Tokamak closure leaves a hole at centre

[PRINCETON, NEW JERSEY] Next week sees the close of a major chapter in fusion research, when for the very last time plasma races around the United States' largest experimental tokamak, at Princeton Plasma Physics Laboratory (PPPL).

Deuterium and tritium ions at up to 500 million degrees Celsius — the hottest matter in the Solar System — will then decline in temperature to the ambience of a spring day in New Jersey, leaving the surrounding laboratory facing an uncertain future.

But the 500 staff of PPPL will have little time for philosophical reflection in the coming weeks. In June, John Schmidt, the laboratory's interim director, will implement a necessarily brutal reorganization that could see as many as 200 of them lose their jobs.

Those remaining will have rapidly to establish a new direction for the laboratory to enable it to retain a leading role in magnetic fusion research without the Tokamak Fusion Test Reactor (TFTR). This machine, which cost \$1 billion to build, completes 15 years of scientifically fruitful operation next Thursday (3 April).

The embattled US magnetic fusion community, whose budget has lost almost half its spending power since 1995 (see *Nature* 375, 622; 1995), is looking to Princeton to provide such leadership after the TFTR shuts. "We expect Princeton to continue to be a centre of excellence, but on a smaller scale," says Anne Davies, head of the fusion programme at the US Department of Energy.

"Our leadership role will change," says Schmidt. "It will derive from the people we have here and their interaction with other institutions." Success, he declares, "will depend on us — not on the Department of Energy". Rush Holt, assistant director, agrees: "Leadership will be ours if we show that we can lead," he says.

To help with the transition, Princeton is being allowed to build the National Spherical Torus Experiment (NSTX), a \$25-million machine in which the doughnut shape of a conventional tokamak is sharply compressed into a ball with a narrow channel running down its centre. The machine, conceived at Oak Ridge National Laboratory in Tennessee, is due to start operating in 1999.

The 100-strong team of plasma physicists who make up the core of the laboratory has stayed basically intact over the past decade, even though the laboratory's total staff — and its budget — have fallen by half. But if the team is to remain together after this summer's further contraction, say fusion researchers, more will be necessary than just the construction of NSTX.

One need is for increased collaboration with the smaller experimental tokamaks at

End of an era? The tokamak at Princeton's Plasma Physics Laboratory is closing after 15 years.

General Atomics in San Diego, California, and at Massachusetts Institute of Technology (MIT), as well as with larger ones abroad — Joint European Torus (JET) in the United Kingdom and JT-60 in Japan. Princeton is seeking \$9 million next year to pay for such activities, including \$2 million for international collaboration.

Another need, according to Miklos Porkolab, director of MIT's fusion science programme, is for more machines — at least one medium-sized one. Princeton hopes to receive \$4 million next year to study three or four advanced tokamaks and alternative options, says Schmidt.

Perhaps above all, the laboratory will need a new director to forge a new direction. Will Happer, chair of the research board at Princeton University, which operates the laboratory, has been searching unsuccessfully since Ron Davidson, the current director, announced last autumn that he intended to depart.

"In this time of major changes in the US magnetic fusion programme, the job of the next director will be exceptionally challenging," says Happer. He points out that PPPL needs not just an exceptional scientist and manager but also "an articulate spokesman for plasma physics research who can help to unify not only the talented plasma physics community in Princeton, but the national community as well".

Given the magnitude of the challenges it faces, many observers feel that Princeton may find it hard to attract a top-flight external candidate to the laboratory — even after the existing management team has completed June's painful restructuring.

Schmidt says that the laboratory, two-thirds of which is structured around TFTR, will return to its previous organizational structure, with, following a long tradition at Princeton, "a combination of modestly sized experiments, broadening the science base".

Researchers at the laboratory are proud of the track record of the machine that shuts down next week. It has set world records for fusion power output, has burned deuterium and tritium together for the first time and has notched up a long list of milestones in plasma physics. "TFTR has been terrifically successful," says Davies.

NSTX will make use of beam drivers and power supplies already being used for TFTR. It will build on what Martin Peng, the programme director, describes as "encouraging" results from the Small Tight Aspect Ratio Tokamak (START), an experiment of similar geometry at Culham in the UK.

The new machine will be built quickly and cheaply, largely using existing components. "NSTX is a good project," says Bruno Coppi, a plasma physicist at MIT who is a critic of conventional tokamaks. "But it isn't highly original."

Coppi has long claimed that compact machines could achieve ignition at far lower cost than current tokamak designs, and suggests that PPPL can prosper by embracing innovative approaches to fusion power. If it does so, he says, "Princeton can use its intellectual strength to spring back".

But doubts about the future are widespread. "Princeton has one of the pre-eminent teams [of plasma physicists] in the world," says Alan Gibson, deputy director of JET. "Whether they can retain that position is open to question. It's going to be difficult."

Much of the US plasma physics community — including MIT's Porkolab — have trained or worked at PPPL and still fervently believe in the need for a strong laboratory there. "It is so easy to destroy, but will take decades to build up if you ever need it again," says Porkolab.

The task of the new director will therefore be daunting. As Porkolab puts it: "He has to find a viable concept beyond NSTX, stabilize the budget, and integrate the laboratory into the rest of the community." All this at a time when the shrinking of the US magnetic fusion budget combined with PPPL's efforts to retain a significant slice has led to friction between the laboratory and the rest of the US magnetic fusion community (see *Nature* 379, 387; 1996).

Now the laboratory is supposed to defend its own position, and provide leadership for the national programme at the same time. Its predicament makes fusion scientists hope for the best, while fearing the worst. "I'm sure it will not collapse," says Coppi. "There is so much knowledge there — it would be a disaster."

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