Recent Simulation for MICE 201 MHz RF Cavity

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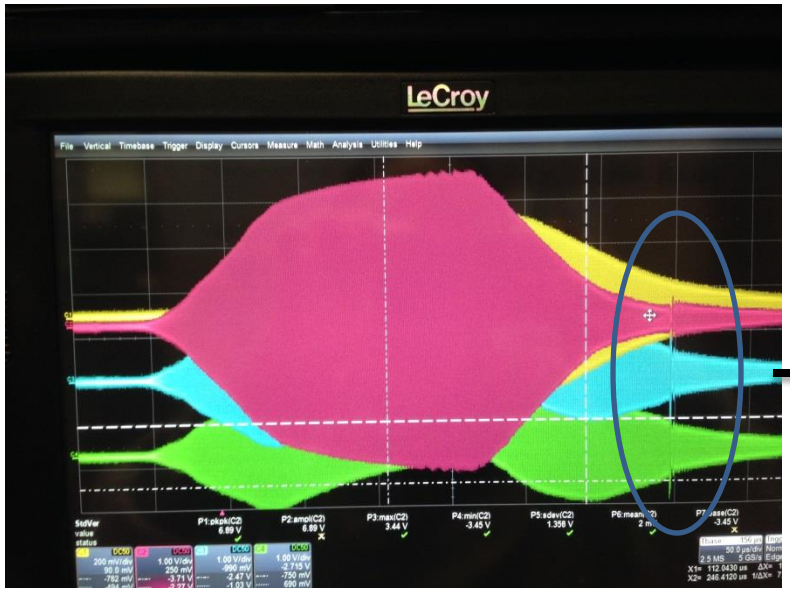
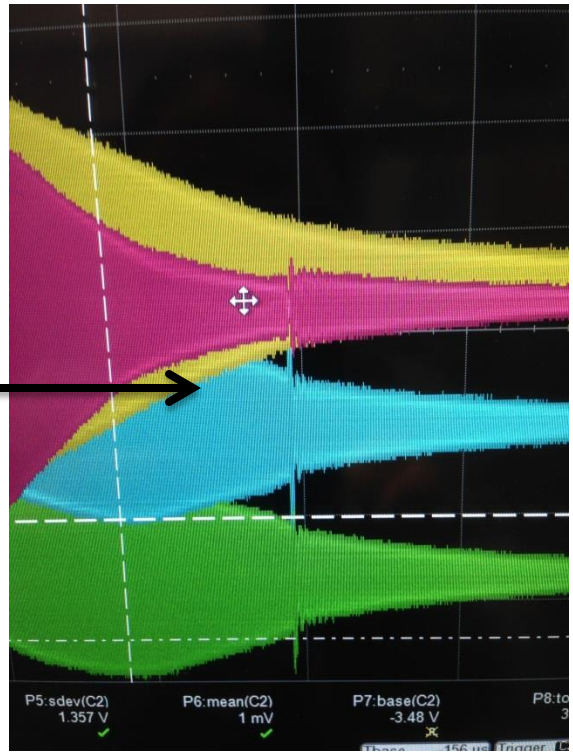
Recent Simulation Work

- MP below 250 kV/m.
- Thermal mechanical stress on the Be window.
- The cavity tuning by Be window spacer.
- RF field map in the cavity.

MP below 250 kV/m





RF signal burst

RF signal of Single Cavity Module in high power commissioning at MTA, taken in September.

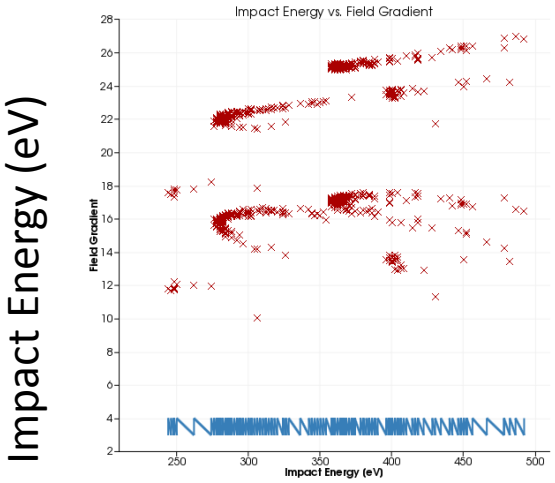
RF signal burst is observed at the droop end. Could it be due to mupltipacting?

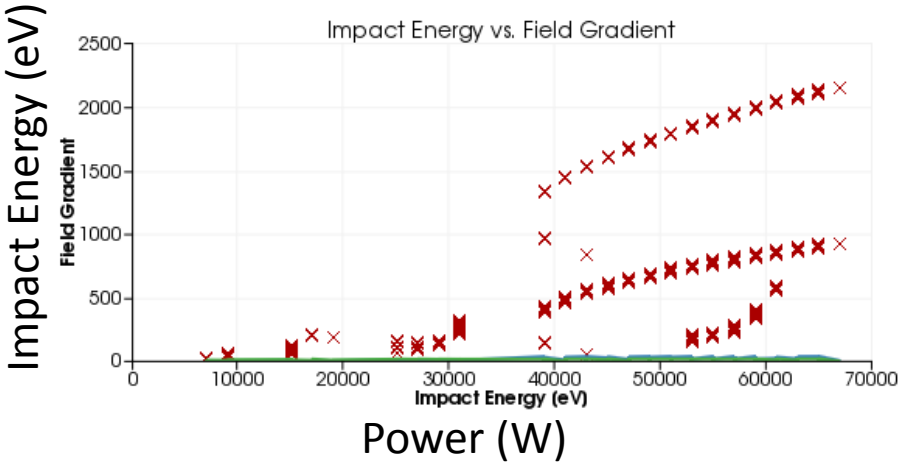
The cavity field level at the burst is ~ 100 kV/m. For all our previous MP study, we never looked at field level below 250 KV/m.

Assuming 8 MV/m ~ 2 MW,
Thus 250 kV/m ~ 2 kW.

MP below 250 kV/m

- Coaxial waveguide.





Power (W)

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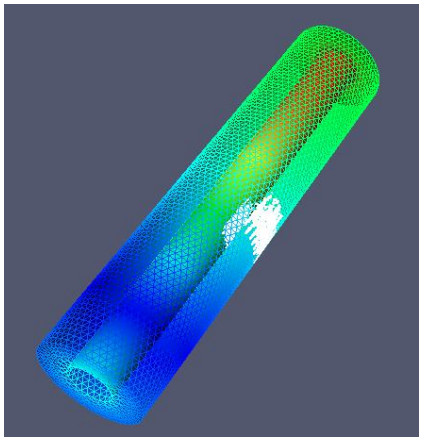


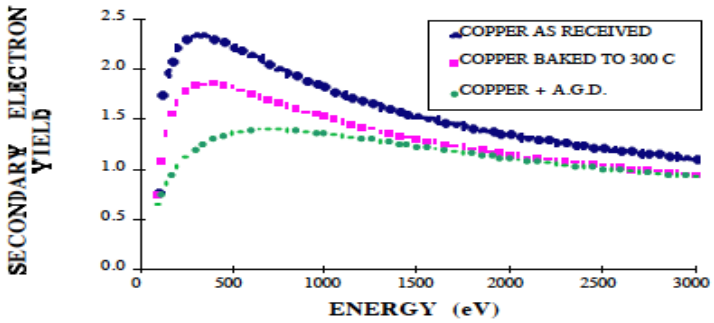


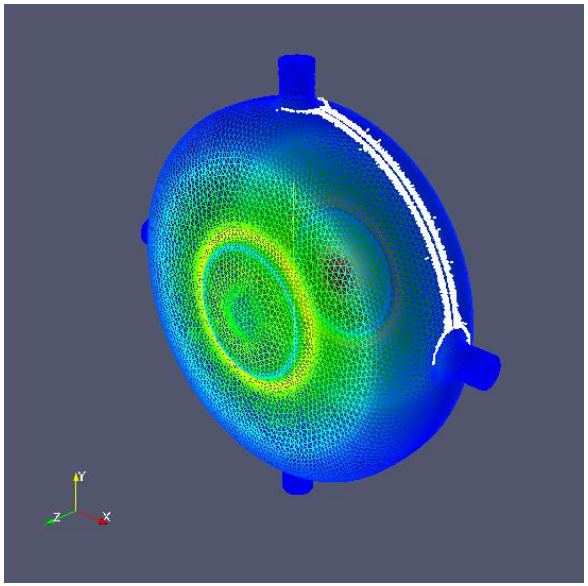
Figure 2: The S.E.Y. of copper for various surface treatments

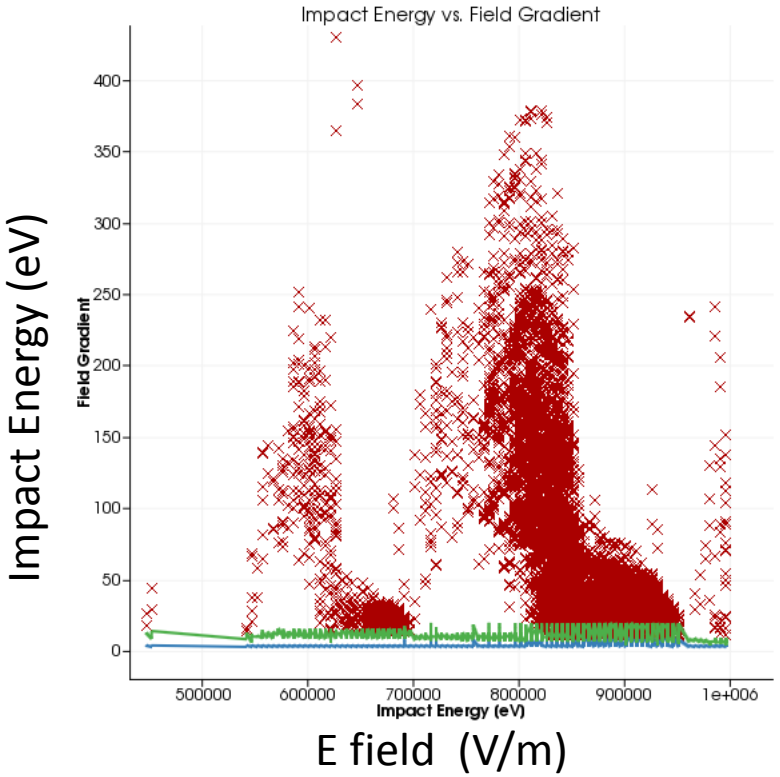
In coaxial waveguide, strong MP is from 40 kW to 70 kW.

No MP observed at around 2 kW.

MP below 250 kV/m

- In the cavity body



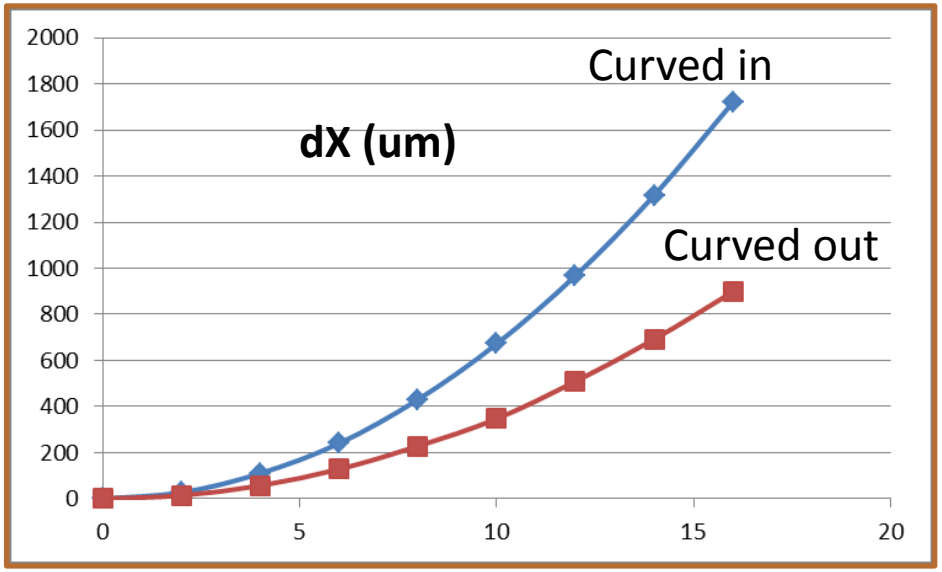


Scan the field level from 0 to 1MV/m.
No strong MP is found below ~ 550 kV/m.

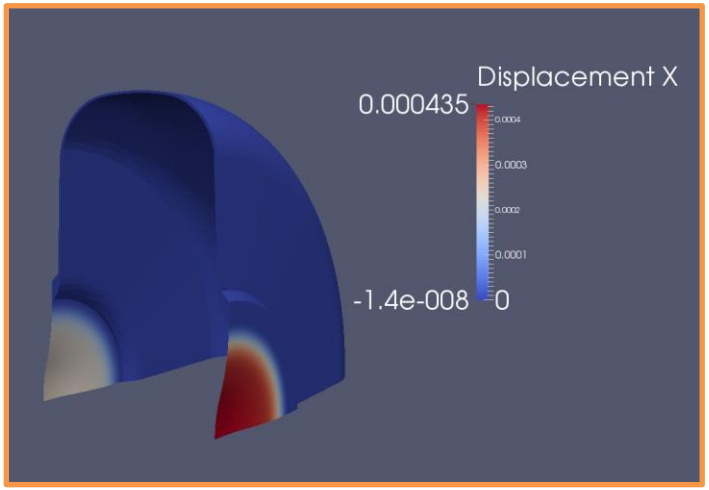
The MP study at the coupler strip region is going on.
We might also look into the RF window region.

Be Window Stress

Thermal Deformation calculated by TEM3P



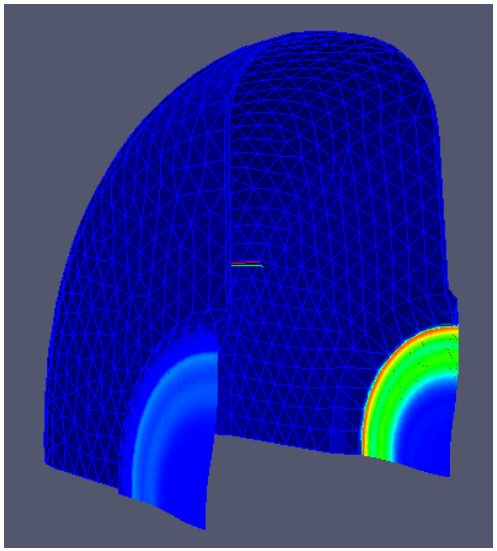
E_eff (MV/m)

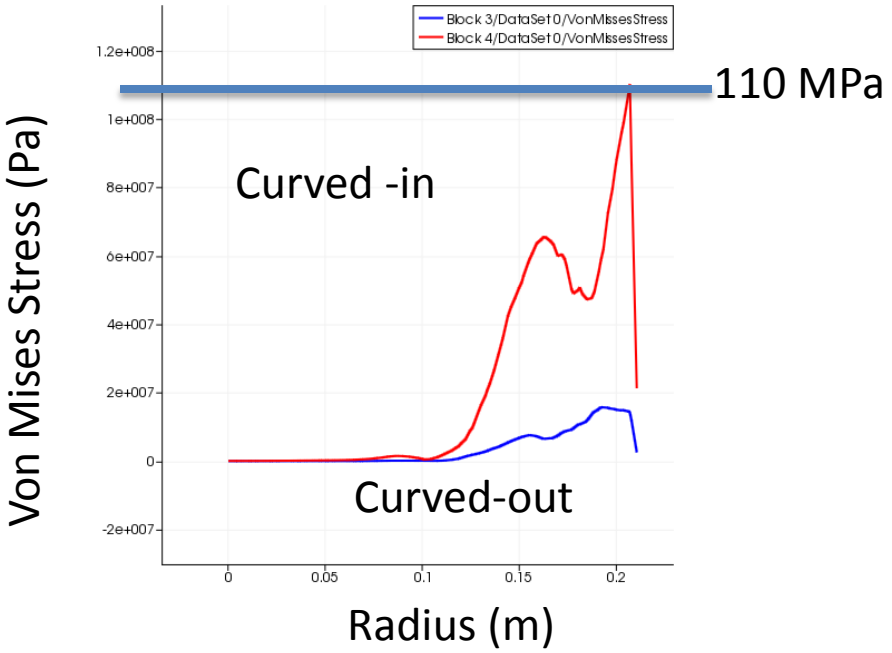


After the spring meeting, we have done the mechanical stress analysis by TEM3P, caused by thermal heating and Lorentz force.

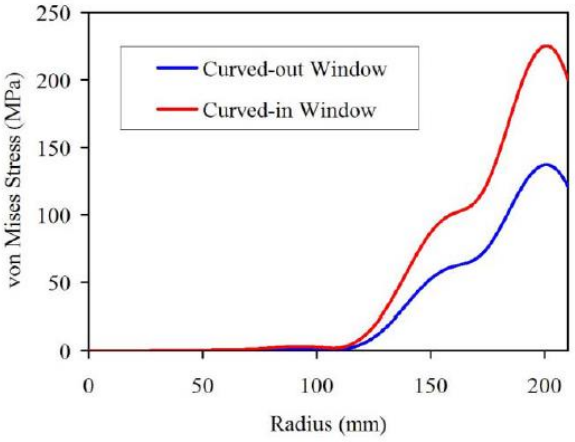
Be window Stress

Von Mises Stress calculated by TEM3P





Von Mises Stress by Ansys (S. Virostek)



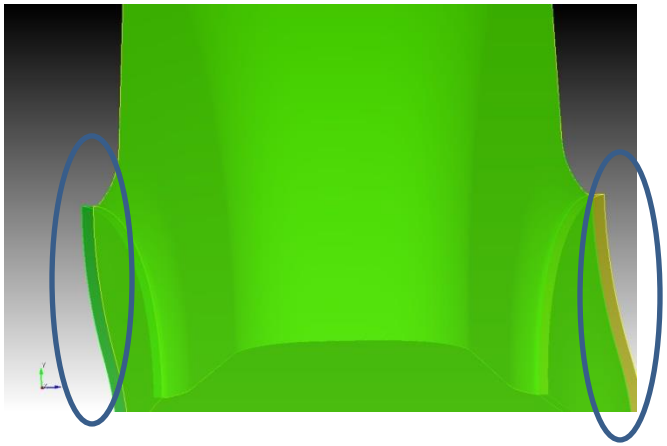
The TEM3P Von Mises stress calculation agrees with previous ANSYS simulation . The difference is from different power dissipation (8.4 kw vs 5.3 kW) and modeling simplification.

Beryllium yield strength ~ 520 MPa. For 16 MV/m and 0.1% duty factor operation, the Be window thermal stress should be within safe region.

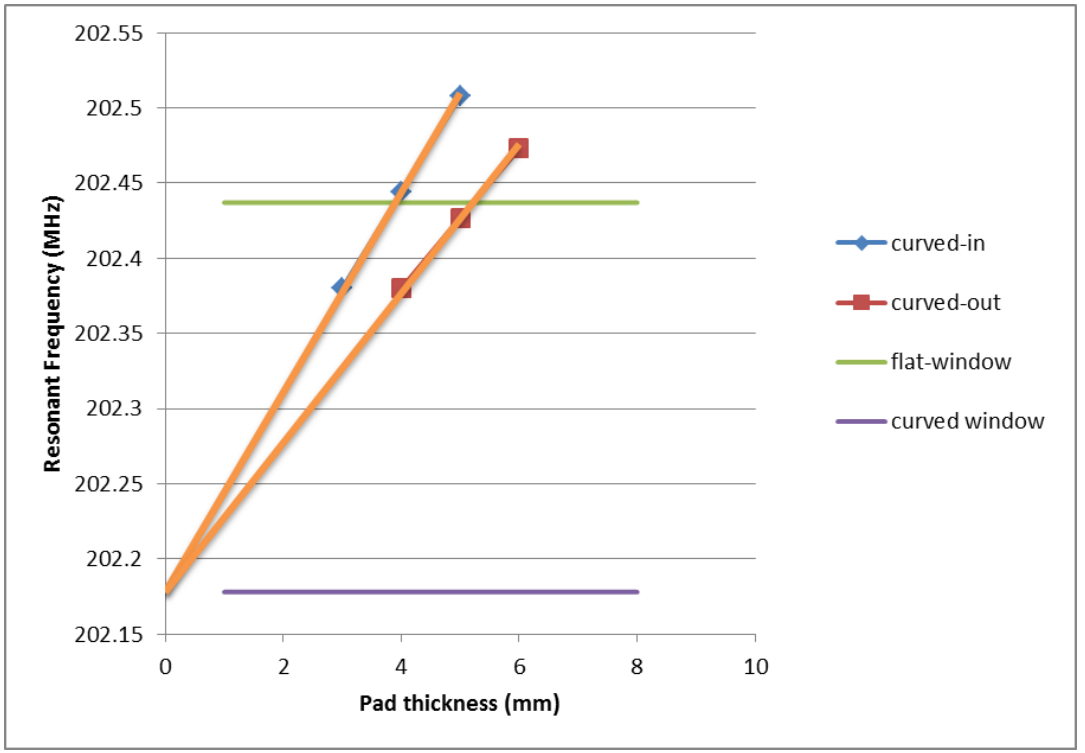
Frequency tuning by Window Spacer

- In current single cavity module test, flat copper windows are installed on the RF cavity, whose resonant frequency ~ 202.233 MHz.
- Later, curved Be window will replace the flat copper window, thus the frequency will shift down due to the window curvature considerably, might even out of the tuner tuning range.
- MTA has proposed to use spacer on the Be window to change the cavity frequency.
- Simulation is carried out to study this tuning scheme.

Frequency tuning by Window Spacer



The windows are extended longitudinally to simulate the copper spacer around the window.

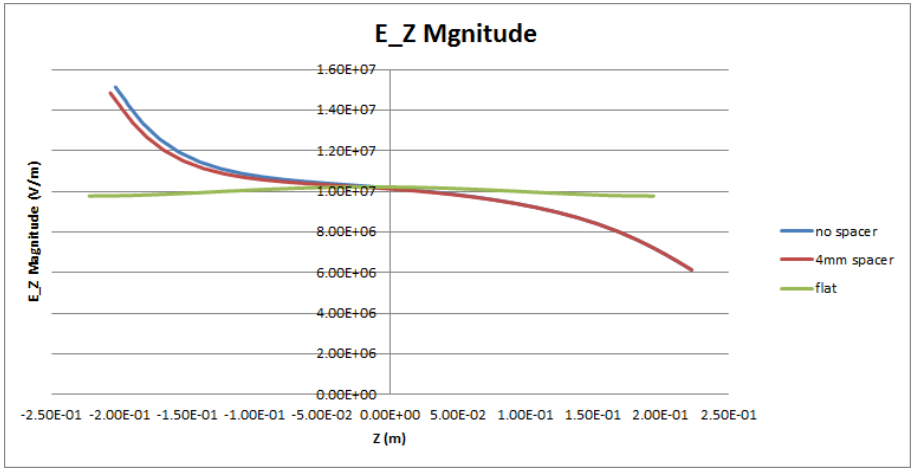


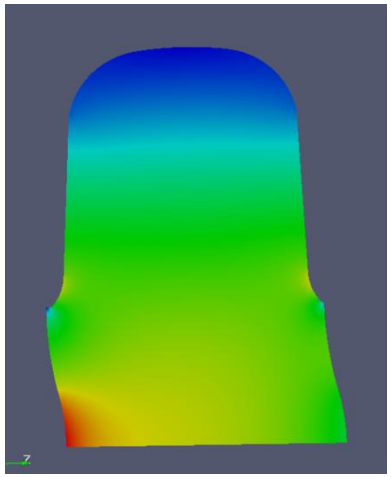
Calculated 3, 4, 5 mm pad for the curved-in side and 4,5,6 mm pad for the curved-out side.

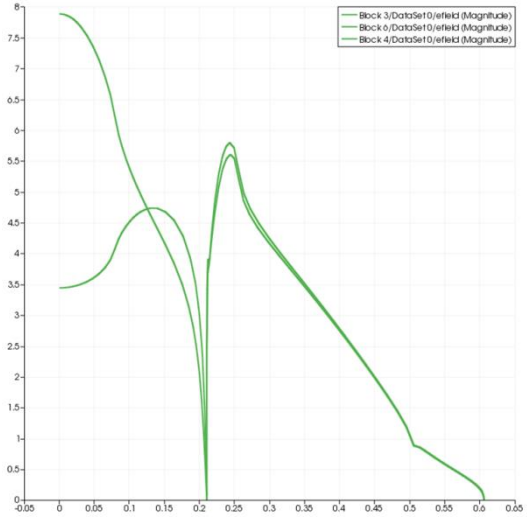
For the curved-in side, the effect on the frequency from the spacer is 66.4 kHz/mm; for the curved-out side, it is 49.6 kHz/mm.

Frequency tuning by Window Spacer

Ez field across center axis







Adding a few mm window spacer has almost negligible affect on the cavity E field (1.3% at the curved in window center) and R/Q .

RF Field in the cavity

- The curved Be window changes the RF field near the central axis. Will this affect the emittance results?
- Each Be windows are made different, thus the field perturbations are different.
- What's the accuracy requirement of RF field map?
- Other smaller effects on the RF field map: coupling port, RF phase difference, etc. Do they need to be addressed?