Обзор *некоторых* докладов на международной конференции ICCF26

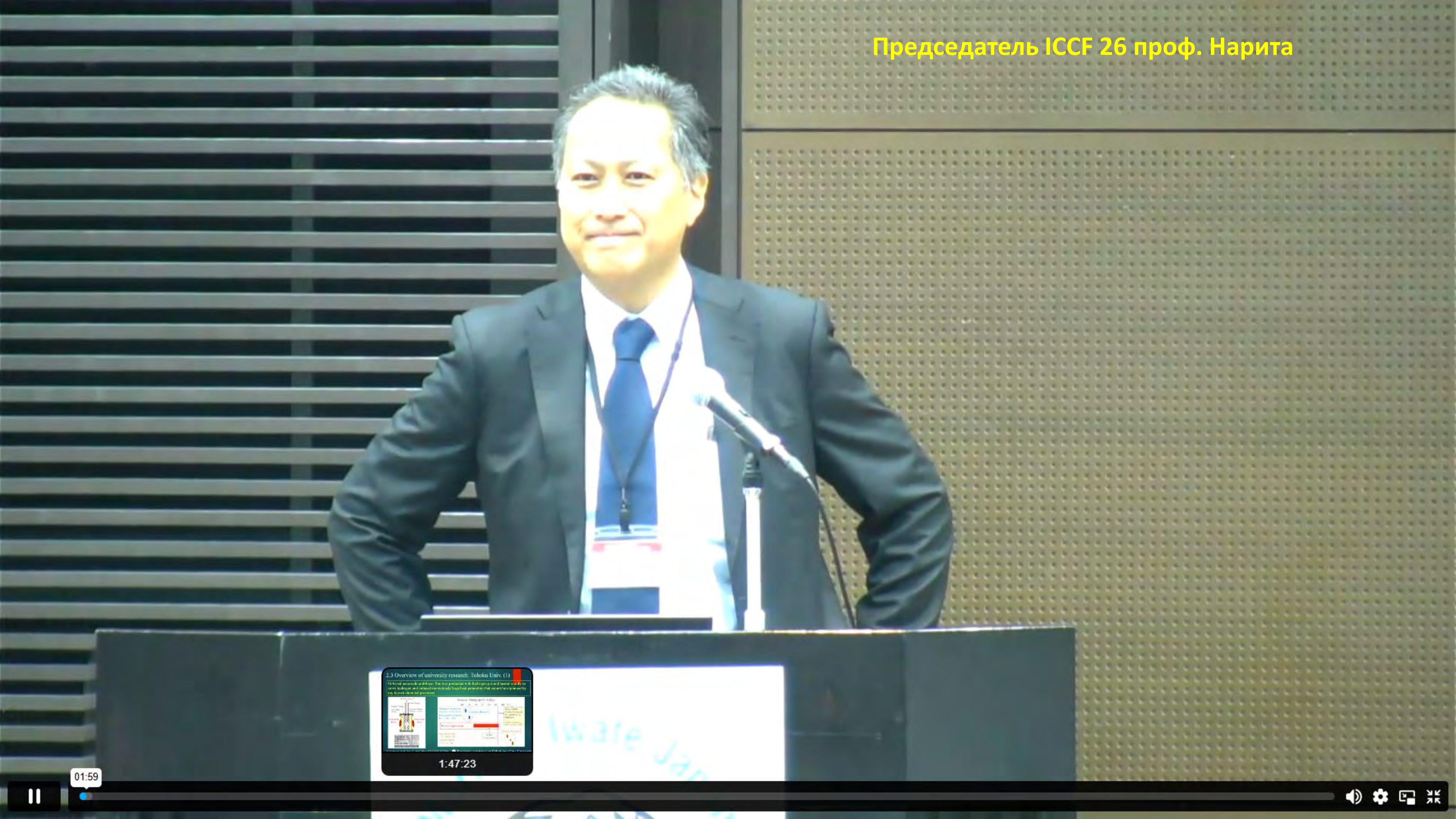
Часть 2.

Традиционная LENR физика и взгляд со стороны плазменной аэродинамики…..

Group Photo @ 4F / Aiina , 2025.5.26(mon)

Photo by Satomi Fujisaki (LOC /Iwate-Univ.)

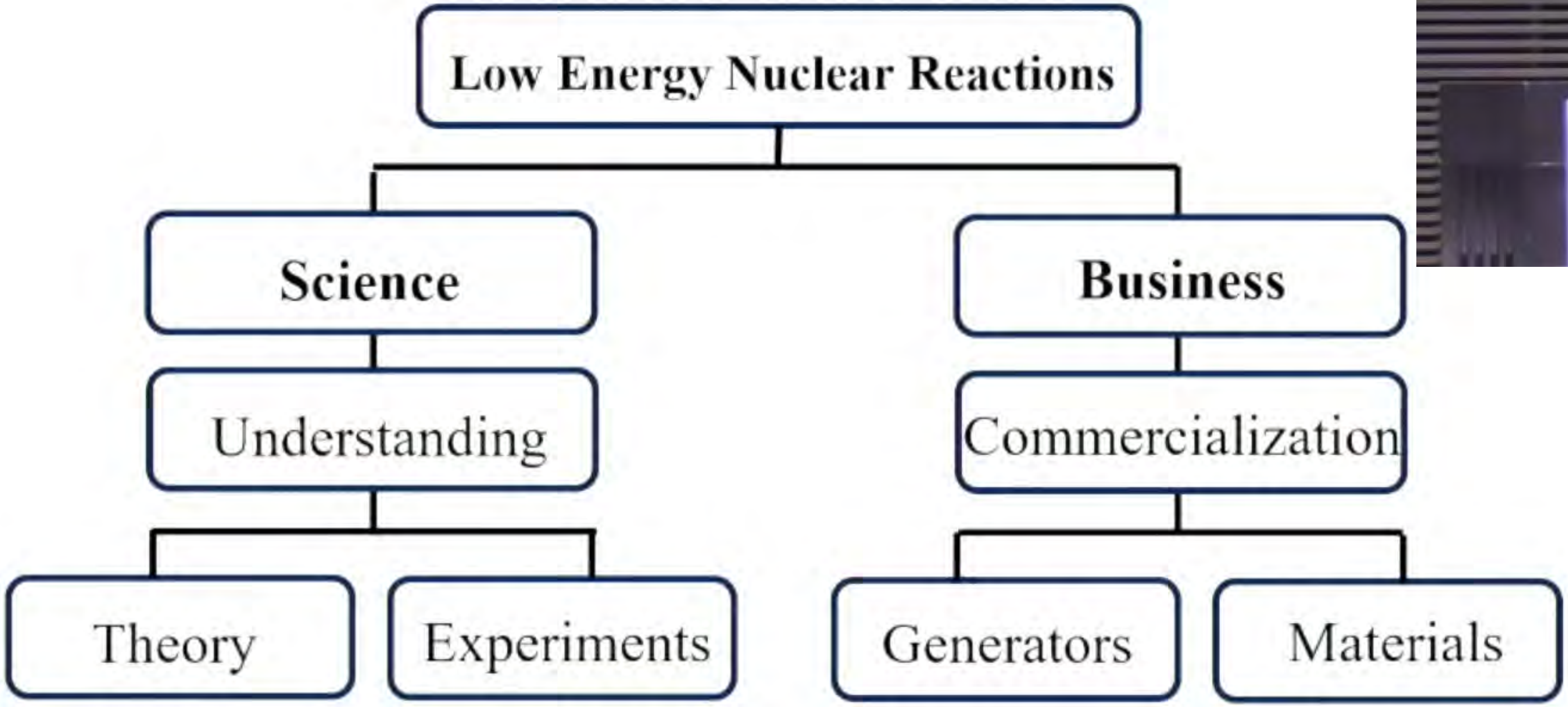

M O R I O K A
00:10


Председатель ICCF 26 проф. Нарита
2.3 Overview of university research: Tohoku Univ. (1)
1:47:23
01:59

Обзор исследований в области LENR в США. Проф. Д. Нагель

Overview of LENR in the United States

David J. Nagel
George Washington University
nagel@gwu.edu



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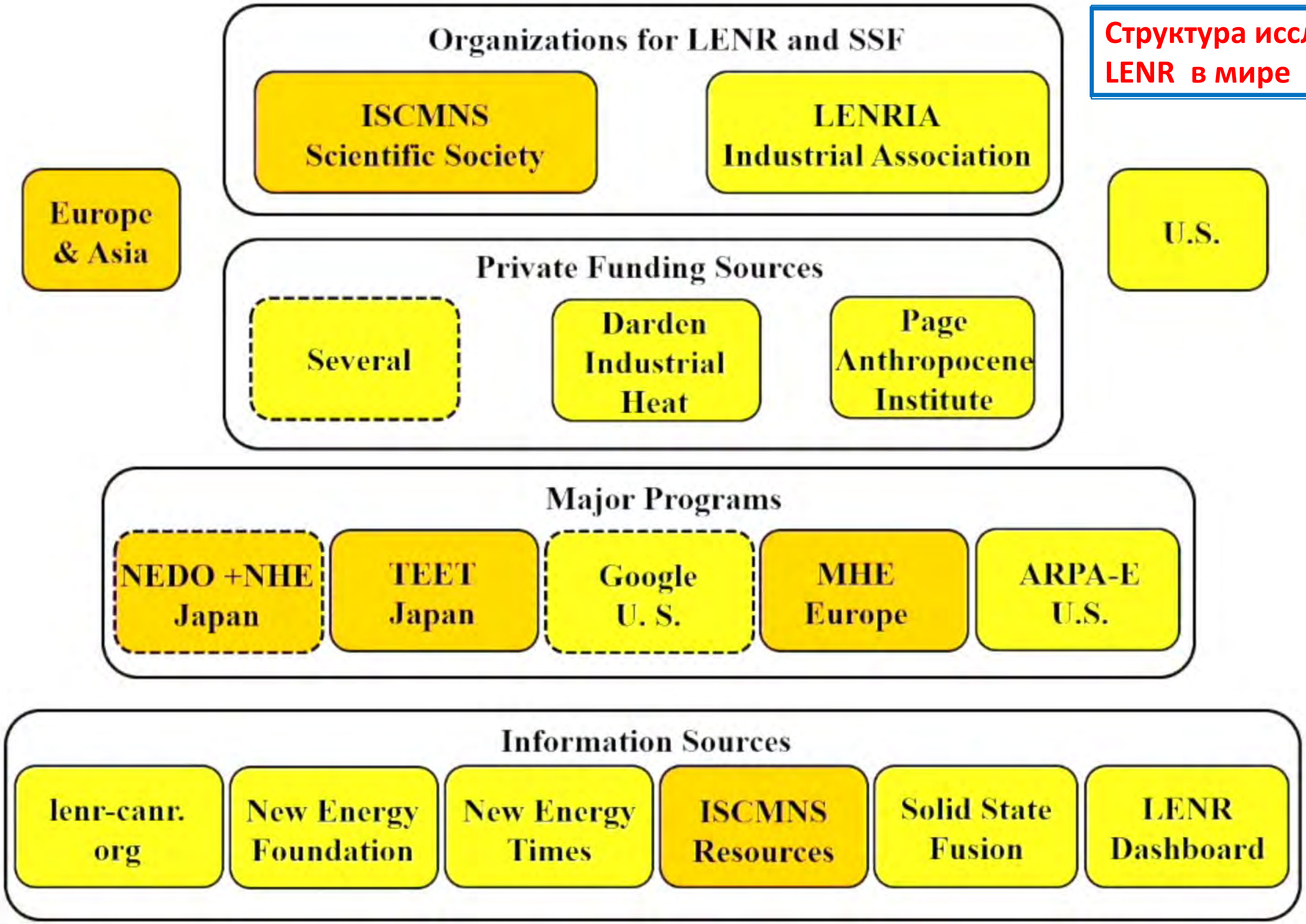
Структура исследований LENR в мире



Список призеров
в конкурсе Проектов
по LENR в рамках
Программы
ARPA- E

LENR Research in the United States

Florian Metzler MIT (2024)

https://www.youtube.com/watch?v=dpGy60aVsNE

ARPA-E LENR Program

U.S. Department of Energy Announced $10 Million in Funding to Projects Studying Low-Energy Nuclear Reactions.

17 February 2023

Energetics Technology Center	Pd-D Co-Deposition onto Coated Radiation Detectors
MIT	Radiation Measurements from Gas-Loaded Metal-Hydrogen Systems.
Stanford University	Radiation Measurements from LENR-Active Nanoparticles & D_2 Gas
University of Michigan	D_2 Cycled through a Chamber Filled with Palladium Nanocrystals
Amphionic LLC	Development of Nano-Materials for LENR
Lawrence Berkeley Nat'l. Lab.	Nucl. Radiation Measurements from Energetic Beams onto Deuterides
Texas Tech University	Advanced Materials Fabrication, Characterization, and Analysis
University of Michigan	Neutron, Gamma, and Ion Emissions from LENR Experiments

https://arpa-e.energy.gov/sites/default/files/2025-01/Project%20Descriptions_LENR.pdf

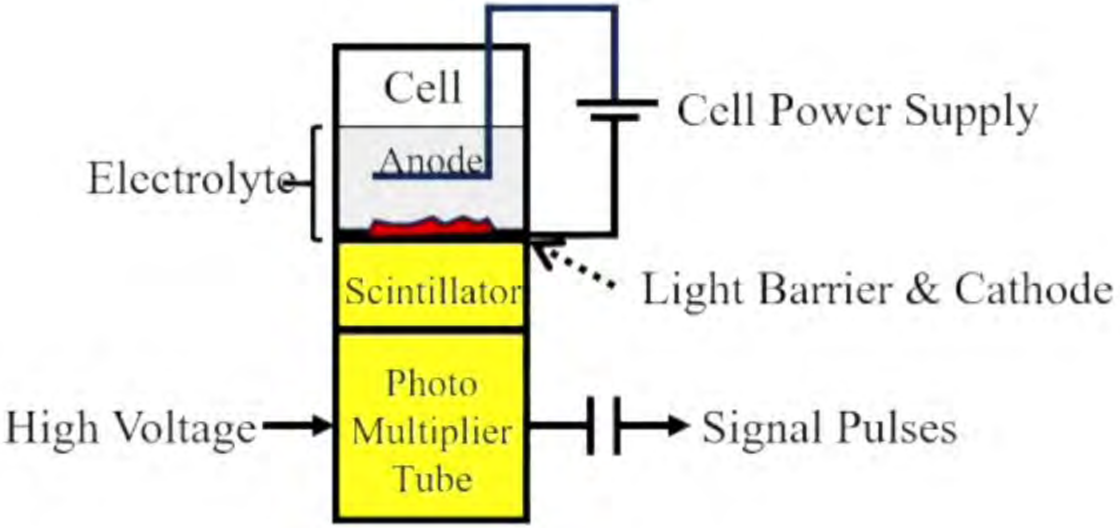
16:08

CATHODE (CATHode scintillat Or Detector for Electrochemistry)

Energetics Technology Center ($1,500,000)

Naval Research Laboratory (Sub-Contractor)

Energetics Technology Center will build upon past successes with **co-deposition experiments** using palladium, lithium, and heavy water together to create an environment in which LENR can occur. **These electrolysis experiments decrease the distance from the cathode (location of LENR) to an electronic detector** capable of detecting nuclear reaction products **to give these experiments the best chance at reliably detecting nuclear reactions**, if they are present.



Systematic Evaluation of Claims of Excess Heat Generation from Deuteration of Palladium-Nickel Nanocomposites

University of Michigan ($1,108,412)

The University of Michigan proposes to systematically evaluate claims of excess heat generation during deuteration and correlate it to nuclear and chemical reaction products. The team plans to **combine scintillation-based neutron and gamma ray detectors, mass spectrometers, a calorimeter capable of performing microwatt-resolution measurements of heat generation, and *ab-initio* computational approaches.** The proposed research will experimentally and theoretically explore the origin and mechanisms of excess heat generation and LENR.

Nanostructured Pd-Anf Composites for Controlled LENR Exploitation

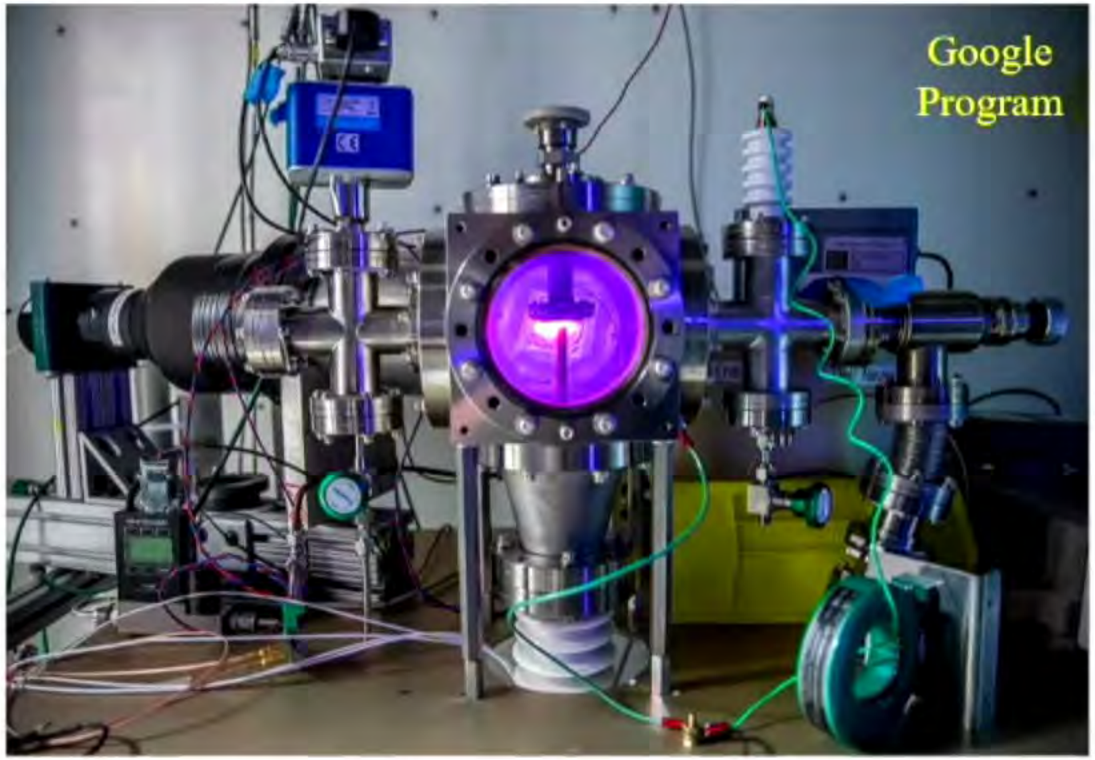
Amphionic LLC ($295,924)

Cathode structure and surface morphology are thought to be essential for LENR reaction rate. Amphionic proposes to **optimize cathode design to form Pd-polymeric composites within which the Pd nanoparticle size and shape are varied, and the interfacial separation and geometry are controlled**. Experiments will focus on exploring if LENR are produced in potential wells existing between two nanoscale surfaces by controlling metal nanoparticle geometry, separation, composition, and deuterium loading.

Quantifying Nuclear Reactions in Metal Hydrides at Low Energies

Lawrence Berkeley National Laboratory ($1,500,000)
University of California Davis

LBNL team proposes to probe for LENR at **external excitation energies below 500 eV**, systematically varying materials and conditions while monitoring nuclear event rates with a **suite of diagnostics**. The team will draw from knowledge based on previous work using higher energy ion beams as an external excitation source for LENR on **metal hydrides electrochemically loaded with deuterium.**



Electrochemical loading and low-energy beam excitation.

Supporting Projects

Advanced Materials Characterization & Nuclear Product Detection for LENR

Texas Tech University ($1,150,000)

Texas Tech University will **develop accurate materials fabrication, characterization, and analysis** to attempt to resolve the physical understanding of Low-Energy Nuclear Reactions (LENR). Texas Tech will also provide **advanced detection of nuclear reaction products** as a resource for ARPA-E LENR Exploratory Topic teams

Ionizing Radiation Detection for Exploratory Experiments in Low-Energy Nuclear Reactions

University of Michigan ($902,213)

University of Michigan will provide capability to **measure hypothetical neutron, gamma, and ion emissions from LENR experiments.** Modern instrumentation will be coupled with best practices in data acquisition, analysis, and understanding of backgrounds to interpret collected data and evaluate the proposed signal.

LENR Companies

Clean Planet
Japan

ENG8
Portugal

HYLENR
India

Thailand

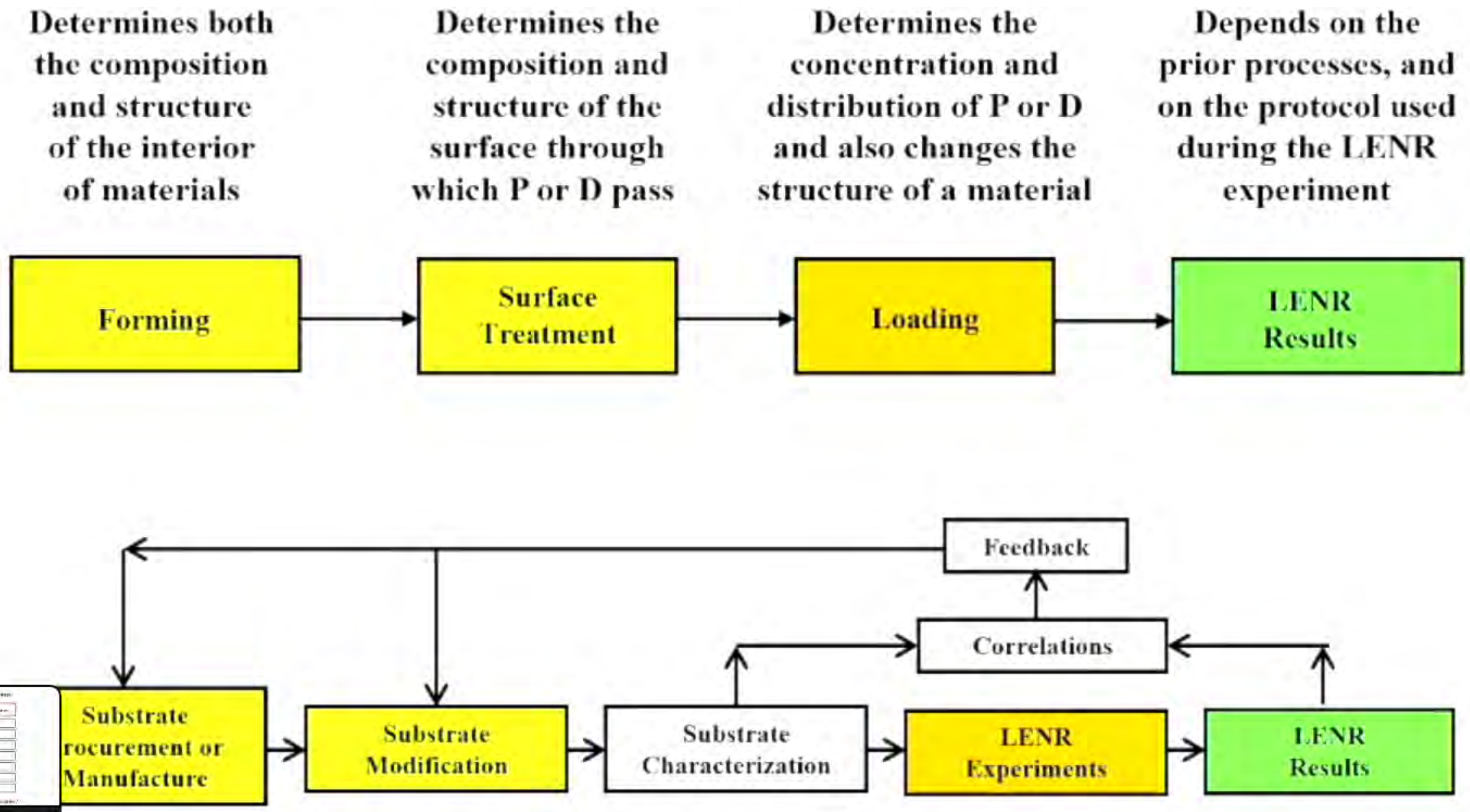
Israel

?????

Brillouin Energy
USA

Leonardo
Corporation
USA

LENR Materials Research



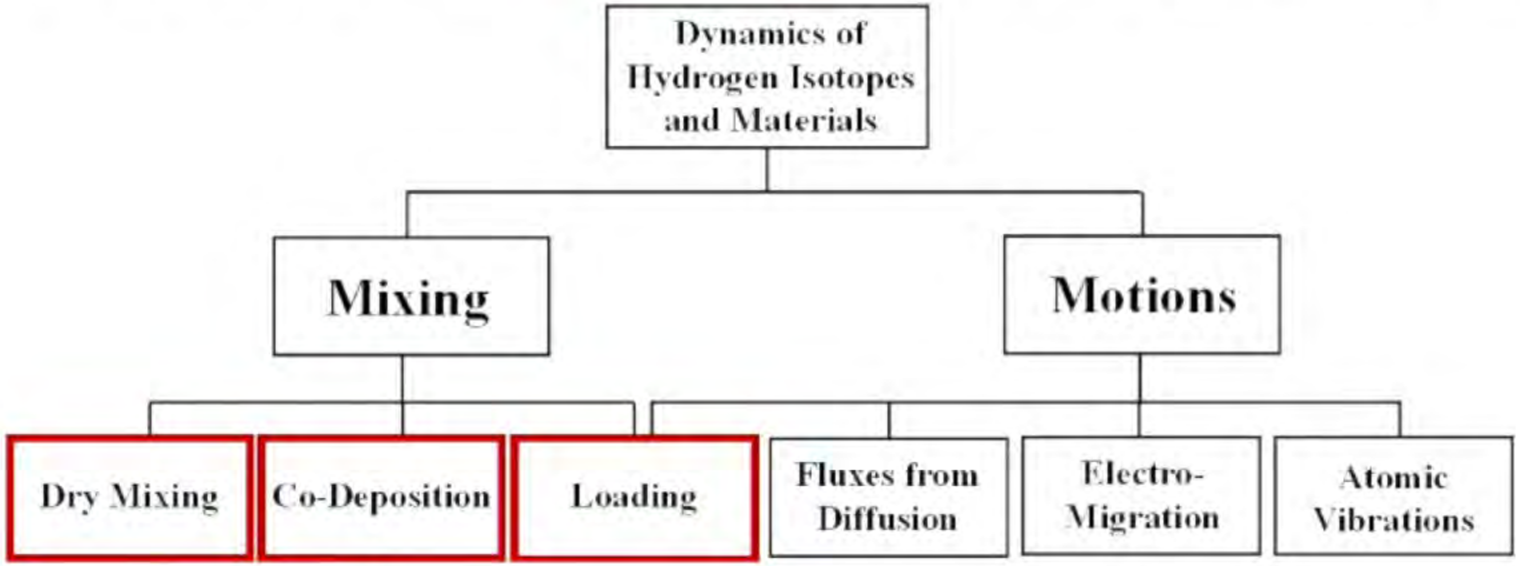
Production of LENR Materials

Materials for LENR experiments have been obtained in three ways:

In one, some materials are procured and possibly modified prior to **loading** of protons or deuterons into them.

In the second method, called **co-deposition**, the materials and hydrogen isotopes are simultaneously electrochemically deposited on a substrate.

The third method involves **dry mixing** of the materials prior to operation.



Diffusion is good (protons and deuterons) and maybe bad (metal atoms).

Testing of Materials for LENR

The most important property of materials
for production of LENR energy
is their ability to produce **output power at high levels**.
The second most important property is their **durability**.

These properties can only be determined by testing the materials
in experiments with suitable excitation.

**Three methods of loading and excitation
have been found to produce LENR:
electrochemical cells, hot gas, or plasmas.**

The materials produced in this program
will be tested with each of these approaches.

THE LENR OUTLIERS

There are at least 6 companies globally working on different aspects of plasma fusion (or in one case Mizuno-fusion) that are currently claiming to have, are approaching or seeking commercial partners –these include:-

HYLENR

BIACO

FUTURE ON

ENG8

?

META-TRON

All propose small, modular energy sources good for off-grid use .
Emphasising decentralisation, zero-CO2 and energy supply security.

Alan Smit

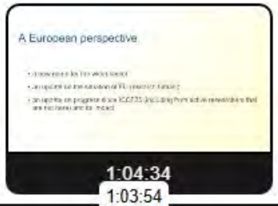
Обзор основных достижений в LENR физике. Взгляд со стороны Президента IWAHLM…

Conclusions

As we have seen, there is a resurgence of interest in commercialising various types of plasma-based LENR technologies. How many - if any -of these make it into Walmart is for the market to decide, but it clearly demonstrates that given a good idea and the right story there is finding available, both public and private. And funders love the word plasma, while many don't know what it is, they all know it's the fourth state of money.

THANKS FOR WATCHING.

PLEASE CONSIDER JOINING ISCMNS.org.
WE ARE STRONGER TOGETHER



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A New and Improved Understanding of Cold Fusion Based on the Observed Behavior

Edmund Storms
Santa Fe, NM

ICCF-26, May 26-30, 2025

Storms2@ix.netcom.com

A New and Improved Understanding of Cold Fusion Based on the Observed Behavior

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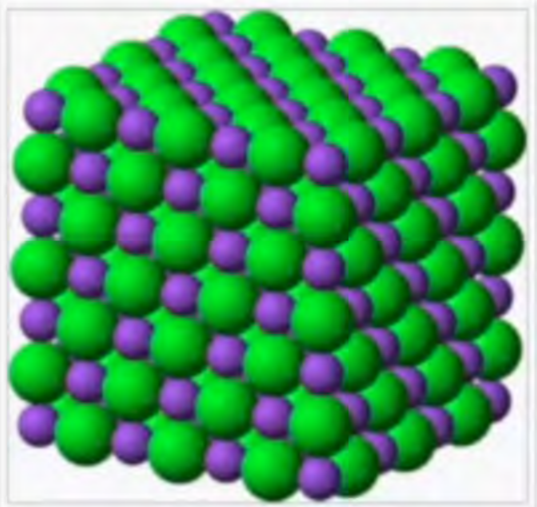
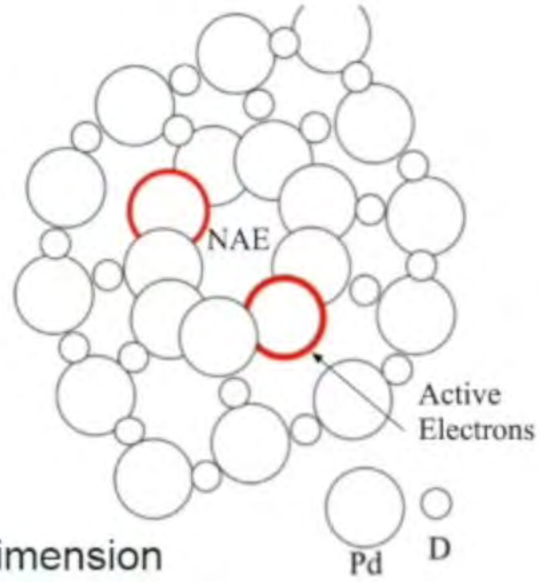
Storms2@ix.netcom.com

Atom Arrangement for the PdD Lattice and NAE





NAE is a three dimension physical void surrounded by electrons on all sides imbedded in the crystal structure.

Description of the NAE

1. The NAE consists of physical gaps or voids in the arrangement of atoms in a solid.
2. A critically small size in the nanometer range is required.
3. These flaws are independent of the crystallographic structure.
4. These gaps are not caused by or related to atom vacancies in the crystal structure.
5. These gaps can be created many different ways including by nano machining or nano etching.
6. The gap is required to change the rules that govern electron interactions so as to reduce the Coulomb barrier between the fuel nuclei **without affecting or conflicting with the chemical environment.**

Examples of How the NAE can be Created

Codeposit (CoD) of a metal (surface)
- Szpak: Slow electrolytic deposit of $PdCl_2$ + LiCl or HCl in D_2O

Sintering of small particles (bulk)
- Arata: Palladium black

Imbedded inert particles in Pd (bulk)
- Storms: Particles of CaO or SiO_2 < 36 micron

Creation of porous material (bulk)
- Takahashi: Oxidized Pd+Zr alloy
- Case: Charcoal + Pd particles
- Mizuno: Stress induced gaps In Ni
- Iman et al.: Stress induced gaps in Pd-B alloy

Accidental formation (surface)

Damage caused by gas discharge
Damage caused by super wave
Damage caused by extended electrolysis
Damage caused by ultra sound and cavitations

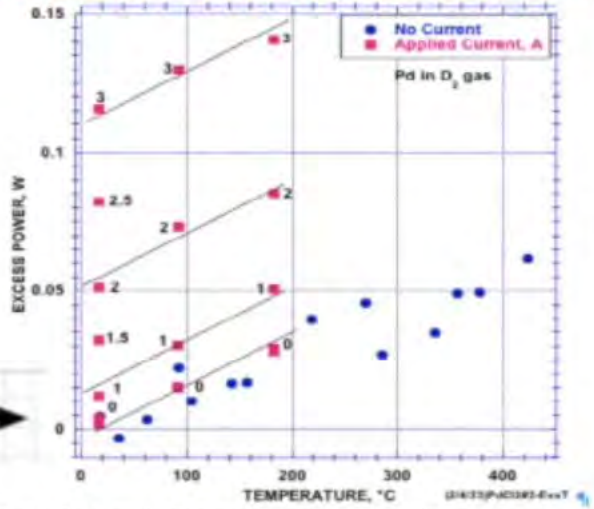
- Nano-machining (surface)

How can the Number of Fusions/sec be Increased?

1. Increased temperature (JCMNS, 36, 377, 2022)
2. Electromigration (Gorsky Effect) + magnetic field
3. Laser radiation
4. Concentration of fuel in the lattice (D/Pd ratio) when the concentration of NAE is large

Each condition increases the rate at which the fuel can reach the NAE.

Note →



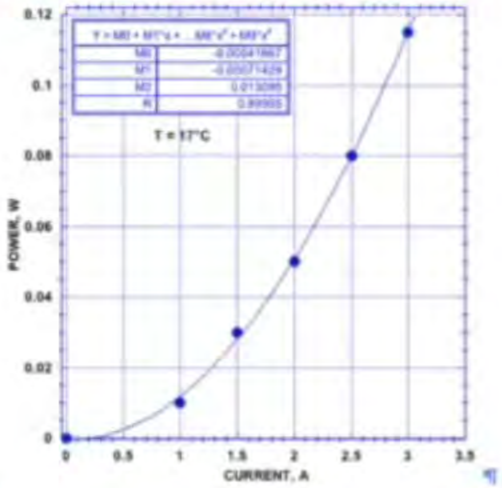


FIGURE 30. Effect of a steady DC passing through PdD at various temperatures in D_2 gas. The amount of applied current is shown in units of ampere(A). The values for "no current" were obtained first followed by the values designated as "applied current". The current at a constant temperature was measured and then the temperature was increased and held for 100 min until the temperature became constant.

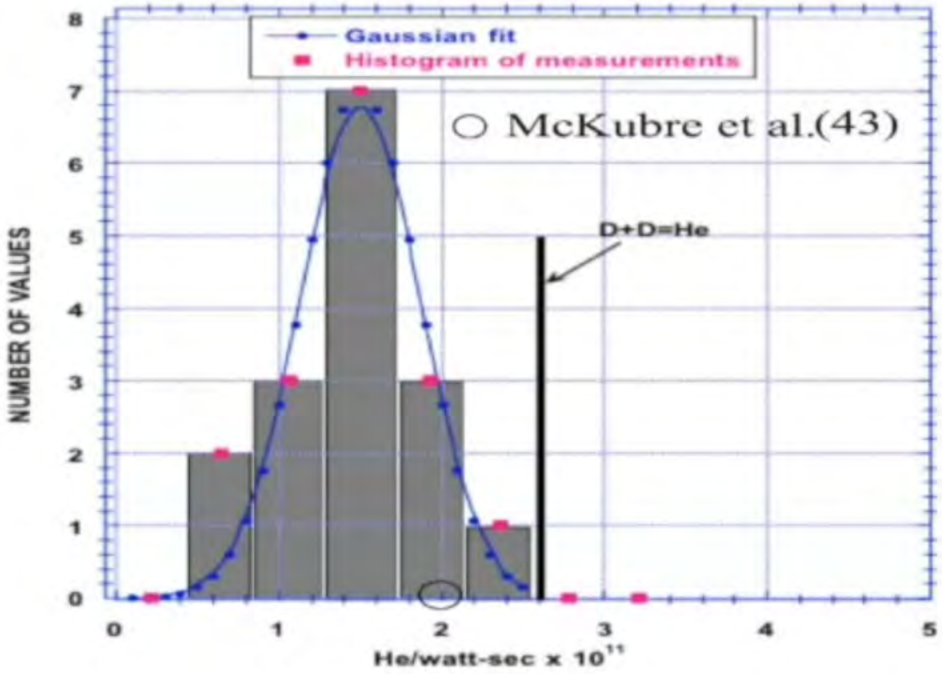
Nature of detected nuclear product

(The proof, the smoking gun, the confession, the fact)

Final nuclear product is ^{4}He when D is used.

n+p + n+p = n+n+p+p + 23.85 MeV (2.6×10^{11} He/watt-sec)

17 values from 4 different studies using electrolysis at 20°C and one using D_2+Pd+charcoal at about 250°C



This creates a serious problem

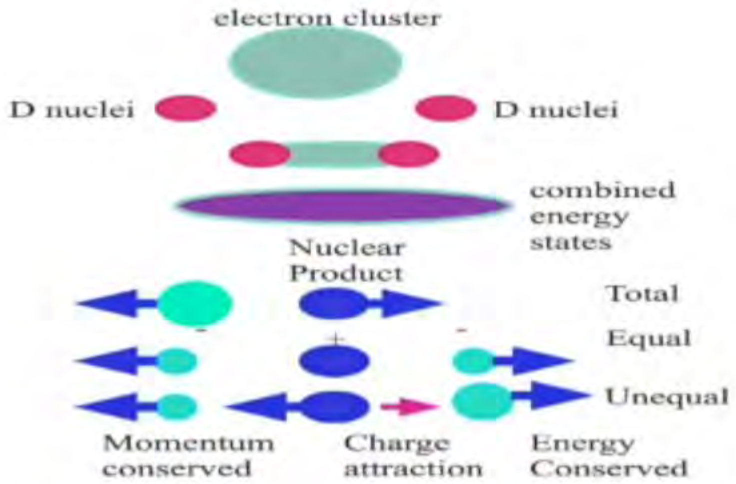
Something else must be emitted with a corresponding momentum.

The electrons that cause the reduction in the Coulomb barrier are proposed to be emitted along with the single nuclear product.

Other nuclear products (neutrons, photons with various frequencies, transmutation products) result from secondary reactions.

18:28

Fusion process



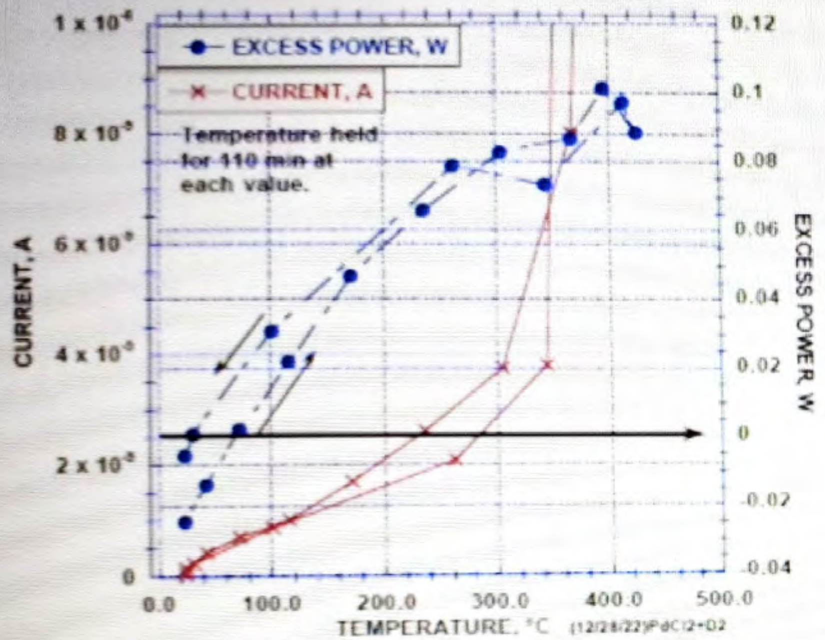
Electron emission is expected to be highly directional and coherent. Secondary photon radiation is expected as reported by Swartz and other people.

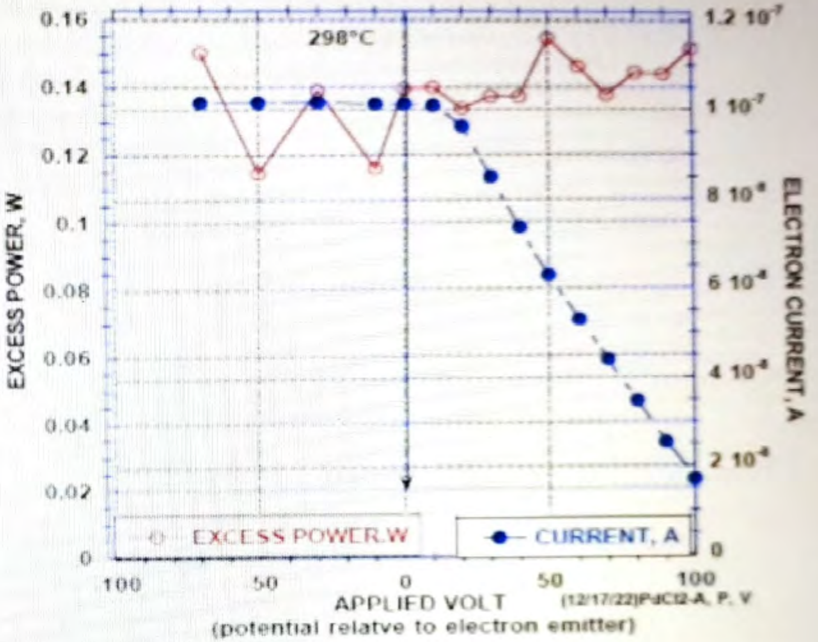
The consequence of all the electrons being emitted in one direction with the nuclear product being emitted in the opposite direction were calculated previously.

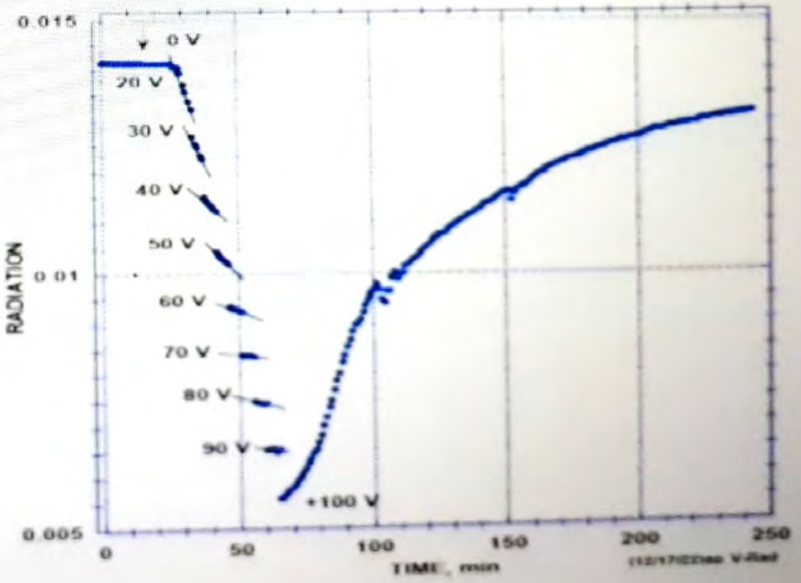
Nature of the Cold Fusion Reaction

1. Coulomb barrier is overcome without applied kinetic energy by a concentrated assembly of electrons.
2. Mass energy is emitted as energetic ion radiation and energetic electrons with helium as the final nuclear product when deuterons fuse. Deuterium results as the nuclear product when H fuse. Tritium results as the nuclear product when H and D fuse. Neutrons and helium result when D and T fuse.
3. The momentum is conserved during each fusion process by the emission of electrons. Only the electrons ejected by d-d fusion have enough energy to escape the material and be detected.
4. The process is spontaneous in the required environment identified as the NAE.
5. Secondary nuclear reactions with energetic emission are produced by local hot fusion and transmutation reactions.

Nature of emitted electrons

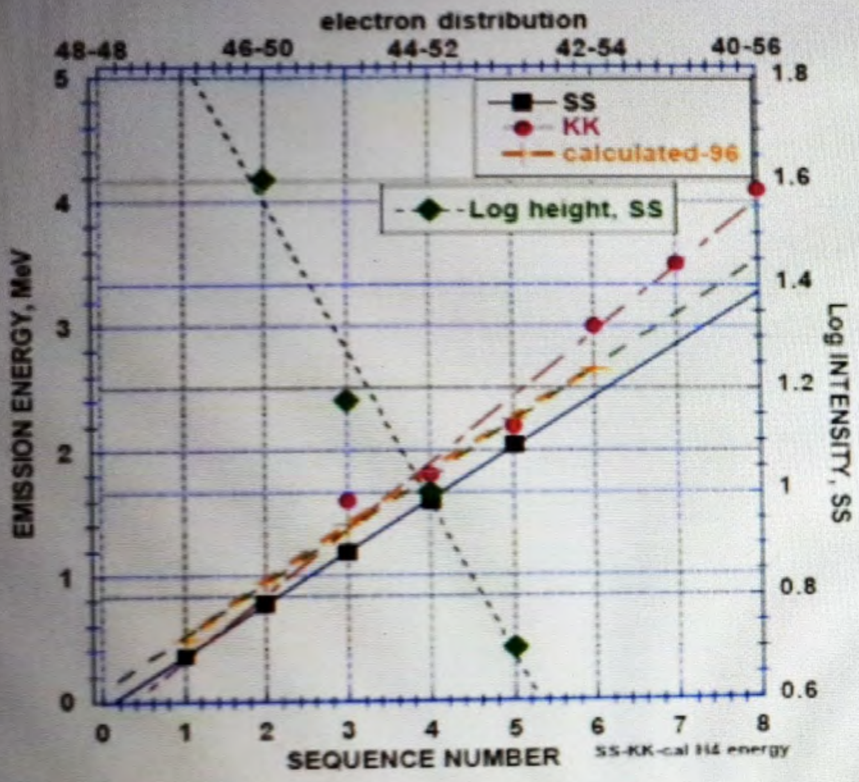


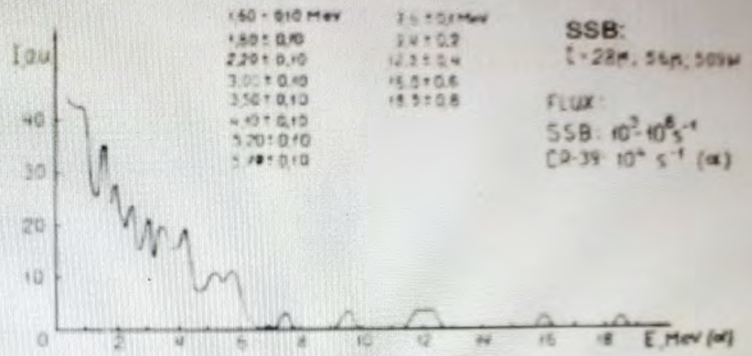




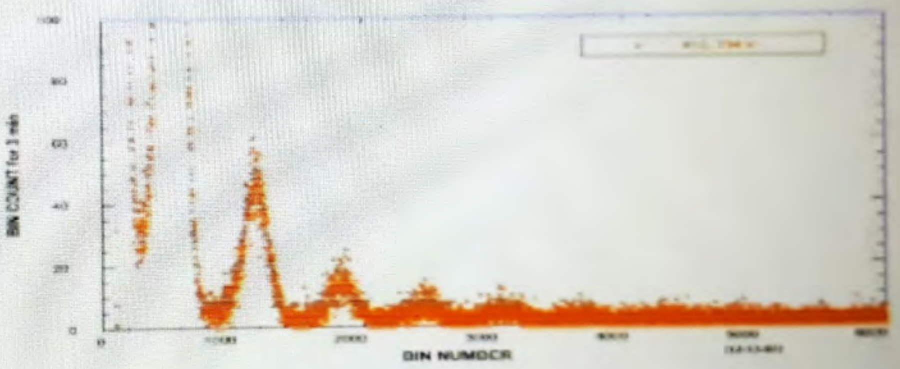
NAE made using CoD with Pd deposited on Pd. Study done using D_2 gas with Pt counter electrode. Electron/He =~30.

Unusual Energy Distribution





Karabut, A.B., Y.R. Kucherov, and I.B. Savvatimova, Nuclear product ratio for glow discharge in deuterium. Phys. Lett. A, 1992. 170: p. 265.



Storms, E., Scanlan, B. Detection of Radiation From LENR, 14th International Conference on Condensed Matter Nuclear Science (2008), Washington, DC www.LENR.org - mixture of H_2 and D_2. emission acts like an isotope of hydrogen

About ½ of the nuclear product has no kinetic energy. Average electron energy is 0.23 MeV. Number of electrons between 90 and 105 fit the data. This is the upper limit to the number of e-.

SUMMARY

Conditions required to create fusion energy

- A special condition (NAE) consisting of a void having a special small size must be formed in large numbers by suitable treatment.
- The material must be exposed to an isotope of hydrogen, preferably deuterium as the fuel.
- The fuel must be caused to move more rapidly from its normal locations in the material to assemble in the NAE.
- A practical generator requires the spent NAE to be easily replaced.

Tracks on CR-39 from the SPAWAR Co-dep Experiment

Duhan Zhang, Peter L Hagelstein

Massachusetts Institute of Technology, Cambridge, MA, US

Pam A Mosier-Boss, Larry P Forsley

Global Energy Corp, San Diego, CA, US

May 25th, 2025

ICCF26

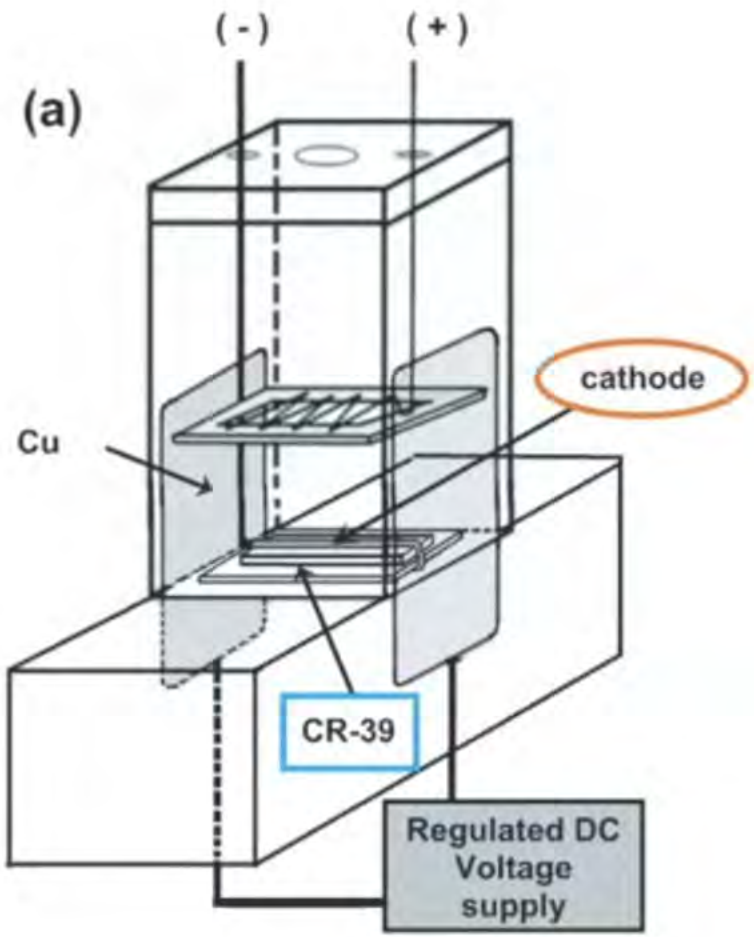
3:51:56

Introduction

- Pam A Mosier-Boss and colleagues reported tracks from Pd/D co-deposition experiments
- We consider these are important experiments and findings
- Potential LENR lab rats
- Motivation to try the experiment in our lab

SPAWAR co-dep setup

- Alloy Pd/D deposit on the cathode
- CR-39 directly contact cathode for tracking particles during deposition

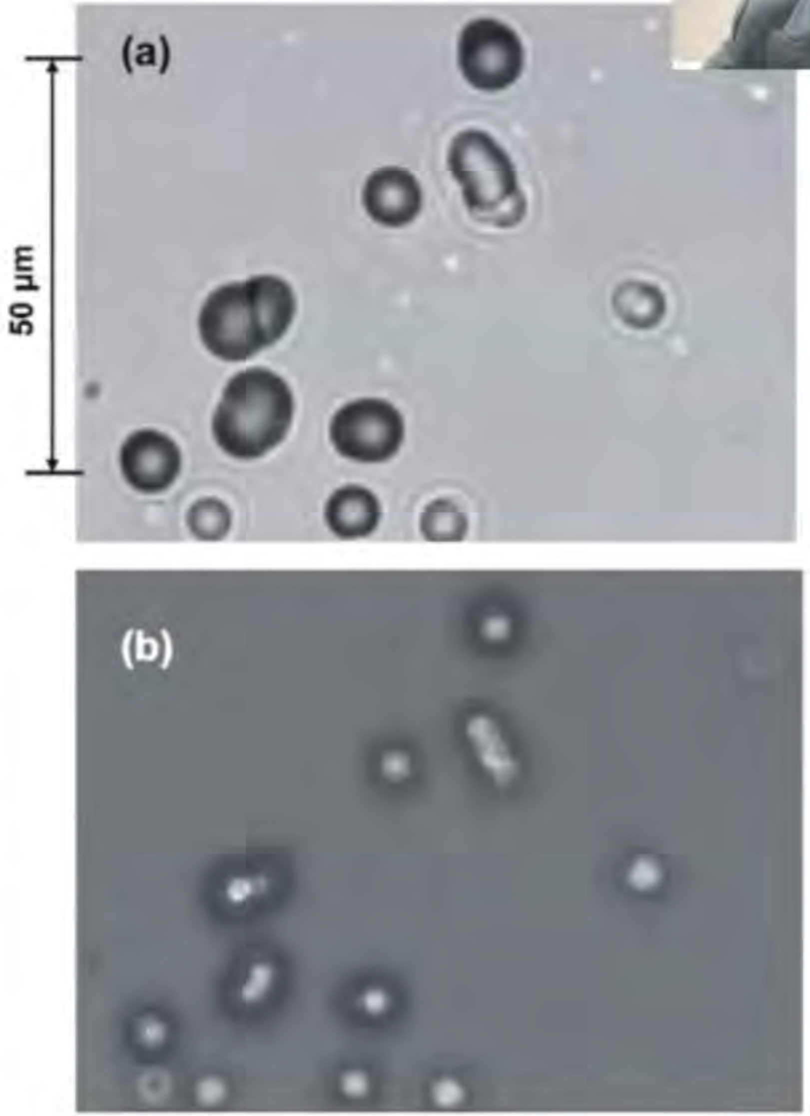


P.A. Mosier-Boss, et al. Eur. Phys. J. Appl. Phys. 40, 293–303 (2007)

SPAWAR co-dep tracks

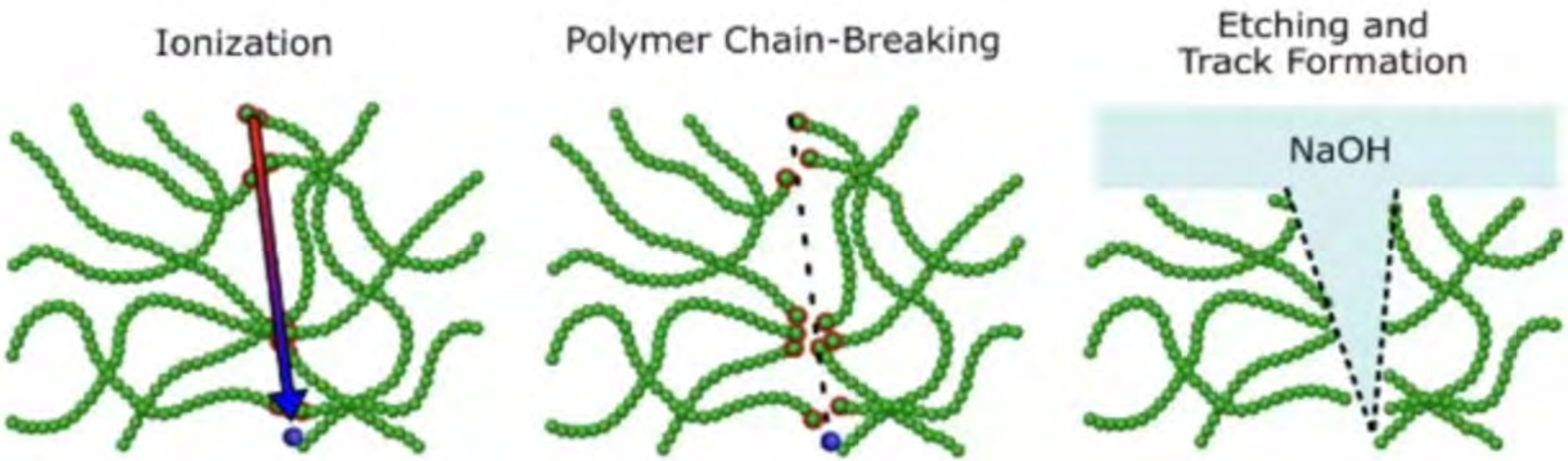
- Detector is in contact with the cathode
- (a) Focus on the surface of the CR-39.
- (b) Overlay of two images taken at two different focal lengths (surface and the bottom of the tracks).

- **Develop the methodology** of using CR-39 to track and study energetic particle generation, e.g. track dimensions and angle, spacer thickness, etching protocol, imaging method



P.A. Mosier-Boss, et al. Eur. Phys. J. Appl. Phys. 40, 293–303 (2007)

Stages of charged particle detection in CR-39

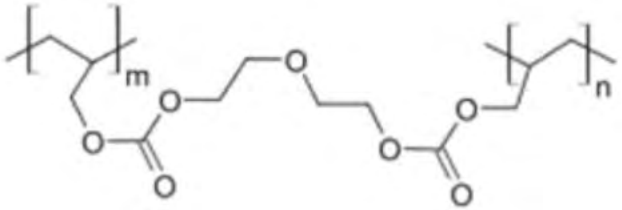


1. Energetic particles deposit energy in the substrate
2. Bonds break in the polymer, and radicals and defects form
3. The open-ended chains are preferentially etched

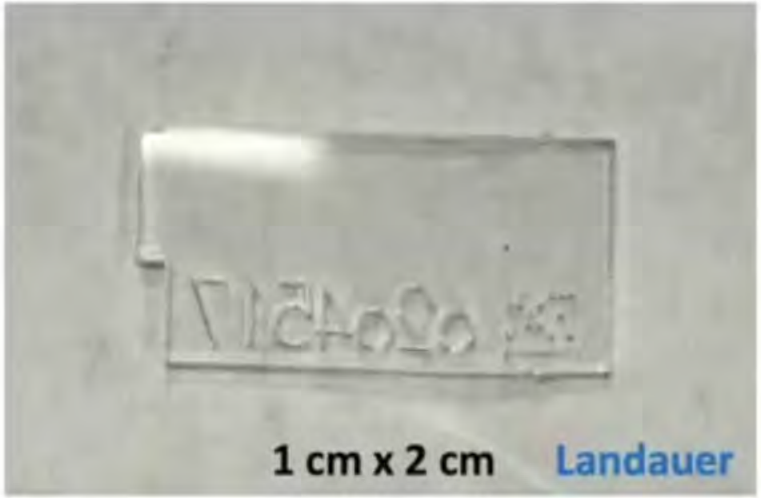
Erik Ziehm, An experimental investigation of low energy nuclear reactions in a dc glow discharge, Ph.D. dissertation 2022

Detector material – commercial CR 39

CR-39, poly(allyl diglycol carbonate)



$(C_{12}H_{18}O_7)_n$



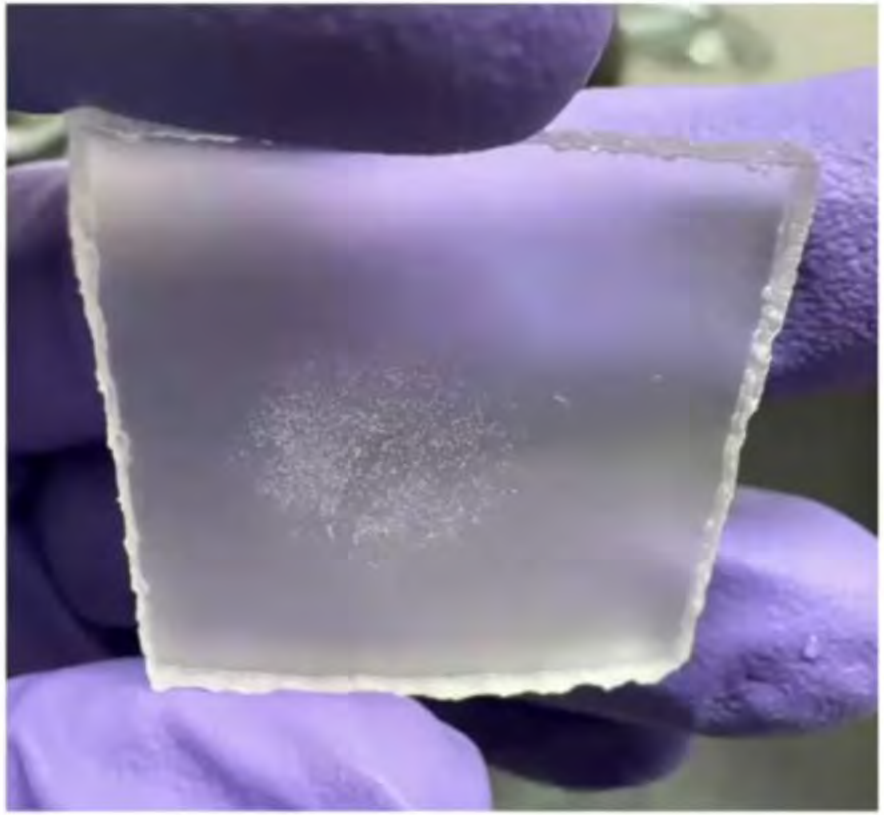
A solid-state passive radiation detector for the emission of energetic charged particles during the reactions

3:54:57

CR-39 various suppliers (SOMO)

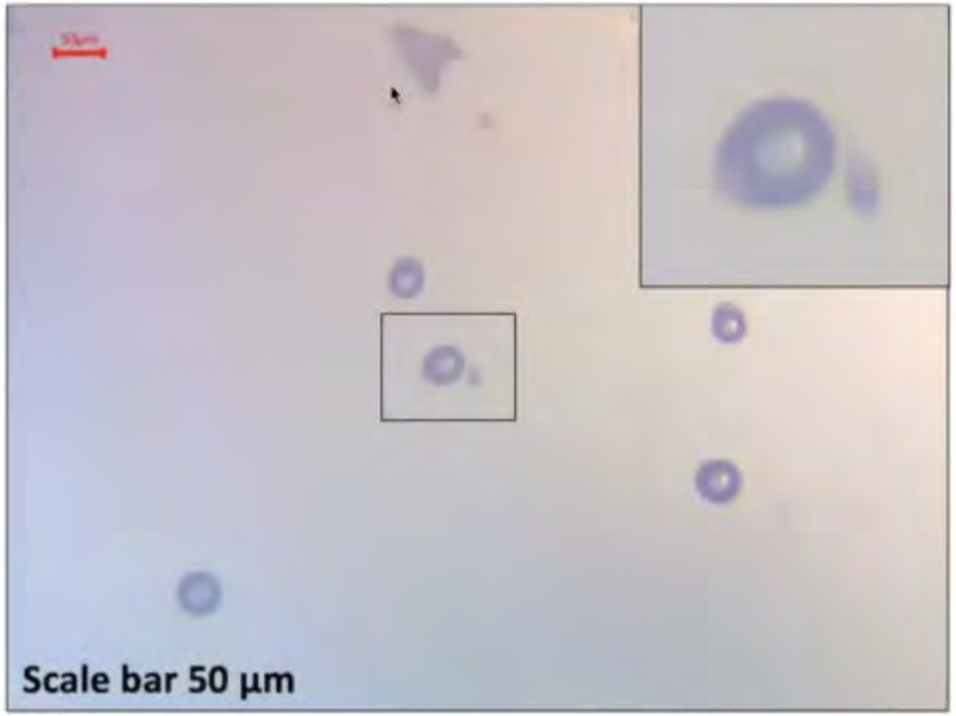
After co-dep

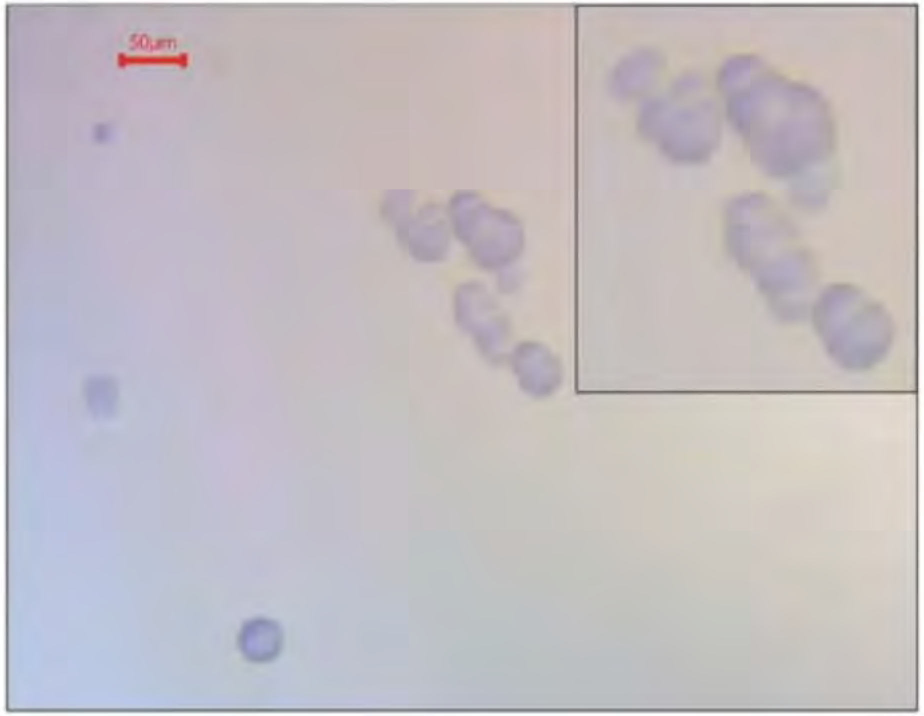
After etching



4:02:34

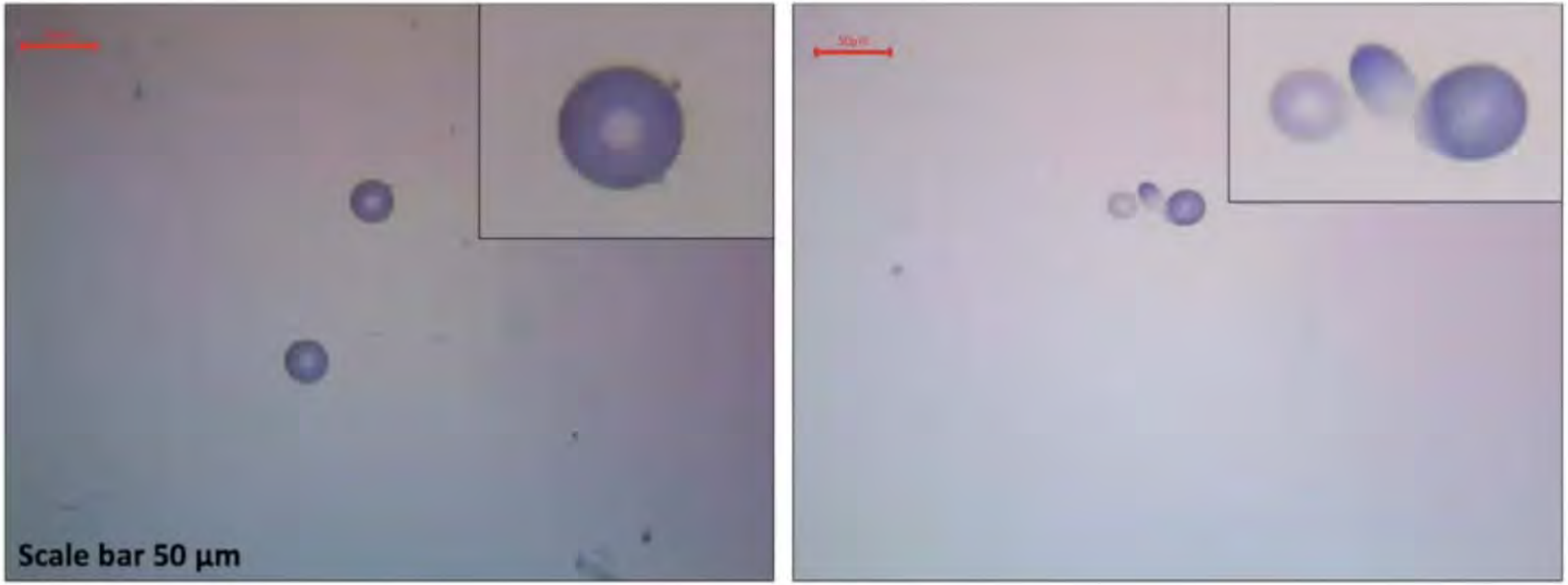
Energetic particle tracks after etching on CR-39





Landauer

Energetic particle tracks after etching on CR-39



Landauer

Conclusion

- Observe tracks from Pam's co-dep experiment protocol
- Suitable for a LENR lab rat
- Triple tracks have been seen – due to energetic neutrons > 10 MeV
- Tracks observed on CR-39 from different suppliers
- Tracks observed on CR-39 outside the electrochemical cell

Experimental exploration of multi-frequency Laser induced LENR in metal-hydrogen system

Linghui Hou[1], Wuyun Xiao[1], #Yanxia Liang[1], Kang Zhou[1], Hui Zhao[1], Dahai Liu[1], Wu-Shou Zhang[2]
[1]State Key Laboratory of NBC protection for Civilian, Beijing 102205, China
[2]Institute of Chemistry, CAS, Beijing 100190, China
E-mail: yxliang0701@126.com

Motivation

- In 1997, V. Nassisi of the University of Lecce in Italy used a 308 nm wavelength isochlorinated excimer ultraviolet laser emitter to illuminate the surface of palladium metal in deuterium gas. Explosion pits were found on the surface of palladium wire, and new transmutation elements were discovered at the pits.
- Later, U. Mastromatteo of Italy conducted a comparative experiment with a 633 nm, 1 mW laser and a 403 nm, 3 mW laser, and found that the 633 nm laser induced a more pronounced LENR effect.
- In 2022, J. P. Biberian of France repeated the experiment and introduced 500 nm blue light as a contrast. The results showed obvious transmutation elements at the 650 nm laser irradiation site, and at the same time, they found neutron radiation twice the background.
- **How dose the wavelength influence the results of LENR?**

Methodology

- **Material preparation**

Since our main objective was to explore the influence of laser frequency, we chose relatively basic materials in the early stage of the experiment, mainly by using a magnetron sputtering instrument to deposit pure palladium on Ni sheets, or alternating plating of palladium with alloys such as copper and nickel.

- **Laser excitation experiment**

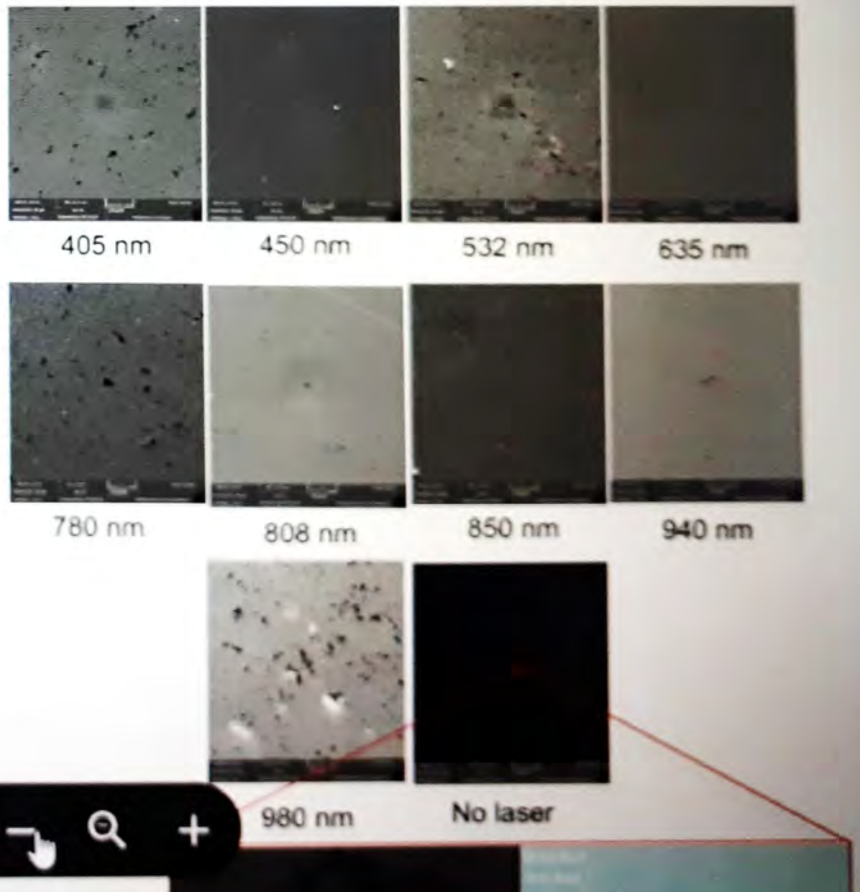
Put the coated material into the reactor, evacuate it to a vacuum, then fill it with deuterium/hydrogen gas, keep the reactor sealed after filling, and use an integrated laser (405, 450, 532, 635, 780, 808, 850, 940, 980 nm with power of 100 mW) to shine the surface of the material through a quartz window.

- **Characterization of Results**

The surface topography and elemental distribution o

- 4. Remove the Pd metal film and test the nuclide composition in the irradiated area at different frequencies
- 5. Analyze the relationship between the elemental transmutation of Pd metal and the frequency of the irradiated laser

Results



through a quartz window.

Characterization of Results

The surface topography and elemental distribution of the material at the illuminated area were detected by means of optical microscopy, SEM/EDX, mass spectrometry, neutron activation analysis, etc.

Analysis of results

For the results obtained, first make a qualitative judgment on whether transmutation has occurred, then summarize the transmutation results under different experimental conditions, and summarize the effect of laser excitation on low-energy nuclear reactions.

(a) Vacuum Chamber

(b) High Temperature Vacuum Chamber

(c) Inside of Vacuum Chamber

(d) DC power supply

(e) Laser Outlet

(f) Laser Integration

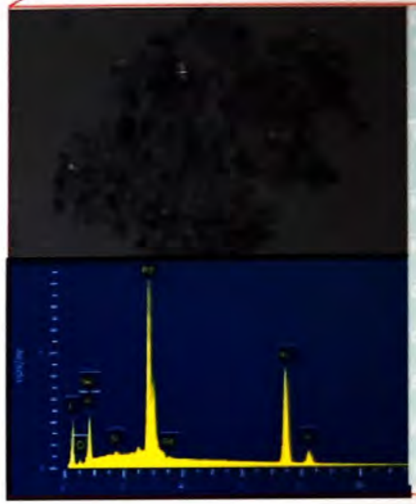
Fig.1 Construction of laser excitation LENR experimental device

Experiment

1. Use a sputtering machine to deposit a layer (or multiple layers) of Pd metal film on a substrate with good thermal conductivity.
2. Place the Pd metal film inside the cavity so that the laser spot is located at different parts of the Pd metal film.
3. Turn on the laser and maintain it for several hours, then stop the test and expel the deuterium gas.

980 nm No laser

C, O, Si.. was found in the area of spots.



	Line types	Weight percentage	Wt % Sigma	Atomic percentage
[illegible]	K line system	52.45	0.54	37.60
[illegible]	L thread system	32.68	0.38	12.93
[illegible]	K line system	12.75	0.80	44.69
[illegible]	K line system	0.85	0.07	2.25
[illegible]	K line system	0.18	0.03	0.27
[illegible]	K line system	1.09	0.17	2.27
[illegible]		100.00		100.00

Discussions and conclusion

- 405, 532, 780, 980 nm and no laser sample has been found black spots, while 450, 635, 808 and 940 nm sample are not found.
- Main ingredients of spots are carbon.
- Laser excitation has both surface thermal effects and can increase the deuterium charge rate.
- The mechanism are different of Laser induced LENR between different Laser output power.
- More comparative experiments and neutron detection will be carried out in the future.

References

[1] V. Nassisi, *Transmutation of elements in saturated palladium hydrides by an XeCl excimer laser.* Fusion Technol., 1998. **33**: 468-475.

[2] P.L. Hagelstein, D. Letts, D. Cravens, *Terahertz difference frequency response of PdD in two-laser experiments*, J. Cond. Matter Nucl. Sci., 2010. **3**: 59-76.

[3] J.P. Biberian, L. Forsley, and P.A. Mosier-Boss, *Transmutation of palladium induced by laser irradiation.* J. Cond. Matter Nucl. Sci., 2023. **37**: 9-22.

Anomalous temperature increases in Cu nano-particles exposed to colliding pulsed super-multi-jets of hydrogen gas

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Previous researches done by the other research group

In some reports, anomalously large heat generation due to the interaction between nano-structured metal and hydrogen gas have been observed.

Kitamura and Takahashi demonstrated that
H-Pd-Ni, H-Cu-Ni gas and particles system produce significant excess heat energy.[1]

[1] A.Kitamura, A.Takahashi, et al, Int. J. Hydrogen Energy, vol. 43, pp.16187-16200, 2018.

Iwamura and Itoh developed an experimental method to observe anomalously large heat generation, using Ni-based nano-structured multilayer metal composites.[2]

[2] Y.Iwamura, T.Itoh, S.Yamauchi, T.Takahashi et al, Jpn. J. Appl. Phys. 63, 037001, 2024.

Most of previous researches conducted experiments under low H_2 , D_2 pressure environment.
There are a few researches about experiments under high H_2 , D_2 pressure over 1.0MPa.

Principle of super-multi-jets colliding proposed by us for high H_2 , D_2 pressure.

In this principle, super-multi-jets colliding hydrogen gas with pulse are injected from the side walls of a chamber.
Around a singular point at the center of the reaction chamber, the colliding leads the self-compression and makes high-pressure region.[3]
[3] Naitoh, K., "Engine," Japan Patent, 5737632, December 15, 2011.

This new compress principle is able to enhance the temperature rise from absorption of hydrogen gas into metal nano-particles.[4]
[4]Naitoh.K, et al. J.Condensed Matter Nucl. Sci.24, pp.236-243, 2017.

Fig. Principle of super-multi-jets colliding[3]

The new reaction system and chamber, depending on the principal of super-multi-jets-colliding

Comparing to the small constant volume chamber, the chamber of the new reaction system was expected to achieve much more colliding pressure. Therefore, it is thought that we are able to observe much more temperature rise.

Table.2 Specification of the reaction system

Material of reaction chamber	SUS316
Material of O-ring	HNBR-70
Endurable gas pressure	12.2 MPaG
Endurable temperature	723 K

Fig.2 Colliding's image in cross section A

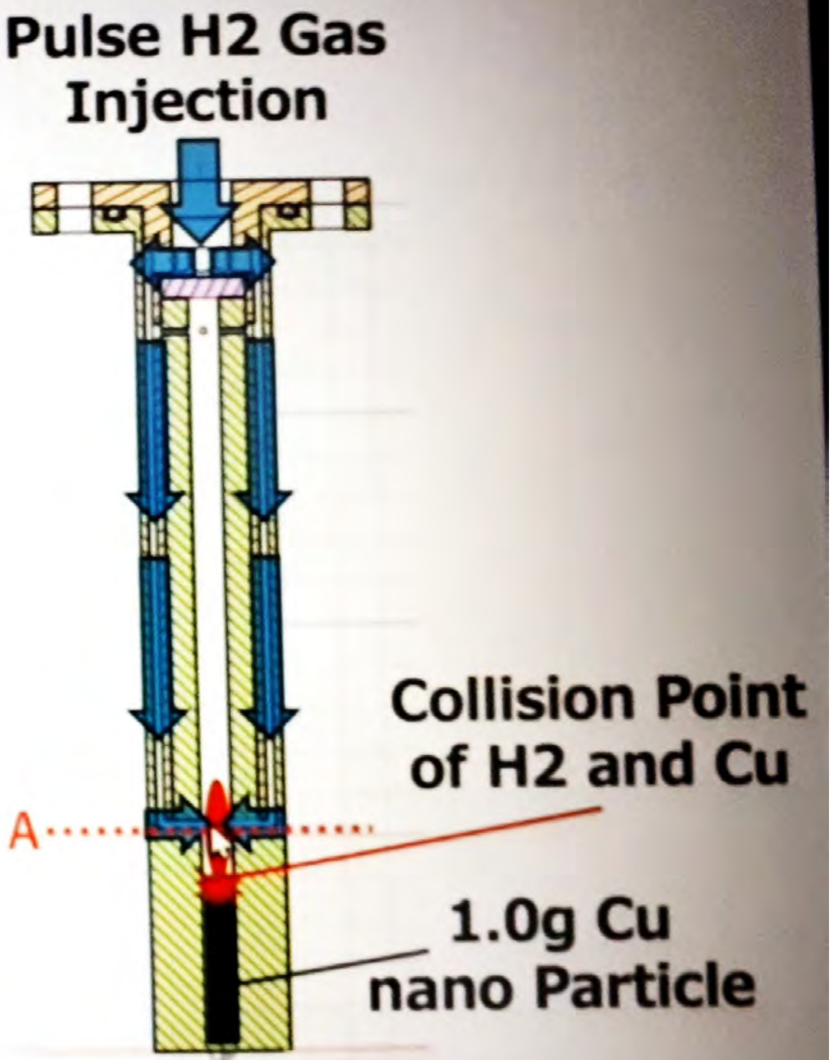


Fig.3 The chamber of new reaction system

Result of the experiment with Cu nano-particles in the new chamber

We have conducted an experiment loading Cu nano-particles in the reaction chamber.

In the experiment with Cu nano-particles, we measured temperature rise over **600 K,** which reached over 1100K.

Table.3 The condition of Cu nano-particles experiment

Sample	Cu
Sample mass	1.0 g
Gas pressure	8.0 MPaG
Heater temperature	573 K

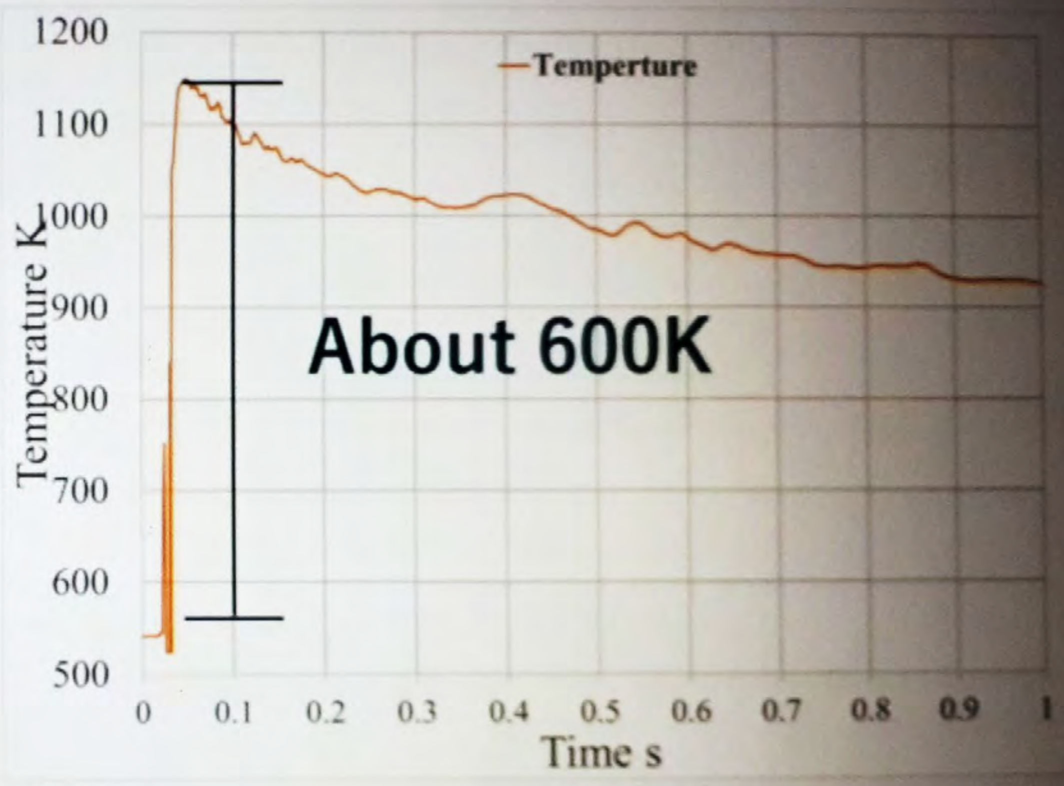


Fig.5 Result of Cu experiment with the new chamber(Cu, 1.0g, 573K, 8.0MPaG)

Result of experiment of Cu with the new chamber

According to the result of blank and Cu, we have calculated apparent temperature rise ΔT_A is over **580 K**.

The apparent temperature rise ΔT_A is calculated as below,

$$\Delta T_{Cu} - \Delta T_{No\ nano-metal-particles} = \Delta T_A$$

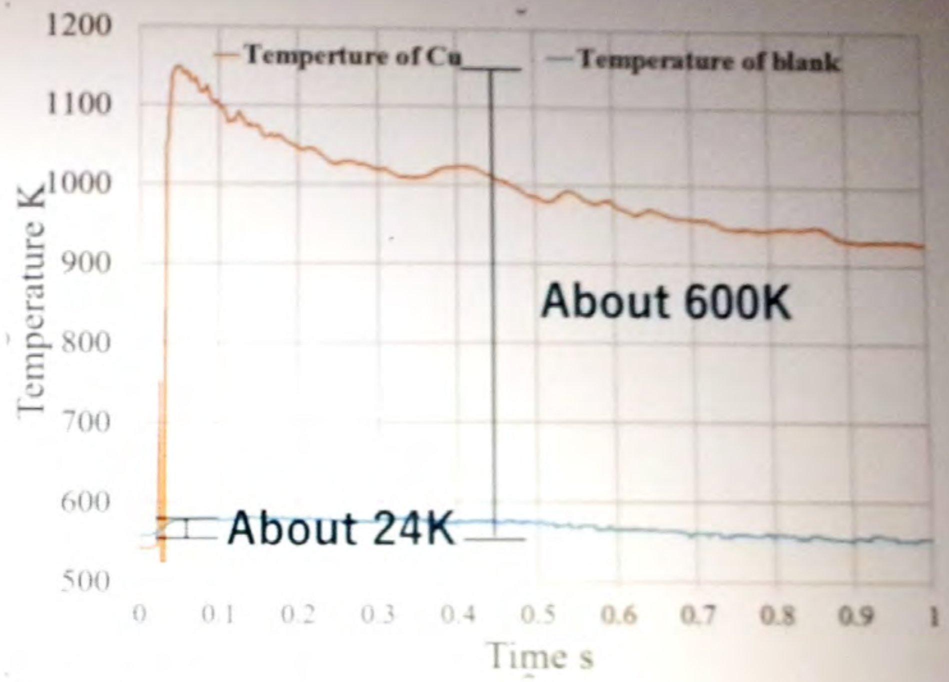


Fig.7 Comparison of temperature changes of Cu and Blank

Table.5 Results of experiments with 8.0MPa pulse hydrogen gas injection

	Initial temperature T_{ini}[K]	Max Temperature T_{max}[K]	Temperature rise ΔT[K]	Apparent temperature rise ΔT_A[K]
Cu	5.41×10^2	1.15×10^3	6.07×10^2	5.83×10^2
No nano-metal-particles	5.57×10^2	5.82×10^2	0.24×10^2	-

Conclusion

- By using 2-color non-contact thermometer, we measured temperature of Cu nano particles set at collision point of super-multi-jets of hydrogen gas.
- The obtained temperature is over **1,100K**, with sample's temperature rise reaching over **600K**.

- We have calculated anomalous heat output from 1.0g Cu nano-particles, reaching **1.8 [kW/g-Cu].** This suggests that anomalous heat output from 100g Cu would reach over **100[kW]**, which corresponds to about 1,000cc reciprocating engine power.
- We will evaluate the anomalous heat from Cu nano-particles more precisely.

Выводы к Части 1

- На конференции отмечена важность
- проведения демонстрационных экспериментов и проверка их со стороны независимых экспертов для ***преодоления недоверия*** **со стороны «большой»** науки и коммерческого сообщества.
- Важность публикации основных результатов, полученных в исследованиях по физике LENR в ведущих научных журналах
- Подчеркнуто наличие значительного **недофинансирования исследований в области LENR физики**
- Представлены **10 основных компаний-лидеров** в мире по созданию LENR реакторов коммерческого типа. Сообщается о намерении этих компаний начать этап коммерциализации таких реакторов. На первом этапе планируется использовать эти реакторы для получения тепловой энергии
- Подчеркнута **важность создания дешевого топлива** (металлических нано-порошков) для создания коммерческого LENR реактора)

Выводы к Части 1. Продолжение

- Перечислены основные экспериментальные и теоретические результаты, полученные в международных Программах в настоящее время

- **Экранировка протонов** малых энергий в металлических нано-порошках и металлических нано-пленках (композитах).
- Наличие **низколежащих резонансов в гелии**
- **Трансмутация начальных химических элементов и изменении их изотопного состава**.
- Выделении значительной **удельной тепловой энергии** в газонаполненных LENR реакторах. Ее величина может достигать **400 КэВ/атом водорода**

- Разработаны новейшие диагностические методы для исследования физических процессов в LENR реакторах, в том числе
- **Проточные калориметры** высокого разрешения,
- **Полимерные детекторы** для изучения треков заряженных частиц
- **Пирометры** для измерения нестационарных потоков оптического и ИК-излучений
- **Ускорители потоков протонов** (дейтонов, тритонов) малых энергий (0.10-10 КэВ)

LENR and Detonation

in Hydrocarbon Plasma

A.I. Klimov, A.S. Pashchina

JIHT RAS, Moscow, Russia

ICCF-26, 26-30 May, 2025, Aiina, Japan

The Main Objectives of This Work

In our papers [1-4] was shown that

- in heterogeneous **hydrocarbon plasma (HP)** it is possible to implement LENR between **carbon nanoclusters and hydrogen ions** (hydrocarbon dissociation products). It is important to note that such LENR uses ***cheap carbon nano-clusters*** (**but not expencive metal nano-clusters**)

- in such HP a large amount of **extra thermal energy** can be released. The value of **COP** is about of **2- 4**.

The problem of **detonation in energy-seturated HP** is studied In this work.

List of Published Papers

[1] Klimov A.I., Brovkin V.G., Pashchina A.S., Study of Heterogeneous Plasma Created by Magneto- Plasma Compressor and Capillary Erosive Discharge// WSMPA 2021, IOP Publishing Journal of Physics: Conference Series **2100,** 2021, 012006, P.1-8

[2] Klimov A., Bityurin V., Kharitonov A., at. el, Shock Wave Propagation through Non- Equilibrium Cluster Plasma, Paper AIAA 2002-7978, 40th AIAA Aerospace Sciences Meeting & Exhibit, 14-17 January 2002, Reno,NV, P.8

[3] Klimov A., Paschina A., et.all.,Stimulated Detonation of a High-Energy Heterogeneous Plasma Formation Created by Capillary Erosive Plasma Generator and Magneto- Plasma Compressor, Russian Journal of Physical Chemestry, 2024, v.18, No 5, P.1415-1421

[4] LENR- Experiment on Heterogeneous Hydrocarbon Plasma Jet Interaction with Ni-Foil-Target, Proc. ICCF-23. 2021, China

Main Stones

1. The calorimetric method of studying energy release **q** and rates of exothermic chemical reactions using shock waves (SW) in chemical physics is well-known and widely used [1]. *This calorimetric method is the most reliable and accurate compared to other known calorimetric methods in any reactors.* The mentioned calorimetric method is based on the Rankine- Huguenot equation [1]:

[1]. F. Bartlme, Combustion Gas Dynamics, M., Energoizdat, 1991, P.237

2. $Da = q/C_pT$

$M^2_{ЧЖ} = V_1^2/c_1^2 = 2(\gamma+1)\, q/C_pT$

$$\boxed{q = c_p T \frac{\gamma - 1}{2\gamma}\left[\frac{p_2}{p_1}\left\{\frac{\gamma+1}{\gamma-1}\frac{\rho_1}{\rho_2} - 1\right\} - \frac{\gamma+1}{\gamma-1}\frac{\rho_2}{\rho_1}\right]}$$

$$\boxed{V_{1,theor} = c_1\sqrt{\frac{p_2/p_1 - 1}{1 - \rho_1/\rho_2}\frac{1}{\gamma}}}$$

M_{CHJ} – the Mach number of the detonation wave (M_{CHJ} >>1)

P_2, P_1- the pressures behind the SW front and before its front

ρ_2, ρ_1- the density of the gas behind the SW front and before its front

q- the specific thermal energy from the exothermic reaction

C_p – the specific heat capacity

γ- C_p/ C_v ratio

T- the gas temperature

вода теплоты обозначим индексом 1, а после — индексом 2. При горении индекс 1 означает исходную смесь газов, индекс 2 — продукты сгорания. Пусть скорость реакции такова, что в конце зоны реакции существует *термодинамическое* и *химическое* равновесие. Далее предположим, что теплопроводность, диффузия вне зоны реакции и влияние внешних сил, как, например, трения на стенке, пренебрежимо малы. Среда — идеальный газ с постоянной удельной теплоемкостью. Наконец, считаем поток до и после фронта реакции физически гомогенным. Под этим может подразумеваться и смесь различных веществ. Поток газа с определенным количеством жидкости в виде капель также можно рассматривать как гомогенный, пока существует термодинамическое равновесие и скольжение фаз отсутствует. Максимально возможный размер капель при этом зависит от остальных характеристик (в том числе и геометрических) поля течения. Выбираем систему координат, в которой фронт реакции или фронт нагрева неподвижен, а скорость набегающего потока u_1 (рис. 3.1). Таков обычный способ рассмотрения *стационарной* задачи.

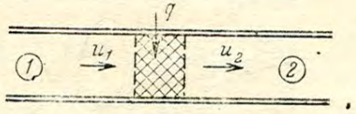


Рис. 3.1. Течение в трубе с подводом теплоты.

Исходными для расчета изменения состояния во фронте реакции являются три уравнения: неразрывности, импульса и энергии [1.11—1.18, 3.2—3.3] [1].

Основные уравнения стационарного одномерного течения с подводом теплоты отличаются от течения без подвода теплоты только аддитивным членом в уравнении сохранения энергии и имеют вид:

уравнение неразрывности

$$\rho_2 u_2 = \rho_1 u_1; \tag{3.1}$$

уравнение импульсов

$$p_2 + \rho_2 u^2_2 = p_1 + \rho_1 u^2_1; \tag{3.2}$$

уравнение энергии

$$\frac{u^2_2}{2} + i_2 = \frac{u^2_1}{2} + i_1 + q. \tag{3.3}$$

[1] Одномерные течения газа подробно рассмотрены в учебниках и монографиях советских авторов. — *Прим. ред.*

К ним добавляется еще уравнение состояния идеального газа (1.2).

В (3.3) q означает подведенное на единицу массы количество теплоты. По определению при подводе теплоты знак q — положительный. Из основных уравнений и уравнения состояния (1.2) с использованием (1.45) и (1.135) после элементарных преобразований получаем уравнения нормального стационарного фронта реакции идеального газа с постоянной удельной теплоемкостью [1]:

$$\left.\begin{aligned}
\frac{u_2}{u_1} &= M_1 - \frac{1}{\varkappa + 1}\frac{1}{M_1}\Big[(M_1^2 - 1) \pm \\
&\pm \sqrt{(M^2_1 - 1)^2 - 2(\varkappa + 1) M^2_1 \frac{q}{c_p T_1}}\Big]; \\
\frac{p_2}{p_1} &= 1 + \frac{\varkappa}{\varkappa + 1}\Big[(M^2_1 - 1) \pm \\
&\pm \sqrt{(M^2_1 - 1)^2 - 2(\varkappa + 1) M^2_1 \frac{q}{c_p T_1}}\Big]; \\
\frac{\rho_1}{\rho_2} &= 1 - \frac{1}{\varkappa + 1}\frac{1}{M^2_1}\Big[(M^2_1 - 1) \pm \\
&\pm \sqrt{(M^2_1 - 1)^2 - 2(\varkappa + 1) M^2_1 \frac{q}{c_p T_1}}\Big]; \\
\frac{T_2}{T_1} &= \left(\frac{c_2}{c_1}\right)^2 = \frac{p_2}{p_1}\frac{\rho_1}{\rho_2},
\end{aligned}\right\} \tag{3.4}$$

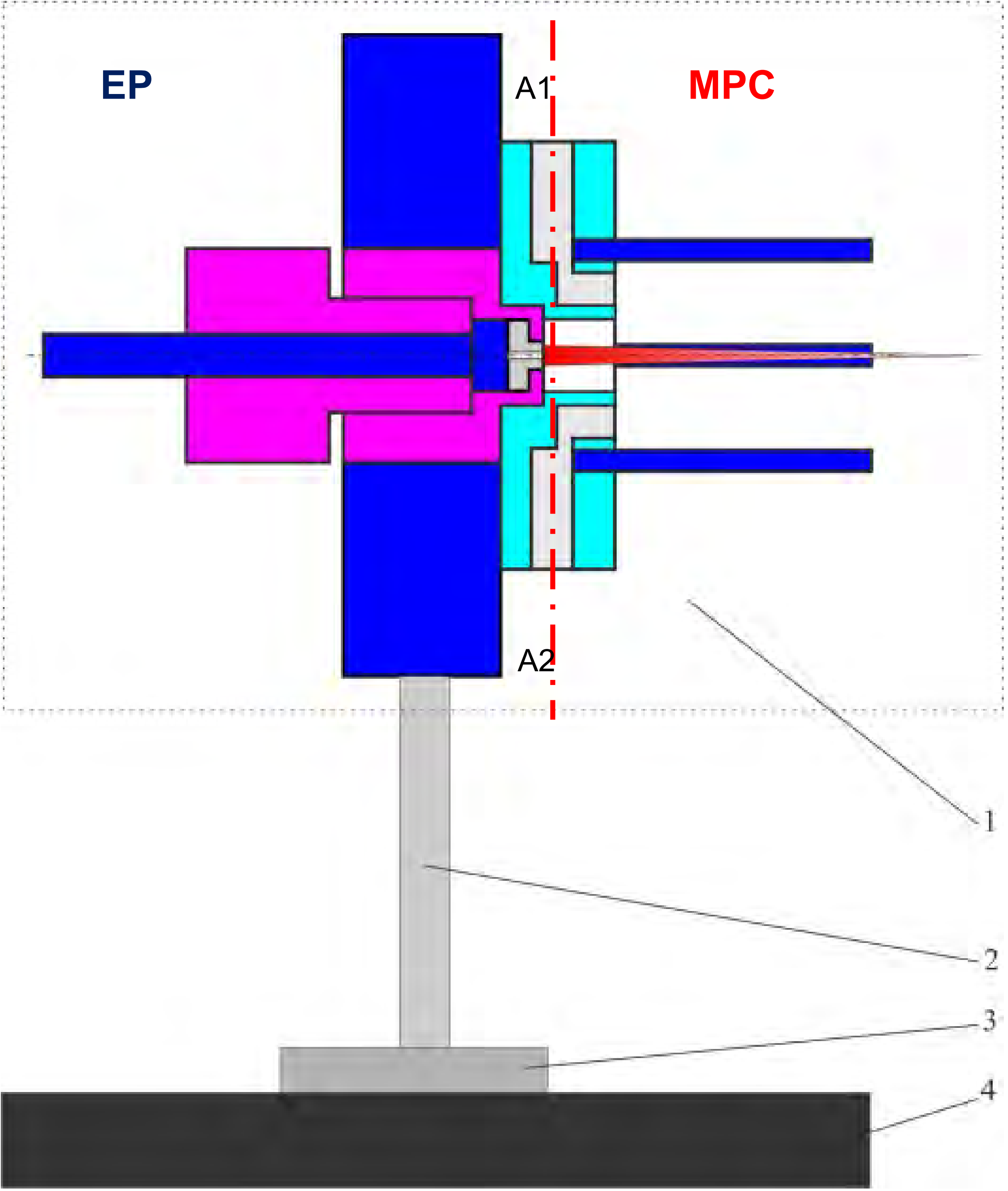
где $M_1 = u'/c_1$ — число Маха набегающего потока (перед фронтом реакции).

На рис. 3.2, *а—г* показаны зависимости давления, плотности, температуры и числа M_2 во фронте реакции от числа Маха натекания M_1 в соответствии с системой уравнений (3.4). Параметром является безразмерная величина подведенной теплоты

$$Q_1 = q/(c_p T_1), \tag{3.5}$$

которую иногда называют числом Дамкелера. Если учитывать зависимость удельной теплоемкости от температуры, то нужно брать либо среднее значение удельной теплоемкости по уравнениям (1.37) и (1.38), либо раз-

[1] Формулы (3.4) представляют интенсивность фронта горения, определяемую по изменениям давлений, плотностей, температур и скоростей потока, пересекающего фронт.

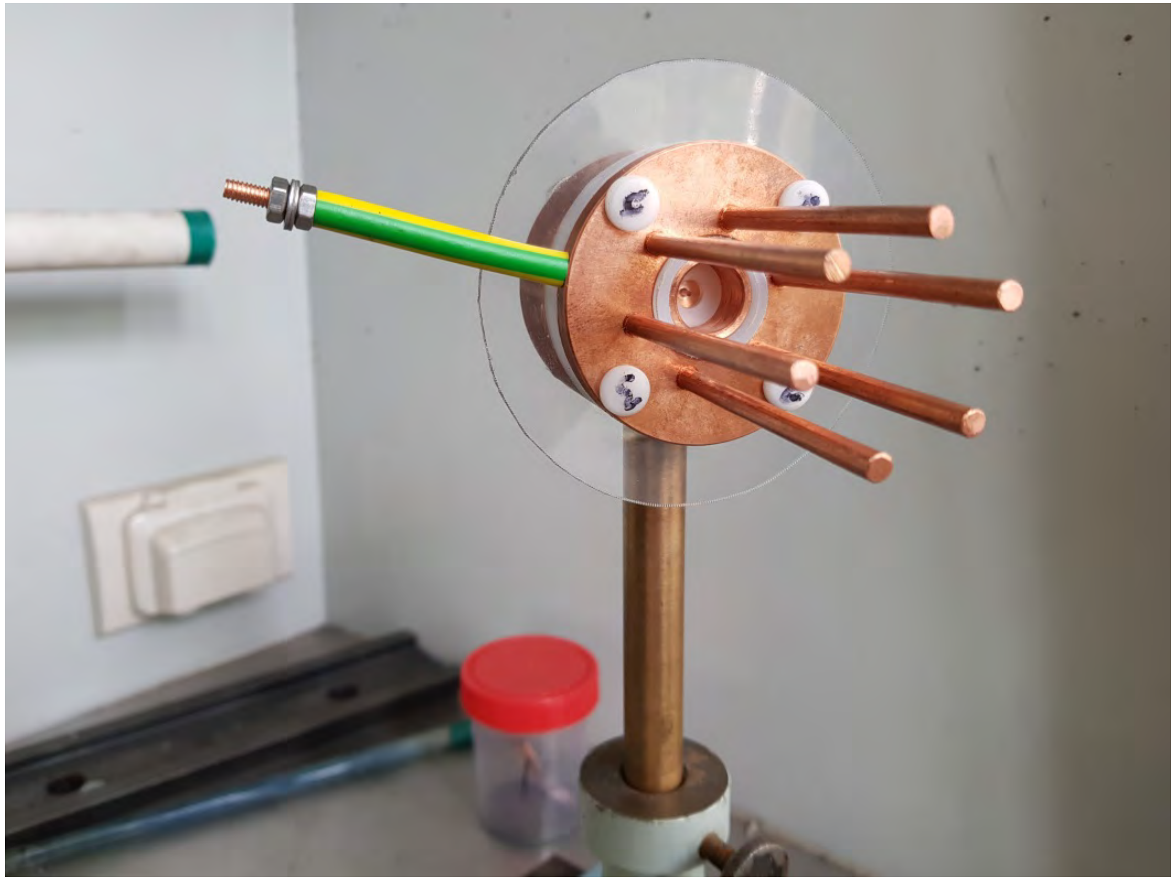


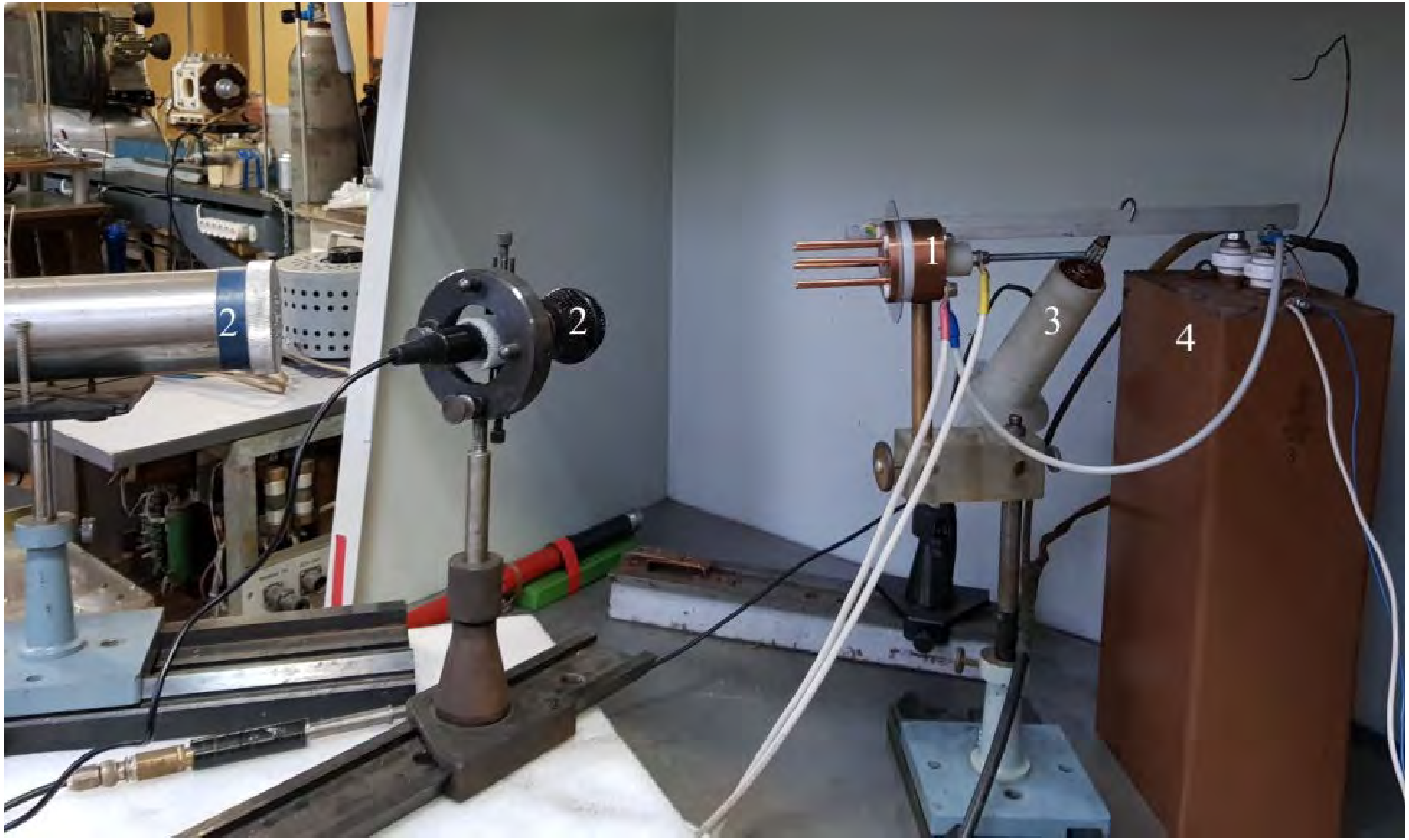
Scheme of experimental set-up MPC-EP

General view of this set up (down).

Erosive plasmatron **EP** - left. Magneto-plasma compressor **MPC**- right, 1- set-up, 2,3 – holder, 4 – rail

Plasma cathode used in MPC at the first time !!!!





MPC-EP and Diagnostic Instrumentation.

1 – **MPC-EP**, 2 –pressure transdusers, 3 – high voltage probe Tektronix P5100, 4 – capacity storage

Experimental Setup.
The Main Physical Mechanisms Used in the Design of this Installation MPC-EP

Step 1.

Modernization of the well-known installation named ***"plasma focus"***. Using **a heterogeneous plasma cathode** created by an erosion plasma generator **(EP)** in the new magnetic plasma compressor **(MPC) at the first time !!!** .

Step 2

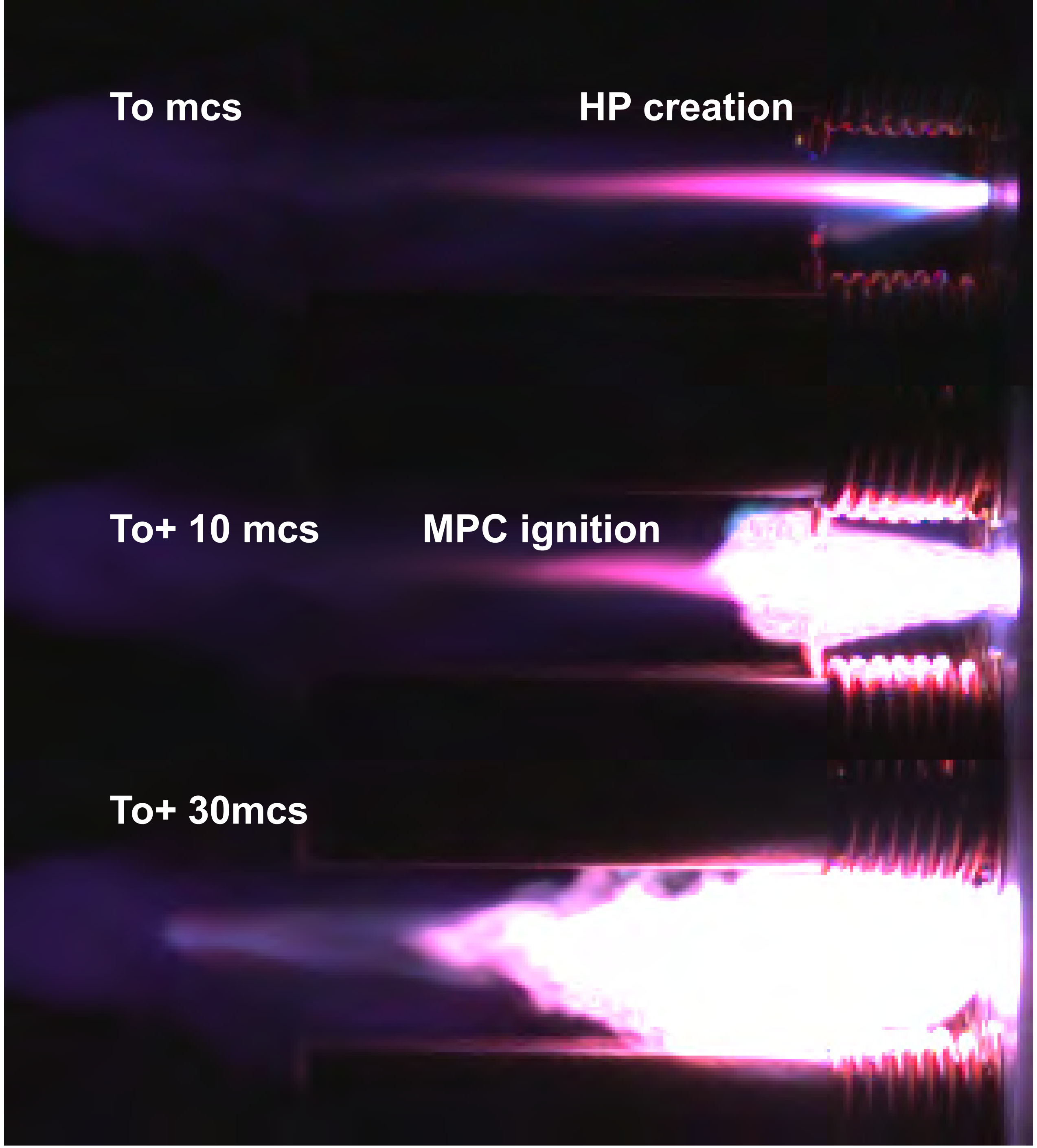
Creation of energy-saturated heterogeneous *hydrocarbon* plasma **(HP)** using an erosive plasma generator **(EP)** with a capillary discharge. Realization of ***LENR regime in HP.***

Step 3

Using ***a trigger mechanism*** created by a magnetic plasma compressor MPC (plasma focus mode) to **accelerate the LENR and convert it into detonation mode.**

Experimental Conditions

- The initial working substances in the **EP** were ***hydrogen-containing substances*** (such as $C_3H_8O_5$, stearin, paraffin, etc.)
- The voltage on the **MPC** capacity storage $C=10 \div 100\ \mu F$ was $U_C \leq 4$ kV. Energy storage up to **300 J.**
- The voltage on the EP storage capacitor varied from $U_{C2}=100$ V to 600 V. Energy storage up to **80 J.**
- The distance **X** from the MPC-EP generator to the pressure transducer P is varied within the range of **X= 10-100 cm.** The distance from P to microphone M was constant and was X_M = **10 cm**.
- The consumption of the working substance ***per one "shot"*** in the **EP** did not exceed **δM_{ch} = 1.2 mg/ shot**



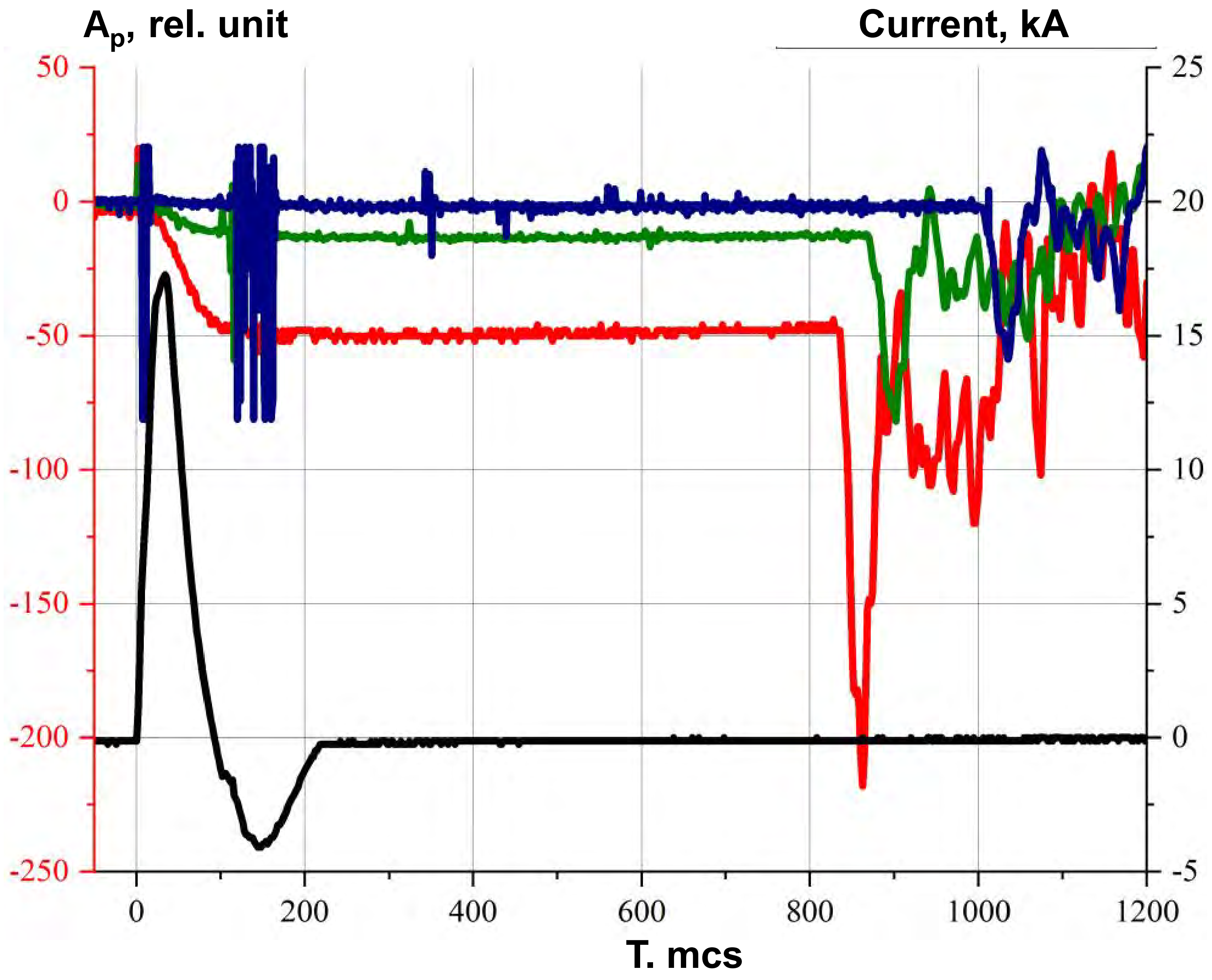
Experimental Results.

Dynamics of development of the combined discharge in the set up MPC-EP at atmospheric pressure.

T_o- erosive heterogeneous plasma jet creation by **EP.** Start of **MPC** operation

"Plasma piston" velocity **V~ 2000m/s,**

at T>To+10mcs



Experimental results. The Typical Experimental Pressure Signals behind Shock Wave (SW) Front

- **MPC** Current - **black (down)**

- Pressure signal behind SW front- **red- MPC+ EP mode**

- Pressure signal behind SW front- **blue,green** - **MPC without EP**

Processing of the Obtained Experimental Results.

1. From experimental data it was found that the Mach number **M** for the shock wave created by the "plasma piston" is **$M \sim 6$** . The volume of the "plasma piston" is about **$V = 10\ cm^3$** . Using well-known gas-dynamic formulas at the shock wave front, one can obtain an estimate of the energy E released during the explosion:

$$\mathbf{E = \Delta P_2 * V \sim 320\ J \quad at\ CU^2/2 \sim 100\ J}\ \text{(electric energy of capacity storage)},\ \mathbf{\Delta P_2 = P_2 - P_1,}$$

where P_2/P_1 pressure jump at SW front

2. Hence, the ***extra thermal energy*** released during the plasmoid explosion

$$\mathbf{E_{ch} = E - CU^2/2 \sim 200J}$$

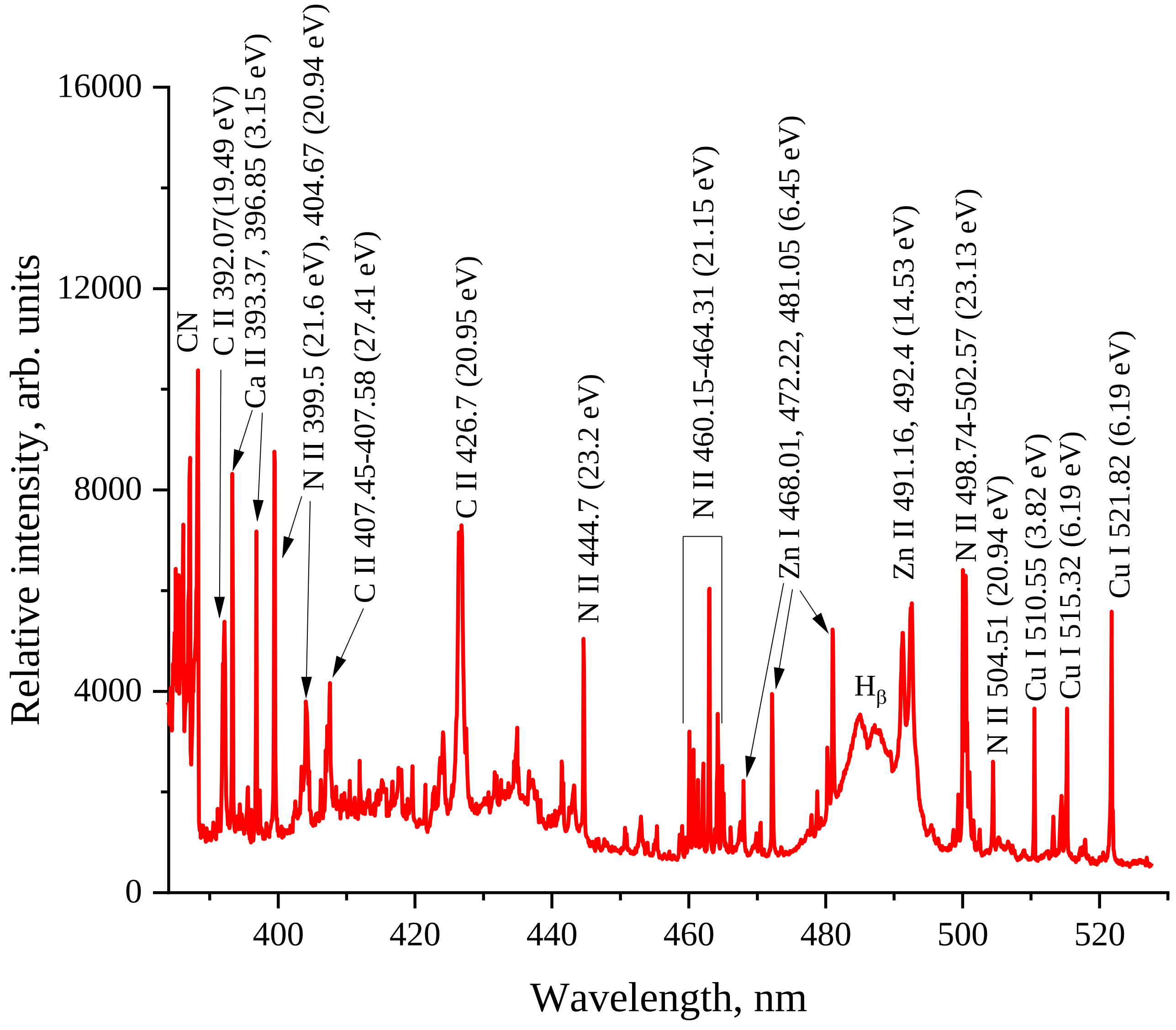
3.The estimation of the specific energy q_x released in stimulated LENR at δM_{ch} **= 1.2 mg** is

$$\mathbf{q_x = \delta E_{ch} / \delta M_{ch} = 200J/1{,}2\ \text{мГ} \sim 2{,}0\ 10^8\ J/kg \sim 2MeV/atom}$$

Transmutation of Chemical Elements in HP

Part 2

Optical Spectra of the Plasma Formation created by MPC-EP.

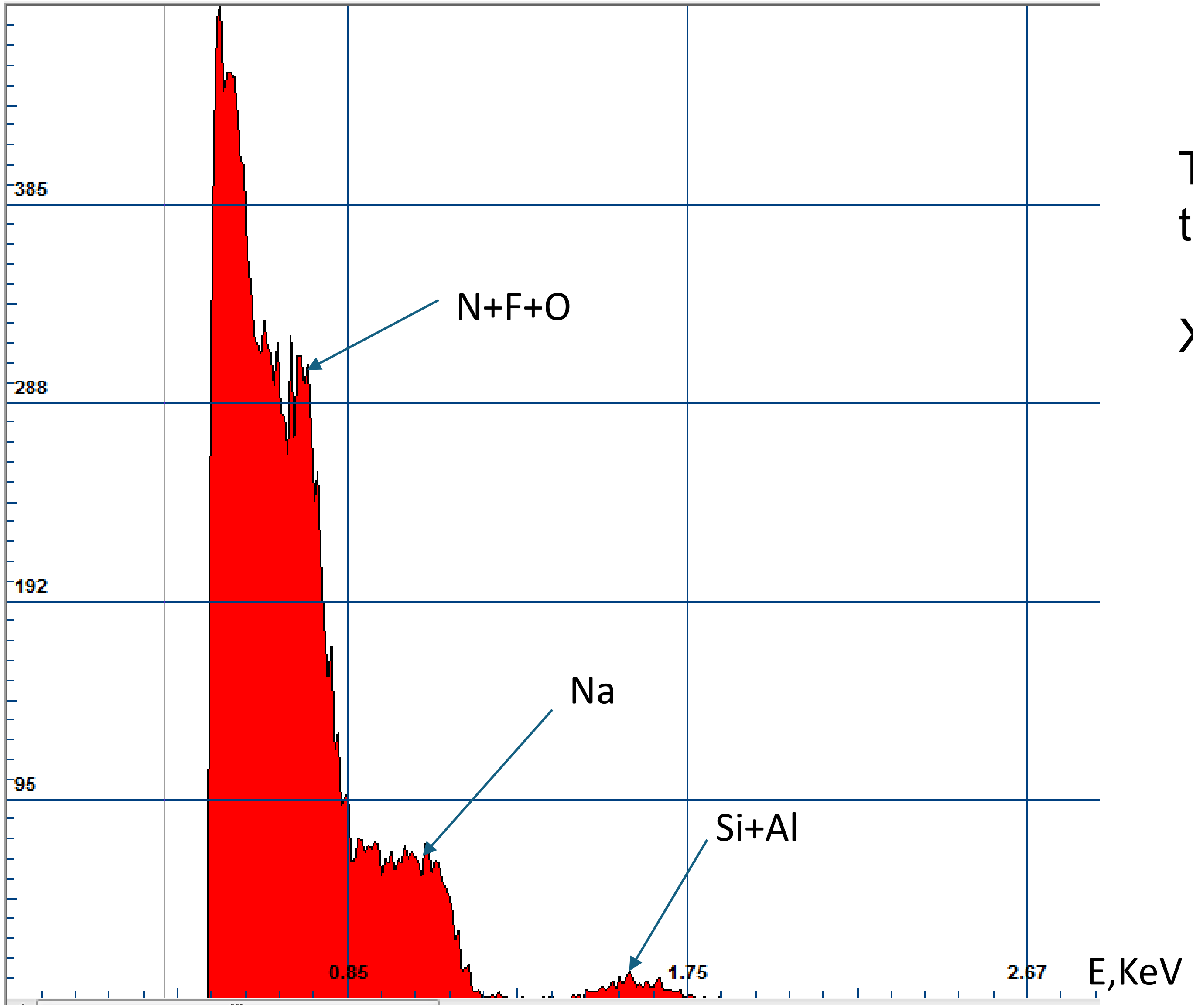


It was found that in heterogeneous plasma spectra the appearance of intense optical lines of new transmuted chemical elements such as **Zn, Ca, Al, Li** is observed.

The Nature of the appearance of these lines is unclear and requires further study.

E (***Ca II***) =**11,87eV**
E (***C II***) = **24,38 eV**
E (***N II***) = **29.06 eV**
E (***Zn II***) =**17.96 eV**

Intensive Flux of Soft X-ray Radiation and Low-Energy Neutrons from the HP Have Been Measured.



Typical soft X-ray radiation spectrum from the **HP**

X-ray spectrograph: - Hitachi-VORTEX-EX

Conclusion

1. A unique plasma setup **MPC-EP** has been created. It is possible to obtain of **a stimulated LENR and its detonation in heterogeneous plasmoid (HP)** created by ***trigger magnetic compressor mechnism*** in this instalation at a static pressure of P_{st} ~ 1 Bar and higher.
2. This **HP** consists of cheap **carbon nano-clustres and hydrogen ions (protons)**.
3. Optical spectra have been obtained in the **HP.** It was revealed that there are many optical lines of new transmuted chemical elements, such as **Li, Al, Ca, Zn** and **their excited states** with high excitation energy about of **20-40 eV.**
4. **Intensive soft X-ray radiation** with a quantum energy of **E < 2 KeV** and **a flux of low-energy neutrons** have been detected in the **HP.**
5. The estimated specific release of extra thermal energy in the HP is about of **2 MeV/atom**

Thank you very much!!!!