Dark Tunnel Ahead for Light Sources

Faced with a flat budget, the Department of Energy is drawing up a plan for synchrotron research over the next decade. Will the solution include closing a facility?

Surrounded by flags and balloons, U.S. politicians last week celebrated the end of a 30-month war between Congress and the White House over how to cut taxes and reduce the federal deficit. The agreement also marks a return to bipartisan support for federal R&D spending and eases fears in the science community that major research programs may be sacrificed to balance the budget. "It's an extraordinary reconvergence," says an ebullient Jack Gibbons, the president's science adviser. But for some areas of research, a balanced budget may not be cause for celebration.

The prospect of level spending through 2002 has led the Department of Energy (DOE) to examine the fate of its four synchrotron facilities. The review has put users in a decidedly somber mood. "They are slicing the salami thinner and thinner," says Brian Kincaid, who directs one of the new facilities, the $100 million Advanced Light Source at Lawrence Berkeley National Laboratory in California. "All the facilities will cross into the red within a year or two—and there will be layoffs and reduced operations if the budget is flat."

About one-third of DOE's $650 million budget for basic energy sciences goes to operate the synchrotrons, where researchers from a wide range of disciplines use beams of x-rays to probe the structure of matter. But department officials says it's not enough to keep all four facilities operating at their current capacity and plan a new generation of machines. As a result, DOE managers are faced with a painful decision: whether to close a facility so that the remainder will prosper and a future generation can be born. They have pulled together a panel of 17 scientists and asked for their no-holds-barred advice. "It's going to be an absolute and total bloodbath," predicts one panel member.

DOE officials insist they have little choice. "It's a combination of two new sources coming on line in the 1990s and a budget that is likely to be flat," says Pat Dehmer, who directs DOE's basic energy sciences division. The 4-year-old Berkeley facility and the $812 million Advanced Photon Source (APS) at Argonne National Laboratory outside Chicago, which opened last year, are members of a third generation of DOE-supported machines that produce brighter x-rays than their older siblings, the National Synchrotron Light Source at Brookhaven National Laboratory in New York and the Synchrotron Radiation Lab at the Stanford Linear Accelerator Center in California. And many researchers say that the United States must begin thinking about a fourth-generation device to maintain its global leadership.

Advanced Light Source
Lawrence Berkeley National Lab
Berkeley, California

Completed: 1993
1997 Operating Cost: $18 million
Technical Specs: High-brightness soft x-ray and ultraviolet radiation
Number of users: 300

National Synchrotron Light Source
Brookhaven National Laboratory
Upton, New York

Completed: 1981
1997 Operating Cost: $25 million
Technical Specs: X-ray, ultraviolet, and infrared radiation
Number of users: 2260

Synchrotron Radiation Laboratory
Stanford Linear Accelerator Center
Menlo Park, California

Completed: 1973
1997 Operating Cost: $17 million
Technical Specs: X-ray and ultraviolet beams
Number of users: 600

Advanced Photon Source
Argonne National Laboratory
Argonne, Illinois

Completed: 1996
1997 Operating Cost: $76 million
Technical Specs: Bright x-ray beams
Number of users: 1300

The crisis facing the light sources, which use x-rays to examine the structure of everything from semiconductors to designer drugs, is testament to their success. While their neutron-scattering cousins have suffered several setbacks in recent years (see p. 761), synchrotrons have entered an exciting era thanks to the new facilities and new applications. "Compared to neutron scattering, this field is not suffering," says Robert Birgeneau, dean of science at the Massachusetts Institute of Technology, who chairs the light-source panel. "This is a rich, vital, extraordinarily active field," adds David Bishop, a Lucent Technologies physicist and panel member drawn from outside the synchrotron community.

But the cost of operating the two new machines, and the continued high demand for the older facilities, is outstripping the $200 million allocated annually to operate the synchrotrons. The sense of foreboding is greatest at Stanford and Brookhaven, home of the two older machines. Brookhaven can hear "kind of a sucking sound. ... There really has been a brain drain" to the new facilities, says Grant Bunker, an associate professor of physics at the Illinois Institute of Technology, who directs a user group at Argonne's APS. "Right now [APS] is where the action is." The new machines, adds Edwin Westbrook, an x-ray crystallographer and director of an APS structural biology team, "are two orders of magnitude brighter than the second-generation sources."

But while some users are attracted to the added brightness of the APS or the soft x-rays at Berkeley's Advanced Light Source, Stanford and Brookhaven officials say their facilities are attracting new researchers from disciplines such as biology that have not been heavy users in the past. Although the number of materials science users at the Brookhaven synchrotron has declined to 900 from a peak of about 1100 in 1993, life science users have grown from a few dozen in 1990 to more than 600 in 1996, according to lab documents submitted to the Birgeneau panel. "They both have huge and well-satisfied user communities," says Lucent's Bishop. "It would be easy if one place was a real clunker, but none of them is like that."

Instead, panel members must wrestle with a number of more subtle factors. Researchers in the Northeast, for example, complain that closing Brookhaven's machine would discourage synchrotron use in their region by requiring researchers to make long trips. "Proximity is important" for those experiments that are not dependent on high brilliance, says Keith Hodgson, a Stanford chemist who represents the Stanford facility to the panel. "You can send your students and samples [a short distance] more easily and cheaply."

That leaves panel members debating whether to recommend that DOE sacrifice the large number of users at one of the second-generation facilities for cutting-edge work at

Industry Chafes at APS Rules

ARGONNE, ILLINOIS—The possibility that the Department of Energy may close a synchrotron to focus operating funds on fewer facilities (see main text) is only the latest flash point between DOE and the user community. Relations between the two have already begun to sour at the Advanced Photon Source (APS), DOE's new flagship synchrotron outside Chicago. The problem centers on DOE's policies toward industrial users, who complain about the fees for conducting proprietary research and the rules governing what research they can do onsite.

Scientists are flocking to the APS, which officially opened in May 1996, to use its powerful, hair-thin x-ray beams for research in physics, chemistry, materials science, and drug discovery. But access to the facility doesn't come cheap. To help defray the cost of building and operating the facility, users have built 40 experimental beamlines, at nearly $4 million apiece, to collect the x-ray data. Most of these groups, known as collaborative access teams (CATs), are consortia of industry, academic, and government labs doing research that ranges from mapping the atomic landscape of proteins to studying the molecular structure of minerals under pressures found at the center of the Earth.

Industrial strength. Procter & Gamble's Joel Oliver is part of a consortium that uses the beamline for drug design.

INTERNATIONAL MOLECULAR CRYSTALLOGRAPHY ASSOCIATION/CAT

While most industrial researchers expect to recoup their company's beamline costs with new products, several have begun to chafe at the additional costs and restrictions for proprietary research. APS currently charges industrial users about $1800 per 8-hour shift to collect data not intended for publication. That fee, say APS officials, offsets the government's cost of running each beamline and ensures that APS doesn't subsidize research that will generate income for individual companies. APS levies the same charge on non-CAT users that conduct proprietary research at the facility. Moreover, it doesn't charge for nonproprietary research headed for the open literature.

Companies don't object to the extra charge itself. What bothers them is the requirement that all CATs must donate a quarter of their beam time to outside users. APS officials say the rule ensures that all qualified users have access, but one company researcher argues that the rule means "we are subsidizing research by other groups and then paying the government full cost recovery" for use of proprietary beam time. By contrast, companies that are not part of a CAT pay only for the beam time needed to do their research. Says DuPont's Richard Harlow, "It's costing us more money to be a member of the club."

APS officials say that the benefits of membership outweigh the cost. CAT members receive ready access to beam time, for example, while non-CAT experimenters must be selected through a peer-review process. CAT members also design their own beamlines and can optimize the equipment for their own experiments, adds Gopal Shenoy, who heads APS's experimental facilities division, whereas outsiders must use what's available.

While Harlow and others agree that ready access and design input into the beamlines are valuable, they say that money isn't the only issue. Even more unsettling, they say, are rules that could allow the government to latch onto new discoveries made at the APS. According to DOE's user agreements, companies that pay to conduct proprietary data collection retain full rights to the data. But if additional analysis of the data is performed onsite, the government can lay claim to any new discoveries on the grounds that it addresses a broader public good.

The upshot, according to Merck's Brian McKeever, is that "we have to do the [data analysis] back home to guarantee we don't fall into a legal trap. ... It tends to slow everything down, because you're not operating as efficiently as you'd like." Shenoy says it isn't likely that DOE would enforce the "march-in" clause, which is a holdover from a 1940s congressional mandate. But industry officials say that such "winking and nodding" at contract language is no way to do business.

Shenoy and others say that the rules for APS governing the cost and conditions for conducting proprietary research are the same as at other DOE synchrotrons. The fact that virtually all the industrial CAT members have signed the agreement, they add, shows that DOE's restrictions are not unduly burdensome. Indeed, Harlow admits that "we haven't had much success" in getting DOE to change the rules even after years of legal wrangling.

But that doesn't mean the companies like the final outcome. "We signed under very strong protest," says Harlow. "It's not a friendly agreement." As DOE tries to rally support for more money to operate the facility, such resentment could come back to haunt it.

–Robert F. Service

the newer ones. They must also weigh which disciplines are likely to produce the best science—and therefore, which facilities should be preserved to ensure that work progresses. "We have to assess [which research] is the most important," says Birgeneau—no simple matter given the diversity of uses for both newer and older synchrotrons.

Some wonder about the wisdom of trying to carve funds from operating costs to develop a fourth-generation source. "It's not on the radar screen—it was added [to the panel's charter] as an afterthought," scoffs Berkeley's Kincaid. But Stanford's Hodgson disagrees. "It would be foolish not to pursue it," he says. "You've got to invest in the future."

Whatever balance is struck, few support the notion of closing one of the machines in the short term. "Most people say it would be premature," says Gopal Shenoy, who heads APS's experimental facilities division. "You need to operate the new facilities for 5 to 10 years and then look to a fourth generation."

One way out of the budget bind may be to seek money from other agencies. Dehmer's basic energy sciences group funds primarily physical scientists, and the growing presence of biologists and environmental researchers has sparked some grumbling among the traditional synchrotron users. Perhaps the National Institutes of Health and the Environmental Protection Agency could help shoulder a share of the beamline costs, if not the operating costs, one panel member says.

So while lawmakers head home for a monthlong recess to trumpet the new budget agreement, the Birgeneau panel will be trying to reconcile competing needs within a limited budget. The committee's recommendations will be hammered out in meetings this month and delivered at the end of September. "It's painful, but we can appreciate the fact that scientists have been asked," says Bishop. "If we duck this, someone less informed is going to decide—and it would be the politicians."

–Andrew Lawler

With additional reporting by Robert F. Service.