U.S. FUSION RESEARCH

# NIF Report Asks for More Time to Achieve Ignition

The National Ignition Facility (NIF) faces an uncertain future after its managers admitted to Congress this month that they need at least another 3 years to try to identify what has prevented the giant laser fusion lab in California from achieving ignition.

The report sharpens an ongoing debate between those who say that NIF is essential to the maintenance of the nuclear weapons stockpile and opponents who claim that NIF is a boondoggle. NIF officials believe that major cuts in the facility's $450-million-a-year operating budget could slow progress. But obtaining enough funding could be difficult given the intense pressure to reduce domestic spending.

When NIF went into full operation in 2009, the facility's managers confidently predicted achieving ignition—a self-sustaining fusion reaction that produces excess energy—before the end of fiscal year 2012. That didn't happen, however, and this month's report, mandated by Congress, doesn't attempt to set a new goal. "At present, it is too early to assess whether or not ignition can be achieved at the National Ignition Facility," wrote Thomas P. D'Agostino, head of the National Nuclear Security Administration (NNSA), which manages NIF at Lawrence Livermore National Laboratory, in the report.

That uncertainty shouldn't count against NIF, say its supporters. "That's the nature of science. It would be absurd to build it and not use it," says Representative Zoe Lofgren (D–CA), whose district abuts the Livermore lab. But Marylia Kelley, director of the Livermore-based campaign group Tri-Valley Communities Against a Radioactive Environment, says: "NIF is actually taking money away from good science and needs to be held accountable."

NIF, which cost $3.5 billion to build, attempts to create a burning fusion plasma by explosively compressing a small capsule of hydrogen fuel with powerful laser beams. Ignition is achieved when the fusion burn is both self-sustaining and produces more energy than the laser pulse that sparked it. A burning fusion plasma, which powers stars and H-bombs, could in theory provide clean and virtually limitless energy.

But NIF's primary goal is to help maintain America's nuclear arsenal. Weapons scientists use it to verify their computer simulations of how bombs operate and to test components for blast-hardness. Ignition is crucial for both energy and weapons goals.

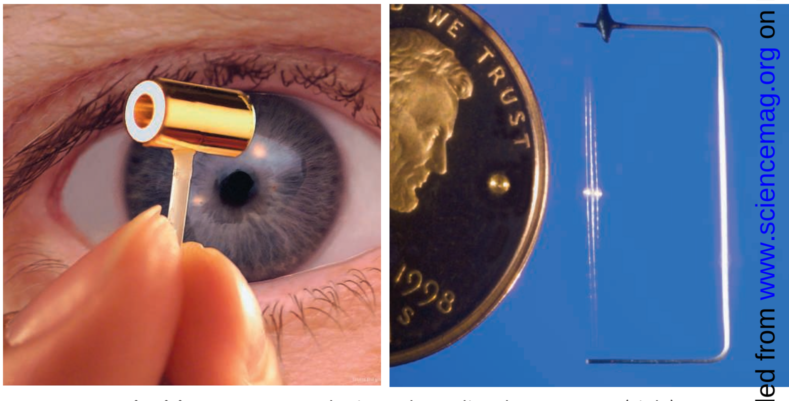
NIF scientists have relied heavily on work with earlier lasers and computer modeling to develop a design for the target—a peppercorn-size sphere full of frozen hydrogen isotopes—and the shape of the laser pulse needed to implode it. Those models predicted that NIF should already be producing ignition. And while NIF's laser, diagnostic instruments, and target fabrication have met or exceeded specifications, the physics of the implosions remains a puzzle.

"The disagreement between NIF experimental data and codes and models reflects an inadequate understanding of key physics issues," the report says. "Mother Nature kind of won on this one," says Mary Hockaday, deputy associate director for weapons physics at Los Alamos National Laboratory in New Mexico and one of the lead authors of the report.

NNSA has proposed a 3-year program to investigate those key physics issues and develop models that are better able to predict what is actually happening. "NIF was sized to do it, and we still believe it's possible," says Christopher Deeney, assistant deputy administrator for stockpile stewardship at NNSA.

NNSA plans to request funding for the new program "not quite at the level in FY2013, but not down significantly," Deeney says. But the current proposed level may not hold up. Senator Dianne Feinstein (D–CA), chair of the Senate Appropriations Subcommittee on Energy and Water Development, writes in an e-mail that "the committee must be assured of substantial progress toward NIF's goal of achieving stockpile stewardship or the $450 million annual cost of operations will be difficult to justify."

The NNSA report says the new program should explore alternatives to the indirect drive approach now used at NIF, in which the laser beams heat a gold cylinder the size of a pencil eraser that surrounds the target. Researchers at the University of Rochester's Laboratory for Laser Energetics and the Naval Research Laboratory in Washington, D.C., have spent decades working on the alternative approach—direct drive—in which the laser beams shine directly onto the target capsule. "Nine times as much energy ends up on the capsule containing the fuel," says Robert McCrory, director of the Rochester lab. The other proposed back-up is a technique devised with Sandia National Laboratory's Z machine that uses huge electrical pulses to crush fusion fuel magnetically.




**Two routes to ignition.** One approach aims a laser directly at a target (*right*), while another uses them to first heat a tiny gold container.

"Indirect drive is still the focus," Deeney says. "If indirect drive encounters problems, we can change horses. But there is no evidence the other approaches won't have the same problems."

The NNSA report assures legislators that the failure, thus far, to achieve ignition will not undermine the safety of current weapons. It says scientists can use results from the underground testing program (which ended in 1992) as well as data from monitoring the weapons themselves.

But the current problems with models and simulations limit the extent to which weapons scientists can use them to modify existing weapons. Critics point to that fact in arguing that NIF's true goal is to keep weapons designers usefully employed in case they are needed to develop new weapons. "You do not need a giant laser to maintain the stockpile we have," Kelley asserts.

**–DANIEL CLERY**

CREDITS (LEFT TO RIGHT): LAWRENCE LIVERMORE NATIONAL LABORATORY; EUGENE KOWALUK/LABORATORY FOR LASER ENERGETICS





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