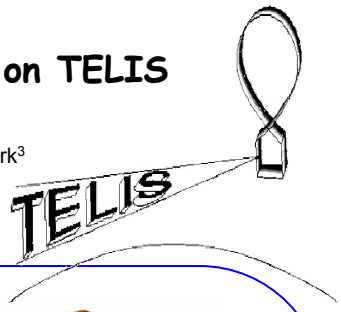
Integration and performance of the flight configuration SIR on TELIS

P. Yagoubov[1], G. de Lange[1], A. de Lange, M. Romanini, *R. Hoogeveen[1]*, V. Koshelets[2], G. Wagner[3], M. Birk[3]

SRON Netherlands Institute for Space Research

[1]National Institute for Space Research, SRON, the Netherlands
[2]Institute of Radio Engineering and Electronics, IREE, Russia
[3]Institute for Remote Sensing Technology, DLR, Germany



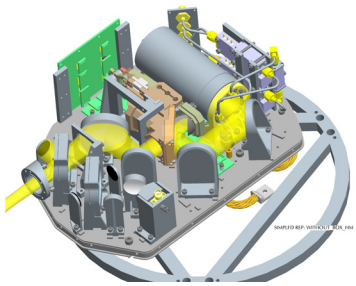
Abstract

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. Many atmospheric trace gases have their rotational transitions in the sub millimeter and THz range, yielding a very rich spectrum. Limb sounding results in very accurate vertical profiles.

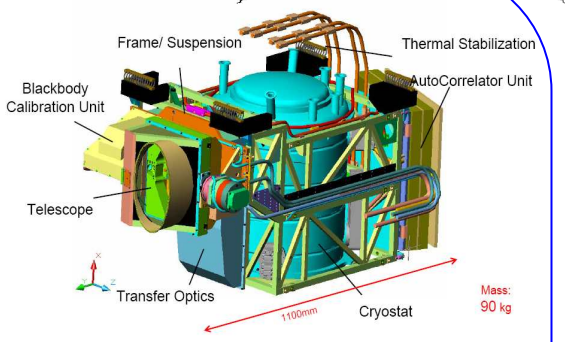
TELIS is designed to be a compact, lightweight instrument capable of providing broad spectral coverage, high spectral resolution and long flight duration (~24 hours duration in a flight campaign). The combination of high sensitivity and extensive flight duration will allow evaluation of the diurnal variation of key atmospheric constituents such as OH, HO2, ClO, BrO together will longer lived constituents such as O3, HCL and N2O. TELIS will fly with a 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 will yield the most complete set of stratospheric constituents. The TELIS instrument serves also as a test bed for novel cryogenic technologies. The first flight is foreseen in Nov. 2007 from Teresina, Brazil.

In this poster we present development status and performance of the 500 - 650 GHz channel for TELIS. It is based on a phase-locked Superconducting Integrated Receiver (SIR) which combines on a 4x4 mm^2 chip the low-noise SIS mixer and its quasioptical antenna, a superconducting phase-locked Flux Flow Oscillator (FFO) acting as Local Oscillator (LO) and SIS harmonic mixer (HM) for FFO phase locking.

In the end 2006 the SIR channel has been delivered to DLR and integrated into the flight cryostat. We present performance of the instrument, laboratory gas cell measurements using flight digital spectrometer, and system stability tests.



Cryogenic part of the SIR channel. It consists of the SIR mixer block surrounded by the antimagnetic shield, reflective optics, Martin-Puplett interferometer acting as a SSB filter, InP based 4-8 GHz IF amplifiers, dc bias filter boards etc.



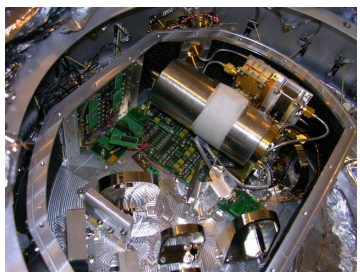


Photo of the integrated into the flight cryostat SIR channel. In the test flight the SIR will operate in double sideband mode; SSB filter is replaced by a set of two plane mirrors

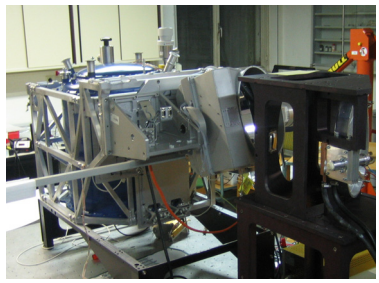
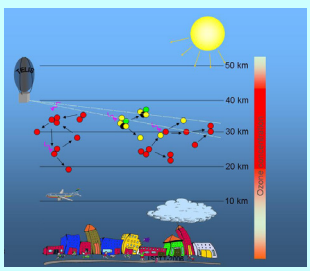
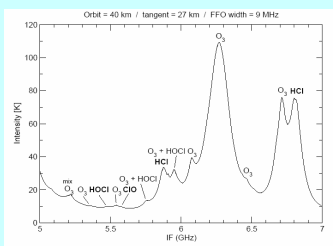


Photo of the TELIS flight cryostat integrated into the frame. At the frame front side one can see the warm optics plate and a pointing telescope.

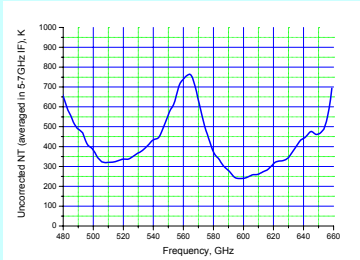
TELIS scientific background



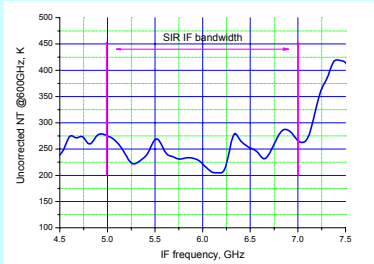


Model of the atmospheric spectrum to be measured with the SIR channel. Receiver operates in DSB mode, LO frequency - 619 GHz.

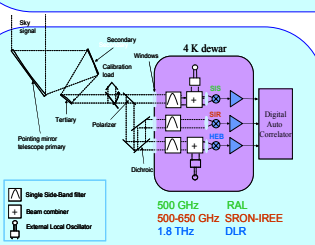
SIR channel performance



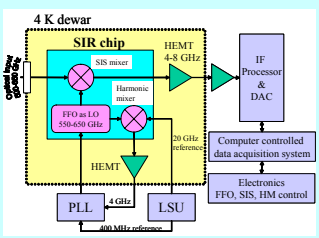
Uncorrected DSB noise temperature of the SIR cold channel, averaged in the 5-7 GHz IF bandwidth.



DSB noise temperature of the SIR cold channel as a function of the IF frequency at 600GHz.



Schematics of the TELIS instrument. Telescope, calibration blackbody and relay optics are common for the three channels. Beam separation between the frequency channels is performed quasioptically by a dichroic filter and a polarizer.



Schematics of the FFO stabilization circuit. FFO frequency is mixed in HM with the 19-21 GHz reference. The mixing product is amplified, downconverted 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.

Gas cell measurements

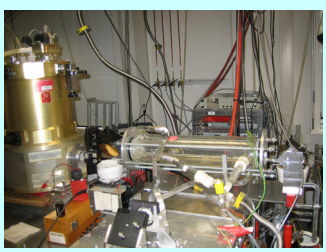
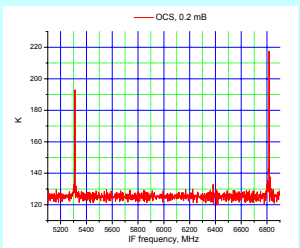
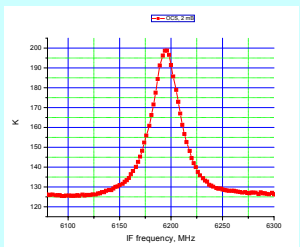


Photo of the measurement setup. Switching mirror selects between "cold" load (receiver beam is directed downwards, as in the picture), "hot" (beam is directed upwards), or "signal" (beam is directed towards the gas cell).

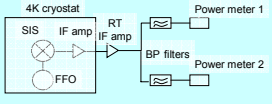


Deconvolved spectrum of the OCS emission lines at a gas pressure 0.2 mBar. LO frequency 624.93 GHz. Two lines are detected, one in the LSB, the other one in the USB. Both lines are saturated, the difference in line strength reflects the sideband ratio of the receiver.

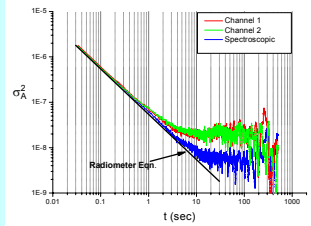


Deconvolved spectrum of the OCS emission line at a gas pressure 2 mBar. LO frequency 625.55 GHz. Integration time 20 sec.

Allan variance measurements



Schematics of the Allan variance measurement setup. Two IF channels are used to determine the spectroscopic (differential) Allan variance. The noise fluctuation bandwidth of each channel is 17 MHz.



System stability of the SIR channel. FFO is phase locked at 600GHz. Green and blue lines present individual channels variance, the black one – radiometric variance.

Summary

TELIS objectives:

- Scientific measurements of Earth atmosphere
- Test bed for novel sensors/technologies
- Validation of satellite missions

SIR channel status:

- SIR channel is integrated into the flight cryostat
- Performance meets baseline specifications
- Test flight in November 2007 in Teresina, Brazil

For further information please contact: p.a.yagoubov@sron.rug.nl

SRON Netherlands Institute for Space Research

DLR

Universität Bern