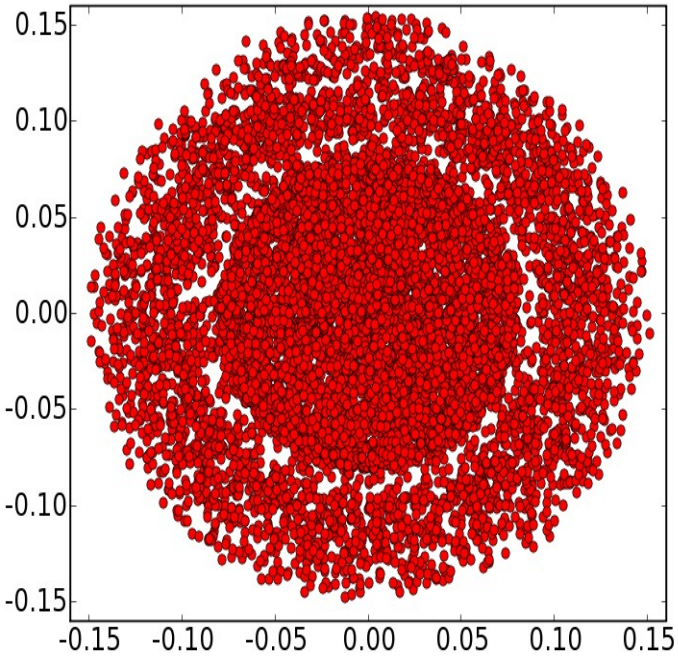
# 3D multipacting simulations in high gradient structures

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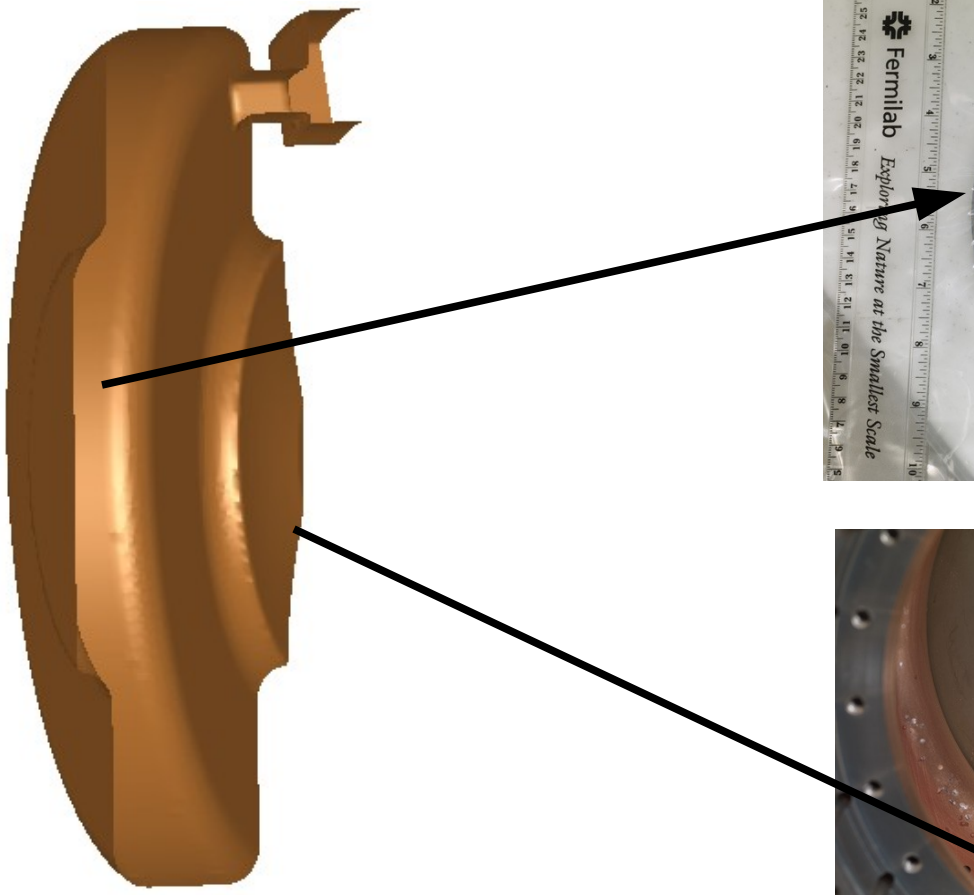
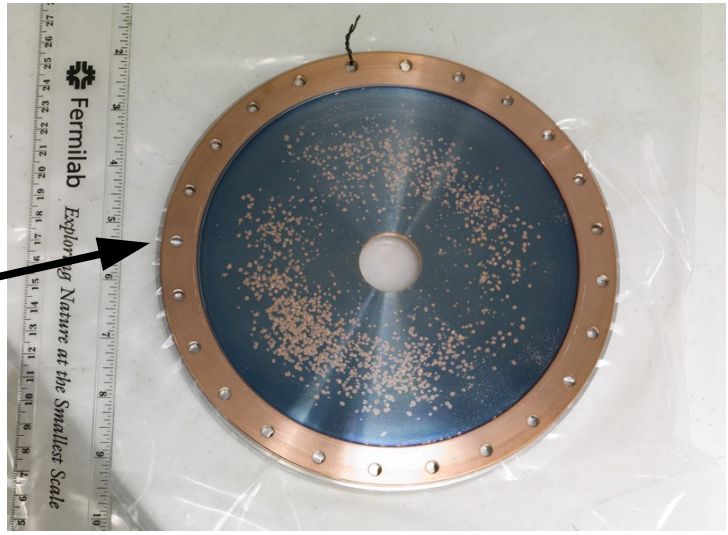
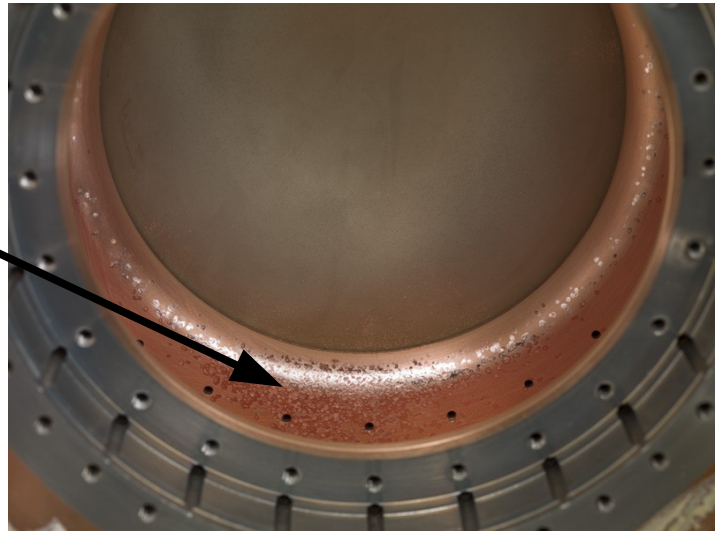
# Motivation: muon collider community would like to understand exact mechanisms for breakdown in 805MHz structures

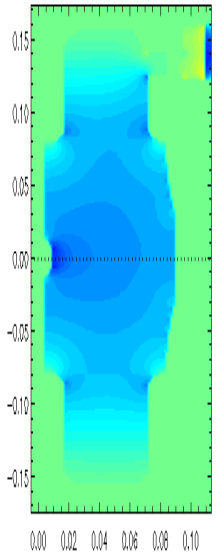


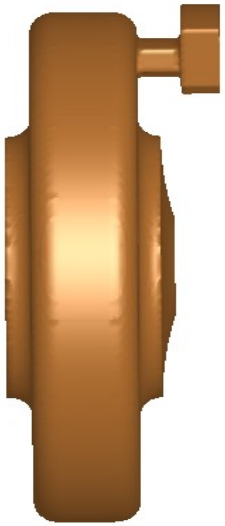


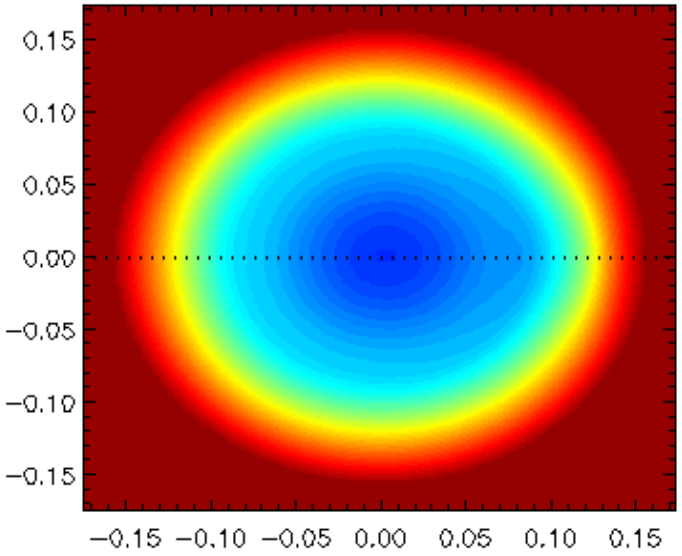



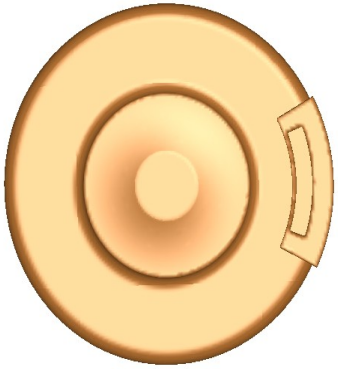
- Higher-order modes (note assymetry)?
- Effects of coupler?

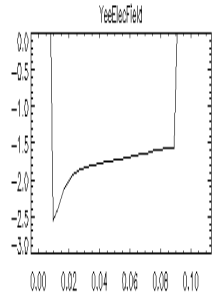
# VORPAL results are helping determine if higher order modes and field enhancement are responsible for breakdown

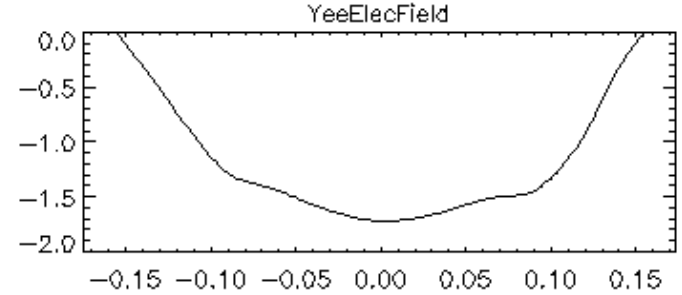




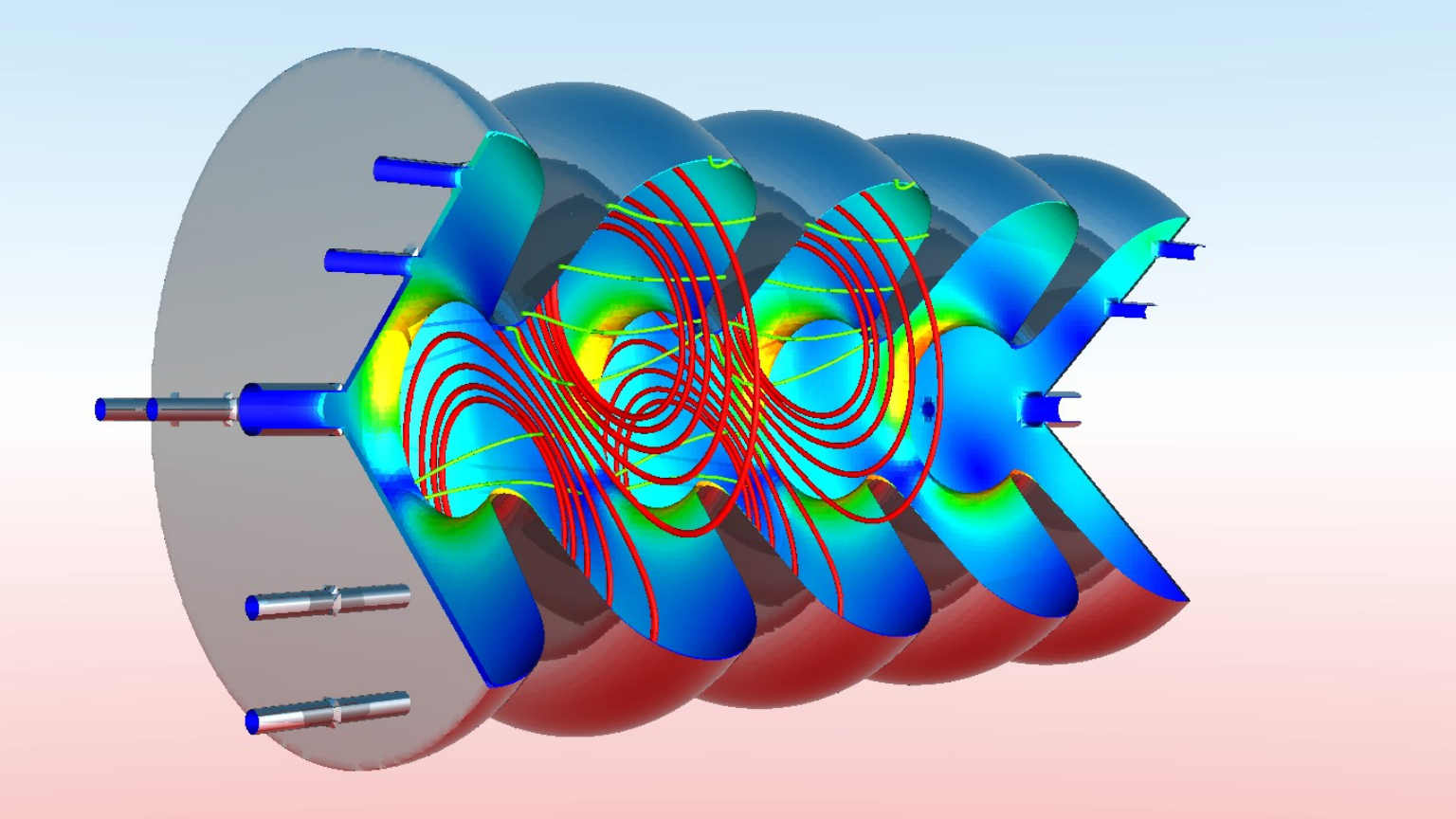






We are benchmarking VORPAL field results for button cavity with MAFIA (so far agreement is excellent)

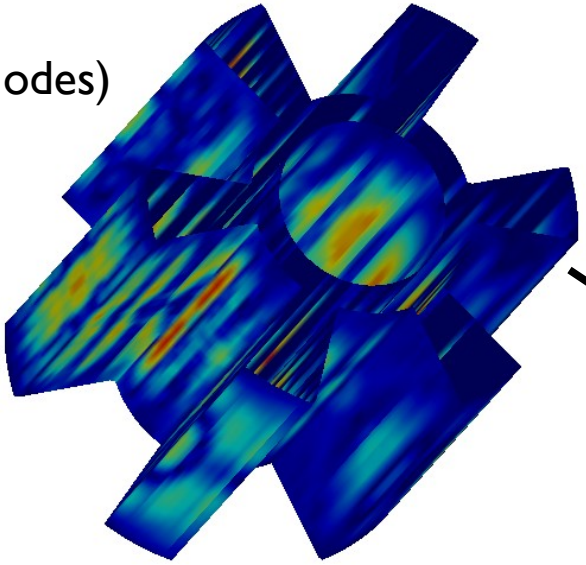
# VORPAL field results are helping researchers determine whether higher order modes are responsible for breakdown



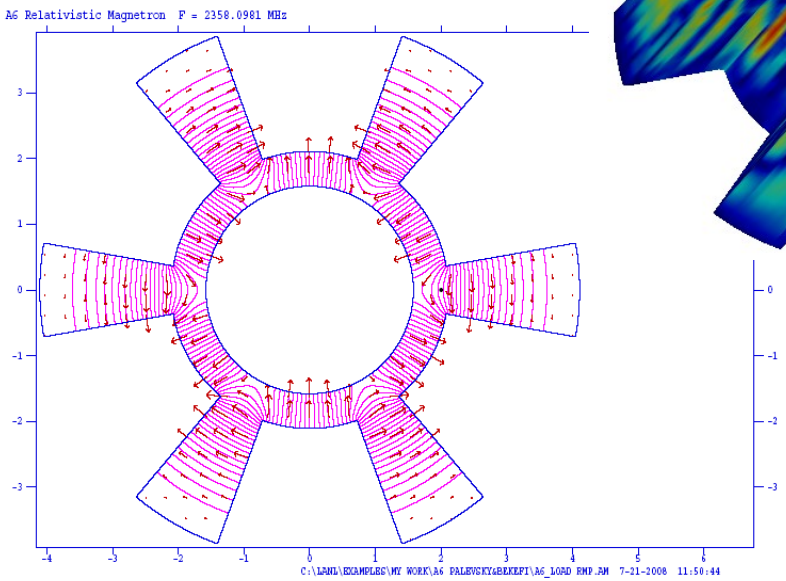
We are benchmarking VORPAL field results for other structures too (also excellent agreement)

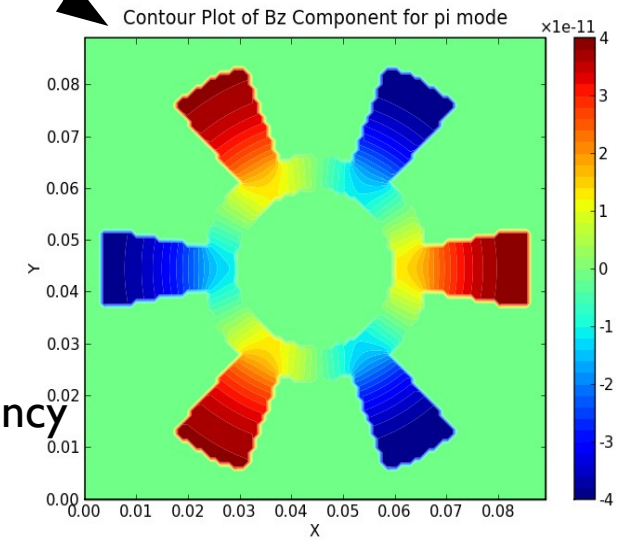
# Time-domain eigenmode extraction allows VORPAL simulations to help understand HOMs

Time domain (all modes)



Eigenmode extraction (new!)



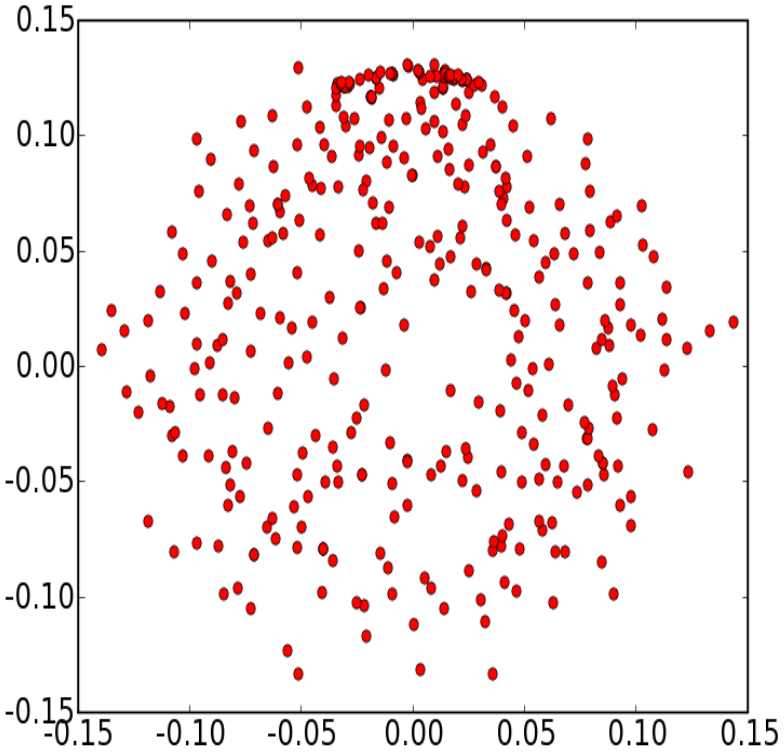



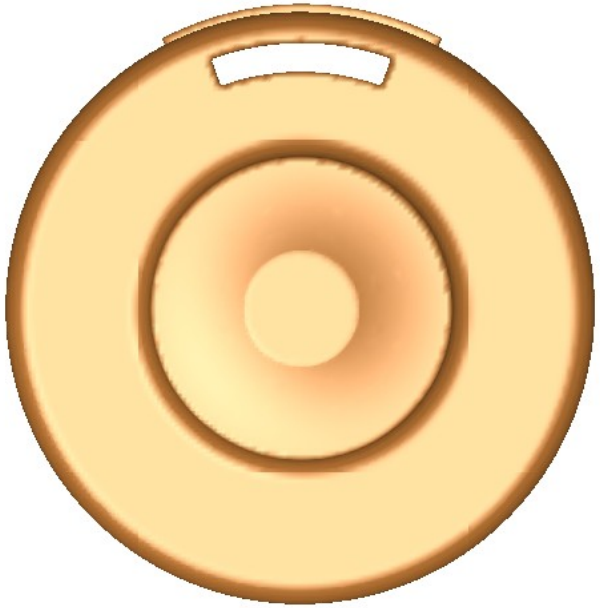

Compare with frequency domain code

- We have benchmarked VORPAL eigenmode results with SUPERFISH
- More on this exciting technique: G. Werner, WG2, Wednesday mornin

# Multipacting does give hints of problems

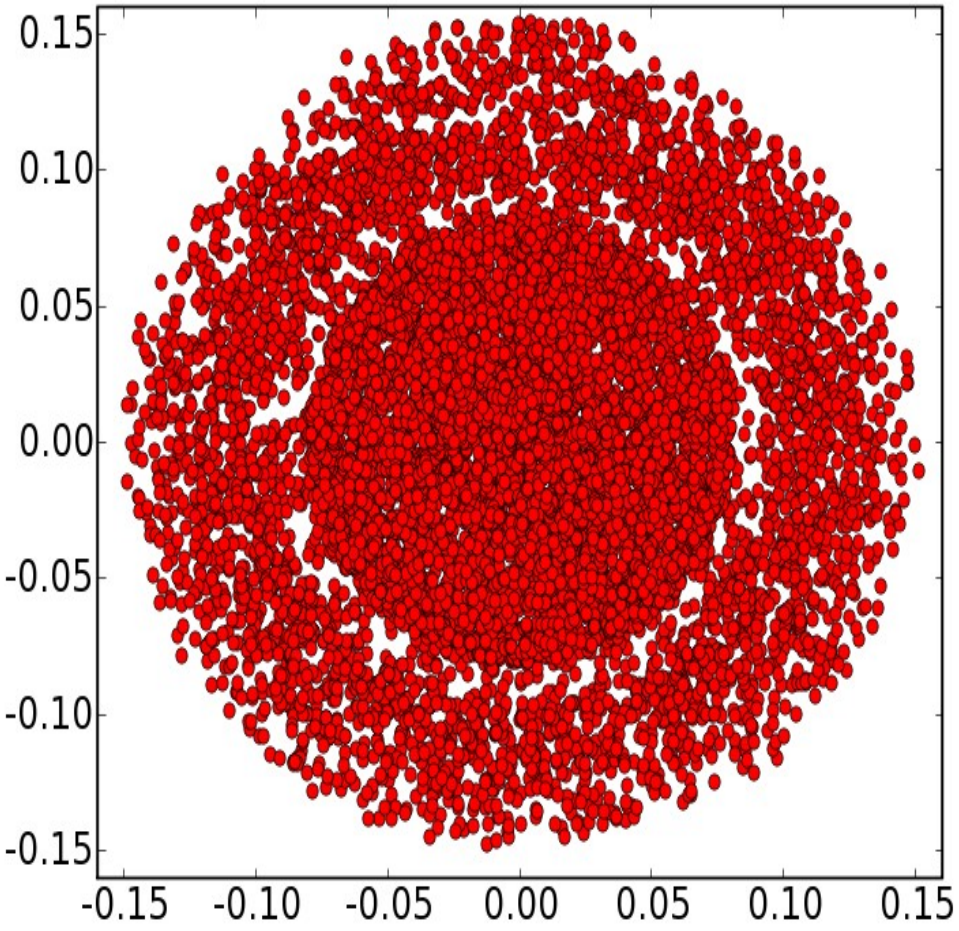
t =15 ns

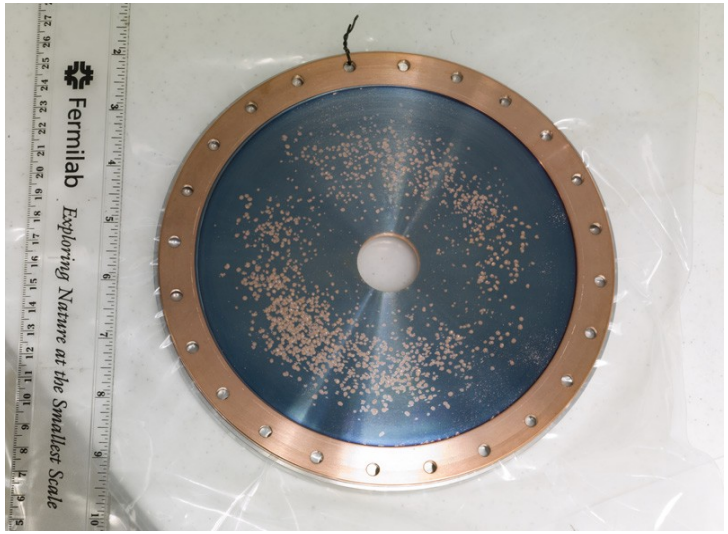


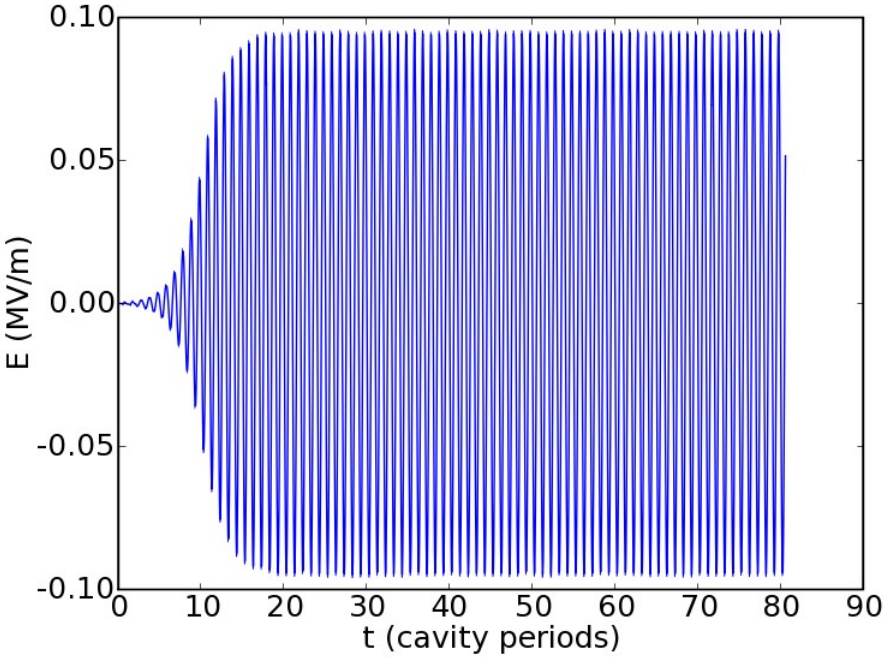
# Multipacting does give hints of problems

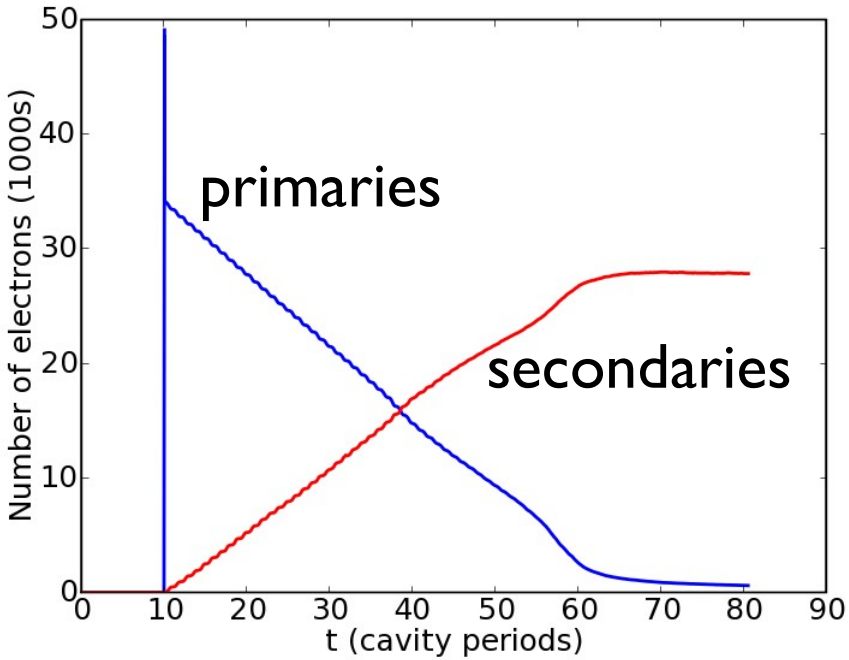
t =35 ns



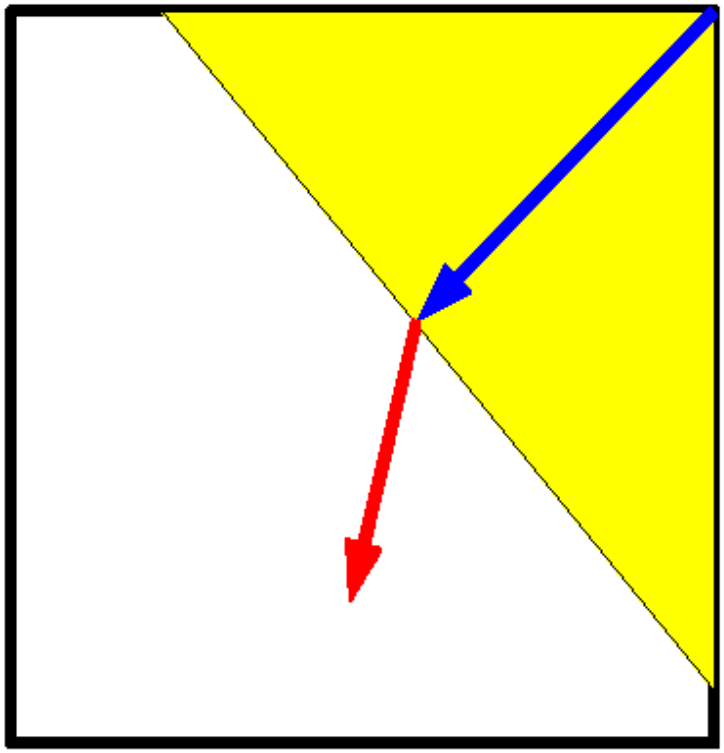
# But multipacting alone is not a problem for the button cavity…



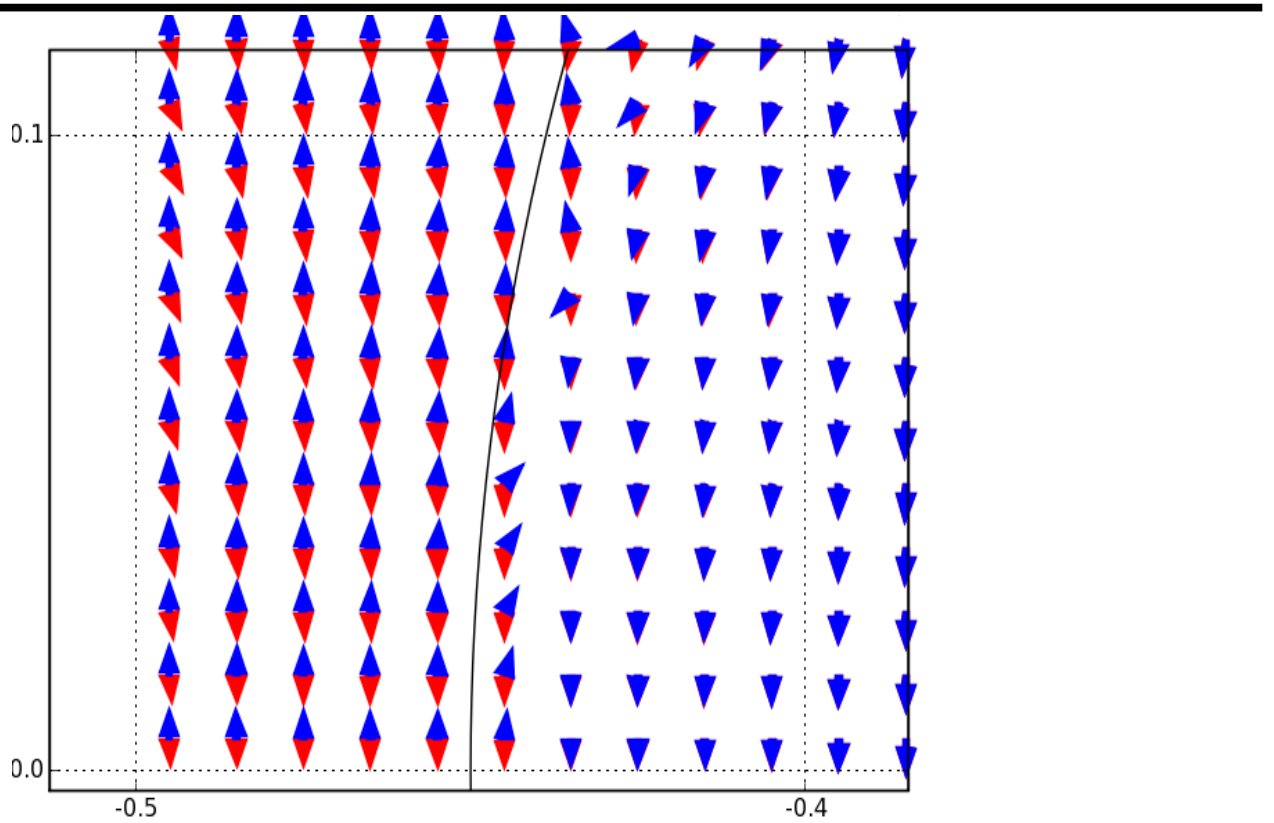

- In the presence of multipacting, fields maintain their structure and number of secondaries levels off
- Next is full breakdown modeling (field emission, ionization, radiation)

# In FDTD emission from cut cells, corrective currents are needed to prevent unphysical charges



The current from the corner (blue) pulls enough charge from inside the conductor (yellow) to cancel the non-physical image charge left behind by the emitted particle.

# In FDTD force calculations in cut cells, new interpolation is needed for accurate particle push




- The red arrows are the fields interpolated from the standard Dey-Mittra fields (note they do not go to zero at the embedded boundary).
- The blue arrows are the fields interpolated from the new constrained Dey-Mittra fields.

# VORPAL field results are helping researchers determine whether higher order modes are responsible for breakdown

| A6 Relativistic Magnetron (RMP 1991) | Err(%) FDTD (GHz) (Staircased) # 10,000 | Err(%) VORPAL (GHz) # 10,000 DM_FRAC=0.25 | Err(%) VORPAL (GHz) # 10,000 DM_FRAC=0.1 |
|---|---|---|---|
| /3 | -4.33984 | 0.22584 | -0.35400 |
| 2=/3 | -3.43666 | -0.50421 | 0.58682 |
| = | -3.36994 | -0.90238 | 0.42425 |
| 0 2nd (2=) | -3.59272 | -0.63788 | -0.47784 |
| =/3 2nd | -3.42072 | 0.34672 | 0.34211 |
| 2=/3 2nd | -3.15342 | -0.12462 | -0.37917 |
| = 2nd | -3.96125 | 0.14421 | 0.04036 |