with us. But it's not fair to distort what we said."

The science council's assessment of the ESS flies in the face of world opinion, says ESS chair Peter Tindemans, an independent science policy expert in the Hague, the Netherlands. He points to the 1999 recommendations of the Organisation for Economic Cooperation and Development's Megascience Forum that existing facilities be upgraded and more powerful ones be built in Europe, the US, and Asia. Europe is currently the recognized world leader in neutron scattering. But, says Mason, "their position could be eroded if you look forward. Japan and the US have gotten to work on megawatt spallation sources, which will leapfrog anything that currently exists."

The ESS design includes two 5-MW stations. "The ESS will have long pulses and very high intensity," says ESS science director Dieter Richter of the Research Center Jülich. "It will be an order of magnitude better [than other next-generation neutron sources] in the crucial area of cold neutrons—like in small angle scattering, neutron spin echo, and reflectometry." And, he adds, "it will be an extremely powerful tool for the investigations of polymers, biological materials, the objects of nanoscience, or any area where you look at relatively large scales and correspondingly slow motions."

Complicating the ESS situation is the FRM2, a research reactor near Munich. Completed last year, the FRM2 has not started up because of opposition to its use of highly enriched uranium. Many scientists doubt that Germany is ready to fund a new neutron source on the heels of its investment in the FRM2, especially with that facility still in limbo. "The FRM2 and ESS are on two levels," says Richter. "The FRM2 is a workhorse. But if you want to be present at the frontier, you need something else—like the SNS in the US or the ESS."

Indeed, the seven subcommittee members who protested the science council's report say the deck was stacked against the ESS. In particular, they say, the chair of the subcommittee, Hans Wolfgang Spiess of the Max Planck Institute for Polymer Research in Mainz, who is also a member of the science council, has long been opposed to neutron research. Taking some blame, ESS planners admit their presentation of the project could have been better.

Not surprisingly, Spiess dismisses claims that he biased the ESS assessment. "The allegations are completely unjustified. It's ridiculous how they accuse me." Spiess and science council spokespeople insist that the review followed proper procedures, and that the final report reflects the subcommittee's views. "I cannot understand why people suddenly changed their mind," says Spiess.

"The accusations are incriminating, unfair, and wrong," says Wedig von Heyden, secretary general of the science council. "In its recommendation, the science council explicitly stressed the importance of neutron scattering but requested that the ESS planners make clearer what neutrons can do that other methods cannot." As a science policy body, he adds, "we have to make choices. We have to compare the projects to each other as regards scientific importance and research policy. The final assessment does not have to simply reflect the experts in any given subcommittee."

Burying the polemics

Some scientists worry that the brouhaha surrounding the ESS will have fallout for other scientific projects, tarnish the science council's reputation, and hurt the ESS's chances for gaining support in other countries. To minimize such damage, the arguments over the procedural flaws should be dropped, says Keimer. "We should focus on the science."

In October, ESS planners submitted a beefed-up case for the project, focusing on the scientific uses of neutrons and their complementarity with other investigative techniques. Says Research Center Jülich Director Joachim Treusch, "The Wissenschaftsrat in Germany is a highly respected unit of referees. It is not very sensible or reasonable to fight against this body, at least not for long. My strategy now is, Let's bury the polemics. Let's improve our case and clear up the open questions. I don't feel that we should argue about priority lists. But we are pretty sure that the Wissenschaftsrat will endorse the scientific case."

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President's Science Council Urges More Money for Physical Sciences, Engineering

In a speech last February at the annual meeting of the American Association for the Advancement of Science (AAAS) in Boston, John Marburger, director of the Office of Science and Technology Policy, defended the significant tilt toward the life sciences in federal science funding. Science was within reach of a "frontier of complexity" that "creates far more opportunities in the life sciences," he said. "Given the new atomic-level capabilities [of biological research], the life sciences may still be underfunded relative to the physical sciences," he concluded.

Yet there was concern both in the physical sciences community and on Capitol Hill over the disparity in the distribution of federal research dollars. A House Science Committee

Citing flat or decreasing federal funding since 1993 in many areas of the physical sciences and engineering, PCAST calls for funding "parity" with the life sciences.

summary of President Bush's proposed fiscal year 2003 R&D budget noted that, although NIH would receive a 17% increase, "all other civilian R&D is collectively frozen." (See PHYSICS TODAY, April 2002, page 31.)

When Marburger made the same "complexity" statement before the Science Committee to justify the funding imbalance, Representative Vern Ehlers (R-Mich.) said that if scientific complexity were the real standard for funding, astrophysics should get the most money. Marburger didn't respond.

Now the debate in Washington over the funding disparity between the physical and life sciences has a new participant, the President's Council of Advisors on Science and Technology (PCAST). In a cover letter to Bush that accompanies a draft version of the report entitled *Assessing the US R&D Investment*, PCAST notes that "the greatest concern to the scientific community is the balance between the physical and life sciences," and goes on to suggest "that Fiscal Year 2004 presents the appropriate opportunity to double federal research investments in physical sciences and four major engineering fields from the FY 2002 levels."

The final version of both the cover letter and the report were being slightly toned down before being sent to the White House—the call for "dou-

bling" was changed to "parity" at Marburger's suggestion, for example. The report was expected to be on the president's desk by the end of October.

Defending NIH increases

Marburger, who as OSTP director is also the cochair of PCAST, said he didn't see any inconsistencies between his earlier statements on federal science funding and the recommendations of PCAST. "I think you can defend the NIH increases and still be in favor of balance in spending," he said. "They are not incompatible, but you cannot expect the government to do everything at once." Beyond that, Marburger said, "the issue is not that physical sciences don't deserve money, but putting money in one area doesn't necessarily mean there is an imbalance. How do we know life sciences is not justified in the money they receive?"

PCAST, which consists of 23 members primarily from industry and academia, based its recommendations on a detailed study of the past 25 years of federal R&D investments. The council commissioned the study from AAAS and the Rand Corp's Science and Technology Policy Institute. PCAST also held several hearings with leaders from industry and the scientific community.

In the report, PCAST defines the imbalance problem by saying, "Today the life sciences receive 48% of federal R&D funding compared to the physical sciences' 11% and engineering's 15%. Even if physical sciences, environmental sciences, math and computer sciences are combined, their total share is only 18%." Addressing arguments similar to those Marburger made to the AAAS and Congress, the report says, "It can be reasonably argued that the increase in funding for the life sciences does not necessarily indicate an underfunding of the physical and other sciences. After all, a major revolution is occurring in the biosciences. . . ."

However, the report continues, the lack of funding in fields other than the life sciences is a concern because

- numbers of both full-time graduate and PhD students in most physical sciences, math, and engineering are decreasing while those in the life sciences are increasing
- facilities and infrastructure for the physical sciences are generally becoming inadequate for the needs of today's research
- it is widely understood and acknowledged that the interdependencies of the various disciplines require that all the sciences advance together.

"For all of these reasons it is valid to question whether the unequal support of certain disciplines jeopardizes progress in others in a significant way," the report says. "These imbalances are not easily rectified, especially not in a constrained budgetary situation. Given the decreases in the physical sciences over the past decade, the focus must be to achieve a rebalance by increasing [funding to] these disciplines and not by decreasing the life sciences." Although the PCAST report does not mention the dollar amounts needed to achieve parity, the Rand report says about $7 billion in increased federal funding is needed for the physical sciences and four specific fields of engineering—electrical, mechanical, chemical, and metallurgy and materials.

In a 29 August meeting to discuss the draft report, Marburger told PCAST members that they should not try to achieve parity too quickly. Congress is still debating the FY 2003 budget, and the administration's FY 2004 budget proposal is already being put together "and looks pretty tight," Marburger said. "It's going to be a tough year to make up a lot of ground." The doubling of the NIH budget has taken five years, he reminded the PCAST members.

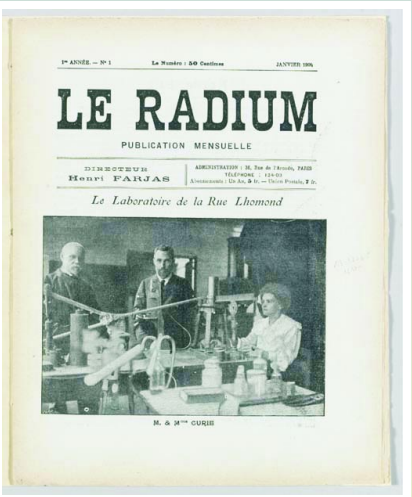
PCAST member Eric Bloch, a corporate R&D consultant and former director of NSF, told participants at the meeting that the $7 billion figure in the Rand report "doesn't include increased funding for math and computer science." Those areas are also underfunded, he said, and "the figure is $10 billion if you include those."

The report does more than just recommend spending more money on the physical sciences and engineering. PCAST also recommends that a "major program of fellowships should be established to attract and support the advanced graduate studies of US citizens in fields of science and engineering that support critical national needs." The report's cover letter notes that, for the past 20 years, there has been a decline in the number of US-born students receiving graduate

Physics Papers Sold at Auction

Modern physics drew nearly $1.8 million at an auction on 4 October. "It was a groundbreaking sale," says Francis Wahlgren, head of the books and manuscripts department at Christie's auction house in New York City. "We've handled Einstein before, but never within the whole context of how he fits into the works of other physicists."

The sale's top draw was an autograph manuscript from 1913–14, with some 50 pages of calculations by Albert Einstein and Michele Besso, in which they checked whether an early version of the general theory of relativity could account for a tiny discrepancy between predictions and observations of Mercury's motion. (It couldn't.) The Einstein–Besso manuscript went to a European dealer for $559 500. One of the few items predating the late 19th century, a fragment of an autograph manuscript by Isaac Newton—some 90 words that he added to the second edition of *Optiks*—brought in the next-largest sum, $89 625, from an anonymous buyer.



CHRISTIE'S

LE RADIUM, the first journal to focus on radium, launched in 1904 and featuring Henri Becquerel (left) and Pierre and Marie Curie on the cover, sold for $2868 at a Christie's auction.

In addition to dozens of Einstein manuscripts, the sale's roughly 3000 books, pamphlets, offprints, letters, and other papers documenting the development of modern physics were penned by Neils Bohr, Ludwig Boltzmann, Paul Dirac, Werner Heisenberg, and James Clerk Maxwell, to name a few. "There is nothing else like this in private hands," says Wahlgren. "Apart from some institutions, you don't see this many manuscripts of this sort together. It's a unique collection."

The collection had been amassed over two decades by Harvey Plotnick of Chicago. Plotnick sold his physics collection to devote money and time to another passion: early Islamic art.

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degrees in the physical sciences and engineering. "This gap at the graduate level has been taken up by an influx of foreign students, but we are facing an overdependence on this talent pool . . .," the letter says. "Testimony from both private industry and the federal sectors expressed strong concerns about the pending retirement of a generation of physical scientists and engineers with few options for replacing them."

The report's final recommendation is a response to the increasingly interdisciplinary nature of science and the difficulty of coordinating programs that are overseen by several different federal agencies and funded by multiple congressional appropriations committees. PCAST calls for the creation of a classification system to "help assess the patterns of federal investment in R&D against its ability to meet national needs." The report also calls for more systematic monitoring of foreign science and technology efforts to ensure that the US stays competitive. **JIM DAWSON**

Fusion Energy Panel Urges US to Rejoin ITER

A burning plasma is within reach and fusion could start providing electricity in as little as 35 years, according to several fusion researchers.

Declaring that the fusion community "sees itself on the threshold of a giant step forward," the Department of Energy's independent Fusion Energy Sciences Advisory Committee has strongly endorsed a recommendation by its Burning Plasma Strategy Panel that the US negotiate to rejoin the multibillion-dollar International Thermonuclear Experimental Reactor project. The endorsement came at the end of an 11 September meeting in which FESAC reviewed the 48-page report titled *A Burning Plasma Program Strategy to Advance Fusion Energy* that recommended rejoining ITER or, as a fallback position, building a smaller US project called the Fusion Ignition Research Experiment (FIRE).

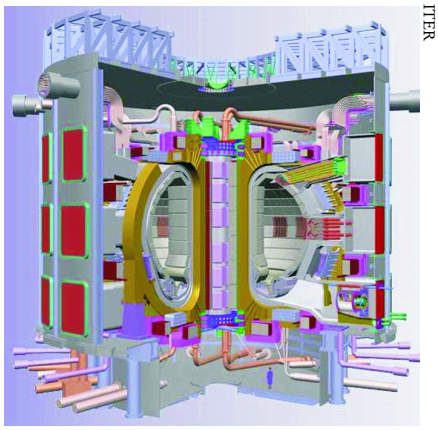
The recommendation that the US enter negotiations to rejoin ITER was enthusiastically embraced by Ray Orbach, director of DOE's Office of Science. Speaking before the National Research Council's Burning Plasma Assessment Committee a week after the FESAC meeting, Orbach said, "The issue for us is how do we approach providing power by the fusion process? Burning plasma physics should be the penultimate step to developing a burning plasma reactor. It's a strong statement, but I think we're in the position to . . . get fusion energy on the [power] grid in 35 years."

The NRC committee listened to two days of presentations about the current state of burning plasma physics and the strategy proposed by the FESAC panel. Orbach asked the NRC committee to deliver a report to him unusually quickly—by early December—so he can use it to support his case that the US rejoin ITER. Haste is necessary, he said, because ITER's current partners—Europe, Japan, Canada, and Russia—are working on a timetable for selecting a site for the facility and expect a final decision in 2004. FESAC and Orbach agreed that the US should try to join ITER as a full partner and have some input into the site selection. To do that, Orbach said, "my perspective is the US should make a decision on whether to enter negotiations by the end of this year, or January or February of next year at the latest."

In a mid-September letter to Richard Hazeltine, chair of FESAC, Orbach asked FESAC to "develop a plan with the end goal of the start of operation of a demonstration power plant in approximately 35 years. The plan should recognize the capabilities of all fusion facilities around the world, and include both magnetic fusion energy (MFE) and inertial fusion energy (IFE), as both . . . provide major opportunities for moving forward with fusion energy." Hazeltine was asked to move quickly to get a preliminary report completed by early next month and a "more detailed plan upon which budgeting exercises can be based" by March 2003.

Orbach's push to move forward was based in part on a white paper prepared for FESAC by six fusion researchers who said if the US participated in ITER and aggressively maintained the rest of its fusion program, "it should be possible to begin operation of a practical demonstration power plant in approximately 35 years." The paper, *An Accelerated Plan to Develop Practical Magnetic Fusion Energy*, was written by Charles Baker, David Baldwin, Robert Goldston, Thomas Jarboe, Stanley Milora, and Miklos Porkolab, all serving on the 47-member Burning Plasma Strategy Panel that wrote the official report to FESAC. The white paper notes that President Bush's National Energy Policy and energy bills on Capitol Hill all point to fusion as a clean energy source. "In parallel with these policy developments," the paper says, "progress in magnetic fusion energy scientific research has been rapid." The scientific results of the past decade, according to the report, "open a pathway to the demonstration of practical fusion electric power. With commitment of effort and focus on critical issues and well-identified milestones, this goal should be achievable."

Orbach tied the development of usable fusion to the global warming issue. To the NRC committee, he distributed charts showing how fusion can contribute to lessening carbon dioxide buildup by 2050. The 35-year goal of getting a demonstration fusion reactor working "is set by environmental needs," Orbach said. "If I could make it happen in 25 years, I would. I think the world needs alternative energy that is CO_2-free, for without it we are on a course with serious consequences." The resurgence of interest in a burning plasma program began with the initiation in 2000 of a series of workshops sponsored by the University Fusion Association. According to the FESAC report, a panel set up after the workshops to assess options "concluded that now is the time for the US to take the steps leading to construction of a burning plasma experiment, and that the funding for the experiment should be in addition to the core fusion energy science budget. . . ." At a July 2002



ITER

ITER IS BEING DESIGNED as a tokamak in which superconducting magnets confine and control a reacting deuterium–tritium plasma.