

Plasma Expansion and Imaging in the WIRX

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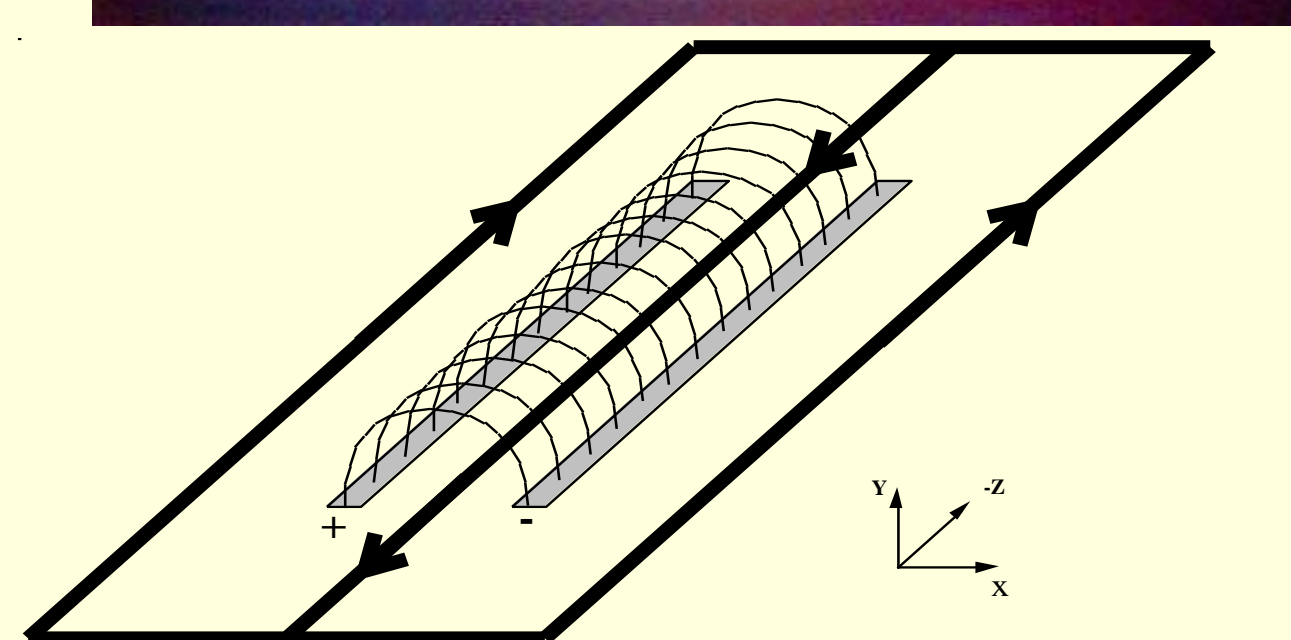
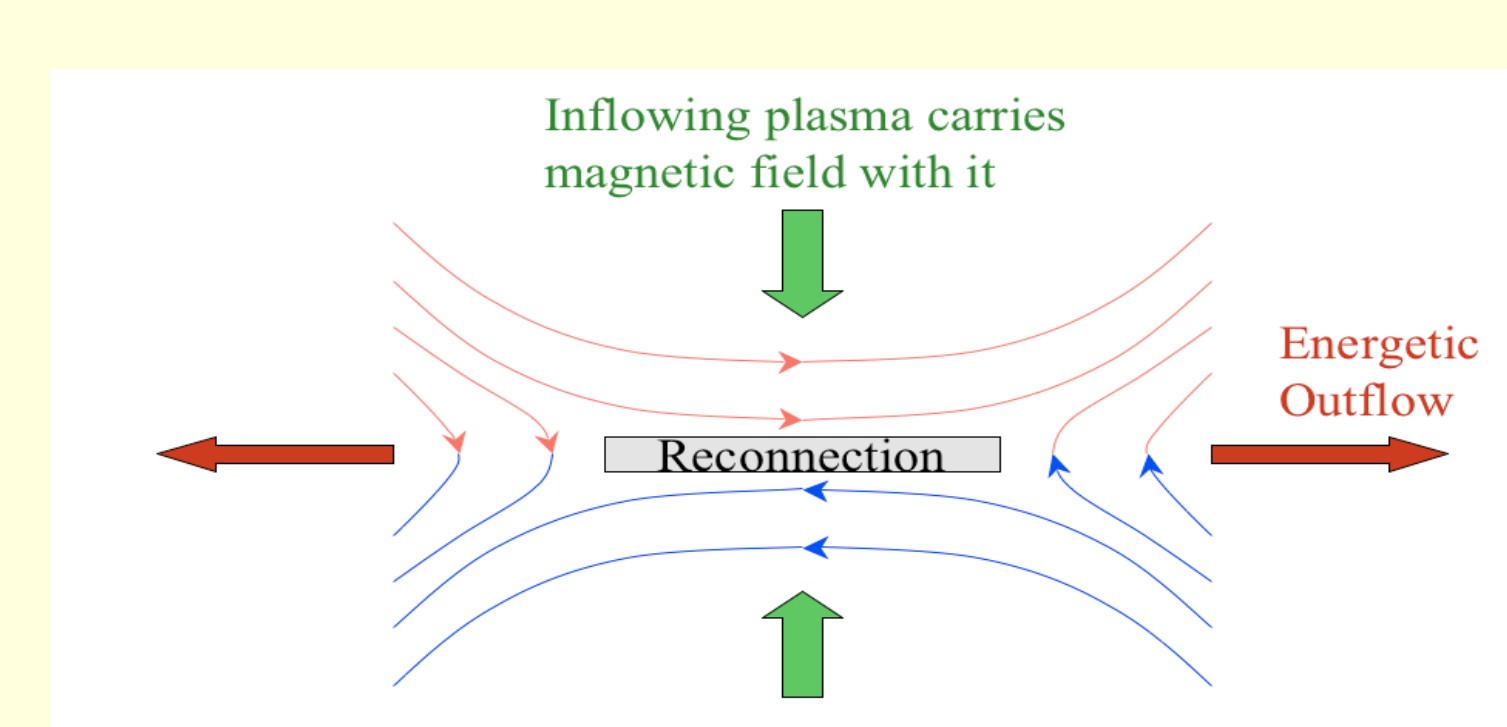
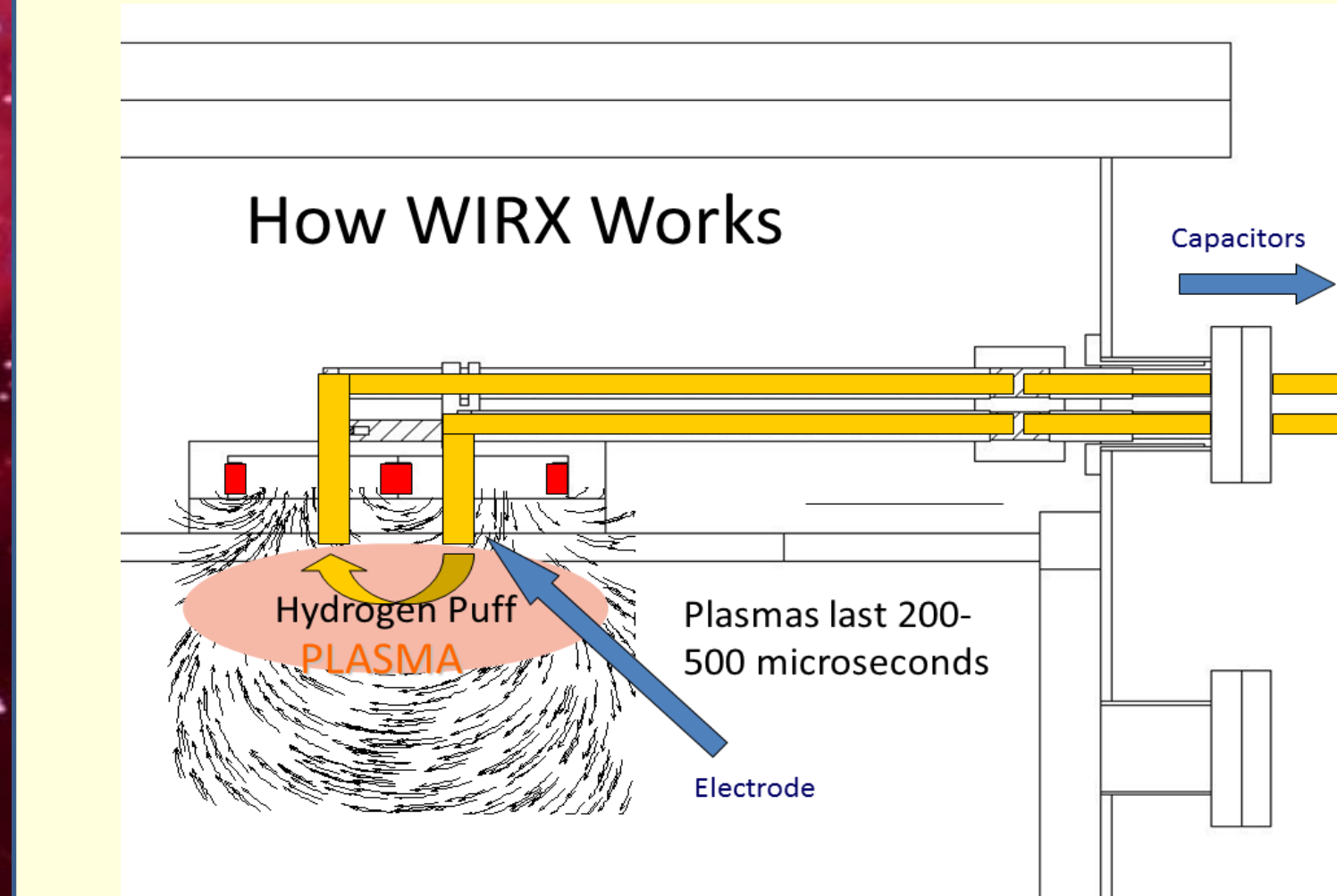
Abstract:

We examine the expansion and evolution in space and time of a plasma arcade in the Wheaton Impulsive Reconnection Experiment (WIRX). In our investigations of the expansion we find a long lived "tail" feature emanating from the arcade. We attempt to explain this phenomenon with a computer model of magnetic field lines near the arcade, and find that the tail does not align with the field lines in the model. We also find other fast time scale events, which seem to influence the intensity of the tail. These other events may be related to magnetic reconnection. Photodiode cameras are nearly complete which will allow continuous light intensity measurements to further study the expansion and evolution of the arcade.



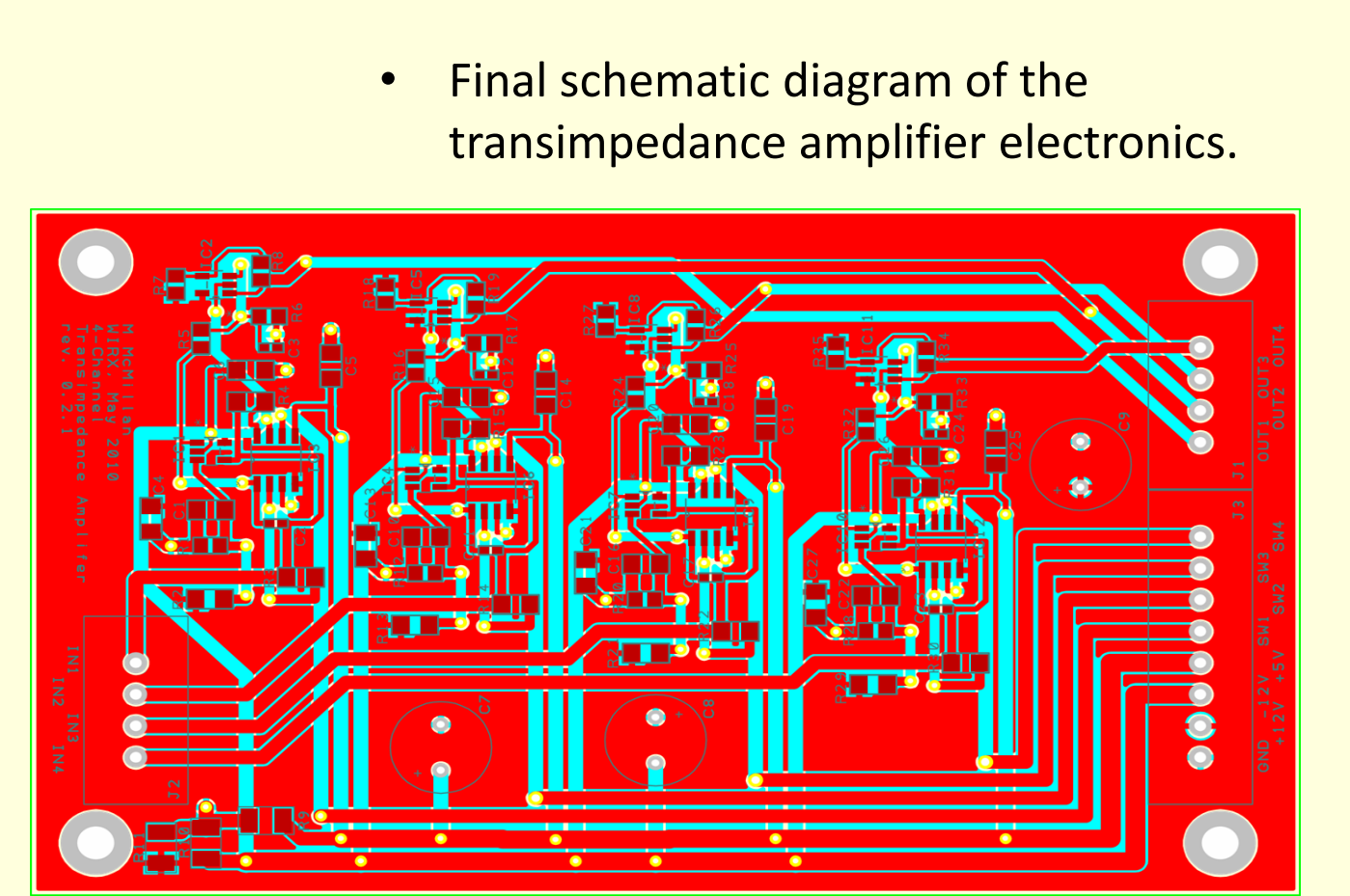
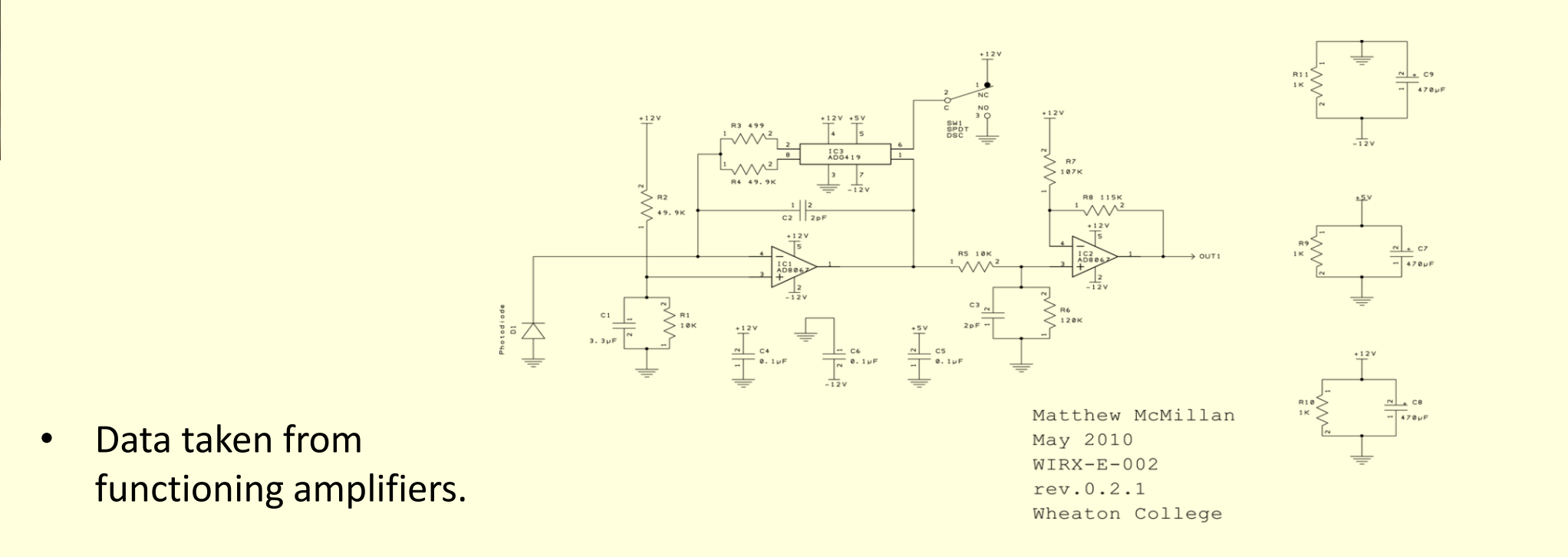
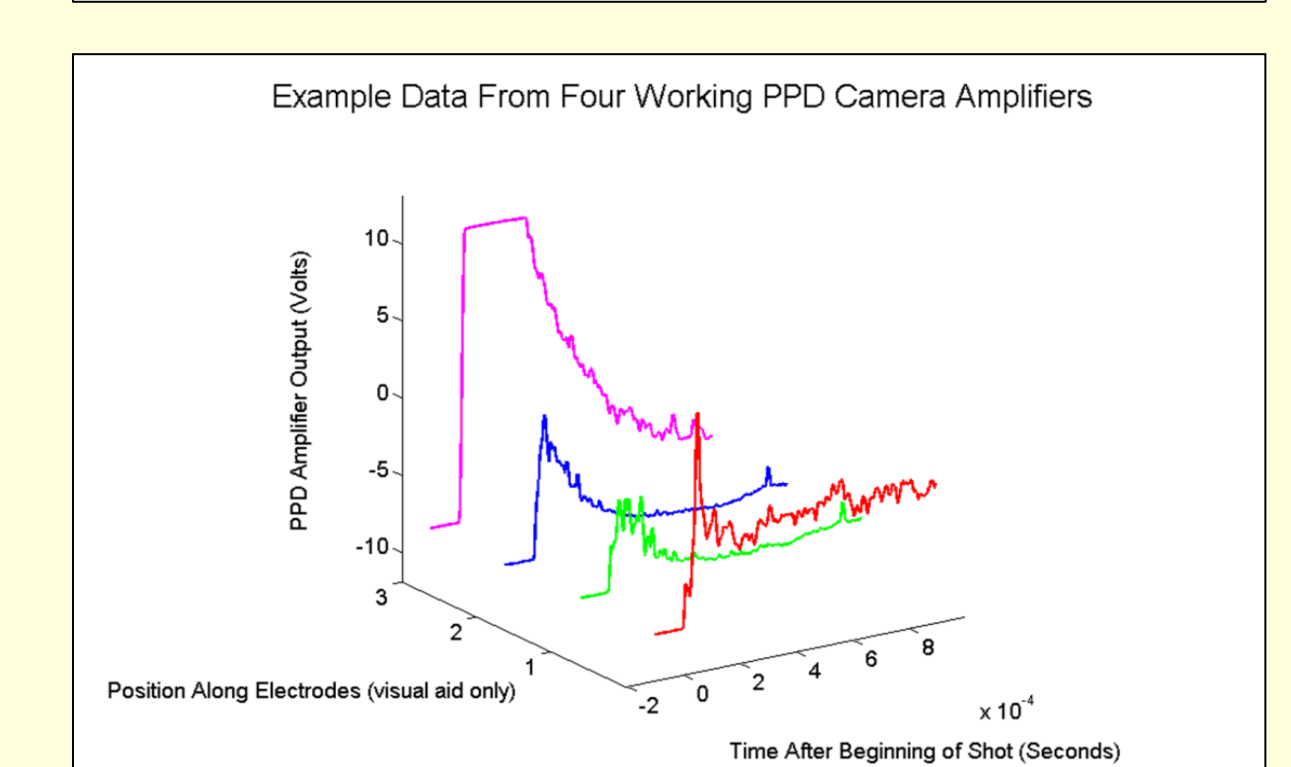
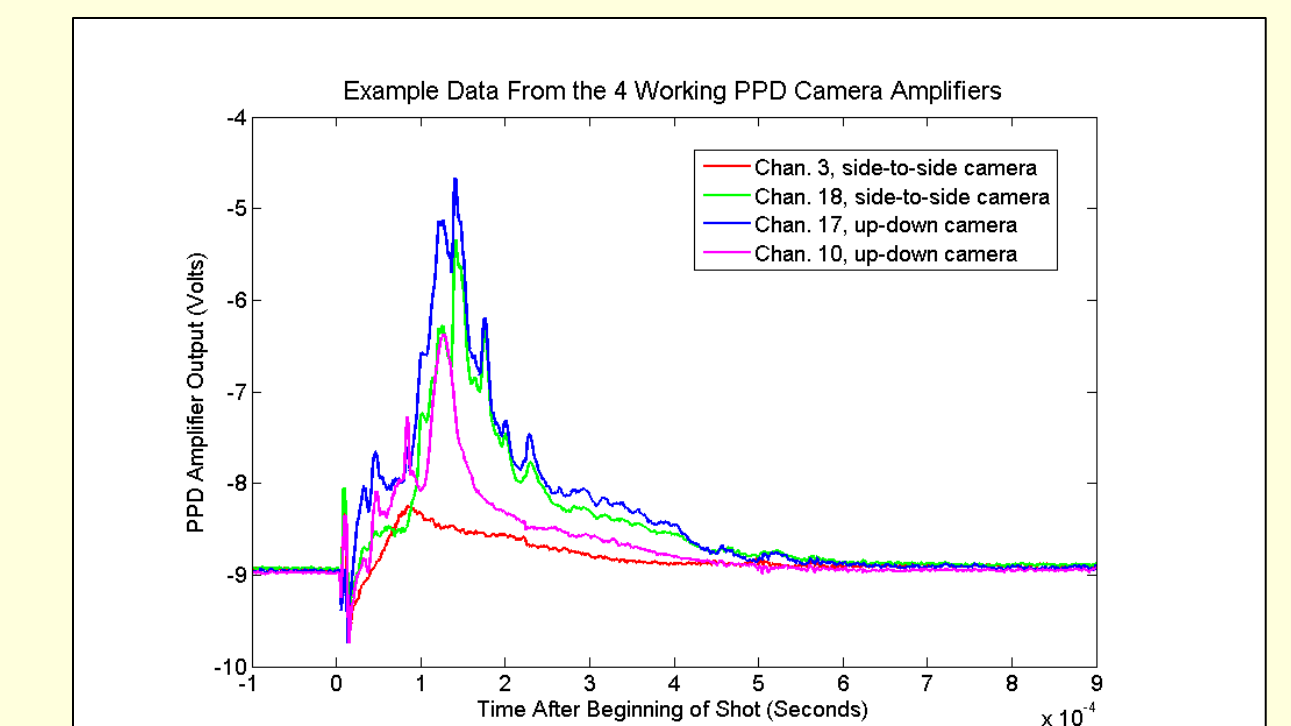
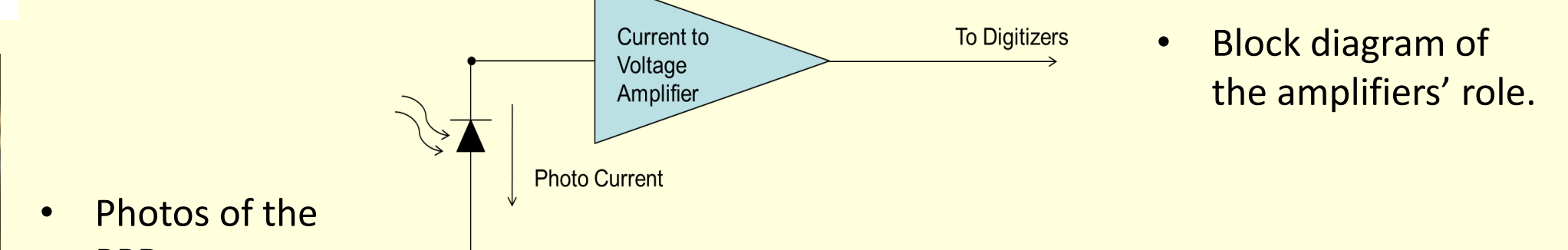
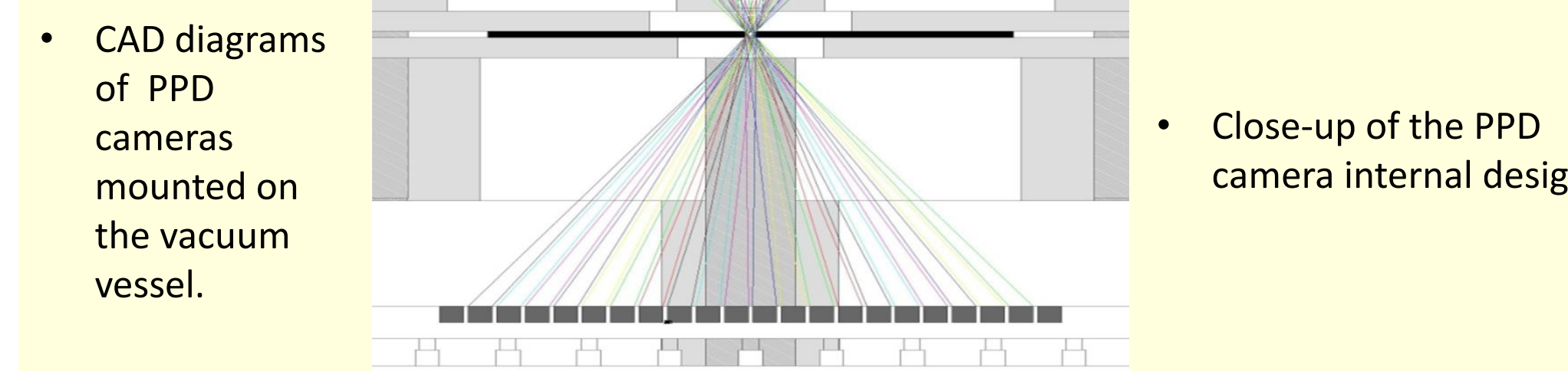
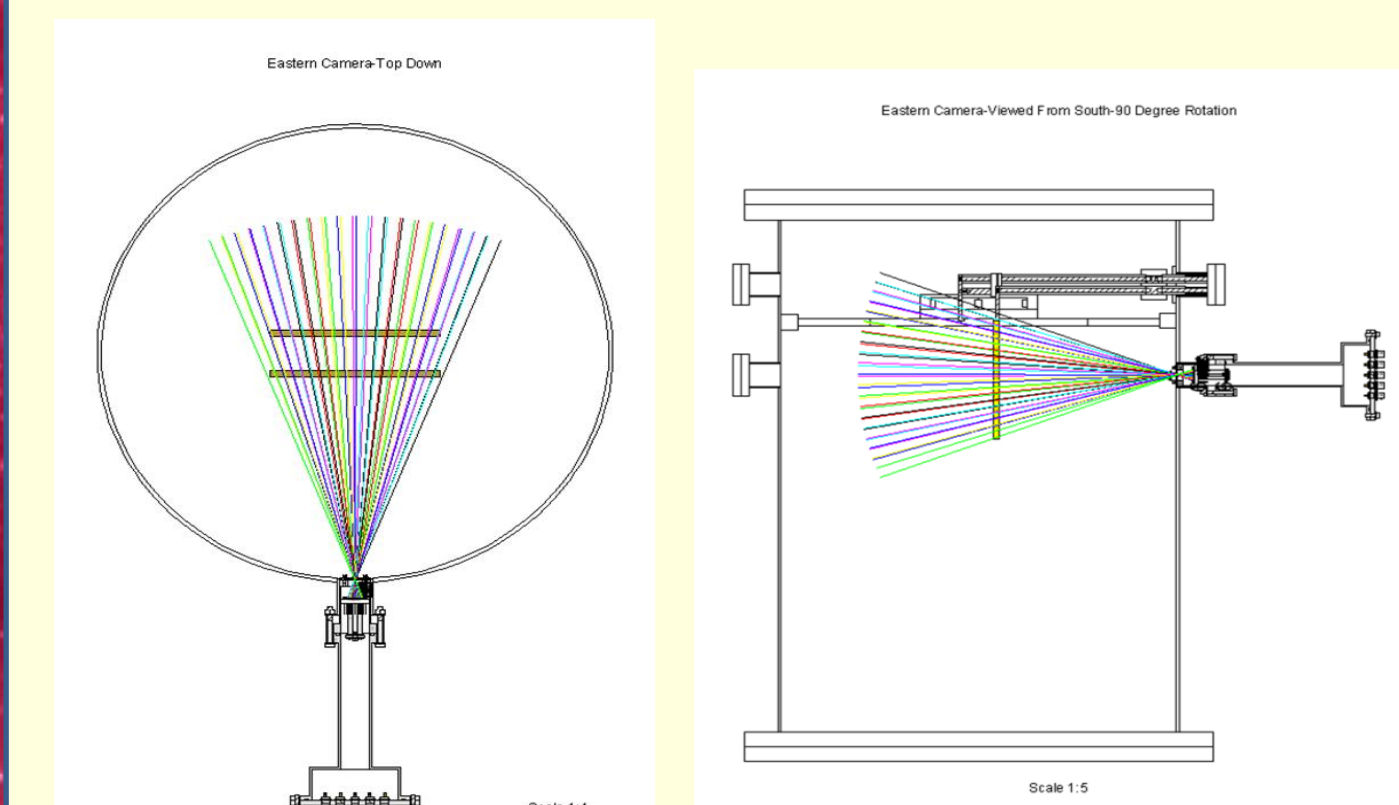
Wheaton Impulsive Reconnection eXperiment

- We study Magnetic Reconnection, a process that converts magnetic energy to thermal energy in a plasma.
- Primary Goal: To learn about 3D magnetic reconnection.
- We use an inverted arcade geometry formed by long parallel electrodes and a figure-eight magnetic coil.



Pinhole Photodiode (PPD) Camera Amplifier Design

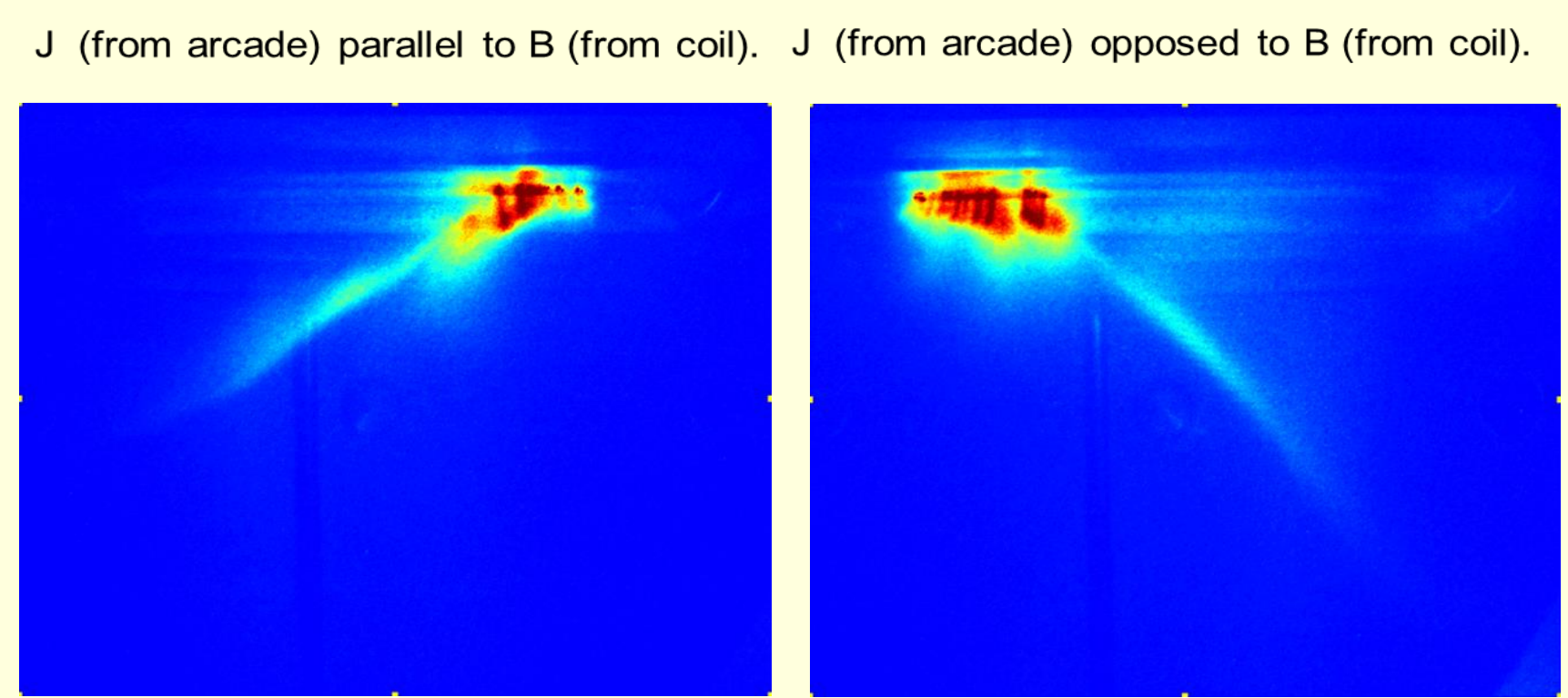
PPD cameras will allow a time-continuous measurement of light intensity from a variety of regions in the plasma chamber. This will help us track the expansion of the arcade.



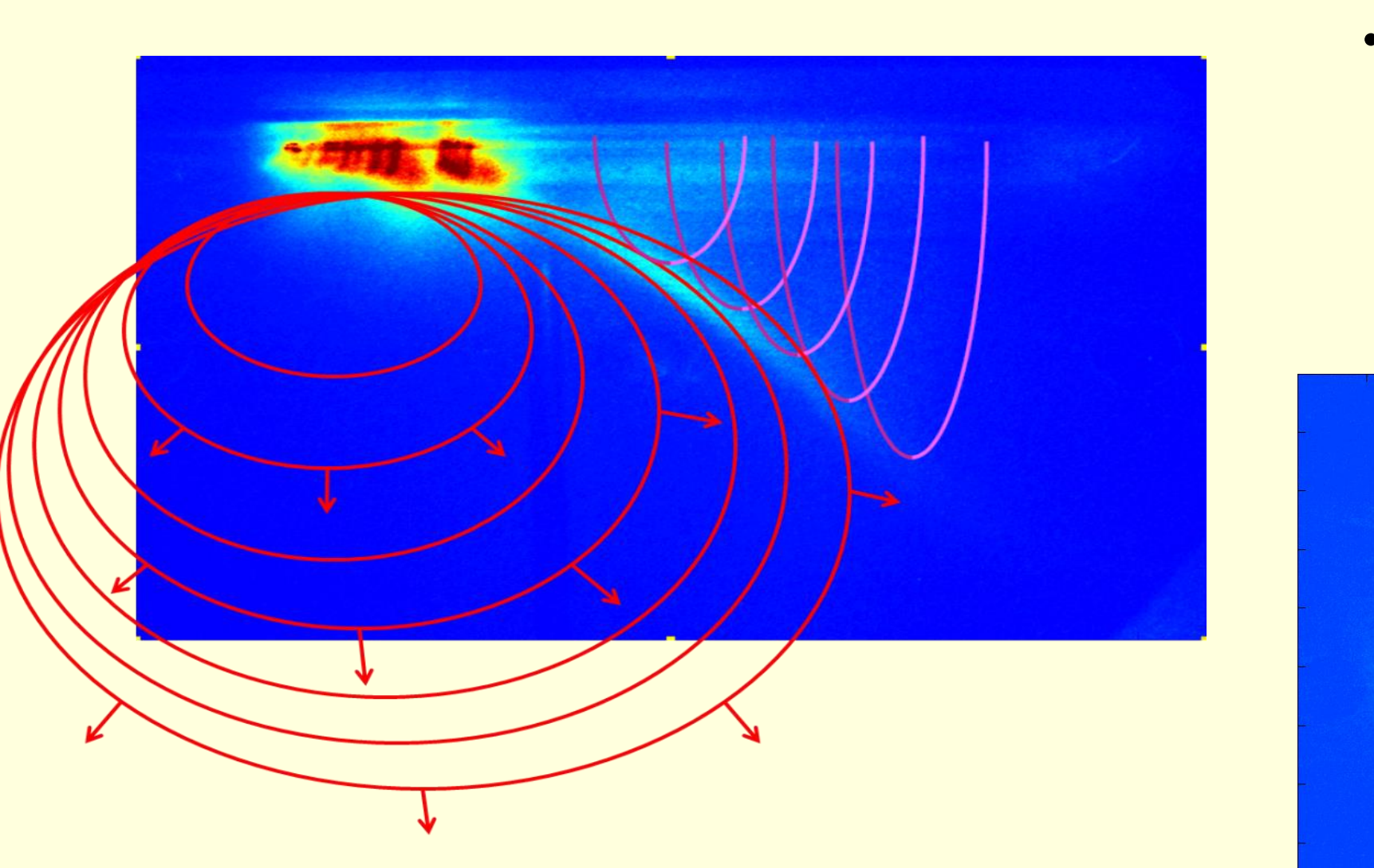
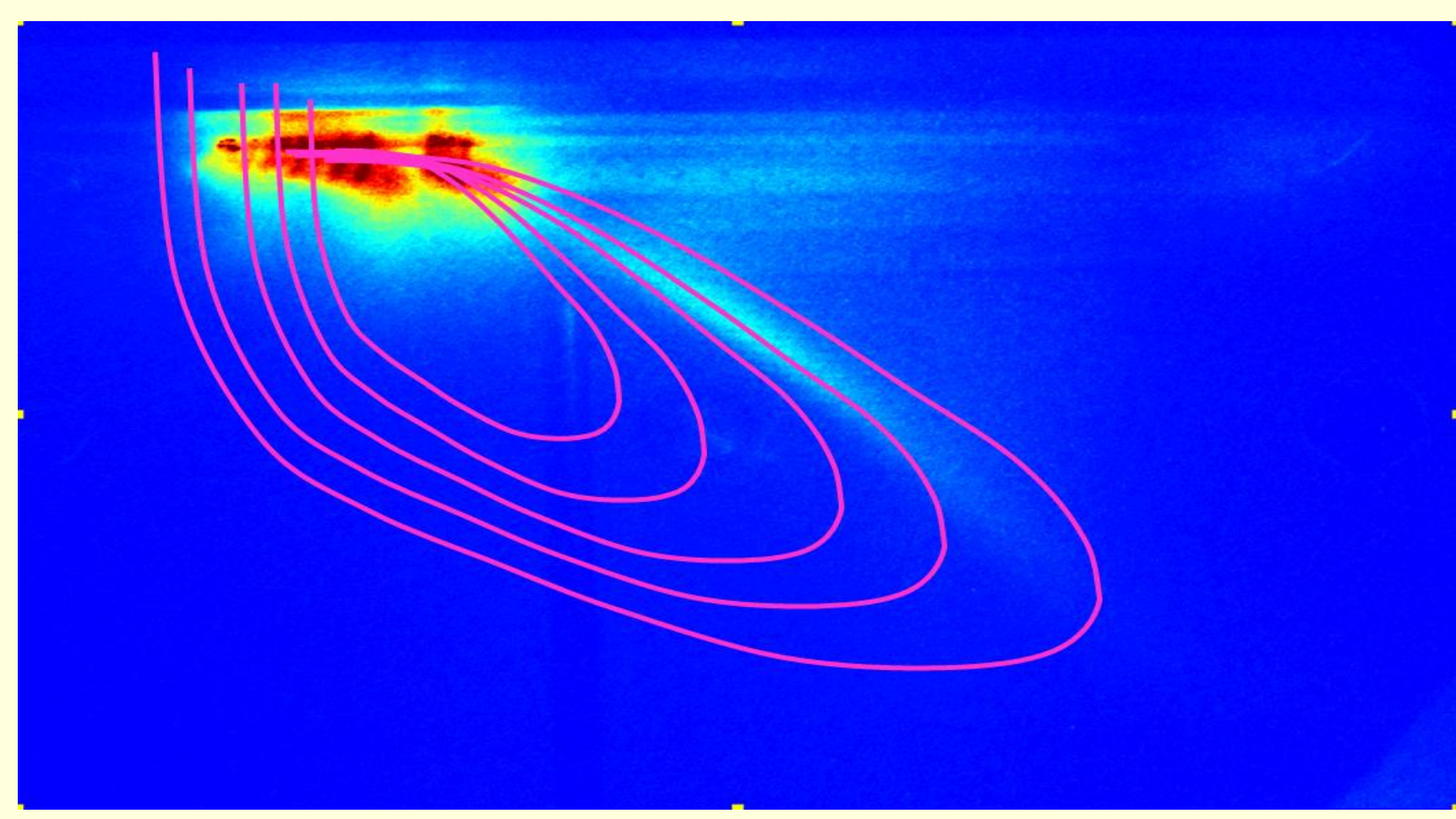
Origin of Tail Feature

We attempted to explain a peculiar phenomenon discovered in our high-speed photographs.

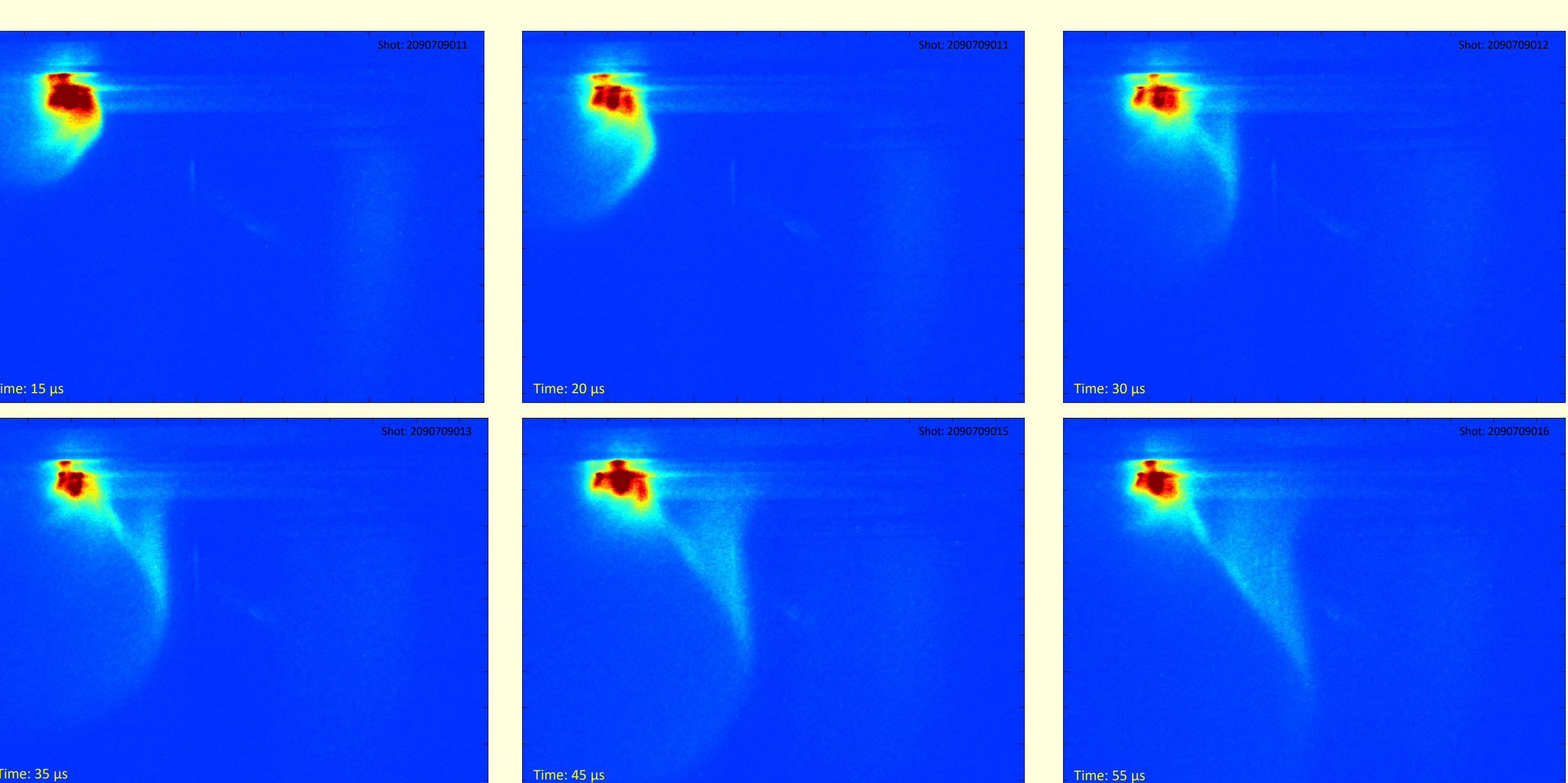
Side view looking at the electrodes:



- Long-lived.
- Only low current plasmas.
- Orientation depends on magnetic field direction from coil.
- 1st hypothesis: field lines coming out from arcade cause tail feature.
- MATLAB model does not support first hypothesis.
- 2nd hypothesis: expanding balls of plasma in combination with the viewing perspective produce a tail feature.

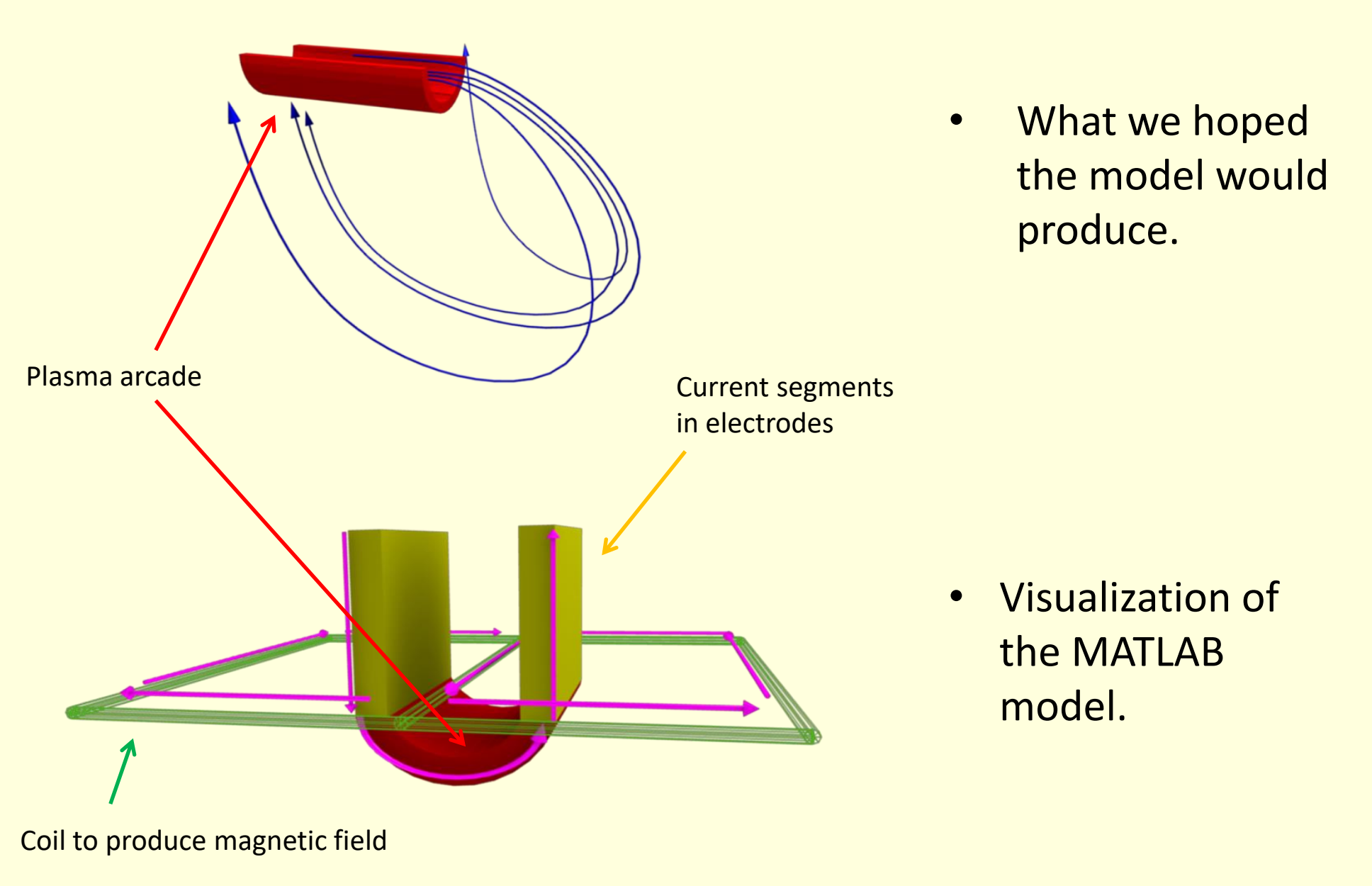


A series of photos showing the development of the tail feature.



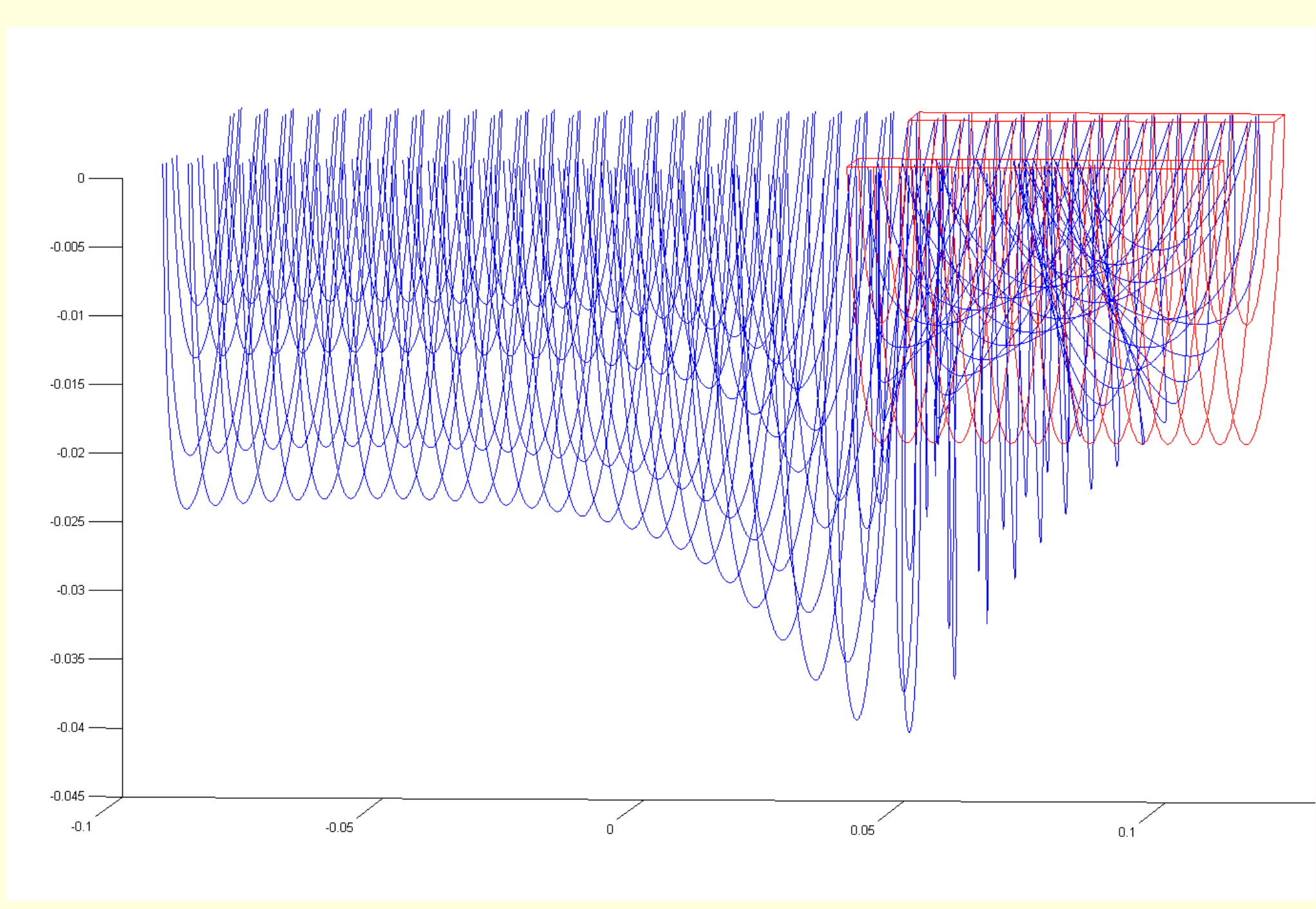
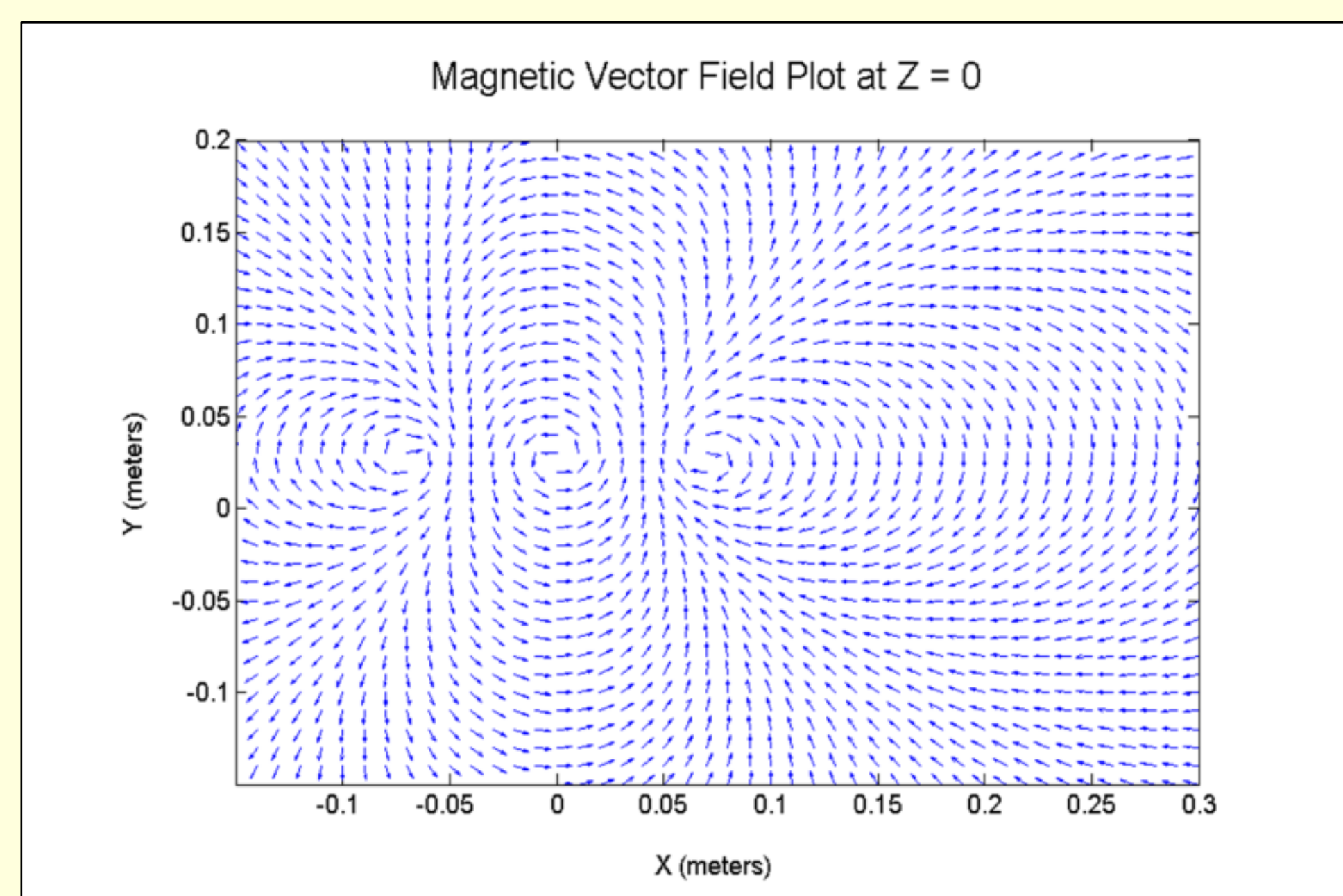
Magnetic Field Modeling

We created a computer model of the experiment in MATLAB to find an explanation of the tail feature.

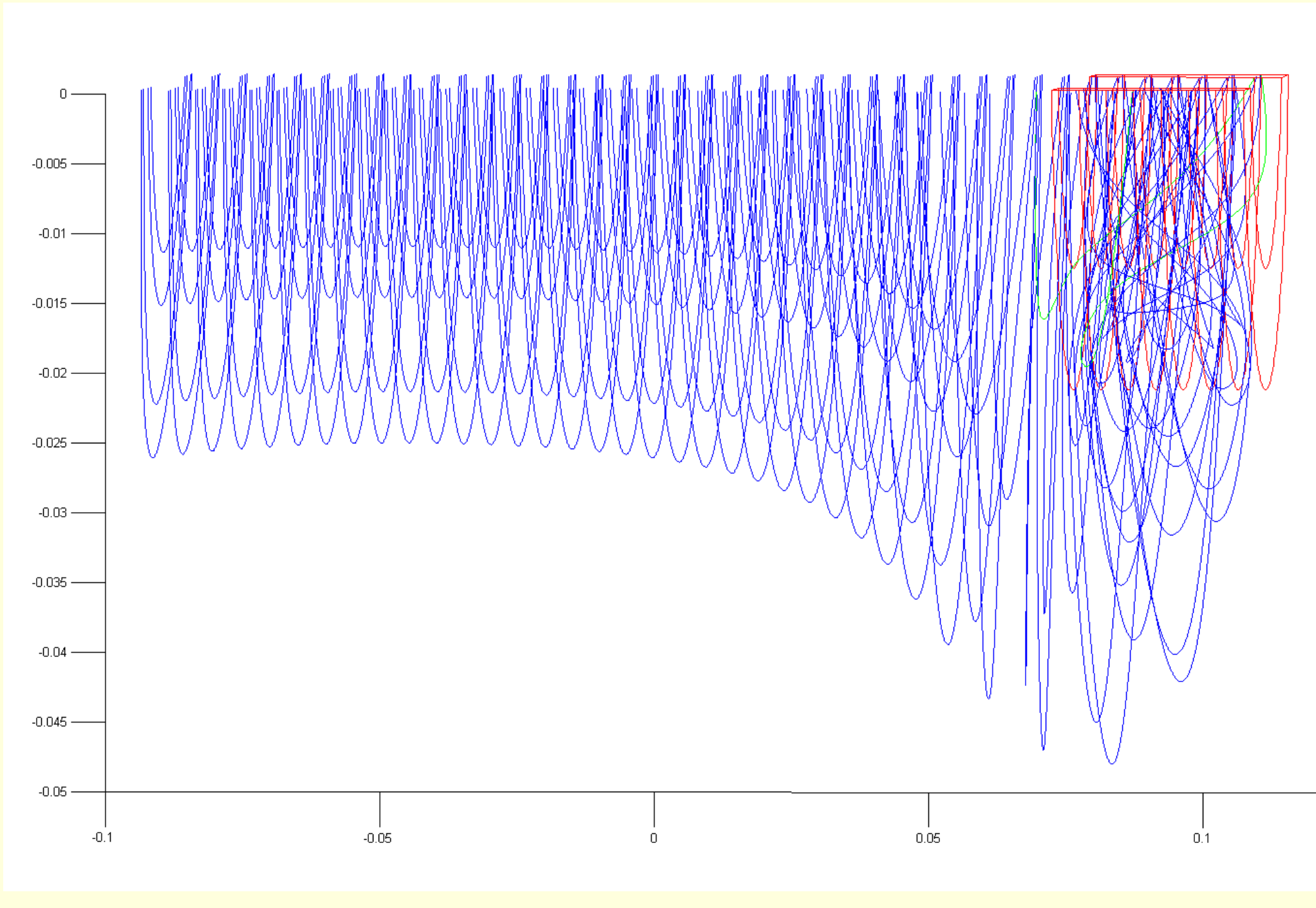


$$\mathbf{B} = \int \frac{\mu_0}{4\pi} \frac{\mathbf{J} \times \hat{\mathbf{r}}}{r^2} dV$$

Sample 2D vector plot demonstrating that the model is functioning properly:

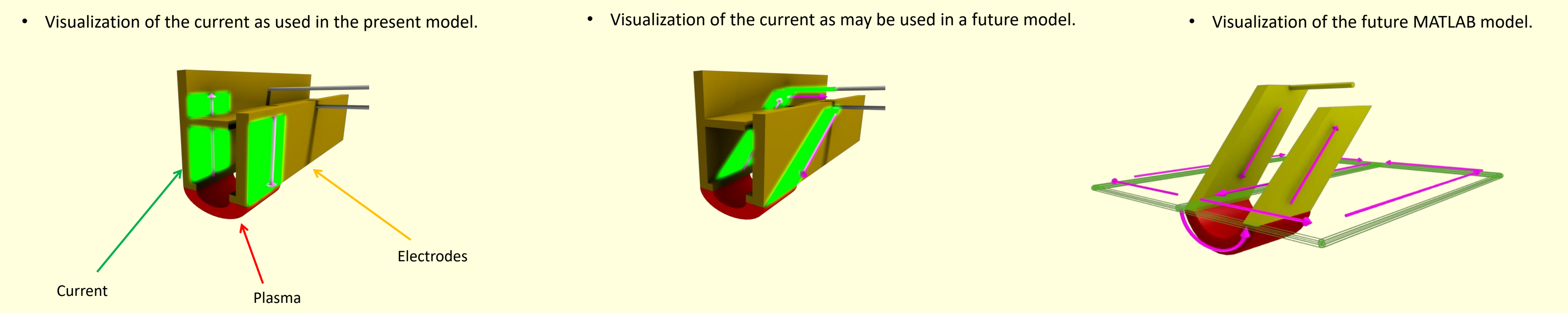


- Results of the model computing the field lines.
- No lines come out as we had hoped.

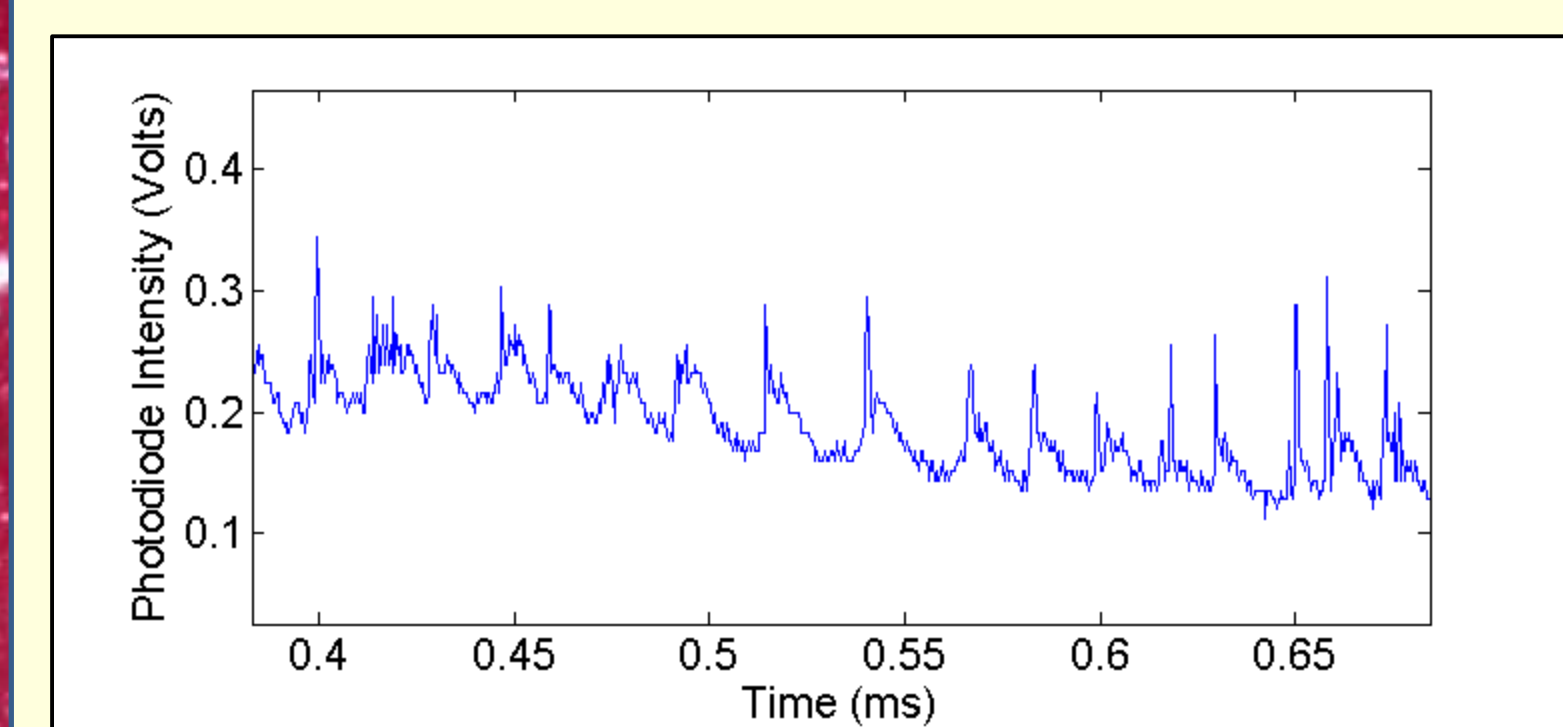


- We tried some other configurations. Here we shortened the length of the plasma arcade.
- The results are not significantly different than the original model.

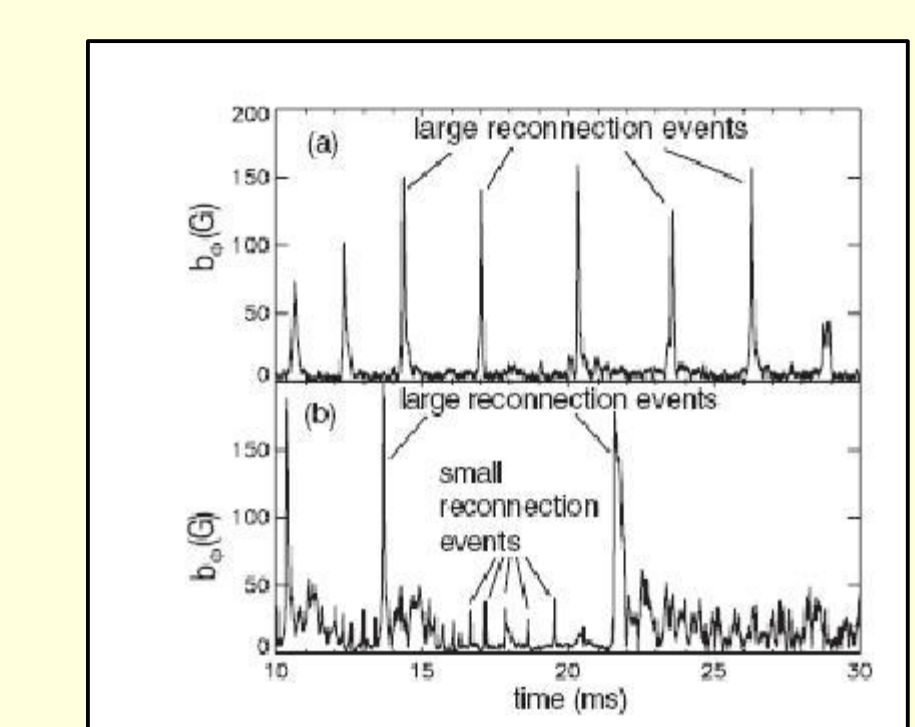
- New idea for model uses slanting current in the electrodes instead of the straight current used earlier.
- We are also considering an MHD model for future research.



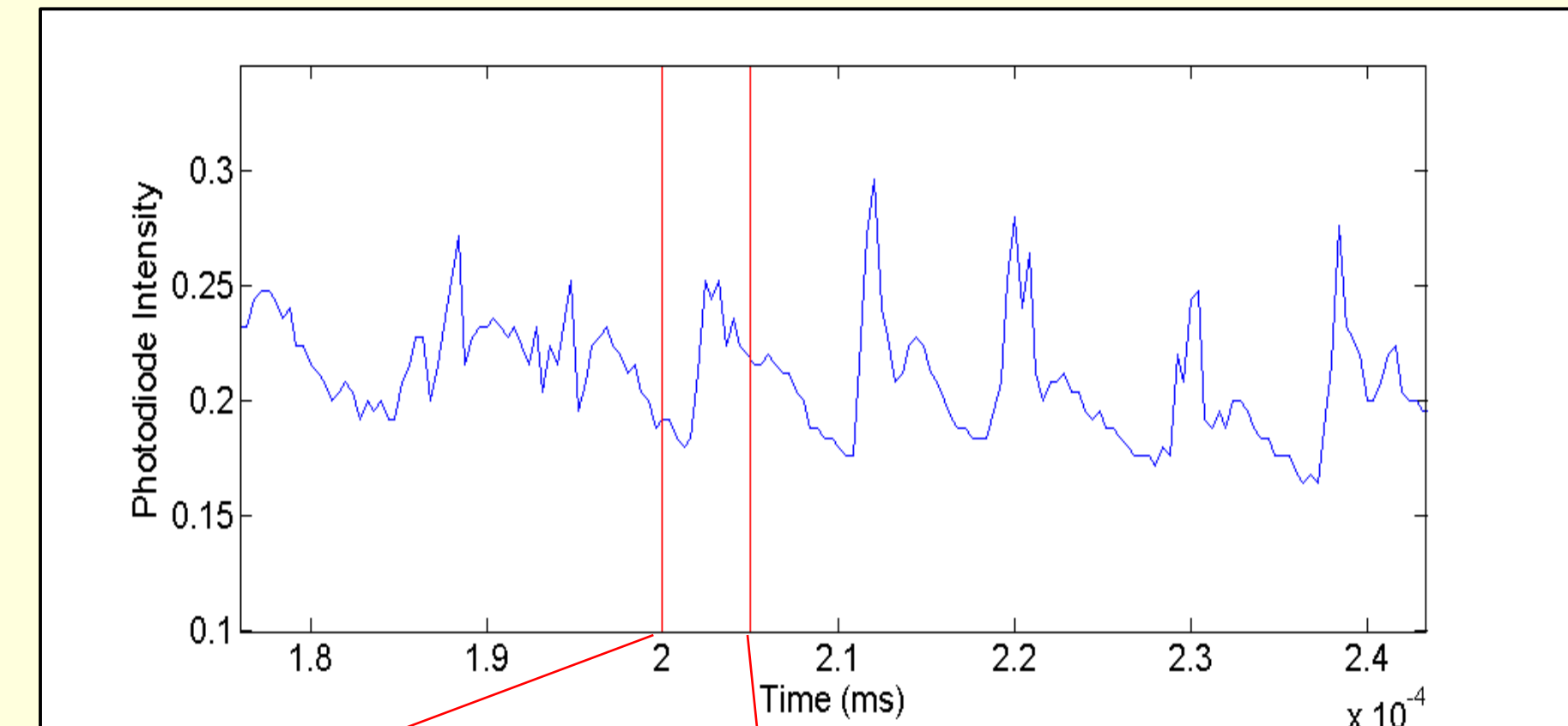
Fast Time Scale Events



- We found fast time scale periodic events.
- These events may be related to magnetic reconnection.
- The events only appeared for a small range of the experimental parameters.



Plot from MST at the University of Wisconsin-Madison. Note the similarity.



Photographs of the Plasma Before and After an Event

