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Cern Large Hadron Collider restarts after 14 months

By Paul Rincon
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Researchers cheer as Large Hadron Collider reboots
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The Large Hadron Collider experiment has re-started after a 14-month hiatus while the machine was being repaired.

Engineers have made two stable proton beams circulate in opposite directions around the machine, which is in a tunnel beneath the French-Swiss border.
The team may try to increase the £6bn ($10bn) collider's energy to record-breaking levels this weekend.

The LHC is being used to smash together beams of protons in a bid to shed light on the nature of the Universe.

It is the world's largest machine and is housed in a 27km-long circular tunnel.

During the experiment, scientists will search for signs of the Higgs boson, a sub-atomic particle that is crucial to our current understanding of physics. Although it is predicted to exist, scientists have never found it.

> **“ It happened faster than anyone could have dreamed of, everything went very smoothly**
>
> James Gillies
> Cern

In pictures: LHC restarts
Large Hadron Collider: Guide
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The LHC: worth the wait?

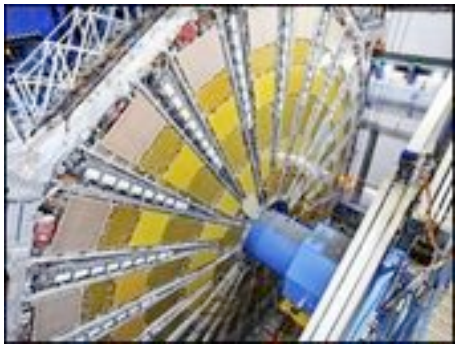
Dozens of giant superconducting magnets that accelerate the particles at the speed of light have had to be replaced after faults developed just days after the collider was inaugurated last year.

Operated by the European Organization for Nuclear Research (Cern), the LHC will create similar conditions to those which were present moments after the Big Bang.

The BBC's Pallab Ghosh in Geneva says the restart of the collider was the moment the scientists had been waiting for.

It means they can once again go in search of the new discoveries they believe will roll back the frontiers of understanding our universe, says our correspondent.

"It's great to see beams circulating in the LHC again," said Cern's director-general Rolf Heuer.



This giant machine part will try to detect the elusive Higgs boson

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Particle physicist Jim Virdee says that scientists are excited that the LHC is coming back online

"We've still got some way to go before physics can begin, but with this milestone we're well on the way."

Engineers sent their first beam all the way round the LHC's circumference 100m underground after 1930 GMT on Friday.

Record attempt

The beams themselves are made up of "packets" - each about a metre long - containing billions of protons. But they would disperse if left to their own devices.

Electrical forces had to be used to "capture" the protons. This keeps them tightly huddled in packets, for a stable, circulating beam.

Engineers had not been expected to try for a circulating beam before 0600 GMT on Saturday.

James Gillies, Cern's director of communications, told BBC News: "It happened faster than anyone could have dreamed of."

"Everything went very smoothly."

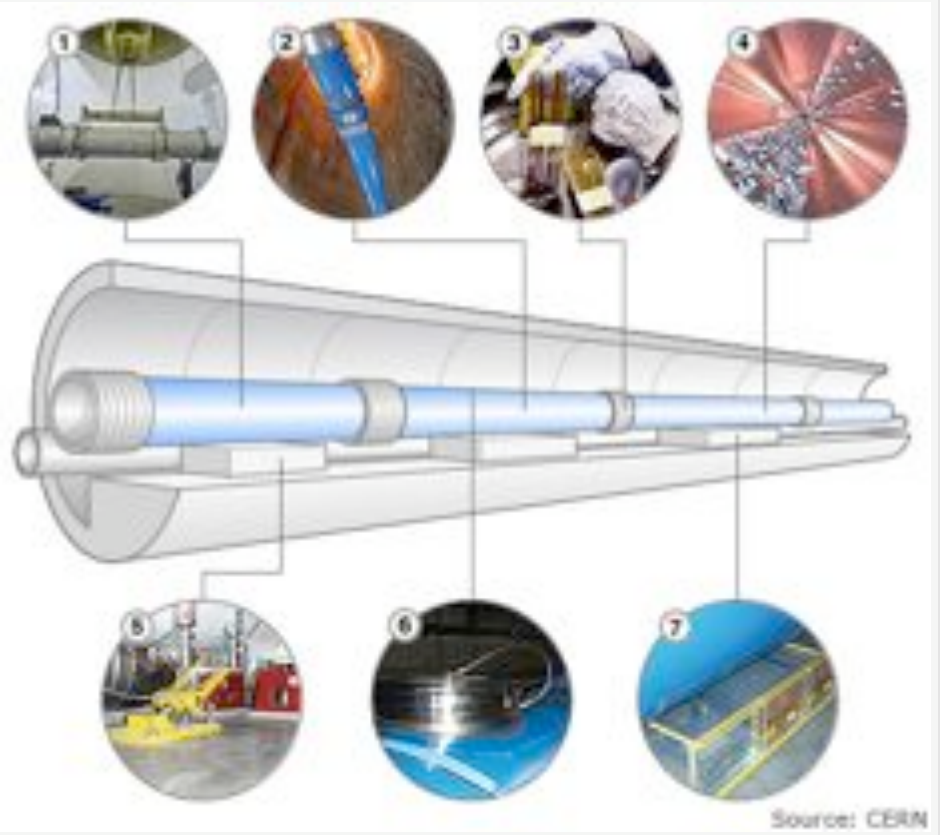
Dr Gillies said that if everything continued to go well, Cern might try to reach a record-breaking beam energy of 1.2 trillion electron volts this weekend.

Only the Tevatron particle accelerator in Chicago, US, has approached this energy, operating at just under one trillion electron volts.

But other team members want to keep the beam circulating at low energy and try for the machine's first proton beam collisions.

"The LHC is a far better understood machine than it was a year ago," said Steve Myers, Cern's director for accelerators.

"We've learned from our experience, and engineered the technology that allows us to move on. That's how progress is made."



1 - 14 quadrupole magnets replaced

2 - 39 dipole magnets replaced

3 - More than 200 electrical connections repaired

4 - Over 4km of beam pipe cleaned

5 - New restraining system installed for some magnets

6 - Hundreds of new helium ports being installed around machine

7 - Thousands of detectors added to early warning system

There are some 1,200 superconducting magnets which form the LHC's main "ring".
These magnets bend proton beams in opposite directions around the tunnel at close to the speed of light.
At allotted points around the tunnel, the proton beams cross paths, smashing into one another with enormous energy. Large "detector" machines located at the crossing points will scour the wreckage of these collisions for discoveries that should extend our knowledge of physics.
Engineers first circulated a beam all the way around the LHC on 10 September 2008.
But just nine days later, an electrical fault in one of the connections between superconducting magnets caused a tonne of liquid helium to leak into the tunnel.

Liquid helium is used to cool the LHC to its operating temperature of 1.9 kelvin (-271C; -456F).

The machine has been shut down ever since the accident, to allow repairs to take place.

Professor Norman McCubbin, from the UK's Rutherford Appleton Laboratory in Didcot, added: "I'm sure every particle physicist has been feeling just a little bit impatient as the 're-start' of the LHC has drawn nearer. It's great to see beams circulating again."

The damage caused to the collider meant 53 superconducting magnets had to be replaced and about 200 electrical connections repaired.

Engineers have also been installing a new early warning system which could prevent incidents of the kind which shut down the experiment.

Cern has spent some 40m Swiss Francs (£24m) on repairs to the collider.

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