

The second experiment is hydrogen loaded into Ni films that are deposited in a diamond particle detector. The promising results of last year have so far not been reproduced. This is a very sensitive experiment, and if it produced high-energy alpha particles, it could all by itself reveal the mechanism of anomalous heat. For this reason, it is a very worthwhile experiment to continue. Five new diamond detectors have been fabricated and are being calibrated for new experiments in the spring.

Professor Helmut Kaiser

SKINR support for Professor Kaiser was terminated due to lack of performance.

International Ad-Hoc Collaborations

SKINR has forged collaborations with 7 research entities in the last 12 months. The purpose is to share materials and results in order to speed up the expansion of the knowledge base in the field. Figure 14 shows the parties involved. Primarily we exchange Pd cathodes and share the results of running them in calorimeters and we analyze each other's materials.

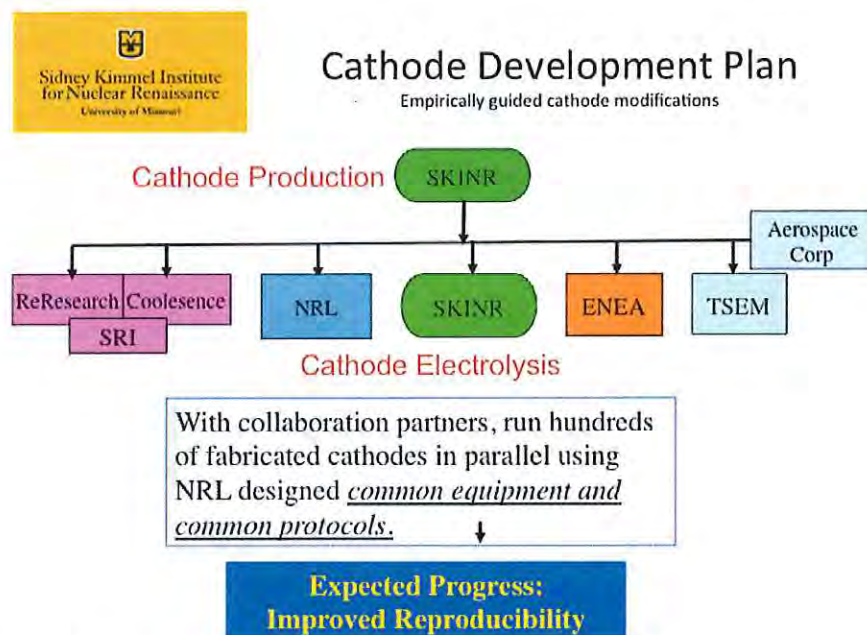


Figure 15

ReResearch and Coolesense are small 5 person companies with excellent scientific talent, NRL is the lead scientific laboratory in DoD, SRI is a nonprofit laboratory associated with Stanford University, ENEA is the Italian equivalent of the US Department of Energy, Aerospace is a large FFRDC (Federally Funded Research and Development Corp.) that builds satellites for the US government and industry. All of these collaborators have been vetted for their exceptional abilities and scientific acumen and are worthy partners for SKINR. SKINR staff has visited each collaborator at least once in the last year and all of the collaborators have visited SKINR at least once in the last year. These exchanges are very useful for planning experiments and performing joint data analyses.

Coolesense has provided SKINR with invaluable information regarding the Pd metallurgy and issues related to loading of Pd with deuterium and SKINR has reciprocated with similar information, and exchanged cathodes with them. Aerospace is analyzing a SKINR cathode that produced excess heat using 20 different analysis techniques that are used in the semiconductor industry. These analyses are hoped to shed more light on the materials aspects required to produce excess heat.

Funding sources

A visit to the office of the secretary of defense (OSD) by Graham Hubler and Rob Duncan in January 2014 arranged by Rob Duncan revealed that OSD is not interested in anomalous heat. Graham Hubler visited DARPA in February 2014 with somewhat the same result. They indicated that they would consider supporting us if we demonstrated reproducible excess heat. They could be revisited in the future if we definitively determine that the Pd NP on Pd cathode excess heat is real. Graham Hubler contacted a venture capitalist to feel them out about future support. The answer was that the VC community is not interested unless we were working on an actual device that produced energy. That is not our mission at the moment but the situation could change rapidly when we get reproducibility.

Electrolysis Cells

Our 9 open cells (the original Energetics workhorse cells) are running and collecting data on various cathodes. Two have been converted to a “hybrid” cell by moving the recombiner from outside to inside the cell. Dr. Azizi’s idea worked out very well as the cell calibrates extraordinarily well. More of the cells will be converted to the hybrid design. A summary of the SKINR cell inventory is included in the appendices. LabVIEW (LV) data acquisition for the Open Cells is currently being upgraded from LV version 6 to LV version 14 using Windows 7 instead of outdate Windows XP. All necessary National Instrument hardware have been purchased to be compatible with the update LV program.

Summary

Our most promising results continue to be the Pd nanoparticle suspensions that co-deposit on the surface of Pd along with deuterium. Reproducible heat up to 50% excess heat is being vetted to determine if it is real. This is very necessary before we report the results. The SWCNT on Pd cathodes gave the largest excess heat results, 5500% COP, but was only obtained in 1 of 20 cathodes. These cathodes are being pursued but with the addition of triggering methods.

The thin membrane experiment that can measure down to 1 keV x-rays emitted from a cathode showed zero x-rays after more than one year of constant running. We had high hopes that this first-of-a-kind experiment would lead us quickly to the mechanism of the AHE, if it were nuclear in origin. This is very significant in that it adds to the growing mystery to the question, “Is the AHE a nuclear process”? While not a definitive experiment, it adds to the accumulating evidence that the AHE is not a nuclear effect.

Based upon the results of experiments in Padua, Italy, in early 2014, SKINR embarked upon triggering mechanisms to force the AHE to turn on very early in experiments. These experiments have the highest priority in plan including RF, acoustic, magnetic pulse, laser, and stress triggering. These techniques are being installed on most of our electrolysis cells. Early results for RF triggering have shown anomalies but it is too early to know if the effects are real.

Our fundamental investigations on loading have reached a profound conclusion – that ability of a cathode to load to high deuterium/Pd ratios is entirely governed by impurities introduced by the materials used in the systems. Previously we did not know if the loading was governed by metallurgy, etching and surface morphology, or impurities. This will allow us to focus on the problem and make rapid progress to solve one of the most vexing problems in the field.

Our cathode development will continue but with better focus by emphasizing impurities and triggering methods.

A significant event in January 2015 was the creation of a program similar to SKINR at TTU headed by Rob Duncan. This is a positive development for the recognition of the field worldwide. The experiments that will be carried out at CERN will also increase our visibility to the greater scientific community. A major event in the field was a special issue of the Journal “Current Science” devoted to the AHE. This is the first major journal to publish peer reviewed articles on this subject. SKINR submitted two articles that were reviewed and accepted for the issue that came out in early March 2015. The legitimacy of the field is growing rapidly.

Part of SKINR’s mission is to check the promising results of other researchers. We will shortly begin experiments on the hydrogen/nickel gas loading system or two European groups who claim success in obtaining excess power. This is of interest since such a system would have useable thermodynamic efficiency and, therefore, make a viable commercial reactor from inexpensive materials.

Much has been learned in 2014. We look forward to a more productive year in 2015.

Notable events

December 2014

- Dr. Orchideh Azizi visited Dr. M. McKubre at SRI, CA
- SKINR Annual report delivered to the Sidney Kimmel Foundation

February

- SKINR staff member Dr. Arik El-Boher delivered an invited talk at a colloquium at the Technical University of Madrid entitled, “Progress Toward Understanding AHE” after the visit to Italy.

- Dr. Arik El-Boher and Dr. JingHao He attended Mitch Swartz's MIT LENR Symposium in Boston and Dr. El-Boher delivered a talk entitled, "Progress Toward Understanding AHE".

May

- Dr. M. Thiole, a scientist from CERN, Switzerland visited SKINR

June

- Dr. Tom Claytor from Lawrence Livermore National Laboratory (LLNL) visited SKINR
- Dr. Vittorio Violante from ENEA visited SKINR
- Drs. Rick Cantwell and David Knies from Coolestence visited SKINR

August

- Dr. Hubler attended National Instruments Week in Austin, Texas

October

- Drs. Hubler, El-Boher and He attended LENR workshop in Erice, Sicily. Attended by our collaborators and several other laboratories, the exchange of information was very valuable.

January 2015

- Dr. Rob Duncan and Dr. Mike McKubre visit SKINR. In January 2015, anonymous donor (Bill Gates) provided \$6 million dollars to Rob Duncan to set up a laboratory at Texas Tech University (TTU). In the visit Dr. Duncan's purpose was to catch up on the activities of SKINR and discuss a research plan for his laboratory. The meeting was cordial it was promised to stay in contact and to collaborate where it made sense to do so. I asked Rob if he would support SKINR financially. He declined but said he would be happy to take a good proposal from SKINR to his benefactor for additional funds.

Publications

Sidney Kimmel Institute for Nuclear Renaissance, G. K. Hubler¹, A. El-Boher¹, O. Azizi¹, D. Pease¹, J. H. He¹, W. Isaacson¹, S. Gangopadhyay² and V. Violante³, to be published in Current Science.

Progress towards understanding anomalous heat effect in metal deuterides, O. Aziz¹, A. El-Boher¹, J. H. He¹, G. K. Hubler¹, D. Pease¹, W. Isaacson¹, V. Violante² and S. Gangopadhyay³, to be published in Current Science.

Review of materials science for studying the Fleischmann and Pons effect, V. Violante¹, E. Castagna¹, S. Lecci¹, F. Sarto¹, M. Sansovini¹, A. Torre ¹, A. La Gatta², R. Duncan³, G. Hubler⁴, A. El Boher⁴, O. Aziz⁴, D. Pease⁴, D. Knies⁵ and M. McKubre⁶, to be published in Current Science.

Hydrogen Effect on Creation of Nanoporous Palladium by Palladium Hydride Wire Explosion, J. Baker*, J. Gahl*, P. Norgard*, O. Azizi, A. El-Boher, G. Hubler, J. He, W. Isaacson**, and D. Pease, to be published in Journal of Applied Physics.

SKINR Talks approved for delivery at ICCF 19, April 12-17, 2014

Search for low-energy x-ray and particle emissions from an electrochemical cell

Final report on calorimetry-based excess heat trials using Celani or Valat - coated NiCuMn (Constanan) wires

Search for excess heat in electrolysis using single wall Carbon nanotubes and Graphene-coated Palladium cathodes

Effect of Pd nanoparticles co-deposited on Pd on H/D absorption and excess heat generation in electrochemical and permeation cells

The effect of cathode pretreatment and chemical additives on H/D absorption into Palladium via electrochemical permeation

On a Possible Cosmological Explanation for the Anomalous Heat Effect

Patents submitted

EGCG stabilized palladium nanoparticles and method for making same, Kattesh V. Katti, Orchideh Azizi, Sagar Gupta, Kavita K. Katti, Arik El-Boher, Robert Duncan, and Graham Hubler

Synthesis of nanoporous Pd by exploding PdH nanowires, Jullian Baker, Jinghao He, John Gahl, Orchideh Azizi, Dennis Pease, Arik El-Boher and Graham Hubler

Enclosures

1, 2, 3) Current science papers

4) Report from Shubhra Gangopadhyay

Appendix I SKINR personnel

SKINR staff

Orchideh Azizi, Ph.D. (Electrochemist)

Martin Di Stephano (Engineer)

Arik El-Boher, Ph.D. (Research Group Leader, Mechanical Engineer)

JingHao He, Ph.D. (Materials Scientist)

Graham Hubler, Ph.D. (Director, Physicist)

Dennis Pease, Ph.D. (Physicist)

Undergraduate students

Dan Paterson

Ben Bolin

Benjamin Davis

Sheng Zou

Graduate students and post-doctoral fellows

Modeste Tchakoua Tchouaso - M. Prelas – Nuclear Engineering

Haruetai Kasiwattanawut –

Peter Norgard – J. Gahl and S. Kovaleski – Electrical Engineering

Jullian Baker –

Dr. Cherian(Joseph) Mathai – S. Gangopadhyay - Electrical Engineering

Dr. Sangho Bok –

Kavita Katti – K. Katti – Radiology

Faculty partners

John Gahl; Electrical Engineering

-Pd(d,p); Ni(p,p) reaction cross-sections on cyclotron, exploding PdH/D wires using pulsed power

Shubhra Gangopadhyay; Electrical Engineering

-CNT and Graphene-Oxide based cathodes, artificially structured cathodes; Pd/Pt/Au deposition on membranes

Kattesh Kattie; Dept. of Radiology

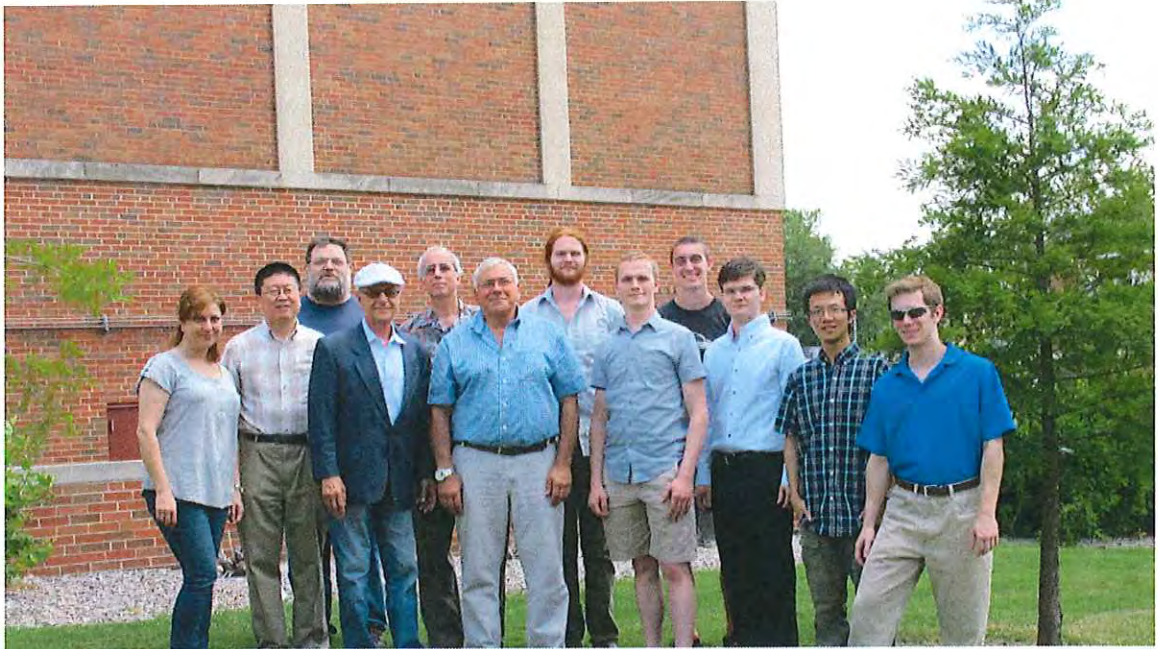
-In situ Pd and other nanoparticle co-deposition with H/D on Pd cathodes

Scott Kovaleski; Electrical Engineering

-Piezoelectric ion sources, low energy ion bombardment

Mark Prelas; Nuclear Engineering

-PdH/NiH films deposited on Diamond particle detectors; Neutrons from thermally shocked TiDx



O. Azizi, J.H. He, W. Isaacson, G. Hubler, D. Pease, A. El-Boher, T. Bruner, B. Davis, K. Lenhard, B. Bolin, S. Zou, D. Patterson

Appendix II SKINR instrumentation

Electrochemical systems:

- 9 open/hybrid cells in isoperibolic calorimeters
- 1 closed cell differential isoperibolic TEM calorimeter
- 2 closed cell isoperibolic TEM calorimeters (from Italy)
- 1 open cell mass flow calorimeters (MFC) with ultrasound stimulation
- 1 open testing cell, no calorimetry
- 2 open cell with thin membrane, no calorimetry
- 1 dual electrochemical cell hydrogen permeation system
- 3 SS closed cell mass flow calorimeters
- 1 laser triggering cell with calorimetry on loaded cathode
- 1 cell allowing stress on loaded cathode

Gas systems:

- 1 High Temperature gas reactor with mass flow calorimetry (MFC)
- 1 laser triggering cell with calorimetry

Diagnostic systems:

- 2 X-ray detectors
- Gamma detector
- Neutron detector
- RF spectrum analyzers (1 kHz - 13 GHz)
- RF generators (1 kHz – 13 GHz)

SKINR Materials characterization

- SEM
- Power spectral density
- AFM
- X-ray diffraction
- X-ray texture
- Electrochemical impedance spectroscopy
- Hydrogen permeation kinetics
- Charging protocols

SKINR materials preparation

Glow Discharge:

- 2 Pd-D₂ Low Temp. Ion Bombardment with MFC
- 1 Ni-H₂ High Temp. Ion Bombardment with MFC
- 2 annealing ovens
- 2 rollers
- Alloy fabrication
- 2 glow discharge cathode etching reactors

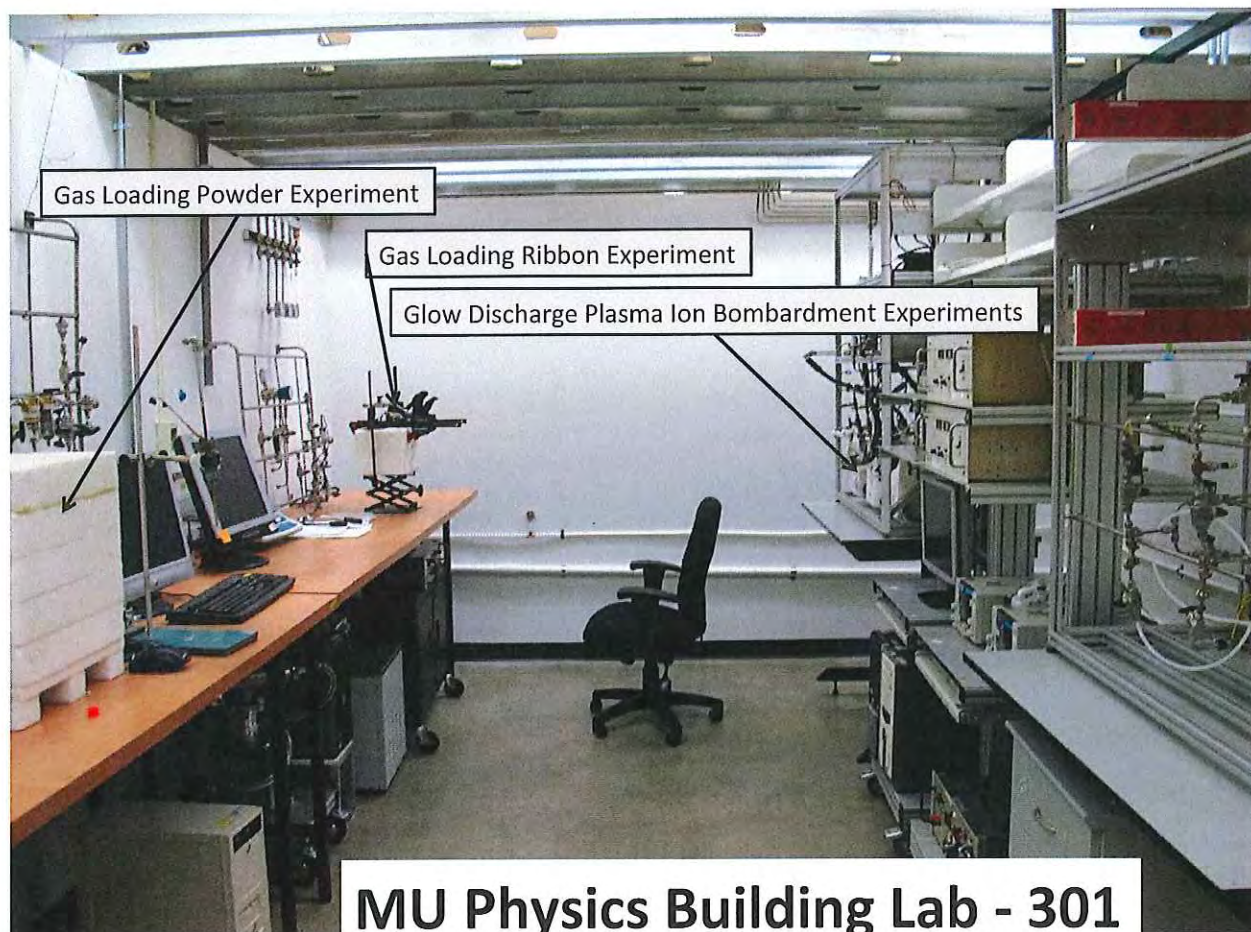
Electrical & Computer Engineering (Dr. S. Gangopadhyay)

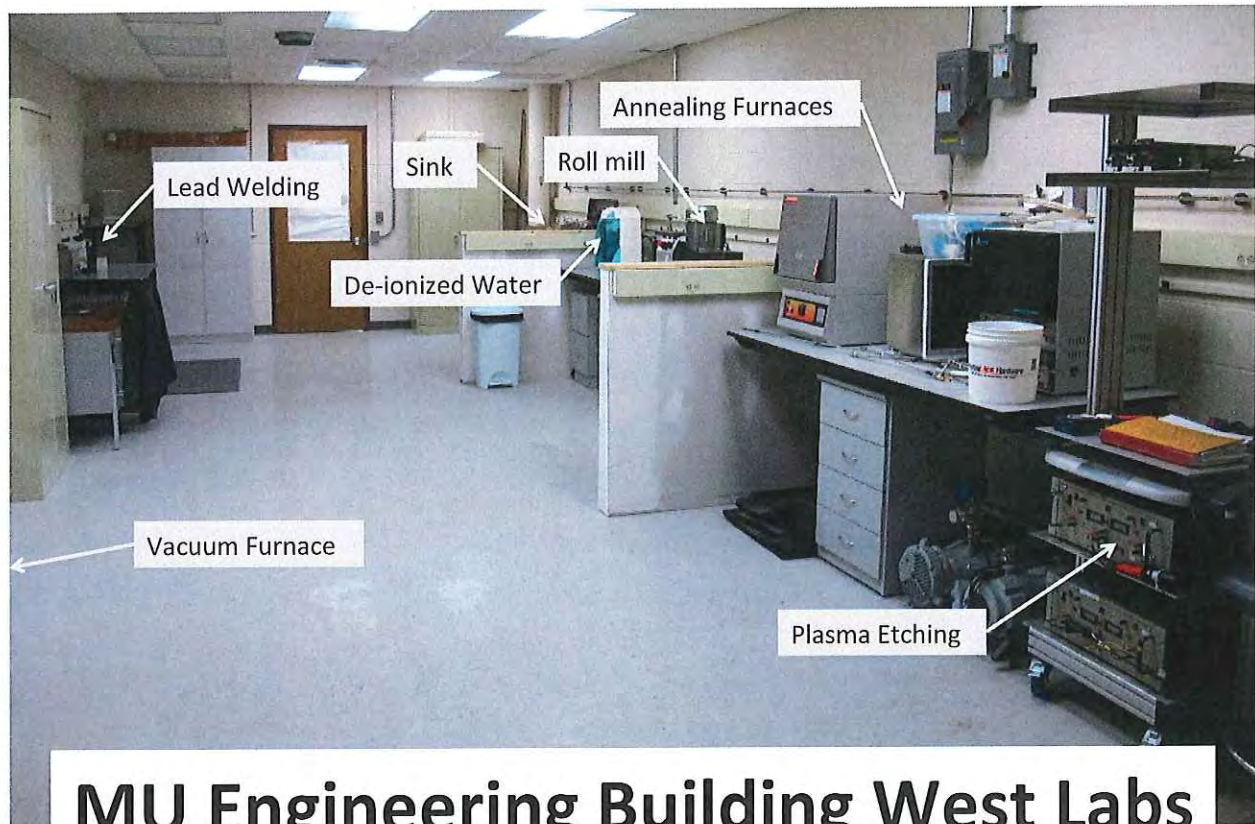
- Thin-film deposition
- CNT composites
- Nanoparticle fabrication and deposition
- Lithographically defined micro- & nano-structures
- Electrodeposition
- Nanoporous cathodes
- Graphene

Department of Radiology (Dr. K. Kattie)

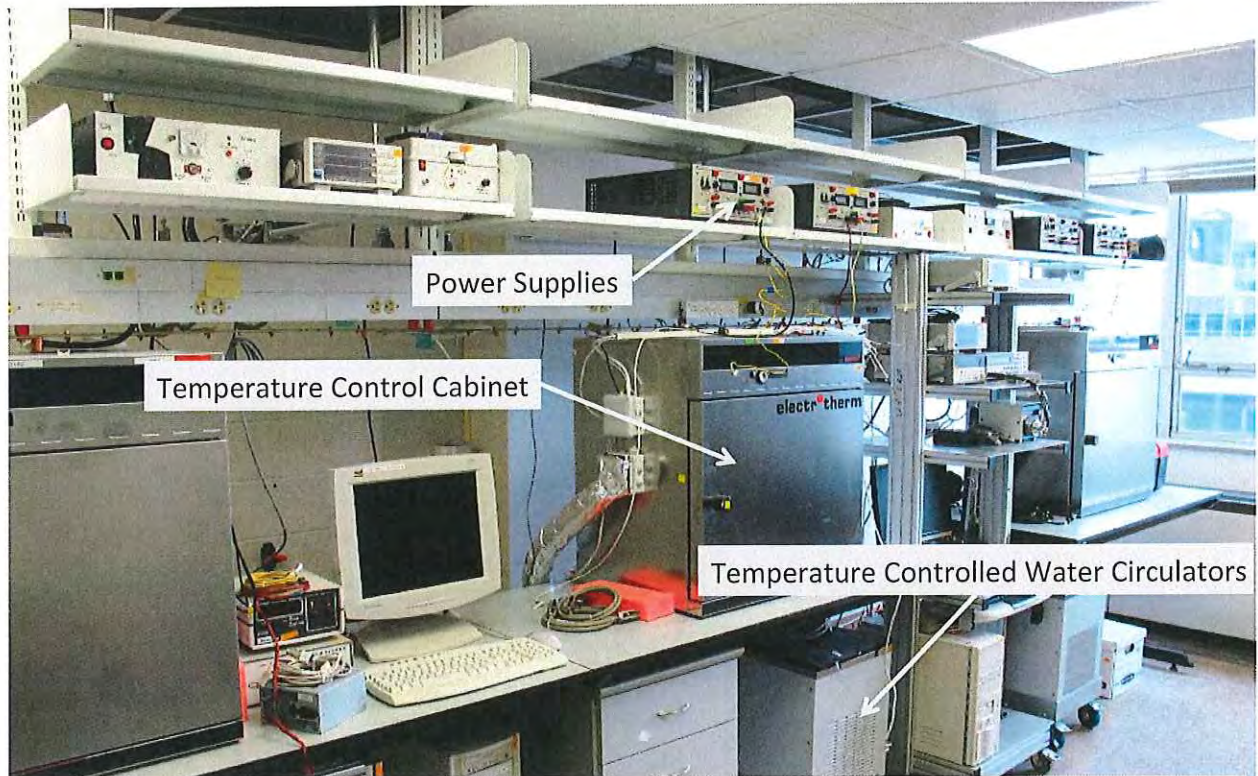
- nanoparticle suspensions for In situ deposition on cathodes

SKINR laboratory photographs





MU Engineering Building West Labs Sample Preparation Room - 135

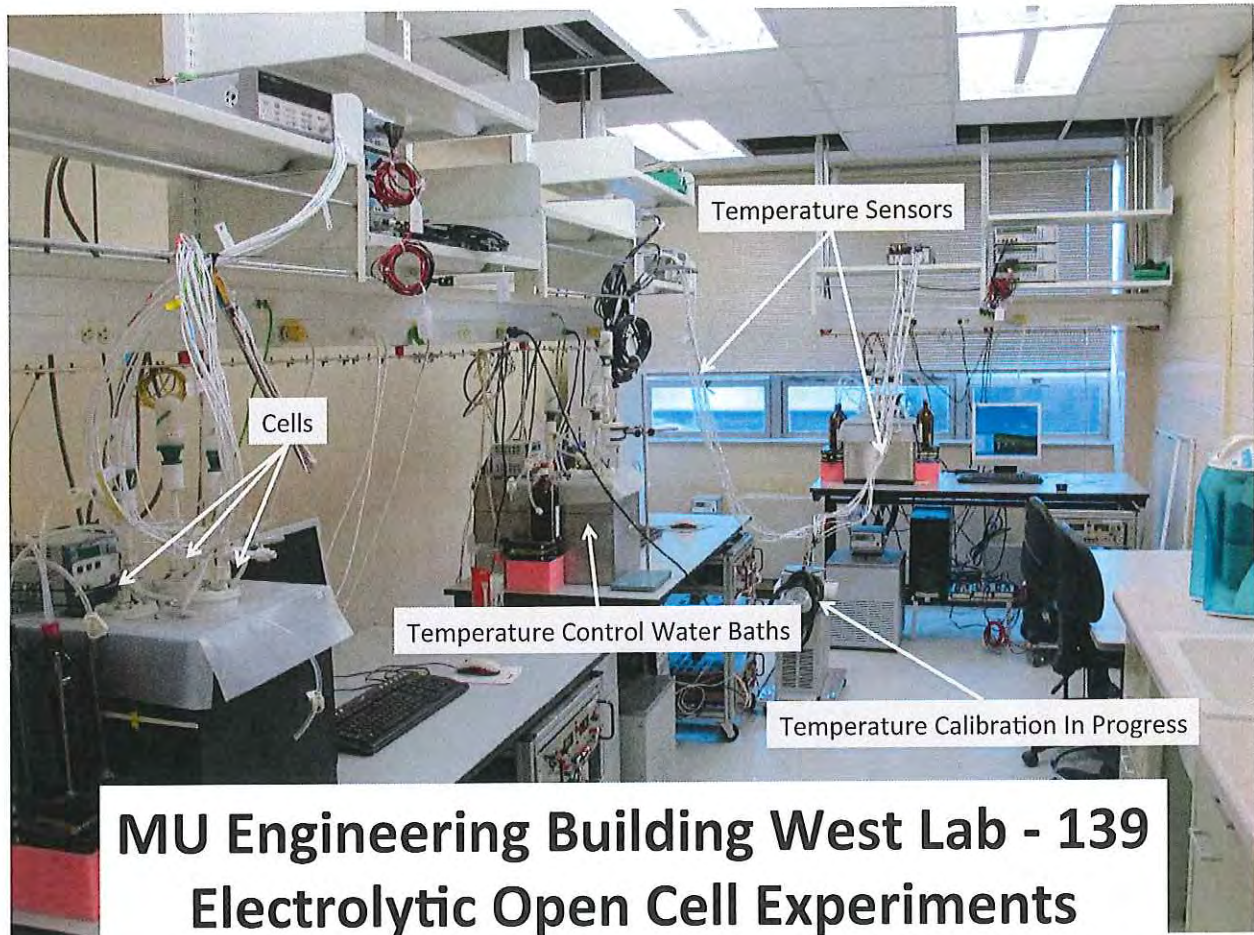


MU Engineering Building West Labs - 137

Ultrasonically Excited Electrolytic Experiments



MU Engineering Building Lab - 137
Hermetically Sealed
Closed Electrolytic Experiments



Institutions:

ICCF
SKINR
MO/MU/UM
CERN
ENEA
NRL
SRI
DoD/OSD/DARPA
FFRDC
VC
TTU

Technical terms:

SWCNT
COP
AHE
RF
NI
EIS
PRC
ALP
CNT
NP
TEM
MFC
EGCG (Patent Application)

Instrumentation:

SEM
EPD
AFM

Units of measurements:

MJ/THz
VSLI

Attachment E.

Year 5 Annual Report, 2016

Highlights of SKINR achievements in the fifth year

Prepared by:

Graham K. Hubler, Director

Sidney Kimmel Institute for Nuclear Renaissance

February 25, 2016

EXECUTIVE SUMMARY

Supplementary funding is aggressively being pursued to extend SKINR beyond February 2017. SKINR has not had significant excess heat events in the past year. This lull in positive events has occurred before in the history of the Anomalous Heat Effect (AHE). Our close collaborators at ENEA, NRL and Coolesence are experiencing the same lull. New initiatives are in place to obtain heat events. New initiatives this year include:

- High temperature H gas loading of Ni
- Acoustic pulse triggering (with battery power supply and Fast Fourier transform)
- Triggering combinations with RF, acoustic pulse, magnetic pulse and laser pulse. Hints of the triggering of a resonance have been observed.
- Membrane experiment with acoustic pulse and temperature sensor
- Perturbed angular correlation (PAC) experiments at CERN
- Au coated Fe and Pd coated Fe nanoparticles

A new collaboration with a major physics laboratory (CERN, Switzerland) was initiated with successful results. A student was hired to analyze the data that is stationed at CERN.

SKINR published 3 papers in Current Science, a mainstream scientific journal, and submitted 3 more for publication in the ICCF19 Proceedings.

SKINR has applied for 3 patents, the most recent covering the technology for converting dark matter into energy. If true, this technology is disruptive and is world changing.

Several non-productive experiments were terminated including carbon nanotube cathodes, Gorsky effect triggering, thermal shock of TiH, ultrasound stimulation, Pd in situ nanoparticle deposition.

SKINR is very optimistic that a breakthrough is near. The expansion of efforts around the world is a very good sign that anomalous heat is being taken more seriously.

Highlights of SKINR achievements in the fifth year

Progress

SKINR has made fundamental progress in the last year. I will describe the various experiments we are performing including their motivation, results, and connections to our collaborators, and finally, list the output in the last year in terms of papers, patents and talks.

Collaborations

• CERN

This collaboration began as a conversation with Dr. M. Thiole and Mr. M. Zoghby from CERN in Geneva, Switzerland, at ICCF18 in Columbia Missouri in 2013. They visited SKINR in 2014 and a plan evolved. CERN is one of the few places in the world where this experiment can be performed. Dr. G. Correia, the group leader at CERN, did not wish to tell his superior that he would be working on the Anomalous Heat Effect (AHE). We bootstrapped a Perturbed Angular Correlation (PAC) experiment in April 2015 and discovered an anomaly in PdD that did appear in PdH. As a result, CERN became interested and more measurements were performed in July 2015. CERN invited me to give a seminar on AHE and our results obtained at CERN. The October 14 seminar was well attended and the audience was very interested and did not show bias against the subject.

I hired a Masters level graduate student stationed at CERN to analyze the 500 spectra taken during the May and July experimental runs. M. Zoghby, a consultant on the CERN projects, donated \$2400 to SKINR to help with the expense of hiring the student.

On December 4, my CERN colleagues gave a poster talk on our results at the annual Users Meeting where users from around the world report their results. Our poster was given the title of the best poster at the meeting.

At the seminar I made contact with Dr. Haraldur Páll Gunnlaugsson of CERN and Dr. Ulli Koester from a lab in Grenoble, France. I am discussing with them fundamental Mossbauer and neutron diffraction experiments, respectively. These are very fundamental solid-state experiments that provide information on the electromagnetic and structural environment at the atomic scale. These measurements fit into SKINR's mission and have never been done on the PdD system during electrolysis. I am also

meeting (by Skype) with the Director of the Plasma Physics lab in Eindhoven, the Netherlands. In my view, these measurements are necessary if we are ever going to understand the AHE. The professional reception of our work comes somewhat as a surprise – it seems European scientists are much more open minded than in the US.

- **Coolescence, LLC**

We have a strong relationship with this company located in Boulder, Colorado. One of my staff from the Naval Research Laboratory left NRL and is employed there. We are working together to solve the long-standing loading problem where it is difficult to load D into Pd to D/Pd fraction > 0.82 . Coolescence is also carrying out model calculations to support the SKINR theory.

- **ENEA, Frascati, Italy**

SKINR and ENEA recently finalized an international collaboration agreement that was initiated nearly 2 years ago. However, after 10 years of a very close partnership with Dr. V. Violante at ENEA, the relationship has gone off the rails. We are collaborating on the experiments at CERN. However, we do not share any our work at SKINR with him. The reason is that he is now partly employed by Rob Duncan at Texas Tech University and he spends months at a time there. He is setting up a laboratory very similar to SKINR and ENEA's in Duncan's lab.

- **Rob Duncan, TTU**

Rob Duncan has set up and Institute at TTU very similar to SKINR with the \$6M he won from Bill Gates. He has promised to perform mass spectroscopy on gas samples that we send to him, but that is all.

Cathode development for electrolysis

A very important task in performing anomalous heat experiments is the development of cathode materials.

Pd coated carbon nanotube cathodes

After running 30 cathodes, we were unable to reproduce the very strong excess heat we obtained in one of the cathodes. This project has been terminated.

Pd NP coated Graphene Oxide

A new exploratory initiative begun late last year is graphene-coated Pd foils and decorated with Pd nanoparticles. Graphene was discovered 10 years ago and will have many uses in the future from electronic devices to structural materials. Graphene has

very unusual electronic properties and the placement of Pd NP on the graphene surface will greatly alter the electronic band structure of the PdNP and may cause ferromagnetism in the Pd. This is a discovery experiment. These cathode structures require considerable development to obtain samples large enough and thick enough to form a cathode. 3 types of cathodes are being produced and tested. Self-standing graphene paper coated with Pd, Pd nanoparticle-coated graphene paper, Self-assembled Pd nanoparticle on graphene-coated Pd foil. 18 cathodes have been tested with null results, and the effort has been terminated.

New alloy compositions

Our collaborators and SKINR have been producing Pd-Rh and Pd-Pt alloys. SKINR has run 15 of these cathodes this year with null results. The motivation has been success in the past using such alloyed cathodes. New variants of these cathodes are in progress.

In situ deposition of Pd nanoparticles (PD NP)

What began in 2013 as promising excess heat with palladium nanoparticles (PdNP) on Pd cathodes was studied over the two years. It took many experiments to determine that the heat was coming from a subtle and unexpected new current path in the cell that only occurs with nanoparticles. This effort was presented as a poster at ICCF 19 and will not be published. The project has been terminated.

High Temperature Gas Loading of hydrogen in Ni wires

After 200 days running 8 different wires, no excess heat was found. This project has been terminated. A poster was presented at ICCF19 and a paper submitted to the proceedings (attached).

High temperature loading of hydrogen into Nickel powder

For several years, a group in Italy has made controversial claims of excess heat using nickel powders loaded with hydrogen at high temperature. Recently, they revealed additional information about the material used in these experiments so SKINR will attempt to determine if the Italian results are real. A gas reactor was modified to accept powder samples and to withstand temperatures up to 1200C. The ceramic tube is loaded with Ni90% AlLiH4 10%, sealed and heated to 1200C. Four runs performed to date did not show excess heat. Many more runs will be performed using our own material and material obtained from a group that successfully measured heat in Russia. Also, comparing notes with other groups has provided new methods of preparing the samples. This method to obtain excess heat is a hot topic in the community at present

as several groups have reported excess heat. This system could be scaled up due to its simplicity. It is also more thermodynamically efficient due to the high temperature. We do not know if those reporting this heat really have the AHE since the groups are secretive. However, we are pursuing this method since if we are successful, a commercial reactor can be conceived using this method.

Fundamental studies - Hydrogen permeation and hydrogen loading

Last year, SKINR conducted extensive gas permeation experiments to study the effect of various treatments of the Pd on the ability of a cathode to load with deuterium. Achieving consistently high loading of Hydrogen (H) and Deuterium (D) in Palladium (Pd) is one of the most challenging issues in the field of Anomalous Heat Effect (AHE). Pretreatment methods include thermal annealing, cold rolling, acid etching, and electrochemical oxidation/reduction. Fundamentally, absolutely no correlations were found with the cathode preparation procedures investigated that implies that the controlling parameter(s) for loading Pd with D is still largely unknown. This suggests that impurities in the system control loading. SKINR gave a talk at ICCF19 on this work and submitted a paper for publication in the proceedings (attached).

Loading studies with our collaborator Coolesence, LLC, are in progress. We have found that parts per billion of impurities in the electrolyte completely determine the ability to load a Pd foil. This makes isolation of the correct impurity mix very difficult. None-the-less, SKINR has found that additions of Hg can be very helpful and Coolesence is working with Pb. We are optimistic that this problem will be solved this year.

Low energy x-ray emission and IR from Pd cathodes

Figure 1 shows schematically the thin membrane experiment being carried out at SKINR. The thin membrane allows transmission of X-rays down to 1 keV, alpha particles over ~20 keV and RF out of the electrochemical system to be sensed by the appropriate detectors in air. Most calorimeters have power sensitivity in the range of 1 to 10 mW. Suppose that the anomalous heat mechanism is active much of the time but at the micro-, nano- or pico-Watt level. The calorimeter is insensitive to such low power outputs. If, for example, in the membrane experiment we detect a 1 keV X-ray at a rate of 1 Hz, the corresponding power is 0.2 femtowatts, an excess power sensitivity improvement of E12. This experiment was run for over a year with null results. It is running now, improved by depositing a Pt resistor temperature sensor over 100 nm Al₂O₃ directly on the airside of a 50 μ m thick Pd membrane. That arrangement provides a very fast, sensitive thermal measurement.

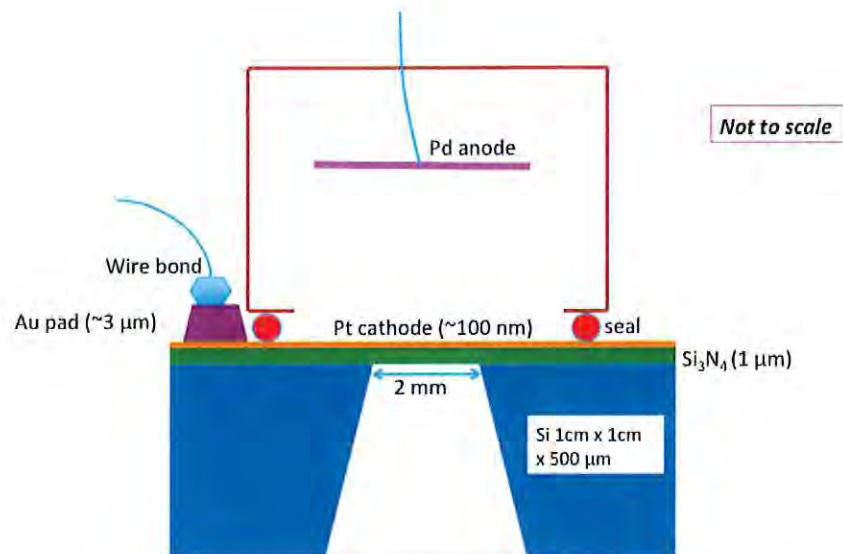


Figure 1. Schematic representation of membrane experiment that allows the detection of low energy x-rays or RF emitted from the electrochemical system. Pd is deposited on the Pt anode or a Pd foil and is simultaneously loaded with deuterium. The x-ray detector is placed on the air side of the membrane. No x-rays have been detected in more than a year of running the experiment.

Triggering of electrolysis cells

Most experiments over the past 20+ years involve electrolysis for many days and then waiting for the cell to produce heat. It has become apparent in 2014 that a method for triggering the cell to induce the excess is a new direction for research.

Magnetic field triggering

In late 2013 our collaborators in Italy used pulsed magnetic field of 1 Tesla, 40 microseconds at a rate of 1/3 Hz. This induced heat in about an hour after application of the pulses. We are still pursuing the activity with new information recently gained. It has been run on many types of different cathodes with no success as yet. We are still pursuing the activity with new information recently gained. We now are combining Magnetic pulse with acoustic pulses. After extensive literature searching we are optimistic that this system will provide a trigger to the AHE.



Figure 3. SKINR fabricated high voltage pulsed current power supply. It delivers a 3000 Ampere, 40 microsecond rise time, 100 microsecond width pulse at 1/3 Hz. This produces a 2 Tesla magnetic field pulse on the cathode that is placed between two electromagnetic coils. The coils were also fabricated by SKINR.

Radio Frequency (RF) triggering

This year SKINR performed a study of the coupling of radio frequency (RF) to PdD by purchasing two RF generators covering the frequency range 100 kHz to 13 GHz. RF antenna were designed and added to several electrolysis cells placed 1 mm from the cathode surface. A series of runs have produced anomalies in the electrolysis current and small changes in temperature that could be considered excess heat, but only at the <1% level. We continue to pursue this with adding other triggering mechanisms such as magnetic and acoustic pulses.

Ultrasound triggering

SKINR is running one ultrasound stimulation cell. These cells produced the highest reproducibility of all the experiments at Energetics up to 2009. After running several cathodes for months at a time, we were unable to reproduce the Energetics results. This project has been terminated.

Acoustic pulse triggering with Fast Fourier Transform (FFT)

A new initiative holds great promise in triggering AHE. The ultrasound system was modified by building a pulse power supply to provide nanosecond rise time high voltage pulses to the ultrasound transducer. A battery to enable the current to fluctuate rather than be held at constant current replaced the electrolysis power supply. A FFT system

was incorporated into the data collection system to determine how the electrolysis system (I, V) responds to the acoustic pulses. A feedback system is being designed to feed back frequencies seen in the FFT. Initial runs have been performed without the feedback and several interesting frequencies have been detected. This project will be aggressively pursued this year.

Laser triggering

Another trigger is laser impingement on the cathode that has received little attention in the field. Laser pulses will excite very high frequency, high-energy processes on the cathode surface such as optical and acoustic phonons, and plasmons. These excitations will decay to lower energy processes so nearly all solid-state excitations are covered. SKINR began a program to excite the cathode with a femtosecond laser.

While hardware for this experiment has been ready for some time, the fs laser facility at another department at MU is undergoing renovation and the lab is shut down. SKINR just purchases a laser on e-bay that has some of the desired characteristics and we will pursue this research direction this year.

The Gorsky Effect triggering

Stress that produces strain on a material is a first order effect never studied in the AHE field. The Gorsky Effect is strong diffusion of hydrogen in Pd induced by the application of constant stress to the Pd foil. A cell was designed and constructed to pull in the foil with a calibrated load. Preliminary data shows a large enhancement in the diffusion as measured by change in the resistance with applied stress. The cell is capable of applying cyclic stress at 0.02 Hz to 100 Hz.. This experiment was run on numerous cathodes with fundamental mechanical formation obtained, but we did not find that it triggered excess heat. This experiment has been terminated.

Theory

A patent was submitted on the SKINR theory with the title. **"Energy generation by efficient inverse-Primakoff Effect conversion of scalar particle dark matter into photons"**. This theory is no better or worse than the 100 or so other theories until experiments prove or disprove the theory. Attributes of the technology are:

Advantages/Improvements of Invention:

- The realization of an inexhaustible and safe source of energy in the form of heat available anywhere on Earth, in the solar system, in the Galaxy, and in the Universe. --
- With quantum cascade technology or low bandgap semiconductor technology, the realization of direct conversion of photons to electric photocurrent for an inexhaustible source of electric power.

Novel Aspects:

-Completely new energy source not related to fossil fuels, nuclear fission or nuclear fusion, solar energy, wind energy or any energy source now used or under development.

Problem Invention Solves:

-Implementation of invention will reduce carbon emissions, provide compact power, solve global warming, will enable space travel and planet colonization. Will provide technological equivalent to Star Trek Impulse Drive.

-Scientific solutions are, methods to map the DM density in our solar system and new constraints on the standard model of particle physics, supersymmetric models and string theories.

How Invention Differs from Other Technologies:

-Completely new energy source not related to fossil fuels, nuclear fission or nuclear fusion, solar energy, wind energy or any energy source now used or under development.

Disadvantages/Limitations:

-None

Experimental evidence compiled over the last 20+ years that nuclear reaction mechanisms underlie the anomalous heat effect (AHE) is not compelling. On the other hand, the fact that there is no neutron or gamma ray emission commensurate with the amount of heat released and the fact that there is no activation of materials in heat producing systems can be considered compelling evidence that the AHE does not involve nuclear physics and, therefore, that the explanation may lie elsewhere. This theory is a possible explanation of AHE and describes a disruptive technology that is world changing.

Perturbed angular correlation experiment at CERN

Last year, ¹⁸¹Hafnium was made radioactive by irradiating it with neutrons in the University of Missouri nuclear reactor. The activated Hf was shipped to the University of Bonn in Germany where the Hf was ion-implanted into 6 Pd foils at energy of 80 keV. The radioactive Pd foils were shipped to CERN in Geneva for perturbed angular correlation (PAC) experiments. Experiments were performed in May and July 2015. CERN is one of the few laboratories in the world that can perform such measurements. CERN is the home of the large hadron collider that detected the famous Higgs Boson last year. Figure 2 shows one of the spectra obtained. It was found that:

-Deuterium loaded Pd showed a high frequency perturbation that appeared only above a D/Pd ratio of 0.81.

-Hydrogen loaded Pd foils did not show this behavior

-There is a fundamental difference between H and D loading that can be interpreted as a collective oscillation of the D sublattice, in support for the theory mentioned above.

- A student was hired to work at CERN and analyze the 500 spectra accumulated for the experiment.

This is an example of fundamental experiments required to obtain information about the local atomic environment of Pd and D. We are pursuing neutron scattering and Mossbauer experiments for this purpose. Having worked with CERN for the PAC experiments is opening doors at other institutions that say, "Well, if CERN is looking at AHE maybe we should too". This collaboration with CERN would not have been possible for an independent company. Only the university affiliation got us in the door.

Collaborations within the University of Missouri

Six scientific groups are collaborating with SKINR. Dr. Duncan set up this arrangement as SKINR was being founded. Work by Professor Kattesh Kattie (Radiology Department) was already discussed. Work by Professors Shubhra Gangopadhyay, John Gahl, Peter Norgard, and Mark Prelas are described below.

Professor John Gahl

Another new initiative is the reproduction and extension of the "exploding wire" experiments conducted by Mike McKubre at SRI who is collaborating with SKINR. His preliminary results showed that by running a current pulse through Pd when loaded with deuterium AH was produced. SKINR has improved the calorimetry, the pulsing supply and added nuclear radiation detectors.. Mr. Jullian Baker will get his PhD on this project. May D loaded Pd wires have been tested and statistics accumulated which show there is ~2x more energy out than is driven into the wires. Many more testing must be done to confirm this conclusion.

Professor Shubhra Gangopadyay

Professor Gangopadhyay has a powerful research group in plasmonics with many graduated students. The state-of-the-art capabilities of her institute dovetail nicely with needs of SKINR for fabrication of cathodes. Cathodes structures fabricated include numerous Pd/Film/CNT/Pdfilm (CNT = carbon nanotubes) cathode structures, Pt thin films on thin Si₃N₄ membranes, and artificially structured cathodes using template and

embossing and Pd NP decorated Graphene. This work supports two Post-Docs and the work appears under cathode development reported above.

Professor Kattesh Katti

Professor Katti fabricates Pd nanoparticles suspended in ECGC that SKINR uses to deposit the NP on cathodes of various types. New particles will be Pd coated Fe and Au coated Fe nanoparticles that are of interest to SKINR. Originally developed for SKINR, professor Katti is using the Pd nanoparticles to develop treatments for prostate, colo-rectal, breast and pancreatic cancer. Clinical trials for prostate cancer were successful. The patent listed below secures this technology for the University and SKINR.

Professor Mark Prelas

The thermal shock of TiD experiments that produced promising results last year have additional data showing mild neutron emission. In this work, TiD shavings are brought to liquid nitrogen (LN2) temperature, then quickly removed from the LN2 and immersed in boiling water. This effect has not been reproduced and will be terminated this year.

The second experiment is hydrogen loaded into Ni films that are deposited in a diamond particle detector. The promising results of last year have so far not been reproduced. This is a very sensitive experiment, and if it produced high-energy alpha particles, it could all by itself reveal the mechanism of anomalous heat. For this reason, it is being continued.

Electrolysis Cells

Our 9 open cells (the original Energetics workhorse cells) are running and collecting data on various cathodes. A summary of the SKINR experimental cell inventory is included in the appendices.

Summary

Supplementary funding is aggressively being pursued to extend SKINR beyond Feb. 2017.

New initiatives this year include:

- High temperature H gas loading of Ni

- Acoustic pulse triggering (with battery power supply and Fast Fourier transform)
- Triggering combinations with RF, acoustic pulse, magnetic pulse and laser pulse. Hints of the triggering of a resonance have been observed.
- Membrane experiment with acoustic pulse and temperature sensor
- Perturbed angular correlation (PAC) experiments at CERN
- Au coated Fe and Pd coated Fe nanoparticles

A new collaboration with a major physics laboratory (CERN, Switzerland) was initiated with successful results. A student was hired to analyze the data that is stationed at CERN.

SKINR published 3 papers in Current Science, a mainstream scientific journal, and submitted 3 more for publication in the ICCF19 Proceedings.

SKINR has applied for 3 patents, the most recent covering the technology for converting dark matter into energy.

Several non-productive experiments were terminated including carbon nanotube cathodes, Gorsky effect triggering, thermal shock of TiH, ultrasound stimulation, Pd in situ nanoparticle deposition.

SKINR is very optimistic that a breakthrough is near. The expansion of efforts around the world is a very good sign that anomalous heat is being taken more seriously.

Notable events

April 2015. The SKINR staff attended the ICCF19 Conference in Padua, Italy. SKINR presented two oral talks and 3 poster session talks (see publication list). The meeting attendance was over 500 making it double the size of any previous ICCF meeting. This increased interest may be attributed to higher visibility of SKINR and a number of groups world wide as described in the text above.

May 2015. SKINR staff member, Dr. JingHao He and our collaborators at CERN in Geneva Switzerland, conducted perturbed angular correlation (PAC) experiments.

July 2015. SKINR staff member, Dr. JingHao He and our collaborators at CERN in Geneva Switzerland, conducted perturbed angular correlation (PAC) experiments.

September 2015. Dr. G.K. Hubler visited Industrial Heat, a venture capital anomalous heat laboratory in Raleigh North Carolina.

October 2015. Dr. G.K. Hubler delivered a seminar at CERN on the topic of anomalous heat.

December 2015. SKINR work at CERN presented by CERN as a poster at the annual CERN users meeting.

January 2016. SKINR staff visits Coolestence in Denver to conduct joint experiments.

Publications

Sidney Kimmel Institute for Nuclear Renaissance, G. K. Hubler, A. El-Boher, O. Azizi, D. Pease, J. H. He, W. Isaacson, S. Gangopadhyay and V. Violante, *Cur. Sci.*, **108** (2015) 555.

Progress towards understanding anomalous heat effect in metal deuterides, O. Aziz, A. El-Boher, J. H. He, G. K. Hubler, D. Pease, W. Isaacson, V. Violante and S. Gangopadhyay, *Cur. Sci.*, **108** (2015) 565.

Review of materials science for studying the Fleischmann and Pons effect, V. Violante, E. Castagna, S. Lecci, F. Sarto, M. Sansovini, A. Torre, A. La Gatta, R. Duncan, G. Hubler, A. El Boher, O. Aziz, D. Pease, D. Knies and M. McKubre, *Cur. Sci.* **108** (2015) 540.

Hydrogen Effect on Creation of Nanoporous Palladium by Palladium Hydride Wi Explosion, J. Baker, J. Gahl, P. Norgard, O. Azizi, A. El-Boher, G. Hubler, J. He, \ Isaacson, and D. Pease, to be published in *Journal of Applied Physics*.

Search for low-energy x-ray and particle emissions from an electrochemical cell, D. Pease et al, to be published in ICCF19 Proceedings.

Final report on calorimetry-based excess heat trials using Celani or Valat - coated NiCuMn (Constanan) wires, A. El-Boher et al., to be published in ICCF19 Proceedings.

The effect of cathode pretreatment and chemical additives on H/D absorption into Palladium via electrochemical permeation, O. Azizi et al., to be published in ICCF19 Proceedings.

SKINR Talks delivered at ICCF 19, April 12-17, 2015

Search for low-energy x-ray and particle emissions from an electrochemical cell, Dennis Pease.

Final report on calorimetry-based excess heat trials using Celani or Valat - coated NiCuMn (Constanan) wires, Arik El-Boher.

Search for excess heat in electrolysis using single wall Carbon nanotubes and Graphene-coated Palladium cathodes, Jinghao He.

26

Effect of Pd nanoparticles co-deposited on Pd on H/D absorption and excess heat generation in electrochemical and permeation cells, Orchideh Azizi.

27

The effect of cathode pretreatment and chemical additives on H/D absorption into Palladium via electrochemical permeation, Orchideh Azizi.

On a Possible Cosmological Explanation for the Anomalous Heat Effect, G.K. Hubler.

28

Seminar at CERN by G.K. Hubler, October 4, 2015.

Patents submitted

EGCG stabilized palladium nanoparticles and method for making same, Kattesh V. Katti, Orchideh Azizi, Sagar Gupta, Kavita K. Katti, Arik El-Boher, Robert Duncan, and Graham Hubler.

Synthesis of nanoporous Pd by exploding PdH nanowires, Jullian Baker, Jinghao He, John Gahl, Orchideh Azizi, Dennis Pease, Arik El-Boher and Graham Hubler.

Energy generation by inverse-Primakoff effect conversion of scalar particles into photons, Graham hubler and Joseph Aviles.

26 -
27 -

Attachments

SKINR facilities

Published and submitted research papers

Patent disclosure form

Appendix I SKINR Staff

Orchideh Azizi, Ph.D. (Electrochemist)

Martin Di Stephano (Engineer)

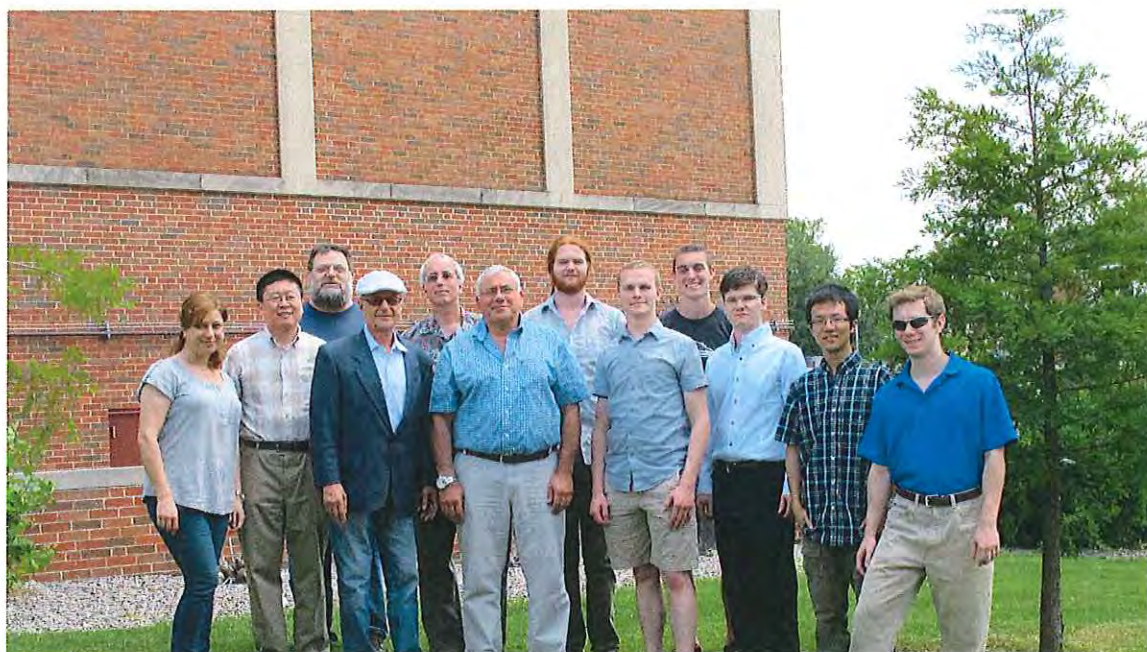
Arik El-Boher, Ph.D. (Research Group Leader, Mechanical Engineer)

JingHao He, Ph.D. (Materials Scientist)

Graham Hubler, Ph.D. (Director, Physicist)

Dennis Pease, Ph.D. (Physicist)

Peter Norgard, Ph.D. (Electrical Engineer in EE department)



O. Azizi, J.H. He, W. Isaacson, G. Hubler, D. Pease, A. El-Boher, T. Bruner, B. Davis, K. Lenhard, B. Bolin, S. Zou, D. Patterson

Attachment F.

Year 6 Annual Report, 2017

Highlights of SKINR achievements in the Final year

(Covering March 2016 to August, 2017)

Prepared by:

Dr. Graham K. Hubler, Director

Sidney Kimmel Institute for Nuclear Renaissance

August 31, 2017

EXECUTIVE SUMMARY

• SKINR had a breakthrough in Late February, 2017. The experiment at CERN described in the last report directly led to this discovery by teaching us an entirely new understanding of the Pd hydride material system. We have obtained reproducible excess heat at a level of 2x more thermal energy output than electrical energy input. This is described in detail below under the heading, *Progress*.

In addition to the breakthrough, there are two new initiatives.

• High temperature gas loading under high pressure deuterium has been implemented to supplement our excess heat results due to its potential to produce larger amounts of excess heat.

• SKINR implemented high resolution imaging of PdH as it de-loads in air. This pinpoints where hydrogen recombination occurs on the surface. H is mostly de-loads from the grain boundaries.

• Experiments that have not produced excess heat but are being kept on hold due their possible connection with our new understanding of Pd hydride are; acoustic pulse, laser, RF triggering; RF characterization of active cathodes; Fast Fourier Transform (FFT) characterization of acoustic pulses on cathodes; and a membrane experiment with acoustic pulse and temperature sensor.

• Experiments that have not produced excess heat and have been terminated are: high temperature H gas loading of Nickel (Ni) powders; Gold (Au)-coated and Iron (Fe)-coated Pd nanoparticles, Pd coated Fe nanoparticles, and 3 nm Au nanoparticles; new alloy additions to Pd; and magnetic field triggering.

- On-going strong collaborations are with; Coolesence, LLC, CERN, and Google.
- Collaborations that were discontinued, for various reasons, are; Professor Mark Prelas, Professor Peter Norgard, Professor Shubhra Gangopadhyay from the University of Missouri, Vittorio Violante from ENEA, Italy, and Rob Duncan from TTU.
- SKINR submitted 3 papers to the ICCF20 Proceedings and presented 5 talks at the conference. A complete bibliography is an addendum to this report.
- SKINR has applied for 3 patents, the most recent covering the technology for converting dark matter into energy. If true, this technology is disruptive and is world changing.
- The Gift funding from Mr. Kimmel was depleted at the end of August, 2017. Supplementary funding is aggressively being pursued to extend SKINR beyond February 2017. A Gift of \$100 K was received in August.
- During August, 2017, SKINR changed its department affiliation at the University of Missouri from the Department of Physics & Astronomy to The Department of Electrical Engineering & Computer Science.

Progress

I will describe the various experiments we initiated, those continued from the last report, and experiments that were terminated, connections to our collaborators, and finally, list the output in the last year in terms of papers, patents and talks.

New Initiatives

Ramifications of the CERN Experiment

SKINR has made fundamental and practical progress in the last year, including a breakthrough where a small but reproducible excess heat signal was obtained in early March 2017.

What led up to this breakthrough?

I attribute our progress to the fact that SKINR largely stayed with our original mission:

The MISSION of SKINR is "to find the origin of the Anomalous Heat Effect (AHE) with a sound materials science approach and with no preconceptions as to the origin of the phenomenon. To publish findings in the open literature and to openly collaborate world-wide with researchers in the field and in cross disciplines".

As stated in last year's report, SKINR conducted an experiment at CERN in Geneva, Switzerland. While we did not immediately know it at the time, the CERN experiment directly led to a new understanding of the Palladium Hydride material system, as it took some time to appreciate broad implications of the experimental results. I introduce the experiment with the slides below that details the logistics required to put the experiment together and the personnel involved. It took two years to convince the CERN scientists to do the experiment and to arrange all of the details. The first slide is the title slide of two talks given about the work (Hyperfine Interactions Conference, ICCF20 conference) showing the people involved. The second slide details the logistics required to conduct the experiment.

In layman's terms, detection of gamma rays from radioactive nuclei introduced into the surface of Palladium (Pd) cathodes as a dilute impurity, allowed the measurement of the electric field at the impurity atoms. What we discovered is that there is a large difference in the electric field for hydrogen (H) versus deuterium (D) above a concentration of H/Pd or D/Pd greater than 0.64. The electric field is 50% greater and asymmetric for Deuterium. This was not known even after Pd hydrides have been studied for over 50 years. The larger asymmetric electric field means that there is 50% greater internal stress in PdD over PdH.



Hyperfine Interactions in Palladium Foils during Deuterium/Hydrogen Electrochemical Loading

Jinghao He¹, Graham K. Hubler¹, Eric Bernardo da Silva², João G.M. Correia^{3,4}, Juliana Schell^{3,5}, Vittorio Violante⁶, Izabela Teles de Matos², Iberê Souza Ribeiro Junior², Artur Wilson Carbonari², Moustapha Thioye⁷, John Gahl⁸, Michel Zoghby⁹

¹ Sidney Kimmel Institute for Nuclear Renaissance, Dept. of Physics and Astronomy, University of Missouri, USA

² Instituto de Pesquisas Energéticas e Nucleares, São Paulo University, Brazil

³ Div. PH-UIS, ISOLDE-CERN, Geneva, Switzerland

⁴ C2TN, Centro de Ciências e Tecnologias Nucleares, Instituto Superior Técnico, University of Lisbon, Portugal

⁵ Experimentalphysik, Universität des Saarlandes, Germany

⁶ ENEA, Italian Agency for Energy New Technologies and Sustainable Development, Rome, Italy

⁷ State University of New York, Stony Brook, USA

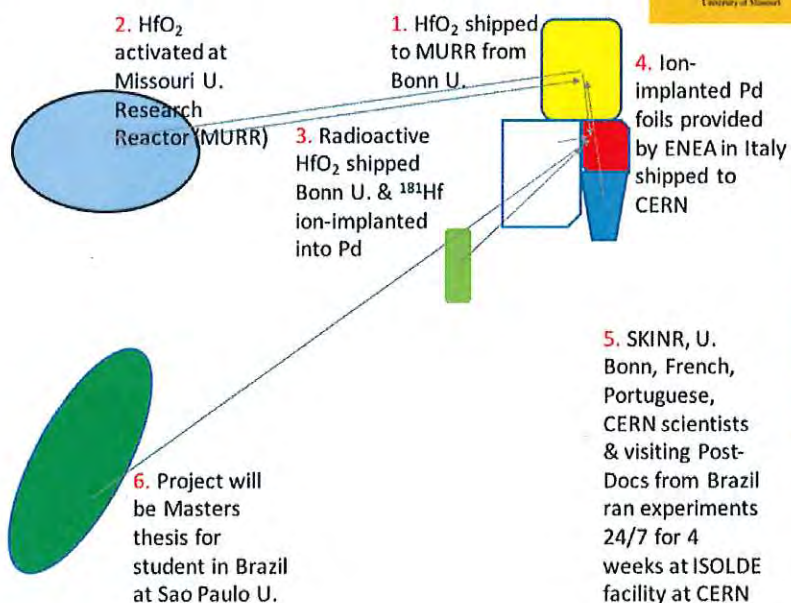
⁸ Nuclear Engineering Program, University of Missouri, USA

⁹ Consultant, Thoiry, France

SKINR Proprietary Information



International Collaboration



SKINR Proprietary Information

After some time spent reading the literature we realized that this fact explains two other anomalies in Pd hydrides and, more importantly, gave us a clue on how to obtain anomalous heat. The anomalies that the CERN experiment explained are the inverse diffusion rate of hydrogen in Palladium (D diffuses faster than H which is opposite theory) and the inverse superconducting transition Temperature (PdD has a higher superconducting transition temperature than PhH which is also opposite theoretical predictions). These two anomalies remained unexplained until now.

As for the search for excess heat, we found evidence that the reason for the larger electric field for D is that a 25% fraction D is stable at a different interstitial lattice site in Pd than H and that lattice site has smaller volume which produces the larger asymmetric electric field and therefore internal stress. For 28 years, researchers on Anomalous Heat believed that one had to have high loading fractions of D/Pd >0.90 to obtain excess heat. The CERN experiment showed us two new facts; prepare PdD samples so that the new interstitial site occupancy by D is maximized, and, that the maximum occupation of that site occurs for D/Pd around 0.64, not 0.90.

In February 2017, we developed a three-prong plan to exploit this new knowledge.

1. Synthesize 9 nanometer (nm) size Pd nanoparticles since the literature indicates that there is 25% occupancy of the newly discovered interstitial lattice site (we previously worked extensively with 50 nm Pd nanoparticles with null results).
2. Heat Pd at 300 degrees Centigrade (C) in 100 atmospheres of D, rapidly cool to minus 200 degrees C (dip in liquid nitrogen,) since the literature shows that this produces a high temperature superconductor due to 30% occupation of the new interstitial site.
3. Load into D into Pd to D/Pd = 0.64 by gas loading at 90 degrees C and pressure of 30 atmosphere and excite the Pd bar with acoustic pulsing at the resonant frequency of the bar. This induces cyclic phase change in the PdD_{0.64} bar and the violent phase change produces high frequency radiation that we think sustains the anomalous heat effect.

In late March, we received the 9 nm nanoparticles from our collaborator Dr. Kavita Katti and we observed anomalous heat in five different calorimeters. We measured 2 times more power out than power in eight times out of eight different experimental runs. In mid-April, I contacted DARPA and Google. Our results interested them and they visited in June 15, 2017. We agreed to conduct stringent tests of our calorimeter systems under their supervision. In other words, they insisted due diligence on our methods and materials. This is fine with SKINR as we are confident of our experimental practices. Upon successful experiments, Google and DARPA will seriously consider funding us. This project is on-going and will last through October, 2017.

The second and third experiments based on our new knowledge will be performed during the coming year, and item 3 will begin in mid-September.

High Temperature Gas Loading of Pd

For the initial effort to set up the experiment #2 in the section above, an apparatus was constructed that allows a Pd foil, bar or rod to be heated up to 310 centigrade in a pressure of 100 atmospheres of Deuterium gas. The apparatus consisted of a long, narrow cylinder that could be inserted into an oven, then rapidly removed from the oven and plunged into a liquid nitrogen Dewar at minus 200 degrees centigrade. This is called a rapid quench where the temperature of the sample changes by 500 degrees in a short period of time. In shaking down the new apparatus new features of loading were discovered that are not in the literature. By monitoring the resistance with fast time response, very large mechanical excitations were discovered that we are sure play a role in the production of excess heat. While in its infancy, this line of research will be aggressively pursued.

High Resolution Imaging of Thermal Emission from Pd Surface

Professor Gangopadhyay developed an optical technique with 300 nanometer resolution that was employed by Dr. Sango Bok, a Post Doc in her group, that measured thermal emission from area(s) on a H loaded Pd foil. The Figure below is an example of such an image. It shows that the de-loading process occurs mostly at the grain boundaries. The thermal emission is caused by H atoms recombining at the surface to form H₂ molecule, an exothermic process. The plan was to repeat this experiment with D loaded Pd and direct laser energy at the surface to see if additional heat could be measured in excess of the known thermal process. Dr. Bok left to take a university job so the planned was experiment never carried out. Nevertheless, the experiment is a god example of innovation carried out by SKINR. A talk was given at the ICCF20 conference on this work.



Progress on On-Going Initiatives

External Collaborations

• Coolesence, LLC

We have a strong relationship with this company located in Boulder, Colorado. Together, we solved the problem of the inability to load Pd with D. It was definitely determined that the loading is completely dependent on parts per billion (ppb) concentration of impurities in the electrolyte. This was a very difficult problem to determine impurity concentrations at such small concentrations. It was solved by adding specific impurities to the electrolyte to overwhelm the trace impurities already in the electrolyte. Coolesence used additive lead (Pb) and SKINR used additive of mercury (Hg). Adding 100 ppb of these impurities to the electrolyte allowed the loading of D into Pd of over $D/Pd > 0.9$ with good reproducibility. Coolesence electrochemical modeling supported these results and both Coolesence and SKINR published papers on these findings.

This finding and the CERN results led us to overturn "facts" that were developed in the early 90's regarding excess heat.

These were:

- a. Must obtain loading of D/Pd greater than 90%
- b. Must have high current density greater than 250 milliamps/centimeter² area of the cathode
- c. Must have large amount of D entering and leaving the cathode surface in a cyclic fashion.

These turned out to be “alternative facts” that have impeded progress over the last 20+ years. None of these “facts” are necessary to obtain excess heat.

• **ENEA, Frascati, Italy**

SKINR and ENEA finalized an international collaboration agreement that was initiated nearly 2 years ago. However, we have not collaborated with ENEA for over a year due to circumstances regarding his relationship with Rob Duncan at TTU.

• **Rob Duncan, TTU**

Rob Duncan visited SKINR in April, 2017. Expecting him to help fund SKINR we were very open about our new understanding and new results. I directly asked him to commit to 1 year of funding for SKINR. He said he would bring the matter up with his sponsors the next week. Dr. Duncan was not very forthcoming about his experimental results. I contacted him twice after the meeting with no response. SKINR now has no interest in talking to, or collaborating with, Duncan at TTU.

Cathode development for electrolysis

A very important task in performing anomalous heat experiments is the development of cathode materials.

New alloy compositions

After running many cathodes with different alloy compositions with no success, this effort was terminated in late 2016.

High temperature loading of hydrogen into Nickel powder

For several years, a group in Italy has made controversial claims of excess heat using nickel powders loaded with hydrogen at high temperature. Recently, they revealed additional information about the material used in these experiments so SKINR will attempt to determine if the Italian results are real. A gas reactor was modified to accept powder samples and to withstand temperatures up to 1200C. The ceramic tube is

loaded with Ni90% AlLiH4 10%, sealed and heated to 1200C. Nine runs were performed without any measure of excess heat. A paper was published in the ICCF20 proceedings and the project has been terminated.

Triggering of electrolysis cells

Most experiments over the past 20+ years involve electrolysis for many days and then waiting for the cell to produce heat. It has become apparent in 2014 that a method for triggering the cell to induce the excess is a new direction for research.

Magnetic field triggering

In late 2013 our collaborators in Italy used pulsed magnetic field of 1 Tesla, 40 microseconds at a rate of 1/3 Hz. This induced heat in about an hour after application of the pulses. SKINR pursued this approach during this reporting period with null results. The project has been terminated. The instruments are kept on hold since they may be useful in future experiments based on our new knowledge of the Pd hydride material.

Radio Frequency (RF) triggering

This year SKINR performed a study of the coupling of radio frequency (RF) to PdD by purchasing two RF generators covering the frequency range 100 kHz to 13 GHz. RF antenna were designed and added to several electrolysis cells placed 1 mm from the cathode surface. A series of runs did not produce excess heat. The project has been terminated. The instruments are kept on hold since they may be useful in future experiments based on our new knowledge of the Pd hydride material.

Acoustic pulse triggering with Fast Fourier Transform (FFT)

A new initiative holds great promise in triggering AHE. The ultrasound system was modified by building a pulse power supply to provide nanosecond rise time high voltage pulses to the ultrasound transducer. A battery to enable the current to fluctuate rather than be held at constant current replaced the electrolysis power supply. A FFT system was incorporated into the data collection system to determine how the electrolysis system (I, V) responds to the acoustic pulses. Many runs have been performed and several interesting features in frequency space have been noted. We have been unable to correlate these anomalies with excess heat, but we continue this effort as we think it will bear fruit with our new understanding of the Pd hydride material system.

Laser triggering

Another trigger is laser impingement on the cathode that has received little attention in the field. Laser pulses will excite very high frequency, high-energy processes on the cathode surface such as optical and acoustic phonons, and plasmons. These excitations will decay to lower energy processes so nearly all solid-state excitations are covered. SKINR began a program to excite the cathode with a femtosecond laser. Many laser stimulation runs were conducted in this reporting period. A series of runs did not produce excess heat. The project has been terminated. The instruments are kept on hold since they may be useful in future experiments based on our new knowledge of the Pd hydride material.

Theory

A provisional patent was submitted on the SKINR theory with the title. **“Energy generation by efficient inverse-Primakoff Effect conversion of scalar particle dark matter into photons”** in April, 2016. A full patent was submitted on April 15, 2017. The provisional patent will be published by the US patent office in October, 2017, and the final patent will be published on October 2018. This theory is no better or worse than the 100 or so other theories until experiments prove or disprove the theory. The probability that it is correct is greater than zero. Attributes of the technology are:

Advantages/Improvements of Invention:

- The realization of an inexhaustible and safe source of energy in the form of heat available anywhere on Earth, in the solar system, in the Galaxy, and in the Universe. --
- With quantum cascade technology or low bandgap semiconductor technology, the realization of direct conversion of photons to electric photocurrent for an inexhaustible source of electric power.

Novel Aspects:

- Completely new energy source not related to fossil fuels, nuclear fission or nuclear fusion, solar energy, wind energy or any energy source now used or under development.

Problem Invention Solves:

- Implementation of invention will reduce carbon emissions, provide compact power, solve global warming, will enable space travel and planet colonization. Will provide technological equivalent to Star Trek Impulse Drive.

-Scientific solutions are, methods to map the DM density in our solar system and new constraints on the standard model of particle physics, supersymmetric models and string theories.

How Invention Differs from Other Technologies:

-Completely new energy source not related to fossil fuels, nuclear fission or nuclear fusion, solar energy, wind energy or any energy source now used or under development.

Disadvantages/Limitations:

-None

Experimental evidence compiled over the last 27+ years that nuclear reaction mechanisms underlie the anomalous heat effect (AHE) is not compelling. On the other hand, the fact that there is no neutron or gamma ray emission commensurate with the amount of heat released and the fact that there is no activation of materials in heat producing systems can be considered compelling evidence that the AHE does not involve nuclear physics and, therefore, that the explanation may lie elsewhere. This theory is a possible explanation of AHE and describes a disruptive technology that is world changing.

Collaborations within the University of Missouri

Six scientific groups are collaborating with SKINR. Dr. Duncan set up this arrangement as SKINR was being founded. Work by Professor Kattesh Kattie (Radiology Department) was already discussed. Work by Professors Shubhra Gangopadhyay, John Gahl, Peter Norgard, and Mark Prelas are described below.

Professor John Gahl and Peter Norgard

This initiative was the reproduction and extension of the “exploding wire” experiments conducted by Mike McKubre at SRI. His preliminary results showed that by running a current pulse through Pd when loaded with deuterium AH was produced. SKINR improved the calorimetry, the pulsing supply and added nuclear radiation detectors. Mr. Jullian Baker earned his PhD on this project this summer. This project was then terminated as the anomalous heat results were inconclusive. After building 3 specialized power supplies for SKINR, SKINR dropped support for Peter Norgard.

Professor Shubhra Gangopadhyay

Professor Gangopadhyay has a powerful research group in plasmonics with many graduated students. The state-of-the-art capabilities of her institute dovetailed nicely with needs of SKINR for fabrication of cathodes. However, after many many cathodes produced by her group did not produce excess heat, this project was terminated and partial support for her Post-Doc and student was terminated.

Professor Mark Prelas

This effort was found to be lacking in rigor and results. It was terminated in early 2016.

Professors Kavita Katti and Kattesh Katti – Medical School

Professor Kavita Katti fabricated Pd nanoparticles suspended in ECGC that SKINR uses to deposit the NP on cathodes of various types. The new particles of Pd-coated Fe, Au-coated Fe nanoparticles, and 3 nm Au nanoparticles did not produce excess heat. SKINR was about to drop support for Dr. Katti when we asked her to synthesize 9 nm Pd nanoparticles. Now with the success of these particles that produce excess heat, her support continues.

Originally developed for SKINR, professor Katti is using the Pd nanoparticles to develop treatments for prostate, colo-rectal, breast and pancreatic cancer. Clinical trials for prostate cancer were successful. The patent listed below secures this technology for the University and SKINR.

Professor Zezong Gu – Medical School

In 2015, SKINR initiated a program to determine if a physics model developed at the Naval Research Laboratory by Yan Kuchеров and Graham Hubler could explain the mild traumatic brain injury (mTBI) sustained by US soldiers who were subjected to explosions in Iraq and Afghanistan. More than 40,000 returning soldiers suffer from this permanent brain damage. The model predicts that the shock wave of the blast produces sub-cellular damage at a dimension of less than 200 nanometers, a dimension that no one is exploring at present. An Army contract was won that features a collaboration between the University of Missouri, Stanford University, the VA, and the University of Alberta, Canada. We expose mice to open field blast, monitor their cognitive behavior, and then perform transmission electron microscopy, the only technique that can detect 200 nanometer-damage to brain cells. Preliminary results are very promising (detection of cellular damage) so that this program may provide a long sought medical answer to the primary cause of mTBI.

Funding

On July 31, 2017, SKINR had a balance of \$66K let from the original Gift from Mr. Kimmel. On August 11, a company Gifted \$100K to SKINR. It is expected that Mr. Kimmel will match the Gift from the company. This will allow SKINR to operate into November, 2017.

SKINR is actively pursuing additional funds from the University of Missouri, DARPA, Google and others, to sustain our effort to July, 2018. This will allow SKINR to meet the research plan outlined above in Items 1, 2, and 3.

Notable events

October, 2016. Three of the SKINR staff attended the ICCF20 Conference in Sendai, Japan. SKINR presented two oral talks and 3 poster session talks (see publication list).

March, 2017. G. Hubler visited a company in the US to discuss funding and collaborations.

April, 2017. Dean of the College of Engineering, Dr. Elizabeth Lobo, visited SKINR.

April, 2017. Full patent submitted to US Patent Office on a Cosmological explanation of the anomalous Heat Effect.

May, 2017. Dr. Azizi visits Coolesence LLC for work on our collaboration.

June, 2017. Representatives from Google and DARPA visited SKINR and set up a collaboration.

August, 2017. SKINR visited by the Vice Chancellor for Research and Chancellor for Economic Development from the University of Missouri to discuss funding.

August, 2017. Nanoparticle Patent granted by US Patent Office.

August, 2017. Patent disclosure submitted to US Patent Office for the new 9 nm Pd nanoparticles.

Publications and Talks for this reporting period

Publications

Final report on SKINR replication experimental program to seek excess heat using Ni powders mixed with LiAlH_4 and free Li under high temperature Hydrogen gas, Arik El-

Boher, Dennis Pease, Martin Di Stefano, Orchideh Azizi, Jinghao He, and Graham Hubler, Proceedings of the 20th International Conference on Cold Fusion, ICCF20, Sendai, Japan, October 3-7, 2016, to be published.

Effect of mercury on loading hydrogen/ deuterium into palladium cathode in alkaline solution, Orchideh Azizi, Jinghao He, Arik El-Boher, Dennis Pease, Martin Di Stefano and Graham Hubler, Proceedings of the 20th International Conference on Cold Fusion, ICCF20, Sendai, Japan, October 3-7, 2016, to be published.

Fluorescence Based Temperature Sensor for In-Situ Sub-Micron Heat Detection on D/H-Loaded Palladium Electrode Surfaces, Sangho Bok, Orchideh Azizi, Biyan Chen, Cherian Mathai, Keshab Gangopadhyay, Jinghao He, Arik El-Boher, Graham Hubler, Shubhra Gangopadhyay, Proceedings of the 20th International Conference on Cold Fusion, ICCF20, Sendai, Japan, October 3-7, 2016, to be published.

Talks

Hyperfine Interactions in Palladium Foils during Deuterium/Hydrogen Electrochemical Loading, J. He, G.K. Hubler et al., ICCF20, Sendai, Japan, October, 2016. 37

Final report on SKINR replication experimental program to seek excess heat using Ni powders mixed with LiAlH_4 and free Li under high temperature Hydrogen gas, Arik El-Boher, Dennis Pease, Martin Di Stefano, Orchideh Azizi, Jinghao He, and Graham Hubler, ICCF20, Sendai, Japan, October, 2016. 37-

Effect of mercury on loading hydrogen/ deuterium into palladium cathode in alkaline solution, Orchideh Azizi, Jinghao He, Arik El-Boher, Dennis Pease, Martin Di Stefano and Graham Hubler, ICCF20, Sendai, Japan, October, 2016.

Measurement Errors and Artifacts in AHE and LENR Experiments, Dennis Pease, Arik El-Boher, Jinghao He, Orchideh Azizi, Martin Di Stefano and Graham Hubler, ICCF20, Sendai, Japan, October, 2016. 38

Fluorescence Based Temperature Sensor for In-Situ Sub-Micron Heat Detection on D/H-Loaded Palladium Electrode Surfaces, Sangho Bok, Orchideh Azizi, Biyan Chen, Cherian Mathai, Keshab Gangopadhyay, Jinghao He, Arik El-Boher, Graham Hubler, Shubhra Gangopadhyay, ICCF20, Sendai, Japan, October, 2016.

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Progress towards understanding anomalous heat effect in metal deuterides, O. Aziz, A. El-Boher, J. H. He, G. K. Hubler, D. Pease, W. Isaacson, V. Violante and S. Gangopadhyay, Cur. Sci., **108** (2015) 565. 41

Review of materials science for studying the Fleischmann and Pons effect, V. Violante, E. Castagna, S. Lecci, F. Sarto, M. Sansovini, A. Torre, A. La Gatta, R. Duncan, G. Hubler, A. El Boher, O. Aziz, D. Pease, D. Knies and M. McKubre, Cur. Sci. **108** (2015) 540. 42

Hydrogen Effect on Creation of Nanoporous Palladium by Palladium Hydride Wire Explosion, J. Baker, J. Gahl, P. Norgard, O. Azizi, A. El-Boher, G. Hubler, J. He, W. Isaacson, and D. Pease, to be published in Journal of Applied Physics. 43

Search for low-energy x-ray and particle emissions from an electrochemical cell, D. Pease et al, to be published in ICCF19 Proceedings. 44

Final report on calorimetry-based excess heat trials using Celani or Valat - coated NiCuMn (Constanan) wires, A. El-Boher et al., to be published in ICCF19 Proceedings. 45

The effect of cathode pretreatment and chemical additives on H/D absorption into Palladium via electrochemical permeation, O. Azizi et al., to be published in ICCF19 Proceedings. 46

SKINR Talks delivered at ICCF 19, April 12-17, 2015

Hyperfine Interactions in Palladium Foils during Deuterium/Hydrogen Electrochemical Loading, J. He, G.K. Hubler et al., ICCF20, Sendai, Japan, October, 2016.

57

Final report on SKINR replication experimental program to seek excess heat using Ni powders mixed with LiAlH_4 and free Li under high temperature Hydrogen gas, Arik El-Boher, Dennis Pease, Martin Di Stefano, Orchideh Azizi, Jinghao He, and Graham Hubler, ICCF20, Sendai, Japan, October, 2016.

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Fluorescence Based Temperature Sensor for In-Situ Sub-Micron Heat Detection on D/H-Loaded Palladium Electrode Surfaces, Sangho Bok, Orchideh Azizi, Biyan Chen, Cherian Mathai, Keshab Gangopadhyay, Jinghao He, Arik El-Boher, Graham Hubler, Shubhra Gangopadhyay, ICCF20, Sendai, Japan, October, 2016.

Hyperfine Interactions in Palladium Foils during Deuterium/Hydrogen Electrochemical Loading, J. He, G.K. Hubler et al., Hyperfine Interactions Conference, Brussels, Belgium, November, 2016.

Search for low-energy x-ray and particle emissions from an electrochemical cell, Dennis Pease.

Final report on calorimetry-based excess heat trials using Celani or Valat - coated NiCuMn (Constanan) wires, Arik El-Boher.

Search for excess heat in electrolysis using single wall Carbon nanotubes and Graphene-coated Palladium cathodes, Jinghao He.

Effect of Pd nanoparticles co-deposited on Pd on H/D absorption and excess heat generation in electrochemical and permeation cells, Orchideh Azizi.

The effect of cathode pretreatment and chemical additives on H/D absorption into Palladium via electrochemical permeation, Orchideh Azizi.

On a Possible Cosmological Explanation for the Anomalous Heat Effect, G.K. Hubler.

58

Seminar at CERN by G.K. Hubler, October 4, 2015.

59

Patents submitted

EGCG stabilized palladium nanoparticles and method for making same, Kattesh V. Katti, Orchideh Azizi, Sagar Gupta, Kavita K. Katti, Arik El-Boher, Robert Duncan, and Graham Hubler. **GRANTED.**

Synthesis of nanoporous Pd by exploding PdH nanowires, Jullian Baker, Jinghao He, John Gahl, Orchideh Azizi, Dennis Pease, Arik El-Boher and Graham Hubler.

Energy generation by inverse-Primakoff effect conversion of scaler particles into photons, Graham Hubler and Joseph Aviles.

Attachments

Published and submitted research papers

Appendix I SKINR Staff

Department of Electrical Engineering and Computer Science

Orchideh Azizi, Ph.D. (Electrochemist)

Arik El-Boher, Ph.D. (Research Group Leader, Mechanical Engineer)

Graham Hubler, Ph.D. (Director, Physicist)

Dennis Pease, Ph.D. (Physicist)

The Medical School

Kavita Kattie, Ph.D. (Chemist)

Attachment F1.

Year 6, Enclosure 1

SKINR Publication List

Publications and Talks for this reporting period

Publications

Final report on SKINR replication experimental program to seek excess heat using Ni powders mixed with LiAlH_4 and free Li under high temperature Hydrogen gas, Arik El-Boher, Dennis Pease, Martin Di Stefano, Orchideh Azizi, Jinghao He, and Graham Hubler, Proceedings of the 20th International Conference on Cold Fusion, ICCF20, Sendai, Japan, October 2-7, 2016, published in Condensed Matter Nuclear Science (2017), pp. 297-303. 63

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Published in Condensed Matter Nuclear Science (2017), pp. 289-296.

Measurement Errors and Artifacts in AHE and LENR Experiments, Dennis Pease, Arik El-Boher, Jinghao He, Orchideh Azizi, Martin Di Stefano and Graham Hubler, ICCF20, Sendai, Japan, October, 2016, to be published.

Fluorescence Based Temperature Sensor for Anomalous Heat from Loaded Palladium Electrodes with Deuterium or Hydrogen, Sangho Bok, Orchideh Azizi, Biyan Chen, Cherian Mathai, Keshab Gangopadhyay, Jinghao He, Arik El-Boher, Graham Hubler, Shubhra Gangopadhyay, Proceedings of the 20th International Conference on Cold Fusion, ICCF20, Sendai, Japan, October 2-7 to be published. 66

Talks

Hyperfine Interactions in Palladium Foils during Deuterium/Hydrogen Electrochemical Loading, J. He, G.K. Hubler et al., Hyperfine Conference, Brussels, September, 2016 67

Hyperfine Interactions in Palladium Foils during Deuterium/Hydrogen Electrochemical Loading, J. He, G.K. Hubler et al., ICCF20, Sendai, Japan, October 2016.

Fluorescence Based Temperature Sensor for Anomalous Heat from Loaded Palladium Electrodes with Deuterium or Hydrogen, Sangho Bok, Orchideh Azizi, Biyan Chen, Cherian Mathai, Keshab Gangopadhyay, Jinghao He, Arik El-Boher, Graham Hubler, Shubhra Gangopadhyay, 20th International Conference on Cold Fusion, ICCF20, Sendai, Japan, October 2-7. 68

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Hydrogen Effect on Creation of Nanoporous Palladium by Palladium Hydride Wire Explosion, J. Baker, J. Gahl, P. Norgard, O. Azizi, A. El-Boher, G. Hubler, J. He, W. Isaacson, and D. Pease, International Journal of metallurgy and metal Physics (2015), 1:002.

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Search for low-energy x-ray and particle emissions from an electrochemical cell, D. Pease, O. Azizi, J. He, A. El-Boher, S. Bok, C. Mathai, S. Gangopadhyay, Kat. Kattie, Kav. Kattie and G. Hubler, Proc. Of ICCF 19, Padua, Italy, April 13-17, 2015, J. Condensed Matter Nuclear Science. (2016), pp. 257-263.

Final report on calorimetry-based excess heat trials using Celani treated NiCuMn (Constantan) wires, A. El-Boher, W. Isaacson, O. Azizi, J. He, D. Pease and G. Hubler. Proc. Of the 19th International Conference, ICCF 19, Padua, Italy, April 13-17, 2015, J. Condensed Matter Nuclear Science, (2016), pp. 68-87.

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J. Baker, J. Gahl, P. Norgard, O. Azizi, A. El-Boher, G. Hubler, J. He, W. Isaacson, D. Pease, "Novel Calorimetry Technique for Pulsed Wires," 2014 IEEE International Power Modulator and High Voltage Conference Proceedings.

Sangho Bok, Orchideh Azizi, Cherian Mathai, Keshab Gangopadhyay, Jinghao He, Arik El-Boher, Graham Hubler, Dennis Pease, Shubhra Gangopadhyay, "Fluorescence Based Temperature Sensor for Anomalous Heat from Loaded Palladium Electrodes with Deuterium or Hydrogen", Proc. of ICCF 20, Sendai, Japan, October 2-7, 2016, J. Condensed Matter Nuclear Science (2017), pp. 85-92.

Orchideh Azizi, Jinghao He, Arik El-Boher, Dennis Pease, Martin Di Stefano and Graham Hubler, "Effect of mercury on the kinetics and mechanism of hydrogen/deuterium loading into palladium in alkaline solution", Proc. of ICCF 20, Sendai, Japan, October 2-7, 2016, J. Condensed Matter Nuclear Science (2017), pp. 289-296.

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On a Possible Cosmological Explanation for the Anomalous Heat Effect, G.K. Hubler. 83

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Posters in ICCF 19:

Search for low-energy x-ray and particle emissions from an electrochemical cell, D. Pease, O. Azizi, J. He, A. El-Boher, S. Bok, C. Mathai, S. Gangopadhyay, Kat. Kattie, 85

Kav. Kattie and G. Hubler, Proc. Of ICCF 19, Padua, Italy, April 13-17, 2015, J. Condensed Matter Nuclear Science (2016), pp. 257-263. 86

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Seminar at CERN by G.K. Hubler, October 4, 2015. 88

Patents submitted

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Energy generation by inverse Primakoff Effect conversion of scalar particle dark matter into photons. Submitted April 15, 2017.

J. Baker, J. Gahl, P. Norgard, O. Azizi, A. El-Boher, G. Hubler, J. He, W. Isaacson, and D. Pease, "Hydrogen Effect on Creation of Nanoporous Palladium by Palladium Hydride Wire. 92

Appendix F. Lab Procedures

Attachment A

“General”: Root Directory

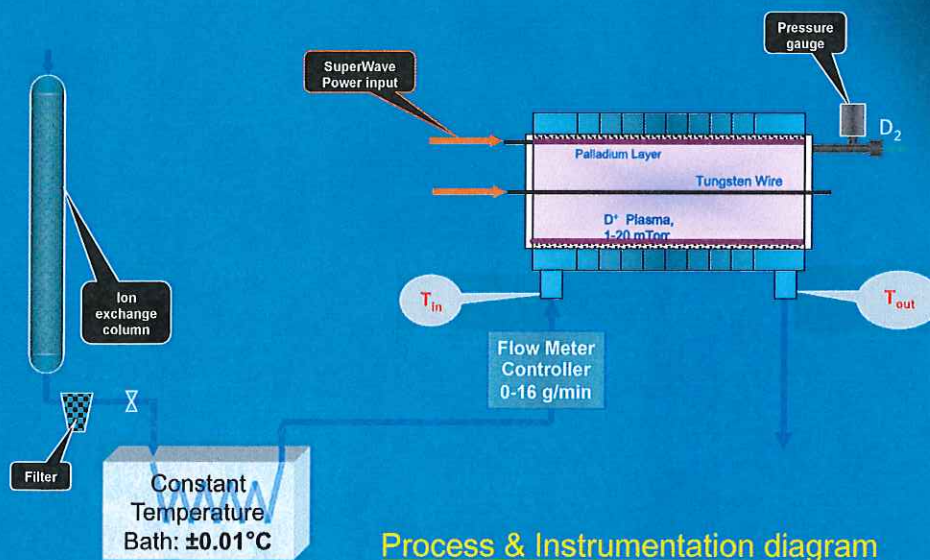
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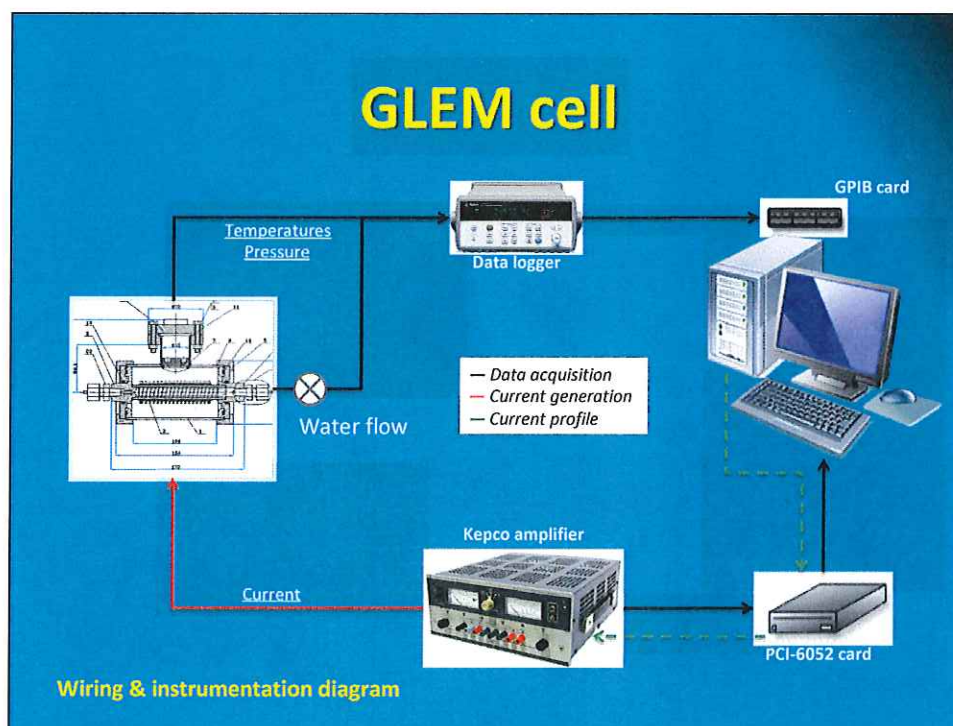
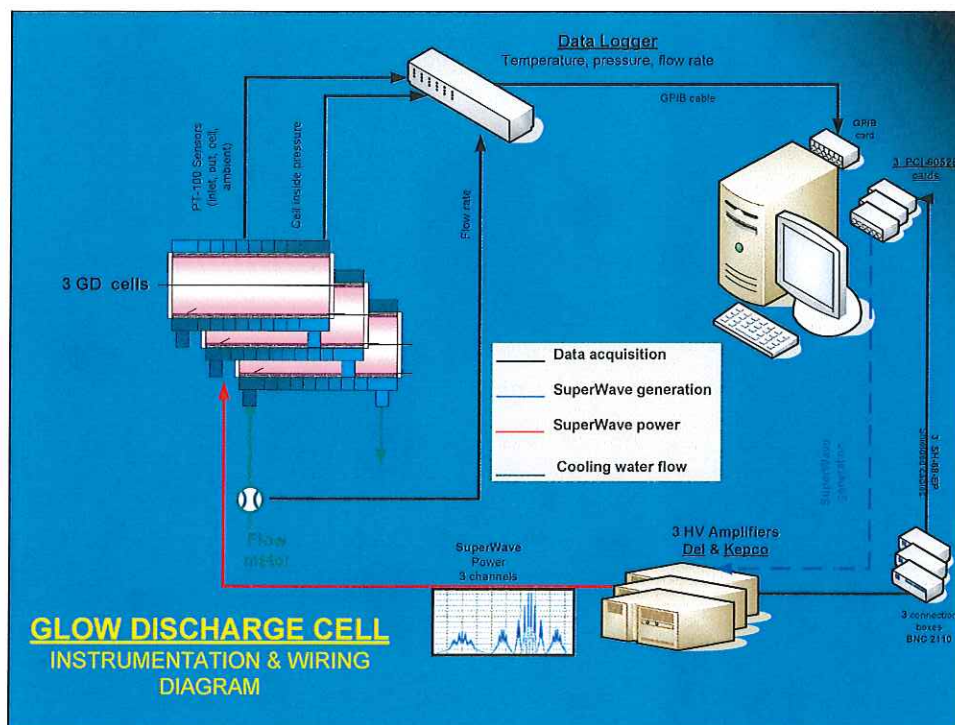
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DATA ACQUISITION SYSTEMS

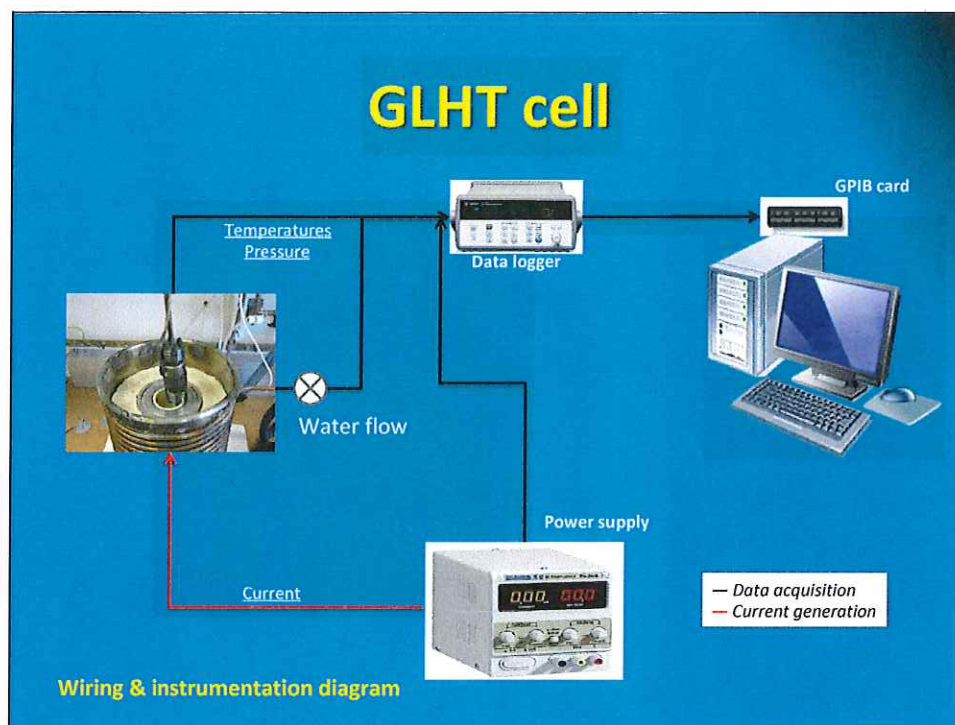
February 2012

GLOW DISCHARGE CELL





GLHT cell



Electrolytic Cell – Isoperibolic calorimeter

DESCRIPTIONS

$$P_{in} = I \cdot V$$

$$P_{in,et} = I \cdot V - 1.5 \cdot I$$

$$P_{out} = k \cdot \Delta T$$

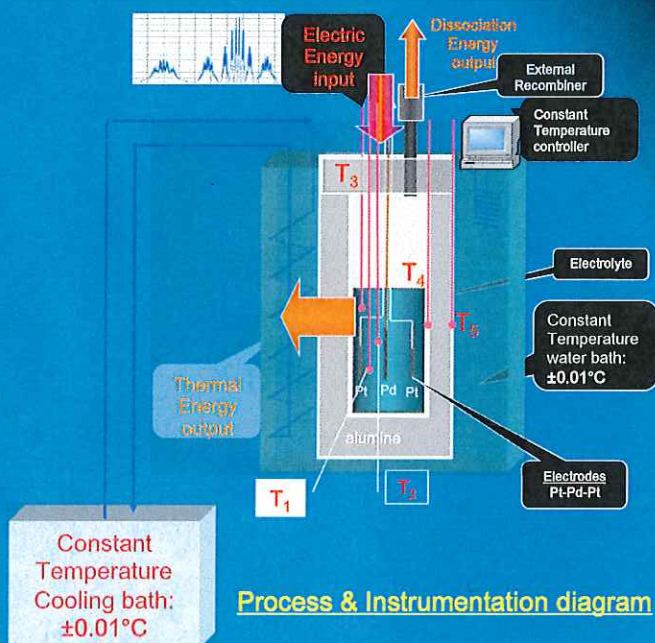
$$P_x = P_{out} - P_{in,et}$$

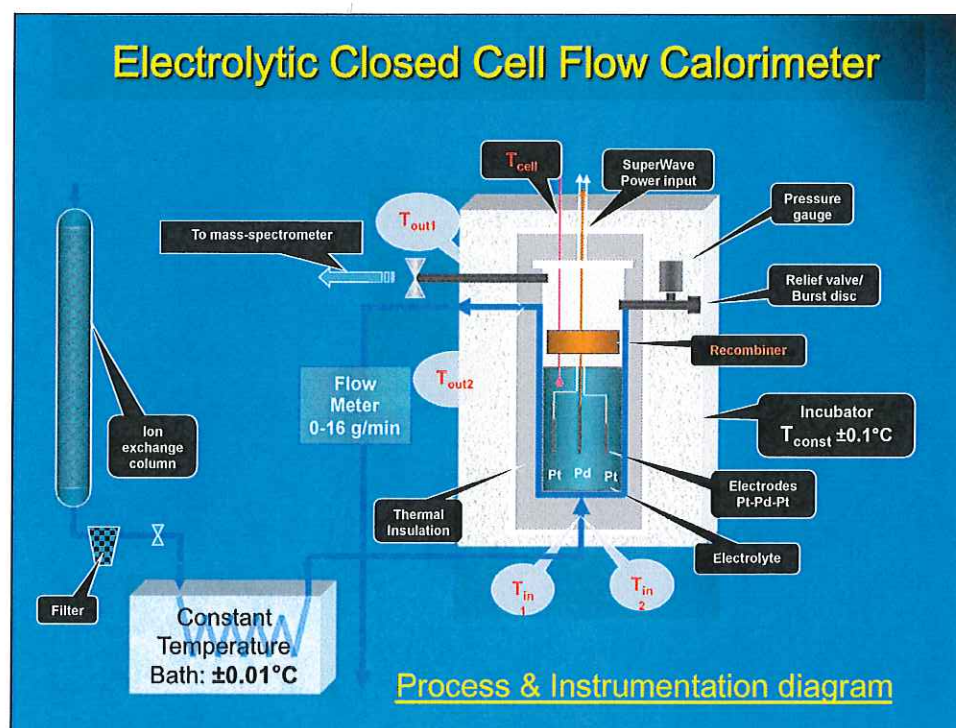
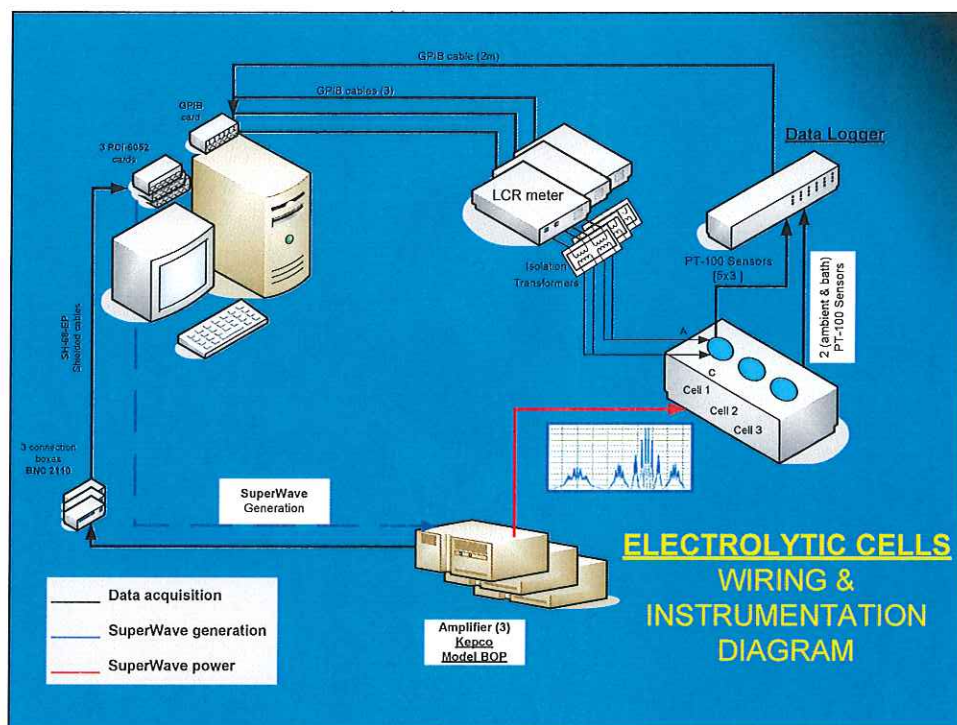
$$COP = P_x / P_{in}$$

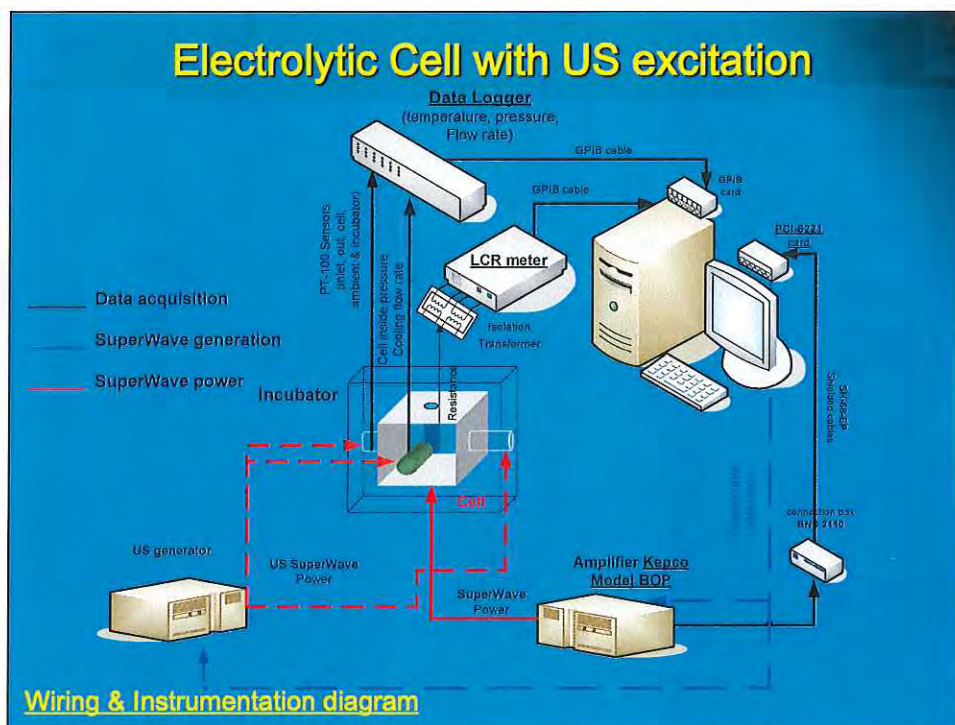
Calibration curve

$$k$$

$$\Delta T = T_4 - T_5$$







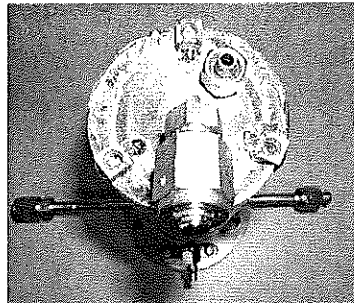
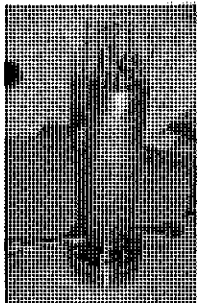
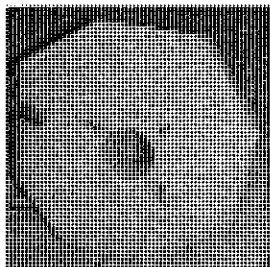
Attachment B

Electrolysis: Closed Cell

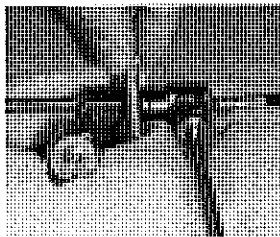
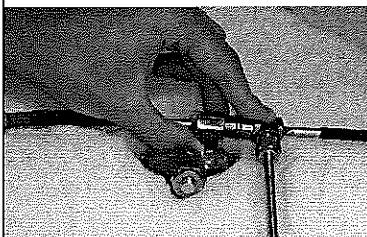
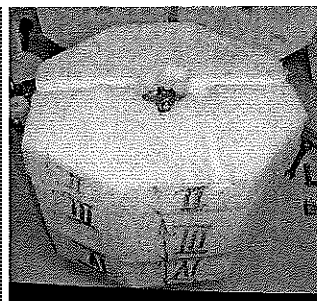
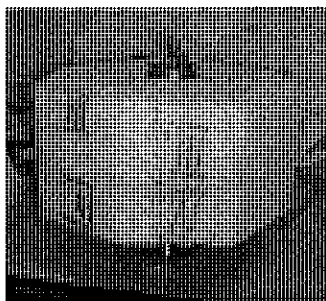
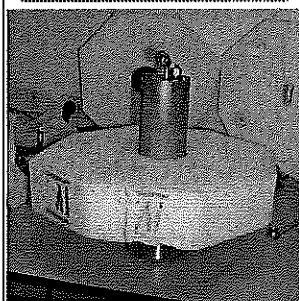
Electrolysis: Closed Cell

Assembly

Put cell upside down and unscrew 3 SS supporting bolts



Superimpose grooves on foam plate IV with tubes on cell body, put on plates IV, III, II

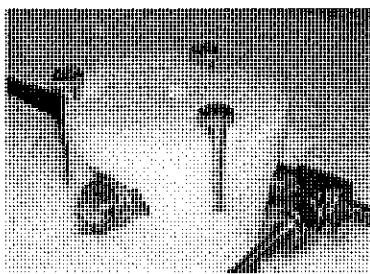
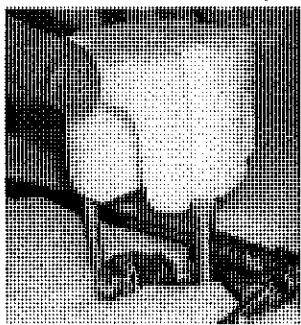


Connect water inlet tube with PT-100 ports.

Then screw back 3 SS supporting bolts

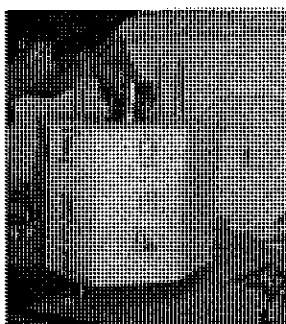
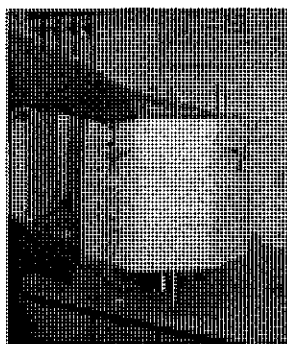
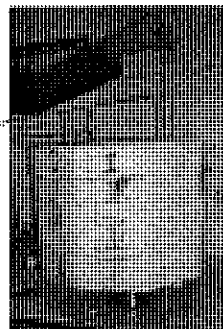
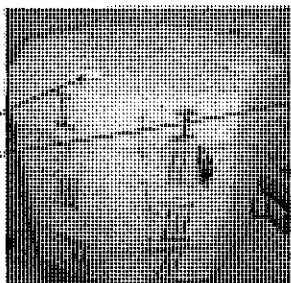
Put on cylindrical foam part shaped to be conformal to the bottom.

Push it down to the stop.

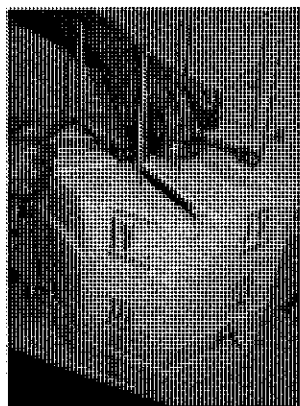


Mount foam plate I (lowest) on the top of assembly superimposing numbers and arrows.

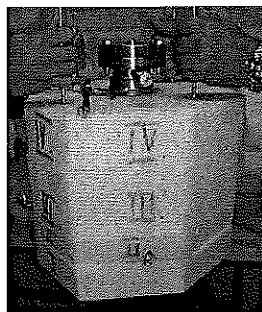
Place Steel dicks into grooves and "thread" fastening rods through the package.



Carefully turn over the package upholding conflat flange

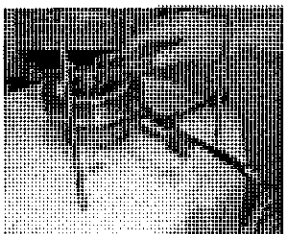


Connect water outlet tube with PT-100 ports.

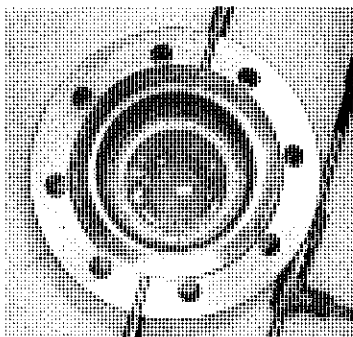


The package now can be moved to chemists for next operations

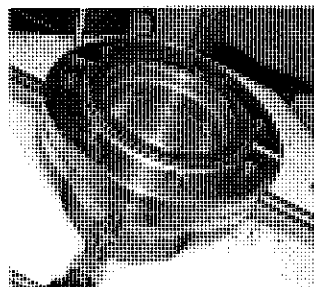




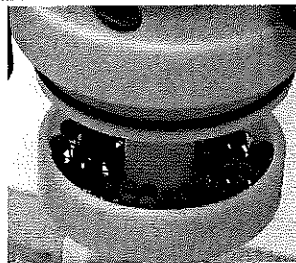
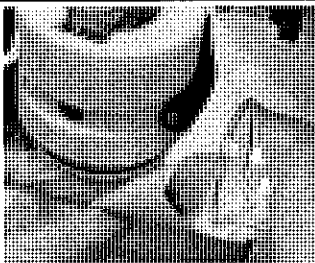
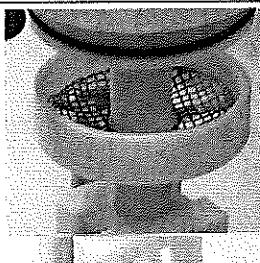
Pour 180(150) ml of electrolyte
(0.1M LiOD in D₂O) into the cell



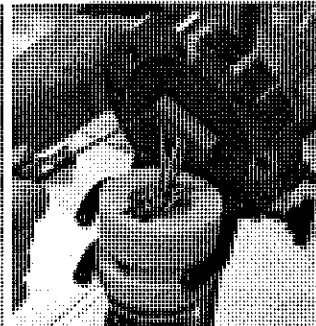
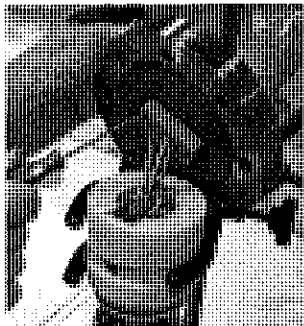
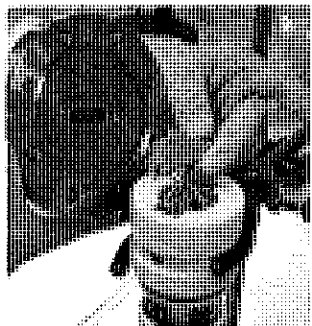
Mount O-ring made either of annealed
copper silver plated (He-tight version)
or Viton (regular use).



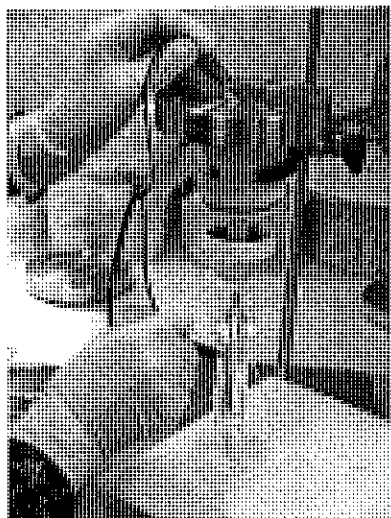
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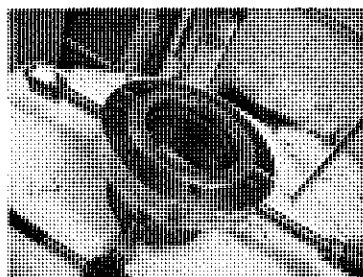
Fill Teflon basket with catalyst – on the picture 0.5%Pd on 3-5 mm Alumina



6 Connect Multipin connector to conflat flange

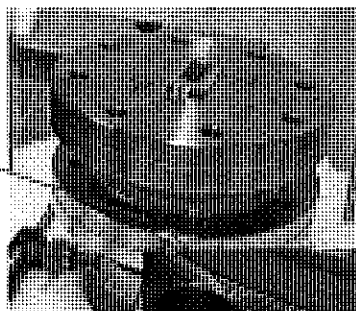
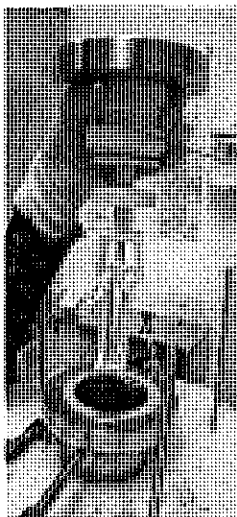


Very important to ringup all wires and connections prior to cell sealing!!!!



Place gasket made of annealed copper silver plated or O-ring made of Viton onto gasket seat.

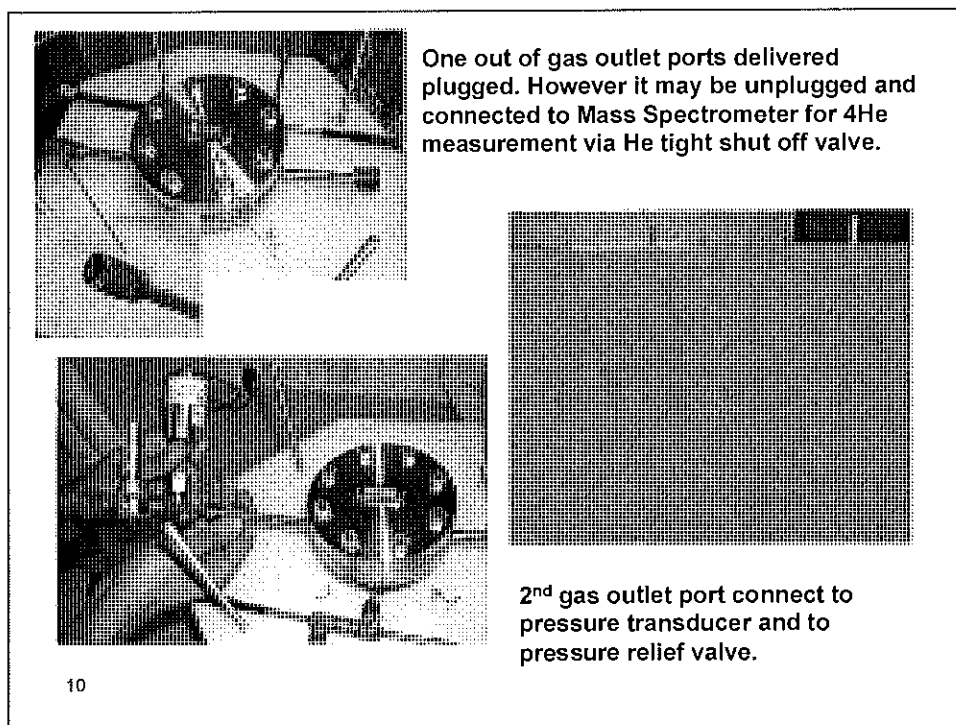
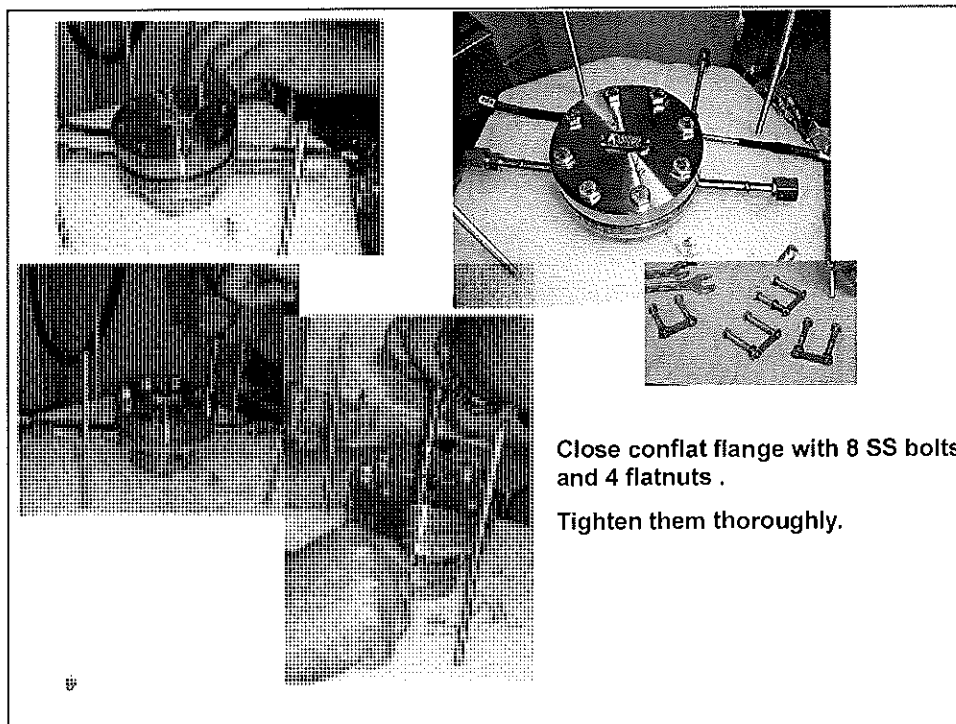
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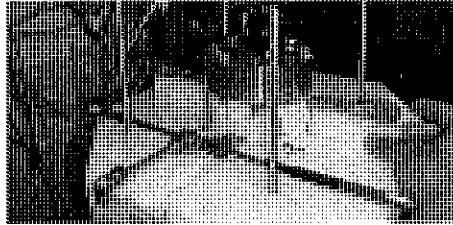


Cautiously insert "sandwich" assembly into the cell.

Make sure that two holes on Teflon flange are superimposed with two grooves on conflat flange that are superimposed with two gas outlet ports.

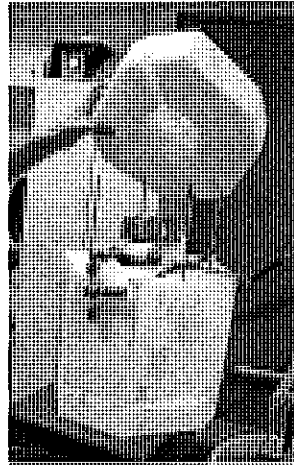
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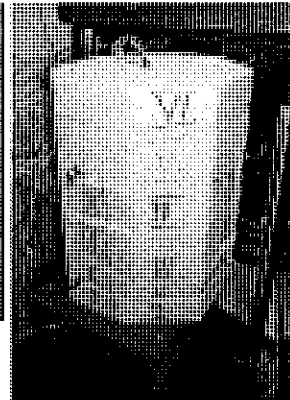
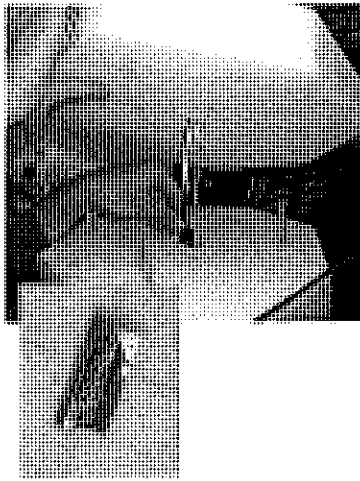
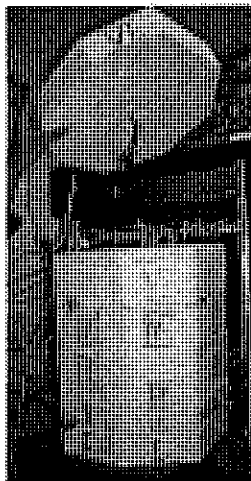


Place small shaped foam parts underneath of gas outlet tubes and Conflat flange edges according to signs on foam plate IV.

Mount foam plate V on a top of assembly.



11

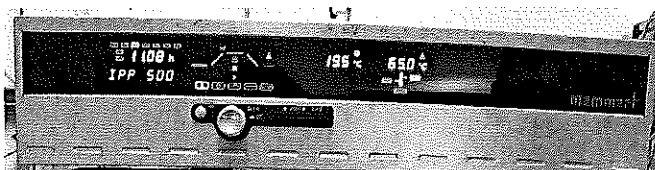


"Thread" air plug with its leads through foam plate VI.

Connect air plug with multipin connector on Conflat flange top.

Mount foam plate VI and tightly screw threaded rods with disks and nuts.

12

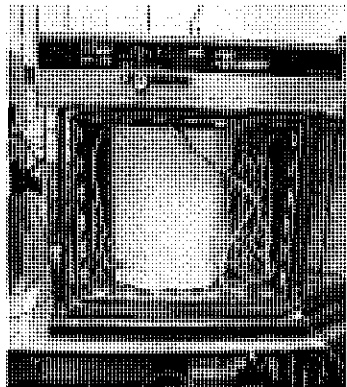


Congratulations!

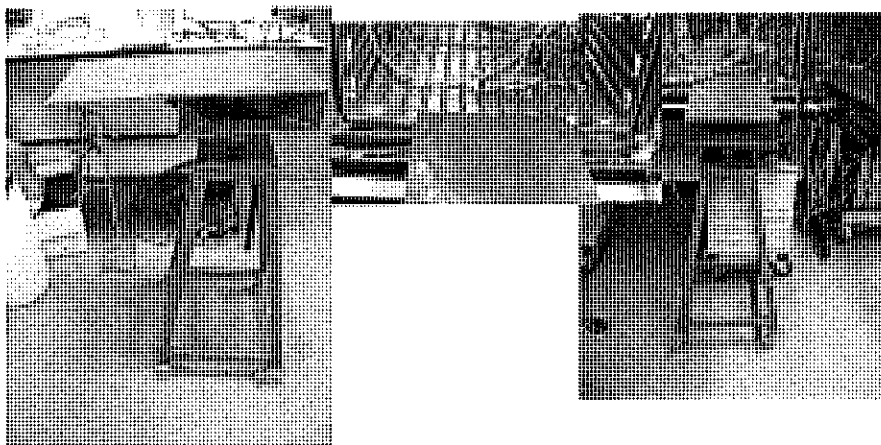
You've successfully finished the assembly.

The last step – place assembly into incubator and connect water inlet-outlet ports with 2 pairs of PT-100 on each port.

As well we control incubator temperature using 3 -wire (one is not in use) PT-100.



13



In order to make cell assembly easier and for transportation, we have constructed special carriage provided with 4 silicone wheels with stoppers and rotated PVC lined asymmetric desk.

Since maintenance bench and incubator bottom are adjusted to be approximately the same height, cell assembly can be easily transported and placed into incubator.

Catalyst



Johnson Matthey

Product code: 127915

15% Palladium/Alumina Spheres 4-8mm, Type 50A

On Weight:	Lot Number:	Assay:	Moisture Content
50g	DLS0078	0.51%	1.10%

Reference No: 127915

Notes: This product is not classified according to the EU regulations
Safety data sheet available for professional user on request
Caution - preparation not yet fully tested

Johnson Matthey PLC
Oschurch Road, Royston Hertfordshire SG8 5HE
Tel: +44(0)1763 253000 Fax: +44(0)1763 253090

Cell Description and Operation

ENERGETICS TECHNOLOGIES Ltd. SYSTEM OF ELECTROLYTIC CLOSED CELLS FOR THE STUDY OF LOW-ENERGY NUCLEAR REACTIONS (LENR) BY ELECTROLYTIC LOADING OF PALLADIUM WITH DEUTERIUM

I. Cell Description

The cell (Fig.1) constitutes a Teflon beaker (Part No.5) closed with Teflon flange (Part No.13) tightly inserted into SS (316 L) housing with cooling water spiral path at the bottom and on the long side of the cell, covered by SS 316 L welded jacket (Part No.1).

At the bottom of the cell a 1/4" tube is welded for air pressure relief, at the end of this tube a 1/4" VCR connector is assembled in order to allow air pressure relief after the Teflon beaker (part No.5) is inserted into the cell and anytime you need as well.

Cooling water inlet is located at the bottom of the cell (part No. 4) and connected to the bottom spiral.

The bottom cooling water inlet allows inserting 2 PT-100. The 2 PT-100 (SS Sheath) are not immersed in the cooling water but are inserted through a tube which is in direct contact with the cooling water.

The tube is filled with thermo conductive paste to improve the heat conductance between the PT-100 and the cooling water (Parts No. 19 & 33).

The cell stands on 3 SS screws (Part No. 14) and on Delrin base (Part No. 18).

The cooling water is leaving the cell after absorbing heat from the cell at elevated temperature through Part No. 3 & 20.

The outlet temperature is measured by 2 SS sheath PT 100 as for the inlet

At the upper side of the cells there are two opposite outlets with 1/4 VCR connectors.

The male 1/4" VCR connector (on the left side of the drawings) delivers closed with plug. Further it can be connected to a mass spectrometer, for He detection.

The female 1/4" VCR (on the right side of the drawing) should be connected to a T 1/4" VCR connector, where a pressure transducer and a pressure relief valve (He tight) are connected (not be shipped).

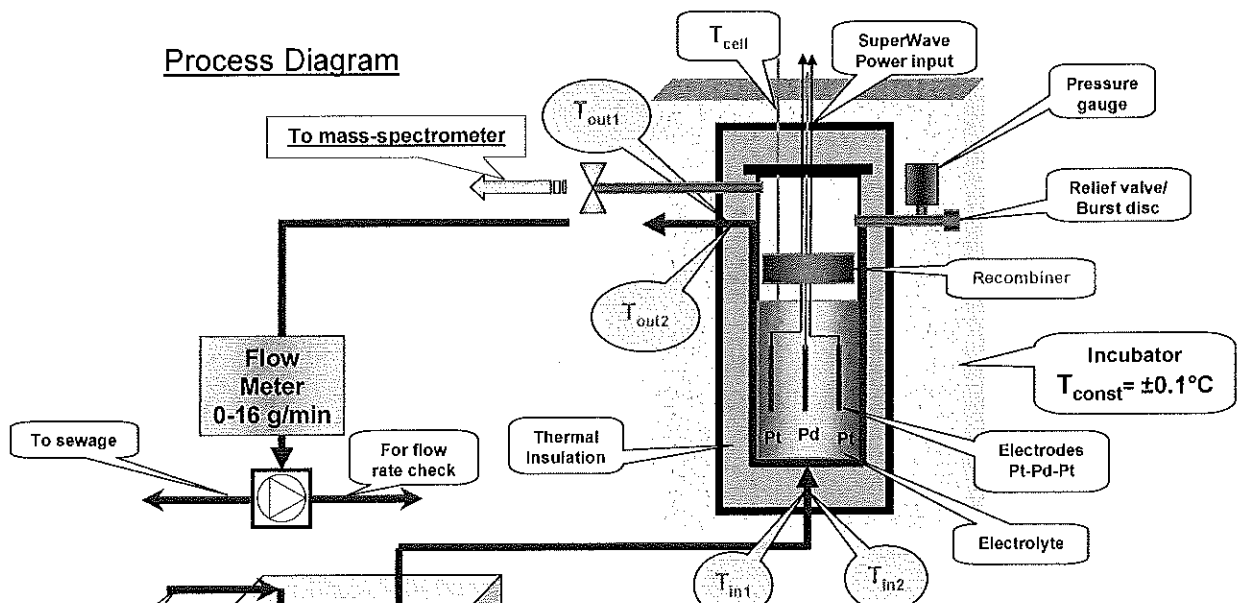
A multi pin connector flange – NW 63 CF (Part No.2) is welded to the cell body (Part No.1) and sealed by cover flange also with multi pin connector, to which an air plug multi pin connector is connected (Part No.31).

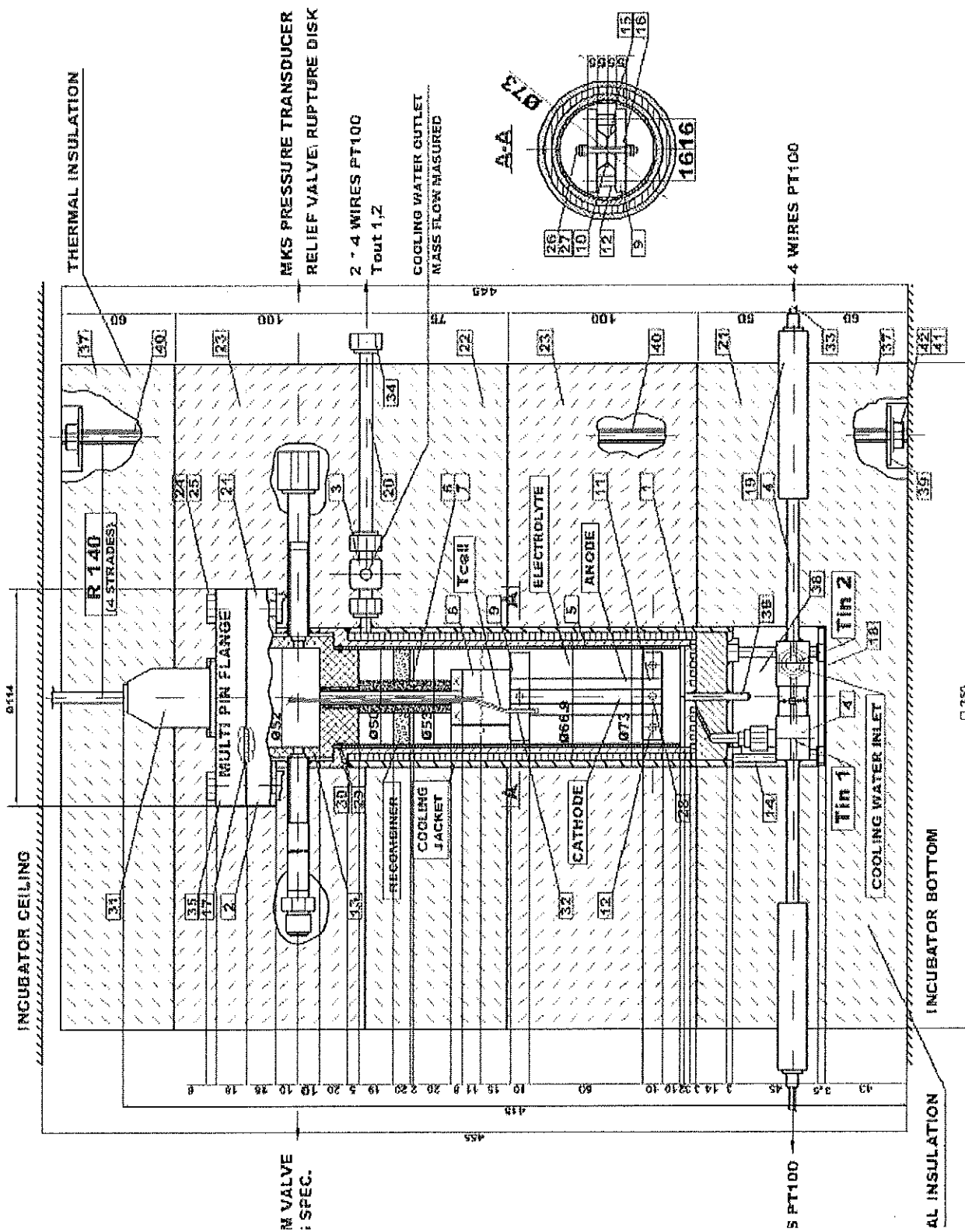
At the cell vacuum side, a multi female sleeves connector is assembled to the welded flange (Part No.2).

All the electric wires are connected to the vacuum side multi female sleeves connectors.

The flanges are sealed with a copper soft (annealed) ring (Part No.17) and a set of bolts and nuts (Parts No. 24 & 25). The ring may be of Viton if there is no demand for He tight.

Fig. 1





42	8	WASHER	1020	1/2"	
41	8	NUT	1020	1/2"	
40	00.30	4	STUD	1/2"	W.DRW
39	00.29	8	WASHER	1/2"	W.DRW
38	00.28	1	RELIEF VALVE	1/2"	W.DRW
37	00.27	2	PT-100	1/2"	W.DRW
36	P-CF	1	PT-100	1/2"	W.DRW
35	HW6304	1	PT-100	1/2"	W.DRW
34	7618	2	NUT	1/2"	W.DRW
33	PT-100	4	PT-100	1/2"	W.DRW
32	PT-100	1	PT-100	1/2"	W.DRW
31	10076024	1	PT-100	1/2"	W.DRW
30	2-034	1	PT-100	1/2"	W.DRW
29	2-032	1	PT-100	1/2"	W.DRW
28	1	PT-100	1/2"	1/2"	W.DRW
27	1	PT-100	1/2"	1/2"	W.DRW
26	1	PT-100	1/2"	1/2"	W.DRW
25	8	NUT	1020	1/2"	W.DRW
24	8	SCREW	1020	1/2"	W.DRW
23	00.26	2	PT-100	1/2"	W.DRW
22	00.25	1	PT-100	1/2"	W.DRW
21	00.24	1	PT-100	1/2"	W.DRW
20	00.23	2	PT-100	1/2"	W.DRW
19	00.22	4	PT-100	1/2"	W.DRW
18	00.21	1	PT-100	1/2"	W.DRW
17	00.17	1	PT-100	1/2"	W.DRW
16	00.13	2	PT-100	1/2"	W.DRW
15	00.12	1	PT-100	1/2"	W.DRW
14	00.20	3	PT-100	1/2"	W.DRW
13	00.09	1	PT-100	1/2"	W.DRW
12	00.08	2	PT-100	1/2"	W.DRW
11	00.07	2	PT-100	1/2"	W.DRW
10	00.06	2	PT-100	1/2"	W.DRW
9	00.05	2	PT-100	1/2"	W.DRW
8	00.04	1	PT-100	1/2"	W.DRW
7	00.03	2	PT-100	1/2"	W.DRW
6	00.03	1	PT-100	1/2"	W.DRW
5	00.01	1	PT-100	1/2"	W.DRW
4	04.00	1	PT-100	1/2"	W.DRW
3	03.00	1	PT-100	1/2"	W.DRW
2	02.00	1	PT-100	1/2"	W.DRW
1	01.00	1	PT-100	1/2"	W.DRW

CLOSED ELECTROLYTIC FLOW CELL

W	ELECTROLYZER	ETA 7.60.00	5
W	ELECTROLYZER	ETA 7.60.00	5
W	ELECTROLYZER	ETA 7.60.00	5

II. Experimental setup.

Figure 2 shows the scheme of experimental setup consisting of :

- working electrolytic closed Helium tight cell constituting of mass flow calorimeter placed into an incubator with thermal stability $\pm 0.1^{\circ}\text{C}$;
- cooling bath maintaining constant temperature of inlet cooling water;
- mass flow controller feeding soft water via cooling bath to cell cooling circuit.

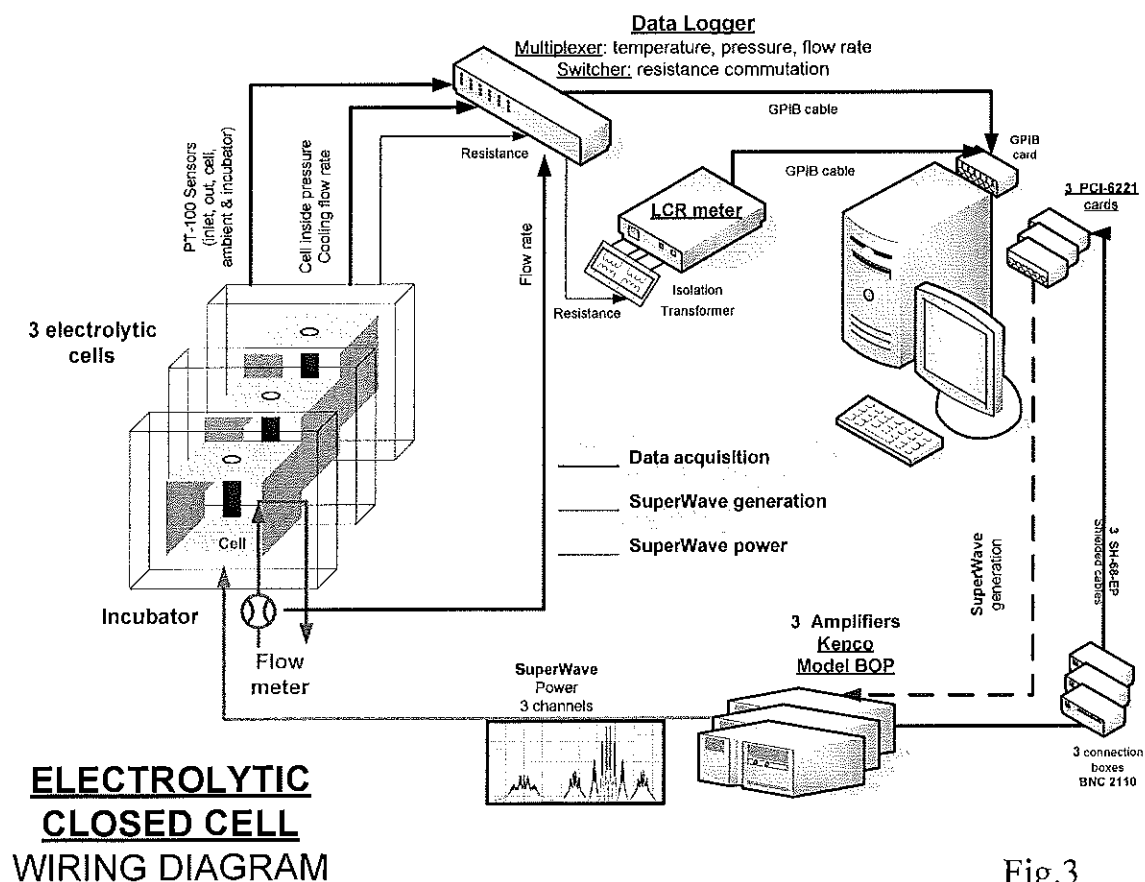
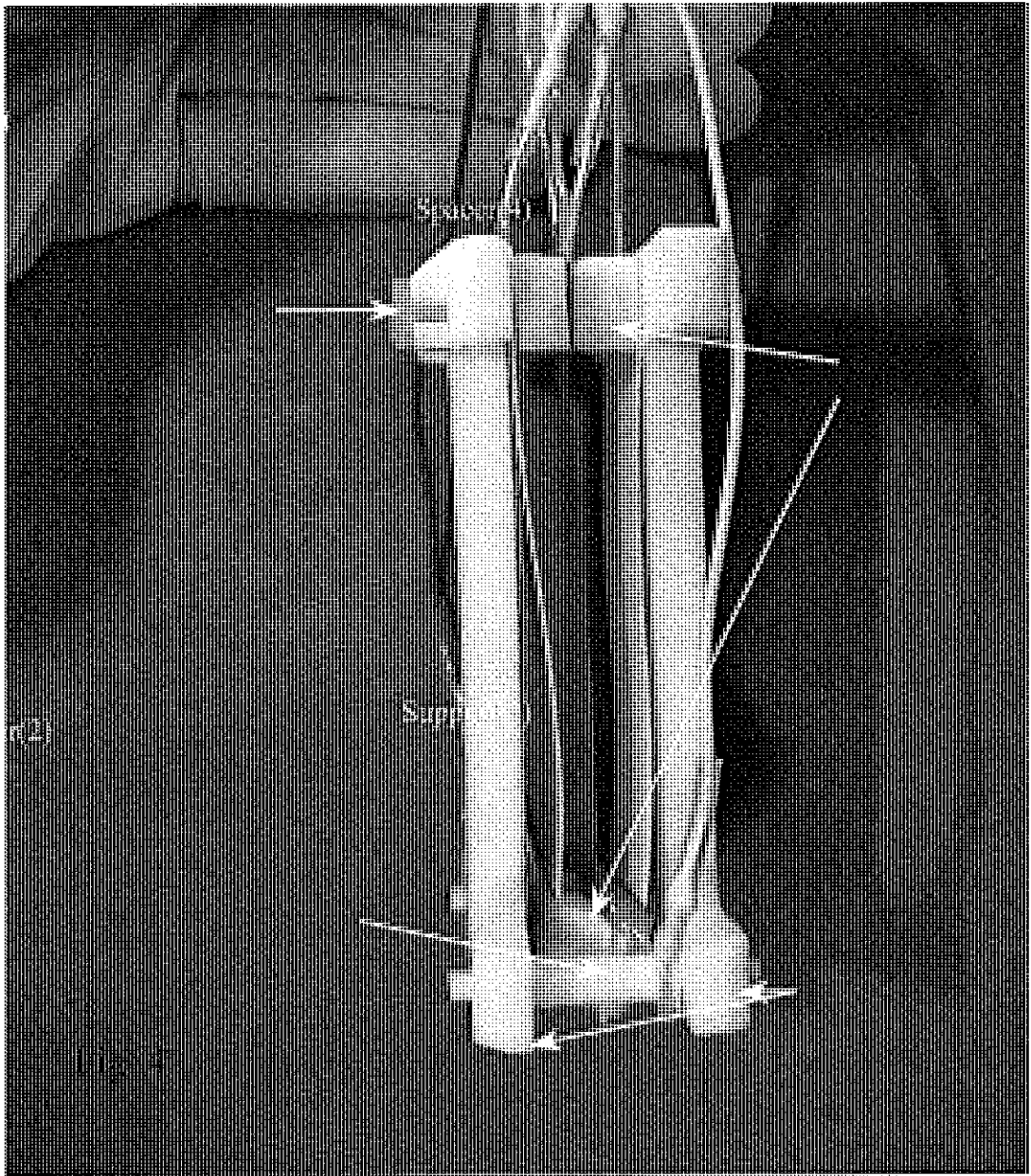


Fig.3

III. Electrode pair assembly.

The internal part of the cell comprises the electrodes holder with a cathode and two anodes (Fig 4). The palladium cathode (Fig. 5) has 5 platinum leads in Teflon shields of respective diameters in order to avoid short-circuit: one lead for current supply and 4 leads for the resistance measurements using a 4-point probe method. Platinum leads are extended with Teflon shielded copper wires; Pt-Cu connections are protected by Teflon tape and Teflon thermo-shrinkable tube.

Two platinum anodes (20 x 80 x 0.1) mm are located symmetrically on both side of the cathode. The anode-to-cathode distance is 5 mm. Each anode has one current-carrying Teflon shielded platinum lead. To prevent short-circuit between the cathode and the anodes, polypropylene capacitor papers 80 x 20 x 0.17 mm are attached to the anodes. The electrodes assembly (sandwich) is composed of 2 supports, 4 spacers and 2 holders made of Teflon and 1 screw with a nut made of polypropylene "Nature" (Fig.4).

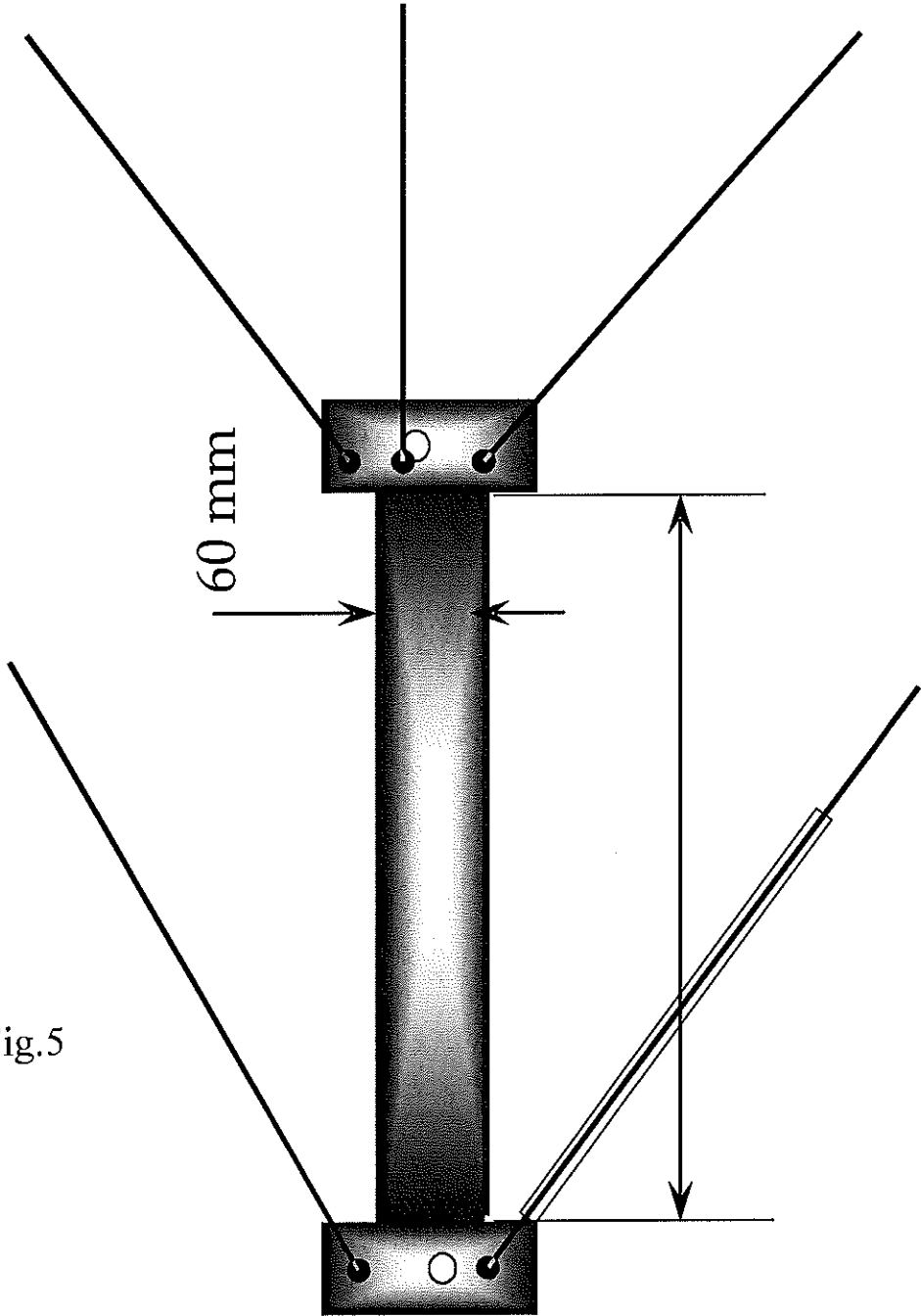


Current lead

7 mm

60 mm

Fig.5



IV. Preparation procedure before run up

1. Cleaning.

Cell and all inner parts are delivered clean. It is sufficient to wash all stuff with alcohol.

Between the experiments the next cleaning procedure should be applied:

- wash carefully the beaker inside the calorimeter 4-5 times with DI water, twice with ethanol, and dried in argon flowing at the rate of 20-25 l/h at least 24 h;
- rinse all inner components of the setup (holders, spacers, etc.) with DI water using soft brush (like teeth brush). In case that all components are still not clean enough (visually) soak them in 2% Micro-90, brush and then if they are still not clean enough etch with so called "piranha" solution (a mixture of concentrated sulfuric acid with 30-33% hydrogen peroxide in 1 : 5-6 ratio by volume). Etching is accompanied by intense gas release, therefore, the respective safety regulations should be strictly observed. Etching is continued until gas release is completely ceased, and then the components are rinsed at least 10 times with DI water and 2-3 times with ethanol and dried. After drying, the components should be kept in a special closed container or zipped plastic bags.

2. Cathode preparation.

Cathodes are supplied after annealing with 5 Pt Ø 0.3 mm welded leads.

- Rinse the cathode with acetone, then with ethanol
- Etch for 1 min in concentrated nitric acid and 1 min in aqua regia diluted with DI water in the ratio 1 : 1. This etching procedure is the most frequent used. But it may be redefined according to some special demands

- After etching rinse the cathodes 4 times with DI water for 30 min each time, once with highly purified DI water, once with acetone, 95% ethanol and absolute ethanol.

More detailed instructions are given in Power Point with illustrations.

Assamble closed cell according to instructions in Power Point with illustrations. After you sure everything (wires, tubes and pressure transducer) is connected go to the step of a pressure stability check.

Operation.

- Record the code name and number of the working cell and the initial cathode resistance R_0 in ini.file (Appendix 2).
- Create SuperWave shape and choice necessary current for starting of the loading process.
- Start DAQ program.
- Turn on the power supply and start the loading.
- Start from low current density.
- Increase the current density step-by-step until the highest possible $D/Pd > 0.95$ ratio is reached.

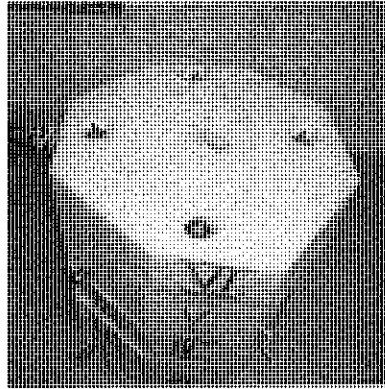
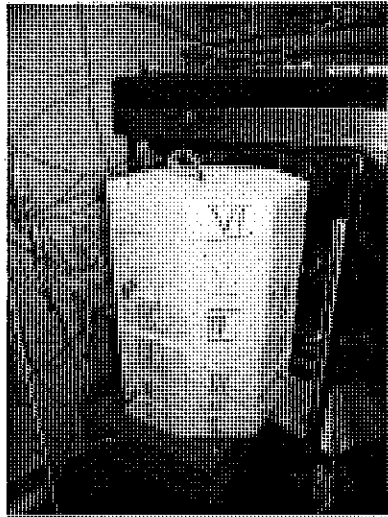
The data obtained in the course of this loadind procedure are kept on the computer hard disc using Data Acquisition LabVIEW software package.

The results of loading are expressed by changes in the cathode resistance ratio R/R_0 .

The desired objective to be attained using SuperWaves is to generate an excessive power (excess heat), which is expressed by an anomalous temperature increase.

Disassembly

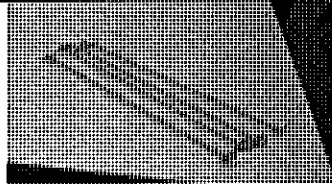
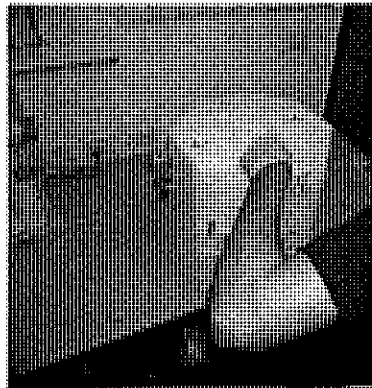
9/25/18



Assembled calorimeter – thermal insulation consists of 6 hexagonal plates made of Rohacell Foam signed with superposed Roman numerals.

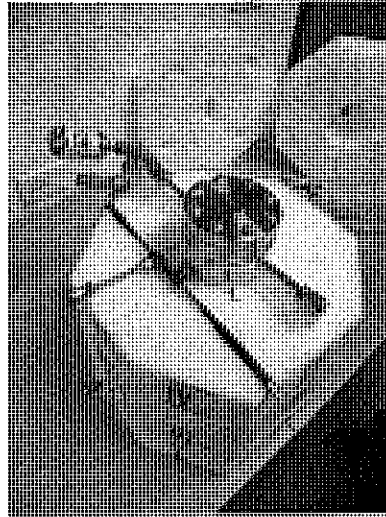
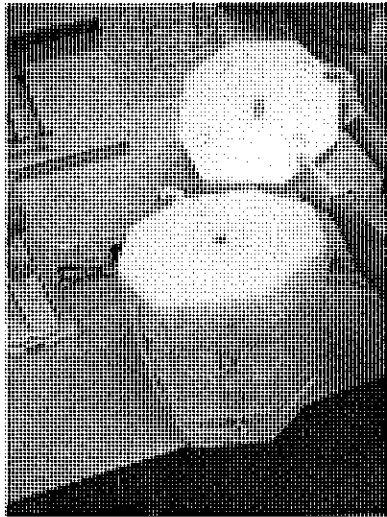
All plates are fastened together using 4 threaded rod, 2 steel disks and 2 nuts

1



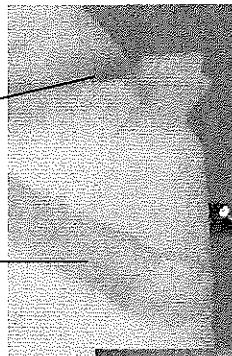
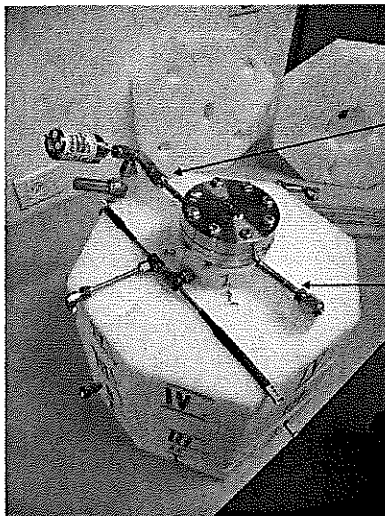
Get off the nuts and pull down all threaded rods

2

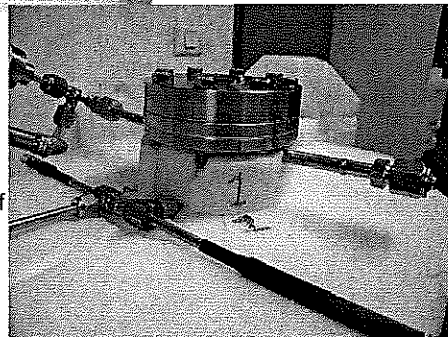


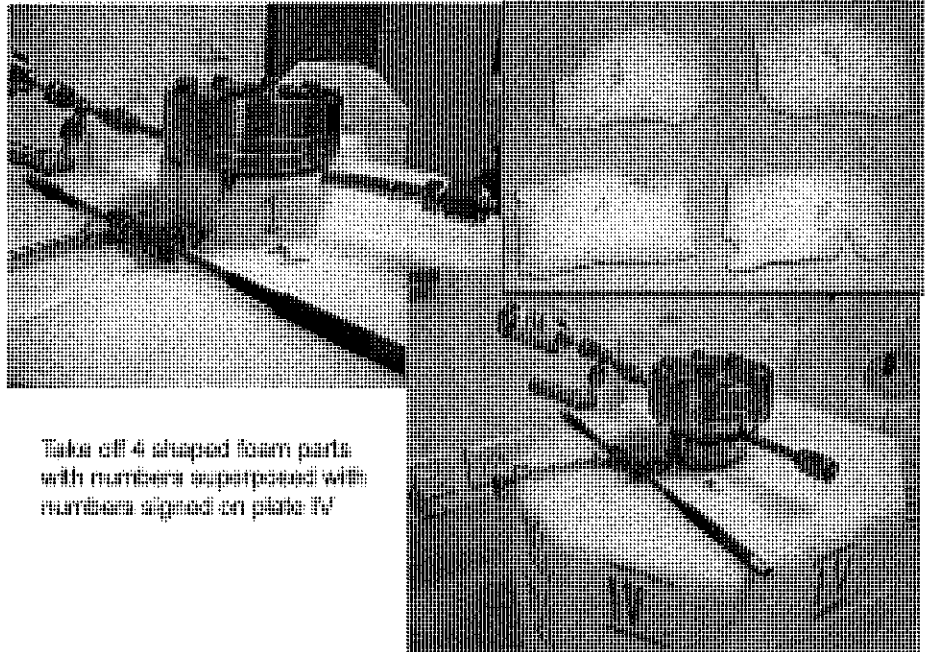
Get off Plates VI and V, take out

3

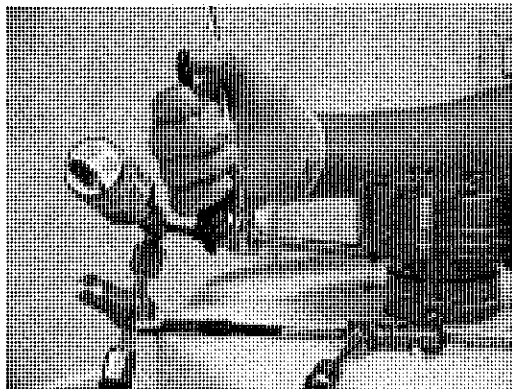


Take off 2 small blocks of foam underneath of steel tubes

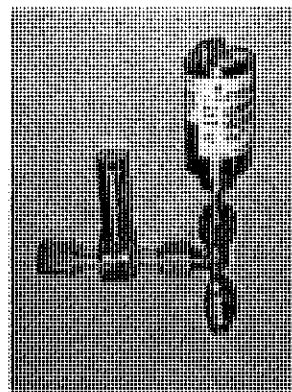


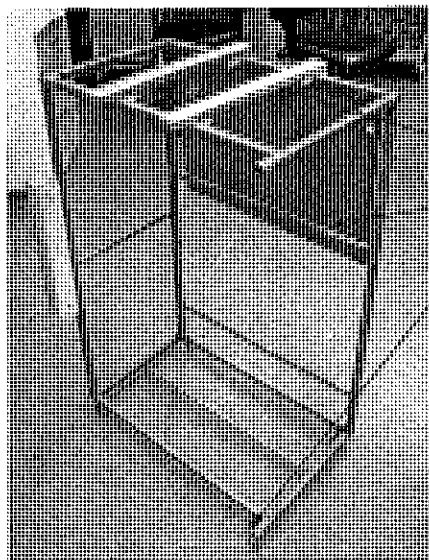


Take off 4 shaped foam parts
with numbers superposed with
numbers signed on plate IV



Disassembly VCR connector leading to Pressure
Transducer/Relief Valve (both not shipped)





In order to ease assembly – disassembly
– moving of the cell we constructed an
auxiliary bench with external dimensions:

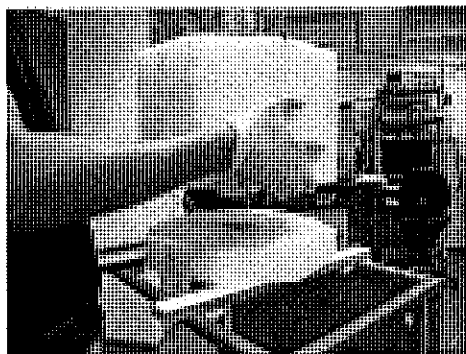
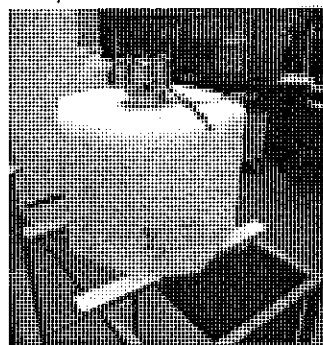
H x L x W = 100 x 66 x 40 cm

Bench provides with

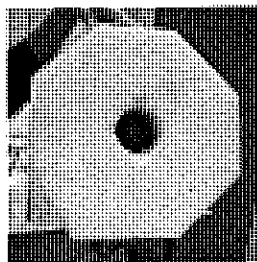
→ 2 wooden guiding bars,

→ removable work plate

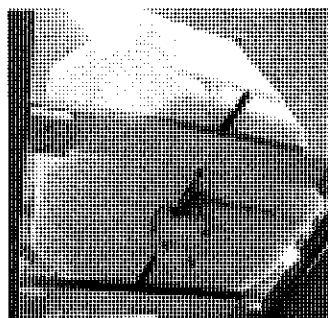
→ 4 small wheels,

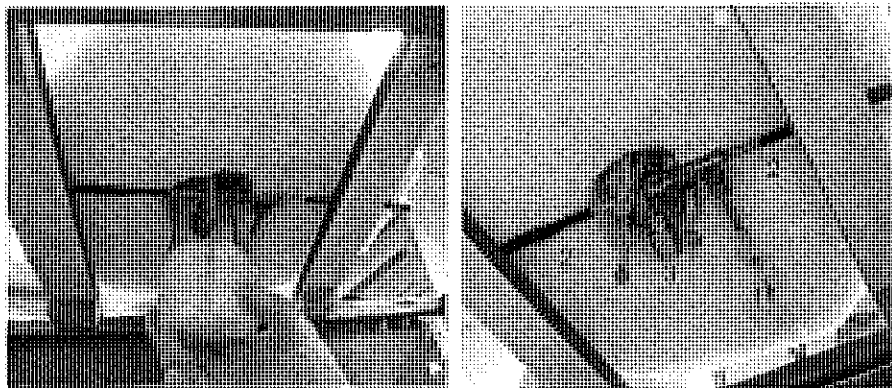


Remove the lowest foam part (I) using
guiding bars on auxiliary bench



Foam Part I

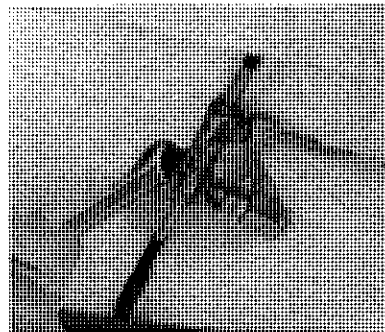
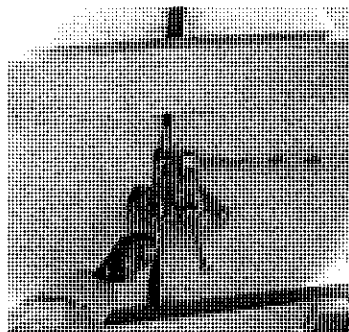




Pull down cylindrical foam part shaped to be conformal to the bottom of the cell with

- water inlet tubes (1),
- PT-100 ports (2),
- air release plug(3)

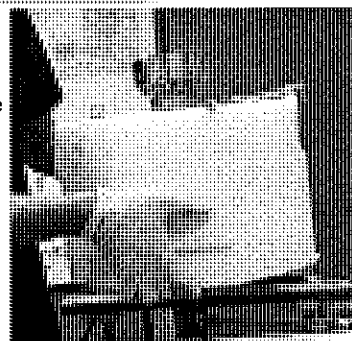
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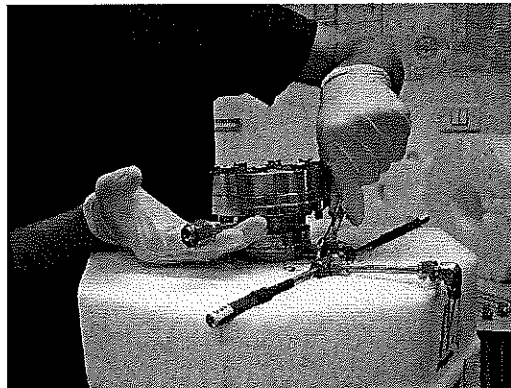


Unscrew 3 SS screws which support the cell.

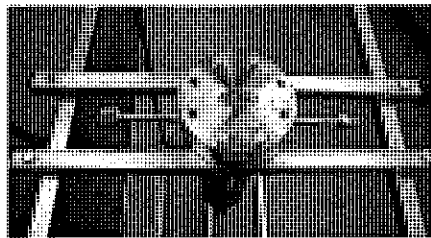
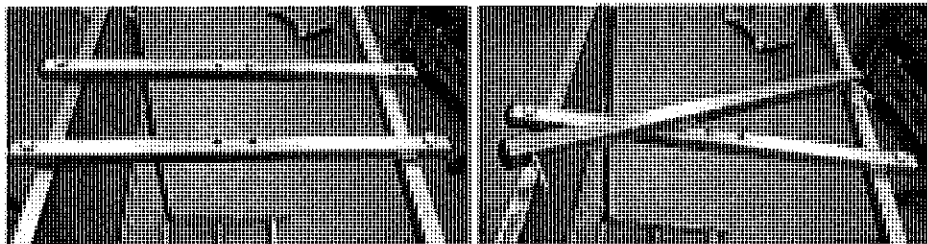
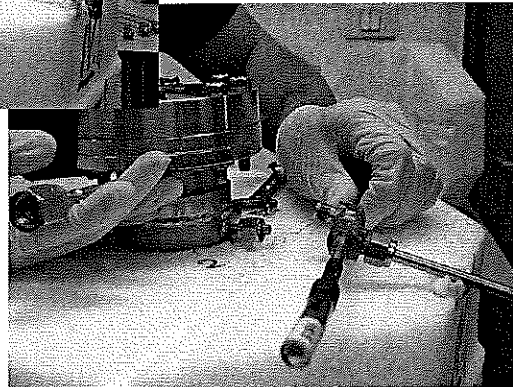
Demount water inlet tube with PT-100 ports and take it off.

Cell with 3 foam plates (II,III,IV) put on guiding bars.





Demount water outlet tube
with PT-100 ports

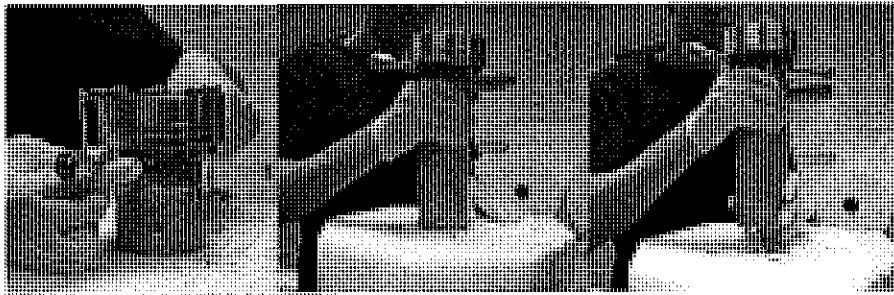


In order to provide access to the bottom of the cell, the cell has to be "suspended".

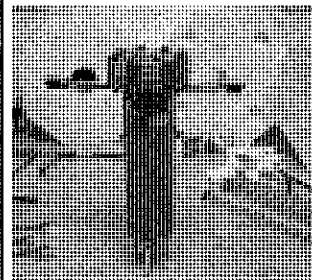
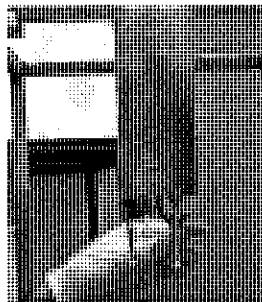
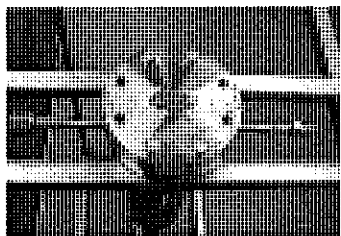
We constructed SS guiding bars with stoppers and two holes distanced exactly as two bolts on conflat flange edge.

12

We ship 2 bars without stoppers, so they could be mounted everywhere you want.

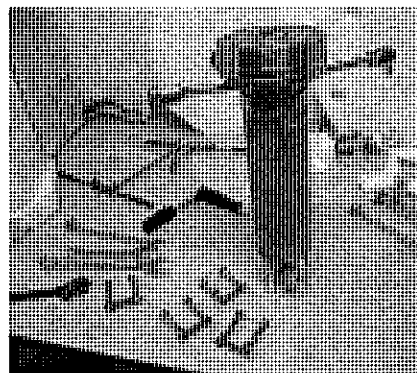
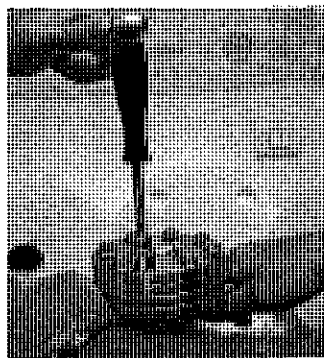


Pull the cell outward.



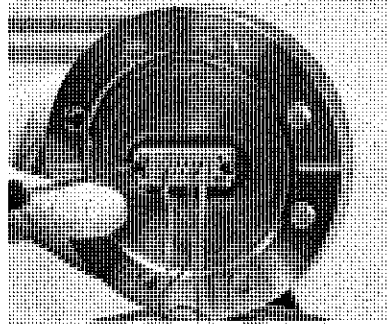
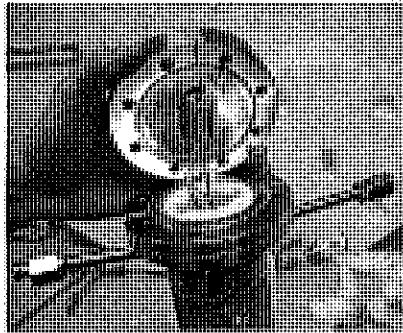
Put on guiding bars, screw back 3 SS screws and place on a lab bench

13

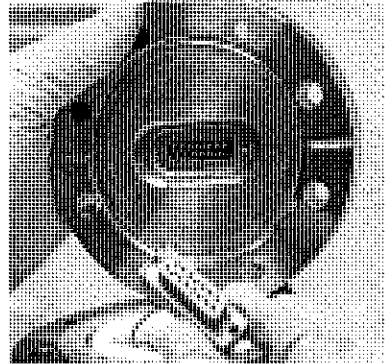


Unscrew 8 SS bolts and 4 plate nuts

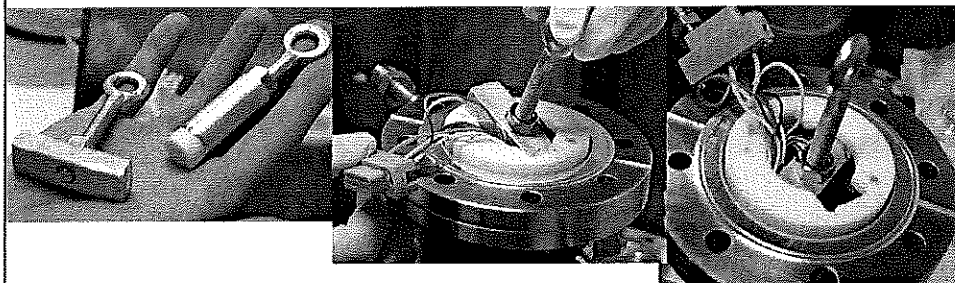
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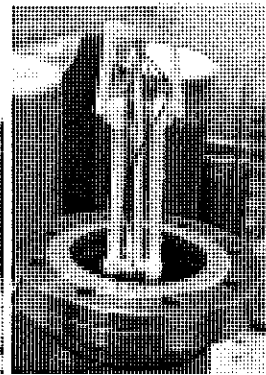
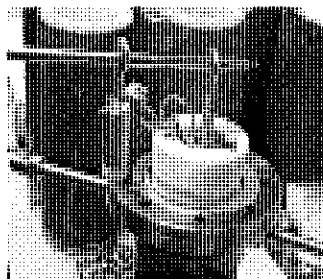
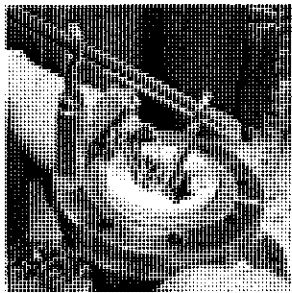
Open the cell.
Unscrew bolts in multipin connector
Detach multipin connector from flange



15



Pull "sandwich" out of cell using 2 special tools
and screw driver as leverage



Closed Cell Brief Description

Closed Flow Cell

Cell Description

The cell is made of SS 316 L with cooling water spiral path at the bottom and on the long side of the cell, covered by SS 316 L welded jacket (Part No.1).

At the bottom of the cell a 1/4" tube is welded for air pressure relief, at the end of this tube a 1/4" VCR connector is assembled in order to allow air pressure relief after the Teflon beaker (part No.5) is inserted into the cell and anytime you need as well.

Cooling water inlet is located at the bottom of the cell (part No. 4) and connected to the bottom spiral.

The bottom cooling water inlet allows inserting 2 PT-100. The 2 PT-100 (SS Sheath) are not immersed in the cooling water but are inserted through a tube which is in direct contact with the cooling water.

The tube is filled with thermo conductive paste to improve the heat conductance between the PT-100 and the cooling water (Parts No. 19 & 33).

The cell stands on 3 SS screws (Part No. 14) and on Delrin base (Part No. 18).

The cooling water is leaving the cell after absorbing heat from the cell at elevated temperature through Part No. 3 & 20.

The outlet temperature is measured by 2 SS sheath PT-100 as for the inlet temperature measured at the bottom.

At the upper side of the cells there are two opposite outlets with 1/4 VCR connectors.

The male 1/4" VCR connector (on the left side of the drawings) delivers closed with plug. Further it can be connected to a mass spectrometer, for He detection.

The female 1/4" VCR (on the right side of the drawing) should be connected to a T 1/4" VCR connector, where a pressure transducer and a pressure relief valve (He tight) are connected (not be shipped).

A multi pin connector flange – NW 63 CF (Part No.2) is welded to the cell body (Part No.1) and sealed by cover flange also with multi pin connector, to which an air plug multi pin connector is connected (Part No.31).

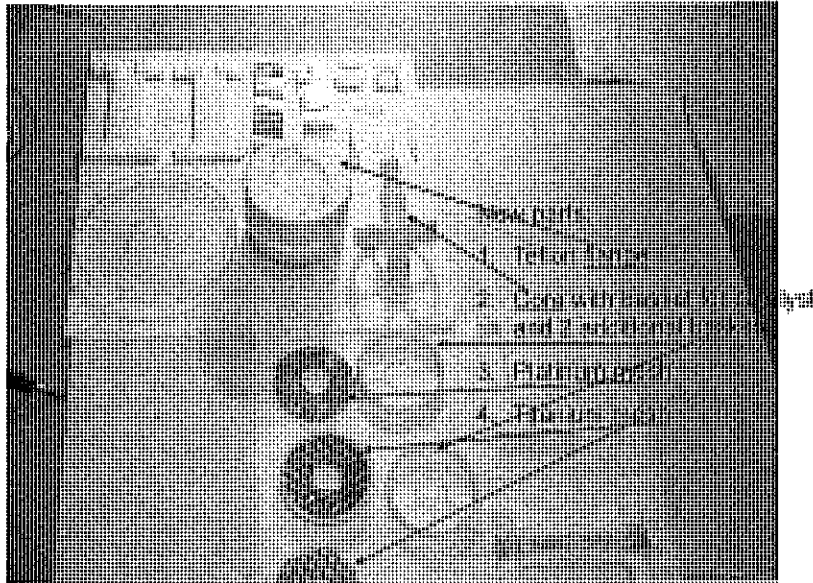
At the cell vacuum side, a multi female sleeves connector is assembled to the welded flange (Part No.2).

All the electric wires are connected to the vacuum side multi female sleeves connectors.

The flanges are sealed with a copper soft (annealed) ring (Part No.17) and a set of bolts and nuts (Parts No. 24 & 25). The ring may be of Viton if there is no demand for He tight.

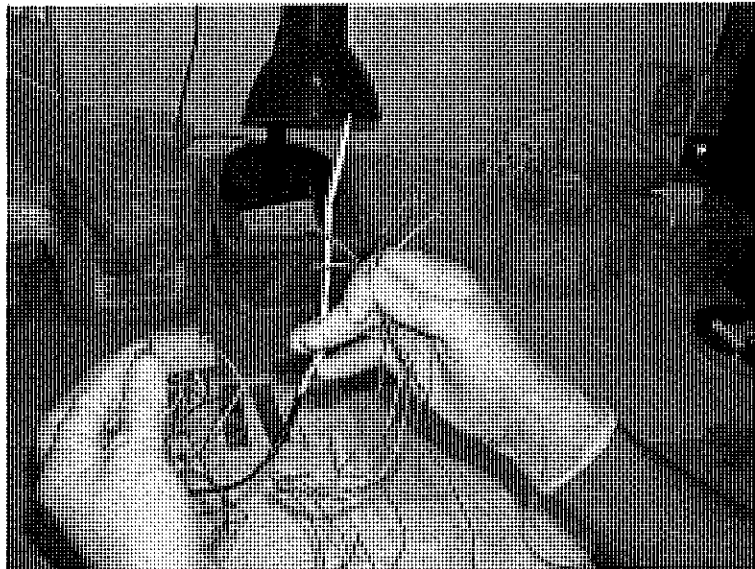
Sandwich

9/25/18

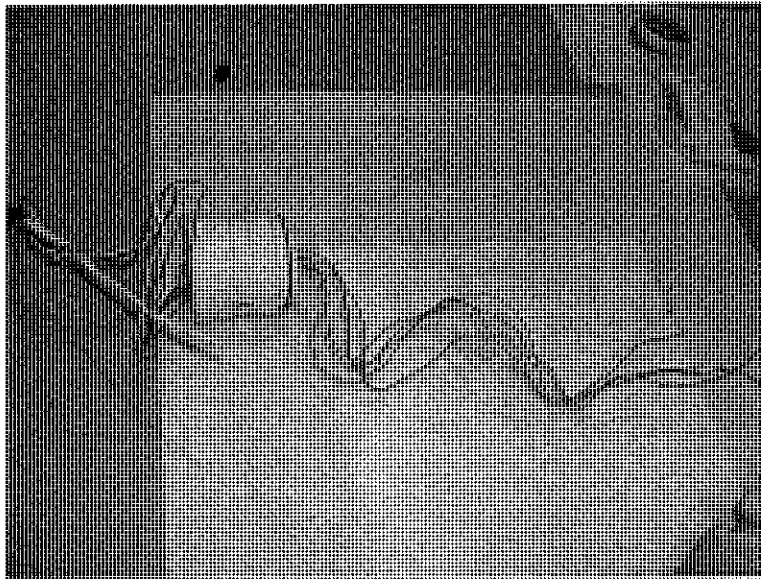


All parts of "sandwich" itself stay as for isoperibolic calorimeter.

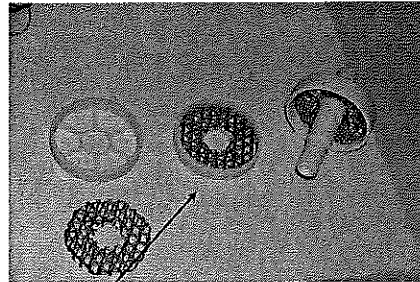
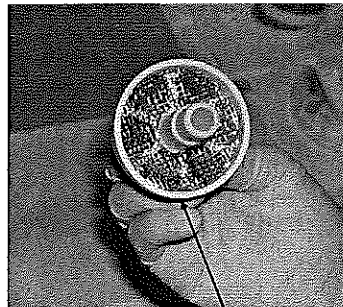
1



Multipin connector made of PEEK with 6 Teflon coated colored wire leads and 1
2 PT-100 Teflon sheathed (the leads are long enough for non-expendable use)

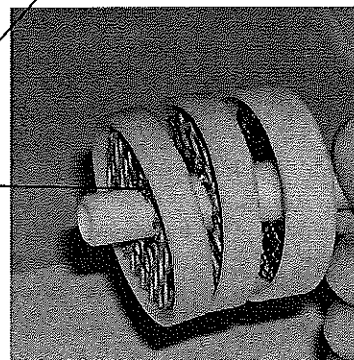


3 "Thread" all 6 leads through Teflon flange

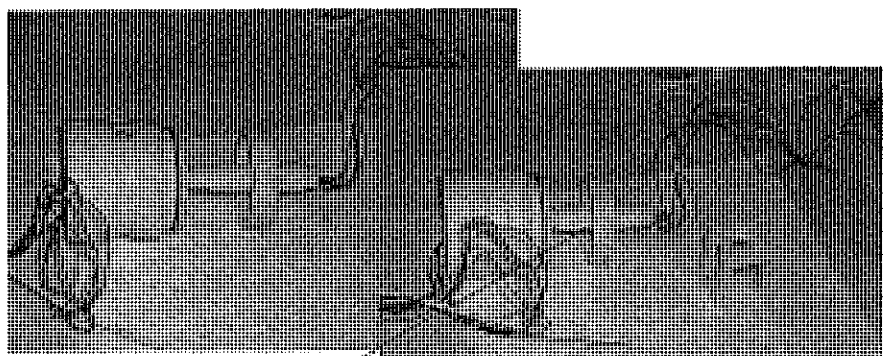


Prepare catalyst assembly.

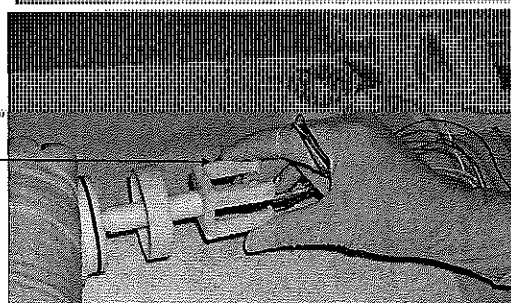
The assembly may consist of 1,2 or 3 storey (1st with Platinum mesh, 2 next with Titanium mesh)



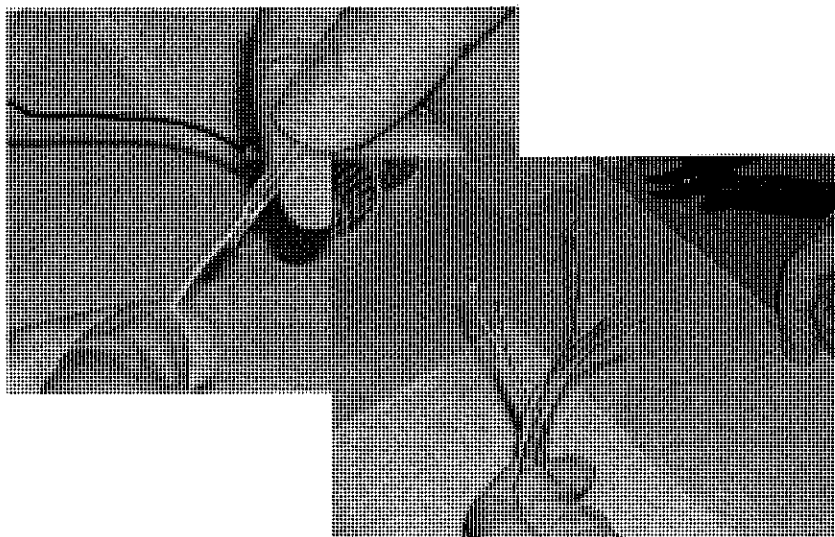
4



"Thread" all 6 leads through
catalyst assembly and "sandwich"
holder

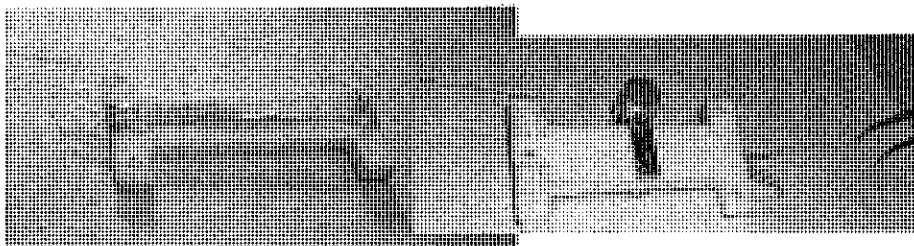


5

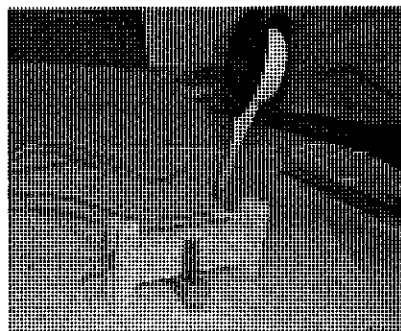


Put on each lead a piece of Teflon heat shrinkable
tube (gauge 16) app. 2.5-3.0 cm length

6



Etched Pd cathode with 5 Pt 0.3 mm leads place on solid Teflon holder, put on all 5 leads heat shrinkable Teflon tube (gauge 30), grip the cathode between 2 solid Teflon holders, connect with copper wire, protect the connection with Teflon tape and shrinkable tube.



7

Copper wire colors are predetermined:

(1) Resistance measurement

Yellow – lower left (Lc) - 5

Black – lower right (Lp) - 6

White – upper left (Hp) - 7

Red – upper right (Hc) - 8

(2) Current Supply

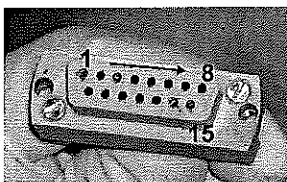
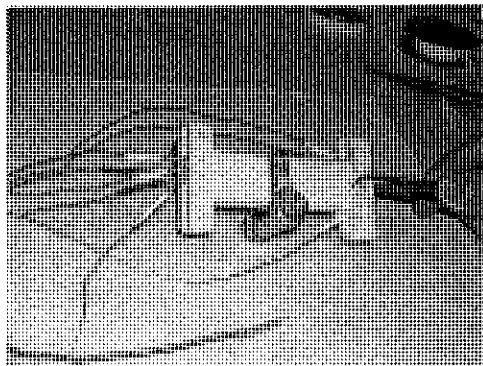
Blue – cathode current - 3

Green – anode - 1

(3) PT-100

Red – 14

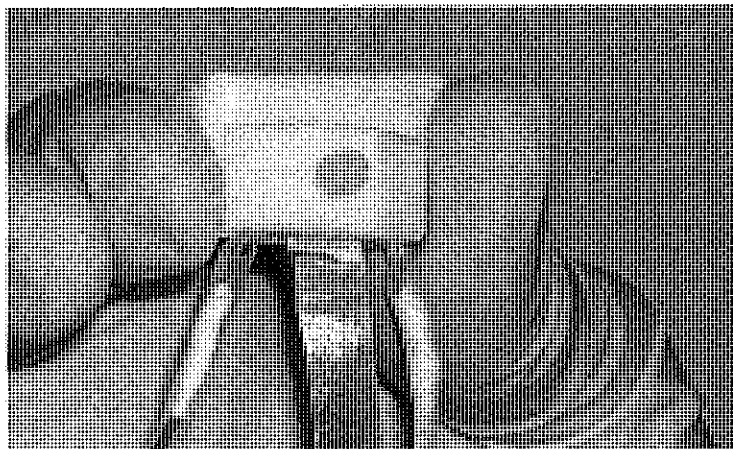
Yellow -15



8

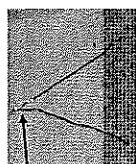
Connector to Closed cell

1	2	3	4	5	6	7	8
+							
9	10	11	12	13	14	15	



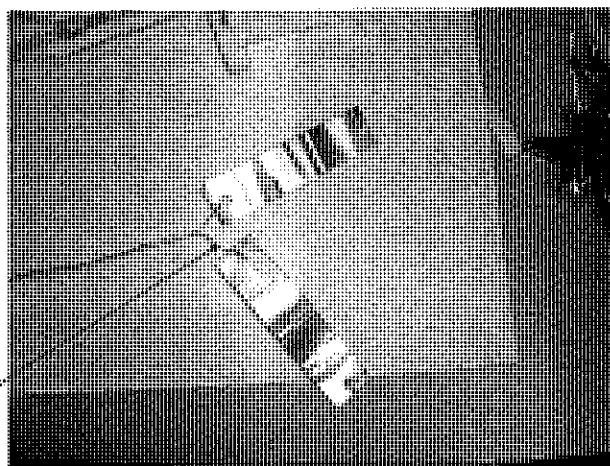
Fix the lower part of the cathode using Teflon trapezes and Teflon sheet, like for open cell.

9



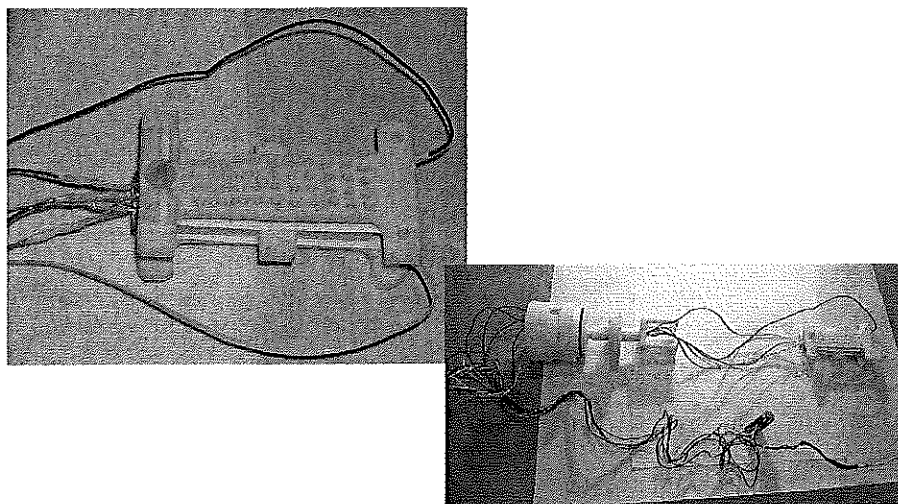
Welded end

Pt 0.5 mm "Wishbone"



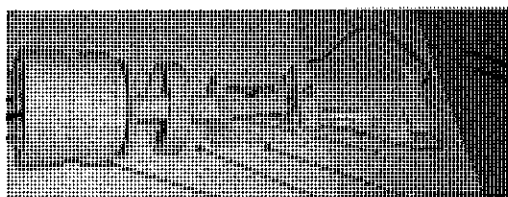
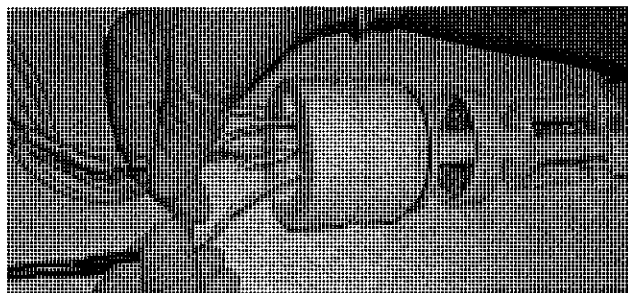
Both Pt anodes are connected to one copper lead using Pt "wishbone" (see schematic view)

10



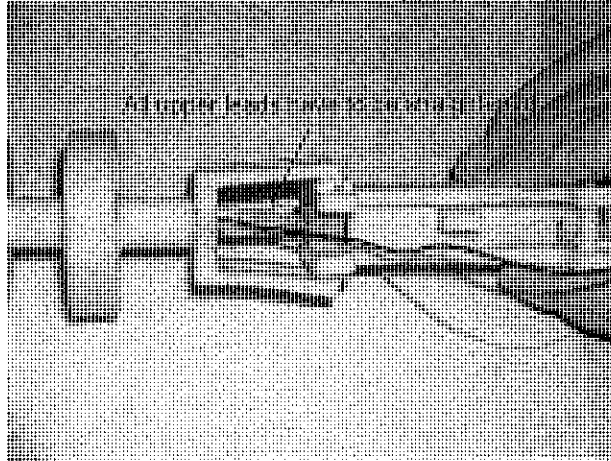
Complete assembly using spacers, PP paper, perforated Teflon holders (like for open cell)

11



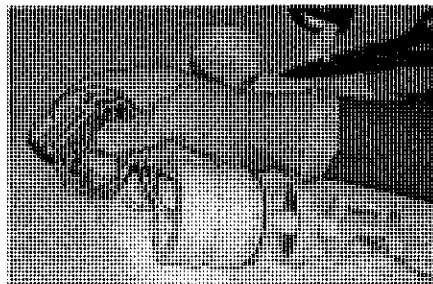
Carefully draw all leads and hold them, screw tightly all parts (flange, core, holder) put inside PT-100 through the Teflon core

12

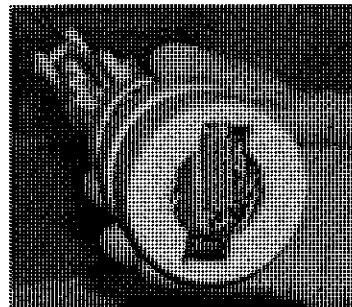


Finally, place "sandwich" into Teflon holder

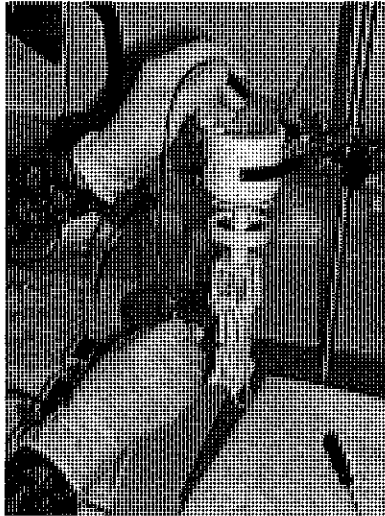
13



Tie all leads together using Teflon tape,
wind them and place inside of Teflon
flange



14



Very important to perform ringup of all connections using tester.

After testing "sandwich" has to be rinsed using acetone and alcohol and then whole assembly will be placed into vacuum oven (desiccator).

Welding + Etching

9/25/18



In order to attach 5 wire leads 0.3 mm Pt use Spot Welding machine.

Special supporting table was constructed in order to ease welding and not deformed the foil. The table has through hole conforming to the shape of lower electrode.



Hold Pt wire with tweezers.
Perform 2-3 "stitches" to each lead



Prepare concentrated Nitric Acid in 25 ml graduated cylinder and Aqua Regia in 50 ml graduated cylinder.

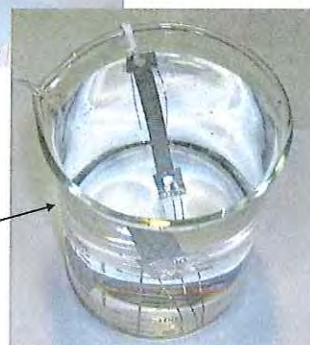
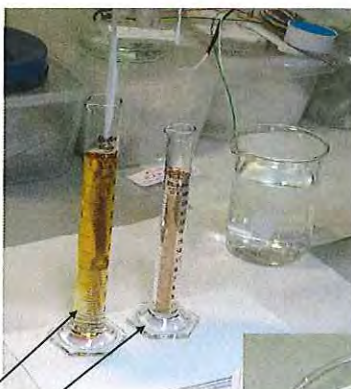
Pour DI water into beaker.

"Thread" Teflon thread through one of holes at foil ear.

Concentration of Aqua Regia and duration of etching should be defined according to demands.

Mostly used - 50%AR 1 min

Each foil should be etched in fresh poured acid and fresh prepared AR

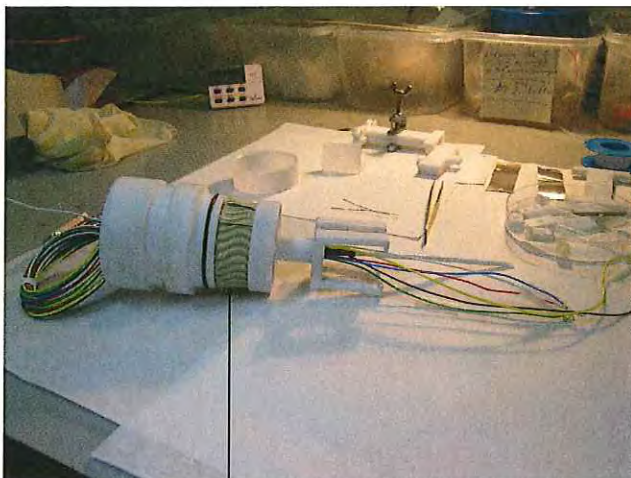


1 – 1 min in HNO_3

2 – 1 min in 50% AR

3 – 3-5 sec in HNO_3

4 – rinse in DI water 4 times 15-20 min each



New catalyst that we should test – fuel cell flexible polymer sheet .

Attachment C

Electrolysis: Open Cell

Electrolysis: Open Cell

Open cell description - procedure -
Feb 2012

**ENERGETICS Ltd. SYSTEM OF ELECTROLYTIC CELLS
FOR THE STUDY OF LOW-ENERGY NUCLEAR REACTIONS (LENR)
BY ELECTROLYTIC LOADING OF PALLADIUM WITH DEUTERIUM**

General description

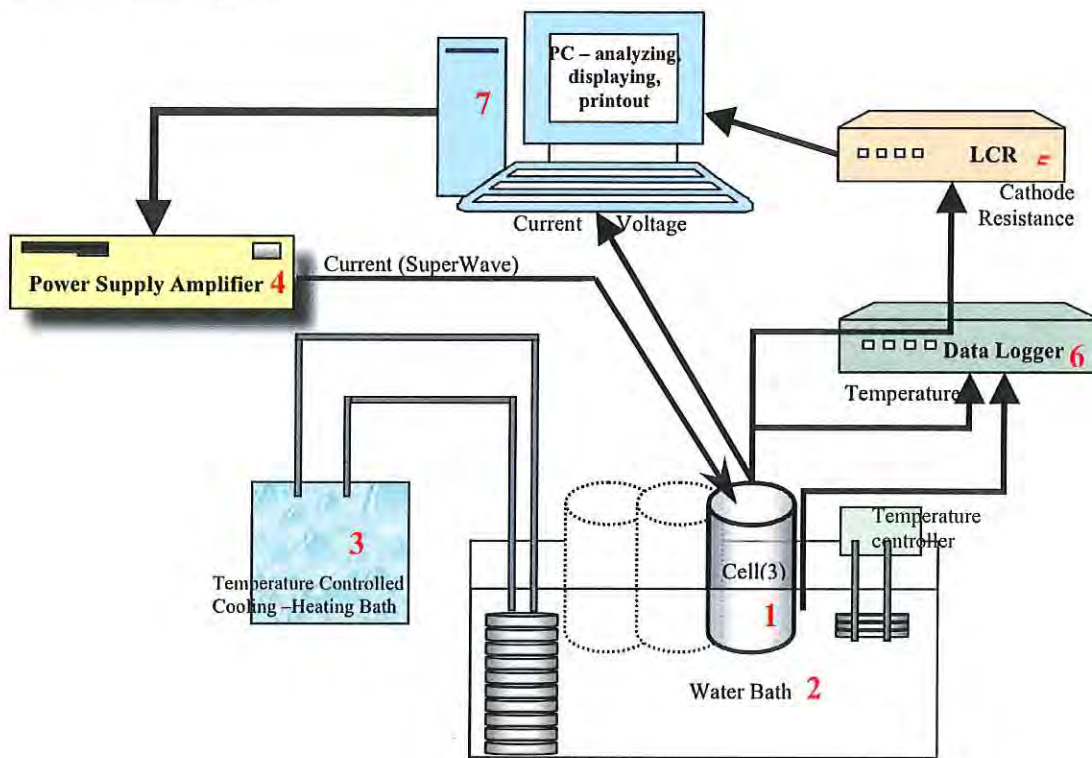


Fig.1

Figure 1 shows the setup consisting of

- three working electrolytic cells (1) constituting isoperibolic calorimeters placed into a constant-temperature heating water bath (2);
- cooling-heating bath (3) maintaining constant temperature in addition to temperature controlled system with heater;
- Power supply (4);
- resistance measuring device LCR (5);
- data-logger (6)
- personal computer (7) for generating of SuperWave and Data Acquisition.

Each electrolytic cell constitutes (Fig.2) a Teflon beaker (10) with electrodes assembled on supports (3) and immersed into an alkali electrolyte. The beaker is located in a calorimeter

constituting two aluminum cylinders (6 & 7) thermally insulated from each other by an alumina powder layer. In order to realize preferential heat release through the lateral walls of the calorimeter, the alumina layer between cylinders is much thinner than the alumina powder layer in the upper cover (17) and in the lower part of the calorimeter. On the upper cover of the calorimeter, there is an external recombiner intended for the recombination of the released hydrogen/deuterium gases and oxygen to produce water. Besides, a siphon pipe (25) is introduced into the cell through the upper cover, enabling to control electrolyte level in the cell.

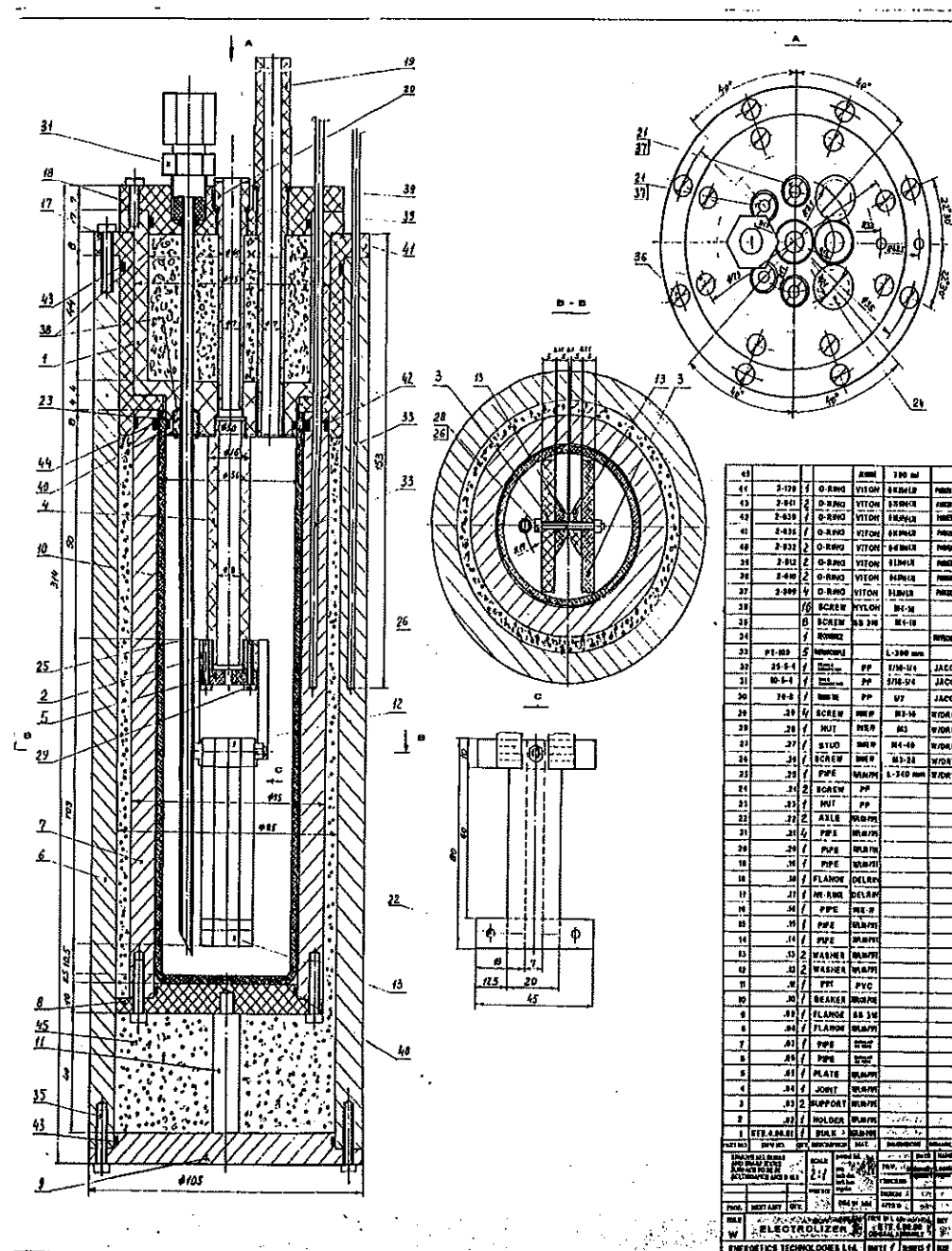


Fig. 2

The siphon is connected with an external vessel with fresh heavy water supply (Fig 3).

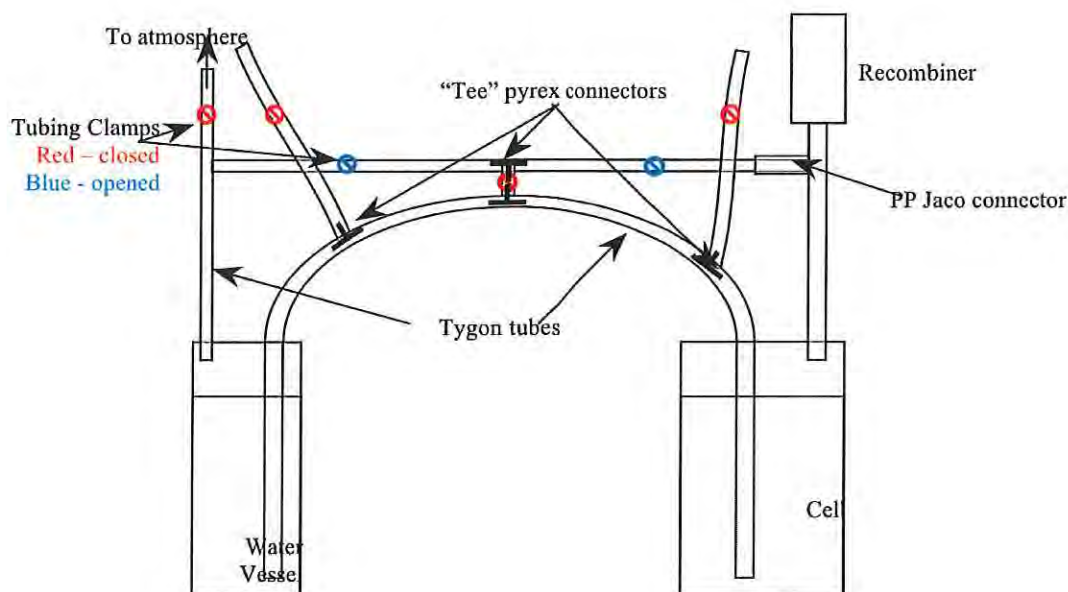


Fig.3

The temperature distribution in each cell is controlled in the course of work by 5 temperature sensors of RTD type (PT-100) (33). Three of them, coated with Teflon, are arranged within the cell at different heights to measure temperature of the liquid at different zones. Two other sensors in stainless- steel tubes are for measuring the heat transfer value operation and are located at the same level in the central part of the calorimeter, inside the internal and external aluminum walls of the latter. The upper cover of the calorimeter has 4 through holes (21) for introducing thermal sensors with Teflon coating and electric leads. In addition, the central tube (20) in the upper cover is used for introducing of a thermo sensor and to support the electrodes holder.

The internal part of the cell comprises the electrodes holder with a cathode and two anodes (Fig 4). The palladium cathode (Fig. 5) has 5 platinum leads in Teflon (TFE thermo-shrinkable tubes) shields of respective diameters in order to avoid short-circuit: one lead for current supply and 4 leads for the resistance measurements using a 4-point probe method. Platinum leads are extended with Teflon shielded copper wires; Pt-Cu connections are protected by two thermo-shrinkable tubes.

Two platinum anodes (20 x 80 x 0.1) mm are located symmetrically on both side of the cathode. The anode-to-cathode distance is 5 mm. Each anode has

one current-carrying Teflon (TFE thermo-shrinkable tubes) shielded platinum lead. To prevent short-circuit between the cathode and the anodes, polypropylene capacitor papers 80 x 20 x 0.17 mm are attached to the anodes. The electrodes assembly (sandwich) is composed of 2 supports, 4 spacers and 2 holders made of Teflon and 1 screw with a nut made of polypropylene "Nature" (Fig.4).

Calorimeter calibration

The calorimeter (except sandwich) is supplied assembled.

- Perform calibration of PT-100 temperature sensors in a separate reservoir using a special option provided by the software. The PT-100 calibration is performed between two points with the temperature difference of $\sim 25\text{-}35^{\circ}\text{C}$.
- Fix calibrated Teflon coated sensors T_1 , T_2 , T_3 at the right height relatively to sandwich on the upper cover of calorimeter (Fig.7).
- Assemble special heater source unit instead of the anode/cathode sandwich. The special calibration unit (Fig. 6) comprises a Teflon core with a platinum wire (1m long and 0.3 mm in diameter) winded around it, with 2 copper leads from each of its ends.
- Fill Teflon beaker with 230 ml of deionized (DI) water, close tightly with upper cover.
- Insert steel sensors T_4 , T_5 into aluminum cylinders (Fig.7).
- Place three calorimeters into the working bath. The working bath temperature set point is as $2.5 \pm 0.1^{\circ}\text{C}$. The bath temperature is maintained constant during calibration and operation.
- At no power wait for temperature difference ($\Delta T = T_4 - T_5$) stabilization.
- Supply electric power step by step from 0 to $\sim 60\text{-}70\text{W}$ (so that the DI water temperature did not exceed $92\text{-}93^{\circ}\text{C}$) with irregular intervals given, by way of example, in Table 1.

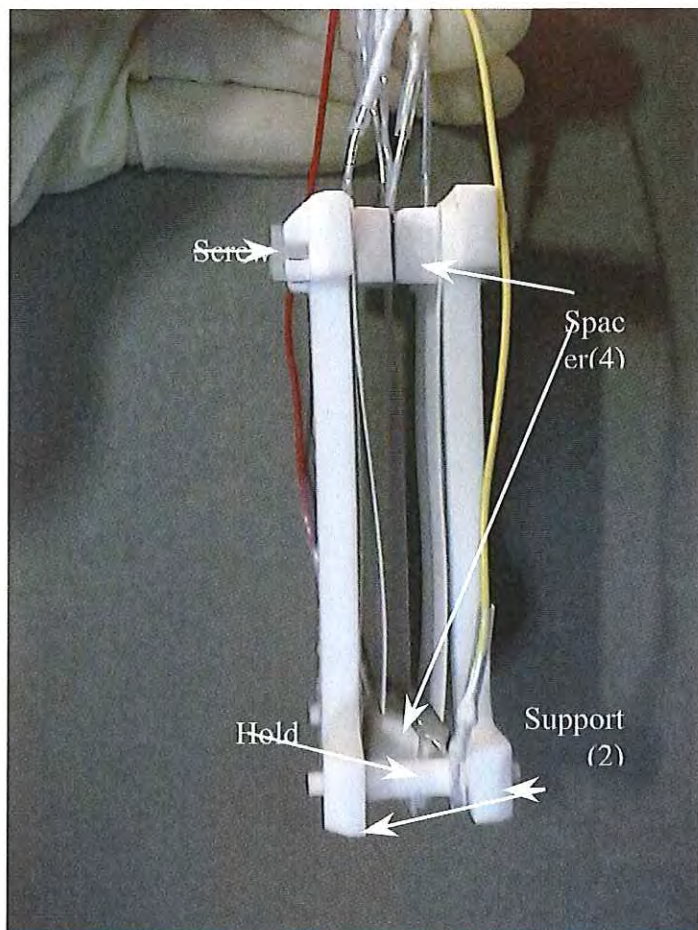


Fig. 4

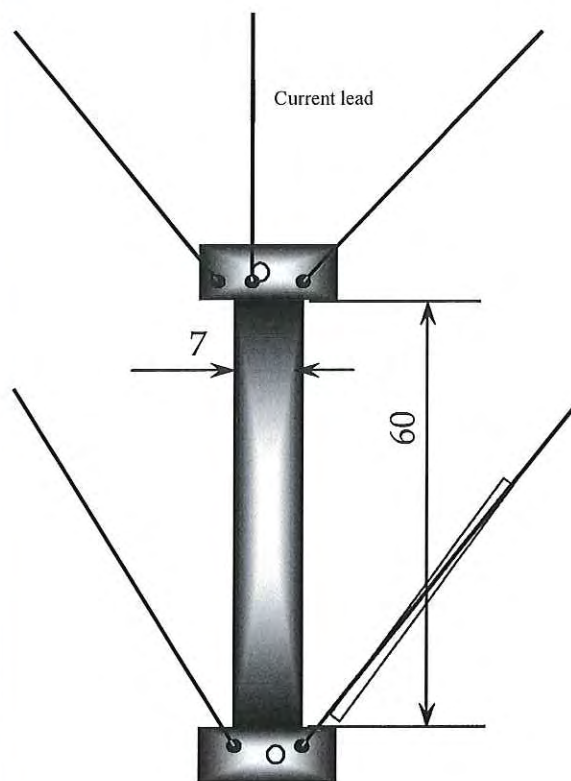


Fig.5

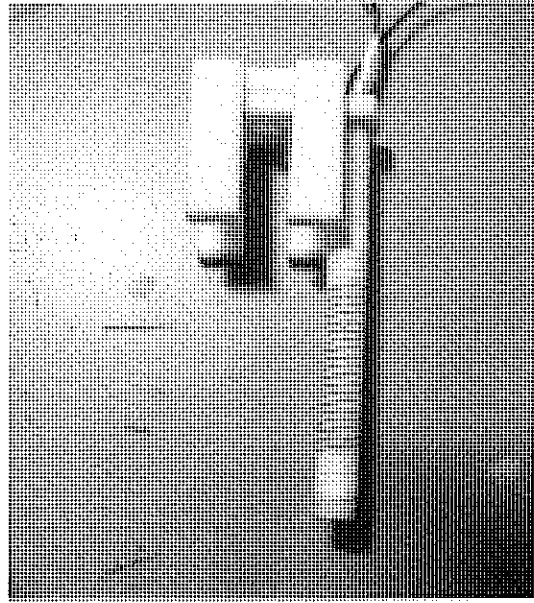
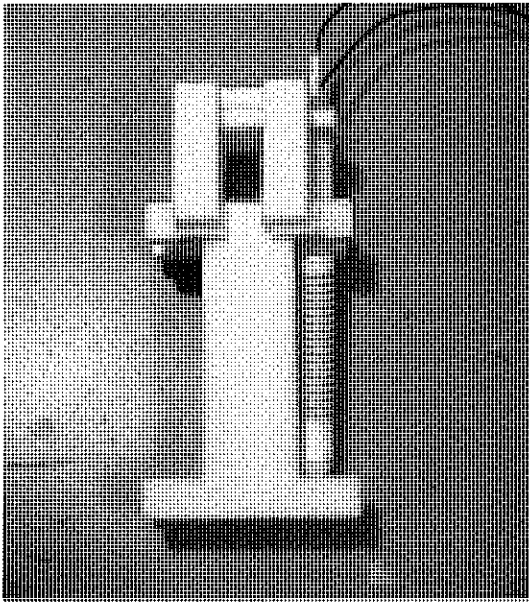


Fig. 6

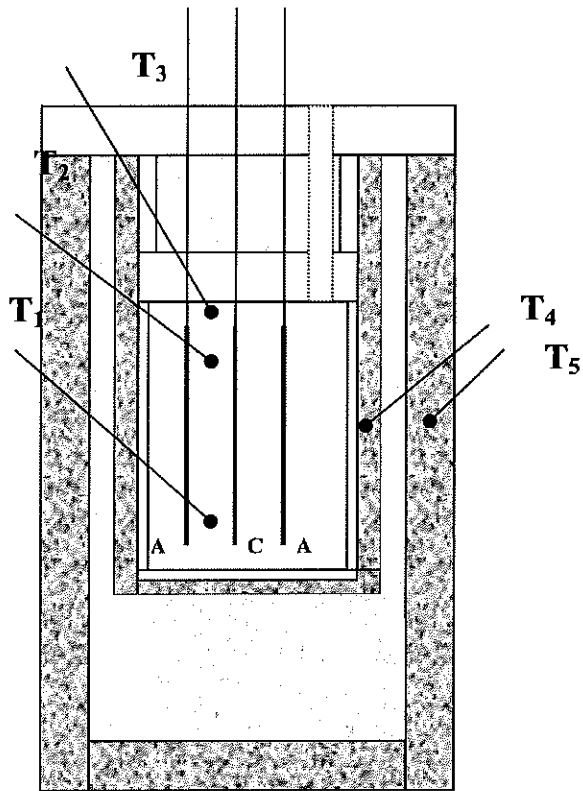


Fig.7

Table 1

Number of step	Supplied power, W
1	0
2	0.25-0.30
3	0.6-0.75
4	1.1-1.25
5	1.5-1.8
6	2.0-2.25
7	4-5
8	10-12
9	20-25
10	50-70

- Insert calibration results into respective Tables (see [Appendix 1](#)) for calculating heat transfer coefficient K and plotting the dependences of K versus the released power and versus ΔT . Besides, a table of K as function of ΔT values is compiled and introduced into the respective ini.file for a given calorimeter (an example is given in [Appendix 2](#)).

Preparation procedure before run up

1. Cleaning.

- After completing the calibrations, wash carefully the beaker inside the calorimeter 4-5 times with DI water, twice with ethanol, and dried in argon flowing at the rate of 20-25 ℓ/h at least 24 h
 - Rinse other components of the setup (holders, spacers, etc.) with a special cleaning solution (2% Micro-90) using a soft brush and then with water. After that they are etched with “piranha” solution (a mixture of concentrated sulfuric acid with 30-33% hydrogen peroxide in 1 : 5-6 ratio by volume). Etching is accompanied by intense gas release, therefore, the respective safety regulations should be strictly observed. Etching is continued until gas release is completely ceased, and then said components are rinsed at least 10 times with DI water and 2-3 times with ethanol and dried. After drying, the components should be kept in a special closed container.
- This procedure should be repeated, whenever necessary, between the experiments.

2. Cathode preparation.

- Cathodes are supplied after annealing, with 5 point welded leads.
- Rinse the cathode with acetone, then with ethanol
- Etch for 1 min in concentrated nitric acid and 1 min in aqua regia diluted with DI water in the ratio 1 : 1.
- After etching rinse the cathodes 4 times with DI water for 30 min each time, once with highly purified DI water, once with acetone, 95% ethanol and absolute ethanol.

3. Assembly.

- Assemble sandwich according to Fig. 4 and the General Description of the sandwich.
- Rinse assembled sandwich with absolute alcohol
- Dry sandwich in vacuum at room temperature for at least 24 hours.
- Fill the Teflon beaker with working electrolyte (0.1 M LiOD/D₂O) in the amount of 230 ml.
- Mount anode/cathode sandwich on the upper cover of the calorimeter, using core tube holder.
- Close calorimeter tightly and place into the constant temperature working bath.
- Connect the leads to the power supply source and to LCR meter, respectively.
- Connect the calorimeter to the water siphon; keep the liquid level in the vessel in accordance with the marked level on the outside wall of the working bath.
- Let the calorimeter to cool down for at least several hours (depending on a concrete situation).

Operation.

- Record the code name and number of the working cell and the initial cathode resistance R_0 in ini.file (Appendix 2).
- Create SuperWave shape and choice necessary current for starting of the loading process.
- Start DAQ program.
- Turn on the power supply and start the loading.
- Start from low current density.
- Increase the current density step-by-step until the highest possible D/Pd>0.95 ratio is reached.

The data obtained in the course of this loading procedure are kept on the computer hard disc using Data Acquisition LabVIEW software package.

The results of loading are expressed by changes in the cathode resistance ratio R/R_0 .

The desired objective to be attained using SuperWaves is to generate an excessive power (excess heat), which is expressed by an anomalous temperature increase.

Equations and Notes

List of equations ET-TIC-ver.3.02

Vdc = raw measured high frequency data

Note that names in **bold** denote arrays

SR – sampling rate **0.5/s**

Measured Values:

Vdc

Idc

Imm Not relevant to SRI

Derived Values:

Vcell = Mean(**Vdc**)

Idc = Mean (**Idc**)

Pin = Mean (**Vdc** * **Idc**)

Imm = Mean (**Imm**) Not relevant to SRI

$T = (T_{1,i} + T_{2,i} + T_{3,i})/3$

$DT = T - T_b$

$R_o = R_i * [1 + \alpha C * DT]$ R_i & αC are constants from DAQ.ini file

$RR = R/R_o$

$Jdc = Idc / A1 * 1000$

$Pd = C * Idc$, C is the Thermo-Neutral Voltage = 1.54 volts

$Pinet = Pin - Pd$

$\Delta T = T_4 - T_5$

$Pout = K * (\Delta T)$

$K = k[0]$ if $\Delta T[0] = 1$ else $K =$ interpolated value of k based on ΔT 's interpolated value data file

$Px = Pout - Pinet$

$Cope = Px / Pin$

$Pexit = KG * DT$ Not relevant to SRI

$Pxg = Pexit - Pinet$ Not relevant to SRI

$Ex = Ex + Px / SR$

$Ein = Ein + Pin / SR$

$Eout = Eout + Pout / SR$

$EexitG = EexitG + Pexit / SR$ Not relevant to SRI

$Einnet = Einet + Pinet / SR$

The Labview is dealing simultaneously with 2 streams of data.

1. High frequency data (V_{DC} and I_{DC}) with 50,000/sec sampling rate provided by prompt National Instruments PCI-6052E card.
2. Low frequency data ($T_1, T_2, T_3, T_4, T_5, R$) with 0.5/sec sampling rate provide by Agilent Data logger.

But in DAQ.ini there is only one sampling rate = 0.5 (see [General] in DAQ.ini).

How can it be that high frequency and low frequency datum have the same Sampling rate? – The answer is: the software was written so that SR is the same for both streams for simplicity.

The high frequency data I_{DC} and V_{DC} are measured and multiplied $I_{DC} \times V_{DC} = Pin$ 50,000 times per second.

50,000 data points for V_{DC} , I_{DC} and Pin are averaged every second and are stored in a buffer of 60 seconds.

The buffer is running: every 2 seconds new average value is entering and the oldest value is leaving the buffer.

It means, every 2 second the computer is averaging the buffer. So the sampling rate for I_{DC} , V_{DC} and Pin is $SR=0.5/sec$.

NOTES:

1. Energetics isoperibolic open cell, is equipped with external recombiner which is not thermally insulated, as a result the water dripping down back to the cell is practically at room temperature.

2. Every cell prior to its operation is carefully thermally calibrated with Pt-Pt electrodes and with input power range: zero up to 70 watts. We plot K versus DeltaT, where K is the cell calibration constant which is taking into account also the heat returned back to the cell from the recombiner. The cell sensitivity is ± 20 m watts.

3. The electric power input is equal to the thermal power input calculated as:

$Pinet = Pin - Pd$.

4. We are calculating P_x (the Excess Power) as: $P_x = P_{out} - Pinet$, for conservative reasons, we are calculating COP (Coefficient Of Performance) as: $Cope = P_x / Pin$, Pin is the total electrical input power which includes the Thermo-Neutral input power.

5. The Labview computer code is integrating the powers to get the energies: E_{in} , E_{inet} , E_{out} and E_x .

6. In the Energetics 34 W data, Exp. # 64a, the 40kJ is the thermal input energy, which took into account also the cell voltage increase from 5 volts to about 15 volts. The 10 volts increase, lead to an increase of the input power by only 0.5 watts. The additional 0.5 watts is contributing to the cell temperature only about 0.5 C. The additional 0.5 watts is only about 1.5% of the output thermal power (about 34 watts).

Heating via resistivity:

P	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
K	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

Material & Equipment -

Appendix 3

Power Supply and Electronic devices for 3 experimental cells

Amplifier	Kepco	BOP50-8DM	3
Data Acquisition/Switch Unit	Agilent	34970A	1
20-Channel Armature Multiplexer Module	Agilent	34901A	3
LCR	Agilent	4263B	3
Kelvin Clip Leads	Agilent	16089B	1
Computer			1
SH-68-68-EP Shielded Cable, 2 m	National Instruments	184749-02	3
PCI-6052E Multifunction I/O Board and NI-DAQ for Win 2000/NT/Me/9x and Mac OS	National Instruments	777745-01	3
PCI-GPIB/LP, NI-488.2 for WIN 2000/NT/XP/Me/9x	National Instruments	778255-01	1
Type X2 double-shielded cable, 2 m	National Instruments	763061-02	4
BNC-2120 Accessory for 68 Pin and 100 Pin E Series Devices	National Instruments	777960-01	3
Lab View	National Instruments		1
UPS for 4000VA or higher			1
Working Bath W*L*H=340*480*330 with Thermo regulator (like Karl Hecht 3185/2)			1
Cooling Circulator	PolyScience	70655	1
Dry Vacuum Pump	Edwards		

1 5-2KVA 110/220 up transformer

1 5-2KVA 110/220 up transformer

Attachment D

Gas Loading Procedure

Gas Loading

High Temperature Cell for Gas Loading of Powders

1

Gas Loading High Temperature (GLHT) Flow Cell.

The GLHT water flow cell is intended to studying anomalous thermal effects at interaction of nickel/palladium nano-powders with hydrogen isotopes at high temperature.

Below (fig.1-4) are the drawings of the Cell.

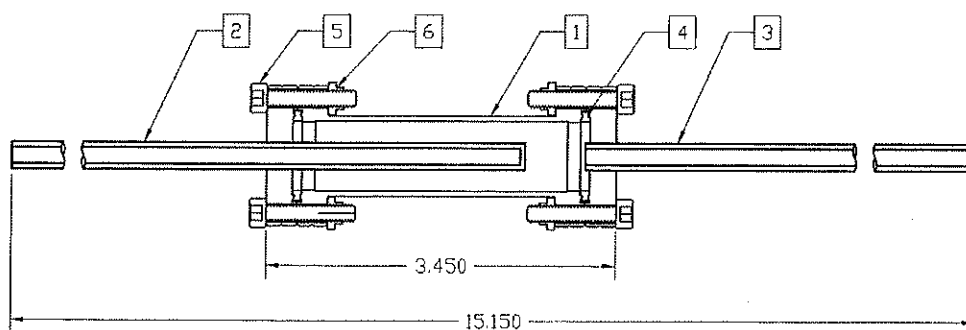


Fig.1. GLHT Cell - general view.

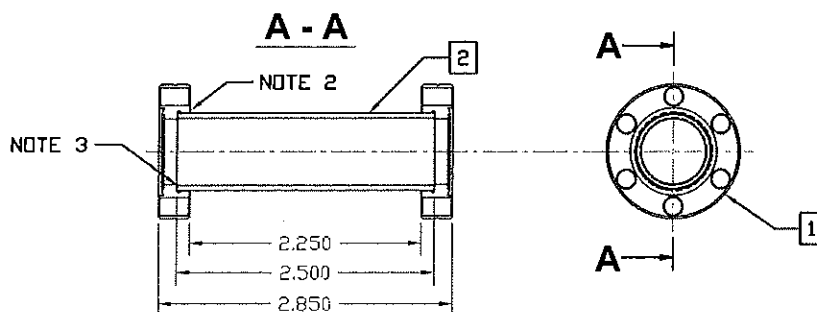


Fig.2. Inner Cell Body

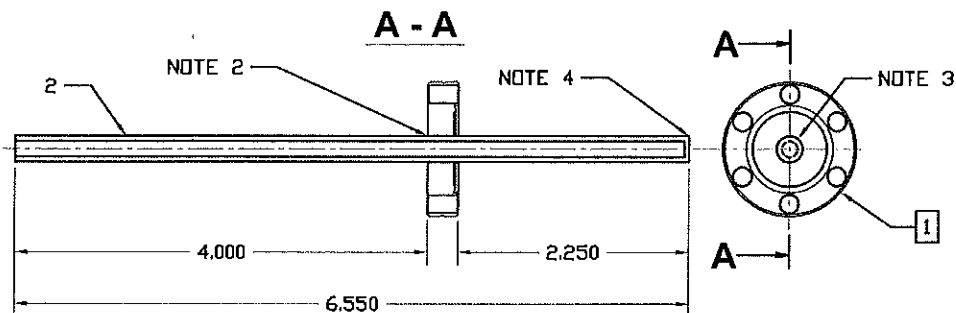


Fig.3. Thermocouple Well Flange

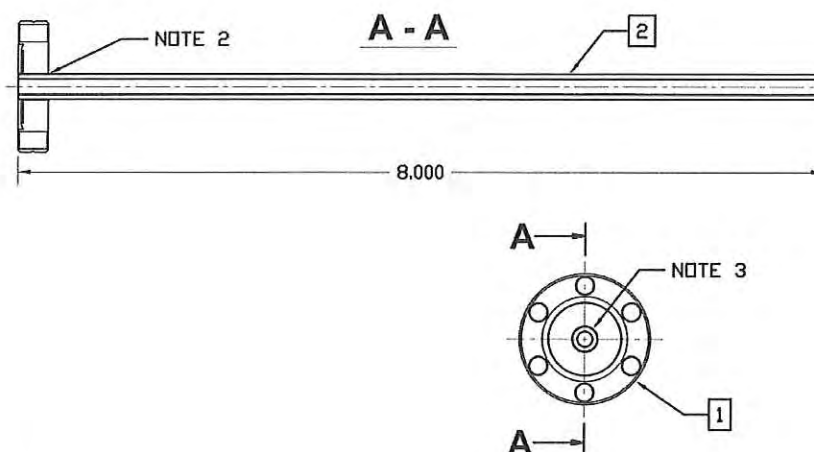


Fig.4. Gas Inlet Flange

As it is shown on fig.3-5, the cell includes a stainless-steel inner body and two SS conflate flanges with welded 1/4" tubes to provide a gas/vacuum inlet and temperature measurements inside the cell. The left tube on the fig.1 is served as a thermocouple well and has a welded dead-end. The right tube on the figure has a Swagelock connector at the end (not depicted). The flanges are sealed with copper washers and two sets of bolts and nuts. The flange with the thermocouple well is sealed permanently, while the second one serves as a cover of the cell.



Fig.5. A Watlow electric nozzle heater.

A nozzle heater (fig.5) is mounted on a central part of the cell which is surrounded by a copper ring. This ring is supposed to provide a uniform temperature distribution along the cell.

A studied powder is placed into the cell in an amount sufficient to cover the thermocouple well. After sealing the upper flange the cell is placed into a water flow heat exchanger in vertical position (fig.6).

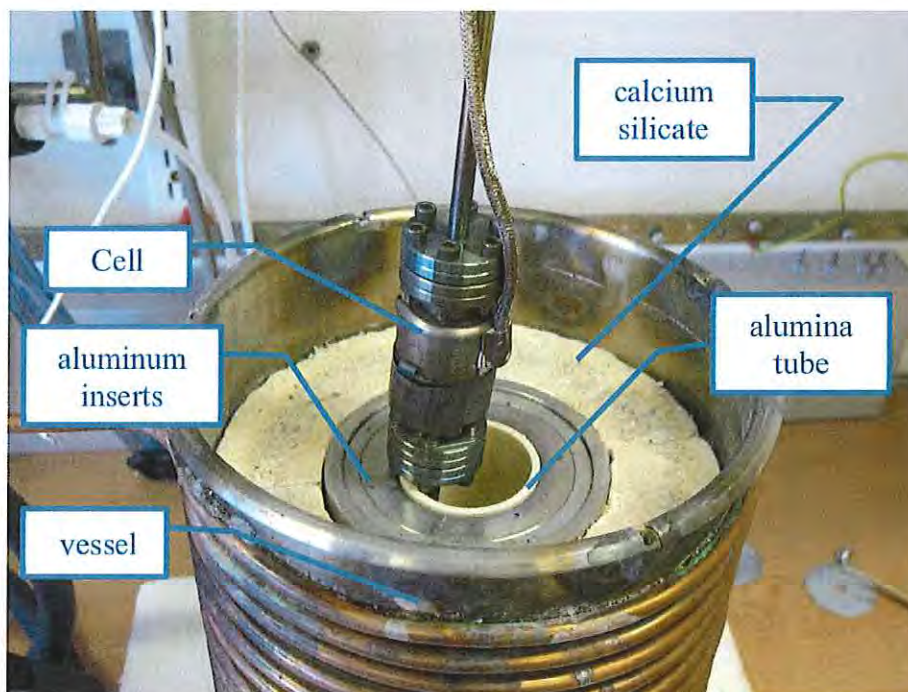


Fig.6. The GLHT Cell with a heater before placing into a water flow heat exchanger.

As it is shown on the fig.6, the exchanger is thin-wall SS vessel wrapped by a number of copper tube coils for cooling water. Inside the vessel there is a hollow calcium silicate cylinder. The inner space of the ceramic cylinder is filled by a set of aluminum inserts embedded tightly one into another. The cell with the powder is placed into the aluminum inserts being electrically isolated from them by an alumina tube (fig.6). The upper space above the cell is insulated by ceramic parts made from

high density calcium silicate shown on the fig.7.

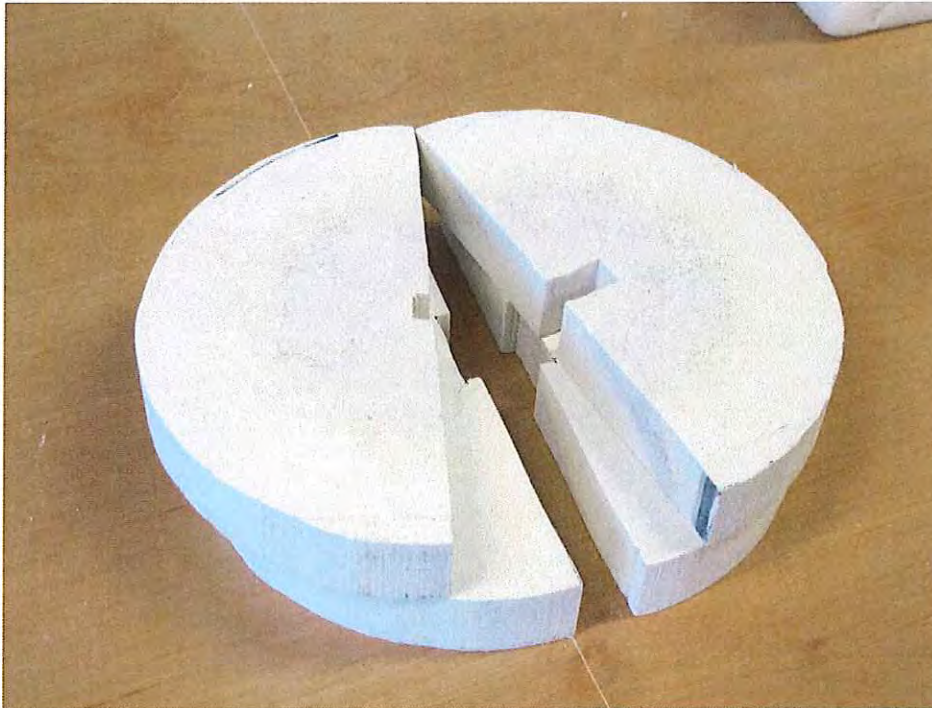


Fig.7. High density calcium silicate insulator.

Finally, the cell and the heat exchanger are placed into a thermally insulating foam shell made of ROHACELL (fig.8 and 9).

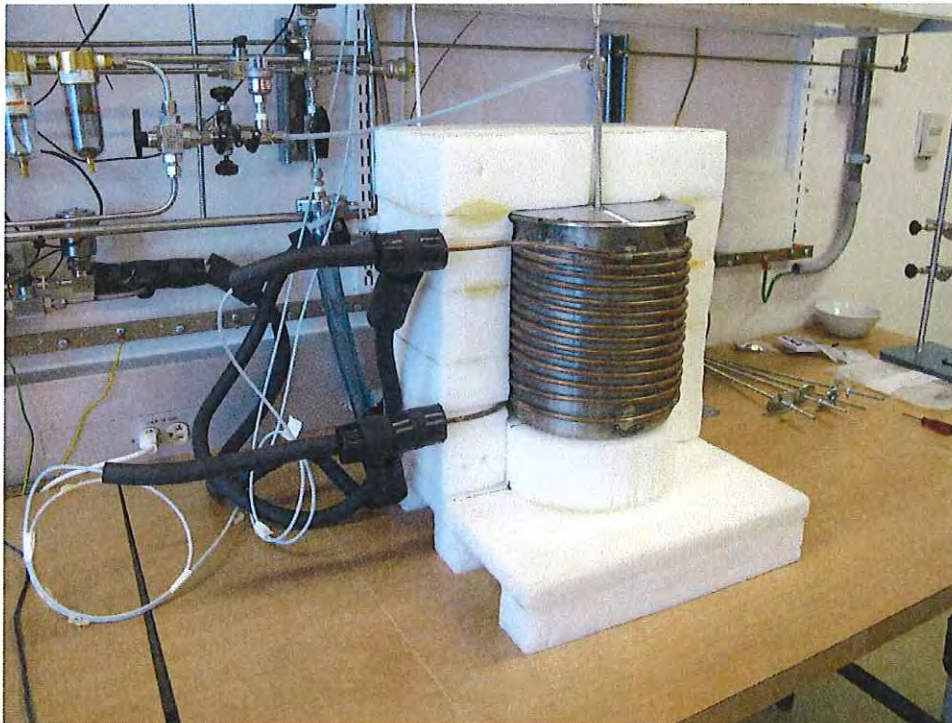


Fig.8. The GLHT Cell with the water flow heat exchanger during assembling.



Fig.9. The GLHT Cell set-up – general view.

The water inlet and outlet allow inserting two RTD sensors (SS sheath PT-100). Both sensors are immersed in water. The cooling water is leaving the cell after absorbing heat from the cell at elevated temperature through the outlet port.

Operating parameters:

Pressure:	up to 15 bar
Cell temperature:	up to 800oC
Voltage:	110V
Water flow:	up to 20L/hr

Gas Loading Electro-migration (GLEM) Flow Cell.

The GLEM water flow cell is designed for studying anomalous thermal effects at interaction of palladium wires with deuterium at high pressure. In the case of applying voltage to the Pd target we have electro-migration of D^+ -ions from positive to negative part of the wire. It is assumed that due to the deuteron electro-migration an additional D/Pd loading factor can be achieved increasing probability of the LENR.

Cell Description

Main parts of the cell include a SS body (fig.1a) and a co-axial heat-exchanger

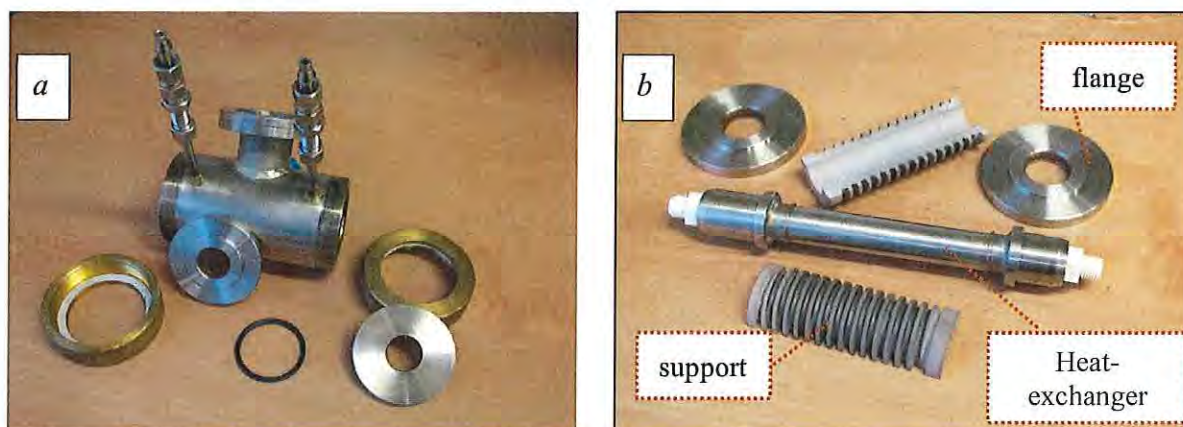


Fig.1. Gas Loading Electro-migration Cell: (a) body and flanges; (b) water flow heat exchanger and two parts of a spiral grooved ceramic (Lava) support.

(fig.1b). The cell is assembled by using two SS flanges with brass nuts and sets of Viton O-rings.

The conflate flange is welded to the cell body and sealed by a cover flange with a multi pin connector, to which an air plug multi pin connector is connected. The flange is sealed with a copper washer and a set of bolts and nuts. (The washer may be replaced by a Viton O-ring (fig.1a) if the temperature of the body does not exceed 200°C).

Two 1/4" tubes with Swagelock connectors at the ends are welded for gas flow or vacuum. At the upper side of the cell body (fig.1a) there is a space for electrical wires connecting to the target.

A sealing of the cell from the sides is carried out by using of two couples of Viton O-rings. One pair of the O-rings is placed into the butt end grooves of the body and sealed by the SS flanges and the brass nuts (fig.1a). The second pair is inserted into the grooves at the orifice of SS flanges and the flanges are put on the ends of the heat exchanger (fig.1b). The exchanger has inside it a narrow spiral path with a rectangular cross-section to improve thermal contact between the heat source and the cooling water.

Two parts of the annealed Lava ceramic support with the spiral grooves are adjacent to the exchanger to provide electrical insulation.

A cooling water inlet is located at the left (longer) side of the heat exchanger while the water outlet is located from the opposite side.

The water inlet and outlet allow inserting two RTD sensors (SS sheath PT-100) – one from each side. Both sensors are immersed in water. The cooling water is leaving the cell after absorbing heat from the cell at elevated temperature through the outlet port. The palladium or nickel target in the form of wire or ribbon is wrapped around the ceramic support adjusted to the heat-exchanging insert. Two 0.5mm (diam.) silver coated copper current leads connect the target with the wires through the gold plated

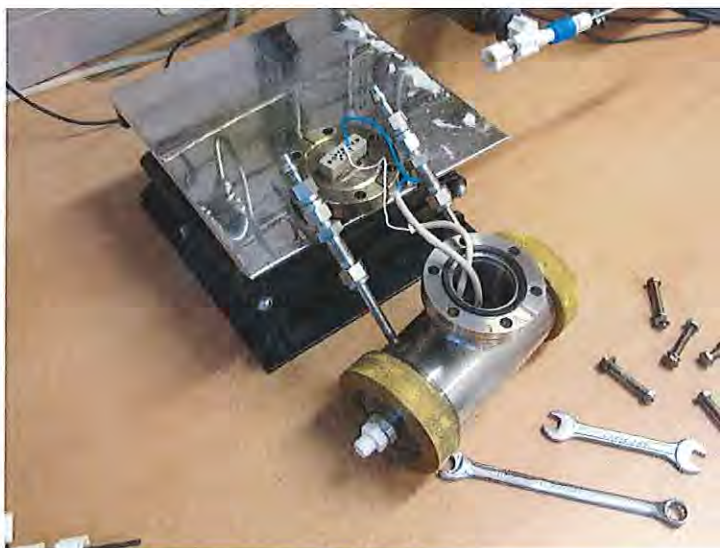


Fig.2. GLEM cell with a target, connected to the multi-pin cover flange.

pins. Flexible high temperature ceramic fibers sleeves pulled on the leads provide electrical insulation inside the cell. (Fig.2).

After the target has been connected to the multi-pin flange and all the wires and connections have been ringed up, the cell is being sealed and connected

- to the gas/vacuum system,
- to water input and output ports,
- to a power supply and

placed into a thermal insulation box. The final stage of the assembling is depicted on the fig.3.



Fig.3. General view of the assembled GLEM cell with a thermal insulating box.

Operating parameters:

Pressure:	up to 15bar (limited by gas feeding system)
Current:	up to 8A (limited by the KEPCO power supply)
Voltage:	up to 50V (-#-)
Input power:	up to 200W (at water flow rate of 2L/hr)
Water flow:	up to 20L/hr
Cell temp.:	up to 150°C (limited by thermal stability of the insulator)

Attachment E

Glow Discharge Procedure

Glow Discharge

Air Cooled Cell Disassembly

Air Cooled Cell Disassembly

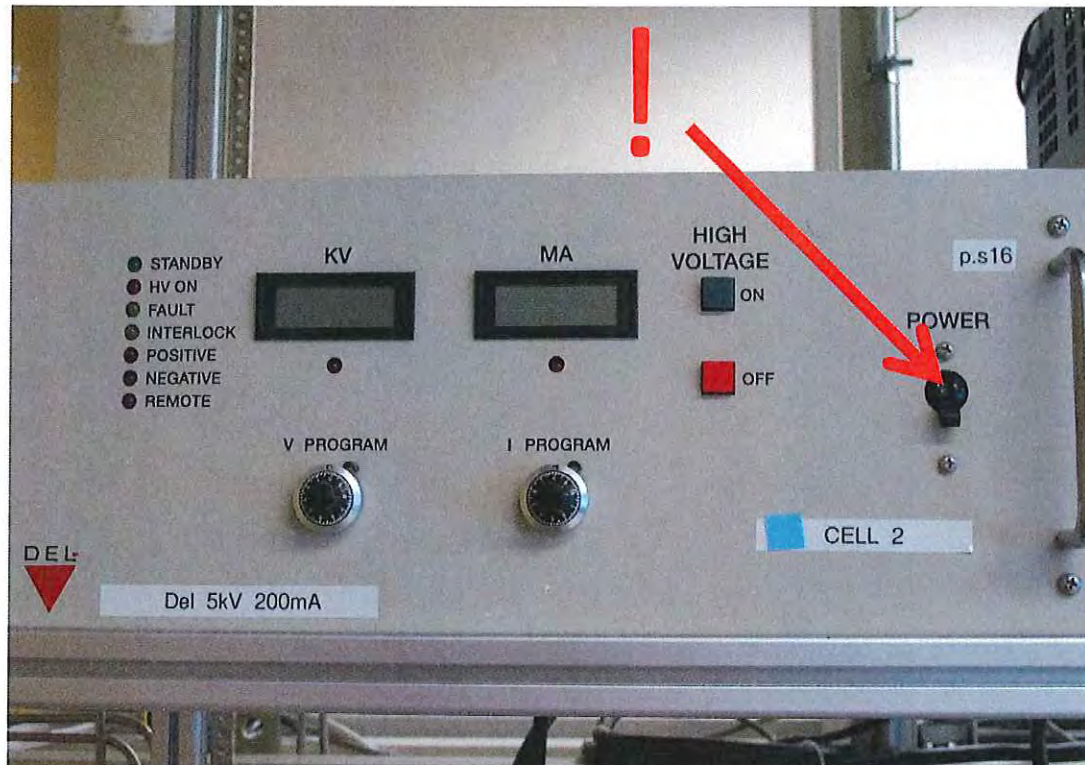
Tools Required:



1. Open end wrenches
2. Chain or pipe Vise Grips
3. Hammer
4. 10mm Nutdriver
5. Fine needle nosed pliers
6. Medium screwdriver
7. Small screwdriver
8. Probes and tweezers for handling palladium
9. Bench vice
10. Shears (not shown)

Procedure:

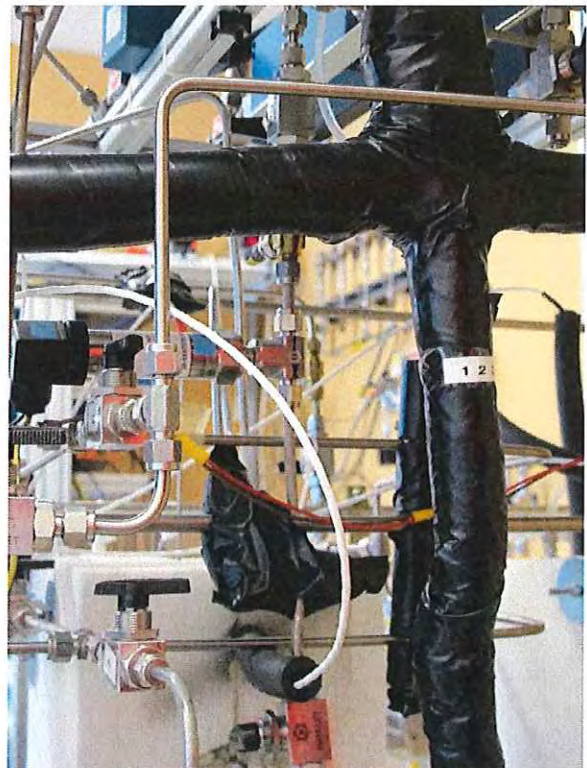
Warning: Ensure the high voltage power supply is off before installing, removing, or adjusting the test cell. Fatal voltages and currents could be applied to cell if the power supply is on.



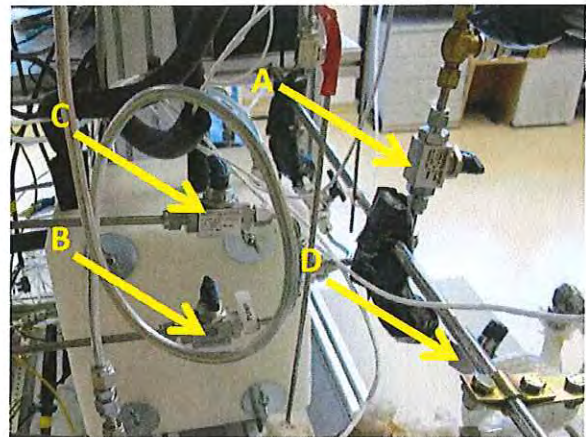
1. Start by disconnecting the power cable using the small screwdriver and 10mm nutdriver.



2. Ensure the isolation valves above and below the pressure transducer are shut.



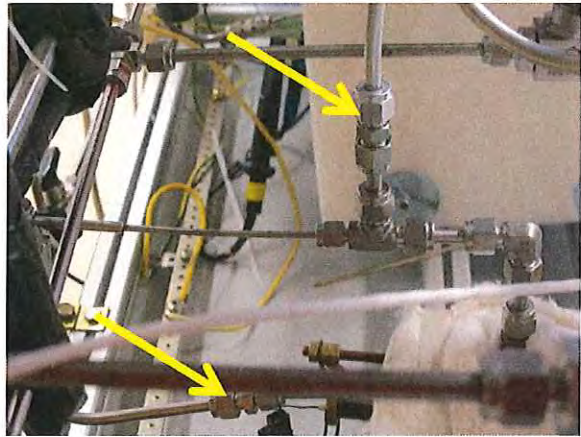
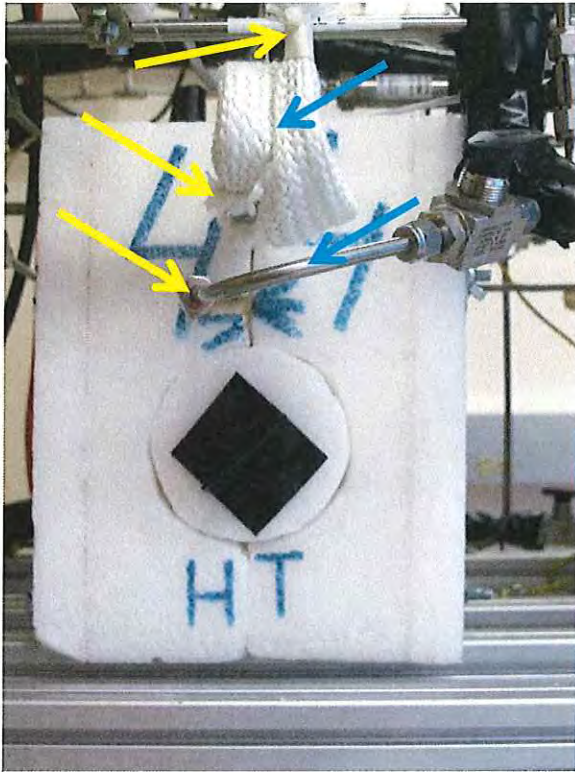
3. Check that both service (A) and working (B) vacuum valves, high pressure gas valve (C) and vacuum port valve (D) are shut.



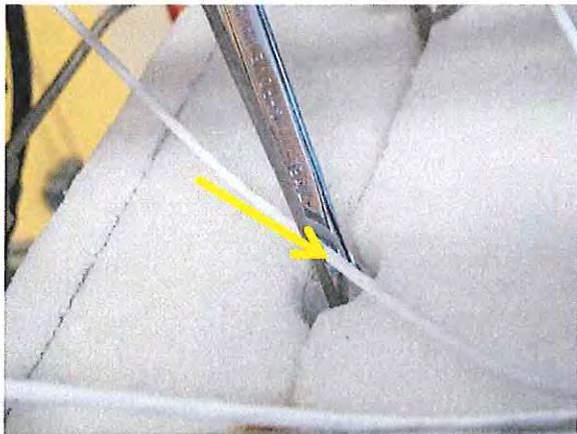
4. Shut the cooling air valve.



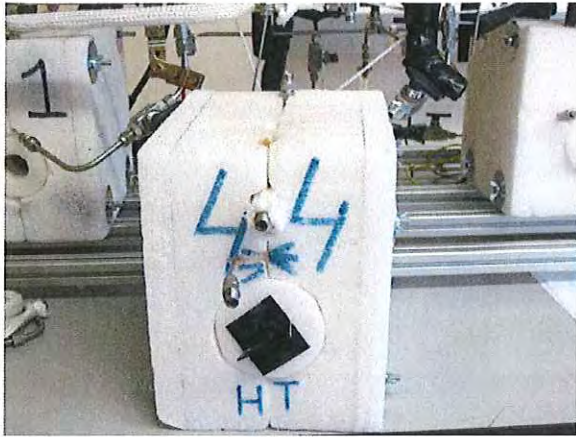
5. Disconnect the fitting on the Cell side of the vacuum port valve, the $\frac{1}{4}$ " side of the fittings on the gas port and vacuum port and the cell side of the aluminum tubes. Remove elbow and expansion loop at front of cell to make room to pull the cell past the piping.



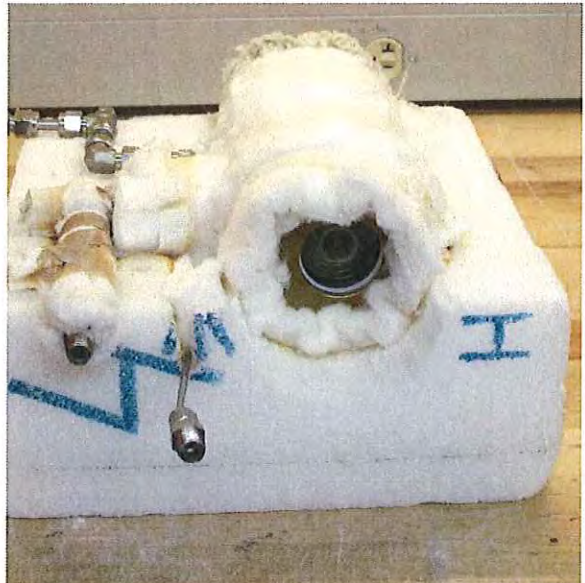
6. Using a $\frac{7}{16}$ " wrench loosen the fitting for the PT100 temperature sensors and pull them out of the fitting leaving the Teflon ferrules in place.



Pull cell out the front of the rack and relocate to the workbench.



7. Remove threaded rods and lay on its side. Lift off rigid foam half.



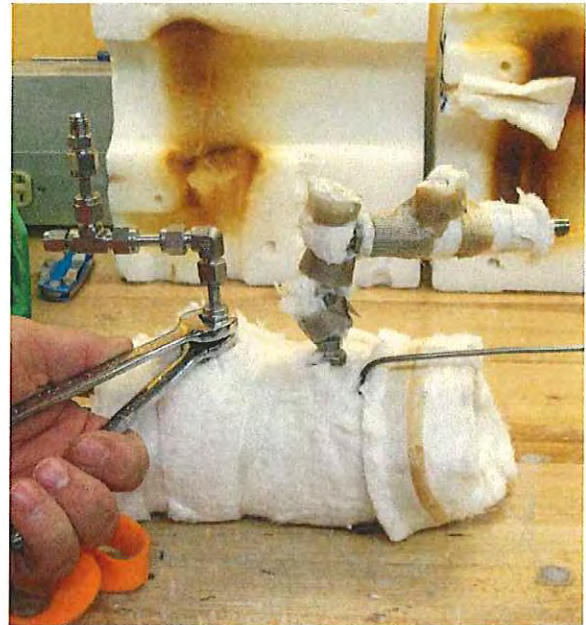
8. Remove mineral wool and lift cell from rigid foam.



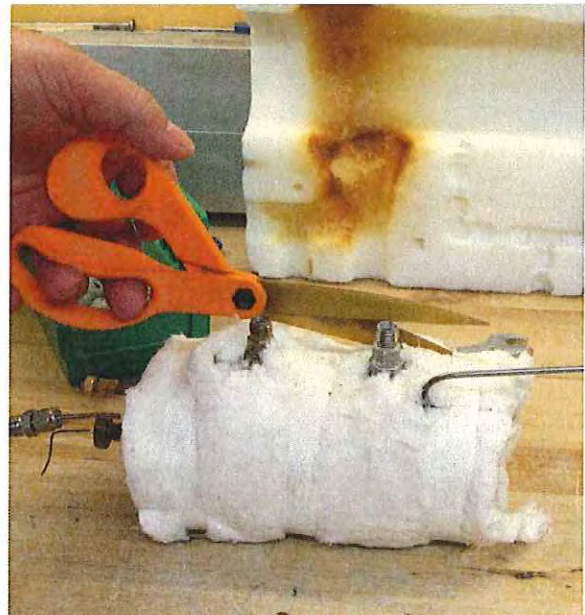
9. Cut high temperature tape and remove insulated fabric wrap on air outlet.



10. Remove air piping at the fittings next to the body. This is to make the body easier to handle during handling and cleaning.



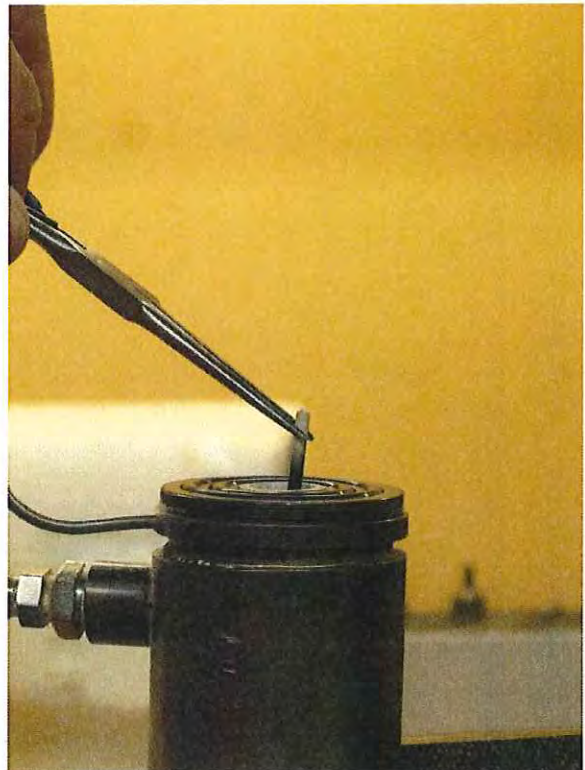
11. Remove insulating fabric; cut tape as required.



12. Clamp in vise with window up.
Remove window flange; you may
need to tap the end of the wrench
to loosen the flange.

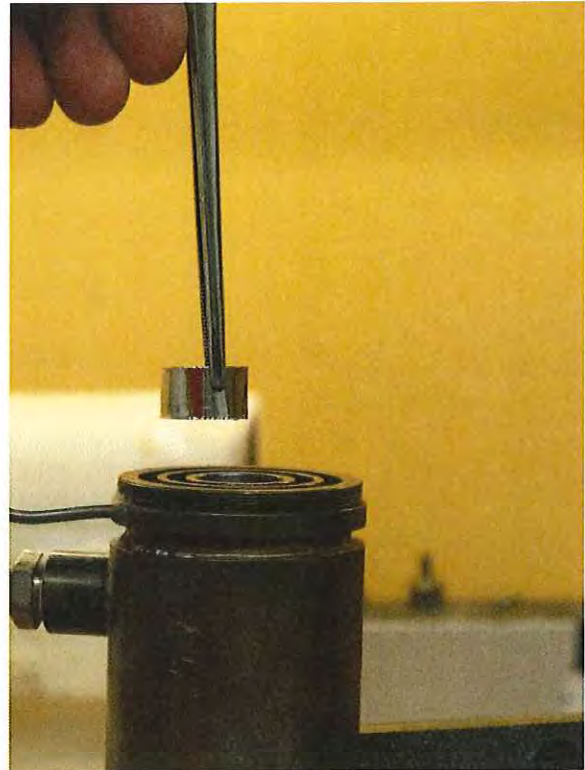


Remove the sapphire window, Chemraz O-rings, the wire cover, and shield.

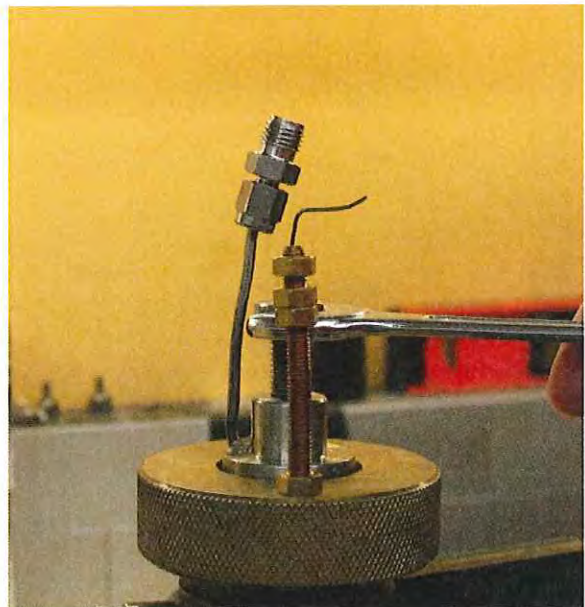


13. Remove the sample. Use tweezers and probes with care to not damage sample, however some force may be required if the sample has been lightly tack welded to the body. Place the sample in a plastic envelope and deliver to the operator.

Caution: The sample should be handled as little as possible and never with bare hands to prevent contamination of the sample.



14. Turn the body over in the vise and reclamp. Loosen the brass bolt.



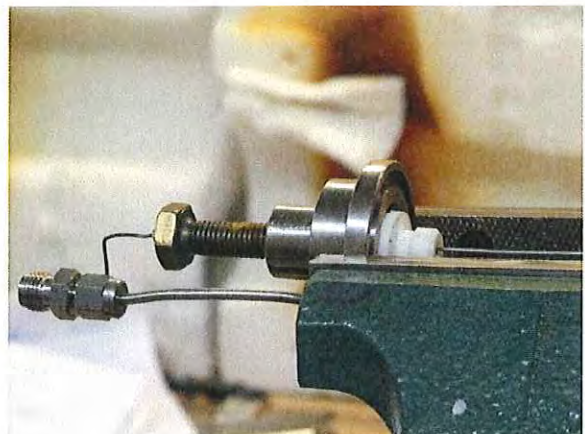
15. Remove the feed through flange.



16. Pull the feed through flange away from the body and remove with all the internal parts.



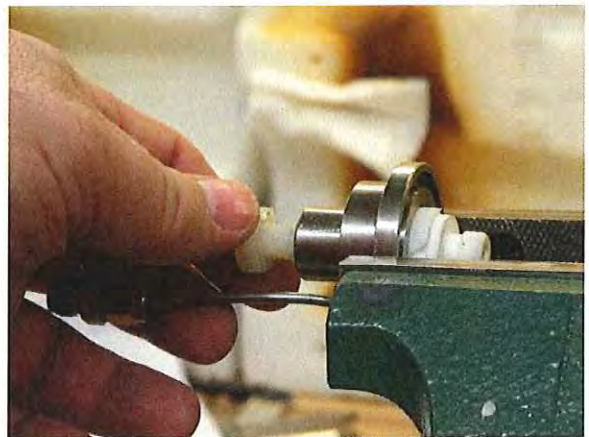
17. Remove the body from the vise and clamp the feed through body in its place. Remove the Chemraz O-ring, the end cap and the spacer.



18. Remove the brass bolt and pull out with ceramic disk and -001 Viton O-ring. Remove bolt, disk and O-ring from wire. Discard -001 Viton O-ring.



19. Using a Nylon bolt, thread the bolt into the feed through body and use it to push the feed through seal out of the body. It is optional to remove the Chemraz O-ring from the seal.

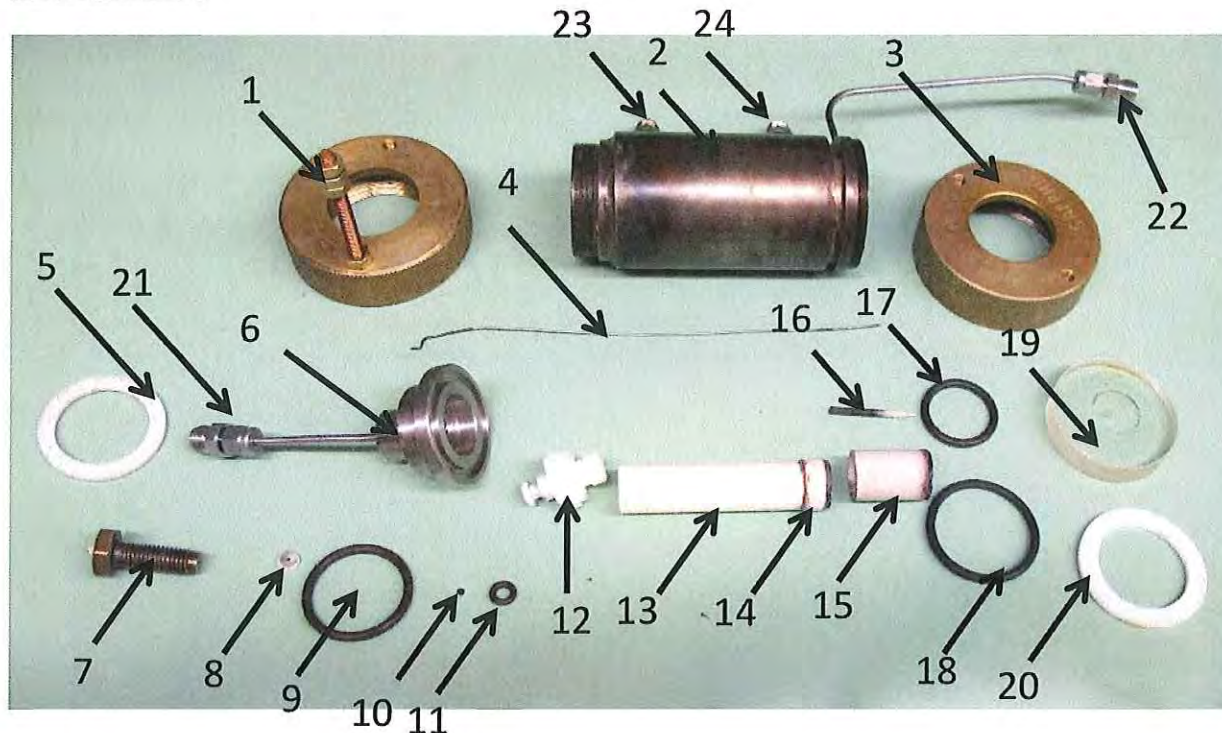


20. Remove the Nylon bolt and the cell is ready for cleaning.

GD Cell Cleaning

Cleaning Glow Discharge Components

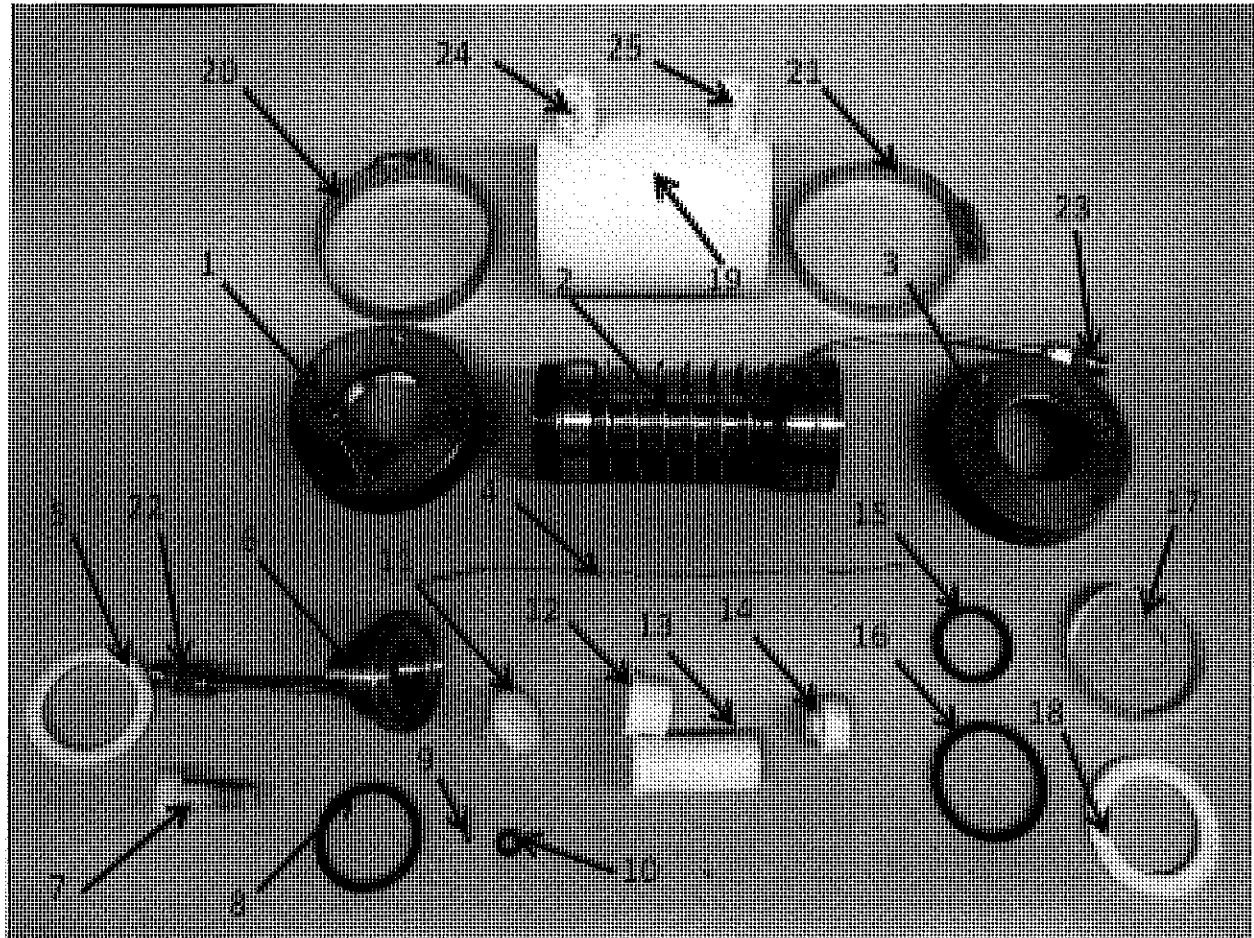
Air Cooled Cell



Cell components:

- | | |
|--|--|
| 1. Feed through flange | 14. End Cap (Alumina) |
| 2. Air cooled body | 15. Shield (20mm O.D. Mullite tube) |
| 3. Window flange | 16. Wire cover (Alumina) |
| 4. Tungsten wire | 17. Chemraz AS-568A-214 (-214) O-ring |
| 5. Small Teflon washer | 18. Chemraz AS-568A-222 (-222) O-ring |
| 6. Feed through body | 19. Sapphire window |
| 7. Brass bolt | 20. Large Teflon washer |
| 8. Ceramic disk | 21. Gas Port |
| 9. Chemraz AS-568A-214 (-214) O-ring | 22. Vacuum port |
| 10. Viton AS-568A-001 (-001) O-ring | 23. Cooling inlet port |
| 11. Chemraz AS-568A-108 (-108) O-ring | 24. Cooling outlet port |
| 12. Feed through seal (Macor) | |
| 13. Spacer (3/4" O.D. Alumina tube) | |

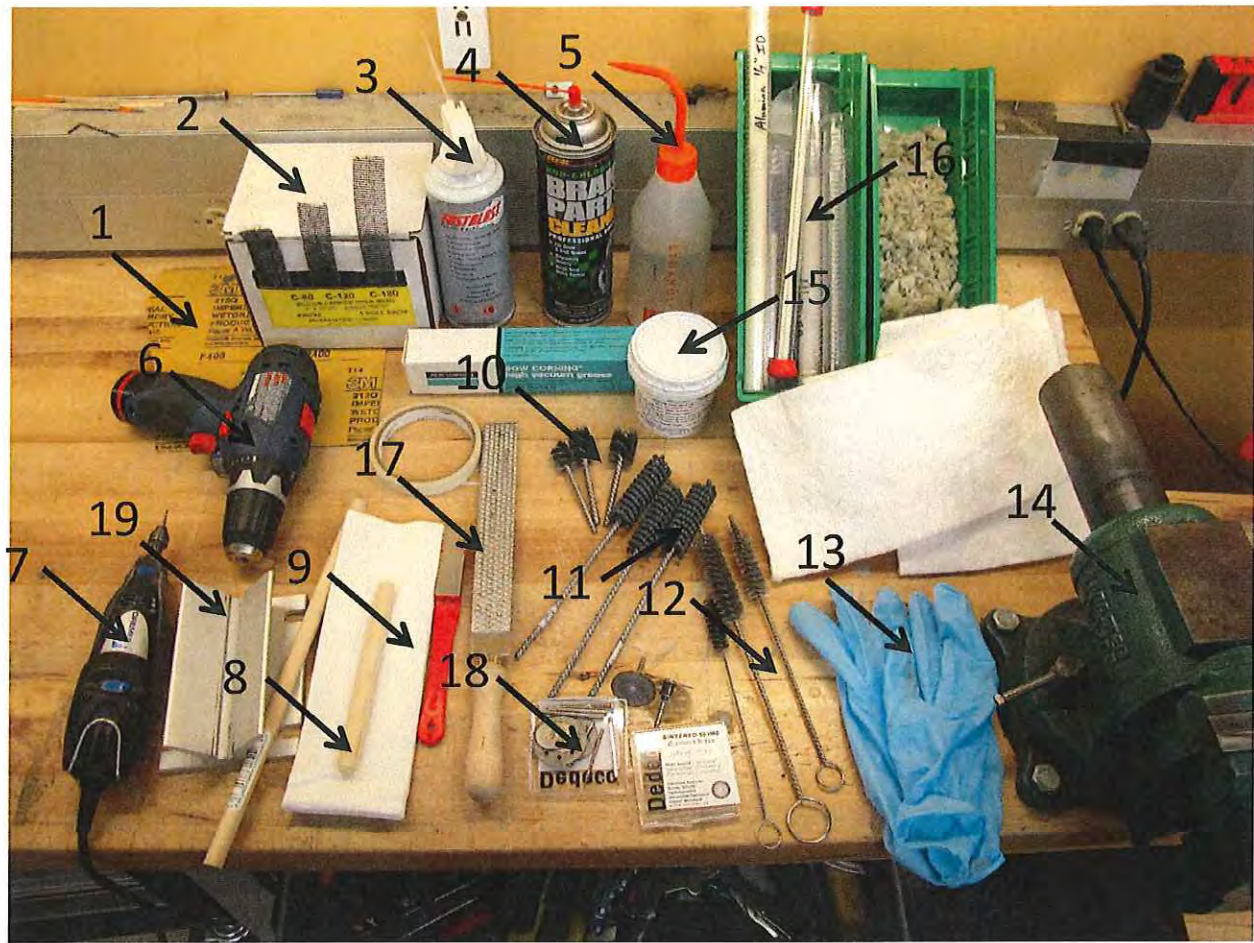
Water Cooled Cell



Cell components

- | | |
|--------------------------------------|--------------------------------------|
| 1. Feed through flange | 14. End Cap (Alumina) |
| 2. Water cooled body | 15. Viton AS-568A-214 (-214) O-ring |
| 3. Window flange | 16. Viton AS-568A-222 (-222) O-ring |
| 4. Tungsten wire | 17. Sapphire window |
| 5. Small Teflon washer | 18. Large Teflon washer |
| 6. Feed through body | 19. Cooling jacket cover (Teflon) |
| 7. Nylon bolt | 20. Rear Hose Clamp |
| 8. Viton AS-568A-214 (-214) O-ring | 21. Front Hose clamp (Notched) |
| 9. Viton AS-568A-001 (-001) O-ring | 22. Gas Port |
| 10. Viton AS-568A-108 (-108) O-ring | 23. Vacuum port |
| 11. Feed through seal (Delrin) | 24. Cooling inlet port |
| 12. Wire support (Teflon) | 25. Cooling outlet port |
| 13. Spacer (Teflon) | |

Tools And Supplies Needed



- | | |
|---|--|
| 1. Wet or dry silica carbide sandpaper | 11. 20mm Cylinder hones (120, 180, and 240 grit) |
| 2. Silica carbide sanding strip | 12. Hand brushes |
| 3. Canned air | 13. Nitrile Gloves |
| 4. Brake parts cleaner (extremely aggressive solvent) | 14. Vise |
| 5. Alcohol | For making new ceramic parts: |
| 6. Drill | 15. Ultra-high temperature epoxy (1260 Celsius) |
| 7. Die grinder (Dremel) | 16. Alumina and Mullite stock |
| 8. Dowels | 17. Diamond files |
| 9. Paper towels | 18. Diamond die grinder bits |
| 10. Stainless steel power brushes | 19. V-block |

Cleaning Body

1. Clamp the

GD Running Procedure

GD Running Procedure

GD system is composed of 3 cells which can be run in parallel independently.

One computer can handle 3 cells independently. LabVIEW software package was developed and installed on the computer. The software allows monitoring all measured and calculated parameter in real time (beside digital screen, some selected parameters are presented online as function of time. In offline, all the stored parameters for a present run can be presented on graphs as requested. In off offline mode, files stored on the computer hard disc can also be presented graphically. The LabVIEW package also contains a SuperWave generator which can send an analog signal of 0-10V to an amplifier which can be operated in constant current or voltage mode. The computer is equipped with 2 National Instruments fast cards for each cell, a total of 6 cards, which are sampling pairs of instantaneous current and voltage, 50,000 times a second, from which the computer is calculating the instantaneous input power ($I \times V$), of the specific cell. The instantaneous input power is then averaged. All other measured parameters are considered the slow sampled parameters, are sampled every 2 seconds by the data logger (Temperatures T_{in} , T_{out} , T_a , mass flows, m and pressure P_g). With the slow sampled parameters, the computer calculates the following parameters: Average water inlet outlet temperature T , Delta outlet and inlet temperature difference, DT , the output thermal power, P_{out} , the Excess thermal power, P_x , the Coefficient Of Performance, COPE, the Excess Energy, E_x , the input energy, E_{in} , the output Energy, E_{out} and the cooling fluid mass flow rate in terms of Kg/s.

The energies, E_x , E_{in} and E_{out} , are calculated by integrating P_x , P_{in} and P_{out} by time.

All the data should be stored, on continuous basis, at least once a week on a server or external hard disc as backup.

The computer can be monitored and controlled remotely using the internet.

The system allows to assemble 3 cells (with sapphire windows or with SS flange) to be run with water mass flow calorimetry. The water mass calorimetry cells can be run with outlet water temperature (T_{out}) close to boiling point. In case of relatively low temperature runs ($<100^{\circ}\text{C}$), Palladium targets are being used. The targets are being bombarded with Deuterium ions. In position 2 (the cell position in the middle), a high temperature cell (specially designed to reach temperature of up to 300°C , usually for Nickel/Nickel alloys targets bombarded by Hydrogen ions) can be run. The high temperature cell has air mass flow calorimetry.

The system has 2 vacuum pumps which can deliver vacuum down to 1×10^{-5} Torr. Each pump has its own vacuum meter (installed on top of each pump) and its own readout unit.

The first pump is a service pump, which allows evacuating a newly assembled cell, while other cells can run independently (using the working vacuum pump).

The vacuum will be applied to the cell for leak test. Once the cell vacuum reached 1×10^{-5} Torr, shut down the inlet and outlet HAM-LET ball shut off valves (not the one which is close to the cell, but the one above the absolute pressure transducer, this will allow continuous monitoring of the cell pressure with time). If there will be a leak, the cell pressure will be gradually increased. If the pressure is kept constant over few hours, then the cell is leak proof.

The GD system has a variety of gas cylinders and network (He, H, D, Ar and a supply of pressurized Air). Each gas outlet coming out of the wall (close to the GD system), ends with a shut off valve. The 4 different gas supplies are connected together through a manifold which is connected to 2 parallel SS lines: one is connected to a high pressure line (the pressure of each type of gas is controlled by a pressure regulator which sits on top of each gas cylinder). The high pressure line feeds the 3 cells through 3 shut off valves.

In summary, each cell can be connected to a service vacuum line (also through a vacuum shut off valve or to a line of high pressure. This allows exposing the cell to vacuum for few hours, and then to D high pressure (5-7 bars, in case of Pd target) for few hours by watching after the cell pressure, one can see the absorption of D into the palladium targets. Usually the pressure may drop below one atmosphere absolute. It is recommended to repeat exposing the cell to D pressure until the Pd target reaches saturation (around 0.75 D/Pd atomic ratio), Then exposed the cell to vacuum of few hours. It is recommended to apply the procedure of pressure/vacuum 2-3 times, in order to assure that the Pd surface is clean and active. Stop the process with high pressure in the cell. The 4 gasses manifold is also connected to an electronic gas low pressure controller which is connected to a pressure controlling unit (the cells can be run independently but with only with one selected gas, this was done in order to save money, if there is a need to run the cells simultaneously with 3 different gasses, then 3 separate low pressure controllers have to be installed). By rotating the potentiometer nub the low cell pressure can be controlled. The pressure at the controller outlet is mutual to all 3 cells. In order to be able to run cells at different cell pressures, a needle regulating valve, on top of each pressure transducer, is mounted. The cell operating pressure has to be adjusted to 1-20 mbara, depends on the current supplied to the cell. For higher currents, higher the pressures are needed. This is in order to maintain stable plasma.

Now the cell is ready for run. The Pd target is loaded D/Pd=0.75 and active. Set the SuperWave configuration as selected including the level of the input average current (at constant current mode, using the LabVIEW SW generator), make sure that the cell is connected to the power

supply, the positive pole to the central tungsten wire and the ground to the Copper bolt, both located at the back side of the cell. Calibrate the power supply using I_{max} procedure, in the LabVIEW package. Calibrate by comparing the current and voltage measured by the data acquisition system to the parameters measured by an independent accurate instruments. Start up the data acquisition of the specific cell, by pushing the button on the computer monitor (the button will turn green). Reduce gradually the cell pressure, by opening all the valves of the specific cell, from the low pressure controller to the cell. The needle valve at the cell entrance is adjusted depends on the cell pressure required. Another needle valve is mounted at the cell outlet to protect the cell from fully evacuated by the work vacuum pump.

The needle valve at cell outlet is also to reduce the H/D flow to minimum. Minimal H/D flow can be monitored by the vacuum meter readout (should be around 1×10^{-5} to 5×10^{-5} Torr).

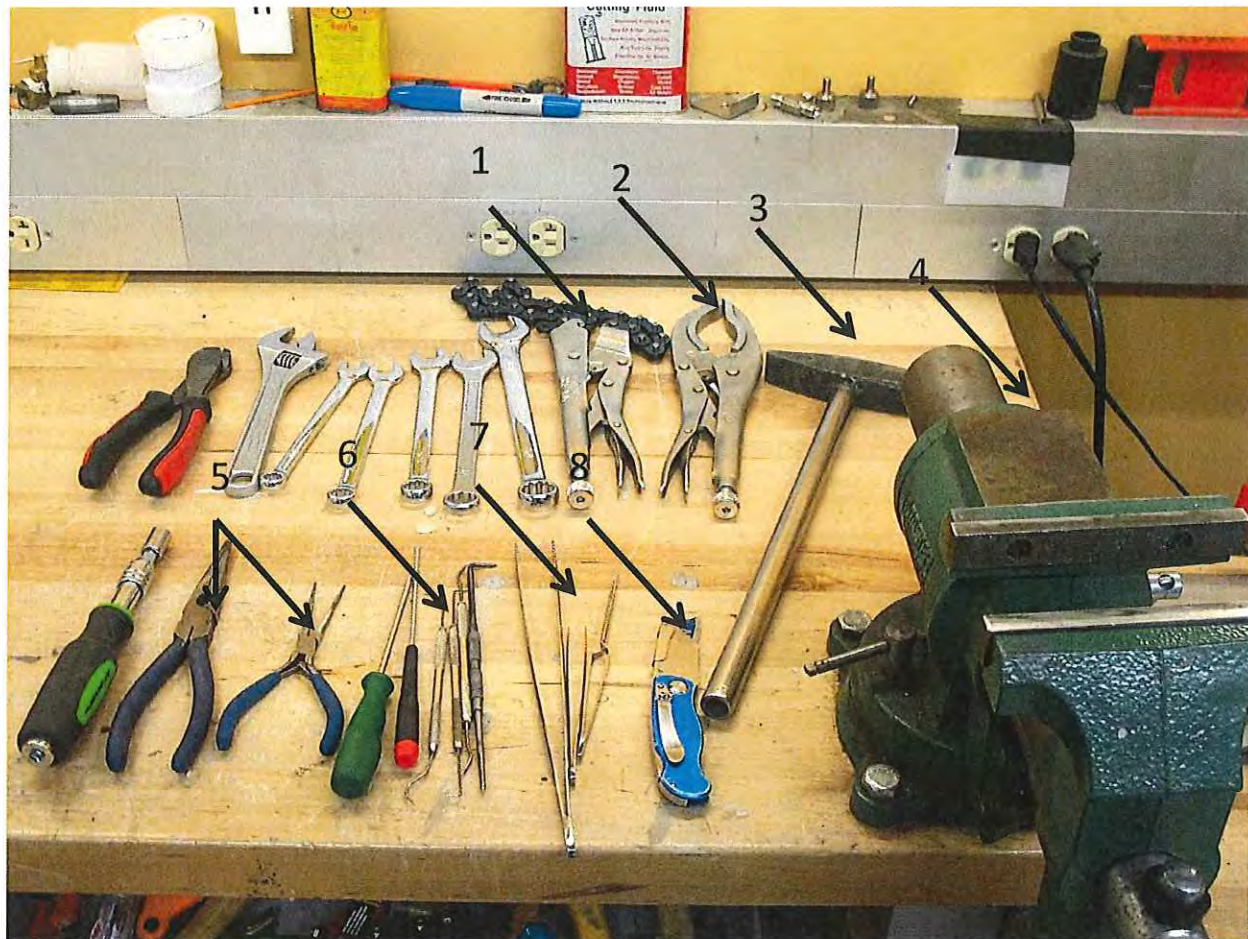
Reduce the cell pressure to about 5 mbarA. Start the cooling fluid flow, using a water mass flow regulator. Use treated water (soft water to eliminate scaling). Water network pressure is 5-6 bars. Let all temperatures stabilized. Push the input power button on the monitor (the button will turn brown). Plasma is now ignited, check that plasma is stable. Adjust the cell pressure as required to maintain stable plasma.

Follow temperatures until stabilization is reached (may take few hours) for the selected electrical power input.

Since the cell is thermally insulated, usually the output power will be 85% to 95% of the input power. If excess heat takes place, then P_{out} will be greater than P_{in} .

GD Air Cooled Cell Assembly

Glow Discharge Air Cooled Cell Assembly



Tools needed:

1. Vise Grip chain wrench for gripping flanges
2. Vise Grip pipe pliers for gripping flanges
3. Hammer to tighten vise
4. Vise with steel jaws to hold cell
5. Needle-nose pliers to manipulate ceramic parts and Tungsten wire
6. Small screwdrivers and probes to manipulate sample
7. Tweezers for holding sample
8. Utility knife for cutting insulation

Not shown:

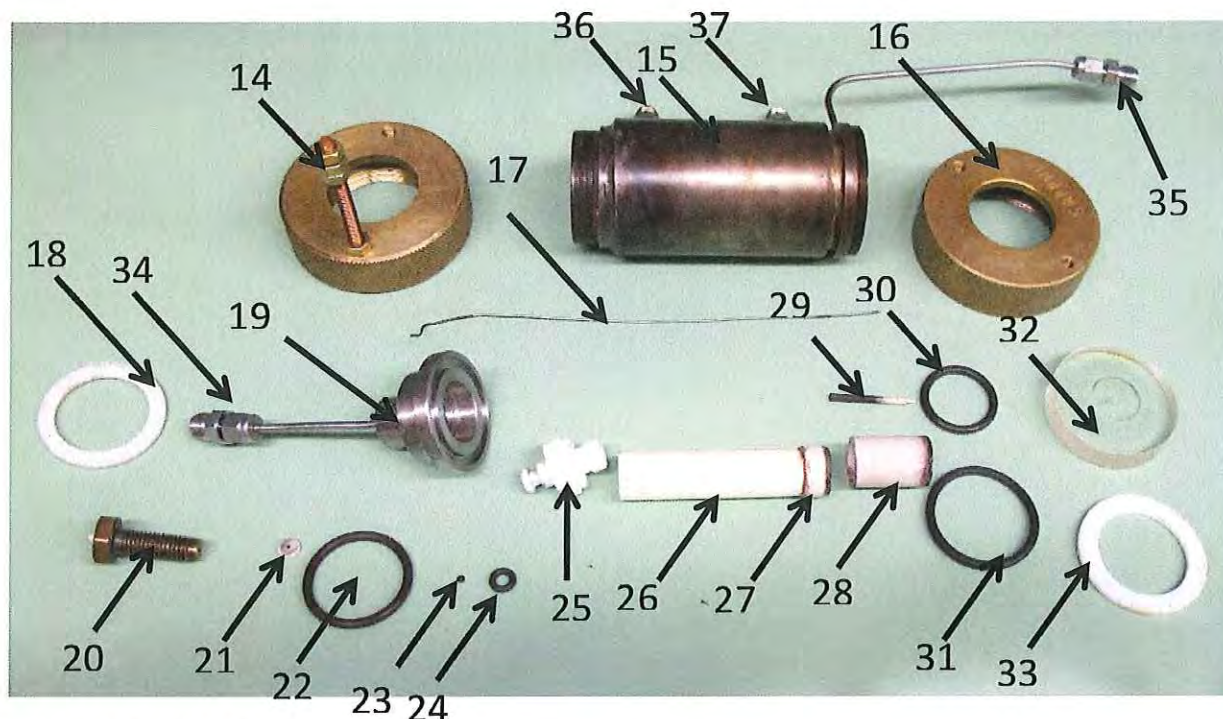
Shears for cutting insulation

Small flashlight for looking into body



Supplies needed:

- 9. Alcohol for cleaning
- 10. High vacuum silicone grease
- 11. High temperature adhesive tape for securing insulation
- 12. 1/4" Silica insulation
- 13. Nitrile gloves



Cell components:

- | | |
|--|--|
| 14. Feed through flange | 26. Spacer (3/4" O.D. Alumina tube) |
| 15. Air cooled body | 27. End Cap (Alumina) |
| 16. Window flange | 28. Shield (20mm O.D. Mullite tube) |
| 17. Tungsten wire | 29. Wire cover (Alumina) |
| 18. Small Teflon washer | 30. Chemraz AS-568A-214 (-214) O-ring |
| 19. Feed through body | 31. Chemraz AS-568A-222 (-222) O-ring |
| 20. Brass bolt | 32. Sapphire window |
| 21. Ceramic disk | 33. Large Teflon washer |
| 22. Chemraz AS-568A-214 (-214) O-ring | |
| 23. Viton AS-568A-001 (-001) O-ring | |
| 24. Chemraz AS-568A-108 (-108) O-ring | |
| 25. Feed through seal (Macor) | 35. Vacuum port |
| | 36. Cooling inlet port |
| | 37. Cooling outlet port |

Glow discharge Air Cooled Cell Assembly

Notes:

1. It is not necessary to disturb the Swagelok adapters on the gas port, vacuum port, cooling air inlet and cooling air outlet. This will prevent wear on the threads and ferrules in these connections.
2. Wear rubber gloves when handling internal parts to prevent the transfer of dirt and oils that can affect the plasma.
3. Care must be taken with the threads on the flanges. If they are cross-threaded the stainless steel body will quickly damage the brass flange beyond repair.
4. The High temp tape is to hold the insulation in place until the rigid foam shell is put on, however the tape does not stick well to the insulation so must be wrapped completely around the body.

Steps:

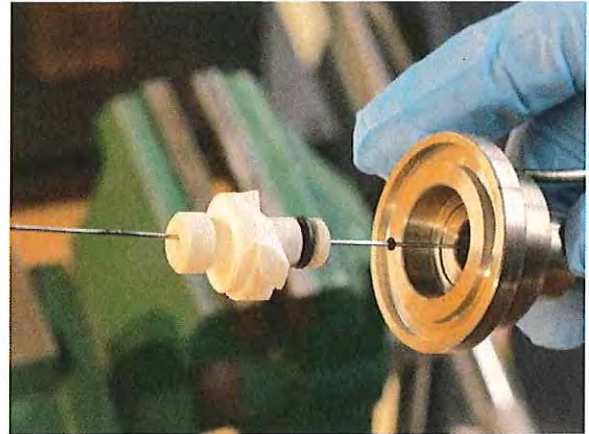
Thread wire through brass screw and ceramic disk. Start the brass screw 3-4 threads into the feed through body.



Clean O-rings with alcohol and then apply a thin coat of vacuum grease to the O-rings.



Thread the wire through the Viton -001 O-ring. Place Chemraz -108 O-ring on the feed through seal. Thread feed through seal onto wire and push into feed through body until the -108 O-ring seats.



Thread spacer and end cap onto wire. Then place Chemraz -219 O-ring into the groove in the feed through body.



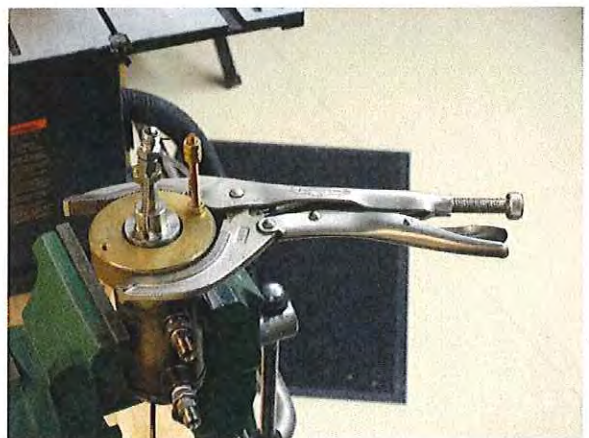
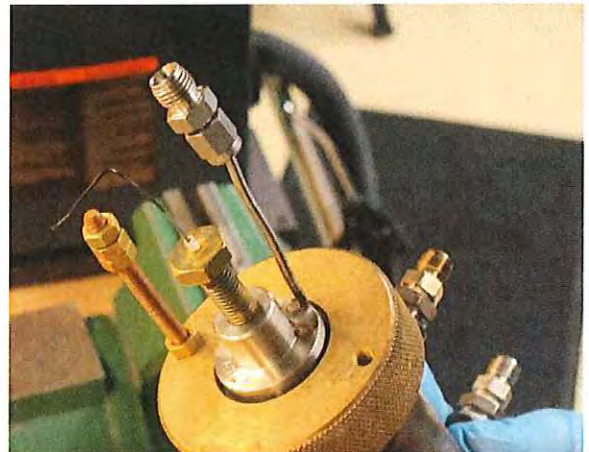
Place the smaller Teflon washer over the gas port and wire and against the feed through body.



Insert the wire, spacer and end cap into the body in the end opposite the vacuum port.



Place feed through flange over gas port and wire. Carefully start threads and tighten hand tight.



Clamp the body in the bench vise; tap vise handle with the hammer to ensure a tight grip, otherwise the body will spin in the vise. Using the Vise Grip chain wrench or the Vise Grip pipe wrench, tighten the feed through flange to compress the O-ring. This normally takes less than a turn after hand tight.

Screw down the brass bolt until it just touches the feed through seal and -001 O-ring. Do not tighten yet.



Turn the cell over and re-clamp in the vise with the open end up. Make sure end cap is as far into the cell as possible.



Install sample using tweezers and probes making sure that the sample is flat to wall and that the far end is held to the wall by the end cap bevel.

Insert the shield making sure not to crush or bend the sample. Make sure the bevel on the end of the shield pushes the sample against the wall.



Slide the wire cover onto the wire. Take care with the pin on the wire cover as it is quite brittle. Adjust the wire such that the pin of the wire cover extends slightly beyond the body.

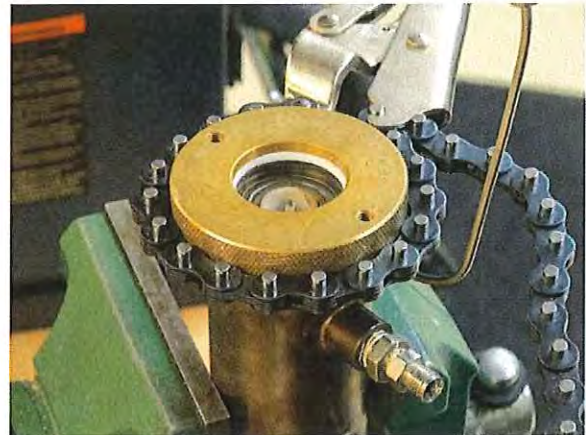


Install the -214 and -222 Chemraz O-rings in the end of the body. Place the sapphire window onto the end of the body with the wire cover pin in the central hole of the window. Push the wire into the brass bolt until the wire is fully into the wire cover and the pin is as far into the window as possible.



Caution: The pin is quite fragile and care must be taken to keep the wire and the window lined up or the pin will snap off.

Place the large Teflon washer on the window and carefully start threading the window flange onto the body and tighten hand tight. Use the chain or pipe Vise Grips to tight the window flange to set the O-rings which will be visible through the window.

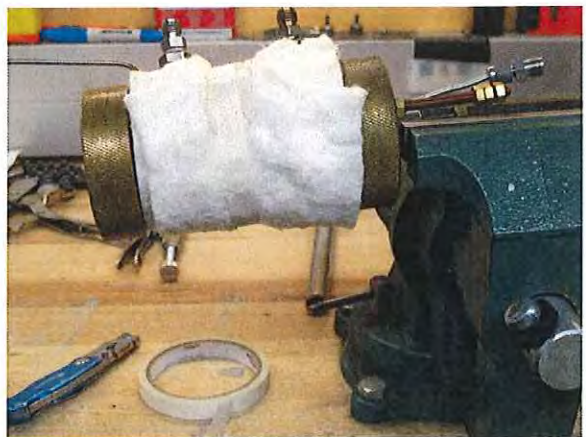


Re-clamp the cell in the vise so it is held by the feed through body in a horizontal position.

Caution: If cell is assembled without a sample then care must be taken not to dislodge the internal parts. The shield and end cap are very susceptible to sliding in the body. Hold horizontal whenever possible.



Wrap the body between the flanges with two layers of $\frac{1}{4}$ " insulating fabric and secure with a strip of high temperature tape.



Wrap on a layer of $\frac{1}{4}$ " insulating fabric that extends $\frac{1}{2}$ " past the ends of the flanges and secure at each end and the middle with high temperature tape.



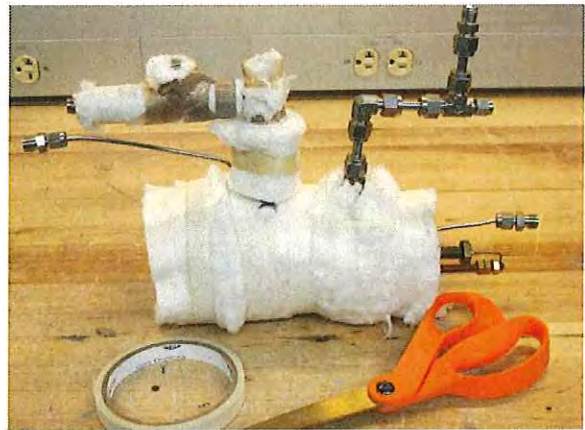
Wrap an additional piece of $\frac{1}{4}$ " insulating fabric over the area from the cooling outlet to the end of the window flange and secure with high temperature tape.



Remove from vice and attach the air piping to the cooling inlet and outlet.



Wrap a two inch wide layer of $\frac{1}{4}$ " thick insulating cloth around the fitting on the cooling outlet port.



The cell is now ready for installation.

GD Hot Cell Installation

Installation Of Air Cooled Glow Discharge Cell

Tools and materials:

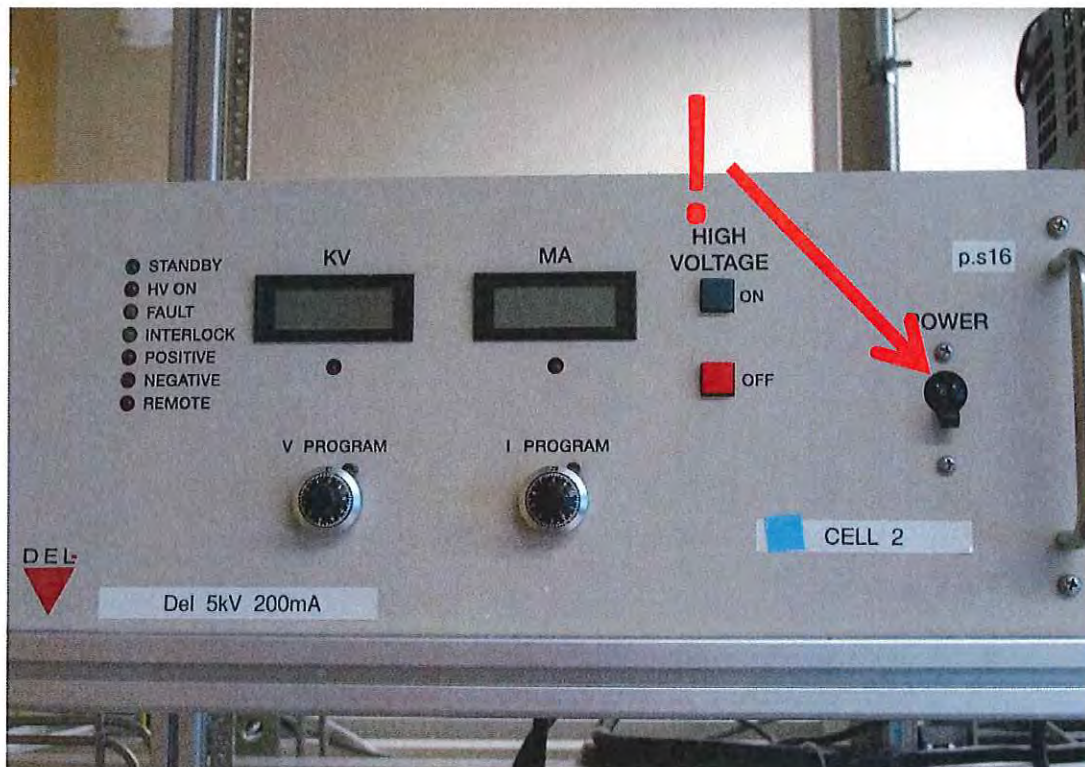


1. Mineral Wool
2. Silicate fabric insulation
3. Foam scrap about 1 1/2 " thick
4. 10mm nutdriver
5. Very small screwdriver (hidden)
6. 7/16", 1/2", 9/16" and 3/4" wrenches
7. Window insulation
8. Threaded rods
9. Rigid foam shell

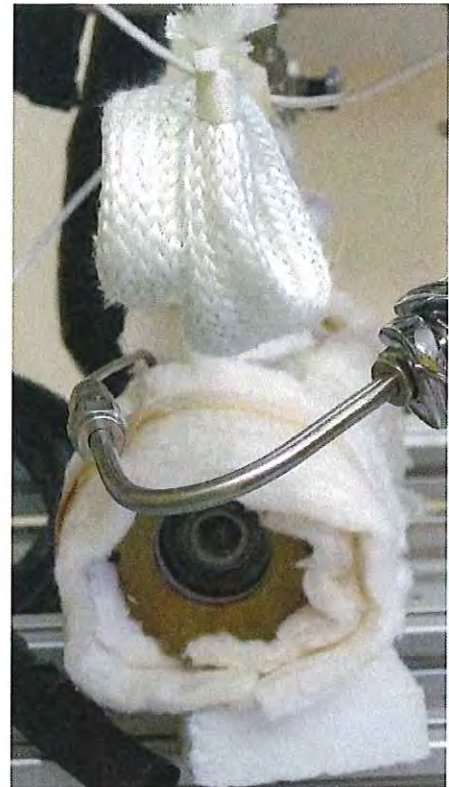
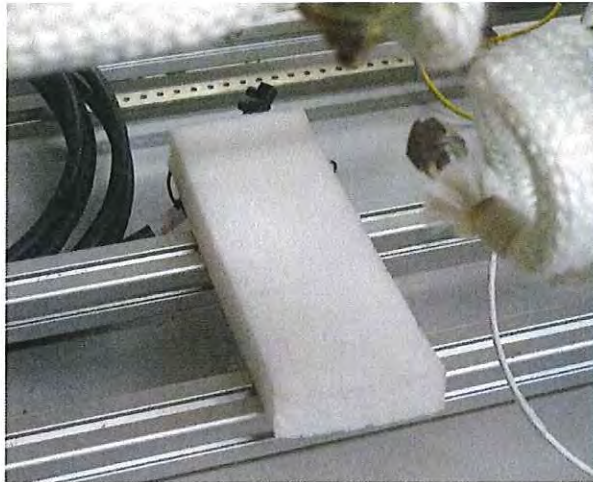
Air cooled cell installation

Caution: If cell is assembled without a sample then care must be taken not to dislodge the internal parts. The shield and end cap are very susceptible to sliding in the body. Hold horizontal whenever possible.

Warning: *Ensure the high voltage power supply is off before installing, removing, or adjusting the test cell. Fatal voltages and currents could be applied to cell if the power supply is on.*



1. Holding the assembled cell horizontal and attaché the cooling inlet and outlet finger tight. Align and attach finger tight the gas port and vacuum port. Support cell from underneath whenever foam shell is not installed.



2. Tighten the cooling inlet and outlet and the gas and vacuum ports as per Swagelok recommendations. Be careful not to over tighten the fittings.

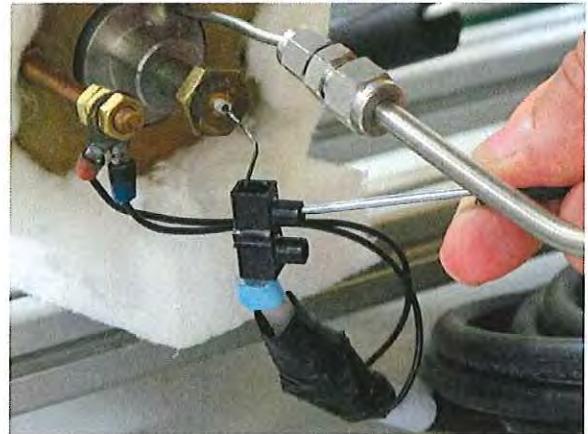
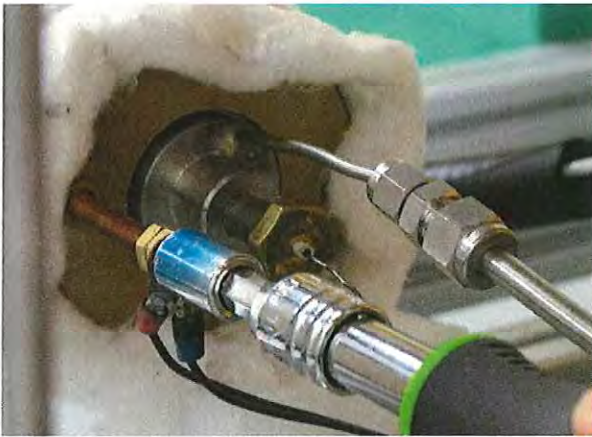


3. Tighten the fitting on the vacuum port isolation valve.



4. Attach the power cable. Place the ground wire on the threaded stud on the feed through flange and tighten with a 10mm nutdriver. Use a miniature screwdriver to tighten the connector to the Tungsten wire.

Caution: Be very careful not to pull the wire out of the cell while connecting it. If you pull the pin of the wire cover out of the sapphire window you will have to partially disassemble the cell to get it back in. Look through the window with a small flashlight to insure that all the internal parts are still in their positions.



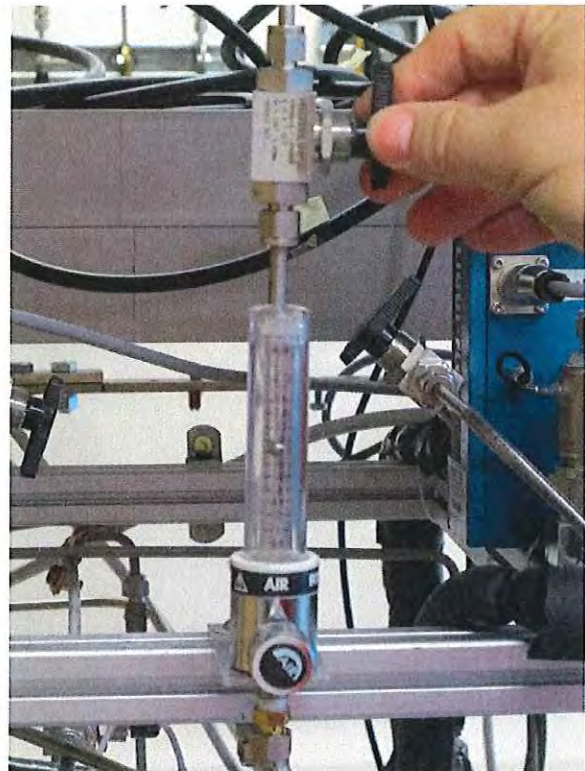
5. Insert the inlet PT100 into the 1/8" Swagelok fitting in the inlet cooling piping. The fitting should have a Teflon ferrule. Insert the PT100 until the tip reaches the elbow and the pull out about 1/2".



6. Insert the inlet PT100 into the 1/8" Swagelok fitting in the outlet cooling piping. The fitting again should have a Teflon ferrule. Insert the PT100 until the tip reaches inside body of the cell, then pull the sensor back about 1/4". The sensor cannot touch the body because it will then read body temperature and not air temperature. Unsure that all the cooling outlet tubing is completely covered by a layer of 1/4" insulating cloth.

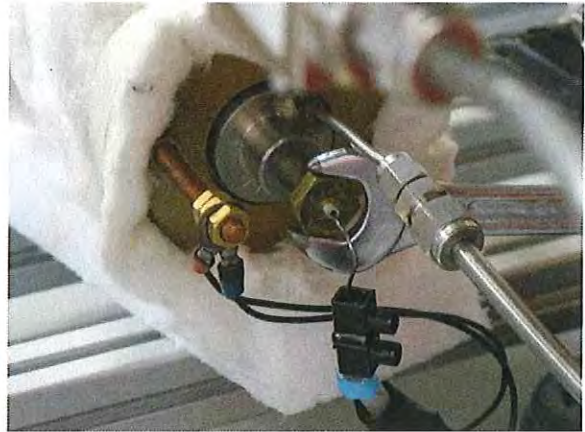


7. Test the flow of cooling air to ensure there are no leaks.

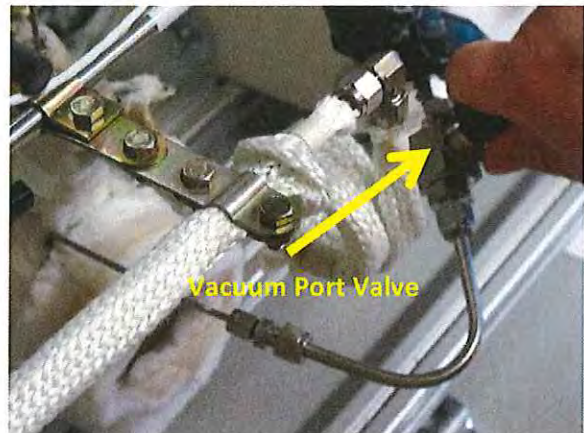
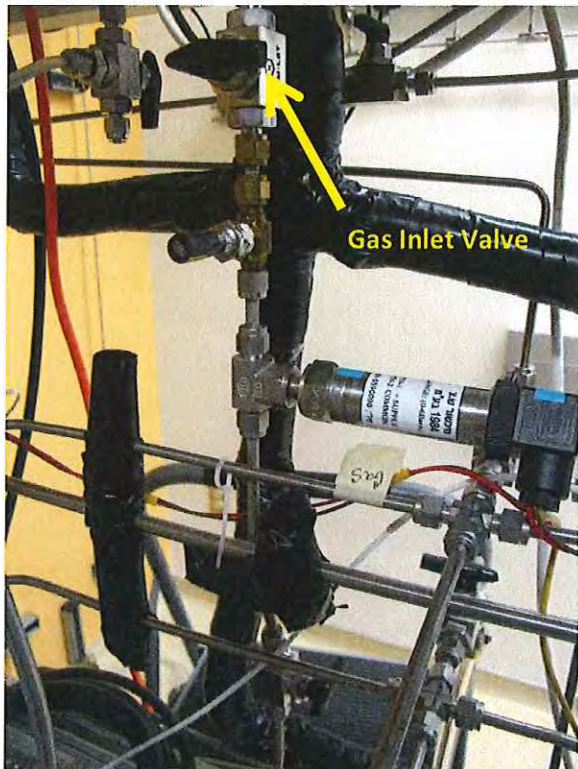


8. Tighten the brass bolt with a 17mm wrench. Only 10-15 degrees is sufficient.

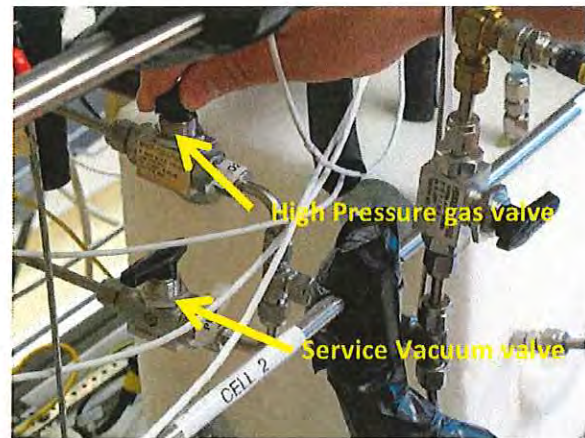
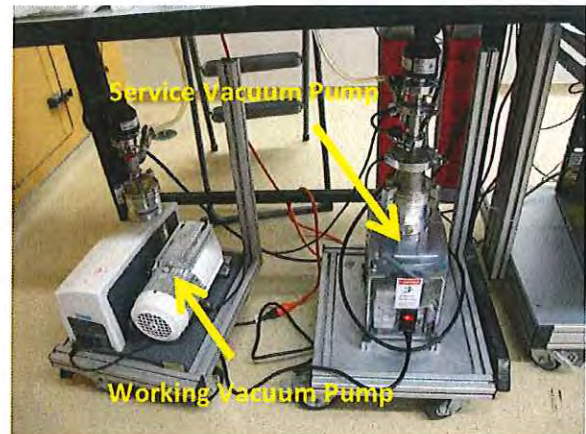
Caution: Do not over tighten the brass bolt. In this step you are only compressing the small -001 O-ring. Over tightening will damage the ceramic feed through seal.



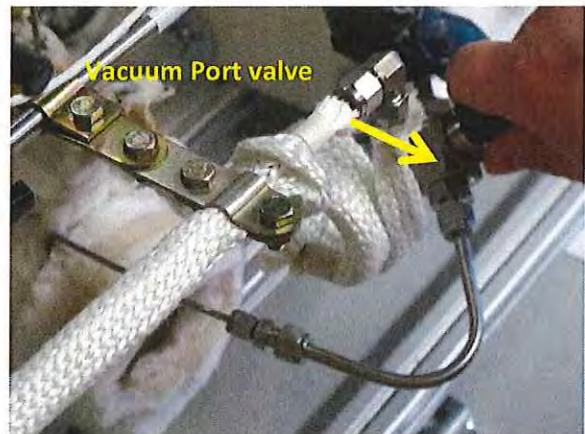
9. Ensure the gas inlet valve above the pressure transducer is shut and then open the vacuum port isolation valve.



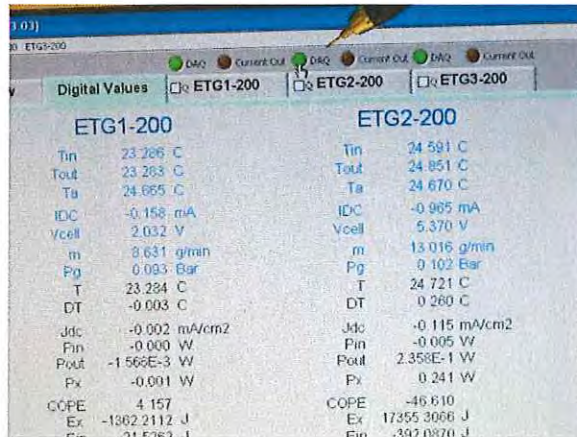
10. Ensure the service vacuum pump is running. Ensure the working vacuum isolation valve is shut and the high pressure gas valve is shut. Open the service vacuum valve and let the pump recover.



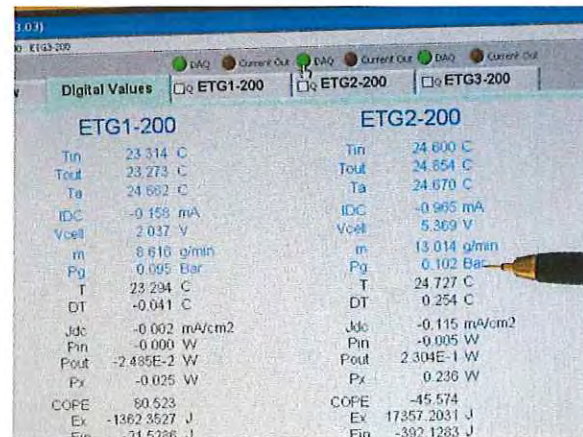
11. Slowly open the vacuum port isolation valve until the service vacuum begins to slow and pause there while the pump recovers. Use the computer to monitor the cell pressure transducer to ensure that the cell keeps pumping down.



12. When the cell pressure reaches a few millibars, close the vacuum port isolation valve. Watch the cell pressure indication; it may rise several millibars, but should stabilize. Once stabilized it should remain unchanged for ten minutes. This ensures you have no gross leaks in the cell.



ETG1-200		ETG2-200	
Tin	23.285 C	Tin	24.591 C
Tout	23.283 C	Tout	24.851 C
Ta	24.655 C	Ta	24.670 C
IDC	-0.158 mA	IDC	-0.965 mA
Vcell	2.032 V	Vcell	5.370 V
m	8.631 g/min	m	13.016 g/min
Pg	0.093 Bar	Pg	0.102 Bar
T	23.284 C	T	24.721 C
DT	-0.003 C	DT	0.260 C
Jdc	-0.002 mW/cm2	Jdc	-0.115 mW/cm2
Pin	-0.000 W	Pin	-0.005 W
Pout	-1.566E-3 W	Pout	2.358E-1 W
Px	-0.001 W	Px	0.241 W
COPE	4.157	COPE	-46.610
Ex	-1362.2112 J	Ex	17355.3066 J
Fin	-21.5363 J	Fin	-392.0870 J

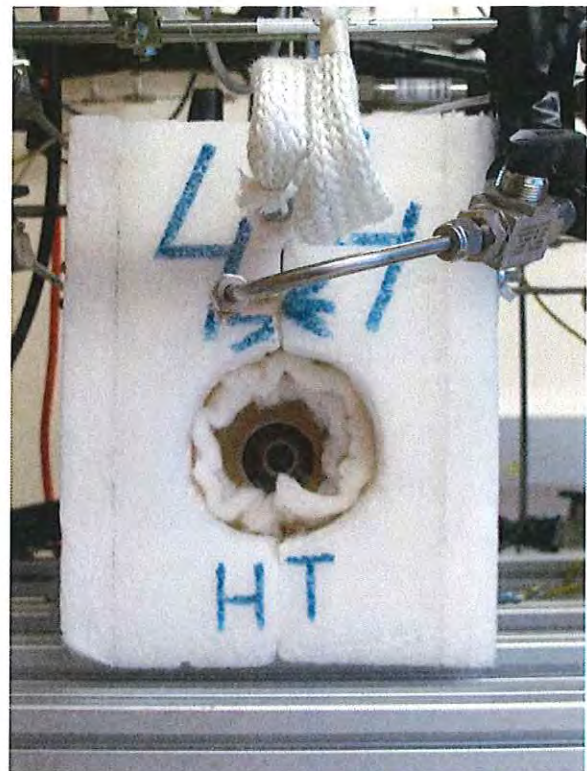
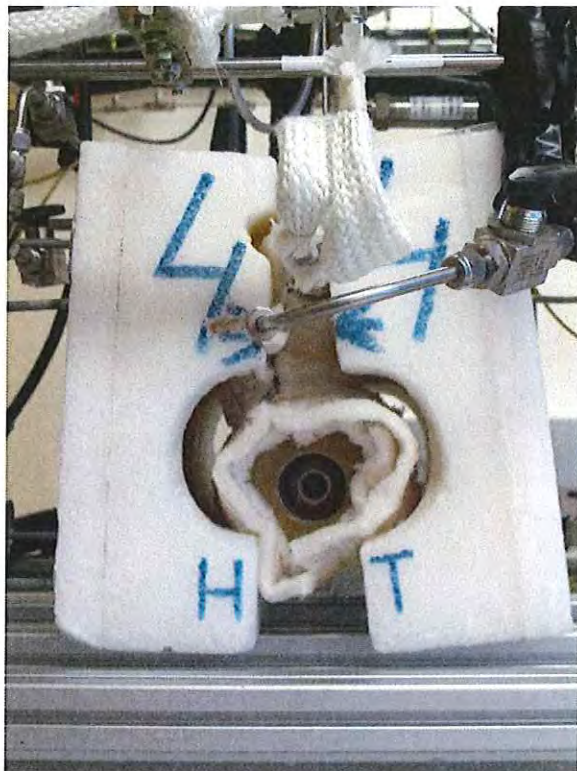
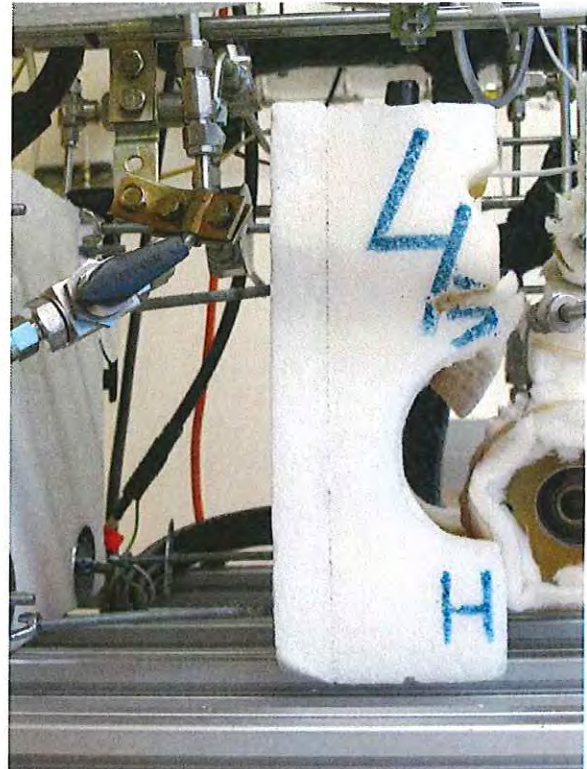


ETG1-200		ETG2-200	
Tin	23.314 C	Tin	24.800 C
Tout	23.273 C	Tout	24.854 C
Ta	24.682 C	Ta	24.670 C
IDC	-0.158 mA	IDC	-0.965 mA
Vcell	2.037 V	Vcell	5.369 V
m	8.610 g/min	m	13.014 g/min
Pg	0.095 Bar	Pg	0.102 Bar
T	23.294 C	T	24.727 C
DT	-0.041 C	DT	0.254 C
Jdc	-0.002 mW/cm2	Jdc	-0.115 mW/cm2
Pin	-0.000 W	Pin	-0.005 W
Pout	-2.485E-2 W	Pout	2.304E-1 W
Px	-0.025 W	Px	0.236 W
COPE	80.523	COPE	-45.574
Ex	-1362.3527 J	Ex	17357.2031 J
Fin	-21.5286 J	Fin	-392.1263 J

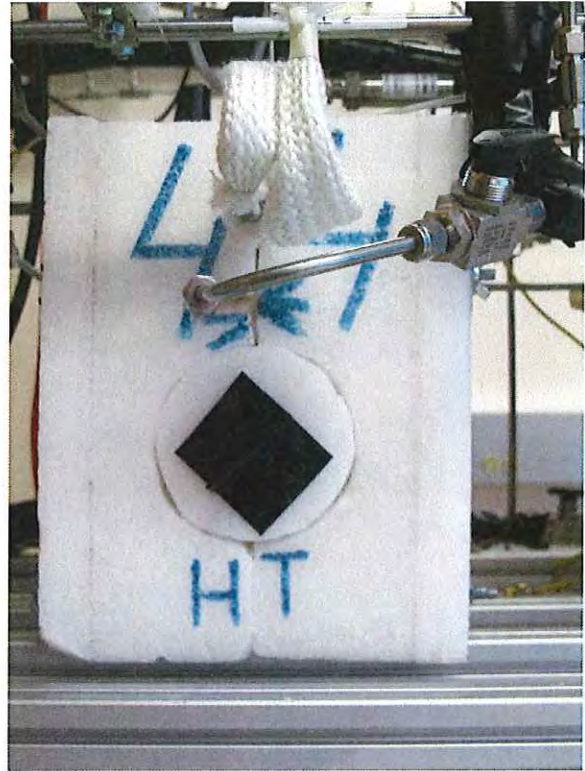
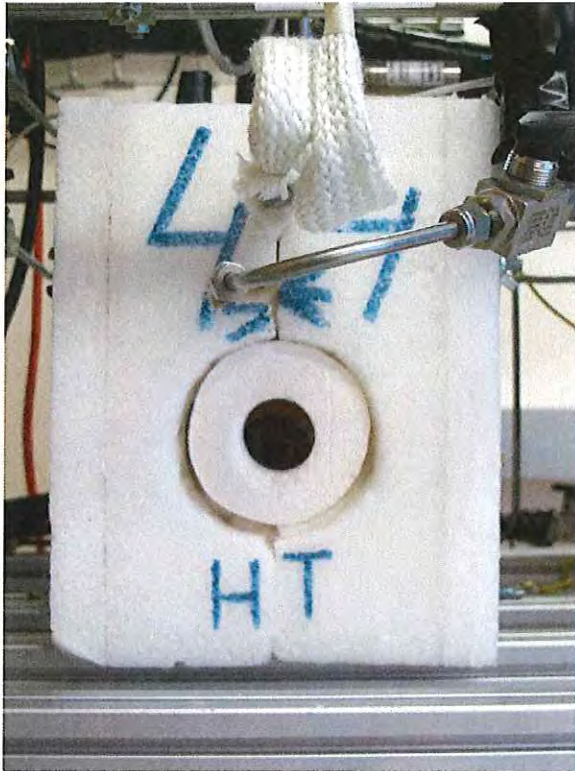
13. Wrap the vertical portion of the cooling outlet tube in a layer of $\frac{1}{4}$ " insulating fabric and secure with high temperature tape.



14. Remove the support under the cell and place the two halves of the rigid foam shell around the cell. Line up the cavities with the cooling tubing. Make sure you insert all the threaded rods into the left hand half before you put on any wingnuts as it will require moving the half around to get them in. Make sure you use the large fender washers to protect the foam. Place the washers and wingnuts on the threaded rods and tighten until you close the gap between the foam halves. Note the fold of insulating fabric in slot for vacuum tube.



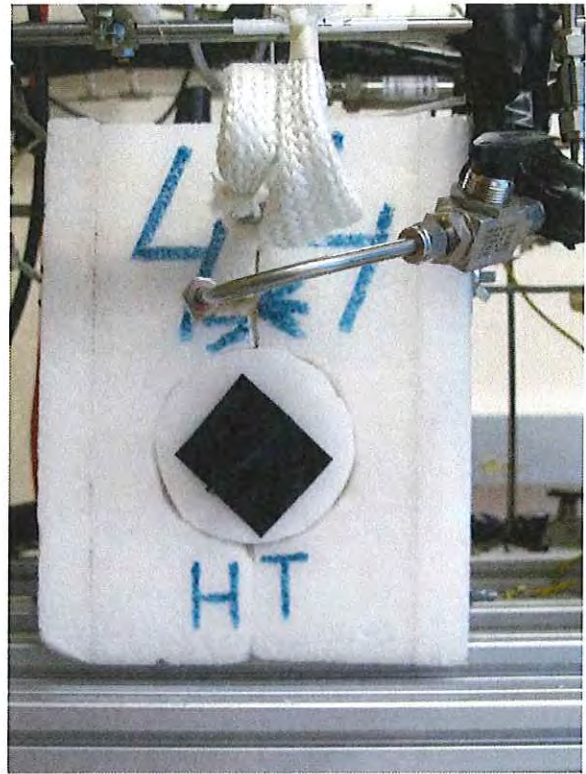
15. Insert the high temperature insulation donut into the window opening as far into the cavity as it will go; it should at least reach the insulating fabric. Next insert the rigid foam disk in the same opening.



16. Fill the cavity on the back with firmly packed mineral wool to the level of the face of the rigid foam shell.



17. Open the vacuum port isolation valve to reapply the service vacuum to the cell and turn over the experiment to the operator.

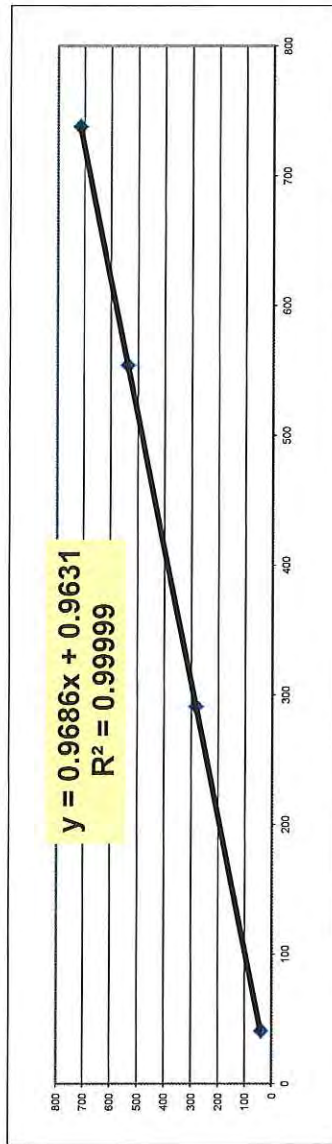
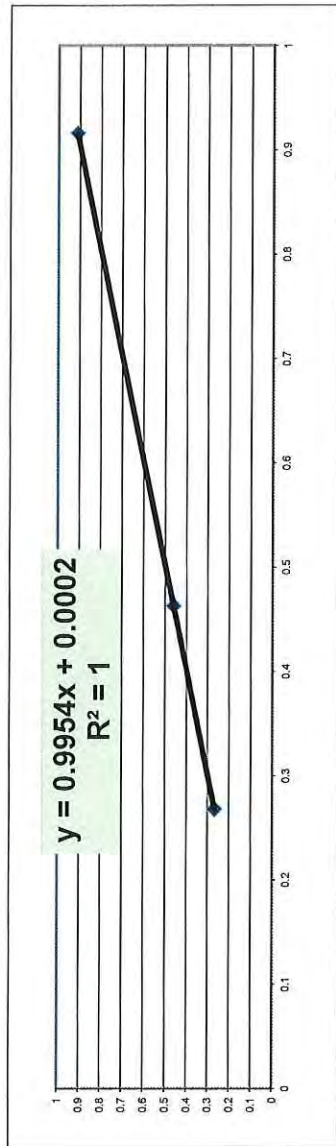
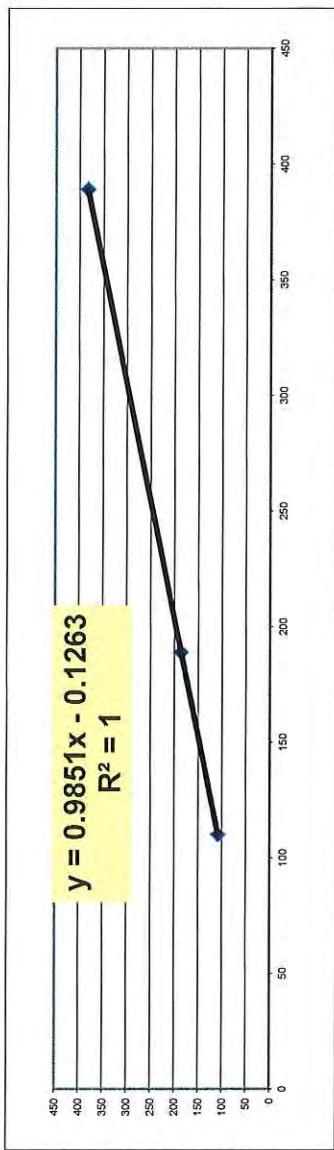


Calibration Ø8

110 108 ch0/1
189 186.4
389 383

0.268 0.267 ch1/1
0.463 0.461
0.916 0.912

ch0/2 40.8 39.6
291 284
554 538
738 715

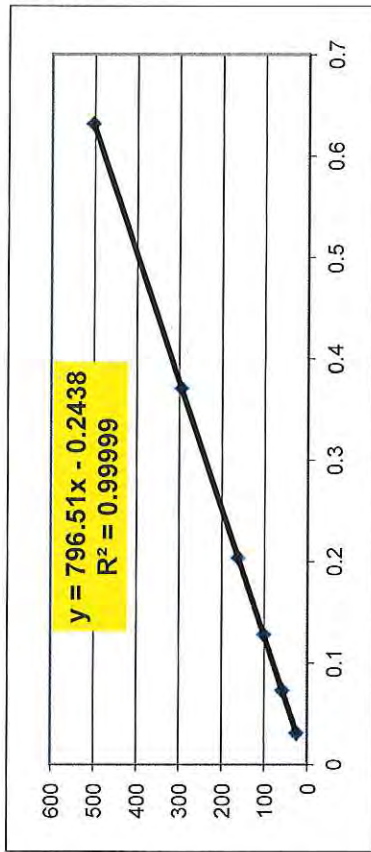


Calibration Ø9

8/13/09

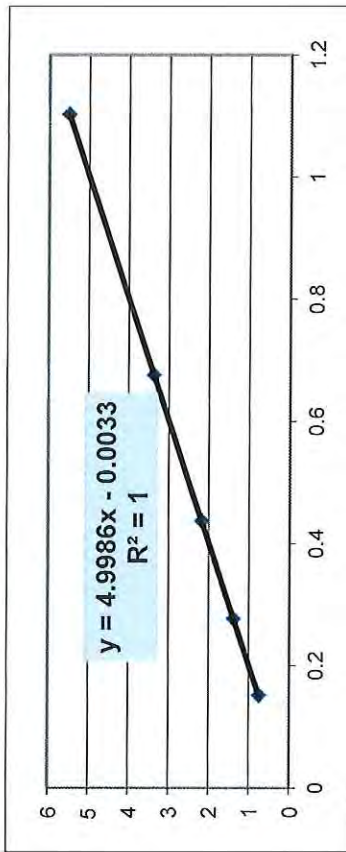
ch1/0

0.031
0.073
0.128
0.2037
0.3708
0.6316



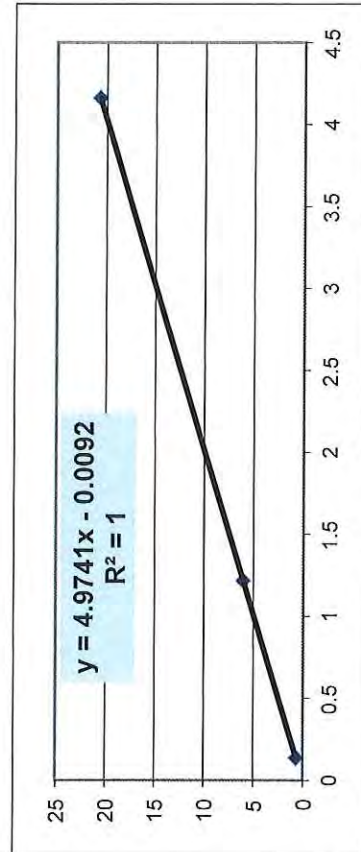
ch1/1

0.1515
0.2765
0.4366
0.6758
1.1028

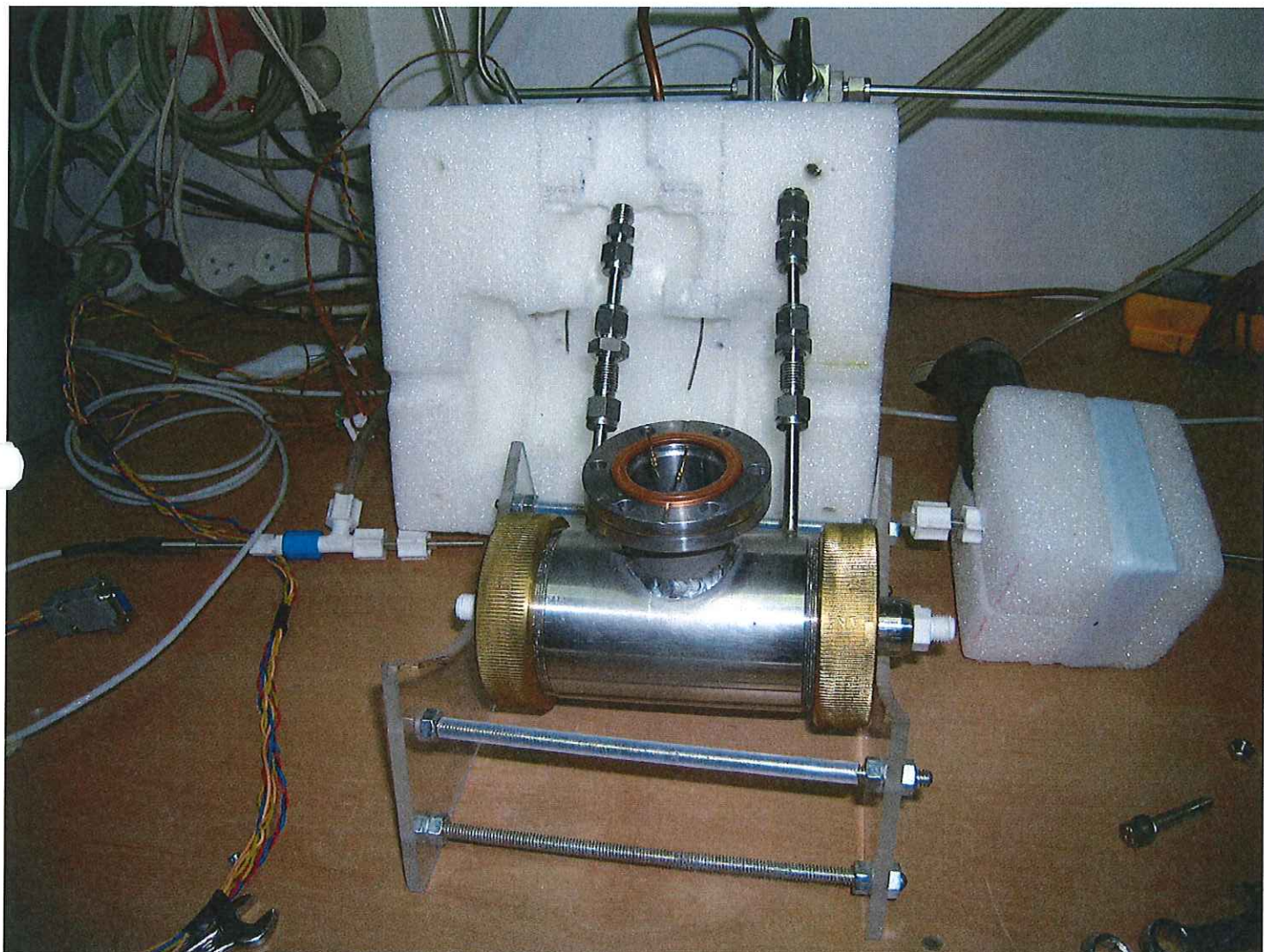


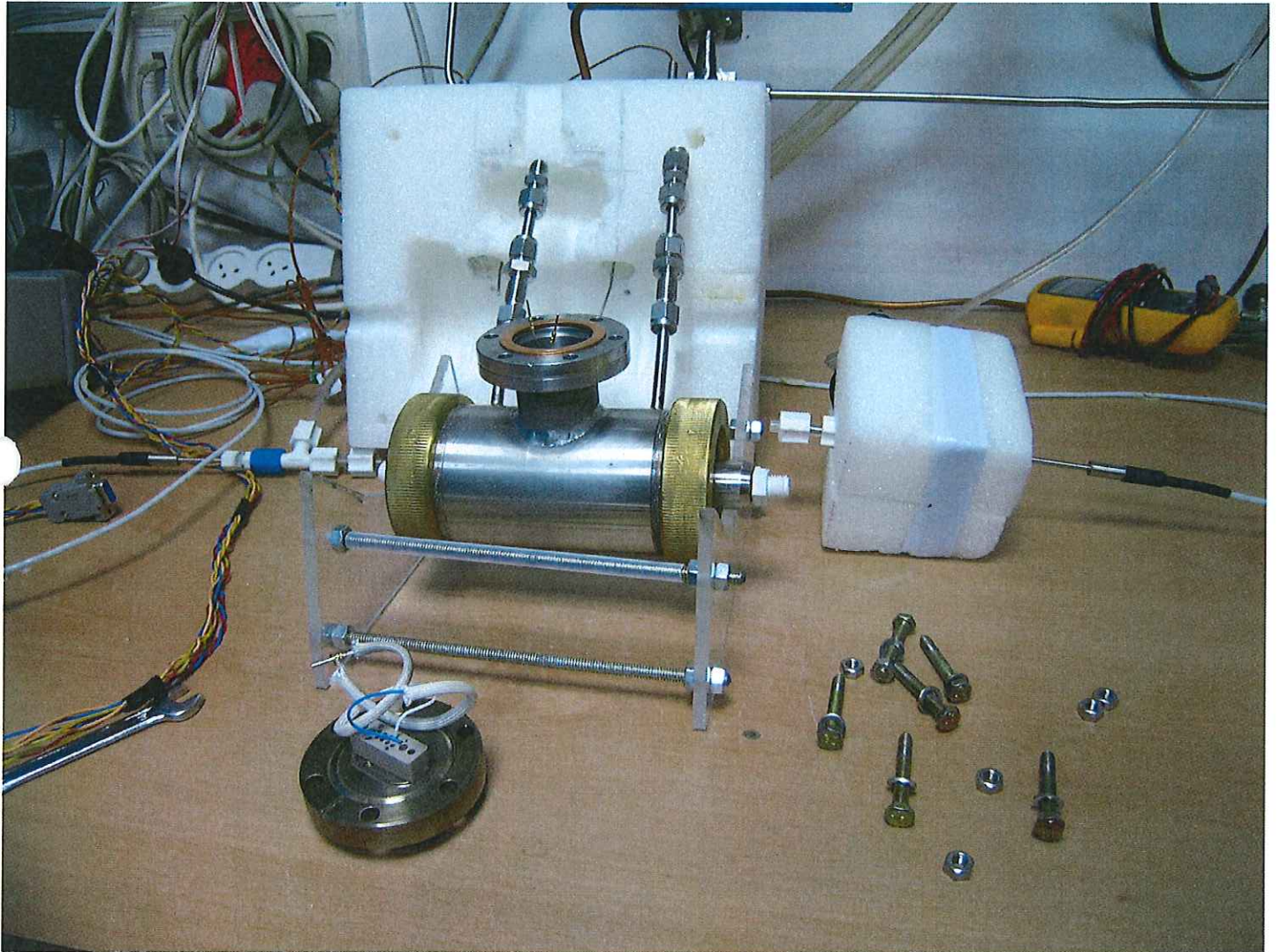
0.137
1.216
4.161

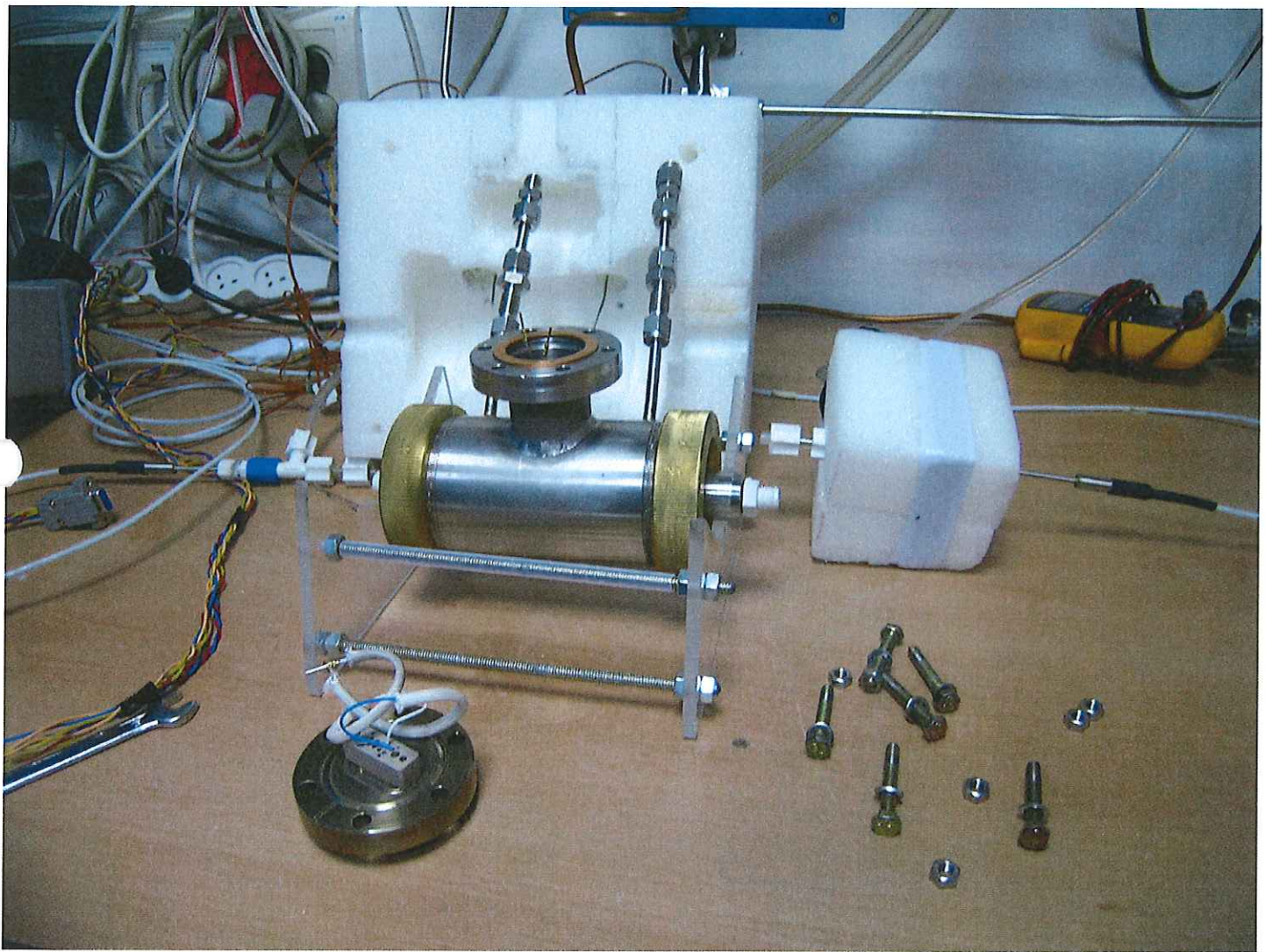
0.677
6.033
20.69

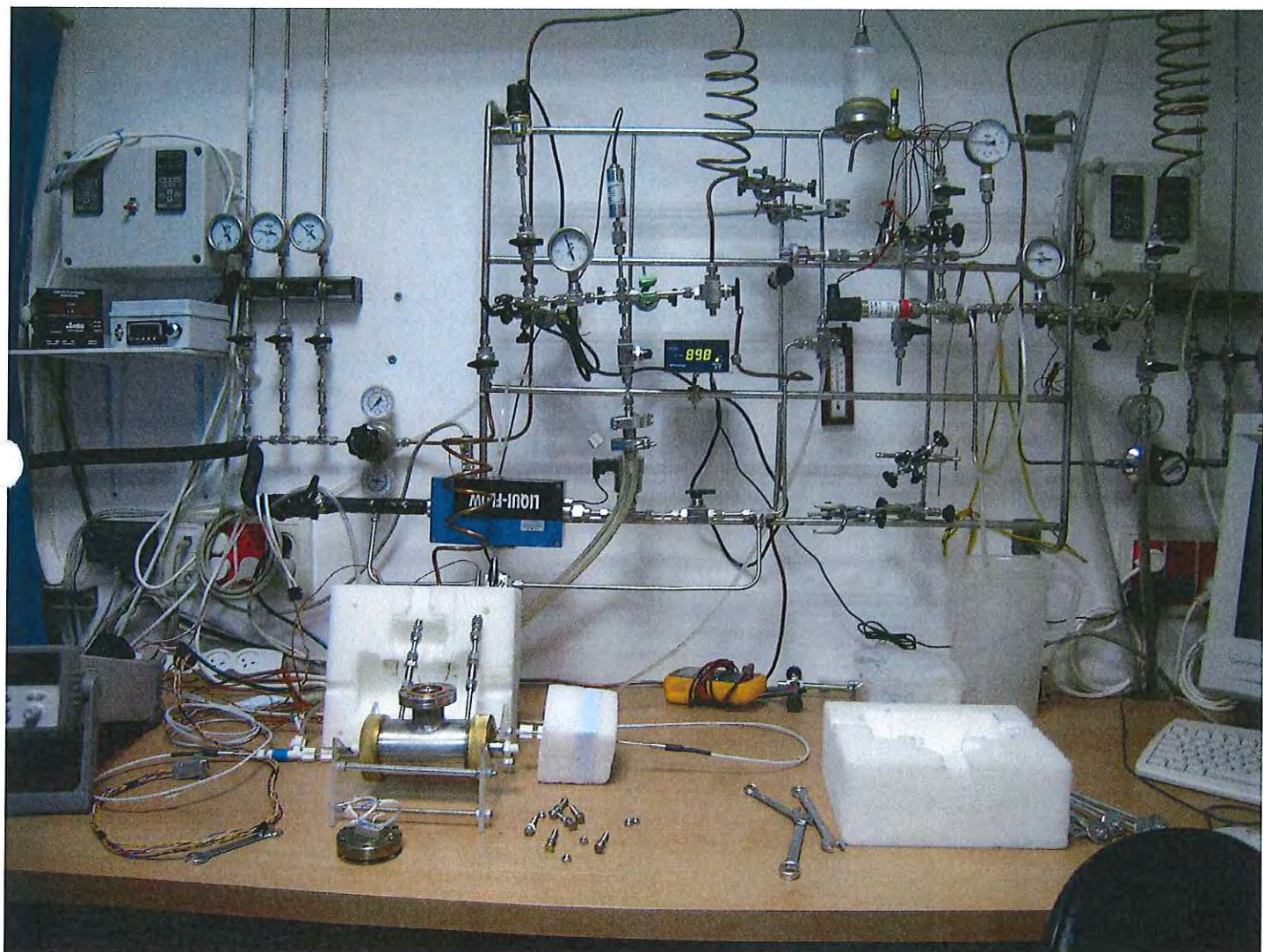


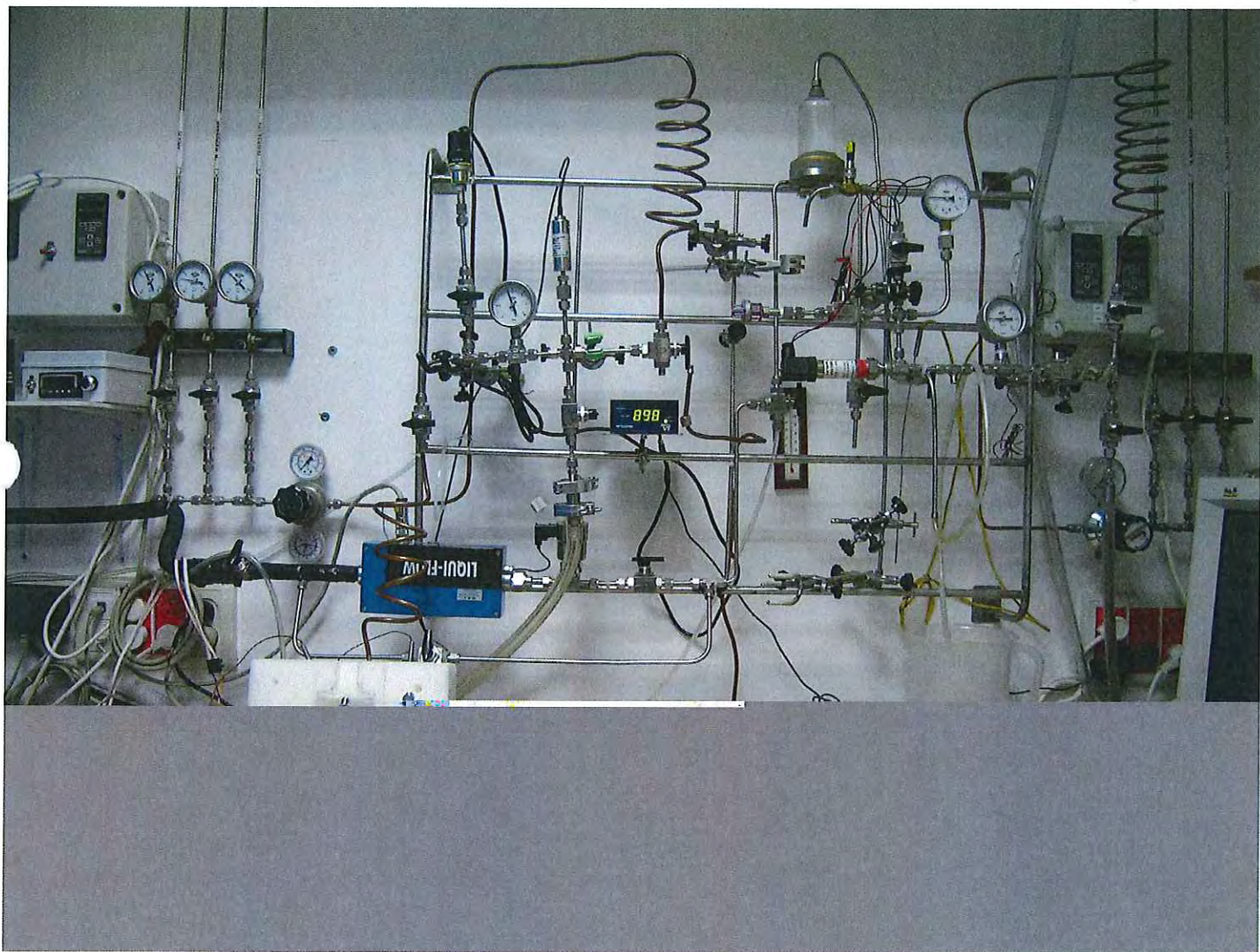
DSCN 4573 to DSCN 4594

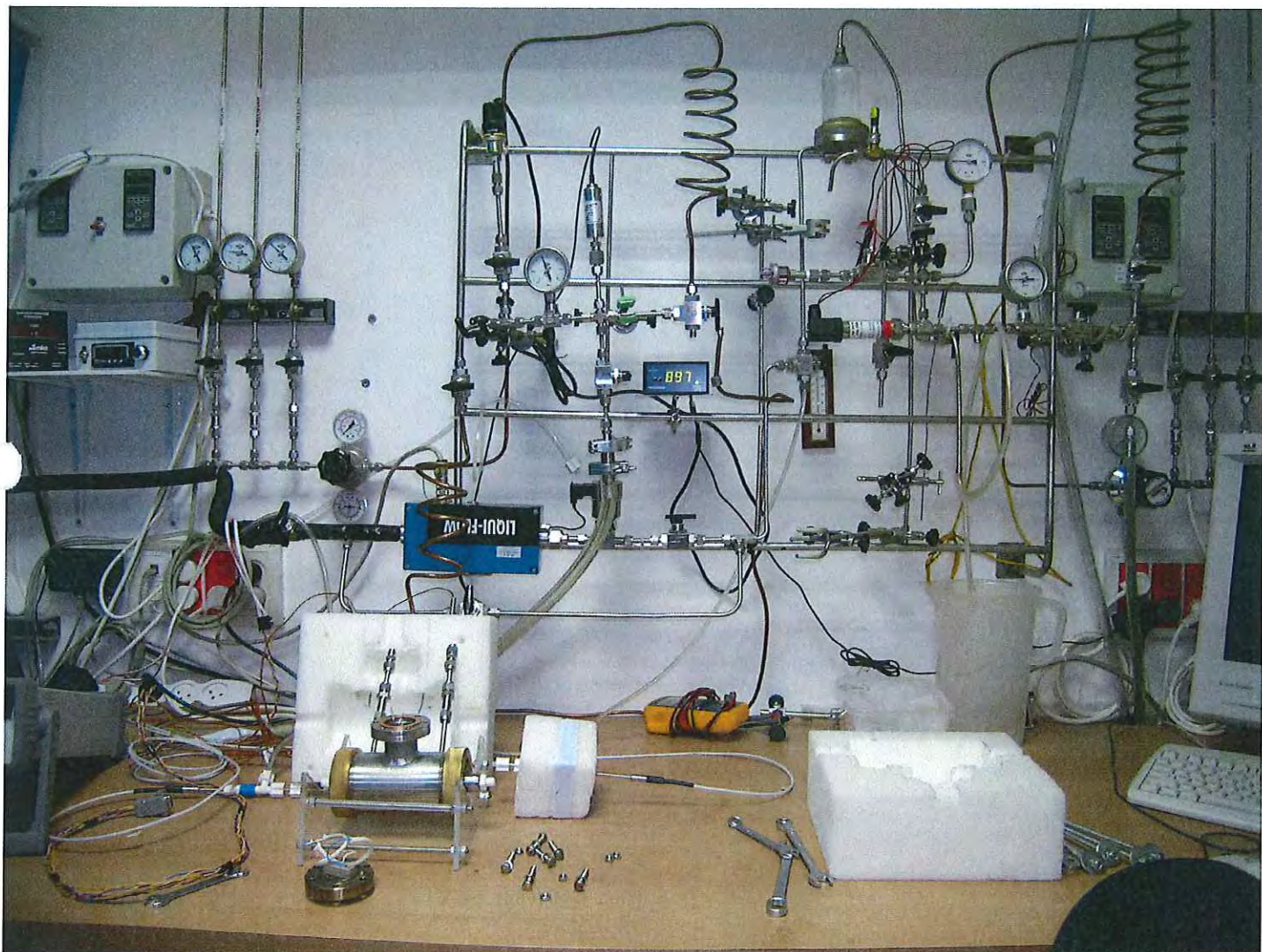


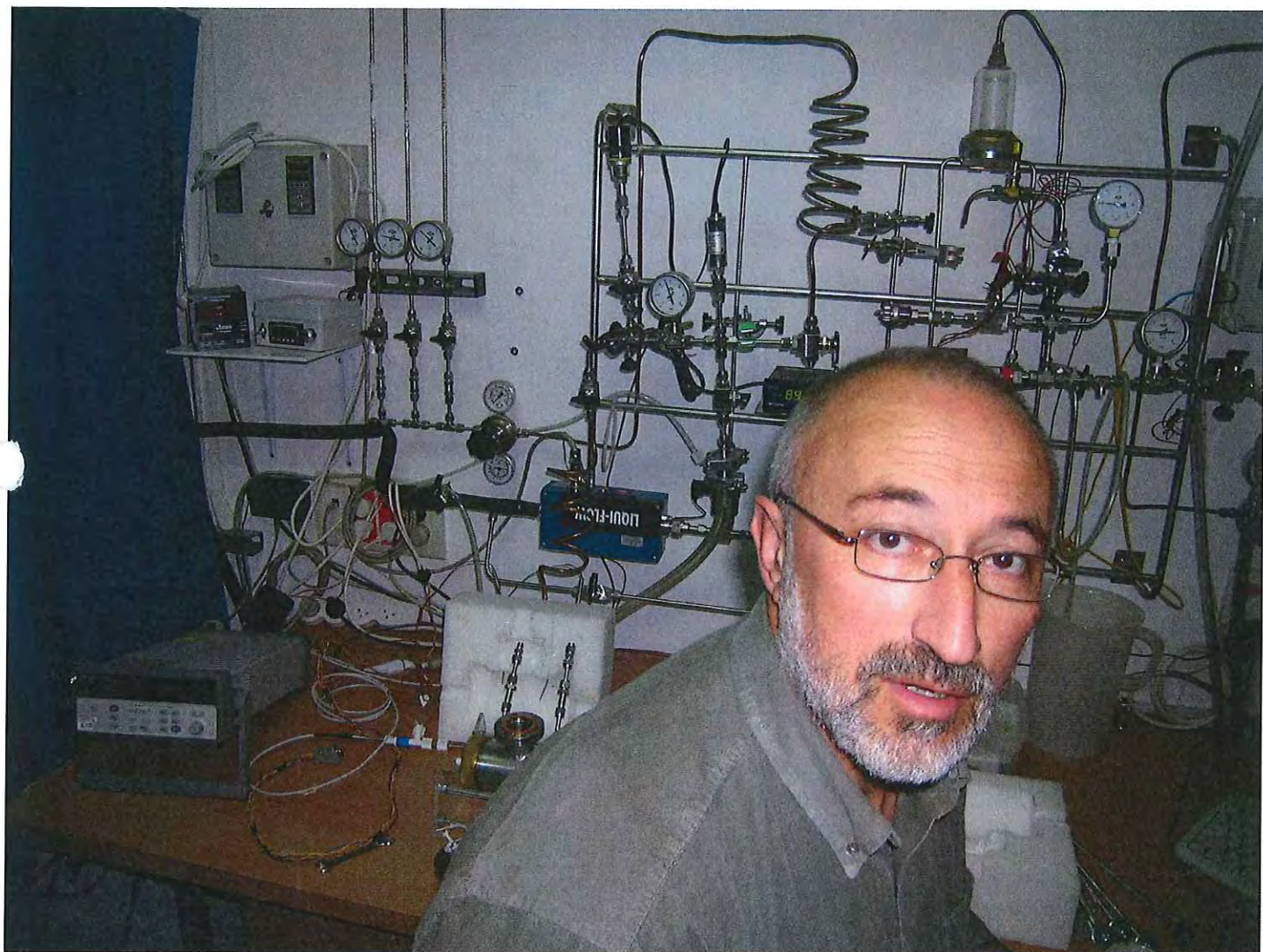


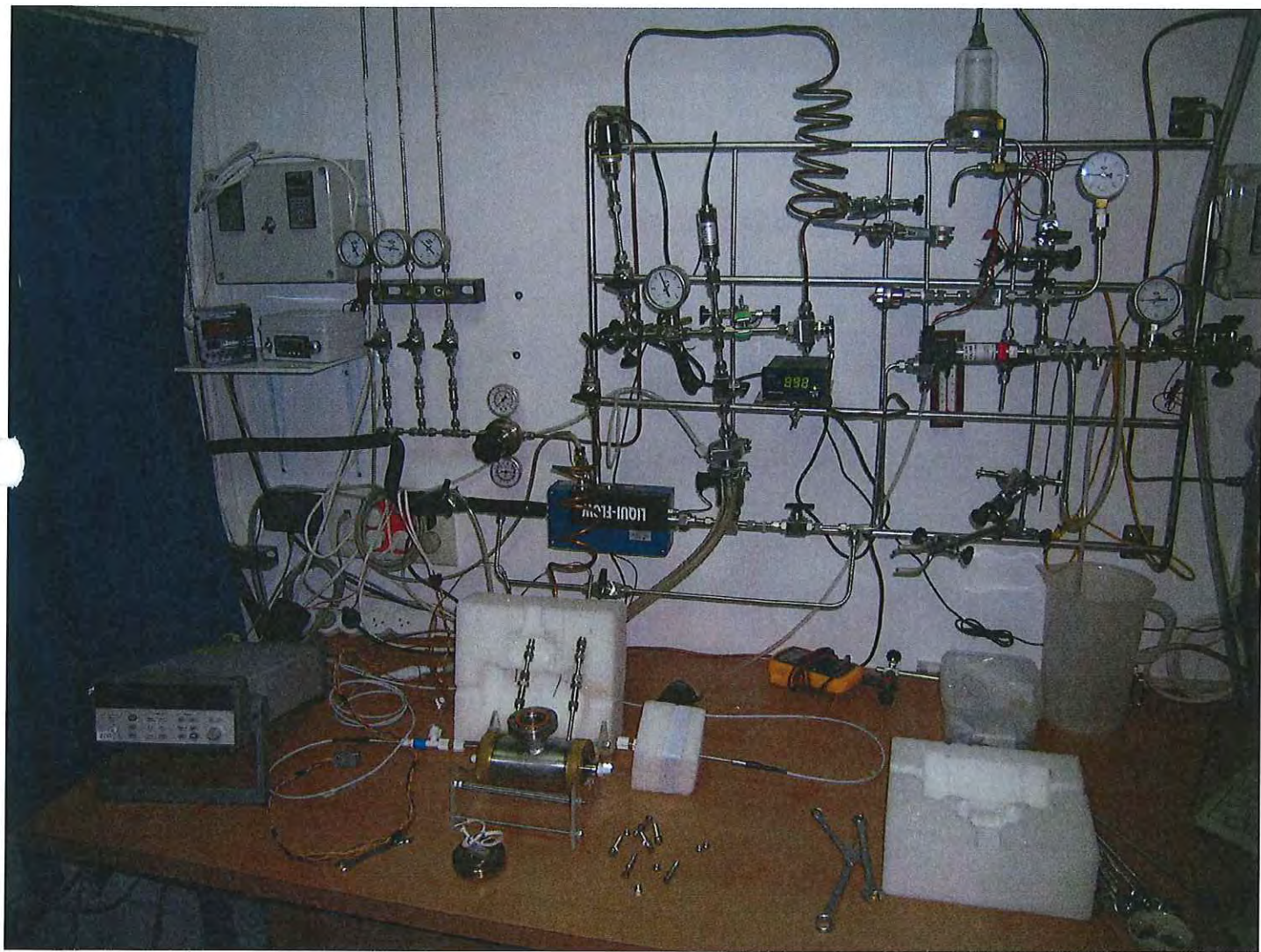




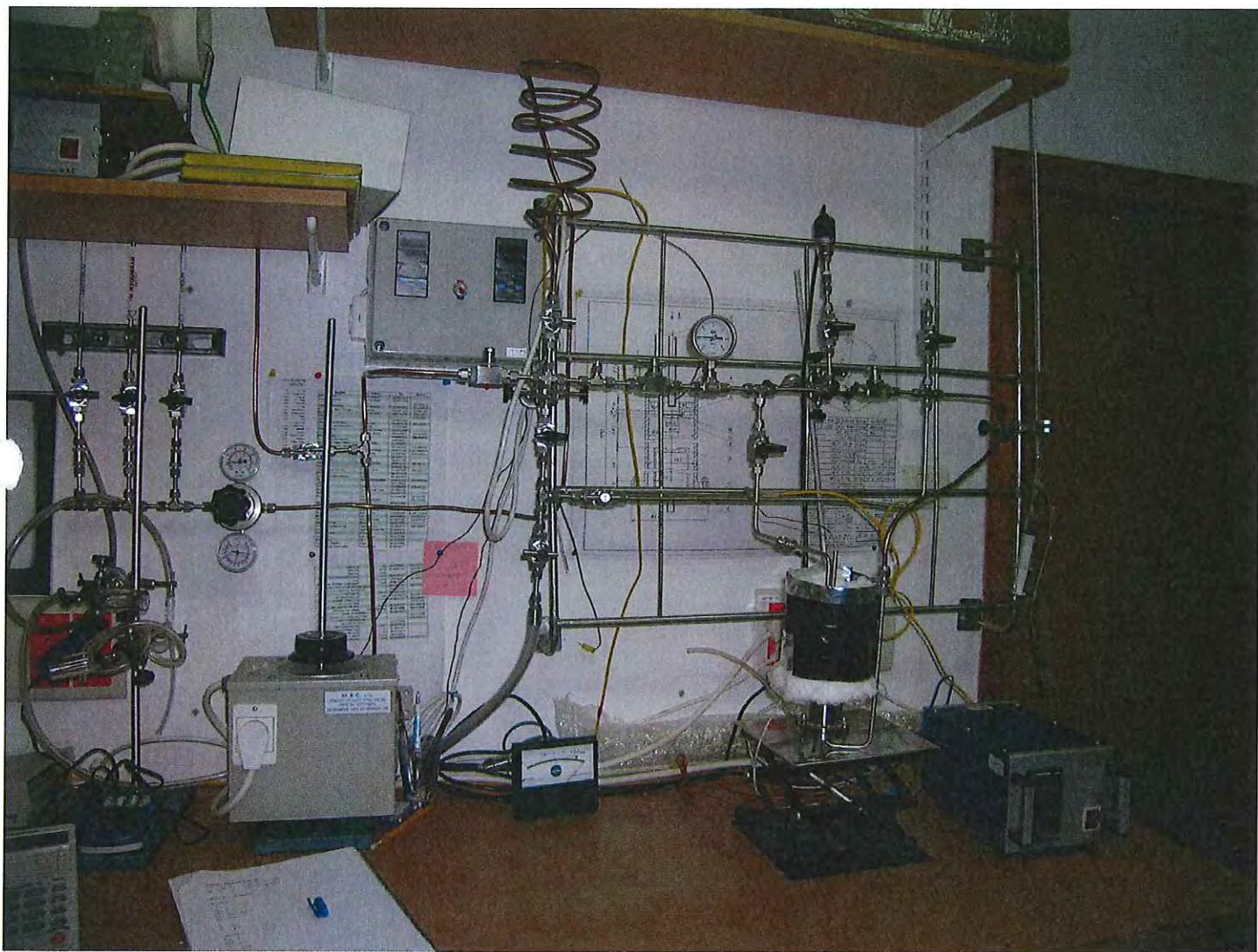




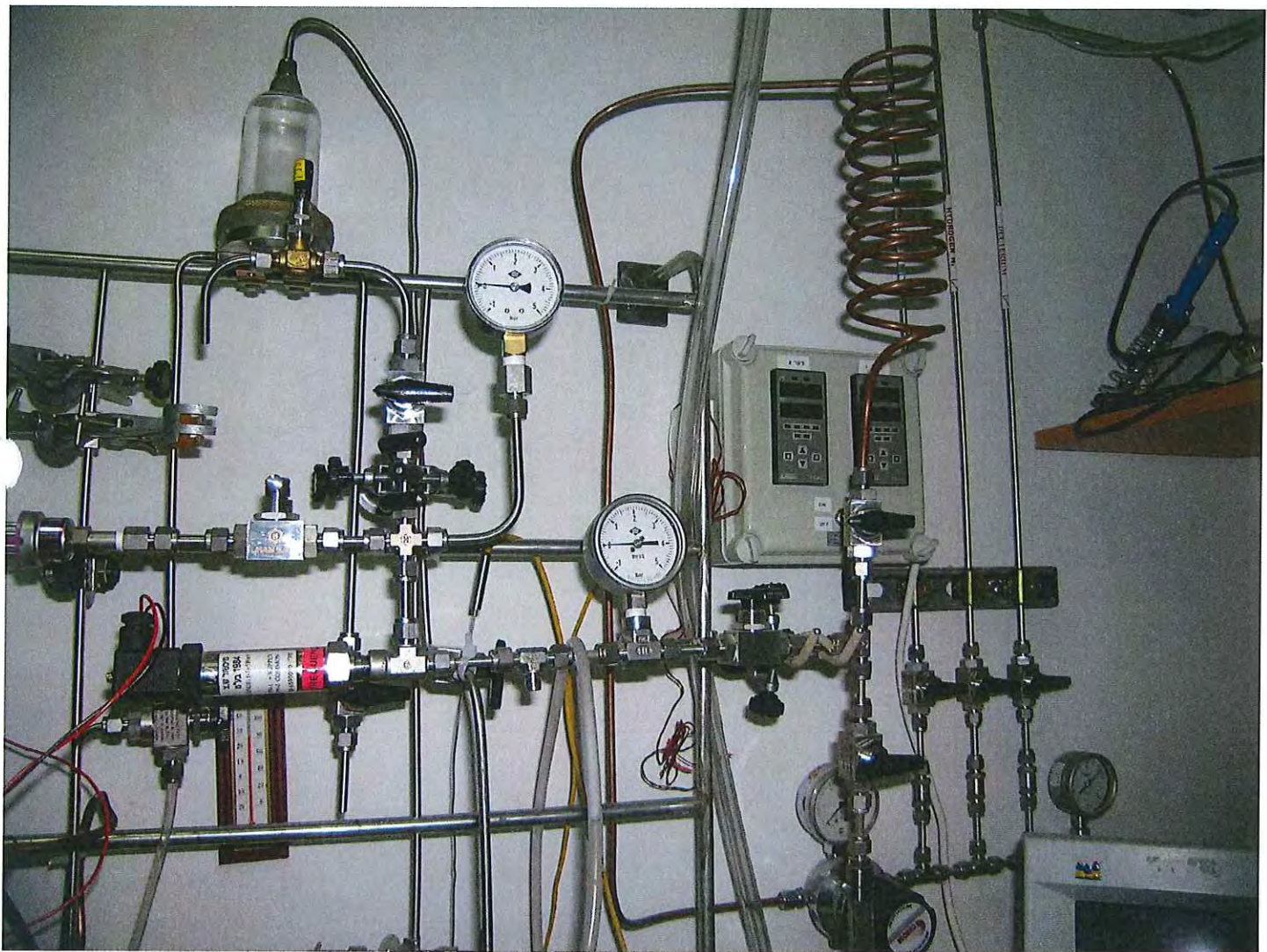






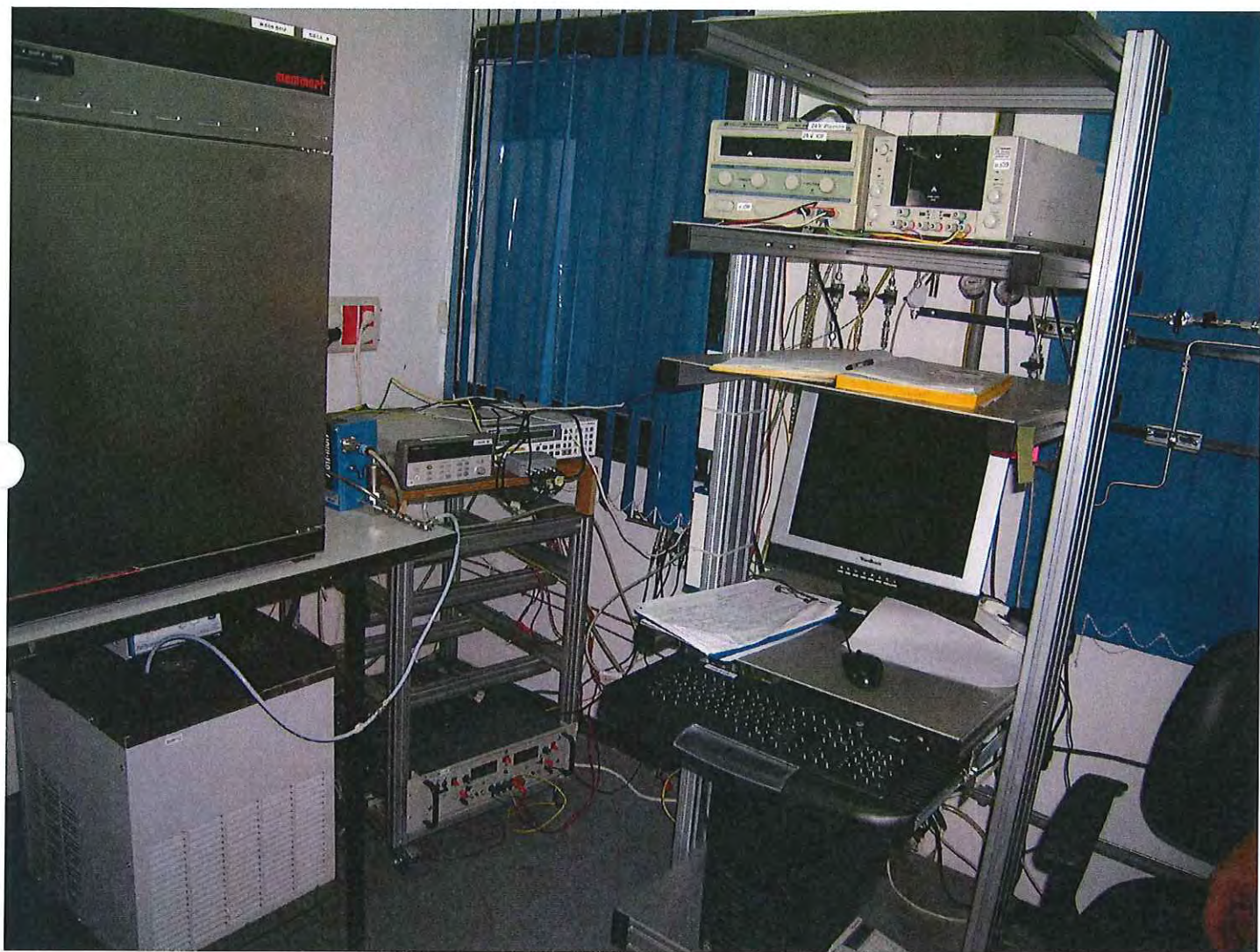


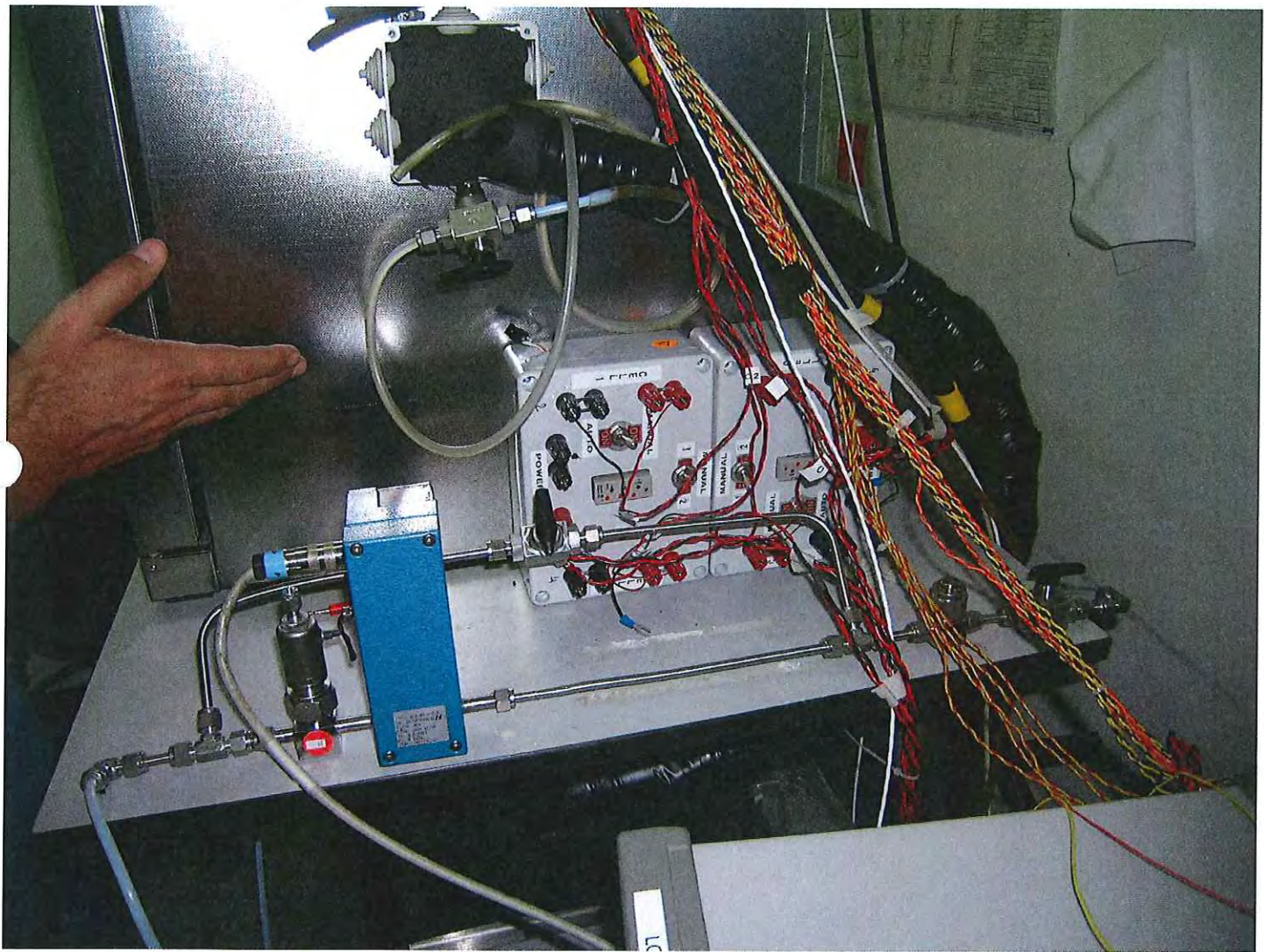


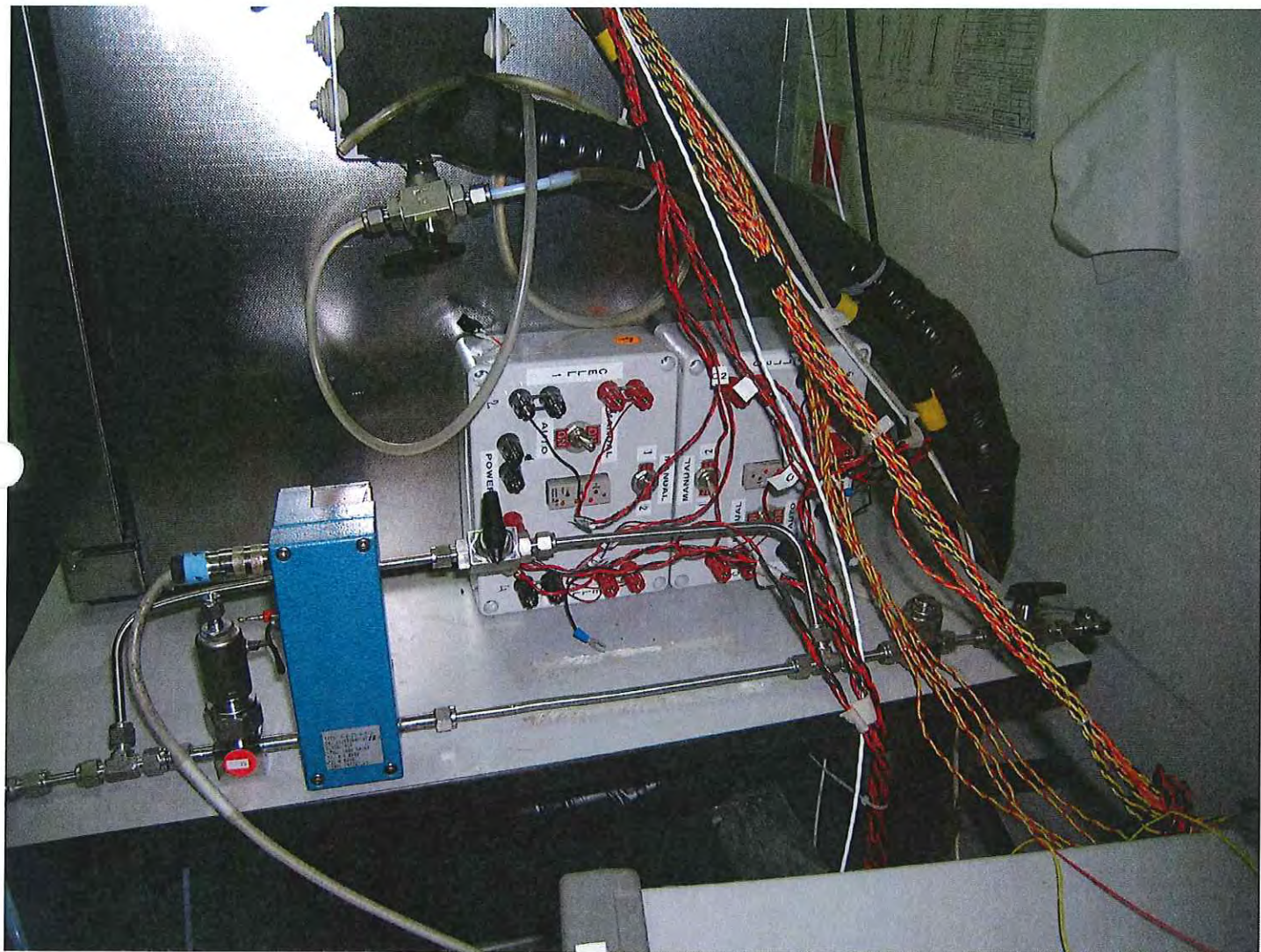


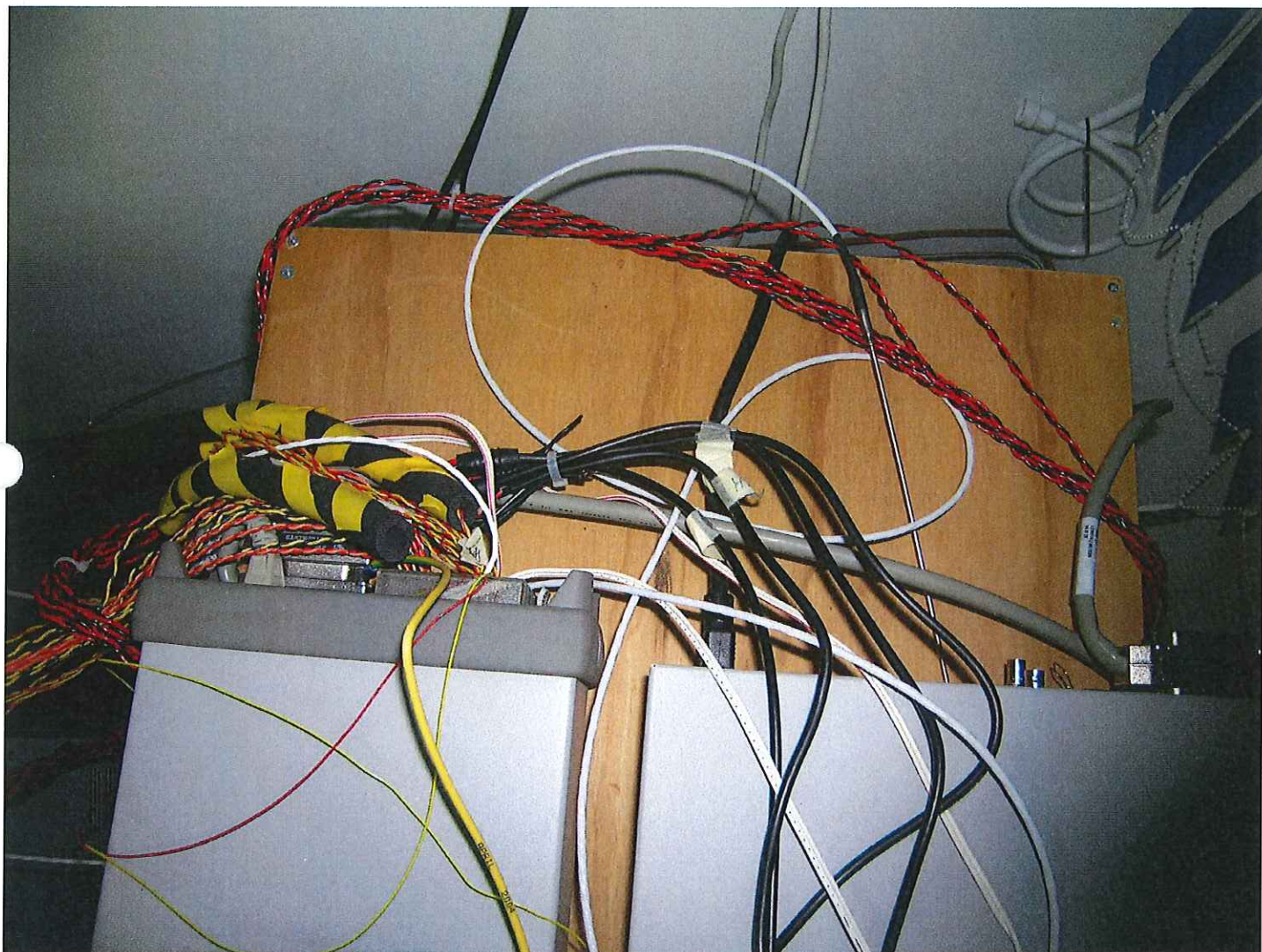


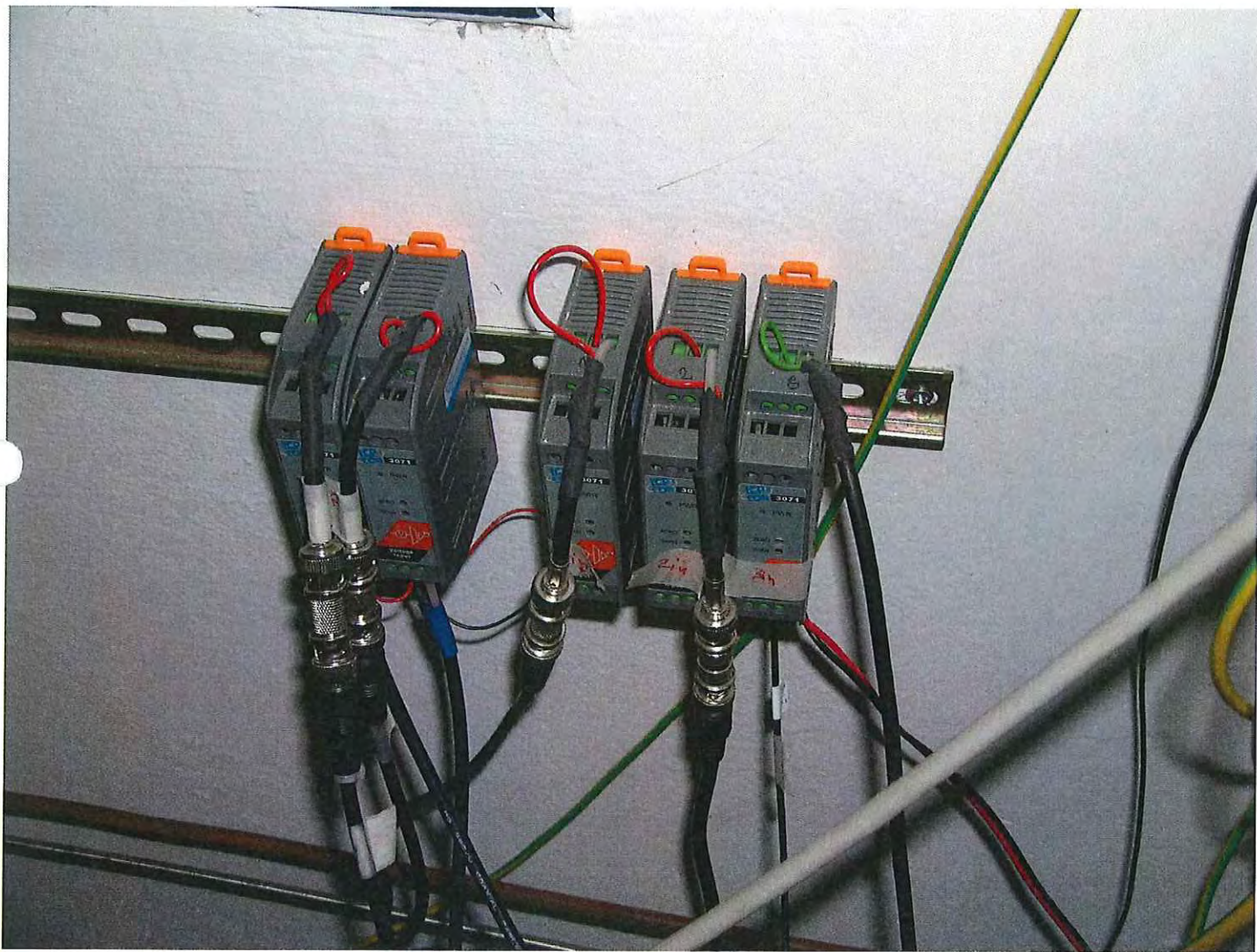




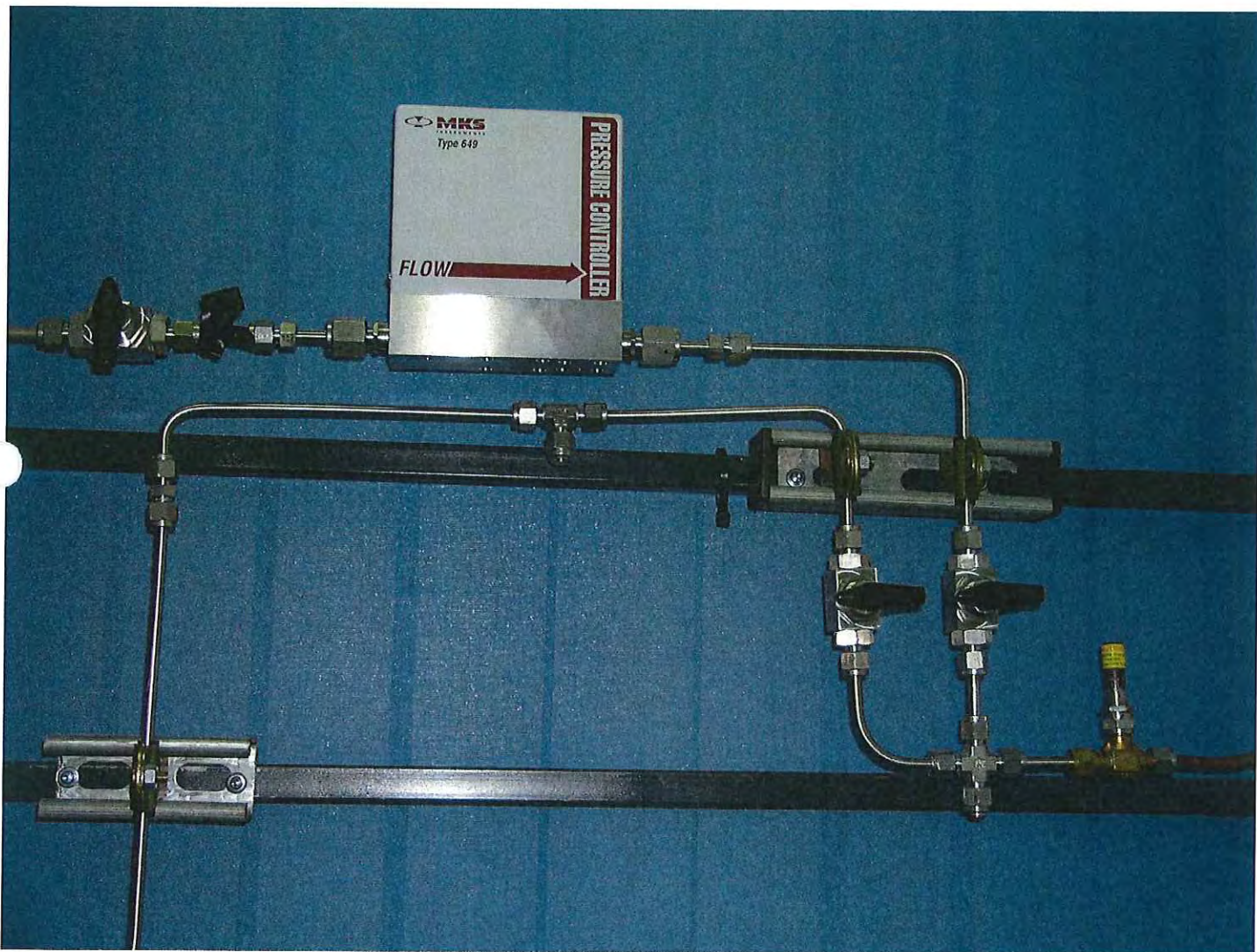












Attachment F

Ultra Sound Procedure

Ultra Sound Cells

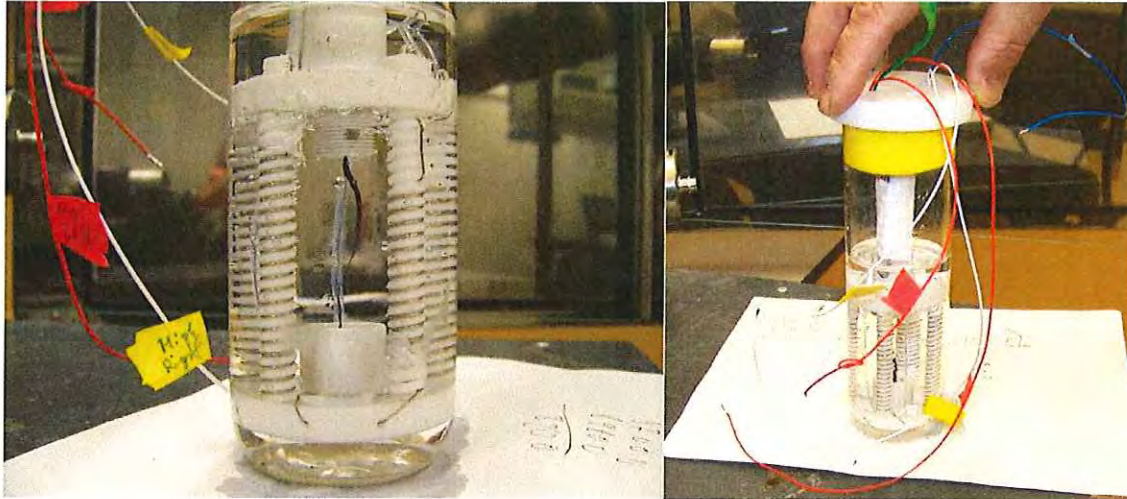
01 Procedure for US lab cells

Guide for US lab cells

B. Khachaturov, JAN 2011

Electrolytic cells with Ultrasonic excitation had the intention to change the surface of cathode during loading of Pd by deuterium. Each US cell consists three main subsystems:

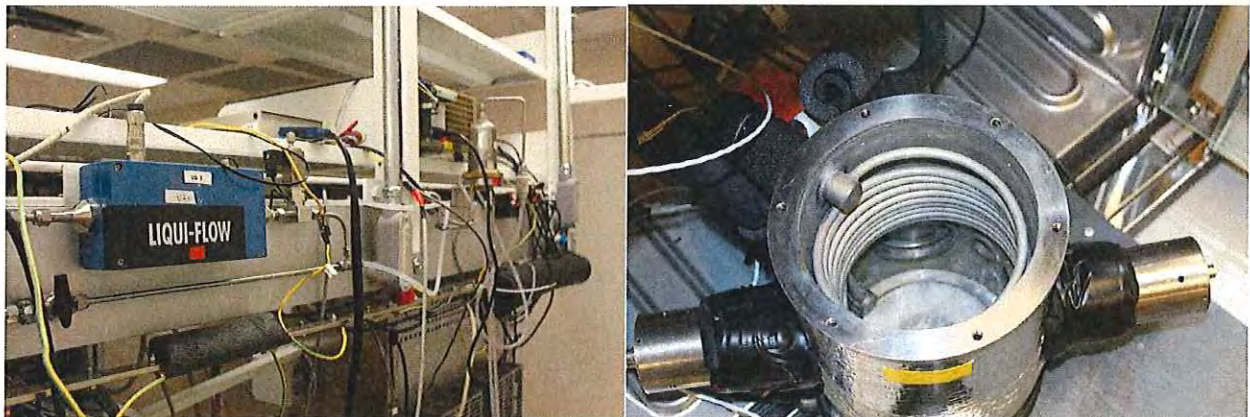
- Electrolytic cell:



- Ultrasonic: transducer(s) and generator:



- Water Flow calorimeter for measuring P_{out} and in the same time for cooling down US cell.

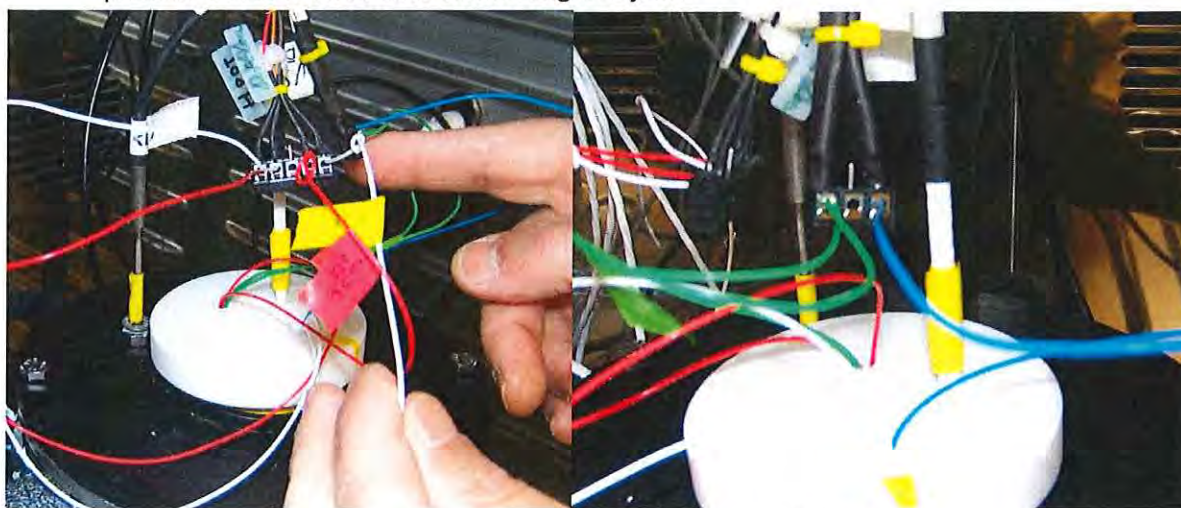


At the present moment all 4 US cells are working at the normal mode. Below are shown set points for parameters of each set-up:

	US1	US2	US3	US4
T incubator [°C]	9	9	8	9
T cooling bath [°C]	8	8	6.2	8
Water flow m [g/min]	21.55	21.55	24.8	21.9
US frequency [KHz]	15	40	32	32
Power US max [W]	10-12	10-12	25	25

The temperatures sensors RTD have calibrated same as water flow meters for all cells.

1. Electrolytic cell for each cell is preparing in the chemistry lab and I getting it as it shown in picture. Leads from cell are connecting to 2 joint:



Left is for R measurement leads, right one for current introducing in to the cell.

- **DO NOT FORGET TO INSERT RTD for measurement of the electrolyte temperature T_{el} !** When the leads connected and RTD have inserted, carefully put the cell in to US container;
- Then insert the RTD for temperature of jacket measurement T_{jacket} ;
- Next step: adjust the US container at the center of magnetic stirrer and move set up in to incubator carefully;
- Check if all 4 cables connected to US transducers

Now set up is ready to use:

- Close the incubator doors and turn on it;
- Check the water flow [behind the incubator]: open valves and switch on power supply for flow meter if it is necessary.

Check set point of temperatures in the incubator and cooling bath.

Start test RUN for the cell with new cathode

Before you'll start it you have to change several parameters in the file **DAQn.txt**

[Calibration Constants]

- **R0** 75.170 the cathode resistance, mOhm
- **P0** -0.720 the constant for tuning zero level of P_x [mW]

[General]

- **Data Directory Name** d:\USNY-0m where **USN** – the number of cell; **-0m** – the serial number of the cathode for given cell n; Y or R – color mark for given cell [Yellow or Red]
- **Cell Name** USN[Y or R]-0M

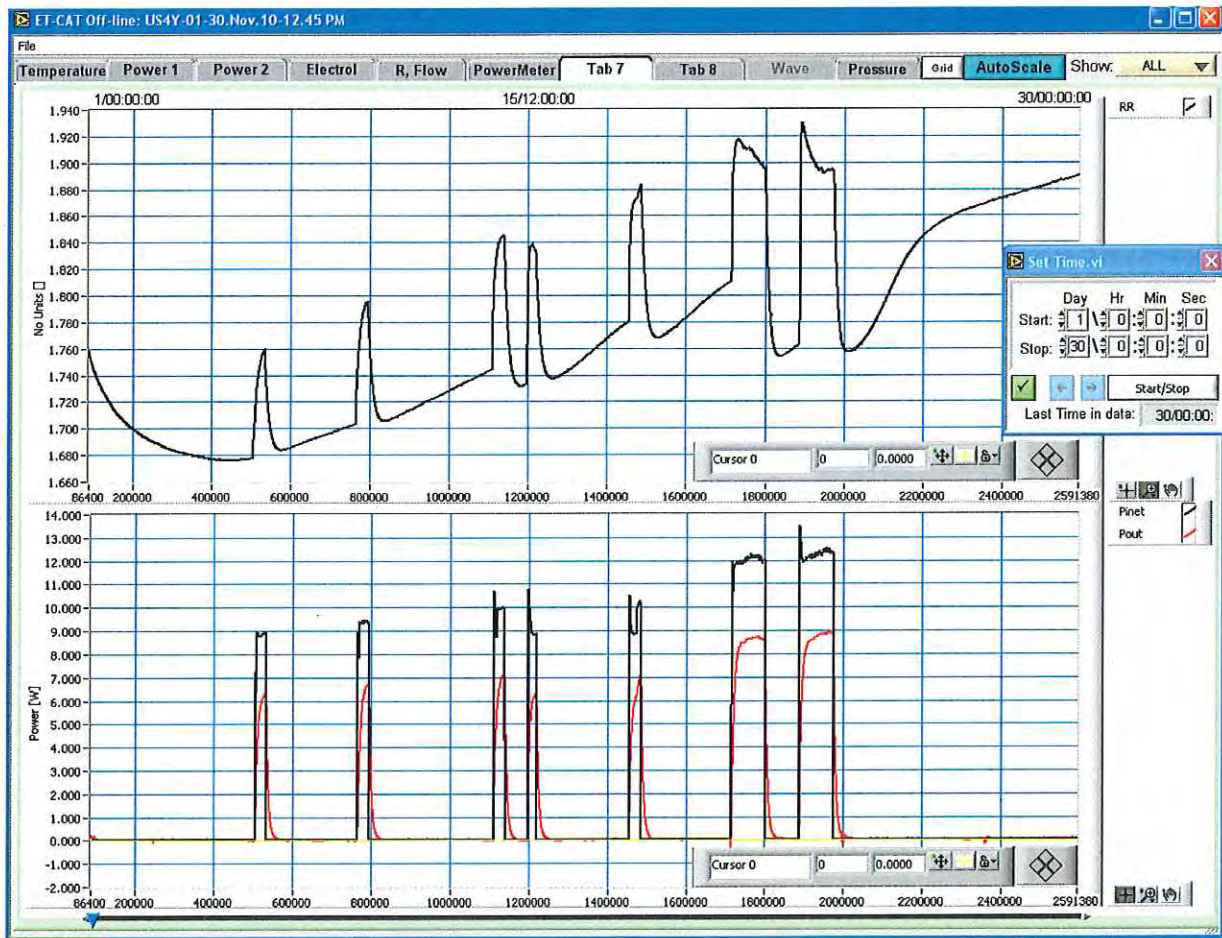
For TEST RUNs I am using Cell Name **USN[Y/R]-0M-test**. **P0** constant you have to change **after** test RUN to equalize $P_x = 0$ value, if average P_x occurs nonzero after temperature stabilization.

Save the DAQ file and now you are ready to start test RUN [without current] for precise definition of R0 and P0 constants.

Usually it takes 10-15 hours for thermal stabilization of the cell.

Start physical RUN

- In the file **DAQn.txt** set proper constants R0 and P0, change cell name to **USN[Y/R]-0M**, where N is cell number, M is cathode number for cell N;
- Turn on US generator and KEPKO. Both WITHOUT output into the cell;
- Start DAQ and continue 6-8 hours without current: this interval you can use for future reference **Pout** when input power **Pin** = 0;
- After this data taken, start current (SW) with average **I=[10-12] mA**;
- **Timing for deloading** of the cathode is the same as for ET cells. Usually T.Z. did it. During deloading of the cathode new **R0 = Rmax/2** must be written into the DAQ file and after deloading procedure it is necessary restart DAQ RUN with new R0;
- Timing for US excitation and US power during the cavitation period you can see in the next picture [30 days period, US4Y cell].

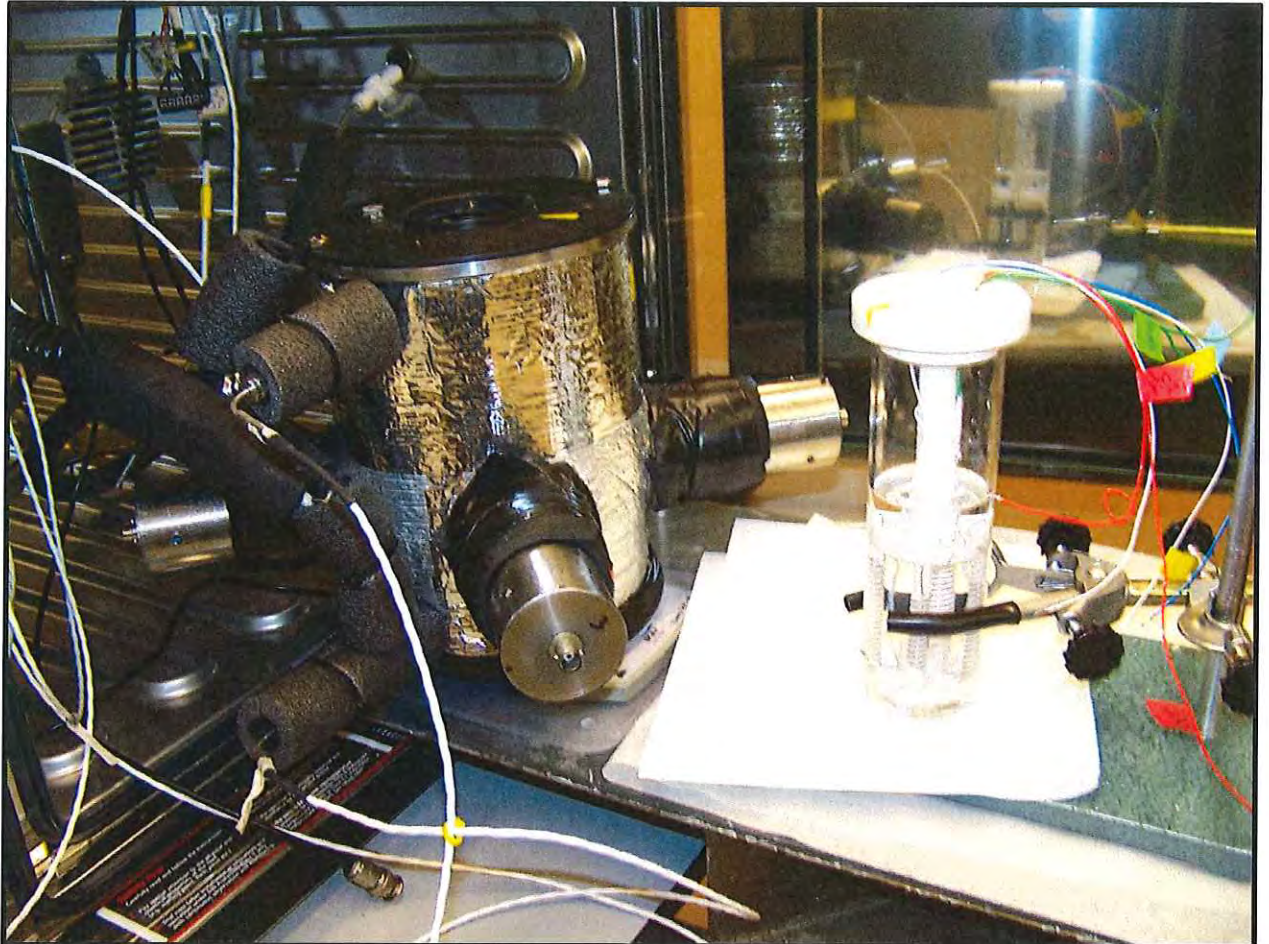


Typical behavior of all parameters for long term period you can find in the corresponding DAQ files the first RUNs in EnergeticsUSA [directories US1Y-01; US2R-01; US3R-01; US4Y-01].

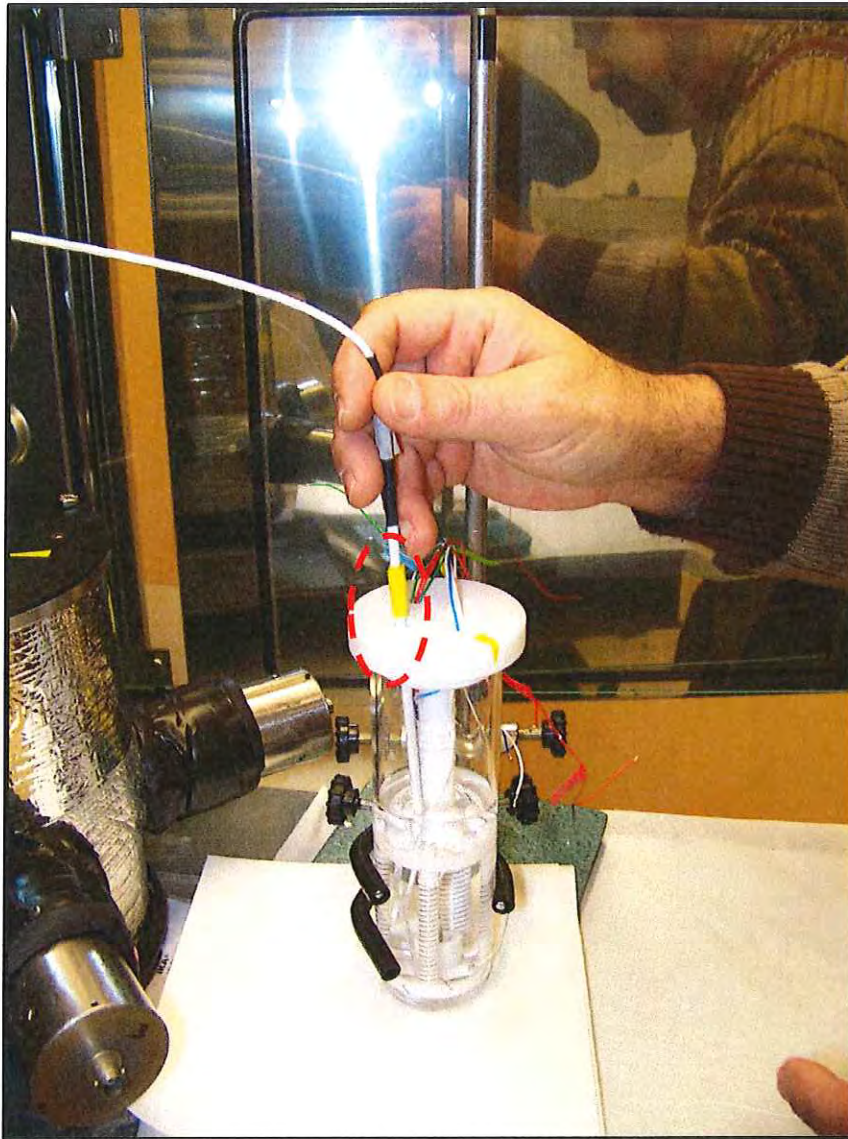
US electrolysis cell running
(on behalf of Boris, 12 January 2011)

Cell is out of Incubator

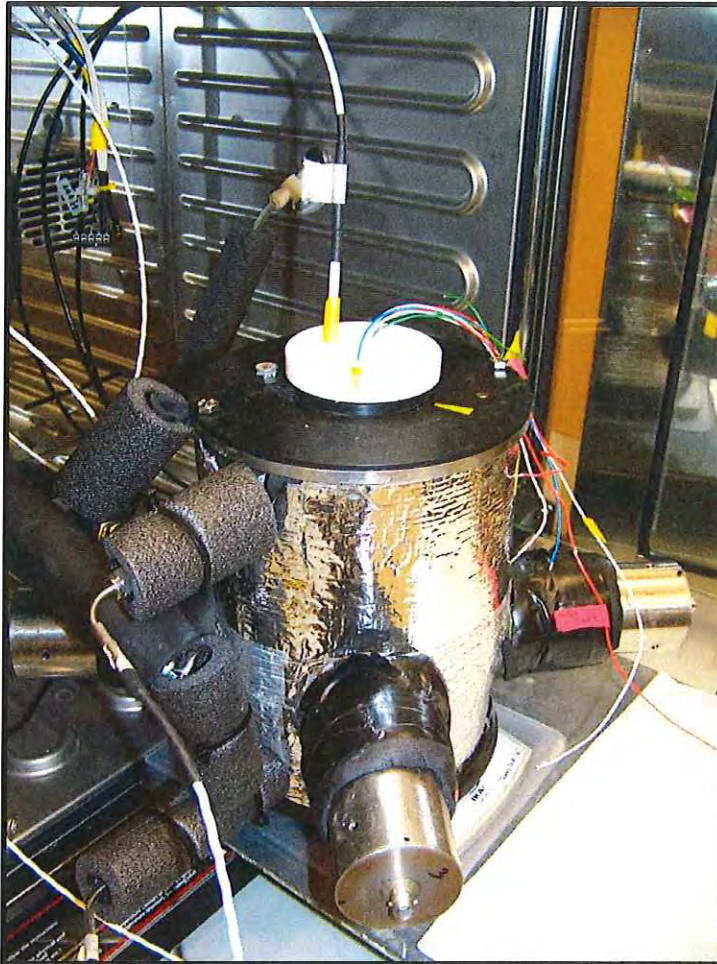
1. Place a cell body on a stirrer. The stirrer is ON all the time and in a correct cell position there are continuous water stirring with an agitator rotating in the bottom center.
2. Place lab support catching a glass insert with assembled electrodes near to the cell body.



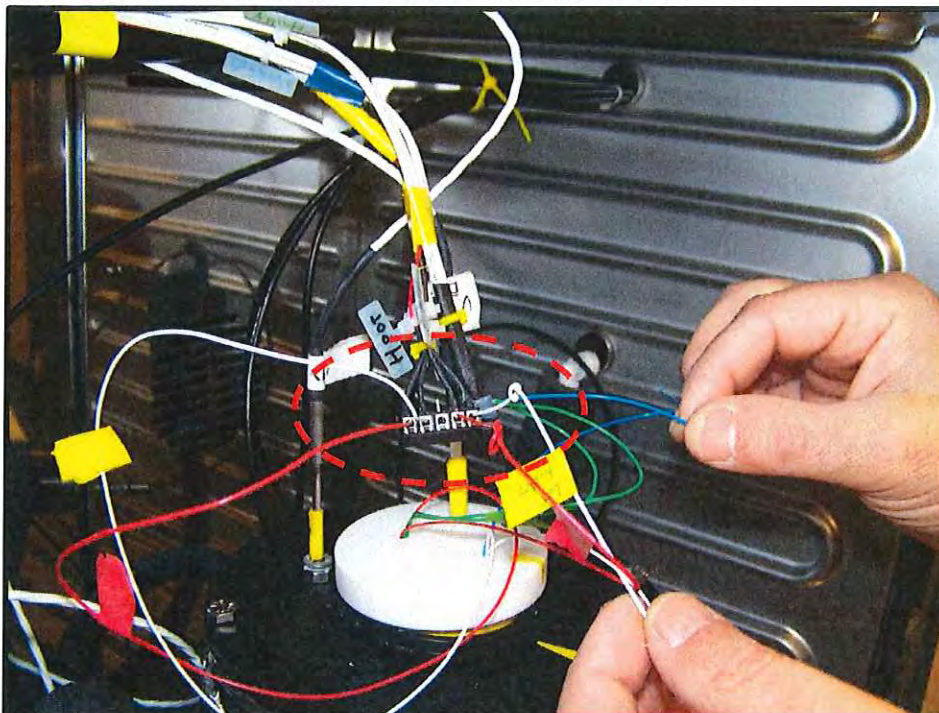
3. Insert RTD100 (plastic) for US electrolyte temperature measurement into the glass.



4. Take the glass and carefully place it into the cell tightly.



5. Connect wires to LCR and power (anode and cathode) contacts.



6. Check Resistance value by DAQ program.
7. Connect US transducers to US generator cables.
8. Insert RTD100 (metallic) into a jacket.
9. Mark actual glass position relative to the body by color tape.



Cell is in the Incubator

1. Carefully push the assembling into the incubator.
2. Run Flow meter (power ON + tap).
3. Close and run the incubator.
4. Change a name of the experiment in a DAQx file.
5. Run data acquisition system for 12 hrs up to complete system thermo stabilization [steady state].

Cell running

1. Turn ON:

- incubator,
- flow meter,
- current generator (Kepco),
- US generator (power only, not START),
- data acquisition system.

Cathode US treatment is started when RR decreasing rate goes to be very low (0.001 per a day, approximately).

For 4 transducers generator (US3 and 4 cells) a cavitation starts at about **10W** power level.

After US treatment stopping and the cell thermal stabilization a deloading process must be performed. The deloading current parameters: from -2 to -3 mA amplitude for 3-6 hrs. The resistance maximal value R_{max} is registered and new R_0 value is calculated by a formula:

$$R_0 = R_{max} / 2.$$

This R_0 value must be written down to a relevant DAQ file. The data acquisition system must be restarted.

Cell disassembling (1 & 2)

2. Turn OFF:
 - current generator (Kepco),
 - US generator,
 - data acquisition system,
 - incubator,
 - flow meter.
3. Open the incubator.
4. Remove upper plastic thermo isolation plates.
5. Disassemble RTD100 from a jacket.
6. Disassemble all wiring to the cell (cathode, anode and LCR's 4 wires).
7. Disassemble RTD100 from the cell.
8. Take a glass with electrolytic cell out of the jacket.
9. Check a distilled water level in the jacket. If the level is low it shows water leakage. In this case an US transducer must be carefully disassembled from a plastic body and all construction (transducer + plastic pot) must be reassembled with silicon glue.

Maintenances

US generator testing

1. Power **ON**.
2. Shift the generator state to MANUAL (where it's relevant).
3. Minimize the power level down to **ZERO**.
4. Push **START**.
5. Check values of US power, frequency and power factor measured by Yokogawa power meter and LabVIEW program.
6. Push START button again to **stop** generation.

Air bubbles evacuation

1. Open a tap on the output of an air trap.



2. Open very easy a by-pass tap.
3. Wait up to complete air evacuation from the trap.
4. Close both traps (first- by-pass; second – air tap).

02 US electrolysis cell running
Jan 2011

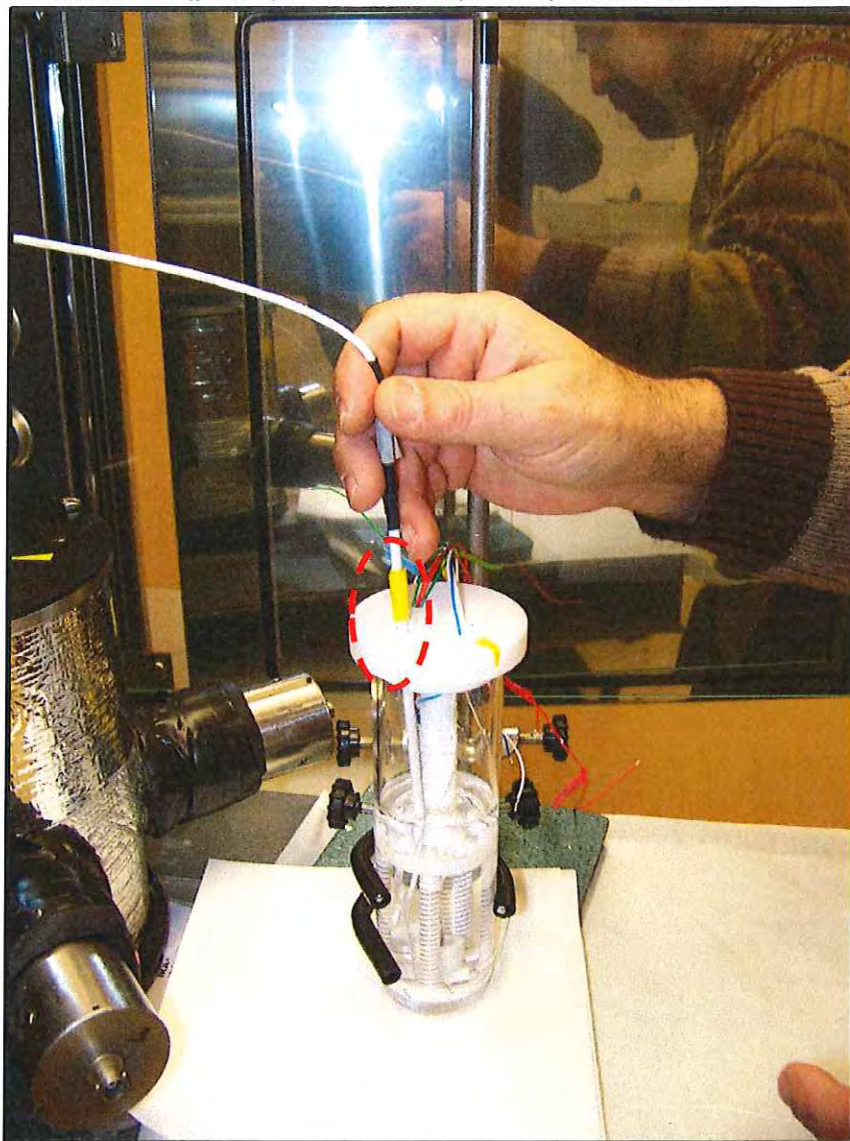
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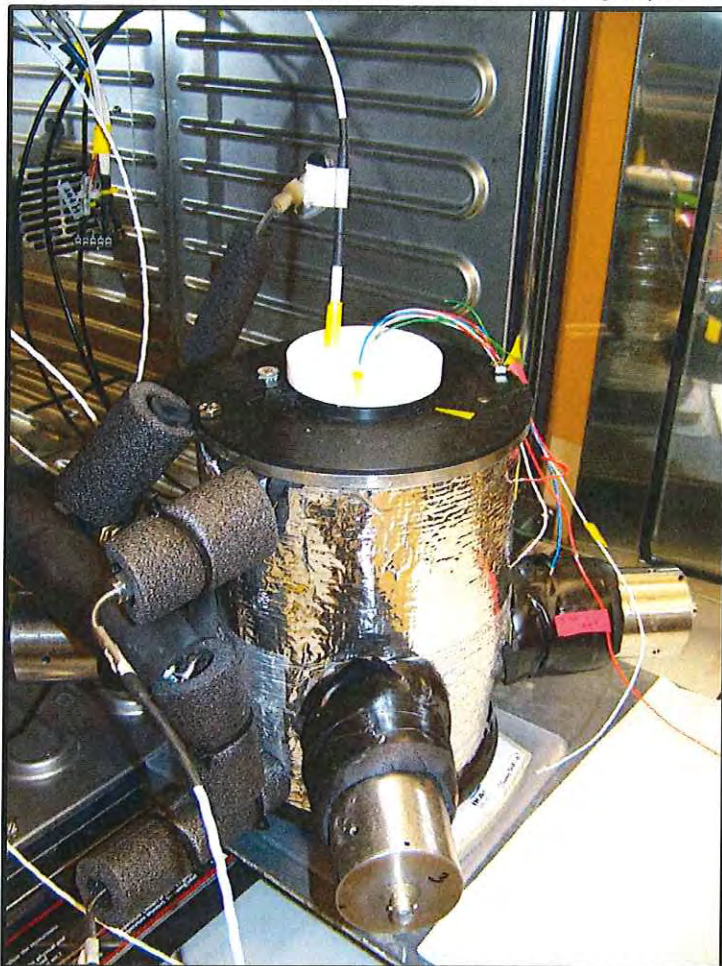
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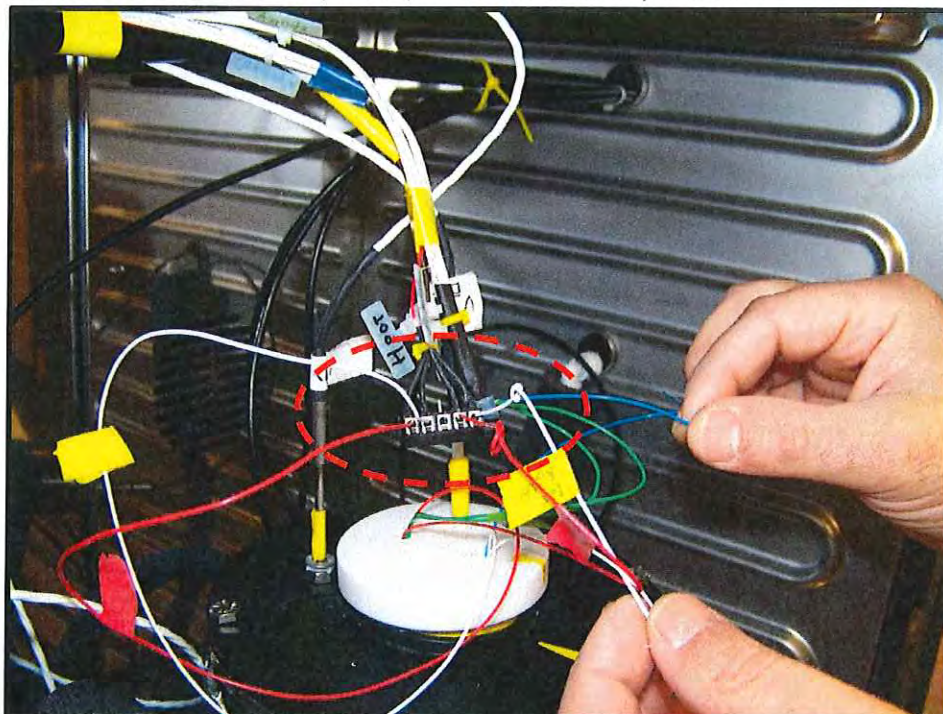
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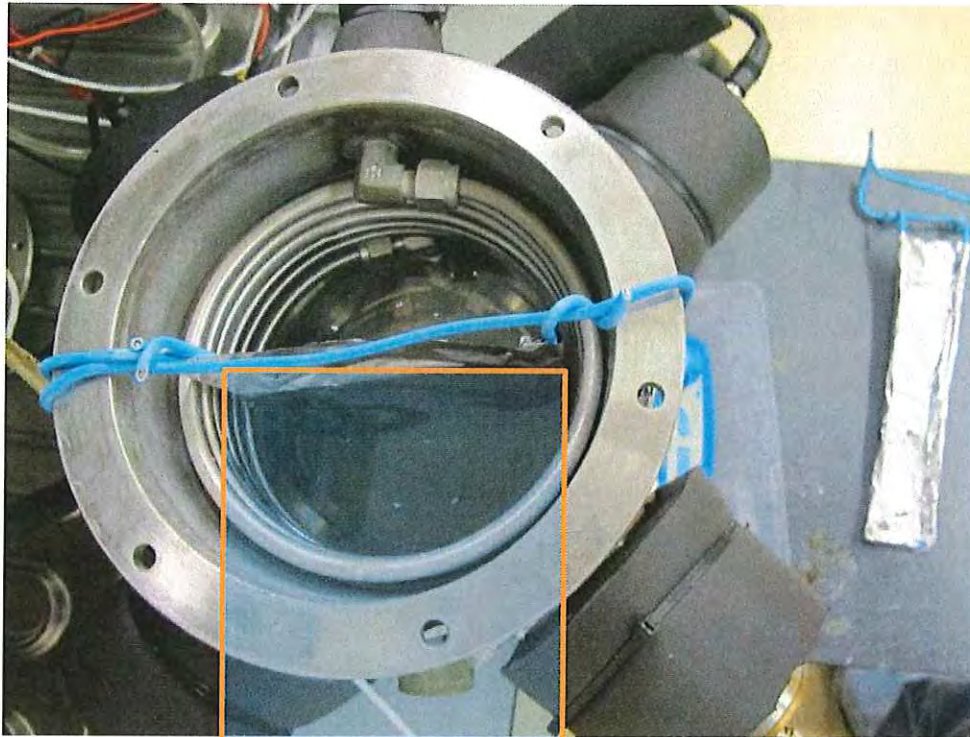
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D3 Cavitation Distribution Evaluation

US 3 cell with Tubular transducers

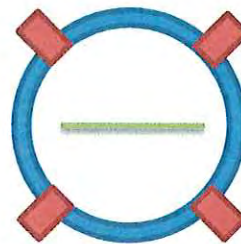
Cavitation field evaluation (performed from 11/11/11 to 12/7/11)

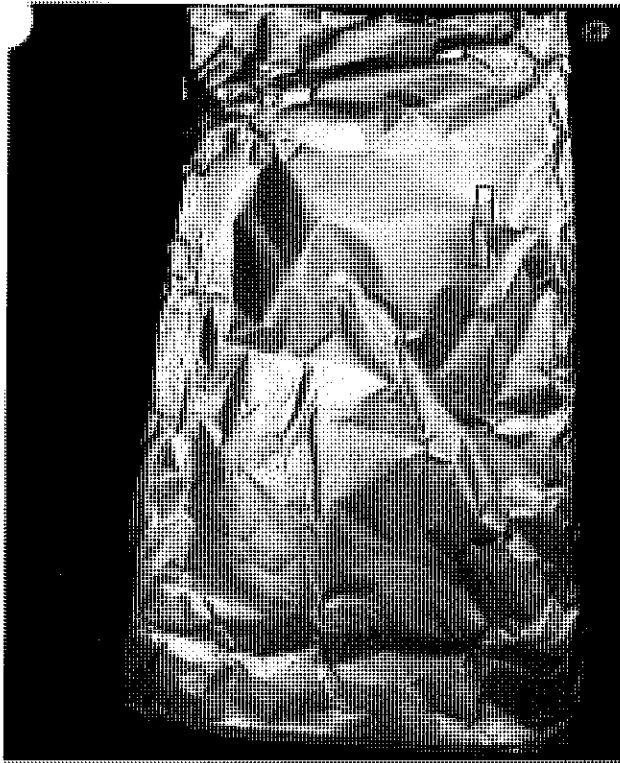
Foil position



Power ~10W

Foil
11×20.5 cm





Sonication: 11 minutes



26 minutes

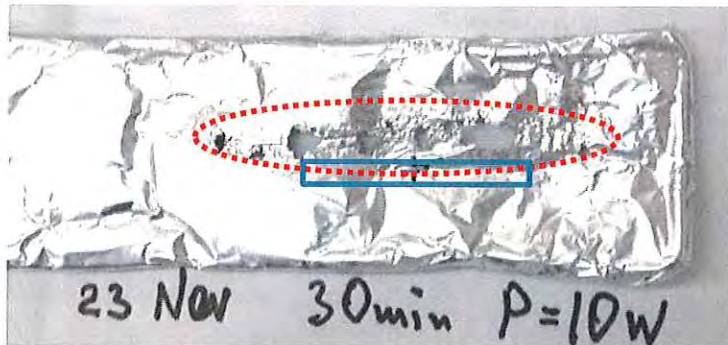


55 minutes

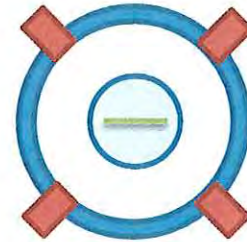


90 minutes

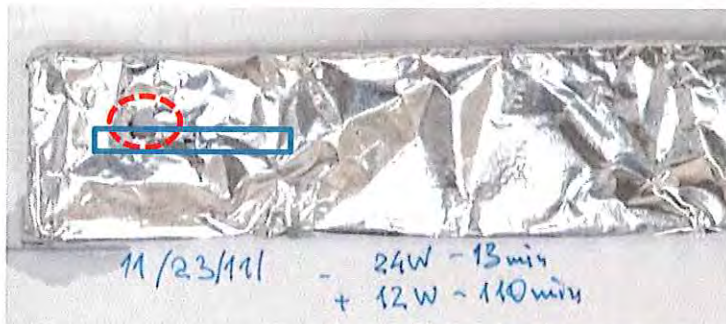
Cavitation test in a beaker with 4 transducers working (3 tests at the same conditions)



10W, 30 kHz, 30 min - Intensive erosion

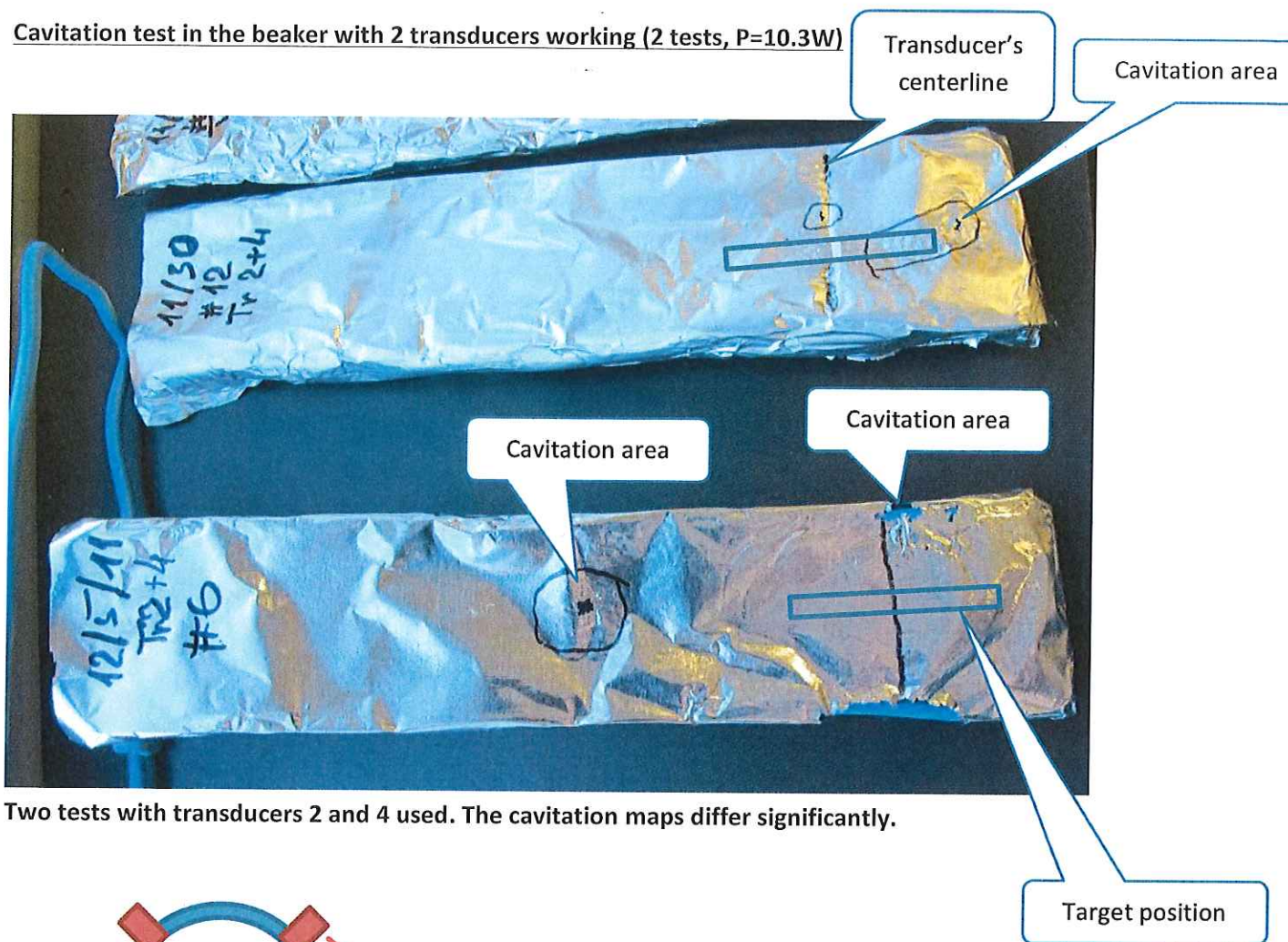


10W, 30 kHz, 40 min – weak erosion

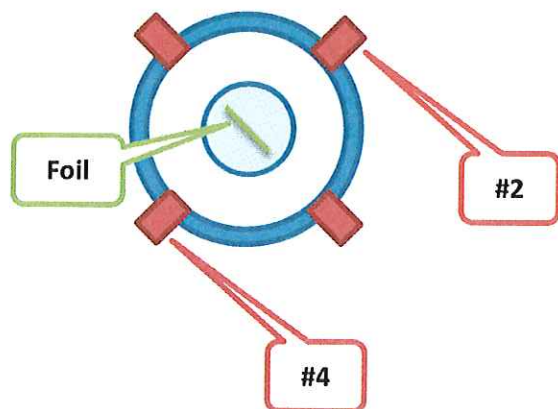


12W for 110 min (no erosion) and 24W for 13 min –one hole

Cavitation test in the beaker with 2 transducers working (2 tests, $P=10.3W$)



Two tests with transducers 2 and 4 used. The cavitation maps differ significantly.



CONCLUSION

Ultrasound generator is extremely unstable. The cavitation map configuration is unpredictable.