

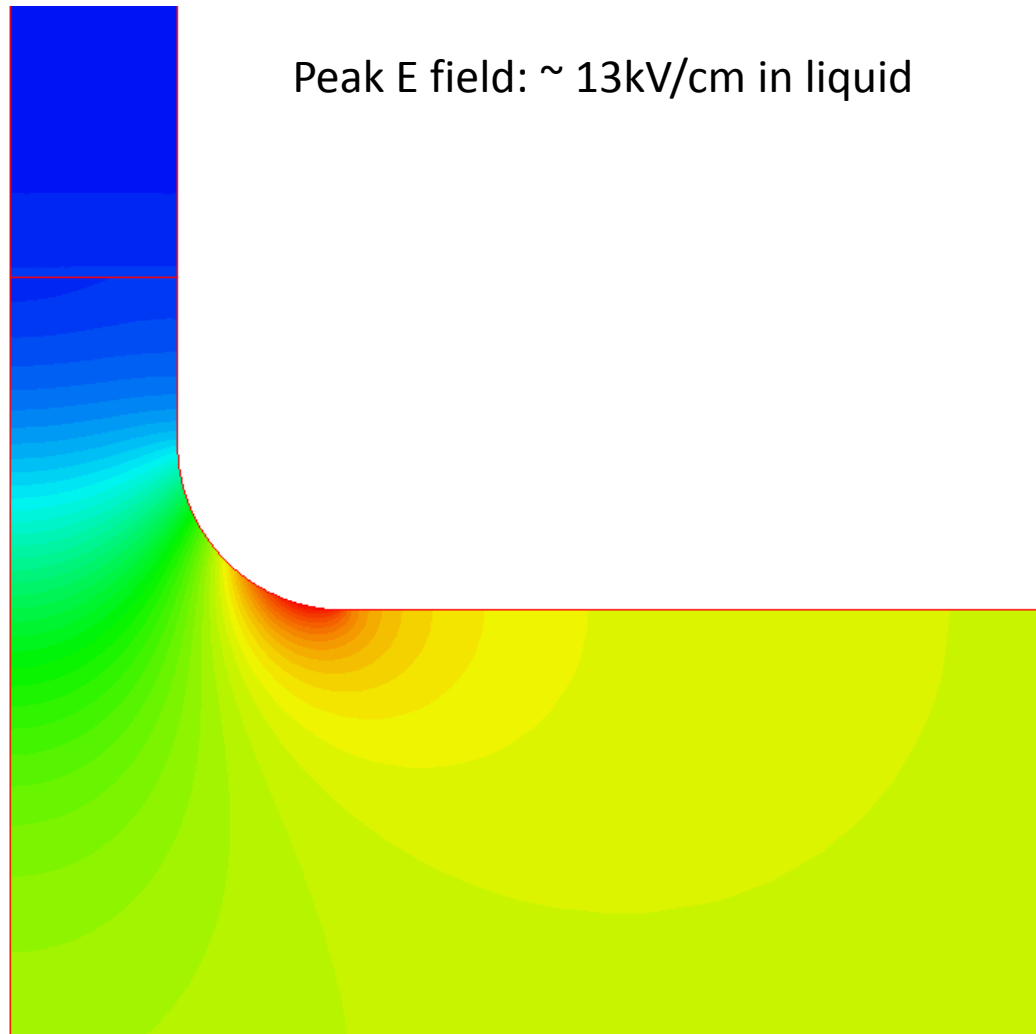
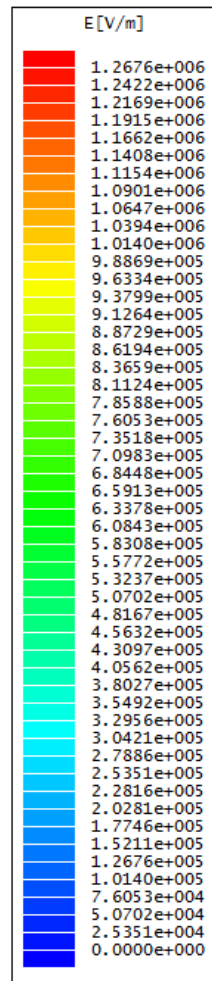
Electrostatic FEA of the Ground Plane Features

Bo Yu

Sept. 14, 2015

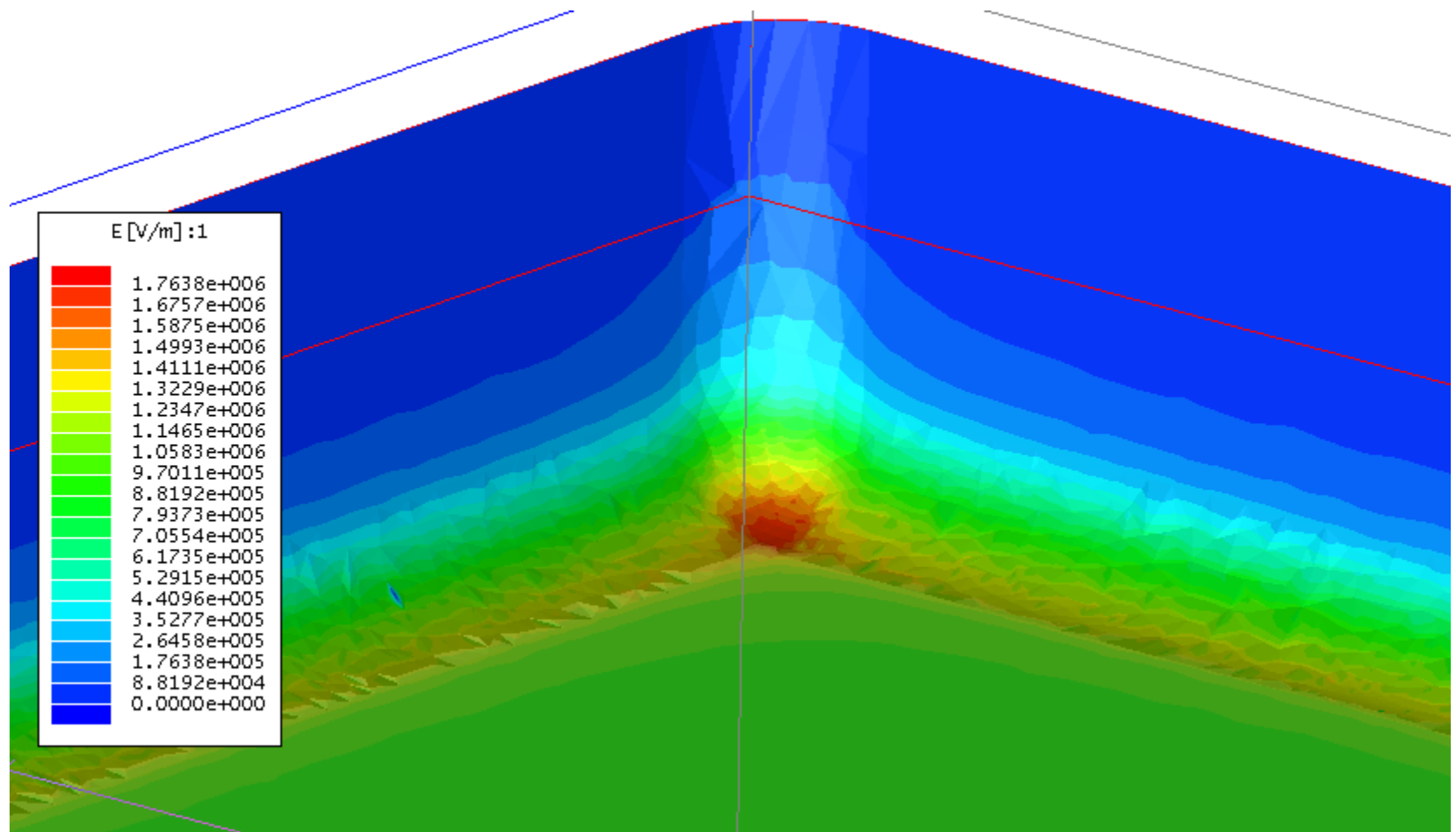
Folded Edge of the Ground Plane

180kV @ 20cm, corner radius 5mm, gap between tiles: 1cm, liquid above ground plane: 1cm



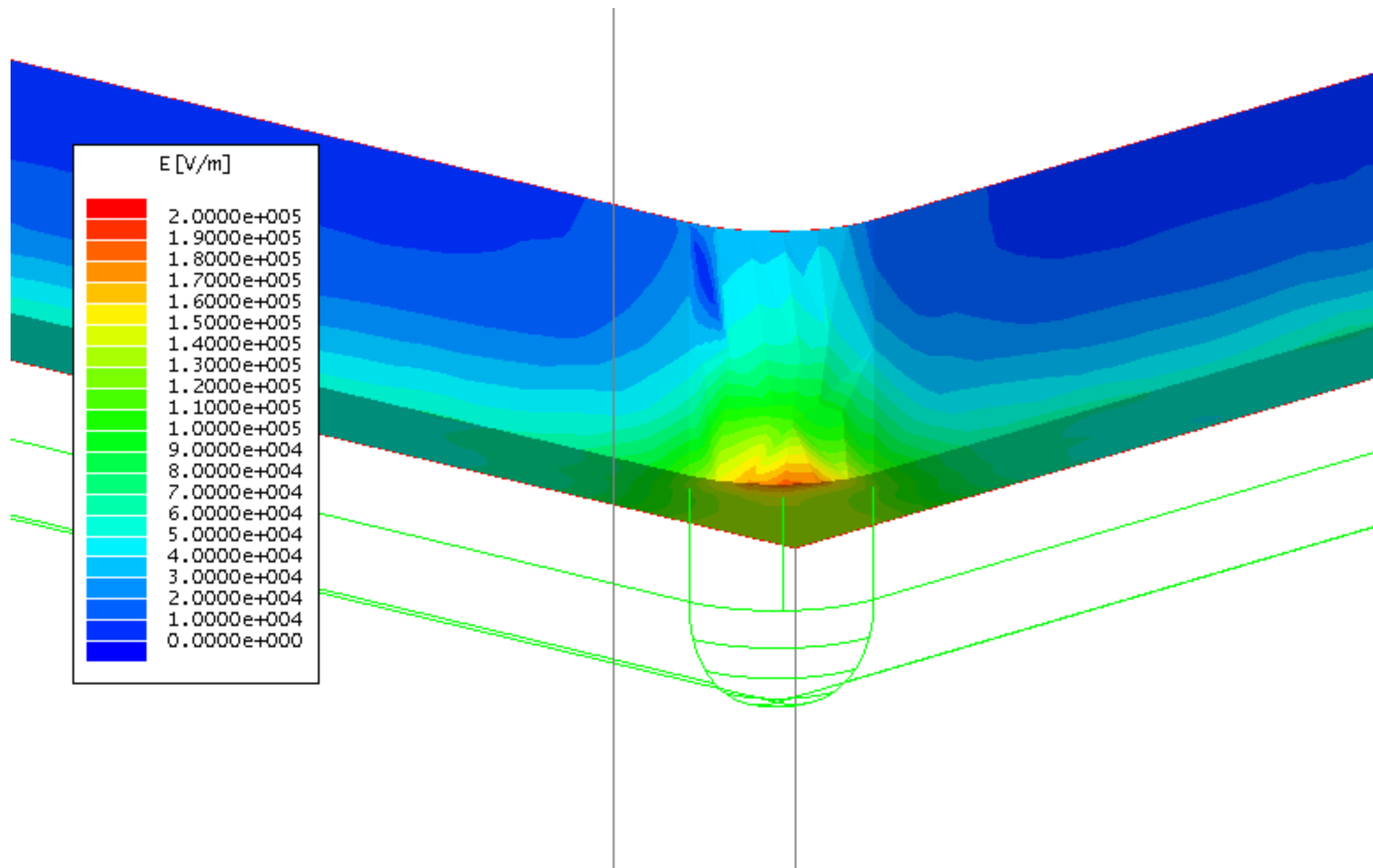
Corner of the Ground Plane

45kV over 5cm, 5mm radius of curvature, 1cm gap between tiles, gas pocket 1cm above ground plane bottom surface. Max E at corner: 18kV/cm



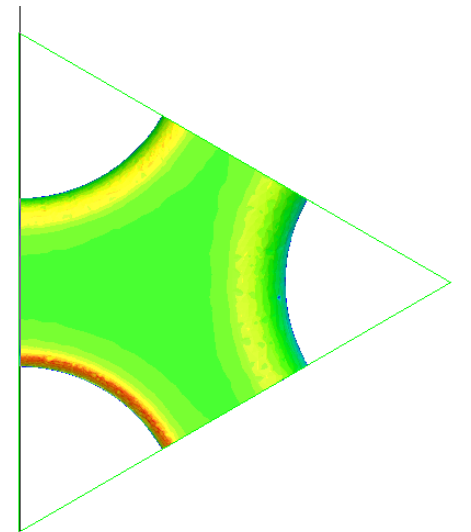
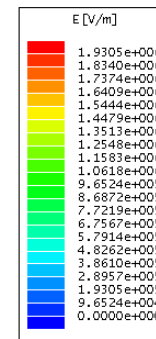
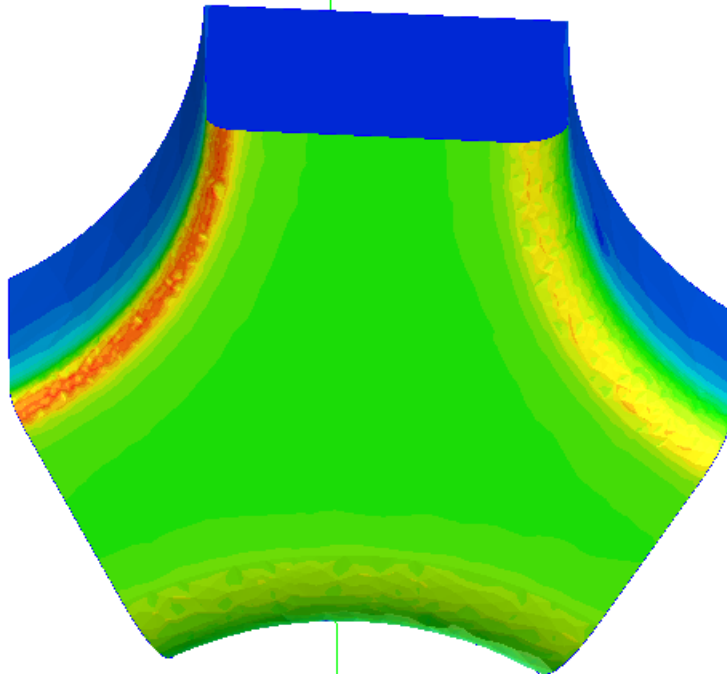
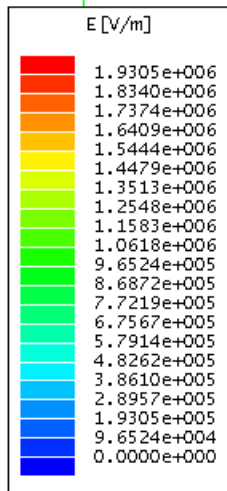
Field in the gas pocket above the liquid

Gas pocket 1cm above bottom of ground plane. Max E field <2kV/cm



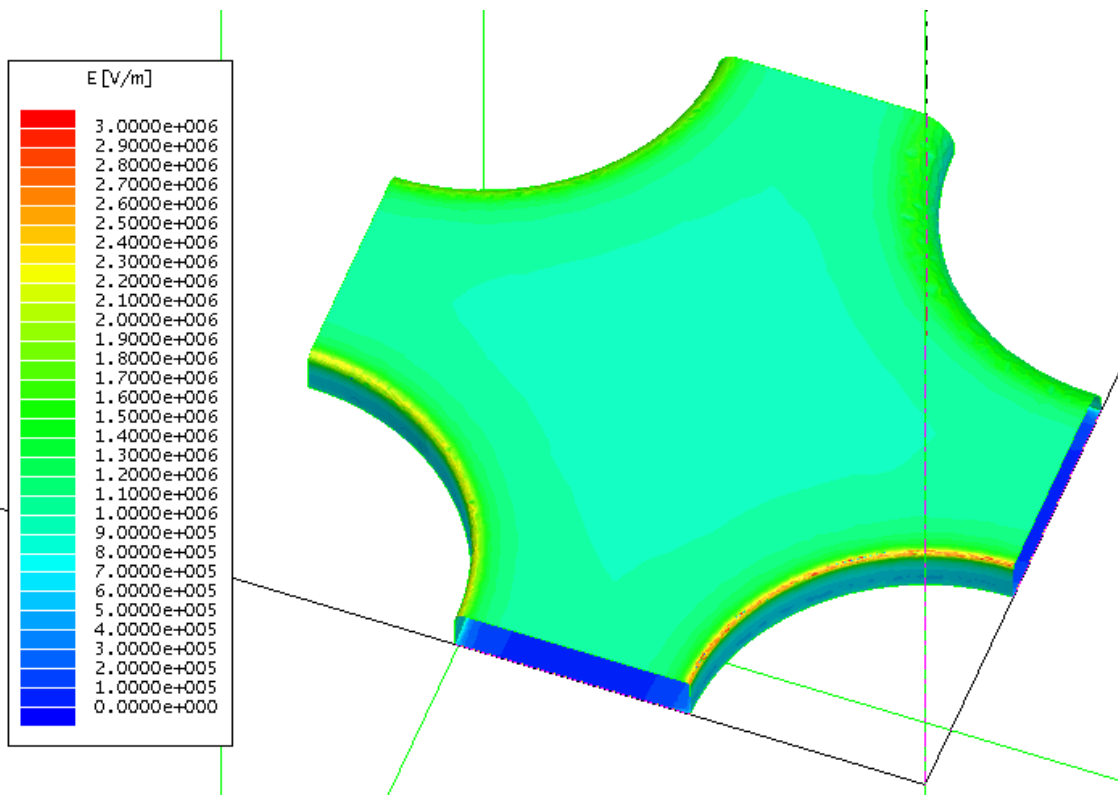
Perforated Metal Sheet

- 0.125" holes at 0.188" center, staggered pattern, 0.05" thick
(McMaster part # 9232T181)
- 3 rounding radii: 0.005", 0.010", 0.020"
- Max. E field at R=0.005" hole is 19kV/cm

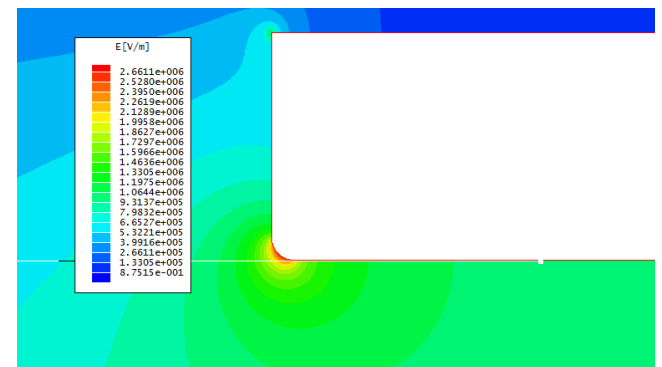


Perforated Metal Sheet, Larger Holes

- 10mm holes at 15mm center, square pattern, 1mm thick
- 4 rounding radii: 0.8mm, 0.4mm, 0.2mm, 0.1mm
- Max. E field at R=0.1mm hole is about 30kV/cm

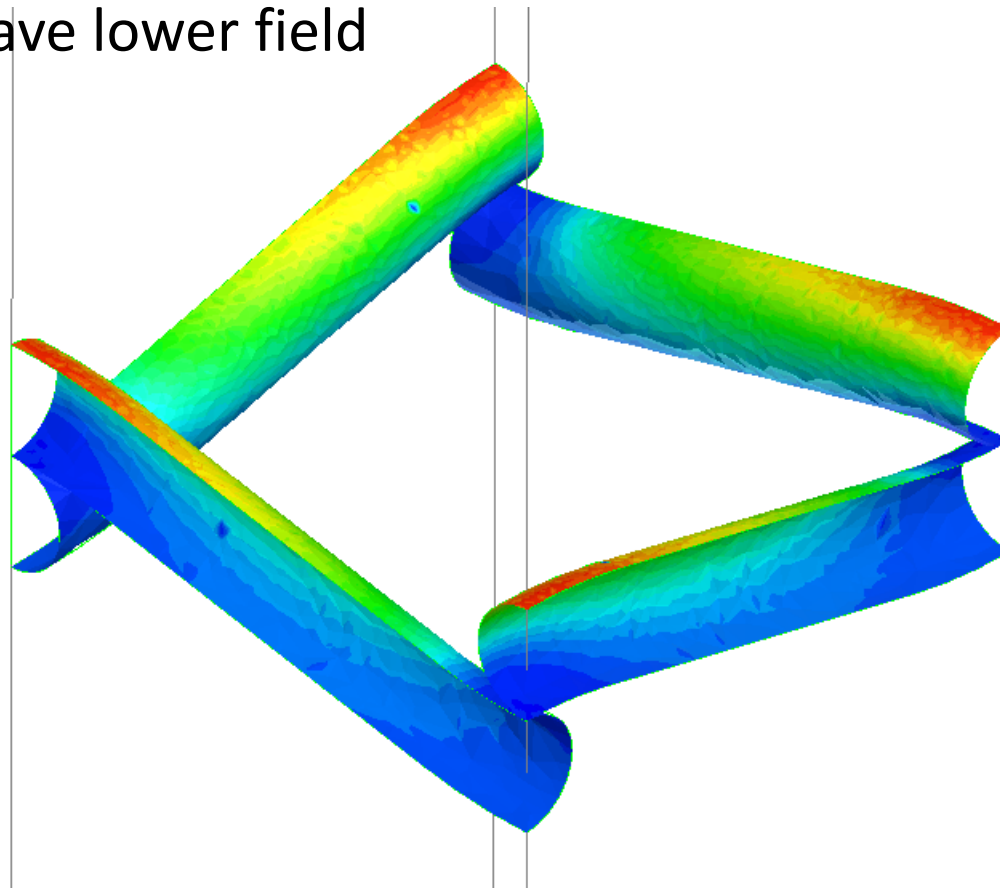
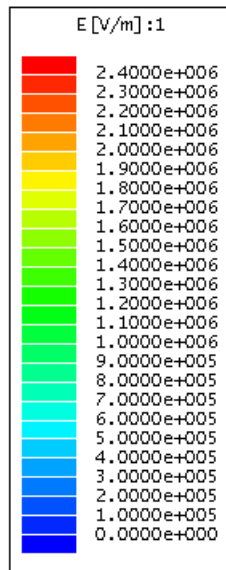


A 2D (cylindrical) FEA shows 27kV/cm on the edge of a 10mm hole with 0.1mm edge radius



Using a Wire Mesh as the Ground Plane

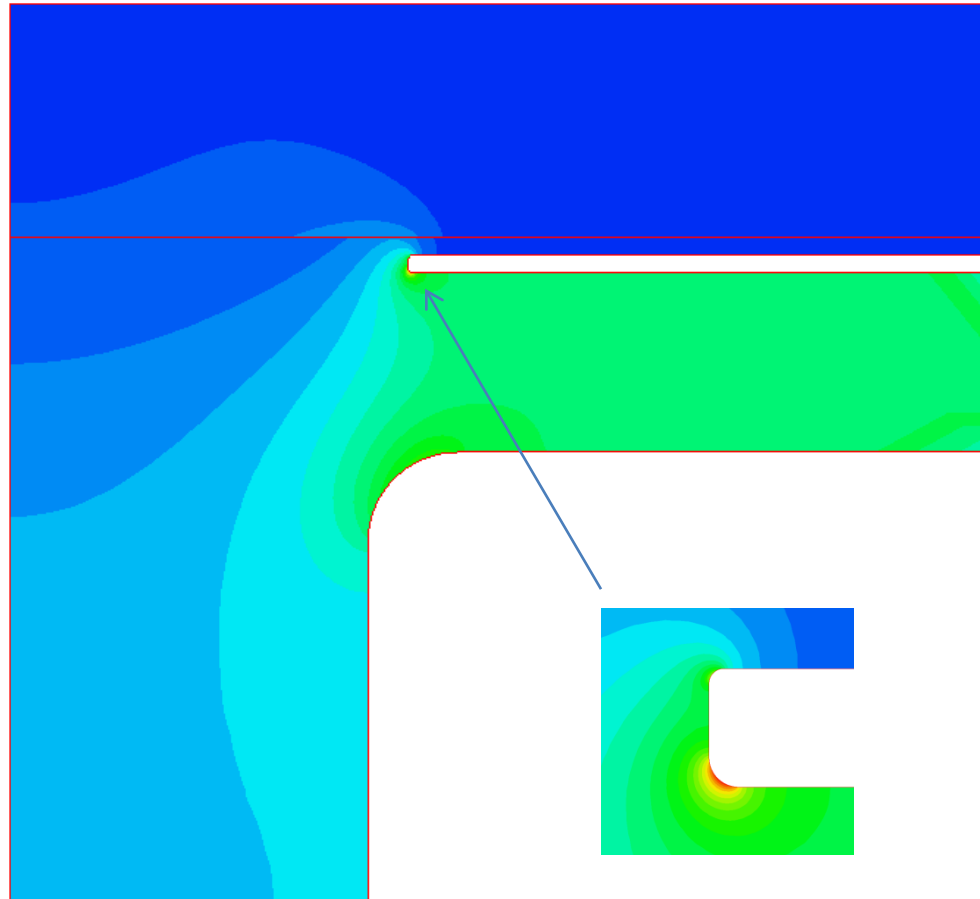
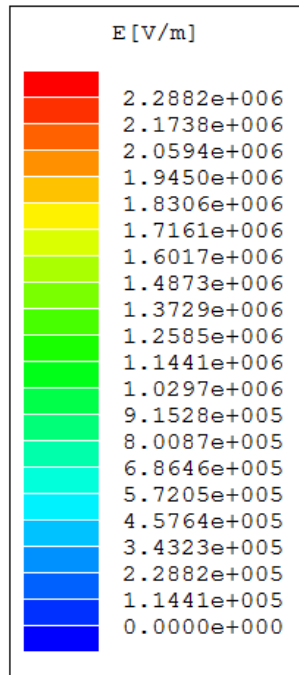
- ¼" pitch, 0.047" diameter (McMaster 85385T28)
- 9kV/cm on one side, $E_{max}=24\text{kV/cm}$
- Other meshes with higher diameter to opening ratio (denser mesh) will have lower field



Overhang of the ground plane

- 2D simulation on 10.18.2015

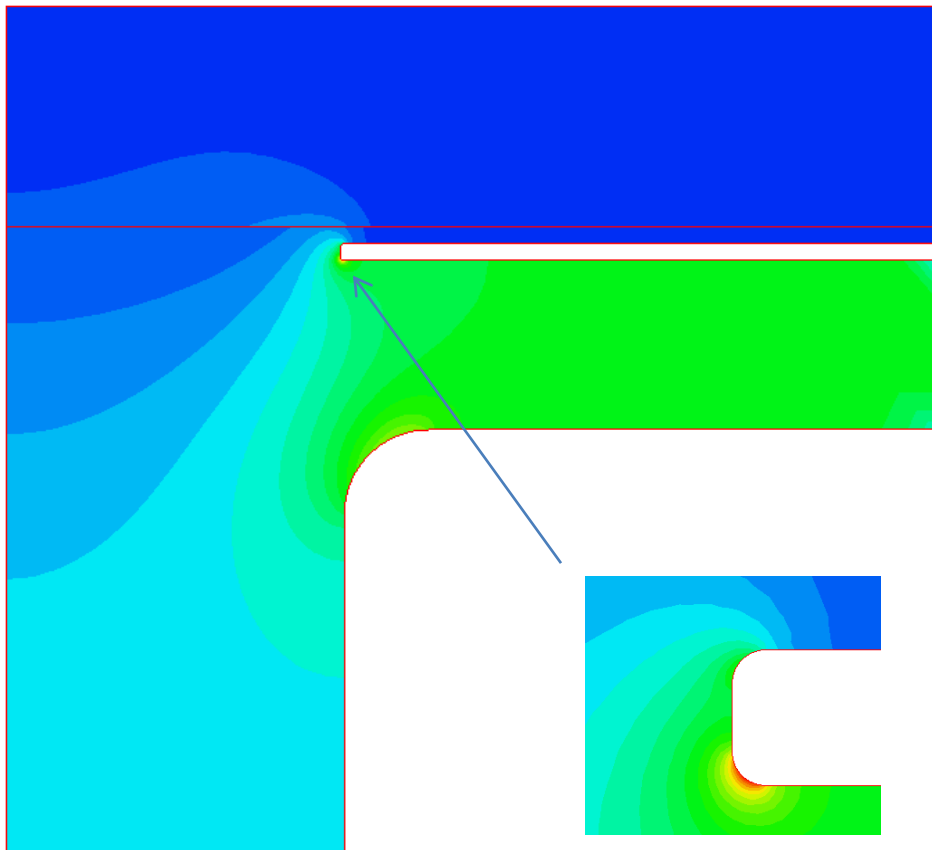
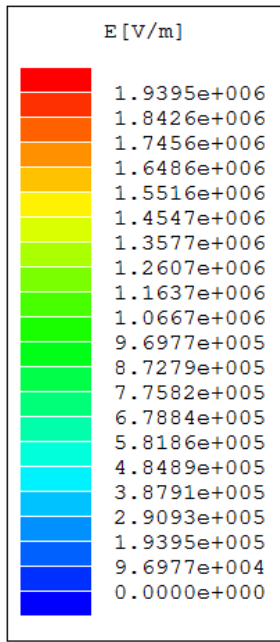
No-overhang of the ground plane



20cm FC to GP spacing
Ground plane edge
radius 5mm
LAr 4cm above GP
bottom
Cryostat vertical wall
40cm from FC

Max LAr E: 23kV/cm
Max GAr E: ~ 3kV/cm

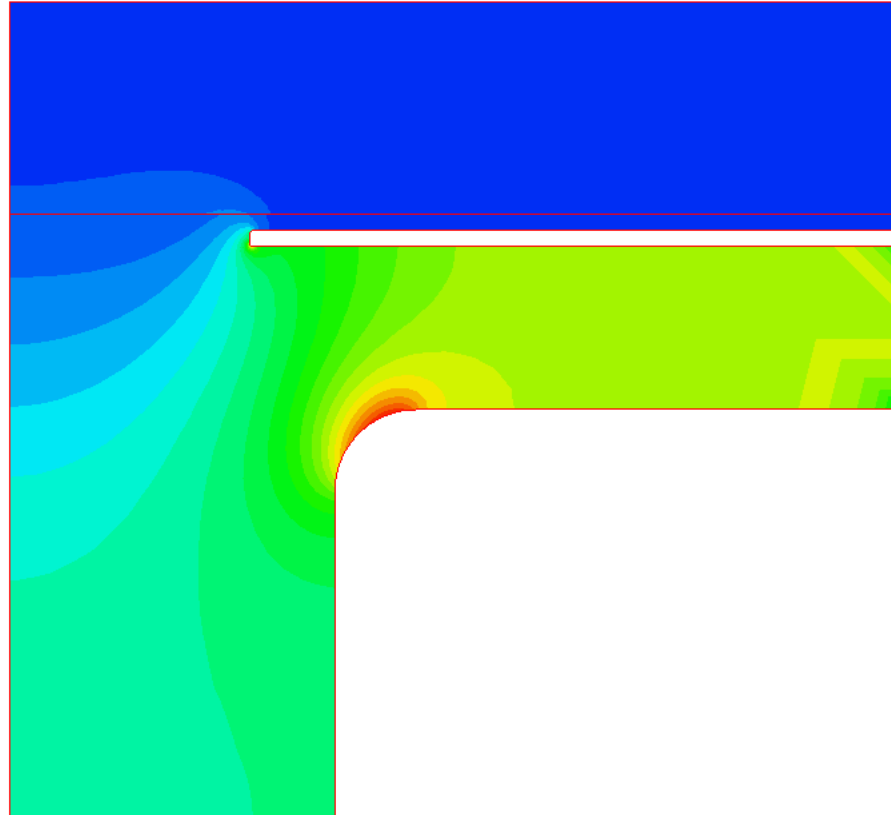
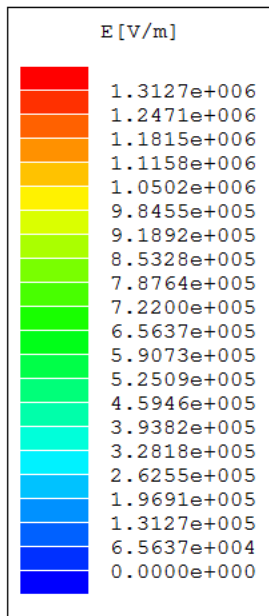
Flush with end wall FC



20cm FC to GP spacing
Ground plane edge
radius 5mm
LAr 4cm above GP
bottom
Cryostat vertical wall
40cm from FC

Max LAr E: 19kV/cm
Max GAR E: ~ 2kV/cm

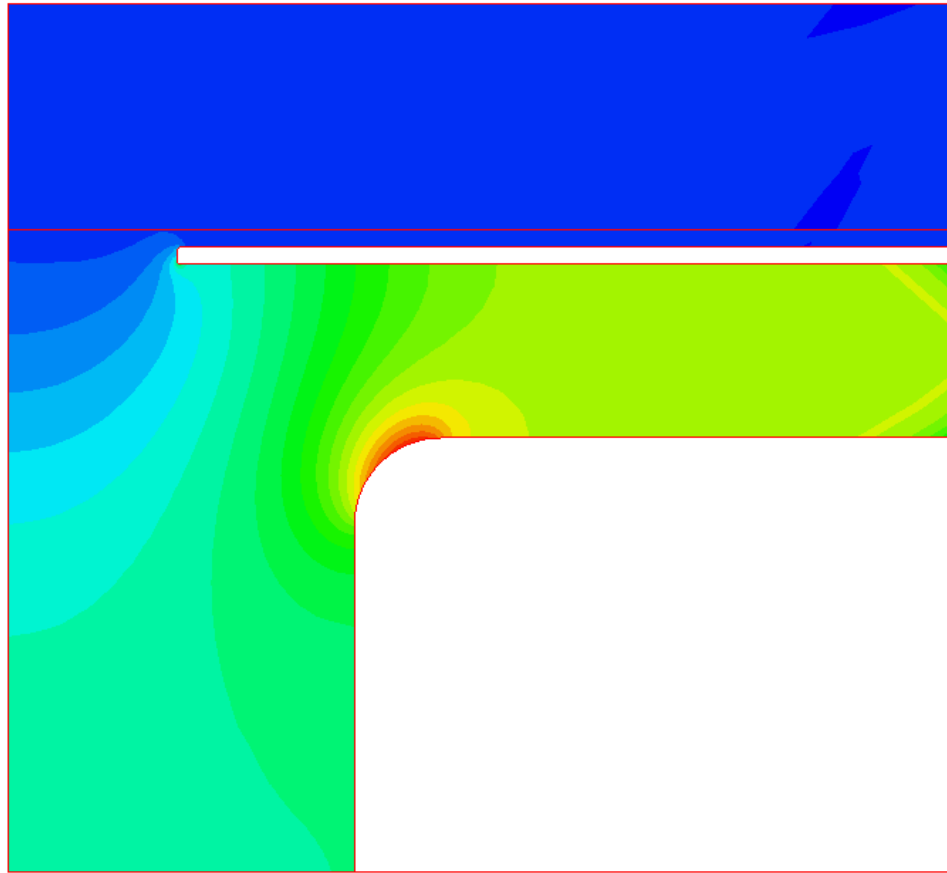
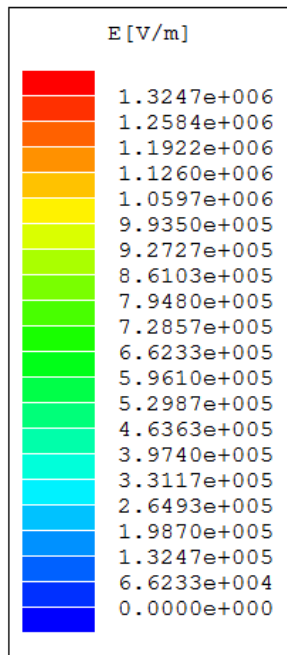
10cm overhang of the ground plane



20cm FC to GP spacing
Ground plane edge
radius 5mm
LAr 4cm above GP
bottom
Cryostat vertical wall
40cm from FC

Max LAr E: 13kV/cm
Max GAR E: ~ 1kV/cm

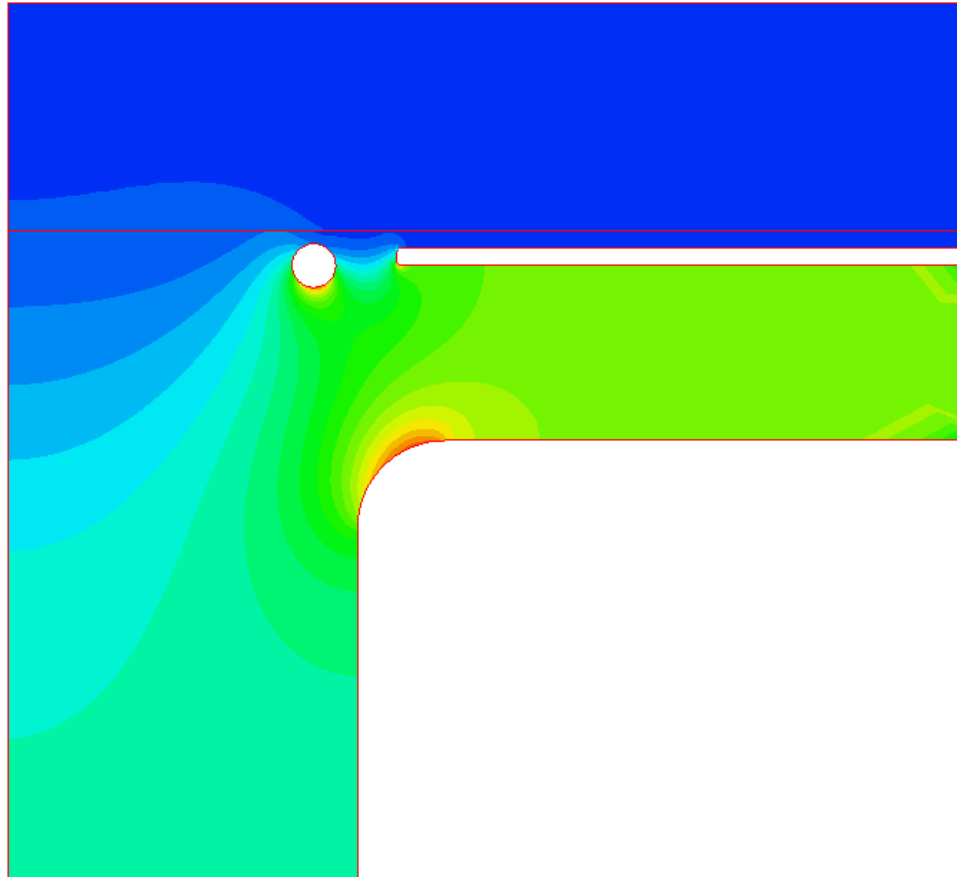
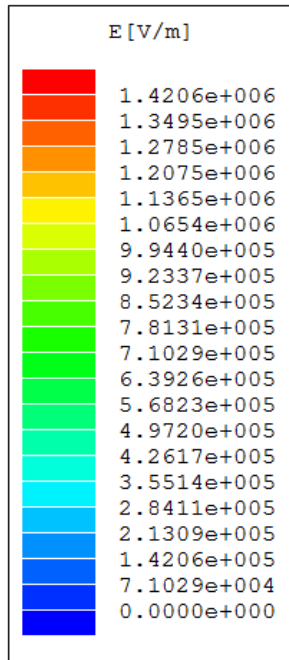
20cm overhang of the ground plane



20cm FC to GP spacing
Ground plane edge
radius 1cm
LAr 4cm above GP
bottom
Cryostat vertical wall
40cm from FC

Max LAr E: 13kV/cm
Max GAR E: < 1kV/cm

No overhang, but with a pipe



20cm FC to GP spacing
Ground plane edge
radius 5mm
LAr 4cm above GP
bottom
Cryostat vertical wall
40cm from FC

Max LAr E: 14kV/cm
Max GAR E: < 1kV/cm

Conclusions

- Ground plane without overhang has 23kV/cm E field at the 0.5cm rounded bottom edge of the ground plane.
- A 10-20cm overhang reduces the E field under the edge of the ground plane by about a factor of 2.
- This overhang is only needed in the cathode half of the field cage.