HYper-spectral Microwave Sounder - HYMS

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Science

•Upper Stratospheric Lower Mesospheric (USLM) observations

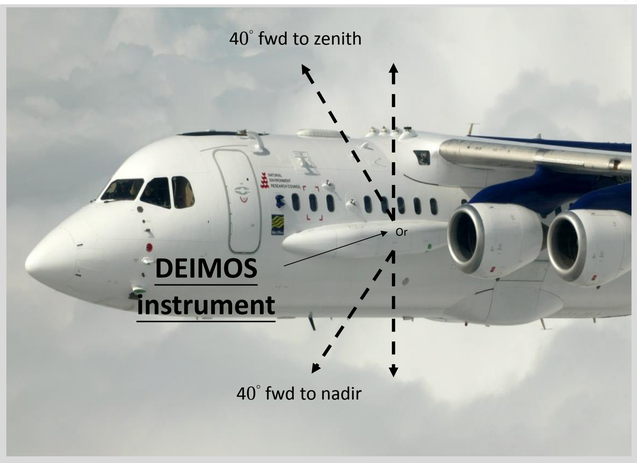
- *Lack of precise atmospheric spectral measurements above 40 km has restricted weather related modelling accuracy.*
- *Airborne microwave 'Hyper-spectral' radiometric observations provide an effective remote sensing solution.*
- *Detects O_2 and H_2O signatures at 60 GHz and 183GHz respectively.*
- *Provides very substantially increased spectral resolution.*
- *Delivers better numerical weather prediction leading to more accurate simulations and forecasts.*
- *Allows effects of narrowband contaminating radio frequency interference (RFI) to be mitigated via spectral algorithms*

Spectral Band		O_2 @60GHz		H_2O @183GHz
Frequency Range (GHz)		48.57.3	63.3-67.9	172 -194
Channel Bandwidth (MHz)	Goal	3	3	40
	Minimum	10	10	400
Polarisation	Goal	QH & QV	QH & QV	QH & QV
	Minimum	QH or QV	QH or QV	QH or QV
Radiometric Sensitivity NEDT (K)	Goal	0	0	0
	Min	1	1	0
Frequency Stability (MHz)	Goal	±1	±1	±25
	Min	±5	±5	±25
Priority		1	1	2

Molecular spectral features observable by the DEIMOS instrument

•Observational requirements

- *Hyperspectral resolution (<10MHz spectral precision).*
- *High sensitivity (NEΔT ~0.4K).*
- *Goal : Dual polarisation observations.*



***Field of view of the DEIMOS instrument on the* FAAM aircraft**

•Observational Techniques

- *Facility for Airborne Atmospheric Measurements (FAAM) BAE-146.*
- *View a range of zenith angles, as well as the more usual nadir angles.*
- *Half Power Beamwidth (HPBW) : 5º to 10º.*

60 GHz Receiver Specifications

- ***Heterodyne radiometer***
  - *Low noise amplifier first element in the Rx chain.*
  - *Sub-harmonic Schottky diode mixer for down-conversion.*
  - *Digital back-end spectrometer*

•Local Oscillator

- *External crystal oscillator reference at 75MHz.*
- *Frequency stability <0.2ppm over 50 °C.*
- *2 Phase Locked Dielectric Resonator Oscillators at 6.5GHz and 30.15 GHz.*

•Wide Band spectrometer

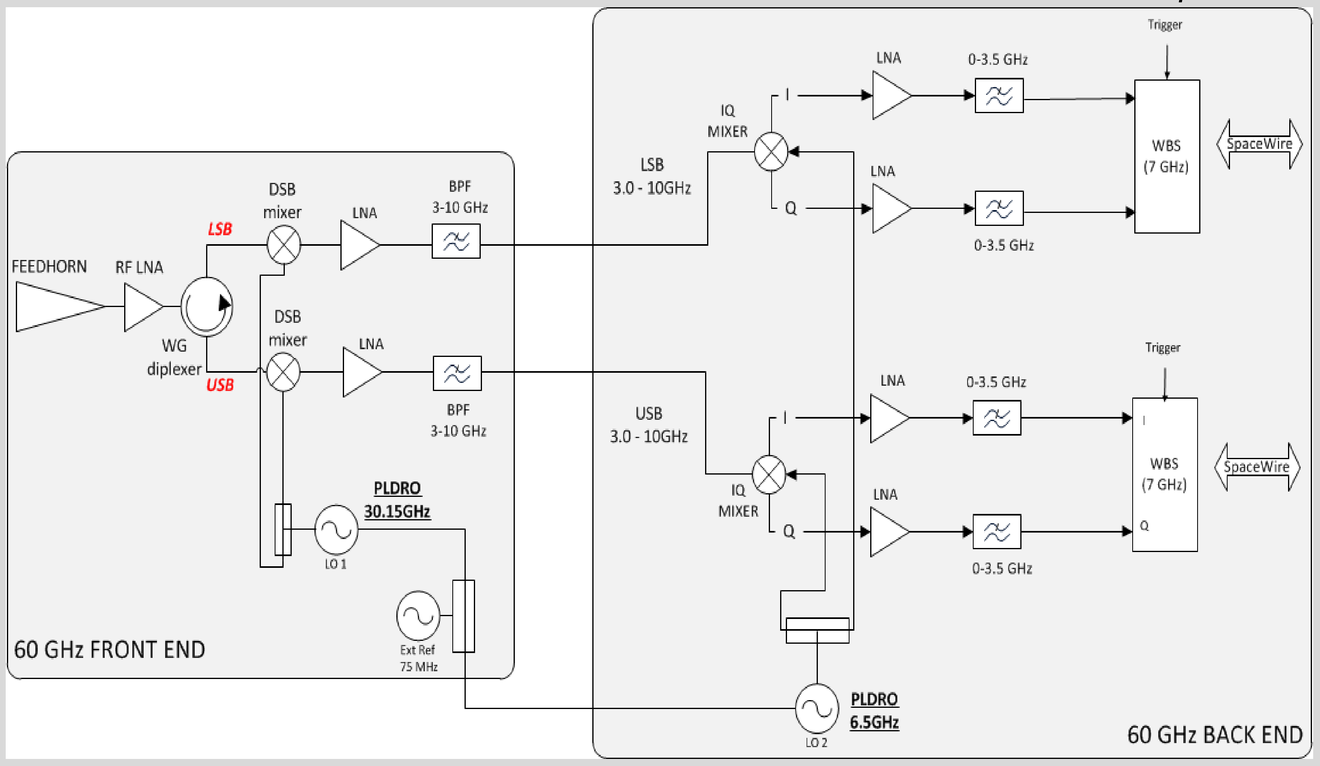
- *High-speed sampling*
- *Digital Fast-Fourier transform.*
- *8 GHz Bandwidth.*

•Double Sideband Detection

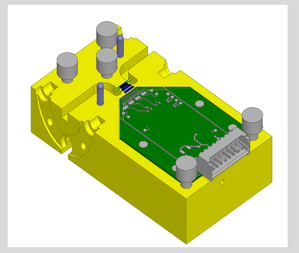
- *LSB : 50.0 – 57.3 GHz and USB : 63.3 – 67.9 GHz.*
- *System Noise temperature : 232 K, IF output : 0 – 4 GHz,*
- *Image Band rejection >40 dB.*

•Components

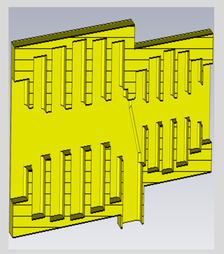
- *RF low noise amplifiers (~40dB gain, NF<2.5 dB).*
- *2 DSB SHM mixers (CL ~3.5 dB, Tmix <400 K).*
- *Low loss waveguide diplexer for side band separation.*



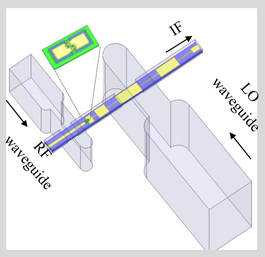
Schematic of the 60 GHz HYMS receiver.



RF LNA design configuration



60GHz Waveguide Diplexer



DSB mixer design configuration

WideBand Spectrometer (WBS)

Airborne Receiver Breadboard Payload

•DEIMOS instrument

- *183 GHz receiver.*
- *60 GHz receiver (HYMS).*

•HYMS calibration

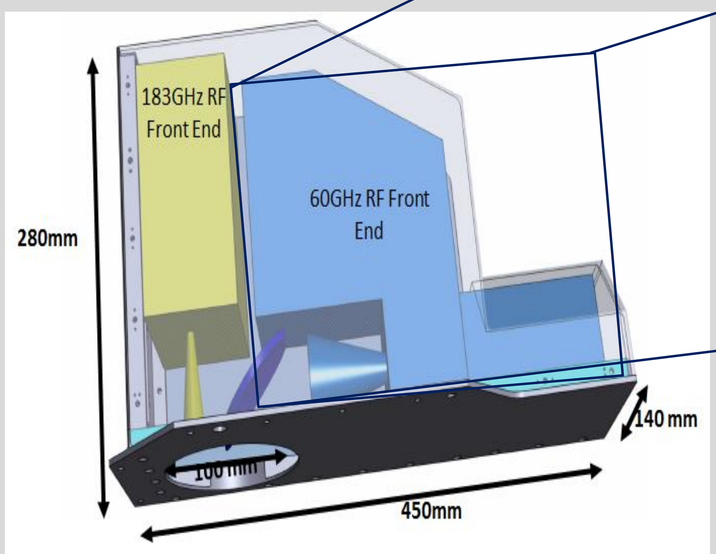
- *Hot/Cold blackbody calibration target.*
- *Radiometric Sensitivity NEΔT ~0.4K.*

•HYMS breadboard

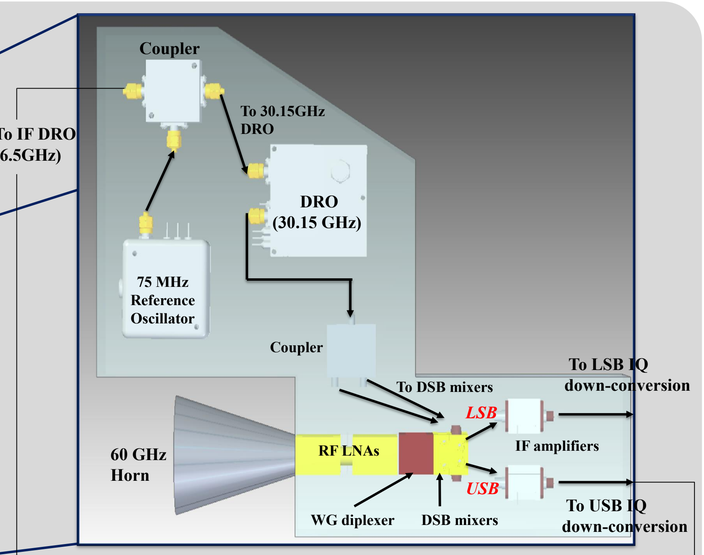
- *Front-End and Local Oscillator inside DEIMOS in a thermally stabilised environment.*
- *Back-End and WBS on 19" rack inside the aircraft.*

Parameter	Value
Scene Temperature	280 K
Cold calibration temperature	253 K
Hot calibration temperature	343 K
Tau scene	300 ms
Tau cold calibration view	600 ms
Tau hot caibration view	600 ms
Tau cal effective	2400 ms
Cal Ave factor	4
$\Delta G/\Delta T$	0.02 dB/°C
$\Delta T/\Delta t$	0.001 °C/s
Intercal period	3.0 s
ΔGrx	1.5E-4 dB

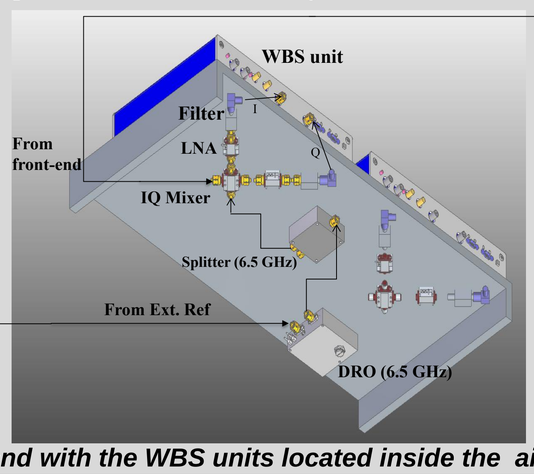
HYMS operational parameters and calibration



DEIMOS instrument – 183 GHz and 60 GHz receivers front-end.



Top view of the receiver Subsystem inside DEIMOS



Backend with the WBS units located inside the aircraft.

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