Cold Fusion

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Summary

- Before1989.
- Cold Fusion History.
- Pons & Fleischmann experiment.
- Excess heat.
- Helium.
- Particles.
- Transmutations.
- Experiments in gas phase.
- Industry
- Theories
- Conclusion

Before
Pons & Fleishmann

Before 1989

Kluev, V.A.; Lipson, A.G.; Toporov, Y.P.; Deryagin, B.V.; Lushchikov, V.I.; Strelkov, A.V.; Shabalin, E.P. Sov. Tech. Phys. Lett. **1986**, *12*, 551.

Kluev, V.A.; Lipson, A.G.; Topornov, Y.P.; Derjaguin, B.; Lushikov, V.I.; Strelkov, A.V.; Shabalin, E.P. J. Sov Tech Physics Lett **1986**, *12*, 1333

Production of neutrons when a mechanical force is applied on heavy water ice or LiD.

Derjaguin, B.V.; Lipson, A.G.; Kluev, V.A.; Sakov, D.M.; Topporov, Y.P. Nature **1989**, *342*, 492.

Production of neutrons when powders of titanium deuterides are submitted to mechanical vibrations.

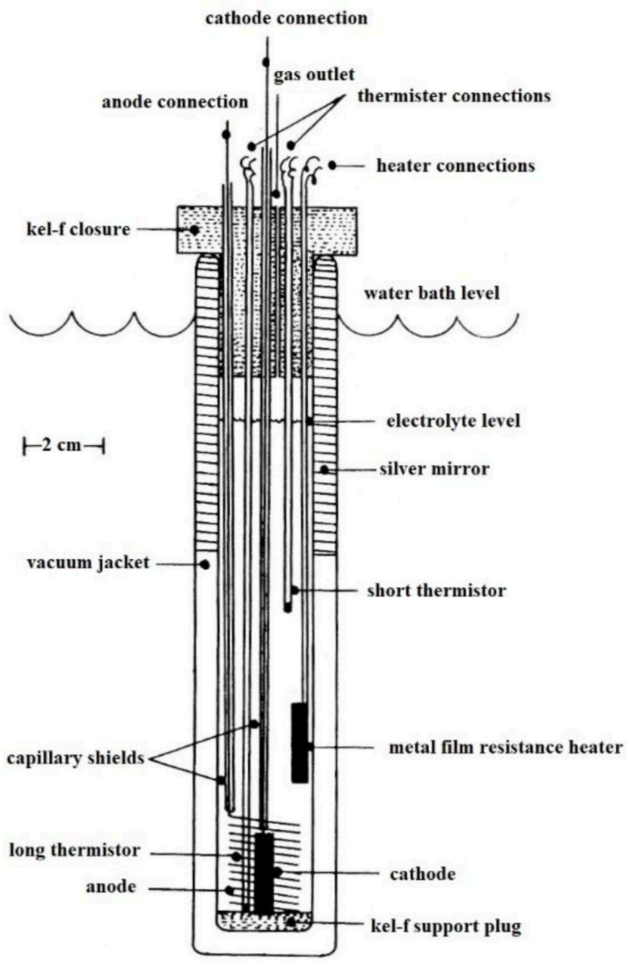
History

- On March 23 1989, Cold Fusion is announced by press conference.
- Immediately afterwards, the scientific community is divided in two groups. The vast majority of the scientists reject cold fusion on theoretical reasons. However, a small minority of experimentalists manages to replicate the original work of Pons and Fleischmann.

Original Experiment of Pons & Fleishmann


AP/file

Experimental Set-up



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ICARUS II Cell

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Possible Reactions

D + D → T + p	4.0 MeV	50%
D + D → He-3 + n	3.3 MeV	50%
D + D → He-4 + gamma	24 MeV	10^{-7}

Three Miracles

If the D+D reaction occurs, then, there are three major theoretical problems.

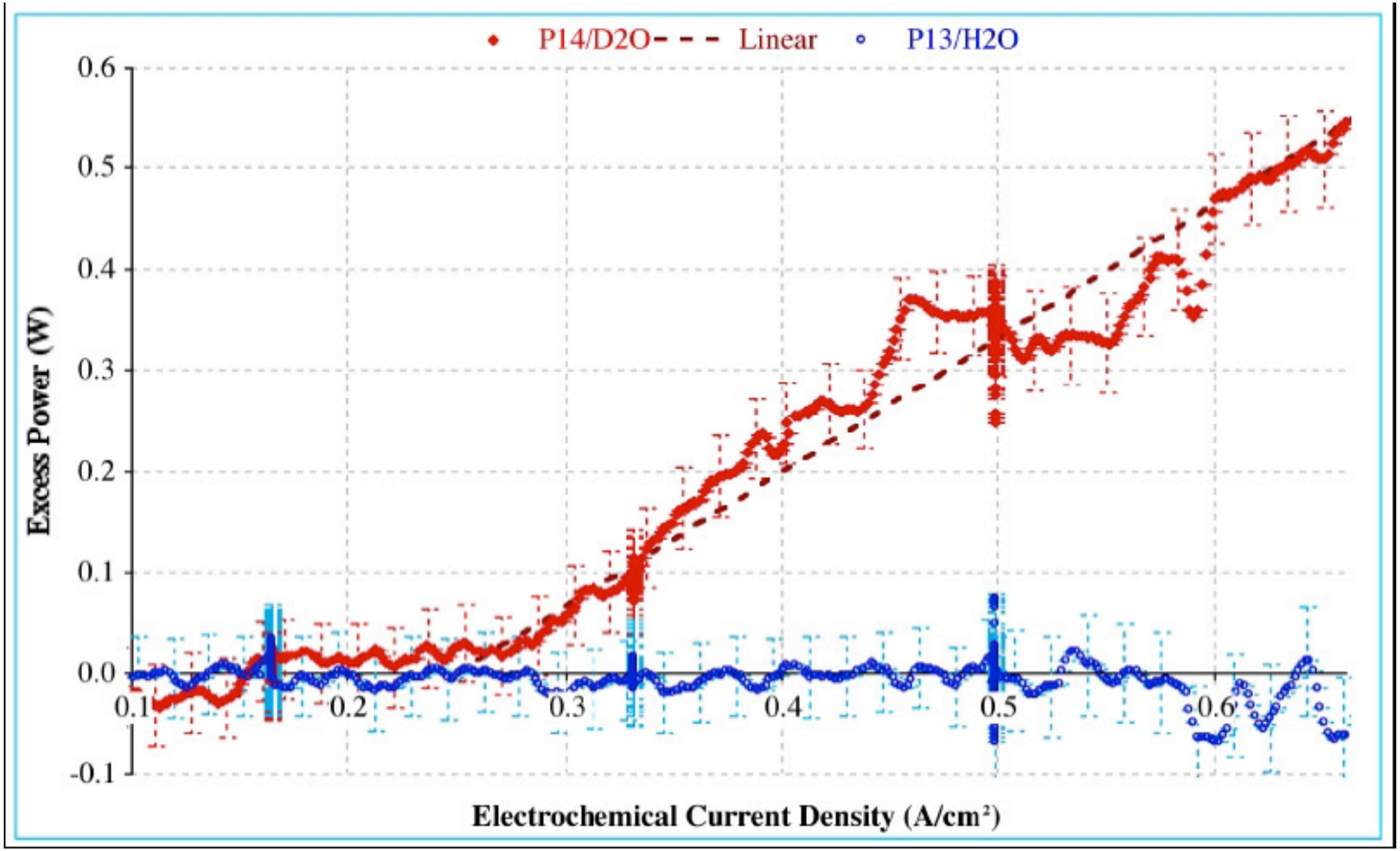
1- Coulomb barrier.

2- No or very few neutrons.

3- No or very few gamma rays.

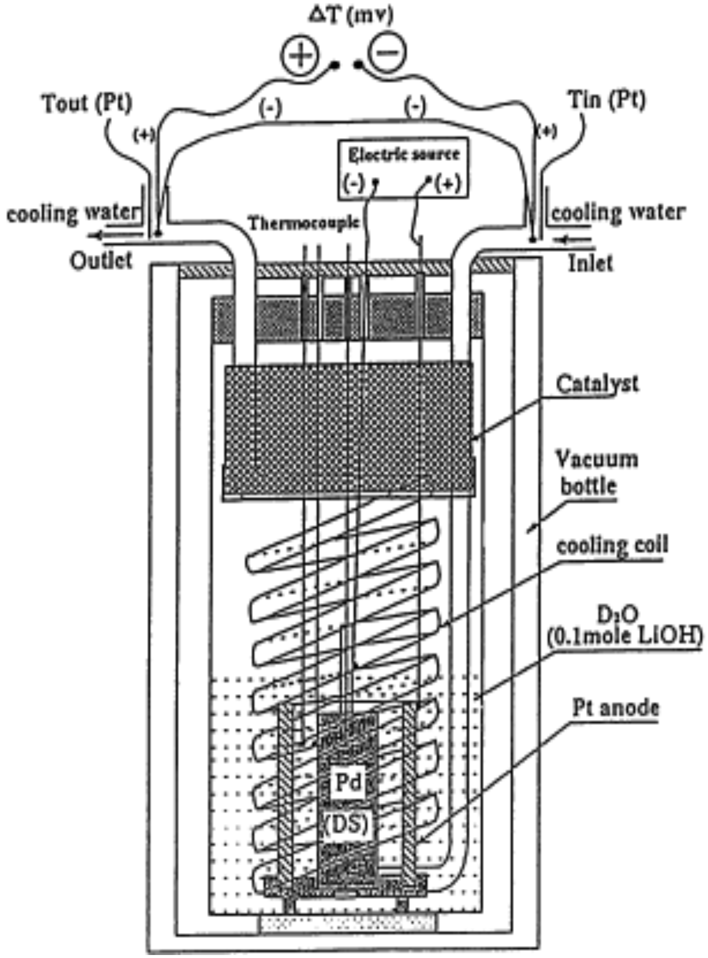
Excess Heat

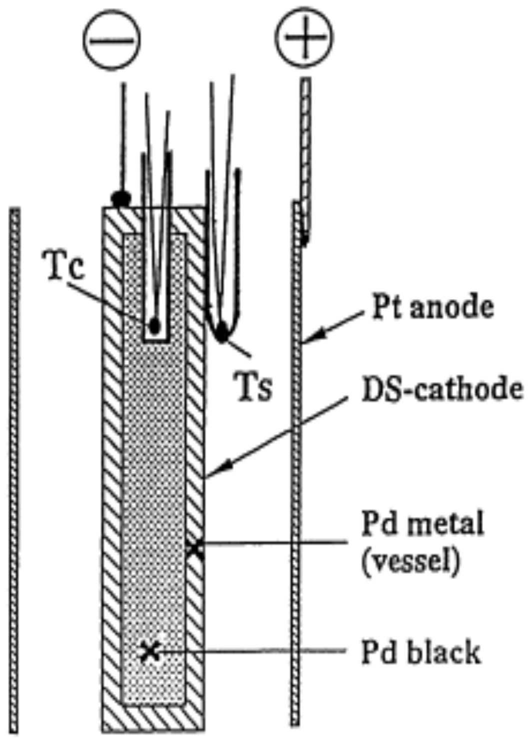
McKubre (SRI)



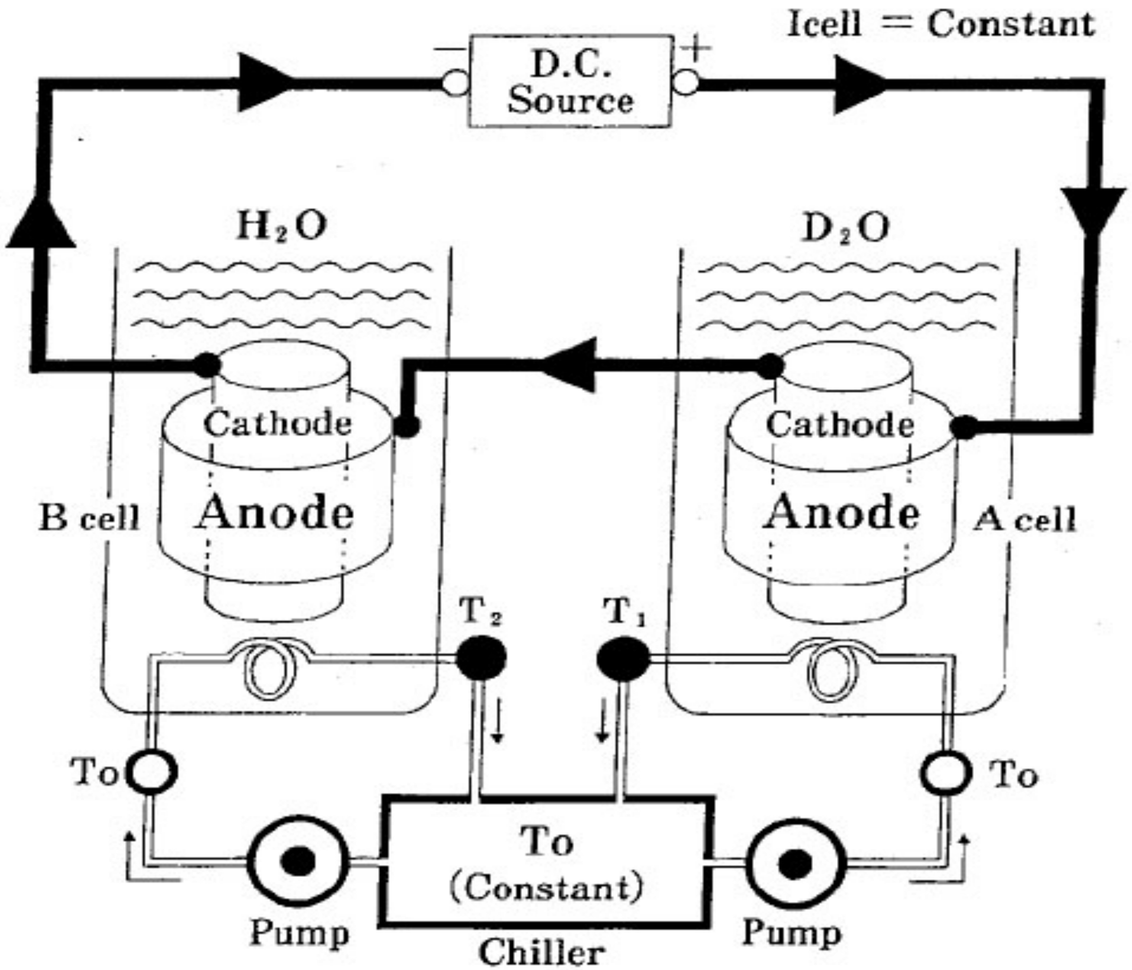
P14/D2O
Linear
P13/H2O
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
0.1
0.2
0.3
0.4
0.5
0.6
Excess Power (W)
Electrochemical Current Density (A/cm²)

Double Structured Cathode: Arata





Experimental Set-up



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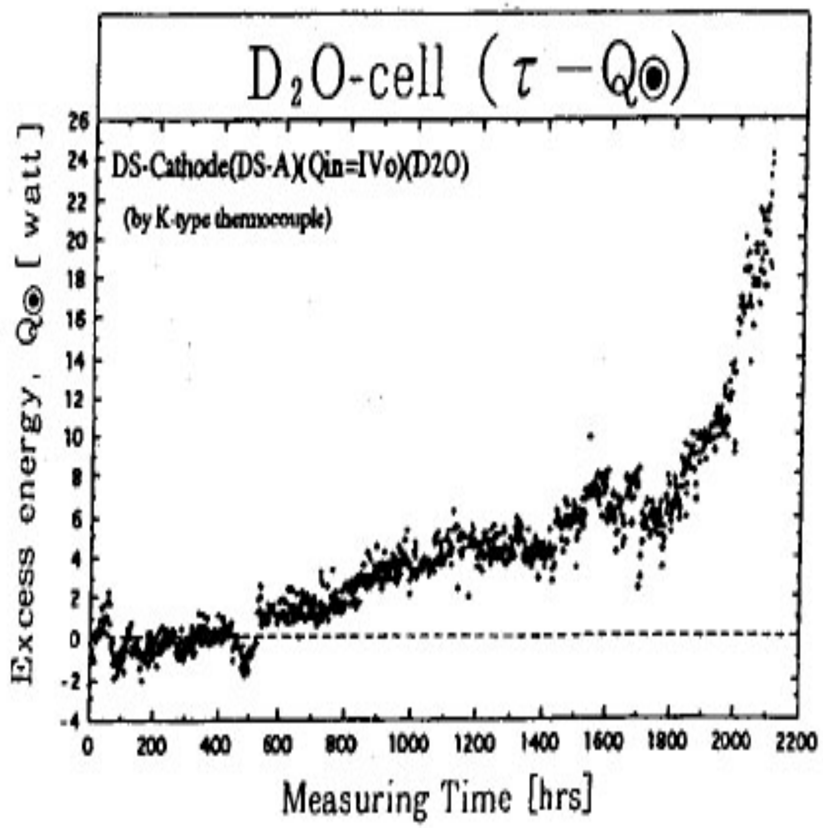
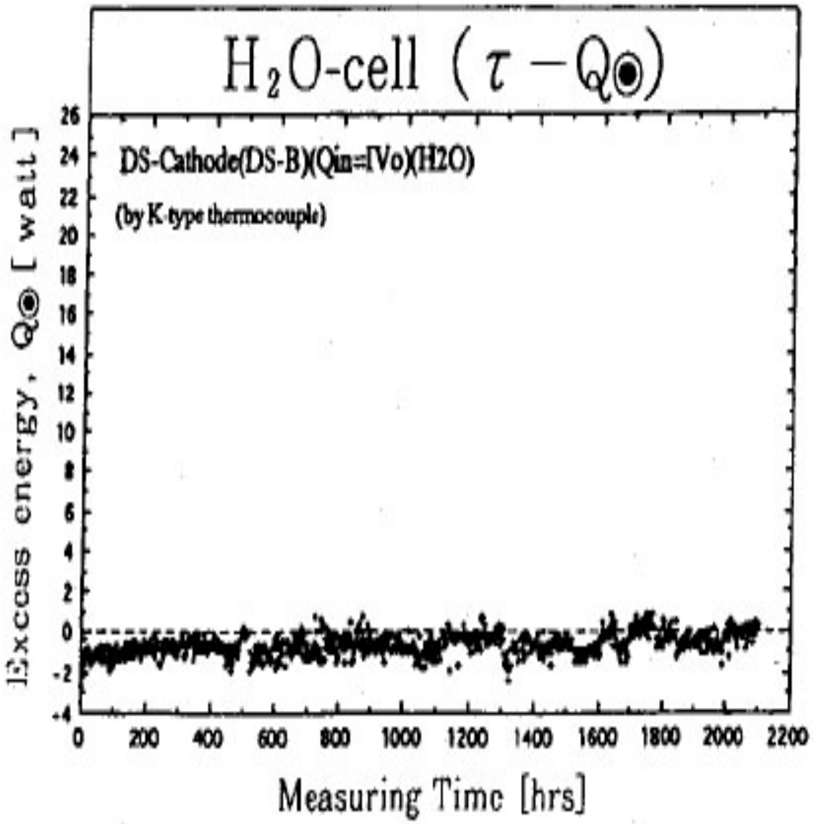
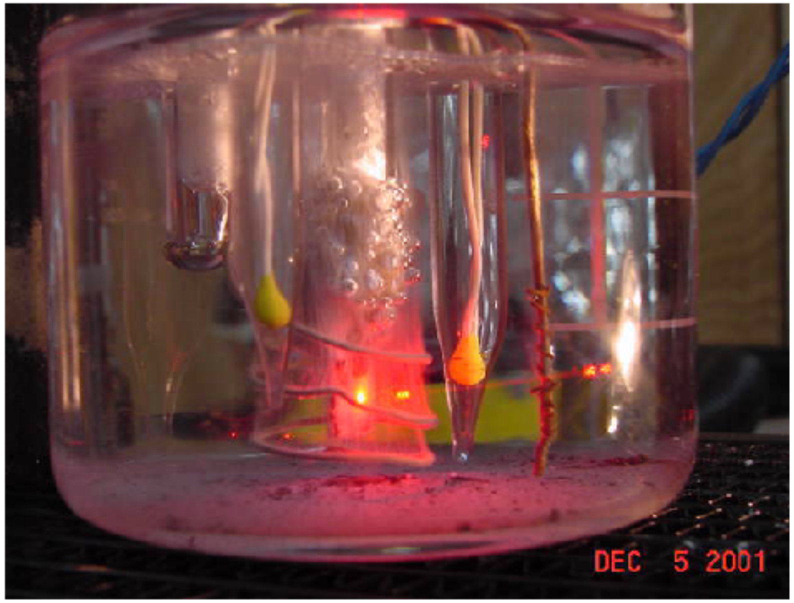
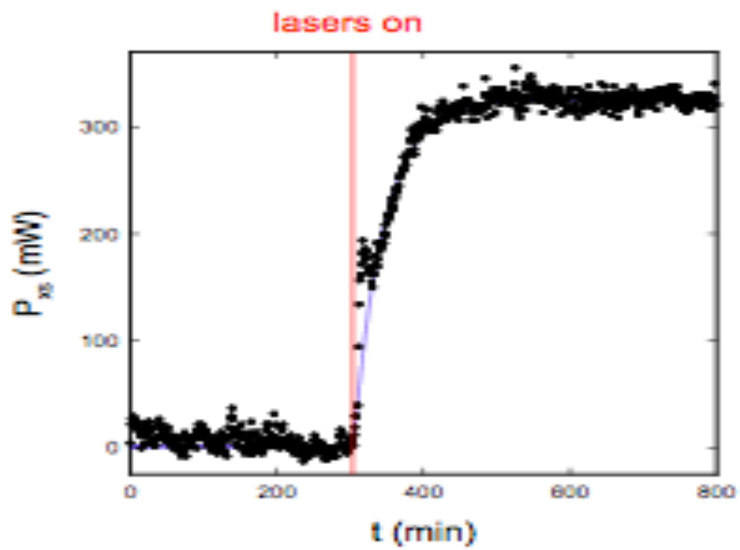
Heavy water/Light water Comparison





Laser Stimulation : Letts-Cravens





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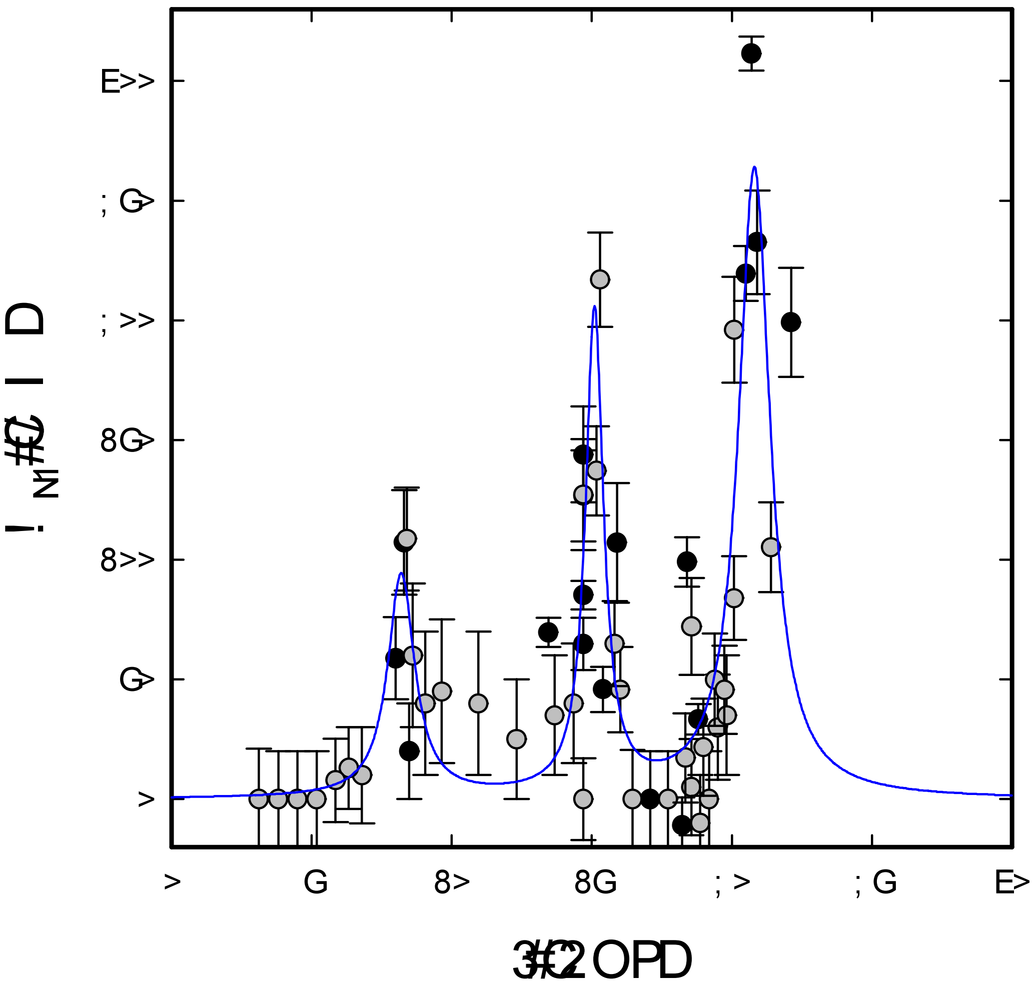

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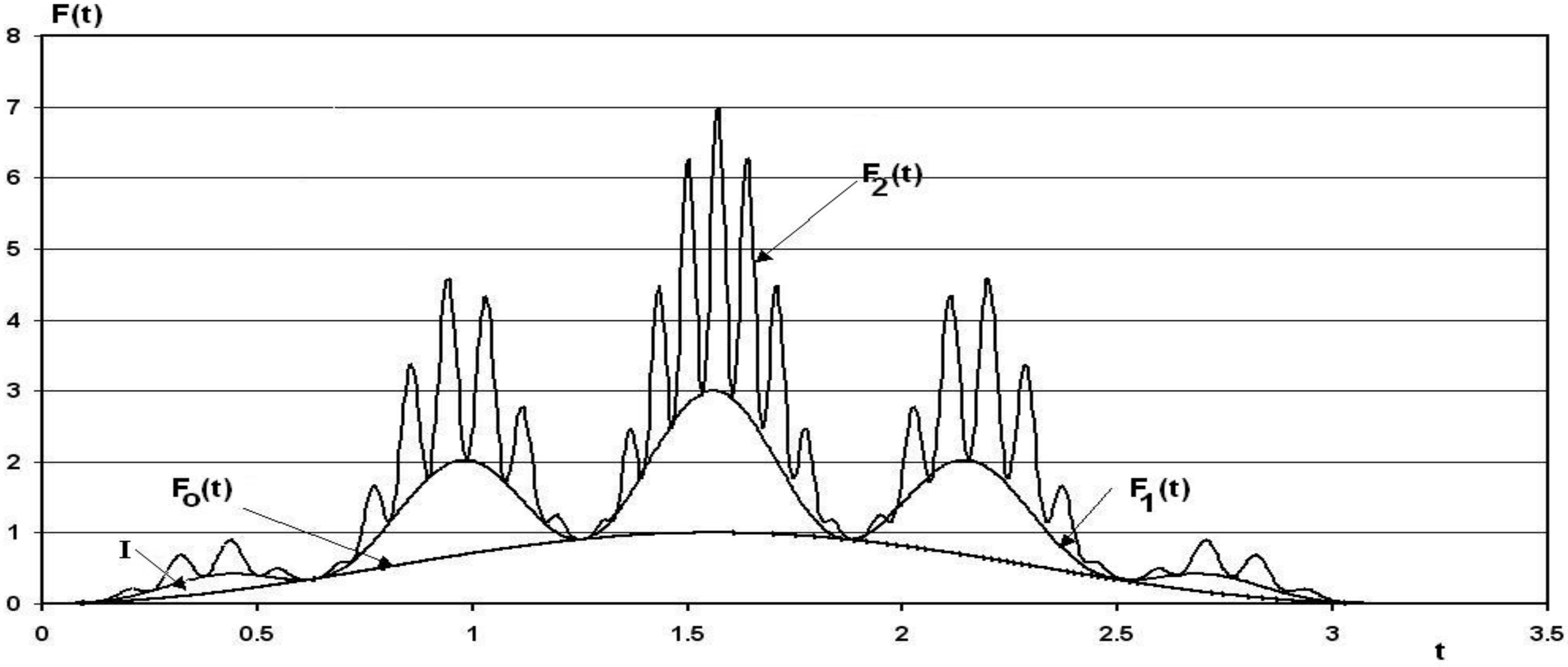
Super Waves : Energetics

$$F_2(t) = A_0 \sin^2(\omega_0 t)[1 + A_1 \sin^2(\omega_1 t)(1 + A_2 \sin^2(\omega_2 t))]$$



Super Waves : Energetics

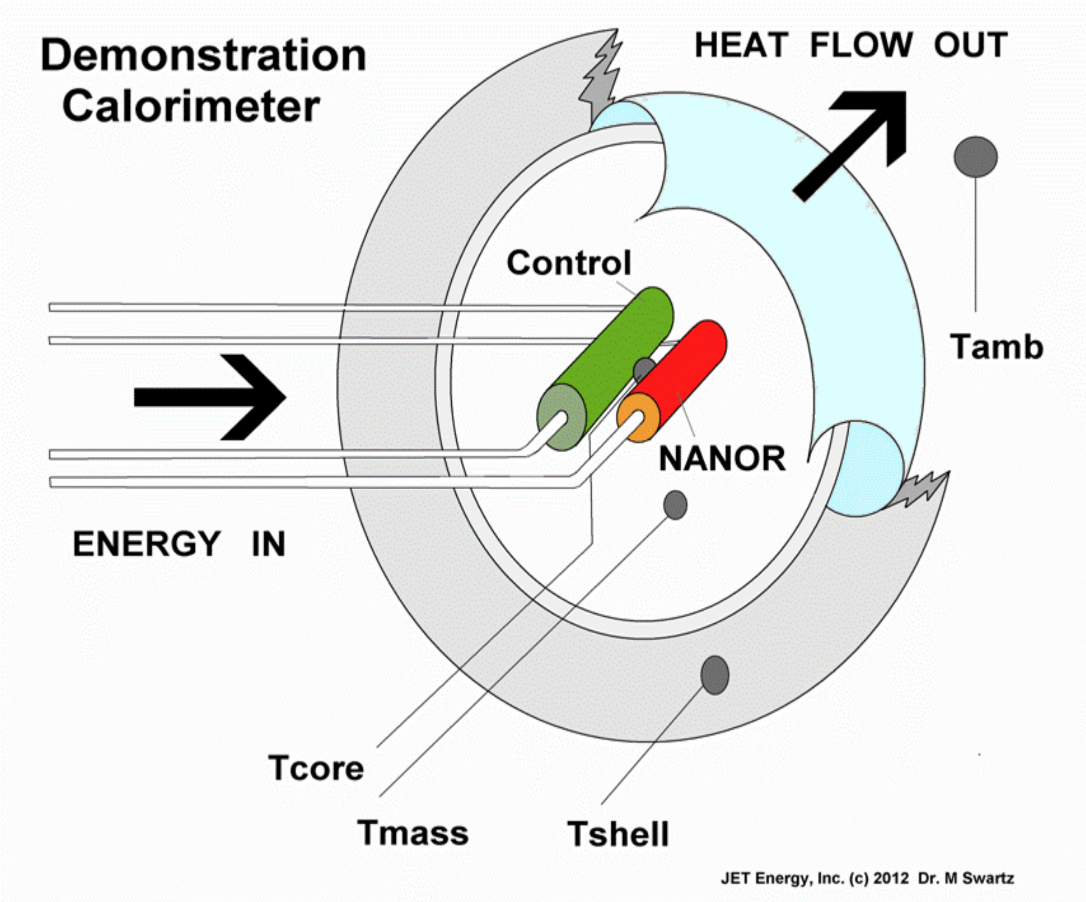
Super Waves : Energetics

Average energy produced ~20 watts

Average energy input : 0.74 watt

Yield : Pout/Pin =25

Nanor : MIT



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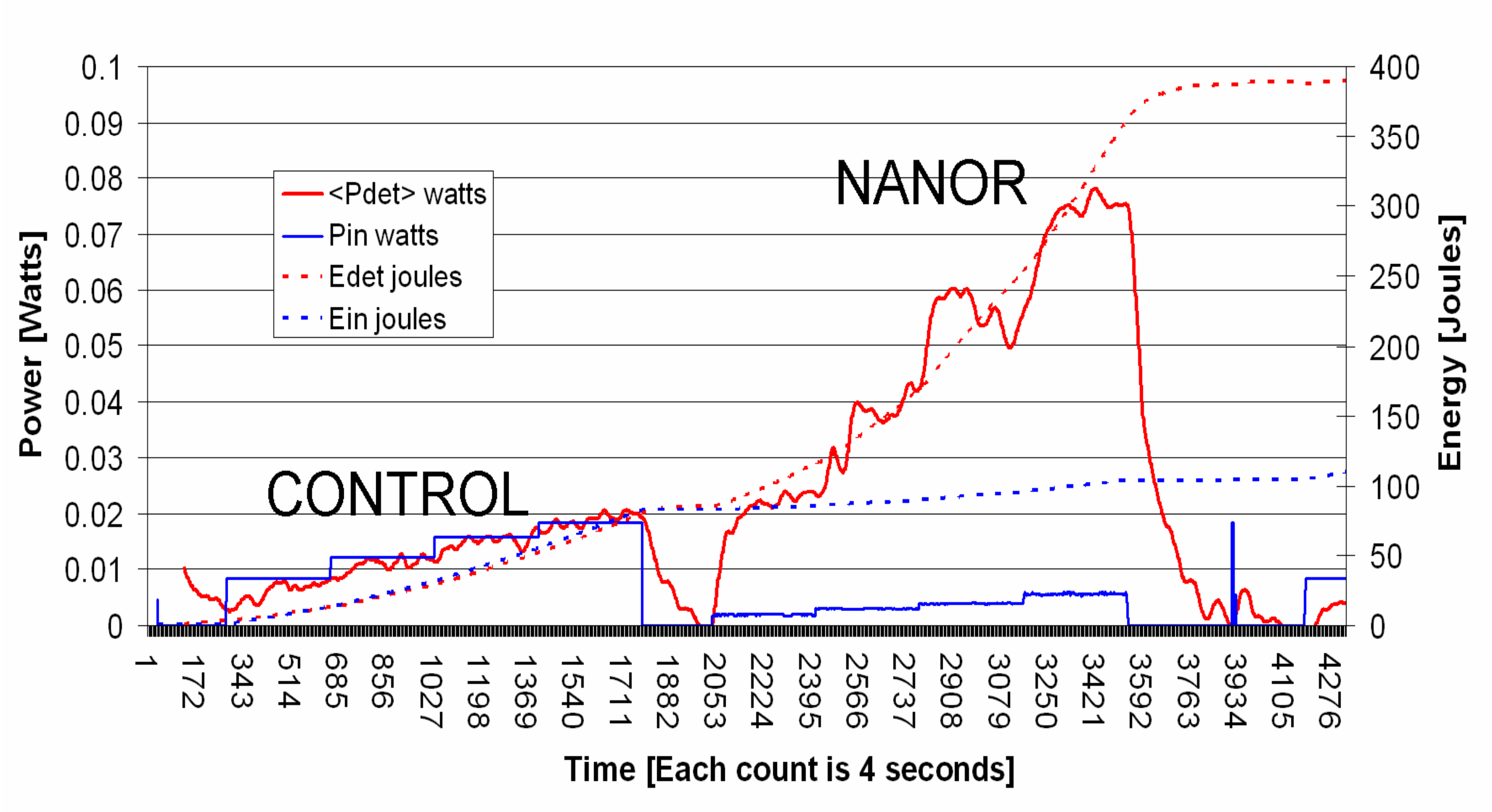
Nanor : MIT



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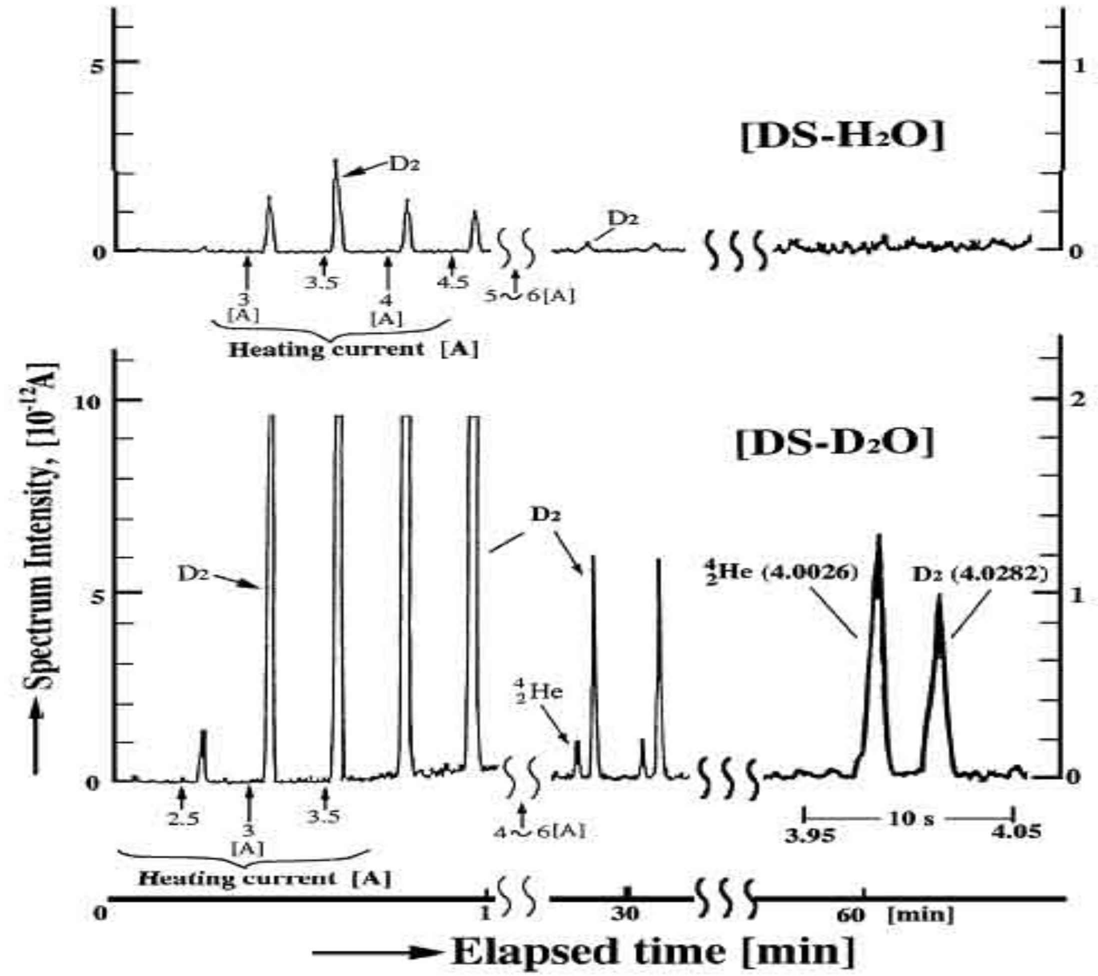
Particules

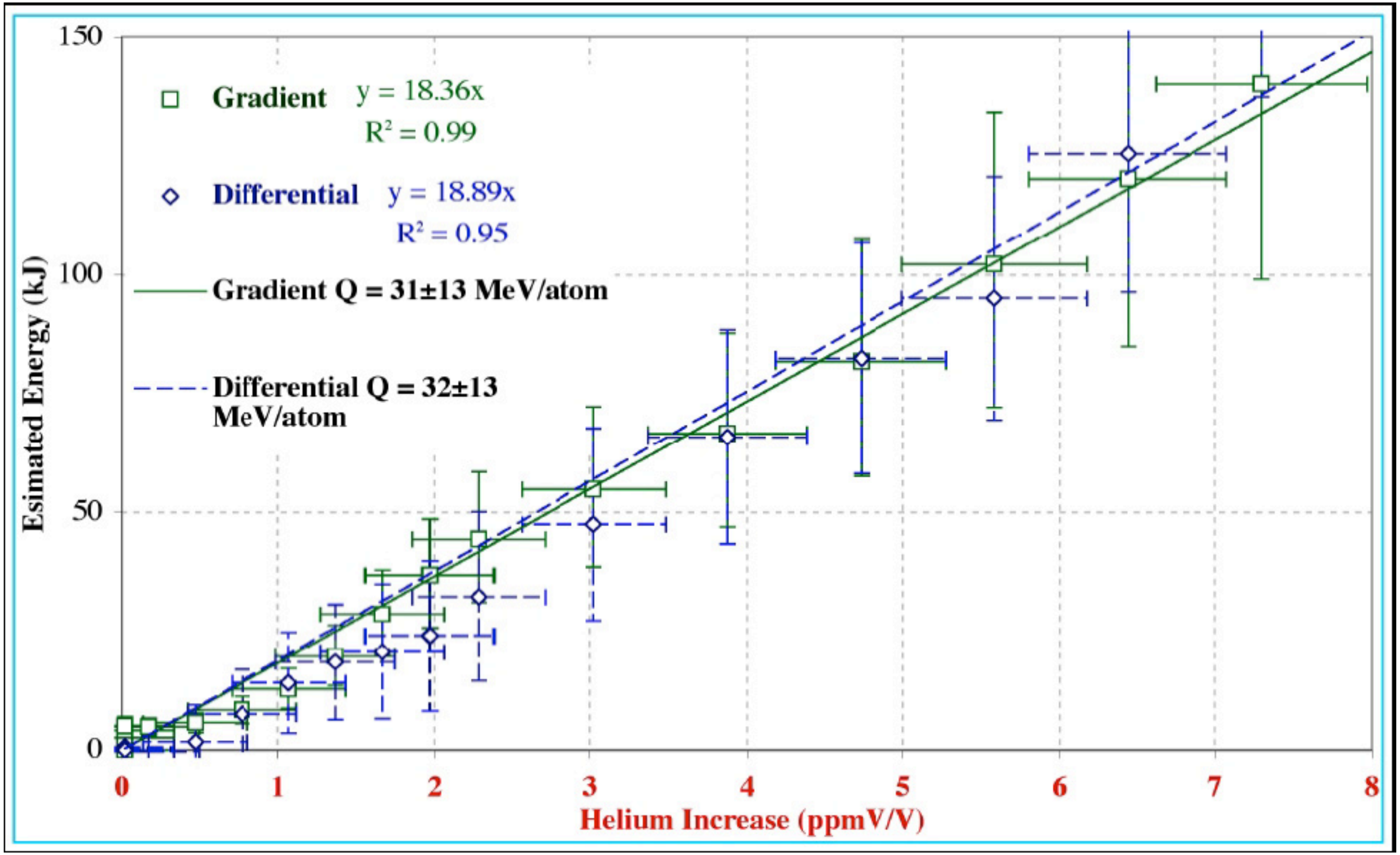
- Helium
- Tritium
- Neutrons
- Protons
- X-Rays
- Alpha particles

Hélium-4

Hélium-4 : Arata



Excès de Chaleur-He-4: McKubre



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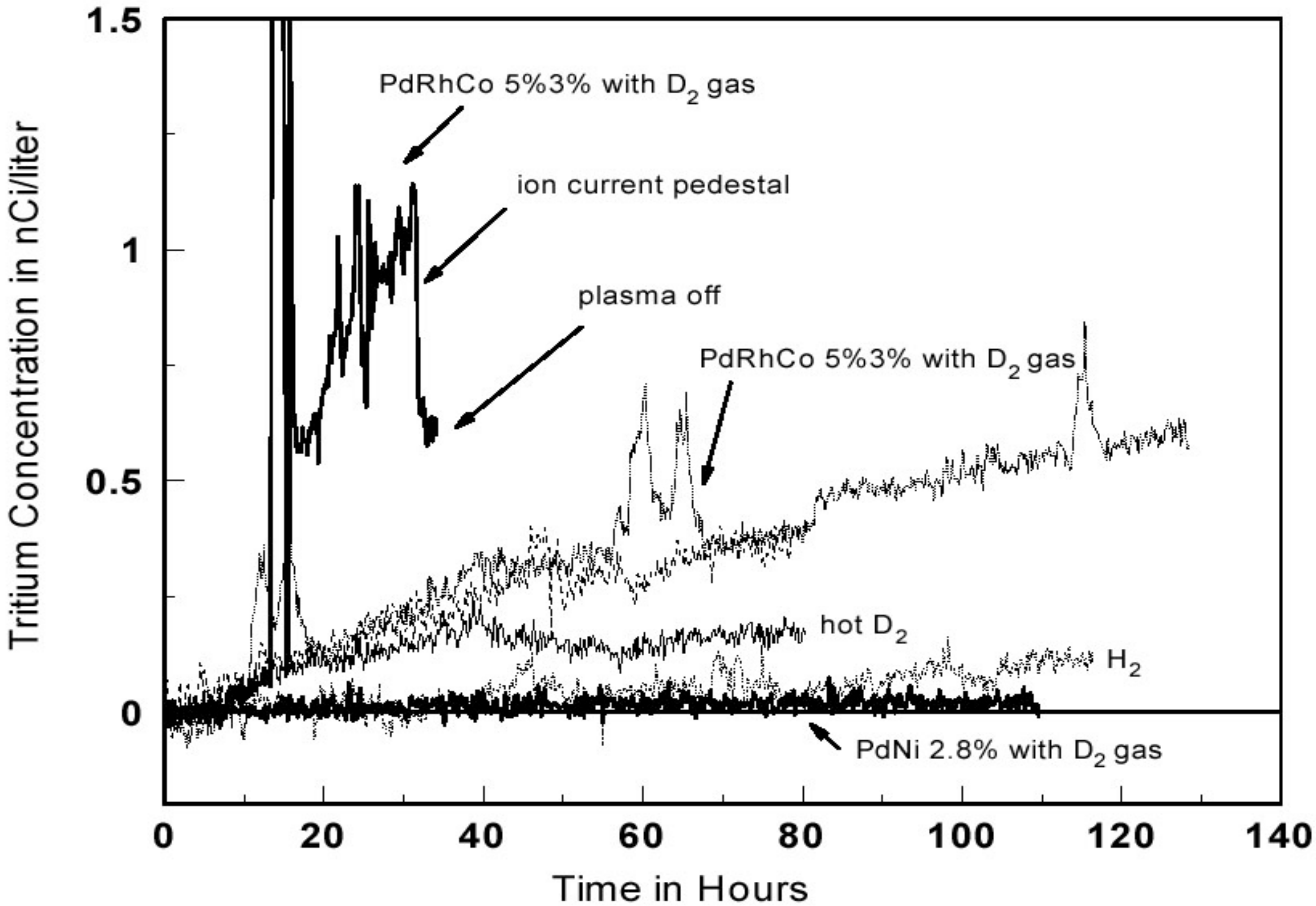
Tritium

Tritium : Claytor



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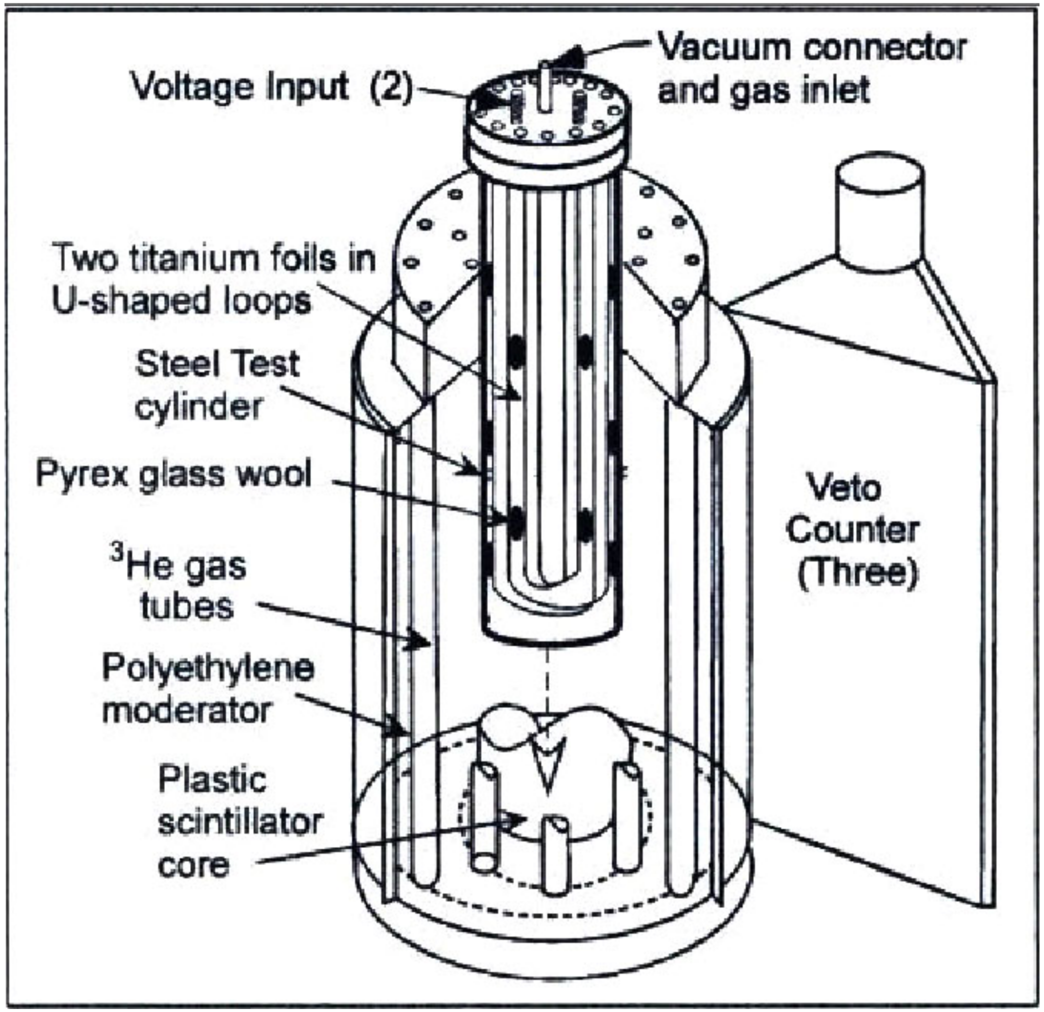
Neutrons

Neutrons : Jones



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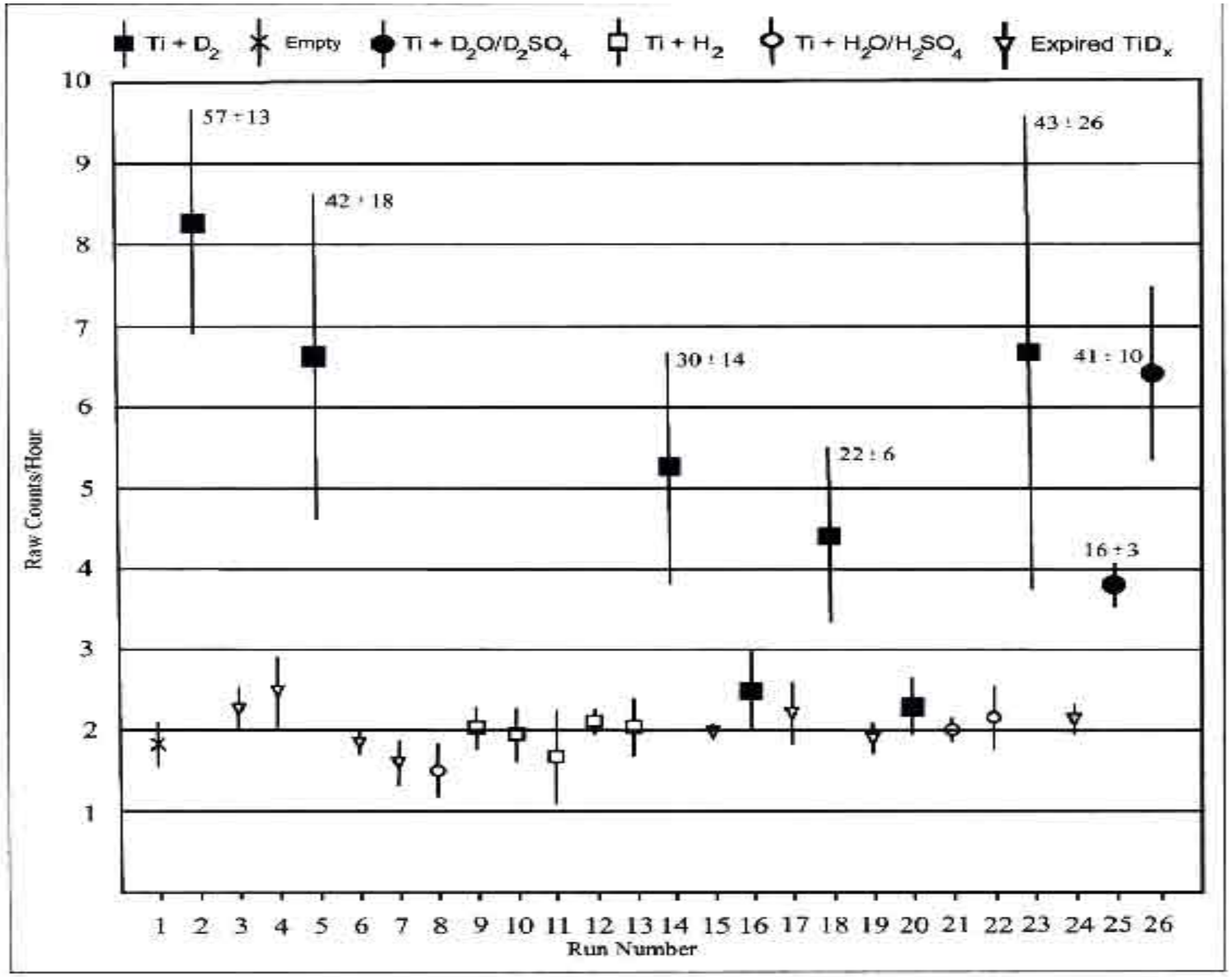
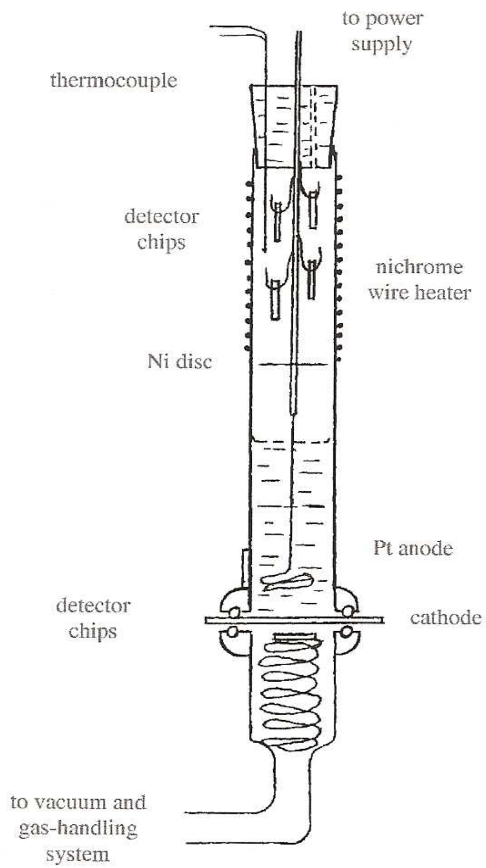
Neutrons : Jones



Alpha Particules

Alpha Particules : Fisher



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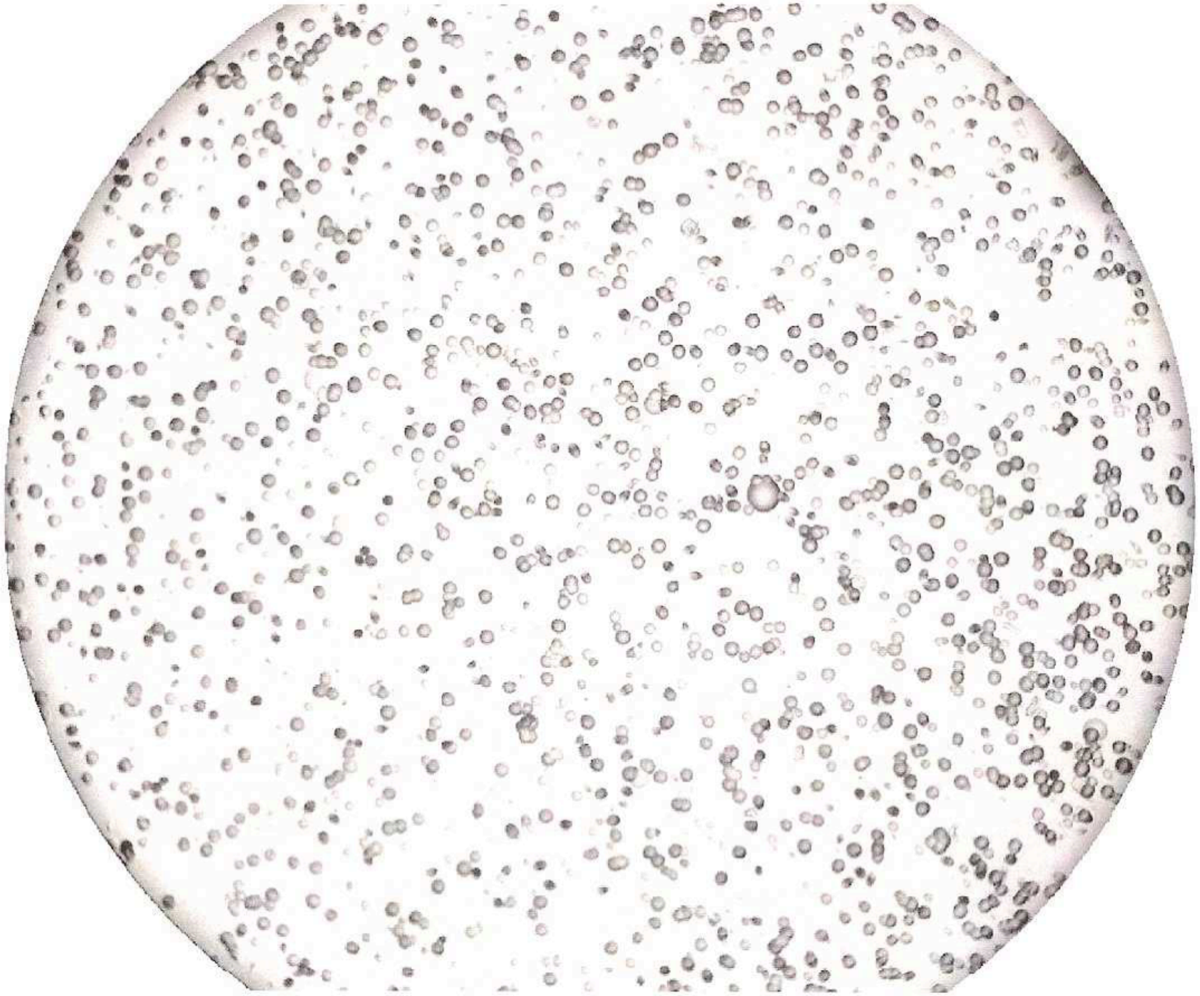
Alpha Particules: Fisher



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Transmutations

Transmutations : Iwamura

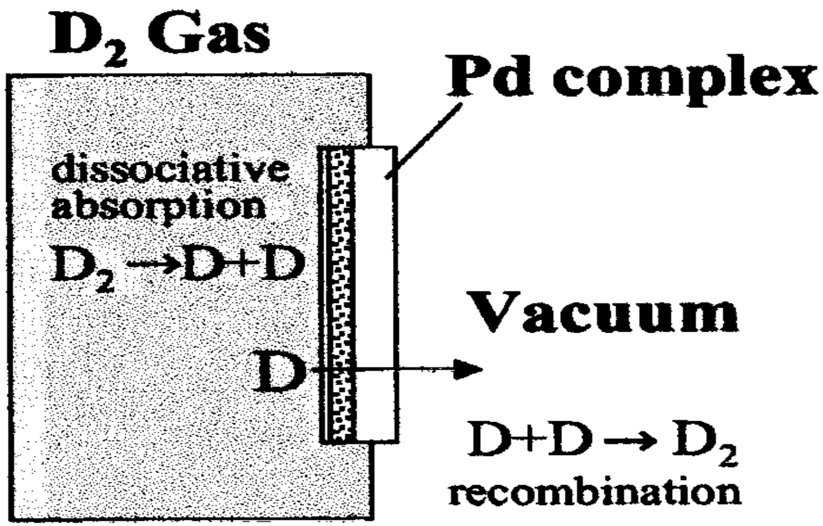
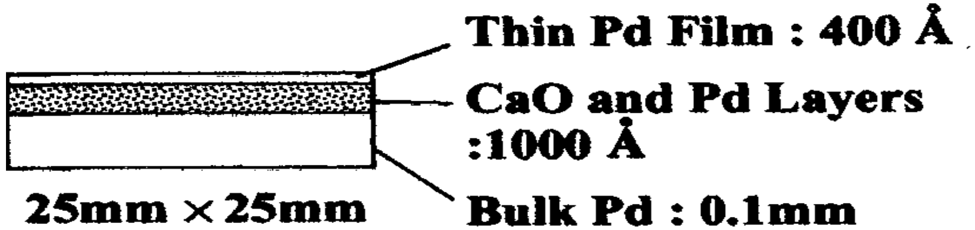


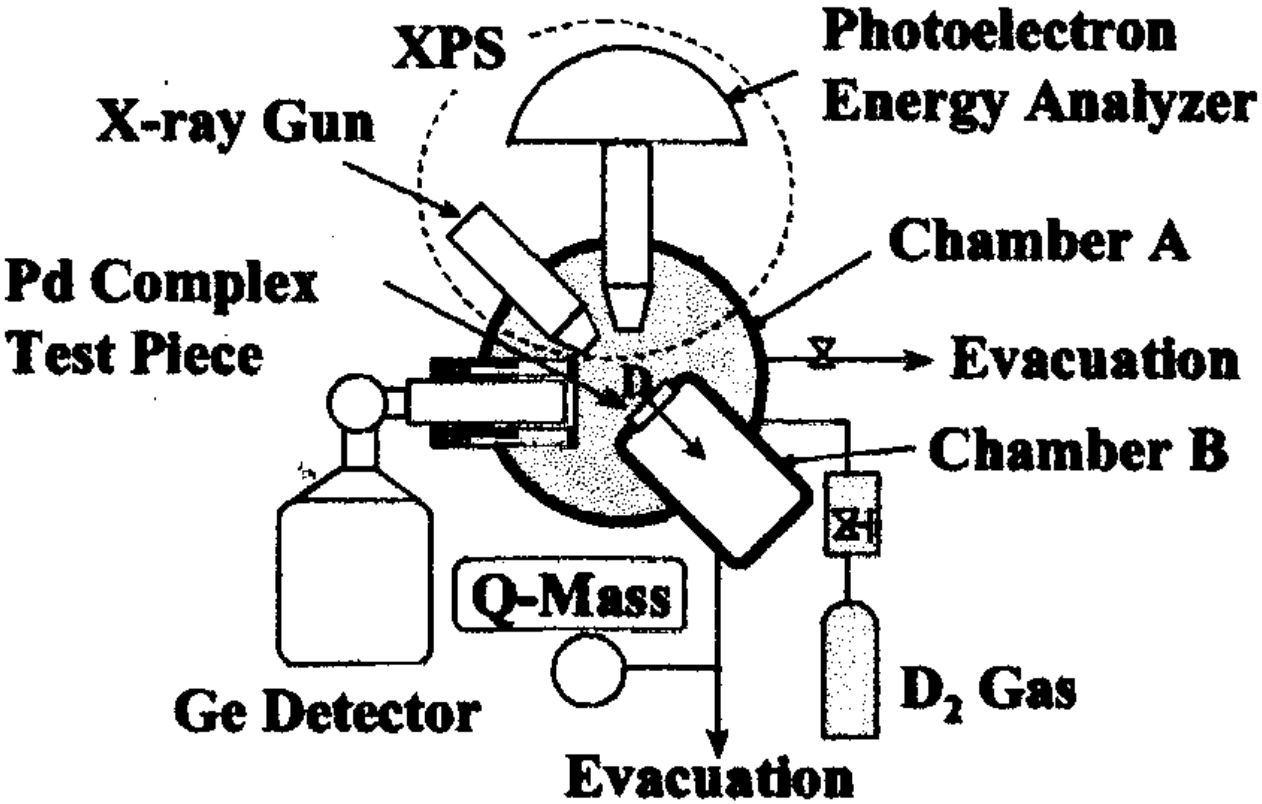
Fig. 1. D_2 gas permeation through the Pd complex.



(a)

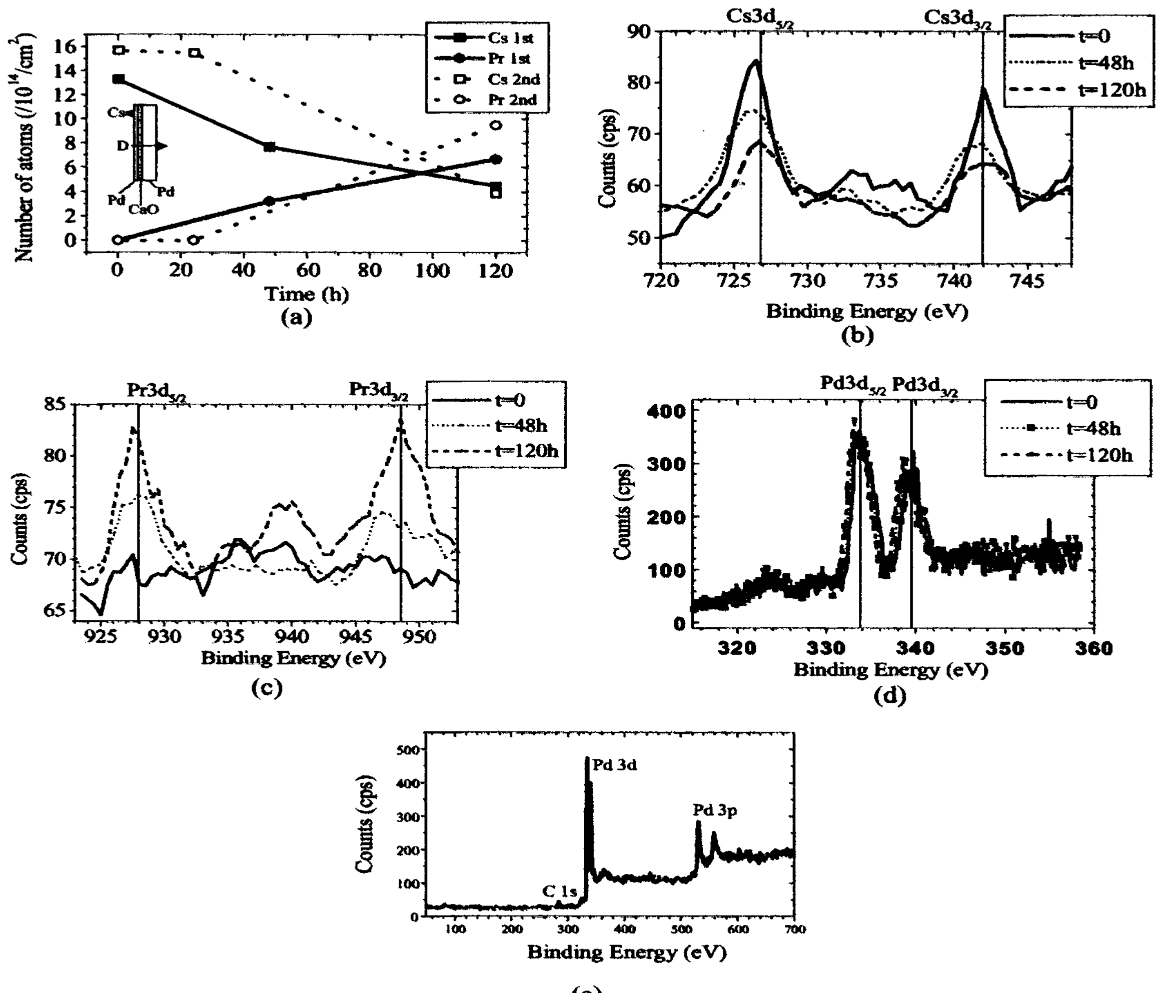
Transmutations : Iwamura

Montage expérimental : Iwamura



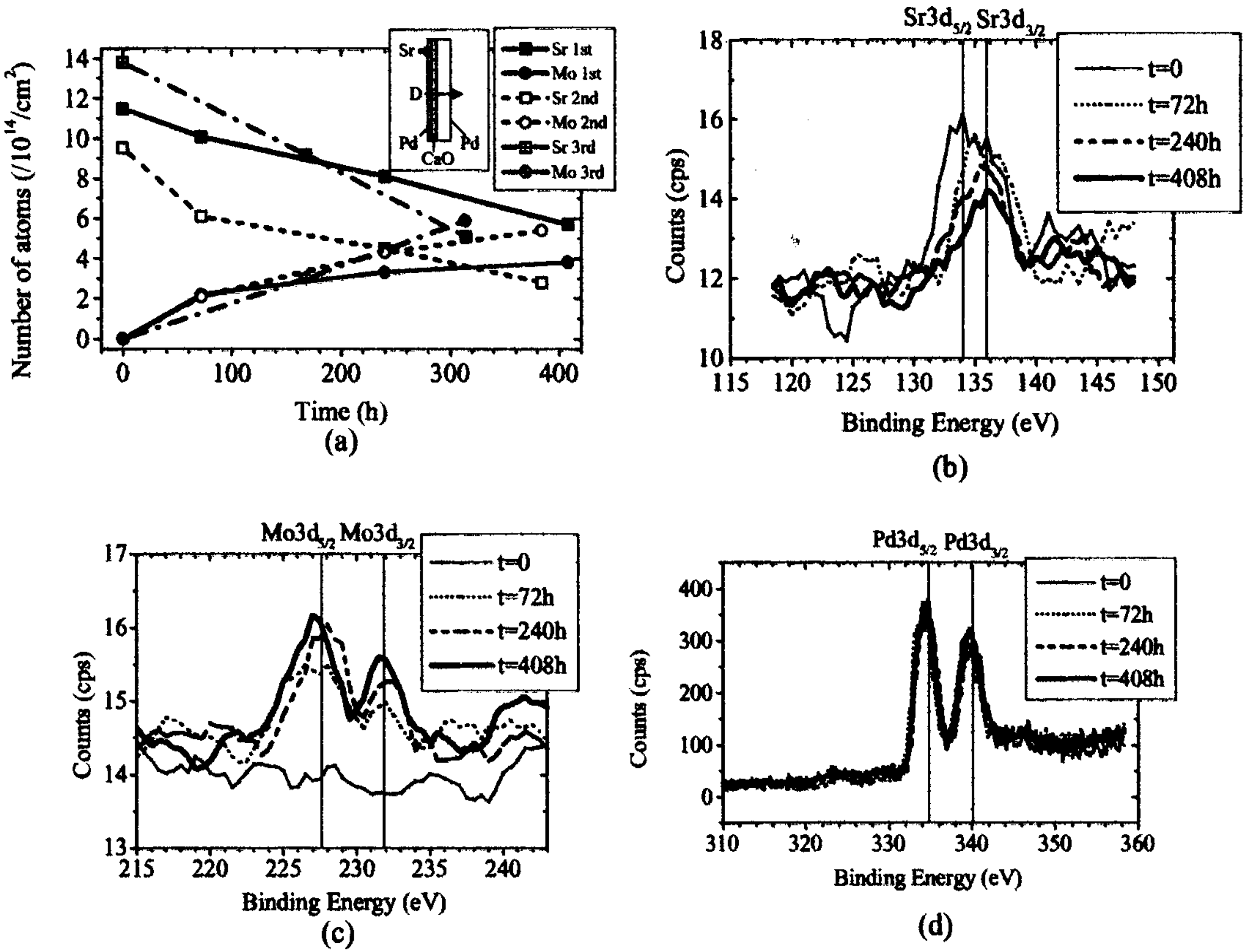
Transmutations : Iwamura

Cs → Pr : Iwamura



Transmutations : Iwamura

Sr → Mo : Iwamura



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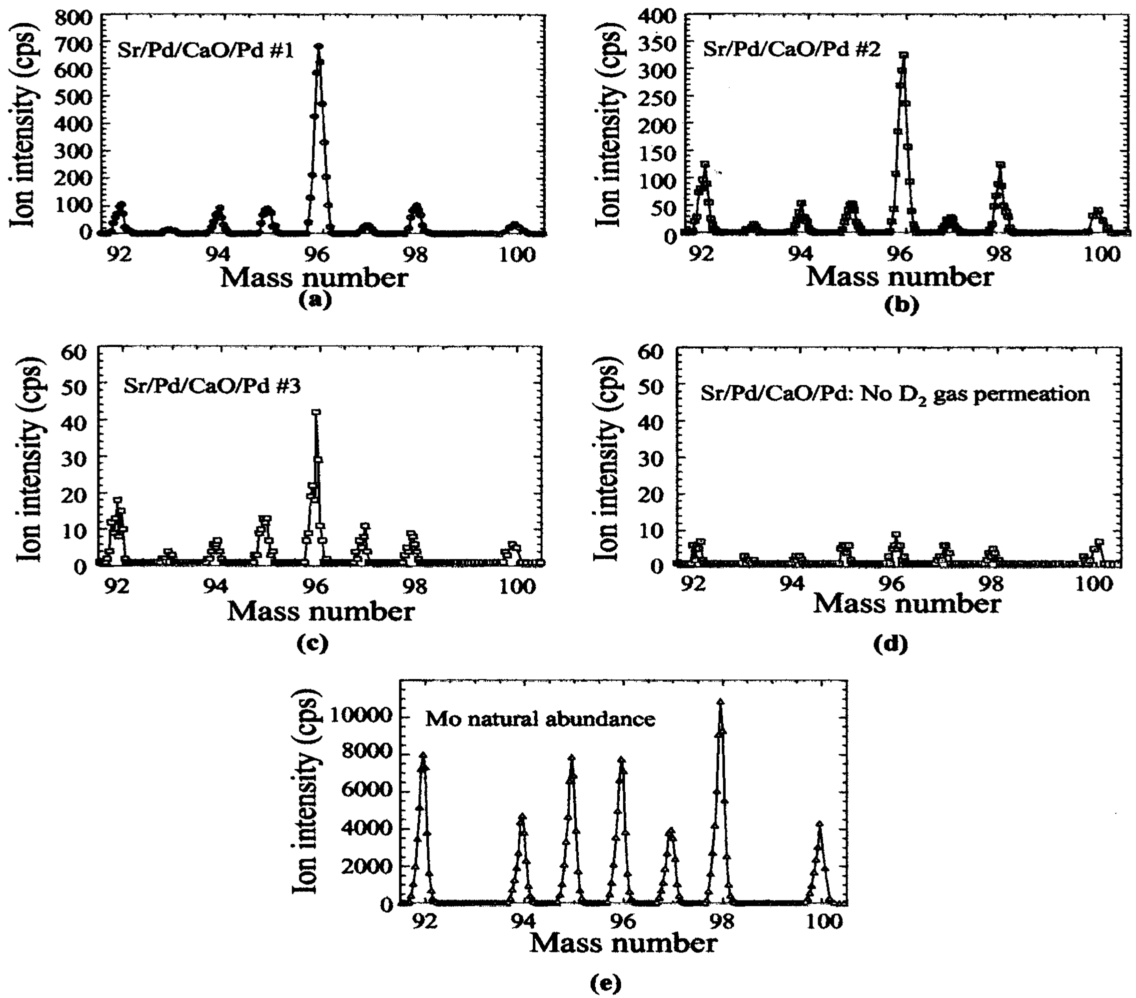
Transmutations : Iwamura

Isotopically abnormal Molybdenum



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Transmutations : Iwamura

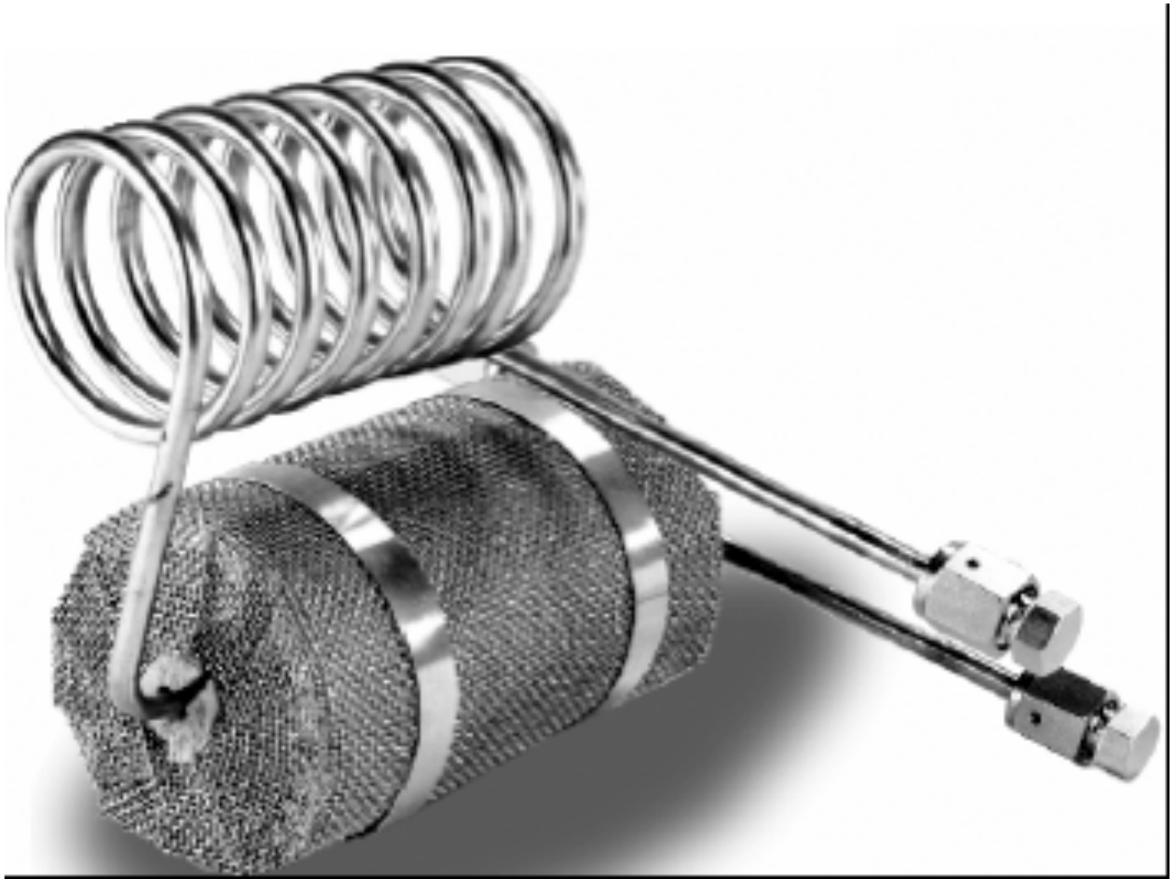
Transmutation Reactions : Iwamura

- $^{88}_{38}Sr + 4\ ^{2}_{1}D \longrightarrow\ ^{96}_{42}Mo$
- $^{133}_{55}Cs + 4\ ^{2}_{1}D \longrightarrow\ ^{141}_{59}Pr$

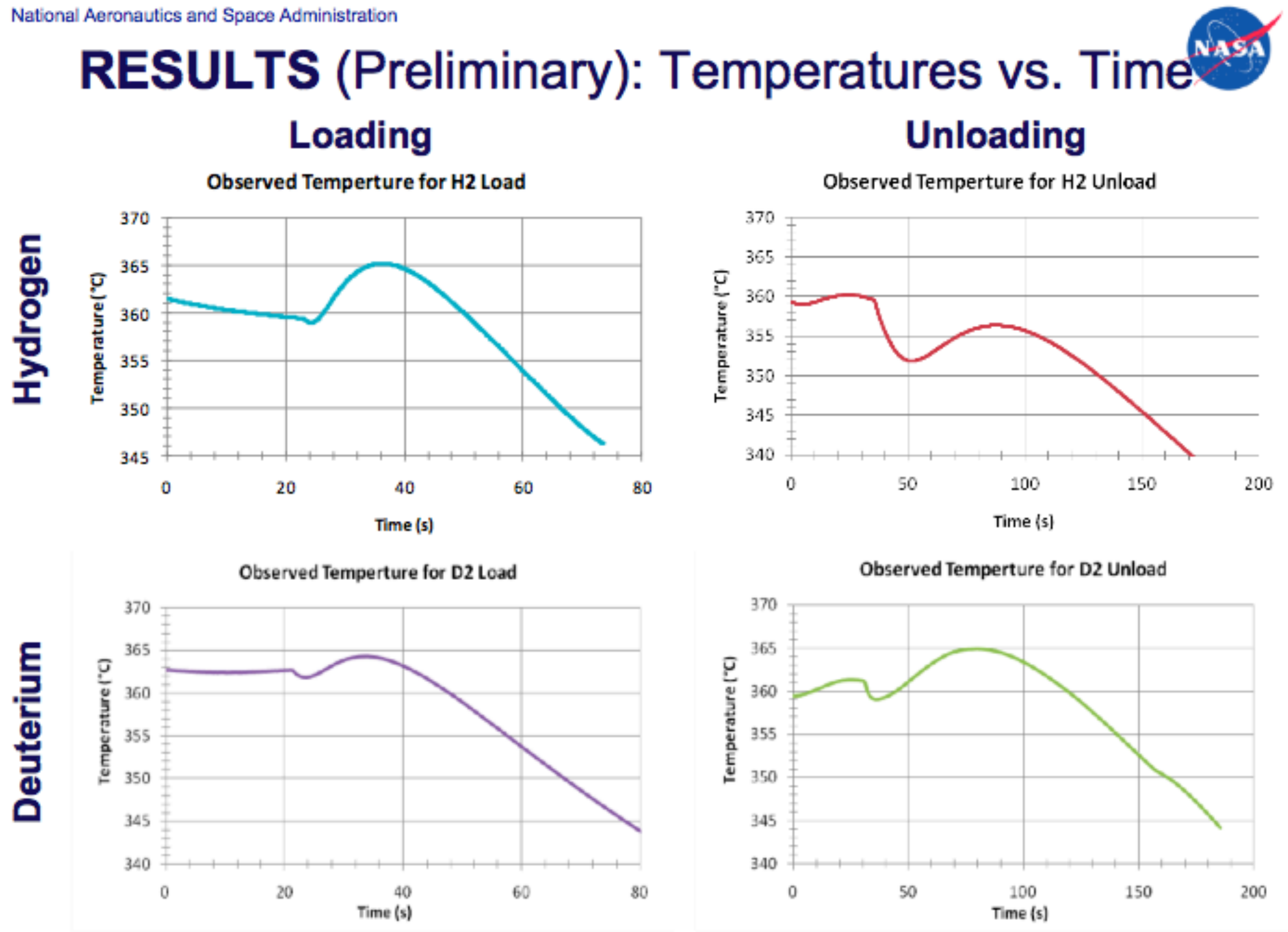
•Sr+4D --> Anomalous Mo isotopic distribution
•Cs+4D --> Pr One isotope
•Ba+6D --> Anomalous Sm isotopic distribution

Gas Phase Experiments

Deuterium Diffusion : Fralick (NASA-1989)



Deuterium Diffusion : Fralick (NASA-2011)



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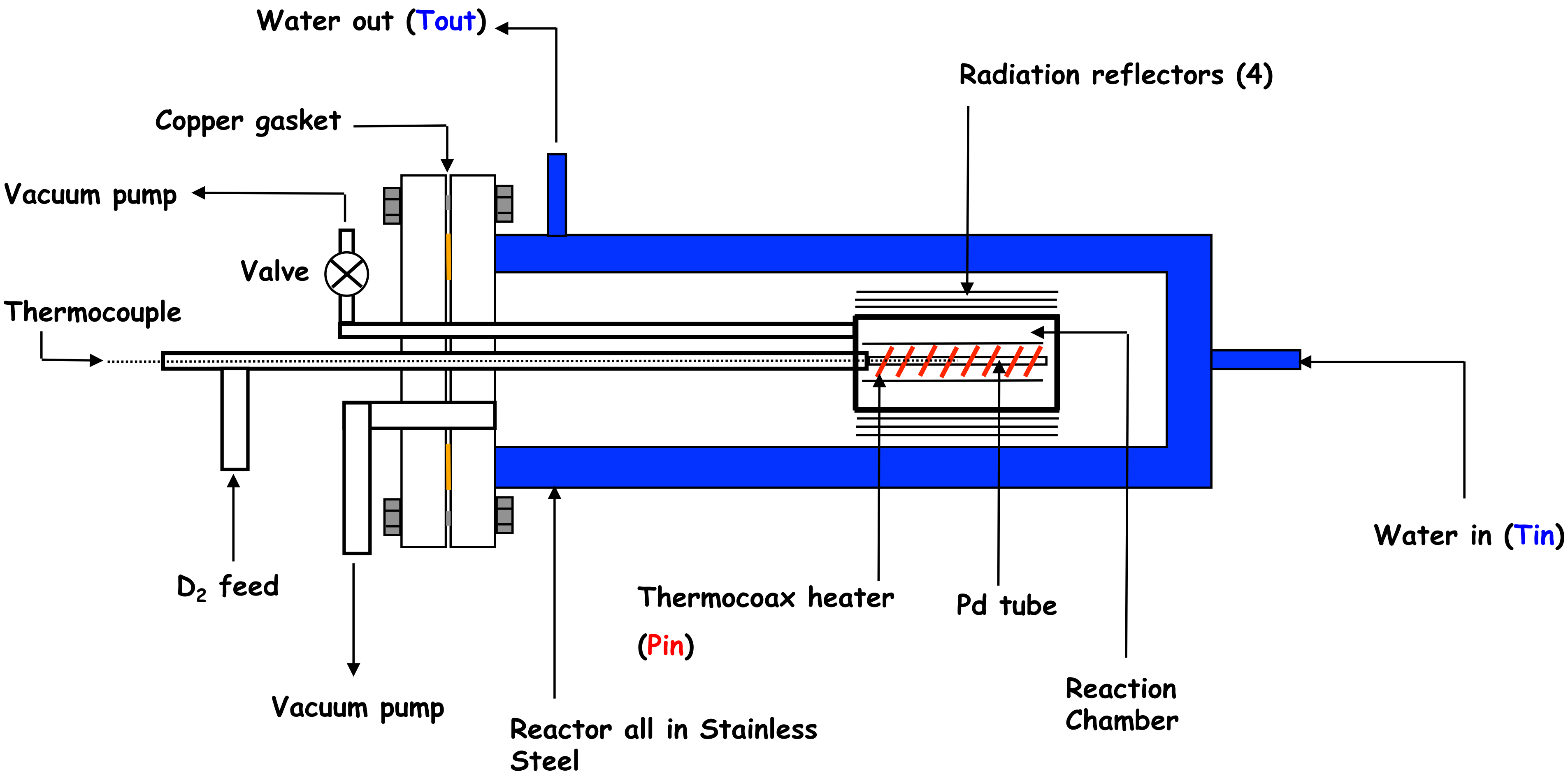
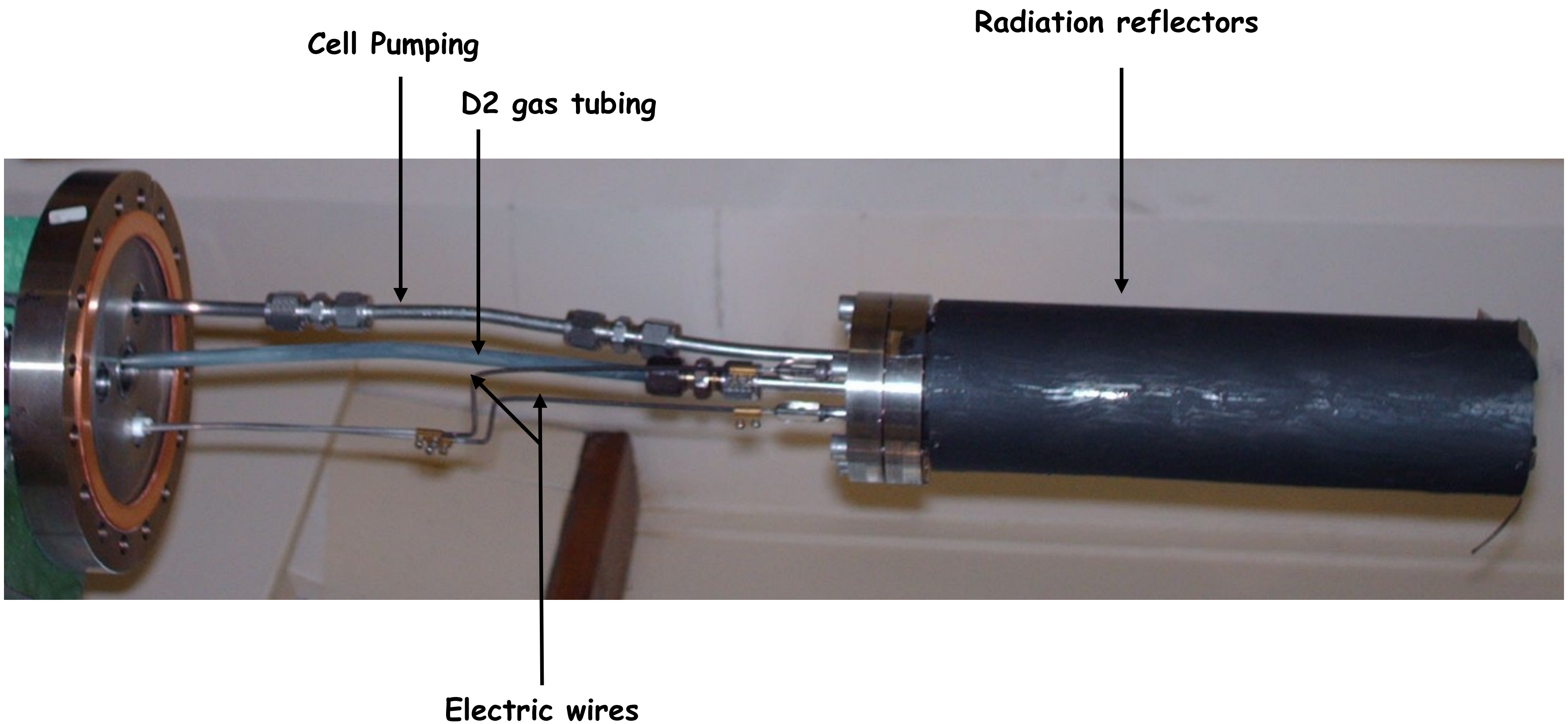
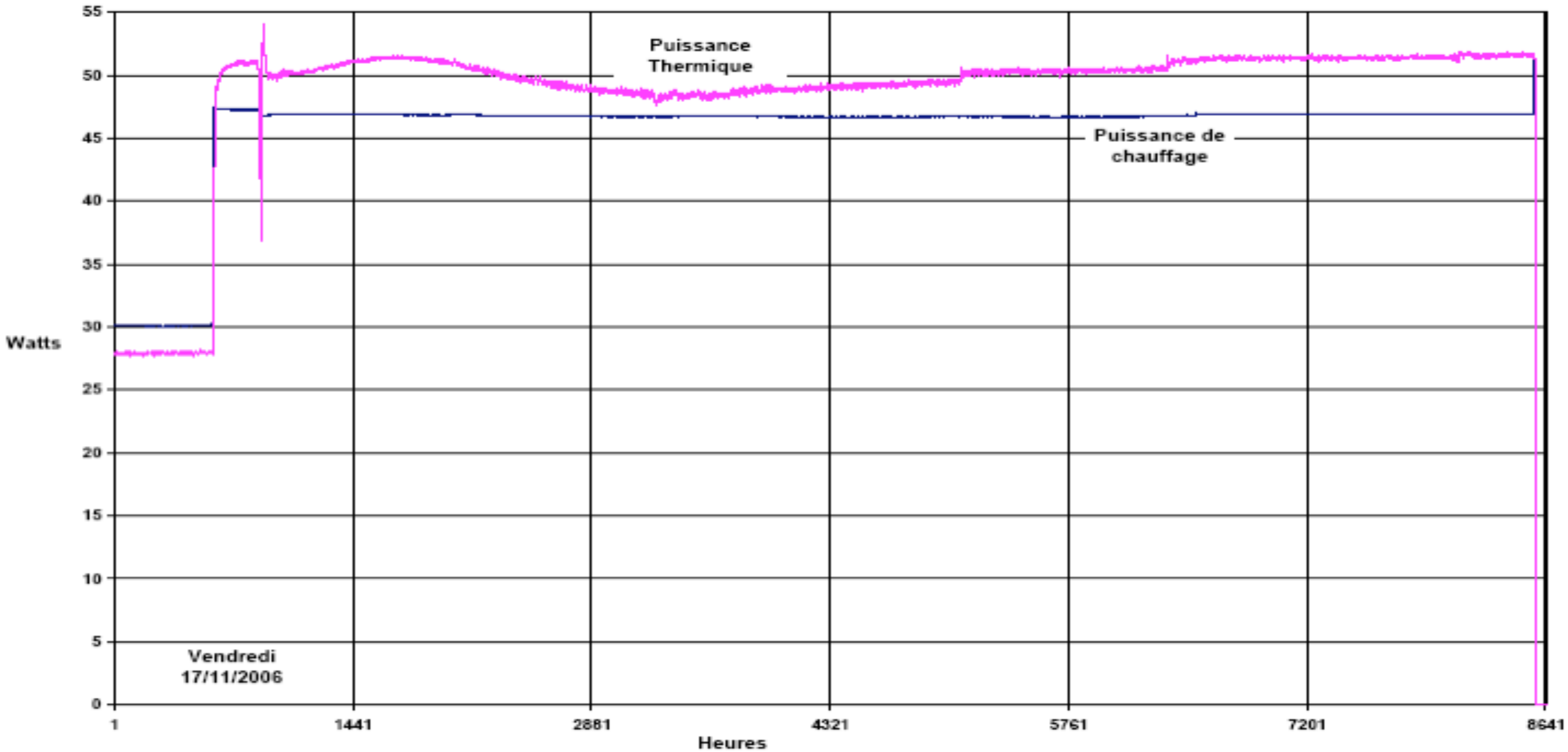
Deuterium Diffusion : Biberian



Deuterium Diffusion: Biberian



Deuterium Diffusion: Biberian



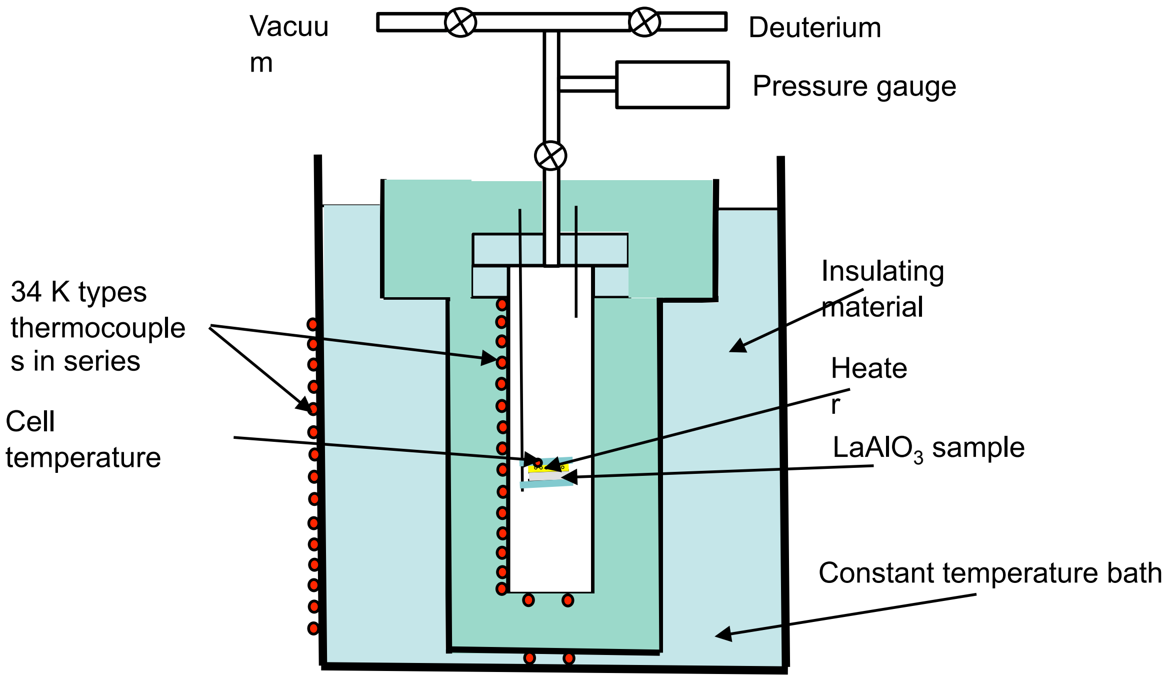
Proton Conductors

Crystals

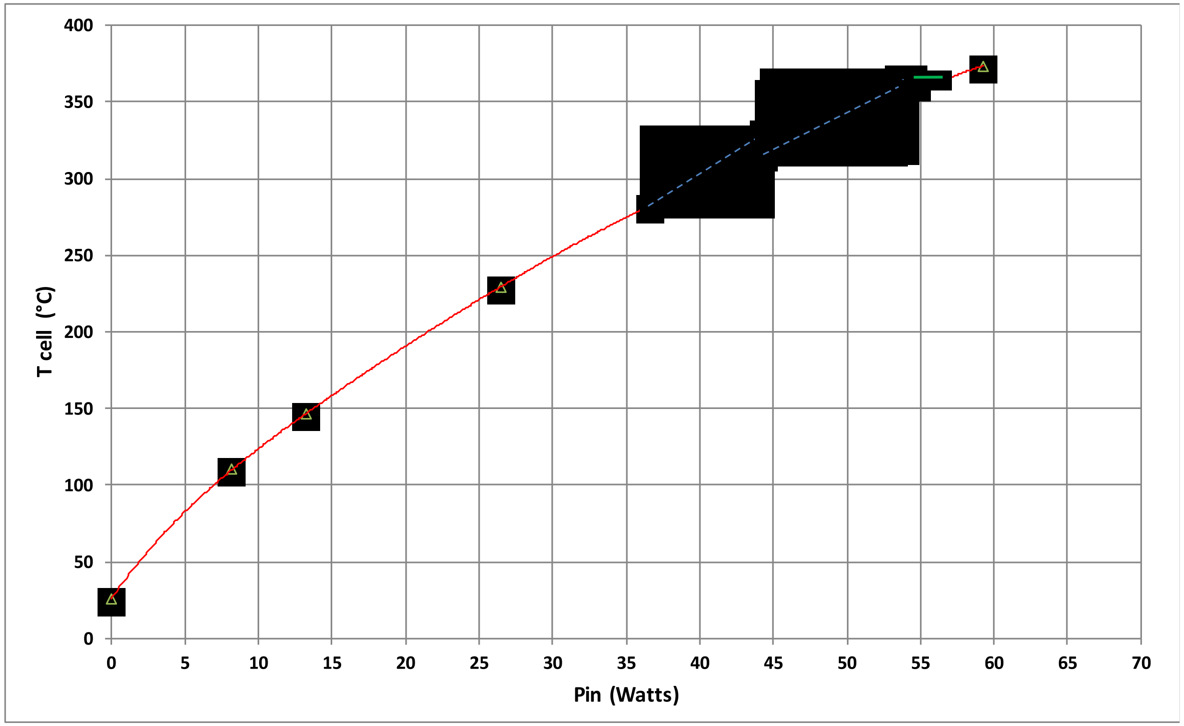
$AlLaO_3$ with La vacancies is an insulator

$AlLaO_3$ heated in a hydrogen or deuterium atmosphere is a proton conductor.

Heat Flow Calorimeter

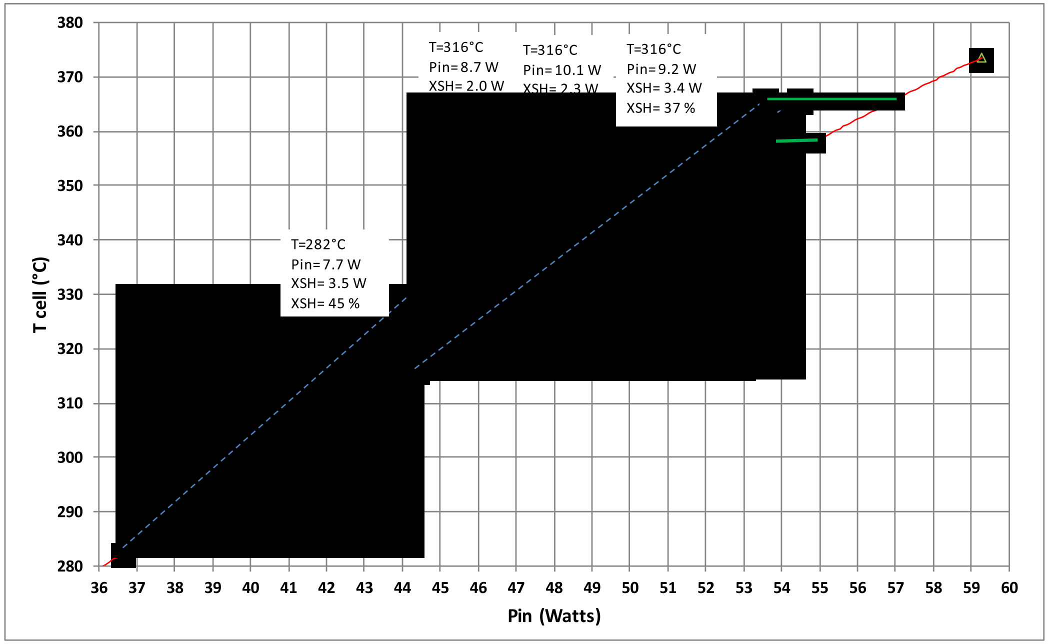


Cell Temperature v.s. Input Power



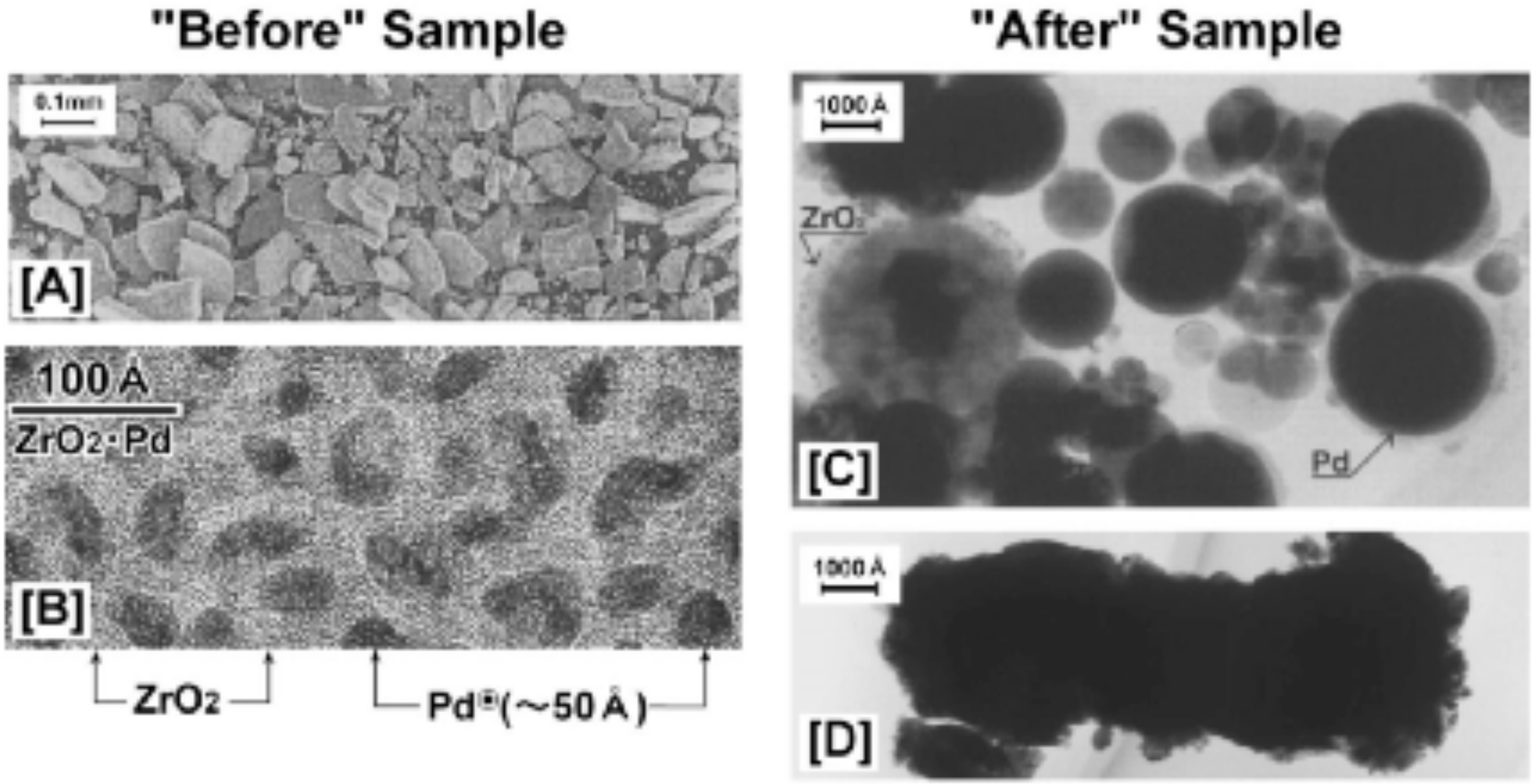
Courbe rouge : température de la cellule avec chauffage seul.
En vert: Green température quand une tension est appliquée sur le cristal $LaAlO_3$.

Zoom

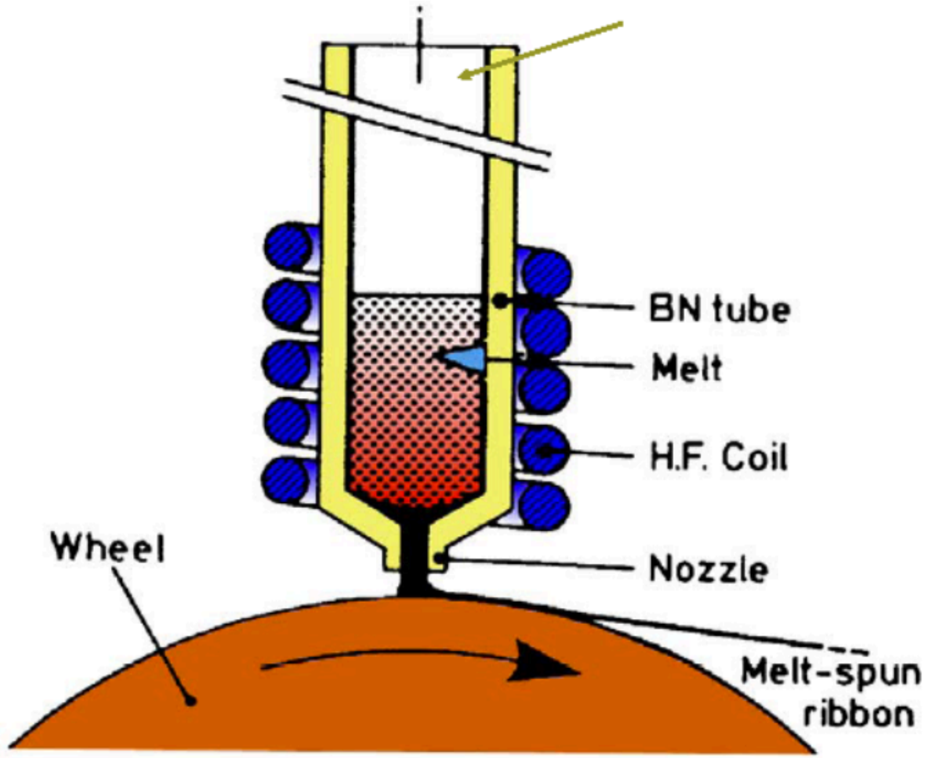


Courbe rouge : température de la cellule avec chauffage seul.
En vert: Green température quand une tension est appliquée sur le cristal $LaAlO_3$.
Lignes vertes: Indiquent l'excès de chaleur.

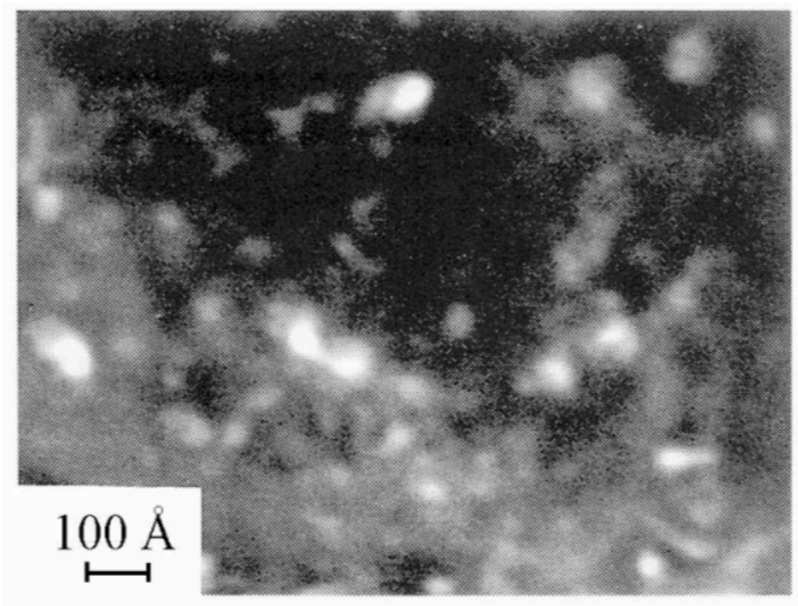
Deuterium / Pd-ZrO2 : Arata



Deuterium / Pd-ZrO2 : Arata



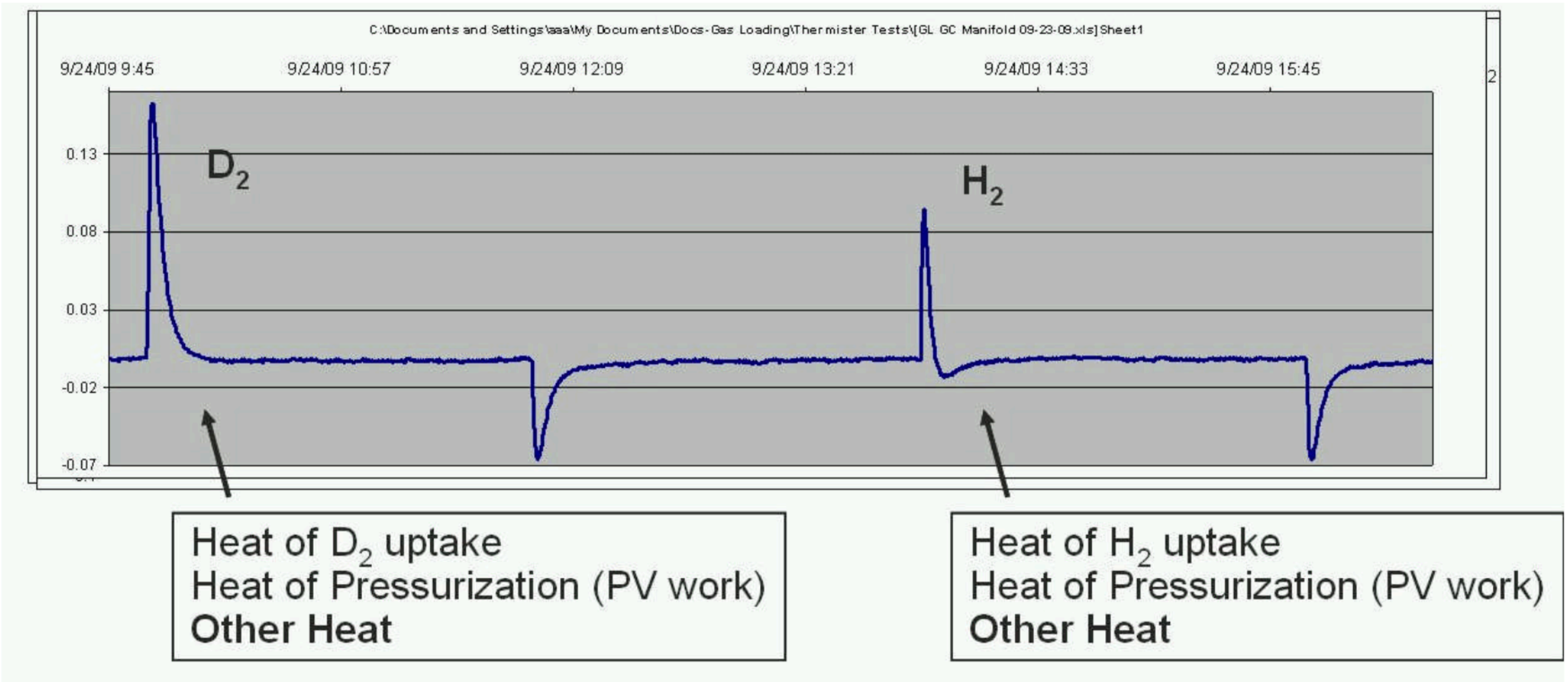
Deuterium / Pd-ZrO2 : Arata



Pd in zeolites: Parchamazad

- Organo palladium to load the zeolites
- The oxide metal interface is very important.

D_2 et H_2 in Zeolites : Kidwell



Theories

- Bose Einstein Condensation
- Electron screening.
- Hydrinos.
- Hydrotons.
- Deep Dirac Levels
- Neutrinos.
- Magnetic Monopoles.
- Gravitational Potentials.
- Poly-neutrons
- Erzions.
- ……………..

Mechanisms

If the D+D reaction is not responsible for Cold Fusion, then there are other options: For example:

With deuterium and lithium:

- D + Li-6 → Be-8 (unstable) → 2 He-4

With hydrogen and lithium:

- H + Li-7 → Be-8 (instable) → 2 He-4

With hydrogen and potassium:

- K-39 + H → Ca-40

More reactions are possible with other metals.

Conclusion

- The scientific demonstration of the existence of Cold Fusion has been made long ago.
- At the beginning of the research most work was done by electrochemistry, but now the focus is on gas phase experiments.
- Nano powders look like being the solution for industrial applications.