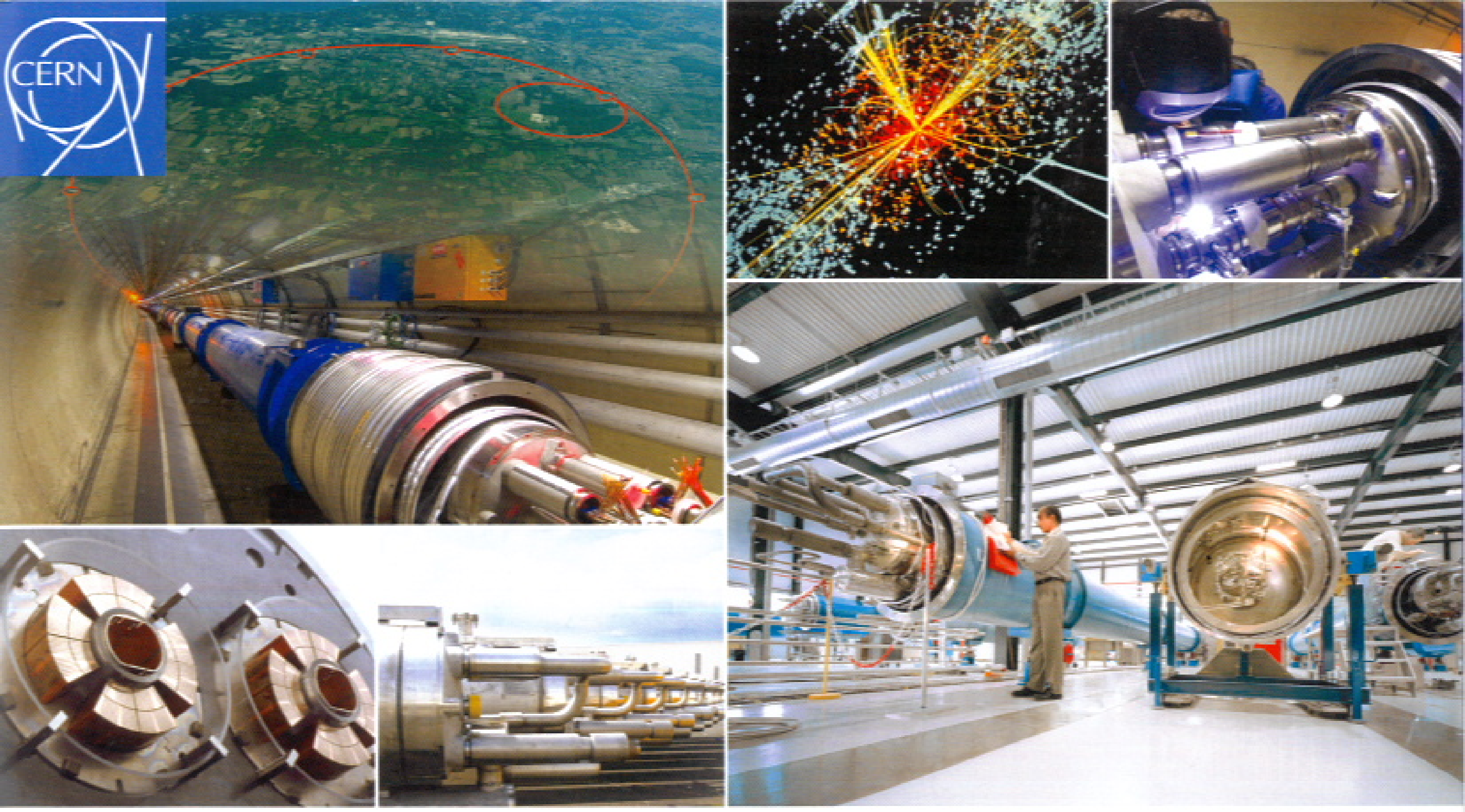


LHC

The Large Hadron Collider

Unique

CERN is building the world's biggest and most powerful particle accelerator—the 27-km LHC.

Scientific

What we learn will take us to a deeper understanding of the Universe.

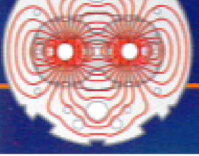
Insight

The results are eagerly anticipated by particle physicists everywhere and could open up new fields of scientific endeavour.

The LHC

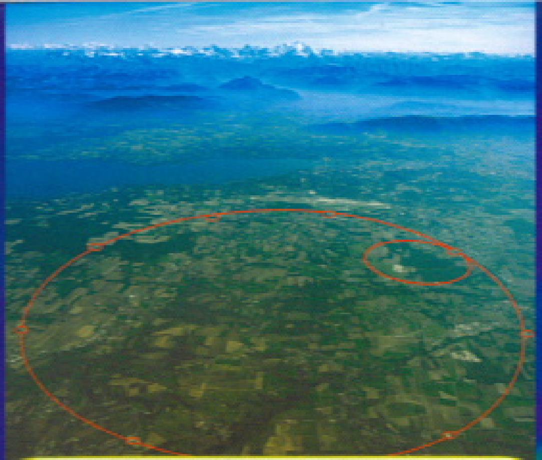
A machine to accelerate two beams of particles in opposite directions to more than 99.9% the speed of light. Smashing the beams together creates showers of new particles for physicists to study.

CERN, the European Organization for Nuclear Research, was founded in 1954. It has become a prime example of international collaboration, with currently 20 Member States. It is the biggest particle physics laboratory in the world, and sits astride the Franco-Swiss border near Geneva.



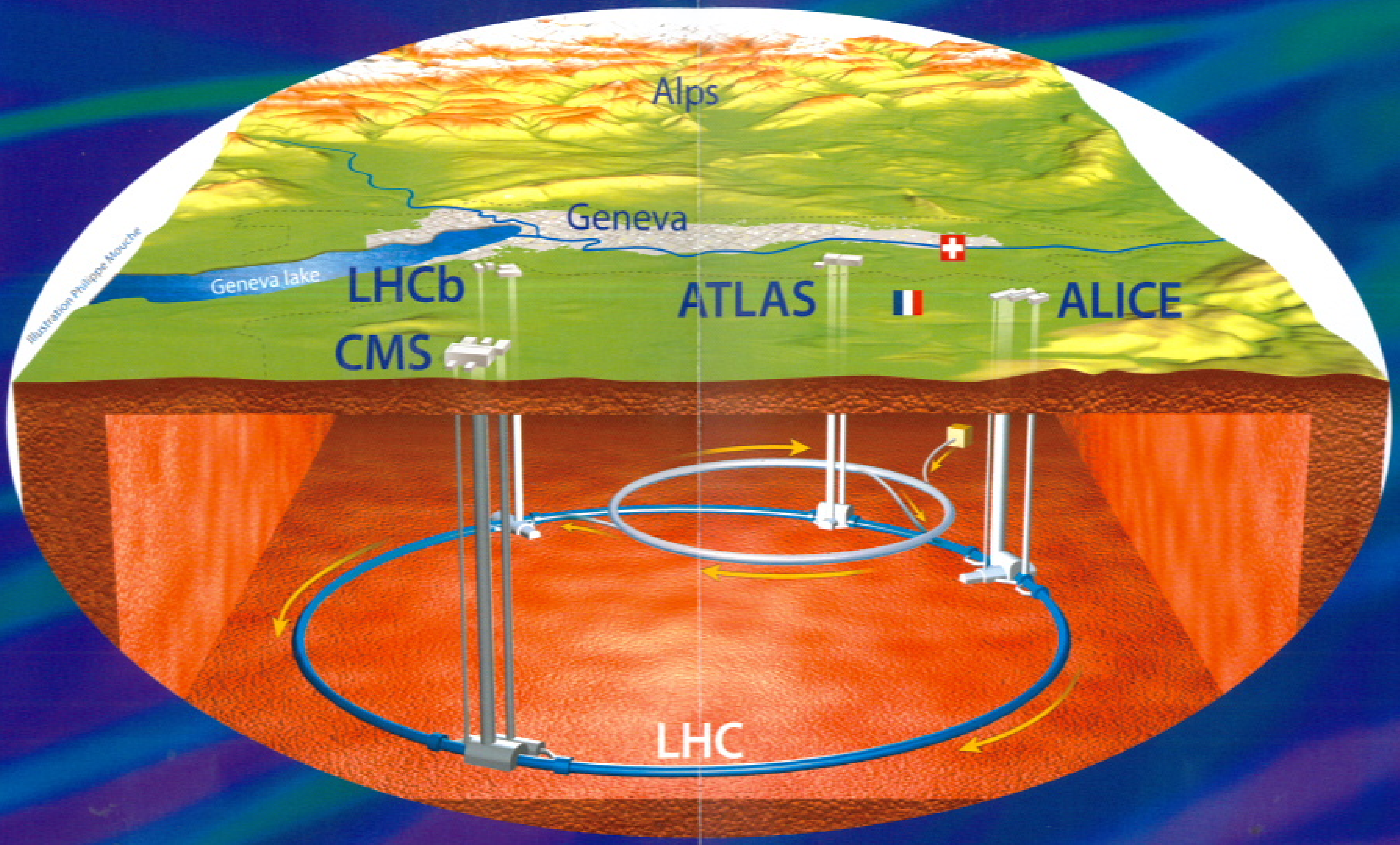
www.cern.ch

LHC >>> the world's most powerful accelerator



Where is it?

The LHC is being installed in a tunnel 27 km in circumference, buried 50-150 m below ground. Located between the Jura mountain range in France and Lake Geneva in Switzerland, the tunnel was built in the 1980s for the previous big accelerator, the Large Electron–Positron collider (LEP).



What will it do?

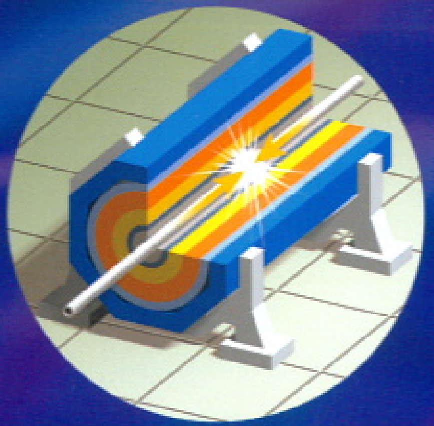
The LHC will produce head-on collisions between two beams of particles of the same kind, either protons or lead ions. The beams will be created in CERN's existing chain of accelerators and then injected into the LHC, where they will travel through a vacuum comparable to outer space. Superconducting magnets operating at extremely low temperatures will guide the beams around the ring.

Each beam will consist of nearly 3000 bunches of particles and each bunch will contain as many as 100 billion particles. The particles are so tiny that the chance of any two colliding is very small. When the bunches cross, there will be only about 20 collisions among 200 billion particles. However, bunches will cross about 30 million times per second, so the LHC will generate up to 600 million collisions per second.

At near light-speed, a proton in the LHC will make 11 245 turns every second. A beam might circulate for 10 hours, travelling more than 10 billion kilometres—far enough to get to the planet Neptune and back again.

What is it for?

Due to switch on in 2008, the LHC will provide collisions at the highest energies ever observed in laboratory conditions and physicists are eager to see what they will reveal. Four huge detectors—ALICE, ATLAS, CMS and LHCb—will observe the collisions so that the physicists can explore new territory in matter, energy, space, and time.



How powerful?

The LHC is a machine for concentrating energy into a very small space. Particle energies in the LHC are measured in tera-electronvolts (TeV). 1 TeV is roughly the energy of a flying mosquito, but a proton is about a trillion times smaller than a mosquito.

Each proton flying round the LHC will have an energy of 7 TeV, so when two protons collide the collision energy will be 14 TeV. Lead ions have many protons, and together they give an even greater energy: the lead ion beams will have a collision energy of 1150 TeV.

At full power, each beam will be about as energetic as a car travelling at 1600 kph. The energy stored in the magnets would be enough to melt 50 tonnes of copper.

How will it work?

After reaching an energy of 0.45 TeV in CERN's accelerator chain, the beams will be injected into the LHC ring, where they will make millions of circuits. On each circuit, the beams will receive an additional impulse from an electric field contained in special cavities, until they reach the final energy of 7 TeV. To control beams at such high energies, the LHC will use some 1800 superconducting magnet systems. These electromagnets are built from superconducting materials.

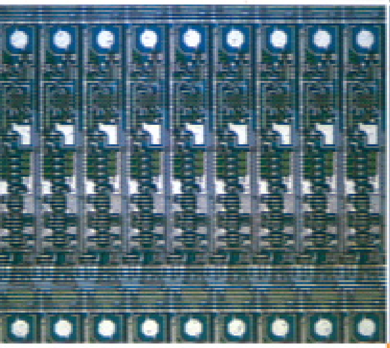
At low temperatures they can conduct electricity without resistance and so can create much stronger magnetic fields than ordinary electromagnets. The LHC's niobium-titanium magnets operate at a temperature of only 1.9 K (–271°C).

The strength of a magnetic field is measured in units called tesla. The LHC will operate at about 8 tesla, whereas ordinary "warm" magnets can achieve a maximum field of about 2 tesla.

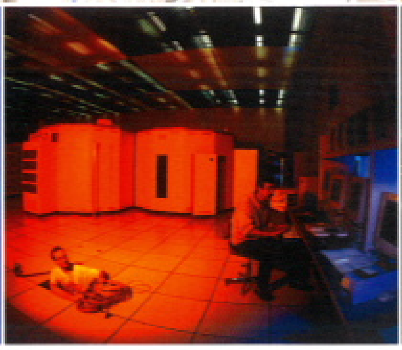
If the LHC used ordinary "warm" magnets instead of superconductors, the ring would have to be at least 120 km in circumference to achieve the same collision energy and it would consume 40 times more electricity.

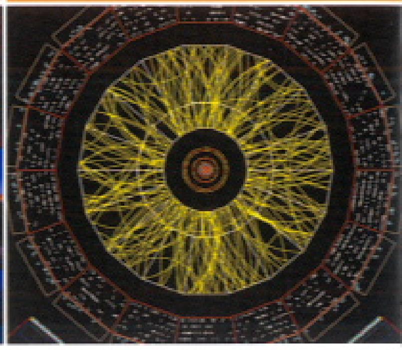
A world-wide network of computers to analyse an enormous amount of data

CERN is currently developing new networking technology called the GRID. This will link tens of thousands of computers worldwide to create a vast global computing resource for the LHC experiments.



The LHC experiments will generate an enormous amount of data. Each year the data will be enough to fill a stack of CDs 20 km tall.

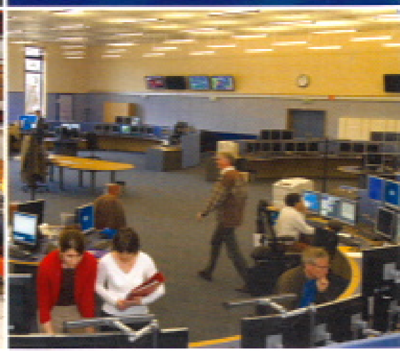




An international effort, the Sun never sets on the LHC project

Acting for its Member States, CERN is investing CHF6 billion in the LHC. This covers the accelerator, computing, and manpower, as well as CERN's contribution to the experiments. However, the LHC is a world project, and about 10% of the accelerator material cost is being contributed by other countries.

More than 10 000 scientists and engineers from around 500 academic institutes and industrial companies worldwide are contributing to the LHC project. Equipment is being built in many European countries, and in others such as Canada, India, Japan, Russia and the US.



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