



Politecnico  
di Bari



# E field simulation status

Lorenzo Magaletti for WG2



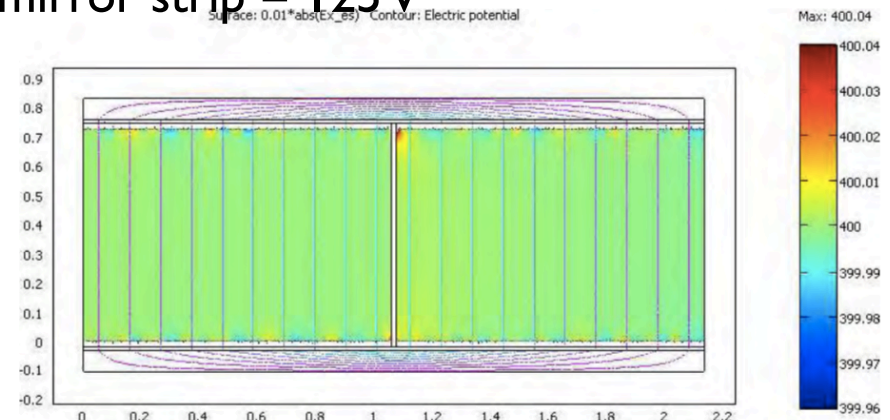
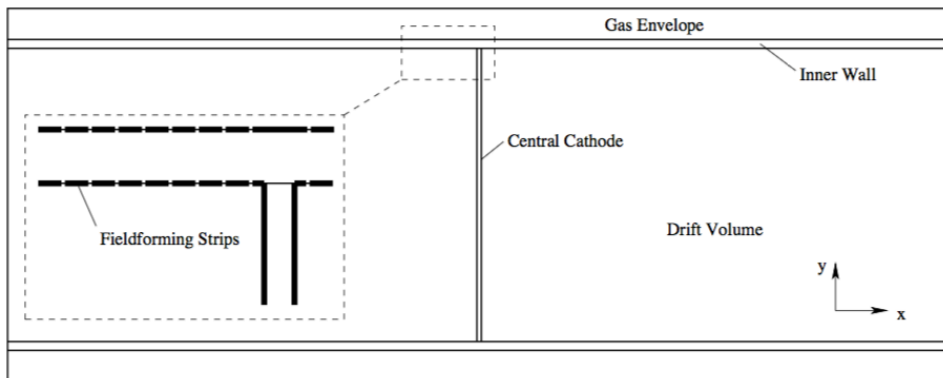
# Overview

- Updates from last ND280 upgrade meeting in Tokai
  - Reminder of results presented at the last ND280 Upgrade meeting
  - Completed the simulation with 3 mm Strips and 5 mm pitch
  - Studied the effect on the E field uniformity of possible cathode configurations
  - Preparation work to simulate FC junctions
- Main goals:
  - **E field uniformity up to  $10^{-4}$**
  - **E field dis-uniformity  $\leq 10$  mm from field strips**

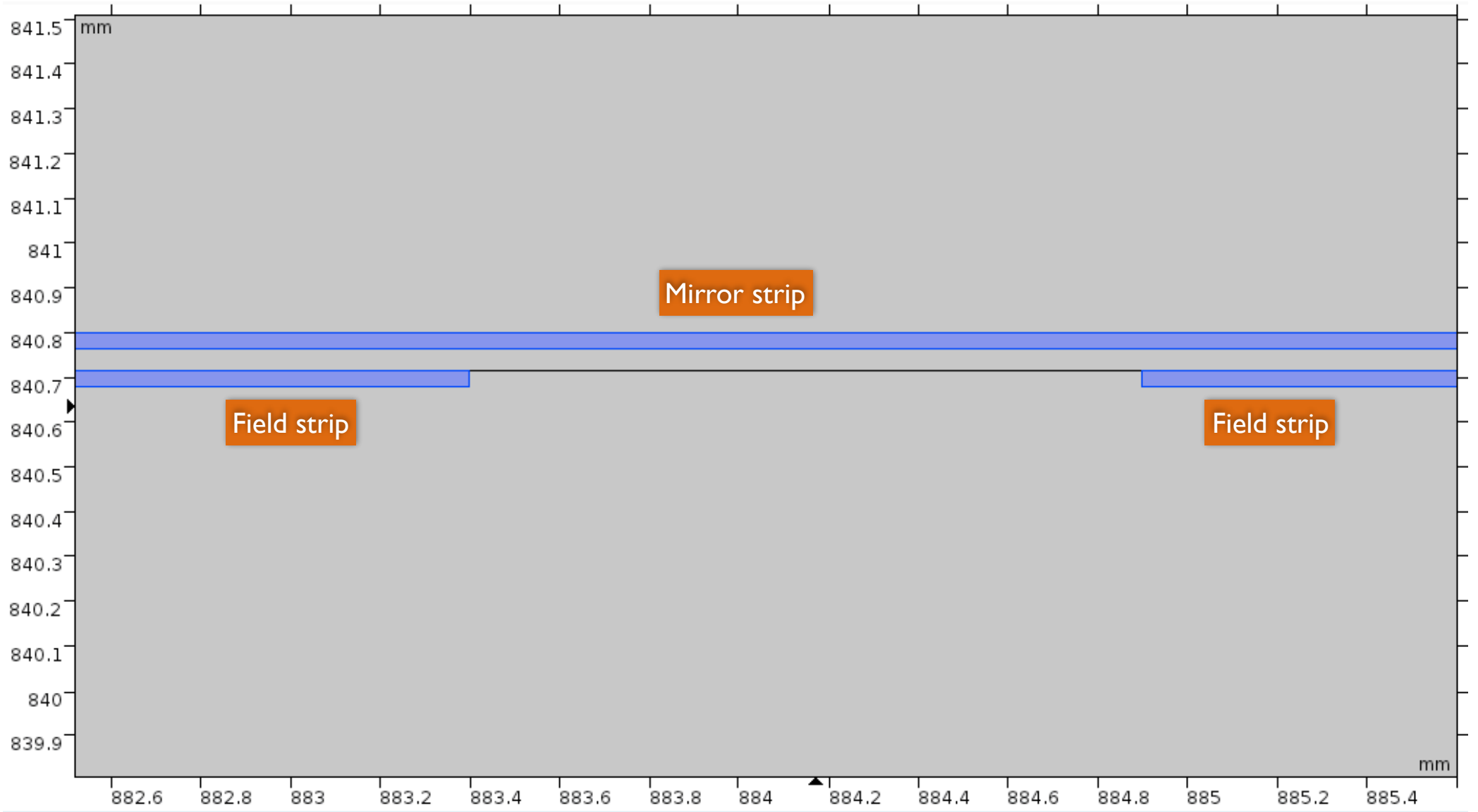
**Strip pitch as “old” TPCs,  
with mirror strips**

# Parameters used

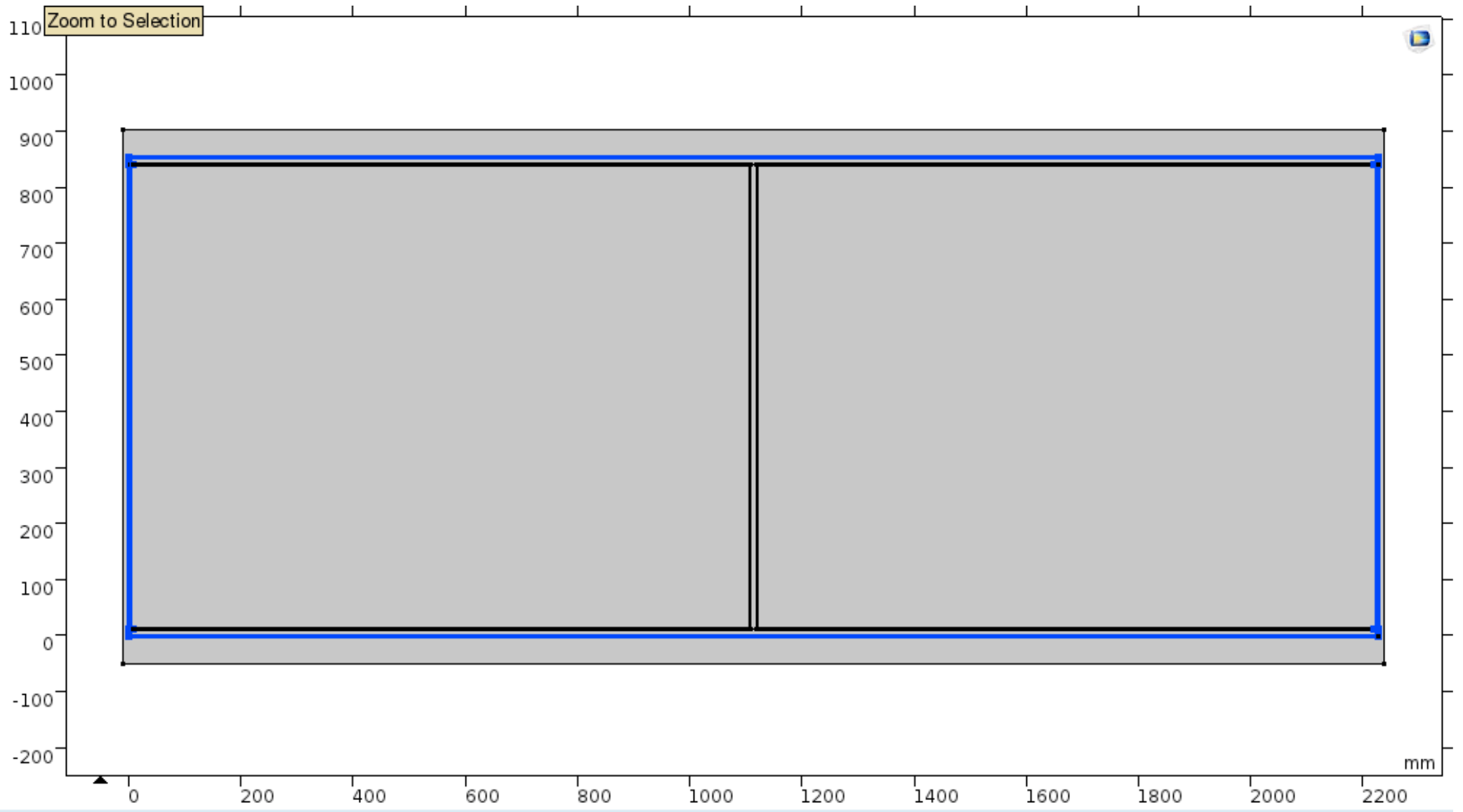
- Field cage wall thickness: 13.2 mm (inner box of current TPCs)
- Strips width: 10mm
- Strips pitch: 11.5 mm
- Strips thick: 35  $\mu\text{m}$
- Resistors between strips: 20  $\text{M}\Omega$
- Number of field strips on each side: 95 (97 with the half strips at the cathode and anode)
- Number of mirror strips on each side: 96
- $V_{\text{cathode}} = -24 \text{ kV}$
- $V_{\text{anode}} = 0 \text{ V}$
- $R_{\text{TOT}} = \sim 1900 \text{ M}\Omega$
- $i = \sim 13 \mu\text{A}$
- Voltage drop between neighbour field strips = 250 V
- Voltage drop between neighbour mirror strips = 250 V
- Voltage drop between neighbour field strip and mirror strip = 125 V



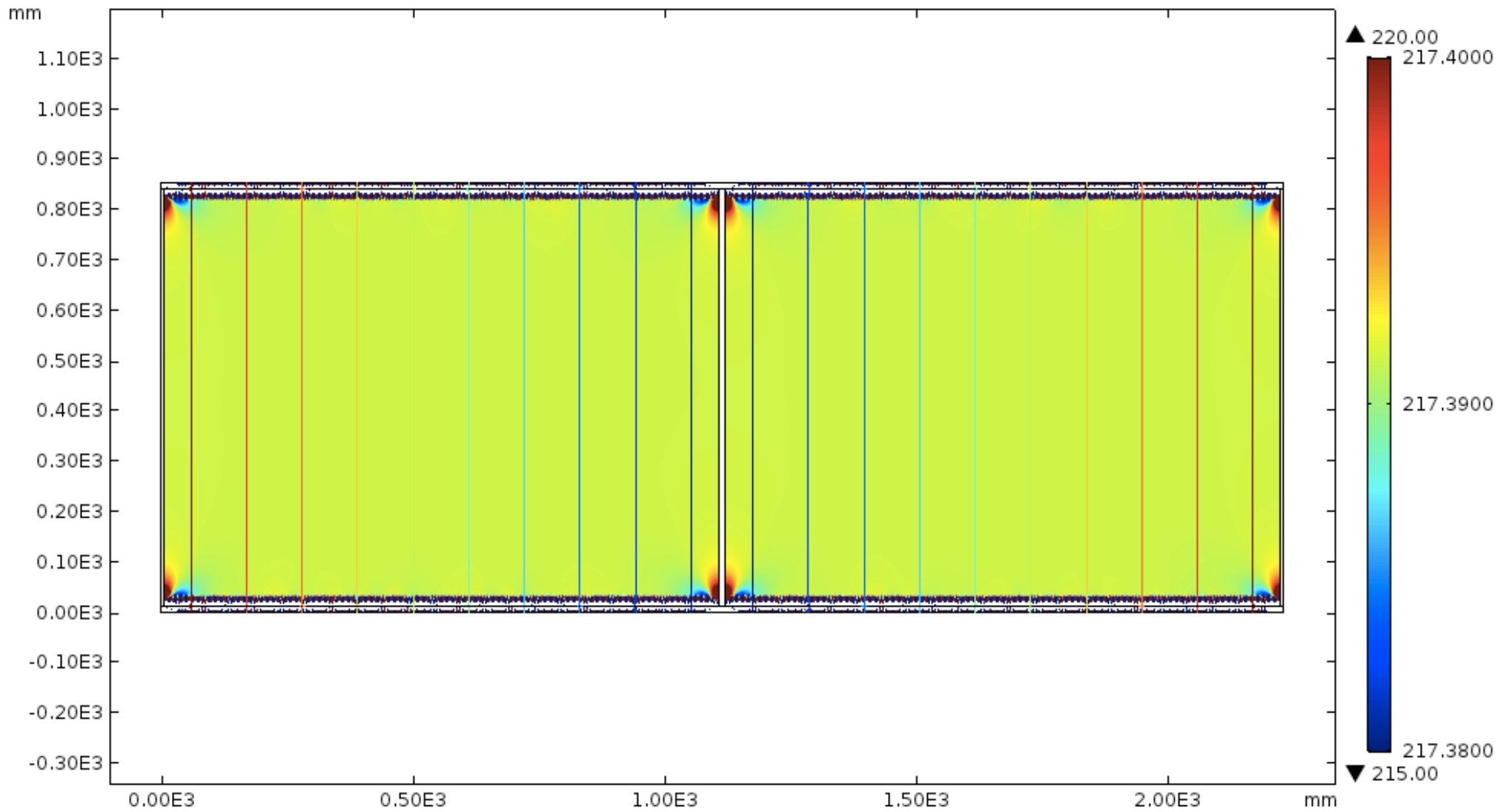
# Field cage design: mirror strip



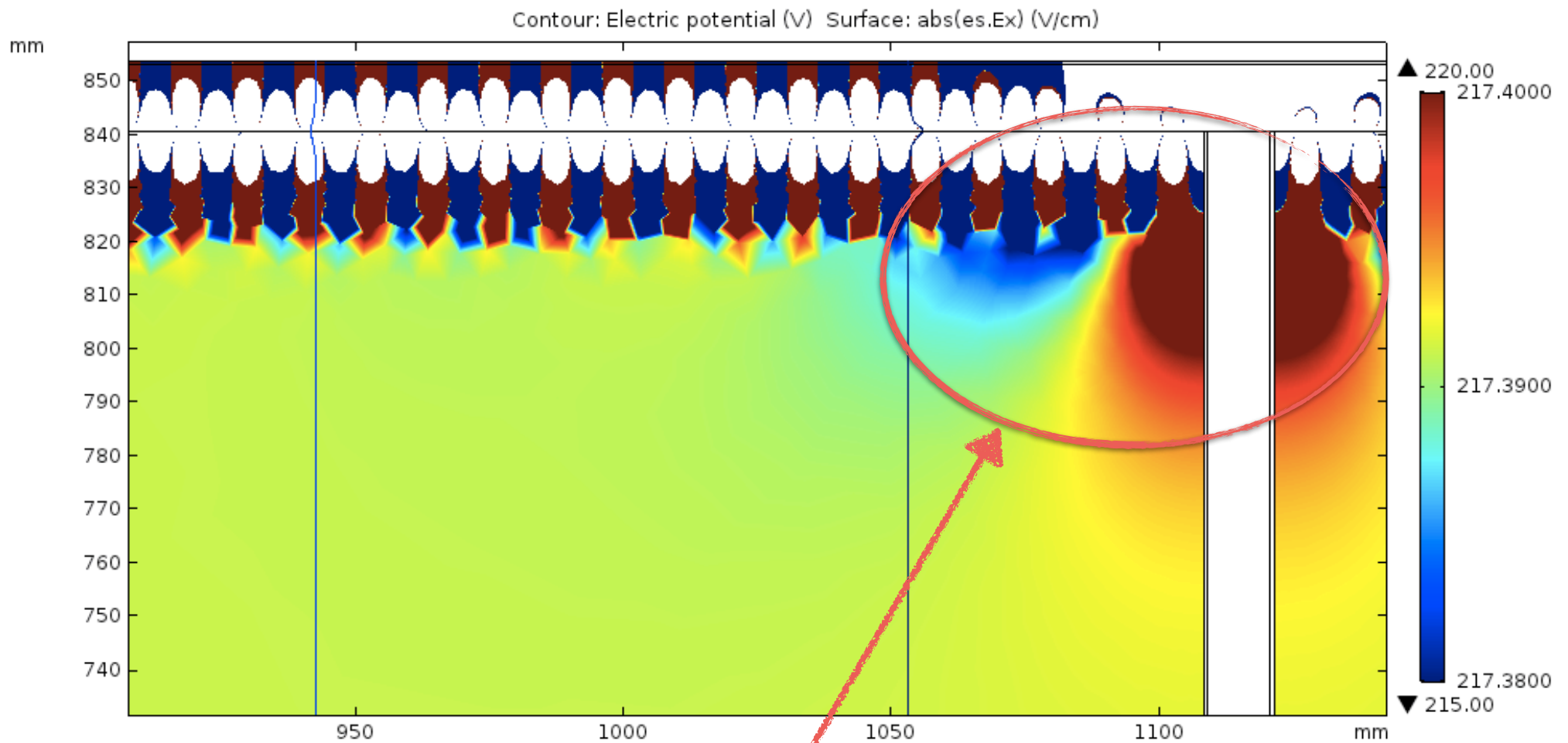
# Grounds



Contour: Electric potential (V) Surface: abs(es.Ex) (V/cm)

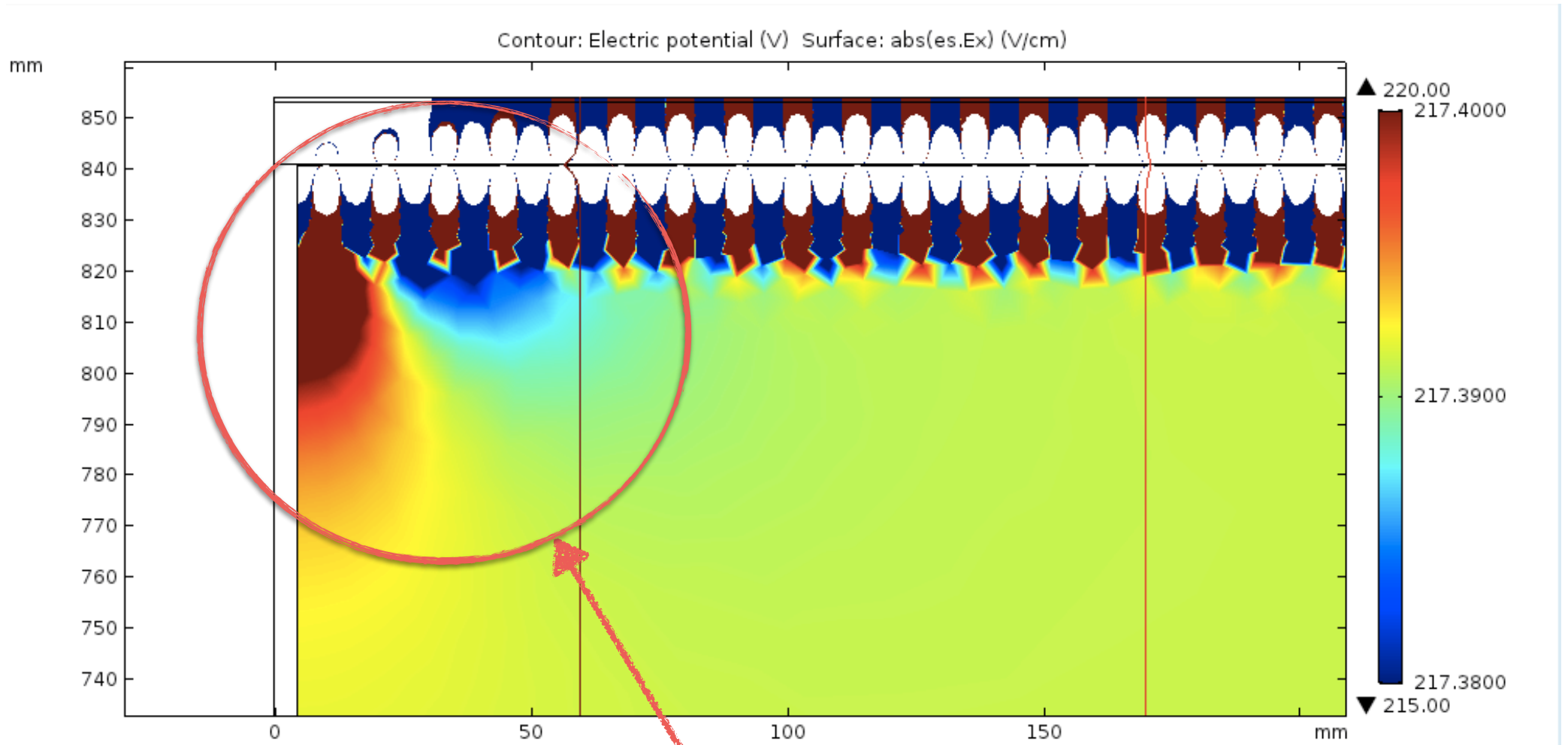


**Good E field uniformity up to  $10^{-4}$  in the middle**

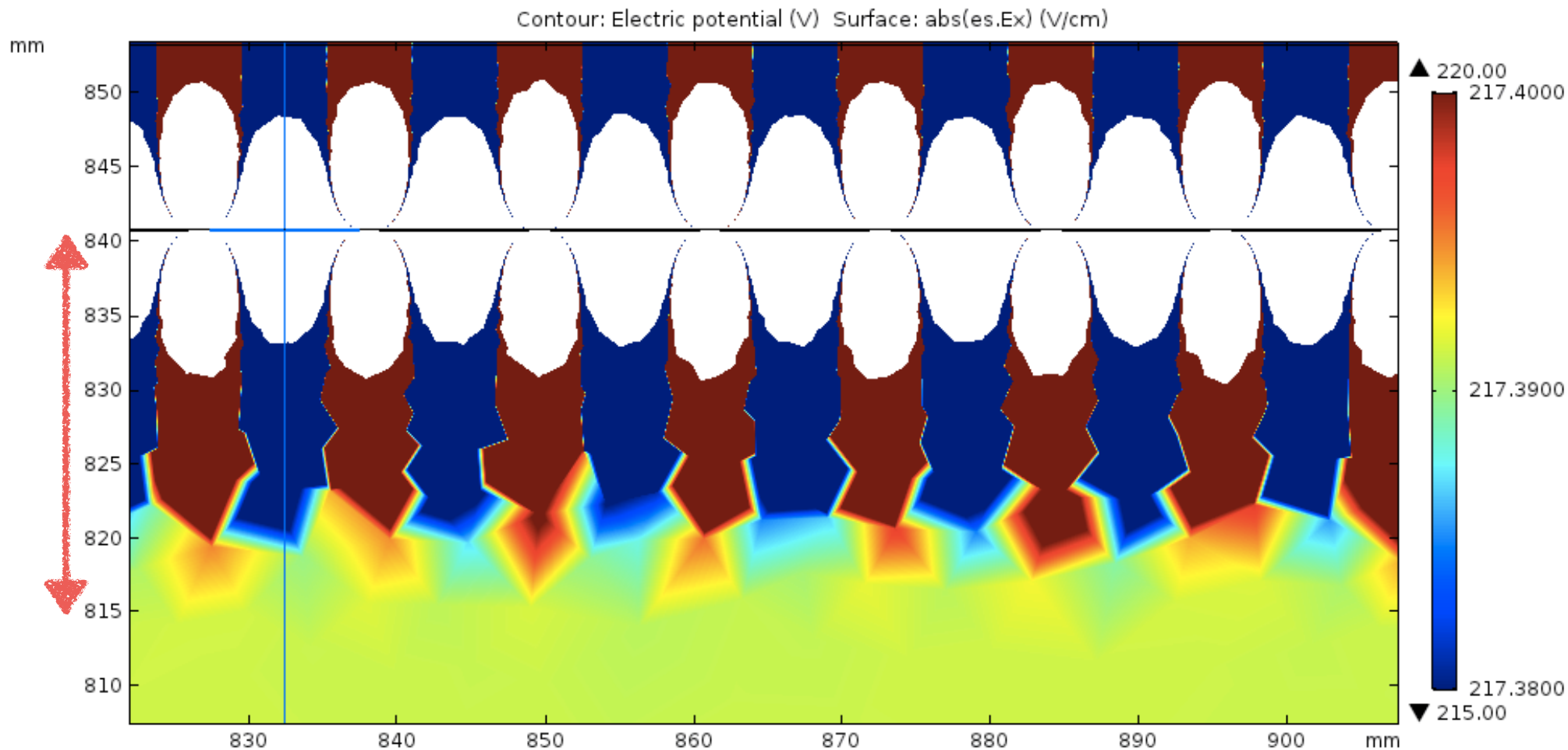


**Huge E field distortion near the cathode as expected**





**Huge E field distortion near the anode as expected**

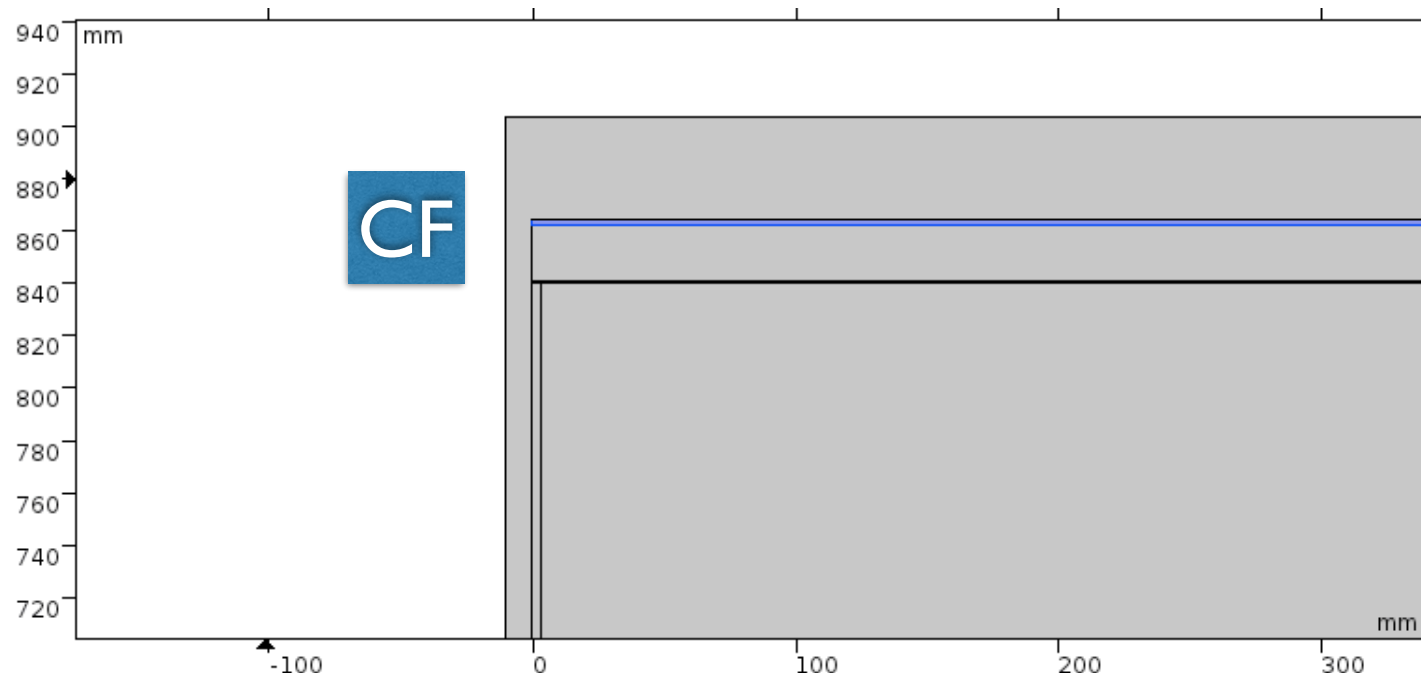


**E field not uniform up to ~ 25 mm from the field strips!  
(in agreement with T2K TPC TDR)**

**ILC-TPC like + 2 mm of CF layer  
with decreased strip pitch**

# Field cage wall parameters

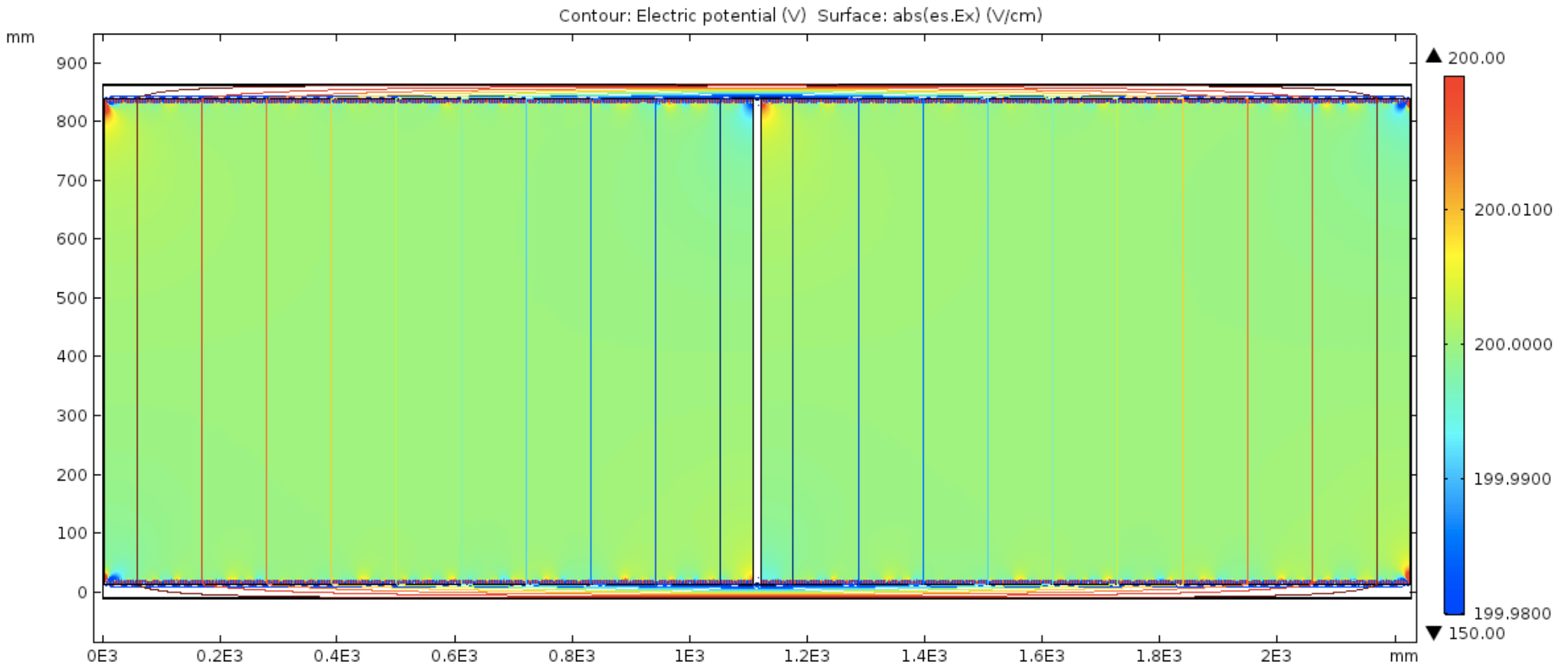
Wall Layers	Thickness	Relative permittivity
Copper shielding	0.01	$1e^{10}$
Polyimide substrate	0.05	3.4
CF prepreg fabric 0/90	2	2.7
Honeycomb	21.5	3.6
GRP	0.3	4.5
Polymide insulation	0.125	3.4
Mirror strips	0.035	$1e^{10}$
Polyimide substrate	0.05	3.4
Field strips	0.035	$1e^{10}$



# Parameters used

- **Strips width: 4 mm**
- **Strips pitch: 5 mm**
- Strips thick: 35  $\mu\text{m}$
- Number of field strips on each side: **220** (**222** with the half strips at the cathode and anode)
- Number of mirror strips on each side: **221**
- **$V_{\text{cathode}} = -22100 \text{ kV}$**
- **$V_{\text{anode}} = 0 \text{ V}$**
- Voltage drop between neighbour field strips = 100 V
- Voltage drop between neighbour mirror strips = 100 V
- Voltage drop between neighbour field strip and mirror strip = 50 V

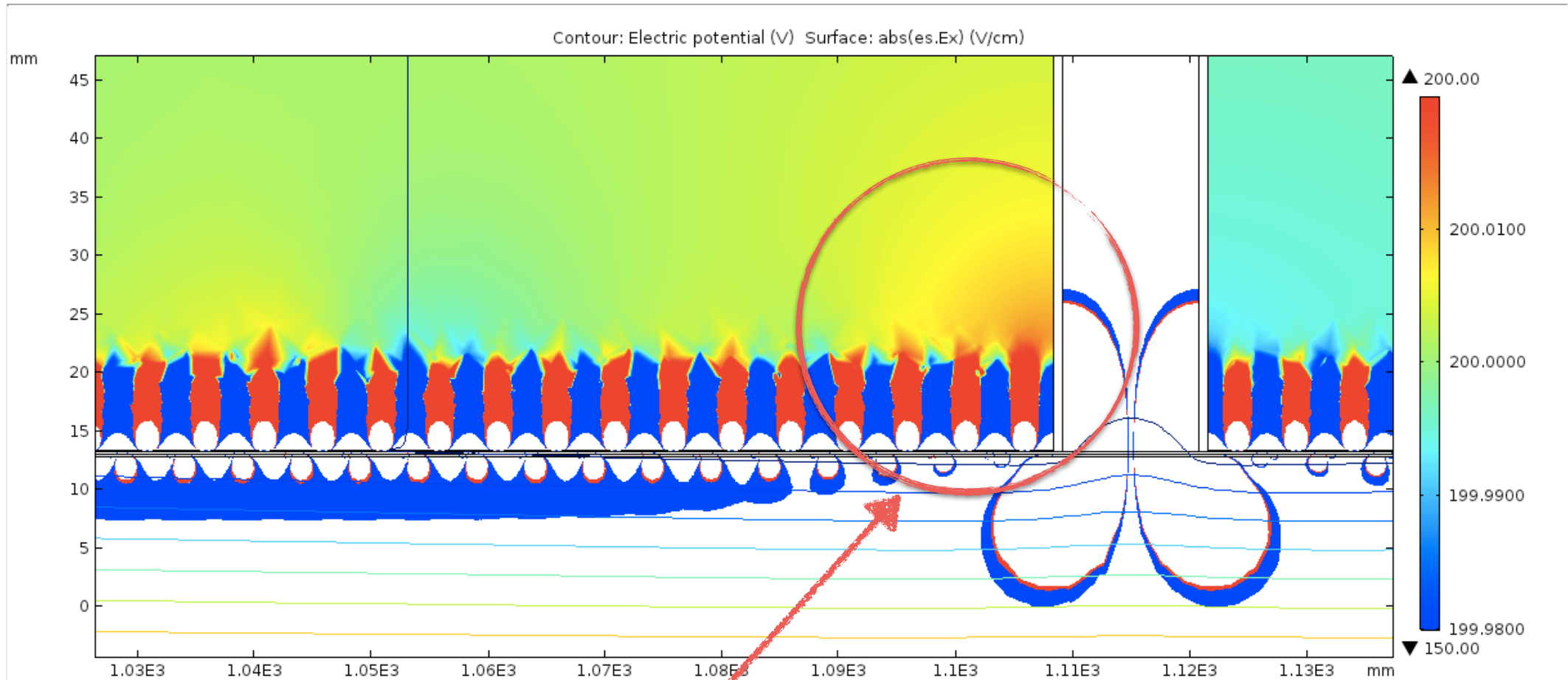
# Results



**Equipotential lines perfectly aligned!**

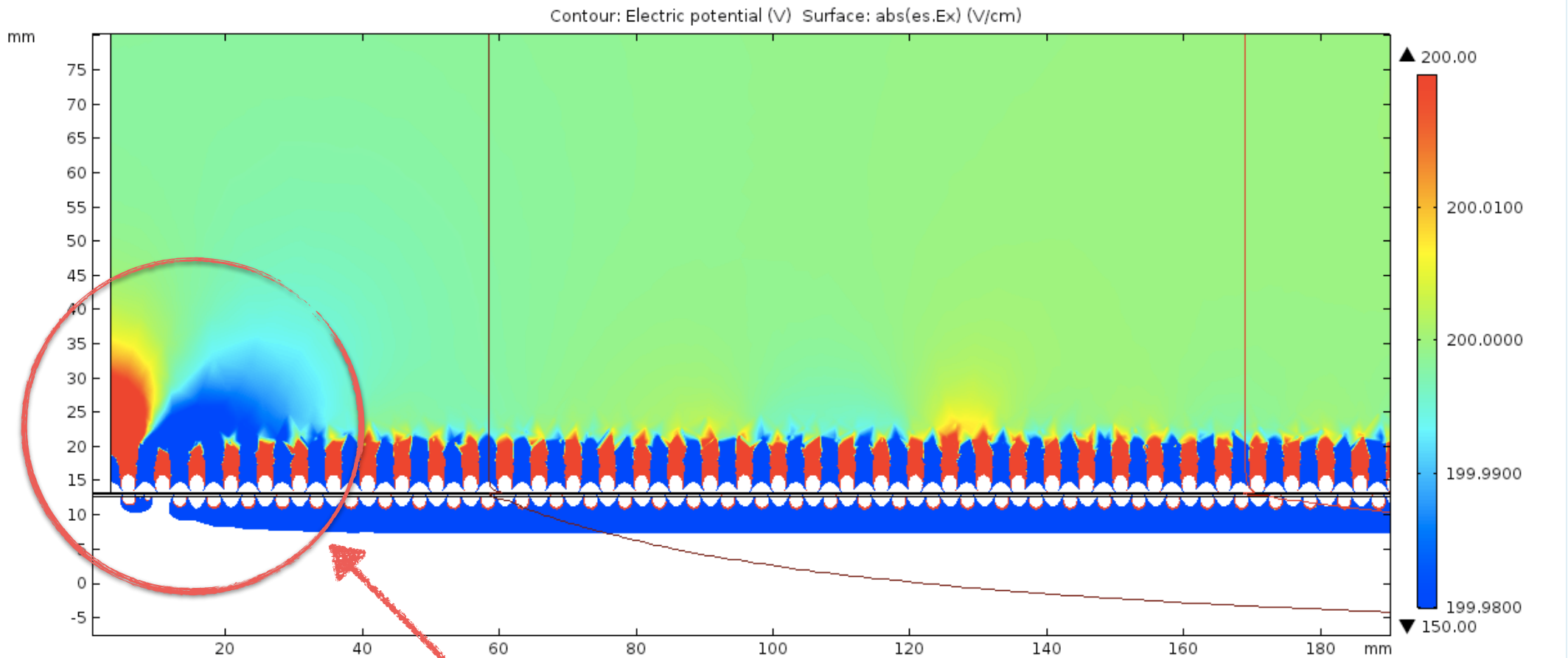
**Good E field uniformity up to  $10^{-4}$  in the middle**

# E Field near the cathode



**Large E field distortion near the cathode as expected.  
Much lower distorsion here w.r.t. previous configuration!**

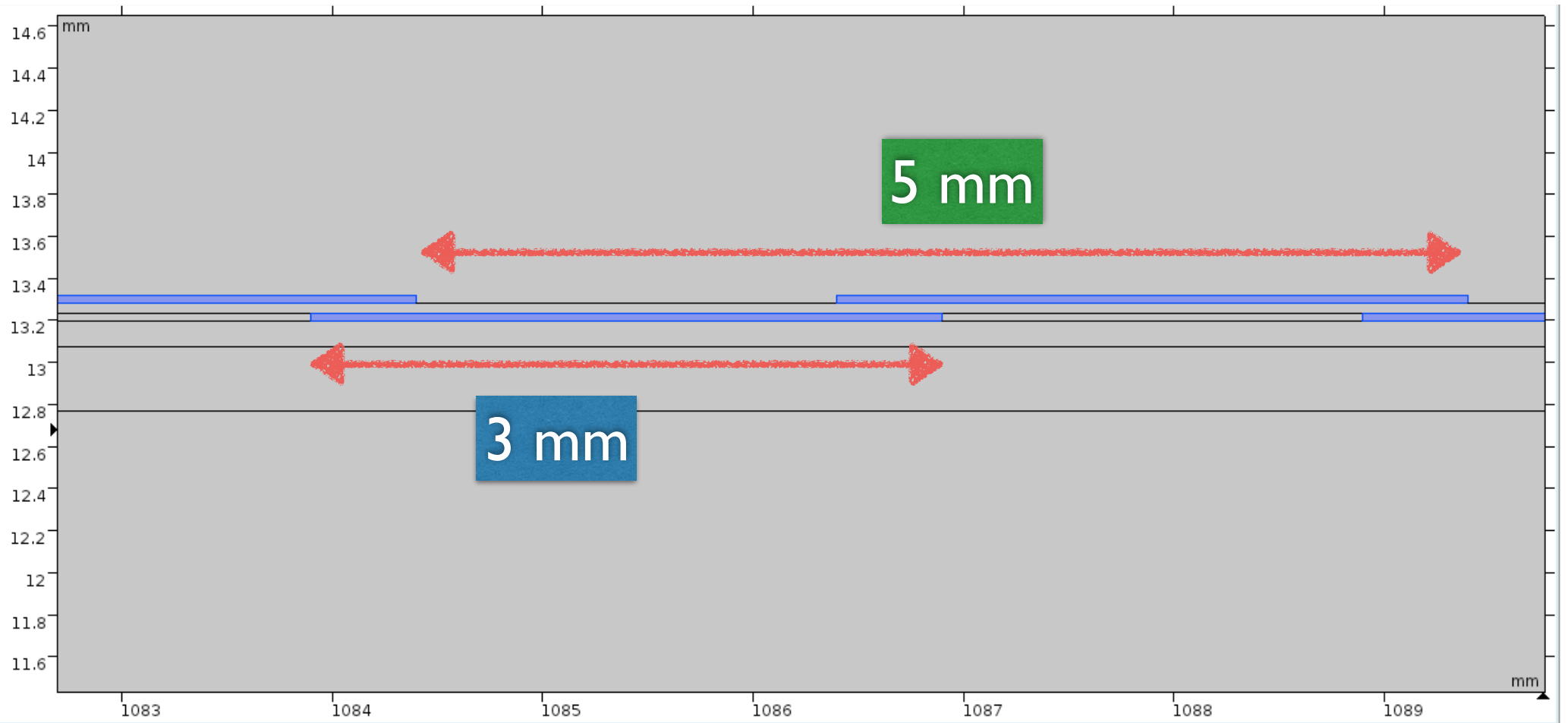
# E Field near the anode



**Large E field distortion near the cathode as expected.  
Much lower distorsion here w.r.t. previous configuration!**

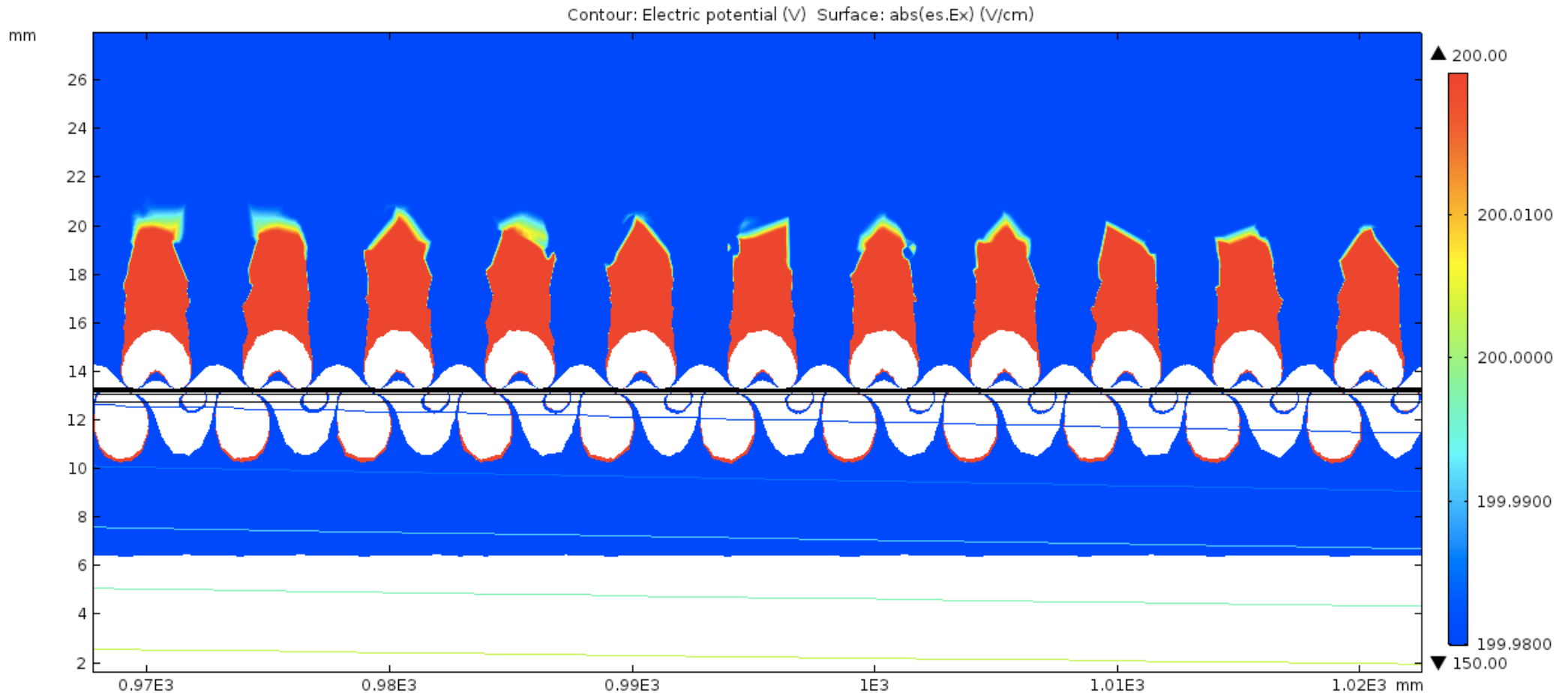


**3mm Strip width (same 5 mm pitch)**



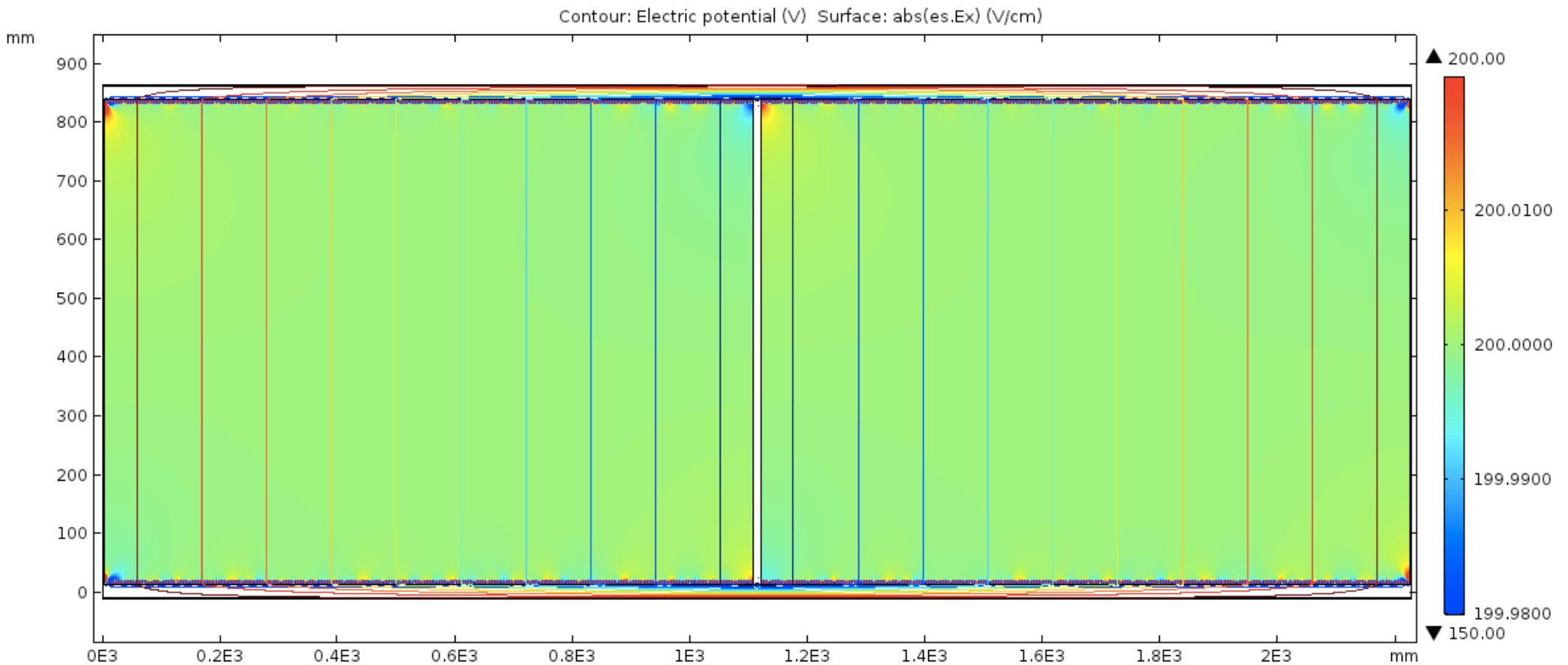
# New Results

**At the last ND280 Up meeting we presented this result that was not final**



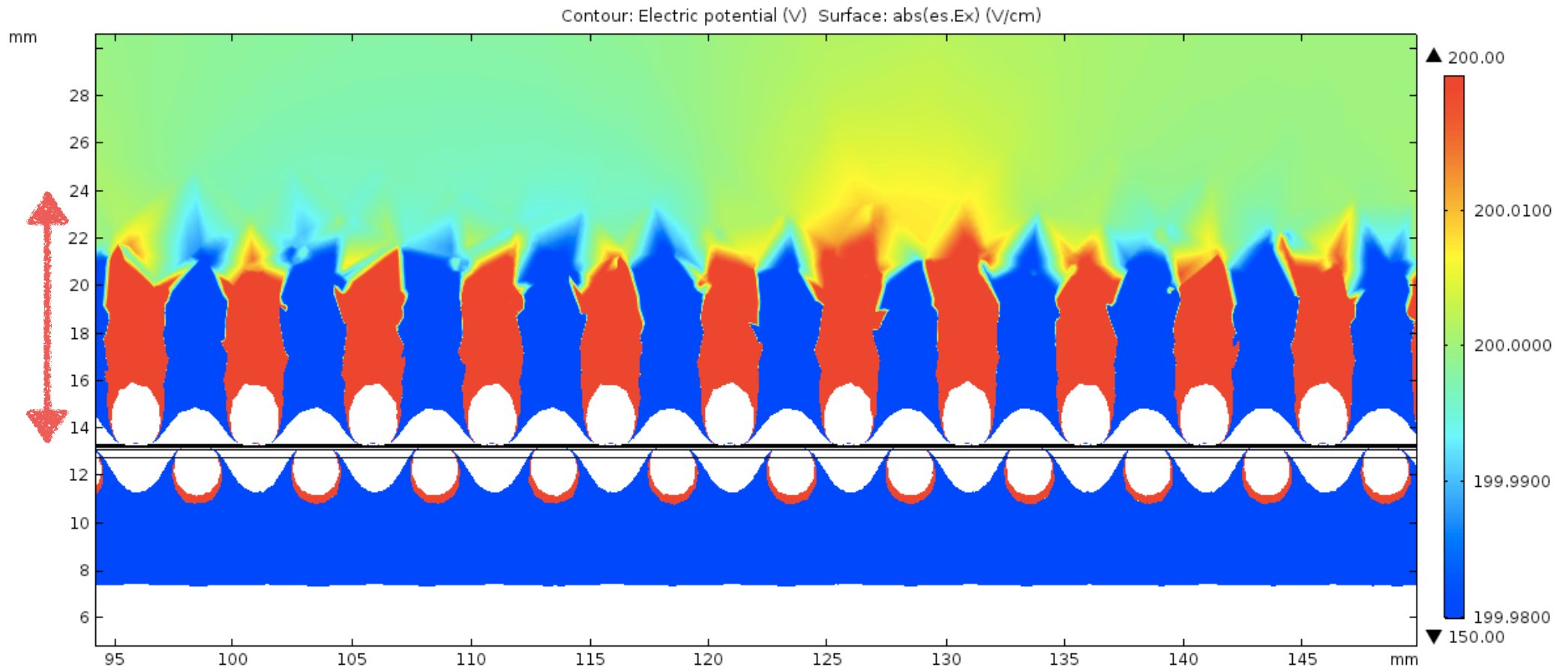
**E field not uniform lower than 10 mm from the field strips!  
Very promising configuration!**

# New Results



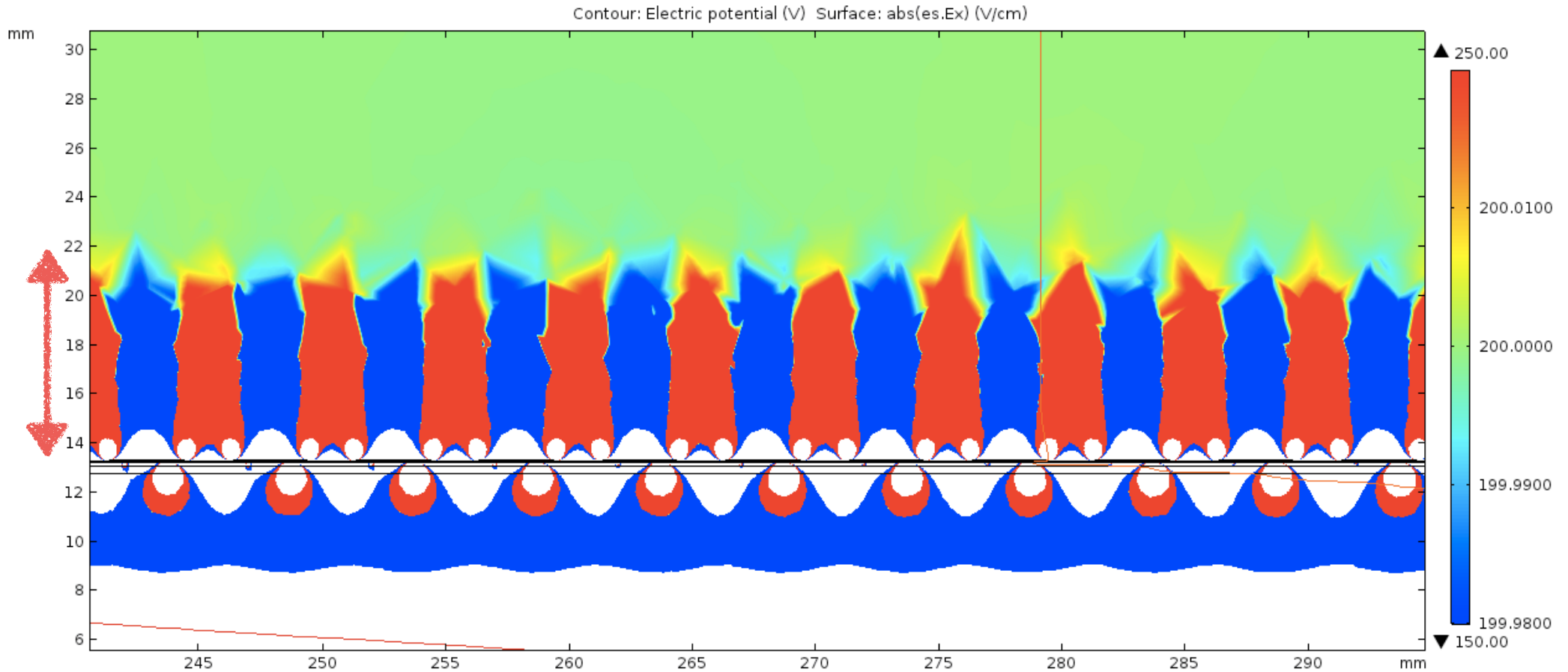
**Almost no differences w.r.t. 4 mm strips (5 mm pitch) configuration, but...**

# E Field close to the field cage wall



**E field not uniform up to ~ 10 mm from the field strips  
much better than previous configuration!**

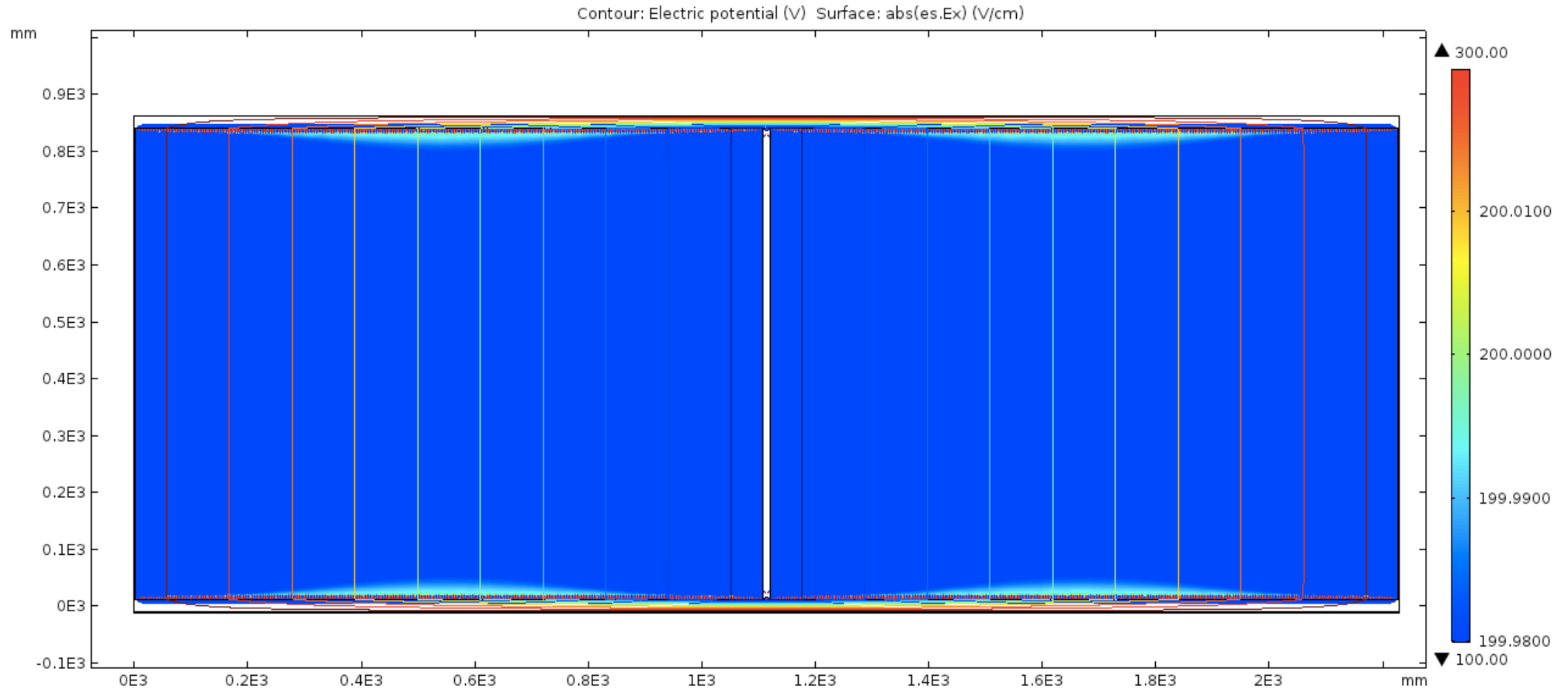
# New Results (zoom near the strips)



**Confirmed E field not uniform lower than 10 mm from the field strips!**

# New Results

**What happens if the half strips are 2 mm long instead of 1.5 mm**

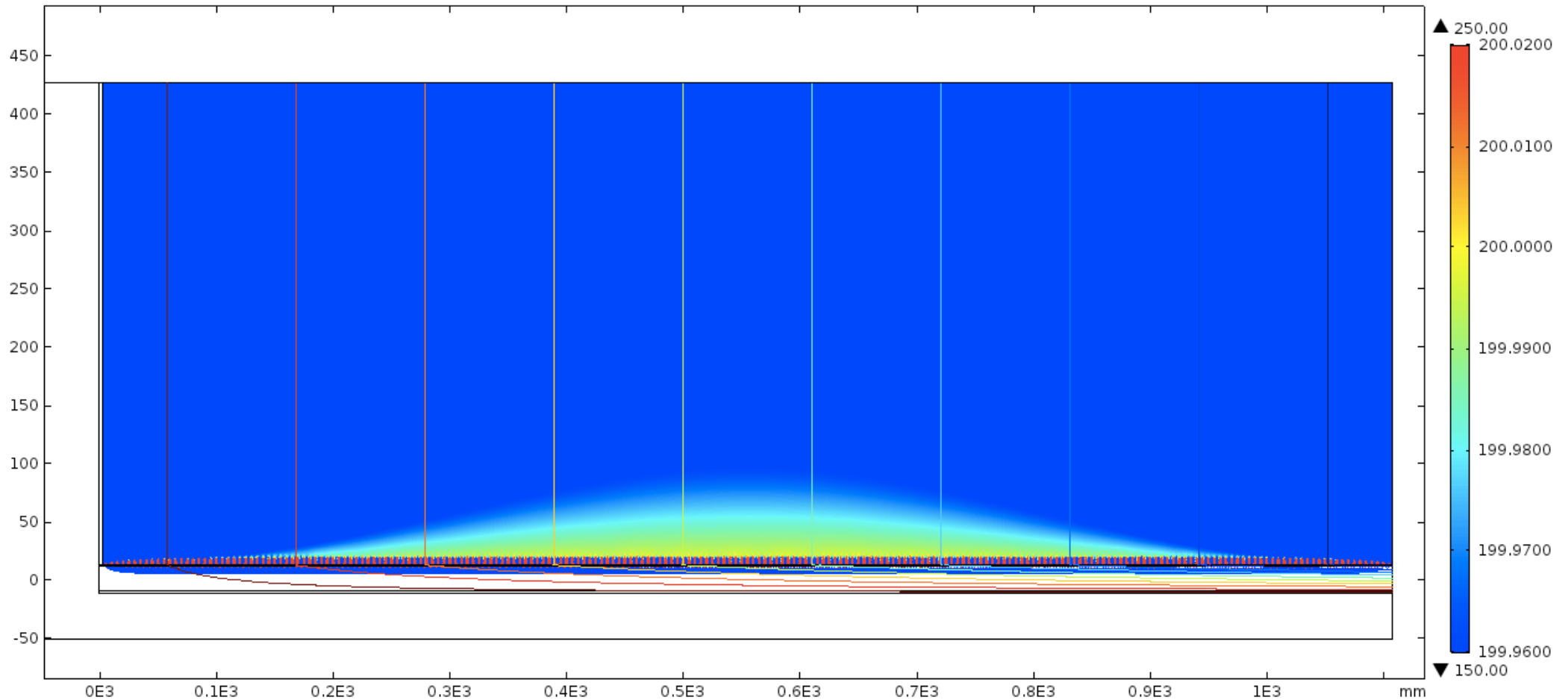


**Large E field distortion can occur!**

# New Results

**What happens if the half strips are 2 mm long instead of 1.5 mm**

Contour: Electric potential (V) Surface: abs(es.Ex) (V/cm)

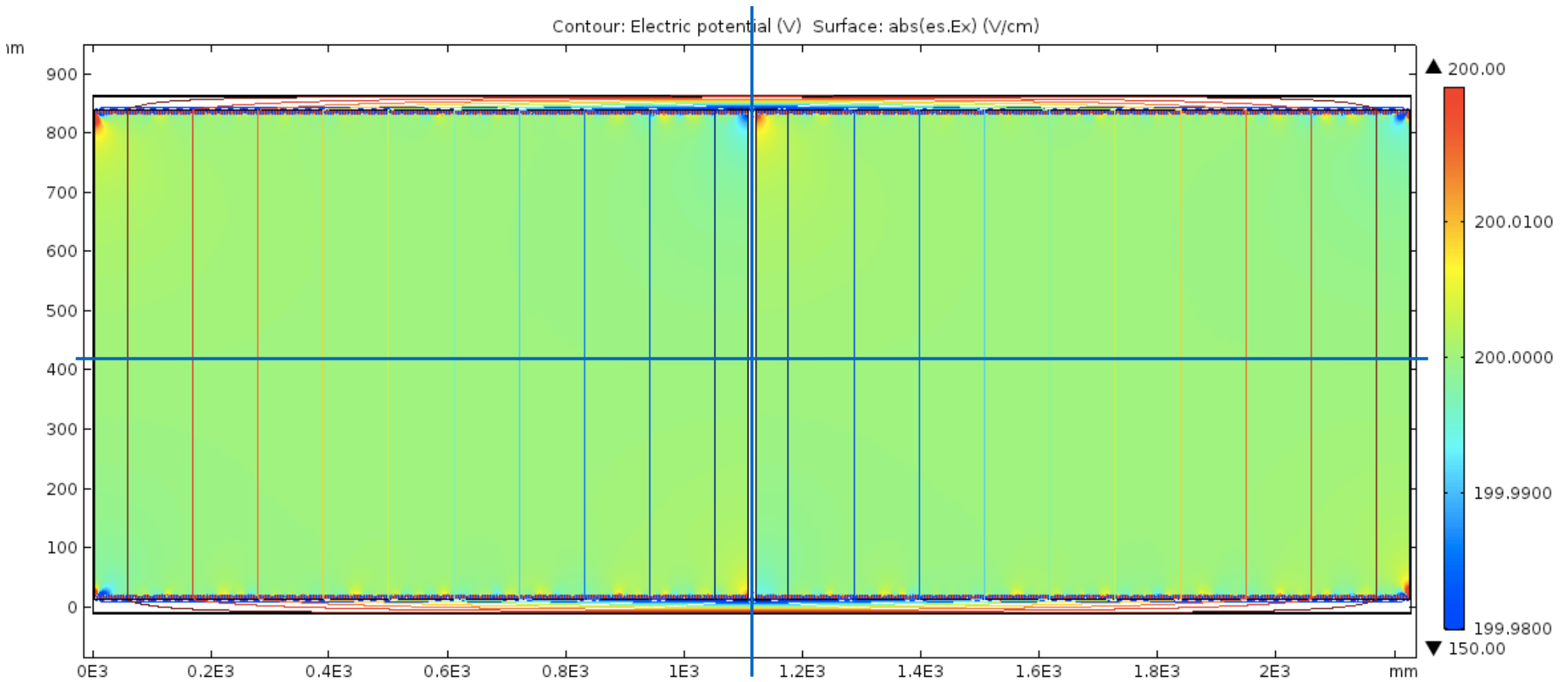


**Large E field distortion can occur!**



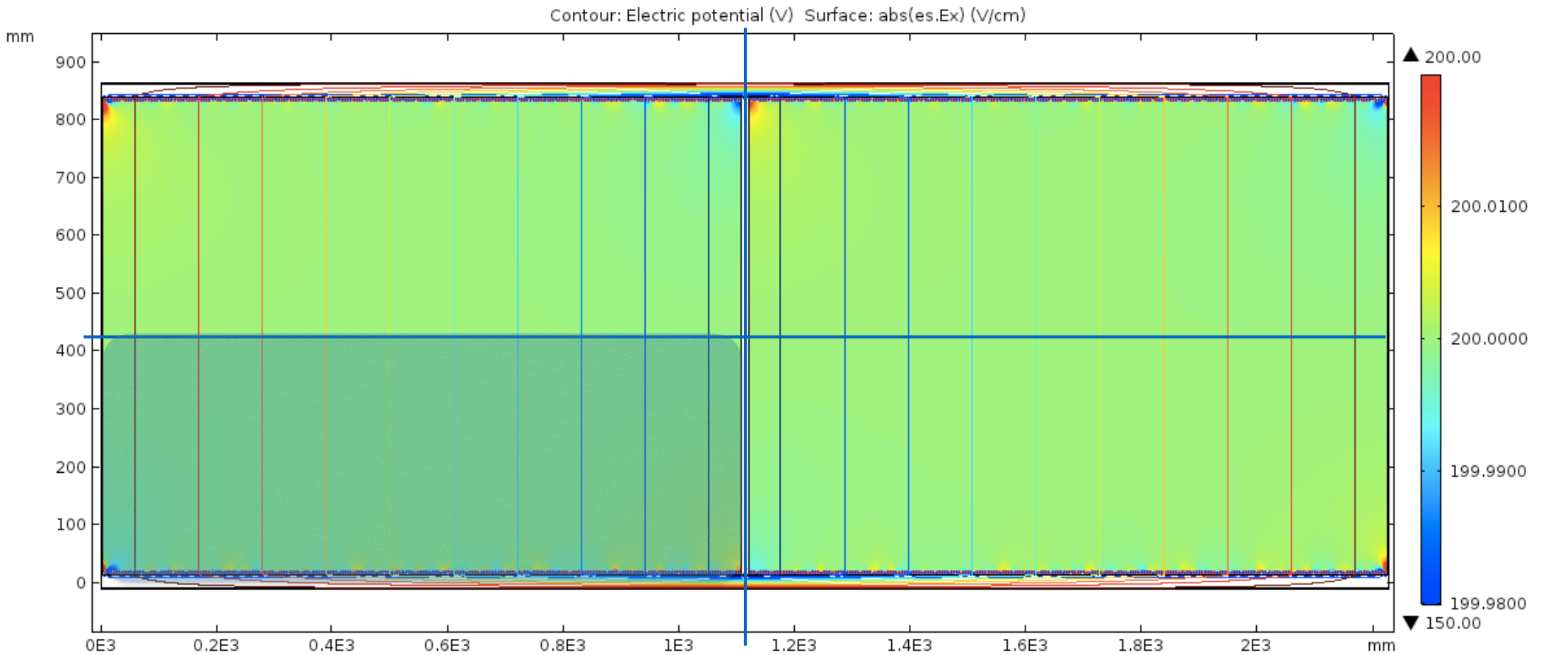
# Cathode configurations

# Taking advance of FC symmetries by using zero charge planes



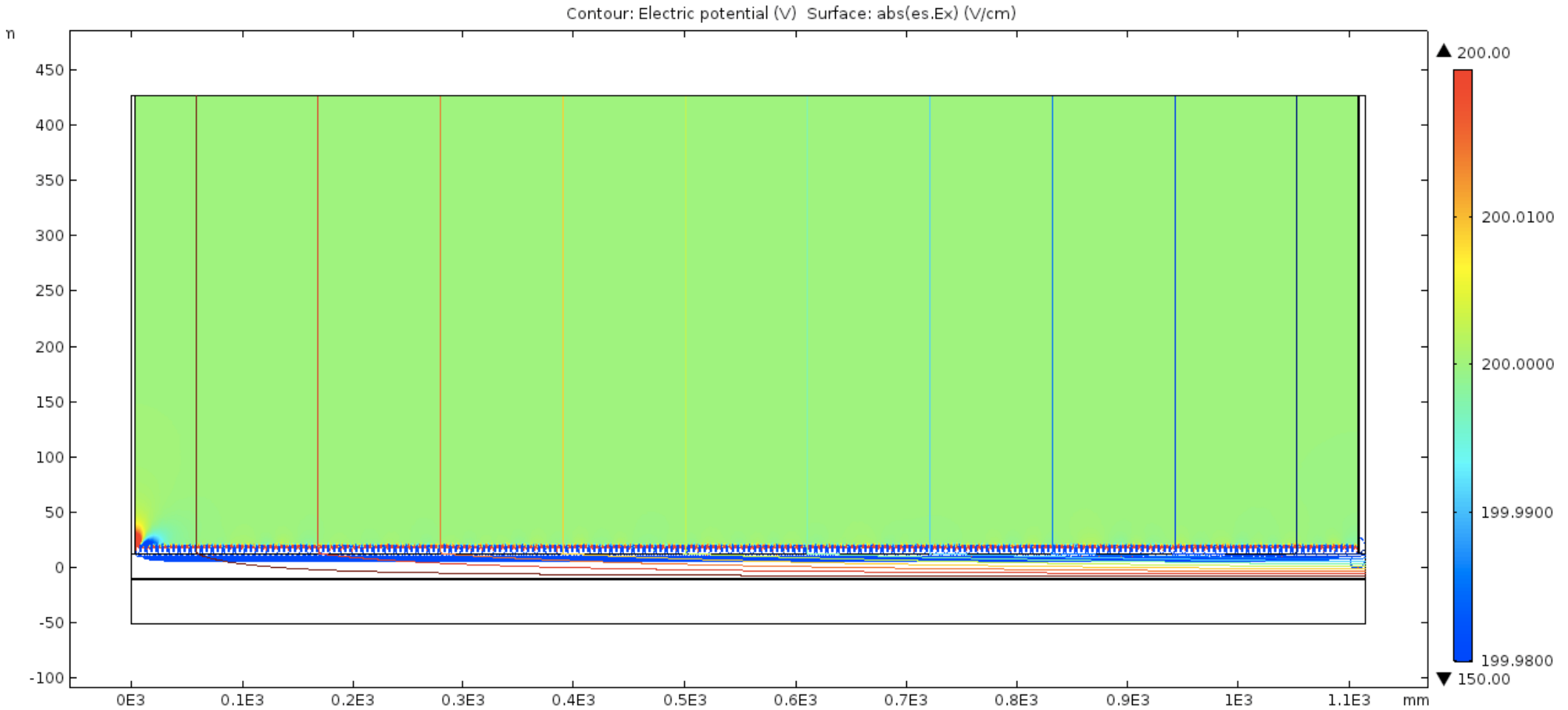
zero charge plane

# Taking advantage of FC symmetries by using zero charge planes

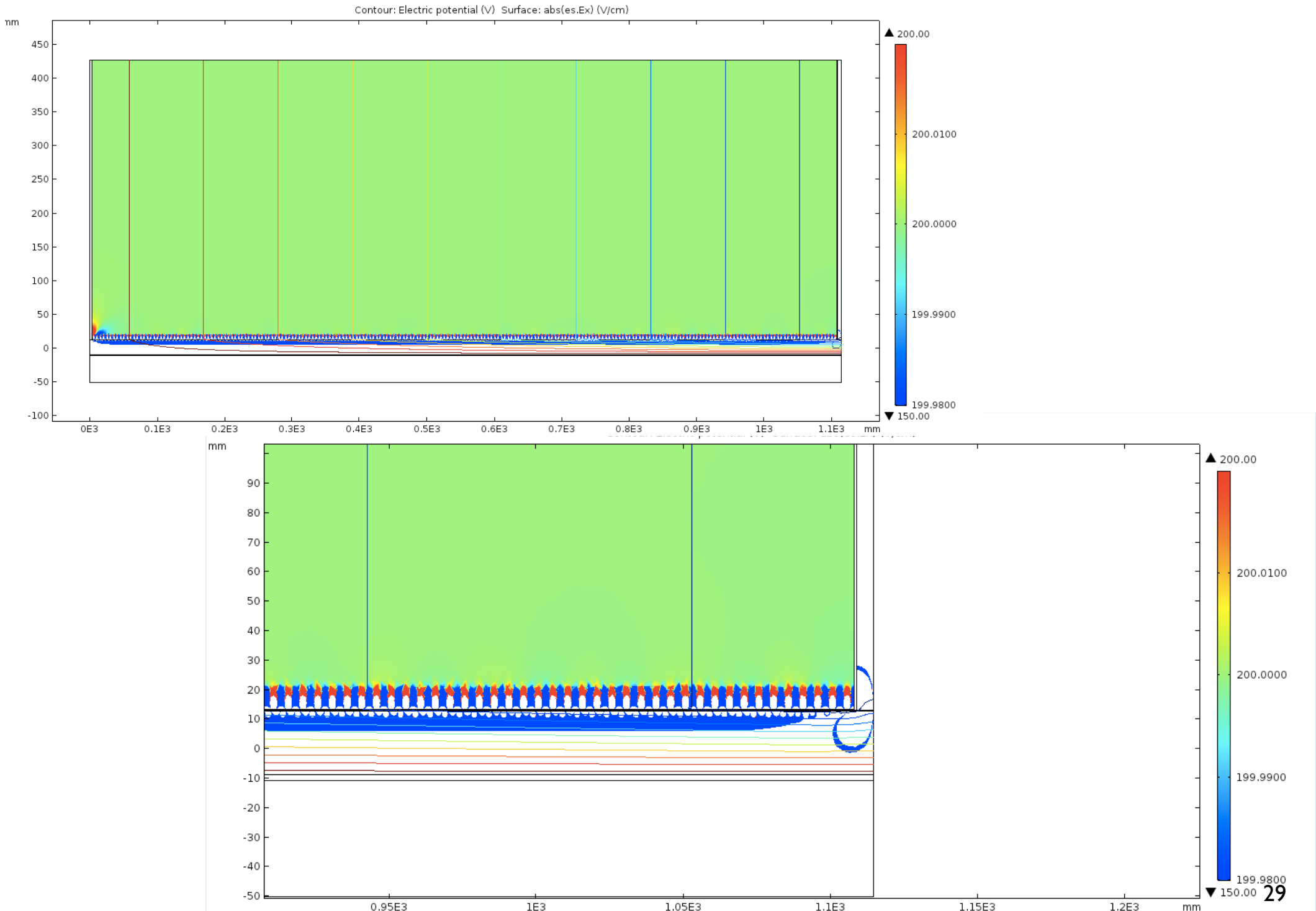


Portion of field cage that can be simulated alone  
by using the zero charge plane

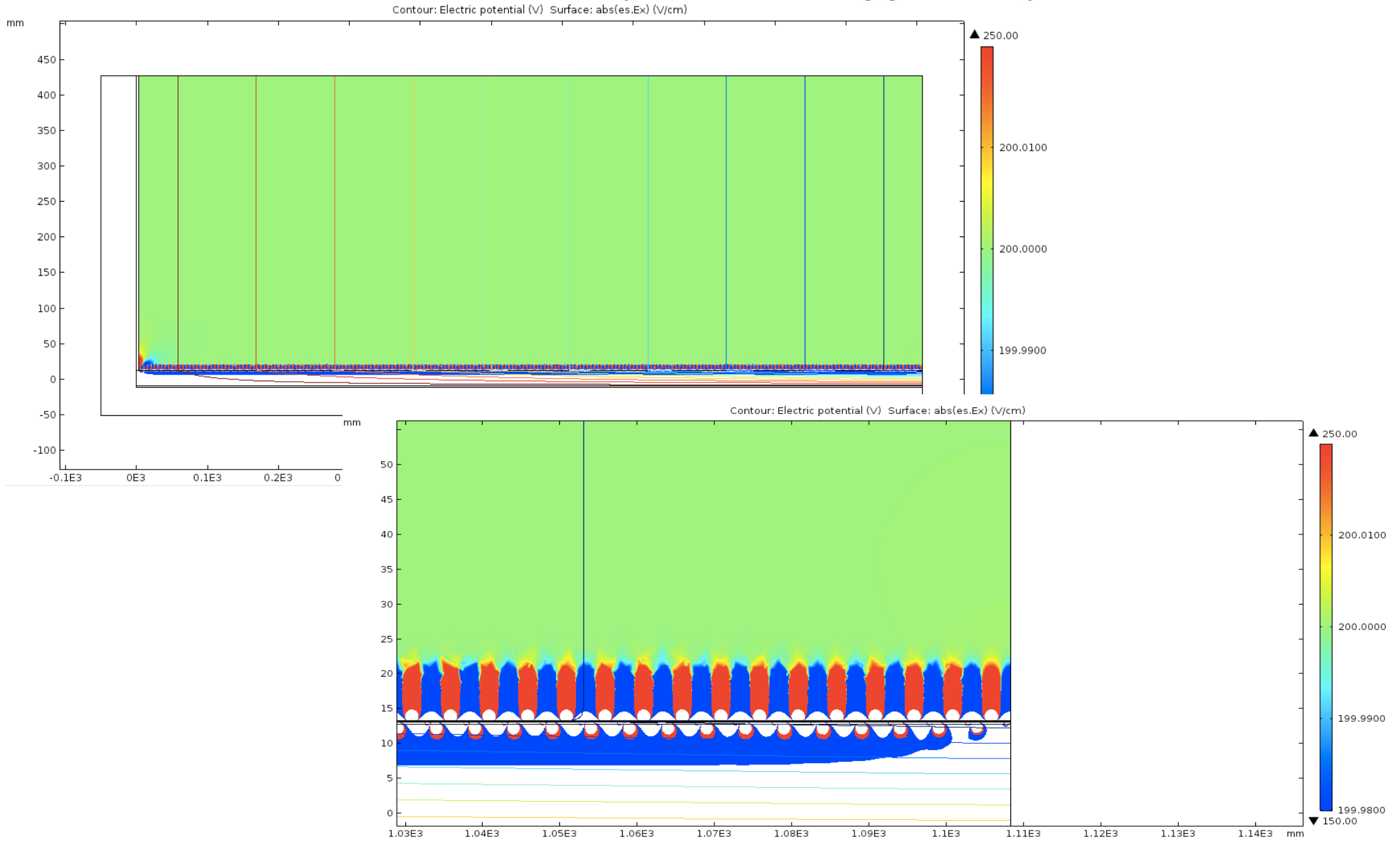
# Taking advance of FC symmetries by using zero charge planes



# Current cathode (13.2 mm)

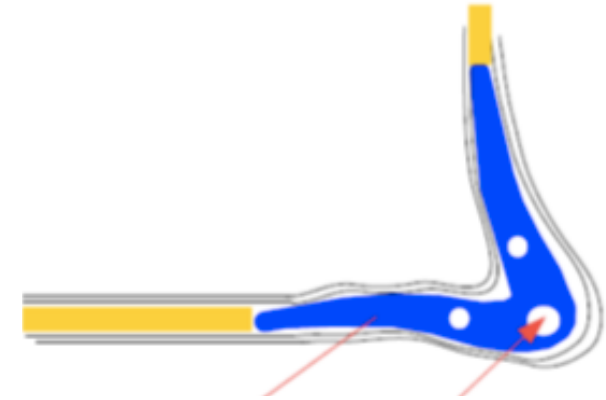
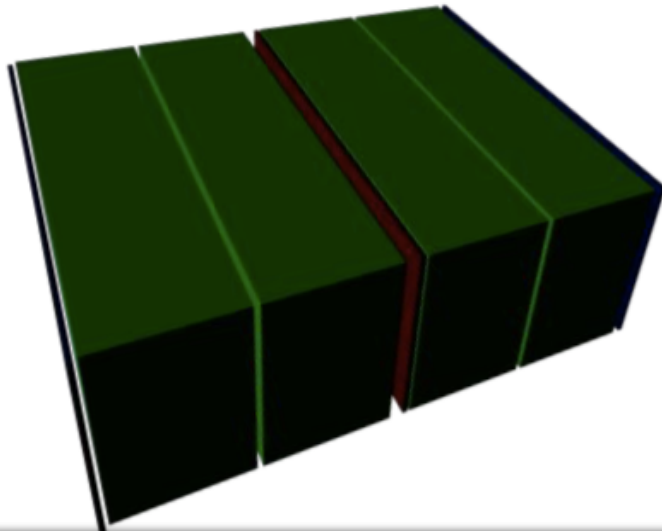


# Cathode foil (0.06 mm copper foil)



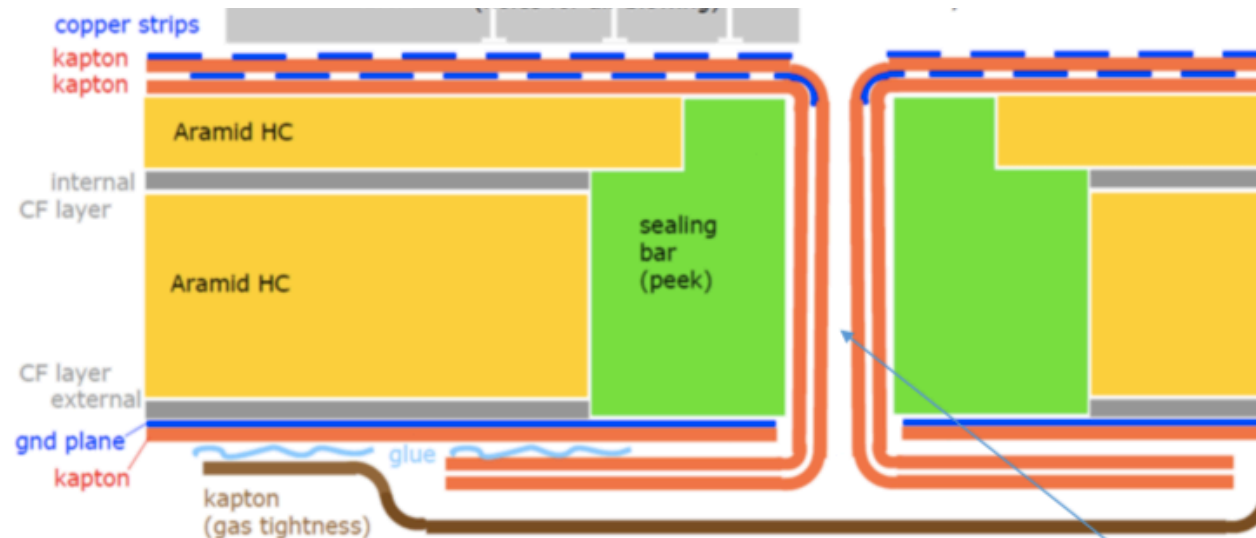
**No critical differences observed in the simulation**

# Field cage walls to test in the simulation



Important to check the effect on the E field uniformity of these parts of the wall

- can simulate only a FC portion to speed up the simulation
- need to understand how to simulate the cathode region



# Conclusions

- Confirmed that better results (non uniformity region lower than 10 mm) can be achieved if we use 5 mm pitch (3 mm strip width)
- No critical differences observed in the E field due to cathode thickness
- **We can take advance from FC symmetries by using the zero charge plane**
  - speed up the simulations
  - effect of the FC junctions under study
- next step: **effect of the FC junctions on the E field uniformity (hopefully this week), inclusion of resistive MM in the simulation**