Our Quest for a Reference Experiment

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Can condensed matter nuclear reactions be **demonstrated** in **fully replicable** form, **on demand? How do we best accomplish this?**

What is our present situation?
(a purely personal perspective)

1. Multiple anomalies have been revealed in condensed matter systems...
2. These anomalies require nuclear explanation(s): Condensed Matter Nuclear Reactions or Science; CMNR or CMNS*.
3. Based on long experience in the field (31+ years), I have accumulated a lot of evidence that Nuclear Reactions do occur in Condensed Matter.
4. Four examples from our work follow…

* *Beijing IAC, ICCF-9, May 2002.*

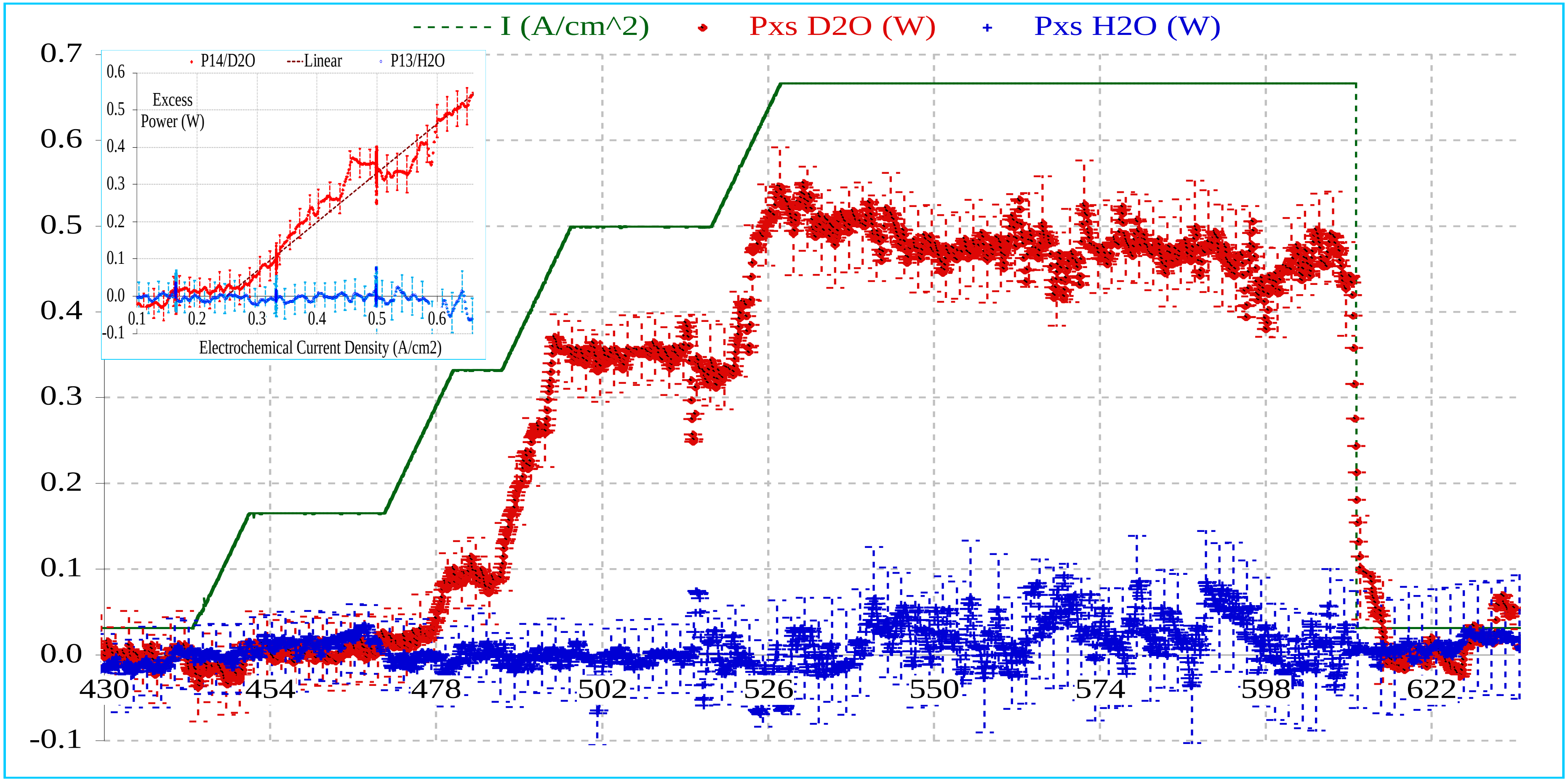
** *Began work on the Pd/D system at SRI in 1978 (EPRI).*

Examples of successful demonstration.

1. Heat (FPHE). Excess heat from Pd/D_2O at levels consistent with nuclear effects but greatly exceeding "chemical" (eV) levels.
   a) E_{XS} up to 20 keV / Pd or D atom (*Energetics ETI-64*).
   b) Thousands of literature examples with lower specific energy levels.
   c) >100 experiments at SRI alone in 4 or 5 different calorimetric modes.
2. Heat and ^{4}He. The production of ^{4}He in chemical energy environments at levels consistent with the measured excess heat.
   a) Miles, Gozzi, Arata, Case, +++.
   b) Four different experiment types at SRI alone.
3. Tritium and ^{3}He *via* ^{3}H decay from electrolytic experiments.
   a) BARC, Storms, Bockris, Will, many others including SRI.
   b) Gas phase experiments [Claytor and others].
   c) *Sporadic and sub-quantitative with heat*.
4. Other nuclear.
   a) Post-test Autoradiography (example at end).
   b) CR-39 results (multiple replications including recent and reported here).
   c) Additional range of nuclear products and effects that are inconsistent with isolated two-body nuclear reaction.

1. Excess Heat [the FPHE]

a. Occasional high reproducibility (up to 73% at SRI) – *but not complete.*
b. Graph reveals controlling parameters: Isotope effect, D/Pd, I or I, t, [*flux*].
c. A multi-parameter empirical expression allows us to explain our failures.



SRI Closed-Cell Mass-Flow Calorimetry Experiments: P13 [H_2O] and P14 [D_2O]

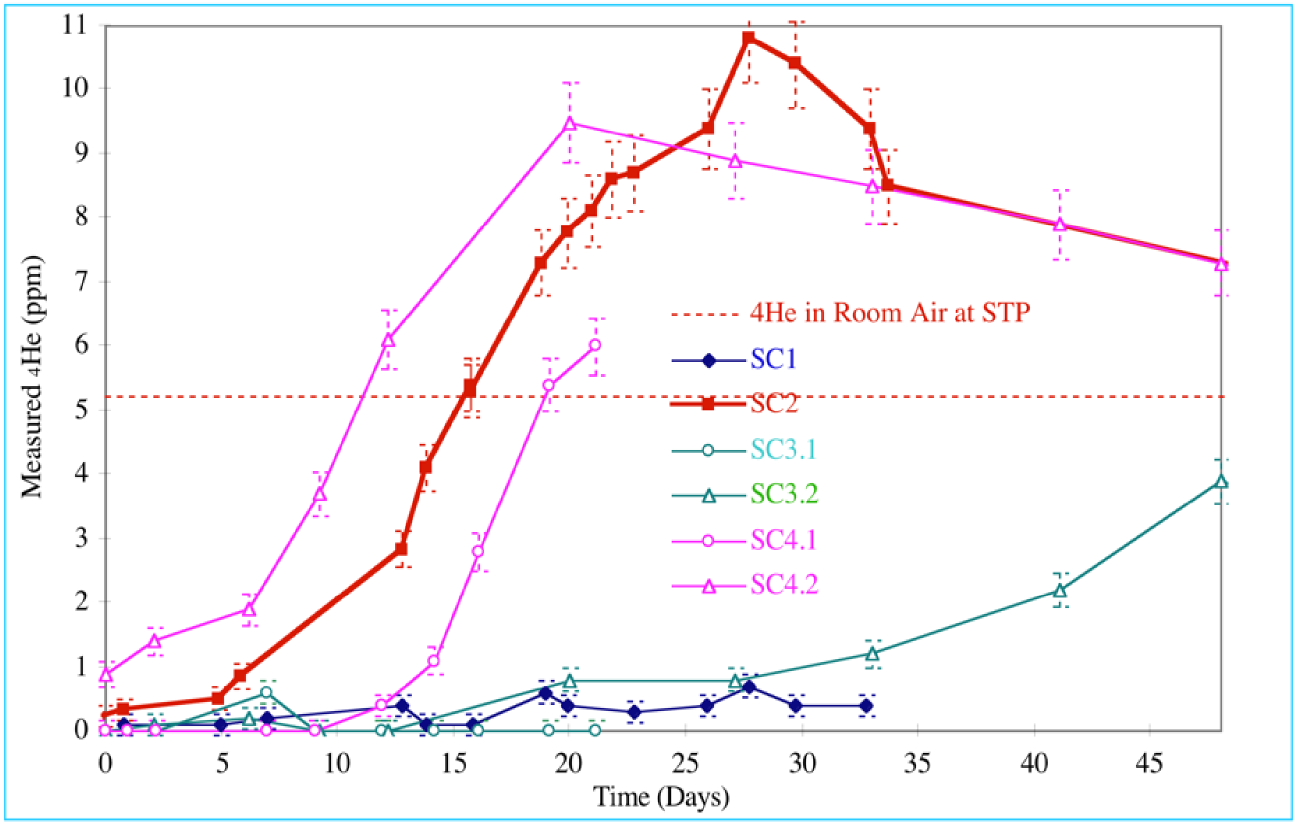
Operated simultaneously, in electrical series, Monitored using the same Instrumentation. McKubre *et al.*, Isothermal Flow Calorimetric Investigation of the D/Pd System, ICCF-2, 1991.

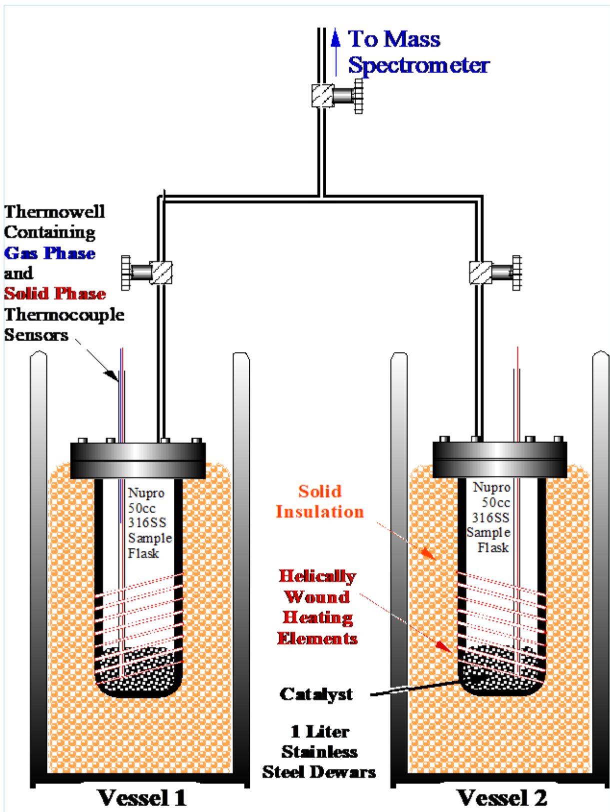
2. Heat and ^4He. SRI replication of Les Case.

H_2 and D_2 Gas with Pd/C Catalyst.

Correlated Heat and ^4He. On-Line Mass Spec.

Differential and Gradient Heat Flow Calorimetry.

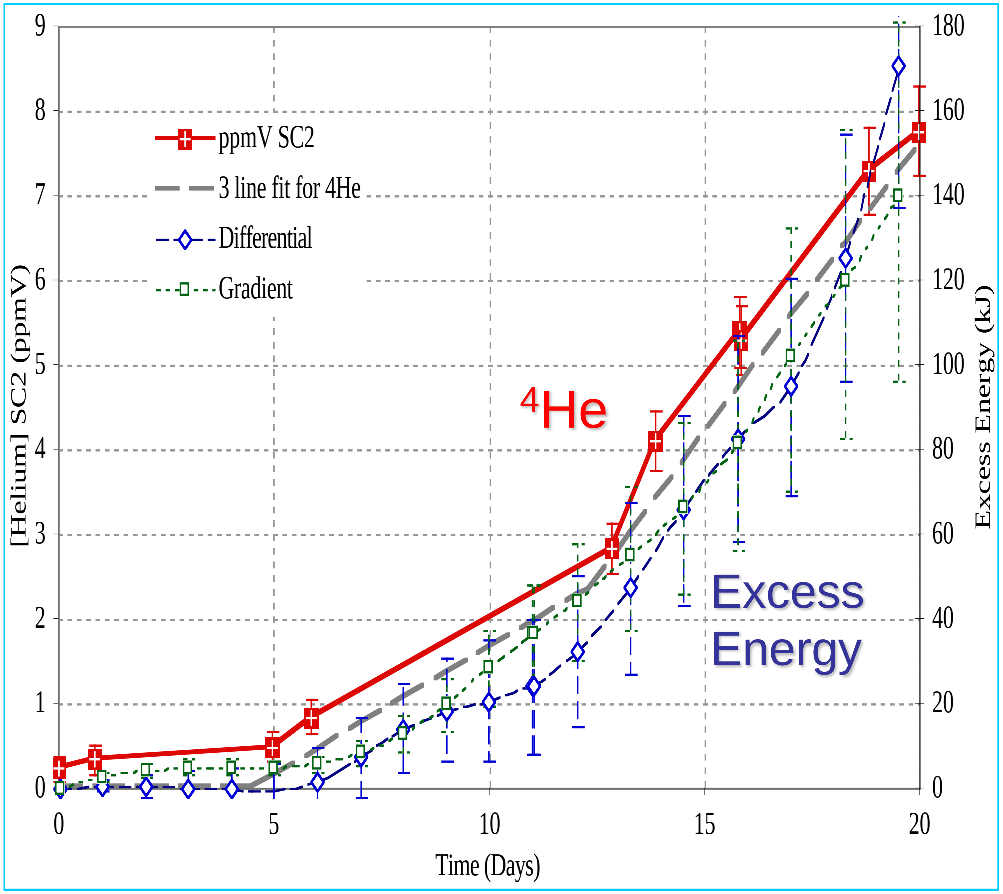


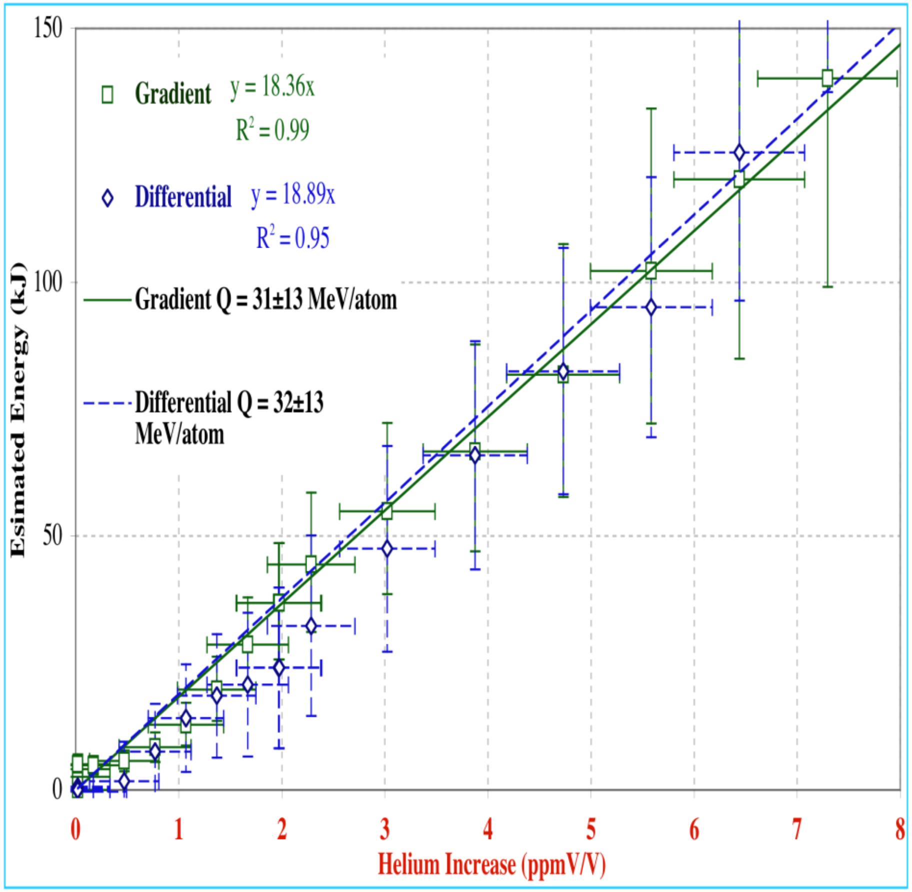


~0.5% Pd (or other PGM?) on coconut shell carbon catalyst. ~2 Atm. H_2 or D_2 , ~200° C.

McKubre *et al*., The Emergence of a Coherent Explanation for Anomalies Observed in D/Pd and H/Pd Systems; Evidence for ^4He and ^3He Production, ICCF-8, 2000.

Case Cell: Correlated Heat and ^{4}He.
Q = 31 ± 13 MeV/atom
Discrepancy due to solid phase retention of ^{4}He.





McKubre *et al.*, The Emergence of a Coherent Explanation for Anomalies Observed in D/Pd and H/Pd Systems; Evidence for ^{4}He and ^{3}He Production, ICCF-8, 2000.

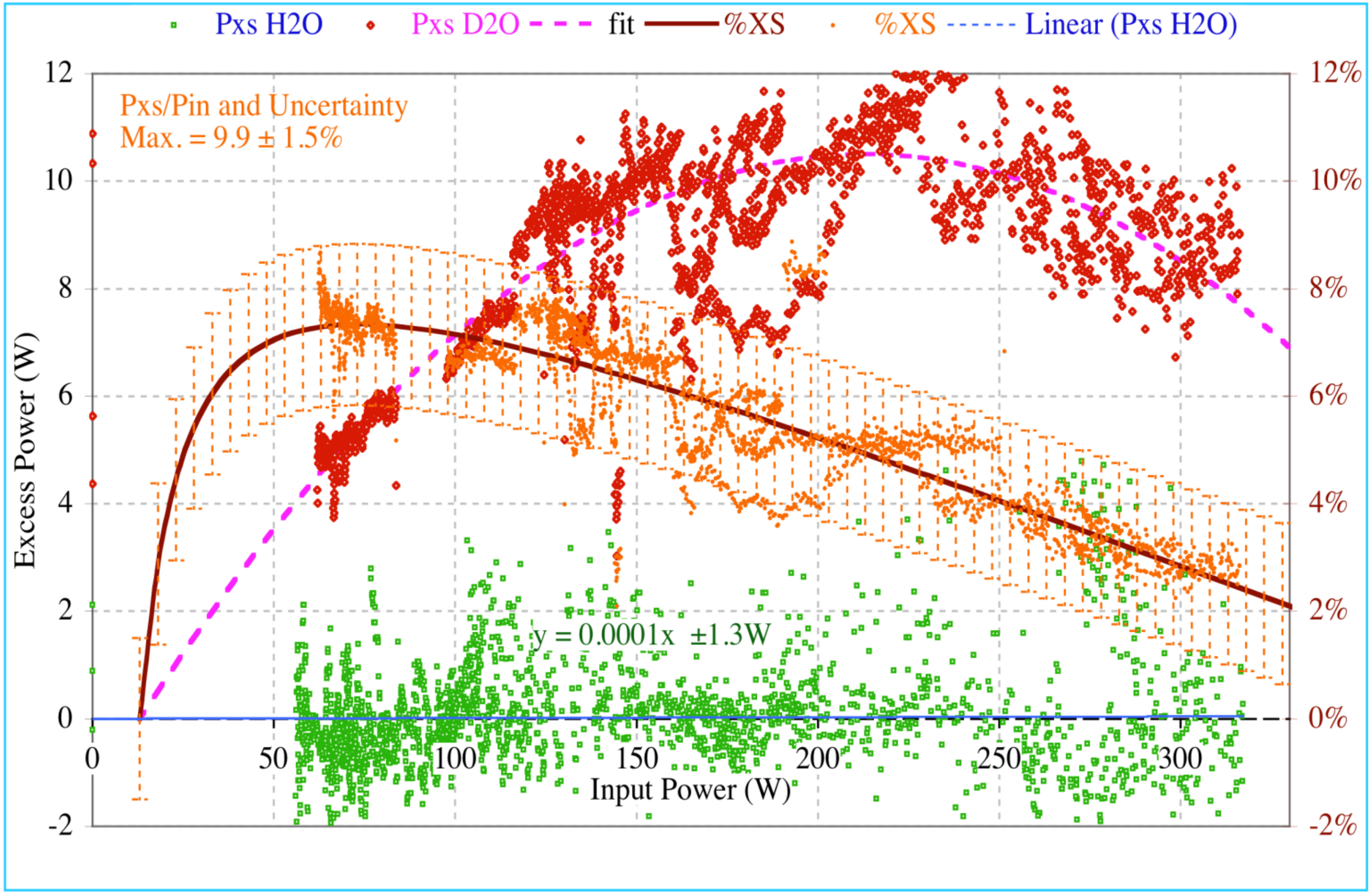
SRI replication of Arata and Zhang "DS" Cathodes.

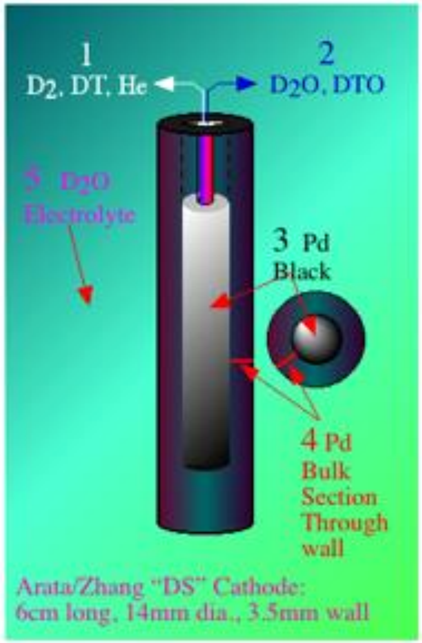
a) Two Cathodes prepared in Osaka to Arata and Zhang's specifications.

b) Two cells operated at SRI simultaneously in LiOD and LiOH.

c) $P_{XS\ LiOH} = 0 \pm 1.3W$. $P_{XS\ LiOH,\ Max} = 12 \pm 1.5\%$ of P_{In}.

d) Post-test analyses revealed ^3H and ^3He in metal phases for LiOD cell (not for LiOH).





External Area ~30 cm²

McKubre *et al.*, The Emergence of a Coherent Explanation for Anomalies Observed in D/Pd and H/Pd Systems; Evidence for ^4He and ^3He Production, ICCF-8, 2000.

3. Evidence for Tritium production.

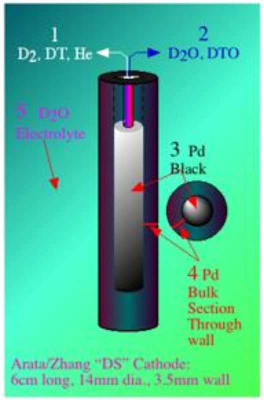
a) Tritium is produced in many CMNS experiments.

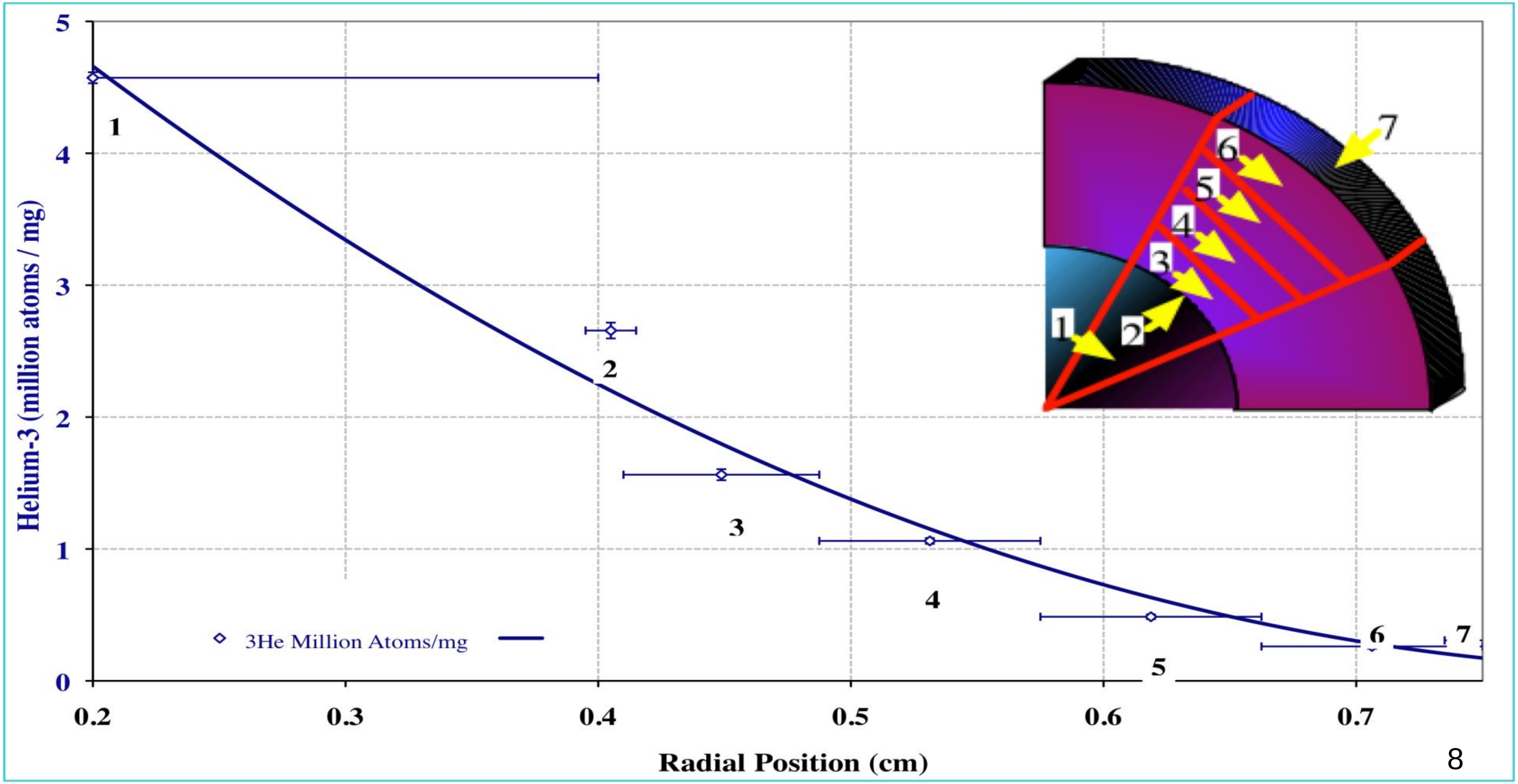
b) Tritium came to us "<u>pre-reproduced</u>" [*Storms, Bockris, BARC*].

c) ^{3}He and particularly $\partial[^3He] / [\partial t]$ provides strong evidence for ^{3}H generation.

d) ^{3}He is the decay product of ^{3}H which diffused from a source inside the electrode.

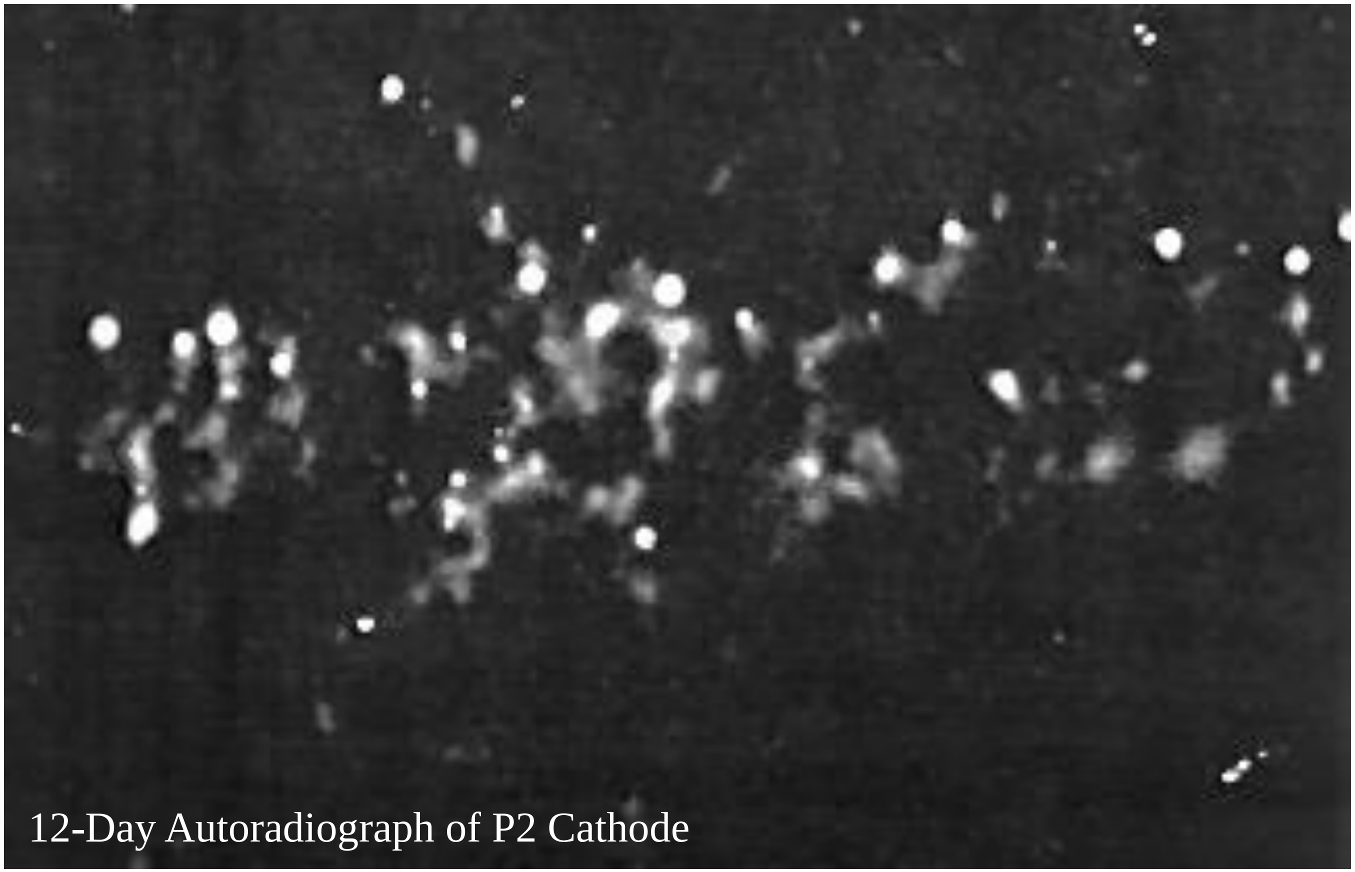
e) This source initiated some time during the period of electrolysis in D_2O.





4. Other Nuclear Evidence.

a. Autoradiography
b. CR-39
c. X-rays, Gamma emission, charge emission
d. Asynchronous neutron bursts



12-Day Autoradiograph of P2 Cathode

Autoradiograph of P2 cathode JM Pd, 4 mm dia., from pressurized cell mass flow calorimeter, after 12-day exposure.

McKubre *et al.* Calorimetry and Electrochemistry in the D/Pd System. in The First Annual Conference on Cold Fusion, ICCF-1,1990.

		Cathode			Electrolyte					Maximum			Duration		Maximum Power			Excess	Total Energy		
Expt.		Length	dia.	A	Type	Conc.	Additive	Bath T	P	I	Loading:		Expt.	Init.	Input	Excess		Obs.	Input	Excess	
	#	(cm)	(cm)	(cm^2)		(M)		(°C)	(psi)	($A\ cm^{-2}$)	R/R°	D/Pd	(h)	(h)	(W)	(W)	%	#	(MJ)	(MJ)	%
4 mm dia. Johnson Matthey in Flow Calorimeter																					
P2	**2**	4.5	**0.4**	5.7	LiOD	1.0	none	4	1000	495	1.617	**0.926**	1393	504	3.8	2.00	**53%**	**4**	50	**1.070**	**2.1%**

Why is the evidence of CMNR not generally accepted? How do we reverse this?

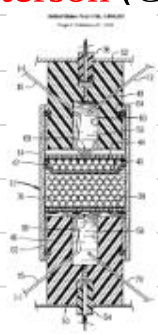
1. The replication challenge…
   a) Demonstrate the effect on demand.
   b) Transport and transplant a successful experiment from one laboratory to another (in the extreme, based on written instructions alone).
   c) Replicate / reproduce <u>reliably</u> the magnitude and timing of the effect.
   d) This level of replicability has *not* been demonstrated.

2. Experiment Replication Criteria:
   a) Keep it simple.
   b) Correlated results >> Single Variable Output.
   c) Reproduce the magnitude and timing – in Detail.
   d) Experiments performed separately and published simultaneously by <u>multiple groups</u>.

A grand challenge!

1. Identify what we consider to the best 3 or 4 experiments.
2. Recruit multiple laboratories to work on them.
3. Write clear scientific papers, including multiple authors from the multiple labs. Do our own peer review first.
4. Publish these papers in JCMNS or other peer reviewed scientific journals.
5. Present the work at ICCF-21 in a special session focused on these replications.

Ordered list of preferred prospective experiments

	Experiment	Advantages	Disadvantages	Year
1	Case-*Like*	*"Cheap and Easy"*	Catalyst concerns:	1998
	Heat, ^{4}He	Few moving parts	Source	
	Supported small-	No Electrochemistry	Cleanliness	
	dimension metal	Mild elevated conditions, P & T	Limited documentation	
	T gradient => Flux		+	
2	Arata & Zhang	Large effect:	Technically Challenging	1997
	Heat	~10% P_{XS}, 10 W, >100 MJ	Very long duration	
	^{4}He, ^{3}He, ^{3}H	Modest Loading Requirement	Potentially hazardous	
		Integral Nuclear Product (^{3}H)	Pd black details?	
			Only 1 replication to date	
			+	
3	Patterson (CETI)	Quick (several / week)	Source and nature of beads?	1995
		Calorimetry "built in" and easy	Heat Flow calorimetry	
		Modest Loading Requirement	Significant loading variability	
			Few independent replications	
			(not successful at SRI)	
			Hidden Details?	
			+ Inventor deceased	
4	SRI "Exploding"	Very quick (several / day)	"Good" Electrochemistry req.	2011
	Wire, Phase-Change	Large percentage effect	Small absolute effect	
	Calorimetry	High accuracy Calorimetry	*No independent replication*	
	^{4}He, ^{3}He, ^{3}H	High precision Calorimetry	*Nuclear products not yet*	
	CR-39?	"Ideal" Screening Tool	*searched for*	
		Originators still available and operational		

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