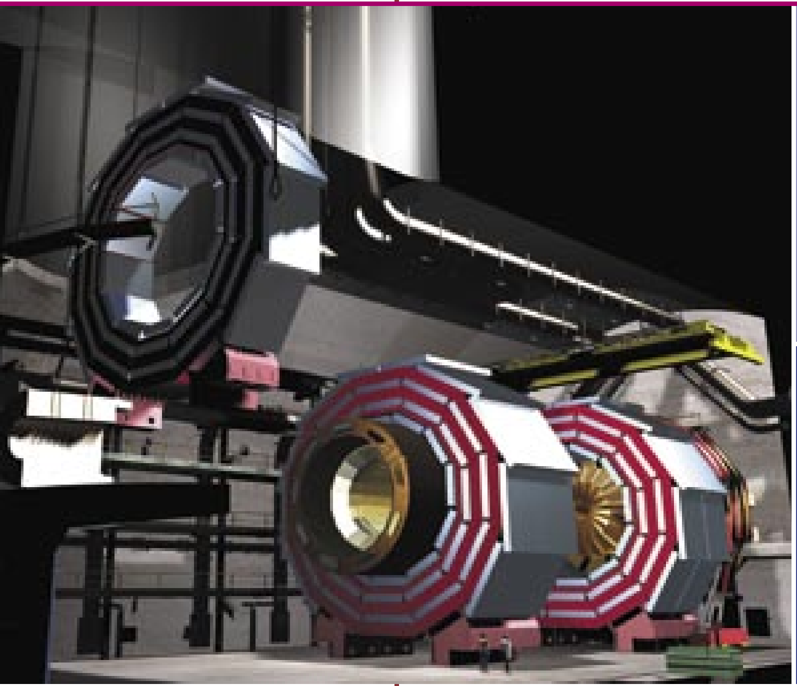
The CMS detector comprises 100 million individual detecting elements, each looking for tell-tale signs of new particles and phenomena—40 million times a second. It is one of the most complex and precise scientific instruments ever constructed. It will operate 100 m underground at the French village of Cessy, just across the border from Geneva in Switzerland, for at least ten years starting in late 2007.



CMS Parameters
12 500 t
21 m long
15 m diameter

The huge size of CMS belies the complexity within. A technician assembles one of the components of the inner tracker using 5-micron thick wires.

The large pieces of CMS, weighing between 200 and 2000 tonnes each, are lowered 100 m into the cavern and then assembled into position.

A Worldwide Enterprise Solving some of the mysteries of the Universe is only possible with the involvement of scientists, engineers and students from a multitude of disciplines. Pieces of CMS have been designed and constructed in institutes around the world, as well as in industry, before being brought to CERN for the final assembly. The data analysis will then be another worldwide endeavour, made possible through innovations in computing technology such as the Grid.

A researcher and a PhD student work together to cable and test some of the readout electronics of CMS.

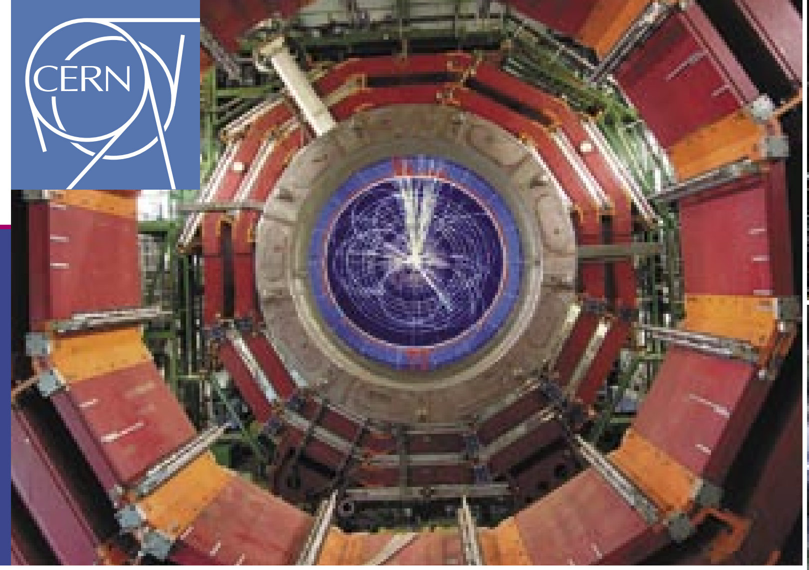
Some collaborators gather in the assembly hall to celebrate the end of construction of an element of CMS.

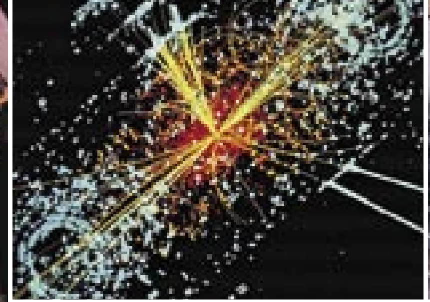
CERN
European Organization for Nuclear Research
CH-1211 Geneva, Switzerland

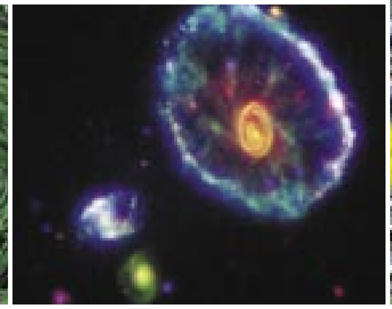
Communication Group, August 2006
CERN-Brochure-2006-007-Eng

CMS Collaborators
38 countries, 182 institutes
1050 physicists, 450 students
1000 engineers & technicians

To find out more about all aspects of CMS, visit our web site at: http://cms.cern.ch

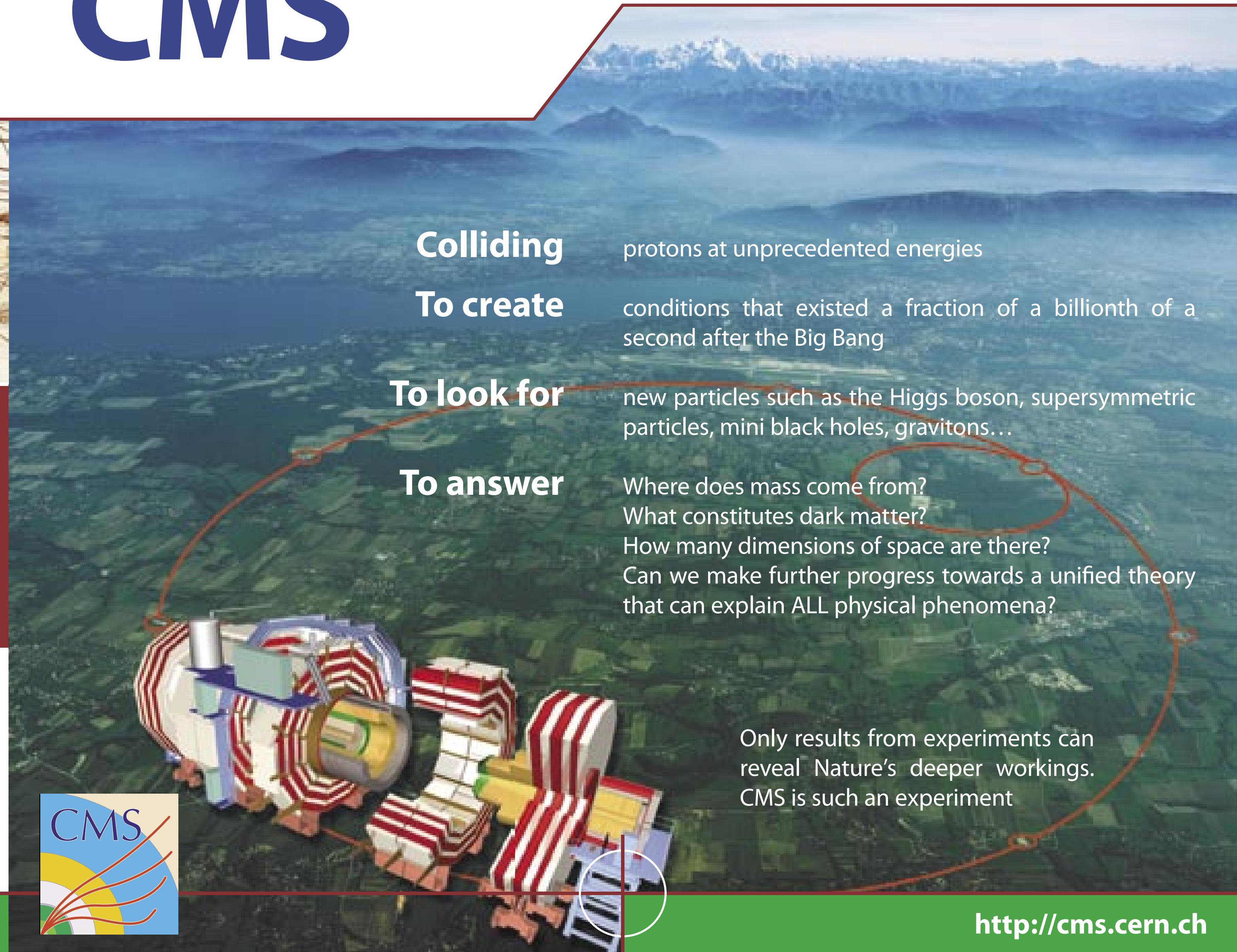






CMS

Compact Muon Solenoid



Colliding protons at unprecedented energies

To create conditions that existed a fraction of a billionth of a second after the Big Bang

To look for new particles such as the Higgs boson, supersymmetric particles, mini black holes, gravitons…

To answer Where does mass come from?
What constitutes dark matter?
How many dimensions of space are there?
Can we make further progress towards a unified theory that can explain ALL physical phenomena?

Only results from experiments can reveal Nature's deeper workings. CMS is such an experiment

The Detector and Detectives

CMS is a large technologically advanced detector comprising many layers, each of which is designed to perform a specific task. Together these layers allow CMS to identify and precisely measure the energies/momenta of all particles produced in collisions at CERN's Large Hadron Collider (LHC).

Tracker

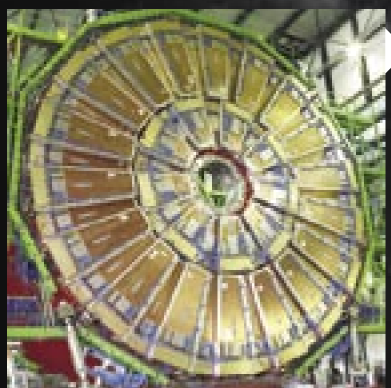
Finely segmented silicon sensors (strips and pixels) enable charged particles to be tracked and their momenta measured. They also reveal secondary vertices (from the decays of unstable particles).

Electromagnetic Calorimeter

Around 80 000 crystals of lead tungstate ($PbWO_4$) are used to measure the energy of incident electrons and photons.

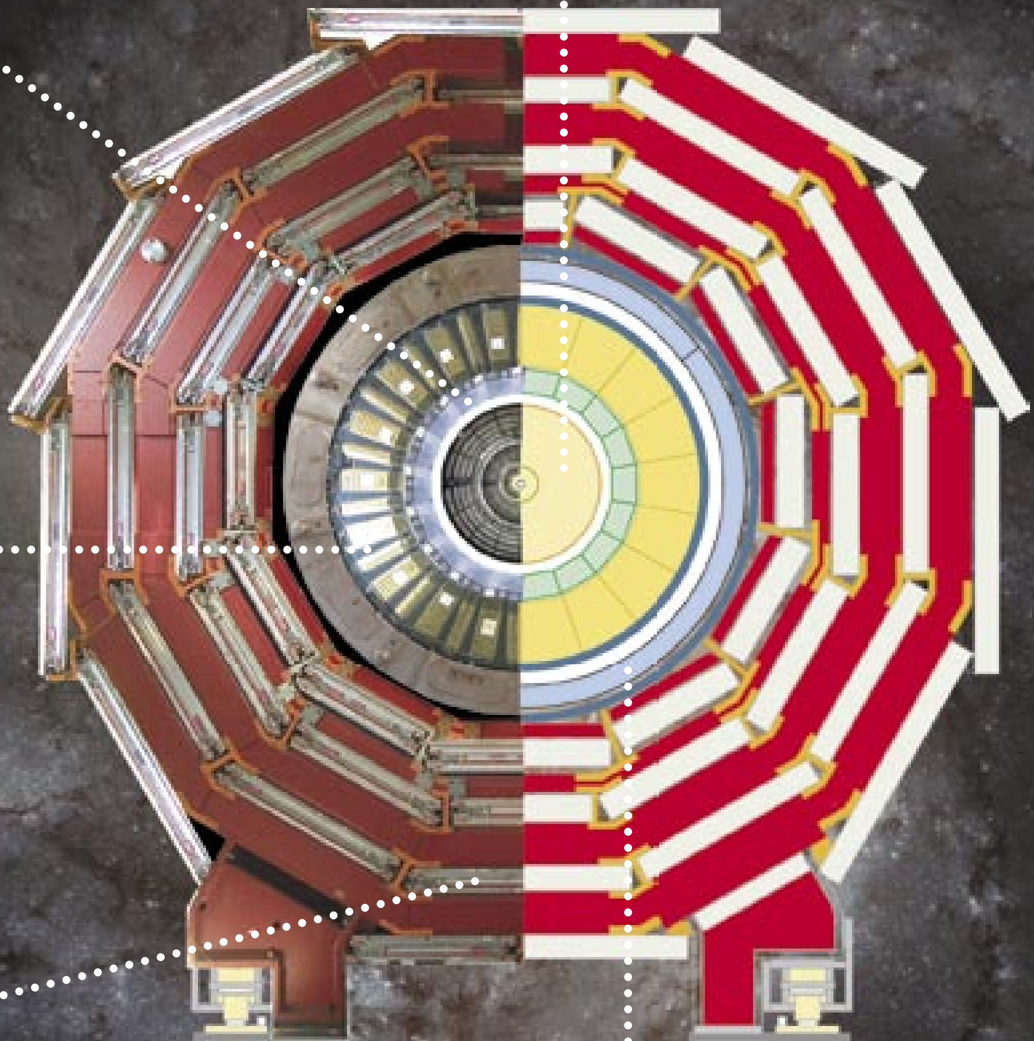
Hadron Calorimeter

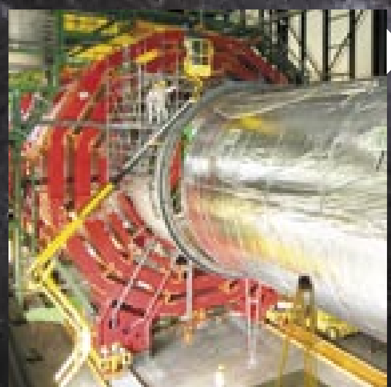
Layers of dense material (brass or steel) interleaved with scintillators (plastic or quartz) allow the estimation of the energy of hadrons, that is, particles such as protons, neutrons and pions.



Muon Detectors

Three varieties of detector are employed by CMS to identify muons (essentially heavy electrons) and measure their momenta: drift tubes, cathode strip chambers and resistive plate chambers



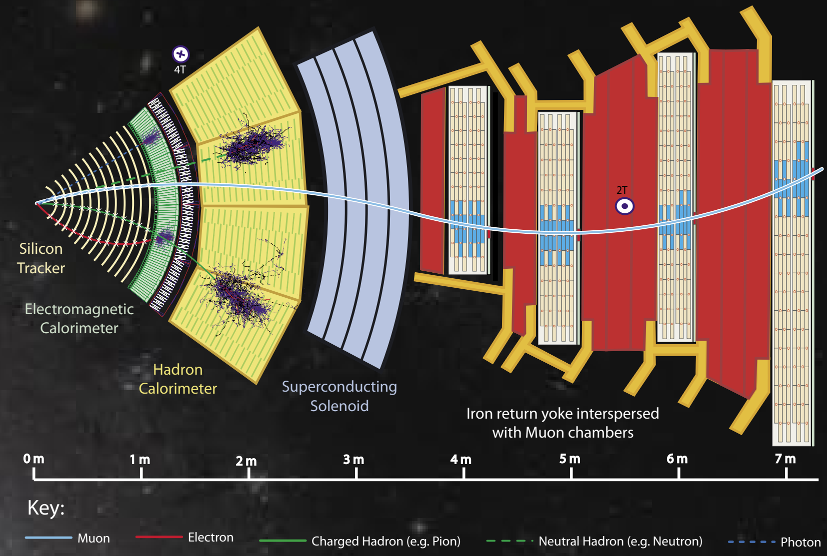


Superconducting Solenoid

Passing 20 000 A along a 13 m long, 6 m diameter coil of niobium-titanium superconductor, cooled to –270°C, produces a magnetic field of 4 teslas. This field bends the trajectories of charged particles, allowing their separation and momentum measurement.

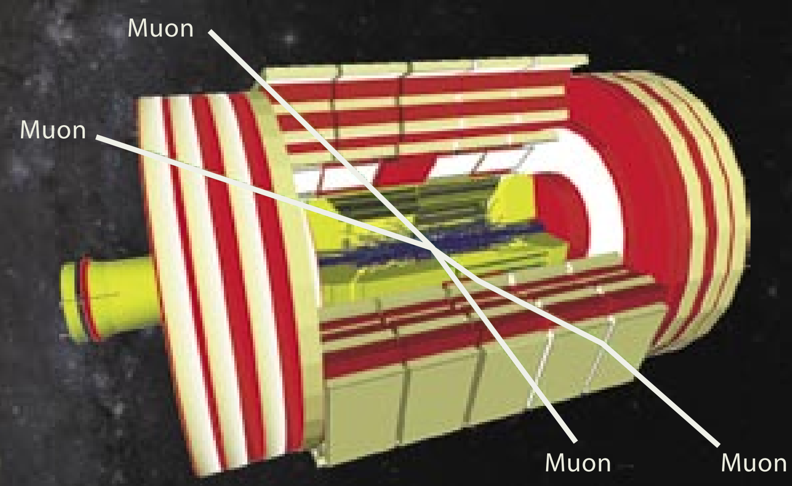
Pattern Recognition

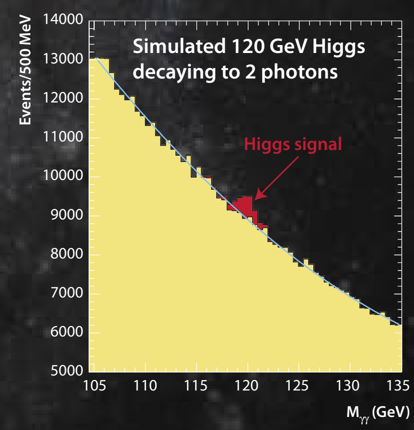
New particles are typically unstable and rapidly transform into a cascade of lighter, more stable and better understood particles. Each type of particle travelling through CMS leaves behind a characteristic pattern, or 'signature', in the different layers, allowing them to be identified. The presence (or not) of any new particles can then be inferred.



Trigger System

To have a good chance of producing a rare particle, such as a Higgs boson, the particle bunches in the LHC collide up to 40 million times a second. Particle signatures are analyzed by fast electronics to save only those events (~100 per second) most likely to show new physics—reducing the data rate to a manageable level. These events are stored for subsequent detailed analysis.





Data Analysis

Physicists from around the world use cutting-edge computing techniques (such as the GRID) to sift through millions of events from CMS to produce plots such as the one on the left (a simulation) that could indicate the presence of new particles or phenomena.