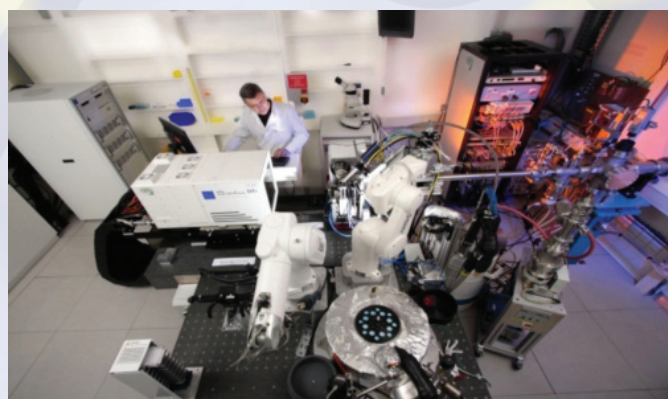


## Collaborative Experiments: Usage of FIP beam line on ESRF Synchrotron remotely from India

With science projects becoming mega science projects such as the Large Hadron Collider, CERN, the requirement of domain specialists, precision scientific instruments and finance has grown so much that some single institutes and countries can ill-afford it. Therefore, it is imperative that "Laboratories will have to become laboratories". While conducting experiments, access to scientific instruments, datasets, software and hardware tools across geographical and administrative boundaries that span many countries is imperative. An environment that virtualizes experiments, data access, data processing & data analysis and also provides seamless access to researchers is the EU-IndiaGrid2 Environment. One such successful step towards realizing this environment has been carried on at ESRF (European Synchrotron Radiation Facility), France, making use of the NKN and TEIN3 infrastructure for Internet connectivity.

Radiation produced in a third generation synchrotron is available in only very few countries. This radiation has been used to determine the three dimensional structure of molecules by crystallography, enabling studies

on structure-function relationships in biological macromolecules and the design of new drugs. The experimental station on the French beam line for Investigation of Proteins (FIP beam line) is dedicated to crystallography of biological macromolecules. The FIP beam line is fully automated and has been enabled for remote access. Under an on-going collaboration, Dr. Jean-Luc Ferrer at IBS (Institut de Biologie Structurale) and ESRF, France, Dr. M.V. Hosur and colleagues at BARC (Bhaba Atomic Research Centre) have collected single crystal X-ray diffraction data by remotely operating the FIP beam line from BARC in India.



## Grid Infrastructures: The worldwide LHC Computing Grid in India

High Energy Physics, through the Large Hadron Collider (LHC) programme, represents one of the unique science and research facilities shared between India and Europe in the field of scientific research in general and in the ICT domain in particular with the Worldwide LHC Computing Grid (WLCG) project. WLCG is the largest grid infrastructure worldwide, created to address the data requirements of LHC (15 million GBytes per year). India has established a regional WLCG Grid network in India with two Tier-2 centres one at the Tata Institute of Fundamental Research (TIFR) in Mumbai for Compact Muon Spectrometer

(CMS) and another at VECC/SINP Kolkata for ALICE (A Large Ion Collider Experiment) plus a number of Tier-3 centres at various Indian universities and of the Indian Department of Atomic Energy (DAE) aided institutions. The migration of WLCG connectivity to NKN in India and the establishment of the 2.5 Gbps TEIN3 link interconnected to NKN provide a substantial burst to the activity of Indian LHC research community allowing these researchers full access to LHC data and widening their possibilities to contribute to the ambitious physics goals of the LCG program.



## TEIN3 and EU-IndiaGrid2: e-Infrastructures building European and Asia-Pacific research collaboration

Increasingly, researchers in India require access to the best modern communications technologies. They are part of a spectacular growth in e-Science – international scientific collaborations requiring substantial bandwidth and computing power. This dimension to the world of research and education helps build a national knowledge base that can help close the digital divide, potentially countering the loss of highly qualified researchers and delivering research to benefit society more quickly and efficiently.

The development of Grid Computing has gone hand-in-hand with advances in global computing connectivity and also e-Infrastructures - innovative research environments in which researchers, whether working in the context of their home institutions or in national or multinational scientific initiatives, have shared

access to unique, distributed scientific facilities including data, networks, tools and computing resources.

A series of European initiatives are involved in deploying and operating the European-wide e-Infrastructure. These initiatives cooperate with national programs at European and extra-European level. EU-IndiaGrid2 supports and fosters collaboration between researchers from Europe and India in a wide range of scientific areas.

Global networks are the glue that hold together scientific research communities around the world. Networks such as GÉANT (The Pan-European Education and Research Network), TEIN3 (The Trans-Eurasia Information Network) and the NKN (National Knowledge Network of India) are all key to this process.

**TEIN3** is the only internet network in the Asian region dedicated to research and education capable of satisfying the intensive computational needs of these demanding users.

**GÉANT**, the largest research and education network ever built for the European academic community enables linking of European Grids: EGEE & WLCG with Indian Grids: Regional WLCG and National Garuda pushing forward collaborative research in areas such as high energy physics, climate change, life sciences, biosciences.

**NKN**, the Indian National Knowledge Network, connects all institutions engaged in research, higher education and scientific development in the country to enable the use of specialised applications, which allow the sharing of high-performance computing facilities.

*"The successful working of the initial phase of the multi-gigabit National Knowledge Network (NKN), Indian Certification Authority, and participation in TEIN3 are some of the important building blocks for supporting virtual research communities in India and their collaboration work with other countries."*



Dr R. Chidambaram,  
Principal Scientific Advisor  
Government of India



# EU-IndiaGrid2 & TEIN3 linking e-Infrastructures across Europe and India



## EU-IndiaGrid2 Sustainable e-infrastructures across Europe and India

Interoperability and interoperation between the major European and Indian Grid infrastructures (EGI, and GARUDA respectively), is a crucial step towards establishing a cross-continent Grid infrastructure, fostering evolution to ensure sustainable scientific, educational and technological collaboration. EU-IndiaGrid2 is paving the way for a "seamless" global integration of Grid infrastructures. With 14 Garuda sites currently connected to the NKN including two LHC computing sites in Mumbai and Kolkata development in building collaborative research communities is advancing well.

*"The main objective of the EU-IndiaGrid2 project consists in enhancing and increasing the cooperation between European and Indian e-Infrastructures for the benefit of EU-Indian collaboration in e-Science. In this respect exploiting major Indian and European e-Infrastructures, such as NKN and GÉANT, as well as the interconnection provided through TEIN3 represents a capital achievement for the project activity".*

*Alberto Masoni, Director of Research at INFN - the Italian National Institute of Nuclear Physics & EU-IndiaGrid2 Project Manager.*

## TEIN3 - Trans-Eurasia Information Network

The third generation of the Trans-Eurasia Information Network (TEIN3) provides a dedicated high-capacity Internet network for research and education communities across Asia-Pacific. TEIN3 already connects researchers and academics in China, India, Indonesia, Japan, Korea, Laos, Malaysia, Nepal, Pakistan, the Philippines, Singapore, Sri Lanka, Thailand, Vietnam and Australia. Bangladesh, Bhutan and Cambodia are in the process of getting connected, bringing the total number of partners involved in TEIN3 to 18. With direct connectivity to Europe's GÉANT network, TEIN3 offers Asia-Pacific a gateway for

global collaboration, enabling over 45 million users at more than 8000 research and academic centres to participate in joint projects with their peers in Europe and other parts of the world.

*"TEIN3 provides high capacity connectivity to Europe and across Asia that helps bring together the world's largest regional research and educational community. Via TEIN3 we see India playing an increasingly major role in European and Asian co-operative programmes".*

*David West,  
TEIN3 project manager, DANTE*

## Grid cooperation in numbers

**4** TEIN3 PoPs in Asia

Over **45** million Asian users connected to TEIN3

**18** TEIN3 partner countries in Asia and Oceania

**8000** research and academic centres enabled to use TEIN3 gateway

Over **80** million potential users thanks to the direct links to GÉANT

**57** Indian R&D Labs and educational institutes connected at 1000 Mb/s up to April 2009 in the initial phase

**14** Garuda sites currently connected to the NKN

**15** Indian Universities in an around Chennai linked through NKN as core locations

Over **60,000** km of optic fibre cables across south India alone

**502** premier institutions will be on NKN by August 2011

## National Knowledge Network

India's National Knowledge Network (NKN) is a high capacity countrywide Infrastructure to support education and research applications requiring high bandwidth in Science, Technology, Higher Education, Healthcare, Agriculture and Governance, using a multi-gigabit platform to connect 1500+ institutions in India to each other and to the rest of the world. The network consists of an ultra-high speed core starting with multiple 2.5/10G and moving towards 40/100 Gbps. NKN aims to facilitate the creation, acquisition and sharing of knowledge resources among the large participating institutions, collaborative research and countrywide classrooms (CWCR) and help the country to evolve as a Knowledge Society.

*"The NKN is a significant step towards ushering a knowledge revolution in the country and poses a challenge to the ways we think and work. Technology is an enabler but efforts beyond that are required to inform, educate and empower people of the country"*

*Kapil Sibal, Union Minister for Communication and Information Technology (C&IT)*