'New era' in physics as world's biggest particle smasher cranks up (Update 2)

June 3 2015

A scientist looks at a section of the Large Hadron Collider (LHC) which was used to prove the existence of the Higgs Boson—also known as the God particle—which confers mass

Scientists on Wednesday hailed a "new era" in their quest to unravel more mysteries of the universe as the world's biggest particle smasher started experiments with nearly doubled energy levels in a key breakthrough.

The tests at the European Organisation for Nuclear Research (CERN) came after a sweeping two-year revamp of the collider and will help scientists to study fundamental particles, the building blocks of all matter, and the forces that control them.

During its next run, researchers will look for evidence of "new physics" and probe "supersymmetry"—a theoretical concept informally dubbed Susy; seek explanations for enigmatic dark matter and look for signs of extra dimensions.

Wednesday's collisions of 13 teraelectonvolts (TeV) followed a muscling of the Large Hadron Collider (LHC), used in 2012 to prove the existence of the Higgs Boson—which confers mass and is also known as the God particle.

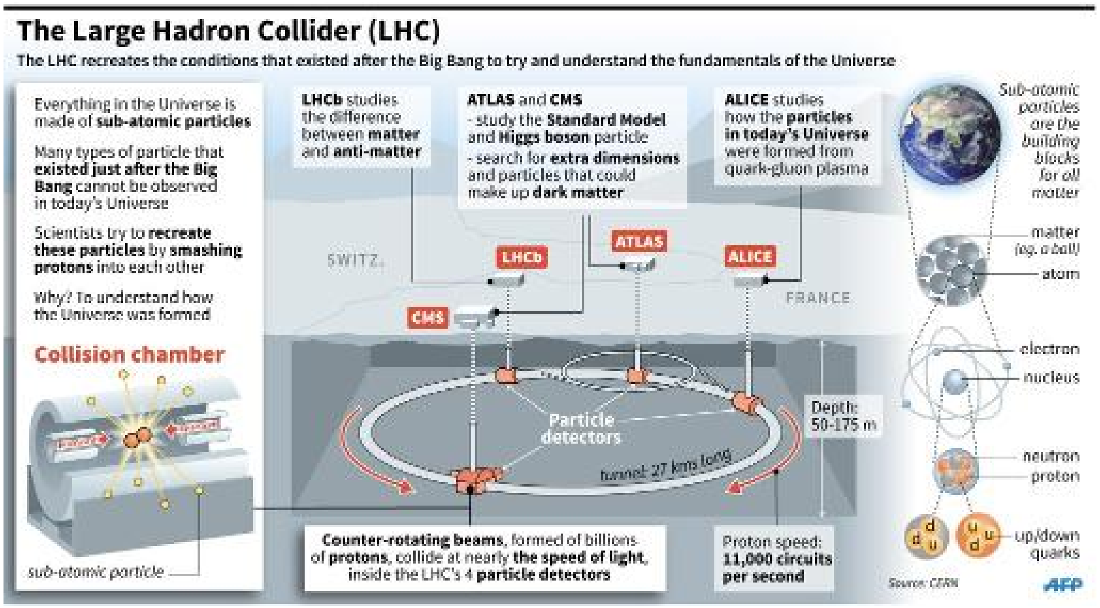
CERN said everything went according to plan at the giant lab, a 27-kilometre (17-mile) ring-shaped tunnel straddling the French-Swiss border.

During what it dubbed as its "Season Two", the LHC will in the course of the next three years strive to fill gaps in the so-called "Standard Model"—the mainstream theory of how the visible Universe was created but which does not explain dark matter.

"It is time for new physics!" declared CERN's outgoing director general Rolf Heuer.

"We have seen the first data beginning to flow. Let's see what they will reveal to us about how our universe works," he said.

"It's not going to happen tomorrow, be patient," he said, as scientists monitoring the event broke into sustained applause and uncorked champagne.



Presentation of the Large Hadron Collider

On May 20, the LHC broke the record for energy levels colliding protons at 13 TeV—or 99.9 percent of the speed of light—for the first time.

The LHC's previous highest energy for collisions was eight TeV, reached in 2012 before it closed for the upgrade.

Unlocking nature's secrets

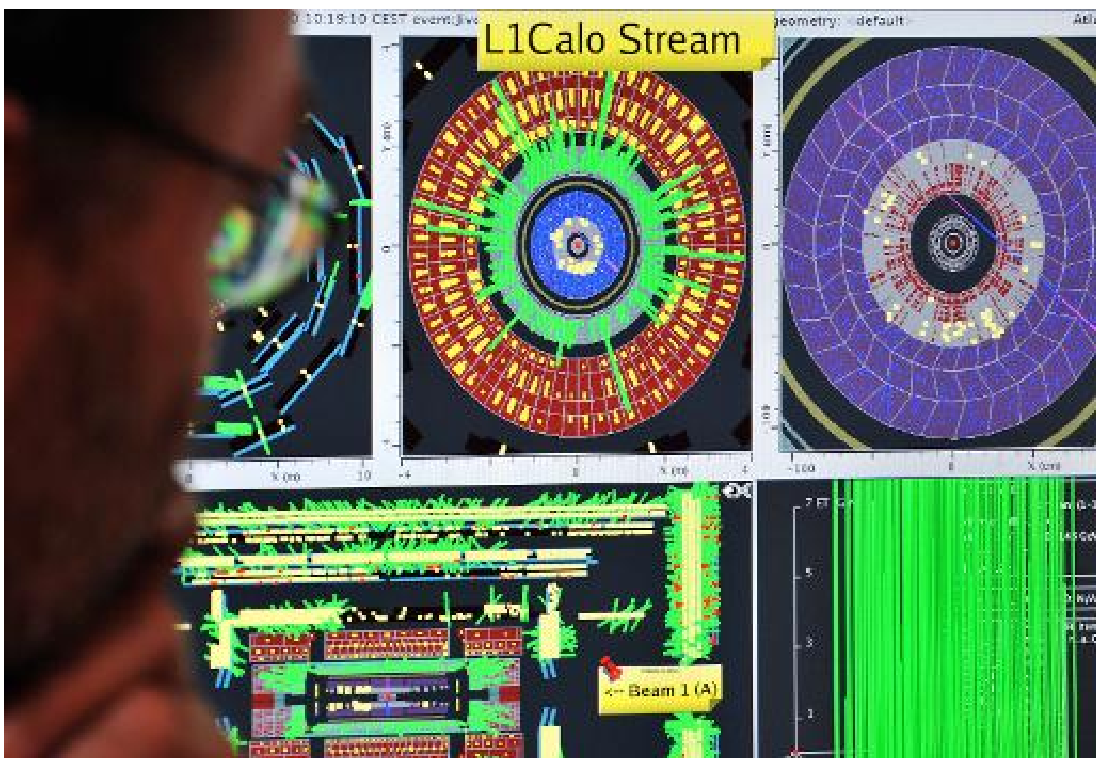
"The collisions we are seeing today indicate that the work we have done in the past two years to prepare and improve our detector has been successful and marks the beginning of a new era of exploration of the secrets of nature," said Tiziano Camporesi, a spokesman for the project.

The LHC was used to prove the existence of the Higgs Boson, a discovery that earned the 2013 Nobel physics prize for two of the scientists who had theorised the existence of the Higgs back in 1964.

The LHC allows beams containing billions of protons to shoot through the massive collider in opposite directions.

Powerful magnets bend the beams so that they collide at points around the track where four laboratories have batteries of sensors to monitor the smashups.

The sub-atomic rubble is then scrutinised for novel particles and the forces that hold them together.



The Large Hadron Collider (LHC) recently broke the record for energy levels colliding protons at 13 teraelectonvolts (TeV)

One teraelectronvolt is roughly equivalent to the energy of motion of a flying mosquito, CERN says on its website.

But within the LHC, the energy is squeezed into an extremely small space—about a million, million times smaller than a mosquito. It is this intensity which causes the particles to be smashed apart.

"It will allow us to follow up on puzzles from our Run 1 studies, and to probe with higher sensitivity the difference in behaviour between matter and antimatter," said Guy Wilkinson, a spokesman for one of LHC's four experiments.

Ordinary, visible matter comprises only about four percent of the known universe.

There is believed to be five to 10 times more dark matter, which together with equally mysterious dark energy accounts for 96 percent of the cosmos.

As part of the two-year recommissioning process, LHC engineers successfully introduced two proton beams, the source material for sub-atomic smashups.

With the upgrade, the LHC can potentially be cranked up to a maximum 14 TeV.

The Large Hadron Collider: A factfile

The most powerful particle smasher in the world, Europe's Large Hadron Collider (LHC), on Wednesday started a new run with almost doubled energy levels.

The LHC in numbers:

- Hydrogen protons (a type of hadron) are accelerated to 99.9 percent the speed of light and rammed into one another in an attempt to create conditions similar to those that existed just after the "Big Bang" that formed the Universe 13.7 billion years ago.

- More than 1,200 superconducting dipole magnets guide two particle beams in parallel but opposite directions in an ultra-high vacuum, about 20 centimetres (eight inches) apart.

- The beams run into each other at four points along a 27-kilometre (17-mile) ring-shaped tunnel that runs about 100 metres (328 feet) underground. Some of the protons collide but the others survive and continue around the racetrack.

- The collision points represent the LHC's four experiments—called ATLAS, CMS, LHCb and ALICE, where physicists look for new particles.

- The beams will each have a maximum potential energy of 7 teraelectronvolts (TeV), thus a collision energy of 14 TeV, though the experiments will start at 13 TeV—the highest ever achieved in a lab.

- One TeV is about the energy of a flying mosquito, but at the LHC it is squeezed into a space about a million million times smaller than a mosquito.

- At full energy, each beam will have energy equivalent to a 400-tonne train travelling at 150 km (93 miles) per hour.

- Every beam contains about 2,800 "bunches" or "packets" travelling with about seven metres (23 feet) between them. Each bunch contains about 100-150 billion protons.

- Each proton will go around the ring more than 11,000 times a second.

- A beam may circulate for 10 hours, travelling more than 10 billion kilometres, which is enough to get to Neptune and back.

- The LHC magnets produce a magnetic field of about 8 tesla, about 150,000 times bigger than Earth's magnetic field.

- To create resistance-free conditions inside the tunnel, the magnets must be chilled with liquid helium to 1.9 Kelvin (-271.3 degrees Celsius), which is colder than outer space.

- There will be a collision every 25 nanoseconds (one nanosecond is a billionth of a second), yielding about 15 million gigabytes of data per year—representing a stack of CDs about 20 km high.

- The LHC cost about 6.5 billion Swiss francs ($7 billion, 6.2 billion euros) to build, with an annual budget of a billion francs a year.

- More than 10,000 scientists work directly or indirectly on the LHC's four experiments.

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