War, Terrorism, and National Security Shape Bush R&D Budget in FY 2004; Civilian R&D Funding Flat

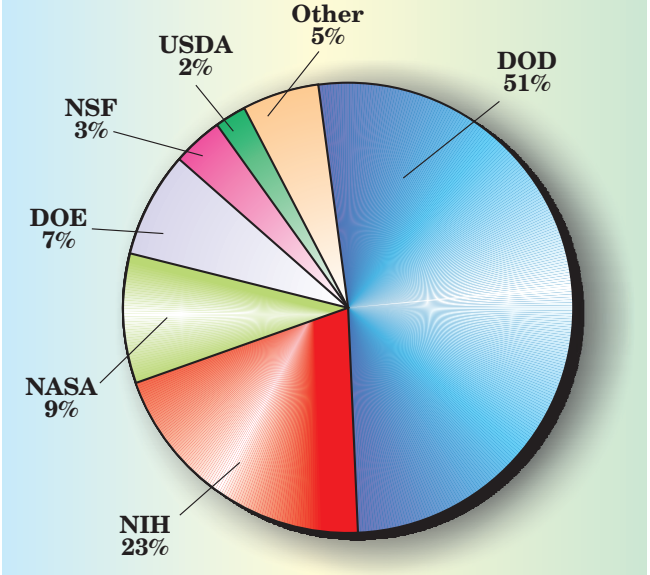
Nondefense physical sciences run a distant second to big increases in weapons development and homeland security in the administration's budget, and Congress is wondering what happened to money it authorized for NSF.

When the Bush administration unveiled its budget proposal last year, its first stated priority was "defeating terrorism abroad," and the second was "protecting the homeland." Accordingly, money flowed to the Department of Defense and to programs that would eventually become part of the newly forming Department of Homeland Security. All agencies, including those that supported science, were directed to shape their funding based on national security, an Office of Management and Budget official said bluntly.

Now, with the war in Iraq coming on the heels of the war in Afghanistan and the more general war on terrorism, national security has gained even more importance in the administration's FY 2004 budget proposal. Even without including the tens of billions of dollars that will be needed to cover the cost of the Iraqi war, the FY 2004 budget proposal-including the federal R&D budget—remains steeped in war and national security concerns. Indeed, a budget resolution passed by the House of Representatives in March carried the stark title: "The Fiscal Year 2004 Wartime Budget Resolution."

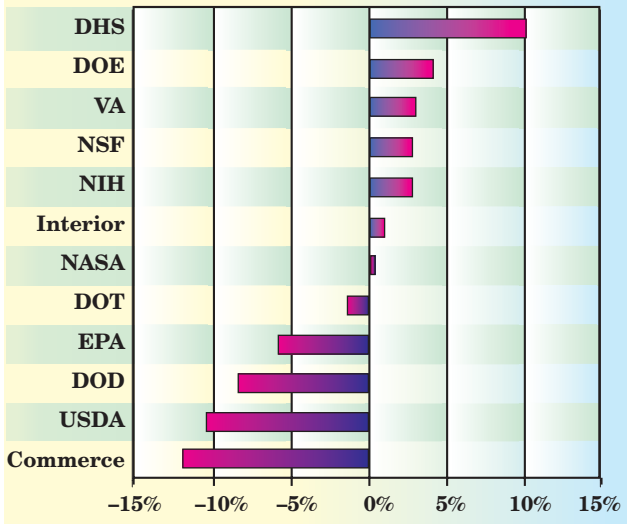
Overall, the FY 2004 budget calls for a record-setting $122.4 billion in federal R&D spending, up 4.4% from

Total R&D by Agency: FY 2004 Proposed



Where Bush's R&D money would go. The Department of Defense remains the largest recipient of federal R&D money in the administration's FY 2004 budget (up 7.1%, or $4.2 billion). Missile defense would increase 22% to $8.3 billion, and $4.4 billion would go to develop a new fighter jet. But basic (6.1) and applied (6.2) defense R&D money would actually fall 7.7% and 14.4% respectively. If the 2.7% proposed increase in the National Institutes of Health budget is taken out, non-defense R&D actually declines by 0.1%. Despite a congressional authorization bill that called for a $6.4 billion FY 2004 budget for the National Science Foundation, the administration has only requested $5.5 billion, a 3.2% increase. The Department of Energy, the major supporter of physical sciences, would receive a 4% increase in R&D money, but all of that would go toward the agency's defense activities. Funding for DOE's Office of Science would remain flat for the fourth year in a row. Of the multiagency initiatives, the major money would go to nanotechnology ($849 million, a 9.7% increase), and networking and information technology research and development ($42.2 billion, a 5.9% increase).

FY 2004 R&D Request: Percent Change from FY 2003



DHS, Department of Homeland Security. DOD, Department of Defense. DOE, Department of Energy. DOT, Department of Transportation. EPA, Environmental Protection Agency. NIH, National Institutes of Health. USDA, Department of Agriculture. VA, Veterans Administration.

Winners and losers in Bush's science funding. The war in Iraq, the war on terrorism, the weak economy, mammoth federal deficits, and the Columbia space shuttle disaster are all significant elements in the mural that serves as the backdrop for the administration's FY 2004 science funding proposals. The request for total R&D funding sets a record at $122.5 billion, 4.4% above the FY 2003 record-setting amount. Of that amount, $1 billion goes to the newly-created Department of Homeland Security, and another $62.8 billion goes to the Department of Defense. While the DOD increase is very big, all of the increase goes into developmental R&D for new weapons systems. Basic and applied research at DOD actually fall in the budget proposal. The five-year budget-doubling plan for the National Institutes of Health is complete, and the new five-year doubling plan for the National Science Foundation has stalled a bit. The administration continues to wage war on congressional earmarks, money aimed by Congress at specific projects, often without regard for merit. Research earmarks totaled $1.4 billion in FY 2003 and will probably reach that level again in FY 2004.

FY 2003's record R&D budget. But the wartime nature of the budget becomes apparent by noting where the increases are aimed. Defense R&D, at $62.8 billion, would total more than 50% of the entire federal R&D budget. According to an American Association for the Advancement of Science (AAAS) analysis, the DOD share "would surpass cold war funding levels at $62.8 billion [up 7.1%], with the entire increase for the development costs of new weapons and missile defense systems." Basic and applied research funding in DOD would actually decline significantly.

At the Department of Energy (DOE), defense R&D would increase 8.6% to $4.2 billion, primarily in funding for the National Nuclear Security Administration (NNSA). The new Department of Homeland Security (DHS), with a proposed budget of $36.2 billion, would have an R&D budget of $1 billion. Much of that research money would go to the newly created Homeland Security Advanced Research Projects Agency (HSARPA), modeled on DOD's DARPA.

Civilian R&D flat

In general, civilian R&D pays the price for the increases in national security R&D. Nondefense R&D would increase by only 1.2%, to $55 billion, in the administration's budget proposal. The National Institutes of Health (NIH), which completed a five-year doubling of its budget last year, would see a 2.7% increase this year. But as comparatively small as that is, the rest of the nondefense R&D budget is tiny enough that, if the NIH portion is removed, overall federal nondefense R&D would decline by 0.1%.

While the cost of war and national security will dominate the budget debate for the next several months, other significant issues—the large and growing budget deficits, the weak economy, and the loss of the space shuttle Columbia—will also influence how much money is available for R&D and where that money goes. In presenting the FY 2004 budget proposal to the House Committee on Science, Office of Science and Technology Policy Director John Marburger said it represented "some extraordinary new vistas of science with the potential to revolutionize our understanding and our capabilities. We cannot fund everything we'd like, but we will fund those exciting and high-priority initiatives that keep this dream of discovery alive."

Several committee members responded with concern about the lack of funding for basic research and, in particular, the flat funding proposed for DOE's Office of Science. Both Democratic and Republican members of the committee have strongly supported increases in science funding for the past few budget cycles, and Judy Biggert (R-Ill.) noted that "scientific research may not be as politically popular as health care and education, but it is as important to progress in these two areas as it is to ensuring America's economic, energy, and national security." Biggert has introduced a bill to increase proposed funding for the Office of Science from $3.3 billion in the Bush proposal to $3.6 billion.

Democrats not happy

The Democrats on the science committee were critical of the Bush R&D spending proposal, stating in their annual "views and estimates" report on R&D funding that the administration's request is "inadequate" and "irresponsible." The report, whose lead author is ranking committee Democrat Rep. Ralph Hall (Tex.) notes that DOE's civilian research programs and several agencies, including NIST and the National Oceanic and Atmospheric Administration (NOAA), face R&D cuts under the Bush proposal.

Citing the needs for more national security research, more investment in the physical sciences, and more funding at NASA because of the Columbia disaster, the Democrats called for an 8% to 10% increase in R&D funding in FY 2004. Without that level of funding, the report concluded, "it seems impossible to do the things we know

National Science Foundation R&D Programs

	FY 2002 actual	FY 2003 estimate	FY 2004 request	FY 2003–04 percent change
	(millions of dollars)*			
NSF total	4774	5310	5481	3.2
NSF R&D	3526	3927	4035	2.8
Research and related activities (R&RA)				
Mathematical and physical sciences (MPS)				
Mathematical sciences	152	178	202	13.1
Astronomical sciences	166	171	183	7.0
Physics	196	205	218	6.1
Chemistry	163	221	182	–17.7
Materials research	219	233	246	5.8
Multidisciplinary activities	25	27	31	16.8
Total MPS	920	1035	1061	2.6
Geosciences (GEO)				
Atmospheric sciences				
Atmospheric sciences research support	126	145	151	4.1
National Center for Atmospheric Research	76	74	79	6.7
Total atmospheric sciences	202	219	230	5.0
Earth sciences	126	152	144	–4.9
Ocean sciences	281	316	314	–0.7
Total GEO	610	687	688	0.1
Engineering	471	531	537	1.1
Biological sciences	510	571	562	–1.6
Computer and information science and engineering (CISE)				
Computer-communications research	70	77	76	–1.5
Information and intelligent systems	52	56	52	–5.7
Experimental and integrative activities	63	68	58	–15.5
Advanced networking infrastructure and research	70	75	68	–9.3
Advanced computational infrastructure and research	87	94	93	–1.3
Information technology research	174	209	218	4.2
Cyberinfrastructure	0	0	20	—
Total CISE	515	579	584	1.0
US polar programs				
Polar research	231	251	262	4.5
Antarctic logistical support	70	69	68	–0.6
Total polar programs	301	319	330	3.4
Social, behavioral, and economic sciences	184	191	212	10.9
Integrative activities	106	147	132	–9.9
Total R&RA	3612	4058	4106	1.1
Major research equipment and facilities†	139	149	202	36.2
Education and human resources‡	894	903	938	3.9
Salaries and expenses	170	193	226	17.2
Inspector general	7	9	9	–4.6

*Figures are rounded to the nearest million. Changes calculated from unrounded figures.

†Funding would continue for Atacama Large Millimeter Array ($51 million); EarthScope geophysical instrument array ($45 million); High-performance Instrumented Airborne Platform for Environmental Research ($26 million); IceCube ($60 million); Network for Earthquake Engineering Simulation ($8 million); National Ecological Observatory Network ($12 million); and South Pole Station Modernization ($1 million).

‡Includes flat funding for the Math and Science Partnership ($200 million) and the Experimental Program to Stimulate Competitive Research ($75 million). Elementary, secondary, and informal education would decrease 8% to $194 million; undergraduate education would increase 4.8% to $142 million; and graduate education would increase 22% to $157 million.

Department of Energy R&D Programs

	FY 2002 actual	FY 2003 estimate	FY 2004 request	FY 2003–04 percent change
	(millions of dollars)[a]			
DOE total	21 317	22 064	23 375	5.9
DOE R&D	8 078	8 205	8 535	4.0
Science R&D programs				
High-energy physics (HEP) total	697	725	738	1.8
Proton accelerator-based physics	388	388	399	3.0
Research	72	74	73	–2.1
University research*	44	46	45	–1.8
National laboratory research†	27	27	26	–2.8
University service accounts	1	1	1	0.0
Facilities	316	314	327	4.2
Tevatron operations and improvements	242	233	248	6.3
Large Hadron Collider project and support	54	67	64	–3.7
AGS operations	6	0	0	0.0
Other facilities	14	14	14	5.7
Electron accelerator-based physics	148	150	159	6.2
Research	30	33	34	1.7
University research‡	20	23	23	1.0
National laboratory research§	10	10	10	3.5
Facilities (B-factory operation and improvement)	118	117	126	7.4
Non-accelerator physics	39	37	43	14.9
University research	10	11	12	5.5
National laboratory Research‖	14	13	12	–8.5
Theoretical physics	43	42	42	–0.6
Advanced technology R&D (accelerators and detectors)	68	87	81	–6.6
Construction	11	20	13	–37.8
Nuclear physics total	351	382	389	2.0
Medium-energy nuclear physics	111	124	124	0.5
Research	31	38	37	–3.3
University research (includes 35 universities)	16	16	15	–0.9
National laboratory research (includes ANL, BNL, LANL, and TJNAF)	15	17	16	–6.6
Other research	0	5	5	0.0
Operations	81	86	88	2.0
Heavy-ion nuclear physics	151	168	168	–0.1
Research	30	36	35	–3.5
University research (includes 26 universities)	12	12	12	3.9
National laboratory research (includes BNL, LANL, LBNL, LLNL, and ORNL)	19	21	19	–11.0
Other research	0	3	4	18.6
Operations (primarily RHIC)	121	132	133	0.8
Low-energy nuclear physics	63	66	69	4.7
Research	40	42	46	9.6
University research (includes 32 universities)	17	18	18	4.1
National laboratory research (includes ANL, BNL, LANL, LBNL, LLNL, and ORNL)	20	20	23	16.0
Other research	3	5	5	3.4
Operations (ATLAS and HRIBF facilities)	22	24	23	–4.0
Nuclear theory	25	25	28	14.2
Fusion energy sciences total	241	257	257	0.0
Science	134	143	145	1.5
Tokamak experimental research	45	49	46	–4.7
Alternative concept experimental research	52	51	52	2.5
Fusion theory	28	28	29	3.3
General plasma science	8	9	11	22.0
Small business research	0	6	7	3.6
Facility operations#	71	79	88	11.5
Enabling R&D	36	36	25	–31.0
Basic energy sciences (BES) total	980	1023	1009	–1.0
Materials sciences	500	548	568	3.7
Chemical sciences, geosciences, and energy biosciences (CGEB)	200	220	221	0.4
National user facilities operations (funding is contained in the materials sciences and CGEB budgets)				
Advanced Light Source, LBNL	38	40	41	3.4
Advanced Photon Source, ANL	89	91	95	3.5
National Synchrotron Light Source, BNL	35	36	37	3.8
Stanford Synchrotron Radiation Laboratory	22	23	26	16.4
High Flux Isotope Reactor, ORNL	39	37	38	4.1
Radiochemical Engineering Development Center, ORNL	7	7	7	0.0
Intense Pulse Neutron Source, ANL	16	17	17	1.1
Manuel Lujan Jr Neutron Scattering Center, LANL	9	10	10	6.1
Spallation Neutron Source, ORNL	15	14	18	27.4
Combustion Research Facility	5	6	6	2.8
Construction**	279	252	220	–12.6
Adjustment	0	4	0	–100.0
Advanced scientific computing research (ASCR) total	150	172	173	1.2
Mathematical information and computational sciences	147	169	170	1.2
Laboratory technology resources	3	3	3	0.0
Biological and environmental research total	554	527	500	–5.1
Energy research analyses	1	1	0	–100.0
Small business innovation research	100	0	0	0.0
Energy supply R&D total	262	309	376	21.9
Renewable energy resources	219	240	250	4.3
Nuclear energy	42	69	127	82.8
Fossil energy R&D	446	483	411	–14.9
Energy conservation	434	427	442	3.6

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we need to do in R&D."

So the stage is set for a summer of Congress pushing for more funding for basic and physical sciences while the administration, faced with mounting deficits and a desire for higher tax cuts, tries to hold the line on spending. The following agency highlights indicate some areas of contention.

National Science Foundation. At first glance, the NSF budget seems to have done reasonably well in the FY 2004 proposal. Bush recommends a 3.2% overall increase for the foundation, an increase of $171 million over the substantial (10.9%) increase Congress gave NSF in FY 2003. And within the 3.2% increase, physics would receive a 6.1% boost to $218 million from current funding of $205 million.

So why did Senate Appropriations Committee Chairman Christopher Bond (R-Mo.) and the committee's ranking minority member Barbara Mikulski (D-Md.) use the words "paltry" and "disappointing" to describe the NSF proposal? Because the 3.2% increase would result in a total NSF budget of $5.5 billion, significantly less than the $6.4 billion authorized for FY 2004 in the NSF Authorization Act, signed by President Bush last December. The bill, widely supported in Congress, was intended to be the first step in a five-year plan to double NSF's budget.

Marburger cited the 10.9% FY 2003 boost in NSF funding by Congress as a reason the FY 2004 proposal was scaled back from the authorized level, and he noted that the NSF increase would still be higher than that for most other R&D agencies. The NSF doubling bill signed by the president resulted in part from a report by the President's Council of Advisors on Science and Technology (PCAST) that said funding for the physical sciences and engineering has not kept pace with that for the life sciences, particularly the large increases NIH has experienced in recent years.

"Given the record of recent years and with the newly enacted NSF Authorization Act, it is likely that Congress will again exceed President Bush's request in FY 2004," said Association of American Universities official Tobin Smith in his AAAS analysis of the NSF budget. The final resolution of the NSF budget debate is crucial to university-based researchers, Smith noted, because while NSF "represents less than 4% of the total federal budget for research and development, it supports roughly 50% of all non-medical basic research at colleges and universities."

Under the proposal, funding would be $1.1 billion, an increase of 2.6%, for NSF's mathematical and physical sciences directorate, which supports astronomical sciences, chemistry, materials research, mathematical sciences, physics, and multidisciplinary activities. The proposal says emphasis will be placed on particle and nuclear astrophysics, computational and information-intensive physics, quantum information science, biological physics, and advanced R&D toward next generation particle accelerators and gravitational wave detectors.

A new science and technology center focusing on biophotonics would be created under the proposal, and full funding would be available for continued operations of the Michigan State University National Superconducting Cyclotron Laboratory, and the Laser Interferometer Gravitational Wave Observatory (LIGO) in Louisiana and Washington State.

NSF also funds 29 materials research science and engineering centers throughout the US, and under the budget proposal, funding would increase 5.8%, from $233 million to $246 million. About $5 million of the increase would go to nanoscale science, which is one of the major focuses for the Bush administration. Indeed, NSF has about $249 million in its budget for projects related to nanoscale science and engineering.

Other priority areas for NSF are information technology research ($218 million), in which the foundation leads a multiagency initiative; mathematical sciences ($202 million), with programs intended to create closer connections between research and education; biocomplexity and the environment ($100 million), which would integrate research in ecological, social, and physical Earth systems; human and social dynamics ($24 million), which would integrate information from biology, engineering, information technology, and cognitive science; and Workforce for the 21st Century ($9 million), which is intended to create a scientifically literate workforce.

Department of Energy. Except for the flood of money flowing to DOD, the administration's emphasis on national security is nowhere more evident than at DOE. The department would see R&D funding increase by 4% to $8.5 billion under the FY 2004 budget, but the entire increase would go to DOE's defense activities. Funding for the Office of Science, which oversees all 10 of the national laboratories and programs in high-energy physics, nuclear physics, fusion research, and advanced computing, would remain flat for the fourth year in a row at $3.3 billion. Within that budget, there is shifting and relabeling of money to keep some programs going.

A $64 million boost in nanoscale science funding, for example, would come largely from a planned decrease in construction costs of the Spallation Neutron Source (SNS). About $12 million for the much-publicized US effort to rejoin the International Thermonuclear Experimental Reactor (ITER) would come mostly by redesignating money already in the Office of Science's burning plasma program.

Overall, DOE's civilian research programs remain essentially frozen at FY 2003 levels and just 0.9% above FY 2002 levels. The largest of DOE's science R&D accounts is basic energy sciences, which would receive $1 billion, a reduction of 1.4% from the FY 2003 levels. However, since much of the reduction would come from the end of SNS construction money, chemical, geosciences, and energy biosciences would remain at the FY 2003 level. Materials sciences would increase by 3.7%.

High-energy physics would receive a 1.8% increase from $725 million to $738 million. About half of the increase would go to enhance operations of Fermilab programs, and to the B-factory at SLAC.

Nuclear physics would receive a 2% increase to $389 million. Last year's increase was 8.8%, aimed primarily at increasing utilization of the Brookhaven Relativistic Heavy Ion Collider and the Thomas Jefferson National Accelerator Facility.

Fusion energy sciences would remain flat at $257 million. Office of Science Director Raymond Orbach has spent much of the last year campaigning to rejoin ITER, and he achieved success early this year when President Bush announced that the US would once again become a partner in the international project. The US left ITER several years ago because of high costs, which have since been cut in half. Orbach has said repeatedly that participation in ITER might allow the first commercial power generated by fusion to be available in about 35 years. Although he got presidential approval to rejoin ITER, Orbach didn't get new money to pay for it, which resulted in reshuffling the existing burning plasma budget. Orbach told a congressional committee in March that although the current ITER spending was "very modest," it is expected to increase significantly in FY 2006. Eventually, the US expects to pay about $100 million a year to participate in the project.

Biological and environmental research, the third largest science division at DOE, would receive a 5.1% cut to $500 million. But in a complicated process of cutting congressional ear-

Department of Energy R&D Programs (continued)

	FY 2002 actual	FY 2003 estimate	FY 2004 request	FY 2003–04 percent change
	(millions of dollars)[a]			
Atomic energy defense activities total	3761	3849	4180	8.8
National Nuclear Security Administration (NNSA) R&D total	3569	3732	4084	9.4
Weapons activities R&D total	2769	2922	3256	11.4
Stockpile R&D	313	467	433	–7.3
Science campaigns	257	255	270	5.5
Advanced simulation and computing	704	704	751	6.6
Inertial confinement fusion	507	504	467	–7.4
National Ignition Facility	245	214	150	–29.9
All other weapons R&D	989	991	1336	34.8
Nonproliferation and verification	195	192	196	1.7
Naval reactors	605	617	632	2.4
Other atomic energy defense activities	31	27	28	5.1
Environmental management	160	91	68	–25.3
Radioactive waste management	60	62	59	–5.4

AGS, Alternating Gradient Synchrotron. ANL, Argonne National Laboratory. BNL, Brookhaven National Laboratory. LANL, Los Alamos National Laboratory. LBNL, Lawrence Berkeley National Laboratory. LLNL, Lawrence Livermore National Laboratory. ORNL, Oak Ridge National Laboratory. RHIC, Relativistic Heavy Ion Collider. TJNAF, Thomas Jefferson National Accelerator Facility.

[a]Figures are rounded to the nearest million. Changes calculated from unrounded figures.

*Consists of groups from more than 60 universities doing experiments at proton accelerator facilities. Most experiments are conducted at Fermilab's Tevatron, while development of the physics program are for the Large Hadron Collider, and the HERA accelerator complex at DESY in Germany.

†The national lab research program is being decreased to provide more support for high-priority Tevatron operations. Fermilab research ($8.5 million) includes data taking and analysis of the CDF, D-Zero, and MiniBooNE experiments, and commissioning of the MINOS detector. LBNL ($5.3 million) and BNL ($7.8 million) research focuses on CDF and D-Zero data analysis, and the ATLAS research and computing program. ANL ($4.5 million) will work on CDF data, ATLAS, and the Zeus experiment at HERA.

‡Consists of about 40 universities working at the BaBar experiment at the SLAC *B*-factory, and groups working at the Cornell Electron Storage Ring.

§At SLAC ($7.1 million), research focuses on data taking from the BaBar detector. LBNL ($3 million) is also working with the BaBar detector, as are scientists at LLNL ($298 000).

||Focused on the GLAST/LAT telescope (SLAC); analysis from the Sloan Digital Sky Survey (Fermilab); and research for the SNAP experiment proposal, and analysis of KamLAND data (LBNL).

#FY 2004 request includes nearly $2 million for the US effort to rejoin the International Thermonuclear Experimental Reactor (ITER).

**Includes nearly $125 million for the Spallation Neutron Source and nearly $85 million for nanoscale research centers at ORNL, LBNL, SNL, and LANL.

NASA R&D Programs

	FY 2002 actual	FY 2003 estimate	FY 2004 request	FY 2003–04 percent change
	(millions of dollars)[a]			
NASA total*	14 892	15 000	15 469	3.1
NASA R&D†	10 244	10 999	11 025	0.2
R&D programs				
Science, aeronautics, and exploration (SAE)‡	6 577	7 015	7 661	
		[7 101]		[7.8]
Space science	2 901	3 414	4 007	
		[3468]		[15.5]
Solar System exploration	639	976	1 359	
		[1046]		[29.9]
Mercury surface space environment, geochemistry and ranging (Messenger)	97	68	43	–37.5
Deep Impact comet mission	91	59	22	–63.2
Dawn asteroid mission	1	36	126	246.3
Small projects§	2	1	0	–100.0
Operations‖	120	311	310	–0.2
Research	227	255	322	26.3
Technology and advanced concepts#	82	246	550	123.6
Mars exploration**	457	496	570	
		[551]		[3.4]
Astronomical search for origins	650	698	877	
		[799]		[9.7]
Hubble Space Telescope	256	228	239	4.6
Stratospheric Observatory for Infrared Astronomy (SOFIA)	38	47	55	16.6
Space Infrared Telescope Facility (SIRTF)	132	80	78	–0.8
Kepler	4	26	51	100.3
Operations††	9	10	25	153.6
Research	116	146	199	36.3
Technology and advanced concepts‡‡	182	284	411	44.8
Structure and evolution of the universe	350	331	432	
		[398]		[8.5]
Gravity Probe B	54	29	15	–49.4
Gamma-Ray Large Area Space Telescope (GLAST)	21	69	116	67.1
Swift Gamma-Ray Burst Explorer	67	34	6	–81.4
Small development projects§§	57	22	58	159.3
Operations‖‖	6	11	10	–3.7
Research##	132	154	187	21.1
Technology and advanced concepts***	13	22	61	183.2
Sun–Earth connections	413	544	770	
		[674]		[14.2]
Solar Terrestrial Relations Observatory (STEREO)	59	74	99	33.6
Solar Dynamics Observatory (SDO)	9	27	66	148.8
Small development projects†††	33	20	55	173.8
Operations‡‡‡	37	44	57	31.7
Research	141	124	178	43.4
Technology and advanced concepts§§§	131	256	314	22.8
Biological and physical research‖‖‖	828	842	973	
		[913]		[6.5]
Earth science	1592	1628	1552	
		[1610]		[–3.5]
Earth system science	1241	1249	1477	
		[1529]		[–3.4]
Development###	666	333	279	–16.2
Operations****	48	248	322	30.0
Research††††	339	357	523	46.4
Technology and advanced concepts	72	65	79	21.3
Earth science applications	95	62	75	
		[81]		[–7.4]
Institutional support	256	318	0	–100.0
Aeronautics technology	1031	986	959	
		[949]		[1.0]
Education programs	227	144	170	
		[160]		[6.2]
Space flight capabilities	8291	7960	7782	
		[7875]		[–1.1]
Space flight	6773	6131	6110	
		[6107]		[0.0]
International Space Station	1721	1492	1707	
		[1851]		[–7.7]
Space Shuttle	3270	3208	3968	
		[3786]		[4.8]
Space flight support	601	239	434	
		[471]		[–7.8]
Institutional support	—	1192	0	–100.0
Aerospace technology (Crosscutting technologies)‡‡‡‡	1518	1829	1672	
		[1768]		[–5.4]

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marks and restoring base program funding, the division actually does reasonably well.

For the second year in a row, the big winner at DOE is the NNSA, with its budget recommended to increase 9.4% from $3.7 billion to more than $4 billion. Stockpile stewardship, which received a whopping 49.2% increase from Congress in FY 2003, would decline 7.3% to $433 million in FY 2004. Advanced simulation and computing, used to do three-dimensional modeling of nuclear weapons detonations, would receive a 6.6% increase, while the National Ignition Facility funding would drop, as expected, by nearly 30% as construction moves closer to completion.

NASA. The FY 2004 budget sees a continuation of belt tightening at the space agency, with the $15.5 billion budget request representing a 3.1% overall increase from FY 2003. However, the destruction of the Columbia on 1 February put the entire FY 2004 NASA budget in doubt. Nearly $6.6 billion of NASA's annual budget is directly affected by the loss.

The mood in Washington was captured by the House Science Committee's Rep. Hall when he said "we need to determine the impact of the Columbia accident on NASA's budget and programs," and whether NASA should delay funding research into future manned spacecraft designs until the US increases the survivability of the shuttle. The accident has already cost NASA $100 million to recover Columbia's debris, and the cost of safety reviews and upgrades for the remaining shuttle fleet remains unknown. Delays caused by grounding the shuttles are also expected to affect NASA's space science budget.

The Columbia accident is also causing significant longer-term changes in the operation of both the shuttle program and the International Space Station. There are no plans to build a replacement shuttle for Columbia, and the burden on the three remaining shuttles to service the space station means that nearly all the science missions will be cut from the shuttle program, according to Roy Bridges, director of the Kennedy Space Center.

With the shuttles grounded, the space station cannot maintain enough of a water supply to support the traditional three-member crews, so the number is being dropped to two. Two-member crews will spend most of their time maintaining the station, leaving no time to do science experiments.

The FY 2004 budget proposal includes almost $973 million for biological and physics research at NASA, a 6.5% increase over the FY 2003 budget. But with no science being done on the space station, it remains unclear how that part of the research budget will finally be allocated. The full impact of the Columbia disaster on the shuttle fleet, said Michael Kostelnik, deputy associate administrator for the space station and space shuttle program, will only become apparent in the FY 2005 budget. NASA intends to continue flying the shuttle in one form or another until 2020.

While the shuttle will remain the only heavy lift option for NASA, a new space vehicle called the Orbital Space Plane, designed to take crews to the space station, may be developed by 2010 from the agency's billion-dollar Space Launch Initiative. Discussions are ongoing to determine if the DOD will fund part of the program.

Three of NASA's major programs, space science, Earth science, and aeronautics, are not directly affected by the grounding of the shuttle fleet. Funding for aeronautics research would remain roughly static, and NASA's commercial technology program would be terminated under the administration's proposal. The Space Science program sees a 15.5% increase in its budget, including a 30% increase for exploration of the Solar System.

The budget proposal also includes three new programs: Project Prometheus for space nuclear power and propulsion systems, optical communications, and the Beyond Einstein initiative. Project Prometheus incorporates last year's nuclear power initiative and a proposal for a $4 billion spacecraft, the Jupiter Icy Moons Orbiter (JIMO), which uses a nuclear-electric propulsion system.

The optical communication program will solve a bandwidth problem in communicating with distant spacecraft by taking advantage of what commercial industry and DOD have done in the field.

The Beyond Einstein initiative provides funds for three key spacecraft programs: Constellation X, a group of x-ray telescopes that will simultaneously study the same object; the Laser Interferometer Space Antenna (LISA), three spacecraft that will study gravity waves; and the Dark Energy Probes, which will determine the amount of dark energy in the universe (see PHYSICS TODAY April 2003, page 10 and page 53).

Earth science funding decreased by 3.5% as most of the major satellite programs—such as AURA, CloudSat, and CALIPSO—are ready for launch in 2004. New initiatives still await the findings of the review of the interagency US Global Change Research Program.

Perhaps the biggest change to NASA is one of the smallest in direct cost: the adoption of a strategic planning office and a new financial management system. Both will help NASA to implement its vision and mission, said NASA Director Sean O'Keefe, and clarify what money is being spent where, a problem that has plagued the agency for several years.

Department of Defense. With the global war on terrorism, as well as the related shooting wars in Afghanistan and Iraq, DOD would see its R&D budget grow to a record-setting $62.8 billion in FY 2004. That $4.2 billion, 7.1% increase would come on top of record-breaking increases of nearly $8.8 billion in FY 2003 and $7.1 billion in FY 2002.

NASA R&D Programs *(footnotes)*

[a]Figures are rounded to the nearest million. Changes calculated from unrounded figures.
*NASA's FY 2004 budget reflects the restructuring of funding into two new appropriation accounts: Science, Aeronautics and Exploration (SAE); and Space Flight Capabilities (SAC). NASA also changed to a full-cost accounting budget format that, for the first time, includes the cost of personnel, facilities, and support within each budget item. NASA included FY 2003 full-cost budget numbers for major programs, and those figures are listed in square brackets. Percent change figures are based on the full-cost budget numbers when possible. NASA will convert its entire budget to full-cost accounting by October. Budget analysts for the American Association for the Advancement of Science noted that, because of the changes in the FY 2004 budget process, a true comparison to FY 2003 is not possible.
†R&D numbers are from analysis by the American Association for the Advancement of Science.
‡Formerly Science, Aeronautics and Technology (SAT).
§The small projects program funds "highly focused, relatively inexpensive missions," NASA says. The current project is Rosetta, an international collaboration to study the origin of comets and the Solar System. Rosetta received nearly $40 million funding prior to FY 2002.
‖Operations is funding for operational missions and the Deep Space Mission System that provides communications with the missions. Missions included in the funding are: Stardust, Genesis, Messenger, Deep Impact, and Cassini.
#This is funding for the development of advanced techInologies needed for specific science missions. NASA is currently funding the in-space propulsion program to develop alternative, more efficient space propulsion systems; Project Prometheus, to develop nuclear-energy-based propulsion systems; and optical communications technology to significantly increase data flow from space missions.
**The Mars program includes funding for the Mars Global Surveyor, the 2001 Mars Odyssey, the 2003 Mars Exploration Rovers, Mars Express, and five future Mars missions.
††Operations funding currently supports the Hubble Space Telescope, the Far Ultraviolet Spectroscopic Explorer (FUSE), as well as SIRTF, SOFIA, and Kepler.
‡‡The advanced concepts funding includes money for the James Webb Space Telescope, the Space Interferometry Mission, and the ground-based Keck Interferometer, and other, smaller projects.
§§Small development projects funding includes money for six planned projects: Herschel, an infrared telescope; Planck, which will make all-sky measurements of the cosmic microwave background; Astro-E2, a Japanese-led x-ray astronomy mission; GALEX, an ultraviolet imaging and spectroscopic survey mission; CHIPS, which will study the interstellar gas around the Solar System; and SPIDER, which will map the cosmic web of hot gas that spans the universe.
‖‖Includes operating funds for the Chandra X-ray Observatory, the Rossi X-ray Timing Explorer, and six other missions.
##Includes analysis of data from ongoing missions and NASA's research program that carries instruments aloft on high-altitude balloons.
***Includes funding for development of the Laser Interferometer Space Antenna (LISA) and Constellation-X x-ray telescope systems.
††Includes funding for SOLAR-B, a Japanese-led sun-synchronous low-Earth orbit spacecraft; the Coupled Ion Neutral Dynamics Investigation (CINDI) project; TWINS magnetosphere spacecraft; and AIM, a project to study polar mesospheric clouds.
‡‡‡Funding to support 14 operational missions, including Voyager, SOHO, TRACE, and TIMED.
§§§Includes funding for the Magnetosphere Multiscale mission, the Solar Dynamics Observatory, and the Geospace Ionosphere/Thermosphere Mapper.
‖‖‖Includes biological and physical sciences research, and commercial research support.
###Includes the launches in FY 2004 of the AURA, CloudSat, and CALIPSO satellites to observe the Earth. The Earth Observing System Data and Information Systemt (EODIS) Science Development, which was funded at $74 million in FY 2003, would receive $98 million in the FY 2004 budget.
****Includes funding for the Total Ozone Mapping Spectrometer (TOMS); the Upper Atmosphere Research Satellite (UARS); The Tropical Rainfall Measuring Mission (TRMM); Earth Radiation Budget Satellite (ERBS); Topex; and EOS.
†††Research funding supports analysis, by more than 1200 outside scientists, of data from NASA Earth observing missions. Much of the work involves developing advanced computer modeling of Earth systems.
‡‡‡Includes orbital space plane development costs and other new technology initiatives.

Department of Defense R&D Programs

	FY 2002 actual	FY 2003 estimate	FY 2004 request	FY 2003–04 percent change
	(millions of dollars)*			
DOD total R&D	**49 877**	**58 646**	**62 821**	**7.1**
Research, Development, Test, and Evaluation (RDT&E)				
Total basic research (6.1)	1350	1417	1309	–7.7
US Army				
In-house independent research	14	21	24	17.0
Defense research sciences	136	140	129	–8.3
University and industry research centers	72	83	85	1.8
Force health protection	0	0	10	—
University research initiatives†	0	0	95	—
Total US Army	221	244	343	40.4
US Navy				
In-house independent research	16	16	17	8.8
Defense research sciences	379	396	369	–7.0
University research initiatives†	0	0	71	—
Total US Navy	395	412	457	10.7
US Air Force				
Defense research sciences	222	218	205	–6.0
University research initiatives†	0	0	117	—
Total US Air Force	222	218	322	47.8
Defense agencies				
In-house independent research	2	2	0	–100.0
Defense research sciences	142	199	151	–24.1
University research initiatives†	278	263	0	–100.0
Government–industry cosponsorship of university research	9	9	0	–100.0
Force health protection	36	15	0	–100.0
Chemical and biological defense research	45	55	36	–34.6
Total defense agencies	512	542	187	–64.6
Applied research (6.2)‡	4094	4289	3670	–14.4
Advanced technology development (6.3)	4430	5067	5253	3.7
Other RDT&E§	38 750	46 941	51 596	9.9
Total RDT&E	48 623	57 713	61 827	7.1

*Figures are rounded to the nearest million. Changes calculated from unrounded figures.
†Includes Defense Experimental Program to Stimulate Competitive Research (DEPSCoR), Historically Black Colleges and Universities (HBCU) scholarships, and the High Energy Research Laser initiative.
‡The Army would see its applied research funds decline 25.2%; the Navy, 33.5%; the Air Force, 8.6%; defensewide would see a decline of 14.4%.

National Oceanic and Atmospheric Administration R&D Programs

	FY 2002 actual	FY 2003 estimate	FY 2004 request	FY 2003–04 percent change
	(millions of dollars)*			
NOAA total	3263	3136	3326	6.0
NOAA R&D	677	684	675	–1.4
Oceanic and Atmospheric Research	321	340	332	–2.3
National Weather Service	22	28	20	–26.6
National Ocean Service	65	70	55	–21.6
National Marine Fisheries Services	163	164	161	–2.0
Other R&D†	105	82	106	29.6

*Figures are rounded to the nearest million. Changes calculated from unrounded figures.
†Includes R&D funds for climate research; weather and air quality research; ocean, coastal, and Great Lakes research; and information technology and education programs.

National Institute of Standards and Technology R&D Programs

	FY 2002 actual	FY 2003 estimate	FY 2004 request	FY 2003–04 percent change
	(millions of dollars)*			
NIST total	685	708	497	–30.0
NIST R&D	503	527	410	–22.1
Scientific and Technical Research and Services (STRS) R&D				
Physics	33	33	47	45.0
Electronics and electronics engineering	41	39	43	11.9
Chemical science and technology	35	36	41	13.6
Computer science and applied mathematics	50	44	50	14.3
Manufacturing and engineering	20	19	22	11.9
Materials science and engineering	58	60	66	10.4
Building and fire research	20	17	23	35.6
Technology assistance	4	4	4	11.9
Research support and equipment†	19	57	34	–40.7
Total STRS R&D	280	308	330	7.3
Industrial Technology Services				
Advanced technology program	159	153	10	–93.4
Manufacturing extension program (non-R&D)	107	106	13	–88.1
Construction‡	64	66	70	6.0

*Figures are rounded to the nearest million. Changes calculated from unrounded figures.
†Includes funding for new measurement and research equipment for NIST's Advanced Measurement Laboratory, due to be completed in October 2003.
‡Includes funding for relocation and other expenses related to the Advanced Measurement Laboratory.

Department of Homeland Security R&D Programs

	FY 2002 actual	FY 2003 estimate	FY 2004 request	FY 2003–04 percent change
	(millions of dollars)*			
Border and transportation security	95	110	172	56.1
Emergency preparedness	0	0	0	–
Information analysis and infrastructure	5	15	5	–66.7
Science and technology	147	521	801	53.7
Coast Guard	19	23	23	0.0
Total DHS R&D	266	669	1001	49.6

*Figures are rounded to the nearest million. Changes calculated from unrounded figures.

While the R&D budget is enormous and growing quickly, virtually all of the increases would go to the development of new weapons systems. Missile defense would increase 22% to $8.3 billion, and a new fighter jet project would get $4.4 billion, a 28% increase.

Although the development side of R&D is increasing dramatically, basic and applied research at DOD would decrease significantly in FY 2004. Basic research, known as "6.1," would fall 7.7%, while applied research, called "6.2," would drop 14.4%. Together the two science categories would decrease 12.7% to $5 billion, below the FY 2001 funding level. In recent congressional testimony, DOD officials said they would support an annual 3% increase benchmark for basic, applied, and advanced technology research, but that is not reflected in the FY 2004 request.

The Defense Advanced Research Projects Agency (DARPA) R&D funding would increase 9.8%, a $264 million increase to $3 billion. The agency intends to focus the increased funding on tactical technology, materials, aerospace systems, electronics, and sensor and guidance technologies.

Department of Homeland Security. The department, which began in March as a real, functioning entity, is a consolidation of 180 000 federal employees from nearly two dozen agencies. Most of its programs, including R&D, are transfers of programs from DOD, DOE, and the Departments of Agriculture and Transportation. In early April, Charles McQueary, a mechanical engineer and former president of General Dynamics, was sworn in as the undersecretary heading the Directorate for Science and Technology.

Under the FY 2004 budget proposal, McQueary would oversee 80%, or about $800 million, of the $1 billion DHS R&D portfolio. It is difficult to draw exact comparisons to past funding levels for programs that are being transferred into DHS, but a AAAS analysis concluded the R&D funding for the transferred programs would increase about 50% in FY 2004.

McQueary's directorate would, according to the DHS proposal, distribute funding as follows: $137 million for development of radiological and nuclear countermeasures; $365 million for development of biological countermeasures; $65 million for chemical or explosive countermeasures; $90 million for threat and vulnerability assessments; $25 million for a standards program to develop, test, and evaluate criteria for homeland defense technologies; $55 million for conventional R&D missions; and $62 million to fund university research, as well as basic research into emerging threats. The directorate would also be home to HSARPA.

NIST and NOAA. R&D funding at NIST would decrease 22%, to $410 million from $527 million. Much of the decrease is due to another attempt by the administration to eliminate the Advanced Technology Program. The ATP, which funds selected high-risk technology projects in private industry, has been under assault by some congressional Republicans for years for "playing favorites" in the private sector. The program was zeroed out by the administration in FY 2002, but saved by congressional Democrats with $123 million. In FY 2003 the administration proposed $81 million and Congress gave ATP $153 million. In FY 2004, the administration is proposing $10 million, just enough to close the program.

NIST's Science and Technology Research Services, which fund's the institute's laboratories in Maryland and Colorado, would receive a 7.3%, or $22 million, increase in R&D funding. About $10 million of that would go for homeland security R&D. The proposal also includes $7 million to equip and operate a new advanced measurement laboratory in Maryland.

NOAA would see a 6% increase to $3.3 billion in its overall budget, but R&D spending would be cut 1.4% from $684 million to $675 million in its FY 2004 budget. The cuts would come primarily from the National Ocean Service, the Office of Oceanic and Atmospheric Research, and the National Environmental Satellite, Data and Information Service.

Jim Dawson and Paul Guinnessy ■