CASE STUDY

Linking European and Chinese Research Infrastructures and Communities

ORIENTplus

High-speed networking: helping to reveal the secrets of the universe

The Large Hadron Collider (LHC) at CERN in Switzerland is the most ambitious and powerful particle accelerator built to date. By smashing protons together at colossal speed, the LHC allows scientists to recreate the conditions that existed a few moments after the Big Bang in an attempt to answer fundamental questions of science and the universe itself. The LHC is truly global in scope, supported by an enormous international community of scientists and engineers. Working in multinational teams all over the world, they are building and testing equipment and software, participating in experiments and analysing data. Dedicated high-speed networks such as **GÉANT** and **ORIENTplus** are key to the success of this unique collaborative endeavour of the international high-energy physics community.

Tackling the data deluge

The LHC contains seven detectors, each designed for certain kinds of research. Two of them, the ATLAS experiment and the Compact Muon Solenoid (CMS), are large, general purpose particle detectors, investigating the origins of mass and looking for clues to the nature of dark matter. Undisputedly, the most famous insight so far has been the discovery of what could be the long-sought Higgs boson. However, there is still much to learn about this new, so-called 'God' particle. And there is still much more territory to cover in the search for new physics. Even during the excitement of that discovery, thousands of scientists continued the important work of analysing the continuing flood of new data pouring out of the detectors – approximately one petabyte of data per second (200,000 DVDs' worth of raw data a second!).

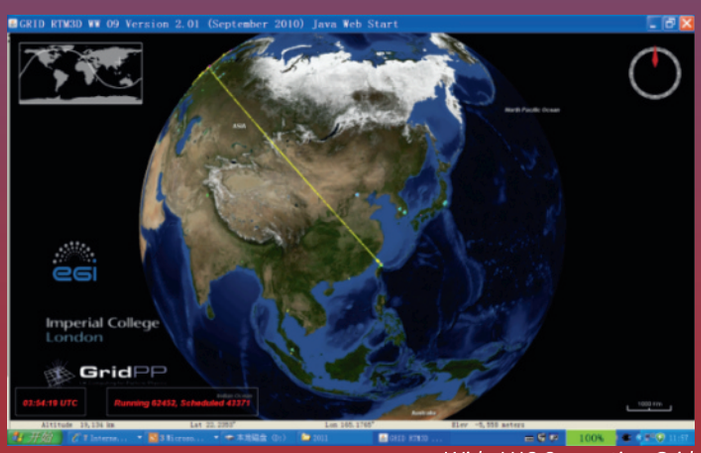
IHEP's computing power – in a nutshell

1088 CPU cores
780 TB storage space
10 GB network connection to CSTNet

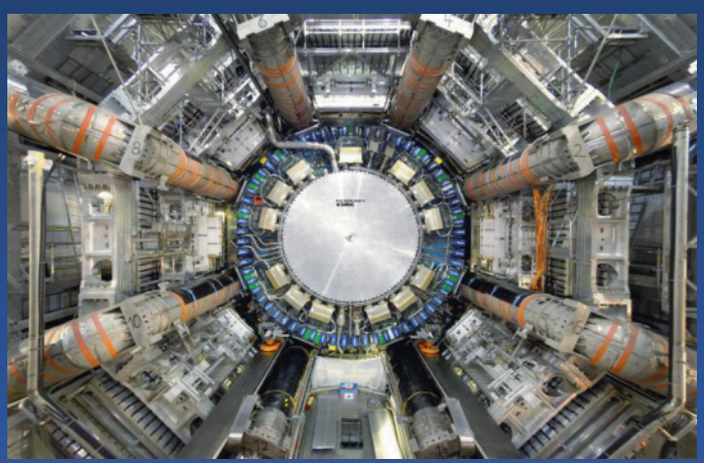
Experiment data exported from IHEP (1 Jan – 1 Dec 2014)

225 TB for CMS
66 TB for ATLAS

CERN does not have the computing resources to crunch all of the data on site, so it turned to grid computing to share the burden with computer centres around the world. Harnessed in a distributed computing service, they form the Worldwide LHC Computing Grid (WLCG), which provides the resources to store, distribute, and process the LHC data. WLCG combines the power of more than 170 collaborating centres in 40 countries around the globe, which are linked to CERN. Every day WLCG processes more than 1.5 million jobs, corresponding to a single computer running for more than 600 years.



Wide LHC Computing Grid



Atlas Detector on Large Hadron Collider(LHC)

The Challenge

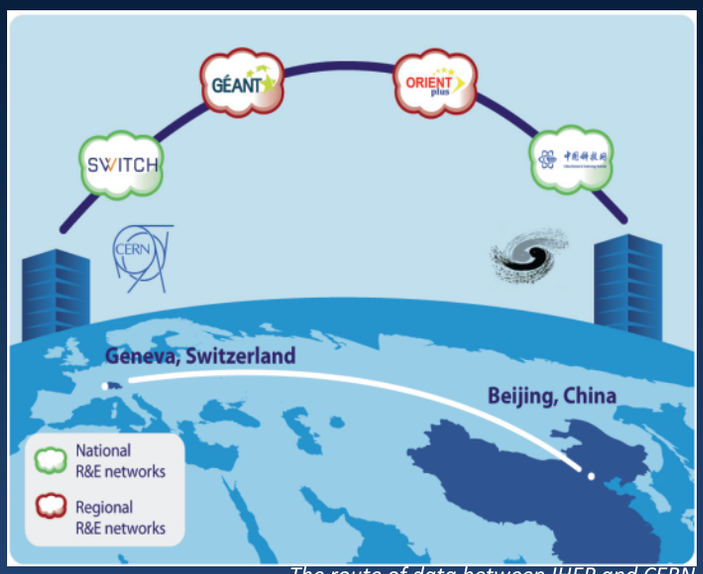
Provide the computing power to tackle the data deluge generated by the LHC experiments and harness the resources of computing centres around the world, including IHEP in China.

The Solution

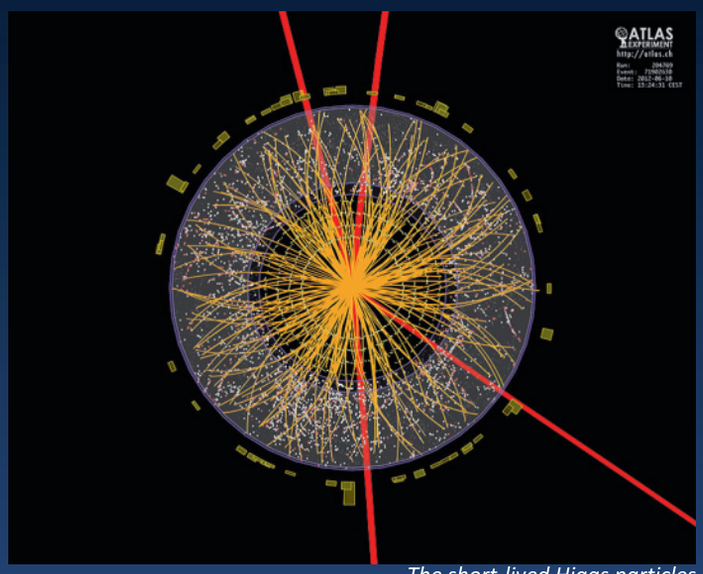
ORIENTplus provides the international connectivity for IHEP to be a major player in the Worldwide LHC Computing Grid.

Key Benefits

ORIENTplus and other research and education networks are a key component of the LHC experiment – allowing high-energy physicists in China to take part in this cutting-edge international scientific collaboration aimed at gaining a fuller understanding of our universe.



The route of data between IHEP and CERN via national and regional R&E networks/links



The short-lived Higgs particles

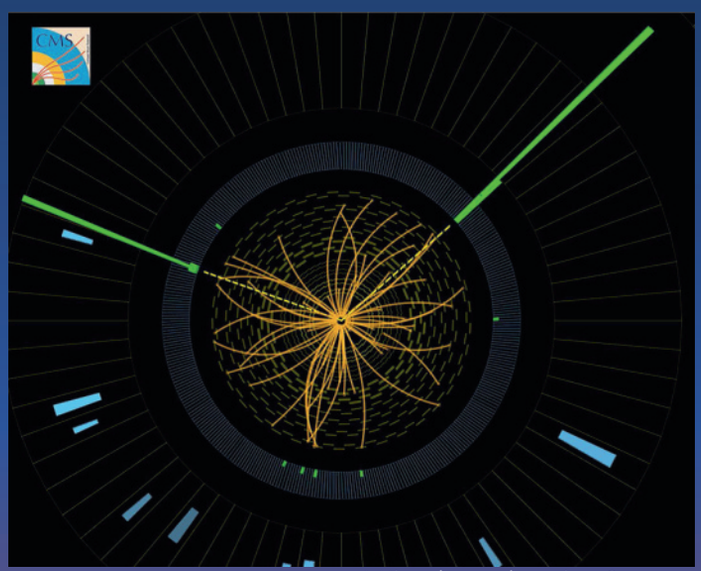
IHEP and its role in WLCG

WLCG gives a community of over 8,000 physicists near real-time access to LHC data, allowing them to collaborate and share their results.

This distributed computing infrastructure is arranged in 'Tiers', called 0, 1, 2 and 3. Each Tier is made up of several computer centres and provides a specific set of services, based on its role in the computation model, which in turn is based on size, characteristics and performance of the site: Tier 0 is the CERN Data Centre which distributes data to 13 major Tier 1 centres around the world which in turn distribute to Tier 2/3 sites. Tier 2s are typically universities and other scientific institutes that can store sufficient data and provide adequate computing power for specific analysis tasks. They handle a proportional share of the production and reconstruction of simulated events.

One of the over 150 Tier 2 computing sites around the world is hosted at the Institute for High Energy Physics (IHEP) in Beijing, actively involved in the computing for the ATLAS and CMS experiments. Specifically for ATLAS, the site has the status of "Tier2 Direct", meaning it belongs to a restricted set of best-performing Tier 2s, in terms of reliability and analysis performance, which are able to distribute to other Tier 2 and Tier 3 sites and to download from any Tier 1.

ORIENTplus, the high-speed research Internet link between Europe and China, is fundamental in IHEP's contribution to the LHC experiments. Thanks to its 10 GB connection to China Science and Technology Network (CSTNeT) and its access to ORIENTplus and other regional and national research and education networks, IHEP is able to be an important player in the WLCG and, by extension, to contribute to shedding light on fundamental questions in physics.



A Higgs boson decay into 2 protons

"IHEP has a long history of extensive cooperation with the high energy physics communities in Europe, the US and Japan, in particular with CERN, INFN, DESY, CNRS, RAL, KEK and PLS. IHEP hosts the BESIII and the Daya Bay Collaborations with the participation of hundreds of scientists from dozens of countries, and also hosts the Sino-Italian Cosmic Ray Collaborations in Tibet. For all these international projects and experiments between China and Europe, especially ATLAS, CMS, DayaBay, ORIENTplus is no doubt the internet accelerator to speed things up!"

Gongxing Sun, Professor and Deputy Head of Computing Center, Institute of High Energy Physics (IHEP)

ORIENTplus – linking China and Europe

- dedicated internet link interconnecting the research and education communities of China and Europe;
- links CERNET (China Education and Research Network) and CSTNET (China Science and Technology Network) with the pan-European GÉANT network via super-fast connectivity between London and Beijing;
- jointly funded by the European Commission through its 7th Framework Programme, the European NREN partners and the Chinese government until 2014;
- at 10 Gbps, the highest capacity link and the shortest network path between the two regions;
- in use by more than 25 substantial, bandwidth-hungry, data intensive collaborations, including participation in the Large Hadron Collider (LHC) studies, Shanghai Astronomical Observatory and genome projects.

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To learn more about ORIENTplus visit:
http://www.orientplus.eu