TITLE:	**Planck LFI CPV: Thermal Susceptibility Test Report (ref: P_PVP_LFI_0016_01)**

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CHANGE RECORD

Issue	Date	Sheet	Description of Change	Release

TABLE OF CONTENTS

1 ACRONYMS

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

2 APPLICABLE AND REFERENCE DOCUMENTS

2.1 Applicable Documents

[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

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] A, Mennella et al., *PLANCK: Systematic effects induced by periodic fluctuations of arbitrary shape*, A&A 384, 736{742 (2002)

[RD4] L. Terenzi et al., *Thermal susceptibility of the Planck-LFI receivers*, 2009, accepted to be published on JINST

3 INTRODUCTION

3.1 Purpose and Scope

The SCS PID will be used to characterise the radiometers front end tehrmal susceptibility (THF). The temperature of the LFI focal plane (FPU) is changed over 4 values, each step having a duration > 3h , depending on the step.
The temperature variations are of about 0.3 K each.
The measured receivers output will be characterized as a function of FPU temperature variations.

3.2 Test configuration

The test configuration is the following

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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4 Test Execution

4.1 Pass-fail criteria, verification matrix

CPV	**P_PVP_LFI_0016_01**	
August, 11-12 2009	**OD 89-91**	**Starting time: 09:15z Aug, 11**
Duration	30 hours	
Test name:	**Lfi Thermal Susceptibility**	
Test objectives:	The SCS PID will be used to characterise the radiometers THF (temperature is changed over 4 values, each step having a duration > 3h , depending on the step). Instrument FPU is excited with delta T variations of about 0.5 K each. Space and time thermal gradient are monitored	

Verification matrix					
Check	**Passed?**			**Recovered?**	
	Yes	**No**	**Notes**	**Yes**	**No**
No unexpected events packets	Yes				
Housekeeping and Science production telemetry as expected	Yes				
Test sequence succesfully run	Yes		All four steady temperature stages reached. Stability is enough for a correct data analysis		
Real time data available	Yes				
No unexpected features		No	One detector saturated (RCA24-11). Susceptibility of the 24 Side arm canl be evaluated by means of 24 Main arm, and then checked from Dynamic response test.	Yes	
Data saved and stored at DPC	Yes				

4.2 Procedure/ Test sequence

Test started on August,11 at 9:15z.
Soon after AOS a telecommand was sent to change the Sorpion Cooler TSA setpoint from 18.5 K to 19.4. After stabilization, just before LOS, three hours later the setpoint was decreased down to 18.7 K. On August, 12 soon after the AOS at 9:10z, the setpoint was raised to 19.0 K. After stabilization, just before LOS, three hours later the setpoint was decreased down to 18.7 K, nominal TSA setpoint temperature for the beginning of First Light Survey.
In Fig. 1, the temperature curves of TSA and focal plane sensors are shown during the whole duration of the test.

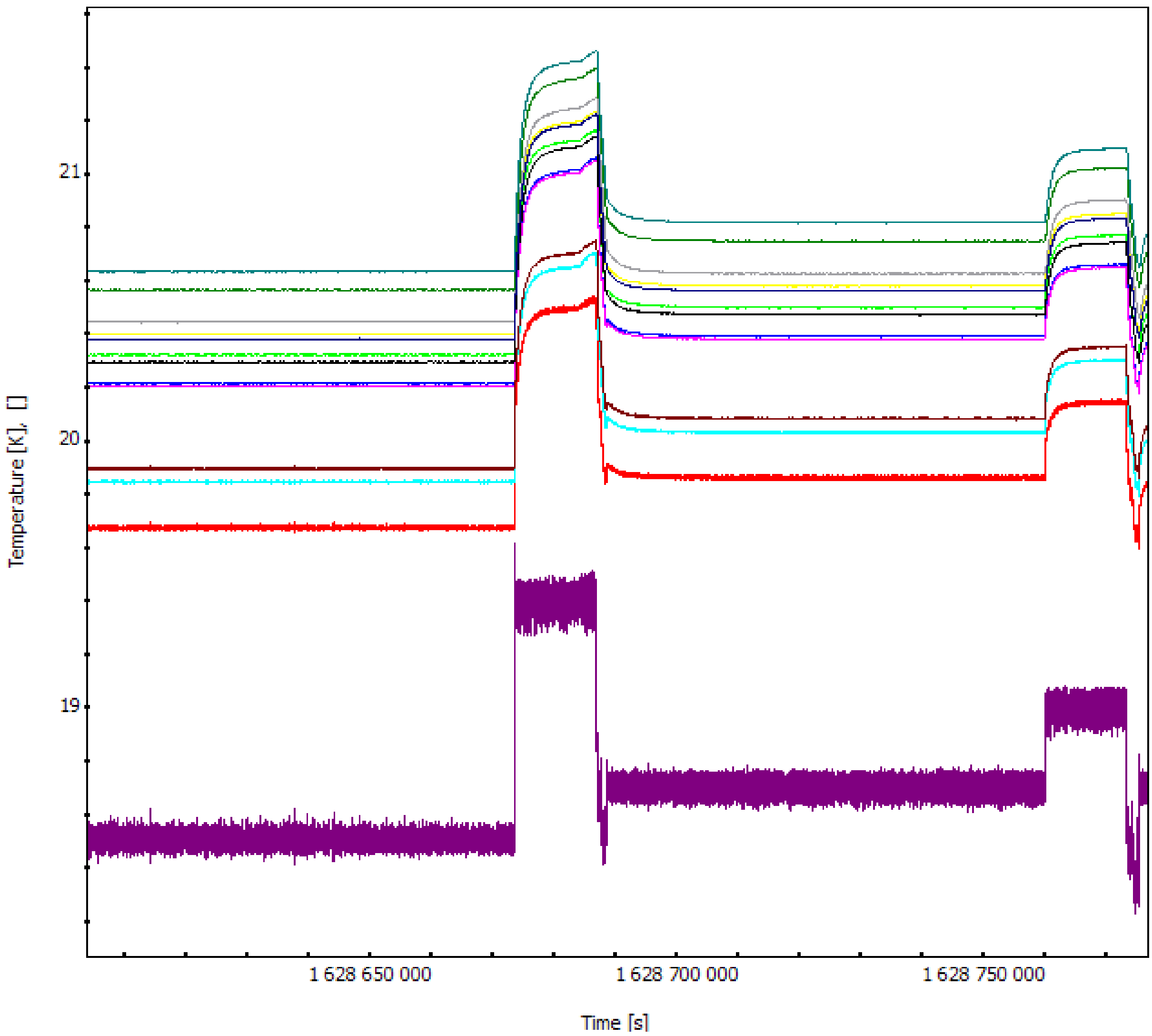

Fig. 1 Global view of the TSA temperature (purple) and of the 12 LFI focal plane sensors, during thermal susceptibility test.

4.2.1 Non nominal features

A problem occurred due to the saturation of the detector LFI24-11, during the test, so that data from that detector can not be exploited. The RCA 24 side arm amplifiers thermal susceptibility are then only recovered by means of detector LFI24-10.

4.3 Data Analysis

The data analysis consisted in analyzing the variation in the calibrated differenced output, with respect to the variations in the front end temperature. The slope of the line fitted to the data (see) is the radiometer transfer function of a temperature variation in the focal plane.

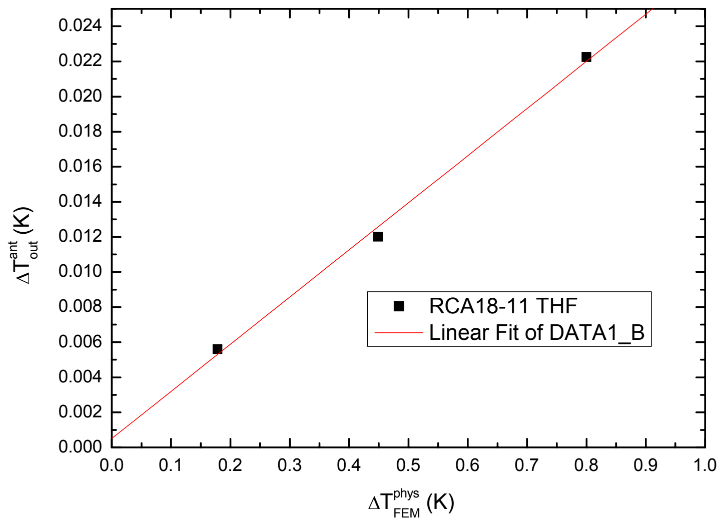

Fig. 2 A line is fitted in the plot of antenna temperature variation vs FPU physical temeprature variations. The slope of the red line is the radiometer transfer function.

For each of the radiometers we used as temperature reference the value measured by the sensor closest to the radiometer under test (see Fig. 3, as a reference to the thermometer location).

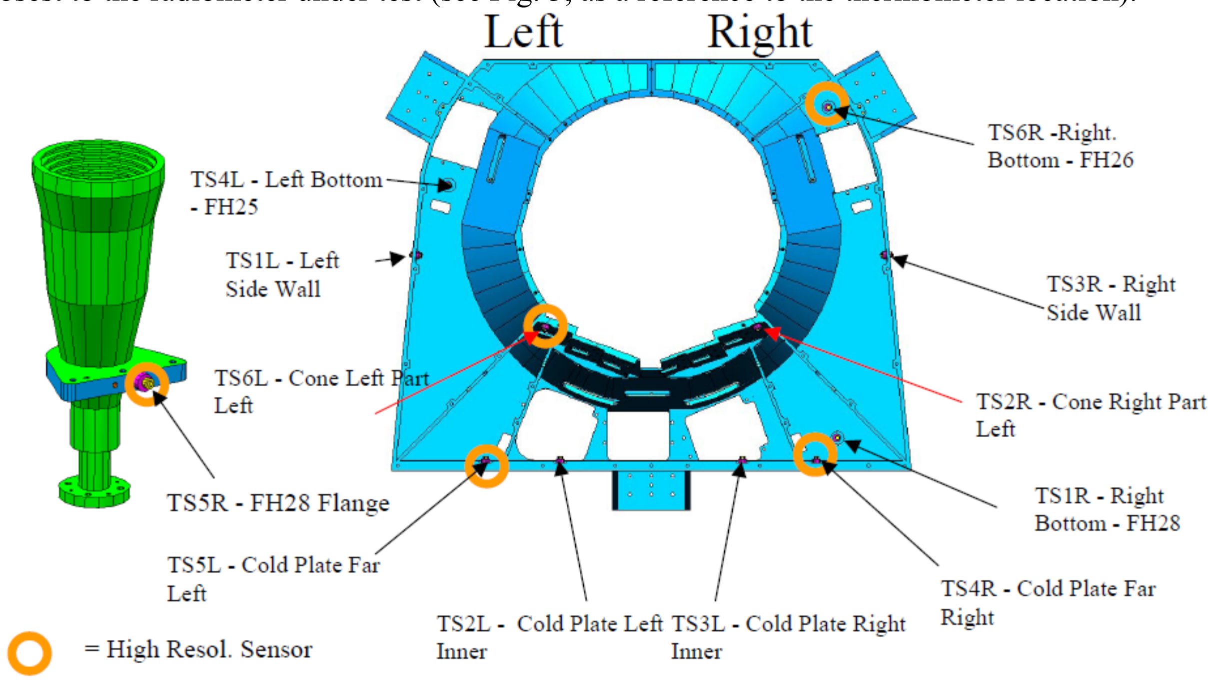

Fig. 3 Position of the sensors monitoring the FPU temperature.

The sensor associated to each radiometer chain is reported in the Table 1, together with final results.

Radiometer (sensor)	M - 00	M - 01	S - 10	S – 11
RCA 18 (TS2R)	0.0368	0.0315	0.0299	0.0269
RCA 19 (TS2R)	0.0424	0.0425	0.0283	0.0347
RCA 20 (TS2R)	0.0472	0.0572	0.0442	0.0471
RCA 21 (TS6L)	0.0292	0.0394	0.0603	0.0672
RCA 22 (TS6L)	0.0766	0.0688	0.0990	0.1025
RCA 23 (TS6L)	0.0422	0.0372	0.0477	0.0520
RCA 24 (TS2L)	0.0170	0.0118	0.0174	0.0025
RCA 25 (TS4L)	0.0139	0.0113	0.0033	0.0040
RCA 26 (TS6R)	-0.0203	-0.0044	0.0084	0.0125
RCA 27 (TS2L)	-0.0049	0.0022	-0.0034	0.0030
RCA 28 (TS5R)	0.0427	0.0290	0.0346	0.0134

Table 1 Transfer functions of the output variation of the radiometers, corresponding to a temperature variation of the FPU temperature, at the level of the sensor reported with the RCA. Units are (K_{ant}/ K). As evident from the table, the red value which was corresponding to the detector having problems during the test, is the only detector which has one order of magnitude difference with its companion detector on the same radiometer branch.

4.4 Conclusions and recommendations

In flight transfer functions between radiometer outputs and main FPU sensors temperature fluctuations are obtained. Results confirms that fluctuations in the main frame are reduced in the signal by a factor of 10 to 200 (comparable with ground test results reported in RD04).
This let the high resolution sensors mean fluctuation peak-to-peak amplitudes, of about 4 mK in steady condition, be reduced of at least one order of magnitude in the output timestream.