leveraging previous and future science investments."

In two years, says Williams, "I hope the NVO will be at a stage where 10 to 20 collections are federated, and that one might have a dozen or so interesting projects going. In five years, the framework will have been used enough, with enough different datasets and computing tools, that it will start to be part of the general infrastructure for astronomers. And in 10 years, nobody will mention it, people will take it for granted."

TONI FEDER

Federal R&D Tops $103 Billion, but Physics Stays Flat

Four years of federal budget surpluses are giving way to deficit spending, thanks in large part to terrorists, war, and recession. As the unanticipated spending began late in the budget process, overall science appropriations increased significantly.

When President Bush released his 2002 budget request early last April, proposed science funding was so heavily weighted toward medical and defense research that most other R&D agencies considered themselves fortunate to just stay even with inflation. House Science Committee Chairman Sherwood Boehlert (R-N.Y.), said the science funding numbers were so bad that NSF should be read "not sufficient funds" instead of "National Science Foundation."

Then, thanks to what Office of Management and Budget Director Mitch Daniels described in a National Press Club speech in late November as "converging factors"—primarily the war on terrorism and the recession—the federal government returned to deficit spending. The rush to spend "had all of the characteristics of a jailbreak, with people running in all directions," he said. Those people, both in the administration and on Capitol Hill, were carrying supplemental spending proposals, and the result for science has been significant.

Federal R&D appropriations climbed to a record $103.7 billion for fiscal year 2002, an increase of $12.3 billion, or 13.5%, over 2001. The National Institutes of Health and the Department of Defense still lead the R&D spending parade, as they did in the original Bush budget proposal. NIH's appropriation of $23.6 billion keeps it on track to double its budget over the five-year period ending in 2003. R&D at DOD jumped 17.3%, or $7.4 billion—from $42.7 billion in 2001 to $50.1 billion in 2002. The DOD increase was $1.7 billion more than Bush asked for.

But with a near tripling of counterterrorism spending, set at $1.5 billion for 2002, and Social Security funds no longer viewed as sacrosanct, money has flowed, albeit less copiously, to almost every other R&D program as well. According to an American Association for the Advancement of Science analysis of the final 2002 appropriations, "all federal [science] agencies received increases for their research portfolios."

While science in general did better than most observers believed it would early on, physics funding at the Department of Energy (DOE) remained fairly flat. High-energy physics, nuclear physics, basic energy sciences, and fusion-energy research programs are all held at about their 2001 levels.

Congress passed the last of the appropriations bills on 20 December, nearly three months after the fiscal year began. The 2002 budget can be seen as a transition budget, one that begins to reflect the new priorities triggered by the 11 September attacks and the ongoing war on terrorism. The following are R&D highlights from key science funding agencies.

▷ **NSF**. After receiving a record increase of about 13.0% in 2001, NSF's proposed 2002 funding increase was a meager 1.3%. Even that small increase was deceptive, because the administration was emphasizing education and human resource programs at NSF. The funding for R&D programs at NSF would have declined 1.6% under the Bush proposal.

In the final funding bill, NSF instead received an overall increase of 8.4%, or $373 million, compared to 2001. Research and related activities, the division that funds most of NSF's R&D, received an increase of 7.7%, or $256 million, over 2001. This boost means that, with the exception of biosciences and social sciences, NSF's research divisions received increases greater than 8.0%. Mathematical and physical sciences received an 8.4% increase to more than $922 million. That amount funds physics and astronomical sciences, and earmarks $4 million for the Telescope Systems Instrumentation Program. The budget document said NSF is expected to make upgrading its astronomical facilities and equipment, including the Green Bank Observatory and Robert C. Byrd Telescope in West Virginia, and the Very Large Array radio telescope in New Mexico, a priority. The US Polar Research Program received a 9.0%, or $18.9 million, increase, along with a 9.3%, or $5.8 million, increase in Antarctic logistical support programs.

Information technology and nanotechnology, two research areas often cited by administration officials as being very important, received major boosts from congressional appropriators. Information technology received $180 million, compared to $155 million in 2001, and nanotechnology increased from $150 million to $199 million. Presidential Science Adviser John Marburger has hinted that those two areas will receive significant increases again in the 2003 budget.

NSF's major research equipment account, which funds construction of large scientific facilities, received $139 million, a 14.1% increase over 2001 and $42 million more than Bush requested. Of that amount, $12.5 million goes to the Atacama Large Millimeter Array radio telescope project. The High-Performance Instrumented Airborne Platform for Environmental Research gets $35 million instead of being eliminated under the Bush budget proposal. There is also $15 million for the IceCube Neutrino Detector project, an Antarctic facility that wasn't included in the administration's budget request. The final budget also includes $875 million for NSF's education and human resources programs, an 11.4% boost from 2001. The new Math and Science Partnerships program, championed by the Bush administration, received $160 million.

▷ **DOE.** Science at DOE was funded at $3 billion, a 2.1% increase of $63 million over last year's budget. Both fusion energy at $245 million and nuclear physics at $355 million received about the same funding as in 2001. The congressional conferees who put together the final numbers urged DOE to use the nuclear physics money to enhance the operation of the Relativistic Heavy Ion Collider at Brookhaven National Laboratory, as well as improve operations at the Jefferson National Accelerator Facility in Virginia.

High-energy physics funding was up only 0.6%, to $706 million, and the

Physics-Related R&D for Fiscal Year 2002

	FY 2001 estimate	FY 2002 request	FY 2002 approved	Percentage gain (loss) 2001–02
	(millions of dollars)			
National Science Foundation (total)	**4417**	**4473**	**4789**	**8.4**
Total research and related activities	3343	3327	3599	7.7
Mathematical and physical sciences	851	864	922	8.4
Engineering	431	431	468	8.5
Geosciences	562	559	611	8.6
Computer and information science and engineering	478	470	516	7.9
US polar programs	273	277	298	9.1
Major research equipment	122	96	139	14.1
Education and human resources R&D	139	139	140	0.3
Other education and human resources programs	646	733	735	13.8
Department of Energy (total)	**19 917**	**19 098**	**21 209**	**6.5**
Total science	2955	2930	3018	2.1
High-energy physics	702	706	706	0.6
Nuclear physics	355	355	355	0.0
Fusion energy sciences	245	245	245	0.1
Basic energy sciences	984	997	1004	2.0
Spallation Neutron Source	278	291	291	4.8
Advanced scientific computing research	166	163	158	(4.6)
Multiprogram laboratory support	22	22	22	0.0
National Nuclear Security Administration (NNSA) R&D	3292	3379	3611	9.7
Weapons activities	2357	2449	2569	9.0
Stockpile R&D	246	306	349	42.2
Inertial confinement fusion	234	223	261	11.9
National Ignition Facility (construction)	197	245	245	24.2
Nonproliferation and verification R&D	204	195	309	51.2
Nuclear safeguards and security	26	26	26	0.0
NASA (total)	**14 253**	**14 511**	**14 902**	**4.5**
Space science	2625	2786	2849	8.5
Biological and physical research*	379	361	714	88.5
Earth science	1716	1515	1573	(8.3)
Academic programs	133	154	231	73.9
Space Station**	2113	2087	1724	(18.4)
Department of Defense R&D, Test and Evaluation	**42 743**	**48 454**	**50 134**	**17.3**
Total basic research (6.1)	1317	1304	1383	5.0
Total applied research (6.2)	3673	3659	4212	14.6
Army	6247	6513	7064	13.1
Navy	9555	10 735	11 422	19.5
Air Force	14 190	14 344	14 528	2.4
Defense Advanced Research Projects Agency (DARPA)	2010	2281	2293	14.1
Ballistic Missile Defense Organization (BMDO)	4204	7606	6995	66.4
Department of Commerce				
Total NOAA R&D	726	772	836	15.3
Total NIST R&D	421	313	493	17.1
Scientific and technical research	268	292	279	4.3
Advanced Technology Program	118	0	150	26.6
Construction	35	21	64	82.8

*This category includes a transfer of $248 million from what was space station research and an additional $55 million for space station equipment.
**About $303 million transferred to "biological and physical research" category.

Source: American Association for the Advancement of Science R&D Budget and Policy Program

basic energy sciences program increased 2.0%. Within the basic energy category, the Spallation Neutron Source received $291 million, a 4.8% increase over 2001 and over the amount that Bush had requested. Money was also included for the SPEAR3 upgrade at the Stanford Synchrotron Radiation Laboratory. DOE's biological and environmental research program, which funds the department's contribution to the Human Genome Project, received $527 million, a 9.6% jump and the biggest increase in the science budget.

Funding for the National Nuclear Security Administration, a semiautonomous agency within DOE, is $7.6 billion for 2002, up 12.2% from 2001 and accounting for more than a third of DOE's budget. Weapons activities R&D received a 9.0% increase, to $2.6 billion. That money funds most of the research at the three weapons labs—Los Alamos and Sandia in New Mexico, and Lawrence Livermore in California. The National Ignition Facility received the requested $245 million for construction.

▷ **NASA.** The mission to Pluto is back on and the International Space Station is diminished in a space agency R&D budget that increased by 3.8%; but, in a process known as earmarking, Congress directed a lot of that money at specific programs. The total NASA budget actually grew by 4.5% compared to 2001, but the agency separates the space shuttle program and treats it as a different funding request. With the shuttle included, the total NASA budget is $14.9 billion.

The science, aeronautics, and technology account, which funds R&D not associated with the space station, received $7.9 billion, an 11.6% increase over 2001. Included in that amount is $33 million in 11 September emergency funding for security upgrades, communications, and information security. Almost half of the remainder is money being transferred from space station research to the agency's biological and physical research program. Space science received $2.8 billion, which is an 8.5% increase over 2001, although changes in NASA's accounting system prevent true year-to-year comparisons.

Within space science, $10 million is designated to go to the "Living With A Star" program, which studies the effects on Earth of solar variability. In addition to designating $30 million for the Pluto–Kuiper Belt mission, the congressional conferees included $92 million for the Next Generation Space Telescope and fully funded upcoming Mars missions.

The space station, with its projected $4 billion cost overruns over the next five years, received $1.7 billion, a cut of 18.4%, or $389 million, from 2001. While the space station loses that money, the actual cut to NASA is about $50 million; the difference is money being transferred from the space station program to separate research accounts.

▷ **National Oceanic and Atmospheric Administration** and **NIST.** The two primary research divisions at the Department of Commerce did well in the 2002 budget, with NOAA R&D increasing by 15.3% and NIST going up by 17.1%. NOAA's National Ocean Service increased 22.9%; oceanic and atmospheric research went up by 15.8%; and the National Environmental Satellite, Data and Information Service increased by 18.8%.

One of the more controversial issues during the funding debate was the successful move in the Senate to save NIST's Advanced Technology Program (ATP) from extinction. The program provides R&D money to promising technologies in private industry, and many Republicans view the aid as "corporate welfare." Bush's budget called for $13 million in ATP funding, just enough to close out previously awarded grants. The House bill followed the administration's lead, but the Democrat-controlled Senate prevailed in not only saving ATP, but in increasing its 2002 budget to $150 million, a 26.6% increase over 2001. NIST's main R&D program, scientific and technical research and services, received a 4.3% increase to $279 million.

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