

GridPP

Computing to unveil the deep structure of the Universe

CERN is currently constructing the world's most powerful particle accelerator, the Large Hadron Collider, which should be ready for operation in 2007. The machine is expected to reveal new physics processes that were crucial in building the Universe we see today. The four experiments at LHC will produce around 10 Petabytes of data each year (10 billion, billion bytes).

This scale of data is unprecedented in the particle physics community, or in any field of science. GridPP is the UK's contribution to establishing the computing resources and framework that will allow the analysis of this data. Over the last three years, GridPP has been working with the particle physicists developing the LHC experiments, to prepare Grid interfaces for the experiments and to integrate the software used by experiments into the Grid.

• LHC experiments

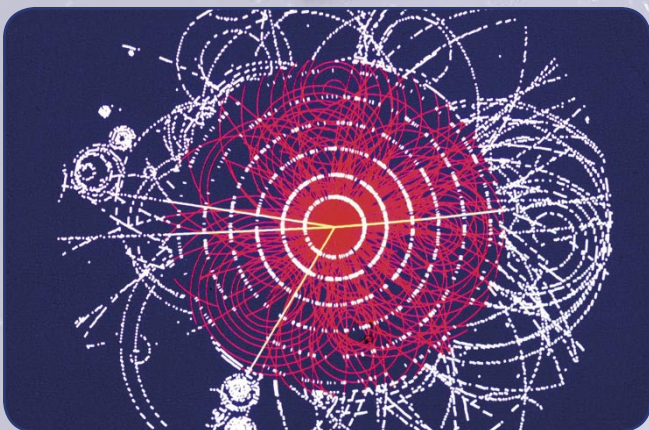
The LHC will supply particle beams to four experiments, positioned around the ring at points where the proton beams collide. Each high-energy collision will generate around 1000 particles, which will shower out into the detectors to be recorded and analysed. Around 40 million collisions are expected each second. After filtering, this will be reduced to around 100 collisions of interest per second from the detectors, to be processed by a world-wide Grid.

The LHC experiments have run a series of Data Challenges on the Grid. These are increasingly large and complex series of computing exercises using simulated data, that test and develop both the experiment Grid applications interfaces and the underlying middleware.

• ATLAS

ATLAS is a particle physics experiment designed to explore the origin of mass itself and study supersymmetry and other new and exciting physics including micro black-hole production. This is the largest collaborative effort ever attempted in the physical sciences and involves over 2,000 scientists from more than 150 universities and laboratories in 34 countries.

The bulk of the GridPP contribution to ATLAS has been to the development of a software framework (known as GANGA), jointly with LHCb. GridPP has also been involved with data challenges, automated software and environment packaging and installation, and a system for producing Monte Carlo data.



A simulation of tracks from the ATLAS detector

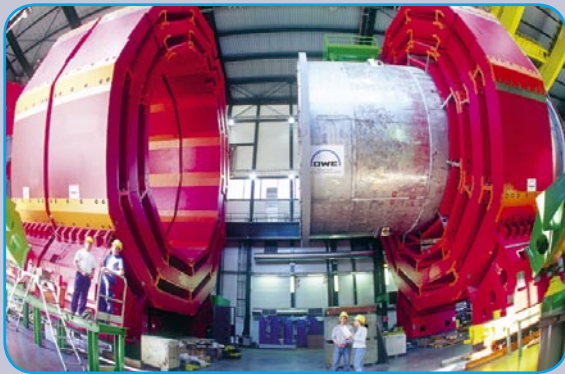
Steve Lloyd, the GridPP collaboration chair, looks up at the pit where the ATLAS detector is being installed



• CMS

The Compact Muon Solenoid (CMS) is a general purpose particle physics detector. GridPP has contributed to three main areas: managing the production Monte Carlo data challenges; enabling the efficient transfer of data from CERN to the geographically distributed national centres; and adapting the job submission and monitoring system to operate across the Grid.

The latest CMS data challenge simulated 5% of the computing workload of the fully operational experiment. Over 75 million events were generated, simulated, reconstructed, reduced to summary data and analysed during the data challenge, resulting in over 150 Terabytes of useful data stored worldwide.



The CMS detector

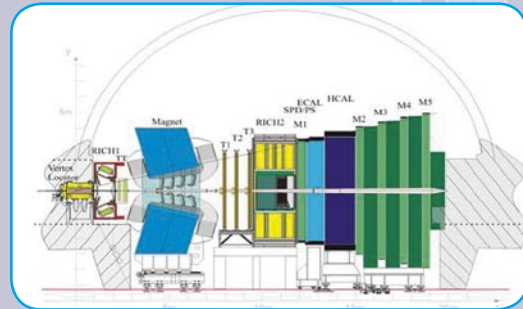
• LHCb

LHCb will study the differences between matter and antimatter. 1000 million short-lived particles of matter and antimatter called B and B-bar mesons will be studied each year. In order to design the detector and to understand the physics, many millions of simulated events also have to be produced.

LHCb has developed DIRAC, a software system that uses Grid deployments such as LCG to allow the LHCb simulations to be running at the same time all over the world. In the UK, LHCb computing and software centres are sited at the Universities of Bristol, Cambridge, Edinburgh, Glasgow, Imperial College, Liverpool & Oxford and at the Rutherford Appleton Laboratory.

• ALICE

The ALICE experiment will inspect collisions of heavy ions, in order to observe the creation of quark-gluon plasma, a new state of matter which can only exist in conditions of extremely high energy density. Around 50,000 particles will be produced in each collision, a large proportion of which must be tracked and identified.



The LHCb detector

Other experiments

GridPP has also worked with a range of non-LHC experiments to enable them to use the UK Grid, including:

UKQCD - Quantum Chromodynamics (QCD) requires access to large supercomputing resources and generates large amounts of raw data. The UK's national lattice QCD collaboration (UKQCD) stores data on QCDgrid, a data grid currently composed of six storage elements at four separate UK sites: Edinburgh, Liverpool, Swansea and RAL.

CDF and DØ - These two experiments at the Tevatron, at Fermilab in the US, have been running for some years. With new UK participation, they recently started a new data-taking period with a large increase in data processing requirements. CDF and DØ evolved a Grid-based computing system, while amending the user interface only minimally, so that it remained easy to use.

BaBar - The BaBar experiment at SLAC in the US had also started with a central computing model, with no serious use of outside resources. However, with an increasing amount of data being taken, a new distributed strategy was set up, relying on the use of large 'Tier A' sites at RAL and other national centres.