

CONGRESS CANCELS SSC AND ALLOCATES HIGH BUDGETS FOR TECHNOLOGY IN 1994

When fiscal 1994 began on 1 October, Congress still had not appropriated funds for any of the R&D agencies; in the weeks that followed, a series of bills, each known as a "continuing resolution" had to be passed for the government to operate at no more than fiscal 1993 budget levels. But by the end of October, all the R&D budgets were in place except for those in Defense and Interior. The results, on balance, were only sort of good. Unarguably the worst result was the decision on the Superconducting Super Collider—virtually a death knell for high-energy physics in the US.

While many of the research agencies received increases, varying from a paltry 2% for NASA to a prodigious 35% for the National Institute of Standards and Technology, the allocations were almost always less than the Administration had requested (see table). What's worse, some important basic science projects were abruptly canceled—among these, the SSC, almost 20% completed under the gentle rolling prairie around Waxahachie, Texas, and the second of two Advanced X-ray Astrophysics Facilities, a single spectrometer mission bearing the appellation AXAF-S that Senate appropriators "reluctantly" considered less than cost-effective.

Tragedy of the SSC

In deleting the SSC, Congress allocated \$640 million for its "orderly termination"—exactly the same amount the Clinton Administration had sought to continue building the massive machine during fiscal 1994. The death of the SSC is both a human and scientific tragedy, affecting the personal and professional lives of some 2000 people already at work at the lab's site or at the offices in Dallas. This number includes about 200 physicists, most of them relocated from Energy Department laboratories and from universities in the US, as well as from labs and universities in Eastern and Western Europe and elsewhere. The purpose of the SSC was to unlock the secrets of elec-

troweak symmetry and to reveal the ultimate origin of particle masses. Without the SSC those scientific problems may remain unsolved—at least until another proton collider is built, most probably the Large Hadron Collider that is now proposed for an existing underground tunnel at CERN, the large European accelerator center outside Geneva. Still, without an SSC, the continued vitality of the US high-energy program is in grave peril. To answer whether the 60-year history of American contributions to particle physics is approaching an end and to examine the options available to the community, Energy Secretary Hazel R. O'Leary directed her High-Energy Physics Advisory Panel to describe the field's future a decade hence. HEPAP was asked explicitly to weigh the possibility of international collaboration with CERN. The panel's schedule calls for submitting an initial report by 28 February and a final report by 30 April.

The fatal blow dealt the SSC in the House is usually attributed to its ascending cost, now estimated at nearly \$11 billion, in a period when Congress is emphasizing deficit reduction and balanced budgets. To be sure, the SSC was a prominent target in a time of scarcity, though allegations of mismanagement didn't win friends in Congress (see *PHYSICS TODAY*, August, page 43). The project's most persistent adversaries in the House, Jim Slattery, a Democrat of Kansas, and Sherwin Boehlert, a Republican of New York, accepted the scientific case for the SSC even as they argued against funding it. "The vote against the SSC was not a vote against science," says John Gibbons, the President's science adviser. "It came at a moment in time when forces intent on getting the budget deficit down were just unstoppable. It does not reflect Congressional attitudes toward basic research. In fact, research came out quite well across the whole budget."

To be sure, compared with almost all other discretionary programs in fis-

cal 1994, the research budgets fared better than might be expected. Ironically, the \$640 million allocated for the SSC's funeral is the largest amount the project ever received from Congress.

The final budgets included a few surprises: The largest big-ticket item, NASA's space station, squeaked through the appropriations process in the House by one vote, after a great deal of jawboning by the White House and by the lobbyists for the aerospace industry who made the arguments for retaining jobs and maintaining foreign commitments. In the end, the station got the full \$2.1 billion that the Administration had asked for.

DOE's two new projects

Though it lost the SSC, the Energy Department gained two new projects: \$36 million was allocated to begin work on the asymmetric B-meson accelerator at the Stanford Linear Accelerator Center and \$17 million of the requested \$39 million was appropriated to continue designing the Advanced Neutron Source, which would be constructed at the Oak Ridge National Laboratory. Although the House-Senate conference report accompanying DOE's bill proposes that ground for the ANS will be broken in 1995, the facility's \$2.7 billion price tag is bound to provoke the nitpicking scrutiny by the department and Congress that contributed to the SSC's debacle.

Here are highlights of the 1994 research budgets in nondefense agencies:

National Science Foundation.

A month after his inauguration, President Clinton asked Congress for a \$16.3 billion "emergency" stimulus package of legislation that included \$207 million to make up the difference between the Bush Administration's request and the cuts made by Congress last year (*PHYSICS TODAY*, April, page 43). But hopes for a larger NSF research budget were shortlived. Congress rejected the new Administration's plea for supplemental funding as an idea whose time had not yet come for a govern-

Bottom lines: Research budgets for fiscal 1994

	FY 93 estimate	FY 94 request (millions of dollars)	FY 94 enacted	Percentage gain (loss)
National Science Foundation	2733.5	3180.2	3027.8	11
Research and related activities	1859.0	2204.8	1998.5	8
Academic research infrastructure	50.0	55.0	110.0	120
Education and human resources	487.5	556.1	596.6	22
Critical Technologies Institute	1.0	1.0	1.5	50
Department of Energy				
General science and research	1417.8	1586.2	1615.1	14
High-energy physics	613.4	627.8	627.8	2
SLAC B Factory	0	36.0	36.0	—
Fermilab main injector	15.0	25.0	25.0	67
Superconducting Super Collider*	514.5	640.0	640.0	
Nuclear physics	309.1	322.3	353.3	14
Brookhaven Relativistic Heavy Ion Collider	70.0	70.0	78.0	11
CEBAF, Newport News, Virginia	32.0	16.6	16.6	(48)
Basic energy sciences	846.4	802.0	802.0	(5)
Argonne 6-7-GeV synchrotron light source	109.1	107.0	107.0	(2)
Oak Ridge advanced neutron source	0	39.0	17.0	—
University and science education programs	55.6	58.0	58.0	4
Fusion energy	331.2	347.6	347.6	5
Magnetic confinement systems	164.2	157.4	170.4	4
Development and technology, including ITER	66.4	81.3	81.3	22
Inertial fusion (nondefense)	6.9	4.0	4.0	(42)
Inertial fusion (weapons R&D)	212.3	188.4	188.4	(11)
Weapons R&D	1499.9	1362.7	1325.6	(12)
Weapons testing	419.4	408.4	403.1	(4)
Defense environmental restoration and waste management	4964.9	5428.1	5181.9	4
National Institute of Standards and Technology	384.0	535.2	518.7	35
Scientific and technical research and services	192.9	241.0	224.5	16
Industrial technology services	86.1	232.5	232.5	170
Construction of research facilities	105.0	61.7	61.7	(41)
NASA	14308.9	15265.0	14551.4	2
Research and development	7080.0	7690.4	7529.3	6
Space station	2122.5	1946.0	1946.0	(8)
Space flight	5058.8	5333.8	4853.5	(4)
Construction of facilities	535.1	565.8	565.7	6
National Oceanographic and Atmospheric Administration	1630.2	1862.7	1927.8	18
Oceanic and atmospheric research and facilities	1502.4	1757.7	1694.8	13

*The requested allocation for fiscal 1994 was converted by Congress to termination expenses.

ment so deeply in debt. Clinton's first budget, however, called for NSF to get a formidable 16% increase, with research programs slated for an 18% boost. In September, Congress trimmed the request to an overall 10% rise and a 7% increase for research programs. It turns out that the agency did better than that when it received a \$22 million windfall after Congress terminated NASA's Advanced Solid Rocket Motor program and redistributed the savings to other agencies. NSF wound up with a total increase of 11%, with research getting nearly 8%.

The boost means a hike from \$1.86 billion for NSF research last year to \$2.02 billion this fiscal year. Even so, it may be harder than ever for scientists to get grants from the agency. Often criticized for reducing the size of grants so that it can award a larger number of applicants, the foundation is now committed to giving bigger sums for longer periods to

individual investigators.

The agency's program to improve facilities and instrumentation at universities and colleges will go up from \$50 million in 1993 to \$110 million. This program consolidates two previous ones for modernizing decrepit research facilities and supporting purchases of research equipment. In its report on the NSF section of the appropriations bill, the House-Senate conference committee noted that NSF had reported in 1988 that for every dollar spent on repairs and renovations at university and college science labs, another four dollars worth of work was deferred. "These funds are designed to assist in modernizing and revitalizing the nation's [academic] research facilities," the committee declared. Lawmakers agreed that the sum, though inadequate to alleviate the rundown condition of science facilities at many institutions of higher-education, was probably the best way to avoid the

onerous practice of "earmarks"—the pork-barrel tactic that allows members of Congress on appropriations committees to dispense money to needy—or just plain greedy—academic institutions. NSF intends to invite proposals for facilities and equipment from universities for competitive merit review.

A Senate proposal to cut \$50 million from NSF's request for high performance computing and communications was restored in part during the House-Senate conference. Now the computing and communications program will grow from last year's \$225 million to \$305 million.

Among the many concerns about NSF expressed in the Senate appropriations committee report, prepared under the aegis of Barbara Mikulski, a Maryland Democrat (see PHYSICS TODAY, October, page 109), was the requirement for useful results from the agency's interdisciplinary science and technology centers on university campuses. Picking up on Mikulski's remarks, Congress asked the foundation to hire the independent National Academy of Public Administration to assess the economic and technological relevance of the centers.

NSF's appropriation, signed into law by President Clinton on 28 October as part of the bill covering VA/HUD and independent agencies, does not include the controversial language of the Senate subcommittee report, which calls for the agency to devote 60% of its funds to "strategic research" (PHYSICS TODAY, October, page 111). Nonetheless, the proposition was not repudiated in the legislation and it is certain to be a contentious matter for the foundation's new director, Neal Lane.

In recent remarks to the foundation's advisory committee on education and human resources, Lane said he is pleased by Congress's demonstration of support, but he acknowledges that "the world has changed." Lawmakers want the agency's research programs to produce results more relevant to the nation's social and economic needs. Nevertheless, he observed, as the Federal government's "best kept secret of success," NSF will continue to support basic research, in the sense that it seeks answers to fundamental questions. But such research, by its very nature, is also "strategic," in that it is the foundation for useful applications of knowledge and understanding of the way the world works.

Energy Department. Along with funding for SLAC's B Factory and Oak Ridge's ANS, the department was given a 38% budget in-

crease for R&D on solar energy and renewables and a 22% hike to study ways and means to promote conservation. Congress also provided \$223 million to carry out provisions of the National Competitive Technology Transfer Act, which encourages DOE's national labs to apply their scientific and technical skills in collaborative efforts with industrial firms as a way of producing new and better products, which should improve US global competitiveness.

While Congress has fully funded the Administration's request for fusion, the House-Senate conference report on the energy and water development bill directs DOE to spend \$2 million to initiate evaluation and selection of a US site for the International Thermonuclear Experimental Reactor. Congress also increased by \$500 000 the \$4 million that the department proposed to spend on studying energy applications of inertial confinement fusion. The fiscal 1994 appropriation does not provide formal approval of the proposed Tokamak Physics Experiment at the Princeton Plasma Physics Laboratory, although it allocates the requested \$20 million for TPX's engineering design, specifically calling for input from industry. The conference members also "strongly urge the department to maintain a viable inertial fusion energy program and move forward with a timely decision on the Inertial Linac Systems Experiment that would allow, if a favorable decision is rendered, construction to begin in fiscal 1995." Congress expects to decide whether to build TPX in the fiscal 1995 budget cycle.

NIST. The largest increase in R&D budgets went to the old National Bureau of Standards, which is now one of the key standardbearers for manufacturing advances. Its \$520 million appropriation is a jump of 35% above last year's \$384 million. Among the principal recipients of this largess are a 17% increase for the agency's laboratory programs and a sensational 170% for the technology outreach programs, which include a 194% leap for the Advanced Technology Program and a 79% rise for the Manufacturing Extension Partnership. ATP was designed by the Bush Administration to accelerate the development and commercialization of promising high-risk technologies such as communications and information systems, electronics, biotechnology and advanced materials, that stand a good chance of enhancing US economic growth. President Clinton's technology strategy calls for ATP to grow from nearly \$200 million

in fiscal 1994 to a whopping \$750 million by 1997.

NASA. After a bitter battle in the House over the space station, Congress allowed the space agency \$2.1 billion for yet another redesign and for further development. That bottom line includes \$151 million for life sciences and microgravity research and \$30 million for station-shuttle integration. But the station is hardly a sure thing. Its ultimate fate remains in doubt, and its defenders worry about the sudden ability of Congress to cut off large high-technology projects such as the SSC and the Advanced Solid Rocket Motor. What's more, some influential lawmakers are reluctant to enter into a partnership with Russia because it may mean a loss of jobs and profits in the US.

The recent statement by Yuri Koptev, general director of the Russian Space Agency, that his country intends to contribute most of the hardware and launch services to build a unified station, now called Alpha, has upset many in Congress. The US already has agreed to pay Russia \$100 million per year for the use of the Mir station over the next four years, and NASA has plans to ask for more money to cover such things as the Salyut "space tug." But it is not at all certain that Canada, Japan and the countries of the European Space Agency will wait out US indecisiveness on the space station. They may decide to cut bait rather than to fish in troubled waters.

Congress also scuttled a NASA program called Toward Other Planetary Systems/ High Resolution Microwave Survey, the deceptive new title of the familiar Search for Extra-Terrestrial Intelligence, which sought to find signs of intelligent life anywhere in the universe. As a \$11.3 million program, SETI had become a tempting target after weeks of wrangling over another controversial program, the ASRM. NASA's budget request for \$280.4 million for ASRM was finally slashed to \$125 million, with a proviso added by the House-Senate conference committee: If NASA decides to place the proposed space station in an orbital inclination of 51.6 degrees, where it will pass over Russia and therefore be accessible to Russian spacecraft, the ASRM is likely to be needed for heavy lift capabilities during construction and operation. But if an alternative approach is adopted and ASRM is no longer necessary, the \$125 million is to be spent to scrap the program. The ASRM was a pet project of Jaime Whitten, the former chairman of the House appropriations committee, in whose district in Mississippi the rocket motor was being built. As for SETI, the

House-Senate conference committee decided to allocate \$1 million to terminate the program.

In a letter to Dan Goldin, NASA's administrator, sent just after the budget was enacted, Mikulski, who heads the Senate subcommittee that sets the space agency's budget, and her counterpart in the House, Louis Stokes, bluntly warned that they expected to cut more than \$500 million from his current \$14 billion next year. "Unfortunately, it is our perception that the budget situation will continue to deteriorate," they wrote. In their view, the space station, the Earth Observing System and the shuttle are "essentially fixed costs," which would place the burden for reductions on space science. In the event the axe falls, the nearly completed AXAF and the Cassini mission, both scheduled for launch next year, are thought to be in jeopardy. The irony does not escape Mikulski and Stokes. They point out to Goldin that this turns upside down the Augustine Commission's report, which called for NASA to put space science first (PHYSICS TODAY, April, page 87).

Behind the Mikulski-Stokes letter is the reconciliation budget bill that passed the House by two votes and the Senate by just one in early August. It imposes greater discipline on spending than it has been given credit for. Conservative Democrats in the House insisted on setting tight caps for the next five years on the third of the budget that is subject to the annual appropriations process, which includes all of the research agencies. The total of this so-called discretionary spending is to be the same in fiscal 1988—\$547.9 billion—as it is in the current fiscal year.

The flat dollar limit isn't quite as binding as it seems because defense spending, which accounts for roughly half of the discretionary total, is scheduled to decline over the five years. The anticipated decline in defense would leave some room for domestic appropriations to rise, but not by much. The domestic increase would be only a hair's breadth above the projected inflation rate, which means that in real terms it would be no increase at all, and certainly not enough to start any new programs without eliminating old programs. The conservative Democrats who bewailed the budget for its failure to cut spending have in effect turned appropriations into a zero-sum game.

If annual defense spending follows the path set for it in the Administration's budget—and if anything it is likely to be a little above that than much below—it will fall about \$40

billion by 1998. That's just about how much domestic spending subject to annual appropriations—not counting interest on the debt or social entitlements outlays—will be allowed to rise under the budget reconciliation act. The average increase would be about \$8 billion or somewhat more than the expected inflation rate of 3% per year. Appropriations have already been under the same pressure for two years now. That's because of the caps that were put on by the 1990 budget agreement, which limited any real rise in discretionary spending. The truth is in the consequences: Outlays for research

have been hard hit and will endure more sacrifice in coming years.

To pass his budget plan in August, the President had to promise further spending cuts from the fiscal 1994 budget. The form that such cuts will take is now unclear, but some lawmakers want to tighten the appropriations caps even more this fall. It is no wonder, then, that John D. Rockefeller IV, who took Al Gore's chair at the top of the Senate's science, technology and space subcommittee, has cautioned the research funding agencies that "the old era is over."

—IRWIN GOODWIN

HUBBLE SPACE TELESCOPE MAKERS PAY FOR COSTLY MIRROR MISTAKE

Concluding a churlish three-year dispute on 4 October, the US Justice Department dropped all its claims against the makers of the defective main mirror in NASA's \$1.6 billion Hubble Space Telescope. The settlement calls for NASA to receive \$25 million from Perkin-Elmer Corporation's optics division in Danbury, Connecticut, which produced and polished the mirror between 1978 and 1981, and Hughes Aircraft, a subsidiary of General Motors Corporation, which bought the optics firm in December 1989, just four months before the telescope was launched and the mirror's spherical aberration was discovered. As part of the agreement in purchasing Perkin-Elmer, Hughes had assumed the company's liabilities.

In a statement about the settlement, the Justice Department said Perkin-Elmer "knew or should have known of the defect" in Hubble's primary mirror. Even so, Justice's statement added, the government has released both companies from all further liability under the False Claims Act. Ever since the distortion was detected in the Hubble mirror, a concave hyperboloid 2.4 meters in diameter, Perkin-Elmer had resolutely denied any wrongdoing. The company insisted that NASA was fully informed of all data for judging whether the telescope's mirror had imperfections.

Hubble's specifications had called for 70% of the "first light" from a star to fall within a circle of 0.1-arcsecond radius. Analysis of the images sent back from the telescope during its checkout in orbit had indicated that only 15% of the starlight was doing so. Optics experts called in by NASA calculated that the edges of the main mirror had been ground 0.002 mm

lower than was called for. As a result, light striking the edge of the mirror focuses 4 cm beyond the focal point of light from the center of the mirror.

NASA's investigation of what went wrong was led by Lew Allen Jr, then director of Caltech's Jet Propulsion Laboratory. The Allen report, issued in November 1990, identified the cause of the flaw that hobbled the Hubble (PHYSICS TODAY, November 1990, page 19). The fault was in an instrument known as the null corrector, which served as an optical template that guided—or rather misguided—the final polishing of the mirror. The report further said that the mirror's makers had ignored at least three telltale signs of danger, all involving tests of the mirror's surface contours that are based on interferograms taken with another null detector of somewhat different design. Another study of the mirror problem was done by NASA's inspector general, who found evidence that Perkin-Elmer withheld significant information and thereby misled space agency officials into believing that the mirror was technically perfect.

Some astronomers and space scientists have questioned the adequacy of the settlement, considering that Perkin-Elmer received \$440 million for building the optical and fine guidance systems for the Hubble. But Edward A. Frankle, NASA's general counsel, argues that the settlement was "fair and reasonable." Indeed, a statement by C. Michael Armstrong, chairman and CEO of Hughes, suggested that Perkin-Elmer and NASA might share the blame. "It is our understanding that NASA knew everything that Perkin-Elmer knew

about the polishing of the mirror. But no one at NASA or Perkin-Elmer ever told Hughes Danbury about a potential problem with the mirror when Hughes Danbury became involved with the Hubble. If they had, Hughes would not have gone through with the purchase or taken over the Hubble contract without proper indemnification."

Despite troubles with the mirror, the telescope has unique capabilities to make observations. For certain studies, such as how galaxies form and evolve over time, Hubble's findings have "absolutely changed our way of thinking," says John Bahcall of the Institute for Advanced Study in Princeton, New Jersey, one of the earliest advocates of building the Hubble.

In early December, NASA plans to send the Endeavour shuttle to the telescope so that astronauts can replace the Wide Field/Planetary Camera with a second-generation camera that was scheduled from the start and install the Corrective Optics Space Telescope Axial Replacement. The camera was redesigned by JPL to correct the effects of the spherical aberration in the main mirror, while COSTAR, which contains optics that can be adjusted from NASA's ground control, is intended to align the light reaching three other Hubble instruments.

—IRWIN GOODWIN

NSF Crosses Potomac and Gets New Digs

Since mid-October the National Science Foundation has been moving to more spacious quarters in a posh new skyscraper—by Washington standards—on the Virginia side of the Potomac, in the Ballston section of Arlington. On the weekend of 3-5 December, the NSF's Mathematics and Physical Sciences directorate will take over most of the 10th floor, with the physics division occupying suite 1015 and astronomy suite 1045. The directorate for the geosciences is scheduled to move house starting 12 November and for computer and information science and engineering on the weekend of 12-14 November.

NSF's official new address is 4201 Wilson Boulevard, Arlington, VA 22230. While telephone calls to agency officials and program directors at the old numbers are now being forwarded, the foundation's new general information number is 703-306-1234. Electronic mail addresses will not be affected.