Martin Fleischmann Memorial Project status review

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Two years have passed since the Martin Fleischmann Memorial Project started developing and operating experiments openly on the Internet. This article recaps the results which the project has been able to nail down so far. Two main aspects of the research were conducted in multiple laboratories – the first one was the replication of the experiments conducted by Francesco Celani on his sub-micrometric featured constantan wires, and the second one dealt with nickel nanopowders inspired by the work of Brian Ahern. Both systems are hydrogen gas in heated environment above Curie temperature.

Keywords: Cold fusion, excess energy, live open science, nickel nano-powders.

Pursuit of a more open science in the Internet age

WHEN writing a scientific paper like this, one must make the description concise and readable, which requires leaving some details unexplained. When reading a scientific paper of this type one always has further questions about the details of exactly what was done to achieve the results presented. These questions are of paramount importance when attempting to replicate a study. A result that is replicable is the fundamental goal of science.

With replicability and full disclosure of every detail in mind, the Martin Fleishmann Memorial Project (MFMP) of researchers set out to design and perform experiments in the field of low energy nuclear reactions (LENR) openly on the web. The methodology has earned the name 'Live Open Science' and consists of publishing the experiment design, an experiment log, and the data streaming out of the experiment live.

The first step of this approach consists of publishing the experimental design on our webpage for comments and criticism. If the fundamental design of the experiment is flawed, constructive criticism early can save a lot of wasted time and effort. The next step is to document the assembly process of the experiment step by step on the web as it happens. Again, this is open to criticism and suggestions.

The testing and commissioning of the apparatus is also done with live data streaming to graphs on the web and daily blogging. This builds supportable credibility that the apparatus performs adequately and that the research team is operating it adequately for the study being done. Outside experts calibrating any test equipment should also be documented. Suggestions from readers following the website are often useful for improving the operation or clarifying testing parameters at this stage of the experiment as well.

Finally, when the apparatus is employed for the real tests in the experiment, the data are live-streamed, every change to the controlled parameters is logged, and interpretation of the results is live-blogged. Constant dialogue with the engaged audience following the experiment is enriching. The authors have benefitted from many suggestions and even complementary analyses made by audience members. This kind of emergent teamwork helping to crowd-source solutions to technical challenges has a lot of potential to change the way science is done throughout the world in the future.

Replication of sub-micrometric treated constantan wires experiment

This is the first replication the MFMP team decided to make in order to empower the crowd and raise public interest in LENR. The experiment presented during the 17th edition of the International Conference on Cold Fusion in 2012 in Korea[1] by Francesco Celani has been widely publicized due to the exposure it had at the National Instruments Week held the previous week before the conference.

This experiment allows visual as well as high gradient thermal variation to a wire located inside a glass tube and was initially designed by Celani as a visual screening tool to assess the stability and efficacy of potential surface modifications made by his group. The calorimetric measurements are based on the Stefan–Boltzmann equation of blackbody emission with a calibrating ratio applied to compensate convective heat behaviour. This experiment, done live at ICCF 17, showed an astonishing excess heat corresponding to 30% of the power input.

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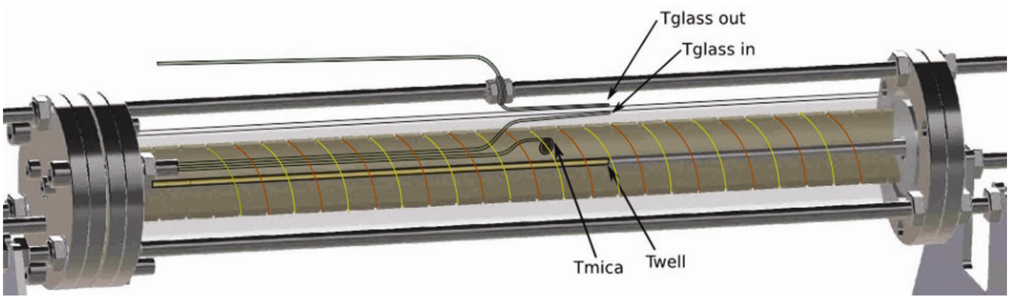

Figure 1. Visual software rendering of the cell internals, with position of the thermocouples. The two wires are wound on the mica plates (in beige) following the pattern of the notches.

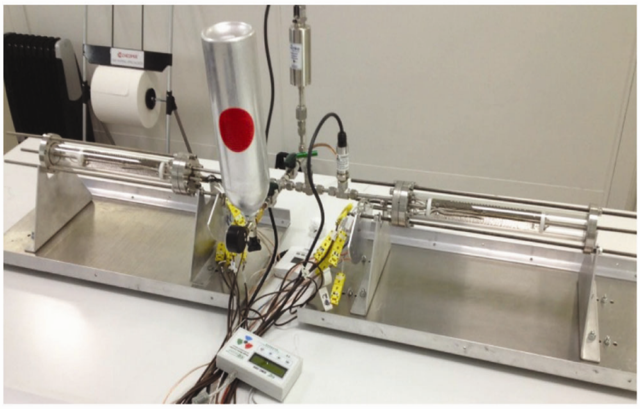

Figure 2. Photograph of the replication set-up with two identical cells.

Apparatus

The replication that MFMP made is as follows: The wire is wound on mica plates which are mechanically held on a stainless-steel tube. The whole system is placed in a borosilicate tube that thermalizes the radiant heat coming from the system. Each end of the tube is equipped with stainless-steel flanges that hold feed-throughs on one side and the internal assembly that positions the wire.

Another parallel wire is mounted to supply heating and calibration capabilities to the set-up. The electrical power is applied to two wires via independent power supplies. The data acquisition (DAQ) records temperature, pressure, power input and time, and broadcasts these measurements live on the Internet to a server that openly shares the data publically.

Temperature measurements are made with K-type thermocouples. Their placement is described in Figure 1. Only the external thermocouple is used as a reference for calculations. The heating is provided by direct current on a wire. These are either nichrome wires or treated constantan wire.

In two years since the project commenced, the system has evolved by absorbing critical input from the scientific community which helped in running, verifying, commenting and developing the set-up. The experiments were performed in two labs during simultaneous runs. Figure 2 shows the latest iteration of the apparatus.

Results

The first full experiment showed an excess energy of 6 W over 48 h. The power input is 48 W, hence the excess energy is 12.5%. This result was obtained by closely following the original protocol that Celani had outlined. All the results from the calibration and the run are summarized in Figure 3. The legend indicates the wire used, the gas type and its pressure. Between the calibration and the run, a constantan wire, used as a control for the test, is swapped with the Celani treated wire.

Further iterations of the experiment included using permanent vacuum as an insulating way of increasing locally the temperature of the wire for similar power input. The protocol, published before the experiment, was composed of a loading phase where only the active cell is filled with hydrogen gas. Then the wire was heated allowing for the microstructure to dissociate and absorb the hydrogen, hence loading the nickel within the constantan[2].

Then both cells were put under vacuum and the power applied identically on both systems.

Even though the results showed lower excess energy (5.3%), the level of confidence from these results was greater due to experience in operating and setting up the system.

Figure 4 shows the evolution of the excess energy as a function of input power for two modes – one where the direct current is applied through the Celani wire and the other a nichrome wire used to heat the chamber.

Even though the results are very small, it shows a variation occurring at triggering temperature, where the power exceeds 10 W.

Replication of Brian Ahern nano-powder experiments

Inspired by reports of anomalous heat by Brian Ahern[3] and others using nickel-based powders with thermal

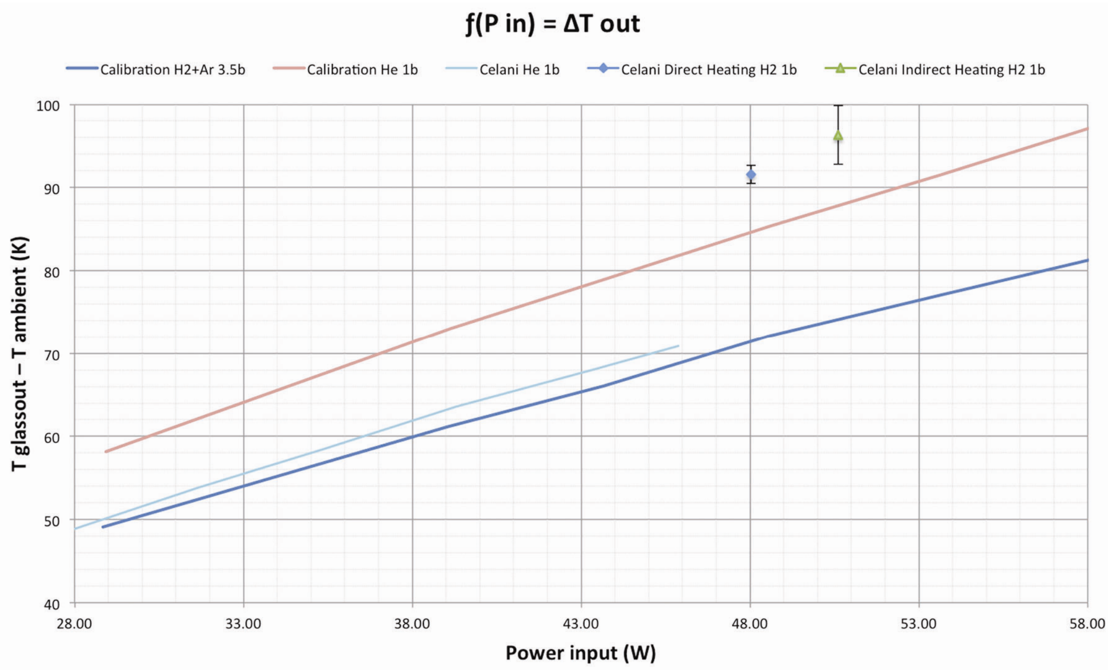

Figure 3. Results from the first original replication of the experiment. Lines are calibrations, large vertical dots are actual runs.

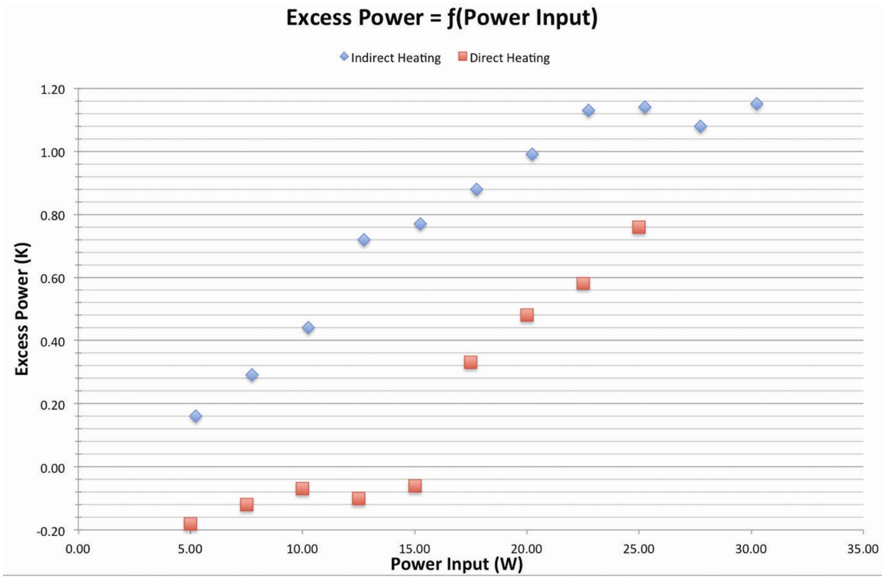

Figure 4. Results of dynamic vacuum on two identical cells, simultaneously, in two different labs.

stimulation, a thermal conduction-based calorimeter was designed, built and used to test three powder samples with no other additives.

The first is a commercially available, micron-scale, filamentary nickel powder commonly called nickel 255. It was employed largely as a baseline test and was not expected to result in interesting events. The second powder was a 10 nm nickel powder from Quantum Sphere Inc. (QSI). This is the same type of powder that Ahern used. He provided the third powder directly. It is a ZrO_2 powder milled to 15 µm, containing nano-islands of 94% Ni and 6% Pd on a molar basis.

Apparatus

The apparatus has a powder chamber made from a ½ inch OD stainless-steel tube inside a vacuum chamber. The vessel has a heater wound around the end, a thermal well coming up from the bottom cap, and two layers of aluminum foil that act as a radiant heat barrier. Outside the stainless-steel vacuum vessel, two layers of tubing carried constant temperature water. The whole apparatus is then contained in an insulation shell to further isolate it from changes in ambient that would add noise to the calorimetry. Figure 5 shows the apparatus and Figure 6 gives a schematic of the cell.

Calorimetry

The heat flows out of the cell containing the powder in three paths – radiation to the shell, conduction up the stem, and convection through the gas within the stem. The radiation is minimized by the radiant heat shields. The convection within the tube is minimized with alumina-felt disks inserted into it. Calorimetry is done by measuring the temperature difference between two high-precision RTDs at points along the stainless-steel tube between the powder and the top flange. The temperature difference was calibrated against power input to the heater. A third-order polynomial was fitted to the resulting curve and used to calculate the heat flow coming out of the cell. Additionally, curves were fitted to each temperature within the cell and each of them was used as an isoperibolic-type calorimetry signal.

The final calorimetry test was purely looking at the temperature within the thermowell in the middle of the powder compared to that measured on the heater outside the powder. If there was heat coming from inside the powder, the temperature in the powder must necessarily exceed the temperature outside it. The cell proved to be stable and it was able to achieve a temperature of 400°C with 5W of input power. This made each measurement of calorimetry inherently more sensitive.

Degassing and hydrogen absorption

Each powder sample was degassed under dynamic vacuum and elevated temperatures from 250°C to 400°C. Degassing was deemed important to the process by many other researchers, including Piantelli and Piantelli[4]. After the vacuum levelled off at a sufficiently low pressure, hydrogen was introduced into the test cell and the valve was closed. Then the temperature was raised slowly and the pressure was observed. The pressure drop was used to calculate the moles absorbed or adsorbed into the powder, though it is possible that some hydrogen may have reduced some oxides to form water that condensed out in the cooler stem of the reactor.

Thermal triggering

After hydrogen was absorbed, the cell temperature was stepped up and ramped up at various rates from room temperature to 500°C. All samples experienced multiple heating and cooling steps, though they did not all see the same steps in the same order.

Results

All the powders absorbed some hydrogen. None gave a clear signal of excess heat. Table 1 summarizes these results and the observations made during the experiments.

There was some apparent change in the gas composition during the test with the nano-nickel powder and the

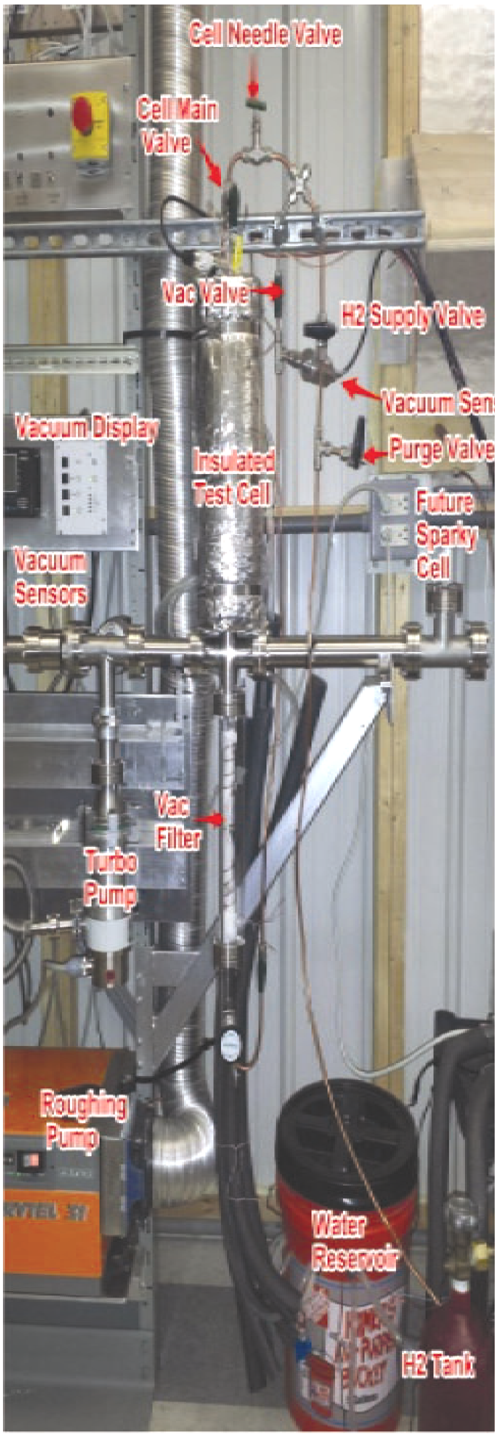

Figure 5. Photograph of calorimeter showing the vacuum apparatus, constant temperature water reservoir and gas plumbing. The location of another test cell being constructed that will include provisions for stimulating the powder with a large spark is also shown.

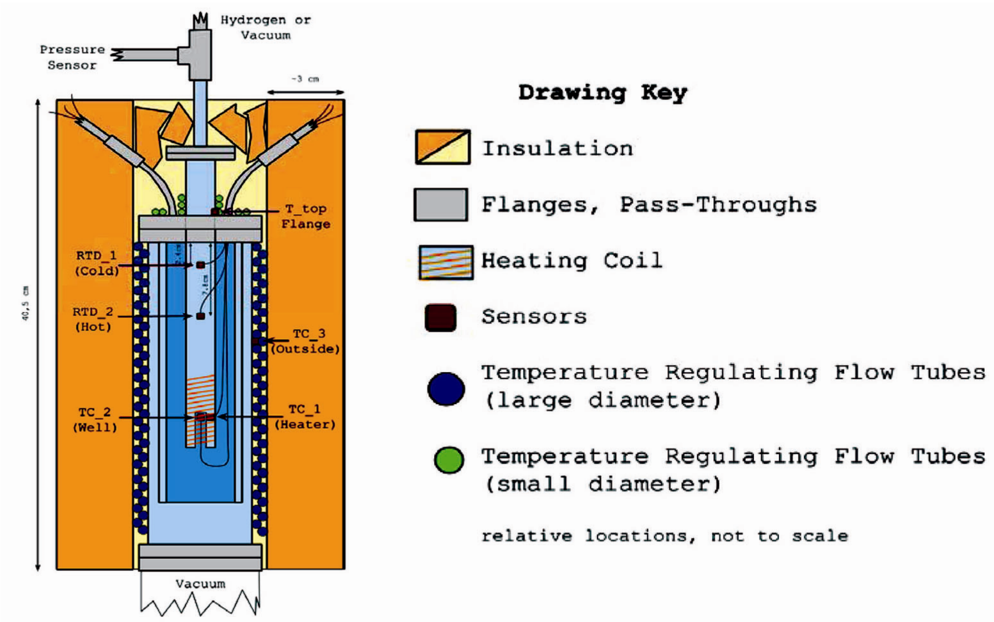

Figure 6. Illustration of the calorimeter apparatus, including sensor locations, water-cooling jacket and insulation.

Table 1. Summary of the three powders tested.

Powder	Powder composition	Degassing comments	H_2 absorption	Excess heat?
Nickel 255 filamentary powder	99.7% Ni approx 2.8 µm	Degassed 12 h at 250°C Clear pulse of gas emitted	Began at 120°C 0.0001 mol H/mol Ni	None
QSI 20 nm Ni	10–25 nm with oxide layer	Degassed over 1 week at various temperatures up to only 180°C to avoid sintering.	Began at room temperature. Up to 0.667 mol H/mol Ni	Possible 5%, but unclear
Sample from Brian Ahern	15 µm ZrO_2 powder with nano-islands of 94% Ni, 6% Pd by mol	Out gassed for 2 weeks at up to 400°C. We learned it had previously been exposed to H_2	Absorbed multiple charges of H_2 up to a maximum of 0.74 mol H/mol Ni + Pd	None

Ahern powder that made the powder run cooler. Replacing the gas with fresh H_2 restored the cell to normal conditions. There was no instrument available to determine the composition of the gas within the cell.

There was a period when the QSI nano-powder appeared to show an increase in temperature slightly as the H_2 continued to absorb H_2 and the pressure dropped. It amounted to approximately 5% more energy out than we were putting into the heater. It is unclear whether that was significant or else an artifact.

Based on this work, it is possible to draw the conclusion that creating a LENR effect requires more than combining nickel powder, hydrogen, and thermal stimulation. Similar is the case with nickel nano-powder or nano-islands in zirconium oxide.

Conclusion

With the help of two different apparatus, the MFMP was able to provide advanced measurements and proper replication to bring greater public understanding to the field of LENR research. Even though our results are very small and in the range of chemical reactions, they provide a baseline understanding in the necessary techniques and technologies. We have confidence in this replication effort and will continue to operate in an open manner via our website.

1. Celani, F. *et al.*, Cu–Ni–Mn alloy wires, with improved sub-micrometric surfaces, used as LENR device by new transparent, dissipation-type, calorimeter. In ICCF-17, Daejeon, Korea, 2012.
2. Celani, F. *et al.*, Experimental results on sub-micro structured Cu–Ni alloys under high temperatures hydrogen/deuterium interactions. In International Workshop on Anomalies in Hydrogen Loaded Metals, Pontignano (Siena), Italy, 10–14 April 2012.
3. Ahern, B., Program on technology innovation: assessment of novel energy production mechanisms in a nanoscale metal lattice. Electric Power Research Institute, 2012 Technical Update.
4. Piantelli, S. and Piantelli, F., Method for producing energy and apparatus therefor. WO 2010/058288, World Intellectual Property Organization, 2010.