Yebes Observatory broad-band receiver ready for VGOS

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European Union
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"A way to build Europe"

Introduction

The Yebes Observatory of the Spanish Centro de Desarrollos Tecnológicos (CDT) has developed an ultra-low noise and broad-band (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.

The 13.2-m radio telescope

It is an elevation-over-azimuth turning-head antenna with a ring-focus optical design and fast moving capabilities (figure 1). It has been recently upgraded with a cladding in the back-up structure to reduce thermal gradients and extend its operating frequency.

Figure 1: The Yebes 13.2-m radiotelescope

The broad-band receiver

The block diagram is shown in figure 2. The front-end (figure 3a) consist 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 in Yebes laboratories. The output RF 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-ends room (450 meters). In this place, the optical receivers are installed together with an RF distribution module and 4 up/down converters (figure 3b).

These converters are fed by the outputs of the distribution module. They allow the selection of 4 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 were developed too.

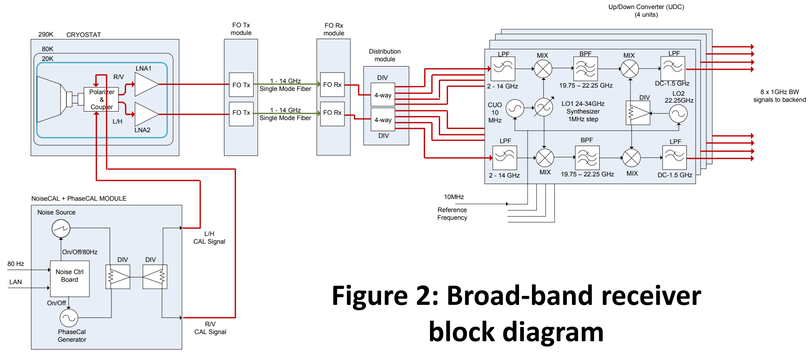

Figure 2: Broad-band receiver block diagram

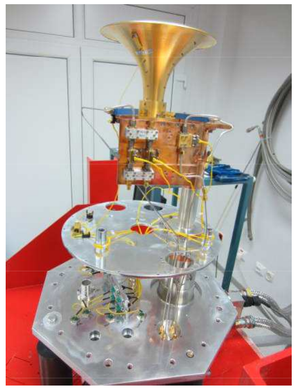

Figure 3a: Dewar internal view

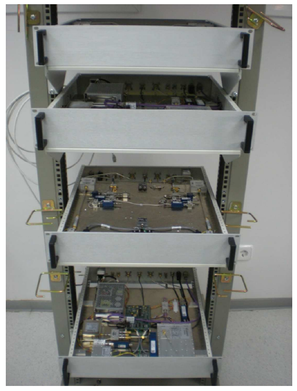

Figure 3b: Up/Down converters integration

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 pre-amplifier had to be removed, to avoid saturation and intermodulation products. The actual Tsys value is estimated to be 43 Kelvin @ 45º elevation.

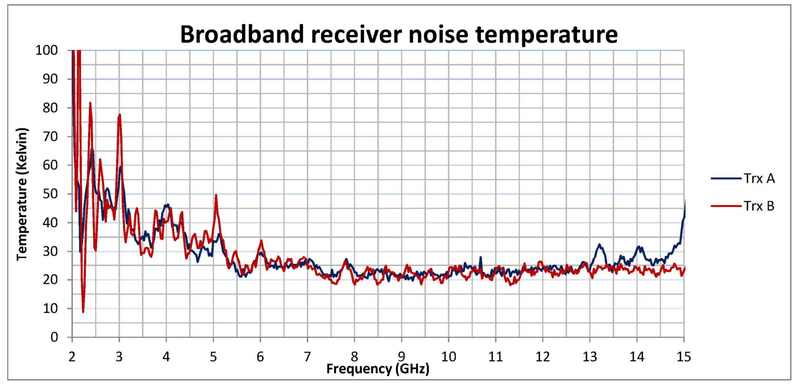

Figure 4: Broad-band receiver noise temperature

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 (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.

Figure 6 shows a pointing cross-scan on radio source Cas-A.

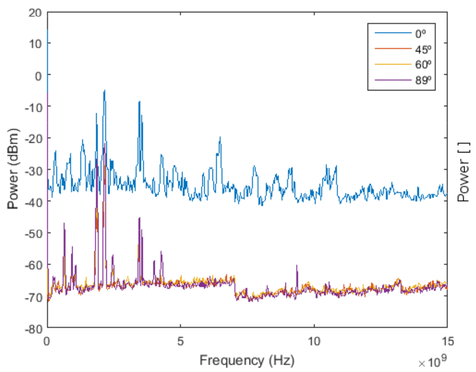

Figure 5: RFI signals in V-pol channel

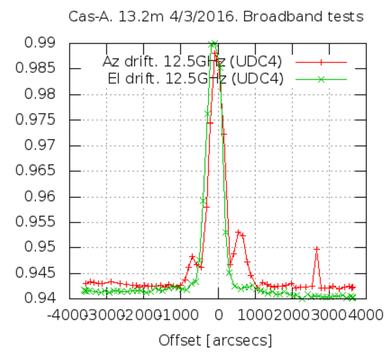

Figure 6: Pointing scan on Cas-A

Conclusions

The Yebes Observatory 13.2 meter radio telescope has been equiped with a ultra-low noise and broad-band cryogenic receiver, converters and back-ends to start VLBI observations.

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