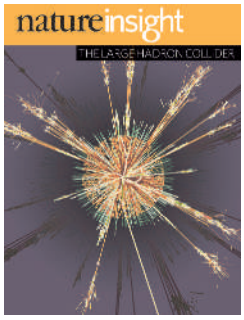

Cover illustration
Simulated outcome of a proton–proton collision at the LHC, showing the tracks left by particles. (Courtesy of CERN)

THE LARGE HADRON COLLIDER

We are on the threshold of a new era in particle-physics research. In 2008, the Large Hadron Collider (LHC) — the highest-energy accelerator ever built — will come into operation at CERN, the European laboratory that straddles the French–Swiss border near Geneva.

In the debris of the collisions between protons in the LHC, physicists are hoping for a sign. Hypotheses such as the Higgs mechanism (and associated particle) and supersymmetry remain to be proved. The high energy of the LHC collisions will give the best ever 'reach': that is, the best chance yet of finding the decisive signature of a Higgs or supersymmetric particle.

In looking forward, we should not forget what lies behind us — the phenomenal success of the standard model of particle physics over the past three decades. The standard model has been tested to a greater degree of precision than any other model in science and has withstood every challenge. But it is incomplete, and the search for the missing pieces of the puzzle is the prime motivation for building the LHC.

The LHC programme is, however, much wider than a search for the Higgs. Alongside the 'general-purpose' detectors, known as ATLAS and CMS, the LHCb experiment will analyse the production of bottom quarks in LHC collisions. This rich system is the key to a better understanding of the phenomenon of CP violation and its connection to the dominance of matter over antimatter in the Universe. In addition, during dedicated runs in which lead ions will collide in the LHC instead of protons, the ALICE experiment will study a phase of matter called quark–gluon plasma, which might have existed shortly after the Big Bang.

This is the story told in this Insight: how the standard model was developed and tested; how it was agreed to build the LHC; how the programme has been realized through decades of effort by thousands of scientists — and how marvellous the rewards might be.

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