	Centre National d'Etudes Spatiales	
SAP_RAD_02 TRO-33-NT-2805-CNES	**Activity : CAL/VAL** **SAPHIR** **Radiometric Gain**	**Prepared by : C. Malassingne** **(EADS-ASTRIUM for CNES)** **A Rosak** **Verified by : N Karouche**

Contents

1. OBJECTIVE

The purpose of this technical note is to provide the variation of the radiometric gains of the SAPHIR instrument observed during the first months in orbit.

Analysis has been conducted to compare the in-flight observations with on ground measurements.

2. METHODS

2.1. OVERVIEW

In orbit radiometric gain is computed at each scan, from samples acquired when antenna is observing successively hot and cold reference targets. The physical temperature of the hot reference target is close to 290K. The Cold Sky brightness temperature, computed from the Planck law, is equal to 4.75K @183.3GHz.

For each scan of the nominal rotating mode, the SAPHIR instrument acquires 182 earth samples, 7 OBCT* samples and 7 Cold Sky samples for calibration purpose.

Each set of calibration samples is averaged to compute the radiometric gain of each of the 6 channels. Gain is computed for each scan period.

*OBCT = On Board Calibration Target

2.2. CALCULATION

The instrument being in nominal mode, for each orbit, and for each channel, the processing is defined as follows :

- Extract and average the 7 OBCT samples for each of the 3733 scans of the orbit.
- Extract and average the 7 Cold Sky samples for each of the 3733 scans of the orbit.
- Extract the physical temperature of the OBCT.
- Compute the gain from the above for each scan
- Compute the average gain for the orbit

3. SUCCESS CRITERIA

There are no stringent success criteria for the gain values except that it should stay compatible with the dynamic range of the ADC*.

Some settable RF attenuators are available in the Back End equipment for each channel to compensate for possible drift of the receivers (ageing, temperature, …) during lifetime.

*ADC : Analog to Digital converter

4. PRODUCTS USED

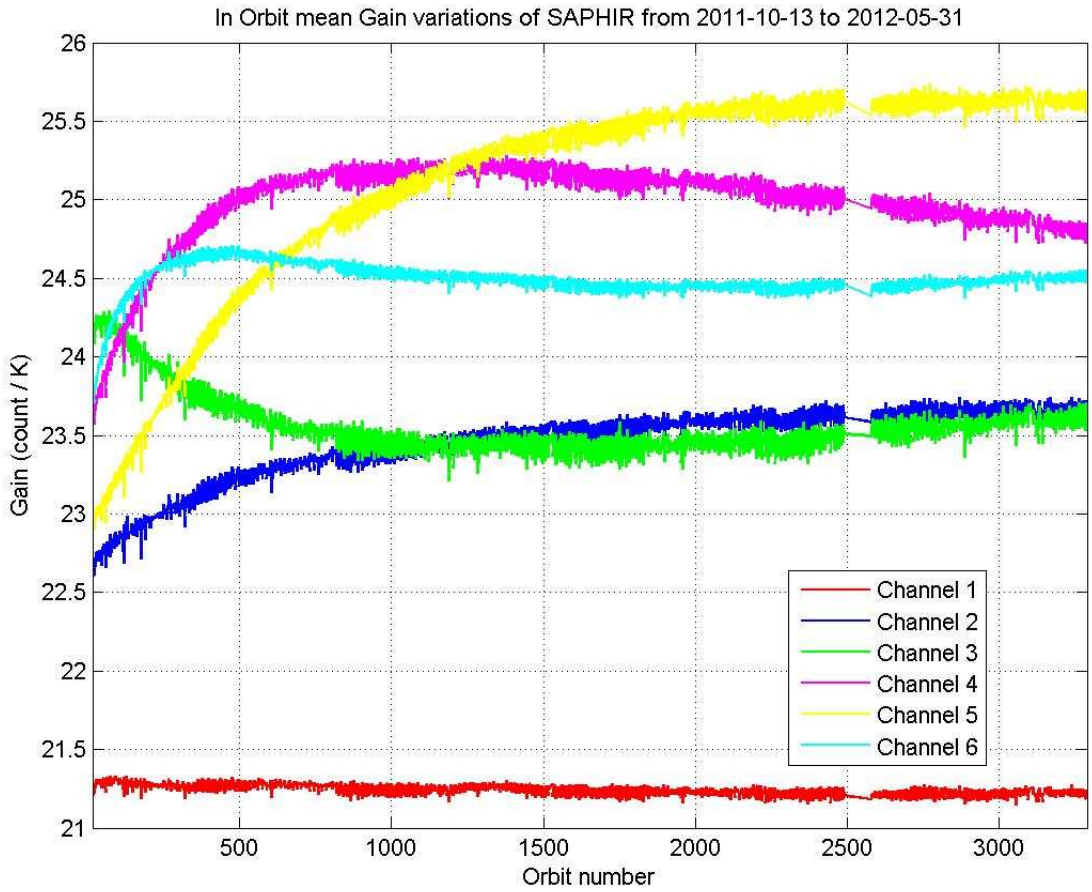
See in the graph below (X-axis).

L0 products (Raw data) are used for this analysis.

5. RESULTS

As shown in the table below, the radiometric gain values are slightly higher than on-ground measurements. There is no impact on the quality of the brightness temperature measurement.

Gain (count/K)	Channel 1	Channel 2	Channel 3	Channel 4	Channel 5	Channel 6
On-ground	20.46	21.45	22.30	22.02	21.53	21.96
In-orbit (few days after launch)	21.3	22.9	24.2	24.2	23.3	24.4
In-orbit (4 months after launch)	21.2	23.5	23.3	25.0	25.4	24.4
In-orbit (8 months after launch)	21.2	23.6	23.6	24.7	25.5	24.5
DeltaG launch / launch + 8 months) (dB)	0.0	0.1	0.1	0.1	0.4	0.0



Here above are illustrated the radiometric gain variations of the 6 channels during the eight first months in orbit. The average gain value for each orbit is plotted on the above graph. Each orbit represents a set of 3733 scans, one gain value is computed for each scan from the seven hot and cold samples and the average gain value over the 3733 scans is then obtained

For all channels except channel 1, (C1 : the closest channel to the maximum of the absorption line) a large variation is observed over the two first months after the instrument switch ON. This behavior is commonly met during the first months in-orbit of the microwave radiometer.

The following can be noted :

C1 is very stable since the instrument switch ON.

C2 is well stabilized since early January 2012.

C3, C4 and C6 are quite stabilized since early January 2012, but still show a little variation.

C5 is stable from April only. The largest variations are observed for this channel : 0,5dB

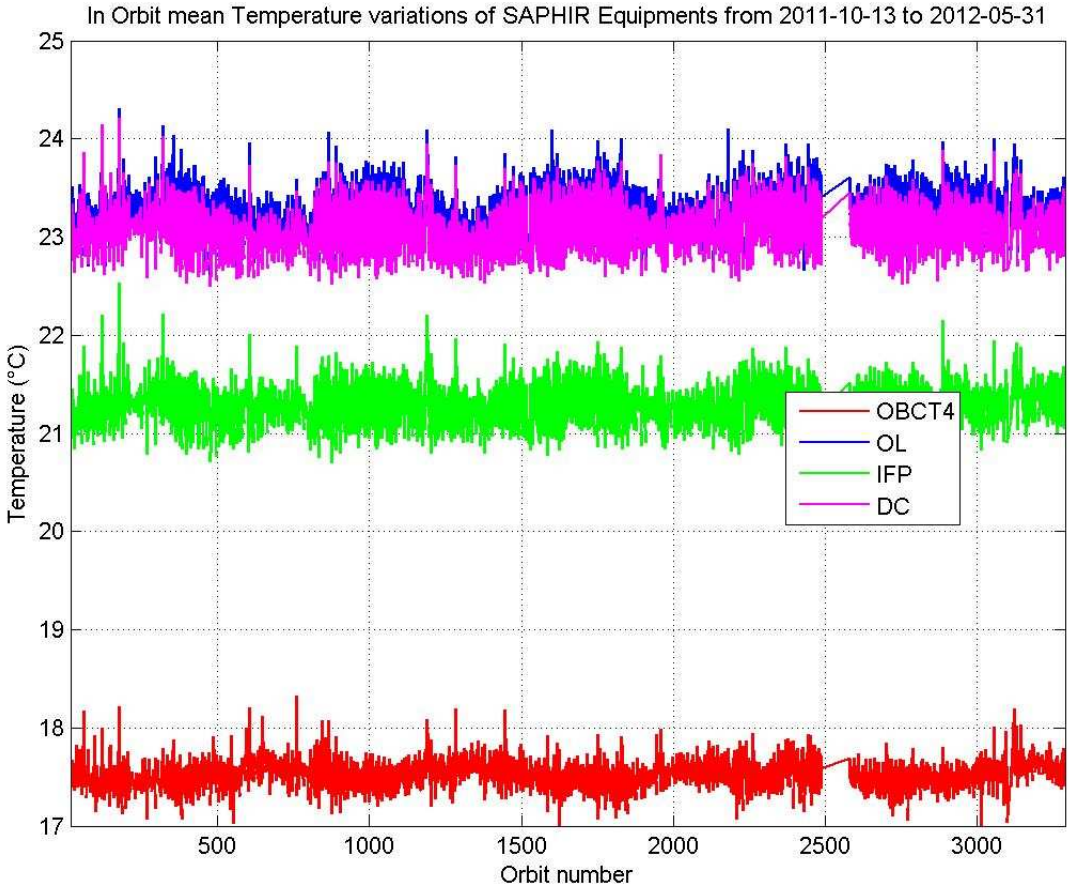
We can note that the gain of channel C3 vary in opposite way than all the others channels.

The switch OFF / ON done in April shows a very little impact on the behaviour of the radiometric gains.

Finally, we can conclude that gains stabilities are satisfactory and all gains are well within the acceptable limits required to be compatible with the performance of the ADC.

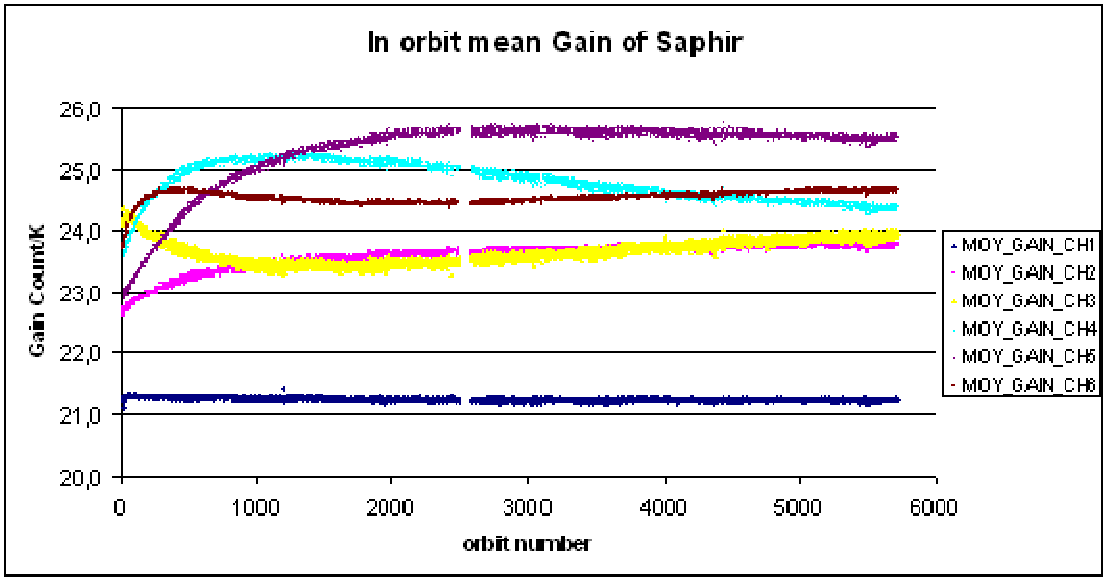
The first days in flight variations are not correlated to equipment temperature variations.

The following graph shows the temperatures of the equipment averaged over one orbit since Megha-Tropiques launch. The temperature variations of main equipment included in the SAPHIR radiometer have been plotted from launch to orbit 2900 approximately. Measured temperature variations are less than : 1.5°C . Maximum variations are observed on both Local Oscillator and Down Converter equipment which are part of the Front End unit.



No relation can be evidenced between the gains variations and the temperature variations of the equipment. The time for stabilization corresponds to some time setting related to characteristics of the radiometer itself.

Average gain of the channels is periodically monitored and results are confirming the above analysis. The graph below provides measurements up to December 2012.



6. CONCLUSION

In-flight measured radiometric gains are nominal and consistent with the on-ground measurements. That means that the RF alignments (tunings) performed during the acceptance test are compatible with the environmental conditions of in-orbit.

After a stabilization period (time period depending of the channel), the gain performances are quite stable.