TECHNICAL CHARACTERISTICS & PERFORMANCE OF THE DEFKALION'S HYPERION PRE-INDUSTRIAL PRODUCT

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***Abstract*—Understanding of the environment that seems common to all successful lab and industrial methods and naturally occurring LENR observed phenomena allows identification of an LENR nuclear-active-environment. When this environment is combined with a reaction control mechanism, many testable predictions result. The common nuclear active environment in which LENR occurs is proposed to be vacancies in the crystal lattice of a heavy metal of a critical size and geometry where excited atoms of hydrogen interact. This process results in different transmutation paths, followed by a resonance process that dissipates energy by emission. DGTG's Hyperion Ni-H LENR reactor is presented, followed by measurements and data collected during different test protocols as well as measurements of transmutations and an open proposal to the scientific community towards LENR industrialization.**

***Index Terms*—LENR, Hyperion, LENR industrialization.**

I. INTRODUCTION

Twenty-three years after Fleischmann and Pons (F-P) announced discovery of "cold fusion", aka Low Energy Nuclear Reaction (LENR), a general acceptable term within the small research community of this field, describing the common basis of observed phenomena or anomalies from interactions between H or D with heavy or light elements, is still absent. The lack of such definition, as well as lack of any independent international scientific body to define standards towards LENR's industrialization, are major obstacles to progress.

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Attempts have been made by various theoreticians to propose a mechanism to explain how the Coulomb barrier can be reduced within the Pd/D or Ni/H or other metal hydride lattices. These models generally involve changing the energy or local concentration of electrons. Initiation of a nuclear reaction in ordinary materials by such processes is prevented by chemical effects, initial conditions, and geometries involved, as discussed in this paper. Instead, the approach used to build the Hyperion LENR Reactor assumes a novel structure in the material enables the LENR process. The mechanism that causes the nuclear reactions occurs only within this structure, which we refer to as the "nuclear (or nuclei) active environment" (NAE). Once this environment forms and is populated by "excited" hydrogen atoms in a Rydberg state, a series of nuclear reactions follows in a dynamic environment influenced by the initial conditions. The challenge is to identify the NAE's characteristics, create as much of it as possible, distribute it properly within a reactor, and then control the reaction. Identification can be accomplished by searching for universal conditions present during all successful production of LENR regardless of the method used or chemical system. Once such a NAE identified, the search for the theoretical mechanism that produces LENR will become easier. Many efforts to understand LENR have been unsuccessful because they reversed this process, by searching for the mechanism first within a single material, such as in H isotopes, Pd or Ni, while ignoring unique NAE's that would be present in all active materials regardless of their composition or method used.

In this paper we present such an NAE as well as an explanation, based on test data on DGTG's LENR Ni/H Hyperion lab prototypes. We address how such reactions can be triggered in nature and controlled in labs followed by heat emission and transmutations, answering the famous three questions raised by Huizenga without the need to introduce new physics. A Hyperion lab prototype utilizing such reactions as well as test protocols used and some test results are presented or referenced. However, certain technical details will be limited to protect DGTG's IP and patent preparations in progress.

Finally, an open cooperation proposal to the scientific community towards LENR industrialization has been included.

II. TECHNICAL PRESENTATION

A. *LENR in nature: What we already know.*

It is well known for decades that fusion phenomena occur in nature or even in man-made structures at low temperatures (less than 10^4K) and low pressure.

Kim *et al* [1] has proposed a theorem on anomalous low-energy enhancement of reaction cross sections observed in sub-barrier heavy-ion fusions and also in light nuclei fusions relevant to original nucleosynthesis and stellar evolution's Pre Main Sequence (PMS) phase.

Another example is Widom, Srivastava, Larsen's theory [2] of the sun's corona paradox where low energy nuclear reactions occur at many different locations in and around the sun through flux tubes with collective magnetic energy. This phenomena is consistent with observed heavy metals emitted by the sun and produced in its corona.

Recently Wallace *et al*. [3] summarized knowledge of isotopic abundance changes as a result of hydrogen diffusion in metals or compounds during volcanic activity in earth's crust such as mud explosions as well as the role of several agents such as elements K, F, and B in Terrestrial Nuclear Processes. This offers an explanation for geophysical heat production in the earth's crust and volcanic explosions.

Besides these phenomena which provide evidence of LENR observed in nature, several reports and academic electrical engineering lectures on sulfur transmutations in SF_6 during high voltage transformer malfunctions exist. This issue was faced as a technical problem while no one realized that there could be an opportunity to understand more fundamental science through studying such transmutations and heat emissions in labs.

DGTG's position as a business entity focused on market penetration and commercialization of its LENR technology was heavily inspired by nature. As products do not need theories to succeed , DGTG has no ambitions to define LENR nor to prove or reject relevant theories. However, DGTD fully supports the progress of scientific knowledge and actively supports and engages in scientific research, internationally providing full access to its labs and data through co-operations.

B. The Hyperion reactor, NAE in use and the triggered reactions

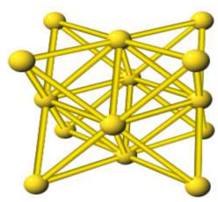
LENR engineering in DGTD's Hyperion reactors involves three main events. NAE forms as the first event. The second event involves hydrogen atoms entering the NAE. Finally, these atoms interact during the third event to cause a series of nuclear reactions. Each of these events can be described as a separate and independent process, starting with the formation of the NAE. The second process, which involves insertion of "excited" hydrogen atoms into the NAE, results in reduction of the Gibbs Energy. The rate of insertion is controlled by an activation energy. This approach allows behavior to be predicted by applying the laws of thermodynamics to a collection of atoms rather than using quantum theory to describe how individual atoms or sub-atomic particles might behave. The actual nuclear reactions that follow, are exothermic and result in nuclear products commonly known to occur.

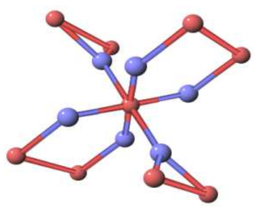
Hyperion LENR Ni/H reactors were engineered by DGTD to manage the last two main events with a control mechanism. Engineering designs were the result of a series of solutions of a geometric-material and team building problem .

B1. Engineering LENR as a geometrical problem

Molecular Hydrogen (H_2) needs to "break" to its atomic form. Several chemical, electrochemical and plasma methods are available . In Hyperion reactors the atomic H has to be "excited" to its Rydberg state. Its electron's trajectory becomes elliptic, so the atom behaves like a dipole. Such dipoles can be polarized and "guided" to a target. At first, we introduced the plasma ignition method (DC pulsed at 24KV/22mA at some KHz) to produce glow discharges in a high pressure (2-8bar) hydrogen envelope, by use of specially shaped tungsten and TZM electrodes, resulting in the above.

We realized that nickel crystals (raw material of 5 microns powder) were "too dense" to act in a LENR reaction, as we desired. We introduced a method to turn the Ni Face Centered Cubic crystals close to a C4 or a Pm3m structure, removing all of the face atoms and some Ni atoms in the edges, using a proprietary technique.





We realized also that ^{58}Ni, ^{60}Ni, ^{62}Ni and ^{64}Ni stable isotopes where "willing" to participate in a LENR reaction, whilst ^{61}Ni was not. So there was no need for any costly enrichment method.

We then had to protect the modified Ni crystals from the high temperatures around the glow discharges (3500 K at its surface, 14000 K in the kernel)[4] distributing them in a special designed "cage" of Ni foam of the same size (5 microns, 200 microns of porous).

Rydberg State Hydrogen (RSH) atoms are short lived, even though their size is relatively big, and they form special bonds with each other. Usually acting in pairs or even in huge lattice-like structures [5]

RSHs need to "travel" towards the NAE without any phase change or total disassociation into protons and electrons, following the magnetic fields created from the plasma current. We use several layers of "agents", coated around a Si-Al ceramic surface surrounding the nickel foam, to help RSH atoms to survive this journey. Some of these agents are ZnO, MgO and ZrO2. We define all such structure of Ni and its surrounding environment as the NAE of the reactions in the Hyperion SS316 lab reactors.

For a period of around 10^{-13} sec, each RSH proton is very close to its electron. Our understanding is that the RSH nuclei is disguised as a neutron. As a result, **Coulomb forces between such nuclei are almost zero** during this short time window.

Heating the NAE to above the Debye temperature (179 ^{o}C for Ni) results in Ni crystal vacancies, created during the NAE preparation phase, changing their atomic separations and shapes. As a result it is known that:

• Nano-charges are created and travel in waves with a speed of 5 km/s between the Ni crystal vacancies[6]

• Huge electrostatic and magnetic forces are created within the nano-NAE vacancies [7],[8]

• Massive interactions occur between the RSH atoms and the NAE [8], [9].

We report that, **when following such a strategy, the result is a series of LENRs, bursting heat energy as long as the Hydrogen atoms are "excited" and polarized**[1].

We have positive results, presented in this paper, from the analysis of NAE with XRF and isotopic mass-spectrometry-ICPMS methods before and after any such LENR of transmutations in:

- Fe-Co-Ni-Cu-Zn and K-Ca , with ppm changes higher than any instrumental analysis error factor
- Li-Be-B species not present before the LENR, detected only by isotopic distract analysis methods (ICPMS).

Any other species (D/T, He or others) were impossible to be traced maybe due to the very short period of their half time.

No high energy gamma emissions have ever been detected nor any gamma emissions outside of the range of 50keV- 300keV have been detected.

The above report indicate strong evidence of a multistage dynamic reaction cycle, dependent on the initial conditions and geometries and controlled by the preparation and excitation of the NAE with heating, pressurizing Hydrogen into the reactor, breaking the H_2 into atoms and "excite" them to their Rydberg states with short controlled glow discharges resulting in:

1. Polarization of RSH atoms from the nano-magnetic fields around the NAE and in the NAE vacancies
2. Interaction of RSH "disguised" protons with the NAE heavy nuclei
3. Transmutation of heavy nuclei followed by gamma emission and heat energy production

followed by

4. Absorption of gamma radiation, most probably by "heavy" electrons
5. Nucleosynthesis of light elements (H to B) followed by heat energy production.

Further optimization of our controls over the total performance of this dynamic multistage LENR cycle is an on going procedure while new specially designed instrumentation for LENR reactors, such as on-line real time spectroscopy, under development by DGDT, will provide new experimental data on each phase of such reaction cycle, providing the scientific community opportunity to build new theories and/or definitions on LENR.

B2. Engineering LENR as a material problem

Creating and maintaining the geometries inside the Hyperion reactor turned to be a serious and complex material problem. New solutions had to be invented, with the cooperation of third labs and institutions, mainly for:

- New technical ceramics (within the reactor)
- Reactor's chamber metallurgy consistent with the specs defined by the reaction's environment (hydrogen leakage, magnetic field noises etc)
- New design of high voltage "spark plugs" that can "survive" inside a LENR reactor
- Safety related materials
- Use of new techniques to produce H from solid state materials
- New coolant media (not changing phase at output temperatures higher than 349 C)
- Data acquisition and control electronics that can "survive" close to the reactor of a Hyperion product.

B3. Engineering LENR as a team challenge problem

Moving from the "garage invention level" up to the industrialization and commercialization level of the LENR technology, we realized that team work and team building strategies are crucial. LENR understanding and control seems to rely on scientific and industrial knowledge from several fields such as astrophysics, metallurgy, volcanism, chemistry, nuclear and plasma physics, nano-science, electrical engineering, heat management, IT,automation and others.

The integration of solutions towards useful and safe commercial products still has to be considered as a challenge for open teamwork and cooperation between the members of the existing small and under-budgeted LENR research community with the emerging LENR industry.

C. Does it work?

First generation Hyperion lab reactors were designed to introduce a robust "triggering" control procedure (start and stop the Ni-H LENR). Results were analyzed using isoparabolic (or static) calorimetric methods.

Second generation lab reactors were equipped with coolant interface and more sensors to perform flow calorimetry and to discover the optimum triggering frequency. Testing[2] of this generation lab Hyperion reactors was based on standards and ICCF literature recommendations [10]

Assistance from experts from eminent international laboratories and National Instruments, has helped us to improve on our setup and to automate all test protocols.

Test and calibration protocols followed the

[1] Measurement methods and results in section C

[2] Photographs and screen shots in the Appendix

procedure:

Calibration of

- Thermocouples
- Digital and Analog Flow meter (scale)
- Electric power analyzer
- Gamma sensors
- Overall calibration using water electric heating elements (water or other coolants cooling the reactor)

Preparation & Run protocol

- Charge the prepared NAE in the reactor
- Electric and Hydrogen leakage tests
- Prepare reactor (dry in vacuum and heat for several hours)
- Preheat reactor (>180C)
- Pump Hydrogen (if not already present)
- Trigger reaction (triggering frequency varies)
- Log all data with NI boards in LabView. These include temperature signals from thermocouples attached inside and around the reactor champer, thermocouples in the coolant media, digital flow meter, pressure digital meters monitoring hydrogen pressure inside the reactor, electric power consumption boards from electric heating elements attached in the reactor and the high voltage triggering source and digital gamma sensors (Sodium Iodine and other Geiger-Muller/dosimeter tubes).
- Analyze data from signals and calculations on performance real time using NI/Lab View systems
- Stop the reaction
- Analyze NAE before and after each test protocol using
  - XRF
  - inductively coupled plasma mass spectroscopy (ICP-MS)
- Evaluate test results versus test protocol's objectives

As a result of several such test protocol runs, we report the performance of the Hyperion lab prototypes as in Table 13. Indicative XRF analysis of possible transmutations has been included in Tables 2 and 3.

TABLE I
RESULTS AND PERFORMANCE

	Minimum	Maximum	Remarks
Operating temperature (in reactor) range	180° C	849° C	Maximum T due to material limitations
Output temperature range	65° C	616° C	Coolant media: Water (65-90 $^{\circ}$C) Water/Glycole(65-170 $^{\circ}$C)
			Thermal oil (65-349 $^{\circ}$C)
DT of "energy bursts" (reaction cycle effect inside the reactor[4])	23° C	87° C	Depends on temperature triggering level
Mean electric energy consumed per triggered reaction cycle	<1Wh	2Wh	
Heat energy produced per reaction cycle	16Wh	92Wh	Depends on temperature triggering level
Over all COP (Total input electric energy : Total output heat energy)	1:8	1:22	Measured in a typical 48h run with a frequency of 10 manually triggered reaction cycles per hour

[3] Repeatability of such test for any scientific body or independent researcher is available at the moment only at DGTD's labs in Greece and Canada following NDA, as already witnessed already by representatives from labs and institutions from EU and USA.

The longest test protocol run so far, using the same charged NAE, lasted for 6 weeks without any drop in the performance. Test duration is heavily related with the material's (not the NAE) resistance to the stress conditions inside the reactor.

TABLE II
XRF ANALYSIS OF NAE[5] (BEFORE A TEST RUN)
TEST ID: 07/18/12 #25

Element	PPM%	+/-
Light Elements[6]	**77.709**	**0.636**
Ni	**9.983**	**0.017**
S	6.954	0.023
Zr	**2.617**	**0.004**
K	**0.972**	**0.013**
Co	**0.807**	**0.006**
P	0.556	0.012
Si	0.185	0.021
Al	0.177	0.076
Zn	**0.029**	**0.001**
Sb	0.012	0.001

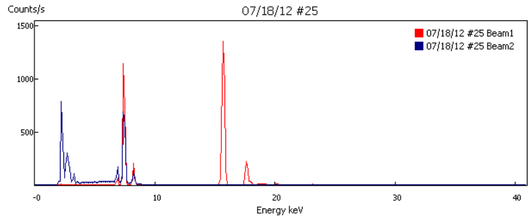


Fig. 1. Graphical analysis of Table II results

[4] Temperature burst signals and energy released per triggered LENR cycle is presented in Fig XX and YY in APPENDIX.

[5] Using Olympus-InnoVx X-5000 equipped with a calibrated Alloy-Plus protocol

[6] Highlighted (bold) elements in Tables II and III indicate elements with significant isotopic changes, as analyzed by ISM-MS

TABLE III
XRF ANALYSIS OF NAE (AFTER A TEST RUN)
TEST ID: 07/18/12 #23

Element	PPM%	+/-
Light Elements	**65.218**	**0.671**
Ni	**19.425**	**0.029**
S	4.827	0.075
Zr	**4.181**	**0.006**
K	**2.635**	**0.069**
Zn	**2.040**	**0.010**
Co	**1.354**	**0.009**
P	1.052	0.060
Ca	**0.716**	**0.036**
Si	0.511	0.103
Fe	**0.391**	**0.006**
Ti	0.281	0.012
V	0.072	0.007
Cu	**0.053**	**0.007**
Cr	0.044	0.004
Sb	0.033	0.002
Pb	0.031	0.001
Sn	0.015	0.001

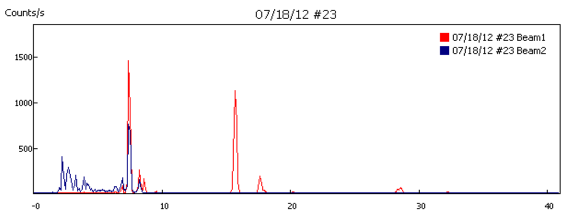


Fig. 2. Graphical analysis of Table III results

D. *Towards an industrialization path of LENR products*

DGTG's plans for the next months include:

- Industrial prototype design and build, following the technical specs released at 11/2011 equipped with
  - Multi-reactor units (9 reactors)
  - Max 45kW(thermal)
- Industrial prototype tests and certifications within the next months
- Setup production lines and support networks within the next year
- Expansion of lab infrastructures in Canada and Switzerland within Q4 of 2012
  - The completion of design, build and test of new instrumentation for LENR such as on On Line- Real time mass spectrometry

Fig. 3. On-line real time mass-spectrometer around a Hyperion reactor (under development)

A successful strategy on LENR commercialization needs to face all the challenges and potentials, such as those analyzed by Dunn[11], as well as crucial still missing prerequisites::

- Standards and protocols for LENR industrial products
- Independent International Scientific and Standards body for LENR definition, industrialization and science. ICCF-17 could play an important role towards this.
- Cooperation in Research
- Cooperation in Development
- Cooperation with more industrial sectors to develop new vertical applications based on LENR products.

DGTG's position is to support any effort towards the above missing prerequisites, providing access to test data and its labs as well as the financial support needed, in analogy to its participation to the emerging market of this new energy source sector.

III. CONCLUSIONS

LENR community in ICCF needs to face the reality and the new challenges of the forthcoming commercialization of LENR. These include the effort of a new definition of LENR and improved theories to fit the experimental data as demonstrated by industry, such as the example of the Hyperion reactors of DGTG.

APPENDIX

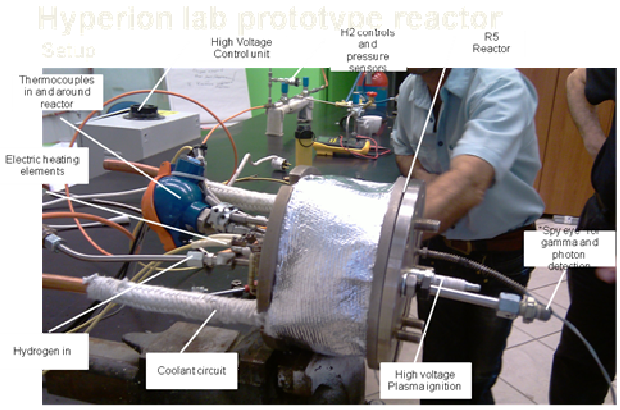


Fig. 3. Hyperion lab reactor (R5) setup

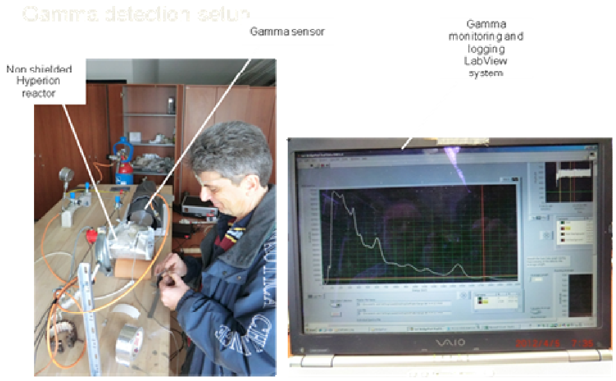


Fig. 4. Hyperion gamma detection setup

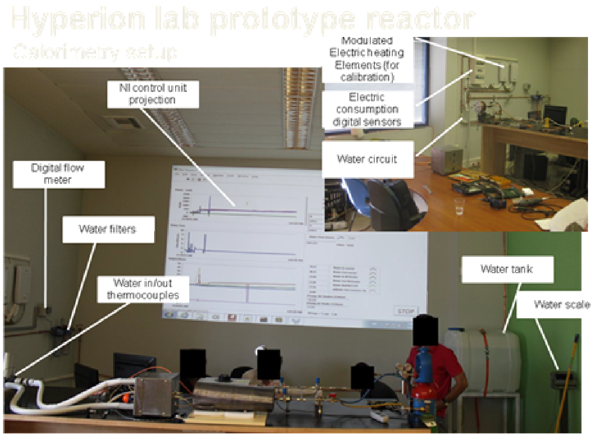


Fig. 5. Calorimetry setup overview

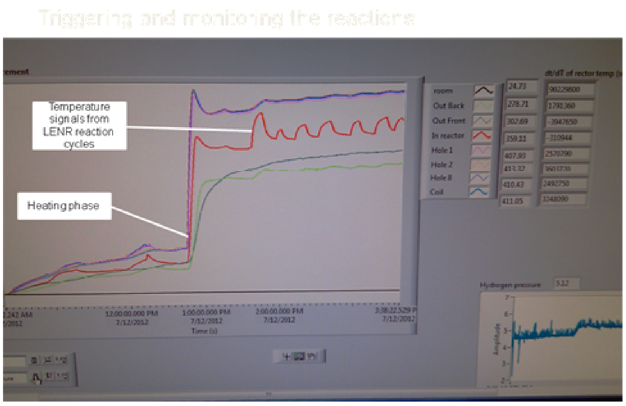


Fig. 6. Monitoring triggered reactions

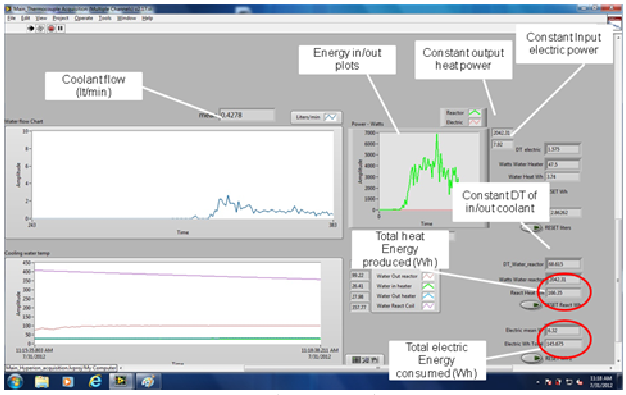


Fig. 7. Monitoring the performance of Hyperion lab prototypes

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