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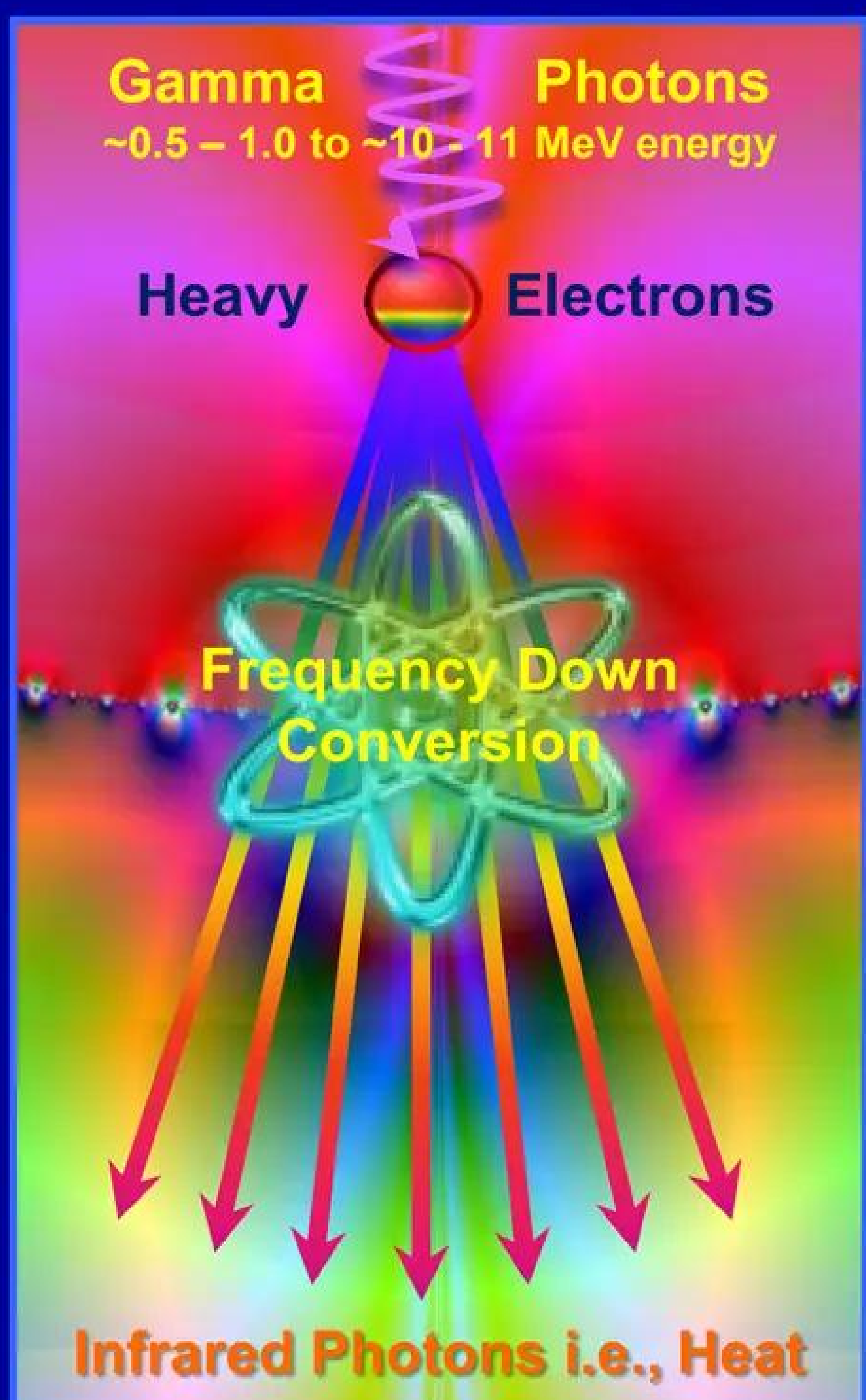
US #7,893,414 B2

"Apparatus and Method for Absorption of Incident Gamma Radiation and its Conversion to Outgoing Radiation at Less Penetrating, Lower Energies and Frequencies"

Inventors: Lewis Larsen, Allan Widom
Issued: February 22, 2011
Assignee: Lattice Energy LLC



Patent Discussion

Dangerous MeV-energy gamma radiation is directly converted into benign infrared heat

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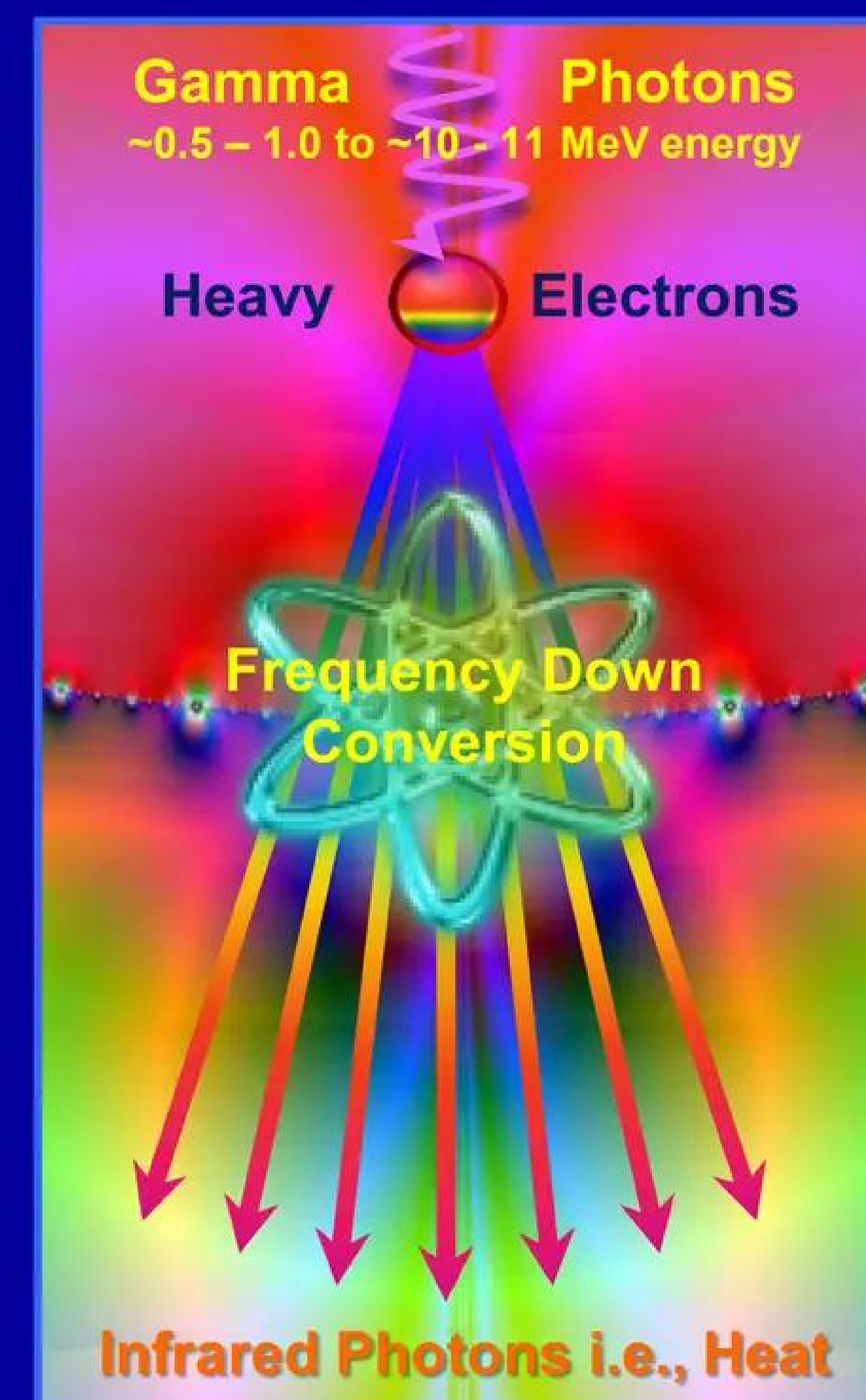

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LENR physics and transmutations now understood and published

Technical papers on the Widom-Larsen theory

"*Ultra low momentum neutron catalyzed nuclear reactions on metallic hydride surfaces*" ***European Physical Journal C - Particles and Fields*** **46 pp. 107 (March 2006) Widom and Larsen** initially placed on arXiv in May 2005 at http://arxiv.org/PS_cache/cond-mat/pdf/0505/0505026v1.pdf; free copy of *EPJC* article available at: **http://www.slideshare.net/lewisglarsen/widom-and-larsen-ulm-neutron-catalyzed-lenrs-on-metallic-hydride-surfacesepjc-march-2006**
"*Absorption of nuclear gamma radiation by heavy electrons on metallic hydride surfaces*" **http://arxiv.org/PS_cache/cond-mat/pdf/0509/0509269v1.pdf (Sept 2005) Widom and Larsen**
"*Nuclear abundances in metallic hydride electrodes of electrolytic chemical cells*" **http://arxiv.org/PS_cache/cond-mat/pdf/0602/0602472v1.pdf (Feb 2006) Widom and Larsen**
"*Theoretical Standard Model rates of proton to neutron conversions near metallic hydride surfaces*" **http://arxiv.org/PS_cache/nucl-th/pdf/0608/0608059v2.pdf (v2. Sep 2007) Widom and Larsen**
"*Energetic electrons and nuclear transmutations in exploding wires*" **http://arxiv.org/PS_cache/arxiv/pdf/0709/0709.1222v1.pdf (Sept 2007) Widom, Srivastava, and Larsen**
"*Errors in the quantum electrodynamic mass analysis of Hagelstein and Chaudhary*" **http://arxiv.org/PS_cache/arxiv/pdf/0802/0802.0466v2.pdf (Feb 2008) Widom, Srivastava, and Larsen**
"*High energy particles in the solar corona*" **http://arxiv.org/PS_cache/arxiv/pdf/0804/0804.2647v1.pdf (April 2008) Widom, Srivastava, and Larsen**
"*A primer for electro-weak induced low energy nuclear reactions*" **Srivastava, Widom, and Larsen *Pramana - Journal of Physics* 75 pp. 617 (October 2010)** **http://www.ias.ac.in/pramana/v75/p617/fulltext.pdf**
"*Erroneous wave functions of Ciuchi et al. for collective modes in neutron production on metallic hydride cathodes*" **http://arxiv.org/pdf/1210.5212v1.pdf (v1 Oct. 17, 2012) Widom, Srivastava, and Larsen**

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Widom-Larsen theory explains all anomalous LENR experimental data

Quoted from Column 24 in the issued patent:

"Together, the four scientific papers by the present inventors comprising Attachments 1-4 can explain all of the major features exhibited in many seemingly anomalous experiments (lumped under the unfortunate term cold fusion) that have previously been regarded by many as theoretically inexplicable. In contrast to earlier theories involving penetration of Coulomb barriers, the present Invention's methods and apparatus for creating low energy nuclear reactions are scientifically reasonable within the context of the well-accepted standard model of electroweak interaction physics. The key process responsible for producing most of the experimentally observed anomalies explained by these publications is not any form of cold fusion, nor is it any form of fission. On the contrary, the key physical processes driving the unique behavior of these systems are primarily weak interactions. The four Attachments extend well-accepted Standard Model physics to include collective effects in condensed matter; no new microscopic physics is assumed or is necessary to explain the data."

Column 24 in patent: LENRs are not "cold fusion" - key aspects electroweak

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surface employed as a cathode within a chemical cell. The electroweak rates of the resulting ultra low momentum neutron production are computed from these considerations."

The arXiv cond-mat/0600059 preprint shows computations demonstrating that the proton to ultra low momentum neutron conversions claimed by the present inventors can take place at substantial production rates inferred from the experimental data that are on the order of 10^{12} to 10^{14} ultra low momentum neutrons per cm^2 per second.

Together, the four scientific papers by the present inventors comprising Attachments 1-4 can explain all of the major features exhibited in many seemingly anomalous experiments (lumped under the unfortunate term cold fusion) that have previously been regarded by many as theoretically inexplicable. In contrast to other earlier theories involving penetration of Coulomb barriers, the present Invention's methods and apparatus for creating low energy nuclear reactions are scientifically reasonable within the context of the well-accepted standard model of electroweak interaction physics. The key process responsible for producing most of the experimentally observed anomalies explained by these publications is not any form of cold fusion, nor is it any form of fission. On the contrary, the key physical processes driving the unique behavior of these systems are primarily weak interactions. The four Attachments extend well-accepted Standard Model physics to include collective effects in condensed matter; no new microscopic physics is assumed or is necessary to explain the data.

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Issued Lattice patent: US 7,893,414 B2

Abstract:

"Gamma radiation (22) is shielded by producing a region of heavy electrons (4) and receiving incident gamma radiation in such region. The heavy electrons absorb energy from the gamma radiation and re-radiate it as photons (38, 40) at a lower energy and frequency. The heavy electrons may be produced in surface plasmon polaritons. Multiple regions (6) of collectively oscillating protons or deuterons with associated heavy electrons may be provided. Nanoparticles of a target material on a metallic surface capable of supporting surface plasmons may be provided. The region of heavy electrons is associated with that metallic surface. The method induces a breakdown in a Born-Oppenheimer approximation. Apparatus and method are described."

Summary:

Gamma 'shielding' mechanism of the Widom-Larsen theory provides a plausible explanation for 'signature' absence of 'hard' >1 MeV gamma emissions from 'green' condensed matter LENRs.

Clean copy of patent as-issued is available at:

http://www.slideshare.net/lewisglarsen/us-patent-7893414-b2

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Explanation of Widom-Larsen gamma shielding mechanism

- ✓ ALL of the many-body particles found within a condensed matter 2 nm to 100 micron 3-D LENR-active 'patch' (in which there is also a total breakdown of the Born-Oppenheimer approximation) — surface plasmon or *π* electrons; protons or deuterons; produced ULM neutrons — oscillate collectively and — key point — are mutually quantum mechanically entangled with each other. This unique characteristic of LENR-active surface sites is explained in great detail in several Lattice SlideShare presentations; *the existence of this Q-M phenomenon is well-supported by recently published, outstanding work by other researchers who operate totally outside the field of LENRs*
- ✓ Because of the above, when an ULM neutron is created collectively, its 3-D DeBroglie wave function must perforce span all three spatial dimensions of the particular LENR-active patch in which it is 'born'. During a brief interval of several picoseconds before such a neutron is locally captured by some atom located with the (we think) oblate spheroidal spatial boundaries of the neutron's extended DeBroglie wave function within a many-body 'patch', it is interacting with MANY different atoms that 'compete' amongst each other to capture it (has a many-body scattering cross-section, NOT 2-body)
- ✓ Note that only a modest percentage of the total number of mass-renormalized electrons located within the 3-D spatial Q-M domain of an LENR-active patch will have absorbed enough energy from the very high (> 2 x 10*11 V/m) local electric field to cross the threshold for making ULM neutrons by a direct e + p electroweak reaction. *Most of the heavier than normal electrons are locally present but unreacted*

Explanation of Widom-Larsen gamma shielding mechanism

- ✓ **When an ULM neutron captures onto an atom located inside the entangled 3-D Q-M domain of an LENR-active patch, there is normally a prompt gamma photon emission by that atom. Well, remember that the DeBroglie wave functions of the entangled, mass-renormalized 'heavy' electrons are also 3-D, NOT 2-D. Since the neutron capture gamma photon emission occurs INSIDE the 3-D quantum mechanical structure of a 3-D LENR-active 'patch', there are always heavy electrons available nearby to absorb such gamma emissions and convert them directly into infrared photons. Ergo, it doesn't matter where a gamma emission occurs inside a given 3-D patch, it will always get converted to IR, which is exactly what has been observed experimentally.** ***You will not observe large fluxes of 'hard' gammas emitted from such a 3-D patch, no matter which x-y-z direction they are measured from***

- ✓ **The above 'shielding' also applies to any gammas that might be produced in conjunction with beta-decays of unstable, extremely neutron-rich isotopes that are briefly present in LENR-active patches before they 'die.' The vast majority of these very short-lived intermediate nuclear products will have disappeared in serial cascades of beta-decay chains into end-product stable isotopes/elements before the dynamic local population of heavy-mass electrons goes completely away. Again, this prediction is very consistent with what is seen experimentally:** ***with mass spectroscopy, post-experiment you can observe the presence of stable transmutation products in which prompt capture gammas were undoubtedly produced along the likely nucleosynthetic pathway, but no 'hard' gamma fluxes can ever be measured during the process of LENR transmutation itself. Ergo, the gammas were converted to something else --- namely infrared (IR) photons that are manifested calorimetrically as 'excess heat'***

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Cover page of patent: shows pertinent details

(12) **United States Patent**
Larsen et al.

(10) **Patent No.:** **US 7,893,414 B2**
(45) **Date of Patent:** **Feb. 22, 2011**

(54) **APPARATUS AND METHOD FOR ABSORPTION OF INCIDENT GAMMA RADIATION AND ITS CONVERSION TO OUTGOING RADIATION AT LESS PENETRATING, LOWER ENERGIES AND FREQUENCIES**

(75) Inventors: **Lewis G. Larsen**, Chicago, IL (US); **Allan Widom**, Brighton, MA (US)

(73) Assignee: **Lattice Energy LLC**, Chicago, IL (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 357 days.

(21) Appl. No.: **12/065,784**

(22) PCT Filed: **Sep. 8, 2006**

(86) PCT No.: **PCT/US2006/035110**

§ 371 (c)(1), (2), (4) Date: **Aug. 14, 2008**

(87) PCT Pub. No.: **WO2007/030740**

PCT Pub. Date: **Mar. 15, 2007**

(65) **Prior Publication Data**

US 2008/0296519 A1 Dec. 4, 2008

Related U.S. Application Data

(60) Provisional application No. 60/715,622, filed on Sep. 9, 2005.

(51) **Int. Cl.**
G21F 7/00 (2006.01)

(52) **U.S. Cl.** **250/515.1**; 250/505.1

(58) **Field of Classification Search** 250/505.1, 250/515.1
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,887,042 A 3/1999 Akamatsu et al.

OTHER PUBLICATIONS

International Search Report re application No. PCT/US2006/035110, dated Mar. 14, 2007.
Written Opinion re application No. PCT/US2006/035110, dated Mar. 14, 2007.

Primary Examiner—Robert Kim
Assistant Examiner—Hanway Chang
(74) *Attorney, Agent, or Firm*—Edward D. Manzo; Husch Blackwell LLP

(57) **ABSTRACT**

Gamma radiation (**22**) is shielded by producing a region of heavy electrons (**4**) and receiving incident gamma radiation in such region. The heavy electrons absorb energy from the gamma radiation and re-radiate it as photons (**38**, **40**) at a lower energy and frequency. The heavy electrons may be produced in surface plasmon polaritons. Multiple regions (**6**) of collectively oscillating protons or deuterons with associated heavy electrons may be provided. Nanoparticles of a target material on a metallic surface capable of supporting surface plasmons may be provided. The region of heavy electrons is associated with that metallic surface. The method induces a breakdown in a Born-Oppenheimer approximation Apparatus and method are described.

23 Claims, 24 Drawing Sheets

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Figure 18 in patent: shows conversion of gamma into infrared (IR) photons

Figure 18. Schematic conceptual diagram showing absorption of a gamma photon by a heavy electron and re-radiation of the energy received from the gamma photon as a mixture of outgoing infrared and soft X-ray photons

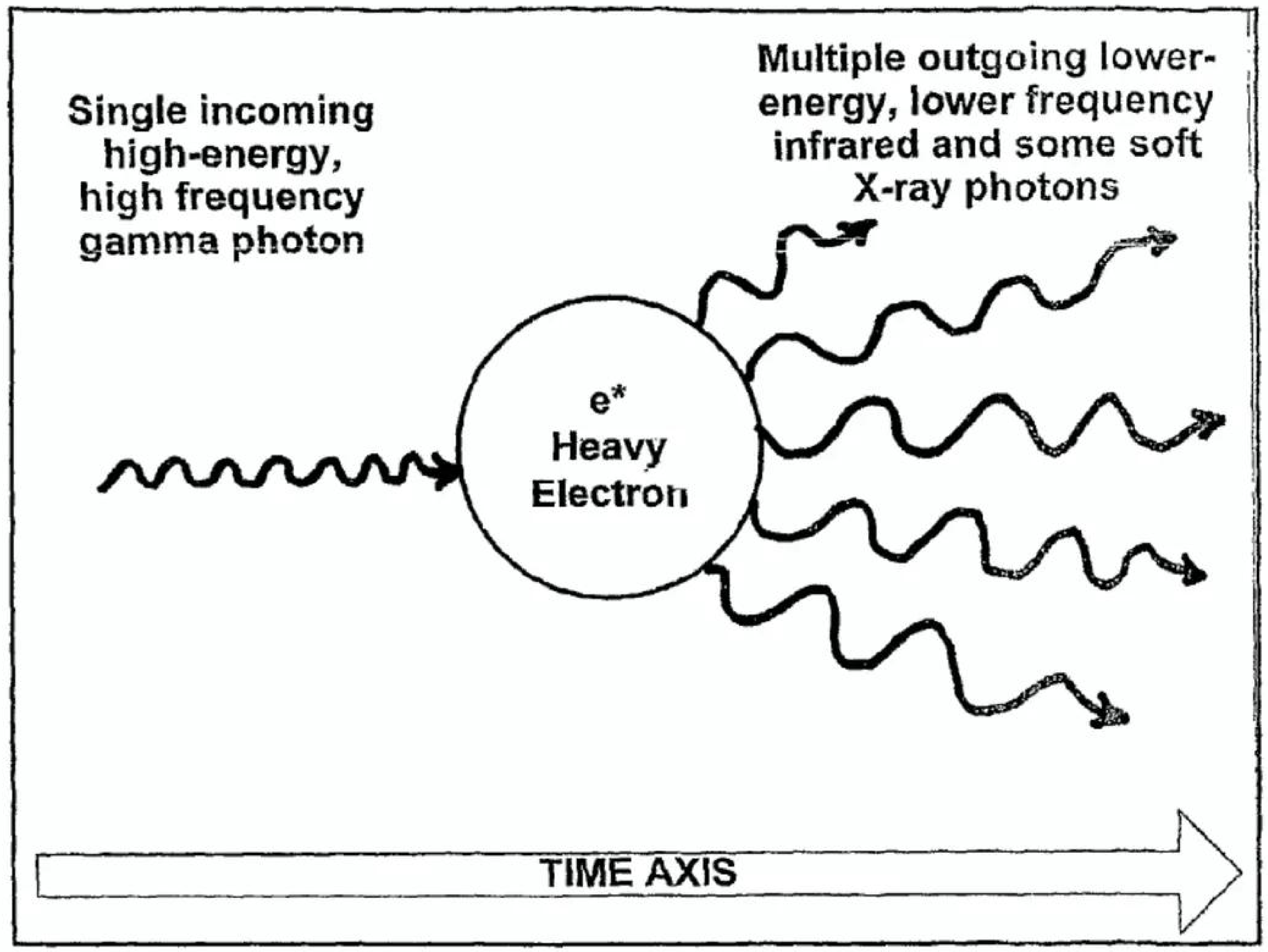


Figure 23 in patent: shows many-body LENR-active 'patches' + nanoparticles

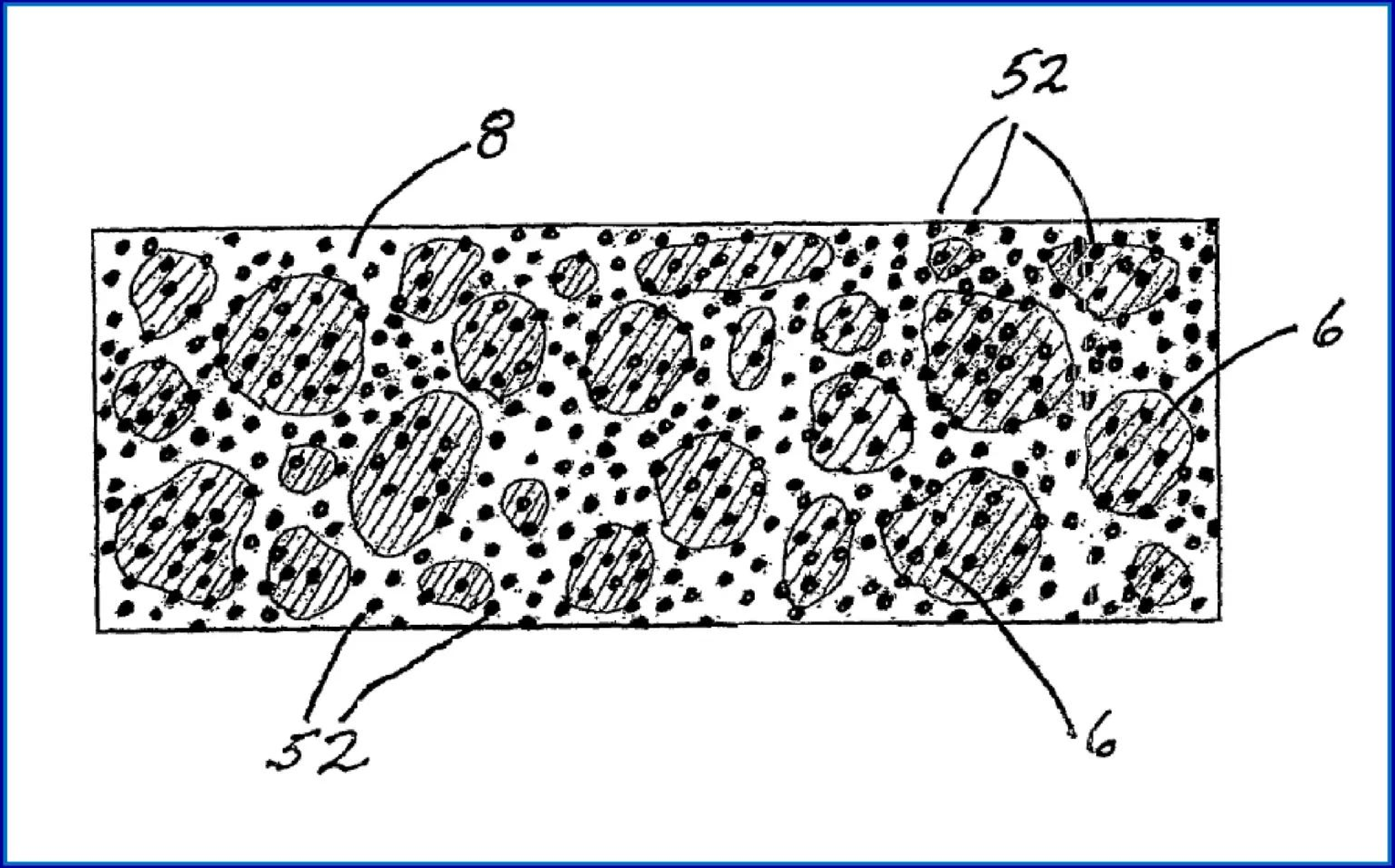
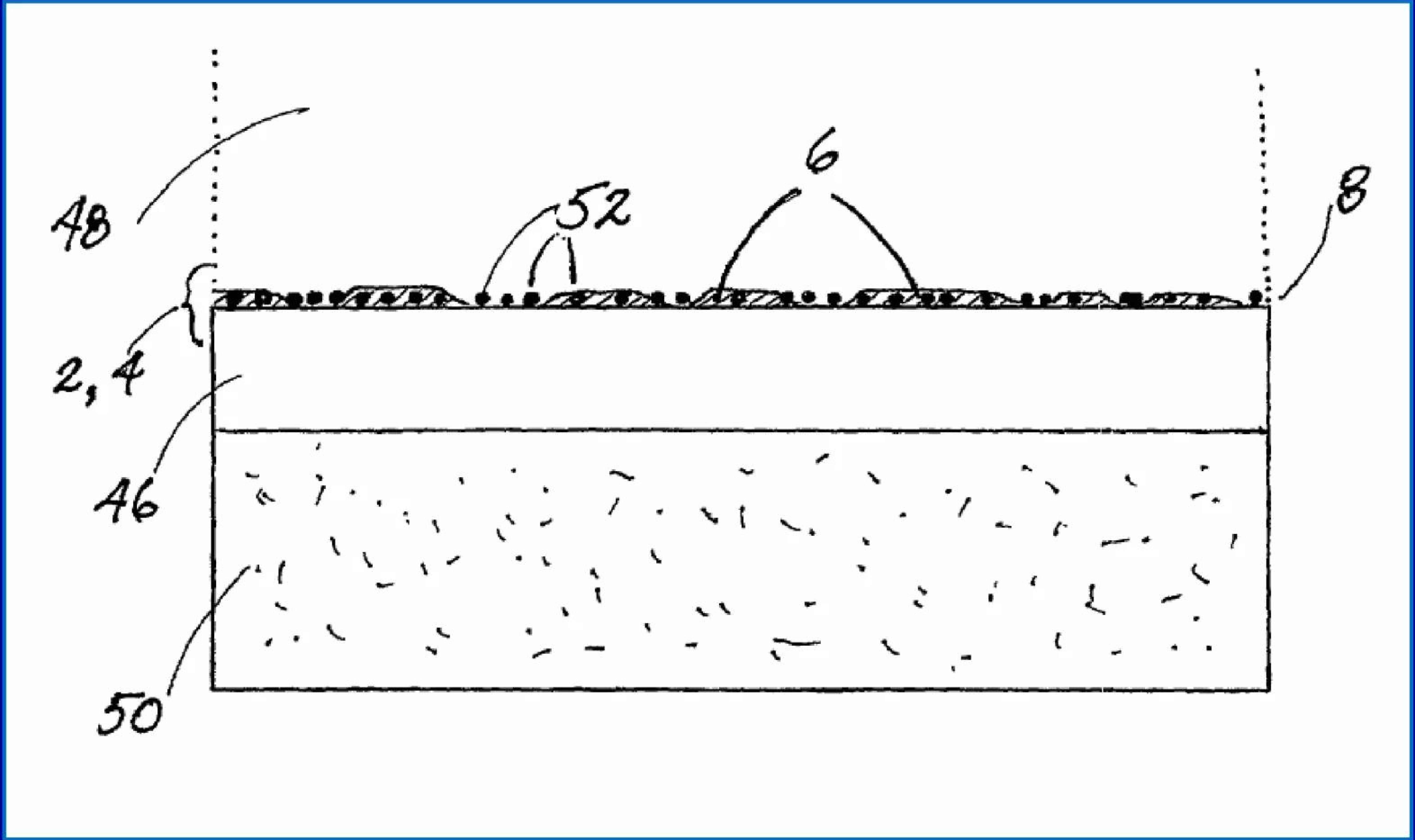


Figure 22 in patent: side view of patches + nanoparticles on hydride surface



Overview of Widom-Larsen theory of LENRs

In condensed matter systems, Steps 1. through 4. occur in nm- to μ-sized 'patch' regions on surfaces; these are called LENR-active sites

Steps 1. thru 3. are very fast: can complete in 2 to 300 nanoseconds

1. **Electromagnetic (E-M) radiation on a metallic hydride surface increases mass of surface plasmon (SP) electrons**

2. **Heavy-mass surface plasmon electrons react directly with (a) surface protons (p^+) or (b) deuterons (d^+) to produce ultra low momentum (ULM) neutrons (n_{ulm} or 2 n_{ulm}, respectively) and an electron neutrino (v_e)**

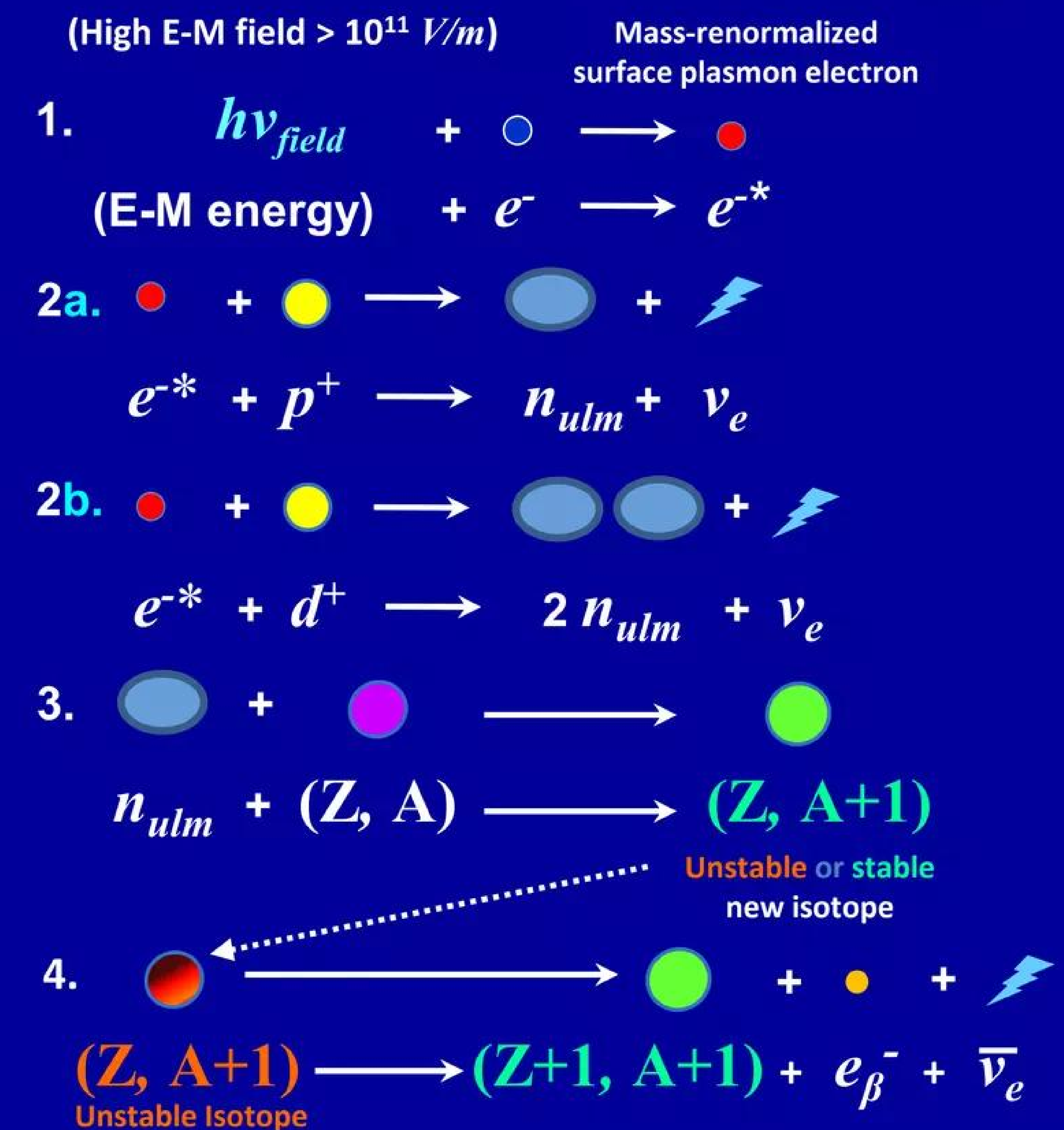
3. **Ultra low momentum neutrons (n_{ulm}) are captured by nearby atomic nuclei (Z, A) representing some element with charge (Z) and atomic mass (A). ULM neutron absorption produces a heavier-mass isotope (Z, A+1) via transmutation. This new isotope (Z, A+1) may itself be a stable or unstable, which will perforce eventually decay**

4. **Many unstable isotopes β^- decay, producing: transmuted element with increased charge (Z+1), ~same mass (A+1) as 'parent' nucleus; β^- particle (e_β^-); and an antineutrino v_e**

Ultra low momentum neutrons are almost all captured locally (very few have time to thermalize and be detected); any gammas produced get converted directly to infrared photons (heat) by heavy electrons

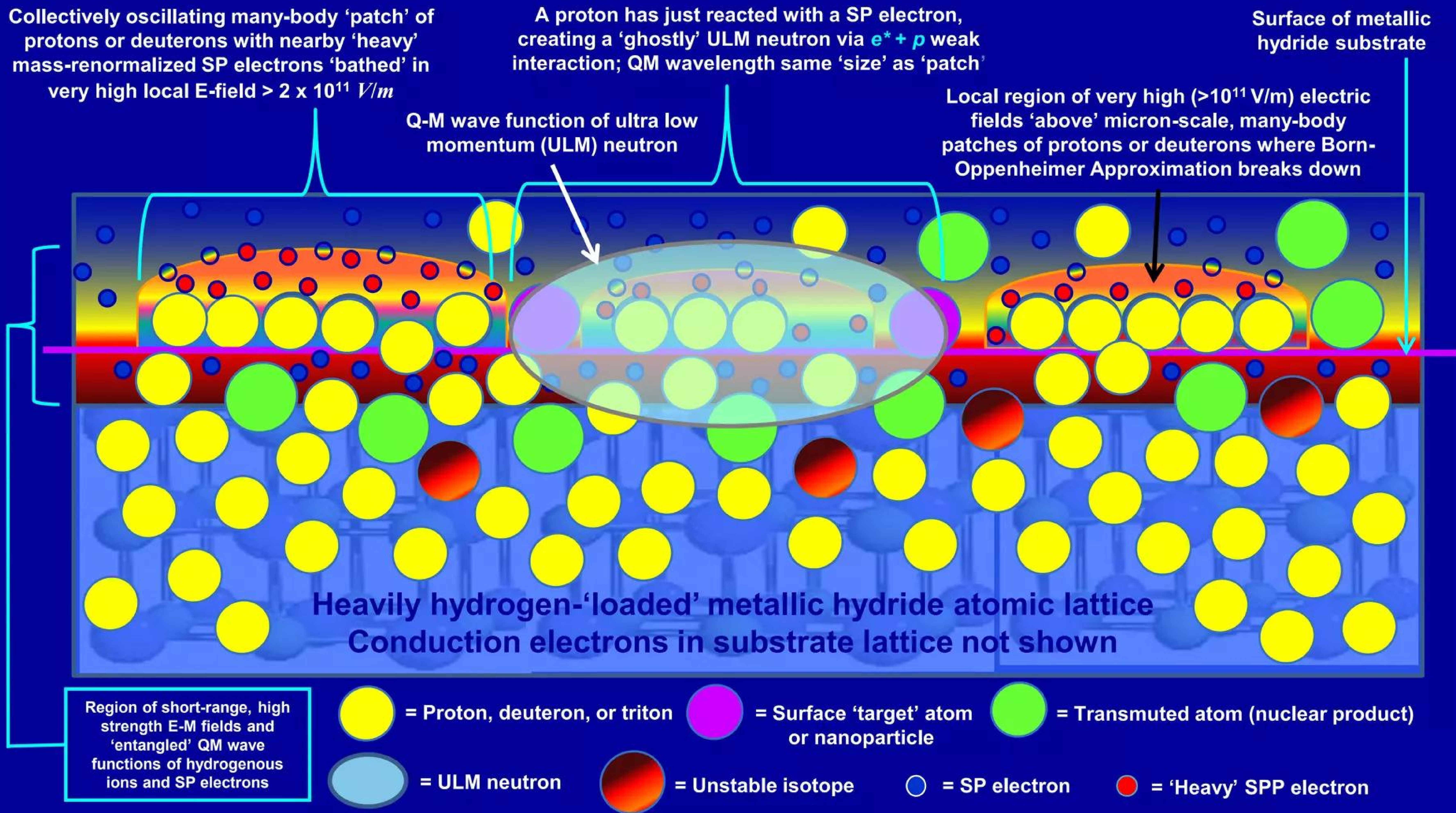
Note: colored shapes are associated with the diagram on next Slide

No strong interaction fusion or heavy element fission occurring below; weak interaction $e + p$ or $e + d$



Weak interaction β^- decays (shown just above), direct gamma conversion to infrared photons (not shown), and α decays (not shown) produce most of the excess heat that is calorimetrically observed in LENR systems

Overview of Widom-Larsen theory of LENRs



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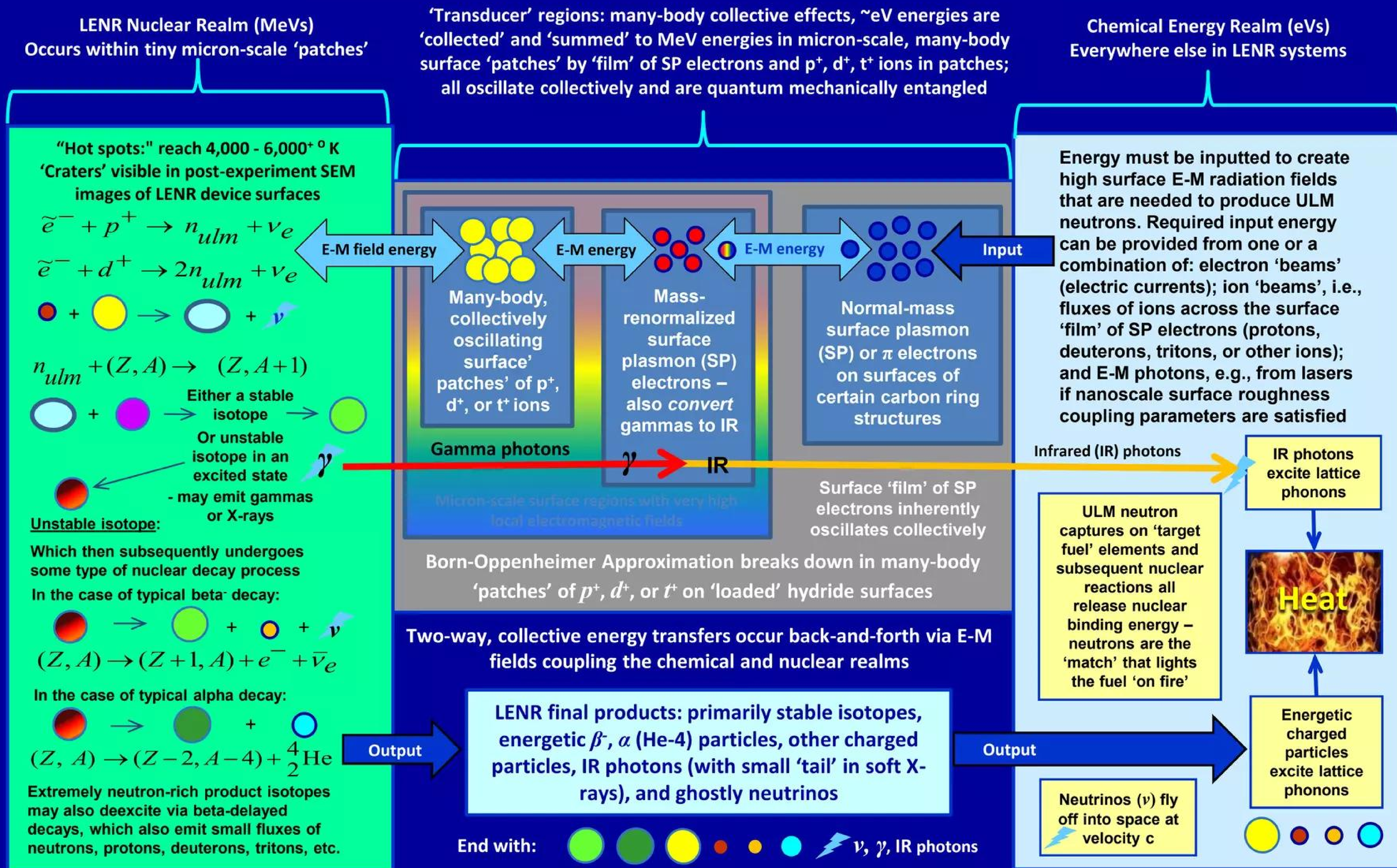
Overview of Widom-Larsen theory of LENRs



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Experimental evidence for Widom-Larsen gamma shielding mechanism

Quoted from Columns 26 and 27 in the issued patent:

"In an apparatus embodying the present invention, the mean free path of a gamma photon with an energy of ~0.5 MeV and ~10.0 MeV can be (and preferably is) extraordinarily short: ~3.4 x 10^{-8} cm, or less than a nanometer. This property has the effect of suppressing emission of externally detectable gamma radiation by the invented apparatus and shielding against incident gamma radiation emanating from external sources in almost any direction. Depending on the specifics of the preferred apparatus, selected materials, and operating conditions, what may be observed experimentally can include:

- ✓ **No significant gamma emissions, mostly just internally absorbed infrared (IR) radiation and charged particle interactions (produced by LENRs) with lattice phonons. Together, they are detected as substantial amounts of measured "excess heat" in a calorimeter; such excess heat would typically be accompanied by various types of nuclear transmutation products; in addition, this may sometimes be accompanied by small, barely detectable fluxes of soft X-rays [Reference Example: "*Large excess heat production in Ni-H systems*," Focardi *et al.*, *Il Neuvo Cimento* 111, No. 11, November 1998 - note: data from this body of Italian experimental work will be discussed herein]**
- ✓ **Significant numbers of nuclear transmutation products in conjunction with little or no measurable excess heat, no detectable gamma emissions, and no detectable soft X-rays [Reference Example: "*Elemental analysis of Pd complexes: Effects of D_2 gas permeation*," Iwamura *et al.*, *Japanese Journal of Applied Physics* 41, No. 7A, pp. 4642 – 4650, July 2002]**

LENR-active surfaces: very complex with many parallel processes

- ✓ **LENR 'hot spots' create intense local heating and variety of surface features such as 'craters'; over time, LENR-active surfaces experience major micron-scale changes in nanostructures/composition**
- ✓ **On LENR-active substrate surfaces, there are a myriad of different complex, nanometer- to micron-scale electromagnetic, chemical, and nuclear processes *operating in parallel.* LENRs involve interactions between surface plasmons, E-M fields, and many different types of nanostructures with varied geometries, surface locations relative to each other, and chemical/isotopic compositions**
- ✓ **To greater or lesser degrees, many of these very complex, time-varying surface interactions are electromagnetically coupled on many different physical length-scales: *E-M resonances are important!***
- ✓ **Surface plasmons and their interactions with nanostructures/nanoparticles enable physics regime that permits LENRs to occur in condensed matter systems under relatively mild *macroscopic* conditions (cores of stars, fission reactors, or supernovas are not required). In concert with many-body, collective Q-M effects, *SPs also function as two-way 'transducers,' effectively interconnecting the otherwise rather distant realms of chemical and nuclear energies***
- ✓ ***Please be aware that a wide variety of complex, interrelated E-M phenomena may be occurring simultaneously in parallel in different nm to μ-scale local regions on a given surface*. For example, some regions may be absorbing E-M energy locally, while others nearby can be emitting energy (e.g., as energetic electrons, photons, other charged particles, etc.). At the same time, energy can be transferred from regions of resonant absorption or 'capture' to other regions in which emission or 'consumption' is taking place: e.g., photon or electron emission, and/or LENRs in which [E-M field energy] + $e \rightarrow e^* + p^+ \rightarrow n_{ulm} + \nu$ --- in LENRs, electrons and protons (particles) are truly consumed!**

Large E-field enhancements occur near nanoparticles:

Pucci et al.: **"If metal structures are exposed to electromagnetic radiation, modes of collective charge carrier motion, called plasmons, can be excited … Surface plasmons can propagate along a distance of several tens of micrometers on the surface of a film."**

"In the case of one nanoparticle, the surface plasmon is confined to the three dimensions of the nanostructure and it is then called localized surface plasmon (LSP). In this situation, the LSP resonance depends on the metallic nature (effect of the metal permittivity) and on the geometry (effect of the confinement of the electron cloud) of the nanostructure."

"If the smallest dimension of the particle is much larger than the skin depth of the electromagnetic radiation in the metal, also real metal wires can be estimated as perfect conductors. For ideal metal objects it is assumed that the light does not penetrate into the particle. This means an infinitely large negative dielectric function. Then, antenna-like resonances occur if the length L of an infinitely thin wire matches with multiples of the wavelength λ."

"Electromagnetic scattering of perfect conducting antennas with *D* smaller than the wavelength and L in the range of the wavelength is discussed in classical antenna scattering theory … It is a frequently used approximation to consider a metal nanowire as an ideal antenna. This approach has been proposed also for the modeling of nanowires in the visible spectral range …"

" … field is enhanced at the tip of the nanowire when the excitation wavelength corresponds to an antenna mode … the end of the nanowires in a relatively sharp and abrupt surface is a perfect candidate to host a lightning rod effect ..."

"… for metallic wires larger than several hundred nanometers. The increasing size of the nanoantennas makes the resonances to appear at wavelengths that present larger negative values of the dielectric function, i.e. for wavelengths well in the mid infrared portion of the spectrum in the case of micron-sized wires. It is actually this extension of the resonant behavior to micron-sized antennas what makes these structures optimal candidates for surface enhanced Raman spectroscopy (SERS) and surface-enhanced infrared absorption spectroscopy (SEIRA)."

Reference:

"*Electromagnetic nanowire resonances for field-enhanced spectroscopy*," Chapt. 8 in "*One-Dimensional Nanostructures*," Pucci et al., Series: Lecture Notes in Nanoscale Science and Technology, V. 3, Wang, Zhiming M. (Ed.), Springer 2008 178-181

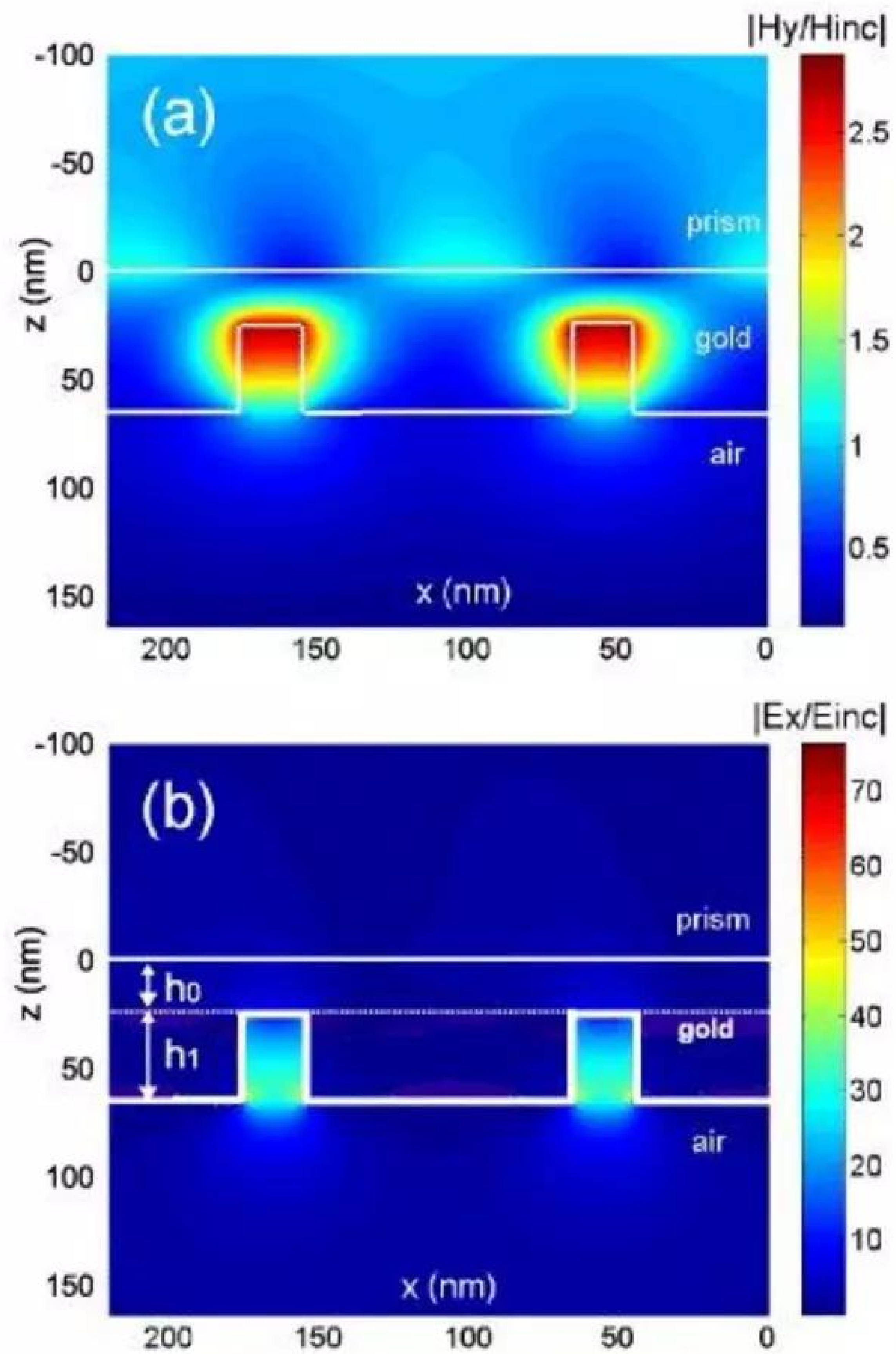
Lattice Comments:

- **In addition to optical frequencies, surface plasmons (SPs) in condensed matter systems often have some of their absorption and emission bands located in the infrared (IR) portion of the E-M energy spectrum**
- **Walls of gas-phase metallic reaction vessels intrinsically have SPs present on their outer and inner surfaces; they can radiate IR electromagnetic energy into the interior space, i.e., open cavity**
- **Metallic surface nanostructures and various types of nanoparticles located inside such reaction vessels also have SPs present on their outer surfaces and interior interfaces, e.g. metal/oxide or metal/gas**
- **Nanostructures and nanoparticles found inside metallic reaction vessels can absorb IR radiated from vessel walls if their absorption bands fall into the same spectral range as IR radiation emitted from the walls**
- **When this occurs, volume of space enclosed in a reaction vessel effectively becomes a resonant E-M cavity: two-way energy transfers via E-M fields**
- **Think of nanostructures and nanoparticles inside reaction vessels as IR 'nanoantennas' with 'send' and 'receive' channels; walls also contain E-M antennas with complementary 'send' and 'receive' channels --- complex two-way interplay between all of them**

Surface plasmons can transport, concentrate, and store energy

Reference:

"*Enhancing reactive energy through dark cavity plasmon modes*"
J. Le Perchec
Europhysics Letters 92 DOI: 10.1209/0295-5075/92/67006 (2010)

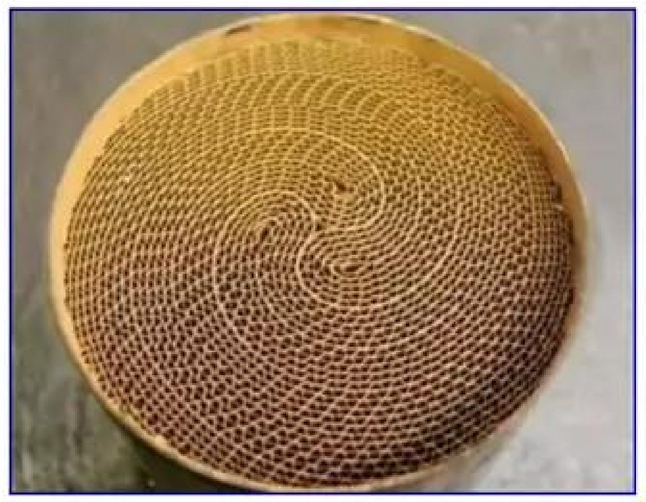


Credit: J. Le Perchec

Abstract:

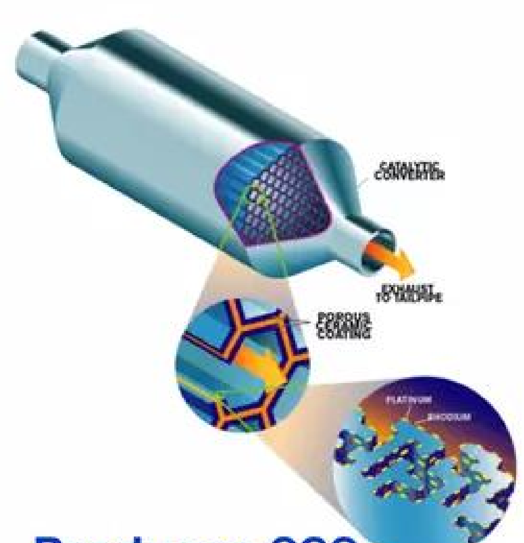
"We present an opto-geometrical configuration in which a metallic surface having nanometer-scale grooves can be forced to efficiently resonate without emitting radiation. The structure is excited from the backside, by an evanescent wave, which allows to inhibit light re-emission and to drastically modify the quality factor of the resonance mode. The energy balance of the system, especially the imaginary part of the complex Poynting vector flux, is theoretically analysed thanks to a modal method. It is shown how the generated hot spots (coherent cavity modes of electro-static type) can store a great amount of unused reactive energy. This behaviour might thus inspire a novel use of such highly sensitive surfaces for chemical sensing."

BMW auto catalytic converter:



End view: metal honeycomb

Below: heated and operating

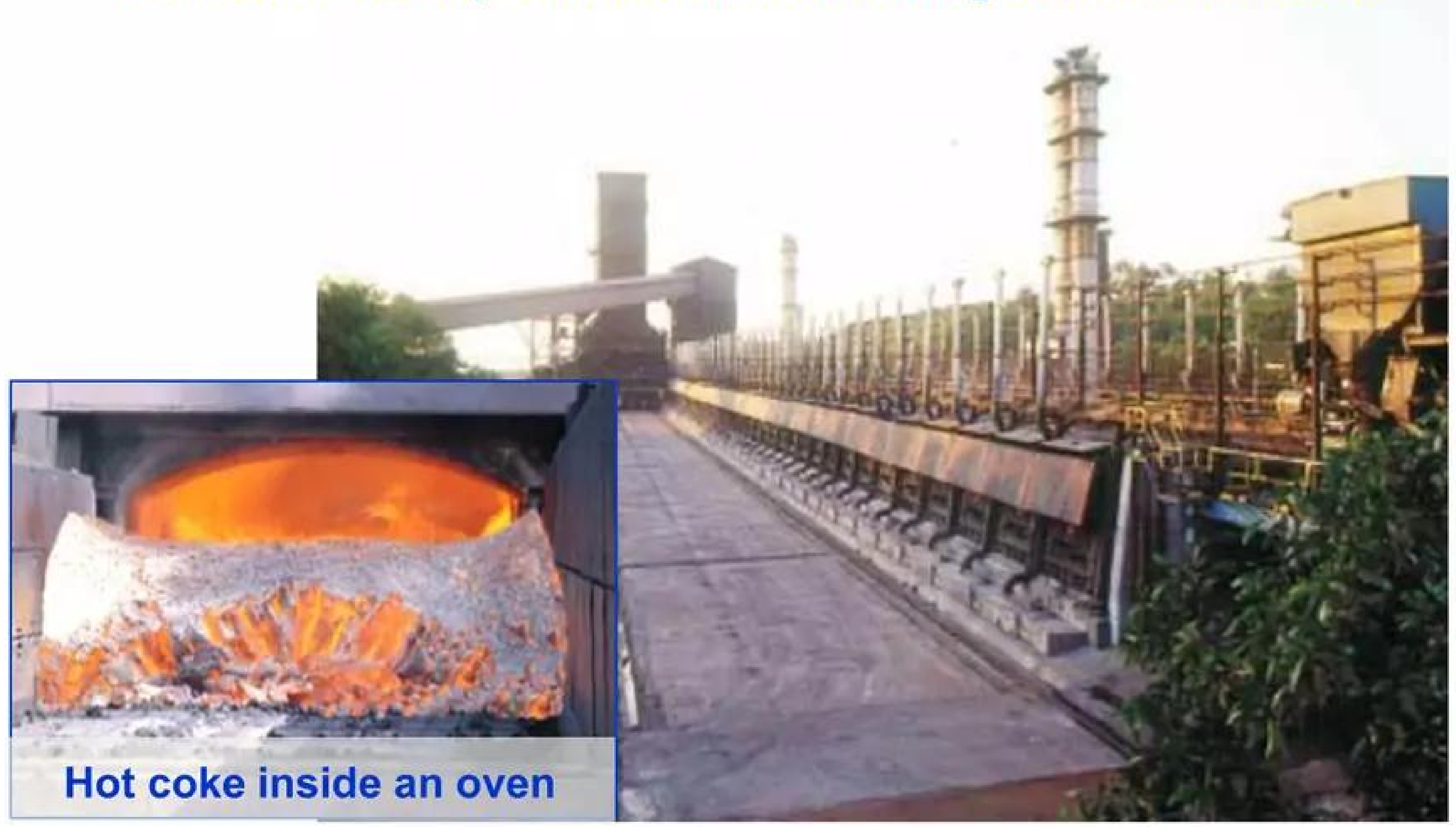


Produces ???

Chemical and nuclear reactions occur in parallel

A common factor amongst these different types of, mainly stainless, steel reaction vessels is that, on some length scales, resonant electromagnetic (E-M) cavities exist inside of all of them. They also typically contain hydrogen isotopes in some chemical form. That, coupled with metallic 'catalysts' (e.g., Ni, Pd) and/or aromatic rings working together with thermal energy (temperature), and/or pressure, and time, can under exactly the right conditions produce detectable LENR transmutation products, e.g., ^{13}C, ^{15}N and 'new' elements, e.g., ^{4}He, ^{14}N, etc. in parallel with a variety of prosaic chemical reactions

Photo of a 'battery' of modern steel coking ovens in Australia



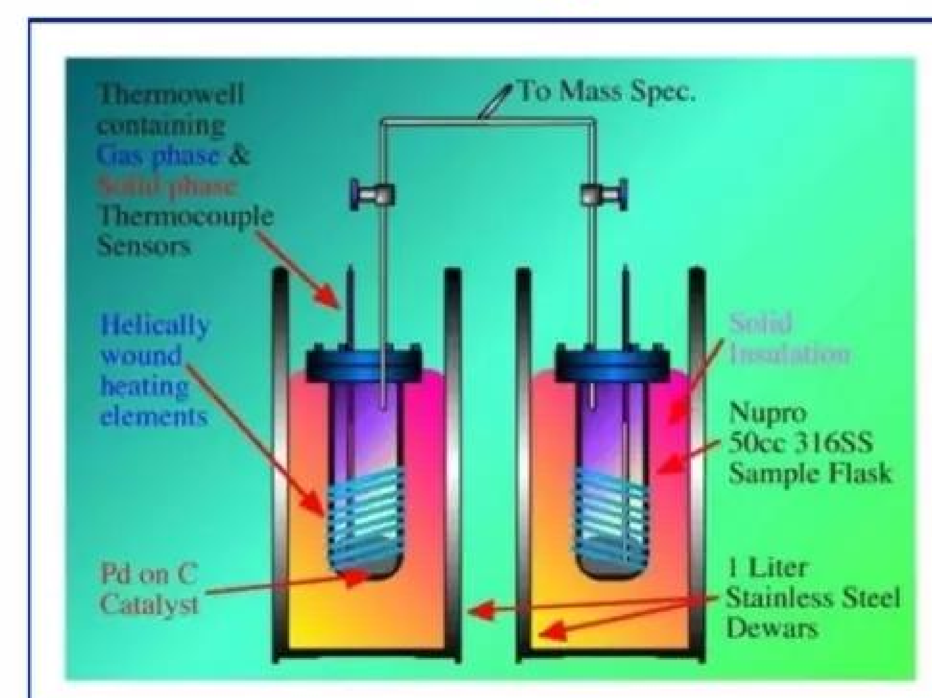
Hot coke inside an oven

2002 IAEA study: coking ovens at S. African steel plant produced >> +$\delta^{15}N$

Hokkaido Univ. 2008 - LENR reactor vessels:

Mizuno produced >>+δ ^{13}C and $^{14}N_2$ from $^{12-13}C_{14}{}^{1}H_{10}$ with Platinum (Pt)

SRI 1999 - Repeated Les Case LENR Experiment with D_2 gas:



McKubre produced ^{4}He from $^{2}D_2$ and $^{12-13}C$ with Palladium (Pd)

Discussion of Ni-H gas-phase experiments exhibiting W-L gamma suppression

- ✓ **First conceived in mid-1989 by Francesco Piantelli, then of the University of Siena, about 1990 a small group of Italian "cold fusion" scientists broke with common practice (vast majority of researchers in field at that time used 'classic' Pons-Fleischmann glass aqueous electrolytic cells with Pt anode, Pd cathodes, and Li salts in D_2O) and began new LENR experiments using stainless steel reactor vessels, Nickel (Ni) metal rods or planar bars, H_2 gas, with only modest gas pressures and initial resistance heating for triggering**

- ✓ **Reported many remarkable results from long series of mostly Italian Ni/H_2 gas experiments conducted and published from 1990 to the present:**
  - **Although reproducibility was very spotty, *very large* amounts of measured heat (up to as much as ~900 megajoules) were produced during certain experiments over relatively long periods of time (months)**
  - **System-startup energy inputs were modest H_2 pressures (mbar up to ~1 bar) with initial heat provided by an electrical resistance heater (Pt heating wire coiled around long axis of ferromagnetic Ni cylinder, or planar Ni bars, attached to three equidistant ceramic support rods)**
  - **Experiments exhibiting very large heat production did not produce any large, readily detectible fluxes of 'hard' (defined as photon energies of ~1 MeV and higher) gamma radiation; no large fluxes of energetic MeV neutrons were detected nor significant production of any long-lived radioactive isotopes --- *anomalously free of dangerous radiation***
  - **Results showed evidence of positive thermal feedback from 420-720^o K. If correct, it suggests walls of SS reaction vessels may be behaving as resonant E-M radiation cavities; thus, *LENRs may turn 'on-and- off'' as Nickel surface nanostructures move in and out of resonance with spectral peaks of temperature-dependent emitted cavity radiation***

Please note:

"*Anomalous Heat Production in Ni-H Systems*," Focardi S., Habel R., and Piantelli F., *Nuovo Cimento*, 107A pp. 163-167 (1994) – peer reviewed

Much of this interesting technical history was recounted in some detail in two well written news articles published by science journalist Steven Krivit in *New Energy Times* Issue #29, July 10, 2008, as follows:

Source URL = http://www.newenergytimes.com/v2/news/2008/NET29-8dd54geg.shtml#pf

Article 12. "*Deuterium and Palladium not required*"

Article 13. "*Piantelli-Focardi publication and replication path*"

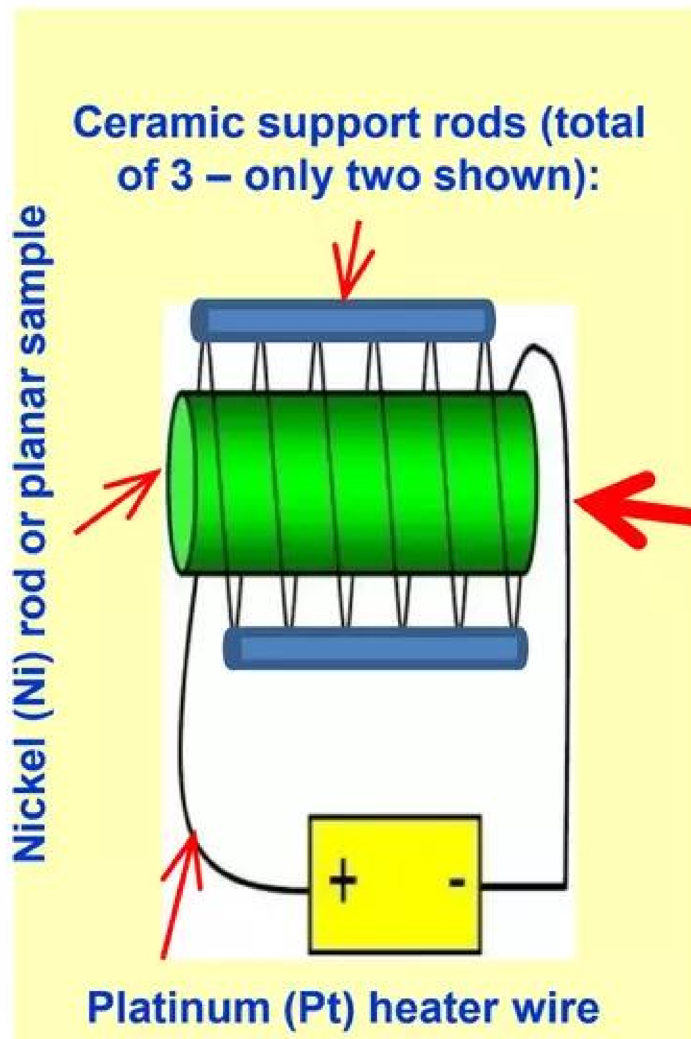
Contains comprehensive list of references to various technical publications by different members of this group of Italian researchers; in some cases, hyperlinks to free downloadable papers are provided

Key point: roots of the gas-phase Ni/H_2 line of LENR experimentation began in Italy roughly 20 years ago

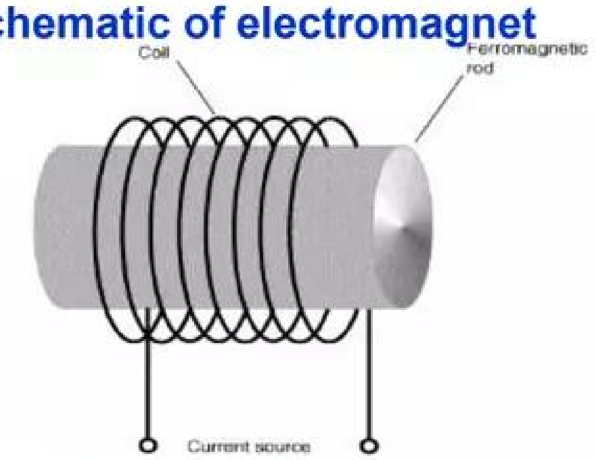
Discussion of Ni-H gas-phase experiments exhibiting W-L gamma suppression

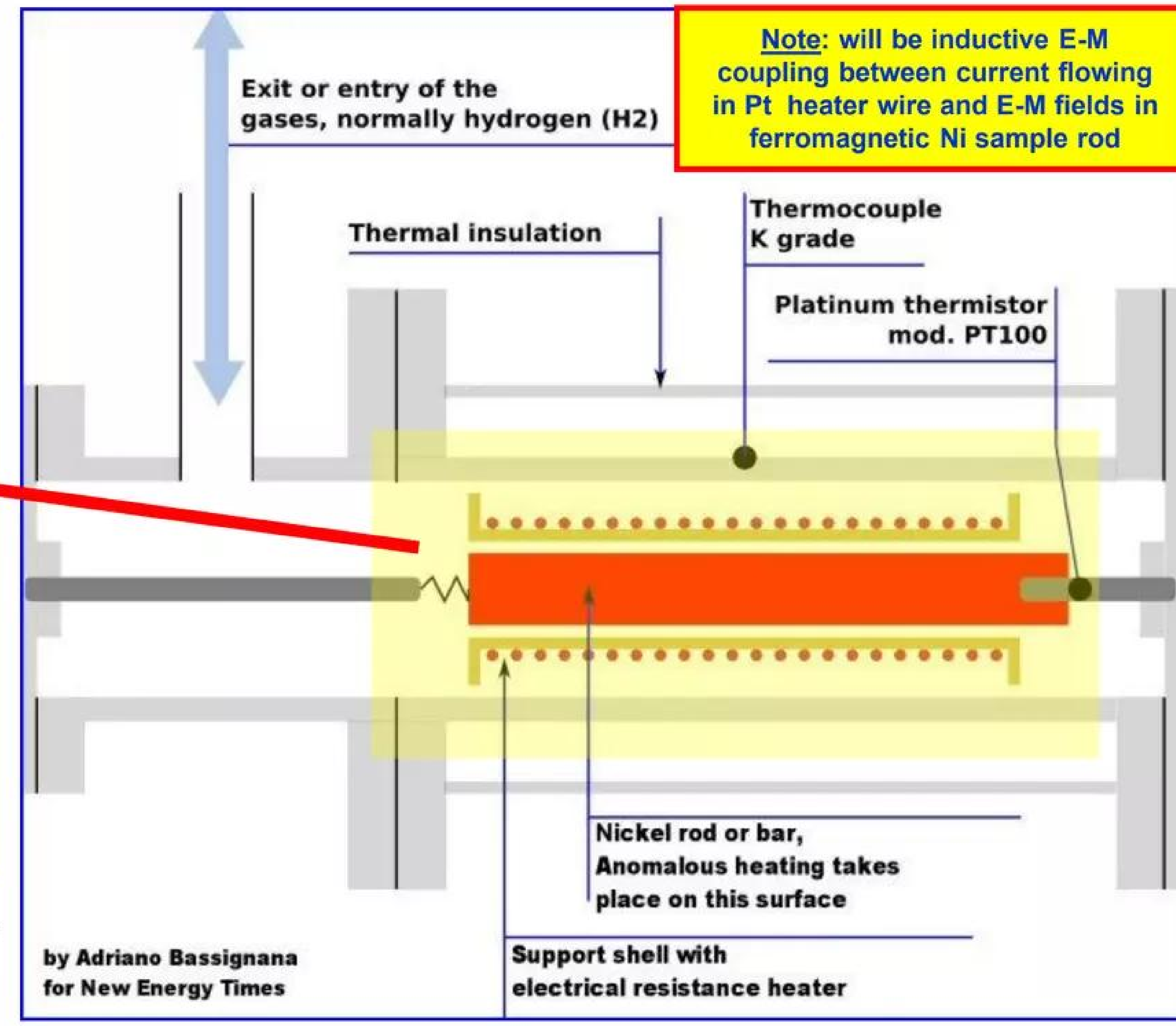
Ca. 1992 Piantelli-Focardi Ni-H Cell (photo credit: S. B. Krivit)

Schematic of electrical resistance heater:



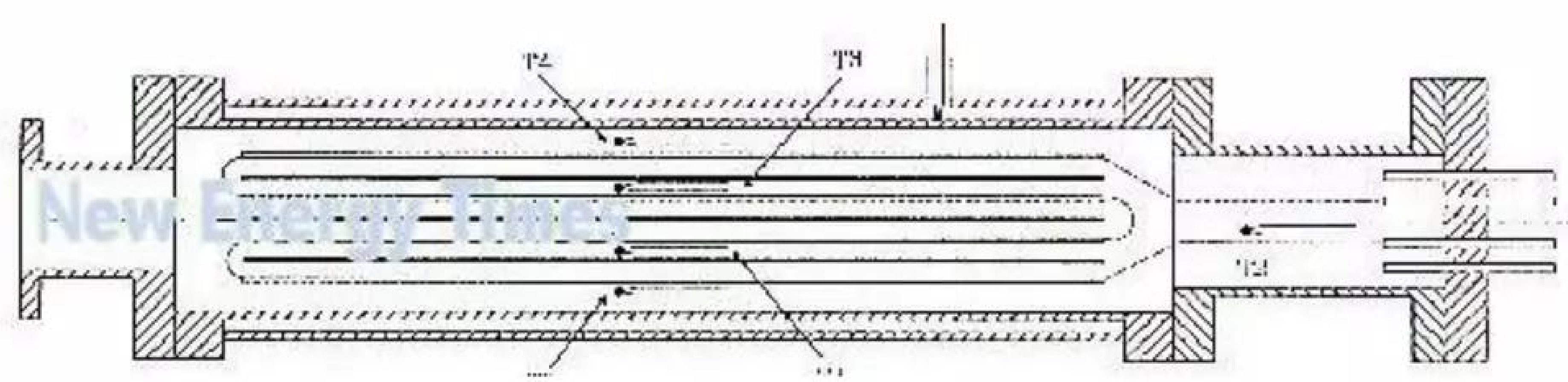
Schematic of electromagnet





Conceptual diagram of Piantelli-Focardi-type Ni-H Cell

Ca. 1992 Piantelli-Focardi Ni-H Cell (photo credit: S. B. Krivit)



Engineering drawing of Piantelli-Focardi-type Ni-H Cell

Discussion of Ni-H gas-phase experiments exhibiting W-L gamma suppression

"Piantelli has some very interesting things to say about deuterium. *New Energy Times* asked him whether he had ever tried using deuterium instead of normal hydrogen. Yes, he said, but if you put the deuterium inside a hydrogen-based experiment, it stops the reaction instantly. Piantelli said that, if he uses just normal hydrogen with very high purity, which may have a trace amount of deuterium, it works fine. But if he injects even just 2 percent or 3 percent of deuterium with respect to the hydrogen, it stops the experiment, kills it. Whether Piantelli had ever tried pure deuterium, rather than pure hydrogen, was not clear."

"This is the strangest information; researchers who are accustomed to working in the deuterium/palladium system say almost the same thing - but the opposite: If you allow any normal hydrogen into the system, you will never get excess heat. It's quite a paradox. For years, the deuterium/palladium researchers have said that the proof that normal hydrogen can't make excess heat is that, time after time, normal hydrogen poisons the excess heat effect in deuterium-based systems. Even the emotive language in their descriptions – 'poisons,' 'kills'—has a similar ring."

Source of quote: S. B. Krivit in Article 12. "*Deuterium and Palladium not required*," *New Energy Times* Issue #29, July 10, 2008

Ca. 2007 Piantelli-Focardi Ni-H Cell (photo credit: S.B. Krivit)

Negative effect of large Hydrogen isotope admixtures fully explained by the Widom-Larsen theory of LENRs:

"(iii) However, one seeks to have either nearly pure proton or nearly pure deuterium systems, since only the isotopically pure systems will easily support the required coherent collective oscillations."

In other words, because their masses differ greatly, substantial admixtures of different hydrogen isotopes will destroy Q-M coherence in the many-body, collectively oscillating surface 'patches' of protons, deuterons or tritons that are necessary to produce ULM neutrons in condensed mater LENR systems

Reference: "*Ultra Low Momentum Neutron Catalyzed Nuclear Reactions on Metallic Hydride Surfaces*," *European Physical Journal C – Particles and Fields* 46, pp. 107 (2006) A. Widom, L. Larsen

Discussion of Ni-H gas-phase experiments exhibiting W-L gamma suppression

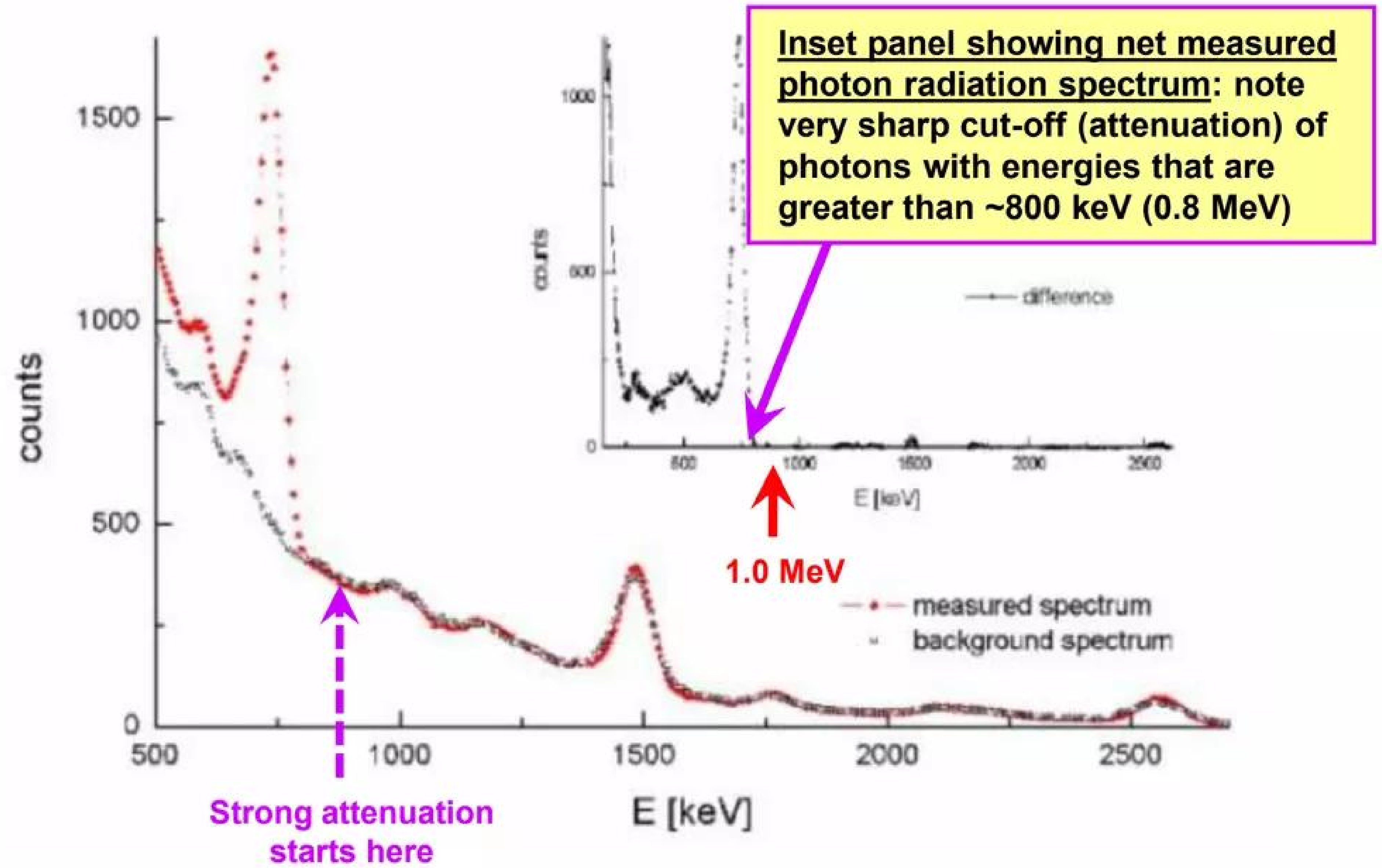
Comments:

In Fig. 7 to the right, the inset panel at the upper right shows the net measured photon radiation spectrum; that is, it represents the radiation spectrum measured during LENR experiments by Campari et al. (2004) from which the known laboratory background radiation spectrum has been subtracted. This reported net radiation spectral data shows substantial attenuation of energetic photons above ~ 800 KeV. Given that nuclear processes were probably occurring in the experimental system during gamma-ray measurements (likely LENR transmutation products were detected in post-experiment EDAX spectral analyses of Nickel surfaces), this is an anomalous, surprising result. Under normal circumstances, nontrivial fluxes of >MeV-energy photons ('hard' gammas) would be expected

Assuming that the underlying measurements by Campari et al. are correct as reported (2004), this anomalous data is explained by the Widom-Larsen theory of LENRs.

Specifically, in condensed matter LENR systems, gammas produced by nuclear processes in energy range of 0.5 – 1.0 MeV all the way up through ~10 MeV are efficiently absorbed by heavy-mass electrons and directly converted into much lower-energy infrared (IR) photons with a somewhat variable, poorly understood 'soft' X-ray 'tail'

Reference: "***Absorption of Nuclear Gamma Radiation by Heavy Electrons on Metallic Hydride Surfaces,***" **A. Widom and L. Larsen http://arxiv.org/PS_cache/cond-mat/pdf/0509/0509269v1.pdf (Sept 2005)**



Source of the above graph: **Figure 7 in "*Overview of H-Ni Systems: Old Experiments and New Setup*," Campari, E., Focardi, S., Gabbani, V., Montalbano, V., Piantelli, F., and Veronesi, S., 5th Asti Workshop on Anomalies in Hydrogen-Deuterium-Loaded Metals, Asti, Italy (2004) free copy online at www.lenr-canr.org**

Also please see Lattice's issued patent:

US #7,893,414 issued February 22, 2011
"***Apparatus and Method for Absorption of Incident Gamma Radiation and its Conversion to Outgoing Radiation at Less Penetrating, Lower Energies and Frequencies***"
Inventors: Lewis Larsen and Allan Widom
Clean electronic copy of issued patent at source URL =
http://www.slideshare.net/lewisglarsen/us-patent-7893414-b2

Full reference:

"*Evidence of electromagnetic radiation from Ni-H systems*"
S. Focardi, V. Gabbani, E. Campari, V. Montalbano, F. Piantelli, and S. Veronesi, CONDENSED MATTER NUCLEAR SCIENCE pp. 70 – 80, Proceedings of the 11th International Conference on Cold Fusion Marseilles, France, 31 October - 5 November 2004
edited by Jean-Paul Biberian (Université de la Méditerranée, France), World Scientific Publishing 2006
DOI No: 10.1142/9789812774354_0034

Source URL (free public copy of conference paper on LENR-CANR.org; this may differ slightly from final version published by World Scientific in 2006) = http://www.lenr-canr.org/acrobat/FocardiSevidenceof.pdf

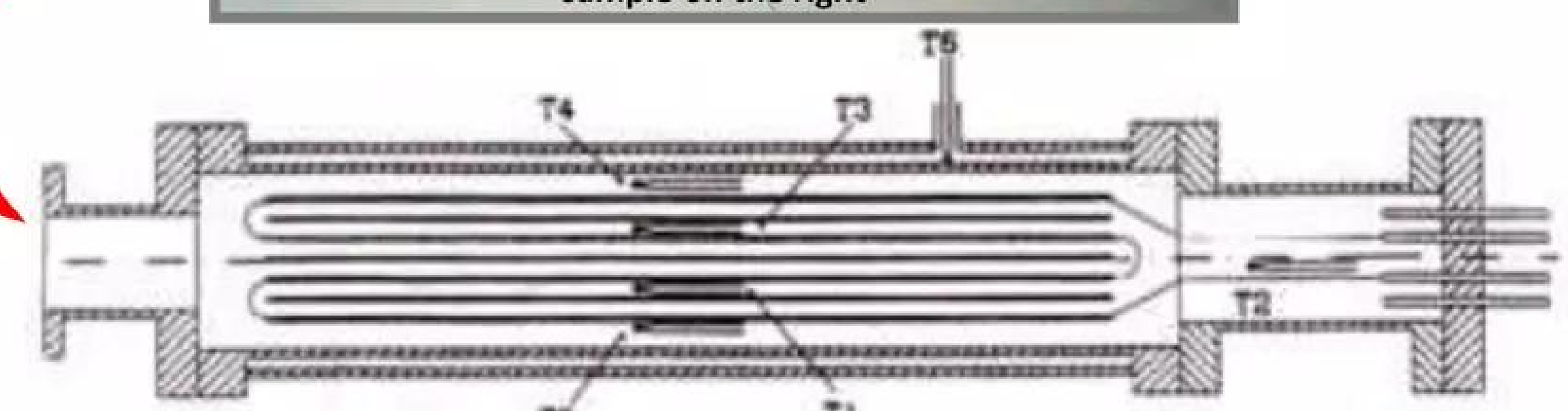
Selected highlights of the experiments:

- This conference paper reports results of three experiments
- Stainless steel used in reaction vessel identified as AISI 304 with standard composition: Iron (Fe) 66 – 74%; Chromium (Cr) 18 – 20%; Nickel (8 – 10.5%); Manganese (Mn) max 2%; Silicon (Si) max 1%; Carbon (C) max .08%; Phosphorus (P) max .045%; and Sulfur (S) max 1% --- CF35 vacuum flanges generally made from Type 316L stainless
- Nickel samples were stated to be "99.5% pure" Ni
- Resistance heater inside reaction vessel was very different design compared to what was used in otherwise similar experiments discussed in the previous slide (Campari et al., Asti 2004). Instead of a Pt heater coil helically wound around the Ni sample; quoting, " ... The heater consists of four plate coils, each made from a small NiCr slab of analogous dimensions, connected in series and held in a ceramic cylinder with the Ni samples in alternating positions."

Selected highlights of the experiments (continued):

- Duration of a given experiment ranged up to 85 days (#1)
- Substantial amounts of excess heat (total of 25 MJ over period of 35 days) were measured during a later phase of Experiment #1; no excess heat seen in Expts. #2 and #3
- In their conclusions about Experiment #1, Focardi et al. suggested that post-experiment "new elements" Cr and Mn widely observed across surface of reacted Ni sample with SEM-EDAX were LENR transmutation products. That may or may not be true, because ablation from vessel walls (Cr 18 -20%; Mn max 2%) and resistance heater surfaces (NiCr alloy) could have easily deposited nanoparticles on surface of 99.5% pure Ni sample. *That said, please note that large amounts of nuclear binding energy can be released simply as a result of ULM neutron captures on stable Ni isotopes*
- Chronology and discussion of key events that occurred in Experiment #1 is presented on next slide

"Figure 1. b) The ceramic holder with a heater inside and a sample on the right"



"Figure 1. a) The experimental cell for three planar samples alternate with four planar heaters. Ti indicates thermocouples"

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Discussion of Ni-H gas-phase experiments exhibiting W-L gamma suppression

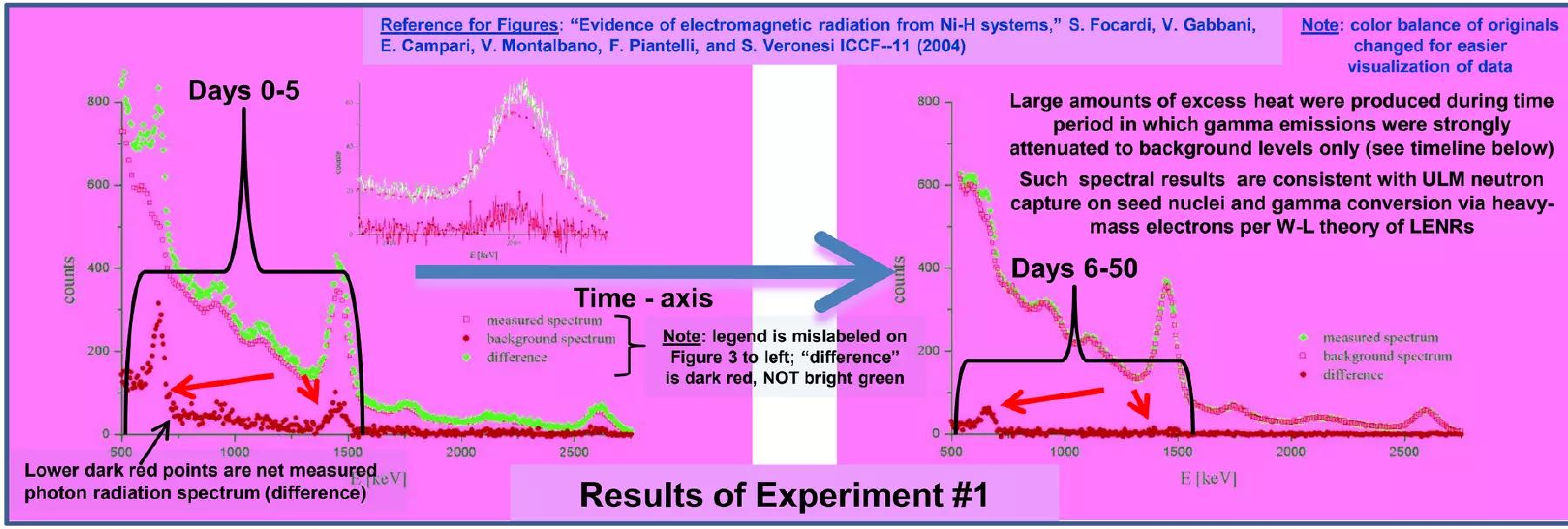


Fig. 3 (left) and Fig.4 (above right) were copied from pp. 3 of Focardi et al. (ICCF-11 in 2004) and annotated by Lattice as shown above

<u>Quoting</u>: "Figure 3. First experiment: background and measured spectra, at the beginning of gamma measurements, obtained with the NaI(Tl) detector placed in front. The background spectrum is a mean of 90 acquisition (live time 12000 s) while the measured one is a mean of 6 acquisitions. The lower curve is the difference between measured and background spectrum."

<u>Quoting</u>: "Figure 4. First experiment: background and measured spectra 45 days after the beginning of gamma measurements, the measured spectrum is a mean of 18 acquisitions. The lower curve is the difference between measured and background spectra."

Timeline and Commentary on Key Events that occurred during Experiment #1

Days into expt.	Focardi et al. remark in their paper	Key event	Lattice comments about key events
Day 0 to Day 5	5 days into degassing phase, net measured photon spectrum changed from spectrum of Fig. 3 to what is shown in Fig. 4	Abrupt decrease in gamma spectrum	Heavy SP electrons begin appearing; fields not yet high enough to make large fluxes of ULM neutrons
Day 6 thru Day 50	Day 19 inject H_2 gas - no change in spectrum; on Day 50 "difference" goes to zero; then <u>only</u> see background radiation	Spectrum changes to <u>background only</u>	Bigger population of 'heavy' SP electrons at larger masses; hit threshold for producing ULM neutrons
Day 51 thru Day 85	<u>Quoting</u>: "*Later on the cell produced excess power (maximum 25 W ...) for about 35 days ...*"	Total of 25 MJ heat prod. over ~35 days	ULM N captures on seed elements, then various decays; gammas converted to IR by heavy electrons

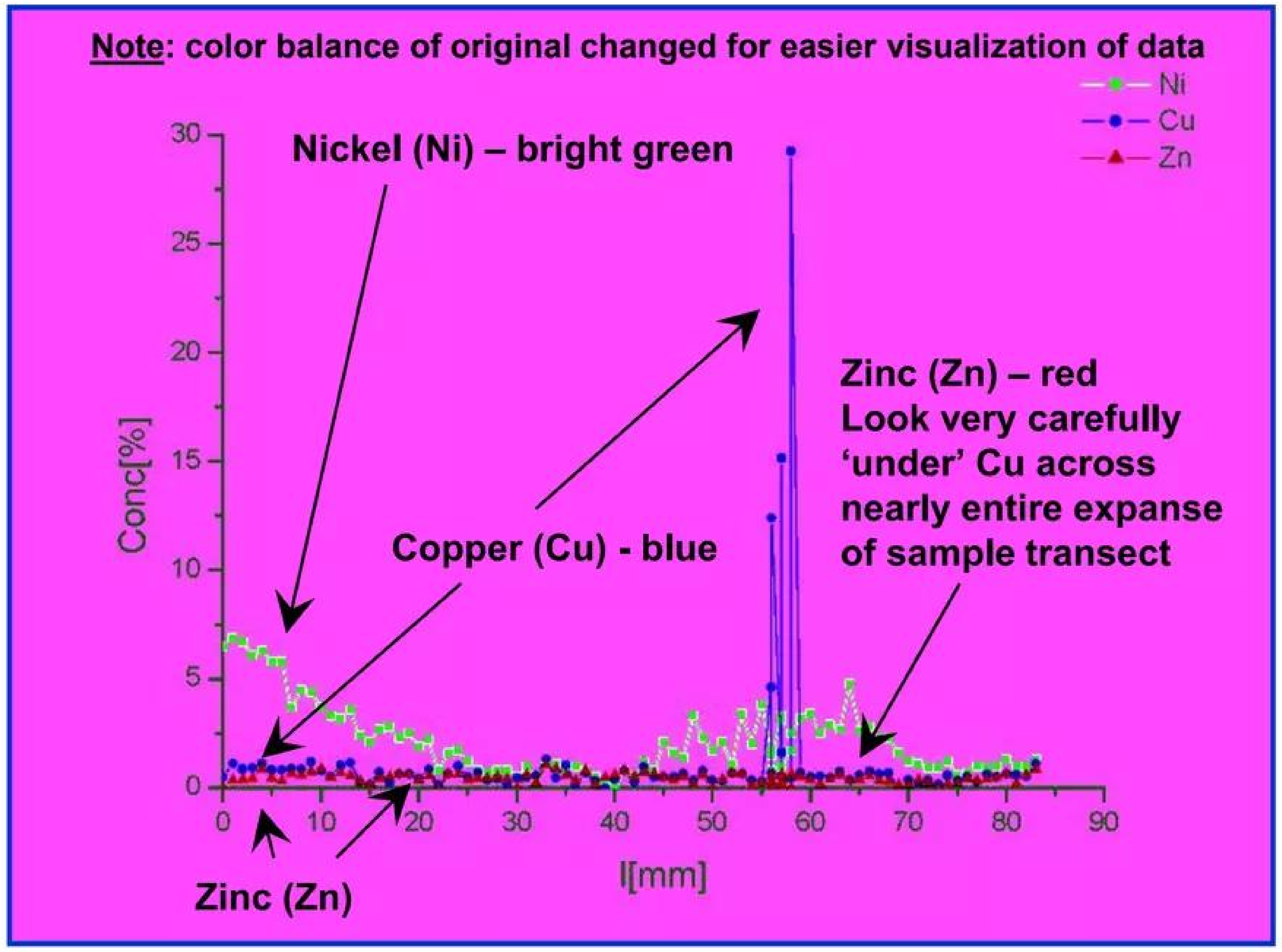
Reference:

"*Surface analysis of hydrogen-loaded nickel alloys*," E. Campari et al., ICCF-11 Conference, Marseilles, France (November 2004)

Selected highlights of the experiments:

- Stainless steel reaction vessel with integrated Pt resistance heater as previously described
- Sample was 9 cm Nickel-alloy rod of composition: Ni (7.6%), Cr (20.6%), Fe (70.4%), and Mn (1.4%)
- Temperature range: 400 – 700° K
- Range of H_2 gas pressure: 100 to 1,000 mbar
- Sample analysis technique: SEM-EDX which determines elements present on surface; can't resolve individual isotopes like ICP-MS or NAA

Comments: Zinc and Copper not initially present in either 'blank' sample or vessel walls. Unless these were contaminants, Zn and Cu are probably LENR transmutation products; consistent with a W-L neutron-capture Ni 'seed' network, a segment of which is illustrated in Slides #28 and 29 herein



Source of adapted graph: Campari et al. (2004) Figure on pp. 6 "Fig. 10 Spatial distribution of Ni and Cu on the sample surface"

Quoting directly from their paper: "In Fig. 10, a quantity of Cu is measured in a narrow zone of the sample. Moreover, in a wide region of the sample, nickel is absent from the surface."

"In contrast, the elemental analysis of the sample rod (Fig. 7) are very different from the *blank rod analysis,* and they are very different from one region to the next along the sample. This is why a systematic investigation along the sample was performed. We obtained the elemental distribution along the rod."

Discussion of Ni-H gas-phase experiments exhibiting W-L gamma suppression

Reference: **“*Analysis of Ni-hydride thin film after surface plasmons generation by laser technique*,” V. Violante et al., Condensed Matter Nuclear Science – Proceedings of the 10th International Conference eon Cold Fusion (ICCF-10 2003), eds. P. Hagelstein and S. Chubb, pp. 421-434, World Scientific 2006 ISBN# 981-256-564-7 Source URL to free copy = http://www.lenr-canr.org/acrobat/ViolanteVanalysisof.pdf**

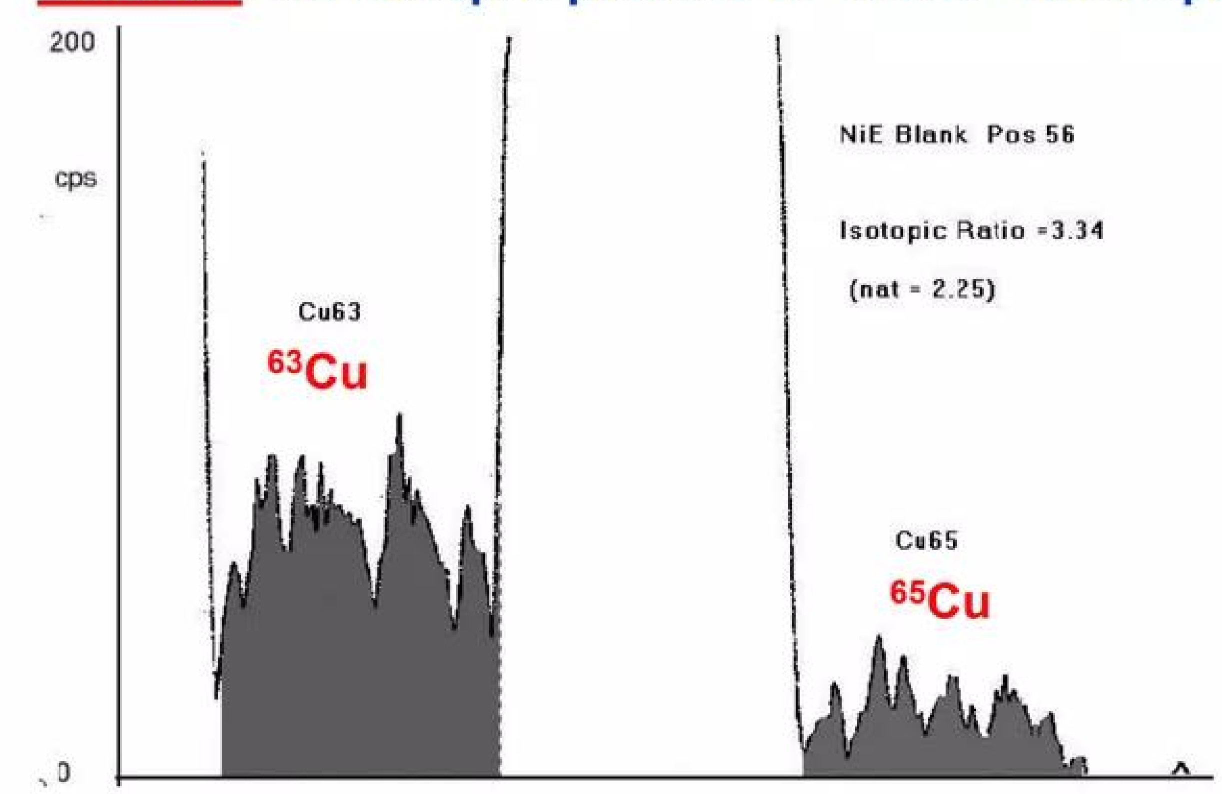
Key highlights of the experiment:

- **Fabricated two sputtered thin-film pure Nickel ‘target’ samples; “black” sample was loaded with hydrogen (made NiH) in electrolytic cell; “blank” sample was not put into the electrolytic cell (not loaded)**
- **Aqueous H_2O 1 M Li_2SO_4 P&F-type electrolytic cell; thin-film Nickel (Ni) cathode; [Platinum pt anode?]; loaded “black” Ni ‘target’ cathode with Hydrogen for 40 minutes at currents ranging from 10-30 mA and then removed it from the aqueous electrolyte bath**
- **Irradiated both samples with He-Ne laser (632 nm beam) for 3 hours**
- **After laser irradiation, analyzed Cu isotopes present on surface in “blank” and “black” Ni samples with SIMS; results shown in Figs. 12 and 13 to right: abundance of ^{63}Cu went down; ^{65}Cu went way up**
- **Suggested surface plasmons might have important role in LENRs**

Comments: **the observed dramatic isotopic shift (^{63}Cu goes down; ^{65}Cu goes up in an experiment) is readily explained by ULM neutron capture on ^{63}Cu ‘seed’ according to W-L theory of LENRs; if data is correct, only other possible explanation is magically efficient isotopic “fractionation” process**

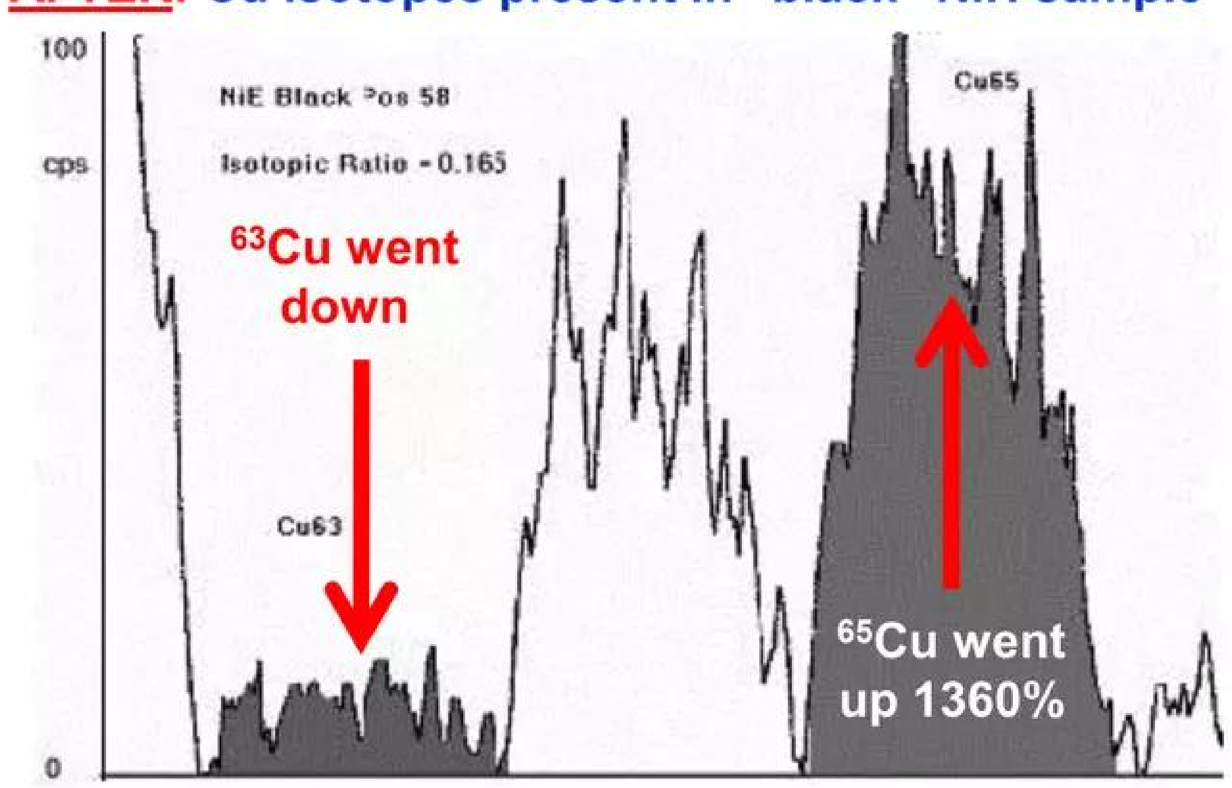
Note: **we have been informed that Violante et al. have openly questioned their own claims for reasons that we find dubious. Readers are urged to review the relevant publications and then judge whether such concerns are plausible**

BEFORE: Cu isotopes present in “blank” Ni sample



Quoting: “Figure 12. Blank of NiE, ^{63}Cu results to be more abundant of ^{65}Cu, the difference with the natural isotopic ratio is due to the small signal on mass 65. The sample was undergone to laser excitation of plasmons-polaritons for 3 hr”

AFTER: Cu isotopes present in “black” NiH sample



Quoting: “Figure 13. Black of NiE, after 40 min electrolysis + 3 hr of plasmons-polaritons excitation by laser. Isotopic ratio is changed of 1360%”

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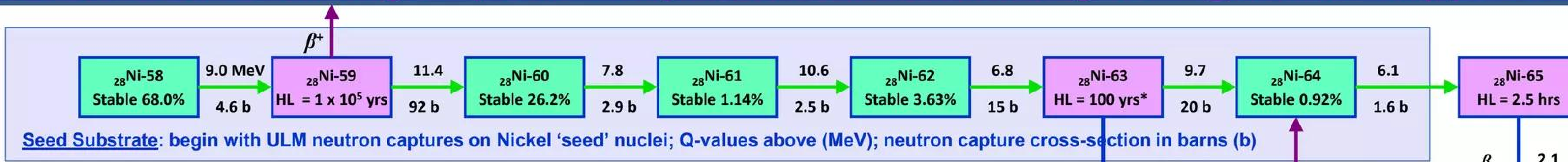
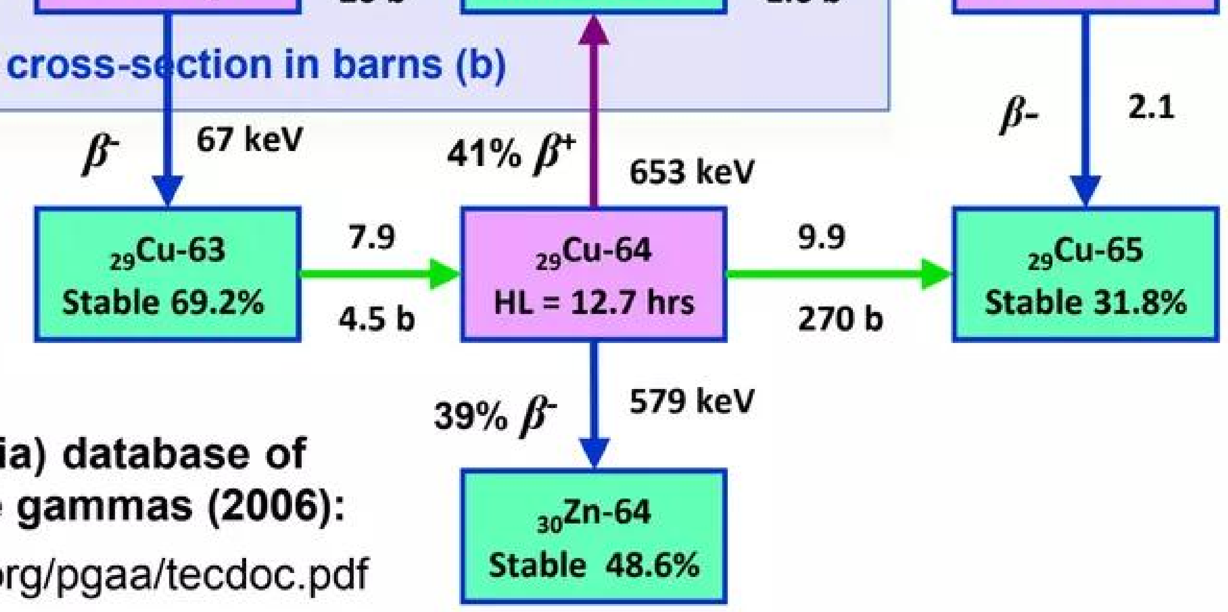
Discussion of Ni-H gas-phase experiments exhibiting W-L gamma suppression





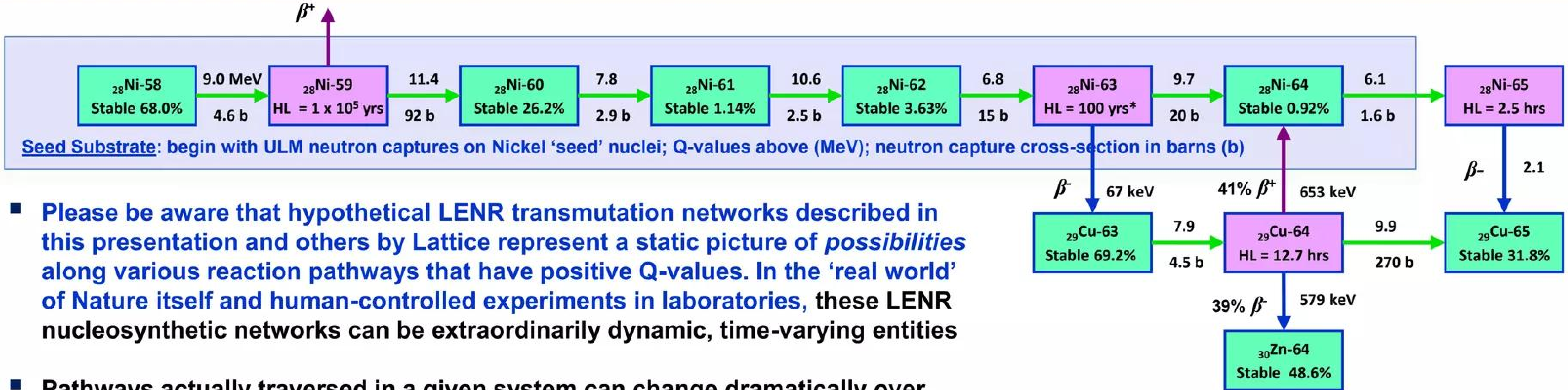
- Thermal triggering and positive thermal feedback have been experimentally observed in gas-phase, metal/H_2 experimental systems using stainless steel (SS) reaction vessels (Italian researchers cited herein and Mizuno in Japan)
- Dangerous fluxes of 'hard' high-energy gammas have never been observed in such systems, even when large amounts of excess heat production occurs
- Yet nuclear transmutation products consistent with neutron-captures have clearly been observed post-experiment with various analytical techniques
- W-L theory explains all of this; it turns-out that conversion of 'hard' gammas into IR by heavy electrons is also crucial to providing a plausible mechanism for positive thermal feedback: it hinges on the idea of stainless steel reaction vessels behaving as if they were resonant E-M cavities in the IR portion of the spectrum
- Please examine the network pathway shown to the right. Note that prompt gamma ray emission can comprise a substantial percentage of positive Q-values for the ULM neutron capture process; that being the case, energy associated with gamma emission can comprise vast majority of pathway's total net Q-value of 57.04 MeV and also the strongly positive total gain across the entire pathway of 8.83
- Now consider a stainless steel reaction vessel with a resonant IR E-M cavity inside it as a system. If neutron captures occurred inside the cavity per network pathway shown at right and gamma conversion by heavy electrons did NOT take place, the vast majority of released nuclear binding energy associated with 'hard' gammas would likely escape through the SS cavity walls (at the wall thicknesses used in laboratory systems) and would thus be 'lost' to the system proper. Without gamma conversion to IR, from the system's standpoint as a resonant IR cavity, net energy gain would likely be negative, not a strongly positive 8.83
- Unlike extremely penetrating 'hard' gammas, SS cavity walls are relatively opaque to IR radiation; moreover, with thermal conductivity of 12-45 W/(m·K) SS 'holds the heat in' much better than Copper at 401 W/(m·K). When gamma conversion to IR DOES occur, released nuclear binding energy in the form of IR tends to stay inside the cavity and is thus available to heat it up and, most importantly, to be absorbed by surface plasmons (found on cavity walls and objects inside the cavity) that can concentrate that energy and transport it to many-body surface 'patches' of collectively oscillating protons or deuterons which in turn can make more ULM neutrons. This 'virtuous circle' enables the possibility of a positive feedback loop between releases of nuclear binding energy, conversion of γ to IR, local energy retention, absorption of cavity IR by SPs on nanostructures, additional neutron production --- in a potentially self-sustaining cycle until the system exhausts its reactants

IAEA (Vienna, Austria) database of prompt (n,γ) capture gammas (2006):
http://www-nds.iaea.org/pgaa/tecdoc.pdf

Summary of energetics for one possible Ni-seed LENR network pathway

Isotope Capturing ULM Neutron or Beta decaying	Capture Q-value in ~MeV (all +)	Some of its Hrd. Gamma Lines* (MeV)	'Cost' to Produce ULM Neutrons	Net Q-value
Ni-58	9.0	8.1, 8.5, **8.9**	0.78 MeV	**8.22**
Ni-59	11.4	Not in IAEA	0.78 MeV	**10.62**
Ni-60	7.8	7.5, **7.8**	0.78 MeV	**7.02**
Ni-61	10.6	Not in IAEA	0.78 MeV	**9.82**
Ni-62	6.8	6.3, **6.8**	0.78 MeV	**6.02**
Ni-63	9.7	Not in IAEA	0.78 MeV	**8.92**
Ni-64	6.1	6.0	0.78 MeV	**5.32**
Ni-65 (decay)	2.1	1.5	~1 (*neutrino)	**~1.1***
Totals (MeV)	**63.5**	**NA**	**6.46**	**57.04**
Gain = (net total Q-value for entire pathway) divided by (total cost) = 8.83				

Discussion of Ni-H gas-phase experiments exhibiting W-L gamma suppression



- **Please be aware that hypothetical LENR transmutation networks described in this presentation and others by Lattice represent a static picture of *possibilities* along various reaction pathways that have positive Q-values. In the 'real world' of Nature itself and human-controlled experiments in laboratories, these LENR nucleosynthetic networks can be extraordinarily dynamic, time-varying entities**

- **Pathways actually traversed in a given system can change dramatically over surprisingly short time-scales and on very small length-scales (nanometers to microns) in response to a myriad of different causative factors. Final product nucleosynthetic results observed in a given experiment run reflect a sum total across many parallel alternate reaction paths --- LENR network computer codes really need to be developed to better understand dynamics of such processes**

- **A frequent question in readers' minds is whether or not LENR networks typically produce final stable products with isotopic ratios that are roughly the *same* as the known natural abundances, or whether they would be more likely to differ? The straight answer to that question, as best we know today, is that sometimes they do, and sometimes they don't --- also, there is compelling evidence that some LENRs do occur outside laboratory settings in Nature**

- **For example, a series of aqueous electric arc experiments conducted at Texas A&M University and BARC (India) in the 1990s apparently transmuted Carbon into Iron (see Slides #46-56 in Lattice SlideShare technical overview dated Sept. 3, 2009, with file title, "Carbon-seed LENR networks"). In those experiments, measured isotopic ratios of the produced Iron did not differ significantly from natural abundances. On the other hand, there are many examples of LENR experiments in which product isotopic ratios differed greatly from natural ones**

Let's take Copper (Cu) for example - see hypothetical W-L LENR network pathway above:

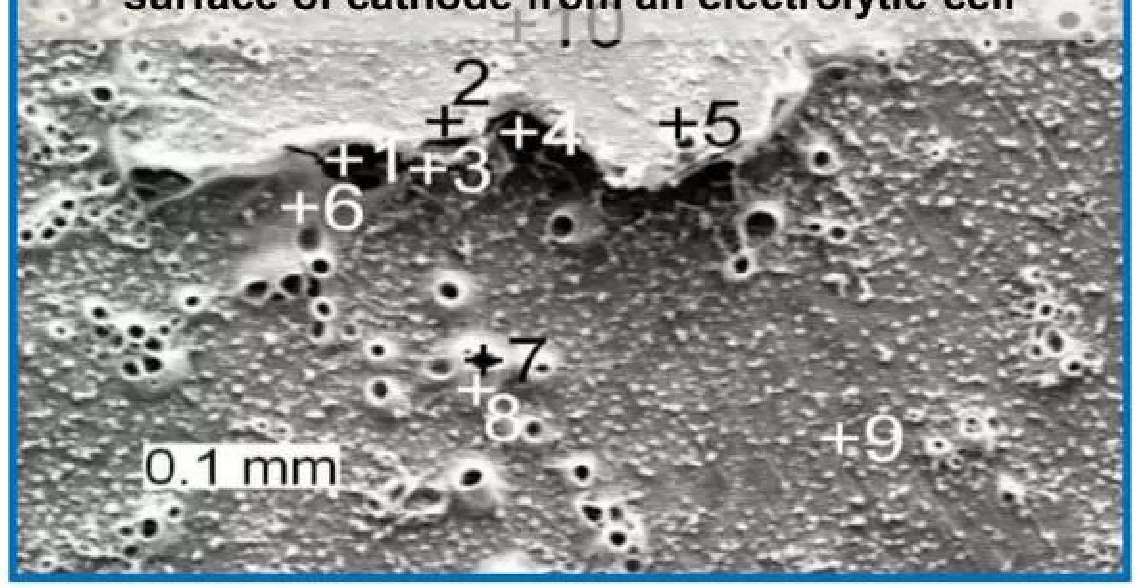
Given the long half-life and slow decay rate of Ni-63, one might reasonably expect that the network would produce Cu-65 at a much higher rate than Cu-63, hence the final elemental Copper isotopic ratio would probably shift in the direction of the heavier species. This is exactly what was observed by Violante et al. (ICCF-10, 2003, see Slide #45 herein)

On the other hand, it is well-known among astrophysicists that in certain very highly ionized states the half-life of Ni-63 can be *reduced* by >200x; i.e., it goes down from ~100 years to ~0.4 yrs. Could something like that ever happen in a condensed matter LENR system? Mostly likely not, but the little micron-scale LENR 'plasma balls' do get awfully hot, but not for a long enough period of time (~200 nanoseconds or less). That said, it would truly be extremely naïve to assume that LENR systems will not deal-out a few more big surprises along the way

- ✓ **When utilizing W-L theory and model LENR transmutation networks to help explain observed experimental data, please note that:**
  - ✓ **Literally ANY element or isotope present inside LENR experimental apparatus that has an opportunity to somehow move into very close physical proximity to surfaces or nanoparticles on which ULM neutrons are being produced can potentially 'compete' with other nuclei (located within the same nm-to-micron-scale domains of spatially extended ULM neutron Q-M wave functions) to capture locally produced ULMNs**
  - ✓ **Thus, some observations of transmutation products may appear oddly mystifying until one determines *exactly what elements/isotopes were initially present inside the apparatus when an experiment began*. In many cases, materials located inside such experiments are very poorly characterized; thus 'starting points' for ULMN captures on 'seed' nuclei may be quite unclear**

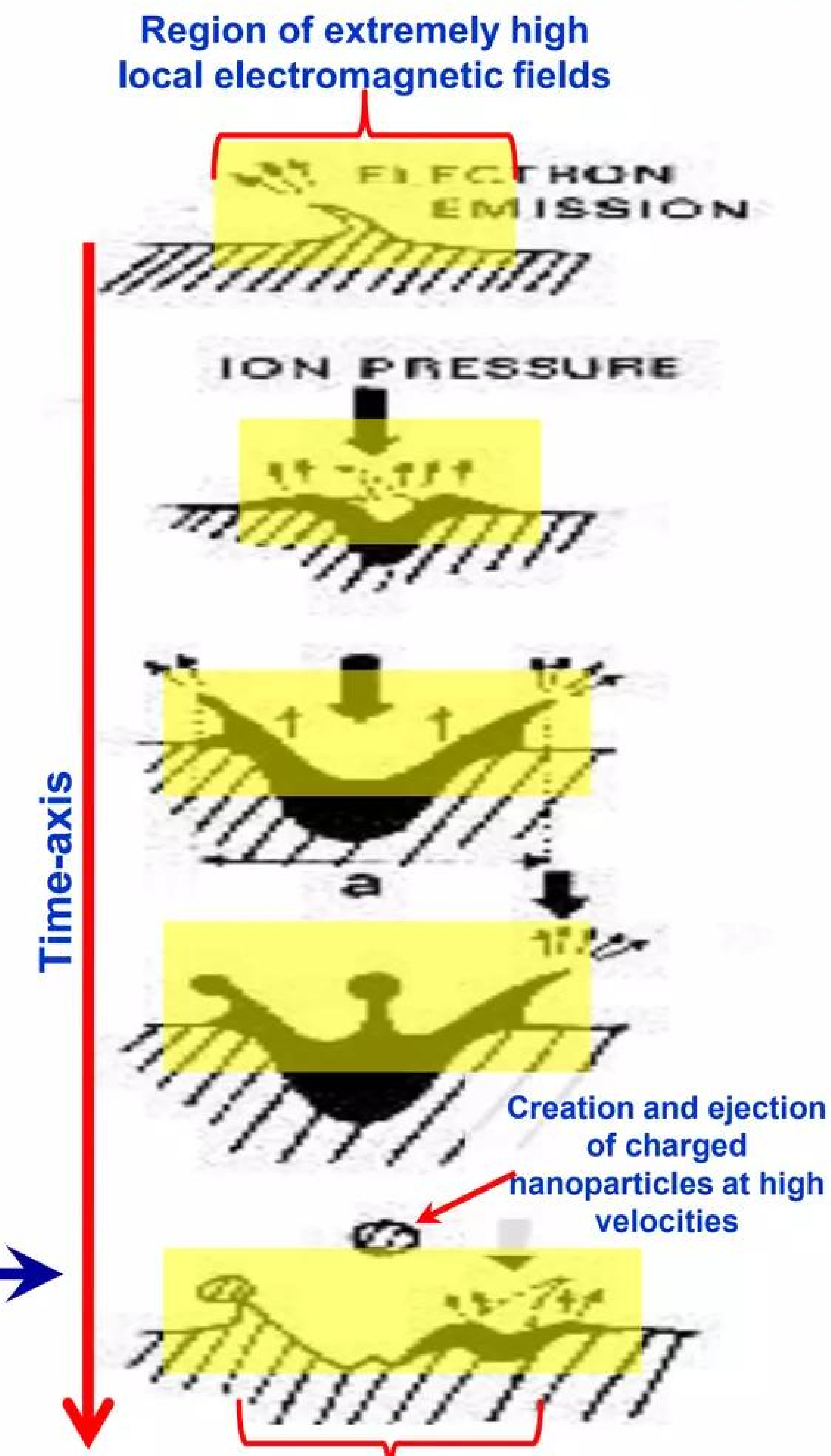
LENR-active surface sites ('hot spots') are not permanent entities. In experimental systems with sufficient input energy, they will form spontaneously, 'light-up' for 10 to several hundred nanoseconds, and then suddenly 'die.' Over time, endless cycles of 'birth', nuclear energy release, and 'death' are repeated over and over again at many thousands of different, randomly scattered nm-to micron-sized locations found on a given surface. When LENRs are occurring, these tiny patches become temporary 'hot spots' -- their temperatures may reach 4,000 - 6,000^o K or even higher. That value is roughly as hot as the surface temperature of the Sun and high enough to melt and/or even flash boil essentially all metals, including tungsten (b.p. = 5,666^{o}C). For a brief period, a tiny dense 'ball' of very hot, highly ionized plasma is created. Such intense local heating events commonly produce numerous explosive melting features and/or 'craters' that are often observed in post-experiment surface SEM images such as for example (credit: Zhang & Dash, 2007):

Post-experiment SEM image of Palladium (Pd) surface of cathode from an electrolytic cell



Discussion of Ni-H gas-phase experiments exhibiting W-L gamma suppression

- ✓ **In gas-phase LENR systems, *especially if they contain tiny 'target fuel' nanoparticles or volatile aromatic compounds*, e.g., benzene or polycyclic aromatic hydrocarbons (PAHs, e.g., Phenanthrene), it is virtually a certainty that walls of reaction vessels will come into intimate physical contact with introduced nanoparticles and/or adhering aromatic molecules**
- ✓ **Contact can occur via gravity or gaseous turbulence that swirls tiny nanoparticles around inside reaction vessels or by condensation of organic residues on walls. Once in close proximity, chemical reactions and/or LENRs can readily occur at points of interfacial contact between walls and introduced nanoparticles and/or organic molecules**
- ✓ **In the case of LENRs, atomic nuclei comprising wall materials at or near a mutual point of brief contact will have an opportunity to 'compete' with nuclei in nearby nanoparticles or aromatic molecules to capture produced ULM neutrons. If wall nuclei capture neutrons, LENRs will then occur in local 'patches,' resulting in surface-altering 'cratering' processes; one type of which is illustrated to right**
- ✓ **Therefore, in such systems wall nuclei atoms can potentially also become 'seeds' in LENR transmutation networks; LENRs occurring in or near walls can cause significant amounts of wall materials to ablate into the local gas in the form of newly created nanoparticles**



Idealized stages in ablative electrical breakdown of nm-to-micron-scale LENR surface sites that form 'craters' seen in many different SEM images

Figure courtesy of B. Jüttner, Berlin

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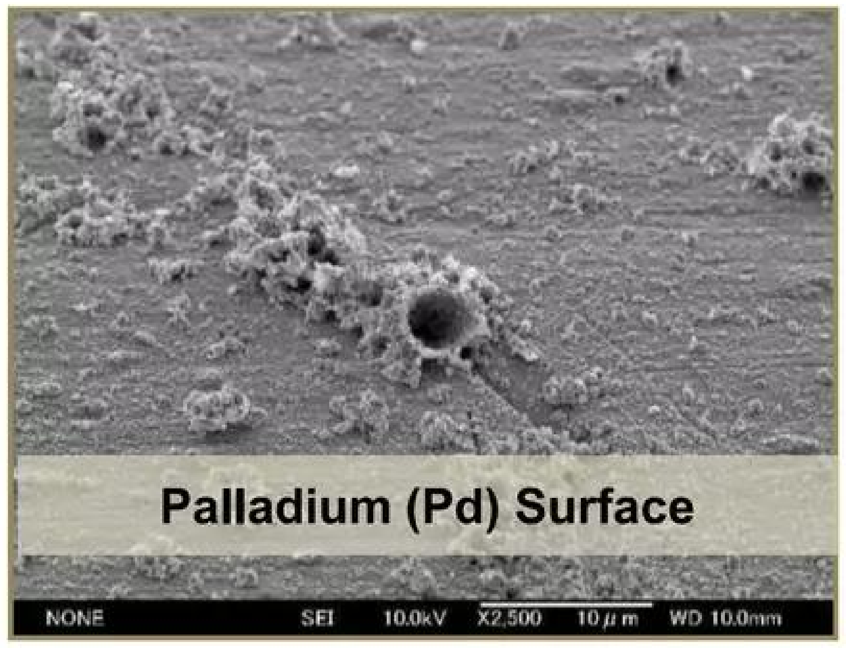
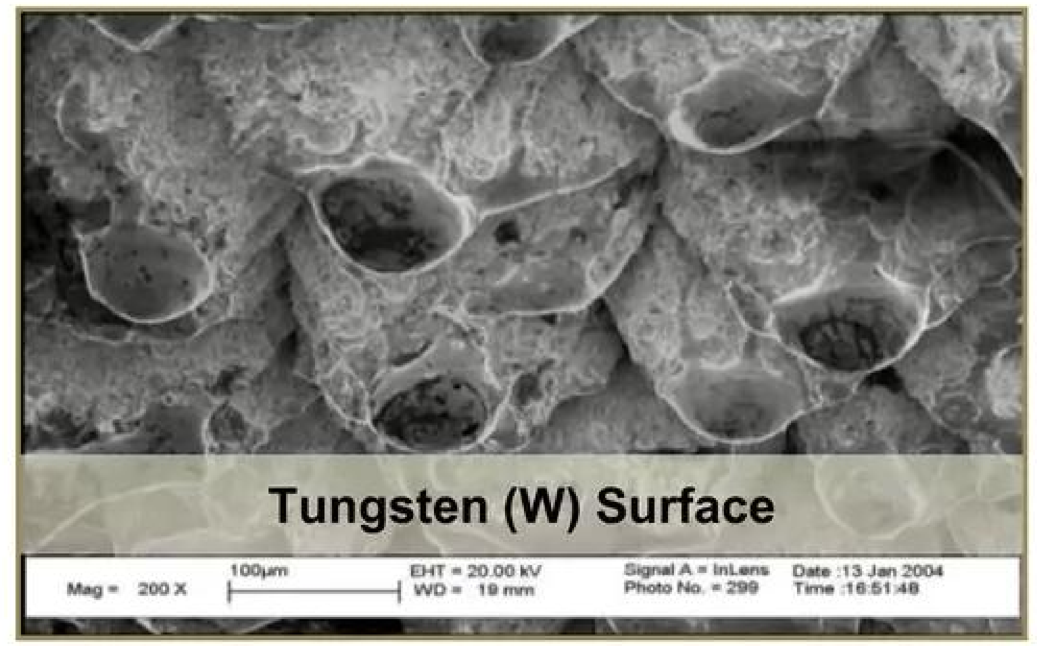
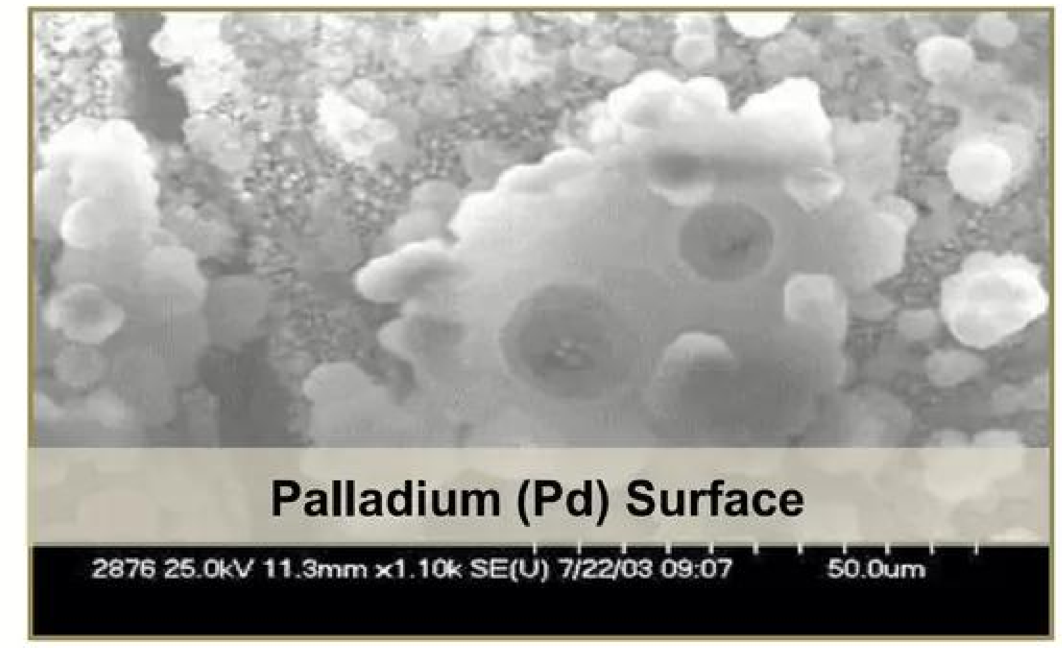
Discussion of Ni-H gas-phase experiments exhibiting W-L gamma suppression



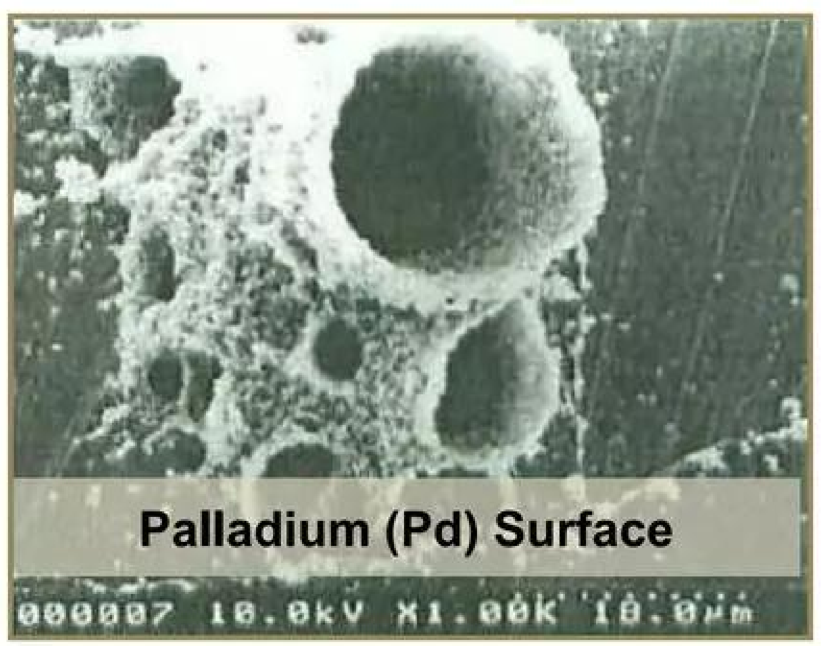
Credit: Y. Toriabe et al.



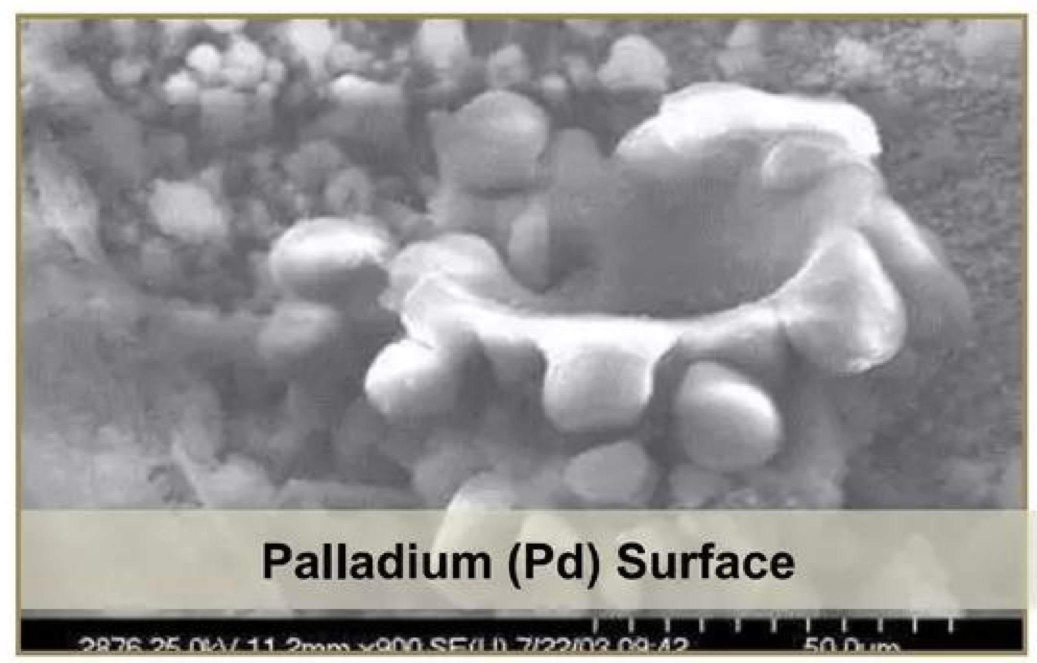
Credit: Cirillo & Iorio



Credit: P. Boss et al.

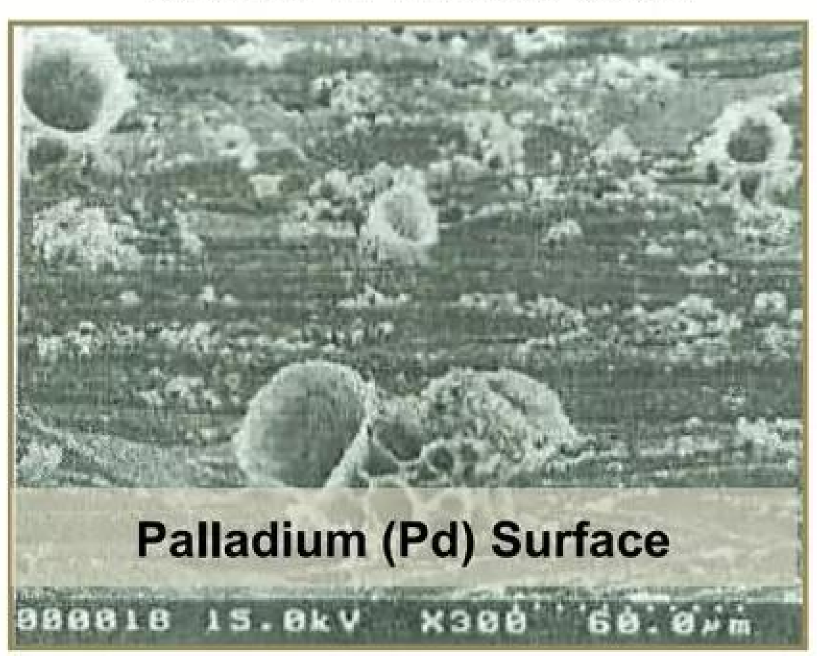


Credit: Y. Toriabe et al.



Credit: P. Boss et al.

Credit: Energetics Technologies Ltd.



Credit: Y. Toriabe et al.

Credit: P. Boss et al.

<u>Note</u>: besides the examples shown here, nanostructures created by LENRs display an extremely varied array of different morphologies and can range in size from just several nanometers all the way up to ~100 microns or more. Electron field-emission sites can be ~similar, but differ subtly in morphology

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Conclusions re W-L theory in Ni-H gas-phase systems

- ✓ **In gas-phase H_2/Ni experimental systems: capacity for substantial production of excess heat, clear evidence for some sort of a positive thermal feedback mechanism, observed transmutation products, and anomalous absence of energetic neutrons and 'hard' gamma radiation are readily explained by the W-L theory of LENRs and Cr/Fe/Ni 'seed' transmutation networks shown herein**

- ✓ **Similarly, W-L theory also readily explains transmutation products that have been observed post-experiment in Ni and Pd 'seed' aqueous H_2O or D_2O electrolytic systems, as well as what appear to be LENR transmutation products observed in emissions from precious metal catalytic converters commonly found in cars and trucks worldwide (see SlideShare dated June 25, 2010)**

- ✓ **Positive thermal feedback has been sporadically reported in electrolytic LENR systems. It has also been reported recently by Mizuno & Sawada (2008) in a gas-phase system with stainless steel reaction vessels using Phenanthrene and metal catalyst seeds, "*The reaction is reliably triggered by raising temperatures above ... threshold temperature of 600^o C and ... hydrogen pressures above 70 atm. It can be quenched by lowering the temperature ... below ~ 600^o C.*" (see Lattice SlideShare presentation dtd. November 25, 2009, titled, "*Mizuno experiments with PAHs*")**

- ✓ **If the apparent positive thermal feedback loop mechanism can be well understood, closely controlled, and incorporated in future LENR-based commercial power generation systems, a wide variety of inexpensive 'seed' nuclei could potentially be 'burned' as nuclear fuels in comparatively simple, relatively unremarkable pressure/temperature/metal reactors employing W-L ULMN-capture LENR nucleosynthetic networks (such as those shown herein) and without releasing any additional Carbon as CO_2, 'hard' radiation, or radioactive isotopes into earth's biosphere**

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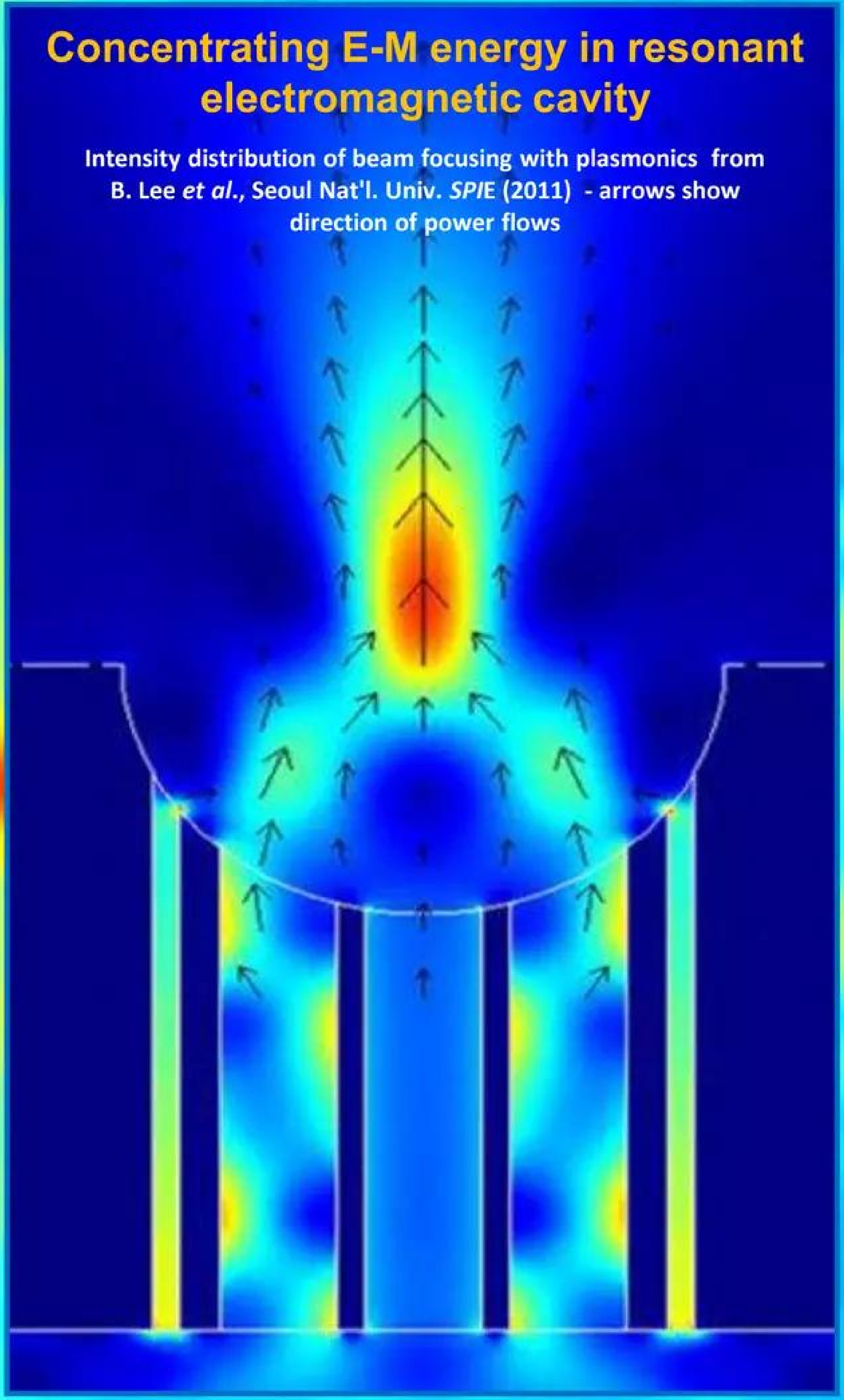
Commercial utility of US 7,893,414 B2's inventive art

Quoting from the issued patent:

"There are additional important commercial uses for preferred embodiments of the invention that provide low cost, low mass, highly effective gamma shielding. Important applications enabled by the invention include:

Compact, long-lived portable power generation devices that can sustain *in situ* operation of ultra low momentum neutron-catalyzed networks of LENRs without any need for significant quantities of additional shielding because the system's heavy electrons function as an integrated gamma shield. Such devices can be designed to exploit differences between the aggregate nuclear binding energies of preferred initial seed materials and the final products (isotopes) of the nuclear reaction networks to create an overall net release of energy, primarily in the form of excess heat. This heat would be generated primarily by preferred weak interactions such as beta decays. When integrated with a variety of preferred types of energy conversion technologies, nuclear heat sources enabled by the invention could be valuable in a variety of civilian and military applications."



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