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# Verification of intermediate nuclear fusions without harmful radiation and the production of magnecular clusters

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**Abstract.** Experiments were conducted to confirm measurements by Santilli [1] of an *Intermediate Controlled Nuclear Fusion* (ICNF) process without harmful radiations. For this purpose we used a steel reactor chamber pressurized with deuterium gas and sparked with carbon electrodes. Thermal measurements on the chamber were analyzed and compared with the total measured energy input to determine excess heat production. Mass spectroscopic analysis were performed on gas samples extracted before and after ignition to verify the formation of magnecular clusters (essentially consisting of clustered molecules) formed as by-products of the intermediate nuclear fusion process. The exterior of the chamber were monitored throughout these experiments with radiation detectors to assess if any harmful radiation were emitted into the environment. These experiments are the precursor to the construction and testing of larger scaled hadronic reactors.

## INTRODUCTION

Controlled tests of the ICNF process without harmful radiations were repeated at the facility of the Institute for Basic Research in Tarpon Springs by a technical team from Princeton Gamma-Tech (PGT). The main diagnostic tools used to characterize the hadronic reactor were supplied by PGT, including the temperature transducers and radiation detectors.

The hadronic reactor is fabricated from a 12-inch outer diameter steel tube with welded end flanges. Two steel plates are bolted to both ends to seal the chamber. A stationary anode is located from one endplate, and a moveable cathode from the other endplate. The electrodes can be changed by opening the chamber to replace the anode and cathode. For the tests described in this article, the electrodes were carbon graphite. The terminals were attached to a Miller Electric Dimension 1000 AC-DC converter, and regulated during the experiments at nominally 40VDC and 900A. A wattmeter was used to determine the exact power consumed by the generator during each experimental run. The temperature of the reactor tube and endplate were monitored with platinum resistive sensors.

Figure 1. Photograph of the opened hadronic reactor

The main concern with any nuclear process intended for energy generation is the potential for harmful radiations. Fission reactors produce considerable amount of all the deadly forms such as alphas ($^4He^{2+}$), betas ($e^-$), neutrons (n) and gamma-rays (γ). Alpha and beta particles can cause the most damage to living cells, but by their very nature of being highly ionizing means they also have very short travel paths, and unless ingested are not of environmental concerns. Neutrons and gamma-rays are considerably more penetrative and therefore more of a harmful environmental radiation to consider. The SAM940 [2] radiation detector consists of a sodium iodide scintillator for identifying sources of gamma-rays and a proportional counter filled with a rare isotope of helium ($^3He$) for neutron detection. The detectors were factory calibrated with potassium ($^{40}K$) for gamma-rays and californium ($^{252}Cf$) for neutrons. Radioactive background levels of the research facility were surveyed with the SAM940, and the instrument then placed in close proximity to the hadronic reactor to constantly monitor any potential harmful radiations emitted during the fusion process.

Figure 2. Photograph of PGT's model SAM940 gamma-ray and neutron detector

## DEUTERIUM CARBON FUSION

The fusion of deuterium and carbon by the ICNF process to form nitrogen can be described using Hadronic Mechanics [3] with the following balanced equation:

$$TR + H\,(2, 1, 1^+, 2.0141) + C\,(12, 6, 0^+, 12.0000) \rightarrow N\,(14, 7, 1^+, 14.0030) + \Delta E_{heat} \quad (1)$$

whereby the first symbol contained within the brackets represent the atomic number of the isotope species, the second symbol the nuclear charge, the third symbol the nuclear angular momentum with parity, and the final fourth symbol representing the atomic mass unit (amu).

The trigger (TR) mechanism to initiate the reaction process is the electric arc that polarizes the carbon and hydrogen atoms to form magnecular clusters. On the atomic distances between the axially coupled atoms, the extremely strong magnetic fields generated by the arc toroidally deform the atomic orbitals and thereby exposing the nuclei from their electronic clouds. The close proximity of the bare nuclei leads to the nuclear fusion with the generation of excess heat ($\Delta E_{heat}$). The mass difference between the fusion product ($^{14}N$) and the parent nuclei ($^2H$, $^{12}C$) is 0.0111amu or the energy equivalent of 10.339MeV.

The hadronic reactor is pressurized with pure deuterium gas by first evacuating with a mechanical vacuum pump the chamber and then backfilling with the gas from a supply bottle. Gas samples were taken before and after each initiated reaction, and sent to an independent laboratory [4] for spectra vapor analysis.

Each experimental run was started close to ambient temperature of nominally 25ºC, with the electric arc powered for 2 minutes. The wattmeter measured an average power consumption of 1550W.hr, which equates to an energy input of 5.4MJ. A total of 3 runs were performed at varying starting pressures of 100, 75 and 50psi. For the 100psi tests, gas samples before (A) and after (B) was taken. The reactor chamber was then purged and refilled with pure deuterium, and a gas sample (C) was taken at a starting pressure of 75psi. After the reaction process at 75psi, a gas sample (D) was extracted. The reactor was then allowed to cool back to ambient and the pressure reduced to 50psi for another reaction, and a final gas sample (E) taken.

Summary of the gas samples extracted from the hadronic reactor:

A) 100psi Before fusion
B) 100psi After fusion
C) 75psi Before fusion
D) 75psi After fusion
E) 50psi After fusion

# RESULTS

## Gas Spectra Analysis

Deuterium is non-combustible, and there were also negligible amount of oxygen contained in the hadronic reactor for any other combustion processes to have occurred. Hence if there were no hadronic chemistry or fusion processes taking place then we would expect to observe similar vapor spectra for the samples taken before and after initiation by the electric arc. The following chart shows the analyzed mass spectra for the 5 gas samples, the reported values are in parts-per-million (ppm) by volume.

| amu | A | B | C | D | E |
|---|---|---|---|---|---|
| 2 ($H_2$) | 288,163 | 185,549 | 141,308 | 158,837 | 201,992 |
| 3 | 49,815 | 438,891 | 64,969 | 461,037 | 1,031,783 |
| 4 ($D_2$) | 12,648,080 | 12,342,540 | 11,357,960 | 11,013,180 | 10,311,080 |
| 5 | 332 | 933 | 223 | 840 | 1,771 |
| 6 | 13,260 | 12,020 | 10,532 | 9,793 | 9,018 |
| 7 | - | - | 190 | 186 | 161 |
| 8 | - | - | - | - | - |
| 11 | - | - | - | - | 40 |
| 12 | 4,850 | 9,025 | 620 | 19,668 | 32,411 |
| 13 | 449 | 400 | 60 | 454 | 1,089 |
| 14 | 57,902 | 11,191 | 104,309 | 118,343 | 125,036 |
| 15 | 1,875 | 1,578 | 653 | 1,644 | 3,369 |
| 16 | 24,627 | 16,952 | 34,481 | 26,993 | 54,958 |
| 17 | 2,269 | 12,165 | 4,479 | 23,534 | 155,606 |
| 18 (Ar, $H_2O$) | 10,248 | 104,140 | 18,576 | 186,414 | 679,276 |
| 19 | 3,242 | 8,594 | 2,823 | 13,890 | 174,468 |
| 20 | 8,302 | 71,458 | 9,302 | 114,013 | 182,857 |
| 21 | - | 729 | - | 1,216 | 2,315 |
| 22 | 222 | 159 | - | 197 | 222 |
| 23 | - | - | - | - | - |
| 24 | 182 | 218 | - | 161 | 1,025 |
| 25 | 633 | 240 | - | 61 | 323 |
| 26 | 2,838 | 1,408 | 245 | 1,103 | 4,415 |
| 27 | 873 | 878 | - | - | 3,145 |
| 28 ($N_2$) | 536,530 | 125,200 | 884,507 | 1,148,545 | 1,301,279 |
| 29 | 4,334 | 2,548 | 6,463 | 10,666 | 14,491 |
| 30 | 3,618 | 5,306 | 5,526 | 10,963 | 22,688 |
| 31 | 178 | 1,601 | 343 | 2,034 | 7,569 |
| 32 ($O_2$) | 111,498 | 13,475 | 205,287 | 17,979 | 42,656 |
| 33 | 139 | 483 | 201 | 622 | 3,539 |
| 34 | 577 | 1,449 | 1,134 | 2,197 | 3,429 |
| 35 | - | 225 | - | 236 | 933 |
| 36 | - | 1,848 | 142 | 2,840 | 4,621 |
| 37 | - | 79 | - | - | 207 |
| 38 | - | 119 | - | 100 | 161 |

| | | | | | |
|---|---|---|---|---|---|
| 39 | 308 | 433 | 104 | 161 | 328 |
| 40 | 5,857 | 563 | 10,687 | 11,468 | 11,465 |
| 41 | 209 | 328 | 80 | 183 | 436 |
| 42 | 197 | 317 | 102 | 246 | 654 |
| 43 | 113 | 295 | - | 188 | 732 |
| 44 ($CO_2$) | 14,262 | 13,828 | 1,848 | 14,241 | 13,508 |
| 45 | 199 | 265 | - | 212 | 282 |
| 46 | 98 | 159 | - | 121 | 308 |
| 47 | - | - | - | - | - |
| 48 | - | - | - | - | 99 |
| 50 | 111 | 208 | - | 101 | 317 |
| 51 | 107 | 218 | - | 61 | 2,740 |
| 52 | 109 | 295 | - | 207 | 459 |
| 53 | - | 107 | - | - | 102 |
| 54 | - | 176 | - | 101 | 223 |
| 55 | - | 185 | - | - | 141 |
| 56 | - | 208 | - | 128 | 306 |
| 57 | - | - | - | - | 40 |
| 58 | - | - | - | - | 140 |
| 60 | - | - | - | 81 | 121 |
| 67 | - | - | - | - | - |
| 69 | - | - | - | - | 391 |
| 71 | - | - | - | - | - |
| 77 | - | 137 | - | 65 | - |
| 78 | 306 | 464 | 100 | 238 | 243 |
| 79 | - | 115 | - | - | - |
| 81 | - | 60 | - | - | - |
| 82 | - | 132 | - | 81 | 130 |
| 83 | - | 60 | - | 40 | 131 |
| 84 | - | 472 | - | 396 | 734 |
| 91 | - | 162 | - | - | - |
| 101 | - | - | - | - | 711 |

The spectral analysis indicates a reduction in the amount of deuterium following each reaction. At 100psi (A→B) the decrease was approximately 2.5%, and at 75psi (C→D) it was 3%. The decrease in the amount of nitrogen in the 100psi data can be misleading, since the evolved nitrogen can be trapped in clustered magnecules as indicated by the existence of higher mass entities in the spectral data following all the reactions. These previously unknown higher mass magnecules are further evidence of the hadronic chemistry taking place.

## Elemental Microanalysis

Samples of deposits on the surface of the graphite electrodes were removed for material characterization in a Scanning Electron Microscope (SEM) using an Energy Dispersive Spectroscopy (EDS) x-ray detector [5]. The detector is a liquid-nitrogen cooled lithium-drifted silicon crystal biased to operate as a semiconductor junction. X-rays liberate electron-hole pairs in the junction, and the amount of charge collected is proportional to the x-ray energies. The electron beam striking the samples generates electronic excitation, and it is the decay of these electronic shells that emits the characteristic x-ray energies unique to each element.

The EDS detector is a PGT's model LS10133 mounted to an ISI Super IIIA SEM. The samples were epoxied to a holder placed directly in line with the electron beam. The long vacuum insulated endcap housing the Si(Li) crystal is inserted into the SEM chamber in close proximity to the sample. Fluorescence x-rays scattering off the target sample and entering the endcap through a thin-walled polymer window are identified by the EDS detector system.

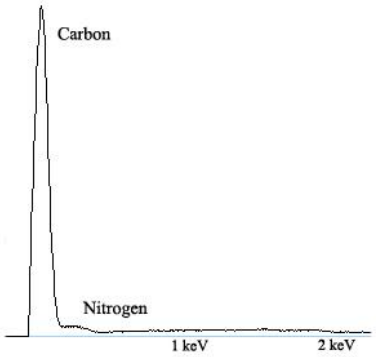

Figure 3. Elemental spectra of deposits on graphite electrode

The elemental microanalysis spectra taken on the surface deposits of the graphite electrodes show a prominent x-ray peak at 277eV (carbon $K_\alpha$). There is a small adjacent peak at 392eV, which is the nitrogen $K_\alpha$ x-ray that is noticeable above the general background level. Since the SEM chamber is under vacuum, then the detected nitrogen must exist in some non-gaseous form, possibly within clustered magnecules [6].

## Thermal Analysis

Platinum resistive temperature sensors were securely fastened to the surfaces of the steel chamber's central tube and one of the endplates. Temperature readings were noted down each minute after the electric arc was powered up to produce a thermal profile of the hadronic reactor. A thermal Finite Element Analysis (FEA) was simulated [7] for the reactor to estimate the expected temperature rise if the only source of heat came from the electric arc. Comparison curves of the measured thermal profiles against the FEA computed values at 5MJ, 5.5MJ and 6MJ energy inputs are shown below.

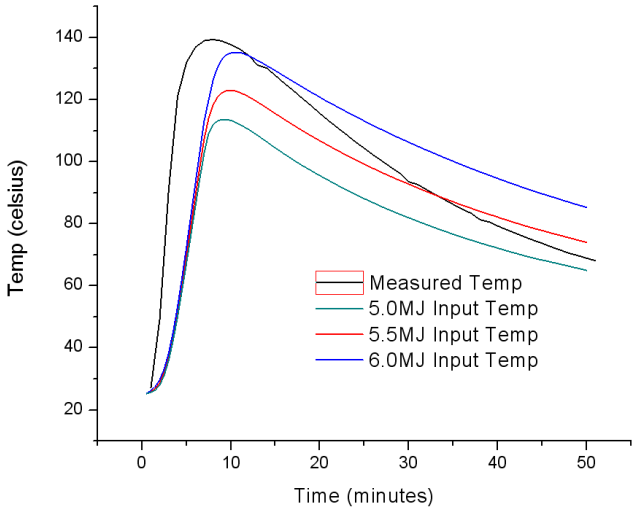

Figure 4. Thermal profiles of tube

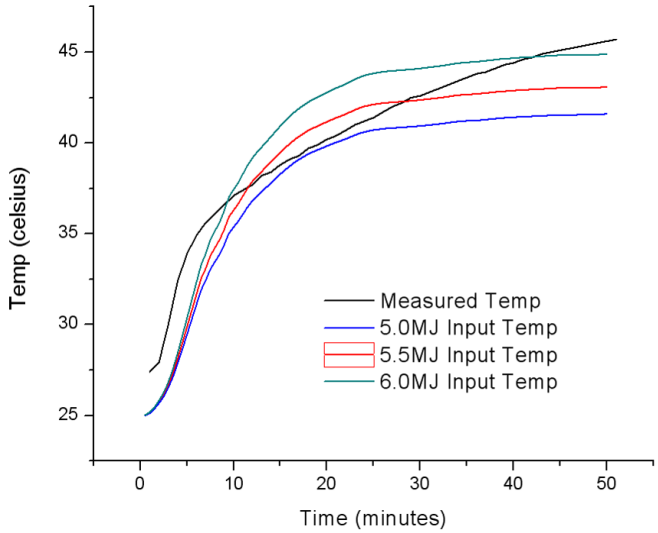

Figure 5. Thermal profiles of endplate

The data indicates the generated excess heat $\Delta E_{heat}$ of approximately 0.5MJ above the total injected energy input of 5.4MJ from the electric arc. From equation (1) we note that each reaction releases around 10MeV of fusion energy, hence if we assume all the excess heat is through the ICNF process, then this is equivalent to the generation of roughly $10^{18}$ or a micro-mole of fusion products.

## Radiation Analysis

The SAM940 sodium iodide scintillator detector is self-calibrating at the potassium ($^{40}K$) energy of 1.461MeV. The helium ($^{3}He$) proportional counter was factory calibrated against a californium ($^{252}Cf$) neutron source. For safety and security reasons the source is embedded in wax and locked inside a steel vault. Opening the vault door and placing the SAM940 instrument approximately a meter from the source, we were able to detect average neutron levels of 0.8 counts per second (cps). With the vault door closed and the instrument removed from the vicinity, the background levels fell to less than 0.03cps.

Compared to normal background levels there were no emitted gamma-rays or neutrons detected emanating from the hadronic reactor during the fusion process occurring within the chamber.

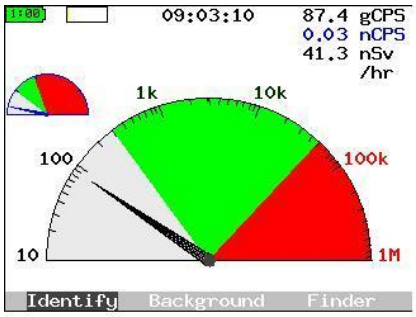

Figure 6. SAM940 Gamma and neutron detection

## CONCLUSION

The results taken from the experimental runs conducted on the hadronic reactor indicates some form of exothermal reaction taking place that produced clusters of higher mass components. Since chemical reactions and combustion cannot have occurred in a pure deuterium environment, the conclusion leads to an indication of the process described as *Intermediate Controlled Nuclear Fusion* without harmful radiations.

## REFERENCES


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