

US falters on commitments to international science projects

ITER and the ILC are the latest in a series of big-ticket science collaborations to fall victim to the US political process.

As the costs for designing, building, and operating accelerators, telescopes, satellites, and other big experimental facilities have grown, the nations that support basic research are turning increasingly to international partnerships to fund them. But what happens when the world's largest supporter of R&D shirks its obligations to those projects?

This year alone the US failed to come up with a \$150 million contribution to ITER, the seven-party €5 billion (\$7.1 billion) fusion experiment getting under way in France. The \$60 million that was expected to pay the US share for an R&D program for the International Linear Collider, which physicists are hoping will become the next flagship particle-physics laboratory, was slashed to \$15 million. Both cuts were the result of an 11th-hour budget showdown between Congress and the White House—a showdown that had nothing to do with the projects. Meanwhile, a \$1.5 billion high-energy physics experiment built for the International Space Station by a 16-nation collaboration has been grounded, as NASA insists its space shuttle is fully booked.

The US commitment to the ISS has been flagging too. Neal Lane, the former NSF director who later served as President Bill Clinton's science adviser, says the current administration made a "stunning reversal" of policy when President Bush announced his "vision for space exploration" in 2004. Its two big policy shifts, a return of manned spaceflight to the Moon and the downgrading of the \$100 billion ISS, were made without consulting other ISS partners, he says. Giovanni Bignami, the former president of the Italian Space Agency (see the story on page 33), says Europeans have been "let down" by what he believes will amount to the US abandonment of the station after 2015. Bush's vision also sharply narrows the scope of NASA-sponsored ISS experiments to those supporting long-duration human spaceflight.

Mixed record

For the most part, US and foreign scientists and policymakers interviewed for this article give high marks to NSF and

NASA for meeting their obligations to relatively small international projects, those involving tens of millions of dollars or less. Albrecht Wagner, director of the German Electron Synchrotron (DESY), says the US has met its commitments to the collaborations at the Large Hadron Collider and Fermilab's Tevatron. Bignami cites the *Swift* gamma-ray-burst observatory and the *Fermi Gamma-ray Space Telescope*, both with significant Italian contributions, as US-led partnerships that have worked well.

On the other hand, notes Wagner, the BaBar collaboration at SLAC had to be terminated prematurely as the US Department of Energy scrambled to make last fall's abruptly mandated program cuts. And last year NASA nearly wiped out a 12-year collaboration with the German Space Agency on the *Stratospheric Observatory for Infrared Astronomy* before reconsidering the move. "It happens again and again with the US that the rug is pulled away" from under its international partners, Wagner laments.

John Marburger, President Bush's science adviser, says he finds it difficult to make a sweeping case for the US as a poor partner. For many countries, he says, the US is the only partner. "There are a huge number of partnerships in the physical as well as the life sciences, some of them quite large, at NSF, USGS [the US Geological Survey], and NOAA [the National Oceanic and Atmospheric Administration]," notes Marburger. "As far as I can tell, the US is a good partner in polar, ocean, and environment research, although normal funding uncertainties do exist in these fields."

Kenneth Pounds, a physicist at the University of Leicester in the UK, observes that the US isn't alone in retreating from its commitments. The UK tarnished its reputation with what Pounds describes as an "ill-chosen" pullout from the ILC. The British also came close to quitting the seven-nation Gemini telescopes effort to build and operate identical visible-IR instruments in Chile and Hawaii. In that case the funding was later found, and the UK stayed in. Pounds, who formerly chaired the Particle Physics and Astronomy Re-

search Council, the independent entity that until mid-2007 administered UK government research grants in those fields, rates the US a 9 out of 10 for joint projects he's been involved with over more than 40 years, but he admits to a few "annoyances," including "dealing with individuals who were clearly not internationally minded."

Surprise on ITER

What particularly befuddles partnering nations is that the merits of the collaborations that suffer are rarely at issue. No one could have foreseen the loss of this year's US contribution to ITER. "It was a bizarre act. It made no sense at all," says Marburger. No congressional objections were raised over the project; House and Senate appropriators okayed the full \$160 million DOE was to contribute. But when congressional leaders were forced to pare spending bills in December to meet Bush's spending caps, they went looking for presidential priorities to cut as payback. They found the increases to the basic research programs in DOE's Office of Science, in NSF, and in NIST that were part of Bush's American Competitiveness Initiative. At DOE, the last-minute cuts fell disproportionately on particle physics and ITER. When it was over, only \$10 million of the \$160 million contribution was appropriated, and even that was due to an oversight.

DOE Undersecretary for Science Raymond Orbach insists that the US commitment to ITER is unwavering. And there is no reason to suggest that either presidential candidate objects to the project. Marburger acknowledges the "huge damage [the reneging] did to US credibility." But he argues that the cut doesn't represent congressional intent, because lawmakers never actually voted on a standalone DOE appropriations bill. "One can reasonably expect the next Congress to fix the situation," he adds.

Officials at ITER declined to comment on the US default. In a statement that was released after the US funding cut, ITER Director-General Kaname Ikeda said loss of the US contribution will cause only a minimal delay in completion of the experimental facilities. But

Petawatt laser probes nature at Texas university

Some things really are bigger in Texas—the petawatt laser built by scientists and engineers at the University of Texas at Austin, for one. “[It] is the highest-power laser in the world,” says Todd Ditmire, director of the Texas Petawatt Laser, which held a ribbon-cutting ceremony on 28 August.

The laser has a peak power of 1.2 PW, or 1.2×10^{15} watts. New amplification technology, namely, a combination of nonlinear optics and doped glass to amplify a broad range of wavelengths, has shrunk the pulse duration down to 165 femtoseconds, from 600 fs at the only other petawatt lasers yet built—one in the UK and one, since decommissioned, at Lawrence Livermore National Laboratory. The shorter pulse time means target materials can be heated faster “than anything expands,” Ditmire says, “and you can get plasmas with solid—or higher—densities.”

A key area of study will be fundamental properties of such dense plasmas: “Electrical conductivity, the equation of state—the sort of thing that astrophysicists want to know,” says Ditmire. The petawatt laser will also be used to accelerate electrons by having them surf on plasma waves. “We should be able to get to 10 GeV,” says Ditmire. “That’s starting to get into a regime in which high-energy physicists might take notice.” Other lines of research include looking at aspects of inertial confinement fusion and ejecting protons from one material to heat a second target to fusion temperatures.

The first research effort, Ditmire says, will be to focus the beam into a gas of deuterium clusters, a few thousand atoms per cluster. “The laser ejects the electrons, leaving a ball of ions. These ions repel each other and the ball explodes.” The resulting ions can fuse with ions from other exploded clusters. “It’s not interesting for energy production, but it’s a bright burst of fusion neutrons,” he says. The neutrons, he adds, can be used in pump-probe materials studies.

The petawatt’s \$15 million tab was footed by the National Nuclear Security Administration through earmarks in energy and water appropriations bills obtained thanks to Texas Republican Senator Kay Bailey Hutchison. “Senator Hutchison has long championed efforts to strengthen innovation and research at our nation’s education institutions,” says aide Courtney Sanders. Hutchison, a member of the Senate Committee on

TEXAS PETAWATT GROUP



Front-end amplifiers fill one of three rooms that make up the world’s most powerful laser. The Texas Petawatt Laser Facility uses power amplifiers scavenged from Nova, an earlier laser from Lawrence Livermore National Laboratory.

Appropriations, was “proud to help make the project possible through federal funding,” Sanders says. The information gleaned from experiments with the laser will “improve our ability to certify the reliability of the aging US nuclear weapons stockpile without underground nuclear testing,” adds NNSA spokesman John Broehm. “Universities are a great resource to better our understanding of the physics and are independent of NNSA methods and conclusions. . . . It is extremely helpful to have this outside perspective.”

“Importantly,” says Ditmire, “this is the only petawatt laser on a university campus in the US. It will play a significant role in educating students in high-intensity laser and high-energy-density science.” Although the laser will not be used for classified research, he adds, “NNSA wants us to train good students who could then go work for the weapons labs.” Mechanisms for outside researchers to use the petawatt laser are still being formulated.

Toni Feder

Kaname’s predecessor at ITER, Robert Aymar, says the damage caused by the missed US payment will be difficult to undo and may cost the US its chance to host the ILC. Pledges of support from partner nations must be “robust,” he says, capable of riding out elections or sudden shifts in domestic policies that may occur in each contributing nation.

Aymar, who is retiring in December as director-general of CERN, says the US is hardly alone in having to cope with such “accidents.” But, he adds, the US may be the only contributor that has both constitutional and cultural impediments to meeting its international commitments. Constitutionally, he notes, one Congress cannot instruct succeeding

Congresses to appropriate funding for anything. Culturally, although the ITER agreement doesn’t carry the same force as a treaty, Aymar observes that the US is the only ITER party that hasn’t ratified the Vienna Convention on the Law of Treaties. That pact commits signatories to abide by their treaty obligations even if they conflict with domestic policies. Finally, he says, the US frequently makes unilateral foreign policy decisions without consulting other nations.

“The US is a large country that assumes it can do everything alone, and that is [often] true. But in that case, in principle it cannot be a partner,” Aymar maintains. With ITER now in the construction stage, a US default or with-

drawal would do much more damage than the last time the US jilted ITER, in 1999. (It rejoined in 2003.)

ILC curtailed

Barry Barish, a Caltech professor who heads the worldwide ILC R&D collaboration, believes the ITER cut was more damaging to US prospects for hosting the ILC than was the big hit the ILC program itself took in the December budget crunch. The \$35 million for the ILC that congressional appropriators have provided for fiscal year 2009 will appear to be a big leap from the \$15 million of FY 2008, but it’s actually back to the FY 2007 level. With the US providing about 30% of the worldwide total,

"the global effort will go on, though with some holes," says Barish. The reduction of US funding has been a particular setback to US development and industrialization programs for making the superconducting RF cavities that are a key ILC component.

Another major international undertaking imperiled by a US change of heart is the \$1.5 billion Alpha Magnetic Spectrometer, a massive high-energy physics instrument designed to be bolted onto the ISS. Built over 14 years with contributions from 16 nations, the now nearly completed AMS was scheduled for delivery via space shuttle until NASA removed it from the shuttle manifest in 2006 (see PHYSICS TODAY, May 2007, page 30). In the wake of the *Columbia* crash and the decision to retire the shuttle fleet in 2010, NASA determined that all remaining shuttle flights would be needed just to finish building the ISS.

Samuel Ting, the MIT physicist who has headed the AMS collaboration, says the US, which contributed just 5% of the AMS cost, "has a moral obligation to [its] partners" to deliver the instrument. Now, with US–Russia relations deteriorating after Russia's August incursion into Georgia, NASA administrator

Michael Griffin has ordered an internal review into the possibility of extending shuttle operations. In an 18 August internal e-mail first reported in the *Orlando Sentinel*, Griffin predicted that the next president will extend the shuttle's life as the "only politically tenable course" to eliminate what he has called "unseemly" US dependence on Russia for access to the ISS after 2010.

What next?

Marburger and other US science policy watchers tend to blame the political system, and the annual appropriations process in particular, for US ambivalence toward big international projects. DESY's Wagner doesn't buy that excuse. "Germany, and all civilized nations," allocate funding on either an annual or biannual cycle, he points out. Although funding cuts may at times have to be made in Germany, they occur only after the parliamentary committees with oversight have consulted and negotiated with the affected agencies. Like other non-US scientists, Wagner worries that the US remains "too self-centered" at a time when international collaborations are becoming increasingly important for big science. Those projects, he says, "are like a symphony.

You can't remove the violins and expect the music to sound right."

Barish cautions against "throwing rocks at Congress" and the legislative process. The short-term nature of the US funding process does offer the advantage of allowing lawmakers to respond nimbly to new developments. He suggests that the Office of Science and Technology Policy, which Marburger heads, might develop some guidelines that would convey to Congress the importance of big collaborations to the continuing health of the US scientific community. Stanford University physicist Arthur Bienenstock, a former associate director of the OSTP, says the new president's science adviser "will have to put in some time with Congress" to explore solutions.

For his part, Marburger believes that particle physics stands out as the field "most vulnerable to US commitments" in coming decades. The field, he says, "has clearly crossed a border into an unknowable future. It remains a glorious, intellectually profound, highly international enterprise in which the US, the world's leading sponsor of science, has the ability and, I believe, the obligation to provide stability as [the field] finds its way." **David Kramer**

India revives neutrino research

Some 45 years after the discovery in India of atmospheric neutrinos, a new lab and detector could put the country back on the international neutrino research scene.

An underground lab planned for India aims to, among other things, nail the neutrino mass hierarchy and increase the number of high-energy experimenters in the country.

The India-based Neutrino Observatory—so named because the 20 physicists at seven Indian institutions who spearheaded INO hope it will eventually become an international project—has in the past year received initial approval and promises of funding from the Indian government. Final approval is expected in the next few months, says project spokesman Naba Mondal of the Tata Institute of Fundamental Research in Mumbai. The project now has some 100 individual members from 25 institutes, with the University of Hawaii the only one outside of India so far. "It is the first time such a large collaboration from various institutions in India have come together to build an experiment that will be located and function in the country," Mondal says. It's also the largest and, at \$220 million—including 10 years of operations—costliest basic scientific project

ever undertaken in India.

The observatory would be dug into the Nilgiri mountains in the state of Tamil Nadu. The site is near a hydroelectric power plant, so roads and other infrastructure already exist. Some 1300 meters of granite would shield the experiments from cosmic rays.

Local environmentalists have opposed the INO site because of a nearby wildlife sanctuary. The observatory would be outside of the protected region, although during the construction phase trucks would drive through it. The project expects to get the green light for the site soon, Mondal says, and INO scientists are talking with ecologists about co-operating on such things as watch towers to monitor elephant movement and vehicle traffic. "Our plan is to develop INO as a model institution combining its scientific goals with preservation of the environment and ecology," he says.

No technological showstoppers

"From time zero, it takes approximately five years to build the tunnel and cavern," says Mondal. The first of three

16-kiloton modules for an iron calorimeter detector (ICAL) will be ready around the same time, he adds, and the full detector will be completed about two years later.

The detector will consist of alternating horizontal layers of iron and resistive plate chambers. Incident neutrinos that interact with the iron will produce muons (in the case of muon neutrinos), which will be detected by the RPCs. (Although ICAL—like other experiments—will also detect electron and tau neutrinos, their signatures are messier.) An applied magnetic field will send resultant negatively charged muons and positively charged antimuons (from anti-neutrinos) along trajectories with opposite curvature. "Because of this ability to distinguish the positively and negatively charged muons," says Mondal, "this detector can in principle determine the ordering of neutrino masses"—one of the fundamental open questions in neutrino physics.

To start with, INO will be used to look for atmospheric neutrinos. "This will work out of the box," says the