

Panel puts aside differences, lists major materials facilities

When President Reagan's science adviser, George A. Keyworth II, called on the National Research Council of the National Academy of Sciences last November to advise the government on the top priorities for major new facilities in materials research, he thought he had ducked the stormy issue of "big" versus "small" science. He took shelter by defining "major facilities" as those costing at least \$5 million. In effect, this limited the Research Council study to new sources of synchrotron radiation, neutron scattering and high magnetic fields. Such facilities represent big science. They are usually located at national laboratories for a wide variety of users, in contrast to specialized materials research labs located at universities and businesses, each with a few researchers and an instrumentation inventory of less than \$1 million.

Large-scale facilities for materials science are traditionally funded by the Federal government. Thus, the Department of Energy supports Brookhaven, Argonne and Oak Ridge national labs, among others, the Department of Defense such places as the Naval Research Laboratory, the National Science Foundation sponsors MIT's Francis Bitter National Magnet Laboratory and the Department of Commerce underwrites the National Bureau of Standards. Early last year, when Keyworth attempted to enlarge this diversified conglomerate by creating a National Center for Advanced Materials, complete with a 1.3-GeV storage ring for a proposed synchrotron light source, at Lawrence Berkeley Laboratory, many materials scientists voiced their outrage. Not only did Keyworth and DOE bypass the conventional peer review in their haste to establish NCAM, ran the complaints, but the real needs of materials research had been neglected. Congress funded only CAM in the fiscal 1984 budget, withholding support for a light source and recognition of a national lab (PHYSICS TODAY, June 1983, page 17). The action seemed to defuse the controversy over big and small materials science—though, with the publication of the Research Council's 78-page report, *Major Facilities for Materials Research and Related Disciplines*, on 3 August, it became clear that the issue is alive and still simmering.

'Wish list.' The committee followed Keyworth's instructions by providing a sensible ranking of proposed major projects for materials research along with recommendations for improving existing facilities—a "wish list" that would total nearly \$1 billion if it were all undertaken over the next decade or

so. In doing this, the committee avoided the question of balance between big and small materials science, NAS President Frank Press points out in a letter to Keyworth introducing the report. At the committee's first meeting last January, Keyworth had cautioned the members against getting entangled in the issue (PHYSICS TODAY, March, page 55).

But, considering that half of the committee's 22 members are engaged in university research, it's not surprising that they took the occasion of the study to go somewhat outside Keyworth's boundaries. Thus, the report exhorts the government, as a prerequisite to constructing major new facilities, to expand its support of smaller research programs, including related instrumentation. It defends this with the argument that small-scale research "continues to provide much of the fundamental new science in the field and to train a large fraction of our scientific and technical manpower." It cites a previous Research Council study of materials research labs at universities in 1971 that identified the need for some \$200 million in new instrumentation. "Only a small fraction of the need was met at the time," says the new report, and the situation at such labs is now critical. Today, the committee asserts, at least \$1 billion—"and some estimates are considerably higher"—is needed to bring materials research labs in universities "up to modern standards."

Another prerequisite is that "resources must be provided to operate existing user facilities productively"—meaning, specifically, that the government should continue to support the large synchrotron facilities at Brookhaven, Stanford and the University of Wisconsin, upgrading these as necessary, since it will take several years or even more than a decade before any new facilities such as those proposed in the report, can contribute to US research in material ways.

In their preface, the committee co-chairmen, Frederick Seitz, former president of Rockefeller University and onetime president of the National Academy of Sciences, and Dean E. Eastman of the IBM Thomas J. Watson Research Center, observe that the members expressed concern throughout the deliberations about "the possible misinterpretation, even misuse, of its report." So the text of the report repeatedly emphasizes that "the knowledge generated by materials research comes from diverse research styles and performers, each vital to the total effort and each complementary to the other." Indeed, because the committee represented the

diversity of research styles and often clashed in deliberations, it is remarkable that agreement on a priority list for major facilities was reached at all. Accordingly, the report is important in reconciling different approaches to materials research.

Strong words. The disparate research styles "must each be well supported for the health of the total effort in materials research," write Seitz and Eastman. "To deny funding to smaller scale research to support major facilities is destructive." Strong words, these, for a committee of Establishment scientists.

In making a distinction between "new large facilities" and "new capabilities" for existing facilities, the committee reveals some of its fears and hopes. For example, US neutron-scattering instruments, which have helped transform scientific understanding of the structure of solid-state materials, polymers and such biological macromolecules as ribosomes and proteins, are now considered by the committee to be "unsatisfactory" and becoming obsolete. Neutron-scattering programs at Argonne, Brookhaven, Oak Ridge, Los Alamos and the National Bureau of Standards, as well as at the University of Missouri, MIT and other universities, attract a large number of researchers and a modest amount of funding, says the report. The US lags behind Europe in the availability of cold neutron sources for certain types of experiments. Key to Europe's success has been the development and use of guide halls and associated instruments for ultra-high-resolution and high-sensitivity spectroscopy. "These currently provide energy resolutions as much as five orders of magnitude better than those available in the United States; they also enable studies of small-angle and medium-resolution diffraction and other new scientific applications," the report asserts. By contrast, the US has only one cold neutron source, at Brookhaven's 60-MW High Flux Beam Reactor, and another under development at the Bureau of Standards. The US has no guide halls to improve the versatility and flexibility of cold or thermal neutron instruments, while 60% of the neutron scattering instruments at Institut Laue-Langevin are located in a large guide hall, and a new guide hall and cold source are scheduled for completion in two years. France also has a new reactor center, called Orphée, at Saclay, near Paris, with two hydrogen cold sources, and Germany is expanding guide halls with new instruments at the KFA research reactor in Jülich and at another reactor in West Berlin. Current operating expenditures for neutron scattering at research reactors

in Western Europe is about \$80 million per year in 1983 dollars, including associated reactor operation costs—roughly three times the US effort.

A somewhat similar situation exists for synchrotron radiation facilities. In the US these range from virtually in-house facilities, such as the Cornell High Energy Synchrotron Source, to larger user-oriented places, such as the National Synchrotron Light Source at Brookhaven, the Synchrotron Radiation Center at the University of Wisconsin and the Stanford Synchrotron Research Laboratory at SLAC. Of these, only the storage rings at Brookhaven and Wisconsin were designed as light sources—all before the full recognition of the importance of insertion devices. While none of the facilities in Western Europe, Japan and the USSR is more advanced than Brookhaven and Stanford, the European Science Foundation is about to approve a long-held plan to build a 5- to 6-GeV synchrotron-radiation facility at a site still to be decided and at a relatively low cost of less than \$200 million.

New opportunities. New facilities for synchrotron radiation research will be needed, says the committee, to make optimum use of the scientific and technological opportunities offered by "wigglers" and "undulators." By providing radiation sources with brightness intensities orders of magnitude greater than now available, such insertion devices will provide better means for probing the detailed electronic structures of materials. As for magnet facilities, the committee finds, as did an earlier Research Council group in 1979, that the availability of higher magnetic fields would open "many new, exciting and profitable areas of research," particularly in improving superconductors and in constructing more efficient superconducting magnets, such as those needed for particle accelerators. Indeed, the committee admits it is hard to think of pioneering research in such fields as plasma, atomic and molecular physics, biology and health sciences, chemistry and earth sciences, as well as materials research, that would not benefit "in some essential ways" from new and upgraded facilities.

In setting its priorities for major facilities, therefore, the committee took note of the possible significance of the research they would produce and such additional factors as: importance in improving the nation's scientific, technological and commercial competitiveness as well as advancing national defense systems; potential for training scientists and engineers through easy access of students and researchers as well as by investigators from other industrial and government labs; availability of less costly alternatives for achieving similar goals; cost effectiveness and operational feasibility.



The 60-MW High Flux Beam Reactor at Brookhaven is the only cold neutron source in the US. The new National Research Council report calls for its upgrading.

The committee ranks its major facilities in the following order:

- ▶ A 6-GeV synchrotron-radiation facility equipped with new insertion devices, producing maximum brightness in the 10-keV region, where most x-ray research is done, to investigate the properties of complex materials. If design work is started immediately and construction begins in, say, fiscal 1987, the machine could be operating possibly by 1992. Estimated cost of such a facility: \$160 million.

- ▶ An advanced steady-state neutron source with about 10 times the flux of today's machines. This machine would give the US new capabilities for high-resolution spectroscopy and small-angle scattering studies. The complexity of the facility requires that planning begin right away so that construction starts in fiscal 1989 and operation begins by fiscal 1996. Final cost: \$260 million.

- ▶ A 1 to 2 GeV synchrotron-radiation facility similar in concept to the machine Keyworth had in mind for Lawrence Berkeley, providing optimal flexibility for both vacuum ultraviolet and soft x rays, where opportunities exist for research in chemical physics, electron spectroscopy and imaging techniques such as microscopy and holography. Cost: \$70 million.

- ▶ A high-intensity pulsed neutron source with a peak flux in the range of 10^{17} neutrons/cm²sec is considered the most promising approach to future advances beyond those attainable with steady-state sources. In the few years that pulsed sources have been available, they have led to innovative research using new time-of-flight techniques for a diversity of users. Although the committee deems this facility to be promising, it states that a decision to build it should await the results of such existing machines as Los Alamos's LAMPF, which seeks to reach 10^{16} neutrons/cm²sec at peak flux. Cost: \$330 million in 1984 dollars.

In addition, the committee recommends new capabilities for existing facilities in the following order:

- ▶ Centers for cold-neutron research should be developed at Brookhaven and the Bureau of Standards should be upgraded with guide halls and special instrumentation. Estimated cost: \$25 million to \$35 million.

- ▶ Insertion devices (wigglers and undulators) are needed to enhance the intensity of existing synchrotron-radiation facilities. Cost: about \$20 million for 6 fully developed lines of storage rings, including some 12 x-ray and vuv instruments

- ▶ Experimental hall and new instruments at the Weapons Neutron Research/Proton Storage Ring at Los Alamos would make the US more competitive in pulsed neutron research. Cost: \$15 million.

- ▶ The National Magnet Laboratory at MIT, the only high-field facility for a variety of users in the US, requires development and instrumentation to explore important problems in condensed-matter science. Estimated cost: \$5 million.

- ▶ Enriched targets for pulsed neutron sources can more than double the available flux at pulsed neutron facilities. Cost: between \$2 million and \$5 million.

The committee does not consider it necessary to initiate all the projects it suggests within the decade. In fact, it holds such action to be imprudent. What's more, it deferred judgment on several specialized facilities, such as the Materials Research Laboratories funded by NSF and DOE as well as other labs and centers for research on ceramics, polymers and materials processing. "The committee heard excellent arguments for new facilities of this type, each of which could easily cost more than \$5 million or \$10 million," says the report. In the end, it deferred these "without prejudice," because of their "open-ended" nature.

"In principle," Eastman explained in an interview, "you can always put together a collection of equipment to come to, say, \$4 million or \$5 million and cover several themes. We did not consider any of these specialized facilities because they are best judged by specific proposals. That's a job for the government agencies and the Congress, not an advisory committee."

Eastman and Seitz, together with Press, have briefed Keyworth and other officials at the White House Office of Science and Technology Policy and DOE. The committee's conclusions and recommendations, are bound to have a

major effect on the future directions of US materials research and on the institutions where research, both large and small, is conducted. The committee members have asked that the priorities be reexamined from time to time by other panels and committees to evaluate the progress of materials research and the needs of the nation in the light of new information and improved technology.

Now that the report has been delivered, the competition will begin for who gets what, when and how as the agencies and OSTP prepare the science budgets for fiscal 1986. —IG

Out on bail, Zehe awaits trial as spy

Alfred Zehe, an East German physicist arrested last November in Boston at the 30th annual symposium of the American Vacuum Society on charges of buying classified US defense documents (PHYSICS TODAY, January, page 53), was released last 3 July on \$500 000 bail paid by the East German ambassador to Washington. Under the terms of the bail order issued a week earlier by US District Judge David S. Nelson, Zehe is restricted to a 10-mile radius of Boston while awaiting trial. He is permitted to leave his apartment—rented for him in the attractive Back Bay district by the East German government—only to visit his lawyer's office and to pursue academic matters, always with the permission of the US marshal. Zehe had been invited to stay with either a biologist at Boston University or a computer scientist at MIT, according to his attorney, Harvey A. Silverglate, but Zehe decided against involving US citizens in his current predicament.

US government prosecutors sought to deny bail for Zehe on the grounds that he might flee the country or that even if he wanted to stand trial, East Germany might spirit him abroad against his will for fear he would defect or turn informer. In opposing a motion for bail, Assistant US Attorney Robert S. Mueller III cited the case of Penyu Baychev Kostadinof, a Bulgarian commercial counselor arrested in New York City in September 1983 on espionage charges. Though the Bulgarian ambassador to Washington offered his assurance that he would be personally responsible for Kostadinof and make sure Kostadinof would appear in court, US District Court Judge David N. Edelstein denied bail. Despite the historic presumption of innocence of the accused, Judge Edelstein decided that "the unique nature of the charged offense and its severe penalties, the heavy weight of the evidence against the defendant... and the defendant's

lack of any meaningful ties to the United States together strongly indicate that, regardless of what reasonable conditions of release are imposed, the risk of flight is overwhelming. This is the rare case of extreme and unusual circumstances that justifies pretrial detention without bail." On appeal, the decision was upheld.

Agent 'Chuzen.' Zehe's lawyer argued that *US v. Kostadinof* was a vastly different case. Zehe was arrested while attending a scientific conference in the US as a "respected member of the international physics community," not as a foreign agent who entered the country to engage in spying, says an affidavit filed with Judge Nelson. Zehe was charged with eight counts of espionage, after he allegedly paid \$15 800 to a civilian technician for the US Navy who used the code name "Chuzen" (but now has come in from the cold to be identified as William Tanner), for plans of a towed-array sonar system for detecting submarines and a "Naval Communications Master Plan." Zehe's defense is that none of the documents was received or reviewed in the US, that all but one were classified "confidential" (with the other, the Master Plan, marked "secret") and that they were about to be downgraded because the Navy considered them just about obsolete at the time.

The documents were brought to Zehe, a professor of physics and director of the Vacuum Physics Group at the Technical University of Dresden, German Democratic Republic, who has been teaching since 1981 at the University of Puebla in Mexico (PHYSICS TODAY, May, page 11). Zehe, his lawyer asserts in a memorandum to the court, did not seek out these plans. "His role, at most, is alleged by the evidence to be that of a scientific expert... to evaluate such material for his government," says the memo. Anyway, Zehe's defense runs, the Navy plans were turned over "voluntarily" by a US citizen to

GDR officials as part of a "sting" operation by US intelligence services. Chuzen was a "double agent," a US Attorney's affidavit now admits, who went to the GDR embassy in Washington, D.C., to offer to sell classified Navy documents that were provided to him by the FBI and Navy Intelligence Service. What followed was a series of five meetings at the East German embassy in Mexico City and a lengthy encounter at a "safe house" in East Berlin where Chuzen passed documents to Zehe and received payments.

Seriousness questioned. Even so, Zehe's lawyer informed the court, "in this case, where the government willingly passed low-level classified data to a foreign country, and where, as a result, there can be no assertion that this country was harmed, the 'seriousness' of the offense must be questioned." One element of Zehe's defense turns on the charge that he committed his spying acts abroad—outside US jurisdiction. The government's argument that the possible penalty of life imprisonment for Zehe's alleged crime is true only in the abstract, says a memo submitted to the court last March. Accordingly, "...when actual cases involving not United States but foreign citizens arrested for espionage are reviewed, a striking pattern emerges: The defendants rarely spend any significant time in jail, but are always or almost always returned to their countries pretrial or shortly after conviction," the memo states. It cites, in particular, the celebrated spy cases involving Rudolph Abel (30-year sentence, but defendant was sent back to the Soviet Union after serving a few years), Igor Y. Melekh (allowed to leave the country before trial; the indictment was dismissed soon after) and Vladik A. Enger and Rudolf Chernyayev (50-year sentences, but the defendants were returned to the USSR).

What sets Zehe's case apart from those of convicted Soviet bloc spies, claims Jeanne Baker, one of his attorneys, is that the US government is using it to send a message—that Soviet agents are running off with national defense secrets. "By catching a 'spy' at an important scientific meeting, virtually at the same time Congress is deciding whether to strengthen the Export Administration Act to restrict the flow of high-technology research and products, the government appears to be conveying a strong signal," she observes.

In ordering the bail, Judge Nelson turned down a request that Zehe be allowed to reside at the mansion in Chevy Chase, Maryland, where the East German ambassador, Gerhard Herder, lives.

No date has been set for Zehe's trial. —IG □