Yebes Observatory Report

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Abstract We present the main activities performed by the Yebes Station during 2017 and 2018.

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 and currently operates two radio telescopes at that site that contribute to the IVS. A 40-m radio telescope, station code "Ys", has been operating regularly since 2008. For the last couple of years, 2017–2018, the 13.2-m VGOS-type antenna inaugurated in 2014 with code "Yj" (RAEGYEB) has been observing biweekly in the VGOS Trial network. Detailed information about RAEGE is available on the Web at http://www.raege.net/. The IGN Yebes Observatory is also the reference station for the Spanish GNSS network and holds permanent facilities for gravimetry. Since 2014, the IGN Yebes Observatory has been a Technology Development Center for the IVS. Activities are described in the corresponding contribution in this Biennial Report.

2 Activities during the Past Year

During the last two years, both telescopes were involved in geodetic observing under the auspice of the IVS. Starting in 2017, the 13.2-m radio telescope was devoted to the initial VGOS Trial series, with experiment code prefix VT7, being one of the first five stations in the emerging VGOS network. In this first year, the telescope participated in 27 sessions, including five CONT17 experiments between the 3rd and 7th of December and two pre-CONT simulation tests carried out on the 4th and 5th of October.

Yebes' 40-m telescope also participated in the CONT17 campaign as a component of the Legacy network. Concerning the regular yearly agenda, Ys took part in a total of 49 experiments, with two type R1 sessions, 21 of type R4, six from the EUR program, four T2, and one experiment with the AUS network. All of this amounts to 54% of the VLBI time of the telescope (2,689 hours in 2017).

In 2018 the VGOS Trial network observed a total of 24 sessions. RAEGYEB could only take part in 14 of these because a severe failure in one of the subreflector encoders made the antenna unavailable during the months of July and August. Furthermore, sporadic failures in the servo encoders subsystem suffered in the last months of 2018 are believed to be the origin of sensitivity lost at high frequencies due to pointing errors. Those errors were detected and corrected by the end of the year with the help of the Haystack correlator.

Legacy IVS experiments were observed by the 40-m dish, with the following observational program distribution: six EUR, 22 R4, two R1, and four T2 sessions — 34 sessions in total, 42% of the VLBI-dedicated use of the telescope (1,784 hours in 2018).

By 2017 it was noticed by Arthur Niell that the CDMS might not be working properly and some extra noise was being introduced into the cable measurements. Local works were done to improve the measure-

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Table 1 VGOS Trial sessions participated by RAEGYEB

	2017	2018
VT obs	27	14

Table 2 IVS observations participated by Yebes 40 m.

YEBES40m (Ys)	2017	2018
IVS R1	2	2
IVS R4	21	22
IVS T2	4	4
EUR	6	6
AUS	1	0
CONT	15	0
TOTAL	49	34

ments by replacing the phase-cal Ground Unit with a new module with little modifications, but that did not allow the measurements to reach the required accuracy either. This was the reason to design a major upgrade to the CDMS that is now being tested on site with promising results.

In 2017 the invariant point of the 13.2-m telescope (IVP) was measured using two different techniques. The results and comparison between both methods can be consulted in the internal report IT-CDT-2017-2. Later that year it was discovered that water condensation on the azimuth encoders caused frequent errors in the ACU that could potentially ruin an observation. A small space under the azimuth cabin was conditioned to prevent condensation on these encoders (see IT-CDT-2017-7 for details). By 2017 the amount of Mark6 storage space was increased to a total of 24 modules, each of them filled with eight disks of 4 TB each to reach a net storage capacity of 768 TB. Also a 10 GB switch was installed in the backends room to route data between the backends and the recorders without needing to change fibers. This setup was demonstrated to be very convenient to prevent human errors.

In 2018 the local tie vector to both radio telescopes was successfully determined (IT-CDT-2018-20.pdf). Other activities with potential impact on VLBI observing include two RFI monitoring campaigns in 1.5 - 15 GHz (BRAND-EVN) (IT-CDT-2017-13) as well as in K-band (IT-CDT-2017-14) conducted by station RF engineers. Finally, the RT40m vertex membrane was replaced between the 18th and the 22nd of September.

3 Current Status

The station runs two active Hydrogen masers from T4-Science that provide the frequency references (5, 10, and 100 MHz and also a 1PPS TTL signal) for all the electronics involved in VLBI operations. Normally only one is “active”, while the other runs as a backup system. A monitoring system developed by Yebes staff allows monitoring and control of the master clocks, as well as fast switching between active and backup units. This scenario is also used with two GPS receivers (CNS Clock II and Symmetricom XLi).

The 40 m is equipped with a simultaneous S/X receiver, a C-band receiver, a W-band receiver, and a simultaneous K/Q-band receiver. The W- and Q-band receivers were built in Yebes labs during 2018 and commissioned on January 2019. All the receivers can record dual circular polarization except the W and Q receivers, which are linear. Continuous calibration is available in the S/X, C, and K receivers using a noise-diode driven by an 80 Hz signal generated in the back-end. Q- and W- band observations can be calibrated with a hot-cold load system.

By the end of 2016, the 13.2-m VGOS-type telescope was equipped with four RDBE-G backends connected to a single Mark6 unit. The frontend signal chain consists of a cryo-temperature QRFH feed connected to Yebes’ own broadband receiver that sends the full 2 to 14 GHz band through optical fiber link to four UDCs. Each of them adapts a 512 MHz band in Nyquist zone 2 to be digitized by an RDBE-G. All the experiments since then have been observed using this configuration, and the whole signal chain has shown good reliability, being able to run for months without human intervention other than routine monitoring operations. YEBES40M is still involved in geodetic VLBI operations under the legacy network. RAEGYEB is doing biweekly observing within the emerging VGOS network.

4 Future Plans

A prototype for the new CDMS system is being tested on the 13.2-m antenna, and it is planned to be used in regular observing starting in the second quarter of 2019. Yebes engineers have also designed an upgrade to the system that will cover the full link between

the H-maser and the phase-cal Antenna Unit. Currently the path between the H-maser and the phase-cal Ground Unit is not being monitored. By the end of last year, four R2DBE units were bought from Digicom. The equipment, which will allow recording of instantaneous bandwidths up to 2 GHz, has already been received and will be installed in the backends room in the next months, to start with the first testing in 2019. The Observatory also bought a DBBC3 backend to be used in high data rate astronomical observations. First fringes have already been obtained with this system, although it is not yet used in normal operations. The recording capability is also expected to increase with the purchase of a new flexbuff system. It is equipped with four 10 GbE interfaces to cope with a potential bitrate of 32 Gbps.

References

1. B. Córdoba, J. López-Ramasco, *Actualización del cálculo del punto invariante de un radiotelescopio. Método de ajuste clásico por círculos. Nuevas medidas en el radiotelescopio RAEGE del Observatorio de Yebes* Technical Report IT-CDT-2017-2
2. C. Albo, J. Fernández, *Acondicionamiento del habitáculo de rotación en acimut del radiotelescopio Jorge Juan de Yebes.* Technical Report IT-CDT-2017-7
3. José A. López-Pérez, P. García-Carreño, *Radio Frequency Interference Measurement Plan in the frame of BRAND-EVN project* Technical Report IT-CDT-2017-13
4. B.Córdoba, J.López-Ramasco. *Realización del local tie de las diferentes técnicas geodésicas espaciales en el Observatorio de Yebes* Technical Report IT-CDT-2018-20