

HERSCHEL / PLANCK

Planck Instrument Testing on AVM

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1. SCOPE

This technical note defines the instrument tests to be performed at AVM level in Planck configuration. These tests include the instrument incoming inspections after delivery to Alenia premises, the activities and interface tests planned for the instrument integration on the test bench and the instrument related tests to be performed during the Planck AVM phase. All these activities and tests are described per test activity in specific form sheets.

The overview on the satellite AVM test programme is addressed in documents AD[02] and AD[03]

The main objective of this document is to allow an early, quick and co-ordinated satellite AVM relevant information exchange as regards to the instrument related aspects. Therefore this document shall be used as reference document for the iteration cycles with all parties involved in the Planck related part of the satellite AVM programme. Furthermore this document serves as reference document for the higher level "H/P Service Module AIT Plan" (AD[01]) providing more details and more actual information with respect to instrument related subjects.

The document is based on the Instrument Interface Documents (AD[04], AD[05] and AD[06]).

This document will be completed by the test specifications for the Planck instrument related AVM activities.

NOTE: this document is a VERY preliminary draft issue and requires comments from all parties. Dedicated meetings will be performed to support this process.

2. DOCUMENTATION

2.1 Applicable documents

Ref.	Reference of document	Title
AD[01]	H-P-PL-AI-0004	H/P Service Module AIT Plan
AD[02]	H-P-1-ASPI-TN-0164	AVM Requirements and Design
AD[03]	H-P-TN-AI-0052	Herschel/Planck SVM AVM Technical Note
AD[04]	SCI-PT-IIDA-04624	Instrument Interface Document IID - part A
AD[05]	SCI-PT-IIDB-HFI-04141	Instrument Interface Document IID - part B – Instrument “HFI”
AD[06]	SCI-PT-IIDB-LFI-04142	Instrument Interface Document IID - part B – Instrument “LFI”
AD[07]	PI-LFI-PST-ID-002	Planck Sorption Cooler ICD – Annex to LFI IIDB
AD[08]	H-P-1-ASPI-PL-0225	Verification Program Plan (VPP)

2.2 Reference documents

Ref.	Reference of document	Title
RD[01]	LI-PH410-300354-IAS 3.0	HFI Test Requirement Sheet List
RD[02]	PL-LFI-PST-PL-010 1.0	LFI Test Requirement Sheet List
RD[03]	H-P-1-ASPI-IS-0121	EGSE Interface Requirements Specifications
RD[04]	H-P-1-ASPI-LI-0058	H/P Hardware Matrix

2.3 Acronyms and abbreviations

Acronyms	Keys
AD	Applicable Document
AIT	Assembly, Integration & Tests
AVM	Avionics Model
EGSE	Electrical Ground Support Equipment
ESA	European Space Agency
ESTEC	European Space research and Technology Center
Ghe	Gaseous Helium
GSE	Ground Support Equipment
HFI	High Frequency Instrument
I/F(s)	Interface(s)
IID	Instrument Interface Document
ISSS-PGSE	Isotope Supply & Storage PGSE
JPL	Jet Propulsion Laboratory
LFI	Low Frequency Instrument
Lhe	Liquid Helium
LN2	Liquid Nitrogen
MGSE	Mechanical Ground Support Equipment
MTD	Masse en Thermal Dummy
NA	Not Applicable
NC	Not Communicated
PACE	Pipe Assembly & Cold End
PACE - GSE	PACE - Ground Support Equipment
PFM	Proto-Flight Model
PGSE	Pneumatic Ground Support Equipment
PLM	PayLoad Module
PPLM	PLANCK PayLoad Module
QLA	Quick Look Analysis
RD	Reference Document
S/C	Spacecraft
STM	Structural & Thermal Model
SVM	SerVice Module
TBC	To Be Confirmed
TBD	To Be Defined
TBS	To Be Specified
TF-PGSE	Tank Filling – PGSE
WU	Warm Unit

3. PLANCK SATELLITE AVM PROGRAMME

3.1 AVM main definitions and objectives

The AVionics Model (AVM) is a bench model on which will be installed the electrical equipment of Herschel/Planck SVM subsystems and then the Herschel/Planck Instruments "Warm-ups" Units.

Only one AVM will be used either in the Herschel configuration (equipped with Herschel ACMS and with Herschel instruments AVM) or in the Planck configuration (equipped with Planck ACMS and with Planck instrument AVM).

The H/P Harness, the H/P avionics subsystems, the relevant SCOE(s) and the CCS compose the SVM AVM.

The SVM AVM, the instrument warm units (WU), their interconnecting harness and the relevant SCOE(s) compose the Satellite AVM

The main objectives of the Satellite AVM test program are the following:

- To verify all SVM units electrical and functional interfaces and their compatibility.
- To validate the Application-Basic on-board software and their functional interfaces.
- To validate the complete set of EGSE needed during the SVM / Satellite tests and the launch campaign.
- To validate the test procedures, the database and the test set up to be re-used for the PFM test campaign.
- **To validate the electrical and functional interfaces with warm units** and CFEs (VMC, SREM & FOG).
- To verify avionics subsystems and on-board software functionality's, including closed loop tests.
- To perform the SVM conducted EMC pre-qualification.
- To support the execution of the SVT#0 on Herschel and Planck configurations

The AVM overall approach (design, test sequence) is fully described in "AVM Requirements and Design" (AD[02]) and "Herschel/Planck SVM AVM Technical Note" (AD[03]).

Hereafter, as a complement to those documents, are described the instrument specific tests activities and the sharing of responsibilities foreseen during all the Instrument AVM phase. Instrument configuration will be precisely defined in the next chapter.

3.2 Instrument Specific Test Activities

3.2.1 Incoming Inspection

The incoming inspection will be performed on all instrument items to be integrated in the Planck AVM in order to assure their quality. The incoming inspection covers the visual inspection of the hardware, the cleanliness control and the check of the documentation.

There is no functional verification during incoming inspection.

3.2.2 Pre-integration tests

In addition to the incoming inspection, as described above, a series of stand-alone tests could be conducted by the instrument personnel prior to integration into the AVM in order to ensure that no damage has occurred during transport. Limited function testing can be carried out on the warm electronics.

Any equipment required for these tests (e. g. IEGSE, test harness, CDMS simulator, FPU simulator) will be supplied by the instruments.

3.2.3 Instrument EGSE Validation

The Instrument EGSE validation will comprise a stand-alone test of the Instrument EGSE (self-test). And then, after connection to the CCS, an interface check will be performed (PIPE protocol). Its objective is to check the proper electrical EGSE – CCS connections and the correct functioning of the EGSE – CCS interface drivers.

Note: This test does not substitute the principle verification of the Instrument-EGSE/CCS interface to be (or already) performed prior the AVM campaign.

For the specific check-out equipment dedicated validation will be performed, as required.

3.2.4 Integration & Test (I&T)

This section and the next one concern the integration of the instrument WU's:

3.2.4.1 Mechanical Integration

Hardware release

Hardware release for integration will be controlled. Parts required for a particular integration activity will be kited to reflect the requirements of the governing procedure prior to the need date. This kiting operation shall include an inspection according to the system/module assembly drawing and subsystem manufacturing drawings to ensure that all parts materials are available and that obvious anomalies are found prior to the beginning of integration activities.

Handling

The handling activities of instrument delivered hardware, in the various integration and testing facilities shall only be carried out using the dedicated MGSE and by trained personnel having the necessary experience.

Only authorised operators will operate, in particular, the overhead crane.

3.2.4.2 Electrical integration

If any flight connectors will be protected by savers during integration, so mating/demating will be made by breaking non-flight hardware interfaces.

Through an official record all connector connections/disconnections shall be traced during the AIT activities. The record shall state :

- unit and harness connectors identification: reference and type
- connection/disconnection dates for:
 - harness connector to saver if any
 - unit connector to saver if any
 - harness connector to unit connector
 - torquing of fixing screws
 - marking (or eventually sticking) of fixing screws

ALENIA QC will manage this document.

Electronic units

There is no functional verification during incoming inspection. The verification of all the unit interfaces before box connection is done through the verification of the received unit data-package documentation : box interface data sheets w.r.t. harness list.

After unit mechanical fitting and fixing bolts torque, a bonding measurement (or insulation as required) between unit case and structure reference grounding point is performed.

Then the electrical integration takes place to make sure that :

- the interfaces are compatible
- the unit, then the overall subsystem are working properly.

The system integration will be performed according to the same principles : electrical interface verification completed by functional checks after final connection as explained here under.

Integration task - Interface checks

Electrical integration will be automated to the maximum extent as is reasonable, and will systematically control all interfaces of a unit being integrated. Before and after connection of harness to dedicated unit connector, the electrical interfaces will be tested. The following tests will be performed to verify the electrical interface compatibility, avoiding any degradation of units:

- grounding verification through grounding measurements at unit and harness connector level
- safety hardware verification of output signals by measurement at emitter unit / harness connector level in unloaded configuration (or test loads) before harness connection to the receiver unit. Such a verification will be restricted to high level signal (power supply - high level command when mixed with other signals on the same connector) and to signals for which a specific measurement is required due to the risk encountered by receiver units and will be detailed in the dedicated subsystem test plans at system level
- standard interface verification of unit before connection to harness
- specific verifications will be detailed in critical signals TRS
- after suppression of break-out boxes/tee adapter, final connection of each harness connector and torquing of fixation screws.

3.2.5 Unit function checks (UFT)

Electrical integration of units and subsystems will be completed by execution of simplified low level electrical and functional tests at units level to verify that the integrated subsystem is functioning properly in the system environment.

This kind of functional checks is restricted to the minimum, in ambient conditions, to validate:

- the electrical I/F compatibility (power, synchronisation, direct commands and acquisitions)
- the instrument software for basic communications (1553 commands and monitoring)
- as far as possible all the TM/TC to check interaction with database.

Only the minimum S/C units operating are needed which means that only the CDMU and the PCPU will be operational and set to nominal configurations without attempting to simulate missions representative scenarios.

Through those different tests, EGSE/units I/F will be also validated.

Test equipment and procedures will be reused as elements of subsequent IST (integrated system test).

3.2.6 System Integration Test (SIT)

Due to the representativeness of Planck AVM warm units and test environment, this step is not foreseen on the AVM test bench.

3.2.7 Integrated Satellite Test (IST)

Its aim is to verify correct operation of the fully integrated satellite in a series of representative mission modes including autonomous (Mission Timeline, MTL and On-Board Control Procedures, OBCPs) and backup modes. This test is an automated test using combination of test procedures developed from units or subsystem level electrical test sequences.

Planck IST will be performed with the AVM warm units (electrically integrated and checked, functionally validated). The Satellite AVM IST specification is not part of this document but it has to be pointed out that WU testing during this IST phase will be limited to instruments/SVM interfaces.

3.3 Planck AVM responsibility sharing

This chapter recalls the sharing of responsibility of tasks between various parties involved in Planck AVM activities: ALCATEL, Alenia and ESA.

Testing activity responsibility:

As prime Contractor ALCATEL Space has the overall responsibility of Planck Satellite.

The SVM is under the overall responsibility of Alenia SPAZIO. It has to deliver fully integrated and electrically tested SVM.

The warm Units integration is performed by ALENIA : mechanical, low level electrical (power distribution, compatibility with PS-ICD). No verification of Warm Units functions and performance is baselined. ALENIA is responsible up to the Warm Units tests excluded.

Warm Units tests are under ALCATEL Space responsibility. Only UFT (not SIT) will be performed on AVM.

The table hereafter present the test responsibility sharing during the Planck AVM test campaign:

AVM Configuration	Tests	Specification	Procedure	Execution	Report	Evaluation
Common H/P SVM Electrical Models	SVM Common S/S I & T and UFT	ALENIA	ALENIA	ALENIA	ALENIA	ALENIA
	SVM Common VMC I & T and UFT	ALCATEL	ALENIA (2)	ALENIA	ALENIA	ALCATEL
	SVM Common SREM I & T and UFT	ESA (2)	ALENIA	ALENIA	ALENIA	ESA (2)
	SVM Common S/S SIT	ALENIA	ALENIA	ALENIA	ALENIA	ALENIA
Planck SVM Electrical Model	SVM Specific Planck ACMS units I & T and UFT	ALENIA	ALENIA	ALENIA	ALENIA	ALENIA
	FOG I & T and UFT	ESA (2)	ALENIA	ALENIA	ALENIA	ESA (2)
	SVM Specific Planck ACMS units SIT	ALENIA	ALENIA	ALENIA	ALENIA	ALENIA
Planck Satellite electrical Model	Planck [I-WU-AVM] I & T	ALENIA	ALENIA	ALENIA	ALENIA	ALENIA
	Planck [I-WU-AVM] UFT	ALCATEL (1)	ALENIA (2)	ALENIA	ALENIA	ALCATEL (1)
	SVM Planck IST	ALENIA	ALENIA	ALENIA	ALENIA	ALENIA
	SVM Planck EMC Conducted Test	ALENIA (3)	ALENIA	ALENIA	ALENIA	ALENIA (3)
	Planck Satellite IST	ALCATEL (1)	ALCATEL (4)	ALCATEL (4)	ALCATEL (4)	ALCATEL (1)
	Planck SVT-0	ESOC	ESOC (4)	ESOC (4)	ESOC (4)	ESOC

(1) with Instrument support

(3) with ALCATEL approbation

(2) with ALCATEL support

(4) with ALENIA support

Table 3-1: Planck AVM testing – Sharing of Responsibilities

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Database and EGSE responsibility:

Planck Instrument units and EGSE data in HPSDB are under instrument responsibility.

Necessary Instrument EGSE are under instrument responsibility and shall be validated by Pls team before delivery.

Harness responsibility:

The SVM contractor is responsible for the harness connecting the SVM units to the warm units.

The harness interconnecting the warm units is under Instruments responsibility and shall be provided and made available to the AVM at the time of the warm units integration.

In case the unit's installation on the relevant AVM panels is not allowed (due to the form and fit of the various warm units/simulators and/or the connectors position/type), the additional harness (cable's extensions and adapters) necessary to connect them to the WU interconnection harness are under instruments responsibility.

Warm unit delivery:

The instrument incoming inspections after delivery to Alenia Spazio (Torino) premises, is under Alenia responsibility and shall be performed with instrument support.

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4. INSTRUMENT DELIVERY

4.1 Hardware

The tables and figure here after summarise the hardware to be used on AVM and to be delivered by LFI and HFI according to AD[04] AD[06] and RD[04]:

Subsystem	Unit		Type	Comments	SVM Interface D = data / P= power	Harness extension required
Radiometer Array Assembly (RAA)						
	DAE Back End Unit (BEU)	PL BEU	AVM	including loads	N/A	
	DAE Power Box (four boxes)	PL CB	QM		P	No
	DAE Power Box/BEU Harness	PL AHA	QM		N/A	
Radiometer Electronics Box Assembly (REBA)						
	Nominal	PL REN	AVM	not form & fit	D/P	Yes
	REBA/BEU Harness	PL EBO	QM		N/A	
Sorption Cooler Subsystem (SCS)						
	SC Cold End (SCCE)	PS M1	Simulator	Power representative	N/A	
	SC Compressor (SCC)	PS M3	Simulator		N/A	
	SC Electronics (SCE)	PL M4	CQM		D/P	No
	SCE/SCC Harness	PS M5B	Simulator		N/A	
	SCE/SCCE Harness	PS M5C	CQM		N/A	
	SCC-SCCE Harness	PS M5D	Simulator	To be confirmed	N/A	

Table 4-1: Planck AVM LFI - Hardware Matrix

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Subsystem	Unit	Type	Comments	SVM Interface D = data / P= power	Harness extension required
FPU and Electronics					
Data Processing Unit (DPU) Nominal	PH BA-N	CQM	Dedicated unit	D/P	
Pre-Amplifier Unit (PAU)	PH CBA	REU/PAU simulator		P	Yes
Readout Electronics Unit (REU)	PH CBC				
DPU-N/REU Harness	PH BBA-N	simulator		N/A	
DPU-N/4K-CDE Harness	PH BBE-N	CQM	From Planck CQM	N/A	
DPU-N/0.1K-DCCU Harness	PH BBC-N	simulator		N/A	
4K Cooler					
4K Cooler Compressor Unit (4K-CCU)	PH DA	4K simulator		N/A	
4K Cooler Ancillary Unit (CAU)	PH DB				
4K Cooler Cold End (CCE)	PH DD				
CDE/CCU Harness	PH DF				
4K Cooler Electronics Unit (CDE)	PH DC	CQM	From Planck CQM	P	No
4K Cooler Current Regulator (CCR)	PH DJ	CQM	From Planck CQM	P	No
CDE/CCR Harness	PH DK	CQM	From Planck CQM	N/A	
0.1K Cooler					
0.1K Dilution Cooler Control Unit (0.1K-DCCU)	PH EB	0.1K		P	Yes
0.1K Harness and fixations	PH ECC	Simulator			

Table 4-2: Planck AVM HFI - Hardware Matrix

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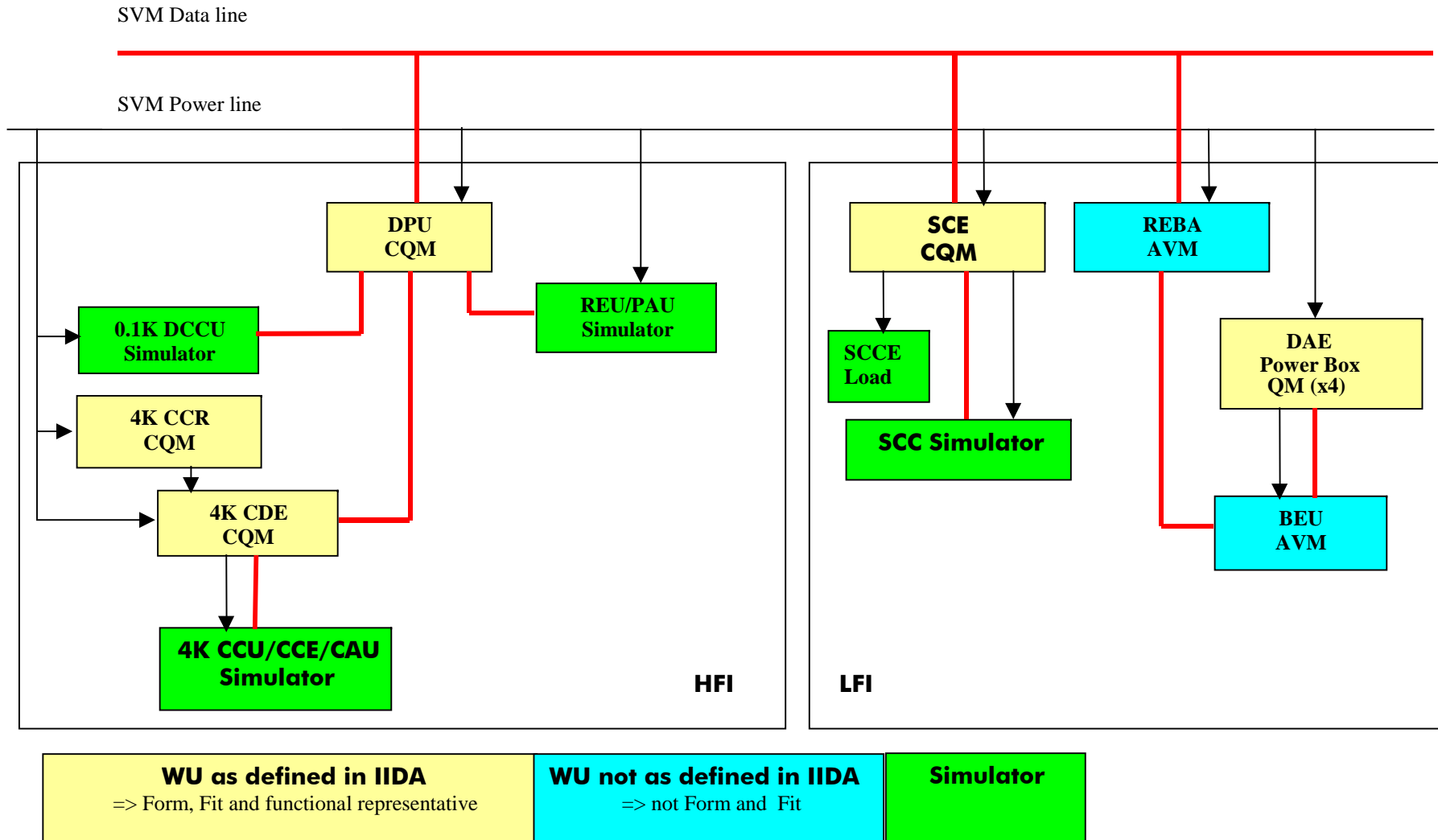


Figure 4-3: Planck AVM WU - Schema

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4.2 EGSE

To be completed

4.3 Documentation

Before hardware delivery; instrument teams shall provide at least the following documentation:

Instrument Incoming procedures
Instrument Hoisting and Handling procedures
Instrument Warm Units User's Manual
Instrument Warm Units I&T procedures
Instrument EGSE Set-up and verification procedures
Instrument Functional test at ambient procedures
Instrument Specific Test procedure (If any)
Instrument EMC test procedures

5. INSTRUMENT TEST ACTIVITY DESCRIPTIONS

All tests shall be performed after successful:

- CDMS and PCS I&T and UFT.
- instrument database verification and integration with the Planck SVM AVM environment.

The Planck Warm Units (CQM/AVM and simulator)) will be integrated on the AVM Satellite in the Planck configuration and will remain here until IOCR (In Orbit Commissioning Review).

To summarise, the following steps are foreseen for both HFI and LFI and are described in the following paragraphs:

- incoming inspection and pre-integration test
- Instrument EGSE compatibility with the Central Check-out (CCS).
- I&T of the instrument units on the AVM bench in Planck configuration.
- Unit functional test: The main objectives of the instrument UFT on AVM are to check the compatibility with the SVM Hardware/Software. Through those different tests, database shall be fully validated. The following will be performed:
 - a short functional test for each instrument to check that they can be powered, commanded and monitored and to validate the different experiment modes,
 - On-board software compatibility maintenance,

In addition, a combined HFI, LFI and SCS test part of the IST will be run to demonstrate Planck SVM and Central Check-out System ability to manage Instruments loads in terms of TM and TC traffic, power, real time analysis.

Those tests shall cover the AVM tests defined for HFI and LFI in respectively RD[01] and RD[02] and summarised in table 5-1 and 5-2.

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VPP (AD[08]) ref	HFI TRS N°	Description	AVM	Nb days	Comments
TRS-P-HFI-UFT-1		Warm Unit I&T	X		Covered by TRS-P-HFI-UFT-24
TRS-P-HFI-UFT-2	H-P-HFI-TRS-0007	4K Cooler Pneumatic Integration on Planck	N/A	N/A	
TRS-P-HFI-UFT-3	H-P-HFI-TRS-0008	0.1K Cooler Pneumatic Integration on Planck	N/A	N/A	
TRS-P-HFI-UFT-4	H-P-HFI-TRS-0009	HFI ambient temperature individual commissioning	X	tbd	
TRS-P-HFI-UFT-5	H-P-HFI-TRS-0010	Payload combined Functional test at room temperature	X	tbd	
TRS-P-HFI-UFT-6	H-P-HFI-TRS-0011	On board software maintenance	X	2	
TRS-P-HFI-UFT-7	H-P-HFI-TRS-0012	FPU vs Telescope alignment check	N/A	N/A	
TRS-P-HFI-UFT-8	H-P-HFI-TRS-0013	Prior to Vibration 0.1K cooler tanks filling	N/A	N/A	
TRS-P-HFI-UFT-9	H-P-HFI-TRS-0014	01.K coolers leak test	N/A	N/A	
TRS-P-HFI-UFT-10	H-P-HFI-TRS-0015B	Short fonctionnal test at ambient condition	N/A	N/A	
TRS-P-HFI-UFT-11	H-P-HFI-TRS-0016	Mechanical testing at system level	N/A	N/A	
TRS-P-HFI-UFT-12	H-P-HFI-TRS-0019	Thermal response for thermal model correlation	N/A	N/A	
TRS-P-HFI-UFT-13	H-P-HFI-TRS-0020	Progressive active cooldown	N/A	N/A	
TRS-P-HFI-UFT-14	H-P-HFI-TRS-0021	Functionnal test in flight like condition	N/A	N/A	
TRS-P-HFI-UFT-15	H-P-HFI-TRS-0022	Cold EMC conductive test	N/A	N/A	
TRS-P-HFI-UFT-16	H-P-HFI-TRS-0023	HFI/LFI compatibility test in cold condition	N/A	N/A	
TRS-P-HFI-UFT-17	H-P-HFI-TRS-0024	HFI auto-compatibility test in cold condition	N/A	N/A	
TRS-P-HFI-UFT-18	H-P-HFI-TRS-0025	HFI susceptibility to SCS radiator T° change	N/A	N/A	
TRS-P-HFI-UFT-19	H-P-HFI-TRS-0026	HFI cooler failure test	N/A	N/A	
TRS-P-HFI-UFT-20	H-P-HFI-TRS-0001	Incoming unpacking and inspection	X	tbd	Offline
TRS-P-HFI-UFT-21	H-P-HFI-TRS-0002	Incoming hardware autonomous test	X	3	
TRS-P-HFI-UFT-22	H-P-HFI-TRS-0003	HFI units interface incoming verification	X	NA	Offline
TRS-P-HFI-UFT-23	H-P-HFI-TRS-0004	EGSE integration with CCS	X	1	TBC
TRS-P-HFI-UFT-24	H-P-HFI-TRS-0005	HFI WU mechanical integration with SVM	X	5	
TRS-P-HFI-UFT-25	H-P-HFI-TRS-0006	HFI FPU integration with LFI one LFI FPU STM for CQM	N/A	N/A	
TRS-P-HFI-UFT-26	H-P-HFI-TRS-0017	Cryogenic Test Preparation	N/A	N/A	
TRS-P-HFI-UFT-27	H-P-HFI-TRS-0018	Cryogenic Facility Cool down	N/A	N/A	
TRS-P-HFI-UFT-28	H-P-HFI-TRS-0027	HFI Cryo Facility warm-up	N/A	N/A	
TRS-P-HFI-UFT-29	H-P-HFI-TRS-0028	HFI Hardware removal from Cryo Facility	N/A	N/A	
TRS-P-HFI-UFT-30	H-P-HFI-TRS-0029	HFI CQM dismounting, packing & shipping	N/A	N/A	
TRS-P-HFI-UFT-31	H-P-HFI-TRS-0015A	4K Cooler Leak Test	N/A	N/A	

Table 5-1: HFI TRS synthesis

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VPP (AD[08]) ref	HFI TRS N°	Description	AVM	Nb days	Comments
TRS-P-LFI-UFT-1	H-P-LFI-TRS-tbd1	Warm Unit Electrical Integration	X	5	
TRS-P-LFI-UFT-3		Knee frequency variation from 20K to 4K	N/A	N/A	
TRS-P-LFI-UFT-4		Functional test in flight like conditions	N/A	N/A	
TRS-P-LFI-UFT-5	H-P-LFI-TRS-tbd2	LFI end-to-end Functional Test at ambient	X	2	
TRS-P-LFI-UFT-6		Noise and Stability Check	N/A	N/A	
TRS-P-LFI-UFT-7		System Noise measurement, linearity and isolation check	N/A	N/A	
TRS-P-LFI-UFT-8		Long term measurement, stability and knee frequency estimation	N/A	N/A	
TRS-P-LFI-UFT-9		Interference between receiver ON/OFF	N/A	N/A	
TRS-P-LFI-UFT-10		Cold EMC conductive test	N/A	N/A	
TRS-P-LFI-UFT-11		LFI susceptibility to RCS Radiator Change	N/A	N/A	
TRS-P-LFI-UFT-12		LFI PID Controller Test	N/A	N/A	
TRS-P-LFI-UFT-13		20K Cooler failure test	N/A	N/A	
TRS-P-LFI-UFT-14	H-P-LFI-TRS-tbd3	Specific REBA Functional Test	X	TBD	
TRS-P-LFI-UFT-15		LFI-Switch off	N/A	N/A	
TRS-P-LFI-UFT-16		LFI-Switch on again	N/A	N/A	
TRS-P-LFI-UFT-17		LFI 4K Cooler failure test - Cooler OFF	N/A	N/A	
TRS-P-LFI-UFT-18		LFI 4K Cooler ON	N/A	N/A	
TRS-P-LFI-UFT-tbd	H-P-LFI-TRS-tbd4	Incoming unpacking and inspection	X	tbd	Offline
TRS-P-LFI-UFT-tbd	H-P-LFI-TRS-tbd5	Incoming hardware autonomous test	X	tbd	
TRS-P-LFI-UFT-tbd	H-P-LFI-TRS-tbd6	LFI units interface incoming verification	X	tbd	Offline

Table 5-2: LFI TRS synthesis

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5.1 Incoming inspection

Title: **Incoming unpacking & inspection**
HFI-TRS-0001
LFI-TRS-tbd4

Experiment: **HFI/LFI**

Objectives:

The incoming inspection verifies that:

- all deliverables are present

for all deliverables items, the visual inspection of the hardware, the cleanliness control and the check of the documentation is successful

Test Description:

The following items will be verified:

- Packing undamaged
 - Seals and straps intact
 - Correct labelling
- Transportation container, inner packing
 - Correct identification (see heading)
 - Equipment correctly and safely packed
 - Equipment hermetically sealed
 - Packed with desiccant
 - Packed with humidity-indicators
 - Packed with shock-indicators
 - Packed with temperature-indicators
 - Container reusable and stackable
- Equipment
 - Identification correct
 - Screw sealing not broken
 - Surface finish undamaged and clean
 - Connector identification correct
 - Connector with protective caps
 - Connector pins clean and undamaged
 - Mounting area clean and undamaged
 - Accessories, bonding points, covers, red-tags

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- Documentation
 - Shipping documentation
 - Log sheets / historical records
 - Handling, packing, transport procedures
 - End Item Data Package
 - Other Documentation
- Other notable defects

Instrument Configuration:

Packed units are delivered at Alenia premises

Specific Requirements on AVM:

Proper area accommodation has to be available

Particular Environmental Constraints:

Class 100 000 clean area is required for units incoming inspection activities.

Success Criteria:

TBD

Duration:

TBD

Applicable:

AVM Planck

5.2 Hardware autonomous test

Title: **Hardware autonomous test**
HFI-TRS-0002
LFI-TRS-tbd5

Experiment: **HFI/LFI**

Objectives:

To demonstrate at instrument level that under comparable conditions delivered hardware functionality has not been modified by transportation to delivery point.

Test Description:

A progressive test of individual units main performances shall be performed.

This activity sequence shall repeat the instrument turn-on, representative mode(s) and switch-off sequences validated before delivery.

After instrument EGSE (and simulators if applicable) switch-on sequence this test shall include:

- switch on,
- Time delivery (TBC),
- HSK production and verification,
- Individual TC sending, acknowledge and verification,
- Different types of TM packets verification,
- EGSE operational validation.

Instrument Operation Team (IOT) shall perform these tests and maintain the units / instrument log books. For educational purpose Alenia and ALCATEL representatives are welcome to witness these tests.

All produced data shall be recorded by the unit(s) or instrument EGSE, processed for real time assessment and finally archived by instrument.

Instrument Configuration:

Instrument units and GSE unpacking and incoming inspection have been successful.

These autonomous tests shall be performed after successful electrical inter-connection of hardware chains tested prior to delivery.

- HFI units with the HFI provided unit EGSE, interface simulators or spacecraft simulator,
- instrument units interconnection (to be detailed),...

Specific Requirements on AVM :

For this activity a TBD table area has to be made available to instrument IOT.

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Particular Environmental Constraints :

Instrument delivered units shall be maintained in class 100 000 or better.

Success Criteria:

No difference should be detected between prior to and after delivery test data.

This autonomous test success shall allow going to the following step of AIT such as formal delivery to Alenia/ALCATEL.

Duration:

Applicable:

AVM Planck

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5.3 Instrument EGSE validation

Title: **EGSE Check Out**

TRS-HFI-0004

TRS-LFI-tbd

Experiment: **HFI and LFI EGSE**

Objectives:

To demonstrate electrical and software compatibility between provided instrument EGSE and Planck CCS:

- Check of Instrument EGSE function (self-test).
- Check of Instrument EGSE interfaces to CCS.

Test Description:

Perform self-test on instrument workstation.

Connect instrument work station to CCS via LAN.

Check connect/disconnect commands to instrument workstation.

Send TM and TC history packets to instrument workstation.

Export instrument command sequences and data base to CCS.

Load/dump OBSW files.

Instrument Configuration:

Instrument EGSE has been successfully delivered and unpacked.

Specific Requirements on AVM:

Particular Environmental Constraints:

None.

Success Criteria:

TBD

Duration:

TBD

Applicable:

AVM Planck

5.4 Mechanical and Electrical integration

5.4.1 Units Mechanical integration with SVM

Title: **WU mechanical integration with SVM**

TRS-HFI-0005

TRS-LFI-tbd

Experiment: **HFI/LFI**

Objectives:

To demonstrate mechanical compatibility between form and fit WU and bench test.

To construct extended Planck AVM including not form and fit WU.

Test Description:

After unit identification check, and using dedicated MGSE when applicable, mechanical integration of delivered warm units on bench test shall be performed according Alenia procedure.

After connectors identification check, the connection of harnesses and bounding straps shall be performed according Alenia procedure.

Instrument Operation Team shall be represented during these activities and the instrument and connectors mating log books shall be maintained.

All produced information shall be recorded by Alenia.

Instrument Configuration:

This integration shall be performed after successful:

- interface verification (see next paragraph: first electrical I/T test step),
- incoming hardware autonomous test,
- connectors savers retrieval if any

Specific Requirements on AVM :

To be agreed with Alenia.

Particular Environmental Constraints :

Instrument units shall be maintained in class 100 000 or better.

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Success Criteria:

This physical integration success is one of the prerequisites allowing to go to the following step of AIT i.e. instrument system level testing.

Duration:

Covered by the 5 days of I&T

Applicable:

AVM Planck

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5.4.2 LFI Units Electrical integration

Title: **LFI Units Electrical Integration**
LFI-TRS-tbd1

Experiment: **LFI**

Objectives:

The instrument electrical integration comprises the check of:

- Unit I/F verification: the hardware compliance to IIDs/Data package data (interface verification). This shall be performed for each unit separately.
- the Warm Units interconnections.
- the connection of the WU to the SVM and the EGSE.

Test Description:

Perform test list is to be agreed and may include:

- unit and connectors identification check,
- bonding measurement (or insulation as required) between unit case and structure reference grounding point,
- isolation test,
- inrush current measurement,
- ...

To be issued

Instrument Configuration:

Warm units has been successfully delivered and unpacked.

The mechanical fitting and the fixing of bolts torque are done.

EGSE integration with CCS performed.

Specific Requirements on AVM:

Particular Environmental Constraints:

Delivered warm units shall be maintained in class 100 000 or better

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Success Criteria:

Measured parameters should be compliant with specified range.

Duration:

Covered by the 5 days of I&T

Applicable:

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5.4.3 HFI Units Electrical integration

Title: **HFI Units Electrical Integration**
TRS-HFI-0005

Experiment: **HFI**

Objectives:

The instrument electrical integration comprises the check of:

- the hardware compliance to IIDs/Data package data. This shall be performed for each unit separately.
- the Warm Units interconnections.
- the connection of the WU to the SVM and the EGSE.

Test Description:

Perform test list is to be agreed and may include:

- unit and connectors identification check,
- bonding measurement (or insulation as required) between unit case and structure reference grounding point,
- isolation test,
- inrush current measurement,
- ...

To be issued

Instrument Configuration:

Warm units has been successfully delivered and unpacked.

The mechanical fitting and the fixing of bolts torque are done.

EGSE integration with CCS performed.

Specific Requirements on AVM:

Particular Environmental Constraints:

Delivered warm units shall be maintained in class 100 000 or better

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Success Criteria:

Measured parameters should be compliant with specified range.

Duration:

Covered by the 5 days of I&T

Applicable:

Planck AVM

5.5 Unit Functional Tests

5.5.1 LFI Functional Test

**TITLE: LFI Functional Test at ambient
LFI-TRS-tbd2**

Experiment: LFI

Objectives:

To demonstrate electrical and software compatibility between LFI and Planck SVM during an end-to-end functional test.

To validate timing signal exchanges, TM/TC interface and database.

Test Description:

After SVM switch-on, it shall include:

- Switch on procedure of LFI and wait for boot
- Monitor all LFI telemetry between each command.
- Check frame synchronisation between the 1553 BC and the RT using CDMU SCOE
- Check the time synchronisation mechanism of the LFI
- re-synchronised (TBC)
- TC packet distribution: check TC acceptance report and TC execution report
- Telemetry Packet retrieval
- End-to-end database verification:
 - All TCs
 - All TM parameters
 - Yellow/Red limits (TBC)
 - Transfer functions (TBC)
 - CCS RTA validation (TBC)
- Perform switch off procedure of LFI

LFI Instrument Operation Team shall be present during the test and maintain the instrument log book.

All produced data including sent commands shall be recorded, archived by the CCS and transmitted on-line to the delivered LFI EGSE for real time assessment by LFI IOT team and archiving.

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Instrument Configuration:

This activity shall be performed after successful electrical integration of:

- LFI with the SVM
- LFI provided EGSE with the CCS.

Specific Requirements on AVM:

TBD

Particular Environmental Constraints:

Clean room, class 100.000 or better. ESD certified area. Relative humidity > 40% and < 55 %.

Success Criteria:

Analysis of HK demonstrates that all sections are operating
Correct execution of all commands

Duration:

TBD

Applicable:

Planck AVM

5.5.2 Specific REBA Functional test

Title: **Specific REBA functional test**

LFI-TRS-tbd3

Experiment: **LFI**

To be issued

5.5.3 HFI functional test

TITLE: HFI ambient temperature individual commissioning
HFI-TRS-0009

Experiment: HFI

Objectives:

To demonstrate electrical and software compatibility between HFI and Planck SVM during an end-to-end functional test.

To validate timing signal exchanges, TM/TC interface and database.

Test Description:

After SVM switch-on, it shall include:

- switch on procedure of HFI DPU and wait for boot
- Monitor all HFI telemetry between each command:
 - HFI DPU in Standby mode;
 - TM packets received are HSK1, HSK2, HSK3.
- Check frame synchronisation between the 1553 BC and the RT using CDMU SCOE
- Check the time synchronisation mechanism of the HFI DPU
- re-synchronised DPU using TC(9,4) TBC
- TC packet distribution: check TC acceptance report and TC execution report
- Telemetry Packet retrieval
- End-to-end database verification:
 - All TCs
 - All TM parameters
 - Yellow/Red limits (TBC)
 - Transfer functions (TBC)
 - CCS RTA validation (TBC)
- Perform switch off procedure of HFI

HFI Instrument Operation Team shall be present during the test and maintain the instrument log book.

All produced data including sent commands shall be recorded, archived by the CCS and transmitted on-line to the delivered HFI EGSE for real time assessment by HFI IOT team and archiving.

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Instrument Configuration:

This activity shall be performed after successful electrical integration of:

- HFI with the SVM
- HFI provided EGSE with the CCS.

Specific Requirements on AVM:

TBD

Particular Environmental Constraints:

Clean room, class 100.000 or better. ESD certified area. Relative humidity > 40% and < 55 %.

Success Criteria:

Analysis of HK demonstrates that all sections are operating
Correct execution of all commands

Duration:

TBD

Applicable:

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5.6 OBSW HFI maintenance

**TITLE: ON-BOARD SOFTWARE
MAINTENANCE
HFI-TRS-0011**

Experiment: HFI

Objectives:

This activity objective is three fold:

- to demonstrate the ability to dump, compare, patch / re-load HFI on-board software,
- to validate involved data buses traffic capabilities and transfer durations evaluation,
- to check instruments and spacecraft software new versions compatibility (TBC) prior to installation on more advanced PPLM/SVM models.

Test Description:

This activity sequence shall repeat the instrument software maintenance sequences validated at instrument level.

After SVM switch-on, Sorption Cooler switch on and LFI switch on sequence (which is the most probable flight turn-on sequence) it shall include:

- HFI, DPU switch on and boot,
- On-Board Time delivery & acknowledge,
- HSK packets production and verification,
- HFI resident on-board software dump and verification,
- Validated software or patch uploading, acknowledgment and completion verification,
- New on-board software dump and verification,
- Restart HFI with modified on-board software,
- Perform shortened instrument functional test.

Instrument Configuration:

This activity shall be performed after successful electrical integration of HFI with the SVM and of HFI provided EGSE with the CCS.

HFI provided patch shall have undergone the full agreed software validation process successfully.

Specific Requirements on AVM:

This activity shall be performed: after successful electrical integration of HFI delivered EGSE with the CCS including database transfer functionalities.

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Particular Environmental Constraints:

Clean room, class 100.000 or better. ESD certified area. Relative humidity > 40% and < 55 %.

Success Criteria:

Analysis of HK demonstrates that all sections of HFI are operating

Correct execution of all commands

Duration:

TBD

Applicable:

Planck AVM

5.7 OBSW LFI maintenance

To be issued.

5.8 Combined Functional Test

Title: **Combined functional test**
HFI-TRS-0010

Experiment: **HFI/LFI**

Objectives:

To demonstrate electrical, power and software compatibility between HFI and Planck SVM with LFI and Sorption Cooler CQM running in parallel.

To validate delivered database under such condition.

To demonstrate Planck and SVM Central Check-out System ability to manage Instruments loads in terms of TM and TC traffic, power, real time analysis,...

Test Description:

Sorption Cooler, LFI and HFI shall be sequentially turned on during this phase.

A progressive test of all HFI electrical interface and performance shall be performed.

This activity sequence shall repeat the instrument individual commissioning sequences as previously validated. Test sequences shall be simplified in order to shorten them and avoid duplication (no full database validation,...).

After SVM or simulator switch-on, Sorption Cooler switch on, LFI switch on and HFI switch on sequence (which is the most probable flight turn-on sequence) it shall include:

- Simultaneous On-Board Time delivery to all "users" & acknowledge,
- Simultaneous HSK packets production and verification,
- Simultaneous Individual TC sending, acknowledge and verification,
- Simultaneous Time tagged Procedure sending to all instruments, acknowledgment and verification (TBC),
- Different types of TM packets verification,
- CCS RTA validation (TBC).

HFI Instrument Operation Team shall be present during the test and shall maintain the instrument log book.

All produced data including all sent commands shall be recorded by the CCS and transmitted on-line to the delivered HFI EGSE for real time assessment. These data shall be further on archived in HFI DPC database.

Instrument Configuration:

This combined test shall be performed:

- after successful mechanical and electrical integration:
- successful individual commissioning of HFI, LFI and Sorption Cooler with the SVM or its

Specific Requirements on AVM:

TBD

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representative simulator,
- successful integration of the HFI, LFI and Sorption Cooler delivered EGSE with the CCS or its representative simulator.

Particular Environmental Constraints:

Clean room, class 100.000 or better. ESD certified area. Relative humidity > 40% and < 55 %.

Success Criteria:

No difference should be detected between instrument individual commissioning test data and payload combined test data / instrument behaviour.

Duration:

TBD

Applicable:

Planck AVM