DANIEL CLERY Dan is a deputy news editor for *Science*.

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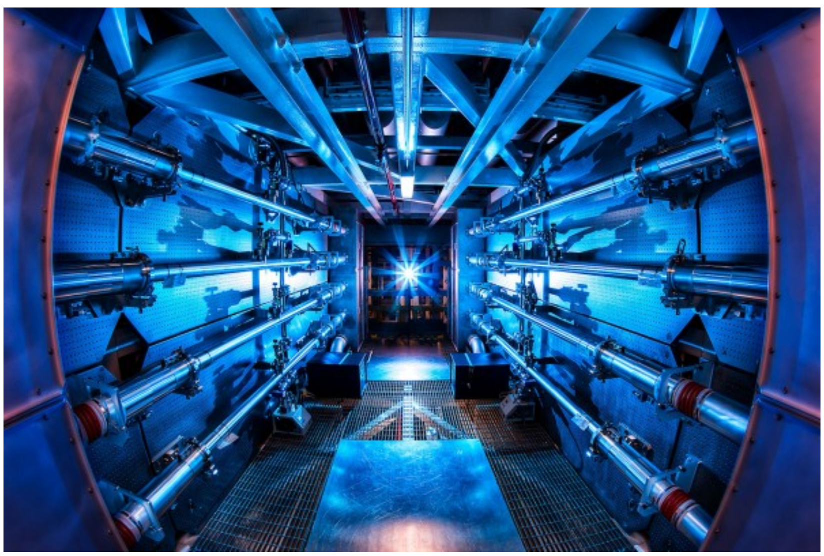
Fusion "Breakthrough" at NIF? Uh, Not Really …

10 October 2013 12:15 pm | 15 Comments



Lawrence Livermore National Laboratory/Wikimedia

Science reporting breakdown? Press reports of a breakthrough at the National Ignition Facility, a powerful U.S. laser system, turned out to be a bit of hype.

One unintended effect of the U.S. federal shutdown is that helpful press officers at government labs are not available to provide a reality check to some of the wilder stories that can catch fire on the Internet. They would have come in handy this week, when a number of outlets jumped on a report on the BBC News website. The National Ignition Facility (NIF) at Lawrence Livermore National Laboratory in California, it reported, had passed a "nuclear fusion milestone." NIF uses the world's highest energy laser system to crush tiny pellets containing a form of hydrogen fuel to enormous temperature and pressure. The aim is to get the hydrogen nuclei to fuse together into helium atoms, releasing energy.

The BBC story reported that during one experiment last month, "the amount of energy released through the fusion reaction exceeded the amount of energy being absorbed by the fuel - the first time this had been achieved at any fusion facility in the world." This prompted a rush of even more effusive headlines proclaiming the "fusion breakthrough." As no doubt NIF's press officers would have told reporters, the experiment in question certainly shows important progress, but it

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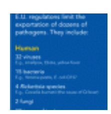

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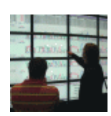

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is not the breakthrough everyone is hoping for.

A memo sent out on 29 September to collaborating labs from NIF Director Ed Moses—which has been seen by *Science*—describes a fusion shot that took place at 5:15 a.m. on 28 September. It produced 5×10^{15} neutrons, 75% more than any previous shot. Neutrons are a product of fusion reactions, so they are used as a measure of success.

For fusion experiments, NIF directs 192 laser beams from all directions at the fusion target in a pulse that carries 1.8 million joules (MJ) of energy. The outer part of the target is a tiny metal can the size of a pencil eraser, called a hohlraum, at the center of which sits a plastic sphere smaller than a peppercorn containing frozen fusion fuel—a mixture of the hydrogen isotopes deuterium and tritium, known as DT. The ultraviolet beams are fired into the hohlraum through holes at each end but not directly at the fuel capsule. Instead they hit the inner walls of the hohlraum, heating it so much that it emits a pulse of x-rays. The x-rays cause the plastic capsule to explode, driving the fuel inward toward its center.

If all goes according to plan, the fuel—compressed to 100 times the density of lead—will ignite a fusion reaction, but the laser-driven implosion does not provide enough energy to burn all the DT fuel. Some energy from the fusion reactions is needed to keep the burn going. DT fusion reactions produce two products: helium nuclei (aka alpha particles), which carry 20% of the reaction energy as kinetic energy; and neutrons, which carry the rest. For fusion to work as an energy source, the alpha particles must efficiently heat up the fuel to keep the reaction running.

To achieve this, NIF researchers have been experimenting with the shape of the laser pulse to make it deliver more power near the beginning. In his 29 September memo, Moses says these improvements had led to alpha-particle heating that doubled the energy yield—"a clear demonstration of the mechanism that is needed to achieve ignition," he wrote. Ignition is the goal of a self-sustaining, alpha-heated fusion burn producing more energy than the laser put in. Moses also says the energy yield (carried by the neutrons and estimated at 14 kilojoules) was more than the x-ray energy absorbed to implode the capsule, a milestone he refers to as "scientific breakeven."

“It is a good experiment,” says Michael Campbell, a former director of NIF who now works for Logos Technologies in Fairfax, Virginia. “From a science standpoint, the target worked well enough for alpha particles to heat some of the fuel.” But Campbell is concerned about overhyping each step in what is bound to be a long haul toward fusion as an energy source. The energy yield in last month’s experiment is still a very long way from ignition, the goal—enshrined in NIF's name—that the facility was expected to reach a year ago. NIF is now partway through a 3-year campaign to nail down why it is struggling to reach that goal. “It’s a science-based program now. They are trying to identify some of the obstacles to getting to ignition,” Campbell says.

One requirement for ignition is that energy output should exceed the energy input from the laser, i.e., that gain (output divided by input) should be greater than 1. NIF's laser input of 1.8 MJ is roughly the same as the kinetic energy of a 2-tonne truck traveling at 160 km/h (100 miles/h). The output of the reaction—14 kJ—is equivalent to the kinetic energy of a baseball traveling at half that speed. Numerically speaking, the gain is 0.0077. The experiment “is a good and necessary step, but there is a long way to go before you have energy for mankind,” Campbell says.

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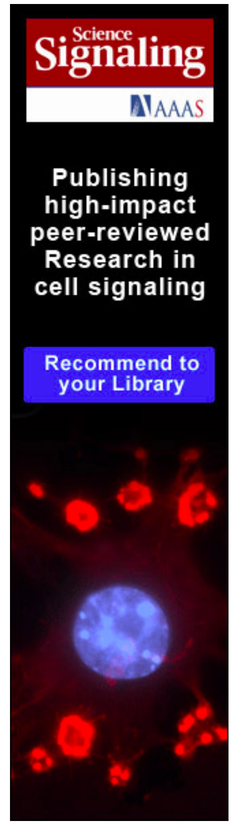

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Avatar **Donald Jasby** • 4 days ago
How do the Livermore researchers know what minute fraction of the laser energy was instrumental in heating the DT fuel capsule?

Only from computer simulation, which has been erroneous up to this point.

And no-one mentions that the electrical energy input to the laser system in each pulse is at least 50,000 times the fusion energy produced in that pulse.

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Avatar **Ignacio Mosqueira** → Donald Jasby • 2 days ago
Computer simulations are reliable for some things and not for others. Simulations may not reveal every problem you will encounter during an experiment but they can certainly calculate the energy budget of the experiment.

The point here is that while this experiment hardly constitutes a proof of concept of the feasibility of fusion as an energy source there is absolutely NOTHING WRONG with putting out scientific progress along the way. In fact, after reading this article I was motivated to look into recent progress on this field and it turns out there is all kinds of progress that I was unaware of.

I am keenly aware of the deleterious effect of the media on science. I live with it on an ongoing basis.

But even if this news release leads to confusion, as I am sure it will, it was still important to report progress in this field.

This is self-evident to me and I trust to others as well.

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Avatar **someguy** → Donald Jasby • 4 days ago
They counted neutron emissions. Apparently, fusion spits out neutrons, whereas lasers don't.

1 Reply Share ›

Avatar **Donald Jasby** → someguy • 3 days ago
The neutron count determines the OUTPUT energy. My comment addressed the INPUT energy to the fuel capsule, which cannot be measured. It is deduced from computer simulations, which usually have dozens of adjustable parameters.

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Avatar **Guest123** • 4 days ago
Scientists are making progress on the quest for fusion power. Why is that not news? Making a headline that there was a breakthrough in no way suggests that the energy output exceeded the energy input and the content of the article was quite clear and in no way misleading.
I could paraphrase this article as "Snot snort, oh my god like...snort".

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Avatar **AlainCo** • 4 days ago
It is funny to see their loose calorimetry based on model, their huge unfounded announces... as if they just were calling their budget not to be shutdown.

while they ridicule the cold fusion guys who prove +500% heat ... not through modeling, but to IR cam or water flow...

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