Planck LFI

TITLE: **Planck-LFI CPV: noise properties verification** (P_PVP_LFI_0018_01, P_PVP_LFI_0019_01, P_PVP_LFI_00119_01)

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Planck-LFI CPV: noise properties verification

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CHANGE RECORD

Issue	Date	Sheet	Description of Change	Release
1.0	10 October 09	All	First issue of document	1.0

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1   ACRONYMS

AIV	Assembly, Integration, Verification
ADC	Analogue to Digital Converter
ASW	Application Software
BEM	Back End Module
BEU	Back End Unit
CCS	Central Check-out System
CDMU	Central Data Management Unit
CPV	Calibration Performance Verification
CSL	Centre Spatiale de Liège
DAE	Data Acquisition Electronics
DPU	Digital Processing Unit
EGSE	Electrical ground Support Equipment
FEM	Front End Module
I-EGSE	Instrument EGSE
ILT	Instrument Level Tests
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
SCS	Sorption Cooler 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

[AD1] Herschel/Planck Instrument Interface document Part A, SCI-PT-IIDA-04624 Issue 3.3

[AD2] Herschel/Planck Instrument Interface document Part B, SCI-PT-IIDB-04142 Issue 3.1

[AD3] Herschel/Planck Instrument Interface document Part B, SCI-PT-IIDB-04142 Issue 3.1, Annex 3, ICD 750800115

[AD4] Herschel/Planck Instrument Interface document Part A, SCI-PT-IIDA-04624 Issue 3.3 Annex 10

[AD5] Data analysis and scientific performance of the LFI FM instrument, PL-LFI-PST-AN-006 3.0

[AD6] Planck-LFI TV-TB test report: executive summary, PL-LFI-PST-RP-040 1.1

[AD7] Testing plan of the LFI instrument during the Planck Commissioning and CPV phase, PL-LFI-PST-PL-043 (4.2)

2.2   Reference Documents

[RD1] Planck Instrument Testing at PFM S/C levels, H-P-3-ASP-TN-0676, Issue 1.0

[RD2] Planck LFI User Manual, PL-LFI-PST-MA-001 Issue 2.1

[RD3] Data Analysis DAE offset test and DAE gain/tuning verification (Ph-5-04-3 of TV/TB tests) PL-LFI-PST-RP-045 Issue 1.0

[RD4]   Data analysis and scientific performance of the LFI FM instrument, PL-LFI-PST-AN-006 Issue 2.0

[RD5] REBA calibration and verification during the LFI CPV phase, PL-LFI-PST-RP-072 Issue 1.0

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3 Introduction

The assessment of the noise properties of the LFI instrument is the main objective of this test. The test is split into two parts:

1. in the first part the LFI is run unswitched acquiring data in all four phase switch configurations. Power spectra from unswitched data is compared in order to assess whether there is any configuration that is preferable from the point of 1/f noise slope;

2. in the second part the LFI is run switched for several hours and the full noise properties are characterised in both switching configurations (A/C or B/D) while the non switching phase switch is kept in its nominal position.

4   Test Execution

4.1   Test configuration

The test configuration is the following

SCOS 2K EGSE 3.1 Release 1.2
RTSILib version 1.0
RTSI Client version 1.2
LEVEL1 (TMH/TQL) version 5.1
LIFE Machine version OM 3.00
IDIS 2.7.3.4

LFI Personnel involved during the test is:

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Industry support	

4.2 Pass-fail criteria, verification matrix

4.2.1 4KHz off (unswitched)

CPV **P_PVP_LFI_0019_01**
July, 30th 2009 **DoY 211** **OD 78**
Duration **3:00:00**
Test name: Noise properties 4KHz off

Test objectives: To characterise LFI noise properties in unswitched conditions in all four switch configurations (apart from LFI23 for which switching configuration is not changed)

Verification matrix					
Check	**Passed?**			**Recovered?**	
	Yes	**No**	**Notes**	**Yes**	**No**
No unexpected events packets	Yes				
No unexpected features		No	For a procedural error data were acquired in COM5 instead than in AVR1. During data analysis, however, it was clear that the compressor was able to handle also total power data without loss of information	Yes	
Data saved and stored at DPC	Yes				

4.2.2 4 KHz on (switched)

CPV **P_PVP_LFI_0018_01**
July, 29-30th 2009 **DoY 201-211** **OD 77-78**
Duration **24:00:00**
Test name: Noise properties 4KHz on

Test objectives: To characterise LFI noise properties in switched conditions in both A/C and B/D switching (apart from LFI23 for which switching configuration is not changed)

Verification matrix					
Check	**Passed?**			**Recovered?**	
	Yes	**No**	**Notes**	**Yes**	**No**
No unexpected events packets	Yes				
No unexpected features	Yes				
Data saved and stored at DPC	Yes				

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4.3 Procedure/ Test sequence and environmental conditions

4.3.1 Test procedure

4.3.1.1 4 KHz off (unswitched)

The procedure of this test is reported in the table below. This procedure assumed to acquire data in AVR1 mode with nominal NAVER (data binning) which implied to run the test in different groups of channels not to exceed the allowed telemetry. The acquisition in AVR1 was intended to avoid using compression with data having a different noise statistical properties compared to those for which the REBA parameters have been optimised.

For a procedural problem the test has been conducted in COM5 rather than in AVR1 mode, but subsequent analysis has shown that quantisation and compression did not alter the data quality too much.

Step	Description	START REF.	DURATION	Time	RCA	YES	NO	Notes
15	Noise properties 4KHz off (UM § 13.1.2.10)							
15.1	Stop calibration Channel	0:00:00	0:01:00					
15.2	Disable 4KHz on A/C, B/D, set Pol=0 on A/C, B/D	0:01:00	0:06:00		All			
15.3	Activate processing type 1	0:07:00	0:05:00		All			
15.4	Enable acquisition (processing A) for channels in table A	0:12:00	0:01:00		21,22,24,27			
15.5	Apply Noise properties test: pol A/C=0,B/D=1	0:13:00	0:22:32		21,22,24,27			
15.6	Apply Noise properties test: pol A/C=1,B/D=1	0:35:32	0:22:32		21,22,24,27			
15.7	Apply Noise properties test: pol A/C=1,B/D=0	0:58:04	0:22:32		21,22,24,27			
15.8	Apply Noise properties test: pol A/C=0,B/D=0	1:20:36	0:22:32		21,22,24,27			
15.9	Disable HK Sequencer	1:43:08	0:01:00		21,22,24,27			
15.10	Apply Noise properties test: pol A/C=0,B/D=1	1:44:08	0:22:32		21,22,24,27			
15.11	Apply Noise properties test: pol A/C=1,B/D=1	2:06:40	0:22:32		21,22,24,27			
15.12	Apply Noise properties test: pol A/C=1,B/D=0	2:29:12	0:22:32		21,22,24,27			
15.13	Apply Noise properties test: pol A/C=0,B/D=0	2:51:44	0:22:32		21,22,24,27			
15.14	Disable acquisition for channels in table A	3:14:16	0:01:00		21,22,24,27			
15.15	Enable acquisition (processing A) for channels in table B	3:15:16	0:01:00		22,23,24,25,27			
15.16	Apply Noise properties test: pol A/C=0,B/D=1	3:16:16	0:22:32		22,23,24,25,27			
15.17	Apply Noise properties test: pol A/C=1,B/D=1	3:38:48	0:22:32		22,23,24,25,27			
15.18	Apply Noise properties test: pol A/C=1,B/D=0	4:01:20	0:22:32		22,23,24,25,27			
15.19	Apply Noise properties test: pol A/C=0,B/D=0	4:23:52	0:22:32		22,23,24,25,27			
15.20	Disable HK Sequencer	4:46:24	0:01:00		22,23,24,25,27			
15.21	Apply Noise properties test: pol A/C=0,B/D=1	4:47:24	0:22:32		22,23,24,25,27			
15.22	Apply Noise properties test: pol A/C=1,B/D=1	5:09:56	0:22:32		22,23,24,25,27			
15.23	Apply Noise properties test: pol A/C=1,B/D=0	5:32:28	0:22:32		22,23,24,25,27			
15.24	Apply Noise properties test: pol A/C=0,B/D=0	5:55:00	0:22:32		22,23,24,25,27			
15.25	Disable acquisition for channels in table B	6:17:32	0:01:00		22,23,24,25,27			
15.26	Enable acquisition (processing A) for channels in table C	6:18:32	0:01:00		19,20,25,26,28			
15.27	Apply Noise properties test: pol A/C=0,B/D=1	6:19:32	0:22:32		19,20,25,26,28			
15.28	Apply Noise properties test: pol A/C=1,B/D=1	6:42:04	0:22:32		19,20,25,26,28			
15.29	Apply Noise properties test: pol A/C=1,B/D=0	7:04:36	0:22:32		19,20,25,26,28			
15.30	Apply Noise properties test: pol A/C=0,B/D=0	7:27:08	0:22:32		19,20,25,26,28			
15.31	Disable HK Sequencer	7:49:40	0:01:00		19,20,25,26,28			
15.32	Apply Noise properties test: pol A/C=0,B/D=1	7:50:40	0:22:32		19,20,25,26,28			
15.33	Apply Noise properties test: pol A/C=1,B/D=1	8:13:12	0:22:32		19,20,25,26,28			
15.34	Apply Noise properties test: pol A/C=1,B/D=0	8:35:44	0:22:32		19,20,25,26,28			
15.35	Apply Noise properties test: pol A/C=0,B/D=0	8:58:16	0:22:32		19,20,25,26,28			
15.36	Disable acquisition for channels in table C	9:20:48	0:01:00		19,20,25,26,28			
15.37	Enable acquisition (processing A) for channels in table D	9:21:48	0:01:00		18,19,26,28			
15.38	Apply Noise properties test: pol A/C=0,B/D=1	9:22:48	0:22:32		18,19,26,29			
15.39	Apply Noise properties test: pol A/C=1,B/D=1	9:45:20	0:22:32		18,19,26,30			
15.40	Apply Noise properties test: pol A/C=1,B/D=0	10:07:52	0:22:32		18,19,26,31			
15.41	Apply Noise properties test: pol A/C=0,B/D=0	10:30:24	0:22:32		18,19,26,32			
15.42	Disable HK Sequencer	10:52:56	0:01:00		18,19,26,33			
15.43	Apply Noise properties test: pol A/C=0,B/D=1	10:53:56	0:22:32		18,19,26,34			
15.44	Apply Noise properties test: pol A/C=1,B/D=1	11:16:28	0:22:32		18,19,26,35			
15.45	Apply Noise properties test: pol A/C=1,B/D=0	11:39:00	0:22:32		18,19,26,36			
15.46	Apply Noise properties test: pol A/C=0,B/D=0	12:01:32	0:22:32		18,19,26,28			
15.47	Disable acquisition for channels in table D	12:24:04	0:01:00		18,19,26,28			

4.3.1.2 4 KHz on (switched)

The test procedure (serving also as a checklist) is reported in the following table.

Step	Description	START REF.	DURATION	Time	RCA	YES	NO	Notes
17	Noise Properties (UM § 13.1.2.15)							
17.1	Acquire in stable conditions	0:00:00	12:00:00	7/29/2009 23:54	All	YES		
17.1	Change switching phase switch	12:00:00	0:00:01	7/30/2009 11:54	All apart from LFI23	YES		
17.1	Acquire in stable conditions	12:00:01	12:00:00	7/30/2009 11:54	All	YES		
17.1	End of test	24:00:01	0:00:00	7/30/2009 23:54	All	YES		

4.3.2 Temperatures

Main temperatures during the test are summarised in Table 1. Details of temperature behaviour it time is reported in Figures 1 through 6. It is to be noticed a slight increase in focal plane temperature (~ 1 mK) in the middle of the test with 4 KHz on (see Figure 5), in correspondence to the phase switch configuration change

Table 1 – Main temperatures (average value) during the noise properties test

Tsky (K)	2.76
Tref (K)	4.37
TFEU (K)	19.6 – 20.6
TBEU (C)	14.6 – 36.7

4.3.2.1 Unswitched part

Figure 1 – Reference load temperature during noise properties test with 4 KHz off

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Figure 2 – Front-end temperature level (left) and fluctuation during noise properties test with 4 KHz off
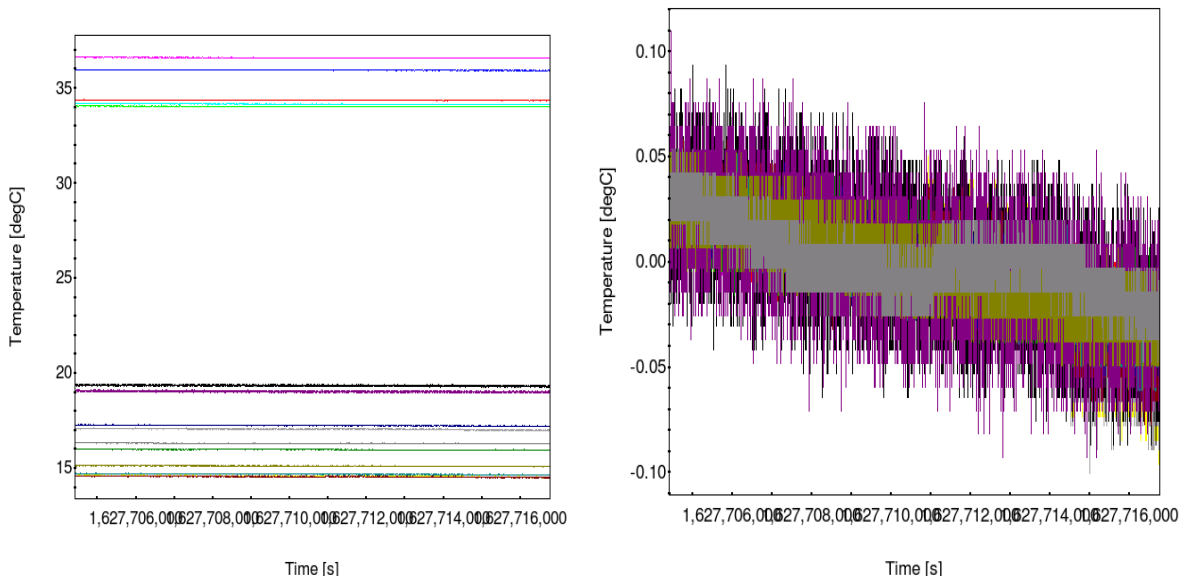
Figure 3 – Back-end temperature level (left) and fluctuation (right) during noise properties test

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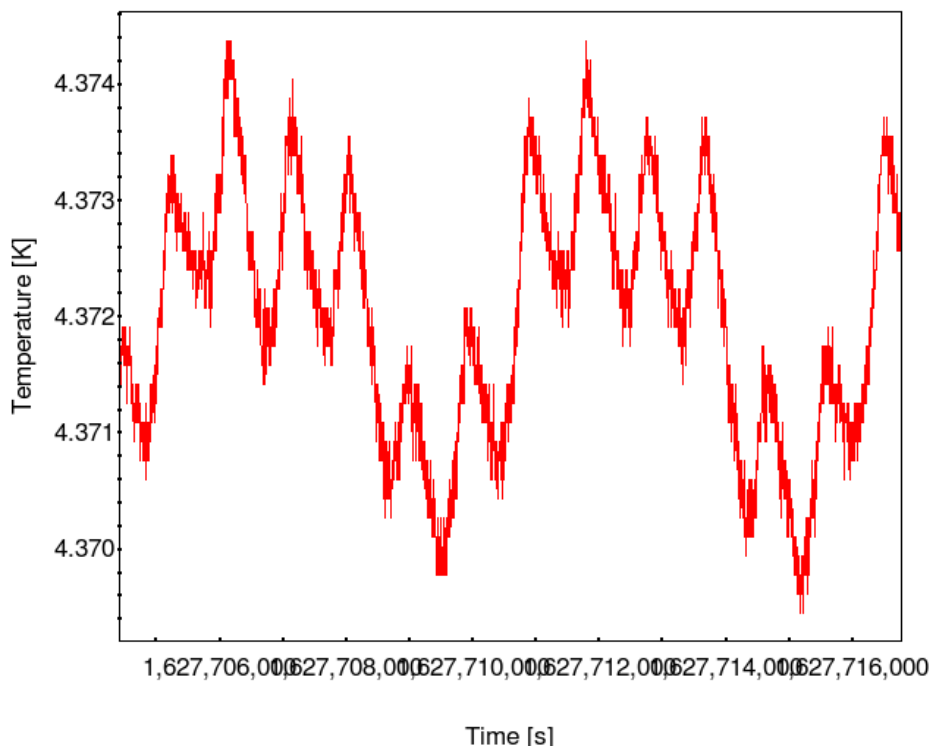
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4.3.2.2 Switched part

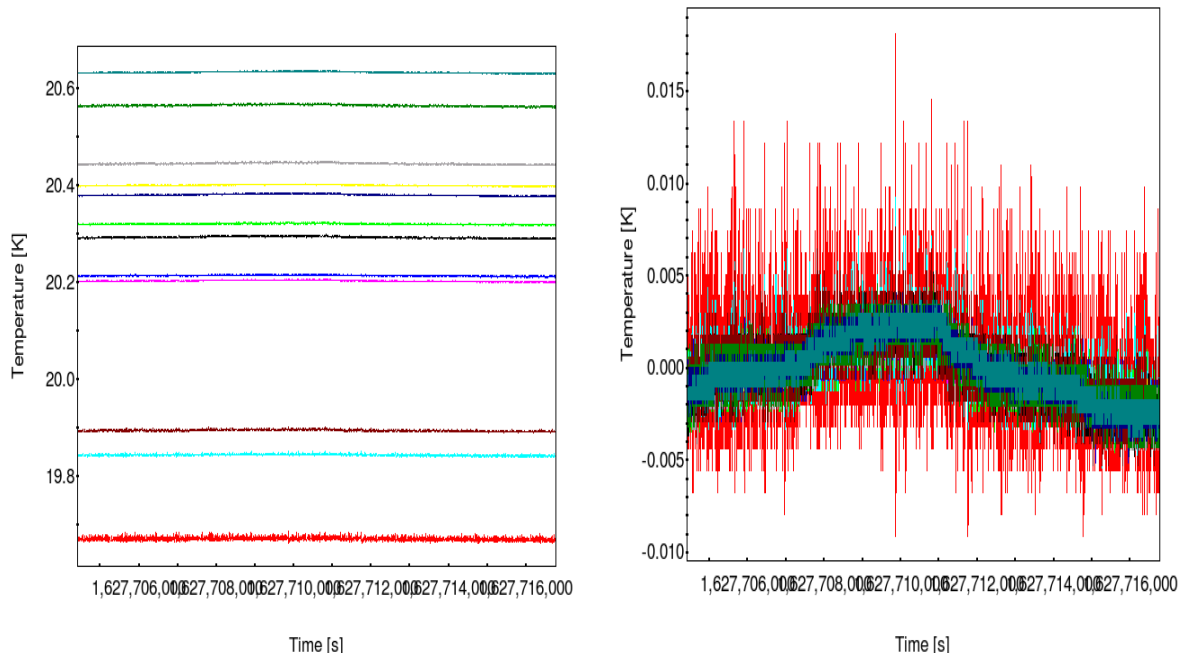*Figure 4 – Reference load temperature during noise properties test*
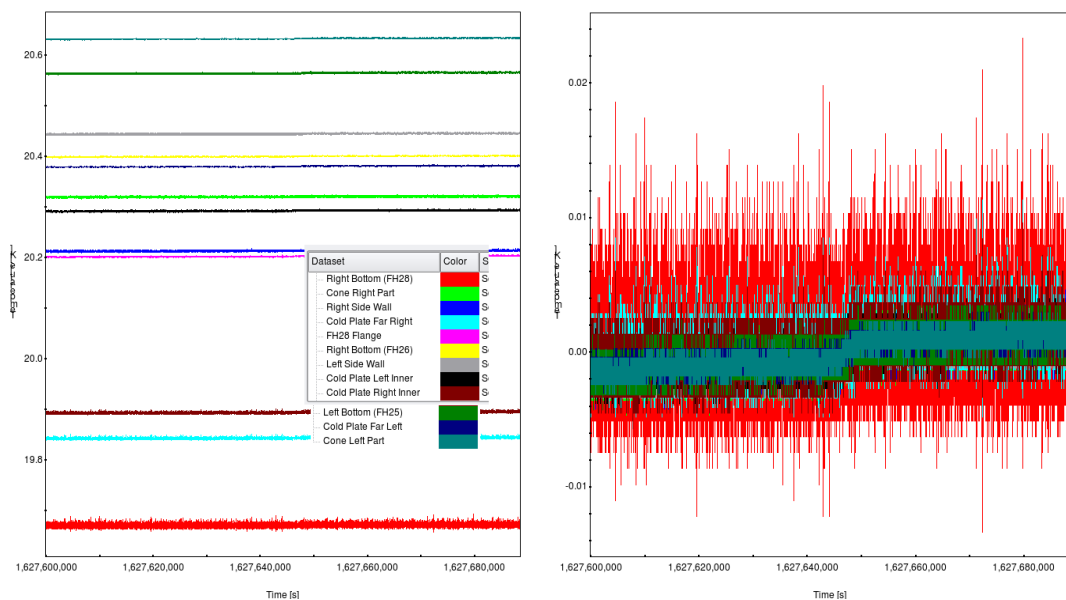
Figure 5 – Front-end temperature level (left) and fluctuation during noise properties test

Figure 6 – Back-end temperature level (left) and fluctuation (right) during noise properties test

4.3.3   Bias and DAE configuration
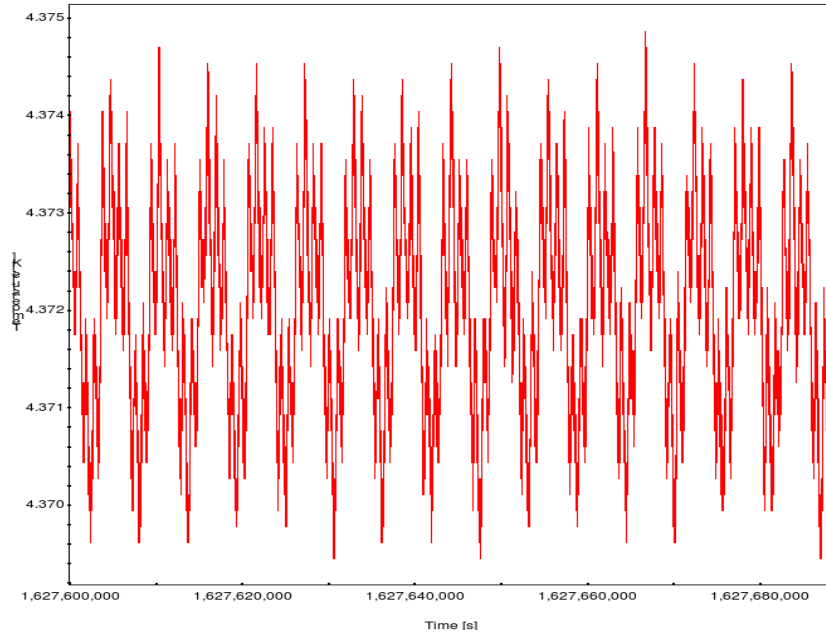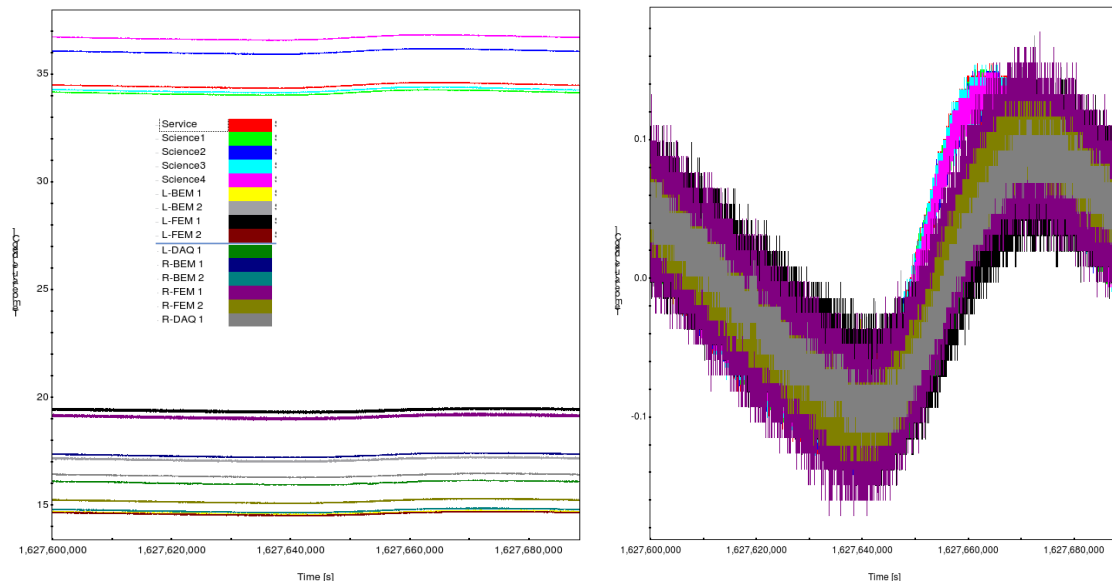
The test has been run in the default bias and DAE configuration. The biases for all 44 ACAs and phase switches are reported in the following table.

Table 2 - Bias configuration during the switched noise properties test

RCA	FEM arm	Vg1	Vg2	Vd	I1	I2
LFI18	S2	216	182	114	255	255
	S1	155	215	138	255	255
	M1	195	189	126	255	255
	M2	198	201	125	255	255
LFI19	S2	204	216	125	255	255
	S1	215	209	120	255	255
	M1	213	206	124	255	255
	M2	211	208	126	255	255
LFI20	S2	188	201	127	255	255
	S1	199	221	132	255	255
	M1	209	219	121	255	255
	M2	215	221	127	255	255
LFI21	S2	205	243	132	255	255
	S1	170	221	136	255	255
	M1	198	207	141	255	255
	M2	196	197	136	255	255
LFI22	S2	206	204	130	255	255
	S1	204	189	128	255	255
	M1	203	194	125	255	255
	M2	178	176	130	255	255
LFI23	S2	190	208	122	255	255
	S1	181	211	118	255	255
	M1	207	192	120	255	255
	M2	210	195	119	255	255
LFI24	M2	225	225	185	205	206
	M1	225	225	191	205	205
	S2	225	225	159	205	205
	S1	225	225	158	205	205
LFI25	M1	225	225	185	205	205
	M2	225	225	187	205	205
	S1	225	225	169	205	205
	S2	225	225	167	205	205
LFI26	M2	225	225	178	205	205
	M1	225	225	176	205	205
	S2	225	225	176	205	205
	S1	225	225	178	205	205
LFI27	M1	240	108	156	148	220
	M2	244	90	157	145	205
	S1	237	102	157	127	184
	S2	246	114	156	148	195
LFI28	M1	243	101	157	130	160
	M2	240	112	156	127	228
	S1	240	84	157	127	222
	S2	245	121	158	103	165

Table 3 - DAE configuration during the switched noise properties test

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RCA	Channel	Gain	Offset	RCA	Channel	Gain	Offset
LFI18	M-00	2	63	LFI24	M-00	11	255
	M-01	1	53		M-01	11	255
	S-10	9	65		S-10	10	255
	S-11	9	135		S-11	10	255
LFI19	M-00	9	146	LFI25	M-00	3	255
	M-01	9	94		M-01	3	255
	S-10	9	147		S-10	3	255
	S-11	9	146		S-11	3	255
LFI20	M-00	9	80	LFI26	M-00	10	255
	M-01	9	82		M-01	3	255
	S-10	9	132		S-10	10	255
	S-11	9	93		S-11	3	255
LFI21	M-00	9	149	LFI27	M-00	9	112
	M-01	9	204		M-01	9	100
	S-10	9	155		S-10	9	106
	S-11	9	156		S-11	9	132
LFI22	M-00	9	229	LFI28	M-00	9	139
	M-01	9	224		M-01	9	98
	S-10	9	223		S-10	9	137
	S-11	9	206		S-11	9	152
LFI23	M-00	9	144				
	M-01	9	122				
	S-10	9	130				
	S-11	9	224				

4.3.4 Phase switch configuration

4.3.4.1 Unswitched acquisition

The test consisted in four acquisitions of 20 minutes (TBC) each in which the following four phase switch configurations have been exercised. Notice that in all cases the 4KHz switching was set to zero for both A/C and B/D. Furthermore no change was applied to LFI23.

Table 4 - Phase switch configurations in the unswitched part of the noise properties test

Acquisition 1				Acquisition 2		
Feed	A/C pos	B/D pos		Feed	A/C pos	B/D pos
18	1	0		18	0	0
19	1	0		19	0	0
20	1	0		20	0	0
21	1	0		21	0	0
22	1	0		22	0	0
23	1	0		23	0	0
24	1	0		24	0	0
25	1	0		25	0	0
26	1	0		26	0	0
27	1	0		27	0	0
28	1	0		28	0	0

Acquisition 3				Acquisition 4		
Feed	A/C pos	B/D pos		Feed	A/C pos	B/D pos
18	0	1		18	1	1
19	0	1		19	1	1
20	0	1		20	1	1
21	0	1		21	1	1
22	0	1		22	1	1
23	0	0		23	1	0
24	0	1		24	1	1
25	0	1		25	1	1
27	0	1		26	1	1
28	0	1		27	1	1
26	0	1		28	1	1

4.3.4.2 *Switched acquisition*

This part consisted in two acquisitions with the following phase switch configurations. The first acquisition run from 2009-07-29T23:05:00 to 2009-07-30T11:05:00, while the second acquisition run from 2009-07-30T12:11:00 to 2009-07-30T23:43:00.

Notice that the switching configuration of LFI23 has not changed because of the know problem in noise properties connected to the B/D switching = 1 status. Therefore LFI23 did not change configuration in the two acquisitions and can be used as a repeatability verification channel.

Table 5 - Phase switch configuration during first part of switched noise properties test

Feed horn	A/C switching	B/D switching	A/C position	B/D position
18	0	1	1	0
19	0	1	1	0
20	0	1	1	0
21	0	1	1	0
22	0	1	1	0
23	1	0	1	0
24	0	1	0	0
25	0	1	0	0
27	0	1	0	0
28	0	1	1	0

Table 6 - Phase switch configuration during second part of switched noise properties test

Feed horn	A/C switching	B/D switching	A/C position	B/D position
18	1	0	1	0
19	1	0	1	0
20	1	0	1	0
21	1	0	1	0
22	1	0	1	0
23	1	0	1	0
24	1	0	0	0
25	1	0	0	0
27	1	0	0	0
28	1	0	1	0

4.3.5 REBA configuration

4.3.5.1 Unswitched acquisition

4.3.5.2 Switched acquisition

The acquisition in switched condition has been performed with the LFI in nominal compressed mod (COM5) with the default parameters in the REBA resulting from the final REBA optimisation [RD5]:

Table 7 - REBA configuration during noise properties test (switched part)

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RCA	Channel	r1	r2	Delta	sq
LFI18	M-00	1	0.5	-2027.88	0.7
	M-01	1	0.5	-2729.95	1.05
	S-10	0.97	0.38	-235.66	0.77
	S-11	1.08	0.5	-1913.74	1.07
LFI19	M-00	1.08	0.5	-2157.77	1.02
	M-01	1.08	0.5	-72.47	1.04
	S-10	1.13	0.5	-85.87	1.66
	S-11	1.08	0.5	-1073.16	1.37
LFI20	M-00	1.13	0.5	-95.77	0.98
	M-01	1.17	0.5	-138.38	0.95
	S-10	1.13	0.5	-1788.48	0.95
	S-11	1.17	0.5	-273.73	1.01
LFI21	M-00	1.04	0.5	-223.4	1.76
	M-01	1.04	0.5	-2632.33	1.79
	S-10	1.08	0.5	-1104.3	1.48
	S-11	1.08	0.5	-1372.34	1.38
LFI22	M-00	1.04	0.5	-2890.26	2.62
	M-01	1.08	0.5	-2634.94	2.38
	S-10	1.04	0.5	-3069.98	1.84
	S-11	1.04	0.5	-3199.96	1.48
LFI23	M-00	1.04	0.5	-1204.43	1.37
	M-01	1.04	0.5	-388.72	1.2
	S-10	1	0.5	-884.04	1.31
	S-11	1	0.5	-3042.1	2.29

RCA	Channel	r1	r2	Delta	sq
LFI24	M-00	0.96	0.5	-3181.09	4.54
	M-01	1.04	0.5	-2727.14	3.56
	S-10	0.88	0.5	-3515.08	5.84
	S-11	0.83	0.5	-4039.87	6.1
LFI25	M-00	0.83	0.5	-3734.2	6.32
	M-01	0.83	0.5	-3936.6	6.4
	S-10	0.88	0.5	-3472.95	5.4
	S-11	0.79	0.5	-3964.33	7.68
LFI26	M-00	0.88	0.5	-3302.25	5.24
	M-01	0.83	0.5	-3558.53	6.66
	S-10	0.96	0.5	-3102.14	4.25
	S-11	0.79	0.5	-3985.84	7.68
LFI27	M-00	1.29	0.38	1931.44	1.28
	M-01	1.29	0.38	2270.51	1.2
	S-10	1.25	0.38	1876.51	1.34
	S-11	1.33	0.38	1645.06	1.44
LFI28	M-00	1.38	0.38	-470.12	1.49
	M-01	1.38	0.38	124.87	1.22
	S-10	1.33	0.38	495.68	1.73
	S-11	1.33	0.38	386.56	1.92

4.3.6   Non nominal features

The procedure was executed correctly without anomalies.

4.4   Data Analysis

4.4.1   Unswitched acquisition

The analysis of this part of the test is summarised in the plots collected in Annex 1. Each plot shows the power spectra of unswitched data for each detector in the four phase switch configurations. The four power spectra are overplotted in different colours showing that no detectable difference can be seen in the 1/f behaviour. This shows that the phase switch positions are essentially equivalent from the point of view of 1/f performance.

4.4.2   Switched acquisition

4.4.2.1   *Comparison of noise properties between the two switching configurations*

Here we discuss the comparison of the LFI noise properties in the two switching configurations. In Fig. 7 we show the % difference in knee frequency. Positive numbers indicate that knee frequencies in the default configuration are smaller and vice versa.

Considering 10% the level of repeatability indicated by LFI23 we see that in general the default configuration (acquisition 1) is to be generally preferred as it yields smaller knee frequencies.

The only noticeable exceptions are represented by LFI26 and LFI24M which display a significant improvement in knee frequency by changing the switching phase switch.
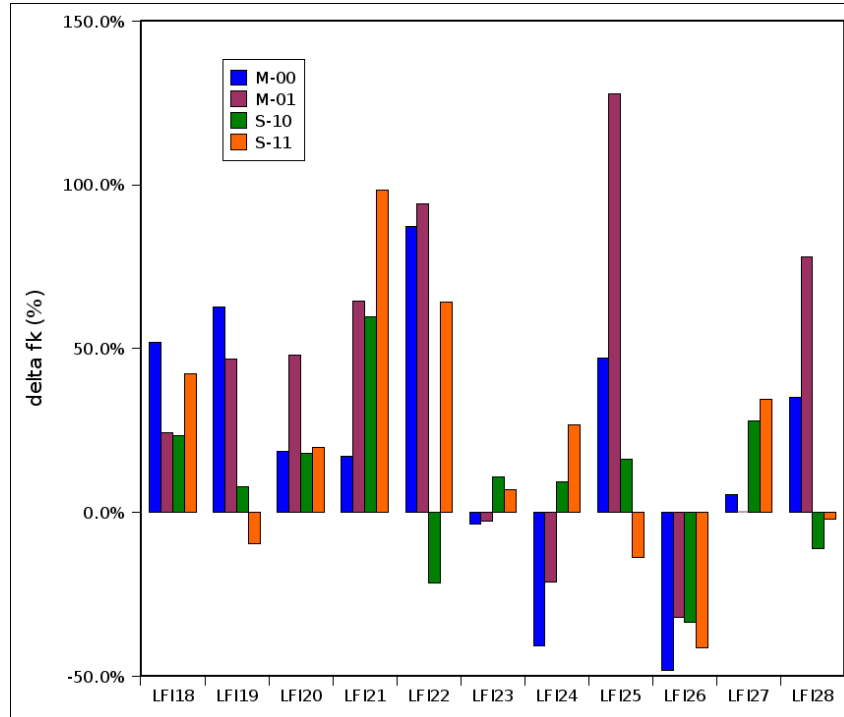

Figure 7 - Percent variation in knee frequency between the two phase switch configurations. The variation in LFI23 can be considered as a reference for the repeatability of this comparison, as LFI23 did not change configuration in the two acquisitions

In Figure 8 we show a similar comparison for the slope. In this case we see variations that are marginally significant, as shown by the variations displayed by LFI23.
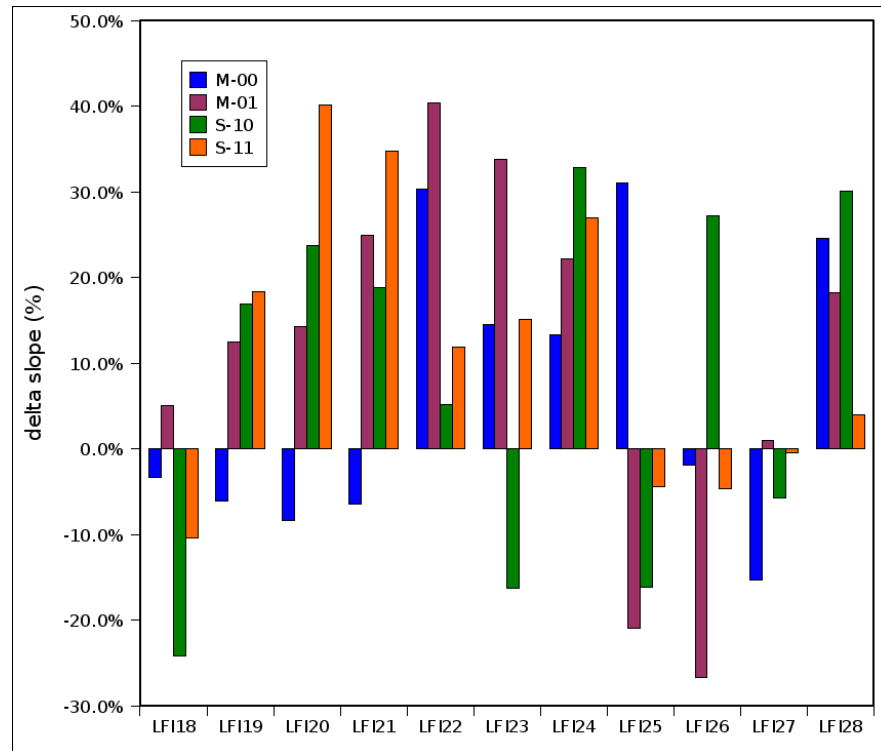
Figure 8 - Percent variation in slope the two phase switch configurations. The variation in LFI23 can be considered as a reference for the repeatability of this comparison, as LFI23 did not change configuration in the two acquisitions

Finally we show in Figure 9 the comparison for the uncalibrated noise. Here variations are generally small, less than 2%, with the exceptions of LFI25M-01 and LFI26M-01 that show variations of the order of 4%.

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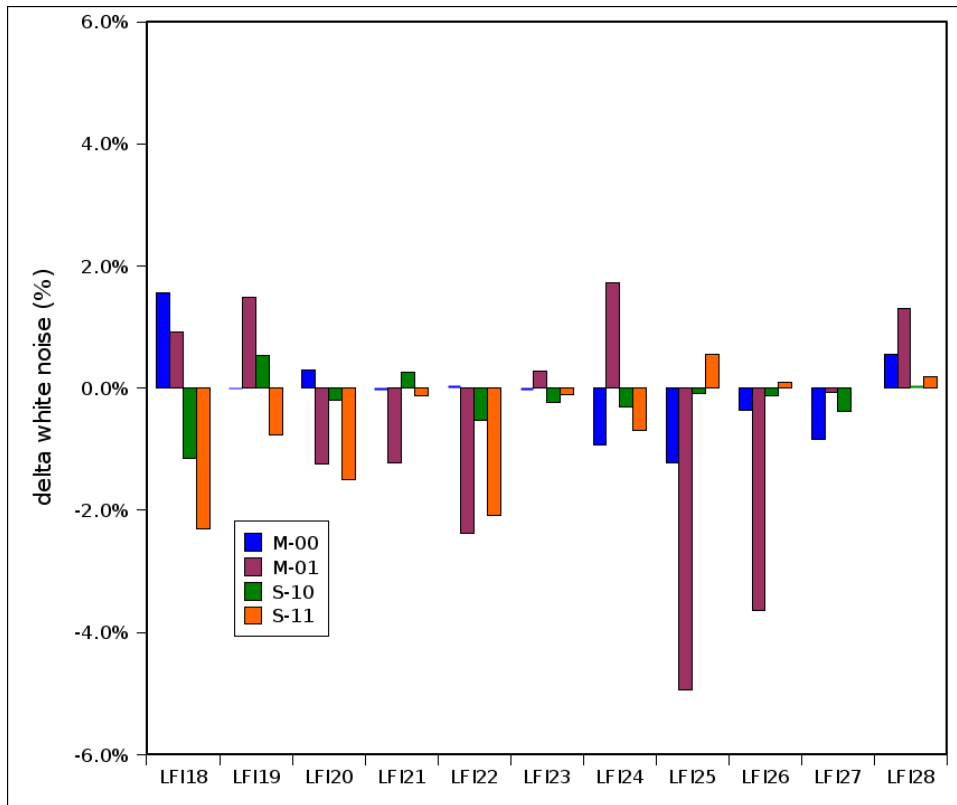
Figure 9 - Percent variation in uncalibrated white noise between the two phase switch configurations. The variation in LFI23 can be considered as a reference for the repeatability of this comparison, as LFI23 did not change configuration in the two acquisitions

4.4.2.2 Tables of noise properties

In the following tables we report the LFI noise properties per detector calculated in the two tested phase switch configurations

Table 8 - Calibrated white noise per detector $K \times \sqrt{s}|$ **for the two tested phase switched configurations**

	M-00	M-01	S-10	S-11
LFI18	703	710	626	569
LFI19	761	721	681	735
LFI20	731	771	816	767
LFI21	572	598	703	808
LFI22	625	649	702	713
LFI23	688	639	688	700
LFI24	653	758	638	558
LFI25	608	587	626	533
LFI26	632	759	668	556
LFI27	407	407	428	450
LFI28	485	480	438	427

	M-00	M-01	S-10	S-11
LFI18	718	705	635	570
LFI19	750	716	704	709
LFI20	732	756	799	780
LFI21	573	601	694	805
LFI22	636	638	701	709
LFI23	682	633	674	699
LFI24	651	750	625	575
LFI25	601	576	626	530
LFI26	646	733	671	565
LFI27	406	409	429	448
LFI28	484	490	428	431

Table 9 - Knee frequencies in mHz for the two tested phase switch configurations

	M-00	M-01	S-10	S-11
LFI18	52	58	43	50
LFI19	47	49	79	86
LFI20	32	28	45	43
LFI21	56	45	45	30
LFI22	51	44	81	43
LFI23	104	76	58	60
LFI24	65	48	60	48
LFI25	29	25	39	45
LFI26	105	71	117	111
LFI27	105	119	83	67
LFI28	79	64	62	61

	M-00	M-01	S-10	S-11
LFI18	80	73	53	71
LFI19	77	73	86	78
LFI20	38	42	53	52
LFI21	66	74	72	60
LFI22	95	86	63	70
LFI23	100	74	64	65
LFI24	39	38	66	61
LFI25	42	57	45	39
LFI26	54	48	78	65
LFI27	111	119	106	90
LFI28	107	114	55	60

Table 10 - Knee frequencies in mHz for the two tested phase switch configurations

	M-00	M-01	S-10	S-11		M-00	M-01	S-10	S-11
LFI18	-1.6	-1.7	-1.9	-1.8	LFI18	-1.5	-1.7	-1.4	-1.6
LFI19	-1.5	-1.3	-1.9	-2.0	LFI19	-1.4	-1.4	-2.2	-2.4
LFI20	-1.3	-1.5	-1.4	-1.3	LFI20	-1.2	-1.7	-1.7	-1.8
LFI21	-1.7	-1.4	-1.3	-1.3	LFI21	-1.6	-1.8	-1.6	-1.8
LFI22	-1.3	-1.2	-1.4	-1.4	LFI22	-1.6	-1.7	-1.5	-1.5
LFI23	-1.5	-1.5	-1.6	-1.5	LFI23	-1.7	-2.0	-1.4	-1.7
LFI24	-1.3	-1.4	-1.1	-1.1	LFI24	-1.5	-1.7	-1.4	-1.3
LFI25	-1.1	-1.5	-1.2	-1.3	LFI25	-1.5	-1.2	-1.0	-1.3
LFI26	-1.3	-1.4	-1.1	-1.2	LFI26	-1.3	-1.1	-1.4	-1.1
LFI27	-1.2	-1.0	-1.2	-1.2	LFI27	-1.0	-1.0	-1.1	-1.2
LFI28	-1.1	-1.1	-1.3	-1.4	LFI28	-1.4	-1.3	-1.7	-1.5

4.4.3 Known anomalies

N/A

4.4.4 New anomalies

N/A

4.5 Conclusions and recommendations

The noise properties test run during the CPV has shown that the instrument behaves as expected from the point of view of the noise. Furthermore we can summarise the following conclusions:

1. the default phase switch configuration is B/D switching apart from LFI23 (A/C switching);

2. this configuration is optimal for all radiometer apart from LFI26 and LFI24M;

3. in these cases a reduction of about a factor 2 in knee frequency can be obtained by changing from B/D switching to A/C switching;

4. there is no appreciable difference in the unswitched behaviour in any of the 4 phase switch positions.

From these conclusions we can formulate the following recommendation:

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1. **verify feasibility of changing the switching configuration for LFI26 and LFI24M, and verify that a change in noise properties is not problematic for map-making;**

2. **assess the benefit of such reduction in knee frequency from the scientific point of view;**

3. **in case the assessment is positive implement the change in phase switch configuration.**