

Electrostatic Analysis of the Gatling Gun Assembly

Qiong Wu

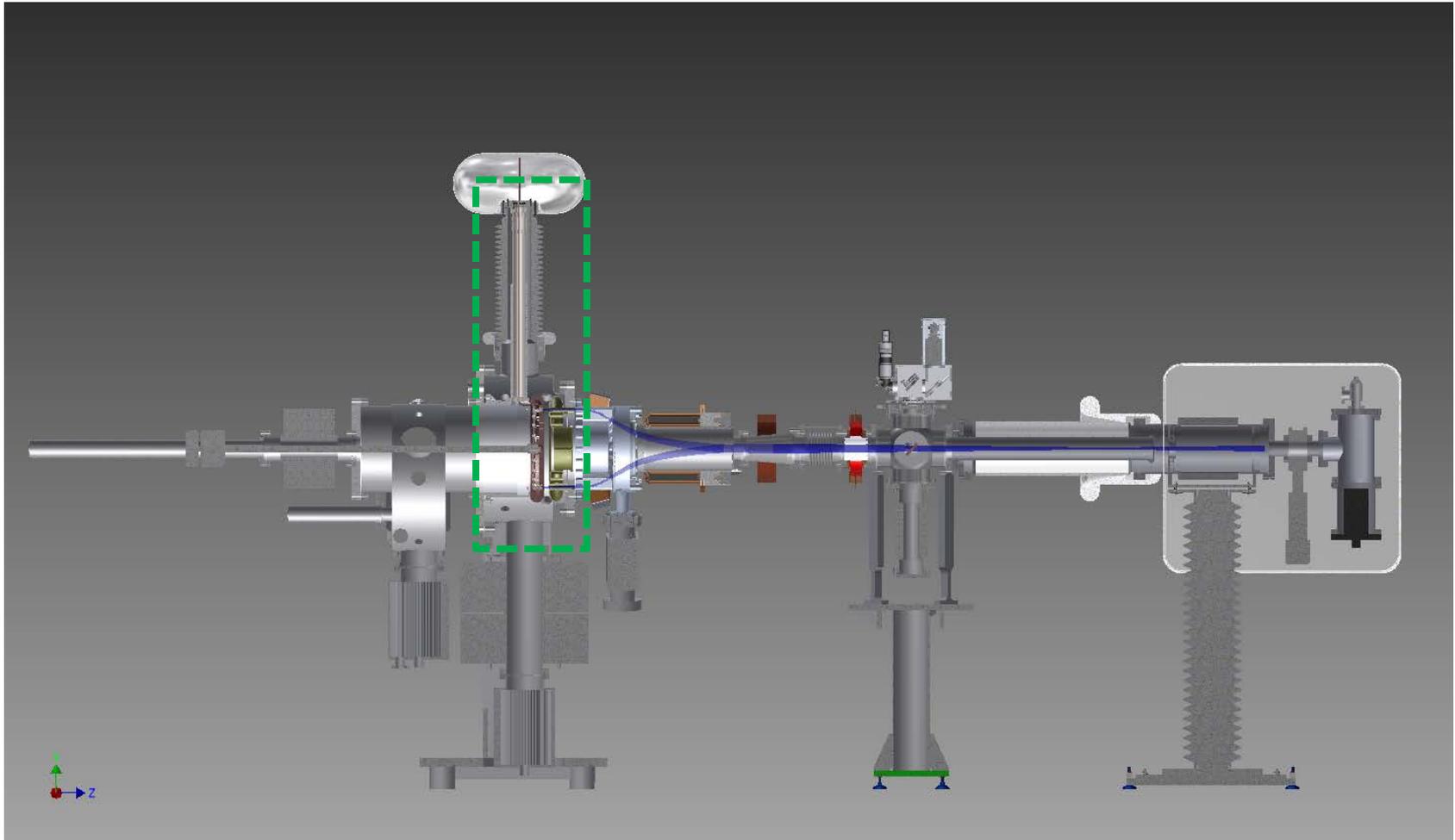
on behalf of the Gatling gun design team

6/28/2012

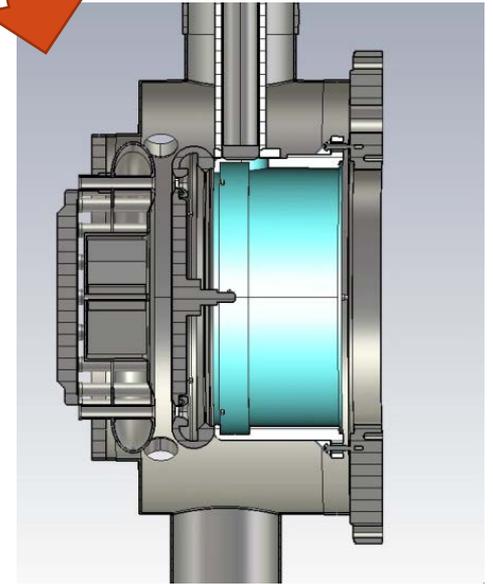
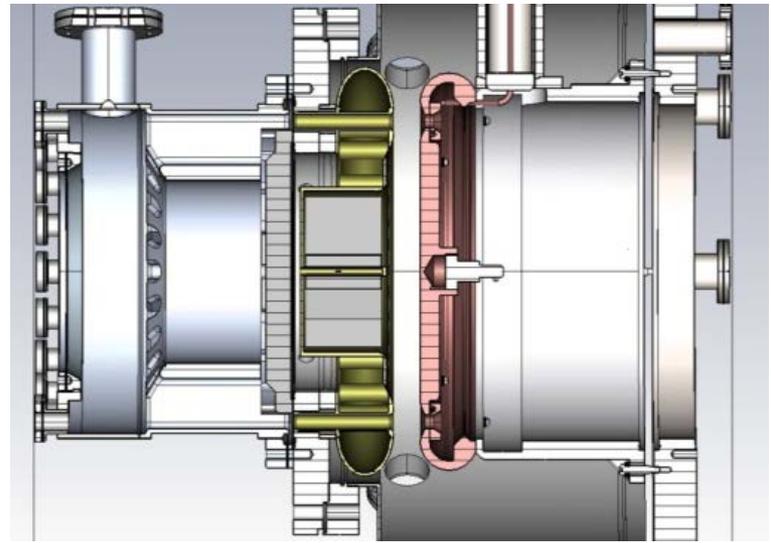
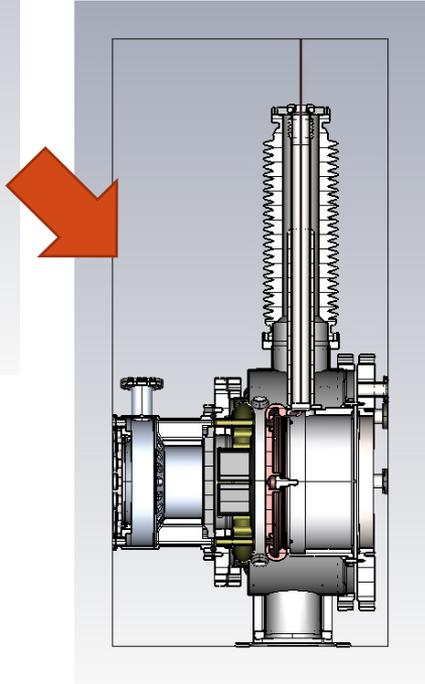
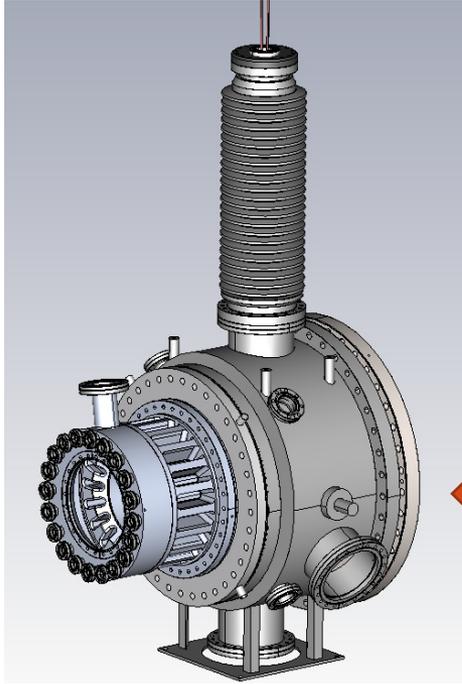
Outline

- Assembly
- Parameters
- E-static study of the original model
- Modification and results
- Summary

The Assembly

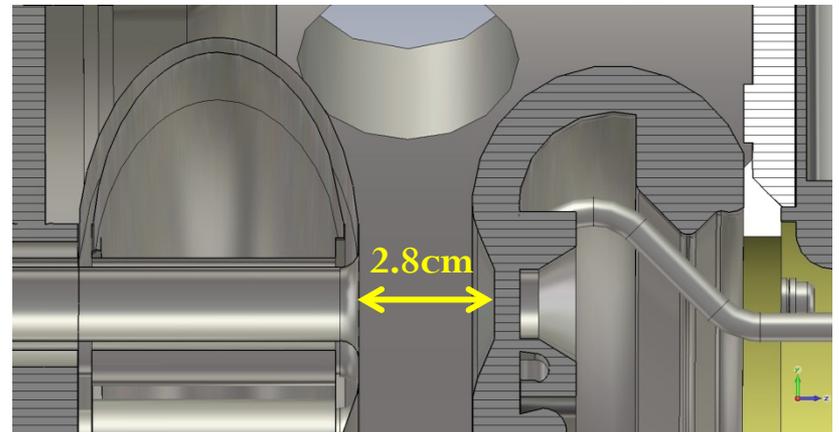


Models

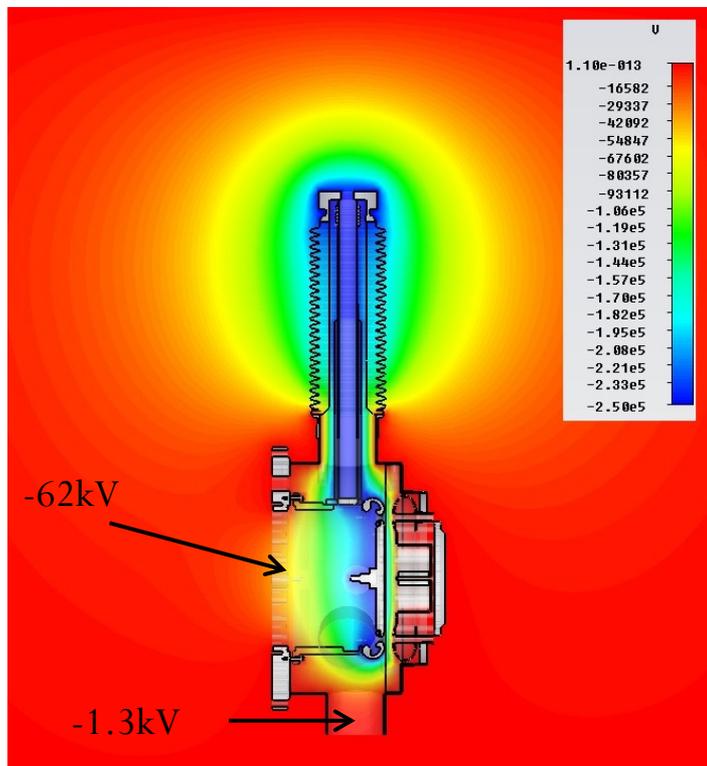


Parameter settings

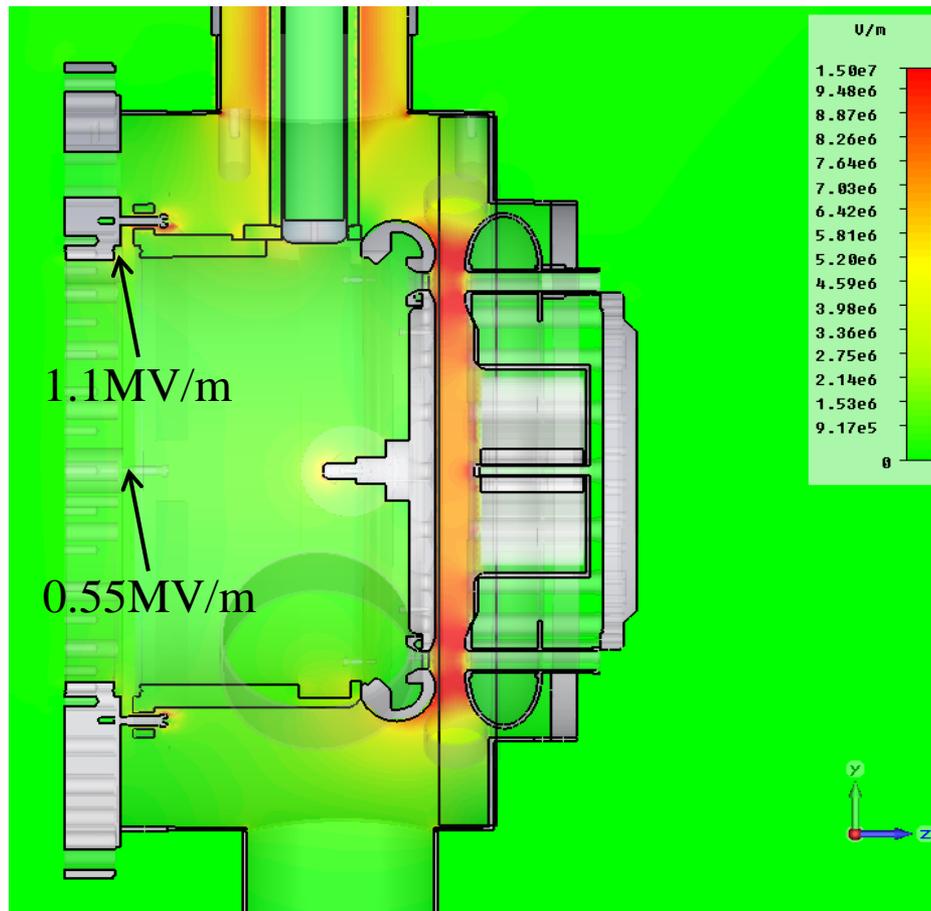
- -250kV @ cathode shroud, water cooling tube, HV feedthrough
- All other conducting surfaces are grounded
- Ceramic breaks and GaAs are set with corresponding dielectric constant (ϵ)
- 2.8cm from the cathode surface to the front surface of the anode



Analysis of the original design

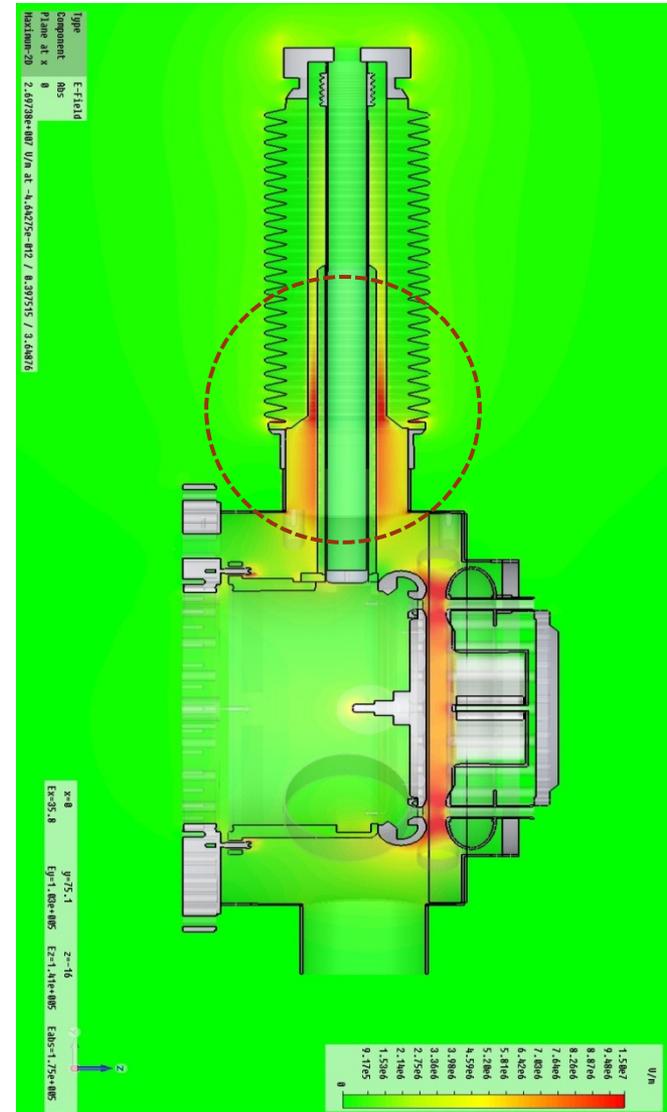
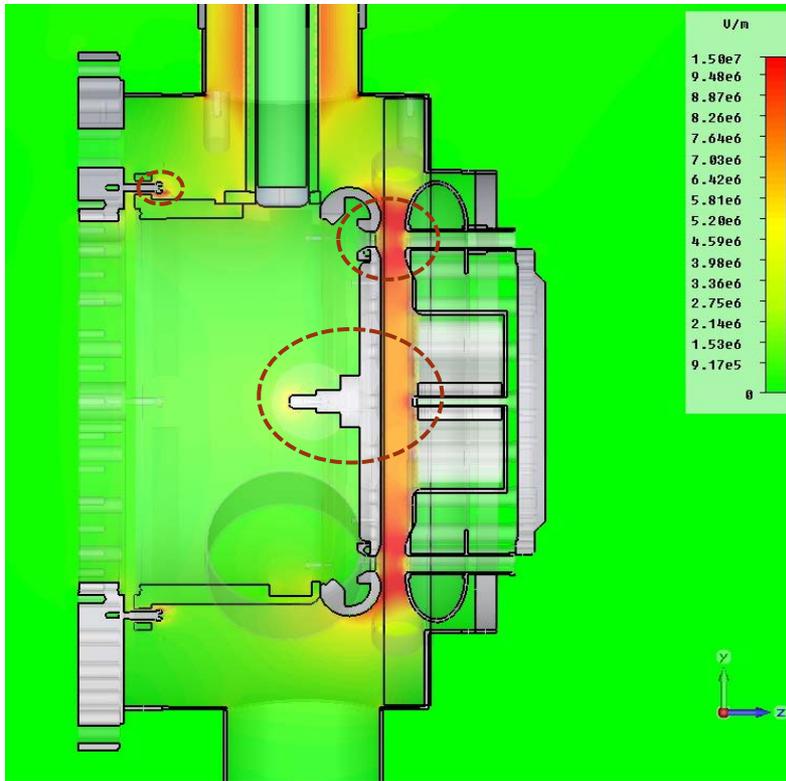


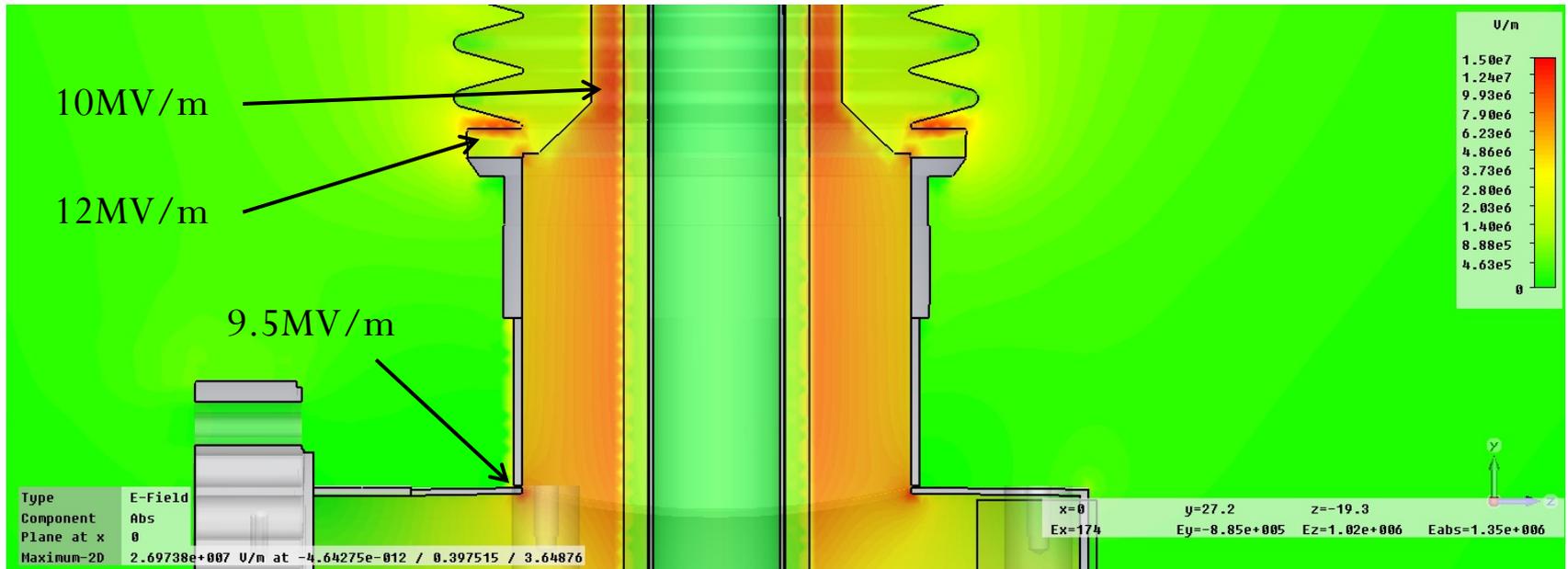
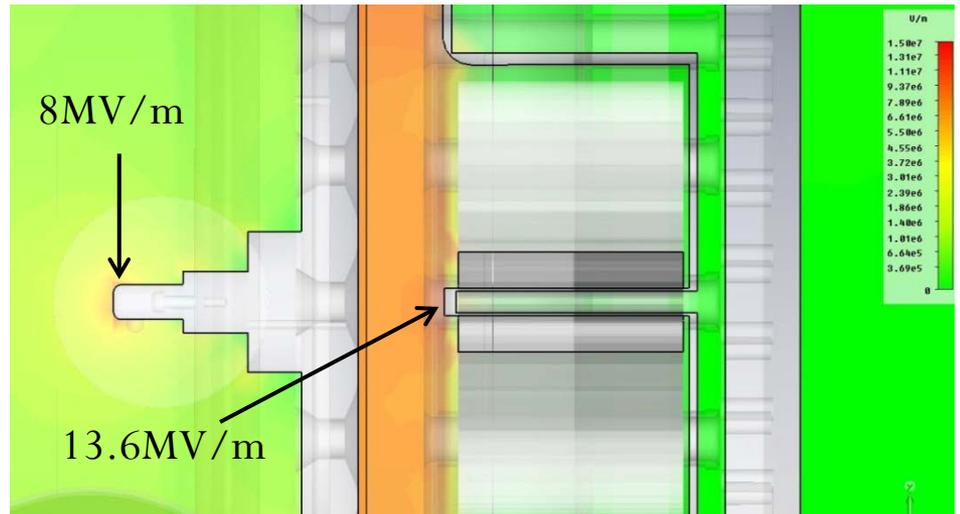
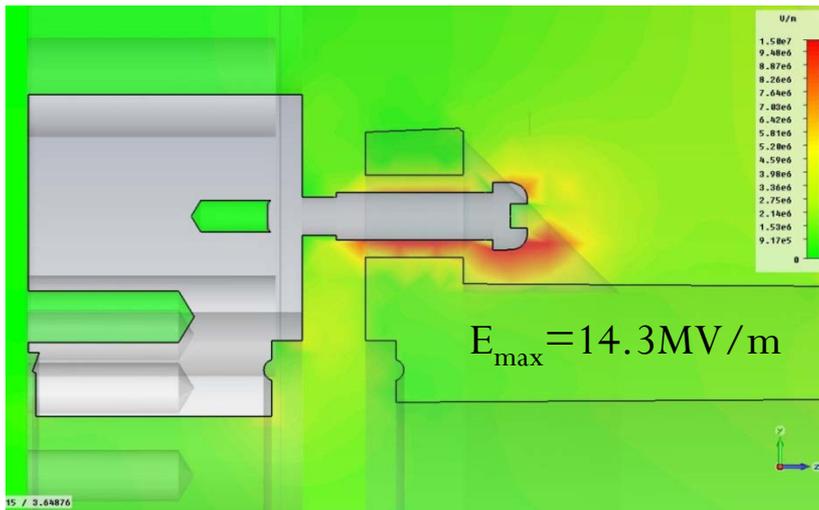
Potential



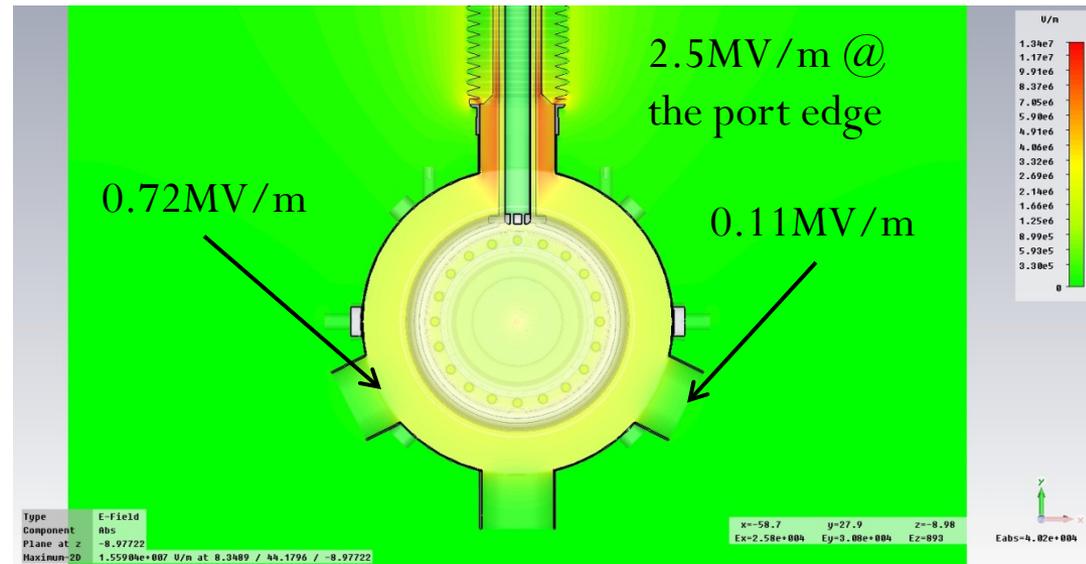
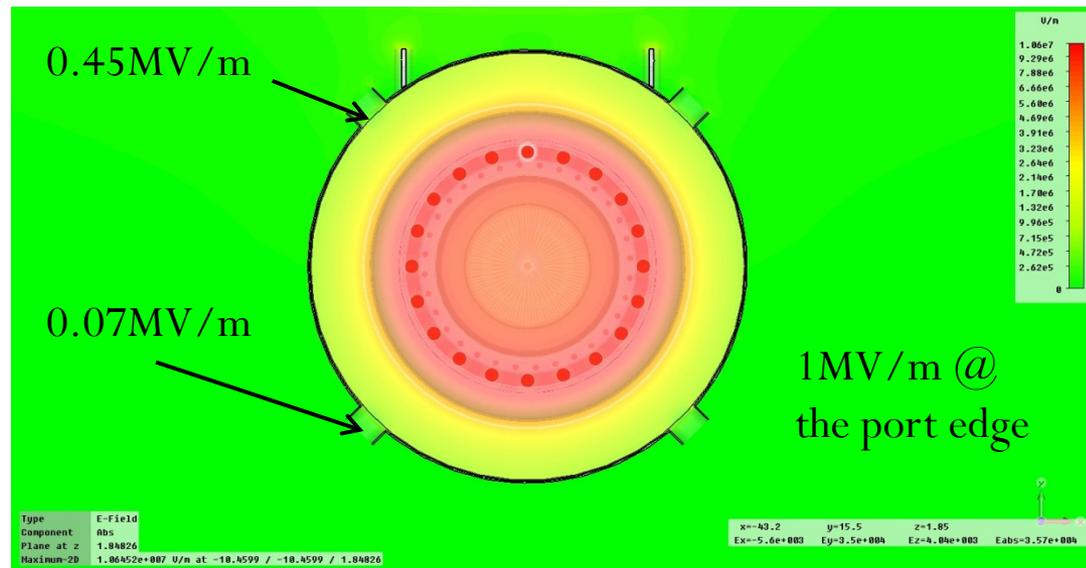
E field

high field regions

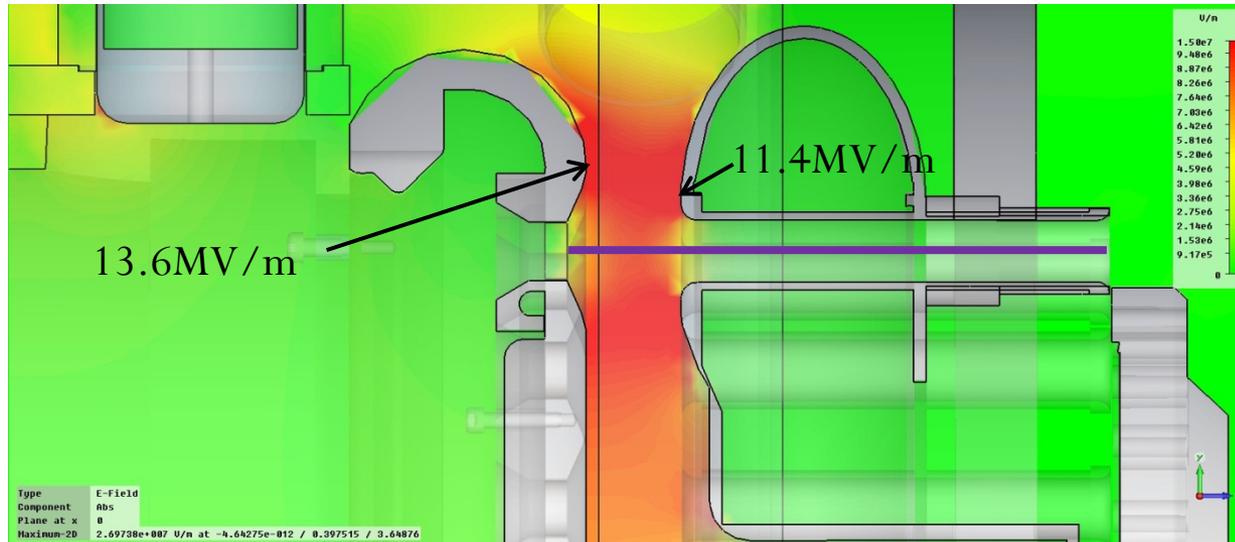




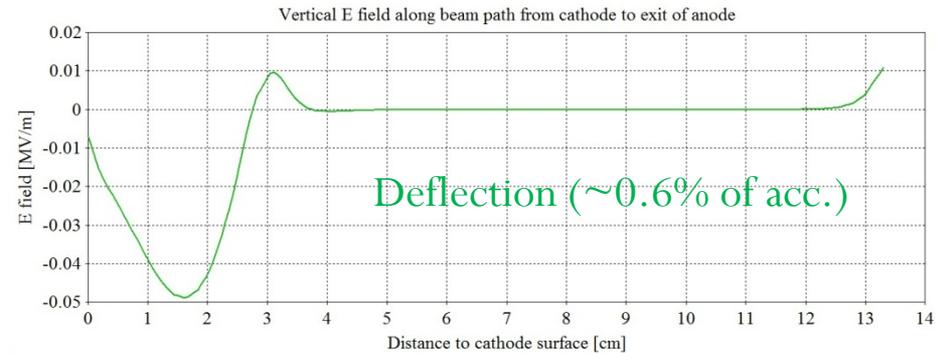
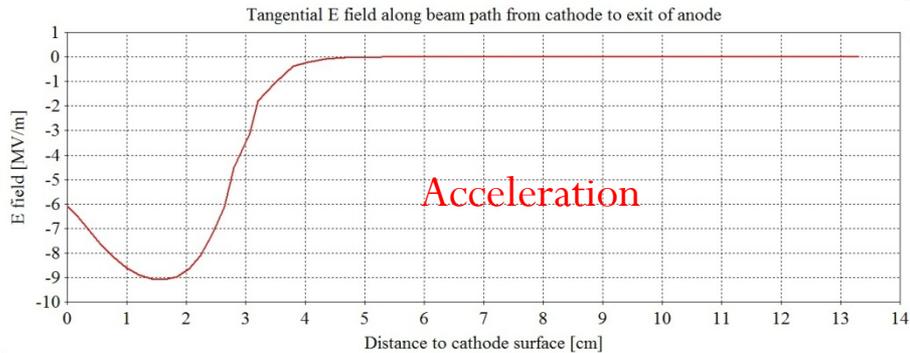
E field in the vessel



E field @ cathode

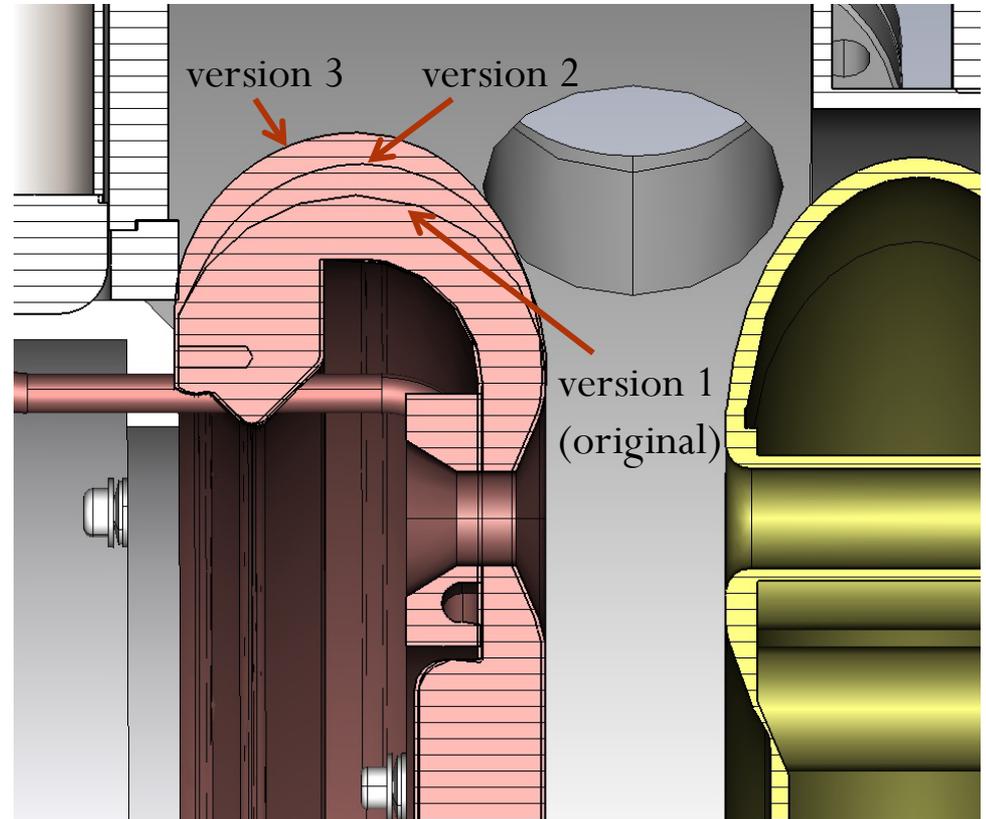
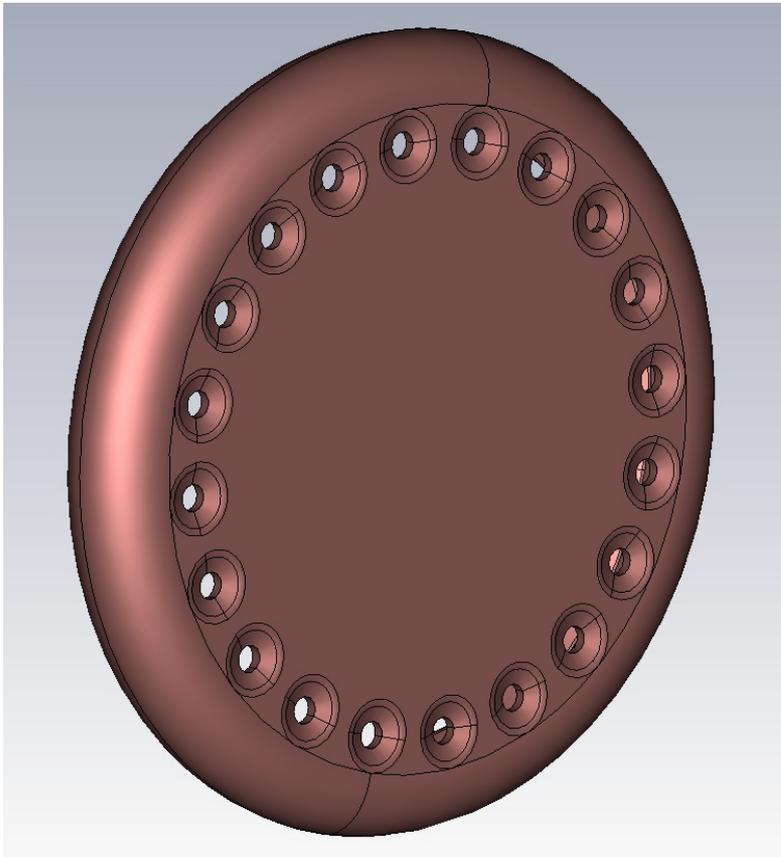


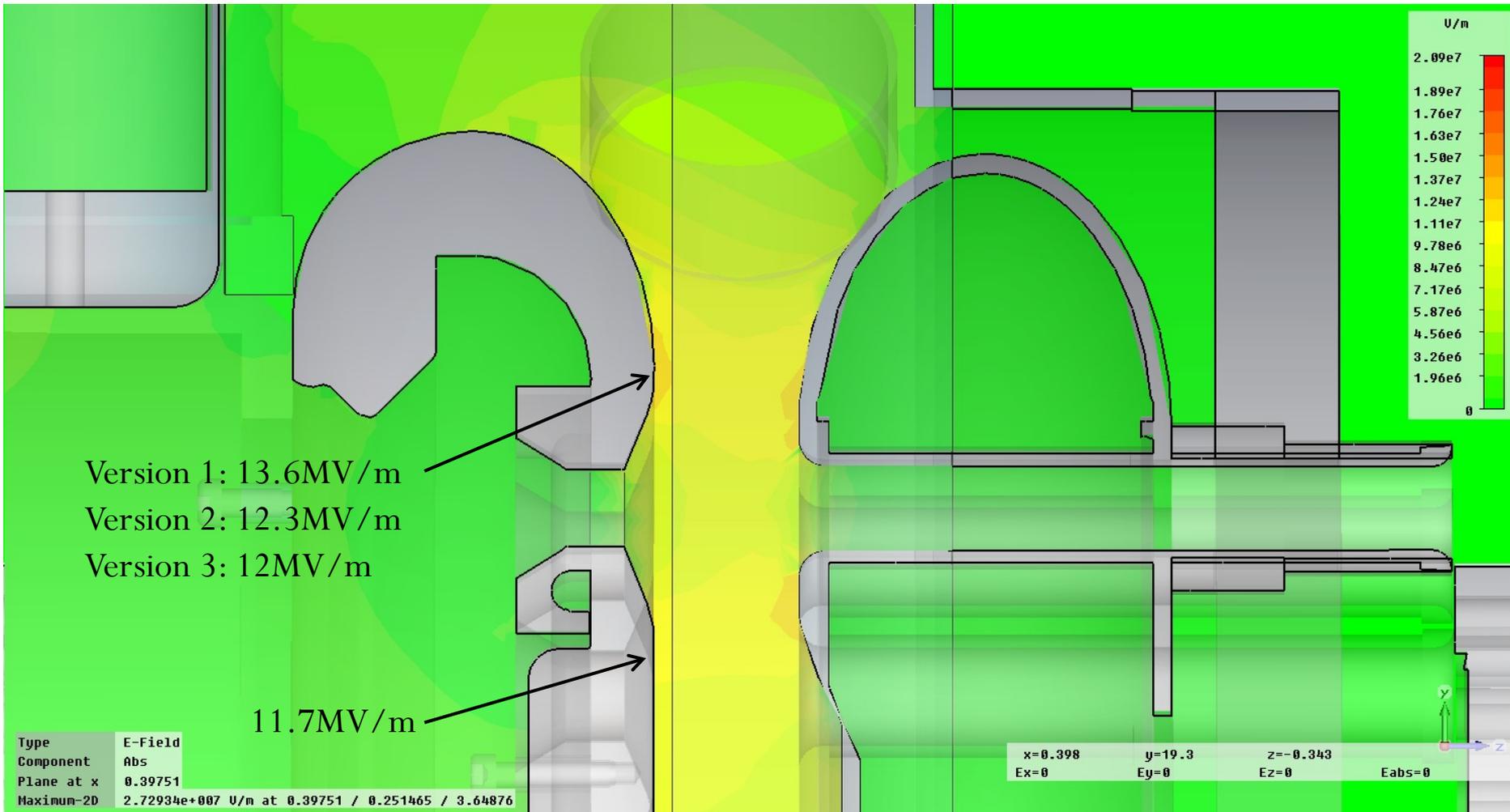
E field along beam trajectory



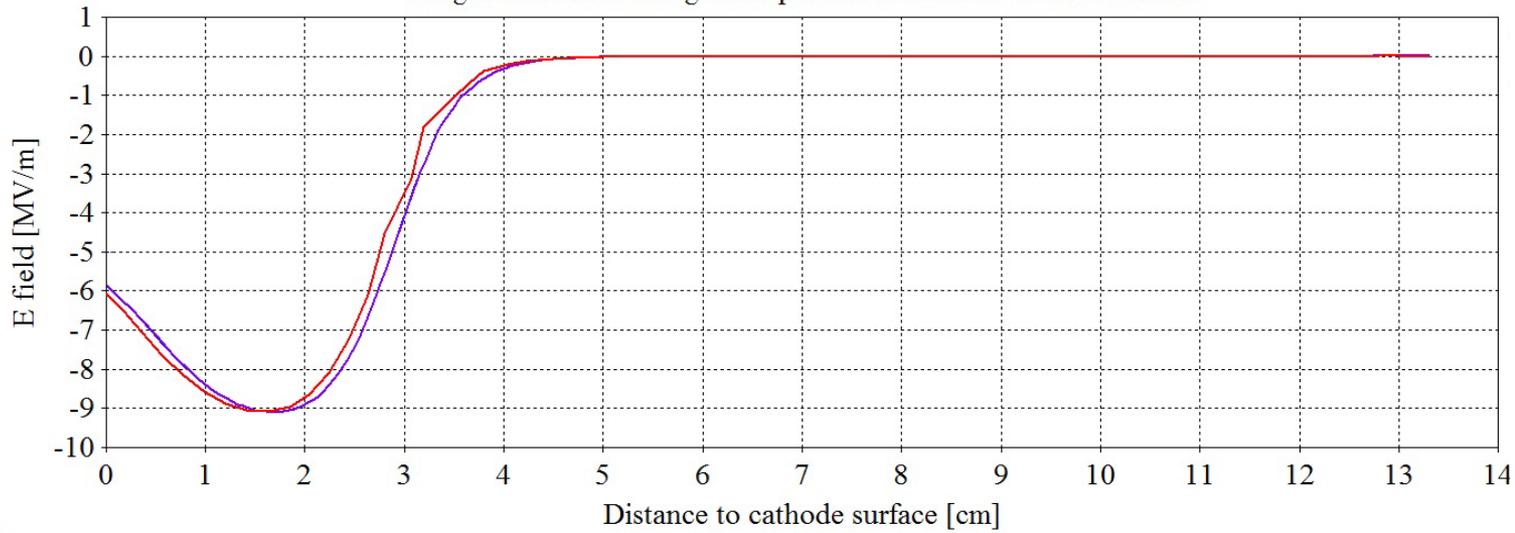
cathode shroud modification

The cathode shroud edge has been changed to a more elongated elliptical curve.



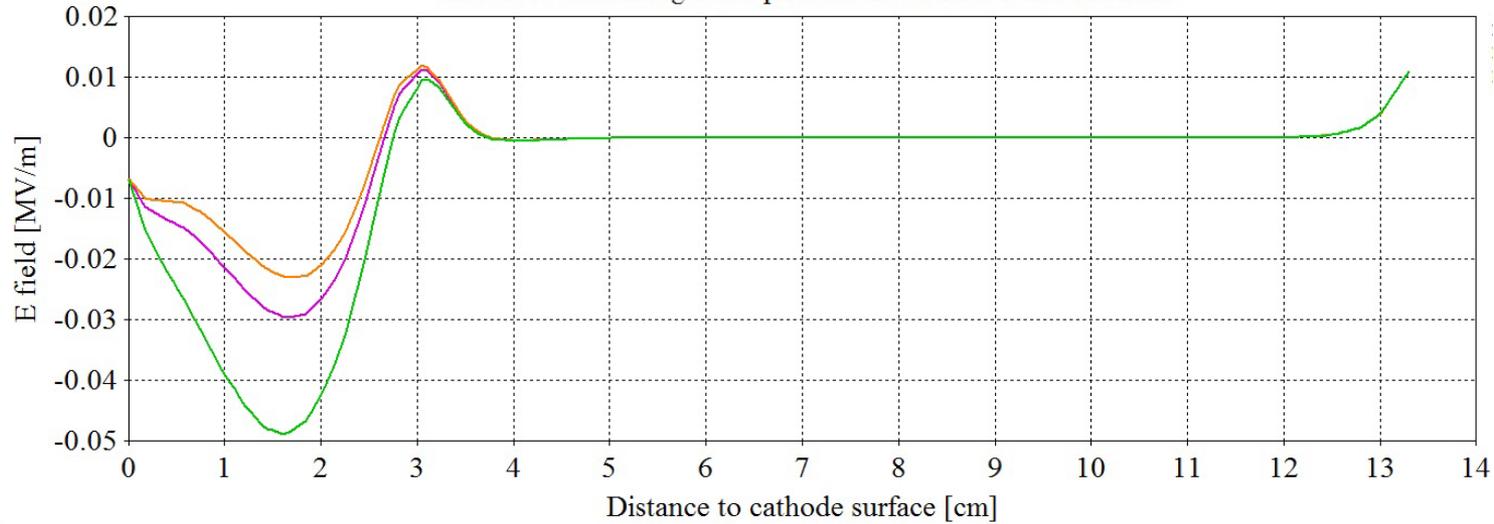


Tangential E field along beam path from cathode to exit of anode



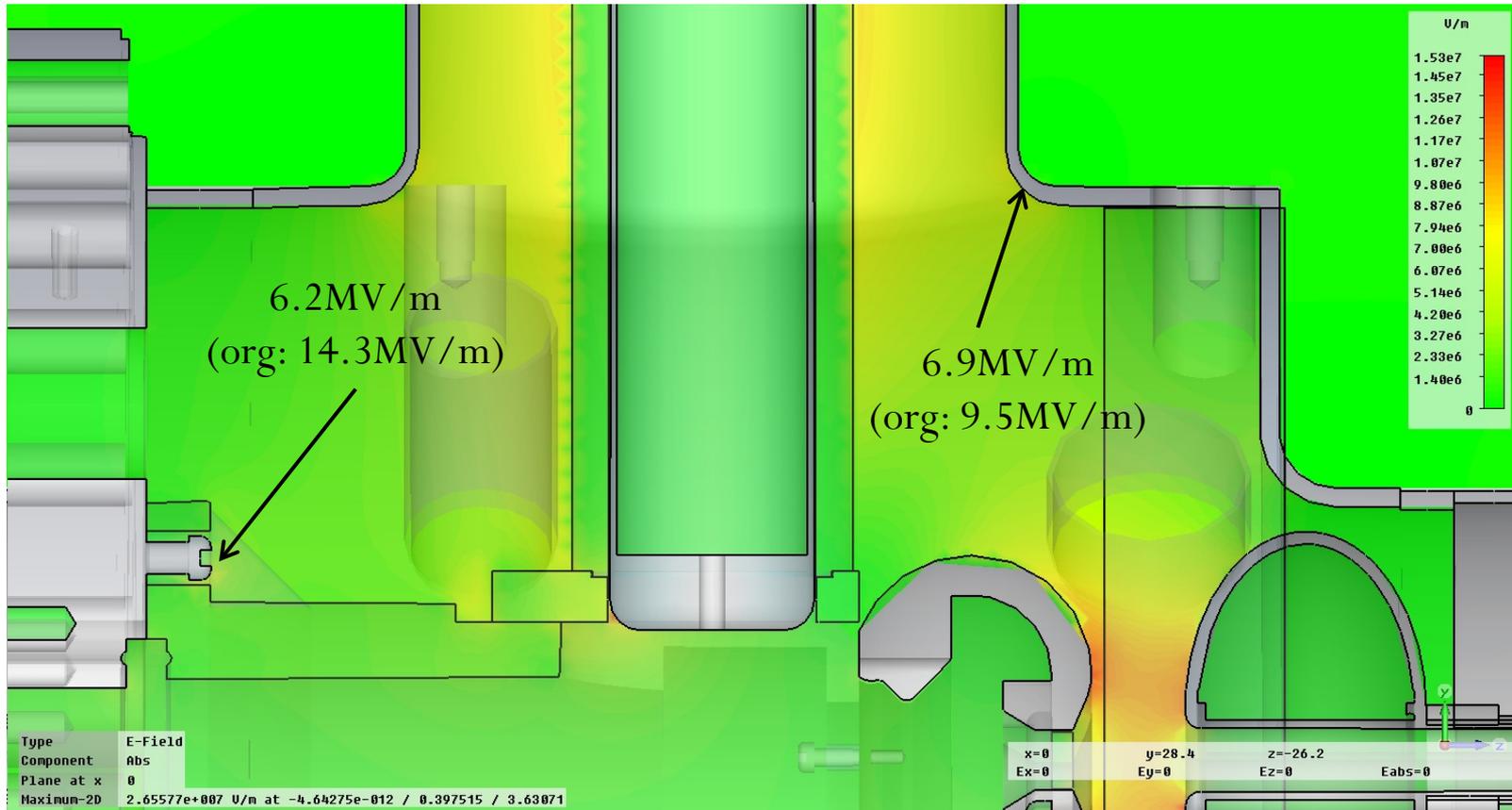
- Version 1
- Version 2
- Version 3

Vertical E field along beam path from cathode to exit of anode

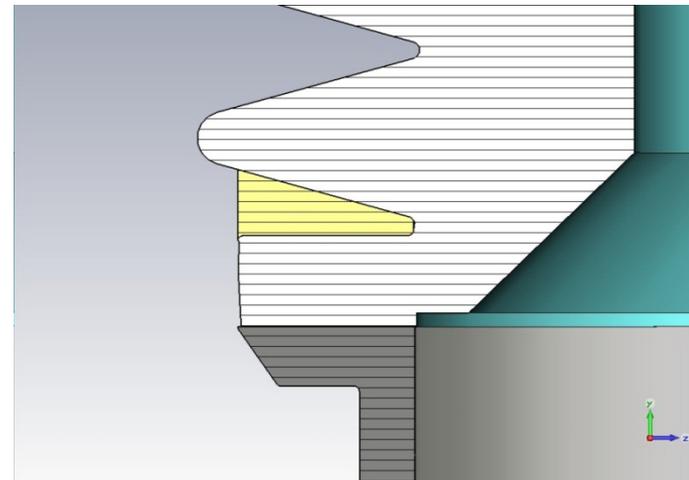
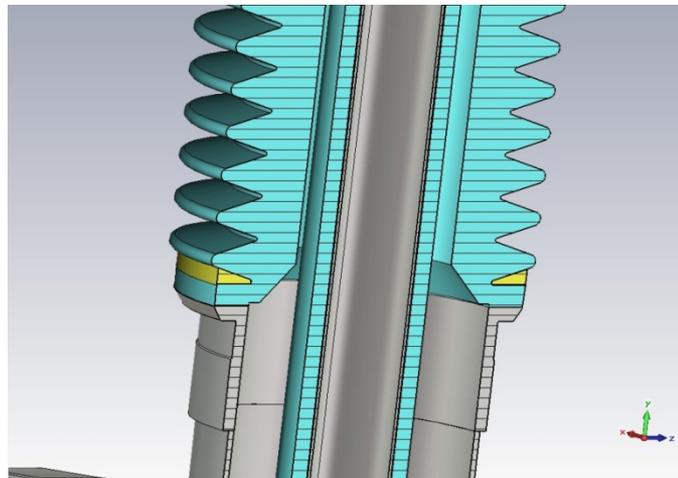
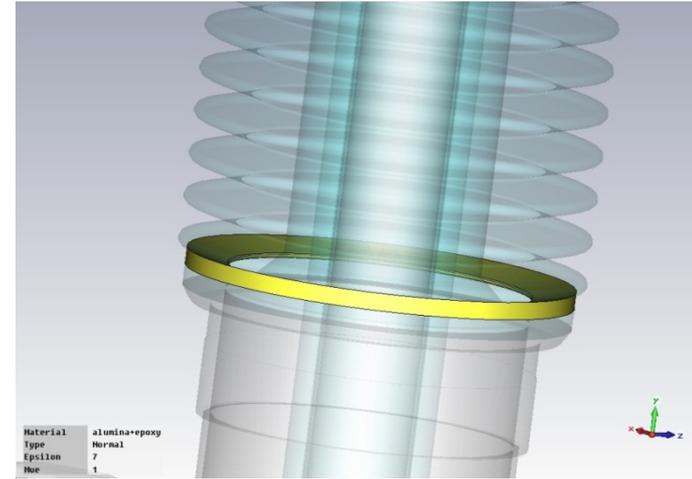
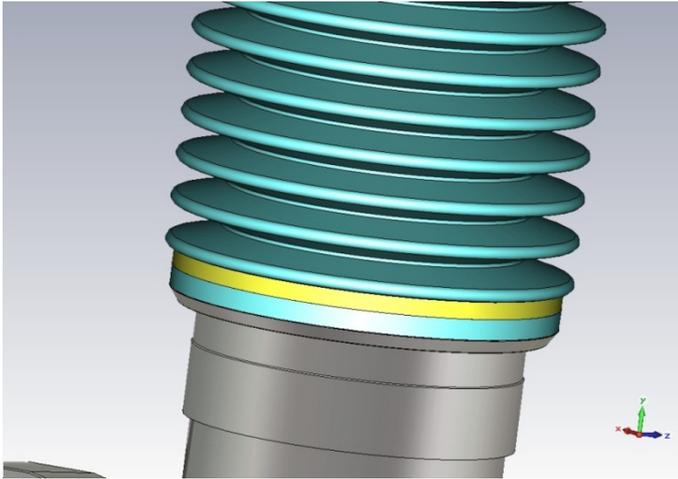


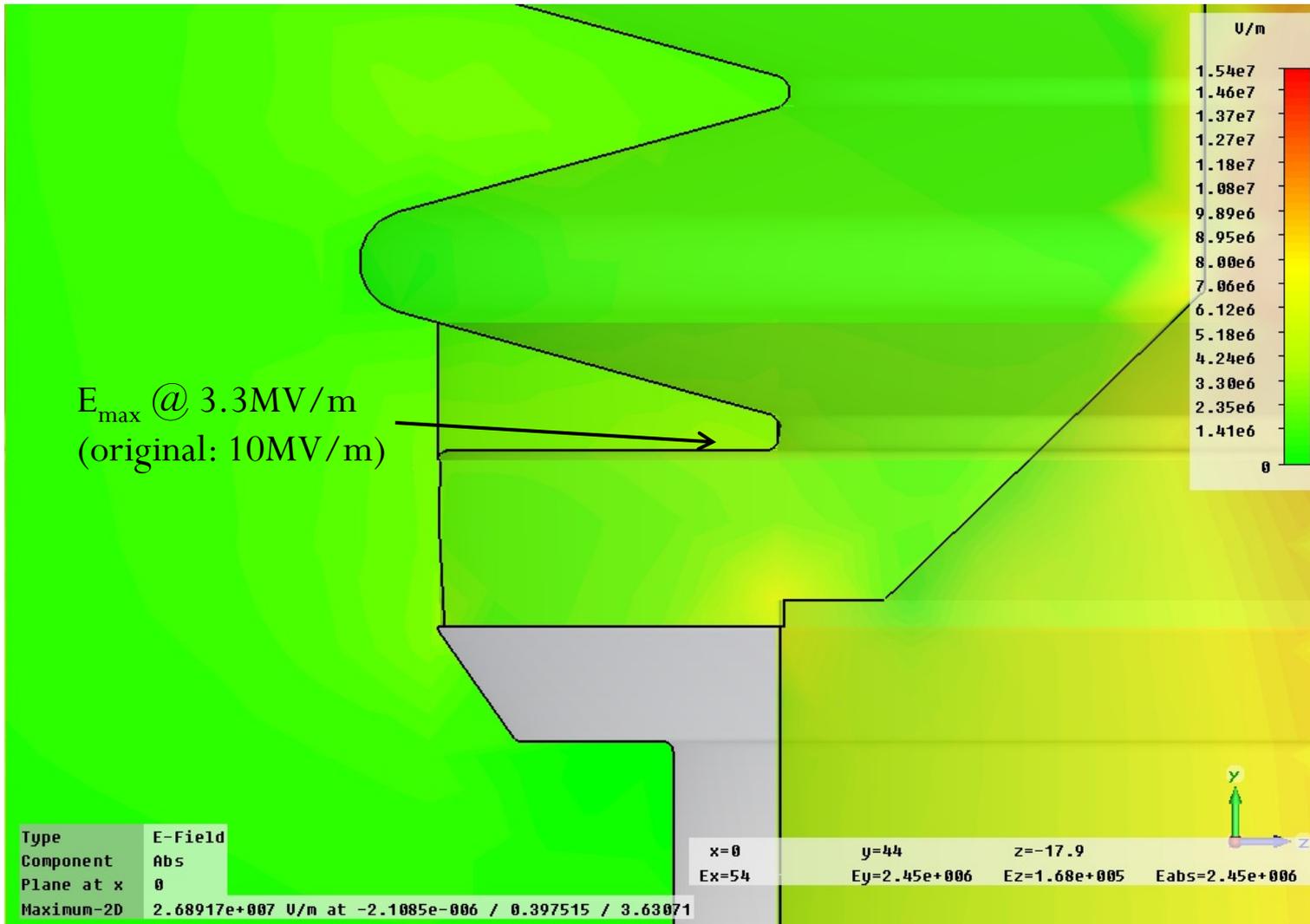
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- Version 3

Modification to other high field regions



Fill ceramic feedthrough with alumina + epoxy ($\epsilon_r=7$)





Summary

- The goal of the Gatling gun assemble is to provide high current polarized electron beam @ above 200keV energy.
- For our simulation of 250kV, the original design shows several ‘hot spots’ ($>10\text{MV/m}$) of electrostatic field region, and the most critical one would be on the cathode shroud surface.
- Modifications have been applied to the design to lower the field level to below 10MV/m :
 - Elongate the cathode shroud outer area
 - Round corners of the vacuum chamber
 - Retract the screw or change to ceramic screw
 - Fill the ceramic corrugation with alumina + epoxy
- The cathode shroud has a peak surface field of 12MV/m for 250kV acceleration, and will drop to $\sim 10\text{MV/m}$ for 220kV
- All other regions have electric field decreased to a safe level after modification

Thank you

Backup Slides

Electric field in x direction

