Passell, T.O., *Radiation data reported by Wolf at Texas A&M as transmitted by T. Passell.* 1995, EPRI.

Radiation data reported by Wolf at Texas A&M as transmitted by T. Passell

ABSTRACT

Three cells were electrolyzed in series at constant low current 42 days near a neutron detector of low background (40 counts/hr) using a protocol of adding boron and aluminum at 0.001 molar to the 0.1 molar LiOD electrolyte at ~18th day. Cathodes were loaded with deuterium at a few 10's of milliamps/cm2, with a 12-hour cryogenic treatment at day 17. Cathodes were sanded and replaced in the cell every 7 days. On the ~21st & 22nd days two successive fast neutron episodes were observed at about 2 times background. The neutron detector is minimally sensitive to gamma rays but gammas were observed near the end of the 20-hour neutron episode. When the cells were dismantled in late Sept 1992, all three cathodes (6 mm diameter x 60 mm long) were observed to be mildly radioactive. Analysis by germanium gamma detectors revealed presence of 100 billion atoms of Ag, Pd, Rh, and (one) Ru isotopes having ratios unlike those from bombardment by high-energy deuteron or proton beams.

This Document

This is a compilation of slides, graphs and tables that Thomas Passell (EPRI) has shown at several conferences. He published some of them in the Journal of New Energy, Vol. 1, Issue 1, and in:

McKubre, M.C.H., et al., *Energy Production Processes In Deuterated Metals*. Vol. 2, 1999, EPRI: Palo Alto.

This material describes experiments conducted in October 1992, by the late Kevin Wolf of Texas A&M University. Wolf died in 1997. He was never able to replicate these results, and he never published or reported them at a conference. However, the research was funded by EPRI, and Passell, the program manager at EPRI, did report the results.

EPRI/NPD

SIGNIFICANCE OF TEXAS A& M FINDINGS IN OCT. 1992

THOMAS O. PASSELL

Electric Power Research Institute

June 19, 1995

EPRI/NPD

THE FINDINGS BY KEVIN WOLF

- •3 Cells Electrolyzed in Series at Constant Low Current 42 days near a Neutron Detector of Low Background (40 Counts/Hr) using a Protocol of Adding Boron and Aluminum at 0.001 Molar to the 0.1 Molar LiOD Electrolyte at ~18th Day
- •Cathodes Were Loaded With Deuterium Slowly at a Few 10's of milliamps/cm2 With a 12-Hour Cryogenic Treatment @ Day 17 and Were Sanded and Replaced in the Cell Every 7 Days
- •On the ~21st & 22nd DaysTwo Successive Fast Neutron Episodes Were Observed at About 2 Times Background. The Neutron Detector is Minimally Sensitive to Gamma Rays but Gammas Were Observed Near the End of the 20-Hour Neutron Episode
- •Upon Dismantling the Cells ~ 9-30-92 all three Cathodes (6 mm Diameter x 60 mm Long) Were Observed to be Mildly Radioactive.
- •Analysis by Germanium Gamma Detectors Revealed Presence of 100 Billion Atoms of Ag, Pd, Rh, and (one)Ru Isotopes Having Ratios Unlike Those From Bombardment by High Energy Deuteron or Proton Beams

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Wolf's Findings

•Isotopes Observed in The Most Active One of Three Cathodes ~9-7-92 at Texas A&M

•••ISOTOPE•••	NO. of ATOMS•••• (Billions)	NO./Ag110m
•Silver-105	26	32
•Rhodium-101m	22	28
•Rhodium-102	12	15
•Rhodium-101	12	15
•Rhodium-102m	6.3	8
•Silver-106m	4.5	5.6
•Ruthenium-103	3.7	4.6
•Rhodium-99	2.7	3.4
•Silver-110m	0.8	1

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Postulated Reactions to Produce The Observed Isotopes

PRODUCT	REACTION
•Silver-110m	Pd-108 (d,Gamma) (Q=+10.9 Mev) or on Impurity Silver -Ag-109 (d,p) (Q=+4.5 Mev)
•Rhodium-99	Pd-102(p,Alpha) (Q=+3.2 Mev)
•Ruthenium-103	Pd-106(d,pAlpha) (Q=+1.2 Mev) or Ru-102(d,p)Ru-103 (Q=4.14 Mev) on Impurity Ru
•Silver-106m	Pd-105(d,n) (Q=+3.5 Mev) or Pd-105(p,gamma) (Q= +5.8 Mev)
•Rhodium-102	Pd-104(d,Alpha) (Q=+8.1 Mev) or Pd-105(p,alpha) Q= +3.6 Mev
•Rhodium-101	Pd-104(p,Alpha) (Q=+3.2 Mev)
•Silver-105	Pd-104(d,n) (Q=+2.0 Mev) or Pd-104(p, gamma) (Q= +4.2 Mev)

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Tentative Conclusions if Wolf's Findings are Confirmed

- Neutron Capture is Precluded as the Primary Mechanism Because These Isotopes Lie on the Neutron Deficient Side of Isotope Stability
- Deuterons or Protons Must Have Somehow Entered Palladium Nuclei with the Subsequent Emission of Alpha (He-4) Particles and Neutrons
- The Protocol for Achieving this Phenomena Has Some Similarities to that Found at SRI for Enhancing Production of Excess Heat (XSH)
- Wolf's Cells Were Not Instrumented to Observe XSH
- All 3 Cathodes Were Activated to Degrees Varying by no more than a Factor of 3
- Replication Attempts Have So Far Failed to Show the Effect

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Tentative Conclusions if Wolf's Findings are Confirmed

- Reactions Postulated to Produce The Observed Isotopes Indicate PROTONS as Well as Deuterons Are Apparently Entering Pd Nuclei
- If Protons Can Enter a Pd Nucleus (Z=46), Then the Light Water XSH Reported on Nickel (28), Silver (47), Tin (50) and Gold (79) May Show Similar Nuclear Signatures Also.
- The Low-Z Electrolyte or Impurity Atoms that Diffuse into or Exist in Cathodes May Similarly Activate to give Both Heat and Nuclear Reaction Products
- If these Pd +D and Pd+P Reactions are Confirmed, then Other Nuclear Reactions Leading to **STABLE** Nuclei Should be Produced - but not Easily Observed
- Since the Activation Levels in Pd are 2 or 3 Orders of Magnitude Above Detector Background, this Phenomenon Provides a Unequivocal Nuclear Signature Observable Outside the Cells Because of the High Penetrating Power of Gamma Rays

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Pd Impurity Light Element Reactions Capable of Making Helium-4, Heat, and Tritium

B-10(d,α)Be-8-->2α	Q=17.8 Mev (He-4=α)
B-11(d,α)Be-9	Q=8.02 Mev
B-11(p,α)Be-8 --->2α	Q=8.58 Mev
Be-9(d,α)Li-7	Q=7.15 Mev
Be-9(p,α)Li-6	Q=2.13 Mev
Be-9(d,T)Be-8 --->2α	Q=4.59 Mev (T=Tritium)
C-13(d,T)C-12	Q=1.31 Mev
O-17(d,T)O-16	Q=2.11 Mev

- All Reaction Products Listed Above (Except Tritium) are STABLE Nuclei

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Unequivocal Ways to Measure Isotope Shifts in Palladium Cathodes

- Thermal Neutron Capture (Prompt) Gamma Rays
  - Sensitive to All Isotopes With Reasonably High Thermal Neutron Cross Section (>0.1 Barns)
  - Each Isotope Gives Many Well-Known Gamma Rays Previously Tabulated by Lone, Leavitt and Harrison to 3 figure accuracy
  - Interferences Should be Managable Using High Resolution Germanium Gamma Detection Since Each Isotope Produces More than One Gamma
  - Cathodes Could be Analyzed Before and After Heat Production in a Neutron Beam to get Accurate RATIO Changes - Method is Non-Destructive and can view the entire Sample
- Various Surface Analysis Techniques
  - The Best of these, Mass Spectroscopy of Stripped (Single Atom) Ions Still Samples Only a Small Portion of the Sample Which May or May Not Have Been Active

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Palladium Neutron Capture Gammas

Pd-102 **0.4% - No Gammas fit Pd-103 levels

Pd-104 **11% - 3 Gammas * Fit Pd-105 levels, namely 325.8 (7.33) 415.0 (0.28), & 560.9 (0.24)

Pd-105 **67% - 7 Gammas Fit Pd-106 levels, namely 615.9 (8.4), 1048.1 (6.77), 1127.8 (2.83), 5404.3 (0.04), 8331.2 (0.11), 8002.6 (0.05) and 7996.3 (0.05)

Pd-106 **1% - 3 Gammas Fit Pd-107 lev els, namely 804.7 (0.62), 1348.7 (0.46), and 1572.6 (1.71)

Pd-108 **18% - 4 Gammas fit Pd-109 levels, namely, 265.9 (0.45), 291 (1.49), 325.6 (7.33) and 338 (6.71)

Pd-110 **0.9% - 2 gammas fit Pd-111 levels, namely 559.4 (0.24), and 1618.6 (1.49)

*Gamma Energies in keV followed by parentheses with the number of those gammas emitted per 100 thermal neutron captures in Pd

**This is the % of all Pd neutron capture events that involve capture in this particular isotope.

Detailed Data from Wolf Electrolysis Experiment of September, 1992

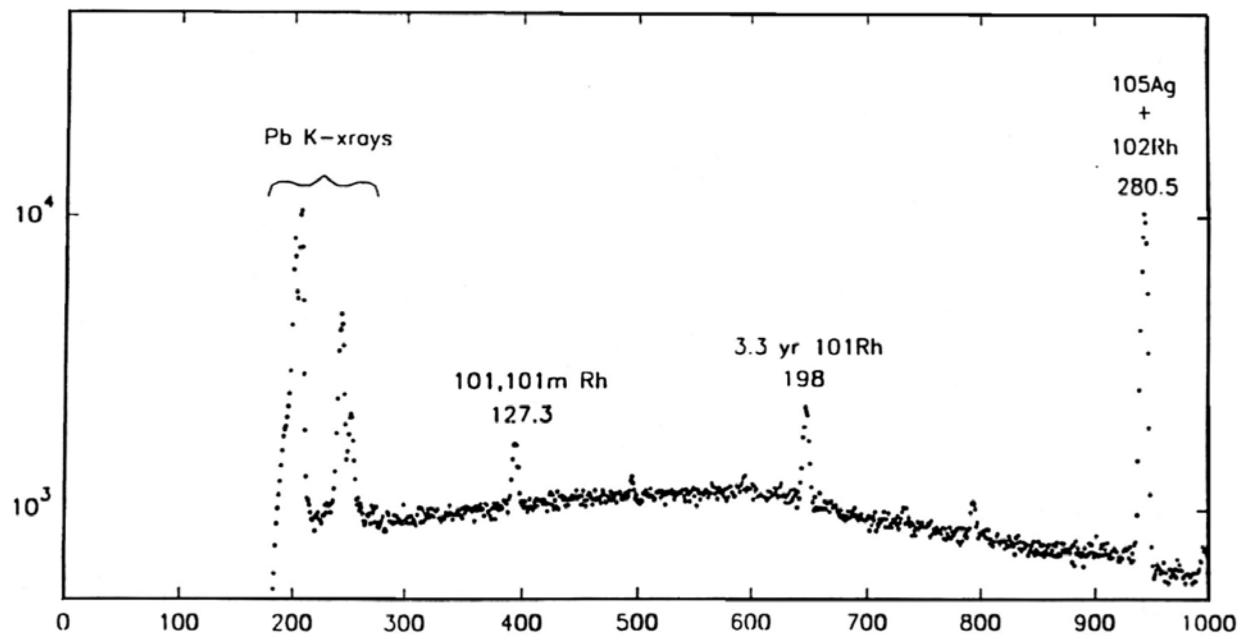

Fig. 1. Gamma Spectrum over the Energy Range 0-295 keV from a Palladium Cathode of dimensions 0.6 cm diameter by 6 cm length loaded with Deuterium in a cell having a Nickel mesh anode and using an electrolyte containing 0.1 M LiOD and ~100 PPM of Boron and Aluminum.

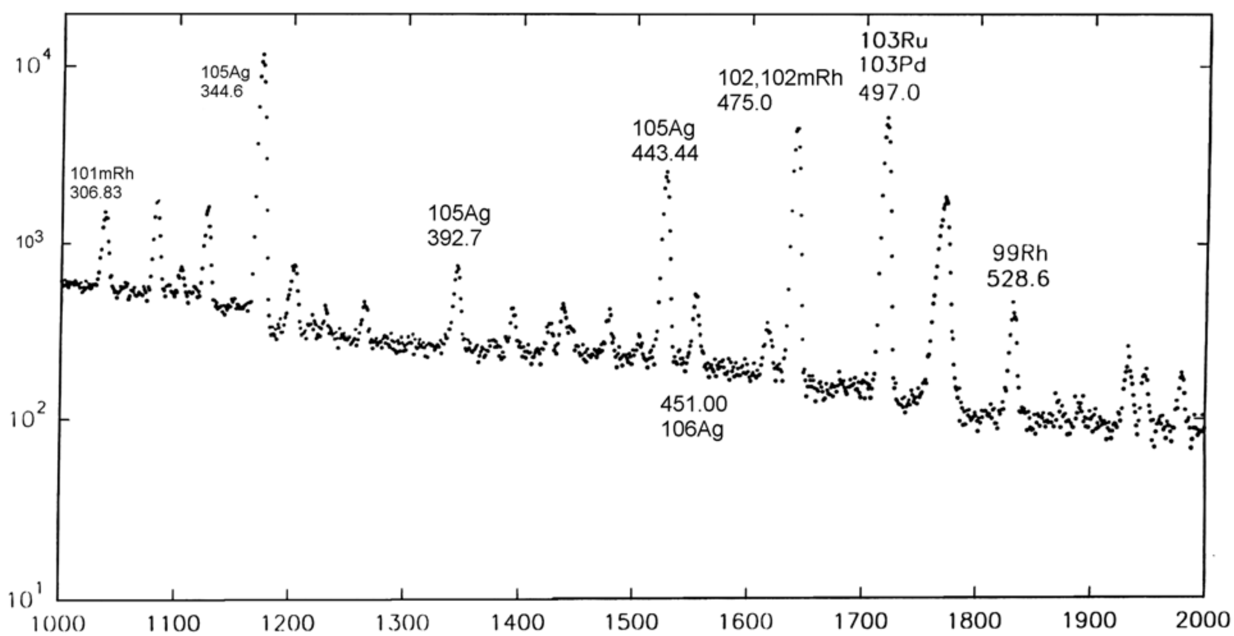

Fig. 2. Gamma Spectrum from 295 keV to 574 keV for the same cathode as in Fig. 1.

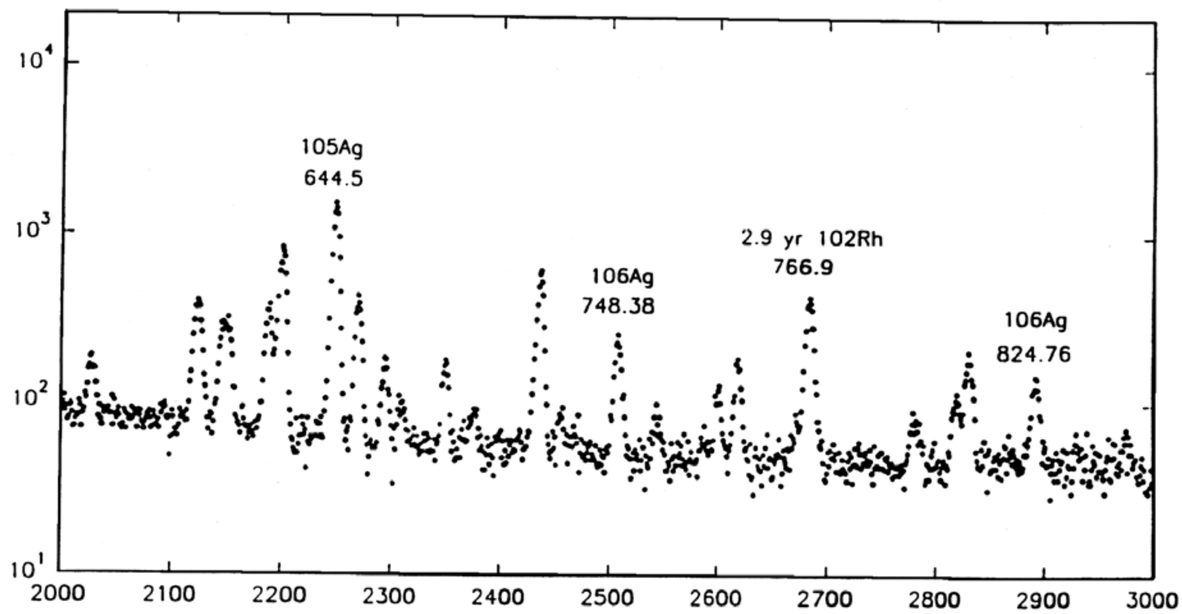

Fig. 3. Gamma Spectrum from 574 keV to 855 keV for the same cathode as in Fig. 1.

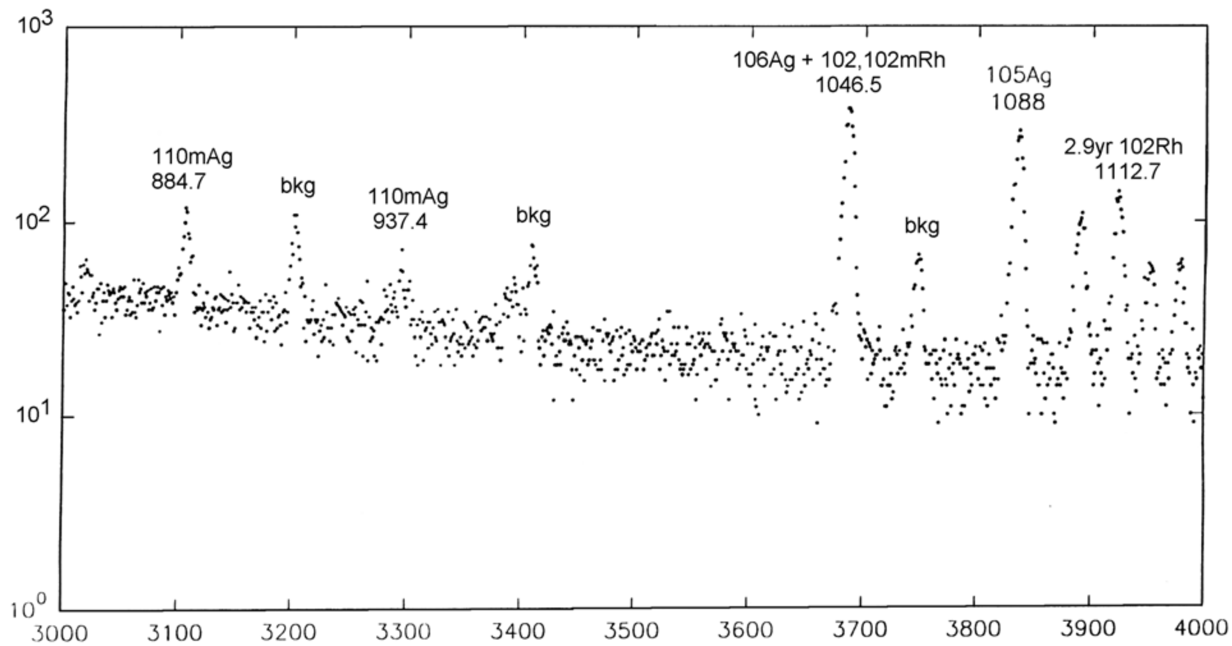

Fig. 4. Gamma Spectrum from 855 keV to 1133 keV for the same cathode as in Fig. 1.

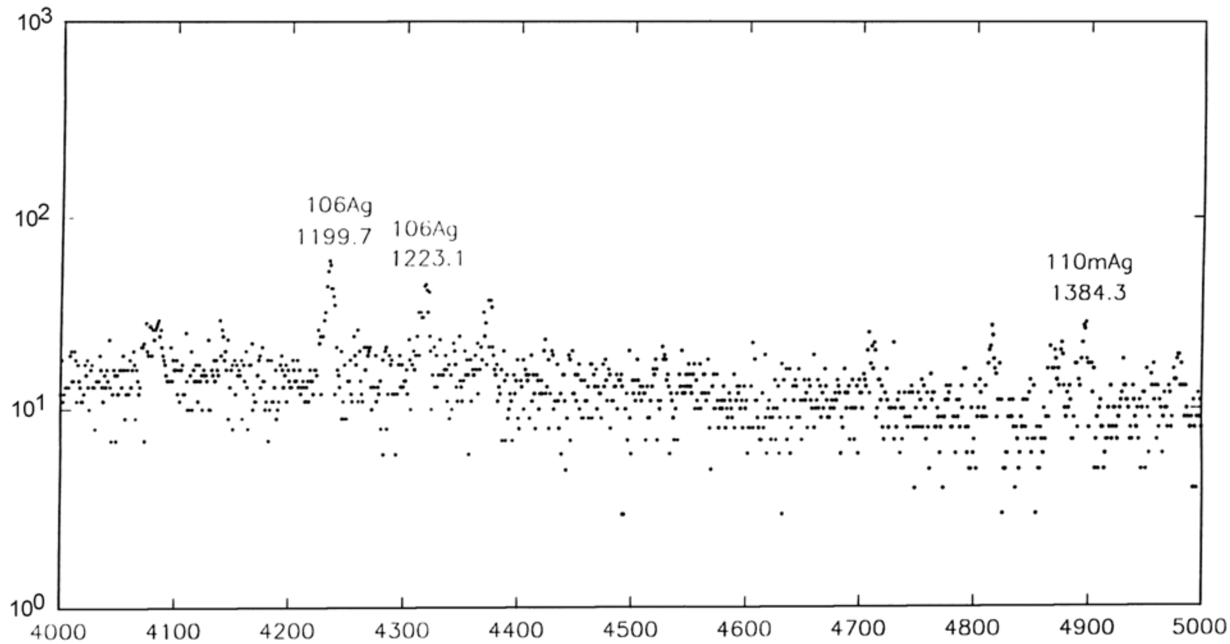

Fig. 5. Gamma Spectrum from 1133 keV to 1412 keV for the same cathode as in Fig. 1.

				Ag-105	Ag-106 m	Ag-107 stable		Ag-109 stable	Ag-110 m	
		Pd-102 stable		Pd-104 stable	Pd-105 stable	Pd-106 stable		Pd-108 stable		Pd-110 stable
Rh-99		Rh-101 and Rh- 101m	Rh-102 and Rh- 102m	Rh-103 stable						
					Ru-103					

Fig. 6. Portion of the Isotopes Table for Palladium, Silver, Rhodium, and Ruthenium. showing Isotopes consistent with the Gamma Spectra in Figs. 1-5.

Handouts from Kevin Wolf at a briefing, April 4, 1993

NUCLIDES AND YIELDS FOR Pd X-2

Z	NUCLIDE	HALF-LIFE	ACTIVITY (d/m)	N_0 (atoms at t=0)
44	^{103}RU	39.35d	1.64×10^{3}	3.67×10^{9}
UL	^{106}RU	366d	348	3.78×10^{8}
45	^{99}Rh	15.Od	1.23×10^{4}	2.74×10^{9}
	^{101g}Rh	3.3y	4.26×10^{3}	1.19×10^{10}
	^{101m}Rh	4.34d	7.27×10^{4}	2.21×10^{10}
	^{102}Rh	2.9y	4.88×10^{3}	1.21×10^{10}
	^{102m}Rh	206d	3.53×10^{3}	6.33×10^{9}
46	^{100}Pd	3.63d	8.41×10^{3}	7.74×10^{9}
UL	^{103}Pd	16.96d	1.64×10^{3}	3.57×10^{10}
47	^{105}Ag	41.29d	2.00×10^{5}	2.62×10^{10}
	^{106m}Ag	8.5d	3.28×10^{4}	4.51×10^{9}
UL	^{108m}Ag	127y	4.15	2.78×10^{8}
	^{110m}Ag	252.2d	894.7	7.87×10^{8}
UL	^{111}Ag	7.45d	3.8×10^{3}	6.56×10^{8}

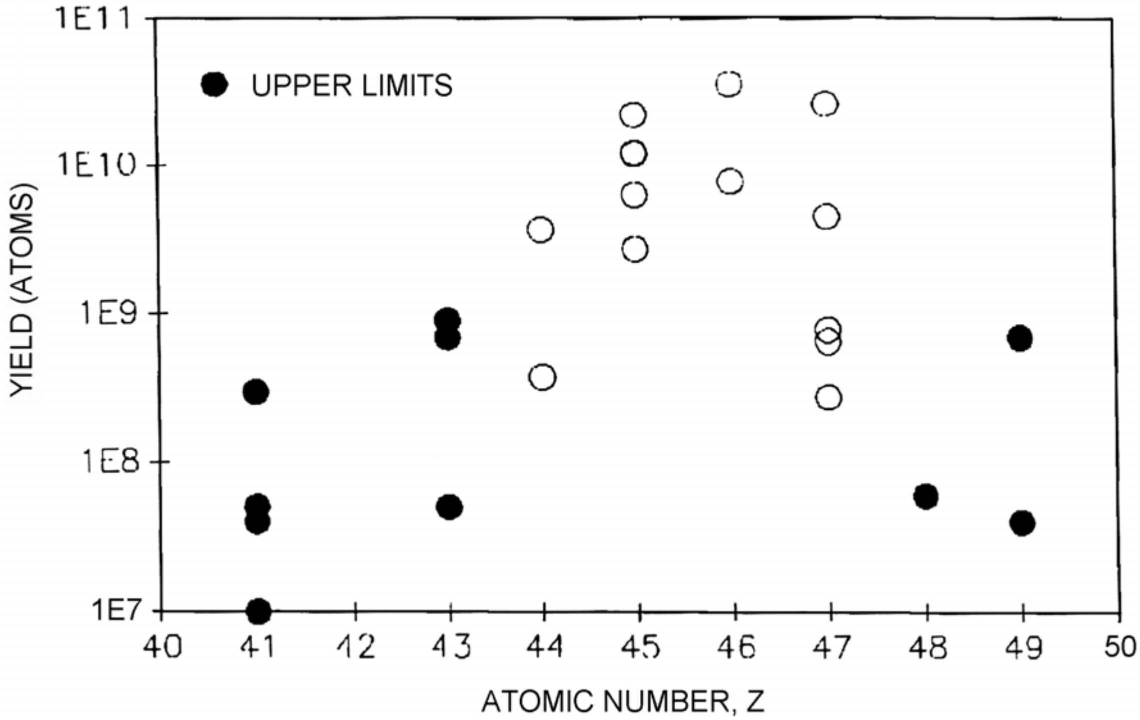

Fig. 7. From Kevin Wolf at a briefing, April 4, 1993

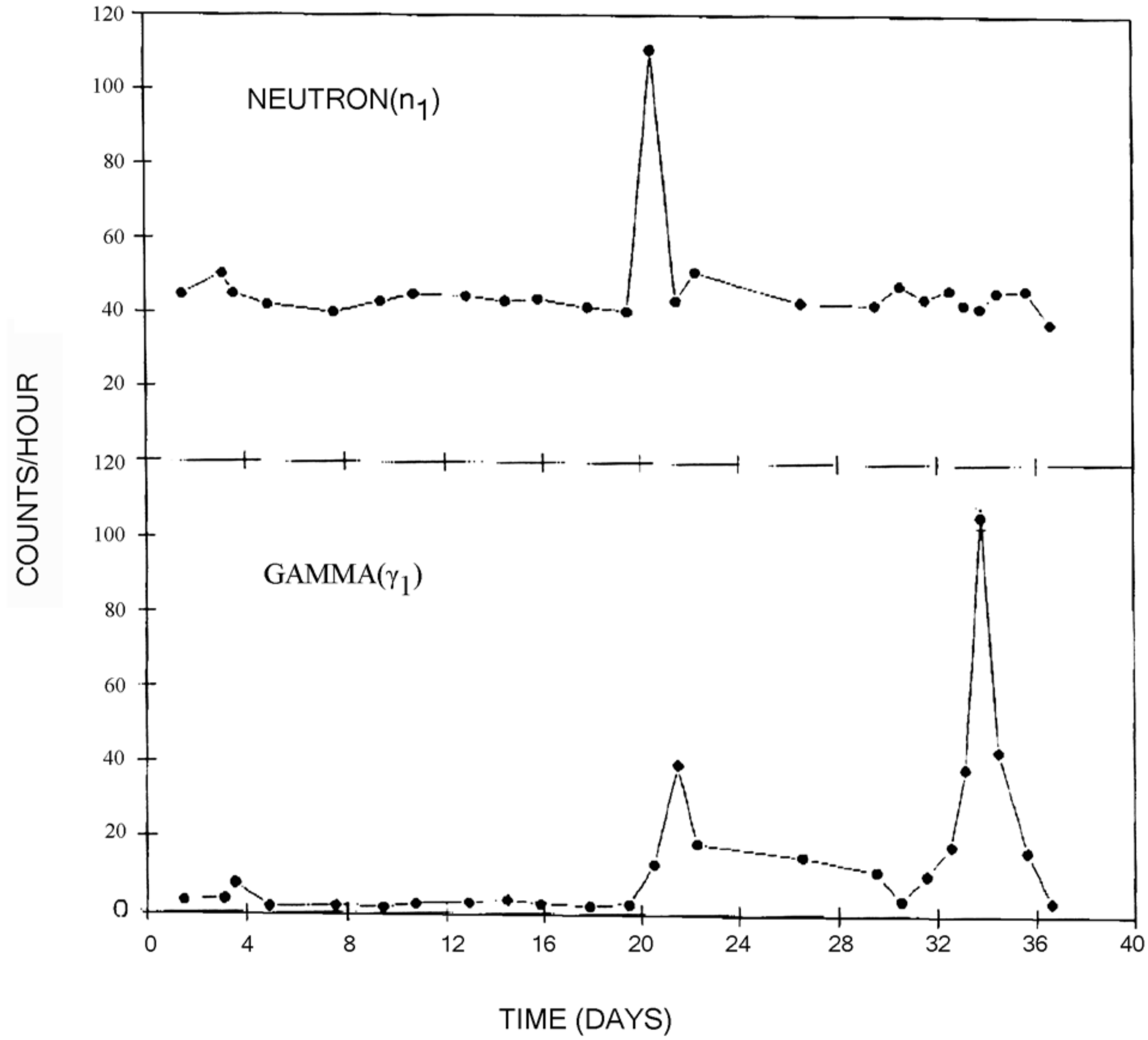

Fig. 8. From Kevin Wolf at a briefing, April 4, 1993

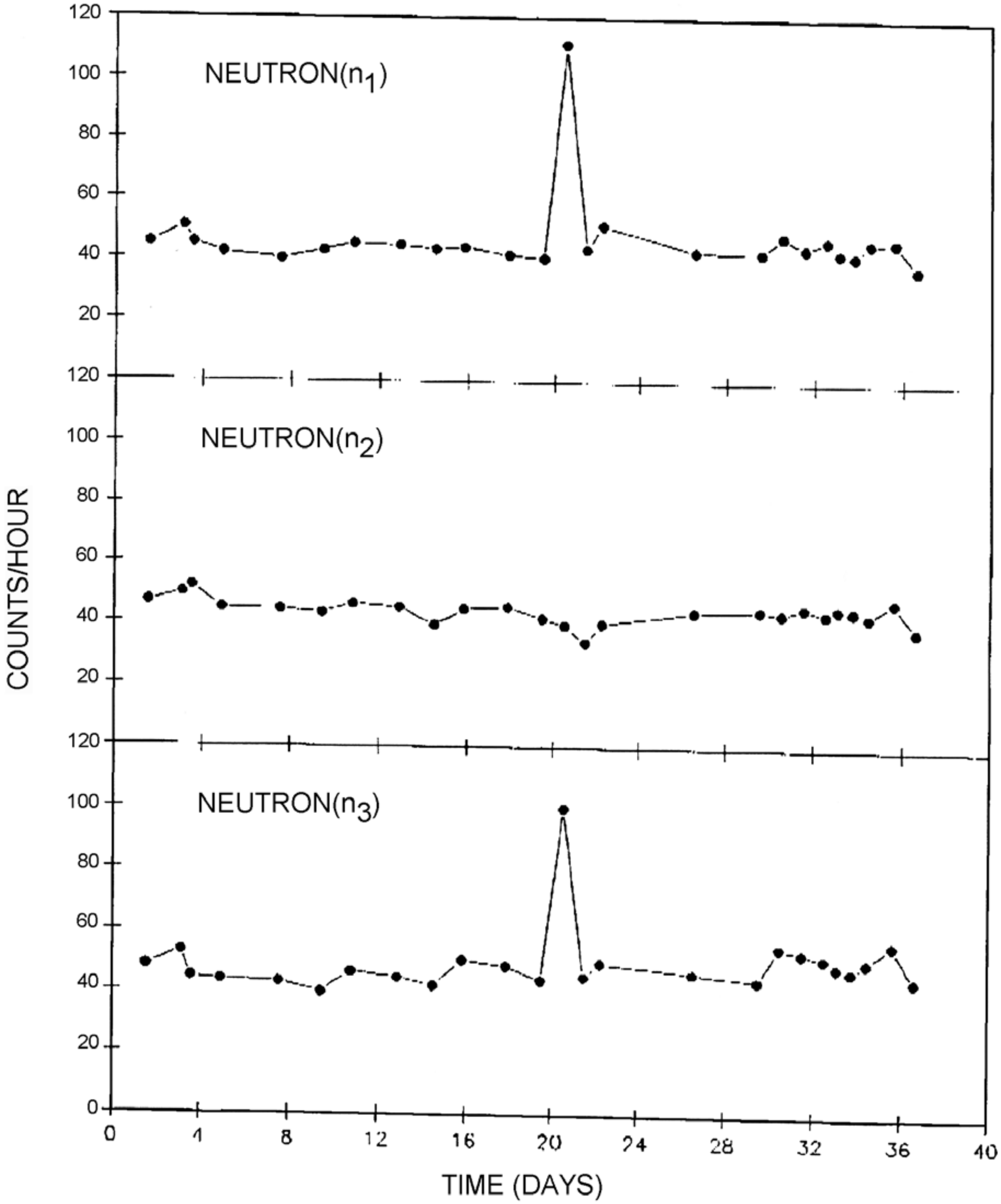

Fig. 9. From Kevin Wolf at a briefing, April 4, 1993