whether it achieves ignition, as a way of attracting bright young scientists to LLNL. Actually, over the past year, the LLNL laser fusion program has lost some of its best laser and target scientists. But if we assume that NIF is eventually completed, at some performance level, then we need to ask a fundamental question: What kind of scientist is needed to maintain an existing set of nuclear weapons, as compared to designing or improving these weapons? Maintenance requires different skills and attitudes than design. Is an entrepreneurial and risky undertaking like the laser fusion program[2] the appropriate vehicle to attract these scientists? Will laser fusion scientists be sufficiently cautious about making changes in the weapons stockpile, or will they be risk-takers? Will they make unnecessary changes in the nuclear weapons to justify, to themselves and to their sponsors, the high capital and operating costs of NIF?

References

1. Lawrence Livermore National Laboratory, *Laser Program Annual Reports*, rep. no. UCRL-50021-80 LLNL, Livermore, Calif. (1980; see figure 2-114) and rep. no. UCRL-50021-81 (1981); available from the National Technical Information Service.
2. S. Bodner, C. Paine, *Nature* **407**, 29 (2000).

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Edward Moses replies: We must respectfully disagree with the opinions of Stephen Bodner. His views of the National Ignition Facility, Nova, and the US nuclear weapons Stockpile Stewardship Program are well known. During the many reviews that preceded the authorization of the NIF Project, Bodner expressed his concerns to the committees. These committees, and those that succeeded them, have continued to support NIF.

Bodner's representation of Nova neglects to mention that, in addition to meeting its 30-terawatt performance goal, it completed 14 000 shots over its 14 years of operation. Nova was the world's premier high-energy density physics experimental facility, where the highest quality data in hydrodynamics, plasma physics, materials science, and inertial confinement fusion were generated and the first x-ray laser was demonstrated. Over 1000 journal articles were produced and a generation of laser and laser-plasma physicists was trained.

Bodner states that NIF's specifications have been "watered down" and the NIF prototype laser, Beamlet, never met its performance requirements. In fact, Beamlet demonstrated full energy, full power, temporally shaped ultraviolet laser pulses. All aspects of Beamlet design and operation were reported in 31 journal articles. Our Beamlet experience gives us high confidence that NIF will meet its full performance goals.

Bodner raises the question of whether NIF scientists will show good judgment as future stewards of the nation's nuclear stockpile. History speaks for itself. During the past 25 years, the very same people who developed and used similar facilities are now an integral part of the nation's Stockpile Stewardship Program, committed to maintaining its safety and reliability without weapons testing. State-of-the-art facilities like NIF are needed to draw and challenge the best-qualified scientists. NIF will play a vital role in our national security while pushing the boundaries of experimental and theoretical science.

Numerous reviews conducted by the NAS, DOE, and the University of California uniformly support the view that NIF can meet its technical and scientific goals. The NIF team is working to ensure this will happen.

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Accelerator Test Facility Hosts User-Oriented Research

Maury Tigner strikes a chord with accelerator scientists in his outstanding description of the science, technology, and culture of particle accelerator R&D (Physics Today, January 2001, page 36).

Tigner refers to his recommendation in the report of the high-energy physics advisory panel's subpanel on accelerator research and development to devote intellectual and monetary resources to high-energy accelerator R&D. That report was instrumental in establishing, in 1982, the Advanced Accelerator Concepts R&D Program in the Department of Energy, Office of High Energy Physics. The program has, for several years, been supporting university, industrial, and national laboratory R&D projects on advanced accelerators. For the past decade, DOE funded, among other things, the Accelerator Test Facility (ATF) at Brookhaven National Laboratory (see http://www.atf.bnl.gov).

The ATF hosts exactly the user-oriented research that Tigner praises in the article section "Hope for the future." Fifteen graduate students have done their thesis research at the ATF since 1992, and the facility currently has 11 university users and 2 small business users. Another indication of the ATF's importance is the number of times it appears in the pages of high-impact journals such as *Physical Review, Physical Review Special Topics—Accelerators and Beams*, and *Science*. ATF users come from all parts of the US and from Russia, Japan, and Taiwan. The research covers advanced accelerator subjects, light-source science, diagnostics, lasers, and high-brightness electron sources. For nearly a decade, the facility has been a leader in accelerator-based particle and light-source research. I would like to think that the Orion project at SLAC, due to come on line in a few years, was inspired at least in part by the ATF.

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Radio Observatory at Maipú Completes Mission, Closes Doors

After 40 years of operation, the Radio Observatory of the University of Chile (ROM), located at Maipú, has closed down. The ROM came to life in 1959, 27 years after Karl Jansky's momentous discovery of cosmic radio waves. The facility was the result of two cooperative programs of the University of Chile, one with the department of terrestrial magnetism (DTM) of the Carnegie Institution of Washington and the other with the University of Florida in Gainesville. These efforts were initiated and encouraged by the late Federico Rutllant, director of the National Astronomical Observatory of the University of Chile, who wanted to have the university involved in radio astronomy. Rutllant's more ambitious interests led to the installation of large international observatories in northern Chile. At the DTM he met Merle A. Tuve, who was enthusiastic about developing radio astronomy in South America.

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In Gainesville, Rutllant met Alex G. Smith, who wanted to observe Jupiter's decametric emission from the Southern Hemisphere.

As a student I tested the prospective sites. After Maipú was selected, I worked with the DTM in designing and building a 1200-meter-long, 16-element interferometer to observe the Sun at 175 MHz. John W. Firor and Bernard F. Burke, then at the DTM, helped me with the fundamentals of interferometry. Jorge May, also a student, worked with Thomas D. Carr on different types of antennas to observe Jupiter. The first successful observation was made on 25 November 1959, when the interferometer recorded a strong solar storm.

As far as we know, the ROM was the first operating radio observatory in Latin America. It worked at very low frequencies and carried out observations of the Sun, pulsars, SN1987A, the Magellanic Clouds, and so forth. However, its most successful tasks were the decametric observations of Jupiter that spanned two Jovian years, and the 45-MHz continuum survey of the southern sky. The latter survey was done with a large filled array that worked as a transit instrument; because of problems inherent in very low-frequency observations, the southern survey took 15 years to complete. The observations were combined later with others made from the Northern Hemisphere with a similar antenna, resulting in an all-sky survey at 45 MHz.

The ROM made significant contributions to teaching. A number of electrical engineering students obtained their degrees under the guidance of engineer Juan Aparici, who was responsible for most of the electronic design and construction. Also, several students received MS degrees in astronomy.

The ROM became a solid research center, establishing cooperative programs with international institutions. The first was in the mid-1980s with Columbia University in the US, through the installation and use of a 1.2-meter dish, built to observe molecular line emission in the mm-wavelength range, at Cerro Tololo InterAmerican Observatory. Carbon monoxide is important in the interstellar medium because it radiates a strong line in the 1–0 transition and is a good tracer of molecular hydrogen, which does not emit radio waves. The main goal, successfully accomplished, was to make a survey of the southern Milky Way in that transition. This pioneer project opened the rich field of mm-wave spectroscopy. Part of the ROM's legacy is a new generation of Chilean radioastronomers who are involved in important cooperative programs with the US, Japan, and several European countries.

The ROM had scant funding, but it received equipment donations from the University of Florida, the NASA satellite tracking station near Santiago, and the European Southern Observatory. Many people associated with the ROM deserve mention here, but space limitations prevent it. Credit for keeping the ROM running belongs to Jorge May.

So, with the great satisfaction of knowing that the ROM achieved its primary goal, yet with deep sadness, we have turned the power off at the Maipú Radio Observatory.

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THE RADIO ASTRONOMY OBSERVATORY at Maipú, Chile, in October 1959. In the left foreground is a Yagi radio antenna of the solar interferometer; on the right is the inclined plane of another antenna. In the middle, near the building, the tall V-shaped structures make up the corner reflector. Both the inclined-plane antenna and the corner reflector were used primarily for observations of Jupiter.

Internet: Valuable Resource and Peddler

University professor Richard Hammond (PHYSICS TODAY, February 2001, page 14) says he was unable to use the Internet to obtain information on the element europium for his daughter's school project. Curious, I also tried a search, using Metacrawler, and it yielded 55 results. I scanned through the titles and quickly located several promising sites. In case Hammond's daughter is still interested, the first one I tried was http://www.klbproductions.com/yogi/periodic/Eu.html which gave a brief summary of europium's chemical and physical properties, atomic structure, and even its history of discovery. In less than five minutes I accomplished what would have taken me at least an hour in the pre-Internet days of driving over to the local campus library, thumbing through a card catalog, and walking down rows of book shelves. The answer to Hammond's question, "Is the Web a valuable source of knowledge or a glitzy new form of yellow pages?" is yes and yes.

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While I agree with many of Richard Hammond's reservations about the Internet as a universal tool for learning and teaching, his example of finding only the price for europium from an Internet search indicates a failure on his part to use it even moderately well. A search using Google led quickly to http://www.webelements.com/webelements/elements/text/Eu/key.html, which gives history, uses,