Indefinite particles

The Large Hadron Collider (LHC) will restart its discovery programme early in 2015 after a two-year shutdown during which Cern has almost doubled the operating power of its S8bn atom smasher.

"There is a new buzz about the laboratory and a real sense of anticipation," says Cern director-general Rolf-Dieter Heuer. "Much work has been carried out on the LHC and it's effectively a new machine, poised to set us on the path to new discoveries."

The thousands of scientists who work on the LHC's multiple experiments hope that the extra energy of its proton-proton collisions will enable them quickly to reveal "new physics" beyond the Standard Model of particles and forces built up over the past half-century. The first run from 2009 to 2012 led to one triumphant discovery: the Higgs boson, which endows mass on other particles and was the last important prediction of the Standard Model to be verified.

Further analysis, carried out during the shutdown, shows the Higgs behaving as a single particle. Physicists were hoping for more complexity — for example, a family of Higgs bosons with slightly different properties — because they know physics has to move beyond the simple Standard Model to explain many phenomena, from gravity to the mysterious dark matter and dark energy that pervade the universe.

The LHC's upgrade from 8TeV to 13TeV (tera-electronvolts is the units used to measure collision energies in particle accelerators) could reveal hints of that sought-after complexity quite quickly next year. "I told the scientists that the Higgs discovery was easy and now the real work starts," says Heuer. "Does the Higgs boson have brothers and sisters?"

"The discovery of a Higgs boson was just the beginning," adds his colleague Fabiola Gianotti. "The increase in energy opens the door to a whole new discovery potential."

The LHC's detectors picked up 14,000 Higgs particles during the first run. The second run is expected to yield 100,000 for analysis.

The two most discussed prospects for discovery when the LHC resumes are supersymmetry — the theory that all fundamental particles in the Standard Model have a heavier partner waiting to be found — and dark matter.

If supersymmetry is correct, the evidence should emerge fairly soon after the restart. The search for the invisible, and so far undetectable, dark matter is likely to take longer.

Meanwhile, Cern has begun the search for a new director-general to replace Heuer who will retire at the end of 2015 after seven successful years. The UK has already proposed a candidate: John Womersley, head of the Science and Technology Facilities Council, which funds Britain's national activities in high-energy physics.

Why global warming is bad for your health

The coldists: Impact of climate change in Europe this century is likely to be on human health — and in particular heat related deaths — according to a new economic assessment by the IU Joint Research Centre, the European Commission's in-house science service. The study looks at the impact of a 3.5°C rise in global average temperature from pre-industrial levels — an increase expected if no concerted international action is taken. The official target is to limit the rise to 2°C by cutting greenhouse gases. Heat-related deaths in Europe could reach 200,000 a year with a 3.5°C temperature rise, according to the study.

The economic cost of premature mortality caused by global warming is estimated at €20bn a year. This exceeds the impact on ocean infrastructure (€4bn) and agriculture (€1bn). The total cost to Europe of unrestrained global warming is put at €50bn a year, though the JRC researchers warn that this figure considerably underestimates the dangers. It neglects some effects — including lost biodiversity and ecosystem losses — which cannot be monetised, and it ignores the possibility of more severe changes if we pass climate "tipping points" such as Antartic or Greenland ice melting more quickly than expected.

A striking finding is how unevenly the impacts are distributed. Southern Europe would bear 70 per cent of the burden; Scandinavia and the Baltic region, just 1 per cent. The only net positive effect the study measured is on energy demand. Overall EU demand would fall by 13.7 per cent with a 3.5°C temperature rise, mainly because less winter heating would be required. Only southern Europe would have to spend more because the need for additional summertime cooling would outweigh the reduced heating.