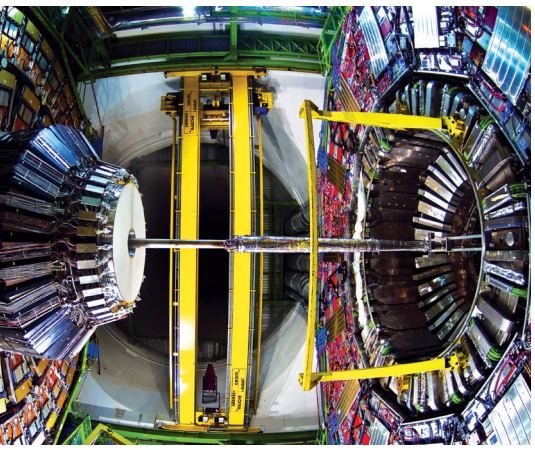
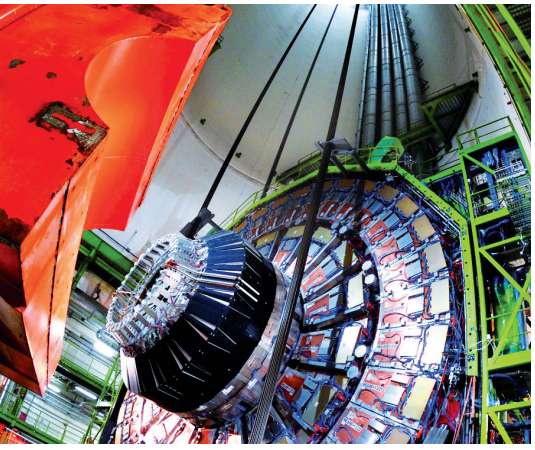
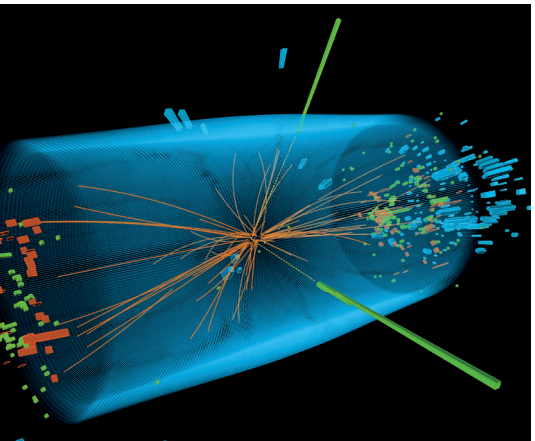




On 4 July 2012, the CMS and ATLAS collaborations announced a major discovery in particle physics: an observation of a Higgs boson at the LHC.



www.cern.ch/cms

Facts about **CMS**

>> At around 14,000 tonnes, CMS is the heaviest LHC experiment. It weighs almost twice as much as the Eiffel Tower, but at 15 metres in diameter and 21.5 metres long, occupies a volume more than 400 times smaller.

>> CMS was built in 15 large slices and many smaller pieces, with different parts of the detector forming layers around the central beam pipe, making each section look like a slice of an onion.

>> The slices were assembled on the surface before being lowered 100 metres underground into the experimental cavern. The heaviest piece weighed almost 2000 tonnes and took 12 hours to be lowered with just 10 centimetres of clearance between it and the shaft.

>> Whilst excavating around the site, CMS engineers unearthed a Roman villa, complete with pots, tiles and coins. The soil that was removed during excavation was eventually made into an artificial hill on the site.

>> The hydraulic jacks and control tower used to lower the slices of CMS into its experiment cavern were then used in Durban, South Africa, to lift the roof of a stadium for the World Cup in 2010.

>> CMS's superconducting solenoid magnet is 6m in diameter, 13m long and the most powerful of its kind ever built. Cooled to -268.5°C, a degree warmer than outer space, it generates a magnetic field 100,000 stronger than the Earth's. The energy stored in the magnet could melt 18 tonnes of gold.

>> The tracker is the part of the detector closest to the collision and so has an incredible density of sensors, its inner section containing 6,000 connections per square centimetre. There are 75 million read-out measurements in total across the tracker, its delicate silicon sensors covering an area the size of a tennis court.

>> The electromagnetic calorimeter (ECAL) contains 75,648 lead tungstate crystals, each of which took 2 days to grow. The material is 86% metal but completely transparent. Each crystal weighs more than 1.5 kg but with a volume roughly equal to that of a small coffee cup.

>> CMS's hadron calorimeter (HCAL) used the brass cases of over a million World War II Russian Navy shells in making some of its detector components. The HCAL also presented an opportunity for American high-school students to contribute to CMS: building 400 HCAL read-out components as part of the QuarkNet programme.

>> There are 1846 muon chambers, a kind of particle detector, within CMS. These contain 2 million wires, each as thin as a human hair. These chambers are aligned with the central tracker to a precision of within one sixth of a millimetr.

>> When performing at peak, the one billion proton-proton interactions that take place inside the detector every second are reduced to 100 events, those that are likely to be signs of interesting phenomena, by an extremely fast "triggering" system. Even so, the information CMS records and makes available for analysis every second is equivalent to that in the 32 - volume Encyclopaedia Britannica.

>> Farms of thousands of computers are used in the final stages of the data selection process at CERN. But this is nothing compared to the tens of thousands of computers, all over the world, that analyse the information. Connected through the Worldwide LHC Computing Grid, they have much more processing capacity than could be achieved by a single supercomputer.

CMS

CMS stands for **Compact Muon Solenoid:** compact because it is "small" for its enormous weight, muon for one of the particles it detects, and solenoid for the coil that forms the basis of its huge superconducting magnet.

CMS is designed to see a wide range of particles and phenomena produced in high-energy collisions in the LHC. The LHC smashes groups of protons into each other at close to the speed of light. It is designed to produce collisions 40 million times each second and at around seven times the energy of the most powerful accelerator built previously. Many of these will just be glancing blows but some will be head-on collisions and very energetic. When this happens, some of the energy is turned into mass and previously unobserved, short-lived particles – which could give clues about how Nature behaves at a fundamental level – fly out into the detector.

The different layers of the detector exploit the different properties of particles to catch and measure the energy or momentum of each one. Each particle that emerges is like a piece of a puzzle and CMS's job is to gather up information about every one so that physicists can put the jigsaw back together and see the full picture of what happened at the heart of the collision.

Scientists then use these data to search for new phenomena that will help to answer questions such as: What is the Universe really made of and what forces act within it? And what gives everything substance? CMS also measures the properties of previously discovered particles with unprecedented precision, and is on the lookout for completely new, unpredicted phenomena.

Collaboration

>> The materials cost of the CMS detector was 550 million Swiss Francs.

>> CMS is a collaboration of more than 2,600 scientists, including around 900 students.

>> CMS involves the work of people in 182 institutes in 42 countries.