

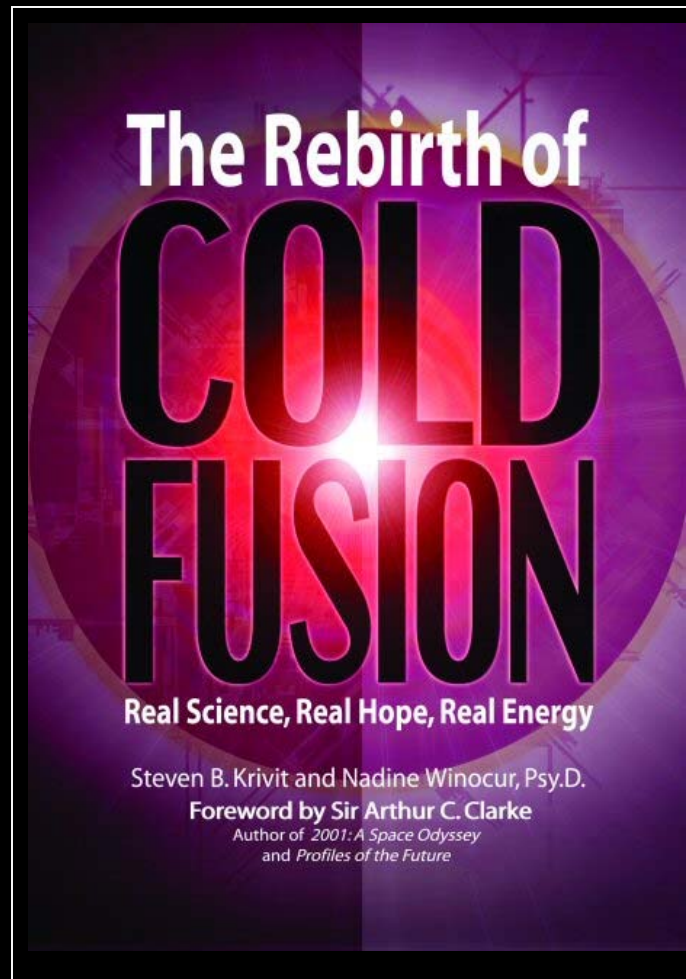
Low-Energy Nuclear Reaction Research – 2008 Update

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Editor, *New Energy Times*
Executive Director, New Energy Institute

American Chemical Society
Philadelphia, PA, August 20, 2008

Overview:

- “Cold Fusion” research: Since 1989
- Krivit Investigations: Since 2000



Simple Pathway to Cold Fusion:



Some Cold Fusion Theorists:

Hagelstein

Chubb, S.

Chubb, T.

Takahashi

Li

DD Thermonuclear Fusion

$D+D > 3He$ (0.82 MeV) + **n** (2.45 MeV)

$D+D > T$ (1.01 MeV) + **p** (3.02 MeV)

$D+D > 4He$ (0.08 MeV) + **gamma ray** (23.77 MeV)

DD Thermonuclear Fusion

$D+D > 3He$ (0.82 MeV) + n (2.45 MeV) [**~50%**]

$D+D > T$ (1.01 MeV) + p (3.02 MeV) [**~50%**]

$D+D > 4He$ (0.08 MeV) + **gamma ray** (23.77 MeV)

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$D+D \rightarrow {}^3\text{He}$ (0.82 MeV) + **n** (2.45 MeV)

$D+D \rightarrow {}^3\text{T}$ (1.01 MeV) + **p** (3.02 MeV)

n:T = ~1:~1

$D+D \rightarrow {}^4\text{He}$ (0.08 MeV) + **gamma ray** (23.77 MeV)

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n:4He = 10,000,000:1

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Typical Cold Fusion Theory

$D+D > 4He$ + **heat (lattice)** (24 MeV / 4He)

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$D+D > 4He$ (0.08 MeV) + **gamma ray (23.77 MeV)**

LENR Experiments

$4He$ + heat + **? (~12- ~48 MeV / $4He$)**

DD Thermonuclear Fusion

$D+D \rightarrow 3He$ (0.82 MeV) + n (2.45 MeV)

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$n:T = \sim 1:\sim 1$

$D+D \rightarrow 4He$ (0.08 MeV) + **gamma ray** (23.77 MeV)

$n:4He = 10,000,000:1$

LENR Experiments

$n:T = \sim 1:1,000,000$

$4He$ + heat + ? (~12- ~48 MeV / $4He$)

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$D+D > 3He$ (0.82 MeV) + n (2.45 MeV)

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$n:4He = 10,000,000:1$

LENR Experiments

$4He$ + heat +? (~12- ~48 MeV / $4He$)

$n:4He = 1:10,000,000$

The 24 MeV Belief

- “The proof is the 24 MeV! McKubre nailed it”
- Scott Chubb, Naval Research Laboratory

"Haven't the [ENEA] Frascati people demonstrated a quantitatively correct correlation of exothermy with He4 yield? In fact, it was this result that turned me into a cold-fusion believer, and I suspect the same is true of many other people as well."

- Julian Brown, Oxford University

The Experimental Evidence for Cold Fusion

Research Group

MeV per Helium-4 Atom

McKubre (SRI Int'l)

13 years ago

31, 38.34, 34.45, 22.85

Miles (U.S.N. China Lake)

14 years ago

39, 25, 44, 88, 83, 52, 62

De Ninno (ENEA Frascati)

6 years ago

103, 88, 124, 103, 103

The Importance of the Normal Water Experiments

Fusion cross-section

Not even “cold fusion” theorists suggest H experiments are fusion.

DD Thermonuclear Fusion

"If something you have been attributing to [D-D] fusion is observed with ordinary water, it means you've been fooling yourself."

- Robert Park, American Physical Society

Normal Water and Hydrogen Experiments

Patterson

Miley

Bockris

Celani

Mizuno

Focardi - Piantelli

Mills

Pons

Mosier-Boss - Szpak

Bush – Eagleton

Violante – Tripodi – Sarto – McKubre – Tanzella

Lipson - Roussetski

Heavy Element Transmutation Experiments

(Miley's List)

Patterson

Bockris

Mizuno

Iwamura

Dash

Takahashi

Arata

De Ninno

Karabut

Savvatimova

Chernov

Dufour

Jiang

Yamada

Kozima

DD Thermonuclear Fusion \neq LENR

- 1. Missing or suppressed gamma**
- 2. Wrong neutron to tritium ratios**
- 3. Wrong 4He to neutron ratios**
- 4. Missing 1st branch of TNF**
- 5. Missing 2nd branch of TNF**
- 6. Weak data for “24” MeV energy**
(wide range, incomplete assay)
- 7. Heavy Z transmutations**
- 8. Normal water and hydrogen expts.**

Fleischmann & Pons

Excess Heat

4He

Fleischmann:

"What else could it be?"

Huizenga's 3 Miracles

How could it possibly be fusion?

- 1. Coulomb barrier**
- 2. No strong neutrons**
- 3. No gamma rays**

Progress is Stunted...

“In my opinion [LENR] has been crippled by wide acceptance of the belief that deuterium fusion of some sort is responsible for energy generation, and also by rejection of alternative [proposed] mechanisms.

“Progress is stunted when we reject a mechanism, because we then fail to undertake the experiments it suggests.”

- John Fisher, LENR Theorist

Q: What Else Could it Be?

A: Neutron Catalyzed Reactions (Weak Interactions)

- Hideo Kozima
- John Fisher
- George Anderman
- Lali Chatterjee
- (Tadahiko Mizuno)
- (Yasuhiro Iwamura)
Iwamura Yasuhiro Itoh Akihiko Gotoh Nobuaki and Toyoda Chiro "Detection Of Anomalous Elements X-Ray And Excess Heat In A D2-Pd System And Its Interpretation By The Electron Induced Nuclear Reaction Model" Fusion Technology, Vol 33 pg 476-492 (July 1998)
- (Stanislaw Szpak)
Szpak S et al "Further Evidence Of Nuclear Reactions In The Pd/D Lattice: Emission Of Charged Particles" Naturwissenschaften DOI 10.1007/s00114-007-0221-7 (March 2007)
- (Allan Widom - Lewis Larsen)

(14 MeV per 4He atom)

Four Years of Investigation:

Fusion Theories: **WEAK**

***LENR Experimental
Evidence:***

STRONG

Nuclear Ash and Effects

Products/Effects	D/Pd	H/Pd (Ni-H)
Heat	Major	Minor (Major)
Helium-4	Major	No (No)
Tritium (no heat)	Rare but Strong	No (No)
(Fast? Slow?) Neutrons	Minor but Strong	Minor
Charged Particles	Minor but Strong	Minor (Minor)
Heavy Element Transmutation	Minor	Major
Gamma-Rays	Minor	Unknown
X-Rays	Minor	Unknown
Hot Spots on Cathodes	Strong	Unknown
Craters, Melting, Vaporization	Strong	Unknown

**Navy SPAWAR San Diego /
JWK Corp.**

Co-deposition Experiment:

Evidence of Neutrons

Evidence of Charged Particles

Co-deposition Experiment:

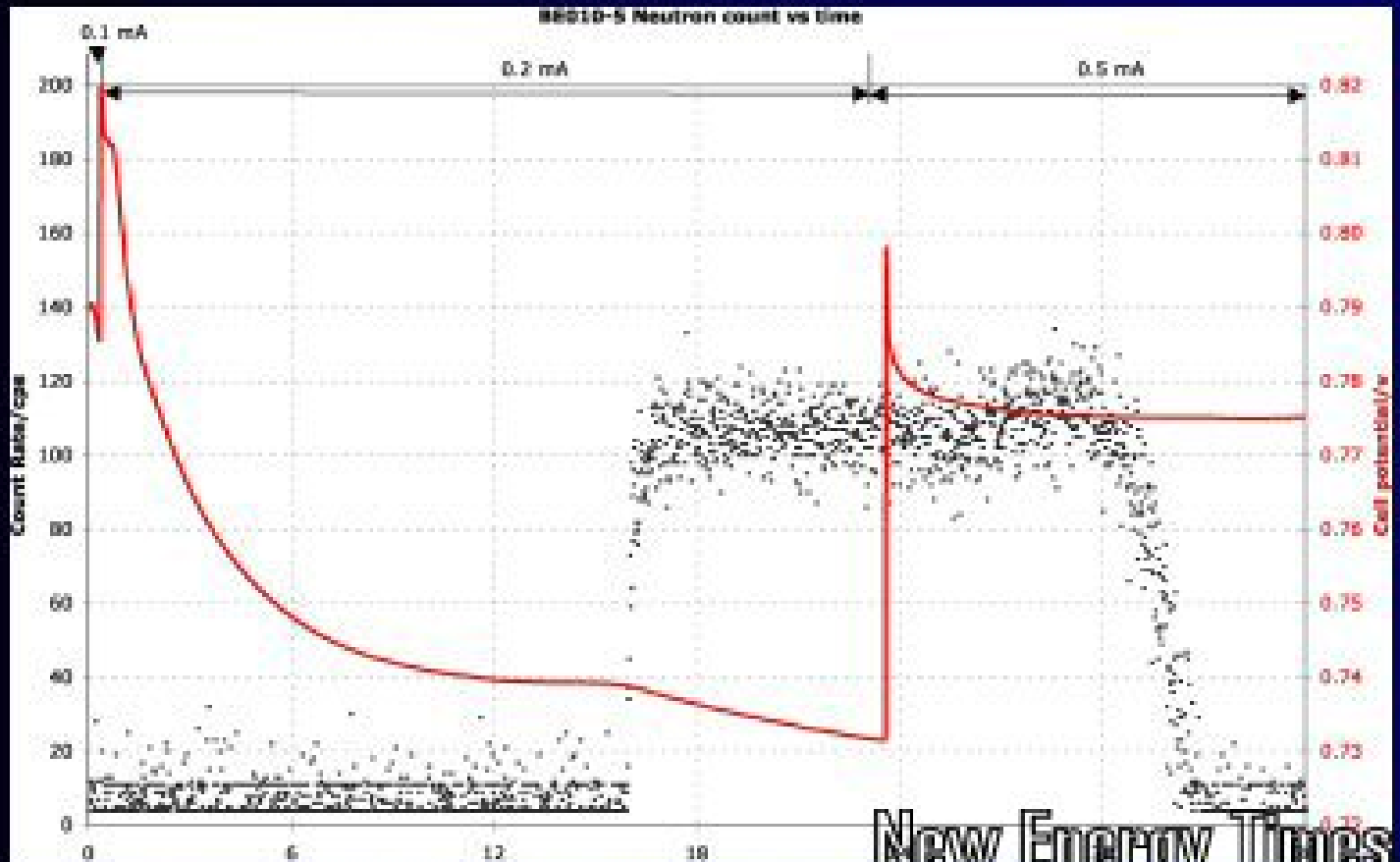
Strong Evidence of Neutrons

**Low Flux
Bursty**

**Instrument: Solid-State Nuclear Track
Detectors and TASL Scanner**

SRI Replication of SPAWAR/JWK

Neutron signal 14x > than background,
14-hour burst (**BF3**) + cell potential drop
(8th Conf. on H and D/Pd Anomalies)

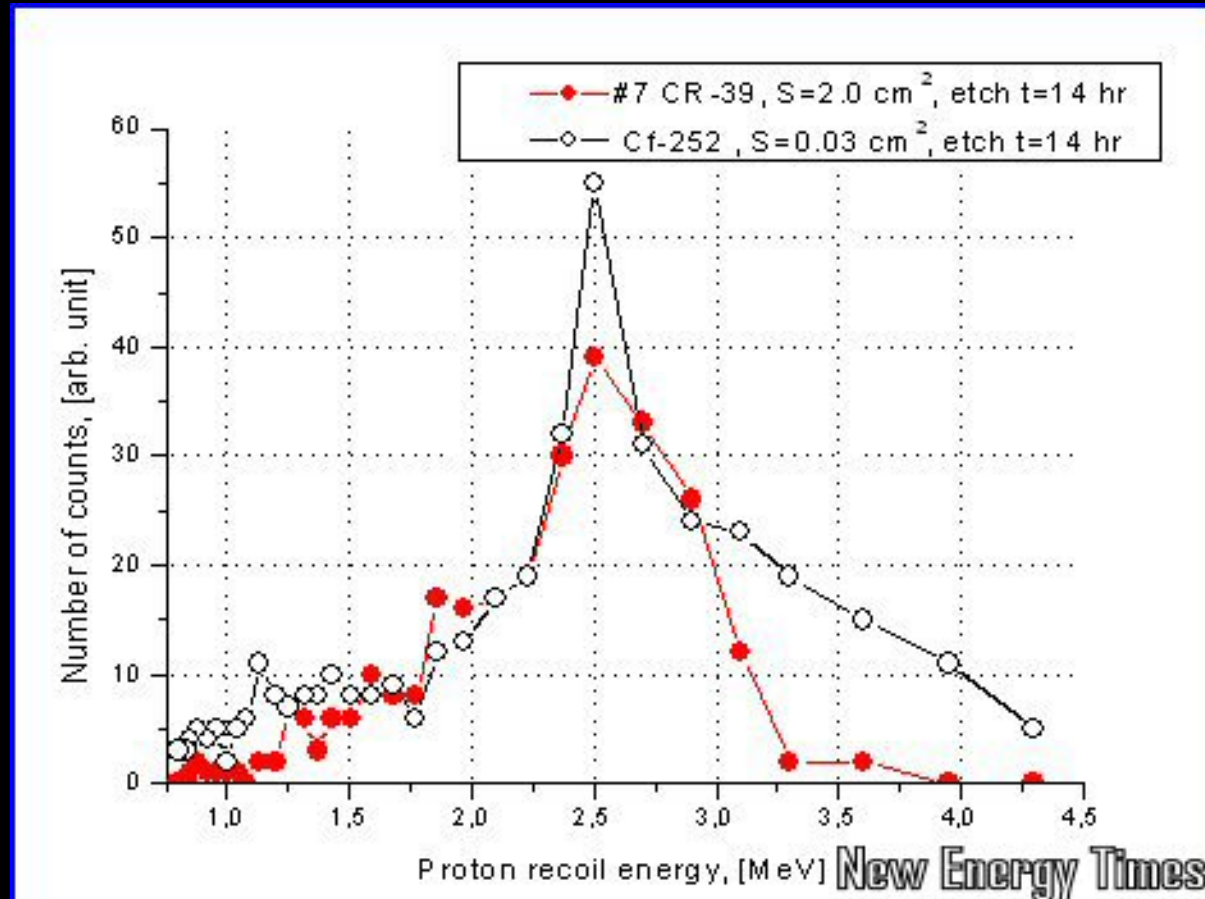


New Energy Times

SRI Replication Confirmation

(RAS – A. Lipson and A. Roussetski)

Sequential Etching



SRI Replication Confirmation

(RAS – A. Lipson and A. Roussetski)

Final Report

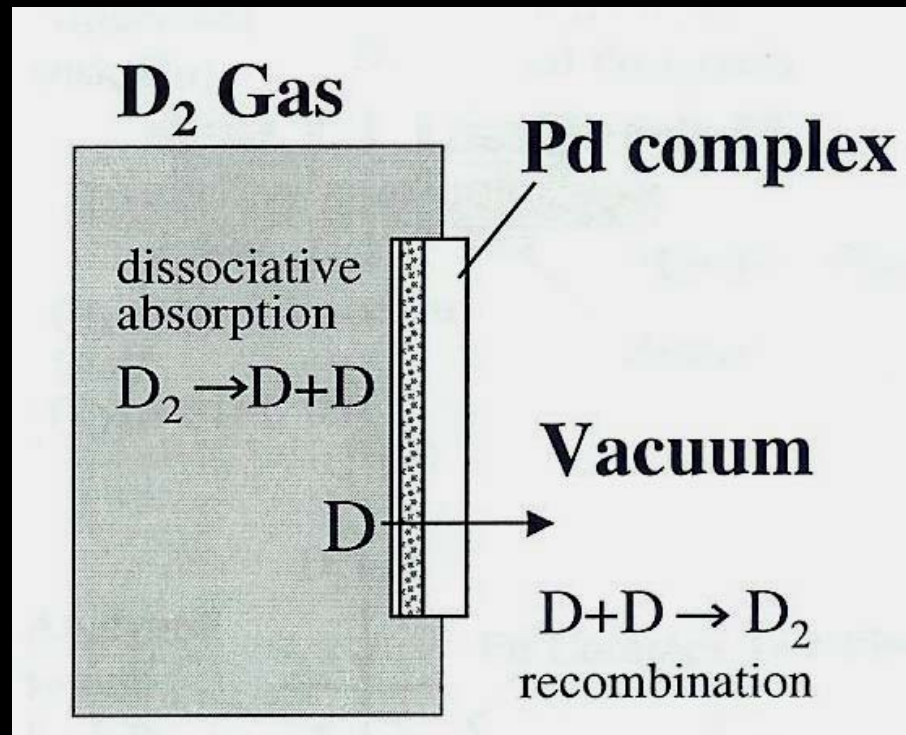
“...both sides of detector [front and back] showed that it contains real nuclear (proton recoil) tracks.

“Not irradiated by airport security”

“In summary, presented experimental evidence can be considered as a strong, unambiguous proof of #7 detector’s fast neutron (2.5 MeV) exposure.”

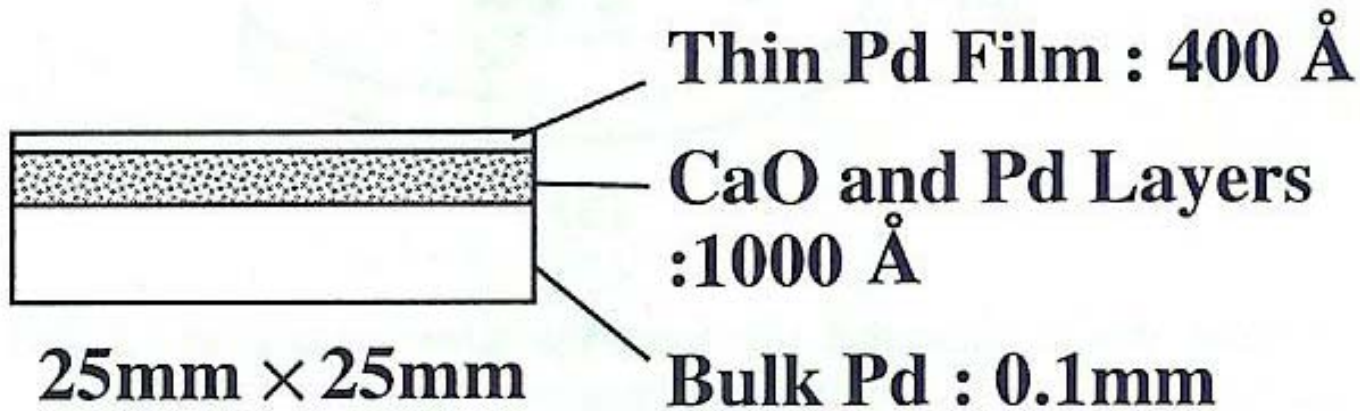
Heavy Element Transmutation

Gas Permeation (Y. Iwamura, Mitsubishi)



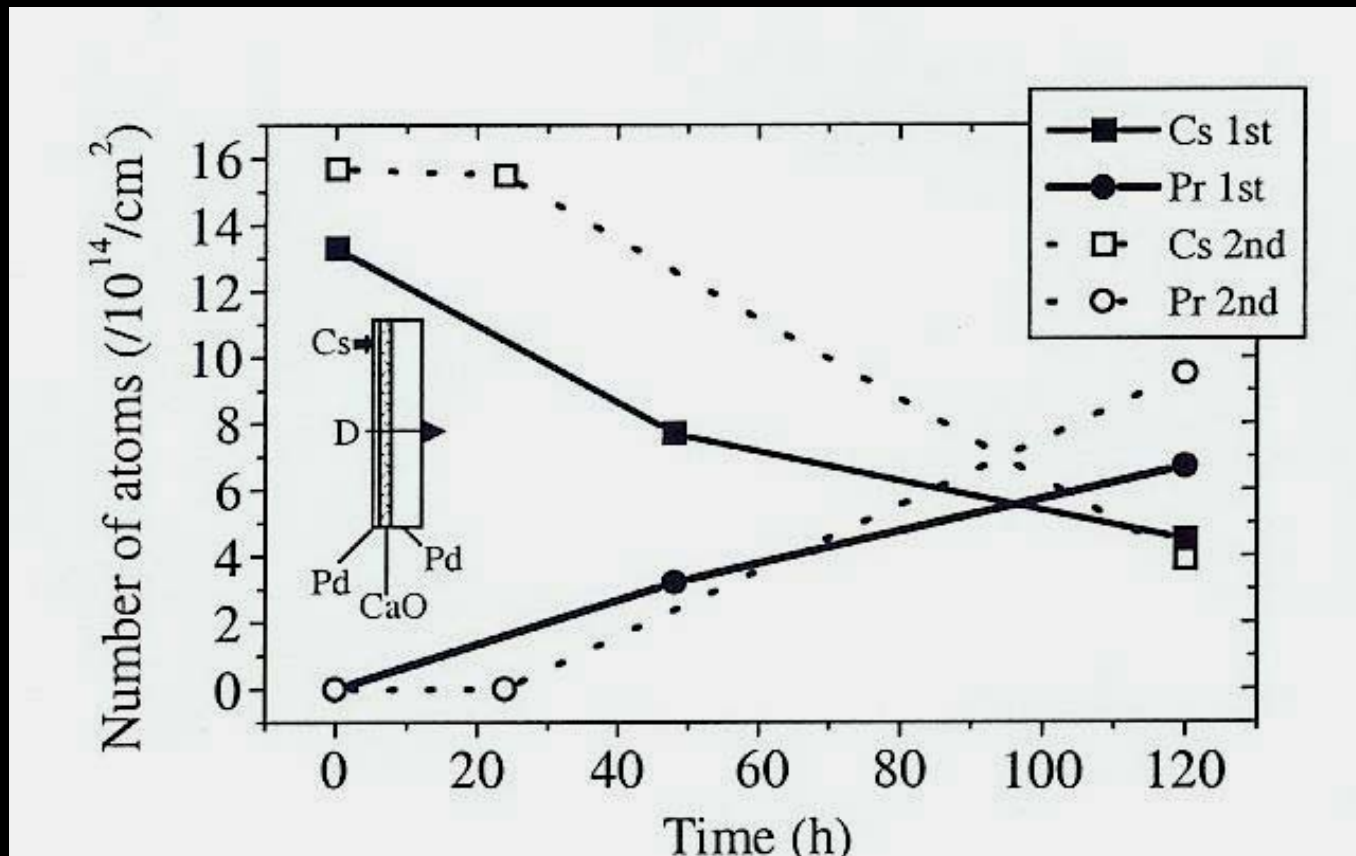
Heavy Element Transmutation

Surface Coatings



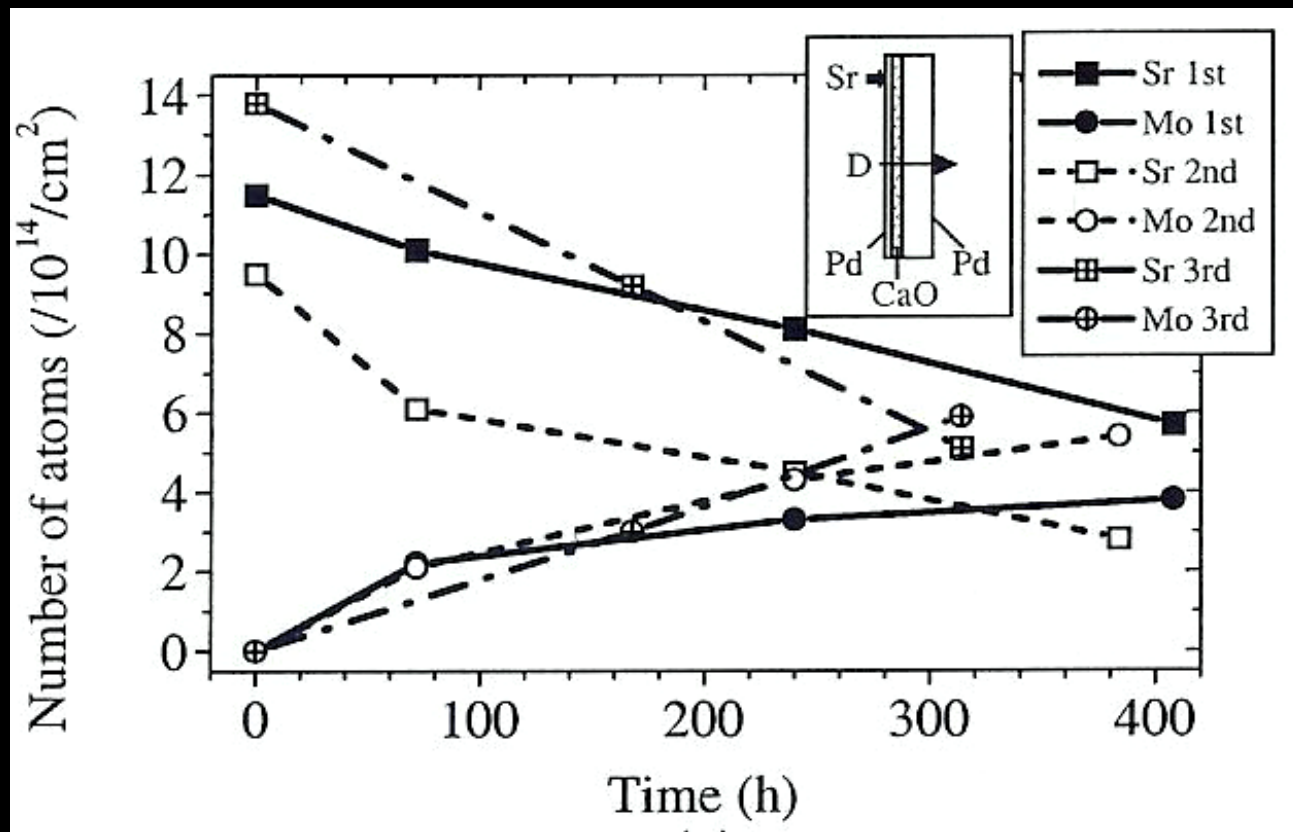
Heavy Element Transmutation

Pr Grows while Cs Decreases



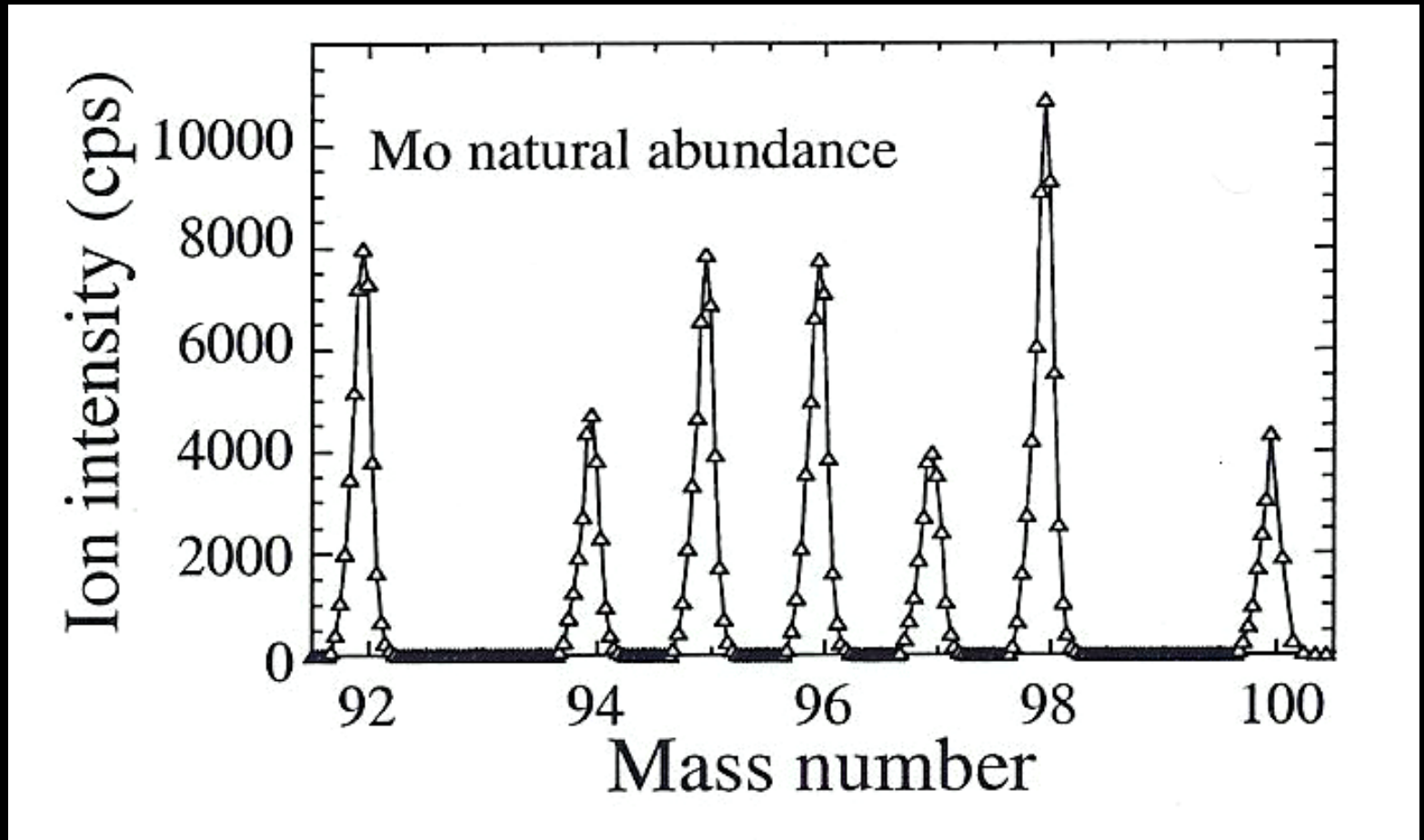
Heavy Element Transmutation

Mo Grows while Sr Decreases



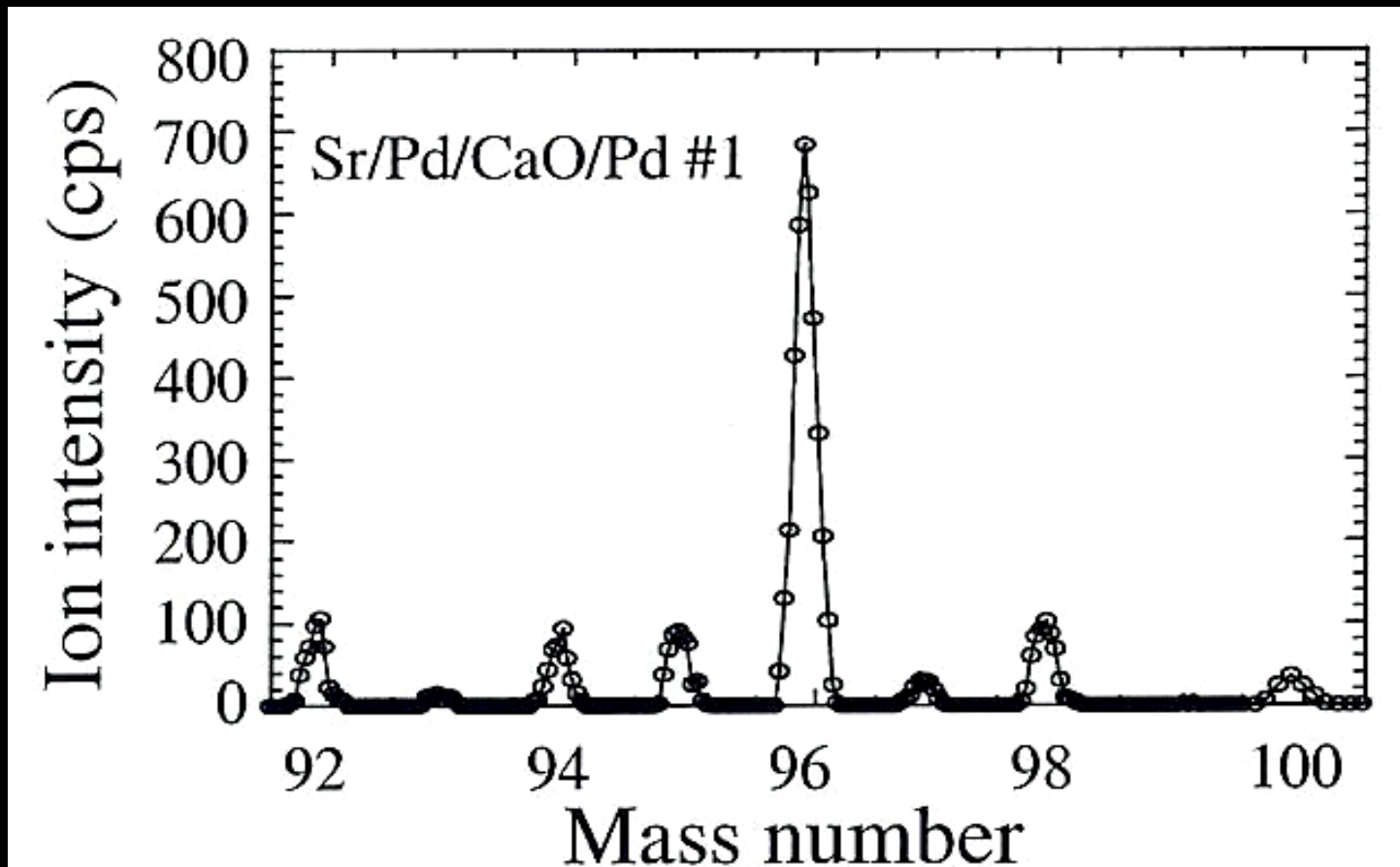
Heavy Element Transmutation

Natural Isotopic Abundance



Heavy Element Transmutation

Anomalous Isotopic Abundance



Selected Excess Heat Claims

Ref	Name	Year	Max.Excess Heat	% Excess Heat	Time	Excess Energy
1	Arata	1999	10w	No data	2000h	No data
2	El-Boher #56	2004	3.5w	80%	300h	3.1 Mj
2	El-Boher #64a	2004	34w	2500%	17h	1.1 Mj
2	El-Boher #64b	2004	32w	1500%	80h	4.6 Mj
3	Focardi	1994	18		319 D	600 Mj
3	Focardi	1994	72		278 D	900 Mj
4	Stringham	2004	40w	No Data	No Data	No Data
5	Takahashi	1992	130w	70%	1440h	No Data

See appendix A for references

Reasons for Commercial Interest

- **Presence of heat, helium, tritium**
- **Absence of Greenhouse Gases**
- **Absence of Strong Prompt Radiation**
- **No Long-Lived Nuclear Waste**

LENR Energy – What is Known

- **LENR works with deuterium and hydrogen**
- **Works with palladium, nickel, titanium**
- **High energy density (higher than U-fission)**
- **Environmentally-friendly**

LENR Energy – Pending Questions:

- **Will LENR pose security risks?**
- **Will it scale?**
- **Will it replace liquid fuels?**
- **What will it cost?**
- **When will it reach application?**

New Energy Times Magazine

www.newenergytimes.com

steven1@newenergytimes.com

Appendix A

Energy Production

1. Arata, Yoshiaki, Zhang, Yue-Chang, "Anomalous production of gaseous 4He at the inside of 'DS cathode' during D_2O -electrolysis," Proc. Jpn. Acad., Ser. B, 75: p. 281 (1999)
<http://newenergytimes.com/Library/1999ArataY-AnomalousProduction.pdf>
2. El Boher et al., "Excess Heat In Electrolysis Experiments At Energetics Technologies," (to be published Proceedings of 11th International Conference on Cold Fusion, Marseilles, France, 2004)
<http://newenergytimes.com/Library/2004ElBoher-ExcessHeatInElectrolysis.pdf>
3. Campari, E., Focardi, S., Gabbani, V., Montalbano, V., Piantelli, F., and Veronesi, S., "Overview of H-Ni Systems: Old Experiments and New Setup," 5th Asti Workshop on Anomalies in Hydrogen- / Deuterium-Loaded Metals, Asti, Italy, (2004)
4. Stringham, R., "1.6 MHz Sonofusion Device," (to be published Proceedings of 11th International Conference on Cold Fusion, Marseilles, France, 2004)
<http://newenergytimes.com/Library/2004StringhamR-1.6MHzSonofusion.pdf>
5. Takahashi, A., et al., "Anomalous Excess Heat by $\text{D}_2\text{O}/\text{Pd}$ Cell Under L-H Mode Electrolysis," Third International Conference on Cold Fusion, Nagoya, Japan: Universal Academy Press, Inc., Tokyo, Japan. (1992)
<http://newenergytimes.com/Library/1992TakahashiAAnomalousExcessHeat.pdf>