Superconducting Integrated Spectrometer for TELIS

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We report on the results of developing a single-chip superconducting integrated receiver which is the key element of the 500 -650 GHz spectrometer for the Terahertz Limb Sounder (TELIS) balloon project. TELIS is a collaborative European project to develop a three-channel heterodyne balloon-based spectrometer for measuring a variety of atmospheric constituents of the stratosphere. The Superconducting Integrated Receiver (SIR) comprises in one chip a planar antenna integrated with an SIS mixer, a superconducting Flux Flow Oscillator (FFO) acting as Local Oscillator (LO) and a second SIS harmonic mixer (HM) for the FFO phase locking.

As a result of the FFO design optimization a free-running linewidth between 9 and 1.5 MHz has been measured in the frequency range 500 – 710 GHz resulting in phase-locking of 35 to 95 % of the FFO power correspondingly. A new generation of the SIR devices with improved FFO performance and optimized interface between FFO and SIS/HM has been developed and comprehensively tested; all required TELIS parameters were demonstrated. Phase–locked FFO operation over entire SIR channel frequency range has been realized, spectral resolution below 1 MHz has been confirmed by gas cell and CW signal measurements. An uncorrected double side band (DSB) noise temperature about 200 K has been measured with the phase-locked FFO. The intermediate frequency bandwidth 4-8 GHz has been realized. To ensure remote operation of the phase-locked SIR several procedures for its automatic computer control have been developed and tested.

To overcome temperature constraints and extend operation frequency of the all-Nb SIR we have developed and studied Nb-AlN-NbN-Nb circuits with a gap voltage Vg up to 3.7 mV and extremely low leakage currents (Rj/Rn > 30). Based on these junctions integrated microcircuits comprising FFO and harmonic mixer have been designed, fabricated and tested; the radiation from such circuits has been measured at frequencies up to 700 GHz. Employment of NbN electrode does not result in the appearance of additional noise. For example, FFO linewidth as low as 1 MHz was measured at 600 GHz, that allows us to phase lock up to 92 % of the emitted by FFO power and realize very low phase noise about –90 dBc. Preliminary results demonstrated uncorrected DSB noise temperature of the Nb-AlN-NbN SIR below 250 K at frequencies of primary TELIS interest around 500 and 600 GHz. We expect that Nb-AlN-NbN-Nb device will be used for the first qualification TELIS flight that is scheduled on April 2007.

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