We1A-6

Radiometric Noise Characterization of the 183-664 GHz Front-End Receivers for the MetOp-SG Ice Cloud Imager instrument – prospects for future missions

B. Thomas[1], G. Sonnabend[1], N. Wehres[1], M. Brandt[1], M. Trasatti[1], A. Andrés-Beivide[2], M. Bergada[2], J. Martinez[2], P. Robustillo[3], M. Gotsmann[3], U. Klein[4]

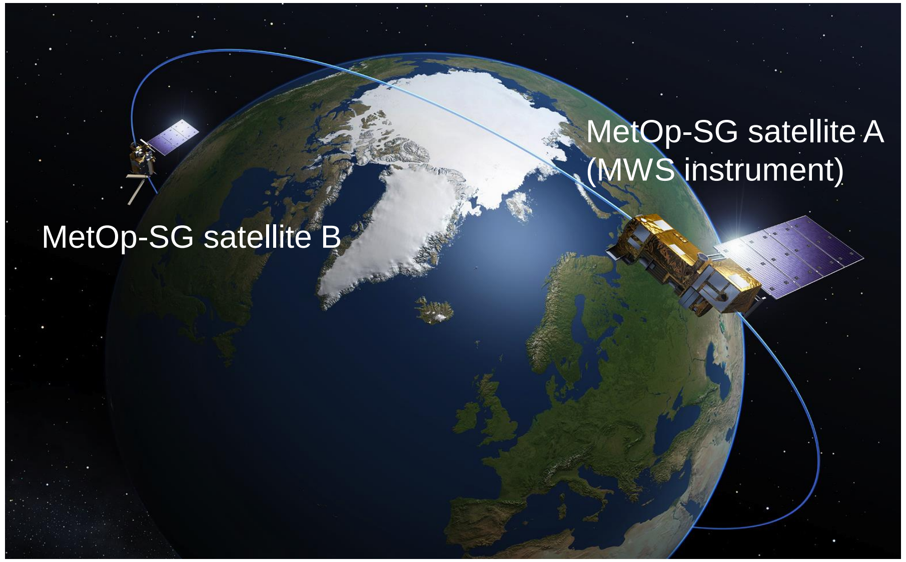
[1] Radiometer Physics GmbH, Germany, [2] Airbus DS Space Systems España, Spain, [3] Airbus DS GmbH, Germany, [4] ESTEC, European Space Agency, The Netherlands

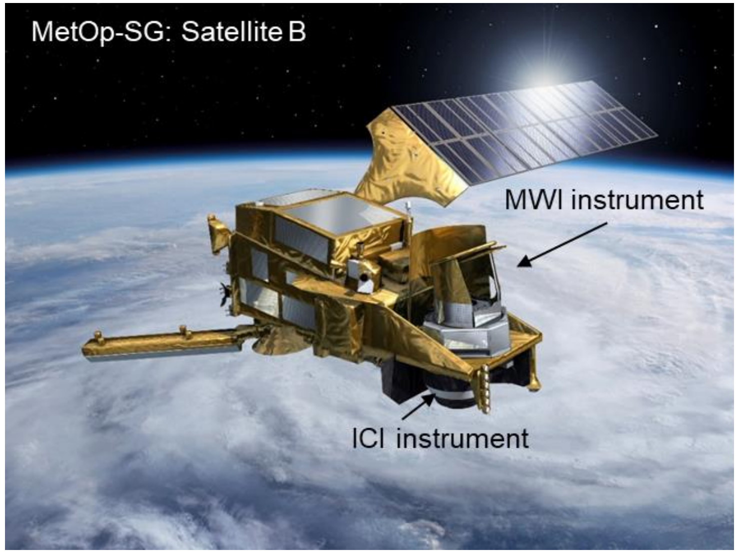
Outline

- Introduction – MetOp-SG
- The ICI instrument
- 183-664 GHz receivers architecture
- 183-664 GHz receivers test results
- Prospects for future missions
- Conclusion

Introduction

- MetOp-SG is part of EUMETSAT Polar System (EPS)
- Goal: provide weather observation continuity for 2025-2045
- two series of satellites (A&B) launched in pairs every 8.5 years
- various microwave instruments (MWS, MWI, ICI)

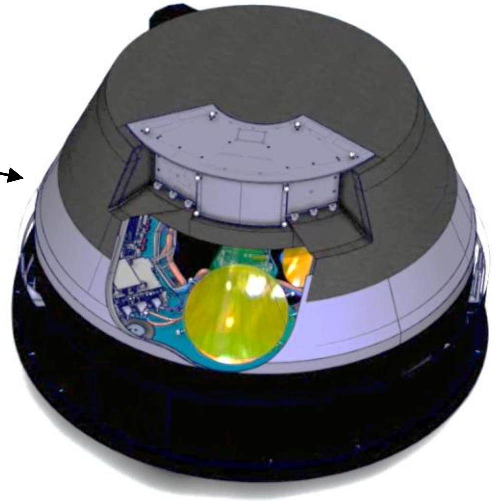




The ICI instrument

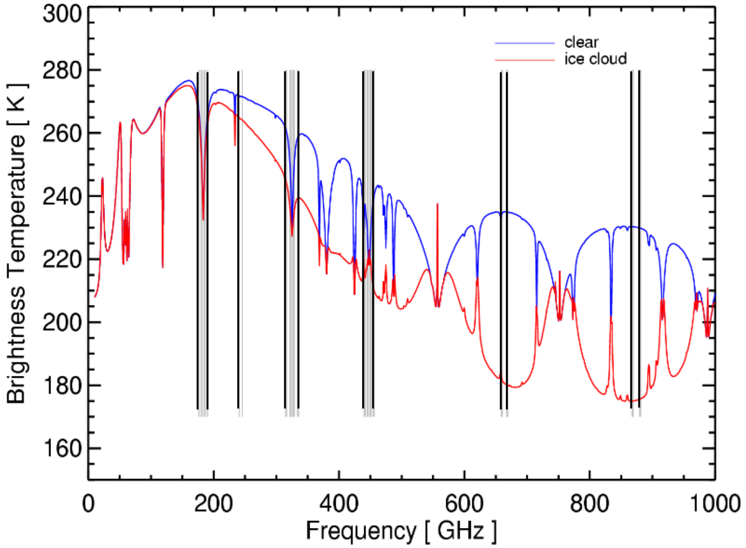
- Conical scanning radiometer covering 183 to 664 GHz
- The field-of-view has a constant nadir angle of 65°
- Lower frequency channels for water vapor profiling
- Higher frequency channels for high altitude ice clouds

Satellite B PFM integration at Airbus-Friedrichshafen



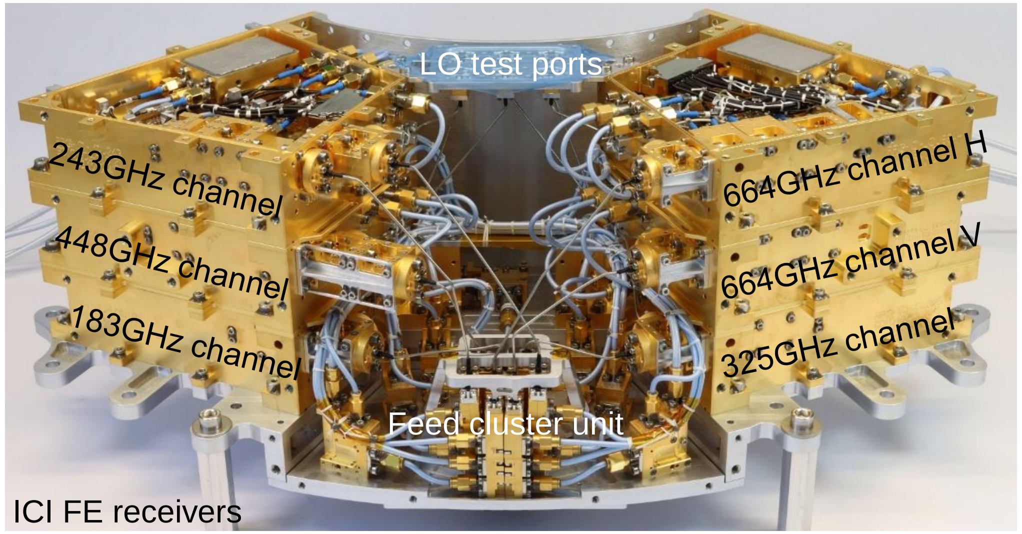
ICI conical scanner instrument

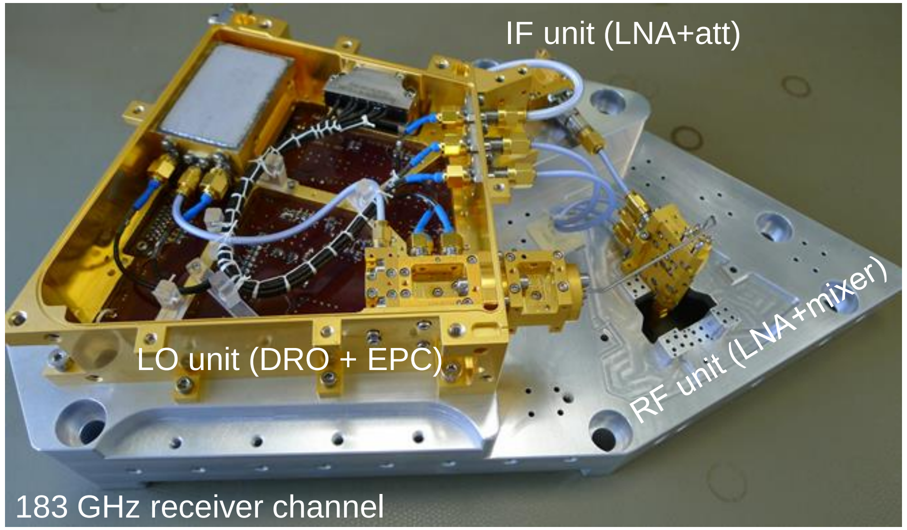
atmospheric response VS ice cloud content



183-664 GHz receivers architecture

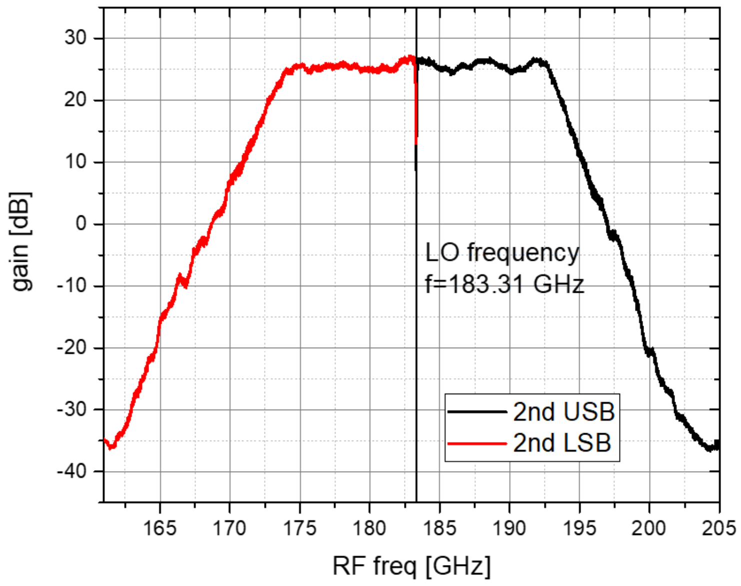
- 7x heterodyne receiver channels operating at 5x frequencies (183, 243, 325, 448 and 664 GHz),
- two of them are dual-polarized (243 GHz, 664 GHz)
- Radiator shield regulates receivers temperature at 28°C
- Total mass: ~8 kg, DC power consumption: ~19W

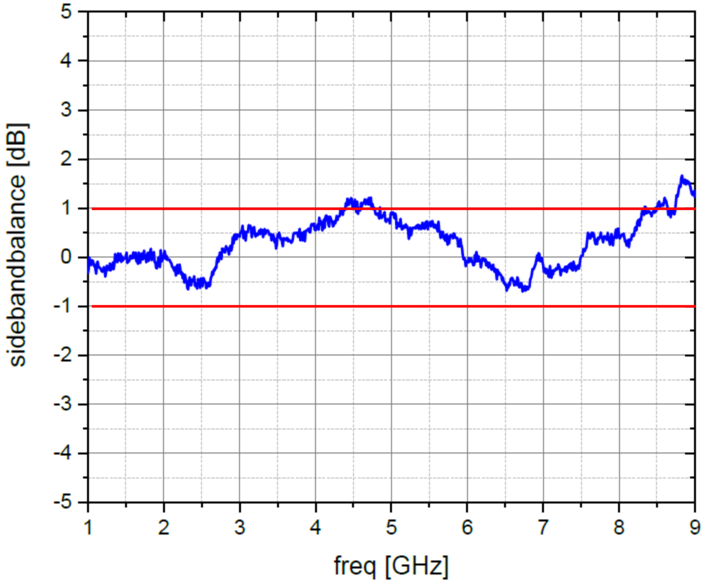


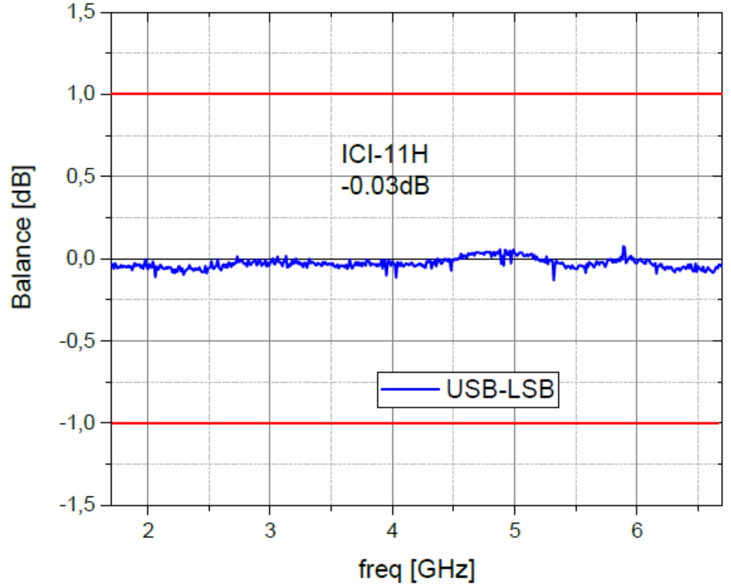


183-664 GHz Gain response tests

- Gain and sideband ratio measured with novel UOSM method (R&S)
- Gain / flatness depend mainly on mixer + LNA matching / tuning
- Sideband ratio is generally compliant to the +/-1dB requirement

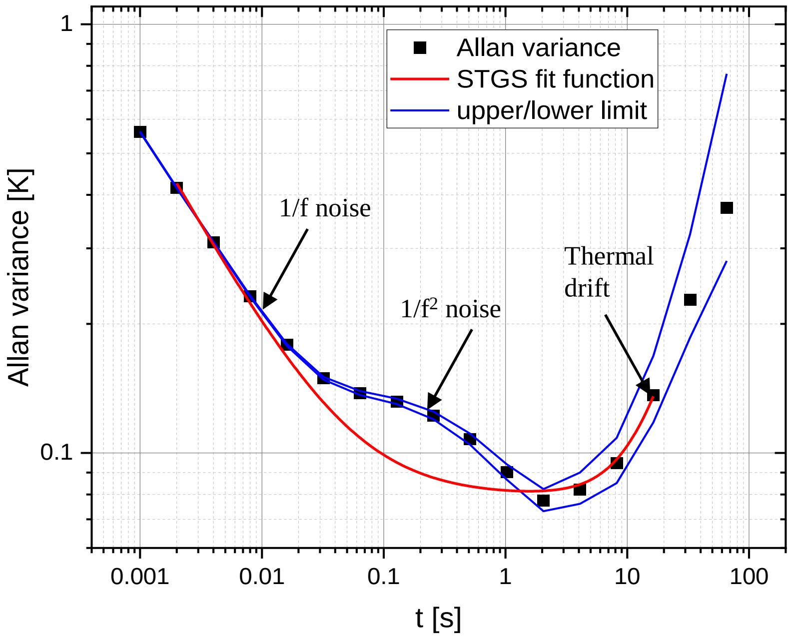


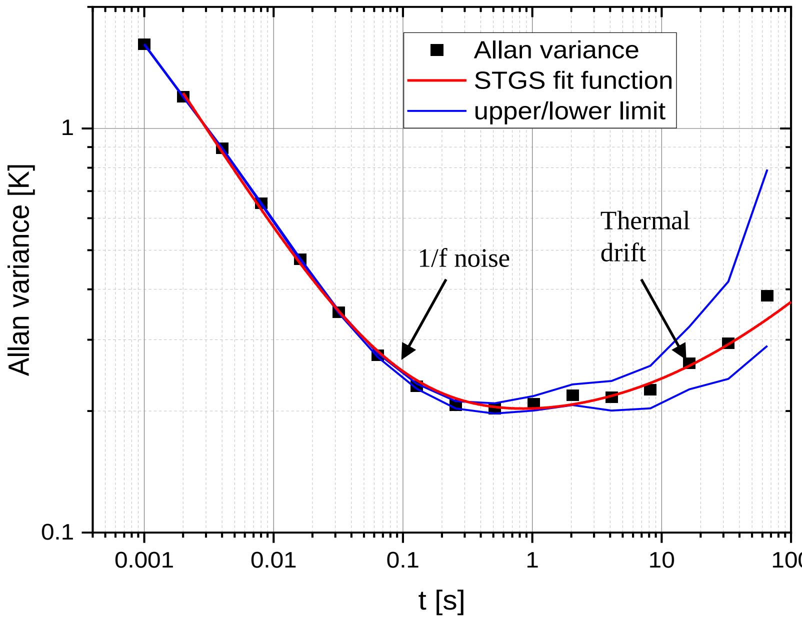




183-664 GHz Allan variance results

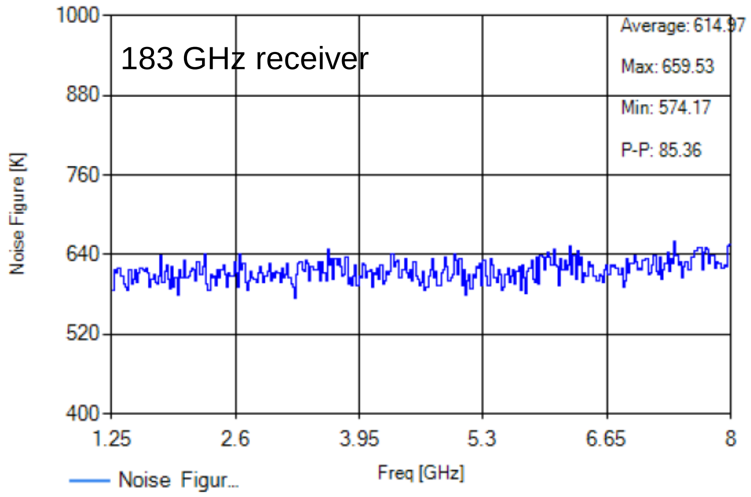
- Short term gain stability pending on the GaAs technology used
- 183 GHz channel uses MMIC based InGaAs mHEMT RF LNA
- 243-664 GHz channels use discrete GaAs Schottky diode mixers

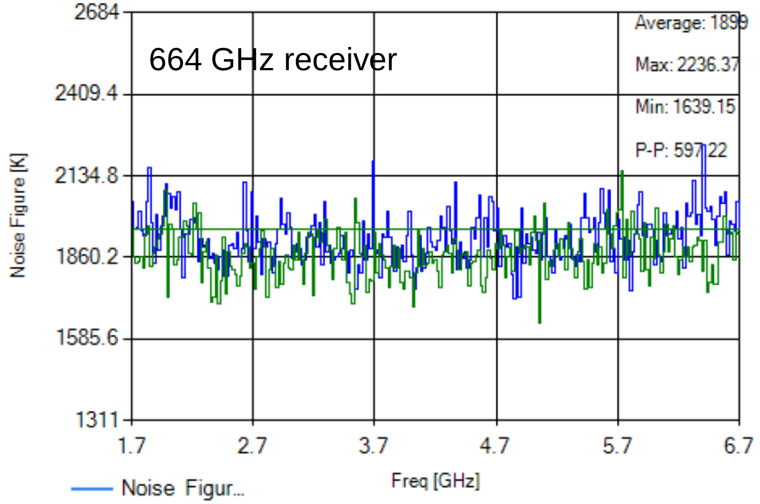




ICI receivers summary performances

PFM Channels	183 GHz	243 GHz	325 GHz	448 GHz	664 GHz
Frequency stability (MHz)	-12.2	-0.7	0.0	0.8	<6.5
Rx NF (dB)	**5.0**	**5.4**	**7.4**	**7.2**	**8.6**
Rx Gain (dB)	30.1	18.6	17	16.8	16.4
Gain flatness (dB)	**1.1**	**1.4**	**1.3**	**1.7**	**1.5**
Short Term Gain Stability 1.10^{-4} (dB)	4.6	2.3	2.6	2.7	3.2
Sideband balance average (dB)	**<0.23**	**0.31**	**<0.30**	**<0.20**	**0.17**
FM2 Channels	**183 GHz**	**243 GHz**	**325 GHz**	**448 GHz**	**664 GHz**
Frequency stability (MHz)	-2.2	-5.1	0.0	0.5	<3.6
Rx NF (dB)	**5.1**	**5.3**	**7.2**	**7.7**	**9.1**
Rx Gain (dB)	30.6	18.2	17.5	17.9	16.1
Gain flatness (dB)	**2.2**	**2.1**	**1.4**	**2.6**	**2.2**
Short Term Gain Stability 1.10^{-4} (dB)	3.6	3.4	2.8	3.1	3.5
Sideband balance average (dB)	**<0.87**	**0.27**	**<0.77**	**<0.8**	**0.3**





Prospects for future missions

- Strong interest to simplify and integrate radiometer payloads
- Allow for integration onto smaller platforms to reduce costs
- Some key technologies need further developments:
  - Low Noise Amplifiers up to 664 GHz with similar noise performance
  - Waveguide based calibration systems with similar accuracy
  - Very compact antenna scan mechanism or beam forming arrays
  - Receiver-on-a-chip type integrated architectures with good local oscillator and 1/f noise performance
  - Direct detection receivers with accurate filtering technology

Conclusion

- MetOp-SG ICI receivers will allow observations over 2025-2045
- Instrument architecture inherited from previous MetOp program
- State-of-the-art performance achieved for 183-664 GHz Schotty and MMIC based receivers
- New developments are on-going to prepare for the next generation of remote sensing passive instruments
- Smallsat missions such as TEMPEST-D and TROPICS are paving the way for New Space missions.

Thank you