CASE STUDY

Linking European and Chinese Research Infrastructures and Communities

ORIENT plus

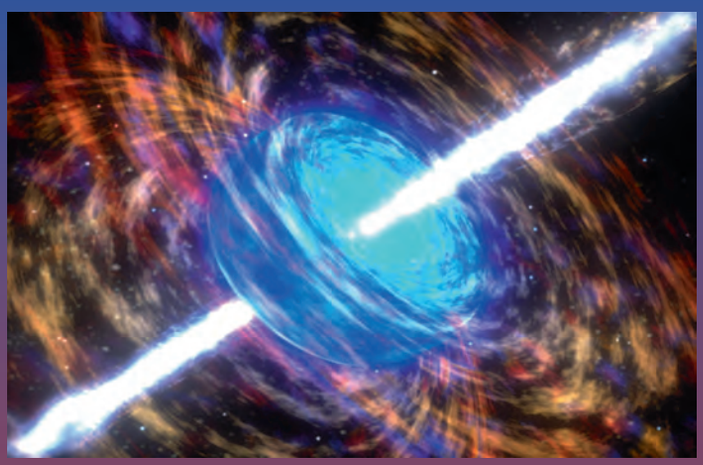
High speed networking: global collaboration, cosmic results

ORIENTplus – a high-speed cross-continental internet link dedicated to the research and education communities – is helping European and Chinese scientists study one of the most puzzling phenomena known to science.
About once a day, the sky is lit up by a brilliant flash of energy. These are gamma-ray bursts – violently energetic eruptions of high-frequency electromagnetic radiation, caused predominately by the explosion of massive stars in distant galaxies billions of light-years away. Understanding these striking phenomena is data-intensive work and calls for a joint effort between scientists across the world. ORIENTplus, a high-speed gigabit link bringing together scientists in China and Europe, is essential for this type of bandwidth-hungry collaborative research.

Understanding 'cosmic showers'

A gamma-ray burst occurring near our solar system could compromise life on our planet. But the possibility of such an event is vanishingly small, with every burst so far detected occurring at cosmological distances, very far indeed from our galaxy.

This research is not solely about revealing the deep mysteries of the universe and particle physics for its own sake. When the cosmic rays – or indeed any solar disturbances, such as magnetic storms and flares – react with the atmosphere they become 'cosmic showers'. These showers are suspected of a role in cloud formation and climate change, as well as being responsible for radiation exposure amongst air crews and passengers on long-distance high-altitude routes. They can seriously damage the sensitive electronics on-board the large number of satellites circling our planet – responsible for important communications and geo-monitoring. There are clear practical benefits in understanding how these showers affect the world around us.



Artist's impression of a gamma-ray burst (NASA / SkyWorks Digital)

Since the massive explosions were first observed in the 1960s, scientists have been struggling to fully understand these exotic events. Using a variety of sophisticated technologies, astroparticle physicists have been gradually laying bare the details of this fundamental process of nature.

China and Italy: connecting, collaborating

One of the latest of these initiatives is the ARGO – YBJ project (Astrophysical Radiation with Ground-based Observatory at YangBaJing), a collaboration between the National Institute of Nuclear Physics (INFN) in Italy and the Institute of High Energy Physics (IHEP) of the Chinese Academy of Science.

As with all research in astrophysics, studying gamma-ray showers produces terabytes of data every year. Only research networks can provide the extremely stable, high-capacity connections necessary for the reliable transfer of these large volumes of data in real time from where the data is collected, to where it is analysed.

This Sino-Italian collaboration began at the end of the 1990s. In its early days, data from the telescope had to be recorded on tapes and dispatched to processing centres using buses and planes. A dramatic improvement in this slow and clumsy transfer method has come about with the arrival of high-speed data communications in the shape of ORIENTplus (and its predecessor ORIENT) and of Sino-European computing collaboration through a computing grid, Euchinagrid. These two developments allow transfer and collaboration in real-time, with data now routed the shortest and fastest way rather than taking a lengthy and uncertain route to its destination in Europe.

The project observes showers of cosmic rays and analyses them. To ensure that showers can be detected without the undue influence of the atmosphere, the ARGO – YBJ telescope was installed at high altitude; siting the facility any lower on the Earth's surface would result in the denser atmosphere absorbing the showers completely. At the same time, more of the radiation's primary features – before it interacts with the atmosphere – can be observed with great precision.

The Challenge

To meet ARGO-YBJ's mission to improve understanding of cosmic radiation, based on data-intensive collaborative research between astrophysicists in China and Italy.

The Solution

Through its connection to CSTNET (China Science and Technology Network), scientists at the ARGO-YBJ telescope facility in Tibet are able to access the high-speed cross-continental ORIENTplus link and the GÉANT network to continuously and seamlessly transfer huge quantities of data in real-time to INFN-CNAF, a dedicated computing centre for high-energy physics experiments in Bologna, Italy, connected to GARR, the Italian research network.

Key Benefits

The power of ORIENTplus has been harnessed as an essential element in enabling a cutting-edge international scientific collaboration between physicists in a remote Tibetan location and in Italy, aimed to provide insights into the mysteries of the universe.

The ARGO-YBJ sensors continuously gather information on these cosmic showers – as well as on many other constituents of the atmosphere (radon, electric fields, aerosols) and monitors the arrival of magnetic storms that have the potential to cause havoc to human civilisation. The remote sensing incorporated in ARGO-YBJ can provide real-time, direct access to this information.

The name ARGO comes from Greek myth. Argus Panoptes (Argus the all-seeing) was a giant with a hundred eyes, and he was always wakeful and alert. He is a fitting inspiration for a device with thousands of 'eyes', constantly scanning the sky for evidence of cosmic radiation.

Science in action: ARGO-YBJ

Inaugurated in 2001, the detection equipment is located in the YangBaJing laboratory on the Tibet plateau, at around 4,300 metres above sea level – meaning that the radiation has to travel through less than 60% of the earth's total depth of atmosphere before it reaches the equipment. At the same time, the location – in a remote and largely uninhabited place – guarantees low pollution, and a climate both stable and predictable, important considerations for work of this kind.

Professor Cao Zhen, the Chinese spokesman for ARGO-YBJ, is in no doubt about the contribution of ORIENTplus to this project:

"*International collaboration between scientists is the only way to achieve a project like this and ORIENTplus makes that a reality for us. We maintain and operate the telescope facility – and all the processing takes place in near-real time thousands of miles away. We are about to launch other exciting projects and both us and our partners in Europe will greatly benefit from the reliable connection offered by ORIENTplus.*"

The installation consists of a 5,700 sq metre array of very sensitive detectors developed and produced in Italy, allowing the collection of a wide range of data. The showers arrive at unpredictable times, so the facility has been designed to capture data continuously. At the same time, the detector array is 'wide-angle' – capable of viewing a large portion of sky. These two design factors result in the capture of a continuous flow of huge volumes of data – a key factor in the decision to deploy a high-capacity link for the vital task of transferring the data and enabling real-time, remote collaboration.

Professor Benedetto D'Ettorre Piazzoli – former Vice President of the National Institute of Nuclear Physics (INFN) in Italy – is the Italian spokesman of the ARGO-YBJ collaboration. He is clear about the importance of ORIENTplus to his project:

"The only places in the world where we can site the telescope are remote and difficult to work in. So we need to be able to transfer terabytes of data every year from the telescope to the processing centre in Italy for analysis and study. It used to be that the only way of doing this was to get our scientists to fly to Italy with suitcases full of data tapes - hardly cutting edge science! Stable, high-capacity networks are therefore absolutely fundamental to our success. ORIENTplus fits the bill and is, frankly, a godsend. Without it, carrying out this research would be nothing more than a scientist's pipe-dream. We have recently upgraded the telescope and we are now producing outgoing traffic that peaks at over 100 Mbps - and it looks like we are going to be making even higher demands on ORIENTplus in the future."

Cutting edge science on top of the world. Made possible by ORIENTplus
(Image courtesy of Cristian Stanescu, INFN)

Revealing the secrets of the universe

The YangBaJing Laboratory is connected to CSTNET, the China Science and Technology Network. ORIENTplus is the essential link between CSTNET and the pan-European data-communications network GÉANT through which the data is transferred to Bologna, Italy, via its Italian counterpart GARR. The result is a direct link between YangBaJing on a remote Tibetan plateau, and the INFN-CNAF supercomputing centre in the heart of Europe – enabling continuous transfer of some hundreds of terabytes of data every year, and making cost-effective scientific collaboration on this scale a practical possibility.

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

Find out more about ARGO-YBJ from:
http://argo.na.infn.it