Tight Times for Materials R&D

Users of Stanford's synchrotron and Brookhaven's neutron source may have to shelve some experiments next year as the labs curtail operations to cope with low budgets

SINCE the 1960s, synchrotron radiation has provided the scientific community with a way to probe the structure of materials. And, in recent years its use by government, university, and industry researchers has exploded. The bright beams of ultraviolet light and x-rays have become essential tools for investigators trying to understand proteins and biological processes, to produce advanced semiconductors, and to unlock the secrets of high-temperature superconductors.

But federal support for operating important synchrotron "light" sources as well as complimentary neutron radiation experiment halls is stagnating or in decline. This funding situation conflicts with the speeches of members of Congress and the Reagan Administration (*Science*, 4 March, p. 1089) that promised strong federal backing for an aggressive research program in high-temperature superconductors. Also in question is the priority the government assigns to other critical biological and materials research conducted at these unique R&D centers.

The research community's demand for access to powerful light sources far exceeds current utilization levels at the Stanford Synchrotron Radiation Laboratory in Palo Alto, Brookhaven National Laboratory on Long Island, and at smaller facilities. The same is true for biologists, chemists, and other researchers who want to use neutron-scattering experiment halls at Brookhaven and Oak Ridge National Laboratory.

The goals of researchers who compete for time at these facilities are varied. IBM researchers tapped Brookhaven's x-ray source to develop an x-ray lithography manufacturing technique to make a computer chip featuring circuits of 0.5 micrometer. Other scientists are after basic knowledge—to understand the atomic arrangements of superconducting compounds, to see how atoms bond at interfaces between different materials, or to decipher the structure of the human cold virus.

But in 1989, the Department of Energy's (DOE) support will not be sufficient to maintain or expand experiment schedules at key federal laboratories. This is creating an uproar among scientists whose work depends on access to general-user facilities created by the government beginning in the 1970s to meet the burgeoning needs of the research community. Stanford's SPEAR synchrotron, says laboratory director Arthur Bienenstock, will run for only 200 of 400 possible 8-hour shifts in 1989. He says "drastic delays" in research will result for the institution's 650 users, including university and industrial investigators—and graduate students whose theses hinge on experimental work.

The prospect of reduced operating time is disturbing to companies such as Xerox, IBM, and Boeing Aerospace, which have invested millions of dollars in equipment and experiments at Stanford. The limited beam time at SPEAR, says Neville Connell, manager of Xerox's general science laboratory at Palo Alto, "will seriously compromise" the company's efforts to develop new materials.

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Just as worrisome is Brookhaven's plan to curtail operation of the High Flux Beam Reactor, which is used for neutron-scattering experiments. Martin Blume, deputy director of the laboratory, says that under DOE's proposed budget the reactor would run just 3 of 11 possible 22-day work sessions in 1989. This is a sharp cutback from the 10 or 11 sessions run in past years.

"That would be a disaster for high [temperature] superconductor research in general," says Robert J. Birgeneau, a professor of physics at Massachusetts Institute of Technology.

A rollback in the High Flux Beam Reactor's schedule for 1989, says Blume, cannot be avoided under DOE's proposed budget. The department proposes to raise the laboratory's funding by 6% to $11.5 million, but this increase and more will be devoured by new security and health requirements imposed by DOE—and other added costs. To run the reactor even on a limited schedule, Blume says he is having to resort to accounting tricks—postponing shipments of spent reactor fuel and deferring new fuel purchases.

Brookhaven's problems go beyond its reactor operations. The 3% increase DOE has allowed for light source operation in fiscal 1989, says Blume, is inadequate to handle the 800 users. To cope with the shortfall, Blume has had to gut the laboratory's own research efforts at the synchrotron rings. This was easier, he says, than telling industry and university research teams that they would have to cut back their experiment schedules at the ultraviolet and x-ray rings. Despite these actions, the lab still may be short $1 million, says Michael L. Knotek, chairman of the synchrotron light source department.

Knotek says it is not practical to impose user fees or other charges because most of the researchers are dependent on government grants anyway. In addition, university and industry research teams have built most of the 90 beam lines coming off the two synchrotron rings and they provide their own instruments. Furthermore, the research teams must maintain operating staffs to assist general users from universities and industry in conducting experiments. Knotek notes that users are charged $100 an hour while conducting proprietary research.

Donald K. Stevens, director of basic energy sciences within DOE's Office of Energy Research, offers no excuses for what he says is a difficult situation. The program funding allowed Brookhaven and Stanford, he admits, is inadequate and reflects a tight budget climate within DOE.

James F. Decker, acting director of the Office of Energy Research, says it is unlikely that funds will be shifted from other department accounts to provide labs with more operating funds. Nor is Energy Secretary John Herrington expected to request a supplemental appropriation from Congress. Decker expressed confidence, however, that priority research projects would go forward at the laboratories.

The department's position runs counter to the recommendation of scientific review panels. The demand for synchrotron and

neutron-scattering user facilities and their operating needs were cited 4 years ago by the National Research Council, which noted that "funds must be provided to operate existing user facilities productively."*

University researchers make up a majority of the users. But there is surging interest in industry, which now accounts for about one-third of demand at the Brookhaven and Stanford synchrotrons. "A lot of American industry has not tapped it because they have not had the personnel to use it. But that is changing," says Stanford's Bienenstock.

Increasingly, companies are hiring personnel with the capability and desire to use federal research facilities, he says. Those that cannot justify in-house talent, Bienenstock adds, are turning to contractors for help. Says David Moncton, a researcher with Exxon, "We are on the verge of seeing synchrotron research methods become a mainstream research tool for America's technology oriented companies."

DOE and the research community, supported by the National Research Council's recommendations, began several years ago to plan new user facilities. Construction of a 2-billion-electron-volt (GeV) Advanced Light Source at the University of California at Berkeley is under way. An even more powerful 7-GeV synchrotron light source, the Advanced Photon Source, is slated for construction at Argonne National Laboratory and other more specialized experimental facilities may follow. Moncton, who has been loaned by Exxon to Argonne to help get the project started, says that corporate and university interest already exceeds the complex's capacity.

While these new facilities are needed, Paul Horn, acting director of physical sciences research division at IBM's T. J. Watson Laboratory, contends that DOE cannot afford to neglect operating laboratories. "It is meaningless to build new sources if we don't even fund existing sources—and we are not doing it well."

In one instance, American biologists, chemists, and material scientists have virtually been locked out of a unique facility because there is no operating budget. In addition to the SPEAR synchrotron source, Stanford has built two beam lines off its PEP electron-positron storage ring, which is used primarily for high-energy physics. But the world's most powerful source of hard x-rays (*Science*, 7 March 1986, p. 1070) has been used for barely 2 weeks in the past 2 years.

"The science is waiting to be done," says Bienenstock, noting that there are researchers who are anxious to get at the 7-GeV light source. Besides being a powerful research tool, the beam lines are seen as a critical training device for operating Argonne's $450-million Advanced Photon Source (APS). This facility would provide more than 2000 users a year with a full-time source of hard x-rays.

"What people do not understand is that we have to develop a reliable means of getting information out of APS and that could take several years," says Joachim Stöhr, a researcher at IBM's research center at Almaden, California. "If we start the learning curve now, by the time the APS comes on we will have the techniques for extracting useful information."

As presently configured, PEP can handle relatively few experiments annually. The machine is primarily used for high-energy physics research. But PEP is available for dedicated use at the desired energy range of 7 GeV for at least 2 months a year at a cost of $1 million a month. Stanford officials, however, note that they cannot swing the electric bill for running SPEAR at full schedule, much less PEP.

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For about $5 million the funding shortfall that is threatening to curtail operating schedules at Stanford, Brookhaven, and elsewhere in 1989 can be avoided. "We are talking about relatively small amounts of money," says IBM's Horn. "One can get a large amount of science and technology out of a small investment."

Researchers working at these user facilities are hampered by more than just laboratory operating budgets. Sometimes they are handicapped by the equipment. At Brookhaven's neutron source, for example, investigators must work with vintage 1966 instruments. The only new spectrometer at the facility is one supplied by the Japanese, who claim 50% of its operating time.

The National Research Council recognized the seriousness of the instrumentation problem in 1984, stating that "The current state of the U.S. neutron facilities is unsatisfactory." But DOE and the Congress have done relatively little since then to address the problem.

U.S. scientists, says Blume, are competing only "through extraordinary effort and ability." He notes that European investigators have a far more powerful research facility available to them at the Institut Laue Langevin in Grenoble, France. "More funding is available for this single facility than for all U.S. neutron facilities combined," Blume noted recently in testimony before the House Subcommittee on Energy Research and Development.

MIT's Birgeneau estimates that new instruments such as powder diffractometers and improvements in the Brookhaven reactor would cost $25 million to $35 million. "We have to be educating a new generation of people in this field," Birgeneau observes. It will be hard "to attract very good people," he warns, without new instruments and new facilities to conduct cutting edge research.

While lacking a solid strategy to assure full use of existing laboratory facilities and for replacing aging instruments, DOE is moving ahead with completely new facilities as called for by the National Research Council. Some scientists, however, are concerned that the United States may squander whatever lead it holds over competitors.

Alan Schriesheim, director of Argonne, notes that the Administration proposes to stretch out the construction of the new photon facility from a target completion date of 1993 to 1996. Meanwhile, the Europeans are moving ahead with a 6-GeV synchrotron that is scheduled to be operational in 1993. Japan is expected to finish a similar project by 1994.

The start of construction of the Advanced Neutron Source, the neutron-scattering community's equivalent of Argonne's photon source, also faces delays. The in-service date for the new reactor already has slipped a year to 1997. Further delays will occur if Congress rejects Oak Ridge's plea to add $5 million to DOE's proposed $3.7 million-budget for project R&D in 1989.

The proposed Oak Ridge reactor would provide a factor of 10 increase in neutron flux over what is available at the Institut Laue Langevin in Grenoble and would serve more than 1000 scientists yearly. The reactor is needed not just to satisfy scientific curiosity, but to replace Oak Ridge's aging High Flux Isotope Reactor. After suspending its operation because of safety questions, DOE has determined its life is limited to perhaps ten more years.

It is not clear whether Congress will take any steps to help the biologists, metallurgists, physicists, and others who depend on synchrotron radiation and neutron sources. But Farrel Lytle, senior research scientist at Boeing Aerospace Co., says it should be obvious to Congress that "It's just dumb to have facilities like those at Stanford and Brookhaven and not run them as much as you can." ■ **MARK CRAWFORD**

**Major Facilities for Materials Research and Related Disciplines*, a report of the National Research Council, National Academy Press, Washington, DC, 1984.