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LHC gets colder than deep space

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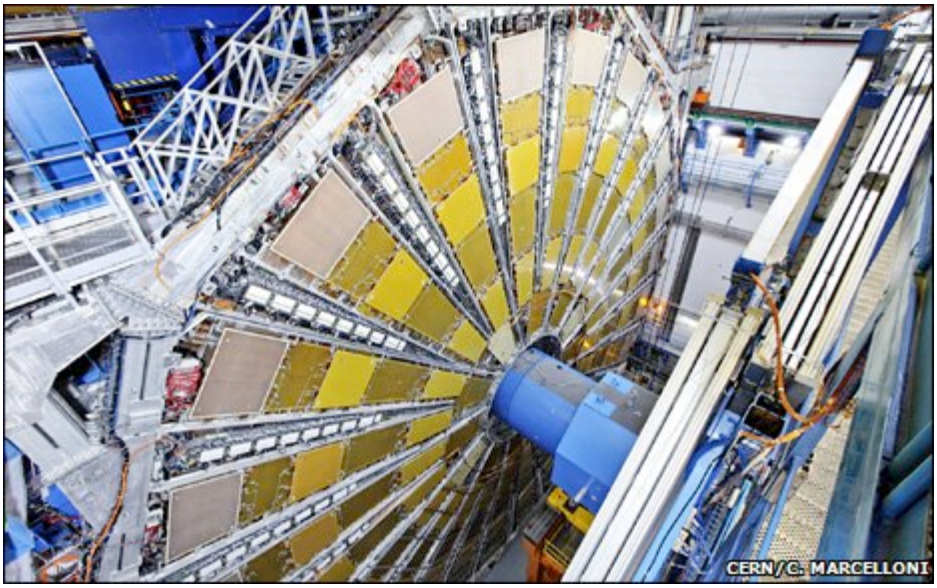

The giant Atlas detector will search for hints of the elusive Higgs boson particle

The Large Hadron Collider (LHC) experiment has once again become one of the coldest places in the Universe.

All eight sectors of the LHC have now been cooled to their operating temperature of 1.9 kelvin (-271C; -456F) - colder than deep space.
The large magnets that bend particle beams around the LHC are kept at this frigid temperature using liquid helium.
The magnets are arranged end-to-end in a 27km-long circular tunnel straddling the Franco-Swiss border.
The cool-down is an important milestone ahead of the collider's scheduled re-start in the latter half of November.

The LHC has been shut down since 19 September 2008, when a magnet problem called a "quench" caused a

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>
> James Gillies, director of communications, Cern

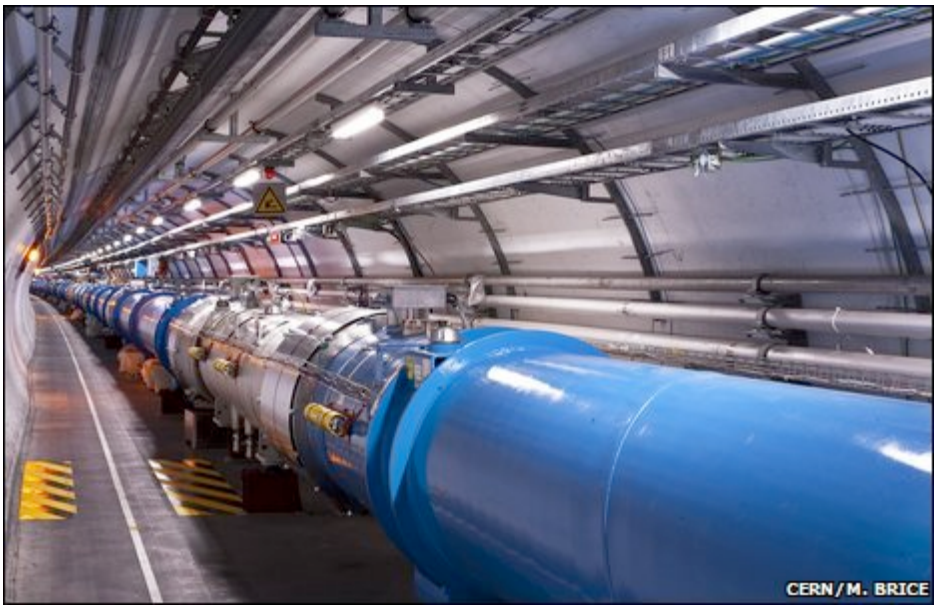
tonne of liquid helium to leak into the LHC tunnel.
After the accident, the particle accelerator had to be warmed up so that repairs could take place.
The most powerful physics experiment ever built, the Large Hadron Collider will recreate the conditions just after the Big Bang. It is operated by the European Organization for Nuclear Research (Cern), based in Geneva.
Two beams of protons will be fired down pipes running through the magnets. These beams will travel in opposite directions around the main "ring" at close to the speed of light.
At allotted points around the tunnel, the proton beams cross paths, smashing into one another with cataclysmic energy. Scientists hope to see new particles in the debris of these collisions, revealing fundamental new insights into the nature of the cosmos.

Awesome energy

The operating temperature of the LHC is just a shade above "absolute zero" (-273.15C) - the coldest temperature possible. By comparison, the temperature in remote regions of outer space is about 2.7 kelvin (-270C; -454F).
The LHC's magnets are designed to be "superconducting", which means they channel electric current with zero resistance and very little power loss. But to become superconducting, the magnets must be cooled to very low temperatures.

Guide to the LHC and how it works

For this reason, the LHC is innervated by a complex system of cryogenic lines using liquid helium as the refrigerant of choice.
No particle physics facility on this scale has ever operated in such frigid conditions.
But before a beam can be circulated around the 27km-long LHC ring, engineers will have to thoroughly test the machine's new quench protection system and continue with magnet powering tests.
Particle beams have already been brought "to the door" of the Large Hadron Collider. A low-intensity beam could be injected into the LHC in as little as a week.
This beam test would involve only parts of the collider, rather than the whole "ring".



The LHC's tunnel runs for 27km under the Franco-Swiss border

Officials now plan to circulate a beam around the LHC in the second half of November. Engineers will then aim to smash low-intensity beams together, giving scientists their first data.

The beams' energy will then be increased so that the first high-energy collisions can take place. These will mark the real beginning of the LHC's research programme.

Collisions at high energy have been scheduled to occur in December, but now look more likely to happen in January, according to Cern's director of communications James Gillies.

Feeling the squeeze

Mr Gillies said this would involve delicate operation of the accelerator.

"Whilst you're accelerating [the beams], you don't have to worry too much about how wide the beams are. But when you want to collide them, you want the protons as closely squeezed together as possible.

He added: "If you get it wrong you can lose beam particles - so it can take a while to perfect. Then you line up the beams to collide.

"In terms of the distances between the last control elements of the LHC and the collision point, it's a bit like firing knitting needles from across the Atlantic and getting them to collide half way."

Officials plan a brief hiatus over the Christmas and New Year break, when the lab will have to shut down.

Although managers had discussed working through this period, Mr Gillies said this would have been "too logistically complicated".

The main determinant in the decision to close over winter were workers' contracts, which would have needed to be re-negotiated, he said.

An upgraded early warning system, or quench protection system, should prevent incidents of the kind which shut the collider last year, officials say.

This has involved installing hundreds of new detectors around the machine.

Cern has spent about 40m Swiss Francs (£24m) on repairs following the accident, including upgrades to the quench protection system.

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