

Observatorio Astronómico Nacional – Yebes

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Abstract

This report updates the description of the OAN facilities as an IVS network station. The construction of the new 40-meter radiotelescope is nearly completed. The new S/X receiver will be installed in 2006. The co-location of geodetic techniques available at Yebes, with the VLBI antenna, the GPS receiver (IGS station), and the new installation of a gravimeter, will allow to become a Fundamental Geodetic Station. The institute staff is also involved in technical developments, and scientific research in geodesy, astrometry and astrophysics.



Figure 1. The new 40-m radiotelescope of OAN at Yebes, for geodetic and astronomical VLBI.

1. General Information: The OAN Facilities

The Observatorio Astronómico Nacional (OAN) of Spain, which is a department of the Instituto Geográfico Nacional (IGN, Ministerio de Fomento), operates a 14 meter radiotelescope at Yebes (Guadalajara, Spain). This facility has been a network station of the IVS until 2003, and has participated regularly in the geodetic VLBI campaigns to study the tectonic plate motions in Europe, Earth rotation, and pole motion.

The construction of a new 40 meter radiotelescope is nearly completed in Yebes (see Fig. 1). A new S/X receiver will be installed in 2006, in order to resume geodetic VLBI observations. The VLBI equipment has been constantly upgraded (including Mark 5A) and is fully operational.

2. OAN Staff Working in VLBI Projects

Table 1 lists the OAN staff who are involved in VLBI studies, some of which can be found at the telescope (CAY) address. The Associated Members of IVS are indicated with an asterisk. The VLBI activities are also supported by other staff like receiver engineers, computer managers, secretaries and students.

Table 1. Staff in the OAN VLBI group (Email: vlbitech@oan.es).

Name	Background	Role	Address
Francisco Colomer*	Astronomer	VLBI Project coordinator	OAN
Jean-Francois Desmurs	Astronomer	Scientist (Astrophysics)	OAN
Jesús Gómez-González*	Astronomer	General Subdirector for Astronomy, Geodesy and Geophysics	IGN
Maria Rioja*	Astronomer	Scientist (Astrometry)	OAN
Pablo de Vicente*	Astronomer	VLBI Technical coordinator	CAY

3. Status of the Geodetic VLBI Activities at OAN

3.1. VLBI

The main contribution of OAN to IVS is the realization of geodetic VLBI observations: the OAN 14-m radio telescope at Yebes has however not participated in any VLBI campaigns since December 2003 due to the failure of the very old telescope control computer (HP1000).

Nowadays most of the activities are focused on the construction of the new 40-m radiotelescope. The system consists of several mirrors that direct the beam from the Nasmyth mirrors to the receivers. Up to seven frequency bands can be supported: S, X, C, Ku, 22 GHz and 30 GHz. This configuration allows simultaneous observations with at least two receivers. The new S/X band receivers will be ready in the laboratory in the summer of 2006.

The Mark 5A system has been inserted on a new rack which also contains a transformer for the Data Acquisition Rack. The VLBA recorder has been deprecated and for the time being is stored apart. The station is now Mark 5-only.

The hydrogen source of the Kvarz CH1-75 maser has been replaced, which should allow optimum performance during the next years.

The weather station has been replaced by a new one with better resolution and which also provides wind speed and wind direction. This station is better placed since it is far from any building.

Table 2. Number of geodetic VLBI sessions in which Yebes has observed (1995-2003),

Experiment type	CORE-B	EUROPE	IVS-T2
Number of Sessions	13	21	5

3.2. GPS

The GPS station at Yebes, established in 1999 and run by IGN, is the reference point of the Spanish fiducial network since 2002. In 2004, it was integrated in IGS with code ‘YEBE’.

In 2001, a new analysis center for EUREF was set up by IGN in Madrid (‘IGE’). It processes 30 stations from Spain, Portugal, Morocco, France, UK, among others. This is one of 15 EUREF LACs.

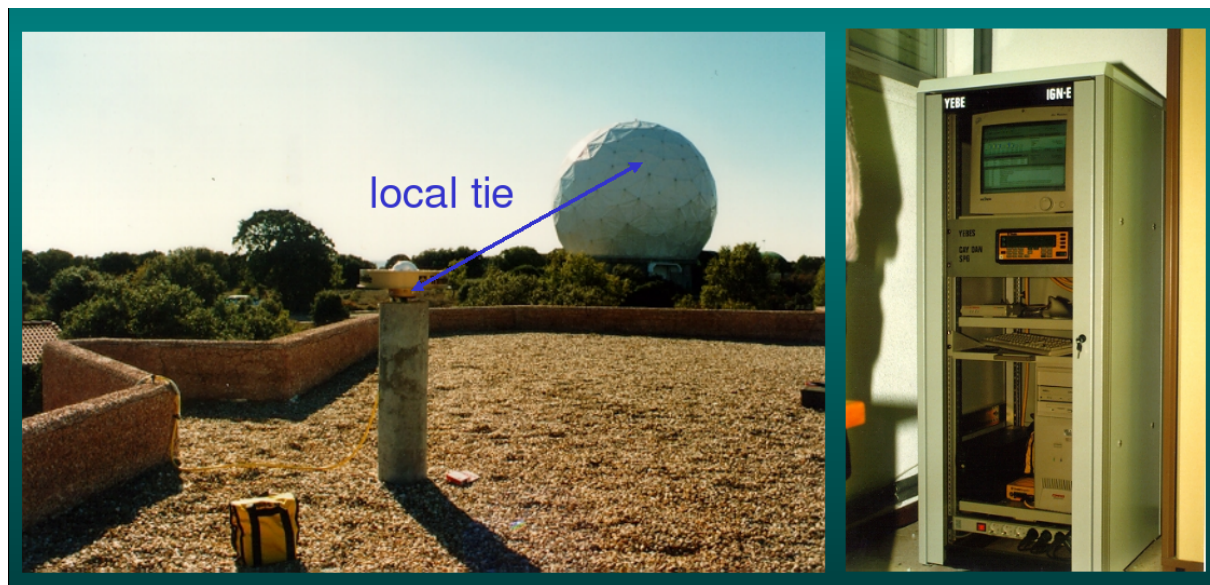


Figure 2. The IGS station “YEBE”.

3.3. Research

The OAN group performs high precision astrophysical VLBI studies of maser emission towards late-type stars, which will not be discussed here. However we point out that we have modified the Astronomical Image Processing System (*AIPS*) to allow the processing of full polarization data on antennas with Nasmyth optics. Similar developments will be needed if full polarization is to be used in geodetic VLBI, following the VLBI2010 project.

The OAN group is working on a new method, *Source/Frequency phase referencing*, to measure frequency-dependent position shifts of source cores with high accuracy. The first successful application to measure the core shift of the quasar 1038+528 A at S and X-bands has been reported, and the results have been validated by comparison with those from standard phase referencing techniques (Rioja et al. 2005). The method is an extension of the technique developed and demonstrated by Middelberg et al. (2005), that uses fast frequency switching observations and relies on the transfer of calibration from the lower to the higher frequency. Our new proposed method endows it with astrometric applications by adding a strategy to calibrate the ionospheric contribution. We foresee that it holds a big potential at high frequencies, in particular when applied to observations of molecular line emission. In geodesy too, the unaccounted source core shifts introduce errors in the estimated ionospheric-free observables, and hence on the astrometric/geodetic

products from the analysis.

4. Future Plans

We expect first-light on the new 40 meter radiotelescope at Yebes in 2006, after the construction and commissioning are finished. The telescope is expected to be operational at S/X bands by the end of 2006 or early 2007. Other frequencies of operation will be 4-7 GHz, 10-15 GHz, 21-24 GHz (first light receiver), 30-32 GHz, 40-50 GHz, and 72-116 GHz. Connection of this telescope to GEANT (1 Gbps fiber optics link) is progressing within the frame of the EXPreS EU project. The measurement of the 40-m phase-center and local-tie to the 14-m telescope and the GPS antenna will also be performed in 2006.

On the other hand, measurements of absolute gravimetry at the 14-m telescope building have already been performed. A project of construction of a building is being finalized, which will allow the installation of permanent equipment for constant gravity monitoring.

Collocation of geodetic techniques (40-m VLBI radiotelescope, GPS receiver in IGS station, and gravimeters) will allow Yebes to become a Fundamental Geodetic Station in the coming years.



Figure 3. Artistic impression of the gravimeter building in Yebes (center), with sketch of the possible location (right) of the gravimeters (left).

References

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- [2] Middelberg, E., Roy, A. L., Walker, R. C., Falcke, H. “VLBI observations of weak sources using fast frequency switching”. *Astronomy & Astrophysics* **433**, p. 897-909 (2005)
- [3] Rioja, M.J., Dodson, R., Porcas, R.W., Suda, H., Colomer, F. “Measurement of core shifts with astrometric multi-frequency calibration”. *Proceedings of the 17th Working Meeting on European VLBI for Geodesy and Astrometry, Noto (Sicily, Italy)*, p. 125-130 (2005)