Electrons Ejected Due of Laser Irradiation of Ultra-Dense Hydrogen Layer on Metals Surface - A New Source of Instant Electrical Energy (review)

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Abstract

Some recent experiments signalize the high-energy particles detected from spontaneous processes in an ultra-dense Hydrogen/Deuterium D(0) layer (UDD) on metals surface due of laser irradiation.

Based on the previously author works about models on nucleons structure and on the bias current inside valence nucleons during $\beta - decay$ stimulation by a laser, in the present one is analyzed the feasibility of these experiments. Thus, by using QM&MD programmes: fhi96md and GAMESS is confirmed the apparition of Rydberg matter (UDD) on the surface of Pd lattice by H(0)/D(0) electron delocalization. Also is proved the author's model of vortex assisted photon beta decay, when a laser photon makes this process much more probable by creating a spot (melt) in nucleon with suppressed order parameter that lowering the energy barrier for vortex crossing together with an heavy electron (*bias current* $e^{\pm}$) as resulting from the decay of the permanent rate of bosons pairs $W^{\pm} \cong 10^{-8}$ as produced inside nucleons by a Schwinger effect. Thus, the obtained electrical current have a power P_w=3.5x10^{12} w<<P_{laser} ~2Pw for a laser spot of size $1\mu m$, that corresponds with ELI laser characteristics, that means not energy gain for this laser type. But if we use others lasers of much smaller power when we have per photons ~10^{-5}w .1ns(T=10^{9}K)~10^{-14} J of duration ~*1ns* and, respectively ~10^{-14} J.10^{13} ~0.1J~10^{8} [w] for a pulse composed of ~10^{13} ph/s, in this case can appears a net gain of 3.5x10^{12}/10^{8}=3.5x10^{4}, which is near that obtained from U235 fission ~200MeV/0.025eV/235x2%=6x10^{5}.

1. The state of art

Motivated on the very recent experiments to study a new type of nuclear fusion process, in this paper a theoretically check of these findings is done. Thus, the attention is focussed on the most recently one [1÷5], when it results that are produced almost no neutrons but instead fast, heavy electrons (muons), since it is based on nuclear reactions in ultra-dense heavy hydrogen (deuterium) (UDD).

Thus, " a considerable advantage of the fast heavy electrons produced by the new process is that these are charged and can therefore produce electrical energy instantly".

High-energy particles are detected from spontaneous processes in an ultra-dense Hydrogen/deuterium D(0) layer [1÷4]. Intense distributions of such penetrating particles are observed using energy spectroscopy and glass converters. Both spontaneous line-spectra and a spontaneous broad energy distribution similar to a beta-decay distribution are observed. The broad distribution is concluded to be due to nuclear particles, giving straight-line Kurie-like plots. It is observed even at a distance of 3 m in air and has a total rate of 10^{7}–10^{10} s^{-1}.

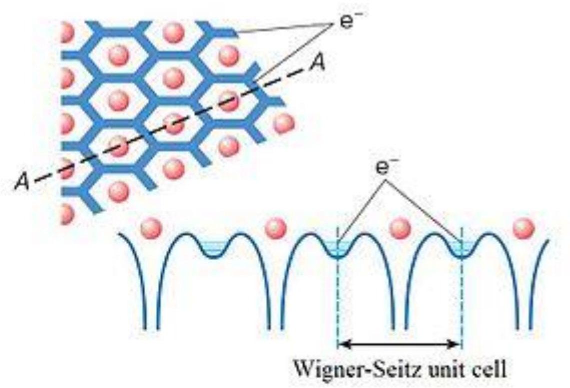

Fig.1 Schematic of valence electron distribution in a Rydberg matter made of excited (n=10) Cs atoms

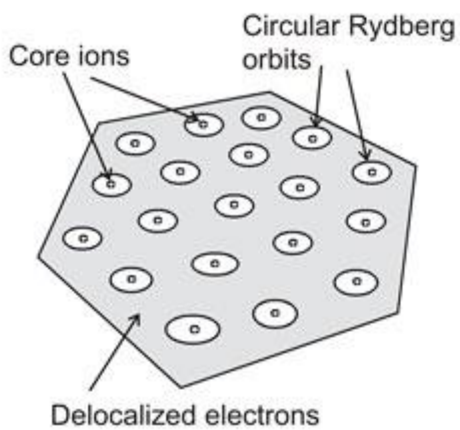

Fig.2 A 19-atom planar Rydberg matter cluster. At the seventh excitation level, spectroscopy on K_{19} clusters showed the bond distance to be 5.525 nm.

Following Wikipedia "the Rydberg matter consists of usually hexagonal planar clusters. Hence, they are not gases or plasmas; nor are they solids or liquids; they are most similar to dusty plasmas with small clusters in a gas. Though Rydberg matter can be studied in the laboratory by laser probing, the largest cluster reported consists of only 91 atoms. Bonding in Rydberg matter is caused by delocalization of the high-energy electrons to form overall lower energy state, figures 1, 2. The way in which the electrons delocalize is to form standing waves on loops surrounding nuclei, creating quantized angular momentum and the defining characteristics of Rydberg matter. It is a generalized metal by way of the quantum numbers influencing loop size but restricted by the bonding requirement for strong electron correlation; it shows exchange-correlation properties similar to covalent bonding. Electronic excitation and vibrational motion of these bonds can be studied by Raman spectroscopy.

Like bosons that can be condensed to form Bose-Einstein condensates (BEC), Rydberg matter can be condensed, but not in the same way as bosons. The reason for this is that Rydberg matter behaves similarly to a gas, meaning that it cannot be condensed without removing the condensation energy; ionization occurs if this is not done. All solutions to this problem so far involve using an adjacent surface in some way, the best being evaporating the atoms of which the Rydberg matter is to be formed from and leaving the condensation energy on the surface. Using cesium atoms, graphite-covered surfaces and thermionic converter as containment, the work function of the surface has been measured to be 0.5eV, indicating that the cluster is between the ninth and fourteenth excitation levels".

Therefore, to compute the critical temperature of an ideal gas of D viewed as bosons of average interparticle distances $(N/V)^{-1/3}$ (where N = total number of bosons in volume V) comparable or smaller than the thermal de Broglie wavelength λ_{dB}, such that quantum effects start to dominate. The quantum effects become appreciable when the particle concentration is greater than or equal to the quantum concentration, which is defined as:

$$n_Q = \left(\frac{mk_B T}{2\pi\hbar^2} \right)^{3/2}$$

Quantum effects appear if the concentration of particles satisfies,

$$N/V \geq n_Q$$

Or, $(N/V)^{-1/3} = \left(\frac{10^{20}}{10^{-15}} \right)^{-1/3} \cong 2\times 10^{-12} < \lambda_{dB} = \frac{h}{\sqrt{2\pi m_H k_B T}} \cong 6\times 10^{-11}[m]$; $h = 2\pi\hbar$ for $T = 500K$.

Ultra-dense deuterium d(-1) or D(-1) is the lowest energy form of deuterium atoms, but above D2 molecules on the energy scale. The D-D bond distance in D(-1) is approximately 2.3 pm [1÷4].

Therefore, UDD could be a BEC if the number of D atoms is $>10^{20}$ as result from [1÷4]

2. The evaluation of reactions feasibility with QM&MD **programmes: fhi96md and GAMESS**

In [6], for the first time it was shown, that to simulate the poly-atoms containg decaying isotopes in Quantum Mechanics and Molecular Dynamics (QM&MD) codes calculations, and to obtain "the screening energy shift" of protons, decay alpha, beta$^+$ particles due of all sourouding interacting effects, it is suficiently only to substitute the code ruly pseudo-potential input for hydrogenlike atoms (including alpha) by a screened Coulomb potential as from the well-known Gamow alpha decay theory.

This it was demonstrated by using a code package **fhi96md** which is an efficient code to perform density-functional theory (DFT) total-energy calculations for materials ranging insulators to transition metals. The package employs first-principles pseudo-potentials,

and a plane-wave basis-set, and is used to done a special calculus for some metals (Pd) where are depozided on the surface and implanted interstitially 2 H ions.
The package **fhi96md** is an efficient code to perform density-functional theory total-energy calculations for materials ranging insulators to transition metals. The package employs first-principles pseudopotentials, and a plane-wave basis-set. For exchange and correlation both the local density and generalized gradient approximations are implemented.
In Polly-atomic systems as for example molecules, crystals, defects in crystals, surfaces, it is highly desirable to perform accurate electronic structure calculations, without introducing uncontrollable approximations.
a) analytical evaluation
Thus, by combining the Gamow decay theory with electrostatic screening in Debye-Hückel approximation (jellium model) the new formula for "the shift" in screening energy has been derived:

$$U_D = \frac{Z_1 Z_2 e^2}{4\pi\varepsilon_0 \lambda_D} \cong 2.09\times 10^{-11} Z_1 Z_2 \left(\rho / T\right)^{1/2}$$

Where λ_D-is the Debye length and ρ-the number density of electrons in background of heavy, positively charged ions of Z_1, and Z_2 charge numbers. With this formula is calculated the penetrability through the potential barrier in terms of the enhancement decay factor, and following the half-lives shortening, the results being in close agreement with as reported experiments.

We may take the barrier to be the sum of a square well nuclear potential of radius R, and a Coulomb potential arising from a charge within R,

$$V(r) = 0 \qquad \text{for} \quad r<R$$

$$= \frac{1}{[4\pi\varepsilon_o]} \frac{Z_\alpha Z_D e^2}{r} \qquad \textit{for} \quad r \geq R \qquad (1)$$

The electron Debye radius around the deuterons in the lattice is given by
$R_D = \left(\varepsilon_0 kT / e^2 n_{eff}\, \rho_a\right)^{1/2} = 69(T / n_{eff}\, \rho_a)^{1/2}$ (m), with the temperature T of the quasi-free electrons in units K, n_{eff} the number of thesis electrons per metallic atom and the atomic density ρ_a in units of atoms m^{-3}. For T = 293 K , $\rho_a = 6 \times 10^{28} m^{-3}$, and $n_{eff} = 1$, is obtained a radius R_D, which is about a factor 10 smaller than the Bohr radius $(\cong 5.2\times 10^{-11} m)$ of a hydrogen atom respectively $\cong 5.2\, pm$ (to note of the Pd atom radius of 137 pm).These results can confirm the UDD, but no the fusion since the Debye radius it needs to be of the order of fm to realize the nucleons melting [7], [8], [10].
With the Coulomb energy of the Debye electron cloud and a deuteron projectile at R_D set equal to $U_e \equiv U_D$, one obtains $U_D = 2.09\times 10^{-11} \left(n_{eff}\, \rho_a / T\right)^{1/2}$ eV. With the Coulomb energy between two deuterons at R_D set equal to U_e, one obtains
$U_e = (4\pi\varepsilon_o)^{-1} e^2 / R_D = 300\ eV$ the order of magnitude of the observed U_e values.
b) The evaluation of 2H in Pd-cell with fhi96MD
The emergency functional the key variable in DFT is the electron density *n* (**r**).
All that our suggest to use for hydrogen-like atoms (for other atoms are kept the original formulations) the pseudo-potential form as in eq.(1) above, so neglecting the non-local contributions at the level of atom itself, respectively:

$$= \frac{1}{[4\pi\varepsilon_o]} \frac{Z_\alpha Z_D e^2}{r} \qquad for \quad r \geq R$$

Consequently, the complementary tool from the all package FHIPP it was modified (the package being of open source type), and the results of their application for pseudo-potentials of alpha particles and protons are shown in figure 1 of [6].

In case of energy of d+d reaction of deuterons implantation in Pd , the code gives $20 * 27.2 = 544 eV$ which is in the range of experimental values (800 eV) for Pd.

c) The evaluation of Pd4H2 system with GAMESS

The chemical reaction H-Pd (i.e the difussion of H as interstitial in metalic lattice of Pd) followed by the formation of covalent bonds (orbitals interference) that produce the breaks of some Pd-Pd bonds. The analysis is done with the programme GAMESS [12], for a metalic lattice with one molecule of H aranged on axes z at different distances with one of their atom as interstitial and the other near the surface. The results are presented in tabels and in figures 3,4, where are represented the electric charges distributions for the first occupied orbital (93), as obtained by processing of output file of GAMESS with ChemCraft. Thus, the distribution of of charges on the interstitial H show a near total „screening" and that disapears the covalent bonds Pd-H , this being sourrounded by an electronic sea like in case of Rydberg atoms, see comparatively the figures 3,4 and cases 1,2, or simillarly with the graphene appeareance. About the fusion, cases 3, 4, and figure 5, since in case 3 the total energy is zero that means no reaction, so only in case 4 in the presence of a electric field it is happen like in case of pyrofusion.

Also from GAMESS results the modification of valences, see tables.

Case 1

ATOM	ATOMIC CHARGE	COORDINATES (BOHR=5.2X10^{-11}m) X	Y	Z
PD	46.0	-0.2730777885	1.0028751964	-0.0017314750
PD	46.0	0.2728712478	-1.0028484748	-0.0018481564
PD	46.0	1.0027585456	0.2729878851	-0.0019883123
PD	46.0	-1.0029650863	-0.2729611635	-0.0015913191
HYDROGEN	1.0	-0.0163682081	-0.0044138829	-0.0017865964
HYDROGEN	1.0	0.0597751983	-0.0012019738	0.7540886725

TOTAL ENERGY = -18995.4778253968

	ATOM	TOTAL VALENCE	BONDED VALENCE	FREE VALENCE
1	PD	4.098	4.098	0.000
2	PD	4.049	4.049	0.000
3	PD	4.000	4.000	0.000
4	PD	4.131	4.131	0.000
5	HYDROGEN	-0.184	-0.184	0.000
6	HYDROGEN	0.455	0.455	0.000

Case 2

ATOM	ATOMIC CHARGE	COORDINATES (BOHR) X	Y	Z
PALLADIUM	46.0	-0.7885775214	0.5946716104	0.0018534815
PALLADIUM	46.0	0.7895876740	-0.5778692426	0.0018839361
PALLADIUM	46.0	-0.5985402857	-0.7817220745	0.0018232496
PALLADIUM	46.0	0.5977351089	0.7650926106	0.0019131785
HYDROGEN	1.0	-0.0318057333	-0.0249813827	0.0036786782
HYDROGEN	1.0	0.0102666831	0.0068124694	-0.7890374236

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   TOTAL ENERGY =  -18949.5205226893
                    TOTAL       BONDED       FREE
  ATOM              VALENCE     VALENCE      VALENCE
1 PALLADIUM           3.721       3.721        0.000
2 PALLADIUM           3.336       3.336        0.000
3 PALLADIUM           3.614       3.614        0.000
4 PALLADIUM           3.088       3.088        0.000
5 HYDROGEN           -0.093      -0.093        0.000
6 HYDROGEN            0.474       0.474        0.000
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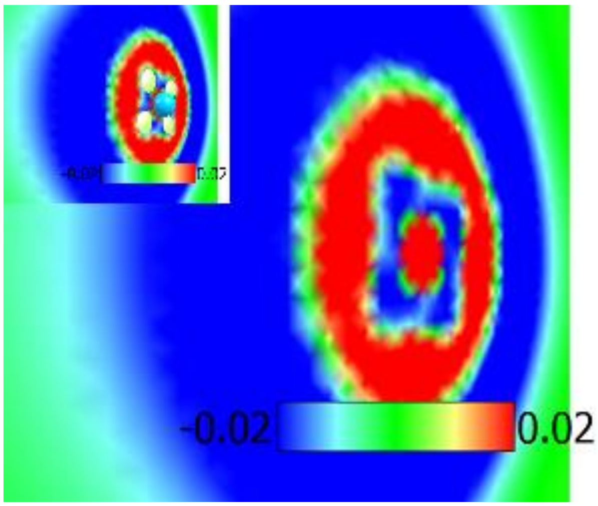

Fig. 3. The last unoccupied orbital (93) for te system Pd4H2, H at surface

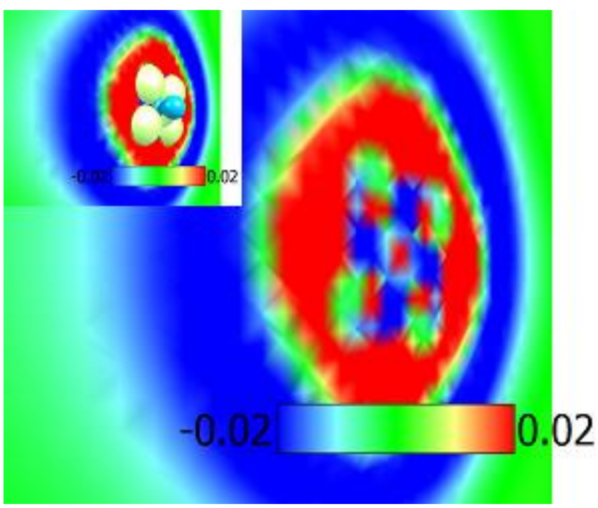

Fig. 4. The last unoccupied orbital (93) for te system Pd4H2, H interstial

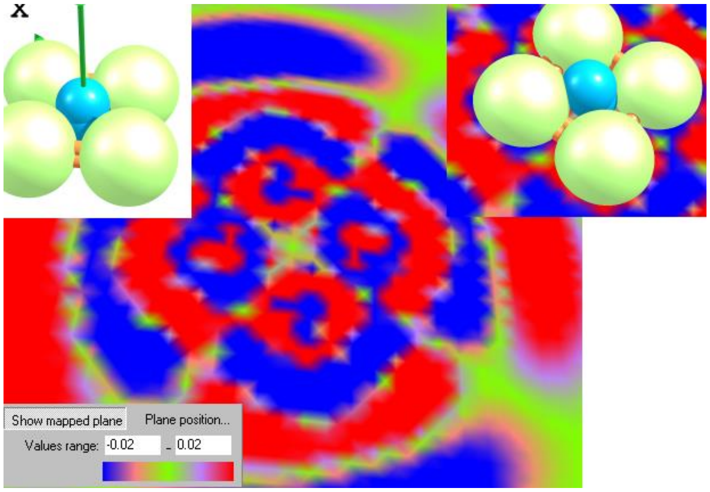

Fig. 5. The last unoccupied orbital (93) for te system Pd4H2, the fusion case.

Case3 (fusion!)
Without electric field

ATOM	ATOMIC CHARGE	COORDINATES (BOHR) X	Y	Z
PD	46.0	-0.2730342251	1.0028869642	-0.0005194825
PD	46.0	0.2728283340	-1.0028602468	-0.0005544069
PD	46.0	1.0027706581	0.2729446388	-0.0005963576
PD	46.0	-1.0029765493	-0.2729179214	-0.0004775318
HYDROGEN	1.0	-0.0163680745	-0.0044131836	-0.0005359811
HYDROGEN	1.0	0.0596385433	-0.0012017985	0.2262266140

TOTAL ENERGY = 0.0000000000

ATOM	TOTAL VALENCE	BONDED VALENCE	FREE VALENCE
1 PD	4.812	4.812	0.000
2 PD	4.770	4.770	0.000
3 PD	4.715	4.715	0.000
4 PD	4.840	4.840	0.000
5 HYDROGEN	-0.456	-0.456	0.000
6 HYDROGEN	0.584	0.584	0.000

Case 4(fusion!)
With electric field

ATOM	ATOMIC CHARGE	COORDINATES (BOHR) X	Y	Z
PD	46.0	-0.2730342251	1.0028869642	-0.0005194825
PD	46.0	0.2728283340	-1.0028602468	-0.0005544069
PD	46.0	1.0027706581	0.2729446388	-0.0005963576
PD	46.0	-1.0029765493	-0.2729179214	-0.0004775318
HYDROGEN	1.0	-0.0163680745	-0.0044131836	-0.0005359811
HYDROGEN	1.0	0.0596385433	-0.0012017985	0.2262266140

TOTAL ENERGY = -18987.8856604911

ATOM	TOTAL VALENCE	BONDED VALENCE	FREE VALENCE
1 PD	4.811	4.811	0.000
2 PD	4.770	4.770	0.000
3 PD	4.714	4.714	0.000

4	PD	4.839	4.839	0.000
5	HYDROGEN	-0.456	-0.456	0.000
6	HYDROGEN	0.584	0.584	0.000

3. How can obtain an electrical current on metallic support of UDD as induced by laser pulses-as new source of energy

As it was mentioned High-energy particles are detected from spontaneous processes in an ultra-dense deuterium D(0) layer [1÷4].

Muons are conventionally measured by a plastic scintillator–photomultiplier detector. Muons from processes in ultra-dense hydrogen H(0) are detected here by a novel type of converter in front of a photomultiplier [4].

3.1 The bias current model of $\beta - decay$ stimulation by a thermal spike of a photon

In order to accelerate the $\beta - decay$ by a single photon reaction, a new model it was proposed in [7], [8], [10] to calculate a *direct reaction of single photon with one of nucleon of the valence n-n; p-p; n-p pairs (see IBM model [30,31]cited in [7]) of the nucleus, that being in the unstable state (a* $\beta - decay$ *nuclide), they are the most susceptible to react with the photon, see some of model's results from [7], figures* $1 \div 4$, *respectively.*

The interaction between a photon of high energy and of low band width $\Delta E/E \leq 10^{-3}$ and of nucleon into state of excitation has been characterized by the beta decay energy Q_β from the nuclei, that is viewed as a *direct reaction*, without the formation of a compound nucleus.

Essentially, the general picture of this model described in details in [8], [9a], [9b] is that the vortex (boson W, figure 6.) crossing may trigger the $s \rightarrow n$ transition. A photon makes this process much more probable by creating a spot (melt) with suppressed order parameter and thus with lower energy barrier for vortex crossing. A sketch of the strip and of the belt across are shown in Figure 7, the induced vortex crossing together with an electron (*travel current* $e^{\pm}$), which turns superconducting hot belt into the normal state resulting in a vortex assisted photon beta decay.

As a consequence of the Lorentz force acting on a vortex crossing a thin and narrow current-biased strip the energy Φ0I/c is released, which for currents I > 0.6Ic suffices to create a normal belt across the entire width w of the strip (extending to a few correlation lengths ξ along the strip).

Therefore, by using the same nucleon model we can account for a vortex (W boson) assisted photon count rate, as in [8], [9a], [9b]:

$$R_{pc} = R_h \left[1 - \exp(-\Re)\right]$$

,where:

$$R_\nu(I,\nu_h)=\frac{4k_BTR_{eff}}{\pi\Phi_0^2}\frac{\xi}{w}\left(\frac{\nu_h}{2\pi}\right)^{1/2}\left(\frac{I}{I_{ch}}\right)^{\nu_h+1}$$

$$\Re\approx\frac{\tau_{GL}R_\nu}{\nu_0-\nu_h}\frac{1-\left(I_{ch}/I\right)^{\nu_h-\nu_1-1}}{\ln\left(I_{ch}/I\right)}$$

The current being

$$I_{ch}=I_{c0}\left(\nu_h/\nu_0\right)^{3/2}$$

$$I_{c0}=\frac{\pi c^2\Phi_0\varepsilon_0}{8\left(2\pi^3x\lambda^5\right)^{1/2}}e^{-x/\lambda}\times10^{15}[A/fm^2]$$

The effective ohmic resistance is $R_{eff} = R_s R/(R_s + 2\pi(\xi/w)^2 R)$.

We can suppose than along the hot belt induced by the incident photon , the charge e^-+W^- creates a *bias current(* $I>2/3e[\left(1/(\nu_h/\nu_0)^{3/2}\right)\cong3]\Rightarrow2e$, see below, who circulates due of the potential difference between the vortex and the rest of isotope.

At the first sight, the ohmic resistance of this ad-hoc electrical circuit created by the *bias current* is given as:

$$R^{-1}=\frac{U_\beta}{\tau_{GL}}\frac{1}{V_{vortex}^2}$$

,where the vortex potential is $V_{vortex}=H_0\xi$,

H_0-an "external" electro-magnetic field of a dipole created by the pair $u\bar{u}$ (the chromoelectrical field)

$$H_0=E_0=\frac{de}{4\pi\varepsilon_0r^3}=8.33e24\left[\frac{N}{C}\right]$$

,where, $r\cong0.05[fm]$-is the electrical flux tube radius, $d=0.7[fm]$-the distance between the two quarks charges, usually $H[A/m]$, but here is used as $B=\mu_0H\left[\frac{J}{Am^2}\right]$

, and the characteristic distance $\xi\le\lambda$, the coherence length,

and the power is $U_\beta/\tau\cong\varepsilon_{vortex(W^\pm)}/\tau$, with $\tau_{GL}=\pi\hbar/(8k_BT_c)=1.5e-24[s]$-the Ginzburg-Landau life time of $W^\pm$ bosons.

Numerically, with $T_{c\_11}=5\times10^{11}K$ (ELI laser); and $T_{c\_9}=10^9K$ (Nd:YAG laser), $E_{prag\_11}=k_BT_{c\_11}\cong43MeV$; $E_{prag\_9}=0.09MeV$, result $\nu_0=\varepsilon_W/k_BT_c=1.e-09/(1.38e-23*2.e12)=36.2$, where $T_c=10^{12}K$ at confinement, and where ε_W results from eq. (2) from [8] as $\varepsilon_W=\varepsilon_{\text{int}}(d=x-\lambda;x=0.14)*0.117[fm]\cong1.e-09[J]$; $R^{-1}=143\Omega$; $R_s=1000\Omega$; $R_{eff}=141\Omega, w\cong1fm$.

With $\Phi_0=2\times10^{-15}[Tm^2]$; $\lambda=0.117fm$; $x\cong\lambda$, it results $I_{c0}\cong3.6\times10^7[A/fm^2]$, $I_{c0W}=I_{c0}.W_{rate}=3.6x10^7.10^{-8}=0.36[A/fm^2]$

$\nu_{h\_11} = \varepsilon_{0h} / E_{prag\_11} = 5\times10^{-11} / E_{prag\_11} = 6.9$,
$\nu_{h\_9} = \varepsilon_{0h\_9} / E_{prag\_9} = 9.6\times10^{-14} / E_{prag\_9} = 6.9$
The total power per pulse of Nd:YAG laser is $P_{tot} = 9.6\times10^{-14} \cdot 5\times10^{13} = 4.6[J]$
$I_{ch} = I/I_{c0} \cdot 3.6\times10^{7} \times area \times rate\_W^{\pm} = 5\times10^{6} \cdot 10^{-8} = 50[mA]$, $area = 1 fm^2$; the production rate of $W^{\pm}=10^{-8}$, $U = R_{eff} I \cong 7[V]$; $I/I_{c0} = 0.138$ as obtained by trials (figure 8), and where ε_{0h} is obtained by using the lower critical field

$$B_0 = H_{c1} = \frac{2\Phi_0}{2\pi\lambda^2}\log\left(\frac{\lambda}{\xi}\right) = \frac{\pi\hbar c}{\pi\lambda^2 c}\log(\kappa) = 1.e15\left[\frac{J}{Am^2}\right]$$

, and with $x \cong \xi = 0.107[fm]$;
respectively: $\varepsilon_{0h} = Vc^2\varepsilon_0 (2H_{c1})^2 / 8\pi = 5.3e-11[J]$
In our first case of *muons born* due of hot spot $\nu_h = 330MeV / E_{prag} = 7.68$ which is obtained by trials. Thus we obtain the average (dc) voltage $V_{dc} = \Phi_0 / c \cdot R_\nu \to 7400V$. We obtain
$\tau_0 \approx d^2 \Phi_0/(2\pi\xi^2 2cR_{eff} I)$, I=50mA, d=1pm, $\tau_0 = 9ns$, the time-of-flight. In fact, this estimate coincides with the time it takes a vortex to cross the strip being pushed solely by the Lorentz force. With these it results $R_\nu=10^{18}$/s.
The value of E_{prag} is determined by trials in order to have $R_{pc}/R_h \cong 1$, see figure 8.
The model results show that in order to have *instant rates(100% decay)*, or a beta decay rate of $R_{pc} = 5\times10^{13} counts/s$, with the incident of single photons rate of $R_{ph} = 5\times10^{13} counts/s$, $R_{pc}/R_h \cong 1$, for all beta-decay isotopes, i.e. these rates are not dependent of the nuclide type, the photons energy needs to be above a threshold energy value of very precise value $5\times10^{11}K \to 43MeV$, but in this case we don't have a net energy gain due of the small current $I_{ch} = 5\times10^{-2}[A]$ due of permanent rate of bosons production by Schwinger effect $W^{\pm} \cong 10^{-08}$ inside the nucleon (see section 3.2 below), which can decay into heavy-electrons (muons) but more sure into electrons.
In the second case of Nd:YAG laser when $T \cong 10^9 K$, the power released by the electrical current is $P_W = RI_{ch}^2 = 0.35[w]$ for each deuteron spike, but for an entirely laser wave (10^{13}photons) when pass along a $1\mu m$ it means a total power $P_{tot}=0.35\times10^{13}=3.5\times10^{12}$[w], $d_{UDD} = 10^{-12}[m]$, or about $\sim3.5\times10^{12}/10^8=3.5\times10^4$ than the power used to produce a such laser spot. These values are in case of ELI-laser when: the power is ~2Pw, the flux $\sim10^{13}$ph/s; flux$\sim10^{24}$w/m^2, or the extracted power is lower~ $3.5\times10^{12}/2\times10^{15}=1.7\times10^{-3}$ times that used by the laser, or without any energy gain. But we can obtain a net energy gain if we use, for example, a smaller laser Nd:YAG when the flux $\sim10^{13}$ph/s, or $T = 10^9 K$, but not smaller than this lower limit value, since the current through the "hot belt" is the same i.e. ~ I_{ch}.
A Nd:YAG laser with pulse energy of < 0.2 J was used, with 5 ns pulses
(or $P_W = 0.1J/5ns = 10^8[w]$) at 532 nm and normally 10 Hz repetition rate [1], where is *claimed* the appearance of a *nuclear fusion!* in ultra-dense deuterium D(-1) induced by

0.2 J pulses with 5 ns pulse length ejects ions with energies in the MeV range. The *ns*-resolved signal to a collector can be observed directly on an oscilloscope, showing ions arriving with energies in the range 2-14 MeV/u at flight times 12-100 *ns*, mainly protons from the fusion process and deuterons ejected by proton collisions. To note, that in order to obtain a net fusion it need a laser more powerful of 10^{12}K or much bigger than ELI (of 10^{11}K) and without net gain of energy, even exists UDD. Electrons and photons give almost no contribution to the fast signal. The observed signal at *several mA peak current* corresponds to 1×10^{13} particles released per laser shot and to an energy release > 1 J assuming isotropic formation and average particle energy of 3MeV as observed, or $\cong 1J/10^{13} \cong 10^{-14} \cong \varepsilon_{0h\_9} = 9.6\times10^{-14}[J] \to 0.6MeV$, and $\tau \cong \hbar/10^{-14}J \cong 10^{-20}\, s$, or in term of pulse duration $\tau = 5ns/10^{13} \cong 5\times10^{-22}[s] \to \tau_{W^\pm} = 3\times10^{-25} s$, see the next section.

The Nd:YAG ns-pulsed laser is focused onto a metallic target plate with a thin superfluid layer of D(-1) [1-4]. The focusing length of the lens is 40 cm, giving a spot size of 30 μm (for a Gaussian beam) and a power density of 3×10^{12} W/cm^2 . The laser is used with 532 nm light at maximum 120 mJ pulse energy, 5 ns pulse length, or $532/c \cong 10^{-18} s$.

But as results from our calculation, in fact the proton signalized in the experiment it could be due of the transformation a neutron of deuteron into proton ($n \to p$) by the laser stimulated beta decay, so there is "not any fusion", see below. Therefore, it is for the first time when these experimental findings confirm author's models [7], [8], [10], the most important are, the particles energy in MeV range, and the current of ~*few mA*, remaining to be confirmed the number of particles as to be equally with number of photons per pulse ~10^{13}.

This vortex-assisted mechanism may be verified by application of magnetic fields, which effectively enhance I_{ch} along with the vortex crossing rates but do not affect the creation of hot spots by photons.

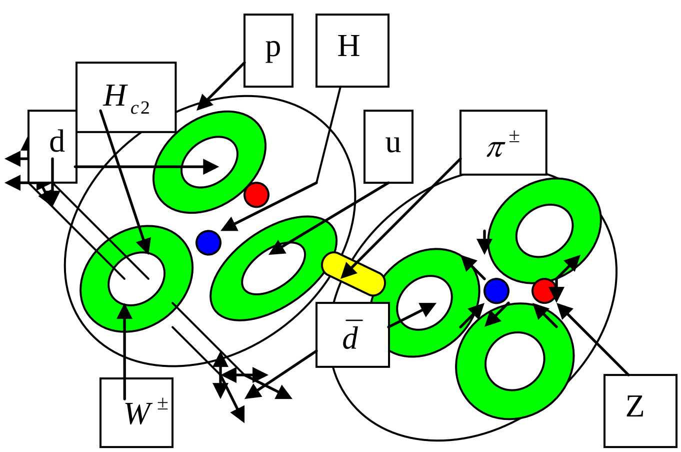

Fig.6. Abrikosov's triangular lattice for a nucleon (proposal [8])

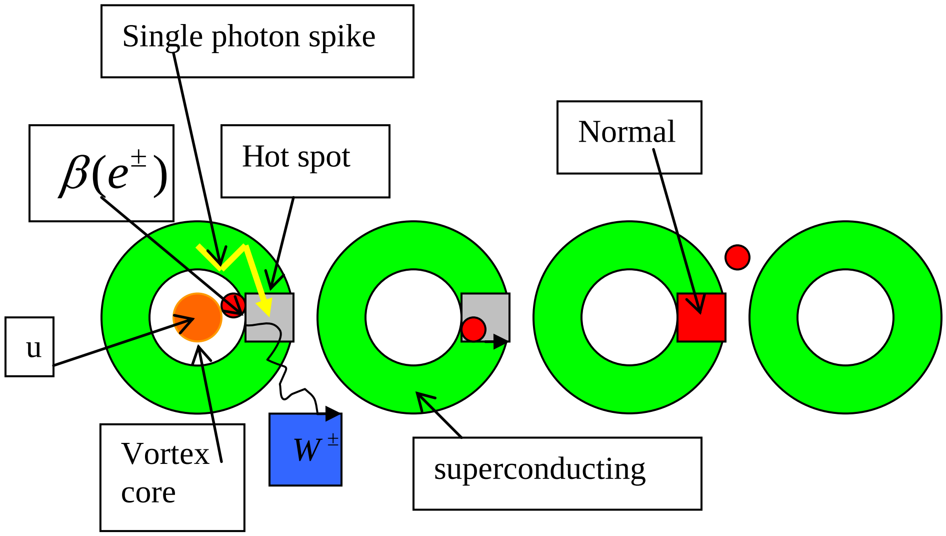

Fig.7. The photonuclear mechanism. From left to right, illustration of incident photon creating superconducting hot spot (hot belt) across nucleon, followed by a thermally induced vortex crossing together with an electron (*bias current*), which turns superconducting hot belt into the normal state resulting in a vortex assisted photon beta decay.

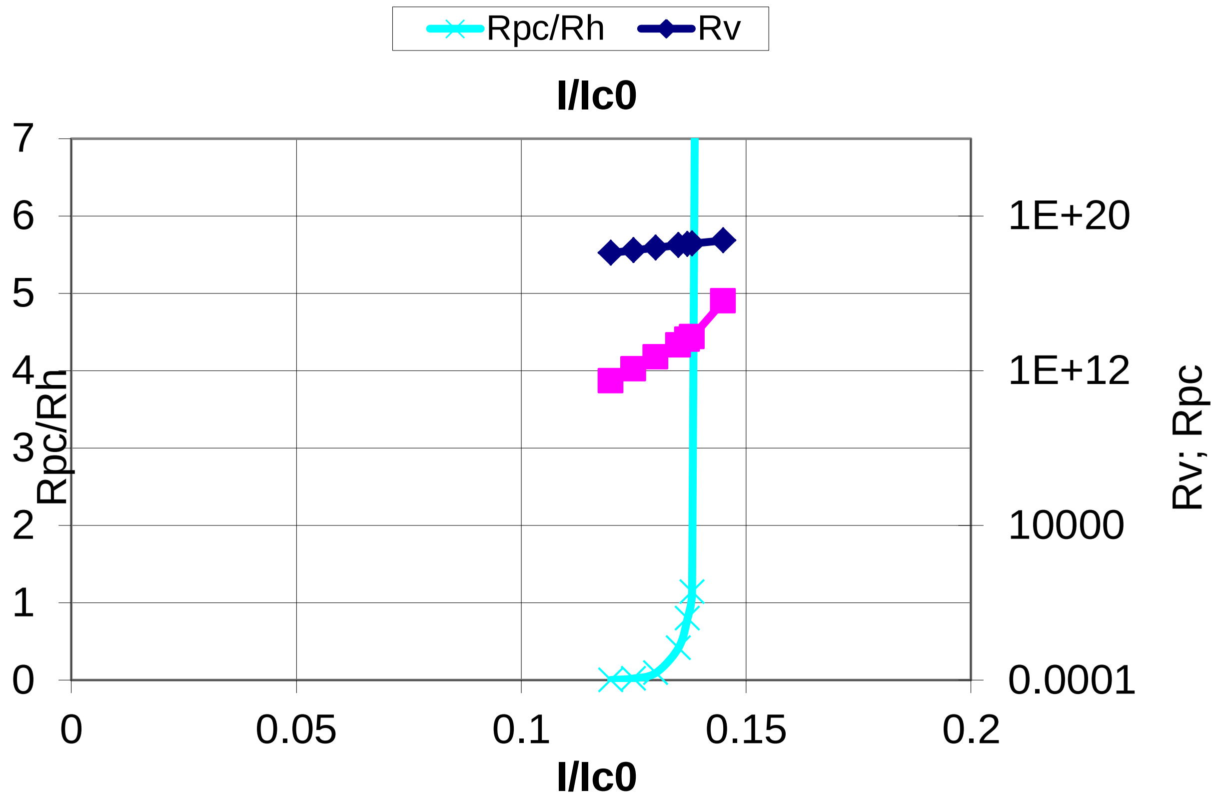

FIG.8. The vortex-assisted photon count rate R_{pc}/R_h vs. *bias current.*

3.2. A strong prove of the model for the free neutron decay calculation

In the following, we will use some results of section 4.1a from [8] when the Compton length is $\lambda_C = \hbar/m_* c = 2.3e-18[m]$, the effective mass is $m_* = 1.44\times10^{-25} kg \to V = 81GeV \to E = 1.1\times10^{28}$, the *critical field* being $E_c = \dfrac{m_*^2 c^3}{e\hbar} \cong 3.5\times10^{28} > E = 1.1\times10^{28}[N/C];\ B = E/c = 3.7\times10^{19}[T]$.

From the section (4.1b) of [8], are used the bosons $W^{\pm}$ pairs generated *inside the nucleons* as due of one quark $u\bar{u} \leftrightarrow u$ as a resultant of $\times 3$ flux tubes vortex potential , see figure (1.b) of [8], respectively $\varepsilon = mc^2 \cong 81GeV$ - which after the release of an electron that it getting the final beta energy as been equally to the out of barrier turning point after the tunneling, and accounting for the valence nucleons interactions (shell-energy levels). The number of *assaults* of the barrier, like in Gamow theory [20, 21] cited in [6] is $n_a = v_b/R_{inner}$; where the velocity is $v_b \cong (2\varepsilon/m)^{1/2} = 2.3\times10^8\ m/s$, where, the inner radius of the barrier is $R_{inner} \cong b = 3.5\times10^{-17}[m]$, see below. For only one of the three vortex-flux tubes ($q\bar{q}g$) we have: $\varepsilon = \hbar eB/m \cong 4\times10^{-9}[J] \to\cong 25GeV$, with the above (B) which is obtained from eq.(1.a) from [8] with the resultant potential

$V = 81GeV$, that corresponds to $m_{q\bar{q}} \cong 29GeV$ from 4.1a of [8], the energy of the particle for the first Landau level (as above), and we can see that it results to be equally with $\approx 1/3$ rest mass of the $W^{\pm}$, that resulting $n_a \cong 7.5\times10^{24}s^{-1}$.

In case of WKB [20] cited in [6], the transmission coefficient is $T = 2\frac{\sqrt{2m|V-Q|}}{\hbar}\Delta r$, and the decay constant $\Gamma = n_a e^{-T}$.

For the thick barrier the transmission coefficient is $T = 2\pi\frac{Qb}{\hbar v} = 2\pi\frac{\sqrt{2mQ}}{\hbar}b$;

, where, the kinetic energy of the particle after the barrier at b is $Q \equiv \frac{1}{2}mv^2$, $b = d_b/2\pi = 3.5\times10^{-17}[m]$, see below, that results $T = 63$; and the decay constant $\Gamma = 3\times10^{-3}s^{-1} \to\cong 324s$

To "materialize" a virtual $e^+ - e^-$ pair in a constant electric field E the separation d must be sufficiently large $eEd = 2mc^2$

Probability for separation d as a quantum fluctuation

$$P \propto \exp\left(-\frac{d}{\lambda_{Compton}}\right) = \exp\left(-\frac{2m^2c^3}{e\hbar E}\right) = \exp\left(-\frac{2E_{cr}}{E}\right)$$

The emission (transmission through barrier) is sufficient for observation when $E \approx E_{cr}$, with $Q = 1/2\,mc^2$, results $T = 2\pi\frac{mcb}{\hbar} \cong \frac{2\pi b}{\lambda_C}$, or

$b \cong d_b/2\pi$.

Now, by using the Schwinger effect as in section 2.1 of the companion author's paper [8] , the number of $W^{\pm}$ pairs produced inside the nucleon (more inside of the only one resultant flux tube , see figures 1.a; 1.b from [8]) due of the potential resultant $u\bar{u} \leftrightarrow 3\times vortex(q\bar{q}g)$ of $V = 80GeV$, results as $R/s = R/V \times V_{vol} = 2.3\times10^{18}s^{-1} \approx n_a$, where $R/V = 2\times10^{71}[1/m^3s]$ and the volume is $V_{vol} \cong (\lambda_C)^3 \cong 1.24\times10^{-53}[m^3] \geq V_b$, the penetration length being the Compton length $\lambda_C = 2.3\times10^{-18}[m]$, and for a four-volume of $V_{Compton} = \lambda_C^4/c \cong 9.5\times10^{-80}[m^3s]$, that results a *permanently rate* $R \cong R/V \cdot V_{Compton} = 10^{-8}W^{\pm}\,pairs$. Thus, it results a main conclusion of this investigation, namely, that the "interacting" potentials inside the nucleons are that were already established in [8], respectively $\cong 80GeV$ around the valence quarks (u, d) which it seems to be "locked" at the electroweak symmetry breaking ($\approx 100GeV$); that of the Giant Vortex (see the insert in fig. 1.a from [8]) at the center of the triangle-the Higgs boson $H = 125GeV$; and that resulting from interaction of $2\times$ inter-pairs of flux tubes as been the neutral boson $Z = 90GeV$.

Therefore, in other words is proved that all the time inside the nucleon are *available* $10^{-8}W^{\pm}$ pairs that seems to corresponds to the "weak interaction" coupling constant 10^{-7}, which is absorbed or emitted by the quarks , resulting an e^+, or e^- which help

the quarks transformation like $(u \to d)$, respectively $(d \to u)$ for beta-decay. In our understanding, the created electron takes the energy at the *turning point* out of the barrier equally with the electron itself for unbounded neutrons, or that of the binding energy of nucleon in isotope nucleus, when it *passes* the barrier of gluon condensate characterized by an *quantum tunneling* suppression given as:
$\exp\left(-\Delta\mathrm{E}\,\tau/\hbar\right) \cong 7.3\times10^{-22}$, where, as the lifetime of $W^{\pm}$ being $\tau \cong 3\times10^{-25}s$. Here, $\Delta\mathrm{E}$ corresponds to the height of gluon condensate barrier, due of the *phase slip* with $2\pi-\varphi$ and of a Φ_0 energy release as: $\Delta E = c^2\Phi_0^2\varepsilon_0/d_b$; $d_b \cong k\lambda_C = 1.98\times10^{-16}$, $k=85$, where the Compton length is just the penetration length for $W^{\pm}$ pair $\lambda_C = 2.3\times10^{-18}[m]$, or in other words just the barrier size, and $\Delta\mathrm{E} = 1.6\times10^{-8}[J] \to 100GeV \approx 3\times 25GeV$ as for $\times3$ sea quarks color flux tubes, see figures 1.a; 1.b. The value of the resulting flux tube it remains as in (4.2.a) of [8], respectively of $0.4GeV$ as the string strength.
Thus, the probability (rate) to produce $W^{\pm} \to e^{\pm}$, into a more simple way- without the external interactions of the neutron (free-not bounded), is given as:
$RV\exp(-\Delta E\,\tau/\hbar) \cong 1.7\times10^{-3}s^{-1} \to \tau_{1/2} \cong 582[s] \approx 612s$, that corresponds for *free neutrons decay* (β^-) by emission of an electron and an electron antineutrino to become a proton $n^0 \to p^+ + e^- + \bar{\nu}_e$, with half-life of $611s$, and $Q_{\beta^-} = m_e v^2 = 0.5MeV$.
In the classic understanding of β^- disintegration $n \to p + e^- + \bar{\nu}_e$, in ours understanding this occurs when one of the down quarks (d) in the neutron (udd) transforms into an up quark (u) due of interacting with the charge of W^+ boson of the pair $W^{\pm}$, transforming the neutron into a proton (uud). In mean time the other part of this pair W^- boson decays into an electron and an electron antineutrino $udd \to uud + e^- + \nu_e$. Probable the claimed energy of boson W^- is the same as to be the necessarily energy to traverse the gluonic barrier, when it decays into e^- at the end.
The free neutron decay
Consequently, for the β^- decay process, the energy combines well with the existing one, that releasing an electron which penetrates the barrier:
$d \to u + W^+ + W^- \to u + e^- + \bar{\nu}_e$
$d(-1/3e) + e^+(+3/3e) = u(+2/3e) + e^-(-3/3e)$
, since $W^- \to e^-$, and $W^+ \to e^+$
In case of β^+ decay, it can only happen inside nuclei when the daughter nucleus has a greater *binding energy* (and therefore a lower total energy) than the mother nucleus. The difference between these energies goes into the reaction of converting a proton into a neutron, a positron and a neutrino and into the kinetic energy of these particles.
Thus, an opposite process to the above negative beta decay, β^+ decay of nuclei (only bounded proton) when $p \to n + e^+ + \nu_e$, or $energy + uud + W^+ + W^- \to udd + e^+ + \nu_e$
, or, $u(2/3e) + e^-(-3/3e) + energy = d(-1/3e) + e^+(3/3e)$.

For free proton decay an *added energy* it seems to be necessarily to reduce the barrier width to $d_b = 9\times10^{-17}[m]$, when the production rate is:

$RV\exp(-\Delta E\,\tau/\hbar)\cong 7\times10^{-29}s^{-1}\to\tau_{1/2}\cong10^{28}[s]$, respectively, an increase to $\Delta E = 3.5\times10^{-8}[J]\geq 225GeV$ from $\Delta E = 1.6\times10^{-8}[J]\to 100GeV$, as for the free neutron, or near $\geq v.e.v = 247GeV$, like at LHC when the gluonic "cover" of protons it was "melted (at least 2 gluons)", and the resulted difference $(\cong 225-100 = 125GeV)$ being just that of the Higgs boson (a quanta of energy!) which it was, in this spectacular way "released" [10] as $2g\to 2\gamma$.

In the process of electron capture, one of the orbital electrons, usually from K or L electron shell, is captured by a proton in the nucleus, forming a neutron and an electron neutrino.

$$p + e^- \to n + \nu_e$$

About others calculations of beta decay processes of different isotopes, see the author's work [7].

4. Conclusions

In the work by using QM&MD programmes: fhi96md and GAMESS is confirmed the apparition of Rydberg matter (UDD) on the surface of Pd lattice by H(0)/D(0) electron delocalization.

There are confirmed L. Holmlid et all. experimental works by using the prior author models of vortex assisted photon beta decay, when a laser photon makes this process much more probable by creating a spot (melt) in nucleon with suppressed order parameter that lowering the energy barrier for vortex crossing together with an heavy electron (*bias current* $e^{\pm}$) as resulting from the decay of the of bosons pairs rate $W^{\pm}\cong10^{-8}$ as produced inside nucleons by a Schwinger effect. The electrical power results as P_w=3.5x10^{12} w<<P_{laser} =2Pw for a laser spot of size $1\mu m$, that corresponds with ELI laser characteristics, or without a any net gain of energy.

For the prior author's models validation are used the results of L.Holmlid et.all. as were obtained with a Nd:YAG laser with pulse energy of < 0.2 J, with 5 ns pulses (or $P_W = 0.1J/5ns = 10^8[w]$) at 532 nm and normally 10 Hz repetition rate. Thus in this case of much smaller power lasers when per photons is obtained ~10^{-5}w .1ns(T=10^{9}K)~10^{-14} J of duration ~*1ns* and, respectively ~10^{-14} J.10^{13} ~0.1J~10^8 [w] for a pulse composed of ~10^{13} ph/s. The net energy is very higher of 3.5x10^{12}/10^8=3.5x10^4 , which is higher that is obtained from U235 fission ~200MeV/0.025eV/235x2%=6x10^5. Therefore, it is for the first time when these experimental findings confirm author's prior series models , the most important are, the particles energy in MeV range, the current of ~*few mA*, voltage on the shunt 7[V], and the time-of-flight 10^{-8} s.

If these electrons are collected in the metallic plate in serried into an electrical circuit, we can constitute a reliable source of direct electricity with the period equally that of laser pulse frequency. It is possible that the neutron of D do not transforms into proton, since the *open hot belt* created due of the laser photon incidence to *close* after electron passage, therefore it is not a consume of D. To obtain a UDD layer the author calculated that is necessary a thermal energy of 800eV to be deposited on the Pd plate in the vacuum chamber containing the D gas, this being in serried into an electrical circuit.

References

1. L. Holmlid and S. Olafsson, “Spontaneous Ejection of High-Energy Particles from Ultra-Dense Deuterium D(0)”. International Journal of Hydrogen Energy 40 (2015) 10559-10567.
   DOI: 10.1016/j.ijhydene.2015.06.116.
2. L. Holmlid and S. Olafsson, “Muon Detection studied by Pulse-Height Energy Analysis: Novel Converter Arrangements”. Review of Scientific Instruments 86, 083306 (2015). DOI: 10.1063/1.4928109.
3. L. Holmlid, “Heat Generation above Break-Even from Laser-Induced Fusion in Ultra-Dense Deuterium”. AIP Advances 5, 087129 (2015); doi: 10.1063/1.4928572.
4. Leif Holmlid, Muon detection studied by pulse-height energy analysis: Novel converter arrangements, Rev. Sci. Instrum. 86, 083306 (2015); http://dx.doi.org/10.1063/1.4928109
5. Leif Holmlid, Heat generation above break-even from laser-induced fusion in ultra-dense deuterium, AIP Advances 5, 087129 (2015); http://dx.doi.org/10.1063/1.4928572.
6. Stefan Mehedinteanu, ON THE NUMERICAL ANALYSIS OF DECAY RATE

ENHANCEMENT IN METALLIC ENVIRONMENT, ACTA PHYSICA POLONICA B No 10, Vol. 38 (2007)

7. Stefan Mehedinteanu, On the Photonuclear Rates Calculation for Nuclear Transmutation of Beta Decay Nuclides by Application of the Ginzburg-Landau Theory, Journal of Nuclear and Particle Physics 2012, 2(3): 57-70 DOI: 0.5923/j.jnpp.20120203.05, http://www.ijnese.org/paperInfo.aspx?ID=4865 , and http://article.sapub.org/10.5923.j.jnpp.20120203.05.html.
8. Stefan Mehedinteanu, The Numerical Analysis of Beta Decay Stimulation by the High Thermal Spike of Photon Incidence to Valence nucleons, 2015, http://www.researchgate.net/profile/Stefan_Mehedinteanu/publications
9. **a)**L.N. Bulaevskii, M.J. Graf, C.D. Batista, V.G. Kogan, Phys. Rev. B 83,144526 (2011).b)L. N. Bulaevskii, Matthias J. Graf, V. G. Kogan, Vortex-

assisted photon counts and their magnetic field dependence in single-photon superconducting detectors, arXiv:1108.4004v3 [cond-mat.supr-con], 2012

10. **Stefan Mehedinteanu,** A NEW MODEL FOR W,Z, HIGGS BOSONS MASSES CALCULATION AND VALIDATION TESTS BASED ON THE DUAL GINZBURG-LANDAU THEORY(revised-2015), http://www.researchgate.net/profile/Stefan_Mehedinteanu/publications
11. Stefan Mehedinteanu, The Quantum Vacuum and the Light Quanta at the Origin of Matter (+Dark Matter) Creation and of Universe Expansion, 2015, **http://www.researchgate.net/profile/Stefan_Mehedinteanu/publications**
12. GAMESS VERSION = 27 JUN 2005 (R2) ,FROM IOWA STATE UNIVERSITY , M.W.SCHMIDT et all, J.COMPUT.CHEM. 14, 1347-1363(1993)