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Planck LFI

Quick Look Data Analysis of LFI from Reference functional test

TITLE:

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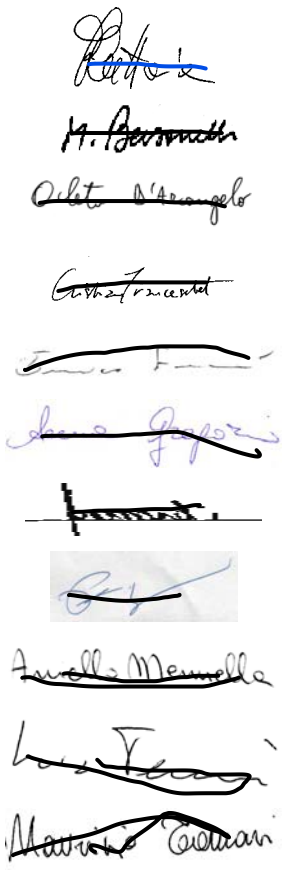
Prepared by	**F. CUTTAIA** **P. Battaglia** **M. Bersanelli** **O. D'Arcangelo** **C. Franceschet** **E. Franceschi** **A. Gregorio** **R. Leonardi** **S. Lowe** **P. Meinhold** **A. Mennella** **L. Terenzi** **M. Tomasi**	**Date:** **September 2008** **Signature:** 
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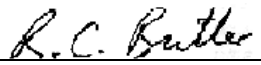
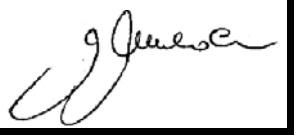
Agreed by	**C. BUTLER** **LFI Program Manager**	**Signature:** **September 2008** 
Approved by	**N. MANDOLESI** **LFI Principal Investigator**	**Date:** **September 2008** **Signature:** 

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CHANGE RECORD

Issue	Date	Sheet	Description of Change	Release
0.1	21-08-2008		Draft issue: quick look analysis	0.1
1.0	15-09-2009		First Issue	1.0

TABLE OF CONTENTS

1 ACRONYMS

AIV	Assembly, Integration, Verification
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
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
TBA	To Be Added
TBC	To Be Completed
TBW	To Be Written
TC	Telecommand
TM	Telemetry
UFT	Unit Functional Test

2 INTRODUCTION

This document has been issued in the frame of ASI contract that has been released for the activities of Planck-LFI Phase E2

2.1 Purpose and Scope

Scope of this document is to give a first quick look analysis response of the functionality of the LFI instrument during the Reference Functional Test performed in CSL- Liegi on July 2008 the 22th.

2.2 Test configuration

The test configuration is the following (TBC)

SCOS 2 K HPCCS Version 2.0.787
LFI Gateway Version V0R9P1
TQL 3.1.2
LIFE Machine version OM 3.00

LFI Personnel involved during the test is:

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3 APPLICABLE AND REFERENCE DOCUMENTS

3.1 Applicable Documents

[AD01] LFI Short Functional Test Procedure (SFT)
HP-LFI-PST-PR_018 Issue 3.0

[AD02] TV-TB LFI test procedure
PL-LFI-PST-PR-021

3.2 Reference Documents

RD 1. LFI Short Functional Test Procedure (SFT)

RD 2. LFI Warm Functional Test Procedure (WFT)
PL-LFI-PST-RP-017

RD 3. HP-LFI-PST-PR_018 Issue 3.0

RD 4. PL-LFI-PST-TN-0082 (1.0) Analysis of Signal Swap in output of Channel 2510 (Action#4 H-PTASF-MN-9737)

RD 5. PL-LFI-PST-TN-080 (1.0) Proposal for LFI test dedicated to characterize New Spikes in the FFT spectrum of Scientific Data

RD 6. PL-LFI-PST-RP-0XXX (1.0) Quick Look Data Analysis of LFI from CRYO-02 functional test

4 Reference Functional test Execution

This Test is divided into two independent sections, having different objectives.
The first section is a pure repetition of CRYO-02 test , at the end of the Tuning and with the Reference load having terminated the cooling down to its lowest temperature. The bias table used is the same of CRYO-02 but the setup condition can be slightly different in terms of FPU temperature (after LUT tables updating), BEU temperature, and general slow drifts of the instrument. The aim of this section is just to verify that properties of the LFI did not change at the end of the Tuning phase when the previous bias are restored.
In the second section the new bias coming from Tuning are uploaded: informations coming from this setup (currents and scientific voltages) will be a Reference point for all the next phases and for the CPV phase.
The entire test is divided into modular blocks: for each block , test results and conclusions are presented.

4.1 Starting point:

The first section (CRYO 02) is performed with the LFI already on from the previous test (ACA Tuning verification using 4K Load modulation). The bias table and the DAE gain and offset table from CRYO 02 have been hence uploaded again.

The initial configuration is summarized in the following table

LFI	*HFI*	*SCS*	*SVM*	*4K stage(K)*	*SKL (K)*	*FPU (K)*	*LBEM (C)*	*RBEM (C*
ON	ON	ON (TSA)	TBC	4.5 K	4.5	TBC K	TBC	12.5 K

The bias configuration adopted for the test is the same of CRYO 02 (06-07-2008).
The Gain as set to 0 for all channels; the offset table is reported for convenience below.

	R0D0	R0D1	R1D0	R1D1
Rca 27	21	0	51	92
Rca 28	102	41	112	143
Rca 24	255	255	255	255
Rca 25	255	255	255	255
Rca 26	255	255	255	255
Rca 18	0	0	204	204
Rca 19	214	204	255	224
Rca 20	204	204	153	143
Rca 21	194	204	255	255
Rca 22	255	255	255	255
Rca 23	173	122	255	255

Table 1: DAE GAIN – OFFSET

A new TQL section was open : the file collecting the test is XXX_0192

4.2 Procedure/Test sequence

The test sequence followed is exactly the same of CRYO 02 and is described in the table below. Channels have been operated all at the same time , changing the P/S and 4KHz polarization in a wise to check functionality for all the possible configurations available.
For each different status, data have been registered for at least 30 minutes. Sometimes the acquisition has been longer.

			Radiometric functional tests				**3.14.00**
TS4				RCA Activation		0.05.00	0.05.00
				Wait for thermalization of the power group		0.30.00	0.30.00
				Configure DAE (Switch ACA on)		0.02.00	0.02.00
				Wait for thermalization of the FPU		0.15.00	0.15.00
				Acquiring data		0.10.00	0.10.00
				Enable 4Khz switching ON A/C		0.02.00	0.02.00
				Acquiring data		0.30.00	0.30.00
				change P/S status on B/D to 1		0.02.00	0.02.00
				Acquiring data		0.30.00	0.30.00
				Disable 4Khz switching ON A/C		0.02.00	0.02.00
				change P/S status on A/C and B/D to 0		0.02.00	0.02.00
				Enable 4Khz switching ON B/D		0.02.00	0.02.00
				Acquiring data		0.30.00	0.30.00
				Conf . Polar : change the A/C Status to 1		0.02.00	0.02.00
				Acquiring data		0.30.00	0.30.00

4.3 Pass /fail criteria

No unexpected event-packets
FEM current consumption as expected
FEM power consumption as expected
All the FEMs respond as expected, when the P/S and 4KHz are exercised in different status.

4.3.1 Results and Conclusions

Session saved in test file **XXX_0192 and XXX_0193**

Pass and Fail Criteria

No unexpected event Packets	PASSED
REBA Power Consumption within the ranges of expected values	PASSED
DAE Power Consumption within the ranges of expected values	PASSED
P/S functionality	PASSED
4KHz functionality	PASSED
The FEM I Drain Currents obtained from Telemetry are	PASSED

within the ranges expected (5%) w.r.t. previous CRYO-02	
No unexpected new features	PASSED

notes	Description
	Apparent data loss around 13:00but seems t be explanable with simultaneous change of 4KHz and P/S status. To be investigated deeper

Table 2: drain current comparison between CRYO 02 and CRYO-02 from reference test; agreement is very good.

RCA #	Detector ID			SCOS Parameter	CRYO 02	REF TEST	DELTA %
CH27	00	00	M1	LM051322	8,2	8,2	0,01
	01	01	M2	LM052322			
	02	10	S1	LM053322			
	03	11	S2	LM054322			
CH24	04	00	M2	LM055322	7,2	7,26	0,83
	05	01	M1	LM056322			
	06	10	S2	LM057322			
	07	11	S1	LM058322			
CH21	08	00	S2	LM059322	16,5	16,54	0,24
	09	01	S1	LM060322			
	0A	10	M1	LM061322			
	0B	11	M2	LM062322			
CH22	0C	00	S2	LM063322	16,3	16,4	0,61
	0D	01	S1	LM064322			
	0E	10	M1	LM065322			
	0F	11	M2	LM066322			
CH23	10	00	S2	LM067322	16,1	16,25	0,93
	11	01	S1	LM068322			
	12	10	M1	LM069322			
	13	11	M2	LM070322			
CH25	14	00	M1	LM071322	12,2	12,32	0,98
	15	01	M2	LM072322			
	16	10	S1	LM073322			
	17	11	S2	LM074322			
CH28	18	00	M1	LM075322	9,66	9,72	0,62
	19	01	M2	LM076322			
	1A	10	S1	LM077322			
	1B	11	S2	LM078322			
CH20	1C	00	S2	LM079322	20,5	20,52	0,1
	1D	01	S1	LM080322			
	1E	10	M1	LM081322			
	1F	11	M2	LM082322			
CH19	20	00	S2	LM083322	17,9	17,92	0,11
	21	01	S1	LM084322			
	22	10	M1	LM085322			
	23	11	M2	LM086322			
CH18	24	00	S2	LM087322	20,7	20,71	0,05
	25	01	S1	LM088322			
	26	10	M1	LM089322			
	27	11	M2	LM090322			
CH26	28	00	M2	LM091322	11,6	11,65	0,43
	29	01	M1	LM092322			
	2A	10	S2	LM093322			
	2B	11	S1	LM094322			

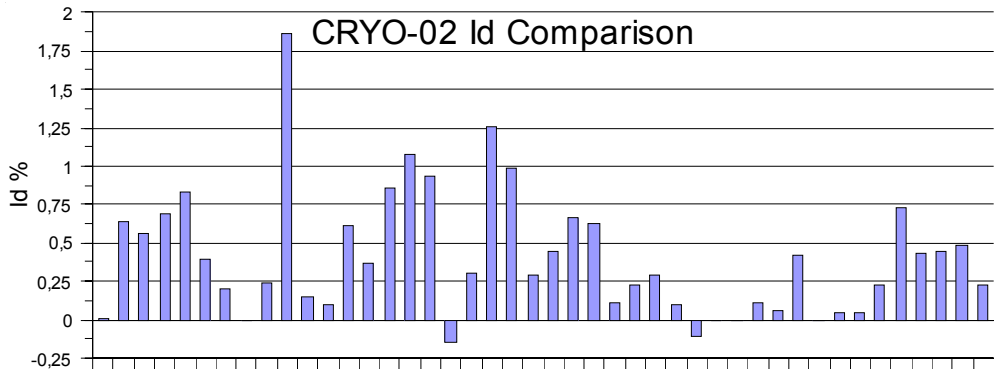


Figure 1 Id comparison between cryo-02 and reference test part 1

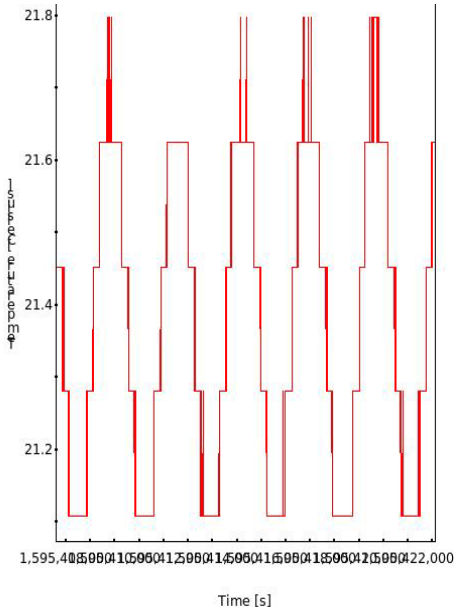


Figure 2 SPU temperature variation during the test: the net change (p2p) is lower than 0.6 K

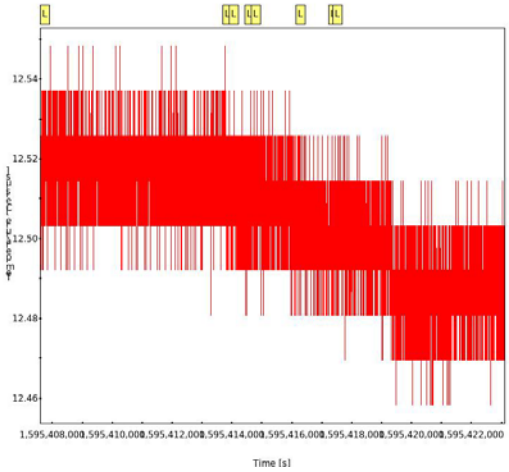


Figure 3 BEU temperature (R-BEM sensor displayed) : it is very stable during the test but far from the condition at ILT where it was about 30 K

4.4 First part: conclusions

During the first part of Reference test all the P/S and 4KHzconfigurations have been exercised: the LFI functionality looks unchanged after the tuning. Drain currents are the same well within 1% except for RCA 24 showing in one channel about 1.7 % difference.

5 Second part: reference test

This test is useful to have a reference point to compare with for all the further activities and for CPV phase. The test is in somewhat similar to CRYO-01 but here the LFI is always on and just the ACA coupled with the one under test is off.
Two ACAs belonging to different channels (RCA) have been operated at the same time, following the schema below:

RCA Under Tests in parallel
RCA 18 + RCA 21
RCA 19 + RCA 22
RCA 20 + RCA 23
RCA 25 + RCA 24
RCA 26 + RCA 27
RCA 28

Table: sequence followed in operating channels during reference test part 2

The start up configuration is summarized in the following table

LFI	*HFI*	*SCS*	*SVM*	*4K stage(K)*	*SKL (K)*	*FPU (K)*	*LBEM (C)*	*RBEM (C*
ON	ON	ON (TSA)	TBC	4.5 K	4.5	20 K	TBC	12.5 K

5.1 Pass /fail criteria

No unexpected event-packets
All the FEMs respond as expected, when the P/S and 4KHz are exercised in different status.
No unexpected features

5.1.1 Results and Conclusions

Session saved in test file **XXX_0194**

Pass and Fail Criteria

No unexpected event Packets	PASSED
REBA Power Consumption within the ranges of expected values	PASSED
DAE Power Consumption within the ranges of expected values	PASSED
P/S functionality	PASSED
4KHz functionality	PASSED
Take note of drain currents	DONE
Take note of scientific output	DONE

5.1.2 Notes

The procedure required to switch off two paired channels before operating on one with the coupled leg off. This operation required two particular cares:

RCA 28 soft switch on (procedure already existing and foreseen by PL-LFI-PST-PR-021.

RCA 24 desaturation procedure. Actually RCA 24 exhibited (traced by NC XXX) unexpected feature during the previous part of the test campaign requiring a customized procedure to recover drain current saturation . The procedure was applied to RCA 24 when the ½ FEM on side was switched off. In particular, it was applied when the test started and the cryo biases table was firstly applied on all LFI; hence it was applied again when the RCA 24 was tested requiring to switch off the side ACAs.

TBW

Table 3: DAE GAIN/ OFFSET applied during the reference test part 2

RCA	CH	DIFF	W RAA	W CSL	DIFF %	TOT RAA
CH27	M1	-5,3	5,90	6,16	4,4	302,78
CH27	M2	1,9	5,68	5,54	-2,4	TOT CSL
CH27	S1	-5,7	6,16	6,46	4,8	305,70
CH27	S2	3,5	6,33	6,07	-4,0	DIFF %
CH24	M2	-55,5	5,90	8,98	52,2	0,96
CH24	M1	22,5	17,87	14,03	-21,5	
CH24	S2	28,5	9,92	7,21	-27,3	
CH24	S1	-30,3	7,52	9,57	27,4	
CH21	S2	-36,0	5,76	7,28	26,5	
CH21	S1	5,7	6,85	6,45	-5,9	
CH21	M1	-9,4	7,05	7,49	6,3	
CH21	M2	-8,5	7,09	7,47	5,4	
CH22	S2	-8,9	5,41	5,74	6,0	
CH22	S1	-12,4	5,50	5,98	8,7	
CH22	M1	-18,0	4,47	5,08	13,6	
CH22	M2	-7,5	5,31	5,57	4,9	
CH23	S2	1,8	5,12	5,10	-0,4	
CH23	S1	-4,7	6,00	6,28	4,7	
CH23	M1	4,6	5,11	4,97	-2,7	
CH23	M2	12,5	5,25	4,76	-9,3	
CH25	M1	18,9	10,14	8,34	-17,8	
CH25	M2	-7,1	8,33	8,93	7,3	
CH25	S1	-5,8	8,43	8,93	6,0	
CH25	S2	16,9	9,06	7,64	-15,7	
CH28	M1	-3,5	6,98	7,15	2,5	
CH28	M2	-4,6	6,54	6,77	3,6	
CH28	S1	-7,5	6,35	6,75	6,3	
CH28	S2	-4,5	7,50	7,77	3,5	
CH20	S2	4,1	6,46	6,15	-4,8	
CH20	S1	-7,6	6,34	6,61	4,3	
CH20	M1	-2,5	6,16	6,16	-0,1	
CH20	M2	-4,5	6,57	6,67	1,5	
CH19	S2	-0,1	5,73	5,64	-1,6	
CH19	S1	-12,0	5,10	5,48	7,3	
CH19	M1	-21,2	5,13	5,87	14,5	
CH19	M2	-14,0	5,89	6,40	8,7	
CH18	S2	-5,1	5,85	5,97	2,0	
CH18	S1	2,0	7,73	7,53	-2,7	
CH18	M1	-27,4	3,98	4,85	21,9	
CH18	M2	-35,7	3,95	5,07	28,5	
CH26	M2	3,1	8,99	8,68	-3,4	
CH26	M1	23,7	8,74	6,72	-23,2	
CH26	S2	-6,5	8,03	8,48	5,6	
CH26	S1	-4,0	10,62	10,96	3,2	

Table 4: LNA bias applied during the reference test part 2

CH27	00	00	M1	LP001320	240	F0	108	6C	156	9C	178	B2	180	B4
CH27	01	01	M2	LP002320	244	F4	90	5A	157	9D	144	90	214	D6
CH27	02	10	S1	LP003320	237	ED	102	66	157	9D	138	8A	192	C0
CH27	03	11	S2	LP004320	246	F6	114	72	156	9C	128	80	200	C8
CH24	04	00	M2	LP005320	227	E3	213	D5	183	B7	91	5B	255	FF
CH24	05	01	M1	LP006320	219	DB	217	D9	200	C8	128	80	250	FA
CH24	06	10	S2	LP007320	225	E1	213	D5	152	98	86	56	215	D7
CH24	07	11	S1	LP008320	219	DB	219	DB	157	9D	84	54	235	EB
CH21	08	00	S2	LP009320	216	D8	223	DF	132	84	255	FF	255	FF
CH21	09	01	S1	LP010320	181	B5	197	C5	136	88	255	FF	255	FF
CH21	0A	10	M1	LP011320	198	C6	207	CF	141	8D	255	FF	255	FF
CH21	0B	11	M2	LP012320	196	C4	197	C5	136	88	255	FF	255	FF
CH22	0C	00	S2	LP013320	206	CE	204	CC	130	82	255	FF	255	FF
CH22	0D	01	S1	LP014320	204	CC	189	BD	128	80	255	FF	255	FF
CH22	0E	10	M1	LP015320	203	CB	194	C2	125	7D	255	FF	255	FF
CH22	0F	11	M2	LP016320	178	B2	176	B0	130	82	255	FF	255	FF
CH23	10	00	S2	LP017320	190	BE	208	D0	122	7A	255	FF	255	FF
CH23	11	01	S1	LP018320	181	B5	211	D3	118	76	255	FF	255	FF
CH23	12	10	M1	LP019320	207	CF	192	C0	120	78	255	FF	255	FF
CH23	13	11	M2	LP020320	210	D2	195	C3	119	77	255	FF	255	FF
CH25	14	00	M1	LP021320	227	E3	212	D4	184	B8	174	AE	235	EB
CH25	15	01	M2	LP022320	219	DB	212	D4	185	B9	89	59	250	FA
CH25	16	10	S1	LP023320	224	E0	216	D8	167	A7	93	5D	255	FF
CH25	17	11	S2	LP024320	223	DF	212	D4	166	A6	119	77	225	E1
CH28	18	00	M1	LP025320	243	F3	101	65	157	9D	132	84	162	A2
CH28	19	01	M2	LP026320	240	F0	112	70	156	9C	117	75	188	BC
CH28	1A	10	S1	LP027320	240	F0	84	54	157	9D	111	6F	168	A8
CH28	1B	11	S2	LP028320	245	F5	121	79	158	9E	99	63	173	AD
CH20	1C	00	S2	LP029320	188	BC	201	C9	127	7F	255	FF	255	FF
CH20	1D	01	S1	LP030320	199	C7	221	DD	132	84	255	FF	255	FF
CH20	1E	10	M1	LP031320	209	D1	219	DB	121	79	255	FF	255	FF
CH20	1F	11	M2	LP032320	215	D7	221	DD	127	7F	255	FF	255	FF
CH19	20	00	S2	LP033320	204	CC	216	D8	125	7D	255	FF	255	FF
CH19	21	01	S1	LP034320	215	D7	209	D1	120	78	255	FF	255	FF
CH19	22	10	M1	LP035320	213	D5	206	CE	124	7C	255	FF	255	FF
CH19	23	11	M2	LP036320	211	D3	208	D0	126	7E	255	FF	255	FF
CH18	24	00	S2	LP037320	208	D0	205	CD	114	72	255	FF	255	FF
CH18	25	01	S1	LP038320	192	C0	197	C5	138	8A	255	FF	255	FF
CH18	26	10	M1	LP039320	190	BE	194	C2	126	7E	255	FF	255	FF
CH18	27	11	M2	LP040320	198	C6	201	C9	125	7D	255	FF	255	FF
CH26	28	00	M2	LP041320	226	E2	217	D9	170	AA	153	99	210	D2
CH26	29	01	M1	LP042320	232	E8	209	D1	169	A9	98	62	245	F5
CH26	2A	10	S2	LP043320	232	E8	217	D9	169	A9	93	5D	230	E6
CH26	2B	11	S1	LP044320	228	E4	226	E2	172	AC	135	87	230	E6

Table 5: Drain Currents measured during the reference test part 2

27	M1	8,17
27	M2	7,26
27	S1	8,53
27	S2	8,05
24	M2	9,99
24	M1	14,44
24	S2	9,95
24	S1	12,9
21	S2	20,44
21	S1	16,66
21	M1	18,75
21	M2	19,82
22	S2	15,47
22	S1	16,7
22	M1	14,34
22	M2	15,06
23	S2	15,1
23	S1	20,82
23	M1	15,05
23	M2	14,7
25	M1	9,38
25	M2	10,02
25	S1	11,23
25	S2	9,61
28	M1	9,7
28	M2	9,22
28	S1	9,13
28	S2	10,49
20	S2	18,72
20	S1	18,87
20	M1	20,62
20	M2	20,71
19	S2	17,13
19	S1	17,92
19	M1	18,31
19	M2	19,98
18	S2	21,54
18	S1	19,97
18	M1	13,65
18	M2	14,5
26	M2	10,67
26	M1	8,15
26	S2	10,8
26	S1	13,47

Table 6: FEM power consumption measured during the reference test part 2 compared with results from RAA ILT: the total consumption is about the same.

5.1.3 Extra features: noisy signal on RCA 25

It was here observed for the first time a very strange effect affecting RCA 25 and presumably caused by a cross talk with RCA 23. The effect consists in a sort of oscillation of the scientific signal in RCA 25 when RCA 23, belonging to the same power group, is polarized B/D PS=1 or is switching on B/D . The effect exhibits as a doubled signal when the RCA 25 is acquired in total power (4KHz off) or as a very thick noisy signal when the 4KHz is enabled. Its effect becomes evident in the 1/f spectrum of the differentiated data sky – r* load. (figure below)

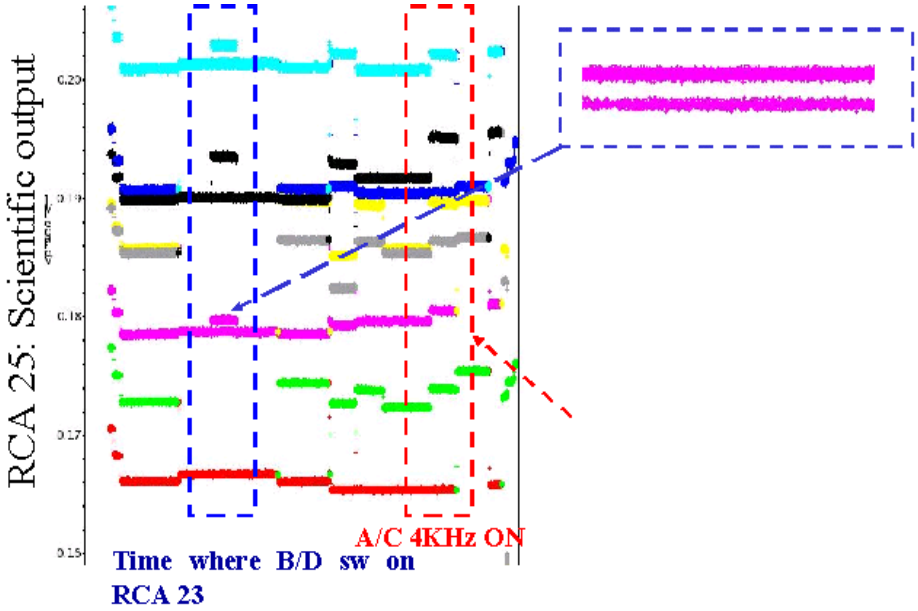
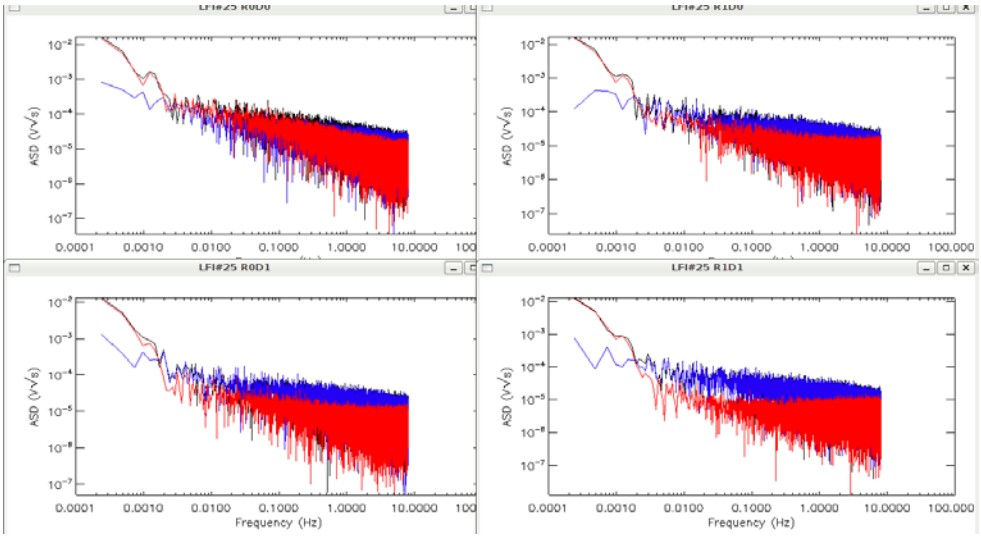


Figure 4: RCA 23 PS (B/D set in direct polarization, 1) produces effect on RCA 25-00-01-10 output (signal split when in total power, high noise when 4KHz on): the effect disappears when PS is changed to 0 or RCA 23 4KHz is enabled on A/C.



This feature was understood to be caused by the anomalous behaviour of the phase switch anomaly on LFI23 that has been traced in NCR Prisma 4356. The analysis is still ongoing and further results will be updated in PL-LFI-PST-TN-087.

6 Conclusion

All the pass/fail criteria requested form the procedure have been fully checked: the Reference Test, comprehensive of the two parts, is to be considered completed and passed.
Data have been stored and analysed.
Other Extra features, as the strange behaviour of RCA 25 or the desaturation procedure applied to RCA 24, are not strictly connected with this test and will be deeper investigated in a dedicated analysis that will be referred to in the next issue of this document.

6.1 To be added (in the next issue) list

Gain and offset table	

6.2 NCR list

Type	Number	Description	Notes
NC	TBC	Noise in RCA 25 signal from RCA 23 PS status	Traced in a dedicated document