University of Rochester in New York. Mukamel notes that the work marries two long-studied areas in optics: multilayer mirrors and a property known as birefringence, whereby light moves at different speeds as it travels through a material in different directions. The offspring of the marriage is an inexpensive plastic film capable of reflecting more than 99% of the light that hits it. (A typical silver-on-glass telescope mirror reflects only 95%.)

The 3M researchers didn't set out to reinvent the mirror. They were developing a new set of mirrors to reflect polarized light out of multiple layers of plastics. Such multilayer mirrors and filters had been around for decades. They take advantage of the fact that light waves bounce off boundaries between two materials that pass light at different speeds, such as air and water. Multilayer reflectors amplify this effect by repeatedly alternating a "slow" material (one with a high refractive index) with another that has a low refractive index. Each boundary between layers reflects a fraction of the incoming light. As light waves reflect off different boundaries, their oscillating peaks and troughs can either line up and reinforce one another or cancel one another out. By controlling the thickness of each layer, researchers can determine how these light waves will interfere and thus which colors of light will be reflected.

The most common multilayer mirrors are made up of alternating layers of two inorganic materials, such as glass and titanium dioxide. Though effective, such mirrors suffer a common drawback: Their refractive index is always the same no matter at which angle the light moves through the film. One result is that certain kinds of polarized light can pass through at sharp angles, because they don't see a change in refractive index as they move through the layers. Polymers, on the other hand, are birefringent: The refractive index can change depending on which way the long, chainlike molecules are oriented in a film.

The 3M researchers wanted to see if they could use that property of birefringent plastics to reflect all kinds of polarized light. They came up with a new proprietary way to extrude sheets of hundreds of alternating layers of two or more common plastics, such as polymethylmethacrylate and polyester. They then followed the common practice of heating and stretching their polymer sheets into thin films. And when they did, they got a surprise: The resulting films not only were nearly perfect plastic mirrors, but remained almost perfect reflectors even at sharp angles.

"When we saw it, we thought something weird was going on," says report co-author Michael Weber. By controlling each layer's thickness and the orientation of the polymer molecules, they found that they could tailor their films to determine exactly which colors and polarizations of light were reflected in any direction. When they searched the literature, they were surprised to find that they were the first ones to control multilayer films in this manner. "It floored us that no one had ever noticed it before," says Weber.

People will be noticing soon. The 3M researchers have already started turning the new films into products both serious and fun. Already on its way to market, Weber says, is a way of using the films to improve the performance of displays for laptop computer and handheld organizers. Set at the back of the display, the 3M film can reflect light from an internal bulb out of the screen, thereby saving energy and battery power. Other soon-to-be-seen products include optical filters, iridescent and reflective packaging, bows and ribbons, and—who knows—off-the-rack rainbows, one size fits all.

–ROBERT F. SERVICE

NATIONAL IGNITION FACILITY

Richardson Puts Laser Project on Short Leash

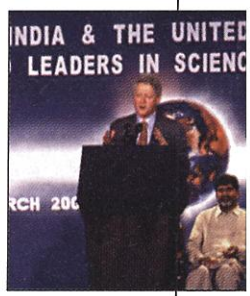
The Department of Energy (DOE) is tightening its oversight of the world's largest laser project, which is years behind schedule and at least $300 million over budget. Energy Secretary Bill Richardson last week announced a series of steps designed to put the National Ignition Facility (NIF) at Lawrence Livermore National Laboratory in California back on track.

The moves aren't the final word on the troubled project, observers predict. Next month federal lawmakers are expected to receive a highly critical audit report from the General Accounting Office, its investigative arm, followed by new cost estimates from DOE that could balloon NIF's price tag. "NIF is headed for choppy seas," predicts one House aide.

The $1.2 billion NIF is designed to focus 192 laser beams on a lozenge-sized target in a bid to test the feasibility of fusion energy and simulate nuclear weapons behavior without actual testing. A host of technical glitches and management missteps have forced Livermore officials to consider scaling back the project and stretching the timeline beyond its scheduled completion in 2003 (*Science*, 17 September 1999, p. 1831). On 24 March Richardson took a series of interim steps, including the appointment of Livermore weapons scientist George Miller to a new

ScienceScope

Giving Back A group of Indian-born business leaders who have made it rich in Silicon Valley has pledged $300 million toward a $1 billion network of private research universities in their native country. Their plan to create a half-dozen Global Institutes of Science and Technology received a pat on the back last week from President Bill Clinton (right), who mentioned it during a speech to high-tech business leaders in Hyderabad.



"I have no doubt they will succeed," said Clinton about plans to set up six nonprofit institutes that would offer undergraduate and advanced degrees in biotechnology, materials science, information technology, and other hot fields to 2000 students on each campus. Officials at the University of California, Berkeley, have agreed to help design the curriculum, lend faculty, and offer distance-learning courses, although details have yet to be worked out. "The students would be exposed to the best facilities and faculties available anywhere," says Purnendu Chatterjee, managing director of the $1.2 billion software management Chatterjee Group of New York, a prime mover in the venture. He said the institutes would also serve as incubators for new high-tech companies. Site selection is expected to be completed over the next 8 to 12 months.

Rescued Legislation aimed at ending 30 years of controversy over "rescue archaeology" in France is close to becoming law. The National Assembly last month voted to approve a proposal by Culture Minister Catherine Trautman that supporters say will improve protection of artifacts threatened by development (*Science*, 14 May 1999, p. 1099). The French Senate was expected to take up the bill as *Science* went to press.

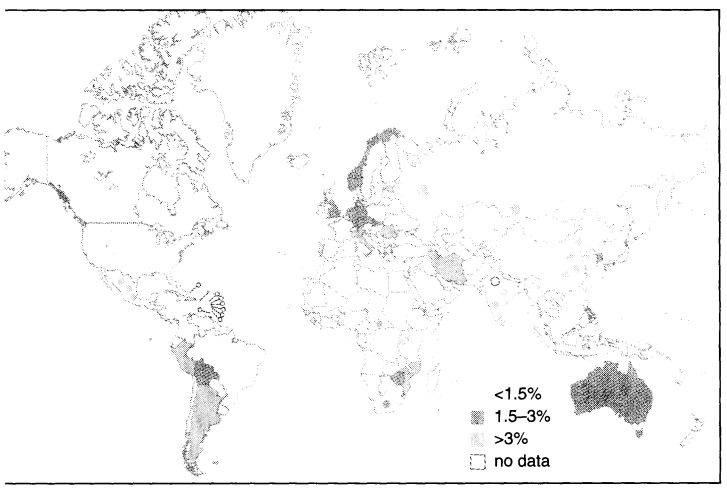
The new law—which would replace an existing agency for rescue archaeology with a new organization under the culture and research ministries and open rescue digs to researchers from universities and the basic research agency CNRS—is being greeted enthusiastically by Françoise Audouze of the Center for Archaeological Research in Nanterre. But Audouze is wary that the law does not adequately define how archaeologists will work with the new organization. Turf battles, she warns, could still hamper efforts to study and save threatened artifacts.

CREDIT: P. BAGLA

INFECTIOUS DISEASE

Drug-Resistant TB on The Rise

Tuberculosis is back with a vengeance. Once nearly vanquished by antibiotics, at least in the developed world, tuberculosis resurged in the late 1980s and now kills more than 2 million people a year—second only to AIDS among infectious diseases. Especially frightening is the emergence of drug-resistant strains. The wake-up call came in the early 1990s, when New York City was hit with an epidemic in which about 9% of cases were resistant to two or more TB drugs. The outbreak took years—and cost $1 billion—to quell. But global trends in resistant TB, though the subject of considerable speculation, have been unknown.



Tough bugs. Prevalence of TB cases resistant to two or more front-line drugs (data collected 1994–99).

Now, the World Health Organization (WHO) has some answers, and they are grim. Drug-resistant TB is rampant and appears to be spreading, WHO concludes in its most comprehensive report to date. Said WHO Director-General Gro Harlem Brundtland: "This report confirms our worst fears." WHO warns that these resilient strains could cripple the economies of developing nations and could erupt in Western countries as well.

Scientists blame the rise of resistant strains on a history of drug misuse. Sometimes doctors do not prescribe the proper course of treatment, which involves taking a mix of drugs for up to 6 months. Understandably, some patients fail to comply. And in many poor or war-torn countries, drugs are not always available.

WHO's new report covers 72 regions and has statistics on 28% of known TB cases. In three of the 28 areas for which data were available from a 1997 WHO survey, the prevalence of drug-resistant TB has skyrocketed. In both Germany and Denmark, it climbed by 50% since 1996, to 10.3% and 13.1% respectively. New Zealand fared even worse—resistance more than doubled to 12%.

Experts agree that treating TB properly from the outset can prevent the rise of resistant strains. The best weapon is a strategy called Directly Observed Treatment, Short-course (DOTS), in which health workers make sure that patients swallow every pill over the long course of treatment. The problem is, only 21% of TB patients around the world received DOTS in 1998. And for TB strains resistant to two or more drugs, known as multidrug-resistant (MDR) TB, conventional drugs and DOTS don't work. Instead, health workers must rely on second-line drugs that are less effective and more expensive. Treatment can cost up to $250,000 per person and take 2 years—well beyond the reach of many poor countries.

Now that MDR TB has arisen, these strains are spreading through communities. The problem is particularly severe in six regions—Estonia, Henan Province in China, Latvia, the Ivanovo and Tomsk regions in Russia, and Iran—where between 5% and 14% of first-time TB cases are multidrug resistant. The spread of resistant strains has ignited intense debate over whether it's best to spend scarce resources on treating the widespread susceptible strains or on tackling MDR strains. One thing that's clear, however, is that the problem is a devil of our own making. Resistance is "almost an inevitable consequence of bacterial evolution and human nature," says molecular epidemiologist Peter Small of Stanford University. "The bug wins again." **–ERIK STOKSTAD**

CREDIT: (LEFT) WHO

PUBLIC HEALTH

Bat Researchers Dispute Rabies Policy

How noticeable is a bat bite? That seemingly esoteric question is center stage in a dispute over the small risk of catching rabies from bats. Based on some puzzling human rabies deaths, public health officials, including the Centers for Disease Control and Prevention (CDC) in Atlanta, recommend that in some circumstances people exposed to bats get rabies shots, even if there's no evidence of a bite. Bat researchers counter that the animals don't attack and leave stealth bites and

ScienceScope

Slight Rebound The National Science Foundation's (NSF's) flagship program to support graduate students is struggling to find talented underrepresented minorities after phasing out a special effort to attract them. The new class of 850 fellows, announced last week, contains 89 minority students pursuing Ph.D.s in science, mathematics, and engineering. Although that's a bit more than last year's crop of 76, the number is a far cry from the 175 minorities who earned the 3-year fellowships in 1998, the last year in which NSF held a separate competition for Hispanics, African Americans, and Native Americans (*Science*, 16 April 1999, p. 411). In addition, the number of minority applicants continues to fall, down 25% in 2 years, while the number of whites and Asians applying has held steady.

NSF officials hope a larger annual stipend, up $1000 this year to $16,200 toward a goal of $18,000, will boost demand. They also invited applicants to write about "any impediments" to a degree, says Susan Duby, head of graduate education, and asked reviewers to ponder NSF's role in serving underrepresented groups. "We're making more of an effort," says Duby, "but we haven't seen the payoff yet."

Resisting TB The effort to beat tuberculosis resistance is getting a boost. The Bill and Melinda Gates Foundation last week announced that it is giving $25 million to a new consortium of foundations, international organizations, and pharmaceutical companies called the Global Alliance for TB Drug Development. The groups will put the funds to use to come up with new drugs and test their efficacy in clinical trials.

And more help may be on the way. On 24 March, U.S. Representatives Sherrod Brown (D–OH, pictured) and Connie Morella (R–MD) introduced a bill that would boost anti-TB spending from $35 million to $100 million to establish effective TB programs, especially in nations that suffer most from the disease.

Contributors: Pallava Bagla, Michael Balter, Jeffrey Mervis, Erik Stokstad