

Upgrade to Large Hadron Collider - CERN

What is the issue?

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- CERN (the European Organization for Nuclear Research) recently found that Higgs boson decays to fundamental particles known as bottom quarks.

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- Testing this and understanding more particles, require an upgradation to the Large Hadron Collider.

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Why to study particles?

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- Particle physics probes nature at extreme scales, to understand the fundamental constituents of matter.

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- Particles communicate with each other in accordance with certain rules.

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- These are embedded in what are known as the 'four fundamental interactions'.

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- The particles and three of these interactions are successfully described by a unified approach known as the Standard Model (SM).

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- The SM is a framework that required the existence of a particle called the Higgs boson.

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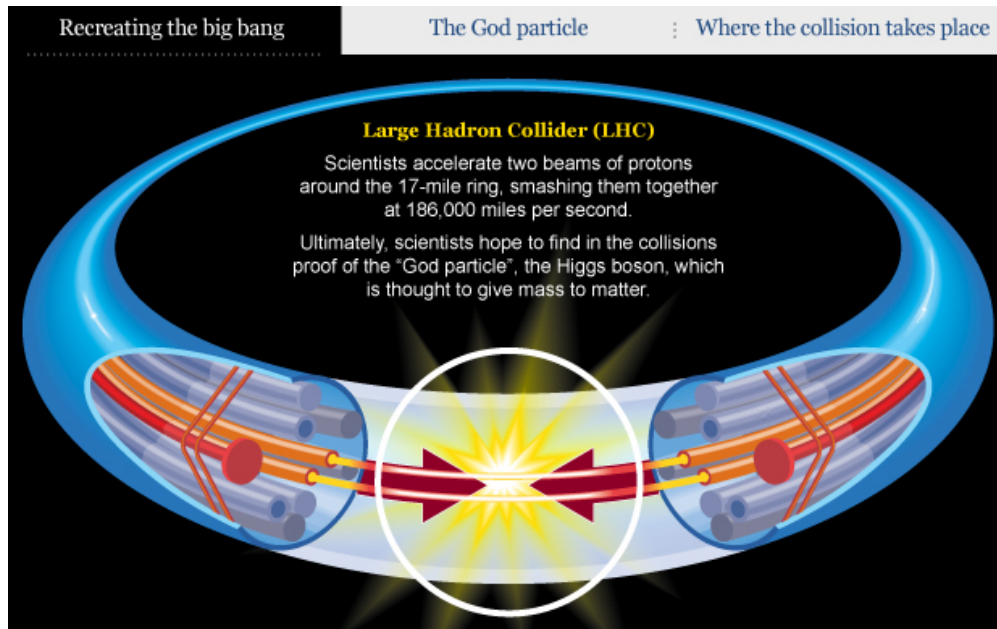
- The Large Hadron Collider (LHC) is the world's largest and most powerful particle accelerator.

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- One of the major aims of the Large Hadron Collider (LHC) was to search for the Higgs boson.

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How are such tiny particles studied?

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- Protons are collected in bunches.
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- They are then accelerated to nearly the speed of light and made to collide.
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- Many particles emerge from such a collision, termed as an event.
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- The emergent particles exhibit an apparently random pattern.
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- But they follow the underlying laws that govern part of their behaviour.
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- Studying the patterns in the emission of these particles help understand the properties and structure of particles.
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What is CERN's proposal?

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- Higgs boson was discovered at the CERN Large Hadron Collider (LHC).
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- The Higgs boson was detected by studying collisions of particles at different energies.
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How will it help?

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- The beam in the LHC has about 2,800 bunches, each of which contains about 115 billion protons.

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- The HL-LHC will have about 170 billion protons in each bunch, contributing to an increase in luminosity.

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- After the upgrade, the total number of Higgs bosons produced in one year may be about 5 times the number produced currently.

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- The experiments will be able to record about 25 times more data in the same period as for LHC running.

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How will it be upgraded?

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- The protons are kept together in the bunch using strong magnetic fields of special kinds.

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- These are formed using quadrupole magnets.

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- Focusing the bunch into a smaller size requires stronger fields.

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- Therefore greater currents are employed, necessitating the use of superconducting cables.

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- Newer technologies and new material (Niobium-tin) will be used to produce the required strong magnetic fields.

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- The creation of long coils for such fields is being tested.

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- New equipment will be installed over 1.2 km of the 27-km LHC ring.

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- This will help in focusing and squeezing the bunches just before they cross.

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- The LHC gets the protons from an accelerator chain.

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- This will also need to be upgraded to meet the requirements of the high

luminosity.

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- Moreover, the length of each bunch is just a few cm.
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- So, to increase the number of collisions a slight tilt is being produced in the bunches just before the collisions.
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- This is to increase the effective area of overlap.
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Source: Indian Express

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