



How the LHC works

The Large Hadron Collider (LHC), the world's largest and most powerful particle accelerator, is the latest addition to CERN's accelerator complex. It mainly consists of a 27-kilometre ring of superconducting magnets with a number of accelerating structures to boost the energy of the particles along the way.

Inside the accelerator, two beams of particles travel at close to the speed of light with very high energies before colliding with one another. 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, achieved using superconducting electromagnets. These are built from coils of special electric cable that operate in a superconducting state, efficiently conducting electricity without resistance or loss of energy. This requires chilling the magnets to about $-271\text{ }^{\circ}\text{C}$, a temperature colder than outer space. For this reason, much of the accelerator is connected to a distribution sys-

tem of liquid helium, which cools the magnets, as well as to other supply services.

Thousands of magnets of different varieties and sizes are used to direct the beams around the accelerator. These include 1,232 dipole magnets of 15 m length which are used to bend the beams, and 392 quadrupole magnets, each 5-7 m long, to focus the beams. Just prior to collision, another type of magnet is used to "squeeze" the particles closer together, to increase the chances of collisions. The particles are so tiny that the task of making them collide is akin to firing needles from two positions 10 km apart with such precision that they meet halfway!

All the controls for the accelerator, its services and technical infrastructure are housed under one roof at the CERN Control Centre. From here, the beams inside the LHC are made to collide at four locations around the accelerator ring, corresponding to the positions of the particle detectors.

(Taken from <http://press.web.cern.ch/public/en/LHC/HowLHC-en.html>)

EXERCISES

1 True or false?

- a. The LHC is a particle decelerator. T F
- b. The LHC can easily fit into a living-room. T F
- c. It is really hot inside the LHC. T F
- d. Inside the LHC the particles travel close to the speed of light. T F

2 Find the mistake and correct.

- a. The LHC is the world's smallest particle accelerator.
- b. Inside the LHC several beams of particles travel at close to the speed of light.
- c. The accelerator is connected to a distribution system of liquid helium, which heats the magnets.
- d. The LHC is the oldest part of CERN's accelerator complex.
- e. The beams travel in the same direction in separate beam pipes.
- f. Making the particles collide is quite a simple job.

3 Match questions and answers.

QUESTIONS		ANSWERS	
A	What kinds of magnets are used in the LHC?	1	At a temperature of $-271\text{ }^{\circ}\text{C}$, which is colder than outer space.
B	At what temperature must the magnets be kept at to work properly?	2	The beams of particles are guided around by a strong magnetic field that is created using superconducting electromagnets.
C	How do scientists manage to control the path of the two beams of particles that travel inside the LHC?	3	Thousands of magnets of different varieties and sizes, including 1,232 dipole magnets of 15 m length and 392 quadrupole magnets, each 5-7 m long.

A	B	C
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