Answer on Question #43247, Physics, Nuclear Physics

large hydron collider is to detect what ?

The Large Hadron Collider has four main particle detectors: ALICE, ATLAS, CMS and LHCb. These detectors are showered with the particles produced when the two beams of protons circulating around the LHC collide.

Detector	Description
ATLAS	One of two general purpose detectors. ATLAS will be used to look for signs of new physics, including the origins of mass and extra dimensions.
CMS	The other general purpose detector will, like ATLAS, hunt for the Higgs boson and look for clues to the nature of dark matter.
ALICE	ALICE is studying a "fluid" form of matter called quark–gluon plasma that existed shortly after the Big Bang.
LHCb	Equal amounts of matter and antimatter were created in the Big Bang. LHCb will try to investigate what happened to the "missing" antimatter.

LHCb

Physics goals

- The experiment has wide physics program covering many important aspects of Heavy Flavor (both beauty and charm), Electroweak and QCD physics. Six key measurements have been identified involving B mesons. These are described in a roadmap document that form the core physics programme for the first high energy LHC running in 2010–2012. They include:
- Measuring the branching ratio of the rare $B_s \rightarrow \mu^+ \mu^-$ decay.
- Measuring the forward-backward asymmetry of the muon pair in the flavour changing neutral current $B_d \rightarrow K^* \mu^+ \mu^-$ decay. Such a flavour changing neutral current cannot occur at tree-level in the Standard Model of Particle Physics, and only occurs through box and loop Feynman diagrams; properties of the decay can be strongly modified by new Physics.
- Measuring the CP violating phase in the decay $B_s \rightarrow J/\psi\ \phi$, caused by interference between the decays with and without B_s oscillations. This phase is one of the CP observables with the smallest theoretical uncertainty in the Standard Model, and can be significantly modified by new Physics.
- Measuring properties of radiative B decays, i.e. B meson decays with photons in the final states. Specifically, these are again flavour changing neutral current decays.
- Tree-level determination of the unitarity triangle angle γ.
- Charmless charged two-body B decays.

ALICE

ALICE is optimized to study heavy-ion (Pb-Pb nuclei) collisions at a centre of mass energy of 2.76 TeV per nucleon pair. The resulting temperature and energy density are expected to be high enough to produce quark–gluon plasma, a state of matter wherein quarks and gluons are freed. Similar conditions are believed to existed a fraction of the second after the Big Bang before quarks and gluons bound together to form hadrons and heavier particles.

ATLAS

One of the most important goals of ATLAS was to investigate a missing piece of the Standard Model, the Higgs boson. The Higgs mechanism, which includes the Higgs boson, is hypothesized to give mass to elementary particles, giving rise to the differences between the weak force and electromagnetism by giving the W and Z bosons mass while leaving the photon massless. On July 4, 2012, ATLAS (together with CMS – its sister experiment at the LHC) reported evidence for the existence of a particle consistent with the Higgs boson at the level of five sigma, with a mass around 125 GeV, or 133 times the proton mass. This new "Higgs-like" particle was detected by its possible decay into two photons and its decay to four leptons.In March 2013, in the light of the updated ATLAS and CMS results, CERN announced that the new particle was indeed a Higgs boson. Having analyzed two and a half times more data than was available for the discovery announcement in July, the confidence of observation has risen to 10 sigma. The experiments were also able to show that the properties of the particle as well as the ways it interacts with other particles were well-matched with those of a Higgs boson, which is expected to have spin 0 and parity +. In 2013 two of the theoretical physicists who predicted the existence of the Standard Model Higgs boson, Peter Higgs and François Englert were awarded the Nobel Prize in Physics. Physicists have now to pursue their measurements to determine if this Higgs particle corresponds indeed to the Standard Model Higgs boson or if it is part of a new physics scenario.

Compact Muon Solenoid (CMS)

The main physics goals of the experiment are:

- to explore physics at the TeV scale
- to study the properties of the recently found Higgs boson
- to look for evidence of physics beyond the standard model, such as supersymmetry, or extra dimensions
- to study aspects of heavy ion collisions.