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Bialko I., Kovalenok V., Lichevskaya S.

The Large Hadrod Collider

Belarusian National Technical University
Minsk, Belarus

The **Large Hadron Collider** (**LHC**) is the world's largest and highest-energy particle accelerator. It was built by the European Organization for Nuclear Research (CERN) between 1998 and 2008 in collaboration with over 10,000 scientists and hundreds of universities and laboratories, as well as more than 100 countries. It lies in a tunnel 27 kilometres in circumference and as deep as 175 metres beneath the France – Switzerland border near Geneva.

Inside the accelerator, two high-energy particle beams travel at close to the speed of light before they are made to collide. The beams travel in opposite directions in separate beam pipes – two tubes kept at ultrahigh vacuum. They are guided around the accelerator ring by a strong magnetic field maintained by superconducting electromagnets. The electromagnets are built from coils of special electric cable that operates in a superconducting state, efficiently conducting electricity without resistance or loss of energy. This requires chilling the magnets to -271.3°C. For this reason, much of the accelerator is connected to a distribution system of liquid helium, which cools the magnets, as well as to other supply services [1].

The collider has four crossing points where the accelerated particles collide. Seven detectors, each designed to detect different phenomena, are positioned around the crossing points. The LHC primarily collides proton beams, but it can also accelerate beams of heavy ions: lead–lead collisions and proton–lead collisions are typically performed for one month a year.

The LHC's goal is to allow physicists to test the predictions of different theories of particle physics, including measuring the properties of the Higgs boson searching for the large family of new particles predicted by supersymmetric theories, and other unresolved questions in particle physics [1].

On 20 November 2009, low-energy beams circulated in the tunnel for the first time, and shortly after, on 30 November, the LHC achieved 1.18 TeV per beam to become the world's highest-energy particle accelerator, beating the Tevatron's previous record of 0.98 TeV per beam held for eight years.

The early part of 2010 saw the continued ramp-up of beam in energies and early physics experiments towards 3.5 TeV per beam and on 30 March 2010, LHC set a new record for high-energy collisions by colliding proton beams at a combined energy level of 7 TeV. The attempt was the third that day, after two unsuccessful attempts in which the protons had to be "dumped" from the collider and new beams had to be injected. This also marked the start of the main research programme.

CERN originally planned that the LHC would run through to the end of 2012, with a short break at the end of 2011 to allow for an increase in beam energy from 3.5 to 4 TeV per beam. At the end of 2012, the LHC was planned to get shut down until around 2015 to allow upgrade to a planned beam energy of 7 TeV per beam. In late 2012, in light of the July 2012 discovery of the Higgs boson, the shutdown was postponed for some weeks into early 2013, to allow additional data to be obtained before shutdown [2].

The LHC was shut down on 13 February 2013 for its 2-year upgrade called Long Shutdown 1, which was to touch on many aspects of the LHC: enabling collisions at 14 TeV, enhancing its detectors and pre-accelerators (the Proton

Synchrotron and Super Proton Synchrotron), as well as replacing its ventilation system and 100 km of cabling impaired by high-energy collisions from its first run. The upgraded collider began its long start-up and testing process in June 2014. The first of the main LHC magnets were reported to have been successfully trained by 9 December 2014, while training the other magnet sectors was finished in March 2015 [2].

Long Shutdown 2 started on 10 December 2018. The LHC and the whole CERN accelerator complex was maintained and upgraded.

LHC became operational again on 22 April 2022 with a new maximum beam energy of 6.8 TeV, which was first achieved on 25 April. This round is expected to continue until 2026 [2].

Now the LHC stands a good chance of finding entirely new subatomic particles. Scientists hope that the collider will help make discoveries that will cause the biggest revolution in physics in the last hundred years.

In addition to trying to discover a new, so-called fifth force of nature, researchers hope to find evidence for the existence of "dark matter," an invisible substance that forms most of the universe.

References:

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