state & society

Budget for Department of Energy emphasizes construction

In the physics-related areas of the Department of Energy R & D budget, the emphasis in FY 1979 appears to be on construction. The programs in high-energy physics, nuclear physics, materials sciences and inertial-confinement fusion have all registered sharp gains in this area; in addition, construction work continues on the Tokamak Fusion Test Reactor and the Mirror Fusion Test Facility, although the overall construction authorization for magnetically confined fusion program has decreased by $10 million. The last-named program, however, is the only one expected to receive a sharp increase in operating funds; inertial-confinement fusion, in contrast, has been allocated $3.5 million less than last year for its operating expenses, and all other physics-related programs have requested only cost-of-living increases for their operating budget figures.

Isabelle. The 400 GeV × 400 GeV proton–proton colliding-beam accelerator that DOE plans to construct at Brookhaven is at the upper right of this artist's drawing. Six experimental areas surround it. The linac and Alternating Gradient Synchrotron are at the lower left of photo.

High-energy physics. William Wallenmeyer, acting director of DOE's high-energy physics program, told us that emphasis in now placed on the obtaining of new facilities, even if this must come to some extent at the expense of operating funds; this is certainly reflected in the budget figures for high-energy physics. (See table 1.)

Brookhaven's Isabelle, a 400 GeV × 400 GeV proton–proton colliding-beam accelerator, appears in a Presidential budget for the first time, although it received from Congress last year a $10.5-million authorization and $5.0-million appropriation that is now being used for architecture engineering services. This year President Carter has requested an additional $264.5 million to complete authorization of the $275-million project. An appropriation of $23 million has been requested for FY 1979 for the first major construction work on this project.

continued on page 78

National Science Board checks up on health of US science

US science is reasonably healthy, but the patient is showing some signs of potential problems. That is one interpretation of the National Science Board's latest attempt to assess the status and health of science, which was recently published as *Science Indicators 1976*. The report uses a variety of criteria to make the assessment, ranging from ages of physics faculty members to the number of innovations produced in industry.

Federally supported R&D in 1976 measured in constant dollar levels was estimated at $15 billion, which represents an 18% decline from the peak reached in 1967. The Federal government continues to be the largest source of R&D funds, providing about 53% of the total in 1976; industry supplied 43%. Industrial R&D rose drastically from 1960 to 1976, from $4.5 billion to about $16.6 billion, according to the report. The biggest chunk of Federal R&D funds (50%) went for defense activities. Civilian areas received 37% and space activities 13%.

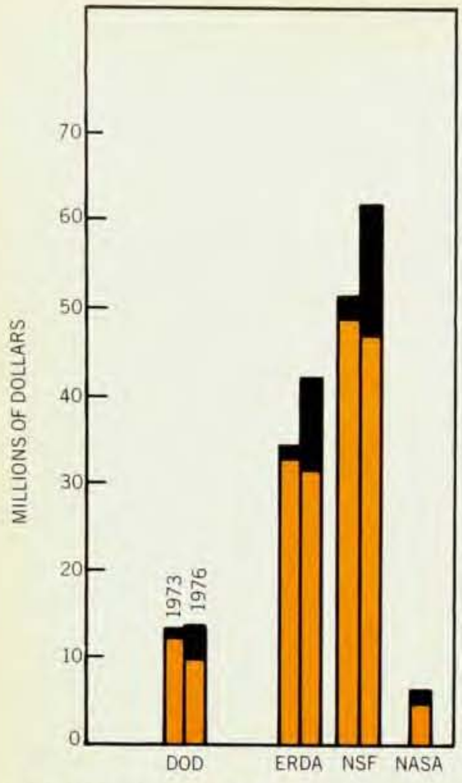
For basic research, the peak year for Federal and industrial support was 1968. By 1976, in constant dollars, the support of each sector was 15% below the peak levels that each had reached in 1968. The Federal government in 1976 gave 68% of the money for basic research, compared with about 60% in 1960. Throughout the 1970's industry spent about 15%, in sharp contrast to the 28% it provided in 1960, the report notes.

Support for basic research in physics from the Federal government was provided primarily by NSF and ERDA, who together spent 84% of the total (see histogram). Similar behavior, in which NSF and one other agency provides the bulk of the support, was observed for other fields of science and engineering.

Industry in 1976 spent 3% of their R&D funds for basic research. For physics and astronomy, industrial basic research has declined 59% below the peak in 1967 (when data first became available). Four industrial categories accounted for 77% of the basic research in 1974. They were chemicals and allied products (39%), electrical equipment and communication (27%), aircraft and missiles (8%) and machinery (4%).

An interesting approach to measuring industrial innovation (by Gellman Re-

0031-9228/78/3104-0077 $0.50



Federal obligations for physics basic research in universities and colleges. The colored bar is in constant 1972 dollars, the black in current dollars. Data for National Aeronautics and Space Admn. in 1973 were not available.

search Associates, *Indicators of International Trends in Technological Innovation,* 1976) is described in the report. A panel was asked to identify a specific innovation and its technological consequences during the period 1953–73. Of the 227 innovations studied, the group listed under electrical equipment and communication such concepts as lasers, videotape and integrated circuits and under professional and scientific instruments a copier using xerography on a wide range of papers, holography via laser, and fiber optics. Small firms (up to 1000 employees) were found to produce about four times as many innovations per R&D dollar as medium-sized companies (1000–10 000 employees) and about 24 times as many as large ones (over 10 000 employees). The total number of innovations produced by small firms was greater than for large companies, and both produced more than the medium-sized ones. Of the innovations, 38% were rated as technological improvements, 28% as major technological shifts and 26% as radical breakthroughs; the rest were rated as imitations. The fraction called radical breakthroughs declined from 36% in 1953–59 to 16% in 1967–73. Major innovations stemmed most frequently from applied research, most of which was done in the innovating firm. Next most frequently, they came from basic research, most of which was again done in the firm. Still less frequently, the innovation came from transfer of technology from an existing product of the same company.

The age of PhD physicists and astronomers working at four-year colleges and universities is rising. The median age rose from 38.9 in 1973 to 39.9 in 1975. At the same time, the percent under 40 years of age dropped from 55 to 51%. Similar changes occurred for chemists and engineers. This aging is to be compared to a fairly constant median age for all doctoral scientists and engineers at four-year colleges and universities (rising from 40.9 to 41.3) and a small drop in the under-forty category from 47 to 46%. On the other hand, computer specialists were, on the average, somewhat younger in 1975 than in 1973.

The report also considered mobility between fields of doctoral scientists and engineers. In 1975, one out of every six was employed in a field other than that of his doctorate. However, the report notes, changing fields can simply be a move from nuclear physics to nuclear engineering, for example. The report says that physics and chemistry have the lowest retention rates for employed doctoral scientists—approximately 70%. The largest group of PhD physicists who switched fields went into engineering; meanwhile those PhD chemists who moved went into the biosciences or only slightly less often into physics. But relatively few PhD engineers and life scientists switched to physics and chemistry.

Science Indicators 1976 is available from the US Government Printing Office (stock number 038-000-00341-1) for $4.75 per copy. —GBL

Budget for Department of Energy

continued from page 77

Carter has also requested an authorization of $38.9 million for the Energy Saver (part of the Tevatron) at Fermilab. An appropriation of only $10.0 million, however, has been allocated for FY 1979; this amount, according to Fermilab's director Robert Wilson, in his letter of resignation (PHYSICS TODAY, March 1977, page 102), is inadequate "to keep the Tevatron project moving at an acceptable and economical rate." The project involves providing a superconducting ring of magnets within the main-ring tunnel to permit protron acceleration up to 1000 GeV within the accelerator when it is operated in the Energy Saver mode. In addition the facility can be operated as a proton–antiproton colliding-beam device, if an adequately intense beam of antiprotons can be achieved.

The Stanford–Berkeley Positron–Electron Project is expected to receive funds in FY 1979 for completing the major part of its initial complement of equipment. In addition, some incremental operating funds are allocated for the pre-operating buildup. FY 1979, however, will be the last year of operation for Argonne's Zero Gradient Synchrotron, although some parts of it will be used for the new Intense Pulsed Neutron Source (see below).

Nuclear physics and nuclear sciences. The only new construction effort in nuclear physics is the $6-million High Intensity Uranium Beams project at Lawrence Berkeley Laboratory. The project consists of adding a third injector to the SuperHILAC and of improving the vacuum system of the Bevatron to provide higher-intensity beams and to allow the acceleration of heavier ion beams in the Bevatron.

No new construction is planned in the nuclear-sciences program, but acting director George Rogosa told us that no close-outs of university accelerator facilities are planned in FY 1979—a reversal of a trend in recent years.

Materials sciences. The FY 1979 budget allocates $1.5 million for the construction of the Intense Pulsed Neutron Source I (which is to cost a total of $6.4 million). It will be using some of the facilities of Argonne's Zero Gradient Synchrotron, which is being phased out after the coming fiscal year. The neutron beams will be used for neutron scattering and radiation effects research. IPNS-I is scheduled to go into operation in FY 1981, but in the previous year construction, if approved, is expected to begin on IPNS-II, which will employ a more powerful proton accelerator than IPNS-I. IPNS-II would provide, when it comes into operation in FY 1985, a peak thermal neutron flux of 1.5×10^{16} and a peak epithermal neutron flux of $3.5 \times 10^{16} n/cm^2$-sec, according to Donald Stevens, director of DOE's materials-sciences program. Total construction cost of the IPNS complex is now estimated at $69 million. In addition, funds are scheduled for the development of advanced instrumentation for this facility.

Fusion. Although the budget outlay for operating expenses is expected to increase sharply this year in the magnetic fusion program (see table 2), overall authorizations for the entire program have increased by only 3% to $334.0 million, and no new construction efforts will be begun. John F. Clarke, deputy director of DOE's Office of Fusion Energy, told us that "In this funding plateau we are concentrating our efforts on the existing experimental facilities to try to extract the necessary data so that we shall be able to specify more precisely what a fusion reactor really is."

The inertial-confinement fusion program has requested a FY 1979 construction authorization of $6 million to continue the $54.5-million High Energy Laser Facility that will house the Antares laser at Los Alamos and $20 million to begin the $195-million Nova Upgrade of the Shiva laser (see page 17, this issue) at Livermore. The Antares carbon-dioxide gas laser is expected to produce 100 to 200 terawatts of laser output in pulses of one nanosecond or one quarter nanosecond duration, while the combined output from the Nova and Shiva lasers is expected to be between 190 and 285 terawatts. Testifying before a House subcommittee in February, C. Martin Stickley, the director of DOE's Office of Laser Fusion, testified that "With the requested level of operating funds we believe we can reach the next major milestone in the program, significant thermonuclear burn of fuel pellets by laser-driven implosion, and reach important decision points with each of the candidate driver systems for a fusion reactor."

Other programs. A $16.7-million authorization and appropriation has been requested to construct a proton storage ring at Los Alamos; it is designed to enhance the neutron-pulse capability (to 2×10^{12} neutrons/sec in a 1-nanosec pulse) of the Weapons Neutron Research Facility at the Los Alamos Meson Physics Facility.

DOD. Defense-related R&D is expected to go from $11.4 billion in FY 1978 to $12.5 billion in FY 1979, an increase of about 9%. Research is up 13.5% or $56 million, to $468 million. For the Air Force, physics-related research would be increased from $15.1 million to $16.6 million; approximately 80% of this would be contracted out. The Army Research Office expects to support $13.8 million (an increase of $1.8 million) of physics-related research under contract, while the Office of Naval Research plans to increase its support in these areas from $22.5 million in FY 1978 to $27.0 million in FY 1979. (Further details about these programs will be given in a forthcoming issue of PHYSICS TODAY.)

Climate program. A consolidated climate program and budget involving eight Federal agencies has been formulated and will be allocated $104 million in FY 1979, an increase of 37% over the previous fiscal year. The growth in funding would be used to develop and procure satellite sensors for monitoring the Earth's radiation budget, ozone and ocean climate variables; to undertake a major field study in the Equatorial Pacific to investigate physical processes involved in climate fluctuations; and to pursue basic research on natural phenomena, especially the effects of changes in carbon-dioxide levels in the atmosphere and oceans. —CBW

Table 1. DOE physics-related research

	(estimated budget outlays) in millions of dollars FY 1978		FY 1979	
High-energy physics				
Fermilab	59.1		57.3	
Brookhaven	33.2		35.8	
Argonne	16.6		15.4	
SLAC	31.2		36.9	
General R & D	45.4		46.6	
Total operating budget		185.5		192.0
Total capital equipment*		42.0		41.2
Total construction*		44.2		59.5
Nuclear physics				
Medium-energy physics	33.0		35.8	
Heavy-ion physics	28.1		30.3	
Nuclear theory	5.2		5.5	
Total operating budget		66.3		71.6
Total capital equipment*		6.7		7.5
Total construction*		4.6		10.4
Basic energy sciences				
Nuclear sciences				
Charged-particle research	6.7		7.5	
Neutron and fission research	8.2		8.8	
Heavy-element research	2.7		3.2	
Isotope preparation	7.4		8.0	
Total operating budget		25.0		27.5
Total capital equipment*		1.1		1.3
Total construction*		0		0
Materials sciences				
Solid-state physics	25.2		28.7	
Metallurgy, ceramics and materials chemistry	36.2		40.2	
Total operating budget		61.4		68.9
Total capital equipment*		5.4		5.9
Total construction*		5.0		16.4
Chemical sciences		53.2		62.3
Engineering, mathematics and geosciences		11.2		23.5
Advanced energy projects		3.0		3.7
Other capital equipment		2.2		1.7

* These figures are budget authorizations, the amounts by which DOE may enter into contracts during the fiscal year; all other figures are budget outlays, the amounts that DOE expects to spend during the fiscal year.

Table 2. DOE fusion research

	(estimated budget outlays in millions of dollars) FY 1978		FY 1979	
Magnetically confined fusion				
Confinement systems	88.7		98.7	
Development and technology	43.6		52.5	
Applied plasma physics	42.7		52.2	
Reactor projects	18.1		17.5	
Total operating budget		193.2		221.0
Total capital equipment*		29.4		25.6
Total construction*		93.8		83.4
Inertial-confinement fusion				
Advanced lasers	9.5		9.1	
Heavy-ion fusion	2.9		3.5	
Systems and advanced technology	3.9		3.0	
Glass laser	9.7		7.2	
CO_2 laser development	10.6		8.4	
Electron-beam source development	4.9		3.0	
Fusion experiments	54.8		58.6	
Total operating budget		96.3		92.8
Total capital equipment*		13.2		8.2
Total construction*		12.4		26.0

* These figures are budget authorizations, the amounts by which DOE may enter into contracts during the fiscal year; all other figures are budget outlays, the amounts that DOE expects to spend during the fiscal year.

in brief

Joseph M. Pettit, president of the Georgia Institute of Technology, has been named to the National Science Board, the policy-making body of the National Science Foundation.