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NATIONAL IGNITION FACILITY

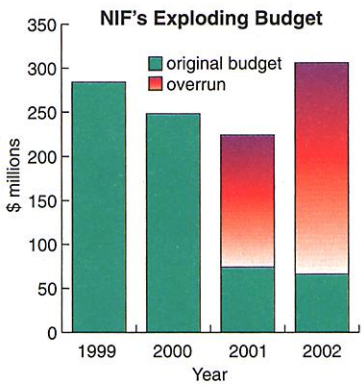
DOE Set to Double Price of Troubled Laser Project

The world's largest laser project will end up costing almost twice as much as originally estimated. Last week, Department of Energy (DOE) officials publicly outlined several options for rescuing the troubled National Ignition Facility (NIF) at Lawrence Livermore National Laboratory in California that will add from $750 million to $1 billion to NIF's current $1.2 billion price tag. Members of Congress—which must approve a new spending plan for the project—are grumbling about the huge overruns, and *Science* has learned that Livermore and DOE officials are at odds over which option should be chosen. Energy Secretary Bill Richardson may decide how to proceed as early as this week.

DOE has already spent nearly $800 million to build NIF (see graphic), which is designed to focus 192 powerful laser beams on a pellet-sized target in a bid to test the feasibility of fusion energy and simulate how nuclear weapons behave. It is a pillar of the department's $4.5-billion-a-year Stockpile Stewardship Program, which aims to preserve the reliability of the country's nuclear arsenal without actual testing. The project ran into serious problems last year, however, after Livermore officials revealed that technical glitches and management missteps would delay the project beyond its scheduled 2003 completion date and drive up costs (*Science*, 31 March, p. 2389). The revelations led to a string of reports critical of NIF's management and the departure or punishment of several top project officials. Through it all, DOE officials could not say for certain how much it would cost to achieve first firing.

NIF planners are now close to calculating that number. In a 9 March letter, DOE weapons program head Thomas Gioconda asked Livermore director Bruce Tarter to flesh out the impacts of six budget options, ranging from substantially scaling back the project to spending an extra $1 billion or more over the next 10 years. A few weeks later, according to notes obtained by *Science*, Gioconda briefed Richardson on the causes of NIF's budget woes and the two leading options. DOE faces a 1 June deadline for giving Congress the new numbers and explaining how it will pay for the overruns.

Transparent costs. Livermore's Ruth Hawley-Fedder is seen through massive crystal at the heart of NIF's ever-more-costly laser.



Surprise rise. NIF construction costs were due to dip sharply next year before overruns.

One problem that plagued NIF was a contingency fund—about $150 million—that planners now say was too small to absorb the inevitable surprises that come with such a technically challenging project. But even a much bigger fund might not have solved the expensive problems that cropped up in building the laser's beam path, the tortuous system of pipes, lenses, and mirrors that guides the powerful light to its destination. The beam path proved "much more complex than originally understood," Gioconda's presentation noted. In particular, Livermore lacked the engineering experience to integrate the system's many parts in a timely fashion. The complexity compounded what he called another "poor" management decision: completing the building to house NIF before the laser's full requirements were known. The result, planners say, is a space that is too small for easy installation. It will cost about $300 million to leap that and other hurdles, such as maintaining the extremely clean environment needed to keep dust out of the beamline.

Livermore officials strongly favor completing the project relatively quickly, by 2007. That so-called Option 1 would spend an extra $390 million over the next two fiscal years (see graph) and raise the total cost to $1.95 billion by 2010 (not counting operating costs). DOE officials, in contrast, prefer Option 3, which would stretch out the work—and the costs—until late 2009. That would raise the total cost to $2.15 billion but add only $100 million per year to NIF's budget.

At a 26 April meeting of a NIF advisory board, Livermore officials argued that Option 3 would kill the project's momentum. "It would put [NIF] on the back burner," lab spokesperson Susan Houghton later explained, making it difficult for Livermore to fulfill existing contracts or retain skilled staff. DOE, for instance, estimates that nearly 150 of NIF's 1000-person workforce might face layoffs under Option 3. Houghton, however, says the lab will "live with whatever it gets."

That decision now rests with Richardson and with Congress, which this week began work on DOE's first spending guidelines for 2001. A strong economy may give NIF supporters plenty of leeway to provide the "relatively modest increases that NIF will need to survive," says a House aide. But "jaws are dropping all over Capitol Hill," he adds. "There are going to be lots of questions about how this happened and how DOE is going to pay for it."

Some of those queries may be answered in an extensive General Accounting Office study due to be delivered later this month, or in hearings that the House Science Committee is considering for June. DOE officials also may discuss which weapons or civilian science programs to trim to pay for NIF at another advisory board meeting scheduled

CREDITS: (TOP) LLNL; (BOTTOM) SOURCE: DOE

for 17 May at Livermore. In the meantime, the black humor surrounding NIF is getting a bit darker. Noting that the laser is often described as a "stadium-sized" project, some DOE employees have proposed that a more fitting benchmark might be the *Titanic*.

–DAVID MALAKOFF

MILITARY ASSETS

Scientists Gain Access To Sharper GPS Signal

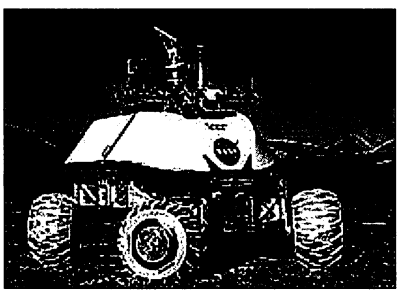
Rarely can the government make thousands of scientists happy by simply flipping a switch. This week, however, U.S. President Bill Clinton did so by ordering his military commanders to turn off a scrambling device on Air Force positioning satellites. The change, effective at midnight on 2 May, provides researchers and commercial users with a 10-fold improvement in their ability to pinpoint the location of receivers on Earth.

Until now, only the U.S. military has had regular access to the high level of precision possible with the constellation of 24 Global Positioning Satellites (GPS). Civilian researchers have had to make do with the scrambled version of the signals, which are based on atomic clocks onboard each spacecraft. "This really opens up the field for scientists," says Charles Challstrom, director of the National Geodetic Survey.

Combining the more exact GPS data with existing maps, for example, will allow scientists in remote territory to plot immediately their locations to within 10 meters, says James Baker, National Oceanic and Atmospheric Administration chief, eliminating time-consuming calculations. Glenda Humiston, Agriculture Department deputy undersecretary of national resources and environment, says that the greater accuracy will allow researchers to probe environmental effects at a much more fine-tuned level; for example, to understand the effects of roads on watersheds.

National security agencies have long resisted any move to improve the precision for civilian and commercial users, arguing that terrorists could make use of GPS signals. And the few civilian researchers temporarily given the codes to receive the more exact signals had to face a process that one Commerce Department official says was "costly and cumbersome." Time-consuming data processing by civilian scientists helped improve the accuracy of scrambled signals, but the quality remained less than that enjoyed by the military.

Eager for benefits ranging from improved car and boat navigation to tracking freight, however, commercial concerns kept up pressure to unscramble the signals. The Administration in 1996 agreed to stop the scrambling within a decade and moved up that timetable after the Defense Department found a way to rescramble the signals in a particular region in case of war, military officials said at a 1 May White House briefing. Now anyone with a GPS receiver anywhere will have access to signals nearly as accurate as those used by the military services.



Keeping track. GPS receivers help Carnegie Mellon University researchers track their NASA-funded robot in Chile's bleak Atacama Desert.

The Administration plans to make GPS even more accurate by adding a second frequency in 2003 that will compensate for disturbances in the ionosphere that interfere with the GPS signals. A third frequency for even greater accuracy is slated for 2006. The government also hopes to improve its ability to estimate the position of each satellite, giving scientists an even better sense of where they are.

–ANDREW LAWLER

ARCHAEOLOGY

Hints of Frequent Pre-Columbian Contacts

Last week's opening of the Smithsonian Institution's exhibition, "Vikings: The North Atlantic Saga," was a glittering black-tie affair, with Scandinavian royals rubbing shoulders with an international scientific crowd. The pomp and ceremony served to popularize the scientific evidence that the first contact between Europeans and Americans was not Columbus's voyage but Viking landfall in Newfoundland, thought to have occurred about A.D. 1000. And at a 2-day symposium, Canadian archaeologist Patricia Sutherland took the Viking story a big step further, presenting stunning new traces of the Norse on northern Baffin Island in the Canadian Arctic, at least 200 years before Columbus. Although not all her colleagues are convinced, Sutherland argues that the evidence shows that in the Arctic, unlike in Newfoundland, the Norse had frequent and prolonged contact with aboriginal peoples—the first sustained close encounter of the Old World with the New. "There was more than just in-and-out trading and 'Goodbye, we won't be back,' " says Sutherland, who suspects that the Norse actually established shore stations on Baffin Island.

The Norse artifacts, including spun and plied yarn, characteristic woodworking, and even carvings with European-like faces, come from sites of arctic hunter-gatherers known as the Dorset. Although archaeologists had suspected that the Norse had traveled the eastern arctic coasts, until recently no one had searched Dorset sites for clues. Researchers had thought that the Dorset had vanished from most of the Arctic by the time the Vikings crossed the Atlantic, although a fragment of a Norse pot did turn up in a Dorset site in Greenland a few years ago. "But that was just a single find," says Bjarne Grønnow, an archaeologist and director of The Greenland Research Centre in Copenhagen, who heard Sutherland present her work at a recent conference in Denmark. "When Pat presented her finds, we all said, 'Wow, it's not just a coincidence. It's really something.' "

Sutherland, who works at the Canadian Museum of Civilization in Hull, first came across the Norse objects while examining the museum's artifacts from Nunguvik, a Dorset site on northern Baffin Island excavated in the 1970s and 1980s. Among trays of distinctive Dorset harpoons and carvings, she pulled out two strands of soft yarn, one 3 meters in length. Neither the Dorset nor other native northern groups were

Face to face. Dorset carving shows Norse and Dorset faces.

CREDITS: (TOP) CARNEGIE MELLON UNIVERSITY; (BOTTOM) CANADIAN MUSEUM OF CIVILIZATION