NUCLEAR FUSION

JET Takes a Step Closer to Break-Even

Researchers at the Joint European Torus (JET), the European fusion test reactor at Abingdon near Oxford, announced last week that they have come closer than ever before to break-even, the point at which a fusion reactor produces as much energy as it consumes. Burning the same mixture of hydrogen isotopes that would fuel an actual fusion power station, JET produced 50% of the energy supplied to the reactor—close to twice the previous record.

In a fusion reactor, deuterium or tritium nuclei (hydrogen atoms with one and two extra neutrons in the nucleus, respectively) fuse and form helium nuclei and neutrons. A small amount of mass is lost in the reaction and is converted into energy. However, fusion takes place only when the deuterium and tritium nuclei are confined inside a torus by powerful magnetic fields and heated to temperatures of over 100 million degrees. Heating the gas to such temperatures with beams of neutral particles, radio waves, and electric currents running through the plasma requires a huge amount of energy.

Until recently, experimental fusion reactors all used a fuel consisting mainly of deuterium and a smaller proportion of tritium (about 11%), which yields less energy. In 1995, however, the Tokamak Fusion Test Reactor (TFTR) in Princeton, New Jersey, burned a 50-50 deuterium/tritium mixture to produce 28% of the energy needed to heat its plasma. Now JET, also burning an equal mix of deuterium and tritium, has moved halfway to break-even, in the process generating more than 12 megawatts of fusion power. "We hope to improve this [output/input ratio] somewhat over the next weeks," says JET director Martin Keilhacker. JET deputy director Alan Gibson explains that they plan to confine the plasma within several different magnetic field configurations: "So far, we have only used the first of these, and some of the others we think probably have promise to go to higher values of this ratio."

Gibson says that the output of TFTR, which was shut down earlier this year, was limited by geometry. "The shape of the cross section of the plasma in JET is D-shaped, while in the TFTR the cross section is circular," he explains. "The D shape has advantages from the point of view of stability," Gibson adds, and allows the use of a diverter, a circular chamber in the bottom of the torus vessel that siphons off impurities that would otherwise slow the reaction. Gibson believes that it may be possible to reach break-even with JET, which will operate until at least 1999. "It depends on how successful we are in fine-tuning the plasma behavior," he says. Experiments with an output/input ratio closer to one are interesting because "the self-heating in the plasma by the fusion power becomes progressively more important, and one of the things we plan to do at JET is to measure this self-heating," Gibson says.

JET

Fusion first. JET sets records with a 50-50 mix of deuterium and tritium fuel.

The results so far, continues Gibson, "are very encouraging for ITER"—the proposed $10 billion International Thermonuclear Experimental Reactor, which, if built, would use the same fuel mixture and would also use a D-shaped plasma and a diverter. However, Michael Mauel of Columbia University, who works on General Atomics' DIII-D tokamak in San Diego, stresses that today's tokamak experiments still aim at improving the physics of fusion rather than demonstrating fusion power. "The importance of the JET experiment is not to demonstrate ignition, but to demonstrate that we understand the physics of plasma at 100 million degrees," he says. "And what is so exciting is that our expectations and our understanding appear to be right."

Other fusion experts are also excited by the news. "It is wonderful that they have achieved high performance, and I hope they continue their experiments," says William Dorland, a researcher at the Institute of Fusion Studies of the University of Texas, Austin. "It is too soon to know what it means for ITER, but it could be good."

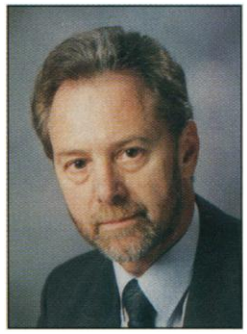
–Alexander Hellemans

Alexander Hellemans is a writer in Naples, Italy.

U.K. ASTRONOMY

Staff Makes Bid to Privatize Observatory

CAMBRIDGE, UNITED KINGDOM—Efforts to save the 300-year-old Royal Greenwich Observatory (RGO) from closure will face a crucial test next week. Earlier this year, RGO seemed headed for oblivion when it lost out in a contest with the Royal Observatory Edinburgh to become Britain's single Astronomy Technology Centre (ATC), serving telescopes in the Canary Islands and Hawaii (*Science*, 11 July, p. 169). But RGO's staff has since come up with a business plan to transform the observatory into a private institution that would build small, robotically controlled telescopes, up to 3 meters in diameter, for the international market. On 8 October, the Particle Physics and Astronomy Research Council (PPARC), which currently funds the two Royal Observatories, will decide whether to allow RGO to pursue this plan. Failure to support it could kill RGO through loss of key staff members.



EADEN LILLEY

Hoping for reprieve. RGO director Jasper Wall.

PPARC's decision in July to merge the Royal Observatories and relocate all instrument-building and technical support to Edinburgh prompted fierce opposition from many astronomers. Science Minister John Battle backed the decision, but asked the council to try to find a way to save the name of the RGO, which is Britain's oldest scientific institution. RGO's rescue plan would achieve that, but it would still require shedding staff, perhaps as many as half of the current 110 employees.

In addition to turning RGO into an international telescope builder, the plan would maintain some functions RGO currently performs for other organizations. "About one-third of our income comes from other activities such as maintaining the Nautical Almanac, gathering satellite tracking data for the Natural Environment Research Council, and public understanding of science initiatives," says RGO director Jasper Wall. The observatory is also in talks with Cambridge University on the possibility of closer links. The RGO and the university's Institute of Astronomy, sited next door, have recently merged libraries. "We now have one of the world's finest astronomy libraries," says Wall.

Hopes that the RGO might survive in some form have won the backing of many British astronomers. "A lot of the world's

small telescopes are old and operated manually, which can be very expensive. I think their plan is a good one," says astronomer Phil Charles of Oxford University. Indeed, Wall says 16 countries have already expressed interest.

Wall argues that the scheme would be a cheap option for PPARC. "The plan would save considerable sums PPARC [has] set aside for redundancies," says Wall, who is anxious for a formal decision at next week's council meeting. Any further delay, he says, could lead to the loss of key staff. But PPARC administrator Jim Sadlier says the plan is not yet complete, and a final decision may be delayed until the end of the year. "We hope we can report positively next week and give a sufficiently strong signal," he says.

The plan could put PPARC in a difficult position, however. An independent RGO might end up competing with the new ATC, which is planned to be up and running next year, as a source of instrumentation for British astronomers. "The RGO mustn't undermine the ATC," says Sadlier. Wall agrees: "We don't want to be in competition," he says. "In the end, we are looking for cost-effectiveness."

For most astronomers, the continuing wrangling and doubt over the RGO's future has been an enormous waste of time and money. "PPARC is the responsible steward for the RGO, and it should continue to fund [the RGO] as a scientific institution," says Astronomer Royal Martin Rees. "It would be a disaster if the RGO were to disappear," says Charles.

–Nigel Williams

CONGRESS AND THE BUDGET

Friendly Finish Looms on Spending

Congress is proving kind to most federal science and technology programs as it wraps up work on the 1998 budget. The National Science Foundation (NSF) can look forward to a 5% boost in research, spending for defense R&D will rise enough to cover inflation, and most technology programs that the Republican Congress loved to hate only a year ago have sailed through both houses.

But some of the details are not so rosy. Cash-strapped NASA, for example, faces another delay in the space station. Congress also ordered the Department of Energy (DOE) to postpone for at least a year the restart of a troubled reactor used by neutron scientists at Brookhaven National Laboratory in Upton, New York. And it failed to grant NSF's wish to build a polar cap observatory near the magnetic North Pole.

Here are some highlights of the appropriations bills that emerged from joint House-Senate conferences last week. They must still be approved by each body and signed by the president:

■ **NSF:** The good news is that the agency's research account will increase by $113 million to $2.55 billion. The bad news is that NSF must spend $40 million of that increase on a plant genome initiative, a project promoted by agricultural lobbyists and championed by Senator Kit Bond (R–MO) that was not part of NSF's request (*Science*, 27 June, p. 1960). The agency's education programs will receive $633 million, a 2% rise that doubles the request.

The toughest decisions came in the agency's account for large facilities. Legislators did not fund a $25 million polar cap observatory to study solar–upper atmosphere interactions, asking for more information on the proposed site near the magnetic North Pole in northwest Canada. Senator Ted Stevens (R–AL) wants the facility built at an Alaskan defense lab, which scientists say would greatly reduce its value. But conferees added $4 million to complete the twin Gemini telescopes and maintained initial funding for the $200 million millimeter array. And they voted $70 million for a new South Pole station, a compromise between the Senate's $25 million increment and the House's $115 million that would have funded the full cost of construction. They also dropped a House plan to give $5 million more to two supercomputer centers being phased out.

■ **NASA:** The space agency received $13.65 billion, $100 million above the request and close to the 1997 level. But that windfall won't go far, as the agency failed to win approval to move money from other accounts into the station budget to meet cost overruns. Lawmakers like Senator Barbara Mikulski (D–MD) worried that other programs—particularly the space shuttle and science efforts—would suffer as a result, so it severely restricted the agency's flexibility. Congressional sources say the language is intended to force the Administration to request a bigger NASA budget, but NASA managers aren't heartened. "We're in a bad situation," says one. "This would force a slip in the station's schedule."

Mikulski also insisted that NASA use more competitive methods to distribute money set aside for programs such as New Millennium, a new program administered by the Jet Propulsion Laboratory in Pasadena, California, that aims to test advanced technology for future space science missions. That move could open the door for Johns Hopkins University's Applied Physics Laboratory in Mikulski's home state.

■ **DOE:** There were few surprises in DOE's final 1998 budget, which meets the Administration's $2.36 billion request for science programs. Conferees did give high-energy physics and nuclear physics slight increases, and added nearly $25 million for several pork-barrel projects in biological and environmental research. DOE can continue to clean up the leaking High-Flux Beam Reactor at Brookhaven, but is forbidden from spending money on restarting it for 1 year. Martha Krebs, DOE energy research chief, says the reactor would not have been ready for a restart then anyway, but that a decision on its future is due in January. However, opponents may try to extend the provision next year.

■ **Environmental Protection Agency:** The agency's science and technology account appears likely to receive $15 million more than the president's request and $80 million above the 1997 level. But the $630 million figure includes $23 million more for a research program on the health effects of particle air pollution, with advice from the National Academy of Sciences. The conferees discarded proposals from the House to funnel this money through other agencies and a Senate plan to set up university-based research centers.

■ **Defense Department (DOD):** Funding for basic science at DOD has survived a roller-coaster ride to finish at about the same level—$1.08 billion—as this year. Applied research funds will increase 8.9% to $3.1 billion. This category includes grant money for university research activities, which increases by 7% to $230.8 million. Total R&D at the Pentagon rises 3.5% to $37.9 billion. In addition, the conferees have retained several popular biomedical programs, including $135 million for breast cancer studies and $45 million for prostate cancer research. "It's a mixed bag," says analyst George Leventhal of the Association of American Universities.

Meanwhile, the massive bill that includes funding for the National Institutes of Health was still in limbo after legislators met last Friday. Biomedical advocacy groups hope the conferees will split the difference between the House's offer of a 6% increase and the Senate's offer of a 7.5% raise.

–Andrew Lawler

With additional reporting by Jocelyn Kaiser, Eliot Marshall, and Jeffrey Mervis.