way of sorting photons according to their orbital angular momentum. In the 24 June *Physical Review Letters*, the team members describe how they first prepared a laser beam containing photons with different amounts of orbital angular momentum. They then split the beam, giving the two branches a further twist of 180° relative to one another, and finally recombined them.

When they come together, because of that extra twist and the symmetry properties of orbital angular momentum, photons having an odd number value of orbital angular momentum exit one way from the recombination point, and those with even values exit at right angles to it. These two sorted beams are then individually fed into a second similar splitting, twisting, and recombining setup and so on, in a cascade. Successive levels sort photons according to different multiples of 2 in their orbital angular momentum. Padgett's team made a trial two-stage cascade, enabling them to sort photons having orbital angular momentum values of 0, 1, 2, and 3. "This is equivalent to reading two bits of data from each photon," says Courtial.

"We will be able with this new method to process information in new ways and perhaps make more secure communications," says Oxford's Burnett. For example, blending several quantum states onto a single photon might offer a new route to quantum computation. Although the system is unlikely to work in optical fibers, Padgett sees numerous commercial prospects in loading data onto a single photon, and he is already talking to communications companies. **–ANDREW WATSON**

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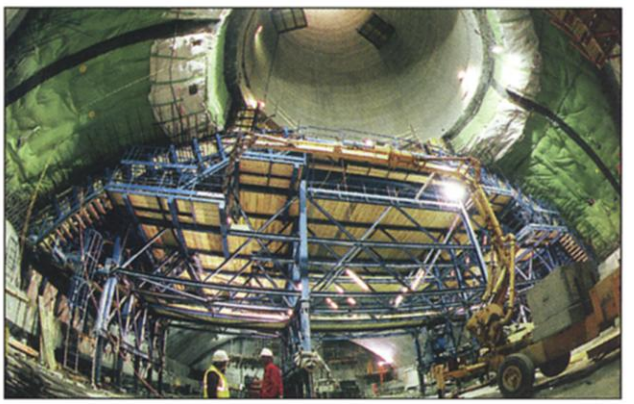
HIGH-ENERGY PHYSICS

CERN Panel Calls for Cuts and Shake-Ups

GENEVA—It's official: CERN must slash other research projects in order to finish the Large Hadron Collider (LHC). That's the conclusion of a group tasked with reviewing the $2 billion megaproject, under construction here at the European laboratory for particle physics, in the wake of cost overruns disclosed last fall (*Science*, 5 October 2001, p. 29). And non-LHC projects might not be the only sacrificial lambs: CERN is coming under pressure to shake up its senior management.

In December, CERN's governing council, outraged by LHC's increasing price tag, appointed a nine-member external review committee (ERC) to assess how best to complete the massive proton collider. In its report, presented last week at the council's biannual meeting in Geneva, ERC praised the design of LHC and the technical competence of CERN staff. But it blasted the lab for "serious weaknesses" in cost control, contract management, and financial reporting, and it called for steps to set things right. CERN council president Maurice Bourquin says the council has accepted ERC's recommendations.

The proposed remedies generally follow those in a medium-term plan that CERN proposed in March (*Science*, 29 March, p. 2341). The committee called on the lab to shift some $300 million from other operations into LHC and stretch out payments for the facility until 2010. Among numerous cost-cutting measures, ERC recommended that CERN shut down both of its existing proton colliders—the Proton Synchrotron and Super Proton Synchrotron—for all of 2005 and reshuffle staff from other accelerator projects to LHC. Finally, ERC's report laid out two models for a new organizational structure aimed at making CERN's management more efficient and accountable.



CREDIT: CERN-GENEVA

Depth charge. Underground construction of the Large Hadron Collider gave CERN's governors a case of sticker shock.

Such changes would be "a big step in the right direction," says Ian Halliday, a council member from the United Kingdom, adding that given the rift between CERN and its council, the negotiations that led to agreement on the report's conclusions "could have gone very badly wrong."

The council has given CERN's management until September to develop a short-term plan for putting most of ERC's recommendations into effect and until December to overhaul LHC's finances. The revision will include cost-to-completion estimates for LHC and a long-term budget and staffing plan for the entire lab. One key ERC recommendation—the call for a "new organizational structure"—although welcomed by council, "will take a bit longer" to implement, says Halliday. CERN director Luciano Maiani's term ends in December 2003, and particulars of the new organizational structure must be worked out in collaboration with his successor, whose name will be known in December 2002.

With a plan in place, the council agreed to release $22 million it had held back from the laboratory's 2002 budget when it launched the ERC investigation. It also approved the lab's proposed $805 million budget for 2003.

CERN's LHC push will hurt smaller projects such as the lab's Antiproton Decelerator, which will also be suspended for 2005. And although CERN will still provide a beamline to send neutrinos to Gran Sasso, Italy, it has withdrawn from the planned experimental portion of the project, which means a halt to neutrino physics for the lab. "Nobody likes it, that's for sure," says Dieter Schlatter, leader of CERN's experimental physics division. Yet most researchers agree that such cutbacks are the price to pay for LHC.

Indeed, all the good news was saved for LHC. Maiani announced that CERN is in the final stages of negotiating a bank loan for an additional $198 million toward the project's construction. He also reported happily that excavation of LHC's two new detector caverns, a major villain in the cost overruns, is now essentially complete. That puts the collider on track to begin operations in mid-2007—2 years late. That schedule is based on staffing levels that are not yet guaranteed, and it assumes that nothing else will go wrong, ERC notes.

Although it would be "dangerous" to think that CERN's problems are solved, Maiani says, the LHC picture is in sharper view than it was a year ago. "We know pretty well how much [LHC] will cost; we know pretty well who will make it; and we are even starting to know who is going to pay for it," he says. **–GISELLE WEISS**

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ASTRONOMY

Cosmic Lenses May Be Magnifying Quasars

Some objects in deep space are not quite as they appear. As their light zips across billions of light-years to Earth, the gravity of matter along the way stretches, splits, and contorts their images. Now, a new study predicts that these mirages, called gravitational lenses, are unexpectedly common for the most distant bodies that astronomers see: quasars near the fringes of the visible cosmos. Up to one-third of these remote beacons might be dramatically brightened by what Harvard University astronomer Abraham Loeb calls "natural telescopes" in the sky. The finding might help resolve a puzzle about these enigmatic