

# RAEGE: An Atlantic Network of Geodynamical Fundamental Stations

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## Abstract

Project RAEGE (*Red Atlántica de Estaciones Geodinámicas y Espaciales*) intends to set up a Spanish-Portuguese network of four Geodetic Fundamental Stations in Yebes (1), Canary Islands (1), and Açores Islands (2), as part of the developments needed for the IVS VLBI2010 scenario. It is envisaged that each Geodetic Fundamental Station will be equipped with one radio telescope of VLBI2010 specifications (at least 12-m diameter, fast slewing speed, but also able to operate up to 40 GHz), one gravimeter, one permanent GNSS station, and, at least at the Yebes site, one SLR facility.

The National Geographical Institute of Spain (IGN) has experience in VLBI, having been a member of the European VLBI Network since 1993 and being one of the founding institutions of the Joint Institute for VLBI in Europe (JIVE), and it has been participating in geodetic VLBI campaigns with the 14-m radio telescope in Yebes since 1995. A new 40-m radio telescope has been built and was recently put into operation. It regularly participates in IVS sessions. There is infrastructure available for the new stations at Yebes and the Canary Islands. An agreement between IGN, the Portuguese Geographical Institute (IGP), and the Regional Government of the Açores ensures that the RAEGE project can become a reality by 2013.

## 1. Introduction

The International Association of Geodesy (IAG) is establishing a Global Geodetic Observing System (GGOS) [1] for a complete and continuous monitoring of the Earth. The International VLBI Service for Geodesy and Astrometry (IVS) provides products to IAG, in particular to the global reference frames through the station positions for plate tectonics (ITRF), coordinates of celestial objects (ICRF), and Earth pole position plus length of day (EOP).

In order to increase the precision of the products by an order of magnitude and to provide fast turnaround of initial geodetic results, upgrades to the current IVS infrastructures and data processing and analysis are needed. The project to coordinate these upgrades is known as VLBI2010 [2], born from the IVS Working Group #3 [3]. RAEGE is the Spanish-Portuguese contribution to the new VLBI2010 scenario.

## 2. The Stations

RAEGE [4] will consist of the construction and operation of four new Fundamental Geodetic Stations, where several geodetic techniques will be co-located. Two stations will be placed in Spain: one in Yebes (Guadalajara) and one on the Canary Islands. The other two stations will be placed in Portugal, on the Açores Islands: one on Santa María and one on Flores (see Fig. 1). The exact location of the last three stations is still to be decided.

At the Yebes station, the National Geographical Institute of Spain (IGN) already operates an observatory with two radio telescopes equipped with VLBI instrumentation (a 14-m antenna and a new 40-m antenna; as a member of the IVS and the European VLBI Network). It also operates the reference receiver of the GPS network in Spain (IGS YEBE). Recently a gravimeter pavilion was built, which may hold up to seven instruments operating simultaneously.

At Canary Islands, IGN operates a geodetic station on Tenerife island. However, conditions suggest consideration of better placements on Gran Canaria (at or close to Maspalomas, where the Spanish INTA operates a satellite tracking station) or on Lanzarote. Studies will be conducted in 2010 to decide the exact placement of this RAEGE station.

Through cooperation between IGN and the Regional Government of the Açores, two RAEGE stations will be placed there on different islands. The best choice is Santa María, on the African tectonic plate, and Flores, on the American plate. These stations could be operated remotely from a control center on the main Açores island of San Miguel. Measurements of local RFI and meteorological conditions will be performed in order to select the most convenient location for these RAEGE stations.

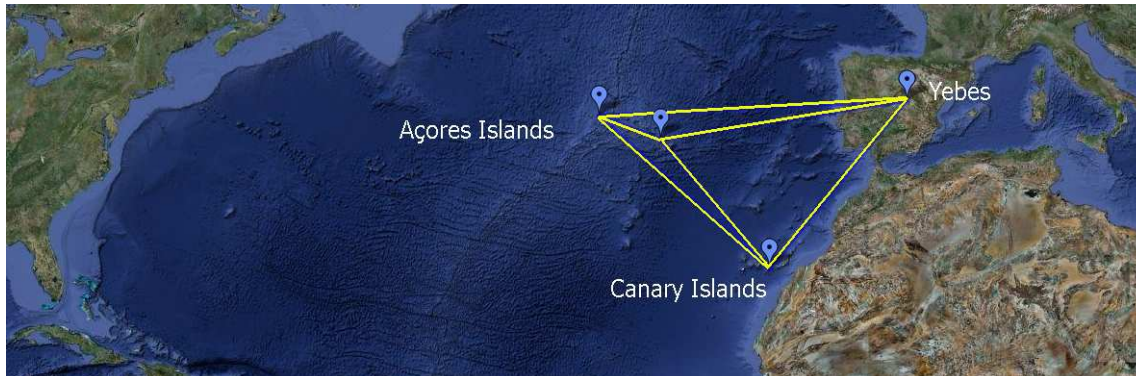


Figure 1. Location of the four RAEGE stations.

### 3. RAEGE Instrumentation

A goal of RAEGE is to build a new antenna of VLBI2010 specifications in Yebes, for which studies have been conducted following the expertise of similar systems such as the Twin Telescope Wettzell (TTW) project already under construction. The new antenna should have a  $> 12$ -m diameter, be capable of operating up to 40 GHz, and have very fast slew rates ( $12^\circ/\text{sec}$  in azimuth) for better determination of atmospheric effects.

The call for tenders for the construction of the antennas was set in May 2010. Two well known companies offered to build the instruments: Vertex (who is building the Twin Telescope Wettzell project) and MT Mechatronics GmbH (who built the Yebes 40-m radiotelescope).

These new radio telescopes will be initially equipped with current state-of-the-art receivers of the S and X frequency bands (2 and 8 GHz), which will be replaced by wideband receivers of the VLBI2010 bands (2 to 14 GHz) when available. Moreover, all equipment needed for VLBI observations (e.g., H-maser, meteorological station) will be provided.

All stations will be equipped with a permanent GNSS receiver (already in operation at Yebes).



Figure 2. Aerial view of the Yebes station, showing the existing and new RAEGE facilities.

All stations will be equipped with a gravimeter. Two such systems are already available at IGN (absolute gravimeters FG5 and A10); one new superconducting gravimeter has been purchased and will be installed at Yebes in May 2010.

Finally, at least at the Yebes station (see Fig. 2), a Satellite Laser Ranging (SLR) telescope will be installed at a new control building under design.

Table 1. RAEGE stations instrumentation.

Station	VLBI RT	GNSS	Gravimeter	SLR
Yebes	X	X	X	X
Canaries	X	X	X	
Sta María	X	X	X	
Flores	X	X	X	

#### 4. Deployment of RAEGE

The call to bid on the RAEGE antennas is open, and the contract for the construction of the first three antennas will be signed in June 2010.

Meanwhile, Yebes and other potential sites on the Canary and Açores Islands are being monitored for the presence of radio frequency interferences (RFI) and meteorological conditions. Some preliminary results are shown in Figs. 3, 4, and 5.

Initial infrastructure work has started in Yebes. Soil trial pit excavations are being made to select the optimum location of the new RAEGE antenna at the observatory premises.

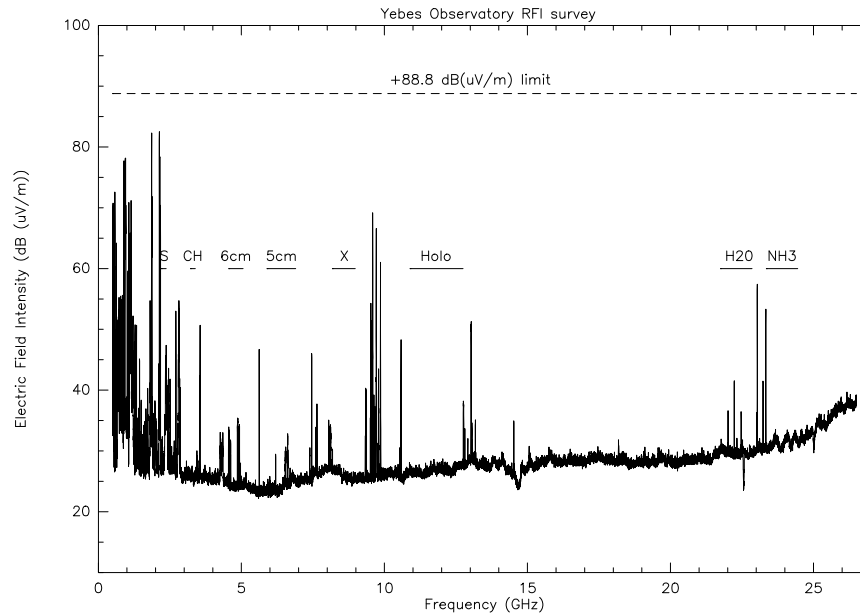


Figure 3. Current radio frequency interference (RFI) status at Yebes (Spain) in the 0 – 26 GHz band.

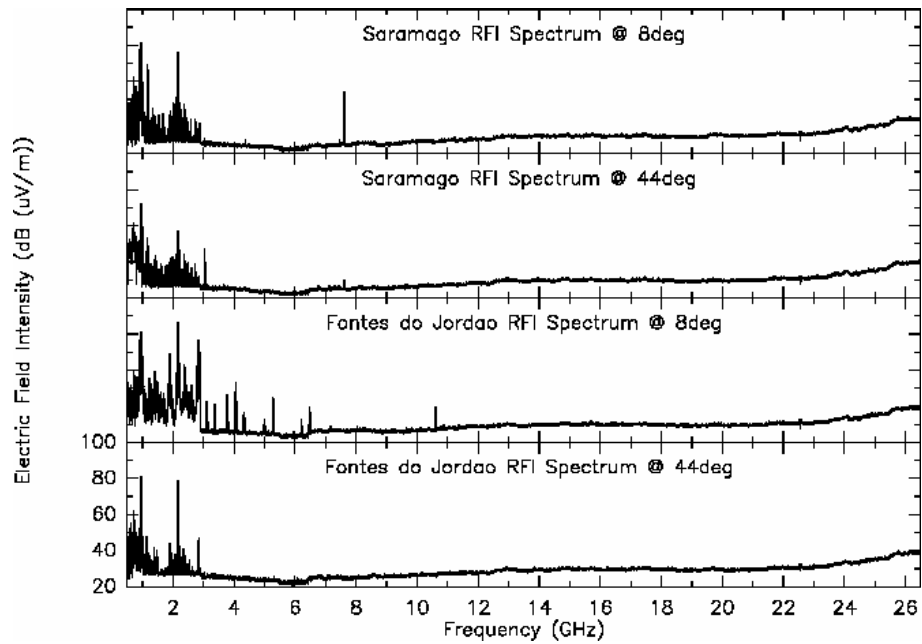


Figure 4. Radio frequency interference status at two sites on the Açores island of Santa María, much cleaner than that in Yebes.

## References

- [1] The Global Geodetic Observing System (GGOS) of the International Association of Geodesy. <http://www.iag-ggos.org/>

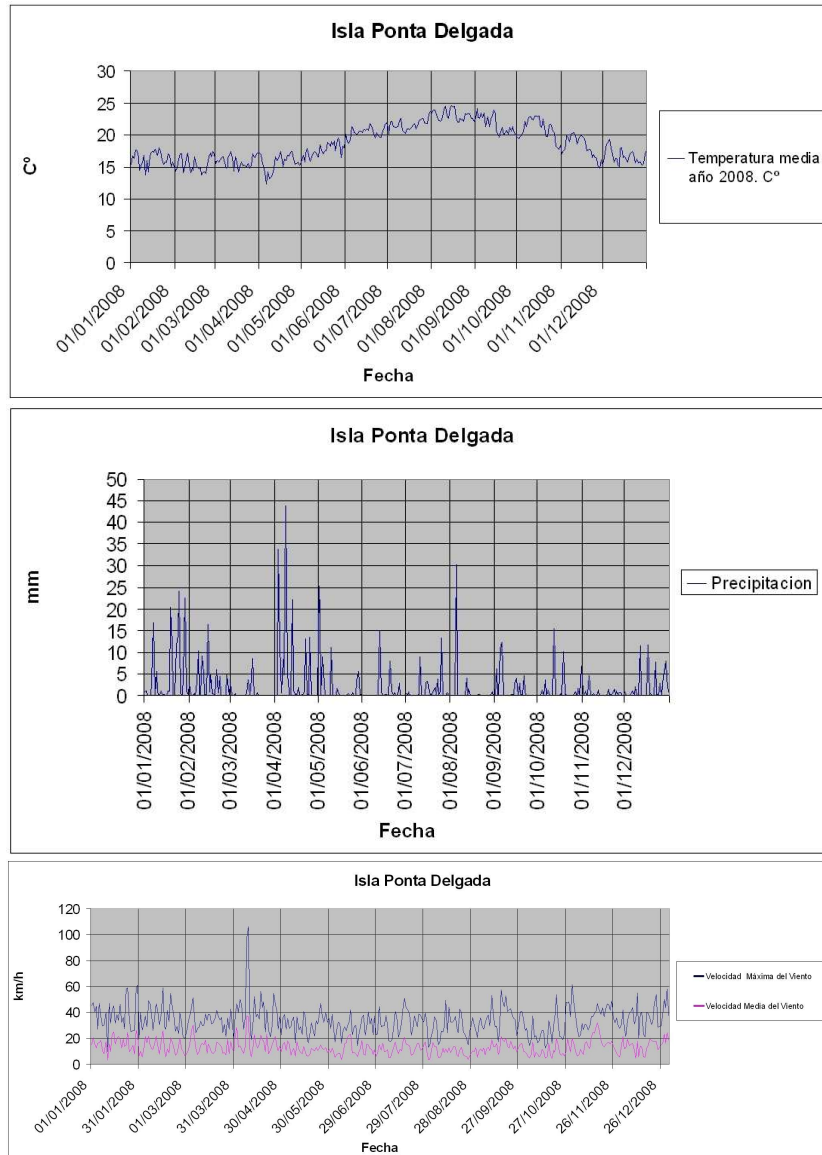


Figure 5. Meteorological conditions (temperature, precipitation and wind velocity) near one Açores RAEGE station.

- [2] Petrachenko, B., Niell, A., Behrend D., et al. Design Aspects of the VLBI2010 System. Progress Report of the IVS VLBI2010 Committee. Report NASA/TM-2009-214180. <ftp://ivsc.gsfc.nasa.gov/pub/misc/V2C/TM-2009-214180.pdf>
- [3] IVS Working Group #3 on VLBI2010. <http://ivsc.gsfc.nasa.gov/about/wg/wg3/index.html>
- [4] Red Atlántica de Estaciones Geodinámicas y Espaciales (RAEGE project) <http://www.raege.net>