

SUPERCONDUCTING HOT-ELECTRON BOLOMETER MIXER FOR TERAHERTZ HETERODYNE RECEIVERS

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A number of on-going astronomical and atmospheric research programs are aimed to the Terahertz (THz) spectral region. At frequencies above about 1.4 THz heterodyne receivers planned for these missions will use superconducting hot-electron bolometers as a mixers.

We present current results of the development of superconducting NbN hot-electron bolometer mixer for GREAT (German Receiver for Astronomy at Terahertz Frequencies, to be used aboard of SOFIA) and TELIS (Terahertz Limb Sounder). The mixer is incorporated into hybrid antenna consisting of a planar feed antenna, which has either logarithmic spiral or double-slot configuration, and hyperhemispherical silicon lens. The best 2200 K double side-band receiver noise temperature was achieved at 2.5 THz. It was constant across a 1 GHz intermediate frequency bandwidth centred at 1.5 GHz. For this operation regime, a receiver conversion efficiency of -16 dB was directly measured and the loss budget was evaluated including optical coupling loss, mixer conversion loss and intermediate frequency mismatch. The mixer response was linear at load temperatures smaller than 400 K. The hybrid antenna showed almost frequency independent and symmetric radiation pattern with the beam-width slightly broader than expected for a diffraction limited antenna.

The receiver was tested in the laboratory environment by measuring a methanol (CH_3OH) emission line at 2.5 THz (84.204 cm^{-1}) in a gas cell with 50 cm absorption path. Fitting of the measured line by the Voigt profile suggests a pressure-broadening coefficient of ≈ 29 MHz/mbar. This reasonably corresponds to the expected line-width deduced from pressure broadening measurements at millimeter wavelengths and, thus, confirms the true heterodyne detection regime of the mixer.