



# Particle Physics: Global collaboration to find the God Particle

The TEIN network enables researchers in Pakistan to join the hunt

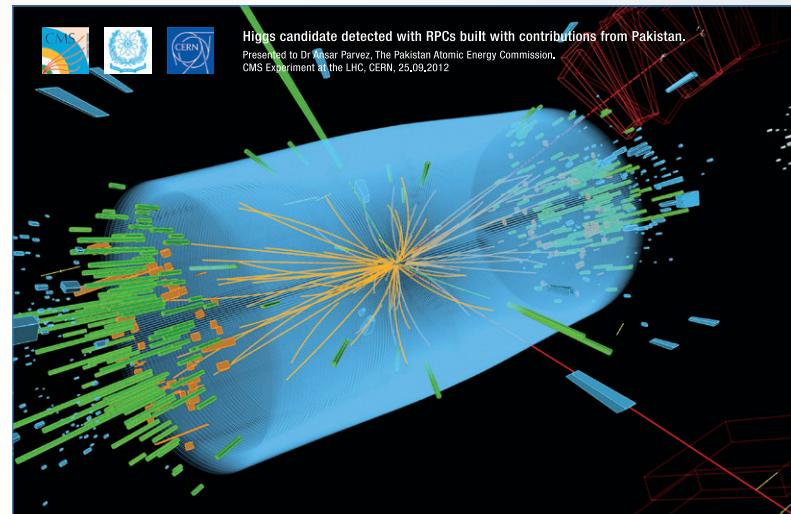
Through CERN's Large Hadron Collider (LHC) experiment, the global particle (or high-energy) physics community is helping us better understand the fundamental laws of nature. Collaboration is at the heart of the LHC project with researchers from across the globe, including those at Pakistan's National Center for Physics (NCP), involved in this ground-breaking experiment. High speed research networks, such as TEIN in Asia-Pacific and its European counterpart GÉANT, are essential to underpin this collaboration, enabling sharing of the petabytes of data created at the LHC, allowing physicists to work together, wherever they are based.

## The hunt for the Higgs Boson

Particle physics focuses on the study of the smallest subatomic particles and how they interact. At the forefront of research is the Large Hadron Collider (LHC), the world's largest scientific experiment. Located at CERN in Switzerland, it aims to answer some of the most important questions in particle physics by measuring high speed collisions between particles in its 27km long tunnel. In particular the experiment aimed to discover the elusive Higgs Boson, or God Particle, which is a key component of the Standard Model theory that is believed to explain how the 'Big Bang' created the universe. In July 2012, CERN researchers announced that they had found the Higgs Boson after analysing 2012 data from the LHC. (François Englert and Peter W. Higgs were awarded the Nobel Prize for Physics in 2013 for their theoretical discovery of the God Particle)

## Globalising high energy physics

The scale of the LHC research spans the world, involving thousands of researchers in different countries who collaborate to build the infrastructure and analyse the enormous volume of data that the LHC's experiments produce. Research networks, such as the Pakistan Education



## The Challenge :

Enable particle physicists in Pakistan to collaborate with the global community and participate in the Large Hadron Collider (LHC) experiment.

## The Solution :

By connecting Pakistan's national research and education network to Europe, the high speed TEIN network links the country's scientists to the world, enabling them to analyse LHC data and share their findings with colleagues in other countries.

## Key Benefits :

By enabling research and learning Pakistan's national research network PERN and the regional TEIN network support the developing Pakistani particle physics community, providing the connectivity needed to increase its size and knowledge through high speed global collaboration.



and Research Network (PERN), TEIN in Asia-Pacific and GÉANT in Europe, are central to this collaboration.

Pakistan is a leading member of the global particle physics research community, and boasts Nobel Prize winning scientist amongst its researchers. It has been heavily involved in the LHC, with scientists working together with their counterparts at CERN on the initiative's such as Compact Muon Solenoid (CMS), ALICE and ATLAS experiments.

For CMS, Pakistan built the magnet feet, contributed to the tracker alignment, and created and installed 320 Resistive Plate Chambers (RPCs). The country has also built mechanical components for the ATLAS experiment and a team of Pakistani engineers and technicians is working in the LHC tunnel, helping to increase performance further for future experiments.

Additionally, young and aspiring physicists at the NCP in Pakistan are heavily involved in the analysis of LHC experimental data and the discovery of the Higgs Boson. This participation in global collaboration is helping to accelerate the training of Pakistani research scientists, by enabling graduate students to connect with the worldwide scientific community and work together with other scientists on the challenging questions, without needing to leave the country.



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Without access to LHC data all our efforts to collaborate with CERN will be futile. Given the amount of data LHC can generate, good internet connectivity is vital. PERN and TEIN have helped experimental high-energy physicists within Pakistan to access this data by providing affordable, reliable connectivity. As well as helping build our knowledge, by using this data around 30 graduate students have been able to complete research work, increasing our capacity and skills within Pakistan.

*Prof. Hafeez Hoorani, Director Research of National Center for Physics, Pakistan*



The Trans-EurAsia Information Network (TEIN) project began in 2000 and is now in its fourth phase, TEIN\*, managed by TEIN\*CC. The project has created a high speed network in Asia-Pacific that links local NRENs together, and provides direct connectivity to GÉANT, the pan-European research network, creating a gateway for global collaboration.

## Collaboration powered by global research networks

The LHC generates over 30 petabytes of data every year. This requires the power of high speed research and education networks, working together, to distribute it around the globe and to enable scientists to collaborate on its analysis. Research networks are also vital to educating graduate students and helping to increase the Pakistani particle physics community. This benefits the entire nation and creates a foundation for future growth and scientific excellence.

To transmit data from the LHC to the NCP in Pakistan, it travels across dedicated connections from CERN via the GÉANT network to TEIN. From there a high speed connection routes information to PERN and then to the NCP. The combination of capacity, reliability and high speed research and education networks makes this global collaboration possible, benefiting the entire particle physics community now and in the future.

Building on the legacy of Nobel Prize Winner Abdus Salam, Pakistan has, over the past 20 years, successfully invested in building a small but active and competitive High-Energy Physics community that has made important contributions and is well integrated into several CERN activities. The CERN-Pakistan co-operation was pioneered on the CMS experiment at the LHC, and has expanded continuously to include the ALICE and ATLAS experiments as well as co-operation on accelerator technology, making Pakistan a significant partner for CERN.

*Dr. Rolf Heuer, Director General of CERN*

## For more information:

TEIN: [www.tein4.net](http://www.tein4.net), [www.teincc.org](http://www.teincc.org)  
GÉANT: [www.geant.net](http://www.geant.net)

PERN: [www.pern.edu.pk](http://www.pern.edu.pk)  
National Center for Physics [www.ncp.edu.pk](http://www.ncp.edu.pk)

CERN: [home.web.cern.ch](http://home.web.cern.ch)