# Neutron Emission and the Tritium Content Associated with Deuterium-Loaded Palladium and Titanium Metals[1]

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An experimental investigation has been conducted on samples of palladium and titanium metals which have been loaded with deuterium through the electrolysis of $D_2O$ and by absorption of $D_2$ gas. In approximately 200 experiments on 25 cells, statistically significant evidence for neutron emission was obtained in three separate experiments from one palladium cathode. Observed rates are 3–4 times the background rate and correspond to source strengths up to 50 neutrons/min. The pulse height response of the NE213 liquid scintillator-based detectors corresponds to that expected for 2.45 MeV neutrons. Tritium has been identified in nine Pd-Ni electrolytic cells, at levels corresponding $10^{12}$–$10^{16}$ atoms. Activity buildup curves indicate that the apparent production occurs over a time period as short as a few hours.

**KEY WORDS:** Cold fusion; neutron emission; tritium production.

## 1. INTRODUCTION

The present paper reports some positive results for neutron emission and for tritium detection from the Fleischmann–Pons[1] type of electroytic cells. The neutron emission corresponds to a source strength of up to 50 neutrons/min, similar to that reported by Jones *et al.*[2] Most of the results are negative with respect to the detection of neutron emission in the 25 active electrolytic and gas phase cells investigated in the present study. The experimental program involved over 200 experiments with the variation of charging times and electrode potentials. Each cell configuration has a corresponding blank experiment with an identical cell which was unpowered or run with the electrode potentials reversed. Only one cell has shown clear indications of neutron emission and on three separate occasions. The results of tritium assays are more encouraging since nine cells have shown levels that are factors of $10^2$–$10^6$ above background. Most of the experiments have been conducted on cells with palladium cathodes. The electrodes range from 0.5–6 mm in diameter and were 4 cm in length.

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The electrolyte generally is 0.1 M LiOD in 99.9% purity $D_2O$. Titanium metal rods have been used in 0.5 mm and 3 mm diameters. All experiments with titanium have proved to be negative, including high pressure $D_2$ gas cells at 1000 psi and at liquid nitrogen temperatures.

The fusion reaction that may be operating is the d + d→ $^4He^*$ reaction which produces 2.45 MeV neutrons and 1 MeV tritons with nearly equal branches, through the de-excitation channels $^3He$ + n and t + p, respectively, as measured at deuteron bombarding energies where fusion is known to occur. The neutron experiments are sensitive to neutron energies of approximately 1–50 MeV to avoid an experiment of a highly specific nature, and to aid in measurement of the cosmic ray background as described later. The tritium measurements use an integral, sampling technique with samples taken from the cell electrolytes and counted with liquid scintillator-based detectors. The possibility of tritium contamination from outside sources must be considered, as discussed later.

## 2. EXPERIMENTAL METHOD

The neutron experiments were performed with fast time-of-flight counters based on 3" × 5" NE-213 liquid scintillators coupled to 5" diameter RCA 8854 low noise phototubes as shown in Fig. 1. The timing capability
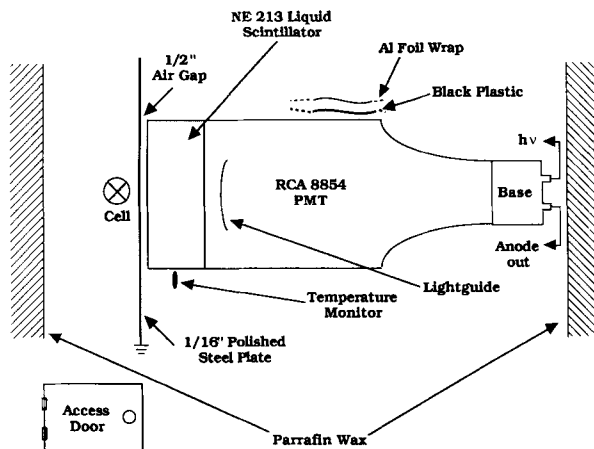
**Fig. 1.** A schematic drawing of a neutron counter used in the present experiments. The geometry is typical of that used in order to optimize the response for timing and the pulse shape discrimination.

cannot be used here, but the geometry of the design is well-suited to the low background requirements of the present work, through optimization of the pulse shape discrimination. The counter is located in a low gamma-ray background area but the pulse shape descrimination is needed to differentiate between neutrons and gamma-rays, in order to achieve a background level of 0.5 c/min in the neutron energy range from 1–2.5 MeV. The lower energy threshold is determined by a constant fraction discriminator set at an electron energy of 0.35 MeV. The neutron response is lower than that of electrons due to saturation properties of the liquid scintillator. The efficiency is approximately 5% including the solid angle for 2.5 MeV neutrons. The contributions due to gamma-ray feedthrough into the neutron region of the pulse shape discrimination spectra are found to be less than 0.1 c/min which was established by testing with gamma-ray sources of various intensities. A Canberra 2160 PSD unit was used with a TH200 fast overlap TAC to provide an identification parameter. Similar rejection performance was obtained with a 12-fold LeCroy 2249SG ADC which was run in parallel. Conclusions of Gai et al. [3] about the inadequacy of pulse shape discrimination are found to be in error for the present situation and can be traced to an inappropriate design of the Yale neutron detectors. Sharp corners in the scintillator containment and long light guides required to couple to relatively small phototubes can result in light traps and long reflection paths which decrease the rejection efficiency of the PSD method. The major contribution to the background level of the present experiment is caused by the neutron component of cosmic ray showers. Most of the electrolytic cells

were constructed for compatibility with the neutron measurements and allowed placement of the palladium electrode within 0.5" of the face of the neutron counter for high geometric efficiency and little degradation of the energy spectrum. The counter and cell were surrounded with 12" of parawax and protected on four sides with an active cosmic-ray shield of plastic scintillator. Charged particles originating from cosmic rays are rejected, and some associated neutron rejection is accomplished by the use of a veto pulse of 5-microsecond duration to take advantage of the correlation of particles in cosmic ray bursts. [4] The system was protected from external noise sources with an antenna pickup system which was checked with a broad range frequency scan in the location of the electrolytic cell and in the adjacent laboratory where the electronics and the computer system were located. The detector was isolated from the cell with a 0.5–mm steel plate and an air gap, and the detector temperature was monitored. The K500 cyclotron was not in operation during the time of the experiments. Data were recorded with Lecroy 2282B and 2249SG ADC's in a CAMAC system handled by an 80386-based small computer. The neutron efficiency and response were measured with three techniques, utilizing a Pu-Be source, a $^{252}$Cf source, and a $^{252}$Cf time-of-flight measurement. The latter technique was used to measure the pulse height response for a given energy neutron, e.g., for 2 MeV neutrons. A solid state detector provided a 100ps reference which signals the occurrence of a spontaneous fission event for the neutron detector. A 1-meter flight path was sufficient to define the neutron enrgy to 10% or better. The neutron energy response calculation discussed later was tuned to reproduce the measured spectra, and the calculation was used mainly for the extrapolation to high geometry. This procedure allows a great deal of confidence in interpretation of the energy spectra, i.e., in knowing the response of the detector to 2.45 MeV neutrons.

## 3. EXPERIMENTAL RESULTS

The analysis of the neutron data provides the counting rate as a function of time and an energy spectrum for specified time intervals. The system is rather insensitive to "bursts" unless the neutrons are within 200 nsec, corresponding to the gate time of the charge sensitive ADC system. Figure 2 shows the time dependence from the on-line analysis in a broad electron energy interval of 0.35–2.5 MeV. Despite the inclusion of extra background, the signal relative to the background rate is quite prominent, reaching 3.6 c/min compared to the background rate of 0.8 c/min. The data had been grouped
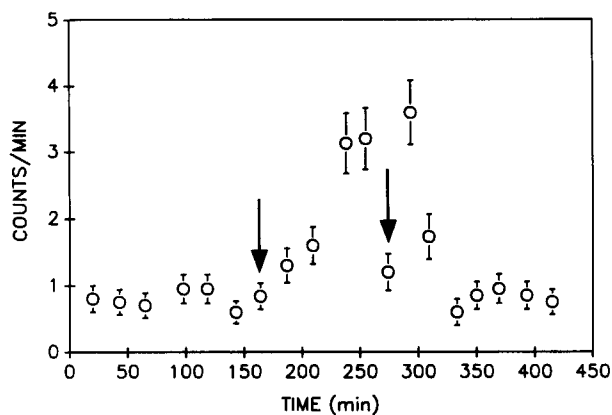
**Fig. 2.** The observed count rate in counts per minute for a neutron counter as a function of time, divided into 15–20 minute intervals. The Pd-Ni cell was installed 0.5" away from the face of the neutron counter at $t = 170$ min (arrow). The cell was rotated away from the counter by a distance of 5" at the $t = 275$ min (arrow), and returned for the next data point.



**Fig. 3.** The observed energy spectrum associated with the count rate data in Fig.1. The number of counts per 0.1 MeV in electron energy units is plotted as a function of electron energy as established with $^{137}$Cs, $^{22}$Na, and $^{60}$Co gamma-ray source Compton edges, and with triggered cosmic ray muons. Above 1 Mev the average of every 5 points is plotted.

into 15–20 min intervals for preliminary analysis. A cell of identical construction had been used for blank runs prior to installation of the cell labeled JBA5. At an elapsed time of 170 min, the cell was installed and the cell current was increased from a low charging value to 140 ma. No further changes were made in the cell parameters. The cell was rotated a distance of 5" away from the face of the neutron counter at $t = 275$ min with a corresponding decrease in count rate, and a corresponding increase when returned back to the usual distance of 0.5" at $t = 300$ min. The rate change is consistent with the efficiency loss due to the loss in solid angle, as expected if the neutrons were emitted from the cell and not from the surrounding material. The rate returned to the background level at $t = 340$ min with no change in cell parameters, signaling the end of neutron production.

The measured energy spectrum lends more evidence to the contention that the emission of 2.45 MeV neutrons has been observed here. The pulse height data corresponding to the four points at $t = 230$–310 min in Fig. 2 were integrated and plotted as the upper curve in Fig. 3 which shows counts per 0.1 MeV energy interval as a function of energy, in electron energy units. The background curve is the sum of two time intervals each, before and after the neutron production corresponding to $t = 140$–175 min and $t = 350$–385 min, respectively. The background energy spectrum is much broader, as expected for cosmic-ray-induced secondary reactions in the surrounding material. In fact, the region above 0.8 MeV is used to tag cosmic-ray showers and provide evidence against interpretation of these data as cosmic-ray-in-
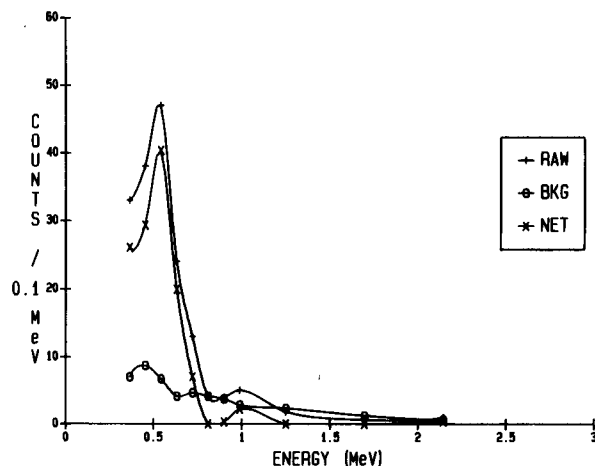
duced secondary reactions in the detector and in surrounding material. It can be seen in Fig. 3 that the net number of counts in the region above 0.8 MeV is nearly zero, and indicates there was no unusual cosmic-ray activity. Of course this argument does not eliminate the possibility that cosmic rays may somehow initiate the d + d reaction in the cell such as with muonic fusion. Comparisions with calculations of the neutron response give good agreement with the present data, and mark the position of the expected broad edge in the spectrum at approximately 0.5–0.6 MeV. The results of a calculation[5] of the expected response is shown in Fig. 4. A more modern calculation[6] of the predicted response is shown in Fig. 5. The latter calculation was performed at ORNL without the benefit of the time-of-flight experimental data described earlier. The experimental data in Figs. 6 and 7 are in reasonable agreement with the calculations and suggest strongly that neutrons from the d + d reaction have been observed. The energy spectrum is quite different from that observed from fission spectrum neutrons, neutrons from natural alpha-induced reactions on light elements, and neutrons from cosmic ray shower-induced reactions in the surrounding material.

The response shown in Figs. 3-6 is 9–10 standard deviations above the background level when an optimized energy integration interval is used (125 $+/-13$ counts). Figure 7 shows the energy spectrum for an earlier measurement on the same cell, taken with a different
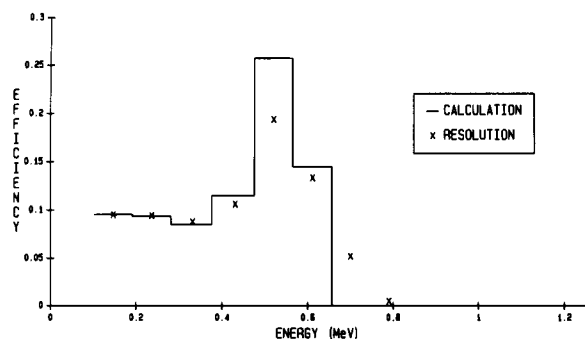
**Fig. 4.** The efficiency of the counters used here for 2.45 MeV neutrons as a function of energy in electron energy units, using the Monte Carlo calculation of Ref.4. The crosses include the energy resolution of the detector and should be compared to the experimental data in Figs. 5 and 6.

relative to the average background is not the full criterion for determination of the significance of the neutron signal. One must compare the count rate relative to the fluctuations possible in the background, as determined by the cosmic-ray showers. Figure 8 shows a plot of the frequency of occurrence of the background count rate for the on-line data to be compared with values of the count-rate data in Fig. 2. The long tail at the highest count rates in Fig. 8 is of concern here, but one can see that there is a large margin of safety for the results in Fig. 2.

Tritium results constitute the second topic to be covered in this paper. The measurements are quite different and much easier than neutron detection, with the major difficulties caused by the low energy of the beta emission (18 keV) and the possibility of external contamination. The activity levels found here eliminate the need for extensive discussions about backgrounds due to cosmic rays or gamma rays. The standard method of tritium detection at the present time is *in situ* water soluble liquid scintillation counting. A commercial LKB WALLAC 1219 counter was used for many measurements, and a tritium counter was built at the Cyclotron Institute with a pair of low noise 2''-diameter phototubes situated on opposite sides of a 1 cm × 1 cm × 3 cm rectangular cell, located in a light-tight box. A 50 ns coincidence requirement minimized phototube noise

neutron detector (but of the same type) and different shielding arrangements (with 4'' of iron surrounding the detector). The statistical significance is somewhat poorer due to a lower rate and a higher background level, caused mainly by cosmic ray reactions in the iron shield. The statistical significance corresponds to four standard deviations above the background (60 +/− 15 counts). Again, the energy spectrum is consistent with that expected for 2.5 MeV neutrons. Of course the statistics
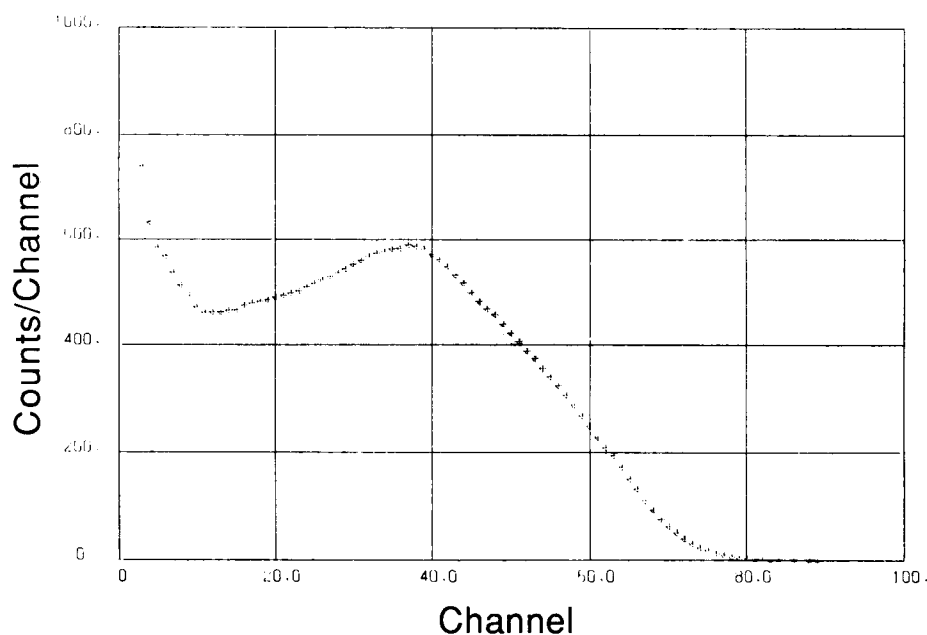


**Fig. 5.** The shape of the neutron energy spectrum expected for 2.45 MeV neutrons for the geometry of the present experiments. The calculation was performed by J. K. Dickens.[6] The abscissa is scaled in channels to correspond approximately to electron energy, 1 MeV = 100 channels.
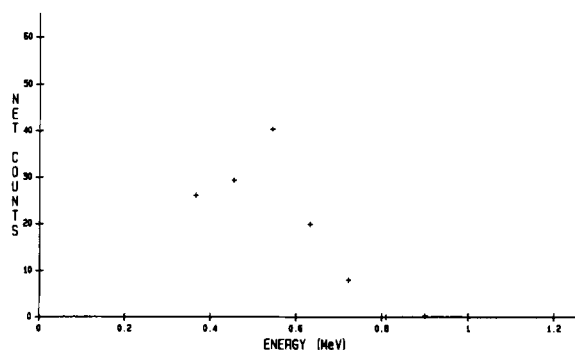
**Fig. 6.** The background subtracted neutron data from Fig. 2 (net) on the same scale as the efficiency calculations in Figs. 3 and 4.
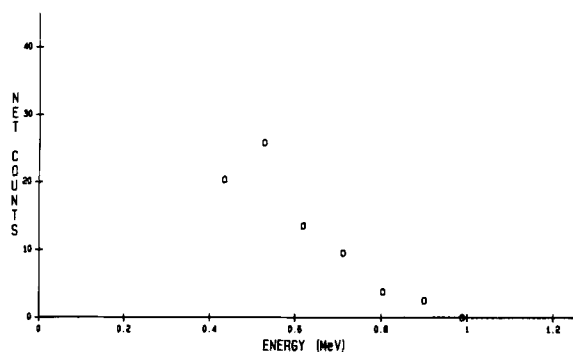


**Fig. 7.** The background subtracted neutron data similar to Fig.5 for an earlier run on the same electrolytic cell.
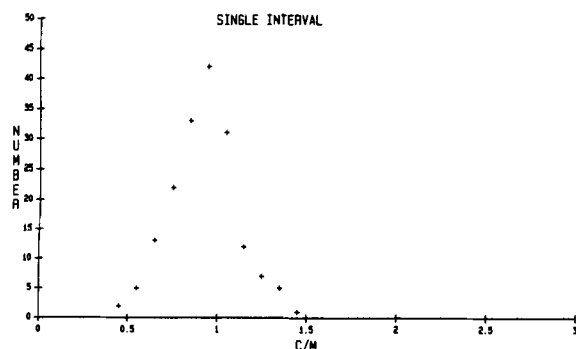


**Fig. 8.** The number of occurrences of a given count rate as a function of that count rate (frequency distribution) for evaluation of the data in Fig. 2. Data were taken with an unpowered cell of identical construction.

contributions. The home-built system allowed careful beta end-point energy determinations to be made, which verified that the activity in question was tritium, and also

allowed a careful search of electrolyte solutions for higher energy alpha emitters which proved to be negative. The activity levels as measured with the two systems at Texas A&M were within 0.5% and rather good agreement has been obtained by at least five outside laboratories. The first outside laboratory to confirm the tritium result was General Motors Research,[7] and researchers at LANL[8] have performed many variations on the sample preparation, the most definitive being vacuum distillation of samples to eliminate any doubt about the sample purity. With the knowledge that tritium has appeared in the electrolytic cells with no chance that chemiluminescence has caused false signals, one must consider the possibility that the tritium was introduced externally.

Tritium has been observed in nine cells constructed in the Bockris laboratory, and many of the necessary blanks have been run, but not in sufficient numbers. Over 30 cells constructed in the Martin laboratory and those for the Srinivasan heat measurements have shown no nuclear effects, even though the cells have a somewhat similar construction with common sources of many of the components. The major differences in construction of the Bockris cells include the use of nickel mesh for anodes, longer charging times, the use of small glass tubes for cell containment, the particular batch of palladium used, and the laboratory where cell preparation took place. From the data in hand, one must outline some quite special circumstances for explanations in terms of contamination. The background level of the heavy water is not a factor for the data presented in Table II as can be seen in Table I, which shows the results of approximately ten determinations for each value quoted. Factors of 2–3 are at the limit for tritium buildup from selective absorption which may explain the cell C-1. The total amount of $D_2O$ added to the cells during the cell lifetime is only a few times the 15 ml cell volume. In the startup of the cold fusion experimental program, many

**Table I.** Tritium Blank Samples, Counter Background Not Subtracted

| Sample description | Counts min$^{-1}$ml$^{-1}$ |
|---|---|
| Millipore $H_2O$ | 23 |
| Aldrich 99.9% $D_2O$ | 64 |
| $D_2O$ with KHP for pH adjustment | 50 |
| $D_2O$ + 0.1 mM NaCN with KHP | 48 |
| 0.1 M LiOD | 68 |
| 0.1 M LiOD with KHP | 65 |
| 0.1 M LiOD + NaCN with KHP | 66 |
| ISOTEC $D_2O$ | 26 |

Table II. Tritium Activity from Palladium–Nickel Cells

| Cell | Electrode treatment[a] | Electrolyte[b] | Activity (d min⁻¹ml⁻¹) |
|------|------------------------|----------------|------------------------|
| C-A[d] | B | 1 | $4.9 \times 10^6$ |
| C-B | C | 2 | $3.7 \times 10^6$ |
| C-C | D | 1 | |
| After charging at 0.05 amp/cm² for 4 weeks | | | 64 |
| After 2 hours at 0.5 amp/cm² | | | 5290 |
| After 6 hours at 0.5 amp/cm² | | | $5.0 \times 10^5$ |
| After 12 hours at 0.5 amp/cm² | | | $7.6 \times 10^5$ |
| C-D[c] | B | 2 | $1.2 \times 10^5$ |
| C-E | A | 1 | $3.8 \times 10^4$ |
| C-F | B | 1 | $6.3 \times 10^4$ |
| C-G | A | 2 | |
| After charging at 0.05 amp for 4 weeks; 0.5 amp, 12 hours | | | 120 |
| After additional charging for 1 week, | | | 250 |
| After 0.1 amp for 24 hours, 0.3 amp for 1 hour | | | $1.5 \times 10^4$ |
| C-2 (3 mm) | B | 1 | $6.3 \times 10^4$ |
| C-3 (3 mm) | C | 1 | 0 |
| C-1 (6 mm) | A | 1 | 69 |

[a] Electrode treatment: A, no treatment; B, vacuum anneal; C, acid etch; D, electroclean.

[b] Solution type: 1, 0.1M LiOD; 2, 0.1 M LiOD + 0.1 mM NaCN.

[c] Verified by second ³H counter at TAMU and by five other laboratories. All electrodes are 1 mm diameter palladium except where noted. A blank count rate of 65 c/min has been subtracted before calculation of activities.

of these cells were not assayed periodically. But those cells labeled C-C and C-G were followed and all solutions were assayed. The tritium appears rather suddenly over a time interval of a few hours as can be seen in Fig. 9. The first point in Fig. 9 was taken after the cell
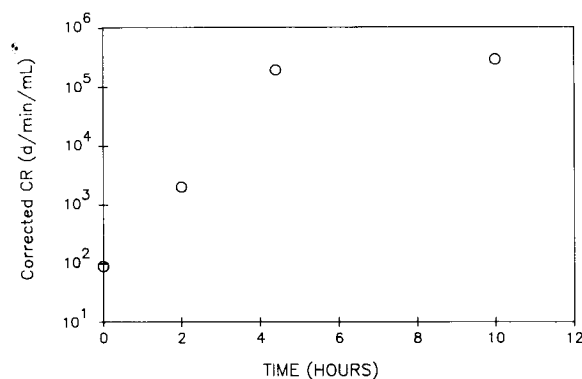


Fig. 9. The count rate measured for cell C-C as a function of time during which the cell was powered at a current density of 0.5 amps/cm². During liquid scintillation counting, a pulse height window was used which was appropriate for tritium beta decay, approximately 2–25 keV. Counter background (65 c/min) has been subtracted. Samples of 1 ml volume were withdrawn from the cell and mixed with 15 ml of liquid scintillator. All samples were counted again 24 hours later in a check for chemiluminescence. The zero of time on the abscissa was taken at the time of cell current increase from .05–0.5 amps/cm².

had charged at low current for several weeks, corresponding to the background level. At that time, the current density was increased to 0.5 amps/cm² and the cell was assayed with 1 ml samples withdrawn every 2 hours. More $D_2O$ was added as necessary from an assayed Aldrich sample. New hypodermic syringe packs were used for each transfer. A nearly constant activity level was reached after 5 hours which is probably indicative of the end of production. Strictly speaking, the constancy could reflect the equilibrium partial pressure of DT in the gas phase compared to the electrolyte concentration. The gas was free to escape through a tube immersed in mineral oil which prevents $H_2O$ contamination from the atmosphere. This experiment was performed in the Bockris laboratory. In a second timed assay series, the results of cell C-G are shown in Fig. 10 as a plot of activity per ml of electrolyte as a function of the date of assay. The cell had been constructed in the Bockris laboratory, charged and run at high current density, and then transferred to a plastic cell and transported to the Cyclotron Institute while charging. An assay in the Bockris laboratory proved to be at the background level and a later measurement at the cyclotron was only slightly above background, which may reflect the use of different tritium counters for the measurements. Assays were performed daily on May 5, 6, and 7 because the cell was situated in the neutron counter arrangement and the current density was increased in an attempt to correlate tri-
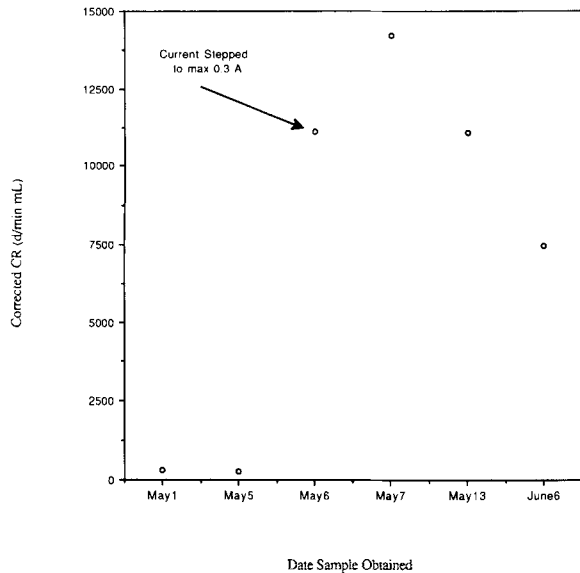
Fig. 10. The disintegration rate in (d/min/ml) in a tritium energy window for cell C-G in Table II as a function of date of assay. Notice that the abscissa is not linear. The current was increased on May 6 where indicated. Simultaneous neutron measurements were made with a negative result.

tium production and neutron emission. During that period, access to the cell was quite limited since the neutron counter is located in a secure area on the experimental floor of the Cyclotron Institute, and the cell is futher protected by 12" of parawax which requires the removal of a shielding block, which occurred only daily for assays and refilling of the cell. The rapid rise from the low count rate of May 1 and 5 to the elevated values of May 6 and 7 cannot be ascribed to outside contamination. Again all electrolyte and $D_2O$ samples were assayed before addition to the cell. The decrease in the activity levels at long times is ascribed to an end of production and to losses due to displacement with $D_2$, since the cell was returned to charging conditions. Later, the electrode was transferred to a new cell and electrolyte, and the current was increased to 0.5 amps/cm$^2$, but no further production was obtained. No gas phase recombination was performed.

A final important result comes from the Bockris laboratory with another cell that produced tritium after 2 months of charging. Prepared at the time of most of the other cells shown in Table II, cell C-H (not shown in Table II) was charged and run at high current density, but with no indication of tritium above background. At that time, a tube filled with platinized alumina beads[7] was fitted onto the cell for recombination of the deuter-

ium and oxygen gases to water, and collection was made in a separate container. After 2 weeks of charging, an assay of the recombination cell indicated $1.5 \times 10^8$ d/min/ml of tritium, and the electrolyte in the Pd-Ni cell contained $5 \times 10^5$ d/min/ml. Strictly by coincidence, both cell volumes were approximately 15 ml of $D_2O$. It had been suspected that large losses had occurred into the gas phase in the results shown in Table II, since data on recombination in the Fleischmann–Pons type of cells have shown that less than 1% of the gases recombine. The number of tritium atoms present here can be calculated to be approximately $10^{16}$, and this was not the highest count in the electrolyte, compared to cells C-A and C-B in Table II. It should be noted that the current density was not high (.05 amps/cm$^2$) during the collection time, although it had been run at 0.5 amps before the installation of the catalyst.
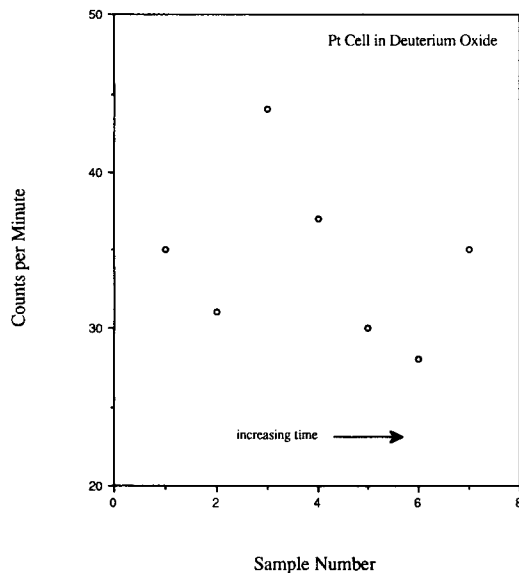
## 4. DISCUSSION OF RESULTS

The neutron results have shown three indications of 1–2 hour periods of neutron emission. One of these indications is over nine standard deviations in statistical significance and two indications have four standard deviations of significance. All indications have occurred with the same palladium electrode. Over 20 cells of similar construction have given negative results. The energy spectra are consistent with those expected for 2.5 MeV neutrons, and the source is from the electrolytic cell as shown by the geometry test in Fig. 2. Some mechanism which involves the neutral component of the cosmic-ray spectrum or thermalized muons cannot be ruled out, but no plausible mechanism has been suggested. The source rates of 20–50 neutrons/min are comparable to those measured by Jones et al.[2]
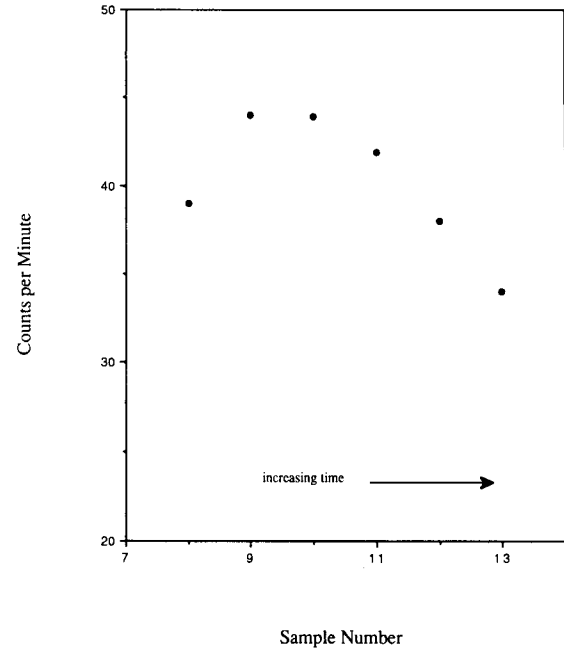
The tritium results show a much higher rate of reproducibility, since cells with eight 1-mm diameter Pd-wires and one 3-mm Pd-rod have shown significant levels. The calculated energy release rate based on the amount of tritium detected is significant, making the results even more important. If the production were through the d + d reaction with a $Q$-value of 4 MeV, the power level is approximately 10 watts/cc of palladium assuming a 5–10 hour generation period and using the activity levels of cell C-H.

The correlation of the results on neutrons, tritium, and heat production has proved to be negative. Obvious heat generation (ignition) by a Srinivasan cell was not accompanied by neutron emission, and none of these cells show tritium production despite an indication of 5–15% excess heat. Cell C-D in Table II has shown both

neutron emission and tritium production, but it is not known if the occurrence was simultaneous. After reprocessing the electrode from cell C-D by melting the Pd, a positive neutron indication was observed but no tritium was produced at detectable levels. Conversely, the measurement on cell C-G failed to give a clear neutron signal during the period of a positive tritium indication. One must use some care in conclusions, since most of these cells were not counted for neutrons at all times. If there is no delayed release mechanism for the tritium, one can state that the branching ratio for neutron production is too low by at least a factor of $10^7$ compared to the observed tritium level in the electrolyte, for the d + d fusion reaction. Caution must be used in this conclusion because of the observation of tritium production in cell C-H well after a period of high current density. Neutron generation should occur due to the secondary reaction of t + d → $^4$He + n to produce 14 MeV neutrons even if the d + d reaction has a modified branching ratio or a different mechanism to avoid compund nucleus formation. The neutron detection system is quite efficient for 14 MeV neutrons and the energy spectra would allow easy identification, at an observed rate of approximately $10^4$/min. Assuming the occurrence of fusion within the Pd-D electrode, the 3 MeV proton that accompanies the 1 MeV triton from the d + d fusion reaction would



**Fig. 12.** The count rate as a function of sample number, taken approximately hourly for sample JB11. The cell contains a 3 mm Pd rod similar to cell C-G in Table II. No counter background has been subtracted.



**Fig. 11.** The count rate in a tritium window (Fig.8) as a function sample number, assayed approximately hourly for cell C-D in which the Pd-electrode was replaced with a 1 mm Pt-electrode and the current density was increased to 0.5 amp/cm². ISOTEC D₂O was used (Table I).

produce no neutrons since it is below the Coulomb barrier for Pd and is not of sufficient kinetic energy for deuteron breakup (3.38 MeV). If a surface reaction occurs, there would be low level neutron production from the small amount of lithium present. The production of x-rays and Coulomb excitation gamma-rays is expected, but the x-ray attenuation within the cell material would reduce the sensitivity of measurements. Measurements are underway with high resolution germanium detectors for 300–500 keV gamma rays characteristic of the energy levels of the palladium isotopes excited by Coulomb excitation. The conclusion can be drawn, however, that if tritium is produced in the cells, an unknown mechanism creates the triton at a low kinetic energy to explain the lack of secondary neutrons. Such mechanisms have been postulated,[9] but no detailed calculations have been performed. Similarly, reactions on heavier targets such as $^6$Li(d,p) may be relevant since one of the decay channels produces tritons. Again the secondary t + d reaction would produce 14 MeV neutrons if the mechanism were through the $^7$Li compound levels, and only the rather improbable neutron pick-up direct reaction remains a possibility. It is believed that despite enhancement by deuteron breakup, the Coulomb barrier on heavier targets essentially eliminates them from consideration.

An almost equally unlikely explanation occurs in terms of tritium contamination, but it is the one being pursued with tests and blanks in the cyclotron laboratories. The palladium cathodes originated from a common batch of material, and similarly for the nickel anodes in the tritium associated cells. From the three samples which have been measured for buildup of tritium in the cells, it must be concluded that the tritium was introduced or was contained within a cell component at the time of cell preparation, but not in the electrolyte. Similarly, the observation of approximately 100 times the activity in the gas phase compared to the electrolyte indicates that the tritium was not introduced directly into the electrolyte as TDO. The palladium is the most likely material for contamination because of its hydrogen storage capability, but all materials are being tested. Up to $10^{-4}$ of the hydrogen sites in the Pd must be preloaded with tritium to account for the yields found. This would be a considerable accident and would probably have required a trip to Savannah River for the cell C-H. Two $H_2O$, LiOH cells prepared from the same batches of the other materials (Pd, Ni, cells, rubber septa, etc.) have failed to produce any tritium. Samples of the Pd and Ni have been sent to LANL for analysis of the preloaded tritium content, and results have shown there is no tritium contamination.[10] Samples of the cell materials have been dissolved and counted for tritium with negative results, including nickel mesh, wire, glass, and rubber. All tools used in the preparation of cells were acid-dipped and the solutions were counted. Finally, the health-physics staff has sampled the laboratories and counted for tritium on a weekly basis. Another type of blank was run by extracting the Pd wire from a cell that had charged for 25 days. The cathode was replaced with a 1 mm Pt wire. The cell was run at high current density and assays followed in the usual fashion as shown in Fig. 11. No tritium above background was detected with this Pt-Ni cell. Figure 12 shows results for a cell prepared in the Bockris laboratory and run at the cyclotron. The negative result in itself constitiutes a type of blank, and there are at least 20 more with no tritium. The program of blanks and testing continues, but at present the strongest argument against tritium contamination is the magnitude of the yields detected at locations where little or no tritium is used, and the unlikeliness of contamination in the refining and manufacture of materials.

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