Design and development of a 600-720 GHz receiver for ALMA Band 9

A.M. Baryshev, R. Hesper, F.P. Mena, B.D. Jackson, J. Adema, H. Schaeffer, J. Barkhof and W. Wild
SRON National Institute for Space Research and the Kapteyn Institute, University of Groningen, Landleven 12, 9747 AD Groningen, The Netherlands

M. Candotti
National University of Ireland, Maynooth, Co. Kildare, (Ireland)

C. Lodewijk, D. Loudkov, T. Zijlstra, O. Noroozian, and T.M. Klapwijk
Kavli Institute for Nanoscience, Faculty of Applied Science, Delft University of Technology, Lorentzweg 1, 2628 CJ Delft, The Netherlands

Abstract

This paper describes the design and development of the ALMA Band 9 receiver cartridges. The ALMA project is a collaboration between Europe, North America, and Japan to build an aperture synthesis telescope consisting of at least 64 12-m antennas located at 5000 m altitude in Chile. In its full configuration, ALMA will observe in 10 frequency bands between 30 and 950 GHz, and will provide astronomers with unprecedented sensitivity and spatial resolution at millimetre and sub-millimetre wavelengths. Band 9, covering 600-720 GHz, is the highest frequency band in the baseline ALMA project, and will thus offer the telescope's highest spatial resolutions.

The ALMA Band 9 cartridge is a compact unit containing the core of a 600-720 GHz heterodyne receiver front-end that can be easily inserted into and removed from the ALMA cryostat. In particular, its core technologies include low-noise, broadband SIS mixers; an electronically-tunable solid-state local oscillator; and low-noise cryogenic IF amplifiers. These components are built into a rigid opto-mechanical structure that includes a compact optical assembly mounted on the cartridge's 4 K stage that combines the astronomical and local oscillator signals and focuses them into two SIS mixers.

In this report we present the noise measurement with an emphasis on the extreme large IF bandwidth (4-12 GHz). IF- gain slope, receiver linearity/saturation, receiver beam pattern and cross polarization level measurements will be presented and compared with expectations. The receiver phase and amplitude stability measurements will be presented and the system aspects related to interferometer will be discussed. Finally, a detailed measurement of LO noise contribution will be presented. This measurement was done by comparing receiver noise measured with internal ALMA LO (multipliers power amplifiers combination) to receiver noise measured by means of Gunn diode, followed by a x2x3 multiplier.