RAEGE Project Update: Yebes Observatory Broadband Receiver Ready for VGOS

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Abstract An update of the deployment and activities at the Spanish/Portuguese RAEGE project ("Atlantic Network of Geodynamical and Space Stations") is presented. While regular observations with the Yebes radio telescope are on-going, technological developments about receivers for VGOS are progressing at the Yebes laboratories.

Keywords VGOS, broadband

1 Introduction

The Yebes Observatory of the Spanish *Centro de Desarrollos Tecnológicos* in the National Geographical Institute (IGN CDT) has developed an ultra-low noise and broadband (2–14 GHz) cryogenic receiver for the VLBI Global Observing System (VGOS) project which has been installed in the new 13.2-m radio telescope (see Figure 1).

The 13.2-m radio telescope is an elevation-over-azimuth turning-head antenna with a ring-focus optical design and fast moving capabilities. It has been recently upgraded with a cladding in the back-up structure to reduce thermal gradients and extend its operating frequency.

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2 The Broadband Receiver

The block diagram is shown in Figure 2. The front-end (Figure 3a) consists of a dewar with a dual linear polarization quadruple-ridged flared horn (QRFH) feed, directional couplers for noisecal and phasecal injection and two ultra-low noise hybrid amplifiers developed at the Yebes laboratories. The cryostat is built over a Sumitomo SRDK-408S2 cold head in a cylindrical dewar made of stainless steel. The top and bottom covers are made of aluminum. In the top cover a vacuum window lets the broadband radiation go through. In the bottom cover are all the RF connectors (signal outputs and calibration inputs), vacuum flanges, the pressure monitor, DC cabling, and housekeeping connectors. Inside the cryostat there is a cylindrical radiation shield made of aluminum and with multilayer isolation (MLI). The temperature of this stage is less than 40 K. Removing the radiation shield, the entire receiver can be easily reached. It is the coldest part of the receiver at a temperature < 10 K. The cold stage is made of copper. The RF output signals from the dewar are sent to RF-over-fiber transmitters, allowing signal transportation through single-mode fiber up to the 40-m radio telescope back-end room (450 meters). In this place, the optical receivers are installed, together with an RF distribution module and four up/down converters (Figure 3b).

These converters are fed by the outputs of the distribution module. They allow the selection of four dual polarization sub-bands in the range 2–14 GHz and its conversion to base-band to feed the VLBI back-ends. NoiseCal and PhaseCal modules were developed too.

Fig. 1 RAEGE "Jorge Juan" radio telescope in Yebes Observatory (Spain).

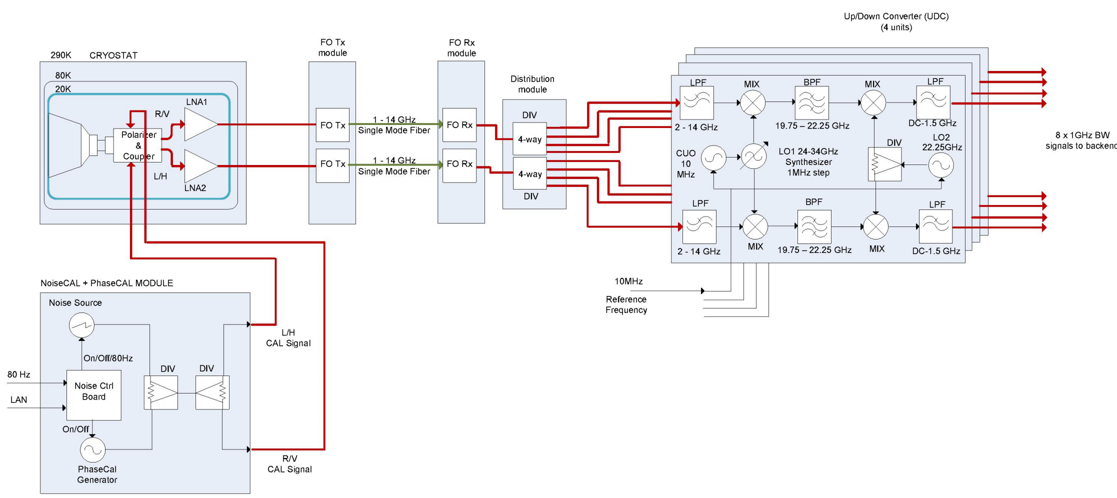

Fig. 2 Block diagram of the VGOS broadband receiver developed at IGN Yebes CDT.

3 Receiver Performance

The measured receiver noise temperature is shown in Figure 4. It can be seen that noise temperature values are distorted by large RFI at low frequencies. Due to these RFI signals, the fiber optic transmitter preamplifier had to be removed, to avoid saturation and intermodulation products. The actual Tsys value is estimated to be 43 K at 45^{o} elevation.

4 On-site Tests

After the installation in the radio telescope, the spectrum of the RF signal at the output of the distribution module was measured at four elevation angles (see Figure 5). It can be seen that, even at high elevation angles, there are large RFI signals in the low frequency part of the spectrum. Actions to mitigate these signals have to be evaluated.

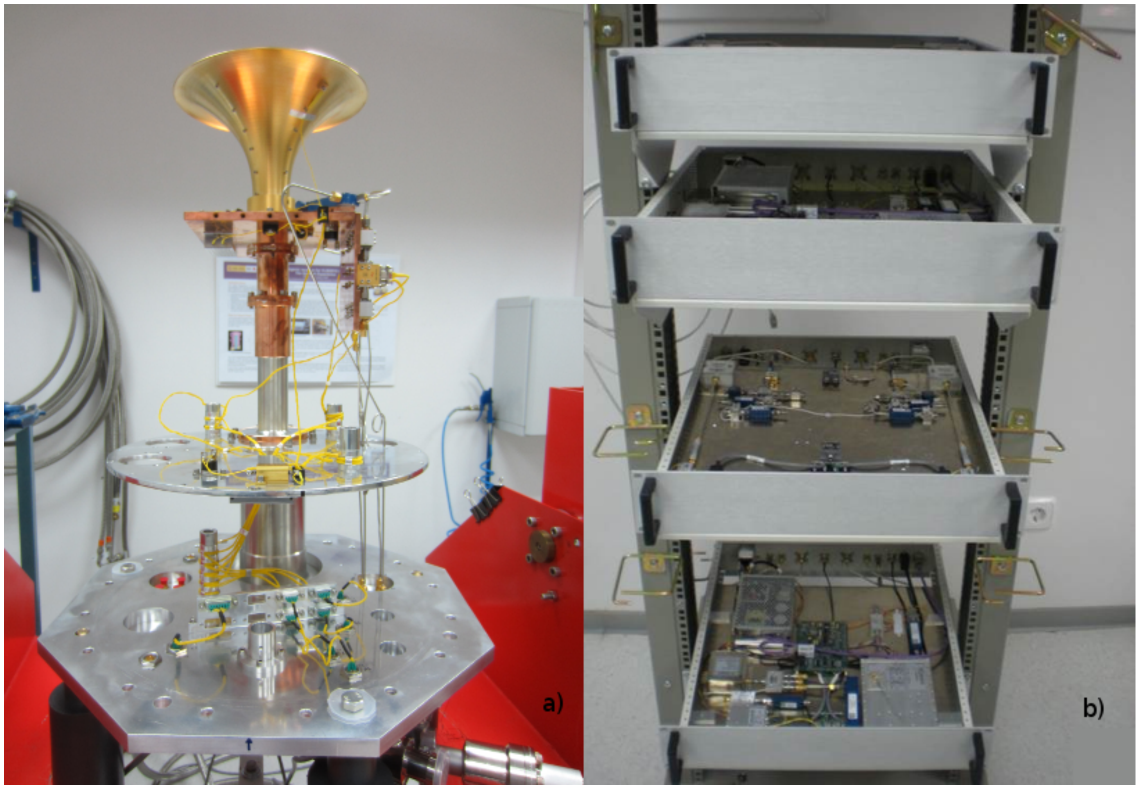

Fig. 3 IGN Yebes CDT broadband receiver: a) dewar, b) modules for RF distribution and up/down converters.

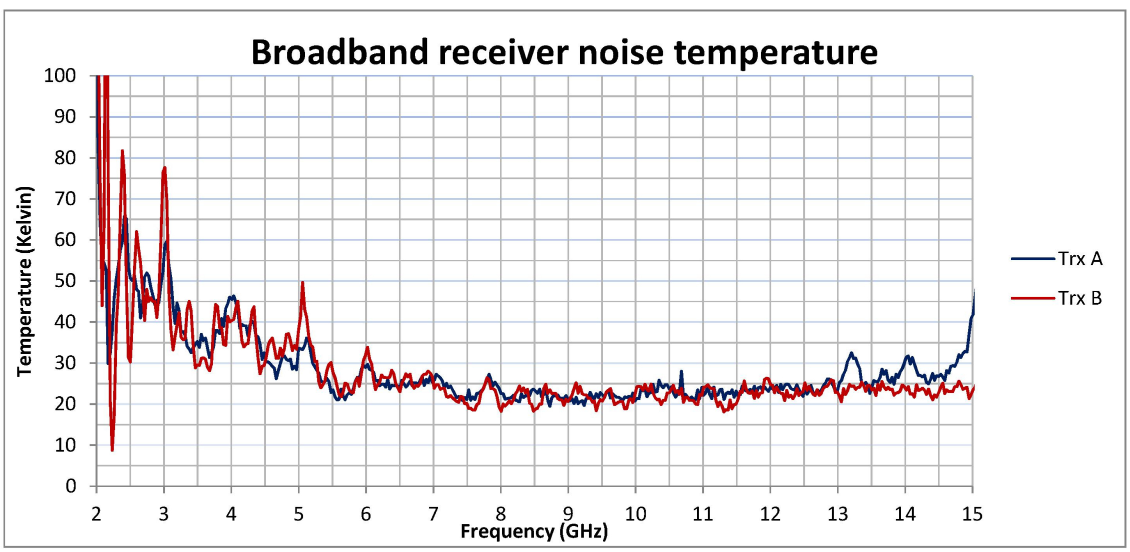

Fig. 4 IGN Yebes CDT broadband receiver performance.

We carried out the first single dish observations with the 13.2-m RAEGE VGOS "Jorge Juan" antenna (see Figure 6). The observations consisted of pointing drifts along the azimuth and elevation axes towards Cas-A, a supernova remnant. This source is intense, and its size is smaller than the beam of the telescope at frequencies below 14 GHz. The first series of observations was uncalibrated because the calibration sys-

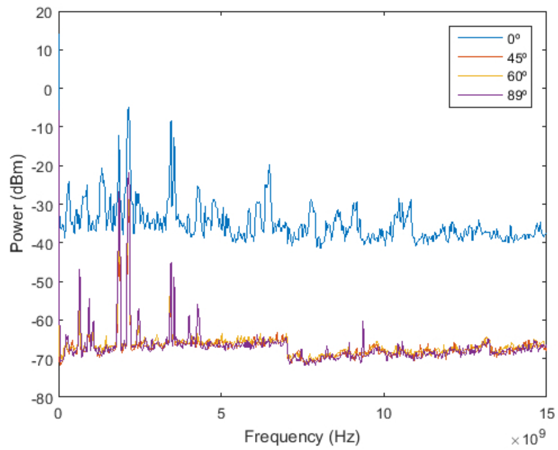

Fig. 5 IGN Yebes CDT broadband receiver RF spectrum.

tem was still undergoing tests. No focus optimization was performed, but the focus position determined with the three-band receiver (S/X/Ka) was used. In order to test the four UDCs, observations at different frequencies and with different units were done. Observations show, in some cases, some lack of repeatability in the pointings for each frequency and different UDCs. We believe this may be caused by RFI. Further observations should be performed to confirm this behavior.

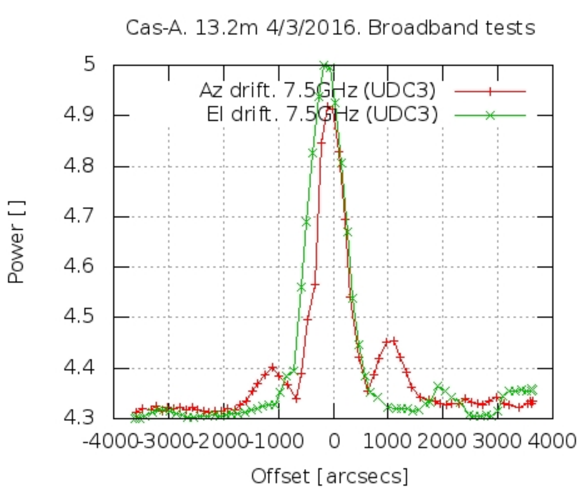

Fig. 6 First observations with the new IGN Yebes CDT broadband receiver.

5 Conclusions

A VGOS compliant broadband receiver has been developed at IGN Yebes CDT and installed on the RAEGE "Jorge Juan" 13.2-meter radio telescope. First light is reported, and work towards the first broadband VLBI fringes is progressing well.

Acknowledgements

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References

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