

# Instituto Geográfico Nacional of Spain

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**Abstract** The National Geographic Institute (IGN) of Spain has been involved in space geodesy activities since 1995. Since 2008, the new 40-m radio telescope at Yebes Observatory has been a network station for IVS and has participated regularly in IVS campaigns. Currently, IGN is involved in the establishment of an Atlantic Network of Geodynamical and Space Stations (project RAEGE). The first antenna, at Yebes Observatory, has been completed. The construction of its first receiver (triband, S/X/Ka) has been finished and is ready to be installed at the telescope. Moreover, the erection of a second antenna of RAEGE (in Santa Maria, Azores islands, Portugal) is almost complete. In order to comply with the VGOS specifications, a new broadband receiver is being developed at Yebes and is expected to be available for observations in 2015.

## 1 General Information

The National Geographic Institute of Spain (Instituto Geográfico Nacional, Ministerio de Fomento), has run geodetic VLBI programs at Yebes Observatory since 1995, nowadays operating a 40-m radio telescope which is a network station for IVS. Yebes Observatory is also the reference station for the Spanish GNSS network and holds permanent facilities for gravimetry. A new VLBI2010-type antenna has been built in

1. Instituto Geográfico Nacional (IGN)

2. IGN Yebes Observatory

3. Secretaria Regional da Ciência, Tecnologia e Equipamentos (Azores, Portugal)

IGN-Yebes Network Station

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Yebes as part of the RAEGE project (the acronym RAEGE stands for “Red Atlántica hispano-portuguesa de Estaciones Geodinámicas y Espaciales”).

## 2 Current Status and Activities

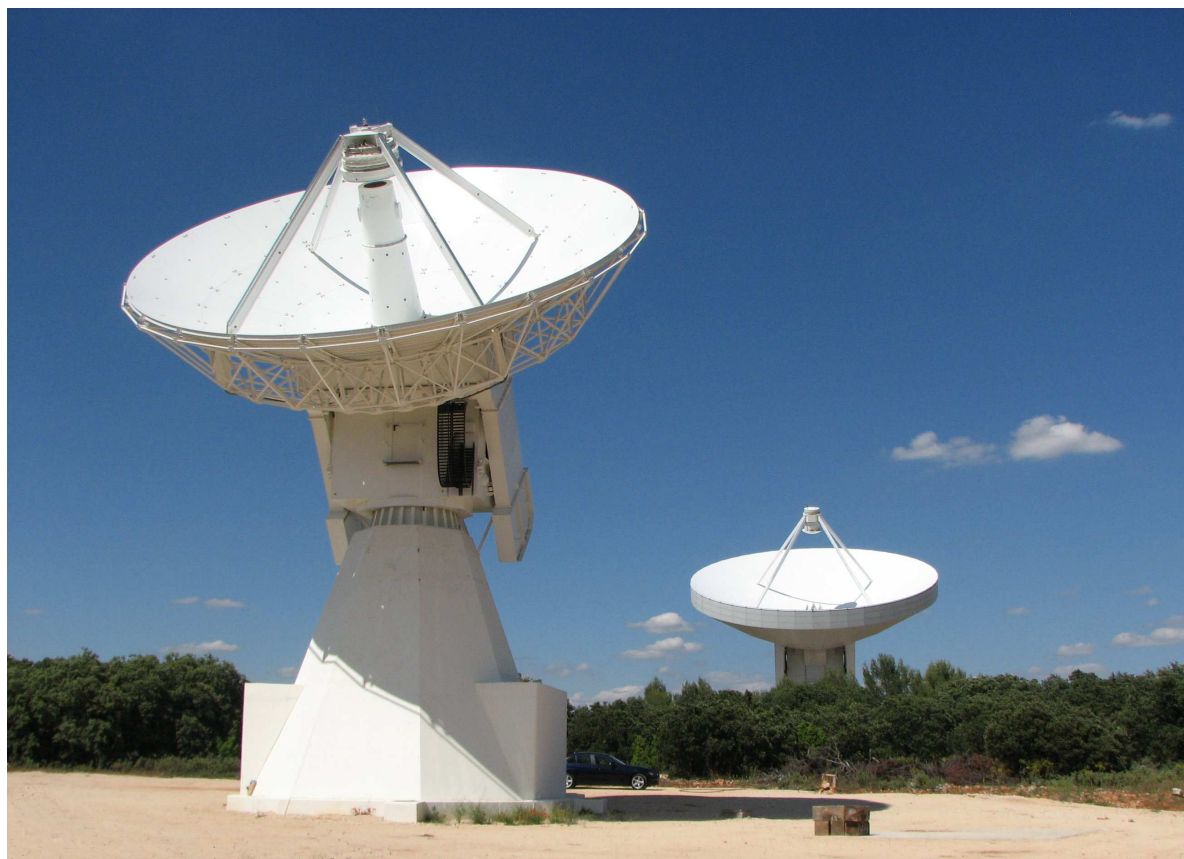
The 40-m radio telescope has participated in 35 sessions (17 R1, 13 R4, three T2, and two EUROPE). All the data is being routinely transferred by Internet to the correlators.

We have purchased 64 Tb of Mark 5 disks to support our participation in the IVS CONT14 campaign.

### 2.1 RAEGE

IGN, together with the Portuguese colleagues in DSCIG (Azores Islands), continues the construction of a network of four new Fundamental Geodynamical and Space Stations. The RAEGE project was described in previous IVS Annual Reports. The Spanish-Portuguese VGOS network RAEGE will be covering three continental plates with sites in Spain at Yebes (Eurasian Plate) and Tenerife (African Plate) and in Portugal on the Azorean islands of Santa Maria (Eurasian Plate) and Flores (North American Plate).

On October 21, 2013, the first VGOS radio telescope of the RAEGE Project was inaugurated in Yebes by the Spanish Minister of Development, D<sup>a</sup> Ana Pastor, and the President of the Regional Government of Castilla-La Mancha, D<sup>a</sup> María Dolores de Cospedal. Both officials unveiled a bronze dedication plaque with the name “Jorge Juan” for the new radio telescope



**Fig. 1** RAEGE first radio telescope, “Jorge Juan”, at Yebes Observatory. In the background, the 40-m radio telescope which currently participates in all IVS campaigns.

(see Figure 2). Jorge Juan was a Spanish Admiral and cosmographer who participated, together with LaCondomine, in the 18<sup>th</sup> century expedition to Peru (now Ecuador) to measure the length of a degree of latitude at the equator and check the polar flatness of the Earth. After his return, the Spanish King Carlos III entrusted him with founding the Royal Observatory in Madrid (ROM, in 1757); today the observatory is part of the Instituto Geográfico Nacional, which – through ROM – is also the host institute of the Yebes Observatory. The “Jorge Juan” radio telescope, designed by MT Mechatronics GmbH and mostly built by Spanish companies, will be fully dedicated to geodetic VLBI. The instrument is the first of four very fast RAEGE telescopes that will be fully VGOS compliant (see Figure 1).

It will be shortly followed by the antenna in Santa María (Azores, see the status of the onsite works in Figure 3 and the control building in Figure 4), whose first light is expected in early 2015.



**Fig. 2** Bronze dedication plaque for the RAEGE “Jorge Juan” radio telescope, unveiled on October 21, 2013 by the Spanish Minister of Development, D<sup>a</sup> Ana Pastor, and the President of the Autonomous Regional Government of Castilla-La Mancha, D<sup>a</sup> María Dolores de Cospedal.

The engineers of the Yebes laboratories have completely designed and built a tri-band receiver and op-



**Fig. 3** Status of construction of the RAEGE antenna in Santa Maria (Azores islands, Portugal).

**Table 1** RAEGE instrumentation parameters.

| Parameter          | Value                                    |          |
|--------------------|--|----------|
| RT Diameter        | 13.2 m                                   |          |
| Optics             | Ring focus                               |          |
| Surface rms        | 180 $\mu$ m                              |          |
| Designer           | MT Mechatronics GmbH                     |          |
| Az/El slew speed   | 12 $^{\circ}$ /sec / 6 $^{\circ}$ /sec   |          |
| Receivers          | triband (S, X, Ka)<br>dual pol (RCP+LCP) |          |
| Band               | Frequency (GHz)                          | Trec (K) |
| S band             | 2.2-2.7                                  | 21       |
| X band             | 7.5-9.0                                  | 23       |
| Ka band            | 28-33 GHz                                | 25       |
| DBBC type          | European DBBC (IRA/INAF)                 |          |
| Recorder           | Mark 5B+/Mark 5C                         |          |
| Yebes connectivity | 10 Gbit/s fiber                          |          |



**Fig. 4** Status of construction of the control and auxiliary buildings of the RAEGE station in Santa Maria.

tics for the S (2 GHz), X (8 GHz), and Ka (32 GHz) frequency bands (see Figure 5). This receiver will be installed at the Yebes RAEGE telescope, which is expected to become available for the IVS in the first half of 2014. An identical receiver was built for GSI

(Japan), and it will be installed at their new antenna in Iishioka.

Detailed information on RAEGE is available on the Web at <http://www.raege.net/>

**Table 2** Staff in the IGN VLBI group (e-mail: [vlbitech@oan.es](mailto:vlbitech@oan.es)).

| Name                     | Background | Role   | Address* |
|--------------------------|------------|--|----------|
| Francisco Colomer        | Astronomer | VLBI Project coordinator   | IGN      |
| Jesús Gómez-González     | Astronomer | Deputy Director for<br>Astronomy, Geophysics, and Space Applications | IGN      |
| José Antonio López-Fdez  | Engineer   | RAEGE Director   | Yebes    |
| Pablo de Vicente         | Astronomer | VLBI technical coordinator   | Yebes    |
| José Antonio López-Pérez | Engineer   | Receivers  | Yebes    |
| Félix Tercero            | Engineer   | Antennas   | Yebes    |
| Susana García-Espada     | Engineer   | geoVLBI expert   | Yebes    |
| Javier López-Ramasco     | Geodesist  | Geodesist  | Yebes    |
| Alvaro Santamaría        | Geodesist  | Geodesist  | Yebes    |

**Fig. 5** Tri-band (S/X/Ka) receiver, designed and built at the laboratories in Yebes Observatory.

In order to comply with the VGOS specifications, a new broadband receiver is being developed at Yebes and should be available for observations in 2015.

IGN expects to participate in the IVS CONT14 campaign with the Yebes 40-m radio telescope and will also take part in the early VGOS tests starting in 2015 with the new RAEGE 13.2-m “Jorge Juan” antenna.

RAEGE is to be completed with two more stations, in Tenerife (Canary islands) and Flores (Azores islands). Site selection for the former is very advanced, near the city of Tegueste, in the northern and most geologically stable part of the island of Tenerife. Figure 4 displays the project of the station infrastructures, including the radio telescope (under construction at MT Mechatronics GmbH) and auxiliary buildings for control, time and frequency, gravimeters, etc. The construction of this station is expected in 2016 and the one in Flores in 2017.

### 3 IGN Staff Working on VLBI Projects

Table 2 lists the IGN staff who are involved in space geodesy studies and operations. The VLBI activities are also supported by other staff such as receiver engineers, computer managers, telescope operators, secretaries, and students.

### 4 Future Plans

First light of the RAEGE radio telescope at Yebes is expected in early 2014. The construction of the second antenna of RAEGE, in Santa Maria (Azores), will also be completed in 2014.