

Herschel Instrument Testing on AVM

H-P-1-ASP-TN-0852

Product Code : 200000

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DATE : 07-01-2005

ISSUE : 1.0

PAGE : 2/45

HERSCHEL/PLANCK		DISTRIBUTION RECORD	
DOCUMENT NUMBER : H-P-1-ASP-TN-0852		Issue / Rev. : 1.0 Date: 07-01-2005	
EXTERNAL DISTRIBUTION		INTERNAL DISTRIBUTION	
ESA	X	HP team	X
ASTRIUM	X		
ALENIA	X		
CONTRAVES			
TICRA			
TECNOLOGICA			
CSL			
HIFI	X		
PACS	X		
SPIRE	X		
		Clf Documentation	Orig.

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ISSUE / REV.	DATE	§ : DESCRIPTION DES EVOLUTIONS § : <i>CHANGE RECORD</i>	REDACTEUR <i>AUTHOR</i>
1.0	07-01-2005	First issue	P. Bourlon

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1. SCOPE

This technical note defines the instrument tests to be performed at AVM level in Herschel 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 Herschel 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 Herschel 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], AD[06] and AD[07]).

This document will be completed by the test specifications for the Herschel 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.

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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-SPIRE-02124	Instrument Interface Document IID - part B – Instrument "SPIRE"
AD[06]	SCI-PT-IIDB-HIFI-02125	Instrument Interface Document IID - part B – Instrument "HIFI"
AD[07]	SCI-PT-IIDB-PACS-02126	Instrument Interface Document IID - part B – Instrument "PACS"
AD[08]	H-P-1-ASPI-PL-0225	Verification Program Plan (VPP)

2.2 Reference documents

Ref.	Reference of document	Title
RD[01]	H-P-1-ASPI-IS-0121	EGSE Interface Requirements Specifications
RD[02]	H-P-1-ASPI-LI-0058	H/P Hardware Matrix
RD[04]	SPIRE-RAL-DOC-001905	SPIRE EQM Test Plan
RD[06]	SPIRE-RAL-DOC-000768	Operating the SPIRE Instrument
RD[07]	SPIRE-RAL-DOC-001652	SPIRE Functional Test Specification
RD[08]	SPIRE-RAL-NOT-000983	Definition of SPIRE CQM Deliverables for System Level Testing
RD[09]	SPIRE-RAL-DOC-001132	SPIRE Warm Electronics Integration Plan
RD[10]	SPIRE-RAL-NOT-000982	SPIRE EQM Test Program Definition Test Case Forms
RD[11]		

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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
HIFI	Heterodyne Instrument for Far Infrared
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
PACS	Photoconductor Array Camera and Spectrometer
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
SPIRE	Spectral and Photometry Imaging REceiver

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Acronyms	Keys
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. HERSCHEL 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" 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, H-EPLM CCU** 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 Herschel 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 Herschel 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.

Herschel 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.

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3.3 Herschel AVM responsibility sharing

This chapter recalls the sharing of responsibility of tasks between various parties involved in Herschel AVM activities: ALCATEL, EADS-ASTRIUM, ALENIA and ESA.

Testing activity responsibility:

As prime Contractor ALCATEL Space has the overall responsibility of Herschel 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.

ASTRIUM-ED has the overall responsibility of Herschel EPLM and it is responsible for AIT of Herschel satellite. Only UFT (not SIT) will be performed on AVM.

The table hereafter present the test responsibility sharing during the Herschel 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
Herschel SVM Electrical Model	SVM Specific Herschel ACMS units I & T and UFT	ALENIA	ALENIA	ALENIA	ALENIA	ALENIA
	SVM Specific Herschel ACMS units SIT	ALENIA	ALENIA	ALENIA	ALENIA	ALENIA
Herschel Satellite electrical Model	Herschel [I-WU-AVM] I & T	ALENIA	ALENIA	ALENIA	ALENIA	ALENIA
	Herschel [I-WU-AVM] UFT	ASTRIUM (1)	ALENIA (6)	ALENIA	ALENIA	ASTRIUM (1)
	Herschel CCU I & T and UFT	ASTRIUM	ALENIA (6)	ALENIA	ALENIA	ASTRIUM
	SVM Herschel IST	ALENIA	ALENIA	ALENIA	ALENIA	ALENIA
	SVM Herschel EMC Conducted Test	ALENIA (3)	ALENIA	ALENIA	ALENIA	ALENIA (3)
	Herschel Satellite IST	ALCATEL (1)	ASTRIUM (4)	ASTRIUM (4)	ASTRIUM (4)	ALCATEL (1)
	Herschel SVT-0	ESOC	ESOC (4)	ESOC (4)	ESOC (4)	ESOC

(1) with Instrument support

(2) with ALCATEL support

(3) with ALCATEL approbation

(4) with ALENIA support

(5) with ESA support

(6) with ASTRIUM support

Figure 3-1: Herschel AVM testing – Sharing of Responsibilities

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Database and EGSE responsibility:

Herschel 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 CONFIGURATIONS

4.1 Hardware

The tables and figure here after summarise the hardware to be used on AVM and to be delivered by SPIRE, PACS and HIFI according to AD[04], AD[06], AD[07] and RD[08]:

Unit		Type	Comments	SVM Interface D =data / P= power	Harness extension required
Instrument Control Unit	FH ICU	DM	Form and fit; no redundancy; function as for FM except for science data handling	D/P	
Local Oscillator Control Unit	FH LCU	simulator	Dummy load only (resistor network to simulate the power interface)	P	Yes
HRS ACS Horizontal polarisation	FH HRH	Simulator	Dummy load only	P	Yes
HRS ACS Vertical polarisation	FH HRV	Simulator	Dummy load only	P	Yes
WBS Electronics for Horizontal Polarisation	FH WEH	Simulator	Dummy load only	P	Yes
WBS Electronic for Vertical Polarisation	FH WEV	Simulator	Dummy load only	P	Yes
Warm Interconnection Harness	FH WIH	Simulator		N/A	

Table 4-1: Herschel AVM HIFI - Hardware Matrix

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Unit		Type	Comments	SVM Interface D =data / P= power	Harness extension required
Focal Plane Unit	FP FPU	Simulator		N/A	
Detector & Mechanism Control	FP DECMEC	BB	To be clarified	P	Yes
Bolometer Cooler Control	FP BOLC	BB	To be clarified	Dedicated power supply	Yes
DPU	FP DPU	AVM	Form and fit; Flight representative; no redundancy; From EQM	D/P	No
SPU nominal	FP SPU1	AVM	not form & fit From EQM	P	Yes
Warm Interconnection Harness	FP WIH			N/A	
DPU to DECMEC		AVM	From EQM		
DPU to SPU		AVM	From EQM		
SPU to DECMEC		AVM	From EQM		
DECMEC to BOLC		AVM	From EQM		
BOLC to FPU		Simulator			

Table 4-2: Herschel AVM PACS - Hardware Matrix

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Unit		Type	Comments	SVM Interface D =data / P= power	Harness extension required
Focal Plane Unit	FS FPU	DRCU Sim. (one box)		P	Yes
JFET Spectrometer	FS FJS				
JFET Photometer	FS FJP				
Cryogenic harness FPU/FJS	FS BS				
Cryogenic harness FPU/FJP	FS BP				
Focal Plane Control unit	FS FCU				
Detector Control unit (DCU)	FS DCU				
Digital Processing Unit	FS DPU	AVM	From EQM form and fit	D/P	No
Warm Interconnection Harness	FS WIH	QM1	From EQM	N/A	

Table 4-3: Herschel AVM SPIRE - Hardware Matrix

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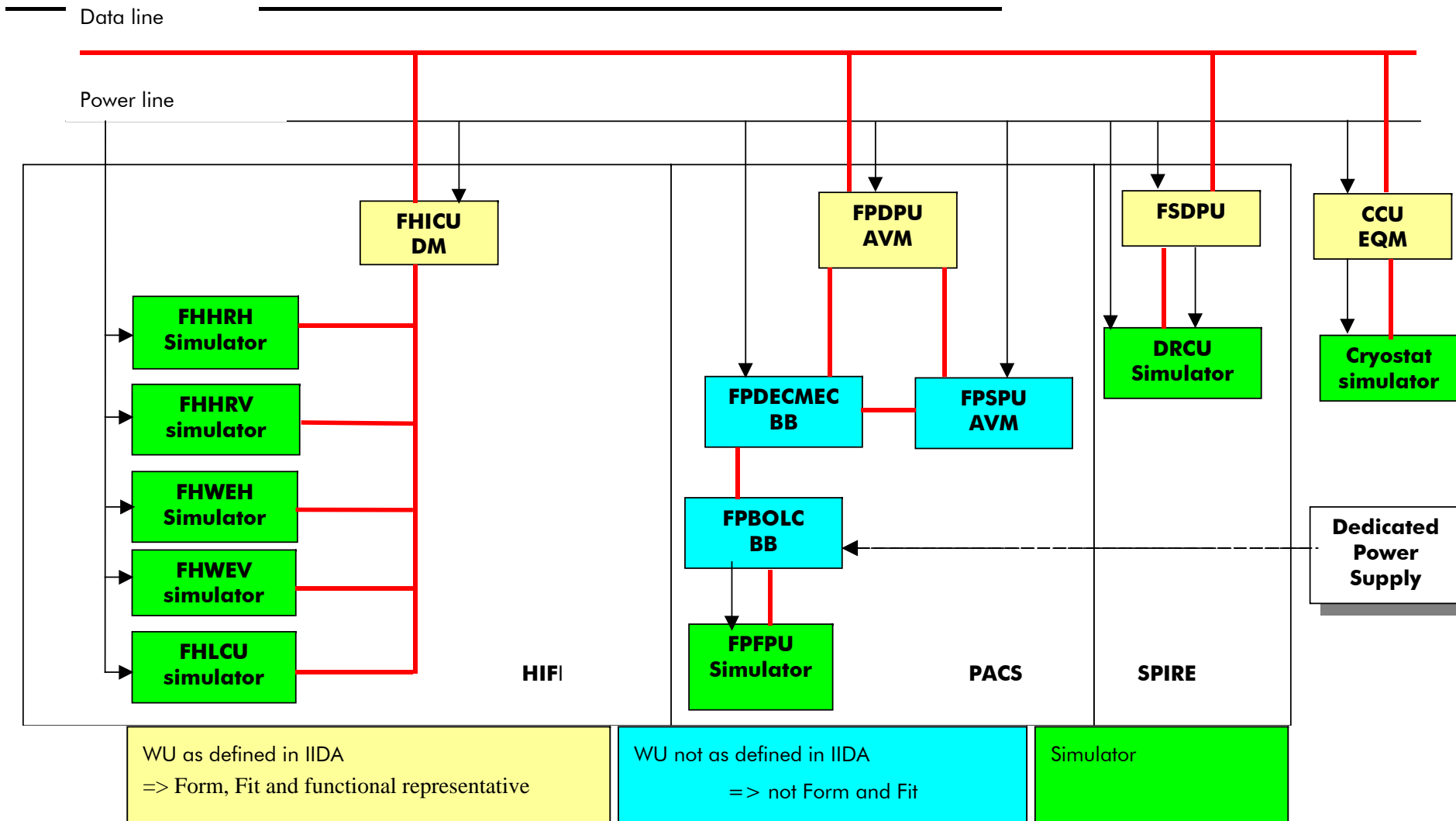


Figure 4-4 : Herschel AVM WU - Schema

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4.2 EGSE

The delivered Instrument EGSE for the AVM level instrument test programme is as follow:

Instrument	GSE	Remarks
HIFI/PACS/SPIRE	2 Instrument EGSE Stations for all 3 instruments	One EGSE Station operated in real time, the other one used as backup or for post processing tasks
HIFI/PACS/SPIRE	CDMS simulator	Loan for stand alone integration checks only
HIFI/PACS/SPIRE	Test harness	Refer to Hardware Matrix

Table 4-5: Instrument EGSE Items

The Instrument EGSE Station is composed by the following items:

- SCOS workstation – used primarily to run the SCOS-2000 software. This will be a PC running Linux with a dual display card driving two displays.
- Analysis workstation – used to run the instrument analysis software (QLA/IA/PCSS). This will be a PC running Linux with a dual display card driving two displays.
- Data Server – used primarily to run the HCSS software. This will be a PC running Linux with a single display and large disk drives with backup facility (to tape/CD TBD).
- Colour laser printer.
- LAN switch - protects the Operational System from the Analysis System allowing access to the external internet from the Analysis System.
- Laptops – used to run instrument specific analysis tools. These are not provided as part of the EGSE but may be used by instrument experts as necessary during testing.

Following figure shows the Instrument EGSE block diagram and provides an overview of the interface to the CCS:

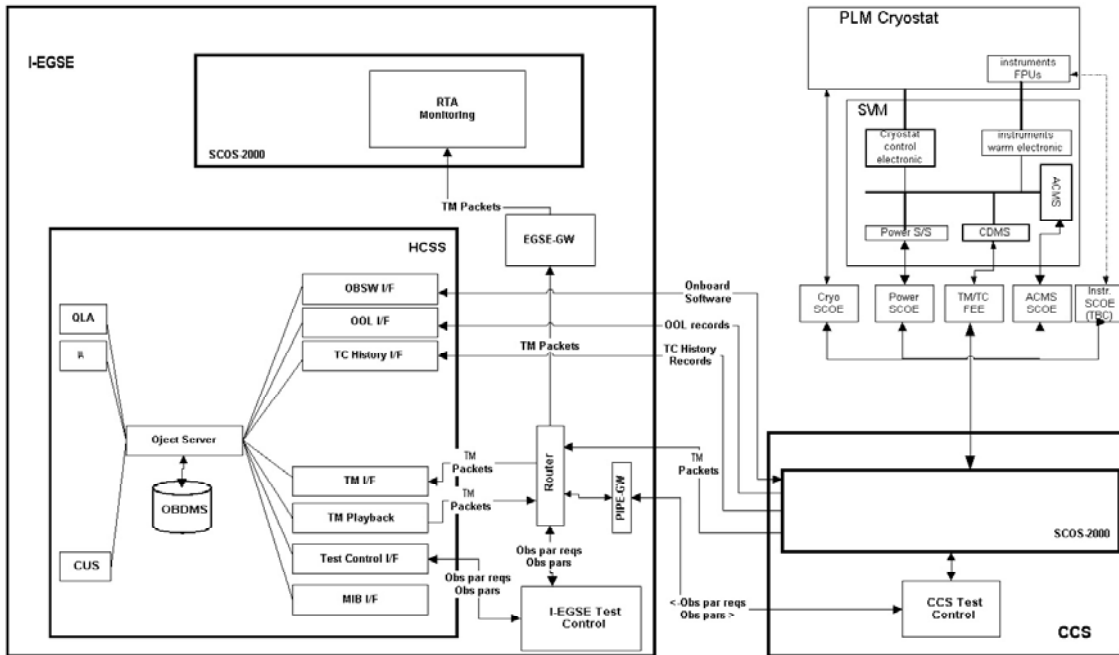


Figure 4-6 : Data Exchange during PLM EQM Test

All AVM level instrument tests will be executed from the CCS light re-using a subset of instrument level test procedures.

The CCS interfaces to the Instrument EGSE uses the PIPE protocol. The database is physically located in the IEGSE (HCSS).

Access to the Instrument EGSE via internet is only foreseen for monitoring (no commanding) and will be provided by the Instrument EGSE itself. Online transfer of recorded data is possible e. g. by FTP.

Simulators and other instrument specific test reqs equipment have no interface to the CCS. I. e. such equipment will be controlled off-line.

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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 Herschel SVM AVM environment.

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

To summarise, the following steps are foreseen for SPIRE, PACS and HIFI and 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 test part of the IST will be run to demonstrate Herschel 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 HIFI, PACS and SPIRE in the VPP (AD[08]) and summarised in table 5-1, 5-2 and 5-3.

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VPP (AD[08]) ref	HIFI TRS N°	Description	AVM	Nb days	Comments
TRS-H-HIFI-UFT-1	H-P-HIFI-TRS-tbd5	Warm Unit Electrical Integration	X	1	
TRS-H-HIFI-UFT-3		Thermal response during system TV/TB test	N/A	N/A	
TRS-H-HIFI-UFT-4		Functional check in cold condition	N/A	N/A	
TRS-H-HIFI-UFT-5		IF properties	N/A	N/A	
TRS-H-HIFI-UFT-6		Receiver tuning	N/A	N/A	
TRS-H-HIFI-UFT-7		Radiometry: determination of noise and gain temperature over the RF band	N/A	N/A	
TRS-H-HIFI-UFT-8		Standing Wave Test for FPU/LOU path	N/A	N/A	
TRS-H-HIFI-UFT-9		EMC	N/A	N/A	
TRS-H-HIFI-UFT-tbd	H-P-HIFI-TRS-tbd1	Incoming unpacking and inspection	X	1	Offline
TRS-H-HIFI-UFT-tbd	H-P-HIFI-TRS-tbd2	Incoming hardware autonomous test	X	1	Done by HIFI
TRS-H-HIFI-UFT-tbd		HIFI units interface incoming verification	X	-	Covered by TRS-H-HIFI-UFT-1
TRS-H-HIFI-UFT-tbd	H-P-HIFI-TRS-tbd4	HIFI WU mechanical integration with SVM	X	1/2	
TRS-H-HIFI-UFT-tbd	H-P-HIFI-TRS-tbd6	HIFI Short Functional Test Warm	X	1h	
TRS-H-HIFI-UFT-tbd	H-P-HIFI-TRS-tbd7	On board software maintenance	X	2	
TRS-H-HIFI-UFT-tbd	H-P-HIFI-TRS-tbd8	Combined Functional test at room temperature	X	Tbd	

Table 5-1: HIFI TRS synthesis

VPP (AD[08]) ref	HIFI TRS N°	Description	AVM	Nb days	Comments
TRS-H-PACS-UFT-1	H-P-PACS-TRS-tbd5	Warm Unit Electrical Integration	X	1	
TRS-H-PACS-UFT-3		Thermal response during system TV/TB test	N/A	N/A	
TRS-H-PACS-UFT-4		Functional check in cold condition	N/A	N/A	
TRS-H-PACS-UFT-5	H-P-PACS-TRS-tbd6	Functional test at ambient involving the CDMU/PACS IF	X	3	
TRS-H-PACS-UFT-6	H-P-PACS-TRS-tbd9	PACS/SPIRE Parallel mode	X	1	
TRS-H-PACS-UFT-7		EMC	N/A	N/A	
TRS-H-PACS-UFT-8	H-P-PACS-TRS-tbd8	Astronomical Observation Template (AOT) Tests	X	Tbd	Offline
TRS-H-PACS-UFT-tbd	H-P-PACS-TRS-tbd1	Incoming unpacking and inspection	X	1/2	Offline
TRS-H-PACS-UFT-tbd	H-P-PACS-TRS-tbd2	Incoming hardware autonomous test	X	Tbd	Done by PACS
TRS-H-PACS-UFT-tbd		PACS units interface incoming verification	X	-	Covered by TRS-H-PACS-UFT-1
TRS-H-PACS-UFT-tbd	H-P-PACS-TRS-tbd3	EGSE integration with CCS	X	1	Offline
TRS-H-PACS-UFT-tbd	H-P-PACS-TRS-tbd4	PACS WU mechanical integration with SVM	X	1	
TRS-H-PACS-UFT-tbd	H-P-PACS-TRS-tbd7	On board software maintenance	X	2	

Table 5-2: PACS TRS synthesis

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VPP (AD[08]) ref	HIFI TRS N°	Description	AVM	Nb days	Comments
TRS-H-SPIRE-UFT-1	H-P-SPIRE-TRS-tbd5	Warm Unit Electrical Integration	X	1	
TRS-H-SPIRE-UFT-3		Thermal response during system TV/TB test	N/A	N/A	
TRS-H-SPIRE-UFT-4		Functional check in cold condition	N/A	N/A	
TRS-H-SPIRE-UFT-5	H-P-SPIRE-TRS-tbd9	Cooler Recycle	X	Tbd	TBC
TRS-H-SPIRE-UFT-6		Photometer Chop Mode	N/A	N/A	
TRS-H-SPIRE-UFT-7		Ambient Background Verification	N/A	N/A	
TRS-H-SPIRE-UFT-8		Spectrometer Mode	N/A	N/A	
TRS-H-SPIRE-UFT-9		EMC	N/A	N/A	
TRS-H-SPIRE-UFT-tbd	H-P-SPIRE-TRS-tbd1	Incoming unpacking and inspection	X	1	Offline
TRS-H-SPIRE-UFT-tbd	H-P-SPIRE-TRS-tbd2	Incoming hardware autonomous test	X	1	Done by PACS
TRS-H-SPIRE-UFT-tbd		PACS units interface incoming verification	X	-	Covered by TRS-H-SPIRE-UFT-1
TRS-H-SPIRE-UFT-tbd	H-P-SPIRE-TRS-tbd4	SPIRE WU mechanical integration with SVM	X	1/2	
TRS-H-SPIRE-UFT-tbd	H-P-SPIRE-TRS-tbd6	Short Functional test Warm	X	Tbd	
TRS-H-SPIRE-UFT-tbd	H-P-SPIRE-TRS-tbd7	On board software maintenance	X	2	
TRS-H-SPIRE-UFT-tbd	H-P-SPIRE-TRS-tbd8	Instrument functional performance (peak-up mode and autonomy)	X	Tbd	

Table 5-3: SPIRE TRS synthesis

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5.1 Incoming inspection

Title: **Incoming unpacking & inspection**

HIFI-TRS- tbd1

PACS-TRS- tbd1

SPIRE-TRS- tbd1

Experiment: **HIFI/PACS/SPIRE/CCU**

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

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- Accessories, bonding points, covers, red-tags
- 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:

Herschel AVM

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5.2 Hardware autonomous test

Title: **Hardware autonomous test**

HIFI-TRS- tbd2

PACS-TRS- tbd2

SPIRE-TRS- tbd2

Experiment: **HIFI/PACS/SPIRE/CCU**

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/ASTRIUM 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/ASTRIUM.

Duration:

Applicable:

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5.3 Instrument EGSE validation

Title: **EGSE Check Out**
PACS-TRS- tbd3

Experiment: **HIFI/PACS/SPIRE/CCU**

Objectives:

To demonstrate electrical and software compatibility between provided instrument EGSE and Herschel 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:

Herschel AVM

5.4 Mechanical and Electrical Integration

5.4.1 Units Mechanical integration with SVM

Title: **WU mechanical integration with SVM**

HIFI-TRS- tbd4

PACS-TRS- tbd4

SPIRE-TRS- tbd4

Experiment: **HIFI/PACS/SPIRE/CCU**

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:

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5.4.2 HIFI Units Electrical integration

Title: **HIFI Units Electrical Integration**
HIFI-TRS- tbd5

Experiment:
HIFI

Objectives:

The instrument electrical integration comprises the check of:

- 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 PACS Units Electrical integration

Title: **PACS Units Electrical Integration**
PACS-TRS- tbd5

TBD

Experiment:

PACS

5.4.4 SPIRE Units Electrical integration

Title: **SPIRE Units Electrical Integration**
SPIRE-TRS- tbd5

TBD

Experiment:

SPIRE

5.5 Unit Functional Tests

5.5.1 HIFI Short Functional Test Warm

Title: **HIFI Short Functional test Warm**
HIFI-TRS- tbd6

Experiment:
HIFI

Objectives:

Confidence test to check electrical integrity and operability of instrument under ambient conditions (to validate timing signal exchanges, TM/TC interface and database).

Verification of the functional performance of the integrated instrument in all modes. Check of the instrument performance as far as possible with AVM configuration.

The test cannot fully verify the instrument function. Evaluation will be based on housekeeping data, evaluation of science data is not foreseen.

Test Description:

Send the following commands: Power On (PLM command), Stand-By, TBD, TBD,... Monitor in parallel instrument power consumption (PLM HK parameters) and instrument HK parameters.

HIFI 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 EGSE for real time assessment by HIFI IOT team and archiving.

Instrument Configuration:

This activity shall be performed after successful electrical integration of:

- HIFI with the SVM
- EGSE with the CCS.

Specific Requirements on AVM:

None.

Particular Environmental Constraints:

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

Success Criteria:

Housekeeping values within pre-defined limits. Correct execution of commands.

Duration:

1h

Applicable:

Herschel AVM

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5.5.2 PACS Full Functional Test at ambient

Title: **PACS Full Functional Test at ambient**
PACS-TRS- tbd6

Experiment:
PACS

Objectives:

Validation of PACS switch-on procedure, including validation of connection between EGSE and instrument, memory load and dump. Validate function of DPU, function of SPU and data reduction/compression SW, validate function of DEC/MEC, validate function of BOLC/A, verify function of detectors, detector readouts, detector heaters and temperature sensors, verify function of mechanisms (grating, chopper and filter wheels), verify function of calibration sources, verify PACS autonomy functions (limit checks), verify PACS telemetry rates, verify time synchronisation procedure between CDMU and PACS, validate PACS deactivation (shut-down) procedure

Verification of the functional performance of the integrated instrument in all modes. Check of the instrument performance as far as possible with AVM configuration.

Test Description:

TBD

PACS 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 PACS EGSE for real time assessment by PACS IOT team and archiving.

Instrument Configuration:

This activity shall be performed after successful electrical integration of:

- PACS with the SVM
- EGSE with the CCS.

Specific Requirements on AVM:

None

Particular Environmental Constraints:

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

Success Criteria:

Housekeeping values within pre-defined limits. Correct execution of commands.

Duration:

3 days TBC

Applicable:

Herschel AVM

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5.5.3 SPIRE Short functional test

Title: **SPIRE Short Functional test Warm
SPIRE-TRS- tbd6**

Experiment:
SPIRE

Objectives:

Confidence test to check electrical integrity and operability of instrument under ambient conditions (to validate timing signal exchanges, TM/TC interface and database).

Verification of the functional performance of the integrated instrument in all modes. Check of the instrument performance as far as possible with AVM configuration.

The test cannot fully verify the instrument function. Evaluation will be based on housekeeping data, evaluation of science data is not foreseen.

Test Description:

The S/C-instrument interfaces are checked by switch on procedure (TBD).

The instrument is placed into a state ready to receive and execute commands (READY – TBC).

Each sub-system is commanded as appropriate to verify its function (TBD).

The instrument is switched back to READY.

The instrument may be switched OFF or to another mode if further tests are planned.

SPIRE 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 EGSE for real time assessment by SPIRE IOT team and archiving.

Instrument Configuration:

This activity shall be performed after successful electrical integration of:

- SPIRE with the SVM
- EGSE with the CCS.

Specific Requirements on AVM:

None.

Particular Environmental Constraints:

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

Success Criteria:

Housekeeping values within pre-defined limits. Correct execution of commands.

Duration:

6h

Applicable:

Herschel AVM

5.6 OBSW maintenance

5.6.1 HIFI OBSW maintenance

Title: **On-Board Software Maintenance
HIFI-TRS- tbd7**

Experiment:
HIFI

Objectives:

This activity objective is three fold:

- to demonstrate the ability to dump, compare, patch / re-load HIFI 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 and instrument switch on, it shall include:

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

Instrument Configuration:

This activity shall be performed after:

- successful electrical integration of HIFI with the SVM and of HIFI provided EGSE with the CCS,
- successful HIFI functional test.

HIFI 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 HIFI 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 HIFI are operating

Correct execution of all commands

Duration:

TBD

Applicable:

Herschel AVM

5.6.2 PACS OBSW maintenance

TRS PACS-TRS- tbd7, TBD

5.6.3 SPIRE OBSW maintenance

TRS SPIRE-TRS- tbd7, TBD

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5.7 PACS Astronomical Observation Template (AOT) Test

Title: **Astronomical Observation
Template (AOT) test**
PACS-TRS- tbd8

Experiment:
PACS

Objectives:

To verify in a short and representative way that the planned observation strategies (command sequences and data acquisition) are compatible with the system, pointing issues cannot be proven.

Test Description:

Test of PACS Single Band Photometry Mode,
Test of PACS Dual Band Photometry Mode,
Test of PACS Line Spectroscopy Mode,
Test of PACS Range Spectroscopy Mode
Test of PACS Calibration Measurement using FPU simulator

Instrument Configuration:

This activity shall be performed after successful electrical integration of:

- PACS with the SVM
- EGSE with the CCS.

Specific Requirements on AVM:

None

Particular Environmental Constraints:

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

Success Criteria:

TBD

Duration:

TBD

Applicable:

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5.8 PACS/SPIRE Parallel Mode Test

Title: **PACS/SPIRE Parallel Mode test**
PACS-TRS- tbd9

Experiment:
PACS/SPIRE

Objectives:
Verification of operability of PACS/SPIRE in parallel.

TBD

5.9 SPIRE Functional performance

Title: **SPIRE functional performance**
SPIRE-TRS- tbd8

Experiment:
SPIRE

Objectives:
Verification of subsystem and instrument functional performance within system environment:

- Peak-up mode
- Autonomy: simulation of failures (FPU, DRCU, DPU)

TBD

5.10 SPIRE Cooler Recycle

Title: **SPIRE Cooler Recycle**
SPIRE-TRS- tbd9

Experiment:
SPIRE

TBC

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5.11 Combined Functional Test

Title: **Combined functional test
HIFI-TRS-tbd8**

Experiment: **HIFI/PACS/SPIRE**

Objectives:

To demonstrate electrical, power and software compatibility between HIFI/PACS/SPIRE and Planck SVM

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:

HIFI, PACS and SPIRE shall be sequentially turned on during this phase.

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, HIFI, PACS and SPIRE switch on sequence, it shall include:

- Simultaneous On-Board Time delivery to all "users" & acknowledge,
- For each experiment mode:
 - 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 and that no TM packets lost on mode transition,
- CCS RTA validation (TBC).

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 EGSE for real time assessment. These data shall be further on archived.

Instrument Configuration:

This combined test shall be performed:

- after successful mechanical and electrical integration of HIFI, PACS and SPIRE with the SVM
- after successful individual test functional test

Specific Requirements on AVM:

None

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for each instrument,
- successful integration of the delivered EGSE with the CCS.

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.

Duration:

TBD

Applicable:

Herschel AVM