

# Yebes Observatory Station Report

## Onsala TOG meeting 25-26 June 2023

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### 1 General status

Over the past year, the 40-m radio telescope has undergone several upgrades to improve its performance. The commissioning of the sub-reflector wobbler system was delayed due to problems with the OHB control system. VLBI and single dish observations resumed in January 2024 with no further impact.

### 2 VLBI Equipment

Following is the description of the equipment used to support the EVN observations:

- DBBC2 backend:
  - 4 CoMo boards (Unica4).
  - 4 ADB2.
  - 4 Core2.
  - Internal Fila10G.
  - Software available:
    - DDC:
      - v105\_1 (June 10 2015). This firmware is used with channel bandwidth narrower than 4 MHz.
      - v107 (beta 4) (June 7 2019). This firmware is used with 4 MHz channel bandwidth or wider.
    - PFB (mode not regularly used):
      - v16\_2 (October 13 2017).

- Fila10G:
  - fila10g\_v4\_1 (reported as 2.8.0, October 20 2017).
- DBBC3 backend:
  - DBBC3-6L-6H.
  - Internal Fila10G.
  - Software available:
    - DDC:
      - v126U (June 23<sup>rd</sup> 2022). This firmware provides 16 BBCs with up to 128 MHz bandwidth.
      - v126E (October 25<sup>th</sup> 2022). This firmware provides 8 BBCs with up to 128 MHz bandwidth, but flatter bandpass.
- Flexbuffs: there are 3 units at the observatory dedicated to observation recording, and one devoted to correlation tasks:
  - flexastro:
    - 36 disks of 10TB capacity. Total capacity of 360TB
    - Software version: jive5ab : 2.9.0 : 64bit : dev : flexastro
  - flexbuff: underwent major upgrade during 2023 to replace aging HDDs by 16 TB units (Seagate part number ST16000NM001G-2KK103)
    - 36 disks of 16TB capacity. Total capacity of 576TB
    - Software version: jive5ab : 2.9.0 : 64bit : dev : flexbuff
  - flexcosmos:
    - 36 disks of 10TB capacity. Total capacity of 360TB
    - Software version: jive5ab : 2.9.0 : 64bit : dev : flexcosmos
  - flexcorr (correlation tasks):
    - 36 disks of 4TB capacity. Total capacity of 144TB
    - Software version: jive5ab : 2.9.0 : 64bit : dev : flexcorr
  - Two additional units (360 TB each) located at JIVE.
- Harrobox running Debian Bookworm (12) acting as a proxy between the FS and the DBBC to allow concurrent connections to DBBC2. JIVE correlator uses this feature to control the flow of data from the Fila10G when doing eVLBI. This host is in the public LAN but allows connections from the private LAN.
- Spare DBBC2 backend is on lend to RAEGSMAR station to support EVN observations. The unit will come back to Yebes to support tri-band observations until DBBC3 is commissioned by JIVE.
- Two H-masers at Yebes and two GPS receivers to keep the maser clocks synchronised. The masers are regularly checked by the manufacturer. Backup maser is currently in standby mode due to low content of hydrogen. Primary maser could follow and therefore will not be able to perform VLBI observations. Contractor Safran to correct the problem at Santa María station and train our staff to correct the problem at Yebes masers. Backup GPS receiver has

failed and has been replaced by an old unit until two new GPS receivers will be purchased for Yebes and Santa María.

### 3 Field System

We run three Field System computers:

- RT40m: FS version 9.13.2 on Debian 7.11 Wheezy, kernel 3.2.0-6-686-pae
- RT13.2m: FS version 10.1.0 on Debian Jessie 10, kernel 4.19.0-19-amd64.
- A test computer which can be connected to any of the non-used backends. Debian Buster and FS 10.

### 4 EVN observations

Below are the metrics for the participation of the Yebes 40-m radio telescope in the EVN observations in 2024, since the report at the last TOG meeting:

EVN session 2024-1: participated in a total of 19 observations (plus 2 CL calibration run and 4 NME or real-time fringe tests).

C-band: performed 10/10 successful observations.

X-band: performed 4/5 successful observations. Observation ec094b was cancelled due to a problem with the antenna controller.

K-band: performed 5/5 successful observations.

EVN session 2024-2: participated in a total of 8 observations (plus 2 CL calibration runs and 4 NMEs).

C-band: performed 5/5 observations. All observations were affected by a sensitivity problem with the CX receiver.

X-band: performed 1/1 observations. It was affected by a sensitivity problem with the CX receiver.

K-band: performed 1/1 successful observation.

Q-band: performed 1/1 observation that was affected by a receiver cold head problem.

EVN e-VLBI: during the first half of the year, Yebes 40-m participated in 4 of the 5 C-band e-VLBI sessions requested (rsy11, ea071b, em165c and eb111). All observations were successful except for the eb111 run (18/06) which was affected by a sensitivity problem with the CX receiver. For em165d we could not participate due to a problem with the receiver cold head.

EVN ToO: Yebes 40-m successfully participated in 1 C-band observation for the rg014 project.

EVN OoS: Yebes 40m participated in 2 X-band observations (gd023d and gb082a). Second observation was affected by a sensitivity problem with the CX receiver.

EVN tests: Yebes 40m participated in several tests during this period, such as the data transfer formatter test with JIVE and the test of the Effelsberg BRAND receiver.

## **5 Storage**

Since the last TOG meeting, no storage purchases have been made for the EVN.

## **6 Spares**

One Mark5B+ system together with some old DBBC2 pieces are available at the station.

## **7 Internet connection**

Internet connectivity is provided by RedIRIS, the Spanish National Research and Education Network (NREN). In January 2023, new network elements were installed at the observatory and the upgrade to a 100 Gbps link was completed. This outside 100 Gbps connection is available to the correlator and the VLBI traffic for e-transfer can be routed through aggregated 10 Gbps uplinks to take advantage of the higher bandwidth. Currently, the observatory supports disk recording (flexbuff) and e-VLBI with maximum data rates of 8 Gbps each.

## **8 40-m radio telescope upgrades**

Two new receivers under development are expected to see first light in the second quarter of 2024. These receivers, the ASTROREC K-band linear polarisation receiver covering the 18-32 GHz range and a wideband CX linear polarisation receiver covering the 4-18 GHz range, will significantly enhance our support to the EVN. Meanwhile, the CX receiver (4.6-9 GHz) is undergoing troubleshooting, as it experienced an amplification problem that has affected

Regarding the progress made in supporting simultaneous VLBI observations in the K/Q/W bands for the application of the Frequency Phase Transfer technique, the KVN correlator recently reported fringes for a K/Q observation performed in 2018 together with the KVN and VERA networks (Ka-VA) , and the FPT results were reported at the recent URSI AT-RASC conference (Figure 1).

Meanwhile, a new fringe test is being organised between Yebes and the KVN to further test simultaneous K/Q/W observations. In parallel, JIVE has already tested remote control of the Yebes and Medicina DBBC3 backends for e-VLBI observations, finding several issues in the JIVE dbbc\_proxy for the DBBC3 that need to be resolved. This backend is required to support tri-band K/Q/W dual polarisation observations.

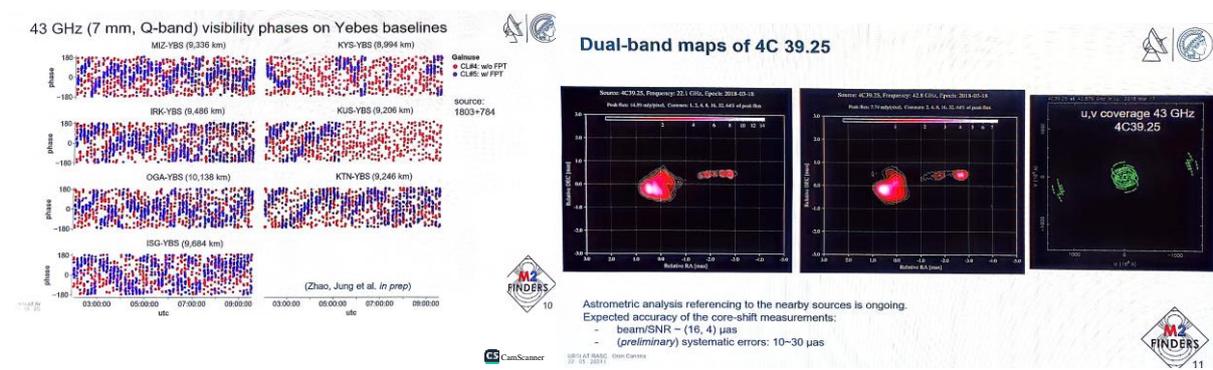


Figure 1: FPT results from a 2018 observation between Yebes and Ka-VA network on K/Q bands (k8076b experiment) showing the benefits of the FPT technique (Zhao, Jung et al. in prep)

## 9 News about Yebes Observatory

Recently it was discovered that the RAEGE 13.2m telescope has suffered severe damage to the azimuth wrap and is currently out of service (Figure 2). It is a major break and the antenna cannot be operated. At the moment we do not have a date for its repair, and it will be several months before it is available again. Therefore, we will not be participating in any IVS sessions for the next few months. This failure is not directly related to the 2021 failure.



*Figure 2: Cable wrap damage*

## 10 Staff

The VLBI group consists of the following members:

- VLBI Scientific Support: Victor Pérez (GMVA/VGOS), Cristina García-Miró (EVN/IVS/GMVA/Global Astrometry).
- VLBI Technical Staff: Javier González (VLBI technical friend), Francisco Muñoz (software development). There is also a team of operators and engineers who support the operation and the various maintenance activities.
- Yebes Schedulers: Belén Tercero, Nuria Marcelino.

Staff news: On 13th May Felipe Paredes left the IGN Fellowship to join a science outreach programme on the Spanish television (RTVE).

Yebes VLBI group - [astrovlbi@oan.es](mailto:astrovlbi@oan.es) (schedules, observations, data transfer, antenna calibration, antabfs files, etc.)

Yebes VLBI technical group – [vlbitech@oan.es](mailto:vlbitech@oan.es) (backends, firmware, etc.)