Yebes Observatory
Station Report

Bonn TOG meeting 24-25 February 2023

1 General status

The 40m radiotelescope has completed 2022 without any big interruption in its operation.

2 VLBI Equipment

Details of the equipment used in EVN observations:

- DBBC2
  - 4 CoMo boards (Unica 4).
  - 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 (hardly ever used):
      - v16_2 (October 13 2017).
    - Fila10G:
      - fila10g_v4_1 (reported as 2.8.0, October 20 2017).
- Flexbuffs
  - flexastro:
    - 36 disks of 10 TB capacity. Total capacity of 360 TB

        - Software version: jive5ab : 2.9.0 : 64bit : dev : flexastro
    - flexbuff:
        - 36 disks of 6 TB capacity. Total capacity of 216 TB

          A third flexbuff type machine has been purchased together with 36 10-TB hard disk drives.
- We use a Harrobox running Debian Jessie (8.2) 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.

At present time RT40m's spare DBBC2 is on lend to NY-Alesund station to replace their faulty unit. It has previously been lent to Santa Maria, but since they have begun VGOS operations with a DBBC3 it is not needed anymore at the Atlantic island. A third Flexbuff system with 144 TB of capacity (36 disks of 4 TB each) has been devoted to correlation tasks.

The original DBBC3-2L-2H has been upgraded to a DBBC3-6L-6H, initial tests have been carried out on the system which apparently is working correctly, but the very first fringe test was not successful. It consisted on a triple band simultaneous test on K/Q/W bands between KVN network and Yebes. It is expected that the hands-on workshop to be done during the TOG meeting at Bonn will help to sort debug configuration errors.

3 Field System

We run three FS computers:

- RT40m: FS version 9.13.2 on Debian 7.11 Wheezy, kernel 3.2.0-6-686-pae
- RT13.2m: FS version 9.12.11 on Debian Jessie 8.10, kernel 3.16.0-4-686-pa.
- A test computer which can be connected to any of the non-used backends. Debian Buster and FS 10.

The IT department is performing testing to replace the old Field System machine by a virtual machine deployed in a cluster. The goal is to have an easier to maintain control system, specially in terms of backups, emergency replacement and resource resizing.

4 EVN observations

Following are the metrics for Yebes 40-m radio telescope participation in the EVN observations during 2022, since last reported in previous TOG meeting:

EVN session 2022-1: participated in 17 observations (plus 2 CL calibration runs)

Q-band: 2/2 successful observations. The global observation gm079 was slightly affected by wind.

C-band: performed 15/15 observations, 13 were completely successful. Only 2 observations were impacted by problems. For eb086b, from 23:30UT antenna did not track due to an antenna controller problem (63% of scans lost). During NME n22c1 fringes amplitude were lower than expected due to a pointing issue in the antenna control code, first 12 scans affected (52% scans degraded).

EVN session 2022-2: participated in 15 observations (plus 2 CL calibration runs)

C-band: performed 15/15 observations, 12 were completely successful. Only 3 observations were impacted by problems. For ed050a the CX-band receiver cryogenic compressor turned off at 161/23:20UT due to excessive ambient temperature at the receiver cabin, reaching nominal values at the end of the observation (50% scans degraded). For ec086c, Fila10G had to be reinitiated during the support as it was producing smaller than expected packets, first 41 scans lost (33% scans lost). For eg111b cryogenic compressor problems affected from 165/13:45UT-165/15:30UT, data degraded during this period (41 scans, 23% degraded).

EVN session 2022-3: participated in 28 observations (plus 3 CL calibration runs)

C-band: performed 16/16 observations, 15 were completely successful. Only 1 observation was impacted by problems. For ec088b observation it was started late (first 85 scans lost, 50% lost) because it was not reflected in the 40m schedule after a recent update by the EVN scheduler.

X-band: performed 7/7 observations, 6 were completely successful. Only 1 observation was impacted by problems. For n22x1 first 2 scans were lost due to a connection problem with the flexbuff recorder (6% scans lost), setup02 corrected per JIVE advise for scan 17 (47% scans degraded).

K-band: performed 5/5 observations, 4 were completely successful. Only 1 observation was impacted by problems. For global observation gp060 experienced problems with the flexastro recorded, swapped to the geodesy flexbuff, four scans lost (No0350-353, 7% lost).

EVN e-VLBI observations during 2022:

During first third of the year, performed 4/4 observations in C-band, partially impacted by several problems. For observation ec082a 47 scans were lost due to an antenna controller problem (8% of scans lost, from 019/9:11UT-019/10:47UT). Observation ea065d started late due to an IF attenuation misconfiguration, 6 first scans lost (1% lost). Observation ea065f was affected by a new RedIris 100Gbps router installation and misconfiguration in the ARP table of our Fila10G, first 16 scans not transferred, problem solved before science run (2% lost). Observation ea065g was affected by an antenna controller problem (13% of scans lost, 102/14:02UT-102/16:10UT).

During second third of the year, performed 2/2 observations in C-band. For observation rm017b success. For observation ea065i lost first 13 scans (2% lost from real-time fringe test part), and performance degraded due to not optimized pointing model, after focus improvement.

During third third of the year, performed 1/1 observation in C-band. For observation ea065j, the schedule was started late due to configuration issues, and first source was lost not affecting the science program (<1% lost).

Rest of the e-VLBI observations in the reported period were performed in L-band, not available in Yebes.

EVN ToO: performed 2/2 observations in X and C bands for the RG013 project. Observation rg013c (C-band) was affected by strong wind gusts towards the end, the antenna had to be stopped from scan no0075 till no0088, 14 scans lost, 16% lost.

EVN fringe test fr064 for Effelsberg linear polarisation wideband receiver test.

Summary: 70 observations performed out of 70 scheduled.

5 Other VLBI observations

Besides the EVN, we regularly participate in several VLBI programs with the Yebes' RT40m: IVS (geodetic observations), GMVA (Global millimetre VLBI), and other projects that are proposed to the PC.

6 Storage

No storage purchases since last TOG.

7 Spares

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

8 Internet connection

Yebes is connected to RedIRIS, the Spanish NREN using a 10 Gb/s dark fiber since May 2012. During 2022 RedIRIS has performed most of the tasks to upgrade their Point of Presence at Yebes Observatory to 100 Gbps. On Monday 23th, January, RedIRIS will made the handover to 100 Gbps.

9 40m radiotelescope upgrades

Dish deformation measurements

The 40-m radio telescope is undergoing several upgrades to improve its performance in relation with its frequency coverage, gain and phase stability and observational efficiency.

It has been just completed the installation of 165 thermal sensors at the back of the paraboloid, tetrapod legs (see Figure 1), counterweights, and fork for modeling studies of structure deformation due to temperature gradients. The Nasmyth receiver cabin has been also thermally isolated to minimize diurnal and yearly temperature variations and improve energy efficiency.

To study the deformations of the paraboloid due to gravity, different measurements has been performed using a laser scanner and a drone (see Figure 2), for comparison. These measurements complement the holographic technique.

Figure 1: Detail of a thermal sensor in one of the tetrapod legs.

Figure 2: Laser scanner (left and center) and drone (right) measurements.

K/Q/W triple band simultaneous observations

With the development of a dichroic mirror for transmission of Q and K bands and reflection of W band (up to 116 GHz) the Yebes Observatory has acquired the capability for simultaneous VLBI observations in K/Q/W bands (Figure 3). Our 40-m would be the first radio telescope in Europe to support this capability. A first test with the KVN was performed in November where issues where found with the DBBC3, demonstration of fringes with the KVN will take place shortly as soon as the DBBC3 is operational.

There is increasing interest in the scientific community to use the Frequency Phase Transfer technique for the highest frequencies to increase the coherence times and therefore improve the sensibility of the observations, allowing weaker radio sources detection, with better fidelity and improve the effective angular resolution. Yebes Observatory was invited to participate in the workshop "Science enabled with multi-band

receivers and Frequency Phase Transfer" organized by MPIfR, 12-14 October, to present the tri-band receiver.

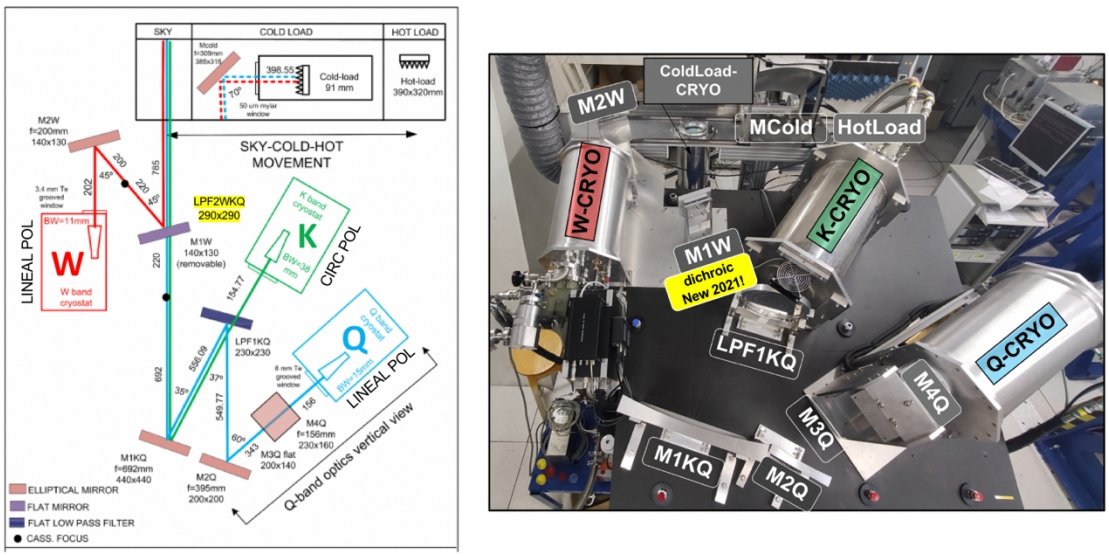

Figure 3: Simultaneous observing with the tri-band K/Q/W receiver, with detail of new dichroic mirror manufactured by Thomas Keating Ltd, in UK.

The observatory also participated in the workshop "Next generation Space VLBI", organized by JIVE and ASTRON, 17-19 October, where the THEZA project was introduced, a concept design that was presented to the ESA Voyage 2050 program, to realize a space interferometer that provides a resolving power 10 times greater than that currently achieved by ground interferometers. Yebes has already demonstrated extensive experience to contribute positively to this space project.

Yebes VLBI group - astrovlbi@oan.es