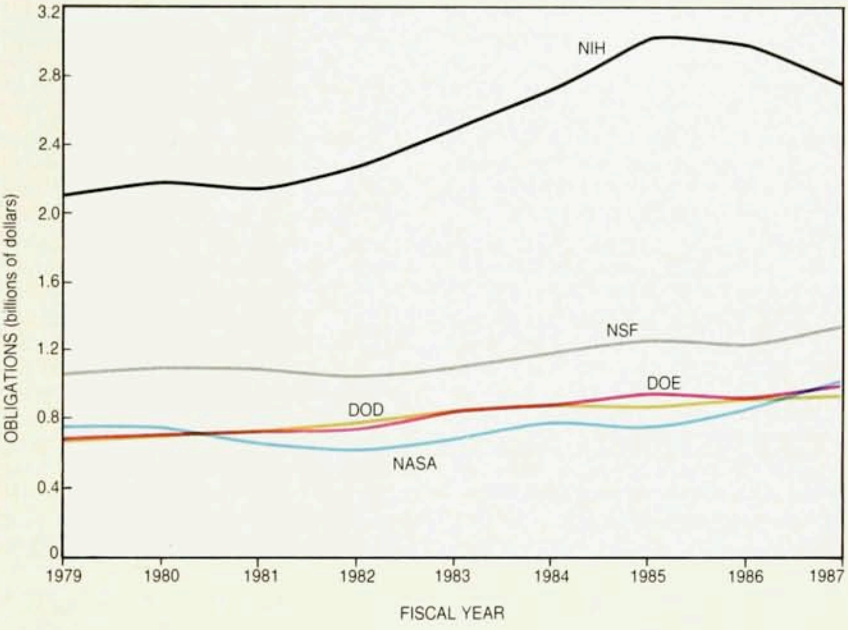
R&D budget for fiscal 1987: Life at the threshold of pain

"Anybody can write a budget," President Reagan's former budget director, David Stockman, used to say. He meant: It's easy to add something here and subtract an item there, making the arithmetic come out right, but what's hard is getting the budget through the political system. This year, worse yet, not only is it necessary to contend with the Congress, but the job is complicated by the Balanced Budget and Emergency Deficit Control Act, better known by the names of its sponsors (Phil Gramm, Warren Rudman and Ernest Hollings), which Congress and the President imposed on themselves last December as a radical measure to reduce the current 12-digit budget deficits by $36 billion each year until 1991.

The stakes for science are serious. If Congress does not accept the Reagan Administration's budget for fiscal 1987, which was sent to Capitol Hill on 5 February, and the White House refuses to compromise points of difference, the situation this year may not be different from in the past. In the event, the game will still be "chicken," with Congress and the Administration on a collision course until the first one blinks and gives way. So far, nobody's blinked. With Congress back after its Easter recess and still at loggerheads, the prospect of a long, hot summer spent wrangling over a budget agreement casts a pall over Washington.



Basic-research obligations of the Federal government in constant (1985) dollars. The figures for 1986 and 1987 are estimates.

Missed deadlines. Congress already has missed several deadlines for adopting an overall budget plan for fiscal 1987. Under Gramm–Rudman–Hollings, Congress cannot enact any appropriations bills for the various Federal agencies until it passes a budget resolution. The Senate Budget Committee took a first step in March by voting to lop $25 billion off the President's request for $311.6 billion for the Defense Department in 1987 and to raise revenues by $18.7 billion. The White House refused to accept any plan that would upset the President's political principles of no Defense cuts and no tax increases.

Deadlock would just make matters worse. With the new fiscal year beginning 1 October, the choices are few. By 1 September the President is required by the terms of GRH to issue an order for automatic cuts, which the law prefers to call by the tongue-twisting term "sequestrations." The cuts for 1987 may come to as much as twice the 4.3% sequestrations that took effect on 1 March for the current budget. Such large slices into the vulnerable parts of the domestic budget (social security and veterans's pensions are among the few exempt programs) and even greater reductions in Defense would ravage many Pentagon plans and distort many research projects at universities and government and private laboratories that rely on Federal funding. Of course the President could break the deadlock by submitting a new budget somewhat closer to what Congress can live with in an election year, but that is unlikely. Thoughts of what life might be like if the automatic GRH ax fell ineluctably on R&D funds for the second year in a row have jolted leaders of the scientific and academic establishments. Alarmed, they have sent manifestos and emissaries to Capitol Hill with pleas to be spared from the GRH chopper (PHYSICS TODAY, April, p. 49).

In response to their joint expression of concern to members of Congress at the end of March, the presidents of 28 scientific and engineering societies were informed that the portion of the 1987 budget earmarked for science and technology, known to White House Office of Management and Budget technicians as "function 250," would not be affected in the Senate plan. It is in fact "one of the few areas to receive a budget increase," said Senator J. James Exon, Democrat of Nebraska, a member of the Senate's science and budget committees. John P. McTague, the President's acting science adviser, boasts that the research base has been

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Department of Energy physics-related research

	FY 85 actual	FY 86 approp	FY 86 GRH adjust	FY 87 request
		(millions of dollars)		
High-energy physics				
Physics research				
Argonne	4.9	5.0	4.8	5.3
Brookhaven	7.1	7.3	7.0	7.6
Fermilab	9.6	9.8	9.4	10.3
Lawrence Berkeley	8.4	8.9	8.5	9.2
Stanford Linear Accelerator Center	11.1	11.3	10.8	11.9
Universities and other DOE laboratories	65.2	68.6	65.8	74.3
Total physics research	106.3	111.0	106.3	118.6
Facilities operations				
Brookhaven	35.8	37.2	35.7	38.4
Fermilab	83.3	88.1	84.5	100.7
Lawrence Berkeley	0.7	0.7	0.7	0.8
SLAC	50.8	51.9	49.8	68.6
Others	2.0	4.5	4.3	4.9
Total operations	172.7	183.1	175.1	213.4
Capital equipment				
Argonne	1.3	0.7	0.7	0.7
Brookhaven, including AGS program	8.4	9.1	8.7	9.4
Fermilab, including Tevatron detectors	27.5	32.4	31.1	30.5
Lawrence Berkeley	1.7	1.5	1.4	1.6
SLAC, including upgrading PEP detectors	9.1	15.1	14.5	21.0
Universities and other DOE laboratories	10.7	14.0	13.4	14.3
Total capital equipment	58.7	73.1	70.0	77.5
Construction				
Tevatron I and II (total upon completion, 133.0)	33.3	8.6	8.2	0.4
SLC (total upon completion, 115.4)	60.5	22.8	21.9	1.0
Fermilab computer upgrade (total, 24.1)	—	3.1	3.0	14.2
AGS accumulator–booster	—	2.0	1.9	3.5
Accelerator improvements, general plant projects	20.2	21.0	20.1	22.7
Total construction	114.0	57.5	55.0	41.7
High-energy technology				
Argonne	1.7	1.5	1.4	1.7
Brookhaven, including SSC work	19.3	20.0	19.0	20.2
Fermilab, including SSC work	27.7	24.4	23.4	24.9
Lawrence Berkeley, including SSC work	8.2	8.1	7.8	8.6
SLAC	16.6	16.2	15.5	16.4
Universities and other labs (includes SSC)	16.7	22.3	21.4	23.7
Total high-energy technology	90.2	92.5	88.5	95.5
Total high-energy physics	**541.9**	**517.2**	**494.8**	**546.7**
Nuclear physics				
Low energy	13.3	12.6	12.1	15.7
Medium energy, including CEBAF R&D	73.8	76.5	73.1	85.0
Heavy ion	49.0	52.4	50.2	63.7
Nuclear theory	9.3	9.4	9.0	10.5
Total construction, including CEBAF	23.3	7.0	6.7	33.3
Total capital equipment	12.7	14.0	13.4	16.0
Total nuclear physics	**181.5**	**171.9**	**164.5**	**224.2**
Basic energy sciences				
Nuclear science	39.6	43.1	41.4	46.9
Materials science	132.2	139.5	134.2	156.1
Chemical science	78.6	81.2	78.1	86.4
Engineering and geosciences	26.1	26.6	25.6	29.4
Advanced energy projects	10.0	7.6	7.3	8.9
Biological energy research	12.4	12.4	11.9	14.5
Applied mathematical science	34.5	39.4	37.9	32.8
Total construction	42.4	70.1	67.5	29.5
Total capital equipment	31.1	27.3	26.2	31.8
Program direction	3.8	3.6	3.7	14.1
Total basic energy sciences	**410.0**	**450.8**	**433.8**	**441.4**
Supporting research activities				
University research instrumentation and support	15.0	17.2	16.6	16.0
Multiprogram laboratories facilities support	33.2	42.1	39.8	60.2
Magnetic fusion				
Toroidal confinement systems	151.4	147.6	141.5	151.8
Mirror confinement systems	54.9	49.1	47.1	25.7
Applied plasma physics	78.9	72.7	69.7	70.7
Development and technology	67.9	59.6	57.1	50.5
Planning and projects	12.2	5.7	5.5	4.8
Capital equipment	27.5	29.5	28.3	13.5
Construction				
FMIF (total estimated cost, 241.2)	3.0	—	—	—
MFTF (total estimated cost, 77.5)	20.1	4.1	3.9	3.8
General plant projects	9.4	9.2	8.8	8.2
Program direction	4.2	3.6	3.6	4.0
Total magnetic fusion	**429.6**	**377.5**	**365.5**	**333.0**
Inertial-confinement fusion (weapons activity)	**180.3**	**155.0**	**148.0**	**23.8**

second only to Defense in the budget for the last two years and that Reagan considers research so "absolutely essential" that it will not be bargained away just to get agreement. Despite the assurances, the science community that depends on Federal support is tense and uncertain about the budget outcome.

House Republicans are exploring a single omnibus appropriations bill as a method of simplifying and speeding the budget process, rather than going through the routine ritual of enacting 13 spending bills—an approach that is backed by some influential Democrats. An obscure change in GRH allows the House to begin debating appropriations bills on 15 May even if a budget resolution has not been approved. Meanwhile, the Supreme Court is deliberating whether the law's automatic deficit-reduction procedures violate the Constitution by giving the Controller General the final word in estimating and authorizing the cuts. Whether or not the high court upholds a lower-court ruling that part of GRH is unconstitutional, the decision, possibly to be issued in June, isn't likely to change the bill's *raison d'être*: Federal deficits will be reduced to zero by fiscal 1991 no matter what procedure is in place.

Space booster. By submitting a budget that meets the bottom line of the GRH target for 1987, at least on paper, the Reagan Administration was attempting to prove that Congress could quickly and easily come to grips with spending bills. To achieve that budget, the Office of Management and Budget ordered agencies to trim back their proposals. To take just one case, OMB virtually eliminated the space station during NASA's negotiations on the 1987 budget. NASA wanted $750 million to get on with the conception and construction of the station. It took the intercession of the President himself, an unabashed booster of the space station, to save it. In the end, OMB allowed NASA to propose doubling this year's appropriation so that the station would get $410 million in the 1987 budget if Congress goes along.

The Reagan Administration's overall budget comes to $994 billion, offset by expected revenues of $850 billion to achieve a deficit of exactly $144 billion—the limit set by GRH for fiscal 1987. To get this, Reagan once again rounded up the customary culprits—urban-development action grants, the Small Business Administration, student loans, Amtrak subsidies, Medicare and Medicaid, among some 40 Federal programs—and called for either deep cuts or outright terminations. The hit list also proposes selling off the government's electric-power marketing agencies, minerals from the strategic stockpiles, and naval petroleum reserves at

Teapot Dome, Wyoming, as well as in California and Louisiana.

In many other respects the new budget has a familiar look. It would provide massive increases for Defense, as usual in Reagan budgets, with the President's own Strategic Defense Initiative, or "Star Wars" program, achieving a distinction of sorts as the Pentagon's costliest single operation. In addition the budget sets forth a new symbol of technological leadership—the latest of Reagan's pet projects, the National Aerospace Plane. A joint project of NASA and DOD that the President advertised in his State of the Union speech as the "Orient Express," it would be capable of reaching the Far East in two hours or so from almost anywhere in the US. R&D for this hypersonic aircraft, which would burn liquid hydrogen in "scramjet" engines, operate from ordinary airports and fly at Mach 12–25, appears for a total of $200 million in the budgets of a handful of agencies for next year.

NASA estimates the cost of launching the plane will come to $8 billion, but Pentagon officials tell Congress it will run "a good deal more." The trouble is, said Colonel Donald I. Carter, deputy undersecretary of Defense for research and advanced technology, the plane is viewed differently "in the eye of each beholder." NASA wants it as a space orbiter. The Defense Advanced Research Projects Agency and the Air Force see it as a multi-Mach transport. SDI wants it to deploy weapons systems in space.

Basic themes. As in the past four years, the budget includes significant increases for the physical sciences and engineering. Indeed, the basic themes of the budget may be found in Reagan's customary script. An enthusiast of the idea that basic research is a source of new technology, the President told an audience earlier this year that "continued strong support for our nation's science and technology has been and will continue to be a policy of this Administration. The goals of this support are enhanced national security, improved quality of life and increased industrial competitiveness. Today, more than ever, we must use our technological resources aggressively in order to retain international leadership."

Though the total 1987 budget would be up only 1% over the current year, its R&D obligations call for an astonishing growth of 16%—from $54.7 billion this year (before GRH cuts) to $63.2 billion next year—the lion's share once again earmarked for military programs in the Departments of Defense and Energy. What the weighty budget documents and the agency budget briefings don't mention is that military R&D, including weapons-related work in DOE, would claim 95% of the $8.8 billion increase in the new R&D budget—23% of this just for increases in the Star Wars program.

Military R&D in Defense and Energy would go up from $35.7 billion this year to $44.4 billion next year, while civilian R&D would be held roughly constant at about $16.4 billion. This means that military spending would claim 73% of Federal R&D funding in 1987—up from 50% in the Carter Administration's last budget in 1980. It is unlikely that Congress will go along with this while the Administration trims some civilian programs.

McTague gave a justification for R&D increases at a time of fiscal restraint to the House Committee on Science and Technology on 6 February, the day following the budget's release. His testimony leaned heavily on the importance of strengthening national defense and industrial competitiveness. Pressure to cut the deficit, said McTague, "means that in fiscal 1987 and beyond the Federal government can fund only those activities that are necessary for it to fund, not those which are merely good and worthy."

Formula cuts. The proposed budget, McTague informed members of Congress, "gets us back on a even keel from the formula cuts [of GRH this year], partially restoring the trend of real growth experienced in the first half of the 1980s. Because of the long-term nature of research and science and engineering training, and the fragility of research teams, steady, predictable funding is especially important for optimizing future returns on our R&D investment."

It is also central to the Reagan Administration credo to return some government programs to private enterprise. Accordingly, since 1981 Federal funding for the development portion of R&D has dropped by about 44% and that for applied research by 8% in terms of constant 1985 dollars. Budgets for basic research, by contrast, have risen 30%. The proportion of basic-science money going to universities and colleges is up 18%. Emphasis on basic research, according to OMB's "Special analysis K" for the new budget, "represents an essential investment in the nation's future." All told, basic research accounts for $8.6 billion in the R&D budget in 1987—an increase of $614 million for all agencies, or 8% higher than the current year.

Not all departments and agencies would share in the proposed largesse. While DOE, NASA and the National Science Foundation would see their combined spending in basic research go up by 13%, agencies supporting primarily life sciences would receive a scant 1.7% rise for basic research—far less than the effects of inflation on the economy. According to an analysis by the White House Office of Science and Technology Policy, support for academic science, after correction for inflation, will drop slightly between fiscal 1985 and 1986, after three straight years of hefty increases. In fiscal 1987, it would climb back to the fiscal 1985 level. In addition the budget sets forth some old targets for sharp cuts—notably biomedical research, magnetic fusion, programs supporting alternative energy sources and energy conservation, and the building- and fire-research centers at the National Bureau of Standards.

Last year Congress imposed a freeze on new R&D projects. This year's budget proposes to fund several new starts. Among them are:

▶ The Continuous Electron Beam Accelerator, which has been in DOE's 1985 and 1986 budgets for construction but was killed by scientific opponents the first time and by the freeze last year. With a revolutionary redesign and an experienced new director (PHYSICS TODAY, February, pages 18 and 51), CEBAF seems to be free of its previous troubles. Even so, the House Subcommittee on Energy Research and Applications cut $8 million from DOE's request for $25 million to begin building CEBAF in 1987—though, to be fair to subcommittee members and staff, the reduction was made with the consent of the machine's director, Hermann Grunder, who made the case for the absolute minimum for getting started.

Another possible hitch for CEBAF appeared unexpectedly during a hearing on DOE's budget before the full Senate Energy and Natural Resources Committee on 18 February. Senator J. Bennett Johnston, a Louisiana Democrat, scolded Energy Secretary John Herrington on the Administration's intention to call it quits on two major projects in his state—the naval petroleum reserve and a dam on the Red River. "If the Administration thinks for a minute you are going to start up a new, expensive project like the Continuous Beam Accelerator and stop the Red River project and stop the Strategic Petroleum Reserve and give us a pittance of what we are entitled to . . . it is going to happen over my dead body," Johnston stormed. As a longtime observer of the physics scene, Johnston has acquired a working understanding of the field. Though CEBAF might cost $236 million to complete, he argued, it was not likely to be "the end-all and the be-all of determining the unified force field or establishing the Big Bang theory or filling in all the gaps of quarks and leptons."

▶ The 1.5-GeV Advanced Light Source that DOE has been trying to build at Lawrence Berkeley Laboratory. First proposed in DOE's fiscal 1984 budget,

National Science Foundation physics-related research

	FY 85 actual	FY 86 approp	FY 86 GRH adjust	FY 87 request
		(millions of dollars)		
Mathematics and physical sciences				
Physics				
Elementary particles	39.8	42.1	39.9	45.7
Intermediate energy	18.3	18.8	17.9	18.8
Nuclear physics	23.0	21.6	20.2	21.2
Atomic, molecular and plasma	13.6	13.7	13.0	13.9
Theoretical	13.9	14.4	13.7	16.0
Gravitational	7.2	8.0	7.6	11.0
Total physics	115.8	118.6	112.3	126.6
Computer research	39.1	40.2	38.3	44.4
Mathematical sciences	47.7	51.7	51.7	59.8
Chemistry, including chemical physics	87.6	89.8	85.5	101.0
Materials research				
Solid-state physics	11.4	11.9	11.3	12.4
Solid-state chemistry	8.2	8.7	8.3	9.1
Low-temperature physics	7.9	8.2	7.8	8.5
Condensed-matter theory	8.2	8.5	8.1	9.8
Metallurgy	9.5	9.8	9.3	10.2
Ceramics and electronics materials	6.5	6.6	6.3	6.9
Polymers	7.6	7.1	6.9	7.5
Instrumentation	6.5	6.2	5.9	6.2
Materials Research Laboratories	27.1	27.2	25.9	27.7
National facilities	11.6	10.7	10.2	10.7
Materials Research Groups	2.5	4.8	4.6	8.8
Total materials research	107.0	109.7	104.6	117.4
Total mathematics and physical sciences	**397.2**	**429.0**	**410.0**	**449.3**
Astronomical, atmospheric, Earth and ocean sciences				
Astronomical science				
Solar-system astronomy	1.2	1.2	1.1	1.2
Stars and stellar evolution	6.0	6.4	6.1	7.0
Galactic astronomy	4.8	5.0	4.8	5.7
Extragalactic astronomy	7.2	8.0	7.6	8.6
Astronomical instrumentation	7.9	5.1	4.9	5.1
Electromagnetic spectrum management	0.1	0.1	0.1	0.1
Astronomy facilities				
National Astronomy and Ionospheric Center	6.0	6.4	6.1	6.4
National Optical Astronomy Observatories, including Kitt Peak and Cerro Tololo	22.8	23.8	22.7	24.2
National Radio Astronomy Observatory	17.3	17.3	16.5	17.3
VLBA construction	9.0	9.0	8.6	9.4
Total astronomical science	82.8	84.2	79.5	85.1
Atmospheric-sciences project	47.6	49.5	47.1	51.3
National Center for Atmospheric Research	43.5	43.1	41.1	45.2
Upper Atmospheric Research Facility	3.9	4.2	4.0	4.1
Earth sciences, including geophysics, lithosphere research and instrumentation	46.0	48.9	46.6	55.0
Ocean-sciences research	58.3	60.0	57.1	66.4
Oceanographic facilities	35.2	35.3	35.3	37.2
Ocean drilling	27.7	28.9	28.9	30.0
Arctic research program	8.0	8.5	8.1	8.9
Total astronomical, Earth and ocean sciences	**353.0**	**362.6**	**347.7**	**383.2**
Antarctic research program	**110.8**	**115.2**	**110.2**	**117.0**
Advanced scientific computing	**41.4**	**45.2**	**43.1**	**47.0**
Science and engineering education				
Graduate research fellowships	27.3	27.3	27.3	27.3
Learning-materials research and development	22.7	25.0	23.8	25.0
Teacher preparation and enhancement	25.2	27.0	25.7	27.0
Studies and program assessment	1.7	2.2	2.1	2.2
College science instrumentation	5.0	5.5	5.2	7.5
Total science and engineering education	**82.0**	**87.0**	**84.0**	**89.0**
Engineering				
Chemical, biochemical and thermal	29.2	29.2	27.8	30.2
Mechanical, structural and materials	23.3	23.7	22.6	26.3
Electrical, communications and systems	25.8	25.7	24.5	26.3
Science base in design and computers	17.5	18.7	17.8	21.7
Fundamental, emerging research	35.0	36.2	34.5	43.1
Cross-disciplinary research				
Engineering Research Center	10.0	25.0	23.8	35.0
Industry–University Projects	6.9	3.5	3.3	—
Industry–University Research Centers	3.0	3.0	2.9	3.0
Total engineering	**150.7**	**162.5**	**157.2**	**185.5**

it, like CEBAF, had been attacked by members of the community as the wrong machine at the wrong place at the wrong time. After the light source was recommended by the Seitz–Eastman committee on major materials-research facilities (PHYSICS TODAY, September 1984, page 57), the dissent quieted, but when DOE sought approval for ALS again last year, the budget freeze left it in the cold.

▶ The Ocean Topography Experiment, a joint US–French satellite to study the surface of the world's oceans. TOPEX, which is marked for $29 million, is NASA's only new start in 1987. Because it will be in a design and planning stage the first year, it should not be affected by the troubles that afflict NASA as a result of the Challenger space shuttle explosion on 28 January.

Despite the tensions between the Administration and Congress over the rest of the 1987 budget proposals and the enthusiasm on Capitol Hill for another budget freeze this year, chances appear good that the new starts will win approval. But some ominous signs of trouble and pain are evident. If past years are any guide to the way Congress will deal with the new budget, it will reduce the totals proposed for military R&D, particularly for Star Wars projects and possibly for chemical-warfare and antisatellite tests, and boost the budget for biomedical research. In the wake of the Challenger calamity, it is already debating whether to realign NASA's budget request or simply provide supplemental funding for a new space shuttle. For a while, Senator Pete V. Domenici, a New Mexico Republican who heads his chamber's budget committee, endorsed the idea of replacing Challenger by re-budgeting $2 billion from NASA's $7.7 billion proposal for 1987. NASA would be unable to spend that amount to construct another orbiter to some new specifications in one year, however, and Domenici is now suggesting that $900 million be made available for a new space shuttle. Some members of Congress prefer to fund a new orbiter from the DOD budget. Support for another shuttle is strong in Congress, which believes it would be politically popular—a salient reason in an election year.

Another major project that vexes Congress is the Superconducting Super Collider. At a hearing before the House Science and Technology Committee on 5 March, Herrington explained that the DOE budget request carried no specific funding for SSC because he had not yet made a decision about its future. SSC's central design group would deliver a new report on the cost of additional R&D and construction by the end of April, he testified, and it would be the basis for another departmental review.

"We are at a decision point," said Herrington. "To further fund any more studies or investigations into it, I think, would not be money well spent. What we as a country need to do at this point is to decide whether we will move forward with approximately a $6 billion-plus program. I don't think we are prepared to do that yet. I don't want to give the impression that we think this is a bad idea. We like the idea of an SSC. It is strictly budget driven as to whether we can, with the best allocation of our funds, move with this project. The report will be important, but it doesn't appear to us to be good management to put any more money in the budget when we are at this point."

Representative Don Fuqua, Democrat of Florida, the committee chairman, asked if Herrington anticipated any construction funding for SSC in 1987. "No, sir," Herrington responded.

Fuqua: "Then that project, as it appears now, is on hold until budget constraints give some relief."

Herrington: "I think that is a good characterization. The only thing I would add is, if the report comes back and more R&D is needed, we can reprogram [DOE's research budget]. We are in a flexible position. We certainly don't want to give the impression that we're opposed to the project. On the other hand, we do not want to waste further funds at this time until we make a decision."

He added: "Many states have appropriated money to set up some sort of program on why [SSC] should be in their state.... The only decision that we have to make now as a country, as a Congress and as an Administration is, 'Can we afford $6 billion plus?' I think we are past the stage of asking, 'Can we do it?' The technology is there. We know how to do it and we can easily pick a place to do it. All we need to know is, can we afford ... to build it? Our judgment in the Administration ... is this is not the year. Do we soothe everybody's feelings by putting a little bit more money in to continue looking at it? I don't think we can afford it.... But we're ready for a decision."

House choice. The SSC issue was also addressed on 18 March when the House Subcommittee on Energy Development and Applications produced its markup of the DOE budget and proposed that the authorization bill of the House Science and Technology Committee should contain the following statement: "The committee is pleased with the excellent progress made by the central design group on defining the scope and cost of the SSC. It is the committee's understanding that the Secretary of Energy will decide during fiscal year 1986 whether or not to proceed with the construction of the SSC in fiscal year 1988 or fiscal year 1989. In the event that either the decision is made not to proceed ... or that there is no decision made during fiscal year 1986, the department is directed to cease all funding for the project in fiscal year 1987." Despite the draconian language of the statement, the members of the subcommittee took a milder tone during their colloquy on the subject. Harold Hansen, the committee's staff director, recalls that House members voiced concern about marking time from year to year waiting for a decision on SSC. "The report language should not be read as an indication the House is backing off," he says. "If another year of study is justified, the House would find a way to fund it."

The subcommittee also socked it to DOE's research functions. In keeping with an agreement between Fuqua and House Budget Committee Chairman William Gray III, a Democrat of Pennsylvania, energy research in the new budget would be reduced by at least $100 million. Gray had sought a $500 million cut in House appropriations for DOE's research program, but settled for less when Fuqua objected. If the subcommittee's report is adopted as written by the House Science and Technology Committee, DOE would be directed to lop $66.3 million from its supporting-research and technical-analysis programs, which would affect multiprogram laboratories such as Argonne, Fermilab and SLAC as well as basic-energy-science and instrumentation grants at universities.

The subcommittee recommends that DOE's request for $91.4 million to be spent in chemical sciences be upped by $5 million and that the proposed $44.3 million for applied mathematics be increased by $11.5 million. But beyond those two changes, the subcommittee provides no help in reallocating funds. Instead, after stating that the $66.3 million cut still leaves $474.7 million for operating costs and research equipment at the labs and universities—a decrease of $21 million, or 4.2%, from the current appropriations before the

NASA physics-related projects

	FY 85 actual	FY 86 approp (millions of dollars)	FY 87 request
Physics and astronomy			
Hubble Space Telescope development	195.0	127.8	27.9
Gamma Ray Observatory development	117.2	87.3	51.5
Shuttle–Spacelab payload development and mission development	105.4	108.3	115.1
Explorer development	51.9	50.7	56.7
Suborbital programs	58.7	63.5	64.4
Mission operations and data analysis	109.1	118.0	172.7
Research and analysis	39.9	51.5	51.1
Total physics and astronomy	**677.2**	**607.1**	**539.4**
Planetary exploration			
Galileo development	58.8	54.2	—
Magellan (formerly Venus Radar Mapper)	92.5	109.3	66.7
Ulysses (formerly International Solar-Polar Mission)	9.0	5.6	—
Mars Observer	13.0	37.8	62.9
Mission operations and data analysis	56.1	83.0	130.2
Research and analysis	61.5	62.9	63.5
Total planetary exploration	**290.9**	**352.8**	**323.3**
Space applications			
Solid Earth observations			
Laser-network operations	8.0	8.5	8.6
Shuttle-Spacelab payloads	12.1	23.1	21.6
Geodynamics	21.9	23.2	23.5
Research and analysis	15.6	20.1	20.4
Environmental observations			
Upper-atmosphere research and analysis	31.0	33.0	33.4
Atmospheric-dynamics and radiation research	28.5	30.3	30.9
Oceanic-processes research and analysis	19.4	20.6	20.8
Space-physics research and analysis	16.7	17.8	18.0
Shuttle–Spacelab instrument development	7.8	5.6	12.0
Earth radiation-budget experiment	8.1	2.0	—
Extended mission operations	29.5	37.0	33.6
Interdisciplinary research	1.0	1.0	1.0
Tethered satellite payloads	3.0	4.5	1.0
Scatterometer	12.0	14.0	35.9
Upper-atmosphere-research satellite	55.7	124.0	152.2
Ocean Topography Experiment	—	—	29.0
Materials processing in space	27.0	35.0	43.9
Communications	60.6	100.3	19.5
Information systems	16.2	18.7	21.2
Total space applications	**374.1**	**518.7**	**526.6**
Space station	**155.5**	**205.0**	**410.0**

Department of Defense research funding

	FY 85 actual	FY 86 approp	FY 87 request
	(millions of dollars)		
Basic research (6.1 category)			
Army			
Physics	21.1	25.1	23.4
Mechanics and energy conversion	16.7	19.6	18.6
Materials	17.1	19.1	17.9
Electronics	26.4	29.6	27.6
Mathematics and computer science	15.6	17.2	16.6
Earth sciences, including geophysics	7.2	7.9	7.7
Atmospheric sciences	9.0	9.6	9.0
Chemistry	25.3	27.5	26.7
Biological and medical sciences	52.6	59.8	50.7
Behavioral sciences	7.1	7.9	8.2
University research instrumentation	10.0	10.0	10.0
University Research Initiative	—	6.1	8.4
Army laboratories independent research	24.3	25.3	19.3
Total Army	**232.4**	**264.7**	**244.1**
Navy			
Physics, astronomy and astrophysics	40.6	50.4	48.3
Mechanics and energy conversion	35.3	31.6	31.0
Materials	30.8	31.1	34.5
Electronics	33.0	31.6	32.4
Oceanography	68.1	80.9	87.5
Mathematics and computer science	29.5	29.6	30.2
Atmospheric sciences	8.9	11.4	13.3
Chemistry	24.8	23.9	27.2
Biological and medical sciences	22.1	20.2	23.5
Behavioral sciences	12.8	12.1	11.9
University research instrumentation	10.0	10.0	10.0
University Research Initiative	—	6.2	12.1
Navy laboratories independent research	24.4	26.2	26.9
Total Navy	**340.3**	**365.4**	**388.8**
Air Force			
Physics, astronomy and astrophysics	27.8	29.2	29.2
Mechanics and energy conversion	36.6	41.2	42.7
Materials	22.1	24.3	26.5
Electronics	20.9	22.4	21.8
Mathematics and computer science	18.4	21.8	22.9
Earth science, including geophysics	2.8	3.0	2.9
Atmospheric sciences	11.8	13.7	13.4
Chemistry	20.6	22.1	23.7
Biological and medical sciences	9.8	10.1	9.8
Behavioral sciences	6.8	8.2	9.6
University research instrumentation	10.3	10.0	10.0
University research initiative	—	6.3	12.5
Air Force laboratories independent research	14.9	16.0	17.5
Total Air Force	**202.8**	**228.3**	**242.5**
Defense Advanced Research Projects Agency			
Electronics	22.5	22.8	25.2
Materials	16.2	17.6	24.3
Mathematics and computer science	28.3	30.4	29.9
Earth science, including geophysics	2.2	2.3	2.4
Behavioral sciences	12.2	14.4	14.1
University Research Initiative	—	6.0	12.5
DARPA laboratories independent research	—	1.7	2.0
Total DARPA	**81.4**	**95.2**	**110.4**
Total Department of Defense basic research	**856.9**	**1024.1***	**985.8**
Strategic Defense Initiative (6.2 and 6.3 categories)			
Surveillance, acquisition, tracking and kill assessment	546	857	1262
Directed-energy weapons	378	844	1615
Kinetic-energy weapons	256	596	1002
Survivability, lethality and key technologies	100	227	462
Systems concept and battle management	108	222	454
Management support	9	13	17
Total SDI	**1397**	**2759**	**4812**

*After Gramm–Rudman–Hollings reduction, total DOD-funded basic research was cut to $966 million. But because the Army transferred in-house salary costs in 6.1 to another budget category in 1986, some $40 million has been added to that department's basic-research program. DOD's basic-research program for fiscal 1986 thus amounts to $1.0 billion, the highest total ever.

GRH reduction and of 9.5% from the department's request of $524.5 in the new budget—the House members leave it to DOE's discretion "to assure that the funds not explicitly identified by the committee may be used for the remaining highest-priority programs."

Lab effects. To make matters worse, the subcommittee would also require DOE to whack about $140 million, or 18.1%, from the proposed 1987 budget figure of $773.4 million for general science and research programs—specifically from high-energy- and nuclear-physics projects, which include completion of Fermilab's proton–antiproton colliding-beam facility, the Stanford Linear Collider and Brookhaven's AGS accumulator–booster. If that $633.7 million figure remains in later iterations of the DOE budget, general science and research will be reduced by $27.7 million, or 4.2%, below the enacted appropriation this year before GRH.

Reductions of such enormity from laboratory budgets would be devastating, the House Science and Technology Committee was told on 5 March. Burton Richter, director of SLAC, a single-purpose lab entirely supported by DOE and serving nearly 1000 physicists and graduate students, spoke of delays in completing and testing the new SLC facility by September, as originally planned. First it was Gramm–Rudman–Hollings cuts and now it appears the 1987 budget may stretch the schedule further, said Richter. If SLAC had to cope with a budget at the current level, said Richter, "we would operate SLC but not much of anything else. We would have to shut down SPEAR [the 3.7-GeV colliding-beam storage ring] and PEP [the 17.5-GeV collider] for a full year and lay off about 200 people—and more if the budget were lower."

A similar horror story was told by Leon Lederman, director of Fermilab, which is used by physicists at some 70 universities. Before the GRH reduction, "Fermilab was riding the crest of great expectations following the technological success of the Tevatron," he said. "After seven years of prodigious and gifted human effort and after expenditure of $350 million, we are on the threshold of scientific exploitations with immense potential for progress and discovery." The cut of $7 million last February forced a slowdown of Tevatron I (the $p\bar{p}$ collider), staff reductions of about 80 people and delays in using the new detectors. "What the Congress and Administration will accomplish if the Gramm–Rudman process is triggered or the budget request is seriously lowered is to convert a successful program into one full of uncertainties, pain and frustration," said Lederman. "History will surely deal severely with the authors of this change, with its unconscionable waste of human and financial capital."

The Energy Department's science budget is the first to undergo the scrutiny of an authorizing committee of Congress, though it still must go through several stages before passage. The budgets of NSF, DOD and NASA have even longer ways to go. But if the agonies of DOE's budget request are any portent of things to come, these will be hard times for science research.

—Irwin Goodwin □