CENTRE NATIONAL D'ÉTUDES SPATIALES	Centre National d'Etudes Spatiales	
MAD_RAD_01 TRO-NT-32-2812-CNES	Activity : CAL/VAL MADRAS Calibration windows	Prepared by : C.Goldstein Verified by : N Karouche

Contents

1. OBJECTIVE

The objective is to verify that the calibration windows dimensioned during the instrument design are compliant with the specifications in terms of angular width, centering and radiometric stability

2. METHODS

For the angular aspects, a general view of the calibration windows is realised thanks to a specific acquisition mode of the electronic module allowing the decorrelation of the acquisition sequence start signal from the 0° signal of the angle encoder. In this mode, the acquisition start has been trigged such that the Earth acquisition window (140° range acquisition) starts at the beginning of the Hot and Cold calibration Zone.

For the angular centering and radiometric performances, a short and long term averaging of the hot and cold windows is realised for each channel.

3. SUCCESS CRITERIA

For the angular aspects:

- Each cold calibration window has to be 6.3° wide at the minimum
- Each hot calibration window has to be 15° wide at the minimum
- Each window has to show clean and stable samples within the zone of useful datas

For the radiometric aspects, useful samples must be stable and similar within the radiometric sensitivity of the considered channel.

4. PRODUCTS USED

For the global angular aspects, the operation of specific acquisition mode has been realised during orbit 1770

For the other aspects, statistic and averaging of samples has been realised on a representative set of orbits (738 to 756)

5. RESULTS

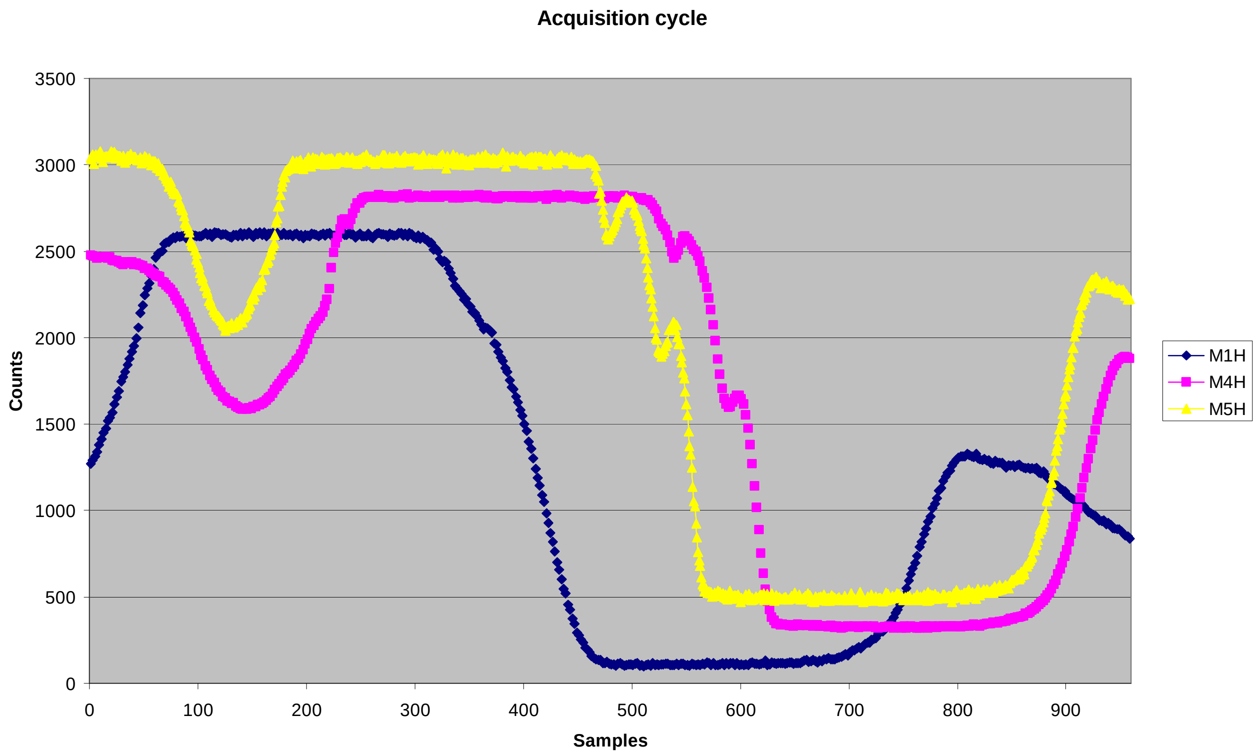
5.1. GLOBAL ANGULAR ASPECTS

The feed cluster is composed of 3 feeds:

- 1 for the 5 Low Frequency channels (LF) from M1H to M3V
- 1 for the 2 Medium Frequency channels (MF) M4 H&V
- 1 For the 2 High frequency channels (HF) M5H&V

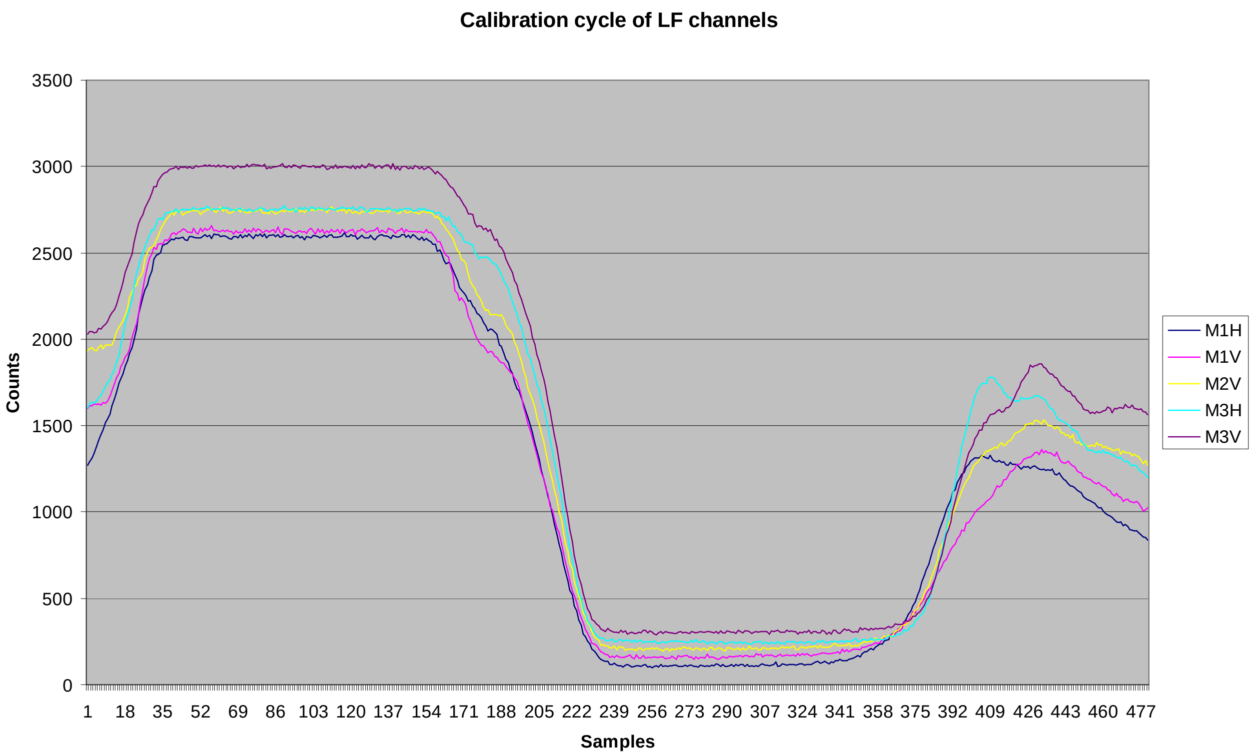
During a calibration phase, the acquisition will be realised first for LF channels, then HF and finally MF channels.

The figure hereunder shows an example of this cycle with only one channel of each feed for more clarity.



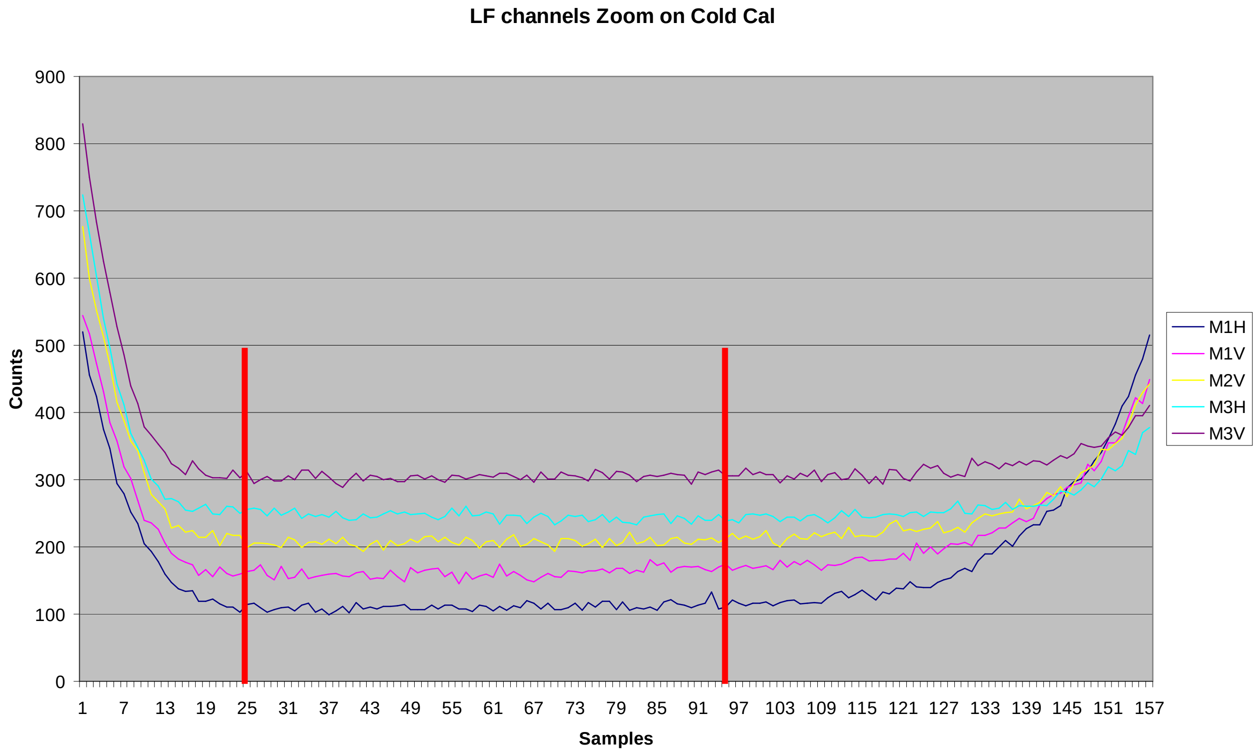
From a qualitative point of view, the calibration zones are flat and clearly defined for each channel. The angular delay between the three feeds is clearly visible.

The figure hereunder shows the complete acquisition of the 5 Low Frequency channels:



Acquisitions of these 5 channels are simultaneous. The global behaviours in terms of flatness and width are similar.

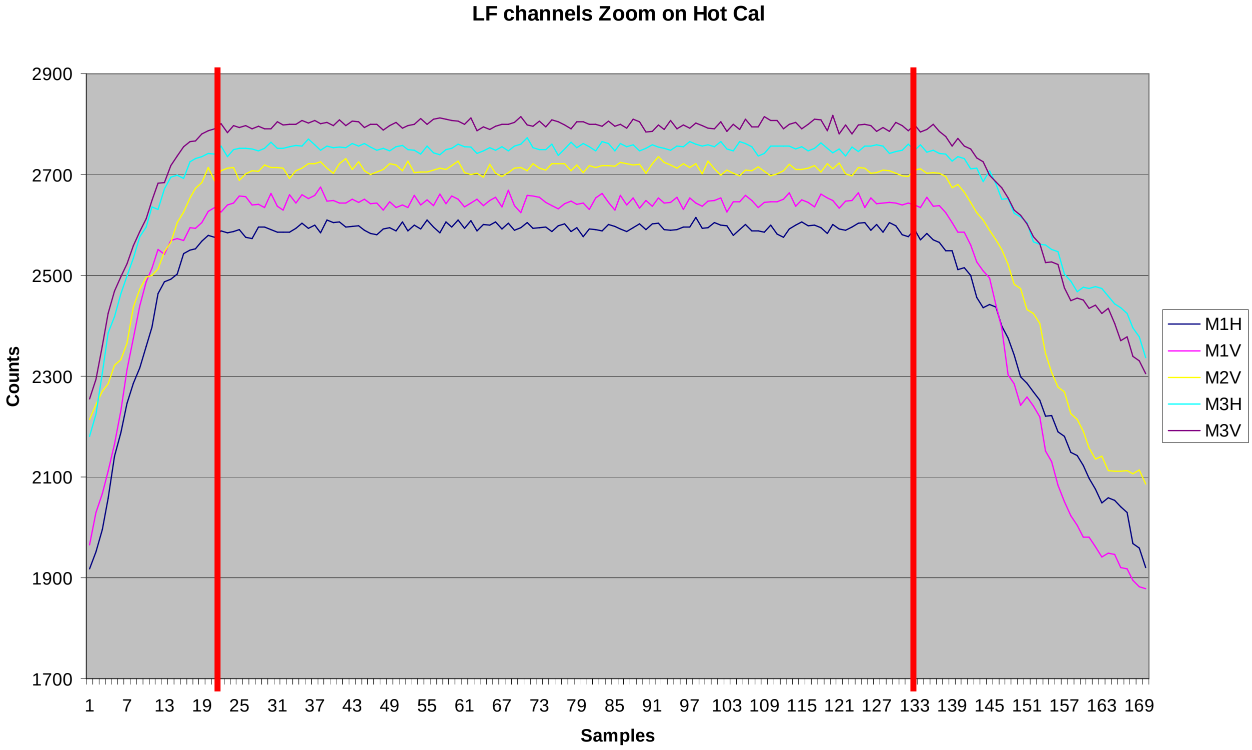
The figure hereunder shows a zoom realised on the cold calibration zone for LF channels:



The 5 channels have been separated of 50 counts for more clarity. A rough and pessimistic estimation of the flat zone for LF channels shows a width of 70 samples of 2 ms. Considering a rotating period of 2483 ms in this mode, this leads to an angular range of 10.1 ° for 6.3° specified.

This exercise has been realised on the two other feeds with similar results.

The figure hereunder shows a zoom realised on hot calibration of LF channels:



The 5 channels have been separated of 50 counts for more clarity. A rough and pessimistic estimation of the flat zone for LF channels shows a width of 110 samples of 2 ms. Considering a rotating period of 2483 ms in this mode, this leads to an angular range of 16 ° for 15° specified.

This exercise has been realised on the two other feeds with similar results.

5.2. WINDOW CENTERING AND RADIOMETRIC STABILITY

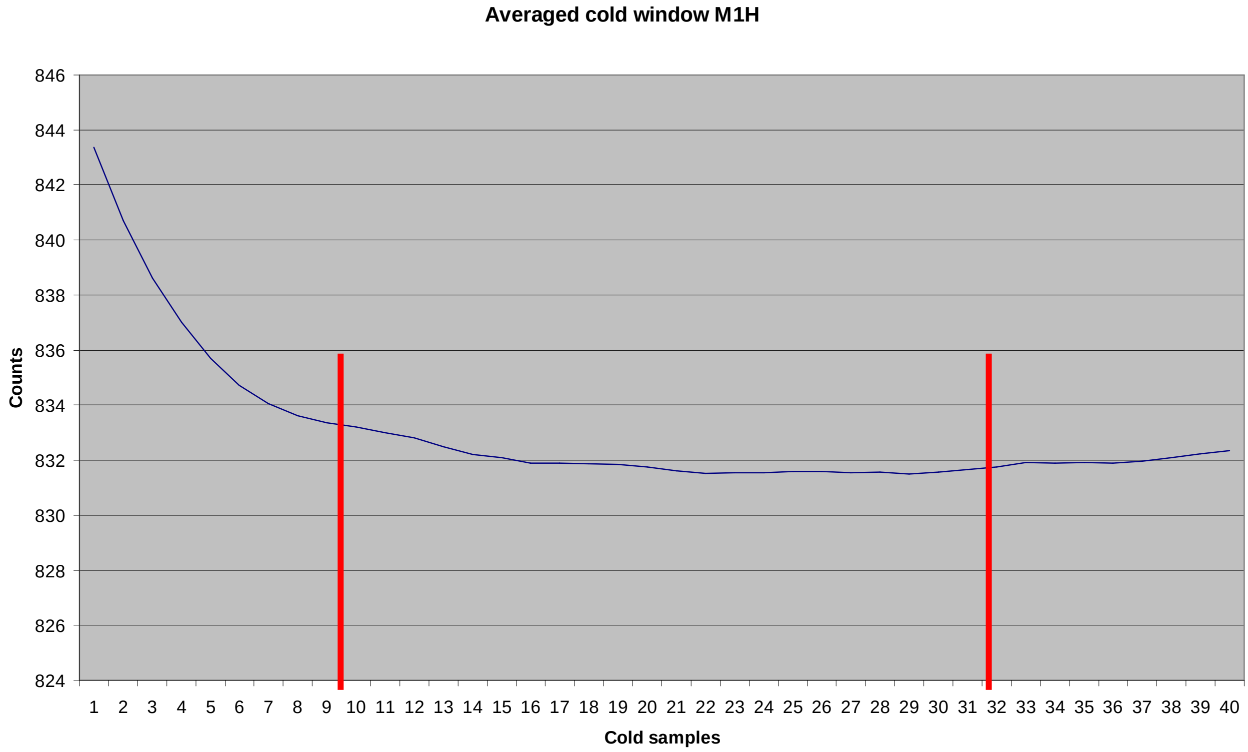
5.2.1. WINDOW CENTERING

Each cold calibration window is made of 40 samples of 2ms for LF and MF channels and 80 samples of 1ms for HF channels.

Inside these windows, a limited number of samples is used to average the cold calibration signal:

- Samples 9 to 31 for LF and MF channels
- Samples 17 to 61 for HF channels

The figure hereunder shows the averaged cold calibration window of channel M1H on 18 orbits:



The result shows a slight shift of the cold window wrt the global cold window position (cf §5.1)

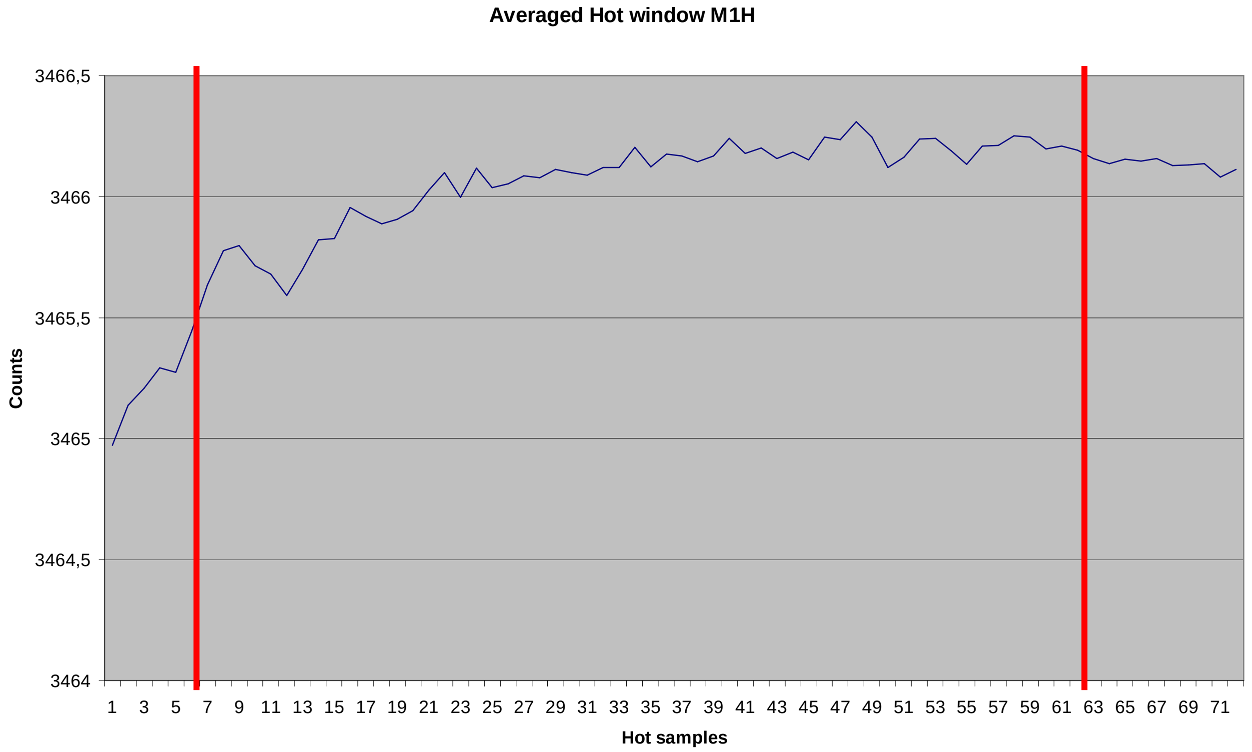
Nevertheless, the useful samples are less affected by this shift. The window shift to optimise the cold calibration window should be of 6 to 7 samples.

Each hot calibration window is made of 72 samples of 2ms for LF and MF channels and 144 samples of 1ms for HF channels.

Inside these windows, a limited number of samples is used to average the cold calibration signal:

- Samples 8 to 63 for LF channels
- Samples 6 to 67 for MF channels
- Samples 1 to 143 for HF channels

The figure hereunder shows the averaged hot calibration window of channel M1H on 18 orbits:



The result shows a slight shift of the hot window wrt the global hot window position (cf §5.1)

Nevertheless, the useful samples are less affected by this shift. The window shift to optimise the hot calibration window should be of 14 to 15 samples.

This exercise has been realised on the two other feeds (MF & HF) with similar results.

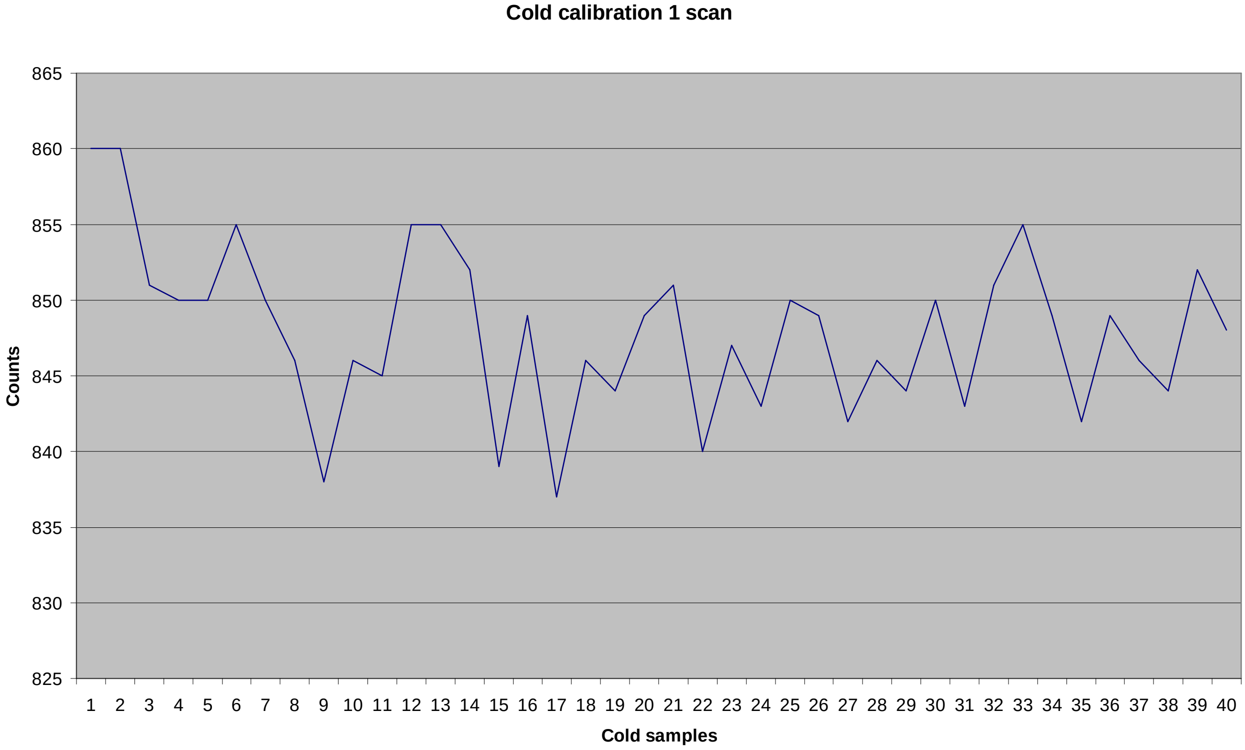
5.2.2. RADIOMETRIC STABILITY

For each scan of the instrument, one cold and one hot calibration are realised. On each of these windows, the useful datas are cumulated in order to reduce the noise.

The noise measured on one sample is linked to the sensitivity of the measurement chain.

The noise of the cumulated samples is decreased by the square root of the number of cumulated samples.

The figure hereunder shows a typical cold calibration measurement on one scan:



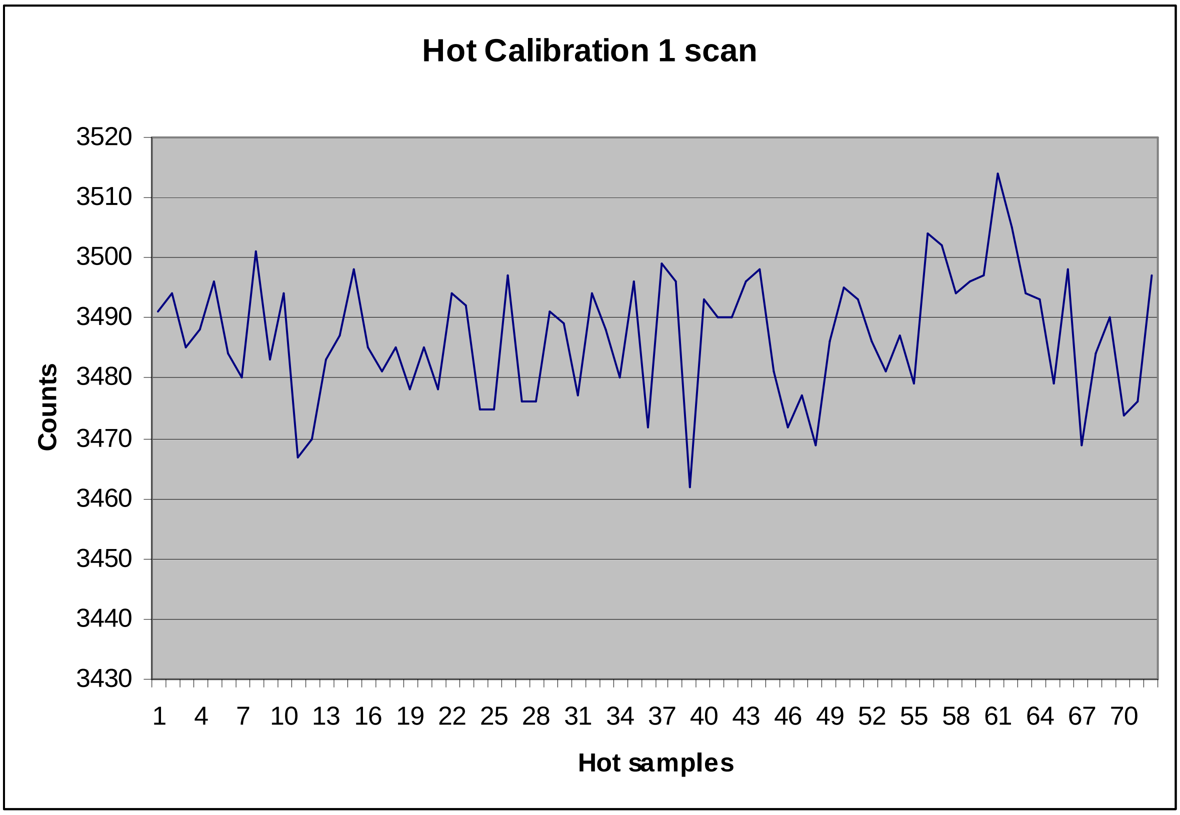
The averaged cold variation shown in §5.2.1 is strongly affected by the lower sensitivity of the receiver on 2ms samples.

The standard deviation of the signal on the useful range is 0.53K. This standard deviation is fully in line with the sensitivity of the measurement chain in cold condition on 2 ms samples.

The standard deviation of the cumulated samples is 0.12K. The theoretical gain due to the sum of the 23 samples is 0.114K.

A comparison of standard deviation on the nominal range of useful datas and a range better centered shifted of 6 samples show no significant difference

The figure hereunder shows a typical hot calibration measurement on one scan:



The averaged hot variation shown in §5.2.1 is strongly affected by the lower sensitivity of the receiver on 2ms samples.

The standard deviation of the signal on the useful range is 1.17K. This standard deviation is fully in line with the sensitivity of the measurement chain in hot condition on 2 ms samples.

The standard deviation of the cumulated samples is 0.151K. The theoretical gain due to the sum of the 23 samples is 0.157K.

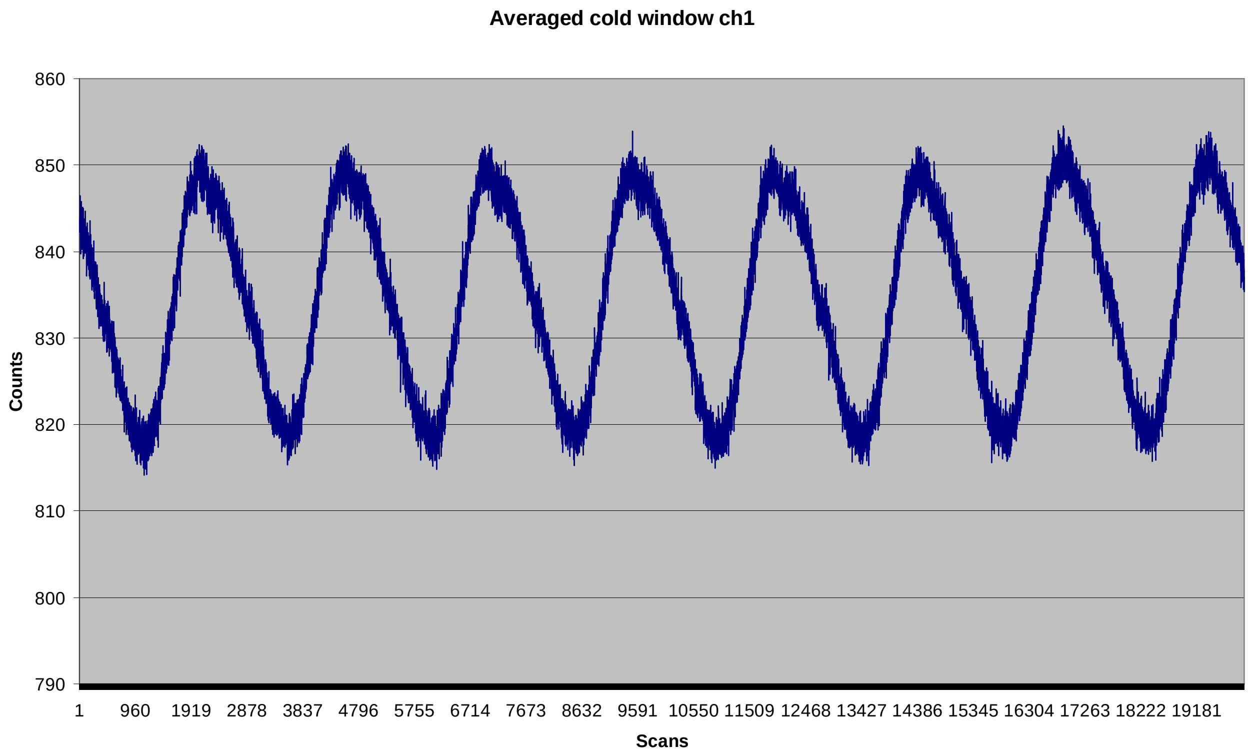
A comparison of standard deviation on the nominal range of useful datas and a range better centered shifted of 9 samples show no significant difference

5.3. LONG TERM STABILITY

5.3.1. COLD CALIBRATION

The figure hereunder shows the variation of the averaged value (23 samples) of the channel 1 cold calibration on 8 orbits.

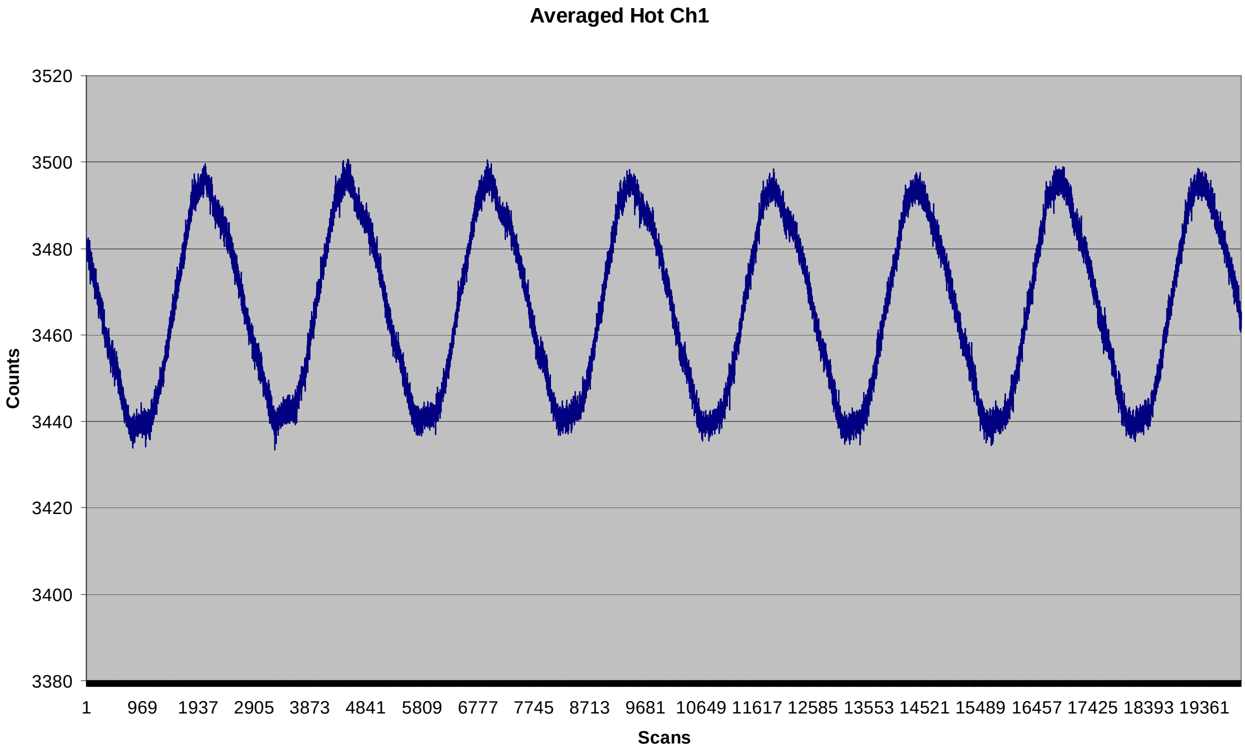
The orbital variation of 30 counts (around 3K) is fully explained, mainly by the calibration reflector loss



5.3.2. HOT CALIBRATION

The figure hereunder shows the variation of the averaged value (56 samples) of the channel 1 hot calibration on 8 orbits.

The orbital variation of 50 counts (around 5K) is fully explained, mainly by the hot target orbital variation.



5.4. RESULT SYNTHESIS FOR THE 9 CHANNELS

The table hereunder shows a typical result computed on a few scans of orbit 738. A verification is periodically realised with the same results.

	M1H	**M1V**	**M2V**	**M3H**	**M3V**	**M4H**	**M4V**	**M5H**	**M5V**
Cold samples	40	40	40	40	40	40	40	80	80
Useful samples	9-31	9-31	9-31	9-31	9-31	9-31	9-31	17-61	17-61
1 sample NedT	0.53K	0.67K	0.72K	0.63K	0.62K	0.39K	0.34K	1.34K	1.24K
Used samples NedT	0.12K	0.13K	0.16K	0.19K	0.16K	0.14K	0.07K	0.30K	0.17K
Hot samples	72	72	72	72	72	72	72	144	144
Useful samples	8-63	8-63	8-63	8-63	8-63	6-67	6-67	1-143	1-143
1 sample NedT	0.93K	1.15K	0.99K	0.81K	0.82K	0.55K	0.52K	1.6K	1.49K
Used samples NedT	0.12K	0.15K	0.1K	0.13K	0.1K	0.09K	0.07K	0.13K	0.12K

6. CONCLUSION

Despite a slight default of centering of the calibration windows which has no visible effect on the performances, hot and cold calibration are fully compliant with the requirements.