Performance of a 275-500 GHz SIS mixer with 3-22 GHz IF

Takafumi Kojima[1], Matthias Kroug, Kazunori Uemizu, Yasutaka Niizeki, Akihira Miyachi, Keiko Kaneko, Yoshinori Uzawa,

The increase of the instantaneous bandwidth of low-noise heterodyne receivers is a key aspect for creating new prospects in radio astronomy at millimeter and submillimeter wavelengths. For example, instruments with wider intermediate frequency (IF) bandwidth would offer better sensitivity and multiline spectral observations without changing the local oscillator (LO) frequency.

Wideband technology with respect to radio frequency (RF) is also beneficial because the possibility to cover wide RF ranges with the same receiver offers new science cases, mostly related to accurate observations of multiple spectral lines with the same receiver calibrations. In addition, the wideband RF technology allows us to reduce the total number of receivers to cover a particular RF range, and thus, to simplify maintenance and operation of telescopes.

So far, we have independently studied and developed wideband RF and IF technologies. The double sideband (DSB) receiver implementing wideband RF components showed about 2 to 3 times the quantum noise over the RF 275-500 GHz with the IF band of 4-8 GHz [1]; The SIS mixer-preamplifier module based on high current density SIS junctions demonstrates low-noise and flat gain over the 3–18-GHz IF range at local oscillator frequencies of 400-480 GHz [2].

Our aim in this study is to develop a wideband RF and IF receiver technology with the same SIS mixer. We have designed and fabricated a wideband RF and IF SIS mixer combining two technologies. As shown in Fig. 1, the preliminary result showed DSB receiver noise temperature below 3 times the quantum noise for the 3-22 GHz IF over the entire LO frequencies. Moreover, the noise temperature averaged over 3-22 GHz was almost comparable with the one for 4-8 GHz. In the symposium, we will present the current status and latest result of the wideband RF and IF SIS mixer.

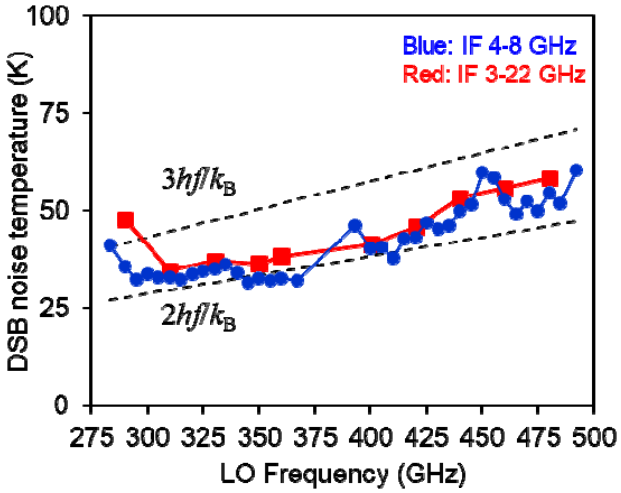

Fig. 1. Measured DSB noise temperatures averaged over 4-8 GHz and 3-22 GHz IF. While an isolator between the SIS mixer and cryogenic amplifier (CLNA) was used in the 4-8 GHz IF, the SIS mixer and CLNA was directly connected without using the isolator in the 3-22 GHz IF.

References

[1] T. Kojima, M. Kroug, A. Gonzalez, K. Uemizu, K. Kaneko, A. Miyachi, Y. Kozuki, and S. Asayama, "275–500-GHz Wideband Waveguide SIS Mixers," IEEE Transactions on Terahertz Science and Technology, vol. 8, no. 6, pp. 638-646, Nov. 2018.

[2] T. Kojima, M. Kroug, K. Uemizu, Y. Niizeki, H. Takahashi and Y. Uzawa, "Performance and Characterization of a Wide IF SIS-Mixer-Preamplifier Module Employing High-J c SIS Junctions," IEEE Transactions on Terahertz Science and Technology, vol. 7, no. 6, pp. 694-703, Nov. 2017

[1] National Astronomical Observatory of Japan, Osawa 2-21-1, Mitaka, Tokyo Japan.

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