

Low noise NbTiN 1.25 THz SIS mixer for Herschel Space Observatory

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We summarize the development of a SIS mixer for the 1.1-1.25 THz band of the heterodyne spectrometer of Herschel Space Observatory (HSO). The quasi-optical SIS mixer has two Nb/AlN/NbTiN junctions with the area of $0.25 \mu\text{m}^2$. The Josephson critical current density in the junction is $30\text{-}50 \text{ kA/cm}^2$. The tuning circuit integrated with SIS junction has the base electrode of Nb and a gold wire layer.

With the new SIS mixer the test receiver maximum Y factor is 1.41. The Y factor is measured with detection of IF power in entire 4-8 GHz IF band. The minimum receiver uncorrected DSB noise temperature is 450 K. The SIS receiver noise corrected for the loss in the optics is $350 - 450 \text{ K}$ across the $1100 - 1250 \text{ GHz}$ band (Fig. 1). The receiver has a uniform sensitivity in the full IF range of $4 - 8 \text{ GHz}$ (fig. 2). The sub-micron sized SIS junction design is optimized to ease the suppression of the Josephson current (fig. 3), and the receiver operation is stable. The measured mixer beam pattern is symmetrical and, in a good agreement with the design requirements, has the $f/d = 4.25$ at the central frequency of the operation band (fig. 4). The developed mixer satisfies the requirements for the use at the HSO.

The minimum DSB SIS receiver noise is close to 6 hv/k , apparently for the first time in the far infrared band. The Local Oscillator power used for frequency mixing is only 100 nW . The combination of a low noise and a low LO power requirement makes the SIS receiver a prospective instrument for exploration in $1\text{-}2 \text{ THz}$ band.

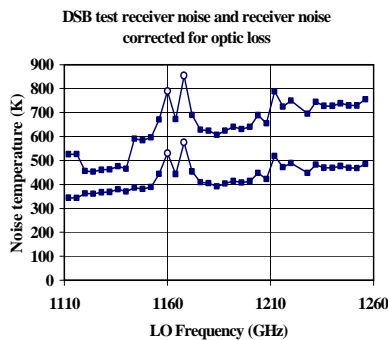


Fig. 1.

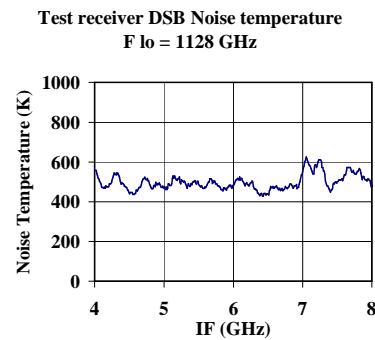


Fig.2

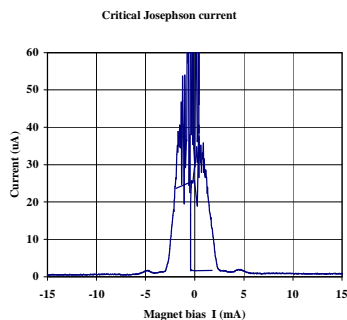


Fig. 3

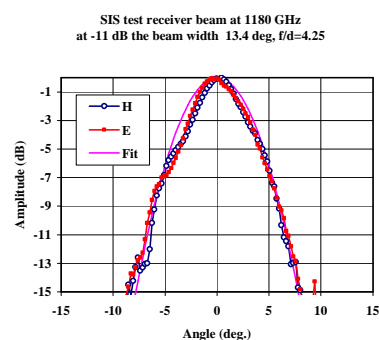


Fig. 4