



Your best source for news and information on low energy nuclear reactions

reprinted from

November 10, 2006 -- Issue #19

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Published by the New Energy Institute Inc. six times per year

<http://newenergytimes.com>

Extraordinary Evidence

Scientists at the U.S. Navy's San Diego SPAWAR Systems Center have produced something unique in the 17-year history of the scientific drama historically known as cold fusion: simple, portable, highly repeatable, unambiguous, and permanent physical evidence of nuclear events using detectors that have a long track record of reliability and acceptance among nuclear physicists.

by Steven Krivit and Bennett Daviss

When Frank Gordon walked to the podium in Washington, D.C., on Aug. 2, it was a small step for a man but a large one for the few hundred determined researchers around the world still probing the mysteries of low energy nuclear reactions, or LENR, historically known as cold fusion.

At the 2006 Naval Science & Technology Partnership conference hosted by the National Defense Industrial Association and the Office of Naval Research, Gordon sat among a panel of 11 experts who had come to talk to the crowd about energy possibilities for the American military. (See related story in New Energy Times Issue #18)

Because the Department of Defense is the largest domestic buyer of petroleum-based fuel, the subject is especially urgent; if the price of oil rises \$10 in a year, the Navy's deputy assistant secretary for research and development, Michael McGrath, had told the group, the hike adds \$1.3 billion to the Department of Defense's budget.

So between speakers on photovoltaic cells and generators powered by ocean waves, Gordon told an assembled crowd of 500 military personnel, government officials, and government contractors about his lab's powerful new evidence that tabletop nuclear reactions can occur at room temperature without producing damaging, let alone fatal, radiation – in other words, evidence that low energy nuclear reactions inhabit the realm of science, not science fiction.



Frank Gordon
Photo: Christopher Hume

“We tell students to do experiments and to put data above dogma,” Gordon told the group. “I don’t know what preconceptions you brought with you today about the idea of low energy nuclear reactions, but I can tell you that we’ve done the experiments, and we have the data.”

The step was large for three reasons. First, the brass at the Office of Naval Research and SPAWAR – the U.S. Navy’s Space and Naval Warfare Systems Center in San Diego, where Gordon heads the navigation and applied sciences department – hadn’t tried to dissuade him when he told them that he and analytical chemist Pamela Mosier-Boss from his lab were coming to the conference.

At SPAWAR, “we’re old news,” Mosier-Boss said. “People are used to us working on this, and they accept that we do what we do.”



Pamela Mosier-Boss
Photo: Christopher Hume

Still, the research that Mosier-Boss and colleague Stanislaw Szpak pursue (as time, funds, and other duties permit) remains so controversial within some naval quarters that those who refuse to abandon it are forbidden – officially in some cases, implicitly in others – from speaking publicly about it.

Second, Gordon’s team had achieved its results with a budget of a few thousand dollars a year of discretionary funds that he controls as a department head.

“We’ve borrowed instrumentation and accepted help from anyone who offered it and purchased some supplies out of our own pocket, but mostly, we’ve worked on our own time,” he said. “Given those constraints, we’ve made excellent progress.”

Third, LENR research has found an unexpected advocate in the National Defense Industrial Association president, Lawrence Farrell, a retired Air Force general. He’d known Gordon and other Navy scientists from Farrell’s days on active duty and came to respect their professional judgment and integrity.

Farrell’s group recently set up an energy security task force in response to the threat that rising oil prices pose to national economic security.

The idea of cold fusion “still has an unfavorable reputation due to publicity arising from the Fleischmann-Pons episode,” Farrell said.

“But something is going on [inside these cells] even if we don’t know yet what it is,” he said, “and even if we don’t know what causes it, we can’t ignore it. This is something we have to take a look at.”

But perhaps even more compelling than these facts is a larger reason for the importance of Gordon’s presence. In his comments, and at SPAWAR Systems Center’s modest display booth, tucked into a back corner of the conference’s exhibit hall, Gordon and Mosier-Boss were making the first public presentation of what may be the most dramatic evidence of low energy nuclear reactions yet: thin chips of plastic costing a few dollars each, resembling microscope slides but smaller, with pits scattered across portions of them as dense as stars across the center of the Milky Way that, nuclear researchers say, can have been caused only by the impact of high-energy particles, which, in turn, can have been produced only by nuclear events.

The Long Journey

In a press conference on March 23, 1989, at the University of Utah, chemists Martin Fleischmann and Stanley Pons shook the overlapping foundations of science, technology, and commerce with the claim that they had produced a radiation-free nuclear fusion reaction in an electrolysis cell on a lab bench – a discovery that implied a new source of cheap, boundless, commercial energy.

Just as startling to scientists, the two researchers appeared to be claiming to have produced a nuclear reaction by chemical means.

Whether these “cold fusion” cells yield surplus energy is still being debated, but not by most of those who have continued the research that Fleischmann and Pons began. They have fashioned research into LENR into a new field of inquiry and have refined technologies and techniques that consistently produce anomalous results that point to nuclear processes at work.

But the field has never had simple physical evidence of those nuclear processes to physically place in the hands of doubters.

Until now. Using a unique experimental method called co-deposition, combined with the application of external electric and magnetic fields, and recording the results with standard nuclear-industry detectors, scientists at the U.S. Navy’s San Diego SPAWAR Systems Center have produced what may be the most convincing evidence yet in the pursuit of proof of low energy nuclear reactions.

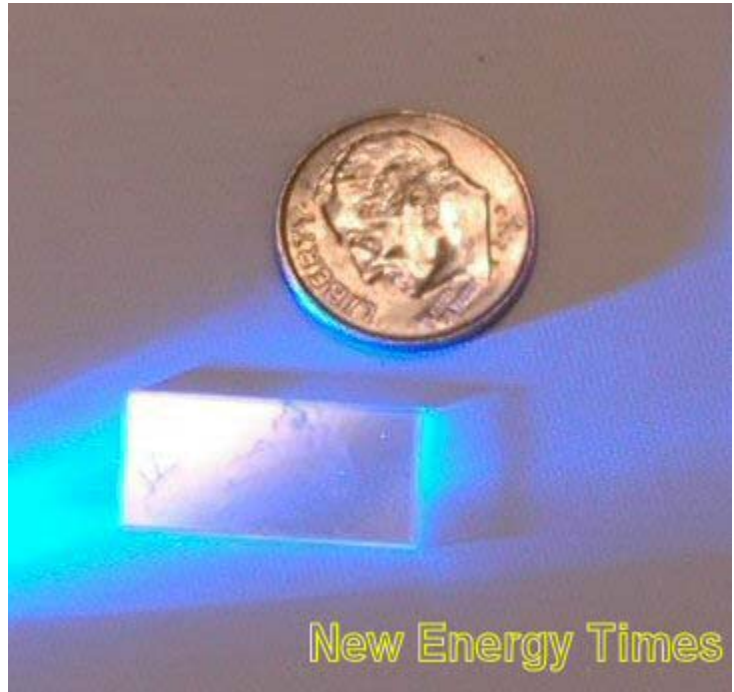
The Missing Link

The chips that the SPAWAR Systems Center scientists had brought to Washington were slices of CR-39 plastic, a common, transparent polymer that resists fogging and abrasions and is used to make eyeglass lenses, among other things.

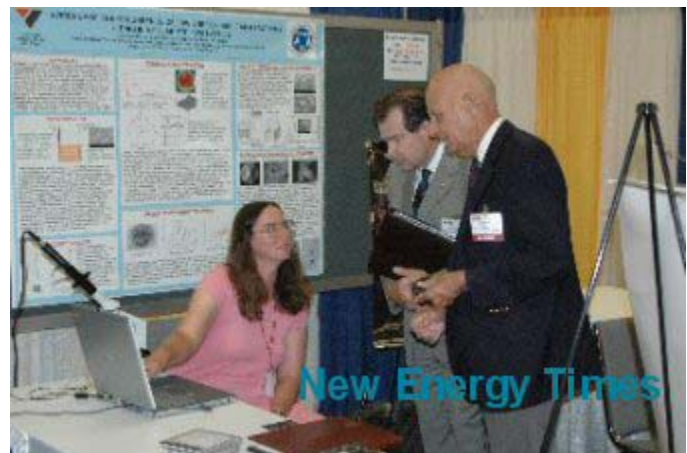
The researchers had placed the small pieces of plastic inside several of their electrochemical LENR test cells to capture and preserve any fleeting evidence of nuclear events.

"We heard about the use of CR-39 detectors from other LENR researchers at the 11th International Conference on Condensed Matter Nuclear Science in Marseilles, France, in 2004," Mosier-Boss said.

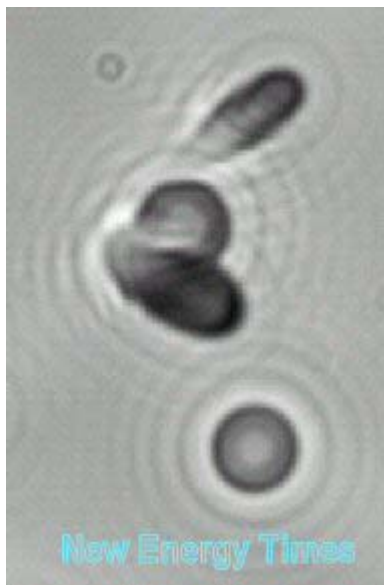
She and her colleagues later learned that these same simple detectors have long been used by researchers in inertial confinement fusion (a form of hot fusion) and other areas of nuclear science to record the passage of neutrons, protons, and alpha particles (the two-proton nuclei of helium atoms stripped of their electrons). The traveling particles' charges shatter the bonds linking the plastic's polymers, leaving pits or "tracks" in the plastic.



CR-39 detector
Photo: Steven Krivit

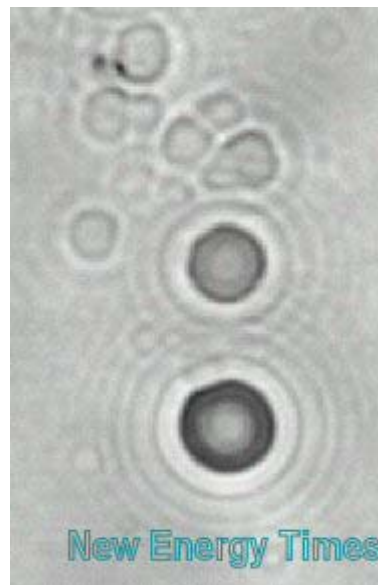


Pamela Mosier-Boss displaying microscope-computer viewing station for the CR-39 detectors
Photo: Steven Krivit



Tracks on CR-39 Detector from Radioactive Uranium Source (500x)

Photo: Pamela Mosier-Boss



Tracks from LENR Experiment (Au/Pd/D, 6000V E-Field, 500X)

Photo: Pamela Mosier-Boss

After a CR-39 detector is exposed to a source of nuclear emissions, the detector is bathed in a sodium hydroxide solution, typically for six or seven hours, at a temperature between 65 and 73 degrees C.

“If the solution is too hot, that damages the chips; if you [wash the detectors] too long, you etch away the pits,” Mosier-Boss noted.

The bath scours away the collision’s debris, and the resulting tracks are visible with a microscope or, if they’re present in sufficient densities, with the unaided eye.

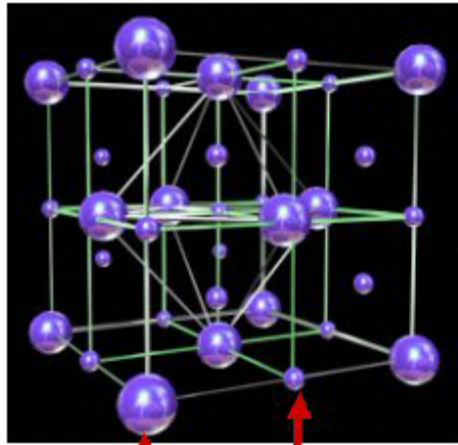
“CR-39 detectors are ideal for detecting particles in LENR experiments because we can put them right inside the cell where the placement of electronics would otherwise be highly impractical,” Gordon said.

“You don’t need complicated instrumentation like you do with calorimetry or tritium analysis,” he said. “It’s an easy detection tool that’s very straightforward.”

That makes it nicely compatible with conventional LENR cells. Typically, researchers working with these tabletop electrolytic experiments lower a palladium rod into a beaker of deuterated, or “heavy water,” so named because it has a high concentration of deuterium, a hydrogen isotope that holds in its nucleus both a neutron and a proton instead of the usual single proton that defines ordinary hydrogen.

When an electric current runs through the solution, the deuterium atoms pack into spaces in the palladium’s latticelike atomic framework.

Palladium Absorption



Palladium atom
Deuterium atom

Image courtesy: J.Dash, J. Freeman, B. Zimmerman

- Palladium is known to absorb up to 900 times its volume of hydrogen.
- Deuterium ions are attracted to the palladium cathode and occupy interstitial positions in the crystal lattice.

Over a period of days or weeks, the deuterium becomes packed, or "loaded," in densities of approximately one deuterium atom for each palladium atom, and then a reaction occurs – no consensus exists about what it is or why it happens – that reportedly releases energy as heat. Typically, this long loading, or "incubation," is a necessary prelude to evidence of any LENR reaction.

A Unique Experimental Method

SPAWAR's researchers, however, have evolved a far speedier technique than the conventional Fleischmann-Pons electrolysis method. They use a unique co-deposition process that Mosier-Boss's colleague, Stanislaw Szpak, developed to abolish the incubation period. Szpak didn't like waiting.

"I thought we should try something else," he said.



Stan Szpak
Photo: Steven Krivit

Szpak and Mosier-Boss's alternative (see diagram "Another Way to Conduct LENR Experiments: Pd/D Co-deposition") passes an electric current through a solution of palladium chloride and lithium chloride. Electrolysis simultaneously co-deposits deuterium and palladium, in particles 60 nm in diameter, in equal amounts onto the cathode's neutral substrate, typically a thin wire made of either nickel or gold.

Another Way to Conduct LENR Experiments: Pd/D Co-deposition

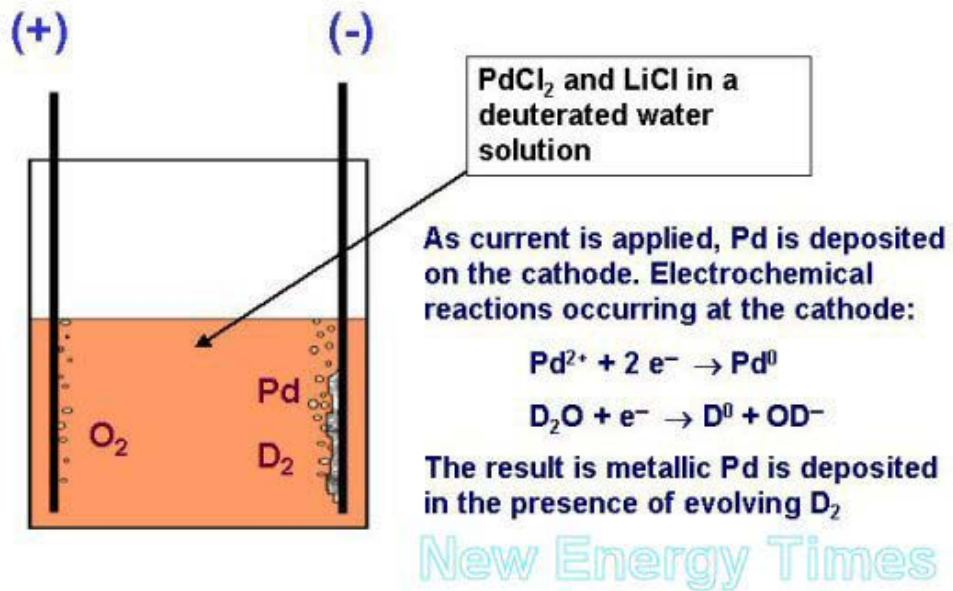


Diagram: Pamela Mosier-Boss

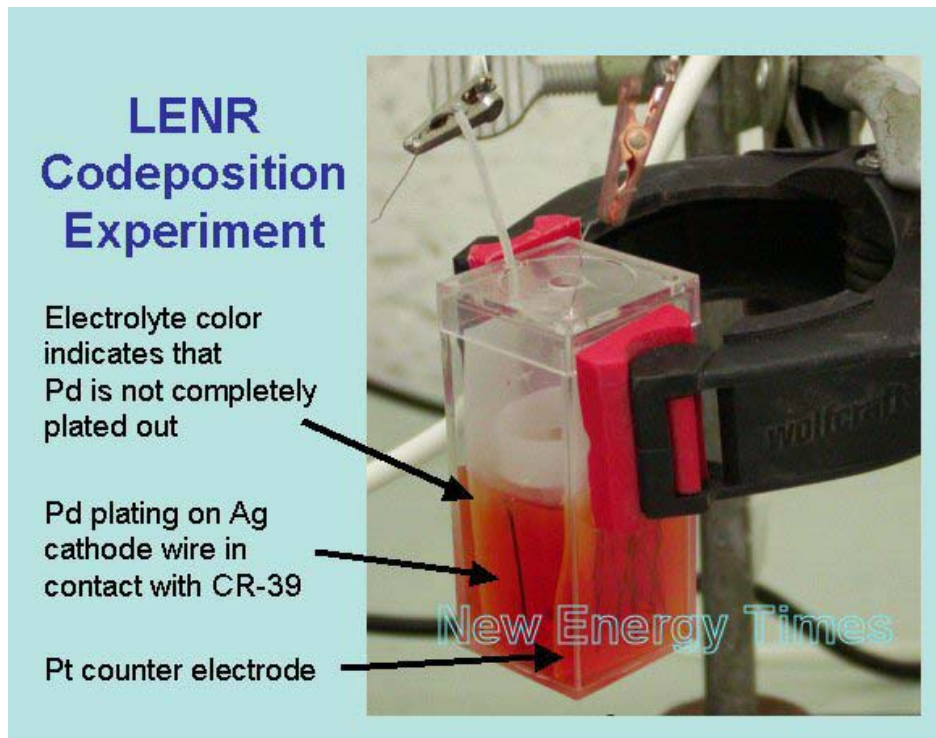


Photo: Pamela Mosier-Boss

"The required 1-1 ratio of deuterium to palladium is achieved almost instantly," Szpak said.

He credited the speed to the large surface area one achieves with the co-deposition method. Instead of waiting for the palladium to charge, or load large amounts of deuterium, it's charged in seconds.

The reaction is just as quick: Minutes, or even moments, after co-deposition starts, the cells show such signature evidence of nuclear reactions as anomalous amounts of tritium, low-intensity x-ray radiation, and increased heat. [1-9]

"The temperature of the palladium electrode turns out to be about three degrees higher than the surrounding solution," Szpak said.

The electrode itself, with its new coating of palladium and deuterium, was a heat source, he said.

Some researchers who have tried the co-deposition process have found it to be tricky, requiring just the right proportions of heat, materials, and deposition rates.

Part of the difficulty may be that a number of those who have attempted to replicate SPAWAR's method have tried to confirm their success by measuring excess heat, which, Mosier-Boss reports, is far more difficult than detecting the presence of other nuclear products, such as tritium.

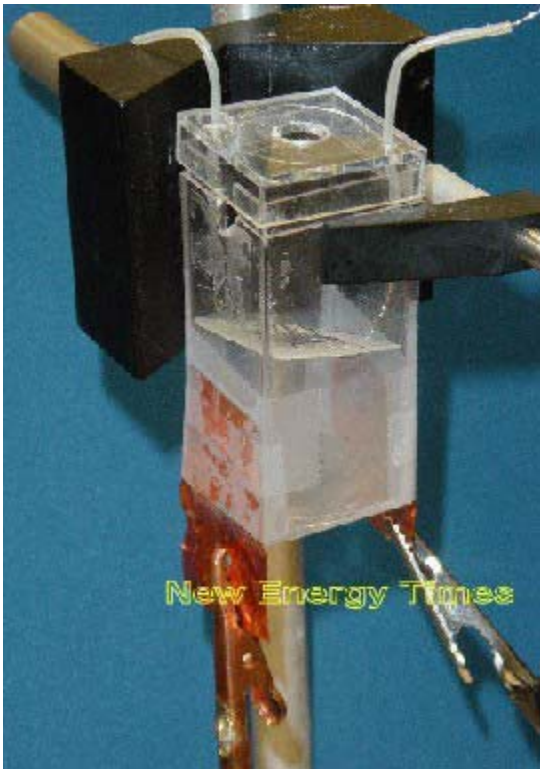
But the SPAWAR team has honed its technique and now reports that the cells deliver evidence of nuclear processes, such as transmuted elements, every time they run an experiment.

Enhancing the Reaction: External Fields

Coming up with the idea of co-deposition didn't deplete Szpak's store of inspiration. Experimental data indicates that LENR cells initiate their reactions, including anomalous heat, by packing deuterium atoms into defects on the surface of their palladium electrodes. To increase the activity of the surface, Szpak thought it would be helpful to try to force the surface to take some other forms, which might, in turn, multiply the defects.

He had been intrigued by the few known LENR experiments that had subjected cells to small electric or magnetic fields in attempts to boost their activity. One of those tests had been conducted in the 1990s by Mosier-Boss and Szpak themselves: They had placed one of their co-deposition cells inside a magnetic field and found that, after co-deposition, the cathode's temperature burned hotter than usual.

Pursuing the idea was simple. Starting in 2002, Szpak and Mosier-Boss affixed copper foils to the outside of their tabletop LENR cells along the bottom of two opposite walls of a square beaker and applied a 6,000-volt current generated by the power module from an old television set (see photo).



SPAWAR cell using external electric field
Photo: Steven Krivit

“In effect, we created a capacitor,” Szpak said, “and inside that capacitor, we put the LENR cell.”

The first result the pair noticed was that, even to the unaided eye, the co-deposited palladium appeared thicker on the cathode after the field was applied than before.

“When you watch the experiment, you can see the cathode expand and contract as the electric field works on it,” Mosier-Boss said. “It was a bit of a surprise to us.”

When they inspected the cathode’s surface using a scanning electron microscope, more changes were apparent.

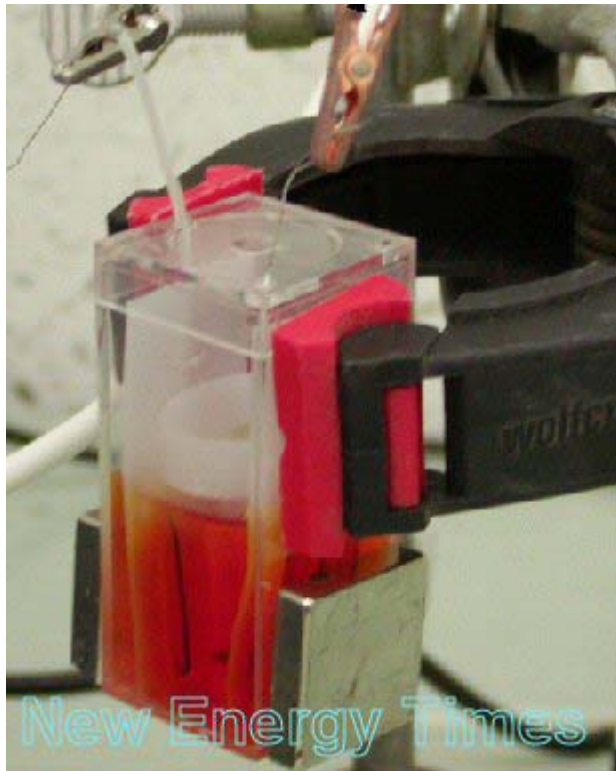
“Co-deposited palladium and deuterium on the surface of a substrate form spherical globules,” Szpak explained. “Under the electric field, they formed plates, ruts, and all sorts of other forms.”

This wasn’t the first time that external fields had been used in a LENR experiment. John O’Mara Bockris et al. performed related work with an external magnetic field in 1993 [10], and an Italian group led by Giuliano Preparata experimented with an electric field to see whether that would enhance the effects.

However, Szpak considers that “completely different.”

Preparata generated an electric field by flowing current through a palladium wire that was exposed to deuterium gas. In the SPAWAR experiment, they surrounded the cathode with an electric field by placing the LENR cell between two pieces of copper foil.

“Ours is the first time that anyone has done exactly what we have done,” Szpak said. In addition to testing the effects of an electric field, Szpak and Mosier-Boss subjected the cell to magnetic fields at a moderate strength of 12,200 Gauss.



SPAWAR cell using external magnetic field
Photo: Steven Krivit



Detail of cell after all palladium is plated onto cathode
wire
Photo: Pamela Mosier-Boss

“The electric field only affects the surface,” Szpak noted. “The magnetic field will affect the surface and also deeper into the material. The question is whether there was any substantial difference [between the effects of the two kinds of fields].”

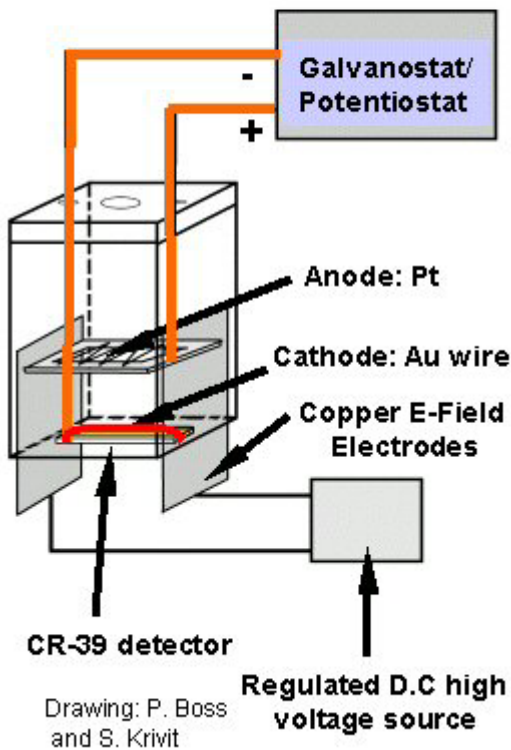
One difference was obvious: Under a microscope, Szpak and Mosier-Boss could see that the magnetic field flattened the tops of the spherical globules of palladium and deuterium, making the blobs look more like layer cakes.

Szpak and Mosier-Boss are mum on the results for now but detail them, as well as the differences between the effects of electric and magnetic fields, in a paper submitted to a peer-reviewed journal in September.

An overall effect of the two kinds of fields is clear. However, under both the external electric and magnetic fields, the test cells produced astonishing quantities of charged particles – far more than any LENR researchers have reported to date. The results, which indicate energies that could only result from nuclear events, have even startled experts in conventional nuclear fusion, who use CR-39 detectors for their own nuclear experiments.

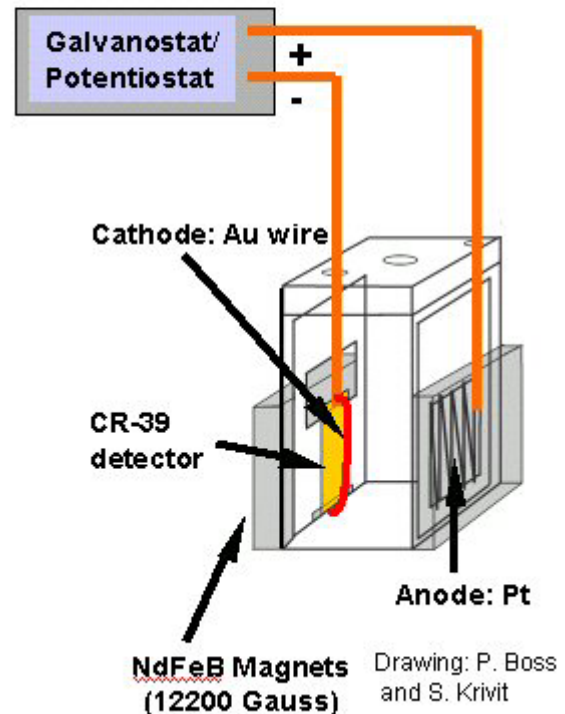
SPAWAR LENR Lab External Electric Field Cell Configuration

Note: These are non-technical sketches.
Do not use these as experimental guides.



SPAWAR LENR Lab External Magnetic Field Cell Configuration

Note: These are non-technical sketches.
Do not use these as experimental guides.



Like most LENR cells, SPAWAR's co-deposition experiments use two or three volts to electrolyze their cells. The group's electric field applies a modest 6,000 volts, across the cell.

Independent nuclear experts who have examined the CR-39 detectors recognize the signature tracks of protons and alpha particles, which, to be ejected from the atoms where they reside, require millions of volts – at least 1,000,000 times more energy than can be produced by any known chemical reaction.

The Power of Plastic

To gather evidence, the team plated a film of palladium particles and deuterium atoms onto a copper mesh or wires of platinum, gold, or silver about .25 mm in diameter. During the plating process, the cathode is in contact with a CR-39 detector in the cell to which the scientists had applied an external electric or magnetic field. After the experiments had completed their runs of eight to 11 days, Mosier-Boss and Szpak saw dense, cloudy areas on the portions of the detector near the cathode.

"The fact that the cloudy areas are observed where the detector was in close proximity to the cathode suggests that the cathode caused the cloudiness," Mosier-Boss said.

As a control, Mosier-Boss also exposed CR-39 detectors to electrolysis in a lithium solution without palladium in it. The result: only a sprinkling of tracks, randomly distributed and so few in number that they could be accounted for by background radiation.

She also immersed the detectors in the usual solution of palladium chloride and lithium chloride in deuterium but without applying the external electric current. The outcome was the same: no unusual shower of tracks from high-energy particles.

In contrast, a side-by-side comparison at identical magnification levels (see photo) of tracks left in CR-39 detectors by depleted uranium and a detector from one of SPAWAR's LENR experiments using an electric field show tracks that appear identical.

"Since the features look the same and since depleted uranium is giving off alpha particles," Mosier-Boss said, "it strongly suggests that the features observed for [our] experiment are also the result of high-energy particles."

Other researchers have used external fields; some have included CR-39 detectors in their cells. But the use of those two design elements in a co-deposition experiment is unique in the reported history of LENR research.

"This combination of co-deposition, external fields, and CR-39 detectors is new in the field," said David Nagel, a physicist and research professor at George Washington University and a former manager in the Office of Naval Research.

Nagel has monitored LENR research from the day that Fleischmann and Pons presented their news at a press conference.

Previous Use of CR-39 Detectors in LENR Experiments

The use of CR-39 detectors in LENR research isn't new. Andrei Lipson, a condensed matter physicist and vice director of a research group at the Institute of Physical Chemistry and Electrochemistry within the Russian Academy of Sciences, led a team that has performed LENR experiments using CR-39 detectors. [10]

He conducted this research with Alexei Roussetski from the Lebedev Physical Institute of the Russian Academy of Sciences and, later, with Eugenii Saunin, also of the Institute of Physical Chemistry, and George Miley, director of the Fusion Studies Laboratory at the University of Illinois.

But their experimental protocol was different, Mosier-Boss noted.

"Rather than searching for high track densities, their focus was more to determine the energies of the particles coming off of the experiments," she said. "While they did not register as many tracks as we see in our experiments, their etched detectors showed tracks that were morphologically similar to ours."

Lipson's group calculated that protons coming from the cathode had energies of 1.7 mega-electron volts, or MeV, and the alpha particles at 11 to 16 MeV – nuclear-scale energies in both cases.

In one notable test, University of Minnesota physicist Richard Oriani and his partner, John Fisher, suspended CR-39 detectors 1.5 cm above and below nickel and palladium cathodes. [11] Although their cell design and experimental method differed sharply from those of the SPAWAR group's, the detectors caught particles that Oriani and Fisher calculated to be traveling at energies of two mega-electron volts, a force liberated only through nuclear reactions.

A five-MeV particle will travel less than half a millimeter in the liquid environment of a LENR cell. The 1.5-cm distance “was the closest that Oriani and Fisher could place the detectors [to the palladium cathode] without impeding the uniform loading” of deuterons, Mosier-Boss explained.

She said that was not close enough to record most of the nuclear particles flying from the cathode.

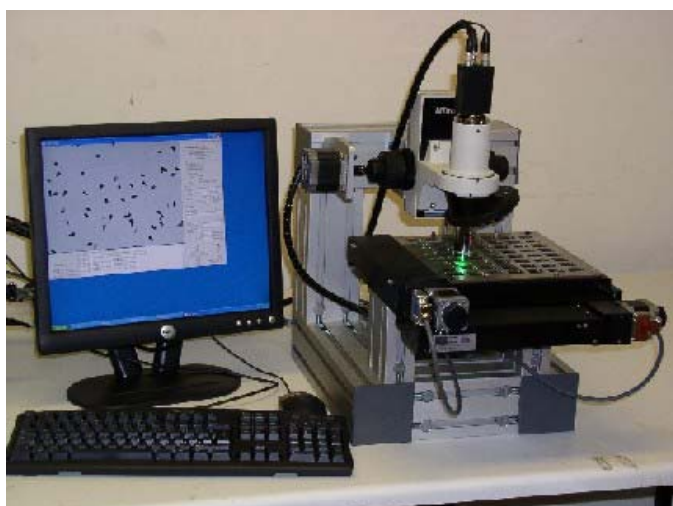
“In our experiments, the co-deposition reaction was performed with the cathode wire wrapped around the CR-39 detector,” she added.

“Oriani and Fisher reported charged particle track densities between 1.5 and 38 tracks per square millimeter; their controls yielded densities of 0.5 to 5.4 tracks per square millimeter,” Mosier-Boss said. [12]

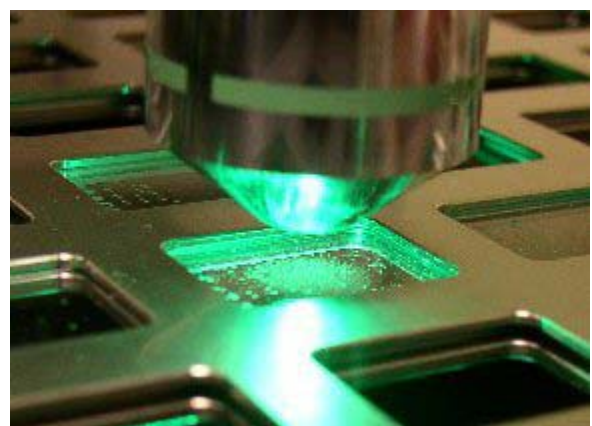
She was quick to emphasize that the results of the SPAWAR team’s co-deposition experiments can’t be compared directly with Oriani’s and Fisher’s because of the sharp differences in cell design.

“We conservatively estimate that our recent external field co-deposition experiments yielded track densities greater than 10,000 tracks per square millimeter in the cloudy areas,” she noted.

The SPAWAR team used a Track Analysis Systems CR-39 scanner to automate the counting of the tracks. However, the team did run into a small glitch: Many of the track densities exceeded the capacity of the machine. The experiment ran for seven days, yielding an average count of one reaction per minute per square millimeter.



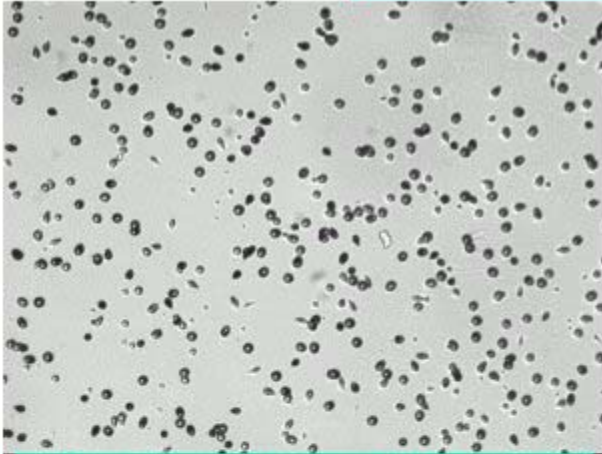
Track Analysis Systems' computerized image analysis system



Scanning an array of CR-39 detectors

The photos below show a control sample of particle emissions from uranium-238 on the top and the SPAWAR chips used in the LENR experiments on the bottom. The raw images are shown on the left and the counted tracks are on the right. The image from the LENR experiment shows one of the chips that exceeded the scanner's capacity, clearly indicating where the scanner stopped counting. (Click image for full-size photos.)

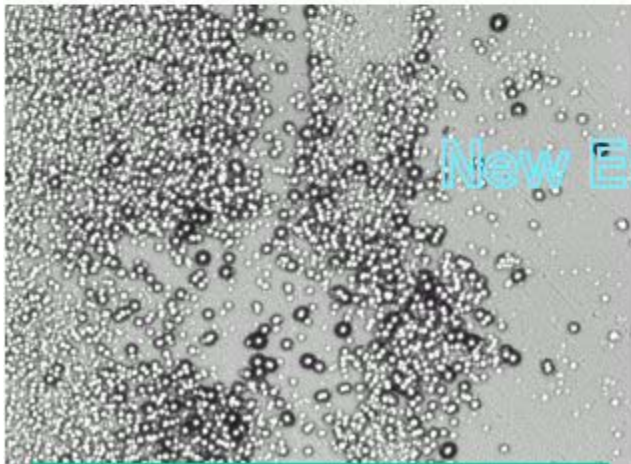
CR-39 Scanning Analysis



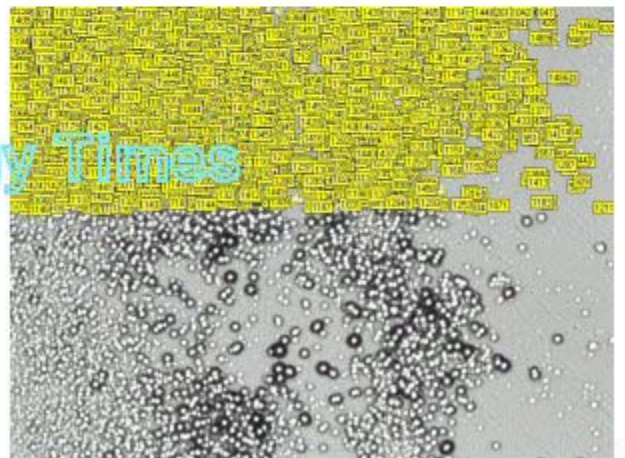
Tracks from Uranium-238 control



Track counting from Uranium-238



Tracks from LENR experiment



Track counting from LENR experiment

New Energy Times

Photos: Lawrence Forsley and Gary Phillips

“Because of the close proximity between the cathode and the detector,” Mosier-Boss added, “we have the optimum geometry to detect any particles that could potentially be emitted from the cathode. Put simply, these newer results are nearly three orders of magnitude greater than the Oriani-Fisher results.”

To help them identify specific kinds of particles and their energies, the SPAWAR researchers can rely on extensive studies that have calibrated such phenomena.

Scientists in the old Soviet Union, chronically short of money, used CR-39 detectors widely in their nuclear research and made a science of “reading” and classifying the distinctive pits that particular kinds of nuclear particles etched into the plastic chips.

In 2003, Lipson, Roussetski, Saunin, and Miley developed a calibration scale that mapped characteristics of CR-39 tracks to the types of charged particles producing the pits and their respective energies. [13] That work was funded by Lattice Energy LLC, a Chicago firm hoping to commercialize LENR technology.

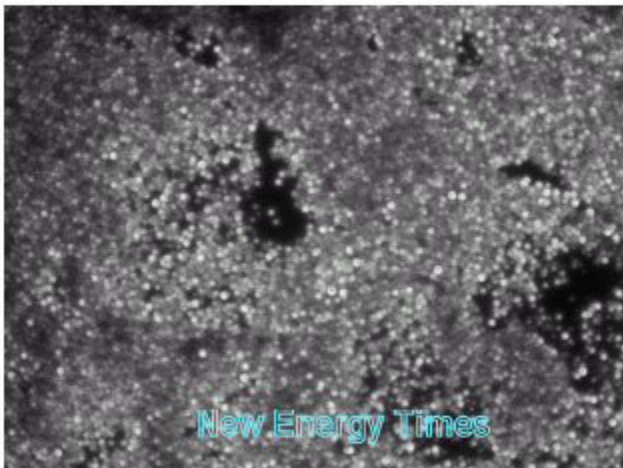
The SPAWAR group is working on a series of experiments that holds the detectors at different distances from the cathode. Because physicists know how far nuclear particles can travel in a given environment, the distances that particles travel will help the SPAWAR team determine just what kinds of particles their cathodes are emitting.

The SPAWAR team is optimistic about what those results will show. With the CR-39 detectors matching results from standard nuclear tests, “it’s hard to argue that this is not some kind of nuclear process,” Gordon said.

Extraordinary Evidence

SPAWAR scientists contend that their CR-39 detectors that captured the particles are physical evidence of not just low-temperature nuclear reactions but also reactions that are unusually intense.

Ni/Pd/D Evidence of Particle Emission in a Magnetic Field 200x Magnification



Numerous tracks caused by high-energy particles. When plated on Ni, tracks are homogeneous in size.

Conventional nuclear scientists well-versed in reading CR-39 detectors agree. A researcher (who asked not to be named) at a major research university was one of the first to analyze SPAWAR’s CR-39 detectors. He said that the detectors held far more tracks than he’d seen in his own inertial confinement fusion experiments.

Gary W. Phillips, a nuclear physicist and expert in CR-39 detectors is similarly surprised by what he saw in SPAWAR’s detectors. Phillips has used the detectors to record nuclear events for two decades.

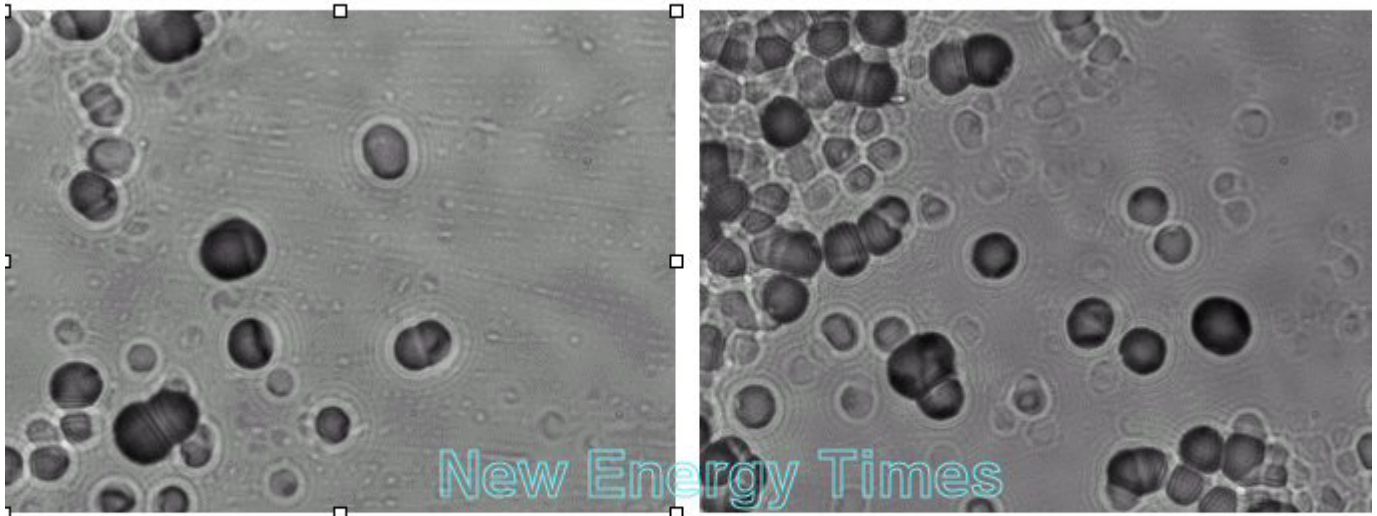
He said that the tracks recorded in SPAWAR’s CR-39 experiments are “at least one order of magnitude greater” in number than those in any other conventional nuclear experiments he’s seen.

Thousands of tracks from the LENR experiment are visible on this CR-39 detector
Photo: Pamela Mosier-Boss

The evidence recorded in SPAWAR Systems Center's CR-39 detectors are "at least one order of magnitude greater" in number than those in any other conventional nuclear experiments he's seen in his 20 years of related experience.

"I've never seen such a high density of tracks before," Phillips noted. "It would have to be from a very intense source – a nuclear source. You cannot get this from any kind of chemical reaction."

Ag wire/Pd/D in Magnetic Field



Dr. Gary Phillips: "They show a number of double tracks which you would see from a reaction that emits two particles of similar mass and energy."

Photos: Pamela Mosier-Boss

Mosier-Boss calls the detectors "the most compelling evidence to date that nuclear reactions are occurring inside LENR cells."

As a bonus, CR-39, like photographic film, is a form of detector known as constantly integrating. Mosier-Boss explained the benefit.

"Our experience so far has shown that particle emissions occur in bursts in LENR cells," she said. "In our experiments, we have a few moments of activity and then, usually, even longer periods of inactivity. When this happens, if we were using electronic counters, the bursts would be averaged out over time."

As a result, the density of the resulting emissions wouldn't show up.

"But when we use a detector like CR-39 or photographic film," Gordon said, "the event is permanently stamped on the medium. When other events happen, they, too, are stamped; the record is cumulative."

"The detectors are like a permanent cloud chamber," he said.

"Because CR-39 detectors aren't electronic," he added, "no one can argue that the observed effects are the result of electronic noise."

"As hard as it might seem to refute the evidence engraved into these deceptively simple detectors, skeptics still try, leveling the usual charges that the scientists are setting up their equipment incompetently, making math errors in their calculations, or reading their data incorrectly.



Lawrence Forsley
Photo: Steven Krivit

The critics' objections just don't wash, according to Lawrence Forsley, president of JWK Technologies Corp., which is carrying out research and development with SPAWAR on condensed matter nuclear science. Forsley has been involved with inertial confinement, mirror and tokamak fusion for 15 years.

"For example," he said, "a five-MeV proton will travel 0.4 millimeters in the liquid environment of a LENR cell and a 32-MeV proton can travel 10 millimeters. To claim that the particle came from somewhere outside the cell means that either it was an energetic neutron which hit a proton causing a knock-on reaction, or the source was a proton with over 32 MeV of energy when it hit the cell, traveled 10 millimeters through the liquid within the cell, and had enough energy left over to damage the CR-39 chip. And the source of a 32 MeV charged particle would be new science and be even more difficult to explain than LENR. So, by Occam's Razor, what you see is what you've got."

There are other possible sources, he acknowledged.

"The Earth is radioactive, after all: thorium and uranium isotopes, radon," Forsley said. "However, it takes a lot of time to get many tracks from these."

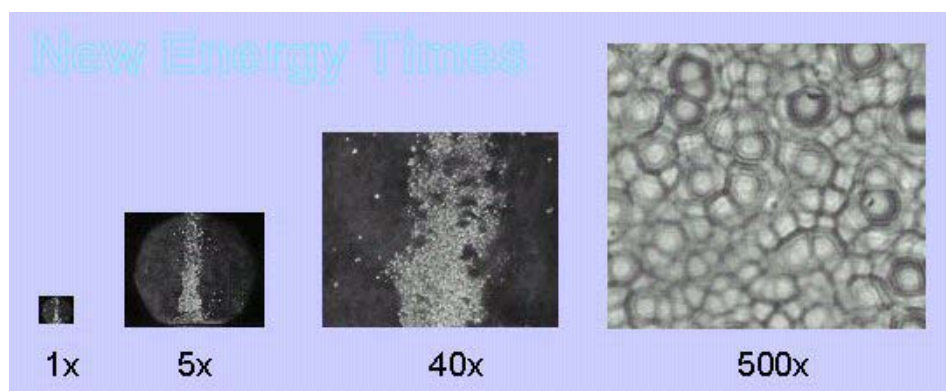
He said that would take vastly more time than the few days or sometimes hours that Mosier-Boss and Szpak run their cells. Also, he noted, external sources likely would leave tracks scattered randomly across the detectors, not concentrated in the region of the electrode, as the SPAWAR detectors show.

While not quantitative, you can see the evidence of the tracks on the CR-39 detectors with the naked eye.

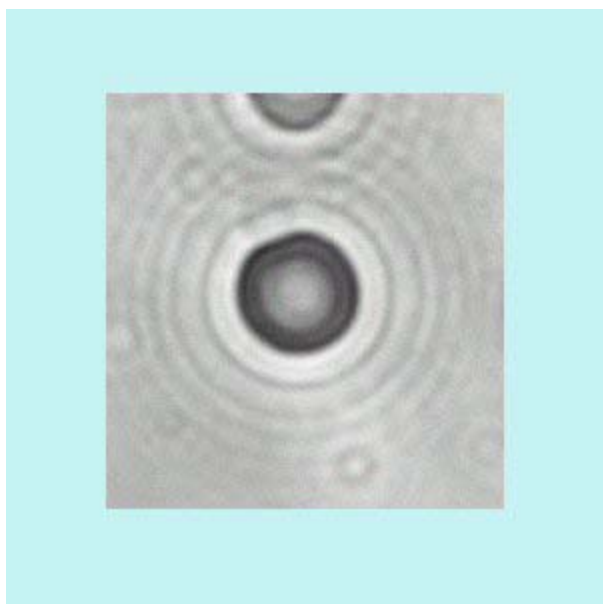
“Unless it was a very broad piece of material emitting the particles,” Forsley said, “a foreign source inside the cell would be detectable by the radial distribution of elliptical tracks. The tracks would be threadlike trails traveling diagonally through the material, which SPAWAR’s detectors don’t show. A point source would be obvious.”



CR-39 detector after exposure to LENR experiment. Detector shows—to the naked eye—the clearly marked pattern of the three cathode wires used in the experiment. Photograph is actual size, zero magnification. Photo: Steven Krivit



Magnification of one region of the CR-39 detector above
Photos: Pamela Mosier-Boss



The impact on the CR-39 detector displays symmetrical concentric rings suggesting that the source of the particle is a specific point source perpendicular to the detector.
Photo: Pamela Mosier-Boss

Periodically, doubters suggest cosmic rays as the source of nuclear signatures, but Forsley dismisses the notion.

“If the rain of cosmic rays was enough to account for the intensity of the tracks visible on these detectors,” he said, “we’d all be cooked.”

Fleischmann and Pons could only speculate that, because their cells were putting out more heat than could be accounted for by chemical means, the effect they recorded was nuclear.

“We now have hard, permanent data in CR-39 detectors,” Gordon said. “There is a lot more experimental data in the field that suggests nuclear reactions are occurring.”

He said that most data, which is gathered by various complex laboratory analyses, instrumentation, and measuring devices, “suffer from being easy targets for unsubstantiated claims that the experiments were flawed or that the data isn’t convincing for one reason or another.”

SPAWAR's new evidence may even be enough to remove the taboo from serious discussions of low-temperature nuclear events. In early September, Mosier-Boss made a presentation on the work to a SPAWAR panel of scientists charged with allotting internal research funds.

"The panel included one individual who has been very skeptical," Gordon noted. "He came to us afterward and said, 'It's clear that there's some kind of nuclear process going on.'"

Seventeen years earlier, the same scientist bet a colleague of Mosier-Boss \$20 that Fleischmann and Pons had made a colossal blunder. Although he isn't willing to pay up, he did vote with the panel's majority to support Szpak and Mosier-Boss's research proposal.

"It looks like we'll have internal funding for the first time in more than 15 years," Gordon said.

However, conventional physics continues to patrol one particular intellectual fence separating itself from LENR's implications. Since 1989's Fleischmann-Pons episode, physicists have been able to dismiss any ideas that LENR cells initiate nuclear events by pointing out that there were no deep-fried scientists, no extra-crispy graduate students, littering the labs where the experiments were conducted.

If these events were nuclear, traditionalists argue, the experiments would spew neutrons in such profusion that no living thing in a normal-size lab would escape damage.

At the American Physical Society's special conference on cold fusion in May 1989, many researchers showed that they had looked assiduously for high-energy neutrons in their experiments and could find none.

The absence of this expected byproduct of nuclear fusion was traditionalists' chief excuse to dismiss claims of "cold fusion" as absurd.

But by now, after tens of thousands of experiments and a steady search for high-energy neutrons, it is clear to LENR scientists that their cells don't produce high-energy neutrons as the dominant, or even a prominent, product. Some researchers do register a few neutrons coming from their cells, but their quantity, as well as their energies, are negligible.

A New Buzz

Results such as those from SPAWAR's experiments, as well as LENR researchers' sheer persistence, are inching the field closer to respectability.

"There's a lot more buzz in government and commercial circles about LENR," Nagel said. "People are saying that maybe we're not all crazy."

Gordon noted that several people approached him during the conference.

"They appreciated my presentation," he said, "and they had no idea that these things were happening in the field."

Although the U.S. Department of Energy has yet to fund studies in the area, the Defense Advanced Research Projects Agency, long known for boldness in funding research, has been

funding small LENR projects quietly for many years and recently has taken a renewed interest in the subject.

“That’s significant because agencies are more comfortable funding what someone else already is funding,” Nagel pointed out. “At some point, this research will take off when the agencies can benefit from the mutual due diligence that each has performed on the subject and feel more confident about not only its reality but its importance.”

Gordon has learned to be philosophical.

“I dragged some nuclear scientists to our National Defense Industrial Association conference booth and engaged some of them in discussions,” he said. “I don’t think they want to talk about this because it challenges their beliefs and they don’t have answers.”

New Energy Times spoke with some of them, but few offered comments.

One said the evidence captured by the detectors was "inexplicable." He also said the SPAWAR researchers should have searched for high-energy neutrons, which are characteristic of conventional nuclear reactions and are consequently easily detectable.

"Any nuclear physicist would have done that," he said.

That would have been a reasonable comment in March 1989 but not now, after numerous LENR experiments have done just that. The fact that Fleischmann, Pons and the hundreds of other experimenters have not died is proof that these experiments do not yield high-energy neutrons or strong gamma radiation.

Indeed, it has become increasingly hard for scientists bound by convention to dispute the mounting data from SPAWAR and other LENR labs.

“We’ve been publicly quiet but scientifically rigorous,” Gordon said. “At SPAWAR Systems Center, we haven’t called press conferences, but we have followed the scientific process of carefully performing experiments and reporting the results in peer-reviewed journals – 15 papers so far.

“We’ve conducted very few experiments looking for excess heat because it’s very difficult to perform good calorimetry.”

Critics can, too easily if erroneously, dismiss claims of anomalous heat. “Did the researcher get the settings right? Or they didn’t do this right, they didn’t account for that,” Gordon said. “Besides, heat evidence doesn’t tell you much about what’s actually happening.”

By using CR-39 detectors, he said, “we’re using instrumentation that the nuclear industry has accepted and used for decades. Even if some skeptics might claim that our experiment is flawed, it’s still producing charged particles. Our experimental results provide compelling evidence that nuclear events are occurring.”

Skeptical physicists asking whether the SPAWAR group performed a quantitative energy analysis were unable to find any such results. However, skeptics are left to confront the fact that only two sources of energy affecting the test cells. The first is a few volts from the current

applied through electrolysis; the second is the external electric field of about 6,000 volts. The particle tracks look identical to tracks made by nuclear particles that have at least 2 million electron-volts.

Because particles carrying millions of electron-volts of energy aren't created by reactions powered by a few thousand volts at most, a larger question lingers: What is the source of the anomalous energy that seems to be arising from within the LENR cells?

"We don't make claims that we've developed a new energy source," Gordon emphasized. "Our hope is that, by developing an understanding of the processes and how to stimulate them, we'll be able to use this knowledge for whatever benefit it may offer."

In the same spirit, he offered no theories to explain the nuclear process he suspects is taking place along those thin layers of palladium in his group's cells.

"There's a saying, 'Theory guides but experiments decide.' Consider our data," he exhorts challengers. "If it is what it appears to be, and the scientific community confirms it through replications, then new theories will need to be considered, and this may be challenging for some people to accept."

Still, not everyone is ready to make room for LENR research in mainstream science. One afternoon at the National Defense Industrial Association conference, Gordon and Mosier-Boss were chatting at their booth with Farrell and a small group of colleagues when Shawn Carlson, a nuclear physicist, stopped by.

Carlson, who served as master of ceremonies at many of the conference's panel discussions, is a MacArthur Foundation "genius grant" winner who first gained fame by debunking pseudoscience and once made a statue of the Virgin Mary cry on television.

As he began to spar with others in the group about those pesky neutrons, branching ratios, and other points of contention sparked by those simple, cloudy plastic detectors lying on a display table nearby, a grin spread across Gordon's face.

"This is great," he beamed. "In the old days, we couldn't even start conversations like this."

* Bennett Daviss is a science writer based in New Hampshire. Steven Krivit writes for and publishes *New Energy Times*, a Webzine specializing in low energy nuclear reaction research.

* For researchers interested in performing a replication of this experiment, please see the Galileo Project Web site, (thegalileoproject.org) for more information.

[Frank Gordon's NDIA Slide Presentation](http://newenergytimes.com/Library/2006GordonF-NDIAPresentation.pdf)

<http://newenergytimes.com/Library/2006GordonF-NDIAPresentation.pdf>

[Pamela Mosier-Boss's NDIA Slide Presentation](http://newenergytimes.com/Library/2006BossP-Pd-D-NDIA-Presentation.pdf)

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[New Energy Institute Short \(non-technical\) Video Documentary](http://www.youtube.com/watch?v=Ke_ZhgAKjhs)

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