The Cold Fusion/Lattice Assisted Nuclear Reaction Colloquium At The Massachusetts Institute of Technology, March 21-23, 2014

Title: Assuring Sufficient Number of Deuterons Reside In The Excited Band State For Successful Cold Fusion Nuclear Reactor Design

Authors of this report:

Robert E. Smith Jr., President/CEO,
Oakton International Corporation (OIC),

Tatyana Khudyakova, Special Assistant to the President, OIC

Purpose

- The purpose of this presentation is to discuss new mechanisms to assure the number of deuterons that can be excited into the band state are sufficient to provide highly probable fusion reactions resulting in successful commercial cold fusion reactor designs.

- Region 3 and possibly a new Region 4 of M. Swartz's Operating Point Manifolds are examined to obtain relatively high thermal and electrical power levels . [4]

- Dynamic direct gas loading of the host lattice enabling or assisting the cold fusion reactions is considered.

heavy water systems, and for excess heat and helium production in palladium-black systems [17, 28-30]. Figure 4 shows OOP manifolds from several independent investigators of excess power gain and incremental helium-4 and tritium production. The horizontal axis is the electrical power input [log watts]. The vertical axis is uncalibrated and linear.

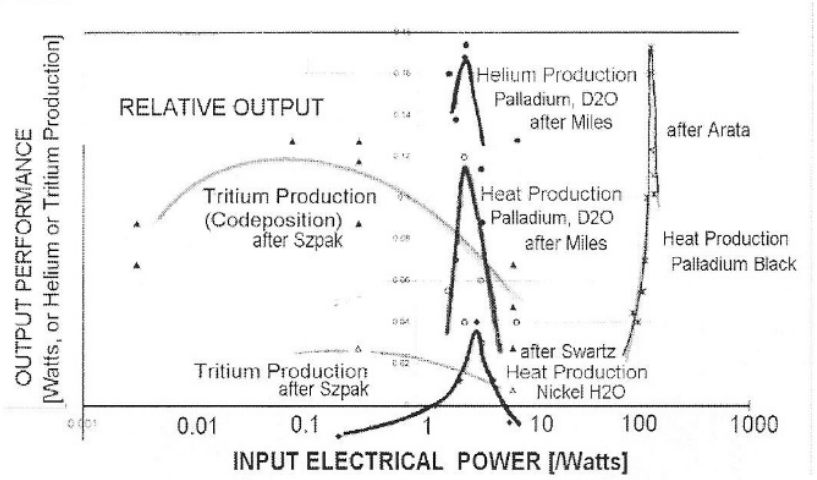


Figure 4 - Multiple Optimal Operating Manifolds of Worldwide LANR Systems

3.1 3RH: Three Regions of LANR Behavior

At the top left of Figure 2 are shown palladium surface globules (A; produced by codeposition upon copper by Frank Gordon, Pamela Boss, and Larry Forsley [19]) involving at least several atomic layers. Palladium rods develop from the globules (B), produced after applied electric fields. This is region 1 in 3RH. To the top right of Figure 1 show morphologies (E) generated by acidic electrolysis generating nanotubes (courtesy of Prof. Dash [20]). This, too, is Region 1 in the 3RH hypothesis.

The top middle image shows the occasional local melting of the palladium surface (C), presumably from the desired reactions. Below it, in the center is a Pd melt cavity produced by cavitational LANR reactions (D) (after Roger Stringham [21]). The volcanic-like burst changes in Pd seen with SPAWAR codeposition and cavitation LANR in thin Pd foils loaded by "sonofusion" (Stringham) suggest melting and subsequent re-solidification of molten metal, reminiscent of nuclear fission fuel metal damage (spontaneous Californium "spike damage"). These show Region 1 and part of Region 2 in the 3RH hypothesis.

Below on the right bottom side are detailed Pd fabrication layers (F), 40 to 100 nanometers wide with a thin CaO layer intercalated (courtesy of Dr. Y. Iwamura [22]). These are Region 2 in the 3RH hypothesis.

Introduction

- T.A. Chubb and S.R. Chubb in their work to establish an Ion Band State Theory introduced the notion that the Coulomb Repulsion Term of the Schrodinger Equation, that is used to discuss the wave-like quasi particle behavior of deuterons and electrons in the band state, can be influenced by the number of unit cells, Ncell, that host metal lattice crystals contain. [1]
- Further, they asserted, from results of experiments performed by Y. Arata, that Ncell should be placed in the denominator of the repulsion term and when Ncell is greater than 10^5 that the term tends to zero and the probability of overcoming the Coulomb barrier is a certainty (1.0).
- Professor P. L. Hagelstein, MIT, in his review of the Chubb theoretical model has indicated that no known mechanism exists that can assure that sufficient numbers of deuterons can reach the band state.
- The authors have studied this issue in detail and are reporting in this presentation ways that a mechanism can be established for a specific reactor design. It is probable that no single mechanism works for all designs, and the mechanism must be tailored to the reactor design of interest.

Discussion

- Many Cold Fusion/LANR experimenters have shown that fusion of deuterium can occur by “tunneling” of a deuteron particle from one potential well to an adjacent potential well within a host metal lattice.
- R. Nieminen and associates [2] have shown that deuterons that are in the potential wells are already in the band state even when they are located in the bottom of the energy wells. These deuterons have a very narrow low level band width.
- When the deuterons are excited within the potential wells they can reach a band state level that allows them to tunnel into adjacent potential wells and they can fuse with a relatively low probability, certainly much less than 1.0. We think that these fusions of deuterium account for most of the fusions that occur in Regions 1 and 2 of M. Swartz’s OOP Manifolds.
- In Region 3, OOP Manifold, Y. Arata has shown with a double Structured cathode that predictable amounts of He-4, He-3 and excess heat can occur as the result of extremely high deuterium loading in the inner shell containing palladium black crystals. After 22 days of loading very high temperatures and pressures are obtained. Palladium crystals smaller than 0.4 microns melt. Experiments performed by Y. Arata and T. Chubb clearly verified the accuracy and precision of Chubb’s band state theory.
- P. L. Hagelstein raises the question: What mechanism explains the high number of fusions taking place in Arata type reactor experiments?

Discussion (continued)

- Since ICCF-18, the authors have studied the works of several people who are expert in band state theory. In nearly all studies the experts examined electrons in the band state, not positive deuterons.

- R. Nieminen and associates considered positive ions as well as negative ions in their experiments. They frequently discussed the temperature, pressure, and width of the bands, as well as, the width of the gaps between the bands. A general result of the experts was that the band width increased with increasing temperature and pressure. They stated the bands occur within and outside of the crystal. They pointed out that the band gap decreases between the band on the surface of the crystal and the band outside the crystal as the temperature and pressure increases. We think the greater temperature and pressure on the Couch-Baker curve , the greater the probability of a positive ion such as a deuteron will leap across the band gap into the band outside of the crystal. This may explain the jump in performance as the result of laser stimulation shown by D. Cravens during ICCF-10.

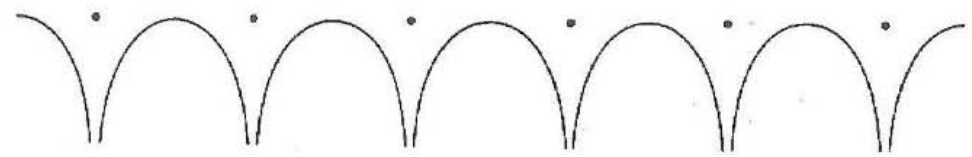
- Metals plated on the surface of a lattice could be the medium for a band state outside of the host lattice and provide enhance d+d wave function overlap in the band. Another force that could be put on the deuterons would be a negative electromagnetic field that causes the force vector on the deuterons to be in the direction normal to the band gap.

New Mechanism

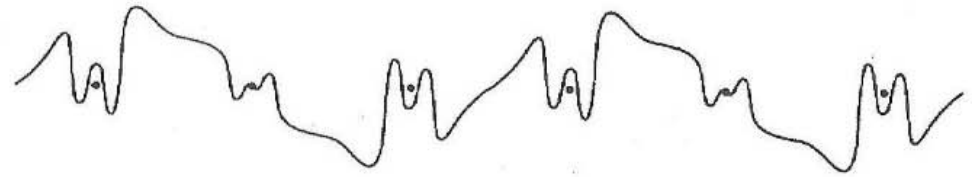
- A new mechanism is needed that utilizes the parameters listed above and additional ways to excite localized and delocalized deuterons across the band gap and into the ion band state.
- R. Nieminen et al, pointed out that the increased weight of a deuteron over light hydrogen gives the deuteron improved methods for transport to higher excited energy band state levels because the heavier deuterons act like particles vs. the very light proton nuclei of light hydrogen. They also indicate that delocalized deuterons vs. localized deuterons in potential wells have a much higher probability of achieving transport to an ion band state.
- The new mechanism must include ways to remove the heat of fusion to prevent melting quenching of the host lattice. The benefit of using deuterium as the coolant AND the fuel is that the dynamic flux of the high pressure and temperature gas moving through the reactor core assures adequate delocalized deuterons for transport to the ion band state.
- The lattice plates must be thin for high surface area and have a sufficient number of holes to assure gas deuterium fusion heat removal and transport of delocalized deuterons throughout the reactor core utilizing the bulk of the lattice atom fractal periodic ordered surface material.

Reactor Designs

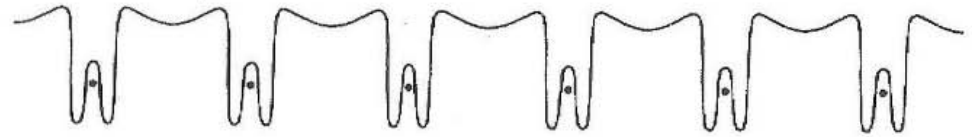
- Each reactor core design will require a new specific deuteron transport mechanism tailored to the system of parameters making up the reactor components.
- Particle physics mathematical tools will be used to calculate fusion reactions resulting from tunneling activity within and between highly loaded potential wells.
- Quantum mechanical wave equations will be used to calculate high probability fusion reactions occurring within band states due to F. Bloch wave functions overlaping.
- Complex gas dynamics will be required to cause a portion of the deuterium gas to diffuse into localized regions of the host lattice via the increased surface area of the holes in the lattice plates.
- The small diameter holes in reactor lattice plates produced by lasers may also be required for pathways for laser stimulation and triggering of fusion reactions.
- High melting temperature metals may be required for band state medium outside the host lattice with a higher melting temperature than gold.



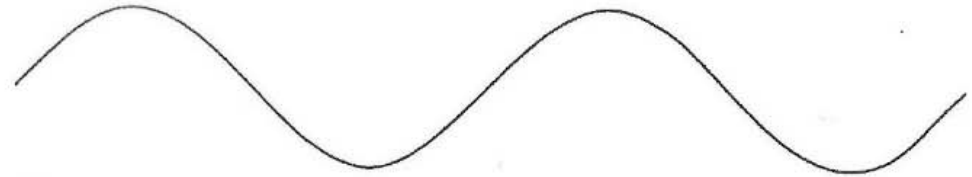
(a) $V(\mathbf{r})$



(b) ψ_k



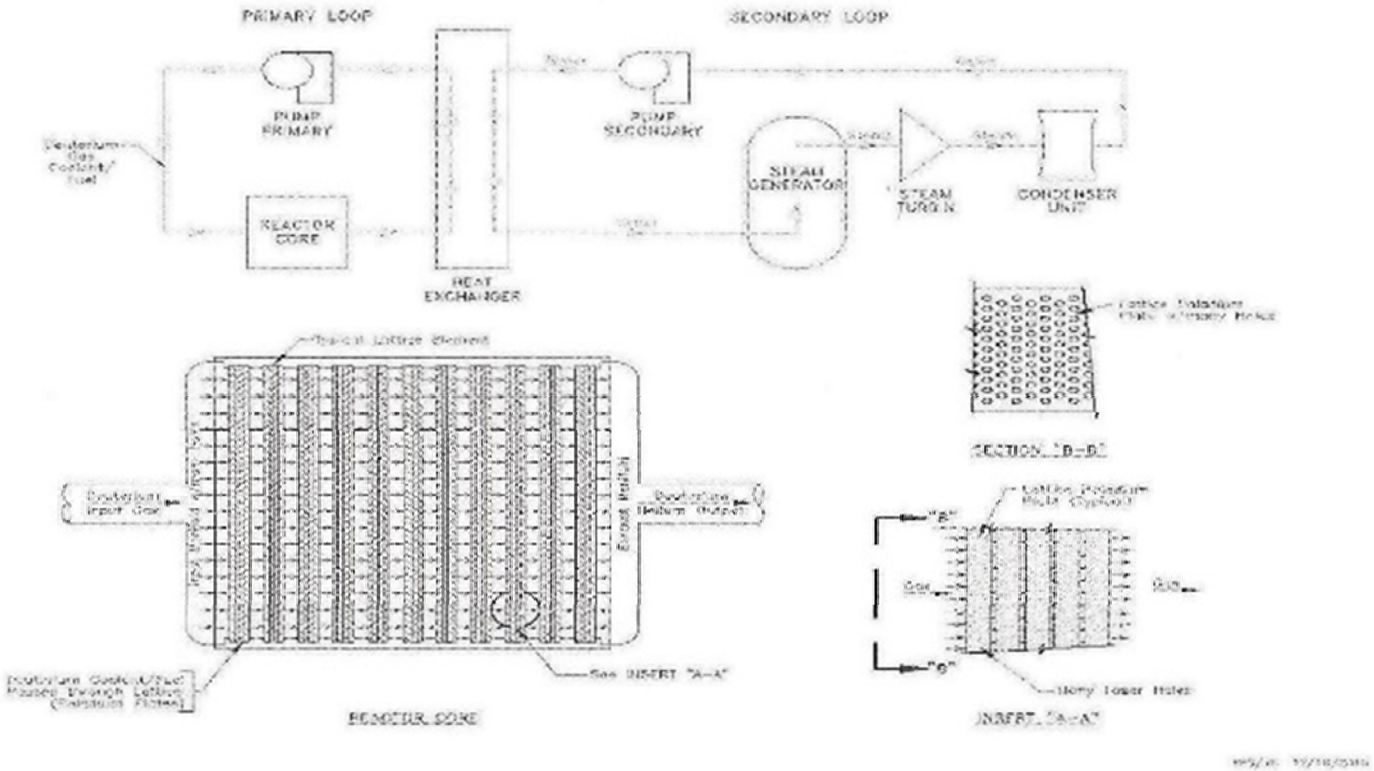
(c) u_k

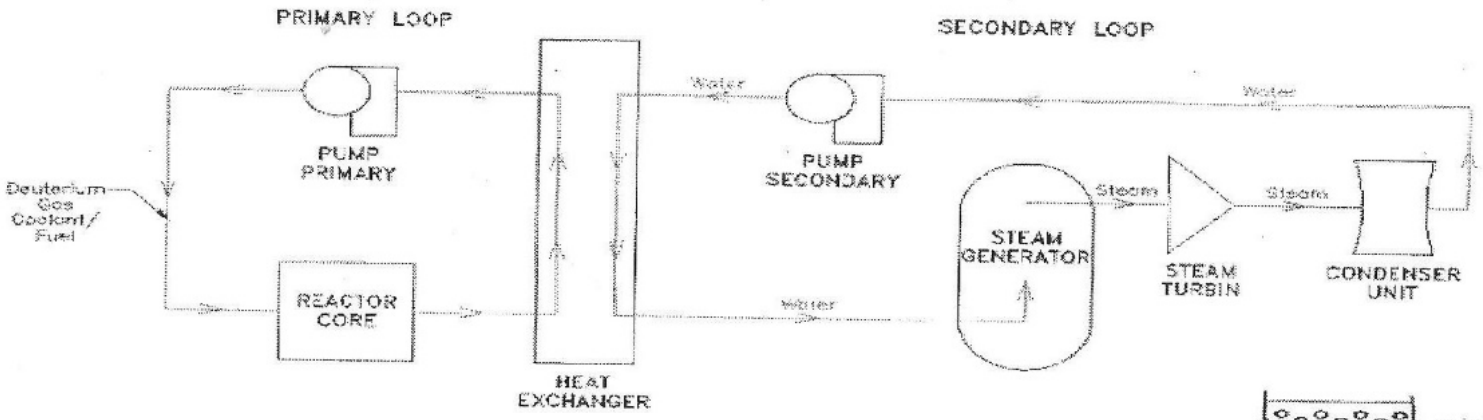


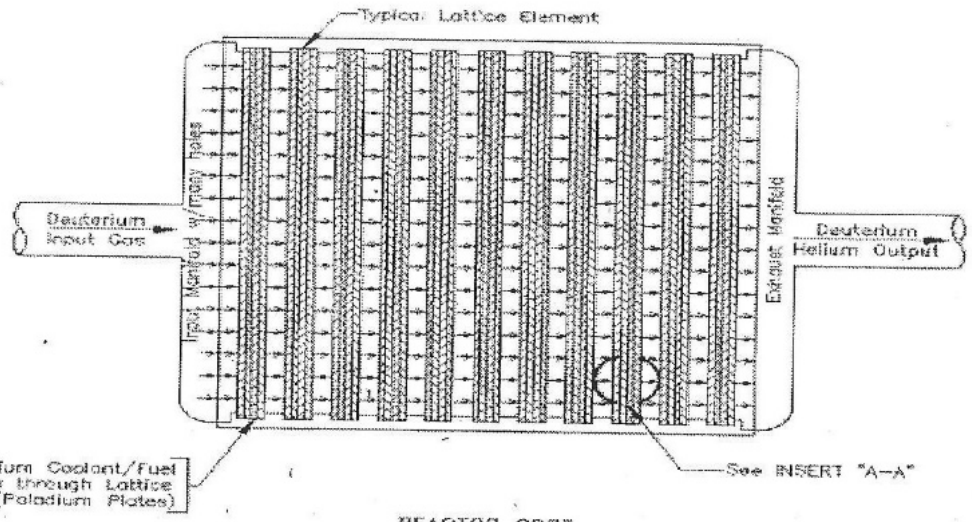
(d) $e^{i\mathbf{k}\cdot r}$

Fig. 2.1 A schematic representation of electronic eigenstates in a crystal. (a) The potential plotted along a row of atoms. (b) A sample eigenstate; the state itself is complex but only the real part is shown. This state can be factored into Bloch function (c), which has the periodicity of the lattice, and (d) a plane wave, the real part of which is shown.

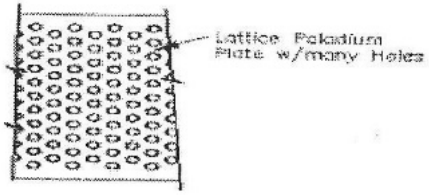
Concept Gas Cooled Cold Fusion Reactor (GCCFR) with Primary and Secondary Loops and Reactor Core



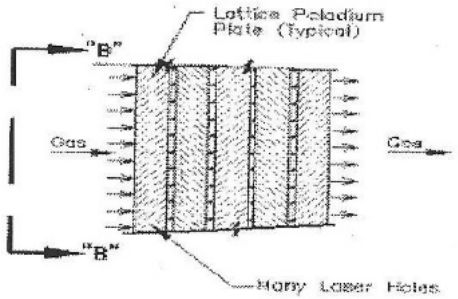




REACTOR CORE



SECTION "B-B"



INSERT "A-A"

RES/kb 12/18/20

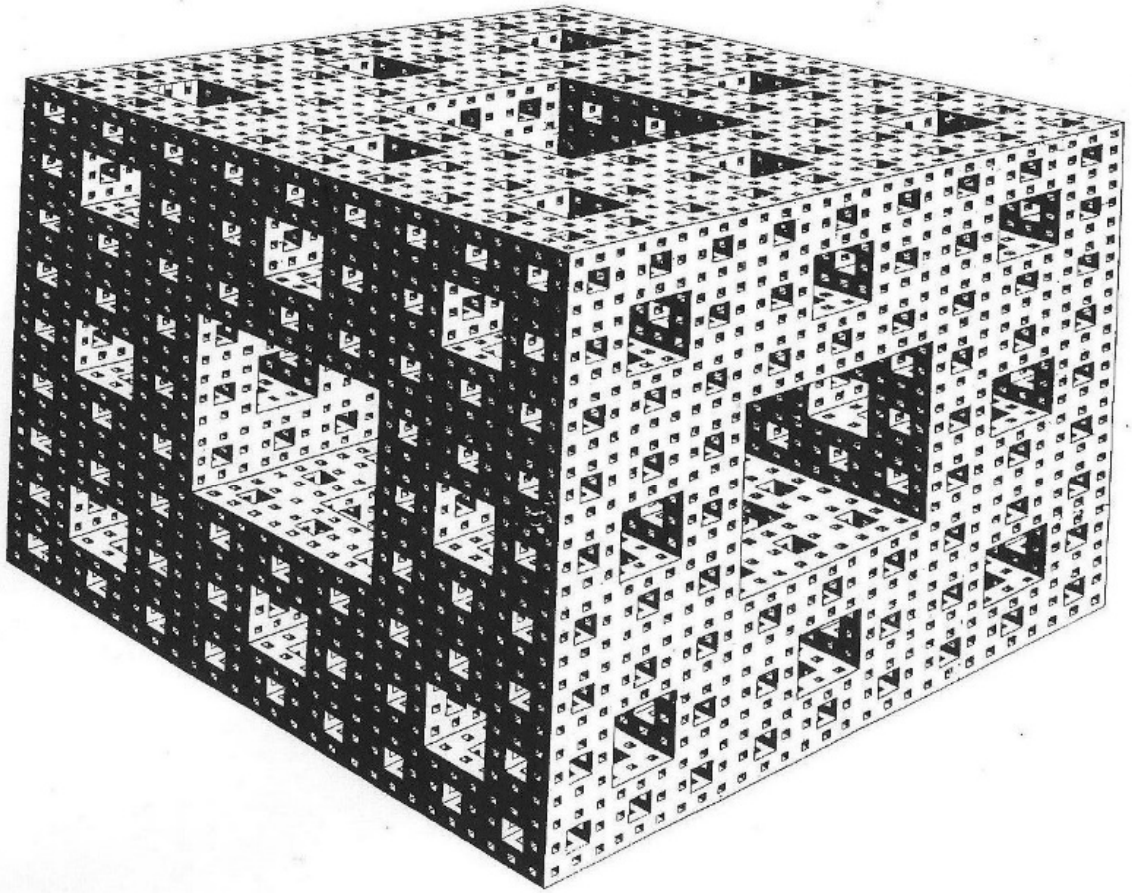


Plate 145 ▫ THE SIERPIŃSKI CARPET (DIMENSION D~1.8928), AND THE MENGER SPONGE (DIMENSION D~2.7268)

SIERPIŃSKI CARPET. In Sierpiński 1916, the initiator is a filled square, while the generator and the next two steps are

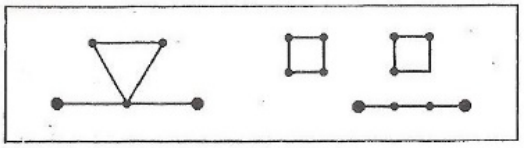
N=8, r=⅓, D~1.8928.

This carpet's area vanishes, while the total perimeter of its holes is infinite.

PLATE 145. THE MENGER SPONGE. The principle of the construction is evident. Continued without end, it leaves a remainder to be called a Menger sponge. I regret having credited it wrongfully in earlier Essays, to Sierpiński. (Reproduced from *Studies in Geometry*, by Leonard M. Blumenthal and Karl Menger, by permission of the publishers, W. H. Freeman and Company, copyright 1970.) The intersections of the sponge with medians or diagonals of the initial cube are triadic Cantor sets.

FUSED ISLANDS. The carpet, as well as the gasket in Plate 143, may also be obtained by yet another generalization of the Koch recursion, wherein self-overlap is allowed, but overlapping portions count only once.

To obtain a gasket, the initiator is a regular triangle, and we take the generator to the left. To obtain a carpet, the initiator is a square, and we take the generator to the right



Two phenomena familiar from Chapter 13 are encountered again: each island's coastline is rectifiable and therefore of dimension 1, and the dimension of the gasket or the carpet expresses the degree of fragmentation of land into islands rather than the degree of irregularity of the islands' coastlines.

Otherwise, the result is unfamiliar: in Chapter 13 the sea is connected, which seems to be a proper topological interpretation of nautical openness. It is also open in the set topological sense of not including its boundary. The novelty brought in by the present construction is that it is possible for the Koch islands to "fuse" *asymptotically* into a solid superisland; there is no continent, and the coastlines combine into a lattice.

◅ Topologically, every Sierpiński carpet is a plane universal curve, and the Menger sponge is a spatial universal curve. That is, see Blumenthal & Menger 1970, pp. 433 and 501, these shapes are respectively the most complicated curve in the plane, and the most complicated curve in any higher dimensional space. ► ■

Reactor Designs (continued)

- The primary loop of the reactor must have a high deuterium gas flux with high mass rate of flow under very high pressure most probably greater than 10 atmospheres and high temperature greater than 450 degrees centigrade, but not high enough to cause melting of the host lattice and to assure that the band gap is low enough to assure high deuteron transport.
- The nuclear fusion ash He-4 and He-3 will add to the volume of the gas coolant and will not be wasted. Other impurities caused by nuclear transmutations must be filtered within the primary loop.
- The economic detractors caused by parasitic loads on the primary loop to power pumps, and instrumentation and reactor controls will be more than offset by the lower cost of deuterium fuel vs. uranium in fission reactors.
- Hybrid computer simulations are required to optimize the simultaneous performance interactions of the many parameters including reactor kinetics, power change instrumentation and controls.
- General Atomics has developed high temperature gas cooled fission reactors.
- The U.S. Department of Energy has the charter to develop All cold fusion nuclear reactors needed by using agencies, both governmental and private.

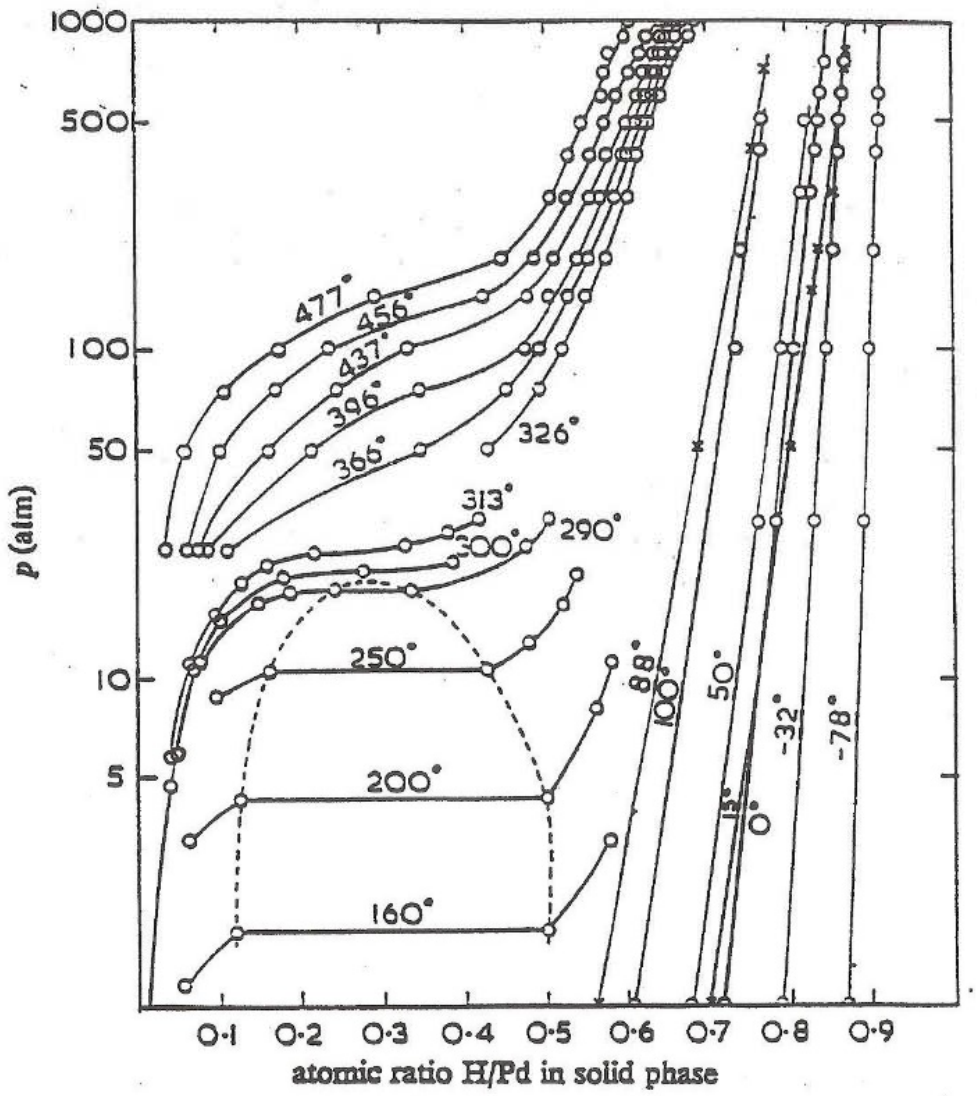


FIG. 2.—Isotherms of the Pd+hydrogen system. The isotherms in the region of two solid phases are those of Gillespie and co-workers. The linear low-temperature isotherms were determined by Perminov and co-workers.

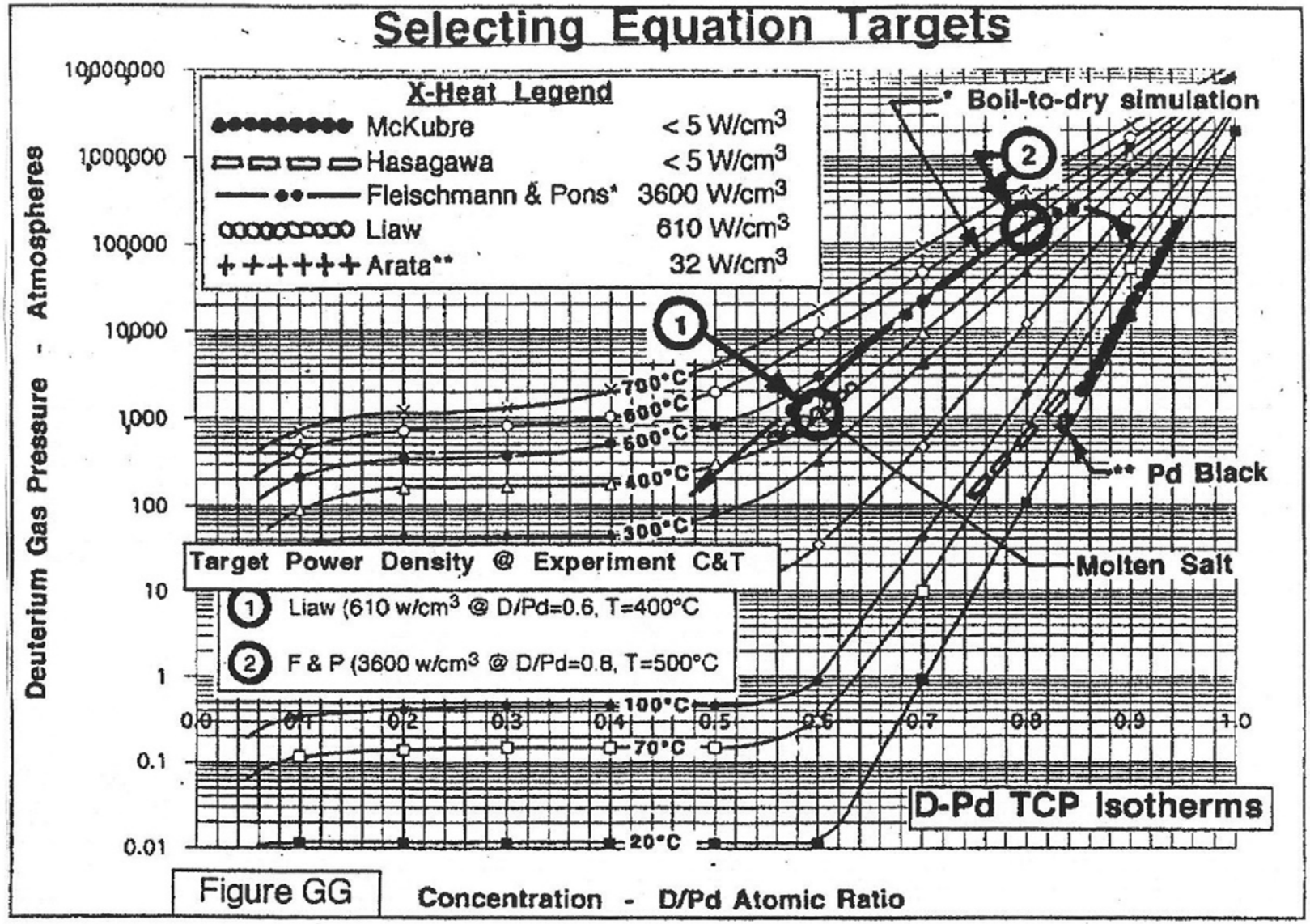
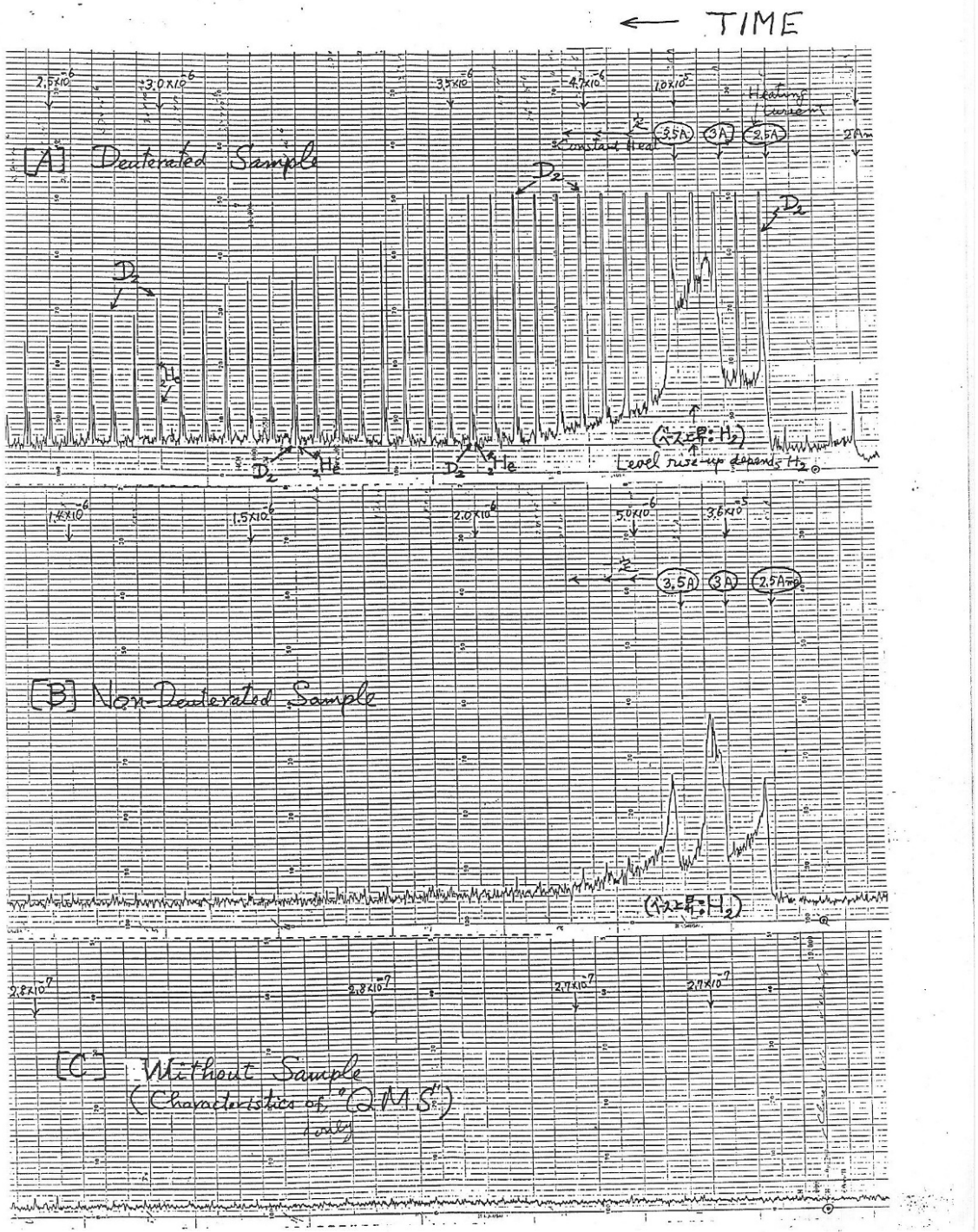

Selecting Equation Targets
X-Heat Legend
McKubre < 5 W/cm3
Hasagawa < 5 W/cm3
Fleischmann & Pons* 3600 W/cm3
Liaw 610 W/cm3
Arata** 32 W/cm3
* Boil-to-dry simulation
** Pd Black
Molten Salt
Deuterium Gas Pressure - Atmospheres
10,000,000
1,000,000
100,000
10,000
1,000
100
10
1
0.1
0.01
700°C
600°C
500°C
400°C
300°C
100°C
70°C
20°C
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
Target Power Density @ Experiment C&T
1 Liaw (610 w/cm3 @ D/Pd=0.6, T=400°C
2 F & P (3600 w/cm3 @ D/Pd=0.8, T=500°C
D-Pd TCP Isotherms
Concentration - D/Pd Atomic Ratio

Figure GG

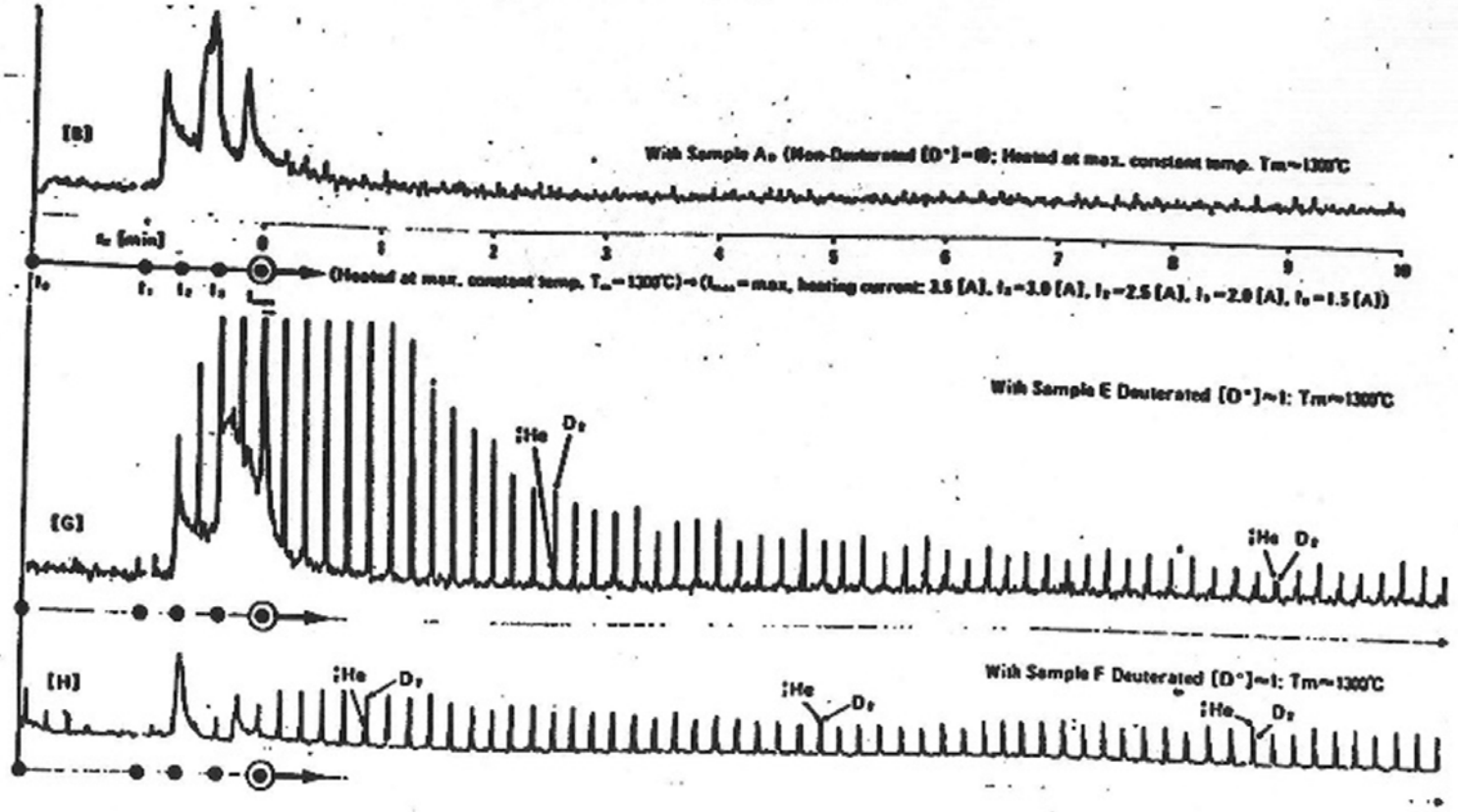
Arata and Zhang Identification of Nuclear Product

- Analyzed gases desorbed from Pd powder at high temperature
- Comparison made:
  - Pd powder that had produced excess heat of order 5 kWh/g
  - Same powder never exposed to D_2 gas
- Gas analysis:
  - Used high resolution quadrupole mass spectrometer
  - Resolved the $^4He^{++}$ and D_2^+ mass peaks
- Data:
  - Repeated scans across mass-4 peak from 3.95 AMU to 4.05 AMU
- Conclusions
  - Strongly trapped Helium-4 present in powder that had produced heat
  - No Helium-4 in powder as received
  - Nuclear product is Helium-4


← TIME
[A] Deuterated Sample
Heating Current
Constant Heat
3.5A
3A
2.5A
2A
D2
H2
He
Level rise-up depends on H2
[B] Non-Deuterated Sample
[C] Without Sample
(Characteristics of "Q.M.S" only)

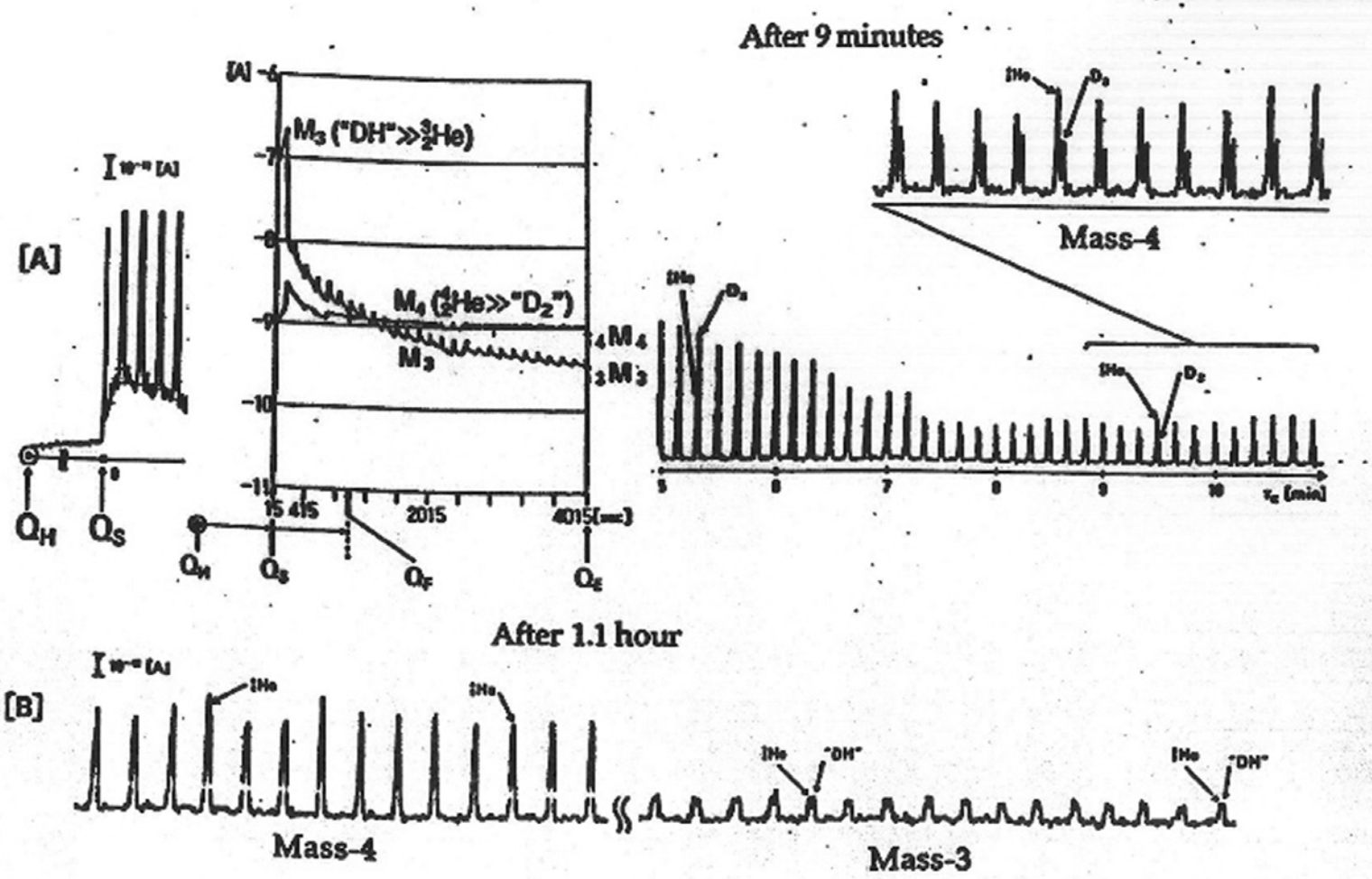
IDENTIFICATION OF NUCLEAR PRODUCT: RESULTS

- Repetitive scans of mass-4 peak:
  - Pd powder as received
  - Deuterided powder that has produced heat, moderate $^4He/D_2$
  - Deuterided powder that has produced heat, high $^4He/D_2$



- Arata/Zhang believe trapped ^4He commensurate with integrated heat output.

Arata and Zhang Measurement of $^3He/^4He$ Ratio



References

1. Chubb, T.A. and S.R. Chubb. "The Ion Band State Theory", in 5th International Conference on Cold Fusion, 1995, Monte-Carlo, Monaco: IMRA Europe, Sophia Antipolis Cedex, France
2. Nienimen R., "Hydrogen Atoms Band Together", Nature, Vol 356, 289 291 26 Mar (1992).
3. Astaldi C. et al, "Vibrational Spectra of Atomic H and Don Cu(110): Evidence for H Quantum Delocalization", Phys Rev Lett, **68.** 90 93 (1992).
4. Swartz, M, "Optimal Operating Point Manifolds in Active, Loaded Palladium Linked to Three Distinct Physical Regions", Proceedings ICCF-14, 2, 639, (2008); ISBN: 978-0-578-06694-3, 639, (2008).
5. Harrison W.A. "Solid State Theory", International Series In Pure And Applied Physics, Professor Stanford University, p 99 (1970).
6. Couch-Baker, S., SRI International; Levine P.L. and Weale, Trans. Faraday Soc., **56,** 357 (1960).
7. Waisman J.L., Sumerl, R.H. "Predicting The Power Of Deuterium-Palladium X-Heat Reactors", (1996)
8. Cravens D.J. and Letts D.G. "Practical Techniques In CF Research Triggering Methods", Proceedings 10th International Conference on Cold Fusion, 171 181 (2003).
9. Liepmann H.W. and Roshko A. "Elements Of Gasdynamics", California Institute Of Technology, John Wiley & Sons, Inc., New York (1958)
10. Mandelbrot B.B. "The Fractal Geometry Of Nature", IBM Thomas J. Watson Research Center, W.H. Freeman and Company, New York, 144 145 (1977).
11. Arata Y. and Zhang Y.C. "Helium (He-4, He-3) within Deuterated Pd-black, Proc. Japan Acad., **73** Ser. B (1997).