# Nervousness in Europe's Fusion Labs

*In spite of apparently strong political and financial backing, Europe's fusion research program is entering a period of uncertainty*

Europe's fusion community is growing nervous about its future prospects. And the cold wind blowing from the United States, where Congress has recently imposed a substantial cut in the Department of Energy's fusion budget, is bringing little comfort.

As it currently stands, Europe's fusion research program is widely acknowledged to be a highly successful example of international collaboration, both in scientific and political terms. Standing at the center, and sometimes described as the "jewel in the crown" of European nuclear research, is the Joint European Torus (JET), an experimental device comparable in size to the Tokamak Fusion Test Reactor (TFTR) at Princeton University but already, according to its ebullient German director Hans-Otto Wüster, outperforming its U.S. rival.

When Britain's Queen Elizabeth and French President Francois Mitterand officially opened JET in England earlier this year, both pointed to it proudly as a symbol of what a united Europe is capable of achieving. Furthermore, the research scope it offers is sufficiently broad to allow several years of operation before the difficult decisions need to be made on the precise form of the machine that should succeed it—and where it should be built.

Already, however, both decisions are beginning to weigh on many minds, for they coincide with an intense debate that is beginning over the impact of the changing economic and energy environment on the optimum strategy for fusion research in Europe. The debate bears many of the same characteristics as that currently under way in the United States (see page 525).

The main focus of attention is the fusion budget of the Brussels-based Commission of the European Economic Community for the 5 years 1985–1989 which will be discussed by research ministers from the EEC member countries at the beginning of December. (Since its early days, Europe's fusion research has been focused through Euratom and coordinated by the Commission, which provides almost half the total research funding. Fusion is currently the largest single item in the Commission's hard-pressed research budget.)

The Commission has proposed a budget of about $560 million for this period. If agreed, it would amount to a real increase of about 6.4 percent over the 1982–1986 program accepted 3 years ago. But given the present intense pressures on the Commission's budget, a reduction in this figure seems inevitable, and the main question is whether there will be slight growth in the program or whether the ministers, under tough pressure from both other research priorities and their own domestic treasuries, will go for a more substantial cut.

Whatever is decided, two priorities are expected to remain at the top of the research agenda. The first is a commitment to the full experimental exploitation of JET, which should start operating with a deuterium-tritium plasma in 1988. The second is the support given to research at laboratories run by national nuclear research organizations (or "associations") throughout Europe which are linked with the Euratom fusion program. In four of these, a series of smaller tokamaks have either been completed or are under construction to carry out complementary experiments to those at JET, such as investigations of the use of superconducting magnets, or much higher magnetic fields. In addition, two alternative configurations to tokamaks are being studied, the stellarator at Garching, West Germany, and the reverse field pinch at Padua, Italy. (Europe, unlike the United States, is not putting any substantial effort either into mirror devices or into laser-based inertial confinement systems.)

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The most obvious target for any cuts would therefore be the planning for JET's successor, the so-called Next European Torus (NET). Officially introduced into Euratom's long-term strategy in 1982, primarily as a planning device to focus research throughout Europe into reactor technology, NET is currently being conceived as a larger tokamak, able to produce plasma-burning pulses lasting at least 100 seconds. As such, NET is itself intended to prove the feasability of the basic technologies for a subsequent demonstration fusion reactor, known provisionally as DEMO. Its price tag is expected to be up to five times the $450-million construction costs of JET.

The proposal timetable for NET begins with a predesign stage lasting from 1985 through 1987, with various other stages culminating in the selection of a site in 1992. Construction would be completed by 1995, to coincide with the phasing out of JET.

Several countries are keen that Euratom member states stick as close as possible to the Commission's proposed timetable. Perhaps the most enthusiastic promoter of fusion research, for example, is West Germany, whose scientific community argues that any loss of nerve could have serious consequences for the overall cohesion of the European effort. The government is publicly supporting this line. "In an area like this where different countries have to work together, they need goals, and they need tough goals, otherwise you lose momentum and there would be no progress," says Hermann Wagner, who is responsible for the fusion program supported by the German Federal Ministry for Research and Technology in Bonn.

At the other end of the spectrum are members states—most noticeably Great Britain—which argue that the time has come to adopt a more cautious (and perhaps less costly) strategy. "One thing that is certain about fusion is that the next steps will be expensive, but fortunately we do not have to rush. Time for once is on our side," Charles Henderson, under secretary responsible for nuclear affairs in Britain's Department of Energy, told the opening session of an international conference on fusion research organized by the International Atomic Energy Agency in London in September. Henderson emphasized that for governments to be persuaded to give their full support, "they must be convinced that the resources are justified, not only with respect to other energy priorities but also with respect to other expenditures."

As in the United States, the debate over the speed with which fusion energy needs to be pursued—and the scientific and technological strategies which

should consequently be adopted—centers on the appropriate balance that should be struck between the scientific and technological components of the overall research program.

Those eager to push ahead to a reactor relatively quickly argue that the time has come to accept that the program should be more technology-driven. "The idea that the science and the technology can exist in series is wrong" says Romano Toschi, head of the 60-member NET design team already working at the Max-Planck Institut for Plasma Physics at Garching. "We have to be able to feed back into the physics the problems that we meet with the technology."

Others, however, are wary of rushing prematurely into reactor technology before the physics is properly understood—or at least until scientists can be relatively confident that nature has no nasty surprises up its sleeve. Robin Nicholson, for example, chief science adviser to British Prime Minister Margaret Thatcher, speculates openly whether fusion research should not be classified as basic rather than applied science.

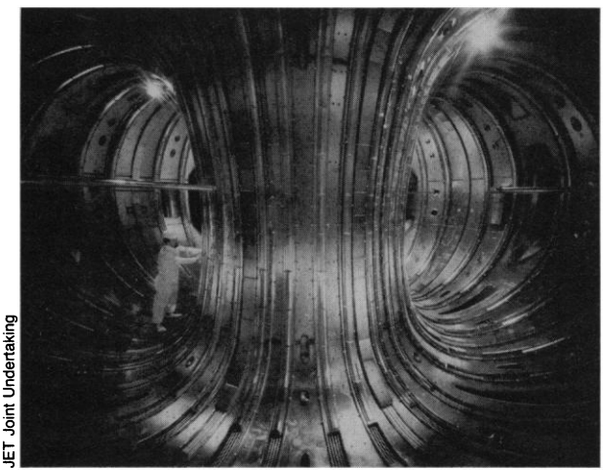
The question of balance, however, is closely linked to the economic urgency felt for fusion. Europe's collective enthusiasm for JET in the early 1970's—indeed, its decision to substantially increase its support for all fields of energy research—largely reflected the shock of the first Arab oil crisis. Faced with dramatically declining forecasts of future energy demand, this sense of urgency has disappeared.

Fusion's supporters continue to argue that fusion is needed as an "insurance policy"—and that the momentum should be sustained on these grounds. So far this has been the case. Figures released last week by the International Energy Agency in Paris show that spending on fusion research among IEA members (excluding the United States) has continued to increase since 1980, despite cuts in virtually all other fields of government-funded energy research (including fast breeder reactors).

Critics of the crash program approach, such as physicist Hermann Bondi, master of Churchill College, Cambridge, and a former chief scientist in Britain's Department of Energy, disagree. Bondi points out that Europe's continued commitment to fast breeder reactors—even if on an extended time scale—means that "if the population accepts breeders, there will be no need for fusion for, perhaps, two to three hundred years."

Even the environmental question, he adds, remains open. Fusion enthusiasts continue to stress the environmental advantages over fission reactors, in particular the relatively low level of waste. Wüster of JET describes fusion as potentially "the acceptable face of nuclear power." But Bondi, who has just retired as chairman of the Natural Environment Research Council, argues that if fast breeders are rejected on environmental or proliferation arguments, then there is no guarantee that fusion reactors will not suffer the same fate, for the potential hazards will not be negligible. "To describe fusion as a clean way of producing energy is irresponsible" says Bondi. "My major worry is the public misconception that still exists that there is no waste disposal problem."

The third dimension to the debate, which hovers implicitly in the background, is the jockeying for position that is already occurring over the eventual siting of NET.



JET Joint Undertaking

***Joint European Torus***

*The "jewel in the crown" of European nuclear research remains top priority.*

Britain's relatively cool enthusiasm for the project, for example, is said by some to reflect its realistic assessment that, with JET already in place, NET is unlikely to be built in the United Kingdom. Furthermore, Britain's fusion scientists are already complaining about the amount of domestic funds used for the European facility and are keen to see more devoted to their own research efforts.

In contrast, West Germany, which agreed in October 1977 after an intense 2-year debate to allow JET's construction at Culham rather than at its own site at Garching, is said to have done so under an informal gentleman's agreement that it would host the next machine. Germany has already said it is keen to do this, and is laying some of the preparatory groundwork at its nuclear engineering research center in Karlsruhe, the most likely candidate site.

France, too, is said to be interested. However, construction of its own tokamak designed to investigate the possible use of superconducting magnets, TORE SUPRA, is not expected to be completed until 1987 or 1988—perhaps explaining the desire of some French officials to put off a decision on final design and cost estimates for NET as long as possible.

Given the various factors involved, the schedule adopted for planning for NET at the December meeting will require a delicate political balancing act. The Commission's own supporting document asks for funding for 160 professional man-years of work on NET over the 3 years of predesign studies, to be complemented by a similar level of support from the national nuclear research organizations and about half this amount from private industry. But Euratom's advisory Scientific and Technical Committee, although agreeing that a large increase for the technology area is justified, argues that "a slower build-up of the NET team would be desirable" and expresses "some concern" with regard to the proposed time scale for NET.

Given the increasing financial pressures on the fusion program, interest has inevitably been growing in the possibility of increased international collaboration, in particular with the United States and Japan. Indeed, fusion research was 1 of the 18 areas identified for close collaboration between Western advanced nations by the summit meeting held in Versailles, France, 2 years ago.

At present, however, enthusiasm for closer links with the United States is not high. Not surprisingly, Europe's fusion research community is reluctant to relinquish the moral satisfaction it gains from its current lead over its transatlantic competitors. Wüster at JET, for example, says that although he sees "a lot of sense in cooperation," there would be many organizational difficulties raised by full U.S. participation in NET.

Such difficulties have already been partly blamed for Europe's reluctance to become fully involved in the U.S. Department of Energy's plans for a Fusion Materials Irradiation Test Project at Hanford, and the project's subsequent cancellation by the Reagan Administration this summer. Following a request from the United States for Europe to take a one-third share in the facility's $125-million construction costs, a panel of scientists set up by the Paris-based International Energy Agency endorsed the technical contribution which a machine, using intense neutron beams to simulate the irradiation of reactor components, could make to Europe's fusion program. Research administrators in Brussels, however, were not prepared to contribute a substantial amount of capital to a project over whose design and operation they would, in practice, have little direct control. They proposed, instead, to make a relatively small initial contribution combined with a more substantial share of running costs. This offer, however, was not sufficient for the Reagan Administration, and the whole proposal has now been put on ice (perhaps for joint implementation later).

The obstacles to collaboration, however, are not only administrative. For there is also a growing feeling in Europe that domestic uncertainties in the United States over its fusion program, and the current divergence in U.S. and European thinking, have increased the difficulties of achieving the type of consensus on strategy endorsed by political leaders at the Versailles summit.

Until recently, for example, it was thought that the United States and Europe might agree to a jointly conceived division of labor on alternatives to tokamaks. Yet the more the United States broadens its own programs of alternatives, the less this is seen in Europe as a viable proposition.

Similarly, hopes in Europe that U.S. experience with its potential successor to TFTR, the Tokamak Fusion Core Experiment, might be completed in time to feed results into the design of NET have diminished as the prospects for the American machine suffered in the recent budget cuts. In such circumstances, the will to achieve a consensus on strategy may still prove elusive.

Nevertheless, even in Europe, it is accepted that continued commitment to a large-scale fusion research program is likely to reflect a balance between political commitments—in particular to a united Europe which can still remain ahead of the United States in some area of technology—and hard-headed cost-benefit analysis, and that the outcome of the current discussions will reflect the compromise between the two.

Some are convinced that excessive penny-pinching must not be allowed to win the day. "There is a certain discrepancy between the economists' concerns with immediate pay-offs, and the more long-term strategic thinking of technology-minded people who say they have a responsibility to look to the future" says Josef Rembser, general director for basic research and international cooperation in the German Federal Research Ministry.

Others are more cautious, accepting for example, that fusion research enjoys its current level of support partly because of its position as the flagship of European research cooperation, but also that its position could be jeopardized if another flagship (perhaps information technology) takes its place.

With several years to wait until a firm commitment to NET is required, no one in the fusion community is yet pushing the panic button. But with the initiative swinging back from the scientists to the politicians, the run-up to the critical 1987 review, when the decision will be taken whether or not to proceed with detailed designs for NET, promises to be anything but smooth.—**DAVID DICKSON**

## Grenoble Wins Synchrotron Battle

*Paris*. The city of Grenoble has been chosen by the French Government, after a fierce political battle with the rival city of Strasbourg, as the site for the construction of a new European Synchrotron Radiation Facility (*Science*, 27 July, p. 391).

The new facility will produce an intense beam of x-rays used for examining the molecular structure of both organic and inorganic material. It will be jointly financed by the French and German governments, with additional contributions from other members of the European Economic Community, and will be based on plans drawn up through the Strasbourg-based European Science Foundation.

Offers to provide a site for the facility had been made by Denmark, Great Britain, and Italy, in addition to France and Germany. By the summer the choice had narrowed to the latter countries, largely because they will be covering the bulk of the capital costs, and subsequently to the two rival sites in France (on the understanding that Germany will receive reciprocal backing for a new supersonic wind tunnel).

Strasbourg had initially been the official candidate of the French government and was strongly lobbied for by the National Center for Scientific Research, the main source of funding for fundamental science in France. However, an independent bid from the Institut Lauë-Langevin (ILL) in Grenoble, a high neutron-flux research facility jointly (and effectively) run by France, Britain, and Germany, quickly gathered support from other directions—in particular Britain's Science and Engineering Research Council—on the grounds that the new facility could share many of ILL's existing facilities and draw on scientific expertise already available.

The competition between the two cities became intense in the last few weeks. The city of Grenoble, for example, offered $8.6 million toward the construction costs of the facility, and Strasbourg, which has been keen to see the Alsace region develop into a center for high technology, came in with an even higher bid of $10.5 million.

After the government's decision was announced last week, the president of the regional council of Alsace, Marcel Rudloff, accused the government of "betraying" earlier promises to the region. He suggested that the German government had previously agreed to share the costs of the facility on the understanding that it would be located in Strasbourg, which lies on the French-German border.

This was denied, however, by the French Minister of Research and Technology, Hubert Curien, who claimed that the choice had in the end been made largely on scientific grounds. Curien points out in particular that the high flux reactor at ILL was "used by the same clientele as synchrotron radiation," adding that the government hopes to sponsor new projects in Strasbourg in fields such as neurochemistry and molecular biology.

—**DAVID DICKSON**