



---

# The Search for Nuclear Particles in the Pd-D Co-Deposition Experiment

Francis L. Tanzella  
Benjamin P. Earle  
Michael C. H. McKubre

8th International Workshop on Anomalies in  
Hydrogen/Deuterium Loaded Metals  
Catania, Italy 13-18 October 2007

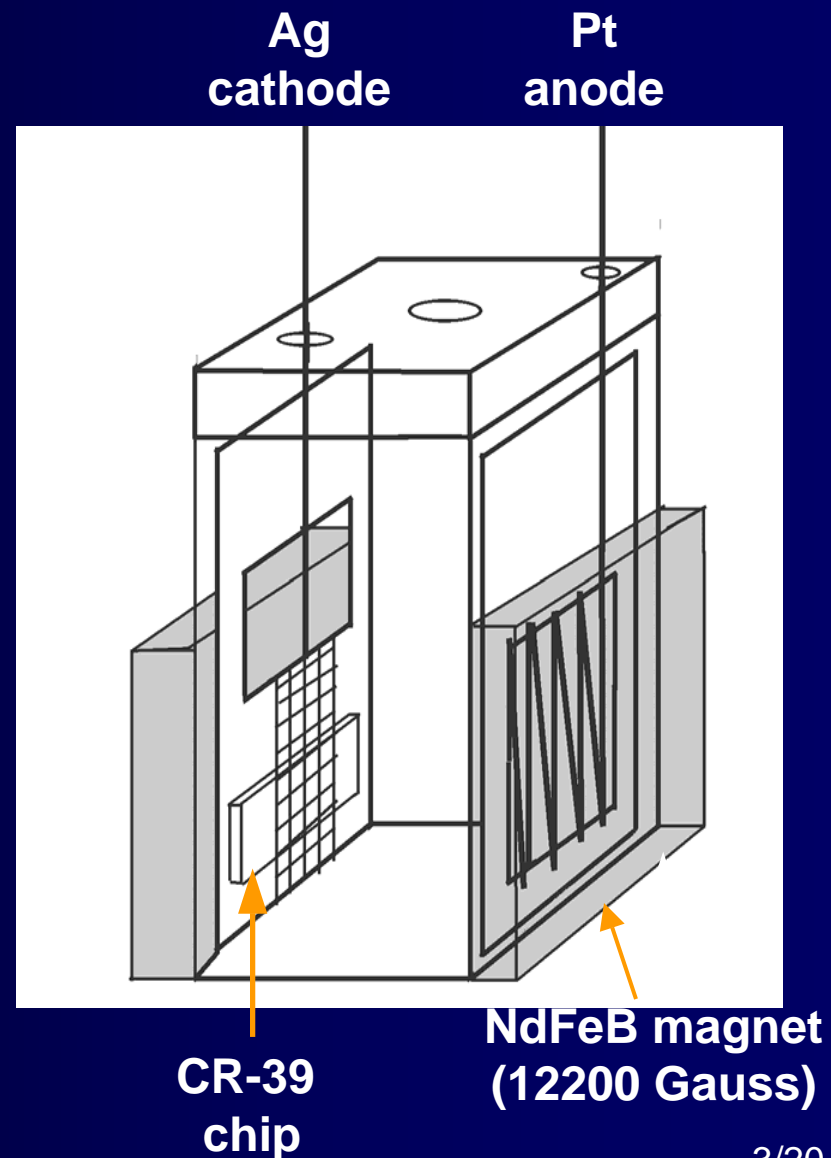
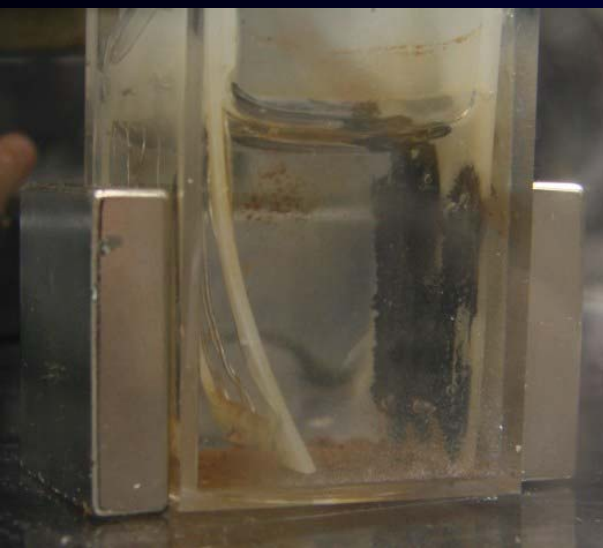
# OUTLINE

---

- Experimental Design and Protocol
- Results: Electrochemistry, SSNTD (CR-39),  
and Neutron Count Measurement
- Conclusions
- Future Work

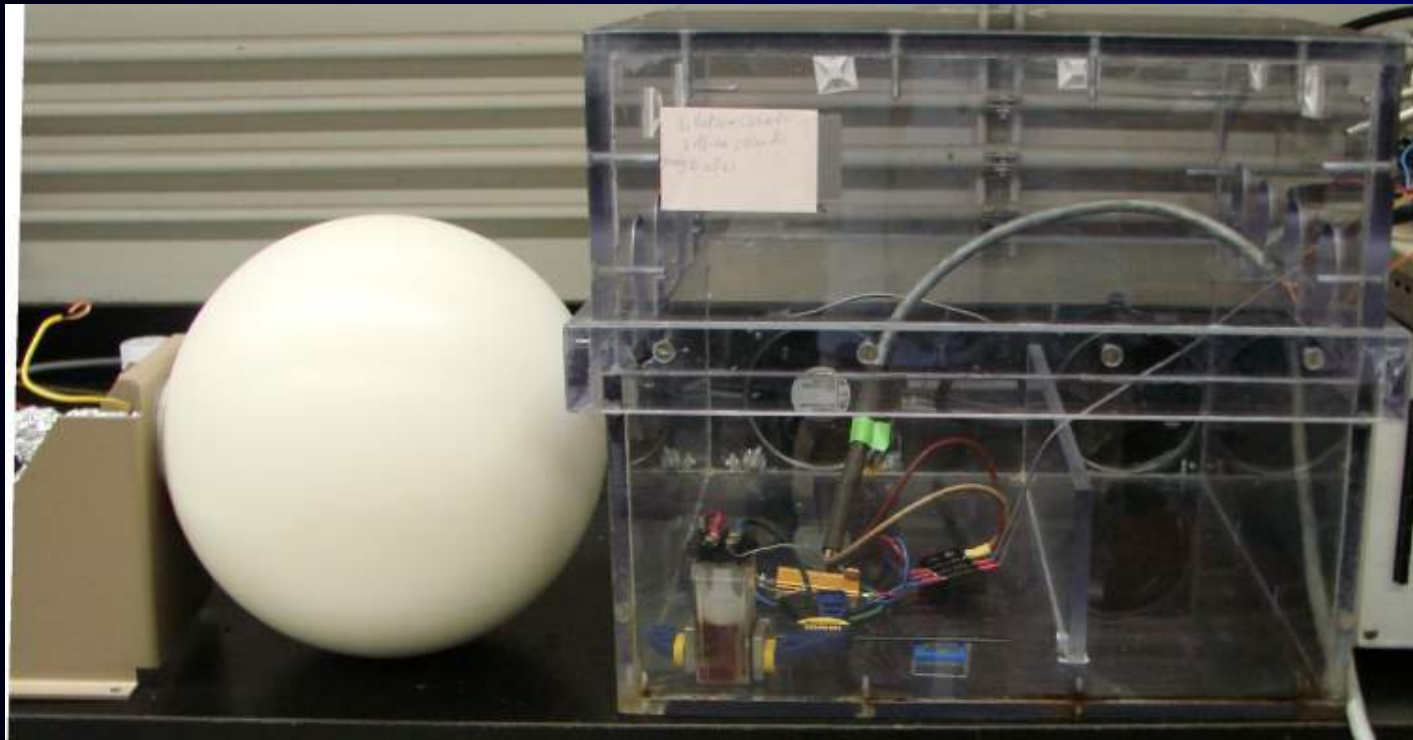
# Experimental: Wet CR-39 Experiments

- All cells had magnets.
- 0.03 M  $\text{PdCl}_2$  ; 0.3 M  $\text{LiCl}$  ;  $\text{D}_2\text{O}$
- 0.2mA for 1 day, 0.5mA until solution cleared then 12 - 48 hours each of 1, 5, 10, 25, 50, and 100mA
- Experiments 3 - 6: cathode was ~16 cm of 0.5mm Ag wire wrapped against the CR-39
- Experiments 3 and 4 used TASL CR-39
- Experiments 5 - 12 used Fukuvi CR-39
- Etched in 6.5 N  $\text{NaOH}$ , for 6.5 hours, at  $65^\circ\text{C}$

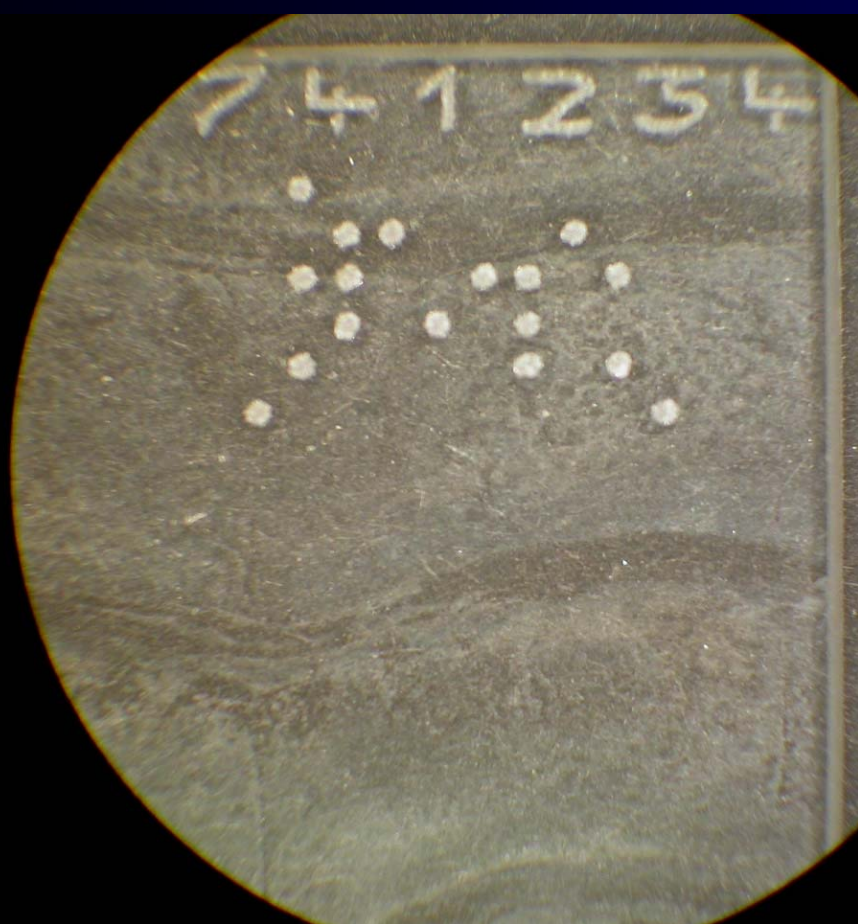


# Experimental: Neutron Counter

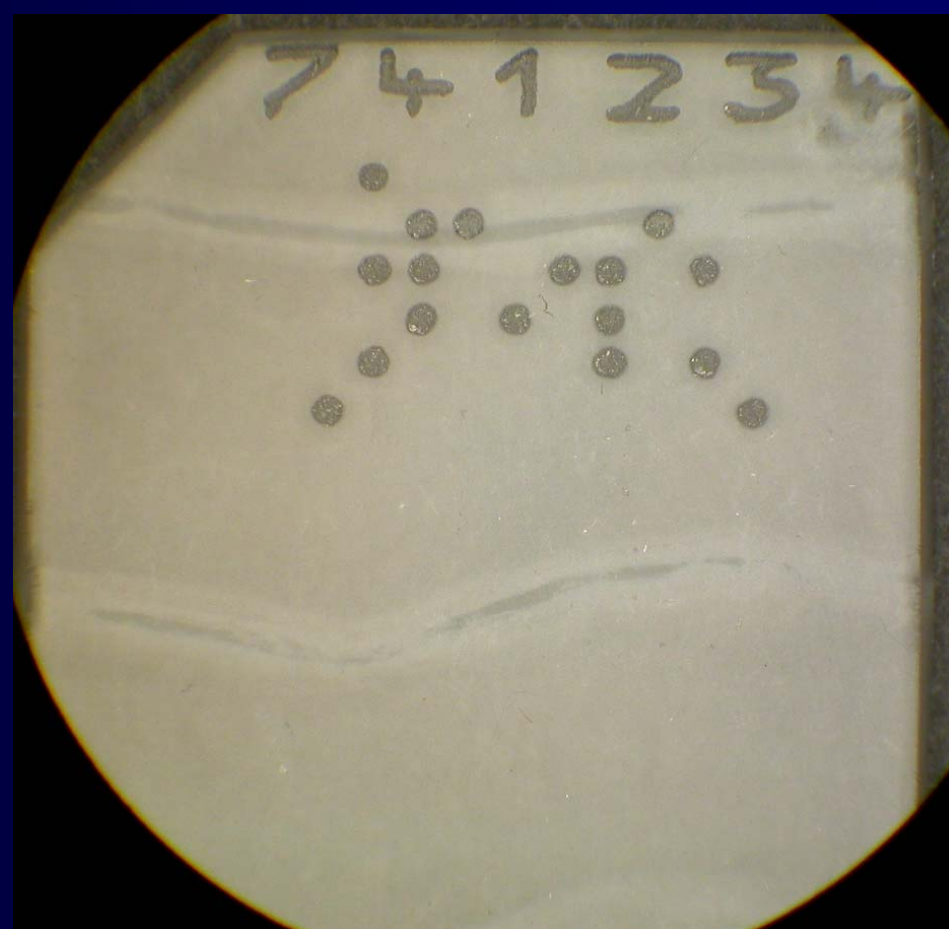
- $\text{BF}_3$  Ionizing neutron detector about 10 cm from operating cell.
- 12mm polycarbonate safety shield might thermalize neutrons and/or allow recoil back to CR-39



# Results: BE008-4 CR-39 (TASL CR-39)

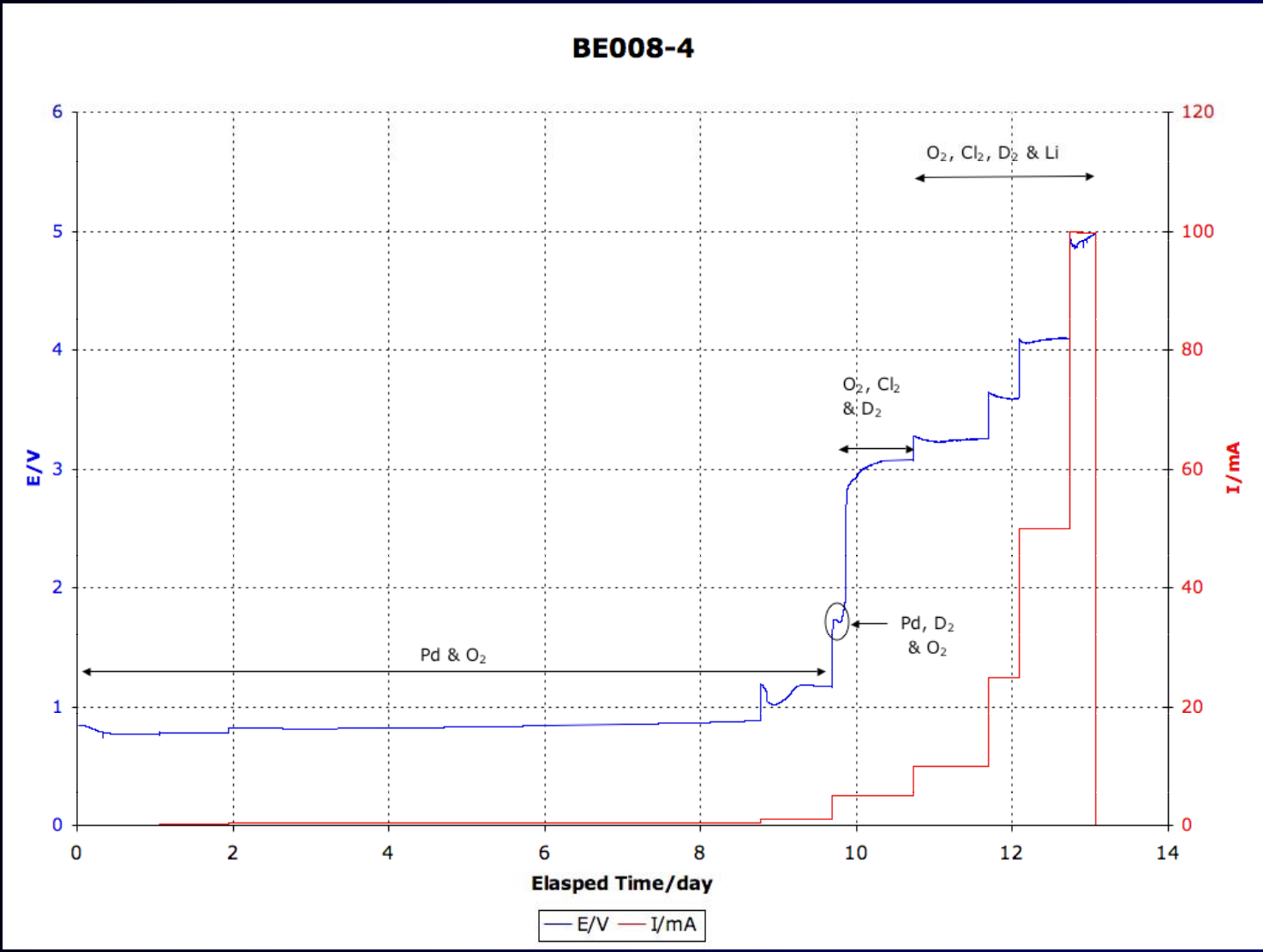


Before Etch



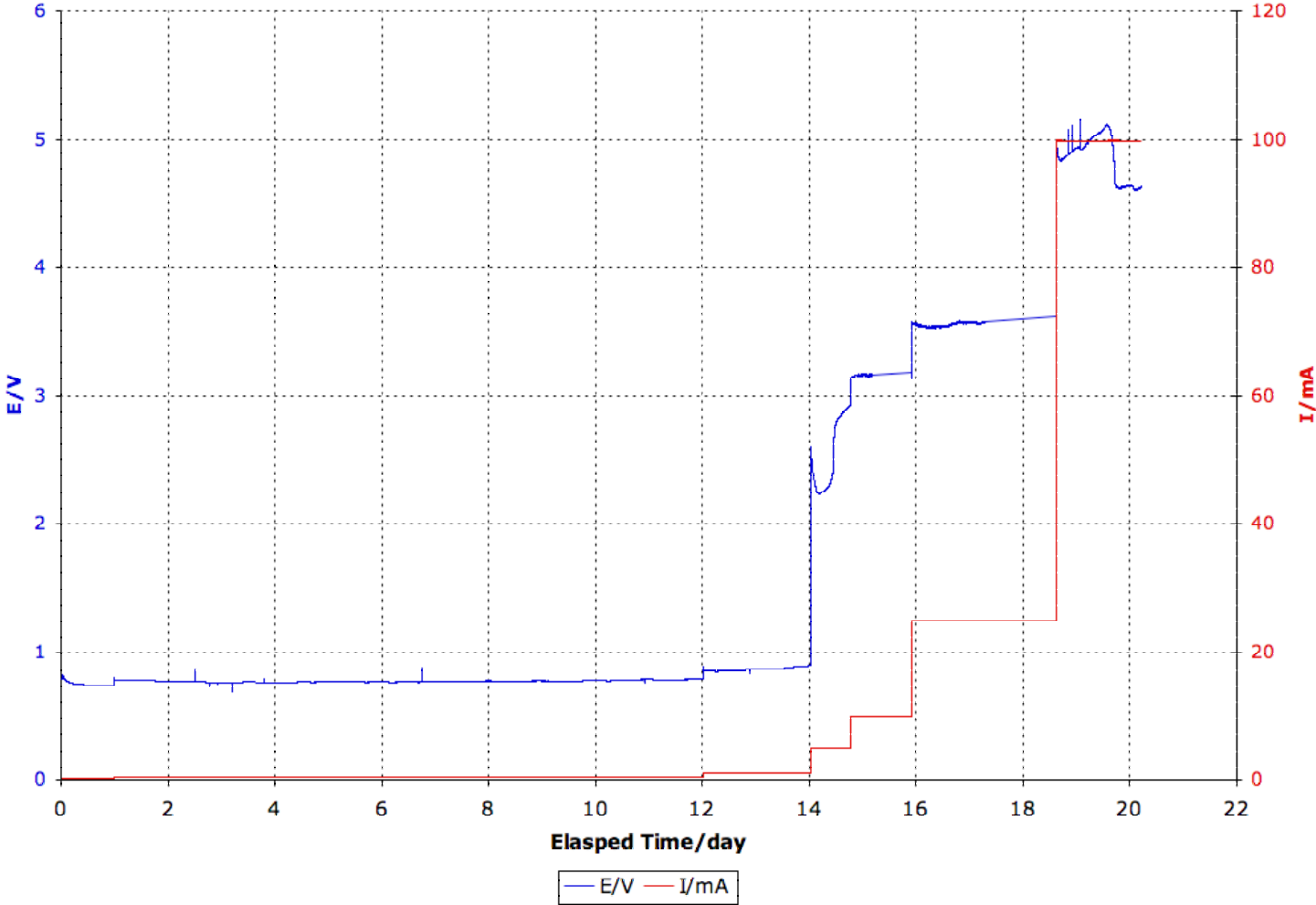
After Etch

# Results: Electrochemical BE008-4

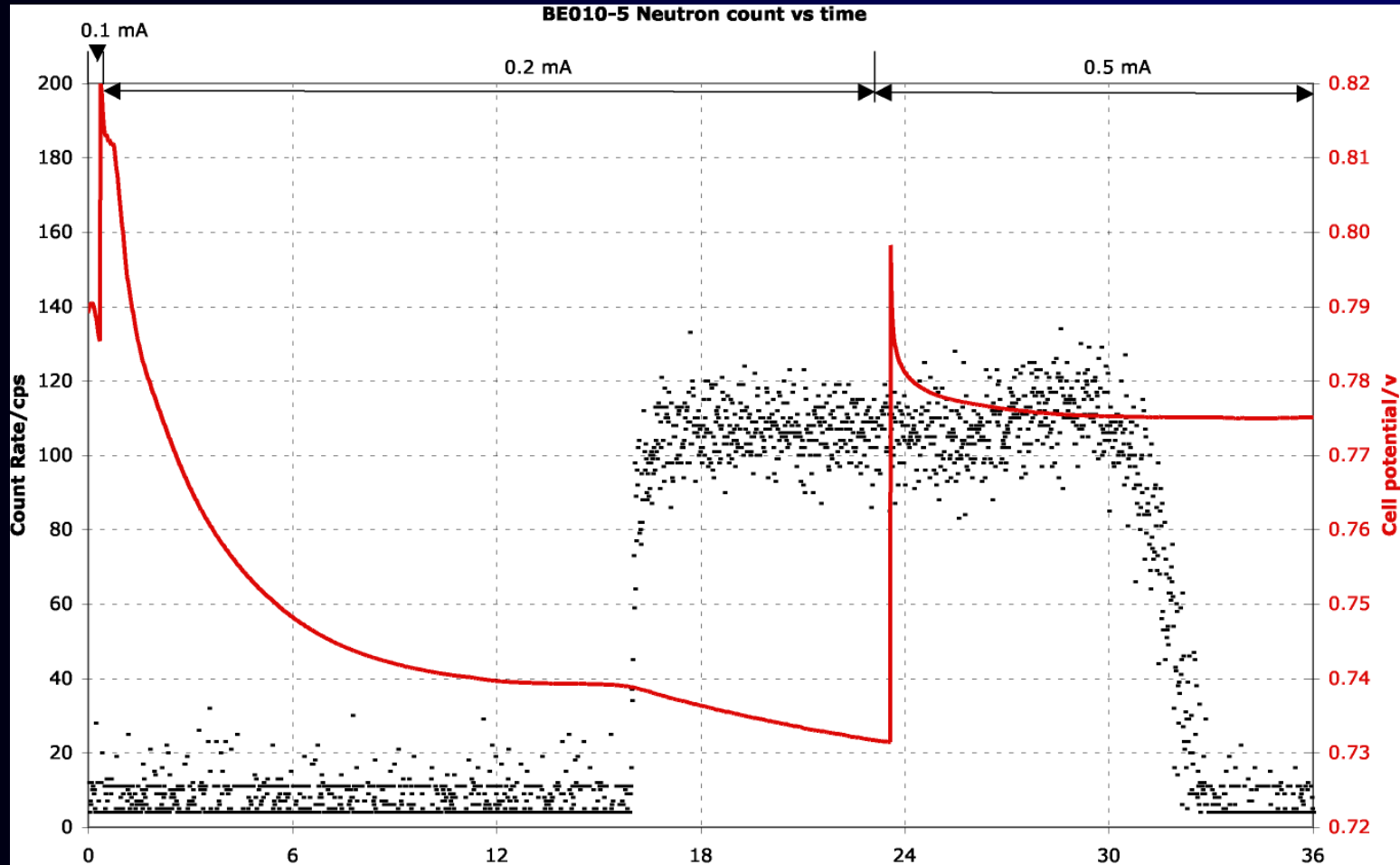


# Results: Electrochemical BE010-5

BE010-5 Current and Voltage Plot

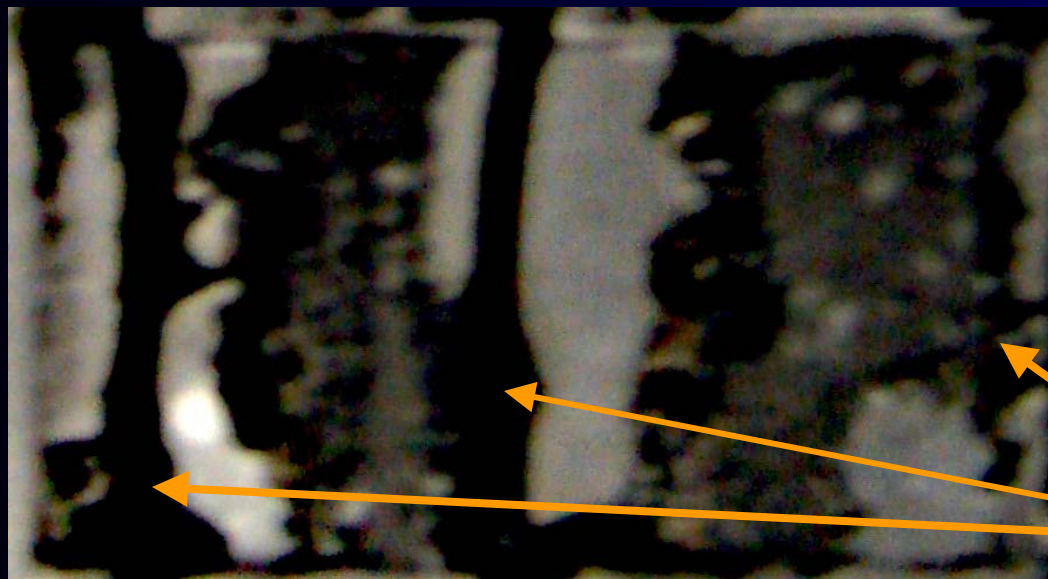


# Results: BE010-5 CR-39 Neutrons



Note decline in cell potential after neutron burst commences - thermal effect?

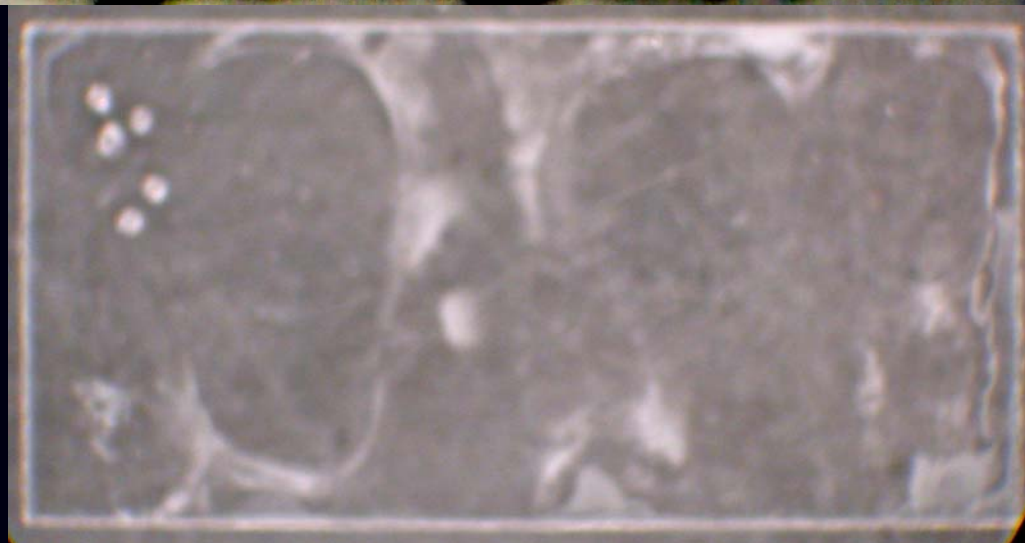
# Results: BE010-5 CR-39



Pd "moss" between Ag wires on CR-39 after removal from cell

Chips exposed while covered with 60  $\mu\text{m}$  polyethylene film

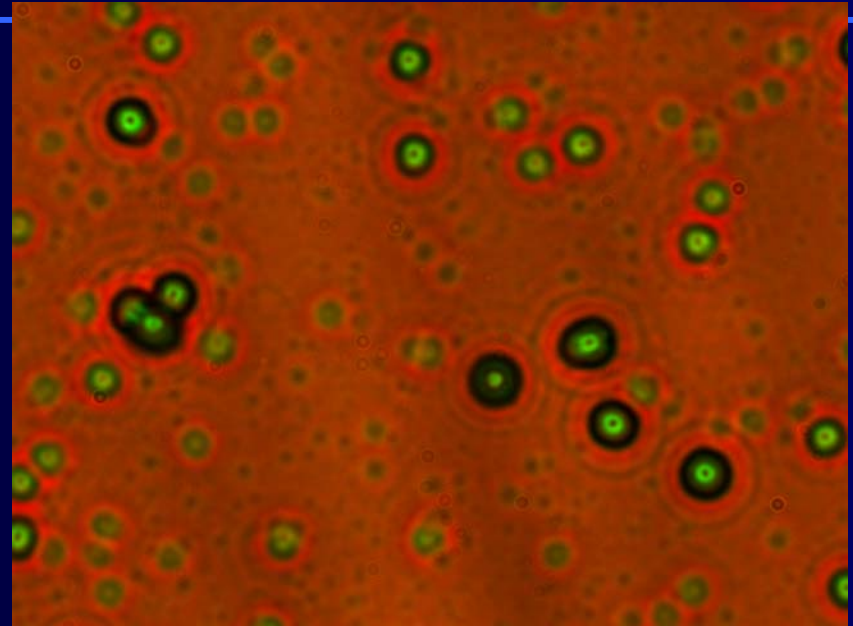
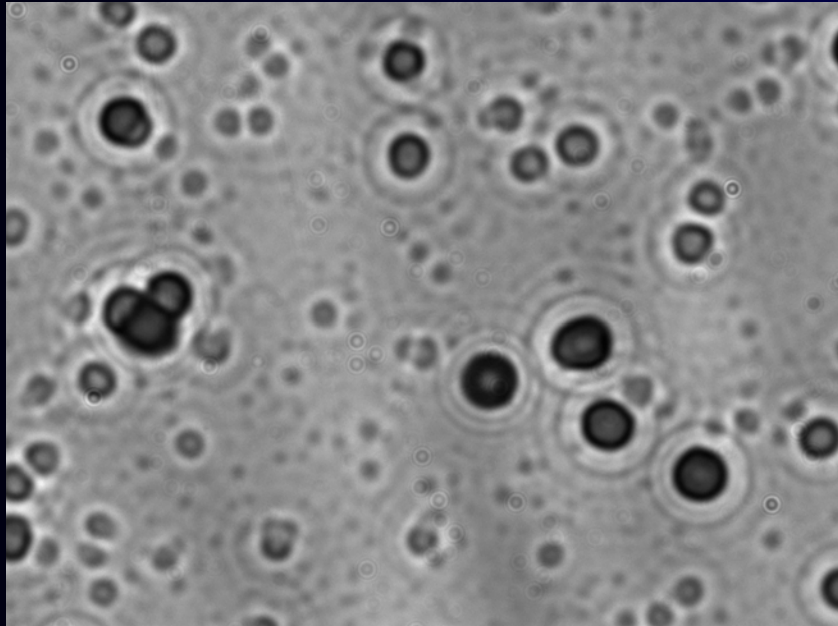
Ag Wires



CR-39 after etching

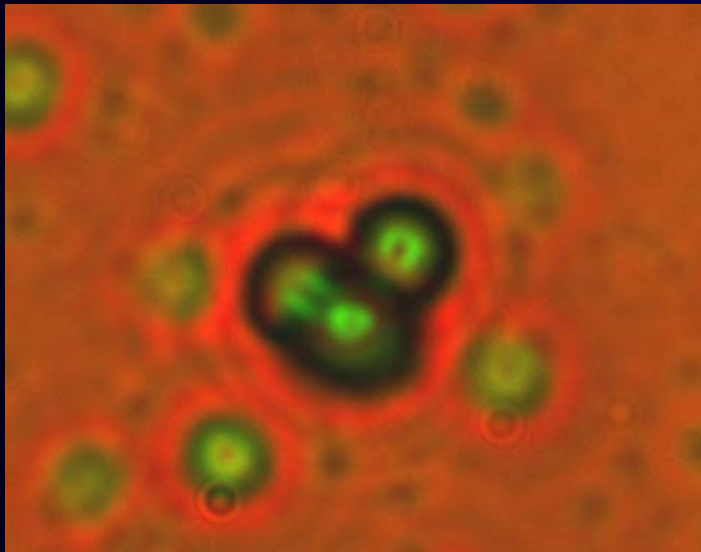
Note outline of Ag wires

# Results: BE010-5 CR-39 (Fukuvi CR-39)



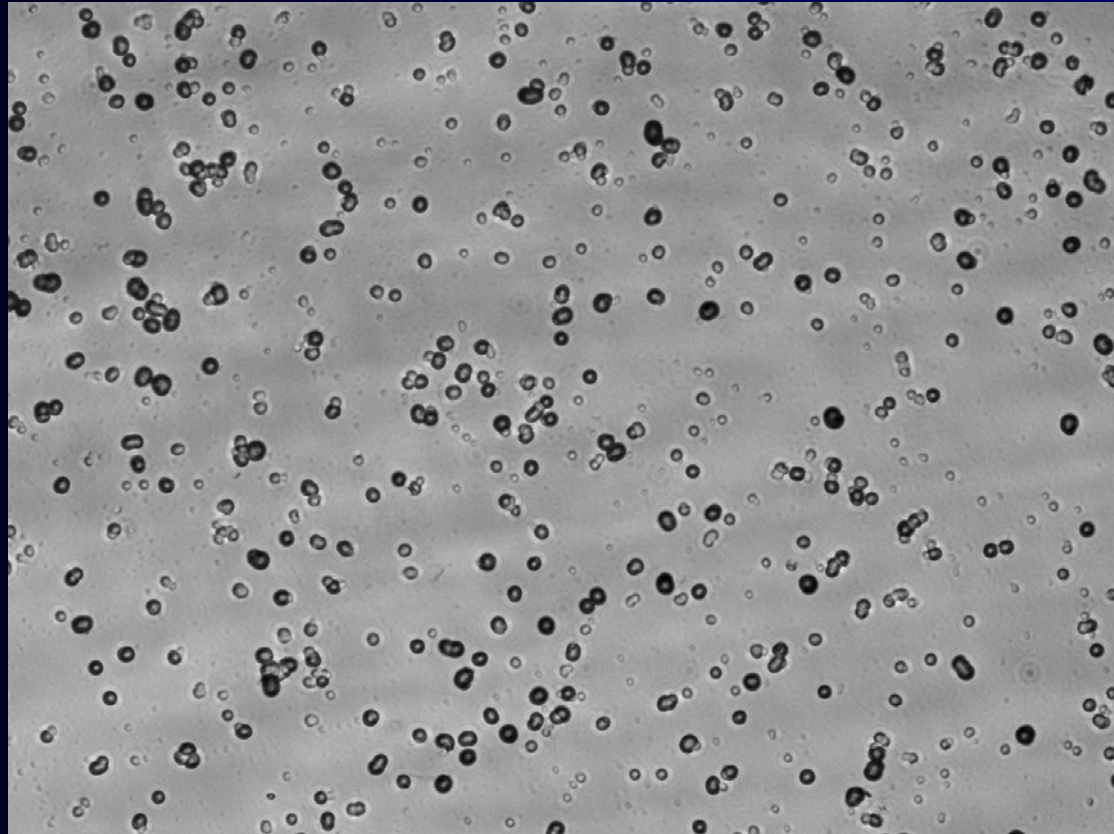
1000 x

Triple track



# Results: BE010-6 CR-39 (Fukuvi CR-39)

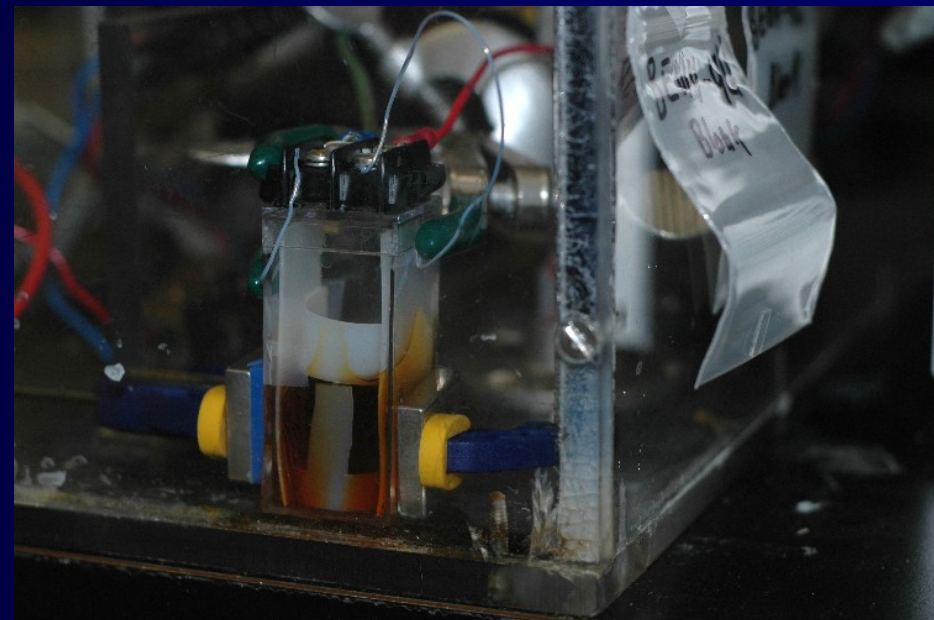
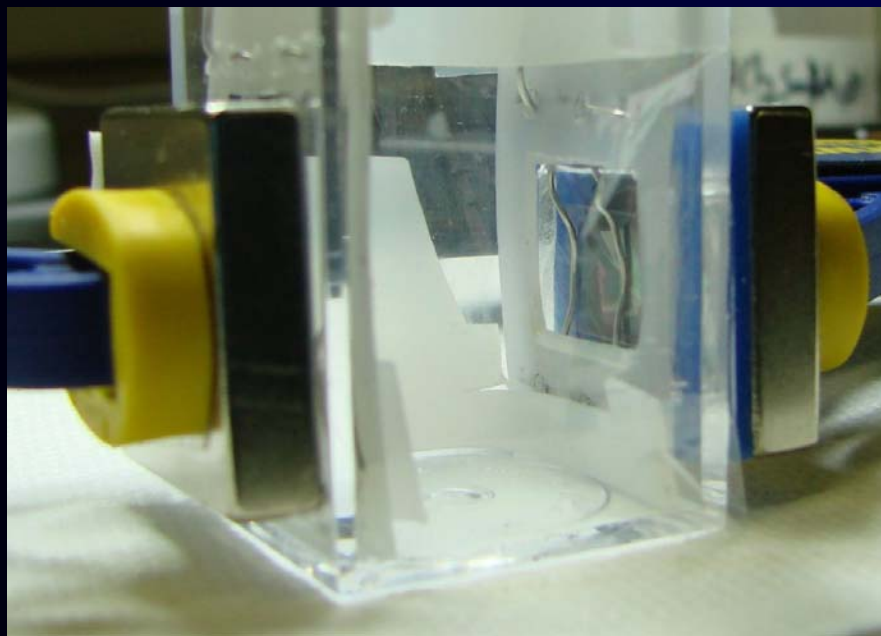
---



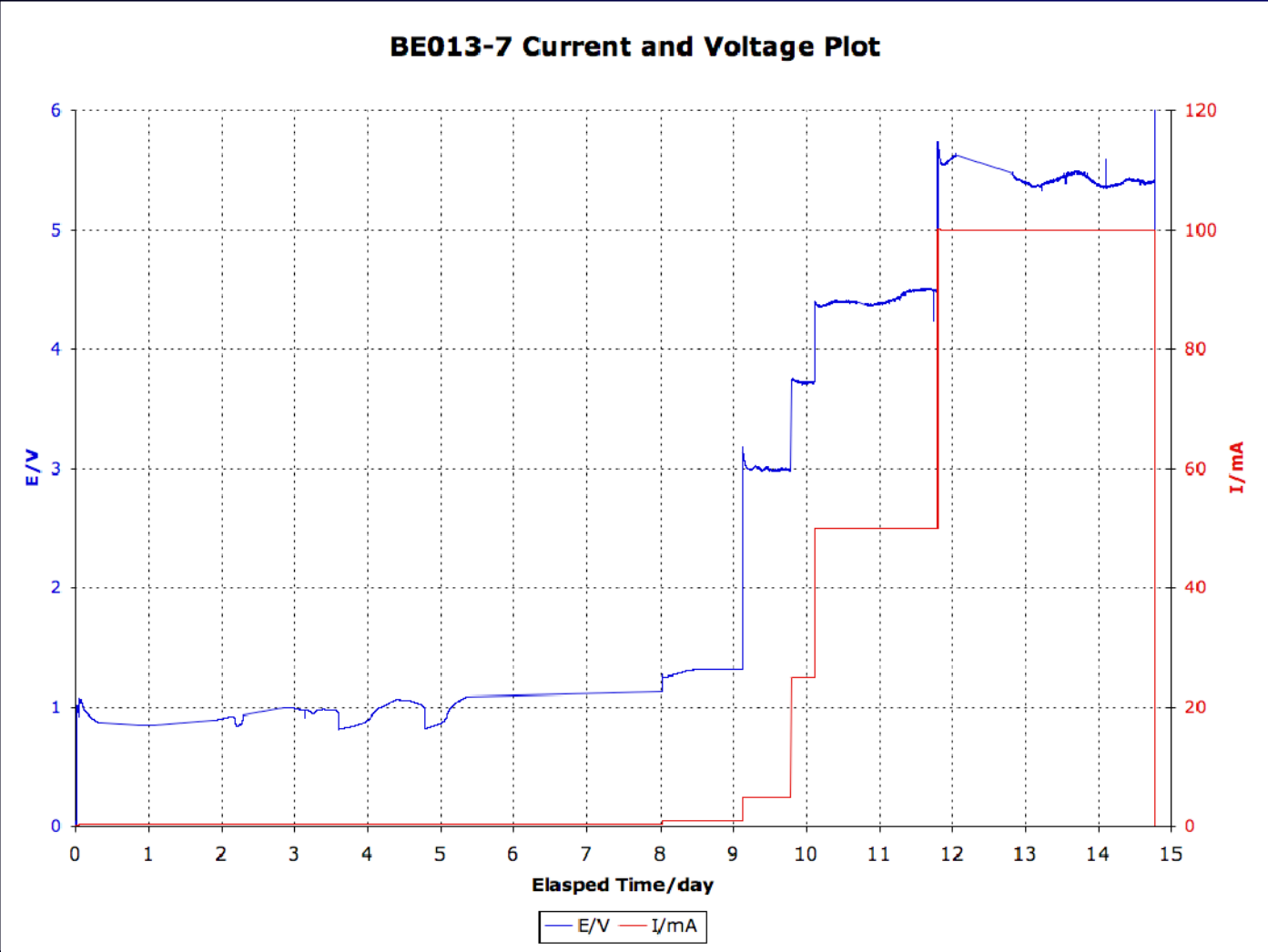
200x

# Experimental: Dry CR-39

- All cells had magnets.
- 0.03 M  $\text{PdCl}_2$  ; 0.3 M LiCl ;  $\text{D}_2\text{O}$
- 0.2mA for 1 day, 0.5mA until solution cleared and then 12 - 48 hours each of 1, 5, 10, 25, 50, and 100mA
- Cathodes were ~16 cm of either 0.5mm Ag or 1mm Au wire pressed against the inside of the  $6\mu\text{m}$  Mylar® window
- Fukuvi/Landauer CR-39 pressed against the outside of the  $6\mu\text{m}$  Mylar® window
- Etched in 6.5 N NaOH, for 6.5 hours, at  $65^\circ\text{C}$

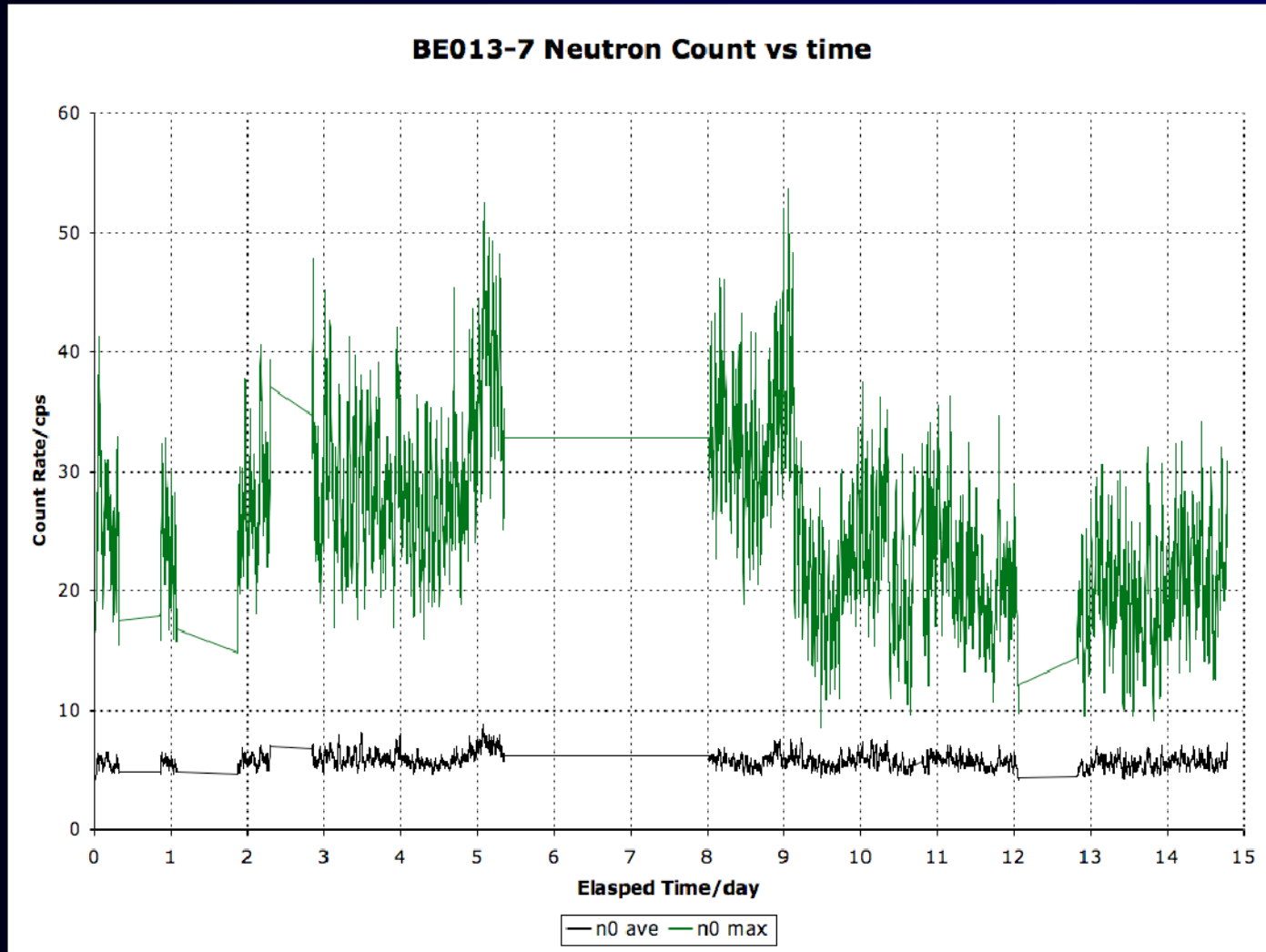


# Results: BE013-7 Current and Voltage



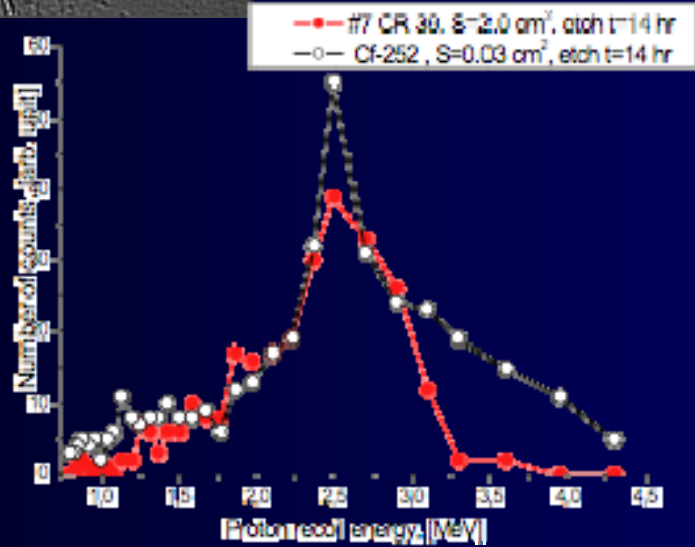
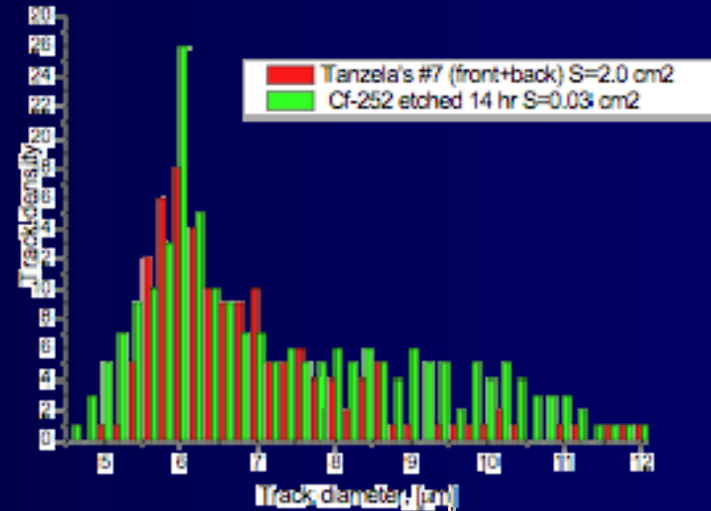
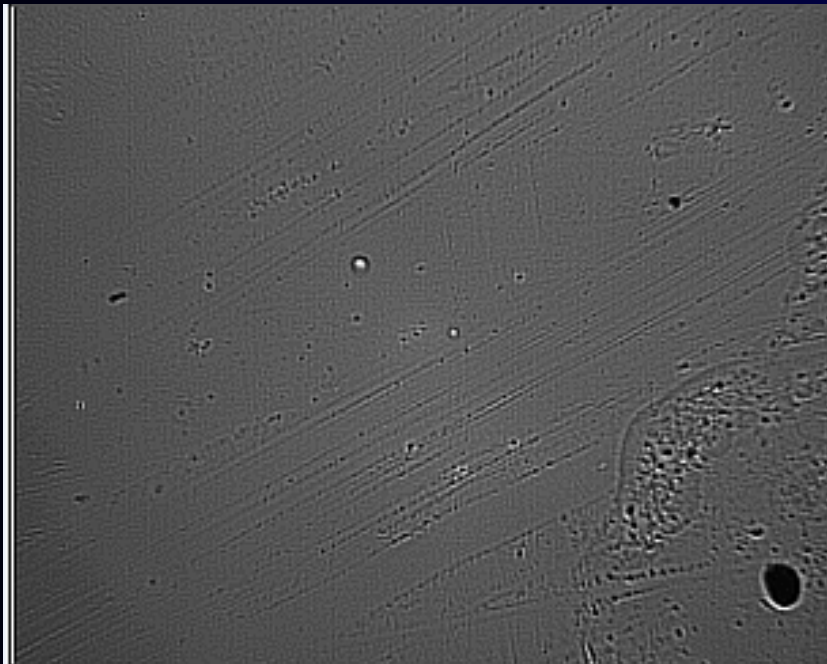
Reproducible current - voltage curve

# Results: BE013-7 Neutrons



Serious data dropouts  
Slight increase of neutron count above background

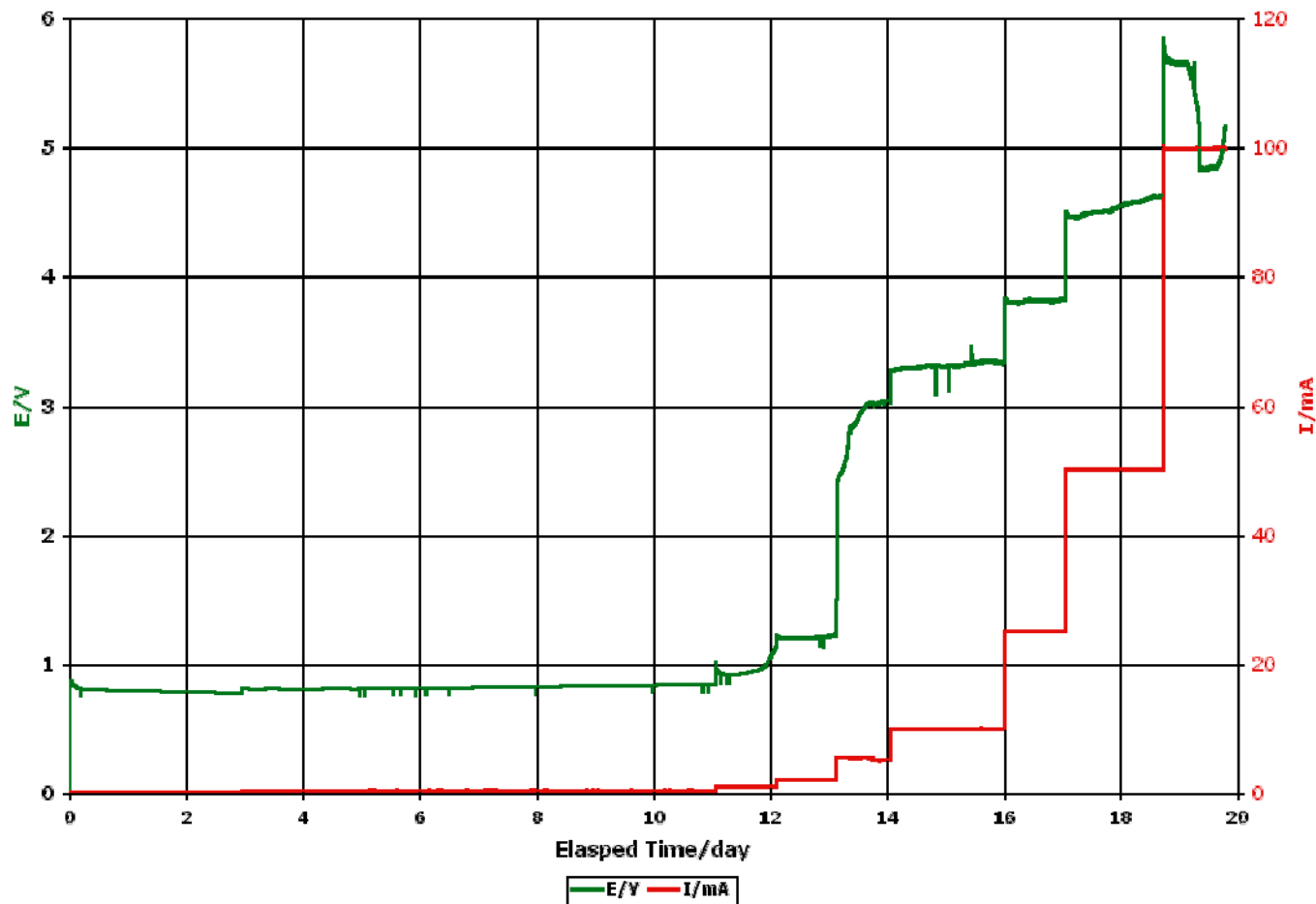
# Results: BE013-7 CR-39 (Lipson Analysis)



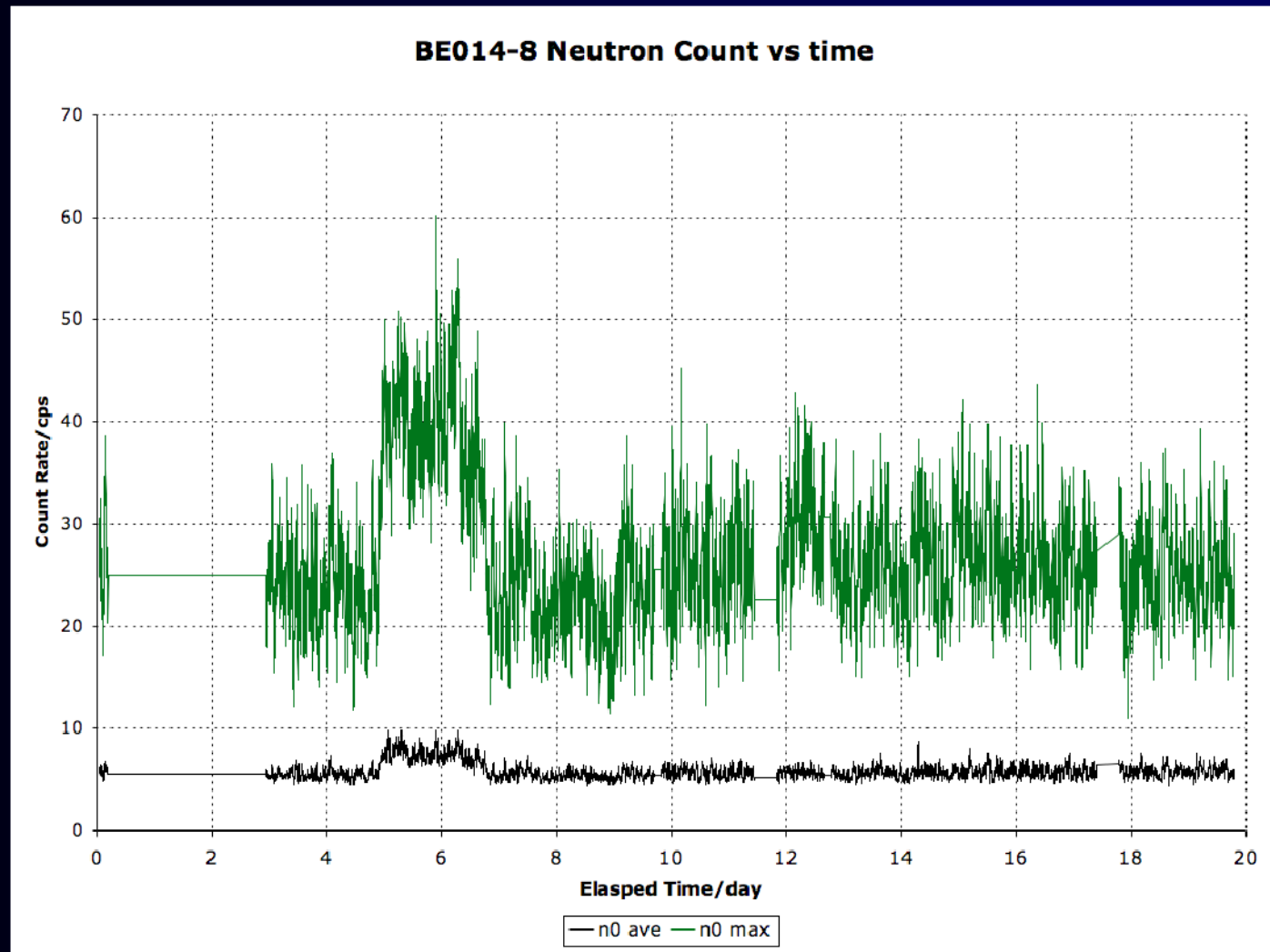
# Results: BE014-8 Current and Voltage



BE013-8 Current and Voltage Plot



# Results: BE014-8 Neutrons



Slight increase of neutron count above background for 48 hours  
No obvious tracks above background seen in CR-39

# Conclusions

---

- 12 Experiments run: 6 with “wet” and 6 with “dry” CR-39
- Neutron count above background suggested in at least 3 experiments
- The cells’ electrochemical behavior is reproducible in all 10 cells.
- Bare CR-39 is seriously attacked by the electrolyzing solution.
- Porous 60 $\mu$ m porous film does not totally prevent chemical attack.
- Depending on analysis (analyst?), CR-39 shows tracks due to protons from recoil of neutrons on polymer backbone, or alphas/protons from electrolyzing co-deposited PdDx.
- One experiment showed both a potential neutron “burst”, measured by one detector, and nuclear particle tracks in CR-39, analyzed by two analysts.
- During the potential neutron “burst”, the cell potential reacted in a manner consistent with electrolyte heating.

# Future Work

---

- Measure solution tritium concentration
- Measure time-correlated alpha/beta energy spectra with 6 $\mu$ m Mylar® film.
- Measure time-correlated gamma energy spectra.
- Perform cathode thermometry or heat-loss calorimetry.
- Measure time-correlated neutron energy spectra(?)
- Develop in-house CR-39 photo-microscopy method.
- Try E-Field variant of PdD<sub>x</sub> Co-deposition experiment.



# Acknowledgements

---

- We would like to acknowledge the advice and efforts of Pam Boss and her colleagues at SPAWAR and in analyzing our CR-39 chips.
- We would like to acknowledge the efforts of Larry Forsley, Andrei Lipson and Alexei Russetski in analyzing the CR-39 chips.
- We would like to acknowledge the encouragement and support of Steve Krivit and New Energy Times
- We would like to acknowledge the laboratory efforts of Thomas Matthews.
- We would also like to thank SRI International for its support of this study.