

PHYSICS COMMUNITY

PPPL Seeks New Director, New Directions

Tightening of Federal funding for magnetic fusion energy research has forced Princeton University's Plasma Physics Laboratory (PPPL), a Department of Energy (DOE) lab, to rethink its goals and strategies, and to revamp its program—as indeed is the case with the US fusion energy sciences program generally. The emphasis is being shifted away from the development of commercial fusion power to smaller research projects in basic science.

In addition, PPPL is seeking a new director to succeed Ronald Davidson, who steps down on 1 January. A plasma physicist, Davidson moved from MIT to become PPPL's director in 1991. He will stay on at Princeton, and says he is “anxious to get back to research and teaching on a full-time basis.”

Davidson's tenure as director saw major achievements during a period of steady decline in US funding for magnetic fusion energy research. Most notable are the experiments done with the Tokamak Fusion Test Reactor (TFTR): Using deuterium-tritium fuel, first 3 MW, then 6 MW and then (the still standing) 10.7 MW records were set for fusion energy production (see PHYSICS TODAY, January 1994, page 17).

“We can do experiments under real fusion plasma conditions,” says PPPL's deputy director Dale Meade, explaining that equal amounts of deuterium and tritium are used at TFTR because “that is what a commercial fusion power plant would use.” Deuterium-tritium plasma is easier to magnetically confine, and the reaction yields 100–200 times more power than other fusion fuels. The usable energy in these reactions is the product neutron's kinetic energy (about 80% of the energy released); the reaction's other product, an alpha particle (carrying the remaining 20% of the released energy) helps to sustain the high temperature needed for the positively charged deuterium and tritium nuclei to overcome electrostatic repulsion so that fusion can occur. (A key aim of fusion energy research, and the main goal of the proposed International Thermonuclear Experimental Reactor, or ITER, project, is to achieve ignition—in which the kinetic energy of the alpha particles sustains the plasma temperature (at about 200 million °C) with no auxiliary heating; see PHYSICS TODAY, June 1996, page 17.) The Joint European Torus, in England, where in 1991 a

Budget cuts are causing the US fusion energy research program to fission.

mix with 12% tritium was used, is the only other tokamak where deuterium-tritium fuel has yet been used.

US fusion downsized . . .

“Fusion energy grew in the 1970s because of the energy crisis,” recounts Anne Davies, DOE's associate director for fusion energy sciences. Then, in the 1990s, “the US fusion program set a goal of 2025 by which to demonstrate fusion power,” with construction of a commercial fusion power plant by 2040. But, as Meade notes, “the budget is no longer consistent with these goals.”

DOE funding for fusion energy research has fallen steadily since it peaked in 1977—and this year's budget is worth only about a quarter of what it was in 1977. The most drastic cut was for the 1996 fiscal year, when US funding for (primarily magnetic) fusion research plummeted from \$365 million



RONALD DAVIDSON

to \$244 million. PPPL's budget went from \$89 million to \$61.5 million, and the lab's staff was reduced by about a third. For FY 1997, the lab's budget was reduced by an additional 6.5%, and the staff is expected to be cut by a further 10% (about 50 people), according to Meade. (By contrast, the corresponding European and Japanese budgets for the FY 1996 were about \$600 million and \$500 million, respectively.)

“Initially we were going to run

TFTR until we needed space for a follow-on machine,” explains Meade. But a series of proposals for next-generation machines faltered one after the other: In 1984 the Tokamak Fusion Core Experiment failed to get funded because it was deemed too ambitious, recounts Meade; in 1991, plans for a \$1.7 billion Burning Plasma Experiment were canceled—the project was too costly; and finally, in September 1995, the Tokamak Physics Experiment, which was to be a collaborative effort of government, industry and university labs, with the key aim of sustaining the plasma for 1000 seconds, was deemed too expensive, even at a substantially cheaper \$700 million. Now, not only is no follow-on machine planned, but TFTR will be shut down this spring.

For TFTR's final run of experiments, scientists plan to use radio frequency waves to create a transport barrier to reduce loss of particles and energy from the plasma. This, says Meade, is “one of the hottest areas of research, and it hasn't yet been tried with tritium.” He adds that “we will have to work hard to get these experiments done in the time left.”

. . . and diversified

Nationally, a shift away from tokamaks, with a spreading of limited resources more widely, is “a central feature of the program's remodeling,” says Davies. “And that means closing larger facilities to make room for diversification.” Adds Davies, “It's wrenching for me. TFTR is an extraordinarily well-diagnosed facility, capable of lots more science. But we cannot afford to run it and to restructure the overall fusion program.”

Noting the changes recommended last January by DOE's Fusion Energy Advisory Committee, a 15-member panel of scientists and engineers from academia and industry, Davies says “We are restructuring the US fusion program around plasma science—regardless of direct connections to fusion energy. We will pool resources to focus more on specific research topics rather than on individual research facilities.” In its summary, the committee wrote that the US should maintain leadership in selected areas: “Such niche leadership is essential for us to be sought by international partners as a valued participant, though perhaps mi-

nor monetary contributor, for internationally launched major facilities." So now, with the limited funding available, PPPL will focus on "smaller, innovative projects, and leverage more off international efforts in fusion energy," says Princeton's Davidson. "The US used to be a major player in fusion research," adds Meade. "But now we are becoming more of a follower than a leader."

One project that does have the go-ahead is the National Spherical Torus Experiment (NSTX), which will produce a nearly spherical plasma. For a given magnetic field, the spherical configuration can confine plasma at a higher pressure than can the conventional torus, says Meade. Since the power produced is proportional to the square of the pressure, NSTX could be

an important step toward developing smaller, more economical tokamaks. A collaboration involving several institutions, NSTX will be built at PPPL. Some existing infrastructure and parts from other facilities—including TFTR—will be used. "It's an \$80 million machine for \$20 million," says Meade. Construction will begin this spring, and the first experiments are scheduled to start in 1999.

Other activities include providing design support and consulting to the Korean Basic Science Institute in Taejeon, South Korea, where scientists are building a superconducting tokamak similar to the Tokamak Physics Experiment that was to have been built at Princeton. And PPPL scientists are considering building a stellarator—for which, unlike tokamaks, magnetic con-

finement is steady state and does not require a large current to flow in the plasma. "Tokamak technology is much further along than stellarator technology," says Meade. "But the next step in producing energy commercially is a big, expensive one. The strategy is to do lower-cost research now, and to continue to develop scientific foundations, so that in better times, or when our energy situation changes, we'll be ready to make the best decisions."

Meanwhile, William Happer, who, with Jeremiah Ostriker, heads the search for a new PPPL director, says Davidson did a "super job," and that he "doesn't know anyone who could have done it better." Princeton's John Schmidt will serve as interim director until the post is filled. **TONI FEDER**

Suicide and Resignation at Russian Nuclear Weapons Labs Symbolizes Plight of Scientists and Increases Fears in West

Among the defining events in Russia's retreat from superpower status was the suicide of one of the country's leading nuclear weapons scientists. The death of Vladimir Nechai, a theoretical physicist who had directed the nuclear weapons laboratory at Chelyabinsk-70 for the past eight years, has stunned the nation. It came only weeks after Vladimir Belugin resigned as director of Arzamas-16, in lighter moments often called "Las Arzamas"—a play on Los Alamos, the US's leading nuclear weapons laboratory.

On 30 October, Nechai was found shot dead in his office, a pistol beside him and a note for his wife, which requested that his body be buried in the town that was built around Chelyabinsk-70, which got its name as a post office box for the "closed city." The lab has been renamed the All-Russian Scientific Research Center of Technical Physics and the town of 46 000 is now called Snezhinsk. Nechai's personal motivations in ending his life may never be known, but his death has been portrayed among scientists and in the

press as a symbol of the decline and fall of Russian science.

At 61, Nechai headed the Center of Technical Physics and was both the manager of the sprawling closed city, secluded in the southern end of the Ural Mountains, and a brilliant weapons designer who had been awarded the Lenin Prize. Colleagues said Nechai, normally calm and cheerful, had become increasingly disturbed by the deepening financial crisis in Russia, which had left many of his staff unpaid since June. Nechai once told

