Ka-band DopplerScatt for Measurements of Ocean Vector Winds and Surface Currents - Instrument progress to date

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Dragana Perkovic-Martin
Chad Baldi, Ken Cooper, Tamas Gal, Ninoslav Majurec, Maxim Neumann, Fabien Nicaise, Ernesto Rodriguez, Karthik Srinivasan,
Jet Propulsion Laboratory, California Institute of Technology

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Why Measure Ocean Currents?

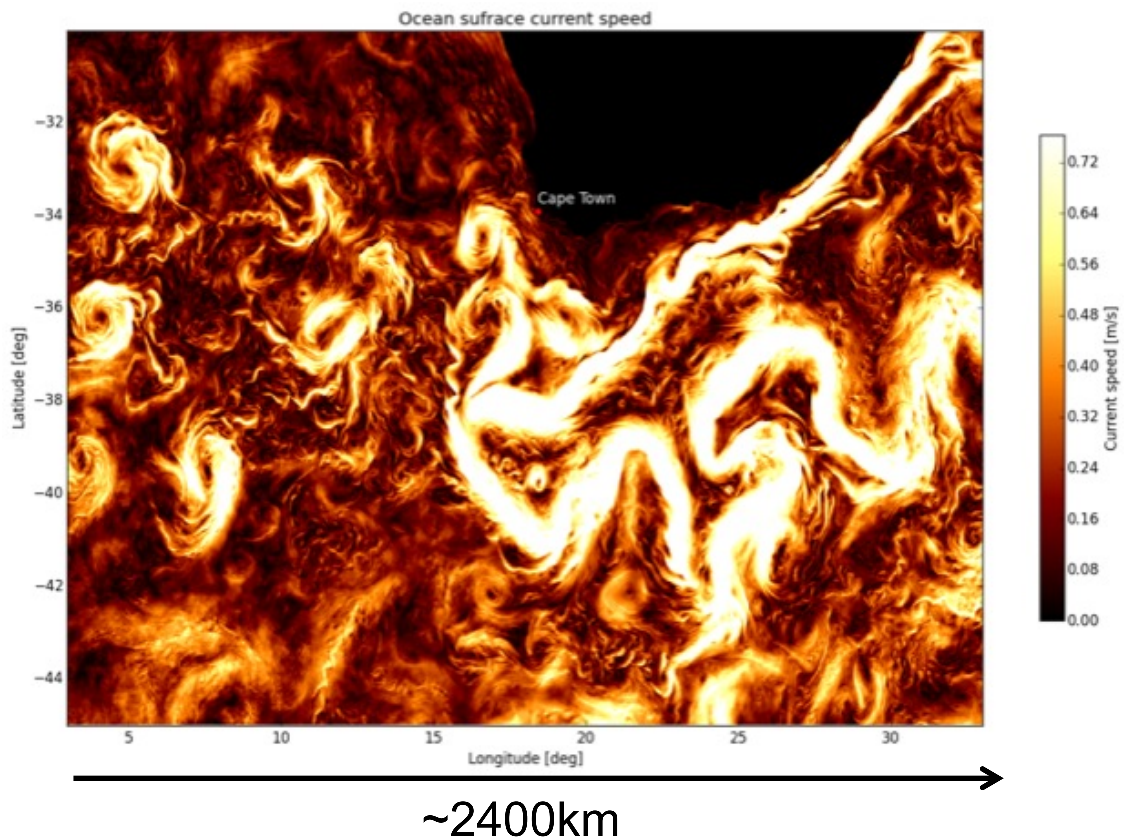


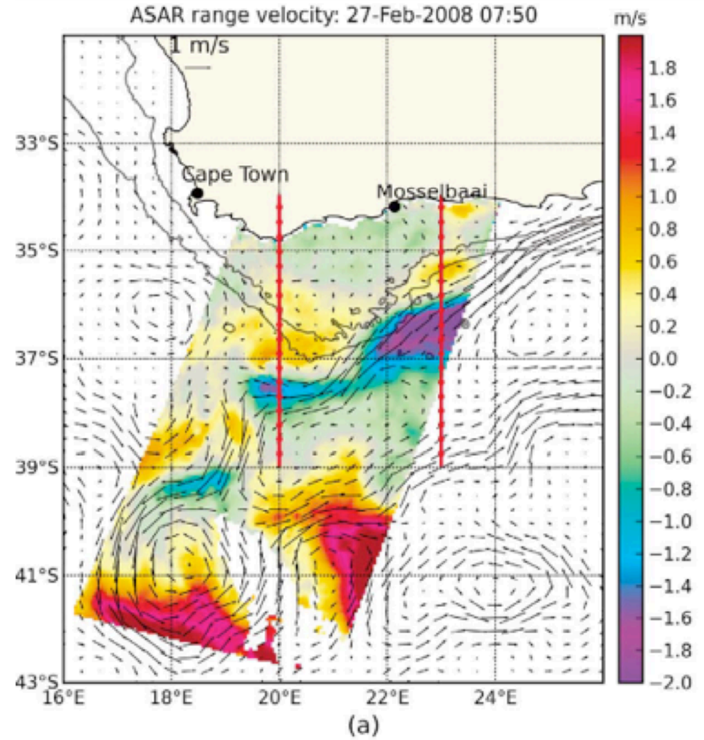
Image of modeled ocean surface currents from the high resolution ECCO2 model.

Currently, we have no way to validate these results at high resolution.

- Ocean surface currents are an essential climate variable
- Knowledge of ocean surface currents will improve our knowledge of energy transfer between the atmosphere and the ocean and our understanding of the advection of heat, nutrients, and pollutants in the ocean.
- Ocean surface currents are a unique complement to the geostrophic currents measured by the forthcoming SWOT mission.

The DopplerScatt Concept

- Coherent radars can measure radial velocities by measuring Doppler shifts.
- The use of Doppler for one component of the surface current velocity has been demonstrated from space using SAR's.
  - Since SAR only looks in one direction, only one component of the velocity is retrieved.
  - Swath width and data rate limitations make SAR's impractical for global coverage
- Rodríguez (2012, 2014) has extended the concept to be able to measure ***both*** components by using a pencil-beam scanning scatterometer.
  - A wide swath coverage would enable global coverage in one day
  - The same instrument would also measure high resolution winds
- The DopplerScatt IIP will demonstrate the feasibility and accuracy of this concept using an airborne instrument and the results will be applicable to future spaceborne missions.



Comparison of surface current radial component measured by ASAR and geostrophic currents from the AVISO altimetry product. Rouault, M. J., Mouche, A., Collard, F., Johannessen, J. A. & Chapron, B. Mapping the Agulhas Current from space: An assessment of ASAR surface current velocities. Journal of Geophysical Research 115, (2010).

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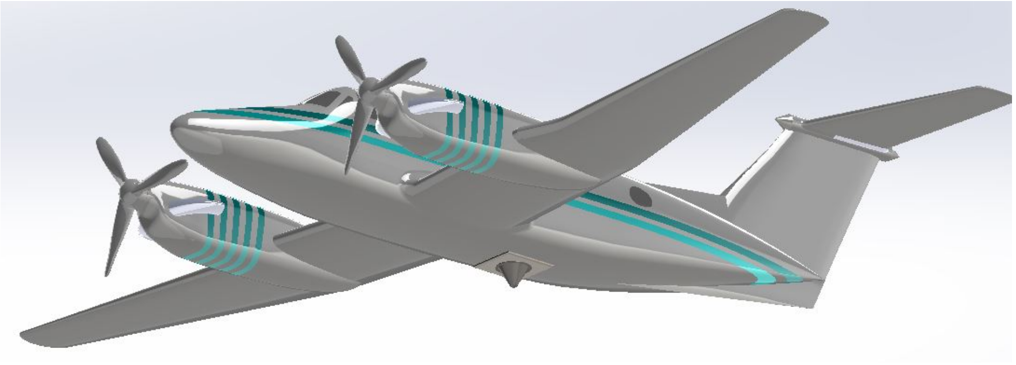
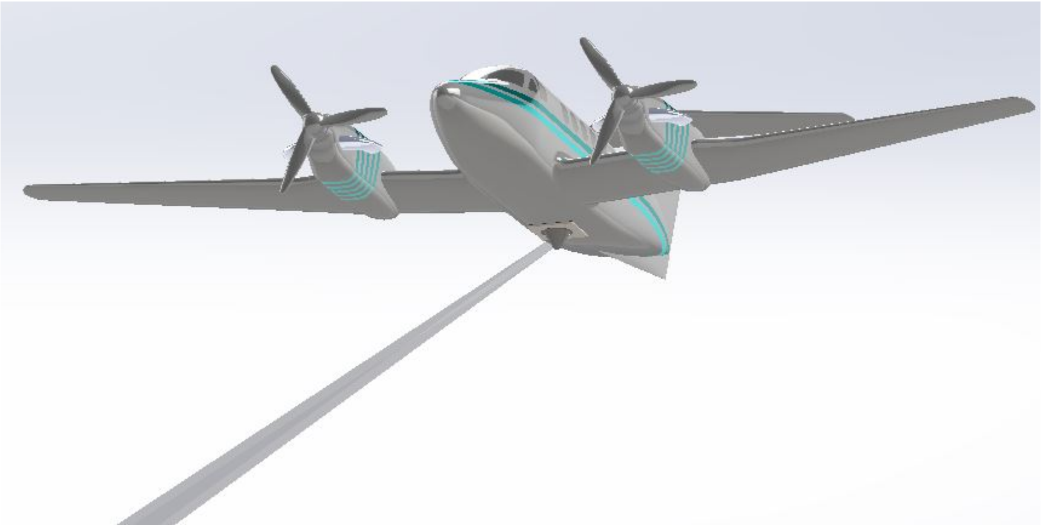
Driving Requirements

Parameter	Value (CBE)
Center Frequency	35.75 GHz
Peak Transmit Power	90 W (110W)
Burst Repetition	8 kHz (5 kHz)
System Noise Figure	10 dB (6 dB)
Antenna Rotation Rate	5-25 rpm (8 rpm)
Antenna Beamwidth	2.9 deg
Velocity Bias	1.0 cm/s
Velocity Precision	10 cm/s
Wind Speed Accuracy	2 m/s (3-20 m/s) 10 % (20-30 m/s)
Wind Direction Accuracy	20 deg
Resolution cell size	5 km





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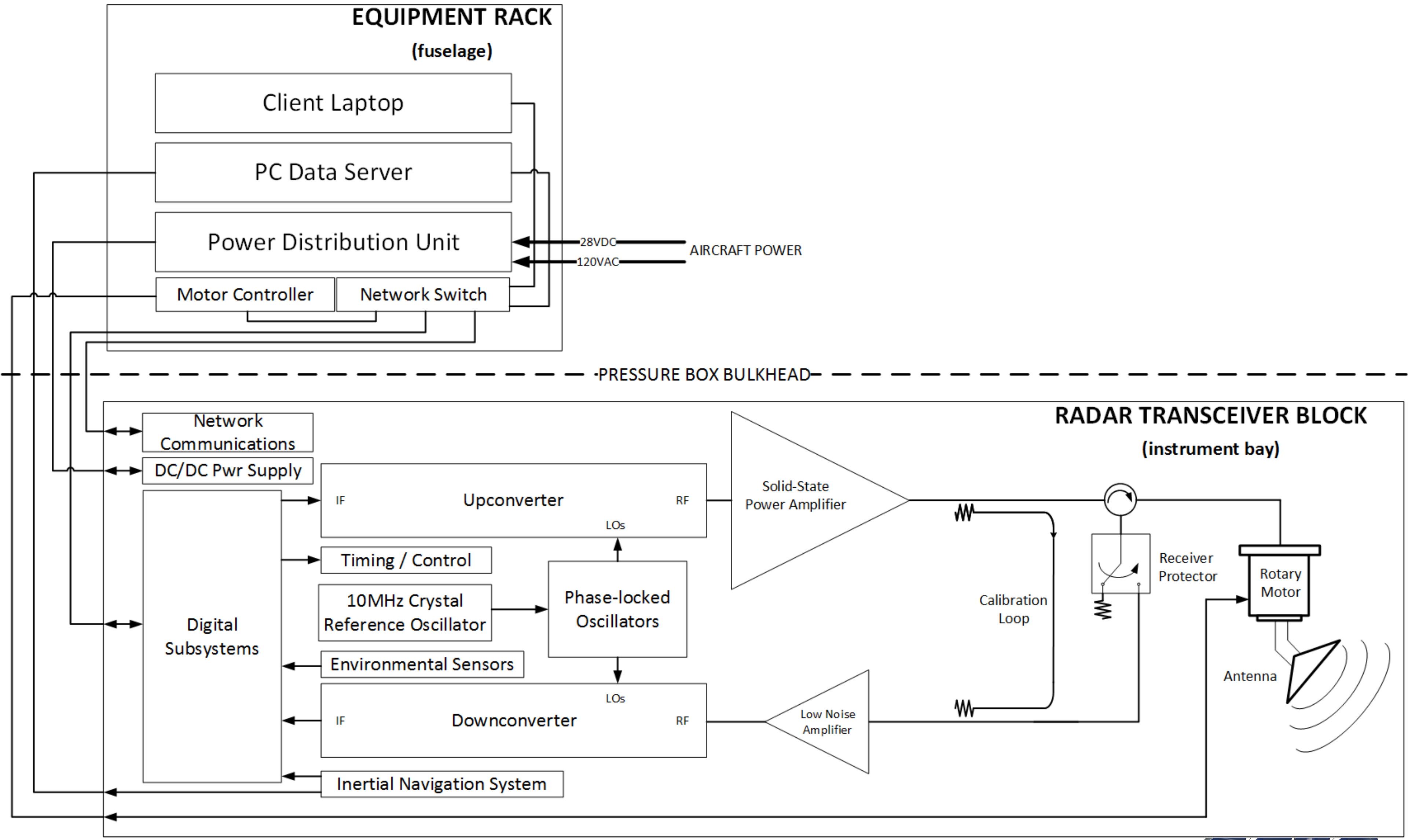
System Architecture Block Diagram



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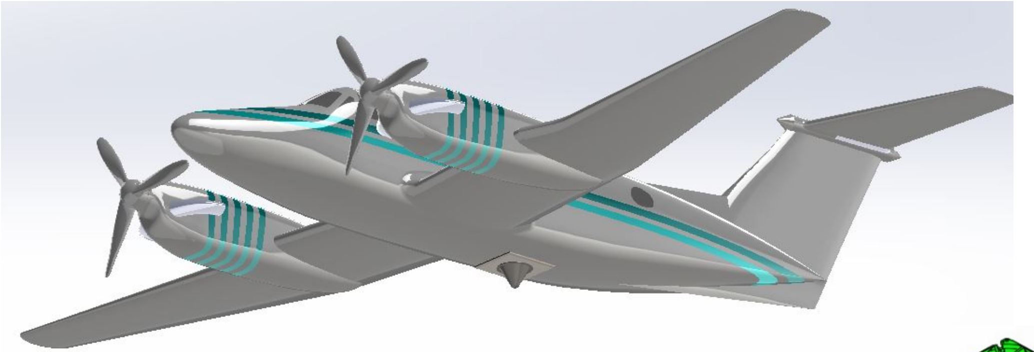
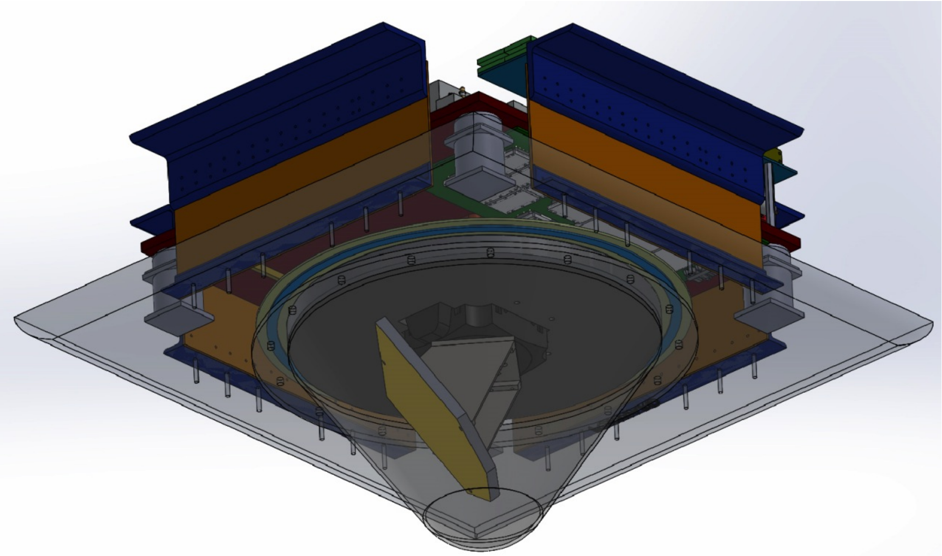
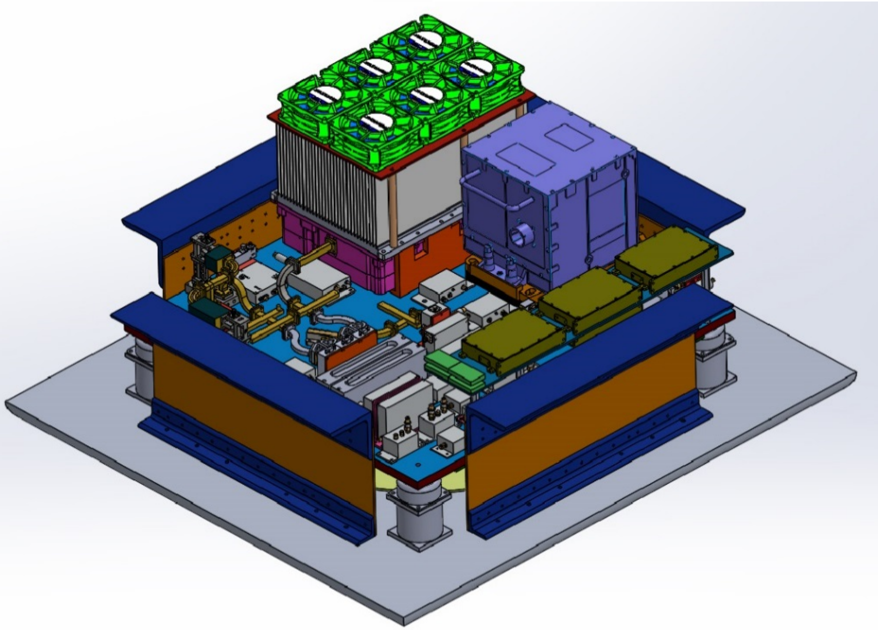
Mechanical Layout

- Instrument Overview



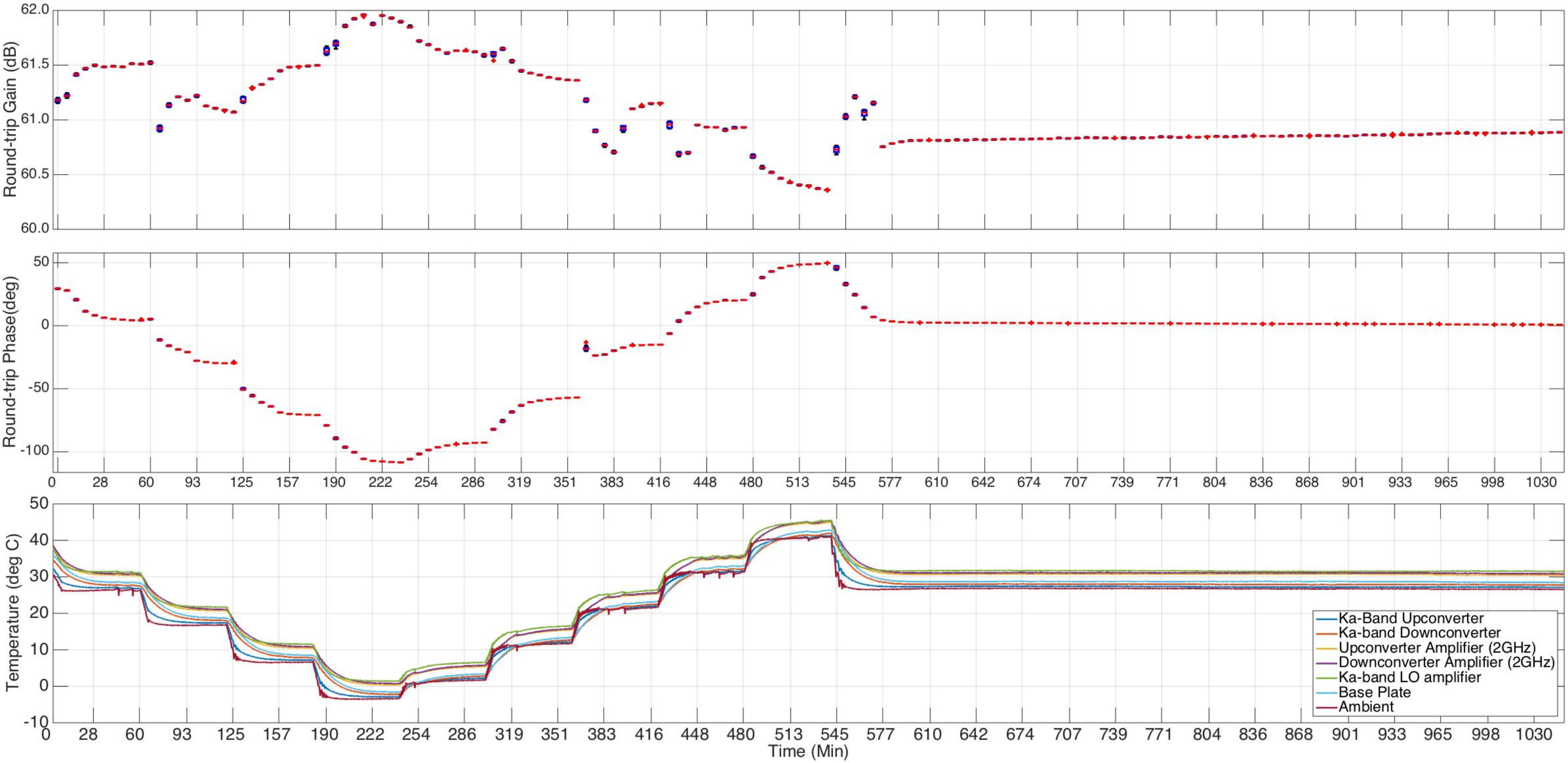


Bottom View



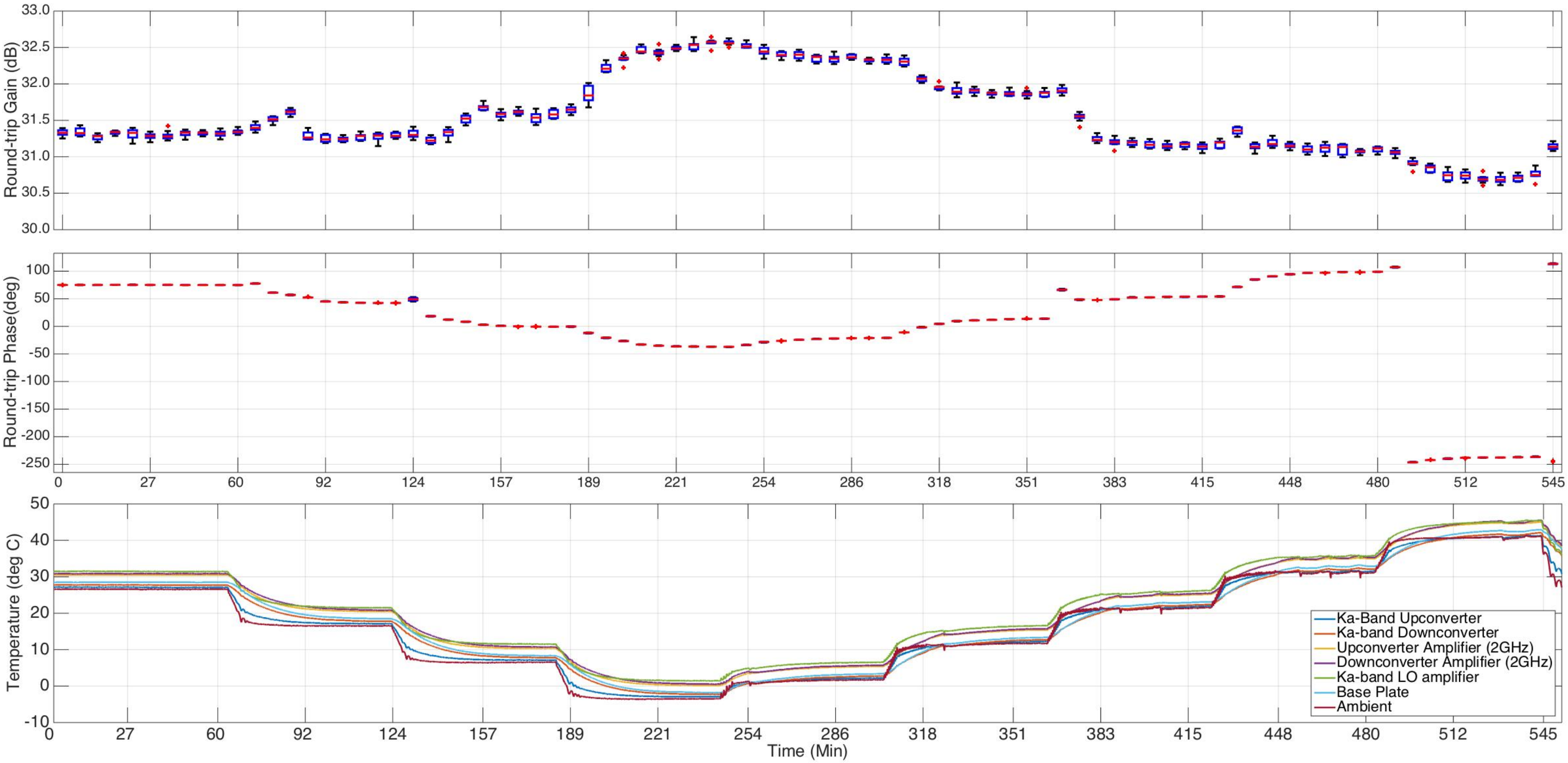
Top View

Up-/Down-converter Full Loop – Echo Path



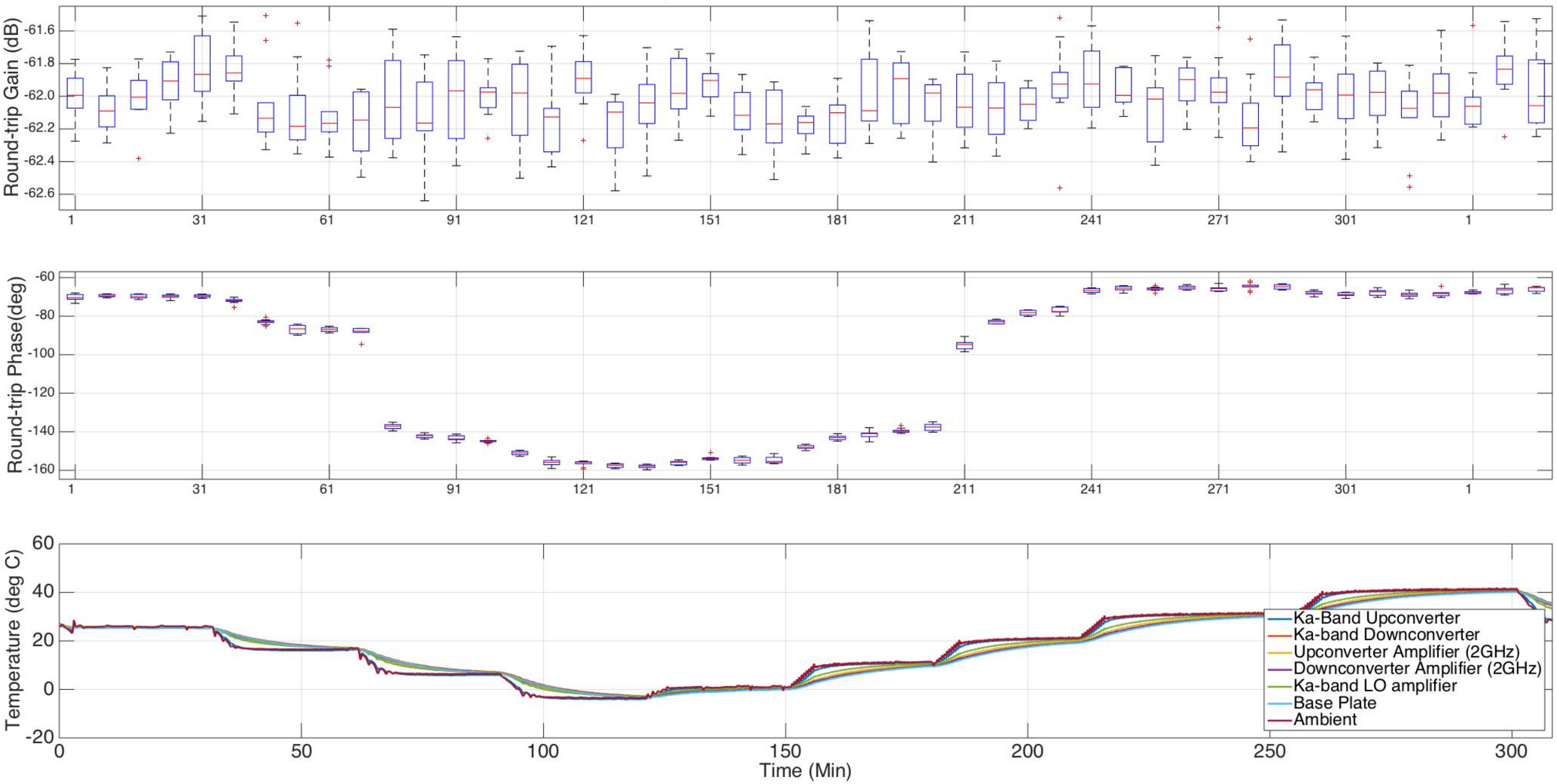
- Amplitude sensitivity of the system : ~ 0.03dB/deg C
- Phase sensitivity of the system : ~ 3.4 deg/deg C

Up-/Down-converter Full Loop – Cal Path



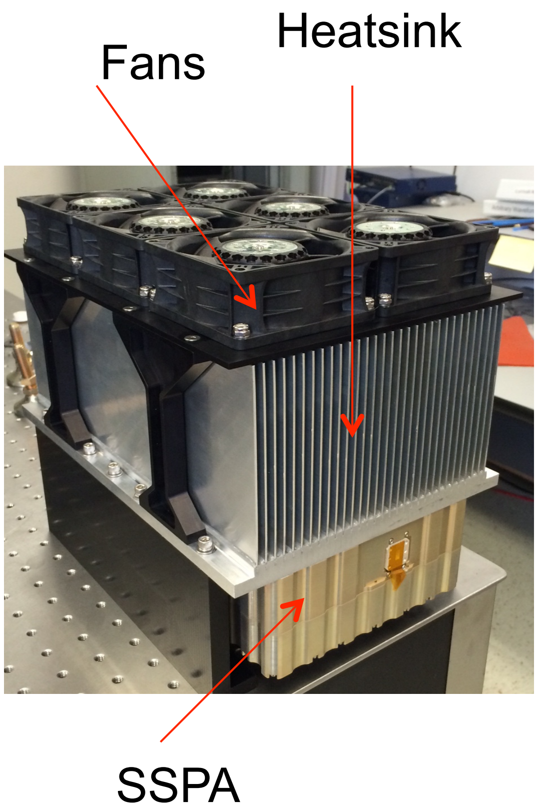
- Amplitude sensitivity of the Cal path : ~ 0.03 dB/deg C
- Phase sensitivity of the Cal path : ~ 3.5 deg/deg C

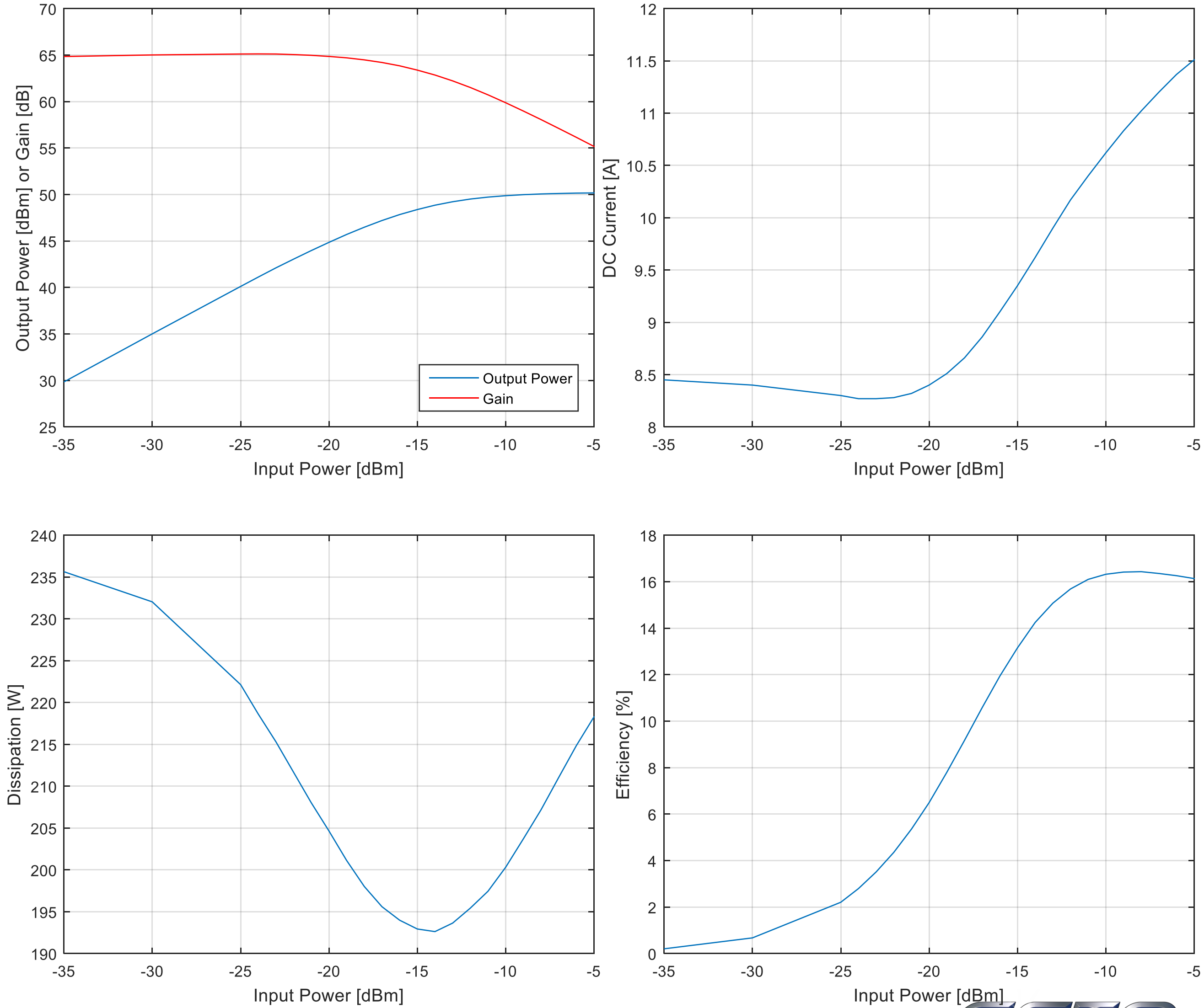
Ka-Band Cables/Attenuators



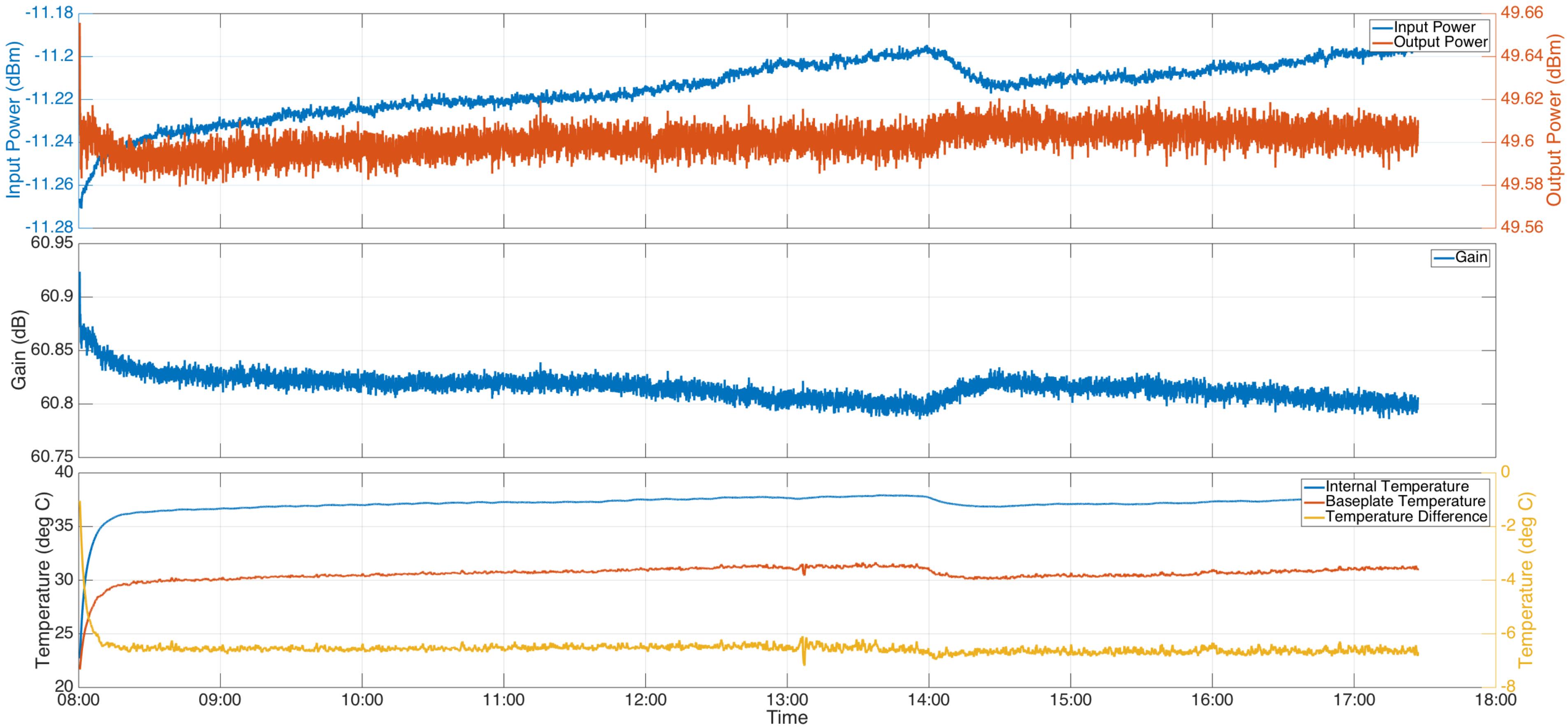
- Amplitude sensitivity : ~ 0.004dB/deg C
- Phase sensitivity : ~ 1.8 deg/deg C

SSPA Testing - Efficiency





SSPA Testing- Long Term



- Results of June 17th test (8 hrs), other days are similar with the greatest changes correlating well with baseplate temperature.
- After removal of a linear trend the output power changes +/- 0.02 dB over test time

Summary

Thermal testing

- Overall up- and down-converters performed well over temperature – small variation in amplitude and phase over long time and temperature scales
- Under transient temperature conditions (2°C/minute temperature ramp), measured amplitude and phase change was of the order of **0.1udB/100uSec and 0.2mdeg/100uSec – negligible within one transmit burst of 100uSec!**

SSPA testing

- The Ka-band SSPA has a peak power of 100W and an efficiency of 16%
- Burn-in time 40 hours.
- Small variations in gain (< 0.05dB) have been detected over 8 hr continuous test times.

Significant Project Accomplishments since May 2014

- Improved the Airborne DopplerScatt simulator to include detailed simulations of ocean surface and radar system performance.
  - We can produce simulated radar data in the form of actual radar data coming through the DAQ
- Completed first tests of:
  - IF/RF up- and down-converter chains under the lab and thermal chamber conditions
  - Digital subsystem back-to-back
  - SSPA laboratory burn-in test (40 hours)