	Centre National d'Etudes Spatiales	
SAP_RAD_05 TRO-33-NT-2806-CNES	**Activity : CAL/VAL** **SAPHIR** **Cold Sky calibration**	**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 verify the performance of the cold calibration and confirm the calibration window used for data processing.

2. METHOD

2.1. OVERVIEW

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

The 7 Cold Sky samples per scan are used to compute the radiometric gain of the instrument. They give the cold reference.

Cold Sky brightness temperature is computed from the Planck's law. It is approximate to 4.75K @183.3GHz.

During the commissioning phase, some specific tests in fixed configuration have been performed. to characterize the Cold Sky acquisition range, we have configured the SAPHIR instrument in the fixed Cold Sky viewing position.

3. SUCCESS CRITERIA

It should be demonstrated that the Cold Sky field of view is free of interference to allow an accurate radiometric gain computation.

The zone of useful samples data (maximum 7 samples) has been verified in flight. This useful samples window is determined to ensure stable observations.

4. PRODUCTS USED

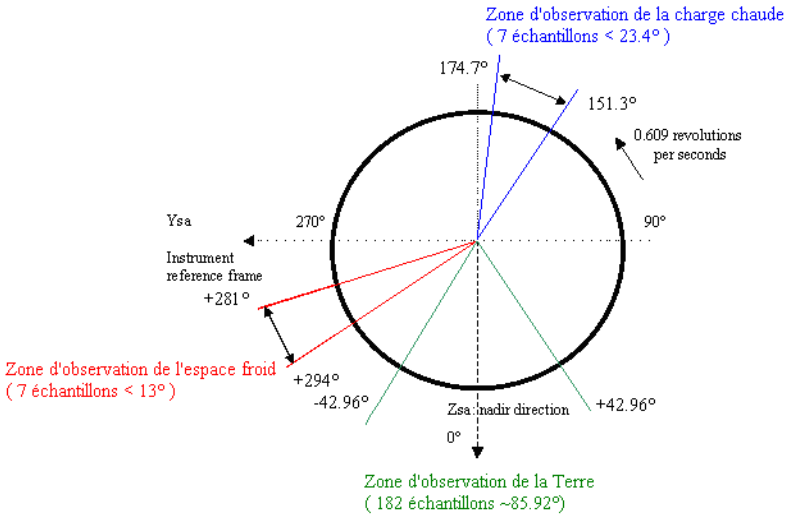
Raw radiometric data (L0 products) of orbits 57 in fixed mode and 503 to 507 and 1389 in nominal rotating mode.

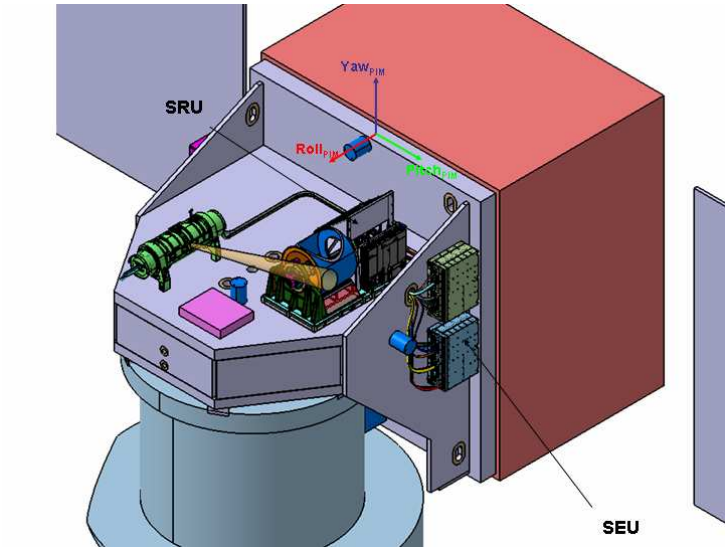
5. INSTRUMENT GEOMETRY

A view of the instrument on the platform is provided below as well as a graph of the scanning pattern. Fields of view corresponding to the different acquisition zones are identified on the graph.

In nominal mode, for each scan, the sample acquisition sequence is defined to provide:

- 182 Earth samples (from sample 1 acquired at -42.96° to sample 182 acquired at +42.96°)
- 7 hot samples when antenna is observing the OBCT* (from sample 1 acquired at +151.3° to sample 7 acquired at +174.7°)
- 7 cold samples when antenna is observing the Cold Sky (sample 1 acquired at +281° to sample 7 acquired at +294°)





General overview of Saphir instrument on PIM

*OBCT = On Board Calibration Target

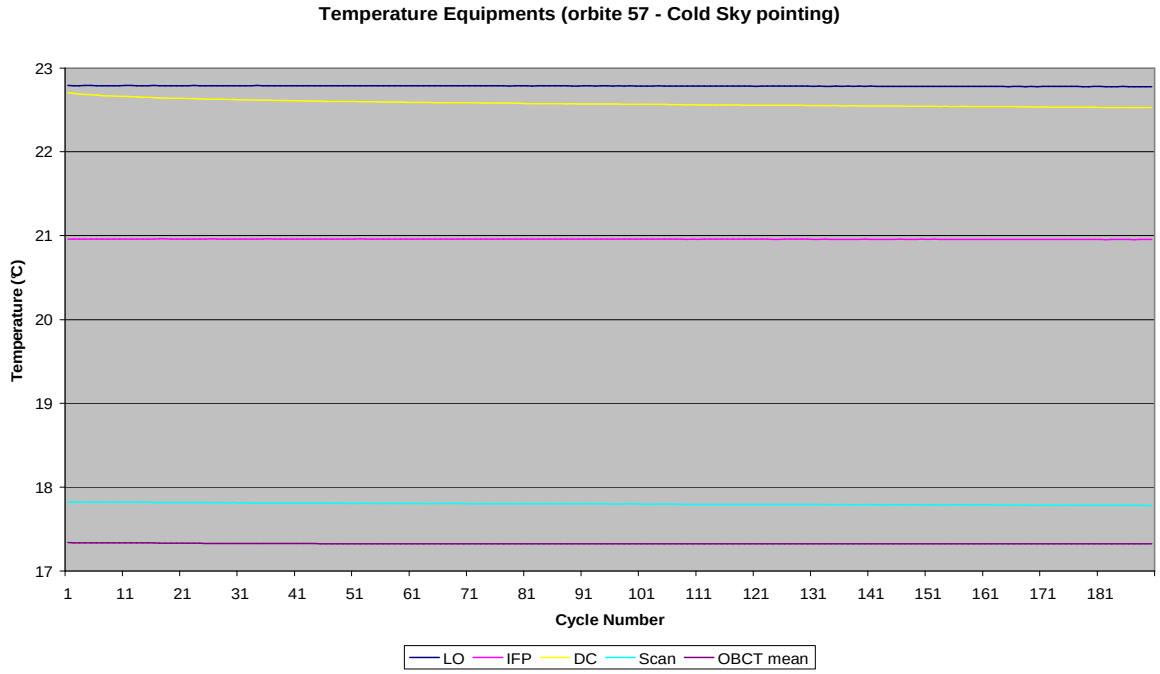
6. RESULTS

6.1. FIXED MODE (COLD SKY VIEWING)

Due to thermal consideration, the fixed mode in Cold Sky position is allowed only for a few minutes.

6.1.1. THERMAL CONDITIONS OF THE INSTRUMENT IN FIXED MODE

The monitoring of the thermistors located on the Front End units (local oscillator and Down converter), the Intermediate Frequency Processor unit and the scan mechanism are illustrated in the figure below. The averaged value of the OBCT temperature is also provided.

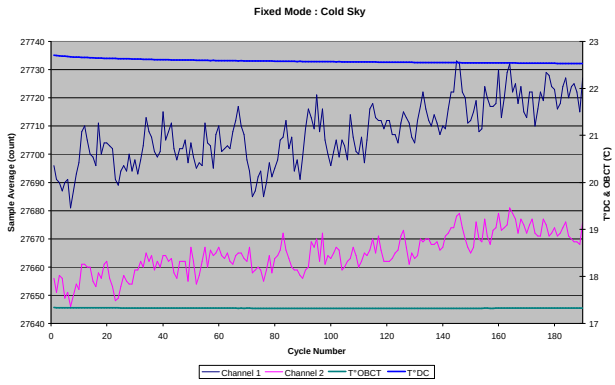


During the 5mn duration of the fixed mode test, the thermal behavior of the equipment was very stable. Some very small variations (less then 0.11K) have been observed on the Down Converter unit as predicted due to the specific configuration : fixed mode with cold sky observation.

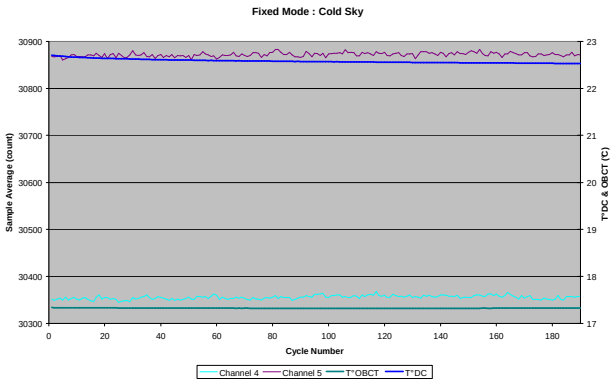
6.1.2. RADIOMETRIC COUNTS RELATED TO COLD SKY OBSERVATIONS

6.1.2.1. COUNT RADIOMETRIC AVERAGING OVER EACH CYCLE

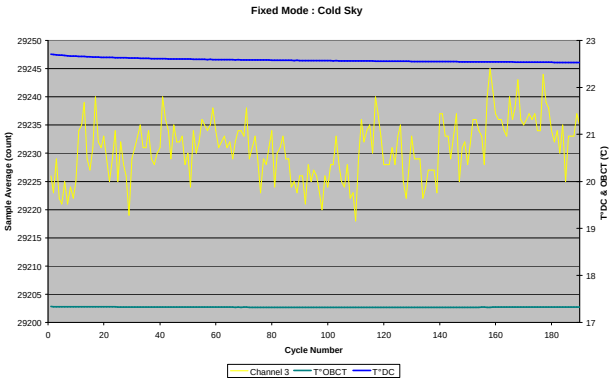
In Cold sky fixed mode, 196 samples are acquired during one cycle period. The full set of 196 samples is averaged over each cycle (or scan). The variation of this average over the duration of the test (approximately 190 cycles) is quite small



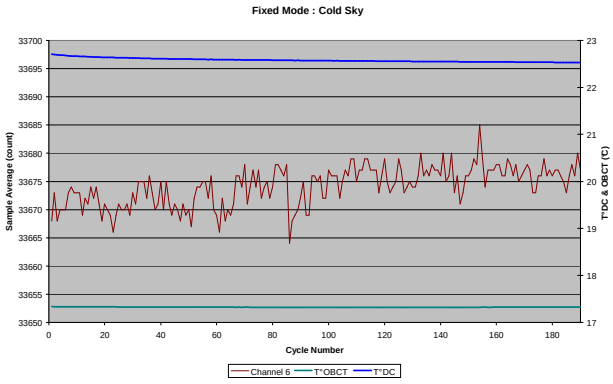
Channel 1 and 2



Channel 4 and 5



Channel 3

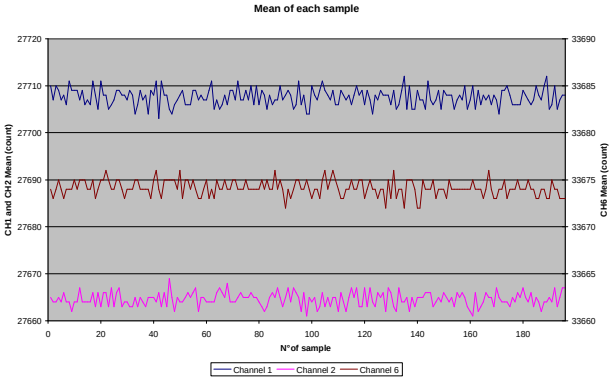


Channel 6

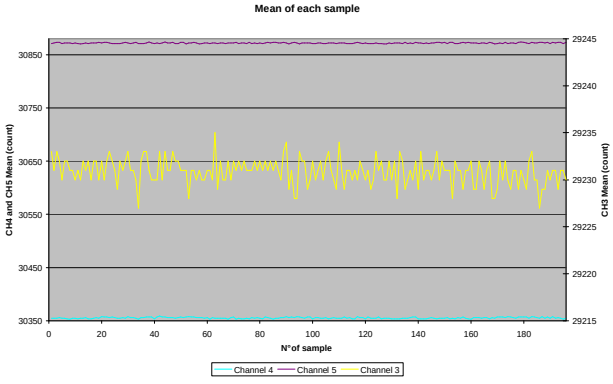
6.1.2.2. COUNT RADIOMETRIC AVERAGING OVER EACH SAMPLE

For each sample (1 to 196), data are averaged over the 5minutes test duration that is to say over the 190 period cycles

The variations are smaller than half the standard deviation.



Channels 1,2 ,6



Channels 3,4,5

Finally, the test demonstrates that no interference is observed for that fixed position and cold acquisitions performed by the instrument are stable

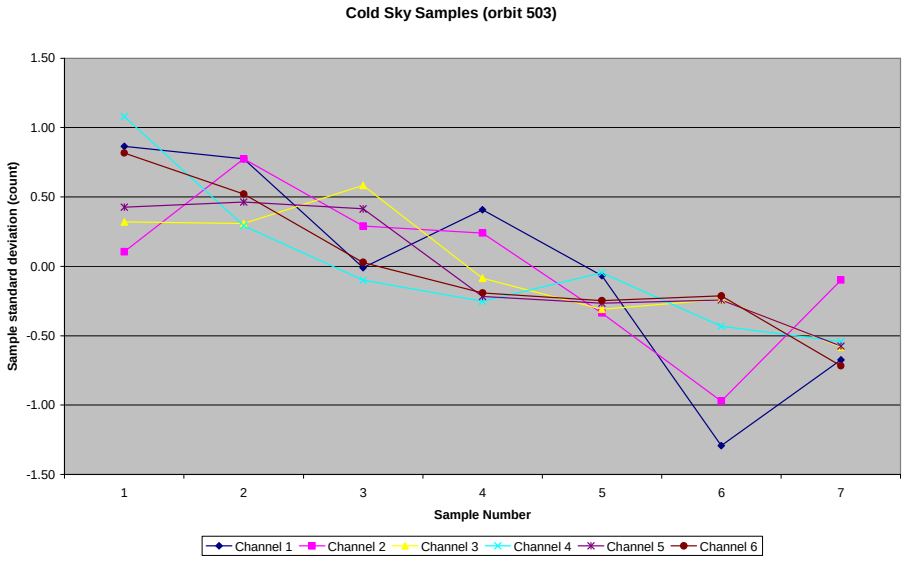
6.2. NOMINAL MODE

6.2.1. RADIOMETRIC COUNT OF THE COLD SKY

6.2.1.1. COUNT RADIOMETRIC AVERAGING OVER EACH CYCLE

The seven Cold Sky samples are averaged each cycle to allow the instrument calibration. The radiometric gain is computed from both hot and cold calibration counts.

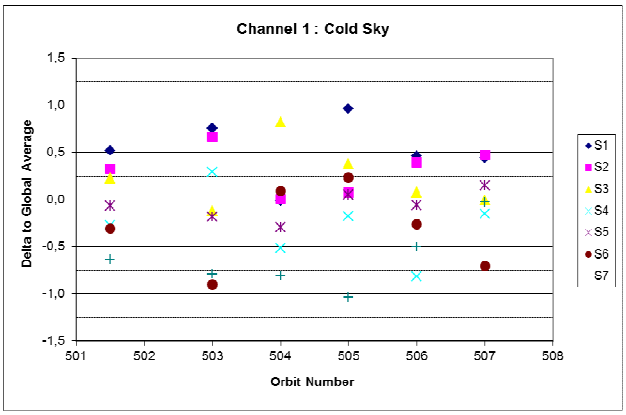
Here after is presented the dispersion of the seven cold count (cold sky) values w.r.t. the averaged value, over a full orbit (3733 scans).

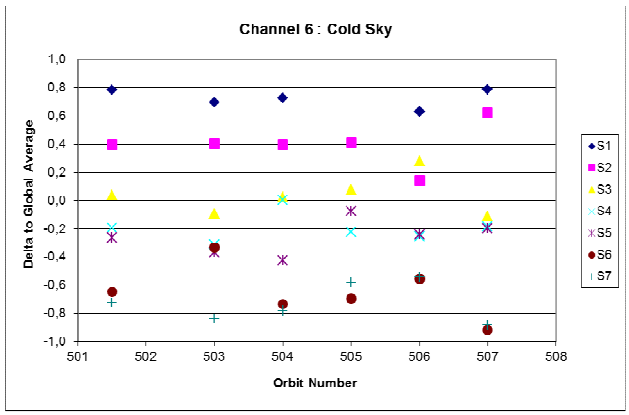


From this observation, we have tried to make a statistical analysis on several orbits to confirm the above variation with respect to the Cold Sky viewing angle range.

The analysis is made on orbits 503 to 507.

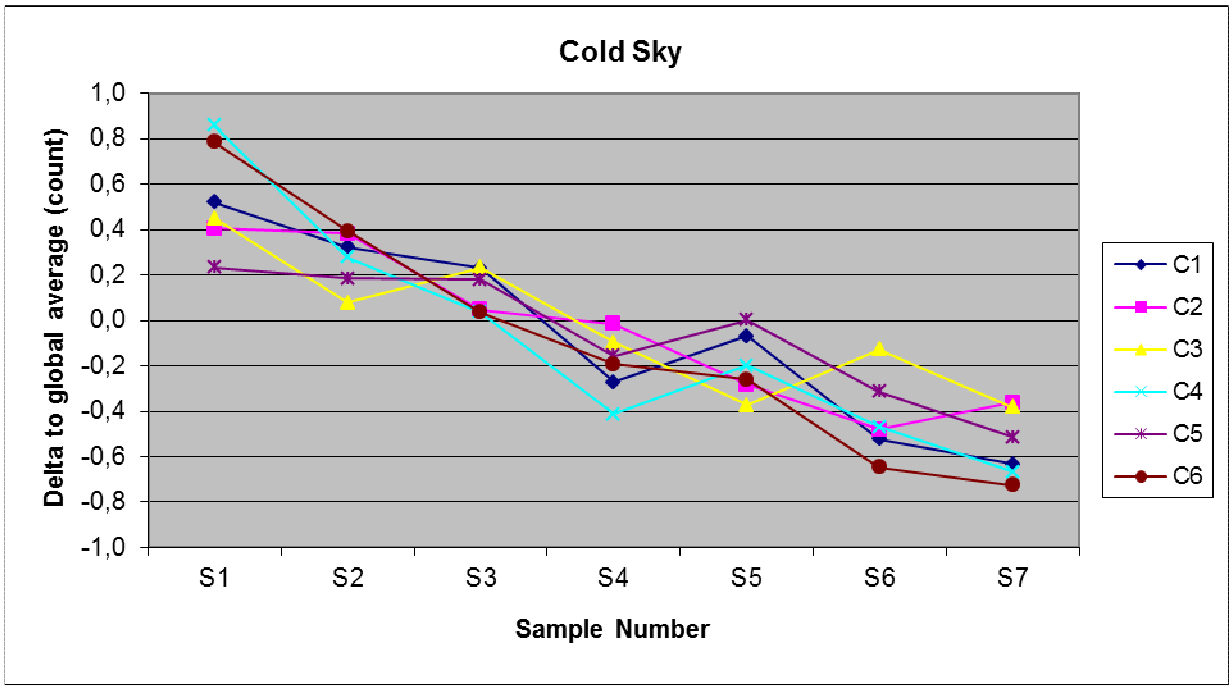
The plots show the average values for each sample number (1 to 7) of each orbit and the global averaged value (over the 5 orbits), plotted for x-abscissa = 501.5.





The averaged over the full set of orbit is plotted for each of the seven samples of each channel on the graph below. It confirms the trend observed on the previous graph.

Analysis and comparison of several orbits help us to conclude that it is independent of the satellite flip.



The observed typical deviation between first and last sample is around 1 count. If we consider a typical gain value of 20K/LSB, it means that the difference between the first sample and the last sample of cold sky is lower than 0.05K. As the cold sky level is obtained by the mean of these 7 samples, we can conclude that the error is lower than 0.025, and consider it as negligible.

7. CONCLUSION

The performance of the Cold Sky calibration is very stable over one full orbit.

The homogeneity of the seven samples acquired over the cold sky view is very good, around 0.05K. The impact on the calibration is negligible, then the 7 samples are then considered in data processing in the computation of cold count average and scan gain.