

# How to Prove that the Rossi/Focardi eCAT LENR is Real

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Version 3.23, April 23, 2011

## 1. Abstract

A new "Cold Fusion" device was recently demonstrated at the University of Bologna, Italy on Jan 15, 2011. Unlike the Pons and Fleischmann setup, which uses Palladium and Deuterium and can take months to perform an experiment, the Rossi/Focardi eCAT uses Hydrogen and Nickel, produces large amounts of power (more than 10kW), and can be turned on and off on command.

A total of four experiments were performed : One in December 2010 by a panel of independent scientists (led by prof Levi), one in January 2011, attended by the same scientists and invited press, and one in February 2011 attended only by Levi, and for which a formal report has not been issued. An additional experiment was conducted in March 2011, by Kullander and Essén.

This paper attempts to prove that the Rossi/Focardi device is real, by ruling out all known fakes. For any particular fake the total energy and run-time is computed, assuming that the ENTIRE unknown volume is occupied by the fake material, and that its conversion to heat energy is 100% efficient. If the fake could run LONGER than the experiment, then it is NOT eliminated. If the fake would run out of fuel before the end of the experiment, then the fake is eliminated.

If ALL known fakes are eliminated, then the device must be real.

The December/January experiments were too short to rule out ANY of these theoretical fakes. But if Levi's informal reports on the February trial are accepted, then ALL chemical fakes are eliminated. However, neither the January or February reports rule out a *Tarallo Water Diversion Fake*.

The March report probably rules out a *Tarallo* fake -- but since the Horizontal arm was NOT unwrapped, it does NOT rule out all chemical fakes.

At present the Rossi eCat has NOT been proven to be real. However, a few simple improvements to the experimental setup will almost certainly do that.

## 2. Introduction

A new "[Cold Fusion](#)" or "LENR" (Low Energy Nuclear Reactions) device -- the Rossi/Focardi Energy Catalyzer or eCAT was recently demonstrated at the University of Bologna, Italy on Jan 15, 2011: [Rossi-Focardi Energy Catalyzer](#)

An second experiment was performed in February : [Cold Fusion: 18 hour test excludes combustion](#) A good summary of these is given by Scott Chubb [Infinite Energy • Issue 96 • March/April 2011](#)

A third test was performed by Kullander and Essén [Experimental test of a mini-Rossi device at the Leonardocorp, Bologna 29 March 2011](#) and [Swedish physicists on the E-cat: "It's a nuclear reaction"](#) : informal reports indicate that they performed a more stringent test on April 21, 2011.

Also see the Wiki [Energy Catalyzer](#)

Cold fusion was first announced by Pons and Fleischmann in 1989, and was rapidly "debunked". But contrary to popular (and mainstream scientific) opinion, Cold Fusion was never actually disproved (see the history section.) Work has continued in a variety of private, university and government studies, with an annual *ICCF* conference, now in its 17th year. Most of the work has concentrated on the Pons and Fleischmann setup, which uses Palladium and Deuterium. It has been replicated hundreds of times, though experiments can take months to run, and require sophisticated calorimetry.

In contrast, the Rossi/Focardi eCAT uses Hydrogen and Nickel, produces large amounts of power (more than 10kW), and can be turned on and off on command. Rossi plans to install a 1MW water-heating plant, made by connecting 100 10kW devices in series and parallel, in Athens, Greece, in October 2011.

Both of these eCAT demonstrations were primarily a "black box" calorimetry experiment. Because his patent application has not yet been approved, Rossi declines to make detailed comments on the process, or to let anyone see inside his "reactor chamber".

Villa notes in his report on the January experiment:

In the present test, as a precautionary attitude, whatever was not known, not disclosed or not understood has been considered as the energy source. This forces to consider relevant only very large energy productions, as those described in [1] where the reactor has been working for weeks and month

....

The duration of the tests would be directly proportional to the mass and volume of unknown origin. For the present set-up a convincing evidence would include a power production of (order of) 10 kW sustained for weeks in a controlled and monitored environment.

This paper attempts to put numbers to that philosophy, by calculating UPPER BOUNDS on what any known chemical process could produce.

If it's not real, how can the experiment be faked? And if it's faked, how can we detect it, or eliminate it?

As Sherlock Holmes said in *The Adventure of the Beryl Coronet*:

"It is an old maxim of mine that when you have excluded the impossible, whatever remains, however improbable, must be the truth.

If all possible fakes are eliminated then the *eCat* must be real -- even though we do not know how it works. If current science can't explain it, then the science is wrong.

### 3. History

Cold fusion was first announced by Pons and Fleischmann in 1989, and was rapidly "debunked".

But contrary to popular (and mainstream scientific) opinion, Cold Fusion was never actually disproved.

Cravens And Letts ([The Enabling Criteria of Electrochemical Heat: Beyond Reasonable Doubt](#)) performed a statistical analysis of 167 papers, and identified 4 criteria which were satisfied in all successful experiments (including Pons and Fleischmann's original paper), and in which one or more were omitted in failed experiments -- including all the original "Debunking" papers. The most important are Lewis (Caltech) -- where NONE of these criteria were met, and Williams (Harwell), in which only ONE was met. These two papers effectively removed Cold Fusion from main stream science (and funding). Cravens And Letts point out that although ignoring these criteria almost guarantees failure, following them improves, but does not ensure success. Alchemists were well advised to include the "eye of newt" in their potions, since they did not understand which of the many steps were critical to success, and which were irrelevant. Perhaps those alchemists used better science than Lewis and Williams.

Also see Krivit: [How Can Cold Fusion Be Real, Considering It Was Disproved By Several Well-Respected Labs In 1989?](#)

Work has continued in a variety of private, university and government studies ([Experiments](#)), with an annual *ICCF* conference, now in its 17th year. Hundreds of papers have been written, some in peer-reviewed mainstream journals. ([Library](#)).

Most of the work has concentrated on the Pons and Fleischmann setup, which uses Palladium and Deuterium. It has been replicated hundreds of times. However, it has not reached 100% reproducibility. Experiments take months to "load" the deuterium into the palladium (though recent experiments with co-depositing deuterium and palladium eliminate this step), and are not guaranteed to work. (Though a set of cathodes which work in one experiment will almost always work in a different set-up). They require very subtle calorimetry over a long period, which introduces doubt into the results.

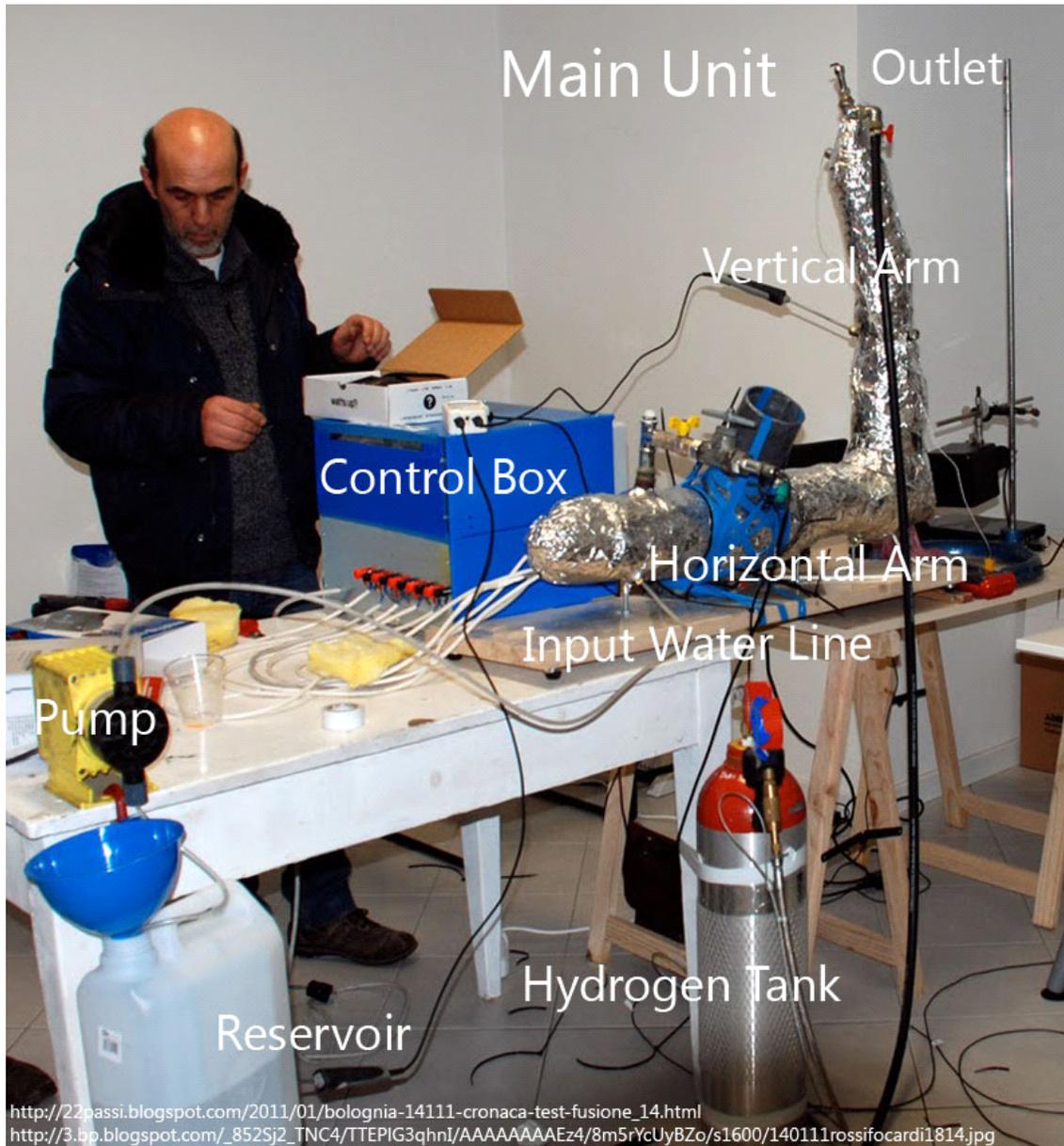
In addition to the calorimetric results, a 'CR-39' polycarbonate detector (long used by the Russians) placed next to the electrode shows clear evidence of high-energy particles (Mossier-Boss et al : [Use of CR-39 in Pd/D co-deposition experiments](#) and [Reply to a comment .. by Kowalski](#)).

The first reported work using Nickel and Hydrogen was by Francesco Piantelli (See articles by Krivit: [Deuterium and Palladium Not Required](#) and [Piantelli-Focardi Publication and Replication Path](#) ).

The Rossi/Focardi *eCat* uses Hydrogen and Nickel, produces large amounts of energy (more than 10kW), and can be turned on and off on command.

## 4. eCAT Demonstrator Apparatus

### 4.1. January eCAT Apparatus



[Image from Passerini Report](#) (January 2011)

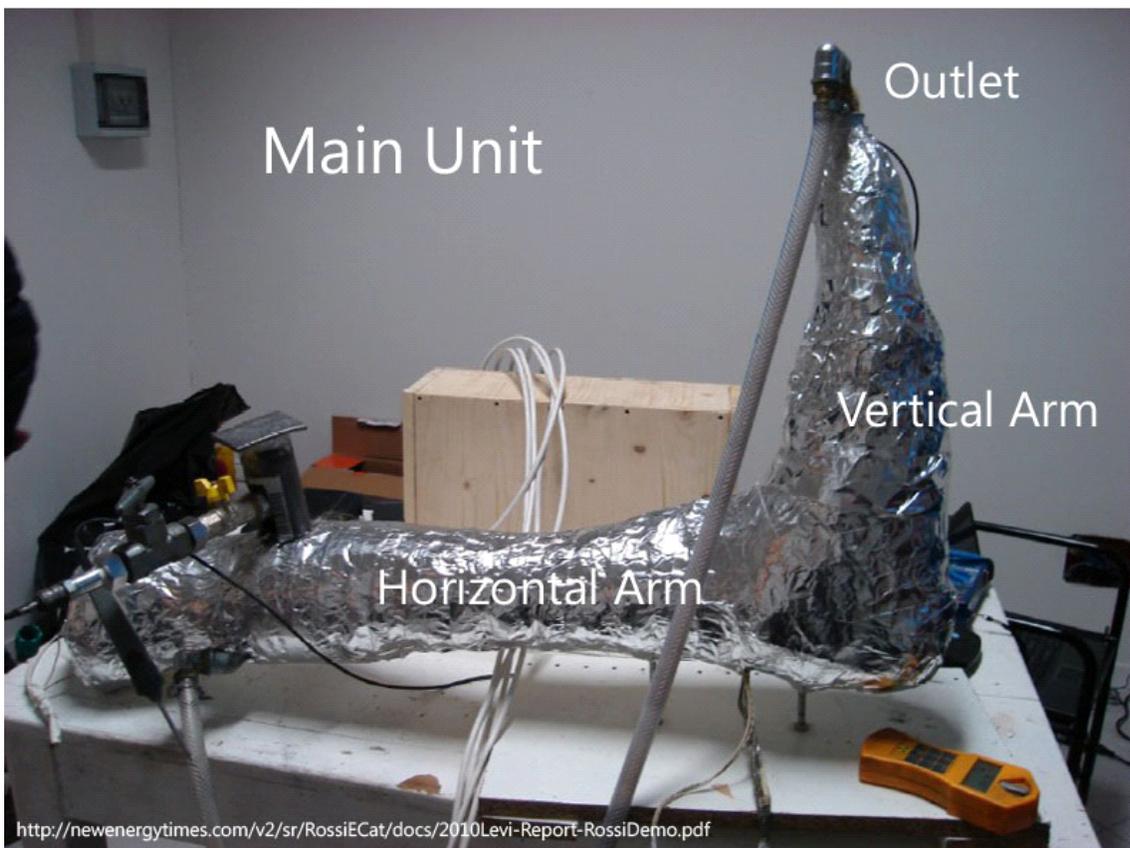


Fig.1

Image from Levi report (December 2010?).

## 4.2. March eCAT Apparatus



Fig 5



Fig 2



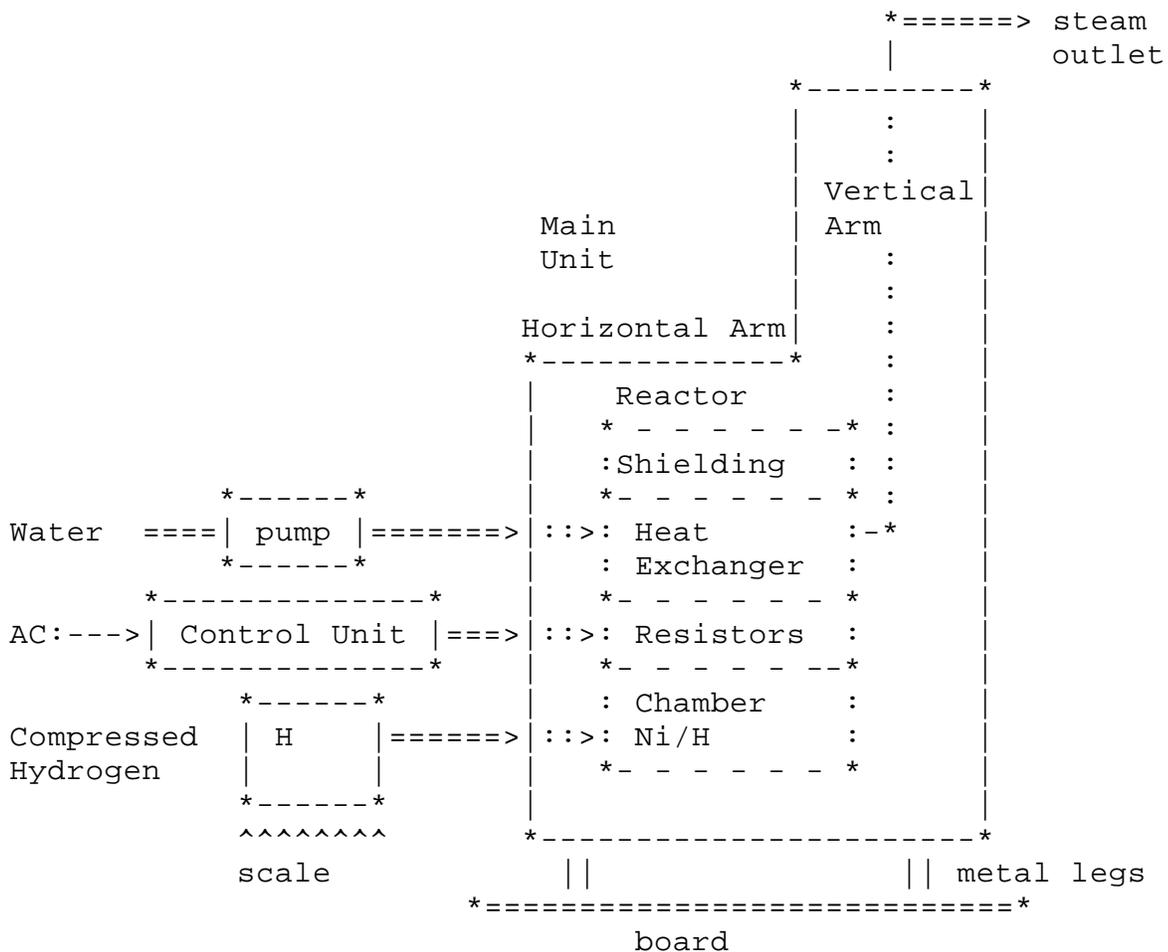
Fig 4



Fig 3

### 4.3. General Structure and Operation

The setup is



The components are:

- Main Unit (Made up of a Horizontal and Vertical Arm)
- Horizontal Arm : Contains the Reactor Unit, reportedly made up of:
  - Chamber -- contains Nickel, fed with Hydrogen
  - Resistors -- used to "ignite" the reactor, then lowered to maintain the reaction
  - Heat exchanger -- heats and/or boils the water.
  - Radiation Shielding -- Lead
- Vertical Arm
- Water and Pump
- Control Unit powered from an AC wall-plug.
- Compressed Hydrogen bottle, weighed before and after.

The entire Horizontal and Vertical arms were enveloped in tinfoil for the December/January trials.

The presence or absence of any evidence of nuclear activity is NOT considered in this paper.

Operation:

- Load the reactor with hydrogen
- Apply 1 kW through the control panel until the reactor "ignites"
- Reduce the input power to 400 W (Jan) or 80 W (Feb)
- Pump water in at a measured rate and temperature
- Jan: Observe steam output, measure temperature and dryness  
OR  
Feb: Measure the water temperature at the outlet
- Accurately measure the weight of the hydrogen bottle, before and after

## 5. Experiments

### 5.1. January 2011 Experiment

In December 2010 a team of scientists was allowed to examine the device, and performed a number of experiments.

In January 2011 a "press" demonstration was held -- though the reactor developed an internal problem (reportedly on the leads to an internal heating resistor), took a long time to "ignite", and ran at lower efficiency (higher input power).

These two will be referred to as the "January" apparatus and experiment.

The things we know about the January apparatus as a whole are:

- The input power to the controller
- The input water volume and temperature
- The output steam temperature and dryness
- The amount of hydrogen used
- ESTIMATED volumes of the various elements (Villa)  
(These could be confirmed from the photographs).
- A very rough estimate of the weight of the Control Box (Levi)

Villa reported:

The basic observable elements are an horizontal metallic tube (approximate length 70 cm, diameter 20 cm, 22 l volume, 30 kg weight as a guess-estimate) as the reaction chamber, a vertical tube for steam output (50 cm length, 15 cm diameter, 9 l volume), a control system box (approx 40x40x40 cm<sup>3</sup> dimensions, 64 l volume, unknown weight), a water pump and an hydrogen bottle.

Levi reported:

Prudentially I have lifted the control box in search for any other eventually hidden cable and found none. The weight of the control box was of few Kg.

The things we do NOT know about the January apparatus include:

- The contents of the controller
- The power from the controller to the main unit
- The output steam volume
- The weights before and after, other than the hydrogen bottle
- Whether any air was taken in by the device, or combustion products released.

ASSUMING that ALL the water was converted to steam the total OUTPUT energy was computed:

- Heat water to boiling point
- Convert to steam
- Heat the steam

Given the rate of flow, the output power (kW) was calculated, and the INPUT power (kW) to the controller was subtracted.

The volume of the various elements were estimated by [Mauro Villa](#) to be:

- Control Box 60 liters
- Horizontal Arm 22 liters
- Vertical Arm 9 liters

The measured values as summarized in [LENR-CANR News](#) are:

- Duration: 1 hour, of which 30 minutes was steam-producing
- Flow Rate: 17.5 L/Hr (292 ml/min)
- Input Power : 400W
- Excess Power 12.5 kW
- Factor  $12.5/0.4 = 31$
- Excess Energy (Excess Power x Run Time): 6.25 kWh
- Hydrogen: less than 0.1 g of hydrogen was consumed.  
If the hydrogen had been burned it would have produced 0.0143 MJ (0.00397 kWh)

At the press conference Rossi announced that they have a working system providing heating in their own plant (presumably with multiple eCATS), and that he plans to install a 1MW Plant in Athens, Greece in October, 2011.

Reports:

- [Giuseppi Levi](#)
- [Mauro Villa](#)
- [Melich and Macy \(New Energy Times\)](#)    [Melich \(ed by Rothwell\)](#)    [Macy \(N.E.T.\)](#)
- [David Bianchini](#)
- [Francesco Celani](#) and [Celani \(Revised, Gamma burst\)](#)

## 5.2. February 2011 Experiment

The February trial reportedly had the same general structure, except that it was only used to HEAT water, not to convert it to steam.

The primary observer of the February run, Prof Levi, was allowed to examine everything EXCLUDING the reactor chamber, which he estimated to be about 1 liter in volume. He reported that a lot of the volume of the horizontal and vertical arms was insulation, and that lead shielding was visible around the reactor chamber.

NytekNIK.se: [Cold Fusion: 18 hour test excludes combustion](#)

"This time I opened the control unit (and examined the interior), as someone said that it could contain a hidden battery. And I can swear in court that the box was empty, except for the control electronics – five very simple PLCs – and it weighed about seven kilograms," said Levi.

"I have also seen inside the reactor device itself – most of the volume is isolation, and most of the weight of about 30 kg is due to lead."

He confirmed that the reactor chamber, supposedly containing nickel powder, the secret catalysts and hydrogen gas, had a volume of around one liter. The reactor chamber was the only part he could not inspect.

LENR-CANR: [Rossi 18-hour demonstration](#)

On February 10 and 11, 2011, Levi et al. (U. Bologna) performed another test of the Rossi device. Compared to the January 14 test, they used a much higher flow rate, to keep the cooling water from vaporizing. This is partly to recover more heat, and partly because Celani and others criticized phase-change calorimetry as too complicated. There were concerns about the enthalpy of wet steam versus dry steam, and the use of a relative humidity meter to determine how dry the steam was. A source close to the test gave Jed Rothwell the following figures. These are approximations: ....

The things we know about the February apparatus as a whole are:

- The Control Unit and all parts of the Main Unit excluding the reactor were inspected.
- The input power to the controller
- The input water volume and temperature
- The output water temperature
- The amount of hydrogen used
- ESTIMATED volume of the reactor CHAMBER is 1 liter
- ESTIMATED mass of the REACTOR (Levi reports that the mass was 30 kg)

The things we do NOT know about the February apparatus include:

- The power from the controller to the main unit
- The VOLUME of the whole REACTOR.
- The weights before and after, other than the hydrogen bottle
- Whether any air was taken in by the device, or combustion products released.

The values reported by Rothwell are:

- Run Time: 18 hours
- Flow Rate: 3,000 L/h = ~833 ml/s.
- Cooling water input temperature: 15°C
- Cooling water output temperature: ~20°C
- Input power from control electronics: variable, average 80 W, closer to 20 W for 6 hours
- Excess Power 16 kW
- Factor  $16/0.08 = 200$
- Excess Energy (Excess Power x Run Time): 288 kWh
- Hydrogen: less than 0.4 g of hydrogen was consumed.  
If the hydrogen had been burned it would have produced 0.0572 MJ (0.0159 kWh)

However, the some of the values reported in Nyteknik are significantly different (and in favor of Rossi's *eCAT*):

"Minimum power was 15 kilowatts, and that's a conservative value. I calculated it several times. At night we did a measurement and the device then worked very stable and produced 20 kilowatts."

Initially, the temperature of the inflowing water was seven degrees Celsius and for a while the outlet temperature was 40 degrees Celsius. A flow rate of about one liter per second, equates to a peak power of 130 kilowatts. The power output was later stabilized at 15 to 20 kilowatts.

Note : Levi has not released a report of this experiment, and Rossi has declined to comment on it.

This paper uses Rothwell's numbers.

### 5.3. Interlude : Other Information, Feb-March, 2011

Rossi continues to provide a trickle of information (some of it conflicting with previous statements) on his blog [JANUARY 15th FOCARDI AND ROSSI PRESS CONFERENCE](#)

For instance, he now [now indicates that](#) it is not the ELECTRICAL power which modulates the output, but the HYDROGEN:

Our plants of 1 MW are made with series and parallels of 10 kW modules. Our 10 kW modules have been tested from 2 years and we have a deep knowledge of them. If the temperature or the pressure inside the apparatus goes critic we cut the hydrogen supply and cool down the E-Cat increasing the flow of water as much as necessary. Consider that we do not use radioactive materials and we do not produce rad waste, that a single module has a volume of about 1 liter and is very easy to cool down with water. Every module is controlled independently from the others and if one module has to be stopped the others can work.

Through a live interview with NyTeknik Rossi answered a number of questions : [E-cat inventor in live chat with the readers \(+ Video Interview\)](#) and [And here are 36 more questions – with Rossi's answers](#) -- though many of these were not technical in nature.

He recently appeared on a US Radio Program : [Andrea Rossi with Sterling Allan on Coast to Coast AM](#)

There is some evidence that the Hydrogen/Nickel reaction can become self-sustaining, so the ratio of output to input electrical power would become infinite.

Since the February experiment was reported, Rossi has reportedly PAID the University of Bologna €500,000 to investigate and develop the eCat device, and presumably under a non-disclosure agreement: [This is how Rossi is financing his E-cat](#) (this Nyteknik article also gives some background on Rossi). Another Nyteknik interview explores the manufacturing : [Cold Fusion: Here's the Greek company building 1 MW](#)

Rossi has stated that NO experimental results will be published for at least a year.

Since many of the original independent observers are now presumed to be under contract to Rossi, some might question their future impartiality. However, as [Levi noted](#):

"If I were an old professor with his career already done, then I would not have anything to risk. But any attempt at fraud on my part would be a terrible personal goal. What could I hope for? To have a title for ten days, and then be thrown from my own department. Because (the matter of) fraud comes up sooner or later. There is no hope for it. So if I ... well, I would be really stupid. Honestly, I would be really stupid!"

## 5.4. March 2011 Experiment

A new test has been released, with pictures of a smaller 5kW device with and without shielding and insulation.

### [Swedish physicists on the E-cat: "It's a nuclear reaction"](#)

"In some way a new kind of physics is taking place. It's enigmatic, but probably no new laws of nature are involved. We believe it is possible to explain the process with known laws of nature," said Hanno Essén, associate professor of theoretical physics and a lecturer at the Swedish Royal Institute of Technology and chairman of the [Swedish Skeptics Society](#).

The new trial was conducted in much the same way as the trial in January, and lasted for nearly six hours. According to observations by Kullander and Essén, a total energy of about 25 kWh was generated.

### [Experimental test of a mini-Rossi device at the Leonardocorp, Bologna 29 March 2011.](#)

Participants: Giuseppe Levi, David Bianchini, Carlo Leonardi, Hanno Essén, Sven Kullander, Andrea Rossi, Sergio Focardi. Travel report by Hanno Essén and Sven Kullander, 3 April 2011.

Any chemical process for producing 25 kWh from any fuel in a 50 cm<sup>3</sup> container can be ruled out. The only alternative explanation is that there is some kind of a nuclear process that gives rise to the measured energy production.

Some additional comments on this experiment are available at [Alekklett's Energy Mix](#)

## 5.5. Photos



Fig 5

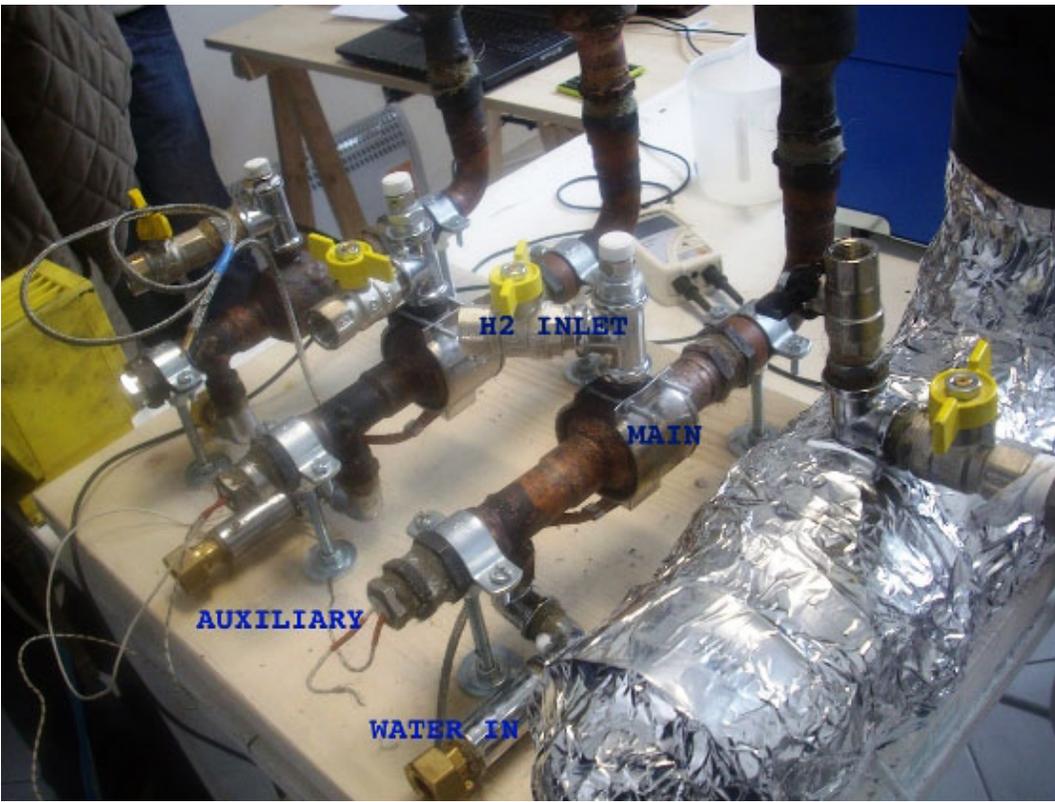


Fig 2



Fig 4



Fig 3

Kullander and Essén report:

During the running we used the rightmost one of the devices, figure 4, which is surrounded by a 2 cm thick lead shield, as stated by Rossi, and wrapped with insulation, figure 5. We had free access to the heater electric supply, to the inlet water hose, to the outlet steam valve and water hose and to the hydrogen gas feed pipe. The total weight of the device was estimated to be around 4 kg.

I read "As stated by Rossi" as "He said so and we believed him" -- not that "he previously stated it and we found it true when we inspected it".

Later in the report they say:

Discussion. Since we do not have access to the internal design of the central fuel container and no information on the external lead shielding and the cooling water system we can only make very general comments.

Nor do they provide a photograph showing the insulation and the lead shield of the horizontal arm.

There is therefore NO proof in the report that the wrapped, horizontal arm contains only equipment identical to the three unwrapped devices.

They DID inspect the vertical arm by unwrapping the insulation (Fig 4), but did NOT inspect the inside of the "chimney".

The complete horizontal arm and the vertical chimney therefore have to be included as "Fake".

They did make one check which WOULD eliminate the Torelli fake (see below).

The 100 °C temperature is reached at 10:42 and at about 10:45 all the water is completely vaporized found by visual checks of the outlet tube ...

However, they do not report that the visual check on the output tube was continuous.

The total volume of the REACTOR was estimated as a sphere:

Reactor Sphere diameter: 7.00 cm  
volume:  $179.59 \text{ cm}^3 = 0.1796 \text{ L}$

Since the horizontal arm was NOT inspected, I have estimated its volume:

Horizontal Arm : cylinder, length: 30.00 cm diameter: 25.00 cm  
volume:  $14725.78 \text{ cm}^3 = 14.7258 \text{ L}$

TODO: estimate the volume of the "steam outlet" section.

The things we know about the March apparatus as a whole are:

- The Control Unit was inspected.
- The input power to the controller
- The power from the controller to the eCat was estimated (The results would not be significantly changed if ALL the input power were sent to the eCat)
- The pressure in the hydrogen bottle.
- The estimated pressure with which the reactor was charged.
- The input water volume and temperature
- The output steam temperature and dryness THROUGH THE INSTRUMENT PORT
- ESTIMATED volume of the Reactor is 0.18 liters (from photos)
- The volume of the wrapped horizontal arm (from photos)
- The volume of the vertical chimney (from photos)
- The mass of the eCat was reported as 4kg -- but it is not clear which parts are included.

The things we do NOT know about the March apparatus include:

- The amount of Hydrogen used
- The VOLUME of the REACTOR CHAMBER -- reported by Rossi to be 50cc
- The weights before and after
- Whether all the water that went in came out as steam (see Tarallo Water Diversion Fake)
- The temperature of the output steam flow OUTSIDE of the eCAT
- Whether any air was taken in by the device, or combustion products released.

The measured values as given in [Experimental test of a mini-Rossi device at the Leonardocorp, Bologna 29 March 2011](#) are:

- Duration: 5 hours 45 minutes was steam-producing
- Flow Rate: 6.47 L/Hr
- Input Power : 300W
- Excess Power 4.39 kW
- Factor  $4.39/0.3 = 14.6$
- Excess Energy (Excess Power x Run Time): 25.2 kWh
- Hydrogen: less than 0.1 g of hydrogen was consumed.  
If the hydrogen had been burned it would have produced 0.0157 MJ (0.00437 kWh)

Note: the amount of hydrogen used was NOT measured. They ACCEPTED Rossi's statement that the central chamber was 50cc. The pressure and mass of hydrogen used could have been used to confirm the volume of the central chamber.

Essen and Kullander consider Nickel and Hydrogen forming Nickel Hydride as a possible fake candidate :

The enthalpy from the chemical formation of nickel and hydrogen to nickel hydride is 4850 joule/mol [6].

But taking the fake as 100% nickel, with EXTERNAL hydrogen, gives an energy density of

Energy by volume : 0.736 MJ/L

which is much lower than other candidates, so I have not used it in an "experiment".

I have included the following in the results below:

- Wrapped Horizontal arm
- External Reactor Volume
- Reactor chamber volume reported by Rossi

Because the horizontal arm was NOT inspected "unwrapped", we have to assume it contained FAKE material. The 6 hour test was NOT long enough to eliminate all of the fakes.

Update April 15, 2011 : Essen and Kullander may be performing another test. [Original Vortex Rossi](#)

Rossi:

Anyway: you will have very soon a report about the same test repeated, with the flow controlled in an “idiot-proof” system... you’ ll see, stay in touch.

## 6. Tarallo Water Diversion Fake

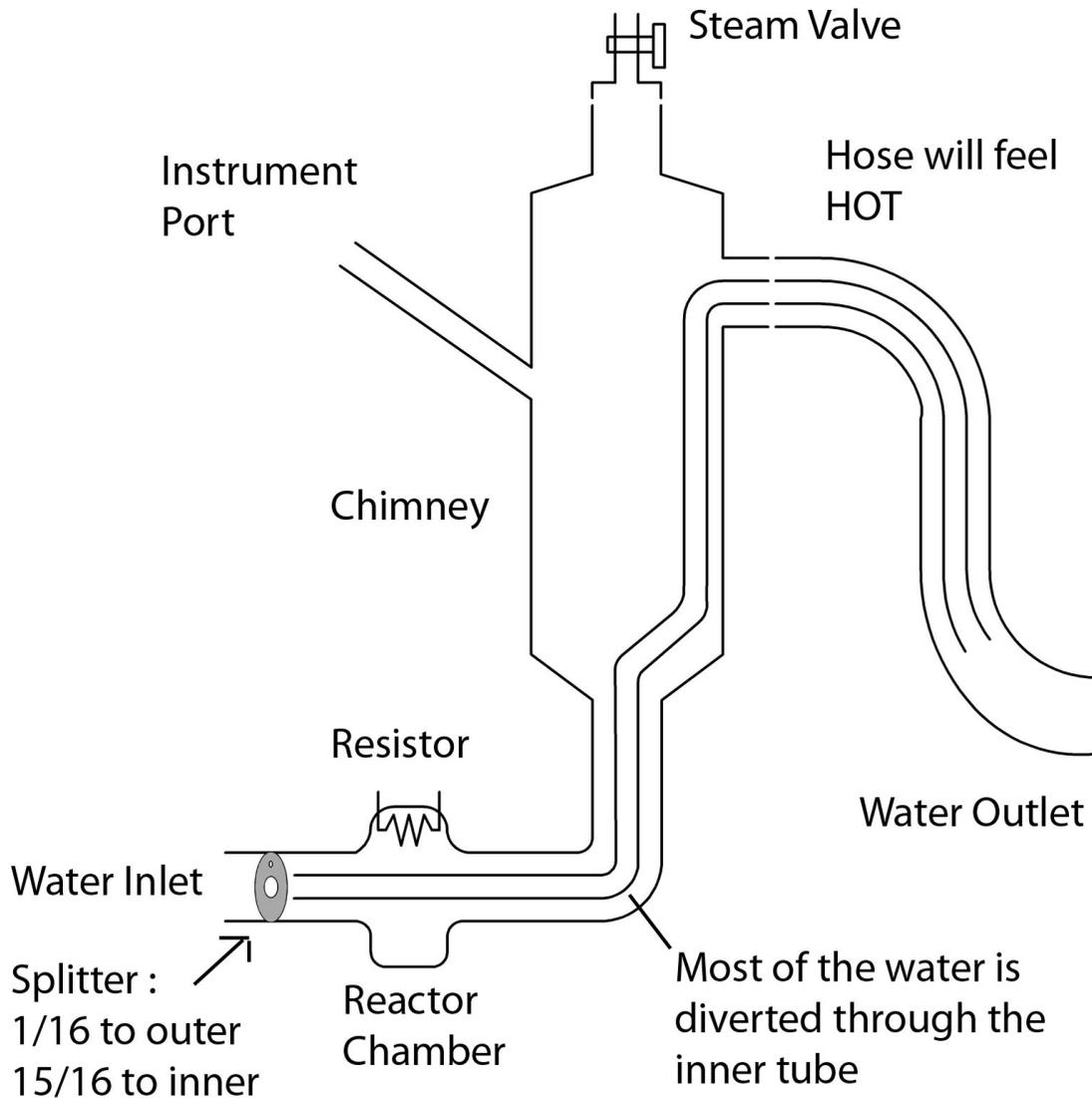
Proposed by : Flavio Tarallo (as reported by Rothwell) : [Vortex](#)

However Flavio Tarallo has proposed an idea that is at least plausible, although highly unlikely in my opinion. He believes the flow of water might be diverted inside the machine, such that one tube leads to the thermocouple and RH meter, and another bypasses them. The flow of water is then joined and it empties out of the end. Let me quote his message describing this:

"The temperature and 'air quality' measurements were taken INSIDE the reactor, (in holes prepared by Rossi) instead at its final output. Nobody could see inside the reactor so there are a lot of possibility. One possibility I thought is that an amount of the water flow have been diverted. One part of the water flow actually goes inside the "hot core", heats and became vapour and another part simply bypass everything in another internal pipe and go directly to the output where it is re-mixed with the first part. Nobody measured the output steam flow or its speed (should be around 74 m/s for 5 g/s flow!!!) The electric power input was sufficient to vaporize the fraction of the water flow that goes into the core and that is measured. With a divertor commanded by a simply thermo-sensor, all can you see from outside is a behaviour like a start of internal energy generation insted it's only the start of a flow fractioning. All this consideration is independent from the honesty of Rossi, there is this possibility so it has to be denied by a new measure (possibly without steam production)."

I do not know if the holes were prepared by Rossi. Anyway, this method would call for a complex set of hidden remote controls, to accommodate observations such as the one that the temperature was higher when input power was reduced from 1000 W to 400 W.

# Tarallo Water Diversion Fake



This is a very serious "unlimited energy" fake. It would possibly not have been detected by the January experiment or the February experiment.

ALL of the measurements in ALL of the experiments were done via the instrument port in the chimney, and would only have measured the temperature and steam dryness in the outer compartment.

The water sent through the "reactor chamber" is simply heated by a resistor, powered from the control box.

The observed "temperature profiles" could easily be accomplished by changing the power sent to the resistor: the connection between the control box and the main unit was NOT measured.

The power loss from the outer HOT section to the inner COLD section is estimated to be about 80W (for a rubber tube 2 cm outer diameter, 1cm inner diameter). This loss would be hidden by diverting more water from the outer to the inner tube, and could be further reduced by the use of insulation.

NEITHER of the following January reports eliminate this fake:

Jacques Dufour also attended the demonstration. He does not speak much Italian, so he could not follow the discussion. He made some observations, including one that I consider important, namely that the outlet pipe was far too hot to touch. That means the temperature of it was over 70°C.

Celani did not see the steam emerge from the end of the pipe, but he reported the whistling sound of steam passing through the pipe. (Dufour did not notice that but he says he is hard of hearing, especially high frequency sounds.) I think there is no question the water boiled, and much of it was vaporized, so there was massive excess heat.

(from [Revised version Celani reports on gamma emission from Rossi device](#))

From the March report :

To the right at the chimney, a black hose of heavy rubber, for high temperatures, carries the hot water/steam to the sink on the wall of the adjacent room. .... We had free access to the heater electric supply, to the inlet water hose, to the outlet steam valve and water hose and to the hydrogen gas feed pipe.

The following was presumably done through either the instrument port or the steam valve -- both of which connect to the OUTER (hot) section of the Torelli fake.

Between 11:00 and 12:00 o'clock, control measurements were done on how much water that had not evaporated. The system to measure the non-evaporated water was a certified Testo System, Testo 650, with a probe guaranteed to resist up to 550°C.

If this visual check was made at the sink in the "adjacent room" then it WOULD eliminate the Torelli fake.

The 100 °C temperature is reached at 10:42 and at about 10:45 all the water is completely vaporized found by visual checks of the outlet tube ...

This test at the steam valve would NOT eliminate the Torelli fake:

... and the valve letting out steam from the chimney.

Future experiments : all measurements must be conducted OUTSIDE of the Rossi Device, not through the "instrument port".

## 7. Methodology for FAKE eCATS and their Detection

As Villa reported:

In the present test, as a precautionary attitude, whatever was not known, not disclosed or not understood has been considered as the energy source.

....

The duration of the tests would be directly proportional to the mass and volume of unknown origin.

The general methodology for Batteries and Chemicals is:

- Choose some kind of FAKE (eg batteries)
- Presume that the ENTIRE unknown structure is made up of the Fake material.
- Make NO allowances for implementation efficiency.
- Make NO allowance for practicality (the material or combustion products might be fatally toxic: the required equipment would be impossibly small).
- Use the energy density (by weight or by volume) to determine the MAXIMUM energy content of the fake.
- Using the observed excess POWER (kW) of the system, determine how long you would have to run it to exhaust the energy.
- If that time is LESS than the observed run time, then the FAKE is eliminated.

For "Unlimited Energy" methods the evaluation as a "black box" becomes more difficult, but generally requires more attention to closing loopholes.

Some kinds of fake could also be detected by analyzing the output:

- Analyze the chemical composition of the output, to make sure no 'combustion' products are hidden
- Make sure that all the water which goes IN goes OUT
- Make all measurements OUTSIDE of the eCAT, so that methods which involve water Diversion are eliminated.
- Make sure that all the water which goes IN goes OUT
- Weigh the device before and after, to see whether chemicals have been consumed, or combustion products stored

... but see *Rothwell's Razor*, below.

Rothwell [argues](#) that some kinds of fakes would have been NOTICED by the observers (For example, if Diesel fuel were burned, there would be copious, fatally asphyxiating fumes --- though in the January experiment they could theoretically have been piped out of the room in the steam pipe.). However, this paper takes an extremely conservative position, distinguishing between "not NOTICED" and "tested and NOT FOUND":

- Anything which is not TESTED must be ruled in favor of the FAKE.

If both the Volume AND the weight are known, then calculate the maximum run time for both, and use the LOWER number.

These calculations assume that the experiment is run at constant power for the duration of the experiment, although during the February test there were reports that it produced 130 kW for short periods. In this case one would compare the total energy output of the fake and the measured values : it is not as easy to predict the time required to eliminate the fake.

If all fakes are eliminated, then, As Sherlock Holmes said -- again and again -- this time in *The Sign of the Four*:

"You will not apply my precept," he said, shaking his head. "How often have I said to you that when you have eliminated the impossible whatever remains, however improbable, must be the truth?"

## 8. Organization

First, we define the Equipment Sections, giving the weight and volume.

Section	Abrev	Mass	Volume
		kg	L
Section Name 1	SEC-1	11.000	12.000
Section Name 2	SEC-2	21.000	22.000
Section Name 3	SEC-3	31.000	32.000

Then we define various "Fake Materials" which could be used.

Material	Abrev	Energy by Mass		Energy by Volume		Comment
		MJ/kg	kWH/kg	MJ/L	kWH/L	
Material 1	MAT-1	12.300	3.417	45.600	12.667	

Finally, we construct "Experiments", in which we put various materials in the sections of the unit (presently fixed at three sections), note the *POWER* that the experiment produced, and the *TIME* it ran for.

We calculate and add up the total *ENERGY* that the sections could contain, and calculate how long the *FAKE* could run at the observed *POWER* level.

If the *FAKE* could run *LONGER* than the actual experiment, then it is *NOT* eliminated.

If the *FAKE* only runs *SHORTER* than the actual experiment, then it is *ELIMINATED*.

Experiment 1 : All sections contain MAT-1							
Section	SEC-1	SEC-2	SEC-3	Fake Energy	Expt Power	FAKE?	
Material	MAT-1	MAT-1	MAT-1			Fake	Expt
Energy	152 kWH	279 kWH	405 kWH	836 kWH	10.0 kW	83.6 Hrs	0.500 Hrs
Fake can run longer than the experiment: fake is NOT eliminated							

Experiment 2 : Only SEC-2 contain MAT-1							
Section	SEC-1	SEC-2	SEC-3	Fake Energy	Expt Power	REAL	
Material	-	MAT-1	-			Fake	Expt
Energy		279 kWH		279 kWH	16.0 kW	17.4 Hrs	18.0 Hrs
Fake cannot run as long as the experiment -- Fake is eliminated							

## 9. Equipment Sections

### 9.1. Control Box

Villa reported the volume as 60 liters.

In January Levi reported its weight as "a few kg".

In February Levi looked inside the control box, and reports its weight as 7 kg

Section	Abrev	Mass	Volume
		kg	L
Control Box	Ctrl	7.000	60.000

### 9.2. Horizontal Arm

The weight is unknown -- estimated by Villa as 30 kg

Villa reported the volume as 22 liters.

Levi reported in February that much of the volume is insulation.

Section	Abrev	Mass	Volume
		kg	L
Horizontal Arm	Horz	-	22.000

### 9.3. Vertical Arm

The weight is unknown.

Villa reported the volume as 9 liters.

Levi reported in February that there are no hidden components.

Section	Abrev	Mass	Volume
		kg	L
Vertical Arm	Vert	-	9.000

### 9.4. Reactor

In February Levi reported:

- The mass of the reactor is 30 kg, and that most of that is lead.
- The volume of the Reactor *CHAMBER* is 1 liter, but did not give not the volume of the *REACTOR* as a whole.

Pending further information, this paper *ASSUMES* that the volume of the reactor as a whole is *HALF* the volume of the Horizontal Arm

Section	Abrev	Mass	Volume
		kg	L
Reactor	React	30.000	11.000
Reactor Chamber	Chamber	-	1.000

## 9.5. March Components

Section	Abrev	Mass	Volume
		kg	L
Horizontal Arm	Horz	-	14.726
Vertical Arm	Vert	-	-
Reactor	React	-	0.180
Reactor Chamber	Chamber	-	0.050

## 10. Batteries and Chemicals

This section describes various techniques and materials which could be possibly used to construct a fake.

The materials are selected from Wikipedia [Energy Density](#)  
(Unfortunately not all entries give the Energy by volume AND by weight.)

The Wiki table gives the Energy Density for some materials, assuming that oxygen is obtained from an external source. If the oxidant also has to be stored, then the Energy Density is reduced in proportion to the mass or volume of the two components. These calculations are shown in a separate section.

The materials selected represent the highest efficiency for any class.

These all have the characteristic that they contain a fixed amount of energy, and can therefore only run for a limited time. A fake made from batteries or chemicals simply has to be run for long enough to exhaust the material.

Batteries could be contained in the Control Box, and in the Main Unit.

### 10.1. Lithium Ion Batteries

Lithium-Ion batteries are listed as the most efficient by volume.

(Lead-Acid batteries are listed for comparison.)

Material	Abrev	Energy by Mass		Energy by Volume		Comment
		MJ/kg	kWH/kg	MJ/L	kWH/L	
Lead-Acid Batteries	Lead B	0.140	0.039	0.360	0.100	
Lithium-Ion Batteries	L-i B	0.720	0.200	3.600	1.000	

Lithium-Sodium batteries are listed as a higher Energy Density by Mass -- but the volume is not given.

## 10.2. Hydrogen Fuel Cell

This method uses a Hydrogen Fuel Cell, which could deliver electric power from the Control Box to the Main Unit.

It could use compressed or liquid Hydrogen, in conjunction with external air, compressed Oxygen or liquid oxygen.

Material	Abrev	Energy by Mass		Energy by Volume		Comment
		MJ/kg	kWH/kg	MJ/L	kWH/L	
Compressed Hydrogen/External Air Fuel Cell	CH/Air-FC	143.000	39.723	5.600	1.556	
Liquid Hydrogen/External Air Fuel Cell	LH/Air-FC	143.000	39.723	10.100	2.806	
Compressed Hydrogen/Compressed Oxygen Fuel Cell	CH/CO-FC	15.990	4.442	3.734	1.037	
Liquid Hydrogen/Liquid Oxygen Fuel Cell	LH/LO-FC	15.990	4.442	3.748	1.041	

Comments : the by-product is water, which could be vented, or, if burned with oxygen, condensed and stored.

## 10.3. Hydrogen burned with Air or Oxygen

This could be used in the main unit only.

This method burns compressed or liquid Hydrogen with external air, compressed Oxygen or Liquid Oxygen

Material	Abrev	Energy by Mass		Energy by Volume		Comment
		MJ/kg	kWH/kg	MJ/L	kWH/L	
Compressed Hydrogen/External Air	CH/Air	143.000	39.723	5.600	1.556	
Liquid Hydrogen/External Air	LH/Air	143.000	39.723	10.100	2.806	
Compressed Hydrogen/Compressed Oxygen	CH/CO	15.990	4.442	3.734	1.037	
Liquid Hydrogen/Liquid Oxygen	LH/LO	15.990	4.442	3.748	1.041	

Comments : the by-product is water, which could be vented into the outlet, or, if burned with oxygen, condensed and stored.

## 10.4. Diesel burned with Air

Material	Abrev	Energy by Mass		Energy by Volume		Comment
		MJ/kg	kWH/kg	MJ/L	kWH/L	
Diesel/Air	Dsl/Air	46.200	12.833	37.300	10.361	

The Wiki Energy density table indicates that diesel has a slightly higher energy content than gasoline.

Diesel or Gasoline would produce large quantities of fumes, which would be very hard to hide from observers. It might be possible to vent it into the steam outlet.

## 10.5. Boron burned with Air or Oxygen

This method uses Boron, burned with external air, compressed Oxygen or Liquid Oxygen, forming solid Boron Trioxide, which can remain in the unit.

Material	Abrev	Energy by Mass		Energy by Volume		Comment
		MJ/kg	kWH/kg	MJ/L	kWH/L	
Boron/External Air	B/Air	58.900	16.361	137.800	38.278	
Boron/Compressed Oxygen	B/CO	18.293	5.081	16.131	4.481	
Boron/Liquid Oxygen	B/LO	18.293	5.081	23.345	6.485	

Boron is hard to ignite in air. Even in Oxygen it has to be raised to a high temperature. It is not clear whether non-toxic, glassy Boron Trioxide is formed by burning, or whether toxic BO and BO<sub>2</sub> compounds are formed.

It might only be feasible to burn powdered Boron : we assume that solid Boron is used.

## 10.6. Aluminum burned with Air or Oxygen

This method uses Aluminum, burned with external air, compressed Oxygen or Liquid Oxygen, forming oxides, which can remain in the unit.

Aluminum is easier to ignite than Boron.

Its energy density is less than Boron, so it would be easier to detect. As with Boron, it might only burn in powdered form.

## 10.7. Beryllium burned with Air or Oxygen

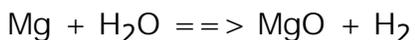
This method uses Beryllium, burned with external air, compressed Oxygen or Liquid Oxygen, forming oxides, which can remain in the unit.

Beryllium is easier to ignite than Boron, but both Beryllium and its combustion products are extremely toxic.

## 10.8. Magnesium and Steam

### Reactions of Metals and Water

Magnesium combines with STEAM to produce Magnesium Oxide and Hydrogen.



The hydrogen can then be burned with Air or Oxygen to produce water.

An initial amount of water can be boiled using the internal resistors, and then the resultant steam can be recycled.

Material	Abrev	Energy by Mass		Energy by Volume		Comment
		MJ/kg	kWH/kg	MJ/L	kWH/L	
Magnesium/Steam	Mg/Steam	24.884	6.912	43.248	12.013	
Mg/Steam/O2	Mg/Steam/O2	14.930	4.147	21.581	5.995	

## 10.9. Explosives

One might expect that Explosives would contain a lot of energy. In fact, most of them do not. For instance, Nitroglycerine only contains 10 MJ/L, compared to Boron/External Air, which has 138 MJ/L. They just release their energy very quickly.

## 10.10. Compressed or Liquid Hydrogen and Oxygen

These ABSORB energy when decompressed or evaporated. It is presumed that this is obtained from the ambient air.

## 10.11. Previously Unknown Chemical Reactions

Rossi has indicated that the reactor chamber has to be re-charged every six months.

A chemical reaction which can produce 10kW for 18 hours (let alone 6 months) would be as big a break-through in Chemistry as a LENR device would be in Physics.

## 10.12. Other suggested fakes (Pending analysis)

This section lists fakes which have been suggested by readers, but which have not yet been evaluated.

- Krzysztof Dydak : The reactor could contain Raney Nickel/air fuel cell fed with hydrazine dissolved in water with caustic.

## 11. Other Fixed-Energy Methods

### 11.1. Pre-loaded Heat Sink

Proposed By : Rothwell ([Rossi credibility](#))

The entire volume is composed of a material with high specific heat.

See [Heat capacity](#), which has an entry for Volumetric Heat Capacity  $J \cdot cm^{-3} \cdot K^{-1}$

Material	Specific Heat	Maximum Temperature	Minimum Temperature	MJ/Liter	Comments
Water	4.21	100	14	0.36206	Boils
Be	3.38	1287	14	4.30274	Melts. Poisonous
Iron	3.53	1538	14	5.37972	Melts
Lead	1.44	327.46	14	0.4513824	Melts

Beryllium and Iron are selected for their high specific heat values. Water and lead are included because they are known to be constituents of the main unit.

These values are loaded into a material table:

Material	Abrev	Energy by Mass		Energy by Volume		Comment
		MJ/kg	kWH/kg	MJ/L	kWH/L	
SPH Water	SPH Water	-	-	0.362	0.101	
SPH Be	SPH Be	-	-	4.303	1.195	
SPH Iron	SPH Iron	-	-	5.380	1.494	
SPH Lead	SPH Lead	-	-	0.451	0.125	

Note that the heat capacity might also explain "heat after death", when the output power continues after the inputs are turned off.

This fake must be entirely contained in the main body of the apparatus.

The upper temperatures are set to the boiling point of water, or for other materials, their melting point.

## 11.2. Input Water Diverted into Storage

Proposed by : Rothwell [Vortex](#) and [Vortex](#)

The water which is pumped INTO the system is NOT all sent into the heat exchanger, but some is diverted into storage.

The volume of the machine is much smaller than the 18 liters of water injected into it over the course of an hour. There is no place inside it to hide the water. The fact that it is a black box does not reduce the certainty of this particular factor in any way.

He said he did not look at the end of the hose in the sink in the bathroom, but he did note that it was making a lot of noise from steam. I think any noise rules out the "diverted water stream" hypothesis. It is a distinct noise, after all, and a flow of 0.3 L per minute of warm water makes no noise at all at the end of the hose.

For example, if the observed output power is 10 times the input power, and only 1/10 the water is converted to steam then the apparent output will be FAKE. It can run until the diverted 9/10 of the water fills the reservoir.

As an UPPER limit, presume that the ENTIRE flow is diverted.

Maximum run time = volume / flow\_rate

	Sections	Volume (liters)	Flow (liters/hr)	Time to Fill (Hrs)
Jan	Horz and Vert	31.00	17.50	1.77
Feb	Horz	22.00	3000.00	0.01
Mar	Horz	14.73	6.47	2.28

## 12. Unlimited-Energy Methods

These have the characteristic that they can run for an unlimited time.

Instead of calculating how long they could run, one has to calculate what is needed to produce the observed power.

### 12.1. Hidden Wires or Tubes

It has been suggested that hidden wires could have provided the observed power (Rothwell: [Hidden wire hypothesis redux](#)). This can only be eliminated by inspecting the apparatus.

Similarly, a small tube could supply gas to the unit (Rothwell: [Vortex List](#)) --- although other methods might detect this (change of weight, imbalance between input and output volumes).

The January experiment was fully open to inspection. There were clearly no hidden wires capable of carrying 10kW or any tubes.

### 12.2. Heat Pump

*KitemanSA* [on the polywell forum](#) suggested that a [heat pump](#) could have provided the observed power.

If these numbers are true, then even with a perfect heat pump, the output power (given max Coefficient of Performance and 80W input) could only be ~4.6kW.

$$\text{CoP} \sim T/\Delta T \sim 300/5 = 60$$
$$60 * 80 = 4800 = 4.6\text{kW}$$

So unless there is significant measurement error or fraud, this isn't a heat pump device either.

Actually...

if the room was at typical room temperature, which is ~21 °C, the theoretical CoP would be infinite, so it COULD be a fancy heat pump.

The Wiki article indicates that the maximum CoP in a Carnot Cycle might be as low as 12.5

The January experiment would have needed a CoP of 31, and the February experiment would need 200.

A theoretical, infinite-CoP heat pump could probably only be ruled out by enclosing the entire Main Unit in a calorimeter. If this were filled with Nitrogen, it would also rule out any method using Air as a fuel.

### 12.3. Nuclear : Plutonium 238

One gram of [Plutonium 238](#) generates approximately 0.5 watts of power.

Material	Abrev	Power by Mass kW/kg	Power by Volume kW/L	Specific gravity
Plutonium 238	Pu238	0.500	0.000	0.000

To produce 10 kW of power one would need 5.00 kg of Pu 238.

Since 1993, all of the plutonium-238 the U.S. has used in space probes has been purchased from Russia. 16.5 kilograms in total have been purchased.

For the proposed 1 MW unit, one needs 500.00 kg -- more than was acquired by NASA.

Note : the Wiki Energy Density value is very high : it is probably the total energy emitted until the Plutonium is effectively depleted.

### 12.4. Reduced Water Intake

Proposed by : XXX on Randi forum and Dr D R Jones on [Alek Lett Blog](#)

Since the flow wasn't monitored continually, the water intake could have been cut off or reduced.

Dr D R Jones : Now if this is simply a hoax then it would have been relatively simple to carry out given the observations above. Instead of an internal heater, substitute a water flow valve (the wires are in the correct place). Let the external 300W heater heat the initial water flow up to 60 Celsius – then get peoples attention by stating that they should watch the computer as the reaction is initializing – then simply close the flow valve so that the water flow is greatly reduced – the insulated device and the 300W external resistor will do the rest. Thus the question to be asked – did either Essen or Kullander monitor the water flow during this transition from flowing water to steam generation?

### 12.5. Accidental Water Diversion Through the eCat

Proposed by : Peter van Noorden ([vortex](#))

Further it would be interesting to know if water can flow through the "chimney" of the reactor directly into the black tube. To figure out what is going on one have to add a substance (dye) to the water and see if the dye can be seen in the " condensed" water.

If non vaporised water is carried to the end of the black tube this will have consequences for the calculation of excess heat.

Rothwell and Stephen A. Lawrence discuss this problem at [vortex](#)

## 12.6. Input Electrical Power

Proposed by : YYYY on Randi forums

A high-frequency component on the power input could give a false power reading.

Solution: monitor the input power with an oscilloscope.

However, since the control wires cannot handle the required 12kW a false reading wouldn't affect the result.

## 12.7. Combustible "Water"

Proposed by : Jones Beene [Vortex](#)

The water supply is not, in fact, water, but a combustible liquid which looks like water.

In the category of clear water-based liquids which burn cleanly enough to be used indoors, and which could be confused with water in a testing arrangement (since it would be so unexpected as the 'trick' used to pull-off the deception) - there are several choices.

These are miscible and with 40-50% water and the resultant blend would be combustible at that dilution level - would go undetected by a group of observers who assumed that it was water. All of these ingredients would be expected to be legitimately found in any company which produces or evaluates alternative fuels - and if the ruse was discovered prematurely . "oops, Igor, you brought in the wrong container," or else "yes, our municipal water is very polluted here".

...

Hydrogen peroxide produces only steam. HOOH is more viscous than water, but appears colorless in solution. It is both an oxidant an a propellant. When used in a blend, it would provide free oxygen and steam, so that air is not needed to combust the other ingredients (or less is needed).

...

## 12.8. Pump Power and Friction

Suggested by : Jones Beene [Vortex](#)

The initial suggestion was that the pump power should be included in the energy budget, as it inputs power into the system:

Jones Beene: The pump's power must be included in P-in.

A liter/sec pump seems to require one horsepower or about .75 kW.

### [223.00-3 Fluid Mechanics - Course 223 FRICTION IN FLUID FLOW](#)

Robin van Spaandonk: If we assume 100 psi for the mains pressure, then a flow rate of 1 L /s equates to a total power of 724 W, assuming all the power in the water gets used. This would raise the temperature of that water by 0.173 °C, so it would at most make a 4% difference, even if it were all included.

In the extreme:

Jones Beene: Allow me to apply reductio ad absurdum to this situation.

Let's say Rossi shows up with a reactor that puts out one megawatt of heat. It requires a large flow of water, which is coming from a local dam and goes into a sewer. This new reactor requires no electrical input at all !! The heat is measured by a thermal circuit that removes heat from the stainless steel reactor, and the new owners of this magical device use it to heat the factory. It remains warm all year without any electricity !

Let's say the device is opened up and found to contain nothing but flow constrictors - which convert water pressure into heat via friction - nothing else.

Is Rossi entitled to claim that the megawatt of heat is "overunity" and therefore free energy ?

(To do : calculate the resistive heating for the given flows, both for the nominal pipe thickness, and where the available area is divided into many smaller tubes)

However, this discussion did lead to another proposal for a "real" energy catalyzer: see the next section.

## 12.9. Magnetostriction and Cavitation

Suggested by : Jones Beene [Vortex](#)

...

The Hydro-Dynamics pump employed cavitation and shock waves from a dimpled rotor spinning inside a housing to increase the temperature of water flowing through the device. It was tested on a number of occasions to be OU, but not reliably. Jed Rothwell has reported on it, as did *Infinite Energy*. Now - imagine the rotor being non-rotating !

Cavitation in the Rossi device could be described as Griggs pump - with the reactor substituted for the dimpled rotor. The reactor cavitates violently, but at low excursion, and would not be noticed in a demo, since the effects are dampened by the water flow. Primarily, it produces cavitation INSIDE the cell, and ironically this would never have been noticed outside the cell except for contrasting the two tests in Bologna, one with low water flow, and one with high. This could be a most fortuitous discovery for anyone working on a replication.

...

The reactor containing the nanopowder would function like a humming transformer core and it could also operate internally with shock waves pushing hydrogen into Casimir cavities. As in the Griggs pump, cavitation generates shock waves which convert mechanical energy into acceleration and eventually into heat energy - in a way that is gainful at times. The Rossi reactor is apparently gainful all of the time, and that could be due to the employment of nano geometry. Many of the common transducers used for sonochemistry are magnetostrictive instead of piezoelectric, as these are more robust at high input. The efficiency is very high.

It is too much of a coincidence that the reactor loses its heating effect at a temperature which coincides with the Curie point of nickel, and is more robust when more heat is removed by higher water flow; not to mention that the "resistors" have a magnetic field. An interesting point is that the inventor may have discovered this inadvertently and never thought to optimize the input power, which should be easier to do via an inductive coil instead of resistance heaters.

...

## 13. Theoretical Experiments -- FAKES by VOLUME

For each type of fake, various "experiments" are defined, with individual sections loaded with fake materials.

For each combination of materials, a number of experiments are evaluated:

- The January Power and Duration, with ALL sections, including the Control Box, filled with fake material
- The January Power and Duration, with the Main Unit filled with fake material. Levi's statement that the control box "weighed a few kg" and therefore cannot contain fake material, is accepted.
- The February Power and Duration, with the Horizontal Arm filled with fake material. Levi's statements about the control box and the vertical arm are accepted.
- The February Power and Duration, with an ESTIMATE of the volume of the whole reactor.
- The March Power and Duration, with the Horizontal Arm filled with fake material.
- The March Power and Duration, with an ESTIMATE of the volume of the whole reactor.

### 13.1. Lithium Ion Batteries

Control Box: Lithium-Ion Batteries Main Unit: Lithium-Ion Batteries							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	FAKE?	
Material	L-i B	L-i B	L-i B			Fake	Expt
Energy	60.0 kWh	22.0 kWh	9.00 kWh	91.0 kWh	10.0 kW	9.10 Hrs	0.500 Hrs
January with ALL sections							
Main Unit: Lithium-Ion Batteries							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	FAKE?	
Material	-	L-i B	L-i B			Fake	Expt
Energy		22.0 kWh	9.00 kWh	31.0 kWh	10.0 kW	3.10 Hrs	0.500 Hrs
January with MAIN unit -- excluding Control Box							
Horizontal Arm: Lithium-Ion Batteries							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	REAL	
Material	-	L-i B	-			Fake	Expt
Energy		22.0 kWh		22.0 kWh	16.0 kW	1.38 Hrs	18.0 Hrs
February with HORIZONTAL unit							
Reactor: Lithium-Ion Batteries							
Section	Ctrl	React	Vert	Fake Energy	Expt Power	REAL	
Material	-	L-i B	-			Fake	Expt
Energy		11.0 kWh		11.0 kWh	16.0 kW	0.688 Hrs	18.0 Hrs
February with ESTIMATED reactor volume							
Horizontal Arm: Lithium-Ion Batteries							
Section	Horz	React	Vert	Fake Energy	Expt Power	REAL	
Material	L-i B	-	-			Fake	Expt
Energy	14.7 kWh			14.7 kWh	4.39 kW	3.35 Hrs	5.75 Hrs
March with HORIZONTAL unit							
Reactor: Lithium-Ion Batteries							
Section	Horz	React	Vert	Fake Energy	Expt Power	REAL	
Material	-	L-i B	-			Fake	Expt
Energy		0.180 kWh		0.180 kWh	4.39 kW	0.0409 Hrs	5.75 Hrs
March with ESTIMATED reactor volume							
<b>FAKE?</b> means that the fake could run longer than the experiment, and is NOT eliminated <b>REAL</b> means that the fake is ELIMINATED by an experiment, so the device could be REAL							

## 13.2. Hydrogen

Controller contains a Hydrogen Fuel Cell, Main unit burns Hydrogen.

Liquid Hydrogen and external Air are the most favorable for a fake.

Control Box: Liquid Hydrogen/External Air Fuel Cell Main Unit: Liquid Hydrogen/External Air							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	FAKE?	
Material	LH/Air-FC	LH/Air	LH/Air			Fake	Expt
Energy	168 kWh	61.7 kWh	25.3 kWh	255 kWh	10.0 kW	25.5 Hrs	0.500 Hrs
January with ALL sections							
Main Unit: Liquid Hydrogen/External Air							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	FAKE?	
Material	-	LH/Air	LH/Air			Fake	Expt
Energy		61.7 kWh	25.3 kWh	87.0 kWh	10.0 kW	8.70 Hrs	0.500 Hrs
January with MAIN unit -- excluding Control Box							
Horizontal Arm: Liquid Hydrogen/External Air							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	REAL	
Material	-	LH/Air	-			Fake	Expt
Energy		61.7 kWh		61.7 kWh	16.0 kW	3.86 Hrs	18.0 Hrs
February with HORIZONTAL unit							
Reactor: Liquid Hydrogen/External Air							
Section	Ctrl	React	Vert	Fake Energy	Expt Power	REAL	
Material	-	LH/Air	-			Fake	Expt
Energy		30.9 kWh		30.9 kWh	16.0 kW	1.93 Hrs	18.0 Hrs
February with ESTIMATED reactor volume							
Horizontal Arm: Liquid Hydrogen/External Air							
Section	Horz	React	Vert	Fake Energy	Expt Power	FAKE?	
Material	LH/Air	-	-			Fake	Expt
Energy	41.3 kWh			41.3 kWh	4.39 kW	9.41 Hrs	5.75 Hrs
March with HORIZONTAL unit							
Reactor: Liquid Hydrogen/External Air							
Section	Horz	React	Vert	Fake Energy	Expt Power	REAL	
Material	-	LH/Air	-			Fake	Expt
Energy		0.504 kWh		0.504 kWh	4.39 kW	0.115 Hrs	5.75 Hrs
March with ESTIMATED reactor volume							
<b>FAKE?</b>	means that the fake could run longer than the experiment, and is NOT eliminated						
<b>REAL</b>	means that the fake is ELIMINATED by an experiment, so the device could be REAL						

## Compressed Hydrogen, External Air

Control Box: Compressed Hydrogen/External Air Fuel Cell Main Unit: Compressed Hydrogen/External Air							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	FAKE?	
Material	CH/Air-FC	CH/Air	CH/Air			Fake	Expt
Energy	93.3 kWh	34.2 kWh	14.0 kWh	142 kWh	10.0 kW	14.2 Hrs	0.500 Hrs
January with ALL sections							
Main Unit: Compressed Hydrogen/External Air							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	FAKE?	
Material	-	CH/Air	CH/Air			Fake	Expt
Energy		34.2 kWh	14.0 kWh	48.2 kWh	10.0 kW	4.82 Hrs	0.500 Hrs
January with MAIN unit -- excluding Control Box							
Horizontal Arm: Compressed Hydrogen/External Air							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	REAL	
Material	-	CH/Air	-			Fake	Expt
Energy		34.2 kWh		34.2 kWh	16.0 kW	2.14 Hrs	18.0 Hrs
February with HORIZONTAL unit							
Reactor: Compressed Hydrogen/External Air							
Section	Ctrl	React	Vert	Fake Energy	Expt Power	REAL	
Material	-	CH/Air	-			Fake	Expt
Energy		17.1 kWh		17.1 kWh	16.0 kW	1.07 Hrs	18.0 Hrs
February with ESTIMATED reactor volume							
Horizontal Arm: Compressed Hydrogen/External Air							
Section	Horz	React	Vert	Fake Energy	Expt Power	REAL	
Material	CH/Air	-	-			Fake	Expt
Energy	22.9 kWh			22.9 kWh	4.39 kW	5.22 Hrs	5.75 Hrs
March with HORIZONTAL unit							
Reactor: Compressed Hydrogen/External Air							
Section	Horz	React	Vert	Fake Energy	Expt Power	REAL	
Material	-	CH/Air	-			Fake	Expt
Energy		0.279 kWh		0.279 kWh	4.39 kW	0.0636 Hrs	5.75 Hrs
March with ESTIMATED reactor volume							
<b>FAKE?</b> means that the fake could run longer than the experiment, and is NOT eliminated <b>REAL</b> means that the fake is ELIMINATED by an experiment, so the device could be REAL							

## Compressed Hydrogen, Compressed Oxygen

Control Box: Compressed Hydrogen/Compressed Oxygen Fuel Cell Main Unit: Compressed Hydrogen/Compressed Oxygen							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	FAKE?	
Material	CH/CO-FC	CH/CO	CH/CO			Fake	Expt
Energy	62.2 kWh	22.8 kWh	9.34 kWh	94.4 kWh	10.0 kW	9.44 Hrs	0.500 Hrs
January with ALL sections							
Main Unit: Compressed Hydrogen/Compressed Oxygen							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	FAKE?	
Material	-	CH/CO	CH/CO			Fake	Expt
Energy		22.8 kWh	9.34 kWh	32.2 kWh	10.0 kW	3.22 Hrs	0.500 Hrs
January with MAIN unit -- excluding Control Box							
Horizontal Arm: Compressed Hydrogen/Compressed Oxygen							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	REAL	
Material	-	CH/CO	-			Fake	Expt
Energy		22.8 kWh		22.8 kWh	16.0 kW	1.43 Hrs	18.0 Hrs
February with HORIZONTAL unit							
Reactor: Compressed Hydrogen/Compressed Oxygen							
Section	Ctrl	React	Vert	Fake Energy	Expt Power	REAL	
Material	-	CH/CO	-			Fake	Expt
Energy		11.4 kWh		11.4 kWh	16.0 kW	0.713 Hrs	18.0 Hrs
February with ESTIMATED reactor volume							
Horizontal Arm: Compressed Hydrogen/Compressed Oxygen							
Section	Horz	React	Vert	Fake Energy	Expt Power	REAL	
Material	CH/CO	-	-			Fake	Expt
Energy	15.3 kWh			15.3 kWh	4.39 kW	3.48 Hrs	5.75 Hrs
March with HORIZONTAL unit							
Reactor: Compressed Hydrogen/Compressed Oxygen							
Section	Horz	React	Vert	Fake Energy	Expt Power	REAL	
Material	-	CH/CO	-			Fake	Expt
Energy		0.186 kWh		0.186 kWh	4.39 kW	0.0424 Hrs	5.75 Hrs
March with ESTIMATED reactor volume							
<b>FAKE?</b> means that the fake could run longer than the experiment, and is NOT eliminated <b>REAL</b> means that the fake is ELIMINATED by an experiment, so the device could be REAL							

## Liquid Hydrogen, Liquid Oxygen

Control Box: Liquid Hydrogen/Liquid Oxygen Fuel Cell Main Unit: Liquid Hydrogen/Liquid Oxygen							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	FAKE?	
Material	LH/LO-FC	LH/LO	LH/LO			Fake	Expt
Energy	62.5 kWh	22.9 kWh	9.37 kWh	94.7 kWh	10.0 kW	9.47 Hrs	0.500 Hrs
January with ALL sections							
Main Unit: Liquid Hydrogen/Liquid Oxygen							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	FAKE?	
Material	-	LH/LO	LH/LO			Fake	Expt
Energy		22.9 kWh	9.37 kWh	32.3 kWh	10.0 kW	3.23 Hrs	0.500 Hrs
January with MAIN unit -- excluding Control Box							
Horizontal Arm: Liquid Hydrogen/Liquid Oxygen							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	REAL	
Material	-	LH/LO	-			Fake	Expt
Energy		22.9 kWh		22.9 kWh	16.0 kW	1.43 Hrs	18.0 Hrs
February with HORIZONTAL unit							
Reactor: Liquid Hydrogen/Liquid Oxygen							
Section	Ctrl	React	Vert	Fake Energy	Expt Power	REAL	
Material	-	LH/LO	-			Fake	Expt
Energy		11.5 kWh		11.5 kWh	16.0 kW	0.716 Hrs	18.0 Hrs
February with ESTIMATED reactor volume							
Horizontal Arm: Liquid Hydrogen/Liquid Oxygen							
Section	Horz	React	Vert	Fake Energy	Expt Power	REAL	
Material	LH/LO	-	-			Fake	Expt
Energy	15.3 kWh			15.3 kWh	4.39 kW	3.49 Hrs	5.75 Hrs
March with HORIZONTAL unit							
Reactor: Liquid Hydrogen/Liquid Oxygen							
Section	Horz	React	Vert	Fake Energy	Expt Power	REAL	
Material	-	LH/LO	-			Fake	Expt
Energy		0.187 kWh		0.187 kWh	4.39 kW	0.0426 Hrs	5.75 Hrs
March with ESTIMATED reactor volume							
<b>FAKE?</b>	means that the fake could run longer than the experiment, and is NOT eliminated						
<b>REAL</b>	means that the fake is ELIMINATED by an experiment, so the device could be REAL						

### 13.3. Diesel Fuel

Controller contains a Hydrogen Fuel Cell, Main unit burns Diesel.

For both, external Air is the most favorable for a fake.

Control Box: Liquid Hydrogen/External Air Fuel Cell Main Unit: Diesel/Air							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	FAKE?	
Material	LH/Air-FC	Dsl/Air	Dsl/Air			Fake	Expt
Energy	168 kWh	228 kWh	93.3 kWh	490 kWh	10.0 kW	49.0 Hrs	0.500 Hrs
January with ALL sections							
Main Unit: Diesel/Air							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	FAKE?	
Material	-	Dsl/Air	Dsl/Air			Fake	Expt
Energy		228 kWh	93.3 kWh	321 kWh	10.0 kW	32.1 Hrs	0.500 Hrs
January with MAIN unit -- excluding Control Box							
Horizontal Arm: Diesel/Air							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	REAL	
Material	-	Dsl/Air	-			Fake	Expt
Energy		228 kWh		228 kWh	16.0 kW	14.2 Hrs	18.0 Hrs
February with HORIZONTAL unit							
Reactor: Diesel/Air							
Section	Ctrl	React	Vert	Fake Energy	Expt Power	REAL	
Material	-	Dsl/Air	-			Fake	Expt
Energy		114 kWh		114 kWh	16.0 kW	7.12 Hrs	18.0 Hrs
February with ESTIMATED reactor volume							
Horizontal Arm: Diesel/Air							
Section	Horz	React	Vert	Fake Energy	Expt Power	FAKE?	
Material	Dsl/Air	-	-			Fake	Expt
Energy	153 kWh			153 kWh	4.39 kW	34.8 Hrs	5.75 Hrs
March with HORIZONTAL unit							
Reactor: Diesel/Air							
Section	Horz	React	Vert	Fake Energy	Expt Power	REAL	
Material	-	Dsl/Air	-			Fake	Expt
Energy		1.86 kWh		1.86 kWh	4.39 kW	0.424 Hrs	5.75 Hrs
March with ESTIMATED reactor volume							
<b>FAKE?</b> means that the fake could run longer than the experiment, and is NOT eliminated <b>REAL</b> means that the fake is ELIMINATED by an experiment, so the device could be REAL							

### 13.4. Boron and Air or Oxygen

Controller contains a Hydrogen Fuel Cell (Liquid Hydrogen/Air), Main unit burns Boron with Air.

Control Box: Liquid Hydrogen/External Air Fuel Cell Main Unit: Boron/External Air							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	FAKE?	
Material	LH/Air-FC	B/Air	B/Air			Fake	Expt
Energy	168 kWh	842 kWh	345 kWh	1355 kWh	10.0 kW	135 Hrs	0.500 Hrs
January with ALL sections							
Main Unit: Boron/External Air							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	FAKE?	
Material	-	B/Air	B/Air			Fake	Expt
Energy		842 kWh	345 kWh	1187 kWh	10.0 kW	119 Hrs	0.500 Hrs
January with MAIN unit -- excluding Control Box							
Horizontal Arm: Boron/External Air							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	FAKE?	
Material	-	B/Air	-			Fake	Expt
Energy		842 kWh		842 kWh	16.0 kW	52.6 Hrs	18.0 Hrs
February with HORIZONTAL unit							
Reactor: Boron/External Air							
Section	Ctrl	React	Vert	Fake Energy	Expt Power	FAKE?	
Material	-	B/Air	-			Fake	Expt
Energy		421 kWh		421 kWh	16.0 kW	26.3 Hrs	18.0 Hrs
February with ESTIMATED reactor volume							
Horizontal Arm: Boron/External Air							
Section	Horz	React	Vert	Fake Energy	Expt Power	FAKE?	
Material	B/Air	-	-			Fake	Expt
Energy	564 kWh			564 kWh	4.39 kW	128 Hrs	5.75 Hrs
March with HORIZONTAL unit							
Reactor: Boron/External Air							
Section	Horz	React	Vert	Fake Energy	Expt Power	REAL	
Material	-	B/Air	-			Fake	Expt
Energy		6.87 kWh		6.87 kWh	4.39 kW	1.57 Hrs	5.75 Hrs
March with ESTIMATED reactor volume							
<b>FAKE?</b>	means that the fake could run longer than the experiment, and is NOT eliminated						
<b>REAL</b>	means that the fake is ELIMINATED by an experiment, so the device could be REAL						

Controller contains a Hydrogen Fuel Cell (Liquid Hydrogen/Air), Main unit burns Boron with Compressed Oxygen.

Control Box: Liquid Hydrogen/External Air Fuel Cell Main Unit: Boron/Compressed Oxygen							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	FAKE?	
Material	LH/Air-FC	B/CO	B/CO			Fake	Expt
Energy	168 kWh	98.6 kWh	40.3 kWh	307 kWh	10.0 kW	30.7 Hrs	0.500 Hrs
January with ALL sections							
Main Unit: Boron/Compressed Oxygen							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	FAKE?	
Material	-	B/CO	B/CO			Fake	Expt
Energy		98.6 kWh	40.3 kWh	139 kWh	10.0 kW	13.9 Hrs	0.500 Hrs
January with MAIN unit -- excluding Control Box							
Horizontal Arm: Boron/Compressed Oxygen							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	REAL	
Material	-	B/CO	-			Fake	Expt
Energy		98.6 kWh		98.6 kWh	16.0 kW	6.16 Hrs	18.0 Hrs
February with HORIZONTAL unit							
Reactor: Boron/Compressed Oxygen							
Section	Ctrl	React	Vert	Fake Energy	Expt Power	REAL	
Material	-	B/CO	-			Fake	Expt
Energy		49.3 kWh		49.3 kWh	16.0 kW	3.08 Hrs	18.0 Hrs
February with ESTIMATED reactor volume							
Horizontal Arm: Boron/Compressed Oxygen							
Section	Horz	React	Vert	Fake Energy	Expt Power	FAKE?	
Material	B/CO	-	-			Fake	Expt
Energy	66.0 kWh			66.0 kWh	4.39 kW	15.0 Hrs	5.75 Hrs
March with HORIZONTAL unit							
Reactor: Boron/Compressed Oxygen							
Section	Horz	React	Vert	Fake Energy	Expt Power	REAL	
Material	-	B/CO	-			Fake	Expt
Energy		0.805 kWh		0.805 kWh	4.39 kW	0.183 Hrs	5.75 Hrs
March with ESTIMATED reactor volume							
<b>FAKE?</b> means that the fake could run longer than the experiment, and is NOT eliminated <b>REAL</b> means that the fake is ELIMINATED by an experiment, so the device could be REAL							

Controller contains a Hydrogen Fuel Cell (Liquid Hydrogen/Air), Main unit burns Boron with Liquid Oxygen.

Control Box: Liquid Hydrogen/External Air Fuel Cell Main Unit: Boron/Liquid Oxygen							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	FAKE?	
Material	LH/Air-FC	B/LO	B/LO			Fake	Expt
Energy	168 kWh	143 kWh	58.4 kWh	369 kWh	10.0 kW	36.9 Hrs	0.500 Hrs
January with ALL sections							
Main Unit: Boron/Liquid Oxygen							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	FAKE?	
Material	-	B/LO	B/LO			Fake	Expt
Energy		143 kWh	58.4 kWh	201 kWh	10.0 kW	20.1 Hrs	0.500 Hrs
January with MAIN unit -- excluding Control Box							
Horizontal Arm: Boron/Liquid Oxygen							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	REAL	
Material	-	B/LO	-			Fake	Expt
Energy		143 kWh		143 kWh	16.0 kW	8.92 Hrs	18.0 Hrs
February with HORIZONTAL unit							
Reactor: Boron/Liquid Oxygen							
Section	Ctrl	React	Vert	Fake Energy	Expt Power	REAL	
Material	-	B/LO	-			Fake	Expt
Energy		71.3 kWh		71.3 kWh	16.0 kW	4.46 Hrs	18.0 Hrs
February with ESTIMATED reactor volume							
Horizontal Arm: Boron/Liquid Oxygen							
Section	Horz	React	Vert	Fake Energy	Expt Power	FAKE?	
Material	B/LO	-	-			Fake	Expt
Energy	95.5 kWh			95.5 kWh	4.39 kW	21.8 Hrs	5.75 Hrs
March with HORIZONTAL unit							
Reactor: Boron/Liquid Oxygen							
Section	Horz	React	Vert	Fake Energy	Expt Power	REAL	
Material	-	B/LO	-			Fake	Expt
Energy		1.16 kWh		1.16 kWh	4.39 kW	0.265 Hrs	5.75 Hrs
March with ESTIMATED reactor volume							
<b>FAKE?</b> means that the fake could run longer than the experiment, and is NOT eliminated <b>REAL</b> means that the fake is ELIMINATED by an experiment, so the device could be REAL							

## 13.5. Magnesium and Steam

Controller contains a Hydrogen Fuel Cell (Liquid Hydrogen/Air), Main unit burns Magnesium in Steam, producing Hydrogen, which is burned with external Air.

Control Box: Liquid Hydrogen/External Air Fuel Cell Main Unit: Magnesium/Steam							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	FAKE?	
Material	LH/Air-FC	Mg/Steam	Mg/Steam			Fake	Expt
Energy	168 kWh	264 kWh	108 kWh	541 kWh	10.0 kW	54.1 Hrs	0.500 Hrs
January with ALL sections							
Main Unit: Magnesium/Steam							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	FAKE?	
Material	-	Mg/Steam	Mg/Steam			Fake	Expt
Energy		264 kWh	108 kWh	372 kWh	10.0 kW	37.2 Hrs	0.500 Hrs
January with MAIN unit -- excluding Control Box							
Horizontal Arm: Magnesium/Steam							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	REAL	
Material	-	Mg/Steam	-			Fake	Expt
Energy		264 kWh		264 kWh	16.0 kW	16.5 Hrs	18.0 Hrs
February with HORIZONTAL unit							
Reactor: Magnesium/Steam							
Section	Ctrl	React	Vert	Fake Energy	Expt Power	REAL	
Material	-	Mg/Steam	-			Fake	Expt
Energy		132 kWh		132 kWh	16.0 kW	8.26 Hrs	18.0 Hrs
February with ESTIMATED reactor volume							
Horizontal Arm: Magnesium/Steam							
Section	Horz	React	Vert	Fake Energy	Expt Power	FAKE?	
Material	Mg/Steam	-	-			Fake	Expt
Energy	177 kWh			177 kWh	4.39 kW	40.3 Hrs	5.75 Hrs
March with HORIZONTAL unit							
Reactor: Magnesium/Steam							
Section	Horz	React	Vert	Fake Energy	Expt Power	REAL	
Material	-	Mg/Steam	-			Fake	Expt
Energy		2.16 kWh		2.16 kWh	4.39 kW	0.491 Hrs	5.75 Hrs
March with ESTIMATED reactor volume							
<b>FAKE?</b> means that the fake could run longer than the experiment, and is NOT eliminated <b>REAL</b> means that the fake is ELIMINATED by an experiment, so the device could be REAL							

Magnesium and Steam, with the resulting hydrogen burned with compressed oxygen

Control Box: Liquid Hydrogen/External Air Fuel Cell Main Unit: Mg/Steam/O2							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	FAKE?	
Material	LH/Air-FC	Mg/Steam/O2	Mg/Steam/O2			Fake	Expt
Energy	168 kWh	132 kWh	54.0 kWh	354 kWh	10.0 kW	35.4 Hrs	0.500 Hrs
January with ALL sections							
Main Unit: Mg/Steam/O2							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	FAKE?	
Material	-	Mg/Steam/O2	Mg/Steam/O2			Fake	Expt
Energy		132 kWh	54.0 kWh	186 kWh	10.0 kW	18.6 Hrs	0.500 Hrs
January with MAIN unit -- excluding Control Box							
Horizontal Arm: Mg/Steam/O2							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	REAL	
Material	-	Mg/Steam/O2	-			Fake	Expt
Energy		132 kWh		132 kWh	16.0 kW	8.24 Hrs	18.0 Hrs
February with HORIZONTAL unit							
Reactor: Mg/Steam/O2							
Section	Ctrl	React	Vert	Fake Energy	Expt Power	REAL	
Material	-	Mg/Steam/O2	-			Fake	Expt
Energy		65.9 kWh		65.9 kWh	16.0 kW	4.12 Hrs	18.0 Hrs
February with ESTIMATED reactor volume							
Horizontal Arm: Mg/Steam/O2							
Section	Horz	React	Vert	Fake Energy	Expt Power	FAKE?	
Material	Mg/Steam/O2	-	-			Fake	Expt
Energy	88.3 kWh			88.3 kWh	4.39 kW	20.1 Hrs	5.75 Hrs
March with HORIZONTAL unit							
Reactor: Mg/Steam/O2							
Section	Horz	React	Vert	Fake Energy	Expt Power	REAL	
Material	-	Mg/Steam/O2	-			Fake	Expt
Energy		1.08 kWh		1.08 kWh	4.39 kW	0.245 Hrs	5.75 Hrs
March with ESTIMATED reactor volume							
<b>FAKE?</b>	means that the fake could run longer than the experiment, and is NOT eliminated						
<b>REAL</b>	means that the fake is ELIMINATED by an experiment, so the device could be REAL						

## 13.6. Water Heat Sink

The entire volume of the main unit is a water heat sink. Note that this cannot BOIL the water for the January experiment.

Control Box: Liquid Hydrogen/External Air Fuel Cell Main Unit: SPH Water							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	FAKE?	
Material	LH/Air-FC	SPH Water	SPH Water			Fake	Expt
Energy	168 kWh	2.21 kWh	0.905 kWh	171 kWh	10.0 kW	17.1 Hrs	0.500 Hrs
January with ALL sections							
Main Unit: SPH Water							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	REAL	
Material	-	SPH Water	SPH Water			Fake	Expt
Energy		2.21 kWh	0.905 kWh	3.12 kWh	10.0 kW	0.312 Hrs	0.500 Hrs
January with MAIN unit -- excluding Control Box							
Horizontal Arm: SPH Water							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	REAL	
Material	-	SPH Water	-			Fake	Expt
Energy		2.21 kWh		2.21 kWh	16.0 kW	0.138 Hrs	18.0 Hrs
February with HORIZONTAL unit							
Reactor: SPH Water							
Section	Ctrl	React	Vert	Fake Energy	Expt Power	REAL	
Material	-	SPH Water	-			Fake	Expt
Energy		1.11 kWh		1.11 kWh	16.0 kW	0.0691 Hrs	18.0 Hrs
February with ESTIMATED reactor volume							
Horizontal Arm: SPH Water							
Section	Horz	React	Vert	Fake Energy	Expt Power	REAL	
Material	SPH Water	-	-			Fake	Expt
Energy	1.48 kWh			1.48 kWh	4.39 kW	0.337 Hrs	5.75 Hrs
March with HORIZONTAL unit							
Reactor: SPH Water							
Section	Horz	React	Vert	Fake Energy	Expt Power	REAL	
Material	-	SPH Water	-			Fake	Expt
Energy		0.0181 kWh		0.0181 kWh	4.39 kW	0.00411 Hrs	5.75 Hrs
March with ESTIMATED reactor volume							
<b>FAKE?</b> means that the fake could run longer than the experiment, and is NOT eliminated <b>REAL</b> means that the fake is ELIMINATED by an experiment, so the device could be REAL							

### 13.7. Beryllium Heat Sink

The entire volume of the main unit is a Beryllium Heat Sink ... pre-heated to its melting point.

Control Box: Liquid Hydrogen/External Air Fuel Cell Main Unit: SPH Be							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	FAKE?	
Material	LH/Air-FC	SPH Be	SPH Be			Fake	Expt
Energy	168 kWh	26.3 kWh	10.8 kWh	205 kWh	10.0 kW	20.5 Hrs	0.500 Hrs
January with ALL sections							
Main Unit: SPH Be							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	FAKE?	
Material	-	SPH Be	SPH Be			Fake	Expt
Energy		26.3 kWh	10.8 kWh	37.1 kWh	10.0 kW	3.71 Hrs	0.500 Hrs
January with MAIN unit -- excluding Control Box							
Horizontal Arm: SPH Be							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	REAL	
Material	-	SPH Be	-			Fake	Expt
Energy		26.3 kWh		26.3 kWh	16.0 kW	1.64 Hrs	18.0 Hrs
February with HORIZONTAL unit							
Reactor: SPH Be							
Section	Ctrl	React	Vert	Fake Energy	Expt Power	REAL	
Material	-	SPH Be	-			Fake	Expt
Energy		13.1 kWh		13.1 kWh	16.0 kW	0.822 Hrs	18.0 Hrs
February with ESTIMATED reactor volume							
Horizontal Arm: SPH Be							
Section	Horz	React	Vert	Fake Energy	Expt Power	REAL	
Material	SPH Be	-	-			Fake	Expt
Energy	17.6 kWh			17.6 kWh	4.39 kW	4.01 Hrs	5.75 Hrs
March with HORIZONTAL unit							
Reactor: SPH Be							
Section	Horz	React	Vert	Fake Energy	Expt Power	REAL	
Material	-	SPH Be	-			Fake	Expt
Energy		0.215 kWh		0.215 kWh	4.39 kW	0.0489 Hrs	5.75 Hrs
March with ESTIMATED reactor volume							
<b>FAKE?</b> means that the fake could run longer than the experiment, and is NOT eliminated <b>REAL</b> means that the fake is ELIMINATED by an experiment, so the device could be REAL							

## 13.8. Iron Heat Sink

The entire volume of the main unit is an Iron Heat Sink ... pre-heated to its melting point.

Control Box: Liquid Hydrogen/External Air Fuel Cell Main Unit: SPH Iron							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	FAKE?	
Material	LH/Air-FC	SPH Iron	SPH Iron			Fake	Expt
Energy	168 kWh	32.9 kWh	13.4 kWh	215 kWh	10.0 kW	21.5 Hrs	0.500 Hrs
January with ALL sections							
Main Unit: SPH Iron							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	FAKE?	
Material	-	SPH Iron	SPH Iron			Fake	Expt
Energy		32.9 kWh	13.4 kWh	46.3 kWh	10.0 kW	4.63 Hrs	0.500 Hrs
January with MAIN unit -- excluding Control Box							
Horizontal Arm: SPH Iron							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	REAL	
Material	-	SPH Iron	-			Fake	Expt
Energy		32.9 kWh		32.9 kWh	16.0 kW	2.05 Hrs	18.0 Hrs
February with HORIZONTAL unit							
Reactor: SPH Iron							
Section	Ctrl	React	Vert	Fake Energy	Expt Power	REAL	
Material	-	SPH Iron	-			Fake	Expt
Energy		16.4 kWh		16.4 kWh	16.0 kW	1.03 Hrs	18.0 Hrs
February with ESTIMATED reactor volume							
Horizontal Arm: SPH Iron							
Section	Horz	React	Vert	Fake Energy	Expt Power	REAL	
Material	SPH Iron	-	-			Fake	Expt
Energy	22.0 kWh			22.0 kWh	4.39 kW	5.01 Hrs	5.75 Hrs
March with HORIZONTAL unit							
Reactor: SPH Iron							
Section	Horz	React	Vert	Fake Energy	Expt Power	REAL	
Material	-	SPH Iron	-			Fake	Expt
Energy		0.268 kWh		0.268 kWh	4.39 kW	0.0611 Hrs	5.75 Hrs
March with ESTIMATED reactor volume							
<b>FAKE?</b>	means that the fake could run longer than the experiment, and is NOT eliminated						
<b>REAL</b>	means that the fake is ELIMINATED by an experiment, so the device could be REAL						

### 13.9. Lead Heat Sink

The entire volume of the main unit is an Lead Heat Sink ... pre-heated to its melting point.

Control Box: Liquid Hydrogen/External Air Fuel Cell Main Unit: SPH Lead							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	FAKE?	
Material	LH/Air-FC	SPH Lead	SPH Lead			Fake	Expt
Energy	168 kWh	2.76 kWh	1.13 kWh	172 kWh	10.0 kW	17.2 Hrs	0.500 Hrs
January with ALL sections							
Main Unit: SPH Lead							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	REAL	
Material	-	SPH Lead	SPH Lead			Fake	Expt
Energy		2.76 kWh	1.13 kWh	3.89 kWh	10.0 kW	0.389 Hrs	0.500 Hrs
January with MAIN unit -- excluding Control Box							
Horizontal Arm: SPH Lead							
Section	Ctrl	Horz	Vert	Fake Energy	Expt Power	REAL	
Material	-	SPH Lead	-			Fake	Expt
Energy		2.76 kWh		2.76 kWh	16.0 kW	0.172 Hrs	18.0 Hrs
February with HORIZONTAL unit							
Reactor: SPH Lead							
Section	Ctrl	React	Vert	Fake Energy	Expt Power	REAL	
Material	-	SPH Lead	-			Fake	Expt
Energy		1.38 kWh		1.38 kWh	16.0 kW	0.0862 Hrs	18.0 Hrs
February with ESTIMATED reactor volume							
Horizontal Arm: SPH Lead							
Section	Horz	React	Vert	Fake Energy	Expt Power	REAL	
Material	SPH Lead	-	-			Fake	Expt
Energy	1.85 kWh			1.85 kWh	4.39 kW	0.421 Hrs	5.75 Hrs
March with HORIZONTAL unit							
Reactor: SPH Lead							
Section	Horz	React	Vert	Fake Energy	Expt Power	REAL	
Material	-	SPH Lead	-			Fake	Expt
Energy		0.0225 kWh		0.0225 kWh	4.39 kW	0.00513 Hrs	5.75 Hrs
March with ESTIMATED reactor volume							
<b>FAKE?</b> means that the fake could run longer than the experiment, and is NOT eliminated <b>REAL</b> means that the fake is ELIMINATED by an experiment, so the device could be REAL							

## 14. Experiments -- FAKES by WEIGHT

At present we have no independent measurements of the weight of the various parts of the *eCat*.

## 15. Rothwell's Razor

This is a variation of (the usually misquoted) [Occam's razor - Wikipedia, the free encyclopedia](#)

... the razor is a principle that suggests we should tend towards simpler theories ... until we can trade some simplicity for increased explanatory power. Contrary to the popular summary, the simplest available theory is sometimes a less accurate explanation.

It is very tempting to propose elaborate schemes by which a fake *eCat* could be detected. For instance, in the author's physorg.com posts he suggested feeding it a brew of various isotopes of water to make sure that the SAME water goes in and comes out.

However, in the [Vortex](#) mailing list [Re: \[Vo\]:Hidden wire hypothesis redux](#)

Jed Rothwell suggests in response to another comment:

This is my point, there may be a million things you haven't thought of.

Nope. That does not work. A good experiment cannot have a million possible problems. If we had to think up a million ways that an experiment might be wrong (or fake -- pretty much the same thing) then no experiment would ever prove anything, and there would be no progress.

A bad experiment can have a large number of possible errors (or ways to make it fake).

....

Flow calorimetry experiments similar to this, with boiling water or flowing water, have been done many times. The potential errors are well understood and their number is strictly limited -- unless you are aiming for the kind of precision SRI achieved.

In an experiment with only 4 main parameters -- input power, inlet temperature, outlet temperature and flow rate -- the number of potential significant errors will [*be*] small, and so will the number of ways deliberately fake data can be surreptitiously introduced. When the method is complicated, and the results close to the margin, with many parameters with, for example, the possibility of recombination producing a significant error, then there are many ways an error can creep in, and many ways to deliberately introduce fake data.

Complexity and a low s/n ratio invite error, misinterpretation or fraud.

## 16. Conclusion

Since the December/January experiments only recorded the inputs and outputs for a short time (30 minutes), almost ANY of the fakes could have produced the result.

For the February experiment Levi was allowed to inspect everything, EXCLUDING only the 1-liter reactor chamber. If you accept all of Levi's February report, then all chemical fakes are conclusively ruled out. Neither the January or February reports rule out a *Tarallo Water Diversion Fake*.

The March report DOES rule out a *Tarallo* fake -- but since the Horizontal arm was NOT unwrapped, it does NOT rule out all chemical fakes.

None of the experiments can rule out a Heat Pump which exceeds known efficiencies by a factor of 100 (or even higher, if the 130kW peak output could be sustained). An *eCat* doing this would be as important an engineering breakthrough as an *LENR* device. Similarly, a previously-unknown chemical reaction which can produce 10kW for 6 months from a 1 liter source would be an equally important discovery in chemistry. As Sherlock Holmes said in *Silver Blaze*:

... and improbable as it is, all other explanations are more improbable still.

Therefore, at present, we cannot conclusively rule out ALL possible fakes, so it is not yet PROVED that the Rossi device is real. However, a few simple improvements to the experimental setup will almost certainly do that.

## 17. Discussion

This paper considers *UPPER BOUNDS* for what a Fake could achieve.

Any actual fake would run into engineering difficulties long before those limits were reached.

When designing a machine for propulsion or for electricity, thermodynamics is your enemy. The heat of friction, for instance, robs your output. But if your machine is simply heating water, then thermodynamics is your friend, or at least neutral.

But the limits of thermal efficiency are not THAT far off 100% : for instance, modern gas furnaces have an efficiency of over 95% ([Furnaces and Boilers](#)). Nor is the assumption that 100% of the weight or volume is fuel : advanced rockets such as the [Proton UR-500](#) have a 95.6% fuel-to-dry-weight factor.

So any discussion of "implementation" is quibbling over less than 5%!

Because of the difficulty of measuring the results with steam (volume and content), future experiments should be used to heat the water (as in the February experiment). For this we need:

- Input electrical power (BETWEEN the control panel and the reactor)  
This must also be observed with an oscilloscope to ensure there is no high frequency/phase component which could confuse a simple power meter.
- Input hydrogen (by weight)
- Inlet temperature
- Outlet temperature OUTSIDE of the eCAT
- Water volume IN
- Water or Steam volume OUT
- Total weight before
- Total weight after
- Detection of a Heat pump requires an air calorimeter round the main unit
- Sealed unit, to prevent drawing air as a fuel (calorimeter filled with Nitrogen)  
OR  
Thorough inspection to check for leaks

As much as possible of the unit should be open to inspection to reduce the volumes (or weights) in which fake material could be hidden, and thus shorten the time needed to eliminate fakes.

## 18. Details

Some of the details have been moved to a separate document: [Details](#)

## 19. Physorg Posts

These ideas were first noted in [PhysOrg](#) (posting as alanf777)

The 1,000-character posting limit made my comments rather hard to read), so I have extracted and clarified them in [Physorg v1](#)

## 20. Acknowledgements

Thanks to Jed Rothwell, Jeff Driscoll and Jones Beene on the "[Vortex](#)" mailing list for information, corrections and comments.

Oh, and thanks to Sir Arthur Conan Doyle, who really, really liked the phrase which Sherlock Holmes used more times than this paper has space for (in *The Sign of the Four*):

Eliminate all other factors, and the one which remains must be the truth."

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