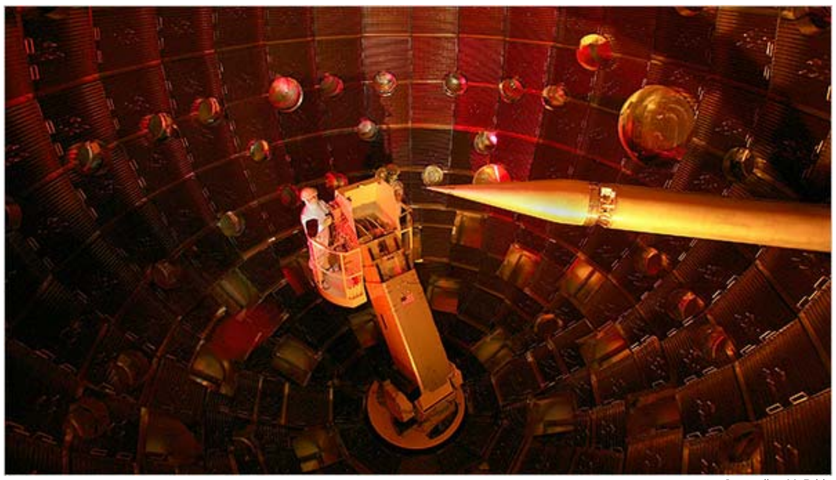
In Hot Pursuit of Fusion (or Folly)



Jacqueline McBride

RAYS OF HOPE The National Ignition Facility in California, was dedicated on Friday.

By WILLIAM J. BROAD
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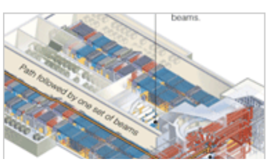
LIVERMORE, Calif. — Here in a dry California valley, outside a small town, a cathedral of light is to be dedicated on Friday. Like the cathedrals of antiquity, it is built on an unrivaled scale with unmatched technology, and it embodies a scientific doctrine that, if confirmed, might lift civilization to new heights.

Multimedia



Graphic

From Laser Light to a Miniature Star

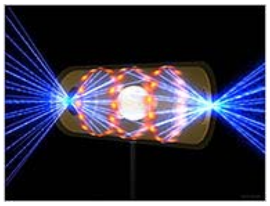
"Bringing Star Power to Earth" reads a giant banner that was recently unfurled across a building the size of a football stadium.

The $3.5 billion site is known as the National Ignition Facility, or NIF. For more than half a century, physicists have dreamed of creating tiny stars that would inaugurate an era of bold science and cheap energy, and NIF is meant to kindle that blaze.

Enlarge This Image

In theory, the facility's 192 lasers — made of nearly 60 miles of mirrors and fiber optics, crystals and light amplifiers — will fire as one to pulverize a fleck of hydrogen fuel smaller than a match head. Compressed and heated to temperatures hotter than those of the core of a star, the hydrogen atoms will fuse into helium, releasing

Readers' Comments


A rendering of a pellet hit by lasers to create nuclear fusion.

bursts of thermonuclear energy.

The project's director, Ed Moses, said that getting to the cusp of ignition (defined as the successful achievement of fusion) had taken some 7,000 workers and 3,000 contractors a dozen years, their labors creating a precision colossus of millions of parts and 60,000 points of control, 30 times as many as on the space shuttle.

"It's the cathedral story," Dr. Moses said during a tour. "We put together the best physicists, the best engineers, the best of industry and academia. It's not often you get that opportunity and pull it off."

In February, NIF fired its 192 beams into its target chamber for the first time, and it now has the world's most powerful laser, as well as the largest optical instrument ever built. But raising its energies still further to the point of ignition could take a year or more of experimentation and might, officials concede, prove daunting and perhaps impossible.

For that reason, skeptics dismiss NIF as a colossal delusion that is squandering precious resources at a time of economic hardship. Just operating it, officials grant, will cost $140 million a year. Some doubters ridicule it as the National Almost Ignition Facility, or NAIF.

Even friends of the effort are cautious. "They've made progress," said Roy Schwitters, a University of Texas physicist who leads a federal panel that recently assessed NIF's prospects. "Ignition may eventually be possible. But there's still much to learn."

Dr. Moses, while offering no guarantees, argued that any great endeavor involved risks and that the gamble was worth it because of the potential rewards.

He said that NIF, if successful, would help keep the nation's nuclear arms reliable without underground testing, would reveal the hidden life of stars and would prepare the way for radically new kinds of power plants.

"If fusion energy works," he said, "you'll have, for all intents and purposes, a limitless supply of carbon-free energy that's not geopolitically sensitive. What more would you want? It's a game changer."

NIF is to fire its lasers for 30 years.

Like the dedication of a cathedral, the event here on Friday at the Lawrence Livermore National Laboratory is to be a celebration of hope. Officials say some 3,500 people will attend. The big names include Gov. Arnold Schwarzenegger, Energy Secretary Steven Chu (whose agency finances NIF) and Charles Townes, a Nobel Laureate and laser pioneer.

In preparation, workmen here last Thursday washed windows and planted flowers on the lush campus, the day auspiciously sunny.

Dr. Moses, who runs science programs for high school students in his spare time, broke from his own preparations to show a visitor the NIF complex.

In its lobby, he held up a device smaller than a postage stamp. This is where it all starts, he said. From this kind of tiny laser, beams emerge that grow large and bright during their long journey through NIF's maze of mirrors, lenses and amplifiers.

The word laser is an acronym for light amplification by stimulated emission of radiation. And each particle of light, or photon, is amplified, Dr. Moses said, to “around 10 to the 25th” photons. Or, “10 million, million, million, million.”

A nearby stand held a thick slab of pink glass about the size of a traffic sign — an example of an amplifier. NIF has 3,200 in all. Dr. Moses said the big step occurred when giant flash tubes — like ones in cameras but six feet long and 7,680 in number — flashed in unison to excite the pink glass. Laser photons then zip through, stimulating cascades of offspring, making the beam much stronger, such amplification happening over and over.

Photons moving in step with one another is what makes laser light so bright and concentrated and, in some instances, so potent.

Dr. Moses picked up a mock capsule of hydrogen fuel. It was all of two millimeters wide, or less than a tenth of an inch.

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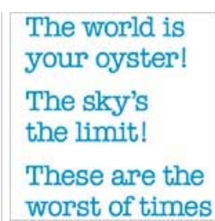

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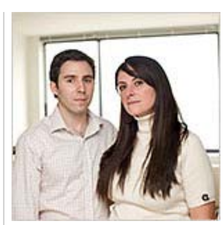

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