

CERN

European Organization for Nuclear Research

Seeking answers to questions about the Universe
What is it made of?
How did it come to be the way it is?

Uniting 7000 scientists from more than 80 countries,
CERN is a laboratory for the world

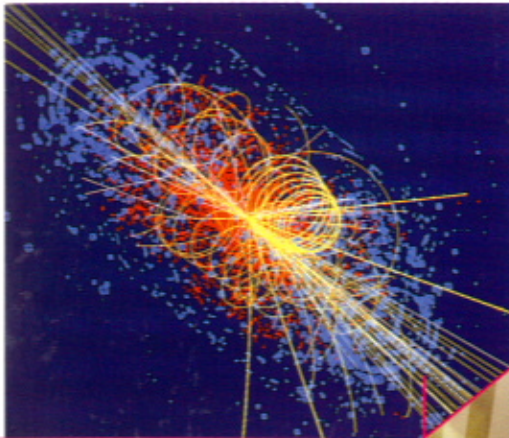
Advancing the frontiers of technology and engineering

Training the young scientists and engineers who will be
the experts of tomorrow

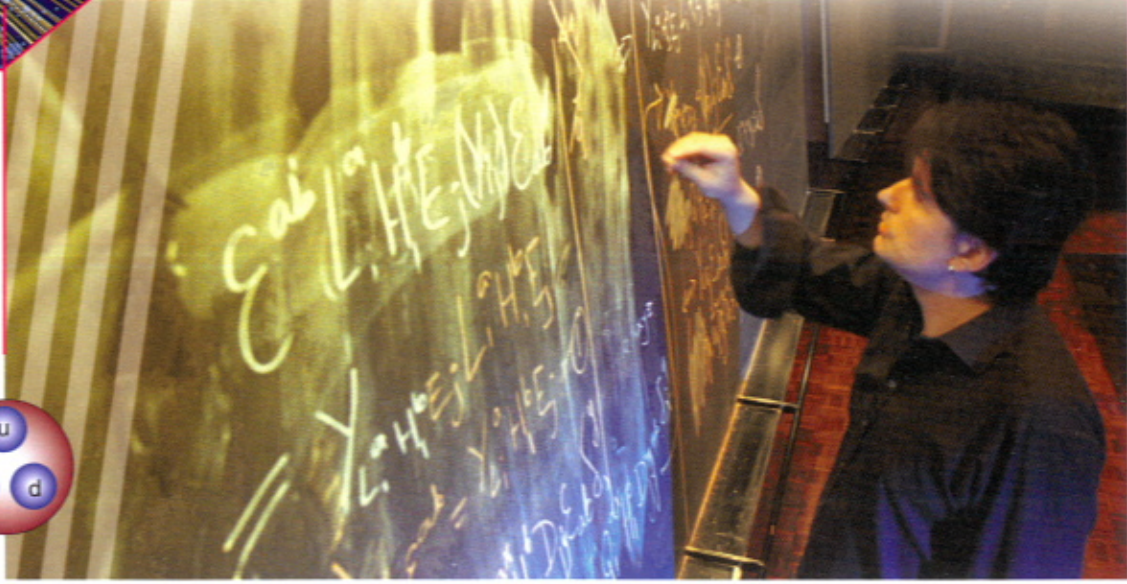
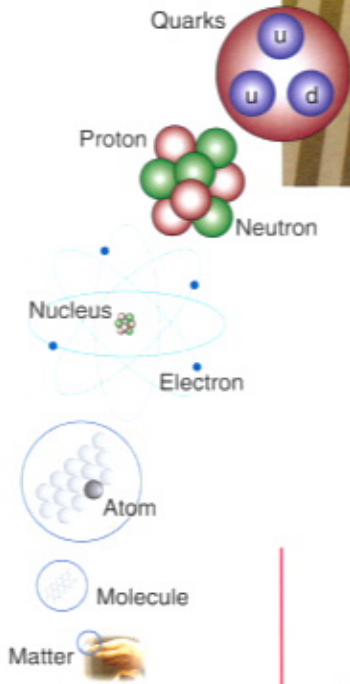
CERN, the European Organization for Nuclear Research, was founded in 1954. It has become a prime example of international collaboration, with currently 20 Member States. It is the biggest particle physics laboratory in the world, and sits astride the Franco-Swiss border near Geneva.

1954

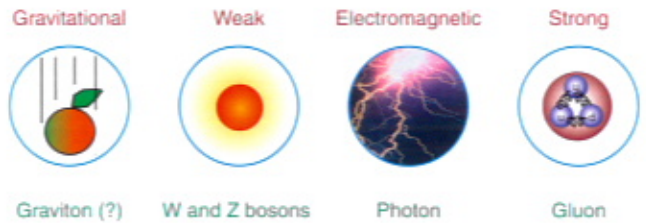
CERN is a laboratory where scientists unite to study the building blocks of matter and the forces that hold them together.



The basic building blocks are tiny particles, much smaller even than atoms. Four kinds of these elementary particles are needed to account for all the matter we see in the world around us. These are the up-quark, the down-quark, the electron and the electron-neutrino.



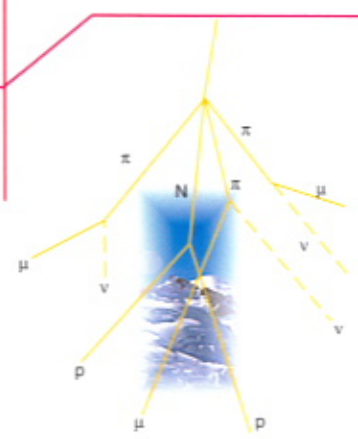
Forces



Carriers

Different forces act between the particles. The strong force, the electromagnetic force and gravity glue the particles together into bigger structures, from the invisibly small atoms to huge galaxies of millions of stars. The weak force changes particles and atoms from one type to another, as in reactions that fuel the sun. The forces are themselves carried by particles that are different from the particles of matter. Force-carrying particles have only a fleeting existence as they carry information from one matter particle to another.

Further kinds of elementary particle exist in nature, for example in cosmic rays. These are invisible showers of particles created when energetic particles from outer space crash into the Earth's atmosphere. In all there are 12 types of particle that form two groups – quarks and leptons (electron-like particles).



1957 First accelerator, the Synchrocyclotron (SC), begins operation

1959 Proton Synchrotron (PS) begins operation

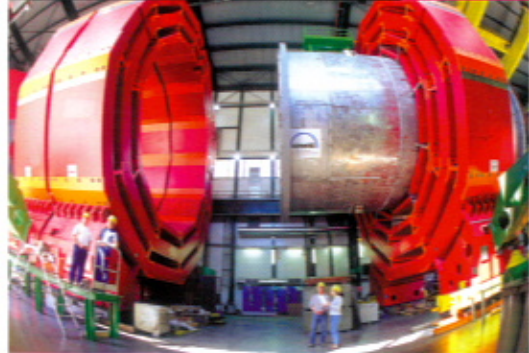
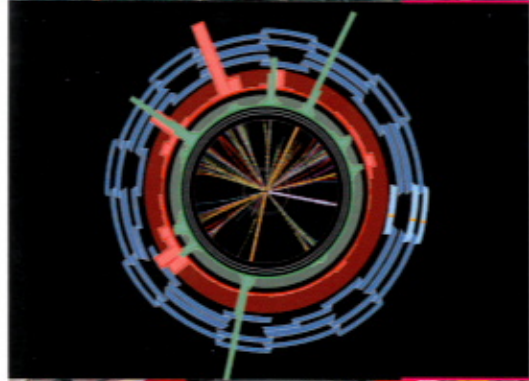
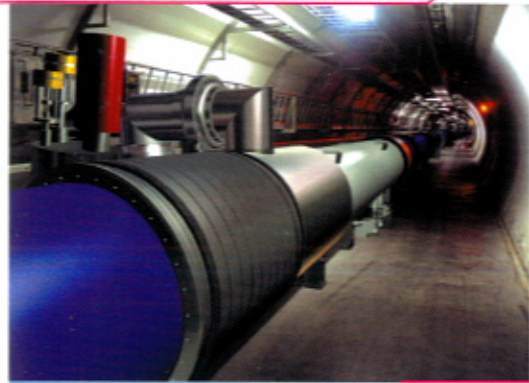
1968 Georges Charpak invents multiwire proportional chamber (Nobel Prize 1992)

1971 Intersecting Storage Rings start operation, the world's first proton-proton collider

1973 Discovery of "neutral currents" first confirmation of the electroweak theory

1976 Super Proton begins c

Physicists at CERN explore matter using machines called particle accelerators. These accelerate beams of particles and smash them into each other, or into other targets, to create high energy conditions similar to those in the first instants of the Universe.

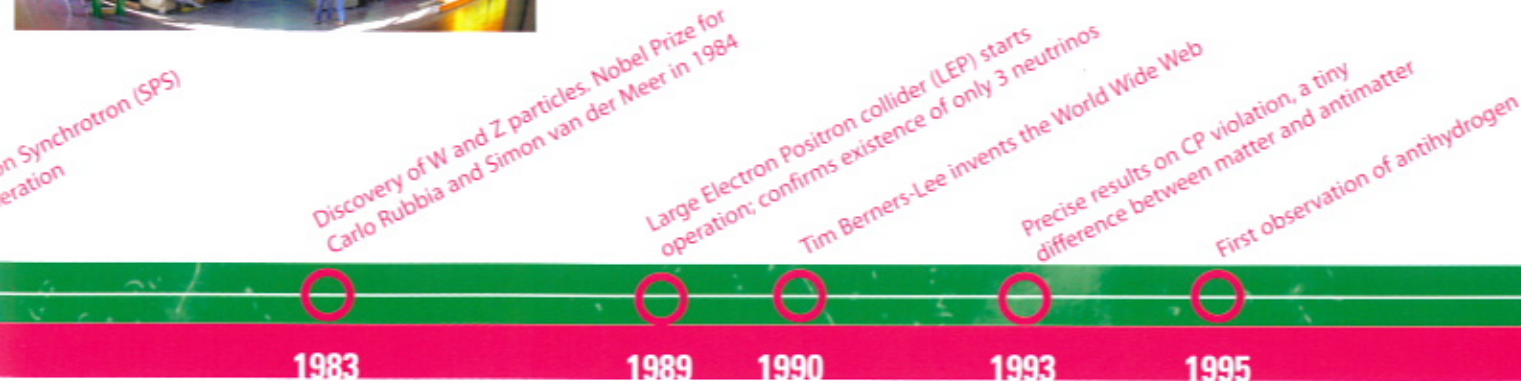


Accelerators use powerful electric fields to give energy to beams of particles, and magnetic fields to guide the beams through the machines. The bigger machines are circular and the magnetic fields are used to steer the particles round and round a ring, so that they collect energy with each lap.

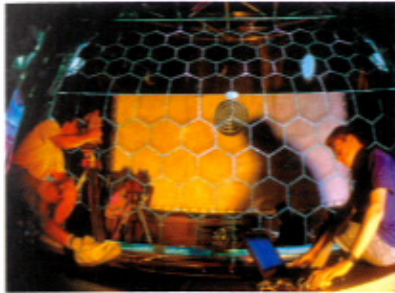
CERN is currently building its most powerful machine ever, the Large Hadron Collider, or LHC. This machine is being installed in a tunnel 27 km in circumference which housed a previous machine, the Large Electron Positron collider, LEP. By studying collisions at higher energies than ever before, physicists working with the LHC will make further progress in understanding the mysteries of how our Universe is made and how it came to be.

Detectors record what happens when the particles collide. The energetic collisions produce many new particles, as energy turns into matter in accordance with Einstein's equation, $E=mc^2$, where E stands for energy, m for mass and c is the speed of light.

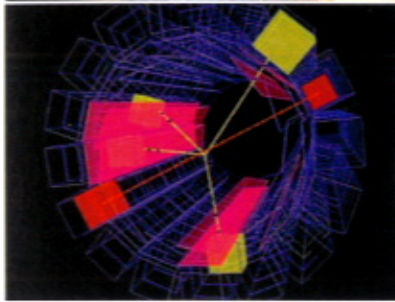
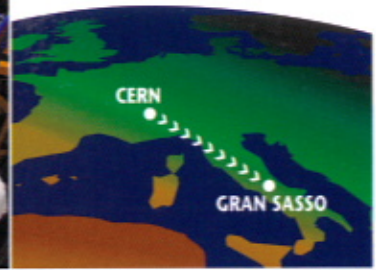
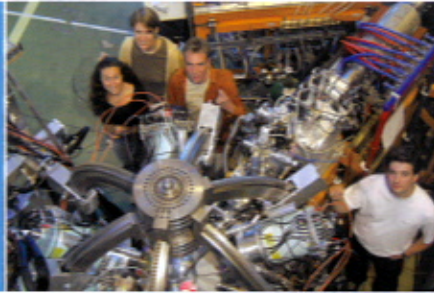
The different layers of a detector measure different properties of the particles produced in collisions. Tracking devices reveal the paths of the particles as they fly away from the collision. Other layers, called calorimeters, measure the energy of the particles. A magnet built into the detector bends the paths of electrically charged particles and helps in identifying the particle types.



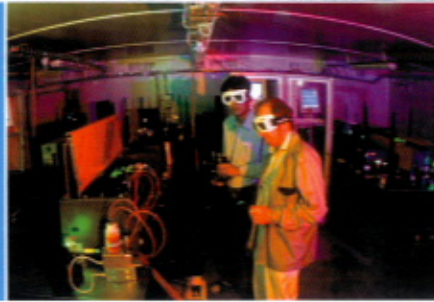
CERN is the world's largest centre for research in particle physics, with several interlinked accelerators that provide many kinds of particle for many different experiments.



CERN delivers a variety of beams including high energy muons to study the structure of the proton, heavy ions to form new states of matter, and radioactive ion beams to observe exotic nuclei.



CERN also produces beams of antiparticles, which are the constituents of antimatter – a kind of "mirror image" of ordinary matter. There are now several experiments at CERN making and studying antimatter.

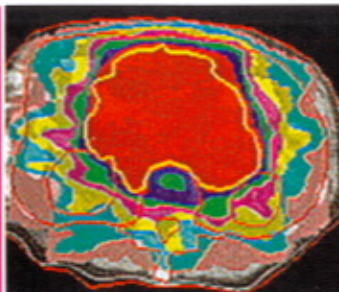


Beams of neutrinos have been important throughout the history of CERN. The latest venture is to send a beam of these very weakly interacting particles under the Earth's surface to the Gran Sasso Laboratory in Italy, 730 km away.

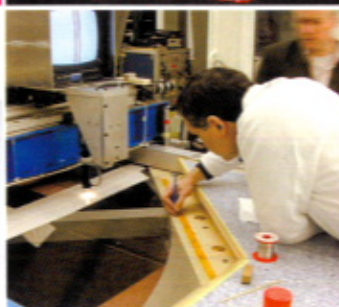
CERN's research at the frontiers of science also pushes back the boundaries of technology. The results, in areas from computing to materials science, can have much broader applications.



The World Wide Web was invented at CERN to help particle physicists around the world to communicate. Now CERN is leading work to create a "computing Grid" that will harness vast amounts of computer power through networks across the world.



Engineering for CERN, especially in cryogenics, superconductivity, vacuum, microelectronics and civil engineering, gives companies experience that they can apply elsewhere.



Particle detectors invented at CERN are used in techniques for medical diagnosis.



Construction of Large Hadron Collider (LHC) begins
 Creation of a new state of matter, quark-gluon plasma, which probably existed just after the Big Bang.
 First results on antihydrogen atoms
 LHC planned start-up

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