

# **History of and Current Claims for Low Energy Nuclear Reactions**

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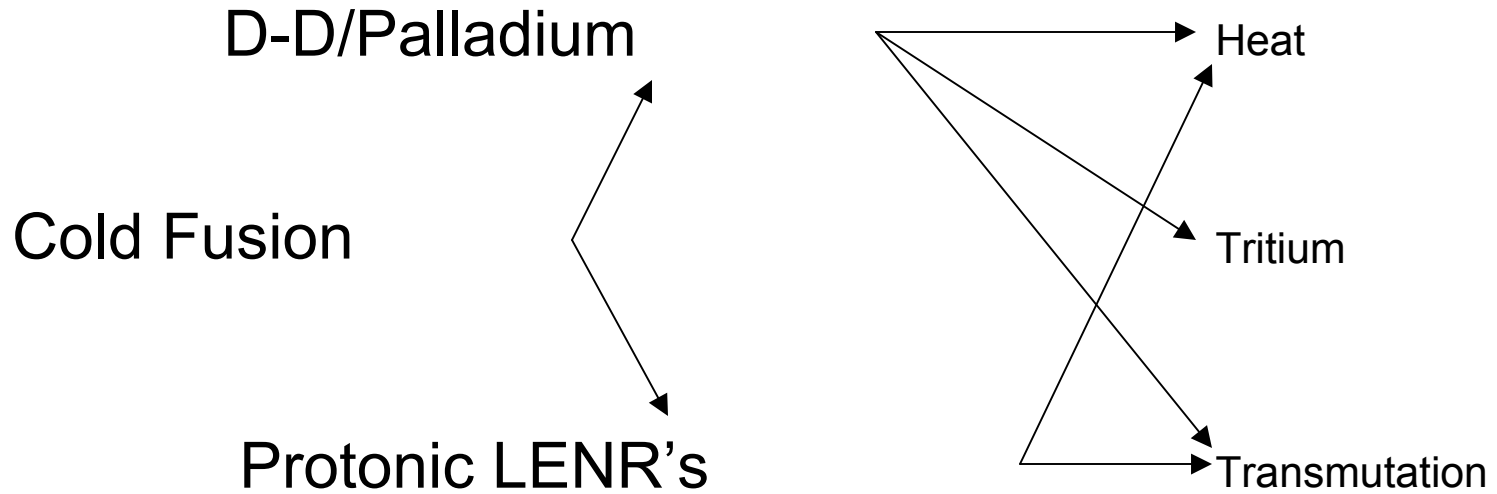
# Low Energy Nuclear Reactions

- Nuclear reactions which occur at “room temperature”
- Known as “cold fusion” in the vernacular
- Discovery announced in 1989
- Many of these nuclear reactions are not allowed by the conventional “laws of physics”

# Applications of LENR

- Transportation
  - Green Car
  - Green Airplane
- Provide power where needed (no grid)
- Replace batteries for military
- Space power
- Produce needed materials, transmute waste

# Cold Fusion Branches



# Announcement of Cold Fusion

- Martin Fleischmann and Stanley Pons, March 23, 1989, at University of Utah
- Electrolysis of heavy water with a Pd cathode created heat at sufficient loading levels of deuterium into the palladium
- Energy out was greater than electrical energy into the system combined with possible chemical reactions

# World Reaction to Announcement

- Amazement—this violates the laws of physics
- Joy—this solves the world's energy problems
- Disappointment—when MIT, Cal Tech, and others couldn't reproduce the effect
- Anger—at apparent fraud perpetrated by Pons and Fleischmann

# Aftermath of Announcement

- Heat production was actually confirmed by some universities (e.g., BYU, Texas A&M, Georgia Tech, Stanford) and some foreign institutes
- Nevertheless, a DOE ERAB and other prominent organizations declared cold fusion as, essentially, a hoax and stated that no government funding should be given to cold fusion research

# Since Then

- CF has received small amounts of USG funding—sometimes cancelled as WF&A
- Programs have continued in a number of foreign countries
- Researchers are achieving a better understanding of what is happening
- Hard to acquire intellectual property in the US



# Hot vs Cold Fusion

- Hot fusion requires high energy, and two reactions predominate
  - $D + D \rightarrow T (1.01 \text{ MeV}) + p (3.02 \text{ MeV})$
  - $D + D \rightarrow {}^3\text{He} (0.82 \text{ MeV}) + n (2.45 \text{ MeV})$
- Cold fusion occurs at room temperature to maybe a thousand kelvins and provides a path for another reaction
  - $D + D \rightarrow {}^4\text{He} (23.8 \text{ MeV})$

# Heat Production

- The excess-heat people believe that the following reaction occurs
  - $D + D \rightarrow {}^4\text{He}$  (23.8 MeV)
- The 23.8 MeV of energy does not come out as a high-energy photon (as it would in free space) but is transferred to the palladium lattice by phonons and comes out as heat
- Researchers are now seeing  ${}^4\text{He}$  in amounts that correlate to the heat production

# Countries With Traditional CF Programs

- US
- China
- Japan
- Italy
- UK
- France
- Russia
- India (?)
- Spain (?)

# “New” Branch of LENR

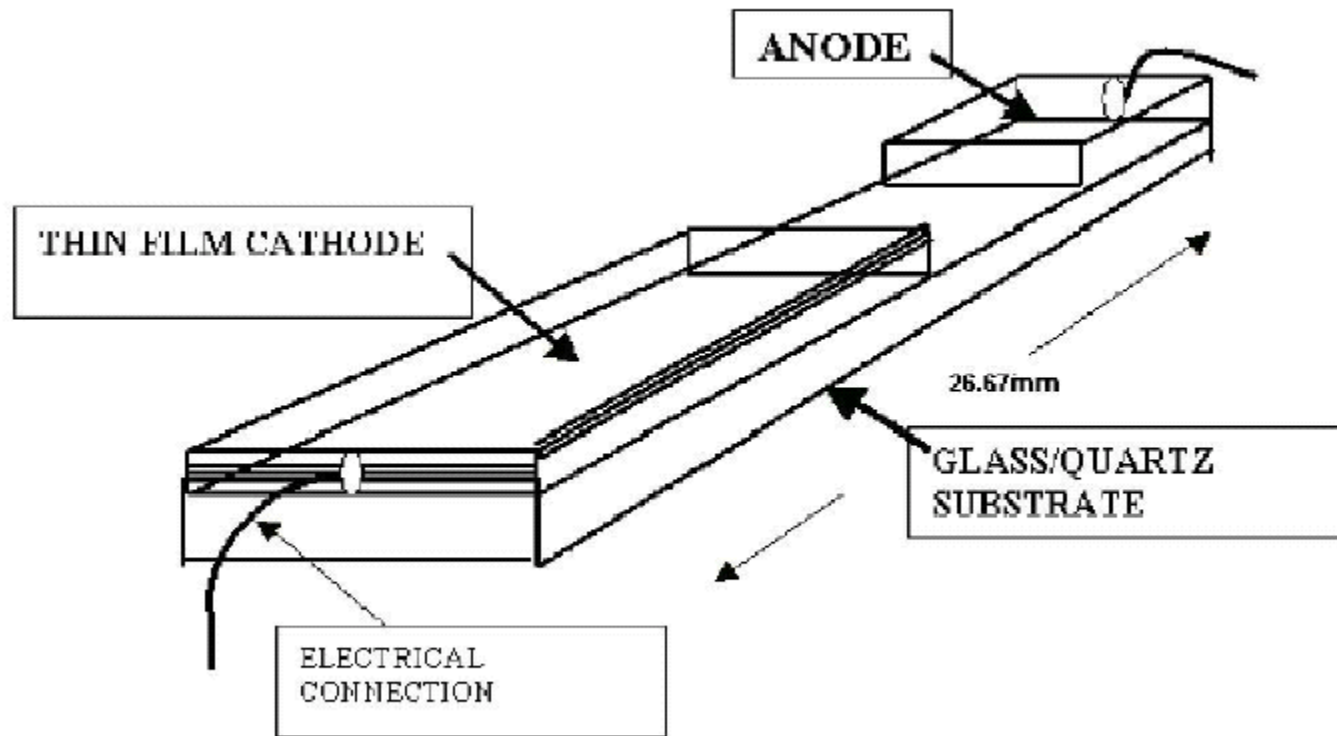
## Protonic LENR’s

- Based on the work of George Miley at UIUC
- Uses protium rather than deuterium
- Theorized reaction occurs at the interface between two thin metal films (typically nickel and palladium)
- A “many-body” reaction involving multiple protons and metal nuclei

# Protonic LENR's

- Produce heat well beyond the range of uncertainty
- Give very reproducible results
- Use thin films, so can be manufactured using existing microelectronic production facilities
- Are getting close to application

# LENR Heat Source



# Countries With Protonic LENR Programs

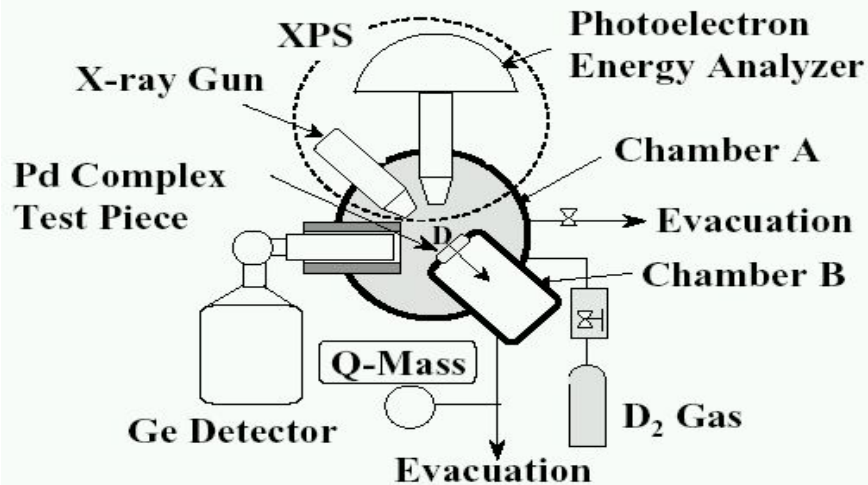
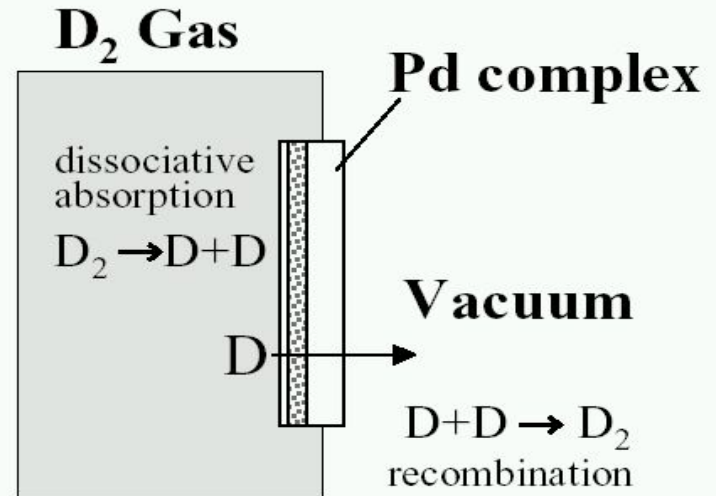
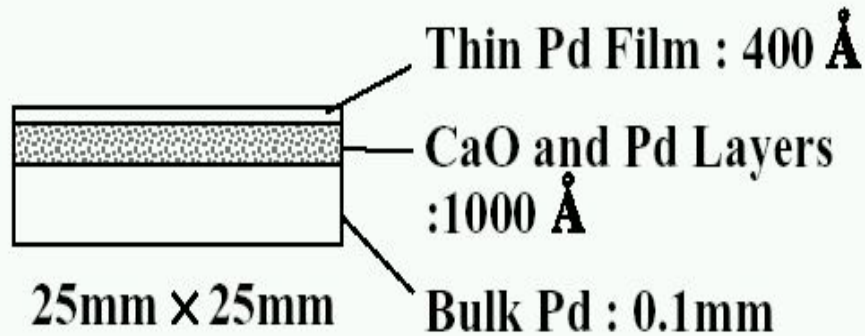
- US
- China
- Japan
- Italy
- France
- Russia
- Israel
- Secret programs

# Transmutation

- Researchers in both types of LENR have been studying the atomic composition of the cathodes before and after the reaction
- Iwamura (Mitsubishi Heavy Industries)
- George Miley's group
- Russians were seeing this back in the early 80's possibly even before Pons & Fleischmann



# Iwamura Experiment

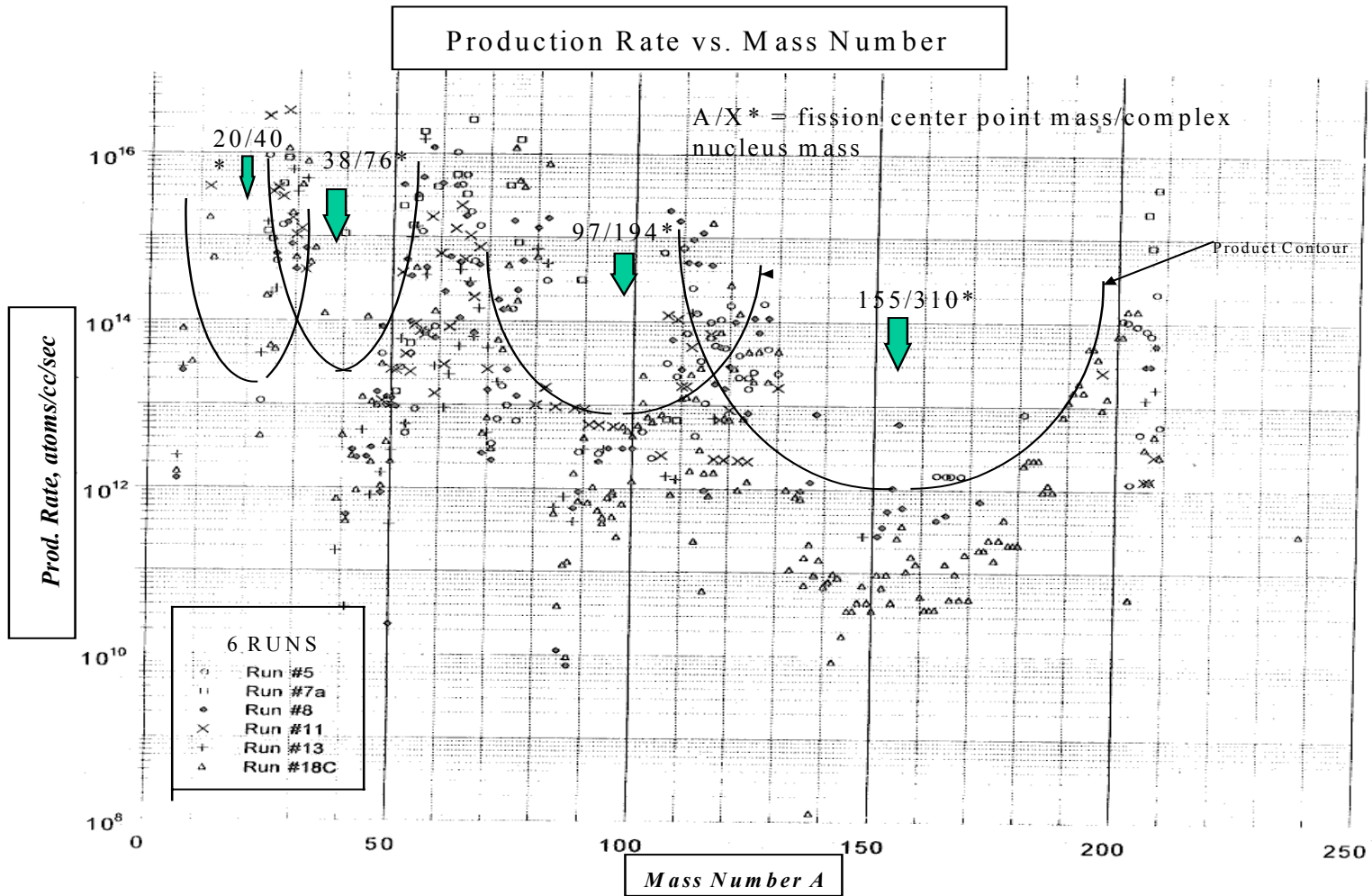


Cs → Pr (55 → 59)

Sr → Mo (38 → 42)

8 amu change

# Miley's Results



# Miley's Results

Frequency	Transmutation Elements
1	23 (F, Lu, Tb, I, Br, Xe, Os, Pr, Li, B, O, Sc, Ge, Se, Rb, Y, Zr, Eu, Sm, Gd, Dy, Ho, Nd)
2	14 (Ag, V, Yb, C, As, Sb, Te, Pd, Au, Cs, Mo, Ba, Nb, In)
3	9 (Cl, Hf, Re, Na, Ga, Sr, Sn, Cd, Ir)
5	4 (Co, S, Ti, Pt)
6	4 (Ni, K, Mn, Pb)
7	3 (Al, Mg, Si)
11	2 (Ca, Cr)
12	1 (Cu)
14	1 (Zn)
15	1 (Fe)

# ICCF 10

- August 25-29, 2003
- Cambridge, Massachusetts
- Host, Peter Hagelstein, MIT
- Co-Host, Scott Chubb, \*\*\*
- Attendees from 13 countries
- ICCF 11 in Marseilles, France in October, 2004

# US Schools at ICCF 10

- Portland State
- CO School of Mines
- MIT
- Eastern NMU
- UC Berkeley
- Utah State
- BYU
- Purdue
- Montclair State (NJ)
- UIUC
- GWU
- U of Minnesota

# Publications at ICCF 10

- Wall Street Journal
- Boston Herald
- American Scientist
- New Hampshire Magazine
- Infinite Energy
- New Energy Times

# US Govt. Agencies at ICCF 10

- NRL
- LANL
- SNL
- SPAWAR
- NSWC
- Naval Postgraduate School
- Draper Lab
- ARL
- BNL

# Foreign Attendees at ICCF 10

- Japan 14
- Russia 8
- Italy 7
- Israel 6
- UK 2
- Nigeria 2
- France 1
- Spain 1
- China 1
- Australia 1
- India 1
- Norway 1



# ICCF 10 Agenda

- Different ways of loading D into PD
- Nuclear emissions
- Production of excess heat
- Letts effect
- Transmutation
- Tritium production
- Calorimetry

# Espionage Against US LENR Program

- Several countries, including cooperation between countries
- Recruiting personnel
- Inserting students
- Funding certain research as US universities
- Hacking into computers

# Conversations with Martin Fleischmann

- Quantum Electrodynamics (QED) are very important to explaining these processes
- QED possibly can model structural bond energy release (SBER), which is important to getting energy release from inert substances or increasing release from energetic substances
- Dual nature of cold fusion
- DU phenomena

# Predictions for the Future

- A reproducible experiment will be put up on a Web site
- The interpretation of the natural world in terms of the QED paradigm will be a major scientific activity in the mid 21<sup>st</sup> century
- An overdue revolution in science will arrive
- The reputations of cold fusion scientists and those who revile them may be reversed

# Scientific Revolutions Periodicity

## Scientific Revolutions



**20 year crisis periods**

# Scientific Revolutions

- The Galilean, about 1593
- The Newtonian, 1664
- The Fluid paradigm originally formulated by Franklin, about 1745
- The Classical Field theory paradigm, rudimentarily formulated by Faraday in 1820 and developed by Maxwell
- The Quantum Mechanics (QM) and Relativity theory paradigm, formulated by Einstein, about 1905