Noise Temperature and Noise Bandwidth of Hot-Electron Bolometer Mixer at 3.8 THz

Ivan Tretyakov[1*], Sergey Seliverstov[1], Philipp Zolotov[1], Natalya Kaurova[1], Boris Voronov[1], Matvey Finkel[1], and Gregory Goltsman[1,2]

[1]*Moscow State Pedagogical University, Moscow*
[2]*National Research University Higher School of Economics, Moscow*

**Email: ivantretykov@mail.ru*

We report on our recent results of double sideband (DSB) noise temperature and bandwidth measurements of quasi-optical hot electron bolometer (HEB) mixers at local oscillator frequency of 3.8 THz. The HEB mixers used in this work were made of a NbN thin film and had a superconducting transition temperature of about 10.3 K. To couple terahertz radiation, the NbN microbridge (0.2 µm long and 2 µm wide) was integrated with a planar logarithmic-spiral antenna. The mixer chip was glued to an elliptical Si lens clamped tightly to a mixer block mounted on the 4.2 K plate of a liquid helium cryostat. The terahertz radiation was fed into the HEB device through the cryostat window made of a 0.5 mm thick HDPE. A band-pass mesh filter was mounted on the 4.2 K plate to minimize the direct detection effect [1]. We used a gas discharge laser irradiating at 3.8 THz H_20 line as a local oscillator (LO). The LO power was combined with a black body broadband radiation via Mylar beam splitter. Our receiver allows heterodyne detection with an intermediate frequency (IF) of a several gigahertz which dictates usage of a wideband SiGe low noise amplifier [2]. The receiver IF output signal was further amplified at room temperature and fed into a square-law power detector through a band-pass filter. The DSB receiver noise temperature was measured using a conventional Y-factor technique at IF of 1.25 GHz and band of 40 MHz. Using wideband amplifiers at both cryogenic and room temperature stages we have estimated IF bandwidth of the HEB mixers used.

The obtained results strengthen the position of the HEB mixer as one of the most important tools for submillimeter astronomy. This device operates well above the energy gap (at frequencies above 1 THz) where performance of state-of-the-art SIS mixers starts to degrade. So, HEB mixers are expected to be a device of choice in astrophysical observations (ground-, aircraft- and space-based) at THz frequencies due to its excellent noise performance and low LO power requirements. The HEB mixers will be in operation on Millimetron Space Observatory.

References

1. J. J. A. Baselmans, A. Baryshev, S. F. Reker, M. Hajenius, J. R. Gao, T. M. Klapwijk, Yu. Vachtomin, S. Maslennikov, S. Antipov, B. Voronov, and G. Gol'tsman, Appl. Phys. Lett., 86, 163503 (2005).
2. Sander Weinreb, Life Fellow, IEEE, Joseph C. Bardin, Student Member, IEEE, and Hamdi Mani, "Design of Cryogenic SiGe Low-Noise Amplifiers", *IEEE Transactions on Microwave Theory and Techniques*, 55, 11, 2007.