After Higgs Boson, scientists prepare for next quantum leap

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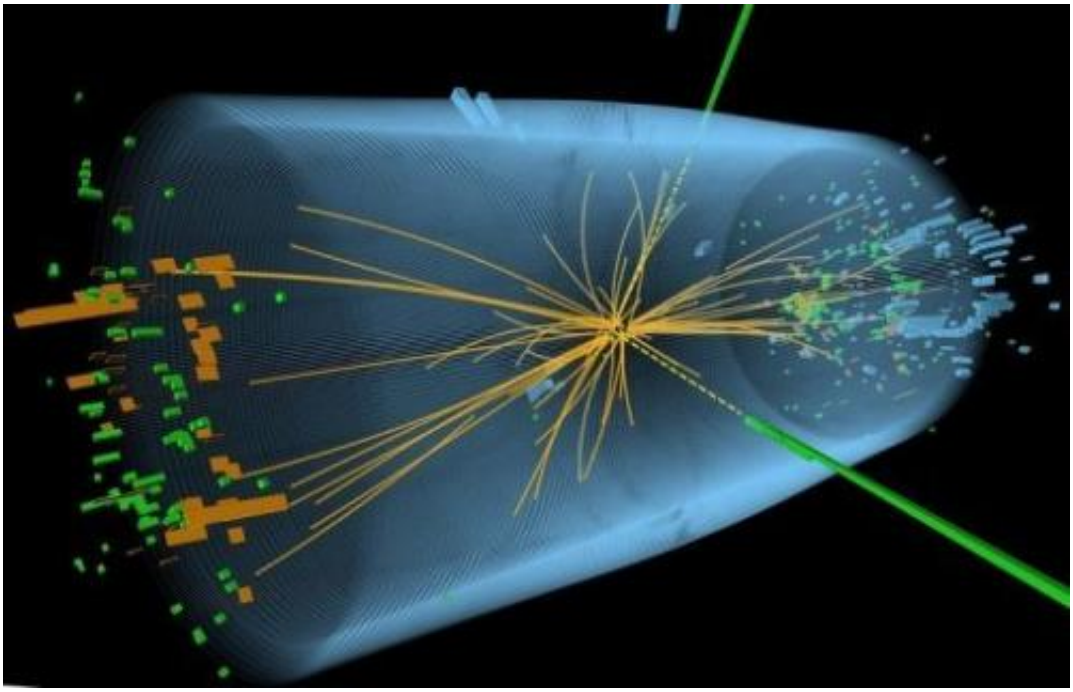

A graphic distributed on July 4, 2012 by CERN in Geneva shows a representation of traces of a proton-proton collision measured in the search for the Higgs boson. Seven months after its scientists made a landmark discovery that may explain the mysteries of mass, Europe's top physics lab will take a break from smashing invisible particles to recharge for the next leap into the unknown.

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From Thursday, the cutting-edge facilities at the European Organisation for Nuclear Research (CERN) will begin winding down, then go offline on Saturday for an 18-month upgrade.

A vast underground lab straddling the border between France and Switzerland, CERN's Large Hadron Collider (LHC) was the scene of an extraordinary discovery announced in July 2012.

Its scientists said they were 99.9 percent certain they had found the elusive Higgs Boson, an invisible particle without which, theorists say, humans and all the other joined-up atoms in the Universe would not exist.

The upgrade will boost the LHC's energy capacity, essential for CERN to confirm definitively that its boson is the Higgs, and allow it to probe new dimensions such as supersymmetry and dark matter.

"The aim is to open the discovery domain," said Frederick Bordry, head of CERN's technology department.

"We have what we think is the Higgs, and now we have all the theories about supersymmetry and so on. We need to increase the energy to look at more physics. It's about going into terra incognita (unknown territory)," he told AFP.

Theorised back in 1964, the boson also known as the God Particle carries the name of a British physicist, Peter Higgs.

He calculated that a field of bosons could explain a nagging anomaly: Why do some particles have mass while others, such as light, have none?

That question was a gaping hole in the Standard Model of particle physics, a conceptual framework for understanding the nuts-and-bolts of the cosmos.

One idea is that the Higgs was born when the new Universe cooled after the Big Bang some 14 billion years ago.

It is believed to act like a fork dipped in honey and held up in dusty air.

Most of the dust particles interact with the honey, acquiring some of its mass to varying degrees, but a few slip through and do not acquire any. With mass comes gravity—and its pulling power brings particles together.

Supersymmetry, meanwhile, is the notion that there are novel particles which are the opposite number of each of the known particle actors in the Standard Model.

This may, in turn, explain the existence of dark matter—a hypothetical construct that can only be perceived indirectly via its gravitational pull, yet is thought to make up around 25 percent of the Universe.

At a cost of 6.03 billion Swiss francs (4.9 billion euros, $6.56 billion dollars), the LHC was constructed in a 26.6-kilometre (16.5-mile) circular tunnel originally occupied by its predecessor, the Large Electron Positron (LEP).

That had run in cycles of about seven months followed by a five-month shutdown, but the LHC, opened in 2008, has been pushed well beyond.

"We've had full operations for three years, 2010, 2011 and 2012," said Bordry.

"Initially we thought we'd have the long shutdown in 2012, but in 2011, with some good results and with the perspective of discovering the boson, we pushed the long shutdown back by a year. But we said that in 2013 we must do it."

Unlike the LEP, which was used to accelerate electrons or positrons, the LHC crashes together protons, which are part of the hadron family.

"The game is about smashing the particles together to transform this energy into mass. With high energy, they are transformed into new particles and we observe these new particles and try to understand things," Bordry explained.

"It's about recreating the first microsecond of the universe, the Big Bang. We are reproducing in a lab the conditions we had at the start of the Big Bang."

Over the past three years, CERN has slammed protons together more than six million billion times.

Five billion collisions yielded results deemed worthy of further research and data from only 400 threw up data that paved the road to the Higgs Boson.

Despite the shutdown, CERN's researchers won't be taking a breather, as they must trawl through a vast mound of data.

"I think a year from now, we'll have more information on the data accumulated over the past three years," said Bordry. "Maybe the conclusion will be that we need more data!"

Last year, the LHC achieved a collision energy level of eight teraelectron volts, an energy measure used in particle physics—up from seven in

2011.

After it comes back online in 2015, the goal is to take that level to 13 or even 14, with the LHC expected to run for three or four years before another shutdown.

The net cost of the upgrade is expected to be up to 50 million Swiss francs.

CERN's member states are European, but the prestigious organisation has global reach. India, Japan, Russia and the United States participate as observers.

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