

REAL-TIME ASTRONOMY: THE SARDINIA RADIO TELESCOPE IS NOW CONNECTED AT HYPER-SPEED

The data of Sardinia Radio Telescope, the most modern and technologically advanced satellite dish in Europe, built by the National Institute of Astrophysics in collaboration with the Italian Space Agency, are now available in real-time for the worldwide community of astrophysics.

In the first weeks of 2018, Sardinia Radio Telescope (SRT) was interconnected to the ultra-broadband of the Italian Research and Education network and to the international GÉANT network thanks to a 107-km-long optical link. Soon after the link went operational, the radio telescope proved its capacities, in a joint observation carried out on 27 February using the VLBI technique (see box on opposite page), which implies having antennas distributed all around the globe to function together as if they were a single dish as large as the distance that separates the individual antennas. It was not the first time SRT was used in a VLBI observation, but it was the first time with SRT equipped with optical fibre. In a few weeks an even more important test called e-VLBI will be carried out: this time a correlation of real-time observational data will be attempted from many parts of the world simultaneously.

A very advanced infrastructure, now connected to the world

The scientific community had been waiting for this moment for years, as the SRT is one of the most powerful and advanced research infrastructures for the study of radio emissions from

celestial bodies and for applications of geodynamics and space sciences. Its adjustable satellite dish is the largest of the three Italian antennas and close to the world's top with 64 metres in diameter. What makes it truly exceptional is the cutting-edge technology that ensures high efficiency in very high-frequency observations. Thanks to a complex system of high precision actuators controlling the 1,000 panels of the antenna, the SRT is in fact able to re-shape its surface to compensate for thermal, gravitational and wind variations, thus achieving levels of accuracy much higher than the old-concept infrastructures. In addition, SRT is able to quickly change the receivers and therefore can move to observations of very different frequencies in the timespan of a few minutes.

"We are very proud of the connection of SRT to our network - said GARR Director, Federico Ruggieri, because we have worked many years to achieve this goal. Once again, the joint commitment between various actors, both institutional and academic, has played a fundamental role in making the most out of this very important national research infrastructure. Thanks to the network connection, SRT can now finally express its full potential and thus make a significant Italian contribution to the big international collaborations".

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The SRT is home to scientific instruments and services of both INAF and ASI: in fact, as well as in radio astronomy research, the parabola is used in monitoring and communicating with interplanetary probes, including Rosetta in 2015 and, more recently, Cassini.

Building a research infrastructure of such complexity took twelve years, from the laying its foundations in 2001 to the inauguration, which took place in 2013. From that moment, the astronomical validation started, and the observations. However, the absence of a high-capacity link has led to the inability to use data in real-time, a fundamental feature to ensure the highest possible accuracy of the data from the detectors. SRT is located in the province of Cagliari, in the region of Gerrei at the site of Pranu Sanguni (Municipality of San Basilio), chosen precisely because located far away from inhabited areas and other human activities, that would interfere with the signals picked up by the infrastructure. To connect it, it was therefore necessary to lay an ad-hoc

fibre for over 100 km. This was made possible thanks to the commitment of the Sardinia Region, which was on the front line in supporting this project from the outset. It provided funding for the construction of the infrastructure as well as for technological development activities and training.

The fibre link makes a big difference

The ultra-broadband link made possible the first real-time observations from SRT, making a huge leap forward in the use of this infrastructure. Until now the data of the observations were recorded on disks that had to be either transmitted on a 256 kbps satellite link or physically transported to the INAF astronomical observatory in Cagliari and from there sent to the processing centres. In addition, the benefits in simplifying data management and in facilitating data protection against accidental loss, the fibre optic connection enables the

correlation with other infrastructures for joint observations and the calibration and immediate correction of errors, an aspect that can really make a difference, considering the uniqueness of many astronomical events.

The optical link has the capacity of 1 Gbps and enables the interconnection of the dish to the entire international NRENs, thanks to the link with the European high-capacity backbone GÉANT. By this summer, the connection will be further expanded up to 10 Gbps, to ensure maximum performance and accuracy of observations. Thanks to the quality of the line, the overall signal attenuation on the 107 km section is low, so as to enable the transmission of the optical signal without the need for intermediate amplification, therefore with higher levels of service.

With this link, the SRT can also be used together with other Italian infrastructures, in particular with the two radio telescopes of Noto and Medicina (Bologna) and also with the European and global ones, through the e-VLBI network.

E-VLBI: Astronomical data in real-time

The VLBI technique (Very Long Baseline Interferometry) allows to combine the simultaneous observations of different radio telescopes, emulating a telescope with a size equal to the maximum separation between the telescopes. In this way, the more the antennas are distant, the greater the virtual radio telescope obtained and the resulting data resolution. In the case of the e-VLBI (electronic-VLBI), thanks to the ultra-broadband link, the observations are also made immediately available to the astronomers, without any delay for the reconstruction of data.