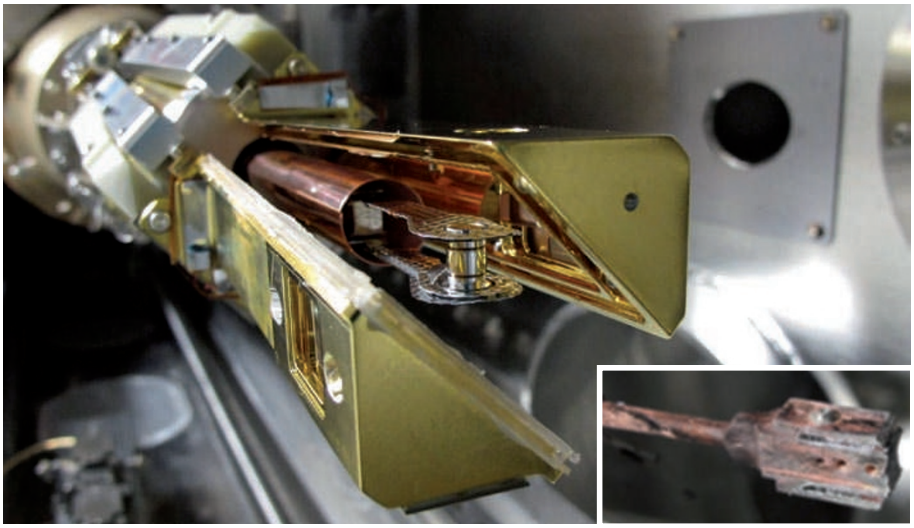
FUSION

# Superlaser fires a blank

*The US National Ignition Facility cautiously approaches the fusion threshold.*

**BY EUGENIE SAMUEL REICH**



LLNL

An ignition target with its protective shroud open and the target assembly (inset) after the recent test shot.

This was to be the year the giant match would light a fire. The National Ignition Facility (NIF), the world's most powerful laser, would trigger ignition in a mixture of hydrogen isotopes by achieving a pressure of 100 billion times Earth's atmosphere and a temperature of 100 million °C. At that point, fusion reactions in the target would produce more energy than the laser consumes. But, an announcement earlier this month about the first full test of the laser — with its price tag in excess of US$3.5 billion — reveals how far off that goal still lies.

In the latest experiment, on 28 September at Lawrence Livermore National Laboratory (LLNL) in California, NIF's 192 laser beams were, for the first time, used on a solid target. A suite of 26 diagnostic instruments kept watch as the beams hit the target — a cryogenically cooled mixture of deuterium, tritium and hydrogen, held within a gold can called a hohlraum. "From the point of view of showing the facility's capability it was spectacular. Everything worked," says NIF director Ed Moses. But despite being billed as an 'ignition experiment', the capsule deliberately wasn't stocked with the mix of isotopes needed for fusion to occur, and the power of the shot was well short of that needed for ignition, because of concerns that the optical elements used to focus the beams might be damaged by anything higher.

During the test, the laser drew 1 megajoule ($10^6$ joules) of energy, much higher than the 0.7 megajoules achieved during experiments in late 2009, but 1.4–1.5 megajoules will be needed for fusion (see 'Inching towards fusion'). "This is not a shot at ignition. It is a proper first test," says David Hammer, a professor of nuclear energy engineering at Cornell University in Ithaca, New York. In 2005, Hammer wrote a report for the JASONs, an independent panel that advises the US government on defence matters, contending that NIF would not achieve fusion this year, as planned. Partly because of the optics issue, NIF isn't expected to achieve ignition before 2012.

NIF was approved in 1993 with a dual goal: to produce data on fusion reactions relevant to nuclear weapons, and to explore laser fusion as a source of clean energy. Its first few years were marked by accusations of poor management and cover-ups of technical problems. In 2000 it was overhauled, and the goal of ignition by 2010 was set in a Department of Energy (DOE) budget request to Congress in 2006. NIF's construction was completed in March 2009, and in testimony to Congress this year, Thomas D'Agostino, DOE under secretary for nuclear security, scaled back the 2010 goal to 'ignition experiments', which he said would demonstrate that ignition could be achieved without actually triggering it.

Because the concentration of energy on some of the laser's optical components is higher than has ever been attempted, the potential for damage due to overheating has slowed progress. Many of NIF's optical components had to be replaced before this latest experiment, and questions remain about how the system will cope with the energies needed to achieve ignition. "We don't claim we understand every single detail," says Moses.

Long-term NIF critic Stephen Bodner, a former director of the laser-fusion programme at the Naval Research Laboratory in Washington DC, says that despite the recent progress there are still serious questions about whether the facility will ever reach ignition. In a paper published online in January (S. H. Glenzer *et al. Science* **327,** 1228–1231; 2010), the NIF team reported that in the December 2009 test, more than 90% of the laser's energy was delivered to the hohlraum, which is meant to concentrate radiation on the pellet of isotopes. But Bodner says that rumours have circulated suggesting that as much as half of the energy was scattered out. Steve Haan, lead designer of ignition targets for NIF at the LLNL, says that, after the paper was submitted, physicists found that around one-sixth of the 192 beams were losing an additional 30–40% to scatter, somewhat more than originally thought.

Siegfried Glenzer, NIF's lead experimentalist, says that number isn't too meaningful because it doesn't take account of amplification of the beam by interaction with plasma from the hohlraum walls. He adds that the overall efficiency of energy delivery in the recent experiment was 88%. Hammer says he expects that the scientific community will learn the full story from presentations by the NIF group at the American Physical Society Division of Plasma Physics meeting in Chicago, Illinois, in November. ■

## INCHING TOWARDS FUSION

A 1-megajoule (MJ) test shot that delivered 0.88 MJ of energy to an ignition target has brought the US National Ignition Facility closer to it goal. About 1.4–1.5 MJ will be needed to ignite fusion.