Superconducting Integrated Receiver for TELIS: optimization and computer control

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Abstract

The Superconducting Integrated Receiver (SIR) contains a few interactive devices: SIS mixer integrated in planar antenna, a superconducting phase-locked Flux Flow Oscillator (FFO) acting as a Local Oscillator (LO), harmonic mixer (HM) for the FFO phase locking. DAQ system IRTECON was created for fast testing and control this complex device.

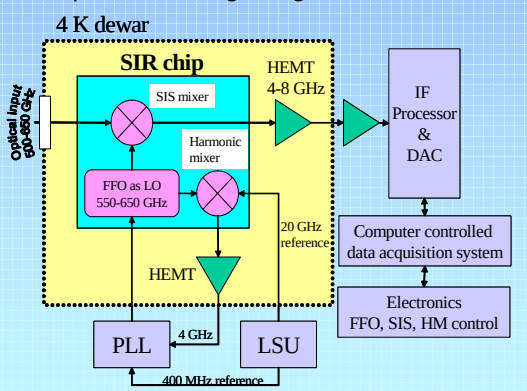
IRTECON system makes it possible to collect data for all internal SIR devices and the SIR as a unit, to create specific measurement procedures, to optimize operational characteristics and to provide real-time SIR control.

Special procedures had been developed and tested with the flight electronics:

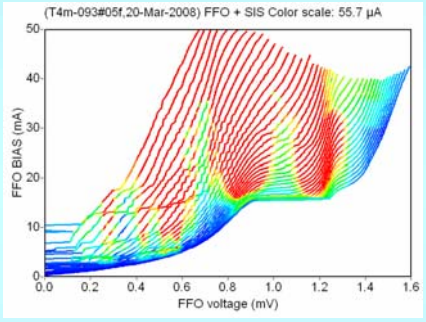
- fast definition of the operational conditions for the FFO (both in the Fiske step and quasi-particle regimes);
- measurements of the free-running FFO linewidth;
- optimization of the LSU and HM parameters;
- optimization of the PLL operation;
- minimization of the SIR noise temperature;
- setting all predefined SIR parameters in the exact sequence for flight (with checking and adjustments);
- continuous monitoring of the main SIR parameters, adjustment (or recovering) the SIR operational state;

The flight version of the program has been created for remote control of the TELIS-SIR in flight. Base algorithms were translated in macros for effective remote SIR control.

Superconducting Integrated Receiver

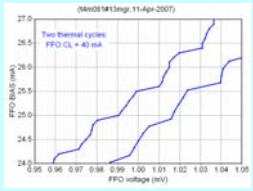


Schematics of the FFO stabilization circuit. FFO frequency is mixed in HM with the 19-21 GHz reference. The mixing product is amplified, down converted and compared with the 400 MHz reference in the PLL. The phase difference signal generated by PLL is used to feedback the FFO control line.

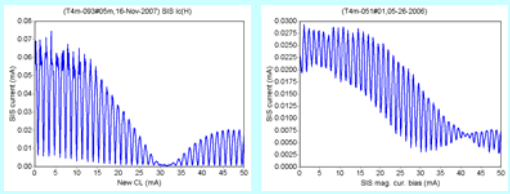


IV-curves of FFO at different magnetic fields. A color scale indicates the regions in which photon-induced current of SIS-mixer is sufficient for receiver operation (the red color means the larger value of the induced current).

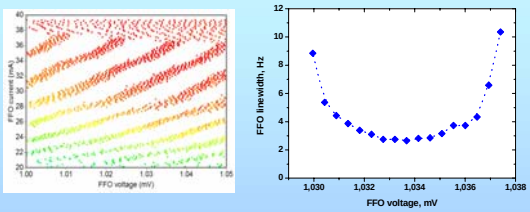
Repeatability of the SIS and the FFO characteristics.



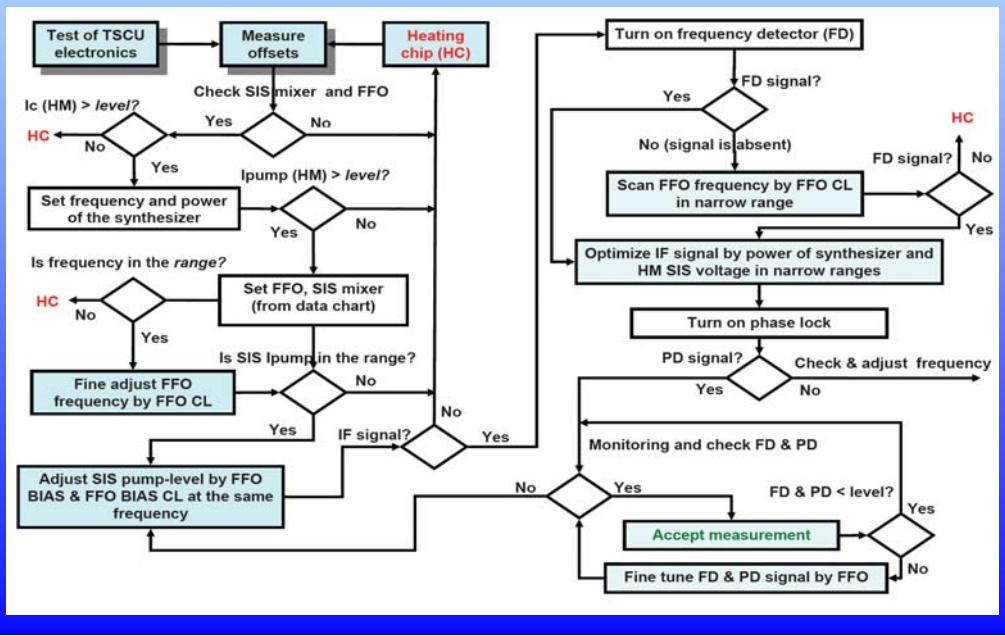
Two FFO I-V curves at the same magnetic current 53 mA after thermal cycle.

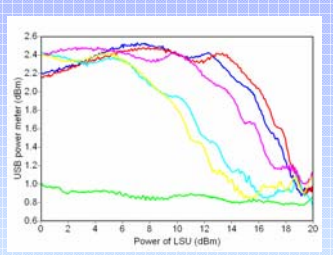


Dependence of the SIS Ic (New CL). Left – picture of "normal" Ic suppression, right - Ic suppression for a SIS with trapped magnetic flux

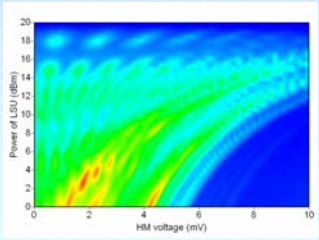


Fiske step regime, FFO frequency of about 500 GHz

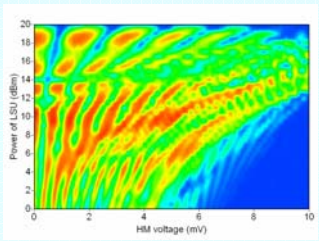




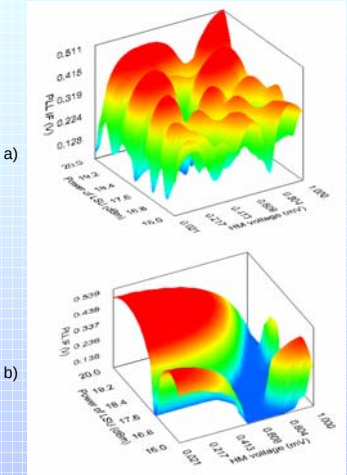
Choosing LSU frequency. Green curve – the best one. FFO frequency = 619.1 GHz



SIS IF dependence on HM voltage and LSU power. FFO frequency = 619.1 GHz, LSU frequency = 20.77 GHz



PLL IF dependence on HM voltage and LSU power. FFO frequency = 619.1 GHz, LSU frequency = 20.77 GHz



Dependencies of the IF output signal on the HM bias voltage and synthesizer power: a) LSU frequency - 19.72 GHz, FFO frequency = 497 GHz; b) LSU frequency - 20.46 GHz, FFO frequency = 495 GHz

Summary

- The complex DAQ system "IRTECON" has been created;
- The set of procedures for optimization of main SIR regimes has been developed and experimentally proven;
- The algorithms to adjust and recover the SIR state have been created;
- The flight program for remote SIR control has been developed;

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