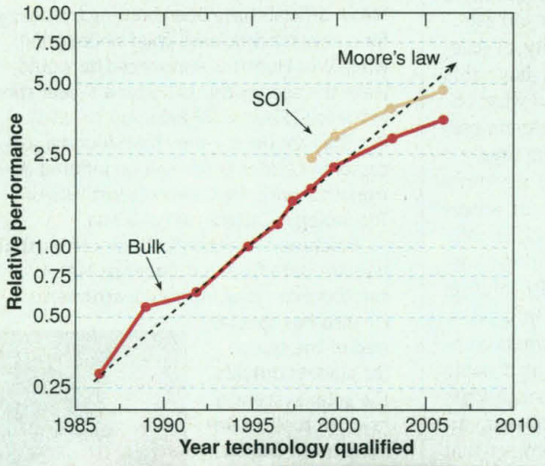
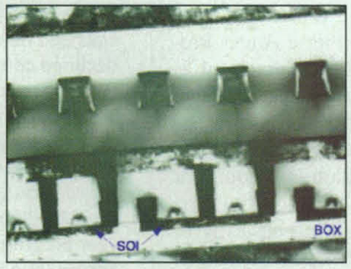
for decades but is expected to begin flattening out soon (see graph).

The key change comes in the base on which transistors and other chip-based circuitry sit. For transistors to switch on, they must electrically "charge up" the silicon beneath them. In conventional microprocessors, built atop a slab of crystalline silicon, that's a time-consuming and energy-draining process. But in the new chips, IBM engineers embed an insulating layer just below the surface, leaving an ultrathin silicon film on top. This thin silicon layer allows silicon-on-insulator (SOI) chips to charge up much more quickly and efficiently.





Back on track? IBM is counting on SOI chips (*right*) to extend Moore's law.

SOURCE: IBM

IBM

"I believe IBM is right on the money on this one," says Dimitri Antoniadis, an electrical engineer at the Massachusetts Institute of Technology, who adds that the high-end workstations that are widely used by scientists will likely be early beneficiaries of the new chips. But other industry observers say SOI isn't all it's cracked up to be. Mark Bohr, an electrical engineer with Intel in Hillsboro, Oregon, says his company has looked closely at the new technology and decided that it's not ready for prime time.

SOI is hardly new. The technology has been around for 30 years and is already used in chips for niche applications, such as those aboard satellites, as well as some types of computer memory. But persistent problems have stood in the way of broader use. For one, the top silicon film often ends up riddled with performance-lowering defects, because creating the underlying insulating layer requires injecting ions into the silicon at great speeds, disrupting the top surface's perfect crystalline order. The insulating layer can also cause transistors on the chip to misfire. It electrically isolates the top silicon layer, which enables it to conduct even when the transistor is turned off.

Bijan Davari, IBM's head of advanced logic technology development, says it took company researchers 15 years to get around these problems. To make the new wafers, IBM researchers inject molecular oxygen just beneath the silicon surface, using a machine called an ion implanter, to form an insulating layer of silicon dioxide. The IBM team then uses a proprietary recipe for processing the wafers—including baking them at about 1400° Celsius for nearly 12 hours—to anneal the damage this causes to the silicon surface, creating a defect-free film atop the insulating layer. Finally, they alter the doping of the semiconductors to minimize misfiring of the transistors, says Davari.

The changes result in SOI chips that achieve 35% gains in speed and efficiency without the drawbacks of earlier SOI devices. Davari argues that this will give IBM about a 2-year lead in the race to pack more computing power into less real estate, as it allows the same-sized transistors to operate at faster speeds. But not everyone agrees. "I think that's optimistic," says Simon Wong, a Stanford University electrical engineer. "The bulk [silicon] technology is very good" and improving rapidly, says Wong. Davari counters that IBM leads in improving bulk silicon chips as well, and their work convinced them that improvements in these chips would soon begin leveling off.

Bohr argues, however, that because the extra processing steps mean higher costs, "a lot of companies have decided that [SOI] will never be the way to go." Perhaps, says Antoniadis. "But it's possible that when they see gigahertz processors coming along on SOI, they will have to pay attention."

–ROBERT F. SERVICE

ASTRONOMY

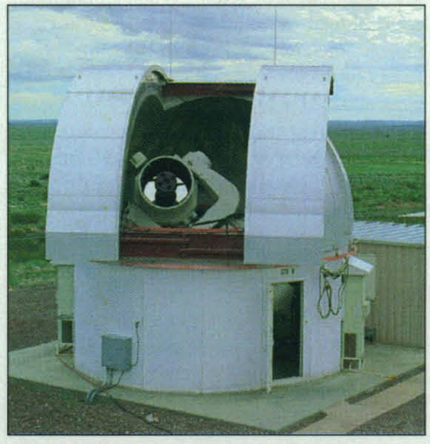
Asteroid Searchers Streak Ahead

With comets and asteroids menacing Earth in movie theaters around the world this summer, the once-arcane field of tracking potential threats from near-Earth objects, or NEOs, is suddenly in the limelight. As it happens, it's also making unprecedented progress. NASA's budget for hunting space rocks doubled to $3 million this fiscal year, and the U.S. Air Force recently unveiled a search system that is bagging NEOs at an unprecedented clip. This week, Air Force and NASA scientists will convene to consider boosting the Air Force's role still further, and other search efforts are also steaming ahead. "The scientists doing the work are really making strides," says Tom Morgan, discipline scientist for planetary astronomy at NASA headquarters in Washington, D.C. "One can afford to be reasonably optimistic about this whole process."

But even with their new search power, astronomers are settling in for a long hunt. They have so far spotted less than 10% of the estimated 2000 large NEOs, notes Brian Marsden, director of the Minor Planet Center at the Smithsonian Astrophysical Observatory in Cambridge, Massachusetts. Even after researchers locate the rest, they'll need at least 20 years to track their motions to determine whether any endanger the planet, says Marsden. And for now, no one knows how much technological might the Air Force will ante up—or how long asteroids will remain a high priority at NASA.

Four years ago, as Comet Shoemaker-Levy 9 blasted into Jupiter, the U.S. Congress asked NASA to devise a 10-year plan to catalog 90% of all asteroids a kilometer across or larger that have orbits approaching Earth's. A team led by the late planetary scientist Eugene Shoemaker said that such a goal would require a $4 million per year search program—quadruple NASA's asteroid survey budget at the time—as well as help from Air Force space-surveillance experts. Now both elements are falling into place.

In particular, Air Force–sponsored research at the Massachusetts Institute of Technology's Lincoln Laboratory in Lexington has yielded an ultrasensitive and fast charge-coupled device (CCD), an electronic imaging chip similar to those in video cameras. The



U.S. AIR FORCE/MIT LINCOLN LABORATORY

Space spy. Astronomers track potentially dangerous asteroids with this 1-meter telescope at the White Sands Missile Range in New Mexico.

CCD was built for a suite of 1-meter Air Force telescopes that track satellites and artificial debris orbiting Earth. But after NASA started pushing its asteroid goal, scientists realized the system was ideal for finding NEOs, too. "No commercially available CCD comes close to having these capabilities," says space-surveillance physicist Grant Stokes, manager of the Lincoln Near-Earth Asteroid Research (LINEAR) program.

The chip records more light than any other CCD and reads out 5 million pixels of data in hundredths of a second. When combined with fast Air Force telescopes, says Stokes, LINEAR can scour huge swaths of the heavens for faint, moving blips: "We're just about capable of covering the entire visible sky from a single site during 1 month."

LINEAR came online in late 1997 at Lincoln Lab's Experimental Test Site in Socorro, New Mexico, and hunts NEOs 10 nights per month. To date, it has unveiled 64 of them, more than all other search programs combined during the same period. A NASA effort at the Jet Propulsion Lab (JPL) in Pasadena, California, called NEAT (Near-Earth Asteroid Tracking), finds almost as many kilometer-sized NEOs, but LINEAR detects many more of the smaller objects, any of which could still wreak havoc if it struck Earth. LINEAR also has spied 10 comets and seven objects called "unusual" by Marsden's clearinghouse. "Whichever category you look at, the rate [from all search programs] has increased five- to 10-fold," says Gareth Williams, the Minor Planet Center's associate director.

So astronomers would like more of a good thing, and they're hoping the Air Force will consider asteroid hunting part of its "planetary defense" mission—and pay for it. The Air Force seems willing to contribute. It may build at least one more LINEAR system dedicated to NEO research, says senior scientist John Darrah of the Air Force Space Command in Colorado Springs.

Meanwhile, other veteran asteroid programs are forging ahead. Spacewatch, at the University of Arizona, will open an additional, larger telescope in 2 years. NASA's NEAT search has new computer equipment and 6 nights per month on an Air Force telescope in Hawaii. Researchers expect that the Air Force will agree to triple NEAT's telescope access at the next meeting between the Air Force and NASA, set for 19 August at JPL, says NEAT principal investigator Eleanor Helin. NASA also anticipates more contributions from NEO observers in the Czech Republic, Italy, Japan, and France.

This meteoric increase in detection rates will force scientists to collaborate more closely, says Donald Yeomans, director of NASA's new NEO Program Office at JPL: "We will want an efficient overall system rather than a group of individuals all vying for the same prize." But principal investigator Robert McMillan of Spacewatch notes that NASA's competitive grants program has thus far not fostered cooperation among the groups. He also wonders whether today's asteroid fad will fall to Earth. "Ten years crosses three Administrations," sighs McMillan. "I'm somewhat skeptical that NASA's enthusiasm will last."

–ROBERT IRION

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SCIENCE AND ETHICS

Tobacco Consultants Find Letters Lucrative

Scientists who consult for industry get a lot of grief for being "hired guns." Now, some critics of the practice are squeezing off a few rounds of their own in response to revelations that surfaced last week. The *St. Paul Pioneer Press* reported that several scientists received payments from the Tobacco Institute—the industry's public relations arm—in 1992 and 1993 for writing letters to journal and newspaper editors criticizing studies on the health effects of secondhand tobacco smoke. The information, mined from a mountain of documents assembled in Minnesota's lawsuit against the industry, indicates that nine individuals received as much as $10,000 for a letter and that the letters were often reviewed by lawyers before being sent to publications such as the *Journal of the National Cancer Institute* (*JNCI*) and *The Lancet*.

To some industry critics, this is yet more evidence that tobacco companies tried to twist science to further their aims. "It's an even bigger perversion of the scientific process than I thought it was," fumes cardiologist Stanton Glantz of the University of California, San Francisco. He and others argue that such letters, which undergo less stringent review than journal articles, may have helped persuade a district judge last month to throw out a 1993 Environmental Protection Agency (EPA) report finding that environmental tobacco smoke (ETS) causes about 3000 cases of lung cancer per year. "They're basically building up a record they could use for political and legal purposes," says Glantz, whose own work has shown how the tobacco industry has funded research to try to debunk the scientific evidence against tobacco (*Science*, 26 April 1996, p. 494).

But authors contacted by *Science* defend their work, arguing that the letters, based on time-consuming analyses, constitute valid scientific communications. And editors have few qualms about publishing them, noting that in most cases the authors disclosed their industry ties. "This is a tempest in an ink pot," says George Lundberg, editor of the

ScienceScope

BIOMEDICAL LOBBYING ANGERS KEY DEMOCRAT

One of the nation's leading biomedical research societies is seeking to mend fences with a key congressman. Last month, the Federation of American Societies for Experimental Biology (FASEB), which represents 56,000 researchers, angered Representative David Obey (D–WI) by pushing for passage of a House spending bill that includes a whopping 9.1% budget boost for the National Institutes of Health (NIH). Obey, the senior Democrat on the powerful Appropriations Committee, supports the NIH increase but was incensed because a 21 July letter from FASEB to lawmakers appeared to support a Republican plan for cutting welfare programs to pay for it—a strategy Obey called "selfish" and "myopic" in a 28 July reply. It's all a misunderstanding, according to FASEB President William Brinkley of Baylor College of Medicine in Houston, who says the society hopes Congress will find new welfare funds when it returns to work next month. Meanwhile, he wants to meet with the lawmaker. "Hopefully we can appease Mr. Obey and get out of his woodshed," he says.

Obey

COORDINATED ATTACK ON ECO THREATS?

The White House has asked federal ecologists to follow the lead of climate scientists and fashion a blueprint for working together and with academia. The idea is to better concentrate the government's scientific firepower on ecological problems involving "multiple stresses," such as a lake hit by both pollution and exotic zebra mussels. For starters, the "Integrated Science for Sustainable Ecosystems" initiative, expected to begin in 2000, would beef up research in four areas—harmful algal blooms, habitat conservation, invasive species, and data networks—say officials with the White House Committee on Environment and Natural Resources, which unveiled the plans last week. Its price tag, which still must win approval from White House budget officials, will be revealed in the president's budget request next February; the big question is whether Congress will agree to pay the bill.

Contributors: Andrew Lawler, David Malakoff, and Jocelyn Kaiser