Express Production Real-time e-VLBI Service
The Next Generation of Very Long Baseline Interferometry

Radio astronomers, network engineers and software designers are pushing the boundaries of radio astronomy through the development of electronic, real-time VLBI, known as e-VLBI.

The goal of EXPReS is to create a production-level, real-time, electronic VLBI service in which up to 16 intercontinental radio telescopes are simultaneously and reliably connected to the central data processor of the European VLBI Network (EVN) at the Joint Institute for VLBI in Europe (JIVE). With an aggregate data flow of up to 16 Gbps into the central processor, EXPReS aims to create a robust e-VLBI infrastructure of continental and inter-continental dimensions. This provides a unique facility to generate high-resolution images of cosmic radio sources in real-time.

Furthermore, EXPR*eS* seeks to design and prototype elements of the hardware, software and data transport services required to support future e-VLBI facilities in which the net VLBI data flows will be hundreds of Gbps. Research into future correlators focuses on deploying the data collection on wide-spread, Grid-based computing resources.

EXPReS and e-VLBI

The 19 astronomy institutes and national research networks involved in EXPR*eS*, Express Production Real-time e-VLBI Service, are working together to connect radio telescopes across the globe via high-speed optical networks. This astronomical technique is called real-time, electronic very long baseline interferometry, or e-VLBI.

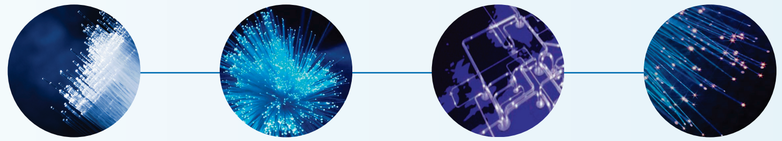
VLBI Technique

Using VLBI, widely separated radio telescopes simultaneously observing the same region of sky can generate very high-resolution images of cosmic radio sources. The detail with which VLBI can image bright radio sources is unsurpassed in astronomy and can be one hundred times better than the resolution of the best optical telescopes. The technique also has practical applications in geodesy (measurement of movements of the Earth's surface and variations in the Earth's rotation rate) and has recently been used in precision spacecraft navigation.

e-VLBI improves on traditional VLBI techniques

Since VLBI telescopes are usually separated by many hundreds of kilometres, data from each telescope is digitally sampled and, traditionally, stored locally on high-capacity computer disk arrays. These disks are physically transported to a central data processor, a supercomputer built for this purpose, where the data from each telescope are decoded, accurately aligned and then correlated for every possible telescope combination.

The total flow of data into the central processor is up to hundreds of Terabytes per observation and is reduced by an order of magnitude after processing. After initial calibration, the reduced data set is handed over to the astronomer, who generates images from the data for further astrophysical analysis.



e-VLBI: Improving Technique

The process of shipping disks is elaborate and expensive, and it can take weeks for the data to arrive at the correlator. Using e-VLBI, however, telescopes send the data over optical networks, allowing it to be correlated in real-time and effectively creating a connected-element interferometer of intercontinental dimensions.

Improved Technique, Improved Science

The increased reliability, robustness and flexibility of this real-time instrument will provide a "target of opportunity" science capability, enabling astronomers to do rapid follow-up observations of unexpected events such as supernova explosions and gamma-ray bursts, but will also be of great importance for high precision tracking of space probes. Moreover, the expected growth of internet bandwidth will lead to significant increases in sensitivity, enabling observations of fainter astronomical sources.

Telescopes Participating in EXPReS