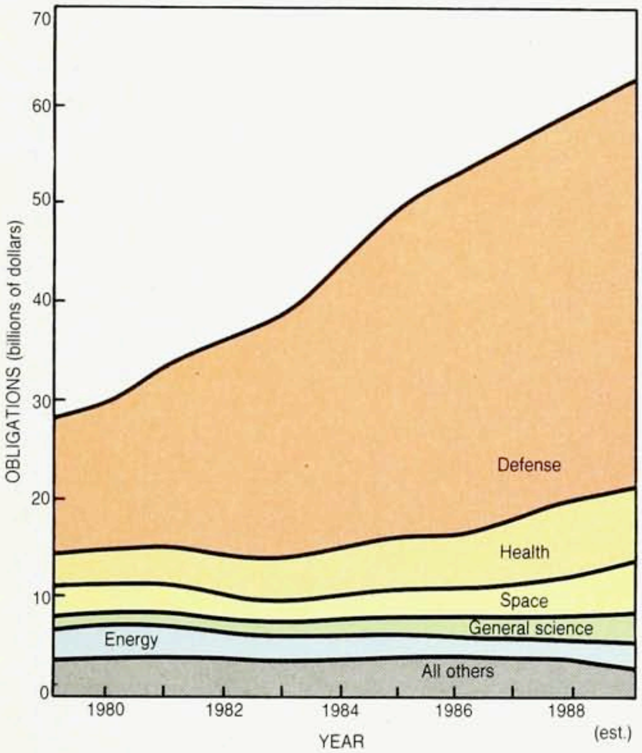
REAGAN'S R&D BUDGET LOOKS GREAT, BUT CONGRESS HAS SOME OTHER IDEAS

The budget process for fiscal 1989 has the appearance of a surreal melodrama. In the twilight of the Reagan era, the budget that the President sent Congress on 18 February contains few surprises. That's because he is sticking to the agreement worked out last November between Congressional leaders and the White House. The bipartisan budget summit agreed to hold nonmilitary discretionary spending to only 2% more than the current budget—that is, to stick to a tight spending lid of $3 billion, the difference between $145.1 billion for domestic discretionary funding this year and $148.1 billion proposed for 1989. The R&D parts of President Reagan's budget must all fit under the $3 billion cap.

On paper, the budget requests for R&D look great. Fearing that the US may lose its lead in space, semiconductors, high-energy physics and other fields of basic research and commercial technology, the Reagan Administration has endorsed a stunning array of large new programs. These include NASA's space station, an orbiting x-ray observatory and advanced technologies that could be applied to a base on the Moon or to human or robotic missions to Mars. Other projects that would get generous allocations are the Superconducting Super Collider, a magnetic fusion machine called the Compact Ignition Tokamak, studies of global atmospheric changes and the National Science Foundation's vaunted new science and technology centers.



R&D funding trends since 1979, depicted in this graph in current dollars for each fiscal year, show rapid ascent of defense while spending for nonmilitary work remains fairly constant. In 1979 the government provided $12.6 billion for defense R&D and $13.2 billion for the civilian side. The 1989 budget request would give $41.2 billion for defense and $21.3 billion for all other R&D. General science includes basic research at NSF and DOE. The area for "all others" includes allocations for natural resources and the environment, transportation and agriculture. (Data from NSF)

The trouble is that all these projects are competing for chunks of the $3 billion limitation. Most of the megaprojects, says Harold Hanson, a former physics professor who is now executive director of the House Committee on Science, Space and Technology, "are on a collision course." In fact, many come under Function 250, the Federal budget category that covers almost all government-supported civilian research in the physical sciences, engineering and technology. Function 250 contains the funds for NSF, NASA and the Department of Energy's basic energy sciences program. It's not surprising, then, that in a time of fiscal restraints and budget crunches the competition is fierce for money within the function. On top of this, the President is asking for larger operating budgets for biomedical research, which includes work on AIDS, as well as for education. Such programs also show up on the discretionary nondefense side of the ledger, but not in Function 250.

In all, the final budget of the Reagan era would increase R&D support to an estimated $62.5 billion, roughly $2.5 billion more than this year. When $2.1 billion for R&D facilities is added, the overall total for R&D obligations would reach $64.6 billion, a boost of 4% above the estimated 1988 level of $61.9 billion. As such, all Federal R&D would go up at the predicted annual rate of inflation—though a few agencies would fare much better than others.

Civilian R&D in the new budget is marked for an estimated $23.7 billion, rising by about $1.6 billion over this year. The request for defense R&D is $38.8 billion, around $900 million more than in 1988. Although the Department of Defense, under the tighter management of its new secretary, Frank Carlucci, is abandoning some R&D programs in response to spending ceilings imposed by the White House–Congress summit agreement, the National Aerospace Plane and the Strategic Defense Initiative would get additional money,

Department of Energy physics-related research	FY 87 actual	FY 88 request	FY 88 current	FY 88 request
		(millions of dollars)		
High-energy physics research				
Argonne	4.9	5.2	5.1	5.3
Brookhaven	7.1	7.4	7.2	7.6
Fermilab	10.2	9.9	8.0	8.4
Lawrence Berkeley	8.6	9.1	9.2	9.6
SLAC, including experiments at SLC, PEP and SPEAR	10.9	11.5	11.0	11.5
Other DOE laboratories	2.0	1.9	1.8	1.9
Universities, including experiments at US laboratories, DESY (West Germany), CERN (Europe) and KEK (Japan)	65.2	74.7	74.4	79.5
Total high-energy physics research	109.0	119.7	116.7	123.8
Technologies for experimental detectors	21.4	N/A	20.3	21.1
Capital equipment, mainly detectors	59.0	N/A	63.8	66.1
Construction, general plant and Fermilab computer	10.0	N/A	16.6	9.4
Nuclear physics research				
Low energy, including accelerator labs at Duke, Texas A&M, Yale and University of Washington	24.0	26.2	26.2	26.3
Medium energy, including LAMPF, MIT's Bates Linear accelerator, and R&D for CEBAF in Virginia	32.7	35.5	35.5	37.6
Heavy ion, including CERN, 88-inch cyclotron at Lawrence Berkeley and R&D for RHIC at Brookhaven	36.4	41.0	41.0	43.3
Nuclear theory	10.0	10.5	10.5	11.0
Capital equipment, mainly detectors	14.8	17.7	16.6	17.5
Construction, including Argonne's ATLAS	4.3	5.2	5.2	5.8
Basic energy sciences research				
Materials sciences, including solid-state physics	118.6	126.0	126.0	134.6
Chemical sciences	79.2	88.2	88.2	93.1
Advanced energy projects	12.6	14.3	14.3	14.6
Applied mathematical sciences	38.3	42.4	42.4	43.0
Energy biosciences	16.3	20.2	20.2	20.8
Engineering and geosciences	29.1	31.4	31.4	33.4
Capital equipment and construction	134.0	110.1	110.1	31.2
Additional projects: Congressional "pork" for universities	99.7	—	125.8	—
Basic research user facilities (operation and construction)				
High-energy physics				
Brookhaven	53.4	N/A	63.5	70.6
Fermilab	119.6	N/A	128.0	139.2
SLAC	71.1	N/A	84.9	100.0
Other operations	6.2	N/A	26.3	27.5
Universities	8.5	N/A	11.5	12.1
Superconducting Super Collider				
Operating expenses	20.0	25.0	25.0	64.0
Capital equipment, including detector R&D	—	—	—	16.0
Construction	—	10.0	—	283.0
Nuclear physics				
CEBAF	22.5	N/A	39.8	52.7
Lawrence Berkeley, including Bevalac	18.5	N/A	18.4	19.0
Los Alamos, including LAMPF	41.1	N/A	41.8	50.9
Brookhaven, including Tandem/AGS facility	7.0	N/A	7.4	0.2
Basic energy sciences				
National Synchrotron Light Source, Brookhaven	18.5	19.6	19.6	20.3
High Flux Beam Reactor, Brookhaven	10.0	10.9	10.9	11.5
Intense Pulsed Neutron Source, Argonne	5.0	5.0	5.0	5.4
High Flux Isotope Reactor, Oak Ridge	15.8	22.8	22.8	23.7
Stanford Synchrotron Radiation Laboratory	9.9	10.3	10.3	10.5
Los Alamos Neutron Scattering Center	1.3	3.0	3.0	3.1
Combustion Research Facility, Sandia	3.5	3.5	3.5	3.6
1–2 GeV Synchrotron Light Source, Berkeley	3.0	20.0	20.0	32.0
6–7 GeV Synchrotron Radiation Source, Argonne	2.0	10.0	10.0	6.0
3 GeV SPEAR injector, SLAC	—	3.0	3.0	12.2
Neutron scattering guide hall, Los Alamos	5.0	8.5	8.5	4.0
University research support, including cooperative centers	15.6	18.4	18.4	15.8
University research instrumentation	4.9	5.0	5.0	5.0
Multiprogram laboratories facilities support	56.7	56.6	53.6	65.9
Magnetic fusion				
Confinement systems	184.8	171.0	158.6	175.6
Applied plasma physics	75.2	73.1	74.8	78.2
Development and technology	50.5	55.9	55.9	54.1
Planning, projects and program direction	4.9	9.1	9.1	9.6
Capital equipment	18.0	4.5	19.7	21.6
Construction, including Compact Ignition Tokamak	8.2	19.7	16.9	20.9
Inertial fusion	151.6	118.5	159.0	163.8
Nuclear directed-energy weapons (for SDI)	169.6	270.7	152.9	154.3

though not as much as the plan put forward last year when Caspar W. Weinberger was in command.

Despite the Administration's efforts to keep within the limits set at the budget summit, many of the new projects and program expansions on the President's agenda are almost certain to be revised, reformed or reversed as Congress seeks to hold the budget deficit to $146 billion, the threshold imposed by the Gramm–Rudman–Hollings deficit control law. One outcome of the summit was that Congress and the White House agreed to reduce growth in defense spending and cut all appropriations by $46 billion in 1989. After accounting for entitlement payments for Social Security, Medicare and similar programs, only $3 billion is left for all discretionary Federal programs. The new budget totals $1.1 trillion, a figure that the House budget committee approved on 23 March and that the Senate is certain to accept. This mind-boggling sum provides $299.5 billion for defense and $934 billion for nonmilitary spending, including $145 billion in interest payments on the national debt. Interest on the debt could now pay for all Federal R&D twice over. It is six times the amount the Administration is asking for civilian R&D. To be sure, one year of debt payments could cover basic research programs, amounting to $10.3 billion in 1989, for at least a decade, even with several "big science" projects thrown into the bargain.

Reagan's last stand

By contrast with the epithets hurled at Reagan's budgets since 1981, this year's spending blueprint was received in Congress with notable restraint. House Budget Committee Chairman William H. Gray III, a Pennsylvania Democrat, said, for instance, that Reagan's final budget reflects priorities much closer to Congress's than in the past. Indeed, Reagan had tried to abolish the Education Department when he first arrived at the White House and sought to starve the agency during his first term. Last year he asked grudgingly for $14 billion for education, only to have Congress increase the department's allocation to $19 billion. Now that the nation's attention has turned again to improving education at all levels, the Reagan Administration wants to raise the department's budget to $23 billion. Funding for NSF's program in science and engineering education is also marked for a substantial increase, from $139.2 million this year to $156 million in 1989. Reagan is a staunch advocate of a doubling of NSF's budget in the next few years as a way of strengthening the nation's industrial position in the world market.

Notwithstanding such priorities, Congress is sure to alter some details of the new R&D budget. The alarm sounded at the very first Congressional hearing on the R&D parts of the 1989 budget on 23 February. In a terse opening statement, Representative Robert A. Roe, the New Jersey Democrat who heads the House science committee, ridiculed the President's request as "an exercise in voodoo budgeting." Roe observed that the three agencies within Function 250 are asking for more than the entire discretionary spending limit for 1989. NASA alone wants $2.5 billion more than it got this year; DOE seeks $400 million more; NSF requests an additional $333 million.

"If you and Congress can pull this off," he told the President's science adviser, William R. Graham, the only witness at the hearing, "it will be nothing short of a miracle. Such sums can be provided only if Congress not only agrees with the proposed priorities and reductions for domestic discretionary spending, but makes further reductions in those programs." Roe listed some programs the Administration has marked for sharp cuts, such as food stamps, Amtrak and agricultural price supports, as well as others sentenced to quick deaths, such as the Economic Development Administration and Urban Mass Transit Grants. Roe seemed to be goading, needling and challenging, all at once. "In a Presidential election year neither Democrats nor Republicans in the Congress are likely to go along with anything of the kind," Roe argued.

In response, Graham claimed "the overall R&D budget does meet the summit constraints. It's not a political gesture in my view. The easy thing to do... is to yield to short-term programs in energy, say, and other R&D programs. We've done exactly the opposite. We have emphasized basic research particularly among the research and development accounts."

Questions of priorities

"These are hollow statements... pie in the sky," said Roe. "On balance you have a good program. However, the realities are otherwise.... There is no sense in wasting time and kidding each other. What would you cut out? There's a feeling on this committee and the Congress that maybe we shouldn't do the Super Collider. There's a feeling among some members that we shouldn't do

National Science Foundation physics-related research

	FY 87 actual	FY 88 request	FY 88 current	FY 89 request
	(millions of dollars)			
Mathematical and physical sciences				
Physics				
Elementary particles	42.1	46.1	41.9	40.7
Intermediate energy (nuclear)	17.6	21.2	17.9	21.4
Nuclear	20.8	22.3	21.1	23.7
Atomic, molecular and plasma	13.3	14.8	13.2	14.4
Theoretical	14.7	16.5	15.4	16.7
Gravitational	8.6	10.4	8.8	9.8
Total physics	117.0	131.3	118.2	126.7
Materials research				
Solid state physics	11.8	12.9	11.6	12.2
Solid state chemistry	8.5	9.6	8.8	9.2
Low-temperature physics	8.0	8.8	8.2	8.8
Condensed matter theory	8.7	10.2	8.8	9.3
Metallurgy	9.5	10.5	9.0	9.4
Ceramics and electronics materials	6.5	7.2	7.7	8.2
Polymers	7.0	8.0	8.1	8.7
Instrumentation	5.0	5.3	4.0	4.5
Materials Research Laboratories	26.6	27.8	26.2	26.9
National facilities	11.2	11.3	11.3	12.8
Materials Research Groups	6.0	8.0	7.4	8.9
Total materials research	108.9	120.0	111.0	118.9
Mathematical sciences	59.9	67.8	63.7	68.0
Chemistry, including physical chemistry	93.8	102.8	94.3	99.2
Astronomical sciences				
Solar system, stellar evolution and galactic studies	27.7	29.5	27.9	29.2
National Astronomy and Ionospheric Center	5.9	6.3	5.9	6.3
National Optical Astronomy Observatories, including Kitt Peak and Cerro Tololo	23.1	25.8	23.3	24.4
National Radio Astronomy Observatory	16.7	19.0	16.9	18.0
VLBA construction	11.4	11.9	11.6	12.0
Total astronomical sciences	85.0	92.6	86.0	90.0
Total mathematical and physical sciences	464.7	514.0	473.0	502.8
Geosciences				
Atmospheric sciences	48.0	54.8	48.8	52.7
National Center for Atmospheric Research	41.3	47.1	42.8	46.1
Upper atmospheric facilities	4.2	4.8	4.8	5.4
Earth sciences, including geophysics, lithosphere studies and instrumentation	49.9	63.4	51.3	59.3
Ocean-sciences research	66.6	74.3	67.4	73.1
Oceanographic centers and facilities	37.2	43.9	37.3	41.3
Ocean Drilling Program	30.0	31.3	30.7	32.1
Arctic Research Program	8.1	8.3	10.8	2.5
Total geosciences	285.2	330.0	291.3	320.9
Antarctic research program	117.0	143.0	124.8	141.0
Computer and information sciences and engineering				
Computer and computation research, including theory, architecture and software	19.0	23.4	20.0	22.3
Information, robotics and intelligent systems	17.0	19.9	17.8	19.9
Microelectronic information and processing	11.6	18.2	13.2	16.0
Advanced computing, including Supercomputer Centers	43.0	48.2	44.3	55.8
Networking and communications research	9.8	13.4	11.6	17.7
Cross-disciplinary activities	16.3	20.0	17.0	17.5
Total computer and information sciences	116.9	143.0	123.9	149.1
Science and Technology Research Centers	—	—	—	150.0
Engineering				
Chemical, biochemical and thermal	28.4	31.5	28.9	31.9
Mechanical, structural and materials	25.1	28.5	25.8	29.1
Electrical, communications and systems	22.6	28.4	23.4	25.3
Design, manufacturing and automation	14.3	18.0	15.4	17.7
Emerging research, including biotechnology and lasers	15.7	19.4	16.6	19.4
Critical systems, including earthquake	24.7	27.7	25.1	28.3
Engineering Research Centers	29.3	48.0	33.2	40.0
Industry-University Cooperative Centers	3.0	3.5	3.2	3.4
Total engineering	163.1	205.0	171.5	195.0
Science and engineering education				
Teacher preparation and enhancement	30.5	30.5	45.5	53.5
Learning materials and informal education	29.5	30.3	37.5	43.5
Undergraduate science, engineering and math	9.5	15.0	19.0	23.5
Research career development	27.3	36.0	34.0	31.0
Studies and program assessment	2.2	3.2	3.2	4.5
Total science and engineering education	99.0	115.0	139.2	156.0

NASA physics-related projects

	FY 87 actual	FY 88 request	FY 88 current	FY 89 request
		(millions of dollars)		
Physics and astronomy				
Hubble Space Telescope development	96.0	94.8	93.1	102.2
Gamma Ray Observatory development	50.5	49.1	53.4	41.9
Advanced X-ray Astrophysics Facility development	—	—	—	27.0
Shuttle-Spacelab payload development	72.8	75.4	54.2	61.5
Payload and instrument development	—	—	43.7	77.1
Space station planning and payloads	15.5	20.0	18.9	8.0
Explorer development	55.7	60.3	67.9	82.1
Mission operations and data analysis	131.0	128.1	132.0	156.2
Research and analysis	53.4	60.1	82.9	89.1
Suborbital programs				
Sounding rockets	30.9	31.3	24.9	25.7
Airborne science and applications	35.6	29.2	7.3	7.8
Balloon program	7.9	8.1	9.9	8.6
Spartan payloads for space shuttle	4.7	4.5	2.6	3.0
Total physics and astronomy	554.0	564.5	610.8	791.6
Planetary exploration				
Galileo development	71.2	55.3	51.9	61.3
Magellan (formerly Venus Radar Mapper)	97.3	59.6	73.0	33.9
Ulysses (formerly International Solar-Polar)	10.3	10.8	7.8	10.3
Mars Observer development	35.8	29.3	53.9	102.2
Mission operations and data analysis	75.1	77.0	74.7	112.7
Research and analysis	69.5	75.3	67.9	83.6
Total planetary exploration	359.2	307.3	329.2	404.0
Science and applications				
Solid Earth observations				
Shuttle-Spacelab payloads	21.4	21.1	20.8	25.3
Geodynamics, including crustal dynamics	31.6	33.1	32.4	33.9
Research and analysis	19.4	22.6	21.1	22.9
Total solid Earth observations	72.4	76.8	74.3	82.1
Environmental observations				
Upper-atmosphere research and analysis	32.7	34.4	32.7	34.0
Atmospheric dynamics and radiation	31.3	32.9	31.4	32.8
Oceanic processes	18.0	21.5	20.2	21.6
Space physics	20.8	21.5	—	—
Shuttle–Spacelab payload development	9.7	19.4	4.1	19.7
Extended missions operations and analysis	33.6	26.8	14.8	18.5
Interdisciplinary research and analysis	1.1	1.1	1.1	1.2
Tethered satellite payloads	5.5	3.1	—	—
Scatterometer	32.9	22.7	22.7	15.8
Upper atmosphere research satellite	113.8	95.4	89.6	103.9
Ocean Topography Experiment	18.9	90.0	75.0	97.8
Global Geospace Science	—	25.0	—	—
Airborne science and application	—	—	21.9	23.0
Total environmental observations	318.3	393.8	313.5	368.3
Materials processing in space				
Microgravity shuttle-station payloads	33.4	31.5	49.8	59.8
Research and analysis	13.9	14.4	12.9	13.6
Total materials processing	47.3	45.9	62.7	73.4
Other physics-related projects				
Research and technology base				
Fluid and thermal physics research	39.1	25.5	24.6	26.5
Materials and structures research	35.5	39.4	37.2	40.1
Information and computer sciences	23.8	20.5	19.0	23.0
Space research and technology				
Project Pathfinder	—	—	—	100.0

the space station.... We're going to have to deal with the issue of what are the priorities. We did that last year when the appropriations committee had to cut both NSF and NASA.... What are your priorities?... You don't really believe that most of the 435 members [of the House] are going to stand still ... and say, 'We'll give you the whole $3 billion for science and space.' You can't believe that, can you?"

Graham: "As I said, the entire budget has a very modest increase.... The Administration has gone though the science and space programs and set those priorities. Last year, for instance, we deferred the science and technology centers at NSF so as not to cut the size of ongoing research grants, the individual researchers' programs." That action, he insisted, was an example of priority setting—"and it was difficult to do."

Roe: "What are we going to say to the people of the country if we cut $200 million out of the food stamp program because we want to do more scientific research? That's going to be extremely difficult, even for the White House."

Graham was also barraged with questions from Sherwood Boehlert of New York and Don Ritter of Pennsylvania about how to chose between the "mega-projects" in the proposed new budget. Graham's often waffled with his answers. Both Republicans, Boehlert and Ritter in other circumstances might have been champions of the Administration's R&D agenda, but at the hearing, usually prefacing their remarks with allusions to large deficits in the Reagan budgets and major discoveries in high-temperature superconductivity, they were downright hostile. "It's somewhat of a fantasy to ask for 20% for NSF after we asked for 17% last year and got only 5.8%," said Ritter. "Honest to God, where is it all going to come from?"

Other voices in Congress asked similar questions. For instance, on 10 March, Edward P. Boland, a suburban Boston Democrat who has been in the House 35 years and heads the House Appropriations subcommittee, which oversees Budget Function 250, warned Reagan that unless he shifted more money to housing programs he could "kiss goodbye to the space station." In the next few months, as push comes to shove in the budget cycle and the election campaign colors the nation's debate over trade, jobs, housing, education and defense, Congress is likely to scrutinize R&D policies and priorities more closely.

Some highlights of the 1989 budget that affect physics and physicists are given below.

National Science Foundation

The Administration proposes to increase NSF's budget by almost 20%, bringing it to $2.05 billion or $333 million more than the current fiscal year. NSF Director Erich Bloch has no intention of abandoning his 1988 proposal to double the agency's budget from its 1987 level of $1.6 billion. Passage of the President's 1989 budget request, he says, would get things "back on track." Bloch recently admitted to the Boland subcommittee that doubling his budget is seen in the scientific community "as a big science project in itself."

One component in his strategy calls for launching 12 to 15 multidisciplinary science and technology centers. Bloch is asking Congress to put up $150 million as a one-year allocation that would be carried on a separate line in NSF's ledgers, apart from the research activities account. This funding approach, agency officials claim, would ensure that the centers are created within the next five years. By providing NSF with enough money to operate each center for five years, Congress could assure the program's stability and encourage states and industries to enter into cost-sharing agreements for the centers. Of the 322 proposals for the new centers awaiting peer review, some 30 are in the field of information sciences and artificial intelligence, 10 in superconductivity research and 90 deal with materials science, including condensed matter.

Scientists and university leaders have mixed reactions to the proposed centers. Many fear that the centers will drain funds from grants to individual researchers. Last year the foundation asked Congress for $30 million to start the centers, but after the agency got significantly less for its entire operation, Bloch decided to put off their start until fiscal 1989. Even so, grants to individual investigators were reduced, causing a furor that has not yet subsided (see page 61).

At a hearing on NSF's budget on 16 March, Representative Bill Green of New York, the top Republican on the House Appropriations subcommittee, warned Bloch that the proposed science and technology centers might be likened to "living on the slope of a political volcano." If the agency's budget is not increased substantially in the next few years, he cautioned, "you may have to choose between supporting the centers or supporting individual researchers."

Boland's subcommittee continues to watch NSF's education program closely. Last year, science and engineering education got the largest percentage increase, some 40%, raising its funding to $139 million. In the proposed 1989 budget, education would receive a 12% hike to $156 million—a request that seems to please Boland and others on Capitol Hill. The major portion of the increase, some $18 million, is designated for precollege education, raising that program to $108 million.

Physics did not do nearly that well. Physics-related research is up only 7% in the new request, the least of any major NSF research component. Included in this are upgrades for the Cornell Electron Storage Ring, the Indiana University Cyclotron Facility and the Michigan State University National Superconducting Cyclotron Laboratory, all coming on line next year. In addition, an increase of $1.15 million is in store for the Fly's Eye facility located at the University of Utah's site at Dugway, where cosmic ray showers in energy ranges up to 10^{20} electron volts are detected. New detectors for Fly's Eye are being built by physicists at the Universities of Chicago and Michigan. The physics program also would provide $1 million for R&D on particle detectors for the SSC and CEBAF.

The theoretical physics program would receive an additional $1 million for a cosmology initiative that supports astrophysics. Astronomy, however, would get minuscule budget increases. This year's budget cuts at NSF's ground-based optical and radioastronomy observatories have already resulted in staff losses of 10%. The outlook for next year is equally dismal. Budgets for the National Optical Astronomy Observatories and National Radio Astronomy Observatory are marked for increases of $1 million each. Construction of the Very Long Baseline Array radio telescope would be stretched out.

Department of Energy

DOE's budget for basic science research, which includes nuclear and high-energy physics, would rise from $1.4 billion this year to $1.7 billion in fiscal 1989—a 25% increase. These totals are affected by several factors that obscure what is really happening, however. First, spending to construct and operate DOE facilities would nearly double, rising from the current year's $575 million to $973 million in 1989. The single largest component is SSC funding, which would leap from $25 million this year to $363 million next year. Of this sum, $283 million would go toward starting engineering studies for construction of the 53-mile oval tunnel and for developing such long-lead items as magnet cable and cryogenic systems. R&D on the magnets, injectors and detectors account for $64 million, while accelerator and detector equipment require $16 million.

A second factor is the impact of the university and hospital "pork barrel" projects that Congress stuffed into DOE's 1988 budget (see page 60). No funds have been included in the 1989

Department of Defense basic research funding (6.1 budget category)

	FY 87 actual	FY 88 request	FY 88 current	FY 89 request
	(millions of dollars)			
Army				
Research, including physics and materials	194.5	—	168.9	173.5
Army laboratories independent research	16.7	—	—	—
Universities research initiative	8.3	24.1	—	—
Navy				
Research, including physics and materials	319.2	368.9	319.4	333.0
Navy laboratories independent research	23.3	22.6	22.6	23.8
Universities research initiative	10.6	24.6	—	—
Air Force				
Research, including physics and materials	197.6	204.2	182.8	189.4
Air Force laboratories independent research	15.0	16.7	15.7	10.2
Universities research initiative	8.5	24.6	—	—
Defense Advanced Research Projects Agency				
Research, including materials and computers	88.9	97.5	80.0	89.5
Universities research initiative	9.0	25.0	—	—
Office of Secretary of Defense				
Universities research instrumentation	—	—	24.6	—
Universities research initiative	—	92.0	85.0	95.0

Strategic Defense Initiative (6.2 and 6.3 budget categories)

	FY 87 actual	FY 88 request	FY 88 current	FY 89 request
	(millions of dollars)			
Directed-energy weapons	853.1	1245.8	832.3	1029.9
Kinetic-energy weapons	722.5	1199.7	791.5	936.3
Surveillance, acquisition, tracking and kill assessment	923.0	1859.5	955.5	1124.6
Systems concepts and battle management	385.8	787.5	503.2	639.9
Survivability, lethality and key technology	375.3	1162.2	448.7	790.4
Total SDI R&D program	3259.7	6254.7	3531.2	4521.1
Construction	10.0	125.0	59.2	90.5
Headquarters management	20.0	27.0	19.8	24.8
Total Defense Department SDI program	3289.7	6406.7	3610.2	4636.4
Department of Energy SDI program	360.3	569.1	353.8	402.0
Total SDI	3650.0	6975.8	3964.0	5038.4

Midnight Riders: Pork in DOE's Science Budget

Few things so concentrate the minds of members of Congress as the prospect of purveying favors to their constituents. In the rush to adjourn after midnight on 22 December, to meet the Christmas 1987 deadline for the 1988 budget, the 100th Congress stuffed goodies worth as much $3 billion, by White House calculations, into the fiscal 1988 continuing resolution (P. L. 100-202) that finally appeared as a mammoth 2300-page, $604 billion appropriations bill. At the time the legislation was passed, Representative Silvio Conte of Massachusetts, the top Republican on the House Appropriations Committee, complained to an almost empty chamber: "Nobody knows what's in the budget bill, not even our own staff and specialists."

Indeed, there was little or no discussion of some items—a new building in a congressman's home district; a project to soothe a senator; a grant to advance a discovery, a technology or a pet cause. There's nothing new or novel about the practice, of course. Congress has been doing it since the early 19th century, when Jacksonian democracy introduced the "spoils" system. By circumventing the established procedure for making laws, which include going before the relevant committees in the House and Senate for consideration and getting approval in both houses, a member of Congress is free to make deals to attach a rider for a special-interest project to an obscure part of some important bill. "I hold my nose and vote for a lot of things around here," says Representative William Lehman, a Florida Democrat who serves on the House Appropriations Committee.

Equally unsettling, the agencies charged with providing the money have little or no chance to examine the merit of the projects or to fit them into their programs.

President Reagan used his State of the Union message to criticize sharply the way Congress attached new items to the budget like ornaments on a Christmas tree. Reagan drew laughs from Congress and editorials in newspapers when he identified a few oddities: "There's millions for items such as cranberry research, blueberry research, the study of crawfish and the commercialization of wildflowers."

More impressive than Reagan's examples are the specific hunks of pork that Congress earmarked in the Department of Energy's science research budget this year. In DOE's basic energy sciences program alone the total comes to $125.8 million. To help pay for its largesse, Congress put $85.5 million on top of the basic energy sciences budget request of $479.1 million. This still left a gap of $40.3 million that the agency will need to fill from its research program.

The 1988 pork in DOE's basic energy sciences budget (in millions of dollars):

Arizona State University, Barry M. Goldwater Center for Science and Engineering	10.0
Louisiana State University, Center for Advanced Microstructures	12.0
University of Alabama at Huntsville, Center for Applied Optics	10.6
Drexel University (Pennsylvania), Center for Automation Technology	6.5
East Central University (Oklahoma), Center for Physical and Environmental Science	4.0
Florida State University Supercomputer Center	11.7
Boston University (Massachusetts), Institute for Advanced Physics Research	8.5
Boston College (Massachusetts), Multipurpose Center	4.0
Columbia University (New York), National Center for Chemical Research	4.0
Loma Linda University Medical Center (California), Proton Beam Demonstration Cancer Center	8.5
Medical University of South Carolina, Cancer Research Center	8.0
Mount Sinai Medical Center (New York), Institute for Human Genomic Studies	12.7
University of Medicine and Dentistry (New Jersey), Institute for Nuclear Medicine	7.5
Jackson State University (Mississippi) and the Ana G. Mendez Foundation (Puerto Rico) for research and education of minority groups	1.5
Children's Hospital of Pittsburgh (Pennsylvania), Pediatric Research Center	15.0
Oregon Graduate Center for research on membrane-based technologies	0.5
Oregon Health Science University, science building	10.0

In addition, DOE is required to fund the following earmarked pork:

Northwestern University (Illinois), materials science research building	6.0
University of Oklahoma at Norman, energy center	5.5
University of South Carolina at Aiken, scientific equipment	0.7
West Virginia University, energy center	6.0
Mississippi State University, AVCO Everett Co and test centers in Montana and Tennessee, magnetohydrodynamics demonstration project	35.0

On 10 March the President sent 46 pages of pork projects, including those listed above, to Congress with the hope that members would "rescind them as soon as possible." It was not a formal request to get rid of the pork, James C. Miller III, director of the Office of Management and Budget, explained to Congress. "Essentially we are leaving it up to you," he said. The result of such an exhortation in the past has been that Congress does nothing about pork. The strange thing about Reagan's list is that it leaves out the items he had cited in his State of the Union address. "Those were used to illustrate the trivial nature of the items," Miller observed. The examples came from committee reports, which are not binding on government agencies unless they become part of a law. But the DOE items must be paid for as Porky goes to colleges and hospitals, thanks to the spoils system developed by the Congress.

—Irwin Goodwin

budget to continue funding those projects.

Finally, the budget outlook for many programs is not readily discernible, in part because DOE has adopted a new accounting procedure that separates construction, operation and maintenance of such user facilities as Fermilab, Brookhaven's National Synchrotron Light Source and Oak Ridge National Laboratory into a new category, "Basic Research User Facilities." When "BRUF" accounts are added to the standard categories of energy sciences at DOE, it appears that basic energy research and high-energy physics would be held to increases of roughly 5% next year. Materials research would rise by 6.8% to $134.7 million, largely the result of a 10% increase in high-T_c superconductivity work supported at DOE labs and at universities.

In other headings, the magnetic confinement fusion budget would go up for the first time in several years, from $335 million to $360 million, and Argonne would begin building its long-delayed 6–7 GeV synchrotron light source. The increase in magnetic fusion is due largely to a decision to prepare for constructing the Compact Ignition Tokamak at Princeton, for which $37 million is requested.

In energy technology research, DOE plans to spend $525 million next year as part of a five-year, $5 billion clean coal initiative that is to be funded jointly with industry. Otherwise, budget requests for fossil fuel research, energy conservation and renewable energy resources closely resemble those of previous years with large cuts proposed. As in the past, Congress is not likely to go along with the Administration's reductions.

NASA

The space agency seems to have won some powerful allies within the White House this year—possibly because of the world attention that Soviet space plans have received and more likely because the grounded US program is a cause of political embarrassment and scientific frustration. NASA's budget request of $11.5 billion is up nearly $2.5 billion from the appropriation in fiscal 1988—a 27% jump. As expected, about $1 billion of this is for the new shuttle orbiter to replace Challenger, which exploded on liftoff in 1986 with the loss of all hands. A second major driver in NASA's budget is the space station, whose funding would be more than doubled, from $392 million to $967 million for full hardware development. Over the next three years NASA wants $6.1 billion pumped into the space station—though it is not certain the project can survive the next few years of deficit cutting.

Overall funding of space science and applications programs would rise by 18% under the Administration's request. The agency seeks $27 million to proceed with a new project, the Advanced X-Ray Astrophysics Facility, which has been a top priority in the astronomical community for nearly a decade. AXAF would be the third of NASA's "Great Observatories," after the Hubble Space Telescope and the Gamma Ray Observatory. Also on the agency's agenda for 1989 is $100 million to begin the Pathfinder technology program to conduct research to support exploration of the solar system by humans and robots. In addition, NASA would put up $110 million to continue procurement of expendable launch vehicles to get science missions off the ground without relying on the shuttle.

Department of Defense

For the first time in the Reagan years, the share of the Federal R&D budget for military programs is set to decline slightly, from 67% to 66%. While DOD is proposing to spend $38.7 billion on research, development, testing and evaluation next year, only $906 million—a mere 2.3%—is designated for basic research, about half of it going to universities. In fact, DOD's basic research budget would increase only 1.5%. Over at DOE, $2.4 billion is to be spent on weapons-related R&D, about the same as in 1988.

SDI is now the largest item in DOD's research and development budget. Last year, Congress appropriated about $3.9 billion for the total SDI program, including $353 million to be spent by DOE on research like the nuclear-pumped x-ray laser project and the SP100 nuclear power reactor for space. The Reagan Administration is asking for $4.95 billion for fiscal 1989, an increase of about 27%. As huge as those figures are, they still fall short of what the White House hoped to spend on SDI.

Defense department officials say the cuts will delay by a year or two the 1992 target date for deciding whether to go ahead with the engineering development of a missile defense system. About half of the SDI budget would be devoted to technologies that could be deployed in a first phase defense, using both space-based and ground-based interceptors, while about 40% of the program will go to longer term research, such as directed-energy weapons.

House budget resolution

To the surprise of many, on 23 March the House Budget Committee adopted a 1989 budget blueprint, well ahead of the sluggish pace in the last three years. The committee called for Function 250 to receive $1.65 billion, of which NASA will get $1.25 billion (half of its request), NSF $300 million additional funding (only $33 million short of the original request) and DOE $100 million more for its general science and high-energy physics programs ($300 million less than it sought). The budget committee did not specify how much of DOE's new funds would go to the SSC. The agency, said Gray, the committee chairman, "could use all of it for the Super Collider, none of it or anything in between." —Irwin Goodwin

NSF, UNDER SIEGE BY PHYSICISTS, ADMITS MISTAKES IN RESEARCH CUTS

The remark had a touch of irony. "The days of NSF as a quiet, obscure agency, insulated from political pressures, are gone," Erich Bloch, director of the National Science Foundation, told the annual joint meeting of The American Physical Society and the American Association of Physics Teachers in January. "We should welcome this." Even as he spoke, the foundation was under siege by battalions of university researchers, many in condensed matter and solid-state physics, which had taken the brunt of cuts when Congress pared NSF's fiscal 1988 funding. Not content with complaining to NSF about the ax it used to chop the size and number of awards in those fields, the scientists protested to key members of Congress and to their staffs on appropriations and budget committees (PHYSICS TODAY, March, page 41).

As inquiries from Capitol Hill piled up on Bloch's desk, he directed a 17-year veteran in NSF's ranks, Richard S. Nicholson, assistant director for mathematical and physical sciences, to issue a communiqué about the action. It was a no-nonsense *mea culpa*. Significant reductions for existing grants in materials research were made, Nicholson admitted, as "the only way that funds can be made available for new awards this year." Some researchers were hit particularly hard, he wrote, because NSF program officials had been "overly optimistic." When the agency's 1988 request for a 16.7% overall boost turned out to be closer to 3.2%, as Congress finally passed its omnibus appropriation almost three months after the start of the fiscal year, almost all the awards in materials science had already been committed. Nicholson stated that though some projects continued to be funded at or even above 1987 levels, most were reduced by 6% to 9%, "and a few even more," so that new investigators with new ideas could be supported.

The cuts were an inside job by program officers, made without benefit of peer reviews. In the end it was theorists, including Nobel laureates Philip W. Anderson of Princeton and J. Robert Schrieffer of the University of California at Santa Barbara, who came out worse than experimenters. A letter from an NSF program officer to N. David Mermin, director of Cornell's Laboratory of Atomic and Solid State Physics, apologized that the reduction had nothing to do with whether the work was "promising and important" but was "across the board" in condensed matter theory.

Though Congressional appropriations for NSF research have been virtually flat since 1985, NSF makes its own allocations of research money. So when push comes to shove, Nicholson's statement admitted, "this situation should not have been allowed to develop. The foundation is taking steps to improve program management procedures."

At a meeting of the National Science Board on 18 March, Bloch stated that NSF was at fault for "not handling the situation as well as we should have. . . . We didn't do a good job of communicating with the communities. . . . We had a similar experience in 1986 when the Gramm–Rudman–Hollings budget-balancing law came in [resulting in a $19 million reduction for the mathematical and physical sciences directorate], but we did a better job then and didn't get all the flak that came our way this time." Bloch told an advisory committee a week earlier that he was "getting a lot of hate mail."

Bloch is taking steps to head off such problems in the future. All financial implications of grants and projects will be recorded in a computer database showing weekly and quarterly outlays and future obligations over three to five years. "It will be relatively easy to keep track of commitments once a trigger mechanism is in place," says Bloch.

—Irwin Goodwin ■