

# 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<sub>2</sub> and H<sub>2</sub>O 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 <sub>2</sub> @60GHz		H <sub>2</sub> O @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

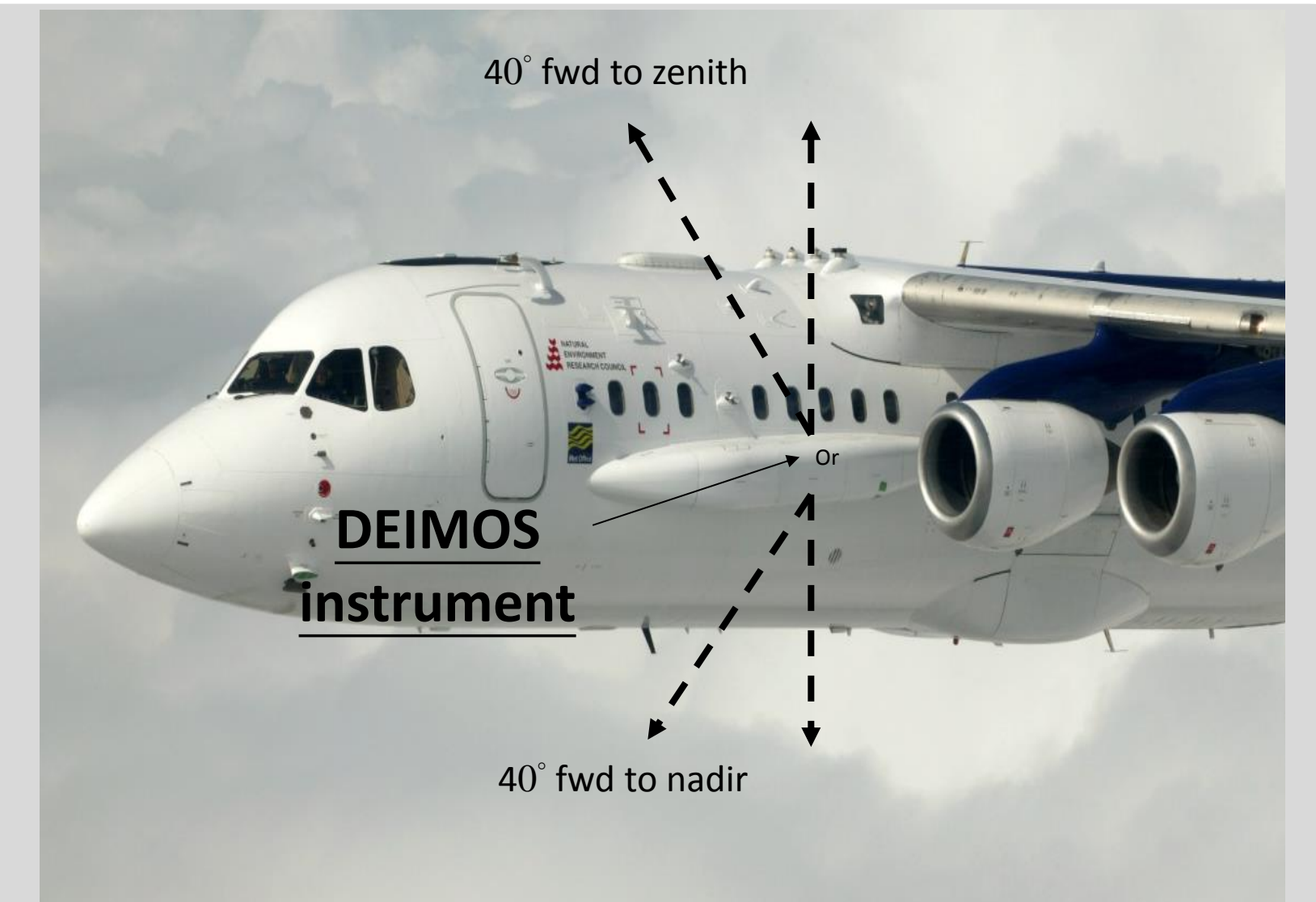
Molecular spectral features observable by the DEIMOS instrument

### •Observational requirements

- Hyperspectral resolution (<10MHz spectral precision).
- High sensitivity (NE $\Delta$ T ~0.4K).
- Goal : Dual polarisation observations.

### •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) : 5° to 10°.



Field of view of the DEIMOS instrument on the FAAM aircraft

## 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

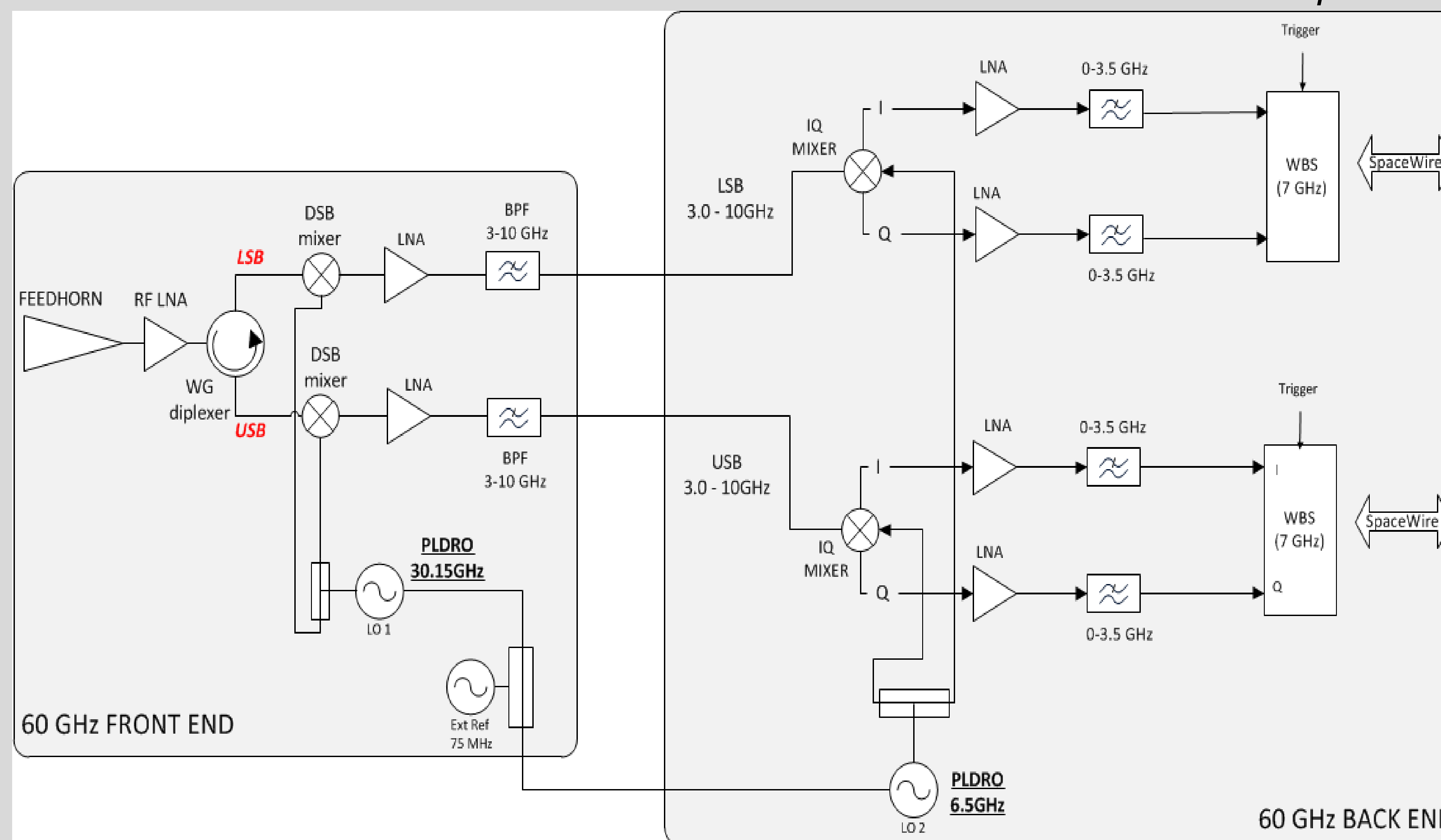
- High-speed sampling
- Digital Fast-Fourier transform.
- 8 GHz Bandwidth.

### •Double Sideband Detection

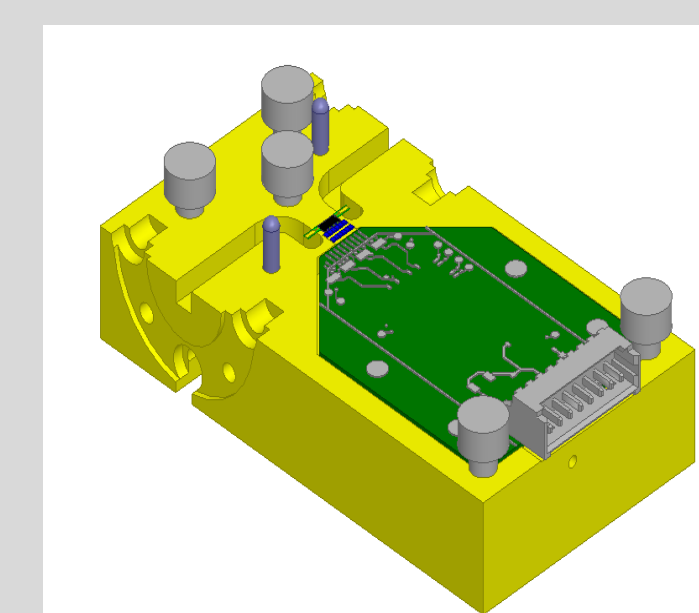
- LSB : 50.0 – 57.3 GHz and USB : 63.3 – 67.9 GHz.
- System Noise temperature : 232 K, IF output : 0 – 4 GHz,
- Image Band rejection >40 dB.

### •Components

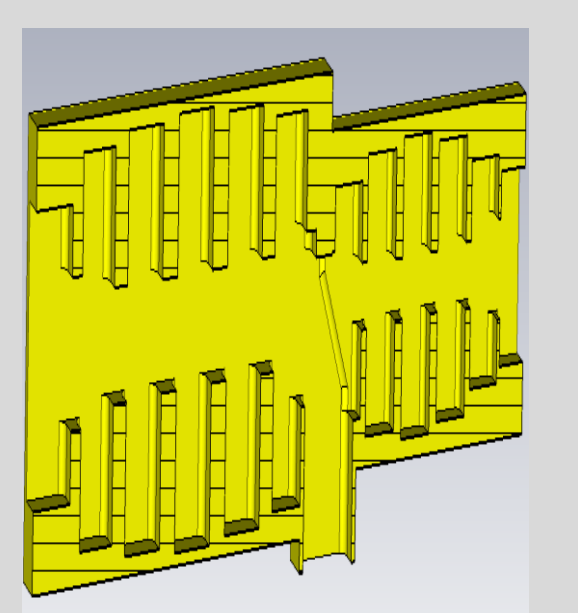
- RF low noise amplifiers (~40dB gain, NF<2.5 dB).
- 2 DSB SHM mixers (CL ~3.5 dB, Tmix <400 K).
- Low loss waveguide diplexer for side band separation.



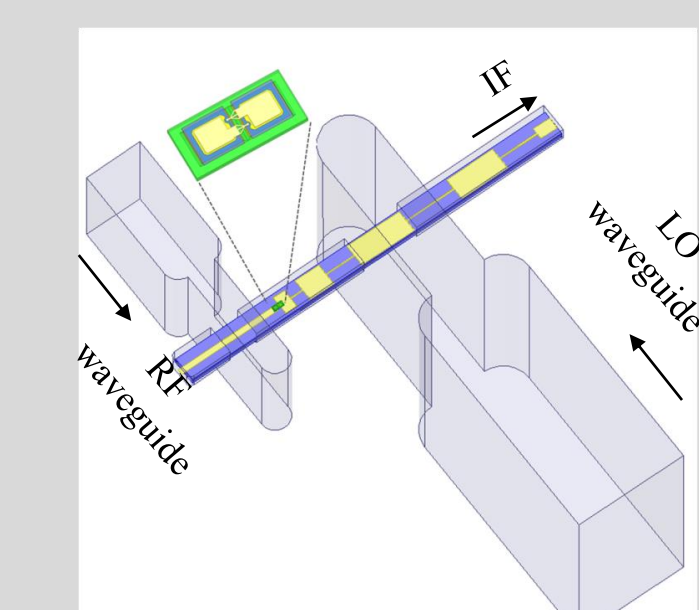
Schematic of the 60 GHz HYMS receiver.



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 NE $\Delta$ T ~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 calibration 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
$\Delta$ G <sub>rx</sub>	1.5E-4 dB

HYMS operational parameters and calibration

