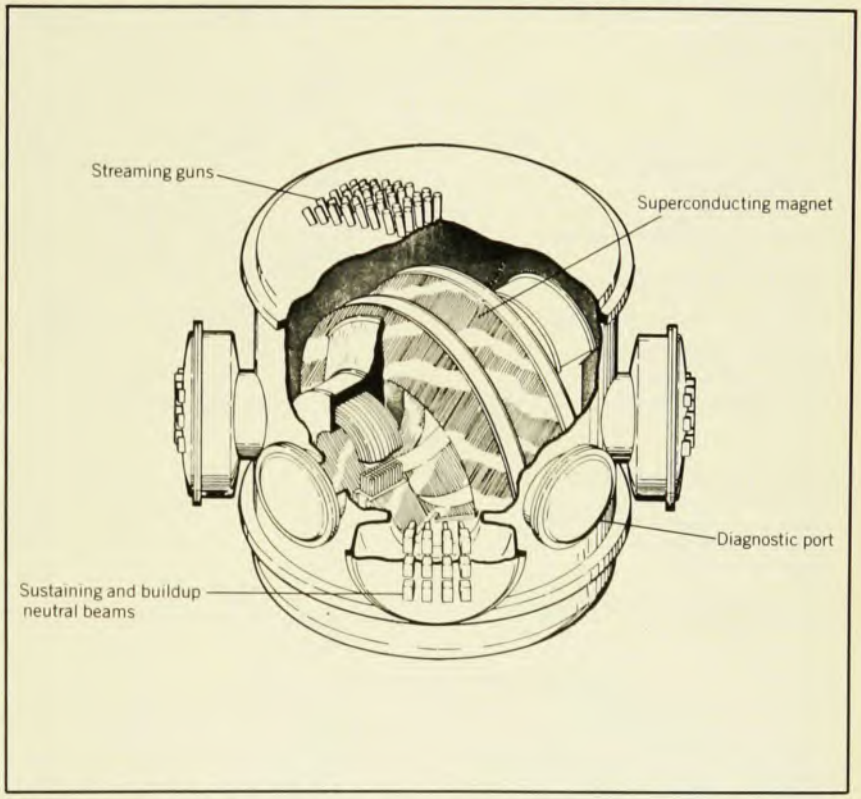
state & society

Federal R&D budget squeezes ERDA fission and fusion

President Jimmy Carter's FY 1978 budget request to Congress for Federal support of research and development reads—not surprisingly—very like unto that submitted in January by his predecessor, Gerald R. Ford. There are some significant differences, to be sure, most notably in energy-research funding. ERDA must reprogram for other areas about $80 million of the funds sought by Ford for magnetic-confinement and laser-induced fusion efforts, and $199 million was slashed from his request on behalf of the Liquid Metal Fast Breeder Reactor. But for ERDA's physical-research programs, and for the other Federal agencies concerned with scientific R&D, there was little change—NASA, with a total R&D request for more than $3 billion dollars, gained another $15 million in the Carter budget, while the National Science Foundation retained all of the Ford increase of $87 million over the FY 1977 program level.

Overall Federal support for the conduct of R&D and for facilities increased by eight percent between FY 1977 and 78—from obligations of $25.92 billion to $27.96 billion. This sum includes $3.04 billion for basic research at universities and government laboratories and in private industry, up nine percent. The Federal Government currently finances about two thirds of the nation's efforts in fundamental research.



Mirror Fusion Test Facility to be built at Lawrence Livermore Lab for a total cost of $94 million. President Carter's $14-million request for it in FY 1978 is $10 million less than that of Ford.

Go-slow on fusion. Few predicted the extent of President Carter's cutbacks in fusion research; his lopping off of many millions of dollars from ERDA programs in this field is being attributed to a preference for short-term energy-saving measures over costly long-range projects. The new Administration has drastically reduced funding for the construction of magnetic-confinement fusion facilities, squeezing the Ford request for $126.3 million in budget authority down to $86.4 million (see Table 1), which is nearly 13% below the FY 1977 figure. (Budget authority is the amount by which an agency may enter into contracts for its programs in a given fiscal year, while budget outlays represent monies actually to be spent during that year.) The facility most affected by the change is Princeton's Tokamak Fusion Test Reactor, for which support has declined from $90 million under Ford to $71 million in the Carter request. This cutback is expected to delay the TFTR's completion by six months and add $10–12 million to its ultimate $228-million estimated pricetag. Another construction effort setback was the Mirror Fusion Test Facility (formerly known as "MX" for Mirror Experiment) to be built (PHYSICS TODAY, November, page 17) at Lawrence Livermore Laboratory. The $94-million project was to receive $24 million for construction in FY 1978; Carter's request is $10 million lower.

In the energy agency's program for laser-induced fusion, construction funds (authority) for the $54.5-million High-Energy Gas-Laser Facility (a CO_2 laser being developed at Los Alamos) nosedived from $14.9 million to $2.9 million between the Ford and Carter requests for FY 1978, which means some delay; however, operating funds related to laser experiments actually increased. Elsewhere in the laser program, the decrease in funds for the neodymium glass laser reflects the current stage of development of SHIVA, a $25-million, 20-armed laser at Livermore that comes on line in 1977. Livermore's Nova, the first step in another high-power laser system, will be delayed for a year by a cutback from $11.0 million to $3.0 million—and an electron-beam facility at Sandia Laboratories fell from $4.4 million to $1.9 million during the budget-trimming process. Money for new laser systems increased over FY 1977 in the Carter budget, but the Ford request (for $1.5 million more) included support for a rare-gas laser program at Los Alamos that was scrapped in the new budget document.

And go-slower with fission. ERDA's breeder-reactor program, the agency's most heavily funded effort, takes the worst beating—budget-authority requests for the LMFBR have plummeted from $855 million for FY 1978 under Ford to $656 million ($30 million less than in FY 1977) under his successor. Carter had

Table 1. ERDA physics-related R&D

	(estimated budget outlays in millions of dollars) FY 1977		FY 1978	
PHYSICAL RESEARCH DIVISION				
High-energy physics				
Fermilab	51.6		58.9	
AGS	30.3		33.6	
ZGS	16.6		18.0	
SLAC	28.4		32.2	
General R&D	37.9		42.8	
Total high-energy physics		164.8		185.5
Nuclear physics				
Medium energy	30.5		33.4	
Heavy ion	25.1		27.2	
Theory	4.9		5.3	
Total nuclear physics		60.5		65.9
Basic energy sciences				
Nuclear sciences	23.3		24.7	
Materials sciences	52.8		58.4	
Molecular, mathematical and geosciences	45.0		52.3	
Advanced energy projects	0		3.0	
Total basic energy sciences		121.1		138.4
Total operating budget		346.4		389.8
Total capital equipment	35.5		42.4	
Total construction	30.2		51.5	
FUSION RESEARCH				
Magnetically confined fusion				
Confinement systems	79.6		87.4	
Development and technology	45.0		50.0	
Applied plasma physics	34.1		37.0	
Reactor project	11.4		13.6	
Total magnetically confined fusion		170.1		188.0
Capital equipment	23.0		27.6	
Construction	98.3		86.4	
Laser-, electron- and ion-beam-induced fusion				
Neodymium glass laser	13.8		9.8	
CO_2 laser development	10.0		9.7	
New laser systems	8.8		9.6	
Laser pellet design, fabrication	13.0		19.8	
Laser target interaction	15.6		24.5	
Laser diagnostic development	3.8		5.8	
Laser system studies, applications	1.8		2.5	
Electron- and ion-beam-induced fusion	9.0		12.3	
Total laser-, electron- and ion-beam-induced fusion		75.8		94.0
Capital equipment	12.8		13.2	
Construction	18.8		7.8	
Total operating budget		245.9		282.0

Table 2. NASA physics and astronomy

	(estimates in millions of dollars) FY 1977	FY 1978
Space telescope	0	36.0
Shuttle/Spacelab payload development	6.0	28.9
Solar Maximum Mission	21.3	30.6
Solar observatories	1.0	1.3
Astronomical observatories	2.6	2.0
High-Energy Astronomy Observatories	39.4	22.4
Orbiting Explorers	30.2	35.0
Suborbital programs	26.0	26.0
Upper atmospheric research	11.6	11.6
Supporting activities	28.2	30.4
Total	166.3	224.2

promised during the campaign that this project would be "severely reduced" (PHYSICS TODAY, October, page 62), and he has made good on that promise. The program's centerpiece, the Clinch River Breeder Reactor to be built in Tennessee, dropped 32%, to $88 million below the previous year's figure; construction has not yet begun on the CRBR, for which ERDA is now seeking a limited-work authorization, and the amputation of funds may delay start-up until mid-1984. The Fast Flux Test Facility out in Richland, Wash., came through unscathed with $57 million for the next fiscal year's request. Another LMFBR category, called "base technology" (including test facilities, advanced fuels, materials-research components, physics, and chemistry), rose from $304 million in FY 1977 to $346 million under Carter, compared to $417 million in the Ford request.

Other approaches. Budget authority for solar-energy R&D at ERDA under the Ford budget rose from $290.4 million in FY 1977 to $305.0 million in FY 1978—with a corresponding hike in outlay funds from $183 to $235 million. The new administration has increased budget outlays by $15 million, and it has shifted the emphasis away from solar-electric efforts (authority money for photovoltaic-cell research falls from $59.4 million in FY 1977 to $52.2 million, the only category that failed to grow) in favor of practical solar-heating-and-cooling schemes that embody rather less physics. Geothermal research is boosted from $54.7 million in FY 1977 to $88.0 million, with no dollar differences between the two Administrations' requests.

ERDA physical research. New construction projects in the FY 1978 budget for the agency's Division of Physical Research include: the National Synchrotron Light Source, to be built at Brookhaven National Laboratory (see PHYSICS TODAY, March, page 17); a $9.4-million combustion-research facility at Sandia, assigned $6.0 million in outlay funds for FY 1978; the $6.0-million upgrading of SuperHILAC and Bevalac at Lawrence Berkeley Laboratory to produce high-intensity uranium beams, estimated to accrue $1.2 million in costs for the coming fiscal year, and electrical substation improvements amounting to a total cost of $1.7 million at the Stanford Linear Accelerator Center. Another important construction effort, first funded in the FY 1976 and '77 budgets, is the Positron–Electron Project at Stanford; estimated FY 1978 obligations for the facility are $29.4 million. Isabelle, a 200 GeV × 200 GeV proton–proton colliding-beam accelerator proposed by Brookhaven, does not appear in the FY 1978 budget request.

The division's classification system for nuclear-research spending has changed from what it was for FY 1977 (see Table 1); low-energy nuclear-physics (neutron

and charged-particle physics and heavy-element research) is no longer counted with medium-energy and heavy-ion studies and theoretical work, but is instead included as "nuclear science" under the new "basic-energy sciences" program. In terms of the former system, it appears that funds have increased for all nuclear research (there was a cut in this field in the FY 1977 request, later made up by Congress), though less so for low-energy work. Another new item is designated "advanced energy projects," created for the evaluation of new concepts that don't fit into an existing program and require investigation or demonstration.

Space agency gets new starts. NASA's budget authority for FY 1978 comes to $4.035 billion, almost exactly 75% of it for R&D. Included in the R&D total is $1.349 billion for the Space Shuttle and $415.7 million for space science, which includes physics and astronomy, lunar and planetary exploration and life-sciences work. The FY 1978 request for physics and astronomy, in particular, is up 34.8% from FY 1977—the largest single item in this portion of the budget this time around is the Space Telescope, funded at $36.0 million (see Table 2). Development of this $435–470-million orbiting observatory nearly made it into the FY 1977 budget; now, NASA plans to select contractors late this summer for the telescope's Support Systems Module and its Optical Telescope Assembly (see page 18).

Also in the physics and astronomy category, HEAO-A, the first High-Energy Astronomy Observatory, is to be launched this month; the second, HEAO-B, is expected to go aloft in June of 1978. IRAS, an infrared astronomical satellite whose cost is being shared jointly by the US, The Netherlands and the United Kingdom, is to be launched in 1981.

The Space Telescope is one new start; the other for FY 1978 is a Jupiter Orbiter-Probe mission whose total cost is estimated at approximately $280 million over five years; it is funded at $20.7 million in the current request. The orbiter component would be expected to operate for 20 months after insertion in Jupiter orbit, using the Jovian satellites' gravitational fields to "pump and crank" its way through 11 encounters. It will also investigate the giant planet's magnetotail. The probe would be designed to survive pressures between ten and 20 Earth atmospheres, telemetering back information on the Jovian environment.

Other planetary efforts include follow-up studies on Mars exploration. Carter increased from $5 to $15 million the FY 1978 funding for preliminary studies of an ambitious post-Viking mobile-lander project that could be launched in 1984 or 1988; a sample-return mission for the latter date is another possibility. Meanwhile, dual launches for Pioneer Venus are to take place in May and August of 1978.

The new administration also added $5 million to the Applications program at NASA for a backup for the LANDSAT-D, or possibly an additional satellite in the Earth-resources-monitoring project of which it is a part. Interesting items not included in the FY 1978 budget include the proposed Lunar Polar Orbiter for lunar mapping and minerals surveying (PHYSICS TODAY, September, page 20), and engineering and design studies for a permanent space station *a la* "2001: Space Odyssey" that could eventually cost a billion dollars.

Steady growth at NSF. A considerable portion of Federal expenditures on civilian basic research is vested in the National Science Foundation; $688.1 million of its FY 1978 budget request of $885

Table 3. NSF physics-related research

	(estimates in millions of dollars) FY 1977		FY 1978	
MATHEMATICAL AND PHYSICAL SCIENCES AND ENGINEERING DIRECTORATE				
Mathematical sciences		19.9		21.8
Computer research		15.5		17.0
Physics				
Elementary particles	19.4		22.1	
Intermediate energy	9.9		10.1	
Nuclear	11.3		12.2	
Atomic, molecular and plasma	5.2		5.8	
Theoretical	6.1		6.8	
Gravitational	2.2		2.4	
Total physics		54.1		59.4
Chemistry		40.2		44.3
Engineering		42.6		46.1
Materials research				
Condensed matter sciences	17.0		19.2	
Metallurgy and materials	12.8		13.8	
National Magnet Laboratory	3.5		3.6	
Materials Research Laboratories	16.9		18.4	
Synchrotron radiation facilities	1.3		5.6	
Total materials research		51.5		60.6
Total		223.8		249.2
ASTRONOMICAL, ATMOSPHERIC, EARTH AND OCEAN SCIENCES DIRECTORATE				
Astronomy		52.3		58.0
Atmospheric		49.6		55.9
Earth		29.0		34.8
Ocean		53.2		58.9
Arctic program		4.7		5.8
Total		188.8		213.4

Washington Bulletins

★ **Robert L. Hirsch has resigned** as Assistant Administrator for Solar, Geothermal and Advanced Energy Systems at ERDA after serving less than a year in that capacity since his appointment by Gerald R. Ford. Hirsch, who has done experimental work in fusion plasma physics, will be deputy manager of the Science and Technology Department at Exxon Corp's New York City headquarters.

★ **President Jimmy Carter's energy-department proposal,** received last month by the House and Senate, has been referred to committee in both bodies. The proposed legislation would merge—and supplant—ERDA, the Federal Energy Administration and the Federal Power Commission to create a new cabinet-level Department of Energy combining regulatory authority with R&D responsibilities.

★ **An intensive review of the LMFBR program** has been ordered by the President and presidential assistant James R. Schlesinger. In the review, ERDA is to reassess the proper role of breeder reactors in the nation's energy future and the timing of current programs, with particular attention to the Clinch River Breeder Reactor project.

million is marked for fundamental research. Improved instrumentation is to be stressed in the new budget, according to NSF Acting Director Richard Atkinson, and the bulk of this year's increases (see Table 3) reflect this emphasis. For example, one-half of the physics division's $5.3-million gain in the new budget request is to go into the conversion of the Cornell University accelerator to an 8-GeV × 8-GeV electron–positron colliding-beam facility. Construction, which essentially consists of building a new magnetic ring in the present tunnel, is to commence with the 1978 fiscal year this October. In the materials-research division, a physics-related effort will be the expansion and development of synchrotron-radiation facilities at the Stanford Synchrotron Radiation Project and the University of Wisconsin, set at $4.2 million.

In NSF's Astronomy program, funds for the National Radio Astronomy Observatory increased from $21.8 million in FY 1977 to $22.3 million in FY 1978, of which $13.0 million is allocated each year to the Very Large Array project under way in New Mexico. Support for the Foundation's Research Applied to National Needs program also rose this time, up $10.4 million to $78.0 million—RANN funding had dropped in the previous budget. The increase is mostly the result of greater emphasis upon earthquake research, for which funds were approximately doubled in FY 1978.

Defense R&D up. Total Research, Development, Demonstration, Testing and Evaluation obligations are 11% greater in the Defense Department's FY 1978 request ($12.3 billion) than in FY 1977. The Pentagon's Office of Defense Research and Engineering continues its programmed beyond-inflation hikes of roughly ten percent for "6.1" (mostly basic) research and five percent for "6.2" exploratory development (including considerable applied work). Basic research for military functions—not including such items as DOD's development of a booster for the Space Shuttle—was supported at a rate of $274 million in FY 1977; the FY 1978 figure, $314 million, is 15% higher. The increase for basic research in physics is expected to be about 12%, but exact figures are not yet available. —FCB

Minorities, women and handicapped assist NSF

The National Science Foundation is seeking to increase the representation of minorities, women and the handicapped in its Rotator Program. Under the program, NSF augments its permanent staff of scientists and other professional employees with qualified individuals from college and university faculties. Approximately 30 such individuals are selected each year and they serve one- or two-year terms aiding the administration of continuing NSF programs.

The NSF particularly welcomes applications from doctoral scientists with six years of successful scientific research experience. In addition, some administrative experience and a broad general knowledge of the applicable field of science are also desirable.

Applications may be made to the program by sending a resumé and statement of interest to Herbert Harrington Jr, Director, NSF Office of Equal Employment Opportunity, Washington, D.C. 20550.

in brief

The American Association for the Advancement of Science is currently accepting nominations for the AAAS–Newcomb Cleveland Prize, which will be given to the author of an outstanding paper published in the "Reports" section of *Science* magazine, 3 September 1976–26 August. The prize consists of $5000 and a bronze medal. Nominations should be sent to AAAS–Newcomb Cleveland Prize, 1515 Massachusetts Avenue N.W., Washington, D.C. 20005.

the physics community

OSA publishes set of uniform color cards

A set of 552 color cards designed by the Committee on Uniform Color Scales of the Optical Society of America is now available. This set of colors represents the culmination of 35 years of research directed toward producing a set of samples whose color differences consist solely of chromaticity differences without luminance differences.

The cards, which are two-inches square, are arranged in a 28-page loose-leaf binder. A set may be ordered for $350 from OSA, Suite 620, 2000 L Street NW, Washington, D.C. 20036.

ACA elects Coppens vice-president for 1977

Philip Coppens, professor of chemistry at the State University of New York, Buffalo, has been elected vice-president of the American Crystallographic Association. The 1976 vice-president, Carroll K. Johnson (Oak Ridge National Laboratory), has succeeded to the office of president of the Association.

Coppens received his doctorate from the University of Amsterdam in 1960, having conducted research in crystallography at the Weizmann Institute since 1957. He then joined the staff of Brookhaven National Laboratory, where he served as a scientist, 1965–68. In 1968 Coppens joined the faculty of the State University of New York, Buffalo.

COPPENS

Included in Coppens's research interests are crystal-structure determination, crystallographic computing, neutron diffraction, electron-density determination by accurate diffraction methods and crystallography at liquid-helium temperatures.

Pakistani meeting to stress current needs

The government of Pakistan has provided $90 000 for the Second Summer College on Physics and Contemporary Needs, which will be held 20 June–8 July in Nathiagali, Pakistan. The College is cosponsored by the International Centre for Theoretical Physics (Trieste, Italy).

The College is intended for physicists with postdoctoral research experience, particularly those from developing countries. Lectures will be given in these areas: physics and technology; physics, energy and natural resources, and physics and the frontiers of knowledge.

Requests for participation and further information may be sent to the Pakistan Atomic Energy Commission, PO Box 1114, Islamabad, Pakistan by 15 April. The Commission will give financial assistance to some participants. □