Physicists closing in on the elusive Higgs boson

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Scientists at a meeting in Grenoble, France, recently stoked speculation that physicists at the world's biggest particle accelerator may soon provide a first look at the elusive Higgs boson - the final piece of evidence needed to prove that the Standard Model of particle physics, which explains the behavior of subatomic particles, is correct.

The $10 billion Large Hadron Collider was built near Geneva by the European Organization for Nuclear Research, or CERN, to create exotic particles that physicists believe existed in the moments after the Big Bang. For the last 14 months, it has been hurtling beams of protons toward each other around a 17-mile track at nearly the speed of light.

UCLA physics professor Robert Cousins has worked on the collider's Compact Muon Solenoid detector since 2000. He talked with the Los Angeles Times from his office at CERN in Geneva about the quest for the Higgs boson.

Q: What does the Large Hadron Collider do?

A: We make all of the particles that have ever been made in the history of high-energy physics, like top quarks and W and Z bosons. We try to find out what the smallest building blocks of matter are and what forces work between them. It's been a continuous search for smaller, smaller, smaller. Basically, it's trying to find out what we're made of.

We're hoping also to make particles that have never been observed before - one of which is the Higgs boson.

Q: What's so great about the Higgs boson?

A: It's often said that the Higgs boson is why particles have mass.

Q: How long have physicists been looking for it?

A: Gosh - four decades. Certainly by the mid- to late '70s we knew it had to exist.

Q: How does it fit into the Standard Model of particle physics?

A: The Standard Model is this big picture that's been developed over decades. It says that the smallest objects are quarks and leptons, and it includes the strong, weak and electromagnetic forces. It says that every force has a particle, called a quantum, associated with it. This goes back to Einstein. The first quantum of a force was the photon, which is the quantum of the electromagnetic force.

The whole picture is tied together with many precision measurements. These show that there is one undetected energy field called the Higgs field. It has a quantum associated with it: the Higgs boson. It's the last piece of the Standard Model that has not been discovered.

Q: Are you getting close to finding it?

A: There haven't been any major discoveries announced yet. What's been reported is that the Large Hadron Collider is working fantastically well.

What caused a stir (late last month) was that because we have so much data, we may be getting close to seeing convincing evidence of the Higgs boson. We have graphs with peaks that could indicate the real Higgs boson - or could just reflect statistical fluctuations.

If things go well, we might know by the end of the year.

Q: If a Higgs boson is produced in a collision, how long does it survive?

A: Not long at all. If the Higgs boson is made, it decays before it travels the length of a single proton. It decays far faster than we can observe it. What we observe are the things it decays to. We measure those and run the equations and physics backward to infer that they came from a Higgs boson.

Q: If you find the Higgs boson, how huge a discovery would it be?

It would confirm that the Standard Model, which was built up over 50 years, really does all fit together. Showing that the Higgs field exists and that it's the reason particles have mass would give experimental confirmation to an enormous body of work.

Q: And if you don't find it?

Occasionally a theorist says that the biggest discovery would be if we don't find it, because that would mean that everything we did up to now is wrong.

I think it would be great to find the Higgs boson and understand its properties. It might not be as simple as we've predicted - there might be more than one Higgs boson, for example. We might discover that the Standard Model is right, but it's incomplete and we need a larger theory.

Then it would be time to discover new forces and new types of matter. There are other discoveries to make at the LHC that would be even bigger discoveries than the Higgs boson because they'd be unexpected.

Q: Does the general public care about this search?

A: We get asked a lot, "What good is this?"

Beginning around 2007, the LHC started to excite the public's imagination. There was this nonsense about us making a black hole that was going to destroy the world ... but that spurred the field into doing a better job of explaining what we were doing.

By the time we turned it on in 2008, there was growing worldwide interest.