CERN Council Decides to Build LHC Now—and Pay for It Later

Contributions from nonmember states will speed up construction of the LHC, but CERN's overall budget remains tight.

The good news for particle physics is that the Large Hadron Collider will be built in a single stage by 2005.

The hoped-for green light was given at CERN's 20 December council meeting in Geneva, Switzerland, where the LHC will be built. The decision required some careful diplomacy both among CERN's 19 member states and with prospective nonmember partners. Some of the member states insisted on reducing their annual contributions to CERN, while others feared that doing so now might frighten off nonmembers from joining the project. In the end, the council agreed to reduce member dues, and ensured that this cut in CERN's budget won't affect the LHC by also agreeing to spread out payment through 2008, and to put the squeeze on CERN's personnel budget, including cutting staff salaries. A delayed-payment scheme, together with substantial commitments from the US, Japan and other nonmembers, will make it feasible to construct the LHC speedily. The cost will be 2.6 billion Swiss francs (about $1.9 billion).

The LHC will produce 14 TeV proton–proton collisions, the highest accelerator energy yet. (The highest currently accessible energy is about 2 TeV at the Fermilab Tevatron in Batavia, Illinois.) It will be built in the existing 27 km Large Electron Positron (LEP) collider tunnel, and will use four existing CERN particle injectors, as well as some of LEP's installations such as cryogenics and electric cabling. The 8.36-tesla superconducting magnets (see photo) will bend beams of counterrotating protons in two separate beam pipes; they will be the highest field magnets ever used in an accelerator, and will account for nearly half the LHC's cost.

The main reason for building the LHC is to look for the mechanisms responsible for electroweak symmetry breaking—that is, to figure out why leptons and quarks have mass. A key emphasis will be the search for the Higgs boson, which, if found, will provide a missing link that would explain how such particles acquire nonzero masses within the Standard Model. But, says Ken Pounds, a UK delegate to the CERN council and chief executive of the UK's Particle Physics and Astronomy Research Council, "While the Higgs is the LHC's highlight objective, there will be a whole range of things to study" in the new energy region. "I think that the most exciting discovery at the new accelerator will be the unexpected," adds Ben Shen, a high-energy physicist at the University of California, Riverside, and a collaborator on the US CMS team. CMS ("compact muon solenoid") will be one of two main LHC experiments; the other will be ATLAS ("a toroidal LHC apparatus").

Both ATLAS and CMS are designed to detect high-momentum transfer events—in particular, the Higgs boson—but the two giant detectors will differ in geometry and technology; the magnetic field configurations will be different, for example, as will the particle tracking systems. "The two detectors will complement each other and provide cross-checking," says US ATLAS team head Bill Willis of Columbia University. "Competition enhances the rate of results. The goal is that at least one of them works."

Two other experiments are also planned for the LHC. One is ALICE ("a large ion collision experiment"), for studying collisions between heavy ions. The other is the LHC-B experiment, with which scientists at CERN will join the race to discover whether *CP* (charge conjugation and parity inversion) violation can be seen in the decay of B particles.

Accelerating the accelerator

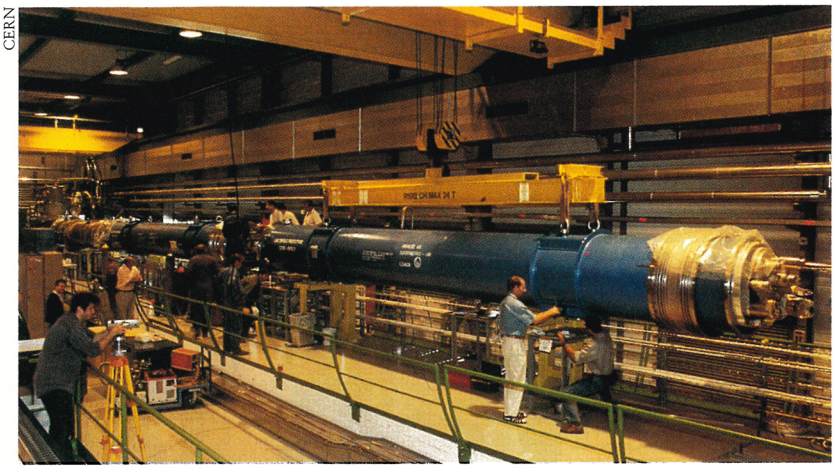
CERN first approved the LHC two years ago (see PHYSICS TODAY, February 1995, page 48). In the original plan, because of budget constraints, the LHC was to be built in two stages by 2008. But now, nonmember contributions will make it possible to build the LHC in a single stage to 14 TeV by 2005. The one-stage plan will provide higher energies sooner, the total cost will be less and upgrade down-time will be avoided.

The US will be the largest nonmember contributor, and has tentatively committed $530 million. About $200 million of the $450 million from the Department of Energy will go toward the accelerator; the rest, along with $80 million from the National Science Foundation (subject to approval by the National Science Board), will go in equal parts to CMS and ATLAS. The US contribution will be in kind, not cash, with the intention that the money benefit US scientists and industry. And, at the December meeting, Japan surprised the council by announcing that it will contribute 3.85 billion yen (about $38.5 million) on top of the 5 billion yen already committed. That is in addition to Japanese R&D for ATLAS. The US will gain official observer status (which Japan has already) after its agreement with CERN has been finalized, and both the US and Japan will participate in discussions pertaining to the LHC at the Committee of Council, the CERN body that discusses issues prior to their ratification by the council. Canada, India, Russia and Israel are also contributing to the LHC project; China will probably participate too.

"The US decision to put money into the LHC accelerator is ground-breaking," says DOE's director of energy research, Martha Krebs. Traditionally, costs for detectors, but not accelerators, have been shared, and there has been mostly free exchange of users. But when the Superconducting Super Collider (SSC) cancellation created a flood of (mostly) American physicists who wanted involvement in the LHC, CERN felt it fair to ask for contributions to the accelerator. "We recognize that we [the world] will be building only one new accelerator at a time, and in order that these facilities benefit (and benefit from) the capabilities of the full international community, we are having to change the way we think about international participation in these projects," explains Krebs.

CERN's director general, Christopher Llewellyn Smith, describes the cooperation as "a major step forward." He notes that the Human Genome Project, for example, though global, is geographically spread out, and that the space station, another major international undertaking, is driven "top down by politics. Collaboration on the LHC, in contrast, is driven by scientists." Adds Llewellyn Smith, "We are very happy that we can build the LHC in a single stage."

CERN



THE STRING OF 10-METER-LONG superconducting dipole magnets shown here sustained 8.36 tesla in a test in December 1994. Some 1232 such magnets will be used in the LHC.

Cutting corners

The latest tussle over CERN's budget began in August, when Germany announced that it needed to reduce its annual contribution. The other member states balked at the idea of granting Germany a special reduction—it was already paying a reduced rate in recognition of financial hardship due to German reunification. Instead, they felt that any reduction should apply to all—but they disagreed by how much to cut annual dues. The UK and a few others joined Germany in calling for steep cuts, while other countries favored smaller ones. Tensions rose further when Germany threatened to withdraw from CERN and to rejoin under different conditions. "We never wanted to leave CERN, but only to change our status," explains council delegate Hans Eschelbacher, deputy director general of science promotion and basic research in Germany's research ministry. "But Germany has to cut spending."

Together, the German and British contributions make up more than a third of CERN's annual budget of 938 million Swiss francs, "so it was clear that outvoting them wouldn't lead to a stable solution," says Llewellyn Smith. But there was some compromise: The council agreed to reduce dues by slightly less than Germany had initially wanted, if still by far more than some countries had hoped. Relative to the amounts foreseen in 1994 (dues are calculated from a GNP-based formula), dues will drop by 7.5% in 1997, 8.5% in 1998–2000 and 9.3% thereafter. "I was pleased with the very constructive atmosphere of the council meeting, right from the start," says Dutch delegate Bernard de Wit, of the University of Utrecht.

The council delegates also agreed to spread out payment for the LHC up to three years beyond the building period, and to take out bank loans when needed. "On paper it all works. But we have no contingency, and some things can't be controlled," says de Wit. But, he adds, "all of the member states recognize that we have worries. This means they are willing to share in the responsibilities." Says UK council delegate Pounds, whose view is echoed by Eschelbacher and others, "The good thing is that we now have stability; CERN can count on the members paying up each year. And the total resources for the accelerator will not be reduced." Pounds adds that settling the budget squabbles "was crucial for getting nonmembers on board."

"Funding for the LHC shouldn't depend on yearly budget struggles," says Takahiko Kondo, a physicist at Japan's National Laboratory for High Energy Physics (KEK) and coleader of Japan's ATLAS team. "Otherwise, one can't ask students to be involved. It was a nightmare for me when the SSC was canceled. I don't want that to happen again."

But the budget shortfall will still have to be made up somehow. The main target is the personnel budget—about half of CERN's total budget. To reduce total expenditure by 1%, salaries across the board will be cut 2.5% in 1997 in exchange for 5.5 days additional leave per person. And salaries are likely to remain frozen for awhile. "I wouldn't mind if my salary were cut even more," says Rolf Landua, a CERN physicist. "But proportional cuts are unfair to engineers, technicians and administrative personnel who aren't motivated by supersymmetry or finding the Higgs. They are forced to sacrifice for the interests of physicists."

Management will also conduct an internal review this year of the salary structure at CERN. "A reduction in staff numbers by 30% over the next ten years is already part of the laboratory's long-term planning," says Llewellyn Smith. Early retirements will be encouraged, and benefits such as family allowances, school fees, home leave and health care are also likely to be cut back. "We are not happy that the brunt of the cuts is falling on the personnel budget," says Derek Ball, vice president of CERN's staff association. He adds that the staff association will meet soon to decide whether—and what kind of—legal or industrial action (such as striking) should be taken.

Nor will there be money for other new projects. In fact, some successful existing projects have been terminated. To free up funds for the LHC, the OMEGA spectrometer and the Low Energy Antiproton Ring projects were shut down at the end of last year. And once LEP is shut down (in 1999 or 2000) to make room for the LHC, there will be a period of "thin physics," as de Wit puts it, until 2005 when the LHC begins operations. "It will be hard to ensure the participation and training of young people, and collaborations with universities," he adds. The closures, agrees Llewellyn Smith, "are sad news. But this is the price we must pay for the LHC."

TONI FEDER

Prospects for Saving Chalk River Accelerator Look Dim

Barring an 11th hour reprieve—and badly needed funds—from the government, TASCC, Canada's only facility for research on nuclear structure, will be shut down next month.

Canada's Tandem Accelerator Superconducting Cyclotron (TASCC) of Chalk River labs, in Ontario, appears doomed to die a quiet death next month, when its funding runs out. The heavy-ion accelerator, an Atomic Energy of Canada Ltd (AECL) facility, is a victim of the government-owned company's decision—in response to severe budget cuts—to axe all programs not directly tied to its commercial reactor business—including all basic research.

Since last March, when the govern-