TITLE:	**Analysis of Voltage Jumps In LFI18 R0D0-R0D1 and LFI26 R1D0-R1D1 and debug procedure on LFI 26 during OD204**
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CHANGE RECORD

Issue	Date	Sheet	Description of Change	Release
1.0	October, 2009	All	First issue of document	
1.1	April, 2012	All	Revised and corrected version of headers	

TABLE OF CONTENTS

1 ACRONYMS

AIV	Assembly, Integration, Verification
AOS	Acquisition of Signal
ASW	Application Software
BEM	Back End Module
BEU	Back End Unit
CCS	Central Check-out System
CDMU	Central Data Management Unit
DAE	Data Acquisition Electronics
DPU	Digital Processing Unit
EGSE	Electrical ground Support Equipment
FEM	Front End Module
I-EGSE	Instrument EGSE
IST	Integrated Satellite Test
AOS	Loss of Signal
OBC	On Board Clock
RAA	Radiometer Array Assembly
REBA	Radiometric Electronic Box Assembly
S/C	Spacecraft
SCOE	Spacecraft Control and Operation System
SPU	Signal Processing Unit
SUSW	Start- Up Software
SVM	Service Module
TBC	To Be Checked
TBW	To Be Written
TC	Telecommand
TM	Telemetry
UFT	Unit Functional Test

2 APPLICABLE AND REFERENCE DOCUMENTS

2.1 Applicable Documents

2.2 Reference Documents

3 INTRODUCTION

This note was aimed at debugging the two features observed during OD 184-185 and OD 188 on channels LFI 26 and LFI18. A dedicated procedure for debugging the LFI 26 issue was also proposed, performed and analyzed in this report.
The two features exhibited as Scientific Voltage jumps both on REF and SKY signals of the two coupled diodes, as reported in the table below.
In the case of channel LFI 26 the signal increased suddenly on both sky and ref without decreasing again. In the case of LFI 18 the signal decreased again.
While the behaviour of LFI 18 was fully understood just from the analysis of the available data, for LFI 26 it was necessary to wait for the proposed extra test, run many days after the event.
Results from this dedicated test are reported in the second part of this note.

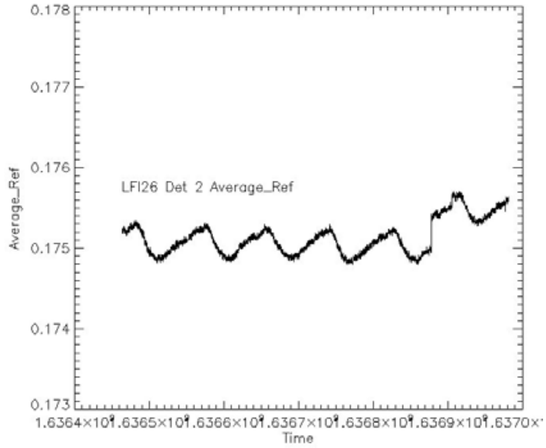


Figure 1 Vout change on LFI 26

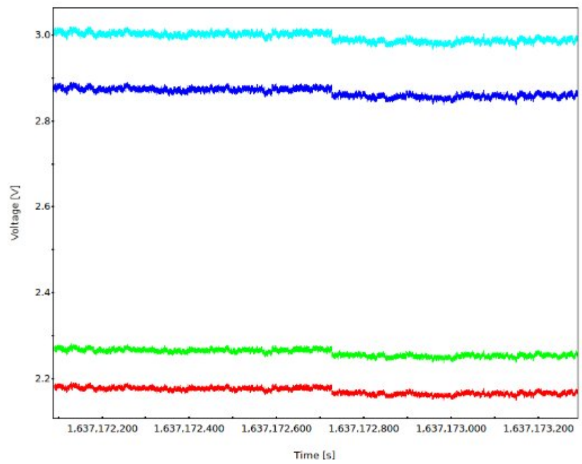


Figure 2 Vout changes on LFI 18

4 PART 1: ANALYSIS OF THE EVENTS

4.1 ANALYSIS OF THE POSSIBLE CAUSES

Here are described the possible physic causes of the observed features.
In principle, a small change in the Vout of both coupled diodes could be due to:

Thermal conditions

a) A change in the thermal conditions of the BEU (modifying the BEM GAIN)
b) A change in the thermal conditions of the FEU (modifying the FEM GAIN)

Electric conditions

c) A change in the BEM offset (simultaneous on two coupled DAE channels)
d) A change in the FEM GAIN (in one or two legs) due to Vg / Vd Bias changes or electric instabilities
e) A change in the BEU power supplier (changing the BEM Gain)
f) A change in the FEM PH SW BIAS (PH SW status or Current bias)
g) The DAE Gain change: excluded due to the small amount of the variation (in the two cases analyzed)

Basing on the data available, it is possible to try to rule out some of the above hypothesis.

4.2 EVENT OBSERVED ON LFI 26:

a) No relevant changes are observed on BEU temperature; the signal change is sudden and not compatible with the inertia of a thermal drift
b) The same as point a)
c) It could be possible; HOWEVER: the offset change should be simultaneous on two DAE channels and different for sky and reference on the same diode (see Figure 8, column DELTA V). Hence does not explain the problem.
d) It could be possible: actually the change in sky and ref keeps proportional on the two legs (columns R and DELTA R, showing that the R change is about 1E-5).
   However, A bias change should be related to a drain current change in the LNAs. In LFI 26 no relevant Id changes are observed. Despite the Id changes are different on the two coupled ACAs (relative variation on S2 is ten times the variation on S1) , however the numbers involved seem to be too low to justify the V change.
   Actually, from I-V curves (below) fits using, as usual, a power law, it comes out that in the case the Id variation was due to a Vg changes on S2, the expected Vout change should be hundred times smaller :

   Vg1 (Id) change ➔ DELTA R1D0_sky (Id) = 2.36 E-6
   Instead of the measured
   DELTA_meas >3 E-4

   Vg2 (Id) change ➔ DELTA R1D0_sky (Id) = 1.16 E-6
   Instead of the measured
   DELTA_meas >3 E-4

   Hence, the difference between expected and measured data is by a factor 50 about.
   This possibility does not fully explain the numbers we are measuring.

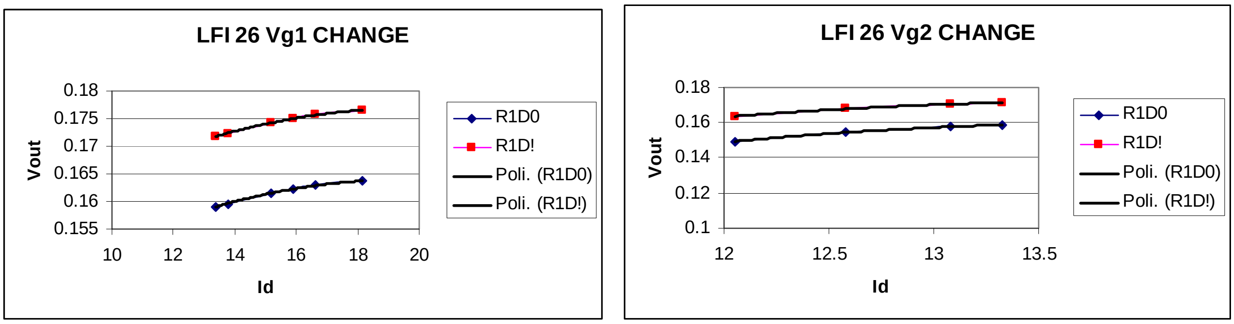


Figure 3 I-V curves for LFI 26 in the Id range considered: left panel , Vg1 is changed keeping vg2 still; right panel, Vg2 is changed keeping Vg1 still.

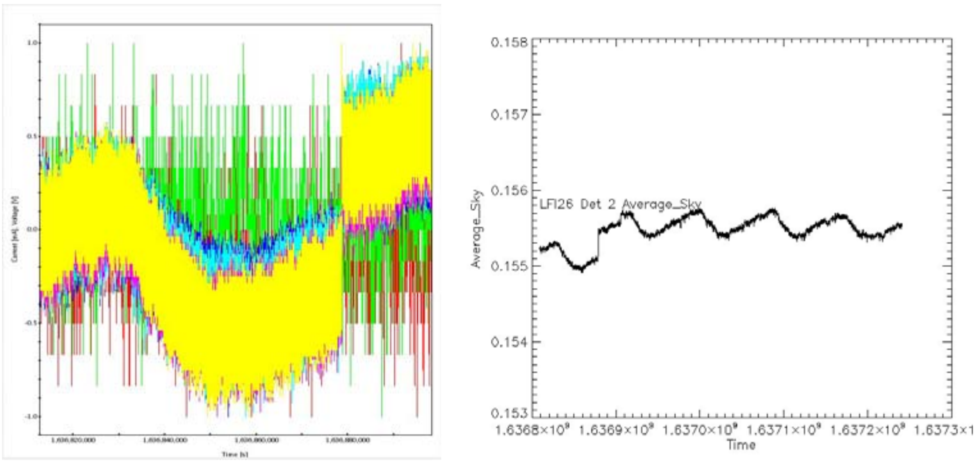


Figure 4 LFI 26 : Vout change (yellow, cyan, traces) vs. Id . the two behaviours seem uncorrelated. The Voltage value keeps constant since the variation occurred on OD 184 (Right panel)

e) It could be possible, since the effect is the same as changing the FEM bias; However the HK acquired do not show major variations and we have no way to monitor the effective voltage powering the BEMs. It can not be ruled out but we have no way to investigate/modify it.

f) The effect of changing the Current in the phase switch not switching exhibits as a change in the loss of radiation travelling that leg. It is proportional to the entering signal that is a combination of sky and ref and hence affects both sky and ref on both diodes, affecting only the amplitude of the signal.

In the case the change is instead over the switching PS, it is expected to create a different reaction on sky and ref signals (changing R before and after the event), that is not observed. The effect of changing the phase switch status on one channel, in the case the TC is not acknowledged, should probably be recognized as a signal swap (we should see the swap of sky ref signals), provided that the change is in some way recognized.

4.3 EVENT OBSERVED ON LFI 18:

a) b) c) The same as said before for LFI 26

d) It seems to be a good explanation: actually , as reported in Figure 8, the signal changes are proportional on sky and ref. Moreover, if we consider the Id change and correlate it with the signal change, a good agreement comes out:

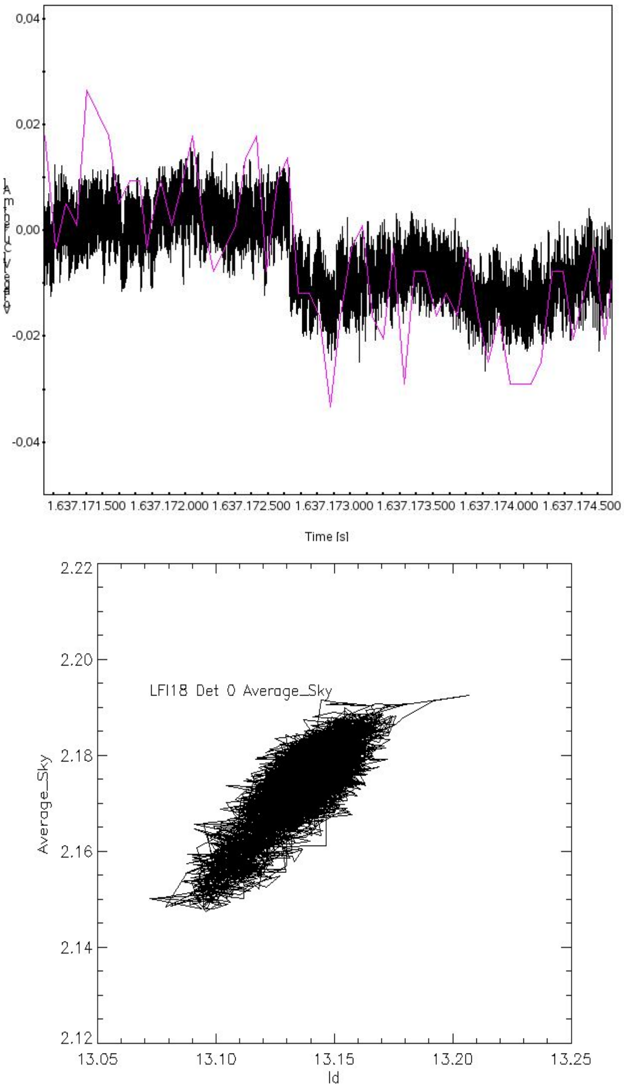


Figure 5 LFI 18: Id (M1, magenta) vs V (R0D0, black) correlation ; right panel: Id(M1) on x axis Vs Vout_R0D0 along three days

If we follow the same approach as for LFI 26, the amplitude of the expected V change due to Id change is :

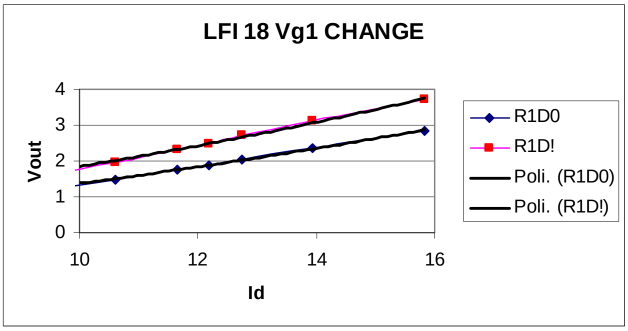
Vg1_M1 (Id) change → DELTA R0D0_sky (Id) = 6 E-3
Vg2_M1 (Id) change → DELTA R0D0_sky (Id) = 5 E-3

Vg1_M2 (Id) change → DELTA R0D0_sky (Id) = 8 E-4
Vg2_M2 (Id) change → DELTA R0D0_sky (Id) = 6 E-4

Instead of the measured

DELTA_meas 1.2 E-2

Hence, the difference between expected and measuered data is by a factor 2 about.



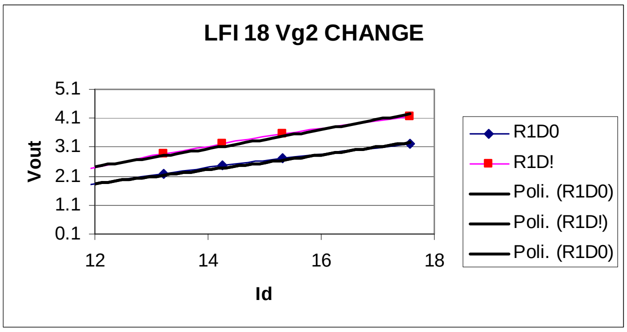


Figure 6 I-V curves for LFI 18 in the Id range considered: left panel , Vg1 is changed keeping vg2 still; right panel, Vg2 is changed keeping Vg1 still.

In add, we see that this behaviour is typical of this channel and that the previous signal level is restored after a certain time:

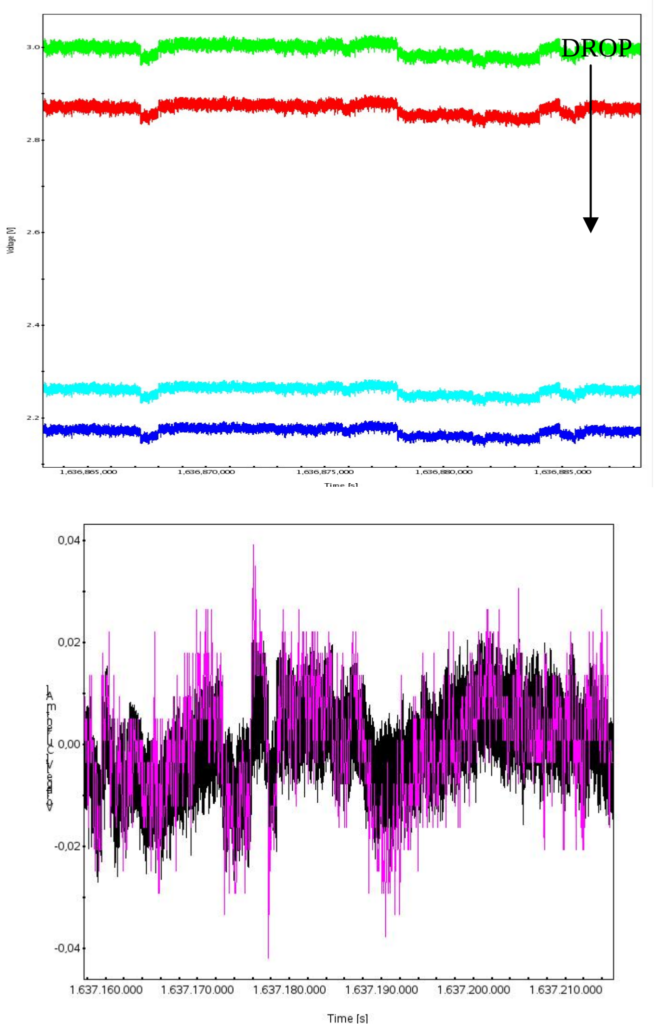


Figure 7 Left panel: Typical behaviour of LFI 18 M (OD 178) ; Right panel: OD 188 : correlation between Vout and Id along 18 hours .

The above explanation seems to be satisfactory, not requiring to investigate also frames e) and f).

LFI 18	0	BEFORE	R	POST	R	DELTA V	DELTA%	DELTA REL SR	DELTA REL R	Tn	DELTA SKY/ REF
M00	SKY	2.17957	0.960929	2.16636	0.960943	-0.01321	-6.08E-03	-4.14E-02	1.46E-05	41.73	1.46E-05
	REF	2.26819		2.25441		-0.01378	-6.09E-03				
M01	SKY	2.87488	0.957046	2.85807	0.957029	-0.01681	-5.86E-03	-4.00E-02	-1.82E-05	37.59	-1.82E-05
	REF	3.00391		2.9864		-0.01751	-5.85E-03				
	S2	18.478	1.163023	18.4731	1.162232	-0.0049	-0.000265	0.99973482			
	S1	15.8879		15.8945		0.0066	0.000415	1.00041541			
	M1	13.1455	0.913123	13.1265	0.912012	-0.019	-0.001446	0.998554638			
	M2	14.3962		14.3929		-0.0033	-0.000229	0.999770773			

LFI26		BEFORE	R	POST	R	DELTA	DELTA rel	DELTA REL SR	DELTA REL R		DELTA SKY/ REF
M10	SKY	0.15509	0.886279	0.155454	0.886338	0.000364	2.34E-03	-8.77E-02	6.67E-05	11.86	6.67E-05
	REF	0.17499		0.175389		0.000399	2.28E-03				
M11	SKY	0.168309	0.903833	0.168627	0.903856	0.000318	1.89E-03	-8.36E-02	2.59E-05	14.67	2.59E-05
	REF	0.186217		0.186564		0.000347	1.86E-03				
	S2	13.6895	1.024778	13.6905	1.024845	0.001	7.3E-05	1.000073049			
	S1	13.3585		13.3586		1E-04	7.49E-06	1.000007486			

Figure 8 Statistics of the changes measured on LFI 18 and on LFI 26.

4.4

5 PART 2: DEBUGGING EVENT ON RCA 26

Possible debugging for LFI 26:

Here follows a proposal for a possible test to be performed on LFI 26 in order to:

1- Understand the cause (whether it depends on a DAE bias change)
2- Recover the baseline : actually, despite the change in the signal level is small, however, depending on the cause also the radiometer properties are now different.

The debugging procedure consists just in the DAE resume procedure with time delays inserted between the individual operations. It can also be viewed as the GAIN default procedure operated over several parameters. It can be fully performed during the real time.

Suggested Procedure for LFI 26:

Set DAE GAIN on S1(1min) and S2
Set DAE OFFSET on S1 and S2(1min)
Set 4KHz default on A/C(1 min)
Set 4KHz default on B/D(1 min)
set P/S default on S1 (1 min)
set P/S default on S2 (1 min)
set I1 default on S1 (1min)
set I2 default on S1 (1min)
set I1 default on S2(1min)
set I2 default on S2 (1min)
set Vg1 default on S1 (1min)
set Vg2 default on S1 (1min)
set Vd default on S1 (1min)
set Vg1 default on S2 (1min)
set Vg2 default on S2 (1min)
set Vd default on S2 (1min)
RESUME DAE DEFAULT (in the case the cause was due to other channels than the LFI 26)

Duration : 16 min

6 PART 3: ANALYSIS OF THE DEBUG PROCEDURE

The debugging procedure was applied during DTCP on OD204 (December 3rd).
An overall view of the R1D0 sky signal and R1D1 ref signal during a range of about 30 days, from OD 180 to 209 (Figure 10), does not show changes comparable to the OD 184 jump during the recovery procedure.

It is worth mentioning the problem occurred with the transponder during OD 192, exhibiting as an abrupt change in the scientific output of the most radiometers caused by the heating up and down of the Back End Unit containing the LFI warm amplifiers, for a period longer than the usual daily three hours.

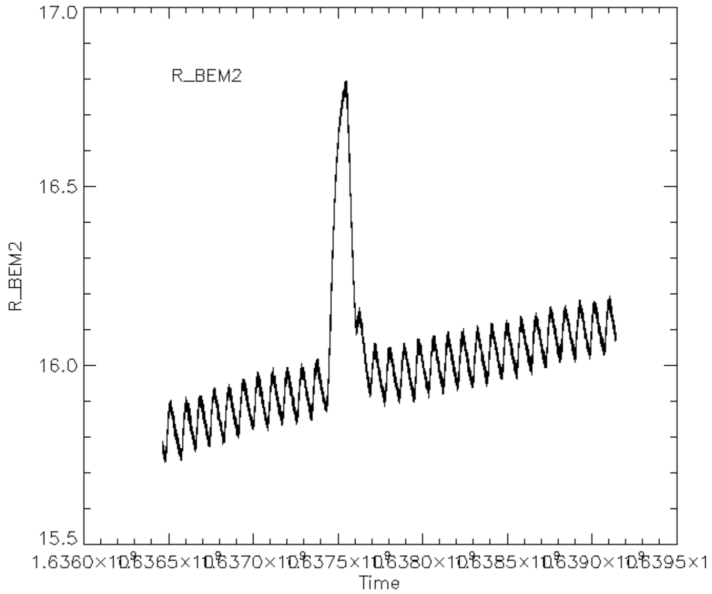


Figure 9 BEU temperature from OD 180 to OD 210: the abrupt increase is due to the transponder heating effect.

We are mentioning it not as something related with the event occurred days before but as something that could have affected the RCA under test before the debugging test.

Actually, as shown by Figure 9, for the time being the BEU temperature is higher than during OD 184. Hence, due to the typical thermal response of the LFI 26 (voltage output anti-correlated with the BEU temperature) we would expect today a Vout lower than that measured after the event of OD 184.

Instead, what we observe today is a larger V out on one diode (R1D0) and a comparable voltage on the coupled diode (R1D1) . The following plots support this thought, showing that the permanent change on LFI 26R1D0 is not correlated with a temperature change in the BEU.

In the two following figures, it is however evident the different behaviours of the two detectors before and after the OD192 long transponder heatup : RCA26 – 10 detector shows a discontinuity in the trend that was not recovered in the following days.

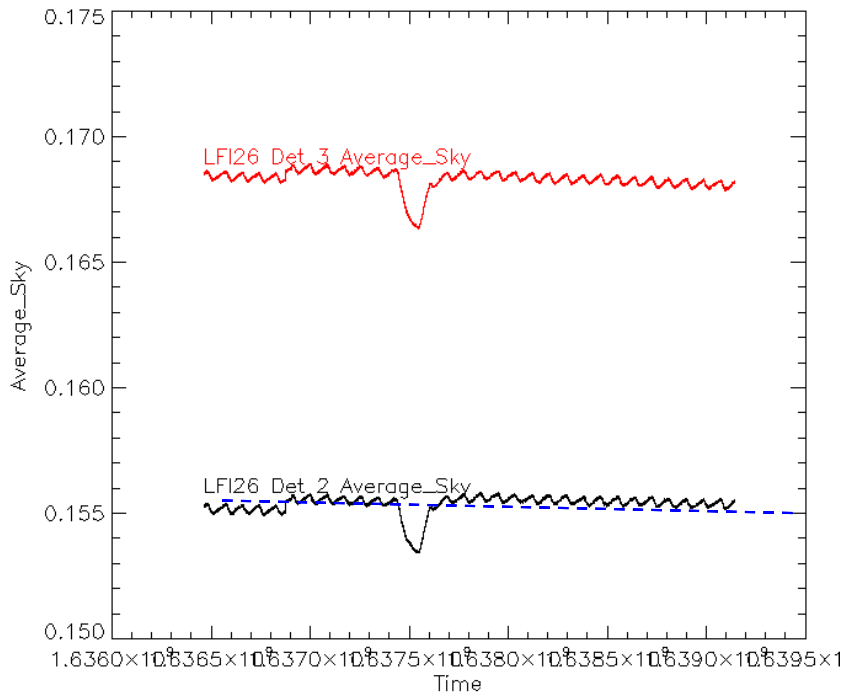


Figure 10 RCA26 R1D0 sky signal (black, bottom) and R1D1 ref signal (red, top) from OD 180 to 210. Jump in the signal during OD184 is evident in the plots together with the 32 hours Transponder on period on OD 191-192. No evidence of a relevant change during the debug procedure applied during OD204 is clearly visible. A further remark is the behaviour of the RCA26 – 10 before and after the transponder long heating; it is evident that while detector 11 has gone back to its previous status, detector 10 has an increased baseline.

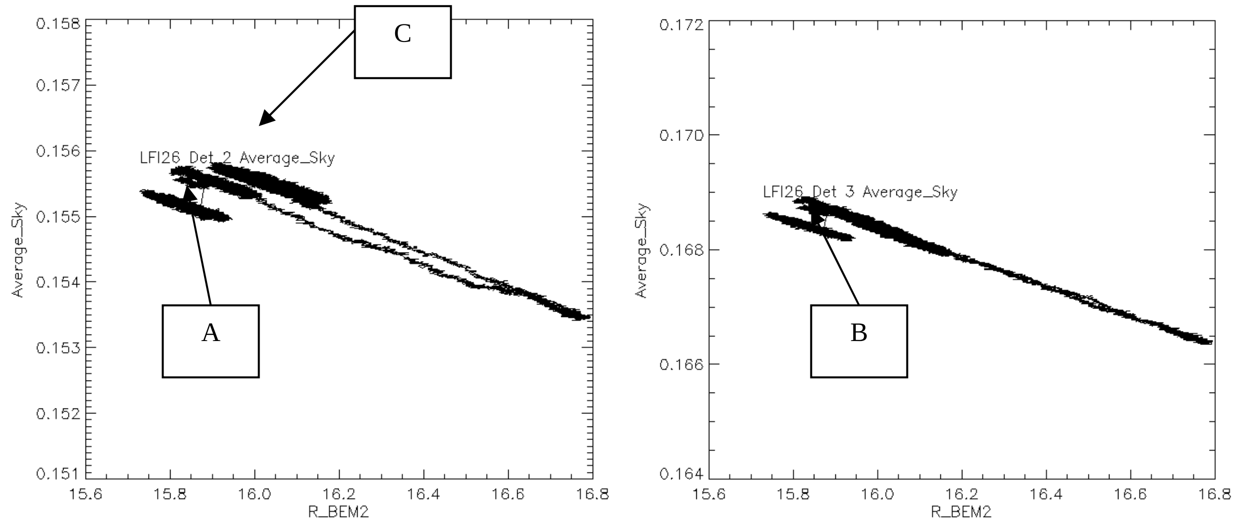


Figure 11 Correlation between RBEM temperature and sky signal on R1D0 (left) and R1D1 (right). In both panels it is evident the discontinuity due to the Voltage (A, B) jump: however, in

R1D0 we observe also a second discontinuity (C) due to the non recovered voltage change following the transponder effect.

Details on the recovery procedure applied are reported below in Table 1.

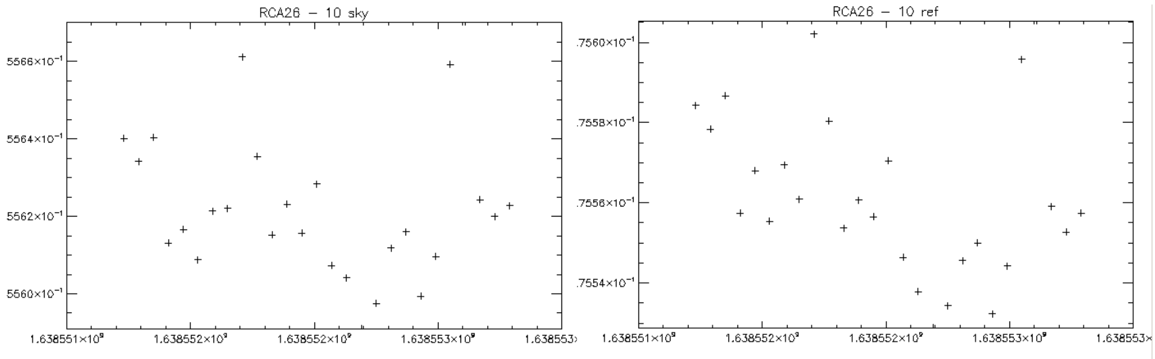
Settings of the default parameters on the RCA26 were applied in sequence after Real time science data acquisition, starting at 17:09:00.

The detailed as run procedure is reported in the following Table 1:

17:10:00	=> Gain on S1 and S2
17:11:00	=> Offset on S1 and S2
17:12:00	=> A/C Sw Status
17:13:00	=> B/D Sw Status
17:14:00	=> A/C Sw position
17:15:00	=> B/D Sw Position
17:16:00	=> I1 on S1
17:17:00	=> I2 on S1
17:18:00	=> I1 on S2
17:19:00	=> I2 on S2
17:20:00	=> Vg1 on S1
17:21:00	=> Vg2 on S1
17:22:00	=> Vd on S1
17:23:00	=> Vg1 on S2
17:24:00	=> Vg2 on S2
17:25:00	=> Vd on S2
17:25:30	=> Dae Default Config

Table 1 procedure and timing

As a first analysis, the average signal was evaluated for each minute (starting from 17:07), on the 40 central seconds, i.e. cutting first and last 10 seconds. Results are reported in the Figure 12.
Time range is from 17:07 to 17:35, when the dedicated scientific real time visibility ended. First three points are taken as a reference before the first setting (Gain) is applied. Last two steps, separated by only 30 seconds, are mixed in a single point.



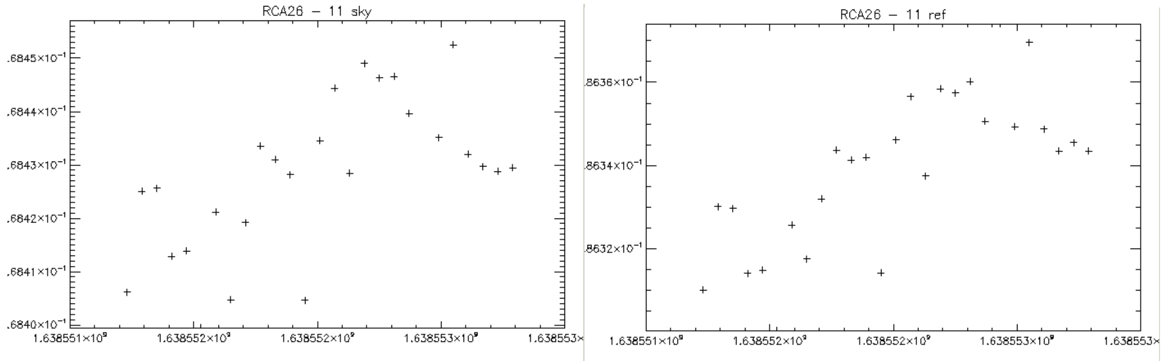


Figure 12 Each point in the plots is the average of 40 seconds of data starting from second 10 to 50 of each minute, from 17:07 to 17:35. So the first 3 points are taken before the procedure is applied, than 16 points report the values for each of the procedure steps and last points give the behaviour until the end of Real Time science acquisition. There is no evidence of a sudden change towards a systematic different level.

In the detector R1D0 a change in both the sky and ref level is visible after the third point, i.e. as the first setting was applied, but the dispersion of the subsequent points show it is not really a definite jump.
In the detector R1D0 the mean value of the first points is at a lower level than in the final part, but no clear and systematic discontinuity or jump is visible.
A further display of the sequence of signal behaviour associated to each of the commands is reported in the Appendix below.

7 Conclusions

The analysis proposed shows that LFI 18 and LFI 26 voltage drops can be related with different causes.

For LFI 18 a possible cause is very likely (drain current drops on M1 LNA) and should exclude any new features on this channel.

LFI 26 instead showed a permanent change in the voltage; different possible causes have been pointed out. A test to be performed during the pass time was proposed to disentangle between them.

The test was performed and data analysis is reported.

The causes investigated with the procedure proposed are clearly ruled out by the results of the test. However, it was pointed out that, due to the long period between the event and the test, something could have changed in the environmental or boundary conditions due to the problem occurred with the RF transponder kept on for a longer time than usual.
In fact, it is worth noting that in the detector R0D1 a change in level was probably occurring in between the appearance of the discontinuity and the performance of the debug procedure.

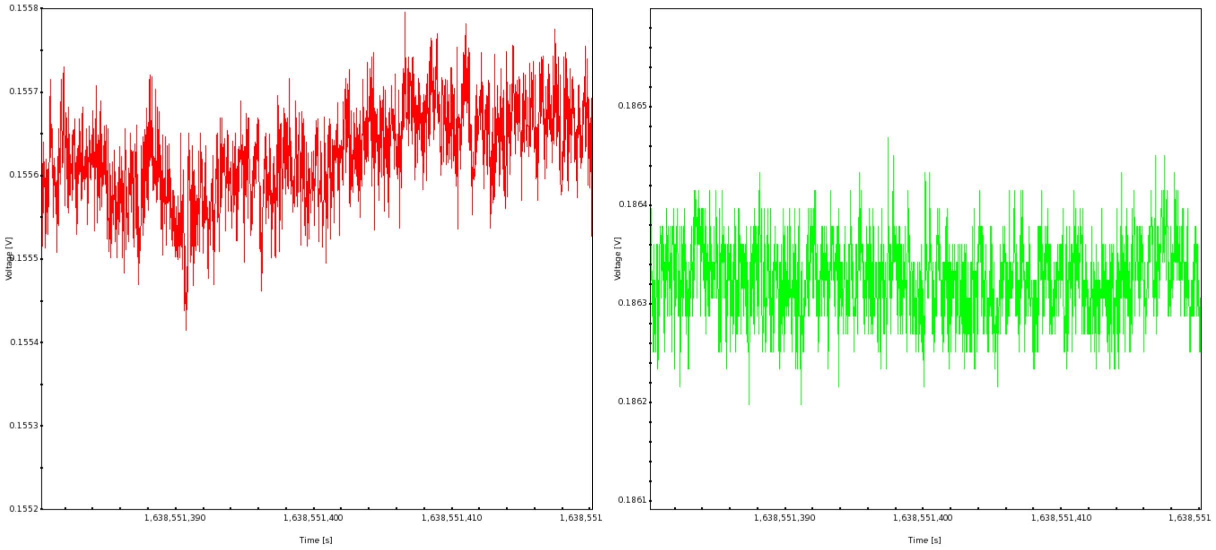
8 Appendix

A zoom of 20 seconds, centered on the TC application time, of the R1D1 ref signal and R1D0 sky, as representatives of the whole radiometer is reported for each minute. The TC is applied in the central point of the graph which is the point referring to the time reported above each of the plots.

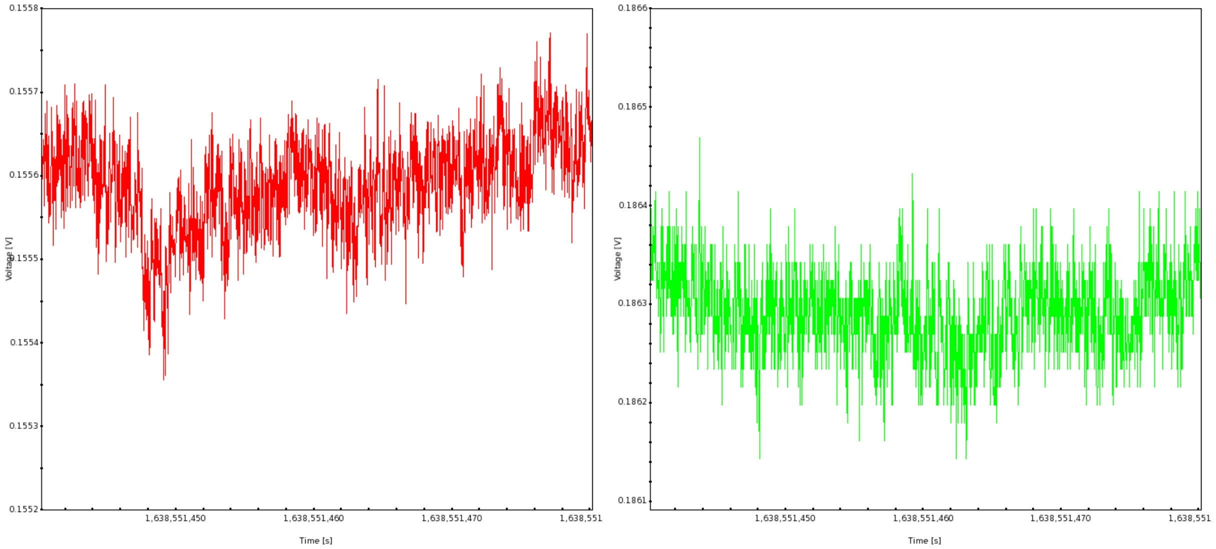
Exceptions are:

- the last two plots, where 60 seconds of data since 17:24:50 to 17:25:40 are reported in order to display both the last two steps separated by just 30 seconds. Left panel is Sky output of the R1D0, right panel is Ref output of the R1D1.
- the first three plotswhich spans 40 seconds; in this way, it was possible to display the only suspect gap soon before 17:11 in the R1D0 that was anyway not outstnading being definitely at the same level of the normal fluctuations.

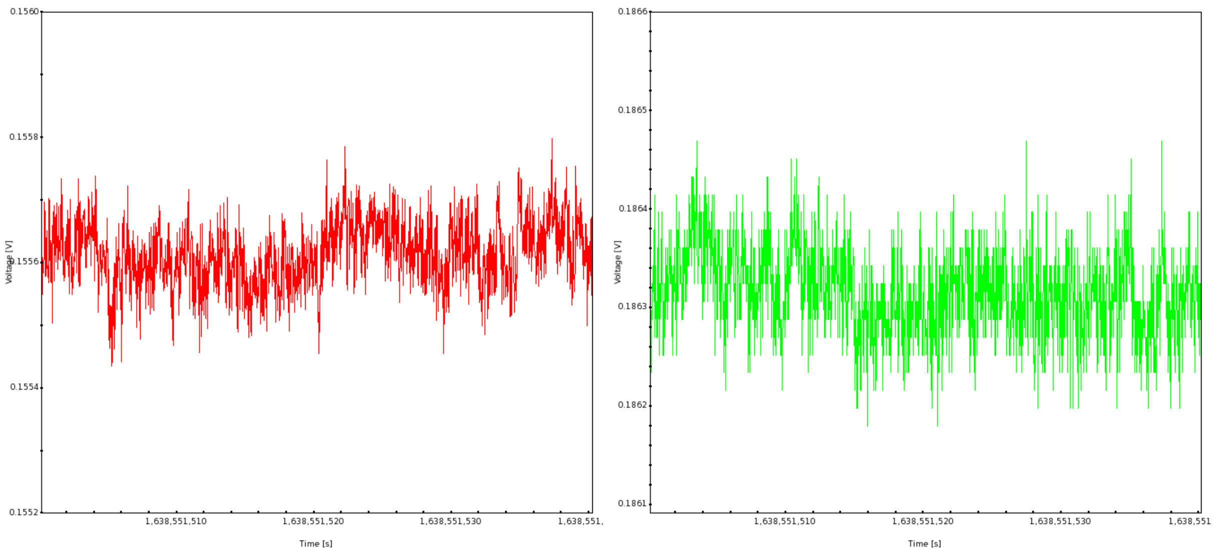
17:10



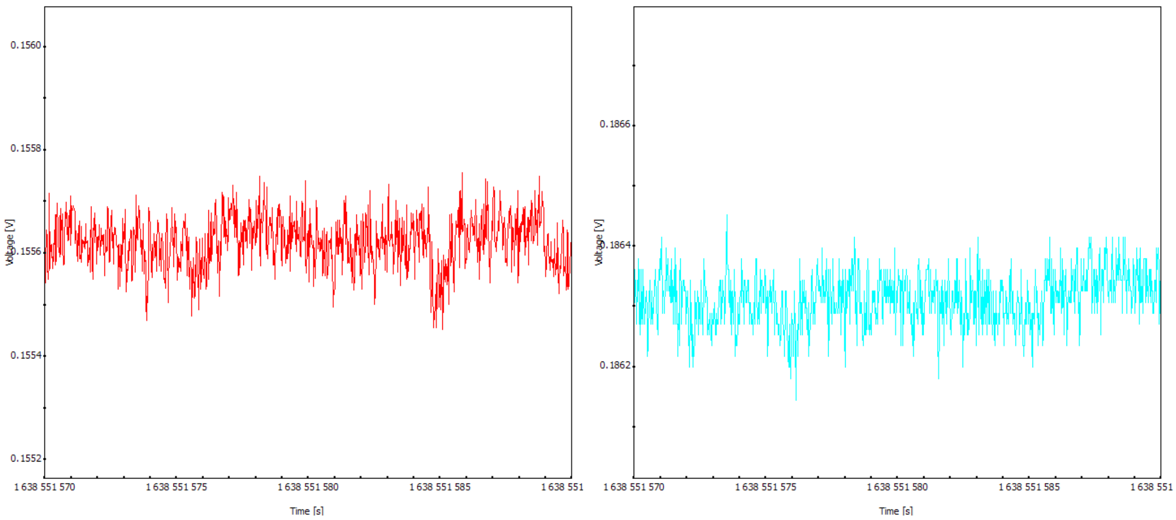
17:11



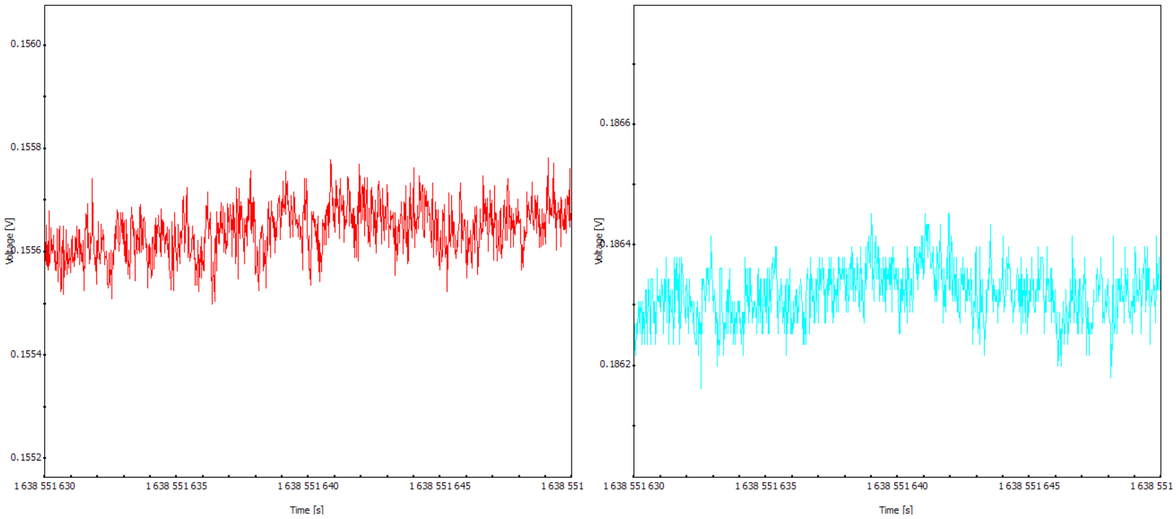
17:12



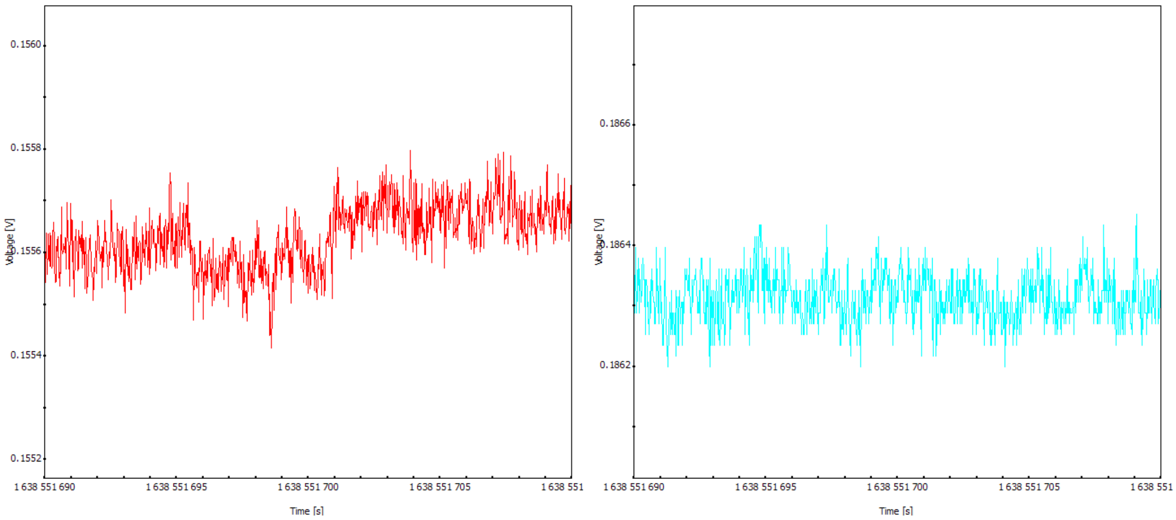
17:13



17:14


0.1560
0.1558
0.1556
0.1554
0.1552
Voltage [V]
1 638 551 630
1 638 551 635
1 638 551 640
1 638 551 645
1 638 551
Time [s]
0.1866
0.1864
0.1862
Voltage [V]
1 638 551 630
1 638 551 635
1 638 551 640
1 638 551 645
1 638 551
Time [s]

17:15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0.1558
0.1556
0.1554
0.1552
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1 638 551
Time [s]
0.1866
0.1864
0.1862
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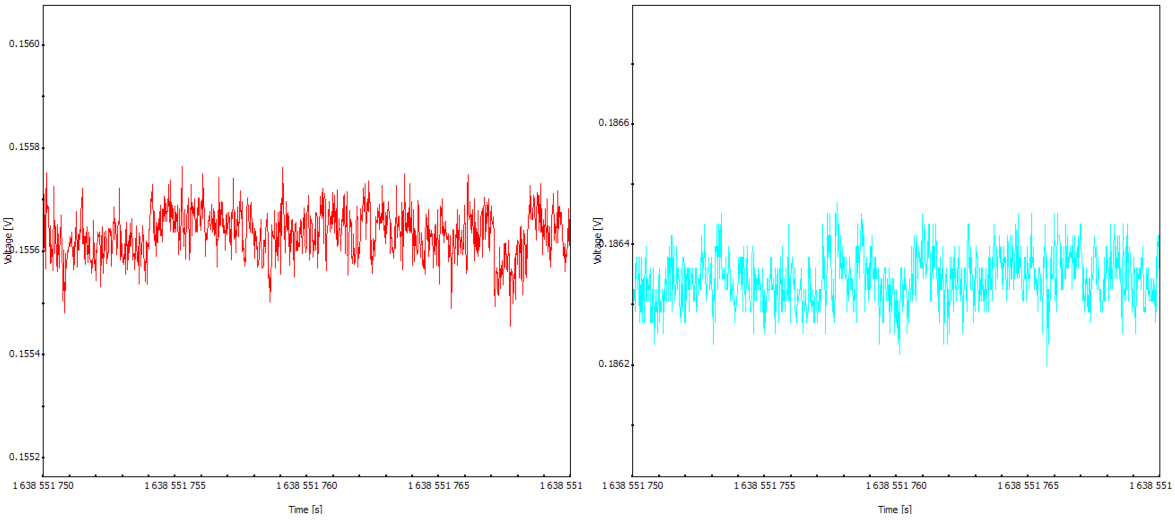
1 638 551 705
1 638 551
Time [s]

17:16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0.1558
0.1556
0.1554
0.1552
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1 638 551 755
1 638 551 760
1 638 551 765
1 638 551
Time [s]
0.1866
0.1864
0.1862
Voltage [V]
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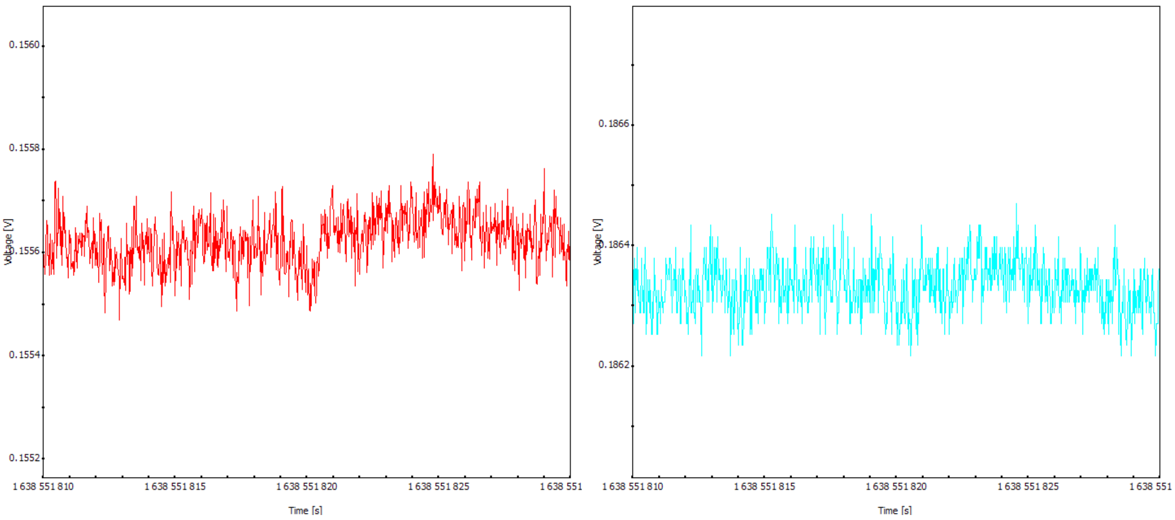
1 638 551 755
1 638 551 760
1 638 551 765
1 638 551
Time [s]

17:17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0.1554
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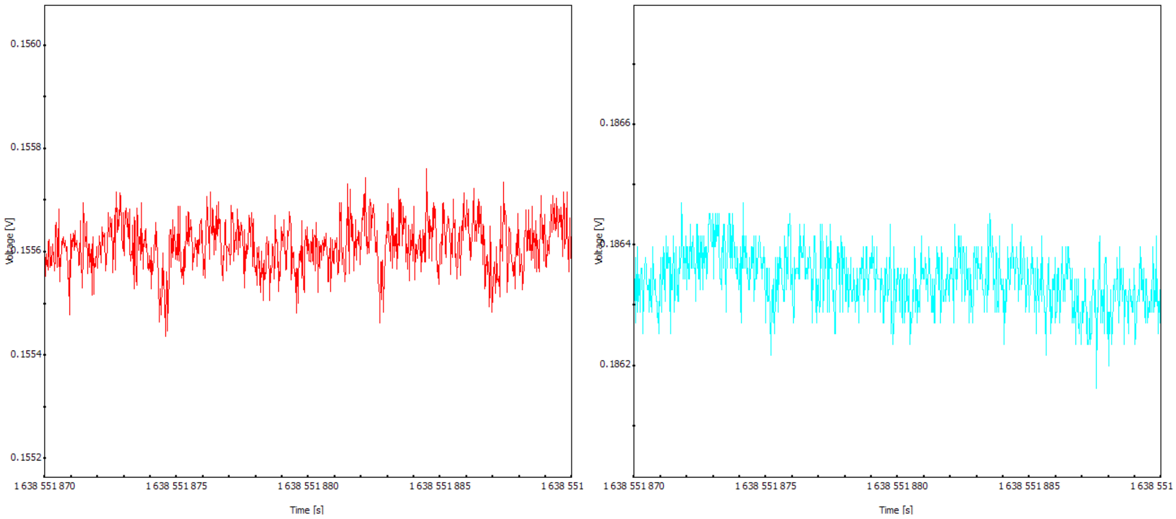
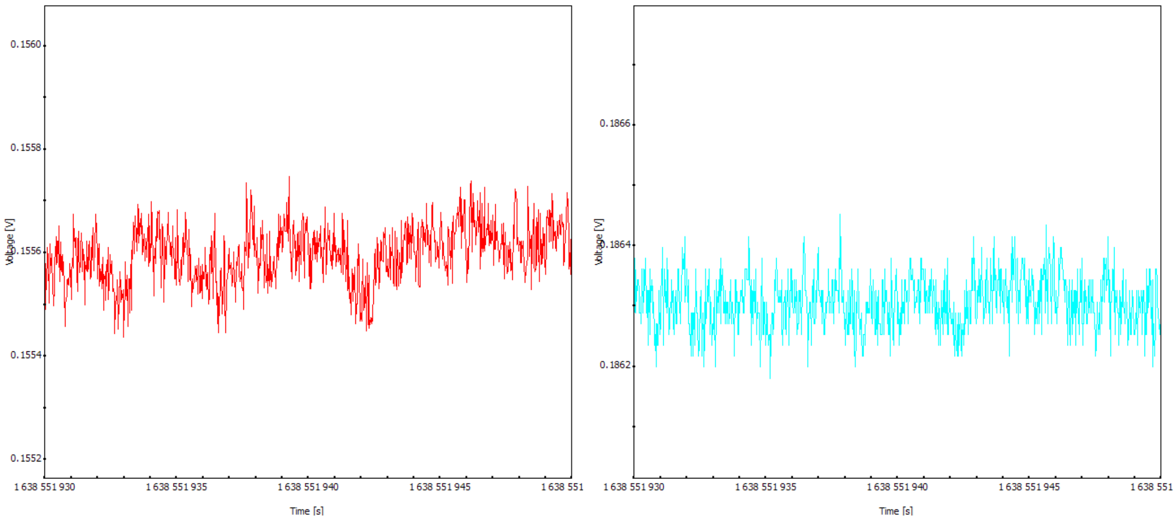
1 638 551
Time [s]
0.1866
0.1864
0.1862
Voltage [V]
1 638 551 810
1 638 551 815
1 638 551 820
1 638 551 825
1 638 551
Time [s]

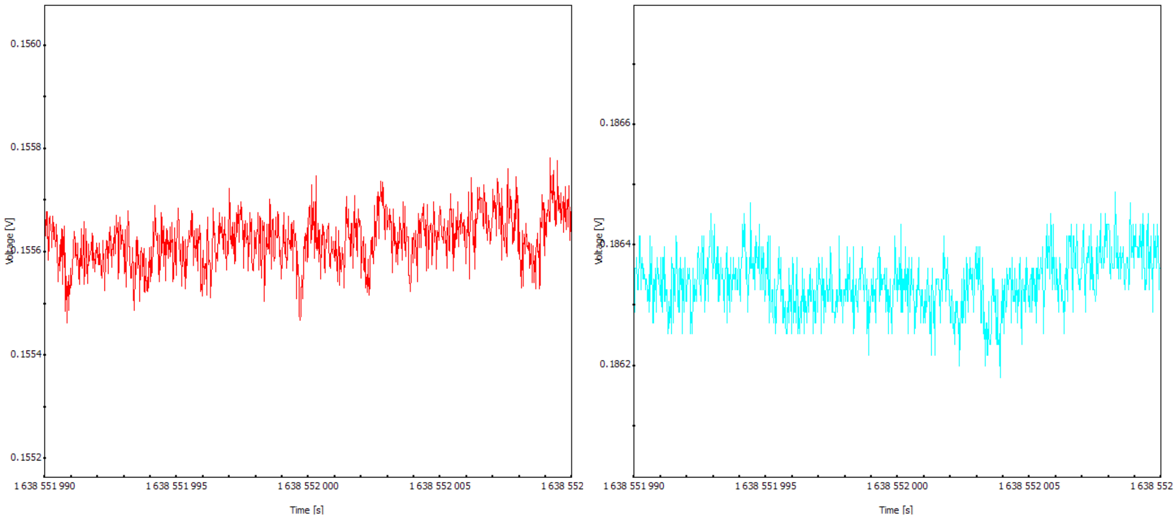
17:18


0.1560
0.1558
0.1556
0.1554
0.1552
Voltage [V]
0.1866
0.1864
0.1862
1 638 551 870
1 638 551 875
1 638 551 880
1 638 551 885
1 638 551
Time [s]

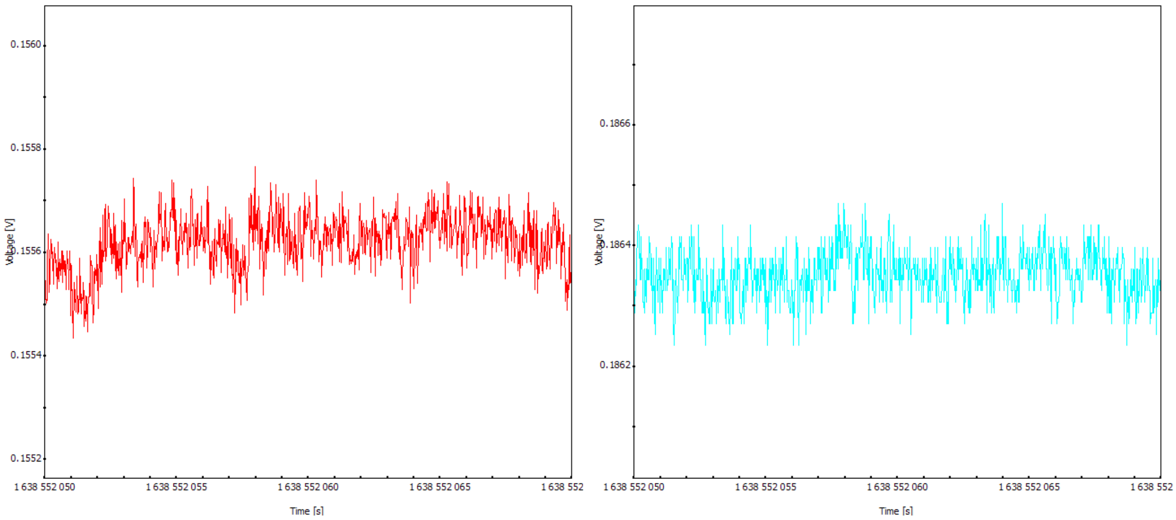
17:19


0.1560
0.1558
0.1556
0.1554
0.1552
Voltage [V]
0.1866
0.1864
0.1862
1 638 551 930
1 638 551 935
1 638 551 940
1 638 551 945
1 638 551
Time [s]

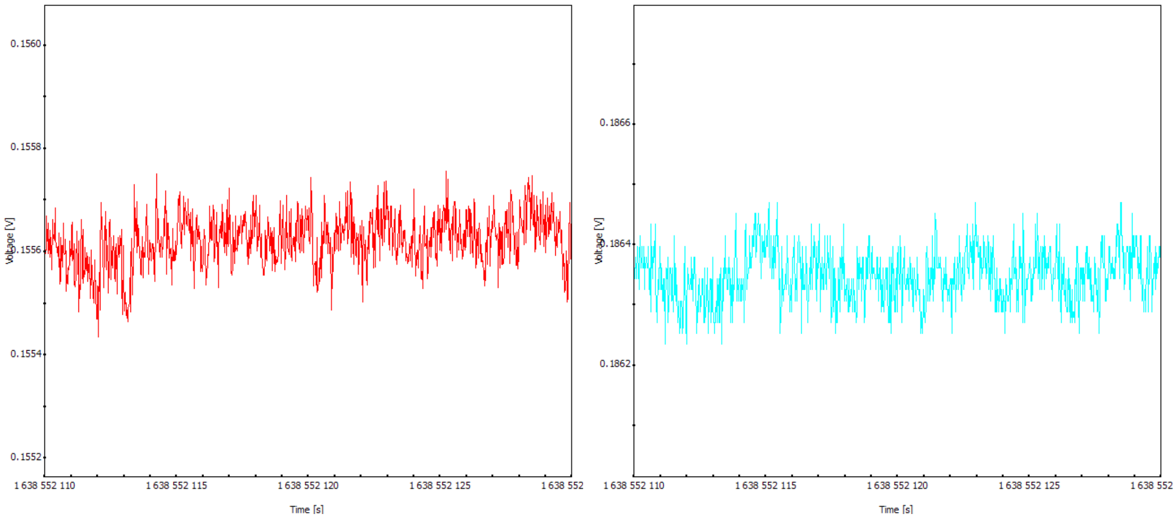
17:20


0.1560
0.1558
0.1556
0.1554
0.1552
Voltage [V]
1 638 551 990
1 638 551 995
1 638 552 000
1 638 552 005
1 638 552
Time [s]
0.1866
0.1864
0.1862

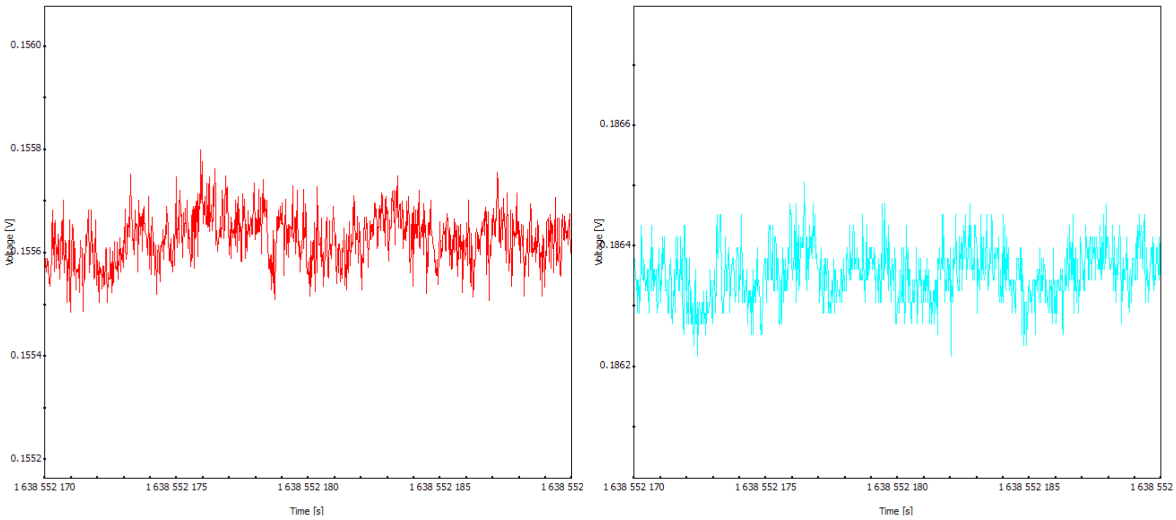
17:21


0.1560
0.1558
0.1556
0.1554
0.1552
Voltage [V]
1 638 552 050
1 638 552 055
1 638 552 060
1 638 552 065
1 638 552
Time [s]
0.1866
0.1864
0.1862

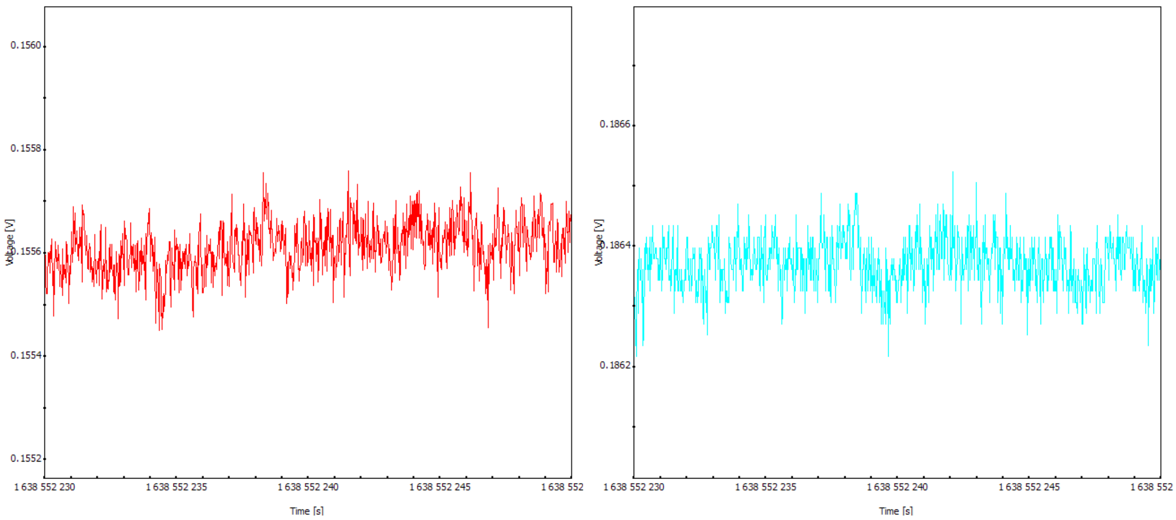
17:22


Voltage [V]
0.1560
0.1558
0.1556
0.1554
0.1552
0.1866
0.1864
0.1862
1 638 552 110
1 638 552 115
1 638 552 120
1 638 552 125
1 638 552
Time [s]

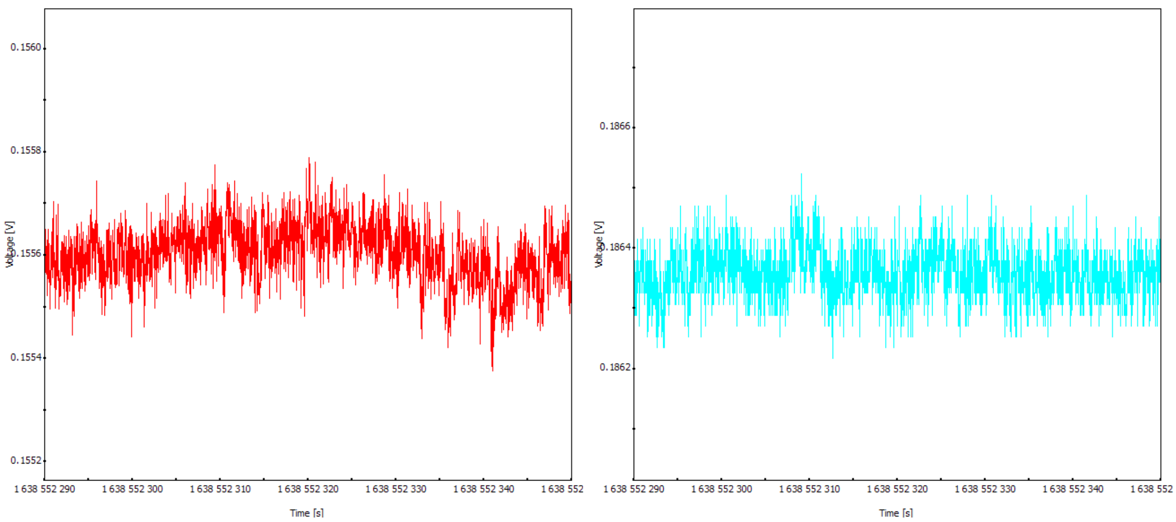
17:23


Voltage [V]
0.1560
0.1558
0.1556
0.1554
0.1552
0.1866
0.1864
0.1862
1 638 552 170
1 638 552 175
1 638 552 180
1 638 552 185
1 638 552
Time [s]

17:24


0.1560
0.1558
0.1556
0.1554
0.1552
Voltage [V]
1 638 552 230
1 638 552 235
1 638 552 240
1 638 552 245
1 638 552
Time [s]
0.1866
0.1864
0.1862
Voltage [V]
1 638 552 230
1 638 552 235
1 638 552 240
1 638 552 245
1 638 552
Time [s]

17:25


0.1560
0.1558
0.1556
0.1554
0.1552
Voltage [V]
1 638 552 290
1 638 552 300
1 638 552 310
1 638 552 320
1 638 552 330
1 638 552 340
1 638 552
Time [s]
0.1866
0.1864
0.1862
Voltage [V]
1 638 552 290
1 638 552 300
1 638 552 310
1 638 552 320
1 638 552 330
1 638 552 340
1 638 552
Time [s]