



## An 18-32.5 GHz, 8.3 K Average Noise Temperature Cryogenic Amplifier for the Front End of Radio Telescope Receivers

M. C. Diez-González\*<sup>(1)</sup>, J. D. Gallego<sup>(1)</sup>, I. Malo-Gómez<sup>(1)</sup>, I. López-Fernández<sup>(1)</sup>,  
R. I. Amils<sup>(1),(2)</sup> and A. García-Merino<sup>(1)</sup>

(1) Yebes Observatory, CDT (IGN), Guadalajara, 19141, Spain, email: m.diez@oan.es

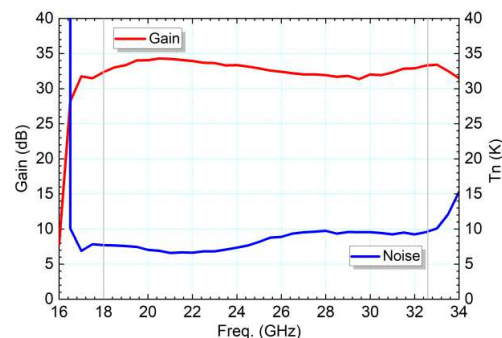
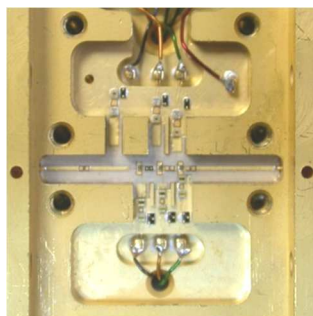
(2) University of Alcalá, 28871 Alcalá de Henares, Spain

The 40m Dish Antenna of Yebes Observatory is presently equipped with a wideband 31-53 GHz Q band receiver mainly used for single dish observations and an independent 21-25 GHz K band receiver used for VLBI (among others). The Q band receiver has been extraordinarily productive as demonstrated by the discovery of more than 50 new molecular species in the interstellar medium. This success has led scientists to encourage the development of a new K-Ka band receiver with improved sensitivity and instantaneous frequency coverage for single dish spectral observations and VLBI from 18 GHz to 32.5 GHz. Regarding spectral line observations, the new receiver may allow the detection of several transitions of heavy molecules, but it will be useful as well for the observation of broad molecular lines, such as CO (1-0), of extragalactic high-redshifted sources or for measurements of wideband cosmic background radiation.

This contribution reports the design, construction and measurement of a cryogenic amplifier (Fig. 1), developed *ad hoc* for the receiver, obtaining a state-of-the-art average noise temperature of 8.3 K with average gain in excess of 32 dB within the band when measured at 7 K. The amplifier incorporates three stages of 0.1x50  $\mu\text{m}$  discrete InP HEMTs and microstrip matching networks on soft substrate. The input interface is a non-standard size waveguide to allow low loss connection to the rest of the receiver input components (polarizer and horn), while the output is a standard coaxial 2.92 mm connector for easy cable routing in the cryostat.

The measurement of the noise temperature at this low level is challenging and requires specialized equipment for obtaining accurate results. In this case, a custom non-standard waveguide size cryogenic variable-temperature load was developed to match to the input flange of the amplifier. The load physical temperature was varied between 20 and 50 K under a PID control to perform the noise power measurement. The error on the measured noise temperature is +/- 0.4K, being dominated by the precision of the temperature sensor diodes.

In addition to the commonly reported noise temperature and gain, we provide measured data of the complete set of noise parameters of the amplifier in terms of noise waves referred to the input of the amplifier and to the impedance of the waveguide using the nomenclature proposed by Meys [1]. This data is seldom provided due to the difficulty of its measurement but provides valuable insight on the performance, allowing easy estimation of the possible degradation of the receiver sensitivity as a function of input mismatch.



**Figure 1.** Gain and noise temperature of an 18-32.5 GHz cryogenic LNA prototype from Yebes cooled at 7 K

1. R. P. Meys, "A wave approach to the noise properties of linear microwave devices," IEEE Trans. Microw. Theory Tech., vol. 26, no. 1, Jan. 1978.