First light from the Superconducting Integrated Receiver on board Terahertz limb sounder TELIS

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***Abstract*— We present the flight configuration and performance of the Superconducting Integrated Receiver (SIR) channel on the TELIS instrument (Terahertz and Submm Limb Sounder). The SIR is an on-chip combination of a low-noise SIS mixer with a quasioptical antenna, a superconducting Flux Flow Oscillator (FFO) acting as Local Oscillator (LO) and an SIS harmonic mixer (HM) for FFO phase locking. The SIR has been assembled, fully integrated into the system and thoroughly tested in preparation for the flight campaign in May 2008 (Teresina, Brazil).**

I. Introduction And Background

TELIS (Terahertz and submm Limb Sounder) is a cooperation between European institutes, DLR, RAL and SRON, to build a three-channel balloon-borne heterodyne spectrometer for atmospheric research [1]. Many atmospheric trace gases have their rotational transitions in the sub-millimeter and THz-range, yielding a rich spectrum. Limb sounding results in the most accurate vertical profiles.

TELIS is designed to be a compact, lightweight instrument capable of providing broad spectral coverage, high spectral resolution and long flight duration (~24 hours duration in a flight campaign).

The 500 - 650 GHz channel is developed by SRON and IREE and will measure profiles of ClO, BrO, O3, HCl, HOCl, H2O and its 3 isotopomers, HO2, NO, N2O, HNO3, CH3Cl and HCN.

TELIS will fly with the existing Fourier transform spectrometer MIPAS-B developed by the IMK (Institute of Meteorology and Climate research of the University of Karlsruhe, Germany). The two instruments together yield the most complete set of stratospheric constituents. The first flight will take place in May 2008 from Teresina, Brazil.

II. Instrument design

The optical front-end of TELIS consists of a pointing telescope, a calibration unit and relay optics, common for the three channels: 500 GHz, 500-650 GHz and 1.8 THz [1].

Frequency separation between the channels is performed quasioptically using a dichroic plate and a wire-grid beamsplitter, allowing simultaneous observations by all receivers. After the splitting, the three beams enter a custom designed liquid helium cooled cryostat. Inside the cryostat the receivers have dedicated cold optics, mixing element and IF amplifiers. Three amplified output IF signals are analyzed using a 2x2 GHz digital autocorrelator. The total instrument is about 1x1x0.6 m^3 and has a weight of 90 kg (see Fig. 1).

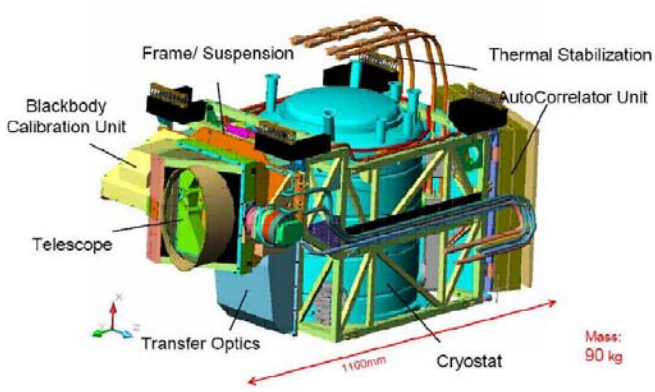

Fig. 1. Schematic of the TELIS instrument.

The 500 - 650 GHz channel for TELIS is based on a phase-locked Superconducting Integrated Receiver (SIR) which combines on a 4x4 mm2 chip the low-noise SIS mixer and its quasioptical antenna, a superconducting phase-locked Flux Flow Oscillator (FFO) acting as Local Oscillator (LO) and a SIS harmonic mixer (HM) for FFO phase locking. The microcircuit is fabricated on a Si substrate using a Nb-AlN/NbN-Nb tri-layer.

Capability of the SIR for high resolution spectroscopy has been successfully proven in a laboratory environment. TELIS will be the first practical implementation of the SIR technology in a science mission and act as a demonstrator for future air- and space-born projects.

III. Results

We will present performance of the completely integrated flight configuration SIR channel, including noise performance (uncorrected double sideband receiver noise temperature below 200 K in about 100 GHz input frequency range), beam pattern measured using compact range, system stability and gas cell measurements using flight electronics and backend spectrometer.

It is expected that at the time of the Conference the instrument has flown for the first time in Teresina, Brazil. We will present the most recent data on the instrument in-flight performance as well as the first spectra obtained during the mission.

References

[1] R.W.M. Hoogeveen, *et al.*, "New cryogenic heterodyne techniques applied in TELIS: the balloon borne THz and submm limb sounder for atmospheric research", Proc. of SPIE, Infrared Spaceborne Remote Sensing XI, 5152, p. 347-355, 2004..

978-1-4244-2120-6/08/$25.00 ©IEEE.