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Arc discharge diagnostics and simulations

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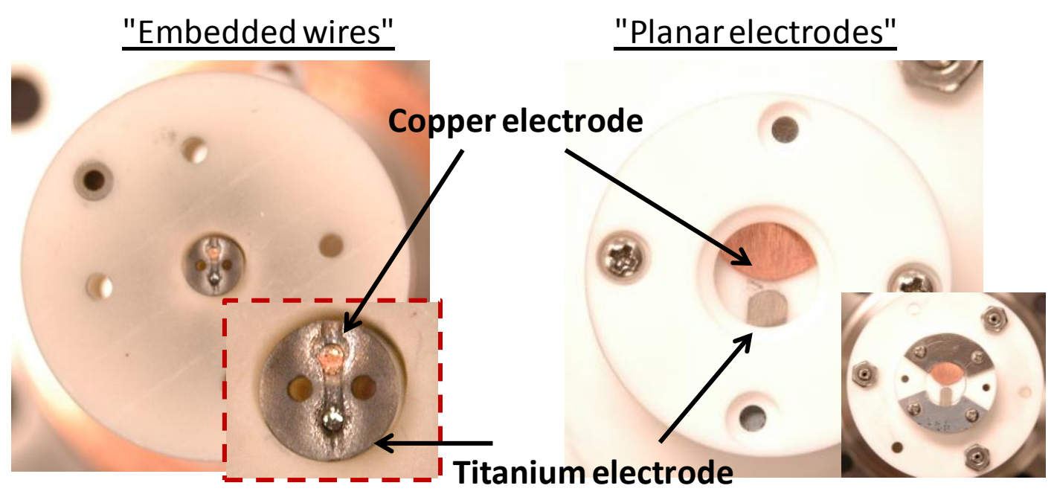
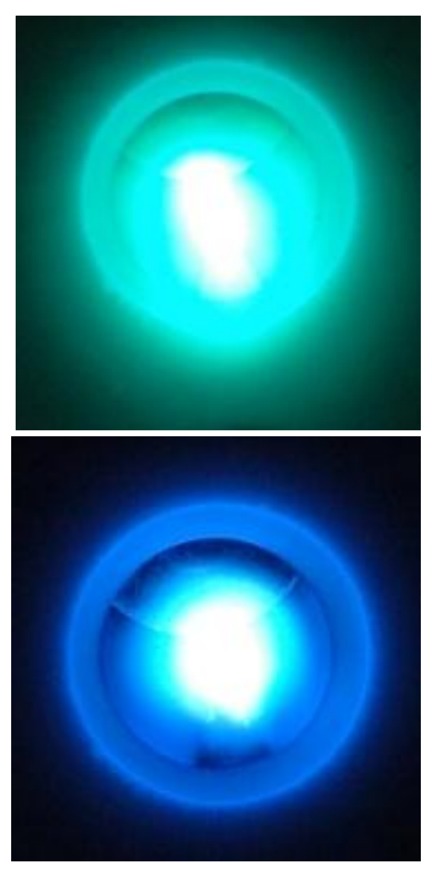
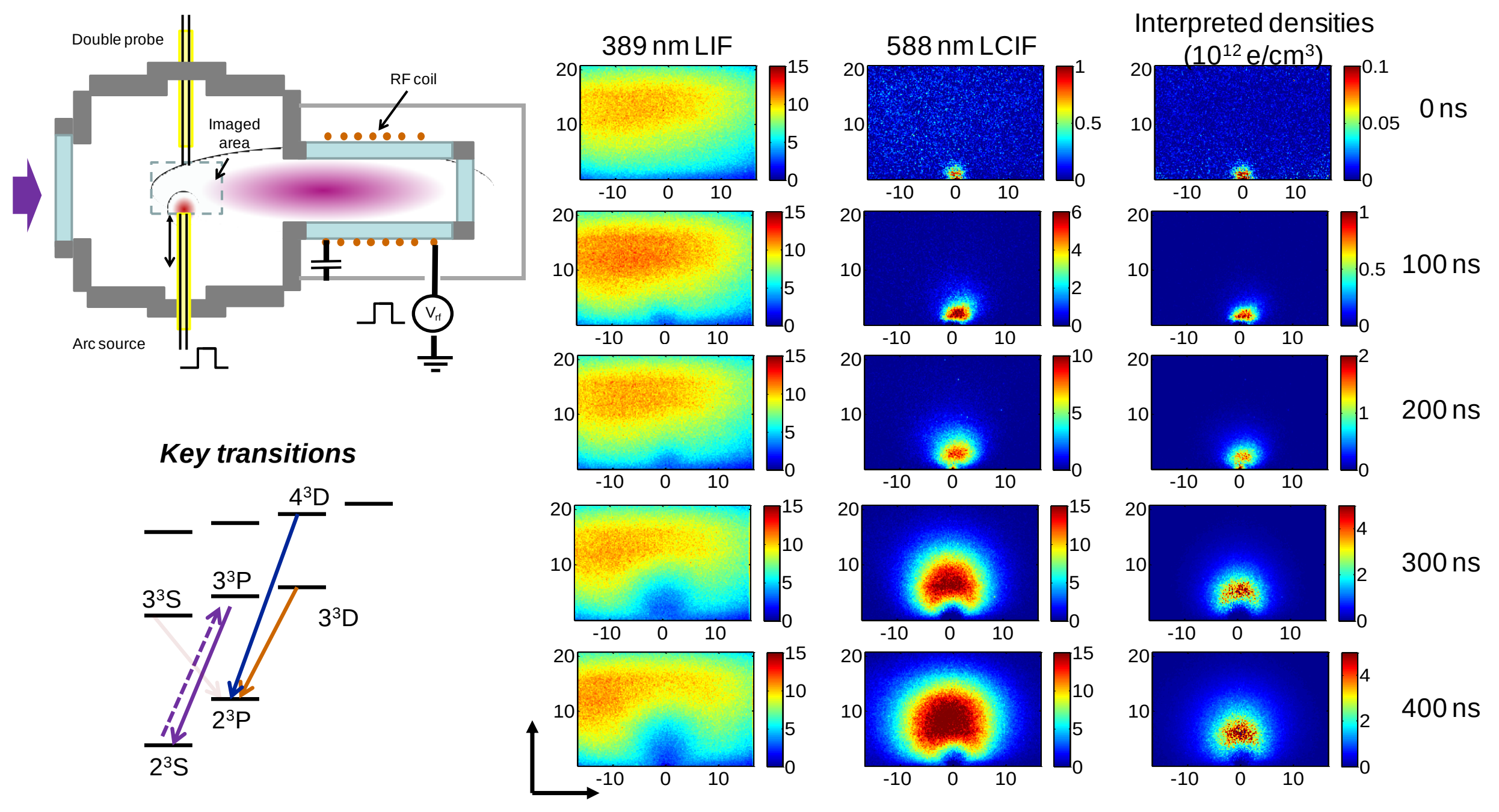
Experimental apparatus for arc discharge diagnostics

- Experiments need to be flexible and versatile
    - Test predictive capabilities of code
    - Target desired physics
    - Overcome intrinsic headaches associated with arcs
- Co-planar two electrode metal arcs embedded in ceramic sleeves
    - Various configurations and compositions
    - Mostly vacuum, but not always





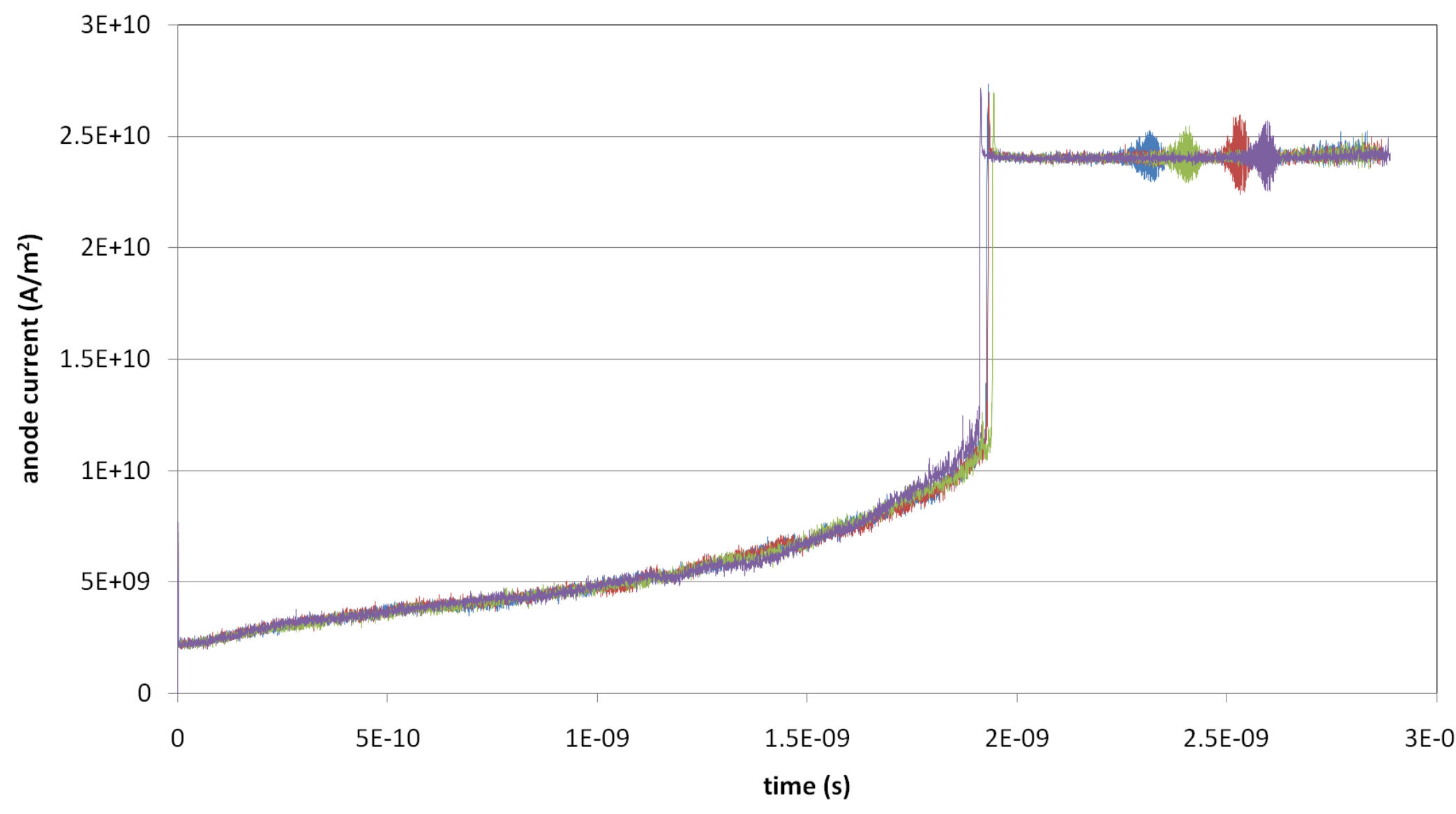
LCIF captures arc generation and expansion



Spatial-temporal maps of arc expansion

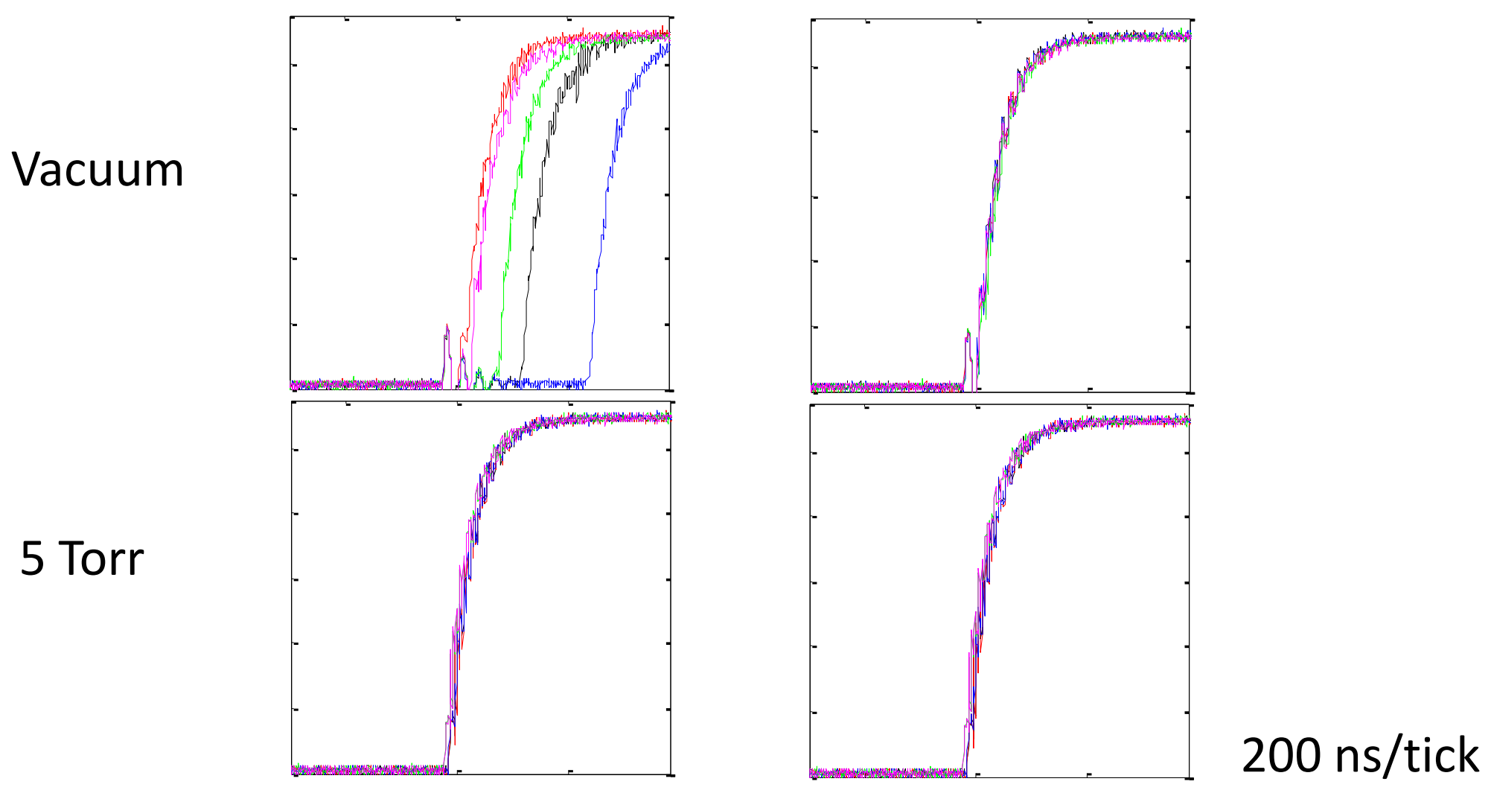
Arc discharge simulation methods and approach

- Particle-in-cell, Monte Carlo collision (PIC – MCC) simulations
- Need an electron production model (i.e. constant emission, F-N)
- Need a gas production model (i.e. initial background gas, sputtering)
- Ionization collisions produce plasma
- Need collision cross-sections and scattering models



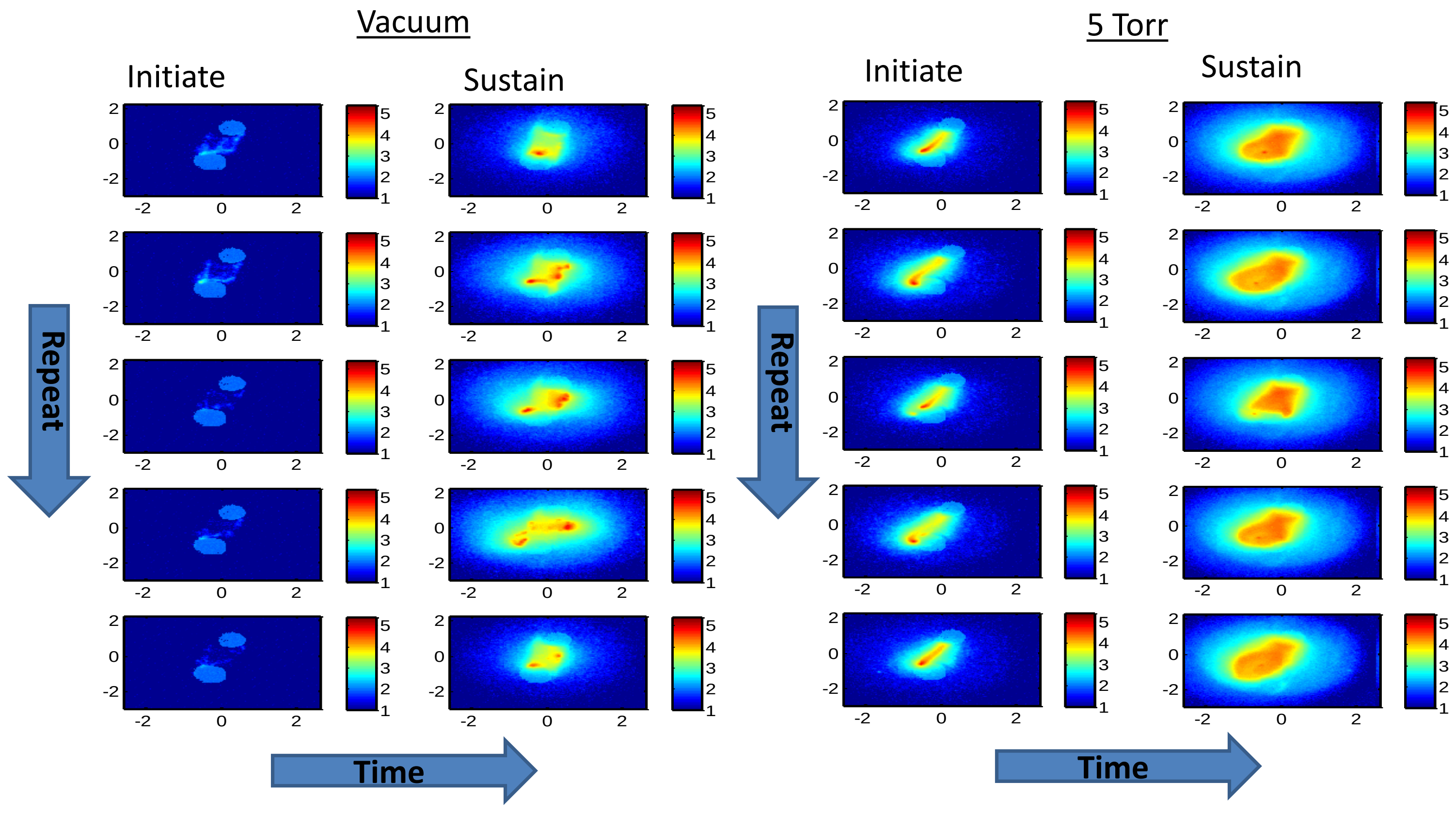
Arc breakdown exhibits stochastic behavior

- No two arcs are ever quite the same
- This makes studies very difficult
- Clever means are needed to reduce variability

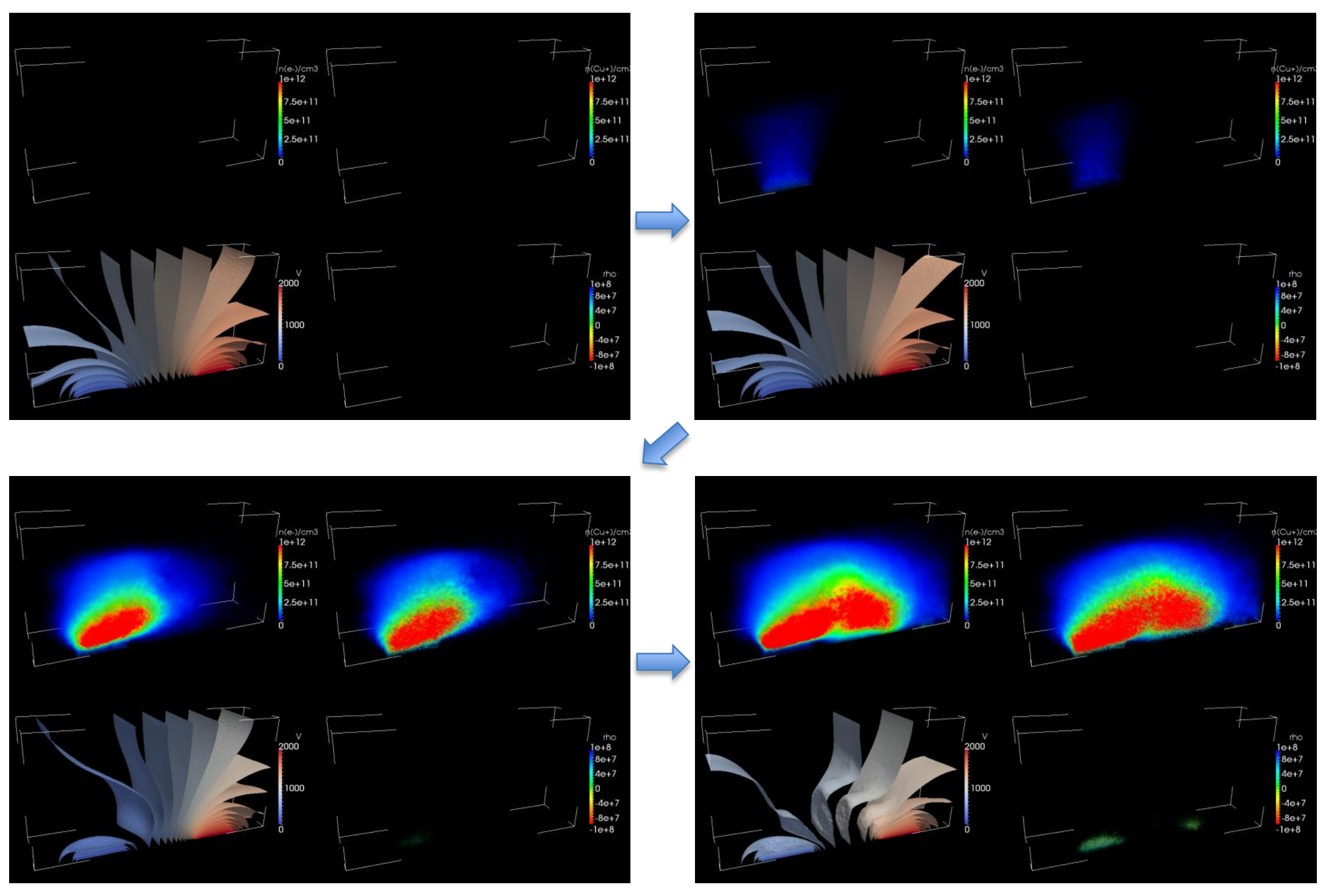


Re-index acquired data to make better sense of observed trends

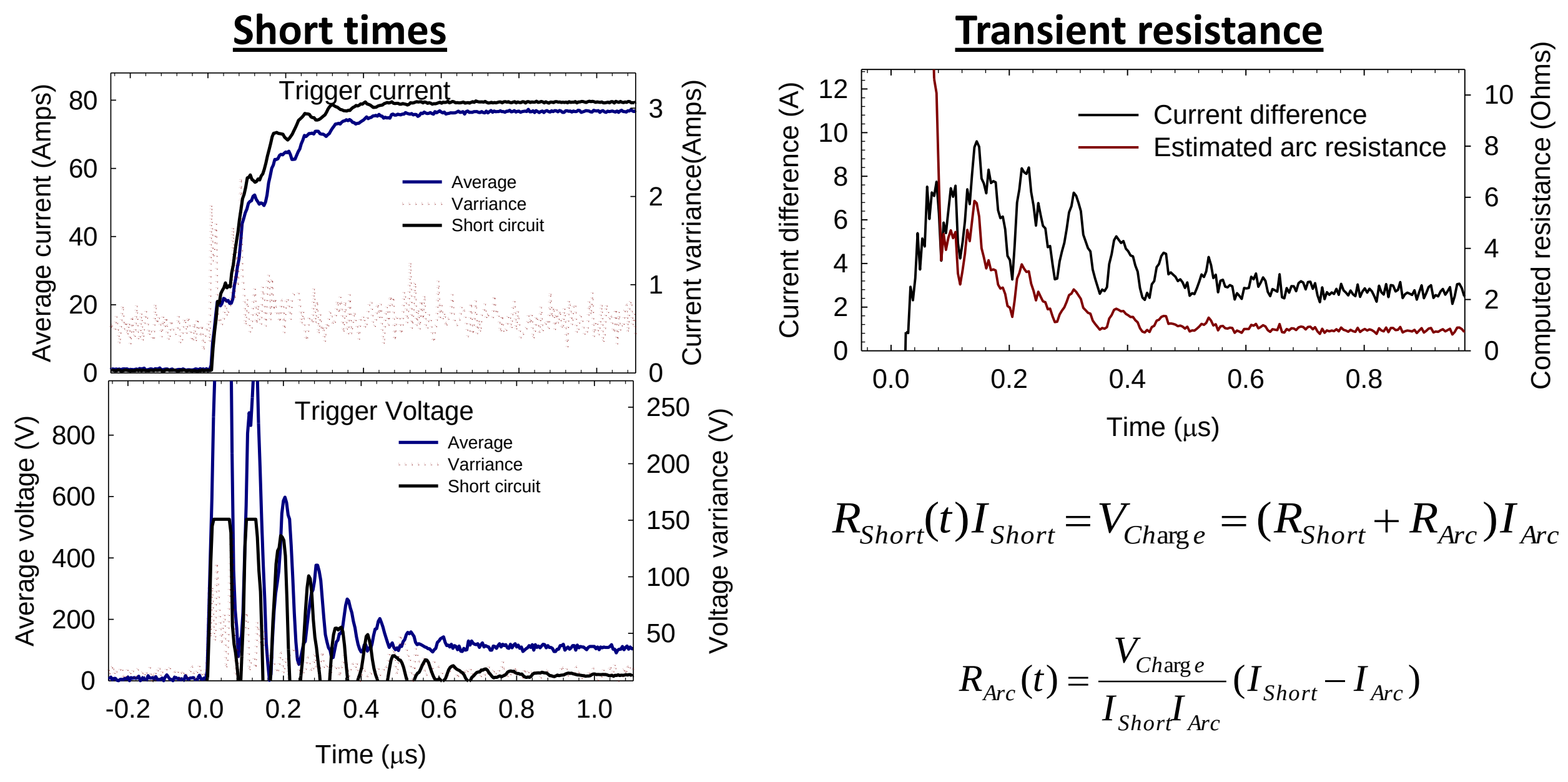
Comparative 2D imaging of arc breakdown



Arc breakdown simulations



Key electrical trends - Initiation

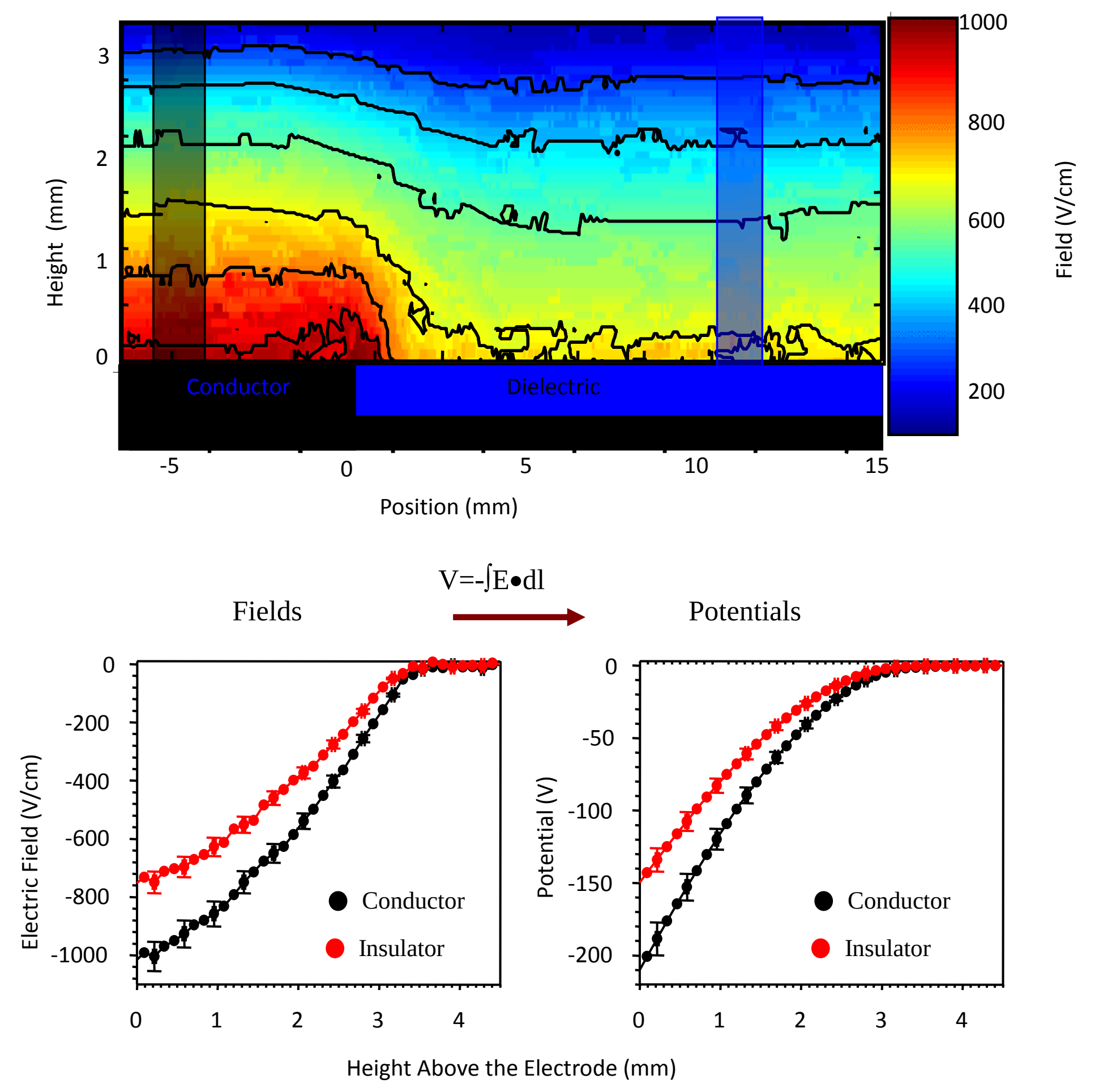


$$R_{Short}(t) I_{Short} = V_{Charge} = (R_{Short} + R_{Arc}) I_{Arc}$$

$$R_{Arc}(t) = \frac{V_{Charge}}{I_{Short} I_{Arc}} (I_{Short} - I_{Arc})$$

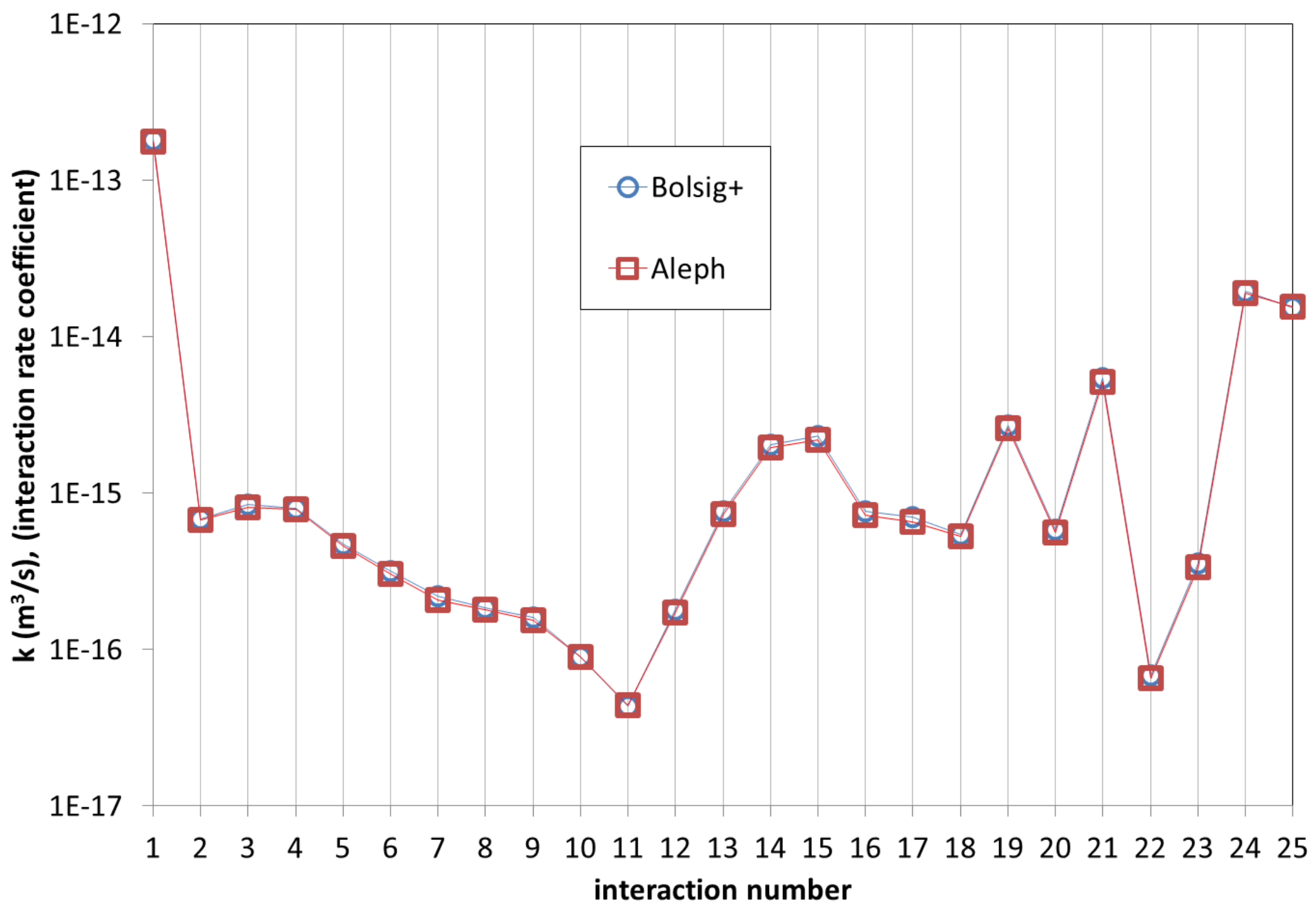
Estimated transient resistance associated with arc development

Fields around the interface possess 2-D structure



400 mTorr Argon; 320 V_{pp} @ 13.56 MHz; 1.5 mm Teflon ($\kappa \sim 2.1$)

Code-to-code comparisons



- Comparison with other simulation software builds confidence in code, models, and approach.
- We have completed an extensive code-to-code comparison of a 1D arc model with CERN/Helsinki group.
- Bolsig+ comparison strengthens confidence in our ability to match ionization rates for complex interaction systems (i.e. 25 distinct electron - N_2 interactions)

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