JAPAN

Pending Reform Plan Lacks Detail

TOKYO—A blue-ribbon advisory panel to Japan's government is expected to release a report next week that could lead to the merger of the country's two major science-related ministries and the granting of greater independence to its extensive network of national labs. Those changes are among a host of recommendations for streamlining the government, aimed at fulfilling a 1996 campaign promise by Prime Minister Ryutaro Hashimoto. But even before the final wording is ironed out, the plan has generated heated political debate.

The report is the result of a yearlong effort by the Administrative Reform Council to draw up a more efficient administrative system for the 21st century. The once sterling reputation of the Japanese bureaucracy has been severely tarnished in recent years by bribery scandals, cover-ups, and general charges of mismanagement, and the reform council was formed to shrink its size and rein in its power. Akito Arima, a physicist who is president of the Institute of Physical and Chemical Research (RIKEN) based near Tokyo, is the sole scientist on the 15-member panel, which Hashimoto chairs.

Although the calls for reform were not aimed at science-related agencies, the council's brief included the Science and Technology Agency (STA), which oversees many of the nation's big-science projects, and the Ministry of Education, Science, Sports, and Culture (Monbusho), which funds most academic research. The council is recommending that the two be merged into a Ministry of Science, Technology, and Education, as proposed in an interim report issued this summer (*Science*, 29 August, p. 1198). It also suggests turning some government service operations, possibly including national research institutes, into independent agencies. The goal is to make them more efficient and better able to meet well-defined goals.

Most scientists are hesitant to endorse or oppose either change until they see the details. "There has really been very little public discussion of the merits and demerits of merging STA and Monbusho," says Keiichi Kodaira, director-general of the National Astronomical Observatory in Tokyo, which falls under Monbusho's jurisdiction. Granting national labs more independence, he says, could free them from cumbersome government-wide regulations governing employment and accounting practices. But how much leeway to give them has yet to be worked out. The report is also silent on how the independent research institutes would be funded.

One reason for the lack of detail may be the amount of time the council devoted to proposed reforms of the powerful ministries of Finance and of Posts and Telecommunications. Last week, the council appeared to soften several interim proposals affecting the two ministries, causing pundits here to lambaste the council for lacking the political will to curb the power of the bureaucracy.

In the meantime, some scientists feel left out in the cold. "The high public and political interest [in other areas] is understandable," Kodaira says. But he worries that the reforms have been pursued with little regard for the long-term implications for research. "It's been a discussion without a vision [for science]," he says.

The reform council's report is expected to be issued on 5 December after its final wording is crafted by the council's secretariat, made up of bureaucrats seconded from various ministries. The reform issue will then be taken up by the three-party coalition government that Hashimoto leads. The next step would be a proposal for reform to the Diet (legislature) that could set the stage for introducing a new, slimmer government in 2001.

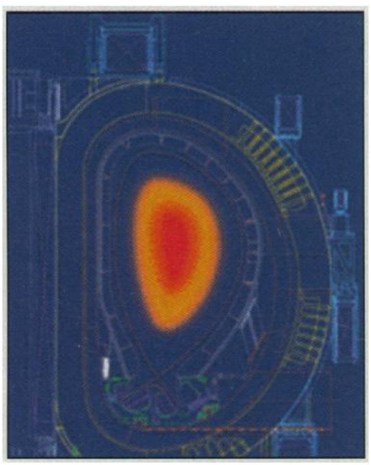
–Dennis Normile

FUSION

Brighter Omens for Giant Reactor?

PITTSBURGH—Turbulence in plasmas, or ionized gases, was once an obscure topic studied far from the public eye. That was before a debate erupted among researchers over whether turbulence would cause heat to leak from a prototype fusion reactor—the projected $10 billion International Thermonuclear Experimental Reactor (ITER)—so fast that it would fall short of its design goals. That debate, first reported in *Science* (6 December 1996, p. 1600), remains unresolved and highly charged. And it received fresh fuel at a tense session here last week, during a meeting of the American Physical Society's division of plasma physics.

A new set of calculations presented at the session suggest that fusion reactors like ITER would leak heat more slowly than predicted by the model that set off the debate last year. That model, developed by researchers at the Institute for Fusion Studies (IFS) of the University of Texas, Austin, and the Princeton Plasma Physics Laboratory (PPPL), treats the plasma as a continuous fluid. The new work takes a different approach: It calculates the trajectories of millions of individual particles in the plasma. This "gyrokinetic" approach points to a much slower turbulent heat loss. "The [IFS-PPPL] predictions are overly pessimistic," says Scott Parker, the gyrokinetic modeler at the University of Colorado, Boulder, who organized the session.



ITER

Heated issue. Theorists debate whether the plasma in ITER, simulated here in cross section, would hold enough heat to ignite a fusion burn.

"Everyone asks about the implications for ITER," adds Parker. "That's the $10 billion question." Neither he nor anyone else is ready to say the results put ITER in the clear. Despite months of detailed comparisons between the two sets of computer codes, Parker and others have been unable to pinpoint why the predictions differ under some conditions. "You can't make the case that you've got a rock-solid theory that's going to predict the performance of ITER," says James Drake, a plasma theorist at the University of Maryland, College Park, who is unaffiliated with either camp. Says PPPL's Gregory Hammett, who spoke at the session: "Our main message last year was that ITER's fusion-power output is highly uncertain." For now that message remains unchanged, he says.

ITER would be by far the largest ever tokamak, a doughnut-shaped device threaded with magnetic field lines that cage hot plasma. If that cage could confine plasma ions at high enough energies for long enough, the resulting fusion reactions might cause the plasma to ignite in a self- sustaining thermonuclear burn. The IFS-PPPL model predicts—although with wide error bars—that the cage will not hold: Turbulence within the ITER plasma will kick enough hot particles through the cage to keep the device from approaching ignition.

To limit the amount of computation required, parts of the model approximate the plasma as a smooth fluid instead of trying to follow each particle as it races through the plasma. The computational savings allow team members William Dorland and Michael Kotschenreuther of IFS and Hammett and Michael Beer of PPPL to check the heat transport over a wide range of plasma temperatures, pressures, and other conditions, and compare the results to those obtained by experiments. But the approach neglects some effects, such as the trapping of individual particles in the troughs of turbulent waves, which could affect the transport.

In an attempt to improve on the fluid approximation, researchers such as Andris Dimits of Lawrence Livermore National Laboratory in California and his co-workers, Parker, and others have now built simulations that follow millions of particles directly. From a physics standpoint, says ITER physicist Marshall Rosenbluth, that approach promises "a more fundamental description" of a real plasma. But Parker notes that the large amounts of computer time required mean that these codes "haven't been compared with experiments the way the IFS-PPPL model has," nor have they modeled the heat transport over as wide a range of plasma temperature and pressure profiles.

The session highlighted a handful of comparisons between the Dimits group's gyrokinetic model and the IFS-PPPL results. There is "perfect agreement" in some comparisons, says Dimits. But other experimentally relevant cases, he says, show that heat "conductivity" is lower in the kinetic simulations by as much as a factor of 3. Combine the best of those numbers with optimistic assumptions about the temperature at the edge of the plasma, says Hammett, and the plasma's center could be hot enough for ITER's output to push into the range that its designers hope for.

But why the two sets of models differ is a mystery. "There's a clear difference, and nobody knows why," says Glenn Bateman of Lehigh University in Bethlehem, Pennsylvania. Dorland says the possibilities include bugs or inadequate numerical resolution in the various codes, something in the detailed physics of wave-particle interactions, or even mundane issues such as the different coordinate systems used by the different groups.

The continuing uncertainty about the outlook for ITER led to jousting at the session between proponents of the project and researchers seen as critical of its prospects. But what's clear, says Drake, is that the past year of jockeying between models has rejuvenated the theory of turbulent heat transport. Converging on a theory everyone accepts is no longer out of the question, he says: "I would not phrase this as a right-wrong issue. We're making tremendous progress; it's very exciting."

–James Glanz

CELL BIOLOGY

Multiple Clocks Keep Time in Fruit Fly Tissues

Anyone who has ever flown across two or more time zones doesn't have to be convinced of the importance of the body's internal rhythms. They are all too apparent—say when the East Coaster visiting California pops awake at 4 a.m. and then has to struggle to keep from falling asleep after dinner. For 25 years, neuroscientists have focused on the brain as the master timekeeper for biological rhythms, controlling everything from normal fluctuations in body temperature to midafternoon slumps. But that view is about to change, at least for fruit flies and perhaps for higher species as well.

On page 1632, a multidisciplinary team led by geneticist Steve Kay of The Scripps Research Institute in La Jolla, California, reports new evidence indicating that fruit flies have independent clocks throughout their bodies. By harnessing recently developed techniques for imaging proteins in living cells, Kay and his colleagues tracked the production of a timekeeping protein, called PER. Previous work had shown that *per*, the gene that makes the protein, cycles on and off in the fruit fly brain to establish the body's daily rhythms (*Science*, 22 March 1996, p. 1671). Kay and his colleagues now find that this cycling is widespread in fruit fly tissues.

They saw PER appear, disappear, and reappear over and over—in the legs, wings, thorax, head, and abdomen of the insect. "This paper shows clocks all over the place, all at once, in a very graphic fashion," marvels Martin Zatz, a physiologist at the National Institute of Mental Health. "Wherever they look, they find clocks."

Each of these clocks can be set independently, by light, and they keep ticking on their own schedule even when they are isolated from the brain, indicating that they don't need input from a master clock to keep time. Other recent work suggests that mammals, too, have multiple clocks. "It is conceivable that individual cells undergo daily cycles of activity and rest just like whole organisms do," suggests Jadwiga Giebultowicz, an insect physiologist at Oregon State University in Corvallis.

If that proves to be the case, the implications are "quite provocative," says Joseph Takahashi, a clock biologist at Northwestern University in Evanston, Illinois. No one questions a role for the brain's clock in overseeing overall rhythms, such as body temperature or behaviors like waking up which involve coordinating several muscle groups and hormonal changes. But these apparently independent clocks may help various parts of the body tailor their protein production to suit the needs of the hour, Takahashi says. Eyes, for example, may produce different mixtures of photoreceptor proteins at different times of day to make adjustments for night vision, while muscles might rev up their metabolism in anticipation of daytime activities.

The idea of the brain's overriding importance in controlling daily rhythms dates back to 1972 experiments on the effects of damaging or destroying a brain structure called the suprachiasmatic nucleus. Doing so changes or eliminates daily cycles in rats, including the rise and fall of the adrenal hormone corticosterone and daily drinking behavior and locomotor activity. While the fruit fly is not advanced enough to have a suprachiasmatic nucleus, its brain also seemed to be required for the insects to keep their daily schedules. Developing fruit flies with damaged brains, for example, emerged from their pupal cases at random times in the day instead of in the morning, as they normally do, and were no longer active primarily in the morning.

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Lighting up. The luminescence (false-colored green) indicates activity of the clock gene **per** in the proboscis and antennae of the fruit fly.

As researchers began discovering the molecular components of this clock, the focus remained on the brain. By tracking down the genes at fault in mutant flies with odd daily rhythms, geneticists discovered clock compo-