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**DOC. TYPE:** **Test Report**

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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

# 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 | | | | |

## 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 PoI=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*

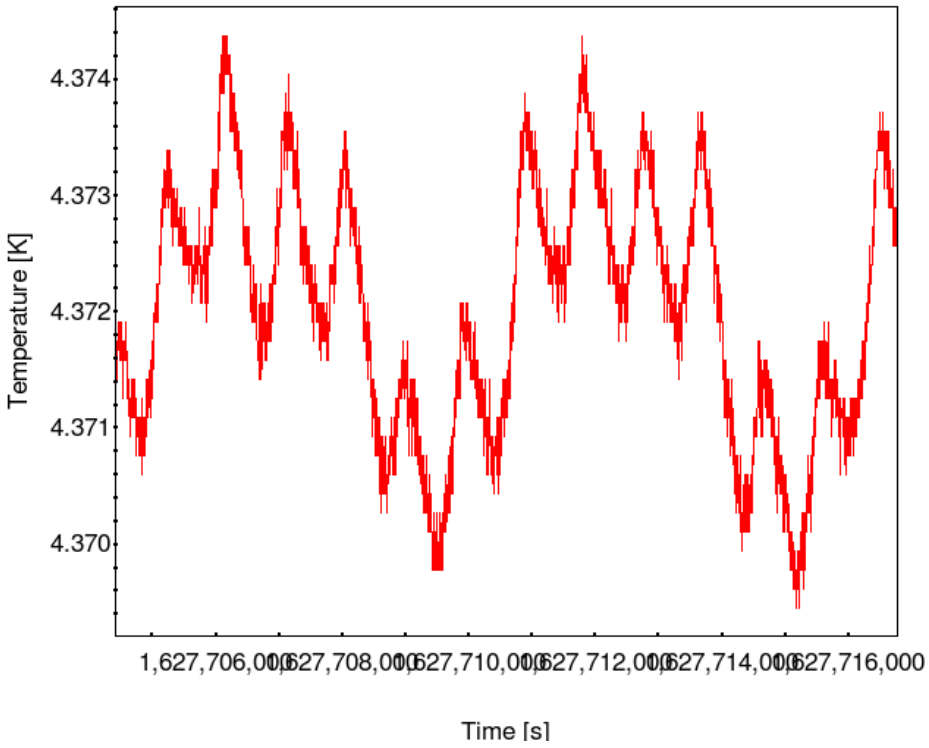


*Figure 1 – Reference load temperature during noise properties test with 4 KHz off*

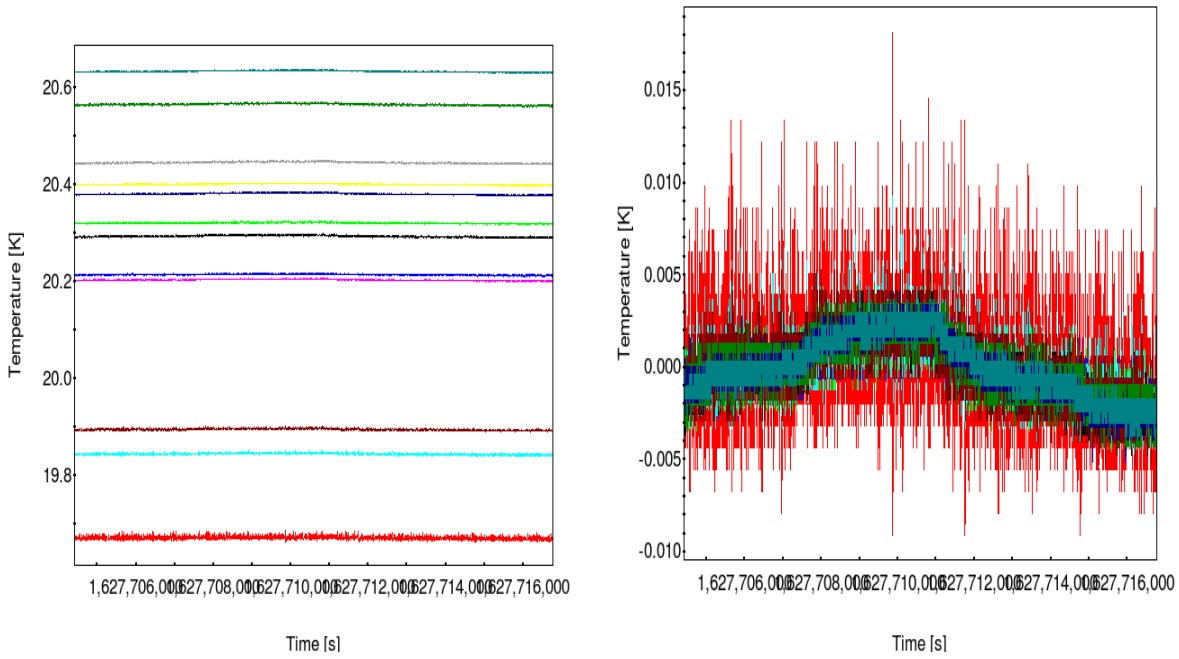


*Figure 2 – Front-end temperature level (left) and fluctuation during noise properties test with 4 KHz off*

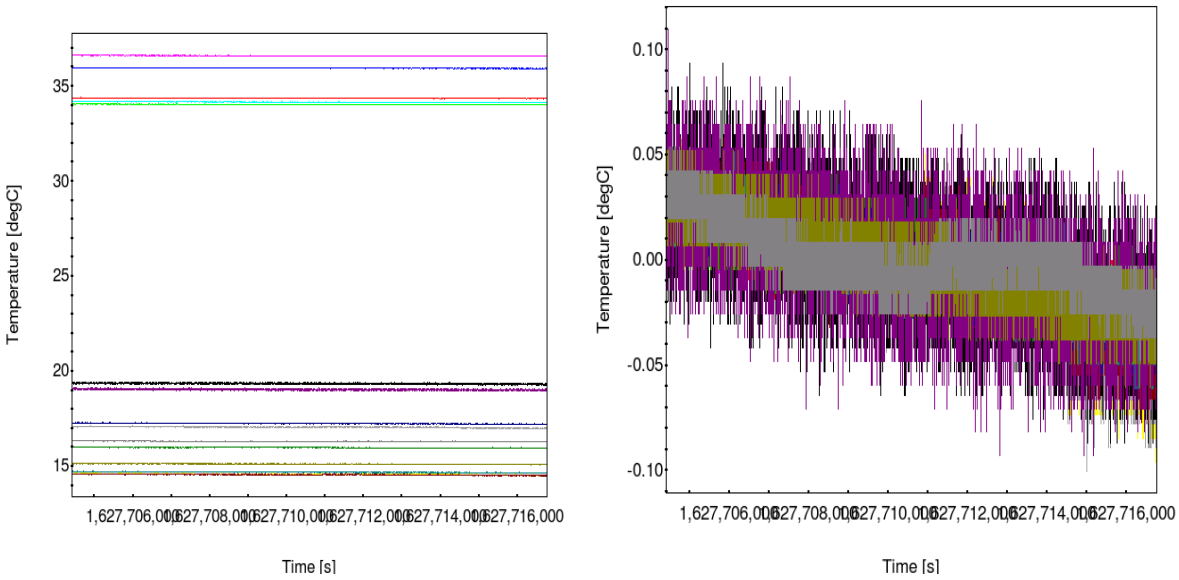


*Figure 3 – Back-end temperature level (left) and fluctuation (right) during noise properties test*

#### *4.3.2.2 Switched part*

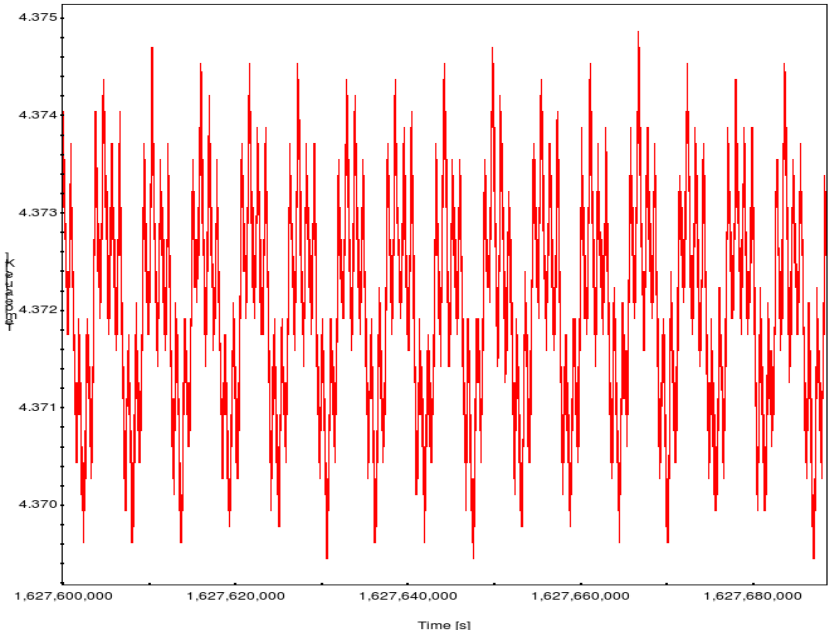


*Figure 4 – Reference load temperature during noise properties test*

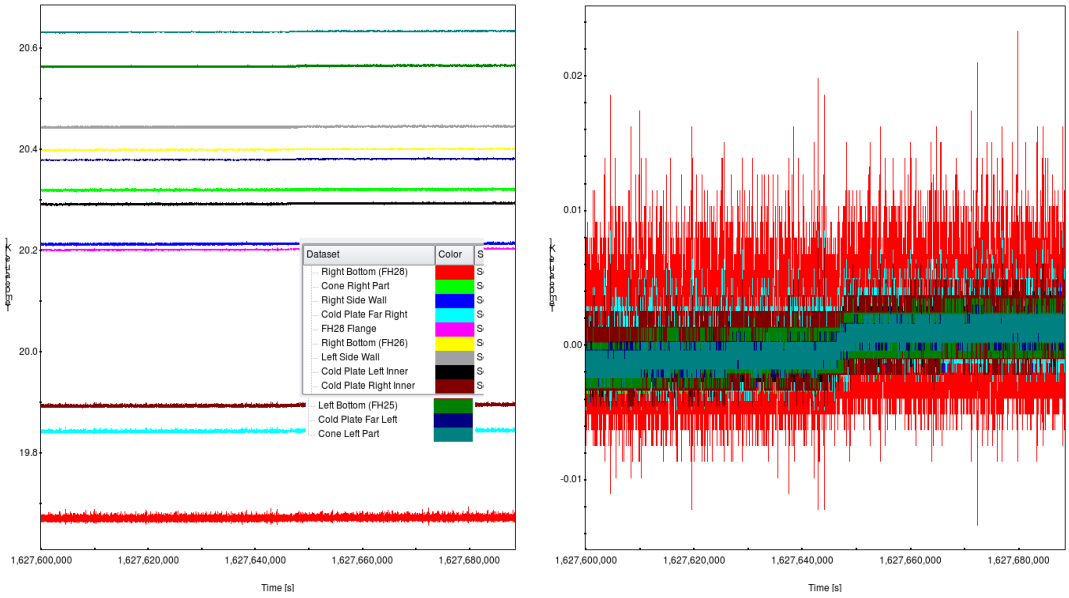


*Figure 5 – Front-end temperature level (left) and fluctuation during noise properties test*

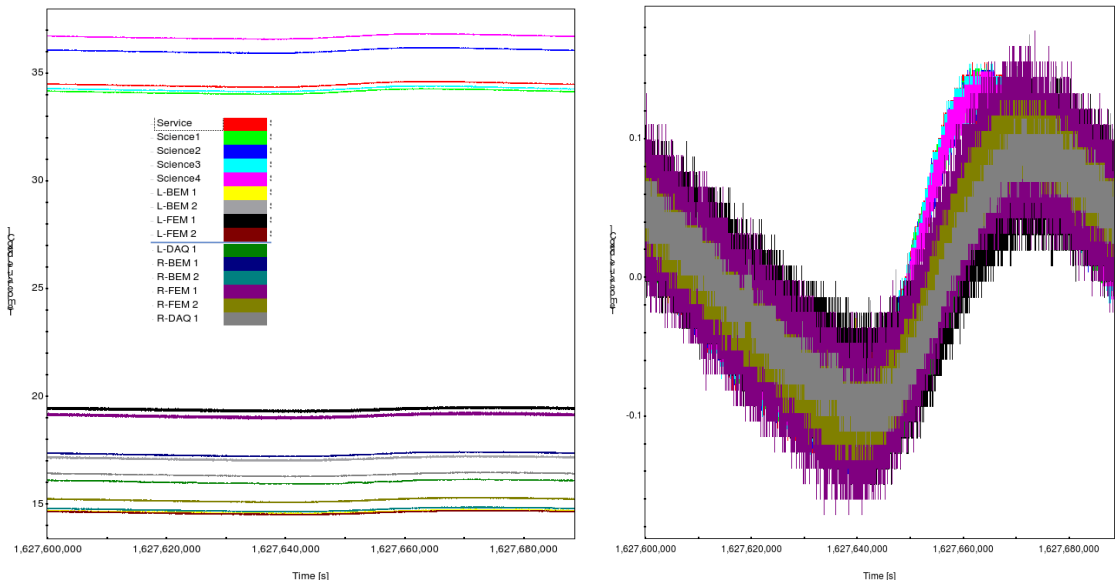


*Figure 6 – Back-end temperature level (left) and fluctuation (right) during noise properties test*

### 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**

| RCA | Channel | Gain | Offset |
|---|---|---|---|
| LFI18 | M-00 | 2 | 63 |
| | M-01 | 1 | 53 |
| | S-10 | 9 | 65 |
| | S-11 | 9 | 135 |
| LFI19 | M-00 | 9 | 146 |
| | M-01 | 9 | 94 |
| | S-10 | 9 | 147 |
| | S-11 | 9 | 146 |
| LFI20 | M-00 | 9 | 80 |
| | M-01 | 9 | 82 |
| | S-10 | 9 | 132 |
| | S-11 | 9 | 93 |
| LFI21 | M-00 | 9 | 149 |
| | M-01 | 9 | 204 |
| | S-10 | 9 | 155 |
| | S-11 | 9 | 156 |
| LFI22 | M-00 | 9 | 229 |
| | M-01 | 9 | 224 |
| | S-10 | 9 | 223 |
| | S-11 | 9 | 206 |
| LFI23 | M-00 | 9 | 144 |
| | M-01 | 9 | 122 |
| | S-10 | 9 | 130 |
| | S-11 | 9 | 224 |

| RCA | Channel | Gain | Offset |
|---|---|---|---|
| LFI24 | M-00 | 11 | 255 |
| | M-01 | 11 | 255 |
| | S-10 | 10 | 255 |
| | S-11 | 10 | 255 |
| LFI25 | M-00 | 3 | 255 |
| | M-01 | 3 | 255 |
| | S-10 | 3 | 255 |
| | S-11 | 3 | 255 |
| LFI26 | M-00 | 10 | 255 |
| | M-01 | 3 | 255 |
| | S-10 | 10 | 255 |
| | S-11 | 3 | 255 |
| LFI27 | M-00 | 9 | 112 |
| | M-01 | 9 | 100 |
| | S-10 | 9 | 106 |
| | S-11 | 9 | 132 |
| LFI28 | M-00 | 9 | 139 |
| | M-01 | 9 | 98 |
| | S-10 | 9 | 137 |
| | S-11 | 9 | 152 |

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

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

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

| Acquisition 4 | | |
|---|---|---|
| Feed | A/C pos | B/D pos |
| 18 | 1 | 1 |
| 19 | 1 | 1 |
| 20 | 1 | 1 |
| 21 | 1 | 1 |
| 22 | 1 | 1 |
| 23 | 1 | 0 |
| 24 | 1 | 1 |
| 25 | 1 | 1 |
| 26 | 1 | 1 |
| 27 | 1 | 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)**

| 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.

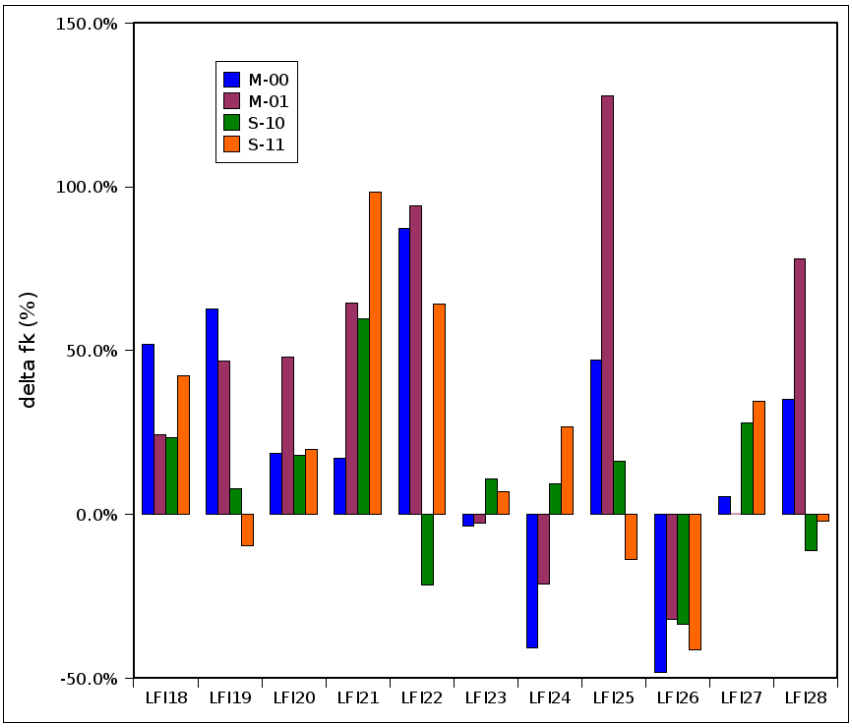


*Figure 7 - Percent variation in knee frequency between the two phase switch configurations. The variation in LFI23 can be considered as a reference for the repeatability of this comparison, as LFI23 did not change configuration in the two acquisitions*

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.

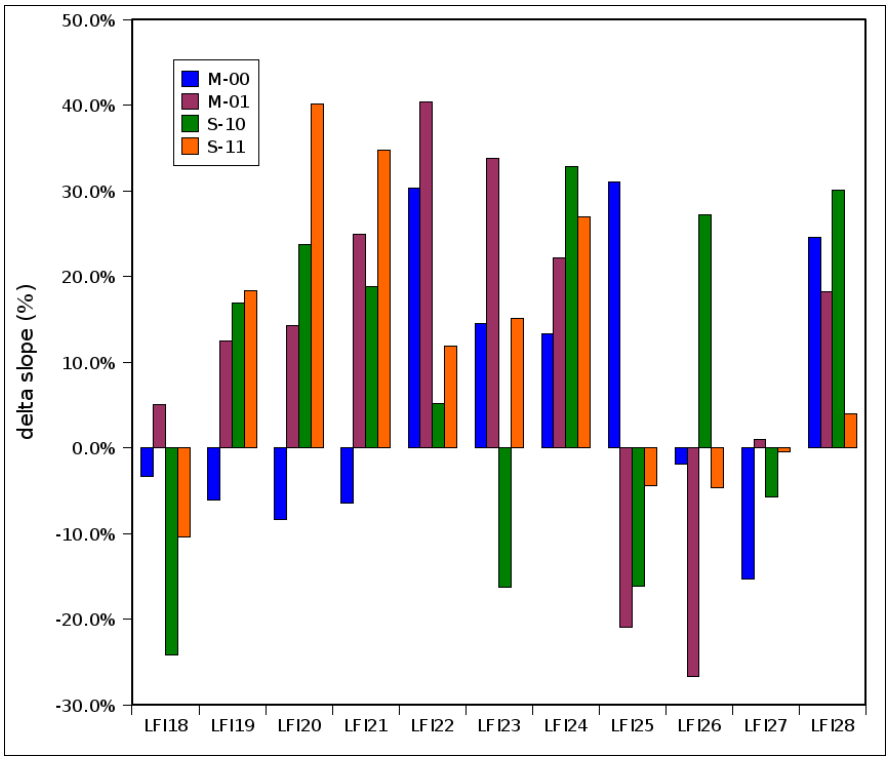


*Figure 8 - Percent variation in slope the two phase switch configurations. The variation in LFI23 can be considered as a reference for the repeatability of this comparison, as LFI23 did not change configuration in the two acquisitions*

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%.

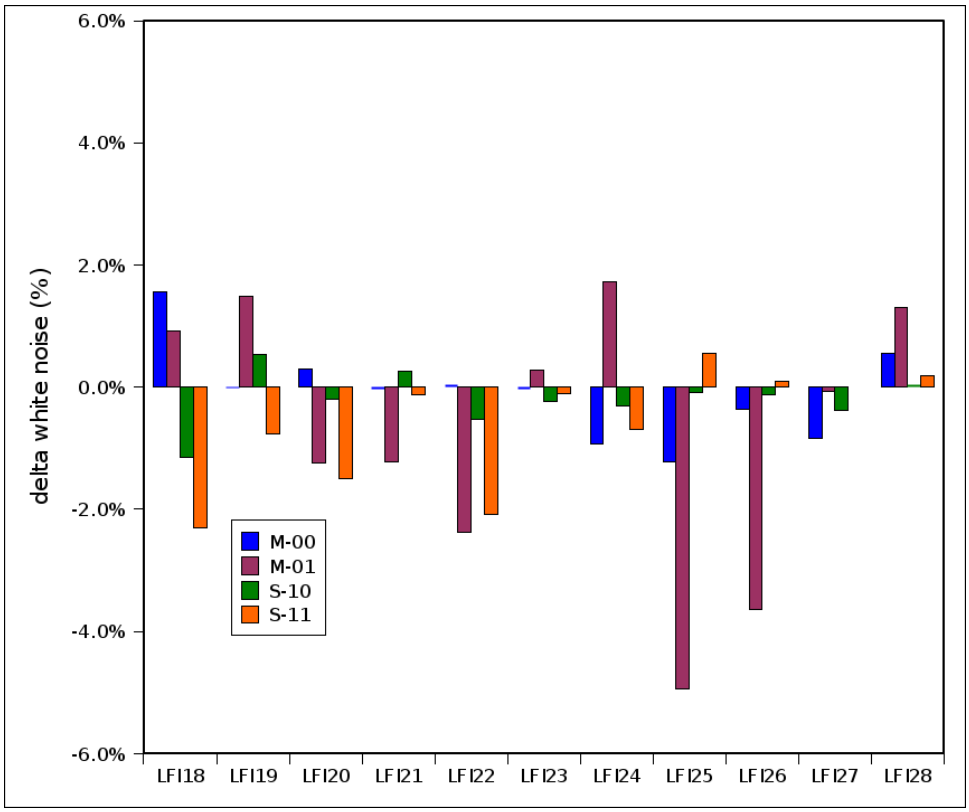


*Figure 9 - Percent variation in uncalibrated white noise between the two phase switch configurations. The variation in LFI23 can be considered as a reference for the repeatability of this comparison, as LFI23 did not change configuration in the two acquisitions*

### *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 $\mathrm{K} \times \sqrt{\mathrm{s}}$ 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 |
|---|---|---|---|---|
| LFI18 | -1.6 | -1.7 | -1.9 | -1.8 |
| LFI19 | -1.5 | -1.3 | -1.9 | -2.0 |
| LFI20 | -1.3 | -1.5 | -1.4 | -1.3 |
| LFI21 | -1.7 | -1.4 | -1.3 | -1.3 |
| LFI22 | -1.3 | -1.2 | -1.4 | -1.4 |
| LFI23 | -1.5 | -1.5 | -1.6 | -1.5 |
| LFI24 | -1.3 | -1.4 | -1.1 | -1.1 |
| LFI25 | -1.1 | -1.5 | -1.2 | -1.3 |
| LFI26 | -1.3 | -1.4 | -1.1 | -1.2 |
| LFI27 | -1.2 | -1.0 | -1.2 | -1.2 |
| LFI28 | -1.1 | -1.1 | -1.3 | -1.4 |

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

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.**