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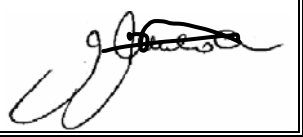
Approved by	**N. MANDOLESI** **LFI Principal Investigator**	**Date:** September 15th 2008 **Signature:** 

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1.0			Entire document	16-09-08

TABLE OF CONTENTS

1 ACRONYMS

AIV	Assembly, Integration, Verification
TBC	To be completed
TBI	To be included

2 APPLICABLE AND REFERENCE DOCUMENTS

2.1 Applicable Documents

[AD01] PL-LFI-PST-PR-021 LFI TV TEST PROCEDURE
[AD02]

2.2 Reference Documents

RD 1. Report on the Pre- and Post-Cryogenic Warm Functional Test, PL-LFI-PST-RP-XXX,
RD 2. Quick Look Data Analysis of LFI WFT, PL-LFI-PST-RP-023
RD 3. Quick Look Data Analysis of LFI Reference Functional test, PL-LFI-PST-RP-0XXX

3 INTRODUCTION

The quick look analysis of POST TV WFT AMB 01 (performed in Liege, CSL, on August 2008) showed some possible non ideal behaviour of LFI 18 S2. In particular, a non clear separation of sky and ref signal was observed under certain conditions.

3.1 Acknowledgments

This document has been issued as a part of the activity performed under the ASI contract for Planck phase E2.

3.2 Purpose and Scope

Objective of this note is to perform a deeper analysis of the LFI 18 S2 behaviour, comparing between results found during different tests: PRE and POST TV, Warm Functional Test in Cannes (August 2007) , CRYO 01 performed in Liege. The aim is to investigate a possible problem related with the PH/SW correct functionality in RCA 18 .
In the case that any problems or unclear behaviour are found, results from this work will be used to prepare an extra test able to finally clarify the residual problems.

3.3 Overview

At the end of the quick look POST TV analysis, it was unclear whether some failure occurred or not on LFI 18 S2 between PRE – TV and POST TV tests (typically during the warm up) . In the following, the main data in our hands, able to trace the LFI 18 A/C phase switch functionality, will be analysed and compared.

The document will proceed following the schema below
.
Compare AMB 01 (when LFI 18 S2 is on) PRE TV and POST TV results in terms of :

- Environmental conditions
- Absolute voltage output
- Relative voltage output
- Ratios sky/ref
- Symmetry of the output

Compare AMB 01 PRE TV and POST TV with AMB 01 WFT in Cannes (2007) and with CRYO 01 in CSL (performed between PRE and POST TV)
Analyse and compare AMB 02 from WFT in Cannes, PRE TV, POST TV and CRYO 02 in CSL.

- Absolute voltage output
- Relative voltage output
- Ratios sky/ref
- Symmetry of the output

Select possible causes able to determine the behaviour observed
Exclude everything can not contribute to cause the problem
When necessary, suggest a possible test to be performed during SVT1 to disentangle the various features.

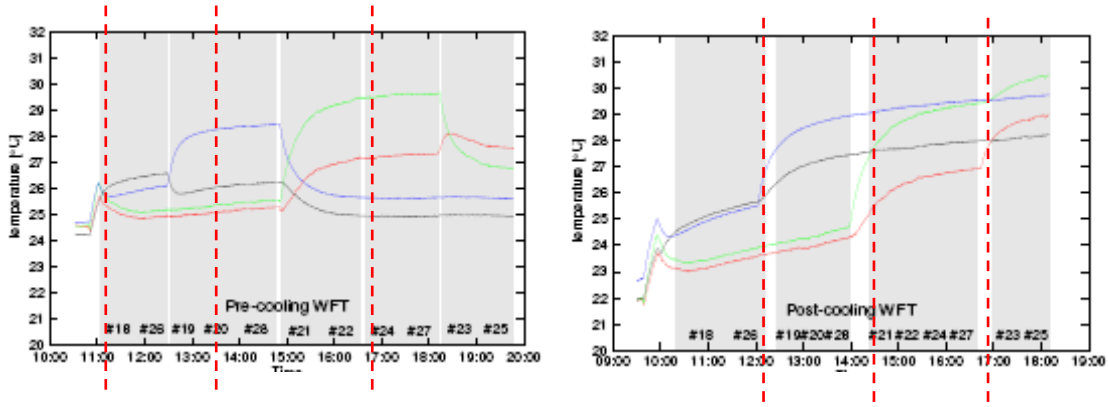
4 ANALYSIS

4.1 Environmental conditions and Procedure

The thermal setup and the procedure followed to switch on channels during POST TV and PRE TV AMB 01 is here analysed.
Some differences have been found in terms of :

Absolute temperature measured by several sensors in the BEU
Procedure followed when passing from a power group to the following.

Actually, by comparing the two plots in the WFT test report (Ref *** , before and after TV, showing some sensors placed in the BEU unit, it is clear that a different procedure was followed to switch on the power groups.



In the right plot (WFT post TV) temperatures increase as far as the procedure goes on, while in the left plot (WFT pre – TV) temperatures decrease any time a power group is fully tested.
It is clear that in the post TV , power groups stay on when they are fully tested and only bias ar set to 0.

It implies that FEM drain currents drop down to 0 in the power groups previously testes when a new power group is switched on, and the same is for VOUT , correctly measuring the BEM offset values , while in the pre-TV test meaningless drain currents and VOUT are displayed. It comes out from the fact that , any time a power group was switched off and the following power group switched on the DAE lost knowledge about the previous initialization. Drain currents plots show whet above.

Moreover, the procedure followed before the switch on of the first power group is different, causing also different reading of the sensors when the test starts. Actually, in the post TV the startup temperatures are lower by about 2 degrees while, because of the heating caused by the procedure , at the end of the last power group are higher than in the corresponding pre TV test.

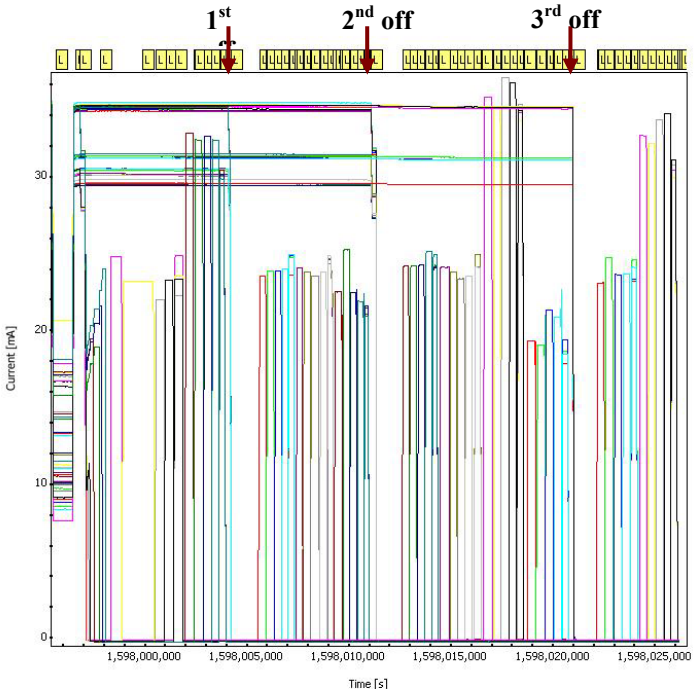


Figure 1 POST – TV WFT: when the test of a power group terminates, just bias are set to 0 but power groups stays on. Currents relative to a power group just switched off drop down to 0 mA.

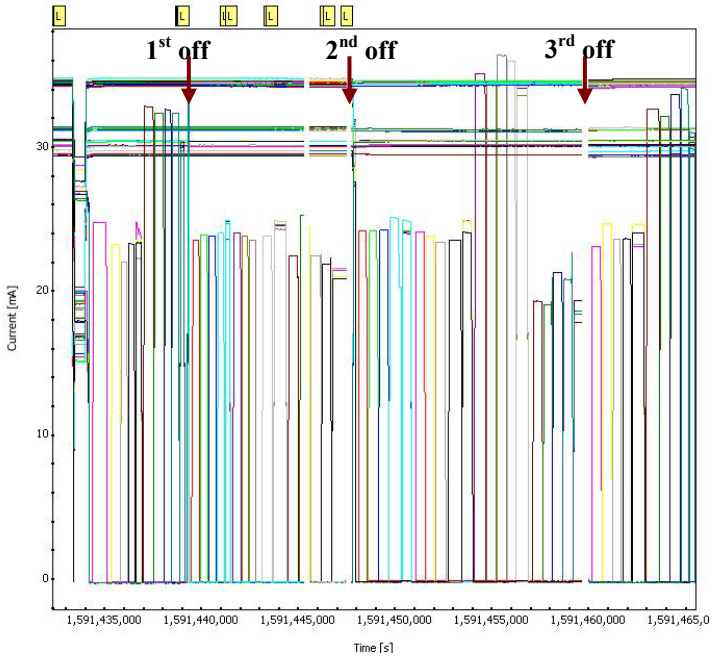


Figure 2 PRE – TV WFT: when the test of a power group terminates, the power group is switched off and the DAE looses the knowledge of its status (as demonstrated by the Id rising again at values > 30 mA)

4.2 AMB 01 comparison

From POST TV AMB 01 analysis it has arisen that the separation sky – ref in diodes LFI18 R1D0 and LFI 18 R1D1 is not clear when S2 is on. In the following, POST TV is compared with PRE TV (**Errore. L'origine riferimento non è stata trovata.**) and WFT in Cannes (2007, RD 1)
Comparison between the two tests is not straightforward because of the different setups. Although not required, absolute voltages can be compared, but taking into account that:

BEU temperatures are different
FPU temperatures are probably different, but there is not any sensor on the FPU calibrated until 300K
The procedure followed is different (power groups off / on)
Loads temperature are different (but is a probably negligible difference because of the high absolute temperature): in any case, they can not have a role when just one ACA is on (since the average of sky-ref is transmitted)

An attempt to correct data taking into account systematic is done considering the DC output from the BEMs when the LNAs are biased 0: we can compare the two tests considering frames when the PW groups are biased with 0 bias. The DC output can be removed before comparing sky and ref , following the relation:

Sky*/Ref* = (Sky – DC_0bias)/(Ref – DC_0bias)

Where Sky* and Ref* are the corrected values and DC_0bias is the output from that diode when LNAs are biased 0.
In the next plots, also the LFI 26 , belonging to the same power group , is shown, although it is nominally off (LNAs biased to 0) . The absolute scientific output are compared in Figure 3 and Figure 4 displaying the quantity R= (V2-V1)/V1, where V2 is the voltage output of the second test and V1 from the first test.
The test considered are: AMB_0183 (AMB 01 PRE TV, [1591434958,1591435036]) ; AMB_0193 (AMB 01 POST TV [1597998891,1597998926]), AMB_0083 (WFT in Cannes [1564900699,1564901037])

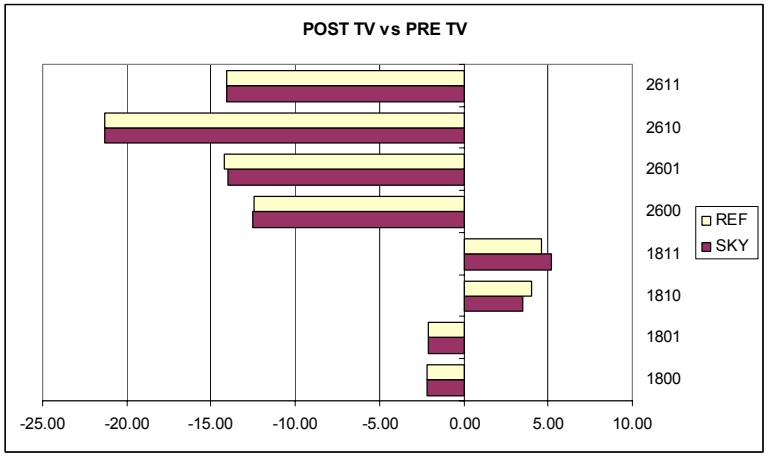


Figure 3 comparison PRE – POST TV : absolute voltage

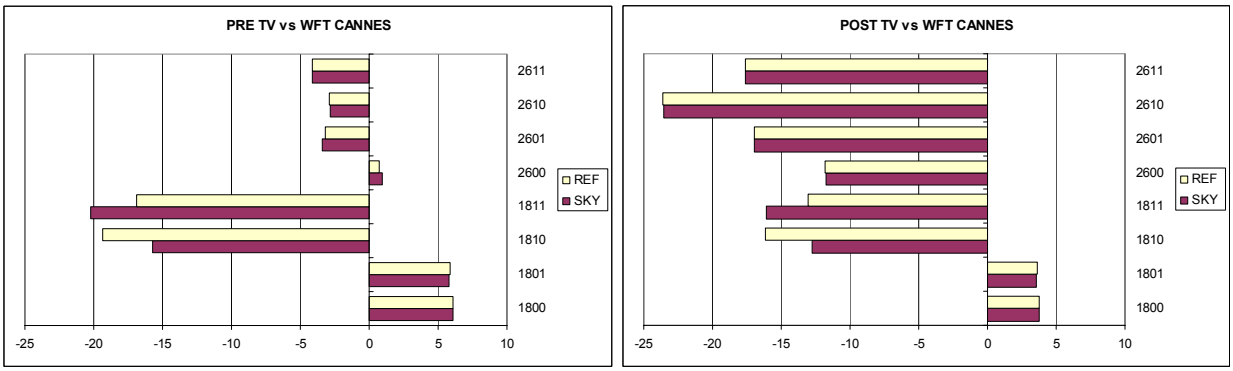


Figure 4 comparison PRE TV – WFT (left panel) and POST TV – WFT (right panel) : absolute voltage

What is evident is a very different behaviour of WFT in Cannes versus PRE and POST TV in CSL (in terms of absolute voltage) ; it must be considered that in the plots displayed above, RCA 26 is off, meaning that voltages are relative to 0 current condition (that however is never absolutely 0), as for RCA 18 S1, M1, M2.

As a check of the phase switch functionality, also the relative voltage on the same diode sky/ref is checked : once again it comes out from that the lager difference is between CSL tests and WFT in Cannes.

In the plot below (Figure 5), the correction for the BEM DC output measured when LNAs are biased 0 is applied: results do not change so much after correction, meaning that, at this level, it can not account for the difference between WFT and CSL.
Moreover, from a qualitative point of view, the POST TV plot is in some way closer to WFT than PRE TV; actually, looking the first change in PH SW status in the plots 7 and 8 both in POST TV and in WFT the signal level drops after change while in PRE TV just a swap in the two signals is observed.

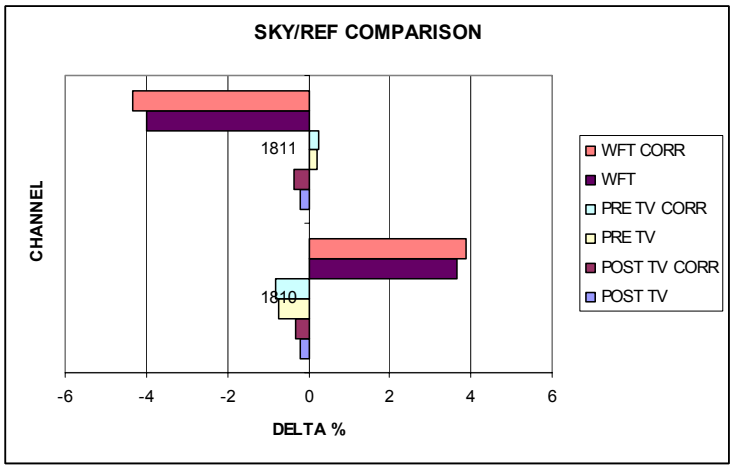


Figure 5 data corrected for the DC BEM output

Differences could be ascribed to other factors, as for example the different electric condition of the PH SW during WFT, due to thermal/ electric differences in the FPU (as partly demonstrated by the large difference also in the scientific output of the diodes R1D0 and R1D1 when S2 is biased). It would imply a strong mismatching in the PH/SW between status 0 and 1.

Many other possibilities are to be excluded, since the coupled LNA is off (biased 0) and hence just the average temperature sky ref is transmitted and through just one LNA.

A possible role of the BEM, apart the DC offset already considered, is to be excluded again because any changes in the BEM gain cancel when considering the ratio sky/ref on the same diode .

The consistency check c= [(sky10+ref11)/(sky11+ref10)] performed over the three data sets considered (Figure 6), apparently suggests that no asymmetrical behaviour is shown: hence, both diodes in the phase switch activated by the 4KHz are working in a consistent way.

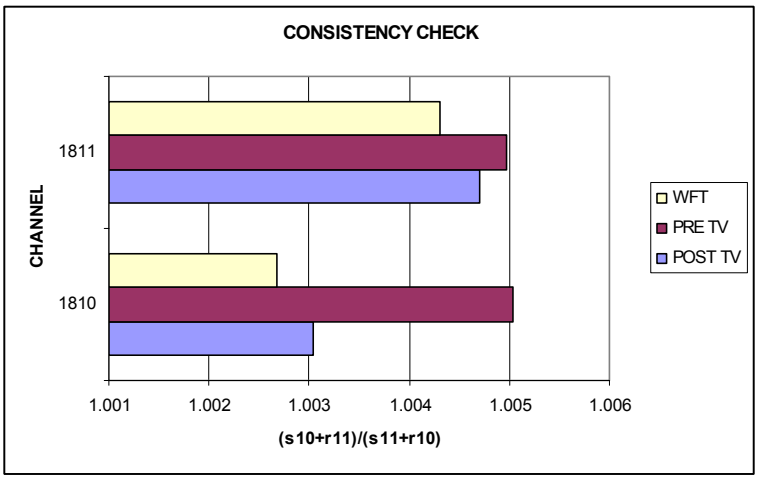


Figure 6 consistency check: c= [(sky10+ref11)/(sky11+ref10)]

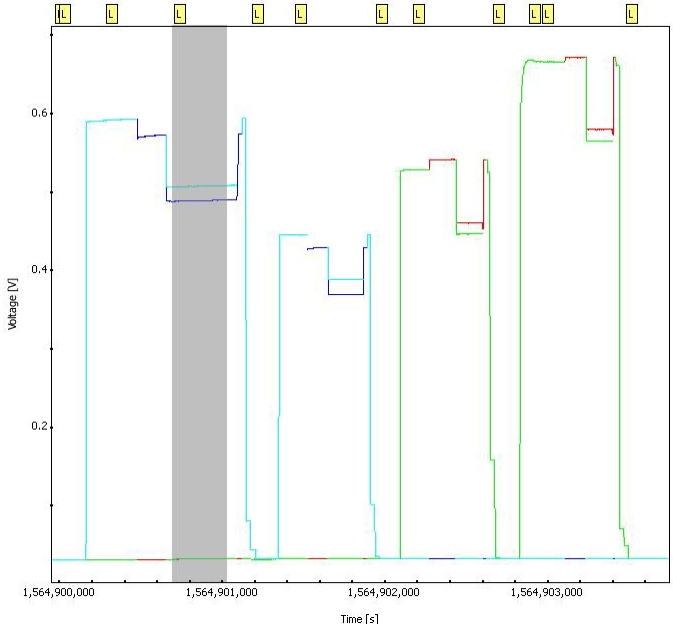


Figure 7 WFT output (AMB_0083) : in the selection the data considered (4KHz on A/C)

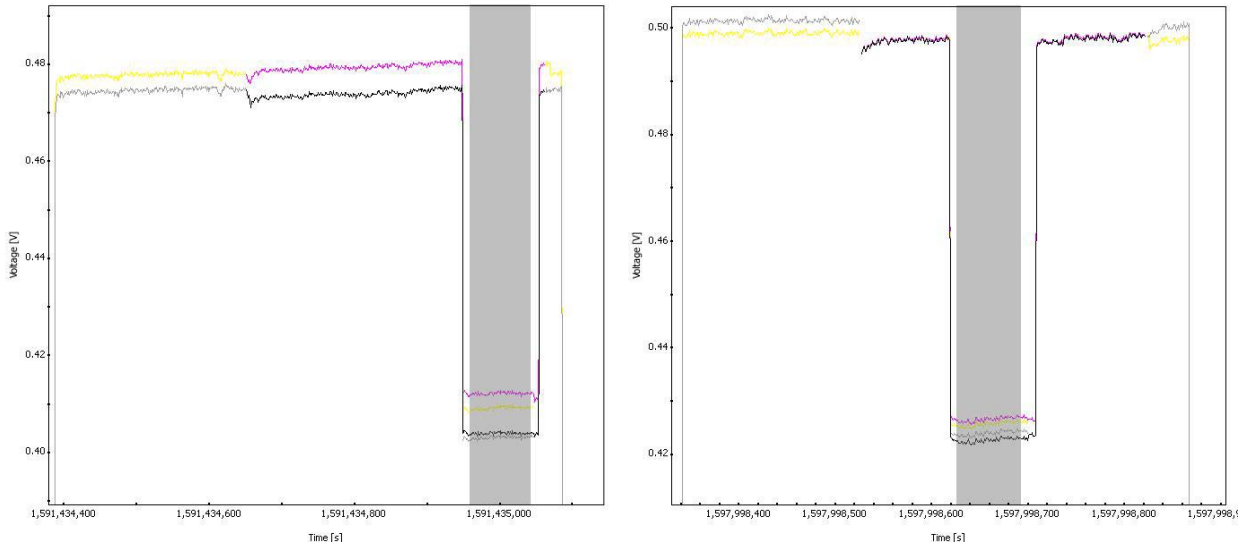


Figure 8 PRE TV output (AMB_0183) and POST TV (AMB_0193) output : in the selection the data analysed (4KHz on A/C)

4.3 AMB 02 comparison

4.3.1 Results

AMB02 enables to investigate the P/S response when both ACAs (S2 and S1) in the Side arm are on: it means that the diode output effectively gives Sky and Ref signals, and not just the average. So some larger difference between the two outputs is expected.
The data sets analysed are :

PRE TV AMB 02 from AMB_0187
POST TV AMB 02 from AMB_0194
WFT AMB 02 from AMB_091
CRYO 02 during reference functional test XXX_0192 (RD 2)

From PRE TV it comes out that the sky / ref separation was not so clear when 4KHz is enabled on A/C , in any polarization of the B/D Phase Switch, as shown in the next table (Figure 9)

A/C ON (0,0)			A/C ON (0,1)			B/D =N (0,0)			B/D ON (0,1)		
0.08058	0.16861	0.99994	0.08330	0.35384	0.99968	0.08364	1.81964	0.98432	0.08532	-1.26078	1.01520
0.08072			0.08360			0.08519			0.08426		
0.09087	0.13891		0.09339	0.25514		0.09493	-1.36142		0.09373	1.72339	
0.09099			0.09363			0.09366			0.09538		

Figure 9 PRE TV: for each 4KHz and PS status are displayed in the following order : sky and ref voltage from R1D0, R1D1,; (1-sky/ref)*100 for each diode; consistency check 'c' over the two diodes.

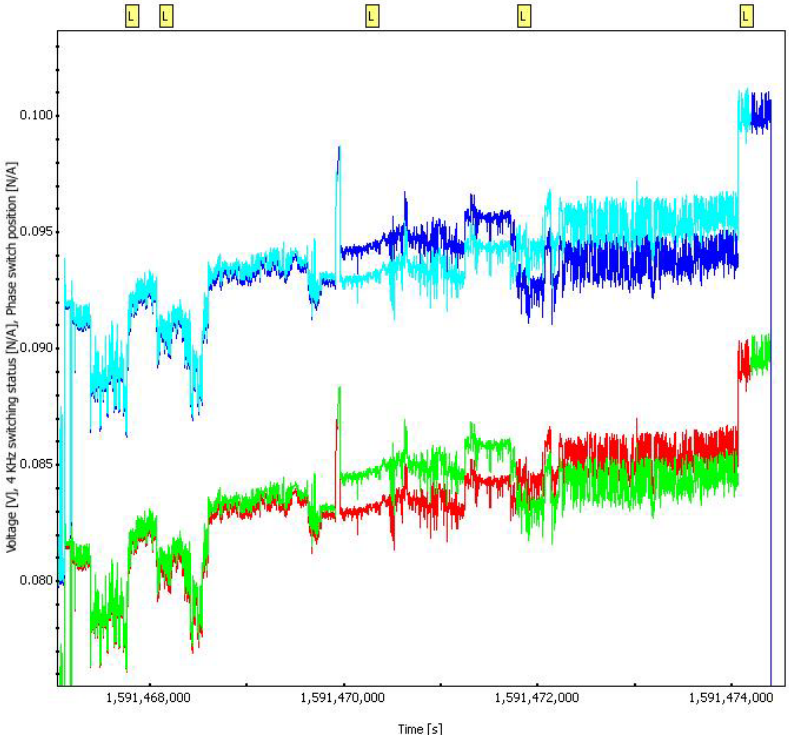


Figure 10 LFI 18 R1D0 and R1D1 output from PRE TV

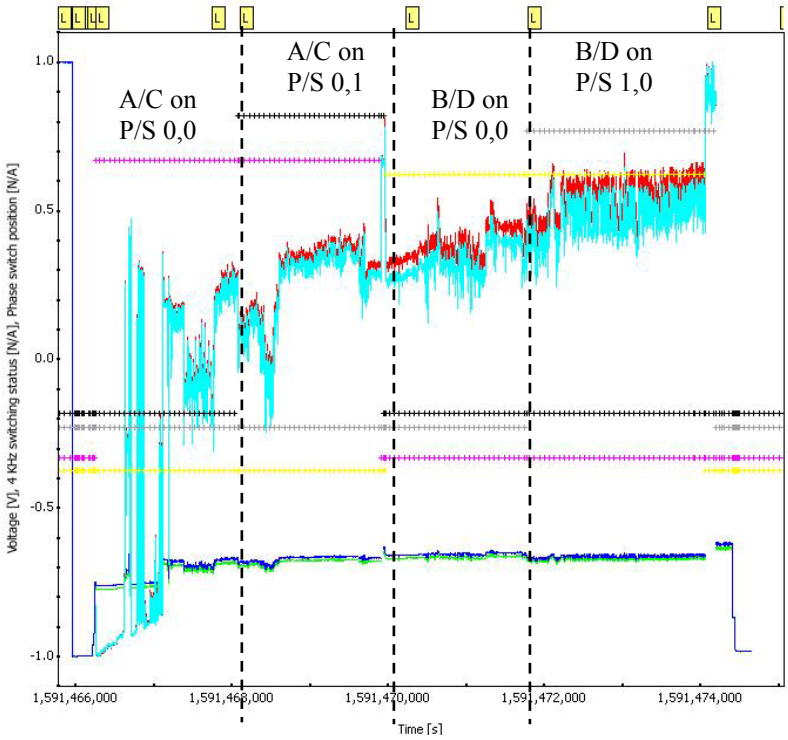


Figure 11LFI 18 R1D0 and R1D1 output vs 4KHz and PS status

A/C ON (0,0)			A/C ON (0,1)			B/D =N (0,0)			B/D ON (0,1)		
0.07366	0.08654	0.99986	0.07244	0.25075	0.99930	0.07035	2.26520	0.98004	0.07190	-1.89124	1.01905
0.07372			0.07262			0.07198			0.07057		
0.08432	0.04967		0.08291	0.08857		0.08187	-1.79174		0.08037	1.88101	
0.08436			0.08299			0.08042			0.08191		

Figure 12 POST TV: for each 4KHz and PS status are displayed: absolute sky / ref voltage R1D0, R1D1, ; (1-sky/ref)*100; consistency check.

PRE/ POST (V_out %)			
ACon(0,0)	ACon(0,1)	BDon(0,0)	BDon(1,0)
-8.592	-13.037	-15.892	-15.726
-8.667	-13.127	-15.508	-16.248
-7.205	-11.223	-13.766	-14.259
-7.288	-11.371	-14.131	-14.121

Figure 13 Vout comparison: POST TV vs PRE TV

Comparison with WFT performed in Cannes on August 2007 gives the following tables:

A/C ON (0,0)			A/C ON (0,1)			B/D =N (0,0)			B/D ON (0,1)		
0.0873	1.59921	0.98698	0.087362	-0.90147	1.01181	0.089233	1.84868	0.98445	0.089459	-1.17966	1.01468
0.088719			0.086581			0.090914			0.088416		
0.099069	-1.04638		0.096629	1.41086		0.10112	-1.30701		0.098363	1.69815	
0.098043			0.098011			0.099815			0.100062		

Figure 14 WFT in Cannes: for each 4KHz and PS status are displayed: sky / ref voltage R1D0, R1D1, ; (1-sky/ref)*100; consistency check.

WFT / CSL				WFT - CSL			
ACon(0,0)	ACon(0,1)	BDon(0,0)	BDon(1,0)	ACon(0,0)	ACon(0,1)	BDon(0,0)	BDon(1,0)
1.083	1.049	1.067	1.049	0.0067	0.0041	0.0056	0.0041
1.099	1.036	1.067	1.049	0.0080	0.0030	0.0057	0.0042
1.090	1.035	1.065	1.049	0.0082	0.0032	0.0062	0.0046
1.077	1.047	1.066	1.049	0.0070	0.0044	0.0062	0.0047

Figure 15 for each 4KHz and PS status are displayed; WFT/CSL is a pure number, WFT-CSL is given in Volts.

4.3.2 Analysis

From AMB 02 analysis it comes out that :

During PRE TV test , A/C switching provides a poor separation between sky and ref , independently on the P/S BD status. However during this test some problems occurred in the beginning affecting the signal stability (fig 10 and 11)
During the WFT test separation was about the same when A/C switching and B/D switching.

Comparison between WFT and PRE-TV gives the same ratios sky/ref when 4KHz is enabled on B/D and smaller (in the PRE TV) when is enabled on A/C.

Comparison between PRE- TV and POST TV (fig 12) gives consistent results (poor separation when A/C switching, much larger when B/D switching.

Consistency checks provides values close to 1 in all cases.

	WFT CANNES				PRE TV				CRYO 02				POST TV			
	1/3	1/4	2/3	2/4	1/3	1/4	2/3	2/4	1/3	1/4	2/3	2/4	1/3	1/4	2/3	2/4
R1D0 REF	0.999	0.976	0.979	0.977	0.967	0.944	0.996	0.976	0.978	0.980	1.020	1.002	1.017	1.024	1.030	1.008
R1D0 SKY	1.025	1.003	0.952	0.979	0.966	0.958	0.981	0.992	0.994	1.000	1.000	1.006	1.015	1.045	1.009	1.029
R1D1 SKY	1.025	1.007	0.956	0.982	0.973	0.969	0.984	0.996	0.991	1.000	0.999	1.010	1.017	1.049	1.013	1.032
R1D1 REF	1.000	0.980	0.982	0.980	0.972	0.954	1.000	0.982	0.966	0.969	1.032	1.003	1.017	1.030	1.032	1.013

In the next two plots the consistency within the same test is compared in the 4 cases : WFT, PRE TV, POST TV, CRYO 02. It is plotted the ratio V/V [4KHz on; (PS A/B, PS B/D)]

V_out [AC on; (0,0)] / V_out [B/D on; (0,0)] ➔ 1/3 (fig 16 left)
V_out [AC on; (0,0)] / V_out [B/D on; (1,0)] ➔ 1/4 (fig 16 right)
V_out [AC on; (0,1)] / V_out [B/D on; (0,0)] ➔ 2/3 (fig 17 left)
V_out [AC on; (0,1)]/ V_out [B/D on; (1,0)] ➔ 2/4 (fig 17 right)

In this way, supposing that the B/D switching configuration is correct (because results never changed between WFT, PRE TV and POST TV) , comparison between ratios over the 4 tests allows to understand if wrong phase switch functionality on A/C produces any voltage drop.

No macroscopic effect is observed.

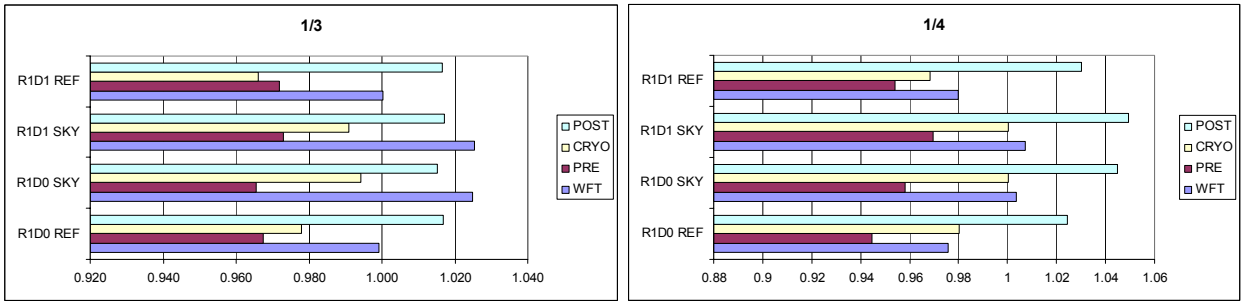


Figure 16

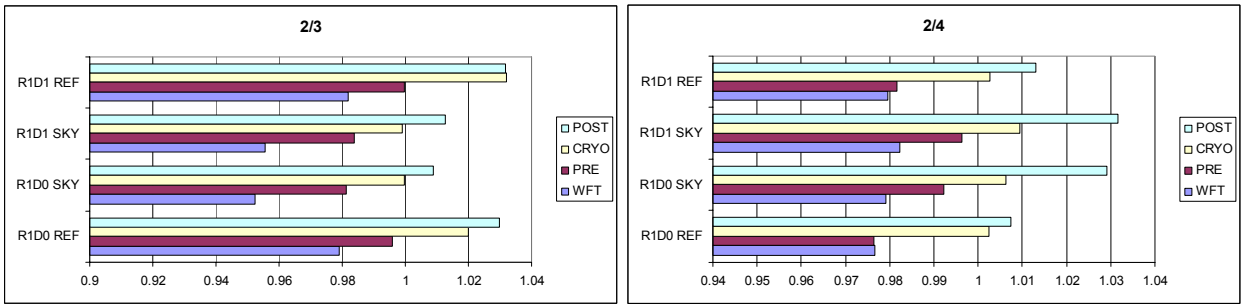


Figure 17

5 CONCLUSIONS

During analysis of POST TV AMB 01 in CSL it was noted a possible change in behaviour of channel LFI18 S2: it corresponds to a particular configuration of the 4KHz switching (A/C on), the only allowed with just one ACA on . The effect is a poor separation of sky and ref signals.

A deeper analysis revealed that this behaviour was already present in PRE TV AMB 01 and during AMB 02 PRE TV and AMB 02 POST TV. It was not clearly present during WFT AMB 01 and WFT AMB 02 , both in Cannes, showing the equal separation when A/C or B/D is switching.

This behaviour excludes that anything has happened between PRE TV and POST TV , although something seems to be changed with respect to WFT in Cannes.
However, the effects observed are very hard to be disentangled. In fact:

1) The electric setup in Cannes was different, as the setup of the other instruments assembled in the payload.
2) No sky load was present in Cannes (but this can affect just AMB 02 results)
3) All the results, also during TV test campaign, show a good internal consistency. In particular:
   Voltage output is symmetric in the consistency check
   No voltage drop is observed when the effect is present (moreover, the relative voltage bad/ good states increases !) Hence, both diodes in A/C (S2) seem to be poorly lossy.
   The ratios between affected and unaffected states is consistent between the different tests
   During cryo02 (that is in nominal cryogenic conditions) the poor separation is not present anymore (although the two loads observed, sky and ref, had very similar temperatures).

Actually, it is also possible that this poor separation is expected since:
a) during AMB 01 just one LNA is on , hence the diode is observing (sky + ref)/2 in both odd and even samples. A difference could be given just by the P/S asymmetric matching when polarized 0 or 1.
b) during AMB 02 , both PRE TV and POST TV , both loads have the same temperature , so it is expected that also the two outputs are very close.

The poor separation could be caused by some variation in the PH SW currents circuit grounding, modifying the response from the previous tests in Cannes.

Basing on the results above, there is not evidence of any unexpected non – ideal behaviour exhibiting after the PRE TV test and differences with respect to the WFT in Cannes can be justified basing on the changed setup and environmental conditions.

Just an instability in the R1Do R1D1 output was found during the PRE TV test: this behaviour is traced by a dedicated NC and is analysed separately in another document..