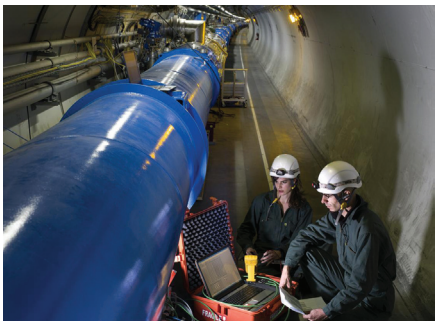
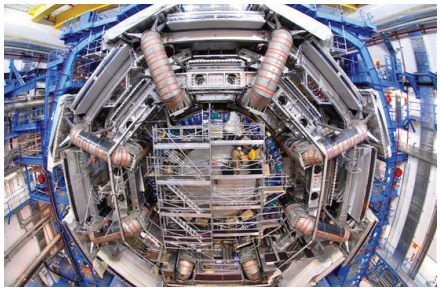
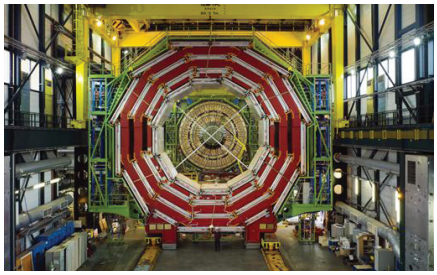
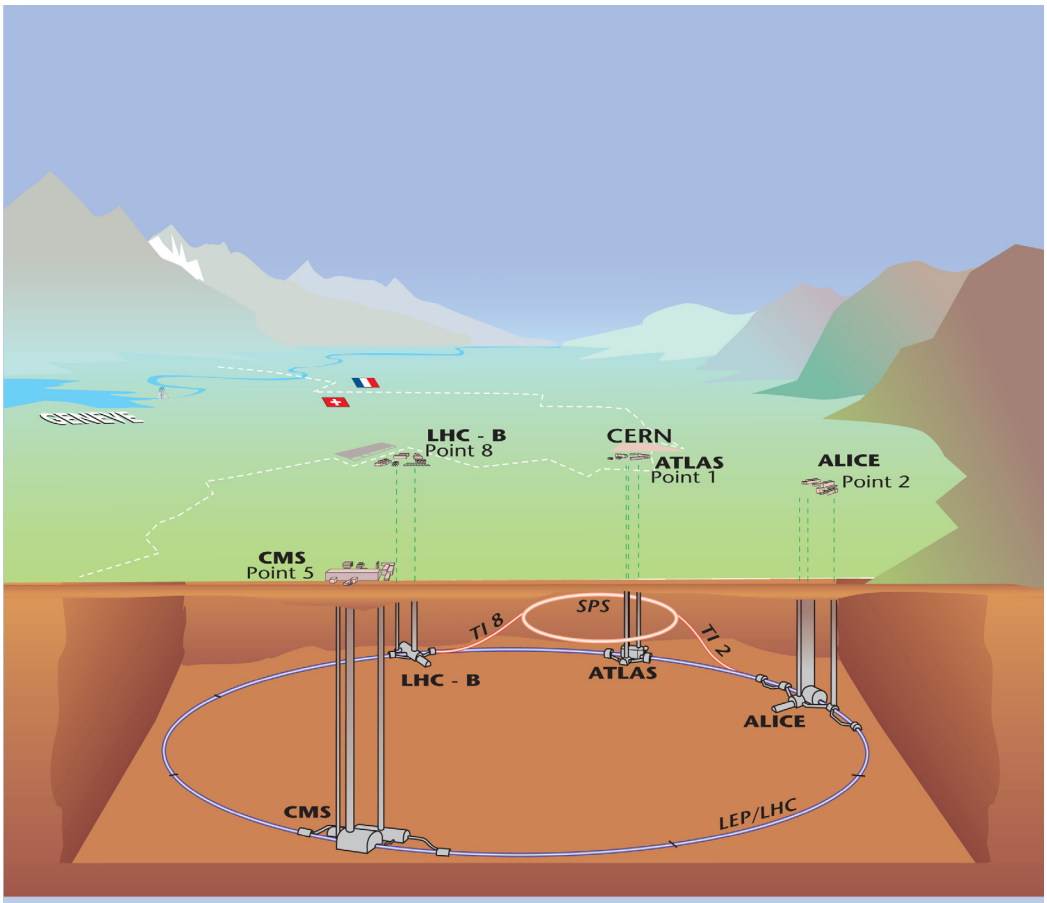
CRYOGENICS OPERATIONS 2008

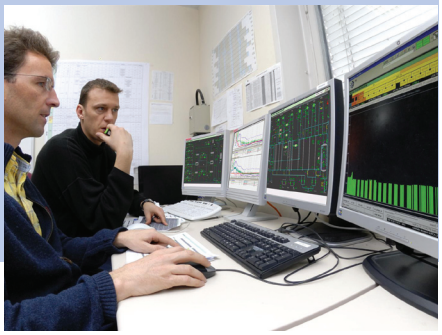






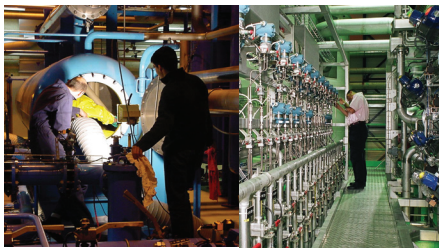


Artist view of the LHC ring



The LHC cryogenic System

From the cryogenic point of view, the LHC is a large distributed helium system operating at a wide range of temperature levels down to 1.8K. The design of these refrigeration plants sets the temperature levels for the whole system at 75, 50, 20 and 4.5K, in addition to the ultimate temperature level produced by the 1.8K refrigeration units that provide the superfluid helium to the "cold mass". The LHC consists of eight 3.3 km long sectors, with access shafts to services on the surface only at the ends of each sector. The layout for the refrigeration system is therefore based on five "cryogenic islands" – three of which serve two sectors, while two serve a single sector each. Thus each "island" must distribute and recover coolant over a distance of 3.3 km and carry kilowatts of refrigeration over long distances with a temperature drop from 1.9 to 1.8 K – less than 0.1 K.



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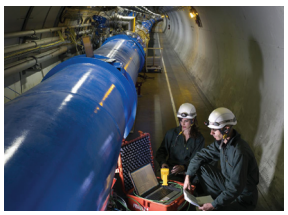
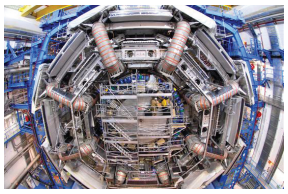
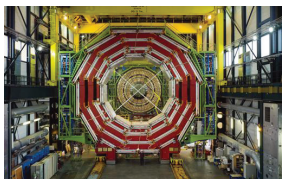
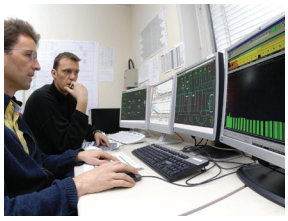
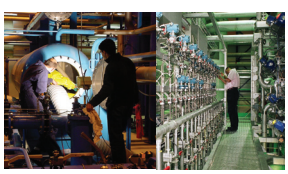
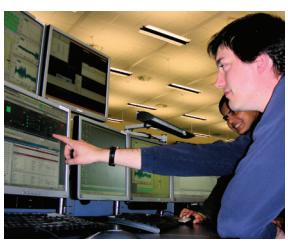
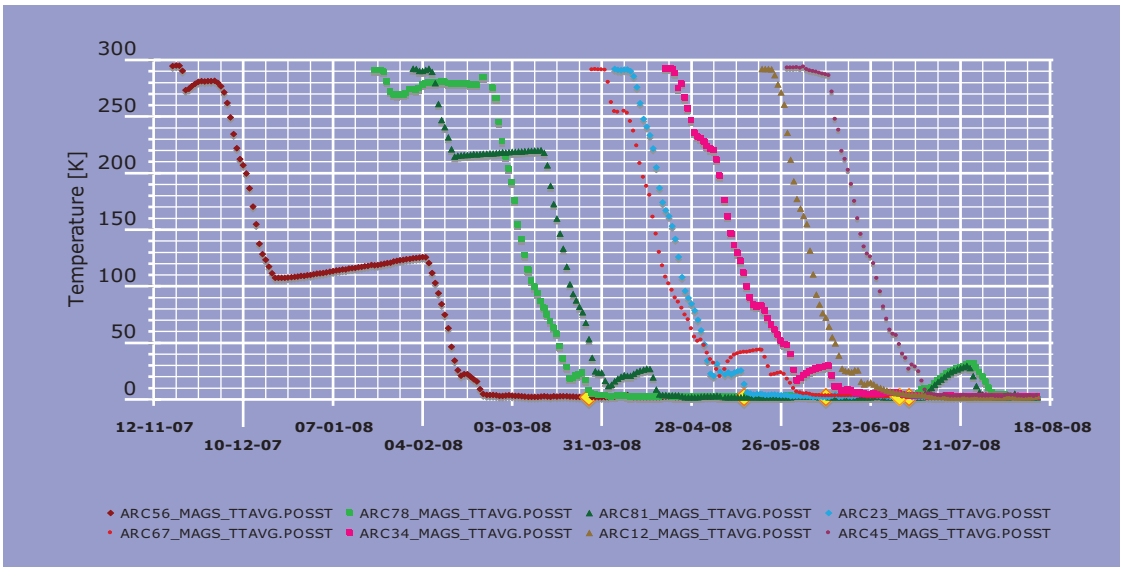




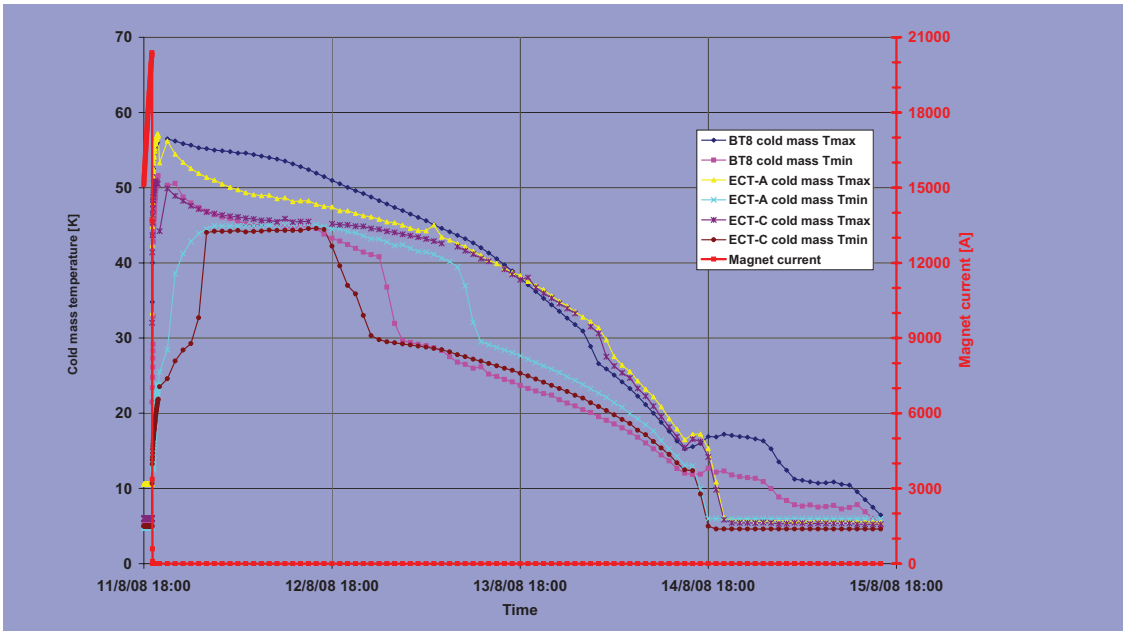


Typical cooldown of the LHC sectors

Particle collisions at LHC

During the acceleration to relativistic velocities the particles are "pumped up" with energy and attain 7 TeV, an energy level corresponding to about 7 thousand times the rest energy of a proton of appr. 1 GeV. At each collision, a few dozen protons interact and recreate conditions that existed just a thousandth of a billionth of a second after the Big Bang, the beginning of our universe some 15 billion years ago. In the collisions, out of pure energy, secondary exotic particles heavier than gold atoms might be produced. These short lived exotic particles and their decay products are measured and recorded by specialised "cameras", the particle detectors. They are installed in underground caverns at each of the four interaction points. Up to 40 million collisions are expected per second. LHC uses four detector experiments; ALICE, LHCb, ATLAS and CMS.

The two largest experiments, ATLAS and CMS, apply cryogenic technologies for the superconducting tracking magnetic systems and in addition ATLAS, uses calorimeters with particle-sensitive ultra pur liquid argon contained in cryostat vessels for measurement of their energy.



ATLAS experiment : quench & recovery of all toroids