Heat Energy from Hydrogen-Metal Nuclear Interactions

By John Hadjichristos, Defkalion Green Technologies CTO
Peter Gluck, Retired from INCDTIM

Heat Energy from Hydrogen-Metal Nuclear Interactions

Presentation items

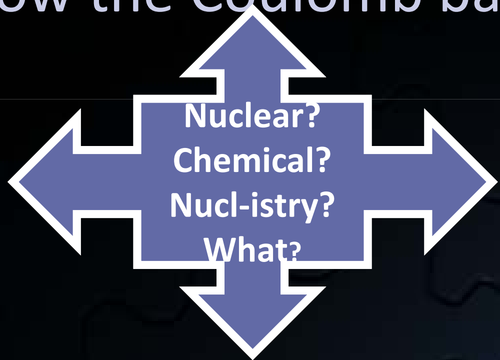
1. **Cold Fusion? LENR?**
   HENI: The need for a new definition
2. **HENI in nature**
   Then, engineering follows
3. **The Hyperion Reactor**
   Behind the scenes
4. **Hyperion Reactor: does it work?**
   Setup, Instrumentation test protocols and results on lab prototypes tests
5. **Towards an industrialization path**
   What is next
6. **References**

1. CF? LENR?

Cold Fusion or Low Energy Nuclear Reaction energy release & transmutations

So far, "defensive" definitions based on numerous observed phenomena in labs versus the "Huizenga's" three questions:

Question #1: how the Coulomb barrier is penetrated



Question #2: the lack of strong neutron emissions

Question #3: the lack of strong emission of gamma or x-rays

…plus one more:

Question #4: What is the level defining "Low Energy?"

Other terms in use…

LENR+

Chemically Assisted Nuclear Reactions (CANR)

Lattice Assisted Nuclear Reactions (LANR)

Lattice Enabled Nuclear Reactions

Condensed Matter Nuclear Reactions (CMNS)

Anomalous Heat Effect

Cold Fusion

…terms used following lab experiments and reporting in 18 ICCFs on:

- Electrochemical loading of Deuteron into Palladium
(Fleischmann–Pons and other numerous repeats)

- Gas Loading of Deuterium into Pd, Ni or alloys, nanoparticles and/or wires nano-coated materials
(Arata; Takahashi&Kitamura; Ahern, Celani and others)

- Gas Loading of Protons into Nickel or other transition metals
(Piantelli, Focardi-Rossi , Mizuno and others)

Followed by numerous reports on

- Anomalous heat production
- Transmutations

Based on

- The “Nuclear” hypothesis ,as dominant
- Linear modeling, ignoring complexities
- Lack of development strategies

And skeptical critics based on

- Poor results, methodologies or measurement instrumentations
- Lack of third party reproduction of experiments
- Lack of a globally accepted theory on the interaction mechanisms on the metal surfaces

Lost opportunities over 25 years

*…"*Cold fusion phenomena are extremely sensitive and much varied nuclear processes appear to take place at localized areas on the surface of some metallic hydrides. The phenomena are generated and stimulated by dynamic factors. Due to their common topology which is not sufficiently controlled at the present, all the phenomena having different mechanisms, appear as chaotic, non-linear, non predictable.
Cold fusion phenomena must be considered as sui-generis heterogeneous catalytic processes and the modern concepts regarding active sites have to be applied in order to understand and direct the reactions"…

UNDERSTANDING REPRODUCIBILITY: TOPOLOGY IS THE KEY.
by Peter Glück [2], 1992

…But ignored since lately

What has changed:

The prerequisites for a paradigm shift

- Huge and increasing demand for clean and safe base energy sources
- Theoretical and experimental evidence
  - Most needed knowledge has been documented and publically announced (although in “bits and pieces”) in different scientific fields (astrophysics, metallurgy, volcanism, chemistry, nuclear and nano-plasma physics, plasmonics and other)
- Existence of new technologies
  - New materials, nanotechnologies
  - IT and lab automation
  - The Internet
- We know that nature can do it!
  - So engineering (μηχανική-which actually means in Greek “cheating the nature for a purpose”), can also do it!

The Paradigm shift

- **Forget** all you know or heard about Cold Fusion/LENR's dogmas!
- Engineering comes first. Then models and theoretical assumptions can be cross-checked

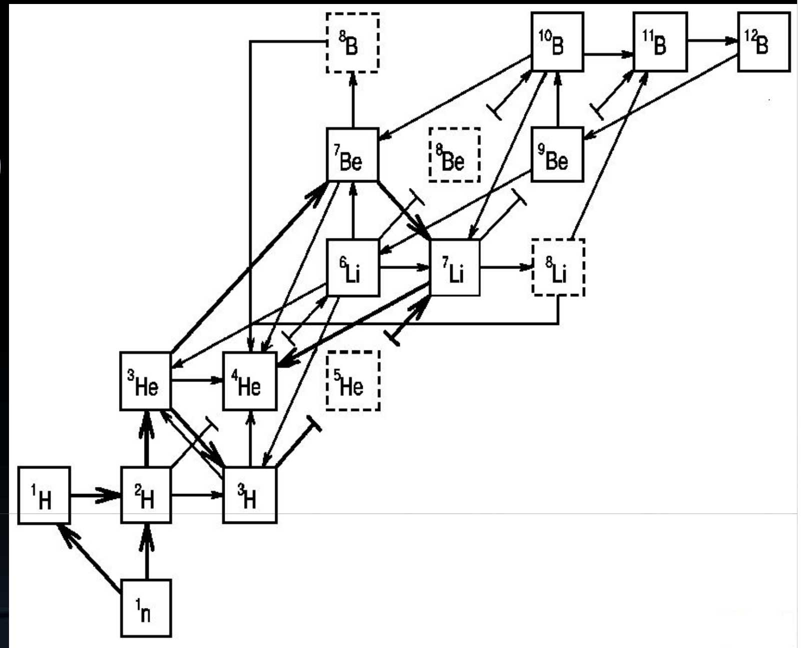
Introducing HENI :
(Heat Energy from Nanoplasmonics/Nanoexplosions Interactions

2. HENI in nature (and not only)

Inspired by nature

- HENI related phenomena in astro-evolution [4]
- HENI as the most probable cause of certain volcanic activity in Earth’s crust [21]
- Transmutations of elements during malfunctions of high voltage equipment [22, 23]

LENR related Phenomena in Stellar-Evolution



- Low Energy Nuclear Reactions (@T<10^4K) During Pre Main Sequence phase (PMS) of the stellar evolution
- Anomalous low-energy enhancement of reaction cross section is observed in sub-barrier heavy-ion fusions and also in light nuclei fusions relevant to original nucleo-synthesis and stellar evolution [4]

Terrestrial Low Energy Nuclear Reactions

- Geophysical heat production in the earth's crust
- Volcanic explosions as a result of Terrestrial Nuclear Processes in the cold earth crust
- Isotopic abundance changes as a result of hydrogen diffusion in metals or compounds during volcanic activity in earth's crust [21]
- Specific "agents" of the terrestrial nuclear processes (K, F, B,…)
- Electromagnetic anomalies and signals prior to seismic events

Transmutations at malfunctions of high voltage equipment

- Sulfur in SF_6 transmutes during high voltage transformer malfunctions (as reported since the last 3 decades in several Electrical Engineering magazines and scientific events) [22,23]

Incident captured on October 30, 2005 at a Pacific Power substation in Corvallis, Oregon by nearby Oregon State University students

- No one ever thought that there could be an opportunity due to such a technical malfunction!

2. The Hyperion Reactor

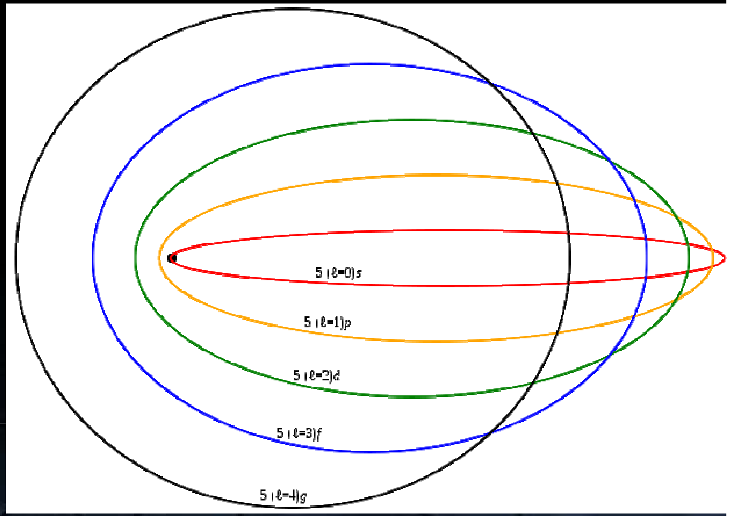
Behind the scenes: Engineering HENI

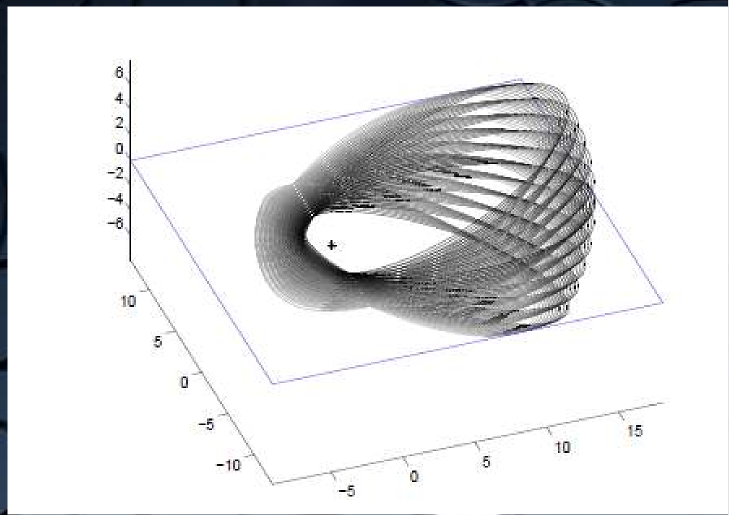
- As a geometrical problem
- As a material problem
- As a team building challenge

Engineering HENI as a geometrical problem

Turning the Hydrogen more reactive

- Very little is really known about the structure of the atomic H!
- Molecular Hydrogen (H_2) needs to "break" to its atomic form. Chemical, electrochemical and plasma methods are available .
- 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 stabilized glow discharges in a high pressure (2-8bar) Hydrogen envelope, by use of special shaped designed Tungsten and TZM electrodes and a negativee feedback magnetic stabilization method to get all the above.

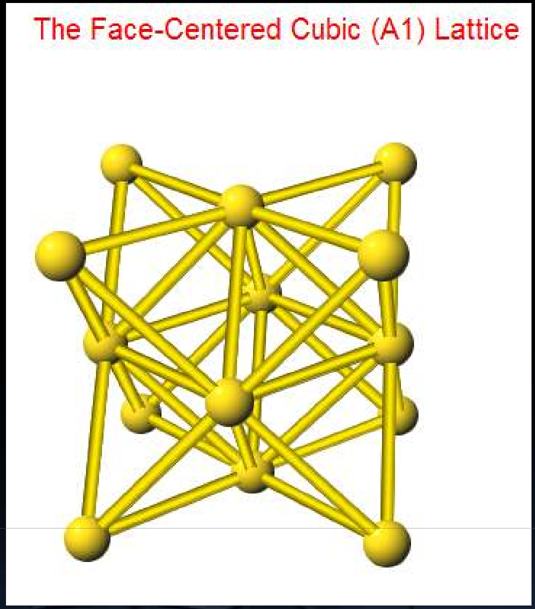


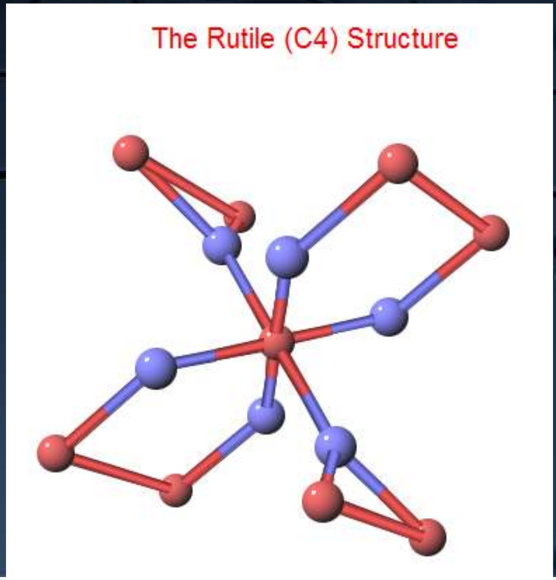


Engineering HENI as a geometrical problem

Making Nickel more receptive

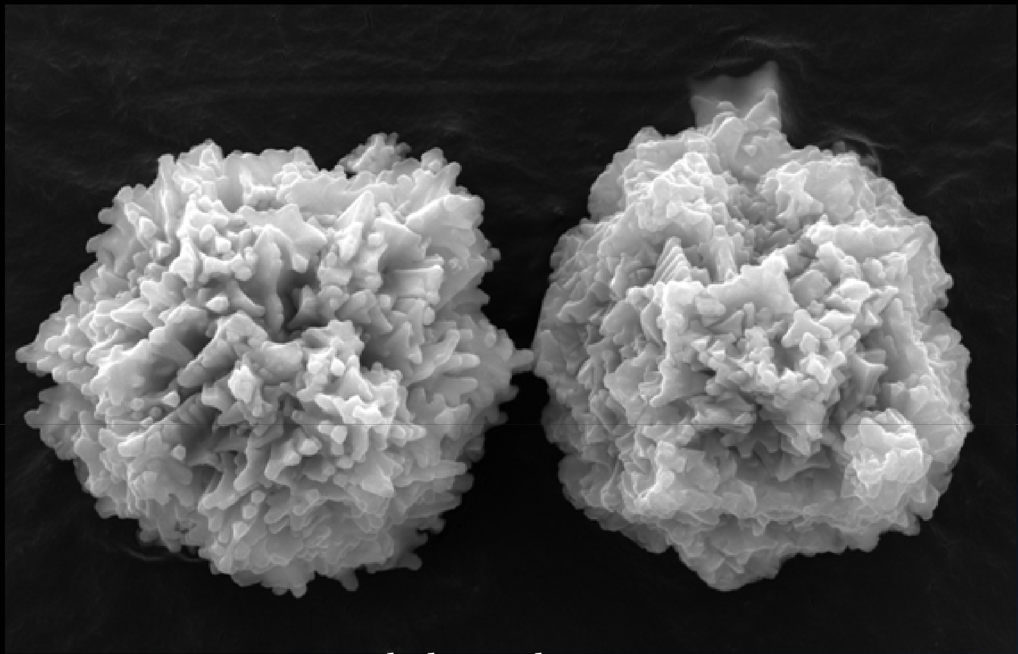
- We realized that Nickel crystals (raw material of 5 microns powder) where "too dense" to act in a LENR reaction, as we wish
- We introduced a method to turn the Ni Face Centered Cubic crystals close to a C4 or a **Pm3m** structure, removing all of the face atoms and some Ni atoms in the edges, using a proprietary technique and take advantage of FCC→BCC transitions in situ
- We realized that ^{58}Ni, ^{60}Ni, ^{62}Ni and ^{64}Ni stable isotopes where "willing" to participate in a HENI reaction, whilst ^{61}Ni was not. So there was no need for any costly enrichment method
- Finally, we had to protect the modified Ni crystals from the high temperatures around the glow discharges (3500K at its surface, 14000K in the kernel) distributing them in a special designed "cage" of Ni foam of the same size (5 microns, 200 microns of porous)





Engineering HENI as a geometrical problem

Nickel raw materials in use



Nickel powder SEM image

Nickel foam SEM image

As a result, Ni, other agents and ceramics create a $48m^2/gr$ surface of NAE (Active Environment)

Engineering HENI as a geometrical problem

Nickel and Hydrogen- Not too far and not too close!

- Rydberg State Hydrogen (RSH) atoms are long lived, whilst their size is relatively big
- RSH need to “travel” towards the NAE without any 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.
- RSH atoms form bonds with each other. Usually they act in pairs or even in huge clusters [3, 18] following Bose-Einstein statistics [5 to 17]
- For a period of around 10^{-13} sec, each RSH in the cluster, trapped by nanomagnetic huge forces on the lattice, is very close to its electron.

Then the RSH nuclei is a “masqueraded” neutron.

- As a result, **Coulomb forces between such nuclei are almost zero** during this short time window [9, 12,13,15,24].

Engineering HENI as a topological problem

What happens inside the Nickel crystal vacancies

- Nothing! (out of ground state collapses, followed some H embrittlment phenomena)
- Unless the Ni crystal vacancies “open and close” changing their size and crystal type. Heating NAE to a higher level than the Debye temperature (179C for Ni) is a good technique for that. Then it is known that
  - Huge electrostatic and magnetic forces are created within the nano-antennas by the dielectric gas [3],[20]
  - Nano-charges are created and propagate in waves with a speed of 5km/s between the Ni crystal vacancies [3, 20], enhanced by gallery whisper effects
  - Massive interactions occur between the RSH BEC clusters in the NAE [24]
- And then… bang! We have HENI bursting heat energy,

as long as the Hydrogen atoms are “excited” and polarized

- But what type of reactions occur?

Understanding HENI

Strong forces or weak forces are involved in HENI?

- Or both?
- We have positive results from the analysis (XRF and isotopic mass-spectrometry ICPMS) of Ni NAE and all “agents” before and after any such HENI of **transmutations** [3] 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 short lived species (H/D/T, He, others?) were impossible to be traced (due to the very short period of their half time?)
- No high energy gamma emissions out of the range of 50keV- 300keV have ever been detected

Understanding HENI

Controlling the reaction

- Prepare and excite the NAE with heating
- Pump or release Hydrogen into the reactor, if not present
- Break the H2 into atoms and "excite" them to their Rydberg state **with short controlled glow discharges**

- Polarization of RSH atoms from the nano-magnetic fields and magnetic traps in the NAE
- Interaction of RSH "disguised" protons with the NAE heavy nuclei
- Transmutation and decays of heavy nuclei followed by low gamma emission and some heat energy production

- Nucleosynthesis of light elements (H to B) followed by heat energy production and EM anomalous emissions

Engineering HENI as a materials problem

- ✓Novel technical ceramics introduced (within the reactor)
- ✓Reactor's metallurgy consistent with the specs defined by the reaction's environment (magnetic fields, noises, H embitterment etc)
- ✓New design of high voltage "spark plugs" that can "survive" in the reactor's stress conditions
- ✓Safety related materials
- ✓Use of new techniques to produce H from solid state materials
- ✓New coolant media (for output temperatures higher than 349 C)
- ✓Data acquisition and control electronics that can "survive" close to the reactor

Engineering HENI as team building challenge

No one knows everything

- Team-work in both business and R&D teams as a core value in our company
- Full collaboration and cooperation with leading entities around the world. Synergies is the name of the game.
- Other institutions (which remain under NDA) have provided invaluable assistance and support in our progress

3. Hyperion Reactor: does it work?

Setup, Instrumentation and results of test protocols on Hyperion lab prototypes

- First generation Hyperion lab reactors where designed to find out a robust “triggering” control procedure (start and stop the Ni-H HENI). Results where analyzed using isoparabolic (or static) calorimetric methods
- Second generation lab reactors where equipped with coolant interface and more sensors to perform flow calorimetry and to discover the optimum triggering frequency
- Standards and literature recommendations where used, as well as assistance from experts from international first level labs, that helped us to improve, on setup and automate all test protocols

Hyperion lab prototype reactor

Performance Test protocols steps [25], http://www.youtube.com/watch?v=HHEtnTO3h6s

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)

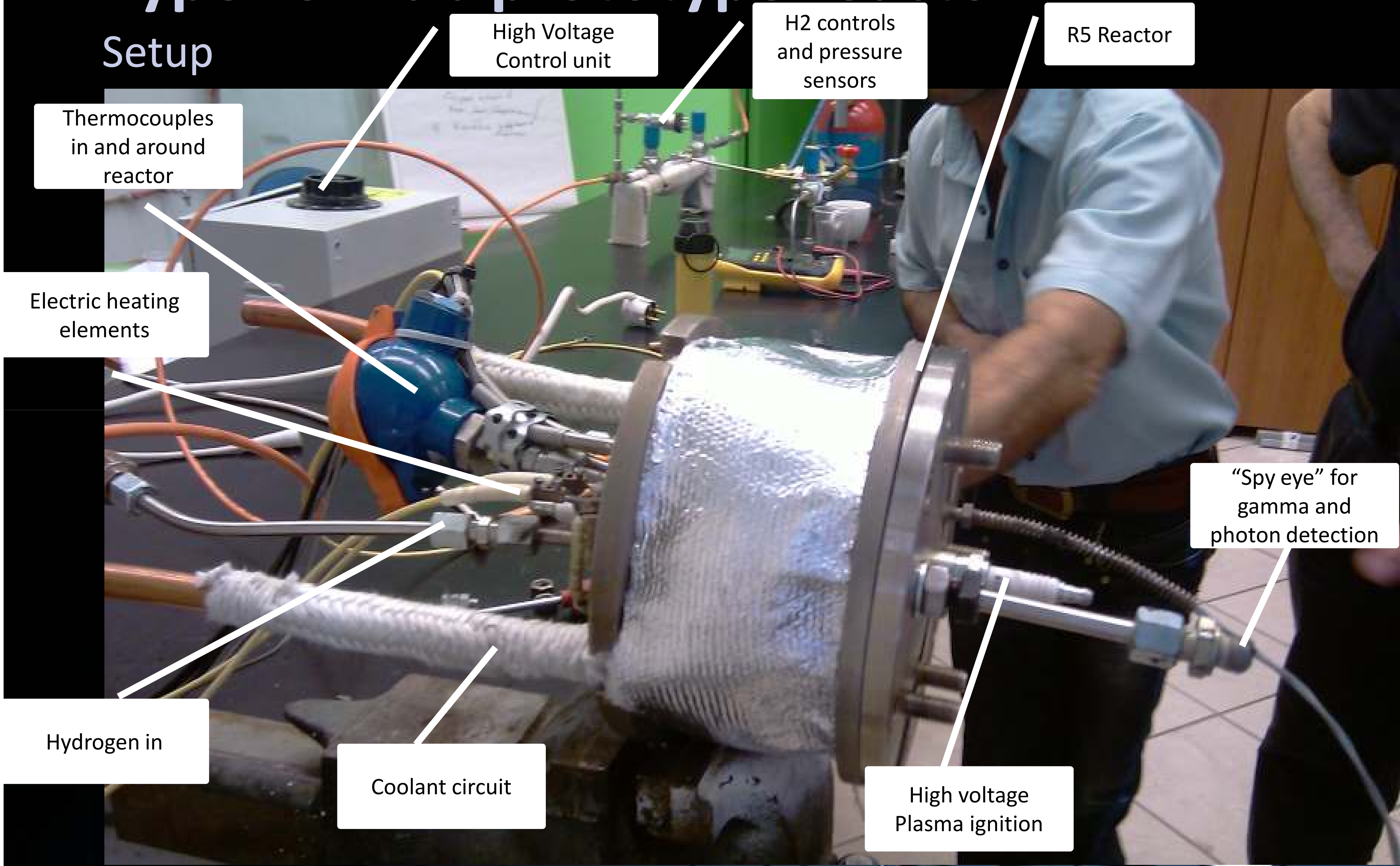
Preparation & Run protocol

- Initiate the reactor with the prepared Active Sites and supportive materials
- Electric and Hydrogen leakage tests
- Prepare reactor (dry in vacuum and heat-several hours)
- Preheat reactor (>180C)
- Pump Hydrogen (if not already in present)
- Trigger reaction (triggering frequency varies)
- Log all data with NI boards in LabView
- Stop reaction
- Analyze data
- Analyze NAE
    - XRF
    - ICP-MS*

* inductively coupled plasma mass spectroscopy

Hyperion lab prototype reactor

Setup



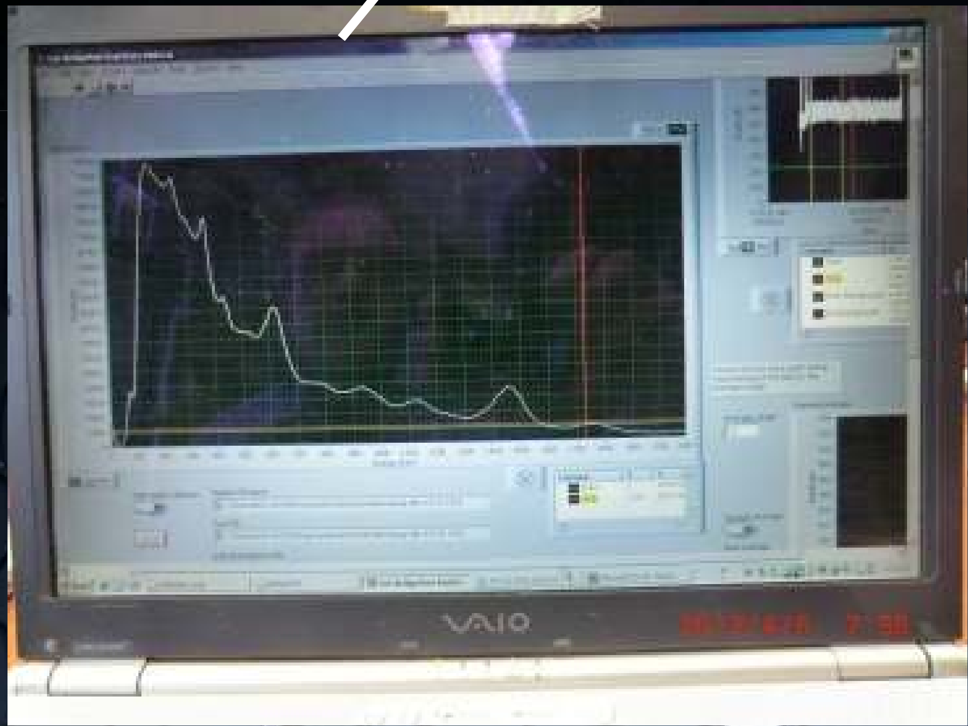
Hyperion lab prototype reactor

Gamma detection setup

Gamma NaI sensor

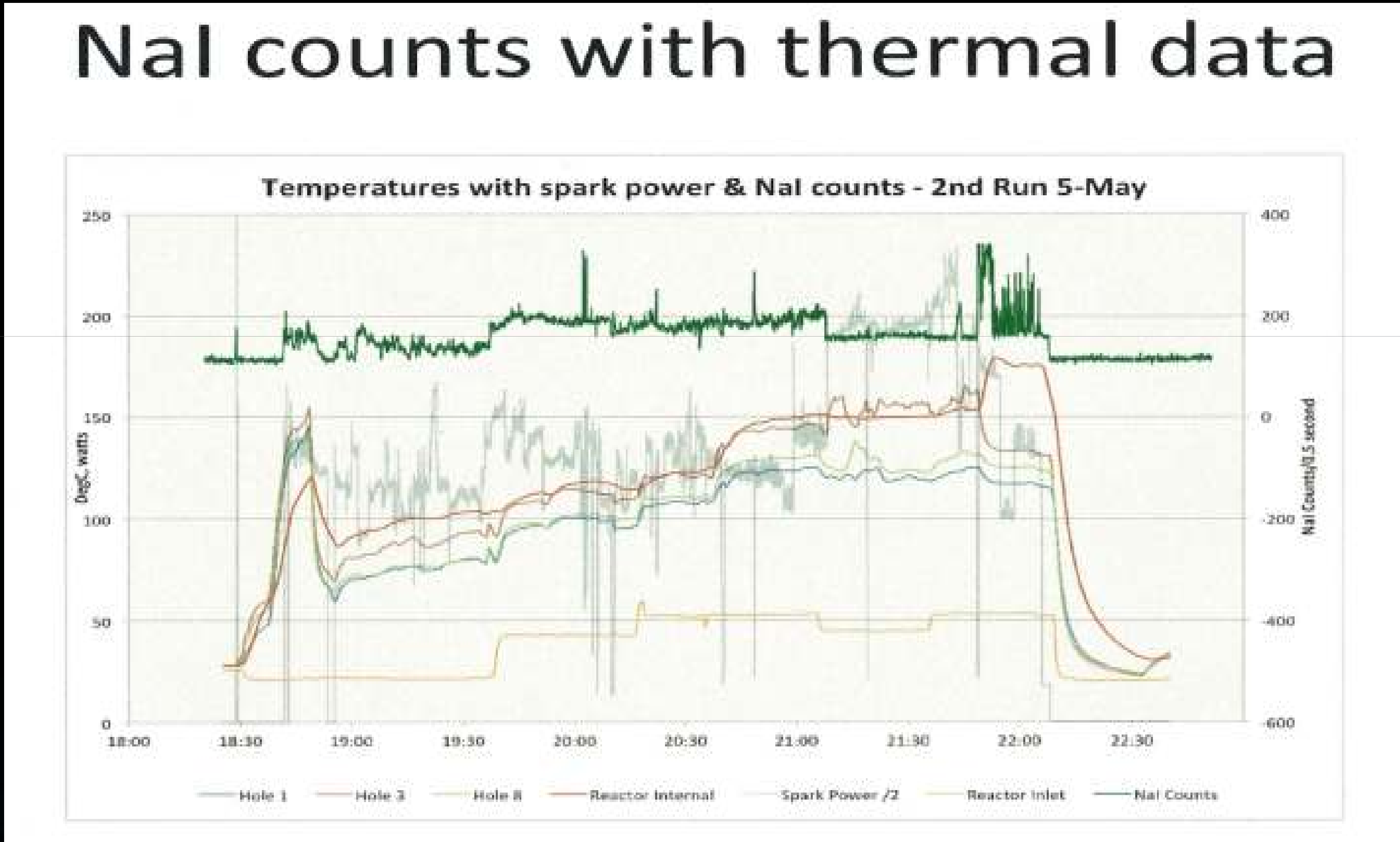
Gamma monitoring and logging LabView system

Non shielded Hyperion reactor



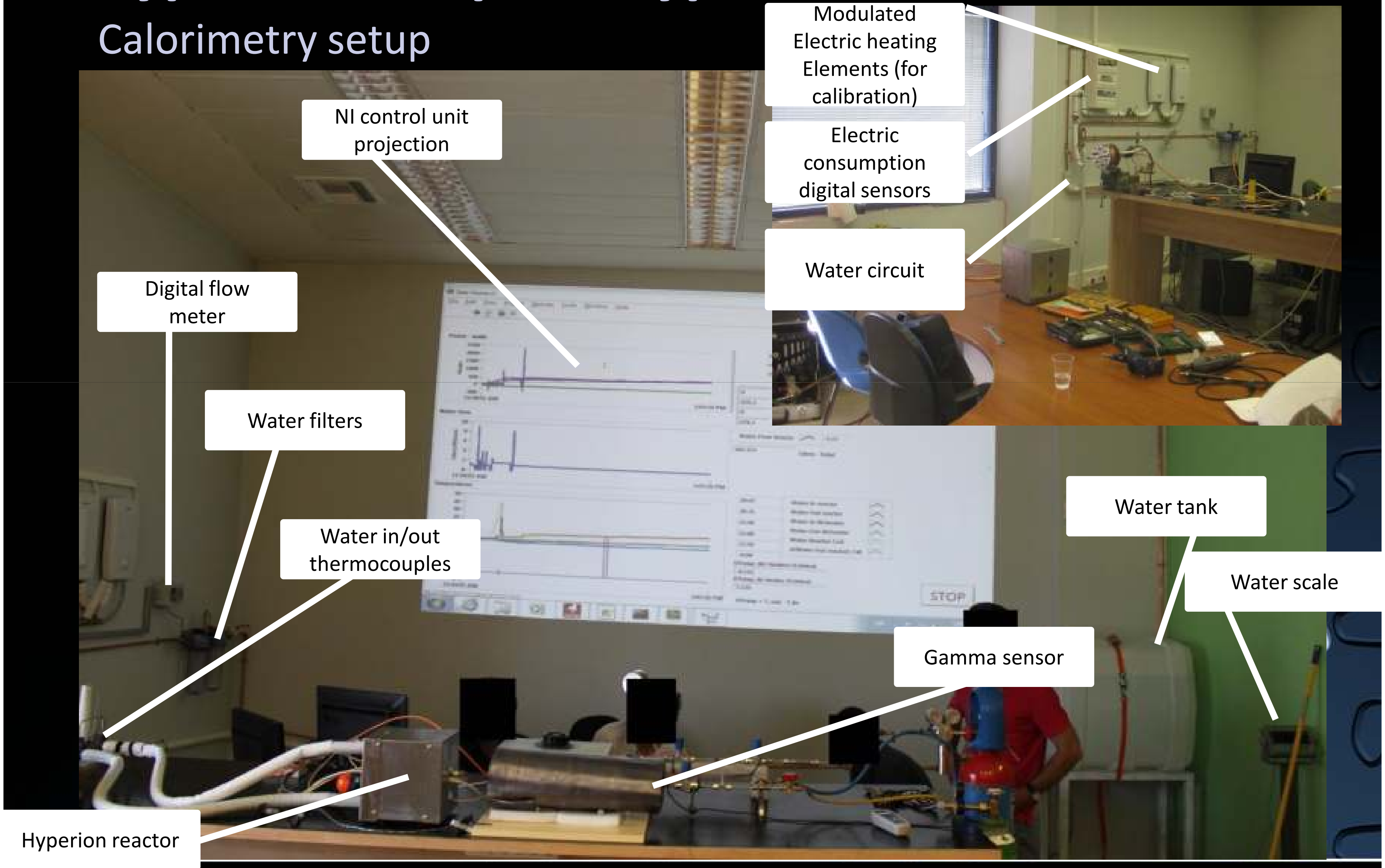
Hyperion lab prototype reactor

Radiation measurements



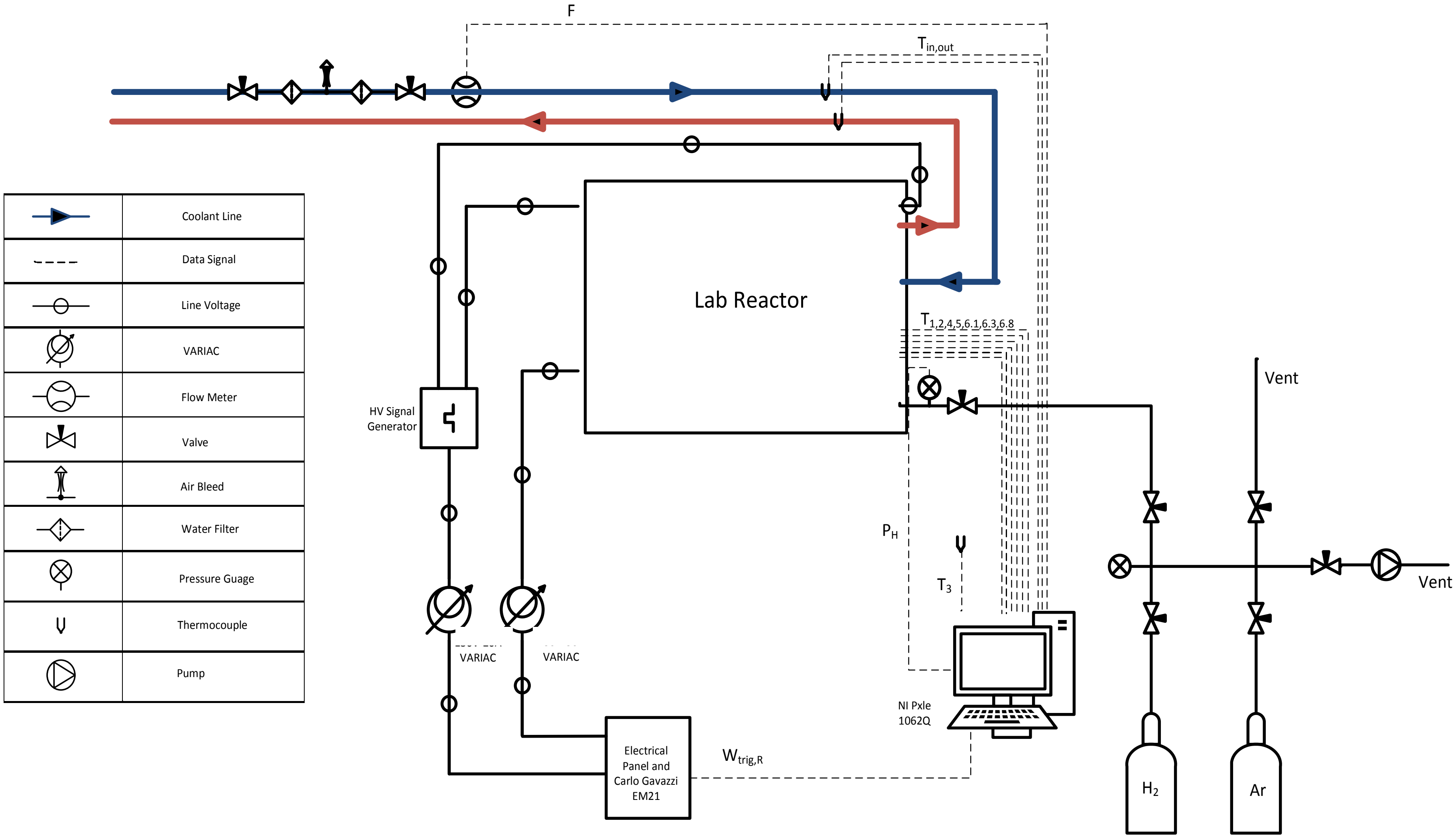
Hyperion lab prototype reactor

Calorimetry setup



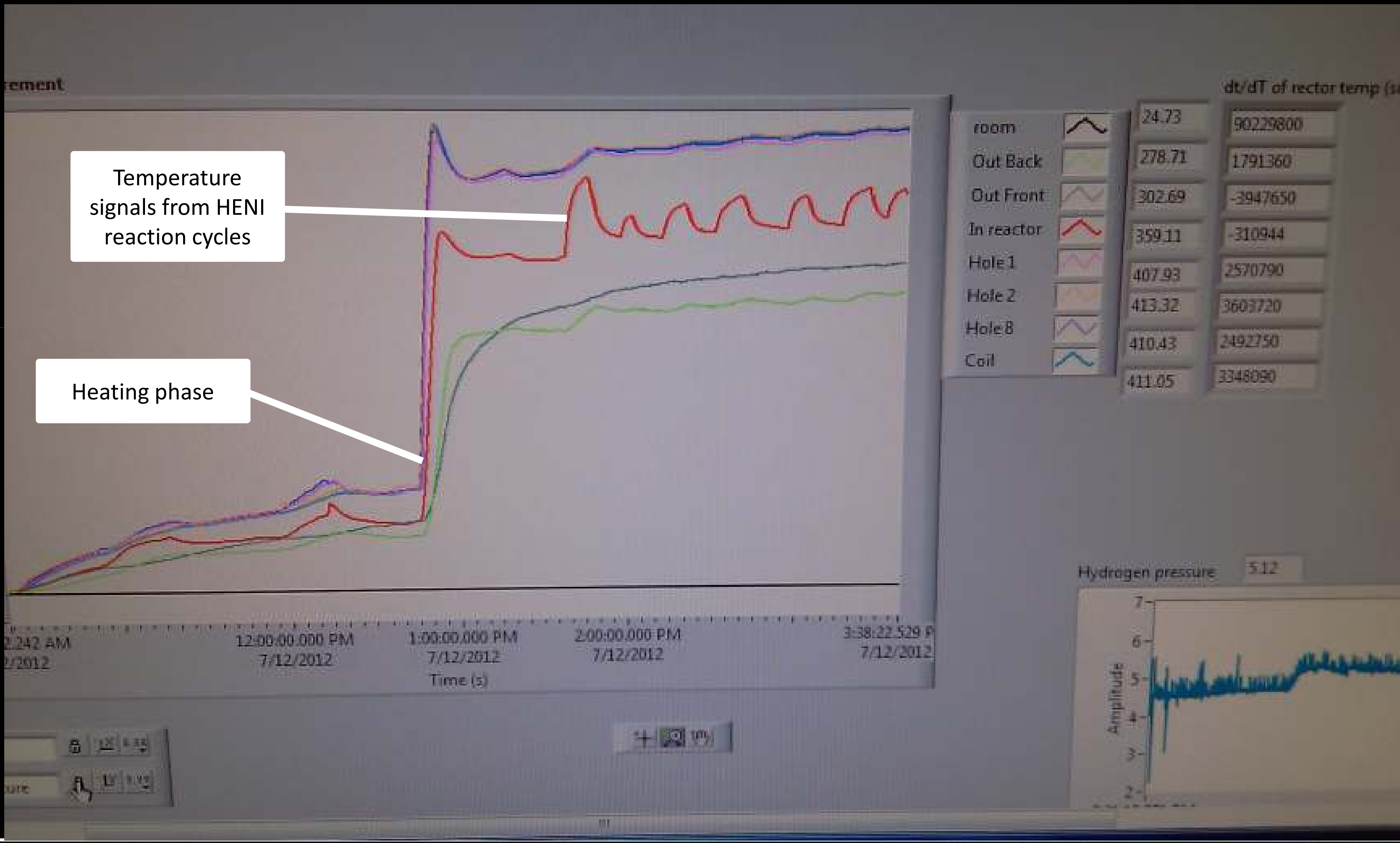
Hyperion lab prototype reactor

Calorimetry setup



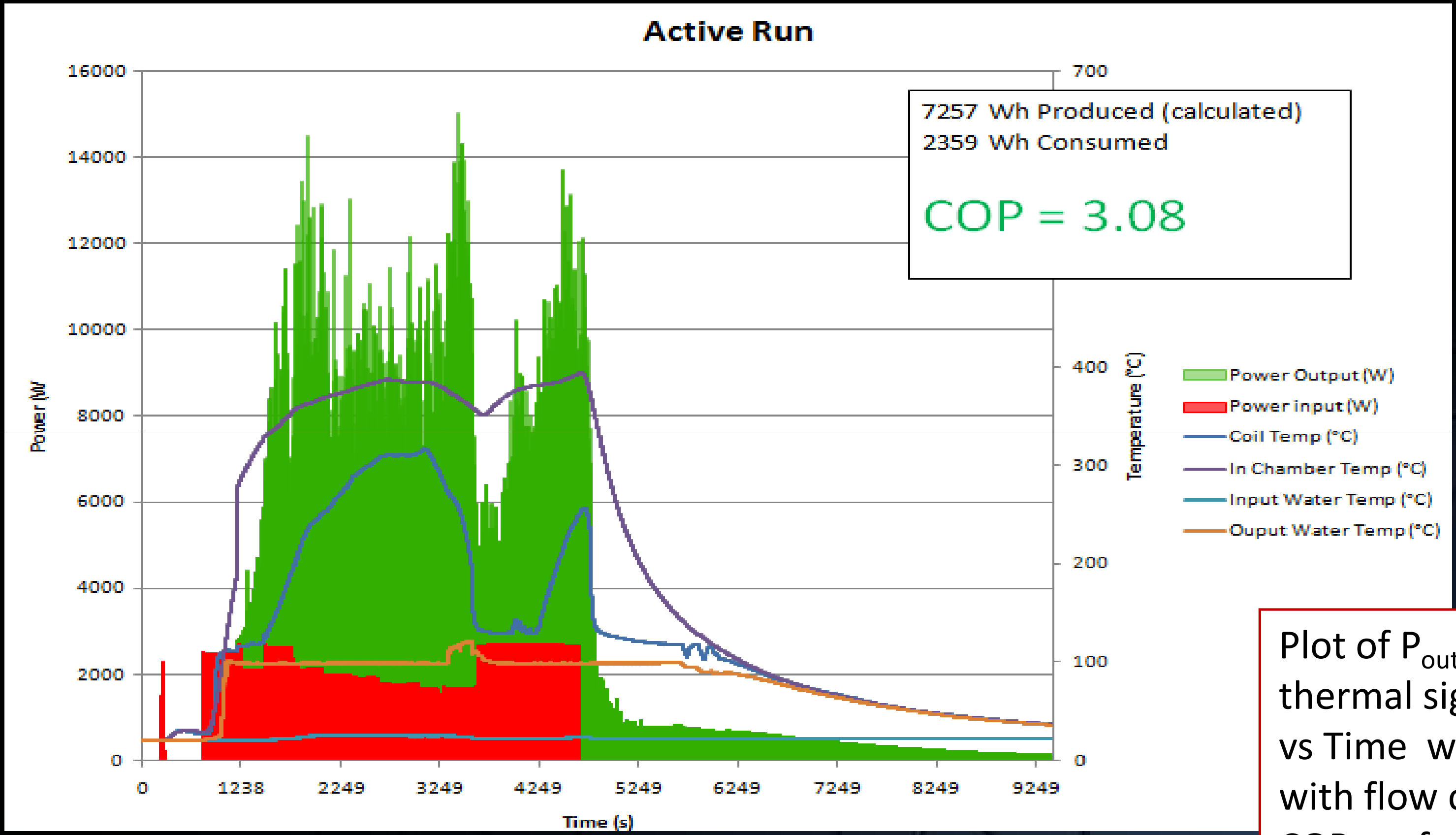
Hyperion lab prototype reactor

Triggering and monitoring the reactions



Hyperion lab prototype reactor

Monitoring the performance

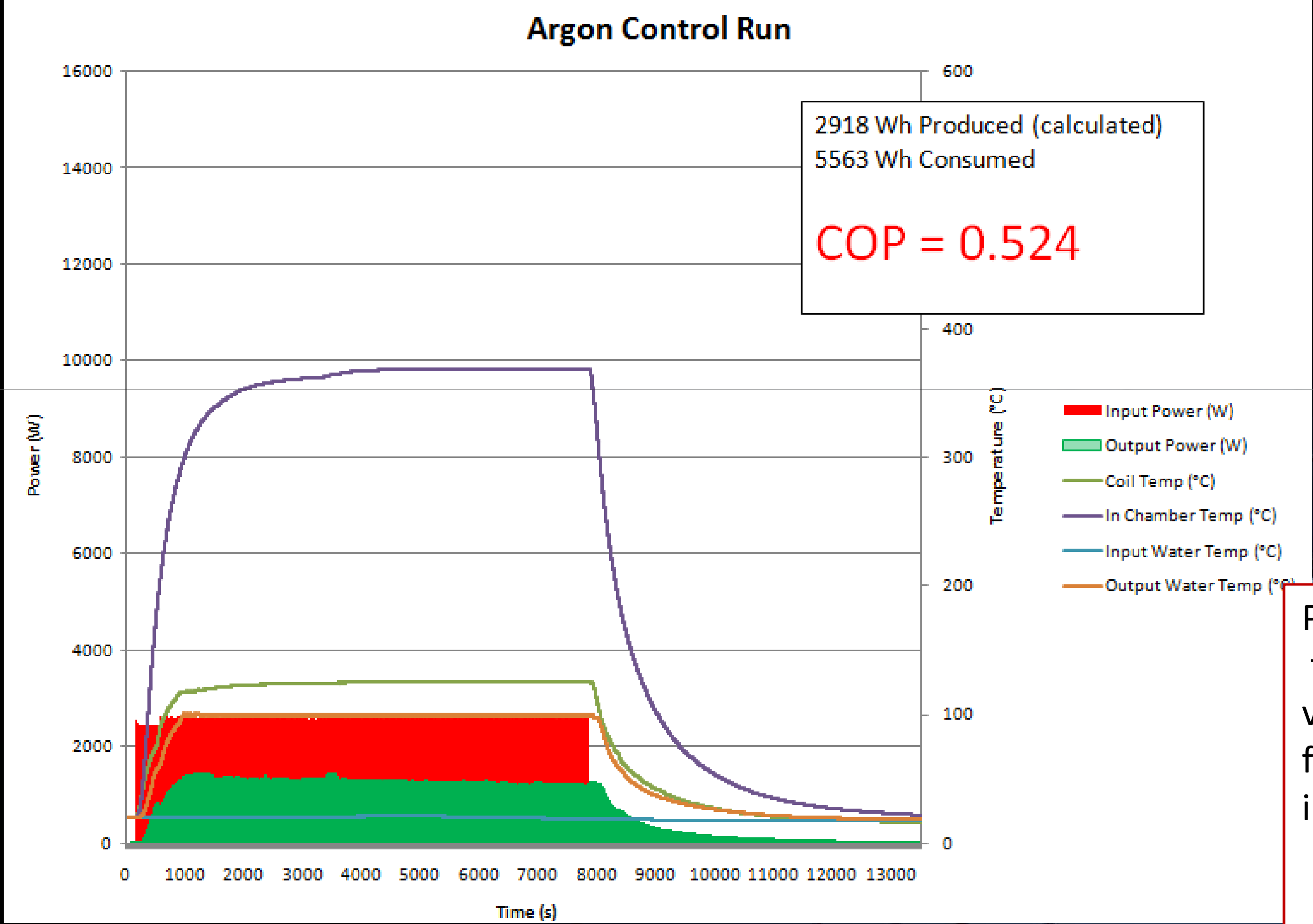


Plot of P_{out} and P_{in} with thermal signals vs Time with Hydrogen with flow calorimeter. COP performance without calculating dry steam enthalpy

May 15, 2013

Hyperion lab prototype reactor

Control of calculated performance



Plot of P_{out} and P_{in} with thermal signals vs Time with Argon with flow calorimeter (same initial and I/O parameters)

May 16, 2013

Hyperion lab prototype reactor

Results and Performance

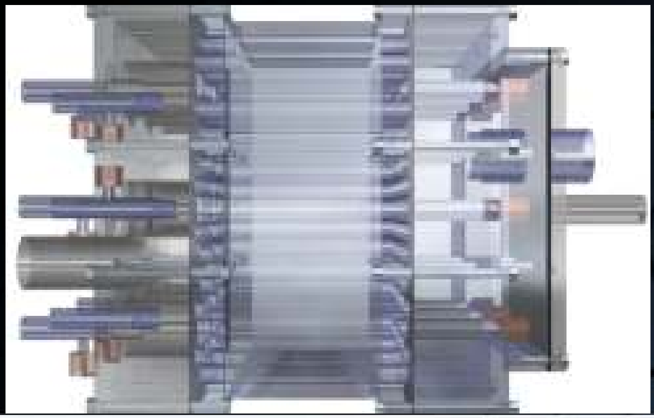
	Min	Max	Remark
Operating temperature (in reactor) range	180C	849C	Maximum T due to material limitations
Output temperature range	65C	616C	Coolant media: Water (65-90 C) Water/Glycole(65-170 C) Thermal oil (65-349 C)
DT of "energy bursts" (reaction cycle effect inside the reactor)	23C	87C	Depends on temperature triggering level
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

4. Towards an industrialization path

What is next

- Industrial prototype design and build (technical specs released at 11/2011)
  - Multi-reactor units (9 reactors)
  - Max 45kW(thermal)
  - Recharge/maintenance every 6 months
- Industrial prototype tests and certifications within the next months (Canada)
- Setup production lines and support networks within the next year (79 countries) with OEM licensing

- Design, build and test new instrumentation for HENI [26]
  - On Line- Real time mass spectrometry



Towards a commercialization path

What has not been completed yet

- Standards and protocols for HENI (or whatever you call it) industrial products
- Independent International Scientific and Standards body for definition, industrialization and science of this new energy sector.
- Cooperation in Research (basic and applied)
- Cooperation in Development
- Cooperation with more industrial sectors to develop new vertical applications based on HENI
- …

References (1)

An indicative list of what we know

1. P. Gluck: "**Some basic principles of Defkalion's LENR technology**",
http://egooutpeters.blogspot.ro/2012/07/some-basic-principles-of-defkalions.html
2. P. Gluck: "**Understanding Reproducibility: Topology is the key**", Fusion Facts vol 3, no11, May 1992

3.J. Hadjichristos, M. Koulouris, and A. Chatzichristos, "**Technical characteristics and performance of the Defkalion's pre-industrial product**," to be published in the Proceedings of the ICCF-17, Daejeon, Korea, 2012.

4.Y. E. Kim, Y. J. Kim, A. L. Zubarev, and J. H. Yoon, "**Optical theorem formulation of low-energy nuclear reactions,**" Phys. Rev. C **55**, 801 (1997).

5.Y. E. Kim and A. L. Zubarev, "**Mixtures of charged bosons confined in harmonic traps and Bose-Einstein condensation mechanism for low-energy nuclear reactions and transmutation processes in condense matters**," in the Proceedings of the ICCF-11, Marseilles, France, 2006, pp. 711-717.

6.Y. E. Kim and A. L. Zubarev, **"Nuclear fusion for Bose nuclei confined in ion traps**," Fusion Technology **37**, 151(2000).

7.Y. E. Kim and A. L. Zubarev, **"Ultra low-energy nuclear fusion of Bose nuclei in nano-scale ion traps,"** Italian Physical Society Proceedings **70**, 375 (2000).

8.Y. E. Kim and A. L. Zubarev, **"Equivalent linear two-body method for many-body problems,"** Phys. B: At. Mol. Opt. Phys. **33**, 55-69 (2000).

9.Y. E. Kim and A. L. Zubarev**, "Ground state of charged bosons confined in a harmonic trap**," Phys. Rev. A **64**, 013603-1 (2001).

10.Y. E. Kim and A. L. Zubarev, **"Equivalent linear two-body method for Bose-Einstein condensates in time-dependent harmonic traps**," Phys. Rev. A **66**, 053602-1 (2002).

11.Y.E. Kim and A.L. Zubarev, **"Time-dependent density-functional theory for trapped strongly interacting fermionic atoms,"** Physical Review A**70**, 033612 (2004).

12.Y. E. Kim, **"Theory of Bose-Einstein condensation mechanism for deuteron-induced nuclear reactions in micro/nano-scale metal grains and particles,**" Naturwissenschaften **96**, 803 (2009) and references therein.

13.Y. E. Kim, **"Bose-Einstein condensate theory of deuteron fusion in metal,"** J. Condensed Matter Nucl. Sci. **4**, 188 (2010), Proceedings of Symposium on New Energy Technologies, the 239th National Meeting of American Chemical Society, San Francisco, March 21-26, 2010.

14.Y. E. Kim, "**Theoretical interpretation of anomalous tritium and neutron productions during Pd/D co-deposition experiments**," Eur. Phys. J. Appl. Phys. **52**, 31101 (2010).

References (2)

An indicative list of what we know

15. Y. E. Kim, "**Nuclear reactions in micro/nano-scale metal particles**," Few-Body Systems **54**, 25-30 (2013). Invited paper presented at the 5th Asia-Pacific Conference on Few-Body Problems in Physics (APFB2011), Seoul, Korea, August 22-26, 2011; to be published in the Proceedings of APFB2011.

16.Y. E. Kim, **"Cryogenic ignition of deuteron fusion in micro/nano-scale metal particles**," Purdue Nuclear and Many Body Theory Group (PNMBTG) Preprint PNMBTG-11-2011 (November 2011). Invited paper presented at Topical Meeting of the 2012 Nuclear and Emerging Technologies for Space (NETS), the 43rd Lunar and Planetary Science Conference, March 19-23, 2012, the Woodlands, Texas.

17.Y. E. Kim, **"Conventional nuclear theory of low energy nuclear reactions in metals: alternative approach to clean nuclear fusion energy generation**," to be published in the Proceedings of the ICCF-17, Korea, 2012.

18.K. Ostrikov, E. C. Neyts, and M. Meyyappan, "Plasma Nanoscience: from Nano-Solids in Plasmas to Nano-Plasmas in Solids" http://arxiv.org/abs/1306.6711

19.Gustav Edman Jönsson, "**Thermal plasmonics Metasurfaces**", Institutionen för teknisk fysik, Kemisk fysik & Institutionen för teknisk fysik, Bionanofotonik, 2013

20.Samuel L. Kleinman et all "**Structure Enhancement Factor Relationships in Single Gold Nanoantennas by Surface-Enhanced Raman Excitation Spectroscopy",** Journal of American Chemical Society, Dec 2012

21. John P. Wallace et all **:"Terrestrial Nuclear Processes: zero momentum light element reactors**", 2012

22. Gregor J., Jakubová I., Šenk J., Mašláni A.: **The role of radiation loses in high-pressure blasted electrical arcs**. Journal of Physics, Conference Series 275 [1], 2011

23. Sun T., Bao H.: **"Non-Mass Dependent Isotope Fractionations of Rarefied Gases (O2, SF6) Under a Thermal Gradient**" American Geophysical Union, Fall Meeting 2010, abstract #V31B-2320

24. Y.E Kim and J. Hadjichristos: **"Theoretical Analysis and Reaction Mechanisms for Experimental Results of Hydrogen-Nickel Systems",** ICCF18 proceedings (to appear), July 2013, https://mospace.umsystem.edu/xmlui/handle/10355/36783

25. http://iccf18.research.missouri.edu/files/day2/Protocol_and_test_results.pdf

26. D. Papanastasiou; I. Orfanopoulos; D. Kounadis; A. Lekkas; I. Nikolos; R. Giles; A. Entwistle; E. Raptakis**: "Performance Characterization of a Differential Mobility Spectrometer Operated in Laminarized Low Pressure Subsonic Flows",** IMS Workshop, ASMS Annual Conference 2013

Putting together all pieces in place

Thank you for your attention!