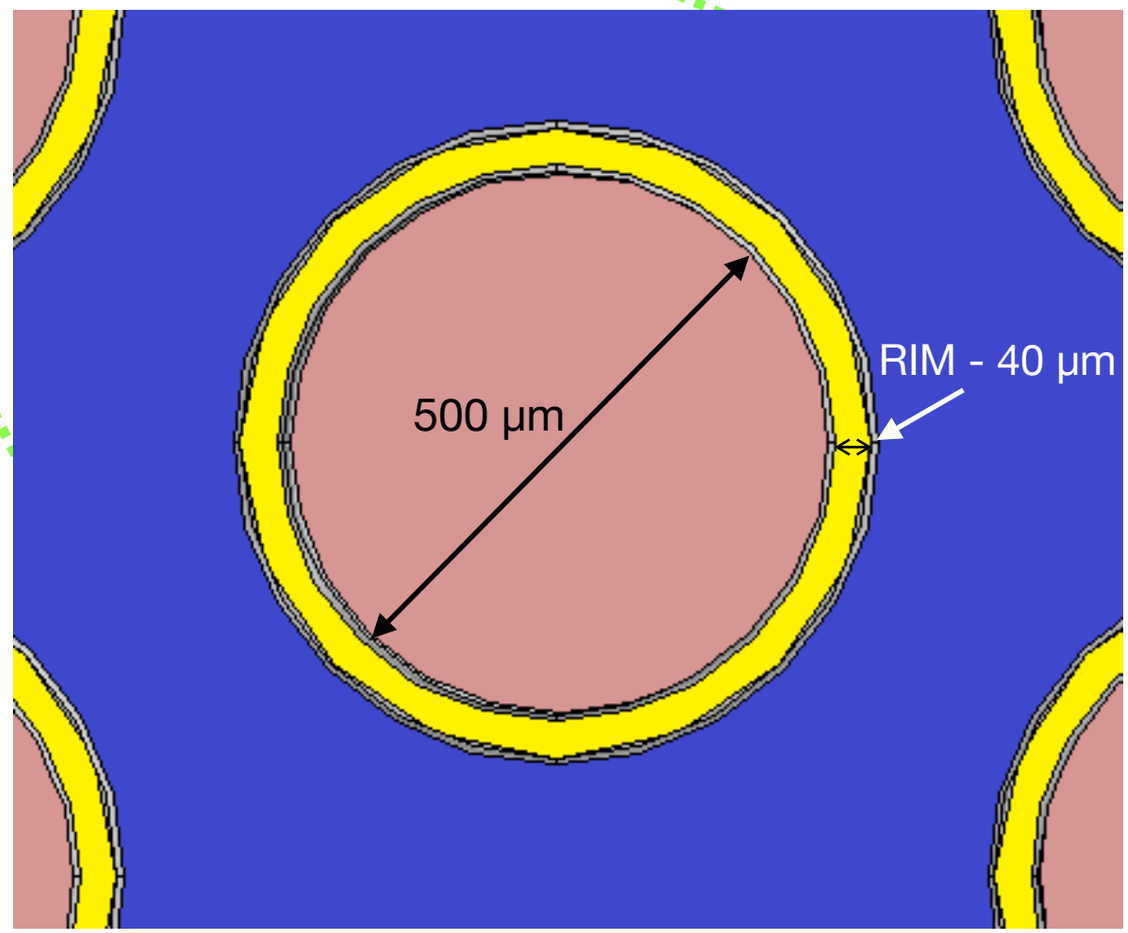
Geometry of the LEMs

Top View



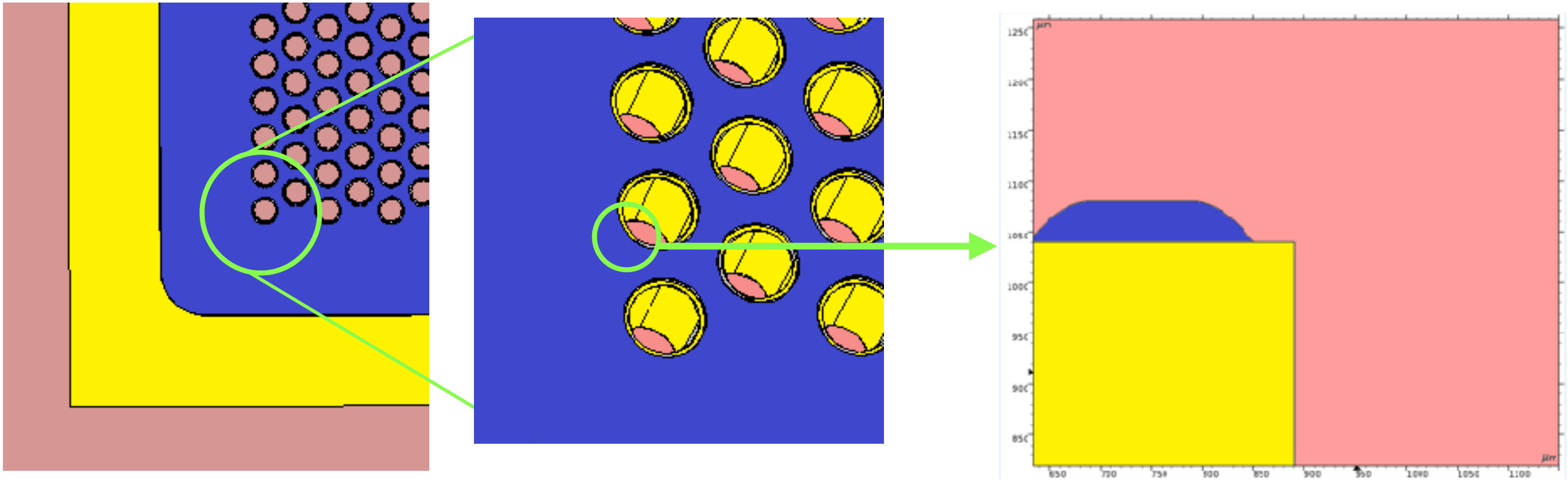
Lateral View



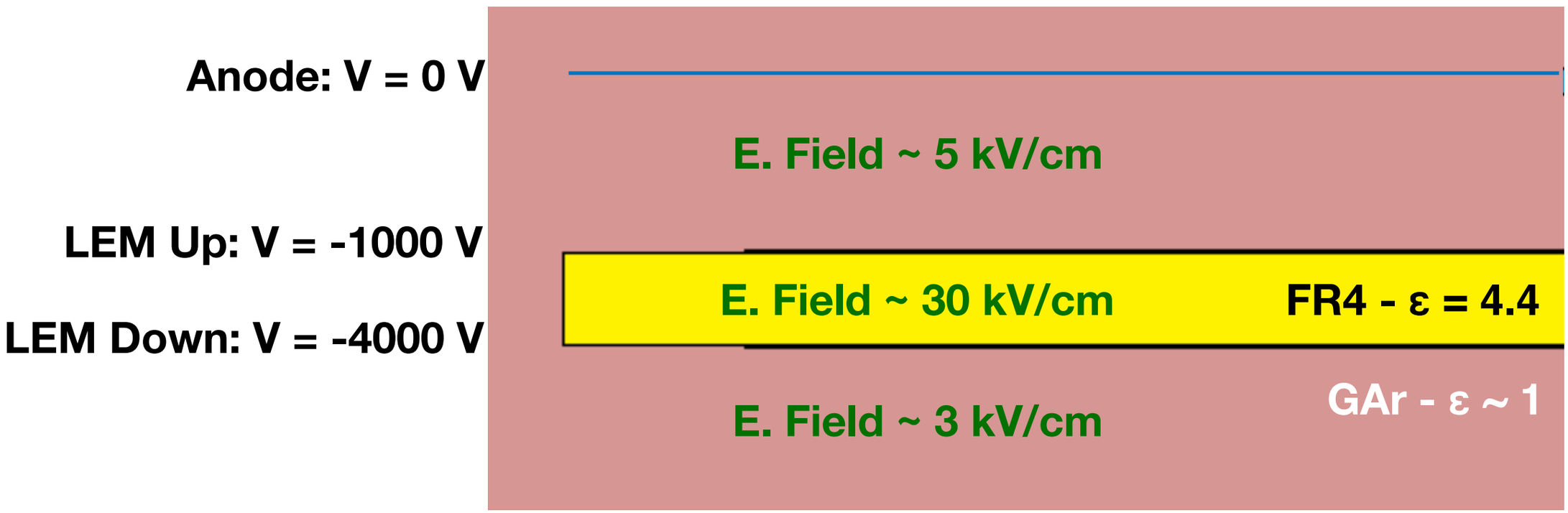


- We included a simplified model of the anode: a copper ground plane with no thickness.
- The holes are arranged as a honeycomb with 0.8 mm pitch.
- The diameter of the holes is 0.5 mm in FR4 40 µm rim.
- To avoid sharp edges that can lead to singular points, the border of all the holes have been rounded

Geometric model - Rim



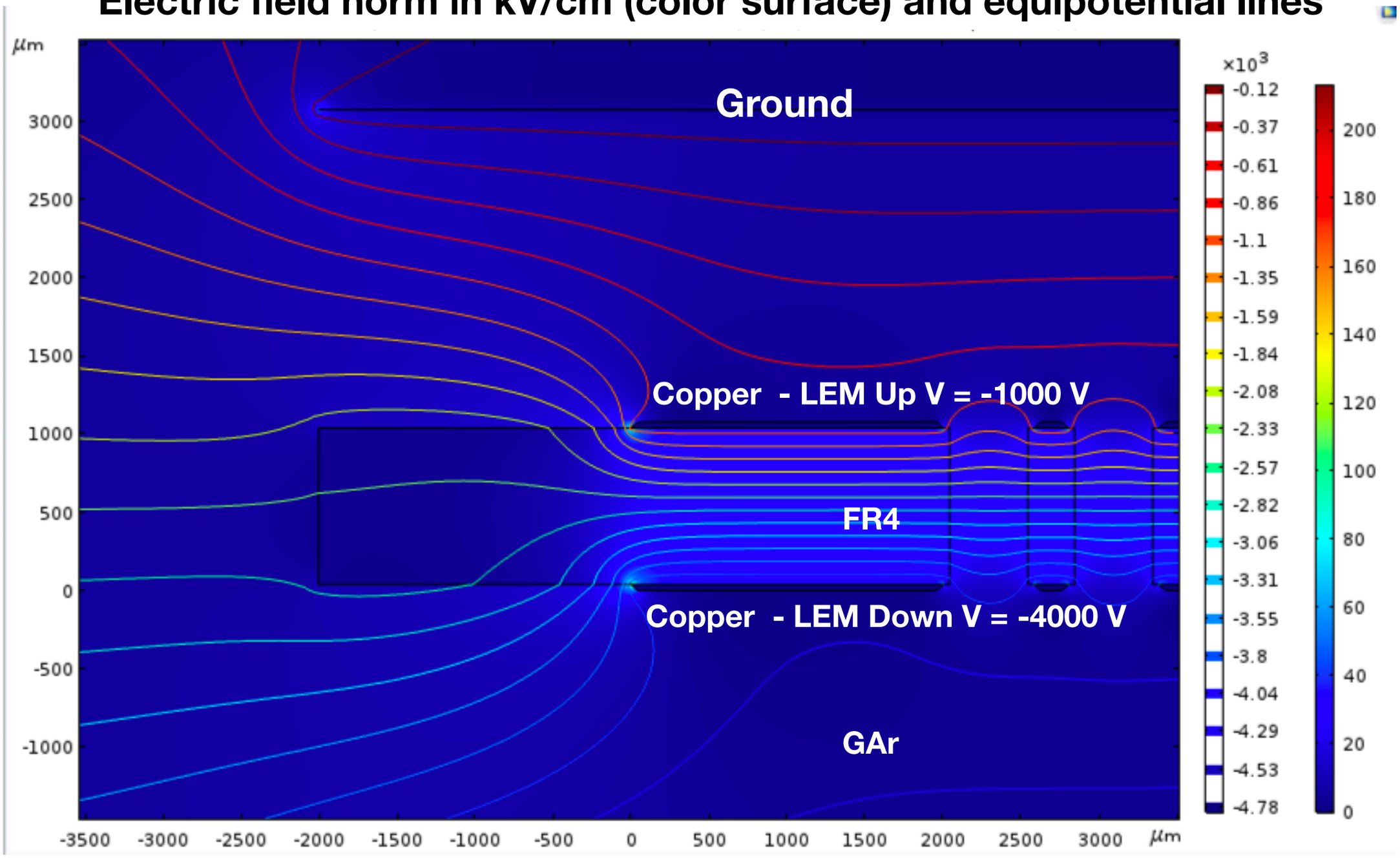
Settings for the simulation



Current LEM design

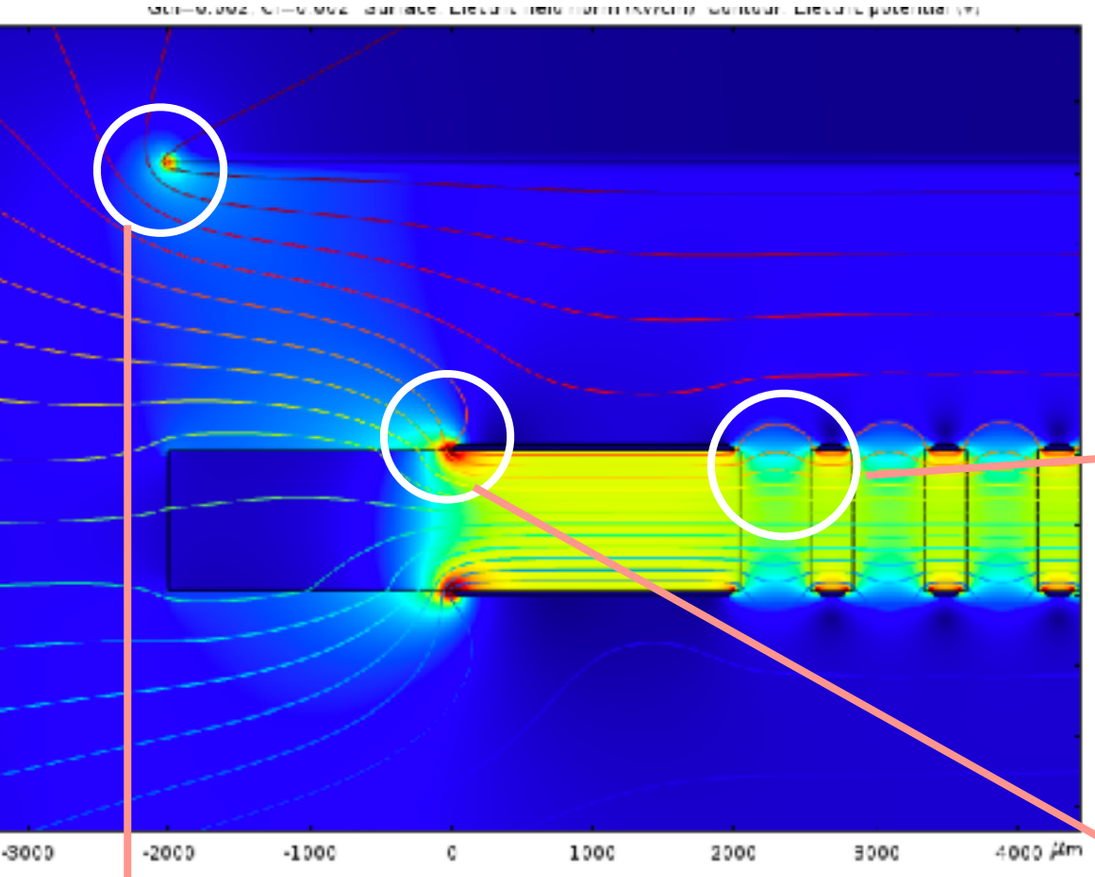
GR = 2 mm & Cl = 2 mm

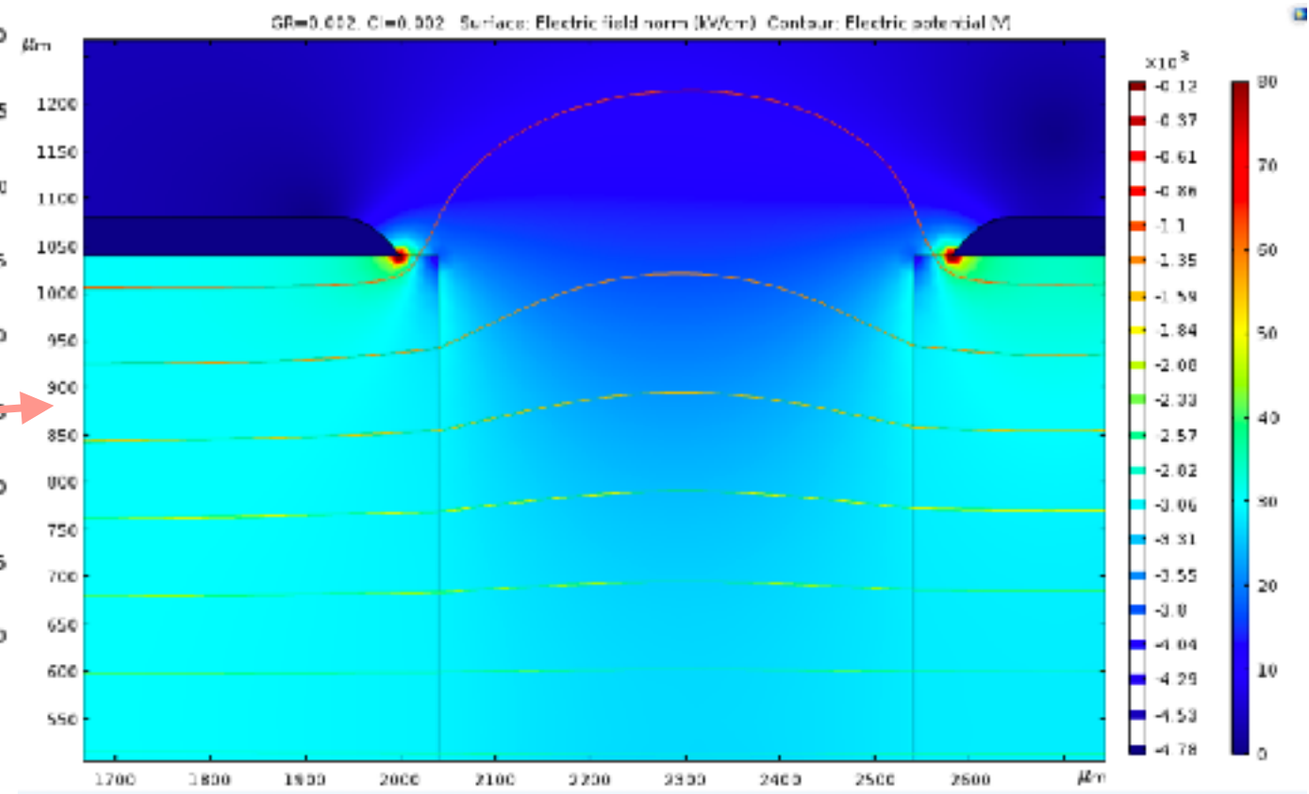
Electric field norm in kV/cm (color surface) and equipotential lines

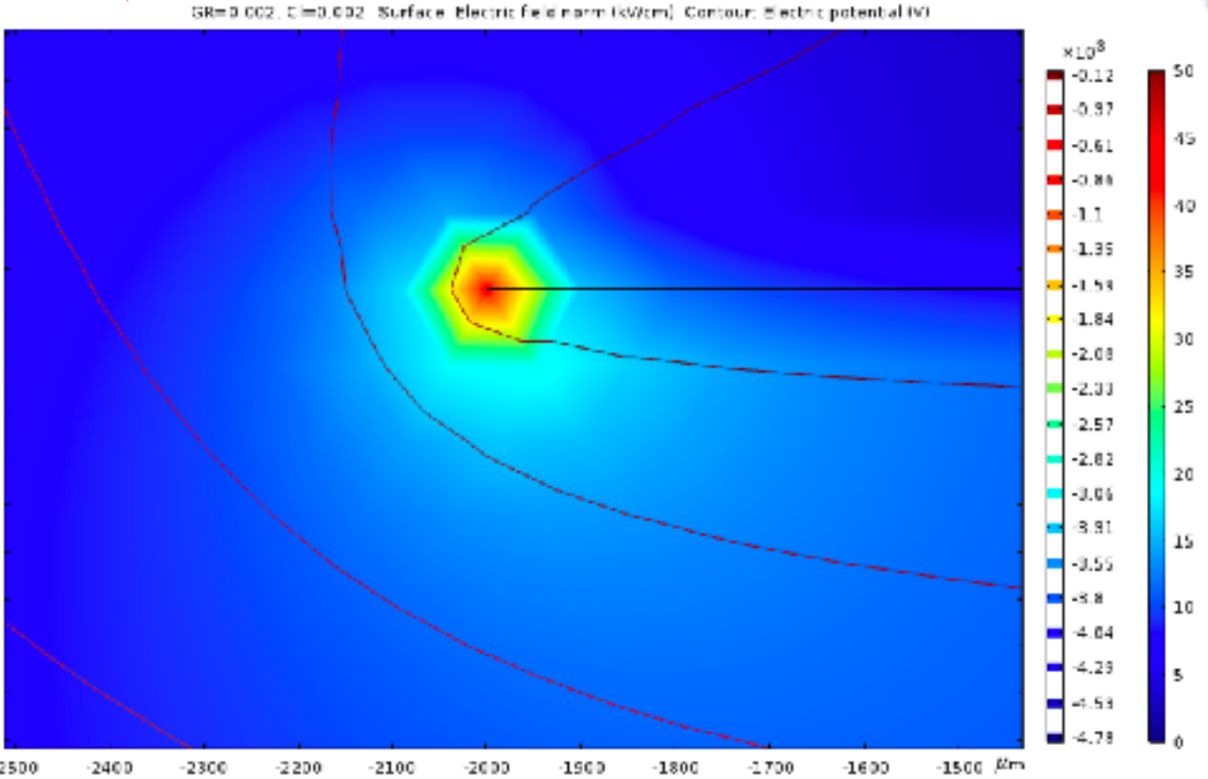


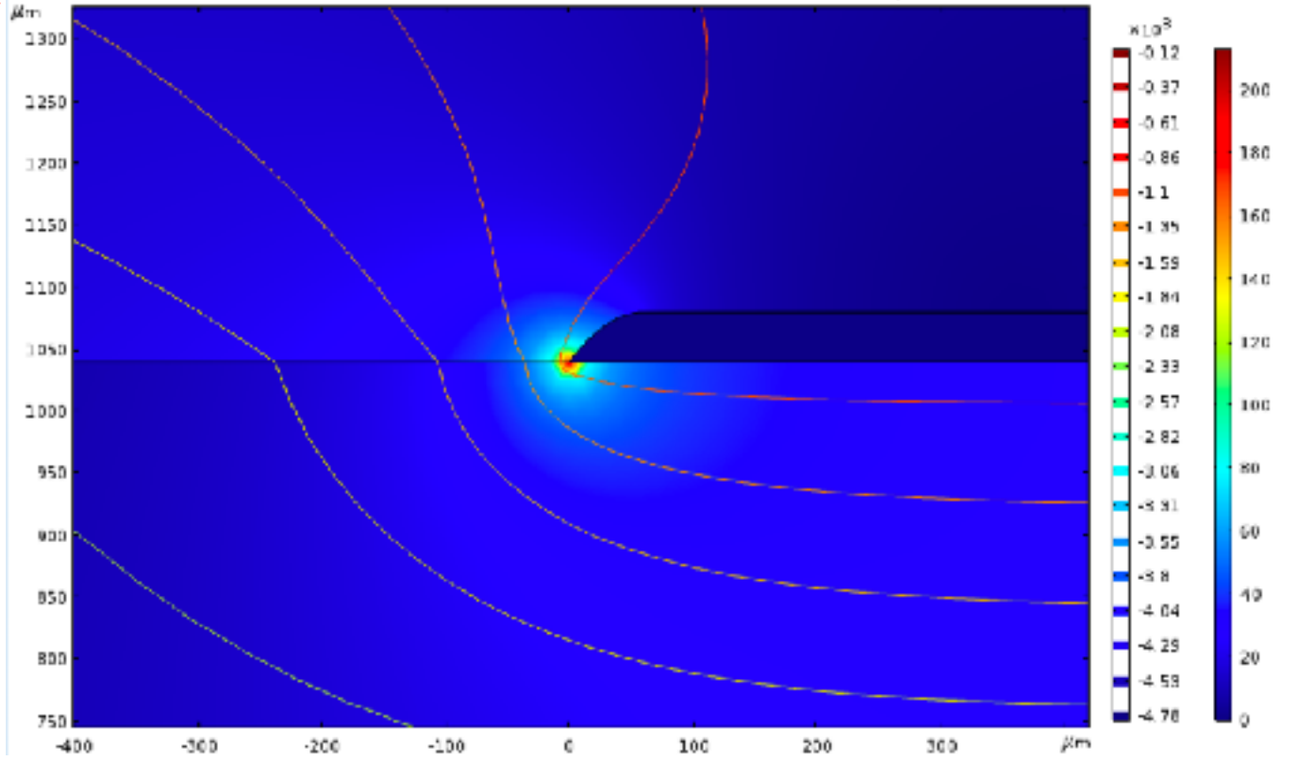
Current LEM design

GR = 2 mm & Cl = 2 mm

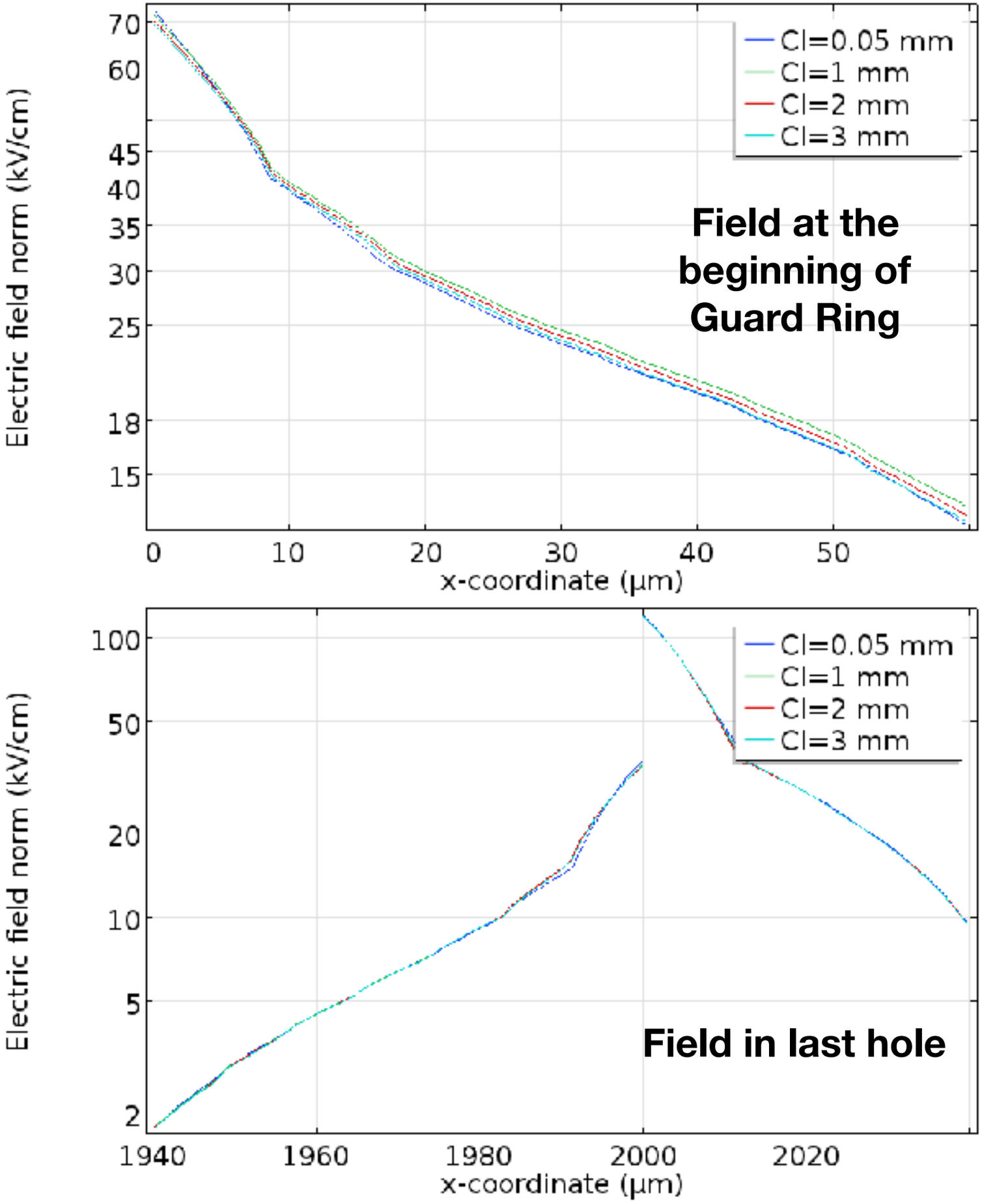


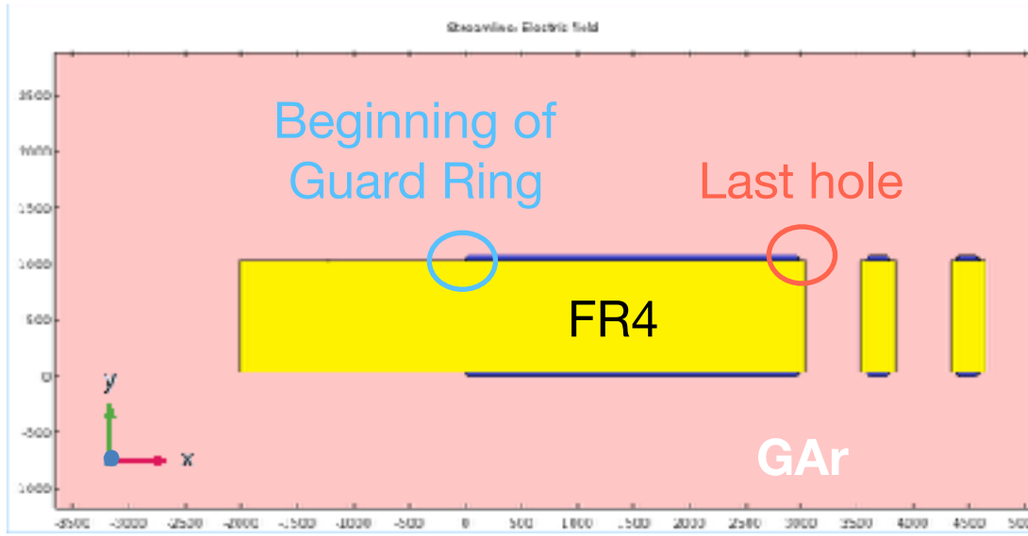






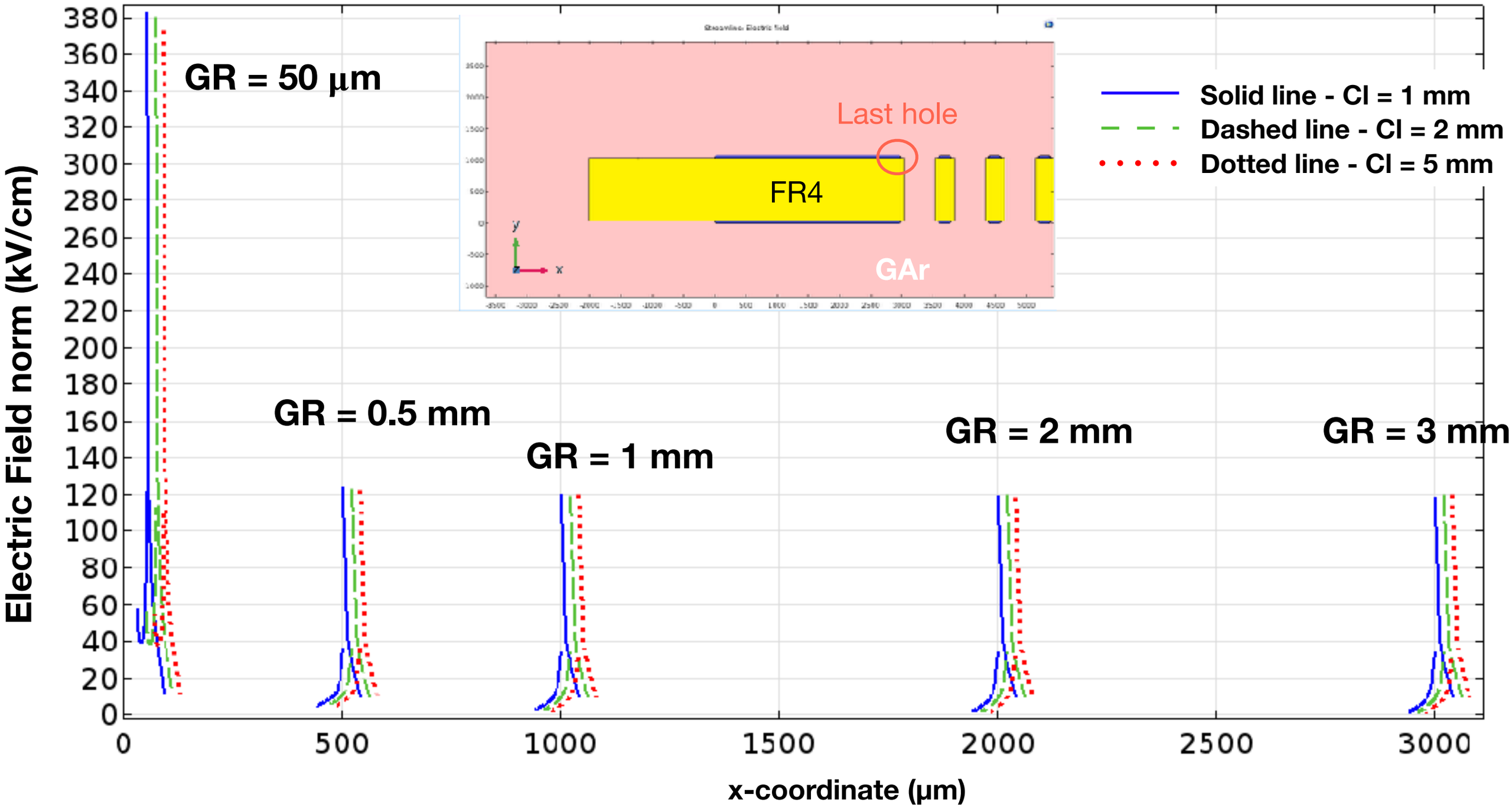
Effect of the Clearance





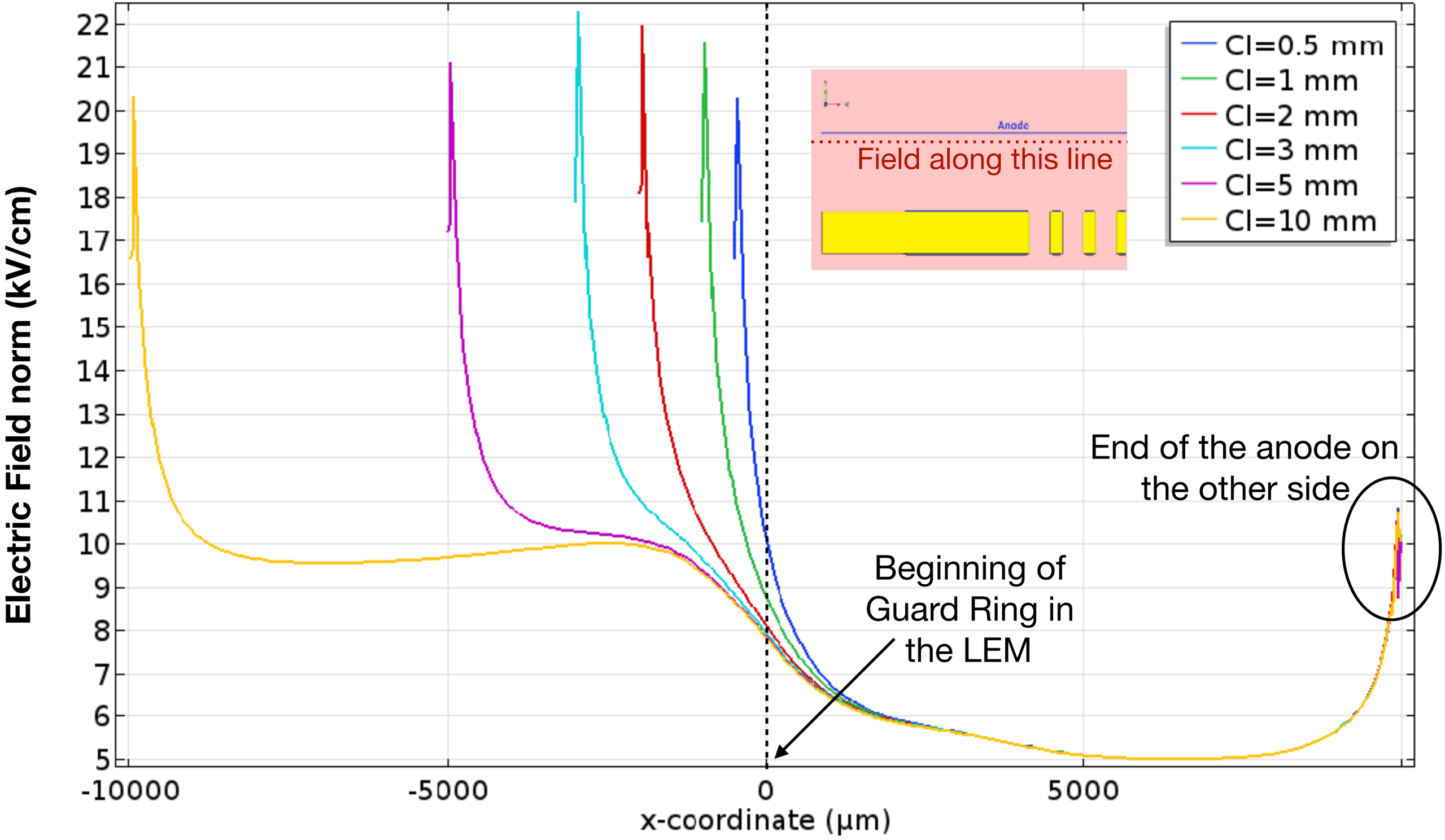
- We compute the field on the surface of the copper plate of the LEM in the two regions drawn above.
- We fix the Guard Ring at 2 mm and compare the field for different values of the Clearance.
- Same behavior in both regions for all values of Cl.

Effect of the Guard Ring in Last Hole



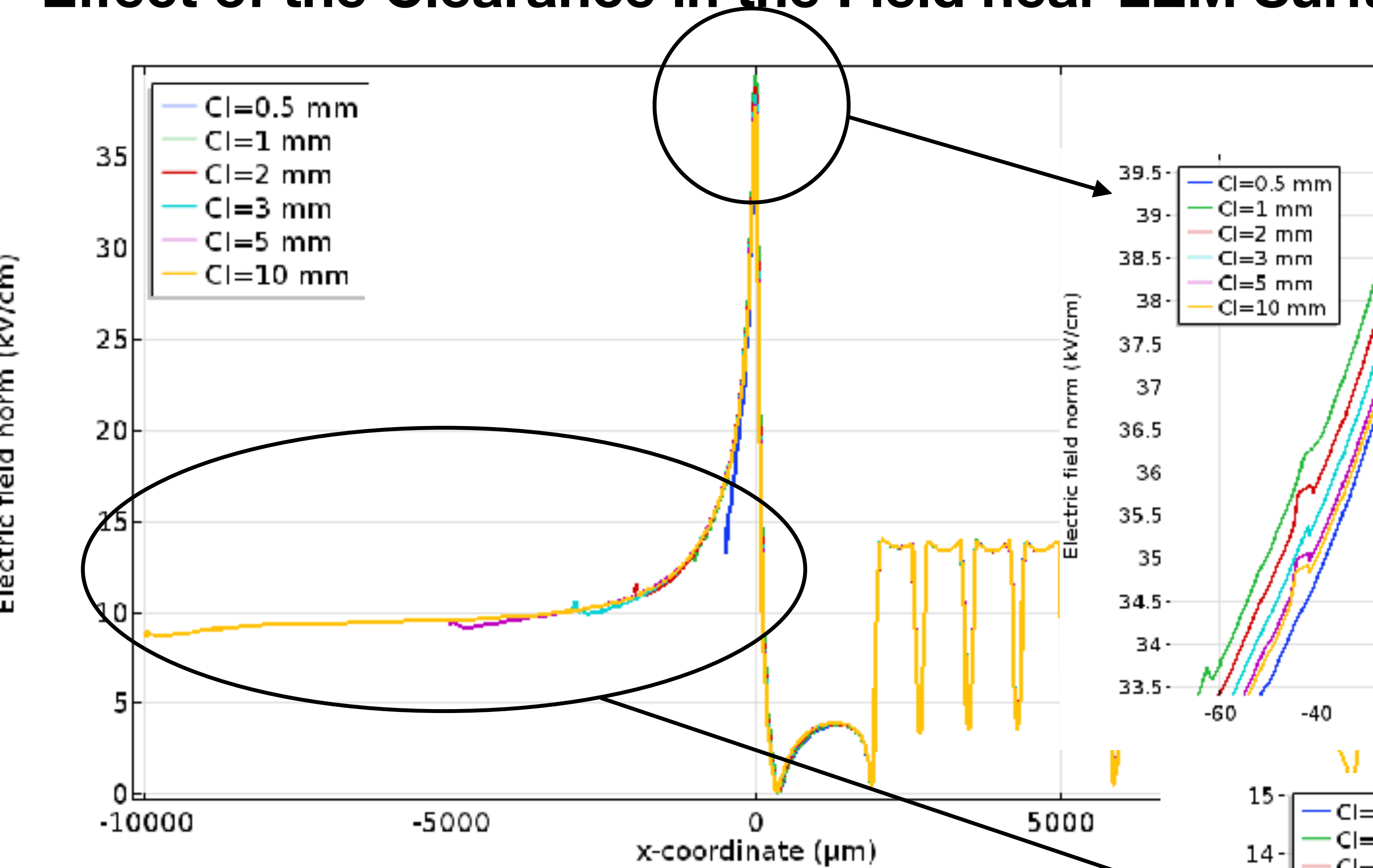
- The field in the last hole decreases as we increase the GR for values GR < 1 mm.
- Above 1 mm the field in this region does not change with the GR for Clearance above 2 mm.
- For Cl < 2 mm the field shows a slight decrease from GR = 2 mm to GR = 3 mm.

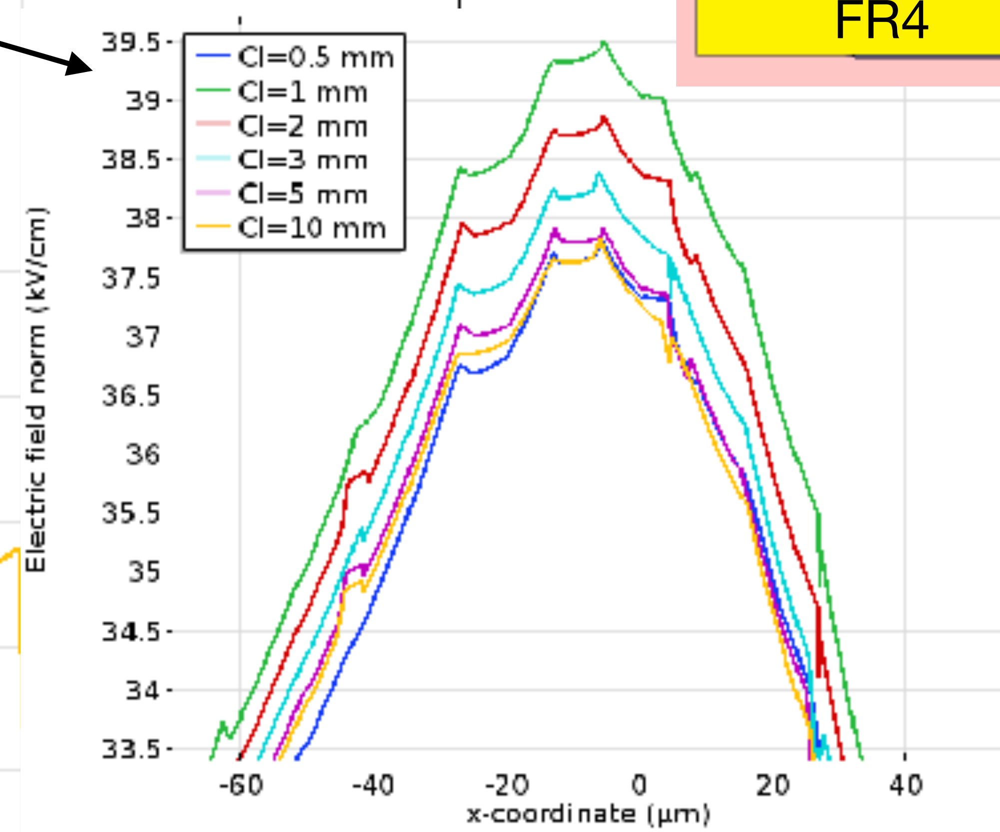
Effect of the Clearance in the Field near Anode Surface

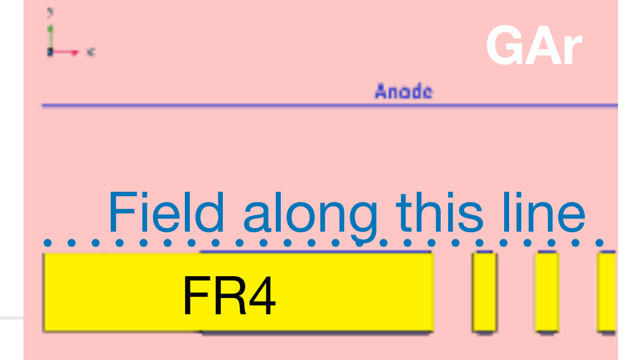


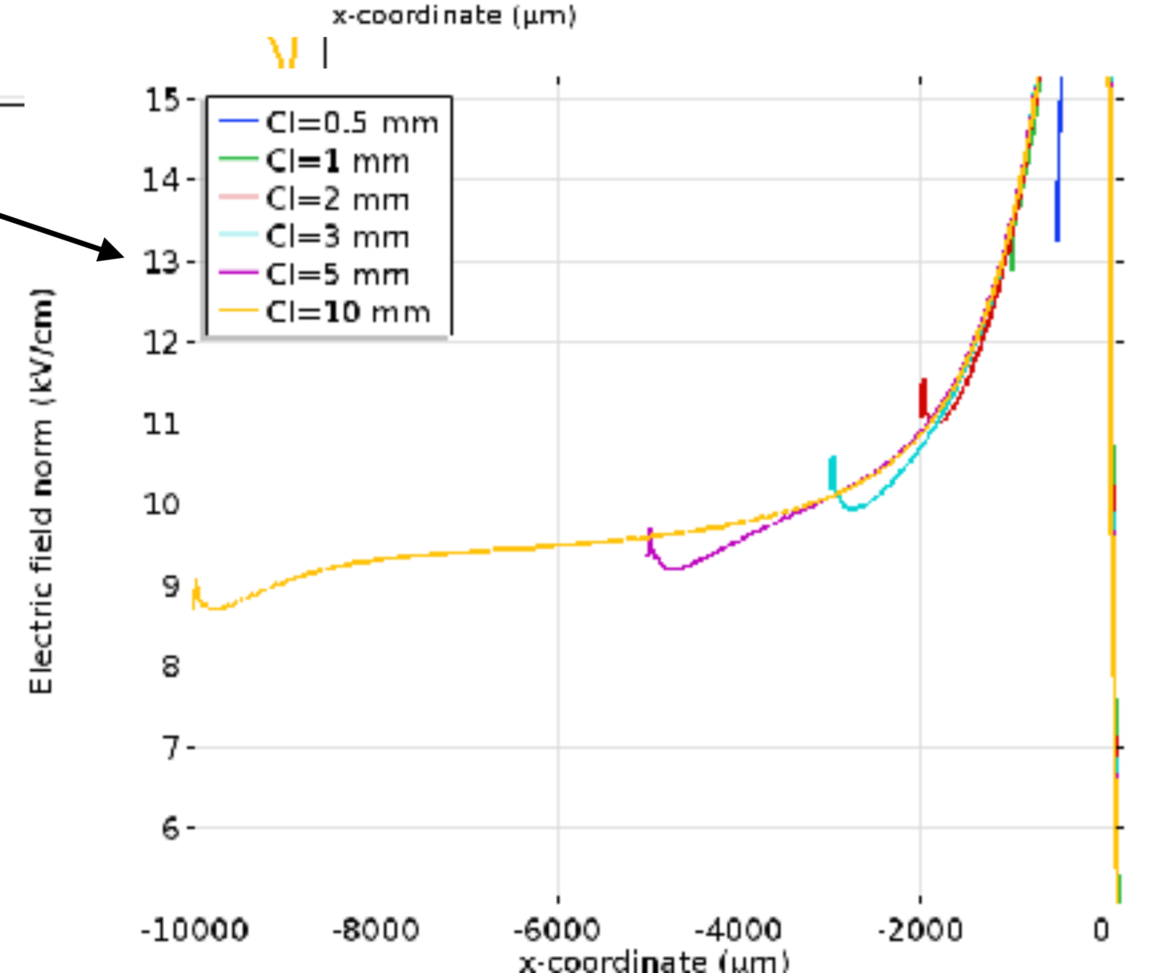
- For clearance up to 3 mm, the maximum field increases when we increase the Clearance. For values above 3 mm the maximum field decreases with Cl, but a constant field of ~10 kV/cm appears in the region between FR4 and anode.

Effect of the Clearance in the Field near LEM Surface









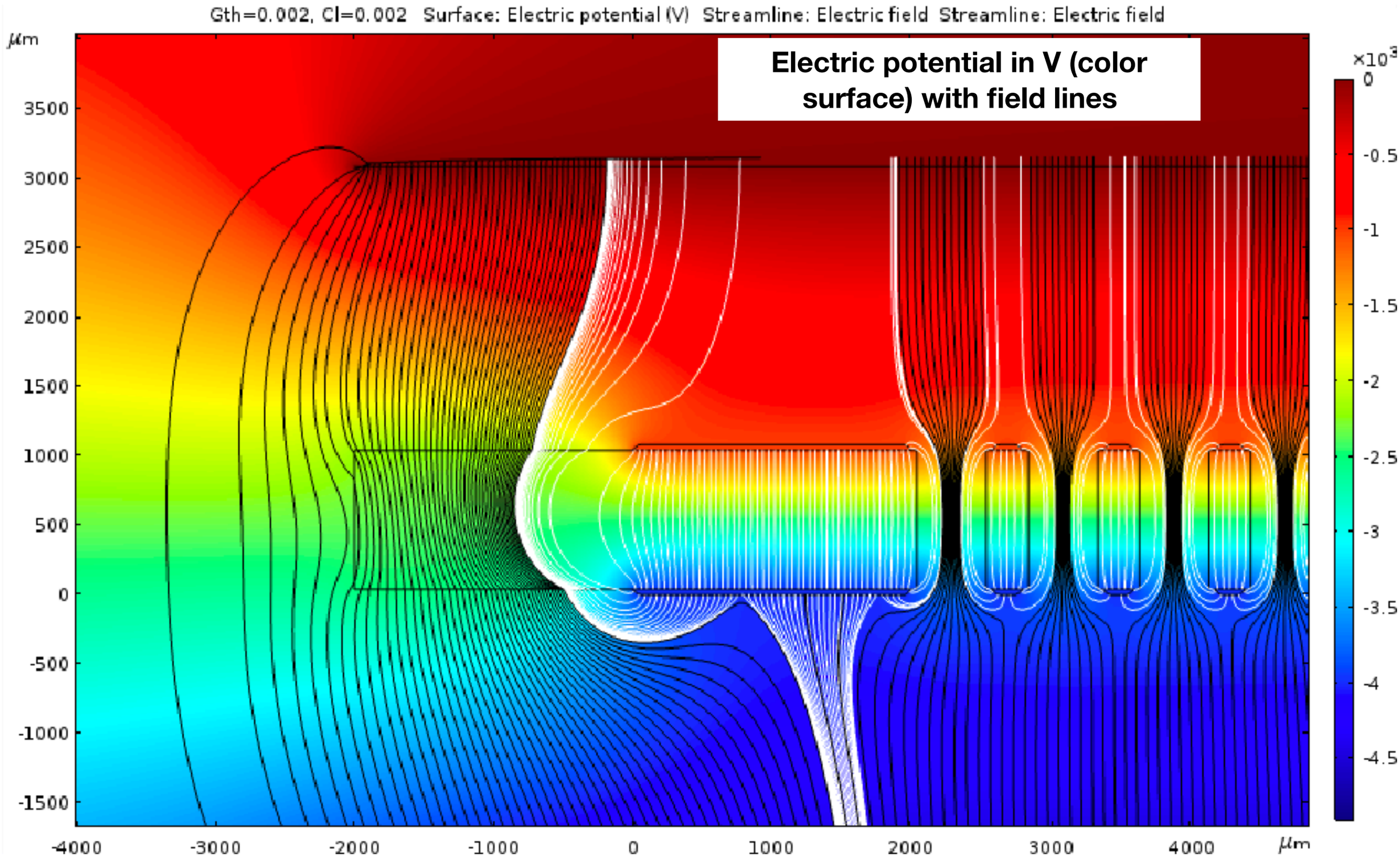
- High field at the beginning of Guard Ring (x=0)
- For Cl > 1 mm, the maximum value reached in this point decreases with the Clearance.
- As the clearance increased, the maximum field reached at the end of the FR4 decreases.
- The larger the Clearance, the bigger the region with constant electric field.

Conclusions

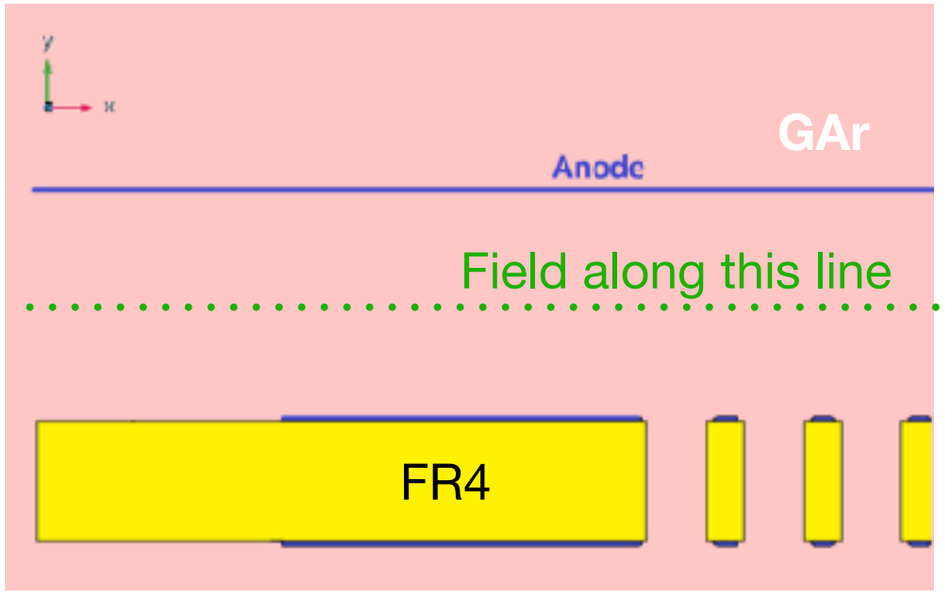
- The Clearance barely affects the field in the beginning of the Guard Ring or the Last Hole.
- For Clearance above 1 mm, the field in the Last Hole reaches its minimum value with Guard Ring of 1 mm, and stays the same for higher values of GR.
- A guard ring above 1mm guarantees the minimum electric field on the last hole and on the end of the guard ring

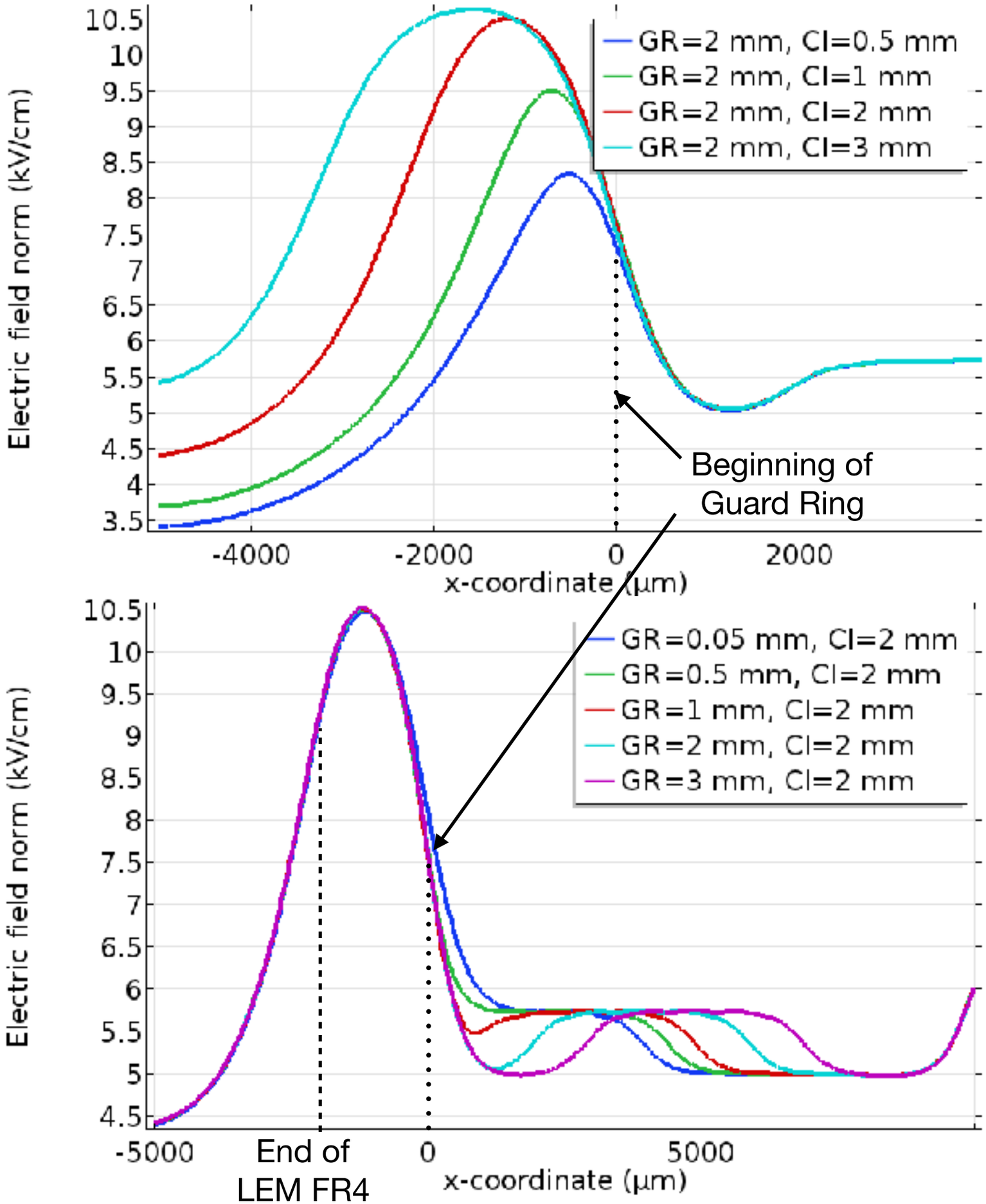
BACK UP

Current design - GR = 2 mm & CI = 2 mm



Field between LEM and Anode





- We compute the electric field norm along a horizontal line between LEM and Anode.
- We both study the effect of the Cl with fixed GR (above) and the effect of the GR with fixed Cl (below).
- For different values of GR the field exhibits the exact same behavior.
- As we increase the Cl, the field between the insulator and the anode is also increased.

Effect of the Guard Ring in the beginning of the Guard Ring