Progress in fusion, but not in its US funding

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Although some countries are, like the US, struggling with funding, they are forging ahead with fusion—especially in Asia.

President Obama's proposed budget for fiscal year 2013 is bad news for both the US domestic fusion program and ITER, the international fusion test reactor under construction in Cadarache, France. (See PHYSICS TODAY, April 2012, page 33.) The domestic program's $300 million would be cut by about $50 million, and an increase of roughly $45 million to ITER's $100 million falls far short of the funding needed to keep up with US construction commitments—9% of the total machine—to meet the first plasma date of 2020.

In late April the Senate appropriations committee endorsed the president's proposal. But the immediate outlook will improve if the House markup, which would provide $475 million—$77 million more than the proposed budget—leads to reprieve for FY 2013. The bigger problem "is the train wreck coming down the tracks," says Raymond Fonck, a University of Wisconsin–Madison physicist and member of the US Department of Energy's Fusion Energy Sciences Advisory Committee (FESAC). "If the program remains capped at $400 million, we either lose ITER or we lose the domestic program."

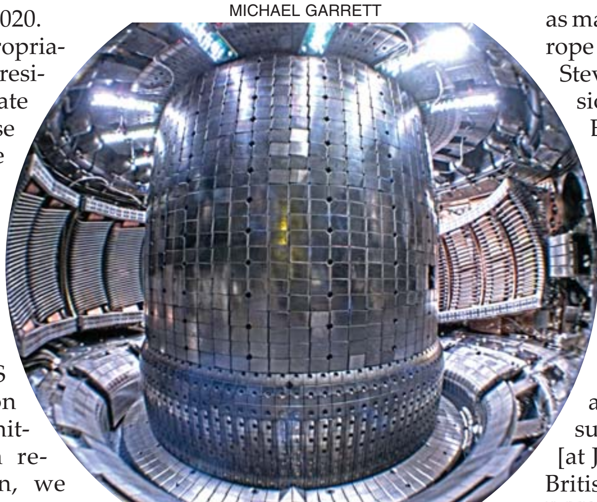
"It's an odd situation," says Fonck. In the fusion community, "there is a sense of tremendous progress and promise, and that the program is ready to bust open into true energy." At the same time, he notes, "We are struggling with what looks like not much commitment on the street. Losing $50 million will cost us hundreds of professionals. That's what we are yelling about."

Domestic casualties

The proposed cuts would shutter MIT's tokamak, Alcator C-Mod, which is used by some 120 people, including students. The run time of the DIII-D tokamak at General Atomics would be reduced by several weeks per year and a planned upgrade would be delayed. An upgrade to the National Spherical Torus Experiment at Princeton Plasma Physics Laboratory would also be slowed down, and the lab would lose some 80 out of 450 people. Under the proposed budget, says C-Mod project leader Earl Marmar, "nothing remains robust. Those three facilities are the only three major experimental facilities in the program. Theoretical and computational projects would also be cut back."

At a February FESAC meeting, Marmar noted that "C-Mod is the only world-class program to study interactions between the hot plasma and the surrounding walls under plasma conditions and power densities required for ITER and for proposed fusion reactors." He objected that the recommendation to close the facility was "abrupt" and came "in the absence of peer review, community input, or a FESAC plan."

MICHAEL GARRETT



If Alcator C-Mod, the tokamak at MIT, closes this fall as the president's budget proposes, the US fusion community would lose a key research and training facility.

Graduate students in the MIT fusion program were so concerned by the president's budget that they launched a website, fusionfuture.org, that combines educational outreach with political news about fusion. "The website gave us a way to feel like we could affect things," says Bob Mumgaard, one of the site's founders. "It's an exciting time to be part of this field, but the budget overshadows that. It's a cold welcome for incoming students."

Exploiting ITER

"It's critical to have a vibrant US program to contribute to the science in ITER, and to build on and take advantage of the science we get out of ITER," says Richard Hawryluk, an ITER deputy director general from the US. "The real question is, Is the US going to maintain substantial intellectual leadership in the fusion program? Or are we going to have a very limited impact on fusion?"

"Some of the best fusion scientists in the world are in the US. There may be as many people from the US as from Europe on the ITER dream team," says Steven Cowley, director of the UK fusion program, which hosts the Joint European Torus (JET), currently the only machine that can operate with deuterium and tritium. "But America can only sustain that if it has a good viable physics program in preparation for ITER. Otherwise people will drift away."

For his part, Cowley says he is "picking out a team of people that are about the right age and making sure they learn as much as they can [at JET], so that in 10 years a bunch of British physicists will have a key role in ITER. If you don't have physics experiments, then you won't have the people who are part of the physics team to operate ITER."

To meet its obligation, the US will have to ramp up spending on ITER. "In any reasonable funding scheme, it's going to be $300 million to $400 million a year," says Marmar. That money was never intended to come from the US domestic fusion program, but "that is where we are headed on a flat budget," notes Marmar, and if it does "you would basically wipe out our community." Although US ITER project manager Ned Sauthoff won't put a figure to it, he says his team has less costly funding scenarios. "We are working hard to determine to what extent we can reduce costs while maintaining performance." If funding falls short for only one year, the ITER organization expects it could shuffle things to avoid delays. "The US is the weakest link," says Stewart Prager, director of the

Princeton Plasma Physics Laboratory. "It's unbelievable."

"The energy conversation"

Indeed, despite tight economies, Europe is on track with its ITER contributions, having recently allocated an additional €1.3 billion ($1.7 billion) to the project; as host of ITER, Europe bears a 45% lion's share. European money for national fusion programs has gone down, says Sibylle Günter, director of Germany's Max Planck Institute for Plasma Physics. "Germany has a strong program, but it's an ongoing discussion. The general problem of the economy hits all countries [in Europe]. The question is how the politics play out." Like the US, the other partners—China, India, South Korea, Russia, and Japan—have each committed to providing 9% of ITER.

China, in particular, is moving aggressively ahead—covering not only its ITER commitments but also planning to build a next-step fusion facility on its own. If the US does not keep up in the field, says Marmar, "we could end up buying fusion reactors from Korea or China. I don't want to see that happen."

"The whole tenor of the energy conversation is vastly different now than it was three and a half years ago," says Cowley. "Then, they were saying we have to find a solution to global warming." But after the nuclear meltdown in Fukushima, "everything has cooled on fission. And although it's clear that there is far more fossil fuel than we should burn, nobody has an appetite for environmental legislation during a recession." As a result, he says, "low-carbon energy, including fusion, has become less and less of a priority."

Still, says Cowley, "it's amazing how much more attention you can get [for fusion] when you can quote that the Chinese are on the march." The fusion community is at "a breaking point," Cowley continues. "If we do not do ITER, we will degenerate. We will lose knowledge that we have built up over 50 years. We are just beginning to do fusion. It's critical that we push on, make sure we do ITER, and move on to deliver commercial fusion energy."

As for the US, some optimism may be drawn from the charge that William Brinkman, director of DOE's Office of Science, put to FESAC on 13 April. He asked the advisory committee to set research priorities for the magnetic fusion energy science program. In doing so, Brinkman wrote, FESAC should assume "that the ITER project is ongoing, will be until the end of this decade, and is supported separately from the rest of the program."

Toni Feder

Stove designed by US national lab improves lives in Darfur

In cutting the wood fuel requirement in half, the stove also reduces Darfuri women's exposure to violence.

When the US Agency for International Development asked physicist Ashok Gadgil seven years ago to see whether food wastes could be used as cooking fuel in displacement camps in Darfur, he quickly concluded that even under the most optimistic scenarios, way too little food waste was available to burn. But Gadgil, acting director of the environmental energy technologies division at Lawrence Berkeley National Laboratory (LBNL), saw another way to improve the lot of Darfuri women in the camps: a stove that would dramatically reduce the amount of wood they had to gather for cooking. Increasing stove efficiency would commensurately reduce women's exposure to sexual assault, which occurs regularly during their lengthy foraging excursions.

Gadgil led a small team from LBNL and the University of California, Berkeley, to Darfur in 2005. His idea, he says, was to "get somebody else's stove to work [better] for them; then I've done my job and I'm out of there." But what the researchers found was that virtually all the food in the camps was being prepared over a "stove" consisting of three stones on the ground. Finding no indigenous stove to improve on, the team set to work at LBNL to modify an Indian stove design to suit the pot shapes, cooking style, type of food, windy conditions, and sandy terrain of Darfur. In consultation with Darfuri women, the designers modified air openings to allow the stove to burn in windy conditions and altered a small firebox opening to reduce the amount of firewood needed.

POTENTIAL ENERGY

A Darfuri mother and child tend to a meal cooking on a Berkeley-Darfur stove.

A big market

"In terms of the physics end of it, of course you want high combustion efficiency, where you're not left with charcoal and smoke, which is where some of the chemical energy could go," Gadgil says. "And you want good heat transfer efficiency, so you're not just heating the kitchen air but putting the heat into the pot."

Of the 2.4 million Darfuris displaced to sprawling refugee camps by an 8-year-old civil war, some 22 000 families now have one of the LBNL-designed stoves. The stoves are built mostly from low-carbon steel sheet but have a cast-iron grate and stainless-steel heat shield. They are built specifically to accommodate the traditional cooking pot used in Darfur. In addition to consuming less than