Planck SCS

TITLE:

PLM SIT @ CSG, Kourou

Quick look data analysis

DOC. TYPE: **REPORT**

PROJECT REF.: **PL-LFI-PST-RP-059** **PAGE:** **I of IV, 12**

ISSUE/REV.: **1.0** **DATE:** **Feb 26th, 2009**

Prepared by	**G. Morgante** ***For the SCS Op Team***	**Date:** **Signature:**	February 26th, 2009
Agreed by	**C. BUTLER** ***LFI*** ***Program Manager***	**Date:** **Signature:**	
Approved by	**N. MANDOLESI** ***LFI*** ***Principal Investigator***	**Date:** **Signature:**	

DISTRIBUTION LIST

Recipient	Company / Institute	E-mail address
G. CRONE	ESA – Noordwijk	Gerald.Crone@esa.int
L. PEREZ CUEVAS	ESA – Noordwijk	Leticia.Perez.Cuevas@esa.int
O. PIERSANTI	ESA – Noordwijk	Osvaldo.Piersanti@esa.int
M. BRAGHIN	ESA – Noordwijk	Massimo.Braghin@esa.int
C. DAMASIO	ESA – Noordwijk	Claudio.Damasio@esa.int
B. GUILLAUME	ESA – Noordwijk	Bernard.Guillaume@esa.int
P. OLIVIER	ESA – Noordwijk	Pierre.Olivier@esa.int
J. RAUTAKOSKI	ESA – Noordwijk	Jan.Rautakoski@esa.int
B. COLLAUDIN	AAS – Cannes	Bernard.Collaudin@alcatelaleniaspace.com
J.P. CHAMBELLAND	AAS – Cannes	Jean-Philippe.Chambelland@alcatelaleniaspace.com
P. RIHET	AAS – Cannes	Patrick.Rihet@alcatelaleniaspace.com
P. STASSI	LPSC - Grenoble	stassi@lpsc.in2p3.fr
F. MELOT	LPSC - Grenoble	frederic.melot@lpsc.in2p3.fr
D. PEARSON	JPL – Pasadena	David.P.Pearson@jpl.nasa.gov
N. MANDOLESI	IASF – Bologna	mandolesi@iasfbo.inaf.it
C. BUTLER	IASF – Bologna	butler@iasfbo.inaf.it
A. GREGORIO	UNI Ts	anna.gregorio@ts.infn.it
LFI System PCC	IASF – Bologna	lfispcc@iasfo.inaf.it
L. TERENZI	IASF – Bologna	terenzi@iasfbo.inaf.it
F. CUTTAIA	IASF – Bologna	cuttaia@iasfbo.inaf.it
A. MENNELLA	UNIMI – Milano	aniello.mennella@fisica.unimi.it

CHANGE RECORD

Issue	Date	Sheet	Description of Change	Release
1.0	Feb 26, 2009	All	Initial Release	===

TABLE OF CONTENTS

1. Applicable and Referenced Documents

Number	Title
AD1	Herschel/Planck IID-A, SCI-PT-IIDA-04624 v. 4.0
AD2	Herschel/Planck IID-B, SCI-PT-IIDA-04142 v. 3.1
AD3	Planck Instrument Testing at PFM S/C levels, H-P-3-ASP-TN-0676, Issue 1.0
AD4	Planck Sorption Cooler ICD, PL-LFI-PST-ID-002 v. 3.1
AD5	Planck SCS User Manual, PL-LFI-PST-MA-002, v.2.0
AD6	Planck SCE MIB User Guide UM-PSCZ-600092-LPSC 01_05
RD1	PLM SIT Test Spec, H-P-3-ASP-TS-1421, v2.0
RD2	SCS Health Test Requirement, H-P-3-ASP-TS-1126, v2.0
RD3	Planck SCS User Manual, PL-LFI-PST-MA-002, v.2.0

2. Introduction

2.1. Scope

Scope of this document is to provide a first quick look analysis evaluation of the functionality of the Sorption Cooler Sub-System during the SIT Test Campaign performed at Centre Spatial Guyanais (CSG), after shipment of the satellite from CSL to Kourou for the Launch Campaign.

The objective of Planck PLM SIT, as described in [RD1], is two fold:

- to verify the correct performance of the satellite systems and the compatibility between all the integrated subsystems and instruments while operating together

- to mimic some basic operating procedures which will be exercised during the different phases of the mission

2.2. Test configuration

The test configuration is described in [RD1] and can be summarized as follows

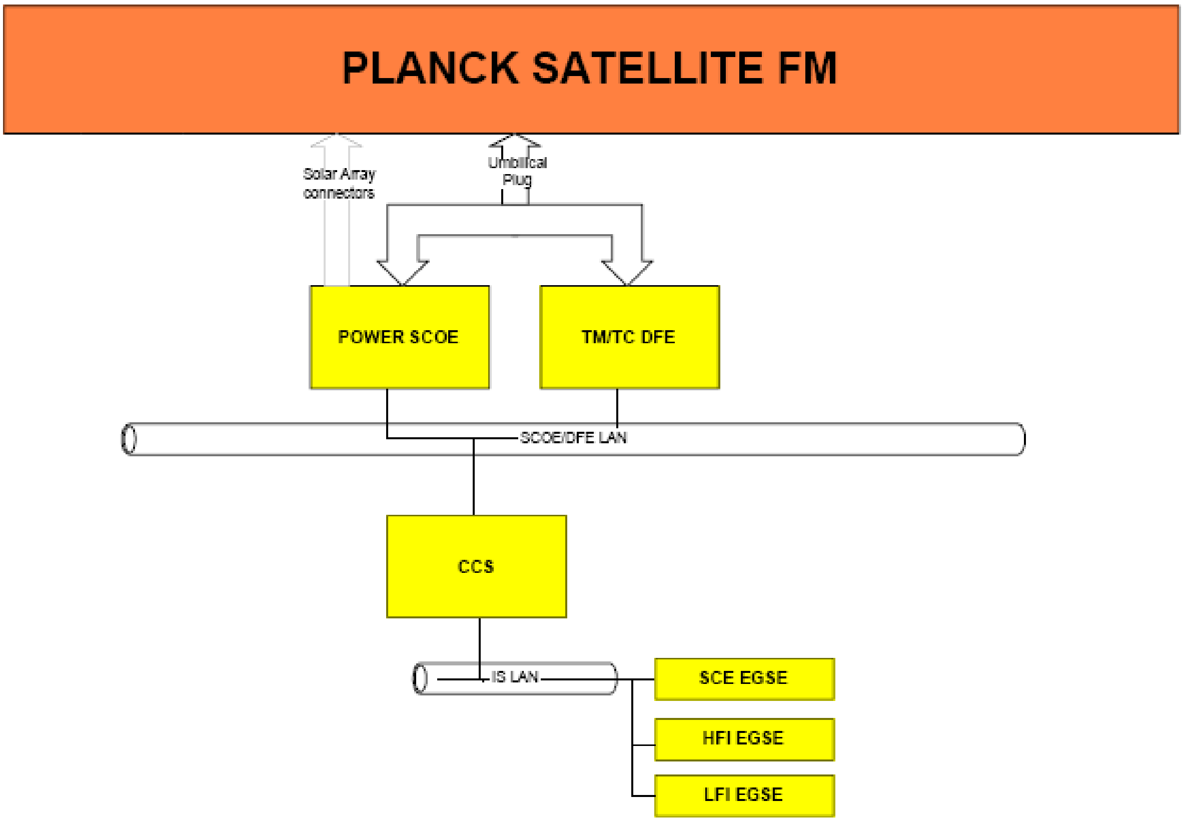

Figure 1. PLM SIT Configuration

For a detailed description of the test configuration refer to [AD3] and [RD1].
For a detailed description of SCS Test see [RD2].

Errore. L'origine riferimento non è stata trovata. shows the minimum configuration of EGSE needed to operate the spacecraft and to perform all functional tests.

The CCS is the system controlling the sequencing of the test and required while the experiment (SCE in this case) EGSE in only limited to monitoring the status of the cooler and the procedures of the test.

2.3. Test Sequence

The test sequence of the PLM SIT is described in detail in [RD1]. The basic principle is to switch ON in sequence the instruments in their nominal “listening mode”:

- HFI (Science Mode)
- SCS (Health Monitoring)
- LFI (Science Mode)

Then each instrument runs functional tests while the other two remain in science mode (HFI and LFI) or Health monitoring (SCS), according to the following table:

Test Step	HFI	SCS-N	SCS-R	LFI
Switch ON S/C in min configuration	OFF	OFF	OFF	OFF
Switch ON HFI-N in Standby	HFI-N Standby	OFF	OFF	OFF
Switch ON SCS-N/load LUT	HFI-N Standby	Switch ON	OFF	OFF
Switch ON LFI-N in Normal Science	HFI-N Standby	Health Monitor	OFF	LFI-N ON
HFI-N Warm Short Functional Test	HFI-N SFT	Health Monitor	OFF	LFI-N Nom Science
HFI-N transition to Observation Mode	HFI-N Science Mode	Health Monitor	OFF	LFI-N Nom Science
Sorption Cooler-N health check	HFI-N Science Mode	Health Check	OFF	LFI-N Nom Science
Switch OFF Sorption Cooler-N	HFI-N Science Mode	Switch OFF	OFF	LFI-N Nom Science
Switch OFF LFI-N	HFI-N Science Mode	OFF	OFF	LFI-N Switch OFF
Switch ON LFI-R in normal science	HFI-N Science Mode	OFF	OFF	LFI-R Switch ON
Switch ON SCS-R/load LUT	HFI-N Science Mode	OFF	Switch ON	LFI-R Nom Science
Sorption Cooler-R health check	HFI-N Science Mode	OFF	Health Check	LFI-R Nom Science
LFI-R WFT (Reduced)	HFI-N Science Mode	OFF	Health Monitor	LFI-R SFT
LFI-R back to Nominal Science	HFI-N Science Mode	OFF	Health Monitor	LFI-R Nom Science
Switch OFF HFI-N	HFI-N Switch OFF	OFF	Health Monitor	LFI-R Nom Science
Switch ON HFI-R in Standby	HFI-R Switch ON	OFF	Health Monitor	LFI-R Nom Science
HFI-R transition to Observation Mode	HFI-R Science Mode	OFF	Health Monitor	LFI-R Nom Science
Switch OFF LFI-R	HFI-R Science Mode	OFF	Health Monitor	LFI-R Switch OFF
Switch OFF HFI-R	HFI-R Switch OFF	OFF	Health Monitor	OFF
Switch OFF SCS-R	OFF	OFF	Switch OFF	OFF

Table 1

2.4. SCS Test summary

This document reports the results of SCS Healthcheck performed during the PLM SIT test at the CSL (Centre Spatial de Liège) facilities on January 30th and 31st 2009. Both SCS TMU's were tested according to the SCS Warm Healthcheck (HC) procedure as described in [RD2].

The test spread over 2 days: on Jan 30th the SCS-N was tested, while the following day was dedicated to the SCS-R.

2.5. SCS sensors

The TMU include T and P sensors, used to monitor and control the SCS, can be summarized in the following tables.

T sensors

Item	Location	Nominal (K)	Resolution requested for specified Range				Type
			Range I (K)	Resolution I (K)	Range II (K)	Resolution II (K)	
T1	LR1	18	16-25	0.010	20-80	1	CERNOX
T2	LR1	18	16-25	0.010	20-80	1	CERNOX
T3	LR2	20	16-25	0.010	20-80	1	CERNOX
T4	LR2	20	16-25	0.010	20-80	1	CERNOX
T5	LR3	20	16-24	0.004			CERNOX
T6	LR3	20	16-24	0.004			CERNOX

T7	JT	20	16-25	0.010	20-150	1	CERNOX
T8	PC3C	55	40-80	0.1	80-330	2	CERNOX
T9	PC3B	70	40-80	0.1	80-330	2	CERNOX
T10	PC3A	80	40-80	0.1	80-330	2	CERNOX
T11	PC2	100	80-150	0.1	150-330	2	CERNOX
T12	PC1	160	140-190	0.1	190-330	2	CERNOX
T13	HPST1	300	220-320	0.040			PRT
T14	HPST2	300	220-320	0.040			PRT
T15	Shell CE1	270	220-350	0.040			PRT
T16	Shell CE2	270	220-350	0.040			PRT
T17	LPSB	300	220-320	0.040			PRT
T18	LPSB	300	220-320	0.040			PRT
T19							
T20	CE1	40	0 - 275	0.3	275-425	1	KTC
T21	CE2	40	0 - 275	0.3	275-425	1	KTC
T22	CE3	40	0 - 275	0.3	275-425	1	KTC
T23	CE4	40	0 - 275	0.3	275-425	1	KTC
T24	CE5	40	0 - 275	0.3	275-425	1	KTC
T25	CE6	40	0 - 275	0.3	275-425	1	KTC
T26	Shell CE3	270	220-350	0.040			PRT
T27	Shell CE4	270	220-350	0.040			PRT
T28	Shell CE5	270	220-350	0.040			PRT
T29	Shell CE6	270	220-350	0.040			PRT
T30	JT	20	16-25	0.010	20-150	1	CERNOX

P Sensors

Name	Location	Nominal (bar)	Range (bar)	Resolution		Accuracy (bar)	Input (Vdc)	Return (Vdc)
				(bar)	(mV)			
P1	CE1	50	0 – 67	0.07	5	0.3 FSR	28	0 – 5
P2	CE2	50	0 – 67	0.07	5	0.3 FSR	28	0 – 5
P3	CE3	50	0 – 67	0.07	5	0.3 FSR	28	0 – 5
P4	CE4	50	0 – 67	0.07	5	0.3 FSR	28	0 – 5
P5	CE5	50	0 – 67	0.07	5	0.3 FSR	28	0 – 5
P6	CE6	50	0 – 67	0.07	5	0.3 FSR	28	0 – 5
P7	HPST	50	0 – 67	0.07	5	0.3 FSR	28	0 – 5
P8	LPSB	0.5	0 – 3.4	0.01	14	0.02	28	0 – 5

Another set of important sensing lines is acquired by the electronics in order to monitor power used or dissipated and to check the SCE box operating temperatures. These extra values are:

SCE sensors

Channel	Type	Range
28V	Internal voltage	26 to 29 V
+12V	Internal voltage	11 to 13.1 V
VCC	Internal voltage	5 to 5.2 V
+15V	Internal voltage	14 to 17.3 V
-15V	Internal voltage	-14 to -17.3 V
31V	Internal voltage	29.9 to 35.7 V
SCE_T(1)	Internal T Readout Module	-24 to +85 C
SCE_T(2)	Internal T Power Module	-24 to +85 C
SCE_T(3)	Internal T Digital Module	-24 to +85 C
SENSE_LPSB	Heater Current	0 to 0.96 A
SENSE_LR3N	Heater Current	0 to 0.80 A
SENSE_LR3R	Heater Current	0 to 0.80 A
GG_CE(1)	Heater Current	0 to 1.84 A
GG_CE(2)	Heater Current	0 to 1.84 A
GG_CE(3)	Heater Current	0 to 1.84 A
GG_CE(4)	Heater Current	0 to 1.84 A
GG_CE(5)	Heater Current	0 to 1.84 A
GG_CE(6)	Heater Current	0 to 1.84 A

2.6. SCS Healthcheck requirements

The main purpose of the SCS Healthcheck is to verify cooler functionality by activating compressor heaters and checking the corresponding sensors response. Three basic verifications define the success of the test:

- No unexpected events packets
- Sensors response as expected
- Power consumption as expected

Details of the SCS Healthcheck process are reported in [RD3].

The Warm Healthcheck is executed during the SIT: it is a reduced procedure with respect to the full Healthcheck, due to the fact that cold sensors and heaters cannot be activated in warm conditions for hardware safety reasons.

3. Verification Matrix and Test Results

3.1. SCS Warm Healthcheck Nominal Unit

SCS Warm Healthcheck process started at 12.40 (UTC) of Jan 30th 2009 on the SCS-N and was completed around 13.20 (UTC). The main objectives of the test were to ensure nominal system health after all previous integration and test activities and to verify unit functionality. This Healthcheck process will provide a reference baseline for the next pre-launch PLM SIT in Kourou.

3.1.1. SCS-N SIT HC Verification Matrix

Test Campaign	**PLM SIT (pre-shipment to Kourou)**				
Test name:	SCS-N SIT HealthCheck				
Test objectives:	To check system health before transportation to Launch Site				
Verification matrix					
Check	**Passed?**			**Recovered?**	
	Yes	**No**	**Notes**	**Yes**	**No**
No unexpected events packets	✓			N/A	N/A
Sensors response as expected			All SCS power consumptions and sensor responses were according to spec, except first HC step, H7 activation: it did not show any power dissipated and any response in LPSB T and P.	✓	N/A
Power consumpiton as expected				✓	N/A

3.1.2. SCS-N SIT HC Test Results

The whole SCS-N HC process is reported in Figure 2 where the upper section of the graph shows the compressor beds temperature and pressure behaviour. The LPSB response is shown in the lower section.

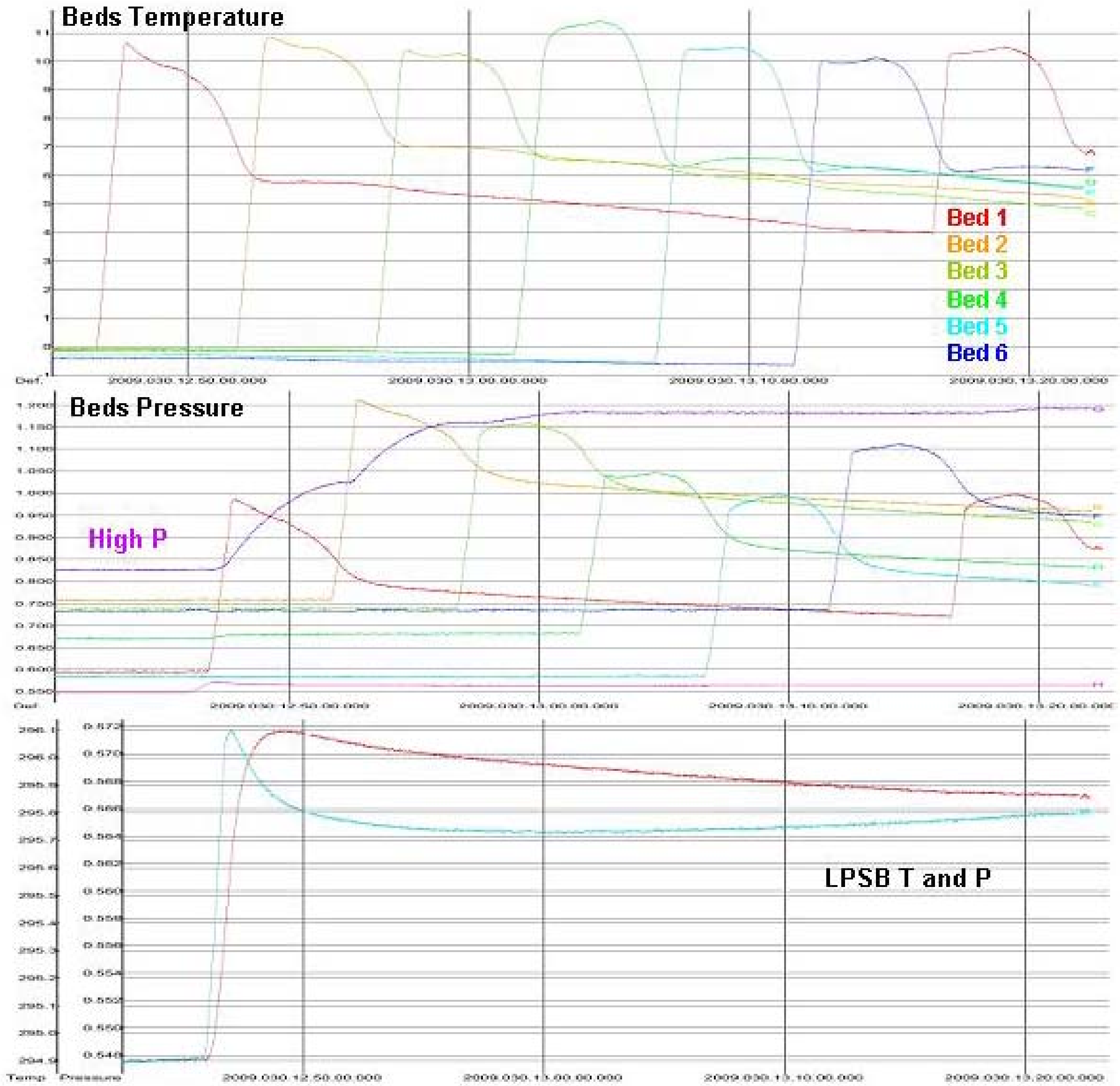

Figure 3. Healthcheck procedure: Beds T and P (upper), LPSB test (lower)

The results of the Compressor Beds Healthcheck process were fully compliant to the functionality requirements while the LPSB showed an anomalous behaviour at the very first step of the Healthcheck process: the activation of H7 (sustain heater). At the beginning of the test, H7 should be activated with max power given that it is a small heater compared to the heavy thermal mass of the LPSB. Figure 3 shows a zoomed area of the LPSB in which is clear that H7 activation did not generate any response in the sensors (a small deviation from trend should be noticed). A check on the current running through the heater confirmed that no power was being supplied to the resistor.

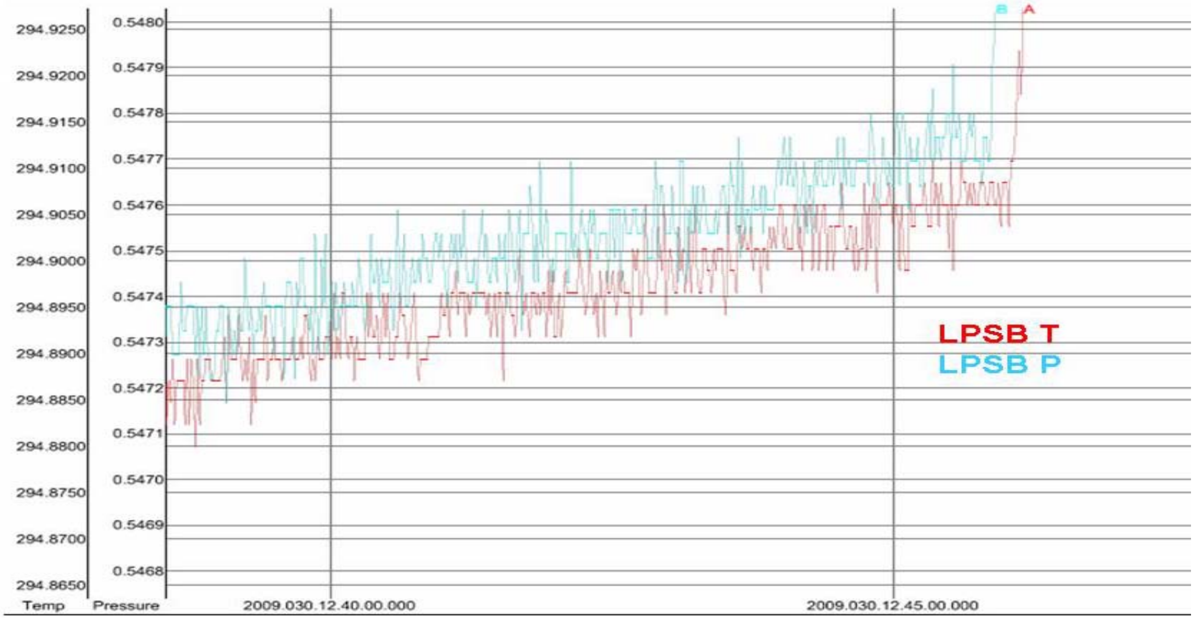

Figure 4. LPSB T and P at beginning of HC process: H7 activation

For this reason a NCR was opened: NC 18872 has been filed and closed the following day. For NC analysis and solution see Par 3.2.3.

3.2. SCS Warm Healthcheck Redundant Unit

SCS-R Warm Healthcheck process started at 12.35 (UTC) of Jan 31st 2009 and was completed around 13.12 (UTC). The main objectives of the test were to ensure redundant system health after all previous integration and test activities and to verify unit functionality. This Healthcheck process will provide a reference baseline for the next pre-launch PLM SIT in Kourou.

3.2.1. SCS-R SIT HC Verification Matrix

Test Campaign	**PLM SIT (pre-shipment to Kourou)**				
Test name:	SCS-R SIT HealthCheck				
Test objectives:	To check system health before transportation to Launch Site				
Verification matrix					
Check	**Passed?**			**Recovered?**	
	Yes	**No**	**Notes**	**Yes**	**No**
No unexpected events packets	✓			N/A	N/A
Sensors response as expected			All SCS power consumptions and sensor responses were according to spec, except first HC step, H7 activation: it did not show any power dissipated and any response in LPSB T and P.	✓	N/A
Power consumption as expected				✓	N/A

3.2.2. SCS-R SIT HC Test Results

The results of the SCS-R Healthcheck process, were identical to the Nominal unit see Fig.5:

- full compliancy to functionality requirements for all compressor beds
- same anomalous behaviour on LPSB H7 heater verification

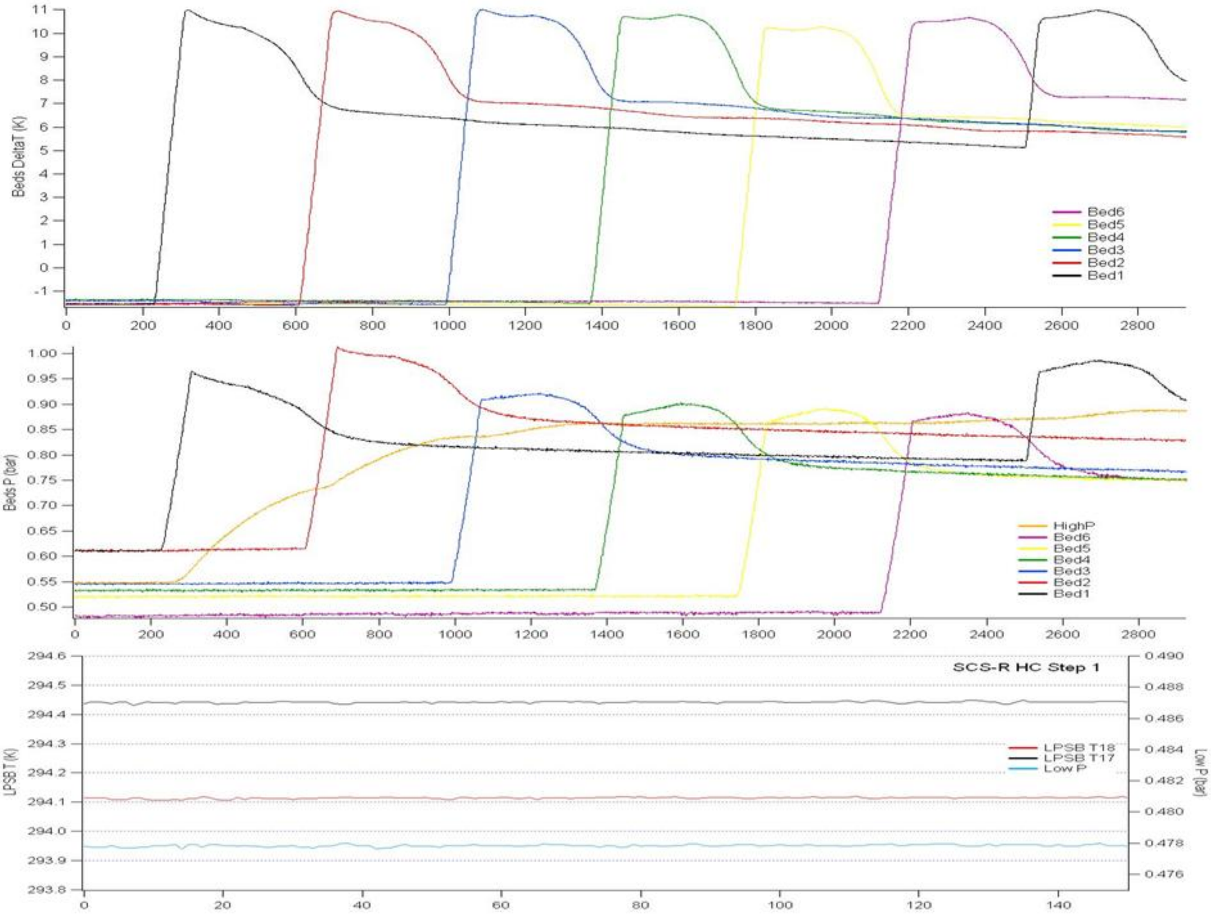

Figure 5. SCS-R HC process: Beds T (upper), Beds P (middle), LPSB T and P (lower)

The repeatability of the anomaly on H7 confirmed root cause and possible solution (see Par.3.2.3)

3.2.3. NC18872 analysis and closure

After further analysis, it resulted that the power applied by the OBSW during Healthcheck step 1 (H7 activation) was not the max available for that heater, but the one reported in the LUT for the nominal operation of the system. That value had been set to zero few days before for safety purposes during the execution of SVT3 test. For this reason, zero power was being applied during H7 activation, as confirmed by the current measurement, and so no

effect on LPSB T and P could be noticed. The proposed solution was to repeat the very first step of the HC on both units at the end of the SIT, after changing the value of the H7 power in the LUT from 0 to 1.3 W. The SCS is the last unit to be deactivated in the SIT sequence so this extra test did not have any delay or impact on instruments testing.
Figure 5 reports the repetition of SCS-N and R H7 activation: it is now clear, even if small, the change in slope of LPSB T and P when 1.3 W are supplied to the heater (compare with Fig.4 lower graph).

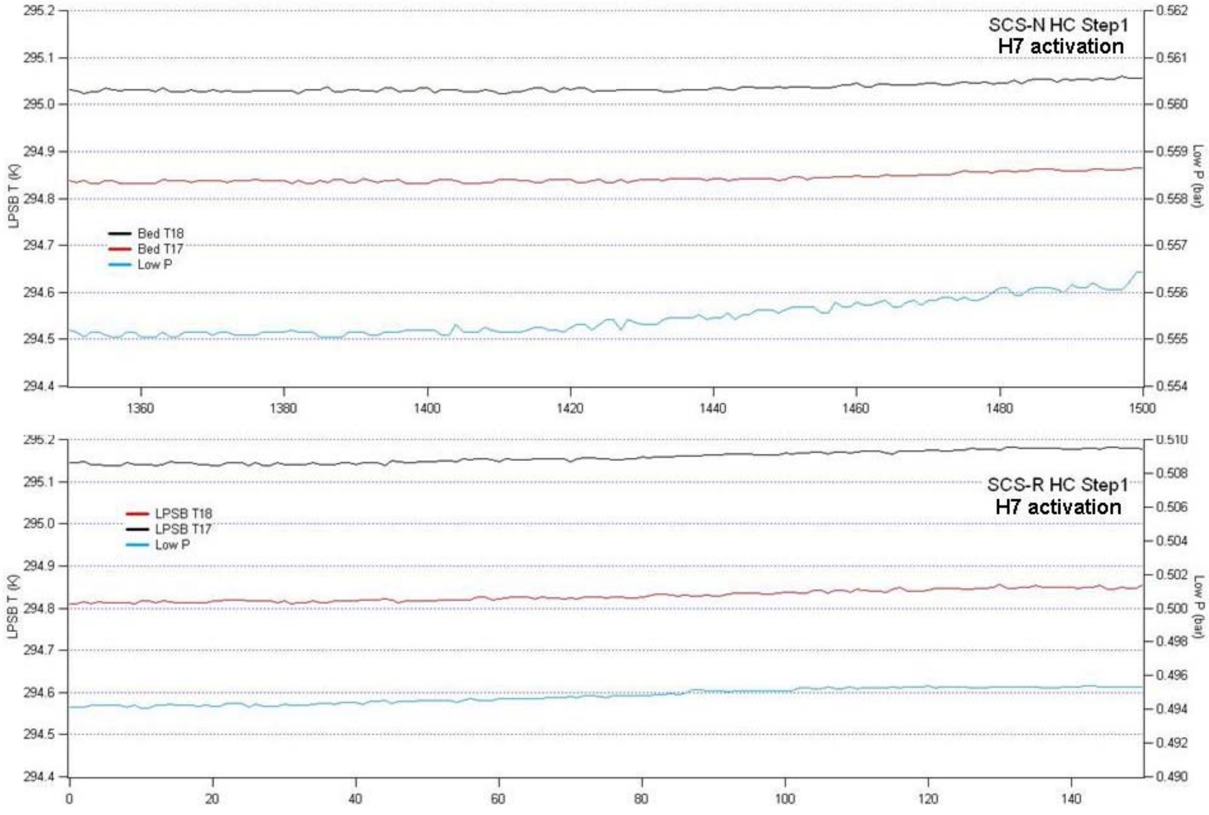

Figure 6. HC first step, H7 activation, repetition (SCS-N top, SCS-R bottom)

No modification to OBSW will be required, since the issue is not a problem for system functionality. In the SCS User Manual it will be reported and highlighted the fact that H7 power applied during Healthcheck is the one defined in the Power and Times LUT section (parameter 0x48, Power_LPSB): when performing the HC, LPSB power in the LUT must NOT be set to zero.

For SCS Team, NC 18872 is fully solved and can be closed.

3.2.4. Instruments Compatibility

The second objective of SCS SIT is to verify that the other units (mainly the two instruments) operations do not affect cooler health and functionality.
SCS units were monitored during the whole duration of SIT and no effects or any kind of influence was noticed on SCS data during instruments tele-commanding or procedure execution. The SCS behaviour showed full compatibility with instruments or spacecraft operations.

3.3. Conclusions

After analysis and solution of NC 18872, the SCS SIT was successfully concluded.
Operating procedures were executed smoothly and without problems. System monitoring parameters were in agreement with specs. No unexpected events were generated and no loss of data was recorded.

Sorption Cooler System during PLM SIT showed full compliancy to health and functionality requirements and to previous reference test results.