

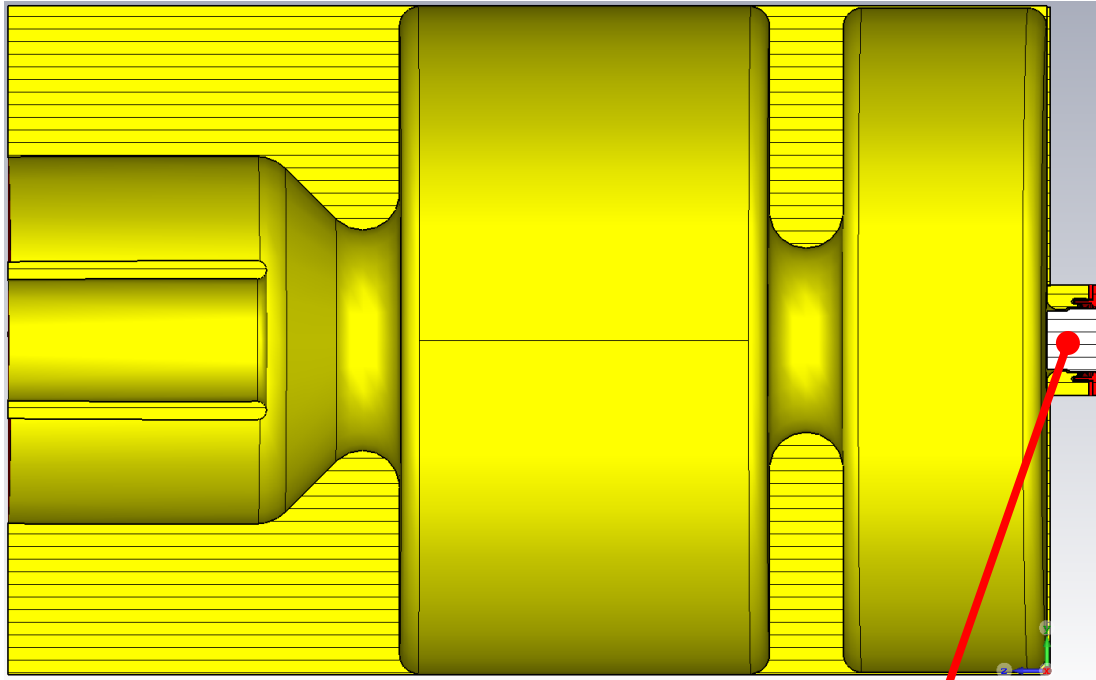
RF simulations for cathode vicinity irregularities of the Gun4.5

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PITZ Physics Seminar #700
Zeuthen, 31.01.2019

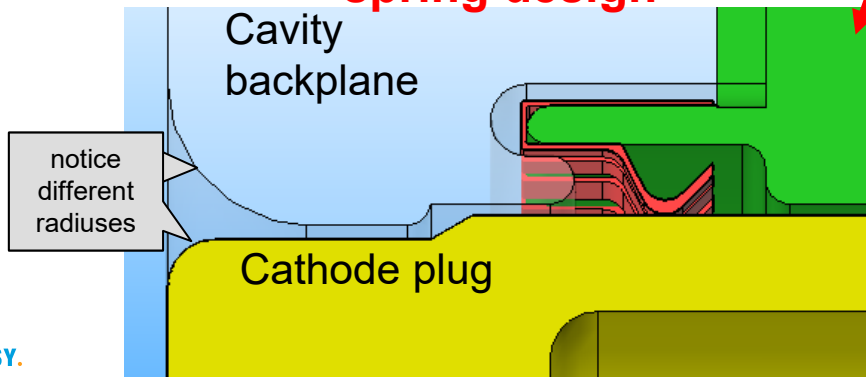


Gun4.5 setup features

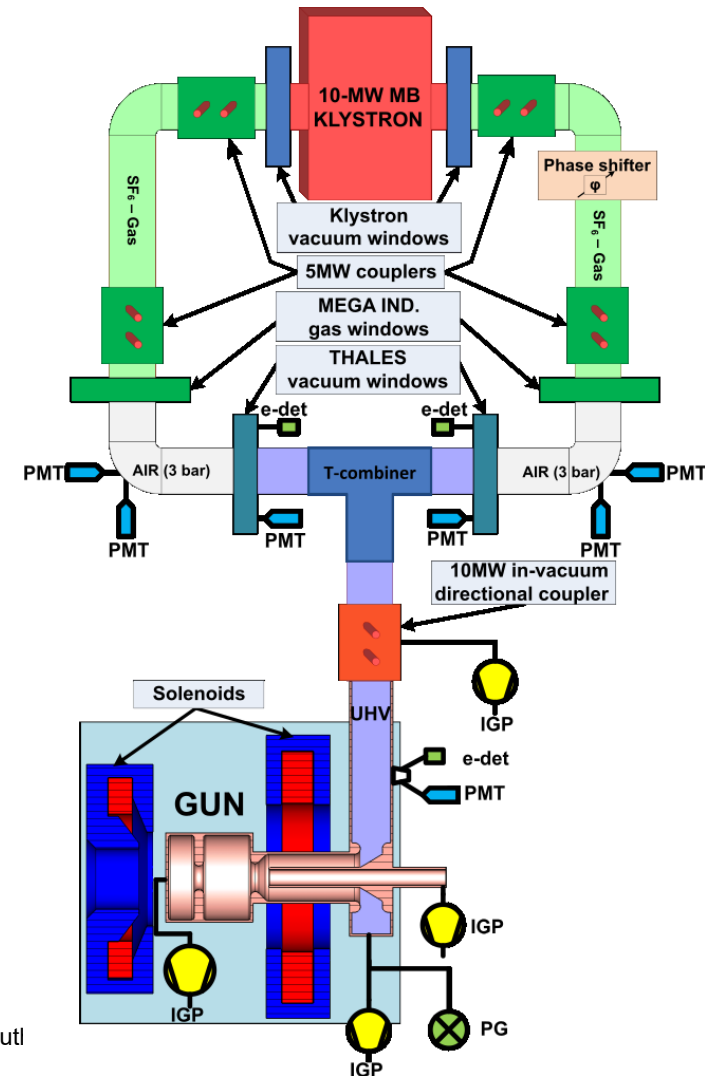
(from 04.04.2018 to 27.07.2018)



"Contact stripe" cathode spring design

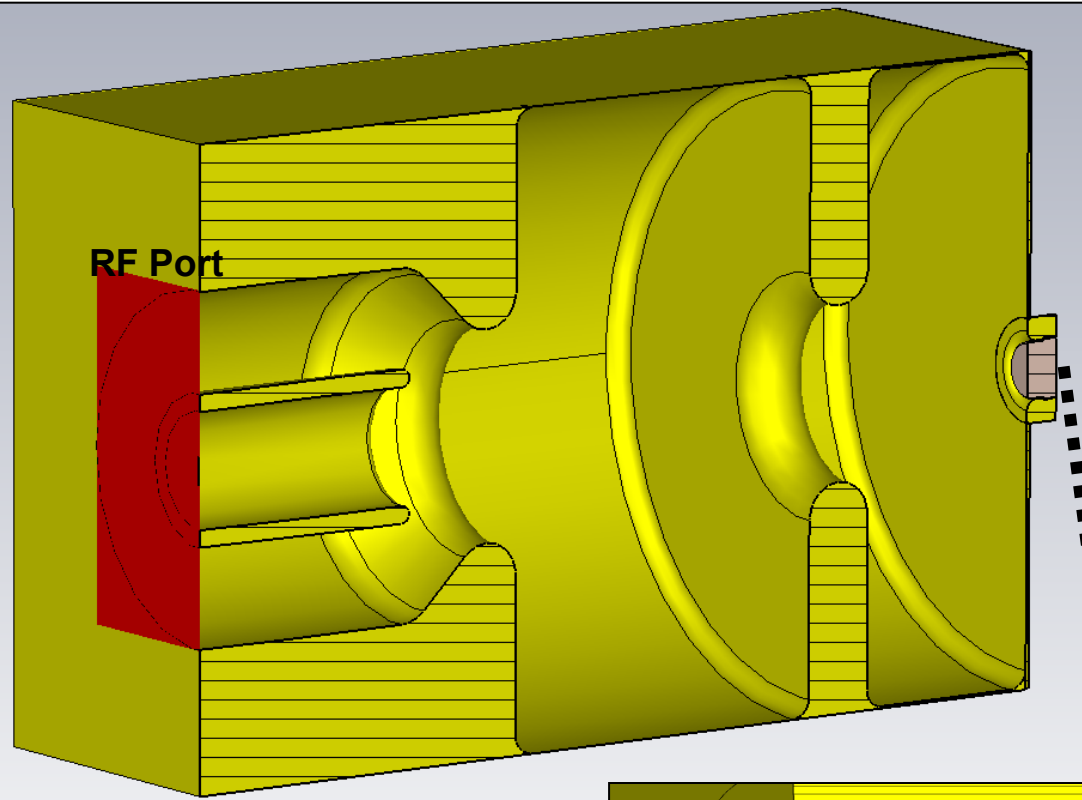


- 2 Thales-type RF vacuum windows
- T-Combiner has optimized RF design for best window positioning for reflections + most compact

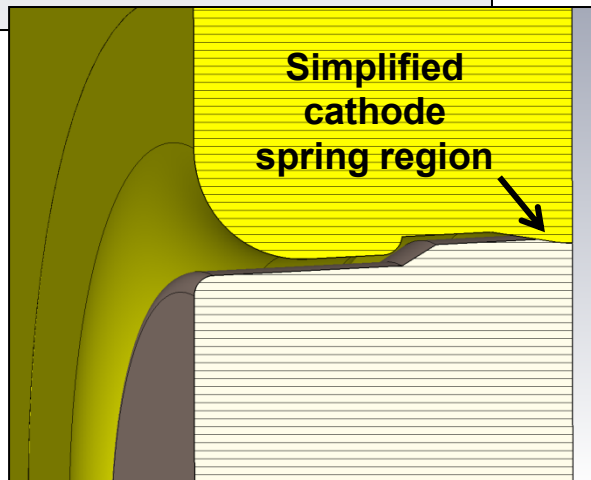
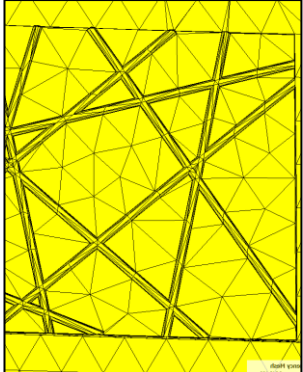


Photomultiplier tube
 Electron detector
 rared sensor
 on getter pump
 ressure reading)
 ressure gauge

CST model of the Gun4.5



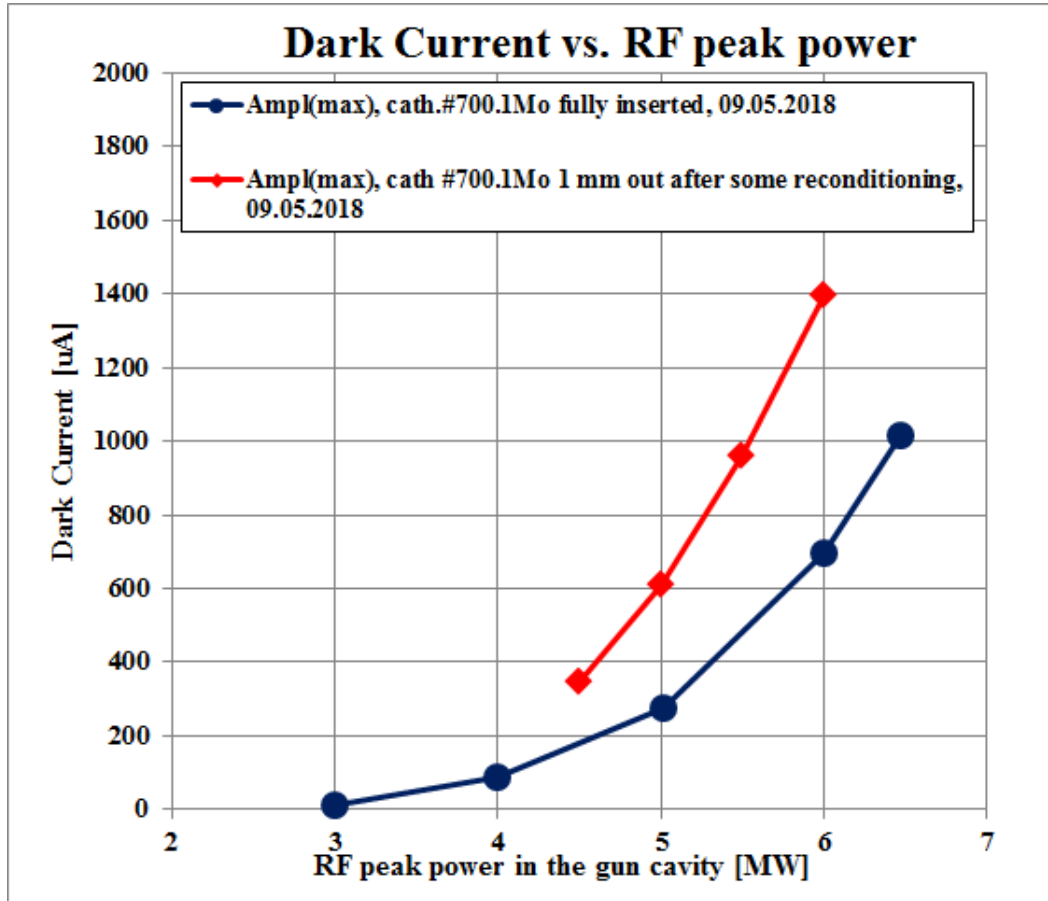
Example of Mesh



Model features:

- The port position was optimized for simplified cathode model of the watch-band cathode spring design
- The radii, **S11** and **FB** of the cells were **optimized for an old model** and did not change here
- **The cathode vicinity geometry** was taken for the **contact-stripe cathode spring design, but simplified** by creating a short-cut at the place where the spring gap begins
- The mesh properties:
 - set acceptable for the whole model
 - for the cathode and cathode vicinity there was used local meshing with a few settings for different solids
 - the tetrahedral mesh with 2nd order curved elements was applied
 - the total number of the **mesh cell per half** a model is **6M..9M**
- **YZ-plane model symmetry** was utilized, but the cathode vicinity surface irregularities placed at the center
- simulations utilized **F-solver**
- the fields strength is calculated according to the rule of **1W forward power**

Dark current of the Gun 4.5



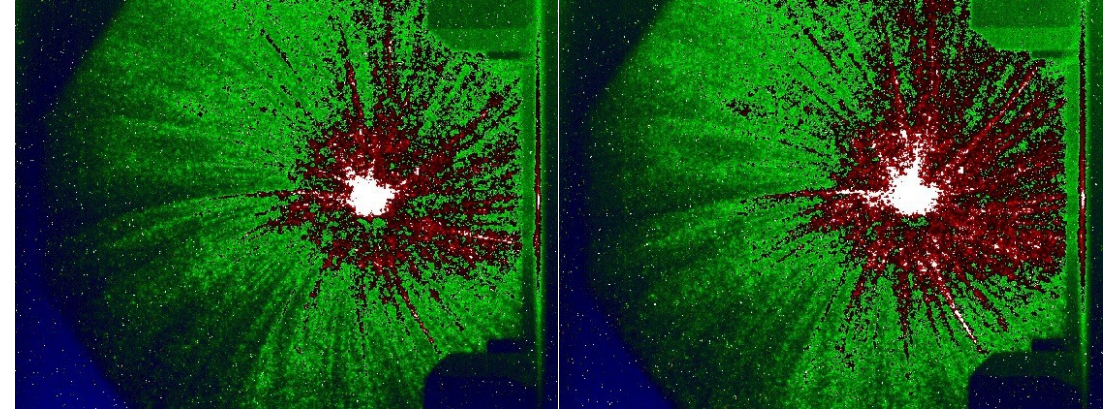
Main conclusion: High DC is coming from back wall of the gun.

Dark current investigations:

Cathode plug insertion orientation change:

DC images at Low.SCR1. I_{main} = 380A

Left: normal cathode orientation; Right: rotated by 180deg → similar DC

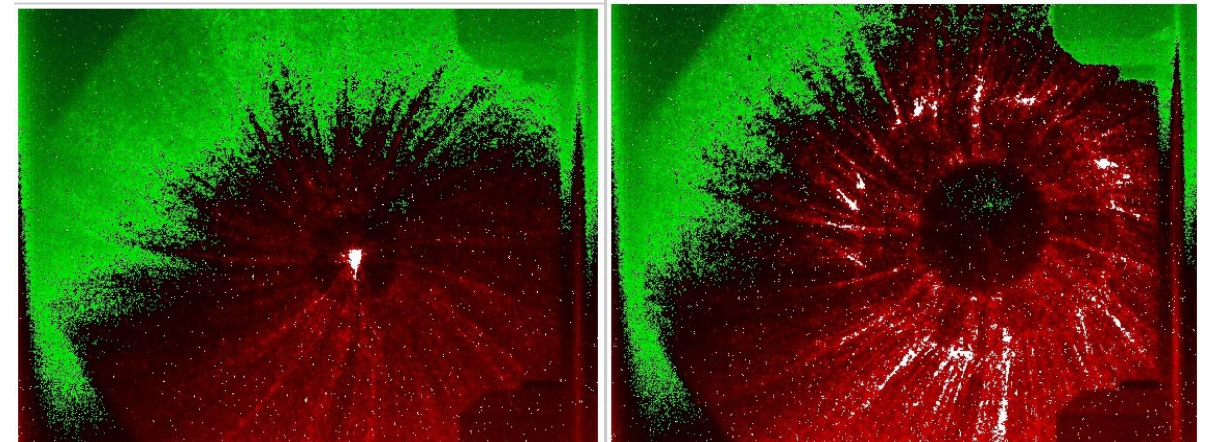


Cathode plug Z position of insertion change:

DC images at Low.SCR1. I_{main} = 390A

Left: normal cathode position; Right: cathode plug is out by 1mm → 2 x DC

09.05.2018 09:25 O. Lishilin, H. Huck DC@Low.Scr1, 09.05.2018 11:41 O. Lishilin, H. Huck, M. Krasilnikov DC@Low.Scr1,



Gun4.5: visual inspection in week 46/47

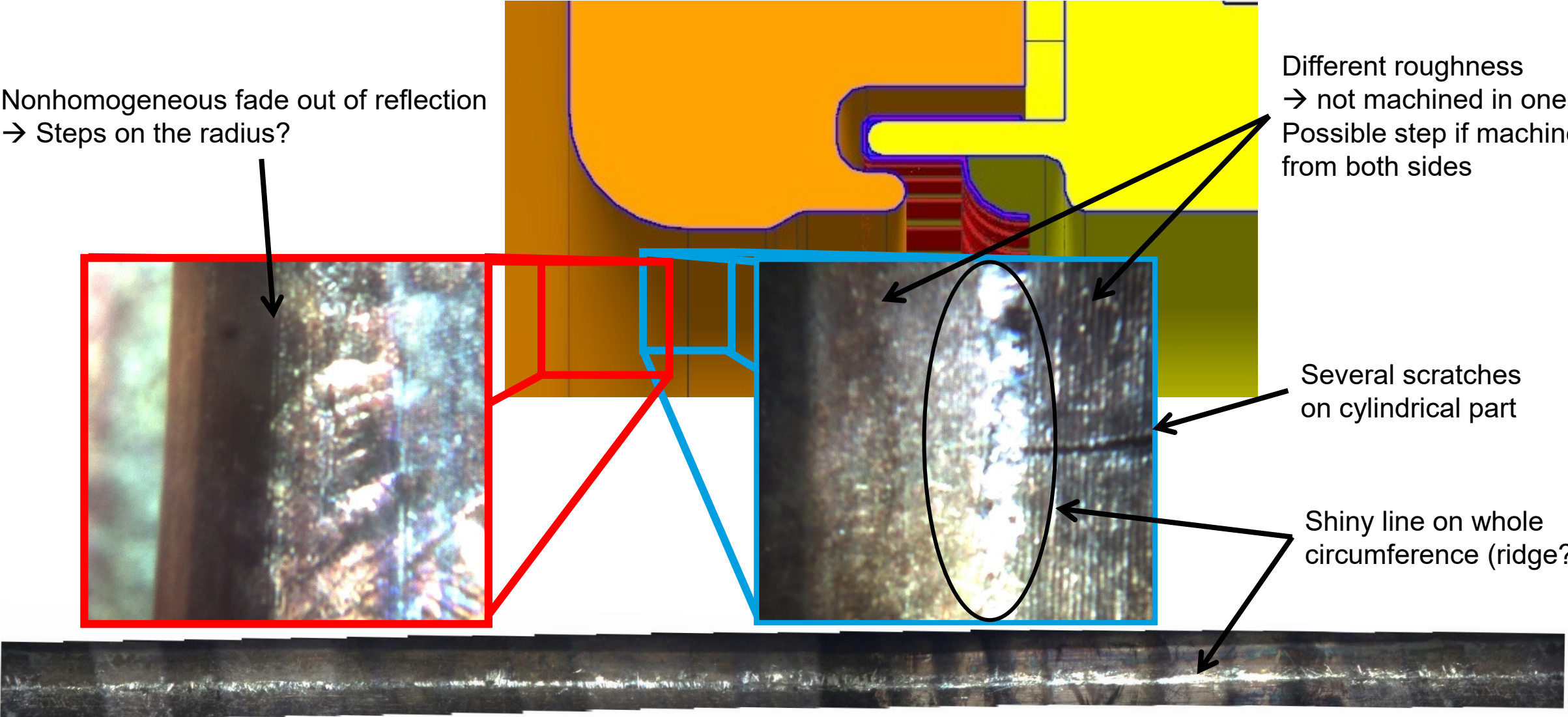
Pictures taken from the cathode side using a stiff videoscope provided by TH-Wildau (by Sebastian Philipp)

Nonhomogeneous fade out of reflection
→ Steps on the radius?

Different roughness
→ not machined in one go
Possible step if machined from both sides

Several scratches on cylindrical part

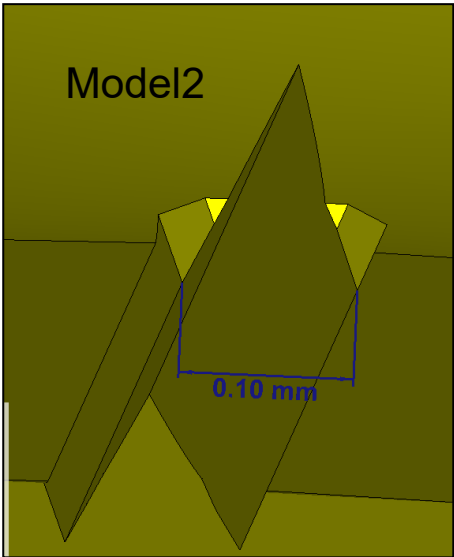
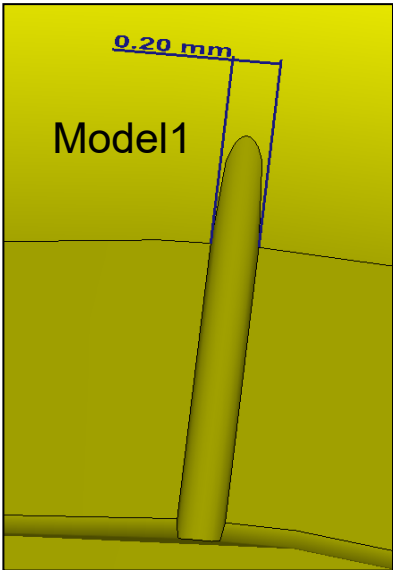
Shiny line on whole circumference (ridge?)



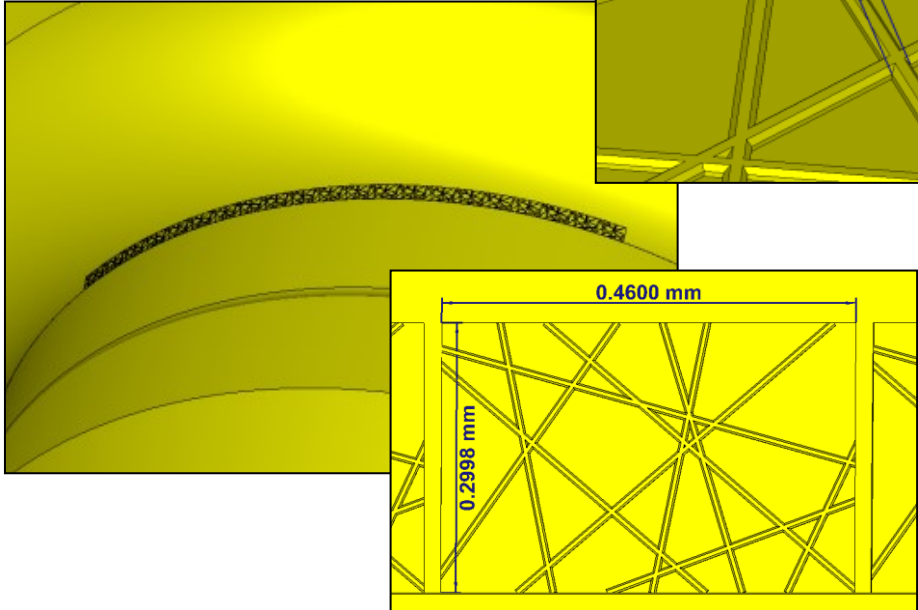
Cathode vicinity irregularities modeling



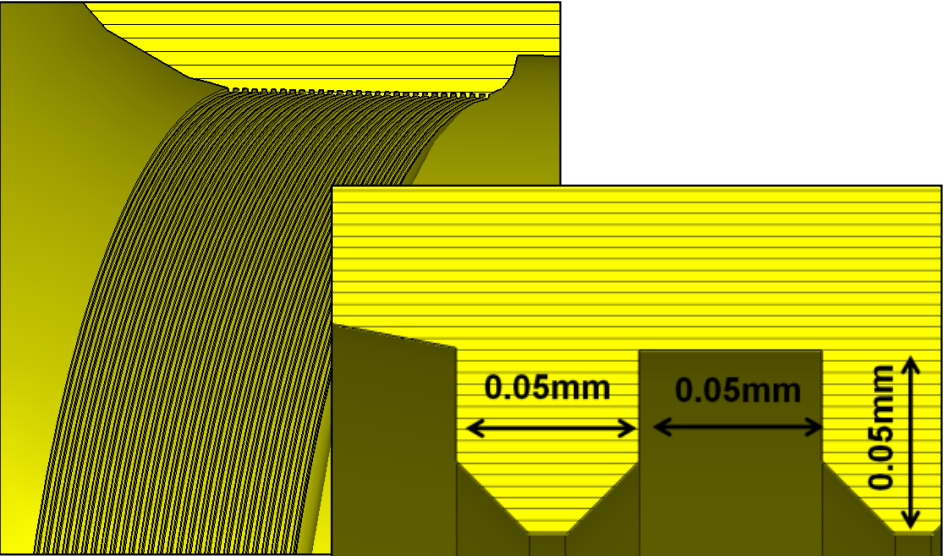
Scratch



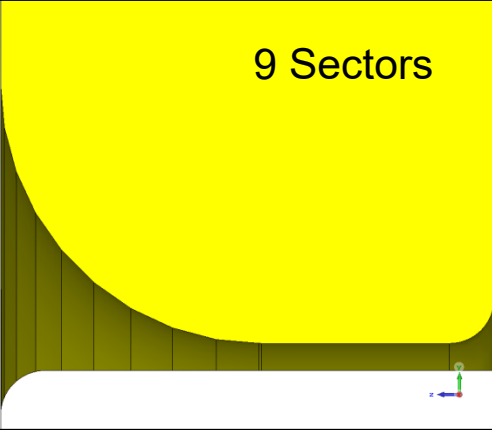
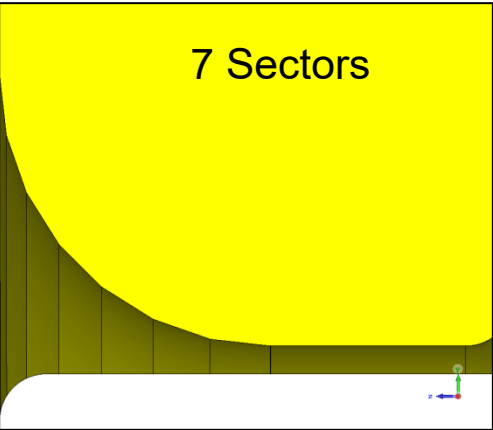
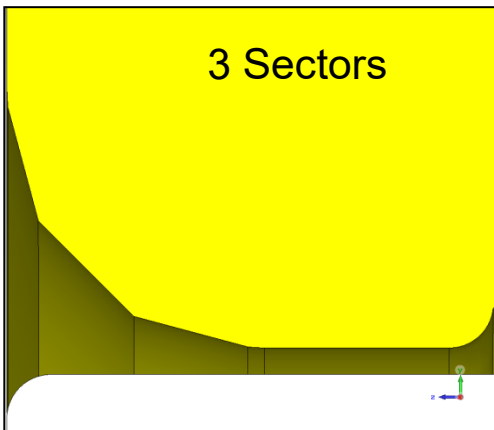
Protrusions (21 pieces)



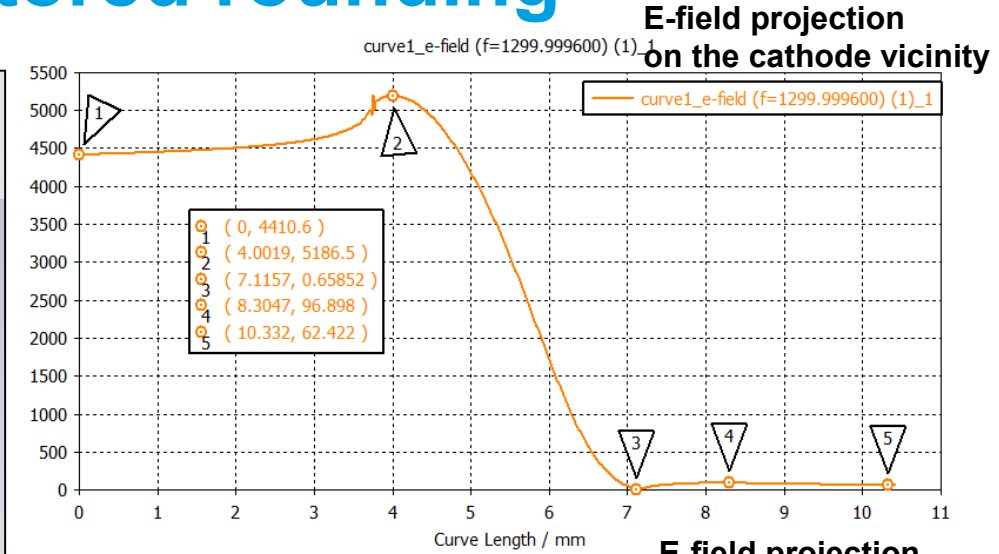
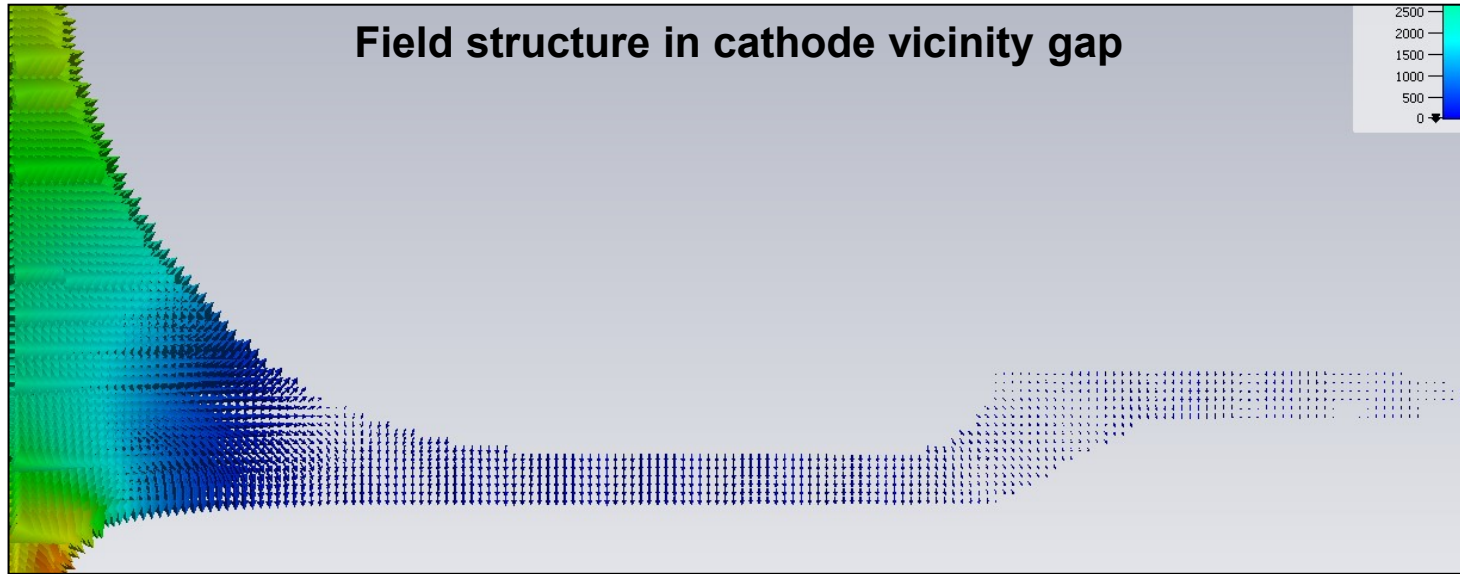
Machining traces (28 crests)



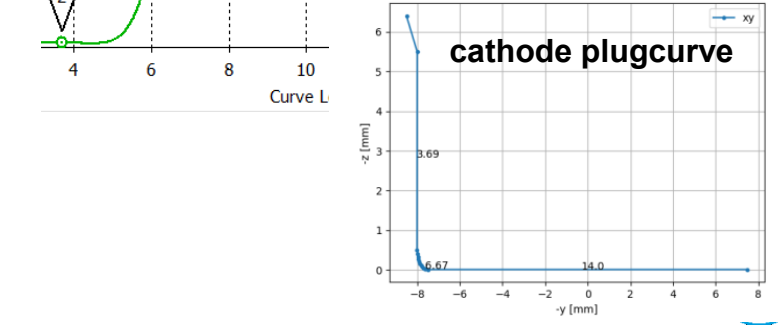
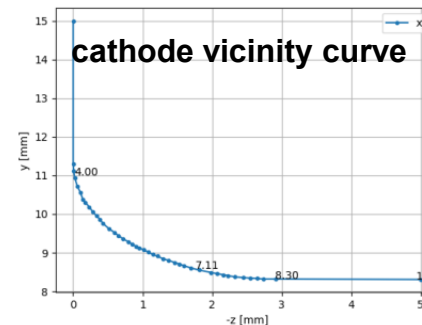
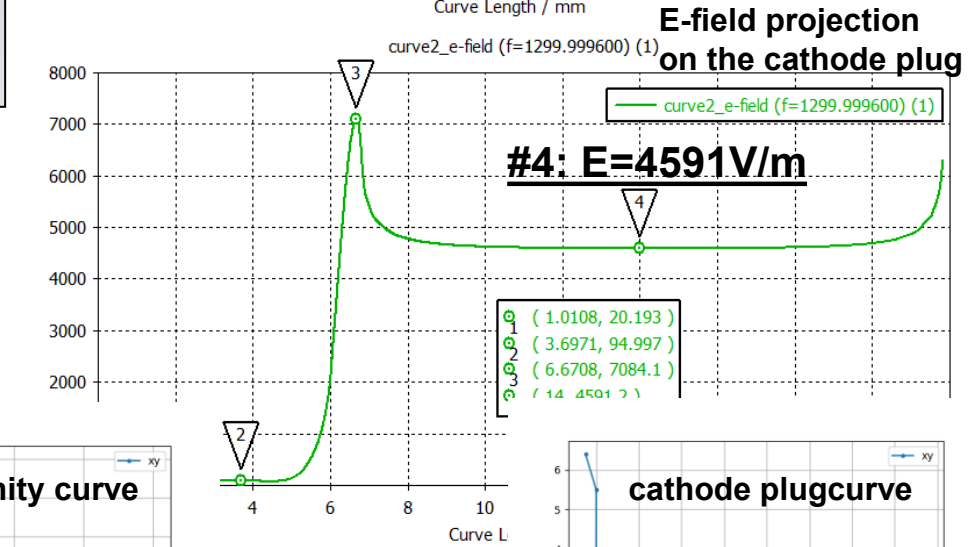
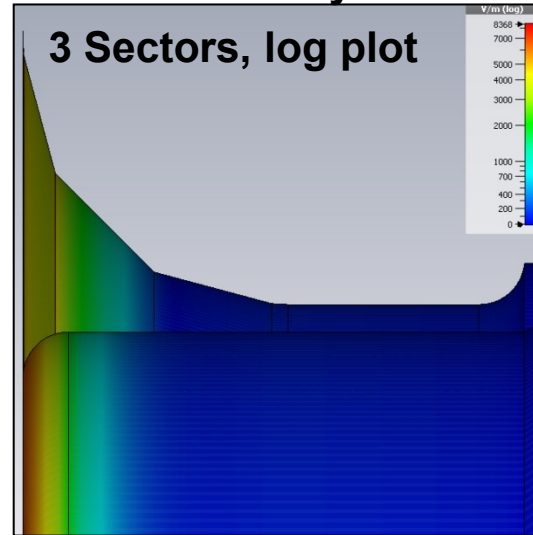
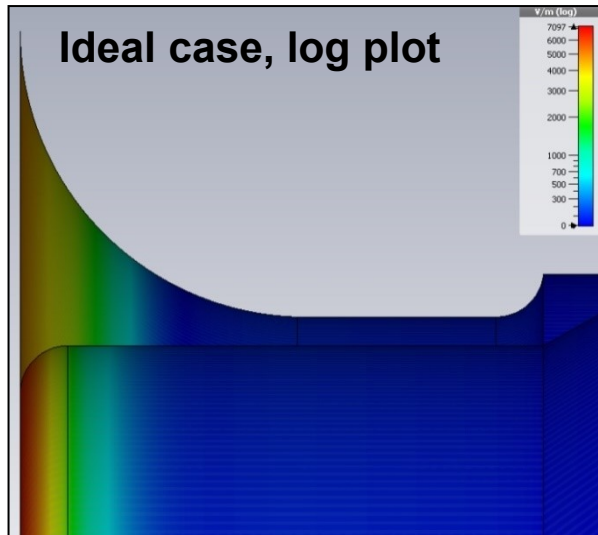
Sectored rounding of the cathode vicinity



Simulation results: Ideal case and Sectored rounding

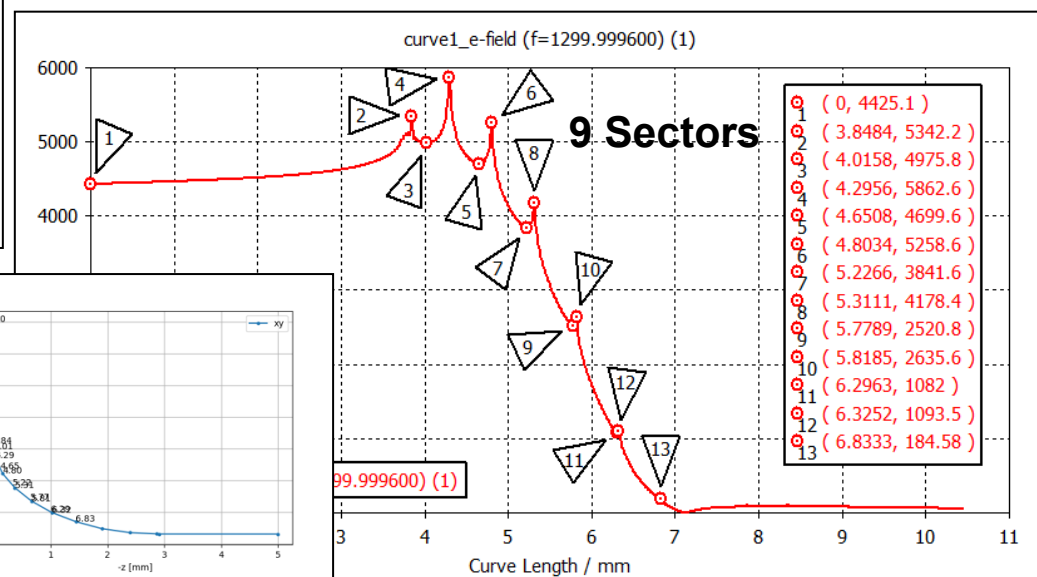
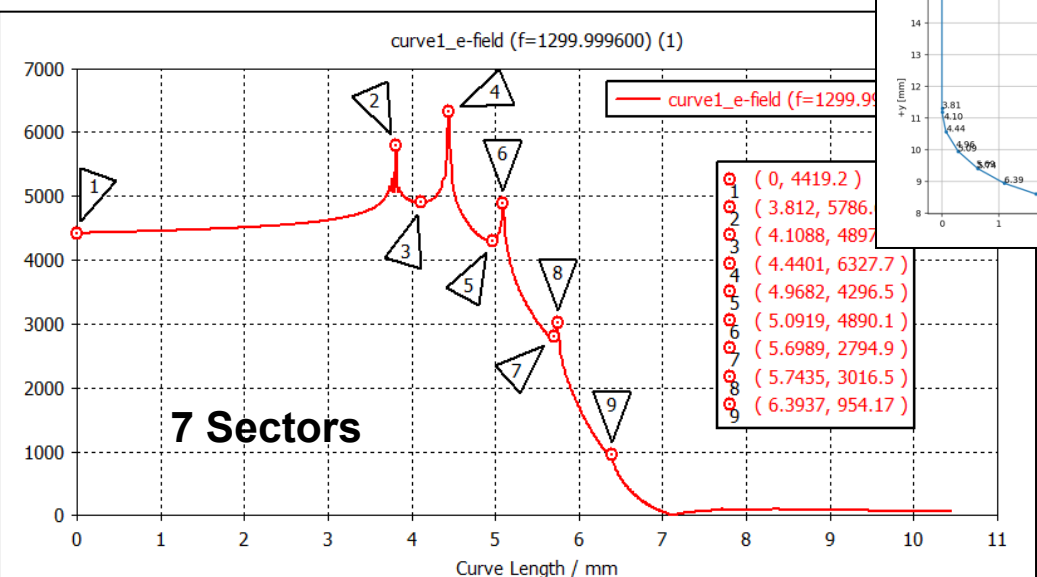
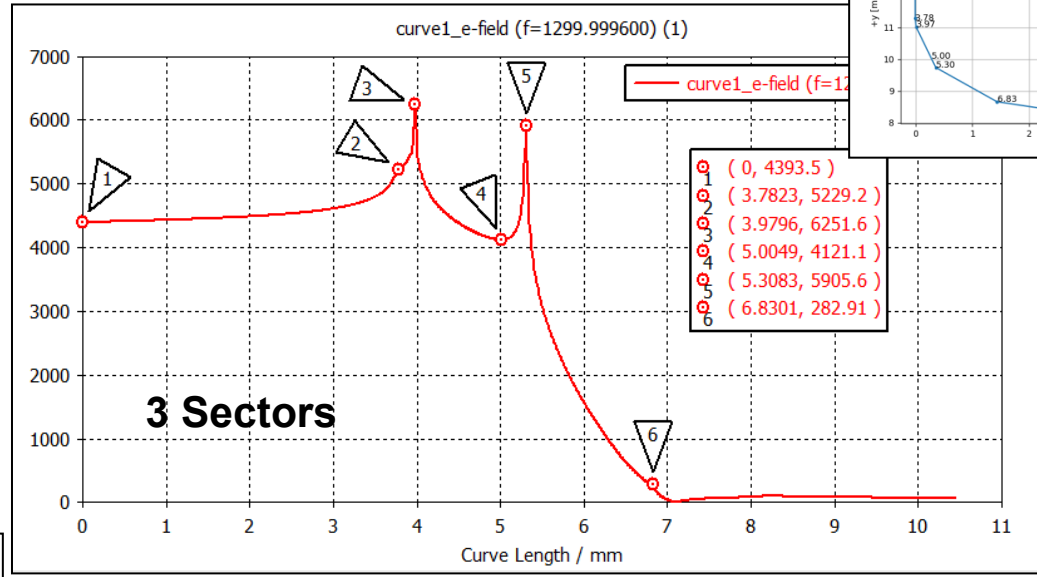
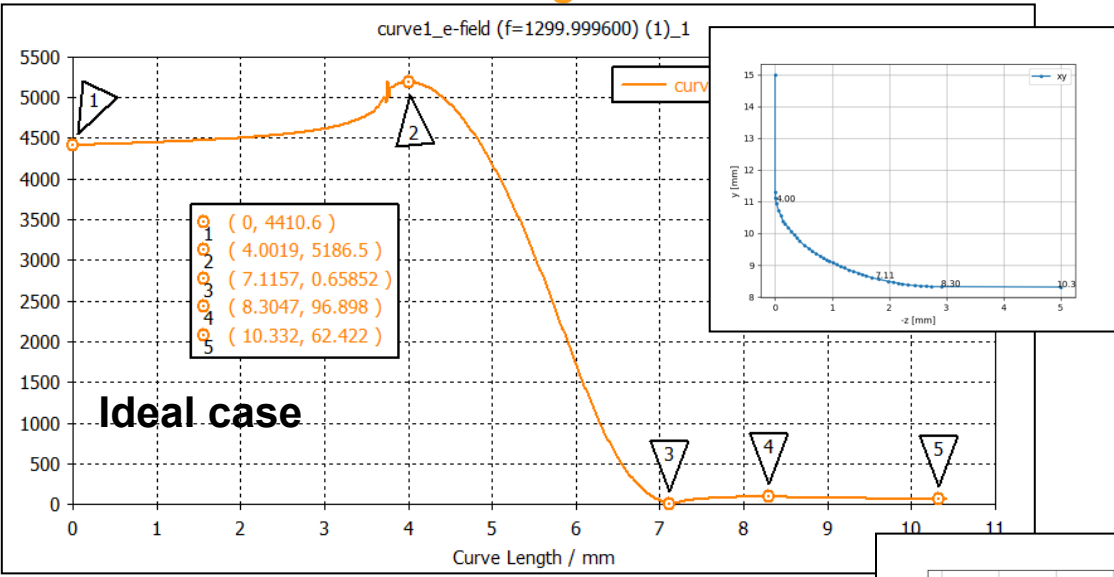
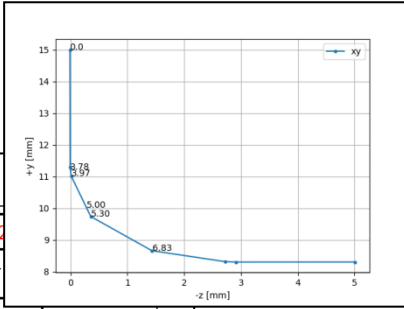


Abs values of the E-field on the cathode vicinity surface



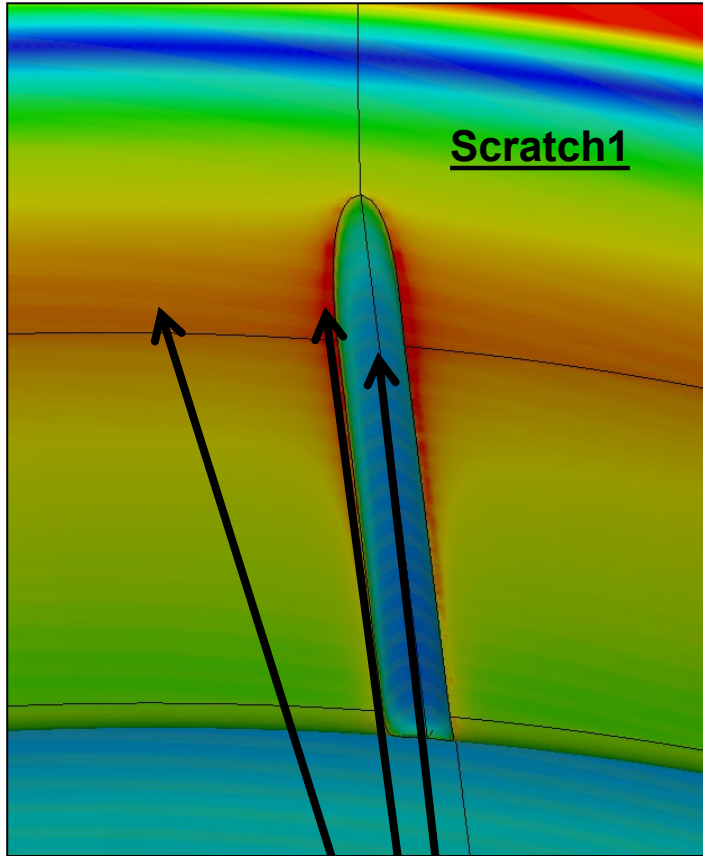
Simulation results: Ideal case and Sectored rounding

$E=4591\text{V/m}$ is field strength at the cathode center

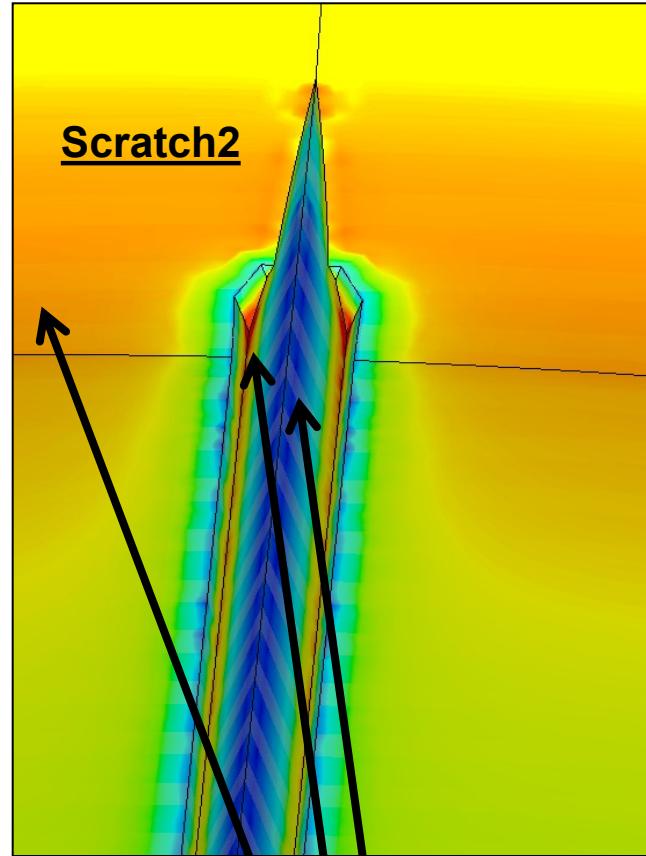


Simulation results

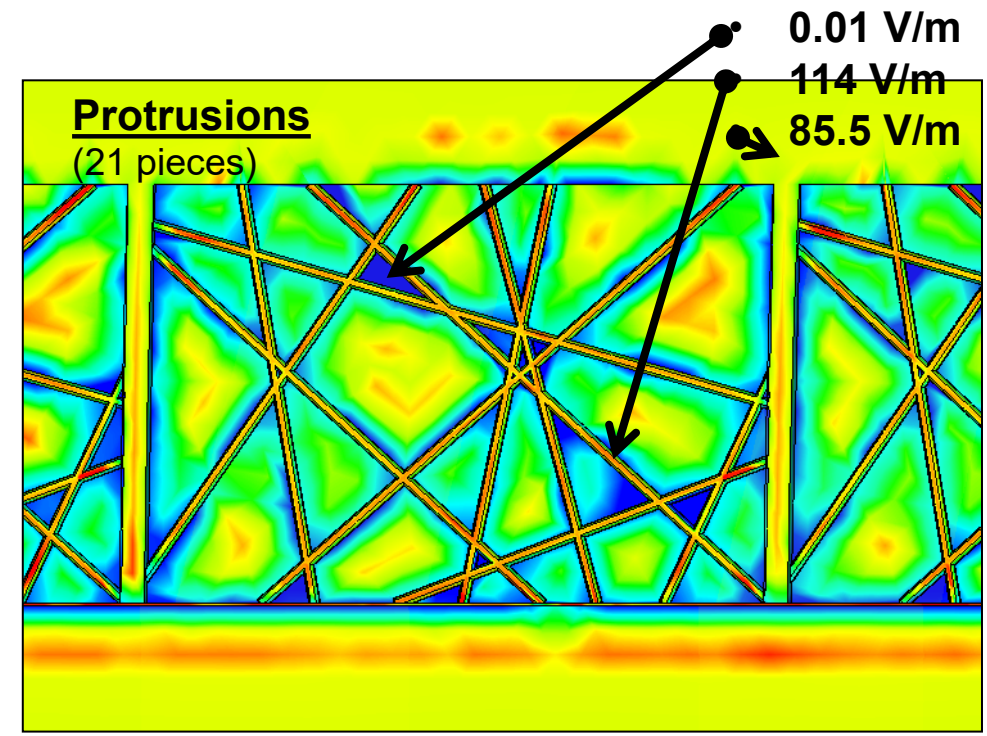
$E=4591\text{V/m}$ is field strength at the cathode center



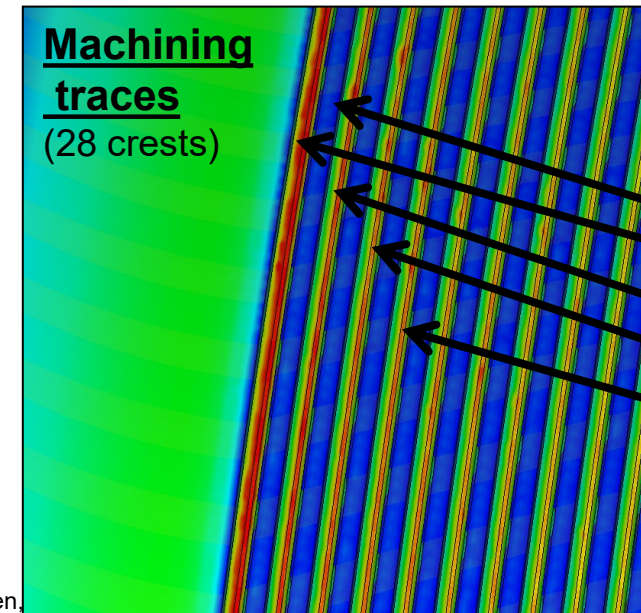
- 17.78 V/m
- 107.9 V/m
- 85.8 V/m



- 3.35 V/m
- 112.5 V/m
- 87.2 V/m



- 0.01 V/m
- 114 V/m
- 85.5 V/m



- 11 V/m
- 170 V/m
- 141 V/m
- 121 V/m
- 56 V/m

Summary

- Irregularities in the cathode vicinity region **do not increase** absolute value of E peak field, but creates field difference at a local spot
- Field ratio around irregularity:
 - Scratch Model1: 6.06
 - Scratch Model2: 33.6
 - Protrusions: **11400**
 - Machining traces: 15.5
 - Sectored cathode vicinity rounding
 - 3 sectors: 1.43
 - 7 sectors: 1.18
 - 9 sectors: 1.17
- **The protrusions** produce the highest electric field ratio that make very high probability of the dark current
- More simulations for gun production tolerances to be done.

Thank You for your attention!



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