The 0.9 and 1.3 THz Superconducting HEB Mixer Receiver for the ASTE 10 m Telescope

T. Shiino[1*], R. Furuya[1], T. Soma[1], T. Sakai[1], Y. Watanabe[1], N.Sakai[1], L. Jiang[2], O. Ohguchi[1], H. Maezawa[3], T. Yamakura[4], Y. Irimajiri[5], and S. Yamamoto[1]

1 The University of Tokyo, Hongo, Tokyo, Japan*

2 Nanjing Forestry University, Nanjing, Jiangsu, China

3 Osaka Prefecture University, Sakai, Osaka, Japan

4 Tsukuba University, Tsukuba, Ibaraki, Japan

5 National Institute of Information and Communications Technology, Koganei, Tokyo, Japan

* Contact: shiino@taurus.phys.s.u-tokyo.ac.jp, phone +81-3-5841-4217

***Abstract*—In the THz region, there exist many spectral lines of various fundamental atoms, ions and molecules, which give us novel information on chemical and physical state of interstellar clouds including star and planet forming regions. Although observations of these lines have successfully been done with Herschel HIFI, further observations with higher angular resolution from the ground-based telescope are still important for some THz atmospheric windows. With this in mind, we have been developing superconducting HEB (Hot Electron Bolometer) mixers for the THz frequency region at The University of Tokyo. By use of these mixers, we have prepared a cartridge-type THz heterodyne receiver for the 0.9 THz and 1.3-1.5 THz bands, and have successfully conducted a commissioning run on the ASTE 10 m telescope (Atacama Chile).**

The receiver is the ALMA cartridge type with a single beam. It can observe the dual bands (0.9 THz and 1.3-1.5 THz) simultaneously in the DSB mode by using the wire grid. The IF band is 1.0-1.2 GHz. As for local oscillators (LOs), we use 3 different multiplier chains driven by a microwave synthesizer for the 3 observation frequencies; 0.9, 1.3, 1.5 THz. In the commissioning run, the LOs for 0.9 and 1.3 THz have been installed. We employ the in-house waveguide HEB mixers for the both bands. Although SIS mixers now show a better performance than HEB mixers at 0.9 THz, we use the HEB mixer to demonstrate observation capability of our HEB mixer. We use NbTiN superconducting films fabricated on a quartz substrate for the HEB mixers. The thickness of superconducting microbridges is 10.8 nm. The receiver performance is measured in the test cryostat, and the minimum receiver noise temperatures achieved are as low as 390 K for the 0.8 THz, 490 K for the 1.5 THz mixers.

The lowest system noise temperature including atmospheric attenuation is around 1000 K at 880 GHz, when the precipitable water vapor is 0.18 mm. From the continuum observation of Jupiter, the beam efficiency is derived to be about 30% at 880 GHz for the illumination of the inner 7 m area of the 10 m telescope. Furthermore, we have succeeded in detecting the spectral line of ^{13}CO (*J*=8-7; 881.3 GHz) toward the Orion A molecular cloud. Now we are improving the mixer to expand the IF bandwidth for the next run, which is expected in 2012.