

With the First Balanced Budget in Three Decades, Clinton's R&D Spending Plan Looks Great, But . . .

Five weeks after President Clinton presented the first budget in nearly 30 years that is actually balanced, Congress started work on its own tax and spending plans for fiscal 1999, which begins on 1 October. However, there appears to be little hankering among the leaders of either political party to venture much beyond Clinton's budget request, except on such domestic issues as highway construction and water projects, which appeal to Republicans and Democrats alike as goodies for their own state or district. Instead, the leaders seem content to let incumbent members return home as much as possible to campaign for reelection and to bask in their high approval ratings.

"Congress is required to enact 13 appropriations bills each year, but this year it seems to prefer to do as little else as possible," says Norman Ornstein, resident scholar at the American

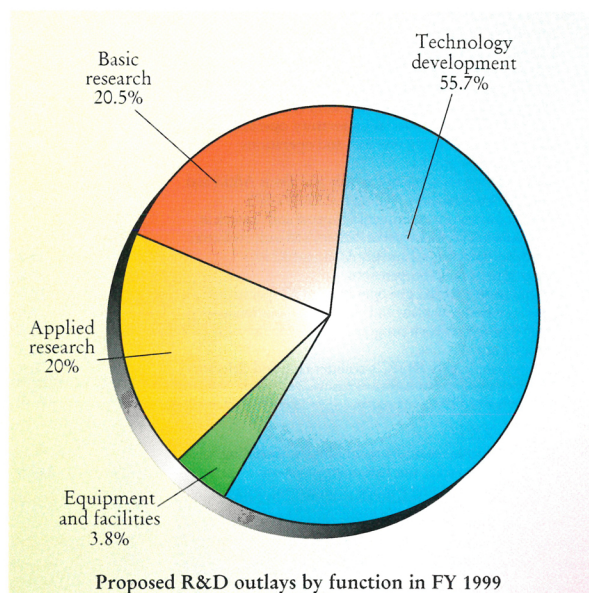
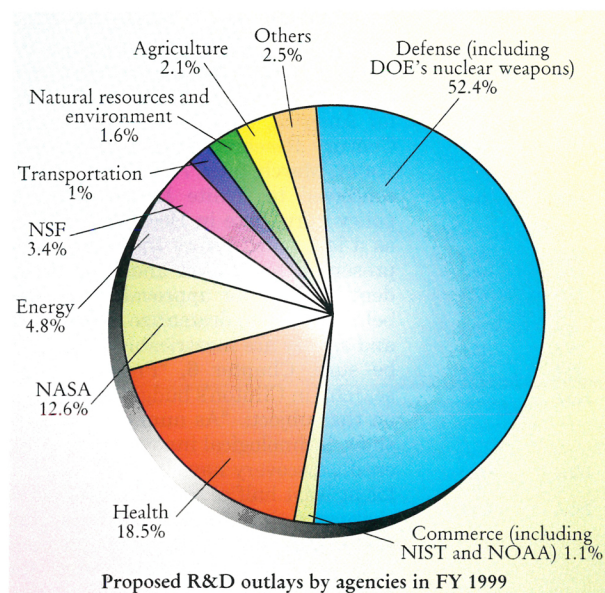
Enterprise Institute in Washington and a keen analyst of Capitol Hill behavior. Senator Richard Durbin, an Illinois Democrat, observes that the second session of the 105th Congress is operating "in slow motion."

The torpid pace of Congress is especially obvious in comparison to the frenzy of the 104th Congress, when Republicans were eager to make good on the campaign promises set forth in their "Contract with America" and confront a President weakened by the loss of his party's majority in the House. This year, Congress is almost certain to pass a budget resolution that deviates only slightly from last summer's agreement on spending limits and a balanced budget. Lawmakers clearly understand that an increase in any of the spending caps will come at the expense of other domestic discretionary accounts—namely, one-third of the \$1.7 trillion budget that includes R&D

activities, education and defense programs, for instance, but excludes entitlements such as Social Security and Medicare.

Clinton's fiscal plan presumes that this year's spending accounts not only will be balanced but will show at least an \$8 billion surplus. Congress's reaction to the surplus marks the opening of a new phase in the budget wars—an end to the battles of the past two decades in which budget deficits largely defined the political parties.

White House budget experts express undiluted optimism. "Our hope is that unlike the past, where we always were uncertain about the future, we've now got agreement. We and Congress have a blueprint . . . that provides for stability and predictability in our science and technology budgets," said T. J. Glauthier associate director of the White House Office of Management and Budget, at a 4 February



How research funds would be divvied up in Clinton's budget! The Clinton Administration's budget would authorize allocating \$78.2 billion for R&D in fiscal 1999, \$2 billion (or 2.6%) more than this fiscal year. But actual spending outlays are figured at \$76.4 billion, which is a tidy \$2.58 billion (or 3.5%) more than Congress had appropriated for the current fiscal year. Of the total anticipated outlays next year, more than half, \$40 billion, would be spent for defense R&D—only 1% more than this fiscal year's expected expenditures. Civilian R&D would rise \$2.15 billion to a record \$36.4 billion, or 6% above the current spending estimate. Though the pie charts for fiscal 1999 don't show most of the nondefense slices growing much fatter than last year's diagram, projections for next year call for slightly bigger pieces for the National Institutes of Health, the Energy Department's science programs and the National Science Foundation.

Under the President's budget, basic research would increase 9% over this year's outlays, to \$15.8 billion, of which \$14.7 billion is designated for civilian spending. Applied research would go up 5% to a tad less than basic science. Meanwhile, R&D support to university scientists and engineers would rise 8%, to \$13.45 billion. If outlays for testing and development are removed from the proposed budget, particularly from the Pentagon's account, outlays for Federal science and technology would come to about \$45 billion, an amount suggested by a National Academy of Sciences report in 1996 as an alternative measure of the government's true investment in research.

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Department of Energy physics-related activities

	FY 97 actual	FY 98 request	FY 98 current	FY 99 request
(millions of dollars)				
Science research and technology				
High-energy physics				
Physics research				
Fermilab	9.7	10.0	10.0	9.7
SLAC	11.0	10.3	11.8	11.8
Brookhaven	7.6	7.7	7.6	7.7
Lawrence Berkeley	10.1	10.1	10.3	10.5
Argonne	5.6	5.6	5.5	5.6
Universities and other laboratories	95.6	97.1	97.0	101.5
Total high-energy physics research	139.5	140.8	142.1	146.9
Facility operations, including personnel and power costs				
Fermilab	183.8	197.2	192.5	209.8
SLAC	94.3	103.5	111.5	115.5
Brookhaven	58.2	57.8	56.3	43.3
Universities and other laboratories	12.2	9.5	8.3	8.3
Large Hadron Collider (to be built at CERN)	2.4*	35.0	35.0	65.0
Waste management activities**	—	5.0	5.0	5.0
Technology R&D for existing and proposed facilities	67.9	62.4	64.3	61.7
Small business research program	—	10.9	13.9	14.6
Capital equipment and construction, including plant projects, completion in FY 1998 of Fermilab main injector and C-Zero experimental hall and SLAC master substation upgrade; continuation of Fermilab NuMI*** project and initiation of Fermilab's Wilson Hall improvement	100.0	50.9	50.9	21.0
Total high-energy physics program	658.2	673.0	679.7	691.0
Nuclear physics				
Low-energy nuclear physics				
Radioactive ion beams at Oak Ridge National Laboratory	12.3	12.3	13.7	14.4
University research	9.5	9.0	9.4	9.6
National laboratory research at Sudbury Neutrino Observatory, a joint US-Canada-Britain project	3.4	3.7	3.5	3.1
Nuclear data activity at Brookhaven	4.8	4.9	4.9	4.9
Small business research program	0.0	0.0	0.8	0.8
Lawrence and Fermi awards to nuclear scientists	0.3	0.3	0.3	0.3
Medium-energy nuclear physics				
University research	11.3	11.6	11.8	11.9
National laboratory research at DESY in Germany, Brookhaven's laser electron gamma source and AGS and Los Alamos's Anderson Meson Facility	14.4	14.6	15.3	14.0
Thomas Jefferson National Laboratory (CEBAF) research	25.1	24.9	28.3	28.6
Thomas Jefferson National Laboratory operations	42.7	42.0	39.8	41.5
MIT Bates Laboratory research and operations	17.9	18.2	18.3	16.6
Heavy-ion nuclear physics				
University research, mainly at Yale and Texas A&M and use of Brookhaven's AGS and CERN's SPS	16.4	16.3	16.5	16.7
National laboratory experimental support and research at Argonne's ATLAS, Lawrence Berkeley's 88-inch cyclotron and Brookhaven's Tandem AGS and RHIC	34.7	35.9	36.0	40.2
National users facilities operations	20.6	17.8	17.9	18.2
Brookhaven's RHIC pre-operations and operations	11.0	19.0	19.0	67.7
Lawrence Berkeley plant and equipment maintenance	5.5	5.5	5.5	5.5
Small business research program	0.0	0.5	0.7	2.1
Nuclear theory	15.2	15.3	15.3	15.6
Construction, largely RHIC's collider ring and detectors	65.0	76.0	59.4	16.6
Total nuclear physics	310.0	327.0	320.7	332.6
Energy supply R&D				
Solar and renewable resources technologies, including photovoltaic and solar thermal energy systems	243.8	342.5	272.2	372.3
Nuclear energy, including isotope production, reactor research and advanced radioisotope power systems	233.8	301.1	266.6	325.8
Fusion energy sciences				
Research program, including tokamak and alternative concept experiments, theory, plasma science and design of International Thermonuclear Experimental Reactor	94.8	93.9	99.8	110.5
Facility operations at Princeton Plasma Physics Laboratory, General Atomics and MIT; also shutdown of TFTR in FY 1997	61.4	63.8	55.1	61.0
Engineering and materials research and technology	62.3	67.3	67.8	50.0
Program direction	8.4	—	6.9	6.7
Adjustments from Energy supply R&D reductions	(2.1)	—	(0.7)	—
Total fusion energy sciences	224.8	225.0	229.0	228.2
Basic energy sciences				
Materials sciences research, including condensed matter physics, metals and ceramics, and materials chemistry	169.2	192.9	195.9	189.1
Small business research program	—	—	9.3	9.9
Congressional direction for three universities	7.3	—	—	—
Chemical sciences research, including atomic, molecular and optical physics	124.9	130.3	128.9	137.5
Small business research program	—	—	4.5	4.7
Congressional direction for three universities	5.4	—	—	—

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briefing on the R&D portion of the new budget. What's more, Glauthier predicted that in fiscal 1999 the surplus might mount to \$9.45 billion, which would be more than enough, he thought, to cover any new R&D programs that year.

But Congress has other ideas about such great expectations. "The funds are expected to be there, and we have a lot of unmet needs," says Thad Cochran, the second-ranking Republican on the Senate Appropriations Committee. "It's taken us a while to get to this point, and we're not going to pass it by." Cochran's more influential colleague, Pete Domenici, the New Mexico Republican who heads the Senate Budget Committee and sits on the Appropriations Committee, insists that Congress will not bust the caps on discretionary spending this year. "For our part, we will live up to last year's agreement with the President," says Domenici.

Indeed, when Clinton's budget request hit the desks of Congress in February, many Republicans proclaimed that the era of big government had returned, despite the obituary on the subject delivered last year by the President. Many of the Republican concerns in Congress centered on Clinton's proposed \$150 billion in new initiatives, which includes a novel concept, the multiagency Research Fund for America, also known as the 21st Century Research Fund (see PHYSICS TODAY, March, page 71). The fund was conceived by White House domestic policy gurus late in December, almost as a last touch before the budget was presented to Clinton and Vice President Al Gore for approval. The idea behind it was to dramatize that science and society are inextricably linked. To be sure, Chapter 6, "Promoting Research," in Clinton's budget is euphoric on the subject: "As numerous studies show, technological innovation and scientific discovery have been responsible for at least half of the nation's productivity growth in the last 50 years, generated millions of high-skill, high-wage jobs, and substantially improved the quality of life in America. . . . No other country in history can match America's record of achievement in science and technology."

In the usual Washington custom, the research fund has already been given the alphabetical nickname of RFFA (pronounced "riffa"). RFFA isn't a fund at all, but a conglomeration of programs from just about all the Federal agencies engaged in R&D. It excludes R&D in the Department of Defense and in the nuclear weapons activities at the Department of Energy, as well programs such as NASA's international space station and DOE's

nuclear power and waste management. In this respect, RFFA is an offshoot of the recommendation made in the 1996 National Academy of Sciences report "Allocating Federal Funds for Science and Technology." That report declares that nonmilitary science and technology budgeting ought to be viewed by the White House and Congress as a constellation, not a patchwork, as is now done in Washington (see PHYSICS TODAY, February 1996, page 47). The budget for civilian science and technology, says the academy report, "should be sufficient to serve national priorities and foster a world-class scientific and technical enterprise."

Spending programs within RFFA total \$31.1 billion for fiscal 1999, and R&D programs outside the fund come to another \$6.8 billion. But the balanced budget act puts a spending cap on research-related expenditures at \$27.8 billion for 1999. The difference between the cap and all R&D spending would be offset, according to Clinton's budget, by \$5.6 billion in receipts from a proposed tobacco tax and the elusive settlement by tobacco companies, as well as from an optimistic projection of increased personal and corporate taxes resulting from this year's rollicking economy and stock market. As a consequence, a balanced budget, once considered a distant if not politically unreachable object, now appears to be in sight—four years sooner than had been projected as recently as last year. The proposed budget assumes that Federal spending will be 20.1% of GDP in 1999, even with the new initiatives—below the 22% average during the Reagan and Bush presidencies, but considerably higher than in 1965, when all Federal expenditures represented 17.6% of GDP, even though Lyndon Johnson was budgeting programs for his Great Society.

Some Republican leaders, like F. James Sensenbrenner Jr, chairman of the House Science Committee, express doubts about Clinton's reliance on increased revenues from a tobacco tax or settlement and other receipts. "By spending money that may not exist, the President is putting funding for his new focus on science in jeopardy," says Sensenbrenner. Indeed, if the money does not materialize, budget increases for R&D would need to come in the form of revenue offsets from unspecified sources.

White House officials claim the offsets will still leave R&D spending below the cap. However, Republicans in Congress are torn between, on the one hand, bashing Clinton for proposing to break the cap and, on the other hand, going on an election-year spending spree of their own. To pass the legis-

Department of Energy physics-related programs, continued

	FY 97 actual	FY 98 request	FY 98 current	FY 99 request
		(millions of dollars)		
Engineering and geosciences, including climate change technology initiative	40.9	41.4	41.2	44.4
Energy biosciences	27.3	27.5	27.4	32.5
Construction and facility improvements	11.5	11.0	7.0	132.4 [†]
Major user facility operations				
National Synchrotron Light Source, Brookhaven	27.4	30.6	31.0	32.6
High Flux Beam Reactor, Brookhaven ^{††}	34.5	25.4	22.9	22.9
Intense Pulsed Neutron Source, Argonne	10.7	11.6	11.2	11.9
High Flux Isotope Reactor, Oak Ridge	27.4	27.8	33.8	29.1
Radiochemical Engineering Development Center, Oak Ridge	6.7	6.7	6.7	7.1
Stanford Synchrotron Radiation Laboratory	20.6	21.0	21.3	21.9
Manuel Lujan Jr Neutron Scattering Center, Los Alamos	7.3	7.7	6.6	7.5
Combustion Research Facility, Sandia—California	5.3	5.2	5.2	5.1
Advanced Light Source, Berkeley	32.9	35.0	30.7	31.6
Advanced Photon Source, Argonne	81.4	84.7	82.4	87.3
Spallation Neutron Source, Oak Ridge	—	—	—	28.6
Congressional offsets applied to basic energy sciences	2.0	—	1.5	—
Total major user facilities	256.2	256.0	253.3	285.6
Computational and technology research				
Mathematical, information and computational sciences	114.8	152.5	127.2	141.3
Laboratory technology research	23.7	15.8	15.8	16.3
Advanced energy projects	11.4	7.6	7.6	3.0
Energy research analyses	2.0	1.5	1.5	1.0
University and science education	—	—	—	15.0
National Renewable Energy Laboratory	3.3	2.8	3.2	5.0
Weapons activities (defense programs)				
Weapons stockpile stewardship				
Core stockpile operations and maintenance, including physics, chemistry and materials science and Accelerated Strategic Computing Initiative (ASCI)	1224.3	1158.3	1379.9	1621.4
Inertial confinement fusion (ICF)				
Target physics, theory and modeling	83.2	86.7	99.3	124.0
Target development, fabrication and handling	29.7	30.7	30.0	28.4
Laser and optics technology development	51.2	55.1	46.5	50.3
National Ignition Facility design and development	59.2	31.3	31.3	6.8
Advanced driver development	8.8	8.6	5.4	0.0
Other ICF activities	2.4	4.6	3.1	4.3
National Ignition Facility construction	131.9	197.8	197.8	284.2
Total inertial confinement fusion	366.5	414.8	413.5	498.0
Technology partnerships (Cooperative Research and Development Agreements or CRADs)	59.4	55.0	55.9	60.0
Education, mainly collaborations among weapons laboratories, industries and universities	10.0	10.0	8.9	9.0
Total stockpile stewardship	1660.2	1638.1	1858.2	2188.4
Stockpile management				
Core stockpile operations and maintenance	1478.1	1444.3	1520.7	1664.7
Enhanced surveillance and evaluation	53.8	60.0	46.1	67.3
Advanced manufacturing, design and production	57.6	103.2	73.3	62.6
Radiological/nuclear accident response	79.6	79.3	78.8	77.6
Tritium source for weapons	150.0	184.5	260.9	157.0
Materials storage, safeguarding and disposition	109.8	107.0	61.4	21.9
Total stockpile management	1928.9	1978.3	2041.1	2051.1
Program direction	325.6	303.5	250.0	260.5
Total weapons activities	3914.6	3919.9	4149.3	4500.0
Fissile materials storage and disposition	100.2	103.8	99.5	164.4
International nuclear safety, including Chernobyl	81.0	81.0	35.0	35.0
Arms control and nonproliferation, including international security, export control and accounting	216.2	234.6	234.6	256.9
Environmental restoration and waste management (nondefense)	571.6	682.4	494.0	462.0
Environmental restoration and waste management (defense)	4397.9	5218.2	4296.5	4259.9

*In FY 1997, \$12.6 million was spent on R&D for the LHC in the high-energy technology activity. The LHC now has a line item of its own.

**Waste management in FY 1997 was funded in DOE's environmental management program.

***NuMI stands for Neutrinos at the Main Injector, a new project to study the properties of neutrinos (in the energy range of 1 GeV to 40 GeV) in detectors at Fermilab and at the Soudan Underground Laboratory in Soudan, Minnesota.

[†]The large funding increase in FY 1999 represents \$128.4 million to begin construction of the \$1.33 billion Spallation Neutron Source at the Oak Ridge National Laboratory. When completed in 2005, the machine will provide a short-pulse spallation source for high-flux neutrons for research in the physical, chemical, materials, biological and medical sciences. In addition, \$28.6 million would be spent in FY 1999 for R&D to support construction; in prior years, R&D was funded by the materials sciences section of basic energy sciences.

^{††}The HFBR was shut down for normal refueling in December 1996 and remains in standby while the Energy Department evaluates the extent of tritium leaks from its spent fuel pool that may be contaminating ground water south of the reactor. Because the HFBR contains radioactive fluids in its primary cooling system, nearly a full staff is needed to maintain the reactor and associated equipment.

National Science Foundation physics-related programs

	FY 97 actual	FY 98 request	FY 98 current	FY 99 request
(millions of dollars)				
NSF total	3298.9	3367.0	3429.0	3773.0
Mathematical and physical sciences				
Physics research, project support	99.2	103.8	104.7	114.0
Physics facilities, user support, including Cornell Electron Storage Ring (CESR)	39.4	44.4	43.8	57.9
Total physics research	138.6	148.2	148.5	171.9
Chemistry research, project support	111.5	118.0	113.1	123.4
Instrumentation and infrastructure	22.2	17.4	22.5	24.6
Total chemistry research	133.7	135.4	135.6	148.0
Materials research, project support	86.8	88.4	89.8	98.9
Materials research science and engineering centers	57.7	58.9	58.4	60.7
National facilities and instrumentation	40.5	38.9	38.5	40.4*
Total materials research	185.0	186.3	186.6	200.0
Astronomy research and instrumentation	41.9	46.0	45.4	50.9
Astronomy facilities**	71.7	72.8	72.4	77.1
Total astronomical sciences	113.5	118.8	117.8	128.0
Mathematics research, project support	72.3	74.0	70.2	79.1
Infrastructure, including increased support for Mathematical Sciences Institutes in FY 1999	20.6	23.0	27.0	35.0
Total mathematical sciences	92.9	97.0	97.2	114.1
Multidisciplinary research project support***	29.8	30.0	30.0	30.0
Total mathematical and physical sciences	693.5	715.7	715.7	792.0
Major research facilities and equipment				
Laser Interferometer Gravitational Wave Observatory†	55.0	26.0	26.0	0.0
Millimeter Array	—	9.0	9.0	9.0
Large Hadron Collider (to be built at CERN)	—	—	—	22.0
Gemini telescopes††	0.0	0.0	4.0	0.0
South Pole station	21.1	25.0	70.0	22.0
Polar support aircraft upgrades	—	—	—	20.0
Polar Cap Observatory	—	—	—	21.0
Total major research facilities and equipment	76.1	60.0	109.0	94.0
Geosciences				
Atmospheric research, project support	89.4	90.5	93.0	102.4
National Center for Atmospheric Research	60.7	60.8	60.8	67.8
Earth sciences research, project support	58.2	58.6	58.6	65.8
Continental dynamics	8.4	8.5	8.5	9.5
Instrumentation and facilities	27.7	28.0	28.0	31.4
Ocean sciences research, project support	113.2	112.2	112.2	127.5
Oceanographic centers and facilities	46.9	52.3	52.3	57.0
Ocean drilling program operations	39.9	41.8	41.8	45.9
Total geosciences	444.3	452.6	455.1	507.3
Computer and information science and engineering				
Computer-communications theory and research	55.7	46.4	60.7	67.5
Information and intelligent systems	34.6	39.9	39.9	46.7
Experimental and integrated activities, including network applications for the Next Generation Internet	56.0	62.3	60.7	72.2
Advanced computational infrastructure and research	76.9	80.0	76.9	81.6
Advanced networking infrastructure and research, including research on the Next Generation Internet	50.0	52.3	46.1	63.1
Total computer and information science and engineering	273.0	280.8	284.2	331.1
Education and human resources	619.1	625.5	632.5	683.0

*NSF's materials research division will provide \$1 million to the Department of Energy for continued planning and development of the proposed Spallation Neutron Source.

**Facilities include National Radio Astronomy Observatory, National Astronomy and Ionospheric Center and National Optical Astronomy Observatory.

***Initiated in FY 1994, this program supports particularly novel, irregular or intricate research and education projects that are sometimes deferred or rejected for existing institutional and procedural reasons. While the program may involve two or more divisions in mathematical and physical sciences, it can reach out to other NSF activities and to university and industrial communities. For example, it engaged the Department of Energy in environmental molecular science and has a partnership with the Defense Advanced Research Projects Agency in thin films.

†FY 1998 funding for LIGO completed the appropriation for its construction at a total cost of \$271.9 million. Support for LIGO operations began in FY 1997 through the physics division, which also provides support for detector R&D. The project, which consists of two L-shaped interferometers—one being built at Hanford in the state of Washington, the other in Livingston Parish, Louisiana—is on schedule and on budget, with first scientific observations planned for FY 2001.

††The Gemini project consists of twin 8-meter telescopes, now being built in Hawaii and Chile, in an international collaboration with Argentina, Brazil, Britain, Canada and Chile. The US is contributing 20% of the total cost of the two telescopes. The US amount is \$92 million—all of this appropriated by Congress in previous years. The FY 1998 appropriation covers technological enhancements and contingency funding.

lative "pork" that benefits their congressional districts, they know they might have to also ignore the caps. An example of this has already occurred. It is the massive \$214 billion bill the Senate passed by a lopsided vote of 96 to 4 on 12 March to pay for highways, bridges and urban transit systems. Money for such construction will need to come from the transportation section of the discretionary spending account, which also is tightly capped.

The DOE budget faces a more direct hit. The issue was explained by Domenici and Zach Wamp, a Tennessee Republican who serves on the House Appropriations Committee, to a roomful of scientists attending a Spallation Neutron Source conference in Washington on 3 March. Each lawmaker warned that the facility proposed for Oak Ridge National Laboratory may not receive the full \$157 million in fiscal 1999 because Congress needs to continue funding about 50 Army Corps of Engineers water projects that were approved last year. These projects alone will account for roughly \$1.3 billion of the 1999 energy and water development appropriation bill, which also funds DOE research programs. "The truth is," said Domenici, "it is almost impossible to cut spending on a water project once it's started."

DOE, which was targeted for extinction by House Republicans just two years ago, would receive a \$213 million increase in its civilian research account, bringing its total for such programs to \$2.7 billion. Much of the increase is designated for the \$157 million down payment to begin building the neutron source at Oak Ridge and \$338 million would go toward energy efficiency and renewable energy activities designed to ward off global climate troubles. The department also would spend \$65 million in 1999 for its participation in CERN's Large Hadron Collider, a \$30 million jump over 1998. However, the fusion energy program would take a small hit, down less than 1%, to \$228 million. Academic research under DOE auspices is projected to go up from \$598 million this year to \$617 million in 1999. This funding supports research in physics, environmental science, computer science, engineering, materials science and chemistry.

Overall funding for the National Institutes of Health once again would get more than a \$1.2 billion boost, or 8%. NIH accounts for fully half of the entire increase for civilian R&D. The new funds are designated to support a wide range of programs, including research on diabetes, brain disorders, cancer, drug demand reduction, genetic medicine, disease prevention strategies, and development of an AIDS vaccine.

The National Science Foundation, which funds nearly half of the nonmedical basic science conducted at academic institutions, would get a 10% increase, or \$344 million more than its current appropriation, principally for information technology, global change and environmental programs. Peer-reviewed research at colleges and universities is projected to increase by 12% in 1999.

The Pentagon's R&D funding would slip 1% to \$37 billion, with the entire decline attributable to decreases in weapons research, development and testing. DOD's basic research component would go up by 6.6%, to \$1.1 billion, and applied research would rise 5%, to \$3.1 billion. In addition to funding in-house laboratories, such as the venerable Naval Research Laboratory, DOD research programs support computer science, mathematics, electronics and engineering at universities.

Not all R&D agencies are slated for increases in Clinton's budget, however. NASA's overall budget would decline \$173 million. As bad as that might seem, it's a lot better than the \$1 billion slash the White House had planned on making last November. Still, space science would increase by \$25 million and microgravity research would go up by \$28 million. The US contribution to the international space station is slated to dip 3.5%, to \$2.3 billion. Even if NASA transfers \$100 million from the science budget this year to pay for half of the \$200 million overrun in the space station, the space science budget will rise, says Dan Goldin, the agency's administrator. The trouble with this defense is that NASA has admitted that the space station will cost \$3.6 billion more than the original \$17.4 billion spending cap that Congress had placed on the project in 1993. The new \$21 billion estimate appears in NASA's budget document, which provides a cost accounting for the space station through 2004. The figures mark the first formal acknowledgment of the extent of the overrun and adds another uncertainty to Clinton's 1999 R&D budget. John McCain, the Arizona Republican who chairs the Senate Commerce Committee, which oversees NASA, has asked the General Accounting Office to provide Congress with a careful analysis of the expected total cost of the project.

Here are some highlights of the R&D budget by individual agency:

Department of Energy. Following the international agreement reached at Kyoto, Japan, in December 1997, the Administration proposes a new program of R&D to reduce greenhouse gas emissions. DOE is the lead agency for attaining higher energy efficiency and limiting carbon emissions

Department of Defense physics-related funding

	FY 97 actual	FY 98 request (millions of dollars)	FY 98 current	FY 99 request
Army				
Research sciences	117.0	138.2	121.8	137.4
In-house laboratory independent research	14.1	15.1	13.7	14.9
University and industry research centers	43.6	45.6	45.1	48.5
Total basic research (6.1)	174.8	198.9	180.6	200.8
Total applied research (6.2)	541.9	462.9	654.1	511.3
Navy				
Research sciences	331.4	366.3	324.5	347.9
In-house laboratory independent research	14.2	15.8	14.2	14.7
Total basic research (6.1)	345.6	382.1	338.7	362.7
Total applied research (6.2)	514.3	490.3	493.6	524.7
Air Force				
Total basic research (6.1)	182.1	226.8	196.3	209.4
Total applied research (6.2)	635.5	593.4	567.8	582.0
Defense-wide				
Research sciences	89.4	76.0	68.3	65.1
In-house laboratory independent research	3.1	2.2	1.5	2.2
University research initiatives	208.7	237.8	222.6	216.3
Gulf War illness research	—	—	—	19.6
Government-industry cosponsorship of university research	—	14.7	7.4	9.9
Chemical and biological defense programs	28.4	25.2	26.3	25.3
Total basic research (6.1)	329.5	355.9	326.2	338.4
Total applied research (6.2)	1130.1	1267.5	1280.6	1401.8
Total advanced technology development (6.3)	2070.7	—	2164.2	1726.6
Defense Advanced Research Projects Agency (DARPA)				
Total basic research (6.1)	89.4	80.9	68.3	65.1
Total applied research (6.2), including materials, electronics computing and Next Generation Internet	691.0	829.9	835.7	1013.1
Ballistic Missile Defense Organization (BMDO)	3360.3	2581.9	3281.7	3178.9
Applied research and support technologies (6.2)	122.2	101.9	109.6	86.9

NOAA physics-related programs

	FY 97 actual	FY 98 request (millions of dollars)	FY 98 current	FY 99 request
Oceanic and atmospheric programs				
Climate and air quality research				
Interannual and seasonal climate research, including El Niño-Southern Oscillation phenomenon	8.0	12.9	12.9	12.9
Long-term climate and air quality, including high-performance computing	35.9	36.9	36.9	42.9
Global Learning and Observation to Benefit the Environment (GLOBE) (NOAA-wide)*	6.0	7.0	5.0	6.0
Climate and global change (NOAA-wide)**	60.0	62.0	60.0	62.0
Atmospheric programs				
Weather research, including numerical modeling and forecasting	38.0	38.0	41.8	39.0
Solar-terrestrial services and research	5.5	5.5	5.7	6.0
Sea Grant college program	54.3	50.0	56.0	50.2
Undersea research program***	12.0	5.4	15.4	4.2
Acquisition of data	12.7	12.5	15.0	12.9

*This program is intended to increase the awareness and understanding of K-12 students in the US to climate and environmental phenomena and processes.

**In 1995, the House attempted to eliminate most of the funds in this program, but the Senate disagreed and placed funds for the program into climate and global change.

***After attempting to cancel this program for five successive years, NOAA has decided to continue the program, which Congress always funds anyway. Still NOAA seeks to decrease the program in FY 1999 by more than \$11 million.

National Institute of Standards and Technology program activities

	FY 97 actual	FY 98 request (millions of dollars)	FY 98 current	FY 99 request
Laboratory research and core services				
Physics	27.8	27.8	27.9	28.4
Materials science and engineering	50.9	50.9	50.9	51.3
Electronics and electrical engineering	35.8	38.1	35.8	38.6
Chemical sciences and technology	31.8	31.8	31.8	39.5
Computer science and applied mathematics	43.0	43.1	43.0	43.9
Research support activities, including postdoctoral fellows	28.6	28.6	28.6	29.2
Manufacturing engineering	18.9	18.9	18.9	19.4
Technology assistance	14.9	18.9	14.9	19.1
Building and fire research	13.4	13.4	17.2	16.7
Total laboratory research and core services	265.0	271.5	268.9	286.3
Advanced Technology Program (ATP)	218.0	275.6	192.5	259.9
Manufacturing Extension Partnership (MEP)	95.0	123.4	113.5	106.8

NASA physics-related programs

	FY 97 actual	FY 98 request	FY 98 current	FY 99 request
Space science and exploration				
Advanced X-Ray Astrophysics Facility (AXAF) development	184.4	92.2	95.8	—*
Space Infrared Telescope Facility (SIRTF) development	—	81.4	55.4	111.7
Gravity Probe-B (relativity mission) development	59.6	45.6	57.3	37.6
Cassini development	74.6	9.0	—	—
Thermosphere, Ionosphere, Mesosphere Energetics and Dynamics (TIMED) development	25.9	48.2	52.7	40.8
Payload and instrument development				
X-ray spectrometer on Japan's Astro-E mission	5.6	7.1	7.1	5.2
Remote sensing instruments on ESA's Rosetta mission	—	—	—	14.8
Cluster-II international solar-terrestrial mission**	—	3.3	3.3	5.0
Shuttle-international astrophysics projects, including Germany's ORFEUS extreme ultraviolet spectrometer and IMAPS interstellar spectrograph and ESA's INTEGRAL gamma ray astrophysics lab	11.3	5.2	7.6	4.4
Explorer series development				
Advanced Composition Explorer (ACE)	12.7	—	—	—
Far Ultraviolet Spectroscopic Explorer (FUSE)	26.0	26.8	22.8	2.6
Medium-class Explorers, including Microwave Anisotropy Probe (MAP) and Imager for Magnetopause-to-Aurora Global Exploration (IMAGE)	39.7	62.4	46.2	44.7
Small-class Explorers, including submillimeter wave astronomy satellite (SWAS), wide-field infrared Explorer (WIRE), high energy solar spectroscopic imager (HESSI) and galaxy evolution Explorer (GALEX)	18.0	37.8	17.8	2.3
University-class Explorers	1.8	4.2	1.3	0.4
HETE-II international study of high energy transient sources***	1.4	3.7	3.7	3.3
Explorer planning	17.9	6.0	21.7	61.0
Discovery series development				
Lunar Prospector	19.8	—	—	—
Stardust to collect dust from comet Wild-2	52.2	42.3	42.3	9.8
Genesis to collect charged particles in solar wind	0.3	31.4	31.4	49.4
Future missions	4.5	20.1	2.8	67.3
Mars Surveyor series development				
98 orbiter and lander	86.3	40.5	41.1	13.3
01 orbiter and lander	—	—	67.0	100.5
Future missions	3.7	64.2	37.1	50.2
Mission operations and data analysis				
Hubble Space Telescope operations and servicing	213.7	163.8	180.4	180.3
Hubble Space Telescope data analysis	40.9	45.7	39.5	45.6
International Solar Terrestrial Physics program	46.2	24.2	50.6	—
Compton Gamma-Ray Observatory	10.6	4.0	4.0	2.7
AXAF mission operations and data analysis	35.5	45.4	41.5	63.3
Galileo mission operations and data analysis	64.4	29.8	29.8	16.0
Cassini mission operations and data analysis	15.0	38.1	38.1	55.8
Mars Pathfinder mission operations and data analysis	9.6	5.8	4.4	—
Near Earth Asteroid Rendezvous (NEAR) operations	3.1	9.5	11.0	14.4
Lunar Prospector mission operations and data analysis	0.8	4.3	4.3	2.0
Stardust mission operations and data analysis	—	—	—	3.5
Mars Surveyor mission operations and data analysis	14.7	19.6	19.5	22.5
Jet Propulsion Laboratory flight support	42.9	36.6	36.6	35.8
Other mission operations and data analysis	99.1	80.6	68.8	84.5
Supporting research and technology				
Space science research and analysis	166.8	217.5	130.5	176.0
Space science technology	55.5	63.6	74.5	85.5
Cross-enterprise technology, including instrument-sensing telerobotics and communications-computing	132.0	130.5	126.3	129.3
Focused programs, including astronomical search for origins' and advanced deep space tech. development	26.7	151.2	170.7	153.2
Flight validation program (or New Millennium Program)	45.6	75.7	39.7	60.4
Suborbital program				
Stratospheric Observatory for Infrared Astronomy (SOFIA)	21.3	45.8	45.8	56.5
Balloon program	14.0	13.7	13.7	13.5
Sounding rockets	24.6	24.9	23.8	29.6
Launch services	240.6	236.3	215.9	203.5
Life and microgravity sciences and applications	243.7	186.9	214.2	242.0
Earth sciences (formerly Mission to Planet Earth)				
Earth Observing System (EOS), including Landsat-7	582.2	679.7	704.6	659.1
EOS data information system (EOSDIS)	234.6	244.7	209.9	256.6
Earth probes, including Total Ozone Mapping Spectrometer	61.8	40.7	48.6	85.9
Applied research and data analysis	393.3	325.3	364.4	365.4
Global Observation to Benefit the Environment (GLOBE)	5.0	5.0	5.0	5.0
Launch services†	84.7	121.9	34.8	—
Academic programs, including teacher enhancement				
Space station research and development	120.4	120.0	120.0	100.0
	2148.6	2121.3	2501.3	2270.0

from the four most carbon-intensive sectors of the economy—buildings, industry, transportation and electricity generation. For instance, the Partnership for a New Generation of Vehicles, a program created with the Big Three automobile companies to develop cars capable of three times the fuel efficiency of today's comparable vehicles by 2004, would go up \$50 million to a total of \$227 million. Most of the \$330 million increase in the department's defense research is for the Accelerated Strategic Computing Initiative, which is expected to result in the world's fastest supercomputers, with the largest memories, for the science-based stockpile stewardship program. The stewardship program seeks to maintain and test nuclear weapons without detonation, which complies with the Comprehensive Test Ban Treaty.

National Science Foundation.

With project support increasing 12%, to \$2.1 billion, the agency will be able, said Neal Lane, NSF's director, at his budget briefing, "to do more of what we already do well." The number of new grants in all six research directorates would rise by 6%, the average size of an award by 8% and their duration would extend from 2.4 years to 2.7 years. A prominent feature of the new budget are two topics dear to Clinton and Gore—education and information technology. NSF would receive \$25 million as part of a \$75 million initiative with the Department of Education to study how schools use personal computers and other educational technologies. The agency also would get \$25 million of the Administration's \$110 million Next Generation Internet project to connect more than 100 universities and national laboratories at speeds 100 to 1000 times faster than today's Internet. NSF also proposes to provide increases next year in programs to support undergraduate research, junior faculty and cross-disciplinary graduate training.

NASA. Despite the cut the space agency would receive in the R&D spending plan, \$2.1 billion, a 4% boost, would go into space science next year and another \$700 million would be allocated for the program over the next five years. The additional funds are expected to be used to initiate a new mission to Jupiter's moon Europa, a sample-return mission to Mars and a series of probes to study the Sun and its effects on the Earth. NASA also intends to develop new gamma-ray, x-ray and infrared telescopes that should help astrophysicists understand the final stages of a star's life, search out the most extreme environments in the universe and observe the early stages of galaxy formation.

IRWIN GOODWIN ■

*AXAF, the third of NASA's great observatories, was scheduled for launch in August 1998, but delays in development and testing, largely caused by budget cuts in Congress during fiscal 1994, resulted in setting the launch for an unspecified date in early fiscal 1999.

**Cluster-I was destroyed in the explosion of Ariane-5 launch rocket in June 1996.

***HETE-I was destroyed on launch in November 1996.

†The Origins program is intended to find answers to fundamental questions about the creation of the universe and planetary systems with such spacecraft as the Next Generation Space Telescope and the Terrestrial Planet Finder.

‡During preparation of the 1999 budget, NASA decided to transfer the cost of launch services to the flight projects that use the services, though EOS AM-1 and Landsat-7, which are scheduled for launch in 1998, are represented in that year's estimate.