Possible signs of the Higgs remain in latest analyses (Update)

December 13 2011

This Thursday, March 22, 2007 file photo shows the magnet core of the world's largest superconducting solenoid magnet (CMS, Compact Muon Solenoid) at the European Organization for Nuclear Research (CERN)'s Large Hadron Collider (LHC) particule accelerator in Geneva Switzerland. Scientists at CERN will hold a public seminar Tuesday Dec. 13, 2011 to present their latest findings from the search for an elusive sub-atomic particle known as the Higgs boson. Physicists are increasingly confident that they have narrowed down the place where it will be found and may even already have hints at its existence hidden away in reams of data. (AP Photo/KEYSTONE/Martial Trezzini, File)

(PhysOrg.com) -- Two experiments at the Large Hadron Collider have nearly eliminated the space in which the Higgs boson could dwell, scientists announced in a seminar held at CERN today. However, the ATLAS and CMS experiments see modest excesses in their data that could soon uncover the famous missing piece of the physics puzzle.

The experiments revealed the latest results as part of their regular report to the CERN Council, which provides oversight for the laboratory near Geneva, Switzerland.

Theorists have predicted that some subatomic particles gain mass by interacting with other particles called Higgs bosons. The Higgs boson is the only undiscovered part of the Standard Model of physics, which describes the basic building blocks of matter and their interactions.

The experiments' main conclusion is that the Standard Model Higgs boson, if it exists, is most likely to have a mass constrained to the range 116-130 GeV by the ATLAS experiment, and 115-127 GeV by CMS. Tantalising hints have been seen by both experiments in this mass region, but these are not yet strong enough to claim a discovery.

Higgs bosons, if they exist, are short-lived and can decay in many different ways. Just as a vending machine might return the same amount of change using different combinations of coins, the Higgs can decay into different combinations of particles. Discovery relies on observing statistically significant excesses of the particles into which they decay rather than observing the Higgs itself. Both ATLAS and CMS have analysed several decay channels, and the experiments see small excesses in the low mass region that has not yet been excluded .

Taken individually, none of these excesses is any more statistically significant than rolling a die and coming up with two sixes in a row. What is interesting is that there are multiple independent measurements pointing to the region of 124 to 126 GeV. It's far too early to say whether ATLAS and CMS have discovered the Higgs boson, but these updated results are generating a lot of interest in the particle physics community.

Hundreds of scientists from U.S. universities and institutions are heavily involved in the search for the Higgs boson at LHC experiments, said CMS physicist Boaz Klima of the Department of Energy's Fermi National Accelerator Laboratory near Chicago. "U.S. scientists are definitely in the thick of things in all aspects and at all levels," he said.

More than 1,600 scientists, students, engineers and technicians from more than 90 U.S. universities and five U.S. national laboratories take part in the CMS and ATLAS experiments, the vast majority via an ultra-high broadband network that delivers LHC data to researchers at universities and national laboratories across the nation . The Department of Energy's Office of Science and the National Science Foundation provide support for U.S. participation in these experiments. Fermi National Accelerator Laboratory is the host laboratory for the U.S. contingent on the CMS experiment, while Brookhaven National Laboratory hosts the U.S. ATLAS collaboration.

Over the coming months, both the CMS and ATLAS experiments will focus on refining their analyses in time for the winter particle physics conferences in March. The experiments will resume taking data in spring 2012.

"We've now analyzed all or most of the data taken in 2011 in some of the most important Higgs search analyses," said ATLAS physicist Rik Yoshida of Argonne National Laboratory near Chicago. "I think everybody's very surprised and pleased at the pace of progress."

Higgs-hunting scientists on experiments at U.S. particle accelerator the Tevatron will also present results in March.

Discovering the type of Higgs boson predicted in the Standard Model would confirm a theory first put forward in the 1960s.

Even if the experiments find a particle where they expect to find the Higgs, it will take more analysis and more data to prove it is a Standard Model Higgs. If scientists found subtle departures from the Standard Model in the particle's behavior, this would point to the presence of new physics, linked to theories that go beyond the Standard Model. Observing a non-Standard Model Higgs, currently beyond the reach of the LHC experiments with the data they've recorded so far, would immediately open the door to new physics.

Another possibility, discovering the absence of a Standard Model Higgs, would point to new physics at the LHC's full design energy, set to be achieved after 2014. Whether ATLAS and CMS show over the coming months that the Standard Model Higgs boson exists or not, the LHC program is closing in on new discoveries.

Factfile on Large Hadron Collider

Here is a snapshot of the Large Hadron Collider (LHC), the giant machine that led the quest to identify a key sub-atomic particle known as the Higgs Boson, which is believed to confer mass.

- The LHC comprises four huge labs interspersed around a ring-shaped tunnel located near Geneva, 27 kilometres (16.9 miles) long and up to 175 metres (568 feet) below ground.

-- Beams of hydrogen protons are accelerated in opposed directions to more than 99.9999 percent of the speed of light. Powerful superconducting magnets, chilled to a temperature colder than deep space, then "bend" the beams so that streams of particles collide within four large chambers.

- The smashups fleetingly generate temperatures 100,000 times hotter than the Sun, replicating the conditions that prevailed just after the "Big Bang" that created the Universe 13.7 billion years ago.

- Swathing the chambers are detectors that give a 3-D image of the traces of sub-atomic particles hurled out from the protons' destruction. These traces are then closely analysed in the search for movements, properties or novel particles that could advance our understanding of matter.

-- In top gear, the LHC is designed to generate nearly a billion collisions per second. Above ground, a farm of 3,000 computers, one of the largest in the world, instantly crunches the number down to about 100 collisions that are of the most interest.

-- Peak LHC collisions generate 14 teraelectron volts (TeV), amounting to a high concentration of energy but only at an extraordinarily tiny scale. One TeV is the equivalent energy of motion of a flying mosquito. There is no safety risk, says CERN (the European Organisation for Nuclear Research).

- Other LHC's investigations include supersymmetry -- the idea that more massive particles exists beyond those in the Standard Model -- and the mystery why anti-matter is so rare compared to matter, its counterpart. Supersymmetry could explain why visible matter only accounts for some four percent of the cosmos. Dark matter (23 percent) and dark energy (73 percent) account for the rest.

- Completed in 2008, the LHC cost 6.03 billion Swiss francs (roughly 5.9 billion euros, 4.5 billion dollars).

Particle physics: A timeline

Following is a timeline of particle physics following the announcement Tuesday that scientists believe they are nearer to finding the elusive Higgs Boson, predicted to be the particle that confers mass.

5th century BC: Greek philosopher Democritus suggests the Universe consists of empty space and of invisible and indivisible particles called atoms.

1802: John Dalton, a Quaker-educated English physicist and chemist, lays groundwork of modern theory of the elements and the atom.

1897: Electron discovered by Britain's Joseph Thomson, who later proposes a "plum pudding" model of the atom. He suggests the atom is a slightly positive sphere with raisin-like electrons inside that have a negative charge.

1899-1919: New Zealand physicist Ernest Rutherford identifies atomic nucleus, the proton and alpha and beta particles.

1920s: Advances in quantum theory, about the behaviour of matter at the atomic level.

1932: Neutron, similar to the proton but with no electrical charge, is discovered by James Chadwick of Britain. The first antiparticle, the positron (the mirror particle to the electron), is discovered by American Carl Anderson.

1934: Italy's Enrico Fermi postulates the existence of the neutrino (Italian for "little neutral one"), a neutral-charge partner to the electron. Theory is confirmed in 1959.

1950s: Invention of particle accelerator leads to surge in discoveries of sub-atomic particles.

1964:

- British physicist Peter Higgs postulates existence of a particle, later known as the Higgs Boson, that provides mass to otherwise massless particles.

- Murray Gell-Mann and George Zweig of the United States propose that protons and neutrons are comprised of quarks.

1974: Development of the "Standard Model," a theory that everything in the Universe comprises 12 building blocks divided into two families, leptons and quarks, and these are governed by four fundamental forces.

1977-2000: Flurry of discoveries that strengthens Standard Model hypothesis, including the existence of bottom and top quarks, tau lepton, gluon, tau neutrino and the W and Z bosons which help carry the "weak" force.

Provided by Fermi National Accelerator Laboratory

Citation: Possible signs of the Higgs remain in latest analyses (Update) (2011, December 13) retrieved 20 March 2024 from https://phys.org/news/2011-12-narrow-higgs-particle.html

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.