Evidence for Anomalous Low Energy Nuclear Reactions

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Topics to be Covered

Reproducibility, Controllability & Optimization

Evidence for Nuclear Reactions

~~Evidence for Surface Reactions~~

Recent Theoretical Developments

Introduction to Reproducibility

The Scientific Method, including reproducibility within and between laboratories, has a large literature, much of it in the Philosophy of Science.

There are essentially two kinds of reproducibility:

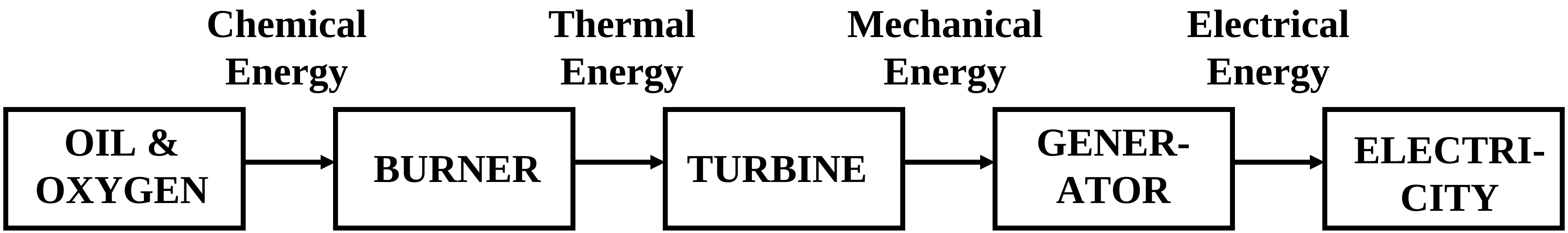
Different things are done, but the results are comparable.
The same things are done, but sometimes the results vary.

The first is characteristic of old and understood technologies.
The second is often the case in new fields when all the relevant variables are not understood or controlled.

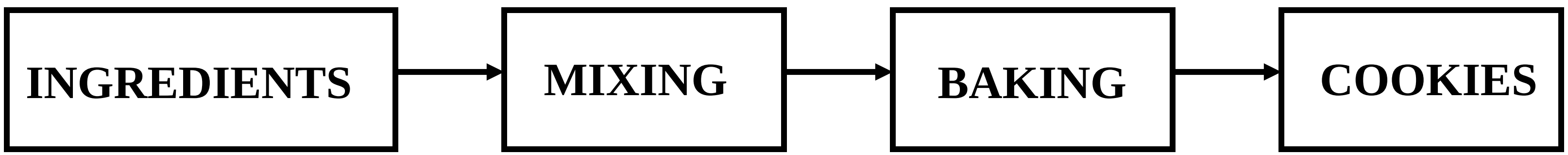
There are many examples of the first type of reproducibility.
LENR is now an example of the second type of reproducibility.

Examples of the First Type of Reproducibility:
<u>Getting the Same Results</u>

ENERGY PRODUCTION: ELECTRICITY FROM OIL



MATERIALS MODIFICATION: MAKING CHOCOLATE COOKIES



IN BOTH CASES, THE INPUT MATERIALS, THE EQUIPMENT, THE PROCEDURES AND THE PEOPLE INVOLVED CAN BE VERY DIFFERENT, BUT THE END RESULT, ELECTRICITY OR COOKIES, IS REPRODUCIBLE.

THE <u>RESULTS</u> ARE REPRODUCIBLE, DESPITE MANY ACTUAL DIFFERENCES IN ALL OTHER ASPECTS OF THE PROCESSES. BOTH CASES ARE OLD AND WELL-UNDERSTOOD TECHNOLOGIES.

Examples of the Second Type of Reproducibility: <u>Doing the Same Things</u>

Five Fundamental Factors

Materials

The materials that actually participate in an experiment are critical to the outcome, and impurities may play a major role.

Apparatus

The equipment determines what is possible, and may contribute materials to the experiment.

Protocols

What is done and when it is done both determine the outcome of an experiment.

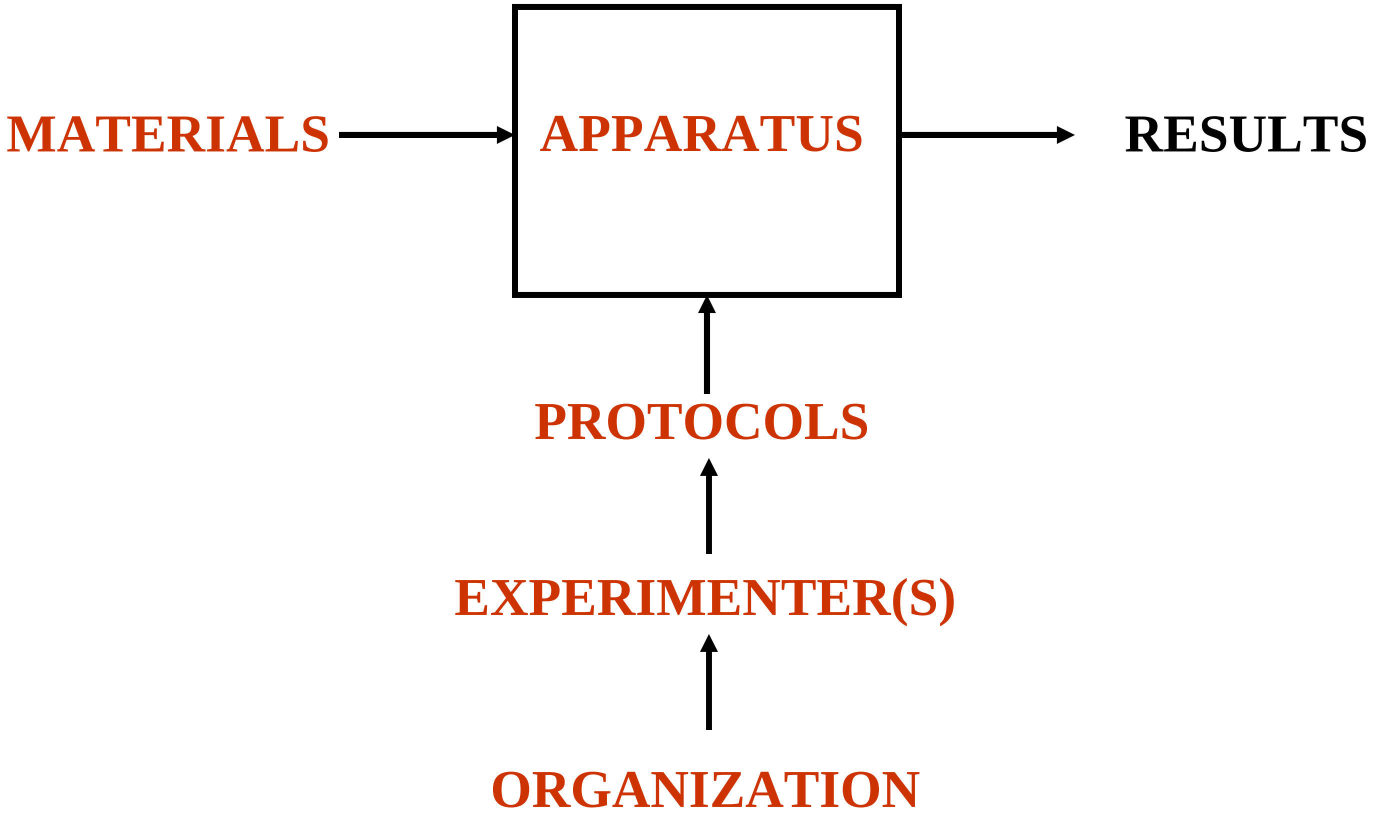
Experimenter(s)

The effects of the knowledge, skills and inclinations of the scientists performing an experiment range from central to subtle.

Organization

The organization within which an experiment is performed can have many impacts on the outcome.

Five Fundamental Factors



The key question is how much variation in the five factors is tolerable in order to achieve either the same or similar results?

Materials

The bulk and surface compositions of electrodes and other structures involved in a LENR experiment are critical

Possible Participation of Impurities

1 Watt = 1 J/sec. or about 10^{13} MeV/sec.

If each nuclear reaction gives 1 MeV, need 10^{13} reactions/sec.

1 ppm is about 10^{17} Nuclei/cm^3, so 0.1 cm^3 = 10^{16} Nuclei

Hence, reactions of 10^{-3}/ sec. of a 1 ppm impurity gives 1 Watt

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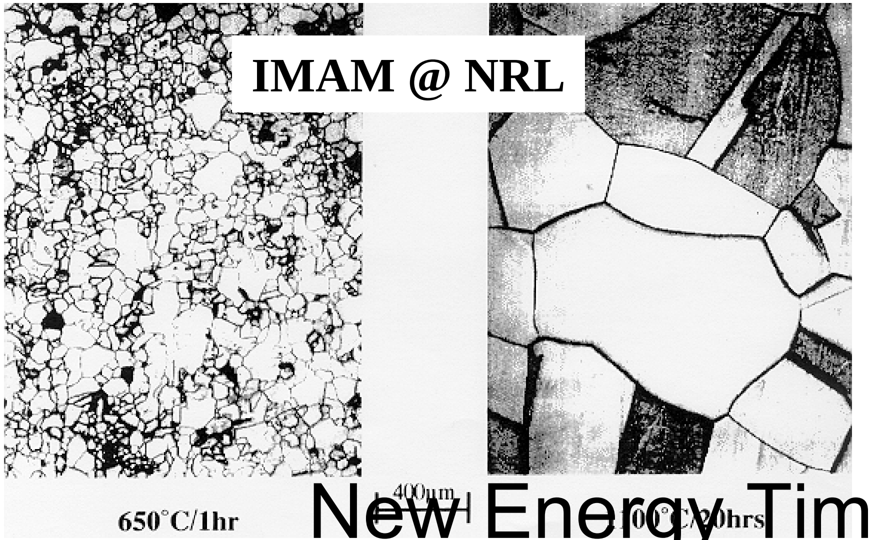
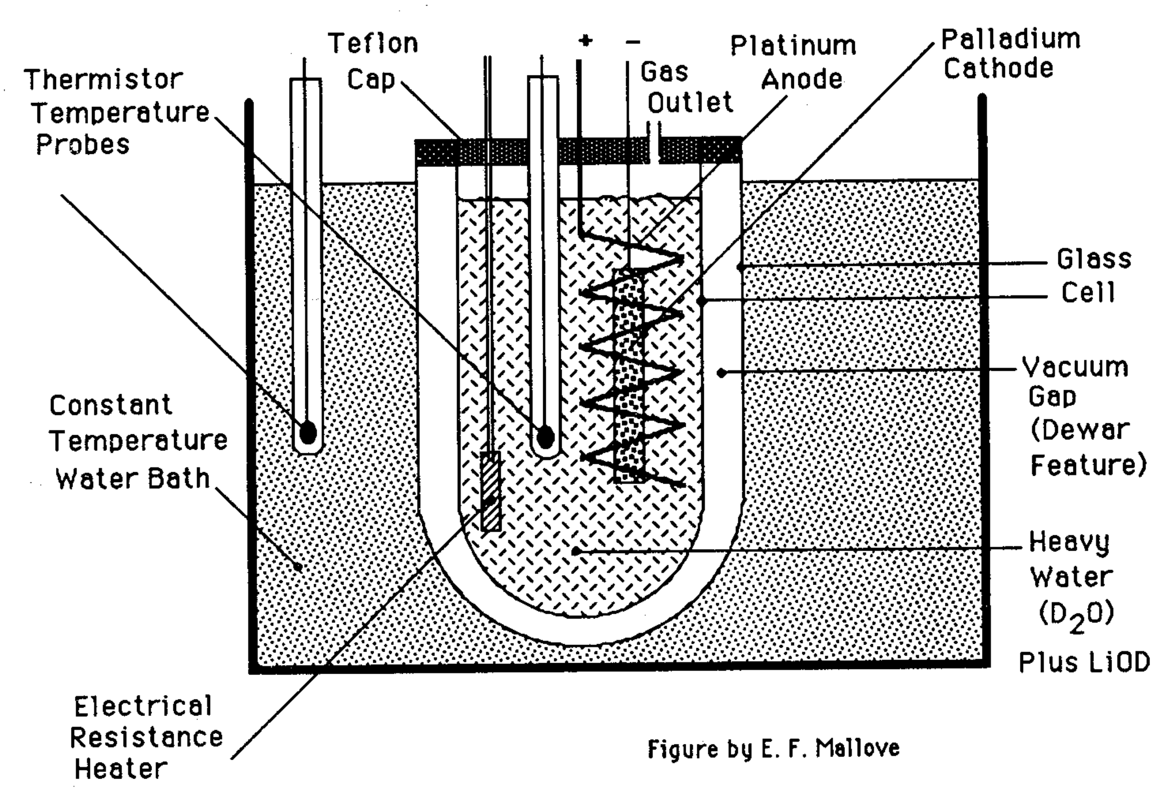
Possible Influence of Impurities on Structure



Crystal structure could be critical.

It depends on many composition and processing variables.

Apparatus



CELL DESIGN: TYPE, OPEN or CLOSED,…

CALORIMETER: HEAT or MASS FLOW, CALIBRATION, …..

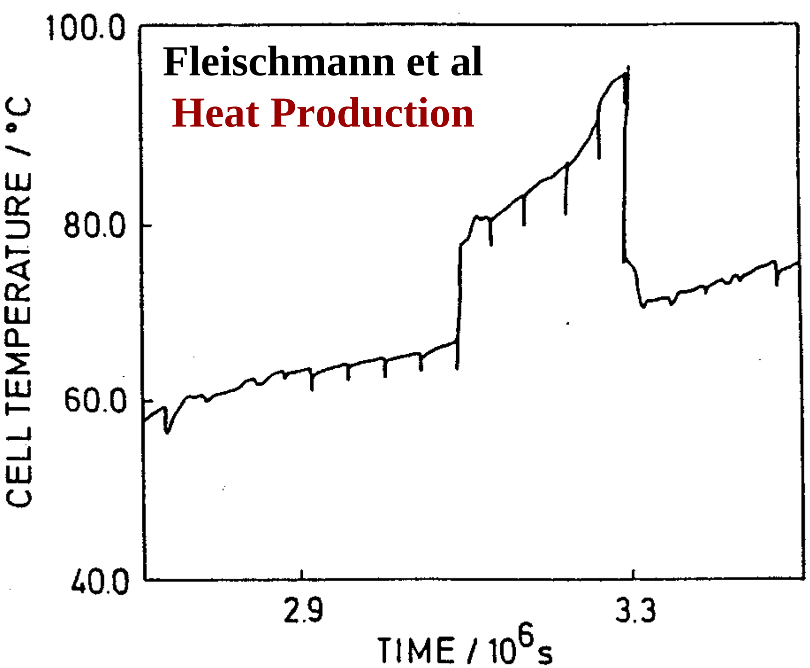
DETECTORS: TYPE, MINIMUM DETECTABLE LIMIT, ……

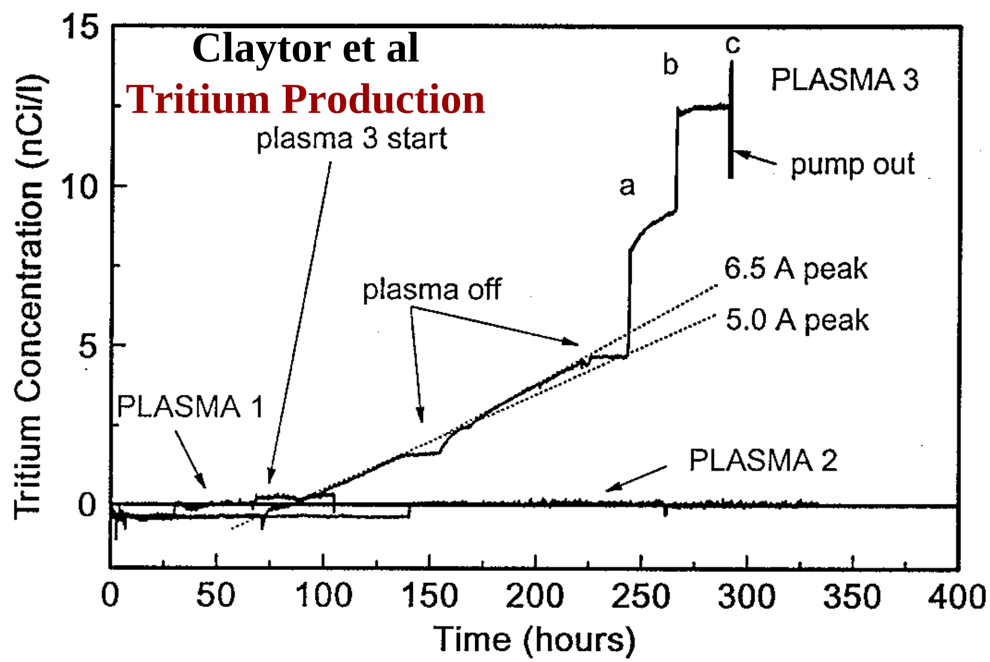
MANY CHOICES AND MOST OF THEM ARE IMPORTANT

Protocols

The ambient conditions, especially temperature, and the levels and time variations of applied voltages and currents, make up the experimental protocols chosen by the experimenter(s).

Dis-equilibrium has been shown to be important in many types of LENR experiments. Two examples are:





Experimenter(s):

The key questions are (a) what knowledge and (b) which of the many requisite skills are possessed by the experimenter(s)?

PHYSICS

CHEMISTRY

NUCLEAR PHYSICS

ELECTROCHEMISTRY

SOLID-STATE PHYSICS & CHEMISTRY

MATERIALS SCIENCE

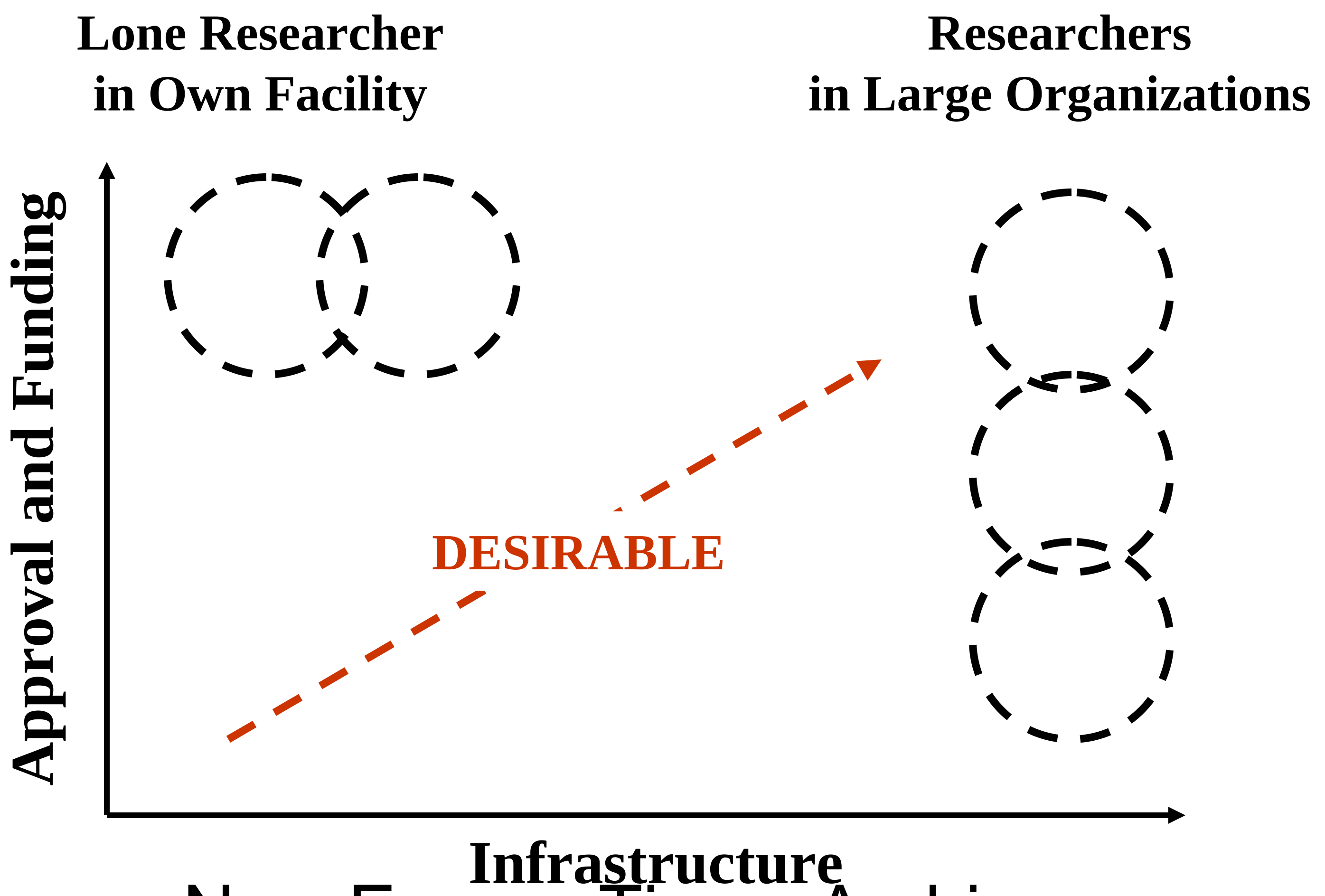
INSTRUMENTATION SCIENCE & TECHNOLOGY

ELECTRICAL, MECHANICAL & THERMAL ENGINEERING

STATISTICS & DATA ANALYSIS

Organization:

Inter-Personal Relationships, Money and Available Assistance are Each Important



Intra-Laboratory Reproducibility

M. H. Miles performed electrochemical experiments from which heat and helium were observed and usually correlated:

Correlated Heat and He were observed in 18 of 21 runs.
Neither were observed in 12 of 12 other runs.

S. Szpak and his colleagues performed co-deposition experiments for over a decade which exhibited "anomalous events virtually 100% of the time", according to F. Gordon. The anomalies include heat, tritium and IR emissions.

Edmund Storms stated that "I can make heat with good success if I treat the sample in exactly the same way." He has demonstrated tests of cathodes prior to a LENR experiment that will show if a particular cathode will not work.

Intra-Laboratory Reproducibility

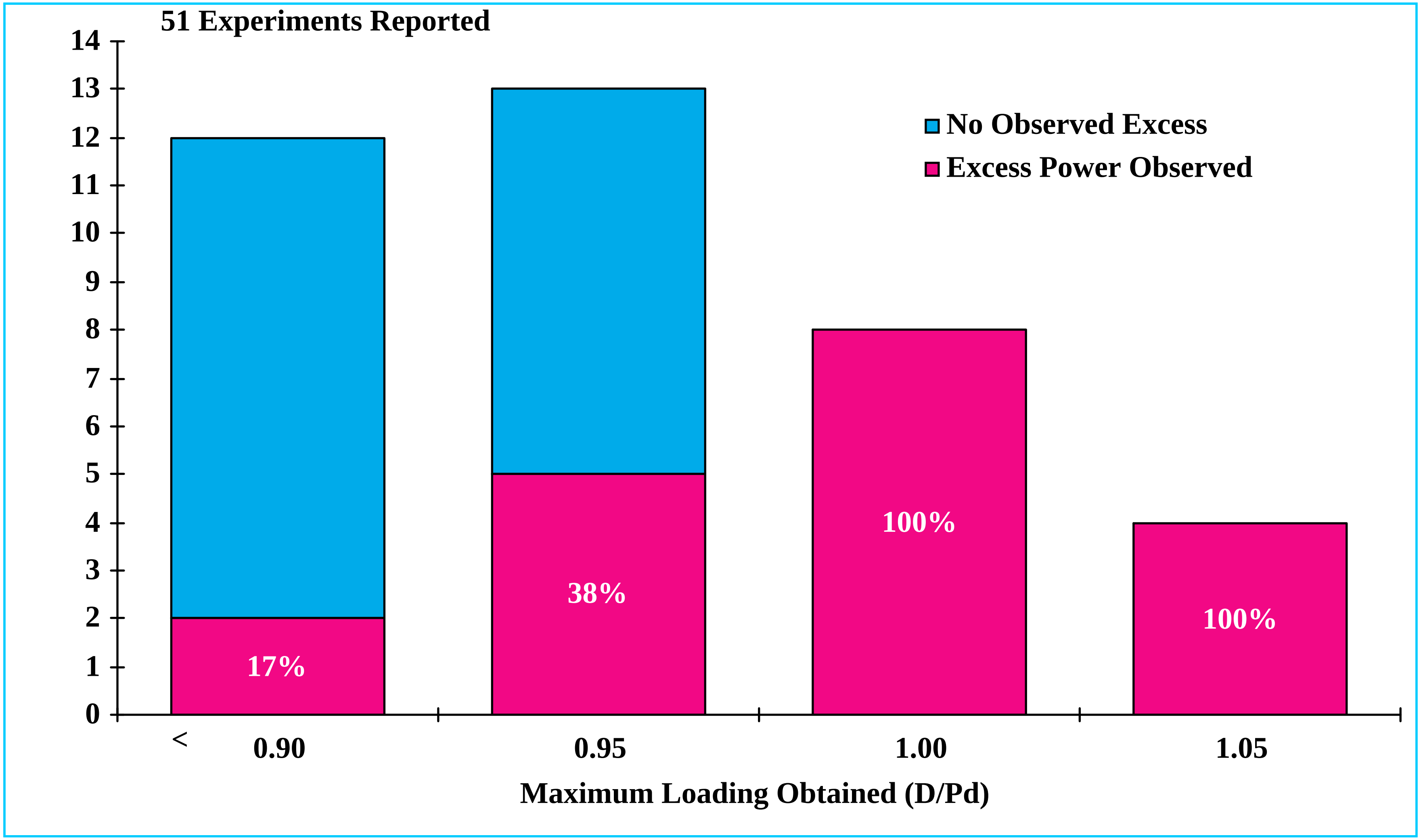
First 25 Runs

First 25 Pd		l	d	A	mM	Electrolyte:	Conc.	Add.	T °C	P (psi)	Max. I: A	/ cm²	Min. R/R°	Max. D/Pd	Expt (h)	Init. (h)	P_{XS} (W)	%	Inpu MJ	Output-Input MJ	%	eV Pd atom	#
Differential Calorimeter (High pressure, Low temperature)															*2.2*	*Years*							
P1a	AECL	5.0	0.7	11	217	LiOD	1.0	none	**7**	**650**	7.5	0.68	**1.20**	**1+**	696	369	1.8	**52%**	3.4	0.07	**2.1%**	3.4	5
P1b	*	5.0	0.7	11	4E-4	LiOD	1.0	none	**7**	**650**	7.5	0.68	Cu Substr.		696	299	0.2	**7%**		0.01		4.E+05	2
P2 Series (High pressure flow Calorimeter)																							
P2	Engel.	4.5	0.3	4.2	36	LiOD	1.0	none	**4**	**1000**	2.1	0.50	1.65	0.95	1393	504	2.0	**53%**	50	1.07	**2.1%**	310	4
P3	Engel.	4.5	0.3	4.2	36	LiOD	1.0	none	4	1000	1.5	0.35	1.70	0.90	1250				18				
P7	Engel.	4.5	0.3	4.2	36	LiOD	1.0	none	8	1000	1.1	**0.26**	Contact Prob.		145				2.1				
P10	Engel.	4.5	0.3	4.2	36	LiOD	1.0	none	35	900	0.2	**0.05**	Contact Prob.		18				0.3				
P11	Engel.	4.5	0.3	4.2	36	LiOD	1.0	none	35	1050	5.0	1.18	1.65	0.95	85				1.2				
P4 Series (Medium Pressure)																							
P4	Engel.	5.0	0.3	4.7	40	LiOD	**0.1**	none	15	100	2.4	0.51	1.80	0.80	1165				17				
P5	Engel.	5.0	0.3	4.7	40	Li_2SO_4	**0.5**	none	16	100	4.0	0.85	1.70	0.90	287				4.1				
P6	Engel.	5.0	0.3	4.7	40	Li_2SO_4	**0.5**	As_2O_3	8	100	2.7	0.57	1.70	0.90	649				9.3				
P8	Engel.	3.0	0.3	2.8	24	LiOD	**0.1**	none	15	100	1.8	0.64	1.65	**0.95**	**186**				2.7				
P9	Engel.	3.0	0.3	2.8	24	LiOD	1.0	none	35	50	1.5	0.53	1.65	**0.95**	**597**				22				
P12 Series (Al & Si)																							
P12	Engel.	3.0	0.3	2.8	24	LiOD	1.0	**^{4}He,Al**	30	50	2.5	0.88	1.55	**0.98**	1631	316	1.0	**10%**	59	0.80	1.4%	**346**	4
P13	Engel.	3.0	0.3	2.8	24	LiOH	1.0	Al	30	50	2.5	0.88	1.1*	**0.98**	815				12				
P14	Engel.	3.0	0.3	2.8	24	LiOD	1.0	**^{3}He,Al**	30	50	2.5	0.88	1.60	0.94	692	184	0.5	5%	10	0.20	**2.0%**	84	2
P15	Engel.	3.0	0.3	2.8	24	LiOD	1.0	**Al**	35	40	2.5	0.88	1.58	**0.97**	1104	684	2.4	**24%**	40	0.55	1.4%	**238**	3
P16	Engel.	3.0	0.3	2.8	24	LiOD	1.0	**^{3}He,Al**	35	40	2.5	0.88	1.70	0.90	1104	948	0.4	4%	40	0.10	0.2%	42	4
P17	Engel.	3.0	0.3	2.8	24	LiOD	1.0	**Si**	29	40	1.1	0.39	1.29	**1+**	1202	1040	0.2	2%	13	0.10	0.7%	42	2
P18	Engel.	3.0	0.3	2.8	24	LiOD	1.0		35	40	Failed early due to electrical contact												
P20	Engel.	3.0	0.3	2.8	24	LiOD	1.0	**Al**	35	40	2.0	0.71	1.55	**0.98**	954	650	0.3	2%	17	0.16	1.0%	71	3
P19 Series (Boron)						Outlet; 2 RTD & 2 thermistors					B effect, multi-humped R response												
P19	Engel.	3.0	0.3	2.8	24	LiOD	1.0	**B**	35	40	1.9	0.67	1.45	**0.99**	1287	261	0.9	340%	23	0.41	1.8%	**180**	4
P21	Engel.	3.0	0.3	2.8	24	LiOD	1.0	**B**	30	40	2.0	0.71	1.60	0.94	764	390	0.6	6%	14	0.04	0.3%	17	2
P22	Engel.	3.0	0.3	2.8	24	LiOD	1.0	**B**	30	40	2.0	0.71	1.30	**1+**	1480	378	0.1	**30%**	21	0.27	1.3%	**119**	3*
C Series (Large Area)																	Last event terminated by H_2O addition *						
C1	JM	30	0.1	9.4	27	LiOD	1.0	Al	30	50	7.2	0.76	1.65	0.93	866	390	1.4	3%	49	1.12	**2.3%**	**437**	1
C2	JM foil	25	µm	60	3	LiOD	1.0	Al	30	50	7.2	0.12	1.60	0.94	356	190	3.0	**10%**	14	0.56	**3.9%**	**2076**	1

M.C.H. McKubre et al. SRI International

Intra-Laboratory Reproducibility

M. C. H. McKubre et al-SRI International



If appropriate conditions were achieved, excess heat resulted.

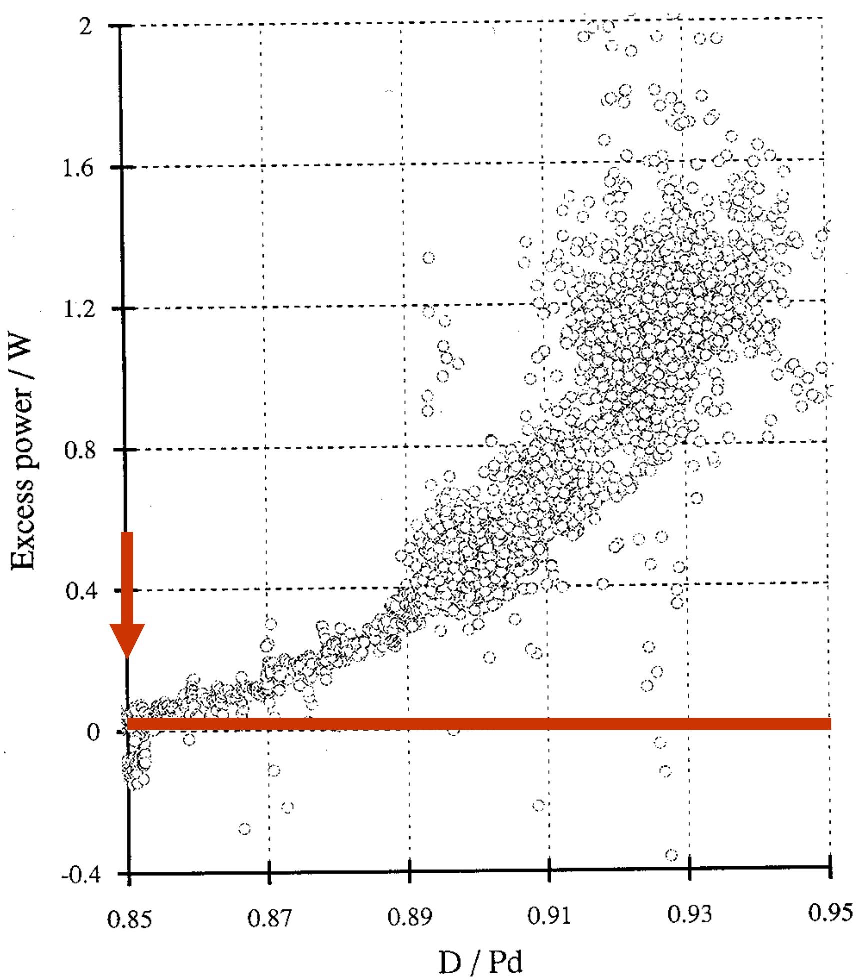
Intra-Laboratory Reproducibility: Krivit's Reproducibility Survey at ICCF-10

Cold Fusion Reproducibility From a November, 2003 survey of 10 respondents							
Researcher's Nationality	**Field of Degree**	**Years of Cold Fusion Research**	**Years of Hot Fusion Research**	**Estimated Number of Experiments Performed**	**Reproducibility Rate 5 Years Ago**	**Reproducibility Rate Last 12 Months**	**Do You Conclude That Nuclear Activity is Occurring?**
Italy	Chem. Engr.	na	yes	na	na	50	na
Russia	Condensed Matter Physics	18	na	1,000	na	60	Yes
Italy	Physics	14	16	300	40	75	Yes
United States	Mass Communications	13	no	6,000	25	75	Yes
United States	Phys. Chem.	14	no	200	10	80	Yes
United States	Metallurgy	14	no	3,000	50	90	Na
Japan	Nucl. Engr.	14	20	20	70	100	Yes
Romania	Atomic Physics	10	no	40	70	100	Yes
United States	Radiochemistry	14	no	700	50	100	Yes
Russia	Nucl. Rocket Engr.	13	2	3,500	na	100	Yes
TOTAL ESTIMATED EXPERIMENTS				**14,720**			
AVERAGE REPORTED REPRODUCIBILITY					**45%**	**83%**	

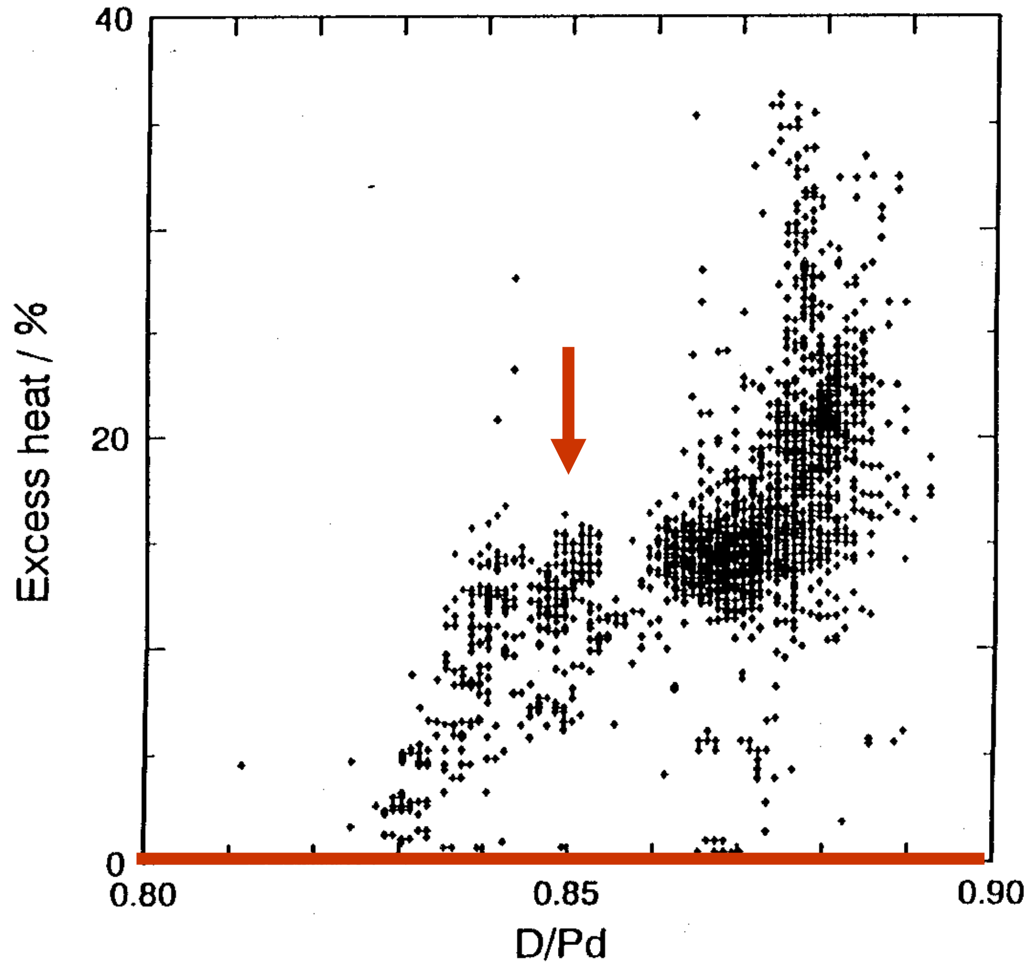
New Energy Times Archives

Inter-Laboratory Reproducibility

Excess Heat Depends on the Loading



McKubre et al

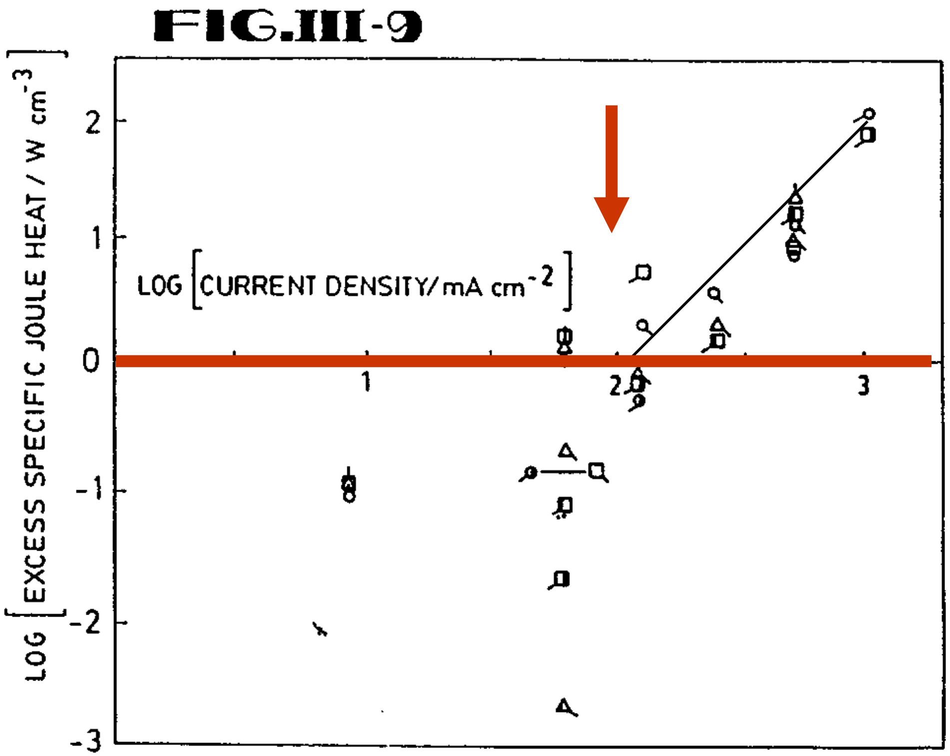


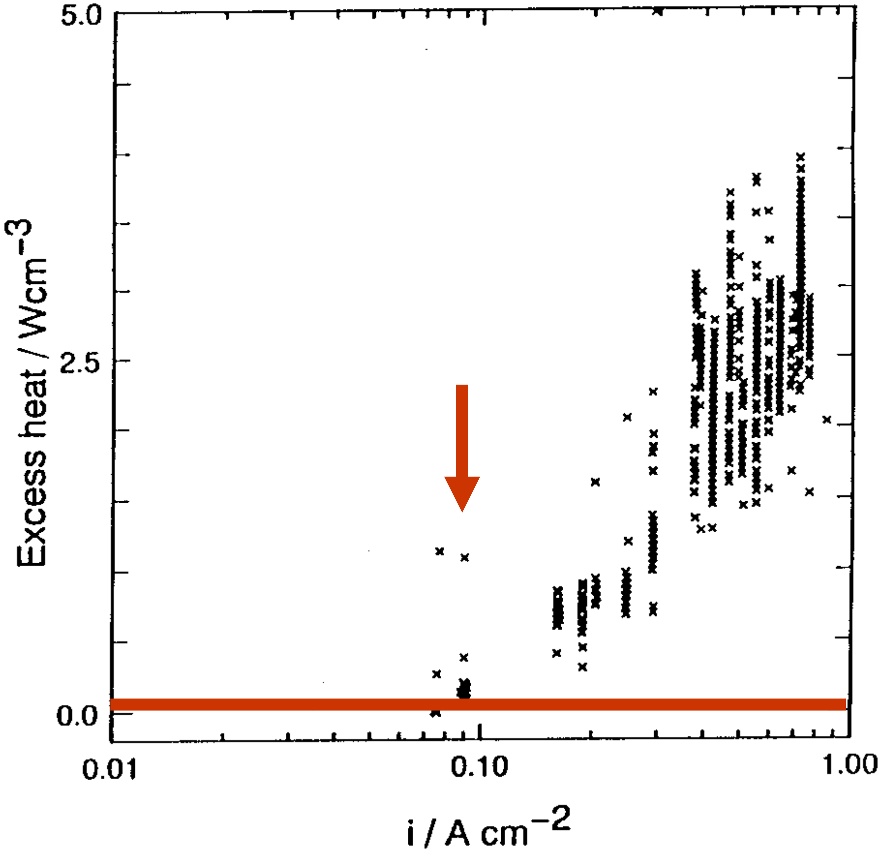
Kunimatsu et al

$P_{xs} \sim [X - X_o]^2$ where $X = D/Pd$

Inter-Laboratory Reproducibility

Excess Heat Depends on Current Density





Pons and Fleischmann **Kunimatsu et al**

$$P_{XS} \sim [A/cm^2 - (A/cm^2)_O]$$

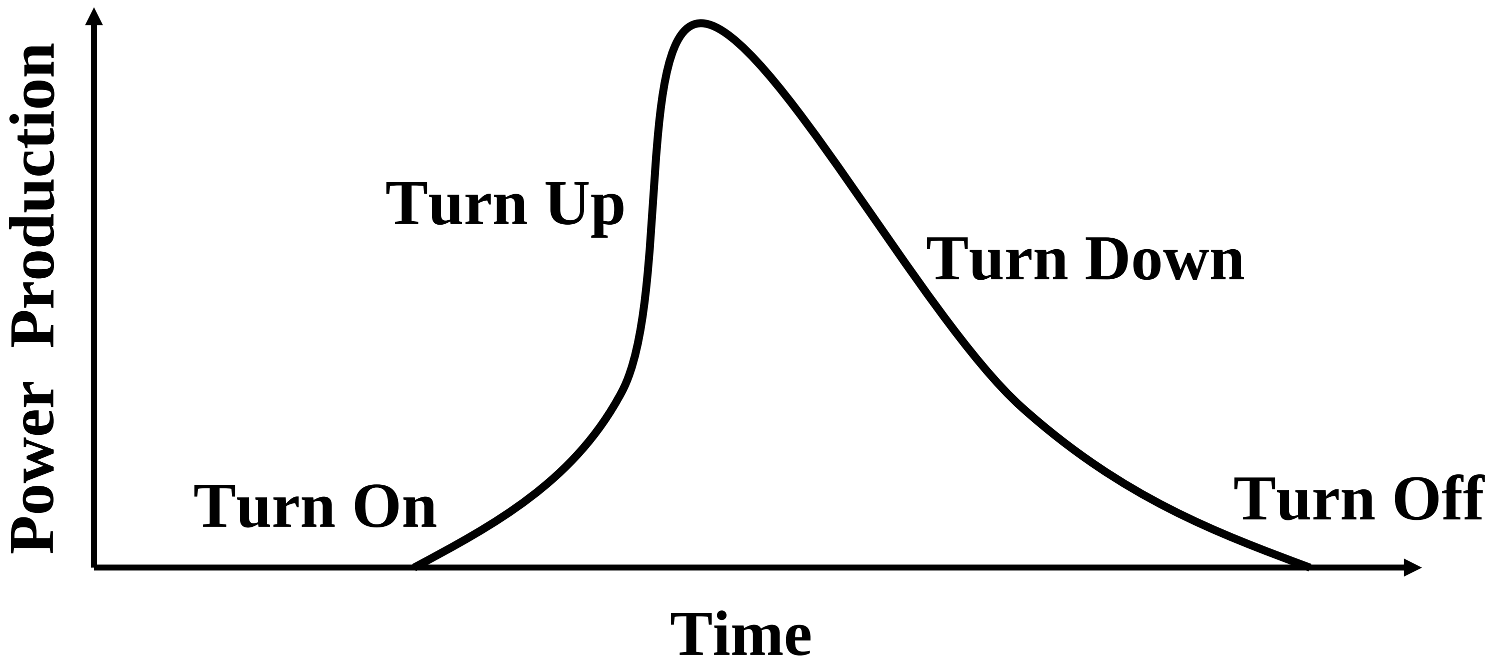
Inter-Laboratory Reproducibility at SRI International

Experimenters (Year)	Nature of Experiment	Outcome @ SRI Int'l.
M. Miles and B. Bush (93)	EC Loading: D-Pd	Low levels of He observed
M. Srinivasan (94)	EC Loading: H-Ni	No excess power; chemical effect
J. Patterson & D. Cravens (95)	EC Loading: H/D-Ni	No excess power
R. Stringham & R.George (96)	Cavitation Loading: D-Metals	No excess power
X. Arata and X. Zhang (96-97)	EC DS Cathode: D-Pd	80% excess energy and He increase ★
F. Celani et al (98)	EC Loading Fine Wires	No excess power
R. Stringham (99)	Cavitation Loading: D-Metals	No excess power
L. Case (98-02)	Heat & Press: D2 + Pd catalyst	Correlated heat and He production ★
D. Letts & D. Cravens (03)	EC Loading + Laser Stimulation	28 W/cm^3 & 25 kJ excess observed ★

The table shows that excess power and energy, sometimes with significant amounts of He, were produced in three of the nine replication attempts. The reasons for the failed replication attempts are not clear.

Controllability of LENR Experiments

For LENR to be a practical source of energy, the reactions must be controllable:



Imagine an automobile without these capabilities!!

Currently, there is even less information on controllability of LENR than on their reproducibility.

Optimization of LENR Experiments

For LENR to be an economical source of energy, the reactions almost certainly must be optimized.

The amount of power and energy produced per kilogram of system weight and liter of system volume must be high enough to breakeven over the costs of materials, and the costs of manufacture, sales and maintenance of the system.

Optimization is needed to (a) achieve economic breakeven and (b) maximize the profit margin.

Again, imagine an automobile that gets poor gas mileage.

Neither available parametric studies not any of the current theories permit optimization of LENR.

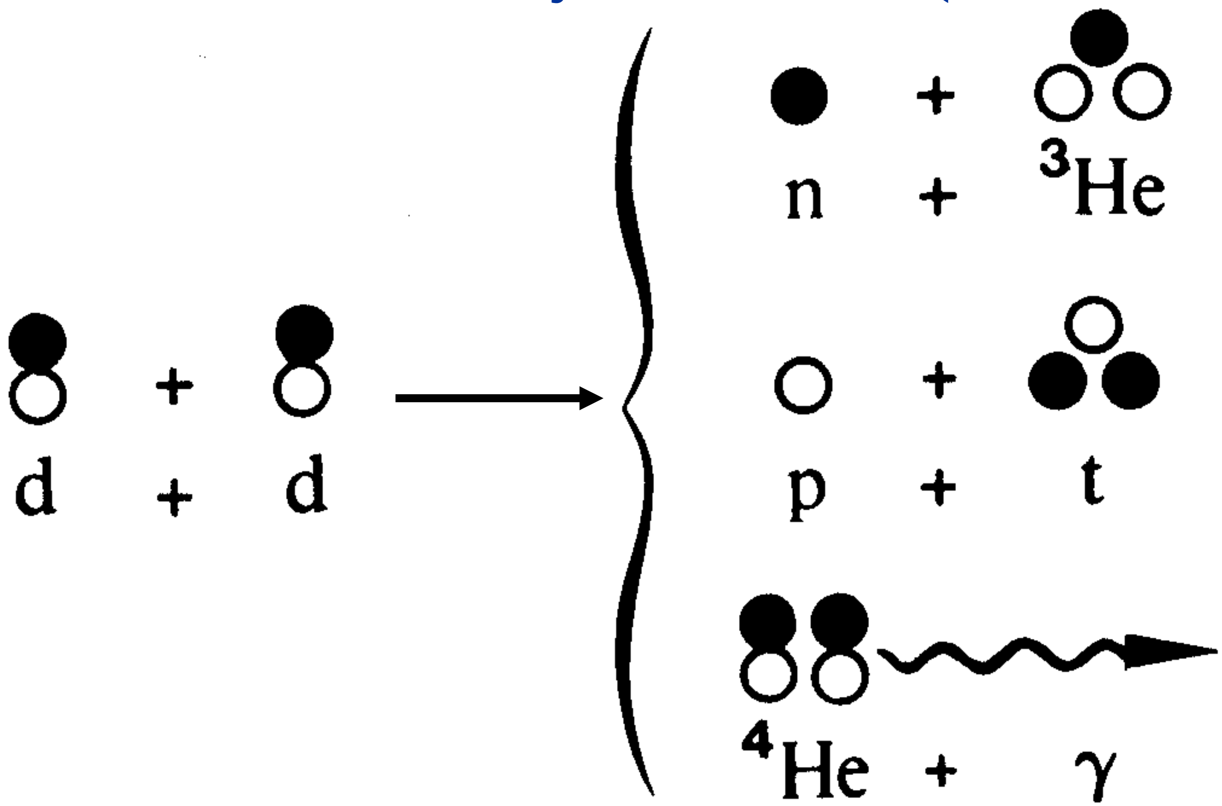
Reproducibility, Controllability & Optimization Summary

	Time in Years or Decades →			
Reproducibility	No	Yes	Yes	Yes
Controllability	No	No	Yes	Yes
Optimization	No	No	No	Yes
Understanding	Increases with time			

Currently, there is significant intra- and inter-laboratory reproducibility, little controllability and little optimization

Evidence for Nuclear Reactions

Ordinary D-D Fusion (Beams or Plasmas)



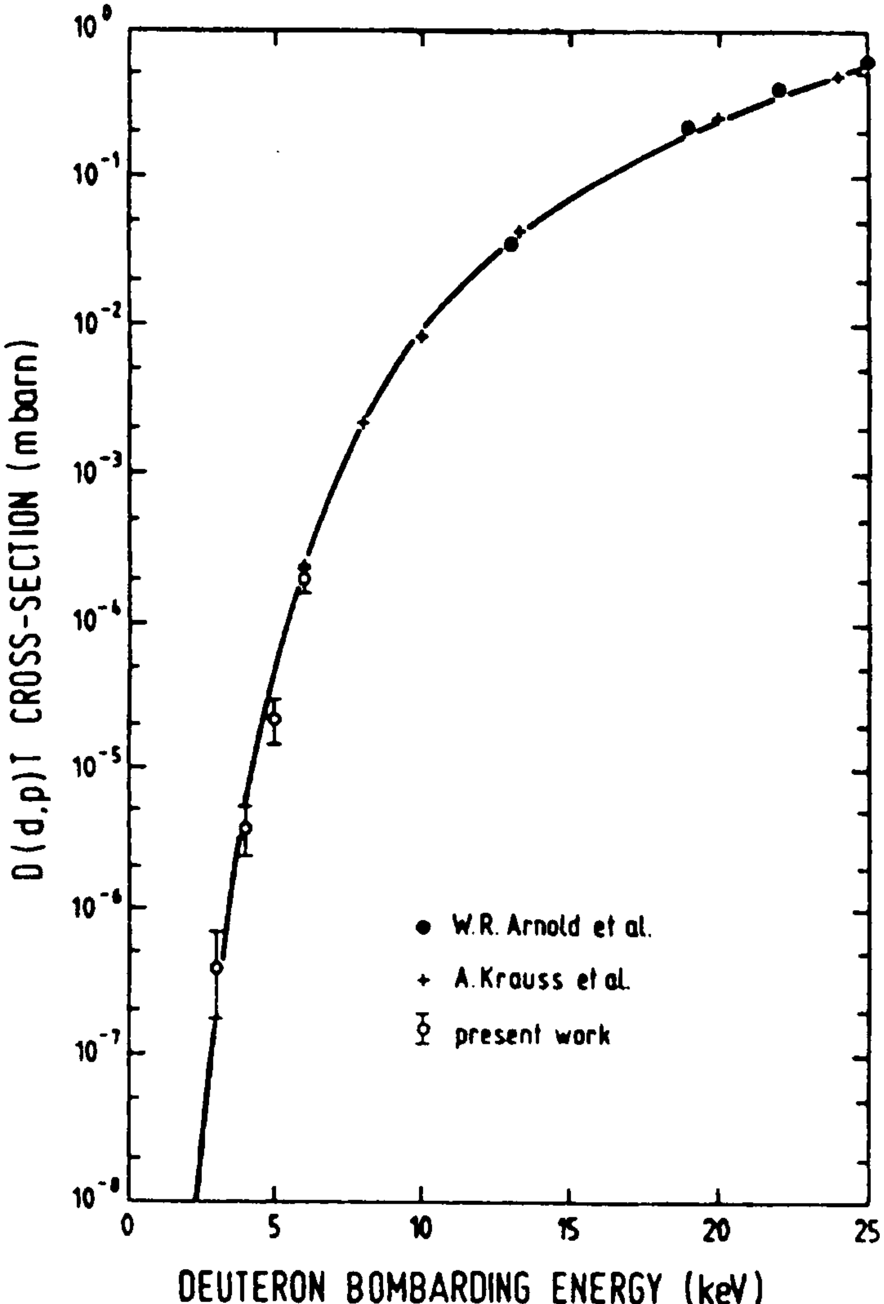
+2.45 MeV (50%)

+3.0 MeV (50%)

24 MeV (10^{-7})

Ignition Temperature = 400 X 10^6 ^{0}c

(about 40 Kev)



Types of Nuclear Evidence

Large Excess Heat

Production of Helium

Heat-Helium Correlation

Production of Tritium

Observations of Neutrons, X-Rays & Gamma-Rays

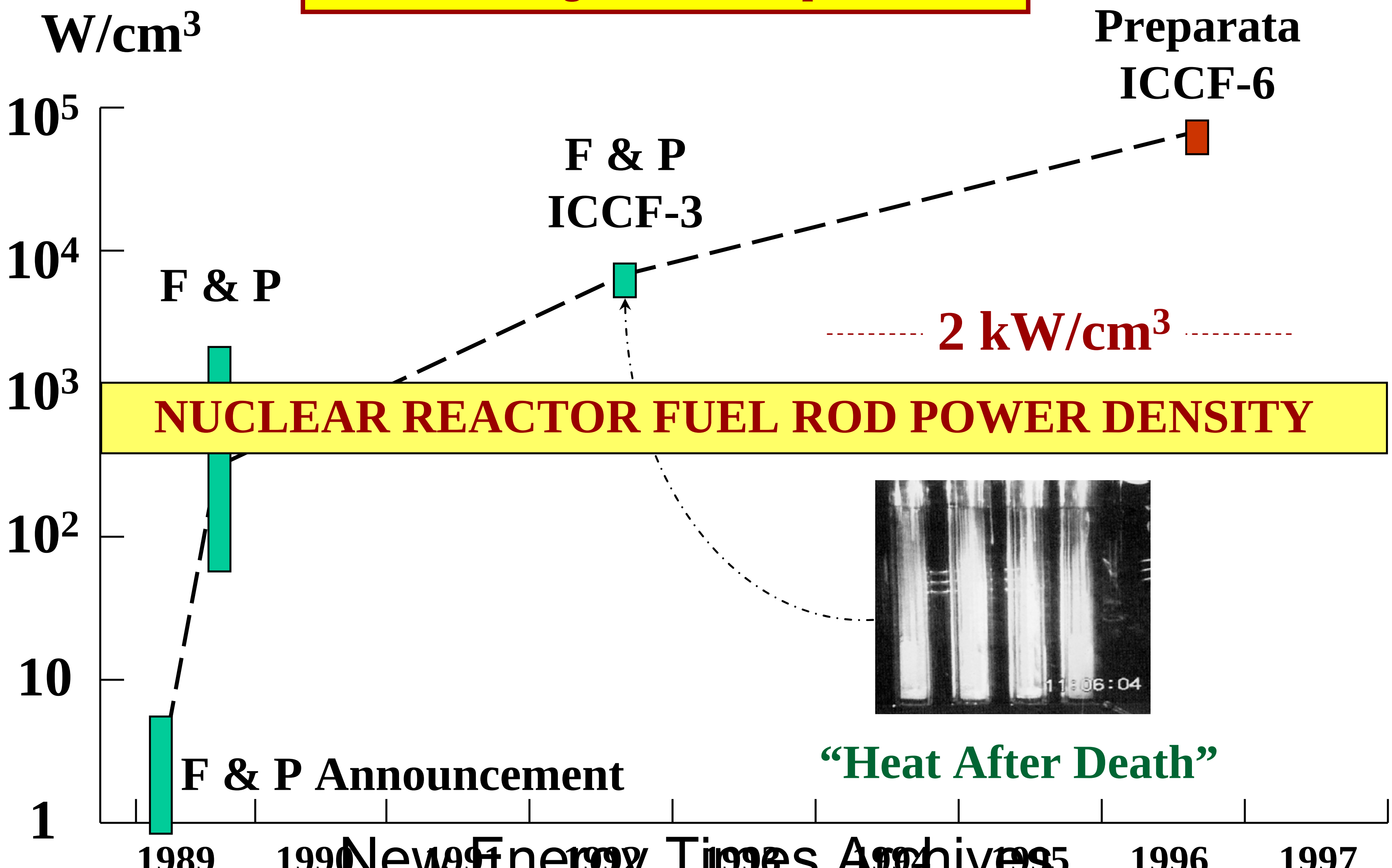
Craters in Cathodes

Hot Spots on Cathodes

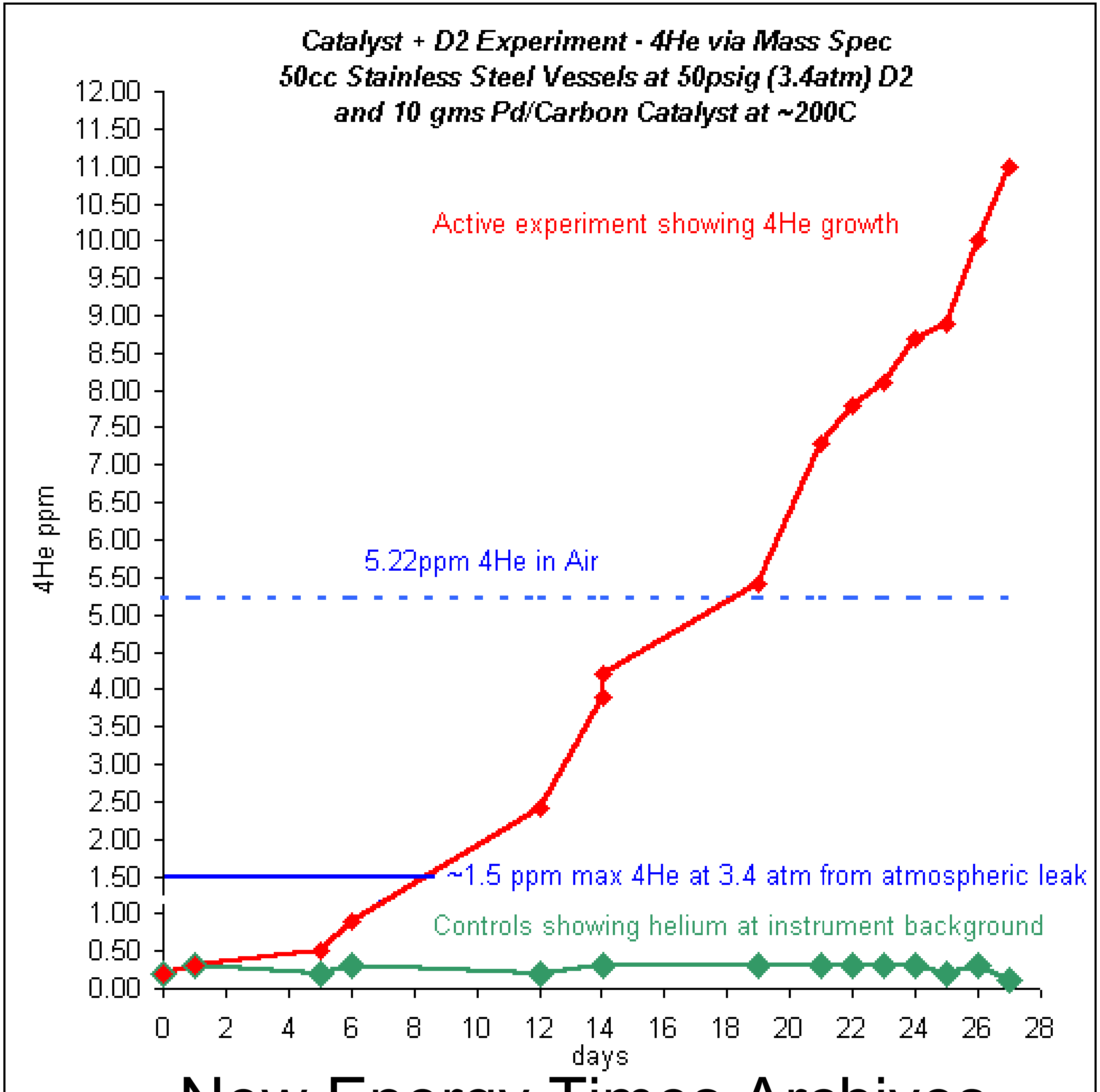
Observations of Unexpected Elements

Large Excess Heat

McKubre et al: 2076 eV per Pd atom
Arata & Zhang: ~20,000 eV per Pd atom

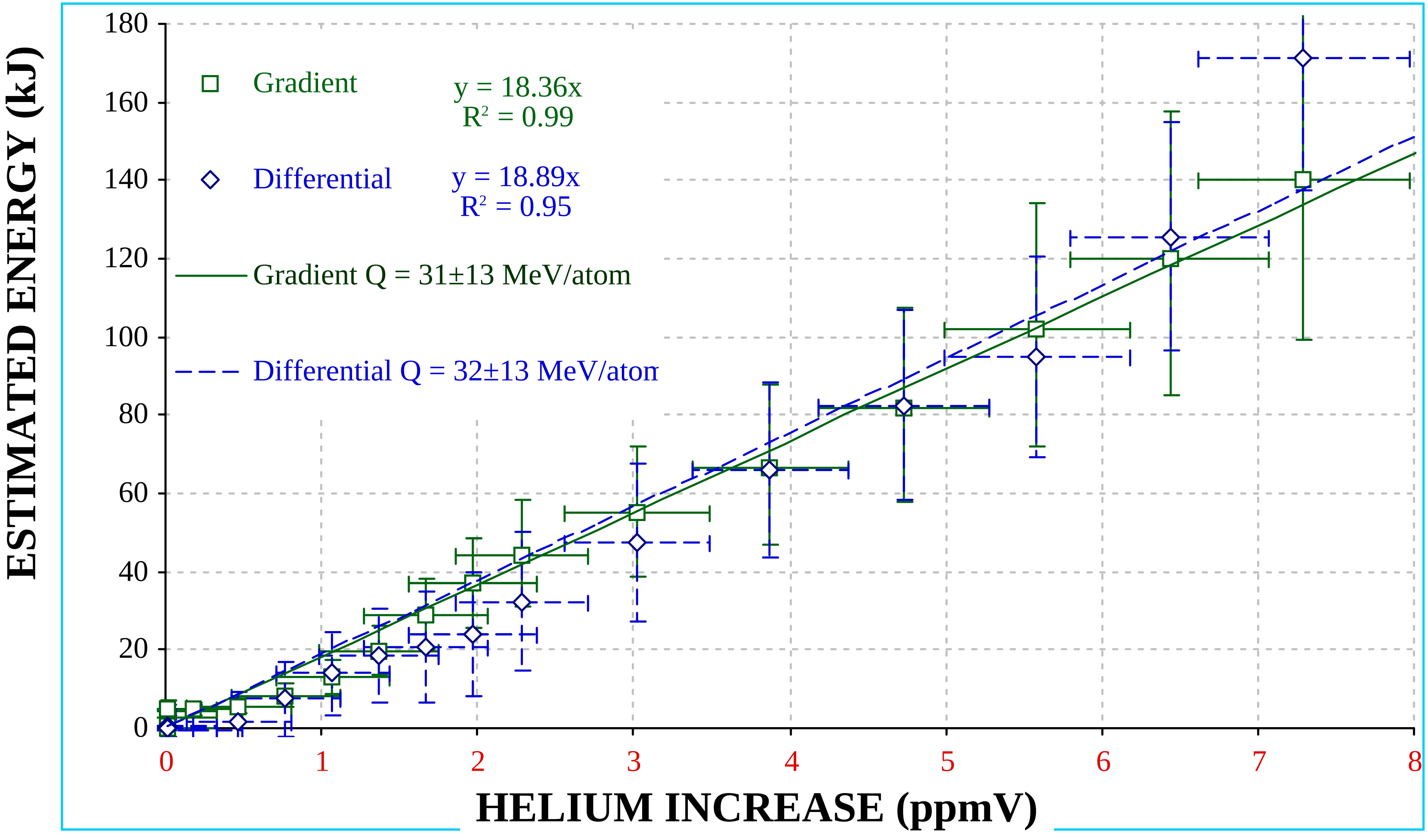


Production of Helium



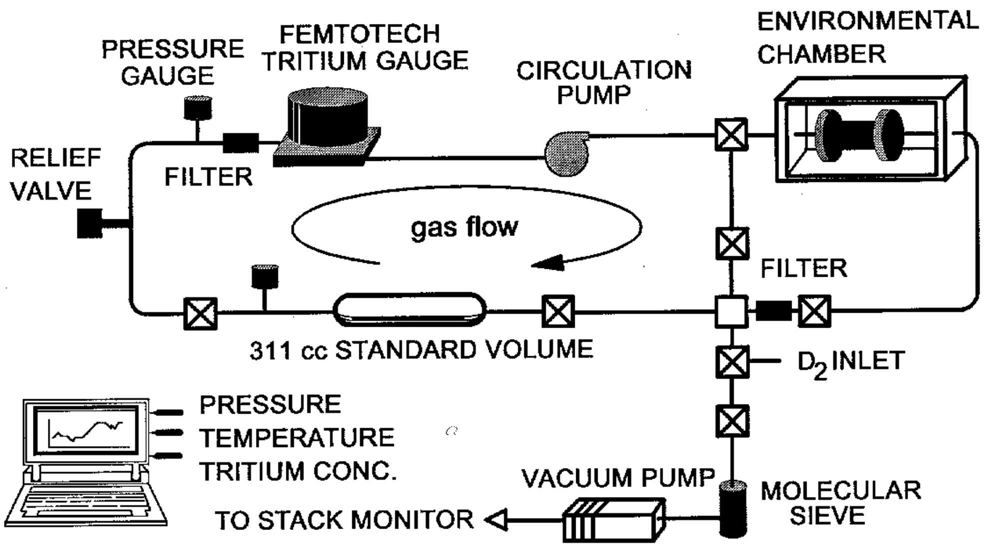
SRI International

Heat-Helium Correlation



McKubre et al, SRI International

Production of Tritium



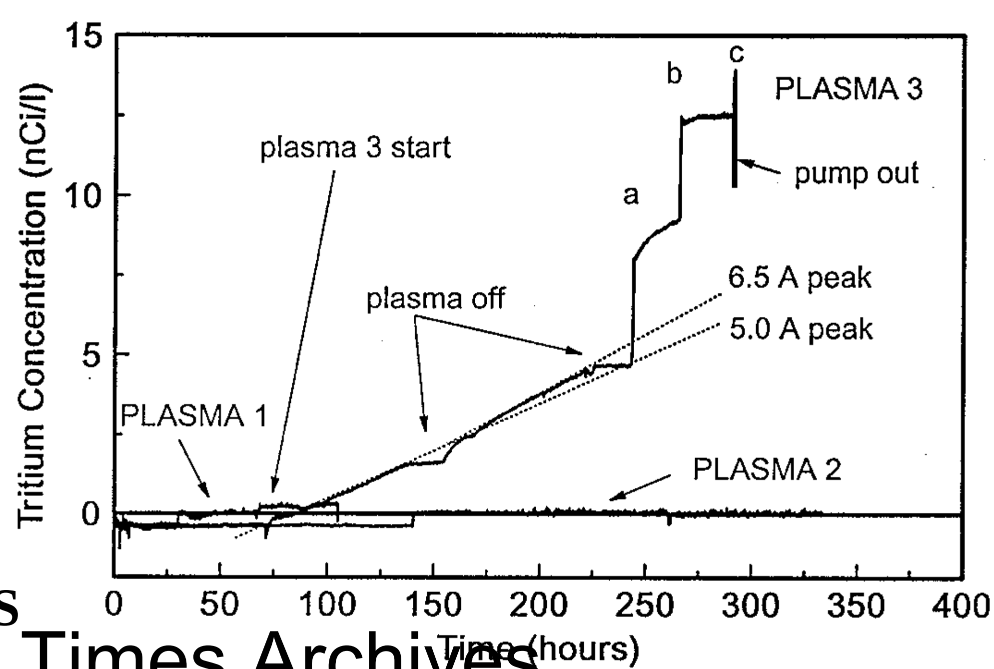
GOOD INSTRUMENTATION

TWO TECHNIQUES TO MEASURE TRITIUM

BASELINE FOR SOME EXPERIMENTS

GOOD SIGNAL TO NOISE

RESPONSE TO VARIATIONS



CLAYTOR ET AL @ LOS ALAMOS

Observations of Neutrons and X-Rays

Low rates of statistically-valid neutron emission have been observed in many “cold fusion” experiments.

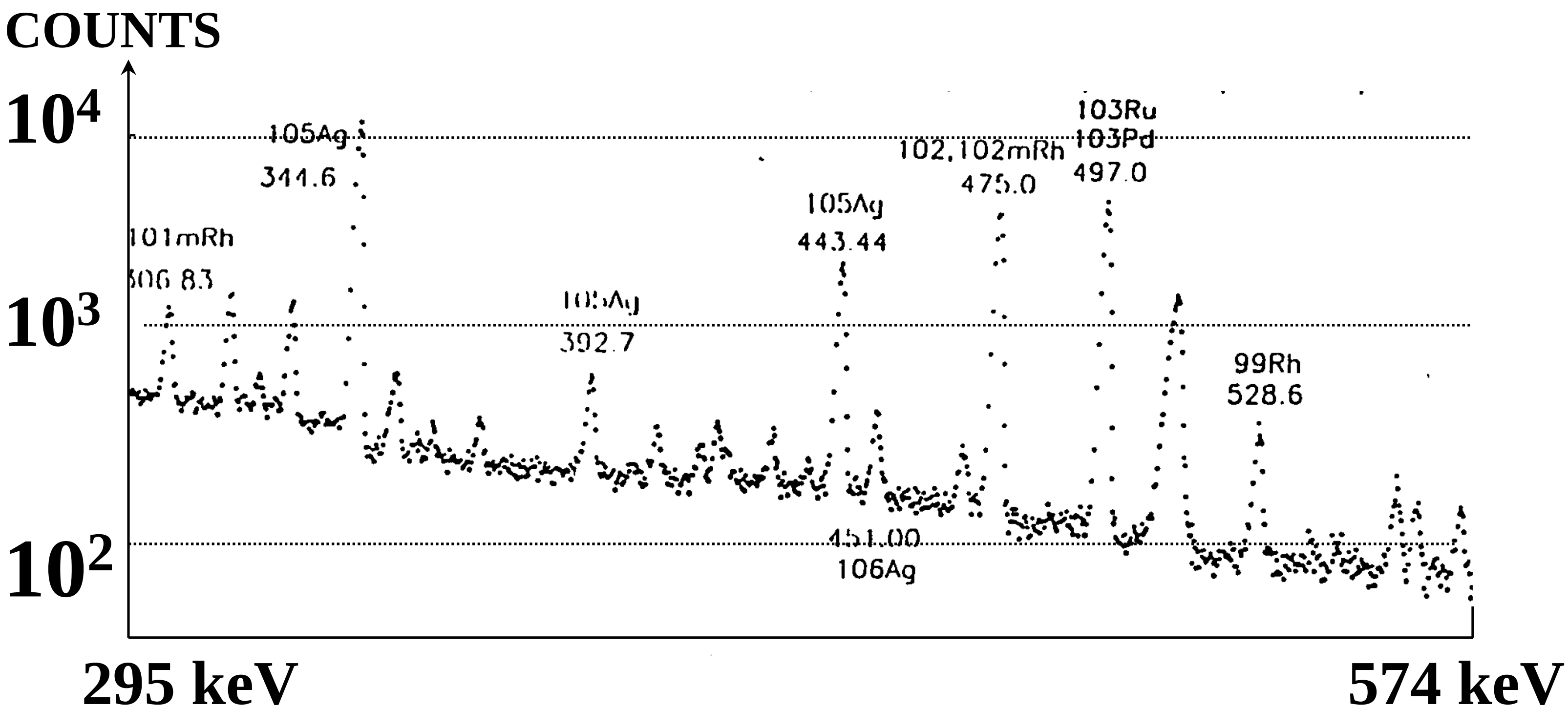
The neutron emission rates are very much lower that expected for the excess powers observed.

X-ray emission has been measured at relatively low levels in many “cold fusion” experiments.

In both cases, reproducibility is generally poor, but neither neutrons nor x-rays will result from chemistry.

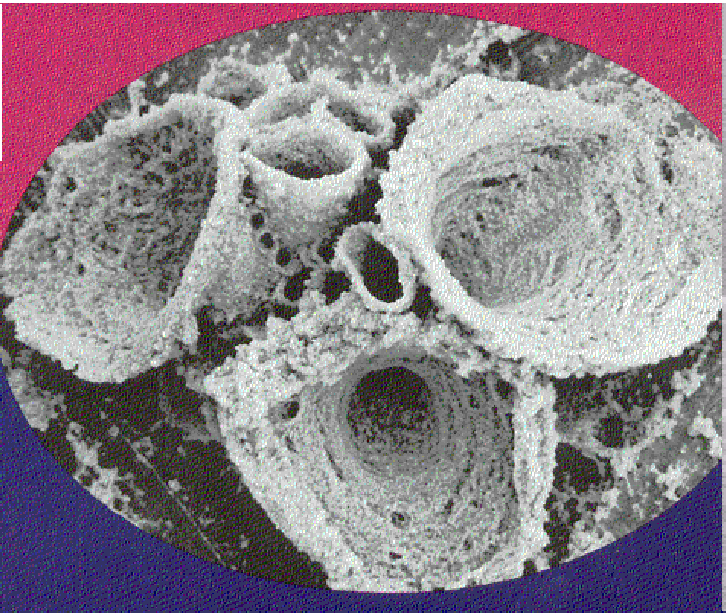
Observations of Gamma-Rays

Kevin Wolfe--Texas A & M University

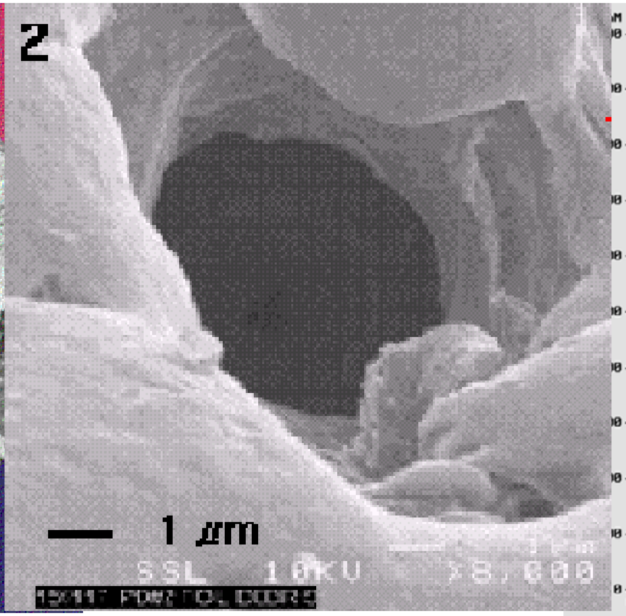


STRONG GAMMA-RAY LINES WITH
EXCELLENT SIGNAL-TO-NOISE
PEAKS OCCUR PRECISELY AT
EARLIER TABULATED VALUES OF LINES
FROM ISOTOPES OF Ru, Rh, Pd AND Ag!

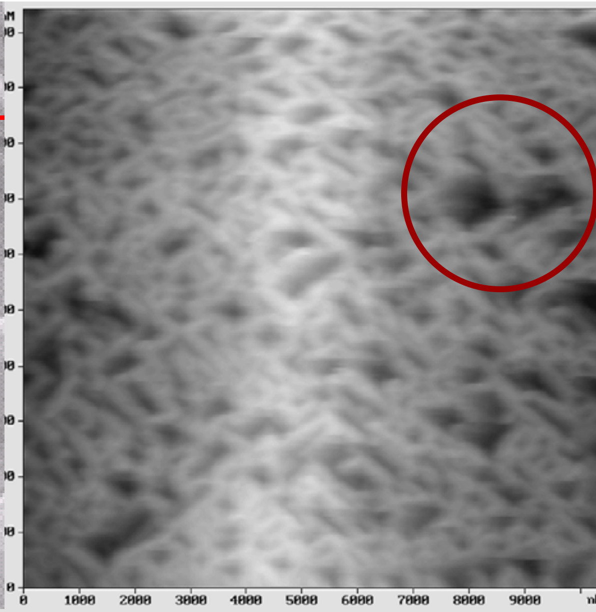
Craters in Cathodes



Mizuno



Stringham

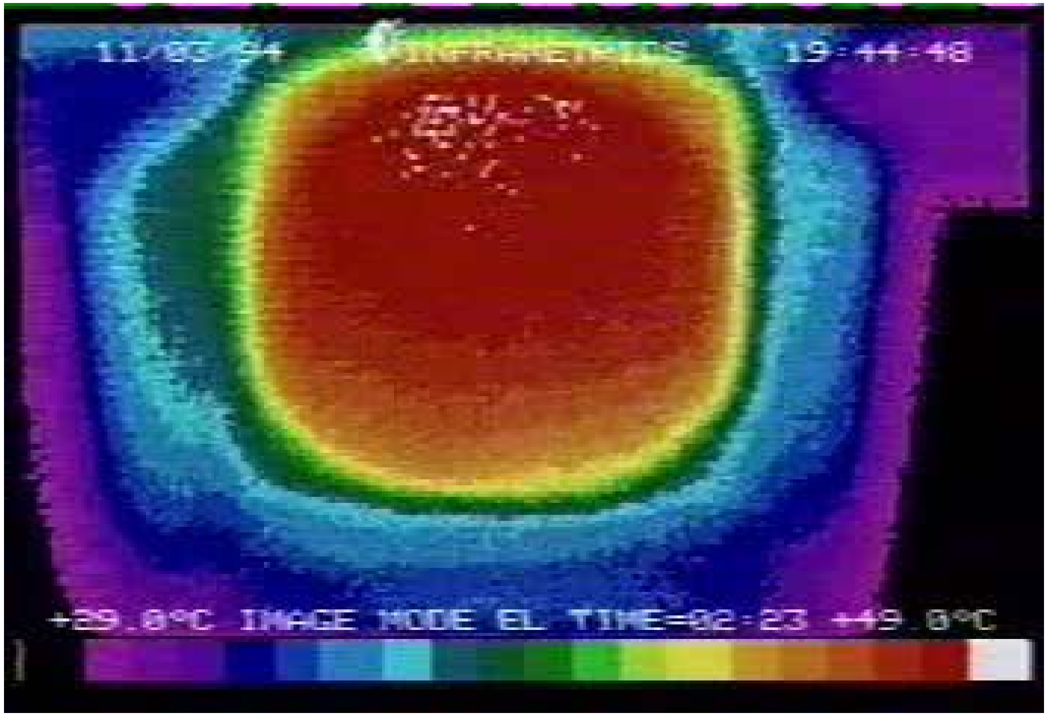


Violante

Chemical energies are insufficient to cause the craters that have been observed on cathode surfaces in many “cold fusion” experiments

New Energy Times Archives

Hot Spots on Cathodes



S. Szpak, P. A. Mosier-Boss, J. Dea and F. Gordon
SPAWAR Systems Center (ICCF-10 in 2003)

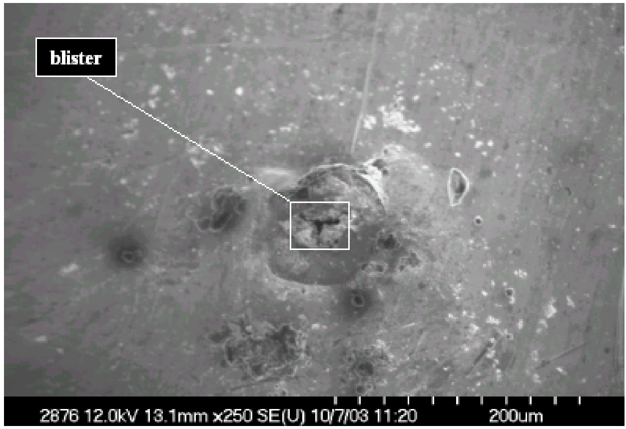
Release of 1 Mev in a cube of Pd 100 nm on a side gives a temperature (T) rise of $\Delta T = 380$ K using $3\,k\,\Delta T/2$ as the increase in vibrational energy, or $\Delta T = 55$ K using the specific heat for Pd = 26 J/K mole

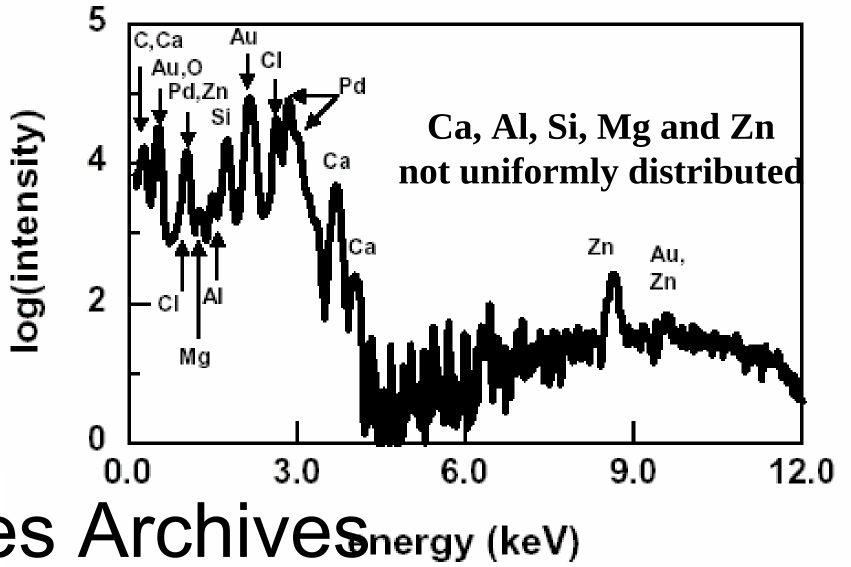
Observations of Unexpected Elements

Labs Reporting Transmutation Results (Compilation by Miley)

Hokkaido Univ., Japan - Mizuno et al.; Notoya et al.
Mitsubishi Corporation, Japan - Iwamura et al.
Osaka University, Japan - Takahashi et al; Arata et al.
University of Lecce, Italy - Vincenzo et al.
Frascati Laboratory, Italy – De Ninno et al.
SIA "LUTCH", Russia - Karabut et al; Savvatimova et al
Tomsk Polytechnical Univ., Russia - Chernov et al.
Lab. des Sciences Nucleaires, France - Dufour et al.
Beijing University, China - Jiang et al.
Tsinghua University, China - Li et al.
University of Illinois, USA - Miley et al.
Portland State University, USA – Dash et al.
Texas A&M University, USA - Bockris et al.
Schizuoka University, Japan – Kozima et al.
Iwate University, Japan – Yamada et al.

S. Szpak et al
SPAWAR Systems Center





Conclusion

**The anomalous effects
seen in "cold fusion" experiments
involve nuclear reactions,
hence, LENR**

Theory

**The new (2 May 2005) paper by Widom and Larsen
offers a multi-step scenario for LENR that
does not require distributed nuclear wave functions,
and has no problem with Coulomb barriers.
It does not require "new physics", and may explain
the low neutron emission.**

Ultra Low Momentum Neutron Catalyzed Nuclear Reactions on Metallic Hydride Surfaces

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Ultra low momentum neutron catalyzed nuclear reactions in metallic hydride system surfaces are discussed. Weak interaction catalysis initially occurs when neutrons (along with neutrinos) are produced from the protons which capture "heavy" electrons. Surface electron masses are shifted upwards by localized condensed matter electromagnetic fields. Condensed matter quantum electrodynamic processes may also shift the densities of final states allowing an appreciable production of extremely low momentum neutrons which are thereby efficiently absorbed by nearby nuclei. No Coulomb barriers exist for the weak interaction neutron production or other resulting catalytic processes.

The sources of the electron mass renormalization via electromagnetic field fluctuations on metallic hydride surfaces and the resulting neutron production are the main subject matters of this work.

Multi-Step Process

1. H or D at surface of Pd vibrate with large excursions

2. The moving H or D interact with surface plasmons to create strong electromagnetic fields

3. The EM fields increase the mass (“dress”) electrons

4. Heavy electrons and H (or D) react via the weak interaction, producing low-momenta (very slow) neutron(s)

5. Neutrons react with elements in the experiment.

The <u>two</u> nuclear reactions in steps #4 and 5 do not have "Coulomb barrier" problems.

They occur within nuclear dimensions, and do not require nuclear wave functions to be distributed in the lattice.

Requirements for Each Step

What are the inputs?

What are the outputs?

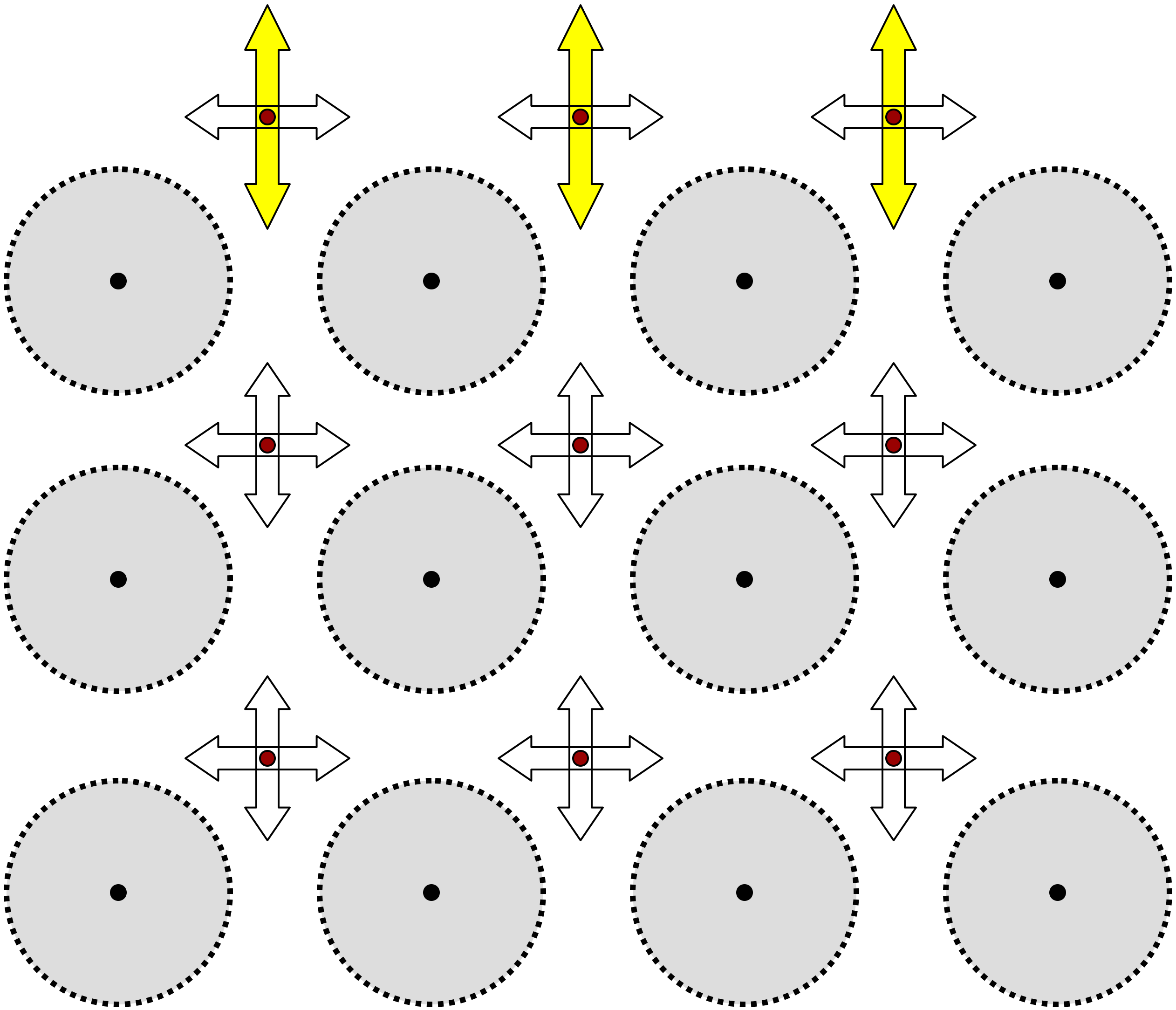
What mechanism is involved?

$$\langle \, i \, | Op | \, f \, \rangle$$

What is the rate of conversion of inputs to outputs?

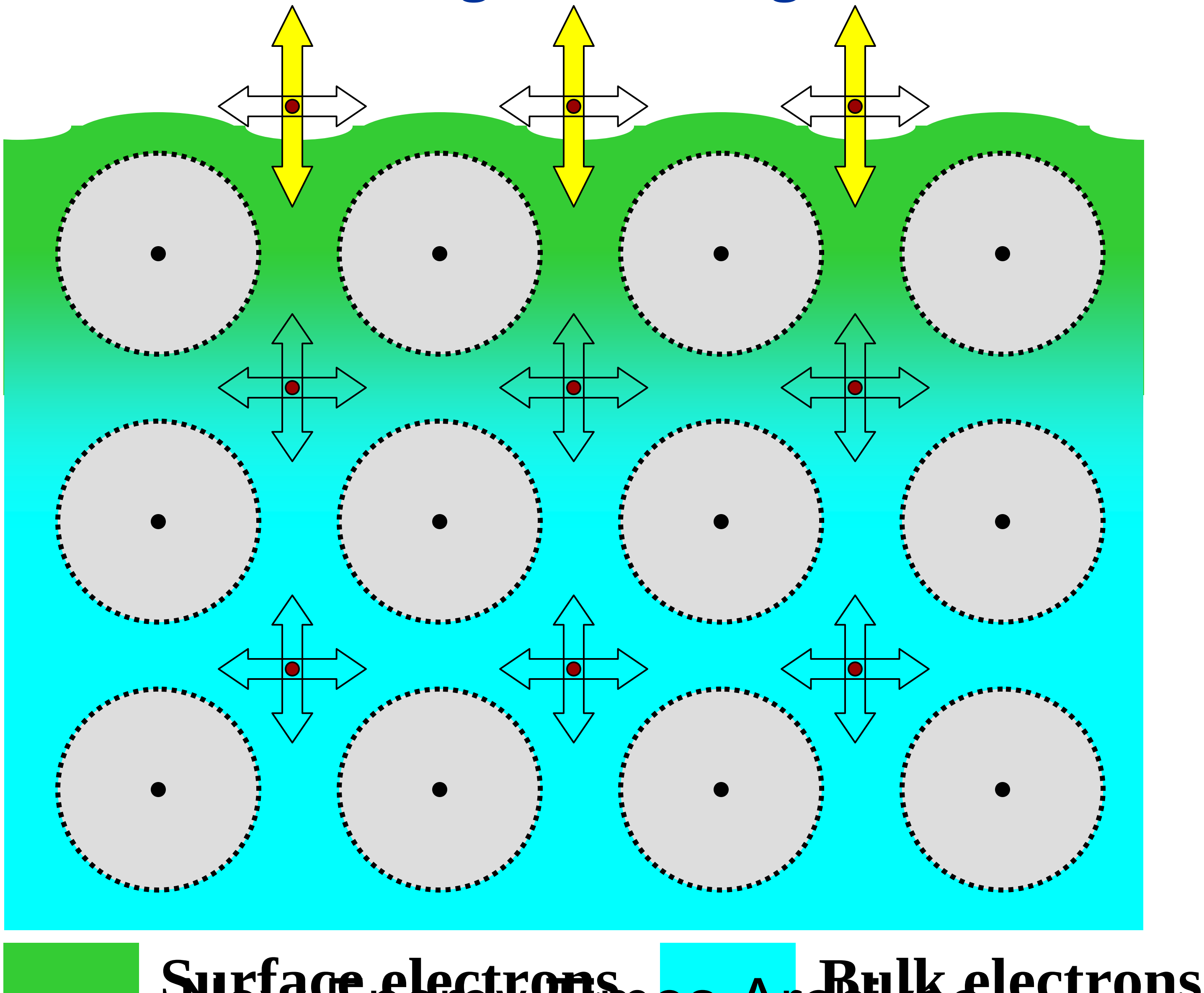
How do the rates depend on the relevant conditions, such as temperature?

1. H or D at surface of Pd vibrate with large excursions



High loading insures H/D population of the surface layer.
Vibrations are thermally driven and temperature dependent.

2. The moving H or D interact with surface plasmons to create strong electromagnetic fields



2. The moving H or D interact with surface plasmons to create strong electromagnetic fields

$$\mathcal{E} \approx 1.4 \times 10^{11} \text{ volts/meter (Hydrogen Monolayer).}$$

$$\sqrt{\overline{|\mathbf{E}|^2}} \approx 6.86 \times 10^{11} (\text{volts/meter}) \sqrt{\frac{\overline{|\mathbf{u}|^2}}{a^2}}\ .$$

$$\sqrt{\frac{\overline{|\mathbf{u}|^2}}{a^2}} \approx 4.2 \quad \text{(Hydrogen Monolayer).}$$

from neutron scattering data at room temperature

Enhancing the surface plasmon density will increase the electromagnetic field strength.
This may be the basis of increases in excess heat that are observed when a Pd cathode is irradiated with a laser.

3. The EM fields increase the mass ("dress")

$$\tilde{M}_e^2 c^2 = M_e^2 c^2 + \left(\frac{e}{c}\right)^2 \overline{A^\mu A_\mu}$$

A is the vector potential, the derivative of which gives the electromagnetic field strength

$$\beta \equiv \frac{\tilde{M}_e}{M_e} = \left[1 + \left(\frac{e}{M_e c^2}\right)^2 \overline{A^\mu A_\mu}\right]^{1/2}$$

The breakdown[12] of the conventional Born-Oppenheimer approximation for the surface hydrogen atoms contributes to the large magnitude of electromagnetic fluctuations.

[12] J.D. White, J. Chen, D. Matsiev, D.J. Auerbach and A.M. Wadke, *Nature* 433, 503 (2005).

Need a field strength vs mass curve.

4. Heavy electrons (leptons denoted l) and H (or D) react via the weak interaction, producing low momenta (very slow) neutron(s)

$$l^- + p^+ \to n + \nu_l.$$

Coulomb attraction.

Need to satisfy energy (mass) conservation:

For H, the required mass enhancement is

$$M_l c^2 > M_n c^2 - M_p c^2 \approx 1.293\ MeV \approx 2.531\ M_e c^2,$$

For D, the required mass enhancement is

$$\frac{\tilde{M}'_e}{M_e} = \beta'(D \to n + n + \nu_e) > 6.88.$$

Note: The reaction with a deuteron makes two neutrons.

Using neutron scattering data, β = 20.6 for H and D, so the electron mass thresholds for reactions with either H and D are exceeded.

5. The new and slow neutrons react with elements in the experiment

Lithium can be a reactant:

$$
\begin{aligned}
{}^{6}_{3}Li + n &\rightarrow {}^{7}_{3}Li\ , \\
{}^{7}_{3}Li + n &\rightarrow {}^{8}_{3}Li\ , \\
{}^{8}_{3}Li &\rightarrow {}^{8}_{4}Be + e^{-} + \bar{\nu}_e \\
{}^{8}_{4}Be &\rightarrow {}^{4}_{2}He + {}^{4}_{2}He.
\end{aligned}
$$

There is no Coulomb barrier, and this is not D-D fusion

$$Q\{\ {}^{6}_{3}Li + 2n \rightarrow 2\ {}^{4}_{2}He + e^{-} + \bar{\nu}_e\} \approx 26.9\ MeV.$$

$$Q\{\ {}^{6}_{3}Li + n \rightarrow\ {}^{4}_{2}He + {}^{3}_{2}He + e^{-} + \bar{\nu}_e\} \approx 4.29\ MeV.$$

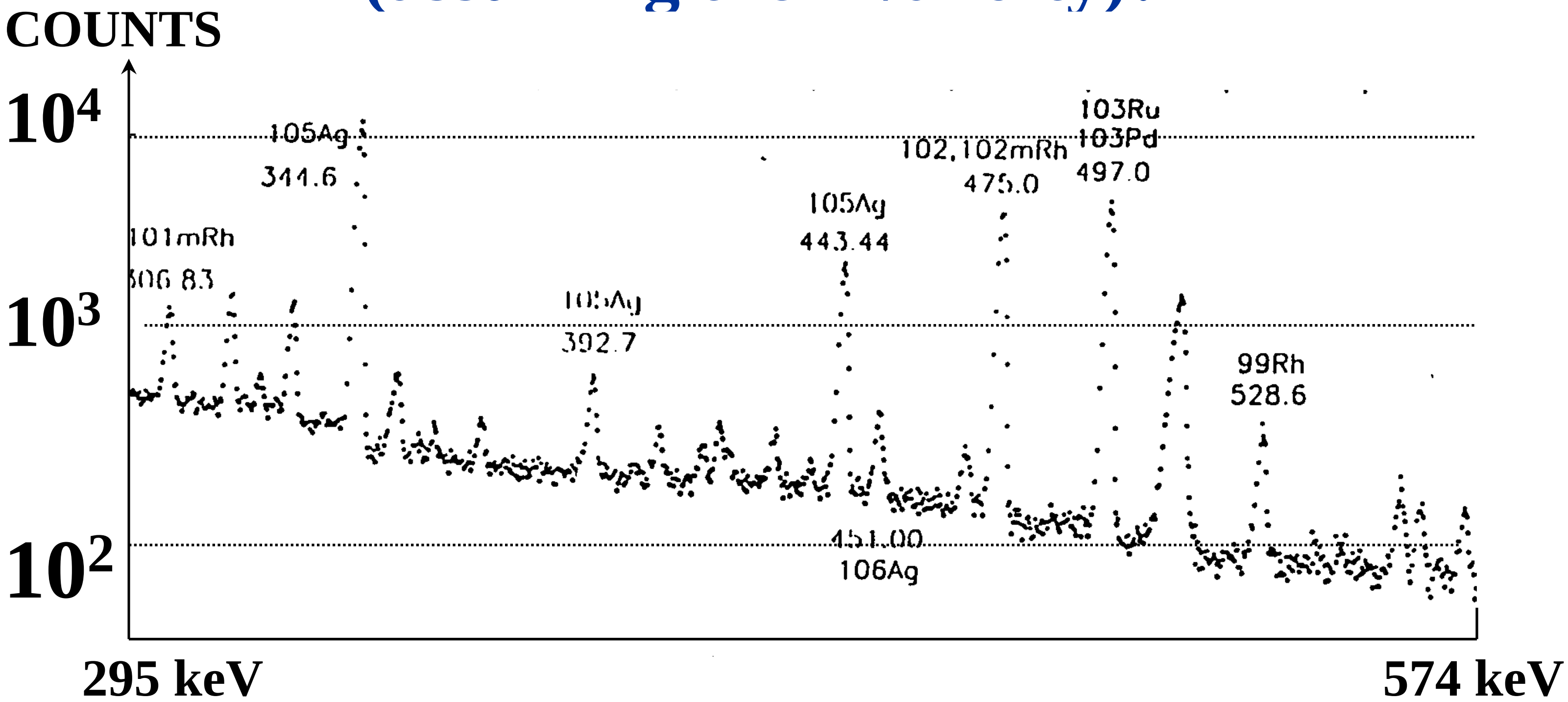
The amounts of excess heat per He produced, and the ratio of He-3 to He-4, both depend on the relative rates of different nuclear reactions.

Widom & Larsen indicate that their theory might be able to explain the transmutation results of Iwamura et al. @ MHI in Japan

In this regard, ultra low momentum neutrons may produce "neutron rich" nuclei in substantial quantities. These neutrons can yield interesting reaction sequences[17].

[17] Y. Iwamura, M.Sakano and T. Itoh, *Jap. J. Appl. Phys.* 41, 4642 (2002).

Can the theory of Widom & Larsen explain the observations of Wolf (assuming their validity)?



Strong gamma-ray lines with excellent signal-to-noise. Peaks occur precisely at earlier tabulated values of lines from isotopes of Ru, Rh, Pd and Ag!

New Energy Times Archives

Other Challenges to the Widom & Larsen Theory from Past Experiments.

Why do H and D produce very different results for Pd cathodes?

Since the theory says that production of excess heat is a near-surface phenomenon, how does excess heat correlate with the area of Pd cathodes in experiments?

Can the theory explain the loading threshold for D and Pd, which is near D/Pd = 0.9, and the quadratic variation of heat production with loading above the threshold?

Can the theory explain current density thresholds, which fall in the range of 100 to 500 mA/cm^2 ?

Is the often-observed need for dis-equilibrium to produce excess heat explicable by enhancement of surface plasmons?

http://www.arxiv.org/PS_cache/cond-mat/pdf/0505/0505026.pdf

Absorption of Nuclear Gamma Radiation by Heavy Electrons on Metallic Hydride Surfaces

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Low energy nuclear reactions in the neighborhood of metallic hydride surfaces may be induced by ultra-low momentum neutrons. Heavy electrons are absorbed by protons or deuterons producing ultra low momentum neutrons and neutrinos. The required electron mass renormalization is provided by the interaction between surface electron plasma oscillations and surface proton oscillations. The resulting neutron catalyzed low energy nuclear reactions emit copious prompt gamma radiation. The heavy electrons which induce the initially produced neutrons also strongly absorb the prompt nuclear gamma radiation, re-emitting soft photons. Nuclear hard photon radiation away from the metallic hydride surfaces is thereby strongly suppressed.

http://www.arxiv.org/PS_cache/cond-mat/pdf/0509/0509269.pdf