Low-Energy Nuclear Reaction Research – 2008 Update

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American Chemical Society
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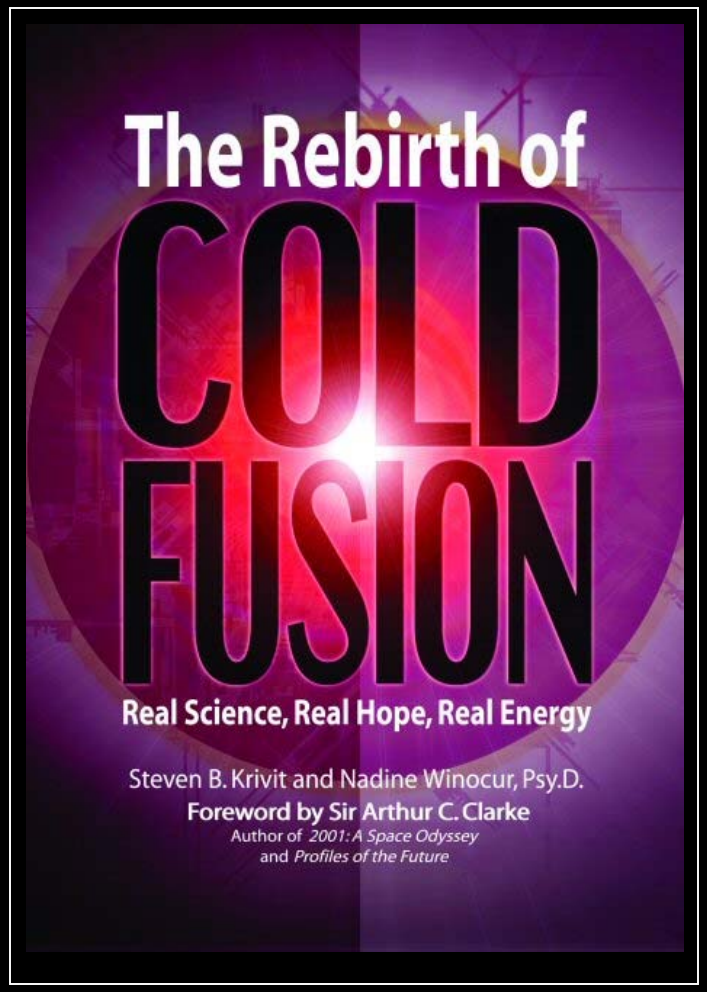
Overview:

- "Cold Fusion" research: Since 1989
- Krivit Investigations: Since 2000



Simple Pathway to Cold Fusion:

D + D > 4He

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%]

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n:T = ~1:~1
D+D > **4He** (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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LENR Experiments

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

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LENR Experiments

n:T = ~1:1,000,000
4He + heat + ? (~12- ~48 MeV / 4He)

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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 ≠ 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 Yasuh ro Itoh akehiko Gotoh Nobuaki and oyoda chiro "Detection Of Anomalous Elements X Ray And Excess Heat In A D2 Pd System And Its Interpretation By he Electron Induced Nuclear Reaction Model " *Fusion Technology*, Vol 33 pg 476 492 (uly 1998)

- (Stanislaw Szpak)

Szpak S et al "Further Evidence Of Nuclear Reactions In he 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

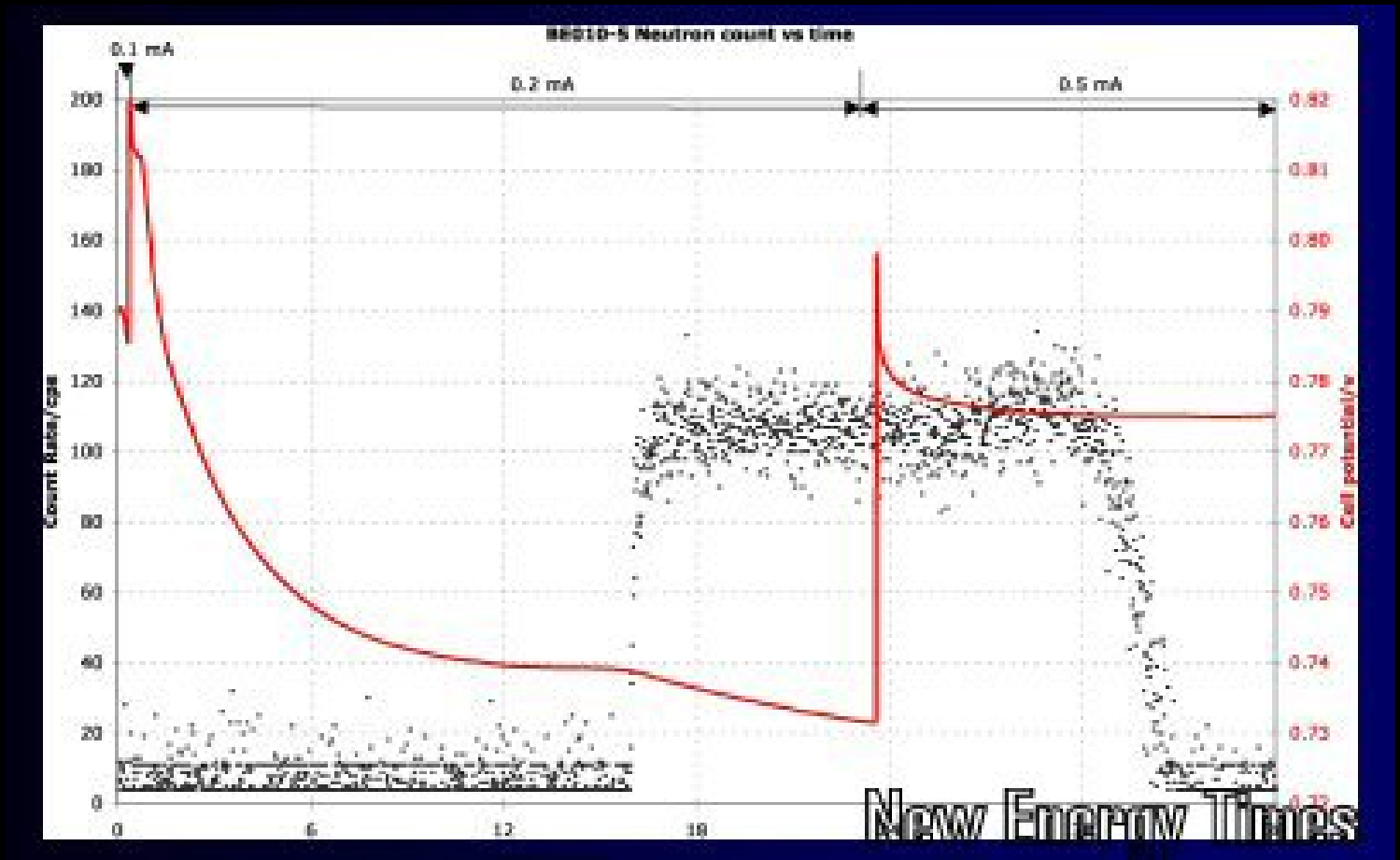
Low Flux
Bursty

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

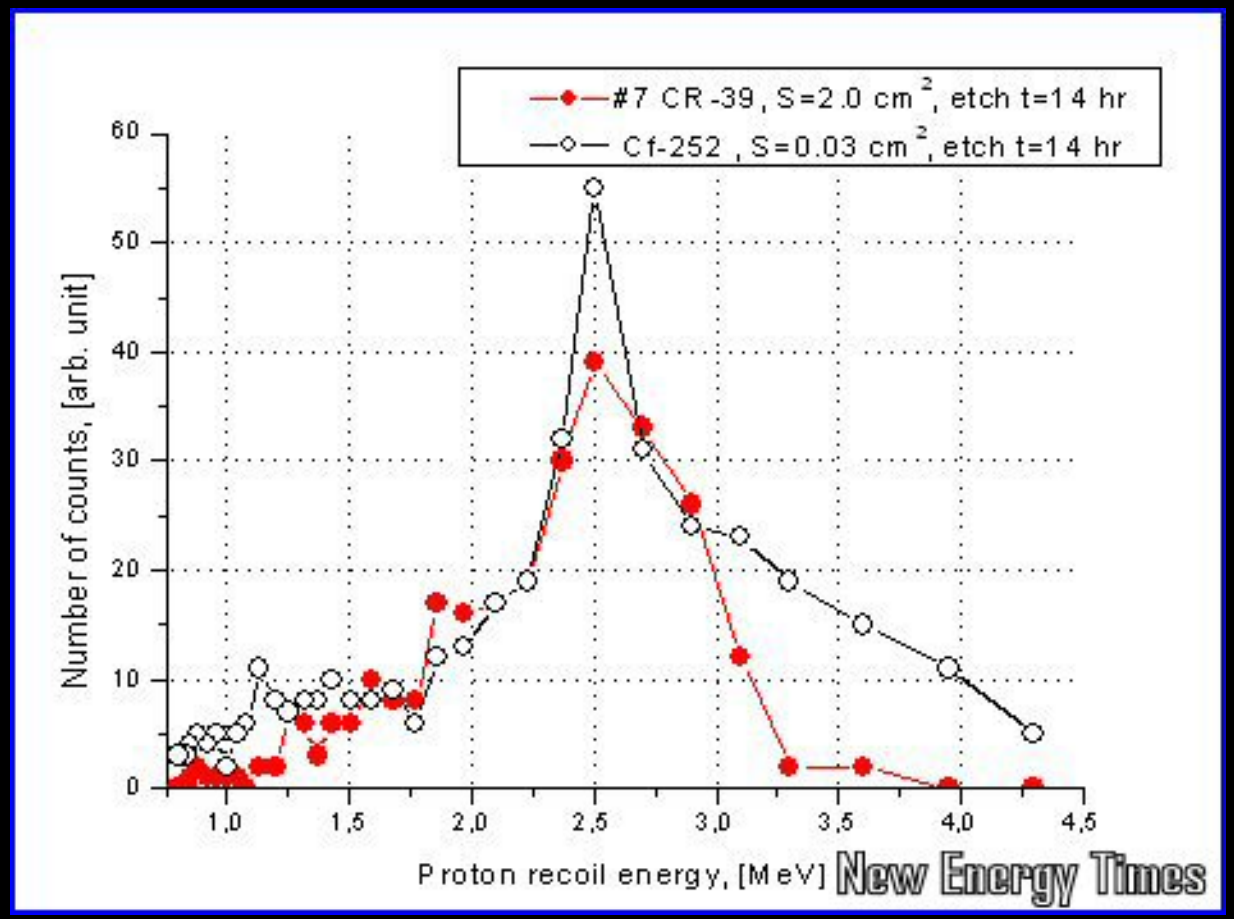
(8th Conf. on H and D/Pd Anomalies)



SRI Replication Confirmation

(RAS – A. Lipson and A. Roussetski)

Sequential Etching



SRI Replication Confirmation
(RAS – A. Lipson and A. Roussetski)
Final Report

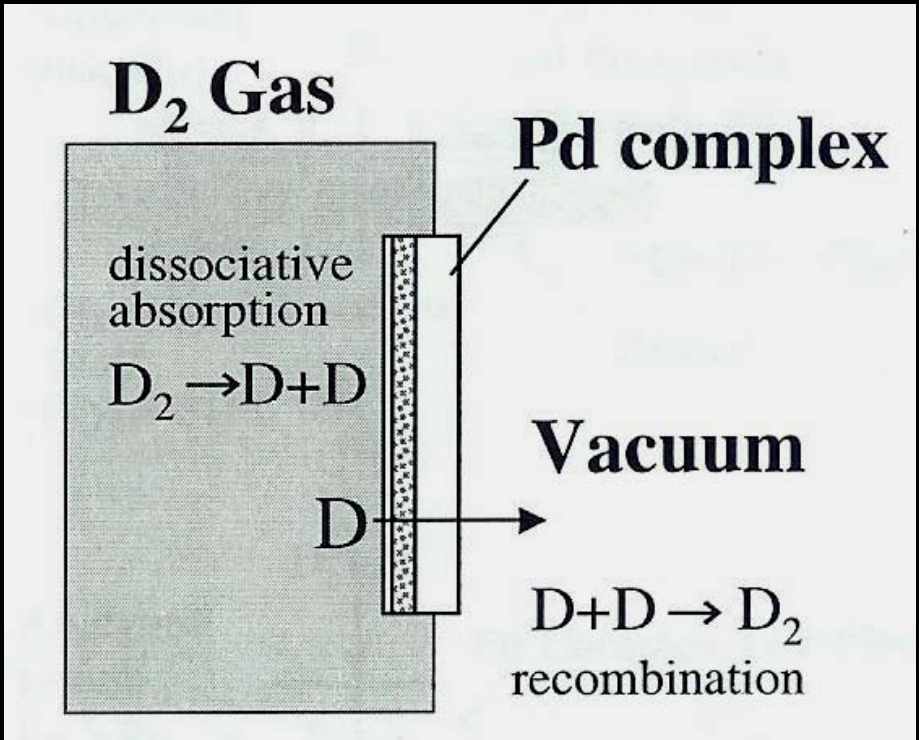
"…both sides of detector [front and back] showed that it contains real nuclear (proton recoil) tracks.

"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."

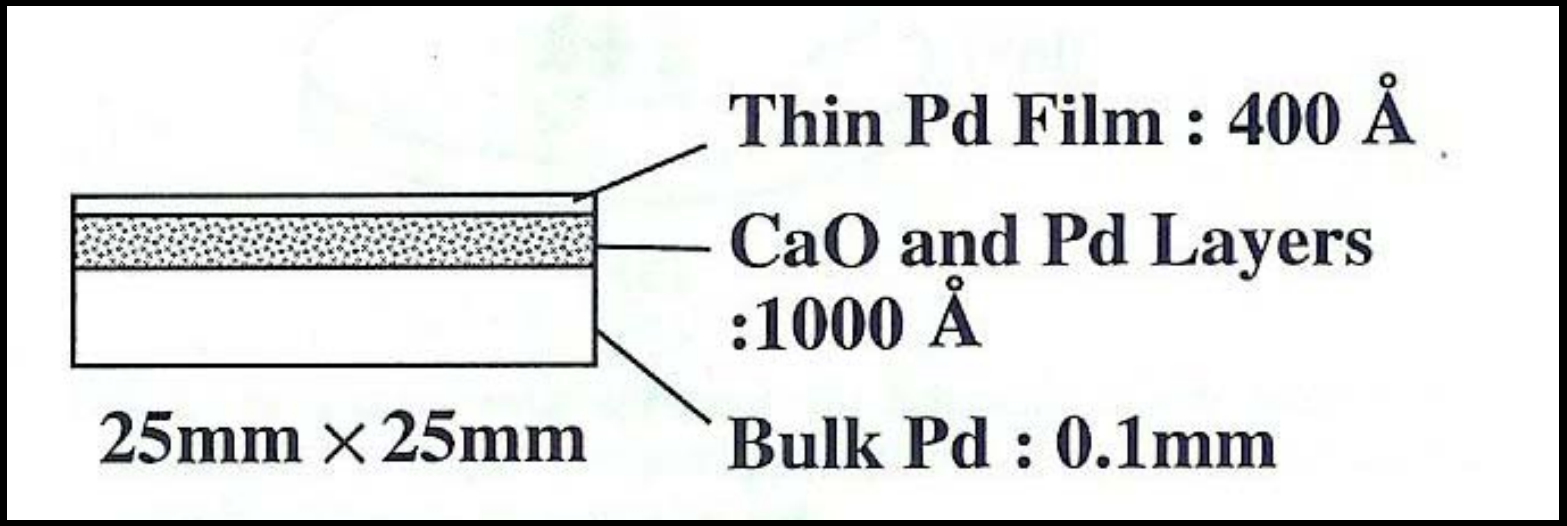
Heavy Element Transmutation

Gas Permeation (Y. Iwamura, Mitsubishi)



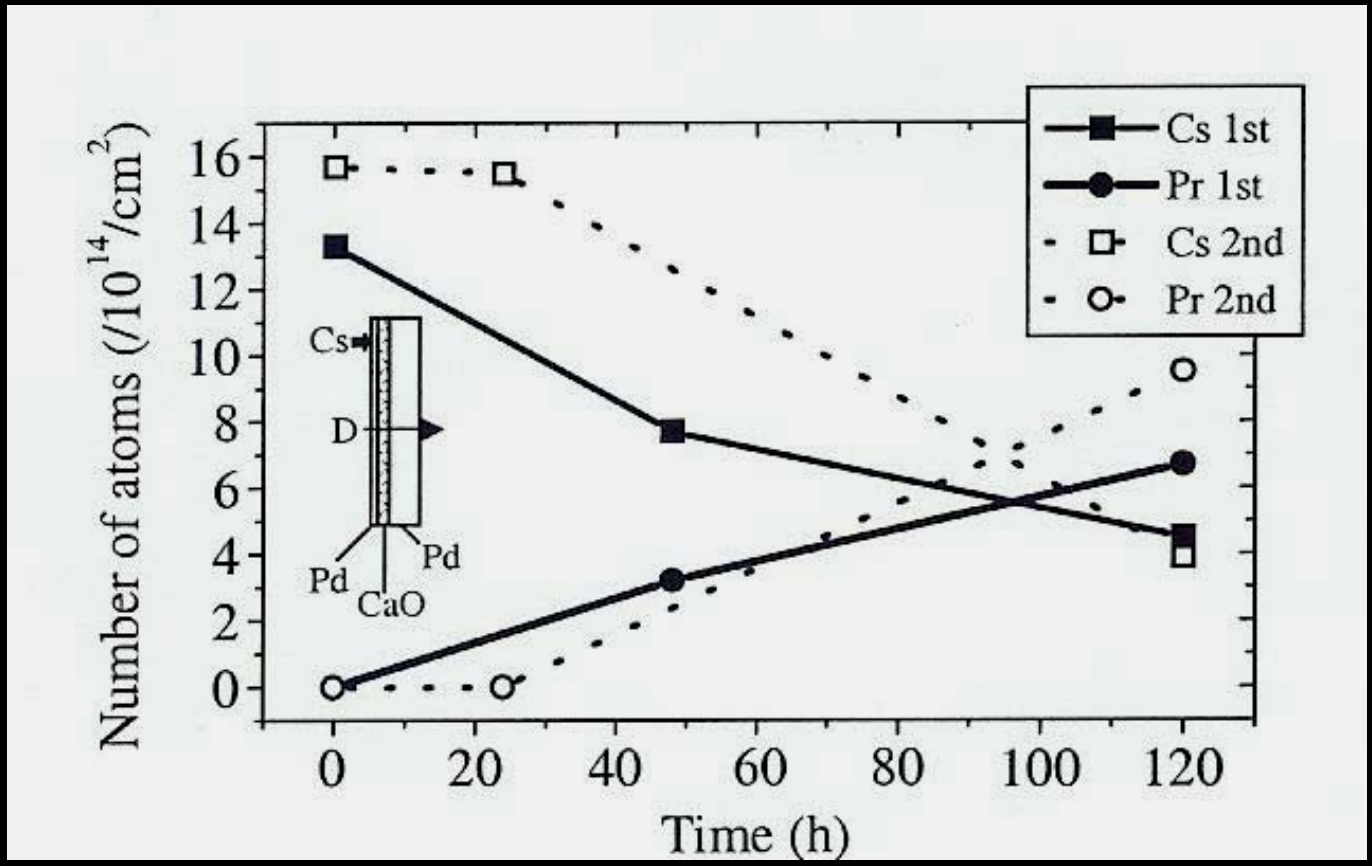
Heavy Element Transmutation

Surface Coatings



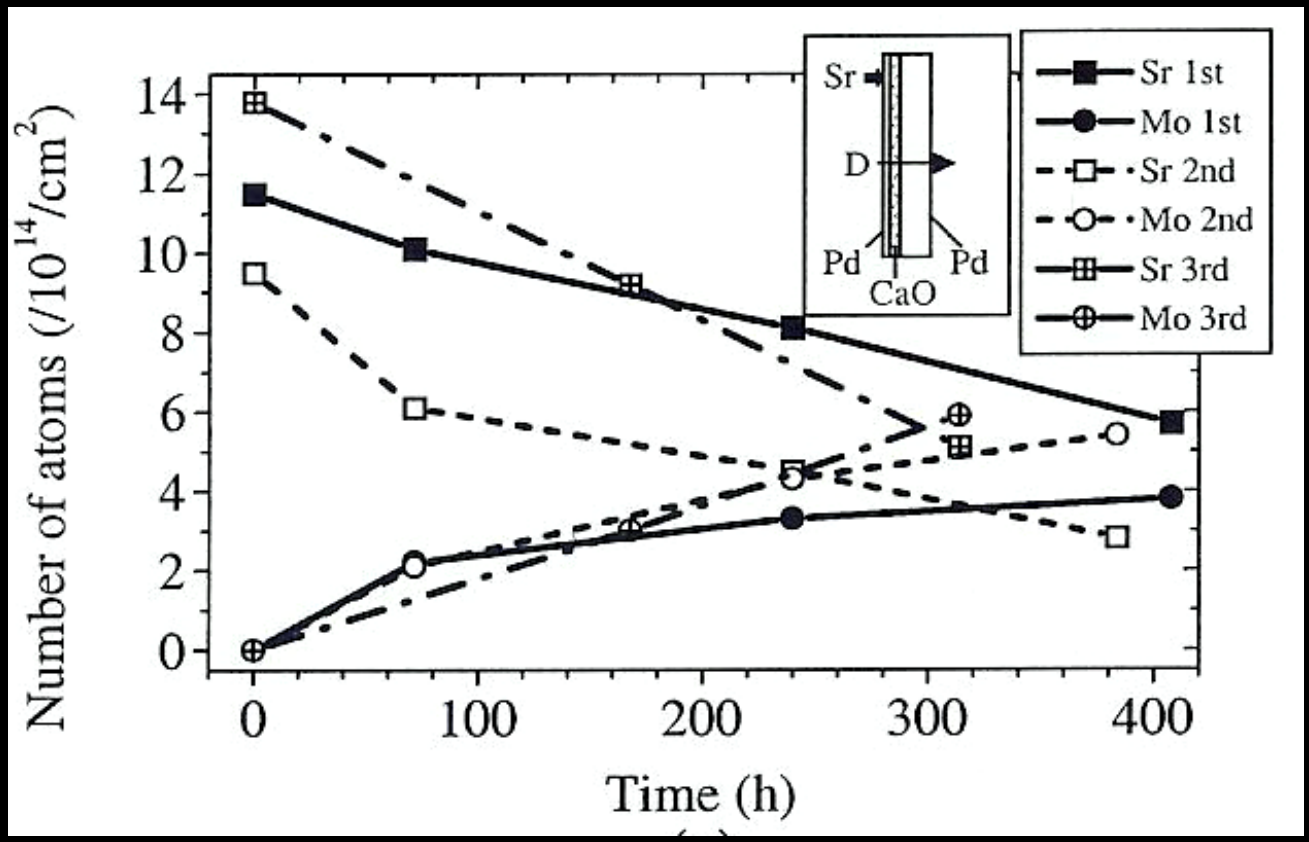
Heavy Element Transmutation

Pr Grows while Cs Decreases



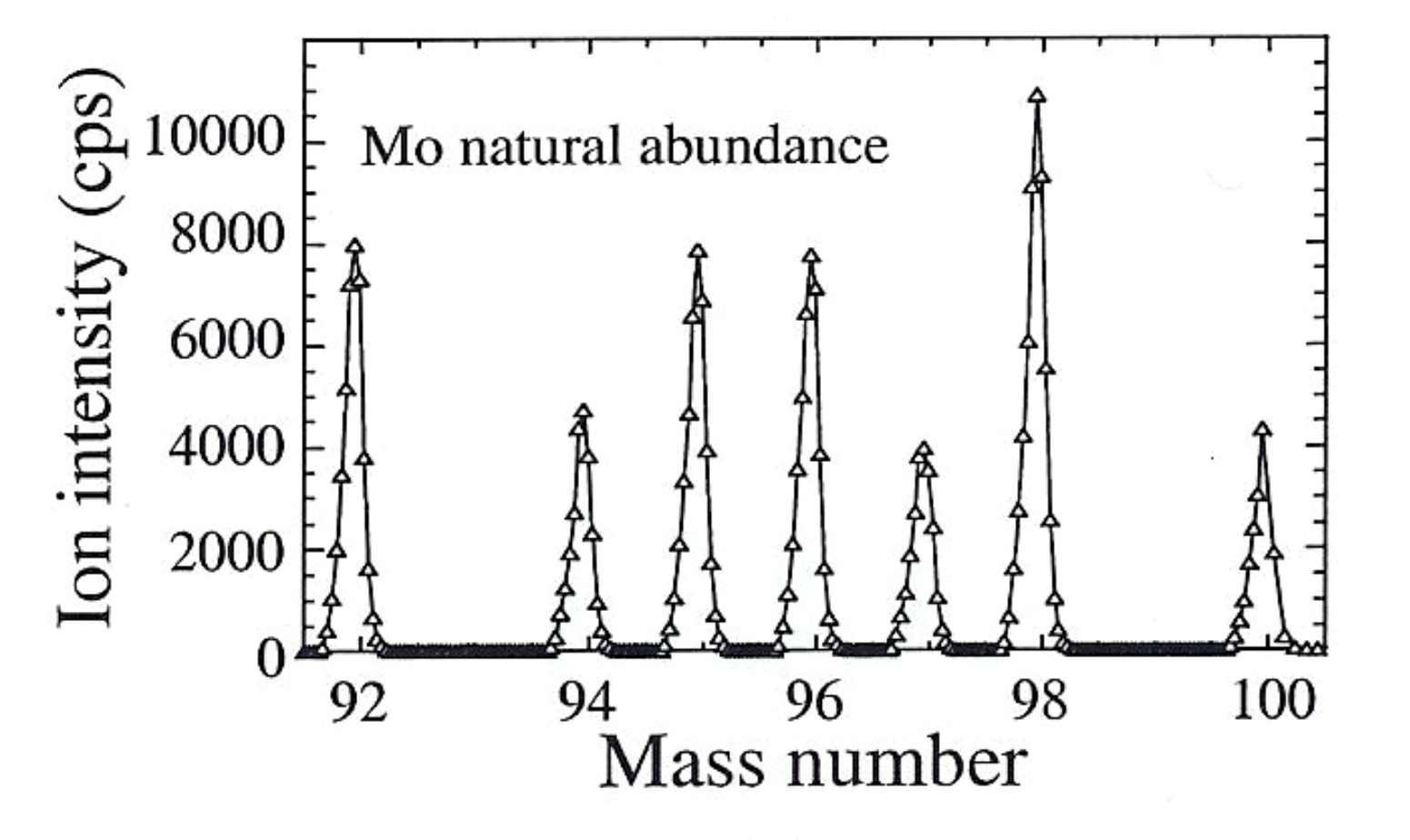
Heavy Element Transmutation

Mo Grows while Sr Decreases



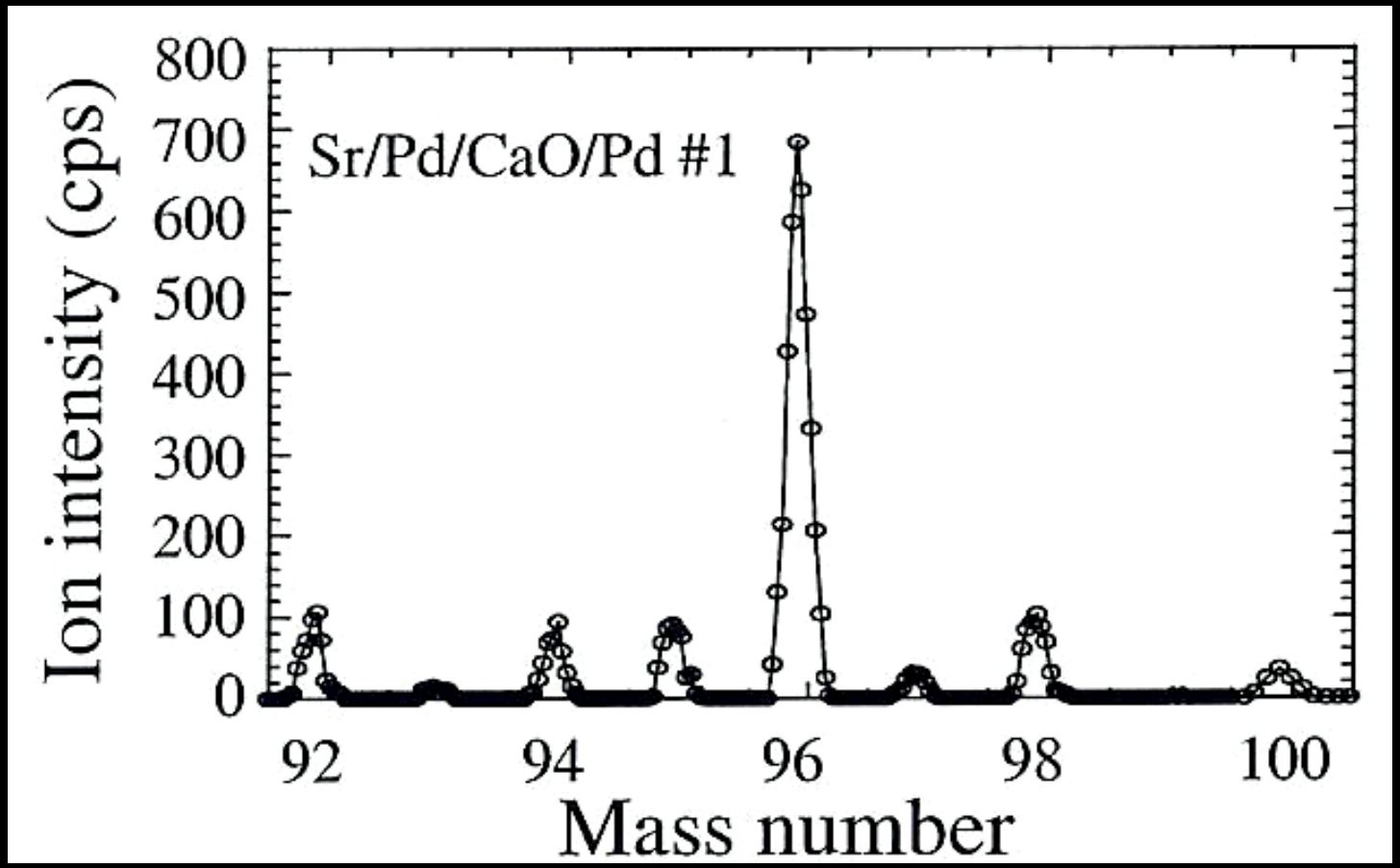
Heavy Element Transmutation

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

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Appendix A
Energy Production

1. Arata, Yoshiaki, Zhang, Yue-Chang, "Anomalous production of gaseous 4He at the inside of 'DS cathode' during D2O-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 D2O/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