Cold Fusion Research

Low Energy Nuclear Reactions (2002)

Dr. John Dash, Mentor
Portland State University

Jeremy Freeman
Mountain View High School

Ben Zimmerman
Wilson High School

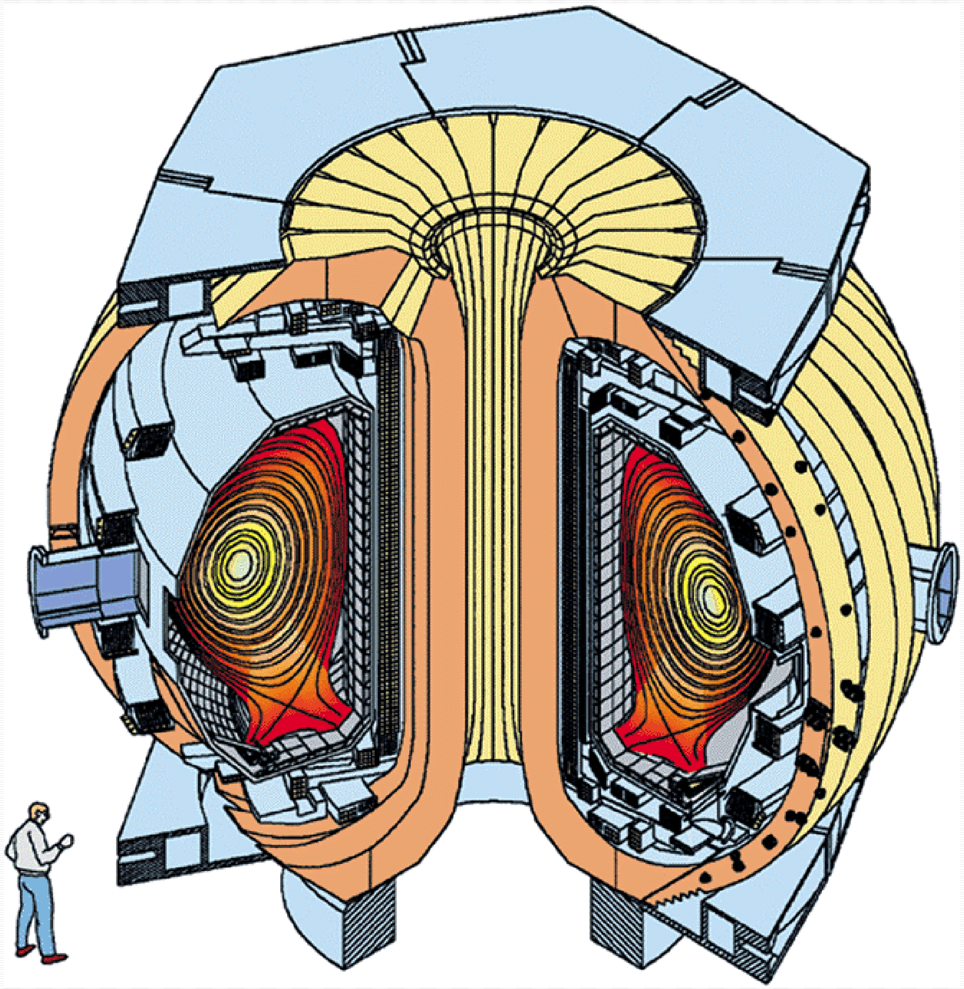
Introduction

Pons (left) and Fleischmann

- March 23, 1989. Electrochemists B. Stanley Pons and Martin Fleischmann shock the world by announcing their discovery of cold fusion.

Possibilities

- The original idea, that Deuterium could fuse in a small cell at room temperature, went against common knowledge.
- The D-D fusion process was only theoretically possible in stars and large Tokamak reactors.
- The startling results reported provided hope for a new source of energy.



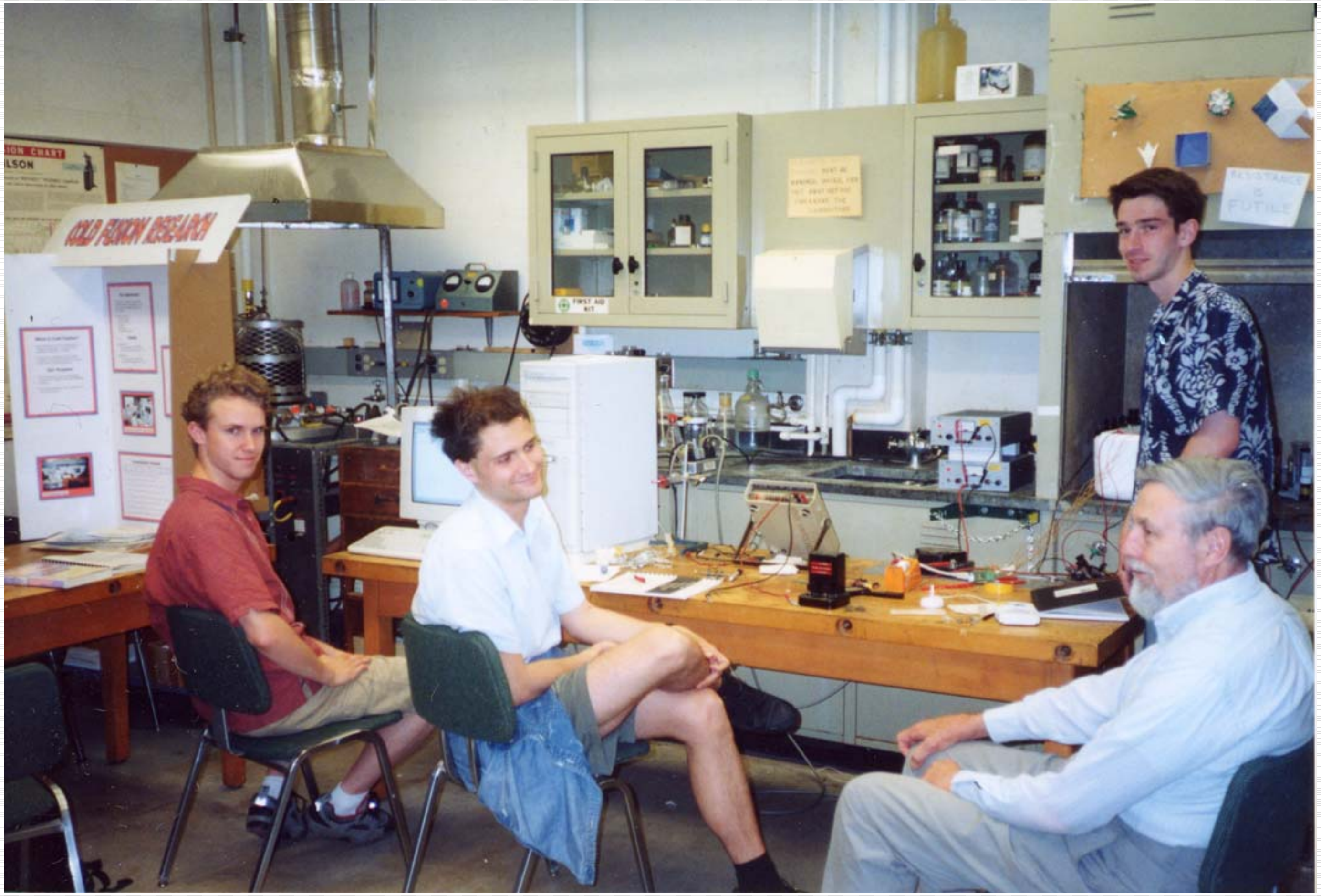
The Skeptical Revolution

- Many, but not all, attempts to replicate the Fleischmann/Pons experiment return null results.
- Severe criticism of the topic appears in the scientific community soon after the 1989 announcement, often referring to the entire field as a “Pathological Science.”
- Cold fusion falls from the media spotlight.

A Decade of Research

- Despite the poor reproducibility of the effect and the opposition of cold fusion skeptics, many researchers continue to pursue their interest in the subject.
- As a result of continuing research, a very large amount of evidence in support of cold fusion has been collected. This evidence includes excess heat, nuclear by-products, and nuclear transmutation.

Our Apprenticeship



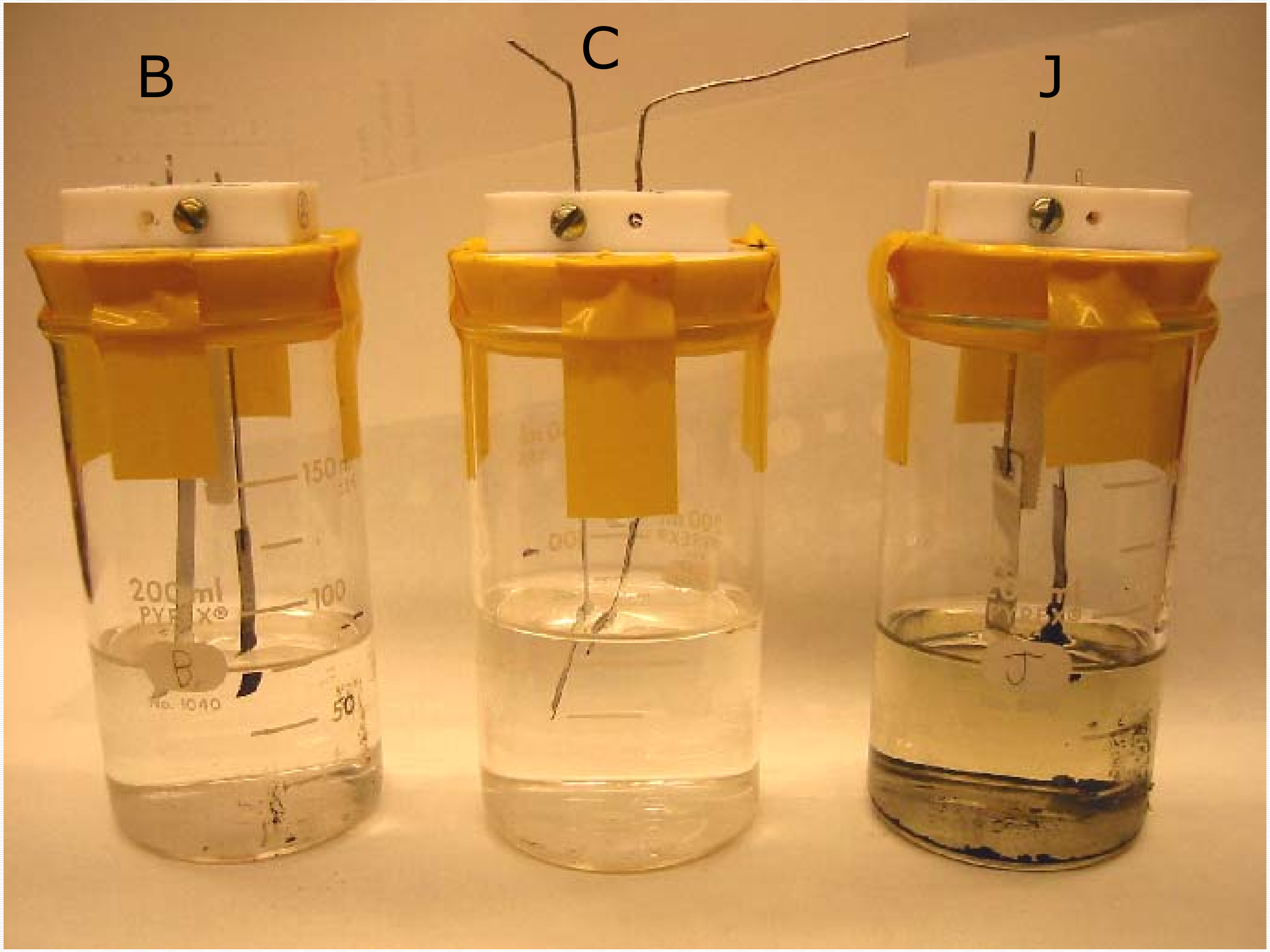
From Left:

Ben, Conrado Salas Cano, Dr. Dash and Jeremy

Specific Aims

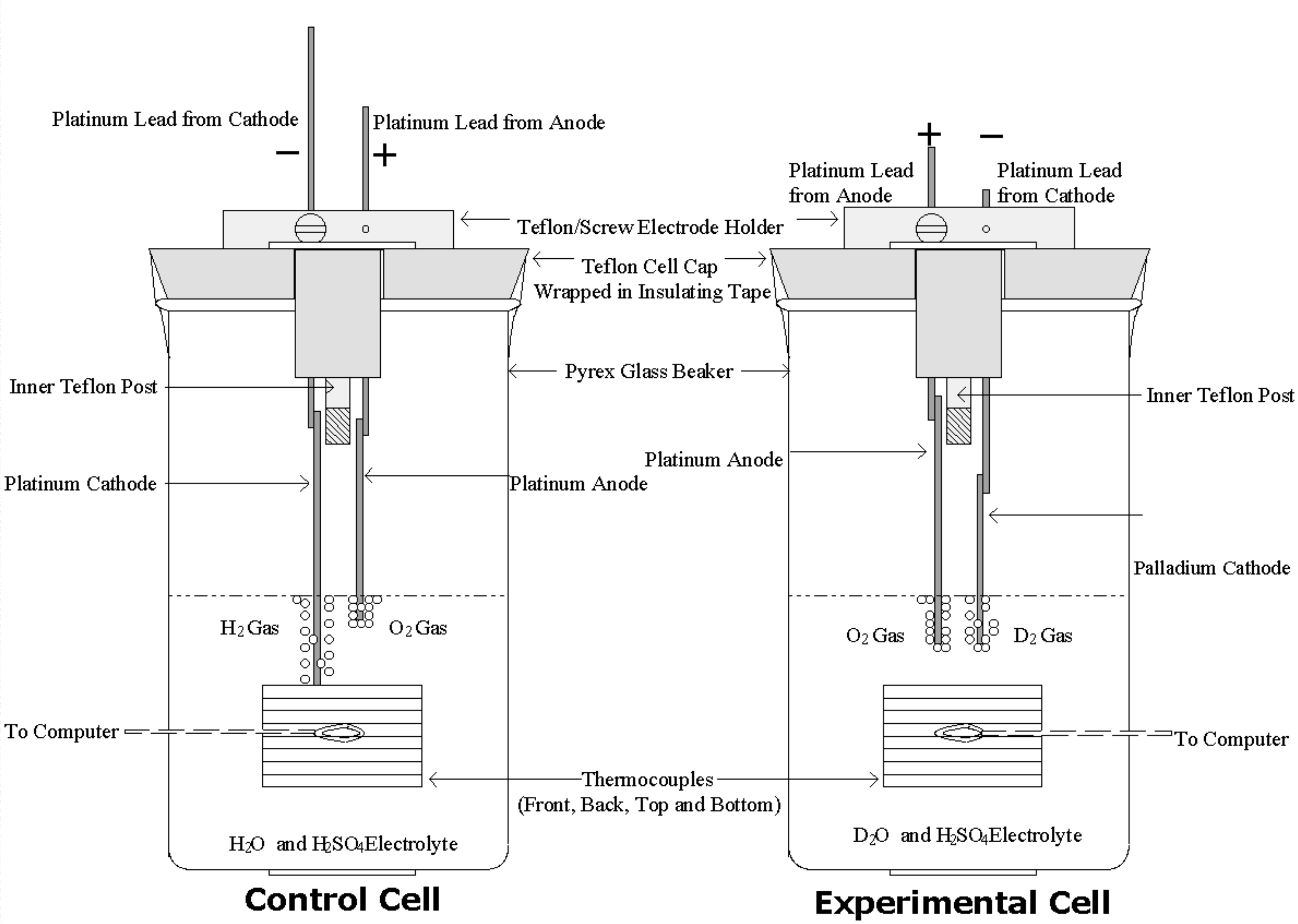
- Reproducibility – Construction of two identical experimental cells, with the goal of achieving positive experimental results for both
- To create a working demonstration of the cold fusion phenomenon
- To reach approximately one Watt of excess heat energy
- To examine electrodes for evidence of micro-chemical changes.

Materials and Methods



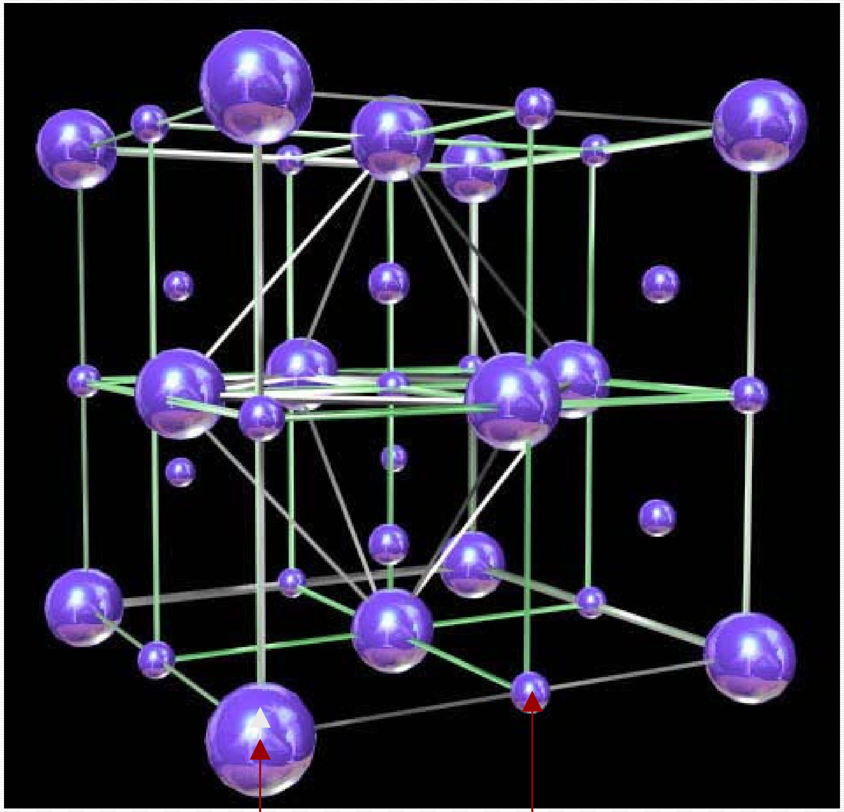
The three cells, midway through the experiments

Cell Design



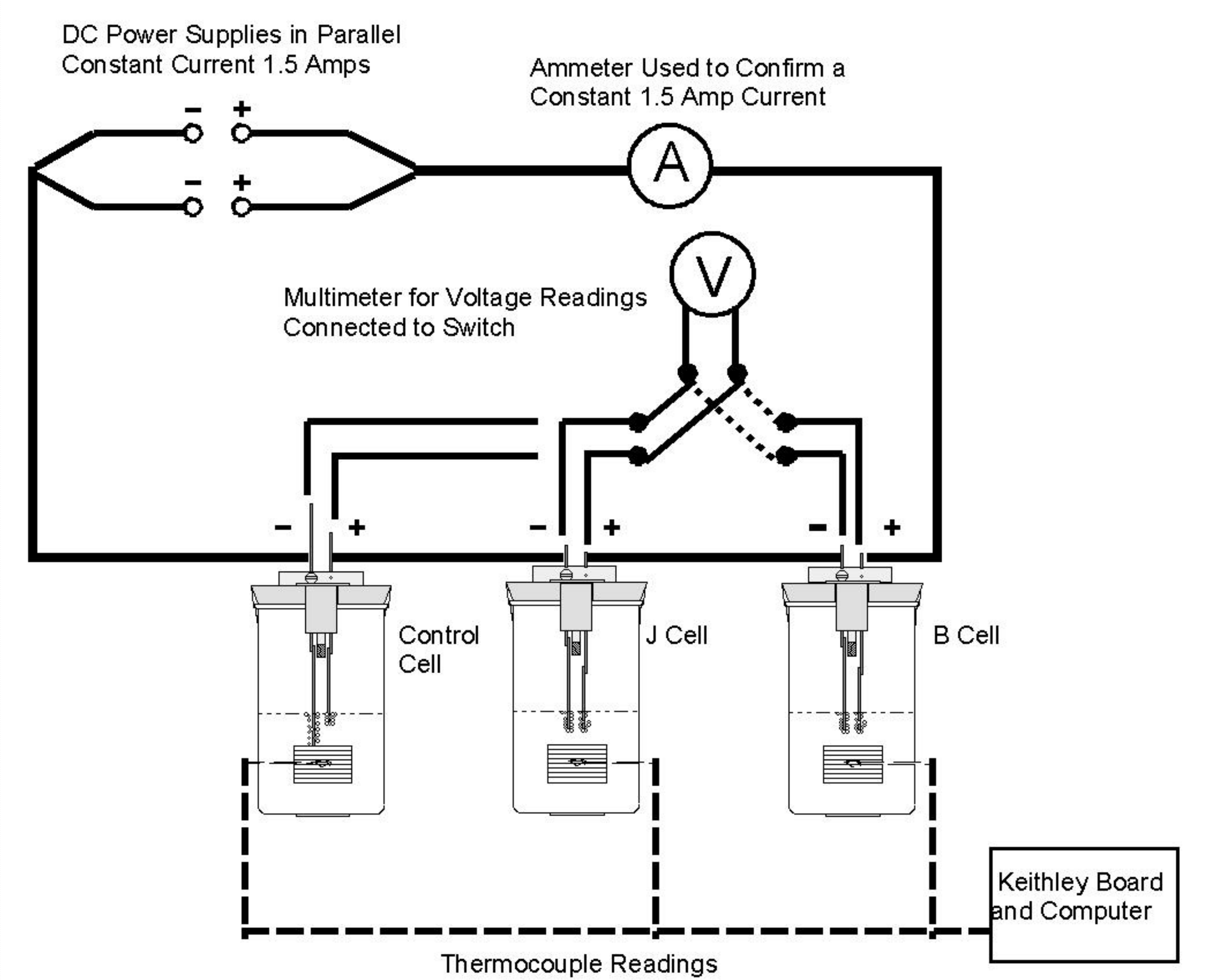
Platinum Lead from Cathode
Platinum Lead from Anode
−
+
+
−
Platinum Lead from Anode
Platinum Lead from Cathode
Teflon/Screw Electrode Holder
Teflon Cell Cap Wrapped in Insulating Tape
Pyrex Glass Beaker
Inner Teflon Post
Inner Teflon Post
Platinum Anode
Platinum Cathode
Platinum Anode
Palladium Cathode
H2 Gas
O2 Gas
O2 Gas
D2 Gas
To Computer
To Computer
Thermocouples (Front, Back, Top and Bottom)
H2O and H2SO4 Electrolyte
D2O and H2SO4 Electrolyte
Control Cell
Experimental Cell

The Purpose of Palladium

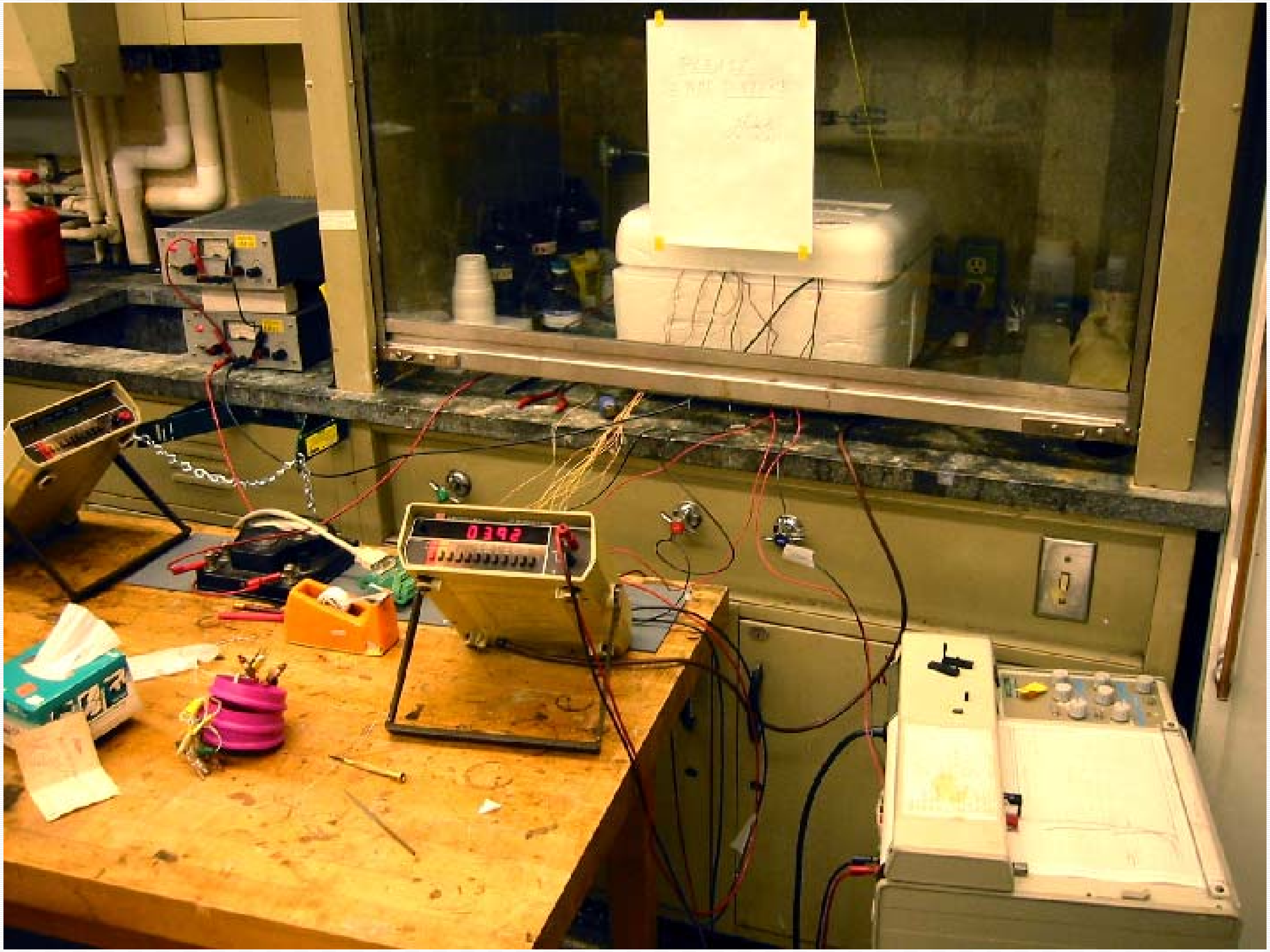


- Palladium is known to absorb up to 900 times its volume of hydrogen.
- Deuterium ions are attracted to the palladium cathode and occupy interstitial positions in the crystal lattice.

Electrical Circuit Diagram



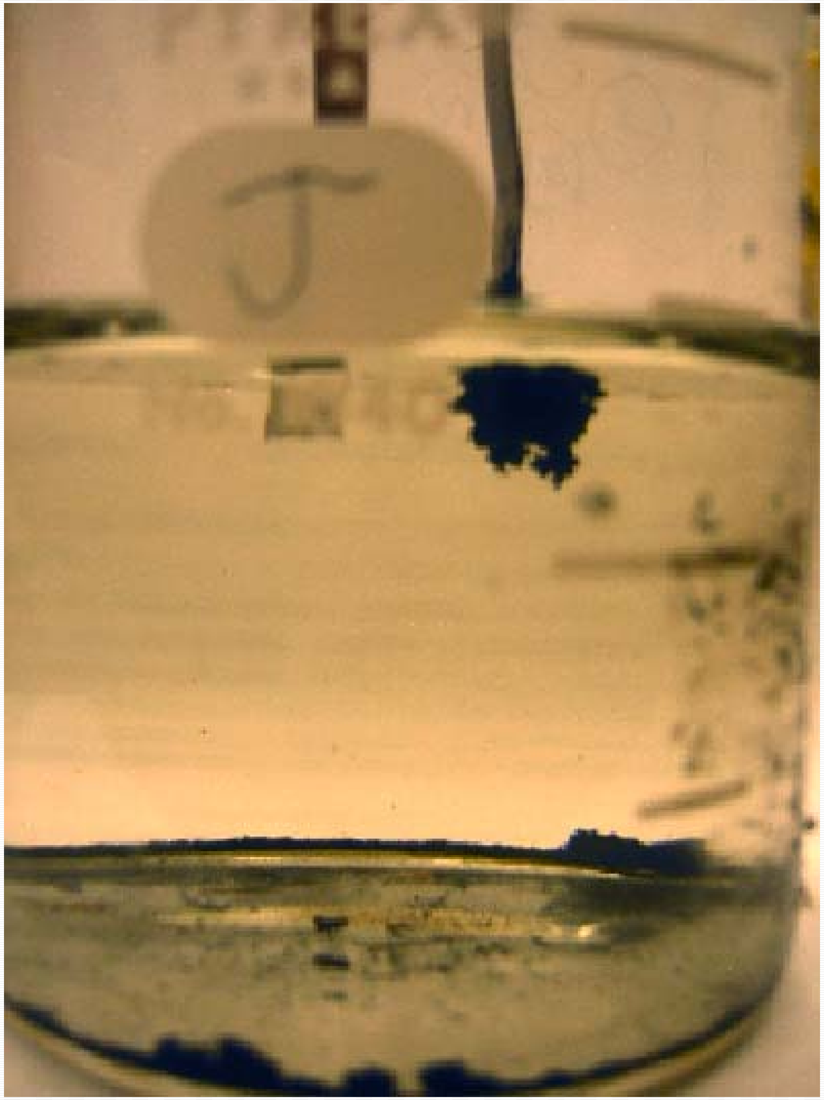
First Experimental Setup



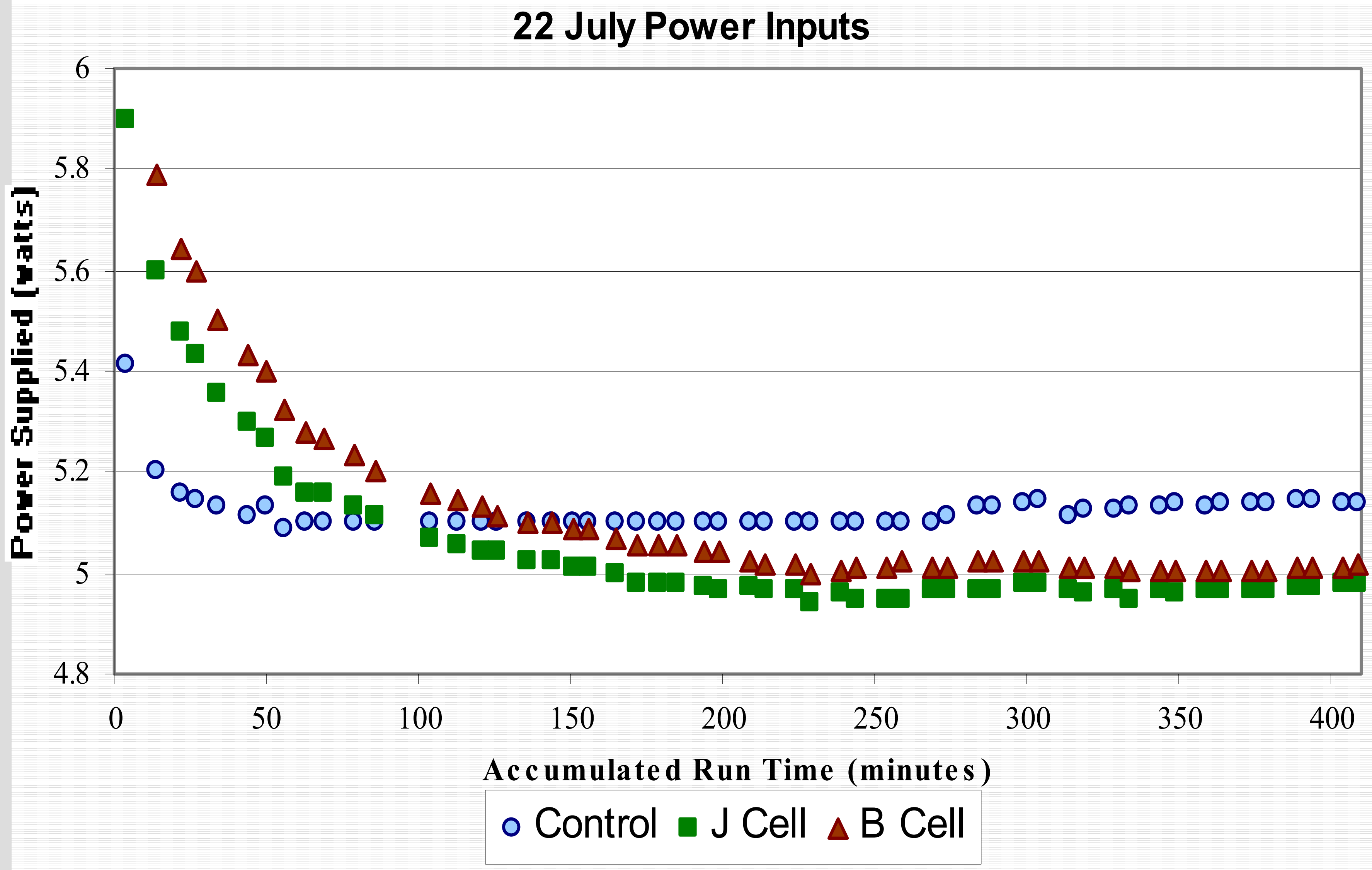
All three cells are placed in insulating cups within the box

J Cell Polarity Reversal

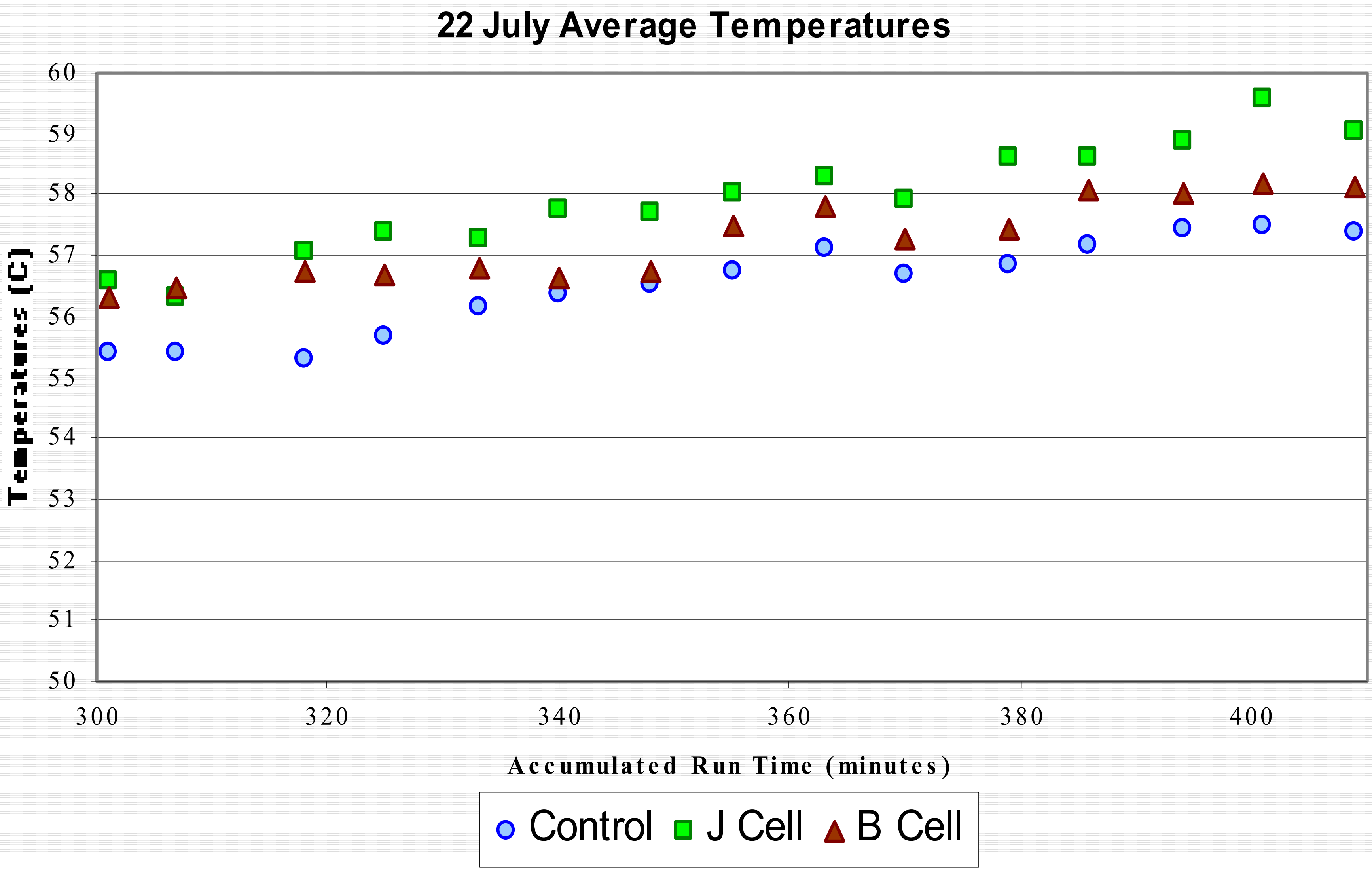
- On the 17th of July, midway through the experiments, the J experimental cell's polarity was reversed, then restored, causing the formation of a greater surface area on the Palladium cathode.



First Setup Results

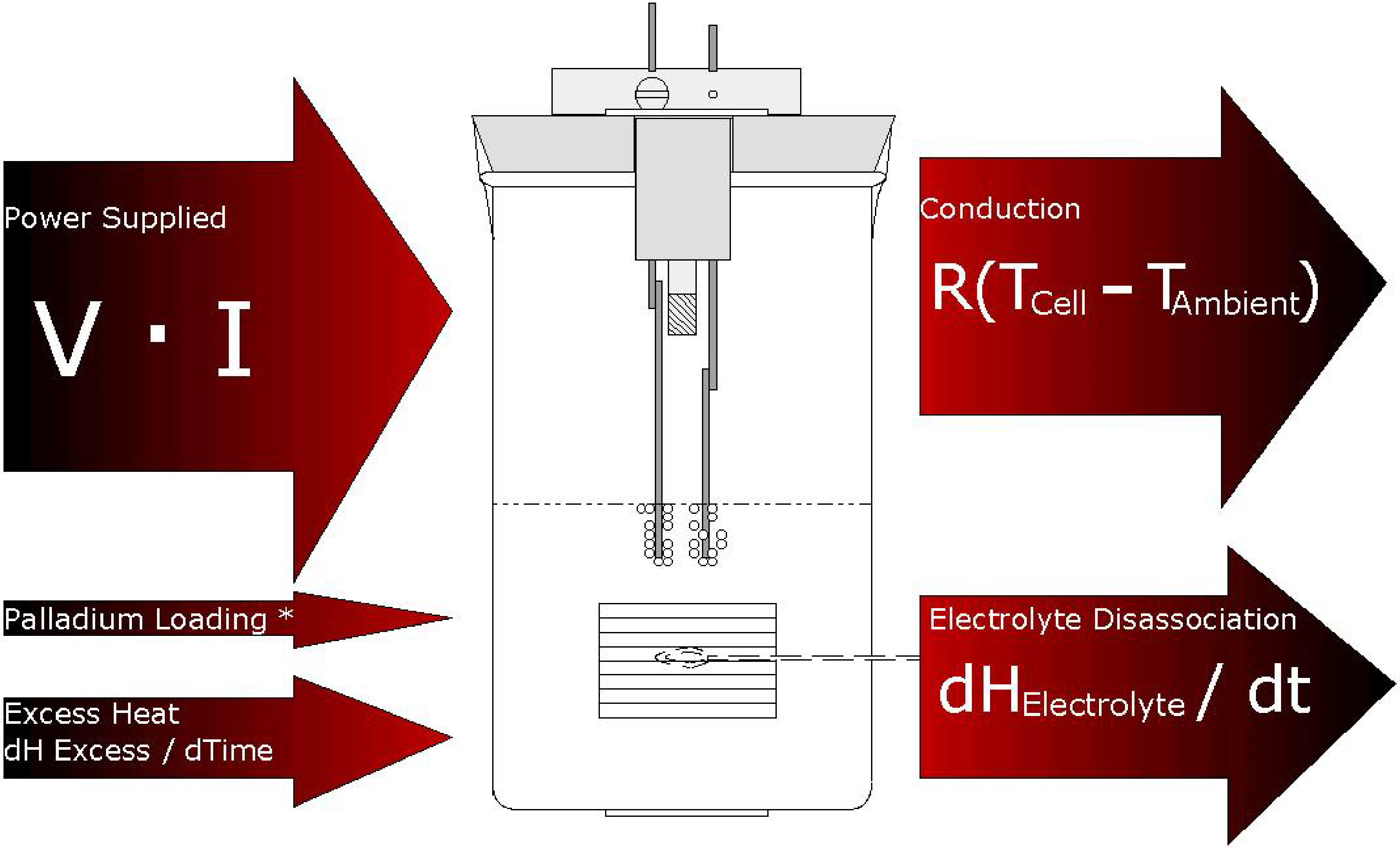


First Setup Results



Steady State

Power In = Power Out



* This term is only applicable during early experiments

Excess Heat Equation

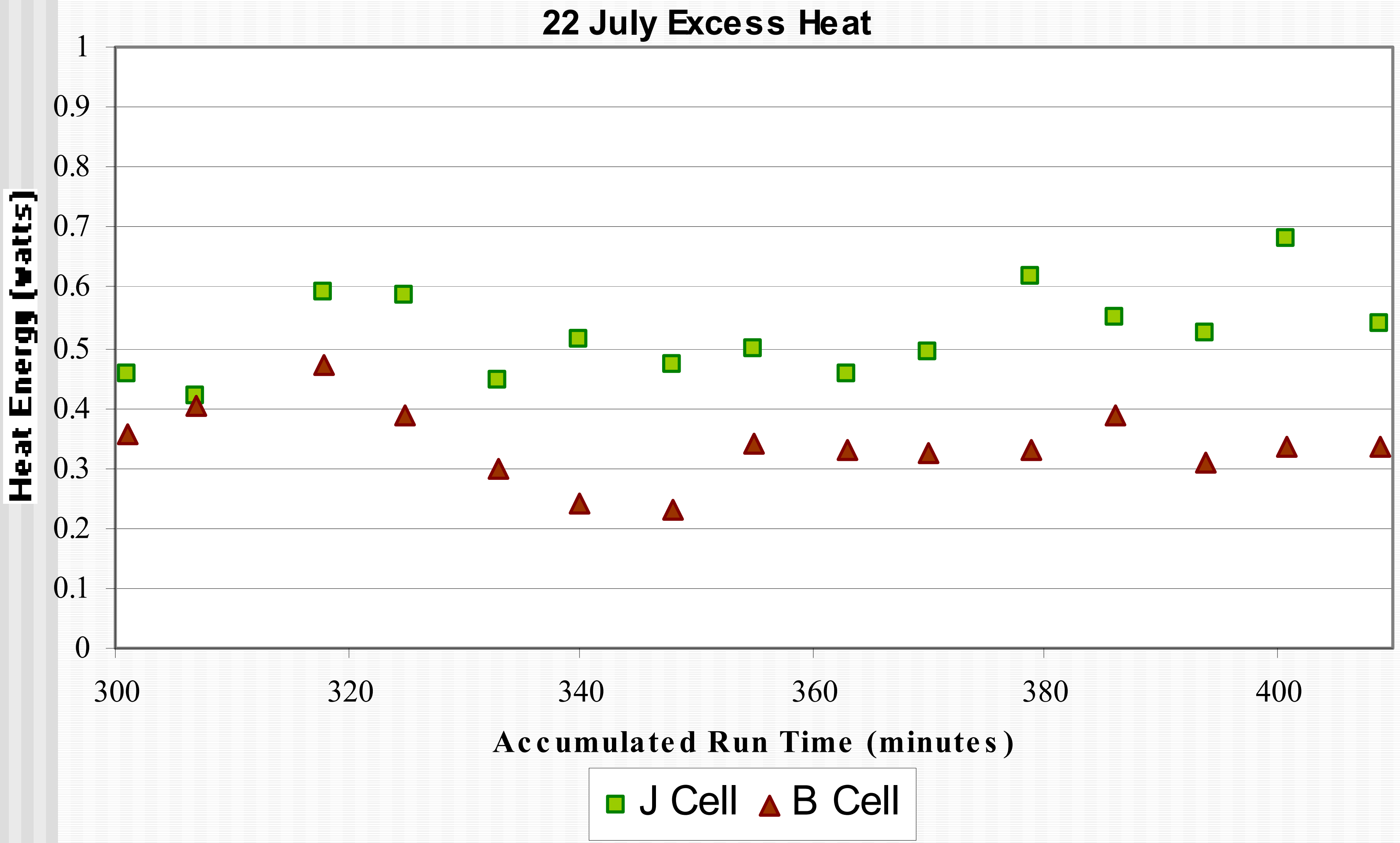
$$Power\ In = Power\ Out$$

$$Excess\ Heat = Power\ Out - Power\ In$$

$$\frac{dH_{excess}}{dt} = \frac{dH_{D_2O}}{dt} - V_D \cdot I + \frac{T_D - T_{ambient}}{T_H - T_{ambient}}\left(V_H \cdot I - \frac{dH_{H_2O}}{dt}\right)$$

- The amount of excess heat produced by the experimental cells was found by comparison with our control cell, which was designed and assumed to produce none.

First Setup Results

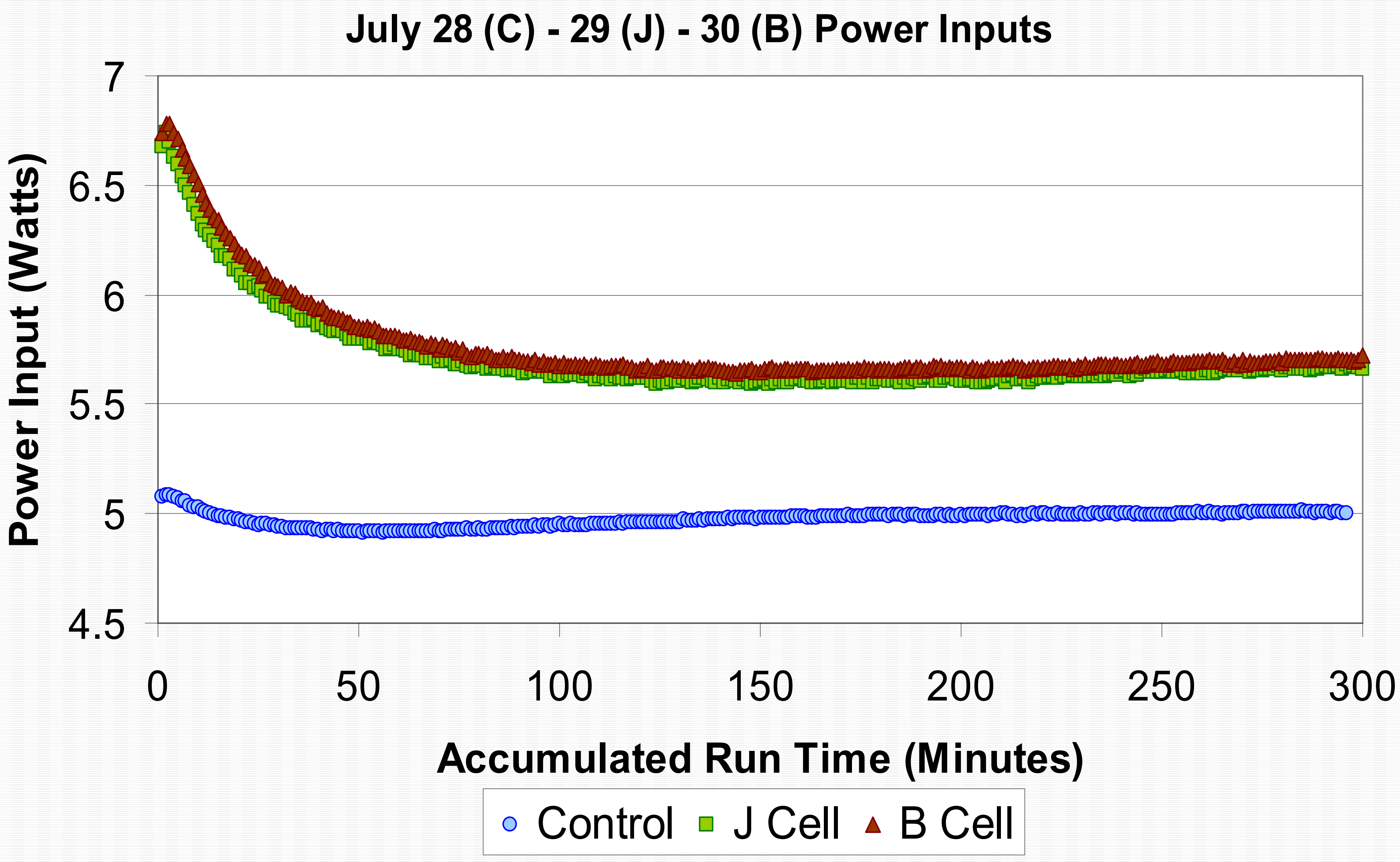


Second Experimental Setup

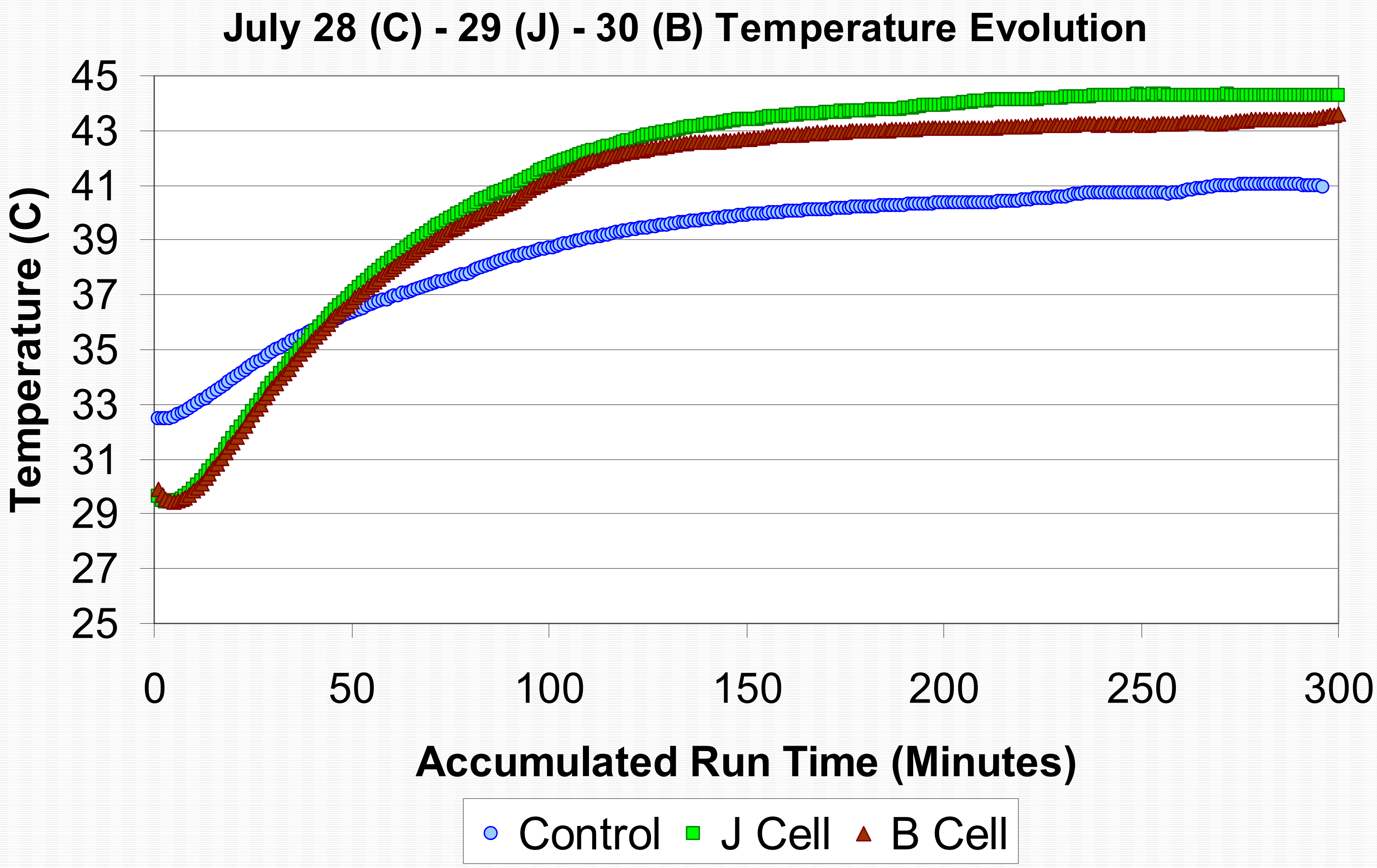
A SEEBECK Envelope Calorimeter was utilized for a second set of experimental data on the same three cells.

This machine (lower green box) contains 100 thermocouples per square inch, which provide a total box output data set.

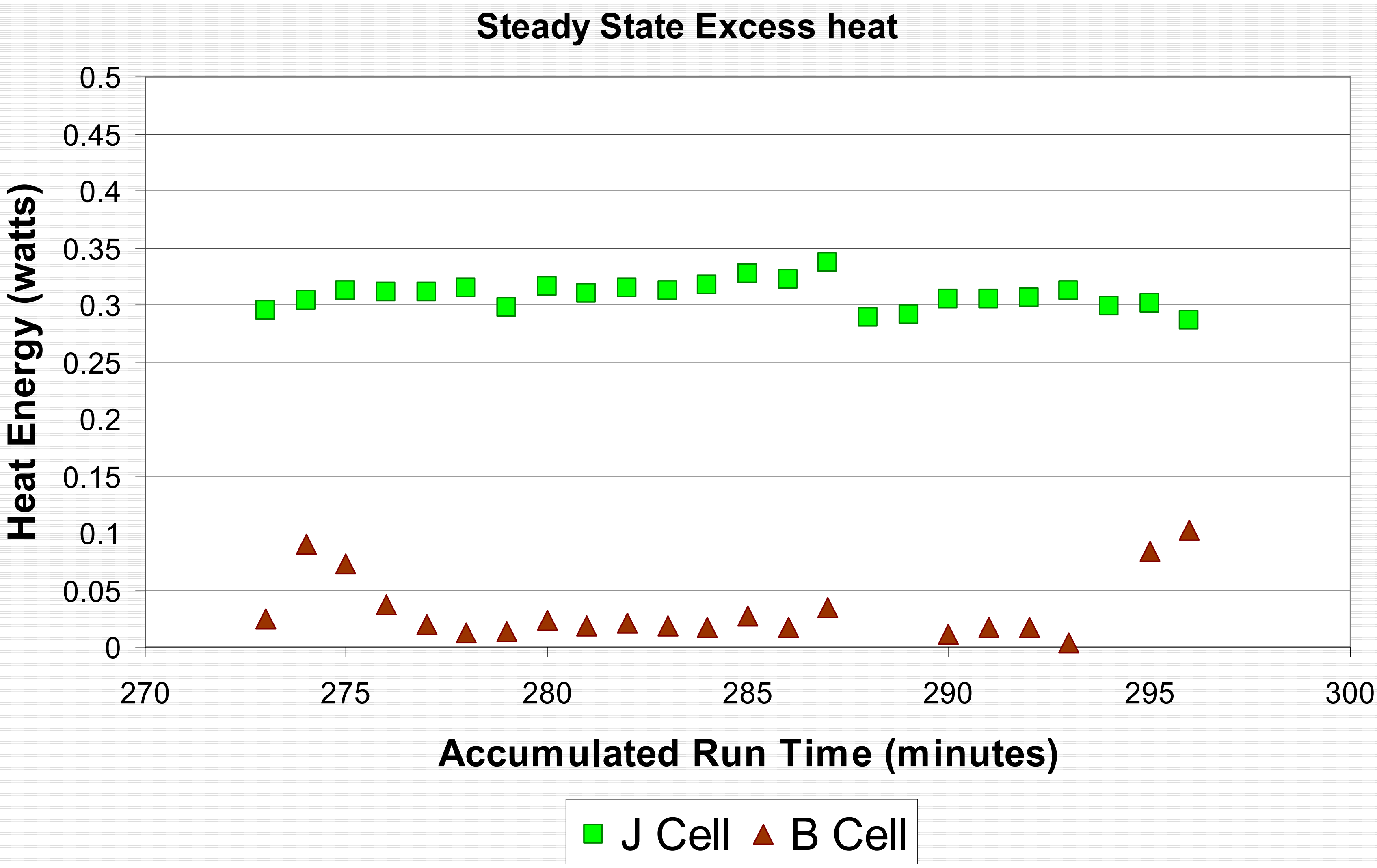
Second Setup Results



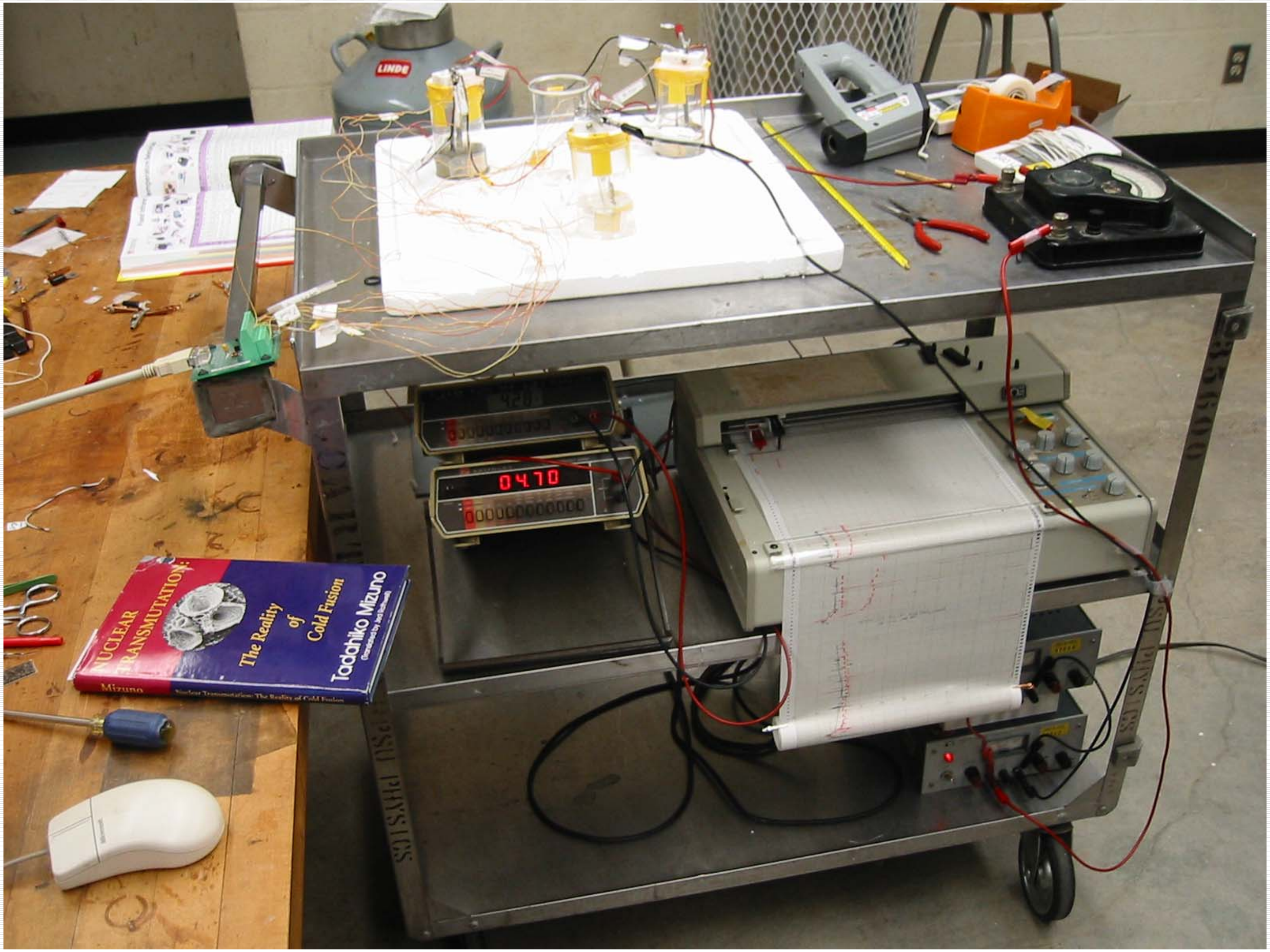
Second Setup Results



Second Setup Results

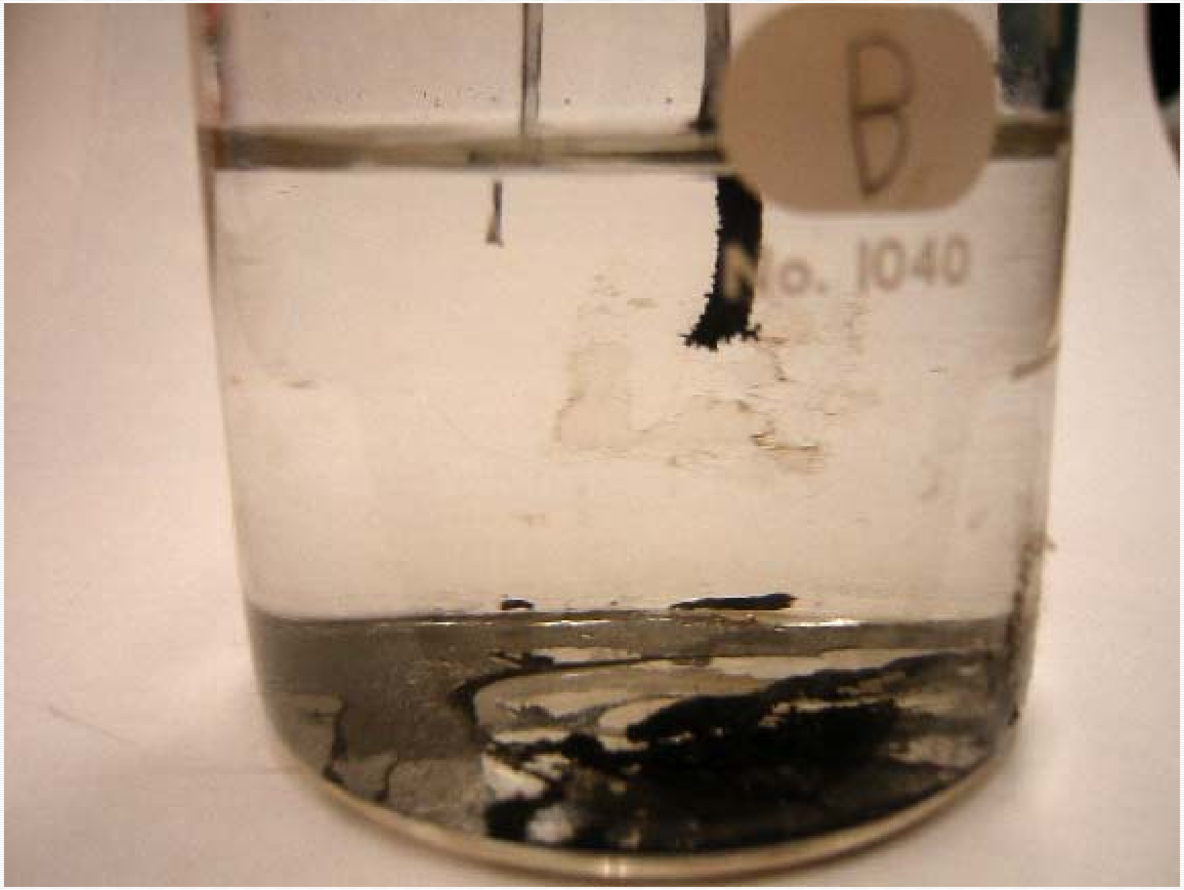


Third Experimental Setup



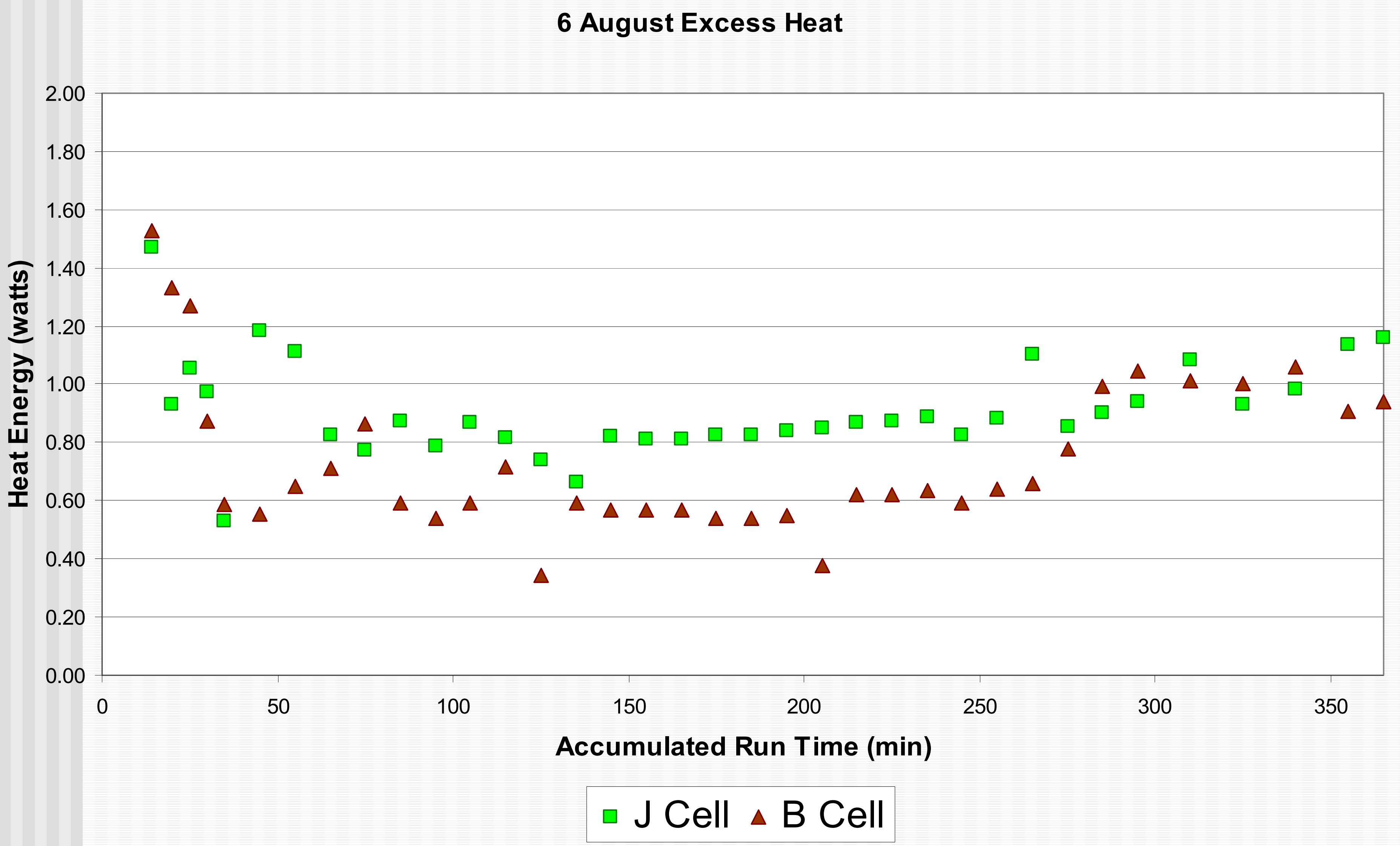
Our mobile, open-air demonstration cart

B Cell Polarity Reversal

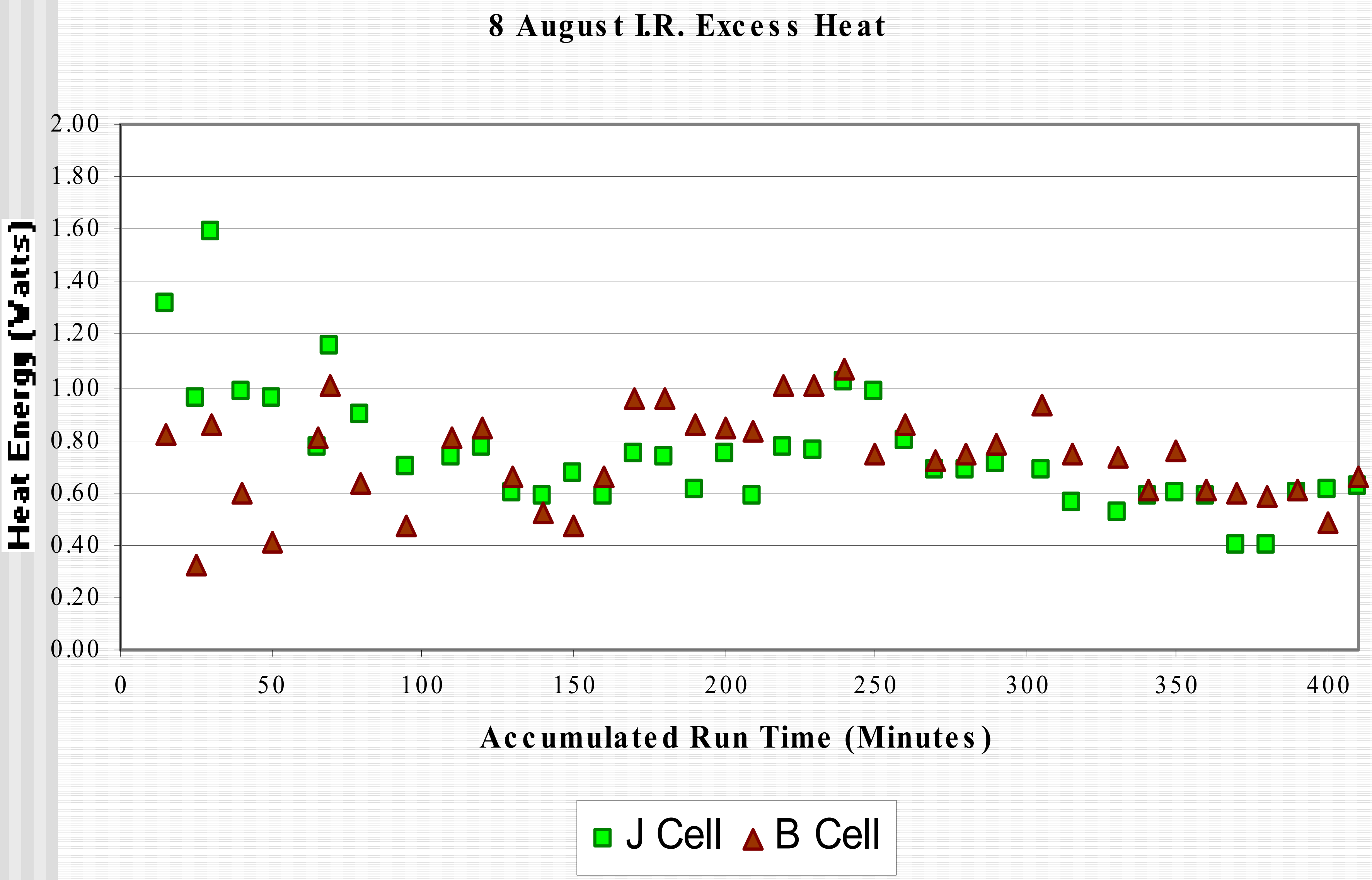


- On the 7th of August the B Cell's polarity was reversed and then restored, resulting in the formation of a larger surface area on the palladium cathode.

Third Setup Results



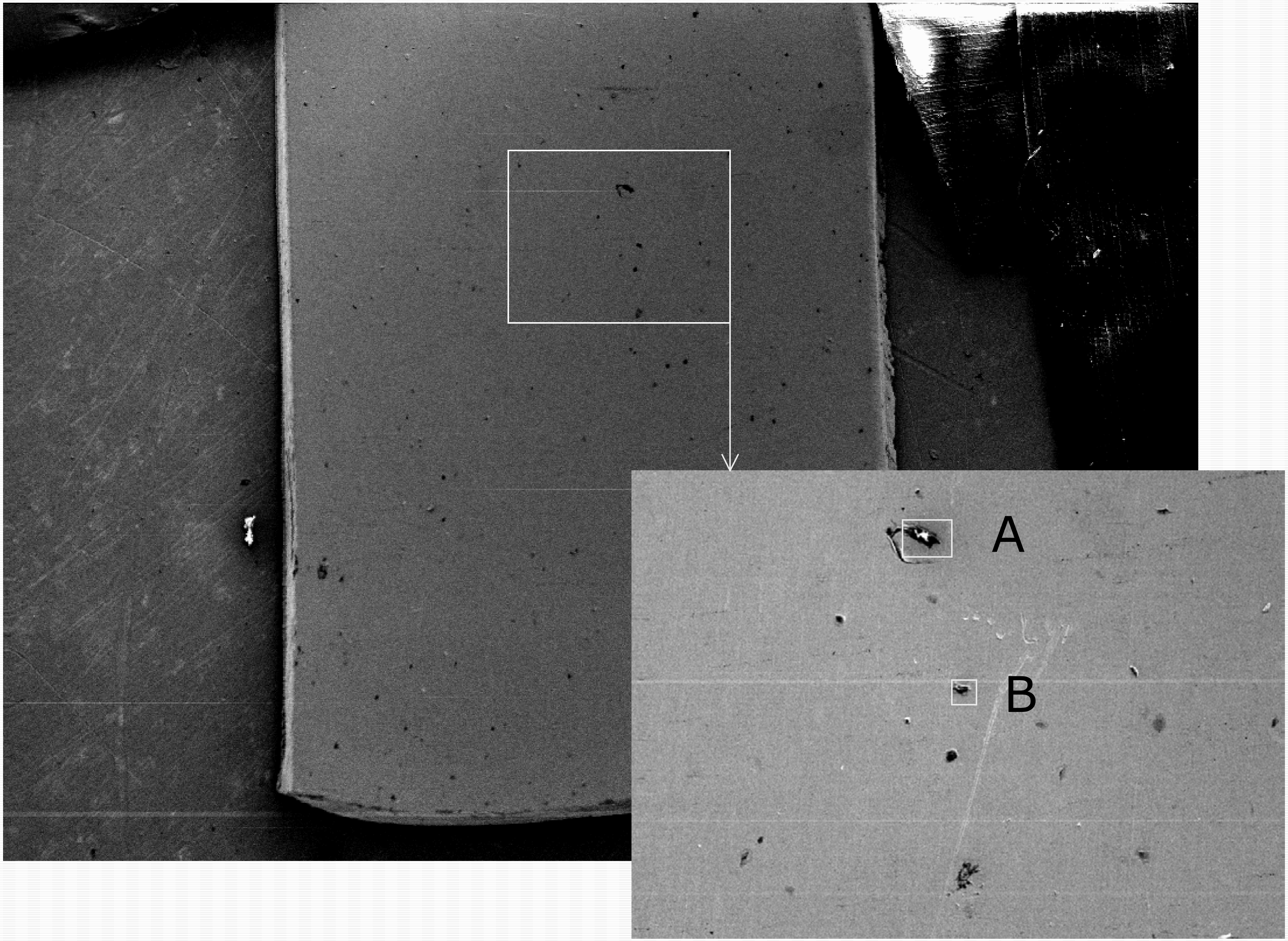
Third Setup Results



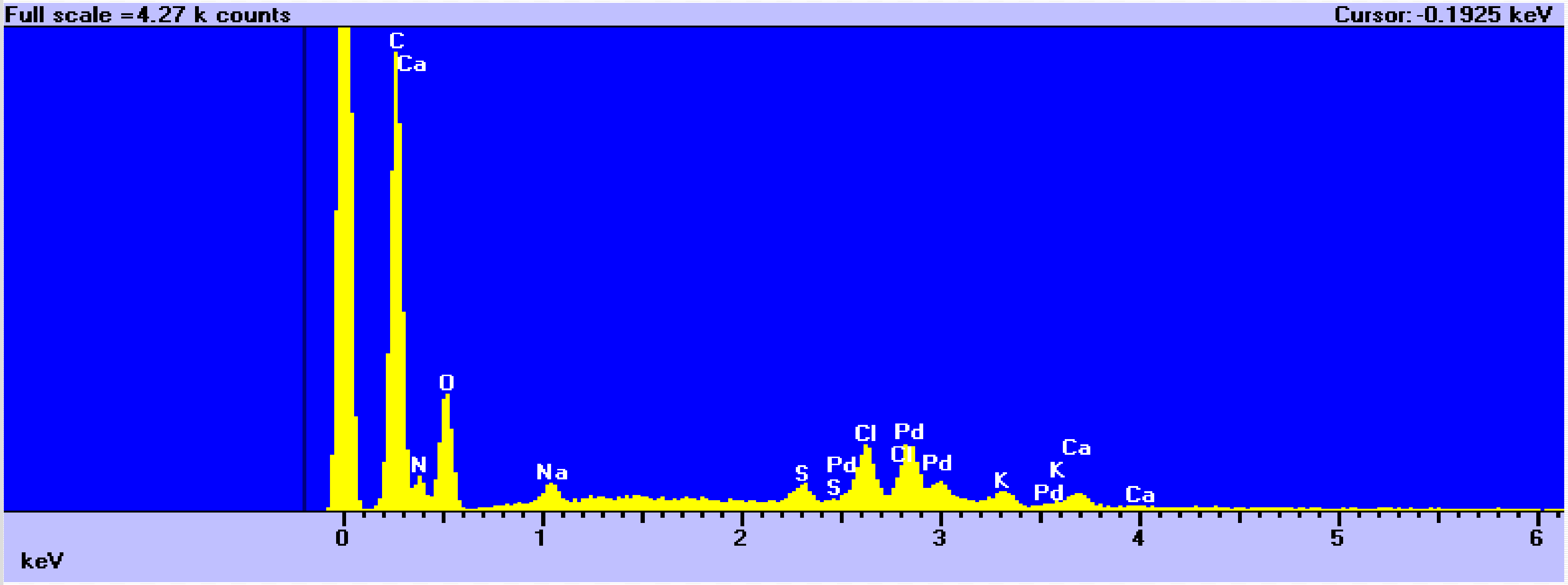
Scanning Electron Microscope

SEM and EDX Characterization

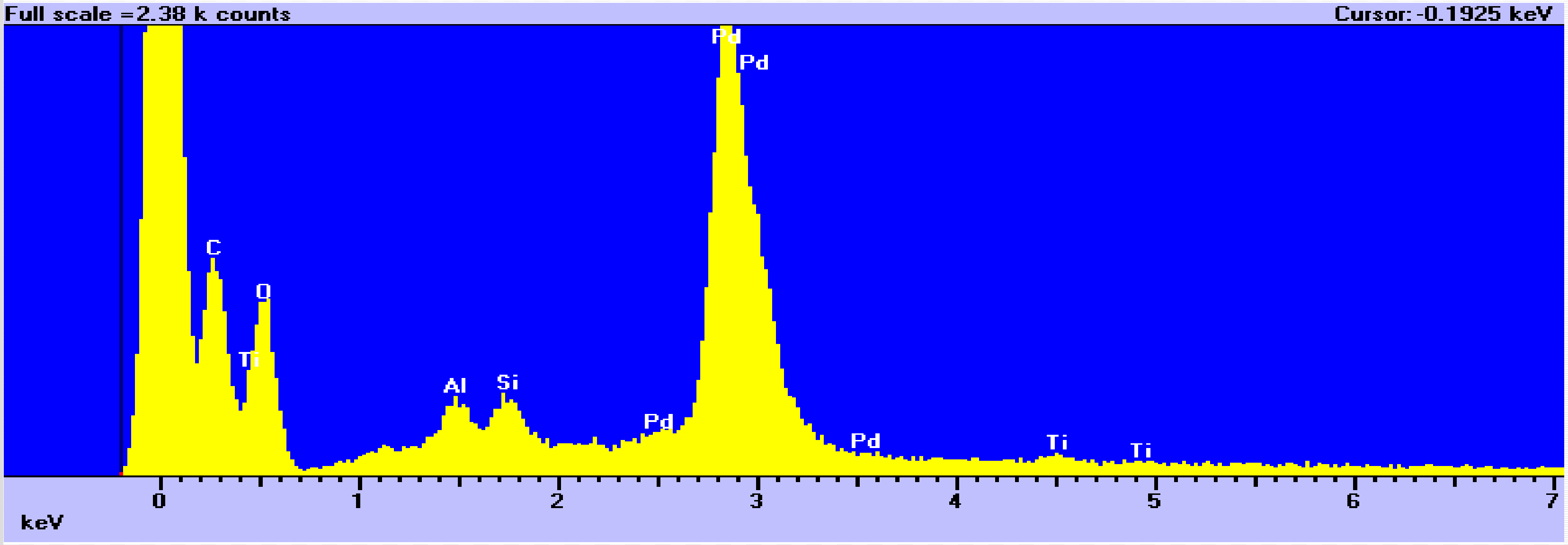
Palladium Before Electrolysis



Palladium Before EDX Spectra



A



B

Palladium Impurities

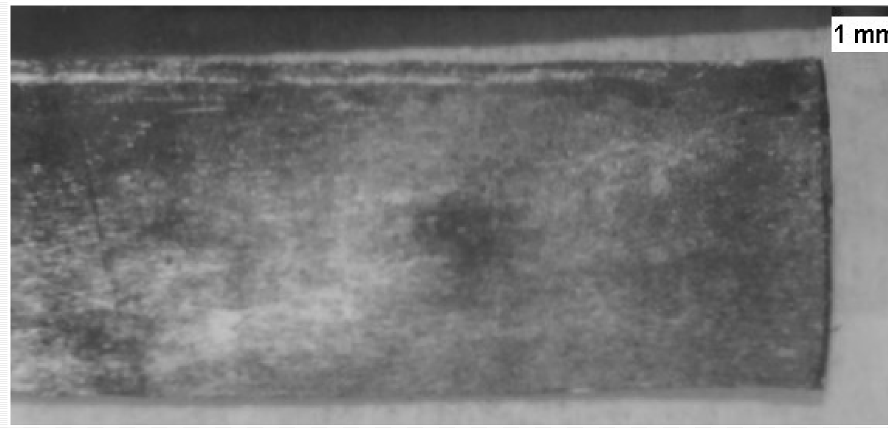
- Existing impurities on the palladium sample consisted mostly of carbon and oxygen. There were small amounts of other elements, but no significant contamination. No silver or cadmium was present.

- Characterization data from a nearly identical experiment* is presented to show micro-chemical changes in composition after electrolysis.

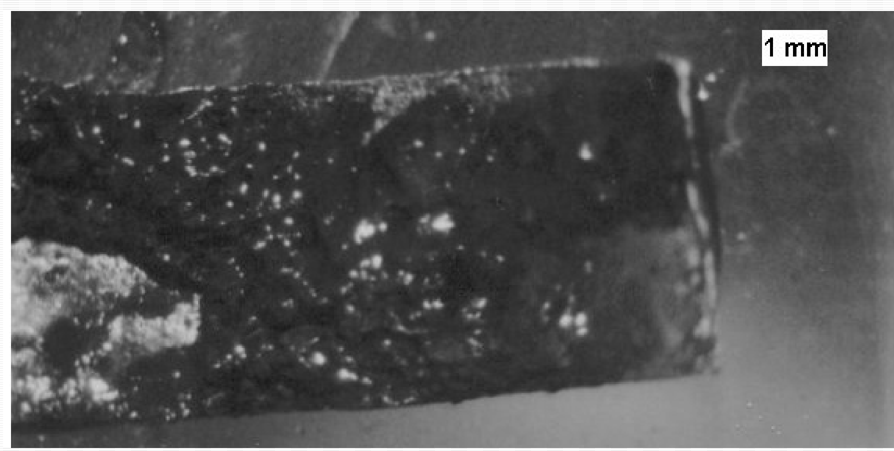
*Conrado Salas Cano’s Master’s thesis

Conrado Salas Cano's D_2O Palladium Cathode

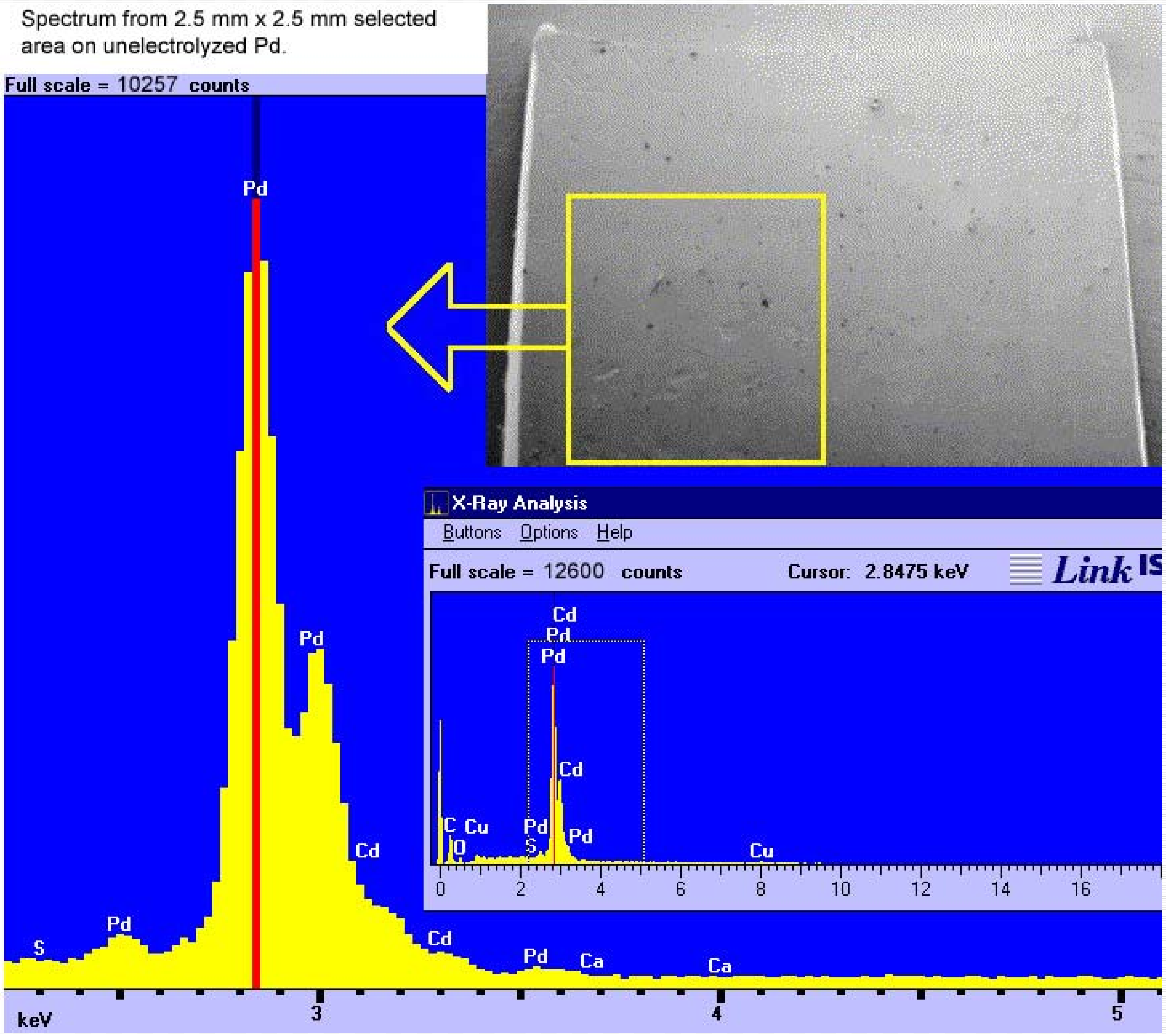
Before



After



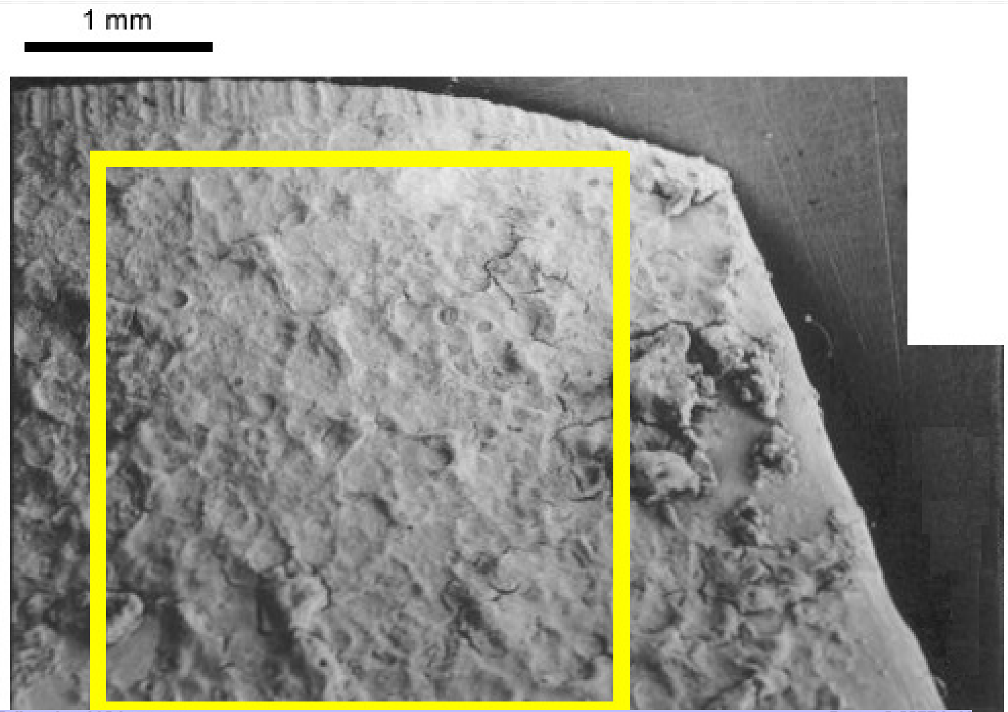
Before Electrolysis Comparison

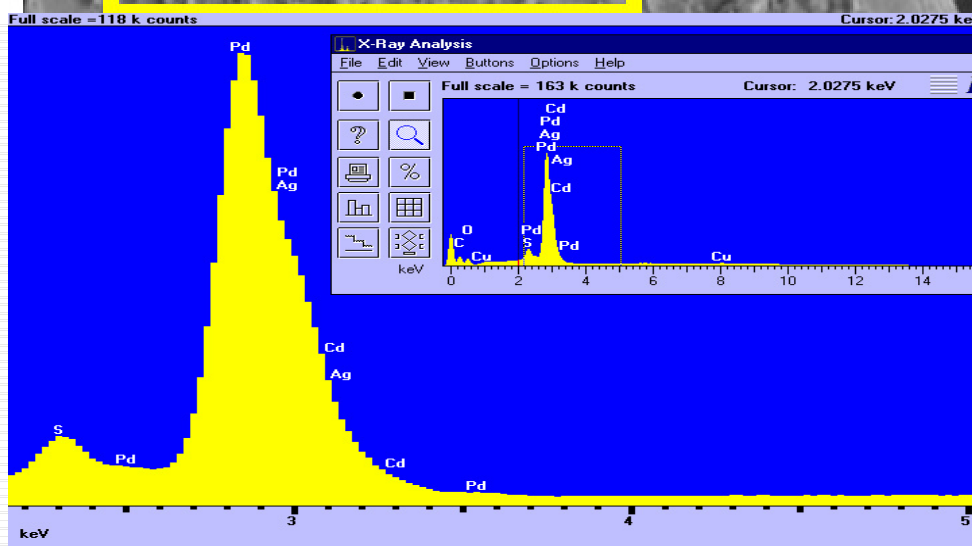


	In number of atoms	In mass	$\sigma_{in\ mass}$
C	41.93%	10.56%	*0.20%*
O	20.69%	6.94%	*0.48%*
S	0.07%	0.04%	*0.06%*
Cu	1.09%	1.45%	*0.24%*
Pd	36.09%	80.51%	*0.85%*
Ag	0.00%	0.00%	*0.70%*
Cd	0.00%	0.00%	*0.42%*
Pt	0.13%	0.51%	*0.20%*

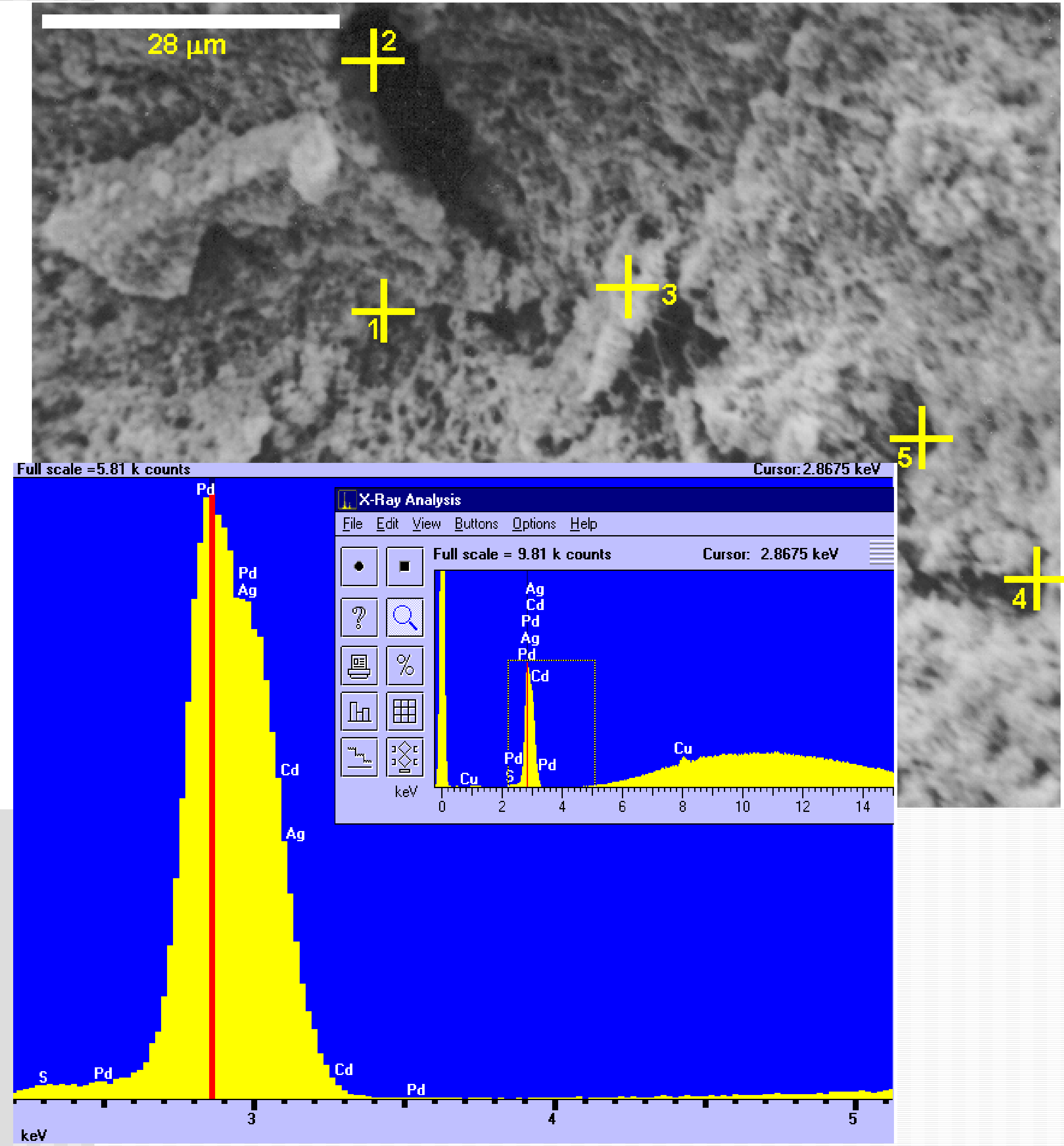
Pd Cathode After Electrolysis

	In number of atoms	In mass	$\sigma_{in\ mass}$
C	12.87%	3.21%	0.07%
O	47.04%	15.59%	0.20%
S	4.55%	3.02%	0.04%
Cu	0.71%	0.94%	0.09%
Pd	33.14%	73.04%	0.31%
Ag	1.43%	3.19%	0.25%
Cd	0.00%	0.00%	0.19%
Pt	0.26%	1.03%	0.08%





Spectrum and SEMQuant from spot #2



	In number of atoms	In mass	$\sigma_{in\ mass}$
C	0.00%	0.00%	0.30%
O	12.68%	2.29%	0.41%
S	2.03%	0.73%	0.07%
Cu	11.50%	8.22%	1.02%
Pd	57.23%	68.5%	1.33%
Ag	16.43%	19.9%	0.81%
Cd	0.00%	0.00%	0.65%
Pt	0.13%	0.29%	0.13%

A Theoretical Explanation

The Trapped Neutron Catalyzed Fusion Model can provide an explanation for excess heat and nuclear transmutation based on the capture of thermal neutrons.

An explanation for the presence of silver after electrolysis is shown below:

$$n + {}^{108}_{46}\mathrm{Pd} = {}^{109}_{46}\mathrm{Pd} + 6.15\,\mathrm{MeV}$$

$${}^{109}_{46}\mathrm{Pd} = {}^{109}_{47}\mathrm{Ag} + e^{-} + \overline{\nu}_e + 1.166\,\mathrm{MeV}$$

The natural abundance of Pd 108 is 27% and Pd 109 has a decay time of 13.6 hours.

Obtained from H. Kozima's <u>Discovery of the Cold Fusion Phenomenon,</u> 1998 Ohtake Shuppan, Inc.

Summary & Conclusions

- Consistently produced excess heat exists for reproducible cell types
- Possible formation of unexpected elements after electrolysis points to nuclear reactions
- Although several theories have been put forth, the driving mechanism responsible for cold fusion still remains largely a mystery.

Key Apprenticeship Learning

- Advanced, analytical laboratory skills development
- Introductory familiarity with SEM, EDS, Calorimeters, and computer programs
- Instant immersion into a higher academic setting
- A fuller understanding of the scientific community

Acknowledgements

- Dr. John Dash, Mentor
- Professor Hideo Kozima, Co-mentor
- Dr. Jon Warner, Co-mentor
- Conrado Salas Cano, Co-mentor
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- Ben and Jeremy's Parents

Questions and Comments