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Development of the 787-950 GHz ALMA Band 10 Cartridge

Y. Uzawa^{1*}, T. Kojima^{1,2}, M. Kroug¹, M. Takeda³, M. Candotti¹, Y. Fujii¹, W.-L. Shan⁴, K. Kaneko¹, S. Shitov¹, and M.-J. Wang⁵

1 National Astronomical Observatory of Japan, Tokyo 181-8588, Japan*

2 Osaka Prefecture University, Osaka 599-8531, Japan

3 National Institute of Information and Communications Technologies, Kobe 651-2492, Japan

4 Purple Mountain Observatory, Nanjing 210008, China

5 Academia Sinica Institute of Astronomy & Astrophysics, Taipei 10617, Taiwan

* Contact: y.uzawa@nao.ac.jp, phone +81-422-34-3807

Abstract—We are developing the Atacama Large Millimeter/Submillimeter Array (ALMA) Band 10 (787-950 GHz) receiver cartridge. The incoming beam from the 12-m antenna is reflected by a pair of two ellipsoidal mirrors placed in the cartridge, and then split into two orthogonal polarizations by a free-standing wire-grid. Each beam enters a corrugated feed horn attached to a double-side-band (DSB) mixer block. The mixer uses a full-height waveguide and an NbTiN- or NbN-based superconductor-insulator-superconductor (SIS) mixer chip. We are testing the following three types of mixer chips: 1) Nb SIS junctions + NbTiN/SiO₂/Al tuning circuits on a quartz substrate, 2) Nb SIS junctions + NbN/SiO₂/Al tuning circuits on an MgO substrate, and 3) NbN SIS junctions + NbN or NbTiN tuning circuits on an MgO substrate. The IF system uses a 4-12-GHz cooled low-noise InP-based MMIC amplifier developed by Caltech. So far, the type 1) has shown the best performance. At LO frequencies from 800 to 940 GHz, the mixer noise temperatures measured by using the standard Y-factor method were below 240 K at an operating physical temperature of 4 K. The lowest noise temperature, 169 K, was obtained at the center frequency of the band 10, as designed. These well-developed technologies will be implemented in the band 10 cartridge to achieve the ALMA specifications.