Eight-month delay for LHC

Details of last month's accident at the Large Hadron Collider (LHC), the world's premier particle accelerator, are emerging — and confirm that the machine will not restart before late May or early June 2009.

Officials at CERN, Europe's particle-physics laboratory near Geneva, Switzerland, say that the time is needed to overhaul a sector of the 27-kilometre-long machine, after an electrical failure on 19 September caused some 6 tonnes of ultra-cold liquid helium to leak into its tunnel. A preliminary report issued on 16 October says that as many as 29 of the nearly 10,000 magnets used to guide the accelerator's proton beam will need to be replaced. Further magnets may need to be removed and inspected, and modifications must also be made to prevent future accidents. "It's a serious incident," says James Gillies, a spokesman for the laboratory.

"The amount of helium released was larger than the valves were designed to handle."

Still, CERN is confident it has the resources to make the repairs. No more than 24 dipole magnets and 5 quadrupole magnets were damaged; CERN has 30 dipole magnets — each weighing 35 tonnes — in reserve, as well as sufficient quadrupoles, says Gillies. Replacement magnets are already being tested in a facility above the buried accelerator tunnel. Nevertheless, Gillies says that the damage will take all of CERN's winter shutdown period to repair. Not including labour and the spares, the work will cost an estimated 100,000 Swiss francs (US$90,000), he says.

The LHC's superconducting magnets generate enormous fields by circulating huge electrical currents with virtually no resistance. To work correctly, they must be immersed in liquid helium and kept at a temperature of just 1.9 kelvin. During the 19 September test, the accident report says, a weld in a superconducting wire connecting two magnets heated above its operating temperature. That in effect turned the wire into a resistor — causing a massive 8.7 kiloamps of power to arc through the liquid helium and puncture into the surrounding vacuum vessel.

In just milliseconds, the arc managed to vaporize a "significant fraction" of the nearly metre-long connection between the two magnets, says Jim Strait, an accelerator physicist at the Fermi National Accelerator Laboratory in Batavia, Illinois, who has been consulting on the accident investigation. The liquid helium flowed through the hole and into an insulating region of vacuum, which was meant to work as a thermos to keep the magnets cool. Relief valves designed to allow the helium to escape were overwhelmed and, within seconds, the pressure in the machine became powerful enough to wrench magnets off their concrete supports.

Strait says that the relief valves' tolerances were based on "incorrect assumptions" about how much helium might escape in an accident. "The total amount of helium released was larger than the valves were designed to handle," he says. "You could call it a design error."

Gillies says that "clearly something was wrong" with the models of how much helium could be released, but he adds that it is difficult to foresee every possible scenario. "This thing is its own prototype," he says.

The electrical arc also penetrated the beam pipes, allowing soot from the accident to contaminate the pipes. "It's a mess in the affected spots," Strait says.

CERN is looking at adding extra relief valves and developing new diagnostics to catch such a failure before it occurs. A late May or early June start-up seems ambitious to Strait, but he has faith in the team at CERN. "It looks very difficult to me, but I would not count them out," he says.

Those awaiting the start of the machine remain stoic. "We are a bit disappointed," says Peter Jenni, a spokesman for the ATLAS detector, which employs more than 2,500 physicists. "But we all understand that in such an enterprise, things can go wrong." ■

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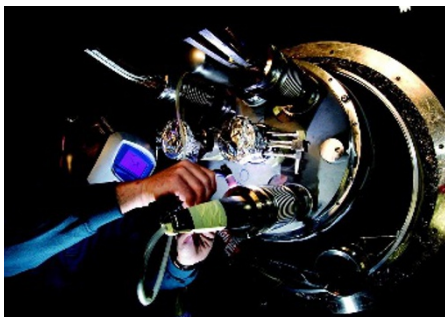

Broken magnets at CERN will need to be replaced.