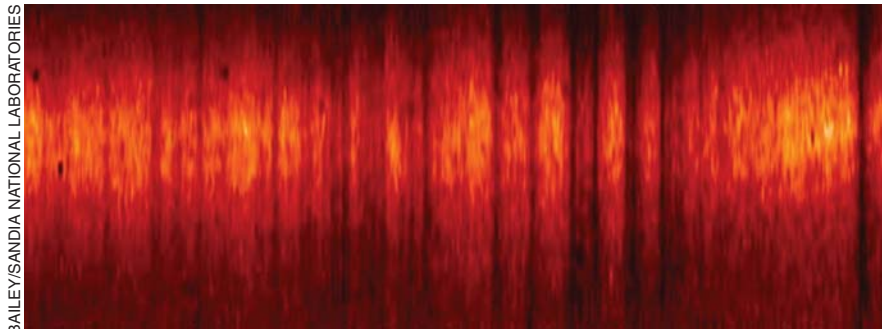




JIM BAILEY/SANDIA NATIONAL LABORATORIES

Transmission through iron plasma, created by heating an iron foil with radiation from an implosion, is used to study aspects of stellar interiors. Incident photon energy increases to the right; the vertical axis represents the width of the foil.

single shot drives all four experiments, each designed to produce a uniform, long-lived (3–100 ns) plasma. The densities span six orders of magnitude and the temperatures vary by a factor of 200.

The stellar interiors project is motivated by disparities between models and helioseismic measurements. In recent years, explains Bailey, the inferred composition of the Sun has been revised, which led to changes in the calculated internal solar structure. As a result, the predicted location for the boundary that separates the inner radiative energy transport zone from the outer convective transport zone now disagrees with helioseismology. That boundary location depends on how much the solar matter attenuates radiation. Bailey and collaborators put iron about 1 mm from the z pinch to measure its opacity at 2.2 million kelvin, the temperature of the radiation-convection boundary in the Sun. “Our goal is to test the physical underpinnings of the models for the opacity,” he says. (See figure, above.)

Roberto Mancini of the University of Nevada, Reno, reproduces photoionizing conditions found in warm absorber plasmas around active galactic nuclei and in winds driven by black hole accretion disks. A cell filled with a mixture of neon and hydrogen gas sits about 5 cm from the z pinch; the pinch x rays turn the neutral gas into a photoionized plasma. “We want to under-

stand the atomic physics and heating of this plasma for a range of ionization parameters,” Mancini says. “We are beginning to see qualitative similarities between our measurements and theoretical predictions, but the quantitative values are different. It’s very exciting.” In separate experiments silicon is photoionized to test a theory about differences in emissions from black hole and x-ray binary accretion disks.

The ZAPP white dwarf studies use the largest sample at the greatest distance, 35 cm, from the z pinch. X rays from the pinch heat a 12- by 1-cm gold foil. As the gold cools, its thermal radiation ionizes hydrogen to re-create conditions in a white dwarf photosphere. “Instead of looking at the light from a white dwarf and inferring the conditions, we are making the conditions and looking at the light,” says Ross Falcon, who is finishing his PhD at the University of Texas at Austin, on his ZAPP work. In particular, Falcon is testing new theoretical calculations that assign systematically more mass to white dwarfs.

Sandia officials see basic research as both intrinsically interesting and key to attracting and keeping good scientists at the weapons lab. “For my own research,” says Knudson, “I find the planetary side of things very rewarding. It’s a factor in keeping me here.”

Toni Feder

Turmoil at ITER continues

Council chair says a new director general, a halving of senior management, and improved relations between headquarters and the project’s seven partners are on the way.

In response to a blistering external review and congressional pressure for the US to end its participation in ITER, the international fusion test reactor being built in France, the project’s top offi-

cial and governing council are scrambling to implement major management reforms.

Robert Iotti, the US-appointed chairman of the ITER Council, says that each

of the 11 recommendations made by an independent management review team last year is being implemented. Those steps include replacing Osamu Motojima, the current director general of the central ITER Organization (IO), and cutting the number of senior managers there by half or more.

“The project is in a malaise and could drift out of control,” warned the review team’s executive summary, which was leaked to and published by the *New Yorker*. The team was headed by William Madaia, former director of Oak Ridge and Pacific Northwest National Laboratories.

Motojima, who also says he agrees with all of the review team’s recommendations, will present his plan for streamlining the 565-employee IO to the ITER Council at a meeting this month. “When I came here in 2010, one of my biggest priorities was cost containment,” says Motojima. “I am pushing through dramatic changes in the structure, culture, and work processes of the ITER Organization.”

Improving interactions

Iotti, who became ITER council chairman this year, says a successor to Motojima will be selected by the end of 2014. The Madaia committee called the ITER leadership “weak” and “lack[ing] a sense of urgency.” It had urged accelerating the selection process for a new director general.

Iotti reports that officials from the IO and representatives from the member states component design and manufacturing operations reached a consensus in early May on how to improve cooperation. “Clearly, the relationship between the ITER Organization and the domestic agencies needs to be put on a path where cooperation exists most of the time,” he says. The Madaia committee had said that the IO staff, which will assemble the tokamak, should view their success as dependent on the domestic agencies’ success. “That has not been the case to date,” the report stated.

Senator Dianne Feinstein (D-CA), who chairs the appropriations subcommittee funding the Department of Energy, has threatened to delete the \$150 million that the Obama administration requested for the US contribution to ITER for fiscal year 2015 (see *PHYSICS TODAY*, May 2014, page 23). “I’m really beginning to believe that our involvement in ITER is impractical, that we will not gain what we hope to gain from it, and instead this money could much better be spent elsewhere,” Fein-



This test stand at Oak Ridge National Laboratory will demonstrate that a US contribution of large-scale 12-inch coaxial transmission lines for ITER's ion cyclotron heating system can perform to specifications.

stein told Energy secretary Ernest Moniz at a 9 April hearing. She added that "this may be an opportunity to experience the power of the purse."

Impatience in the Senate

Iotti expressed disappointment after meeting with Senate appropriations staff on 5 May; he said they appeared unwilling to accept that the reforms will take time to implement. Many of the recommendations require lengthy series of multiple actions, and some won't be fully implemented until mid 2015. "They didn't seem to be particularly willing to understand that explanation," he says. He found no similar impatience in meeting with House appropriators.

A Senate source says that while Feinstein hasn't made up her mind, she remains skeptical about whether the IO can make the necessary reforms at reasonable cost and in a timely fashion. Many of the same management issues had been raised in a 2011 management review conducted by an Indian team.

"The difference is the attitude of the council has changed," Iotti says. "They're going to do something about it." The Madia committee urged the council to "start acting like the board of directors that you are on this project: Take action," Iotti says. "This time they took it seriously."

Unlike the two directors general to date, the next won't necessarily be Japanese, Iotti says. Japan was given the right to name the first director general as consolation for losing the competition for the ITER site to the European Union. Motojima, the second to serve, was appointed after the partners agreed to extend Japan's privilege. Motojima says he has sometimes been prevented

from appointing the most qualified individuals to key posts at the IO without regard to nationality. But Iotti says Motojima has had that ability; he just hasn't always been willing to resist political pressures.

US demands accepted

Feinstein and the Madia committee both were highly critical of the absence of a baseline schedule. The last estimate, for a 2019 completion date, was set in 2008, but it is widely acknowledged that a more realistic date will be around 2023. Iotti says it will take until mid 2015 to establish the baseline schedule. A new cost estimate will accompany the schedule, to be stated in "ITER units of account," a virtual currency. Since the vast majority of contributions from the project partners are to be made in kind, each nation must calculate the value of its contribution in its own currency.

With a 9.1% stake in ITER, DOE has produced cost estimates for its contribution alone that range from \$3.9 billion to \$6.5 billion. The disparity is mainly attributable to contingency amounts (see PHYSICS TODAY, February 2014, page 20). The lower estimate, prepared by the US ITER Project Office, includes \$1 billion to accommodate the expected 3- to 4-year delay in completion. The higher figure assumes greater costs caused largely by schedule slippages. The higher number was calculated by the Office of Project Assessment in DOE's Office of Science.

Realistic and blunt

Deputy Secretary of Energy Daniel Poneman told Feinstein on 9 April that DOE had stated "very bluntly and very clearly that we need to respond and the international organization running the

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ITER project has to respond to all of those management assessment recommendations, has to come up with an action plan, and has to execute.” Poneman joined Moniz at the Senate hearing because Moniz has recused himself from fusion matters. Moniz was previously a physics professor at MIT, which is a DOE fusion-program contractor.

The Obama administration has capped the US annual contribution to ITER at \$225 million, but it has never

come close to including that much in a budget request. Congress appropriated \$199 million for ITER in fiscal year 2014. Edmund Synakowski, associate director of fusion energy sciences at DOE’s Office of Science, told an advisory committee in April that the \$150 million requested for ITER in FY 2015 was appropriate in view of the lack of a baseline schedule. But Ned Sauthoff, director of the US ITER Project Office, told the same meeting that next

year’s request will cause the project schedule to slip further.

Iotti says the ITER project needs to “demonstrate substantial real progress by the middle of 2015; then the project is not only salvageable but will be successful.” At that point, components will start to show up at the site, buildings will be constructed, and, he says, “people will start to think differently, thinking that this is actually going to happen.”

David Kramer

Nuclear energy output slows as climate warms

New reports from the Intergovernmental Panel on Climate Change and the US government say the window is closing for actions to avert the worst effects of warming.

Despite emission reductions by the US, Russia, and some other nations, worldwide anthropogenic greenhouse gas emissions accelerated at an annual rate of 2.2% from 2000 to 2010 and reached a record high of 49 billion metric tons of carbon dioxide equivalent in 2010, according to the fifth assessment of the Intergovernmental Panel on Climate Change (IPCC). By comparison, emissions grew at an annual average rate of 1.6% during 1970–2000. Carbon dioxide equivalent is a unit of measurement used to convert the heat-trapping effects of other greenhouse gases such as methane.

A separate report released on 6 May by the US Global Change Research Program (USGCRP) says that the effects of climate change are already being felt in the US. Effects include longer summers, rising tides, more prolonged heat waves, heavier downpours, and regional changes in the varieties of plant and bird species.

Without any further policy actions to

control emissions of greenhouse gases, the world is likely to see a rise of up to 4.8 °C in the average global temperatures by the end of the century, according to the IPCC. That is more than double the 2 °C rise from preindustrial-era temperatures that scientists have estimated to be the upper limit if the worst impacts of climate change are to be averted.

The USGCRP assessment, which was based on the results from 16 climate models, predicts that if emissions from fossil-fuel combustion are left unchecked, temperatures could increase by up to 5.6 °C by the end of the century. Even with substantial reductions in CO₂ emissions, the temperature could rise as much as 2.8 °C by 2100, says the report.

Viewed against that backdrop, the recent closures of five US nuclear reactors and the threat of additional plant retirements caused by economic pressures on an aging nuclear fleet jeopardize the Obama administration’s commitment to reduce US greenhouse gas emissions to 17% below 2005 levels by 2020.

The US is the world’s second largest emitter of greenhouse gases, behind China. The IPCC estimates that global emissions will need to be slashed by up to 70% by midcentury in order to remain below the 2 °C threshold.

Worldwide, energy production is the largest source of manmade greenhouse gases; it accounts for 35% of total

emissions. Also the fastest-growing emitter, energy supply contributed 47% of the increase in emissions in the 2000–10 period, said the IPCC assessment, the third installment of which was released in mid-April.

Low-carbon sources—nuclear, renewables, and fossil fuels coupled with carbon capture and storage—must grow from their current 30% share to 80% of world electricity production by 2050, the IPCC says. But nuclear’s global share has been declining, from 17% in 1993 to 11% currently, according to the International Atomic Energy Agency.

Off the table

“If you read the IPCC reports, they are clear that maybe we are out of time, but certainly we have little time” to reduce greenhouse gases in earnest, said Carol Browner, former Environmental Protection Agency administrator, at a Washington, DC, conference hosted by the Center for Climate and Energy Solutions (C2ES) on 28 April. “I used to be antinuclear until after I left EPA and started to realize the single biggest problem the world needs to address is climate change, and that you can’t take off the table a technology that is basically carbon free,” Browner said.

Nuclear reactors provide 60% of the nation’s current supply of zero-emissions energy, more than four times the amount generated by wind and solar combined, according to the Energy Information Administration (EIA) of the Department of Energy. About one-fifth of all US electricity is nuclear generated. Since 2005, US CO₂ emissions from the electric-power sector have fallen by 15%, largely due to a shift from coal to natural gas, the economic recession, and increases in energy efficiency and wind generation, according to C2ES. But the EIA forecasts that in the absence of new policies, the proportion

ENERGY



The Vermont Yankee nuclear power plant is one of five US commercial nuclear reactors whose owners have recently announced closures.