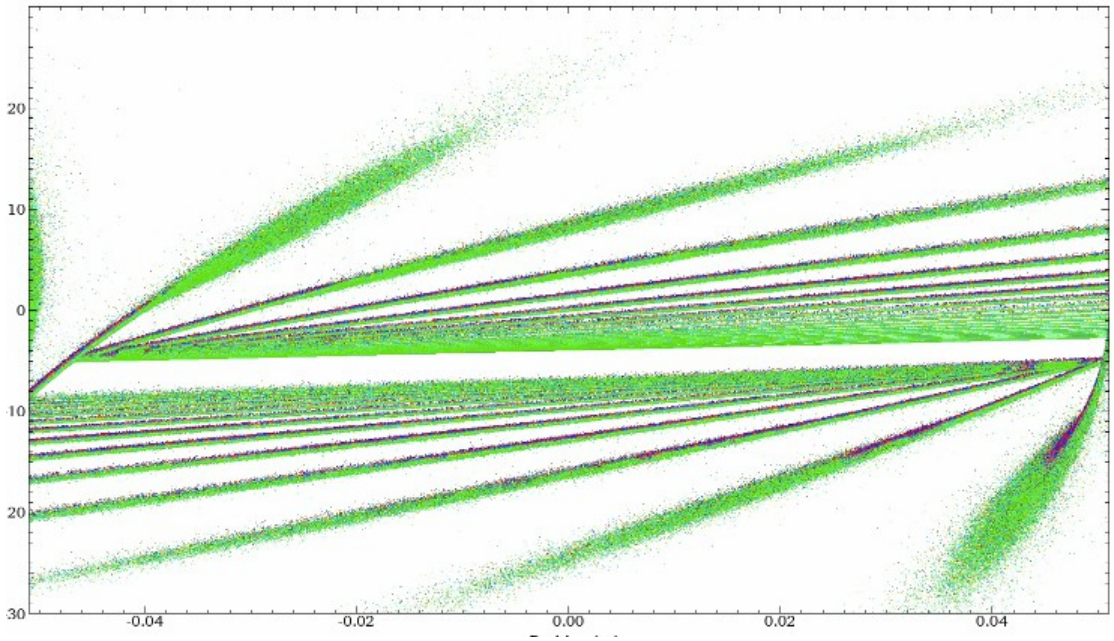
Multipactor saturation in rectangular waveguides



Peter Stoltz

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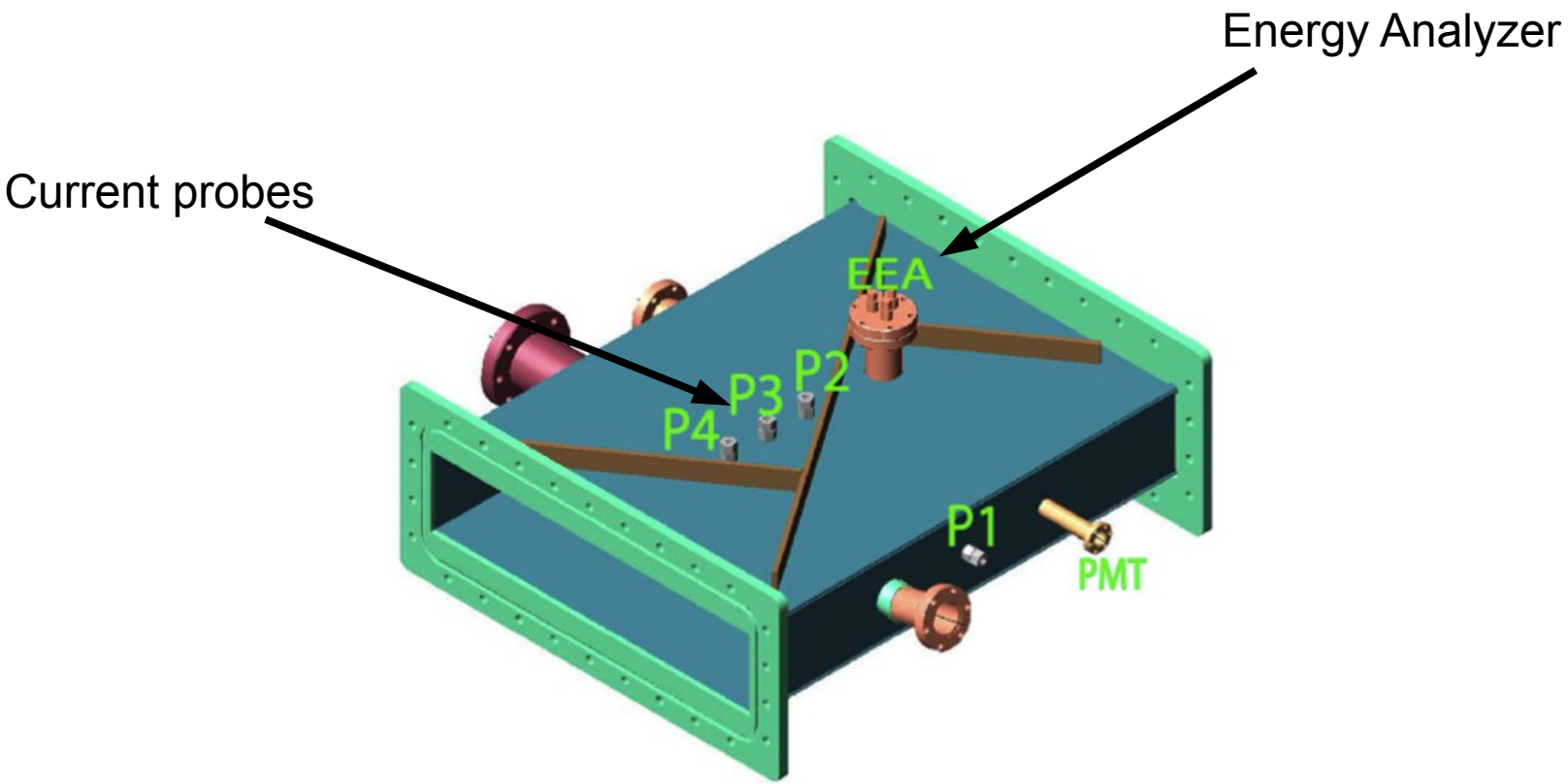
MeVArc Oct 3 2012

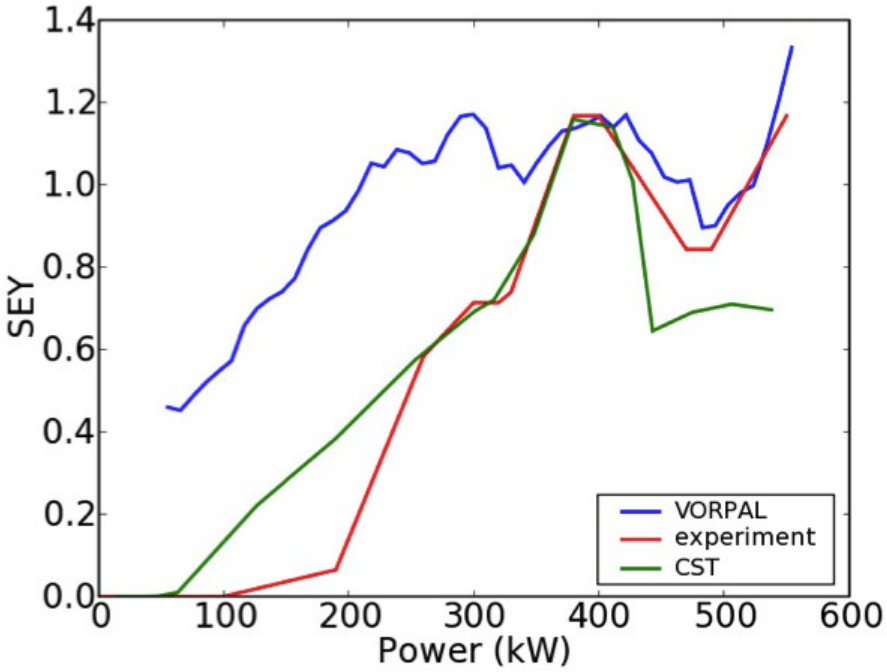
Tech-X is a computational science company headquartered in Boulder, CO

- Founded in 1994
- 65+ employees today
- Offices in US (Boulder & Buffalo), UK, and Taiwan
- Main focus is computational electromagnetic, beam and plasma science
- Especially focused on high performance computing

A collaboration between Cornell University and UK organizations diagnosed multipactor in rectangular waveguides in early 2000s

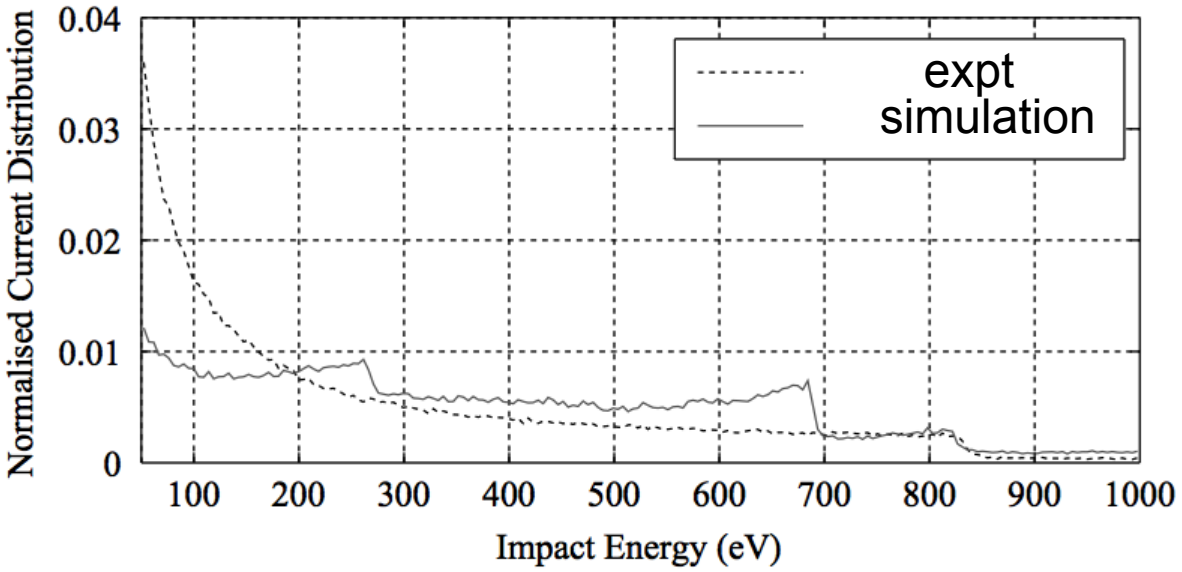


We were able to compare our multipacting results successfully with experiment and another code



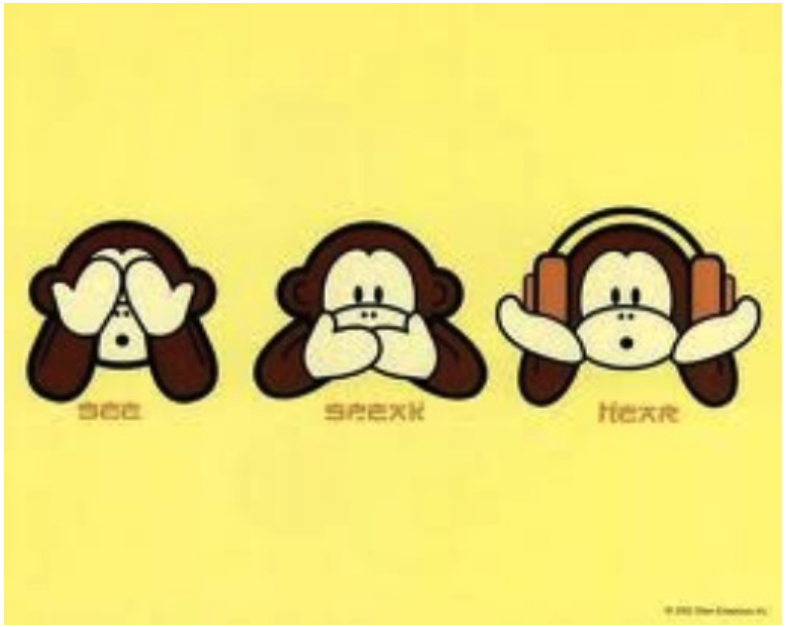
Everything is great, right? Problem solved! But...

The energy distributions of the impacting electrons did not match!



Sigh...

I suggested one method for dealing with this disagreement



Peter's suggested approach

My much smarter UK collaborators had a better idea for explaining the disagreement

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Phase space analysis of multipactor saturation in rectangular waveguide

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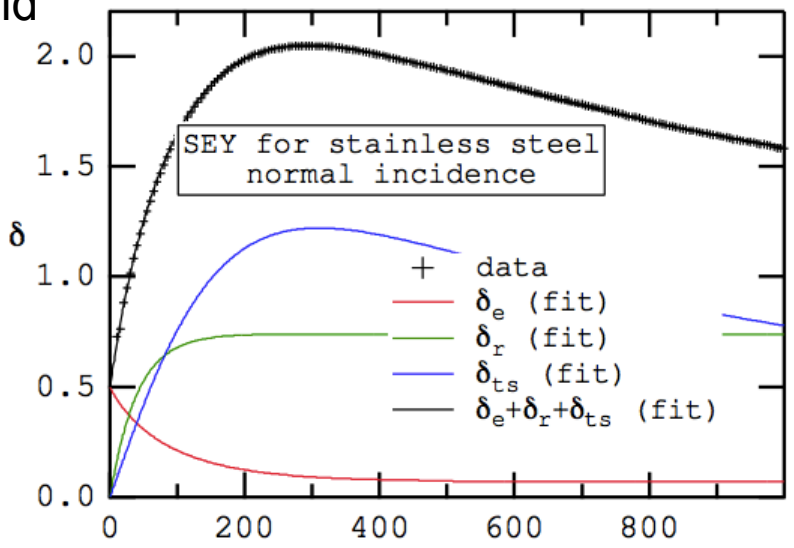
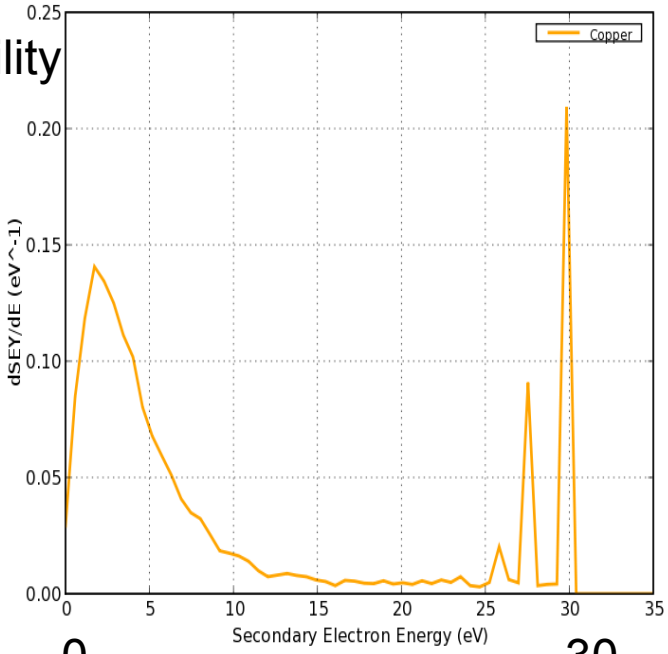
For these saturation simulations, we used Furman and Pivi f ts to the secondary yields

Yield



Incoming Energy (eV)

Probability

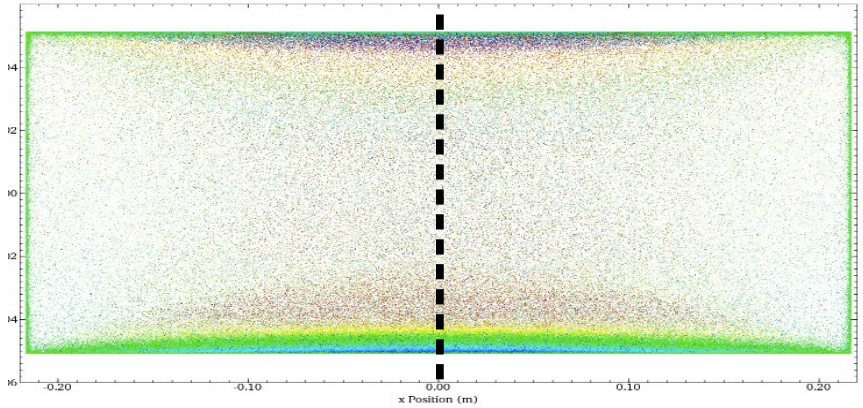


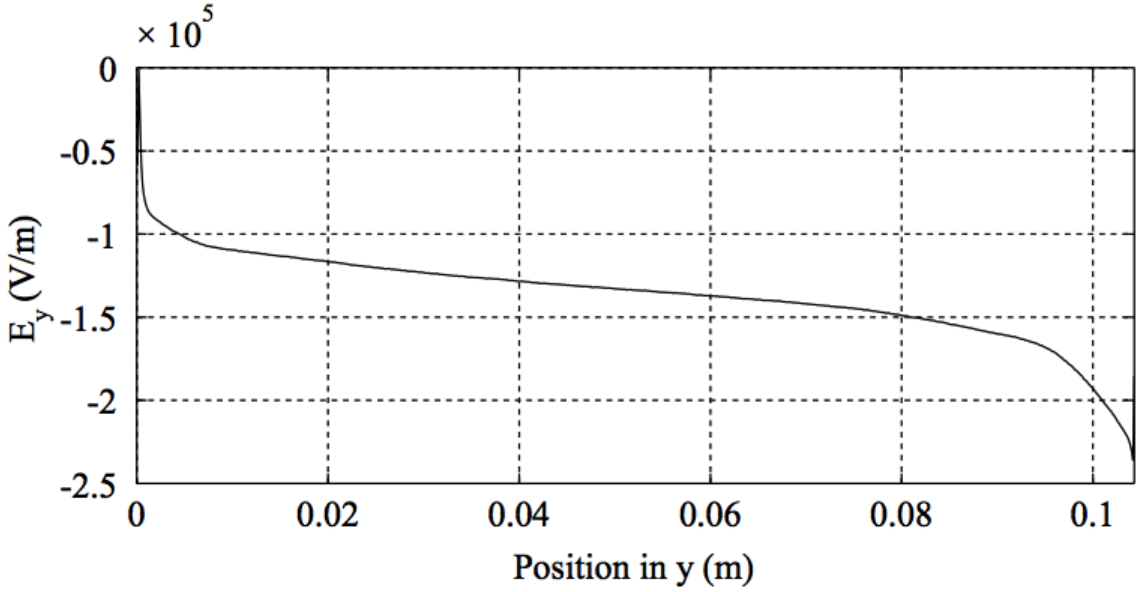
0 30

Outgoing Energy (eV)

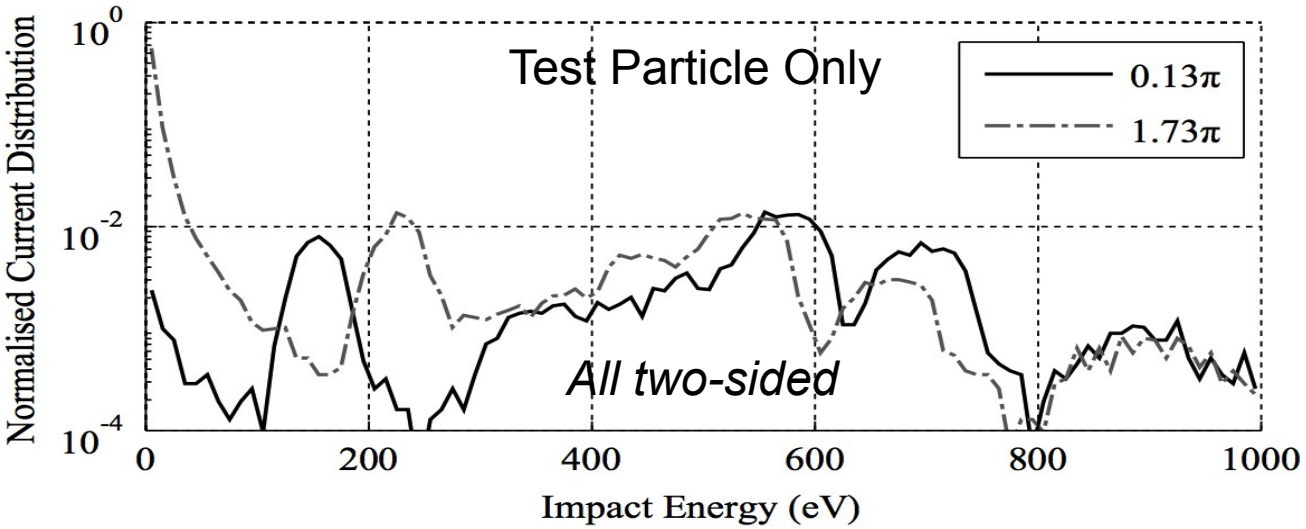
This model separates out the emitted electrons into low (blue), medium (green), and high (red) energy

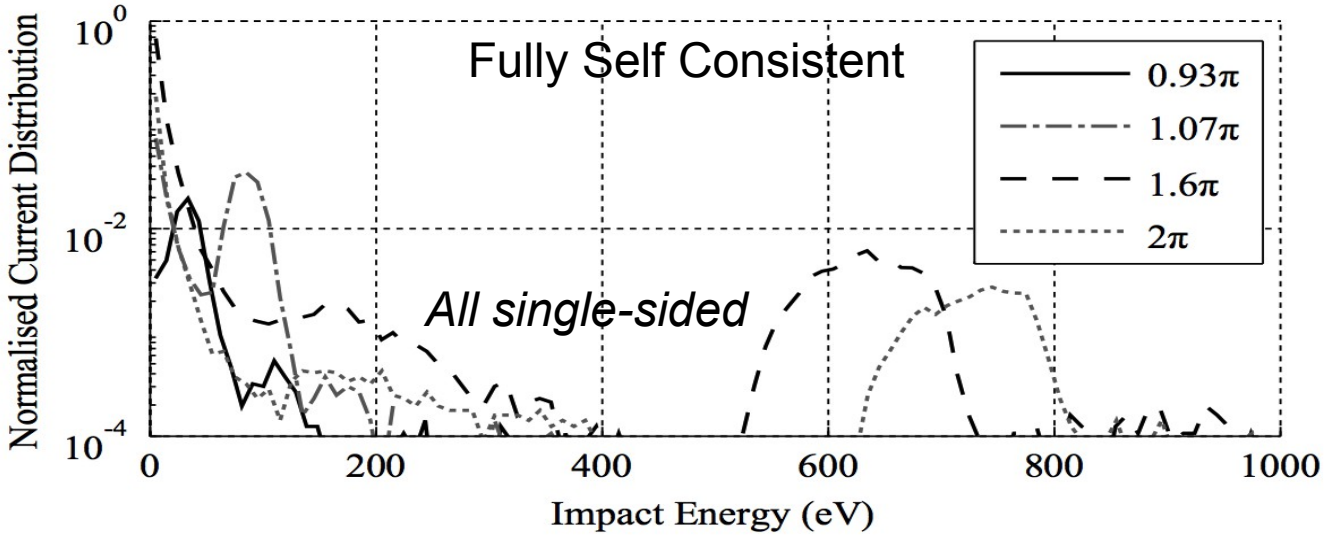
In the saturated state the electric field now depends on y-position



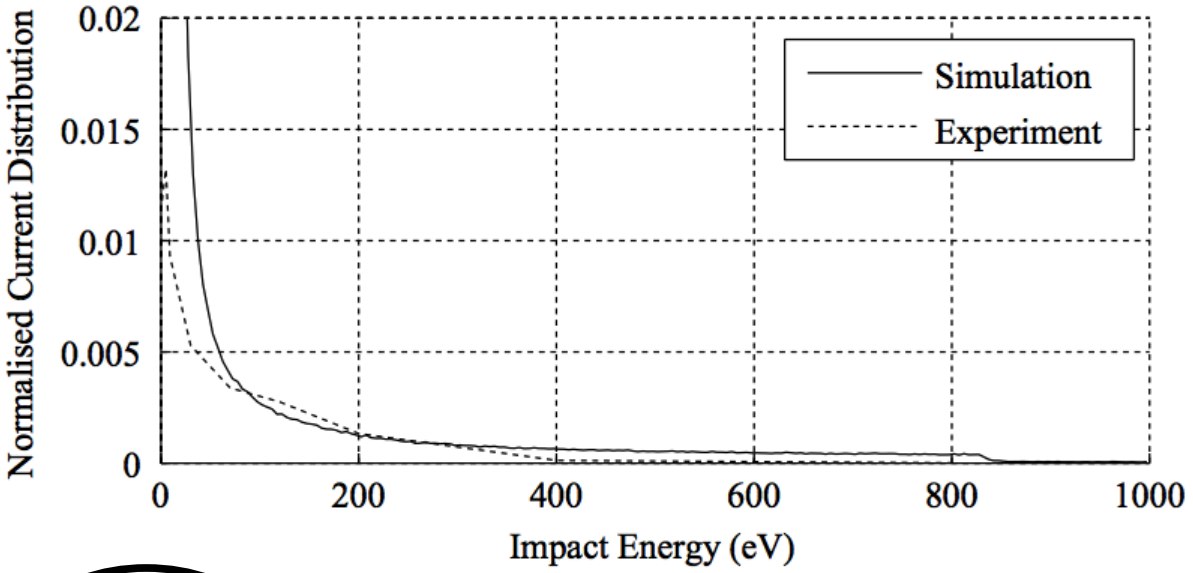


Self consistent, saturated multipacting has a different energy spectrum

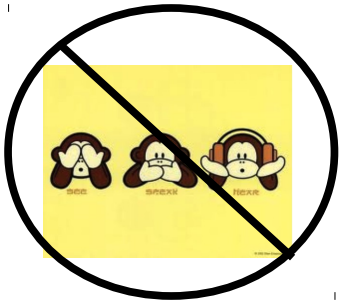




Including saturation effects gives much better agreement between simulation and experiment

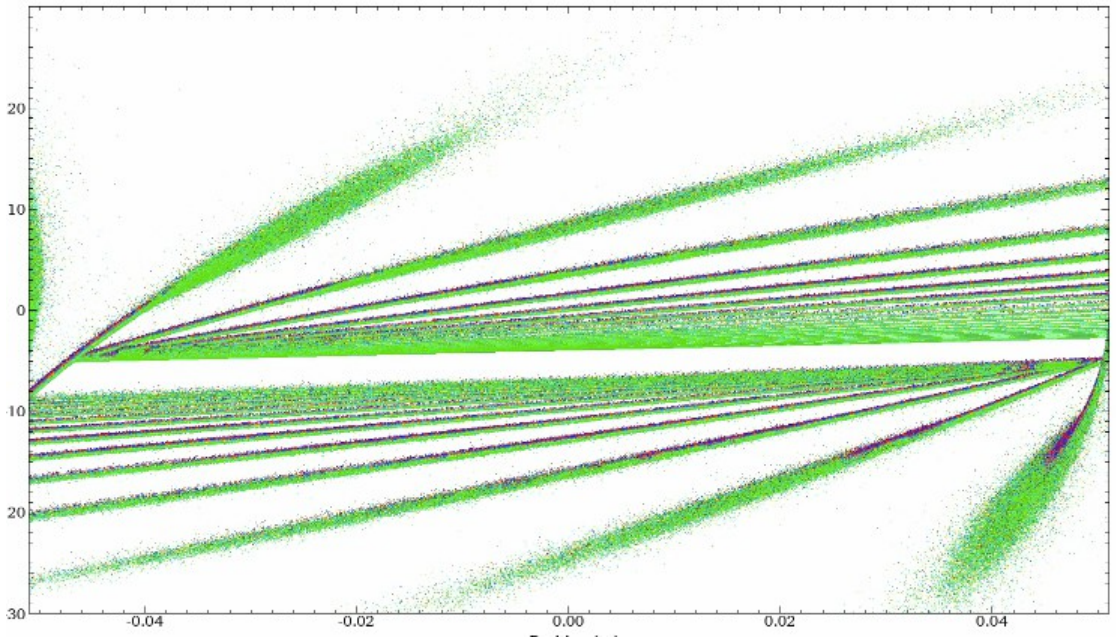


Peter:



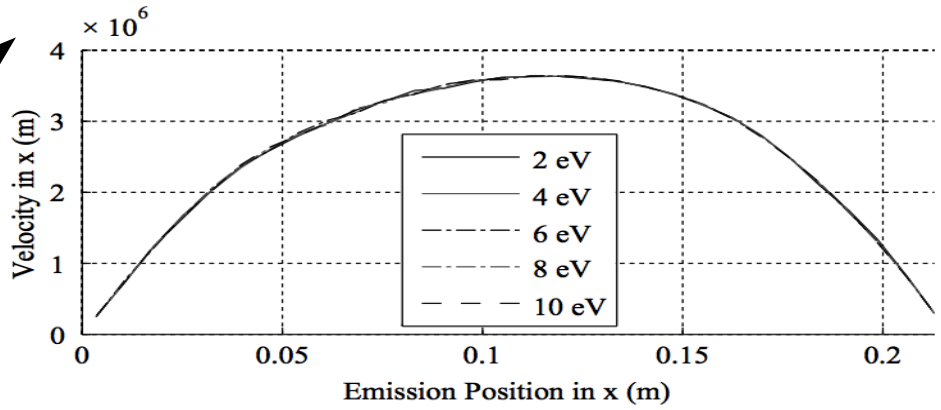
"I totally knew that was it..."

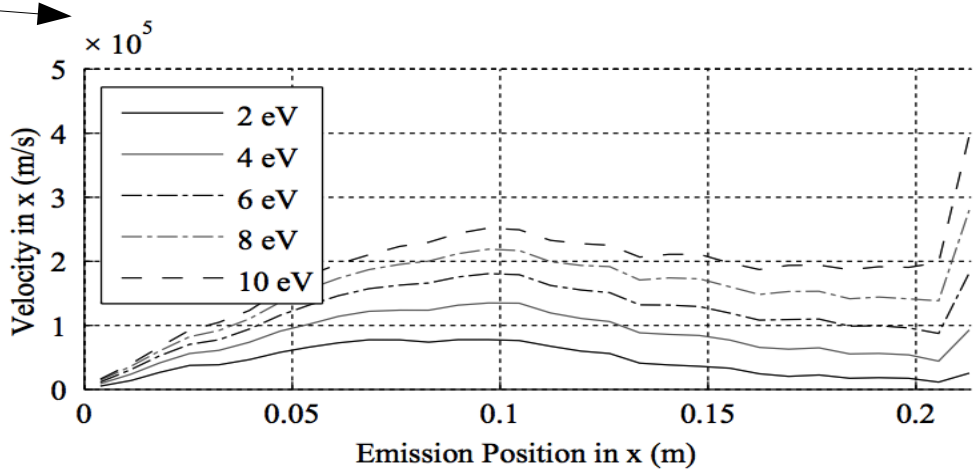
Thanks....

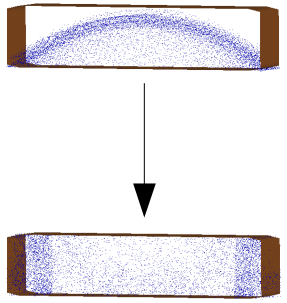


Ponderomotive push is reduced in saturated state

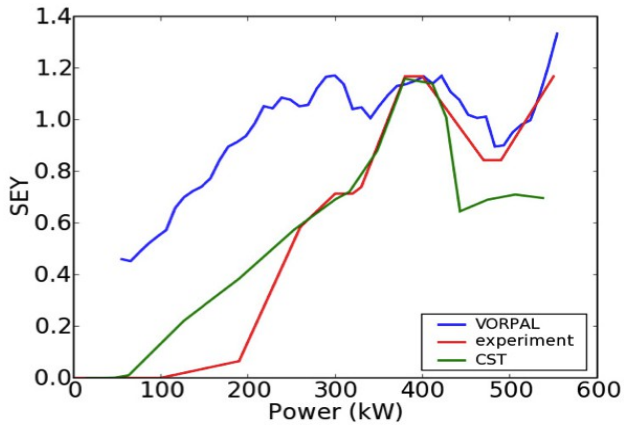
Order of magnitude different

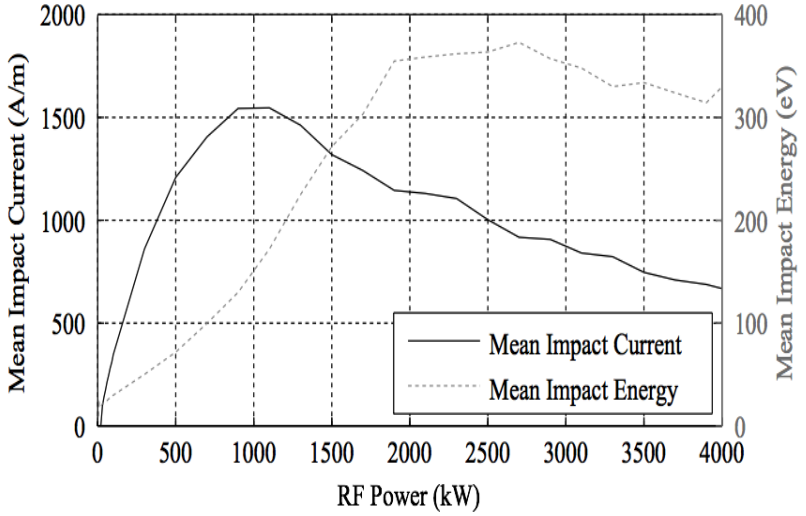






One more thing now that we don't understand...

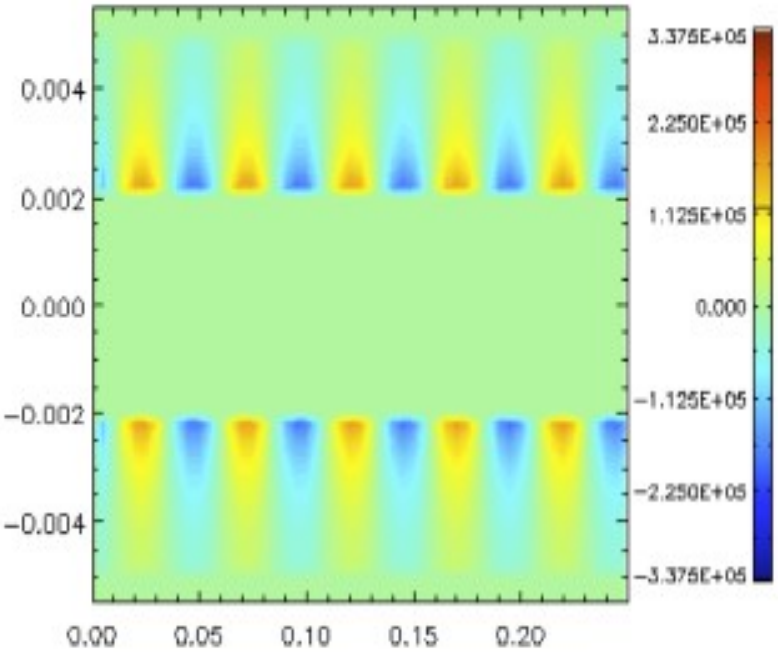




Why doesn't the current v. power agree better?

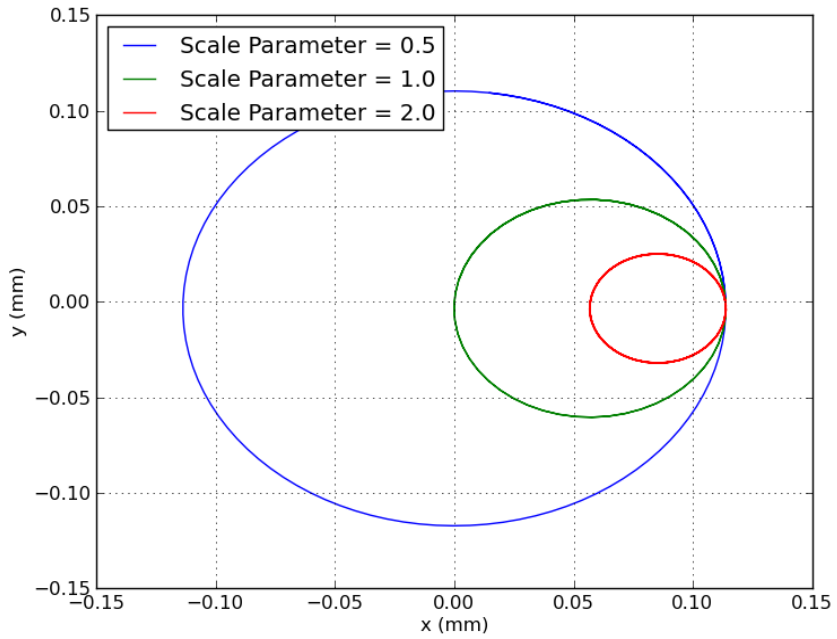
Scanning over power is the one thing everyone wants to do, but it's time consuming with a time domain code

An example geometry and some seed electrons

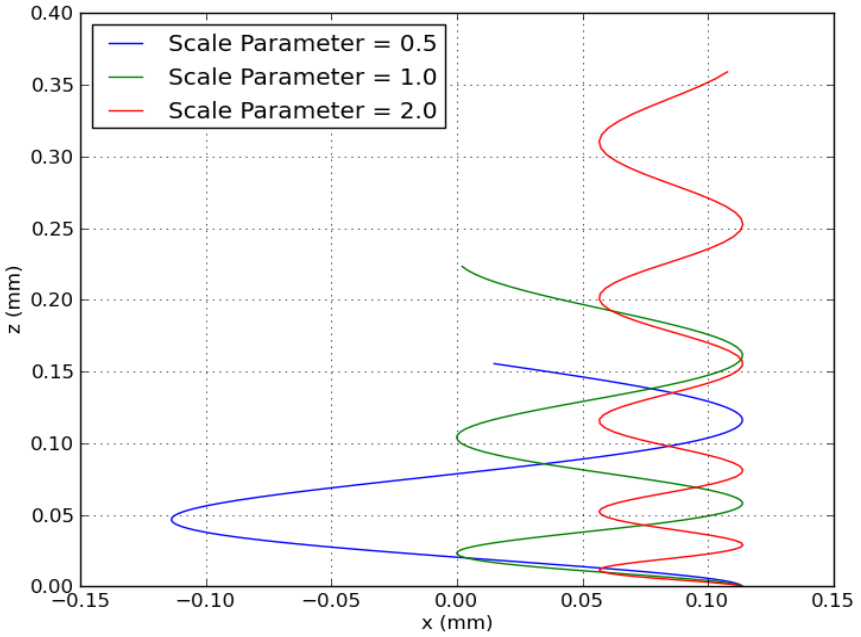


Electric field pattern is the same for all power levels....can't we exploit that?

We implemented particles that experience different field strengths in the same simulation



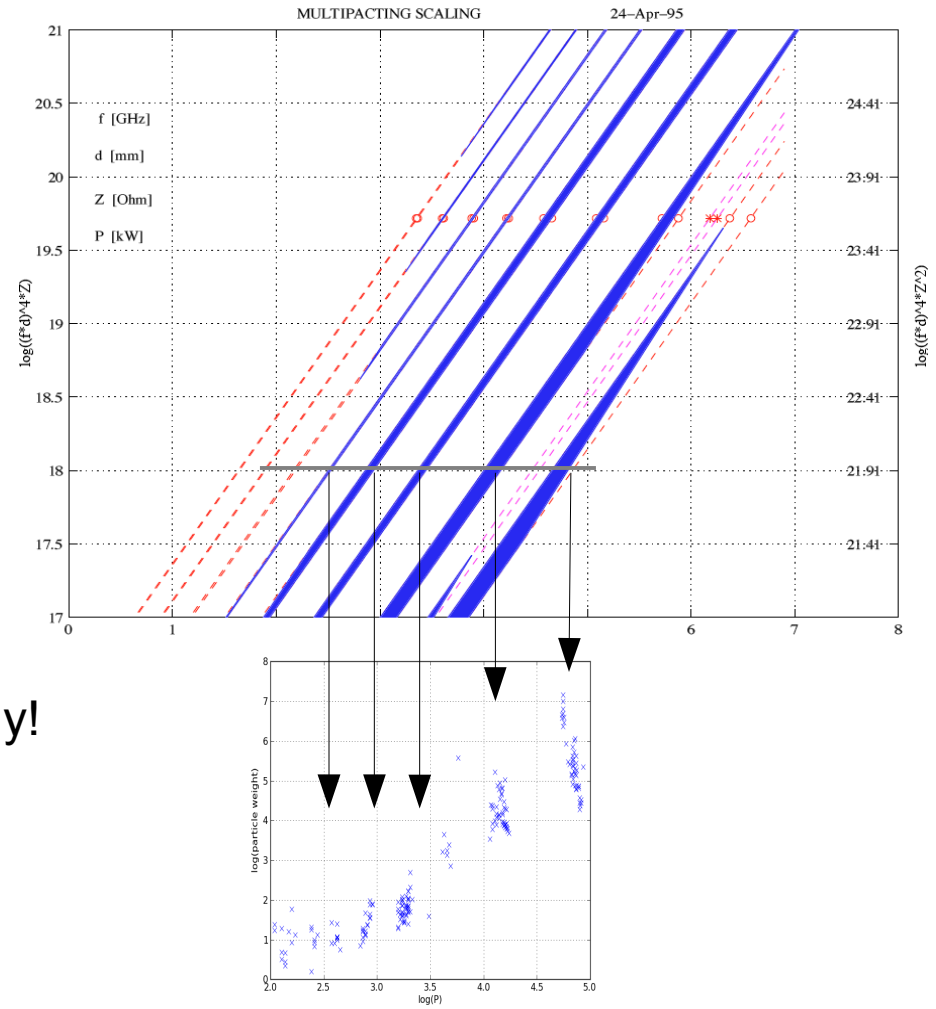
Gyro-radius scales inversely with scaling parameter demonstrating proper scaling for magnetic field



Distance traveled scales with the square of scaling parameter demonstrating proper scaling for electric field

Test particle only!

The "field scaling" multipacting simulation agree with theoretical resonances in a coax



Test particle only!