Fermilab faces up to uncertain future

Colin Macilwain

John Peoples will retire next year as director of Fermilab, leaving it in solid shape. But with CERN expected to usurp its position at the forefront of high-energy physics, and doubts about government investment, his replacement must find a way of ensuring a secure future for the US lab.

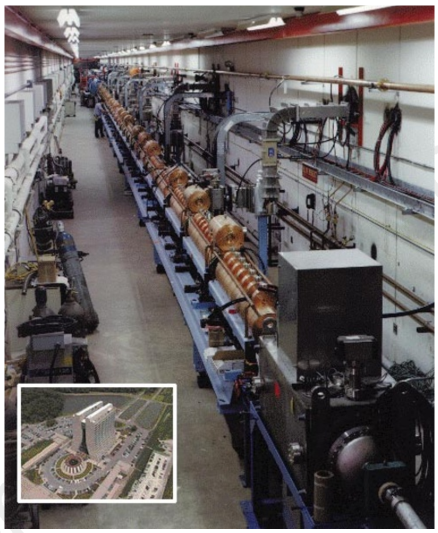
[BATAVIA, ILLINOIS] Wilson Hall, the modernist, 15-floor citadel that houses most of the physicists at the Fermi National Laboratory, brings an air of permanence to the laboratory that many more hastily constructed government facilities sorely lack. But in a few years' time that permanence will be tested.

A search is underway for a successor to John Peoples, who will retire as director of the largest US particle physics laboratory next summer. The challenge for the new director will be to find a role for Fermilab in six to eight years' time, when the Large Hadron Collider (LHC) at CERN, the European laboratory for particle physics, effectively usurps its position at the frontier of high-energy physics.

The director's appointment is crucial, says Peter Rosen, head of the high-energy physics programme at the Department of Energy, which funds the laboratory. "The person coming in will have to develop a clear vision for Fermilab beyond 2005," he says. "That's an important issue for high-energy physics — not just in the United States, but on a global scale, too."

In the short term, Fermilab's prospects are bright. Construction of a new main injector is to be completed this year, enabling its accelerator ring, the Tevatron, to resume operations next year with a far higher beam intensity than before. Two of the three main components of the $530 million US contribution to the LHC are led from the Illinois laboratory. And several medium-sized projects are under way, including the Neutrinos at the Main Injector experiment, which would fire neutrinos at an underground target 500 miles north of the lab in a disused iron mine in Minnesota.

But, in the longer term, the challenge facing the laboratory is substantial. Since the 1993 abandonment of the Superconducting Super Collider in Texas, doubts persist about the willingness of the US government to pursue future multi-billion dollar investments in high-energy physics. In any case, the High Energy Physics Advisory Panel, following a report completed in February by a subpanel chaired by Fred Gilman, has called for a conceptual design report on a 1 TeV electron–positron linear collider, placing this Next Linear Collider (NLC) at the head of its list of possible investments.



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Straightforward future? Physicists from Wilson Hall (inset) operate the Tevatron, which receives protons boosted by the linear accelerator (above).

But as Ken Stanfield, Fermilab's deputy director, readily concedes, electrons are not Fermilab's area of expertise. The NLC will be built in Japan or at the Stanford Linear Accelerator Center in California, or not at all. Some Fermilab physicists predict that its costs will run too high, providing an opportunity for a rival proposal. One of the physicists, Bill Foster, suggests that the NLC costs could surpass $3 billion and that an alternative that would advance particle physics at less cost could move to the front of the queue. "The first [team] that comes in with a $2.5 billion machine" will be best placed to get there, Foster predicts.

Following the Gilman report, steps are being taken to refine two such approaches, either of which could be built at Fermilab. A steering committee has been established to plan for a future Very Large Hadron Collider (VLHC). The secretary of the committee, Fermilab physicist Ernest Malamud, says it will form three working groups — dealing with accelerator physics, accelerator technology, and magnets — to explore the technical challenges of designing a ring that would give proton energies of up to 100 TeV.

The working groups, open to scientists from all over the world, will explore both the possible approaches to a VLHC — a huge ring with a low magnetic field, sometimes known as the Pipetron (see *Nature* **385,** 471; 1997), and a compact ring with a very high magnetic field. The working groups will concentrate on cost issues, Malamud says.

The other option is for a muon collider. Recognizing the technical and fiscal constraints on electron and proton colliders, this approach would instead try to make use of the muon, a subatomic particle that decays in two microseconds if left alone, but whose properties would allow for very high-energy collisions in a ring of manageable size.

"We don't know if muon colliders are feasible or not," admits Steve Geer, a Fermilab physicist working on a research collaboration devoted to muon collider concepts involving the Illinois laboratory, the Brookhaven National Laboratory in New York and the Lawrence Berkeley National Laboratory in California. Muons and anti-muons would be generated by bombarding a target with protons. The team is tackling technical challenges, such as designing a target to survive the bombardment of protons, and finding a way to compress the resultant cloud of muons and anti-muons and accelerate them round a ring in opposite directions before they decay. If such a collider were feasible, it could reach very high energies in a small space, and two generations of machine could fit into Fermilab.

"The muon collider could have a lot more energy than the LHC and be accommodated on this site," says Stanfield. Asked if a major new accelerator will ever be built at Fermilab, Stanfield admits to some uncertainty, citing political problems that the lab will confront if it attempted to tunnel off-site.

Much of the lab's effort is already devoted to the US contribution to the LHC. Fermilab leads the US contribution to the Compact Muon Solenoid (CMS), one of two targets being designed for the LHC (the US contribution to ATLAS, the other target, is being coordinated at Brookhaven). The $200 million US contribution to the construction of the accelerator itself is also managed at Fermilab, although much of the money will be spent with outside industrial contractors.

Each detector project has been reviewed by a team jointly appointed by the Department of Energy and the National Science Foundation, the other agency supporting the US contribution. In the case of the CMS, the outcome was that the proposed scope of the detector will be curtailed to allow the level of contingency funding — 40 per cent — which the reviewers believe is needed to make absolutely certain that the project remains within budget. Stanfield, who has overall management responsibility for the US contribution to the CMS, says the contingency money can be used later to restore the detector to its original specification, if it isn't needed to cover unexpected costs. □