Cold Fusion

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03/27/95

Dr. Walter Polansky
Div. of Advanced Energy Projects
ER-16, MS F-240, GTN
United States Department of Energy
Washington, DC 20585

Dear Dr. Polansky:

Enclosed is the information you requested. Also included are selected abstracts from the Anaheim meeting. Note the sonication work by Stringham and George, Brian Oliver did some of the helium analyses reported.

Note Prof. Fleischmann's comment about positive feedback. I will speculate that this relates to the build-up of the surface film modifying the cathode. The necessary condition may be to build up the film and the overpotential it induces slowly and homogeneously to achieve an abnormally high overpotential and thereby high fugacity.

I would take Dr. Claytors' ability to make tritium as a "smoking gun" that nuclear processes are induced. Success in his case is dependant on the quality of the palladium used, but what that quality is remains somewhat obscure.

Our position remains that the fundamental science needs to be done. We are not interested in media attention and intend to simply play it straight.

Sincerely,

Ben Bush

Ben Bush, Ph.D.

059. CORRELATIONS OF EXCESS POWER AND HELIUM PRODUCTION. M. H. Miles and K. B. Johnson, Naval Air Warfare Center Weapons Division, China Lake, CA 93555-6001

Within the past three years, several experiments involving the electrolysis of D_2O + LiOD solutions using palladium cathodes have produced significant amounts of excess power at our laboratory. Electrolysis gas samples collected from these experiments using both glass and metal flasks have contained larger quantities of ^4He than control experiments where no excess power was observed. A total of 16 electrolysis gas samples collected during episodes of excess power have shown higher levels of ^4He while 11 gas samples collected when no excess power was observed gave lower background levels of ^4He. The more accurate measurements place the rate of helium production at 10^{11} $^4He/s \cdot W$. This is the correct magnitude for typical fusion reactions that produce ^4He as a product. Nevertheless, most experiments at our laboratory have failed to produce any significant excess power, hence progress in this field remains slow and frustrating.

060. ELECTRON-CAPTURE-DELAYED FISSION OF $^{228}Np^*$, K.E. Gregorich, S.A. Kreek, H.L. Hall, R.A. Henderson, J.D. Leyba, K.R. Czerwinski, B. Kadkhodayan, M.P. Neu, C.D. Kacher, T.M. Hamilton, M.R. Lane, E.R. Sylwester, A. Türler, D.M. Lee, M.J. Nurmia, D.C. Hoffman, Nuclear Science Division MS-88, Lawrence Berkeley Lab., Berkeley, CA, 92720.

The electron-capture-delayed fission from a ^{228}Np precursor has been studied. ^{228}Np was produced at the LBL 88-Inch Cyclotron by the $^{233}U(p,6n)$ reaction utilizing a stack of 23 ^{233}U targets. 2373 pairs of coincident fission fragments were recorded, giving an asymmetric fission mass distribution, and an average total kinetic energy of 169±6 MeV. The half-life of ^{228}Np was found to be 61.4±1.4 s. By measuring α-decay chains, we found the ^{228}Np α-decay branch to be 60% and the electron-capture decay branch to be 40%. The delayed fission probability was found to be $(2.0\pm0.9)\times10^{-4}$. A measurement of K-capture X-rays coincident with fission fragments resulted in less than 25% of the expected coincidences. This can be explained by the lack of a second minimum (fission isomer) in the ^{228}U fission barrier, allowing the fission to proceed before the K-vacancies from the ^{228}Np electron capture fill.

*Work supported in part by Office of Energy Research, US Department of Energy, Contract DE-AC03-76SF00098

061. TRITIUM PRODUCTION FROM A PLASMA DISCHARGE ON PALLADIUM . T. N. Claytor, D. G. Tuggle and D. D. Jackson, Los Alamos Nat. Laboratory, Los Alamos, NM 87545

Over the past year we have been able to demonstrate that a plasma loading method produces an exciting and unexpected amount of tritium. In contrast to electrochemical hydrogen or deuterium loading of palladium, this method yields a reproducible tritium generation rate when various electrical and physical conditions are met. We will show tritium generation rates for deuterium-palladium foreground runs that are up to 25 times larger than hydrogen-palladium control experiments using materials from the same batch. The reproducibility of the technique and the large signal to noise over background has allowed us to vary parameters that have been difficult to investigate with previous methods. We intend to illustrate the difference between batches of annealed palladium and as received palladium from several batches to demonstrate that the tritium generation rate can vary by a factor of 40 from batch to batch. The effect of other metals, wire and plate thicknesses on the tritium generation rate will be shown. We plan to discuss these new procedures, present typical results, and speculate concerning the implications for further work.

062. EVAPORATION RESIDUE MEASUREMENTS AT 0 DEGREES IN THE Xe+Ti SYSTEM
J. Li, B. Xiao, K. Hagel, F. Haddad, N. Mdeiwayeh, J. B. Natowitz and R. Wada, Cyclotron Institute, Texas A&M University, College station, TX 77843

First measurements of evaporation residues detected at 0° in the Xe + Ti system using a n[illegible]ss Achromatic Recoil Spectrometer (MARS) will be presented. Effects of fission dynami[illegible] expected to manifest themselves in the cross sections of evaporation residues will b[illegible].

063. THE DECAY OF ^{200}Pb
D.Fabris, INFN Sezione di Padova, I-35131 Padova, Italy.

Dynamical effects in the fission of the ^{200}Pb compound nucleus has been studied using the reaction $^{19}F + ^{181}Ta$ at six incident energies between 90 and 140 MeV. The decrease of the fission width as a function of the excitation energy was extracted analyzing the excitation function of energetic γ-rays in coincidence with fission fragment and evaporation residues. Further experimental work on light charged particles and low energy γ-rays is in progress to study the interplay between structure and dynamics in the decay of ^{200}Pb nuclei

064. FISSION TIME SCALES FROM NEUTRON EMISSION IN Ne + Re AND Ar + Ho REACTIONS.
I. Tilquin, Y. El Masri, Th. Keutgen, A. Ninane, M. Parlog, University of Louvain, Belgium ; F. Hanappe, University of Brussels, Belgium ; G. Bizard, D. Durand, F.R. Lecolley, F. Lefebvres, T. Nakagawa, J. Peter, R. Regimbart, B. Tamain, LPC of Caen, France ; G. Costa, G. Guillaume, B. Heusch, A. Huck, S. Monatassin, CRN of Strasbourg, France ; K. Hagel, J. Natowitz and T. Rabah, Texas A & M University, USA

The properties of neutrons emitted in Ne + Re and Ar + Ho reactions, leading to the same fissile CN ^{205}At at the same excitation energy, have been measured to establish the dynamical fission time scales (normal and fast fissions). The neutron multiplicities and kinetic energies were determined using the new french-belgian neutron multidetector DEMON composed from 96 large volume NE213 cells.

065. DYNAMICAL EFFECTS IN LOW ENERGY FUSION-EVAPORATION REACTIONS

G. Viesti
Dipartimento di Fisica, Universitá di Padova, I-35131 Padova, Italy

The population of superdeformed (SD) and hyperdeformed structures (HD) in nuclei with mass A∼150 is influenced by the asymmetry in the entrance channel of the reaction (SD) as well as by the presence of charged particles in the evaporation chain (HD). Recent proton-gamma coincidence experiments performed with the γ-ray spectrometer GASP at Legnaro (Italy) indicate a link between the population of evaporation residues (SD and HD) at very high spin and the dynamical hindrance of fission. The possibility of dynamical effects during the equilibration phase of the compound nucleus at low excitation energy will be also discussed.

066. ENTRANCE CHANNEL DEPENDENCE OF FUSION-FISSION DYNAMICS IN HEAVY ION REACTIONS, R.K. CHOUDHURY, NUCLEAR PHYSICS DIVISION, B.A.R.C., BOMBAY - 400 085, INDIA

Heavy ion fusion-fission reactions involve complex nuclear dynamics during the shape evolution of the composite nucle[illegible]rious quantities such the angular momentum, entrance channel ma[illegible]metry and the fissility of the compound nucleus are expected to pla[illegible]e in

052. CALORIMETRY OF THE PD-D_2O SYSTEM: THE DRIVE TOWARDS HIGH LEVELS OF LOW GRADE HEAT. M. Fleischmann and Stanley Pons, IMRA Europe S.A. Science Center, 220 Rue Albert Caquot, Sophia Antipolis, 06560 Valbonne, France

We review some of the factors which prompted our search for anomalously fast nuclear reactions of D^+ electrochemically compressed into Pd (and Pd-alloy) host lattices using calorimetry as a principal means of investigation. The most surprising results are that the high levels of excess heat generated are not accompanied by the expected levels of tritium and neutrons (low but significant levels of these "nuclear ashes" are detected). It has been found that excess heat generation is dependent on the protocol of the experiments mainly because of positive feedback. A rationale for such positive feedback is presented; this also leads to oscillation in the system properties which must be minimised so as to reach high levels of excess enthalpy generation at intermediate temperatures (~100°C i.e. low grade heat). We illustrate the progressive development by the achievement of specific rates of ~20Wcm^{-3}, ~100Wcm^{-3} and 4$kWcm^{-3}$ corresponding to those of gas cooled, pressurised water and fast breeder reactors. The highest levels require restrictions of the engineering of the systems which we will outline.

053. GAS PHASE CHROMATOGRAPHY OF THE HEAVIEST ELEMENTS AND THEIR HOMOLOGS. E.R. Sylwester, K.E. Gregorich, D.M. Lee, M. Hsu, C.D. Kacher, B. Kadkhodayan, D.A. Keeney, M.R. Lane, M.F. Mohar, N.P. Neu, N.J. Stoyer, A.C. Veeck, Y. Watanabe, J.C. Yang, D.C. Hoffman, Lawrence Berkeley Laboratory, MS 70A-3307, Berkeley, CA 94720.

Gas phase chromatography has been used to determine the volatility and adsorption enthalpy of the group 4 and 5 chlorides and bromides, including those for Rf and Ha. These studies provide a valuable tool for determining whether trends in the chemical properties of groups 4 and 5 are continued in Rf and Ha, and for predicting the chemical properties of the other transactinides. The data collected on these elements show the possibility of a relativistic effect which would change the electronic level structure of the heaviest elements and which would in turn change their predicted chemical properties.

*This work is supported in part by the Office of Energy Research, US Department of Energy under contract DE-ACO3-76SFO0098.

054. ASSIGNMENT OF A 2.1s SF ACTIVITY TO ^{262}Rf.* M.R. Lane, K.E. Gregorich, D.M. Lee, M. Hsu, C.D. Kacher, B. Kadkhodayan, D.A. Keeney, M.F. Mohar, N.P. Neu, E.J. Osterrieder, N.J. Stoyer, E.R. Sylwester, A.C. Veeck, Y. Watanabe, J.C. Yang, and D.C. Hoffman, Lawrence Berkeley Laboratory, MS 70A-3307, Berkeley, CA 94720.

We have produced the isotope ^{262}Rf via the ^{244}Pu(^{22}Ne,4n) reaction and measured its spontaneous fission properties and partial excitation function. Our work supports assignment of this SF activity to decay of ^{262}Rf. We measured 200 coincident spontaneous fission fragments and determined the half-life to be 2.1±0.2s. The kinetic energy and mass-yield distributions were determined and the mass-yield distribution is predominately symmetric with a FWHM of 19.6 mass units. This may be the same as the $1.2^{+1.0}_{-0.5}$s spontaneous fission activity reported by Lougheed et al. as the alpha-decay daughter of ^{266}Sg.

*Work supported in part by Office of Energy Research, US Deptartment of Energy under Contract DE-ACO3-76SFO0098.

055. ON-LINE LIQUID-SCINTILLATION-COUNTING IN HEAVY ELEMENT RESEARCH. B. Wierczinski, Lawrence Berkeley Laboratory, Nuclear Science Division, MS88, 1 Cyclotron Road, Berkeley, CA 94720

Investigation of the chemical behavior of the heavy elements requires fast automated systems for chemical studies and for measurement of α-particles and spontaneous fissions. We developed a liquid-scintillation-counting system which allows continuous measurement of α-energies and detection of spontaneous fissions in flowing liquid samples. In recent on-line-studies we obtained an α-energy resolution of ~ 200 keV FWHM for ^{233}U. The use of pulse-shape-discrimination provides adequate discrimination against β- and γ-radiation even in the presence of fission products. The overall efficiency for counting of α-particles and spontaneous fissions is estimated to be ~98 %. Measurements of ^{252}Cf-standards have successfully been performed to check the validity of the system for the detection of α- to spontaneous fission-decay ratios. Results from the use of this system in heavy ion reactions will be discussed.

056. CATION-CATION COMPLEX FORMATION AMONG ACTINIDES*
Nancy J. Stoyer and Darleane C. Hoffman Department of Chemistry, University of California, Berkeley CA 94720; and Robert J. Silva, Lawrence Livermore National Laboratory, Livermore CA 94550.

The +5 oxidation state of U, Np, Pu, and Am is a linear dioxo cation with a formal charge of +1. These cations have been found to form complexes with other cations including actinide cations. The first cation-cation complex, $NpO_2^+ \cdot UO_2^{2+}$, was reported by Sullivan, Hindman, and Zielen in 1961. Actinides have small molar absorptivities and cation-cation complexes have small formation constants; therefore, Laser-Induced PhotoAcoustic Spectroscopy (LIPAS), a relatively new and sensitive absorption spectroscopy technique, was used to overcome these obstacles. Results obtained using LIPAS for $NpO_2^+ \cdot UO_2^{2+}$, $NpO_2^+ \cdot Th^{4+}$, $PuO_2^+ \cdot UO_2^{2+}$, and $PuO_2^+ \cdot Th^{4+}$ cation-cation complexes will be presented.

*Work supported in part by the Glenn T. Seaborg Institute for Transactinium Science, Lawrence Livermore National Laboratory for the U.S. Department of Energy under Contract W-7405-ENG-48.

057. EVIDENCE FOR THE ELECTROCHEMICAL PRODUCTION OF TRITIUM AND HELIUM, J. O'M. Bockris, Chemistry Department, Texas A&M University, College Station, TX 77843

Tritium production by electrochemical means has been described in more than 20 peer reviewed papers and reported at meetings in about 100 independent reports. Most of the evidence comes from the Pd-D_2 system in D_2O-LiOH solutions.

In spite of the widespread reporting of tritium formation in the cold in many countries, the conditions whereby it can be turned on have not yet been determined. The production is enhanced by specific surface conditions, and a D/Pd ratio between 0.8 and 0.9 (higher values give the heat - and decrease the tritium). The rates reported vary from 10^4-10^{10} atoms cm^{-2} sec^{-1}.

He^4 production has been evidenced from only a few laboratories (difficulty of measurement in the presence of D). It occurs to 100 times above background in Pd. The enhanced He^4 in the gas given during electrolysis of D_2O accounts > 50% for the observed excess heat.

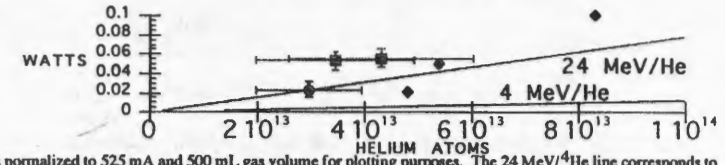
058. SOLVENT EXTRACTION STUDIES OF RF (ELEMENT 104)*, D.D. Kacher, K.E. Gregorich, D.M. Lee, A. Bilewicz, Y. Watanabe, B. Wierczinski, B. Kadkhodayan, E.R. Sylwester, M.R. Lane, D.A. Keeney, E. Osterrieder, A. Veeck, N. Stoyer, M. Hsu, J. Yang, and D.C. Hoffman, Nuclear Science Division, 70A-3307, Lawrence Berkeley Laboratory, Berkeley, CA 94720

The chemical behavior of the group 4 elements Zr and Hf and the pseudo-group 4 element Th has been examined by performing solvent extractions of the appropriate tracers from HBr or HBr/LiBr solution with 0.35 M tributylphosphate in benzene. The extraction of Zr, Hf, and Rf was investigated over a range of HB4 concentrations from 7.5 M to 9.0 M. These results indicate that Rf forms weaker complexes with bromide than either Hf or Zr. Metal-bromide stability in the 4+ elements decreases in the order Zr>Hf>Rf>Th.

*Work supported in part by Office of Energy Research, US Department of Energy under Contract DE-AC)3-76SFO0098.

045. NUCLEAR PRODUCTS COMMENSURATE WITH ENERGY GENERATED DURING D_2O ELECTROLYSIS AT PALLADIUM CATHODES; QUANTITATIVE ANALYSIS. B. F. Bush,[1] *J. J. Lagowski,[1] M. H. Miles[2]
[1]UT, Dept. of Chem., Austin, TX, 78712, [2]NAWC-WPN, Research Dept., China Lake, CA 93555

It is well known that the Pons & Fleischmann effect does not produce the same kind of nuclear products that would be expected during plasma hot fusion experiments; indeed neutron and γ - ray fluxes commensurate to excess heat generated have not been observed. We report the generation of helium quantitatively commensurate to the amount of excess energy generated as heat during electrochemical calorimetric experiments. Preliminary results are shown in the plot below:



The data is normalized to 525 mA and 500 mL gas volume for plotting purposes. The 24 MeV/^{4}He line corresponds to $^2H + {}^2H \rightarrow {}^4He + 24$ MeV, the most energetic reaction known, while the 4 MeV/^{4}He line is shown likewise to add perspective. The quantity of helium produced compared to the energy generated indicates that a high energy nuclear process is induced during electrolysis.

046. AN OVERVIEW OF EXCESS HEAT PRODUCTION IN THE D/Pd SYSTEM AT SRI. Steven Crouch-Baker, Alan Hauser, Nada Jevtic, Michael McKubre, Stuart Smedley, Francis Tanzella, Energy Research Center, SRI International, Menlo Park, CA 94025

Experiments have been undertaken to demonstrate and quantify the rate of heat production of palladium cathodes loaded electrochemically with deuterium. Excess heat has been observed in these experiments at SRI on more than 40 occasions in accurate and stable isothermal mass flow calorimeters. The excess power appears to be correlated with at least three criteria: the degree of deuterium loading (specified as the atomic ratio D/Pd), the time for which high loading is maintained, the interfacial current density. The correlation between excess heat production and these three variables will be discussed. In addition, the results of experiments designed to search for further products of the heat producing reaction will be reported.

047.

Improved Protocols for Observation of Anomalous Heat from Deuterated Palladium
Dennis J. Cravens, Vernon Regional Junior College, Vernon, Texas 76384

A series of low precession experiments were conducted to screen factors relevant to the observation of anomalous heat from deuterated electrochemical systems. Techniques are presented which were found to improve the opportunity for observation of the heat. The effect was found to be very sensitive to experimental protocol. Warnings against some common errors in protocol are offered. The improved techniques include proper selection and handling of materials, correct features within the design of experimental apparatus, sequence and magnitudes of electrical currents, and patience.

048.

Excess Heat During Electrolysis of 1 M LiOD in Fuel Cell Type Closed Cell
K. Kunimatsu, N. Hasegawa, Y. Yamamoto, N. Hayakawa
IMRA Japan Co., Sapporo, Japan

Electrolysis of 1M LiOD was conducted using Pd Cathodes from various sources in a fuel cell type closed cell using a fuel cell anode. The cathode loading by deuterium, D/Pd, and excess heat were monitored simultaneously as a function of current density from the pressure decrease of D2 gas in the cell and by monitoring cathode temperature as a function of electrolytic input power, respectively. Up to 35% excess heat was recorded for D/Pd > 0.80 - 0.84 with a threshold current around 100 ~ 200 mA/cm^2.

049. DEMONSTRATION OF ANOMALOUS HEAT FROM THE "COLD FUSION" EFFECT
Edmund Storms, 270 Hyde Park Estates, Santa Fe, NM. 87501

Heat production by an unexpected process is the most challenging aspect of the "cold fusion" phenomenon to accept. Many studies have been done in ways that invite criticism and easy rejection. A few recent studies have attempted to eliminate obvious errors and, thereby, reduce the ease of rejection. In addition, several of these studies have revealed important variables related to improving reproducibility. This paper will describe heat measurements done at the Los Alamos National Laboratory using a closed, pressurized, stirred calorimeter having two independent methods of calibration. Results using several batches of palladium are discussed in terms of those characteristics that lead to reproducibility using the electrolytic loading technique.

050. CALORIMETRIC OBSERVATION OF EXCESS HEAT DURING ELECTROCHEMICAL INSERTION OF DEUTERIUM INTO PALLADIUM. Turgut M. Gür, Martha Schreiber, and Robert A. Huggins, Department of Materials Science and Engineering, Stanford University, Stanford, CA 94305

In order to address the energy break-even issue, the thermal behavior of the Pd-D system was studied during electrolysis of heavy water in a thermodynamically closed cell. A specially designed isoperibolic calorimeter was developed for this purpose and was fully characterized. Eleven pretreated, fresh Pd cathodes were individually tested in identically designed calorimeters and their thermal behavior were monitored starting from time zero. In two of the cases, excess power was observed in which the overall energy balance became positive after a relatively short period, leading to the generation of significant amounts of excess energy. In one case, excess power was maintained over a period of ten days, and produced over 23 MJ of excess energy per mole of palladium.

051. PROSPECTS FOR THE FUTURE DEVELOPMENT OF COLD FUSION. H. Ikegami, National Institute for Fusion Science, Chigusa-ku, Nagoya 464-01, Japan

Almost five years have passed since the first announcement of cold fusion in March of 1989. Over this period there have been, from time to time, a number of reports of the observation of excess heat and nuclear reactions. Concerning nuclear reactions, there still remains the controversial questions of ***fusion***, which has given its name to the phenomena associated with cold fusion. In any event, so long as the reproducibility remains so poor, it is impossible to resolve such questions and the original controversy has not faded away. From the very beginning of cold fusion, it has been generally conceded among scientists that the claimed excess heat cannot be merely a result of the ordinary DD fusion. Neutron emissions were extremely weak and sporadic, which made almost nothing of correlation measurements between excess heat and fusion reactions. Another peculiar feature of the nuclear reactions, associated with cold fusion, lies with the observation that the generation of tritium, which is concurrent with neutron emission, is nonetheless more than ten million times larger than that of the neutrons, and still it is not clear how this relates to the heat. Moreover there are claims that the excess heat production can be correlated to the production of helium-4 as nuclear ashes. These findings have promoted exotic theoretical models to explain cold fusion mechanisms.

and memory of a new discharge source which operates on CO_2 gas supplied directly from a CNH combustor. The discharge within the source is energized by 2.45 GHz microwave power; no tungsten filaments are needed. The discharge cavity is self cleaning through an arrangement where it is constantly 'scrubbed' and sputter-etched by an oxygen discharge. When needed, spurts of higher pressure oxygen can be introduced to the discharge chamber that oxidize any carbon which may have deposited onto the walls and convert it to CO gas that can be quickly pumped away. There are no rubber O-rings needed in critical places and gold coatings are used on all of the internal surfaces.

039. GENOTOXICITY OF NICOTINE AND ITS DERIVATIVE NITROSAMINE STUDIED BY ACCELERATOR MASS SPECTROMETRY. X.S.Li, Y.F.Liu, J.Y.Shi, X.Y.Wang, Department of Technical Physics, Peking University, Beijing 100871

DNA adduction with nicotine and nicotine-derived nitrosamine, 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanone(NNK) in mice at environmental doses has been observed using ^{14}C-labels by AMS. Formation of NNK-DNA adducts is linearly dependent on chemical form of carcinogen NNK binding to DNA is speculated. It is primarily proposed that nicotine appears carcinogenic via its conversion to nitrosamines. A detection limit of DNA adducts of 1 adduct per 10^{11} nucleotides has been achieved.

040. RATIONALIZATION OF 'COLD FUSION' VIA ELECTRON CAPTURE MODEL, G. Andermann, Department of Chemistry, University of Hawaii, Honolulu, Hawaii 96822-2275

In spite of recent publications in respected journals skepticism continues regarding the existence of anomolous low energy (excess heAT) and high energy nuclear events observed with 'cold fusion' phenomena. This skepticism is justifiable due to the high degree of irreproducibility of the observations and the apparent inability to provide a theoretical rationalization for the simultaneous existence of both low and high energy events and for their irreproducibility. By usine the electron capture model and thereby creating thermal dineutrons as well as vacancies in the valence orbitals of the Pd-D 'matrix', where the probability of electron capture and the resultant vacancy creation is highly sensitive to the dynamics of the experimental variables, it is possible to rationalize all of the observed high and low energy events and their irreproducibility. If this model is correct, then the term 'cold fusion' is a historically significant misnomer. According to the proposed model the anomolous phenomena are best described by the terminology of 'correlated nuclear transformations and low energy events' controlled by the dynamics of labile valence electron structures in deuterium packed Pd.

041. RELATIVE SPACE DYNAMICS THEORY FOR NUCLEAR CHEMISTRY, T. Garcia, L. Slaughter, E. Stedman, and W. Slaughter, RESEARCH DATA ANALYSIS, Box 324, Redlands, CA 92373-0324 (909) 798-0890 [message machine]

A practice for centuries has been to conceive of some sort of mathematics and then apply to observed scientific data. Instead, we wish to go over the derivation carefully in which any observation must carry with it from scientific space to mathematical space three unknowns whether one may be known or not (e.g. perhaps the creation time of an unstable nuclide): a linear observed space translation (+ or -), an upper limit, and a lower limit. Many observations of this century have pointed to exponents as a more likely behavioral index: $x = \ln(\theta + \theta_{trans})$, so that some value of x lies in the range between x_{lower} and x_{upper}. Then segments A and B below and above x (see diagram) are used to define an S-transformation of the original θ variable,

x_{lower} — A — x — B — x_{upper}

Such an S-fuction gets rid of all dimensions. $S(\theta) = \ln\frac{A}{B} = \ln\left[\frac{\ln(\theta+\theta_t)-x_L}{x_U-\ln(\theta+\theta_t)}\right]$

For "no discrimination of variables" and for time, t, a similar S(t)-S-transformation of time is formed the same way. Then a sum and di[illegible]e of the two S-functions is done by computer analysis.

042. FIELD MEASUREMENT OF TRACE LEVEL Ar-41 CONCENTRATION IN ENVIRONMENT USING PORTABLE SPECTROMETER C. Chung, Institute of Nuclear Science, National Tsing Hua University, Hsinchu 30043, TAIWAN R.O.C.

Rapid, quantitative determination of individual rare gaseous radionuclide is the most difficult task in the field of environmental monitoring of radiation. A method to measure in situ concentration contributed from argon gaseous radionuclide was developed using a portable gamma ray spectrometer. The portable HPGe detector has calibrated with sensitivity of 0.36 nSv/h per cpm of the 1294 gamma, emitted from the radioactive Ar-41. Field measurement are conducted both inside and outside of the containment of a nuclear facility during the reactor full power operation; isodose-rate contour curves are mapped. The in situ measurement can be readily performed at various locations near a nuclaear reactor with the 14 kg portable spectrometric unit. With a longer measurement period, the level of Ar-41 can be determined down to 0.1% of the natural background.

This work is financially supported by the NTHU, Ministry of Education.

043. Mass Spectrometric Helium Analysis of Solid and Gas Samples From Cold-Fusion Type Experiments

B.M. Oliver Rockwell International Corporation, Rocketdyne Division 6633 Canoga Avenue, Canoga Park, CA 91309

A custom mass spectrometer system, operating in static mode, has been used to measure helium in both solid and gas samples from cold-fusion type experiments. The mass spectrometer is a 2-in. Radius, 60°, permanent angle magnet instrument with a single electron-multiplier collector. Depending on the absolute levels of helium expected, the analysis are conducted by isotope dilution or by measuring absolute collector values. Solid samples are vaporized to ensure complete helium release. Prior to analysis, the fraction of sample gas to be analyzed is exposed to a series of physical and chemical getters, including room temperature Zr-Al alloy (SAES type 101) and liquid-nitrogen cooled activated charcoal. This is done to remove active gases and hydrogen isotopes which could interfere with the helium determinations. Generally, the analysis protocol is to analyze an equal or greater number of "controls" along with the samples to accurately characterize system background and reproducibility. Absolute sensitivity for the system is approximately 1×10^9 atoms. Absolute accuracy is 1% or better for helium levels $> 10^{11}$ atoms.

With few exceptions, helium analysis of solid samples from cold fusion type experiments have yielded no excess helium above usual system background. A few samples have shown helium levels in the low 10^9 atom range, and some gas samples have shown ^4He levels up to several hundred ppm.

044. CAVITATION INDUCED SOLID STATE PRODUCTION OF HEAT, ^3HE, AND ^4HE

Roger Stringham & Russ George, E-Quest Sciences Inc., PO Box 60642, Palo Alto, CA. 94306

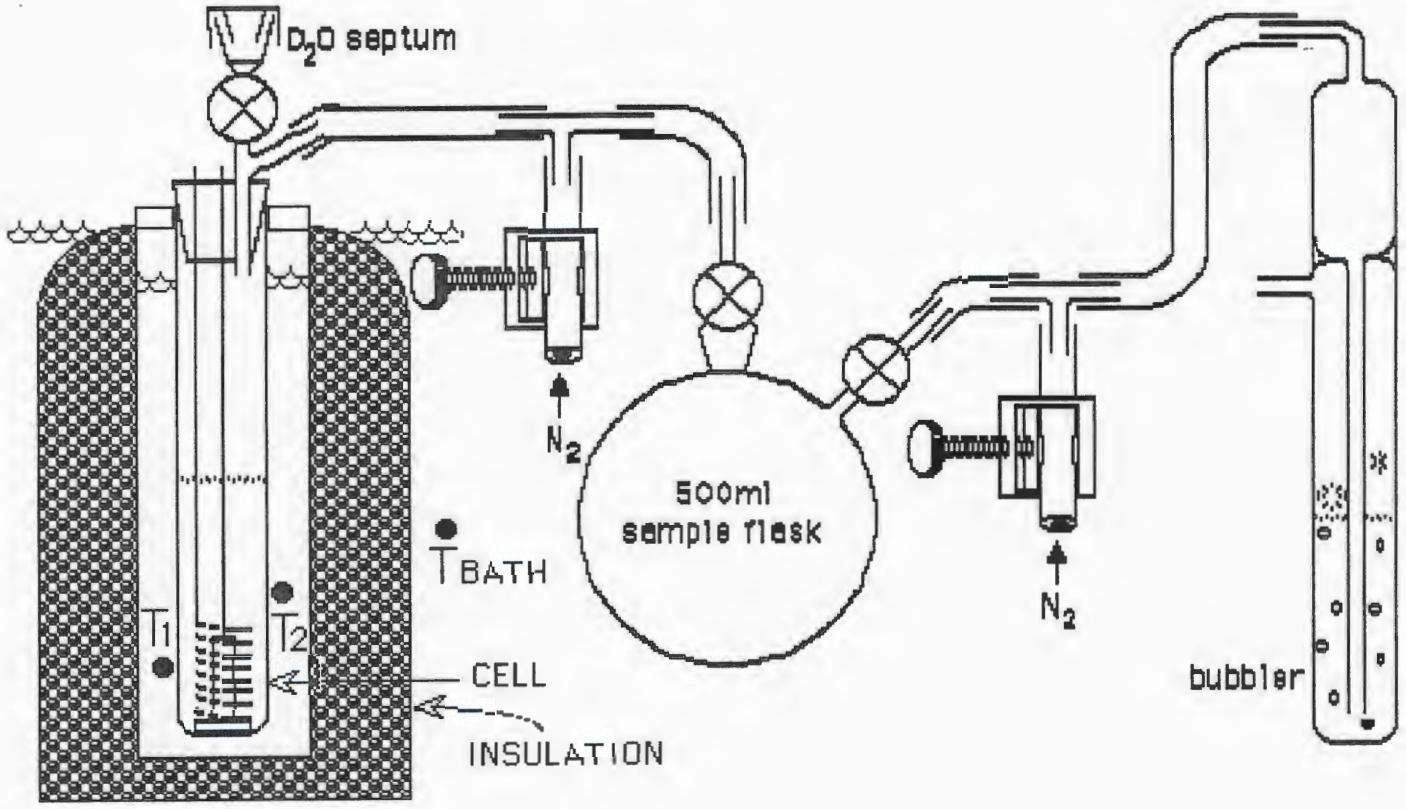
The authors report production of heat, ^3He and ^4He via cavitation-induced solid state nuclear processes at near room temperature. Demonstration experiments conducted by the authors at Los Alamos National Laboratories involved bombardment of palladium and titanium with intense ultrasound while immersed in circulating D_2O. Gas samples representing a large fraction of the total produced were taken after a few hours of operation and analyzed using mass spectroscopy at Rockwell International's laboratory with the support of the Electric Power Research Institute. In the case of the argon pressurizing gas used in the experiments a ^4He level of >0.475 appm ±0.008 appm (4.75×10^{14} atoms) was determined. A sample of reaction gas taken after a 3,5 hour experiment revealed levels of ^4He at 2.550 appm ±0.01 ppm (31.46×10^{14} atoms). A reaction gas sample taken following a 24 hour experiment showed the level of ^4He to be 552 appm ±1.0 appm (>7460 x 10^{14} atoms). ^3He was measured and a skewing of the ^3He:^4He ratio is far outside (1000x) of the natural abundance ratio. ^4He levels in these experiments were in good agreement with measurements from similar experiments as determined by tw[illegible]te independent laboratories. Monitoring for neutrons, gamma, and tritium revealed no signals above bac[illegible]

INTRODUCTION:

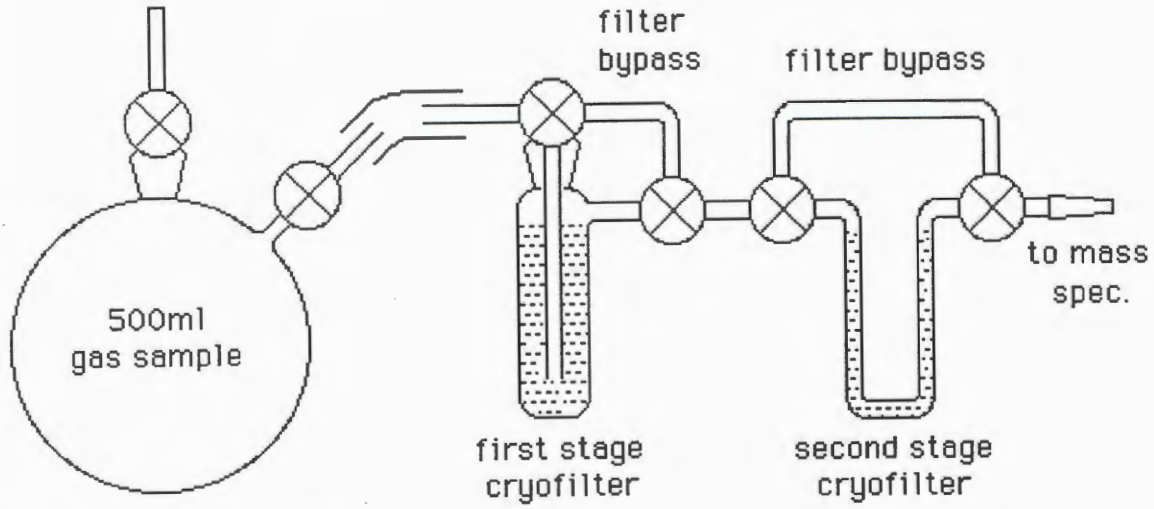
1) **Nuclear products are produced in the quantities expected for a high energy nuclear process which deposits its energy as heat.**

2) **Nuclear reactions are 1,000,000 times more energetic than chemical reactions.**

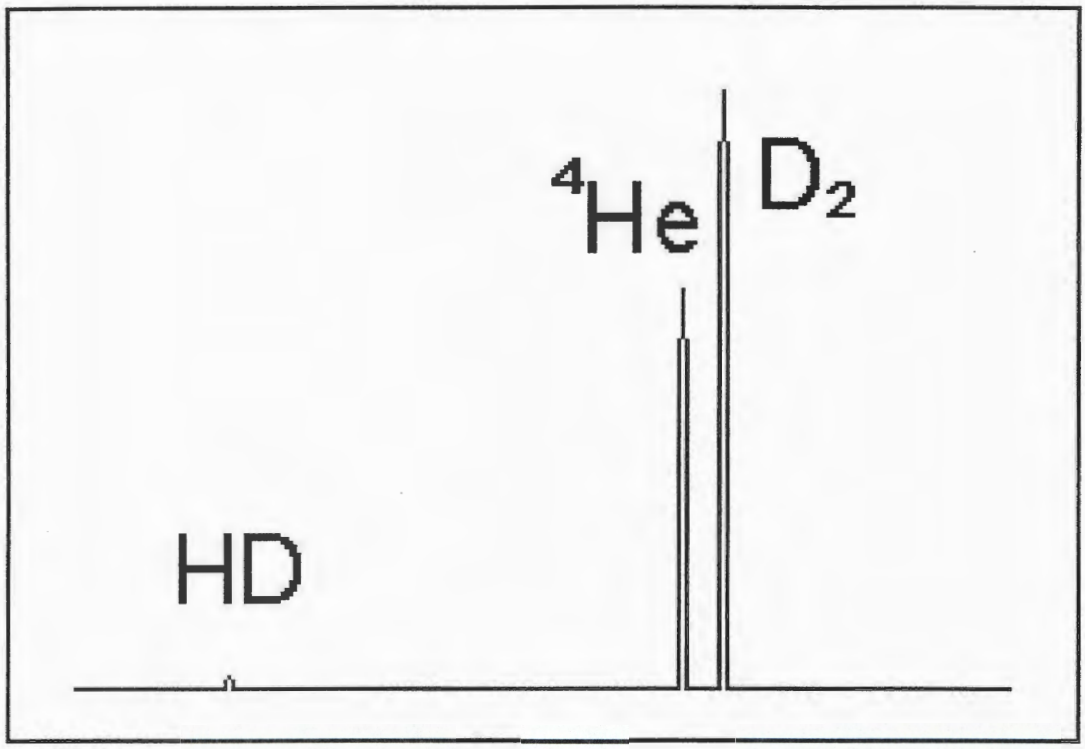
3) **Excess heat is real, excess heat generation is not traceable to a chemical process.**



- **Isoperibolic Calorimetry ±10-20 mW**
- **Glass Collection Flasks**
- **Fairly large excess heat events were observed.**



Liquid Nitrogen cooled two stage activated charcoal cryofilter removes D_2 and O_2 from gas sample.



- **Mass Spec. baseline separates ^{4}He from D_2.**
- **No ^{3}He observed.**
- **^{4}He observed and identified by its ionization potential and mass.**

RESULTS:

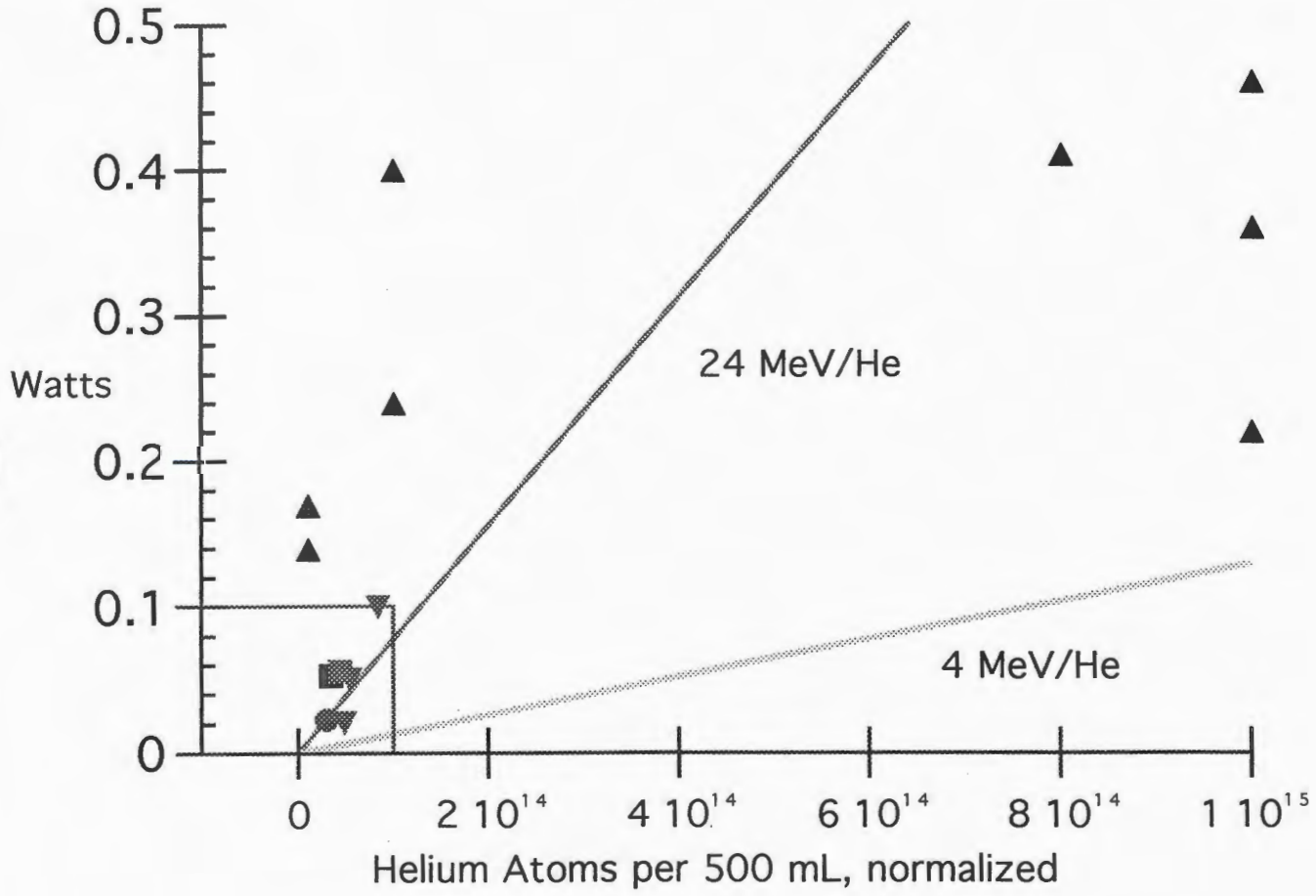
- **8 samples taken during periods of substantial energy generation contained detectable ^4He.**

- **6 control samples taken during H_2O electrolysis and no energy generation did not contain detectable ^4He.**

- **The odds of getting this result by random chance is $(1/2)^{14}$ or 0.0061%**

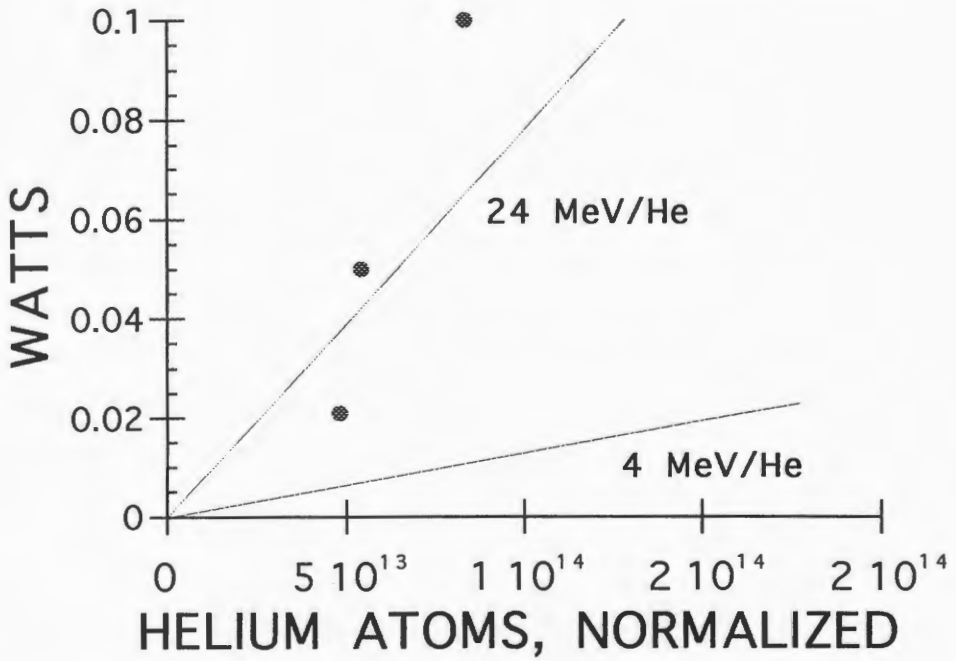
1. J. Electroanal. Chem., 304, 271, (1991)
2. J. Electroanal. Chem., 346, 99, (1993)

ESTIMATE of quantities of ^{4}He observed, based on later research.



- **Non-quantitative.**

Early Quantitative Data



- **^{4}He diffusion was measured, diffusion was back calculated to sample collection time.**

- **Confirmed: Early results are qualitatively correct.**

3. **Fusion Technology, vol. 25 (no. 4) 478-486 (1994)**

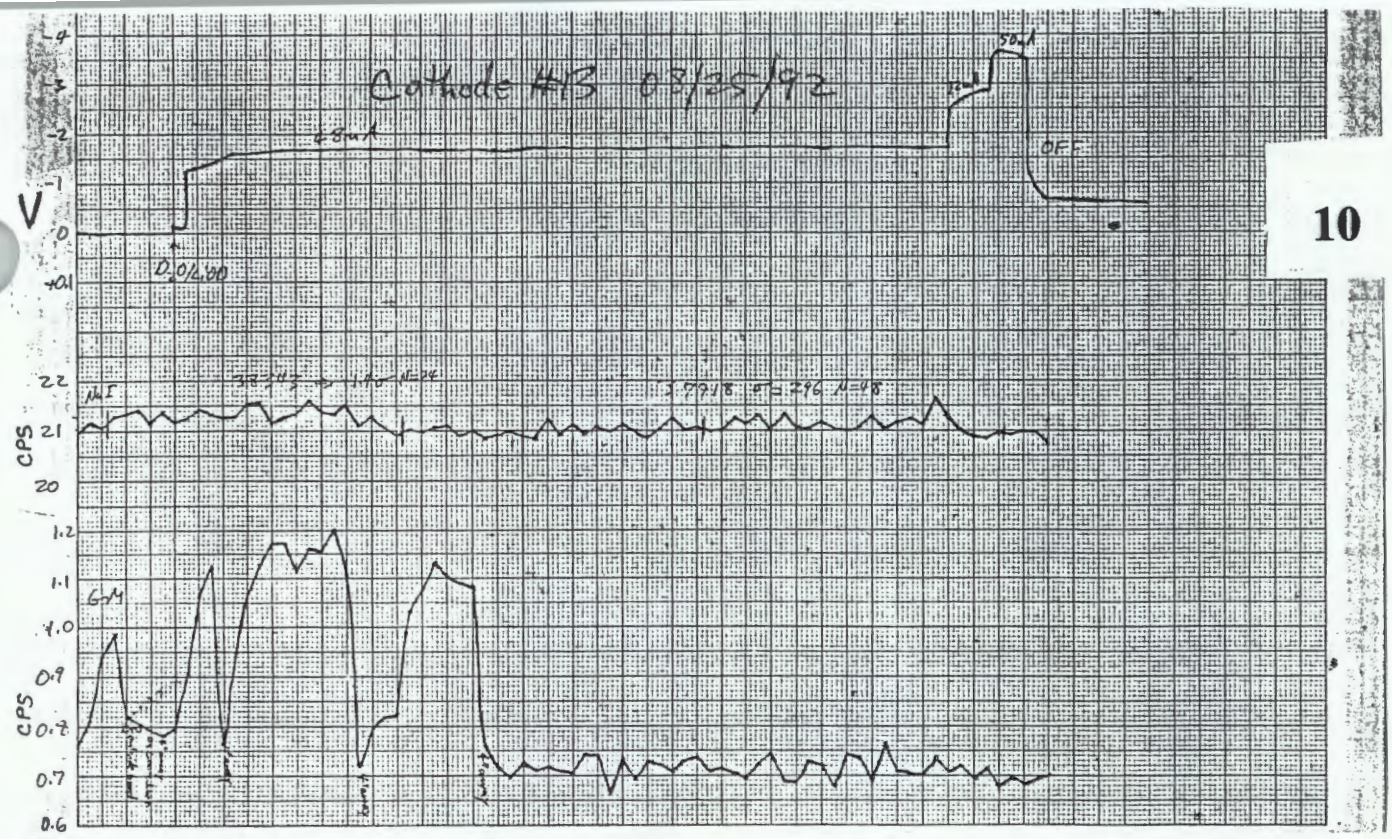
Szpak Codeposition:

Electrolytic deposition of Pd and deuterium from Li_2PdCl_4 solution of D_2O.

- pH of solution is unstable during electrolysis: ~$PdCl_2$-->$Pd^{(0)}$ + DCl, pH decreases, then Cl_2 gas is evolved.
- Rarely gave excess heat. Recombination ($D_2 + O_2$-->D_20) and explosions were common.
- Sometimes caused high counts on Geiger counter.

Electroplated Cathode Developed:

- Used H_20 based commercial plating bath.
- Baked cathodes in vacuum oven at ~120 ^oC, then polished.
- Gold flashed copper used as substrate.
- Plating did not survive electrolysis, no excess heat.
- Gave indications of radiation with Geiger counter.



- Count rate decreased when Geiger-Mueller detector was moved away from the cell.
- Radiant intensity decreases in approximate accordance to 1/(Distance)^2.
- Lead covered G-M detector gave high counts, suggesting the presence of high energy gamma radiation.
- Landauer G-9 dosimeters showed 30mR versus control, of hard gamma radiation (over 100 KeV).
- Attempted gamma ray spectroscopy failed.

Calorimetry: The measurement of Energy.

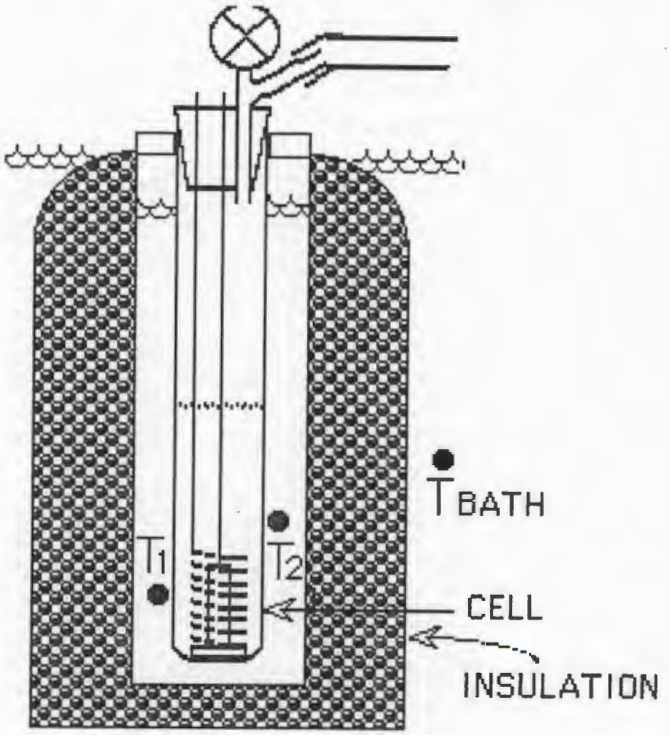
- Excess Heat = Energy (out)-Energy(in)
- "Closed"cell Energy(in) = $I(V_{cell})$
- "Open"cell Energy(in) = $I(V_{cell}-1.53)$

  Because 1.53 volts worth of energy leaves the cell with the $D_2 + O_2$ gas that is formed.
- Gas formation rate is measured and the volume corrected for ambient pressure.

4. J. Phys. Chem. vol. 98, no. 7, 1948-1952 (1994)

ISOPERIBOLIC Calorimetry:

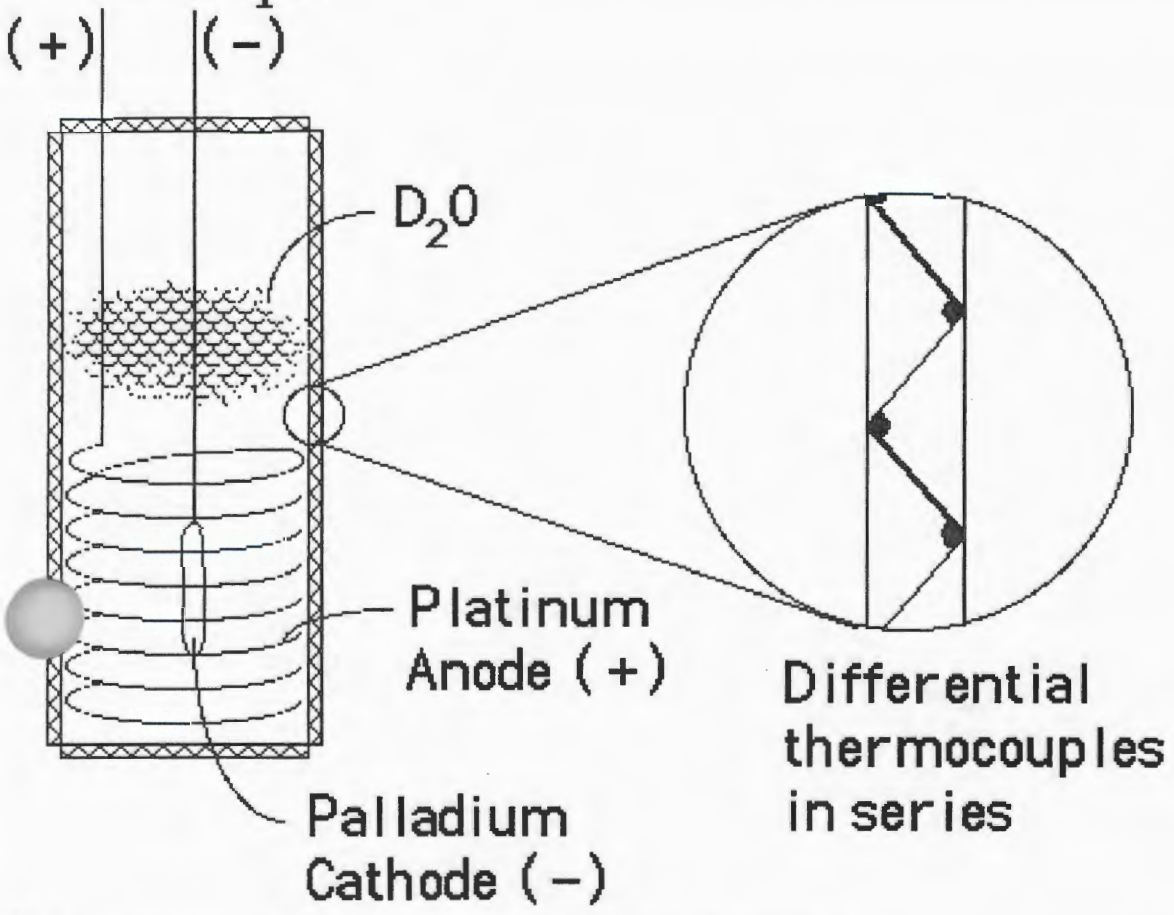
- Assumes thermal homogeneity



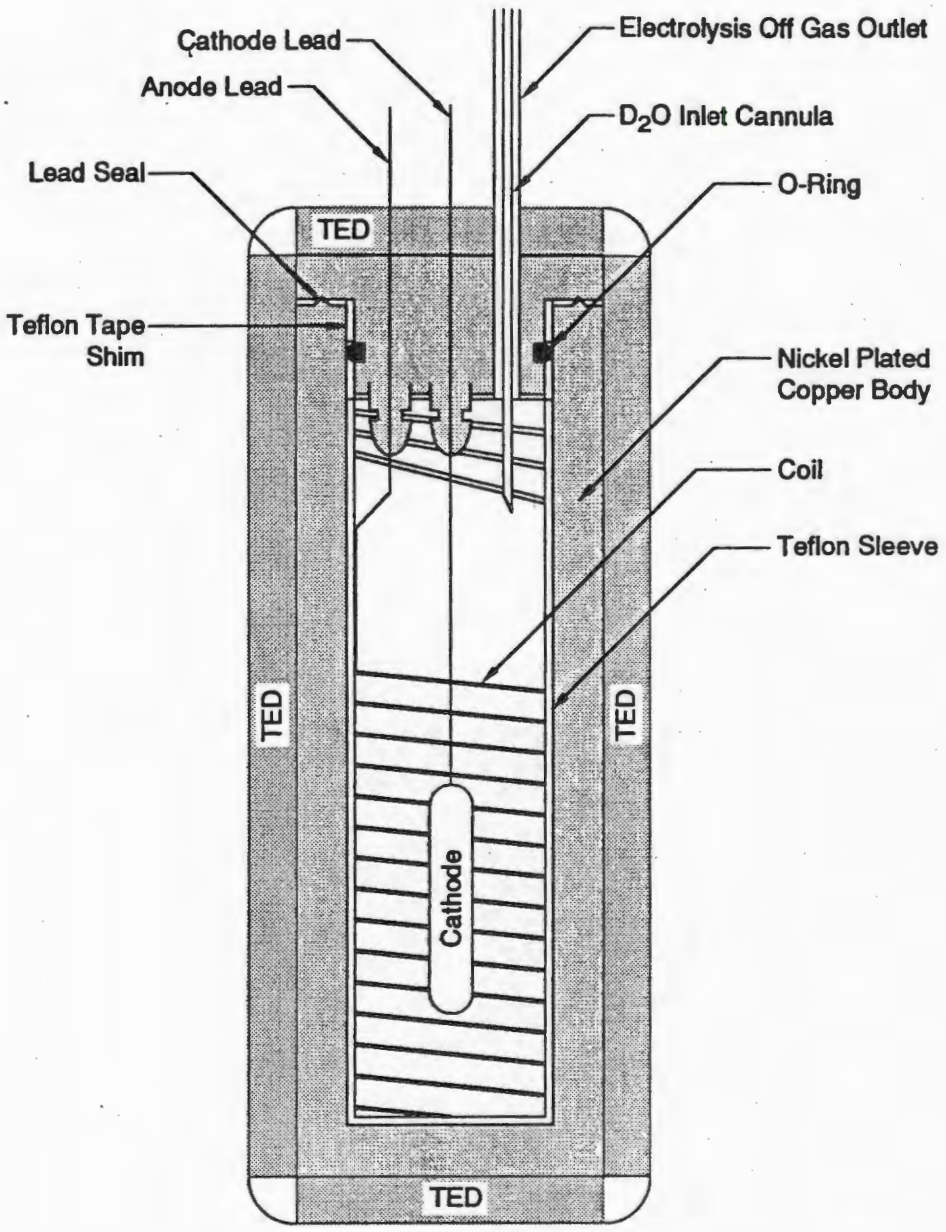
- 10-20mW typical accuracy
- ~Linear response:
  Energy(out)=k(ΔT)+b
- Measure ΔT to 0.01 °C.
- Narrow power range.
- Cell temperature is variable.
- τ~ 25 minutes, which means that it takes ~ 2 hours to reach 99% of equilibrium (S-L-O-W response).

Seebeck$_m$Calorimetry: Integrating heat flux calorimetry.

- Like a high performance Calvet calorimeter.
- Differential mode thermocouples, connected in electrical series comprise a thermal flux transducer envelope.



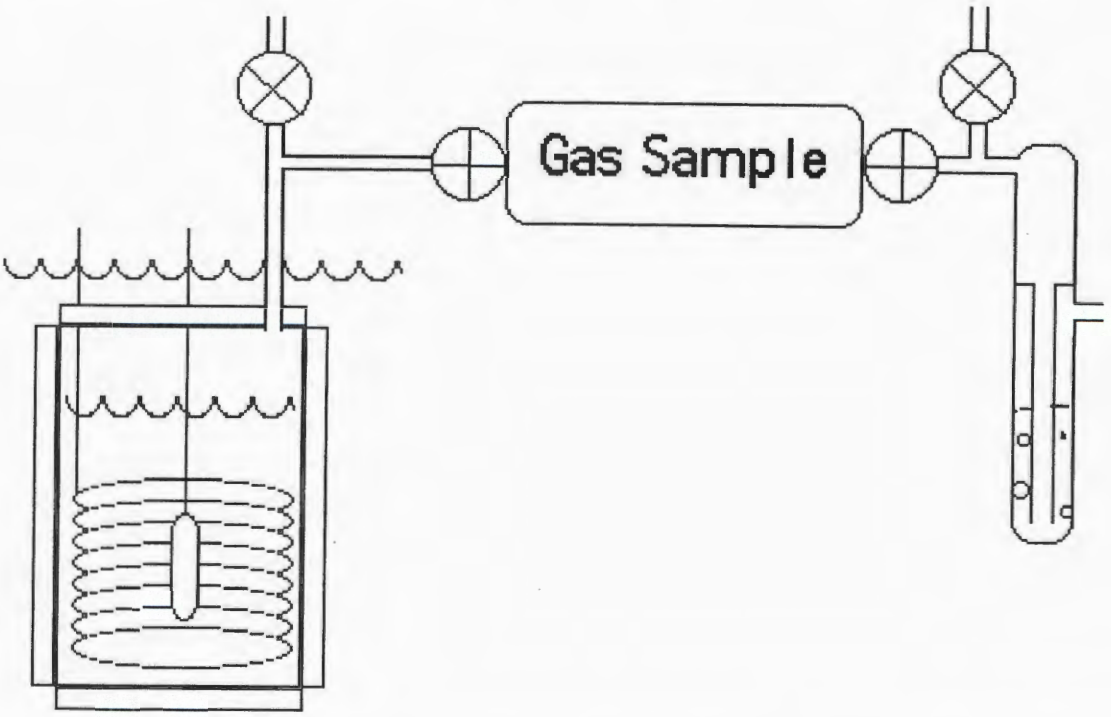
- Energy(out) = k(Vtransducer)
- Enormous dynamic range (mW to ~100W)
- τ~5minutes: ~$\frac{1}{2}$hour to reach 99% of equilibrium (FAST response).
- Narrow temperature range.



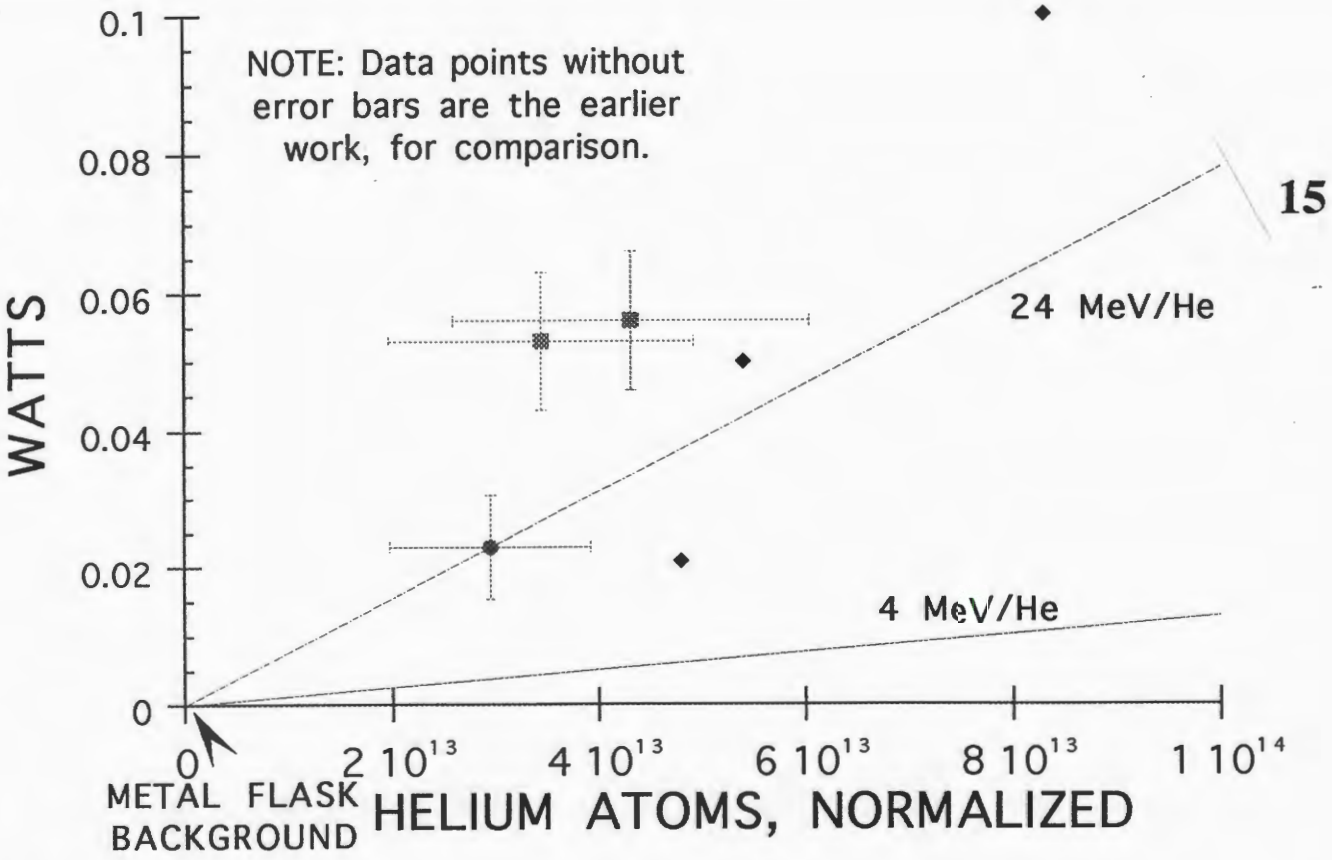
Cell

All Metal cell, using metal seals throughout system. Helium can not diffuse through seals.

Seebeck energy vs. helium study.



- All metal system: no helium diffusion.
- ±10mW due to primitive data acquisition system.
- Metal ions from calorimeter and gas manifold inhibit excess energy generation.
- ^{4}He background below detection limit of 1±1 ppb.

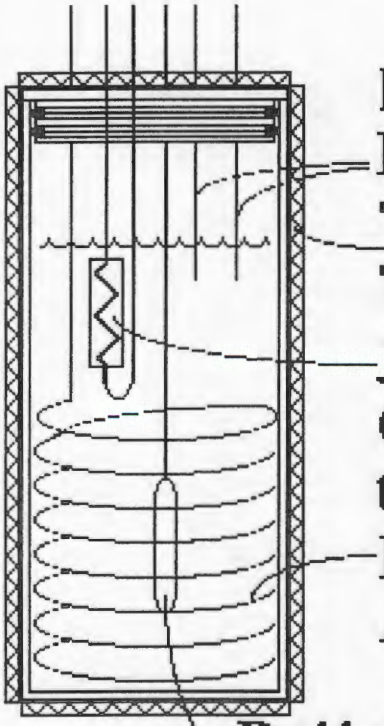


- **Helium background checked on similar flasks to check for flask leakage on a better Mass Spec.**
- **Flasks do not leak even when "containing" vacuum over 3 weeks.**
- **<u>Helium is commensurate to a high energy nuclear reaction.</u>**
- **Precision is to low to identify reaction pathway.**
- **Slight deficiency of helium may indicate helium occlusion in the cathode.**

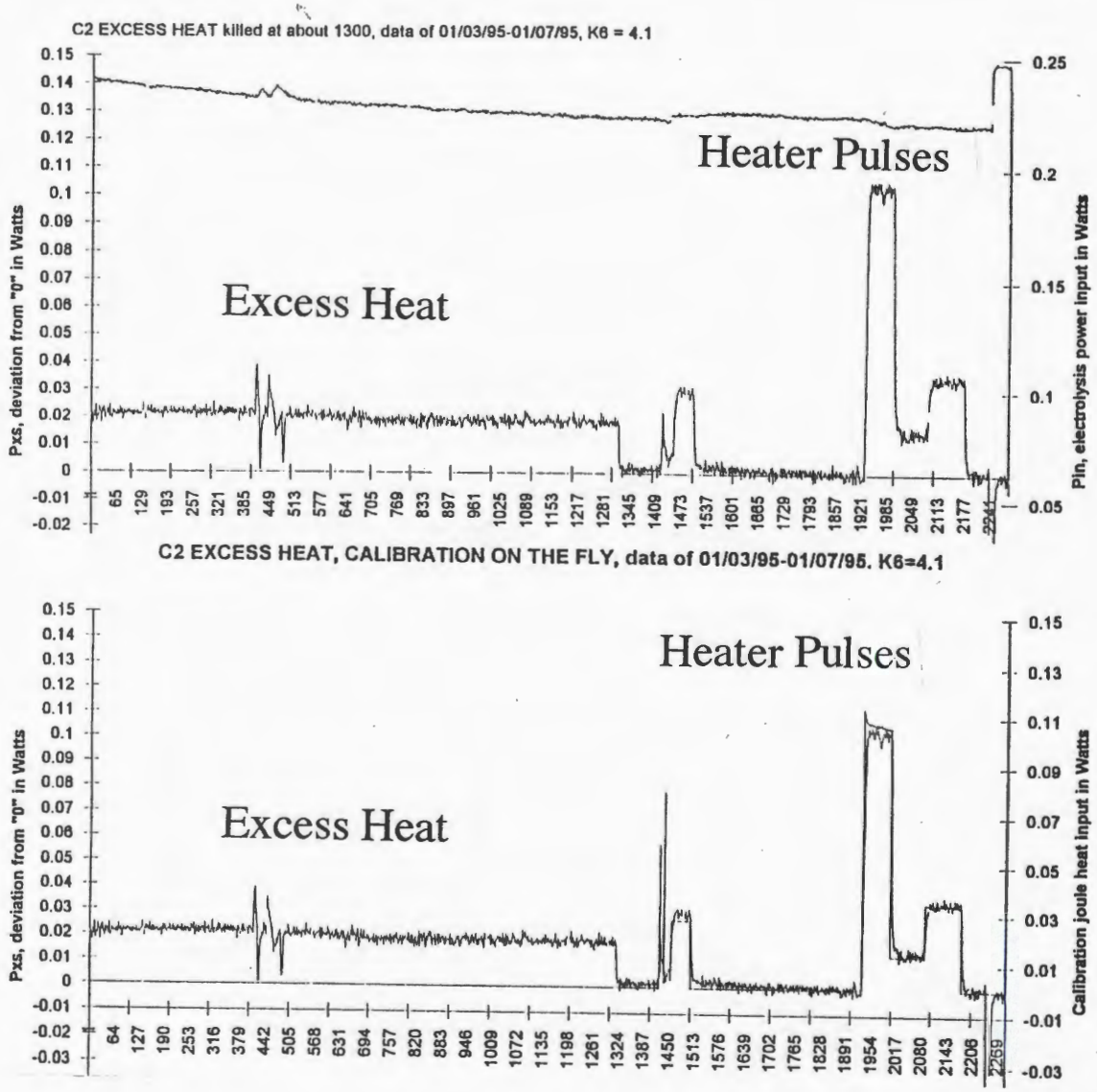
FUTURE EFFORT:

- **Same experiment with higher precision.**
- **Measure the ^{3}He:^{4}He isotope ratio routinely.**
- **Measure excess power to high accuracy ~$\pm$1mW.**
- **<u>Correlate high accuracy helium versus heat data to identify the nuclear reaction explicitly.</u>**
- **Develop custom cathode materials for reproducibility.**

Seebeck Calorimeter with an Electrolysis Cell

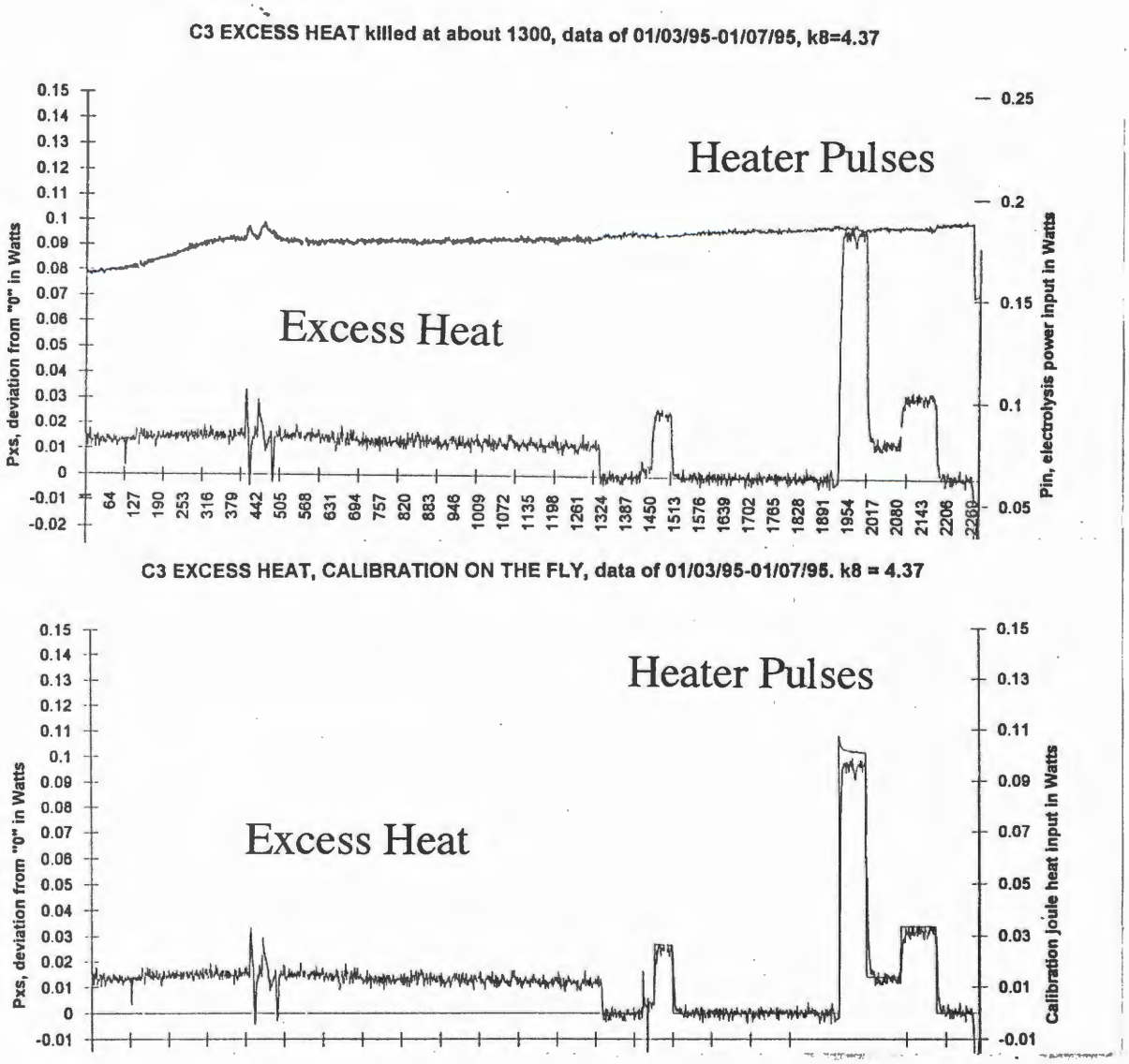


Calorimeter C2:



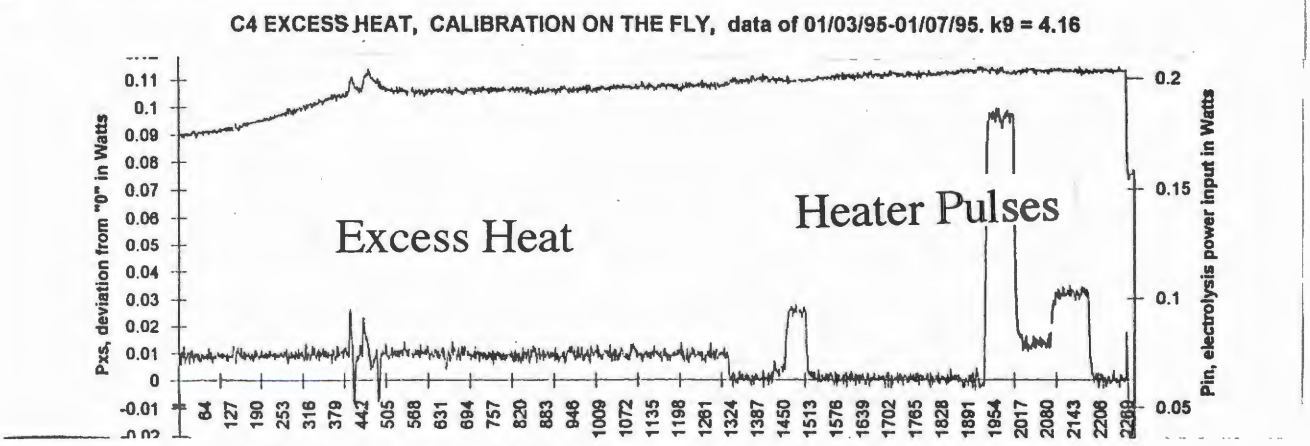
- **Excess heat terminated when ohm meter applied to fluid level sensor.**
- **Data points taken every $1/2\,\tau$ i.e. every 2 minutes.**

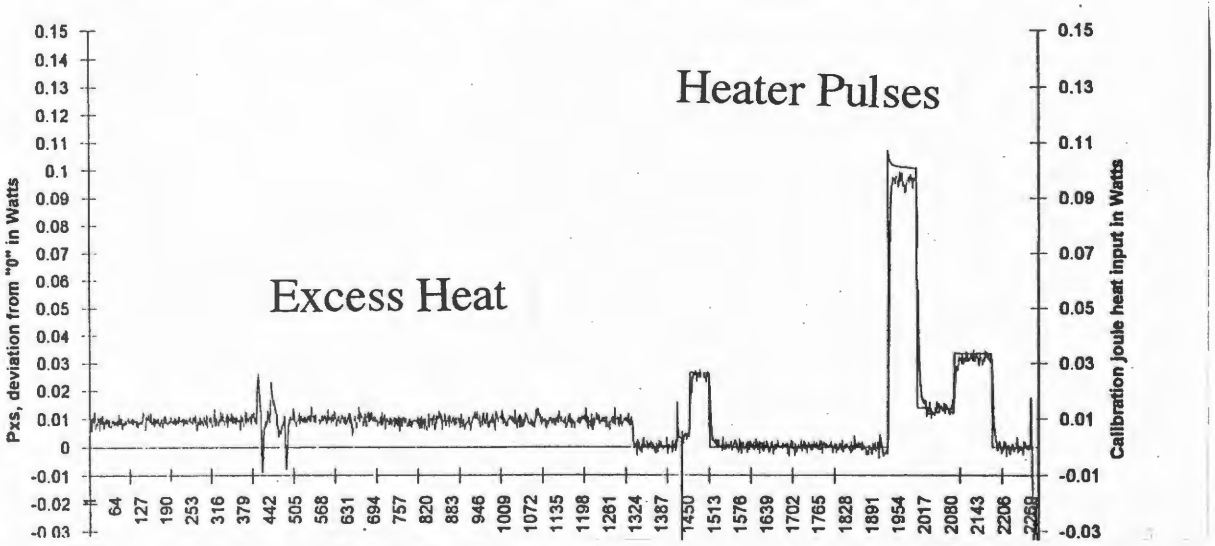
Calorimeter C3:



- C2, C3 and C4 experiments are parallel.
- Experimental accuracy is about ±1mW.

Calorimeter C4:





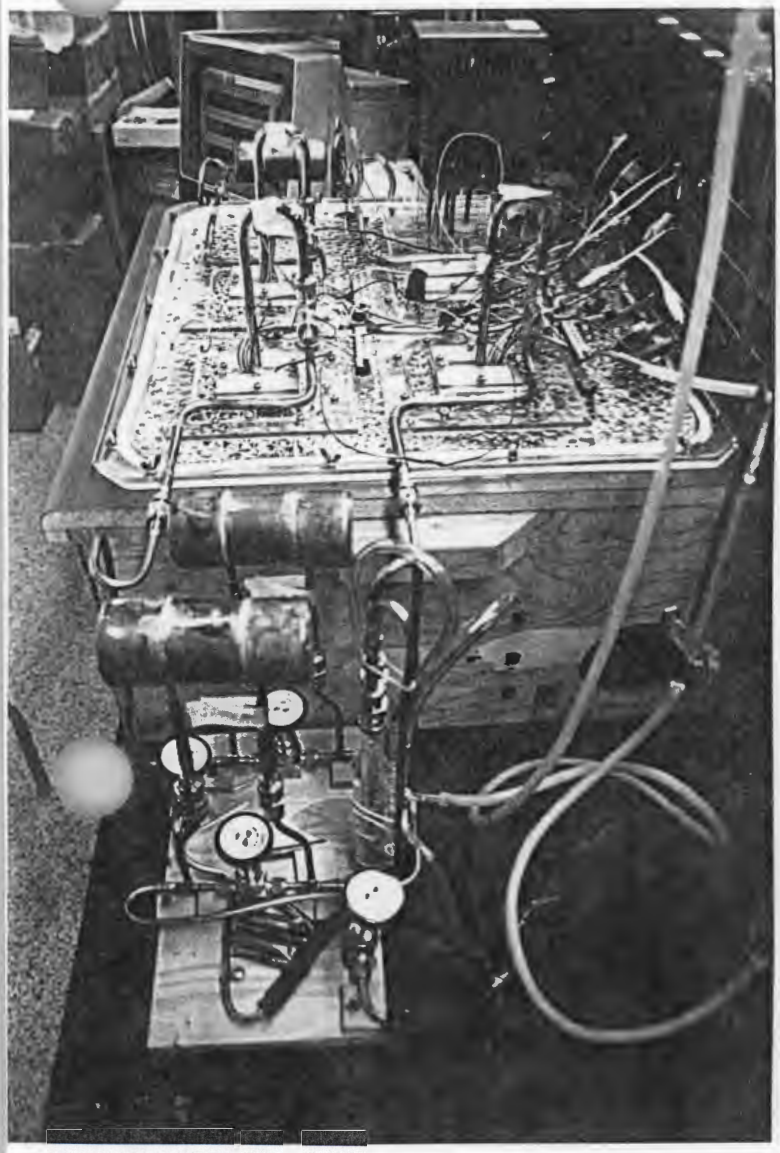
- **Several days worth of data is depicted in each plot set.**
- **The instantaneous termination of the excess heat is consistent with a surface effect.**

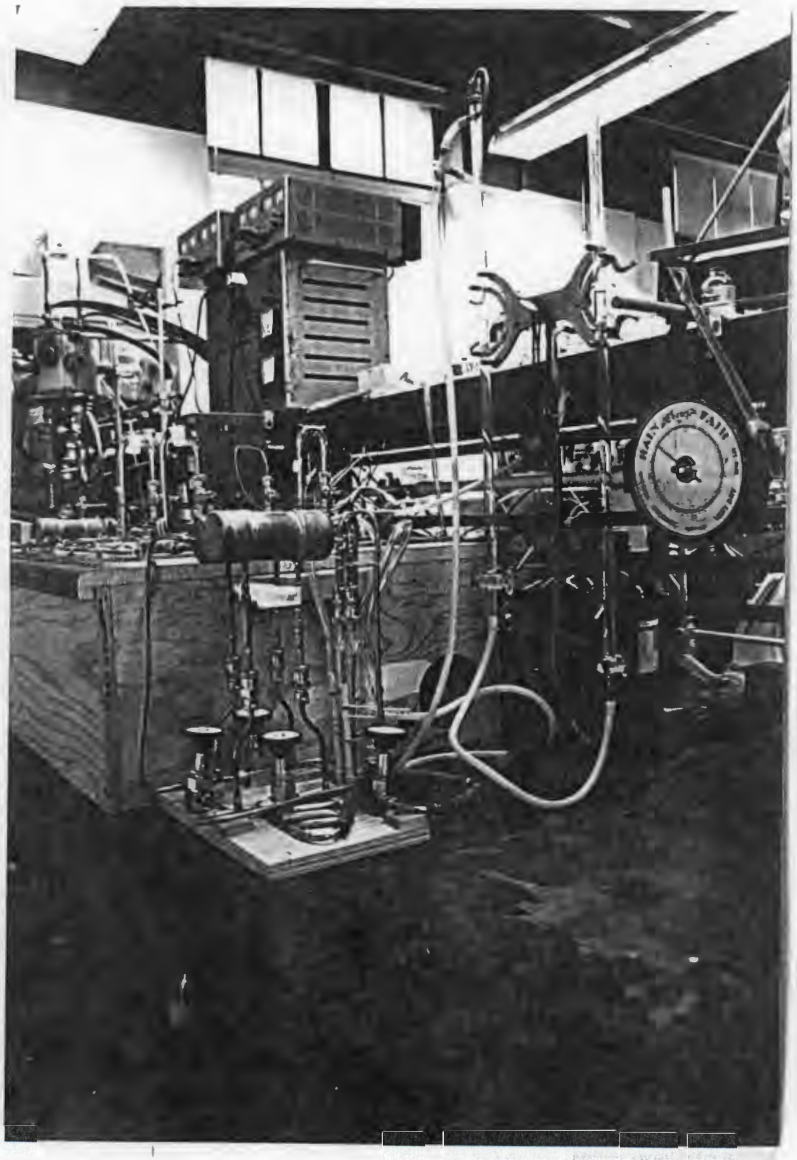
Excess heat was observed in 3 out of 3 tries.

cell	cath. dimensions DmmXLcm	current density mA/cm^2	cath. vol. cm^3	cath. area cm^2	Excess power mW
C2	6X2	33	0.51	3.77	22
C3	3X2	43	0.13	1.88	14
C4	3X2	64	0.06	1.26	10

- Amount of excess heat scales to the surface area of the cathode.
- Instrumentation problems developed and gas samples were not taken in time due to logistics.

Photographs of Equipment

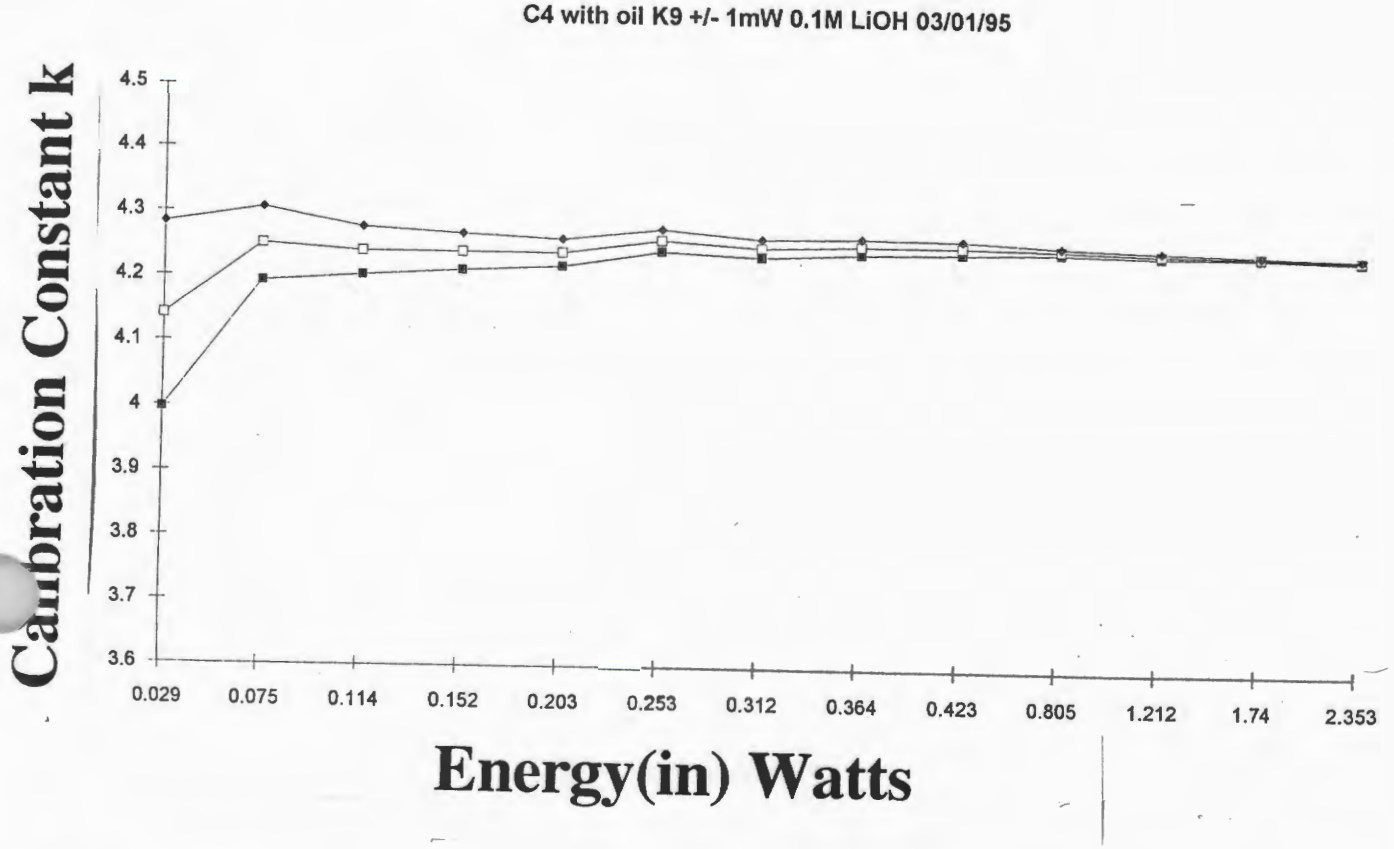




LEFT: View looking down on water bath, copper sample flasks and gas manifold valves in foreground, data acquisition system in background behind another sample flask.

RIGHT: View on level showing: balancing burette apparatus for measuring gas evolution rate, barometer in view is obsolete, two DC power supplies in top of photograph.

- **Work continues to fully characterize the calorimeters.**



- **The plot represents the error of the calorimeter calibration constant necessary to induce a ±1mW error, as a guide to accuracy.**

CONCLUSIONS:

- The excess heat which is observed is caused by a reaction which produces ^4He.
- The suite of reactions produces very little penetrative radiation.
- Improved experimental precision may allow explicit identification of the nuclear reaction pathway.
- Atmospheric contamination is not significant.

Acknowledgments:

FUNDING:

1. **Robert A. Welch foundation.**

2. **American Society for Engineering Education Fellowship - under the United States Navy.**

3. **Electric Power Research Institute**

4. **Dr. John Fontanote/equipment: NAWC-WPN**

Selected References:

1. **B.F. Bush, J.J. Lagowski, M.H. Miles and G.S. Ostrom, "Helium Production During the Electrolysis of D_2O in Cold Fusion Experiments," J. Electroanal. Chem., 304, 271 (1991).**

2. **M.H. Miles, R.A. Hollins, B.F. Bush, J.J. Lagowski, and R.E. Miles, "Correlation of Excess Enthalpy and Helium Production During D_2O and H_2O Electrolysis using Palladium Cathodes," J. Electroanal. Chem. 346, 99 (1993).**

3. **M.H. Miles and B.F. Bush, "Anomalous Effects Involving Excess Power, Radiation and Helium Production During D_2O Electrolysis Using Palladium Cathodes," Fusion Technology, vol. 25 (no. 4) 478-486 (1994).**

4. **M.H. Miles, B.F. Bush, and D.E. Stillwell"Calorimetric Principles and Problems in Measurements of Excess Power During Pd-D_2O Electrolysis," J. Phys. Chem. vol. 98, (no. 7) 1948-1952 (1994)**