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 began 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.**