Development Progress and Production Plan of ALMA Band-1 Receivers in Taiwan

Yuh-Jing Hwang [1*], Chau-Ching Chiong [1], Yue-Fang Kuo [1], Hong-Yeh Chang [2], and Zuo-Min Tsai[3], Chi-Chang Lin[1], Shou-Shien Wong[2], Yo-Sheng Lin[2], and Huei Wang[4]

1 Academia Sinica Institute of Astronomy and Astrophysics, Taipei 10617 Taiwan, ROC

2 Department of Electrical Engineering, National Central University, Jhongli, Taoyuan 32001 Taiwan, ROC

3 Department of Electrical Engineering, National Chung-Cheng University, Minhsiung, Chiayi 62102 Taiwan, ROC

4 Department of Electrical Engineering, National Taiwan University, Taipei 10617 Taiwan, ROC

* Contact: yjhwang@asiaa.sinica.edu.tw, phone: +886-2-2366 5340

***Abstract*—An international collaboration between Taiwan, Canada, and Chile are formed to develop the components and cold cartridge assembly of the ALMA Band-1 receivers. In Taiwan, a series of 31.3-45.0GHz millimeter-wave components are developed for the ALMA band-1 receivers. The components are mainly based on 0.15-um GaAs MHEMT MMICs. The key components include two three-stage 31.3-45GHz low-noise amplifiers (LNA), bandpass or high-pass filters, a cascode PHEMT mixer and a 4-12GHz IF amplifier. The MMIC designs are iterated several times, the latest results measured by probe and then tested in packaged modules.**

The 30-50GHz MMIC LNA exhibits 20-28 dB gain and 20-30K noise temperature under 16 K cryogenic temperature environments. The cascode PHEMT mixer uses a common-source transistor as gain stage and the following cascode transistor as mixing device. The measured results on the packaged module shows -5 to +2dB conversion gain under 2-dBm LO power over 4-14GHz IF frequency range. The filters designed and fabricated by GaAs foundry service shows in-band insertion loss less than 3 dB and the out-band rejection as high as 30-40dB.

The local oscillator aiming for 27.3-33GHz frequency tuning range is composed by a phase-locked GaAs HBT MMIC voltage-controlled oscillator cascaded by a buffer amplifier. For comparison on the phase noise performance, an ALMA baseline design based on the commercially available 13-17GHz YIG-tunes oscillator with active frequency doubler is also developed. The measured RMS jitter of the HBT VCO LO is around 51 fsec and the version of YIG is less than 30fs over 1K to 1MHz frequency offset.

The lens, receiver horn, orthomode transducers, and the cold cartridge assembly are developed by consortium laboratories in Canada and Chile. As the development of the key components in all three consortium laboratories approaching to the expected specification soon, a production plan is also proposed. Once the prototype cold cartridge assembly pass the qualification, production will be conducted in Taiwan to install and operate the Band-1 receivers in ALMA after the end of 2018.