

lem. In his testimony, Albright noted that ignition will help weapons scientists resolve remaining uncertainties with the physics of boosted fission—a process that occurs in the primary stage.

One area of concern is the shape of the imploding fuel; Moses describes the D-T fuel as compressing into a diamond shape rather than the desired sphere. But recent experiments have demonstrated an ability to manipulate the shape, he says.

Crandall says ignition simulations used in designing NIF failed to foresee the deleterious changes in hohlraum radiation that take place during experiment runs. He now estimates that NIF has less than a 50% chance of reaching ignition with indirect drive. That compares with the 75% probability reported to Congress at the time NIF was given the green light, he notes.

Stephen Bodner, the former head of the Naval Research Laboratory's (NRL's) ICF program, predicted asymmetries and other trouble with the NIF hohlraum design nearly 20 years ago. The symmetry might be improved by increasing the size of the hohlraum, he said, but that would require a laser with as much as five times the energy of NIF.

Other ICF devices, including Omega and the NRL's Nike, have pursued a direct-drive approach to fusion, in which

laser beams impinge directly on the fuel target. Those, however, are far too small to approach ignition. Omega has been performing experiments using a modified symmetry approach known as polar direct drive, which NIF was built to accommodate. According to Crandall, extrapolations of experimental results at Omega indicate that if performed on NIF, polar-direct-drive shots could get somewhat nearer to ignition than has been attained with indirect drive.

Moses stresses that LLNL has no prejudice against direct drive, but he notes that the Omega extrapolations have not been peer reviewed. Modifying NIF to do polar-drive experiments would cost \$200 million or more, he says. But Betti says that Rochester estimates those costs at \$40 million to \$50 million and that indirect-drive experiments could run in parallel with those using polar direct drive. The NNSA's current plan is to evaluate the polar-direct-drive option on NIF in FY 2015.

Meanwhile, though, NIF's struggles with ignition might dim prospects for all ICF. Stephen Obenshain, who now directs NRL's \$6 million Nike program, worries what might happen if indirect drive doesn't pan out. "Do you kill off everything? Do you kill off all the other options? We have a lot of concern about that."

David Kramer

Budget gains for physical sciences will be uncertain at best

The administration's spending blueprint for 2014 finds room for a new space mission and increases for the physical sciences, but R&D budget decreases are looming.

Although President Obama's proposed fiscal year 2014 budget almost certainly won't be enacted as written, his request reaffirms the administration's commitment to science and technology. But with the sharp partisan divide over how to reduce budget deficits, and with sequestration's across-the-board spending cuts scheduled to increase, it appears likely that next year's science and technology budget will decline.

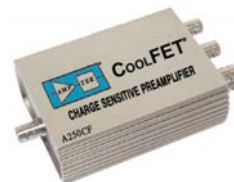
The White House plan puts total spending for basic and applied research at \$68.1 billion, an increase of \$4.8 billion, or 7.5%, over FY 2012 levels. (Comparisons are to FY 2012 because the FY 2013 budget process remained incomplete as the request was finalized.) Overall, nondefense R&D would increase 9.2%, to \$69.6 billion, but defense R&D

would fall 5.2%, to \$73.2 billion. By far the largest component of defense R&D consists of weapons systems development. The request would add a total of \$1 billion, or 8%, to the budgets of three key federal supporters of basic physical sciences research: the Department of Energy's Office of Science, NSF, and the laboratory programs of NIST. Obama has carried forward an initiative begun under President George W. Bush to double the budgets of those three agencies.

The FY 2014 budget request, submitted to Congress on 10 April, more than two months late, exceeds the cap on discretionary spending established under the 2011 Budget Control Act. The president has proposed a combination of tax increases and cuts to entitlement programs to pay for the increased spending. Leadership of the Republican-controlled

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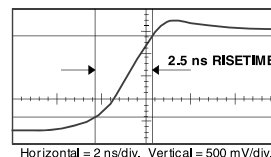
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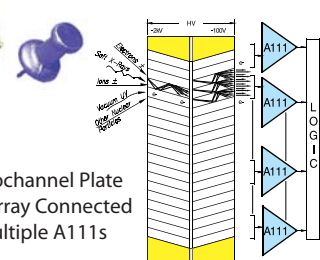
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House of Representatives has made clear its opposition to tax increases.

Mixed reactions

"We're very pleased" with the request, says Alan Leshner, CEO of the American Association for the Advancement of Science. "The strategy of going back to 2012 as a starting point will help us to navigate past the sequestration. The recommitment to NIST, DOE, and NSF is very encouraging. It also sends a very important message to the next generation of young researchers that there is a national commitment to scientific discovery and innovation." But when asked about the chances for the budget's enactment, Leshner said, "Will it happen? I have no idea."

Hunter Rawlings, president of the Association of American Universities, also lauded the request. "AAU and its member research universities have frequently expressed our view that the nation can and should reduce budget deficits but maintain strong investments in research and education," he said in a statement. "Such spending is critical to the nation's long-term economic growth, health, and national security."

House Science, Space, and Technology Committee chairman Lamar Smith (R-TX) complained that "the Administration continues to favor subsidies as-

sociated with its green energy agenda over basic research that helps keep America competitive." In a statement, Smith said, "The bankruptcies of Solyndra, Abound Solar, and Beacon Power have demonstrated a lack of accountability within the President's green energy initiatives. The President now wants more money to fund more pet projects, when it is clear that his administration has not been responsible with the taxpayer dollars that have already been spent."

Smith's reference was to the 55%, nearly \$1 billion, increase sought for DOE's Energy Efficiency and Renewable Energy program, for a total of \$2.8 billion. Congress has repeatedly pared big increases for that program, notes Michael Lubell, director of public affairs for the American Physical Society. He predicts the House will again push back against big increases to the DOE program and other applied research initiatives. He says the administration would be more likely to gain bipartisan support for big increases in basic research.

NASA

The budget request includes a surprise new mission for NASA—to robotically find, capture, and tow an asteroid into an orbit 64 000 km (40 000 miles) outside

the Moon's. Once there, the asteroid would be visited by astronauts who would study it and return samples to Earth. The asteroid mission perplexed some members of the Science Committee. At a 17 April hearing, Smith told presidential science adviser John Holdren that the proposal hadn't been vetted by any NASA advisory panel; Smith said that most of the scientific community would prefer that NASA pursue a manned mission to the Moon instead.

Holdren replied that NASA "has developed an extraordinarily ingenious and cost-effective new approach to that mission." Besides, the space agency had already planned to visit the orbit to which the asteroid would be towed because it is an "equilibration point and a way station for heading to Mars," Holdren said. He added that many scientists who were initially unhappy with the idea of exploring an asteroid have since become enthusiastic about it.

The overall budget for NASA would remain essentially unchanged from FY 2012 at \$17.7 billion. The agency's science programs, at just over \$5 billion, also are flat. Planetary science would decline by 19%, to \$1.2 billion, with the biggest reductions made to the Lunar Quest and Mars Exploration programs. Funding for the International Space Station would rise to \$3 billion from \$2.8 billion, and human exploration would grow to \$3.9 billion from \$3.7 billion.

Department of Energy

The Office of Science at DOE would receive a 5.7% boost, to \$5.2 billion. Basic energy sciences, its largest component, would grow 13.2%, to \$1.9 billion. Scientific user facilities, most of which are funded through basic energy sciences, would see an increase to \$990 million, from \$839 million in FY 2012. The Linac Coherent Light Source-II at SLAC, an upgrade of the heavily oversubscribed x-ray laser scientific user facility, would receive the go-ahead for construction, with funding of \$95 million. The Facility for Rare Isotope Beams, a heavy-ion nuclear physics accelerator at Michigan State University, would get initial construction funding of \$55 million, although formal project approval isn't expected until this summer.

The budget for Brookhaven National Laboratory's Relativistic Heavy Ion Collider would increase by \$2 million to \$165 million, and operating time on the machine would increase by 970 hours, to 2770 hours. Earlier this year it was thought that DOE might shut down the collider for budgetary reasons (see

R&D in the FY 2014 budget by agency

	FY 2012 actual	FY 2014 budget	FY 2012–14 change*	FY 2012–14 percent change
	(millions of dollars)			
Defense (military)	72 916	68 291	–4 625	–6.3
S&T (6.1–6.3)†	12 058	11 984	–74	–0.6
Health and Human Services	31 377	32 046	669	2.1
National Institutes of Health	30 012	30 490	478	1.6
All other Health and Human Services	1 365	1 556	191	14.0
NASA	11 315	11 605	290	2.6
Energy‡	10 811	12 739	1 928	17.8
Atomic Energy Defense	4 257	4 888	631	14.8
Office of Science	4 463	4 744	281	6.3
Energy programs	2 091	3 107	1 016	48.6
National Science Foundation	5 636	6 148	512	9.1
Agriculture	2 331	2 523	192	8.2
Commerce	1 254	2 682	1 428	113.9
NOAA	574	733	159	27.7
NIST§	557	1 626	1 069	191.9
Interior	820	963	143	17.4
US Geological Survey	673	761	88	13.1
Transportation	921	942	21	2.3
Environmental Protection Agency	568	560	–8	–1.4
Veterans Affairs	1 160	1 172	12	1.0
Education	397	352	–45	–11.3
Homeland Security	481	1 374	893	185.7
All other	925	1 376	451	48.7
Total R&D	140 912	142 773	1 861	1.3

*All comparisons are between 2012 and 2014 because of the late completion of 2013 appropriations.

†Defense S&T total encompasses basic and applied research and advanced technology development.

‡DOE 2014 total includes mandatory proposal for the Energy Security Trust.

§NIST 2014 total includes mandatory proposal for the National Network for Manufacturing Innovation.

Source: White House Office of Science and Technology Policy.

PHYSICS TODAY, March 2013, page 32).

Funding for fusion energy would jump 16.6%, to \$458 million, to accommodate a \$225 million US contribution to ITER, which is being built in France. Last year the US contribution to the international fusion energy reactor was \$105 million. The domestic fusion program would drop to \$223 million, from \$296 million in FY 2012. The Alcator C-Mod, an experimental tokamak reactor at MIT, would be shut down and dismantled. High-energy physics would increase by less than 1%, to \$776 million.

Nuclear weapons activities, the major source of funding for the DOE weapons laboratories, would increase 4.1%, to \$7.9 billion. But support for the agency's nonproliferation programs would decline by 7%, to \$2.1 billion. Senator Dianne Feinstein (D-CA), chair of the Appropriations Committee's energy and water development subcommittee, sharply criticized that cutback during a 14 April hearing, saying that it would delay by eight years ongoing programs to convert research reactors to low-enriched uranium, and set back by 20 years efforts to secure radiological sources (see PHYSICS TODAY, May 2012, page 24).

The Advanced Research Projects Agency-Energy, which supports a variety of high-risk clean-energy technologies, would get a 37.8% increase, to \$379 million. A new Energy Security Trust would fund research on clean-energy transportation technologies for 10 years with \$2 billion from federal oil and gas leasing revenues.

NSF and other agencies

The FY 2014 proposal would boost NSF's budget 8.4%, or \$593 million, to \$7.6 billion. Funding for research grants would rise 9.1%, to roughly \$6.2 billion. Within that amount, the budget of the Directorate for Mathematical and Physical Sciences would increase 5.9%, to \$1.4 billion. NSF supplies 45% of all federal support for basic academic research in the physical sciences.

Funding for major research equipment and facilities construction would increase 6.6%, to \$210 million. The request includes \$28 million for initial construction funding of the Large Synoptic Survey Telescope, a project led by SLAC, and for funding to further develop the National Ecological Observatory Network, the Advanced Technology Solar Telescope, the Ocean Observatories Ini-

tiative, and the Advanced Laser Interferometer Gravitational-Wave Observatory.

Although the Department of Defense's R&D budget would fall \$4.6 billion, to \$68.3 billion, the cuts would be concentrated in weapons systems development. The Pentagon's basic research programs would increase 6%, to \$2.1 billion.

Funding for NIST's laboratory programs would increase 21%, to \$754 million. NIST's overall budget request would balloon because of a one-time proposed \$1 billion expenditure to launch a network of manufacturing institutes under an initiative known as the National Network for Manufacturing Innovation. Matching funds would be provided from private and other nonfederal sources. The institutes would become self-sustaining within five to seven years. But the initiative must be authorized by Congress.

Funding for the Department of Homeland Security R&D budget would surge by 185.7%, to about \$1.4 billion, but most of the \$893 million increase would go to fund the construction of the \$714 million National Bio- and Agro-Defense Facility to study emerging diseases.

David Kramer

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