Superconducting Local Oscillators: Development and Optimization.

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Different types of the superconductor local oscillators (SLO) were considered for integration with a SIS-mixer to build fully superconducting integrated receivers (SIR). The Josephson Flux Flow Oscillators (FFO) based on Nb-AlOx-Nb and Nb-AlN-NbN junctions have proven to be the most developed for such integration. The continuous frequency tuning of the FFO over the 250 - 750 GHz frequency range and the possibility of SLO phase stabilization have been achieved. The output power of the FFO is sufficient to pump integrated on the same chip SIS mixer in a wide frequency range; the FFO power can be electronically adjusted. The FFO free-running linewidth has been measured between 0.3 and 5 MHz; resulting in the spectral ratio of the phase-locked FFO from 99 to 70% over the whole frequency range. The possibility of reaching the phase noise of the order of -90 dBc at an offset from a carrier frequency of more than 100 kHz has been demonstrated experimentally. These achievements enabled the development of a 480 - 650 GHz integrated receiver for the atmospheric-research instrument TELIS (TErahertz and submillimeter LImb Sounder). The concept of using cryogenic PLL for the efficient synchronization of the superconducting local oscillator has been proposed and tested; a key element of this concept is a new element of superconducting electronics - cryogenic phase detector. Due to its compactness and low loop delay, a bandwidth of the synchronization as large as 70 MHz has been achieved.

To improve further FFO parameters and to extend its frequency range a number of new FFO designs were developed and investigated. The goal is to simplify the FFO operation at lower frequencies (through Fiske steps suppression at frequencies below Josephson self-coupling boundary) as well as to extend the FFO operation frequency beyond 1 THz. Optimization of junction topology and parameters of integrated superconductor local oscillators with NbN and NbTiN electrodes is under way. A new generation of the integrated receiver circuits with operating frequencies up to 1.2 THz is under development. The results of numerical modeling and tests will be presented.