LABORATORIUM FÜR HOCHENERGIEPHYSIK
LHEP
UNIVERSITÄT BERN

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Design of the HV setup for n2EDM

COMSOL SIMULATION OF THE PRECESSION CHAMBER

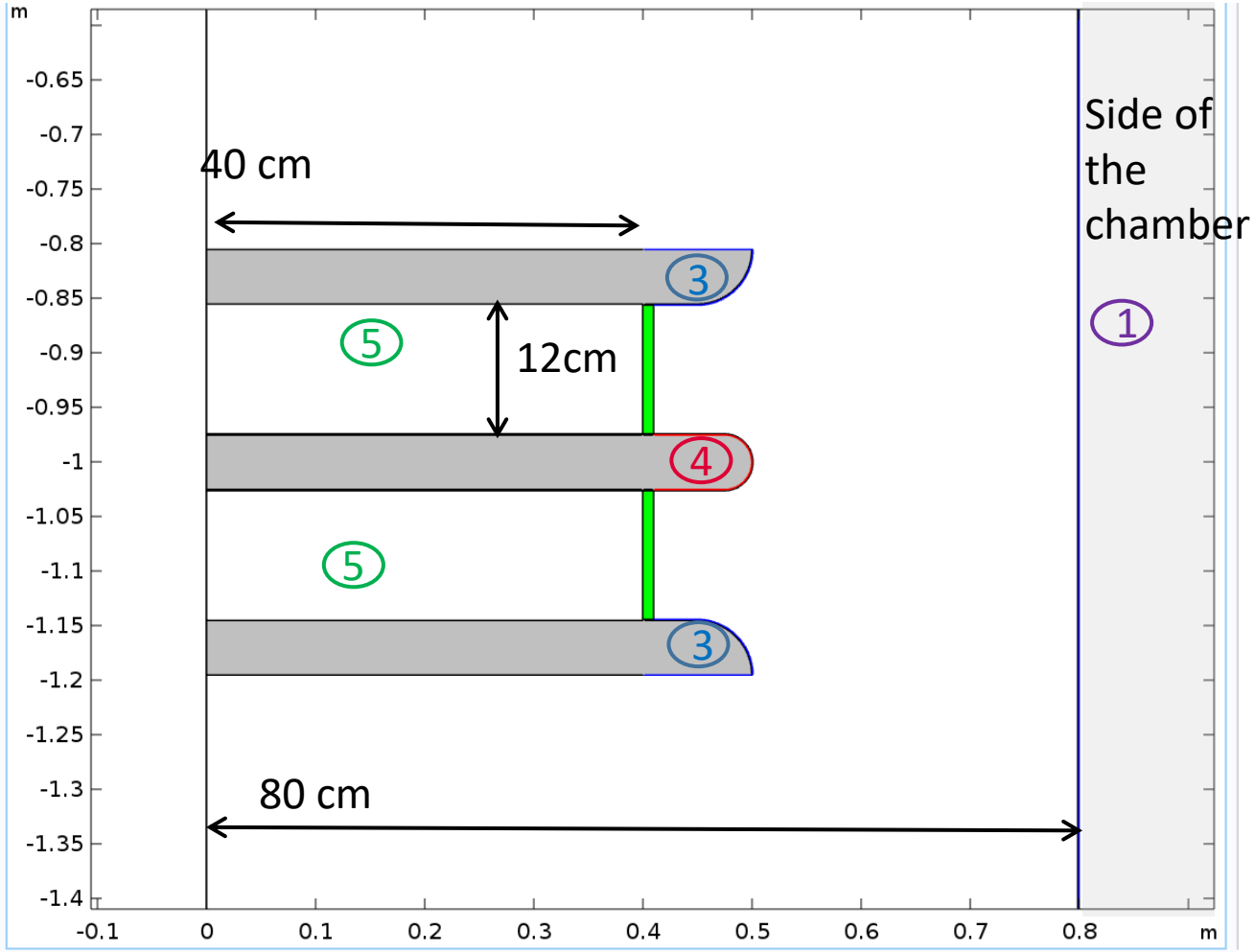
Overview:

- Generalities about simulation
- Criteria for the general design
- Dummy design for comparison
- General design
  - Thickness of the electrodes
  - Length of the electrodes
  - Corona HV?
  - Insulator ring
  - Protecting cage
- Design of details
  - Quartz window
  - Groove geometry

Generalities about simulation

Applied voltage (4) 250kV
Inside chamber (5) ~40cm
Separation ~12cm
ε_r~3.5
Minimal radius of the electrodes~ 45cm

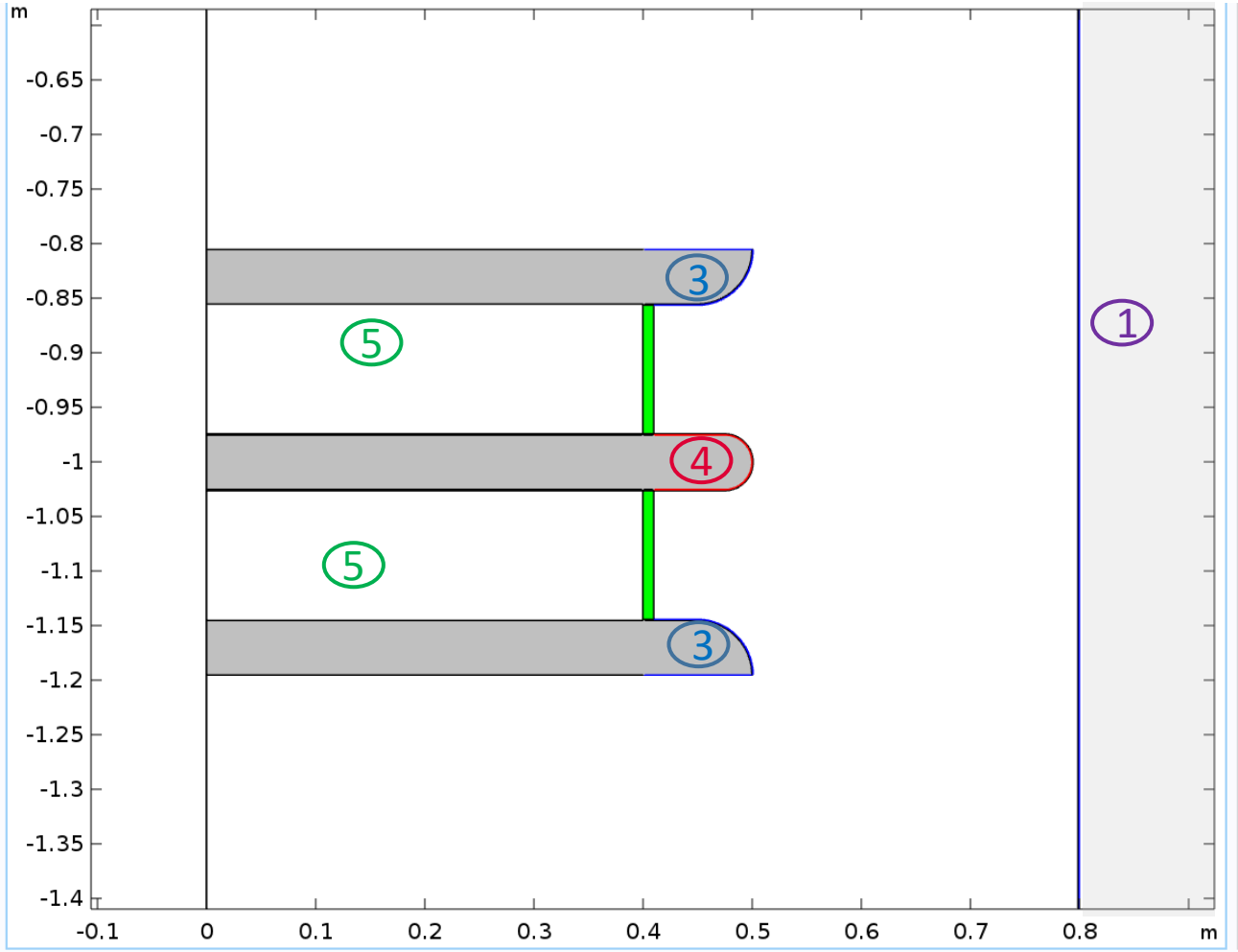
Ground lines (meas.)
HV lines (meas.)
Insulator
Aluminium



Important criteria for the general design

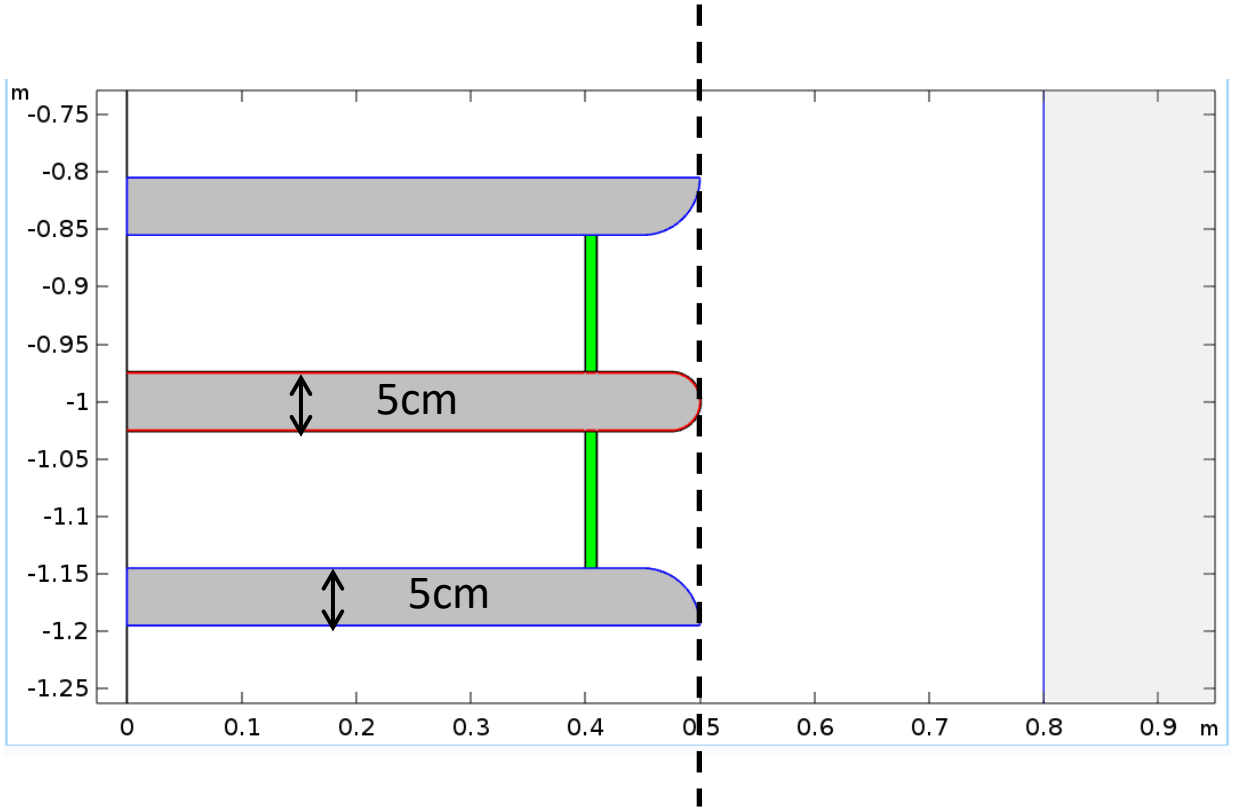
1. Field on the side of the vacuum chamber
2. Hot spot (>50 kV/cm)
3. Field on the ground electrode (<20.8 kV/cm)
4. Field on the HV electrode
5. Homogeneity

   (max –min field)



Dummy design for comparison

- Vacuum chamber: 2.4 kV/cm
- Hot spot: none
- Gr. electrode: 22.5 kV/cm
- HV electrode: 44 kV/cm
- Homogeneity:0.7 kV/cm



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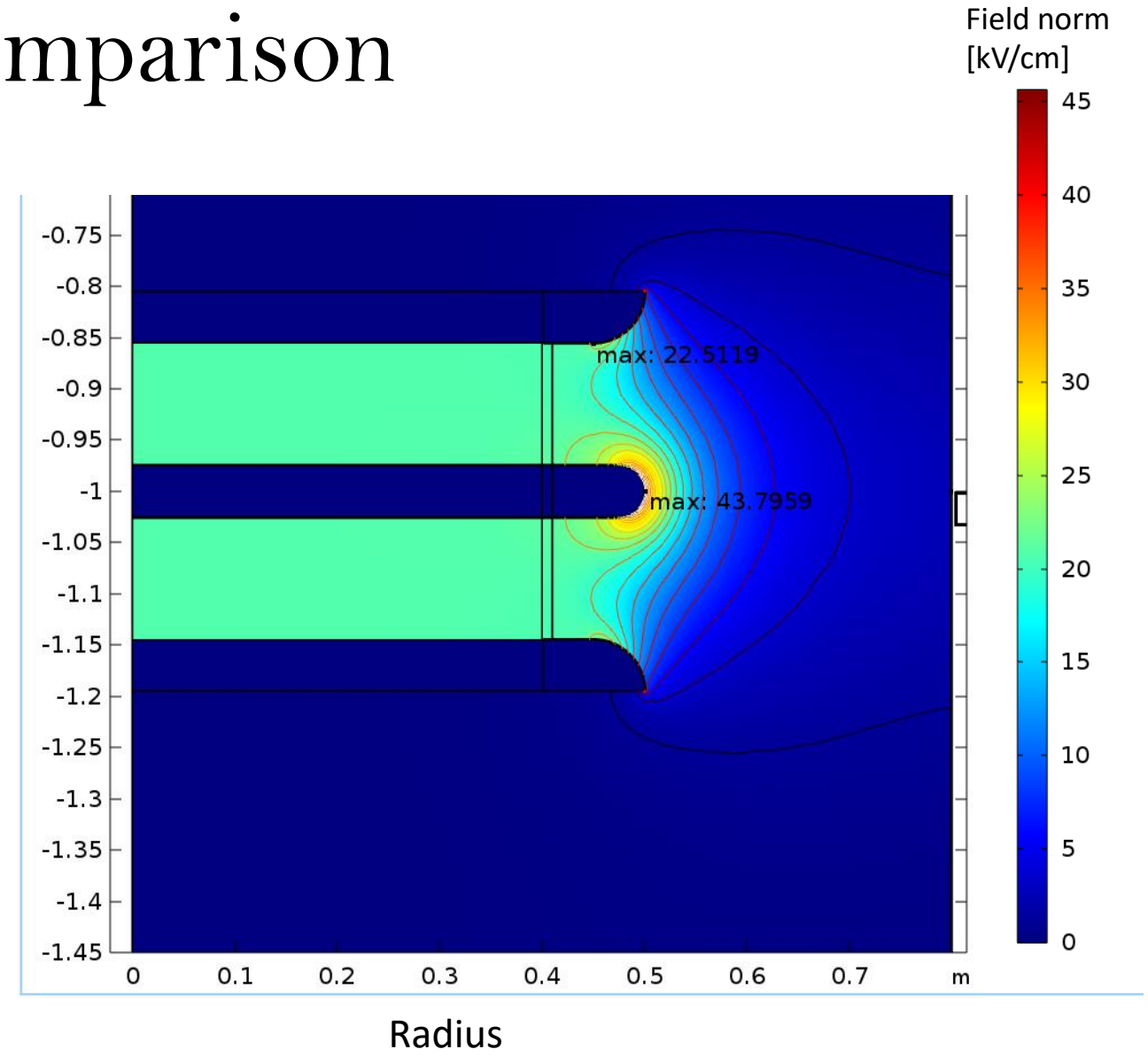
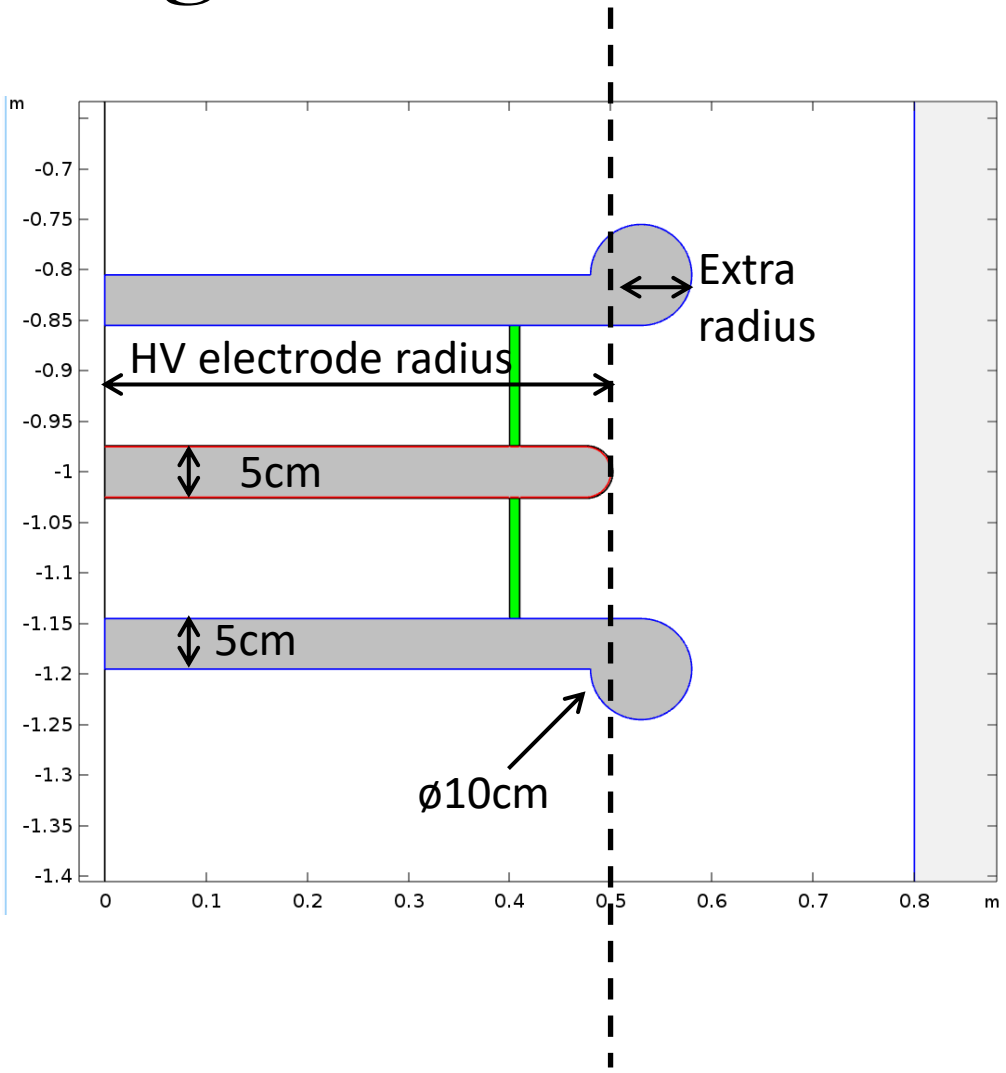
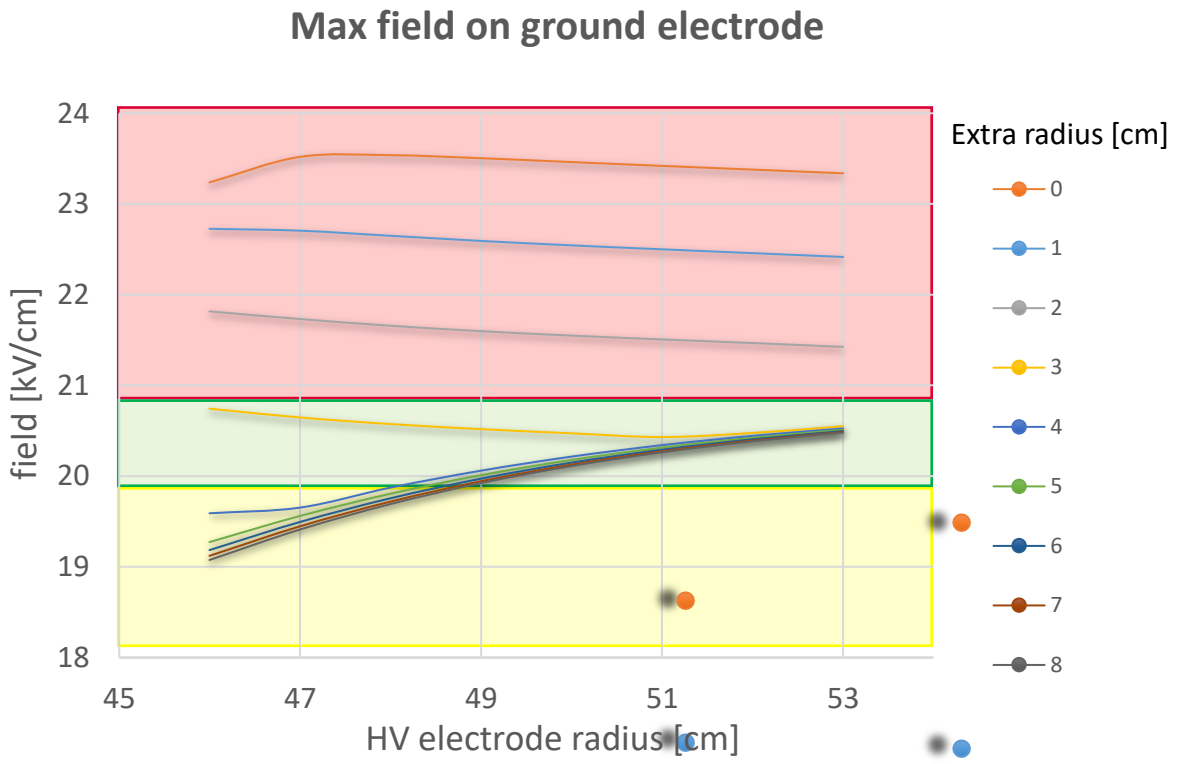


General design

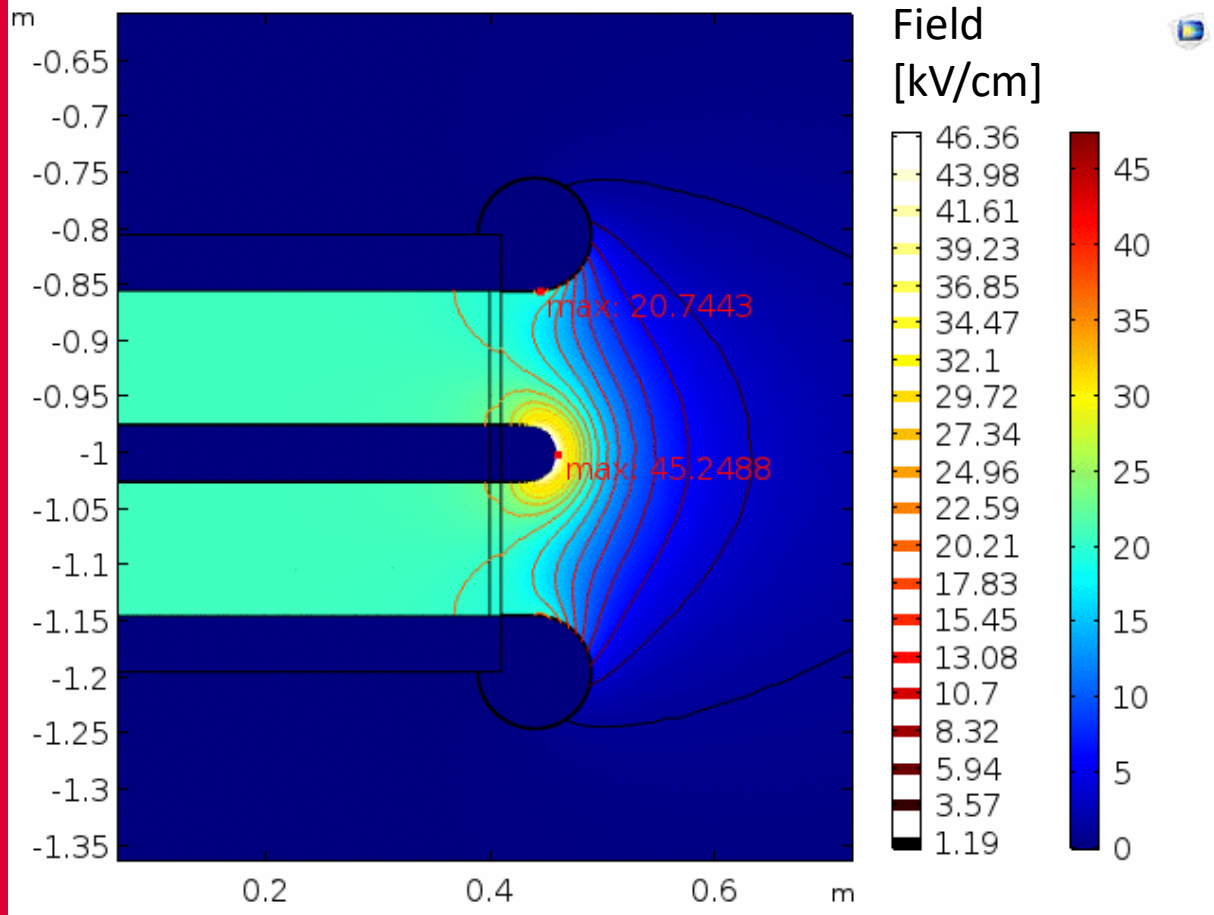
Length of electrodes



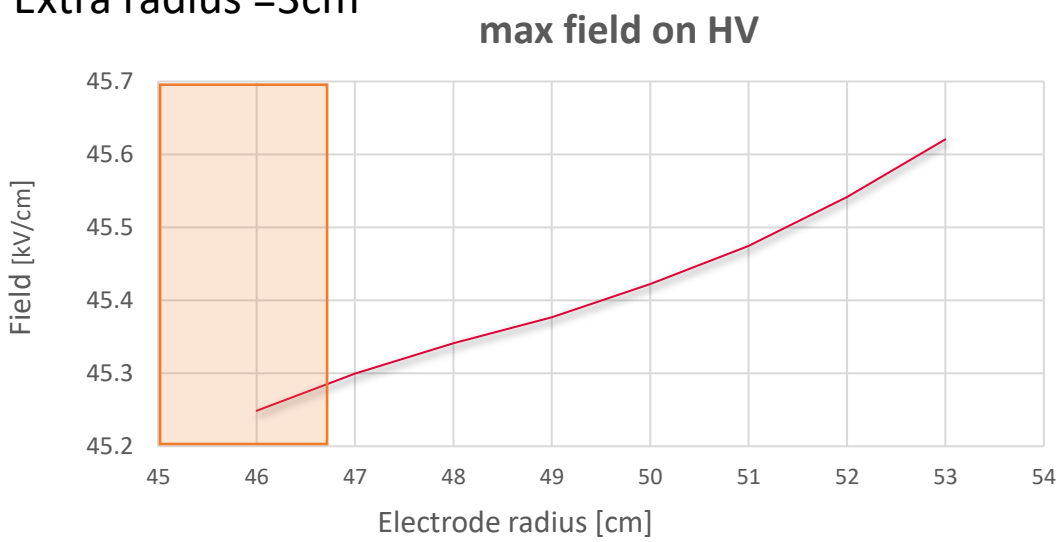


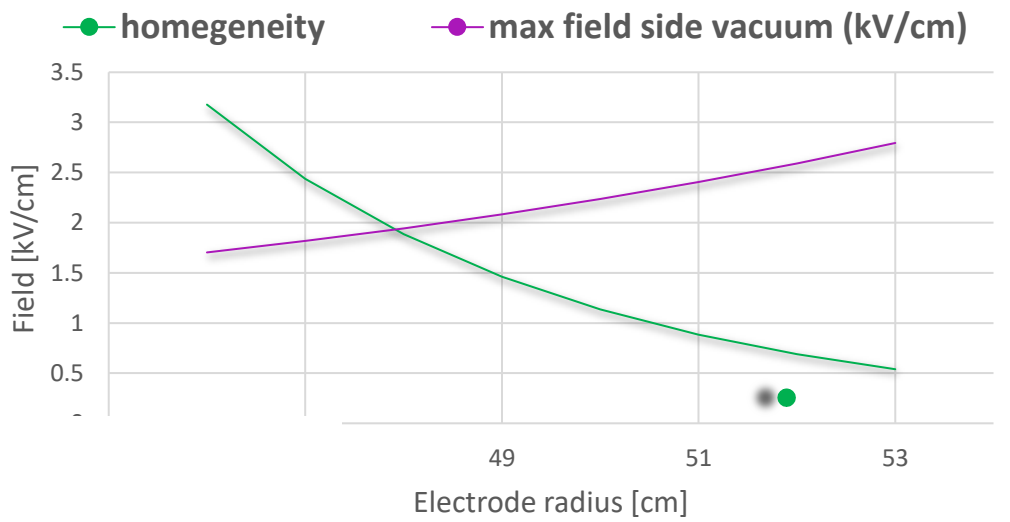
Extra length ϵ [3,4] cm

Length of electrodes



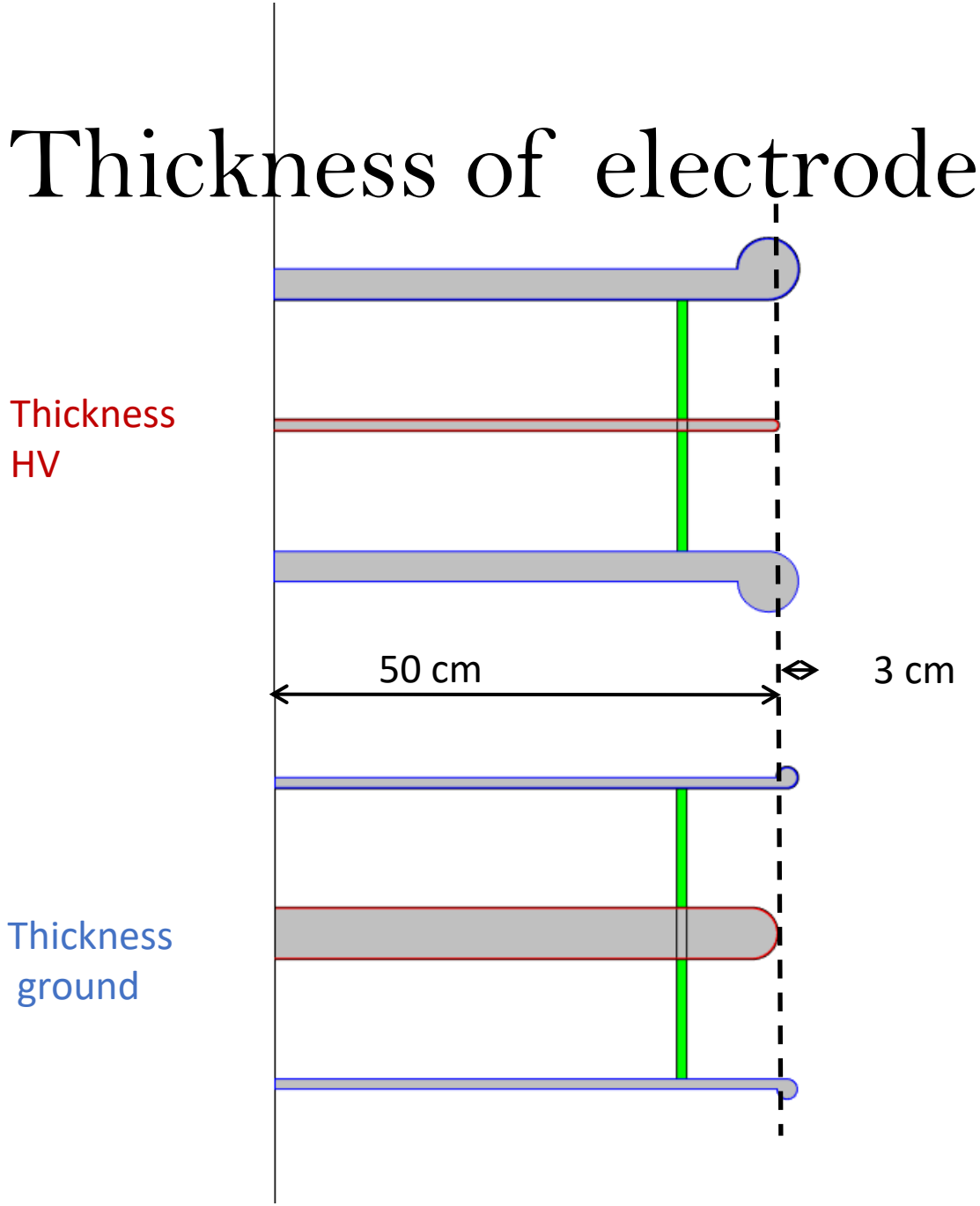
Extra radius =3cm

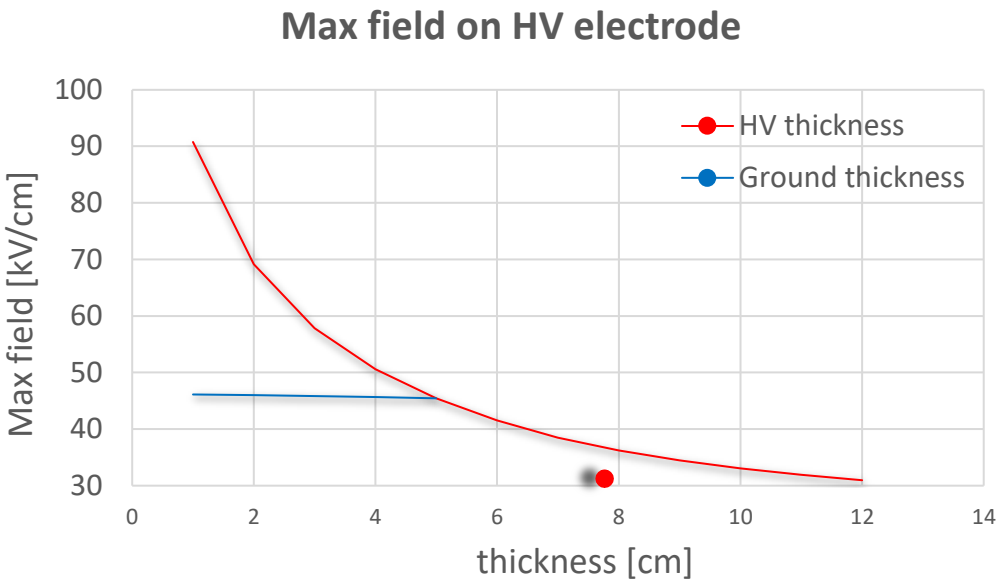


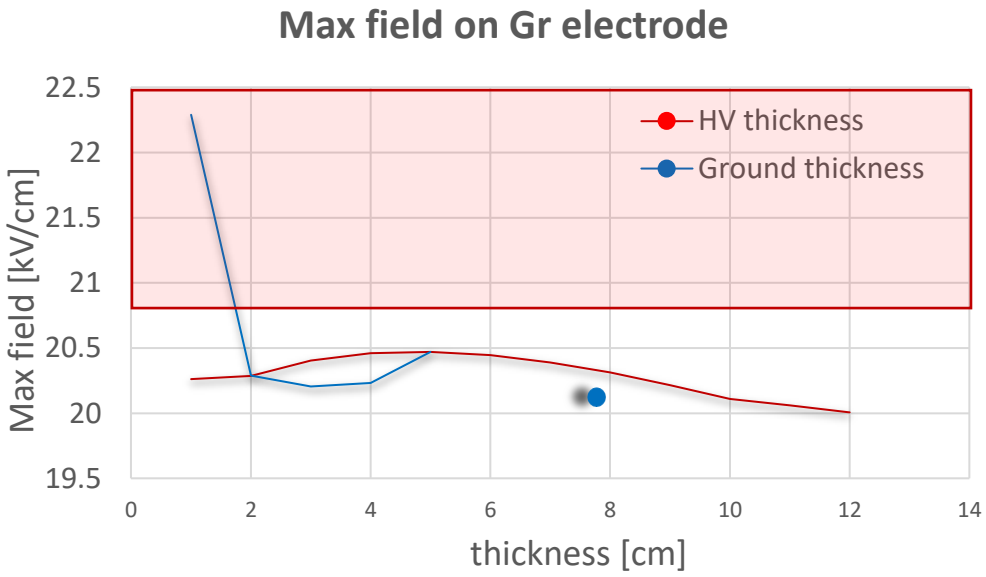


Electrode radius ≥ 47 cm

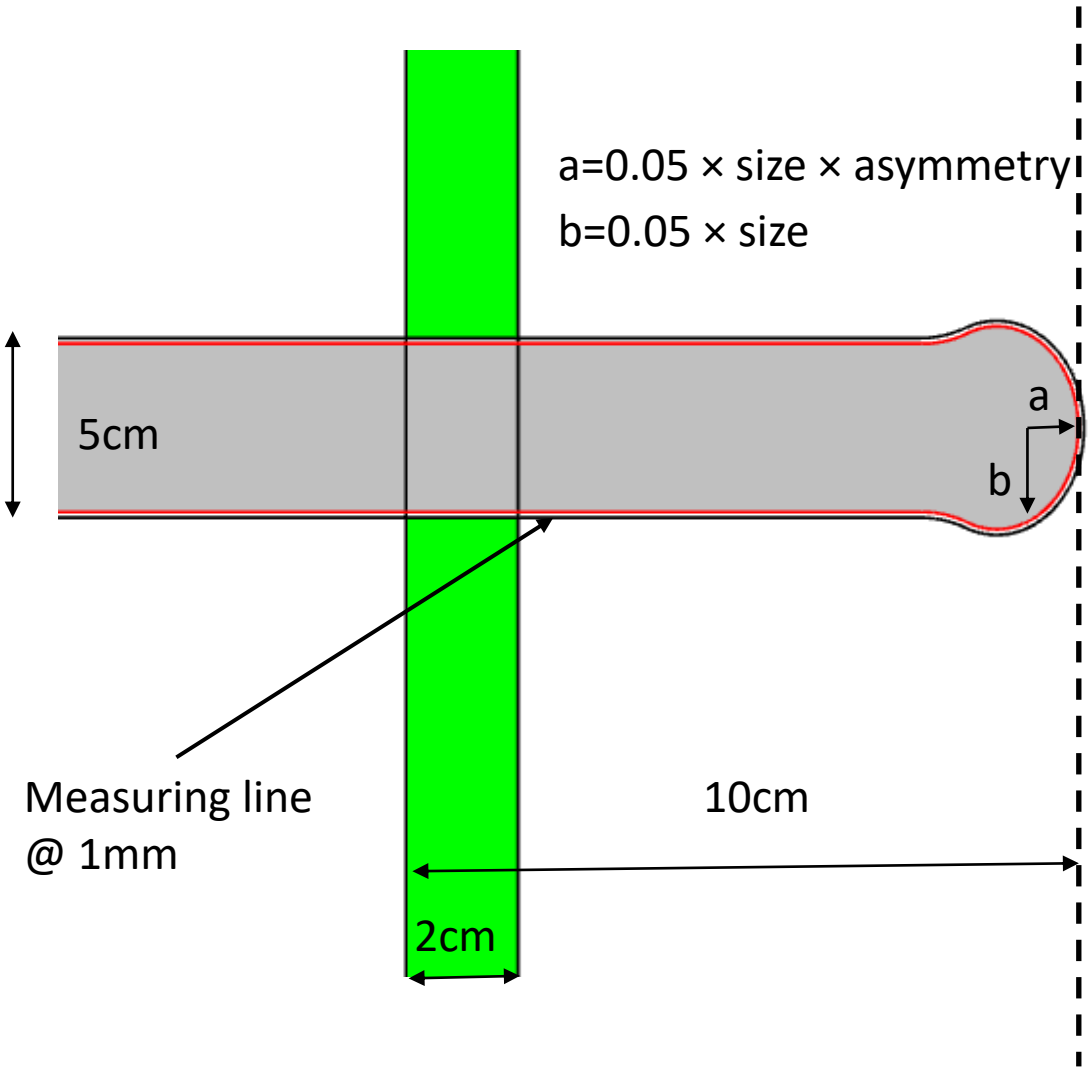
Thickness of electrodes

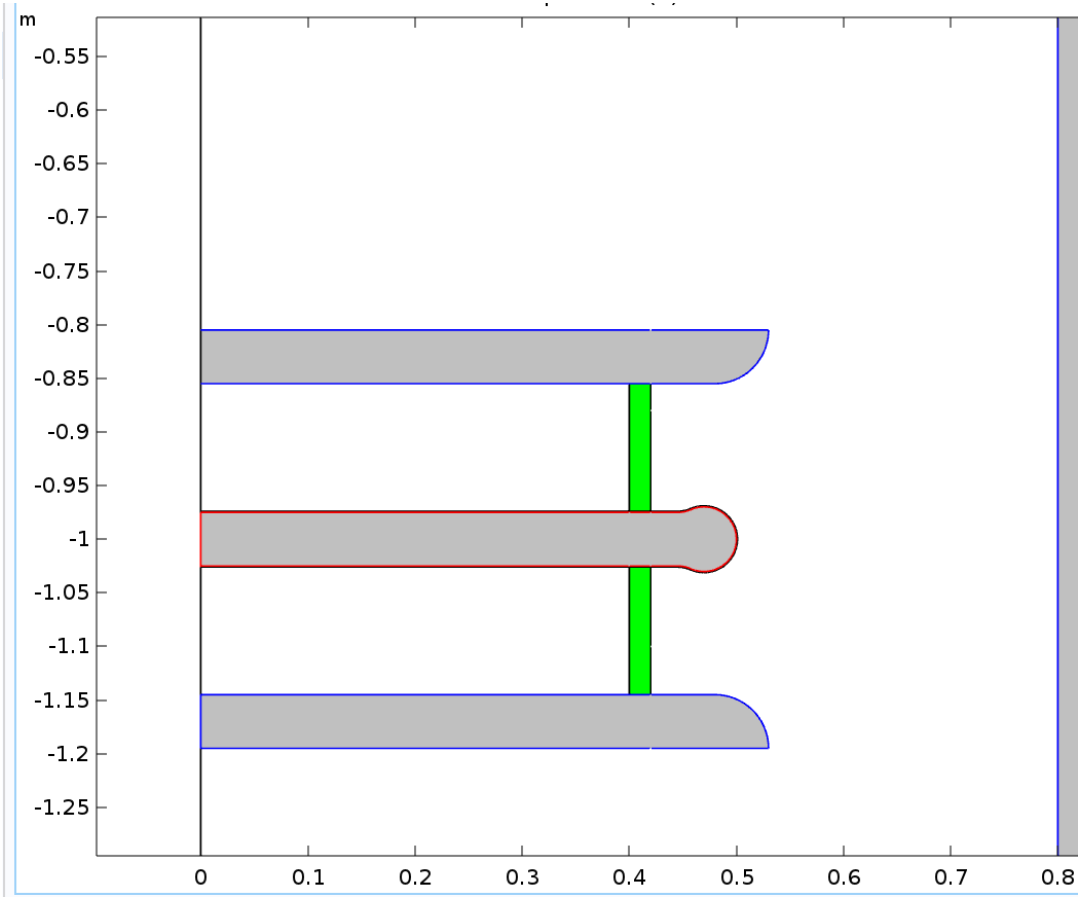






Corona on the HV electrode





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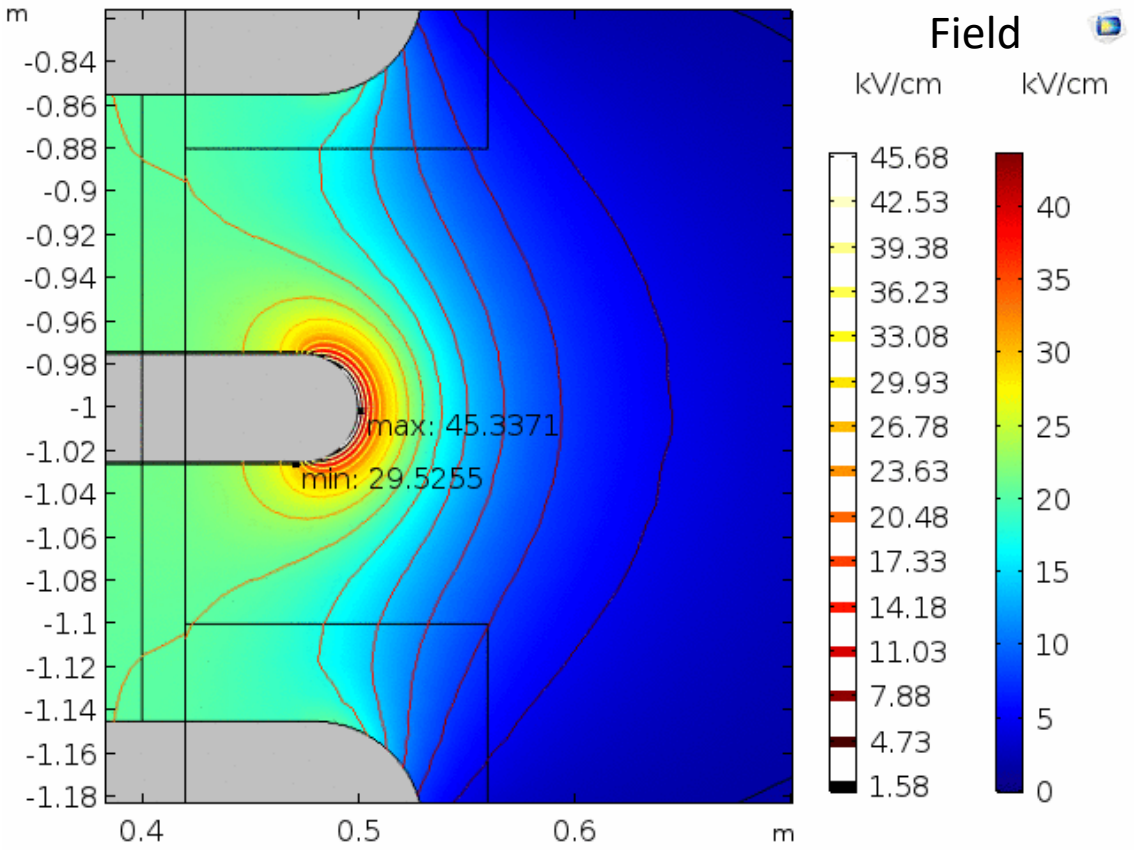
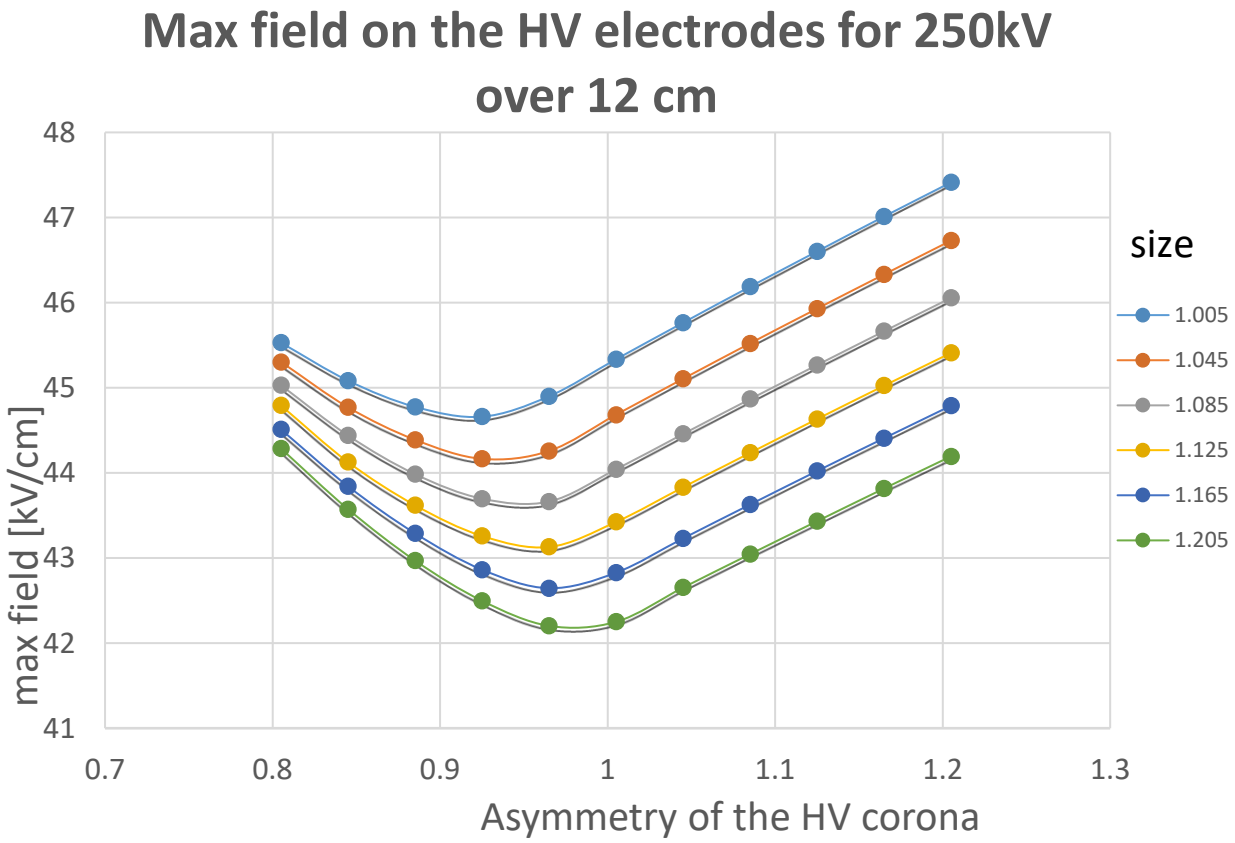


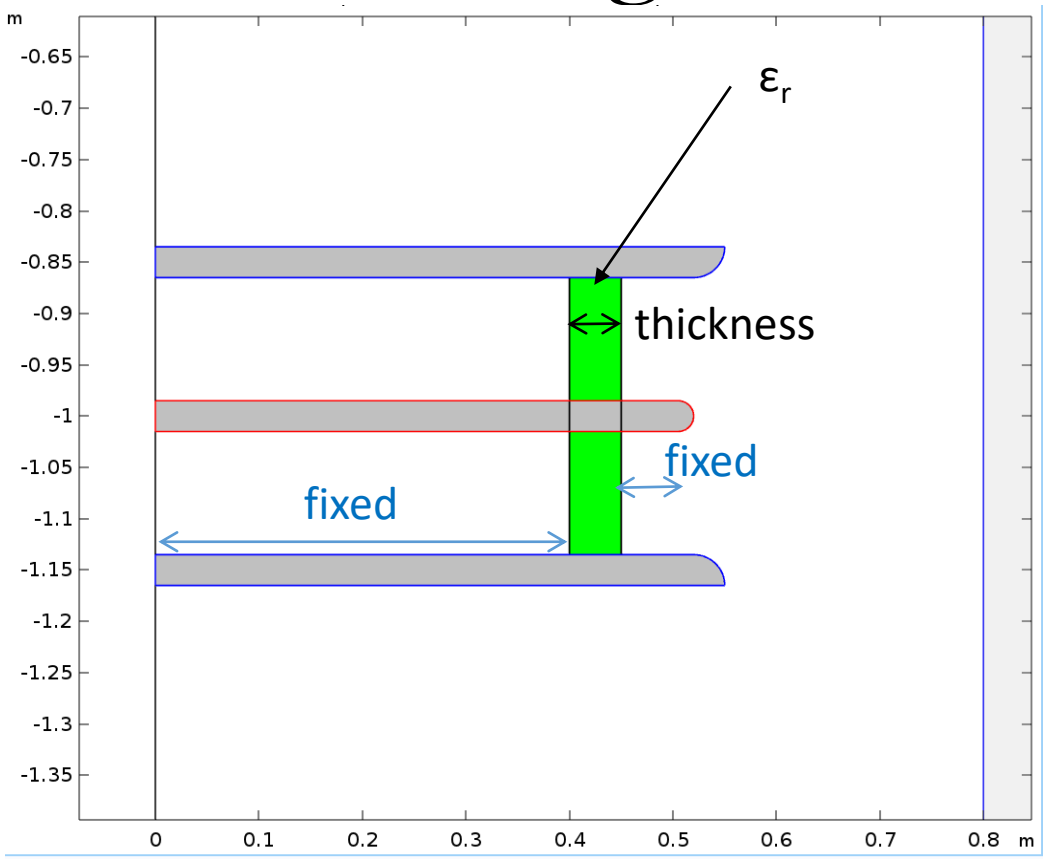


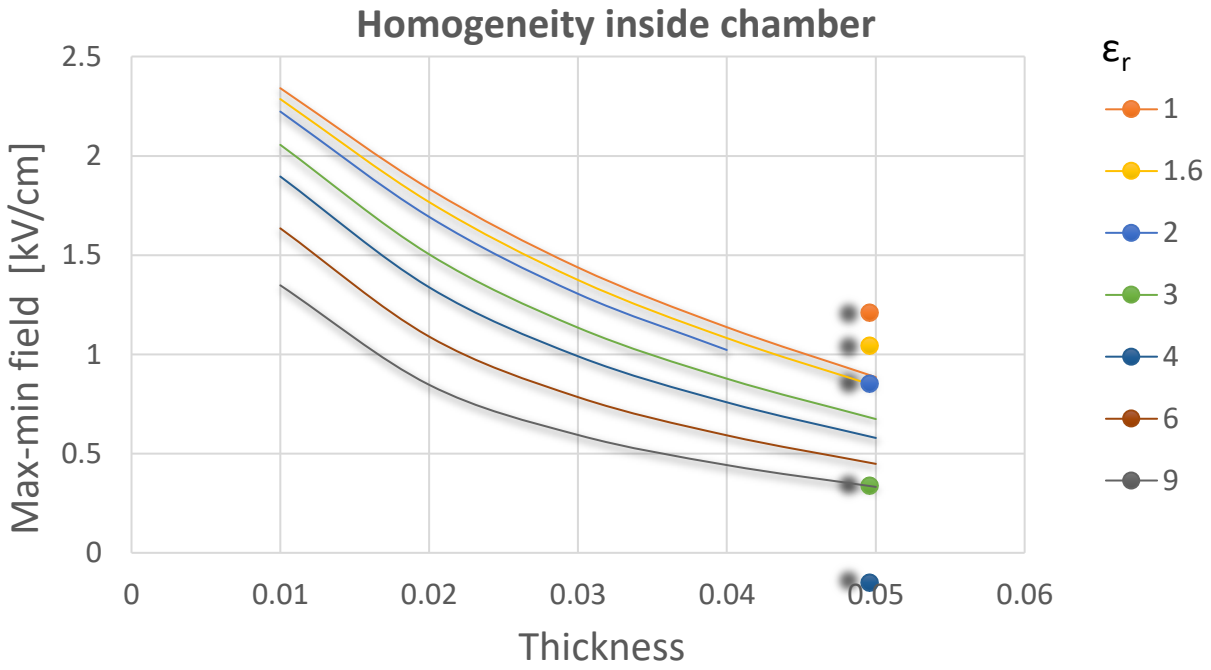
Asymmetry ~ 1

Relative size ~ 1.2

⇨ 8% lower field on HV

Insulator ring





Thicker = 'GOOD' for Homogeneity

Design dependent of mechanical constraints!

Protecting cage

Max field on the chamber

- With 7 rings :

  0.07kV/cm

- With 3 rings :

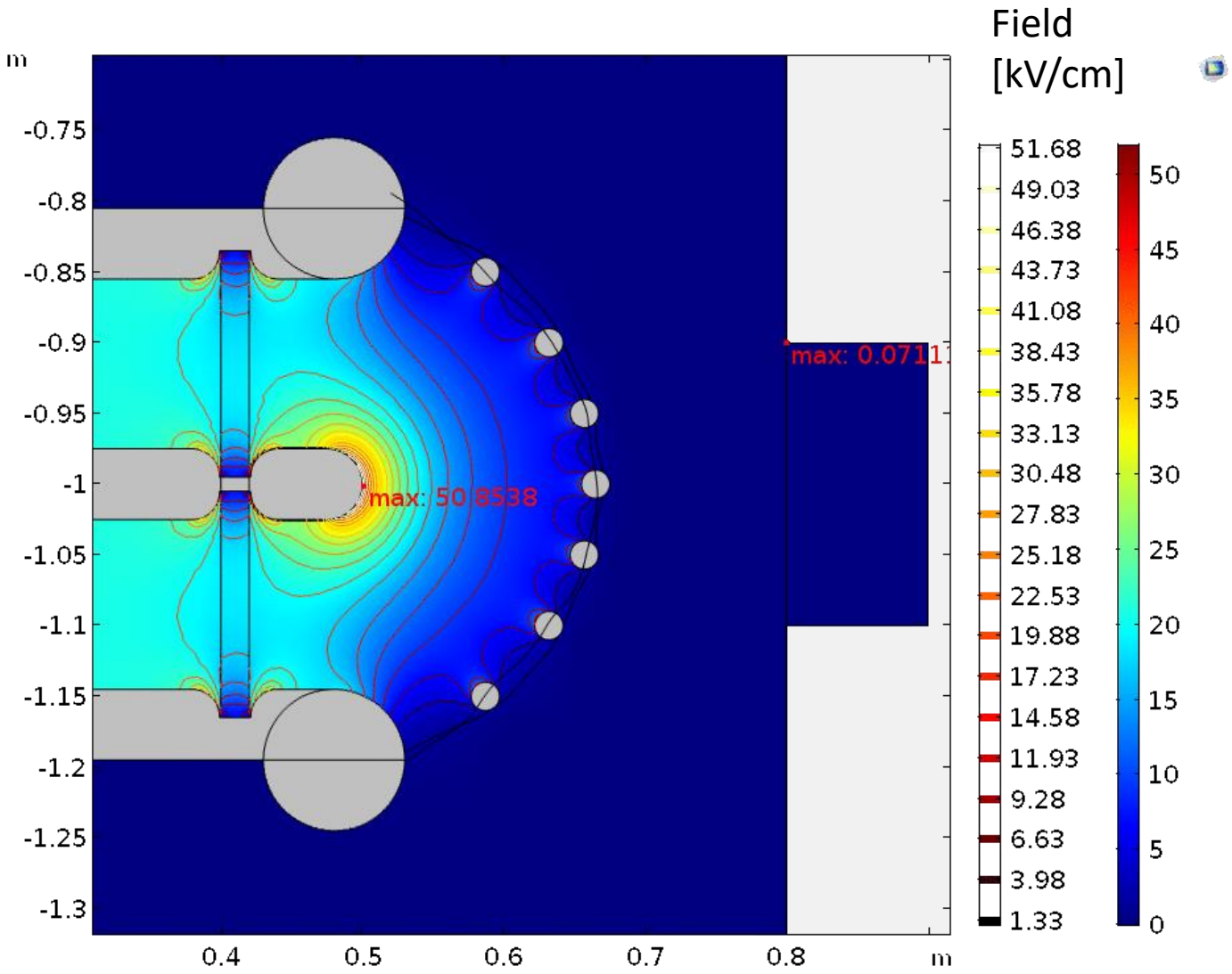
  0.49kV/cm

- Without:

  hot spot ?

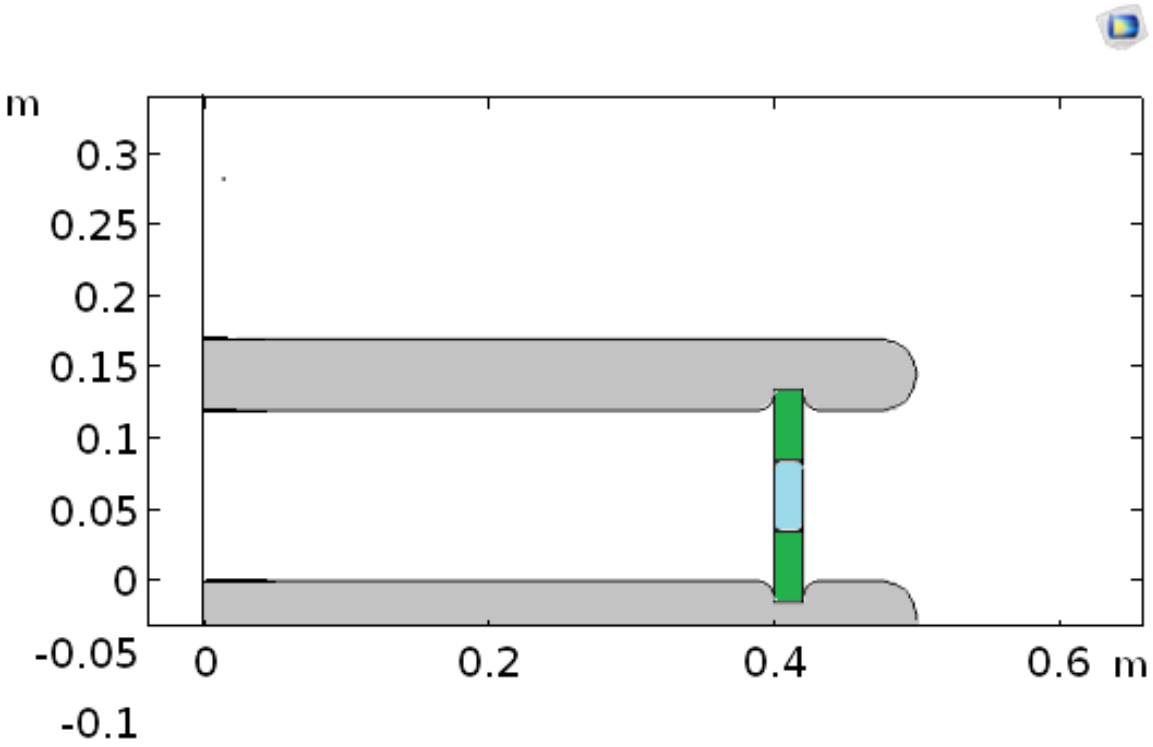
  3.19 kV/cm at least

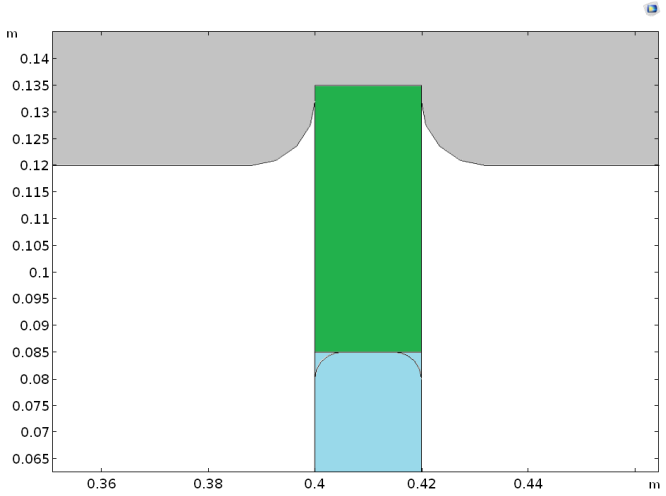
Without sharp edge

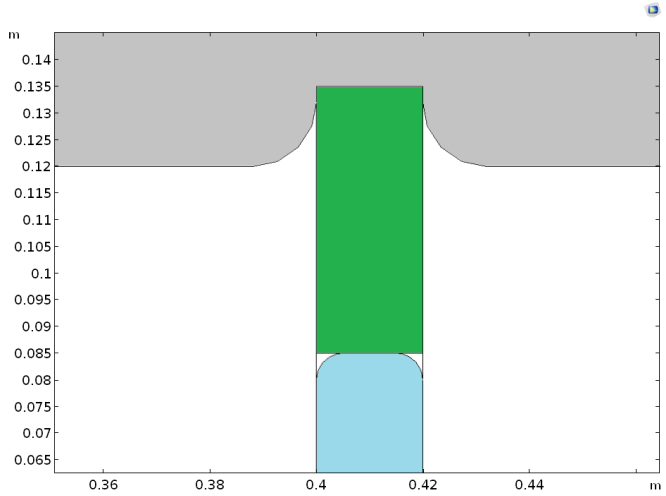


Design of the details

Quartz window: first ideas for n2EDM

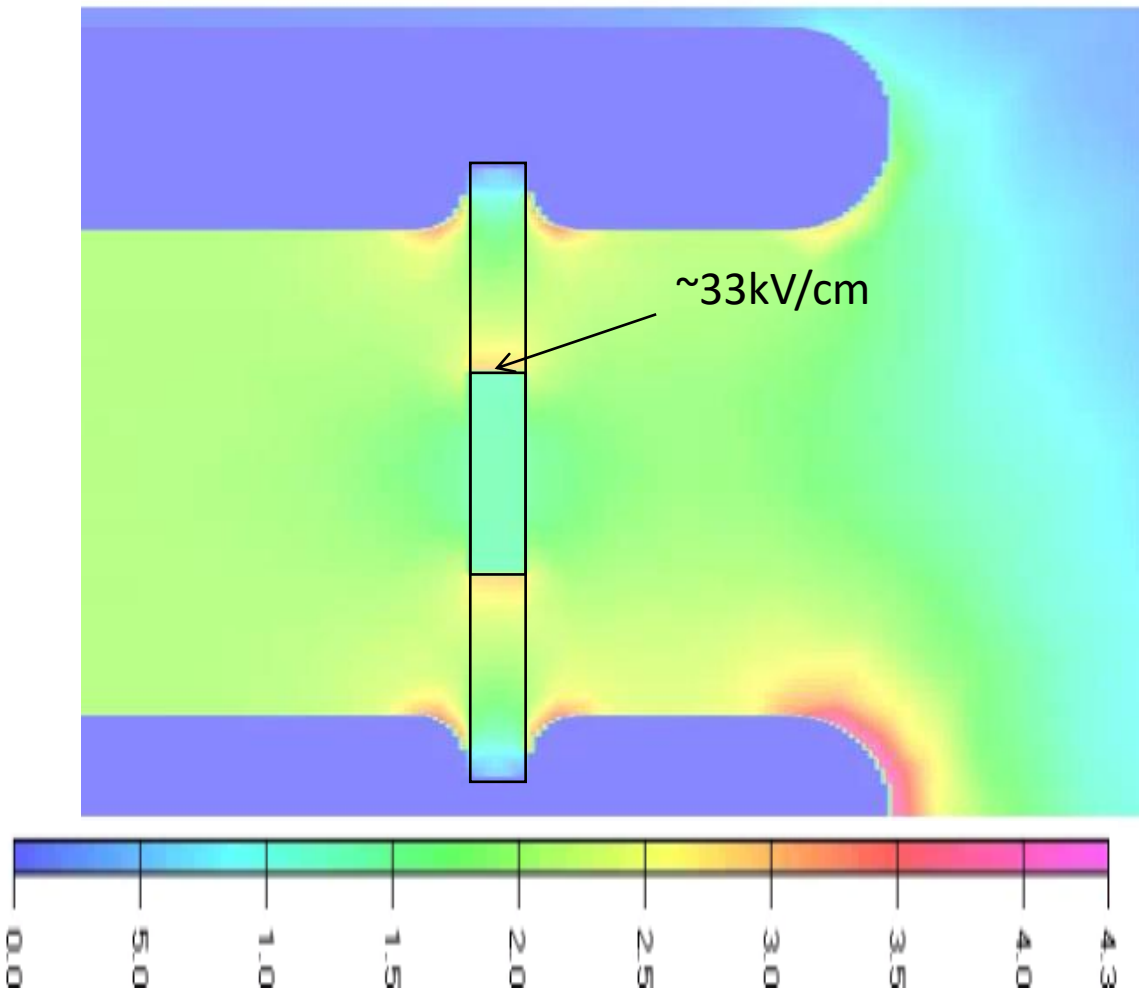


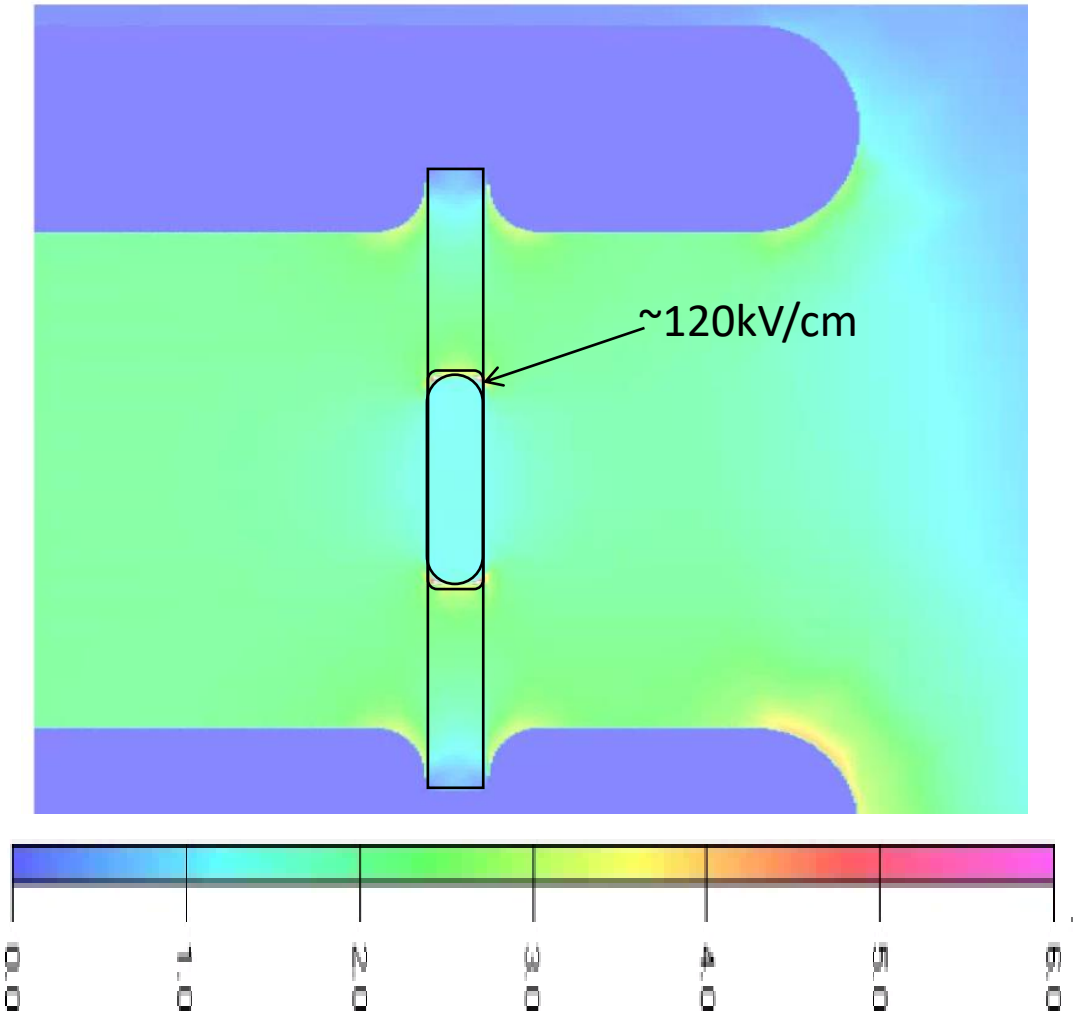




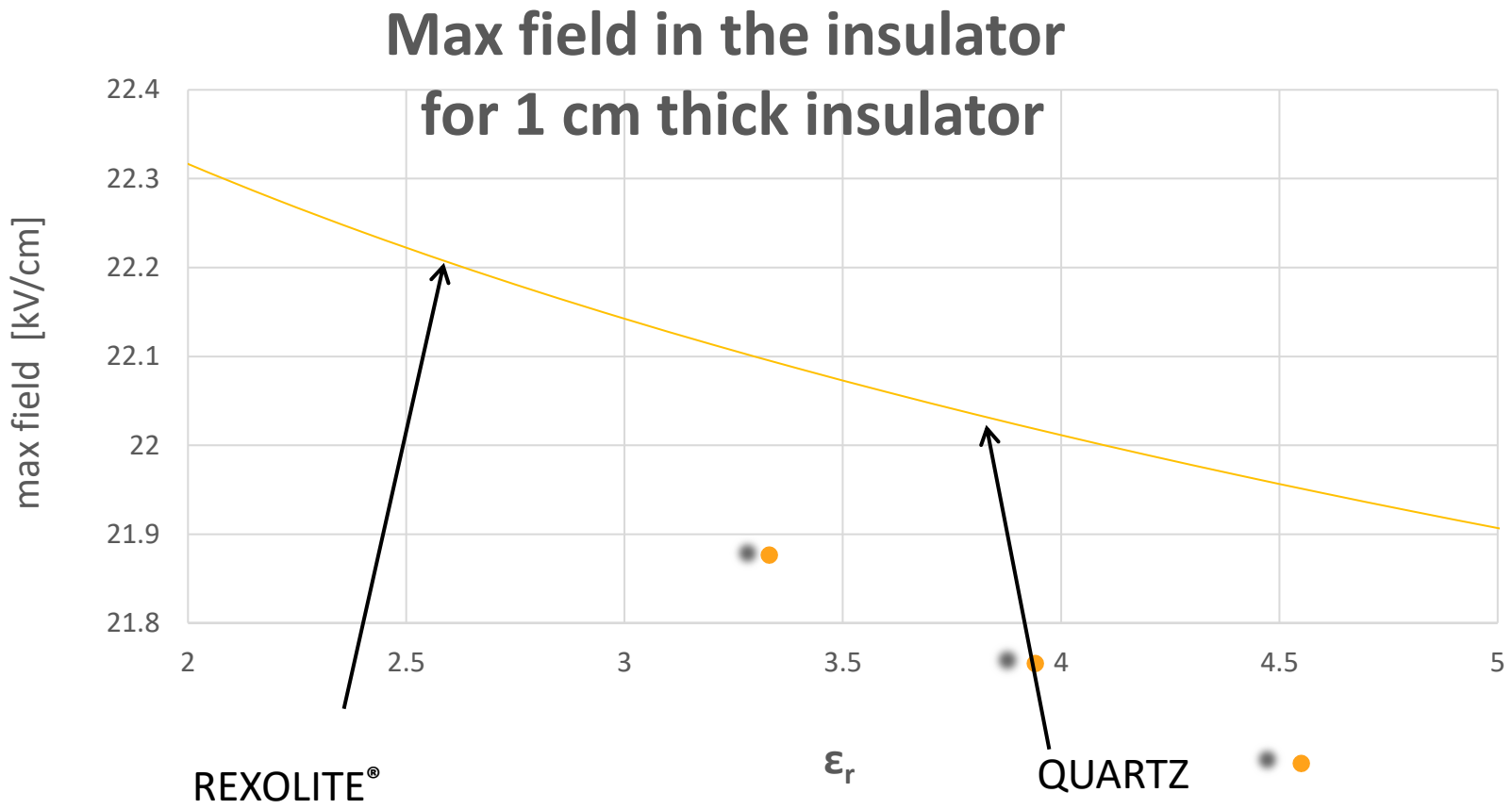
Opera design from Jacob

Quartz window

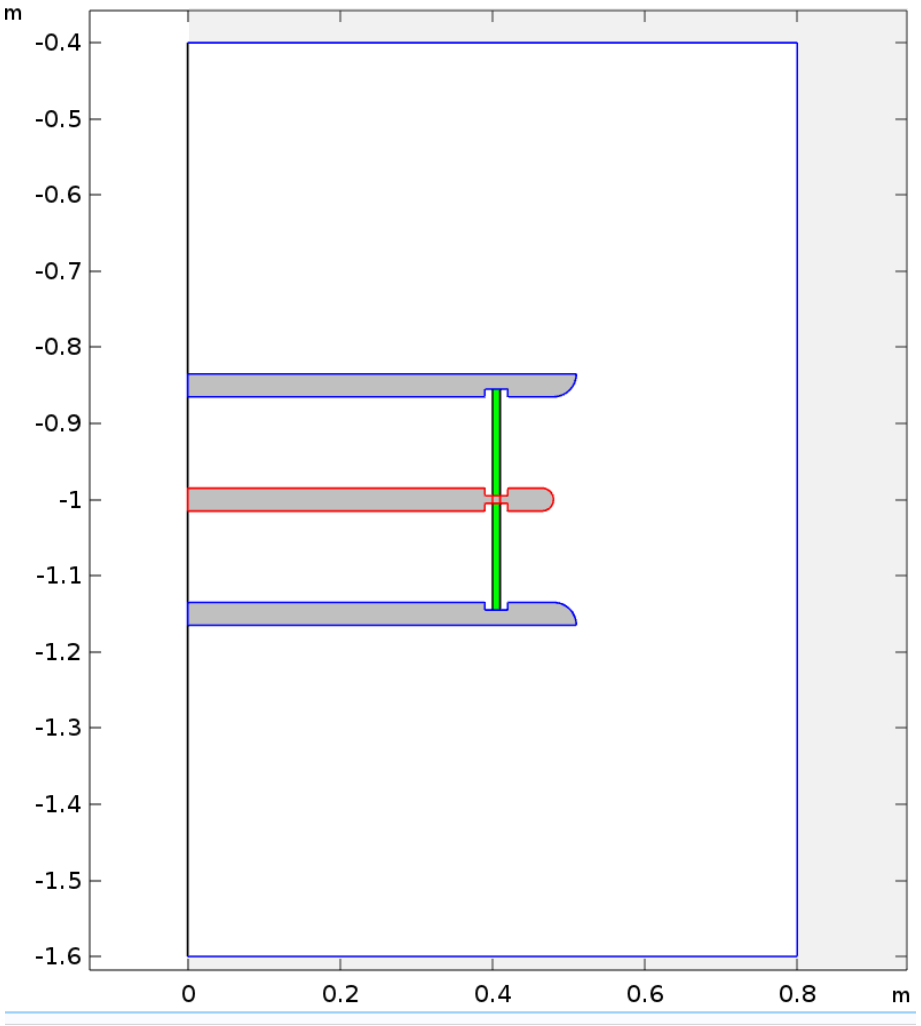


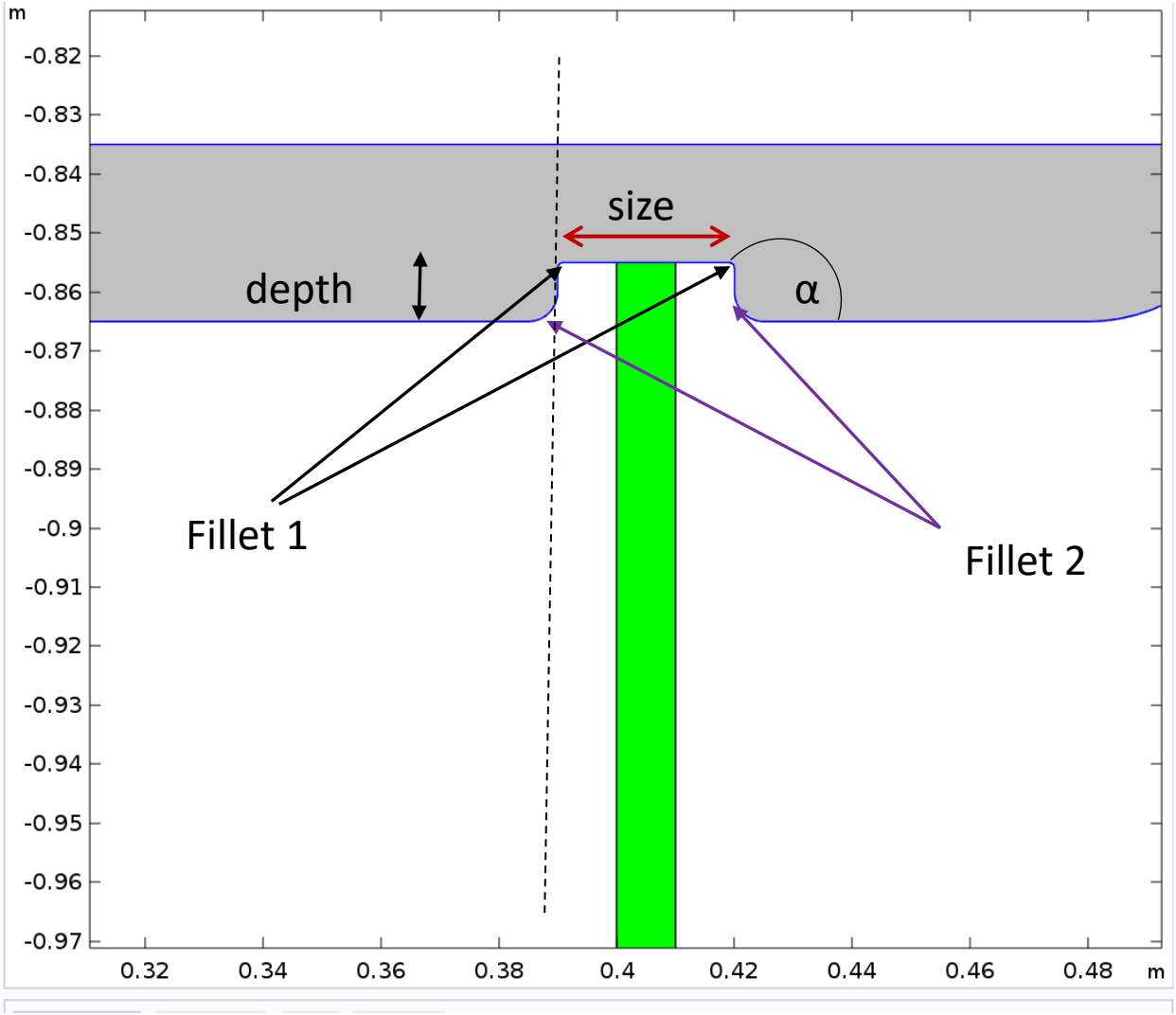


Quartz window: insulator material test for n2EDM



Groove geometry

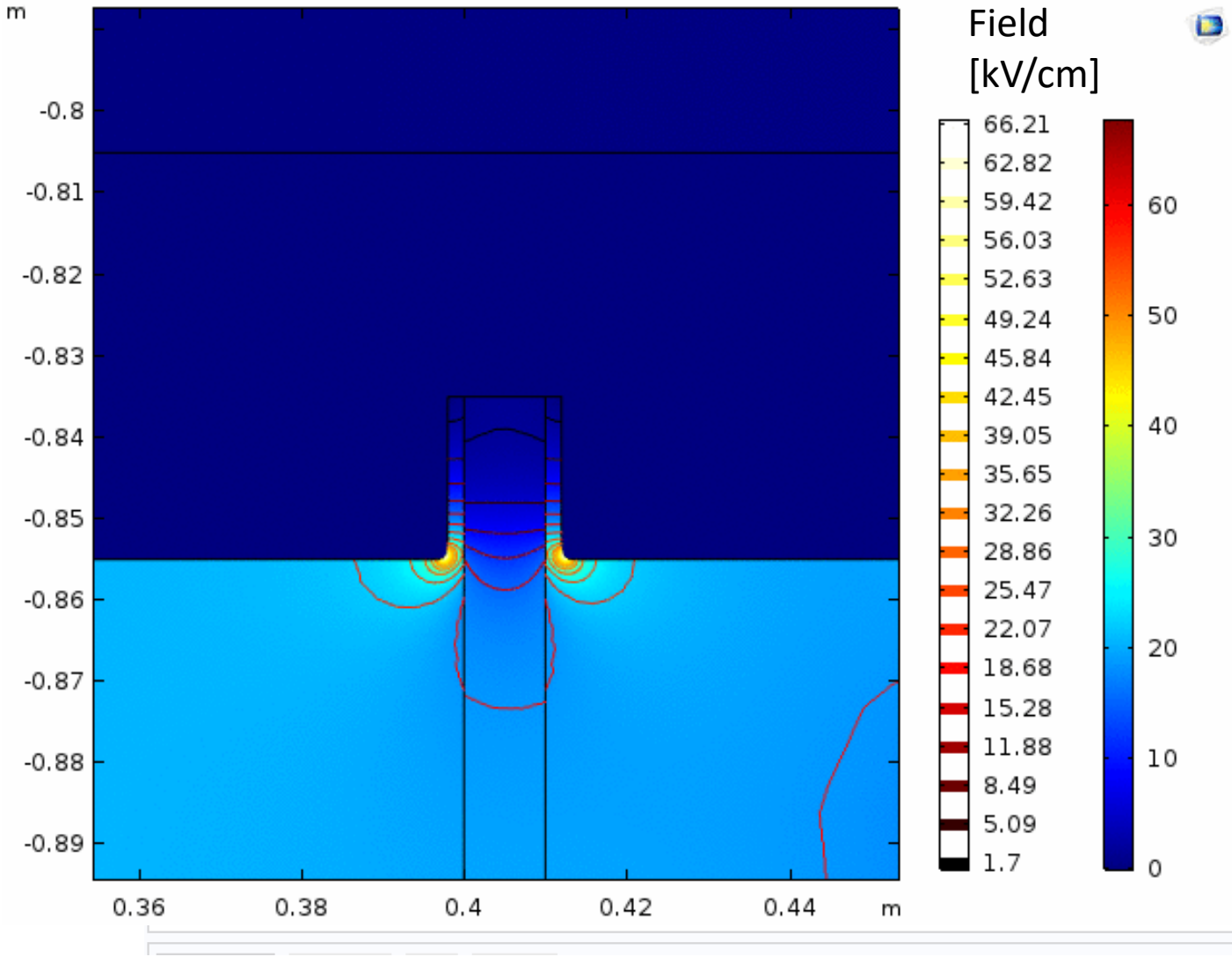




Groove geometry

		nEDM (previous) design:
Depth	↗	15mm
Size	↘	~20mm
Fillet1	—	0
Fillet 2	↗	R=12mm
α	—	90°

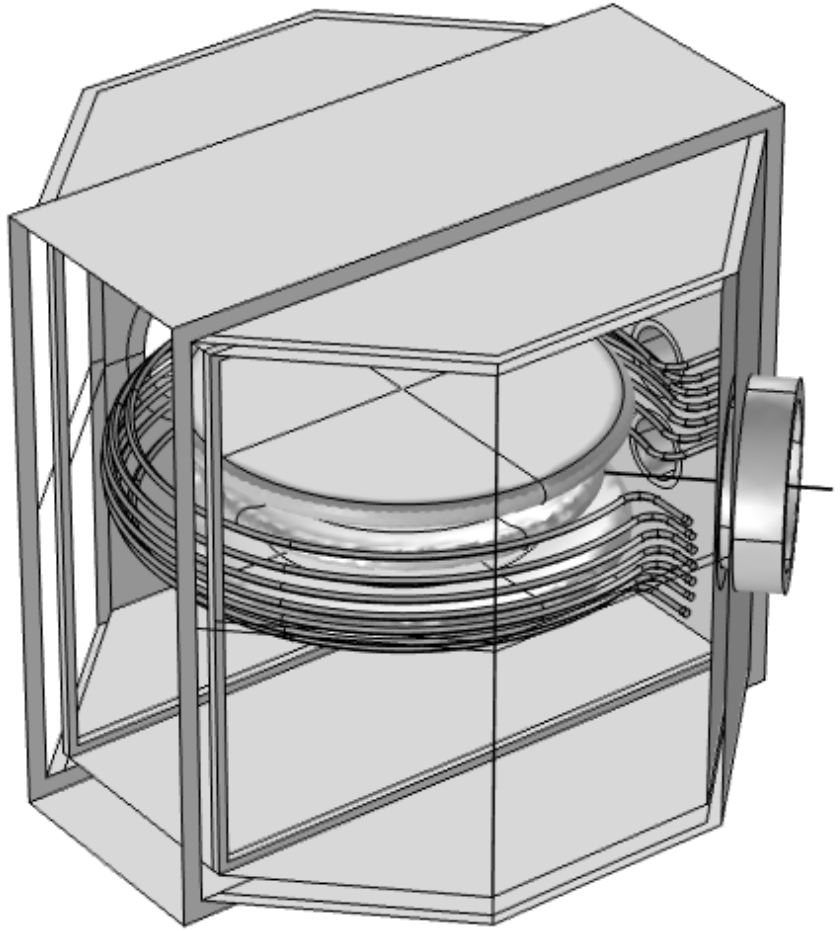
Depth as much as possible
Fillet 2 r = Depth
α =90° (easier to machine)
Size - as close as possible ?



Proposition of design

PROPOSITION

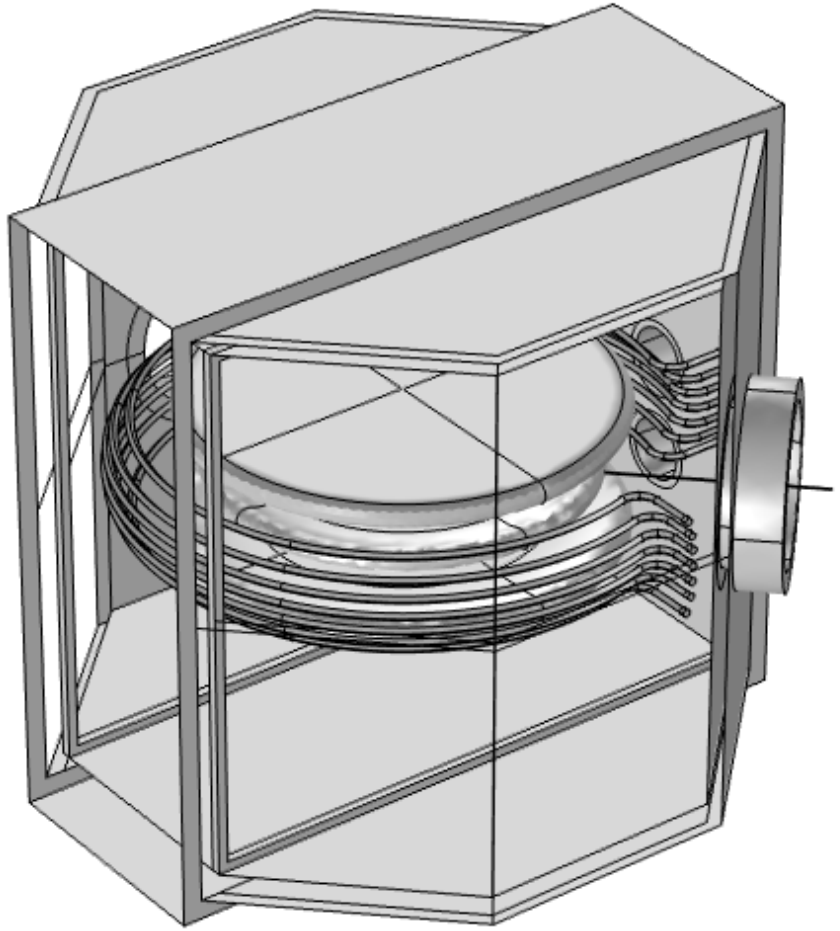
Overall design



Comsol design from Andrew Mullins

Parameters	Values and comments
Radius of HV/Gr	HV ≥ 47 cm Gr ~ HV + 3 or 4 cm
Thickness HV/Gr	HV>4cm Gr~ 3cm with sphere
Thickness of the insulator	>2cm
Corona HV	Asymmetry 1 Size [1,1.2]
Protection cage	Yes ~ 3 rings ?
Feedthrough	On going
Groove	deep outside fillet Square shape
Quartz window	Insulator thickness

Overall design



Comsol design from Andrew Mullins

Quartz window

O-ring

To be continued ….

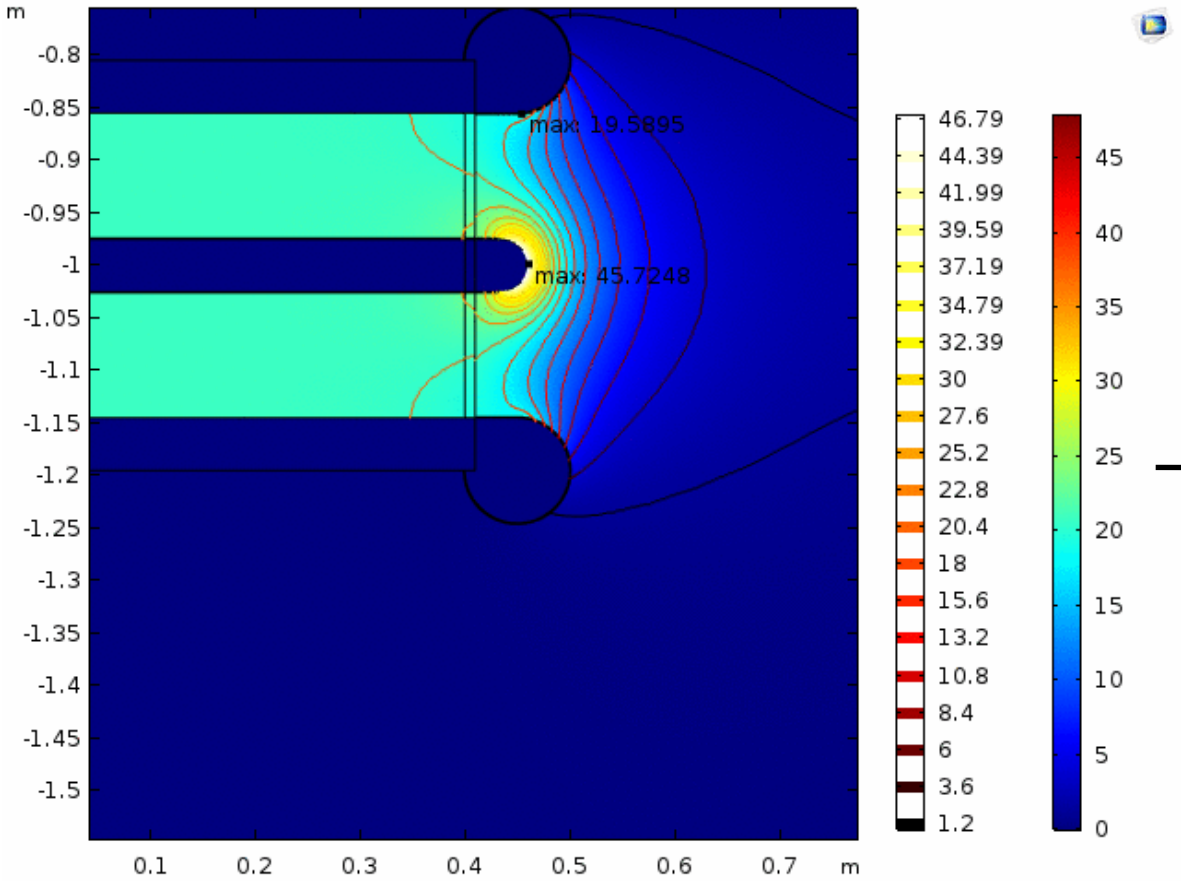
Groove

Protecting cage

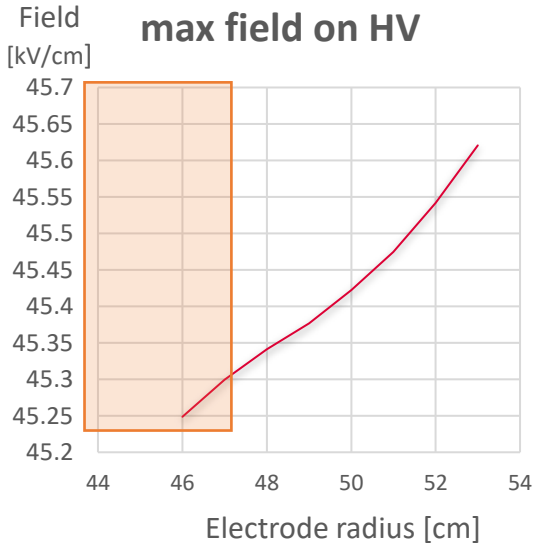
Feedthrough

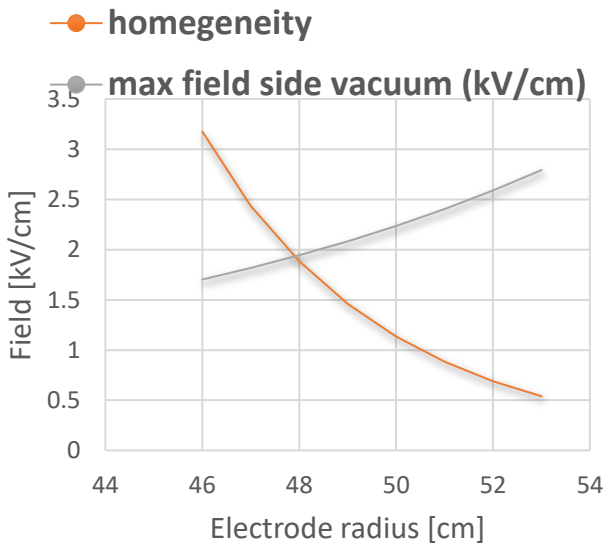
Appendices

Length of electrodes

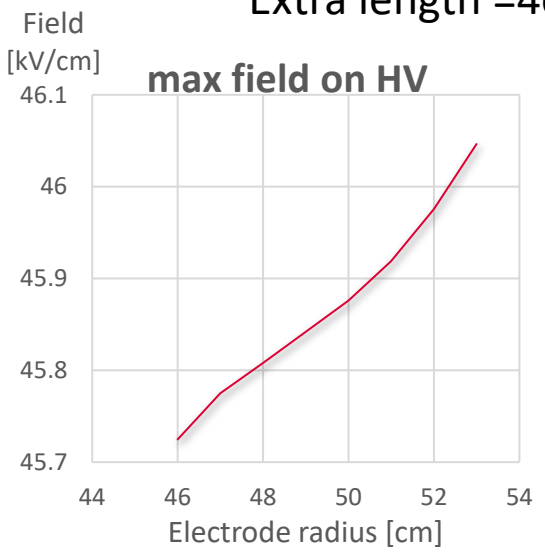


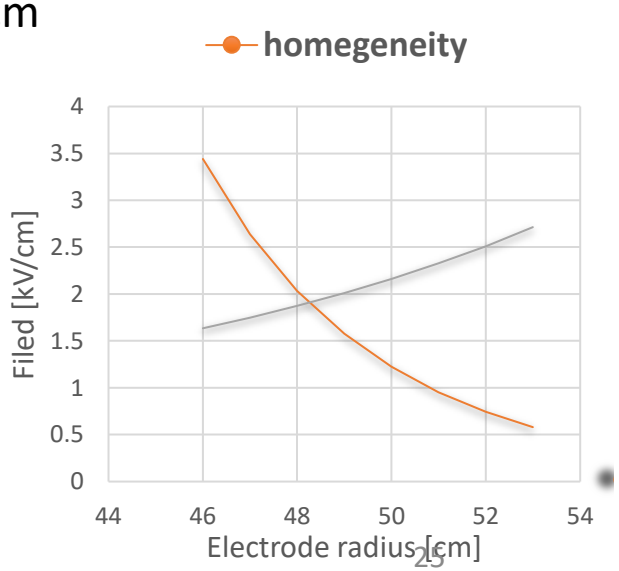
Extra length =3cm





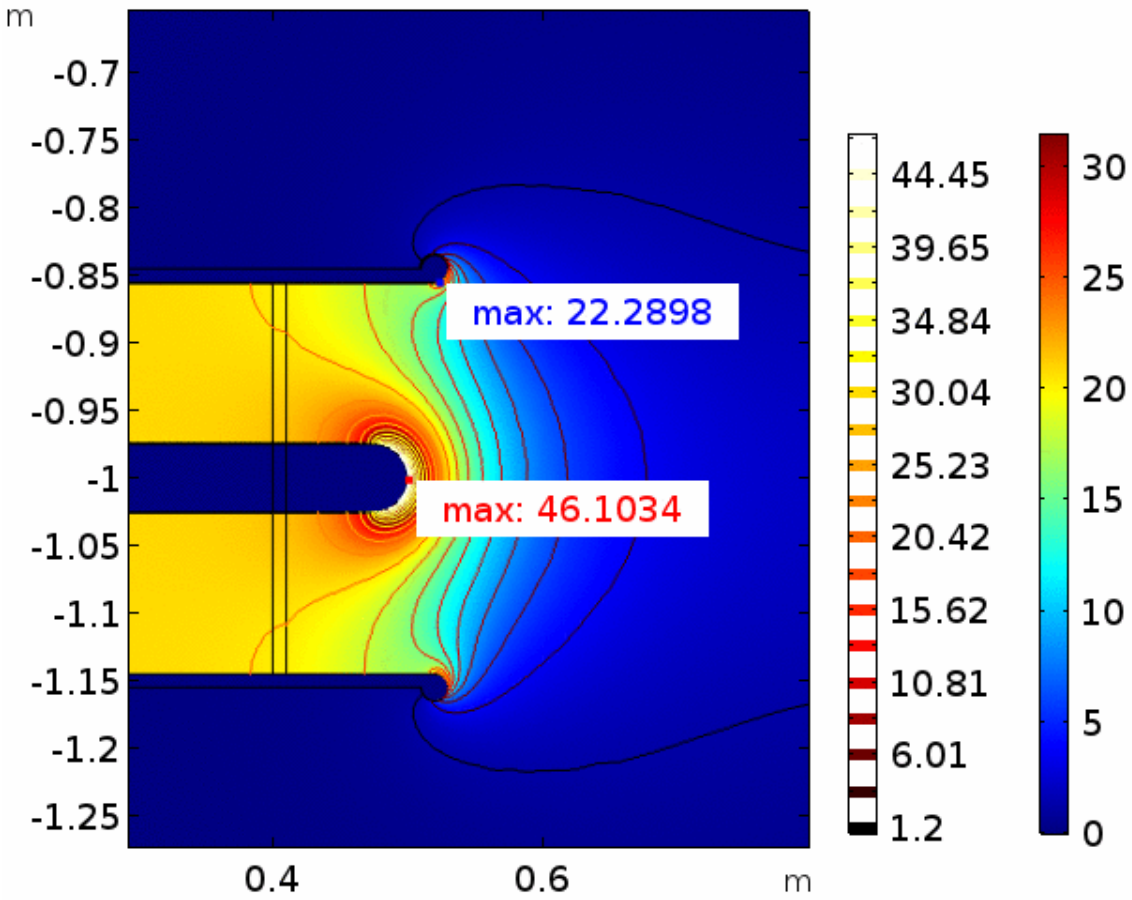
Extra length =4cm

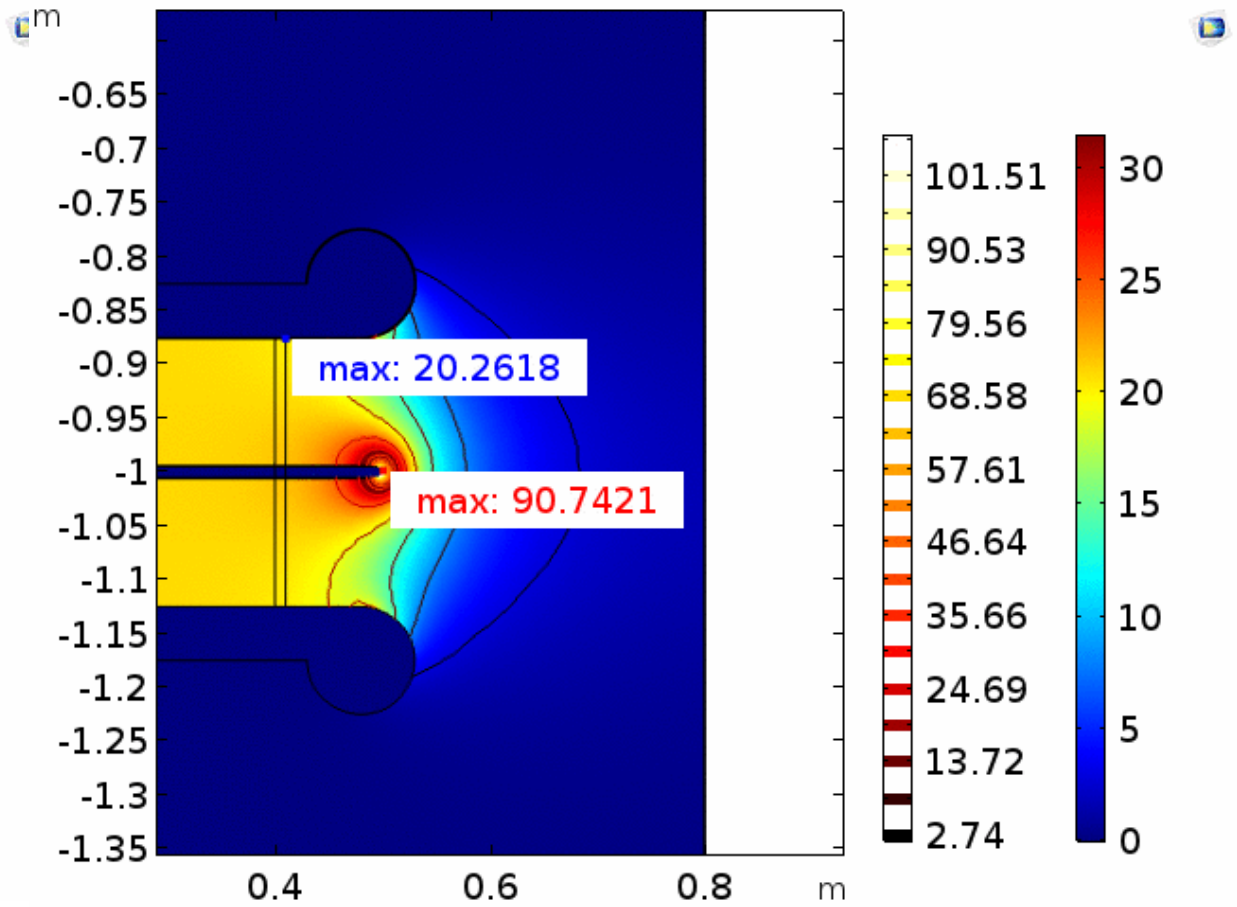




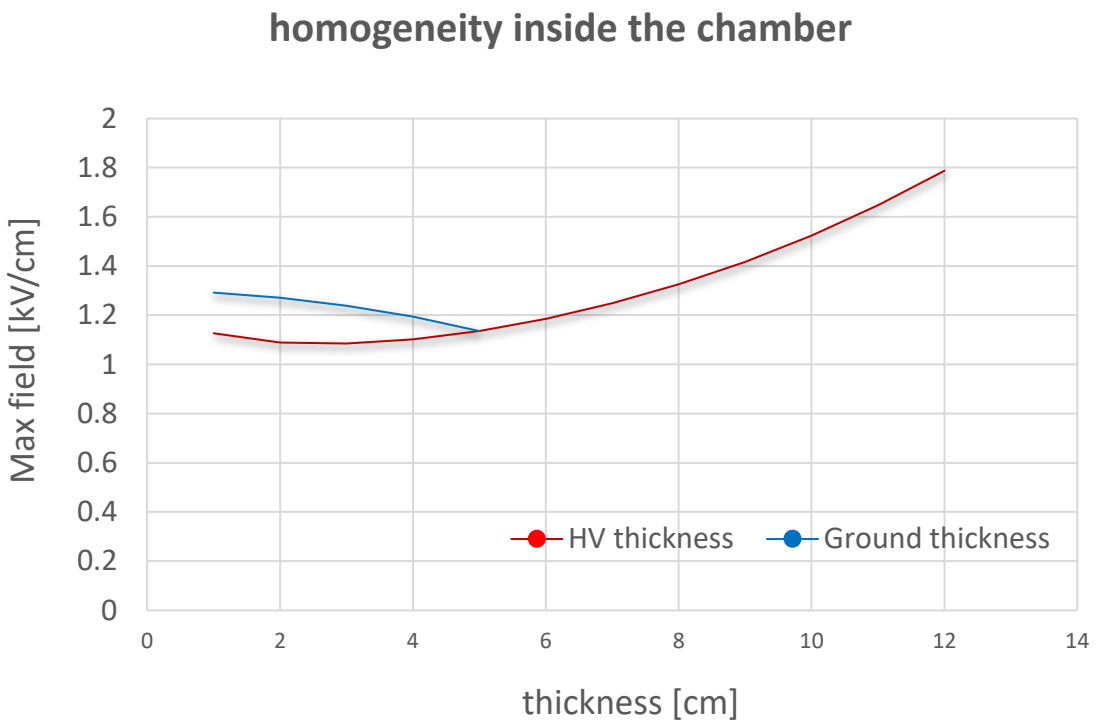
Electrode radius >47cm

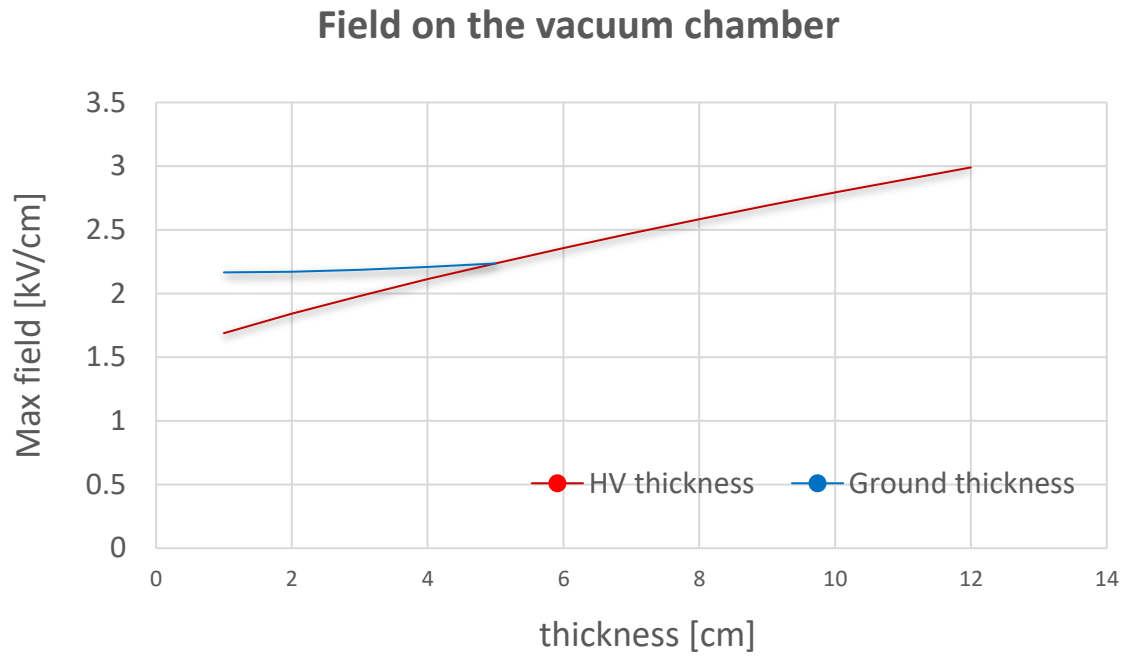
Thickness of electrodes





Thickness of electrodes





Protecting cage

Max field on the chamber

- With 7 rings :

  0.07kV/cm

- With 3 rings :

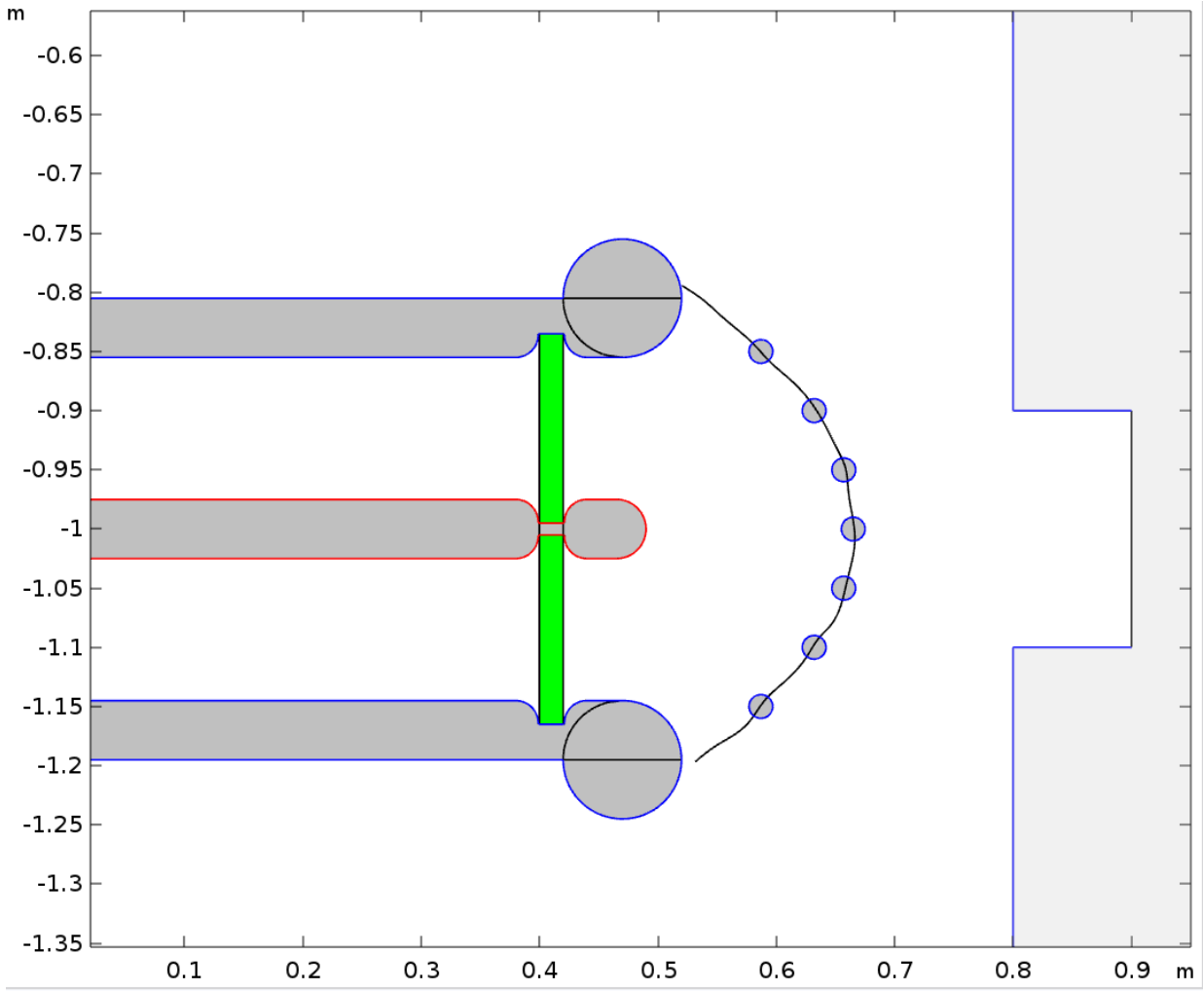
  0.49kV/cm

- Without:

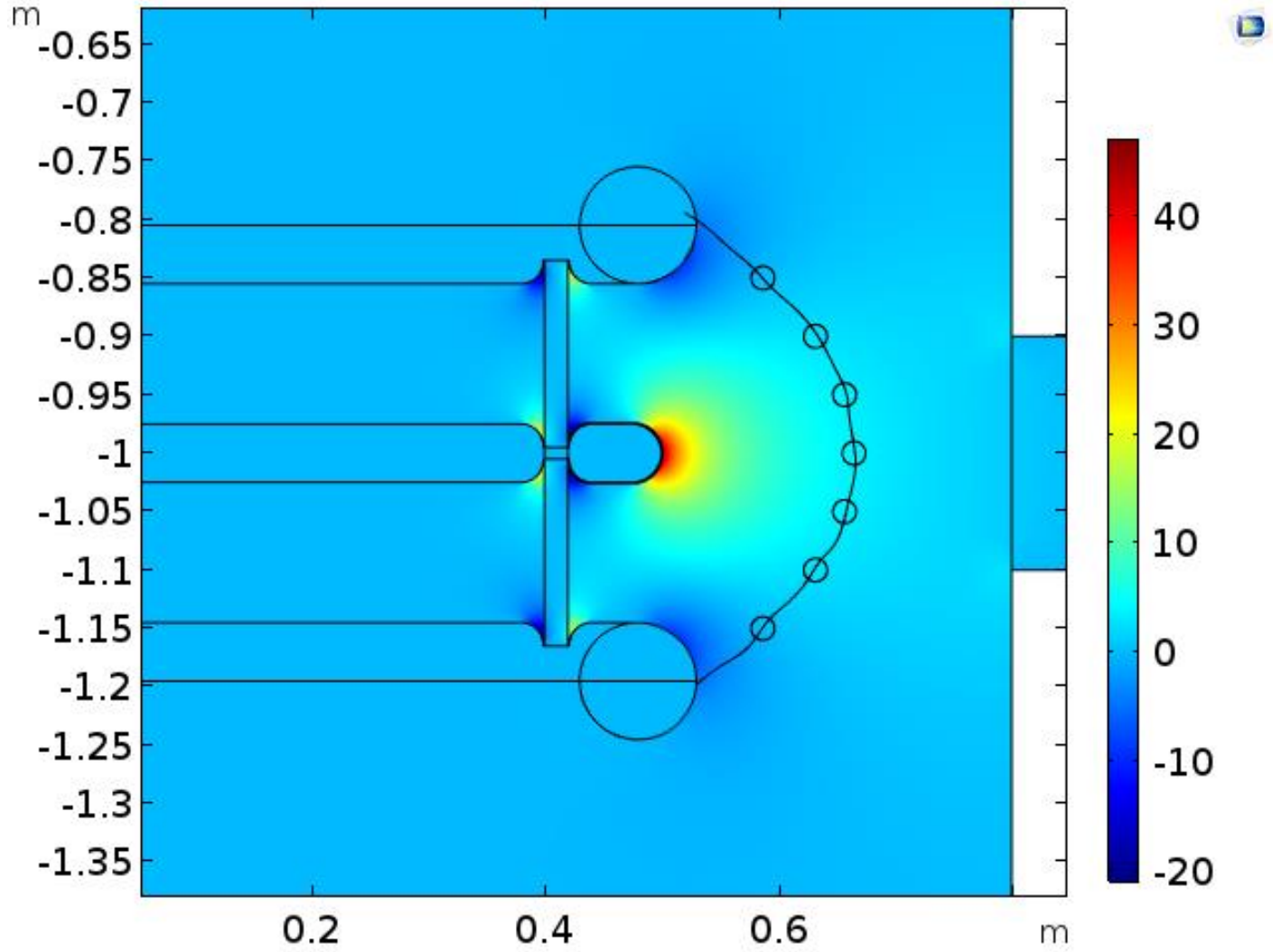
  hot spot ?

  3.19 kV/cm at least

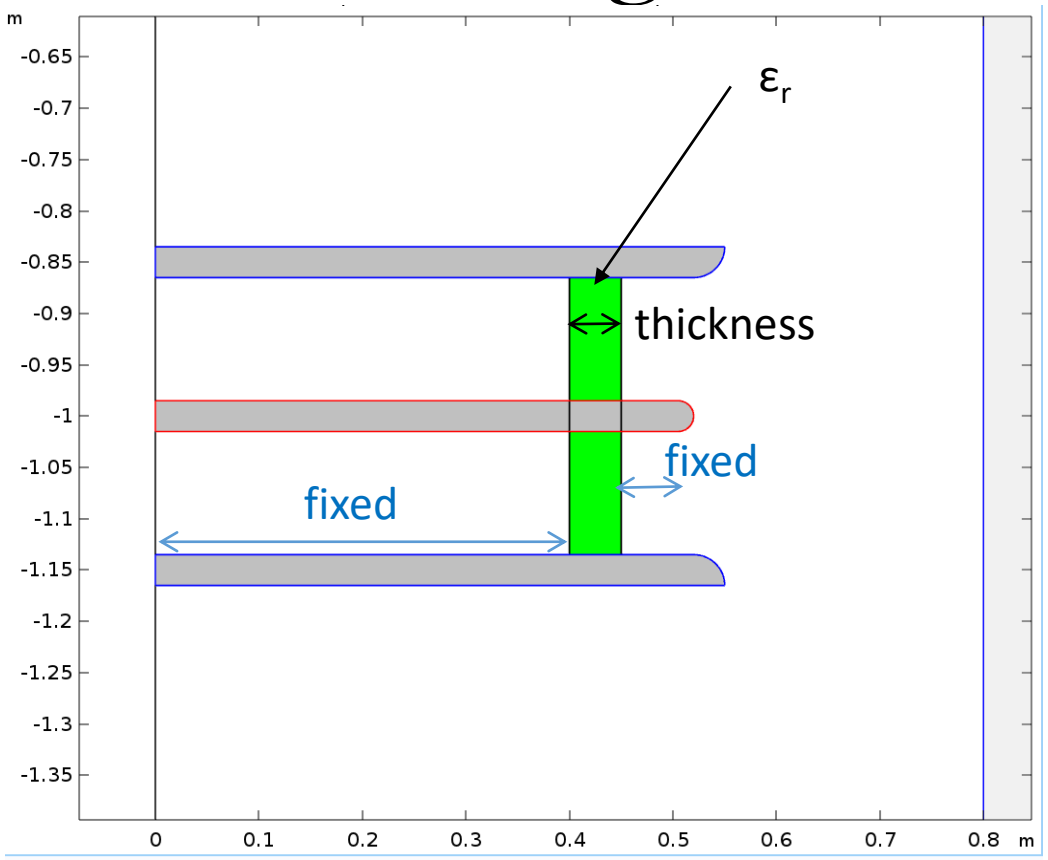
Without sharp edge



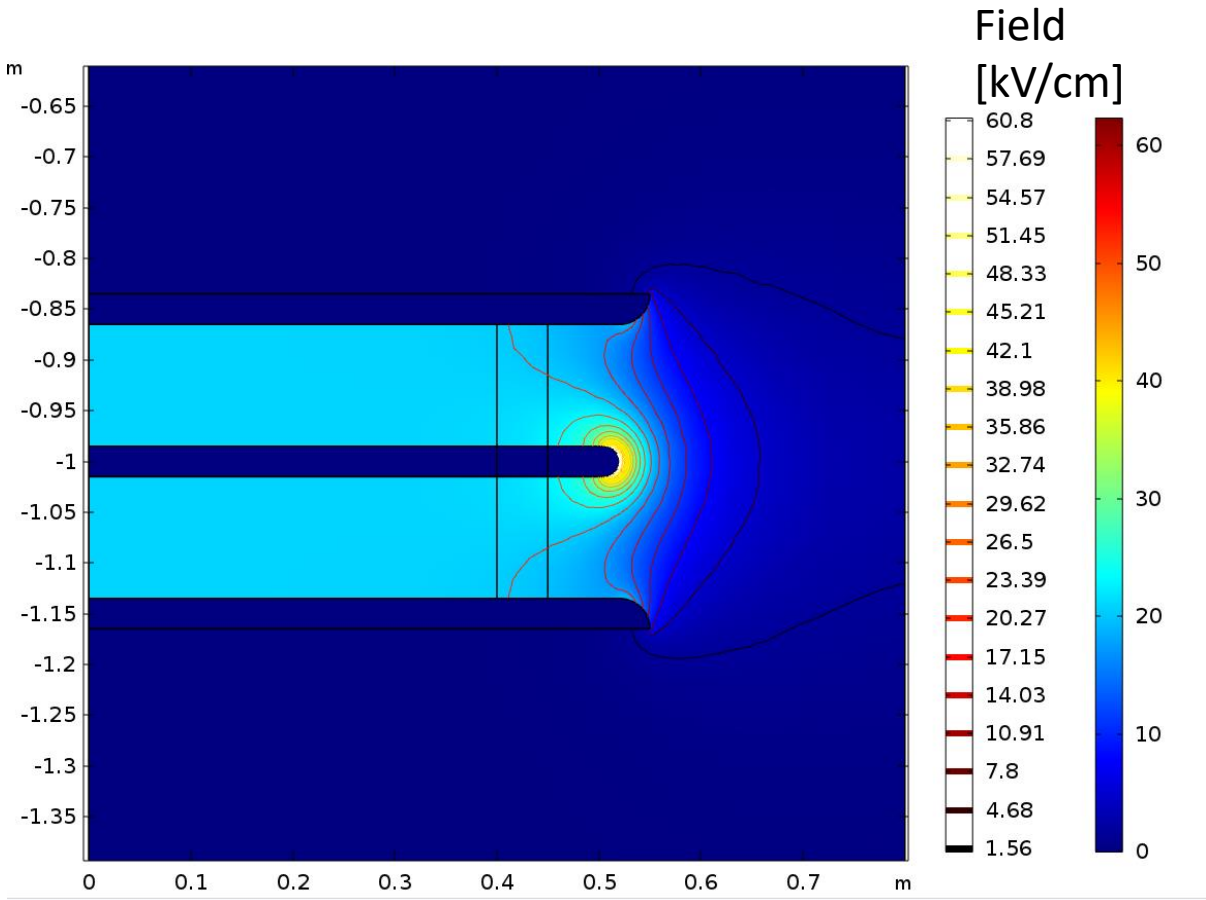
Protecting cage: radial field



Insulator ring : material

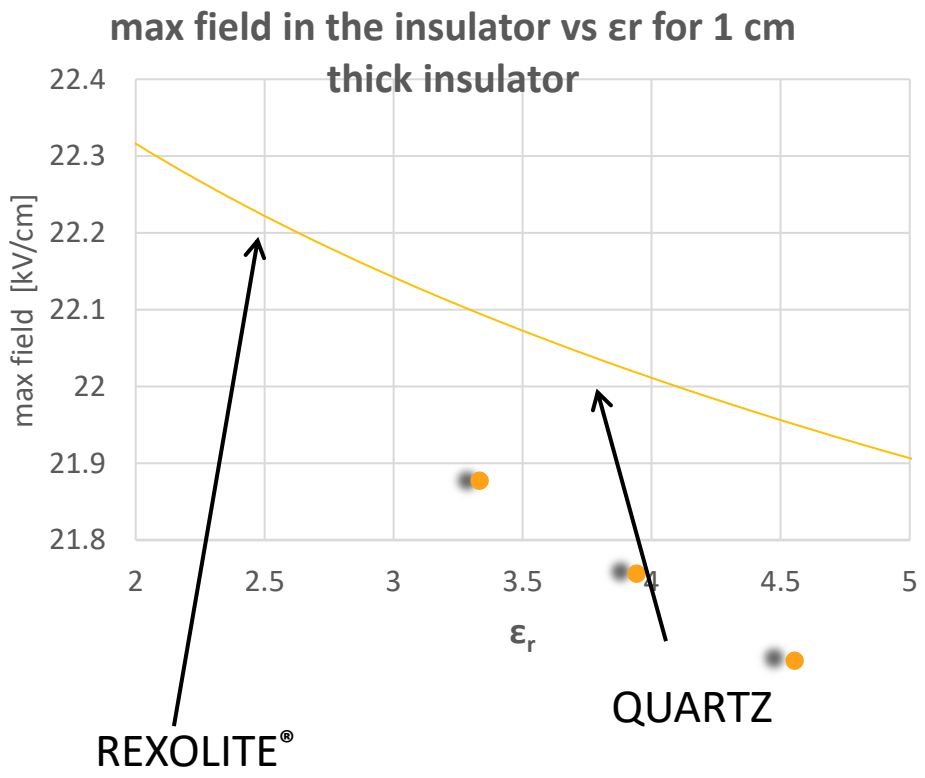


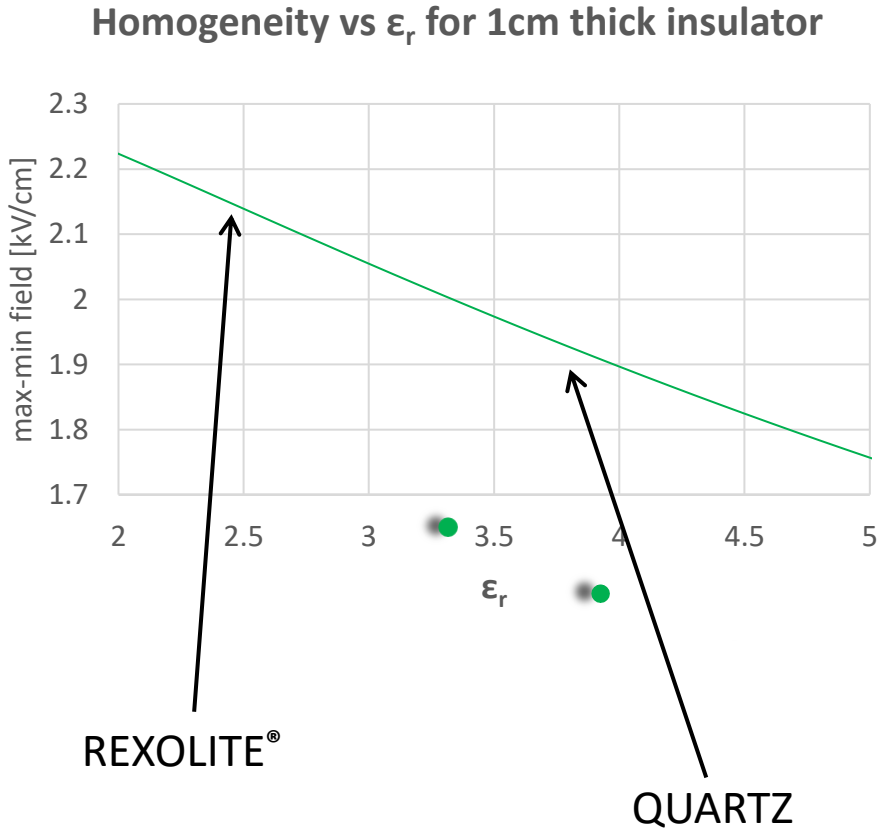
Geometry reminder



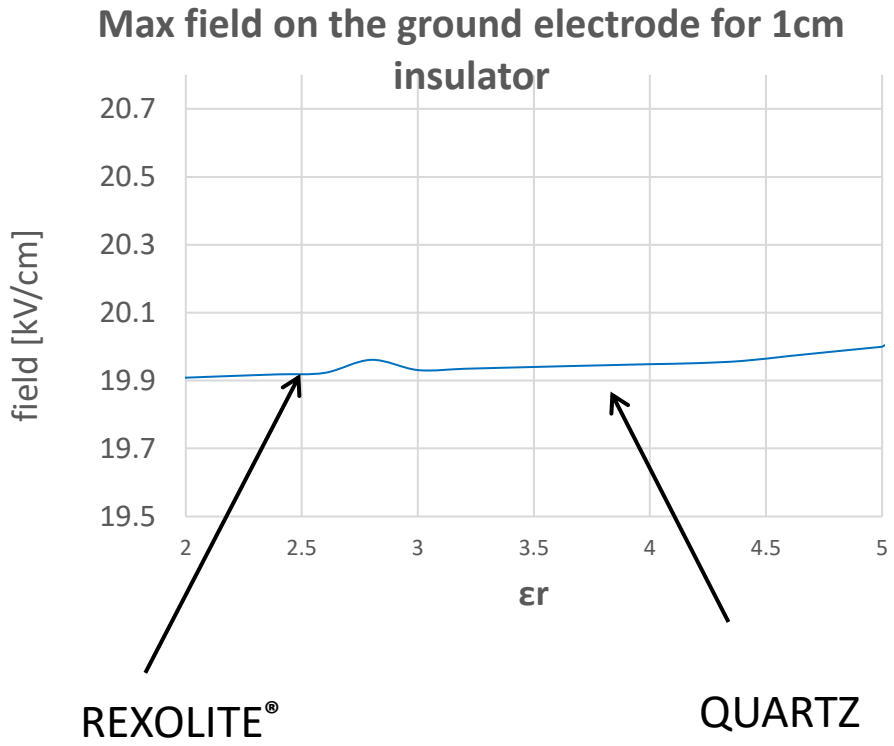
DETAIL DESIGN

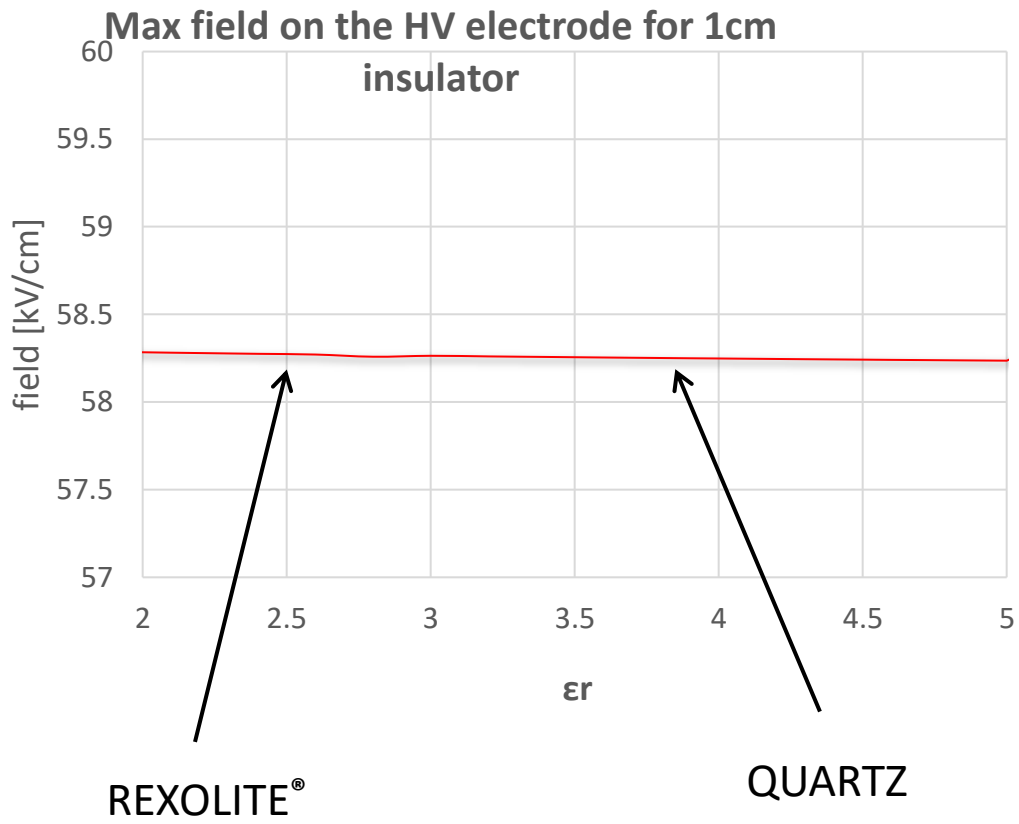
Quartz window: insulator material test for n2EDM





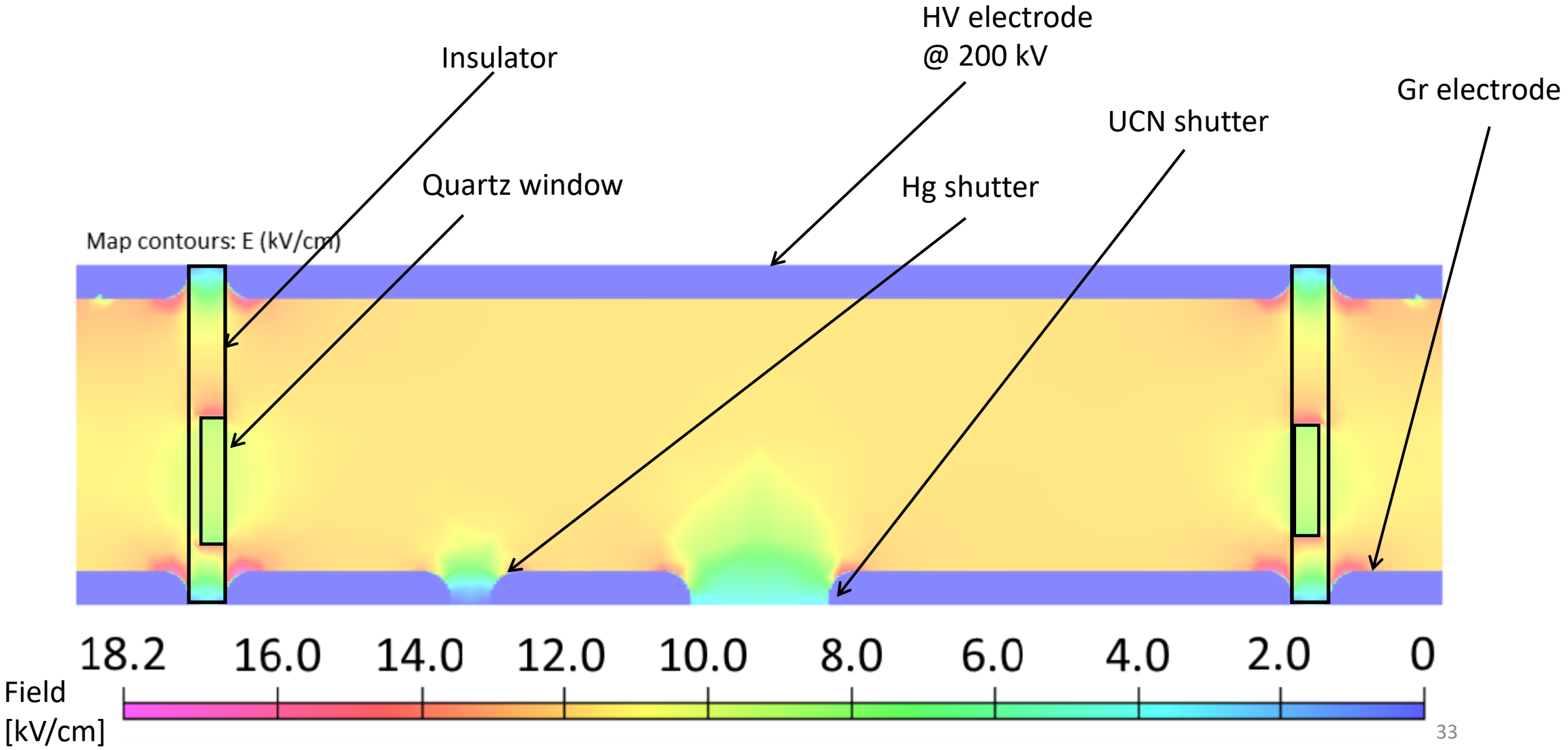
Quartz window: insulator material test for n2EDM



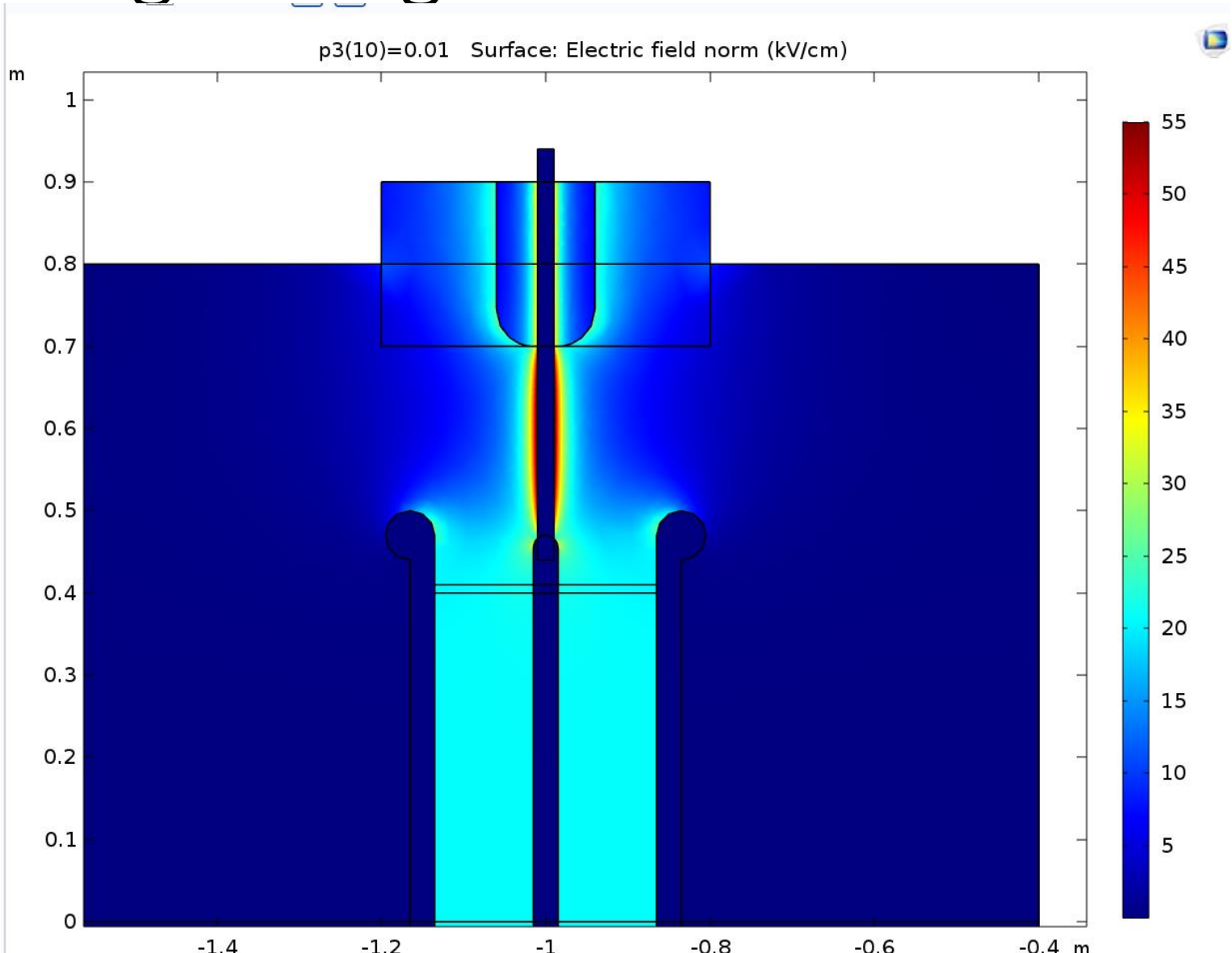


DETAIL DESIGN

Quartz window: simulation of OILL nEDM

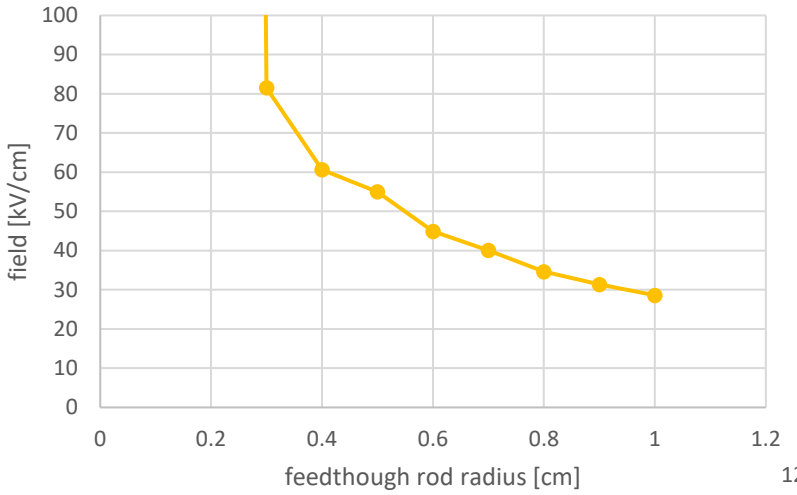


Feedthrough design

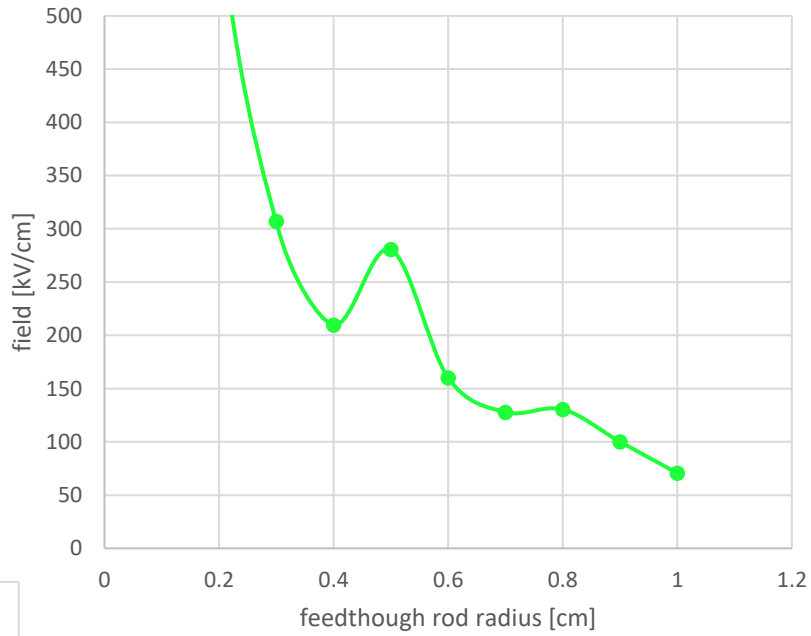


Feedthrough design

max field on the surface of the feed insulator



max inisde the feed insulator



max field on the side of the vacuum chamber