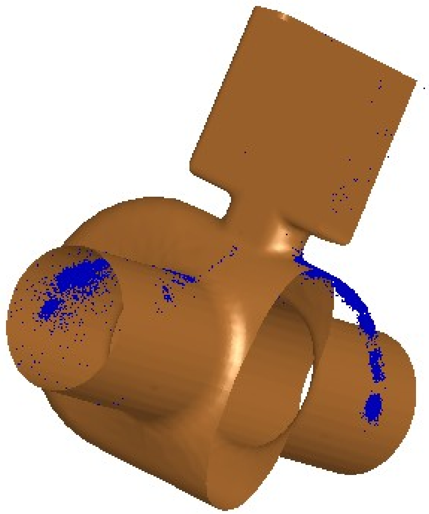
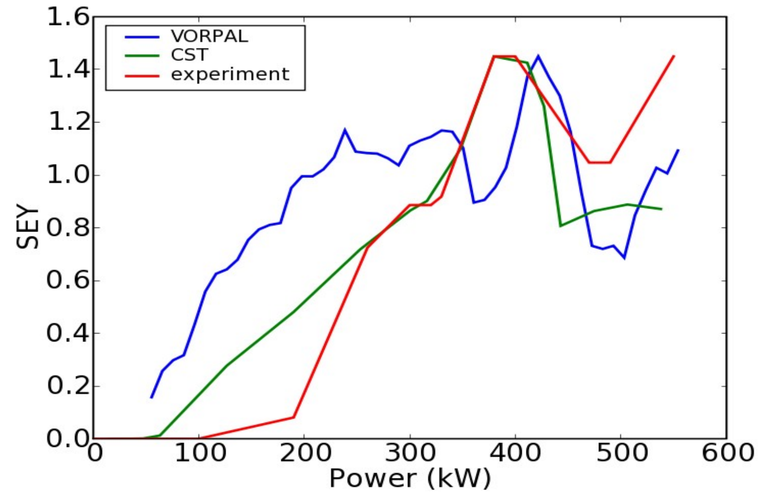
Multipactor Simulations





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Thanks: G. Burt, C. Lingwood, C. Nieter, B. Rimmer, C. Roark, J. Smith, D. Smithe, H. Wang
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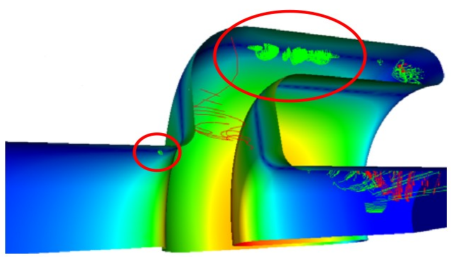
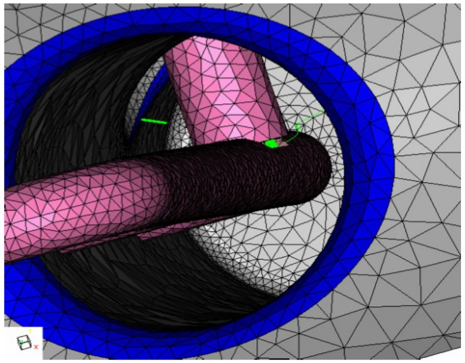
TECH-X CORPORATION

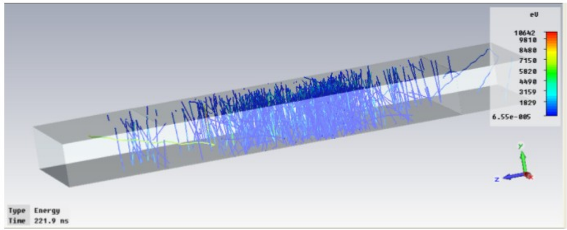
Multipacting simulations can help to design crab cavities



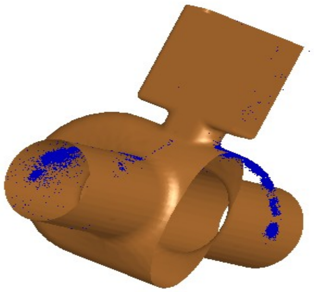
Track3P
(SLAC)



Analyst
(FNAL)



CST-PS
(Lancaster)

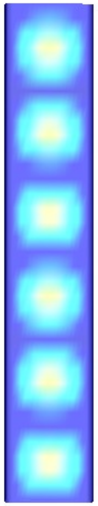


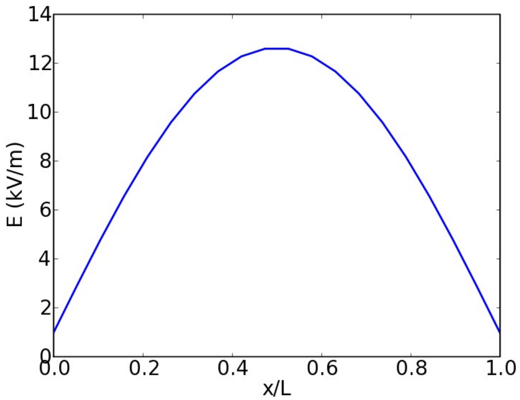
VORPAL
(Tech-X, Jlab, BNL)

Researchers need confidence multipacting simulations give correct results

500 MHz CESR Waveguide provides an opportunity for comparing simulations with theory, experiment, and other simulation

Ponderomotive theory* gives an opportunity for verification

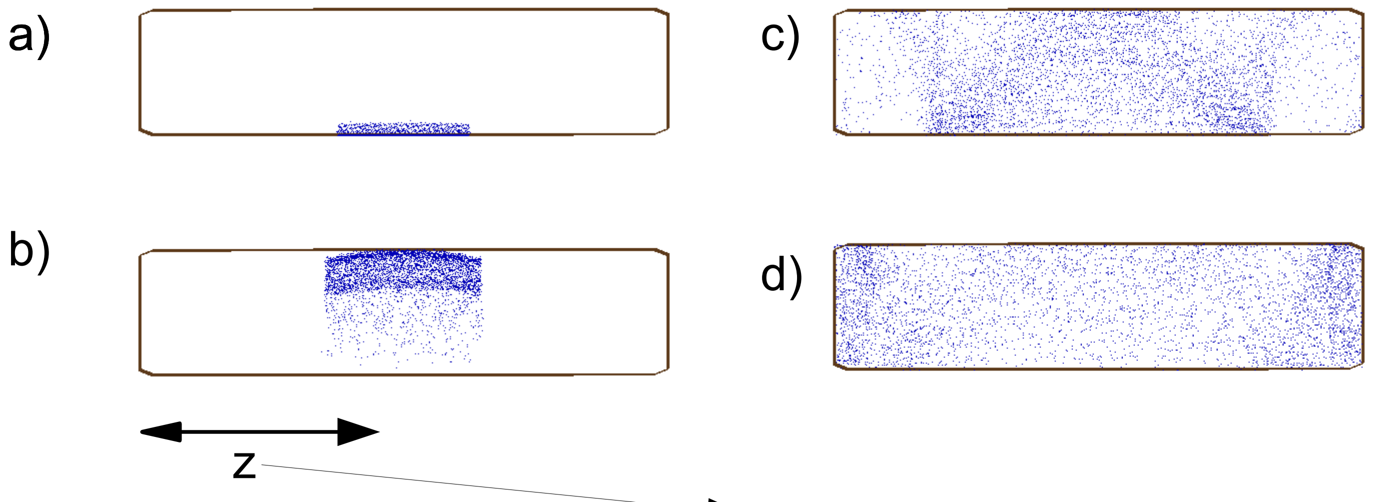




$$F_p = -\frac{e^2}{4m\omega^2}\nabla E^2$$

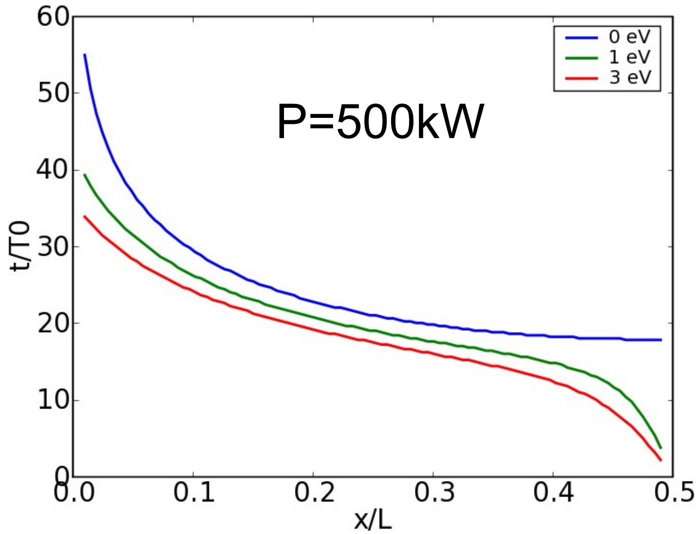
*V. E. Semenov, E. I. Rakova, D. Anderson, M. Lisak, and J. Puech, "Multipactor in rectangular waveguides," Phys. Plasmas 14(2007) 033501.

Ponderomotive theory gives an opportunity for verification

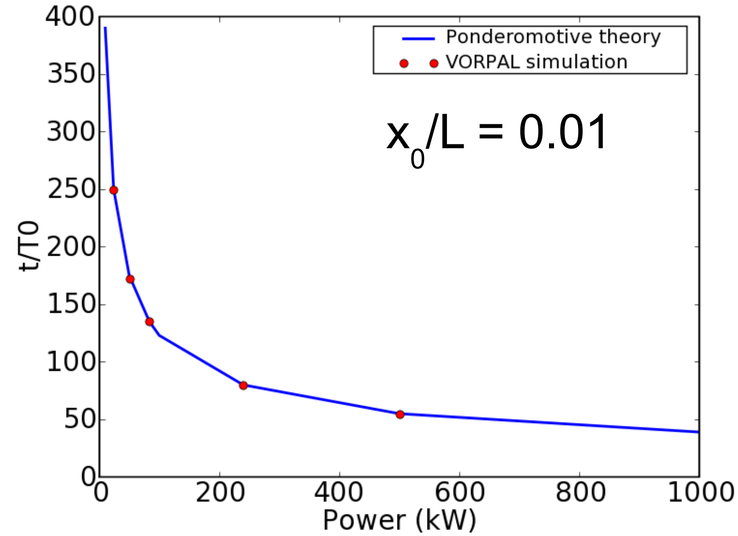


$$t_p = \left(\frac{2z}{F_p/m} \right)^{0.5}$$

Simulations and ponderomotive theory agree for range of powers of interest

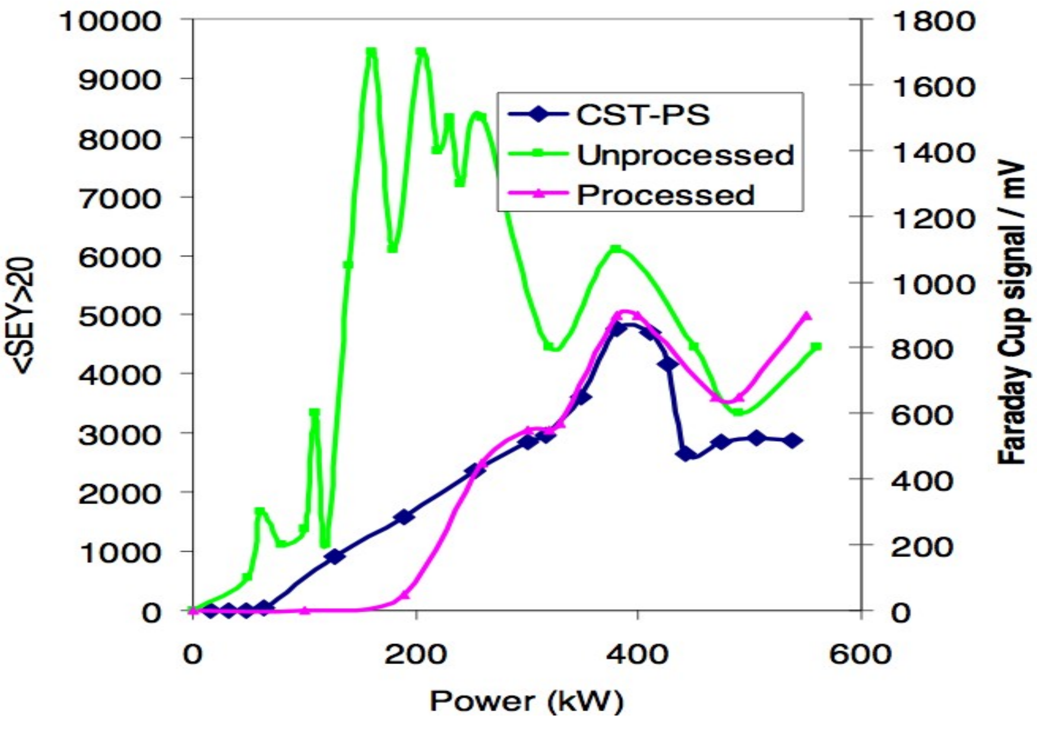


Time (from ponderomotive theory) to drift to edge as a function of distance from waveguide center

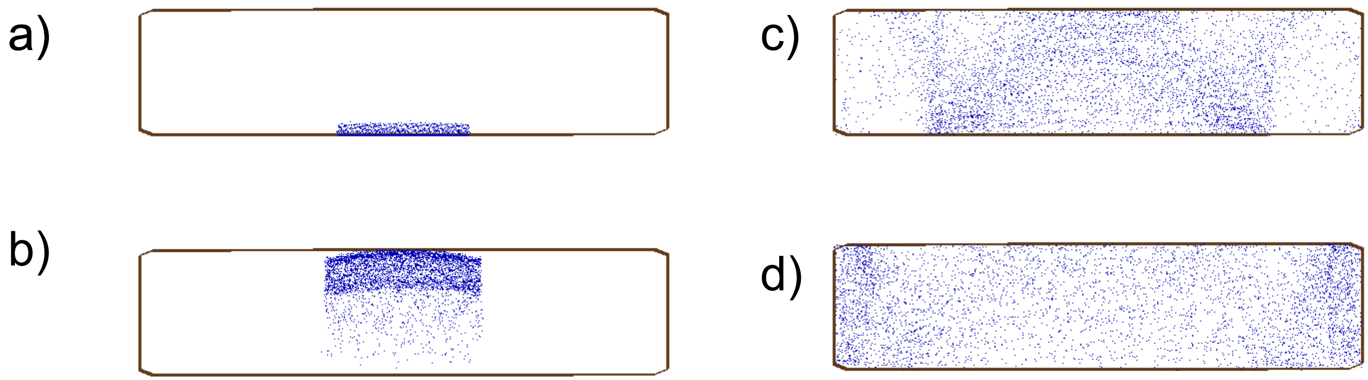


Time to drift to edge as a function of power (theory and simulation)

CESR 500 MHz rectangular waveguide provides opportunity for validation as well



We use 20-impact rule to count multipacting

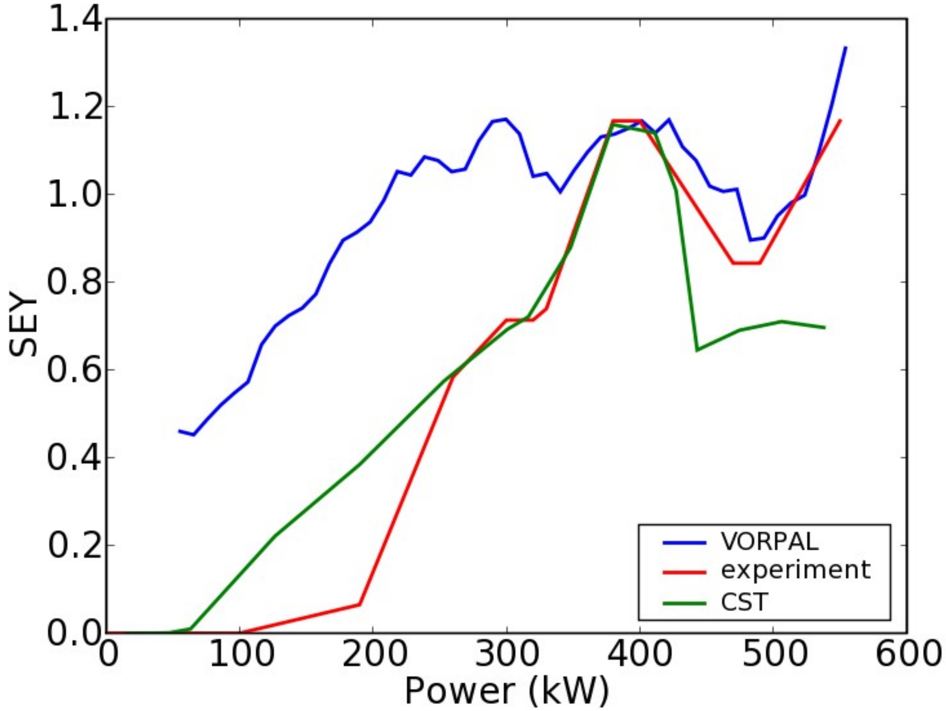


$$SEY = \frac{log\left(\frac{N_f}{N_i}\right)}{20}$$

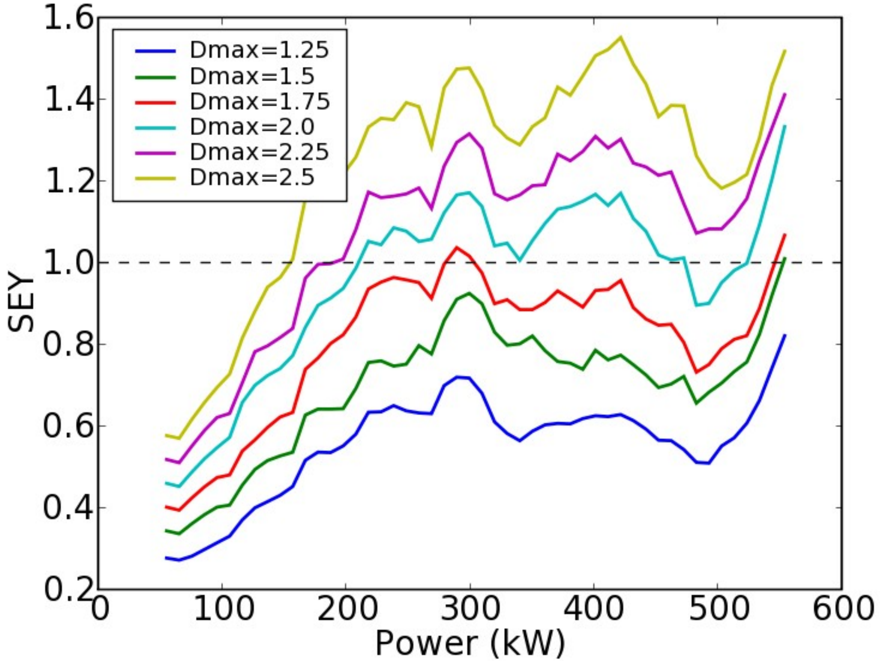
Simplifying assumptions allow the simulations to complete more quickly

- 2D
- Fixed energy of secondary emission
- No space charge

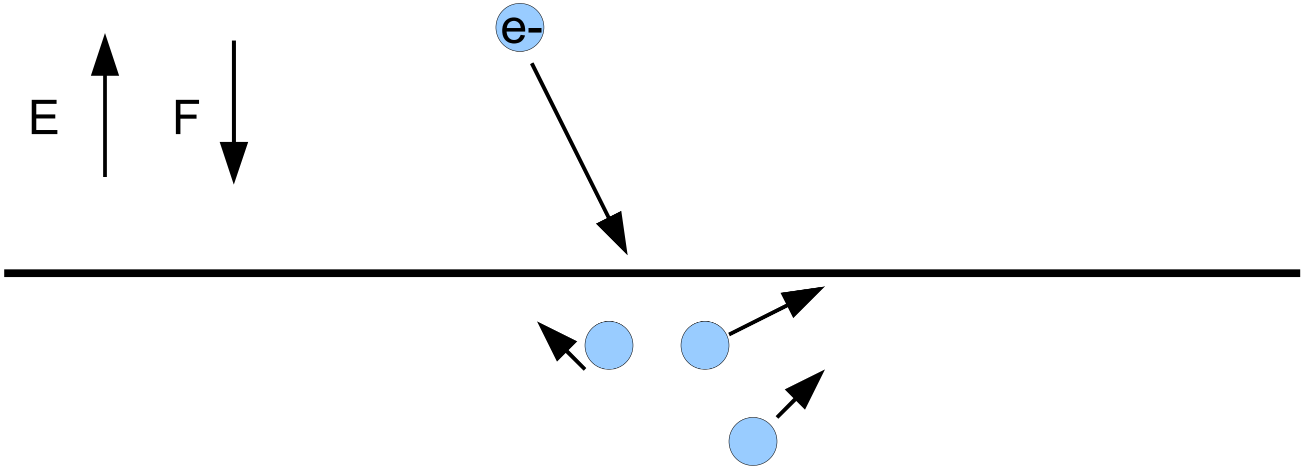
VORPAL simulations agree qualitatively with experiment and with CST simulations



Varying SEY maximum can give an indication of strength of multipacting



We investigate the effects of suppressing the electron yield due to electric field



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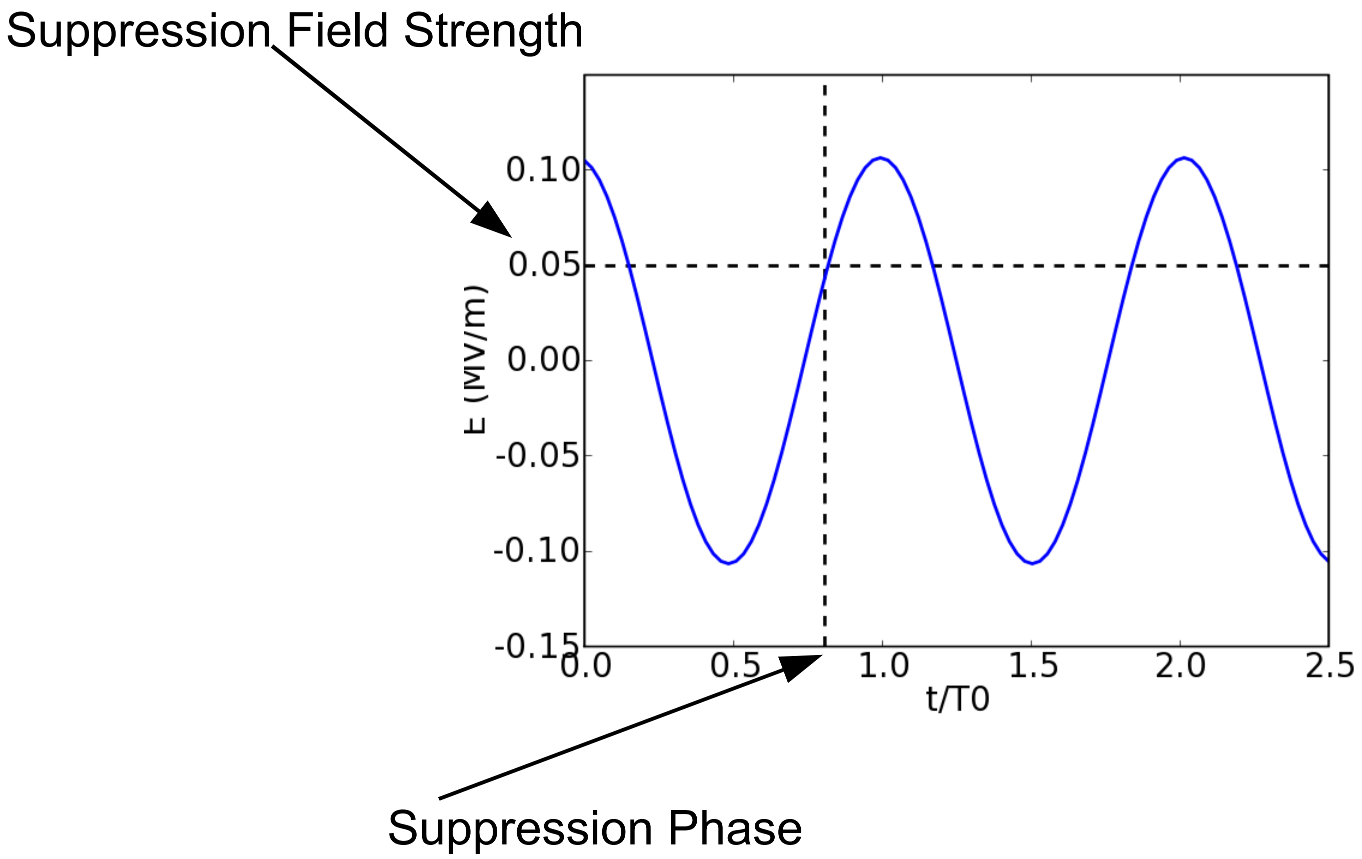
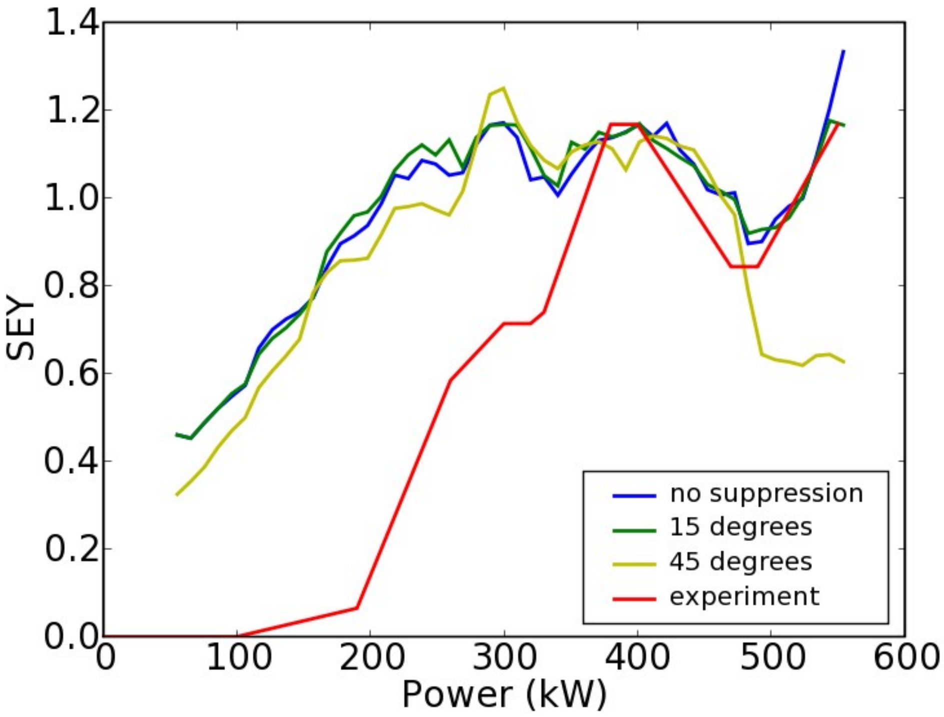
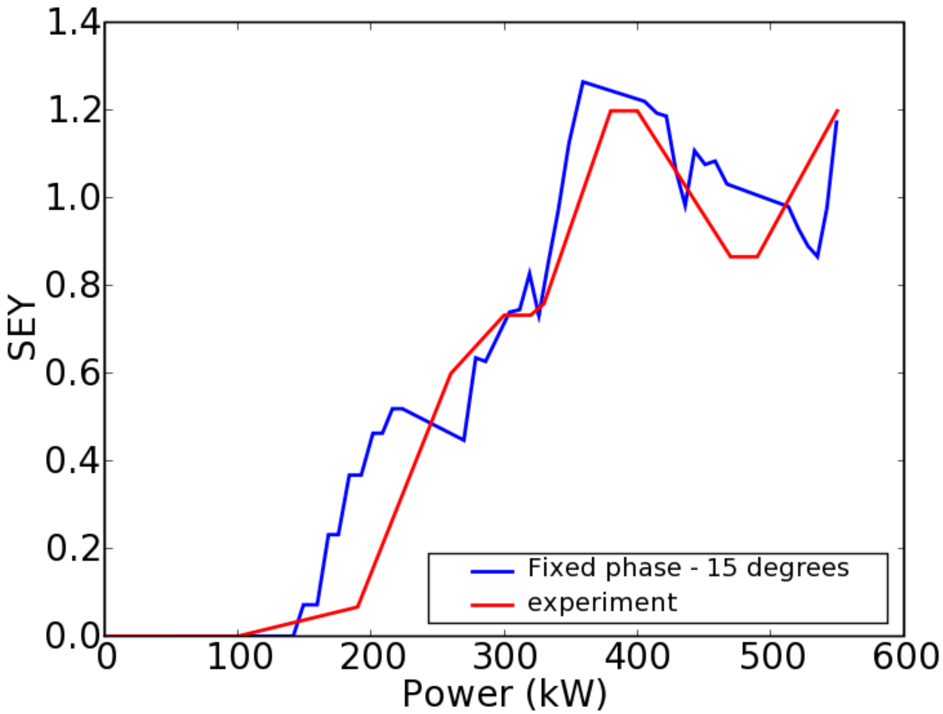


Enough suppression affects high power result



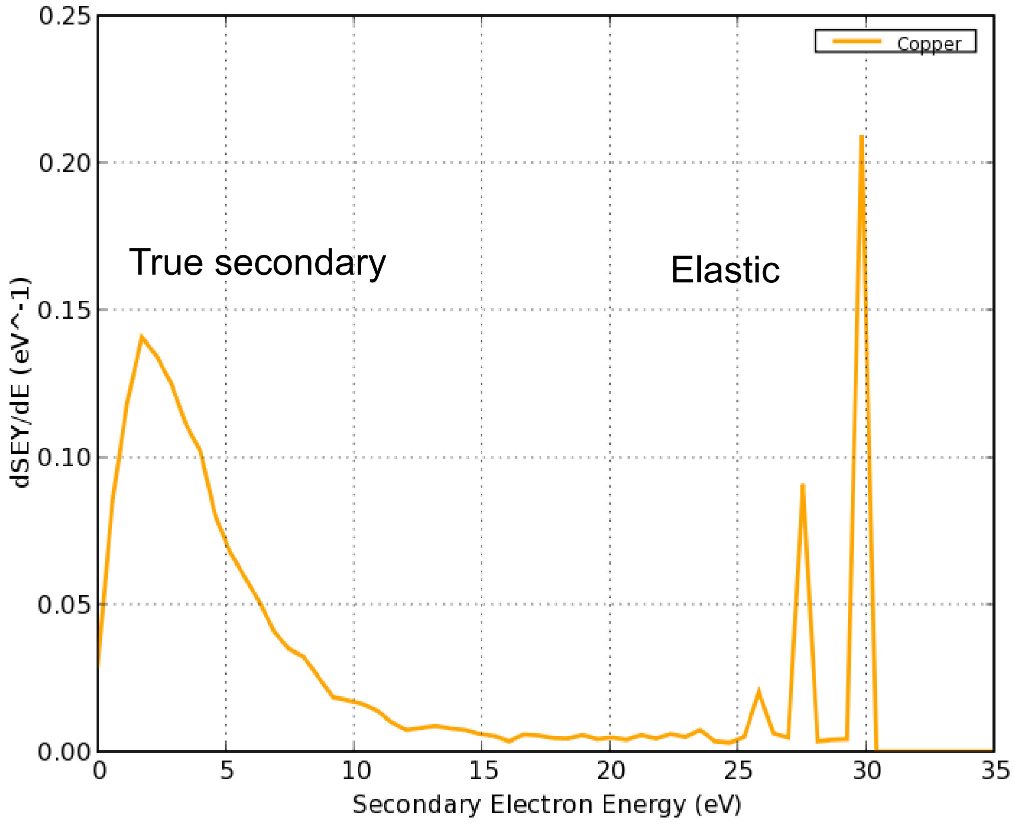
Suppression phase is normalized a field at 500 kW

Suppressing emission for a fixed phase gives surprising agreement with experiment

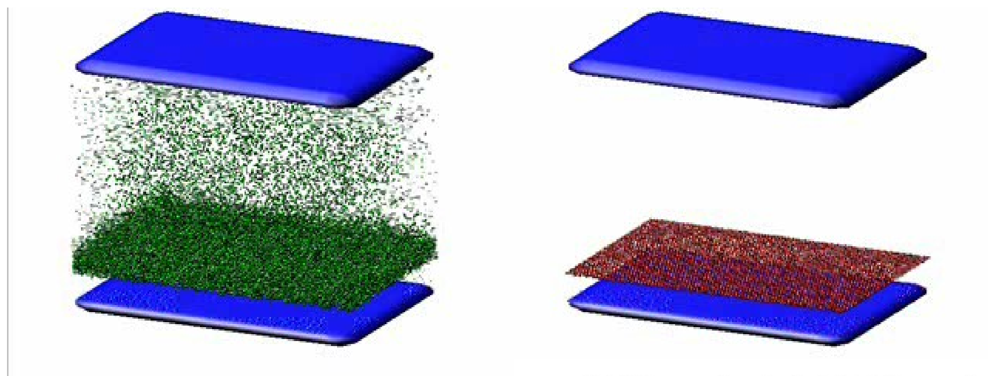


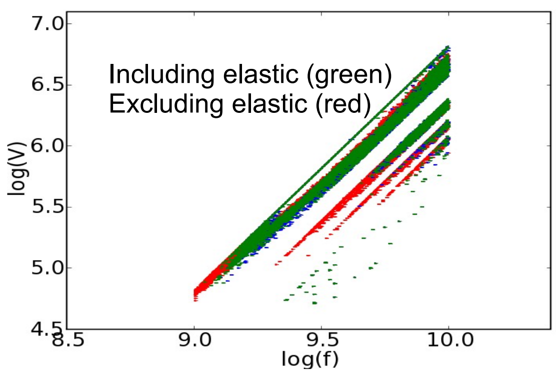
Suppressing the same phase for all powers means changing the field strength for which emission is suppressed (not sure of physical justification?)

Including realistic secondary emission model is an important next step

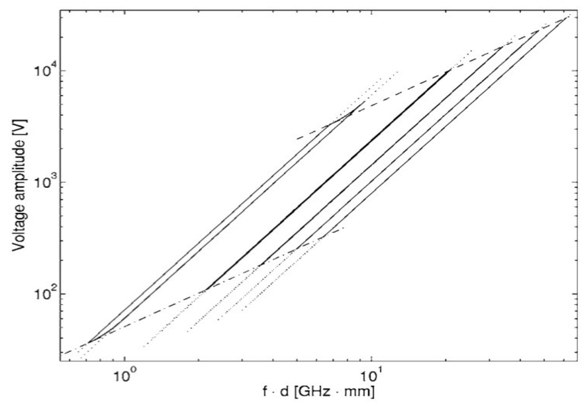


Realistic secondary models result in differences with simplified approaches



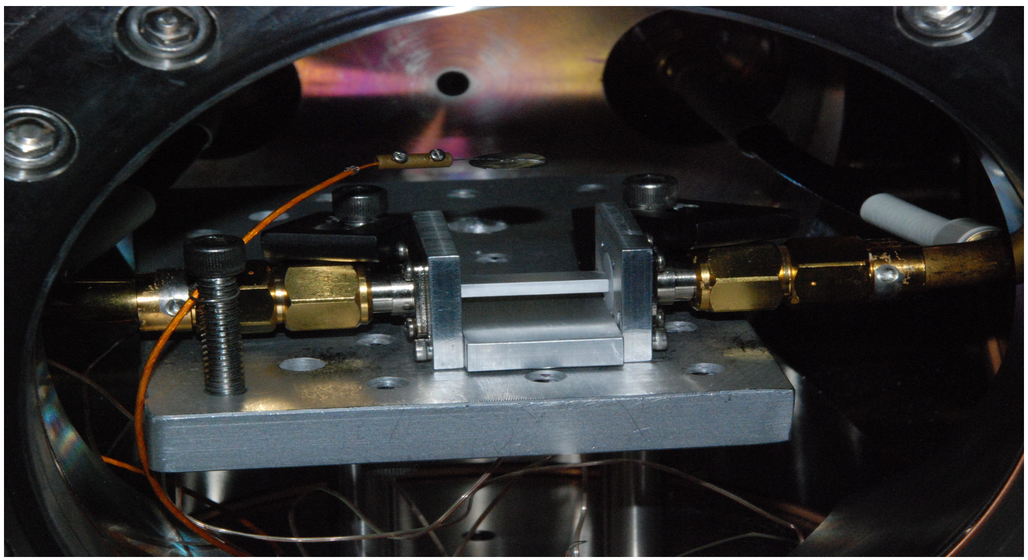


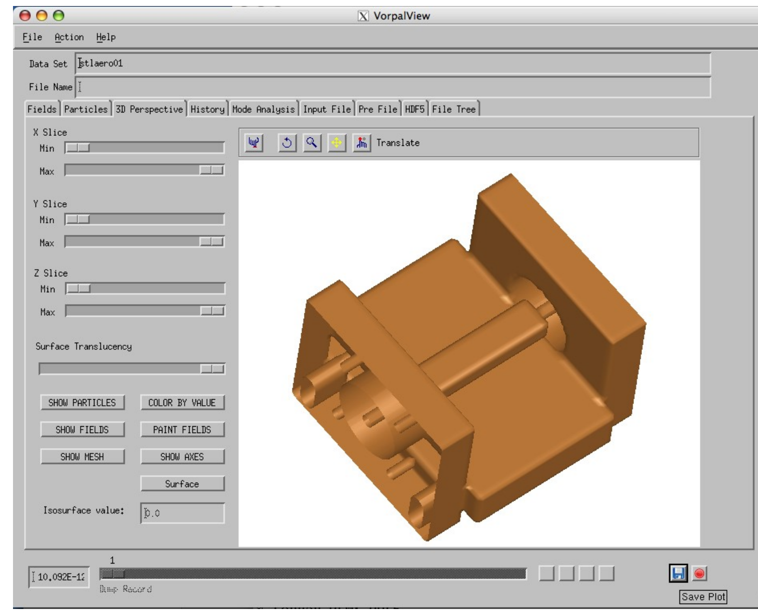
VORPAL



Analytic

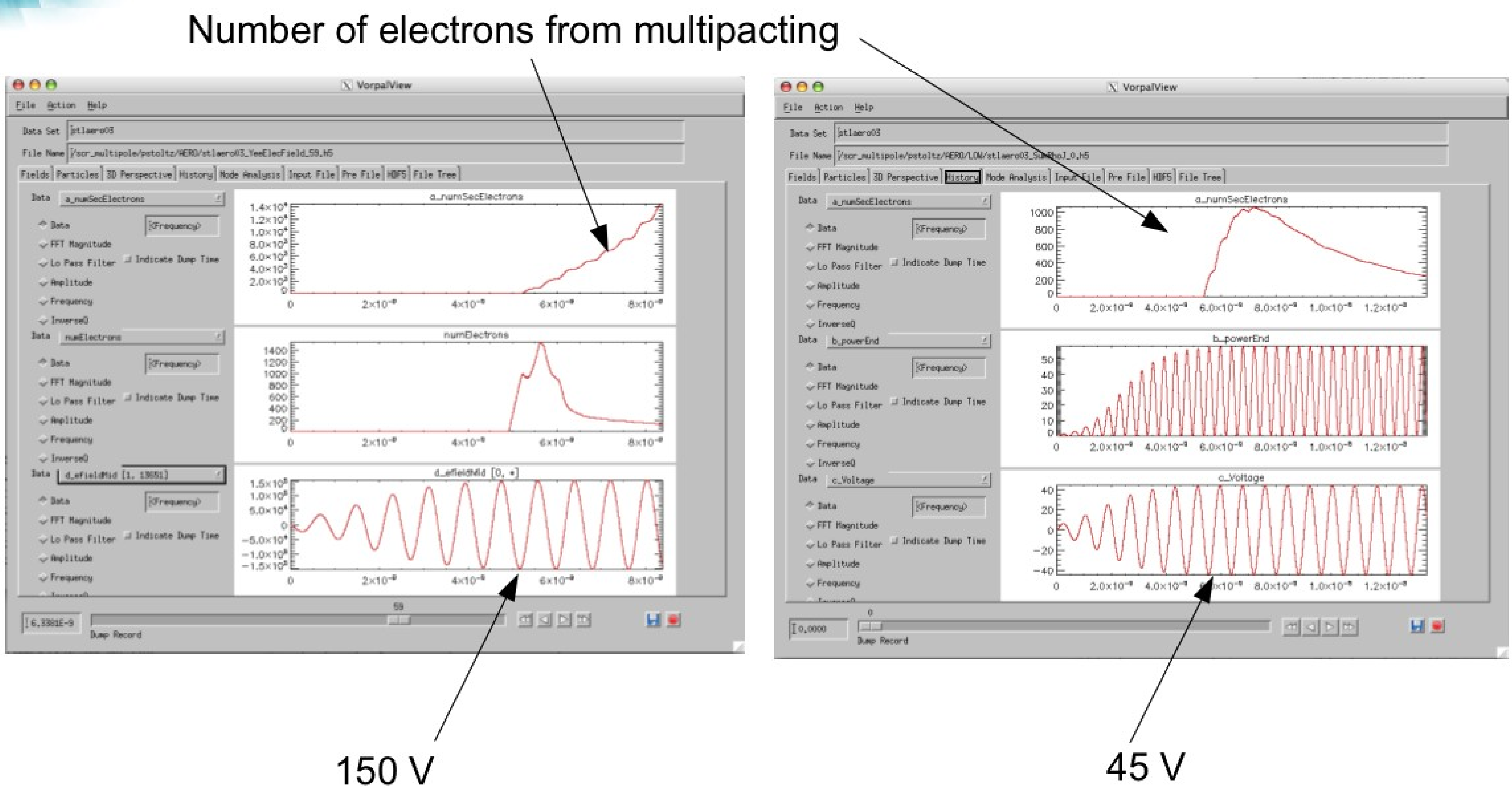
We are also collaborating with Aerospace Corp. to further benchmark



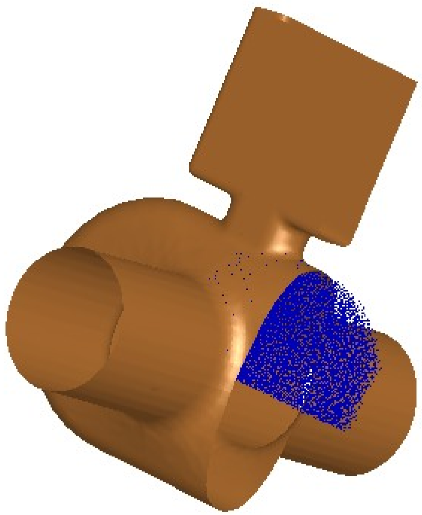


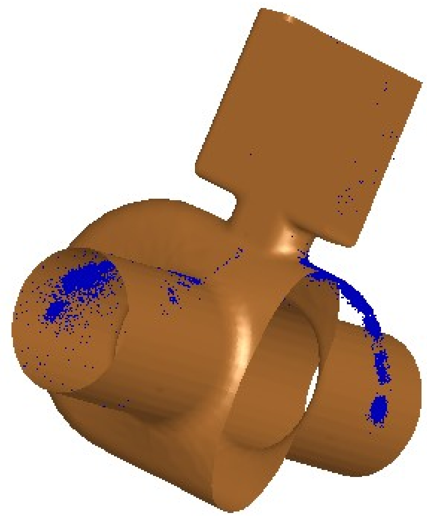
We are comparing VORPAL simulations (right) with multipacting experiments (left) for coaxial stripline systems

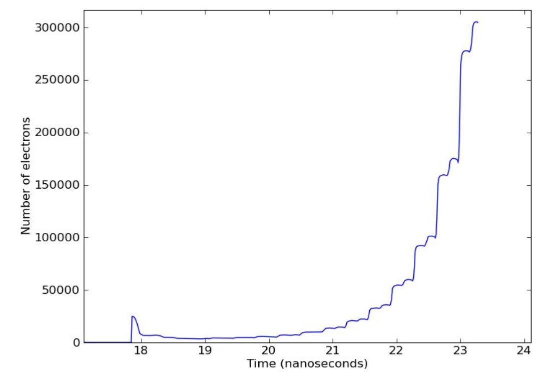
Second benchmark: model one voltage known to multipact experimentally and one known to not



Multipacting simulations hope to help design crab cavities







t = 0

$T = 25\,T_0$

Multipacting simulations have been done for a elliptical crab cavity design from JLab

- TM110 for ~25 mode periods
- Future parameter scans over operating regime will help find potential multipacting problems

Preliminary simulations show possible multipacting in UK crab design

- E_{peak} ~10 MV/m