TRAC Program - Fermilab

Anthony Cerqua

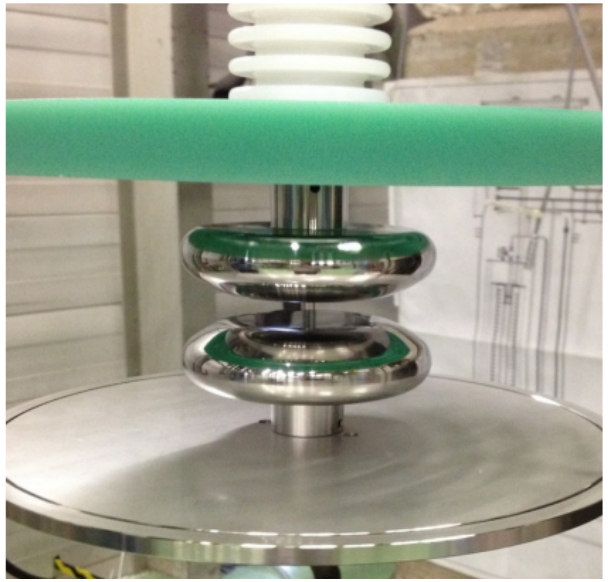
Summer 2015

Intro

- Mentor(s): Sarah Lockwitz and Hans Jostlein
- Area of Study: Liquid Argon
- Experiment: BLANCHE

BLANCHE Experiment

- Previous studies of the dielectric breakdown in liquid argon



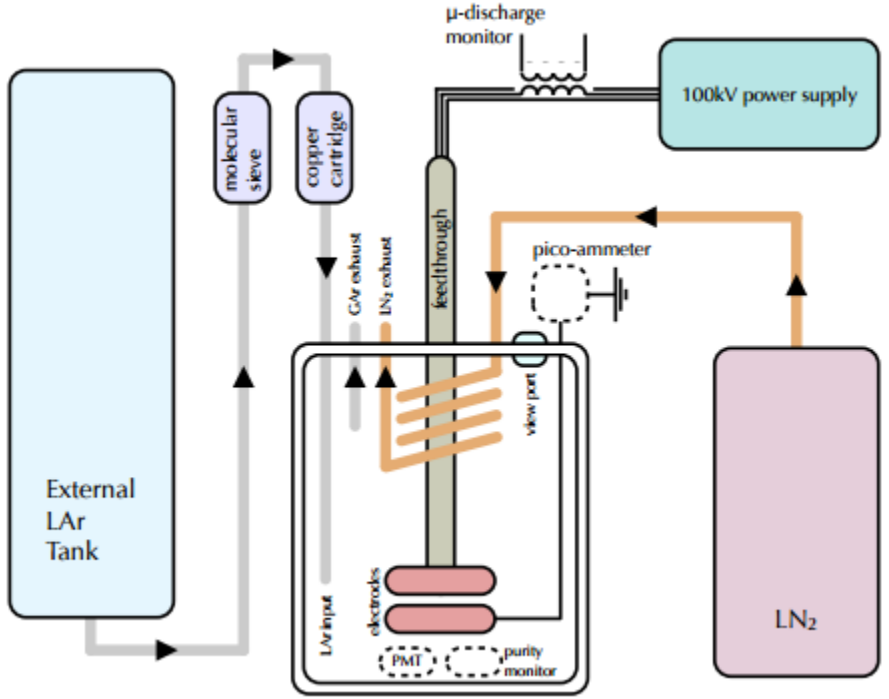
Evidence of electric breakdown induced by bubbles in liquid argon[a]

F. Bay, C. Cantini, S. Murphy, F. Resnati,[†] A. Rubbia, F. Sergiampietri, and S. Wu

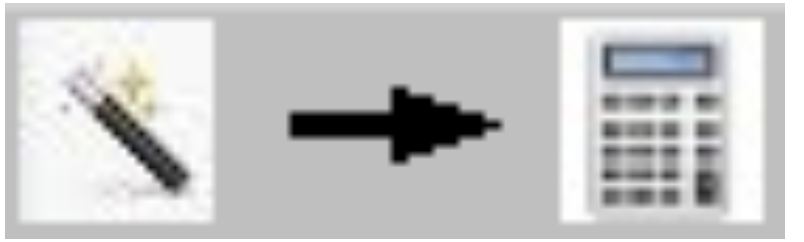
ETH Zurich - Institute for Particle Physics,

Otto-Stern-Weg 5, 8093 Zurich (Switzerland)

(Dated: 13 January 2014)

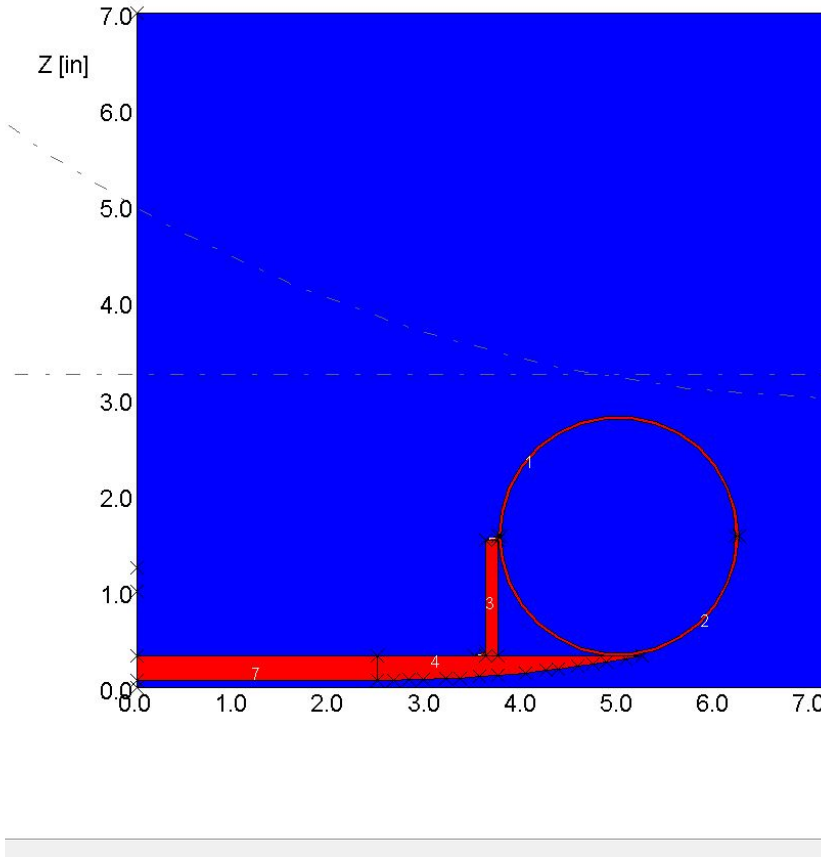


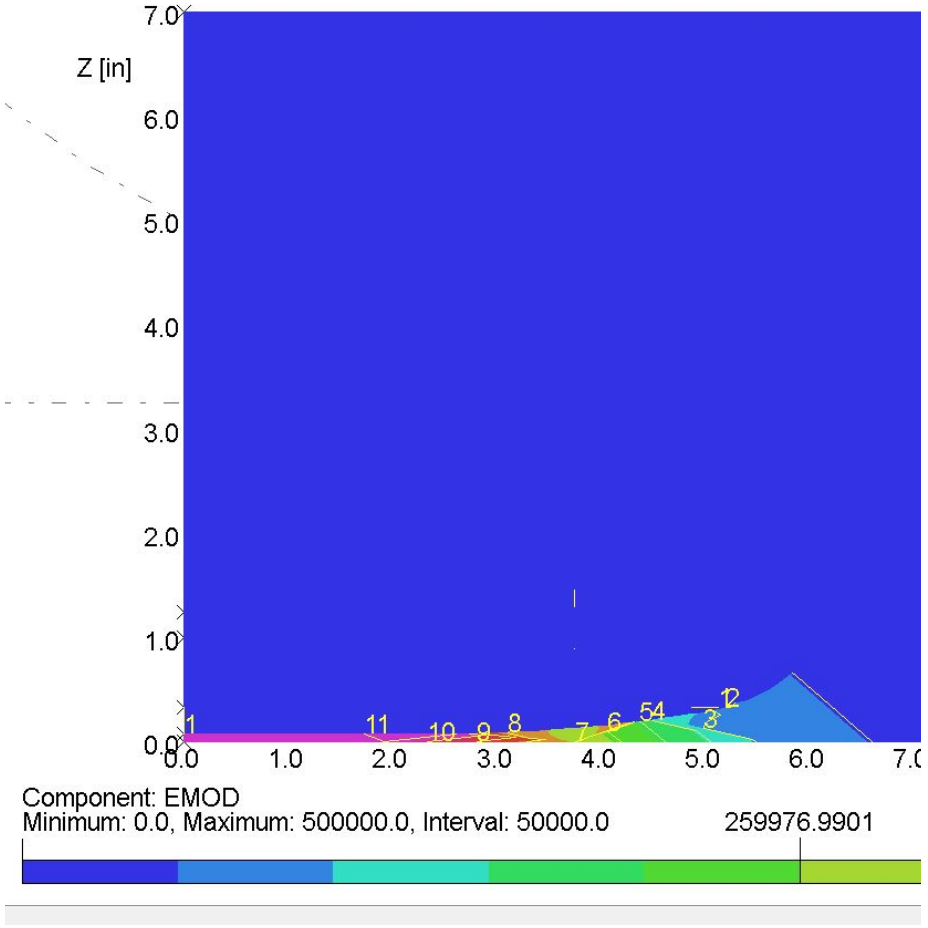
Blanche Experiment



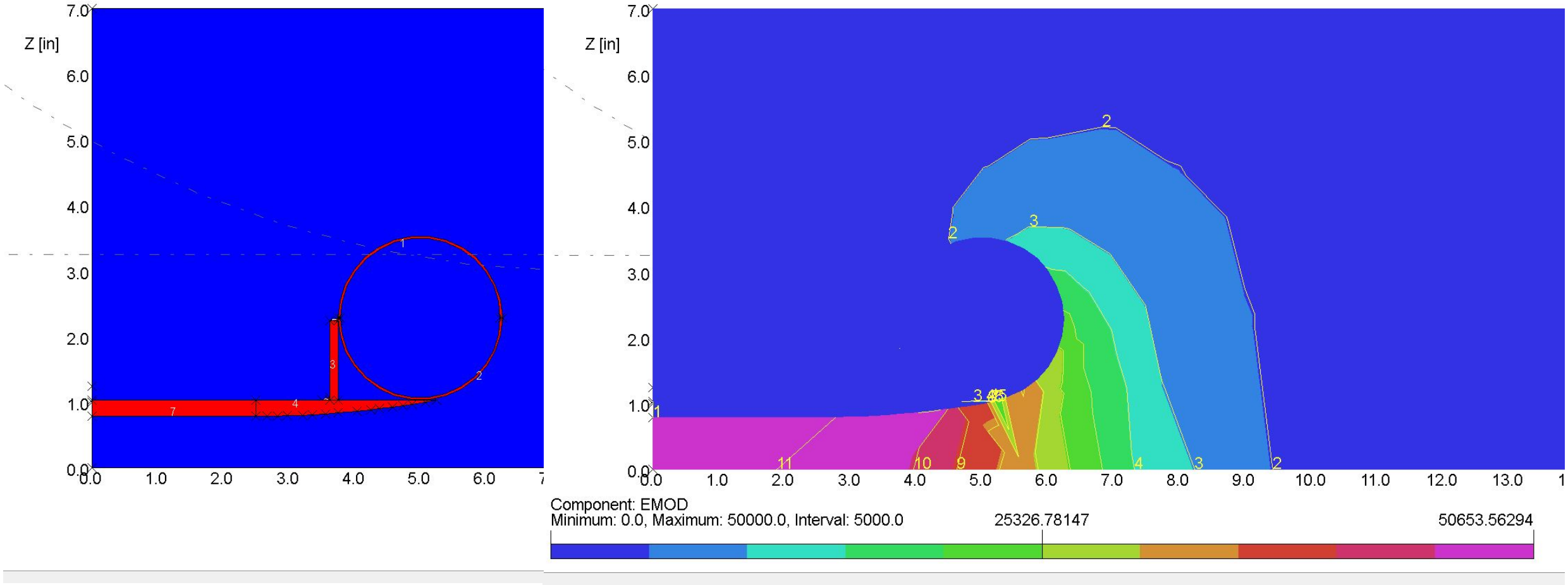
- Procedure: Increase voltage across electrodes (up to 150 kV) until breakdown (spark) occurs
- Modifications: Different shaped electrode (uniform electric field) and adjustable distance between electrodes

Finite Element Analysis - Opera





Finite Element Analysis - Opera



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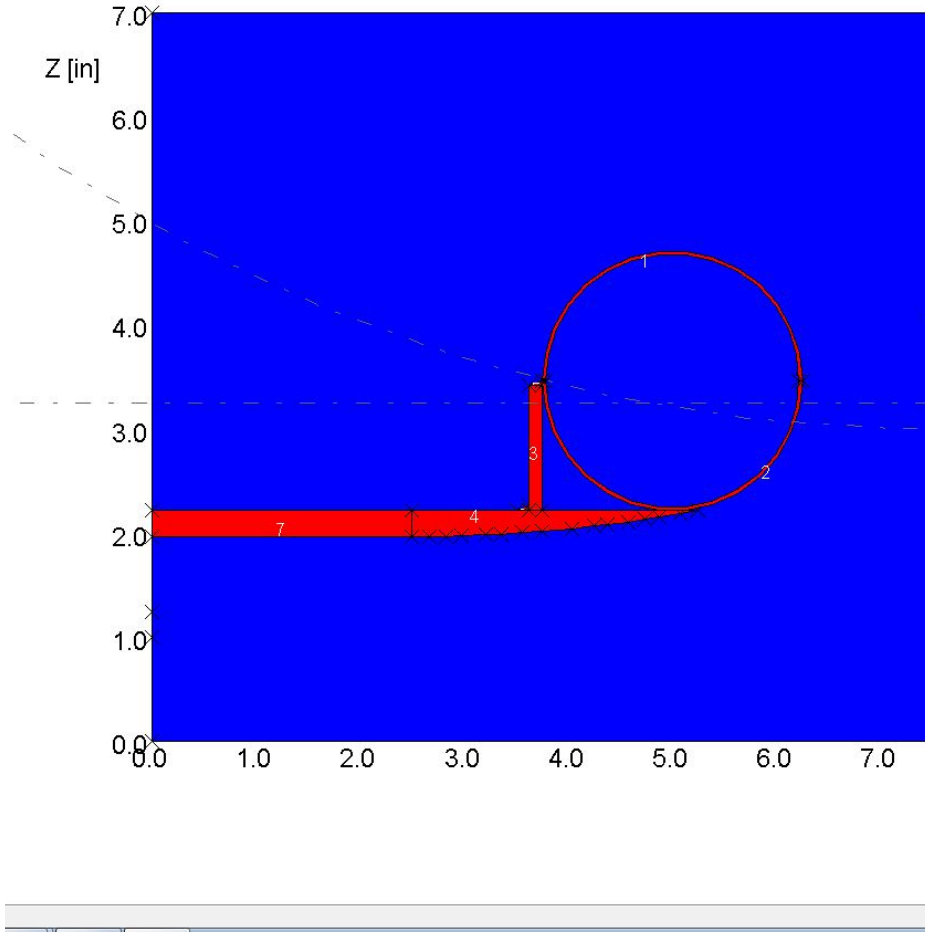
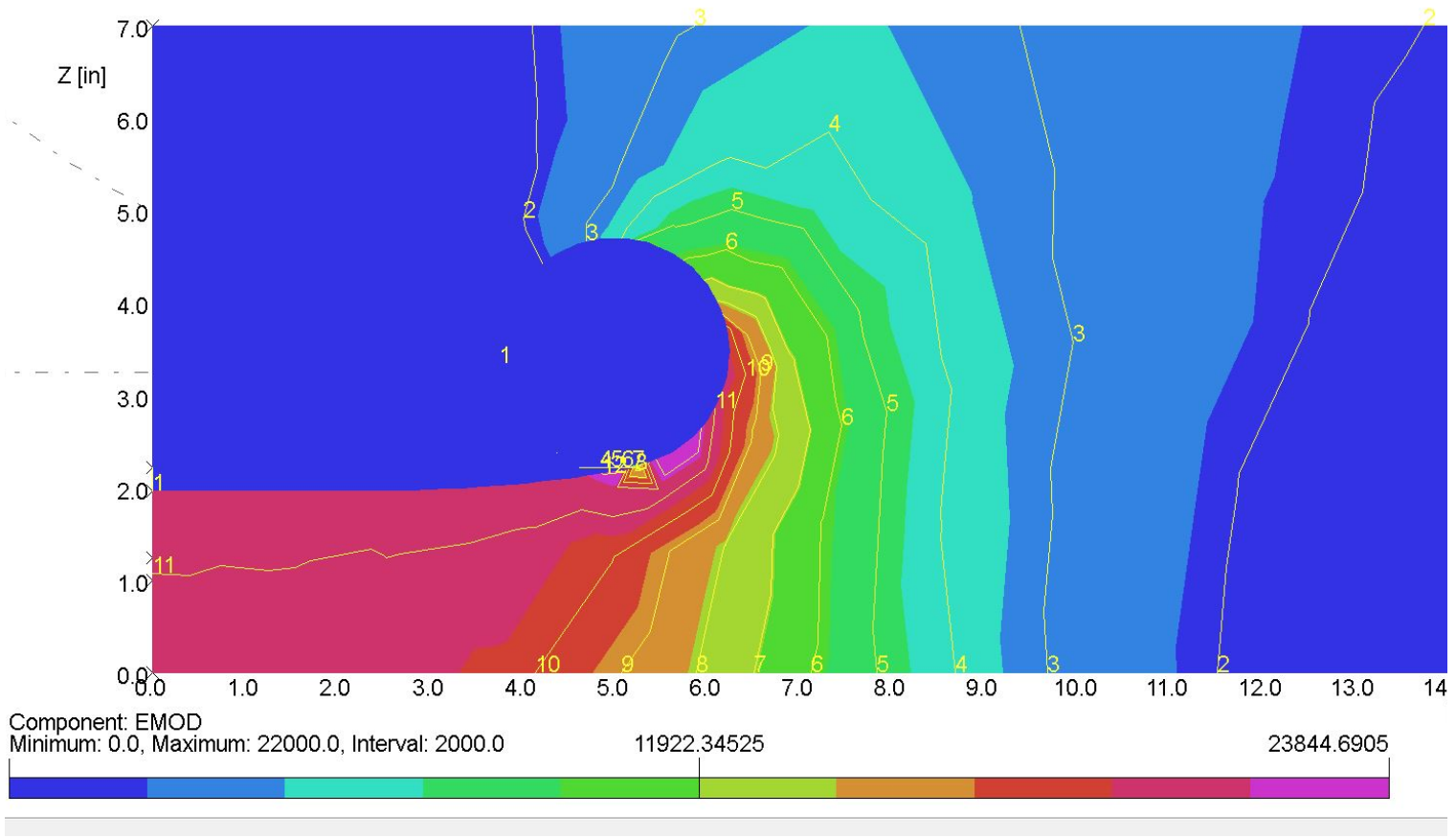
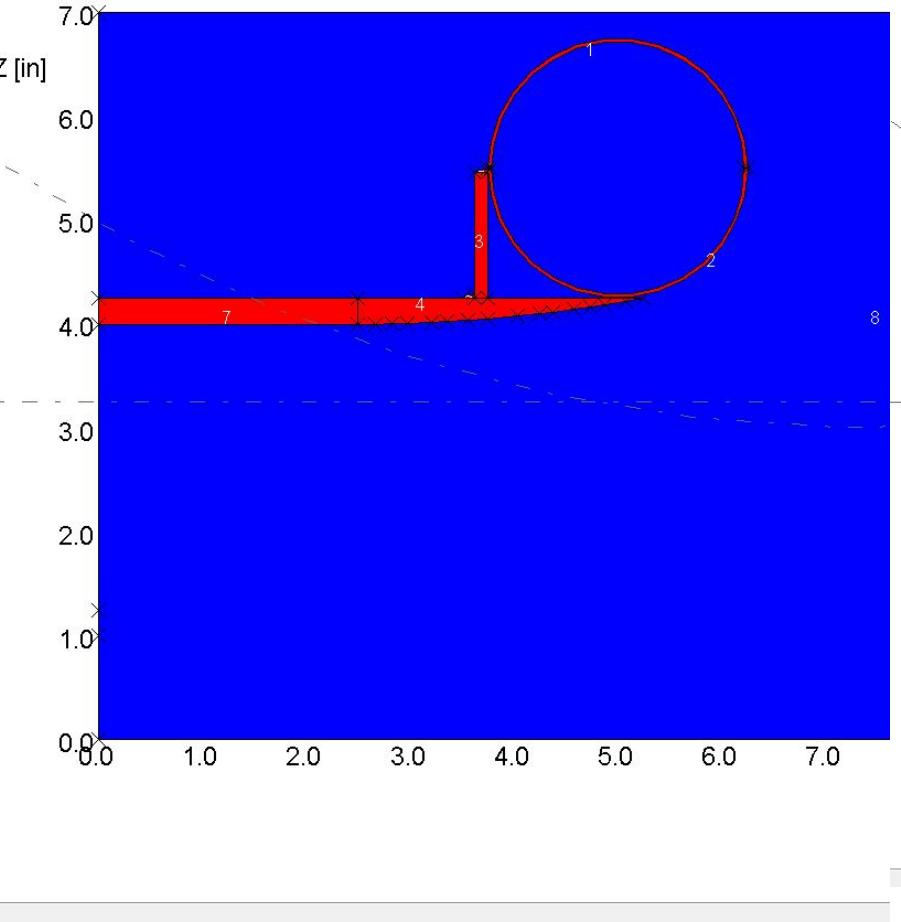
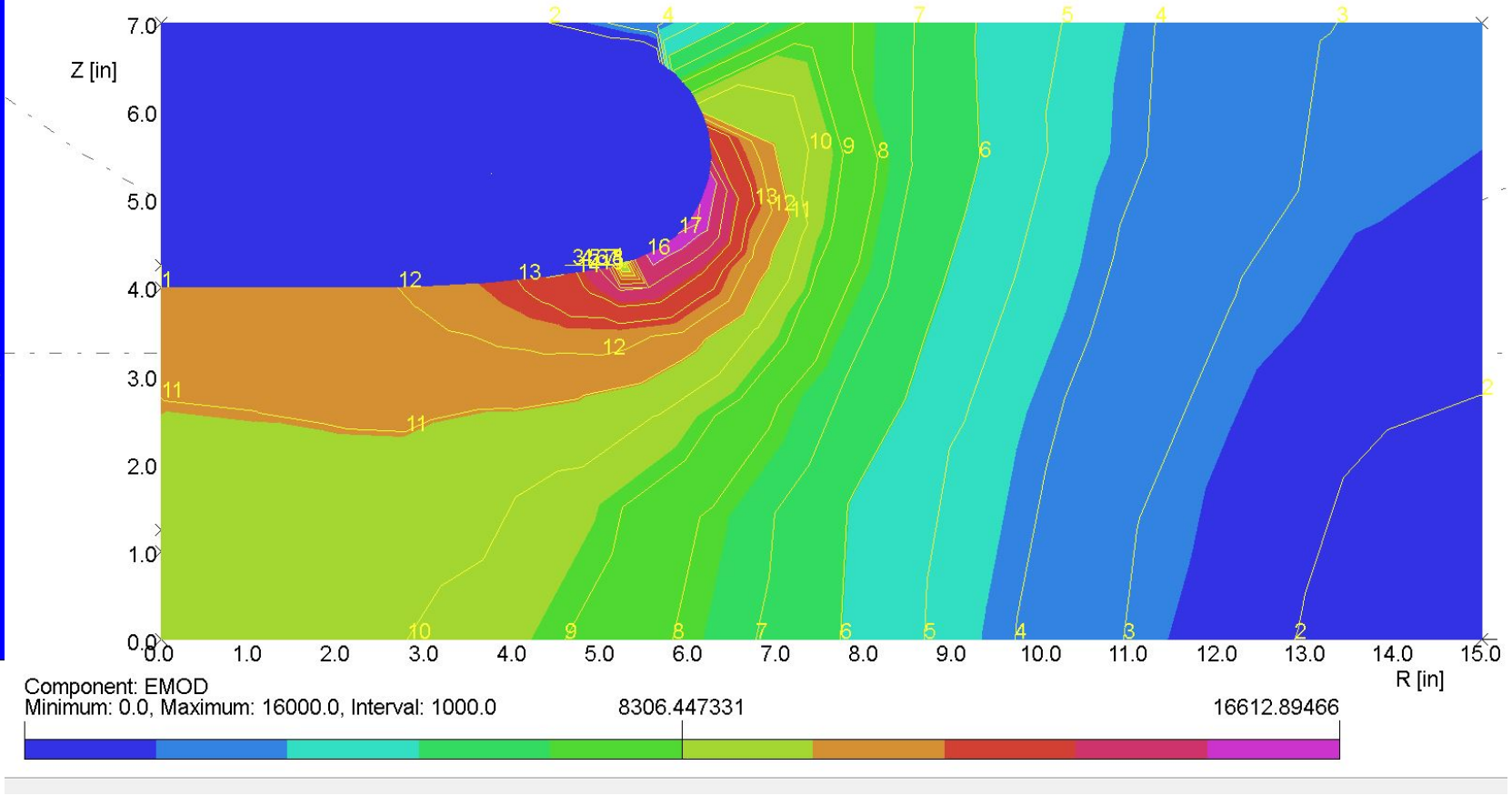




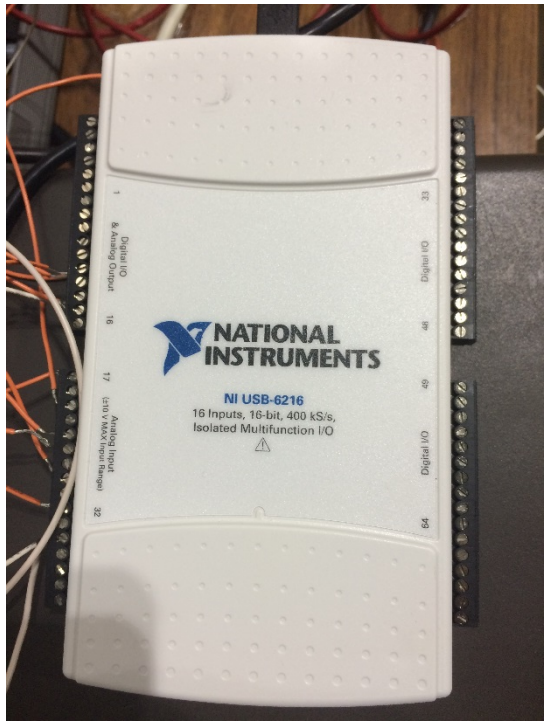
Finite Element Analysis - Opera

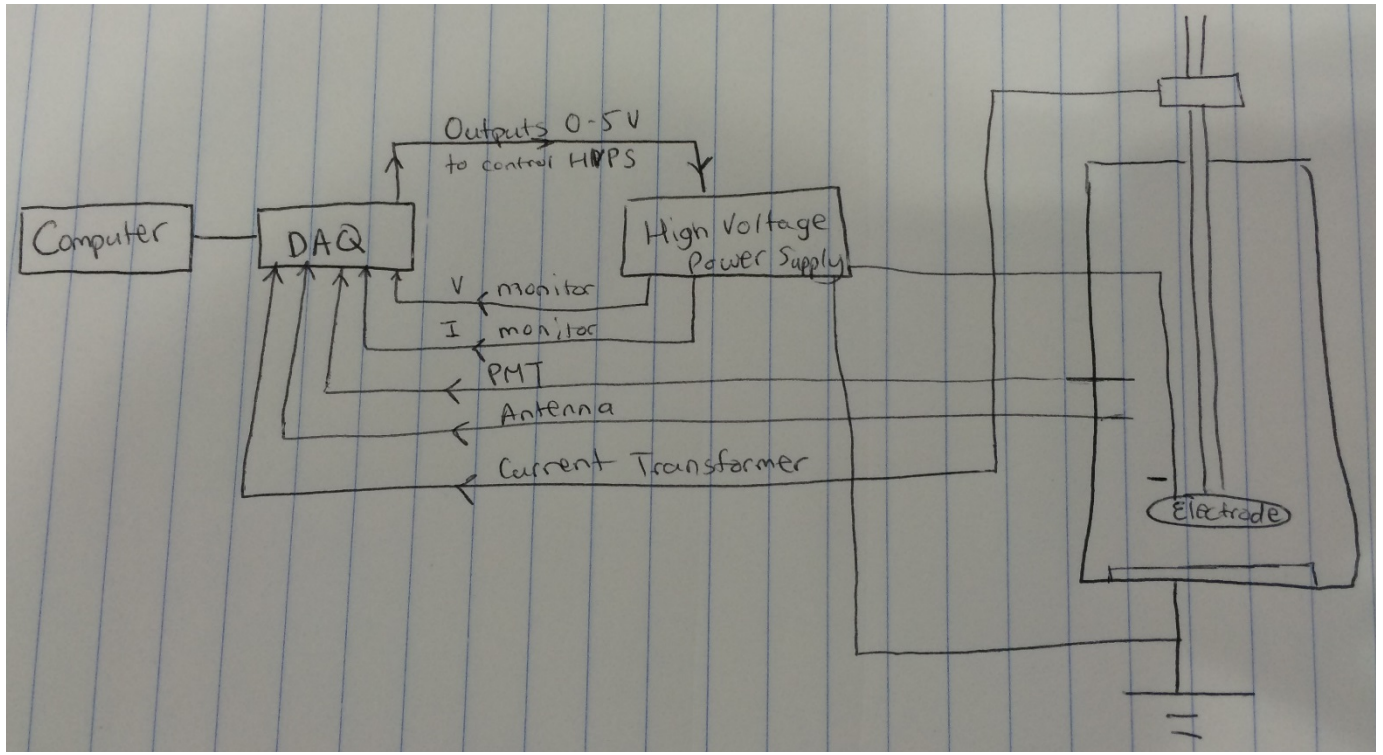




LabView

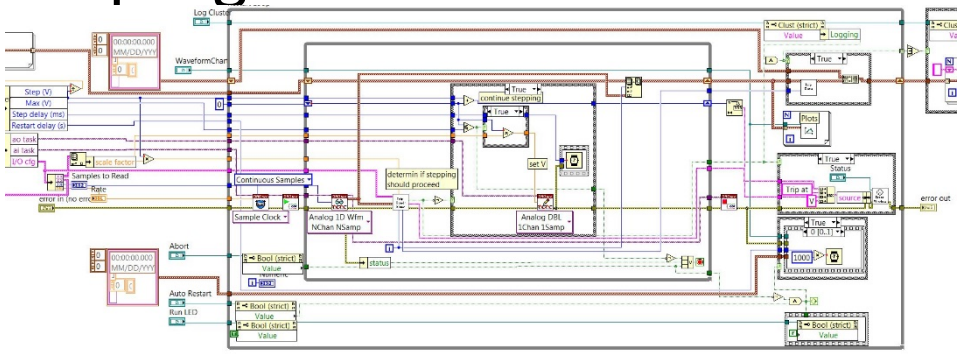
- Function: LabView acts as a control interface for the Glassman Power Supply, in addition to collecting data and writing to file

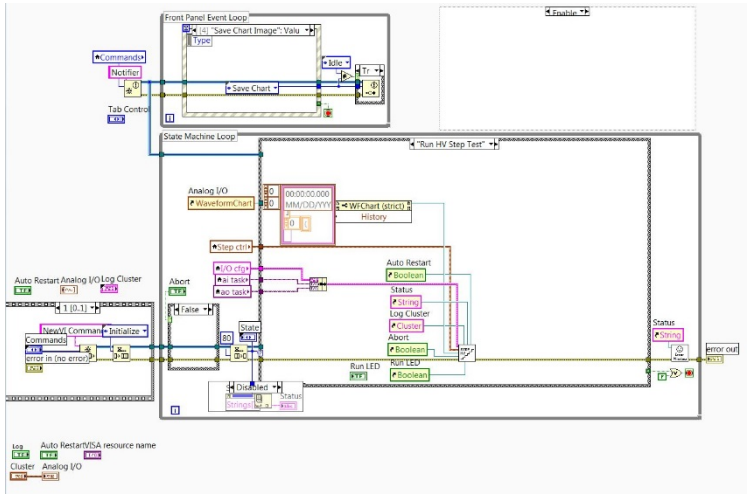


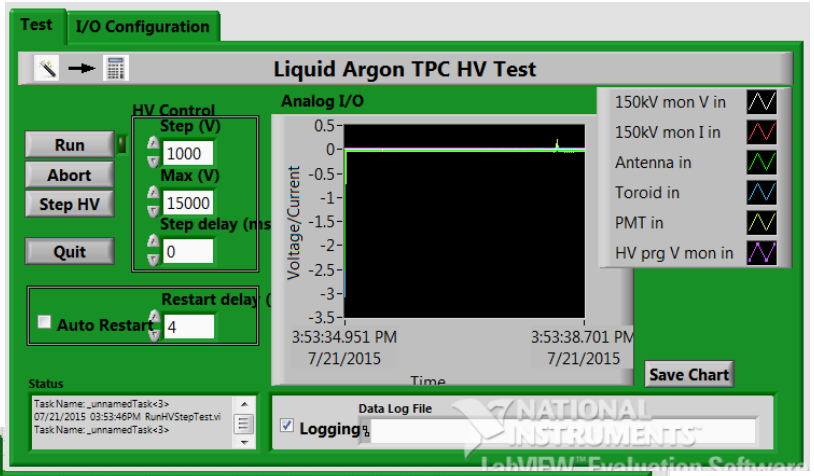


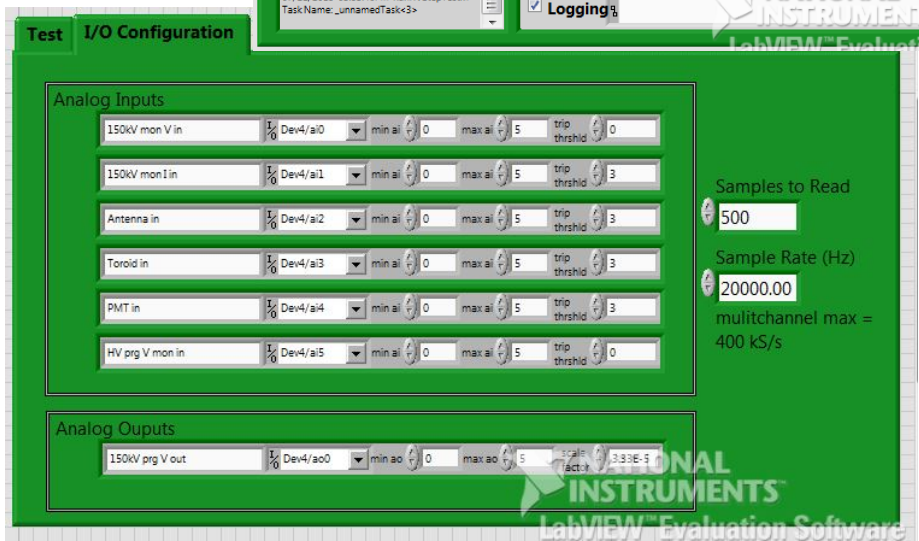
LabView (cont.)

- Eventually enrolled the help of David Slimmer who wrote our final program



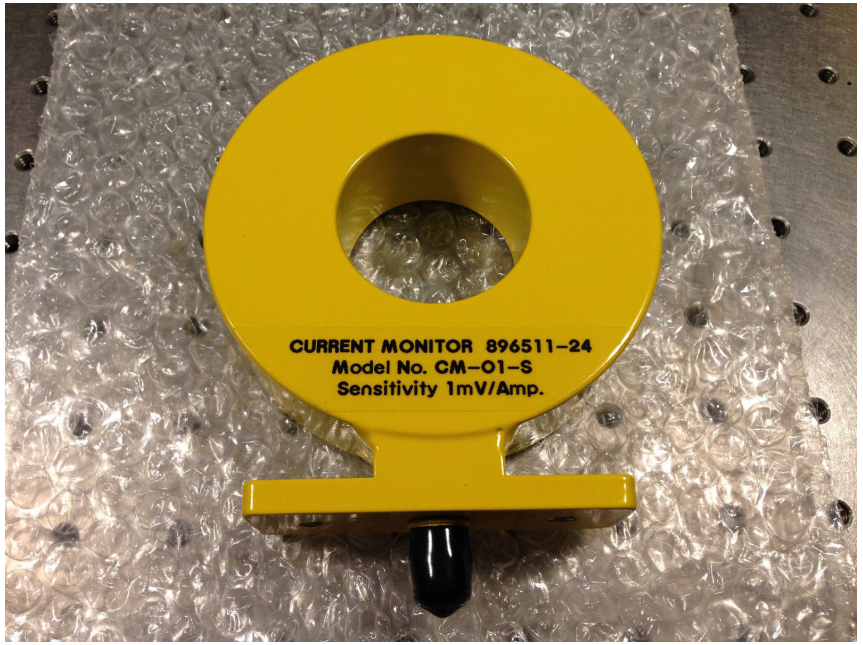


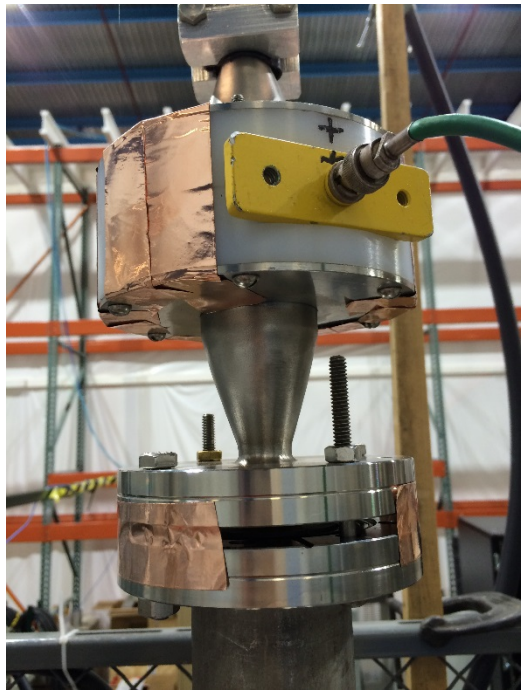




Current Transformer

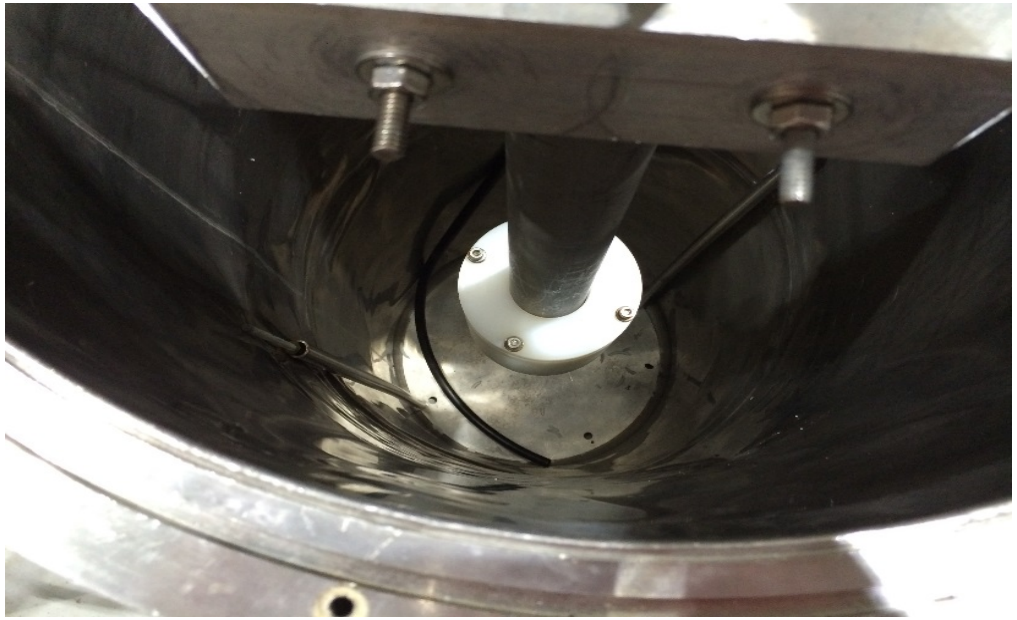
- Function: In the event of a spark, a small current is created that might be too small or too quick to read. A current transformer is able to amplify the signal. This signal can then tell the power supply to shut down.





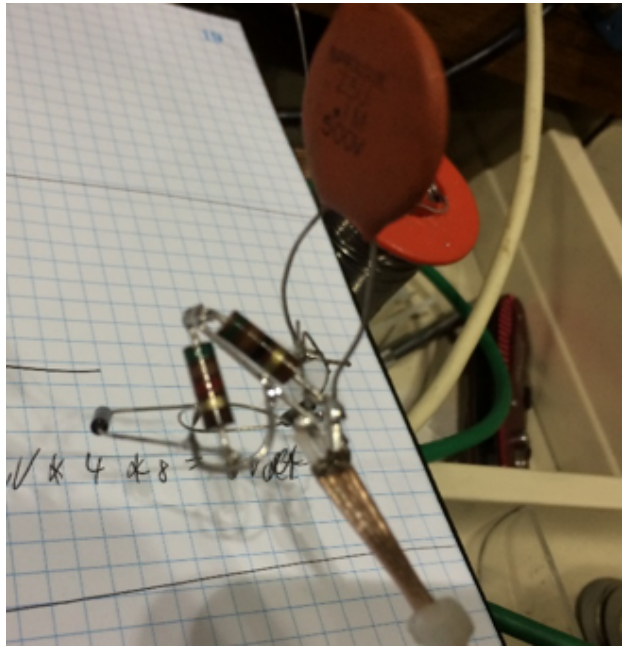
Current Transformer Testing

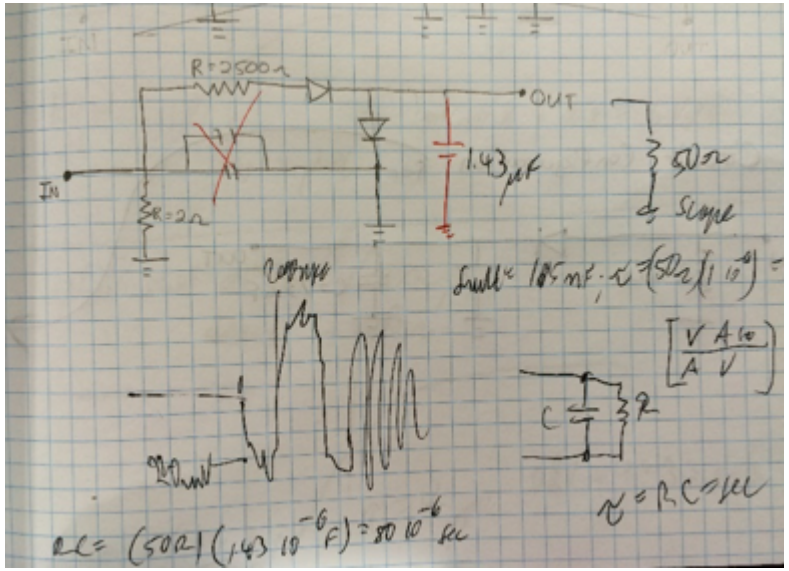
- Used the Glassman power supply to create a voltage difference between a nail and ground
- Eventually a spark was created which was detected by the transformer

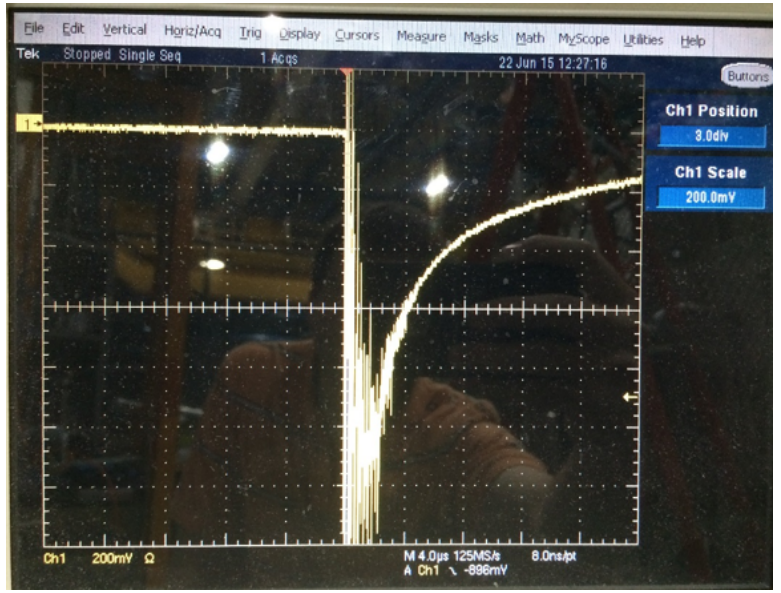


Current Transformer Circuit

- Unfortunately, this signal was too short (less than 1 microsecond) to be detected with the anticipated sampling rate of the DAQ
- Developed RC circuit that would be charged by the transformer and discharge a longer signal for our triggering devices to detect

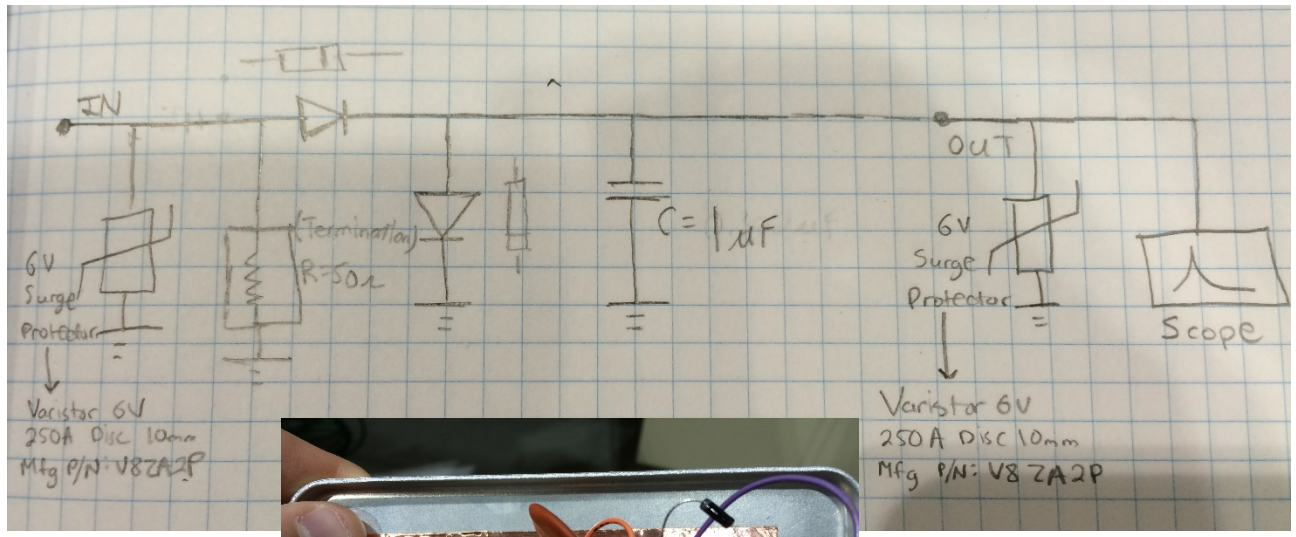


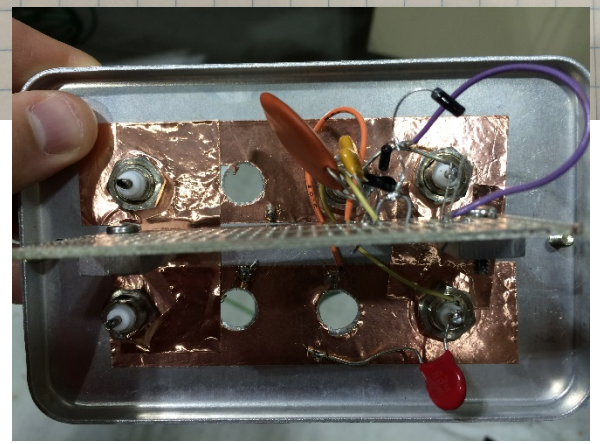


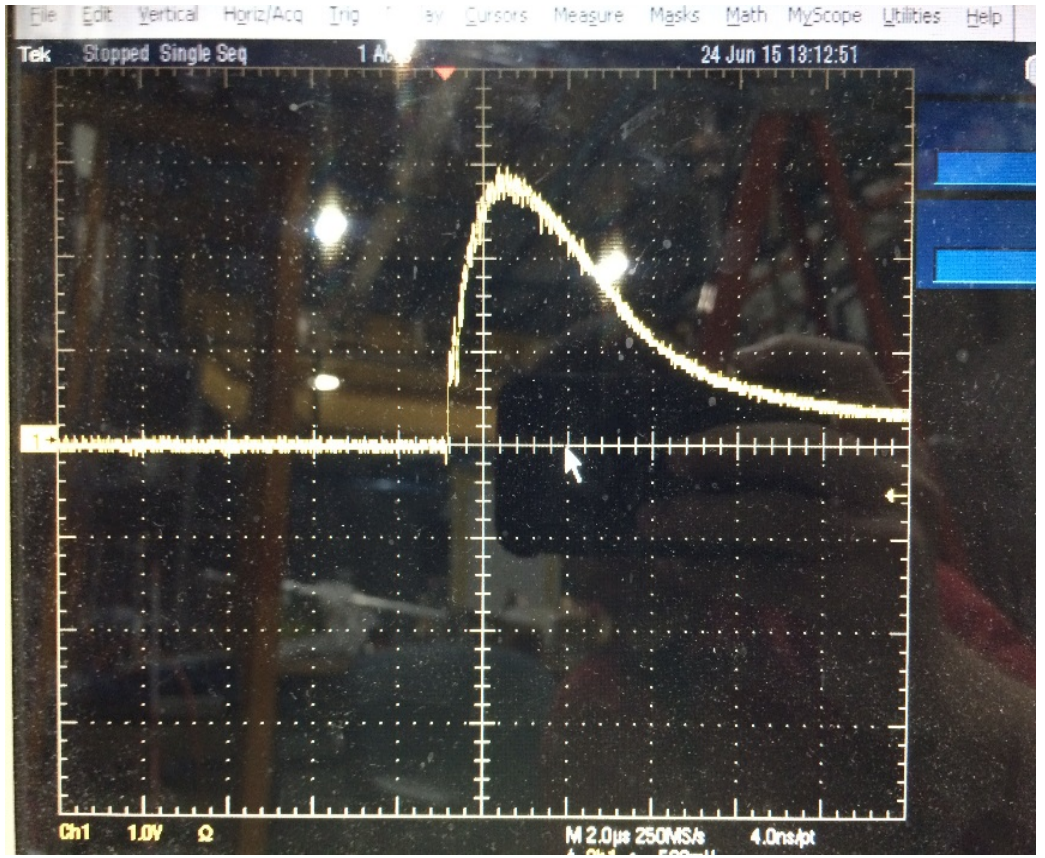


Current Transformer Circuit

- RC circuit with a time constant greater than 20 microseconds and 1 V
- Same circuit/transformer will be added to MicroBoone

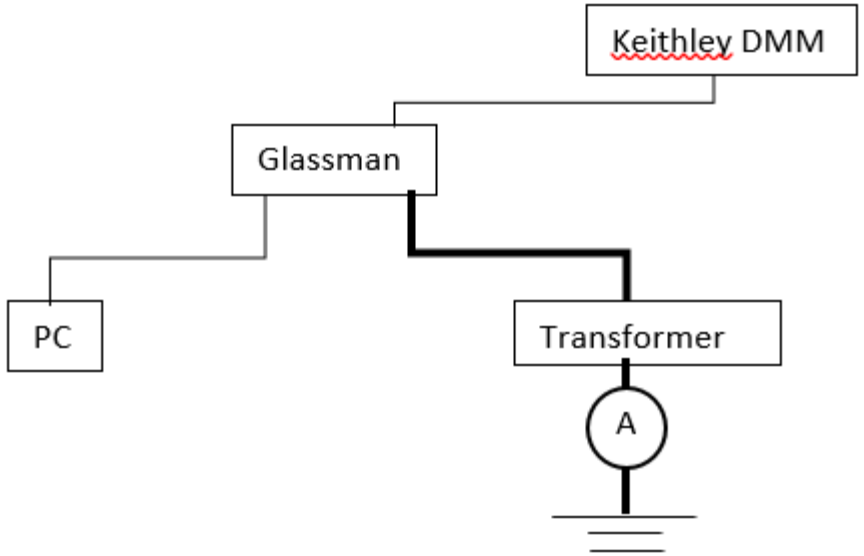


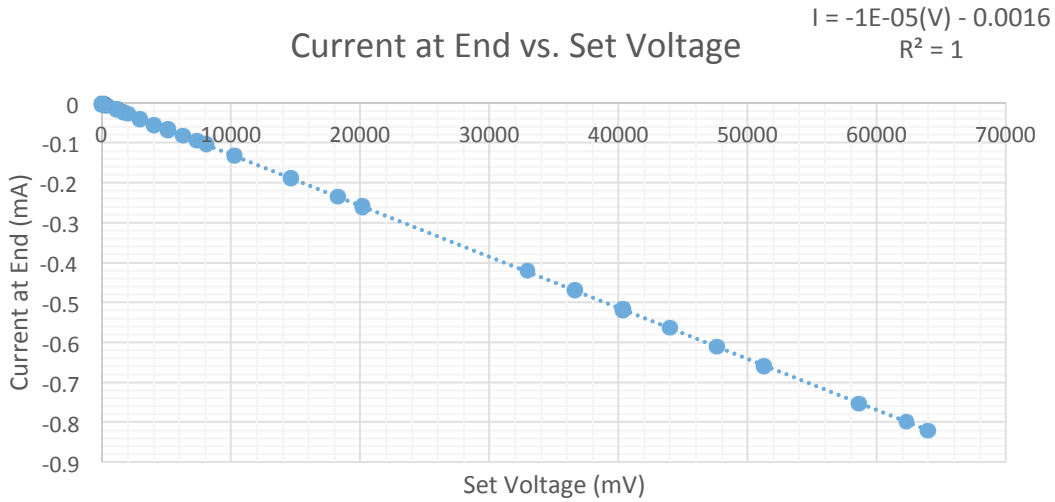




Power Supply Calibration

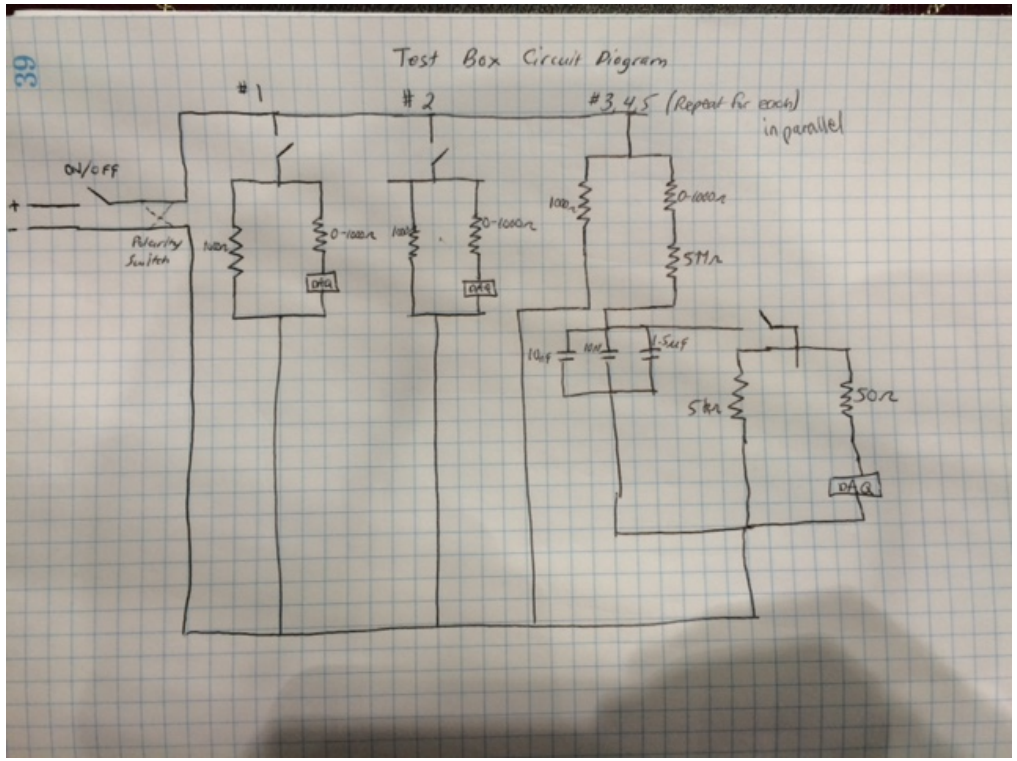
- Using a digital control for the Glassman Power Supply, so each bit corresponds to approximately 37 V (which means we can only set the voltage to within approx. 20 V)
- To find any offset at low voltages, set up an ammeter between power supply and ground and graphed set voltage against current observed
- Determined that there is a 0.0016 mA current offset in all readings that must be accounted for

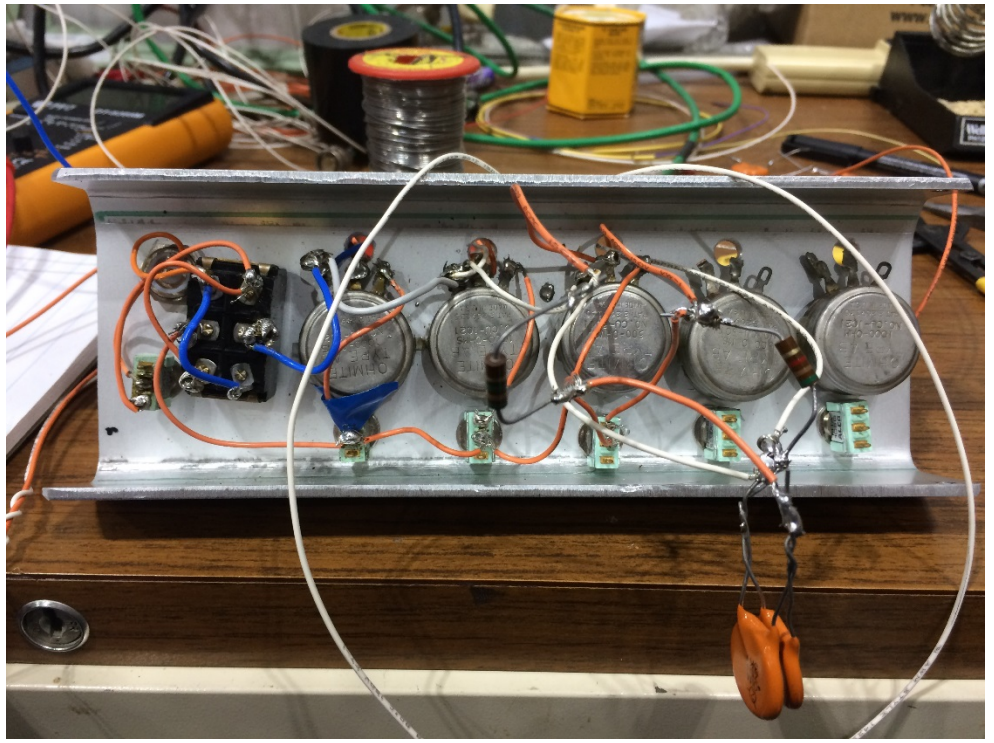




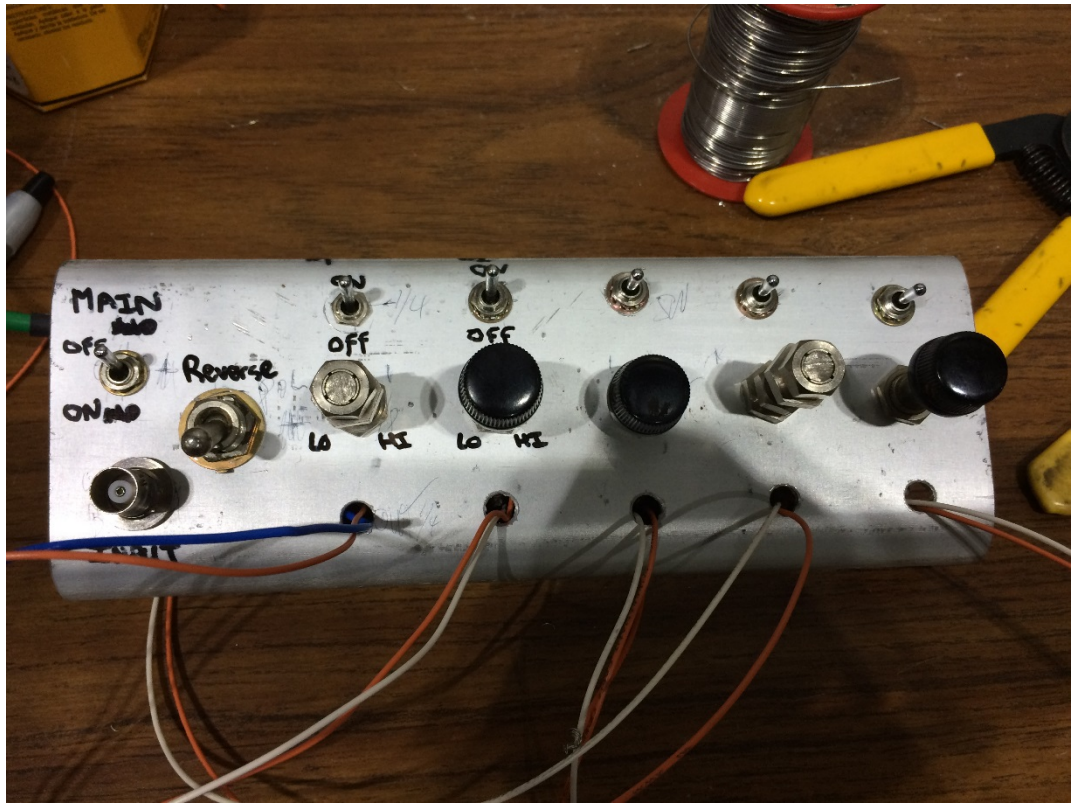
LabView Testing

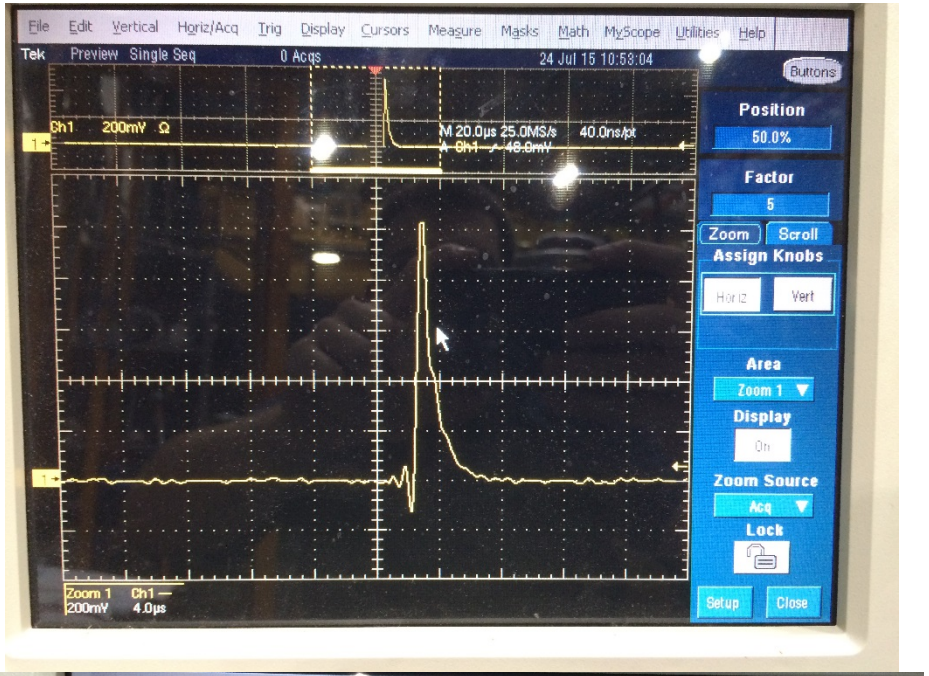
- To test our LabView program's ability to ramp voltage and stop based upon outside triggers, we created a test box

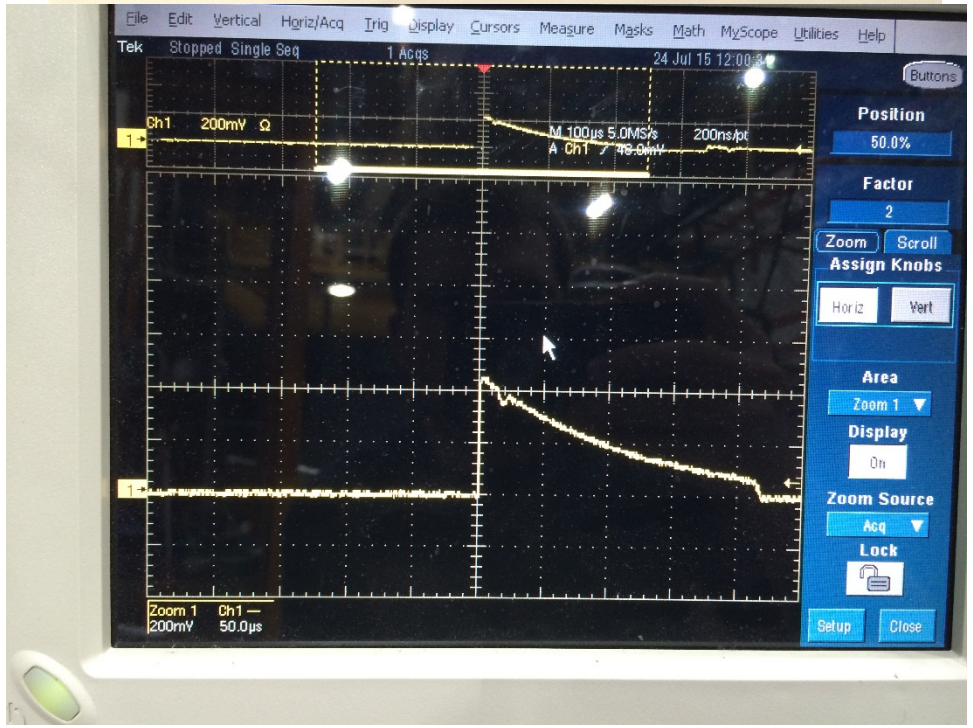




LabView Testing







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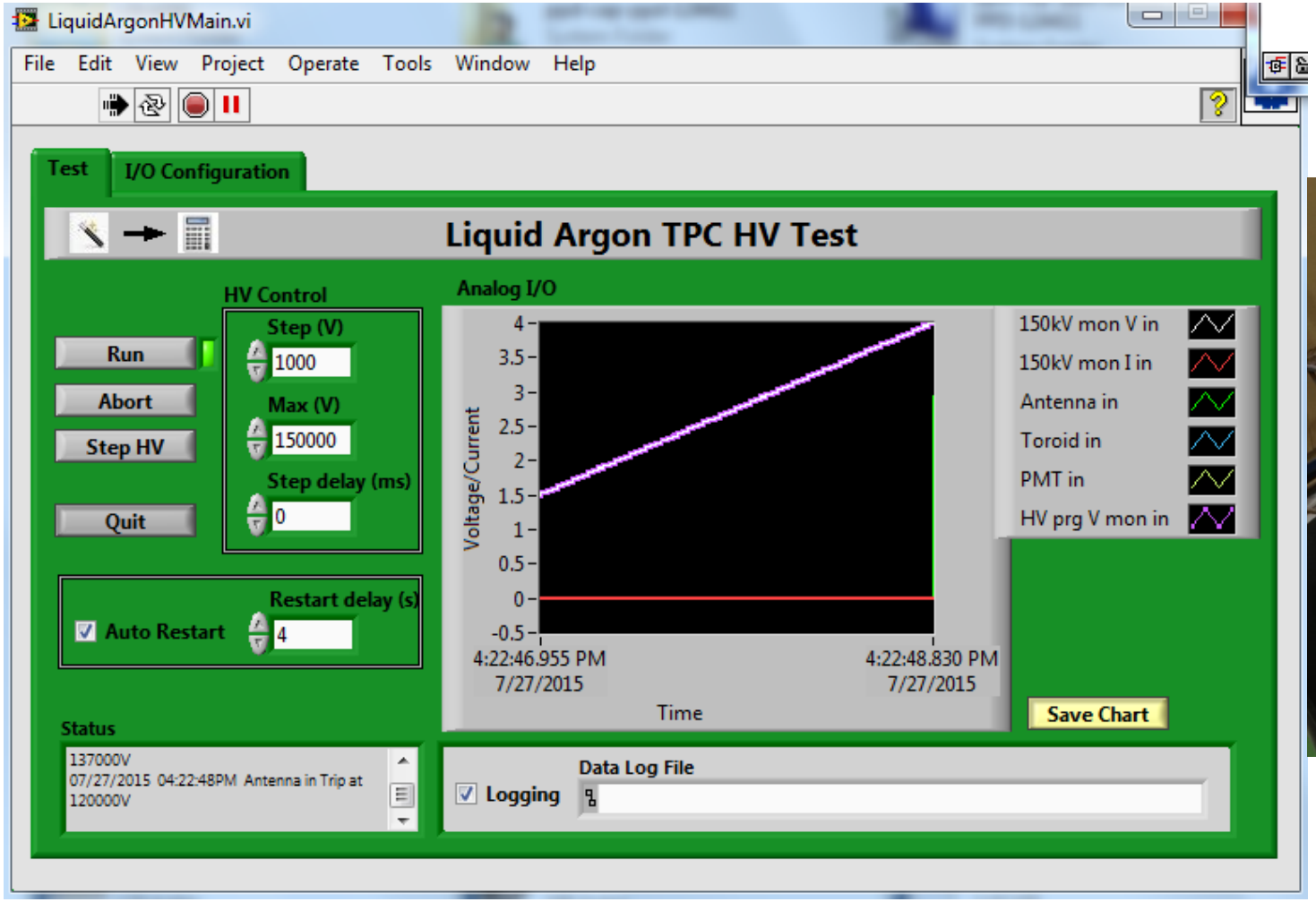

Slooooooooo-Mo

- Edgertronic High Speed Camera
- Will be used to see propagation of sparks in liquid argon

- Video at right: 700 ISO, 2,000 fps

Back to the Classroom – Lessons Learned

- Science (research) is non-linear (even more so than engineering)
- Learn the most when you figure something out yourself
- Technical skills: RC Circuits, soldering

- Bring in more current events/recent discoveries to encourage students to be citizens of science and support causes

THANKS!!!