On the threshold of new territory

Rolf Heuer on the physics potential of the LHC's first long run

With stable beams regularly circulating and colliding in the LHC, we have started the physics programme at 7 TeV. At a recent workshop in Italy, participants had the chance to take stock of what lies in store for the LHC's first physics run.

Our objective over the next 18 to 24 months is to deliver one inverse femtobarn of data to the experiments. In other words, enough data to make significant advances across a wide range of physics channels.

Waiting for collisions in the LHC... *Image: CERN*

Take supersymmetry. ATLAS and CMS will each have enough data to significantly extend today's sensitivity to new discoveries. Experiments today are sensitive to some supersymmetric particles with masses up to about 400 GeV. An inverse femtobarn at the LHC pushes that up to about 800 GeV. This means that in the next two years, the experiments at the LHC will explore as much territory in their quest for SUSY as has been covered in the history of particle physics to date. In other words, the LHC has a real chance over the next two years of discovering supersymmetric particles, possibly elucidating the nature of the dark matter that accounts for about a quarter of the mass and energy of the Universe.

The Higgs particle is another example. The last word that CERN had to say on the matter came from LEP almost ten years ago. In the last year of LEP running there were tantalising signs that the Higgs might have made an appearance but all we could say for sure was that the Higgs must have a mass above about 115 GeV. Since then, the Tevatron has done great work towards ruling out some of the mass range that the Higgs could inhabit. With an inverse femtobarn of data from the LHC, the combined analyses of ATLAS and CMS will be able to explore a wide mass range, and there's even a chance of discovery if the particle has a mass near 160 GeV.

At the more exotic end of the potential discovery spectrum, LHC experiments will be sensitive to new massive particles that could herald the presence of extra dimensions. Discoveries up to masses of 2 TeV will be possible, whereas today's reach is around 1 TeV.

All this makes now a very good time to be a particle physicist, and in particular a student of particle physics. Some 2500 graduate students are eagerly awaiting data from all the LHC experiments, ALICE, ATLAS, CMS, LHCb, LHCf and TOTEM. They're a privileged group, set to produce the first PhD theses at the new high-energy frontier.

Two years of continuous running is a tall order both for the LHC operators and the experiments, but it will be well worth the effort. By abandoning CERN's traditional annual operational cycle we're increasing the overall running time and discovery potential over the next three years. This run will be followed by preparations for 14 TeV collisions in a single shutdown and another major advance into new territory as great as the one we are on the threshold of achieving.

-- Rolf Heuer