

## Basic Science Funding Flat, as War, Deficit, and Hurricane Recovery Squeeze Federal Budget

**Most R&D agencies barely held their own in yet another year of modest science funding. A proposed across-the-board 2% cut could push many science programs into the red.**

**A** little more than a year ago, in the wake of congressional approval of the fiscal year 2005 spending bill, US Office of Science director Raymond Orbach was upbeat. His office within the Department of Energy had received a 4.3% increase in R&D money and Orbach was widely regarded as the big winner in a federal science budget that was mostly flat. The good times were short-lived, however.

This year, as the FY 2006 federal budget numbers are finalized, the only solace Orbach can take is that his office, with a 0.9% increase, did a little better than DOE as a whole, which received a 0.5% cut. And even that small comfort may fade if Congress applies an across-the-board 2% rescission to the entire federal budget. Such a rescission is a strong possibility as Congress struggles to find ways to pay for the multi-billion-dollar reconstruction costs of Katrina and the other hurricanes that lashed the Gulf states during the past year.

If the rescission happens, then even the modest gains of non-defense R&D for FY 2006—now set at 2.4%—will all but vanish. That would continue a decades-long trend of flat or declining federal support for basic research for the physical sciences, mathematics, and engineering. In the past couple of years, more than a dozen reports have warned of the long-term economic consequences of failing to invest in basic research. The most recent, “Rising Above the Gathering Storm,” by the National Academy of Sciences, called for a 10% increase in the federal investment in basic research in each of the next seven years (see PHYSICS TODAY, December 2005, page 25).

The FY 2006 budget shows no indication that the administration is heeding the NAS recommendation. Indeed, the mounting deficit, along with the high costs of the war in Iraq, the war on terrorism, and now devastating natural disasters, has made it increasingly difficult for supporters of science in Congress to shift more money toward basic research. Efforts to ade-

quately fund nuclear physics programs at Brookhaven National Laboratory on Long Island, New York, and the Thomas Jefferson National Accelerator Facility in Newport News, Virginia, ran into problems in part because the same pot of money also had to fund the Army Corps of Engineers levee reconstruction in New Orleans.

Overall, the federal R&D investment in FY 2006 will be \$135.8 billion, or \$3.5 billion above what President Bush requested last February. But of the \$3.5 billion congressional increase, almost all will go to the Department of Defense for weapons development and to NASA for space exploration work. (Congressional conferees were still finalizing the DOD budget as PHYSICS TODAY went to press.)

According to an American Association for the Advancement of Science analysis, the federal non-defense R&D research portfolio, which includes basic and applied research, totals \$57.1 billion, a 2.1%, or \$1.2 billion, increase over last year. But two-thirds of that increase goes to NASA for applied research in space exploration technologies.

“Total federal basic research would increase just 0.4 percent to \$27 billion,” the AAAS analysis concluded. “Most agencies’ basic research investments would either decline or increase by less than 1 percent in 2006, with the notable exception of the National Science Foundation, with a 2.8 percent increase.”

### Nuclear physics cuts

Most troubling to the physics community is the significant cut in the nuclear physics budget in DOE’s Office of Science. The administration’s proposed 8.4% cut in nuclear physics to \$370.7 million has caused great concern among officials at Brookhaven and Jefferson, two centers of nuclear physics research. The concern turned to optimism when both the House of Representatives and Senate came in with funding that was not only millions more than the administration

proposed, but better than last year’s funding of \$404.8 million.

But when House and Senate conferees met, the optimistic nuclear physics numbers went away and, in a last-minute decision, the conferees reverted to the Bush funding level of \$370.7 million. In a statement on the Senate floor, Senator Hillary Clinton (D-NY) said that Office of Science programs are funded “at a level significantly below the value of these programs to the future security and economic health of the nation.”

Brookhaven officials said that if the funding cuts held, then about 100 of the lab’s 2700 employees would be laid off and the Relativistic Heavy Ion Collider (RHIC) would be shut down for a year. Jefferson Lab officials predicted 40 layoffs and a 25% to 30% reduction in operating times at the Continuous Electron Beam Accelerator Facility (CEBAF).

Brookhaven director Praveen Chaudhari said that a combination of the Bush administration’s funding proposal and a dramatic surge in electricity costs in the wake of Hurricane Katrina caused some of RHIC’s problems. Based on the \$370.7 million Bush was proposing for nuclear physics, he said, “we were scheduled to run for 12 weeks. If you take five weeks to cool down and warm up again, you are left with six or seven weeks to do physics. This is just marginally acceptable in any normal use of that word.”

Chaudhari was proceeding with the scaled-down plan for RHIC when electricity prices rose dramatically. The result for RHIC would be an increase in power costs of several million dollars. Add to that the \$13 million cut Bush proposed for RHIC in FY 2006, then adjust for inflation, Chaudhari said, “and that makes it a \$20 million cut if we just want to do what we did in 2005.”

“We don’t think that it makes sense to have an independent run with that kind of funding in 2006,” he said. Instead, Chaudhari is working on a scenario that would mothball RHIC until FY 2007, which begins on 1 October 2006, then combine whatever money can be saved from this year with the 2007 funding and do a longer run.

The loss of 100 employees is still possible, Chaudhari said, but he is looking at what other programs can be deferred and what money can be re-allocated to reduce the layoffs. “You don’t want to lose your expertise and you don’t want to be unsafe,” he said.

Samuel Aronson, Brookhaven’s associate laboratory director for high-energy and nuclear physics, said bluntly, “We will not run the machine, so the experiments will not get new data this year. We’ve gotten good long runs every year for the last five years, and we’ve profited nicely scientifically from that.”

He said he sees the mothballing of RHIC as “a serious glitch . . . but the program is certainly strong enough to withstand a one-year glitch like this.” The effort now, he said, “is to make sure that ’07 is a healthy run.”

## Divining the future

At Jefferson Lab, director Christoph Leemann is trying to minimize the impact of the budget cuts and at the same time divine what the FY 2007 budget holds in store. “How one thinks about and deals with the current problem is in some sense informed by the FY expectations,” he said. “If this [reduced funding] was the baseline for our operations from now on, that would call for permanent adjustments in operating. You can save money two ways: You employ fewer people and you buy less stuff. And somewhere that translates into output and it could mean, in just total user hours, a reduction of up to one-third compared to ’05.”

When Leemann saw Bush’s proposed cuts last February, he tried to prepare. “I installed a hiring freeze in ’05 because I had a certain model of the outside world,” he said. “I held that model until after the House and Senate marks [when money was added to the nuclear physics budget]. That made us very optimistic.”

Then came the last-minute cuts by the conferees and the optimism was gone. “This will mean less physics out of our ongoing programs, and at this moment there is no extra money for our 12 GeV upgrade [to CEBAF].” In its 2003 facilities plan, DOE listed the upgrade as a “near-term priority.”

While there is mounting pressure on the administration from scientists, academic communities, and industrial leaders to view an increase in basic research dollars as a national security issue, the priority the administration will give non-defense science in the FY 2007 budget remains unclear. For the moment, the focus is on the FY 2006 numbers. Here are the

## Federal R&D Programs

|                                                                                   | FY 2005<br>estimate | FY 2006<br>request | FY 2006<br>conference | Percent<br>gain (loss) |
|-----------------------------------------------------------------------------------|---------------------|--------------------|-----------------------|------------------------|
| (millions of dollars)*                                                            |                     |                    |                       |                        |
| <b>National Science Foundation</b>                                                |                     |                    |                       |                        |
| <b>Total R&amp;D</b>                                                              | 4057                | 4170               | 4165                  | 2.7                    |
| Total research and related activities (R&RA)*                                     | 4221                | 4333               | 4375                  | 3.7                    |
| Mathematical and physical sciences                                                | 1070                | 1086               | 1097                  | 2.5                    |
| Engineering                                                                       | 561                 | 581                | 586                   | 4.4                    |
| Biological sciences                                                               | 577                 | 582                | 587                   | 1.9                    |
| Geosciences                                                                       | 694                 | 709                | 716                   | 3.1                    |
| Computer and information science<br>and engineering                               | 614                 | 621                | 627                   | 2.1                    |
| Social, behavioral, and economic sciences                                         | 197                 | 199                | 201                   | 1.9                    |
| International programs                                                            | 34                  | 35                 | 35                    | 3.3                    |
| US polar programs†                                                                | 344                 | 387                | 391                   | 13.4                   |
| Integrative activities                                                            | 130                 | 135                | 136                   | 4.8                    |
| Major research equipment                                                          | 174                 | 250                | 193                   | 11.0                   |
| Education and human resources R&D                                                 | 140                 | 115                | 131                   | -6.8                   |
| (Less non-R&D funding for R&RA)                                                   | -477                | -529               | -534                  | 11.9                   |
| <b>Department of Homeland Security</b>                                            |                     |                    |                       |                        |
| <b>Total R&amp;D</b>                                                              | 1243                | 1287               | 1294                  | 4.1                    |
| Science and technology                                                            | 1047                | 1287               | 1276                  | 21.9                   |
| Biological countermeasures                                                        | 363                 | 362                | 380                   | 4.8                    |
| National Biodefense Analysis and Counter-<br>measures Center (construction funds) | 35                  | 0                  | 0                     | -100.0                 |
| Chemical countermeasures                                                          | 53                  | 102                | 95                    | 79.2                   |
| Explosives countermeasures                                                        | 20                  | 15                 | 44                    | 123.4                  |
| Radiological and nuclear countermeasures                                          | 123                 | 246                | 212                   | 73.0                   |
| Threat and vulnerability assessment                                               | 66                  | 47                 | 43                    | -34.7                  |
| Standards                                                                         | 40                  | 36                 | 35                    | -11.8                  |
| Support of DHS components                                                         | 55                  | 94                 | 80                    | 46.4                   |
| University programs                                                               | 70                  | 64                 | 63                    | -10.0                  |
| Emerging threats                                                                  | 11                  | 11                 | 8                     | -25.6                  |
| Rapid prototyping                                                                 | 76                  | 21                 | 35                    | -53.9                  |
| Counter MANPADS‡                                                                  | 61                  | 110                | 110                   | 80.3                   |
| SAFETY Act§                                                                       | 10                  | 6                  | 7                     | -30.0                  |
| Interoperable communications                                                      | 21                  | 21                 | 27                    | 26.2                   |
| Critical infrastructure                                                           | 27                  | 21                 | 41                    | 51.1                   |
| Cybersecurity                                                                     | 18                  | 17                 | 17                    | -7.2                   |
| R&D consolidation                                                                 | 0                   | 117                | 100                   | —                      |
| Rescission                                                                        | 0                   | 0                  | -20                   | —                      |
| Coast Guard                                                                       | 18                  | 0                  | 18                    | -1.4                   |
| Border and transportation security (TSA)                                          | 178                 | 0                  | 0                     | -100.0                 |
| <b>Department of Energy</b>                                                       |                     |                    |                       |                        |
| <b>Total R&amp;D</b>                                                              | 8614                | 8393               | 8695                  | 0.9                    |
| Total science                                                                     | 3334                | 3184               | 3354                  | 0.6                    |
| High-energy physics                                                               | 736                 | 714                | 724                   | -1.7                   |
| Nuclear physics                                                                   | 405                 | 371                | 371                   | -8.4                   |
| Fusion energy sciences                                                            | 274                 | 291                | 291                   | 6.1                    |
| Basic energy sciences                                                             | 1105                | 1146               | 1146                  | 3.7                    |
| Spallation Neutron Source                                                         | 113                 | 149                | 149                   | 31.5                   |
| Advanced scientific computing                                                     | 232                 | 207                | 237                   | 2.0                    |
| Biological and environmental research                                             | 582                 | 456                | 586                   | 0.6                    |
| National Nuclear Security Admin.                                                  | 4080                | 3968               | 4015                  | -1.6                   |
| Naval reactors                                                                    | 772                 | 756                | 759                   | -1.7                   |
| Weapons activities                                                                | 3083                | 2940               | 2934                  | -4.9                   |
| Science campaigns                                                                 | 276                 | 262                | 279                   | 1.3                    |
| Advanced simulation and computing                                                 | 697                 | 661                | 606                   | -13.0                  |
| Inertial confinement fusion                                                       | 536                 | 460                | 549                   | 2.5                    |
| All other weapons activities R&D                                                  | 1575                | 1557               | 1499                  | -4.8                   |
| Nonproliferation and verification R&D                                             | 224                 | 272                | 322                   | 43.8                   |
| Energy supply R&D                                                                 | 423                 | 397                | 473                   | 11.8                   |
| <b>NASA</b>                                                                       |                     |                    |                       |                        |
| <b>Total R&amp;D</b>                                                              | 10 705              | 11 497             | 11 481                | 7.3                    |
| Total science, exploration, and aeronautics                                       | 9051                | 9661               | 9734                  | 7.6                    |
| Total exploration capabilities#                                                   | 7114                | 6763               | 6644                  | -6.6                   |
| Inspector General                                                                 | 31                  | 32                 | 32                    | 3.2                    |
| (Less non-R&D activities)                                                         | -5491               | -4959              | -4929                 | -10.2                  |
| <b>Department of Commerce</b>                                                     |                     |                    |                       |                        |
| Total NOAA R&D                                                                    | 650                 | 534                | 668                   | 2.7                    |
| Total NIST R&D                                                                    | 461                 | 416                | 448                   | -2.7                   |

\*R&RA funds are not appropriated by directorates and the conference directorate figures are based on American Association for the Advancement of Science estimates.

†The FY 2006 request and conference figures include transfer of polar icebreakers costs from the Coast Guard.

‡Counter MANPADS is the program to protect civilian aviation from small, shoulder-fired missiles.

§The purpose of the SAFETY Act is to encourage the development and deployment of anti-terrorism technologies.

||The FY 2006 budget proposes to consolidate TSA and Coast Guard R&D within the Science and Technology Directorate.

The congressional conference committee has kept Coast Guard R&D separate.

#Includes funding for the International Space Station, Space Shuttle, and space and flight support.

agency highlights.

**National Science Foundation.** The science foundation receives \$5.6 billion, which amounts to a 3% increase of \$165 million in its overall budget. The increase is a comeback from the nearly 2% drop in last year's budget, and the \$5.6 billion figure matches what NSF received in 2004. So NSF is back to where it was two years ago, but the 2006 budget includes polar icebreaking costs that were previously paid for in the US Coast Guard's budget.

NSF's R&D budget totals \$4.2 billion, an increase of \$108 million, or 2.7%, over FY 2005. The research and related activities account receives a 3.7% increase of \$155 million, but the largest jump within R&RA is the \$48 million in non-R&D money to cover the takeover of the icebreaker ships.

The major research equipment and facilities construction (MREFC) account receives a \$19 million increase to \$193 million. There will be no new projects started in FY 2006, and funding was provided for four of the five existing projects—Scientific Ocean Drilling, Atacama Large Millimeter Array, EarthScope, and the IceCube Neutrino Observatory. The Rare Symmetry Violating Processes project is not funded (see PHYSICS TODAY, October 2005, page 27).

**Department of Homeland Security.** DHS receives a 4.1% increase to \$1.3 billion for R&D. Although that is better than most other R&D agencies, it is a dramatic scaling down of the budget increases the relatively new department saw in its first few years. The FY 2005 R&D budget of \$1.2 billion was \$102 million more than the department asked for and a nearly 20% increase over FY 2004.

Almost all of the DHS R&D money goes to the Directorate of Science and Technology. The budget shifts money away from programs such as rapid prototyping and vulnerability assessments and toward countermeasures programs for radiological, nuclear, chemical, and explosives threats.

**Department of Energy.** Beyond the problems with funding DOE's nuclear physics program, the R&D budget includes a 6.1% increase in fusion funding and a 2% increase in advanced scientific computing research. About \$56 million of the increase in fusion money was intended to go to ITER, the international fusion reactor project. But Sherwood Boehlert (R-NY), chairman of the House Committee on Science, threatened to kill US participation in ITER if it was funded at the expense of existing US fusion programs. As a result, \$30 million was moved from ITER into domestic fusion projects.

High-energy physics receives \$724 million, a cut of 1.7%. The cut would have been worse, but Congress gave the physics program \$10 million more than the administration requested.

DOE's defense R&D is down from FY 2005, with its Weapons Activities Program at \$2.9 billion, a decrease of 4.9%. An attempt by Sen. Pete Domenici (R-NM) to kill the National Ignition Facility failed, and the project received nearly \$142 million (see PHYSICS TODAY, August 2005, page 28). There are no funds for the Robust Nuclear Earth Penetrator project, but \$25 million was authorized for the Reliable Replacement Warhead, a new program intended to develop a new warhead design using existing nuclear weapons.

**NASA.** The space agency receives an

overall increase of 1.3%, or \$215 million, but R&D funding jumps 7.3% to \$11.5 billion. That increase appears largely because of mid-year cuts to the R&D budget when money was shifted to the space shuttle program for the July 2005 mission that was to mark the program's return to flight status.

The 7.3% increase in R&D funding will go entirely to the new Constellation Systems Program to develop the president's Moon-Mars vision. Physical and biological research and a propulsion technologies program see sharply reduced funding.

**Department of Commerce.** R&D at the National Oceanic and Atmospheric Administration (NOAA) is up \$18 million, or 2.7%, but the funding includes \$51 million in congressional earmarks for Alaska fisheries and marine mammals R&D. NOAA's oceanic and atmospheric research unit receives a 3.8% cut to \$325 million.

NIST R&D falls by 2.7%, but the institute's scientific and technical research and services program, which funds the NIST research labs, is up 5.4% to \$334 million. The Advanced Technology Program, an annual target for elimination by the administration, is cut 43%, but survives with \$80 million in funding. The Manufacturing Extension Partnership receives \$106 million, well above the \$47 million in phase-out money the administration requested.

Another \$49 million goes to major renovations of NIST facilities in Maryland and Colorado as part of the construction and research facilities unit. But, according to AAAS analysts, \$127 million in congressional mandates was included for building projects in states that don't have NIST research facilities.

**Jim Dawson**

## Mauna Kea Telescopes Step Up Collaborations

If the Gemini and Subaru observatories pull off a proposed joint Wide-Field Multi-Object Spectrograph (WF MOS), the collaboration would epitomize nascent trends in astronomy toward both time-swapping and large "campaign" projects.

The observatories on Mauna Kea have dabbled in time-swapping for a couple of years. Since the beginning of last year, for example, Gemini and Keck have traded five nights a semester. The arrangement gives Keck users access to Gemini's mid-infrared imager and spectrometer, and the Gemini community uses Keck's high-resolution optical spectrograph. On a smaller scale, Keck and Subaru have

**Tight budgets and pricey instruments are spurring a trend among observatories to swap time. To work, though, cultural, technical, financial, and administrative wrinkles need to be ironed out.**

swapped nights here and there, and, starting later this year, Gemini and Subaru plan to exchange five nights a semester.

But the WF MOS collaboration would be much more ambitious, says Gemini acting director Jean-René Roy. "Japan effectively becomes a new partner in Gemini, and Gemini becomes a new partner in Subaru. This is really a new paradigm." The twin 8.1-meter Gemini telescopes, one on Mauna Kea and the other in Chile, have seven member countries, with

the US holding a 50% share. Subaru is Japan's only 8-meter-class telescope; the country's next-largest telescope is 1.88 meters in diameter.

### "Joined at the hip"

The idea for WF MOS came from the Gemini community. A key motivation for the instrument is to probe dark energy in a new way, by measuring the distribution of galaxies (see the story on page 32). "We would measure what amounts to a fundamental scale in the universe at different epochs—before