

# What is the Large Hadron Collider?

July 5, 2022

**In news-**The world's most powerful particle collider, the Large Hadron Collider (LHC), under its third run has begun smashing protons into each other at unprecedented levels of energy on July 5.

## **LHC's Latest upgrade-**

- It was shut for three years and restarted in April 2022.
- **This is the LHC's third run**, and from July 5, it started to **operate round-the-clock for four years** at unprecedented energy levels of 13 tera electron volts. (A TeV is 100 billion, or 10-to-the-power-of-12, electron volts. An electron volt is the energy given to an electron by accelerating it through 1 volt of electric potential difference.)
- **Scientists aim to be delivering 1.6 billion proton-proton collisions per second** for the ATLAS and CMS experiments.
- This time, the proton beams will be narrowed to less than 10 microns a human hair is around 70 microns thick to increase the collision rate.
- **ATLAS is the largest general purpose particle detector experiment at the LHC; the Compact Muon Solenoid (CMS) experiment is one of the largest international scientific collaborations in history**, with the same goals as ATLAS, but which uses a different magnet-system design.

## **About Large Hadron Collider (LHC)-**

- The **LHC is a giant, complex machine built to study particles** that are the smallest known building blocks of all things.

- **“Large”** refers to its size, approximately 27km in **circumference** buried 100 metres underground on the Swiss-French border.
- **“Hadron”** because it accelerates protons or ions, which belong to the group of particles called hadrons.
- **“Collider”** because the particles form two beams **travelling in opposite directions**, which are made to collide at four points around the machine.
- In its operational state, **it fires two beams of protons** almost at the speed of light in opposite directions inside a ring of superconducting electromagnets.
- The magnetic field created by the superconducting electromagnets keeps the protons in a tight beam and guides them along the way as they travel through beam pipes and finally collide.
- Since the LHC’s powerful electromagnets carry almost as much current as a bolt of lightning, they must be kept chilled.
- The **LHC uses a distribution system of liquid helium** to keep its critical components ultracold **at minus 271.3 degrees Celsius**, which is colder than interstellar space. Given these requirements, it is not easy to warm up or cool down the gigantic machine.
- After the discovery of the Higgs boson, scientists have started using the data collected as a tool to look beyond the Standard Model, which is currently the best theory of the most elementary building blocks of the universe and their interactions.

### **Previous runs & ‘God Particle’ discovery-**

- Ten years ago, **on July 4, 2012, scientists at CERN had announced to the world the discovery of the Higgs boson** or the **‘God Particle’** during the LHC’s first run.
- The discovery concluded the decades-long quest for the **‘force-carrying’ subatomic particle**, and proved the existence of the Higgs mechanism, a theory put forth in

the mid-sixties.

- This led to Peter Higgs and his collaborator François Englert being awarded the Nobel Prize for physics in 2013.
- The Higgs boson and its related energy field are believed to have played a vital role in the creation of the universe.
- The LHC's second run (Run 2) began in 2015 and lasted till 2018. The second season of data taking produced five times more data than Run 1.
- Now, the third run will see 20 times more collisions as compared to Run 1.