Supercollider Faces Budget Barrier

The SSC could lead to the creation of a new national laboratory, but budget constraints may force Congress to shelve the high energy physics project for some time

THE speaker of the House of Representatives, James Wright, Jr. (D–TX), was in West Virginia for a Democratic strategy meeting on 30 January when he got the news from a reporter that President Reagan was proposing to build the Superconducting Super Collider (SSC). He was surprised. "A super what? . . . You mean they want to spend $4 billion to build a tunnel that's 52 miles around." By now there is not a member of Congress or a state governor who does not have at least a rudimentary idea of what the SSC is—and of the economic lift it could give their respective states.

In fact, if hearings held 7–9 April by House and Senate committees are any indicator, the SSC's scientific mission has been upstaged to an extent by the gold-rush atmosphere that permeates deliberations on whether to go forward with the particle accelerator. The construction project alone will employ as many as 4500 people during the 8 years it takes to build the supercollider. The resulting research complex will cost an estimated $270 million annually to operate, and provide about 2500 permanent jobs.

The purpose of the 40-trillion-electron-volt (TeV) proton-proton particle collider is to enable physicists to better understand the properties of fundamental particles—quarks and leptons—and the forces that affect them. In particular, researchers hope to close gaps in the Standard Model of high energy physics, and to structure broader theories. Collisions produced in racetrack-shaped SSC would be 20 times stronger than those produced in the 1.8 TeV accelerator at Fermi National Accelerator Laboratory in Illinois. These more intense collisions of subatomic particles, says theorist Steven Weinberg of the University of Texas, are needed to open new windows on the structure of matter.

Project advocates also argue that without the SSC, the United States will be overtaken in time by the Europeans, Japanese, and Soviets as existing U.S. facilities become outdated. While Fermilab currently has the world's most powerful accelerator, the 14 member states of the European Laboratory for Particle Physics (CERN) are considering building an accelerator to produce collisions with energies of 17 TeV (*Science*, 27 March, p. 1567). Fermilab Director Leon Lederman, citing the long-term benefits to industry, said, "I think it is very important that we be among the world's leaders in this area."

Not surprisingly, the members of Congress, governors, and other state officials testifying before the House Science, Space and Technology Committee hailed the SSC as an essential undertaking. The competition between the states hoping to land the project is stirring up support for the new accelerator in industry and at the local level.

In Ohio, for example, everyone from primary school superintendants to the state legislature has been included in that state's drive to capture the SSC. DOE officials estimate that as many as 30 states could submit site proposals on the particle collider. The project is so important to Illinois, which could see Fermilab eventually shut down if the SSC is located elsewhere, that the governor has asked the legislature to appropriate another $15 million to complete the state's site proposal. Illinois already has spent $4.5 million on the undertaking.

Key members of House and Senate appropriations and authorizing committees also have praised the SSC concept. "It can serve as a beginning of our nation's recovery as the world leader in science and technology," says Robert A. Roe (D–NJ), chairman of the House science committee. But even as governors race to meet the Department of Energy's (DOE) 3 August deadline for submission of siting proposals, Roe and other House and Senate leaders wonder how they will ever set the project in motion.

Senator Bennett Johnston. *"I don't want to cannibalize everything in science for this one project."*

Major construction is supposed to get under way in 1989, but when Reagan endorsed the SSC in January, he did not tell Congress how to pay for the new collider. The Administration only pledged that the SSC would be built with new funds—not money that would normally flow to ongoing scientific endeavors funded through the National Aeronautics and Space Administration (NASA), DOE, National Science Foundation (NSF), and elsewhere.

In fiscal year 1988, the SCC's cost would be just $35 million—all of which could be drawn from DOE's high energy physics research budget, although operations at Fermilab and the Stanford Linear Accelerator Center might suffer somewhat. But key congressional leaders are reluctant to commit to the project now because of the massive outlays that lie ahead.

In 1989, spending would soar to $348 million and peak at $709 million in 1994, before accounting for inflation. DOE estimates that inflation could raise the collider's costs to $5.32 billion, plus or minus 10%. Actual costs could grow even larger if the start of construction is delayed and inflation is higher than expected.

The DOE energy research budget for science already is crowded with an array of costly projects such as the Continuous Electron Beam Accelerator Facility, which already is under construction. Congress must come up with another $2.7 billion between now and 1994 to construct these new research facilities. It also is struggling to fund NASA's space station, costs for which may easily exceed $16 billion in the coming years (*Science*, 27 February, p. 965).

The difficulty of proceeding with just the current research agenda, much less the SSC, is reflected in the House Budget Committee's recent budget action for FY 1988, which starts on 1 October. It has imposed a virtual freeze, limiting the collective research budget for NASA, DOE, and NSF to $10.3

billion compared to the $11.5 billion requested by the Administration.

Despite the budget crisis, the House and Senate authorizing committees may approve bills that call for proceeding with the SSC. But Senator Bennett Johnston (D–LA), chairman of the appropriations subcommittee on energy, notes that such action will be meaningless unless the appropriations committees have sufficient money with which to act. That is unlikely without new revenue sources, a decision to run a bigger federal budget deficit, shifting funds from other federal programs to the research budget, or cutting back other science programs. The latter option is unacceptable, says Johnston. "I don't want to cannibalize everything in science for this one project."

While Alvin W. Trivelpiece, outgoing director* of the Department of Energy's Office of Energy Research, says "the SSC is the tool that is going to be needed to make progress," he is in basic agreement with Johnston. He told House science committee members on 7 April that the department ". . . would not proceed with this if [the SSC] were to impinge on other things. That's my opinion." Indeed, a number of members of the scientific community advised House and Senate members to shelve the SSC concept for a while if a new funding stream cannot be tapped for the facility.

"We believe that the case for the SSC is strong," said Sheila E. Widnall, president of the American Association for the Advancement of Science and a professor of aeronautics and astronautics at the Massachusetts Institute of Technology. But Widnall added that "if proceeding with the SSC means anything less than vigorous growth in other fields of science, then we would very reluctantly suggest that the SSC be deferred." J. Robert Schrieffer of the University of California at Santa Barbara, went further, citing the need to dramatically improve funding for science as a whole.

Perhaps the most critical witness to appear before Congress was Philip W. Anderson, a solid-state theoretical physicist at Princeton University. Stating that he was speaking against the project "because . . . colleagues who understand this case are hesitant to make it . . . ." Anderson said the central issue "is a competition for resources." In particular, he complains that the glamour of high energy physics attracts talented students away from atomic, solid state, and other physics disciplines that can be pursued in small laboratories.

A number of members of Congress, including Representative Don Ritter (R–PA), asked whether federal funds might be better spent in other areas of basic and applied research that would produce near-term benefits for American industry. Ritter and other witnesses also suggested that the SSC perhaps should be delayed to see if new superconducting materials that are now the subject of intense research can be used in the SSC's 10,000 magnets (see sidebar).

The contest to land the SSC presents still more political headaches. Some state officials are questioning the fairness of DOE's site selection schedule and criteria. Governor James G. Martin of North Carolina complained to House science committee members that the 4 months allowed by DOE for preparation of SSC proposals are inadequate. Officials in North Carolina, Texas, Florida, and elsewhere would like the 3 August deadline extended to the end of the year.

"What's so wrong with waiting 4 more months to make the umbrella bigger," says Representative Thomas McMillen (D–MD), whose state is not expected to bid for the SSC. Asked whether the deadline was cast is stone, DOE's Trivelpiece replied, "As far as we are concerned, yes."

Yet another issue is whether rich states such as Texas or California will have a real advantage over poorer states in the site selection decision. While Illinois may end up spending close to $20 million preparing its bid for the supercollider, Idaho has committed just $400,000 to the effort. The amount

*Trivelpiece has served as director of Energy Research at DOE since 1981. He is leaving the department to become executive director of the American Association for the Advancement of Science.

Will New Materials Stall SSC?

While funding is the central issue governing whether the Superconducting Super Collider (SSC) gets built, the discovery of new rare-earth oxide ceramics that exhibit superconducting properties could affect what Congress decides to do. What is special about these new superconductors is that they operate at temperatures above the boiling point of liquid nitrogen (77.4 K), a less costly refrigeration method compared to the helium system that is now planned for the SSC. Further breakthroughs, researchers speculate, could even lead to superconducting materials that operate at room temperature.

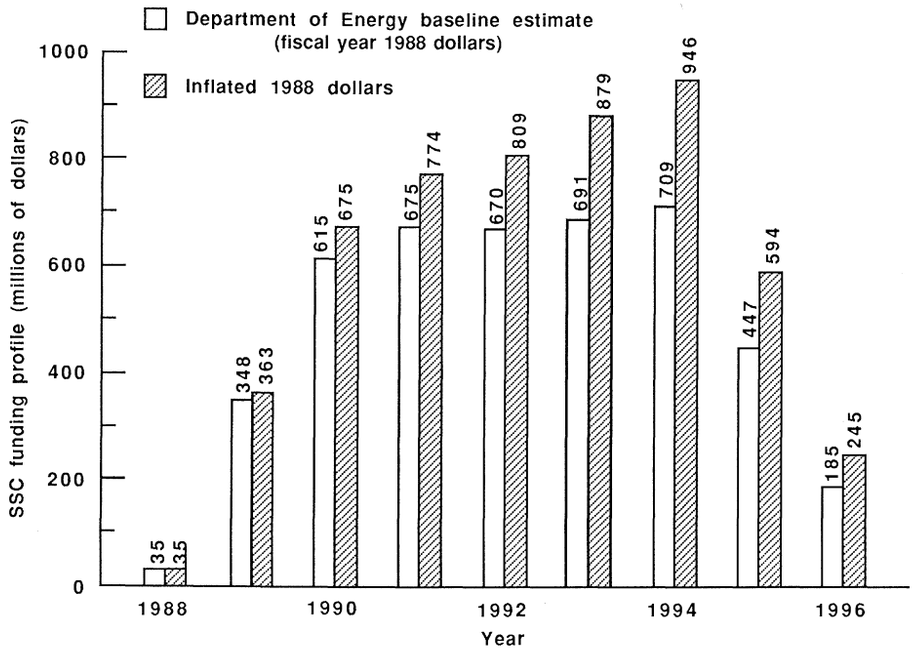
Several House and Senate members and a number of witnesses who testified at recent congressional hearings have questioned whether the United States should wait a few years before proceeding so that the SSC could utilize this new technology. "I don't want to see it delayed. But I also don't want to see the community rush forward with an outmoded technology," says Betsy Ancker-Johnson, a vice president at General Motors Corporation and the former chairman of the physics review panel of the Energy Research Advisory Board.

As proposed now, the SSC would require 10,000 helium-cooled magnets with windings made of niobium-titanium wire. While the performance of these magnets is fairly well understood, they must be operated at about 4.35 K. To maintain temperatures close to −450 F, the SSC will have to rely on a network of ten cryogenics plants costing an estimated $129 million. New superconductors that could be cooled with liquid nitrogen would reduce both capital and operating costs. But working magnets incorporating the new materials may be years away.

Despite the promise of new superconductors, which were the subject of a packed gathering at an American Physical Society meeting last month (*Science*, 27 March, p. 1571), Department of Energy and industry officials oppose delaying the SSC. Says John K. Hulm, director of corporate research at Westinghouse, "A great deal of scientific and engineering work lies between the development of a superconductor and the achievement of a sophisticated magnet cable."

Production of a suitable cable and magnets from these new materials could easily take several years, if not a decade, adds Hulm. The penalty for delay, DOE officials point out, could readily exceed the expense of the SSC's helium cryogenics system, which is just a fraction of the $4.4-billion project cost.

Indeed, John M. Rowell, assistant vice president of technology research at Bell Communications Research, notes that the critical current-carrying capacity of these new oxides will have to increase 100 times to be of practical use at the boiling point of liquid nitrogen. Furthermore, Rowell notes that these superconducting oxides have been captured as ceramics, a form that is unsuitable for making wire. Until they take on the flexible properties and mechanical strength of accepted superconducting magnet materials, says Rowell, their application may be limited to electronics and certain forms of power transmission. ■ **M.C.**



Projected SSC costs. *Congress must approve hefty budgets for the SSC in the coming years if the accelerator is to begin operation in 1996.*

of money some states are spending, Trivelpiece says, is excessive for a 200-page proposal. The problem goes beyond the paper proposal. States are expected to provide the government land with suitable geologic characteristics and rights-of-way for the SSC. But states that can afford it also may donate money, buildings, and other assistance, all of which can influence site selection.

Tension over the SSC is building in the industrial sector, too. Carl H. Rosner, president of Intermagnetics General Corporation of Guilderland, New York, wants to limit participation of foreign vendors. The Administration, however, sees broad international cooperation as a way to lower the SSC's cost. The United States might find it hard to stop European and Japanese companies from bidding on the project if their governments put up cash for the SSC.

Nevertheless, Intermagnetics, a manufacturer of superconducting wire and magnets contends it would do "critical damage to the viability of U.S. industry" in the field of superconductivity. Also vying for magnet contracts are Italy's Ansaldo, Brown Boveri of Switzerland, General Dynamics, and Westinghouse.

Still another potential problem may arise in DOE's selection of a general contractor for the project. The department has received an unsolicited proposal to manage the SSC project from Universities Research Association (URA), operator of Fermilab and parent to the SSC's Central Design Group. While it is conceivable that DOE could award the nonprofit group the contract, a controversy could develop if other companies are not permitted to compete for the prize. Martin Marietta's Harrison C. Wroton says his company has operated under the impression that such a task would be subject to competitive bidding. DOE officials say department procurement rules prohibit them from discussing the matter, but they indicate that no decision has been made yet on URA's proposal.

Despite these uncertainties and the fiscal concerns cited by members of Congress, ranking majority and minority leaders such as Roe, Johnston, Senator James McClure (R–ID), and others seem to recognize the supercollider as the next logical step in particle physics. But to sustain what political momentum the SSC has, proponents may have to compromise on the site selection timetable, if not the entire project schedule. "It looks pretty tough right now," says URA's Ezra Heitowit in sizing up the funding outlook. And things could get a lot tougher, observes Representative Jim Chapman (D–TX). "Once the site selection is made there will be less support for this project."

If there is a chance for a political breakthrough, it may not come until next year, and even then presidential politics could get in the way. But when Congress does act, says Trivelpiece, it should make its commitment "with the depth of understanding that support must be there." That commitment won't be forthcoming, says Roe, unless there is "a strong public consensus for this project to go forward." ■

MARK CRAWFORD

Superphénix Springs a Leak

Paris

Europe's fast breeder reactor development program has received a major setback with the discovery of a sodium leak deep inside the French reactor Superphénix. The cause of the leak is not yet known, and according to French officials it could take several months to diagnose and repair.

The leak has not occurred in the main cooling tank surrounding the combustible elements, but in a subsidiary tank where the fuel rods are stored temporarily during their removal from the core of the reactor.

At the end of last month, it was discovered that 20 of the 700 tonnes of liquid sodium contained in the subsidiary tank had leaked into the 15-centimeter gap separating the tank from its protective concrete casing. Subsequent measurements last week revealed that the sodium was continuing to leak into the gap at a rate of 500 kilograms a day.

On 10 April, officials from Electricité de France—France's national utility, which had covered 51% of the costs of construction of Superphénix as an "industrial prototype"—admitted that they had still not figured out the cause of the leak, and had failed to confirm earlier reports that the problem might have been caused by a faulty weld.

Even a relatively minor mechanical failure, they say, is likely to require "long and costly" repairs. If further investigation reveals the need for a major redesign of the subsidiary tank, the officials say that a replacement could cost up to $15 million. Furthermore, its design and installation could require shutting down Superphénix, which came into operation in December 1985, for up to a year.

The sodium leak has come at a difficult time for the French government, which has so far had little success in persuading either Italy or West Germany, its two main financial partners in the construction of Superphénix, to make any commitment toward the construction of its planned successor, Superphénix 2.

Electricité de France itself has become increasingly lukewarm about the immediate need for fast breeders in general and Superphénix 2 in particular, especially in light of the continuing decrease in the cost of uranium. It is calculated that electricity produced by Superphénix is currently more than twice as expensive as that produced from conventional light water reactors. Even with major technical improvements in the new design, the cost difference is likely to remain at least 45%. ■ DAVID DICKSON