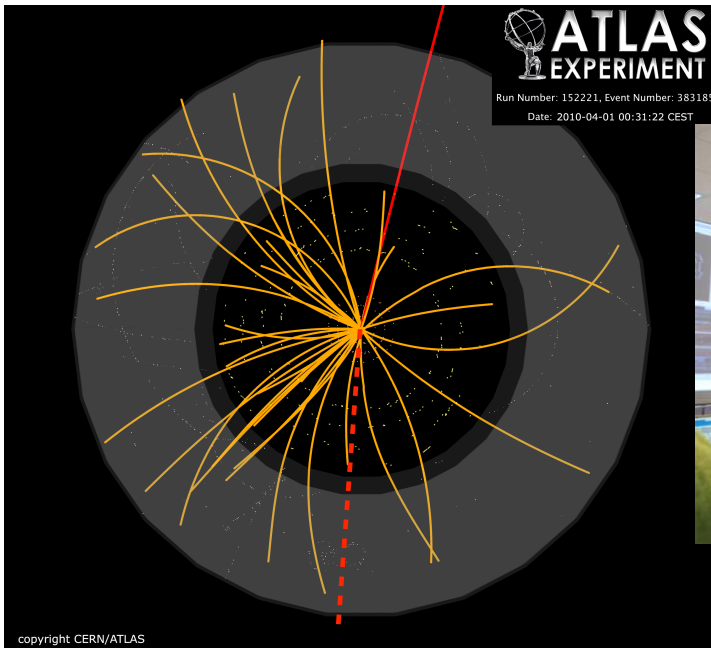




The World's biggest science experiment



STFC's Dr Steve McMahon, Project leader on the ATLAS Silicon Tracker (SCT) waiting for the first beam at the LHC (Credit: CERN)

First W Boson seen by the ATLAS experiment (Credit: CERN/ATLAS)

The Large Hadron Collider (LHC) is the most powerful particle accelerator ever built. Based at the European particle physics laboratory CERN, near Geneva in Switzerland, it is one of the world's largest laboratories and is dedicated to the pursuit of fundamental science.

The LHC lets scientists reproduce the conditions that existed within a billionth of a second after the Big Bang. This is the moment, around 14 billion years ago, when the Universe is believed to have started with an explosion of energy and matter. During this first moment of time the particles and forces that shaped our Universe came into existence.

Scientists recreate these conditions by accelerating two beams of high-energy protons or lead ions inside the LHC's 27km circular tunnel, which crosses the French-Swiss border 100m below the ground. The beams travel in opposite directions at close to the speed of light and then collide together millions of times a second.

In March 2010 the LHC achieved a world record highest energy of collisions at 7TeV and the first particle physics results that go beyond the reach of previous experiments have been published.

Through STFC's subscription, the UK is one of the biggest investors in CERN and through its membership UK companies can bid for lucrative high-tech contracts. In addition UK scientists, with funding from STFC, have contributed vital hardware, computing and expertise to the LHC.

This benefits both the economy and the UK's science base as:

- UK industry won more than £27 million worth of contracts from CERN during the construction of the LHC
- UK industry continues to win, on average, around £15m every year in contracts from CERN. In 2009, UK IT company Viglen won a £1.8m contract to provide part of the required processing power needed to analyse data from the LHC
- More than 20 research groups across the UK helped prepare for the LHC and are now involved in the scientific research programmes

A number of spin-off technologies have come from scientists' work in preparing for the LHC and many new applications are anticipated – hardly surprising since the last major experiment at CERN

The Science and Technology Facilities Council

resulted in the creation of the World Wide Web. The British engineer and computer scientist, Tim Berners-Lee, designed the Web to make it easier for scientists in different locations to work together.

The next leap in connecting computers is cloud computing and the Grid. The internet and World Wide Web let us share information easily but these go a step further by letting people share things other than files and facts, such as processing power and data storage space. The Grid has many applications but the first will be to share out the processing of the huge quantities of data (roughly 15 million gigabytes) that the LHC generates annually – enough to fill more than 20 million CDs.

GridPP is the UK's contribution to this and is a collaboration of particle physicists and computer scientists from 19 UK universities and STFC's Rutherford Appleton Laboratory.

STFC spin-out company Constellation Technologies is using computing technology developed for the LHC to provide products and services to industry and academics.

Research undertaken at the LHC is also expected to have wider benefits for society potentially leading to new cancer therapies, types of medical and industrial imaging, and manufacturing processes.

There are four main experiments at the LHC – each installed in huge underground caverns around the four collision points of the LHC beams.

ATLAS and CMS are both designed for a wide range of physics, from searching for the Higgs Boson and extra dimensions to giving clues to the nature of dark matter.

ALICE is a heavy-ion detector to study the state of matter that probably existed just after the Big Bang before particles such as protons and neutrons were formed.

LHCb is a b-physics detector set up to explore why matter survived after the Big Bang and built our Universe.

Each of the four experiments is run by its own collaboration of international scientists. The largest of these is ATLAS, which has nearly 3,000 scientists from 37 countries working on it.

Research and development is taking place for eventual upgrades to the tracking detectors for both ATLAS and CMS to extend the scientific reach of these experiments even further.



Aerial view of CERN (Credit:CERN)

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