1

National Aeronautics and Space Administration	# Disclosure of Invention and New Technology (Including Software)	Form Approved O.M.B. NO.	DATE
		CONTRACTOR CASE NO.	
		NASA CASE NO. (OFFICIAL USE ONLY) LAR-17791-1	

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In completing each section, use whatever detail deemed appropriate for a "full and complete disclosure." Contractors/Grantees please refer to the New Technology or Patent Rights - Retention by the Contractor clauses. When necessary, attach additional documentation to provide a full, detailed description.

1. DESCRIPTIVE TITLE
Apparatus and Method for Selective Enhancement of Surface Plasmon Polaritons to Initiate and Sustain Low Energy Nuclear Reactions in Metal Hydride Systems

2. INNOVATOR(S)
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3. INNOVATOR'S EMPLOYER WHEN INNOVATION MADE
NASA

4. PLACE OF PERFORMANCE
NASA Langley Research Center, Hampton, VA, 23681

5. EMPLOYER STATUS
GE

GE = Government
CU = College or University
NP = Non-Profit Organization
SB = Small Business Firm
LE = Large Entity

6. ORIGIN
- [X] NASA In-house Org. Mail Code . . ______
- [ ] Grant/Cooperative Agreement No. ______
- [ ] Prime Contract No. . . . . ______
  Task No. ______ Report No. . . . ______
- [ ] Subcontractor; Subcontract Tier . . . ______
- [ ] Joint Effort
- [ ] Multiple Effort
- [ ] Other No. . . . . ______

UPN(s)
Bad Program Number: "39"

NASA LANGLEY RESEARCH CENTER PATENT COUNSEL

7. NASA CONTRACTING OFFICER'S TECHNICAL REPRESENTATIVE (COTR)

8. CONTRACTOR/GRANTEE NEW TECHNOLOGY REPRESENTATIVE (POC)

23351

9. BRIEF ABSTRACT

(A general description of the innovation which describes its capabilities, but does not reveal details that would enable duplication or imitation of the innovation.)

The innovation presented here describes a method and apparatus which, by design, creates an environment for enhanced surface plasmon polaritons (SPP) at selected frequencies to initiate and sustain Low Energy Nuclear Reactions in metal hydride systems. LENR have been studied for decades and are commonly, but incorrectly, referred to by the alternative name "Cold Fusion". LENR is used to define non-traditional methods (traditional methods would be fusion and fission) to access energy from nuclear reactions. The primary fuel is hydrogen or deuterium (although other elements can be made to work) and energy is released through the conversion of mass to energy (E=mcc) via the transmutation of elements. While evidence of energy production via LENR continues to mount and experiments are increasingly more reproducible, the quantity and quality of excess heat produced by LENR has not improved much in the last 20 years and remains nothing more than a laboratory curiosity. A new theoretical development (by Widom and Larsen 2006 - henceforward referred to as WLT) describes the strong tie between Surface Plasmon Polaritons (SPP) and LENR. The innovation described in this disclosure presents a method and apparatus detailing a range of embodiments that enhance the SPP distribution at specific frequencies which are required to initiate LENR. The method details the required arrangement and shape of metal particles or surfaces that resonate at specific frequencies. The apparatus is how these arrangements are realized and operate in an actual device.

[redacted]

3

SECTION I - DESCRIPTION OF THE PROBLEM OR OBJECTIVE THAT MOTIVATED THE INNOVATION'S DEVELOPMENT

(Enter as appropriate: A.- General description of problem/objective; B.- Key or unique problem characteristics; C.- Prior art, i.e., prior techniques, methods, materials, or devices performing function of the innovation, or previous means for performing function of software; and D.- Disadvantages or limitations of prior art.)

Low Energy Nuclear Reactions have been observed for nearly one hundred years and remain a little understood phenomena. More recently, since , LENR have been studied in laboratories world-wide under the name of "Cold Fusion". Despite the amount of activity and increasingly reproducible experimental results, there has been little advancement in either the control/reliability of devices or quality/amount of energy/heat produced. Until very recently, there have been many competing theories purporting to explain the physics of LENR, but none have produced any actionable guidance or testable predictions. The result has been attempts at progress and increased understanding by trail and error. There is no agreed to description of the environment required to initiate and sustain LENR, let alone prescriptions for or practical devices that create such an environment. The result is that experimentalists guess at what is required and utilize the following forms:

electrochemistry - smooth electrodes comprised of plates, wires, or screens
metal powders - random shapes and sizes
flat metal surfaces - large smooth rods, blocks, and thin films
multi-layer thin films - smooth single or alternating layers of materials

Close microscopic inspection of the successfully activated LENR devices indicates that the problem lies not in the quality of the heat produced, but rather the fraction of the device that is partaking in LENR. Very small regions are observed where there has been an obviously large amount of energy released in a very small area (typically only a few microns across) while the vast majority of the sample appears totally unaffected (non-participatory).

In a peer-reviewed scientific paper, Widom and Larsen presented a possible physical explanation for LENR. Their proposed mechanism states that initiation of LENR activity is due to the coupling of SPP to a proton or deuteron resonance in the lattice of the metal hydride. The coupling requires SPP of specific frequency and sufficient amplitude to initiate and sustain LENR. Their theory goes on to describe the production of heavy electrons which undergo electron capture by a proton thereby producing a neutron which is subsequently captured by a nearby atom transmuting it into a new element and releasing positive net energy in the process. Whether the full details of WLT are correct or not, the importance of SPP driven proton oscillations in the LENR-active metal hydride systems is supported by actual experimental evidence. This resonance in the metal hydride system exists independently of the correctness of WLT and is likely required to initiate and sustain LENR in metal hydride systems.

By developing a device which, by design, significantly enhances the amplitude of SPP in a narrow range of frequencies (tailored to the specific metal/alloy composition and physical operating environment of the device) over the entire surface or volume of the device, this innovation dramatically increases the energy output (energy density) due to LENR. These devices also present a direct method to control the rate of energy production (power output).

Surface Plasmon Polaritons exist in conductive interfaces naturally as they arise from thermal noise of the conduction electrons. SPP can also be driven directly by various methods (applied fields or currents, particle fluxes through the metal surface, incident beams of photons or energetic particles, excited directly by plasmonic circuit elements or devices). Most of these excitation methods produce broad-band or spectroscopically wide distributions of SPP with few, if any at the correct frequencies. By designing and fabricating a particle, surface, or volume which naturally resonates at a preferred frequency (much the same as the way a bell rings with a specific tone when struck with an arbitrary impulse), these same excitation mechanisms will produce a tailored spectrum of SPP response initially. That spectrum will eventually decay into the blackbody spectrum/distribution. Continuous excitation along with the preferred device resonance will produce the desired amplitude and frequency spectrum of SPP and initiate and sustain LENR on/within the device.

All of the publicly available reports, presentations, and publications support the belief that no one is

intentionally designing devices based upon the importance of the contribution of SPP to establishing an LENR-active environment. There is no known prior art supporting the intentional design and fabrication of devices to enhance SPP amplitudes at specific frequencies with the intent to initiate and/or sustain LENR. There is evidence in the existing body of experimental data supporting the importance of SPP to initiating LENR, however, these instances appear to be random chance events in an otherwise uncontrolled aspect of the experiment.

5

SECTION II - TECHNICALLY COMPLETE AND EASILY UNDERSTANDABLE DESCRIPTION OF INNOVATION DEVELOPED TO SOLVE THE PROBLEM OR MEET THE OBJECTIVE

(Enter as appropriate: existing reports, if available, may form a part of the disclosure, and reference thereto can be made to complete this description: A.- Purpose and description of innovation/software; B.- Identification of component parts or steps, and explanation of mode of operation of innovation/software preferably referring to drawings, sketches, photographs, graphs, flow charts, and/or parts or ingredient lists illustrating the components; D.- Alternate embodiments of the innovation/software; E.- Supportive theory; F.- Engineering specifications; G.- Peripheral equipment; and H.- Maintenance, reliability, safety factors.)

The innovation being disclosed is the intentional design and fabrication of metal particles or surfaces with specific sizes, shapes, orientations, surface textures, or other relevant geometrical properties as required by the elemental composition of the metal hydride/deuteride and the working environment of the device (aqueous, gaseous, pressures, temperatures, dielectric constant of materials at the metal interface, ...) such that there exists a fundamental resonance in the SPP response of the device at the proper frequency/frequencies to initiate and sustain LENR. There are multiple embodiments of this innovation: Individual metal/metal-hydride particles; Two dimensional metal/metal-hydride surfaces; and Three dimensional structures and/or arrays of particles.

Individual particles, by themselves, are the simplest but least effective embodiment of the innovation. Spherical or nearly spherical particles naturally resonate at a frequency where the particle circumference is equal to a multiple of the SPP wavelength (Mie theory). Similarly, long and thin, needle-like particles or whiskers can resonate in modes analogous to small antenna when the length of the particle is a integer multiple of one half the SPP wavelength. Larger and more complex individual particles can also be effective SPP resonators and are placed in the class of two dimensional surface embodiments described in the next class of devices. Basically these are periodic structured variants of the platonic solids (tetrahedron, cube, octahedron, icosahedron, dodecahedron, ...) or more complex shapes such as geodesics or fullerene-like shapes or arrangement of surface features.

Two dimensional embodiments are comprised of periodic textures or arrayed structures which, by design, resonate at specific SPP frequencies. Examples are triangular, rectangular, or hexagonal arrays of posts (cylinders, truncated cones, or derivatives of these with more complex, non-circular bases) where the array of objects creates and reinforces a natural SPP resonance at the desired frequency either in the array elements themselves or on the surface in the voids between array elements (see figure for a example embodiment, provided separately). The array elements may also be shaped depressions in the metal surface, such as bowls, polygonal-based cylindrical/conical holes, or more complex textures. The primary advantage of arrays of elements over individual particles is that the array geometry (pattern and spacing) amplifies the resonance of the individual elements through a mutual interaction of multiple similar elements or by establishing the resonance of otherwise non-resonant elements - where the details of the array geometry itself creates or reinforces the desired resonance.

Three dimensional embodiments are periodic arrays of elements in three dimensions or volume-filling fractal forms of 2D embodiments just discussed. Periodic arrays in 3D can take a variety of forms analogous to the 2D case as may be seen in common materials such as the array of locations of atoms in various crystal forms, the locations of objects closely packed to minimize volume, or the quasi-crystilline arrays of particles found in dusty plasmas under certain conditions. This last example is perhaps the most useful in that the array can be formed within a moving and dynamic fluid. These fluid forms represent an important embodiment for use in high power devices. Again as was seen in the 2D case, the array elements may themselves be, but are not required to be, resonant at the desire frequency. An example of an array of resonant elements would be a number of properly designed metallic whiskers oriented and spaced in a regular 3D rectangular array within an inert supporting matrix such as a ceramic. Another would be resonant metallic particles that were electrically charged and self organized into a quasi-crystaline array within a dusty plasma. The geometry of this fluid crystal comprised of the dusty plasma could be controlled by adjusting the rate of mass flow through a device or by altering the geometry of the tube, body, or orifice through/over which the dusty plasma flows (the same resultant changes in pressure and/or temperature would be used to provide the SPP excitation). In both these cases it is the combination of the resonant elements coupling to and reinforced by the resonance of the overall array geometry that produces the desired effect. For arrays of non-resonant elements, the geometry of

6

the array is critical in establishing the desired resonance. Arrays of non-resonant elements are usually limited to 2D surface or 3D fractal embodiments because the required geometry must be tightly established and controlled.

The function of the array is to establish a resonance in a SPP traveling along the surface of the metal, in the case of 2D forms, or for the other forms, to strengthen the amplitude of the SPP traveling over the surface of the individual elements by controlling their mutual coupling (primarily inductive) and the array's positive reinforcement taking into consideration the speed of propagation of the SPP or EM field oscillations in the material and the spacing and orientation of the array elements. The coupling of elements controls the (increases/decreases) amplitude and (decreases/increases) the spectral width of the resonance.

The 2D embodiment of cylindrical posts arranged in a hexagonal array (see figure provided separately) has been modeled extensively. The properties of this type of device, frequency of resonance and the Q (FWHM/resonant frequency), have been explored for various array spacings as well as cylinder radii and heights. Large arrays of these simple elements can be designed for any frequency in the important terahertz region (THz) with Q values ranging from 5 to 50 and probably higher. Most importantly, the devices can and are currently being fabricated. There is also some evidence available from electro-chemical cells where the regions exhibiting LENR activity have arrays of metal dendrites which have, by a totally random process, formed small isolated SPP resonators consistent with the modeling done to date.

One method of controlling the resonant frequency is to alter the geometrical spacing of the array by varying the temperature of a device fabricated of/on a material with a sufficiently large coefficient of thermal expansion. Conversely, a resonator which is inherently stable over a wide range of operating temperature would need to be fabricated of/on a material with a small coefficient of thermal expansion.

7

SECTION III - UNIQUE OR NOVEL FEATURES OF INNOVATION AND THE RESULTS OR BENEFITS OF ITS APPLICATION
(Enter as appropriate: A.- novel or unique features; B.- Advantages of Innovation/software; C.- Development or new conceptual problems; D.- Test data and source of error; E.-Analysis of capabilities; and F.- For software, any re-use or re-engineering of existing code, use of shareware, or use of code owned by a non-federal entity.)

LENR experiments to date are improving in term of reliability, but the amount and quality of the energy output (primarily heat) remains poor. Microscopic inspection of the surfaces of reactor components indicate that on a very local level, the power density (quality of heat) is very high. The poor performance of the device is simply due to the very small fraction of the device that is LENR active - very small, several orders of magnitude less than 1%. This is a direct result of these experiments all relying on random chance to create the proper environ for SPP resonance at the desired frequency. In the case of the electrochemical cell commonly used in LENR experiments, the formation of resonant arrays of metallic dendrites with just the right spacing, diameter, and length is pure chance. Modeling of devices demonstrates that there is a small non-zero chance that given enough time, random clusters of dendrites will, as they grow during electrolysis, resonate and that the frequency of the resonance may sweep through the right frequency and do so slowly enough for initiation of LENR. Dendrite spacing is linked to metallic grain size on the cathodic metal. Growth rate and diameter are linked to the rate of electrolysis. However, none of these properties or procedures are being controlled with the intent to create a specific geometry or to otherwise control the ability of SPP on these devices to resonate at specific frequencies.

This innovation is the first to design and fabricate devices with the specific intent to establish and control the frequency (and Q) of the SPP resonance and its uniformity over large regions (surfaces or volumes). Such devices not only increase the fraction of the device participating in LENR from some very tiny fraction to near 100%, but also LENR active when the devices are first created (unlike the current state of the art which requires hours or days of electrolysis to grow the metal dendrites or other resonant textures).

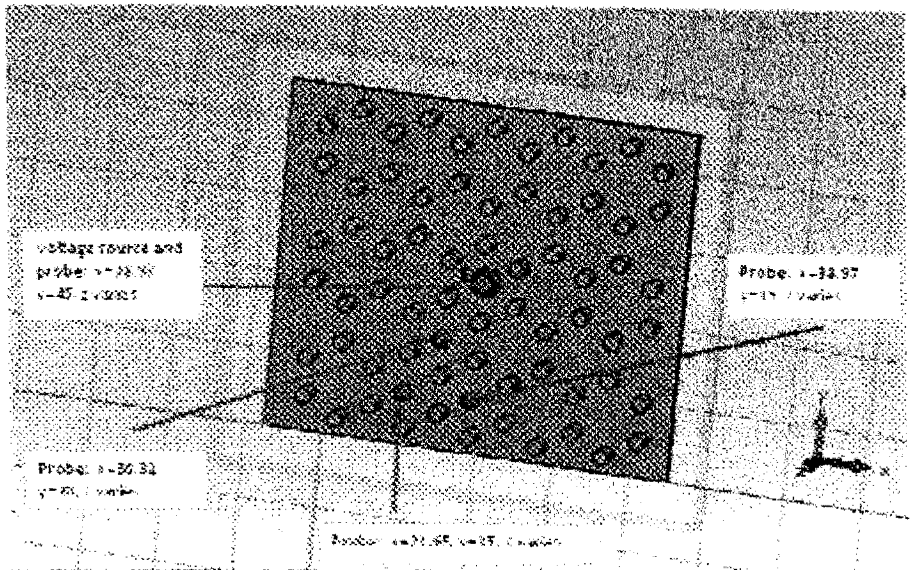
Evaluation of the performance of this innovation will be done on a series of 2D hexagonal arrays of truncated cones fabricated out of fused silica with a thin film of metal applied to the surface. The series will span a range of frequencies in the 7 to 25 THz region with each device having a Q of approximately 20. After thorough modeling, design of the devices is complete. Fabrication will occur in the fall and testing will begin in early Testing will determine the efficiency of the design (fraction of the device participating in LENR activity).

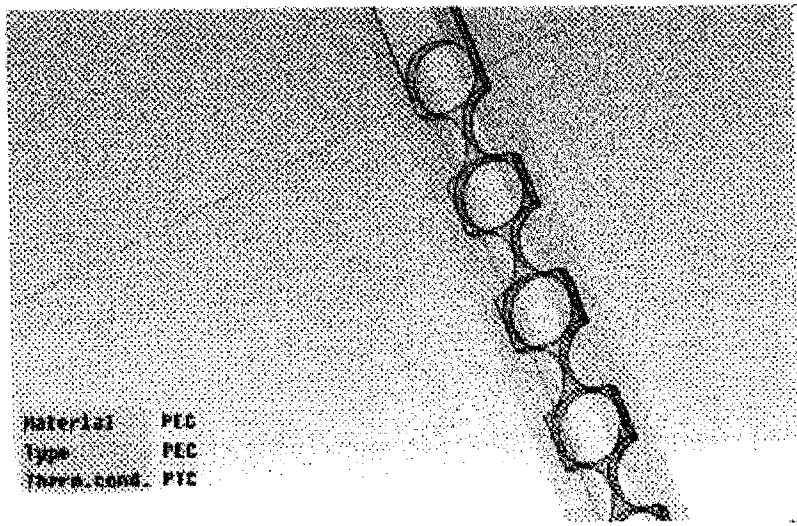
There is no known application, adaptation, or reuse of existing IP in this innovation. Larsen Patents (list to be provided separately) relate primarily to the physics (unpatentable) and not to the specific embodiment of a device which seeks to optimally tailor the response of SPP according to W-L theory. The Larsen patents talk about what an apparatus might do or would be useful for, but they do not indicate how such a device might actually be made to work. They do not indicate the knowledge or understanding of the specific properties (materials and form) such a device must have to function.

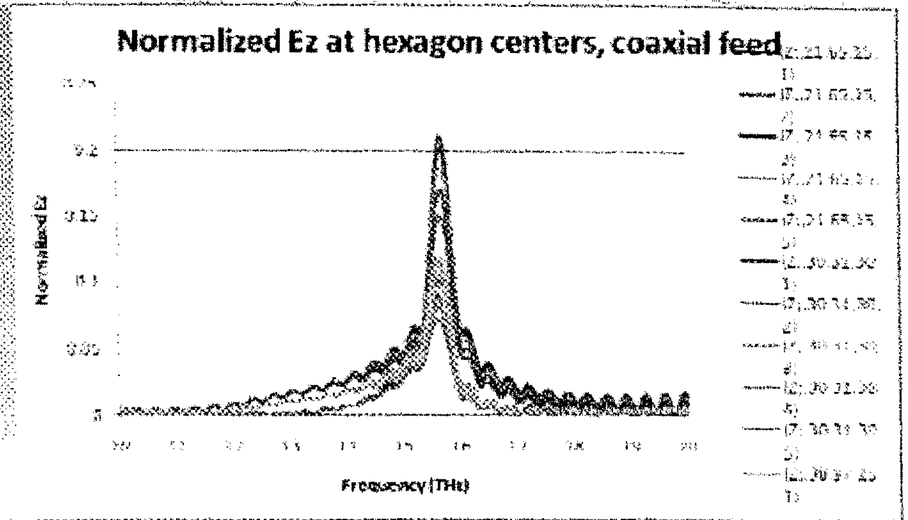
EM Modeling & Device Design

- Device is an hexagonal array of cylindrical cavities or posts

- Q is typically between 20 and 30







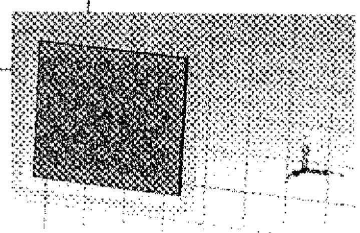
Species	THz	Step	Q	Lo
	29.8	1.4	21.3	
	28.4	1.4	20.3	
	27.0	1.4	19.3	
	25.7	1.3	19.8	
	24.5	1.2	20.4	
	23.3	1.2	19.4	
	22.2	1.1	20.2	
NiH	21.1	1.1	19.2	
	20.1	1.0	20.1	
	19.2	0.9	21.3	
	18.3	0.9	20.3	
	17.4	0.9	19.3	
	16.6	0.8	20.8	
	15.8	0.8	19.8	
NiD?	15.0	0.8	18.8	
	14.3	0.7	20.4	
PdH	13.6	0.7	19.4	A
	13.0	0.6	21.7	B
	12.4	0.6	20.7	C
	11.8	0.6	19.7	D
	11.2	0.6	18.7	E
	10.7	0.5	21.4	F
	10.2	0.5	20.4	G
	9.7	0.5	19.4	H
	9.2	0.5	18.4	I
PdD	8.8	0.4	22.0	J
	8.4	0.4	21.0	K
	8.0	0.4	20.0	L
	7.6	0.4	19.0	M
	7.2	0.4	18.0	N
	6.9	0.3	23.0	O

Med

A B C D E F G H I J K L M N O

Hi	A	R
	L=5.0	
A	6.89	2.74
B	7.15	2.74
C	7.40	2.73
D	7.67	2.73
E	7.95	2.73
F	8.27	2.73
G	8.59	2.73
H	8.93	2.73
I	9.30	2.74
J	9.72	2.75
K	10.13	2.76
L	10.59	2.79
M	11.10	2.83
N	11.59	2.87
O	12.11	2.94

Post c-c spacing	Array size	Cells Across	Total Cells
20	1500	43.30	1624
15	1500	57.74	2887
12.11	1500	71.51	4429
8.27	1500	104.72	9497
6.89	1500	125.69	13682



A	E	I	M	B	F	J
H	D	O	K	G	C	N
L		A	E	I	M	B
K	G	C	**1**	N	J	F
O	D	H	L		A	E
C	N	J	F	B	M	I
G	K	O	D	H	L	

B	F	J	N	C	G	K
E	A		L	H	D	O
I	M	B	F	J	N	C
L	H	D	**2**	O	K	G
	A	E	I	M	B	F
D	O	K	G	C	N	J
H	L		A	E	I	M

C	G	K	O	D	H	L
F	B	M	I	E	A	
J	N	C	G	K	O	D
I	E	A	**3**		L	H
M	B	F	J	N	C	G
A		L	H	D	O	K
E	I	M	M	F	J	N

D	H	L		A	E	I
G	C	N	J	F	B	M
K	O	D	H	L		A
J	F	B	**4**	M	I	E
N	C	G	K	O	D	H
B	M	I	E	A		L
F	J	N	C	G	K	O

	Bandwidth FWHM	Wavelength microns	Min & Max	Number of Test Samples
			0.45	
Q	20	22	2	
Ratio	1.05	13.64 THz		31

	Microns	THz
NiH	7.0	21.4
NiD?	9.9	15.2
PdH	11.0	13.6
PdD	17.0	8.8

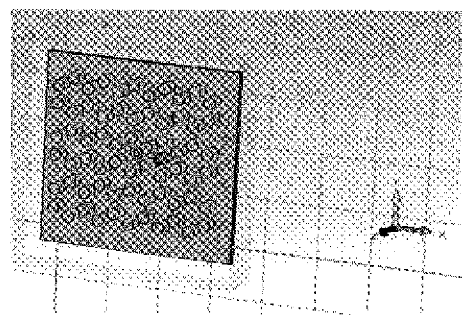
					Scale	Step	Q	Lo	Med	Hi	A	R
0	0.281	3.09										
0	0.295	3.25										
0	0.310	3.41										
0	0.326	3.58										
0	0.342	3.76										
0	0.359	3.95										
0	0.377	4.15										
0	0.396	4.35										
0	0.416	4.57										
0	0.436	4.80										
1	**0.458**	**5.04**	29.77		29.8	1.4	21.3				L=5.0	
1	**0.481**	**5.29**	28.35		28.4	1.4	20.3					
1	**0.505**	**5.56**	27.00		27.0	1.4	19.3			A	6.89	2.74
1	**0.530**	**5.83**	25.71		25.7	1.3	19.8			B	7.15	2.74
1	**0.557**	**6.13**	24.49		24.5	1.2	20.4			C	7.40	2.73
1	**0.585**	**6.43**	23.32		23.3	1.2	19.4			D	7.67	2.73
1	**0.614**	**6.75**	22.21		22.2	1.1	20.2			E	7.95	2.73
1	**0.645**	**7.09**	21.15	**NiH**	21.1	1.1	19.2			F	8.27	2.73
1	**0.677**	**7.45**	20.15		20.1	1.0	20.1		A	G	8.59	2.73
1	**0.711**	**7.82**	19.19		19.2	0.9	21.3		B	H	8.93	2.73
1	**0.746**	**8.21**	18.27		18.3	0.9	20.3		C	I	9.30	2.74
1	**0.784**	**8.62**	17.40		17.4	0.9	19.3		D	J	9.72	2.75
1	**0.823**	**9.05**	16.58		16.6	0.8	20.8		E	K	10.13	2.76
1	**0.864**	**9.50**	15.79		15.8	0.8	19.8		F	L	10.59	2.79
1	**0.907**	**9.98**	15.03	**NiD?**	15.0	0.8	18.8		G	M	11.10	2.83
1	**0.952**	**10.48**	14.32		14.3	0.7	20.4		H	N	11.59	2.87
1	**1.000**	**11.00**	**13.64**	**PdH**	13.6	0.7	19.4	A	I	O	12.11	2.94
1	**1.050**	**11.55**	12.99		13.0	0.6	21.7	B	J			
1	**1.103**	**12.13**	12.37		12.4	0.6	20.7	C	K			
1	**1.158**	**12.73**	11.78		11.8	0.6	19.7	D	L			
1	**1.216**	**13.37**	11.22		11.2	0.6	18.7	E	M			
1	**1.276**	**14.04**	10.68		10.7	0.5	21.4	F	N			
1	**1.340**	**14.74**	10.18		10.2	0.5	20.4	G	O			
1	**1.407**	**15.48**	9.69		9.7	0.5	19.4	H				
1	**1.477**	**16.25**	9.23		9.2	0.5	18.4	I				
1	**1.551**	**17.06**	8.79	**PdD**	8.8	0.4	22.0	J				
1	**1.629**	**17.92**	8.37		8.4	0.4	21.0	K				
1	**1.710**	**18.81**	7.97		8.0	0.4	20.0	L				
1	**1.796**	**19.75**	7.59		7.6	0.4	19.0	M				
1	**1.886**	**20.74**			7.2	0.4	18.0	N				
1	**1.980**	**21.78**			6.9	0.3	23.0	O				
0	2.079	22.87										
0	2.183	24.01										
0	2.292	25.21										
0	2.407	26.47										
0	2.527	27.80										
0	2.653	29.19										
0	2.786	30.65										
0	2.925	32.18										
0	3.072	33.79										
0	3.225	35.48										
0	3.386	37.25										
0	3.556	39.11										
0	3.733	41.07										

A	E	I	M	B	F	J
H	D	O	K	G	C	N
L		A	E	I	M	B
K	G	C	**1**	N	J	F
O	D	H	L		A	E
C	N	J	F	B	M	I
G	K	O	D	H	L	

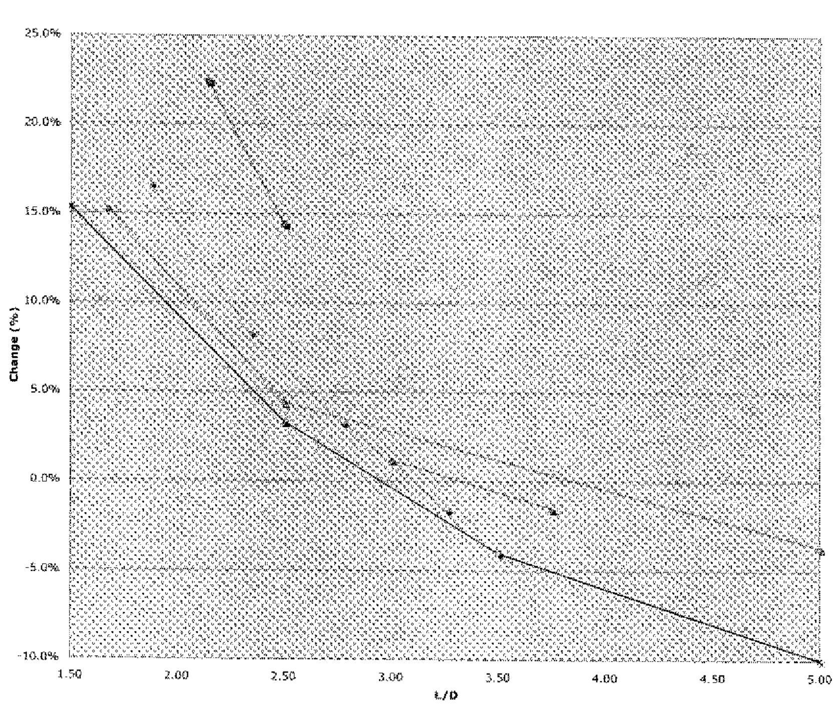
B	F	J	N	C	G	K
E	A		L	H	D	O
I	M	B	F	J	N	C
L	H	D	**2**	O	K	G
	A	E	I	M	B	F
D	O	K	G	C	N	J
H	L		A	E	I	M

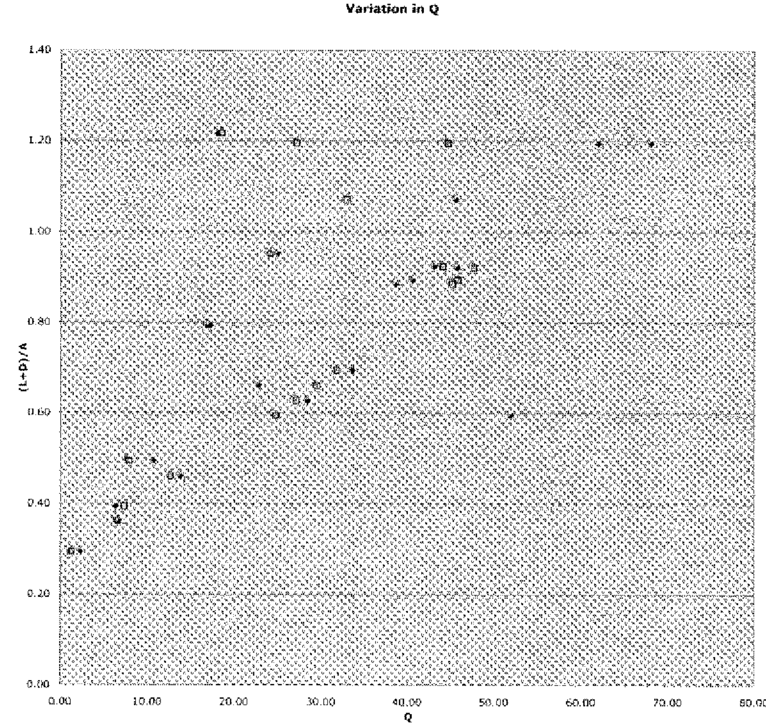
C	G	K	O	D	H	L
F	B	M	I	E	A	
J	N	C	G	K	O	D
I	E	A	**3**		L	H
M	B	F	J	N	C	G
A		L	H	D	O	K
E	I	M	M	F	J	N

D	H	L		A	E	I
G	C	N	J	F	B	M
K	O	D	H	L		A
J	F	B	**4**	M	I	E
N	C	G	K	O	D	H
B	M	I	E	A		L
F	J	N	C	G	K	O



L	D	A	F	Q	L/D	A/D	A/L	M	f-theory	delta f	delta f %	Model dF	Predict f	error in f	(L+D)/A	Guess Q	R	Predict Q	error in Q
												for 7.5 only							
7.5	3.0	8.75	19.62	67.77	2.50	2.92	1.17	2.56	17.14	2.48	14.5%	12.6%	19.30	1.6%	1.20	66.50	2.48	26.85	-41
7.5	3.5	9.00	20.40	17.74	2.14	2.57	1.20	2.25	16.67	3.73	22.4%	20.8%	20.13	1.3%	1.22	68.06	3.73	18.23	0
7.5	2.3	11.00	13.42	38.34	3.26	4.78	1.47	3.74	13.64	-0.22	-1.6%	-0.4%	13.58	-1.2%	0.89	44.86	1.00	44.86	7
7.5	2.7	11.00	14.08	45.42	2.78	4.07	1.47	3.35	13.64	0.44	3.3%	4.4%	14.23	-1.1%	0.93	47.41	1.00	47.41	2
7.5	3.2	11.50	14.13	42.82	2.34	3.59	1.53	3.05	13.04	1.09	8.3%	9.5%	14.28	-1.0%	0.93	47.63	1.09	43.84	1
7.5	4.0	12.00	14.58	24.71	1.88	3.00	1.60	2.62	12.50	2.08	16.6%	16.7%	14.59	-0.1%	0.96	49.58	2.08	23.84	-1
7.5	2.0	15.00	9.85	28.14	3.75	7.50	2.00	4.81	10.00	-0.15	-1.5%	-2.2%	9.79	0.7%	0.63	26.83	1.00	26.83	-1
7.5	2.5	15.00	10.12	22.49	3.00	6.00	2.00	4.28	10.00	0.12	1.2%	1.1%	10.11	0.1%	0.67	29.17	1.00	29.17	7
5.0	2.0	6.50	21.31	45.34	2.50	3.25	1.30	1.88	23.08	-1.77	-7.7%	-5.1%	21.90	-2.8%	1.08	57.88	1.77	32.76	-13
5.0	2.0	15.00	11.22	13.50	2.50	7.50	3.00	3.21	10.00	1.22	12.2%	-1.0%	9.90	11.7%	0.47	15.17	1.22	12.43	-1
5.0	1.0	15.00	11.49	6.02	5.00	15.00	3.00	4.31	10.00	1.49	14.9%	-3.8%	9.62	16.3%	0.40	10.50	1.49	7.05	1
5.0	0.5	15.00	11.29	6.45	10.00	30.00	3.00	5.41	10.00	1.29	12.9%	-5.2%	9.48	16.1%	0.37	8.17	1.29	6.33	0
1.0	2.0	10.00	18.60	2.00	0.50	5.00	10.00	0.51	15.00	3.60	24.0%	-0.1%	14.99	19.4%	0.30	3.50	3.60	0.97	-1
3.0	2.0	10.00	17.30	10.44	1.50	5.00	3.33	1.54	15.00	2.30	15.3%	-0.8%	14.88	14.0%	0.50	17.50	2.30	7.61	-3
5.0	2.0	###	15.50	33.30	2.50	5.00	2.00	2.56	15.00	0.50	3.3%	-2.2%	14.68	5.3%	0.70	31.50	1.00	31.50	-2
7.0	2.0	###	14.40	40.30	3.50	5.00	1.43	3.59	15.00	-0.60	-4.0%	-4.2%	14.37	0.2%	0.90	45.50	1.00	45.50	5
10.0	2.0	10.00	13.50	61.70	5.00	5.00	1.00	5.12	15.00	-1.50	-10.0%	-8.6%	13.71	-1.6%	1.20	66.50	1.50	44.33	-17
5.0	1.0	###	14.45	51.60	5.00	10.00	2.00	3.66	15.00	-0.55	-3.7%	-8.6%	13.71	5.1%	0.60	24.50	1.00	24.50	-27
5.0	2.0	###	15.66	33.30	2.50	5.00	2.00	2.56	15.00	0.66	4.4%	-2.2%	14.68	6.3%	0.70	31.50	1.00	31.50	-2
5.0	3.0	###	17.30	16.90	1.67	3.33	2.00	1.92	15.00	2.30	15.3%	4.3%	15.64	9.6%	0.80	38.50	2.30	16.74	0
5.0	2.3	6.75	25.47	39.00	2.22	3.00	1.35	1.75	22.22	3.25	14.6%	-1.2%	21.96	13.8%	1.07	57.69	3.25	17.76	-21
5.0	2.8	7.50	24.15	17.50	1.82	2.73	1.50	1.60	20.00	4.15	20.8%	4.7%	20.95	13.3%	1.03	54.83	4.15	13.21	-4
5.0	2.5	8.00	21.30	21.00	2.00	3.20	1.60	1.85	18.75	2.55	13.6%	1.7%	19.06	10.5%	0.94	48.13	2.55	18.87	-2
5.0	3.0	8.00	23.02	12.00	1.67	2.67	1.60	1.56	18.75	4.27	22.8%	6.7%	20.00	13.1%	1.00	52.50	4.27	12.30	0
5.0	2.5	7.00	25.42	27.00	2.00	2.80	1.40	1.64	21.43	3.99	18.6%	2.2%	21.89	13.9%	1.07	57.50	3.99	14.41	-13
5.0	1.5	6.00	25.21	57.00	3.33	4.00	1.20	2.21	25.00	0.21	0.8%	-14.9%	21.28	15.6%	1.08	58.33	1.00	58.33	1





for 7.5 only

L	D	A	F	Q	L/D	A/D	A/L	M	f-theory	delta f	delta f %	Model dF	Predict f	error in f	(L+D)/A	Guess Q	R	Predict Q	error in Q		
7.5	3.00	8.75	19.62	67.77	2.50	2.92	1.17	2.56	17.14	2.48	14.5%	43.4%	24.58	-25.3%	1.20	66.50	2.48	26.85	-41	11.06	7.43
7.5	3.50	9.00	20.40	17.74	2.14	2.57	1.20	2.25	16.67	3.73	22.4%	60.2%	26.70	-30.9%	1.22	68.06	3.73	18.23	0	18.14	10.03
7.5	2.30	11.00	13.42	38.34	3.26	4.78	1.47	3.74	13.64	-0.22	-1.6%	12.4%	15.33	-14.2%	0.89	44.86	1.00	44.86	7	-1.92	1.69
7.5	2.70	11.00	14.08	45.42	2.78	4.07	1.47	3.35	13.64	0.44	3.3%	20.6%	16.44	-16.8%	0.93	47.41	1.00	47.41	2	3.94	2.80
7.5	3.20	11.50	14.13	42.82	2.34	3.59	1.53	3.05	13.04	1.09	8.3%	29.6%	16.91	-19.6%	0.93	47.63	1.09	43.84	1	11.02	3.86
7.5	4.00	12.00	14.58	24.71	1.88	3.00	1.60	2.62	12.50	2.08	16.6%	46.2%	18.27	-25.3%	0.96	49.58	2.08	23.84	-1	23.96	5.77
7.5	2.00	15.00	9.85	28.14	3.75	7.50	2.00	4.81	10.00	-0.15	-1.5%	3.8%	10.38	-5.3%	0.63	26.83	1.00	26.83	-1	-3.38	0.38
7.5	2.50	15.00	10.12	22.49	3.00	6.00	2.00	4.28	10.00	0.12	1.2%	8.8%	10.88	-7.5%	0.67	29.17	1.00	29.17	7	2.70	0.88
5.0	2.00	6.50	21.31	45.34	2.50	3.25	1.30	1.88	23.08	-1.77	-7.7%	8.9%	25.13	-17.9%	1.08	57.88	1.77	32.76	-13	-3.23	2.06
5.0	2.00	15.00	11.22	13.50	2.50	7.50	3.00	3.21	10.00	1.22	12.2%	1.7%	10.17	9.4%	0.47	15.17	1.22	12.43	-1	27.45	0.17
5.0	1.00	15.00	11.49	6.02	5.00	15.00	3.00	4.31	10.00	1.49	14.9%	-1.5%	9.85	14.3%	0.40	10.50	1.49	7.05	1	33.53	-0.15
5.0	0.50	15.00	11.29	6.45	10.00	30.00	3.00	5.41	10.00	1.29	12.9%	-2.5%	9.75	13.6%	0.37	8.17	1.29	6.33	0	29.03	-0.25
1.0	2.00	10.00	**18.60**	**2.00**	0.50	5.00	10.00	0.51	15.00	3.60	24.0%	0.2%	15.02	19.2%	0.30	3.50	3.60	0.97	-1	24.00	0.02
3.0	2.00	10.00	17.30	10.44	1.50	5.00	3.33	1.54	15.00	2.30	15.3%	1.4%	15.20	12.1%	0.50	17.50	2.30	7.61	-3	15.33	0.20
5.0	2.00	10.00	15.50	33.30	2.50	5.00	2.00	2.56	15.00	0.50	3.3%	3.8%	15.56	-0.4%	0.70	31.50	1.00	31.50	-2	3.33	0.56
7.0	**2.00**	**###**	**14.40**	**40.30**	3.50	5.00	**1.43**	3.59	15.00	-0.60	-4.0%	7.4%	16.11	-11.9%	0.90	45.50	1.00	45.50	5	-4.00	1.11
10.0	2.00	10.00	**13.50**	**61.70**	5.00	5.00	1.00	5.12	15.00	-1.50	-10.0%	15.1%	17.26	-27.9%	1.20	66.50	1.50	44.33	-17	-10.00	2.26
5.0	1.00	10.00	14.45	51.60	5.00	10.00	2.00	3.66	15.00	-0.55	-3.7%	-3.4%	14.49	-0.3%	0.60	24.50	1.00	24.50	-27	-3.67	-0.51
						5.00	2.00					3.8%								4.40	0.56
5.0	**3.00**	**###**	**17.30**	**16.90**	1.67	3.33	2.00	1.92	15.00	2.30	15.3%	14.8%	17.21	0.5%	0.80	38.50	2.30	16.74	0	15.33	2.21
5.0	2.25	6.75	25.47	39.00	2.22	3.00	1.35	1.75	22.22	3.25	14.6%	13.5%	25.23	1.0%	1.07	57.69	3.25	17.76	-21	6.66	3.00
5.0	2.75	7.50	24.15	17.50	1.82	2.73	1.50	1.60	20.00	4.15	20.8%	20.7%	24.14	0.0%	1.03	54.83	4.15	13.21	-4	11.67	4.14
5.0	**2.50**	**8.00**	**21.30**	**21.00**	2.00	3.20	1.60	1.85	18.75	2.55	13.6%	13.7%	21.32	-0.1%	0.94	48.13	2.55	18.87	-2	8.70	2.57
5.0	3.00	8.00	23.02	12.00	1.67	2.67	1.60	1.56	18.75	4.27	22.8%	23.1%	23.07	-0.2%	1.00	52.50	4.27	12.30	0	14.57	4.32
5.0	**2.50**	**7.00**	**25.42**	**27.00**	2.00	2.80	1.40	1.64	21.43	3.99	18.6%	17.9%	25.27	0.6%	1.07	57.50	3.99	14.41	-13	9.13	3.84
5.0	1.50	6.00	25.21	57.00	3.33	4.00	1.20	2.21	25.00	0.21	0.8%	-0.8%	24.79	1.7%	1.08	58.33	1.00	58.33	1	0.30	-0.21
5.0	**3.10**	**###**	**14.32**	**16.00**	1.61	3.84	2.38	2.14	12.61	1.71	13.6%	11.3%	14.03	2.0%	0.68	30.15	1.71	17.58	2	19.27	1.43
5.0	**2.55**	**9.24**	**18.03**	**27.70**	1.96	3.62	1.85	2.05	16.23	1.80	11.1%	10.9%	18.01	0.1%	0.82	39.70	1.80	22.10	-6	9.45	1.78
5.0	**2.62**	**7.18**	**25.07**	**21.40**	1.91	2.74	1.44	1.60	20.89	4.18	20.0%	19.7%	25.00	0.3%	1.06	56.79	4.18	13.59	-8	10.31	4.11

Length	21000	microns	
Width	15000	microns	
Thickness	0.25	microns	
Volume	78750000	microns^3	
	0.000079	cc	
Ni Density	8.908	g/cc	
Ni Mass	0.00070	g	
Ni AW	58.693	AU	
H Mass	1.2E-05	g	Assumes 1:1 stoiciometry of NiH
LENR Energy	3.7E+11	J/g	Assumes completion of Li-cycle
Energy	4422279	J	Assumes 100% conversion of H in lattice
Dynamite stick	2.1E+06	J/stick	
Dynamite equiv.	**2.1**	sticks	

L	Freq	A	R
5.00			
A	**27.0**	6.89	2.74
B	**25.7**	7.15	2.74
C	**24.5**	7.40	2.73
D	**23.3**	7.67	2.73
E	**22.2**	7.95	2.73
F	**21.1**	8.27	2.73
G	**20.1**	8.59	2.73
H	**19.2**	8.93	2.73
I	**18.3**	9.30	2.74
J	**17.4**	9.72	2.75
K	**16.6**	10.13	2.76
L	**15.8**	10.59	2.79
M	**15.0**	11.10	2.83
N	**14.3**	11.59	2.87
O	**13.6**	12.11	2.94

L is post height
A is post spacing
R is post mean radius

Hexagonal array of cylindrical posts (as in exmple drawing)

c-c spacing microns	Array size microns	Number of Cells
30	1500	2875
15	1500	11500
10	**1500**	**25875**
7	**1500**	**52806**

L is post height
A is post spacing
R is post mean radius
Everything is in microns
<u>R assumes 0.25 micron metal thicknes</u>
Mask must allow for post taper

Freq THz	Step	Q	Lo	Med
29.8	1.4	21.3		
28.4	1.4	20.3		
27.0	1.4	19.3		
25.7	1.3	19.8		
24.5	1.2	20.4		
23.3	1.2	19.4		
22.2	1.1	20.2		
21.1	1.1	19.2		
20.1	1.0	20.1		A
19.2	0.9	21.3		B
18.3	0.9	20.3		C
17.4	0.9	19.3		D
16.6	0.8	20.8		E
15.8	0.8	19.8		F
15.0	0.8	18.8		G
14.3	0.7	20.4		H
13.6	0.7	19.4	A	I
13.0	0.6	21.7	B	J
12.4	0.6	20.7	C	K
11.8	0.6	19.7	D	L
11.2	0.6	18.7	E	M
10.7	0.5	21.4	F	N
10.2	0.5	20.4	G	O
9.7	0.5	19.4	H	
9.2	0.5	18.4	I	
8.8	0.4	22.0	J	
8.4	0.4	21.0	K	
8.0	0.4	20.0	L	
7.6	0.4	19.0	M	
7.2	0.4	18.0	N	
6.9	0.3	23.0	O	

L=5.0	**A**	**R**
A	6.89	2.49
B	7.15	2.49
C	7.40	2.48
D	7.67	2.48
E	7.95	2.48
F	8.27	2.48
G	8.59	2.48
H	8.93	2.48
I	9.30	2.49
J	9.72	2.50
K	10.13	2.51
L	10.59	2.54
M	11.10	2.58
N	11.59	2.62
O	12.11	2.69

A	E	I	M	B	F	J
H	D	O	K	G	C	N
L		A	E	I	M	B
K	G	C	**1**	N	J	F
O	D	H	L		A	E
C	N	J	F	B	M	I
G	K	O	D	H	L	

B	F	J	N	C	G	K
E	A		L	H	D	O
I	M	B	F	J	N	C
L	H	D	**2**	O	K	G
	A	E	I	M	B	F
D	O	K	G	C	N	J
H	L		A	E	I	M

C	G	K	O	D	H	L
F	B	M	I	E	A	
J	N	C	G	K	O	D
I	E	A	**3**		L	H
M	B	F	J	N	C	G
A		L	H	D	O	K
E	I	M	M	F	J	N

D	H	L		A	E	I
G	C	N	J	F	B	M
K	O	D	H	L		A
J	F	B	**4**	M	I	E
N	C	G	K	O	D	H
B	M	I	E	A		L
F	J	N	C	G	K	O