

GTS 300 kV p-gun CST microwave studio simulations

Gabriel Palacios

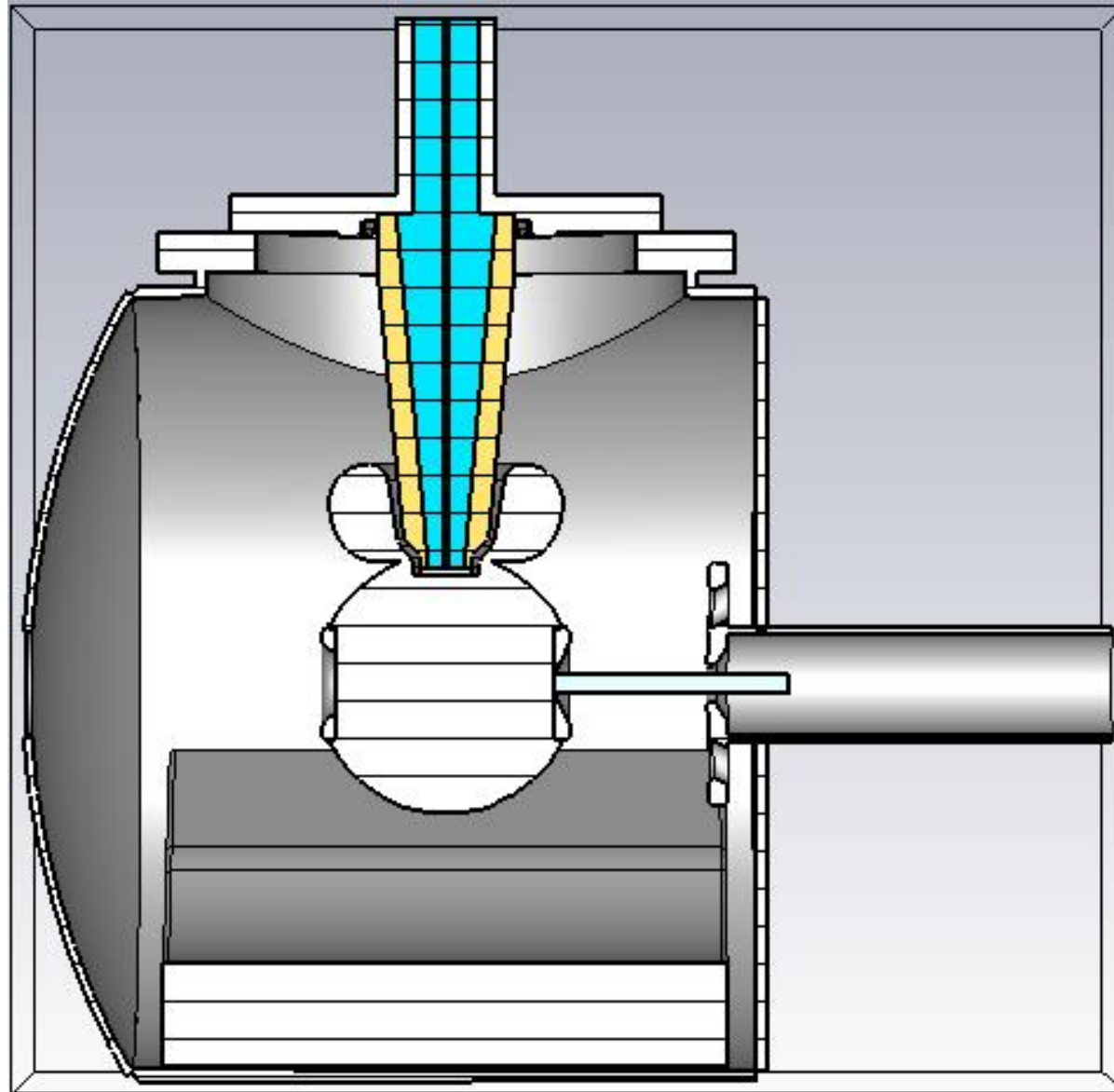
gpala001@odu.edu

06/16/18

Summary

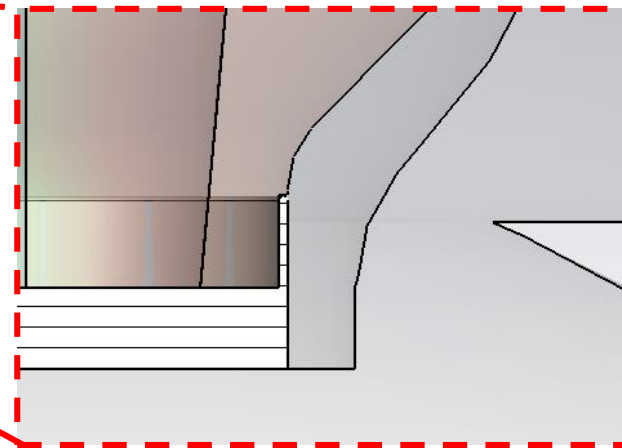
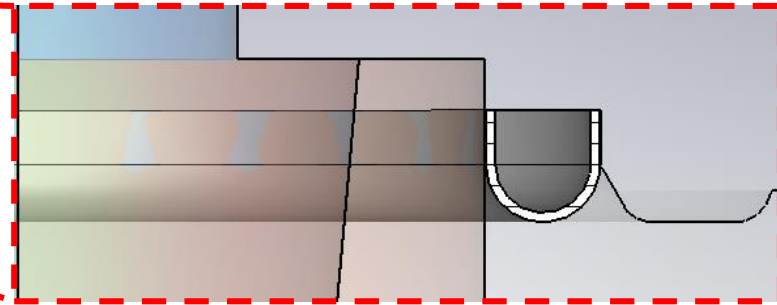
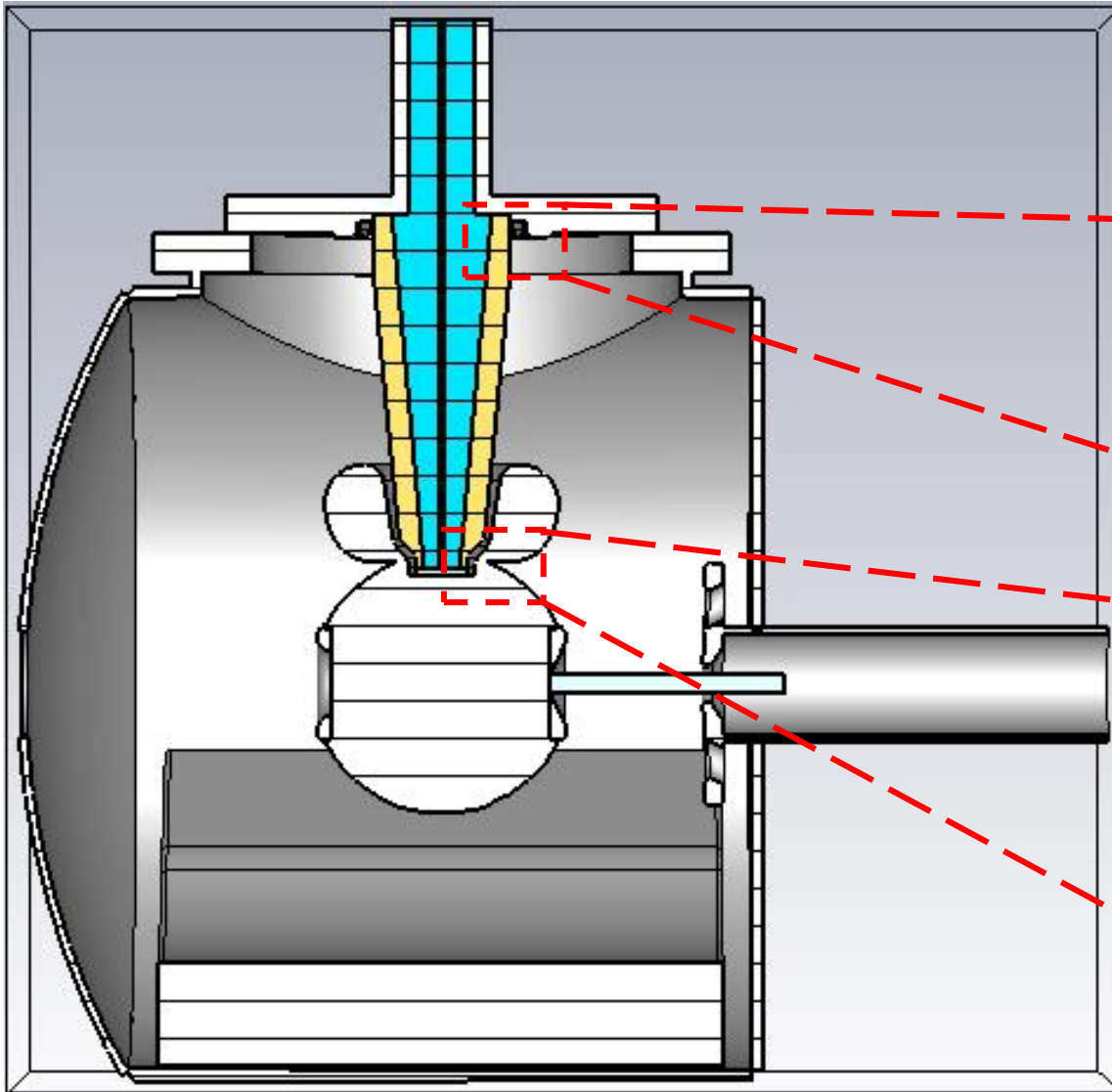
- Solidworks
 - Geometry modifications
- CST
 - Details of simulation
 - Electric field and potential plots
- Additional slides

Solidworks geometry modifications:

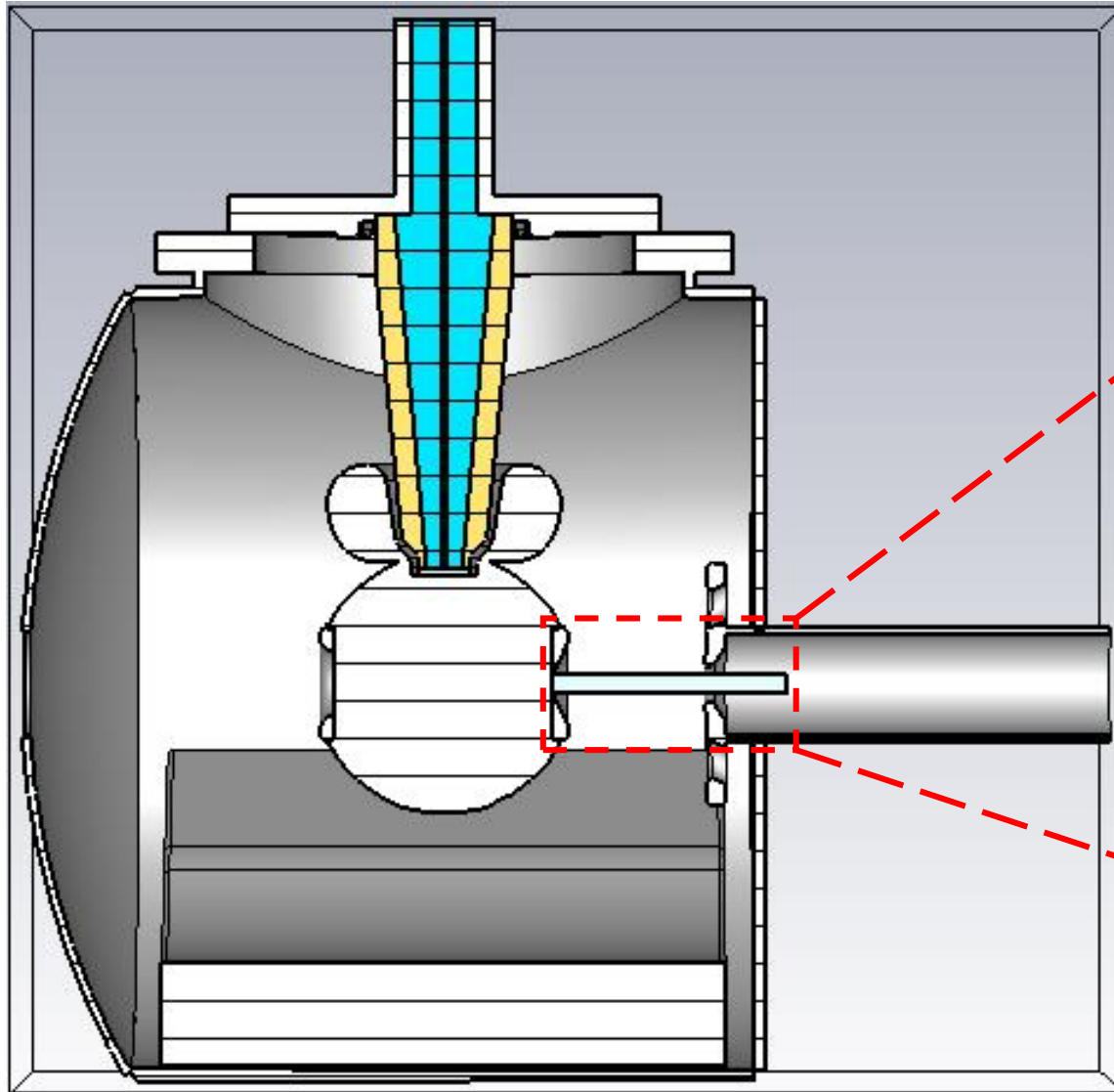


Solidworks geometry modifications:

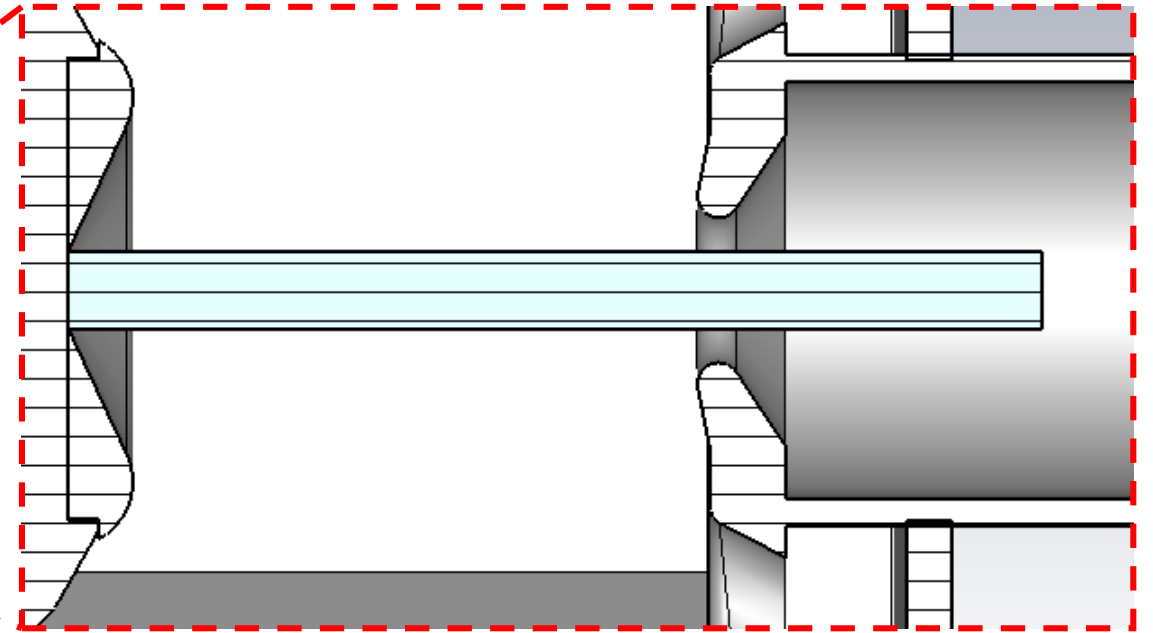
As Fay suggested, it was better to separate the model into pieces. Specially the small parts near the Kovar ring, the cathode triple-point junction and added a cylinder for the field maps at the cathode-anode gap.



Solidworks geometry modifications:

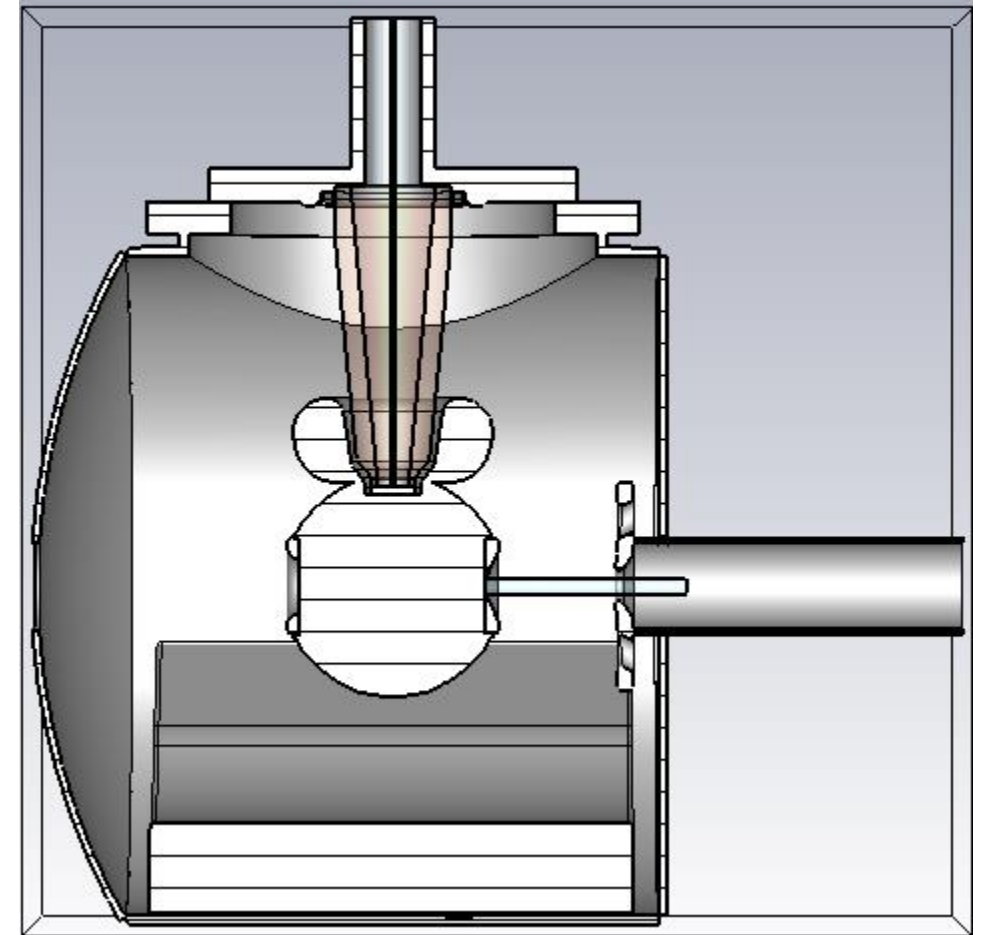
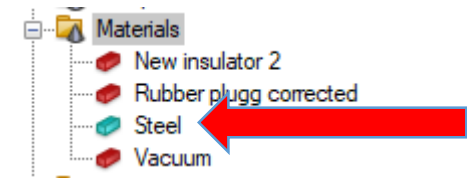
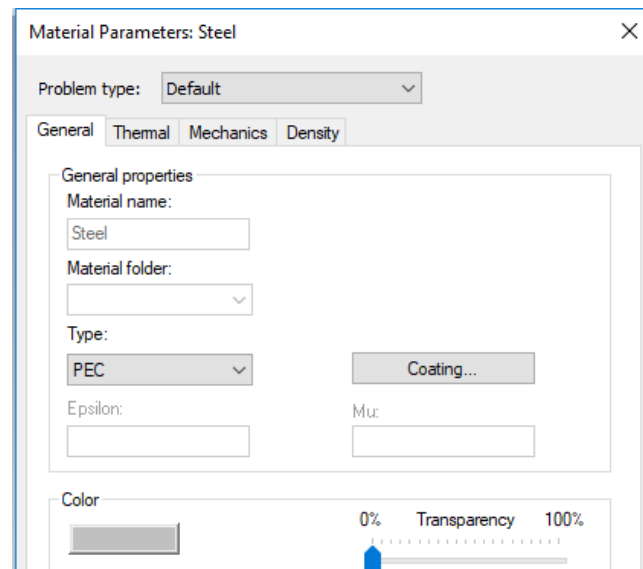


...and added a cylinder for very fine meshing to obtain very fine field maps at the cathode-anode gap.



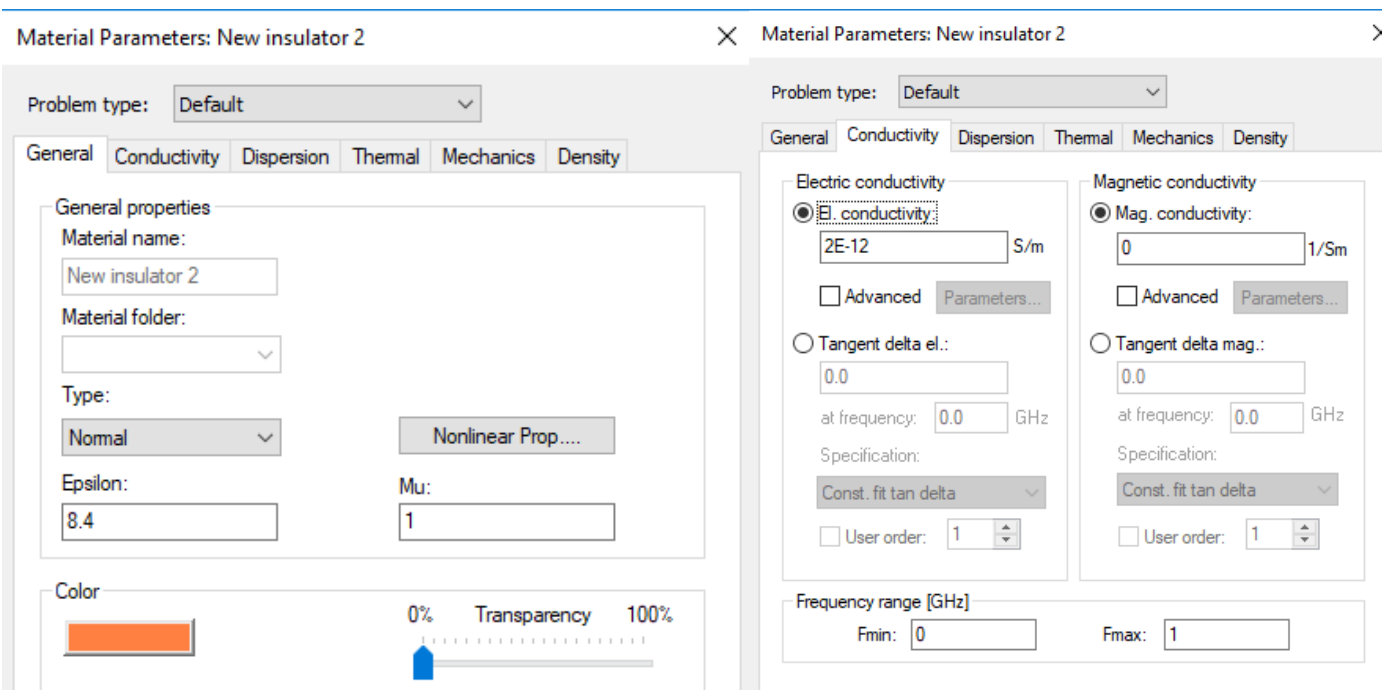
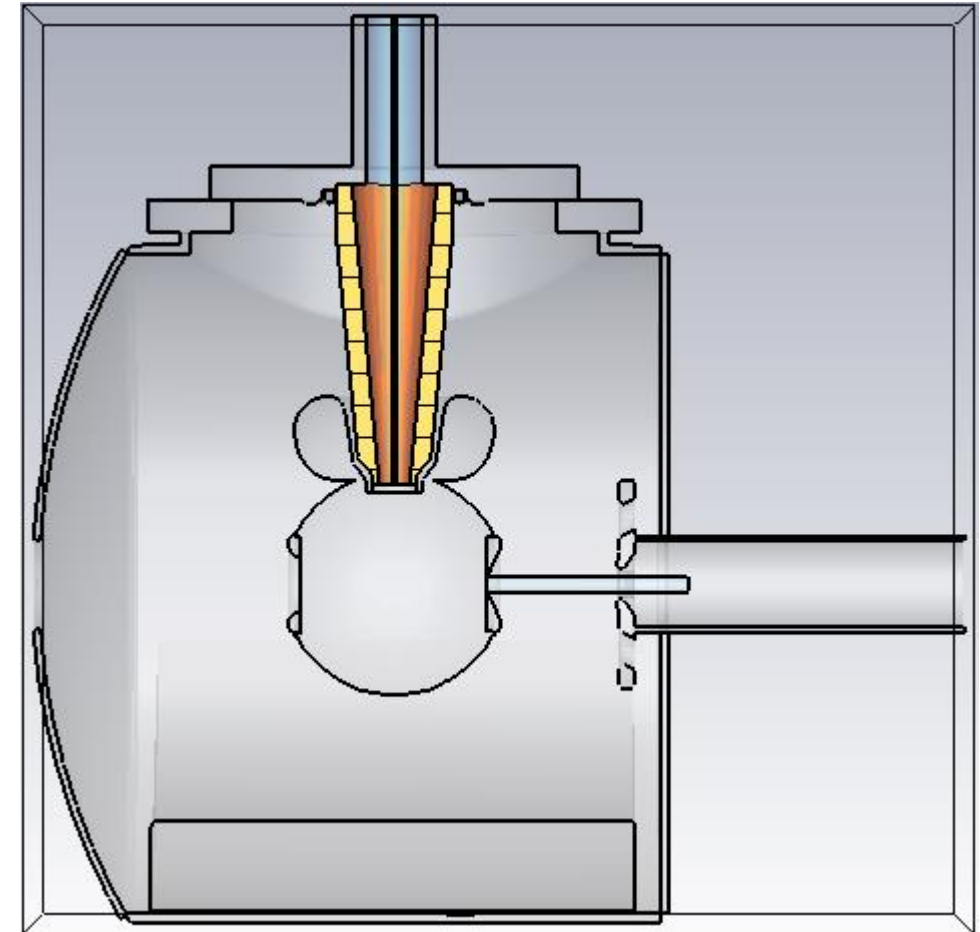
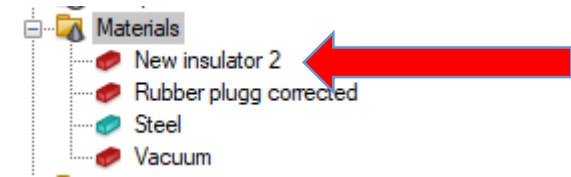
CST materials: PEC

- Steel for all metal components with Perfect electric conductor (PEC). Since this is a preset we don't need to define anything. Also, Thermal, Mechanical and Density properties are not included in the calculation.



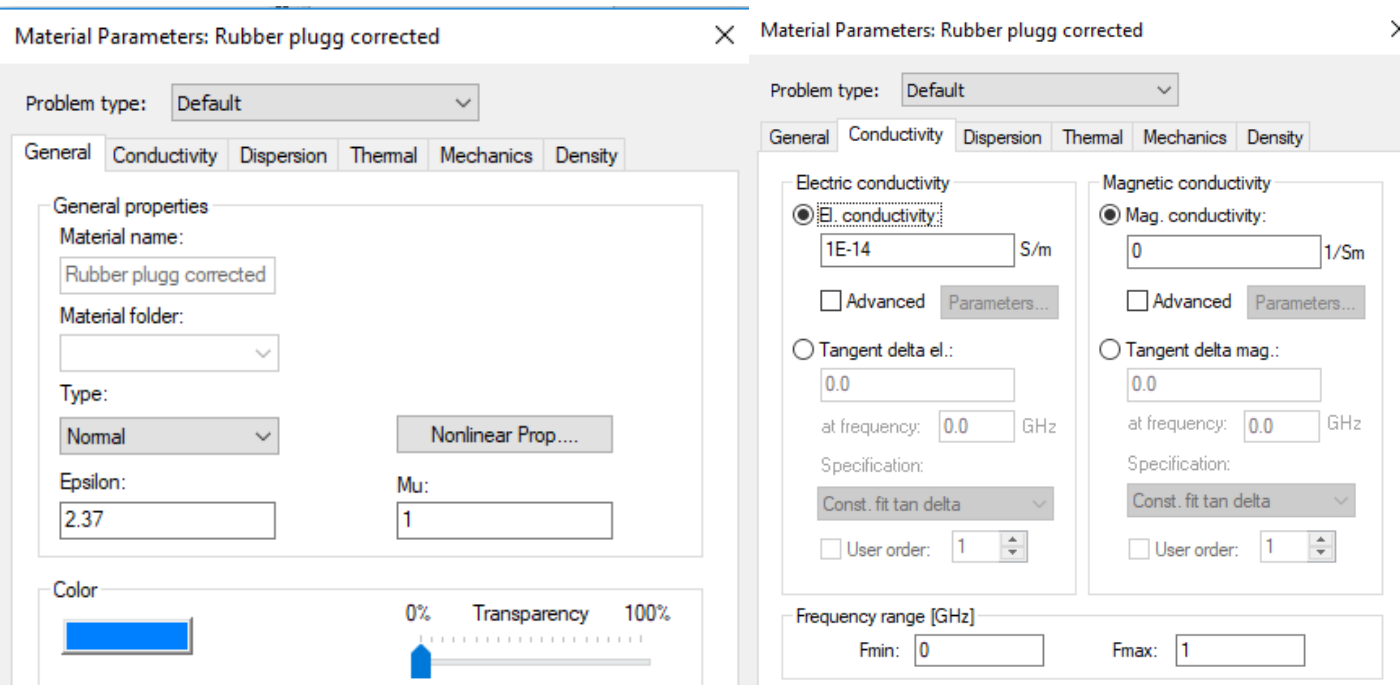
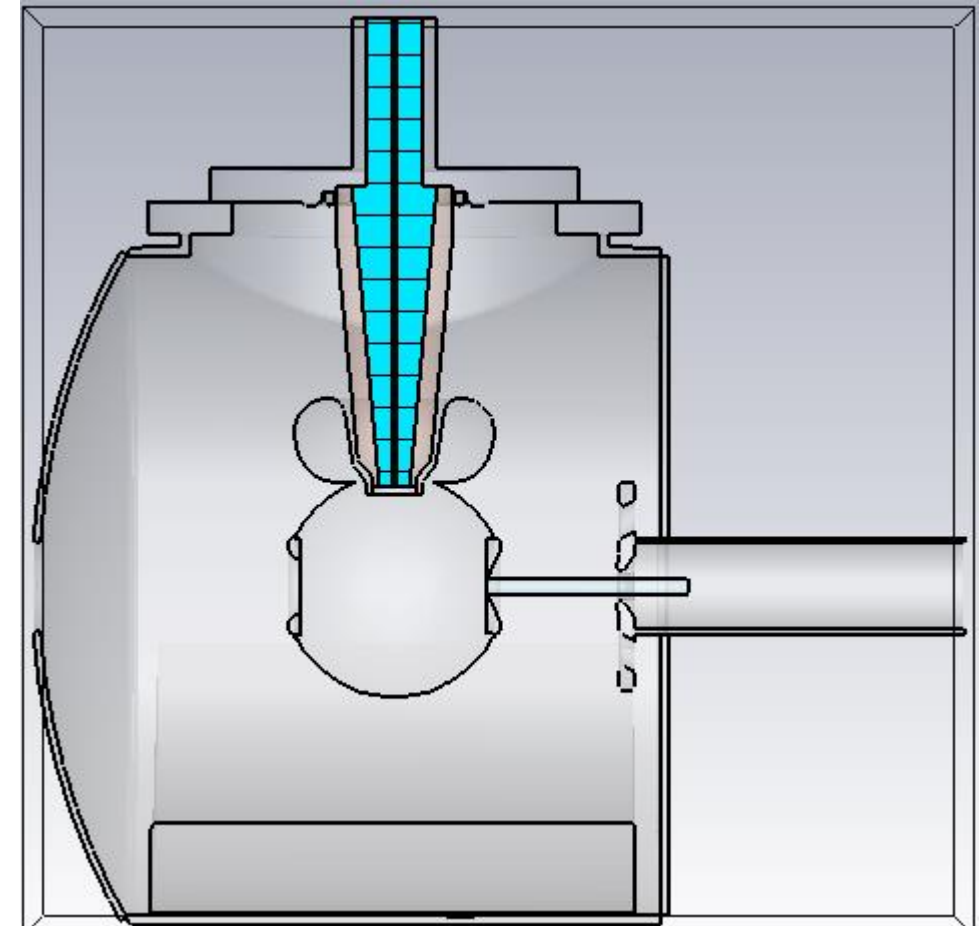
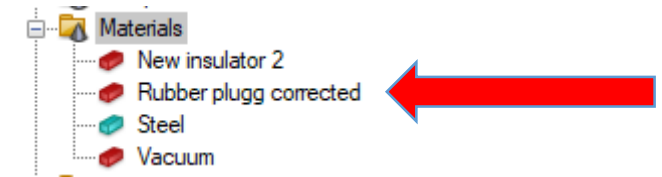
CST materials: Insulator

- For **black** alumina I used the same parameters as in COMSOL.
- $\epsilon=8.4$
- $\sigma=2\text{E-}12$ [S/m]



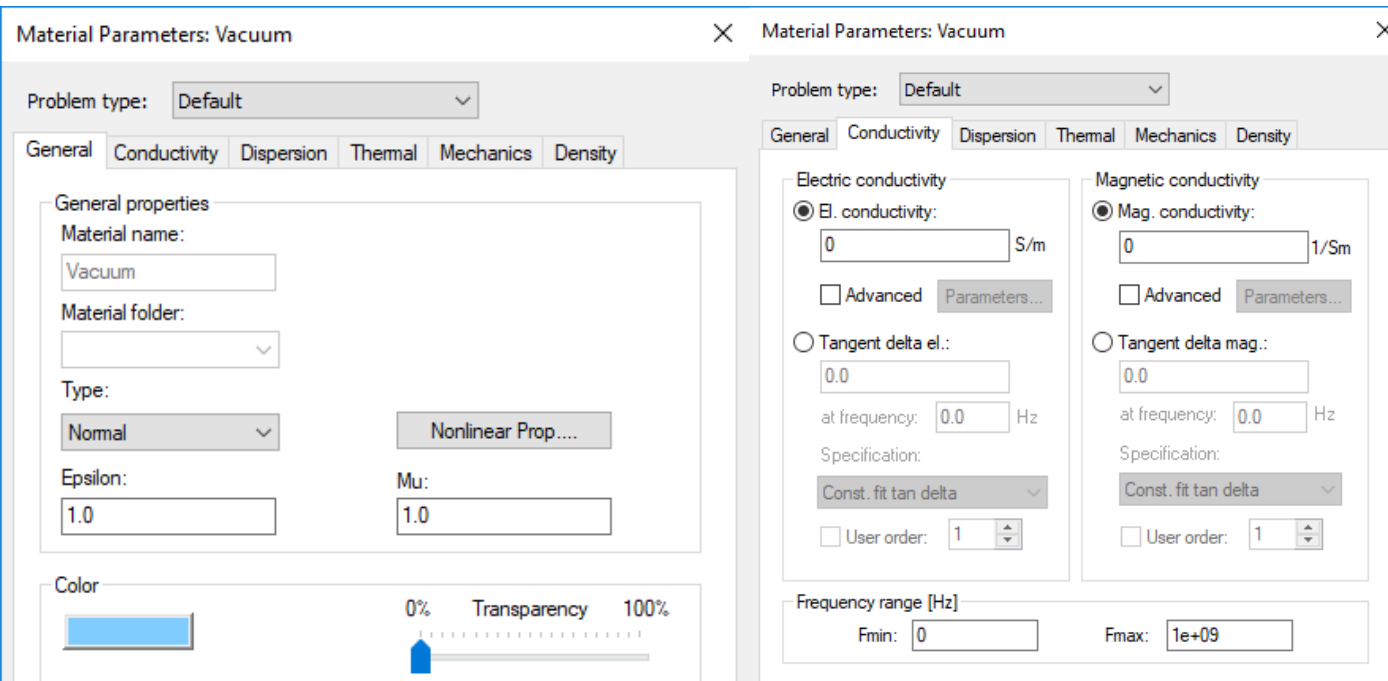
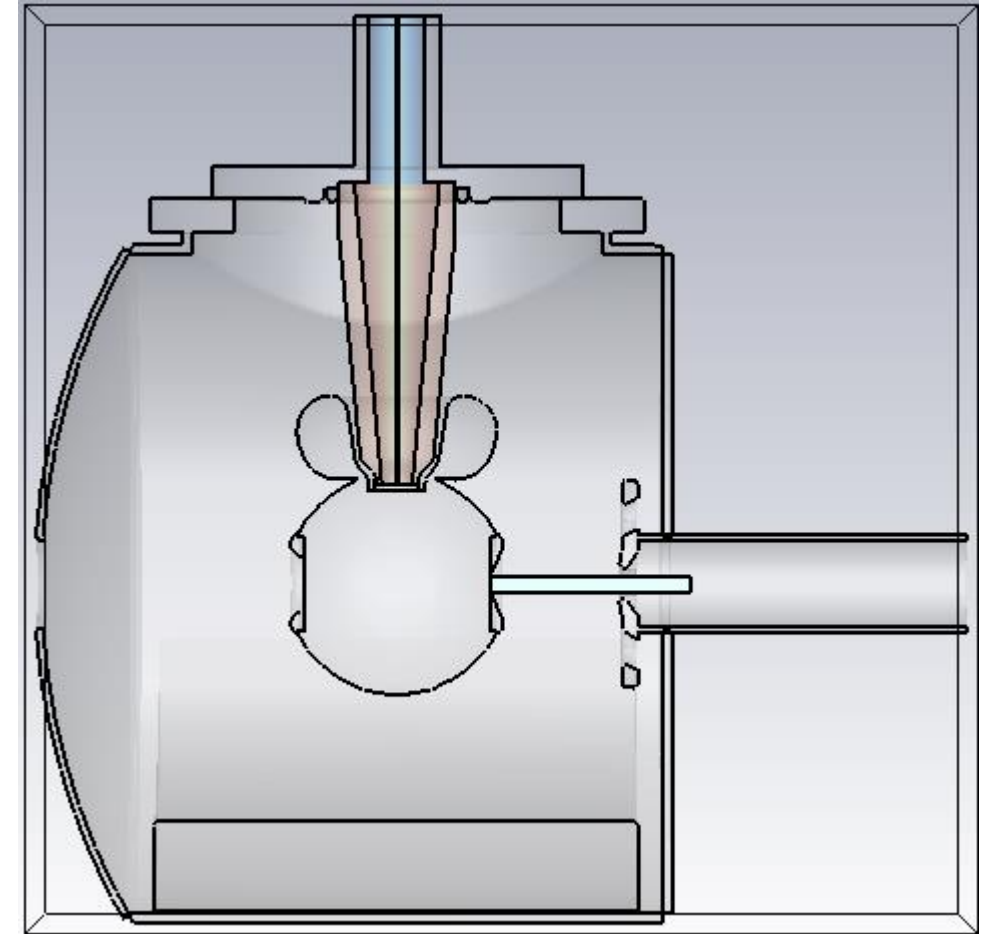
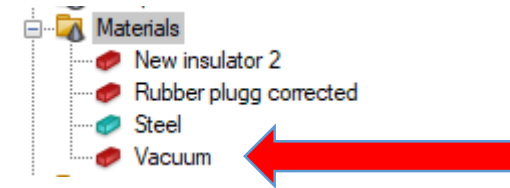
CST materials: Insulator

- For rubber I used the same parameters as in COMSOL.
- $\epsilon=2.37$
- $\sigma=1\text{E-}14$ [S/m]



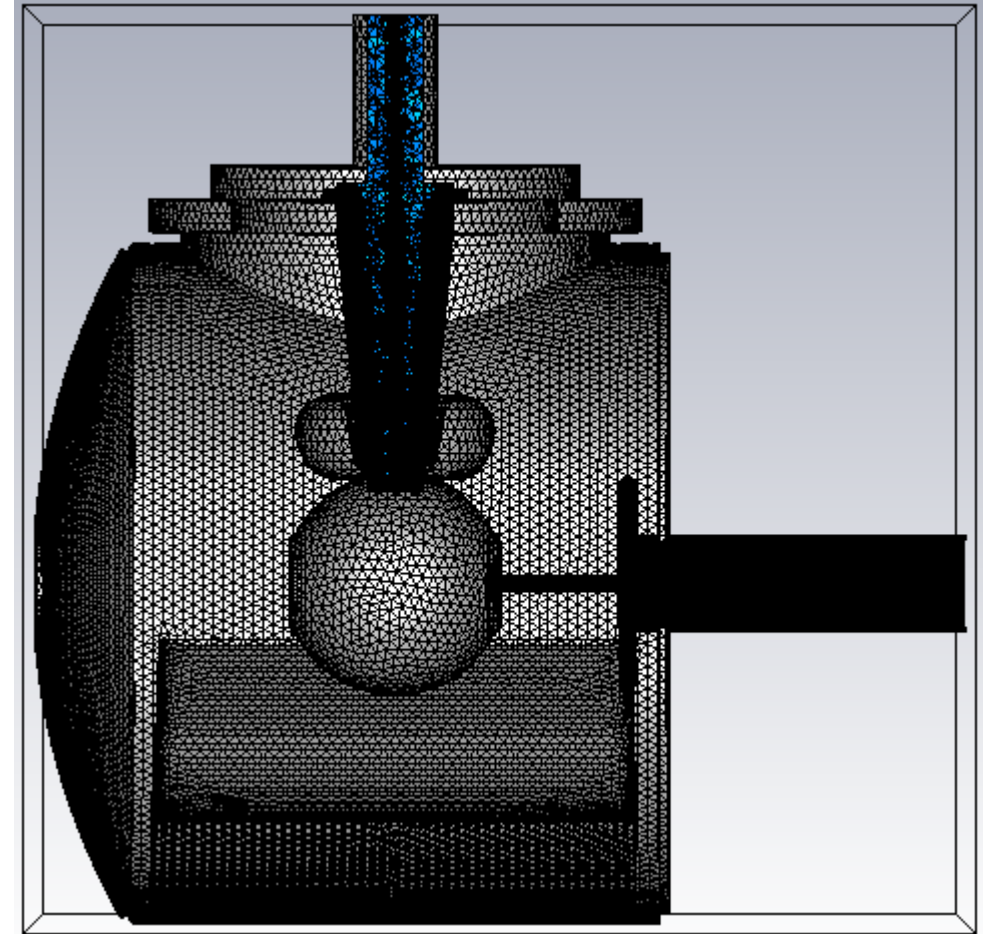
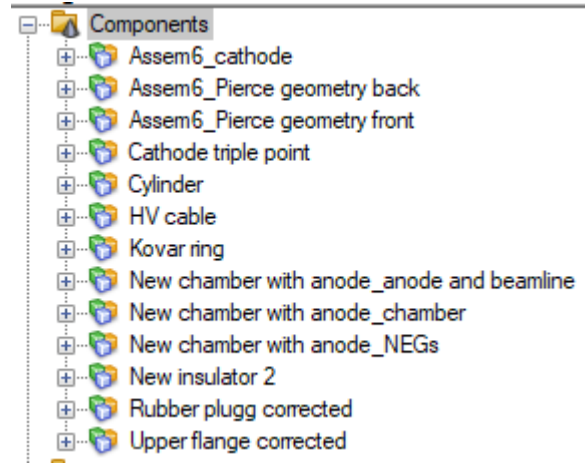
CST materials: Insulator

- For vacuum cylinder and surroundings.
- $\epsilon=1.0$
- $\sigma=0$ [S/m]



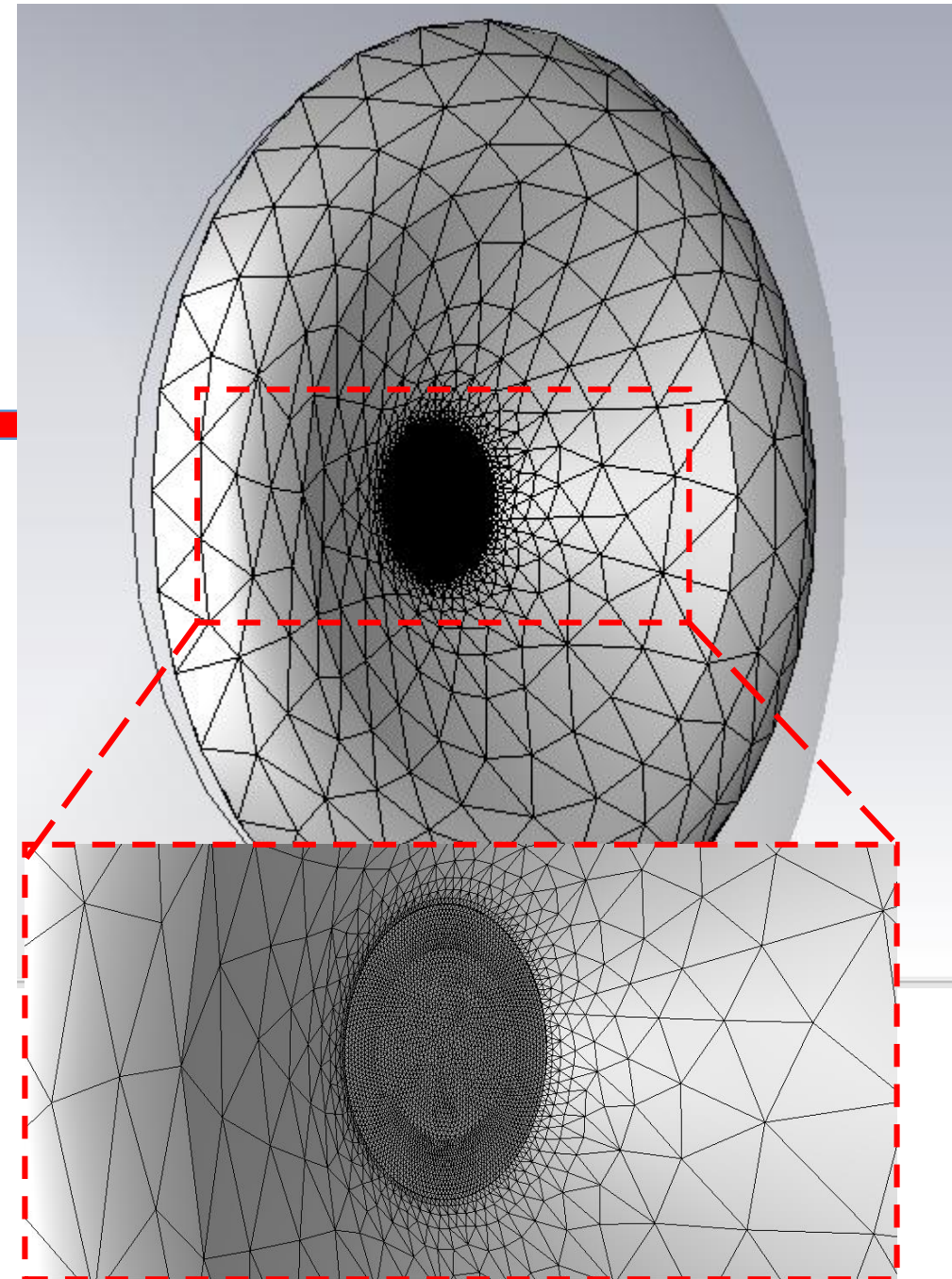
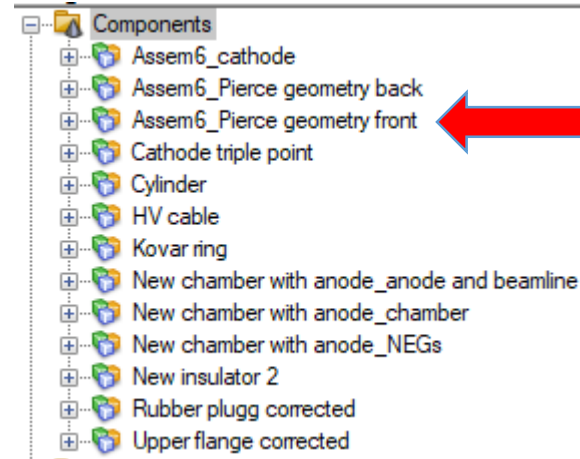
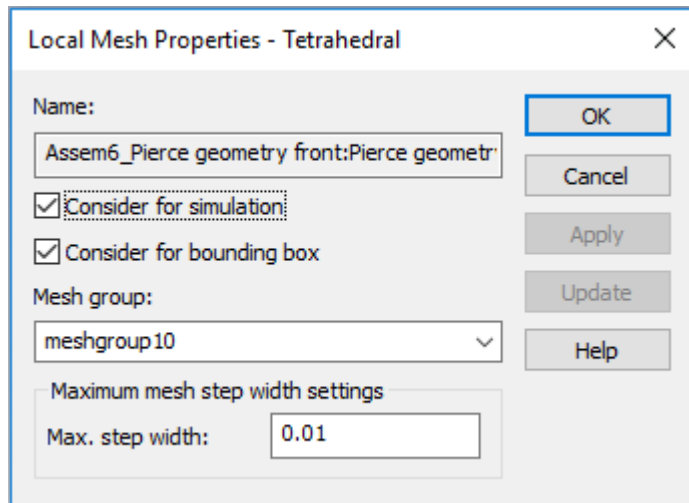
CST mesh:

- The mesh was separated into (maybe too many) pieces. :P
- The important part is, I only set some individual parts that require fine detail and left the rest to be auto-meshed.



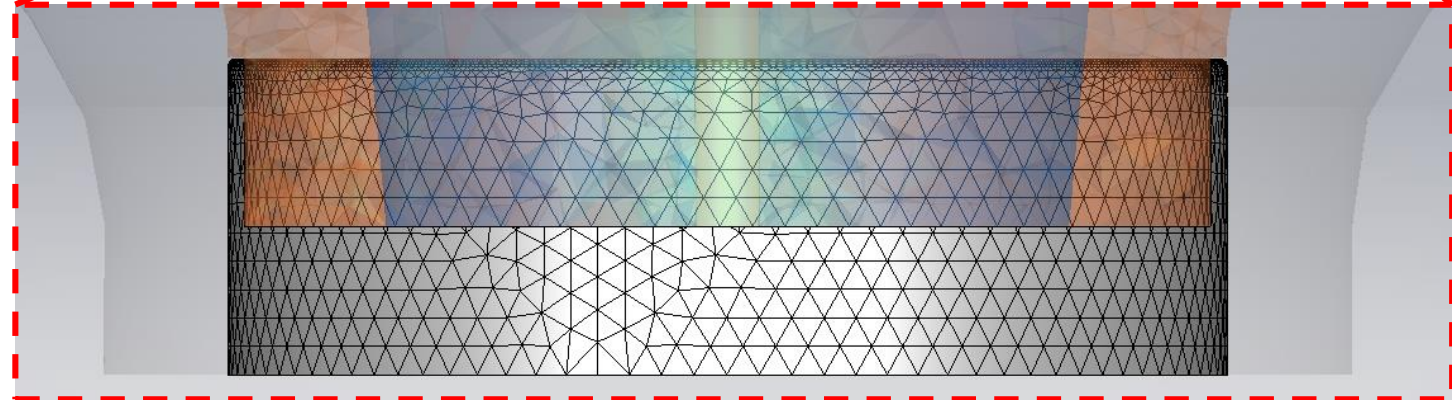
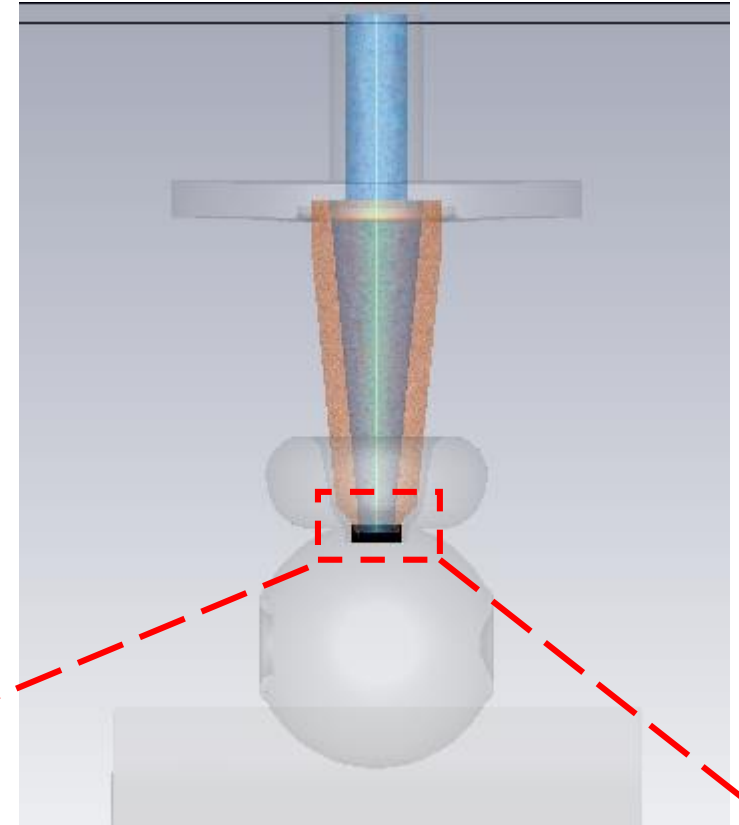
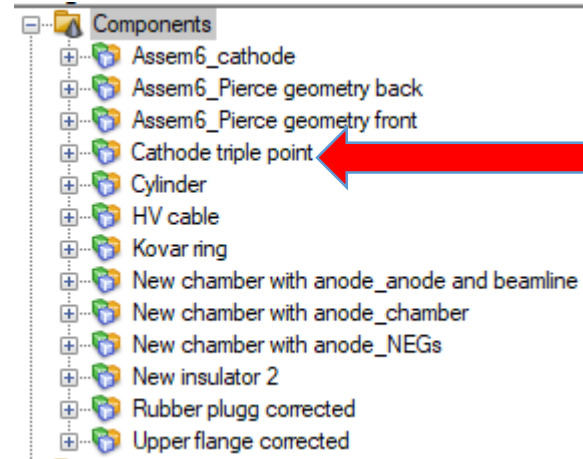
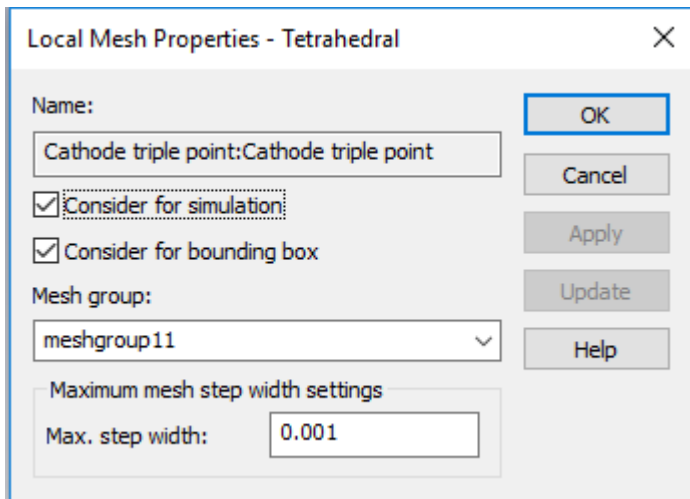
CST mesh: Pierce geometry

- The front Pierce geometry has a maximum step width of 0.01m.



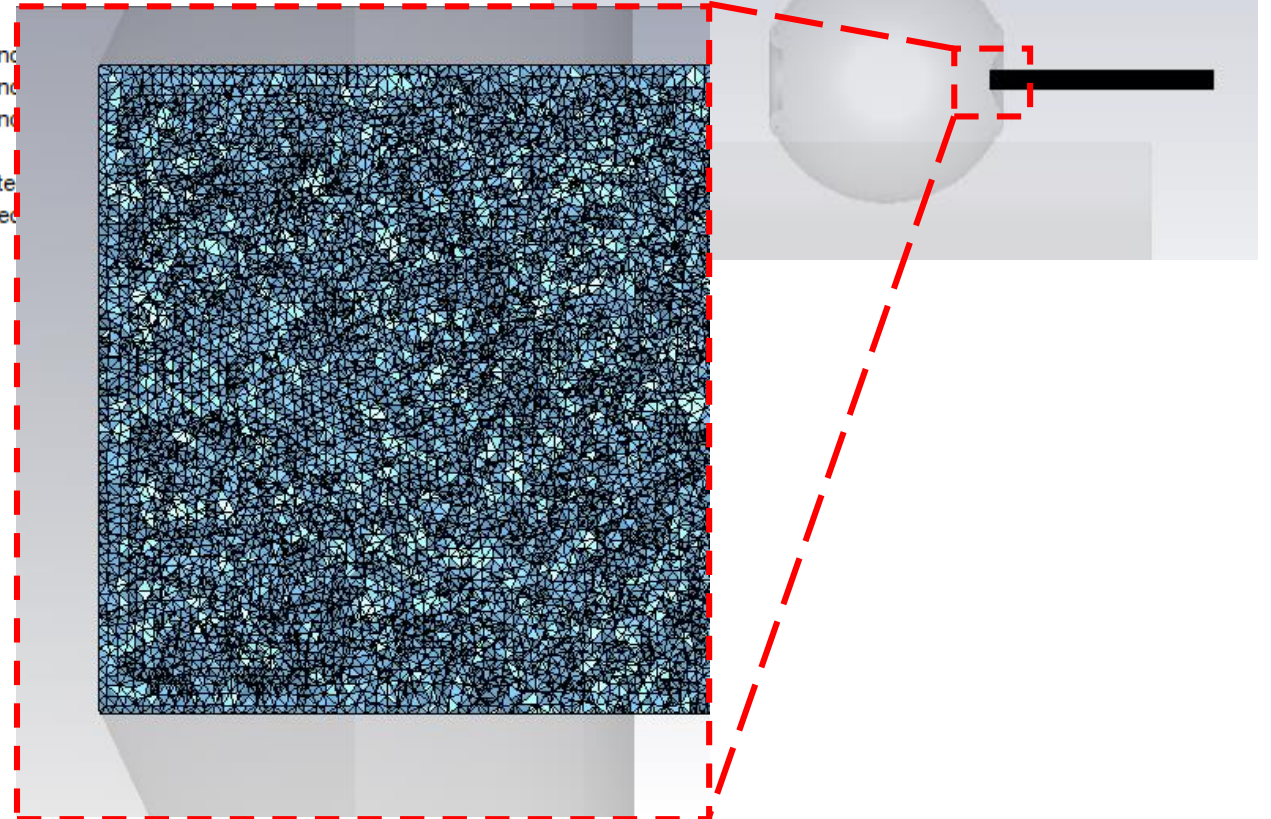
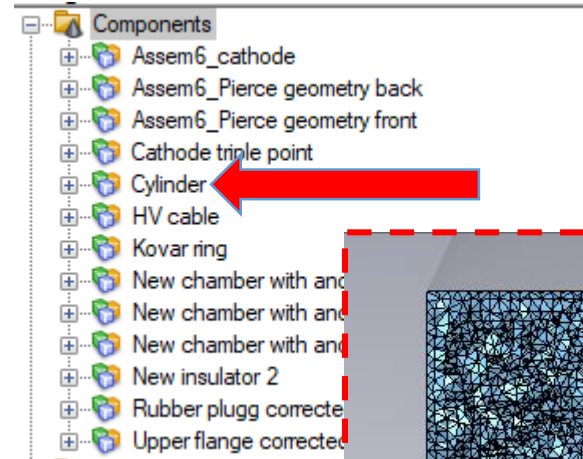
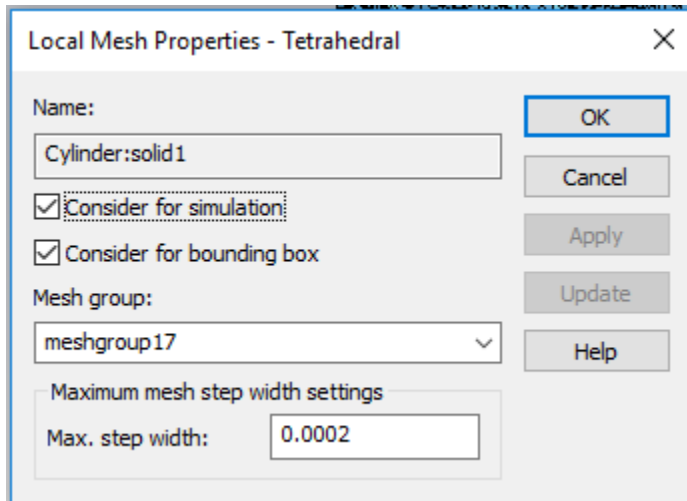
CST mesh: Cathode triple-point

- The cathode triple-point has a maximum step width of 0.001 [m].



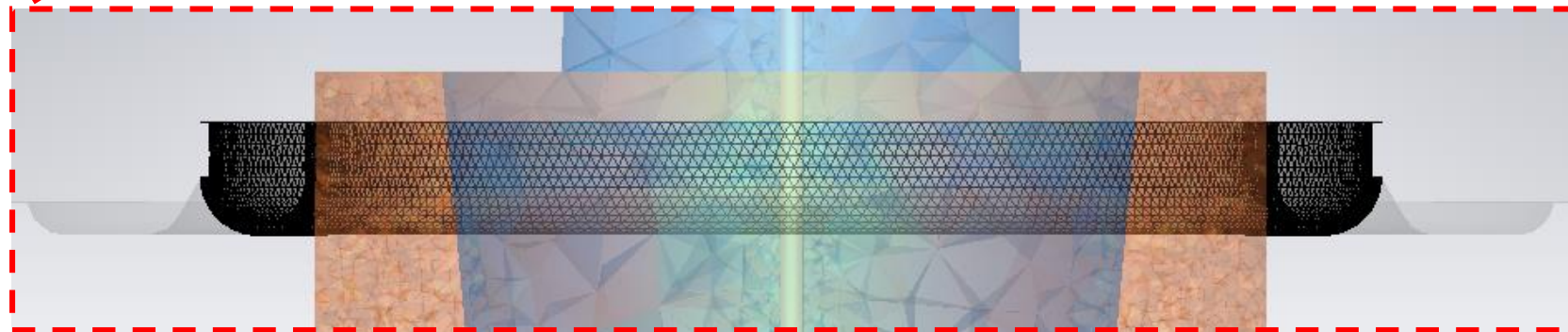
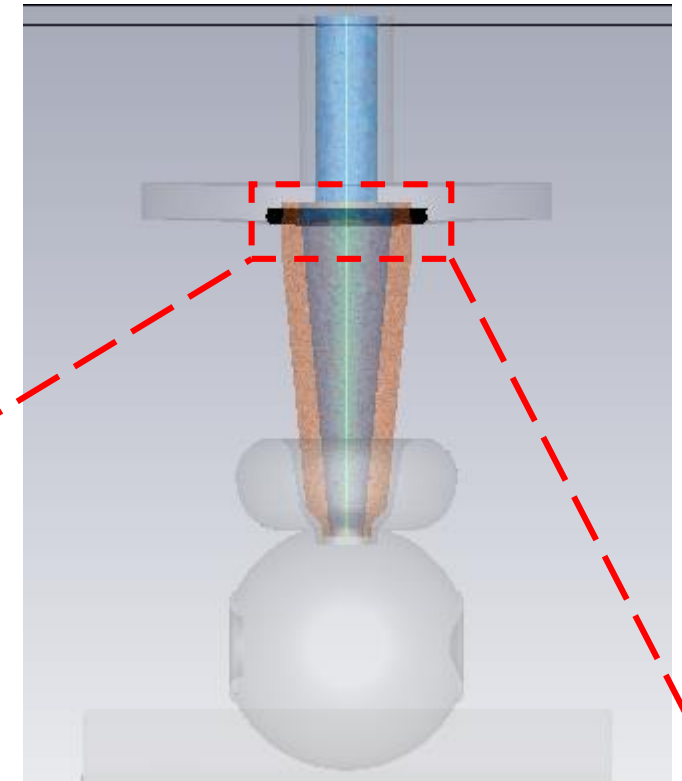
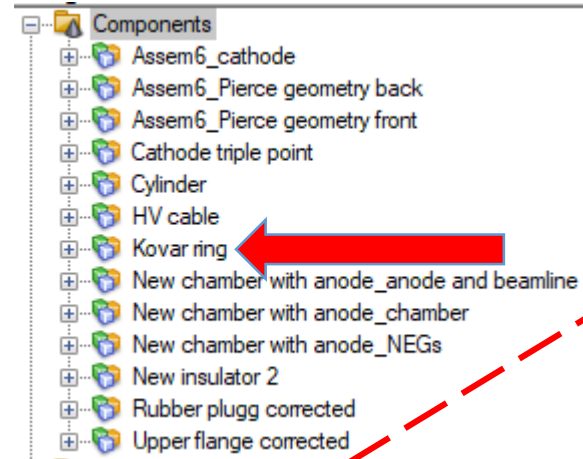
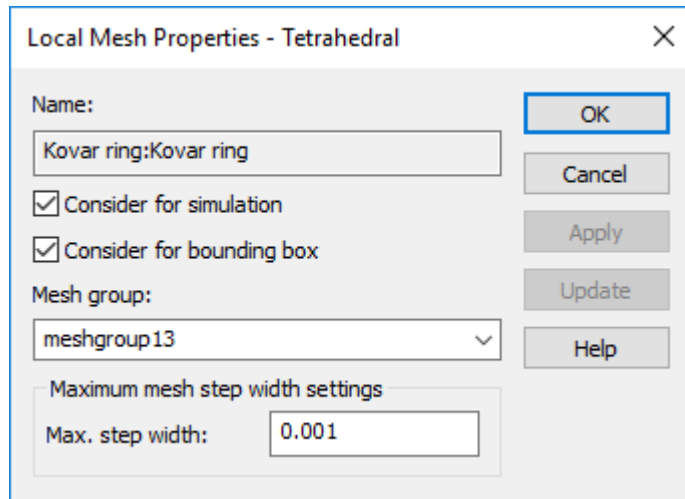
CST mesh: Cylinder for field maps

- The cylinder for field maps has a maximum step width of 0.0002 [m].



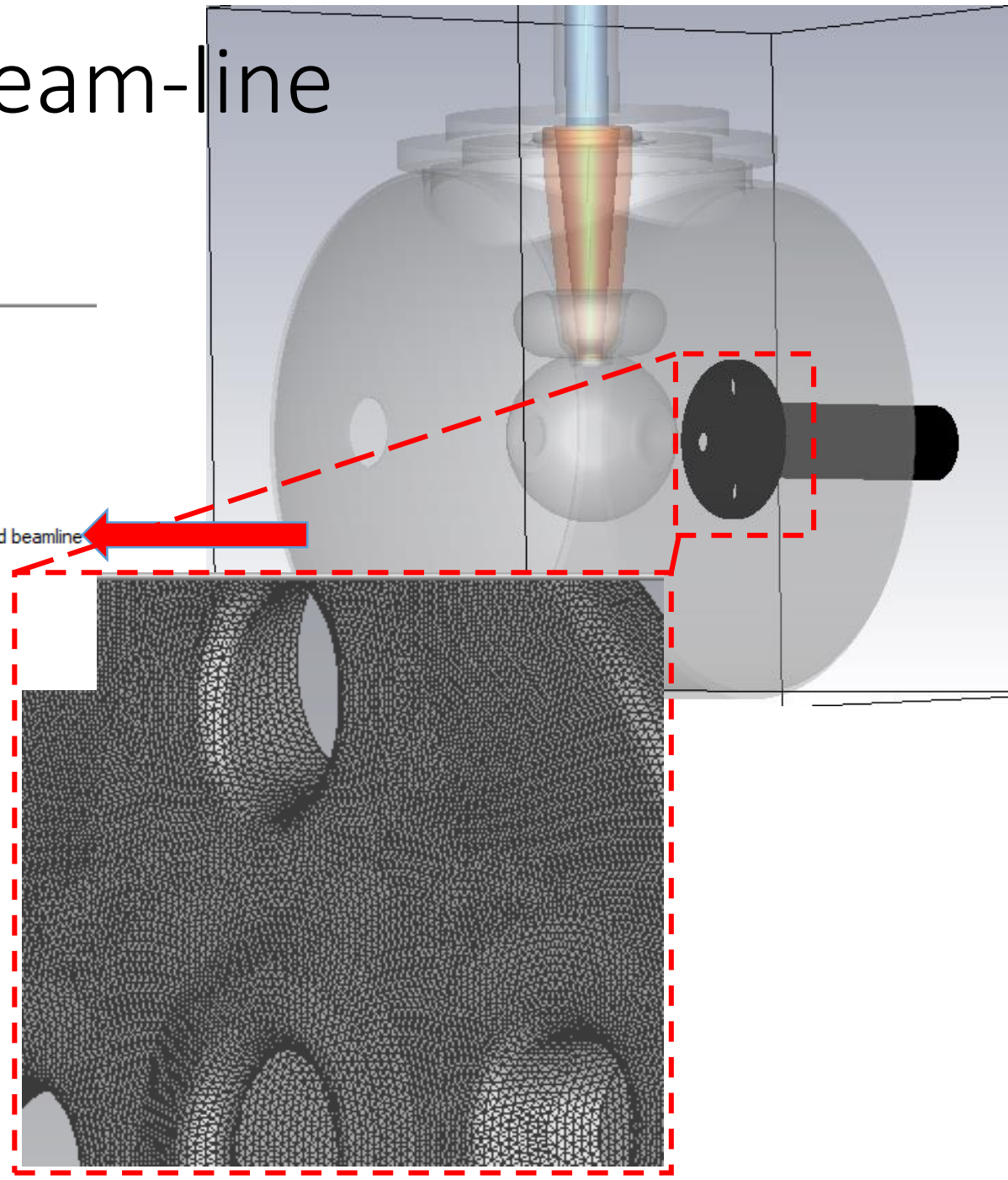
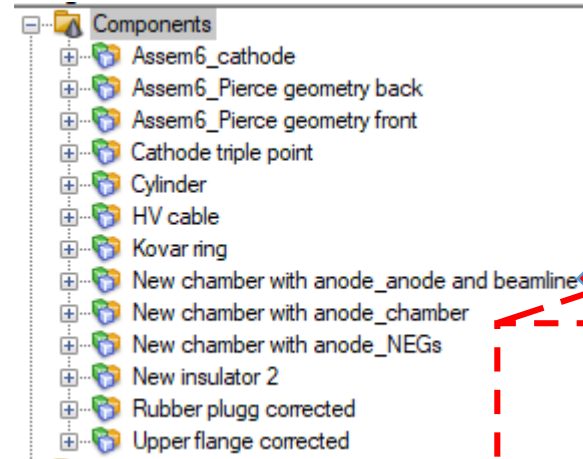
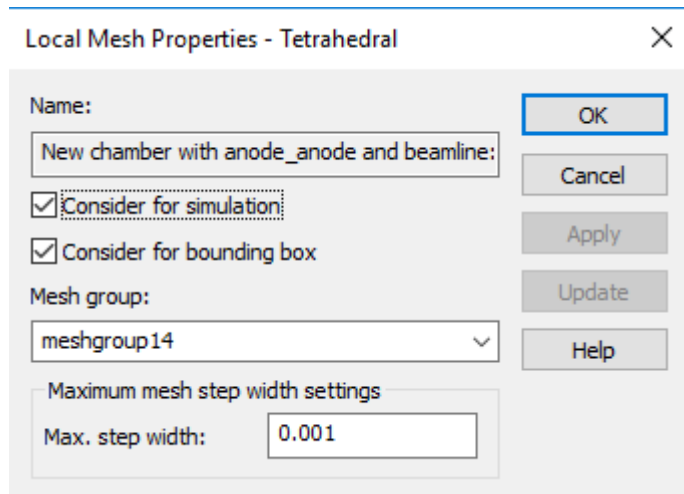
CST mesh: Upper Kovar ring

- The Kovar ring that holds the insulator to the upper flange has a maximum step width of 0.001 [m].



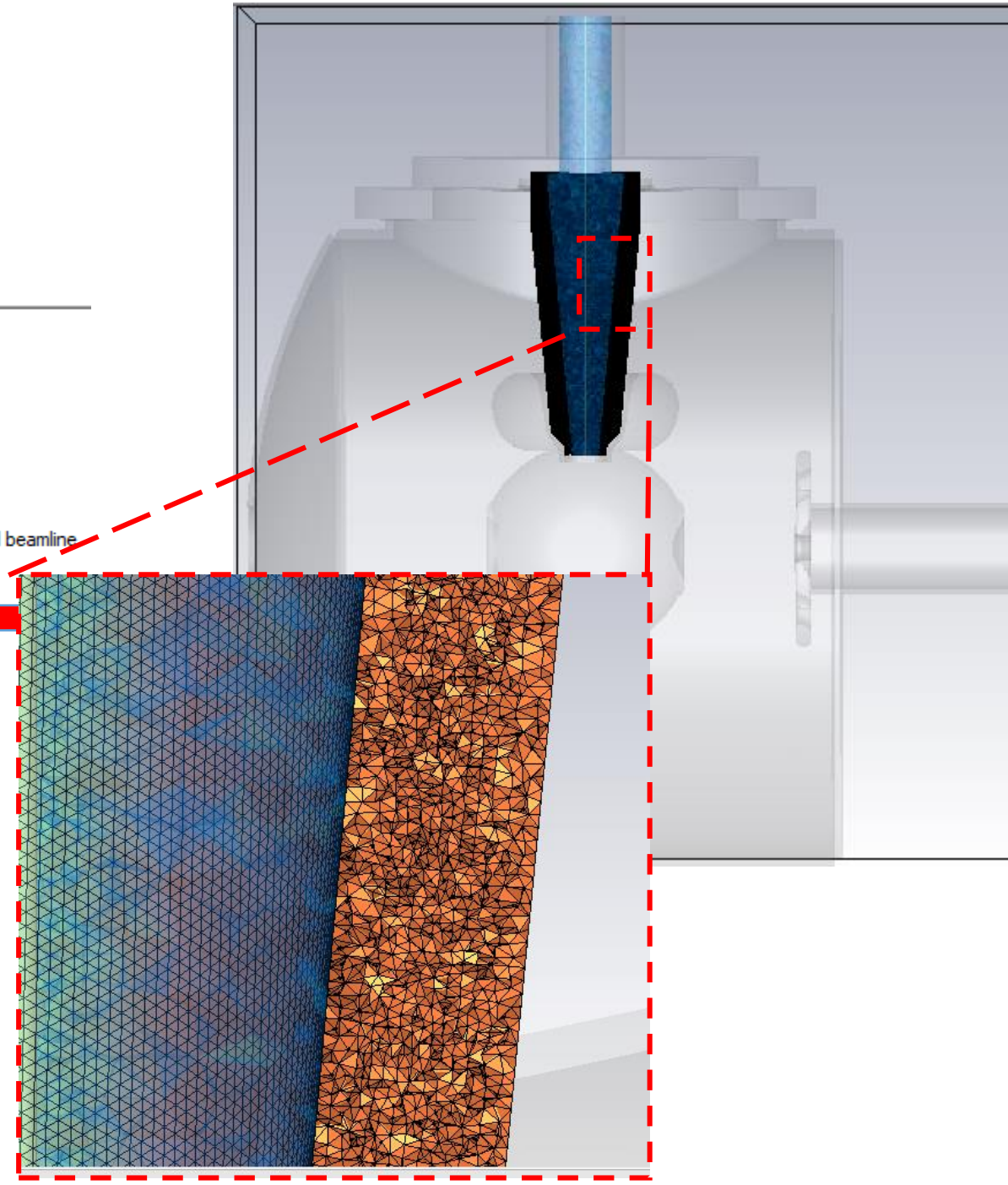
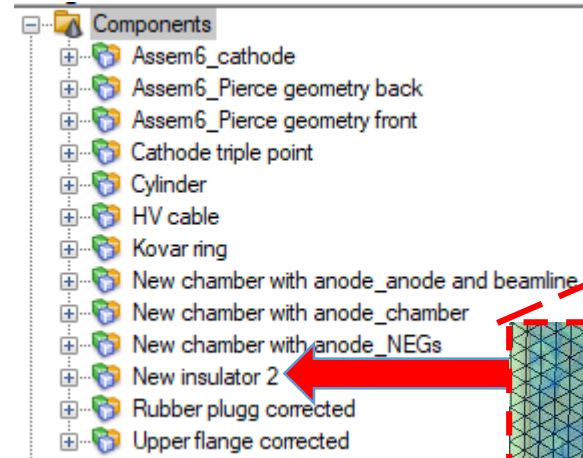
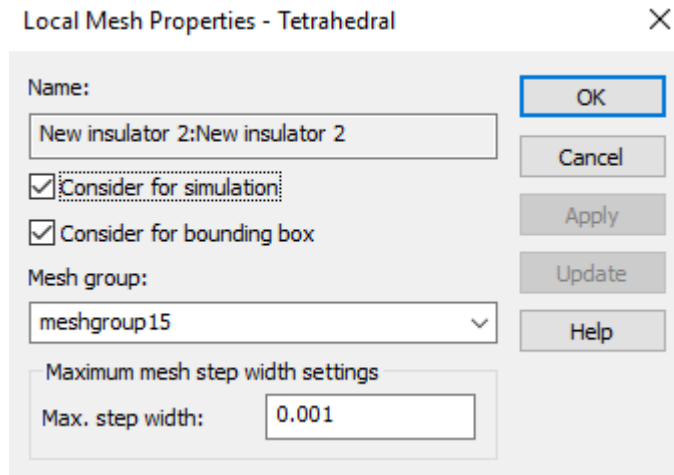
CST mesh: Anode and beam-line

- The anode and beam line have a maximum step width of 0.001 [m].



CST mesh: Insulator

- The insulator has a maximum step width of 0.001 [m].



CST mesh: Rubber plug

- The rubber plug has a maximum step width of 0.01 [m].

Local Mesh Properties - Tetrahedral

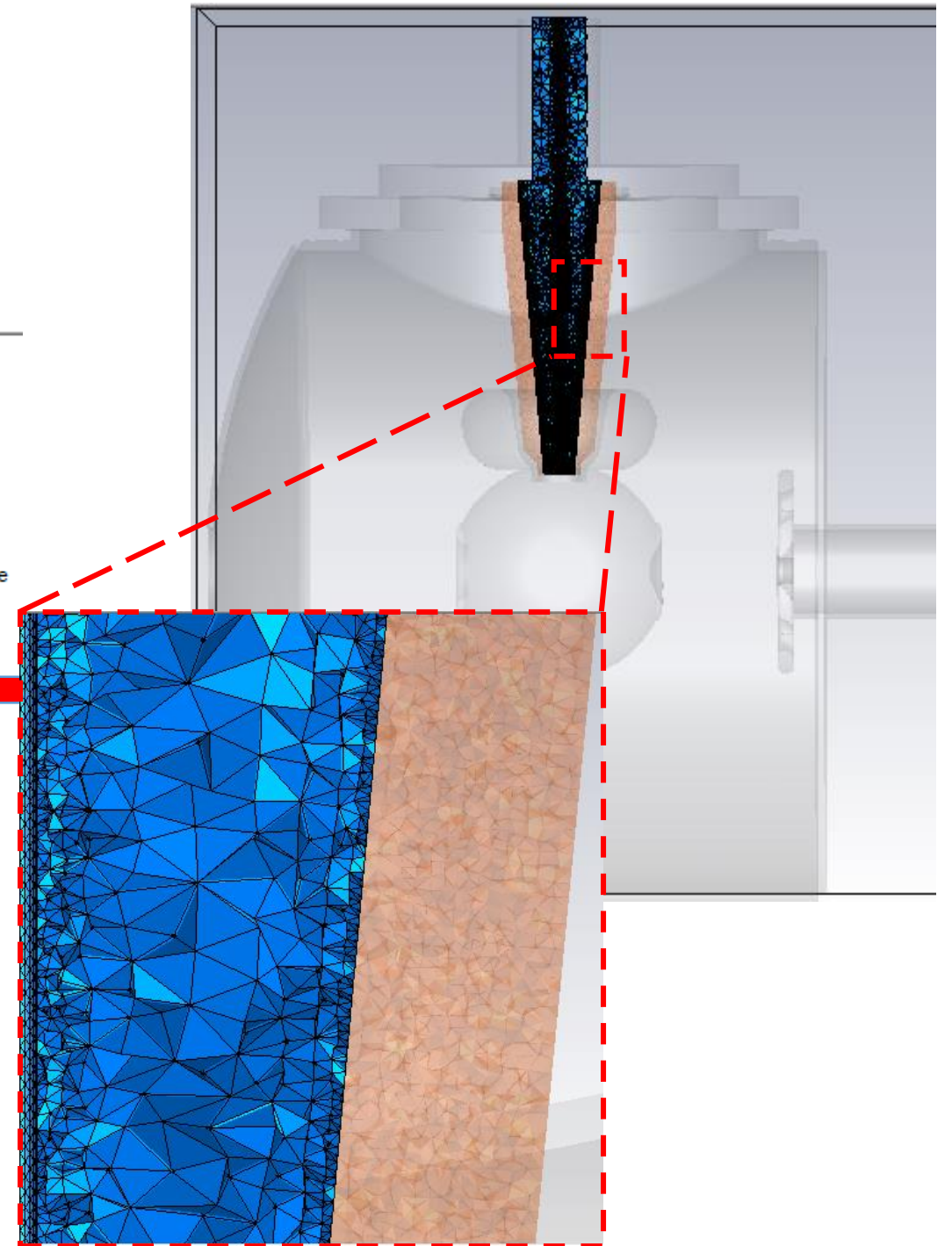
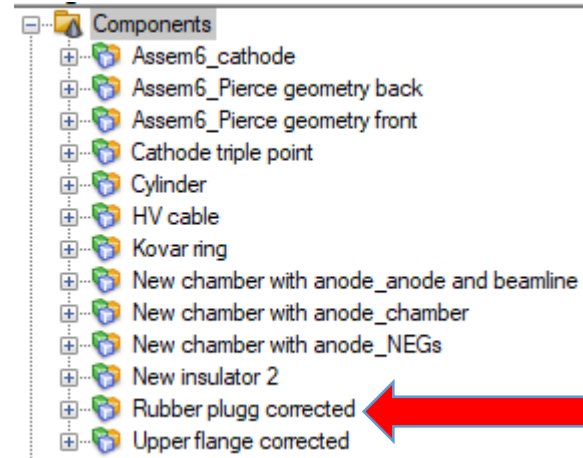
Name:
Rubber plugg corrected:Rubber plugg correcte

☒ Consider for simulation

☒ Consider for bounding box

Mesh group:
meshgroup16

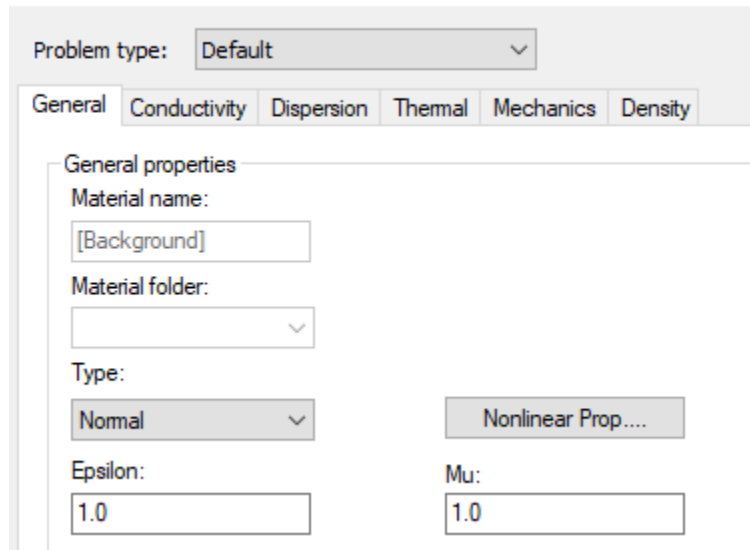
Maximum mesh step width settings
Max. step width: 0.01



CST simulation: Background

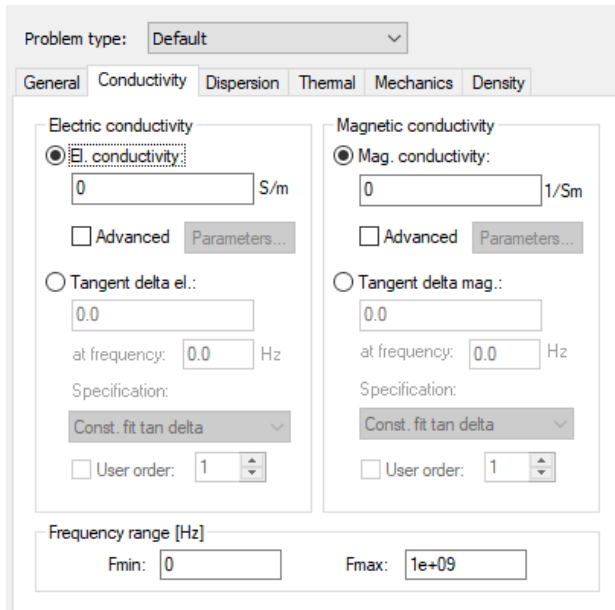
- The background is defined as vacuum.

Background Material Parameters

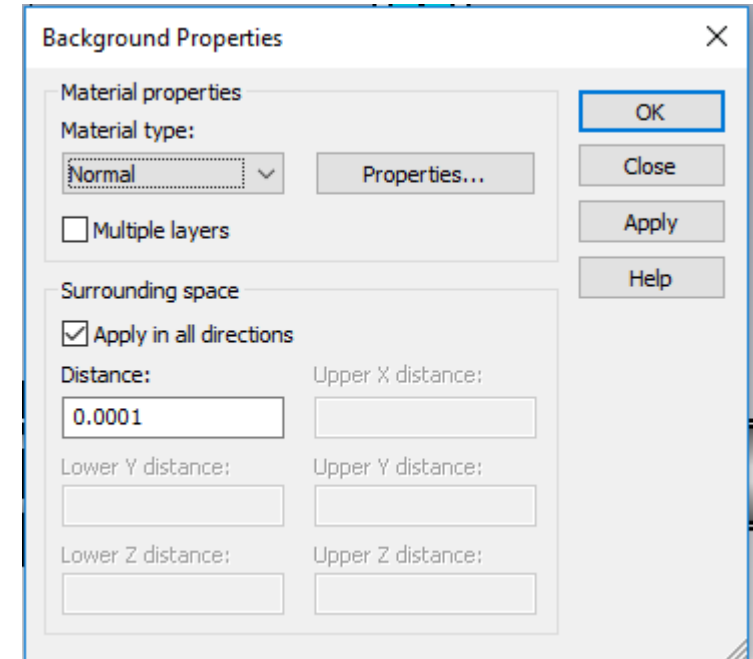


Background Material Parameters dialog box. The 'Problem type' is set to 'Default'. The 'General' tab is selected. Under 'General properties', the 'Material name' is '[Background]', the 'Material folder' is empty, and the 'Type' is 'Normal'. The 'Epsilon' is set to 1.0 and the 'Mu' is set to 1.0. A 'Nonlinear Prop....' button is visible.

Background Material Parameters



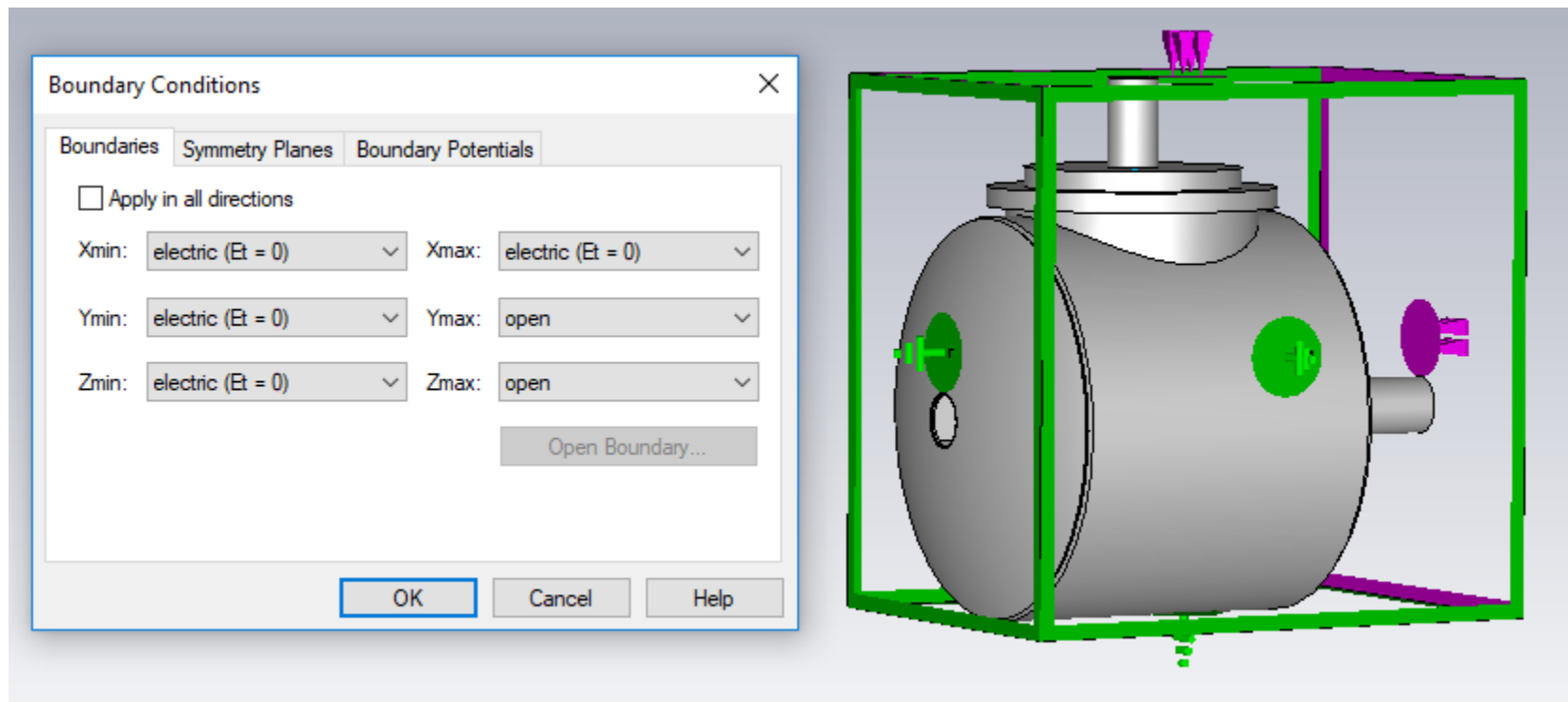
Background Material Parameters dialog box, 'Conductivity' tab. The 'Problem type' is 'Default'. The 'Electric conductivity' section has 'El. conductivity' selected with a value of 0 S/m. The 'Magnetic conductivity' section has 'Mag. conductivity' selected with a value of 0 1/S/m. Both sections have 'Advanced' and 'Parameters...' buttons. The 'Frequency range [Hz]' is set from Fmin: 0 to Fmax: 1e+09.



Background Properties dialog box. The 'Material properties' section has 'Material type' set to 'Normal' and a 'Properties...' button. The 'Surrounding space' section has 'Apply in all directions' checked. The 'Distance' is set to 0.0001. There are buttons for 'OK', 'Close', 'Apply', and 'Help'.

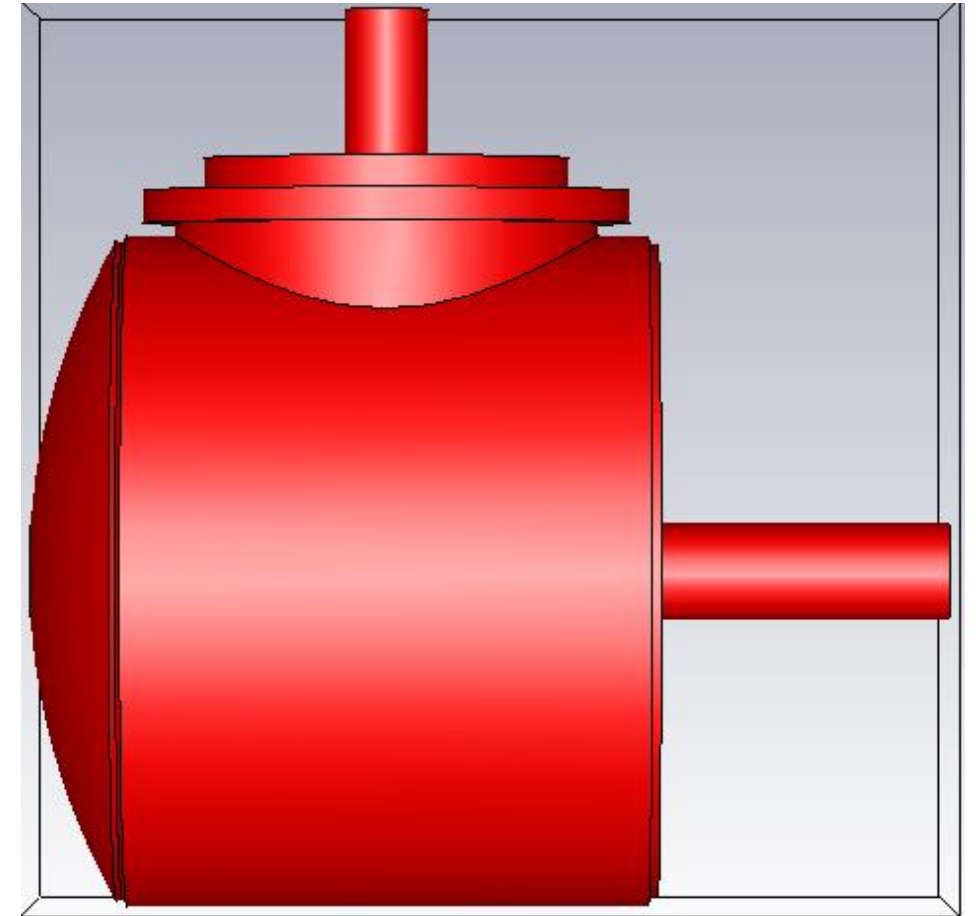
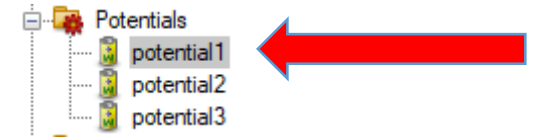
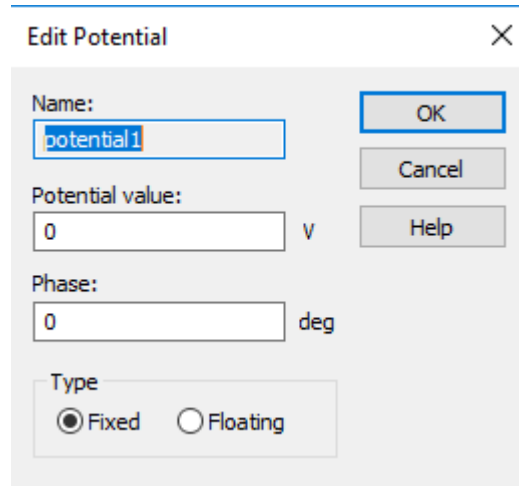
CST simulation: Boundaries

- The boundaries are set to ground except the top and the back of the beam line



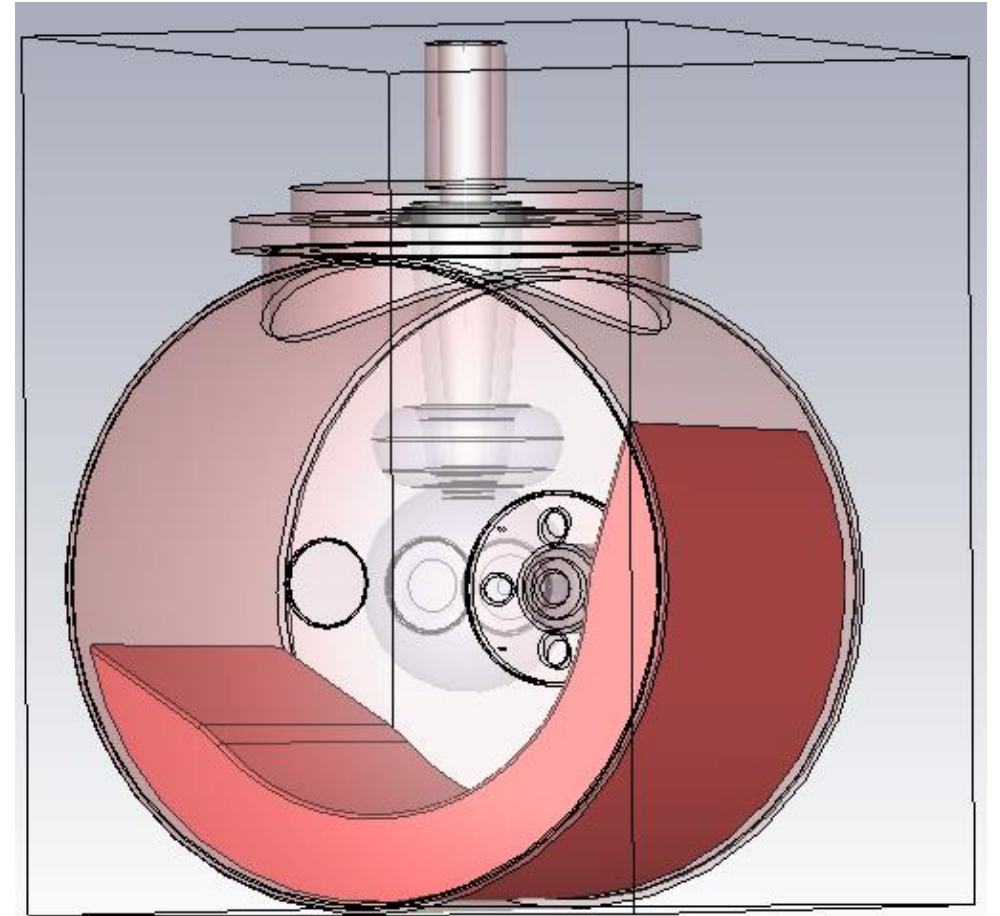
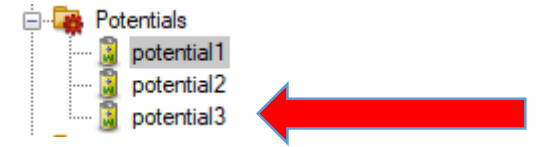
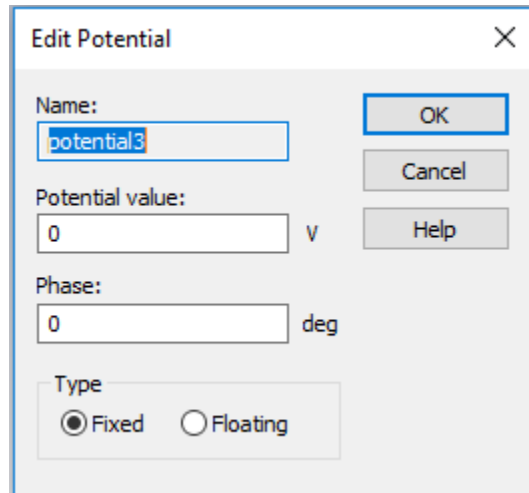
CST simulation: Potential

- I defined the potential in three parts:
 - Chamber, upper flange, Kovar ring, anode and beam-pipe at 0 [V]



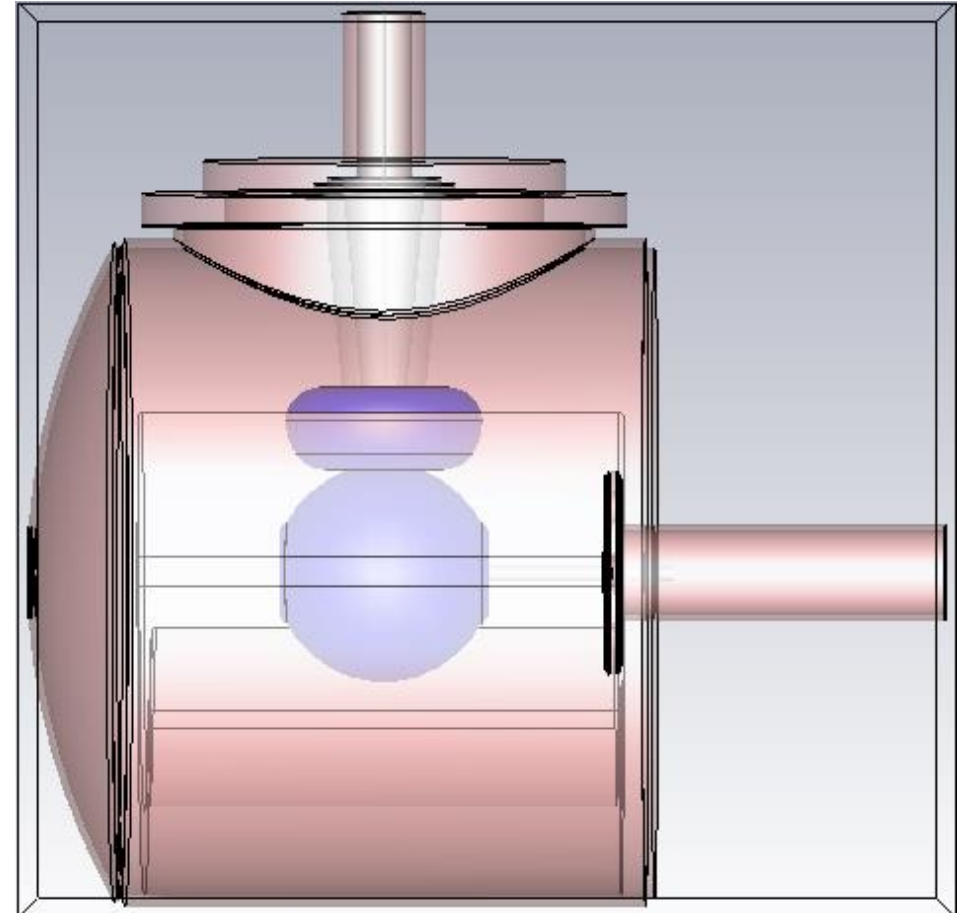
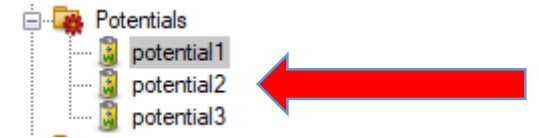
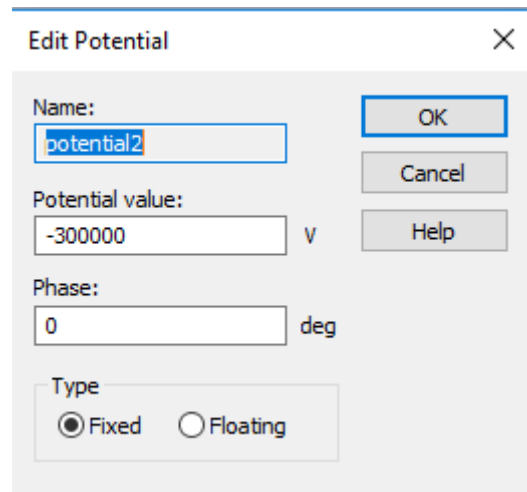
CST simulation: Potential

- I defined the potential in three parts:
 - Also the NEG's at 0 [V]



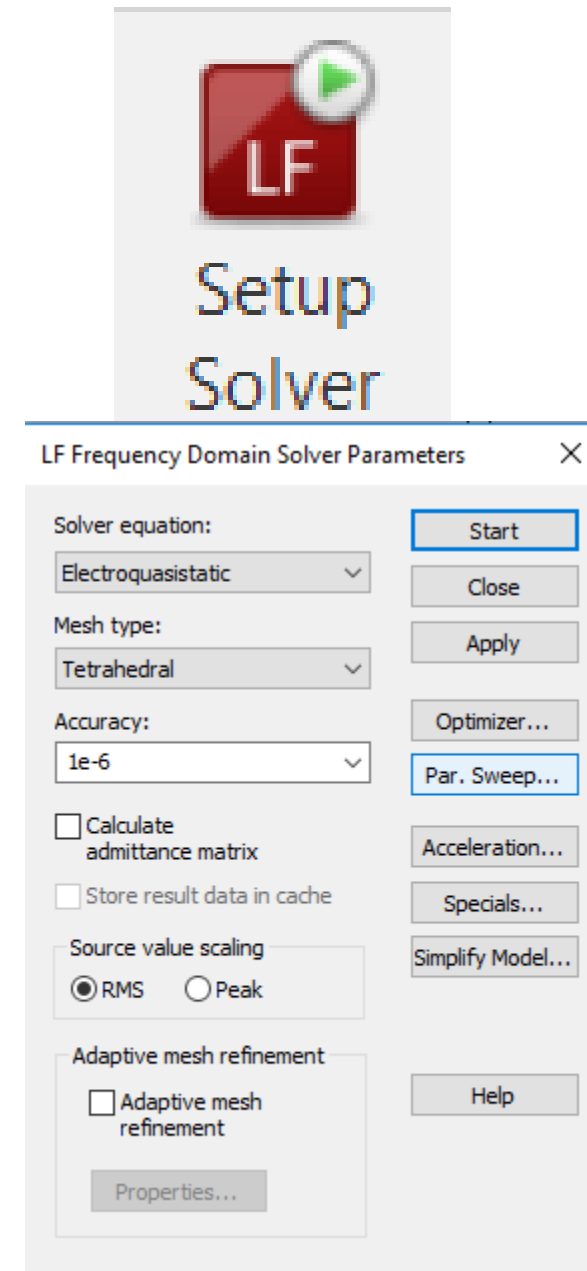
CST simulation: Potential

- I defined the potential in three parts:
 - Cathode electrode (including Pierce geometry), shield and high voltage cable at -300 [kV]

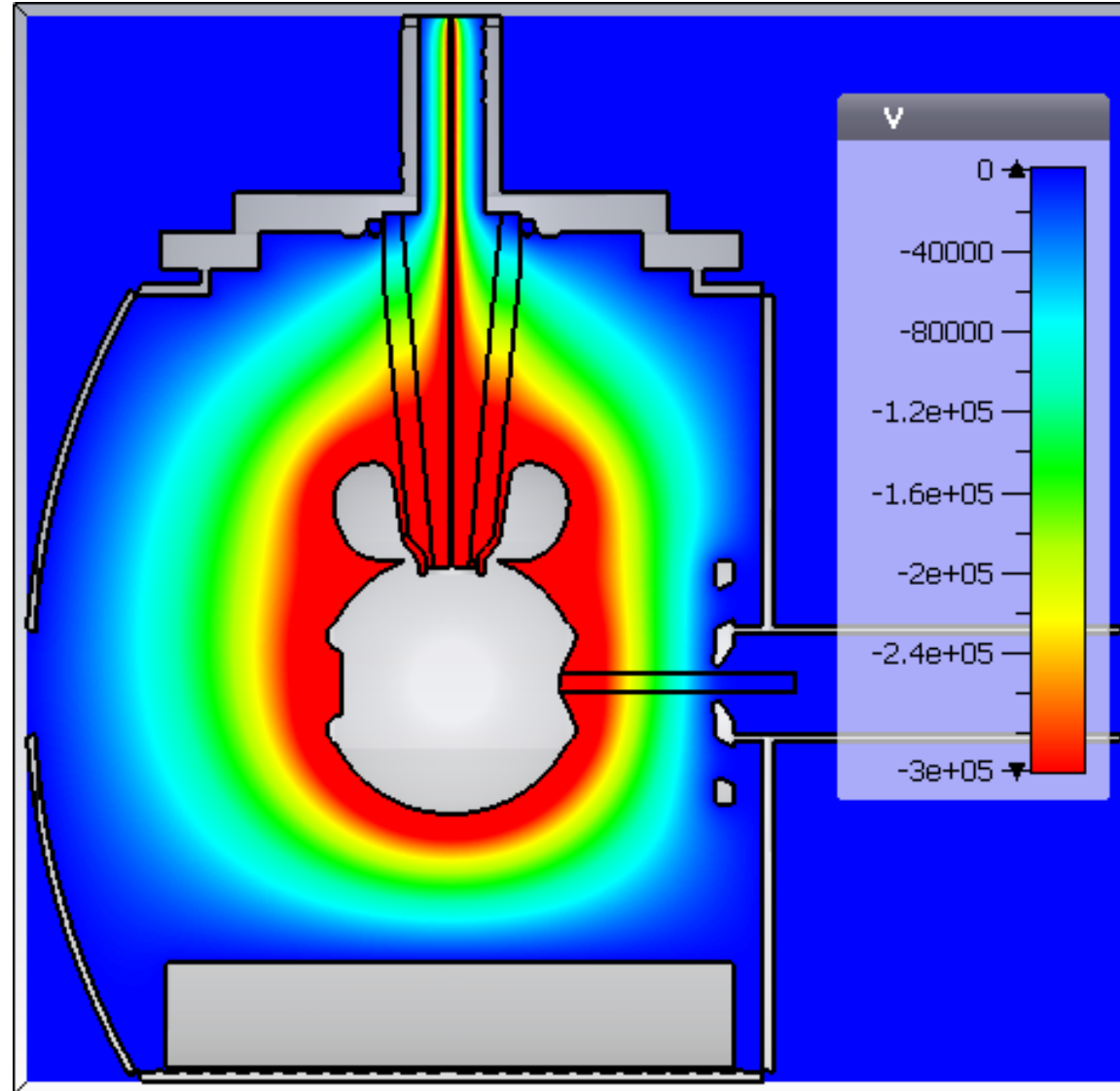


CST simulation: Solver

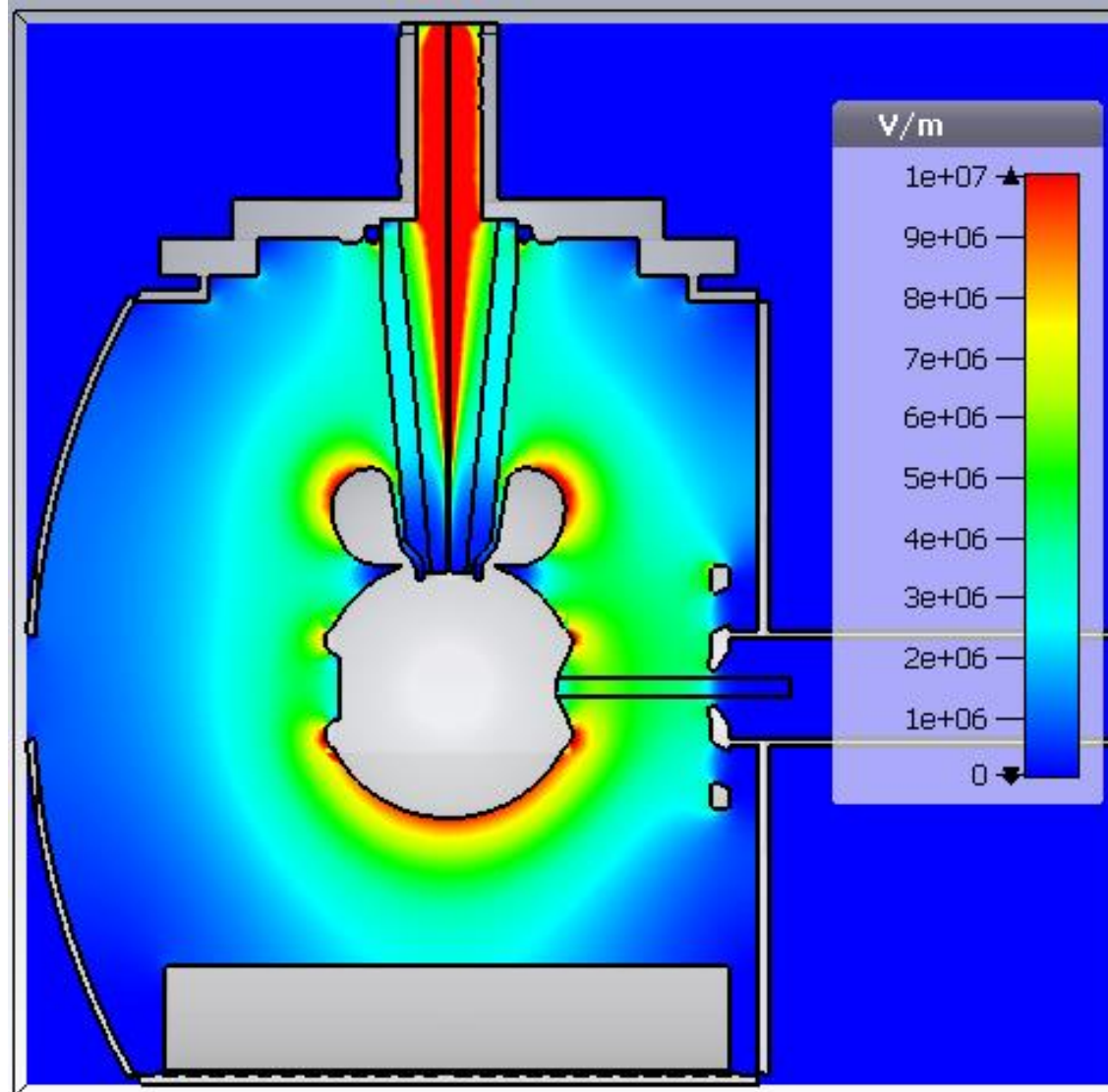
- Used the Low frequency as suggested by Fay.
- Did not use the adaptative mesh refinement this time.



CST results: Potential

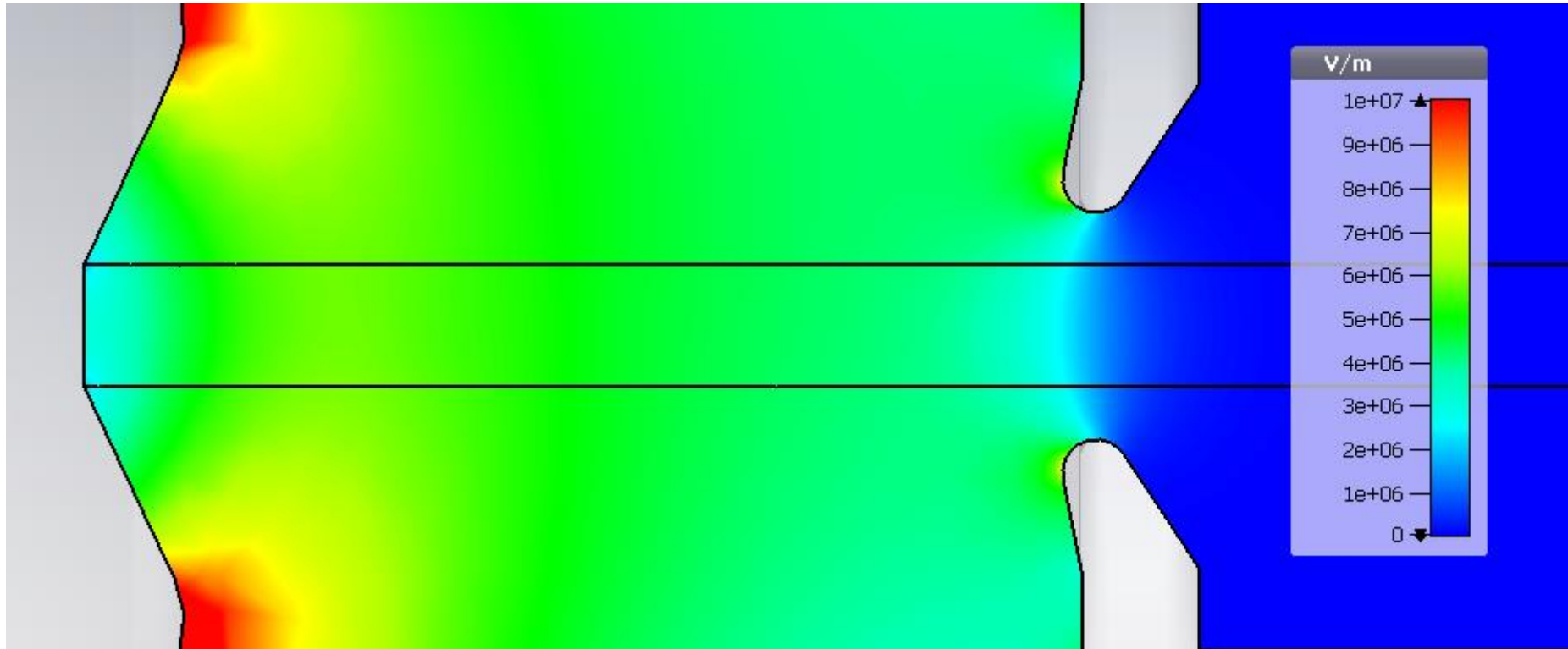


CST results: Electric field norm



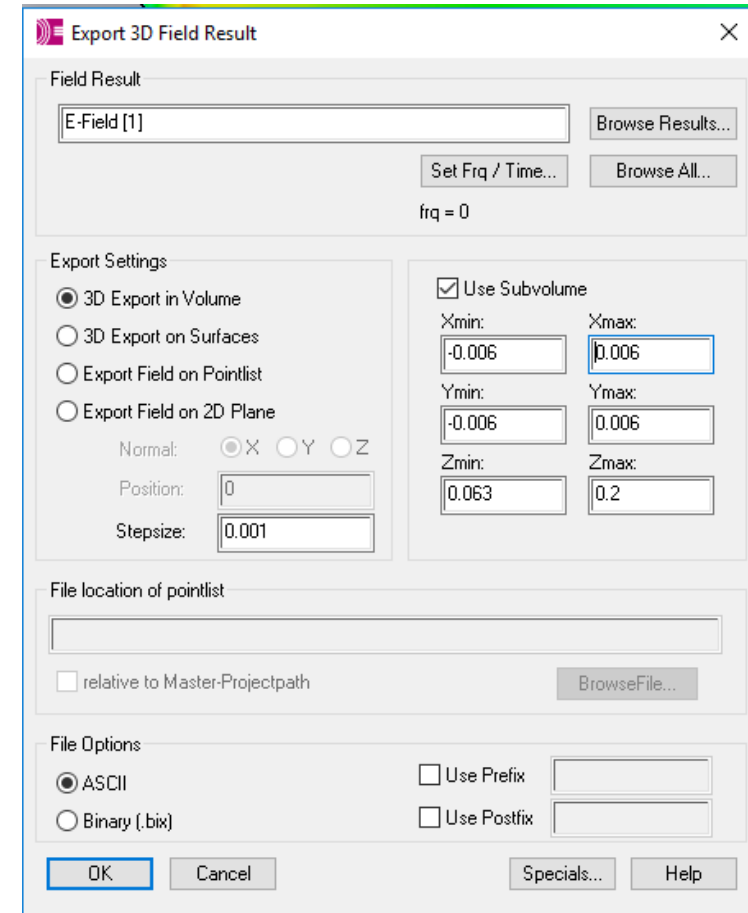
CST results: Electric field norm

Cathode- anode gap close up.



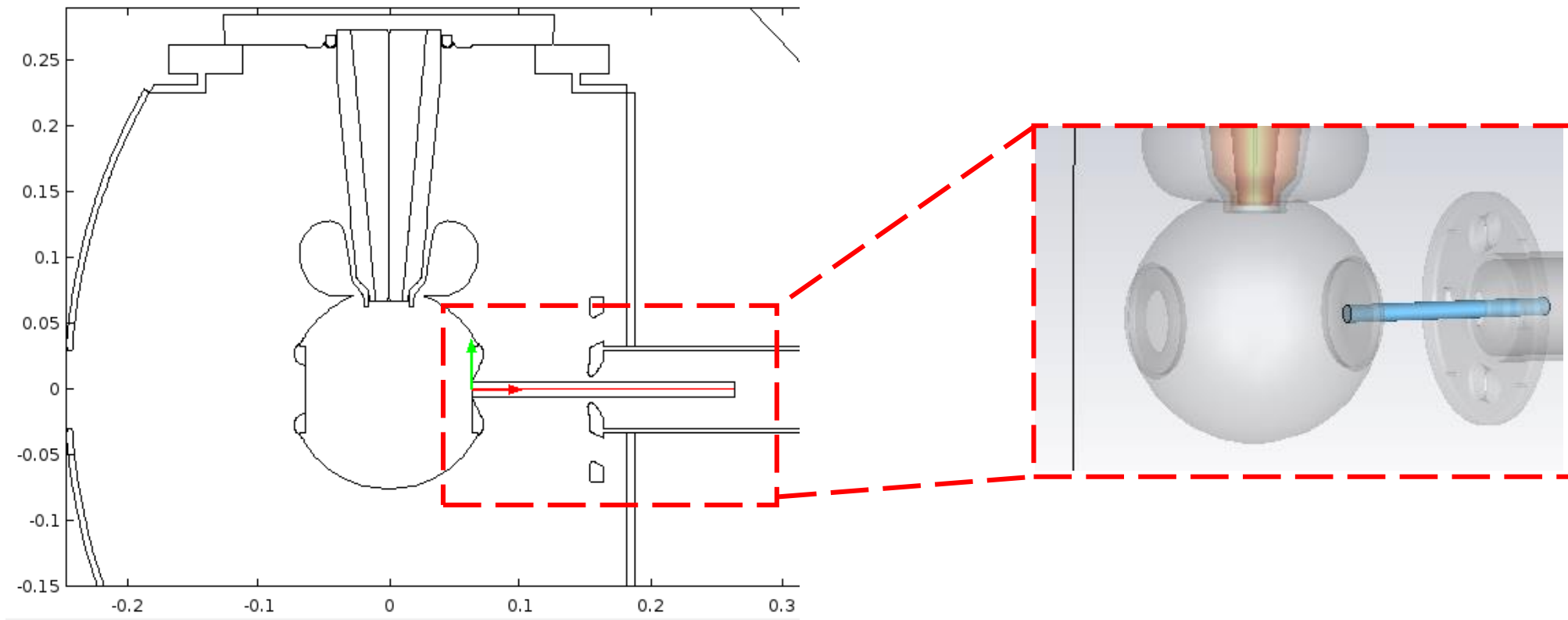
CST results:

- The results for electric field magnitude and potential plotted as false color. Also produced 2D and 3D field maps for the cathode-anode gap.



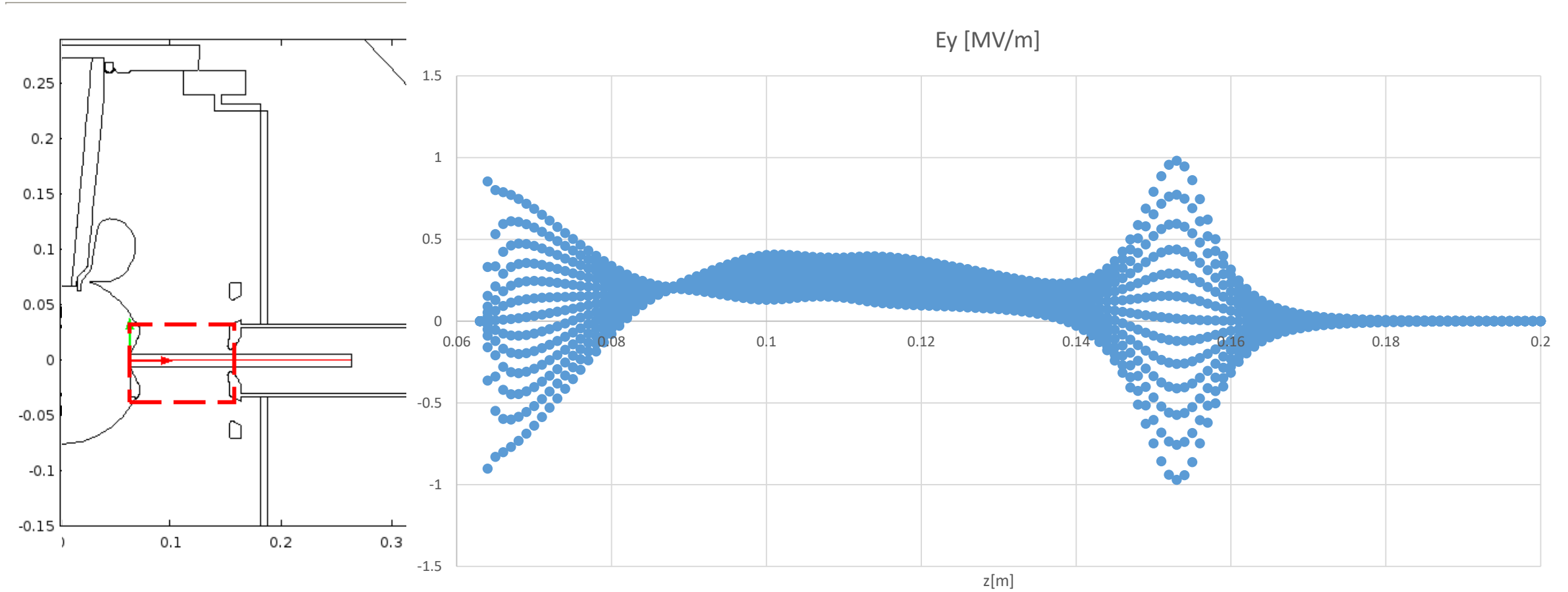
Photocathode-anode line:

The data for the following plots was taken along a horizontal line from the center of the photocathode to the back of the chamber passing through the anode center as shown in the red line



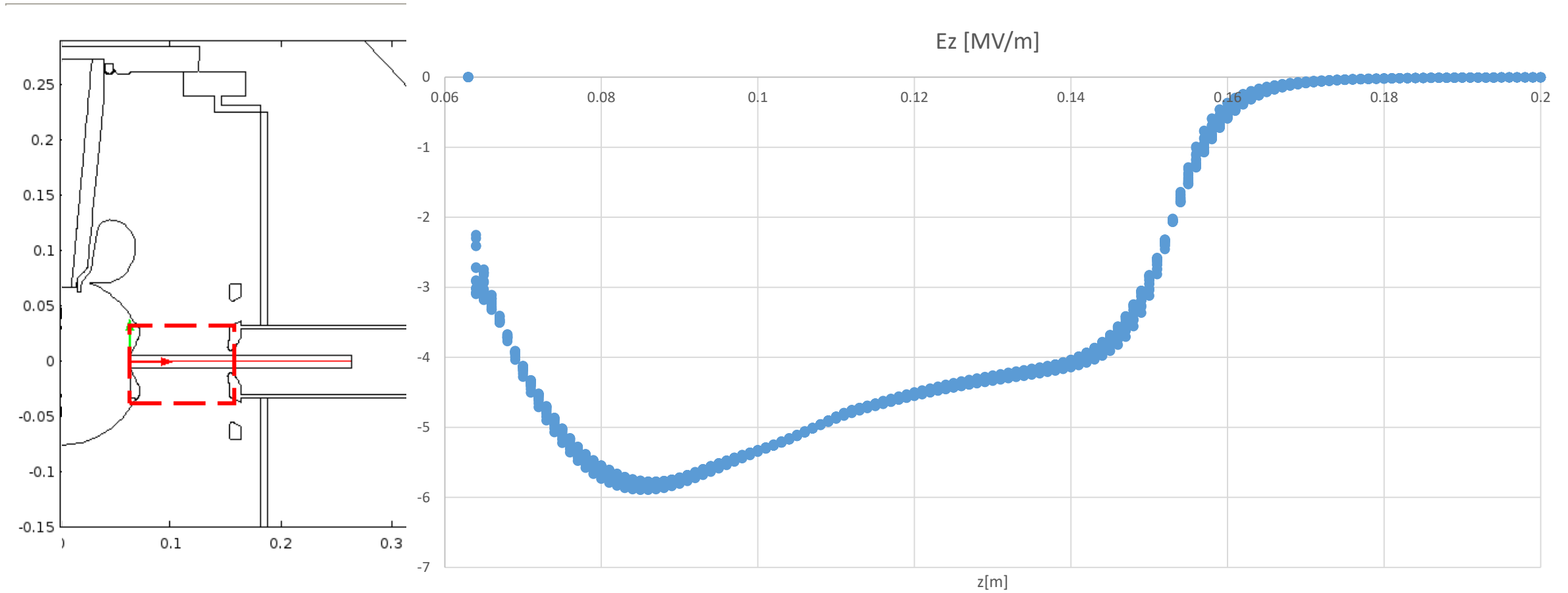
Photocathode-anode line :

- This image shows the electric field E_y component in MV/m as a function of position on the z axis.



Photocathode-anode line :

- This image shows the electric field E_z component in MV/m as a function of position on the z axis.

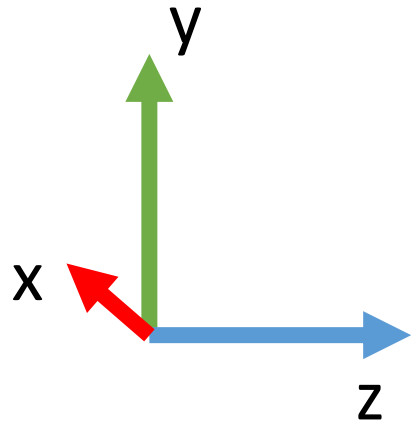


Future steps

- Recalculate for the **white insulator** case and obtain field maps.
- Use to investigate the upper flange triple-point.
- Get fields on the insulator surface for insulator studies.

Fin.

CST frame of reference:



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