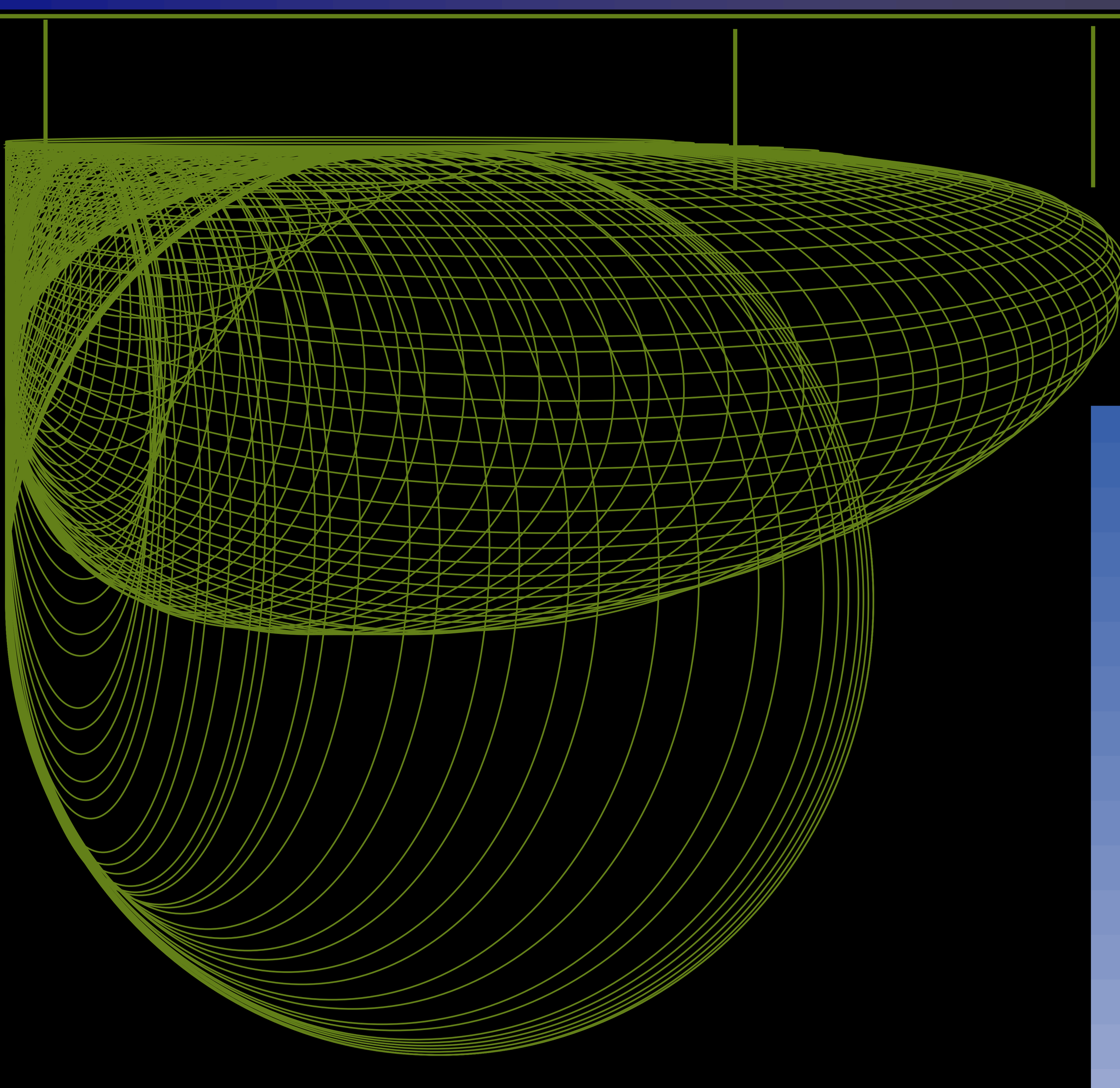
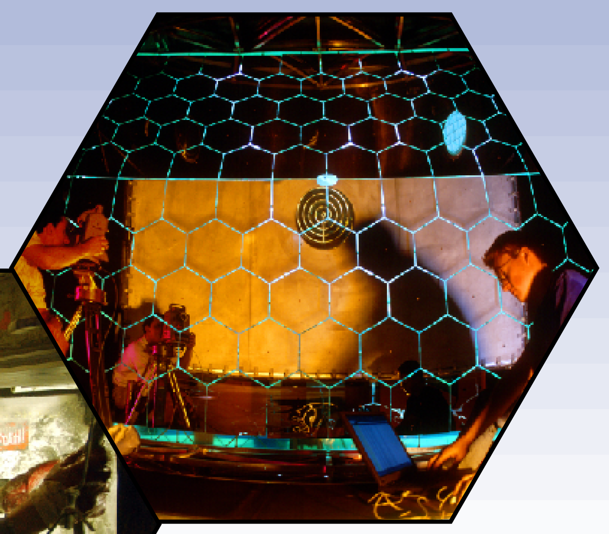
CERN - getting to the heart of the matter



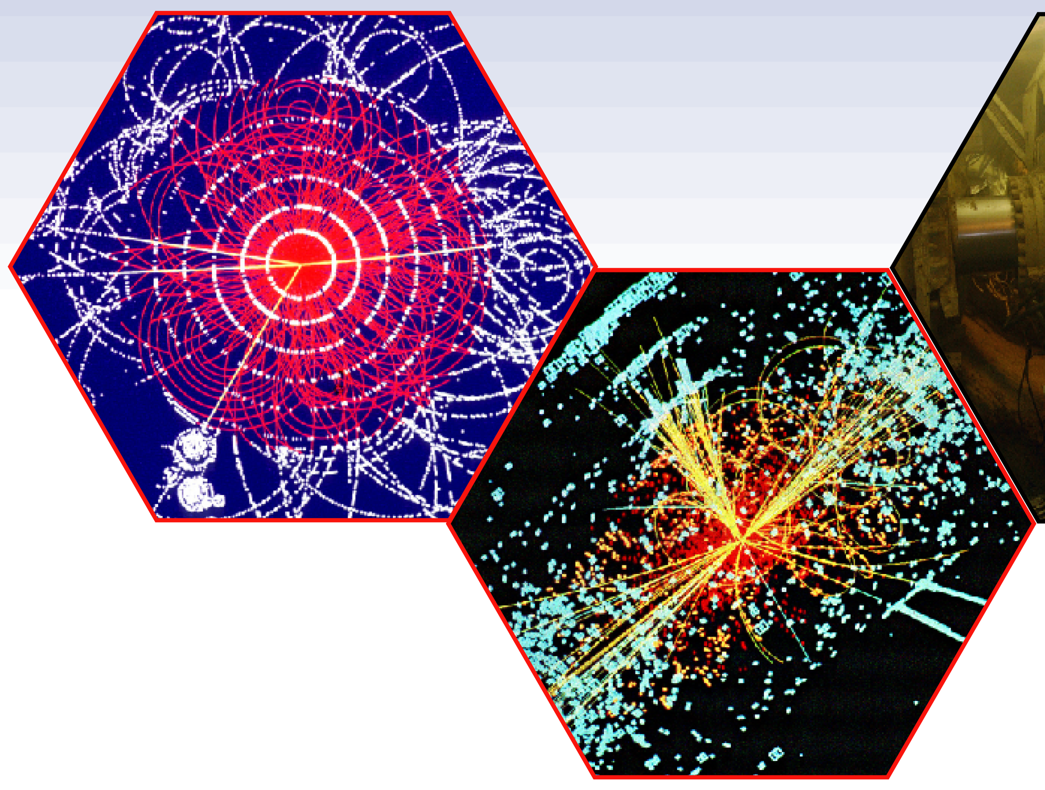
Understanding matter

Although we know much about matter as it is today, there are still many questions that remain unanswered. Even the ubiquitous proton holds unsolved mysteries. The proton has a property called spin - an intrinsic angular momentum - but precisely how the quarks and gluons inside the proton contribute to its spin is still unknown. This puzzle is being studied by the COMPASS experiment at CERN. Other outstanding questions concern the particles called neutrinos, which have very little mass, but which seem to be able to change from one type to another as they travel through matter. Experiments are preparing to study this effect with a beam of neutrinos that will go from CERN to the Gran Sasso laboratory in Italy.

Inside the COMPASS experiment's ring-imaging Cherenkov detector - a powerful tool for particle identification.



Excavating the decay tunnel for the CERN neutrinos to Gran Sasso project. From 2006, this is where neutrinos will begin their 730km journey through the Earth to Italy's Gran Sasso laboratory.



Simulations of tracks that would be left by the decays of Higgs particles in the ATLAS (top) and CMS experiments

Einstein's unfinished business

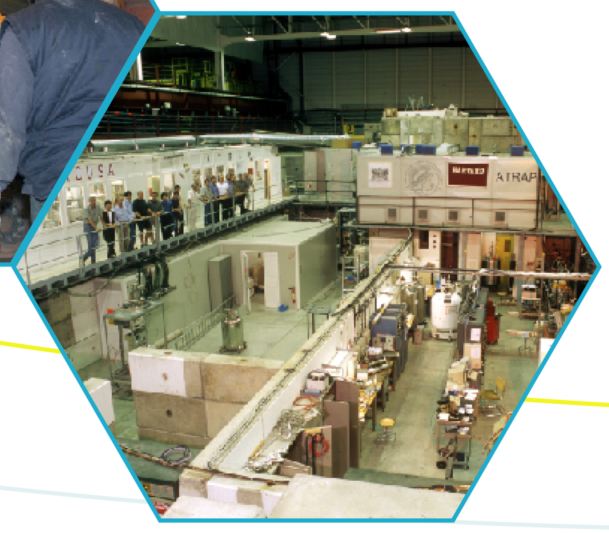
Newton was the first to describe gravity, and Einstein gave us the modern theory of gravity. But neither could explain mass. Why are some particles massive while others have no mass at all? And why do fundamental particles have such a range of different masses? The mystery of how particles gain mass could be explained by a new kind of physics that predicts the existence of Higgs particles, not yet detected. The search for Higgs particles is one of the top goals for LHC experiments.

Into the antiworld

At the very beginning of the Universe, equal amounts of matter and antimatter existed. If antimatter were really an exact mirror image of matter, everything would have annihilated to leave just energy. However, there is sufficient matter left in the Universe to make up everything around us todayÉ why? Experiments at CERN were the first to produce and study whole atoms of antihydrogen in 2002. In the future, new experiments will deepen our understanding of matter-antimatter asymmetry.

Inside the NA48 experiment, scene of measurements revealing Nature's preference for matter over antimatter.

Magnet coils for the LHCb experiment arrive at CERN. LHCb will provide the definitive measurements of matter-antimatter asymmetry.



ASACUSA, ATRAP and ATHENA, three experiments making use of CERN's unique low energy antiproton facility to study the properties of antimatter.

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