ArcPic simulations results updates

13/8/2013

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Outline

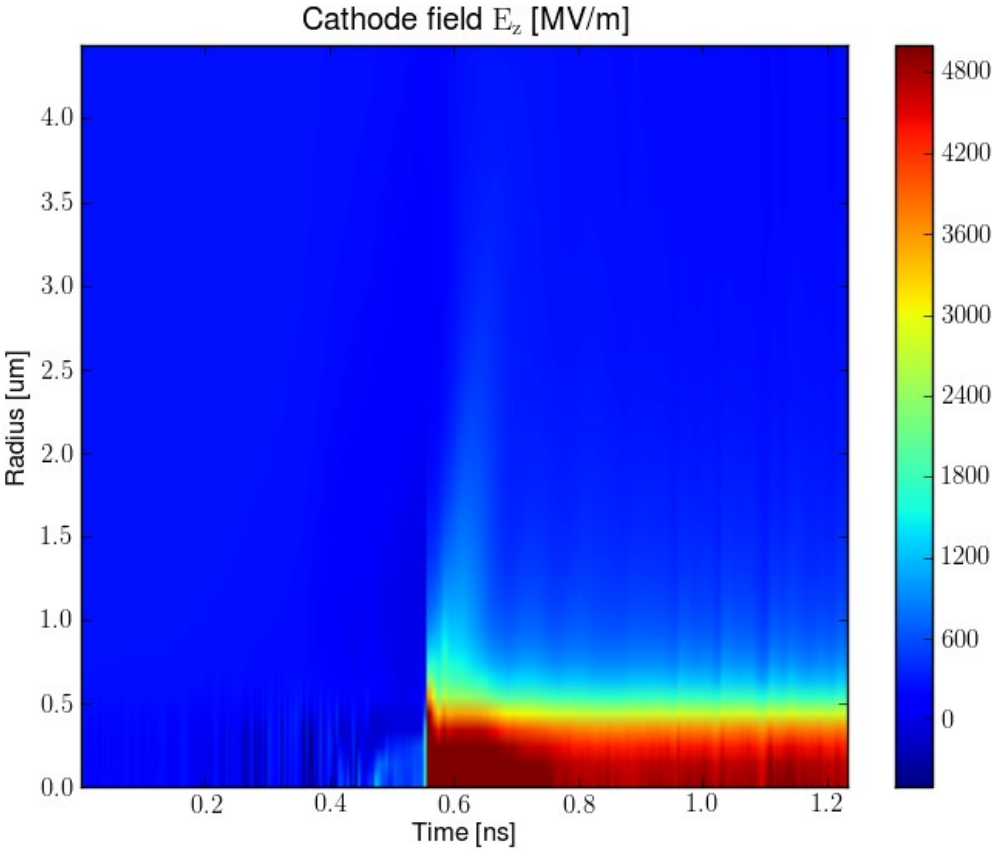
- New analysis
  - Cathode field
  - Electric field
  - Particle impacts
  - Currents
- Plasma oscillations during breakdown
  - Convergence check for superparticle ratio
- Heat spike sputtering

Most data here presented via “standard” run, as usual

However some data has been produced at lower superparticle ratio (~5 vs. ~21 => better statistics)

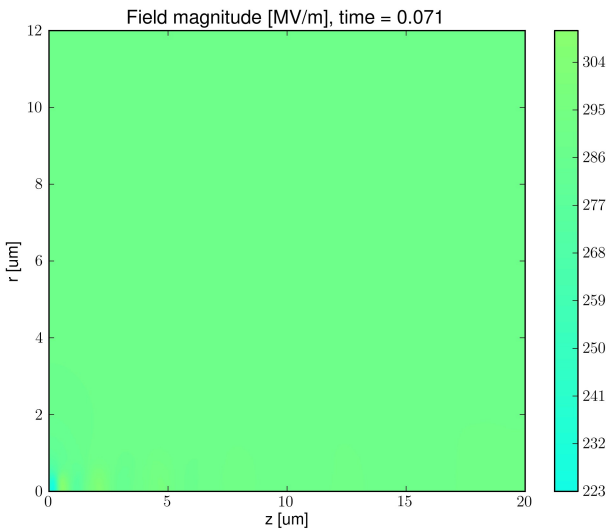
New cathode field analysis

- Plotting the field on the cathode as a function of time
- Clearly see the strong increase in field when ignition happens
- Pre-breakdown field sign flipping due to space charge also visible
- Radius of high field region ~= 0.4 µm = injection radius...
- When breakdown occurs, precursor + “overshoot”
- Some post-breakdown oscillation visible

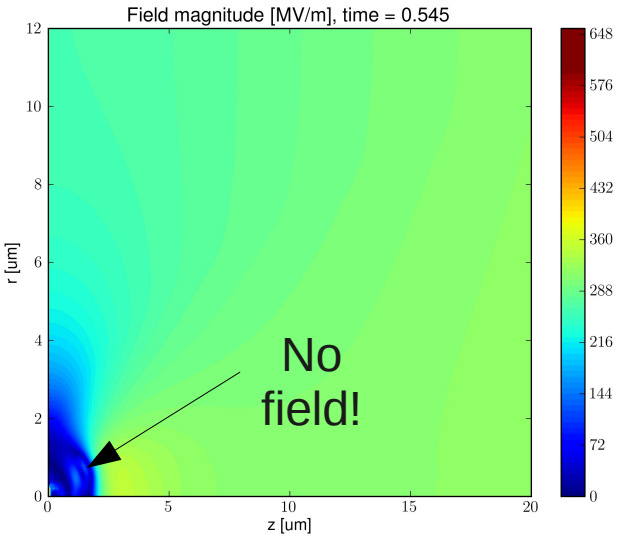


New electric field analysis

- Plotting the field in the volume
- Field patterns surprisingly complicated!

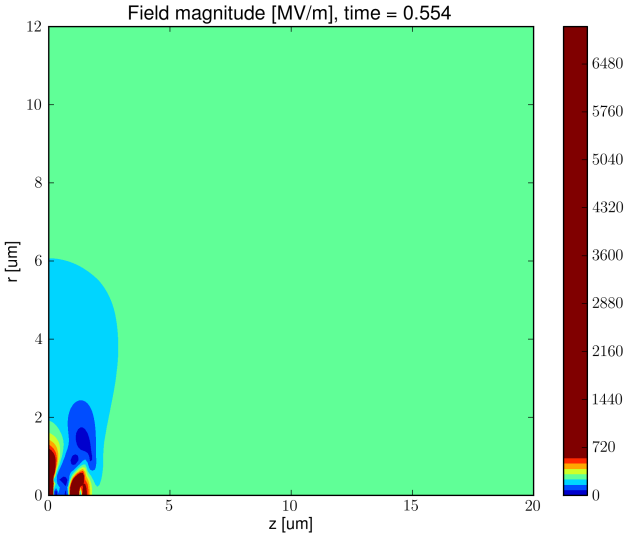


Field emission



Just before breakdown

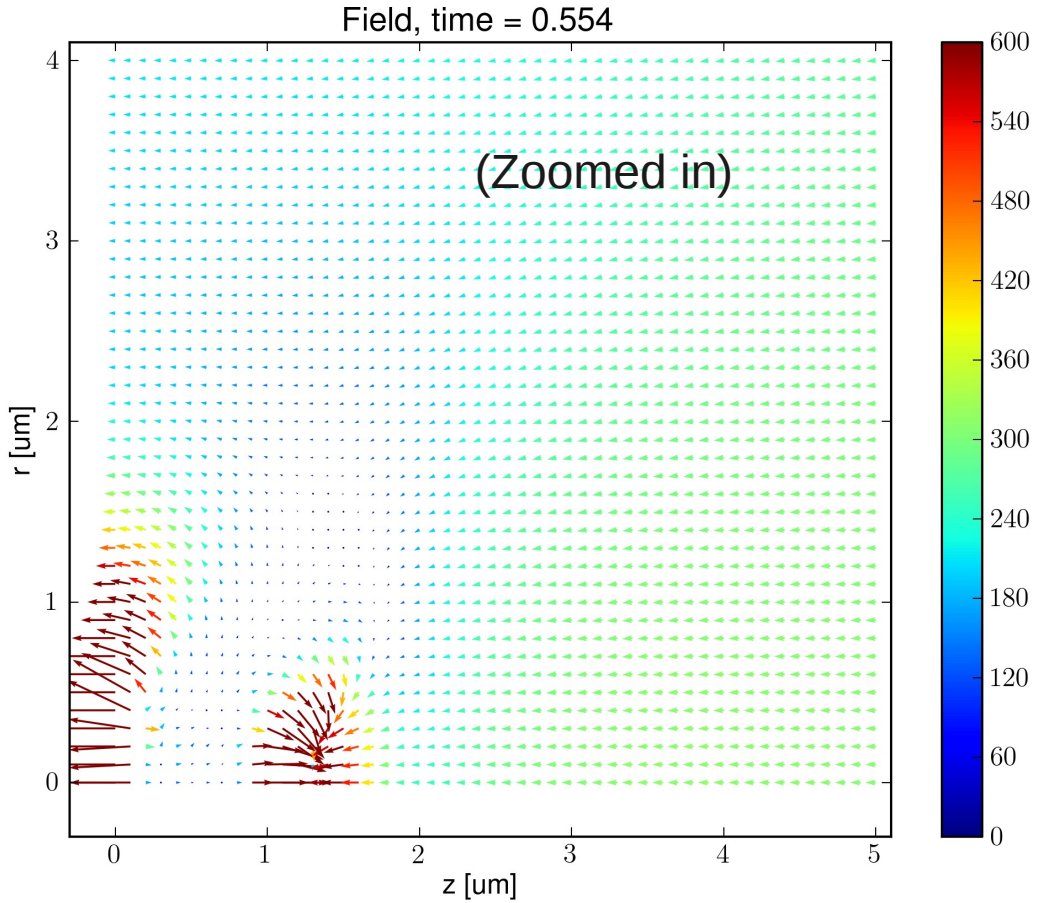
dt = 0.01 ns

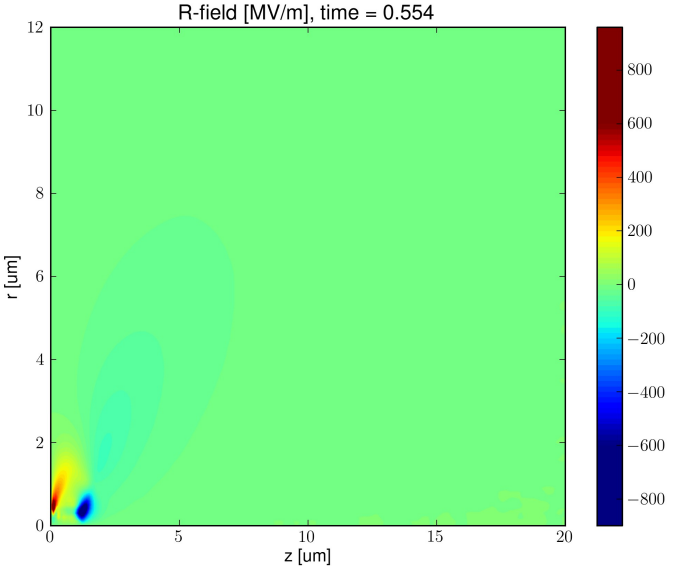


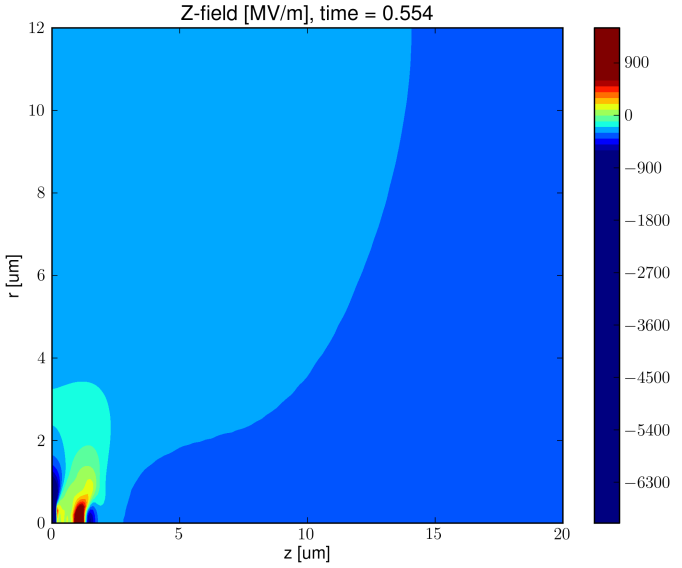
Just after breakdown

New electric field analysis

- R- and Z-fields also complex



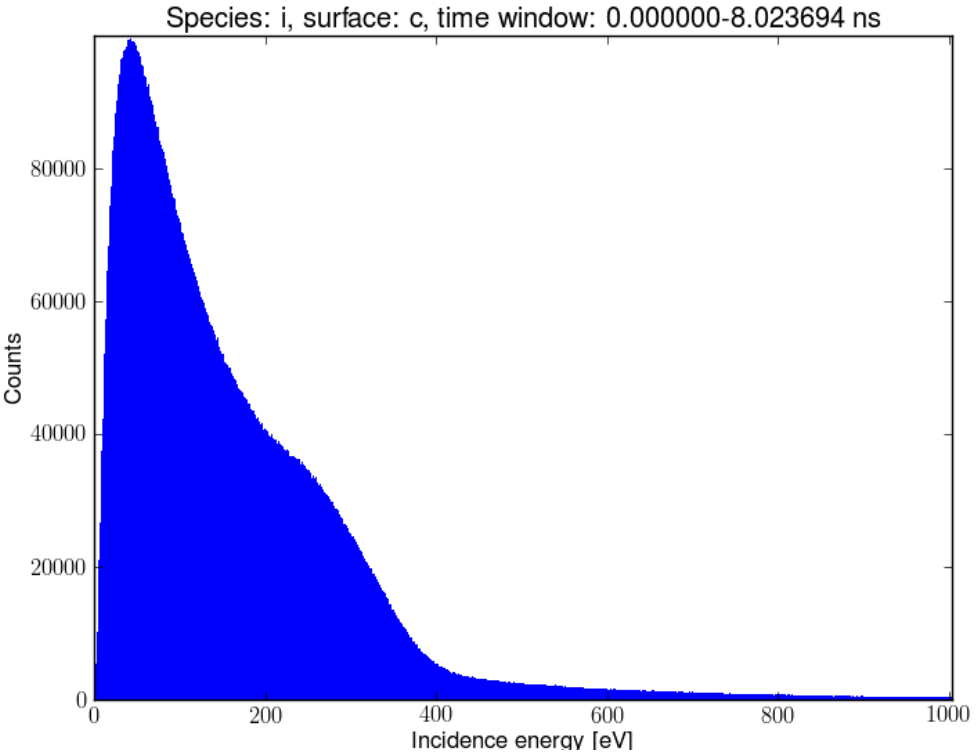


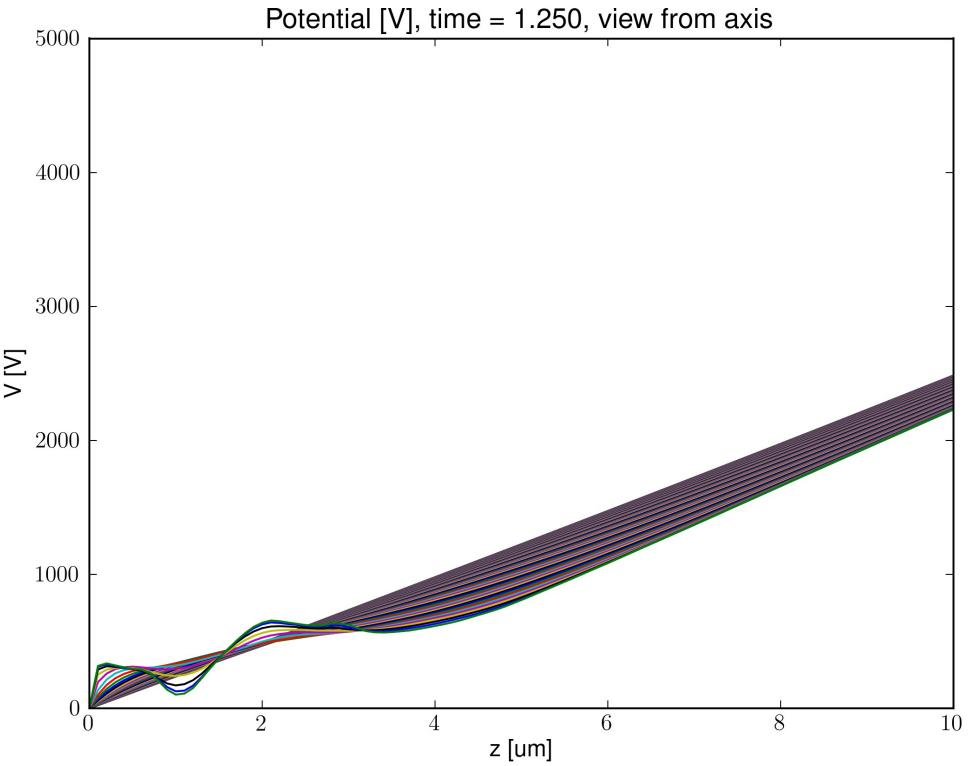


New electric field analysis

Particle impacts

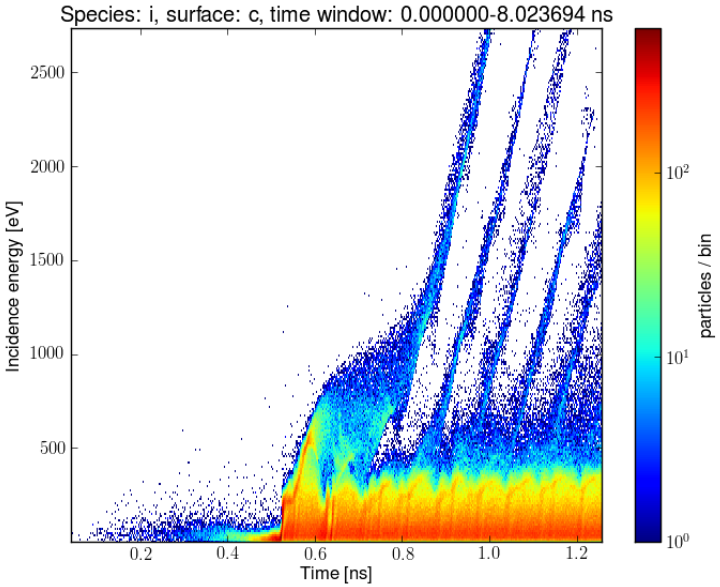
- Energy spectrum shows lower peak than found in 1D
- Consistent with sheath voltage ≈> 50 V

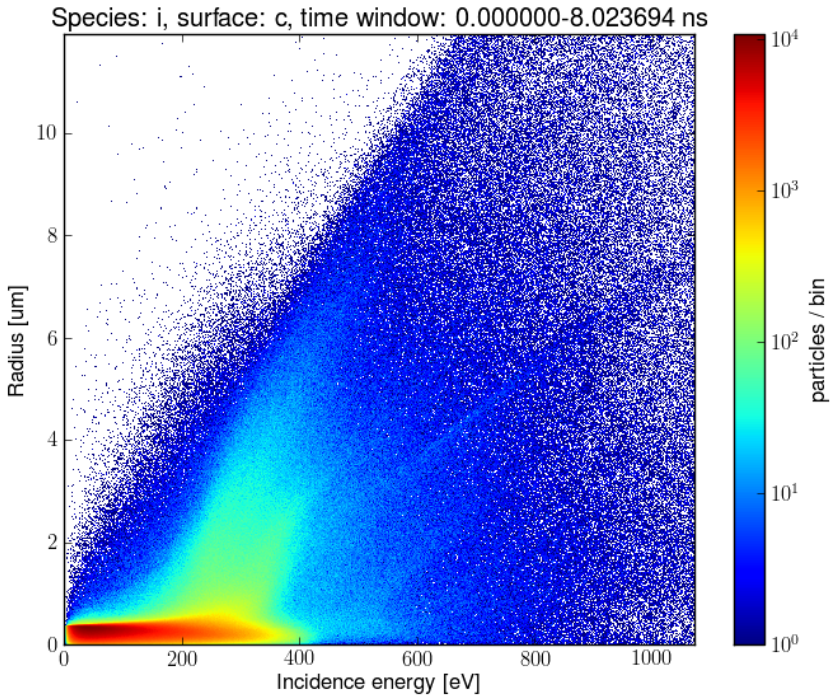


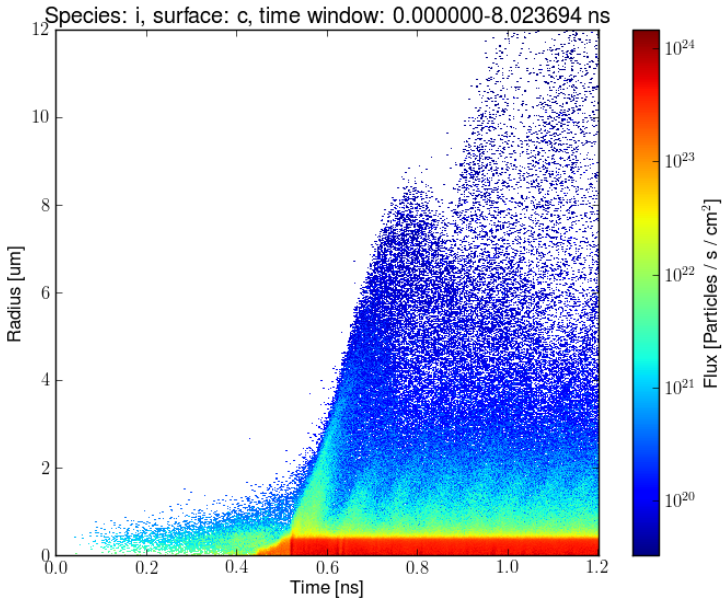


Particle impacts

- Also interesting: Correlations with time, impact radius, and energy

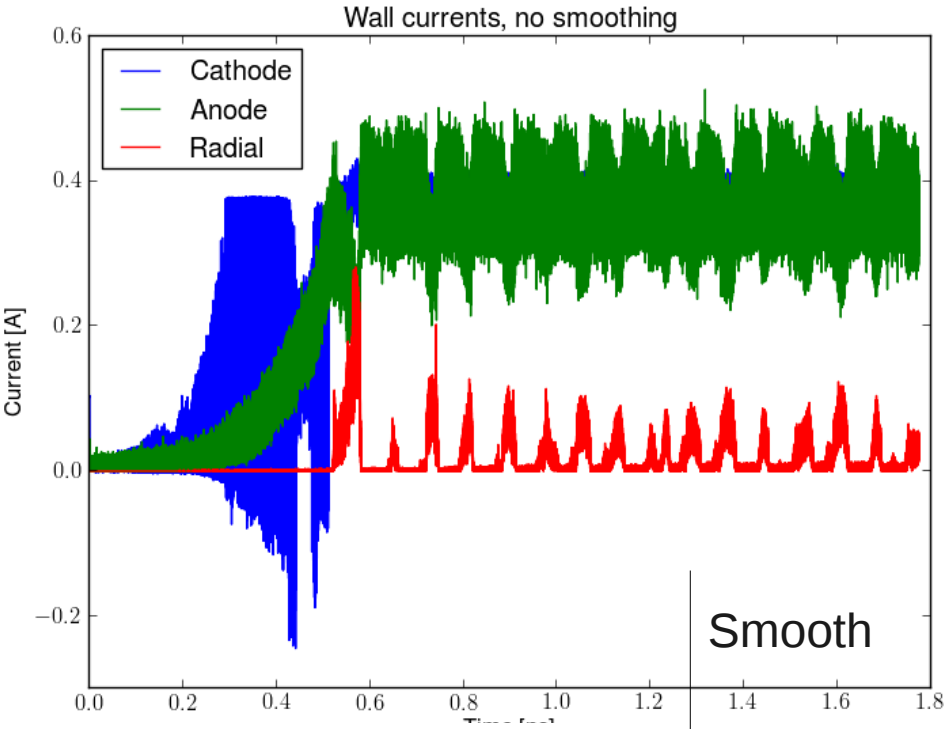


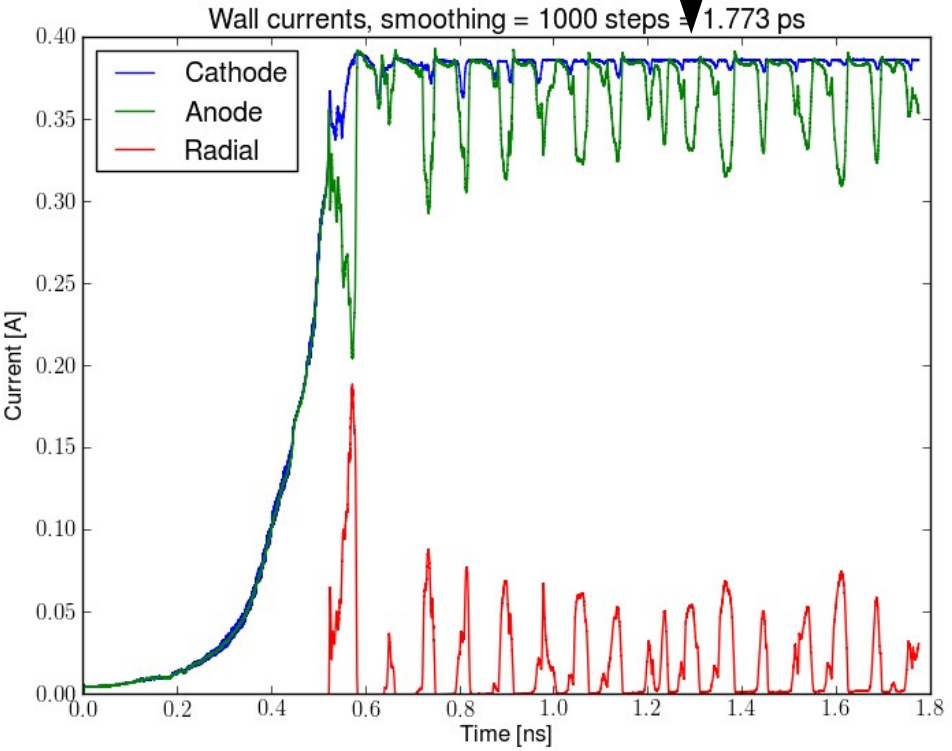


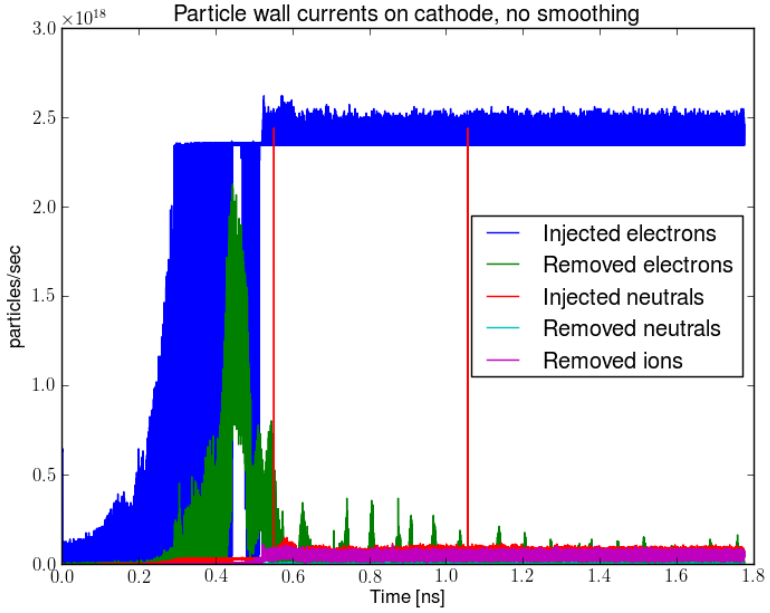


Currents

- Slow oscillation during breakdown clearly visible
- Noisy electron emission, especially before breakdown
- Some particles escape through si wall, but this is far from the plasm system large enough

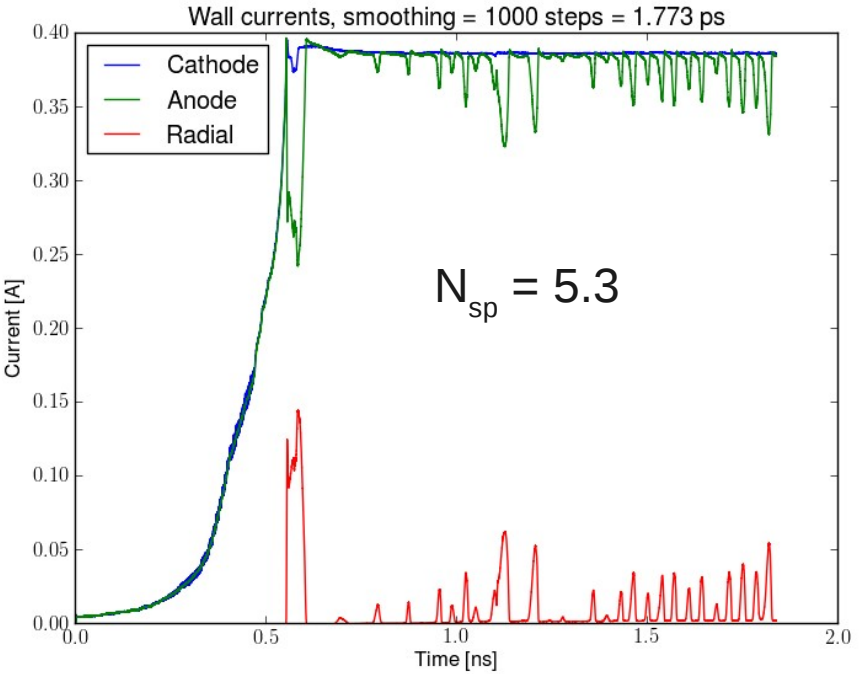


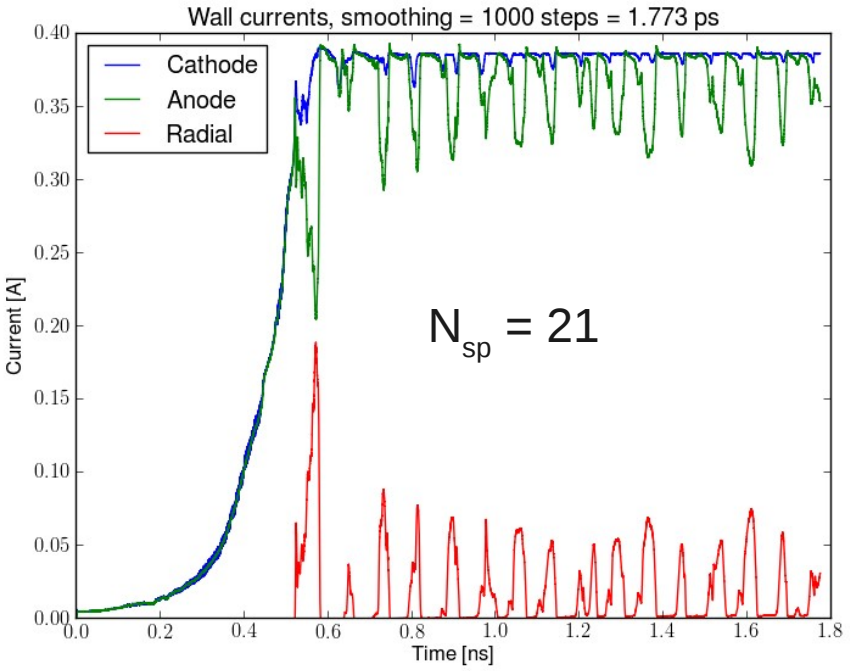


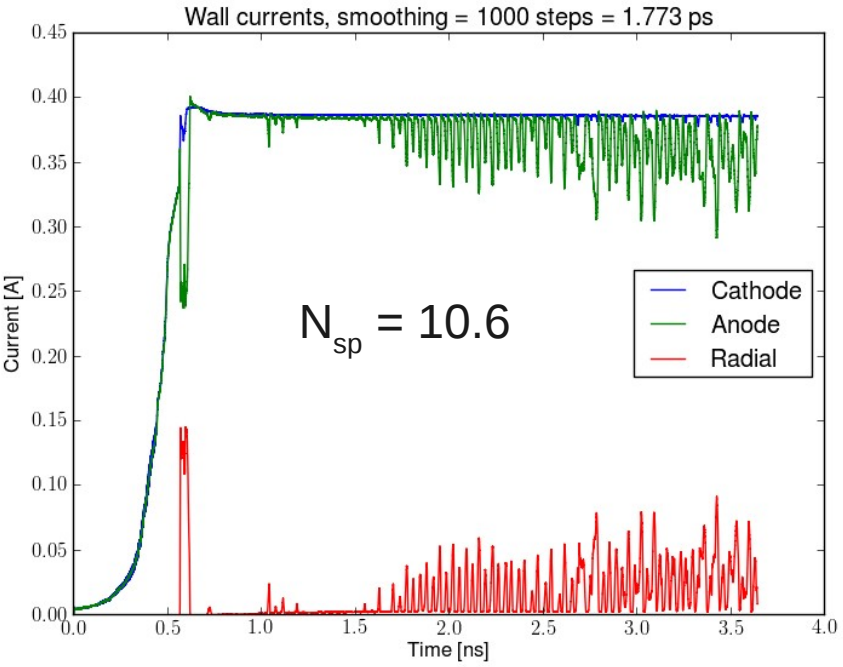


Plasma oscillations during breakdown

- Visible on previous plots
- Frequency 30 GHz
- Also visible in field- and particle plots
- Weaker when increasing the superparticle ratio, but frequency constant







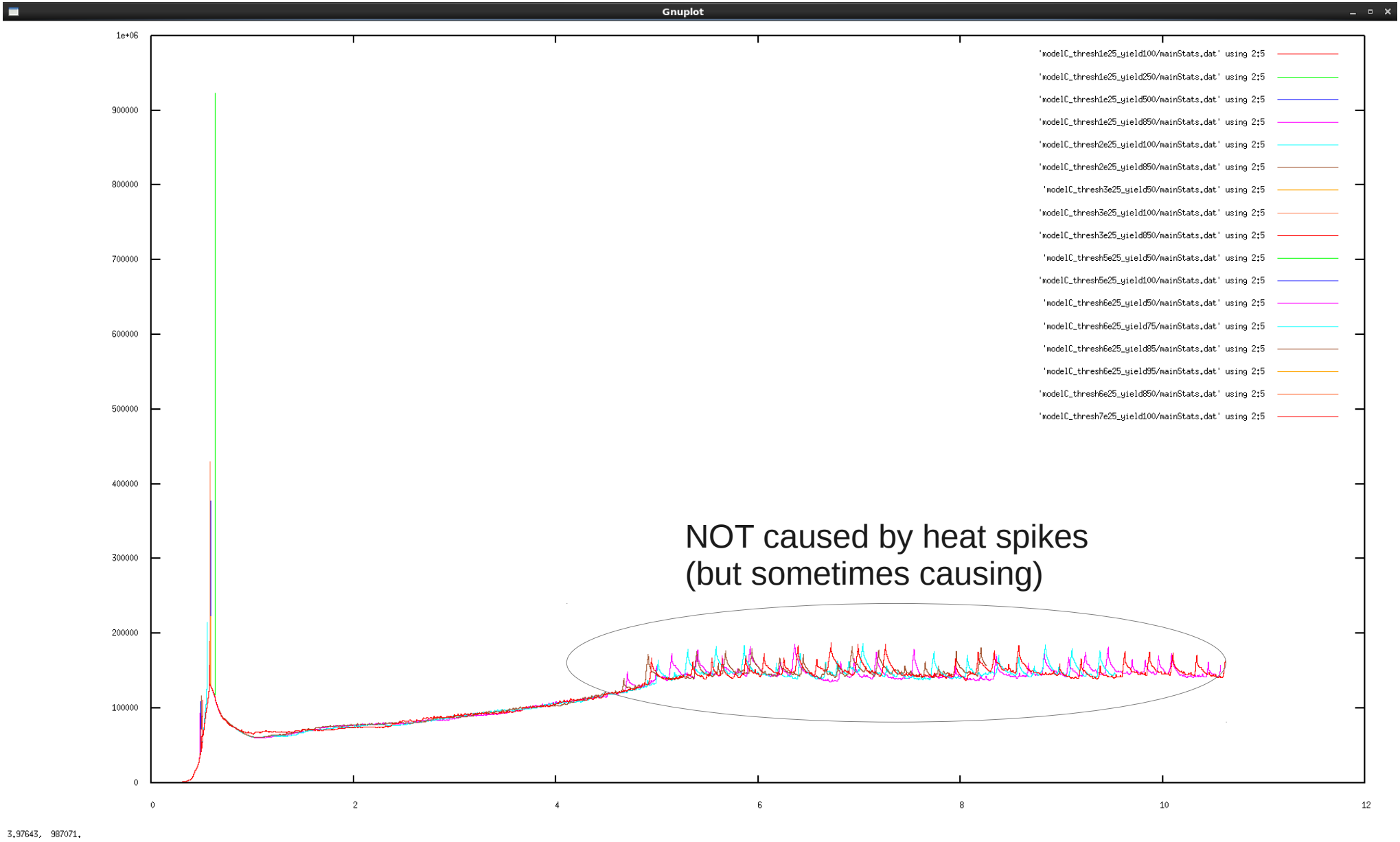
Heat spike sputtering

- Old model:
  If ion current* > 10^7 A** in ANY cell, emit 1000 Cu superparticles and no Yamamura-Tawara sputtering
- New model:
  If Cu current* > threshold T, emit Cu with yield Y in addition to Yamamura-Tawara sputtering (Y<= 20)

- In new model, threshold checked for circular areas with increasing r
- If average current within any such area > T => heatspike
- Heatspike radius = radius of largest area fulfilling condition
- Scanning T and Y
- If T or Y too high => runaway
- If T or Y too low, no effect

*) Only count particles with energy > 23.383 eV
**) 10^7 A = $6.24*10^{25}$ ions/cm^2/s

Heat spike sputtering



Heat spike sputtering