BBC NEWS

LHC's particle search 'nearing'

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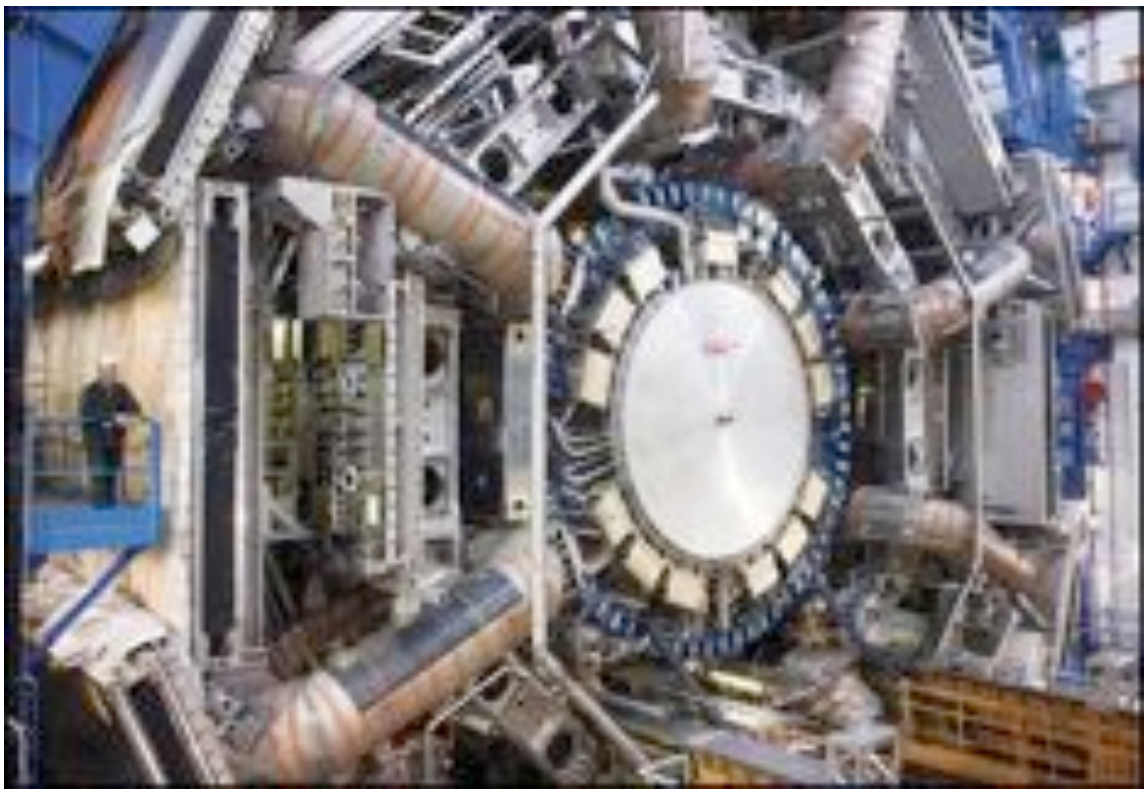

The Large Hadron Collider could soon begin a search for new sub-atomic particles, a leading physicist says.

If commissioning work goes well, the LHC could become sensitive enough to probe a hitherto unexplored domain in particle physics by the end of summer.

Among the first candidates for discovery are two boson particles that have been predicted to exist.

The £6bn ($10bn) collider is being used to smash together proton beams to shed light on the nature of Universe.

The machine has seen half a billion of these collisions since beams crossed for the first time in November 2009.

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Dr Tony Weidberg, University of Oxford
It is operated by Cern (the European Organization for Nuclear Research), based near Geneva. The machine itself is housed in a 27km-long circular tunnel under the French-Swiss border.

It is designed to search for the elusive Higgs boson and study new physics predicted to exist at the 1,000 gigaelectronvolt (GeV) scale (approximately 1,000 times larger than the mass of a proton).

One of the first prospects for new discoveries at this mass scale are particles known as W prime and Z prime bosons. These are heavier versions of the W and Z bosons, which are responsible for weak interactions.

The weak interactions are one of the four fundamental interactions of nature, alongside gravity, the strong interaction and electromagnetic force.

The W and Z bosons were discovered at Cern in the 1980s at the 100 GeV (gigaelectronvolt) mass scale. Particle physicists need to push particle accelerators to ever higher energies in order to detect higher-mass particles, so the LHC was built to be more powerful than any previous "atom-smasher".

If all goes well, the machine could be sensitive enough to probe the 1,000 GeV scale within a few months, according to Dr Tony Weidberg, a particle physicist at the University of Oxford, UK.

Energy boost

Dr Weidberg works on the LHC's Atlas experiment, which is one of two enormous "multi-purpose" detectors looking for new phenomena in the particle collisions (the other is the Compact Muon Solenoid, or CMS).

The collider will operate at 3.5 TeV (teraelectronvolts) this year and next year - about half the energy it was designed for. But engineers have been steadily increasing the intensity - or luminosity - of the beams.

In order to do so, they need to commission more and more of the LHC's protection system which ensures that if control of the particle beams is lost, they do not plough holes through the magnets designed to bend them around the tunnel.

LHC DETECTORS
CMS - Multi-purpose detector which will search for new physics, including the Higgs boson
Atlas - Similar scientific goals to CMS; will explore nature of fundamental matter and forces
Alice - Will re-create a liquid state of matter which existed just after the Big Bang
LHCb - Detector is designed to answer a specific question: where did all the anti-matter go?

Totem - Will measure the size of protons and how they scatter, among other things
LHCf - Will simulate cosmic rays, naturally occurring charged particles from outer space
Atlas has already identified what appear to be lower-mass W bosons from their "decay products" in collisions at the LHC. Although the W boson was already known to physicists, identifying known particles is vital for calibration of the detectors like Atlas.

The LHC is designed to look for new physics beyond the Standard Model - the framework drawn up in the 1970s to explain the interactions of sub-atomic particles. But the model is now regarded as incomplete, a mere stepping stone to a deeper understanding of laws governing the Universe.

The discovery of higher-mass W and Z bosons would shed important new light on these interactions. The lower-mass versions fall into a category called gauge particles, which are associated with a particular form of "handedness".

In this scheme, particles can be described as left-handed, right-handed or as combinations of both. The W boson is described by physicists as "left-handed".

"We're into speculation here, but one possibility is that the Universe is really symmetric at high energies and that there are right-handed W bosons as well," said Dr Weidberg.

"For some reason, they happen to be much heavier than the left-handed W bosons we know."

Dr James Gillies, director of communications at Cern, said the LHC was "still on course" to be exploring the 1,000 GeV mass range during its first run (scheduled to last between 18 and 24 months). But he said he could not say for sure whether it would be this year.

LHCb, another large detector, will focus on exploring the nature of anti-matter. The detector recently identified a pair of sub-atomic particles known as Charm and Strange Beauty - the first time they have been seen with this experiment.

Dr Tara Shears, who works on LHCb, said that sighting the Strange Beauty particle was particularly exciting for her team.

"This is the first of a type of particle that we're going to use to try to give us a handle on anti-matter and why it behaves differently to normal matter," the University of Liverpool researcher told BBC News.

"We're going to use matter and anti-matter versions of this particular particle to really probe our understanding of what's going on in a way that we haven't been able to with other experiments."

Dr Weidberg said the LHC would probably not be sensitive enough to conduct searches for the Higgs boson until 2011 at the earliest.

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