Superconducting Integrated Receiver with HEB-Mixer

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Detectors in THz range with high sensitivity are very essential nowadays in different fields: space technology, atmospheric research, medicine and security. The most sensitive heterodyne detectors below 1 THz are the SIS-mixers due to its extremely high non-linearity and low noise level. Nevertheless, their effective range is strongly limited by superconducting gap Δ (about 1 THz for NbN circuits). Above 1 THz the detectors based on HEB (hot electron bolometers) are more effective [1]; their operation frequency is not limited from above and can be up to 70 THz [2]. HEBs can perform as both direct and heterodyne detectors (mixers). All HEB-mixers are used with external heterodyne, most useful are synthesizer with multipliers, quantum cascade lasers or far infrared lasers and backward-wave oscillators.

Superconducting integrated receiver (SIR) is based on implementation of both SIS-miser and flux flow oscillator (FFO) acting as heterodyne at single chip [3]. Such receiver has been successfully applied at TELIS balloon-borne instrument for study of atmospheric constituents [4] and looks as very promising device for other THz missions including space research. Thus, there is a task to expand its operating range to higher frequencies. The frequency range of the SIR the operation is limited by both the SIS-mixer and the FFO maximum frequencies. The idea of present work is implementation of the HEB as a mixer in the SIR instead of the SIS traditionally used. We introduce the first results of integrating the HEB-mixer coupled to planar slot antenna with the FFO on one chip. For properly FFO operation the SIS harmonic mixer is used to phase lock the oscillator. The scheme of the SIR based on the HEB-mixer is presented in fig. 1.

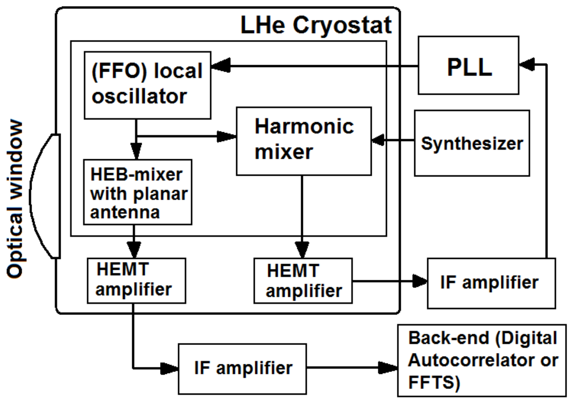

Fig.1. Block-diagram of the superconducting integrated receiver based on hot electron bolometer

We have demonstrated the principal possibility of integration of both the HEB-mixer and the flux-flow oscillator on a single chip and succeed with sufficient power coupling for properly receiver operation. We measured the direct response of the HEB coupled to the antenna at THz frequencies by the FTS setup and noise temperature of the receiver with standard Y-factor measuring technique. The SIR operating range 450-620 GHz was achieved with the best uncorrected noise temperature of about 1000 K. One should note that it is still quite low frequencies for effective operation of the HEB-mixer; therefore we expect to obtain the better results for frequencies above 700 GHz (up to 1.2 THz). Another additional task is to increase the FFO frequencies by using NbTiN electrodes instead of NbN; currently we are working on this issue.

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