

# Recent EM work relating to SciDAC

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- UK LHC crab cavity design (work funded by SciDAC)
- Virtual cavity prototyping (new SBIR Phase I)
- Crab cavity particle dynamics (SBIR Phase II ending Aug 2010)
- Multipacting (SBIR Phase II ending Dec 2009)

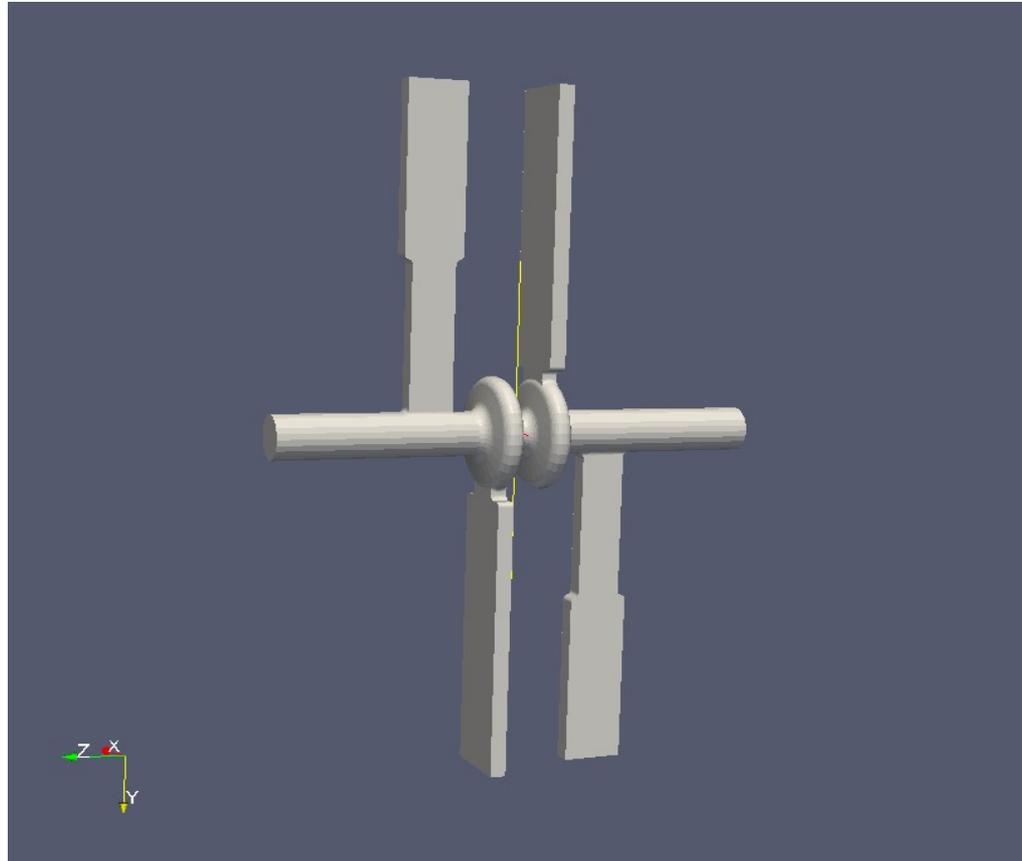


# Parallel capabilities of VORPAL allowed more detailed studies than with MWS

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*For VORPAL runs, we used  
 $dx = 0.005$  [m]  
~2000 processors on  
Franklin at NERSC*

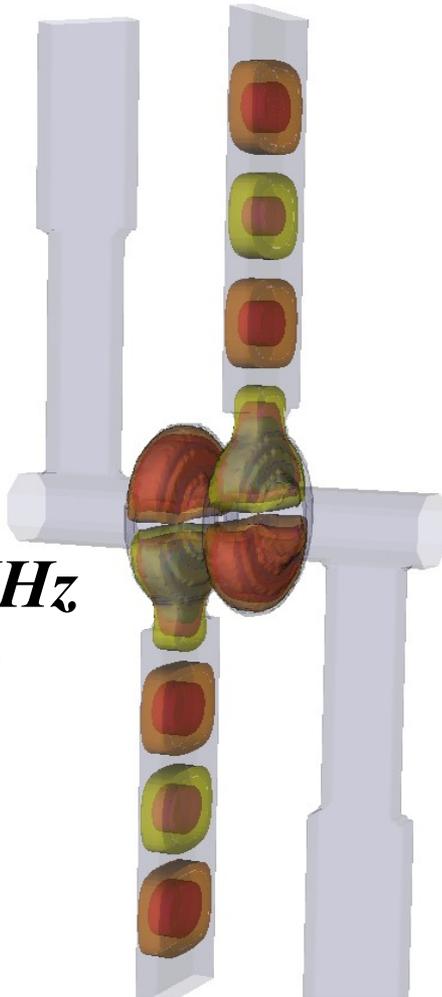
*MWS runs used 10-20 times  
fewer cells*



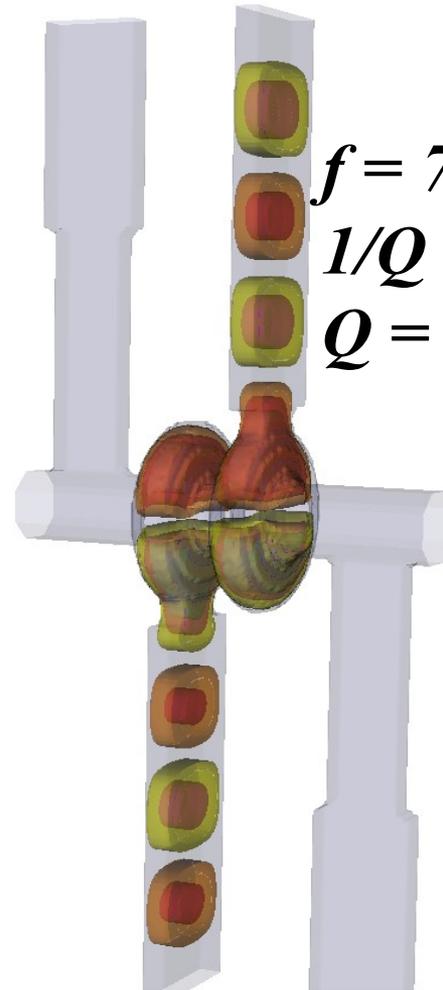


# Improved visualization is possible due to SciDAC tools

$f = 778.38 \text{ MHz}$   
 $1/Q = 0.0130$   
 $Q = 76.9$



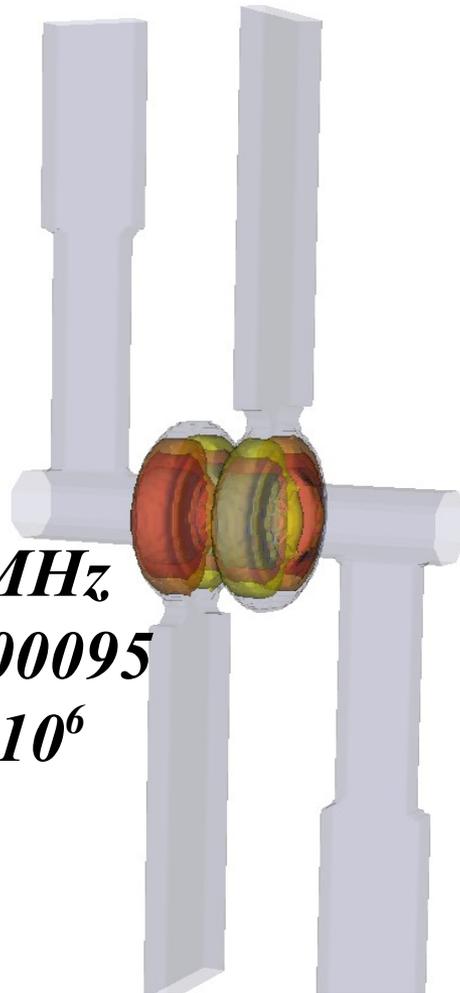
$f = 783.06 \text{ MHz}$   
 $1/Q = 0.0134$   
 $Q = 74.6$



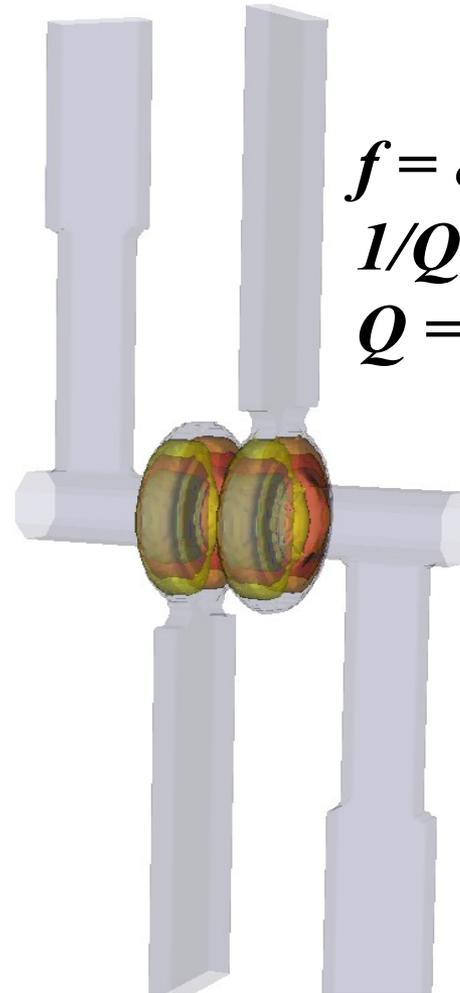


# Improved visualization is possible due to SciDAC tools

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$f = 804.597 \text{ MHz}$   
 $1/Q = 0.00000095$   
 $Q = 1.0526 \times 10^6$



$f = 808.796 \text{ MHz}$   
 $1/Q = 0.00000182$   
 $Q = 0.5495 \times 10^6$



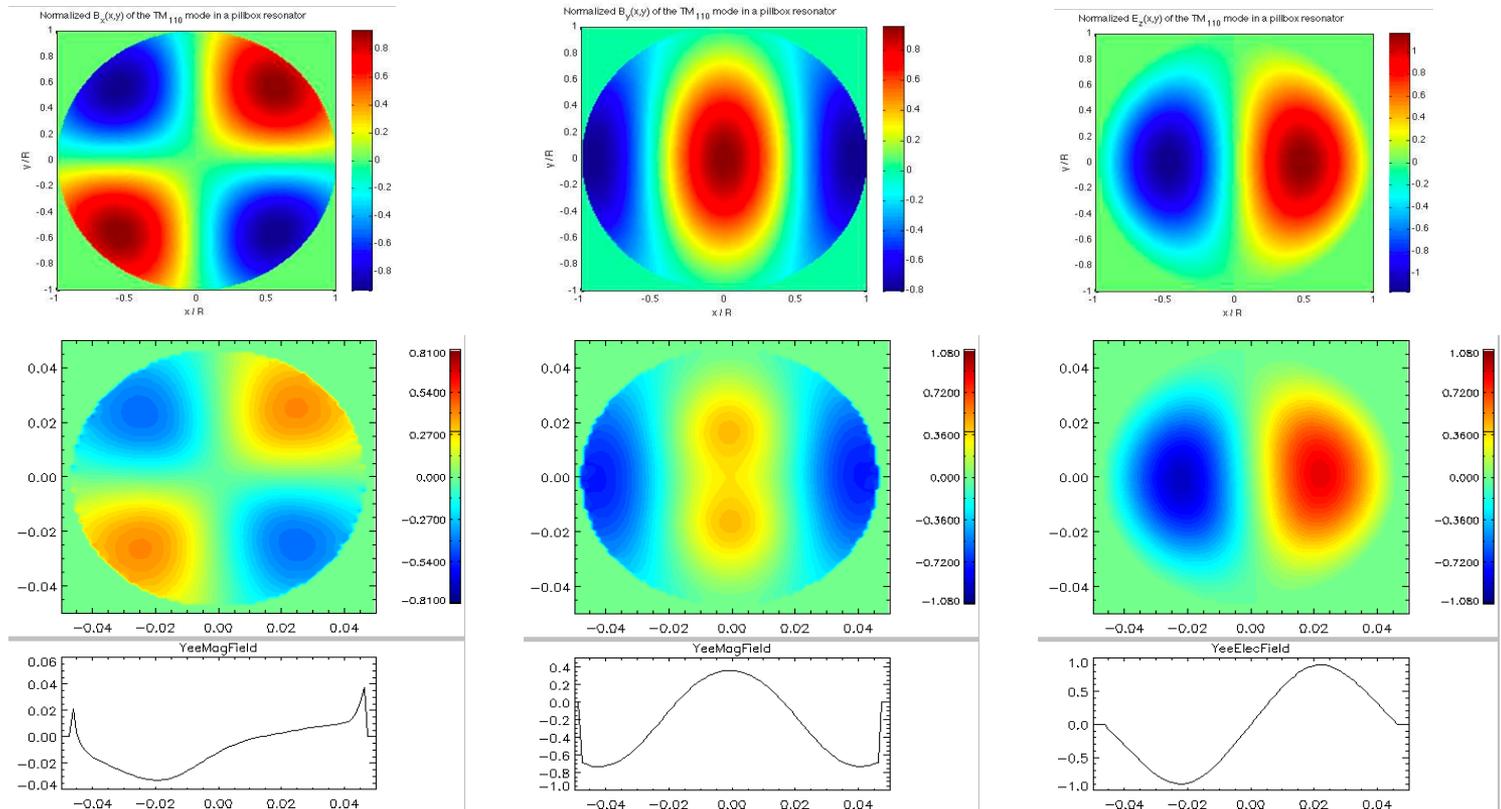
# Benchmarking of VORPAL with MWS

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	f (100 MHz)		Q	
	VORPAL	MWS	VORPAL	MWS
	7.784	7.783	76.9	30.5
	7.830	7.830	74.6	35.7
	8.05	8.00	1.05e6	2.11e6
	8.09	???	0.55e6	0.9e6



# Turning VORPAL sims into maps relies on a mode analysis technique



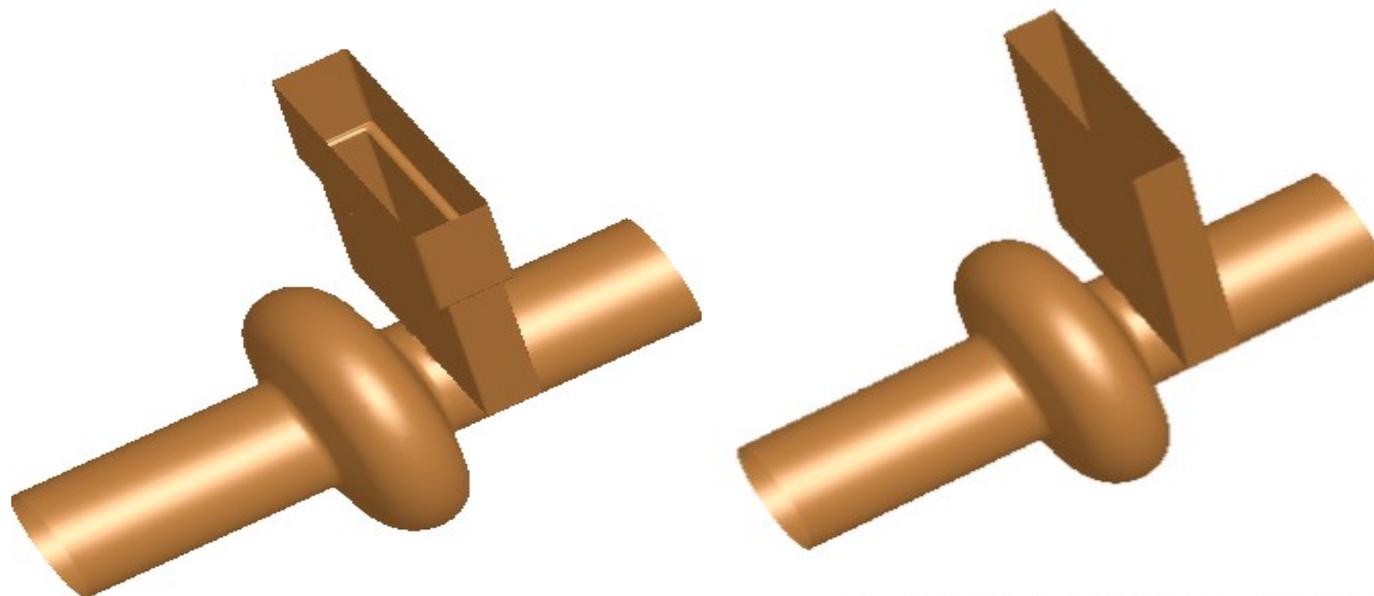
The  $B_x$ ,  $B_y$ , and  $E_z$  field distribution in the  $x$ - $y$  plane for the  $TM_{110}$  mode in a cylindrical resonator (top row, analytical result) and the  $TM_{110}$ -like operating dipole mode extracted from our VORPAL simulation of the ILC crab cavity (bottom row)



# Objectives for Virtual Cavity project (Phase I SBIR begun July 2009)

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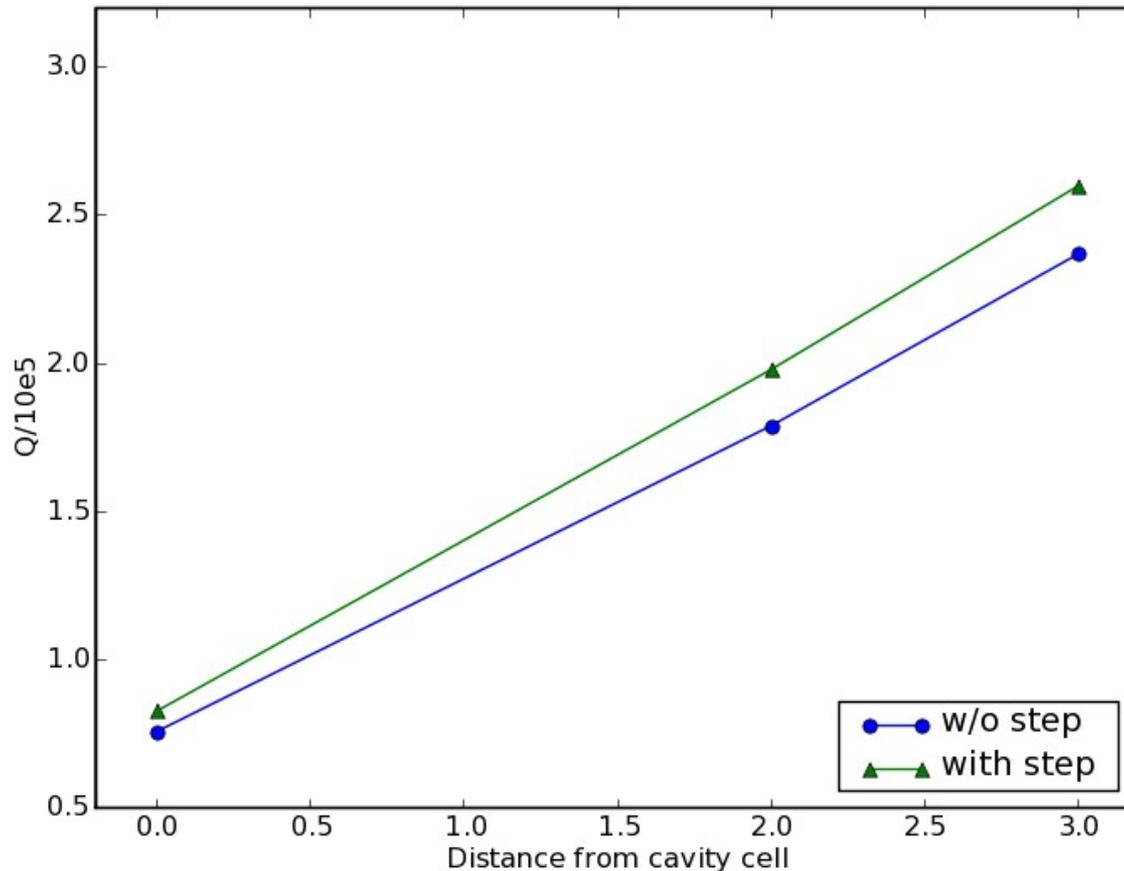
- Develop a library of common cavity geometry elements and associated boundaries for VORPAL
- Benchmark VORPAL simulations developed with this library against existing cavity designs
- This will make it easy for researchers to prototype cavity designs using VORPAL





# VORPAL simulations demonstrate how the presence of the step affects $Q_{\text{ext}}$

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# VORPAL results compare well with experimental data and other codes

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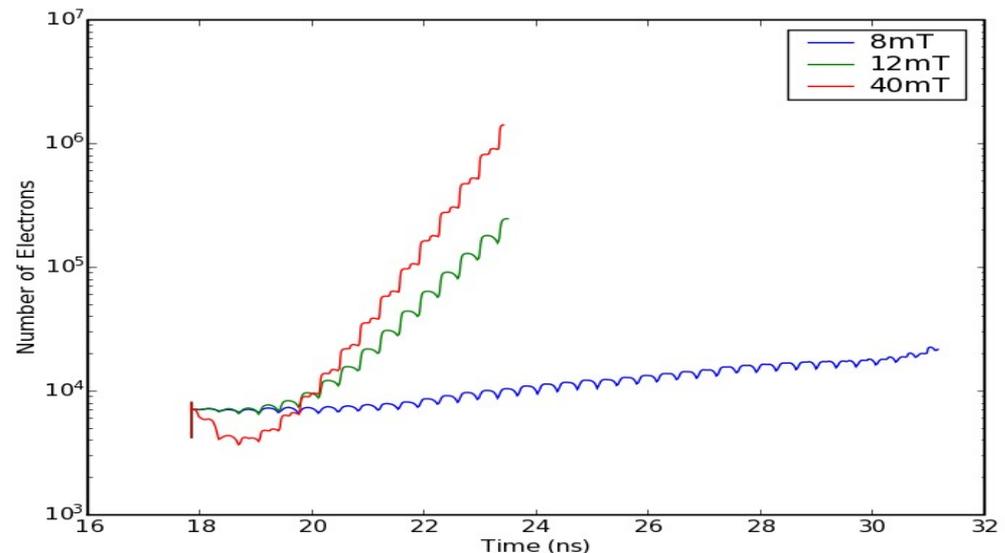
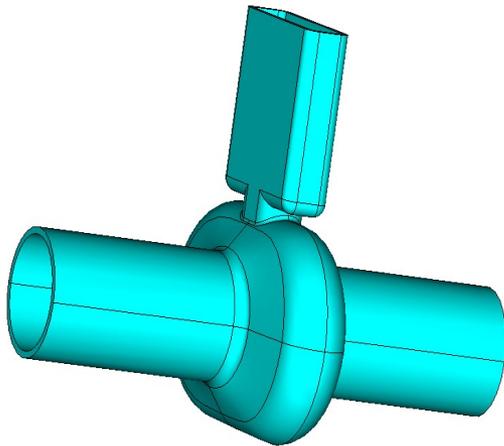
	VORPAL	MAFIA	MWS	Experimental data
Q/10e5 w/o step	2.37	2.4	2.00	1.84 (1.75..1.99)
Q/10e5 with step	2.60	3.5	2.53	2.58 (2.51..2.67)



# Recent work with Jefferson lab helps researchers understand design options

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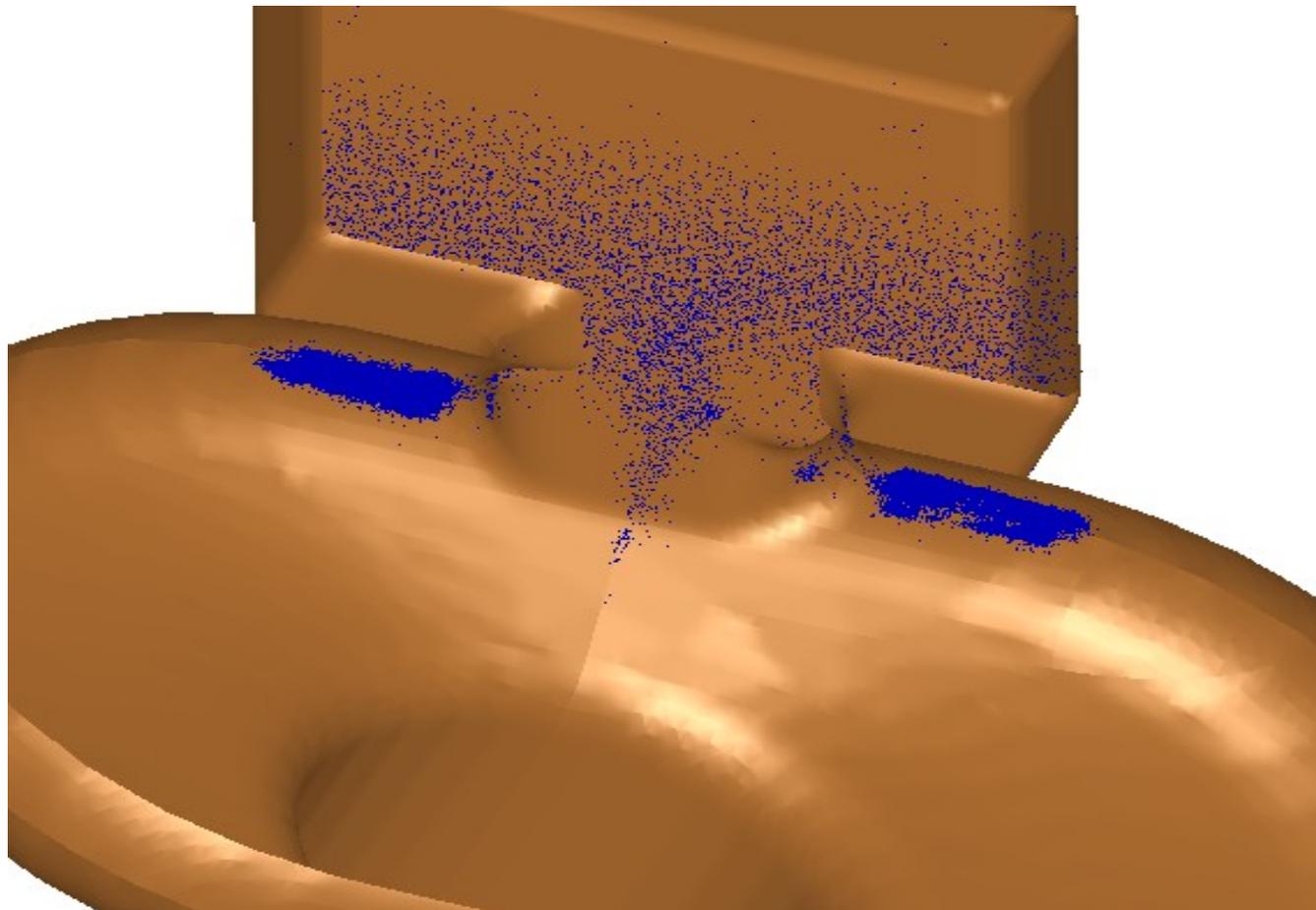
- Searching for multipacting in ANL crab cavity design
  - Recent tests imply multipacting may be a problem for the design
- We ran simulations over a range of field levels looking for multipacting
- Exponential growth in the number electrons was observed near the fields where problems were observed in the experimental tests





# Location of electron build up can be correlated with observed damage

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# Particle tracking with VORPAL allows identification of particle trajectories

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