Integrated Submillimeter and Terahertz Receivers with Superconducting Oscillator

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ABSTRACT

The Josephson Flux Flow Oscillator (FFO) has proven to be a perfect on-chip local oscillator for integrated submm receivers. Local oscillators based on Nb-AlO_x-Nb FFOs have been successfully tested from about 120 to 700 GHz (gap frequency of Nb) providing enough power to pump an SIS-mixer (about 1 μW at 450 GHz); both the frequency and the power of the FFO can be dc-tuned. Recently a possibility of FFO phase locking has been experimentally proven for the first time for ANY type of Josephson oscillator.

The concept of a fully Superconducting Integrated Receiver (SIR) has been developed and experimentally demonstrated in a tight collaboration between the Institute of Radio Engineering and Electronics (IREE-Moscow) and the Space Research Organization of the Netherlands (SRON-Groningen). A single-chip submm wave receiver includes a planar antenna integrated with a SIS mixer, pumped by an internal superconducting FFO as local oscillator (LO). A DSB noise temperature below 100 K has been demonstrated around 500 GHz. A compact array of 9 SIRs has been developed and tested. Each pixel contains an *internally pumped* receiver chip, which is mounted on the back of an elliptical silicon lens.

A breadboard of a superconducting integrated spectrometer with a phase-locked FFO has been tested showing that the frequency resolution of the full receiver is as low as 10 kHz at 364 GHz. The effect of broadening of a spectral line of SO_2 gas at 326,867 MHz is measured for a laboratory gas cell at 300 K within the pressure range of 30-300 mbar. This study provides an important input for future development of a balloon-based 500-650 GHz integrated receiver for the Terahertz Limb Sounder (TELIS) scheduled to fly in 2004-2005.

To extend an operational frequency of SIR above 0.7 THz, the gap frequency of Nb, an NbN-based flux-flow-type Josephson oscillator has been developed and preliminary tested. These experimental results indicate that FFOs with high-J_C NbN/AlN/NbN junctions are applicable for an on-chip LO up to 1 THz. First results for linewidth measurements of NbN/AlN/NbN junctions will be presented.