World's largest laser gears up for ignition experiments

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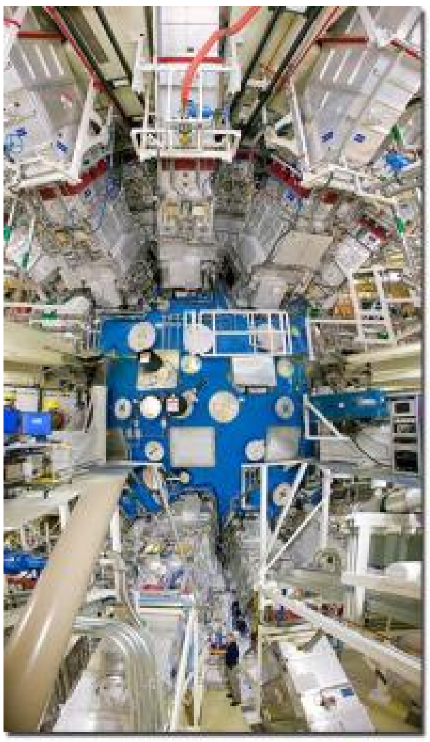

Composite photo shows all three floors containing the 264,000-pound, 10-meter diameter target chamber. Diagnostic instruments will be attached to the round hatches. Photo montage by Jacqueline McBride

(PhysOrg.com) -- Construction of the National Ignition Facility (NIF), the world's largest and highest-energy laser system, was essentially completed on Feb. 26, when technicians at Lawrence Livermore National Laboratory (LLNL), where the laser is located, fired the first full system shot to the center of the NIF target chamber.

The test was the first time all 192 laser beams converged simultaneously in the 10-meter-diameter chamber. NIF has met all of its project completion criteria except for official certification of project completion by the U.S. Department of Energy, due by March 31.

"This a major milestone for the greater NIF team, for the nation and the world," said Edward Moses, LLNL's principal associate director for NIF & Photon Science. "We are well on our way to achieving what we set out to do - controlled, sustained nuclear fusion and energy gain for the first time ever in a laboratory setting."

"Although not required for formal completion of the NIF Project," added Project Director Ralph Patterson, "it is extremely satisfying to wind up the project by firing all beams."

An average of 420 joules of ultraviolet laser energy, known as 3-omega, was achieved for each beamline, for a total energy of more than 80 kilojoules (a joule is the energy needed to lift a small apple one meter against the Earth's gravity).

The energy level will be increased during the next several months, and when all NIF lasers are fired at full energy, they will deliver 1.8 megajoules of ultraviolet energy to a BB-sized target in a 20-nanosecond shaped laser pulse, generating 500 trillion watts of peak power -- more than the peak electrical generating power of the entire United States. This is considered more than enough energy to fuse the hydrogen isotopes of deuterium and tritium in the target into helium nuclei (alpha particles) and yield considerably more energy in the process than was required to initiate the reaction.

For the past several weeks scientists and technicians have been conducting readiness tests within the NIF. "The system already has produced 20 times more energy than any other laser system, and will triple that number in the months ahead," Moses said. "NIF is well on its way to producing breakthroughs in science never imagined. Through our readiness testing we will see glimpses of what that future will bring."

The facility will hold an official dedication ceremony on May 29. Scientific experiments will start as soon as this spring, including high-energy-density studies in support of the National Nuclear Security Administration (NNSA)'s Stockpile Stewardship Program. The program ensures the safety and security of the nation's nuclear weapons stockpile.

Later in the year, the National Ignition Campaign, a multi-institutional effort that will take NIF from a construction project to routine operations as a highly flexible high-energy-density science facility, will begin conducting a series of shots to prepare for the first credible attempts at ignition planned for late 2010.

In addition its work in stockpile stewardship, NIF will be a key player in providing energy security for the United States.

By demonstrating the ability to attain fusion ignition in the laboratory, NIF will lay the groundwork for future decisions about fusion's long-term potential as a safe, virtually unlimited energy source. Fusion, the same energy source that powers the stars, produces no greenhouse gases and is environmentally more benign than fossil-fuel or nuclear-fission-based energy.

NIF also is an important tool for astrophysicists engaged in the study of how materials change when they are subjected to the tremendous gravitational pressures inside planets.

At last month's annual conference of the American Association for the

Advancement of Science in Chicago, Raymond Jeanloz, professor of earth and planetary science at UC Berkeley, discussed research that he and his colleagues will carry out on NIF.

"NIF has given us a real breakthrough experimentally, so we can actually study the properties of matter at these conditions," Jeanloz said. "This is a new kind of chemistry of materials that we're on the brink of being able to explore."

"That NIF is now well on its way to initial ignition experiments in 2010 is a tribute to the ingenuity, dedication and hard work of an extraordinarily talented team of scientists, engineers and technicians, supported by an equally talented and energetic administrative staff," Moses said.

"The year 2010 will mark the golden anniversary of the demonstration of the first laser and the concept of inertial confinement fusion," he said. "Our goal is to achieve fusion ignition and burn, launching a new era of high energy density science and energy research. As a national and international user facility, NIF will provide unique opportunities to expand the frontiers of science in areas that will help safeguard our national and global security, provide alternatives for clean energy in the future, and enhance our understanding of the universe.

"We have an incredible amount to do and an incredible amount to learn," Moses said. "Completing the construction project and transitioning NIF to an operating facility is something we're very proud of, and what we're about to do with it will be even better."

The last of NIF's 6,206 various optical-mechanical and controls system modules, called "line replaceable units" or LRUs, was installed on Jan. 26. The first LRU, a flashlamp, was installed on Sept. 26, 2001.

Workers have aligned and tuned NIF's final optical assemblies, which focus and convert the frequency of the project's 192 laser beams as they enter the target chamber and converge on the tiny target. Experimental systems and diagnostics are also being installed. Software for the integrated computer control system, which handles shot automation, has been completed.

Charles H. Townes, who won the 1964 Nobel Prize in physics for developing the laser, visited NIF on Dec. 19 and said he was "amazed" by the facility's capabilities. "When I was inventing the laser and hoping to build the first one, I was hoping to get...milliwatts of power with a small laboratory device. I just never imagined anything like this coming out of it."

Provided by Lawrence Livermore National Laboratory