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Title: **Instrument Testing on PLM PFM and Satellite Level**

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Draft	06.06.02	all	Draft for review and comments	
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1 Scope

This plan defines the instrument tests which will be performed on PLM PFM and satellite level during the Herschel satellite AIT programme. This includes the instrument incoming inspections after delivery to ASED, the activities and interface tests planned for the instrument integration on the satellite and the instrument related tests to be performed during the various PLM PFM and satellite test phases. All these activities and tests are described per instrument and per test activity in specific form sheets.

In addition, the document gives an overview on the satellite AIT programme, addresses the delivery and test configuration of the instruments and specifies any constraints to be respected for the instrument ground operations.

The main objective of this document is to allow an early, quick and co-ordinated satellite AIT relevant information exchange as regards the instrument related aspects. Therefore this document shall be used as reference document for the iteration cycles with the parties involved in the instrument related part of the satellite AIT programme. Furthermore this document serves as reference document for the higher level Satellite AIT Plan (RD 1), in providing more details and more actual information with respect to instrument related subjects.

The document is based on the Instrument Interface Documents (AD 1, AD 2, AD 3 and AD 4) and EPLM AIV and Satellite AIT Requirements Specification (AD 5) and takes into account the current status of the satellite AIT planning and the information provided by the instrument contractors. In case of changes of the planning this document will be updated accordingly (‘living document’).

Note:

The existing issue 1 is the initial issue of this document based on a very first iteration of this subject with the instrument contractors. Further iterations will be performed in due coarse with the results being reflected in a next issue/revision of this document.

2 Documents

2.1 Applicable Documents

AD 1	SCI-PT-IIDA-04624	Herschel/Planck Instrument Interface Document, Part A	Issue 2/0, 31.07.2001
AD 2	SCI-PT-IIDB/SPIRE-02124	Herschel/Planck Instrument Interface Document, Part B, Instrument “SPIRE”	Issue 2/0, 31.07.2001
AD 3	SCI-PT-IIDB/HIFI-02125	Herschel/Planck Instrument Interface Document, Part B, Instrument “HIFI”	Issue 2/1, 03.01.2002
AD 4	SCI-PT-IIDB/PACS-02126	Herschel/Planck Instrument Interface Document, Part B, Instrument “PACS”	Issue 2/0, 31.07.2001
AD 5	HP-1-ASPI-SP-0008	Herschel EPLM AIV and Herschel Satellite AIT Requirements Specification	Issue 2, 23.07.2001
AD 6	HP-2-ASED-PL-0007	Herschel PA Plan	Issue 1, Rev. 3
AD 7	HP-2-ASED-PL-0023	Herschel Contamination Control Plan	Issue 1

2.2 Reference Documents

RD 1	HP-2-ASED-PL-0026	Satellite AIT Plan	Issue 1, 03.05.2002
RD 2	HP-1-ASED-TN-0055	Trade Off for the Herschel Cryo Test Adapter	Issue 1, 22.05.2002
RD 3	HP-2-ASED-RP-0001	H-EPLM Thermal Model and Analysis	Issue 2
RD 4	HP-1-ASPI-LI-0077	List of Acronyms	

3 Objective of PLM and Satellite PFM AIT Programme

3.1 PLM and Satellite PFM AIT Programme General Objectives

The main objective of the PLM PFM and satellite test programme is the flight acceptance of the satellite.

As regards the instruments this includes the verification of the mechanical, thermal, electrical, electromagnetic and operational compatibility of the instruments with the satellite in flight representative cryogenic conditions. Further objective is the verification of the instruments performance as far as possible in the existing ground test conditions.

3.2 Instrument Test Definitions and Objectives

The following table gives an overview of the instrument tests to be carried out on PLM/satellite level with their instrument related objectives.

Test	Test Objectives	Conditions	Remarks
Instrument Incoming Inspection	Visual inspection of the instrument for damage. Check of completeness of hardware items and documentation.	Ambient	
Instrument EGSE Validation	Check of Instrument EGSE function (self-test). Check of Instrument EGSE interfaces to CCS.	Ambient	
Instrument Electrical Integration Check	Check of input/output circuits function and characteristics, shielding and grounding.	Ambient	Test of FPU's (as far as possible under ambient conditions) and warm units.
Instrument Alignment Check	Check of alignment and validation of alignment procedure (as far as possible).		Check will be performed in warm and cold conditions
Instrument Short Functional Test Warm (SFT Warm)	Confidence test to check electrical integrity and operability of instrument with the FPU under ambient conditions. Evaluation should preferably be based on housekeeping data (evaluation of science data should not be required).	Ambient	Test is planned before cool down of the cryostat (warm conditions). PLM level test.

Test	Test Objectives	Conditions	Remarks
Instrument Short Functional Test Cold (SFT Cold)	Confidence test to check electrical integrity and operability of instrument under 'reduced' FPU operating conditions. Evaluation should preferably be based on housekeeping data.	Tank temperature: 4.2 K	Test is planned after cool down (He1) and between environmental tests.
Instrument Short Functional Test He2 (SFT He2)	Confidence test to check electrical integrity and operability of instrument under nominal FPU operating conditions. Evaluation should preferably be based on housekeeping data.	Tank temperature: 1.7 K	Test is planned after He2 production. SFT He2 is subset of IMT.
Instrument Specific Performance Test (SPT)	Verification of dedicated aspects of the performance of the integrated instrument.	Tank temperature: 1.7 K	SPT's are subsets of IMT.
Integrated Module Test (IMT)	Verification of the functional performance of the integrated instrument in all modes and check of the instrument performance (no degradation with respect to instrument level test results).	Tank temperature: 1.7 K	Includes SFT He2 and SPT's. PLM level test.
Integrated System Test (IST)	Same as for IMT but on satellite level.	Tank temperature: 1.7 K	Includes SFT He2 and SPT's. Satellite level test.
EMC Test	Check of instrument functional performance under electromagnetic worst case conditions (conducted and radiated susceptibility).	Tank temperature: 1.7 K	Instruments to be in the most sensitive mode(s). PLM and satellite level
Sine Vibration and Acoustic Noise Test	Verification of workmanship. Verification of alignment stability.	Tank temperature: 1.7 K	Satellite level test.
TB/TV Test	TMM validation. Verification of instrument performance in nearly flight conditions.	Tank temperature: 1.7 K, TV	Satellite level test in TV chamber.

Test	Test Objectives	Conditions	Remarks
System Validation Test (SVT)	Verification of instrument commanding, telemetry and science data from/to the control centre.	Tank temperature: 1.7 K	Satellite level test.

Table 3-1: Instrument related Tests on PLM PFM and Satellite Level

4 PLM PFM and Satellite AIT Flow

4.1 Activities Overview

Figure 4-1 gives an overview of the tasks which are planned to be performed during the PLM PFM and satellite AIT programme (for details see RD 1).

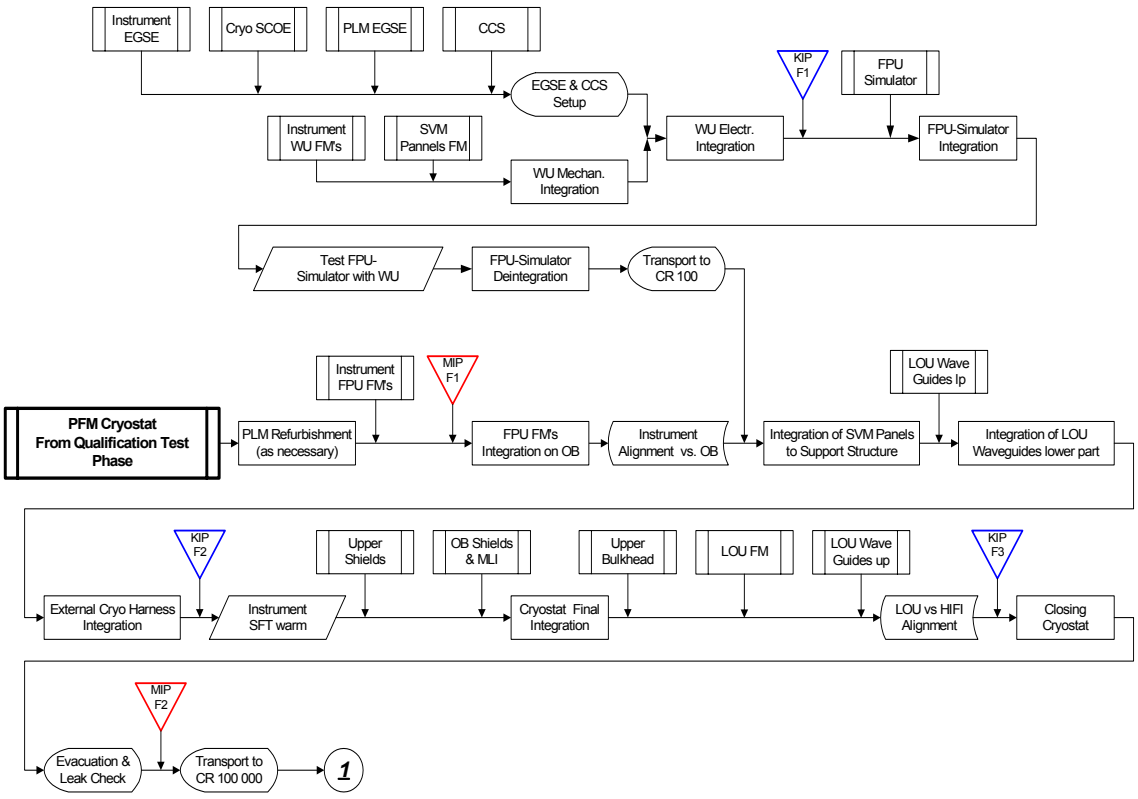

Figure 4-1: PLM PFM AIT Flow in Clean Room Class 100

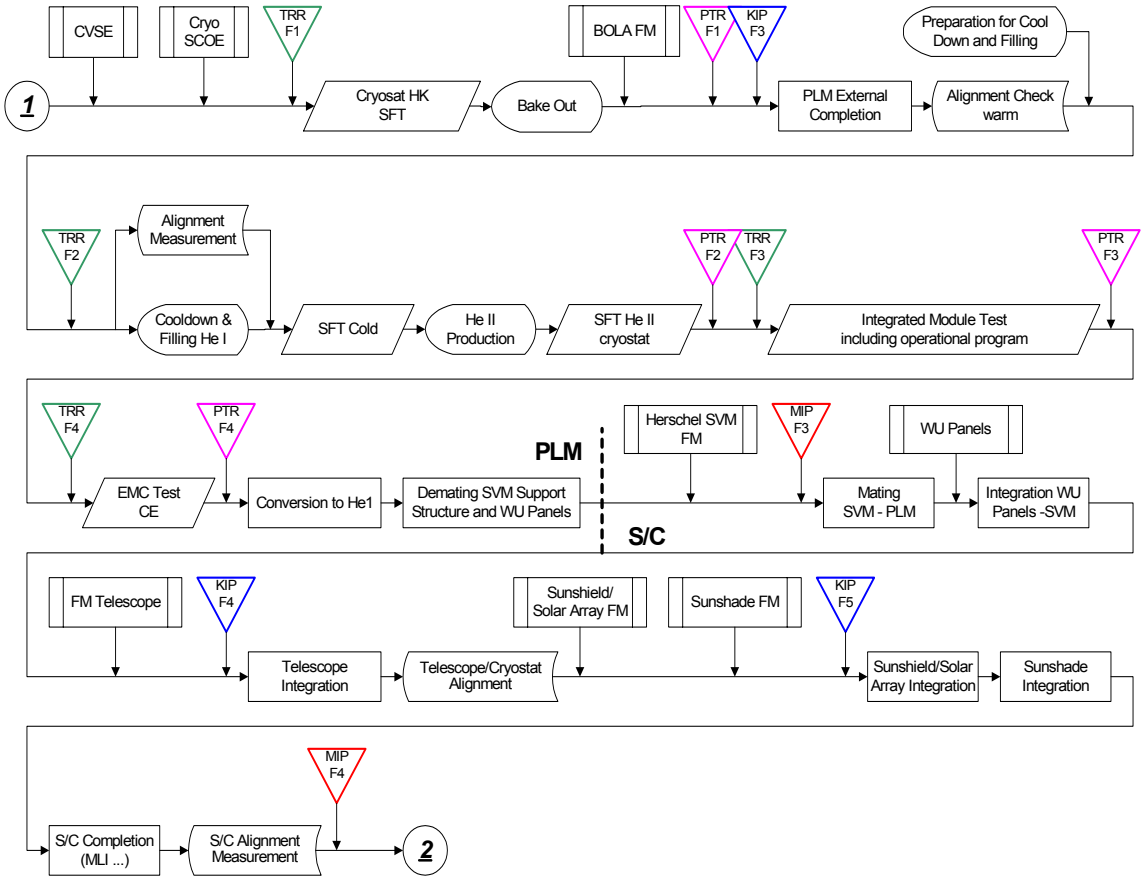

Figure 4-2: PLM PFM and Satellite AIT Flow in Clean Room 100.000

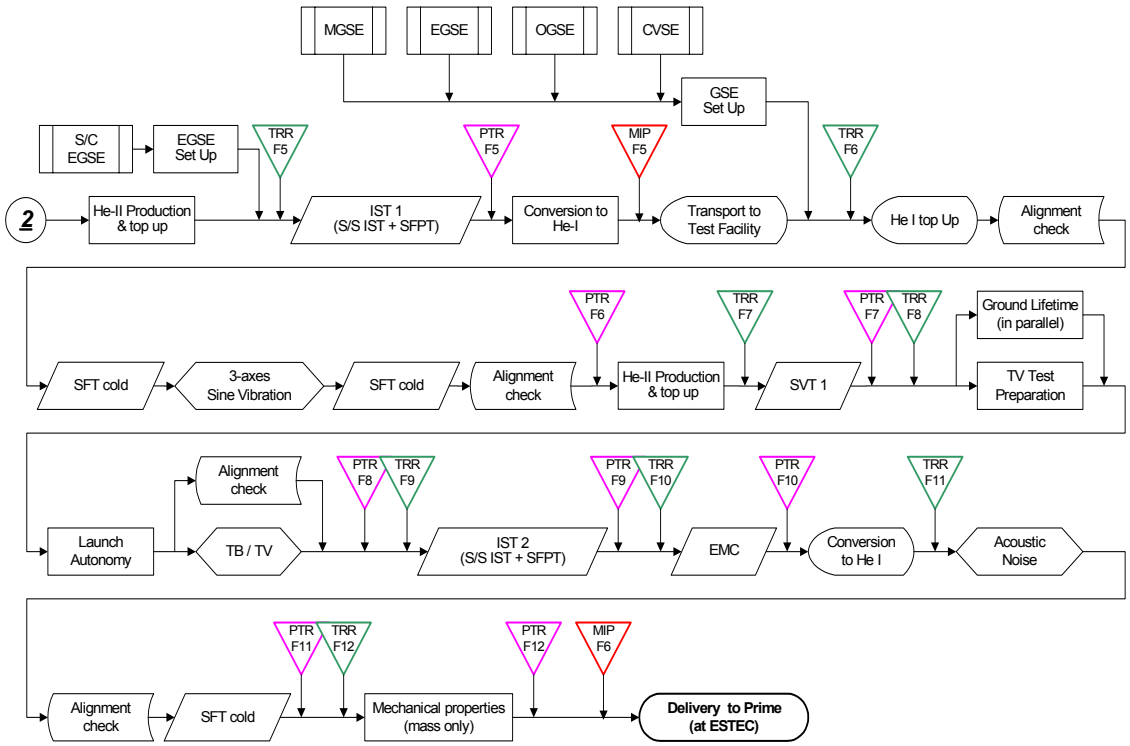

Figure 4-3: Satellite AIT Flow cont'd

4.2 Instrument Related Test Activities

4.2.1 Incoming Inspection

The incoming inspection will be performed on all instrument items to be integrated on the PLM, in order to assure their quality.

The incoming inspection covers the check of the shipment documentation, the visual inspection of the hardware, the cleanliness control (TBC), and the check of the end item data package.

4.2.2 Instrument EGSE Validation

The Instrument EGSE validation will comprise a check of the instrument SCOE (self-test) and its interface to the CCS.

The principle function and operability of the EGSE together with the satellite and the test procedures have already been validated during the EQM programme.

4.2.3 Electrical Integration Test

The electrical integration test for the FPU's will be performed on unit level after the unit integration in the CVV prior to closure of the cryostat. The test comprises a continuity check of all electrical interfaces at the minimum. The check includes the cryostat internal harness and harness connections (i. e. measurement is performed from CVV connectors external side). In order to minimise the risk on the FPU's health, it is assumed that this test is performed with a dedicated test equipment to be provided by the instruments, rather than with standard lab equipment (as e. g. ohmmeter) (TBC).

The warm units (plus HIFI LOU/ plus PACS BOLA) will be electrically checked in their entirety per instrument. The checks will use the FPU simulators. The instruments are controlled by the instrument EGSE (TBC).

4.2.4 Alignment Check

The first alignment check will be performed on PLM level after the evacuation in order to quantify potential displacements due to evacuation.

The second alignment check will be performed after the cool down, during the re-adjustment of the tank straps.

Further alignment checks are planned prior and after the environmental tests on satellite level (sine vibration, TB/TV test and acoustic noise test). During the TB/TV test the alignment will also be monitored within the TB/TV chamber in order to verify the predicted displacements due to outer cool down of the CVV and atmospheric pressure release.

The entire alignment check, incl. the alignment of the optical bench, is based on the alignment measurements between the HIFI FPU and LOU using the alignment camera system.

4.2.5 Short Functional Test (SFT)

The short functional test (SFT) is a tool to verify the electrical integrity and operability of the instruments in short time (few hours). It is assumed that the test evaluation is based on housekeeping data rather than scientific data. It is further assumed that the test does not require specific conditions of the PLM or satellite (e. g. cryostat orientation) or specific GSE.

There are defined three types of SFT's, each adapted to specific thermal environmental conditions for the FPU's: ambient, cold with He1 (normal boiling helium) and cold with He2 (supra fluid helium).

4.2.6 Specific Performance Test (SPT)

The specific performance test (SPT) is a tool to verify the instrument performance on PLM and satellite level.

The main objectives of the HIFI SPT's are to

- Ensure that the instrument is working properly and that the performance is within the predicted limits derived from the instrument level test results.
- Determine the impact of standing waves in the local optical path (LOU to FPU) by a dedicated 'reduced' standing wave test (TBC).

For PACS the objective of the SPT's are the verification of the

- Function of the instrument nominal and redundant units, sensors and mechanisms
- Instrument operability in general (switch-on/off procedures, time synchronisation with CDMU, autonomy functions, cooler recycling, operation modes, etc.)
- Detectors signal quality
- Performance of internal blackbody sources
- FPU thermal behaviour

The tests include

- Cryostat background measurements (representative telescope flux simulation).
- Calibration measurement using FPU internal blackbodies.

The SPIRE SPT's are based on the need to look at the following aspects:

- Recovery from cooler recycle.

- Settling time for photometer mode switch on.
- Switching from photometer to spectrometer mode.
- Switching from SPIRE prime to PACS/SPIRE parallel (TBC).
- Total cooler hold time during nominal operations.

At least one full operational cycle of the cooler (nominal 48 hours) is required in order to evaluate the hold time of the cooler under nominal in flight operating conditions. Two cooler cycles which need not be contiguous are preferred.

All SPT's are based on instrument level tests in order to allow an easy performance assessment by comparing the PLM or satellite level test results with the instrument level test results, assuming that the environmental conditions are comparable.

The SPT's require in-orbit representative thermal conditions inside the cryostat and mostly also for the detector back ground. This will be achieved by specific cryogenic means which are described in RD 2.

The following SPT's are defined per instrument (see also section 8.8 of this document):

HIFI

- IF Properties
- Receiver Tuning
- Radiometry
- Reduced Standing Wave Test 1) (TBC)

PACS [2)]

- Full Functional Test
- Short Performance Test
- Astronomical Observation Template (AOT) Tests
- PACS/SPIRE Parallel Mode

SPIRE

- Cooler Recycle
- Photometer Chop Mode
- Ambient Background Verification
- Spectrometer Mode
- PACS/SPIRE Parallel Mode

[1] A ‘full’ standing wave test involving a secondary mirror simulation is considered not to be feasible with reasonable effort. Hence it is planned to perform measurements only related to standing waves on the LO path between LOU and FPU.

[2] It is assumed that the cooler recycle is part of the Short Performance Test. It would be preferred to break down the Short Performance Test into its different subsets with the cooler recycle one of them, as for SPIRE.

4.2.7 Integrated Module Test (IMT)

With respect to the instruments the Integrated Module Test (IMT) is a sequence of tests which will be performed on PLM level and which allows a full assessment of the functional and measurement performance of the integrated instrument, as far as it is possible on this level.

Thus the IMT is composed of functional tests and performance tests using the procedures of the SFT’s and the SPT’s.

During the IMT the constraints of the PLM tilting angle during PACS and SPIRE cooler recycles will be considered.

The testing of the SPIRE instrument is planned around the recycle of the 300 mK cooler. In the IMT two full cooler recycle periods are foreseen.

An in-orbit representative thermal background will be achieved by specific cryogenic means which are described in RD 2.

Figure 4-4 shows the sequence of individual tests which will be performed during the IMT.

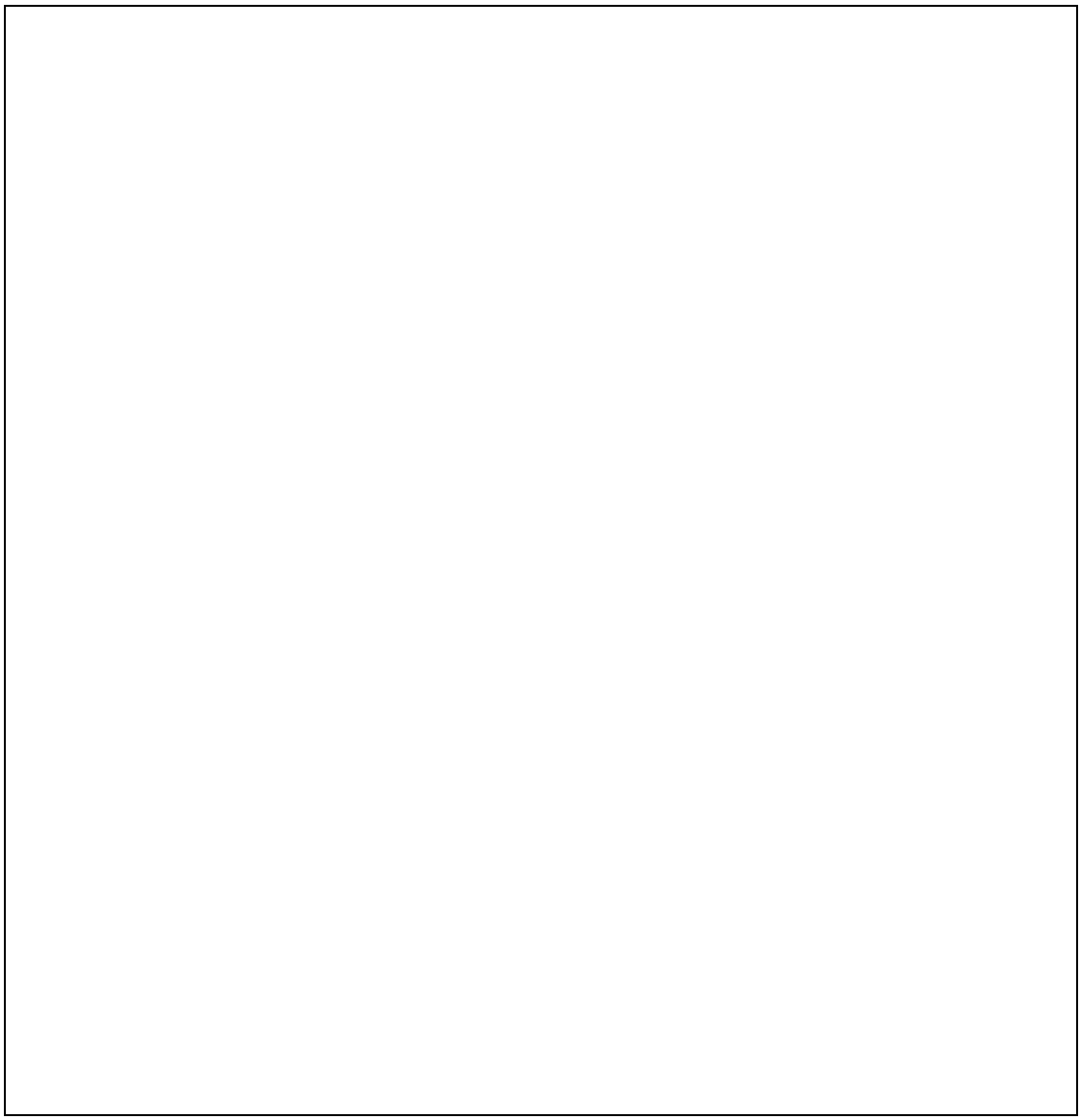

Figure 4-4: IMT Activity Flow

4.2.8 Integrated System Test (IST)

The individual instrument related test sequence for the Integrated System Test (IST) which is performed on satellite level is practically the same as for the IMT which is performed on PLM PFM level (see Figure 4-4).

However, the IST set-up is different to the IMT set-up: During the IST the instruments are controlled via the satellite bus, whilst during the IMT the instruments are connected to the EGSE (satellite bus not yet integrated).

Two IST runs are planned, the first, called IST1, will be performed directly after the completion of the satellite integration, the second, called IST2, after the sine vibration and TB/TV tests.

4.2.9 EMC Test

On PLM PFM level the EMC test comprises measurements of the conducted emission per instrument (CE test). On satellite level the EMC test is composed by measurements of the conducted emission (CE test) and radiated emission (RE) and the verification of the functional performance of each instrument under conducted and radiated electromagnetic distortions (CS and RS test). During the conducted and radiated emission measurements the instruments are individually switched in a mode with maximum generation of electromagnetic distortions. During the conducted and radiated susceptibility test the instruments are switched in a mode with highest sensitivity to electromagnetic distortions.

The instruments will be tested individually, i. e. the EMC test configurations and sweeps will be repeated for each instrument.

During the EMC test the constraints of the PLM tilting angle during PACS and SPIRE cooler recycles will be considered.

An in-orbit representative thermal background will be achieved by specific cryogenic means which are described in RD 2.

Figure 4-5 and Figure 4-6 describe the instrument tests and modes to be performed within the EMC tests on PLM PFM and satellite level.

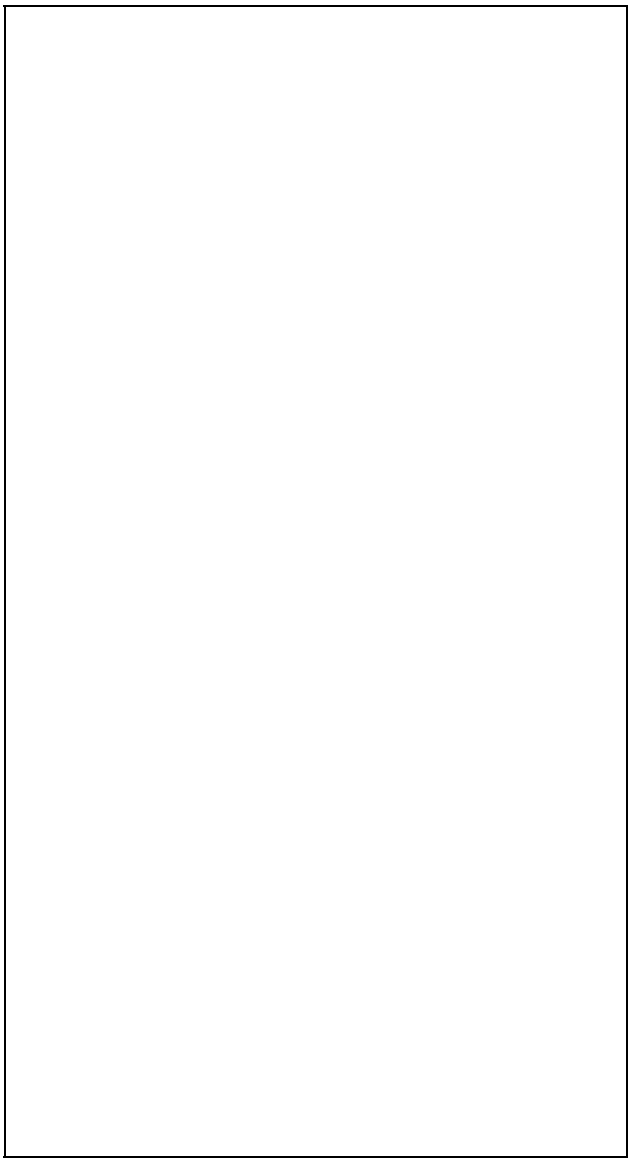

Figure 4-5: EMC Test Activities Flow on PLM PFM Level

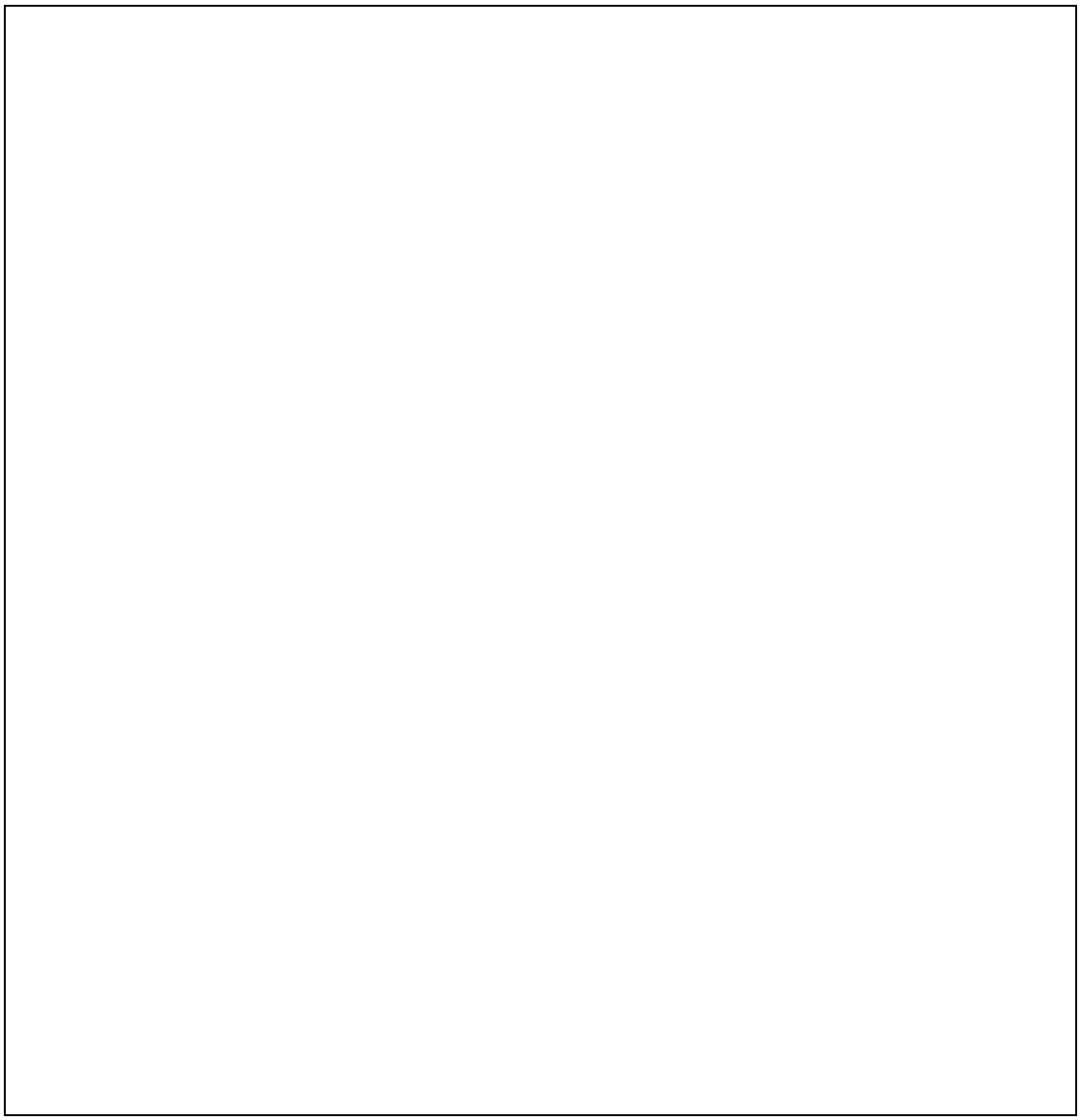

Figure 4-6: EMC Test Activities Flow on Satellite Level

4.2.10 Sine Vibration and Acoustic Noise Test

Both tests are performed on satellite level. The main objectives as regards the instruments is to check the workmanship and the stability of the alignment.

During both tests the instruments are switched off.

4.2.11 TB/TV Test

The TB/TV test is performed on satellite level only.

One objective of this test as regards the instruments is the instrument TMM validation.

Another objective is the verification of functional performance of the instruments in nearly flight conditions (details TBD).

During the TB/TV test all relevant instrument temperatures are continuously monitored.

For the verification of the instruments functional performance a similar test sequence as for the IST will be performed (see Figure 4-7). The tests will be carried out after the temperature stabilisation in cold.

During the TB/TV the constraints of the PLM tilting angle during PACS and SPIRE cooler recycles will be considered (as far as possible).

The testing of the SPIRE instrument is planned around the recycle of the 300 mK cooler. In the TB/TV test two full cooler recycle periods are foreseen (TBC).

An in-orbit representative thermal background will be achieved by specific cryogenic means which are described in RD 2.

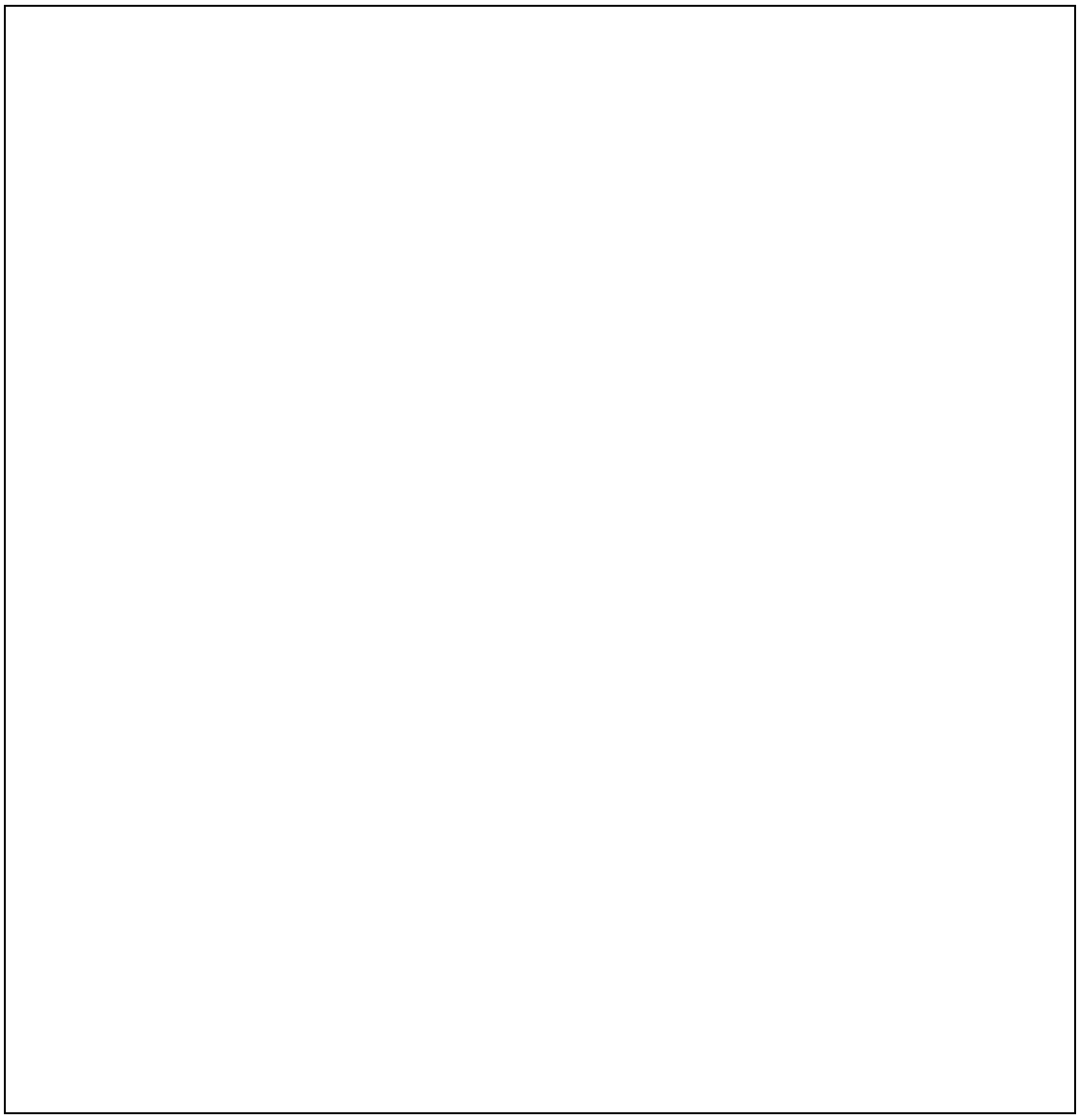

Figure 4-7: TB/TV Test Activities Flow (TBC)

4.2.12 System Validation Test (SVT)

The TB/TV test is performed on satellite level only with the satellite directly linked to the control centre.

As regards the instruments the objective of this test is the verification of the instrument commanding by the control centre and the instrument telemetry and science data transmission to the control centre.

Goal is to validate all defined instrument commands. Furthermore the telemetry formats and source packets will be evaluated.

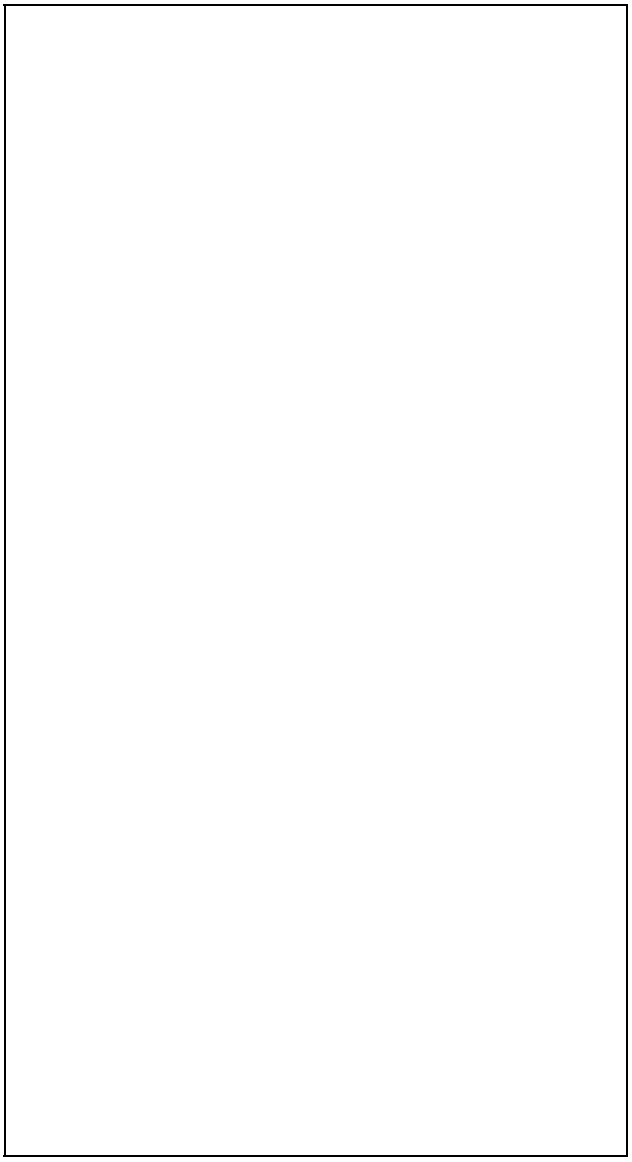

Figure 4-8: SVT Activities Flow (still TBD)

5 Instrument Configurations

5.1 Delivered Instrument Flight Hardware Items

5.1.1 HIFI PFM Deliverables

The HIFI instrument delivery configuration for the PLM PFM programme is as per Table 5-1.

Unit	Model	Remarks
FPU	PFM	1 box
LOU	PFM	1 box
FCU	PFM	1 box
LSU	PFM	1 box
LCU	PFM	1 box
HRI	PFM	1 box
HRH	PFM	1 box
HRV	PFM	1 box
WEH	PFM	1 box
WEV	PFM	1 box
WOH	PFM	1 box
WOV	PFM	1 box
ICU	PFM	1 box
WIH	PFM	Warm units interconnection harness

Note: Cryo harness and HIFI Waveguide Assembly will be provided by ASED.

Table 5-1: HIFI Instrument Hardware Items

5.1.2 PACS PFM Deliverables

The PACS instrument delivery configuration for the PLM PFM programme is as per Table 5-2.

Unit	Model	Remarks
FPU	PFM	1 box
DPU	PFM	1 box
SPU	PFM	2 boxes (one prime and one redundant)
DECMEC	PFM	2 boxes (one prime and one redundant)
BOLC	PFM	1 box with prime and redundant sections
BOLA	PFM	1 box
WIH	PFM	Warm units interconnection harness

Note: Cryo harness will be provided by ASED.

Table 5-2: PACS Instrument Hardware Items

5.1.3 SPIRE PFM Deliverables

The SPIRE instrument delivery configuration for the PLM PFM programme is as per Table 5-3.

Unit	Model	Remarks
FPU	PFM	
JFS	PFM	
JFP	PFM	
DCU	PFM	
FCU	PFM	
DPU	PFM	1 box with prime and redundant sections
DMU	PFM	2 boxes (one prime and one redundant)
WIH	PFM	Warm units interconnection harness

Note: Cryo harness will be provided by ASED.

Table 5-3: SPIRE Instrument Hardware Items

5.2 Delivered Instrument GSE Items

The delivered GSE for the PLM PFM programme is as per Table 5-4.

Instrument	GSE	Remarks
HIFI	CW test signal source	Used for TBD tests
	LO beam splitter	Used for TBD tests
	FPU simulator	For warm units post integration test
	EGSE to perform electrical interface checks on the FPU at ambient (TBC).	
	HIFI EGSE	To be detailed
PACS	FPU Simulator	For warm units post integration test
	EGSE to perform electrical interface checks on the FPU at ambient (TBC).	
	PACS EGSE	To be detailed
SPIRE	HSCDMU simulator EGSE	Only available for electrical integration test
	HJCDU simulator EGSE	Only available for electrical integration test
	FPU Simulator	For warm units post integration test
	EGSE to perform electrical interface checks on the FPU at ambient (TBC).	
	Shutter EGSE	Used for TBD tests
	SPIRE Test Facility Control System (TFCS)	Used for TBD tests
	SPIRE EGSE Router	Used for TBD tests

Table 5-4: GSE Items

5.3 Delivered Instrument Documentation

For each instrument an EIDP will be provided.

6 Instrument Related Test Set-up

6.1 EGSE Set-up

The principle PFM PLM test set-up is shown in Figure 6-1. It consists of a Herschel representative data- and power front end to operate the instruments and the Cryo SCOE to control the cryostat. A CCS "light" serves as Core EGSE. The interfaces between Core EGSE and Instrument EGSE are the same as on satellite level.

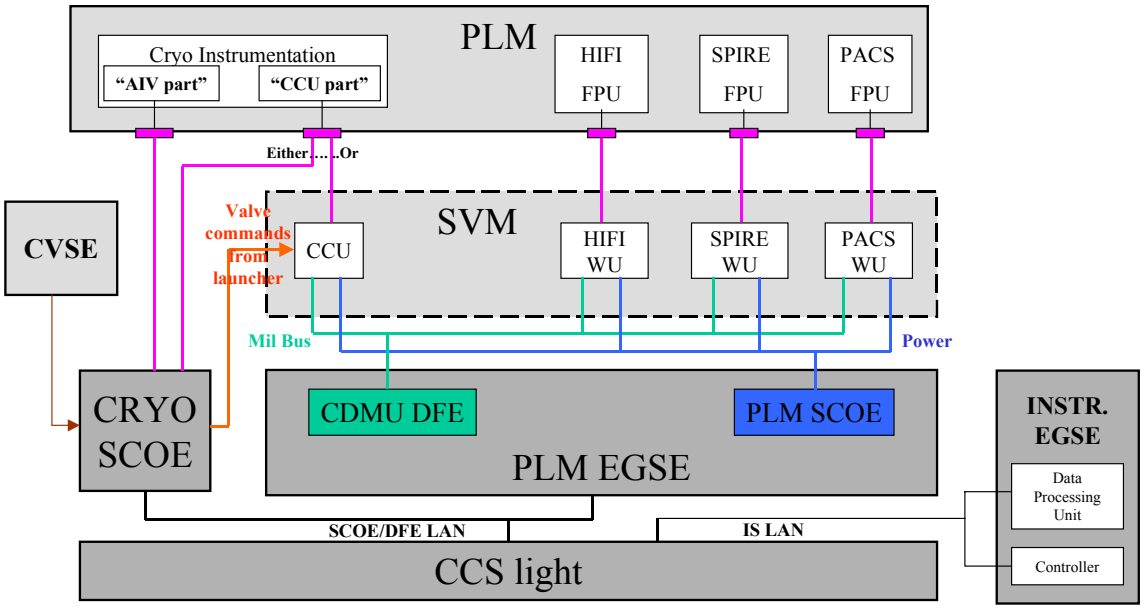

Figure 6-1: Principle EGSE Set-up for PFM Tests

The test set-up for the satellite tests is depicted in Figure 6-2.

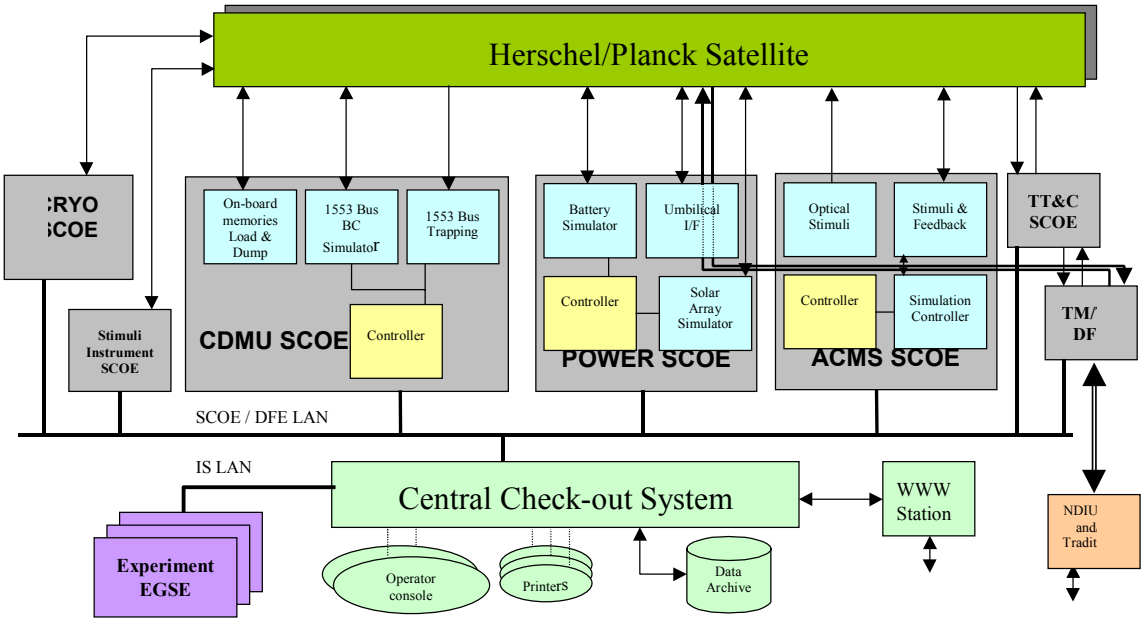

Figure 6-2: Principle EGSE Set-up for Satellite Tests

The specific test set-ups which will be implemented for the PLM PFM level instrument tests are shown in Figure 6-3, Figure 6-4 and Figure 6-5.

[Here block diagrams shall be introduced which show all required instrument related specific test set-ups, e. g. for the electrical integration tests of the FPU and for the warm units.]

Figure 6-3: Specific HIFI Test Set-up

[Here block diagrams shall be introduced which show all required instrument related specific test set-ups, e. g. for the electrical integration tests of the FPU and for the warm units.]

Figure 6-4: Specific PACS Test Set-up

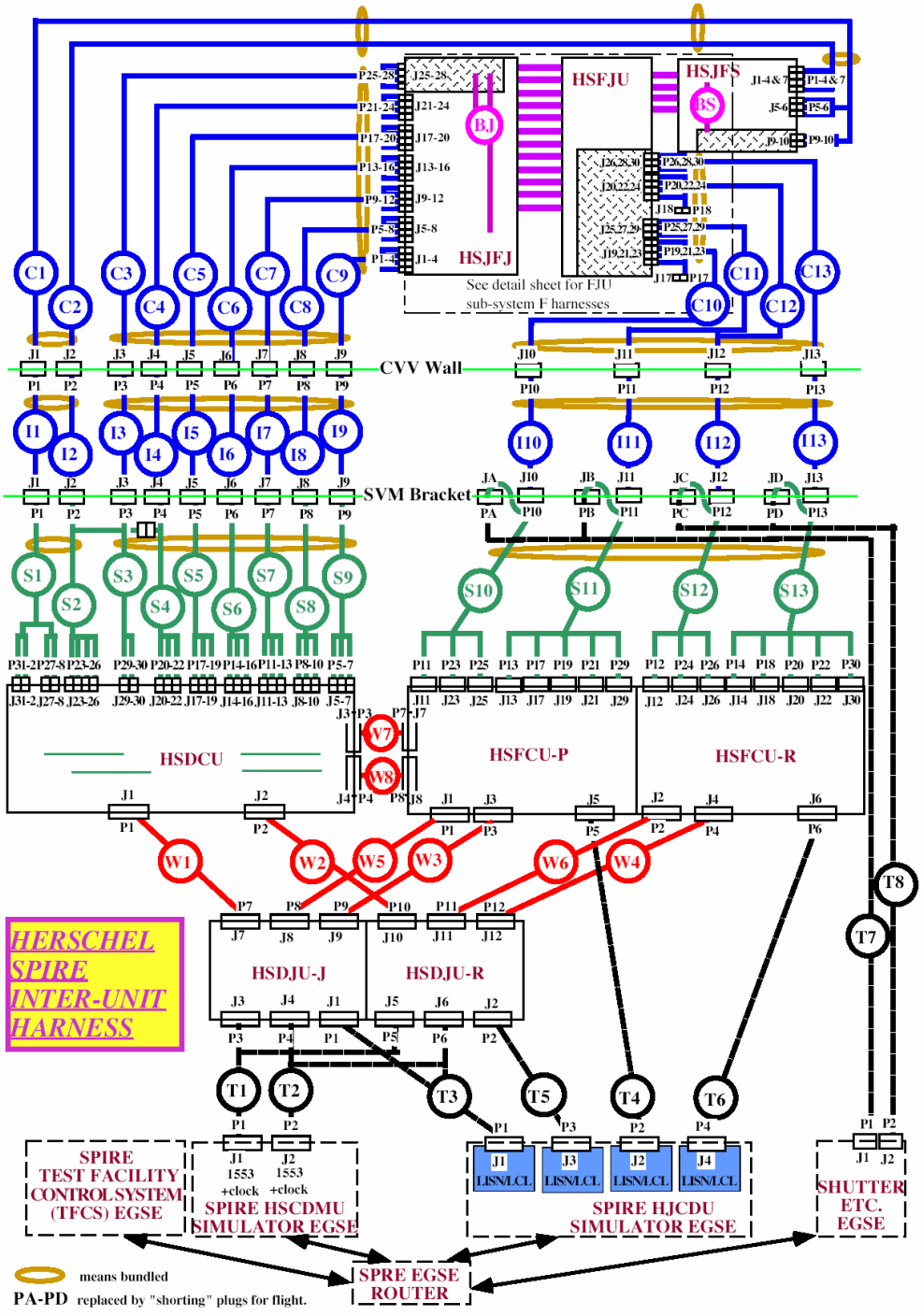

Figure 6-5: Specific SPIRE Test Set-up for the Instrument Electrical Integration Check (TBC)

6.2 Test Facility

The PLM tests (incl. EMC test) will take place in a clean room class 100 000 in a test facility at Astrium GmbH. The layout of the Astrium GmbH test facility in Ottobrunn is shown in Figure 6-6. For details see AD 06.

The satellite environmental tests (sine vibration, acoustic noise, EMC and TB/TV) will be conducted at ESTEC or IABG facilities (TBC).

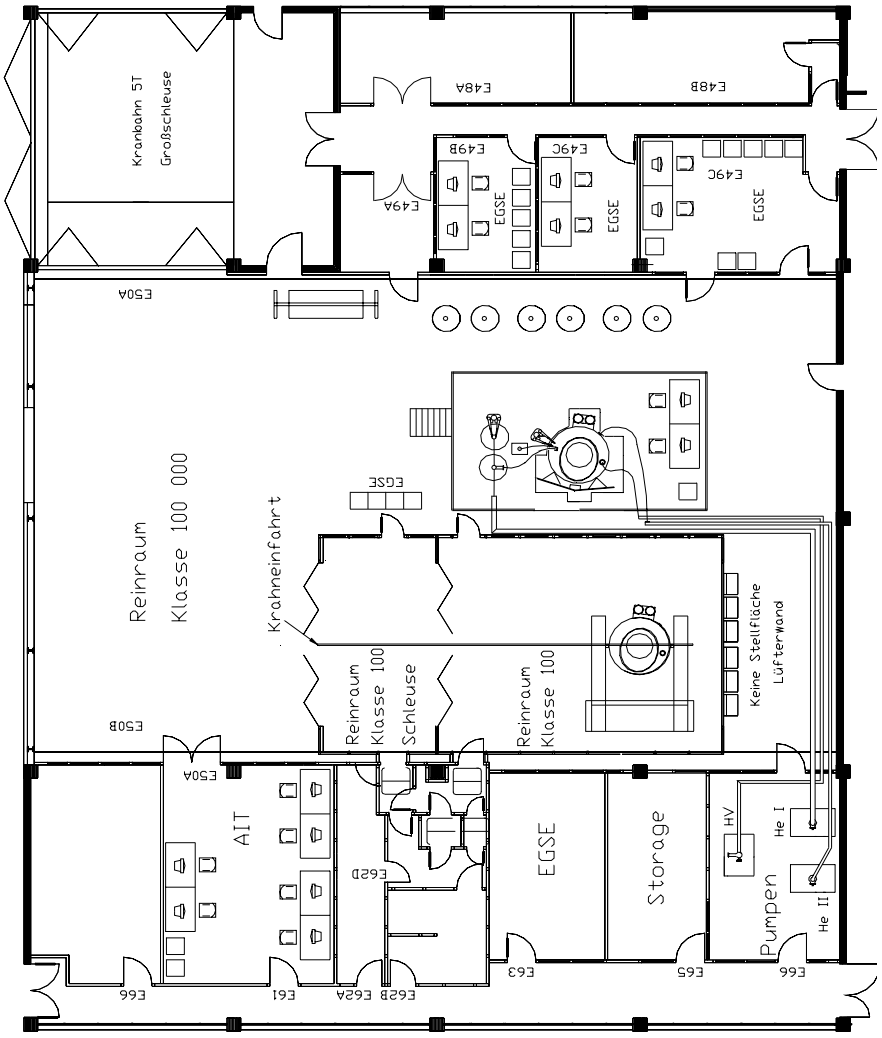

Figure 6-6: Layout of Test Facility

7 Instrument Related Test Constraints

7.1 Operational Constraints

The operational restrictions, constraints and limitations from instrument side which have to be respected during their integration and tests at PLM PFM and satellite level are summarised in Table 7-1.

	HIFI	**PACS**	**SPIRE**
Critical commands	None	TBD	TBD
Critical instrument H/K parameters	None	TBD	TBD
ESD critical connectors	None	TBD	TBD
Red/green tagged items relevant to the test	None	TBD	TBD
Specific handling constraints	None	TBD	TBD
Protective covers to be used	None	TBD	TBD
Warm-up times	None	TBD	TBD
Specific PLM orientations	None	20° during cooler recycle (TBC)	17° during cooler recycle (TBC)
TBD			

Table 7-1: Instrument Ground Constraints

7.2 Sensor Background

PACS and SPIRE require a dark background for their sensors during some of the performance tests. The dark background is provided by a specific CTA which has the following specification (for details see RD 2):

TBD

7.3 Temperature Ranges

The L0, L1 and L2 temperature levels provided by the Herschel PFM cryostat at the FPU thermal links are listed in Table 7-2. The given ranges are valid for the corresponding instrument in operation. For details see RD 3.

	HIFI		**PACS**		**SPIRE**	
	min [K]	max [K]	min [K]	max	min [K]	max
At He1 conditions	L0: 4.2 L1: L2:	L0: L1: L2:	L0: 4.2 L1: 4.2 L2:	L0: L1: L2:	L0: 4.2 L1: L2:	L0: L1: L2:
At He2 conditions	L0: 1.7 L1: 1.7 L2: 9.0	L0: 3.0 L1: 10.0 L2: 15.0	L0: 1.7 L1: 1.7 L2: 9.0	L0: 3.0 L1: 6.0 L2: 15.0	L0: 1.7 L1: 1.7 L2: 9.0	L0: 3.0 L1: 8.0 L2: 15.0

Table 7-2: Interface Temperatures provided by the Herschel PFM Cryostat

8 Instrument Test Activity Descriptions

This section describes the individual test activities per instrument which will be performed on PLM PFM and satellite level. Each test activity is self-contained.

The principle objectives of the test groups are as per section 3.2.

For each single test activity a dedicated test procedure will be established per unit and/or subsystem to be tested, as far as applicable.

For the PLM PFM and satellite level tests the test procedures developed for and validated at the instrument and PLM EQM level tests will be re-used with no or minimal modifications.

8.1 Incoming Inspection

8.1.1 HIFI Incoming Inspection

Title:	*Experiment:*
Incoming Inspection	**HIFI**

Objectives:
Visual inspection of the delivered instrument for damage. Check of completeness of hardware items and documentation.

Test Description:
Check each unit on shipment notification, complete and correct documentation, visual inspection of damage of transport container (prior to unpacking) and damage and cleanliness of unit,

Instrument Configuration:	*Specific Requirements on PLM and/or satellite:*
The delivered units are as per Table 5-1. Probably three separate shipments: 1) FPU, 2) LOU and 3) warm units plus IEGSE.	N/A

Particular Environmental Constraints:
Clean room, class 100 for FPU, class 100.000 or better for other units. ESD certified area. Relative humidity > 40 % and < 55 %.

Success Criteria:
Documents complete and correct, no damage on delivered hardware.

Duration:	*Applicable:*
3 h	PLM PFM

8.1.2 PACS Incoming Inspection

Title:	*Experiment:*
Incoming Inspection	**PACS**

Objectives:
Visual inspection of the delivered instrument for damage. Check of completeness of hardware items and documentation.

Test Description:
Check each unit on shipment notification, complete and correct documentation, visual inspection of damage of transport container (prior to unpacking) and damage and cleanliness of unit,

Instrument Configuration:	*Specific Requirements on PLM and/or satellite:*
The delivered units are as per Table 5-1, packed in separate transport boxes (TBC).	N/A

Particular Environmental Constraints:
Clean room, class 100 for FPU, class 100.000 or better for other units. ESD certified area. Relative humidity > 40% and < 55 %.

Success Criteria:
Documents complete and correct, no damage on delivered hardware.

Duration:	*Applicable:*
3 h	PLM PFM

8.1.3 SPIRE Incoming Inspection

Title:	*Experiment:*
Incoming Inspection	**SPIRE**

Objectives:
Visual inspection of the delivered instrument for damage. Check of completeness of hardware items and documentation.

Test Description:
Check each unit on shipment notification, complete and correct documentation, visual inspection of damage of transport container (prior to unpacking) and damage and cleanliness of unit,

Instrument Configuration:	*Specific Requirements on PLM and/or satellite:*
The delivered units are as per Table 5-1, packed in separate transport boxes (TBC).	N/A

Particular Environmental Constraints:
Clean room, class 100 for FPU, class 100.000 or better for other units. ESD certified area. Relative humidity > 40% and < 55 %.

Success Criteria:
Documents complete and correct, no damage on delivered hardware.

Duration:	*Applicable:*
3 h	PLM PFM

8.2 Instrument EGSE Validation

8.2.1 HIFI EGSE Check Out

Title:	*Experiment:*
EGSE Check Out	**HIFI**

Objectives:
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:	*Specific Requirements on PLM and/or satellite:*
As per Table 5-4.	None.

Particular Environmental Constraints:
None.

Success Criteria:
TBD

Duration:	*Applicable:*
TBD	PLM PFM and satellite

8.2.2 PACS EGSE Check Out

Title:	*Experiment:*
EGSE Check Out	**PACS**

Objectives:
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:	*Specific Requirements on PLM and/or satellite:*
As per Table 5-4.	None.

Particular Environmental Constraints:
None.

Success Criteria:
TBD

Duration:	*Applicable:*
TBD	PLM PFM and satellite

8.2.3 SPIRE EGSE Check Out

Title:	*Experiment:*
EGSE Check Out	**SPIRE**

Objectives:
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:	*Specific Requirements on PLM and/or satellite:*
As per Table 5-4.	None.

Particular Environmental Constraints:
None.

Success Criteria:
TBD

Duration:	*Applicable:*
TBD	PLM PFM and satellite

8.3 Electrical Integration Test

8.3.1 HIFI Electrical Interface Test

Title:	*Experiment:*
Electrical Interface Test	**HIFI**

Objectives:
Check of input/output circuits function and characteristics, shielding and grounding.

Test Description:
TBD for FPU (dedicated EGSE from HIFI needed)
TBD for LOU plus warm units (with FPU simulator)

Instrument Configuration:	*Specific Requirements on PLM and/or satellite:*
The units to be tested are as per Table 5-1.	None

Particular Environmental Constraints:
Clean room, class 100 for FPU, class 100.000 or better for other units. ESD certified area. Relative humidity > 40% and < 55 %.

Success Criteria:
Input/output circuit characteristics, isolation and bonding resistances as per spec.

Duration:	*Applicable:*
1 day	PLM PFM

8.3.2 PACS Electrical Interface Test

Title:	*Experiment:*
Electrical Interface Test	**PACS**

Objectives:
Check of input/output circuits function and characteristics, shielding and grounding.

Test Description:
TBD for FPU (dedicated EGSE from PACS needed)
TBD for BOLA plus warm units (with FPU simulator)

Instrument Configuration:	*Specific Requirements on PLM and/or satellite:*
The units to be tested are as per Table 5-1.	None

Particular Environmental Constraints:
Clean room, class 100 for FPU, class 100.000 or better for other units. ESD certified area. Relative humidity > 40% and < 55 %.

Success Criteria:
Input/output circuit characteristics, isolation and bonding resistances as per spec.

Duration:	*Applicable:*
1 day	PLM PFM

8.3.3 SPIRE Electrical Interface Test

Title:	*Experiment:*
Electrical Interface Test	**SPIRE**

Objectives:
Check of input/output circuits function and characteristics, shielding and grounding.

Test Description:
TBD for FPU (dedicated EGSE from SPIRE needed)
TBD for warm units (with FPU simulator)

Instrument Configuration:	*Specific Requirements on PLM and/or satellite:*
The units to be tested are as per Table 5-1.	None

Particular Environmental Constraints:
Clean room, class 100 for FPU, class 100.000 or better for other units. ESD certified area. Relative humidity > 40% and < 55 %.

Success Criteria:
Input/output circuit characteristics, isolation and bonding resistances as per spec.

Duration:	*Applicable:*
1 day	PLM PFM

8.4 Alignment Check

8.4.1 HIFI Alignment Test

Title:	*Experiment:*
Alignment Test	**HIFI**

Objectives:
Check change in alignment of FPU and LOU after evacuation and cool down, prior and after sine vibration and TB/TV test and inside the TV chamber. With this check also the alignment of the optical bench with respect to the CVV is covered.

Test Description:
During this test the relative alignment between the LOU and FPU will be monitored. The alignment devices located on the FPU and alignment devices installed on the LOU will be used. The alignment will be checked by an external alignment camera (TBC). The alignment state will be recorded prior to evacuation, after evacuation / prior to cool down, prior and after sine vibration and TB/TV test and inside the TV chamber.

Instrument Configuration:	*Specific Requirements on PLM and/or satellite:*
As per Table 5-1 plus alignment devices on FPU and LOU plus alignment camera (TBC). Note: the alignment devices on the FPU are fix.	None.

Particular Environmental Constraints:
Clean room, class 100 for FPU, class 100.000 or better for other units. ESD certified area. Relative humidity > 40% and < 55 %.

Success Criteria:
Alignment stays within the predicted error budget.

Duration:	*Applicable:*
2 days per alignment check (TBC)	PLM PFM and satellite

8.5 Short Functional Test Warm

8.5.1 HIFI Short Functional Test Warm

Title:	*Experiment:*
Short Functional Test Warm	**HIFI**

Objectives:
Confidence test to check electrical integrity and operability of instrument under ambient conditions for both, the FPU and the warm units prior to the evacuation of the CVV. The operability of the FPU under ambient conditions is limited, therefore 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.

Instrument Configuration:	*Specific Requirements on PLM and/or satellite:*
As per Table 5-1 and Table 5-4.	None.

Particular Environmental Constraints:
Clean room, class 100 for FPU, class 100.000 or better for other units. ESD certified area. Relative humidity > 40% and < 55 %.

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

Duration:	*Applicable:*
TBD h	PLM PFM

8.5.2 PACS Short Functional Test Warm

Title:	*Experiment:*
Short Functional Test Warm	**PACS**

Objectives:
Confidence test to check electrical integrity and operability of instrument under ambient conditions for both, the FPU and the warm units prior to the evacuation of the CVV. The operability of the FPU under ambient conditions is limited, therefore 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.

Instrument Configuration:	*Specific Requirements on PLM and/or satellite:*
As per Table 5-1 and Table 5-4.	None.

Particular Environmental Constraints:
Clean room, class 100 for FPU, class 100.000 or better for other units. ESD certified area. Relative humidity > 40% and < 55 %.

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

Duration:	*Applicable:*
TBD h	PLM PFM

8.5.3 SPIRE Short Functional Test Warm

Title:	*Experiment:*
Short Functional Test Warm	**SPIRE**

Objectives:
Confidence test to check electrical integrity and operability of instrument under ambient conditions for both, the FPU and the warm units prior to the evacuation of the CVV. The operability of the FPU under ambient conditions is limited, therefore 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.

Instrument Configuration:	*Specific Requirements on PLM and/or satellite:*
As per Table 5-1 and Table 5-4.	None.

Particular Environmental Constraints:
Clean room, class 100 for FPU, class 100.000 or better for other units. ESD certified area. Relative humidity > 40% and < 55 %.

Success Criteria:
Housekeeping values monitored via CCS and QLA within pre-defined limits derived from instrument level test results. Correct execution of commands.

Duration:	*Applicable:*
about 6 h	PLM PFM

8.6 Short Functional Test Cold

8.6.1 HIFI Short Functional Test Cold

Title:	*Experiment:*
Short Functional Test Cold	**HIFI**

Objectives:
Confidence test to check electrical integrity and operability of instrument. 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.

Instrument Configuration:	*Specific Requirements on PLM and/or satellite:*
As per Table 5-1 and Table 5-4.	None.

Particular Environmental Constraints:
L0: TBD, L1: TBD and L2: TBD.

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

Duration:	*Applicable:*
TBD h	PLM PFM and satellite

8.6.2 PACS Short Functional Test Cold

Title:	*Experiment:*
Short Functional Test Cold	**PACS**

Objectives:
Confidence test to check electrical integrity and operability of instrument. 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.

Instrument Configuration:	*Specific Requirements on PLM and/or satellite:*
As per Table 5-1 and Table 5-4.	None.

Particular Environmental Constraints:
L0: TBD, L1: TBD and L2: TBD.

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

Duration:	*Applicable:*
TBD h	PLM PFM and satellite

8.6.3 SPIRE Short Functional Test Cold

Title:	*Experiment:*
Short Functional Test Cold	**SPIRE**

Objectives:
Confidence test to check electrical integrity and operability of instrument. 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.

Instrument Configuration:	*Specific Requirements on PLM and/or satellite:*
As per Table 5-1 and Table 5-4.	None.

Particular Environmental Constraints:
L0: TBD, L1: TBD and L2: TBD.

Success Criteria:
Housekeeping values monitored via CCS and QLA within pre-defined limits derived from instrument level test results. Correct execution of commands.

Duration:	*Applicable:*
about 6 h	PLM PFM and satellite

8.7 Short Functional Test He2

8.7.1 HIFI Short Functional Test He2

Title:	*Experiment:*
Short Functional Test He2	**HIFI**

Objectives:
Confidence test to check electrical integrity and operability of instrument. 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.

Instrument Configuration:	*Specific Requirements on PLM and/or satellite:*
As per Table 5-1 and Table 5-4.	None.

Particular Environmental Constraints:
L0: TBD, L1: TBD and L2: TBD.

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

Duration:	*Applicable:*
TBD h	PLM PFM and satellite

8.7.2 PACS Short Functional Test He2

Title:	*Experiment:*
Short Functional Test He2	**PACS**

Objectives:
Confidence test to check electrical integrity and operability of instrument. 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.

Instrument Configuration:	*Specific Requirements on PLM and/or satellite:*
As per Table 5-1 and Table 5-4.	None.

Particular Environmental Constraints:
L0: TBD, L1: TBD and L2: TBD.

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

Duration:	*Applicable:*
TBD h	PLM PFM and satellite

8.7.3 SPIRE Short Functional Test He2

Title:	*Experiment:*
Short Functional Test He2	**SPIRE**

Objectives:
Confidence test to check electrical integrity and operability of instrument. 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.

Instrument Configuration:	*Specific Requirements on PLM and/or satellite:*
As per Table 5-1 and Table 5-4.	None.

Particular Environmental Constraints:
L0: TBD, L1: TBD and L2: TBD.

Success Criteria:
Housekeeping values monitored via CCS and QLA within pre-defined limits derived from instrument level test results. Correct execution of commands.

Duration:	*Applicable:*
about 6 h	PLM PFM and satellite

8.8 Special Performance Tests

8.8.1 HIFI IF Properties

Title:	*Experiment:*
IF Properties	**HIFI**

Objectives:
Check IF standing waves due to representative coax cables between IF box and spectrometers as well as spectral features due to leakage / finite shielding / isolation.

Test Description:
In this test the IF chain of HIFI will be checked in a representative environment. Important changes with respect to HIFI DM tests are the change in harness (coax cables) and the environment (different locations / geometry / configuration and other systems involved). It is therefore needed to check the IF properties of the HIFI IF chain in terms of gain, noise, spectral ripple and spectral artefacts (spurs).

Instrument Configuration:	*Specific Requirements on PLM and/or satellite:*
As per Table 5-1 and Table 5-4.	None

Particular Environmental Constraints:
Mass flow rate: 2.2 mg/s.
L0: TBD, L1: TBD and L2: TBD.
Sensor background TBD.

Success Criteria:
IF gain / noise, ripple and spectrum within values applicable to IF chain.

Duration:	*Applicable:*
1 day	PLM PFM and satellite

8.8.2 HIFI Receiver Tuning

Title:	*Experiment:*
Receiver Tuning	**HIFI**

Objectives:
Relate pump current to LO power (expressed in μA). Generate update of tuning tables corresponding to current state of integration (parameters to be updated will be defined in the HIFI DM phase).

Test Description:
Because the FPU to LOU alignment might be slightly different to that during the HIFI instrument level test phase new relations between LOU power parameter settings and pump current on the FPU mixers have to be established. It might furthermore be possible that because of different temperature levels and because of a different environment configuration wise the tuning tables need an update. The updating of the tuning tables is furthermore an exercise that has to be verified since this procedure is needed during the in-orbit calibration.

Instrument Configuration:	*Specific Requirements on PLM and/or satellite:*
As per Table 5-1 and Table 5-4.	None

Particular Environmental Constraints:
Mass flow rate: 2.2 mg/s.
L0: TBD, L1: TBD and L2: TBD.
Sensor background TBD.

Success Criteria:
Establishment of relation between pump current and LO power setting. Successful generation of updated tuning tables. Deviations determined by comparing to measurement results obtained during HIFI instrument level test are within TBD % or understood.

Duration:	*Applicable:*
3 days	PLM PFM and satellite

8.8.3 HIFI Radiometry

Title:	*Experiment:*
Radiometry	**HIFI**

Objectives:
Determination of (conversion) gain and noise temperature over the RF band.

Test Description:
The noise temperature and gain will be determined at a limited number of points within the mixer bands that are present. This test is needed to verify proper heterodyne functioning before entering the detailed performance assessment during EMC test.

Instrument Configuration:	*Specific Requirements on PLM and/or satellite:*
As per Table 5-1 and Table 5-4.	None

Particular Environmental Constraints:
Mass flow rate: 2.2 mg/s.
L0: TBD, L1: TBD and L2: TBD.
Sensor background TBD.

Success Criteria:
Deviations determined by comparing to measurement results obtained during HIFI instrument level test are within TBD % or understood.

Duration:	*Applicable:*
1 day	PLM PFM and satellite

8.8.4 HIFI Reduced Standing Wave Test

Title:	*Experiment:*
Reduced Standing Wave Test	**HIFI**

Objectives:
Assessment of the level of reflections in the LO path (LOU to FPU).

Test Description:
During this test the level of reflections in the local optical paths (LOU to FPU) will be measured. Such reflections will cause artefacts in the instrument scientific data and it is important to verify that they are effectively suppressed. For reflections in the LO path, the LOU to FPU mixer coupling as a function of LO frequency will be measured.

Instrument Configuration:	*Specific Requirements on PLM and/or satellite:*
As per Table 5-1 and Table 5-4.	Flight representative spacecraft configuration. For the LO path the test configuration will include representative baffles, shields and LO windows along the LO beam path.

Particular Environmental Constraints:
Mass flow rate: 2.2 mg/s.
L0: TBD, L1: TBD and L2: TBD.
Sensor background TBD.

Success Criteria:
Verification of baseline ripple of < 0.1% (TBC) of system noise level. Verification that the variation in LO path coupling due to standing waves is less than 20% peak-to-peak as a function of frequency.
Comparison with measurement results obtained during HIFI DM ILT shall confirm LO path losses are within 20 % or understood.

Duration:	*Applicable:*
3 days	PLM PFM and satellite

8.8.5 PACS Full Functional Test

Title:	*Experiment:*
Full Functional Test	**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, validate function of redundancy chains: not available at PFM Test, verify PACS autonomy functions (limit checks), verify PACS telemetry rates, verify time synchronisation procedure between CDMU and PACS, validate PACS deactivation (shut-down) procedure.

Test Description:
All available detector channels will be exercised by stimulation of internal sources and use of an external source (simulation of expected telescope background).

Instrument Configuration:	*Specific Requirements on PLM and/or satellite:*
As per Table 5-1 and Table 5-4.	PLM tilted about 20° to +y during cooler recycle.

Particular Environmental Constraints:
Mass flow rate: 2.2 mg/s.
L0: TBD, L1: TBD and L2: TBD.
Sensor background TBD.

Success Criteria:
Deviations determined by comparing to measurement results obtained during PACS DM ILT are within TBD % or understood.

Duration:	*Applicable:*
3 days (TBC)	PLM PFM and satellite

8.8.6 PACS Short Performance Test

Title:	*Experiment:*
Short Performance Test	**PACS**

Objectives:
Validation of PACS activation sequence, test PACS FPU thermal behaviour, performance test of PACS mechanisms, synchronous operation and grating offset accuracy, cooler recycling, detector electronics signal quality photoconductor part, detector electronics signal quality bolometer part, detector signal quality photoconductor part, detector signal quality bolometer part, performance of internal blackbody sources, check of spectrometer, cryostat background measurements (representative telescope flux simulation).

Test Description:
All available detector channels will be exercised by stimulation of internal sources and use of an external source (simulation of expected telescope background).

Instrument Configuration:	*Specific Requirements on PLM and/or satellite:*
As per Table 5-1 and Table 5-4.	PLM tilted about 20° to +y during cooler recycle.

Particular Environmental Constraints:
Mass flow rate: 2.2 mg/s.
L0: TBD, L1: TBD and L2: TBD.
Sensor background TBD.

Success Criteria:
Deviations determined by comparing to measurement results obtained during PACS DM ILT are within TBD % or understood.

Duration:	*Applicable:*
3 days (TBC)	PLM PFM and satellite

8.8.7 PACS Astronomical Observation Template (AOT) Tests

Title:	*Experiment:*
Astronomical Observation Template (AOT) Tests	**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 internal blackbodies.

Instrument Configuration:	*Specific Requirements on PLM and/or satellite:*
As per Table 5-1 and Table 5-4.	PLM tilted about 20° to +y during cooler recycle.

Particular Environmental Constraints:
Mass flow rate: 2.2 mg/s.
L0: TBD, L1: TBD and L2: TBD.
Sensor background TBD.

Success Criteria:
TBD.

Duration:	*Applicable:*
TBD day	PLM PFM and satellite

8.8.8 PACS PACS/SPIRE Parallel Mode

Title:	*Experiment:*
PACS/SPIRE Parallel Mode	**PACS**

Objectives:
Verification of operability of PACS/SPIRE in parallel. Monitoring of PACS thermal behaviour with SPIRE being switched on.

Test Description:
PACS activation including cooler recycling,
PACS thermal behaviour, with SPIRE being switched on,
Test of PACS/SPIRE parallel mode AOT with PACS in single band Photometry mode,
Test of PACS/SPIRE parallel mode AOT with PACS in dual band Photometry mode,
PACS deactivation.

Instrument Configuration:	*Specific Requirements on PLM and/or satellite:*
As per Table 5-1 and Table 5-4.	PLM tilted about 20° to +y during cooler recycle.

Particular Environmental Constraints:
Mass flow rate: 2.2 mg/s.
L0: TBD, L1: TBD and L2: TBD.
Sensor background TBD.

Success Criteria:
Deviations determined by comparing to measurement results obtained during PACS DM ILT are within TBD % or understood.

Duration:	*Applicable:*
1 day	PLM PFM and satellite

8.8.9 SPIRE Cooler Recycle

Title:	*Experiment:*
Cooler Recycle	**SPIRE**

Objectives:
To verify the temperature stability and balance of the SPIRE instrument during and after cooler recycle mode operations.
To prepare the instrument for operation with the photometer or spectrometer detectors.

Test Description:
The cryostat will be placed in a condition that as nearly as possible replicates the expected flight conditions i.e. the mass flow rate and shield temperatures must be those expected in flight. The SPIRE cooler recycle sequence will be carried out and the temperatures of the various stages monitored. The results will be compared to those from the SPIRE Instrument Thermal Model (ITMM)

Instrument Configuration:	*Specific Requirements on PLM and/or satellite:*
As per Table 5-1 and Table 5-4.	PLM tilted at least 17° around z-axis to +y. This operation can be carried out with the PLM rotated to 90° in the same direction.

Particular Environmental Constraints:
Mass flow rate: 2.2 mg/s.
L0: TBD, L1: TBD and L2: TBD.
Sensor background TBD.

Success Criteria:
Cooler is successfully recycled and temperatures settle to within operational limits as predicted by the SPIRE ITMM.

Duration:	*Applicable:*
about 3 h	PLM PFM and satellite

8.8.10 SPIRE Photometer Chop Mode

Title:	*Experiment:*
Photometer Chop Mode	**SPIRE**

Objectives:
To verify the temperature stability and balance of the SPIRE instrument during photometer chopped mode operations.

Test Description:
The cryostat will be placed in a condition that as nearly as possible replicates the expected flight conditions i.e. the mass flow rate and shield temperatures must be those expected in flight.
The ambient background in the instrument is such as to allow meaningful signals from the detectors to be seen. This will be verified by a dedicated measurement.
The SPIRE cooler has been recycled and the instrument is at nominal temperature.
The photometer JFETs are switched on and the instrument temperatures allowed to settle.
A simulated photometer chop observation is carried out – this will include operation of the photometer calibrator and beam steering mirror.
The results will be compared to the ILT and the SPIRE ITMM.

Instrument Configuration:	*Specific Requirements on PLM and/or satellite:*
As per Table 5-1 and Table 5-4.	None

Particular Environmental Constraints:
Mass flow rate: 2.2 mg/s.
L0: TBD, L1: TBD and L2: TBD.
Photon background on the detector in the 420-580 μm band within x5 (TBC) of that expected in flight – this equivalent to a blackbody of <~ 20 K in the beam of SPIRE.
This may be achieved using the SPIRE shutter (TBD).

Success Criteria:
The instrument temperatures stay within pre-defined limits as predicted by the SPIRE ITMM.
No excess background is seen on the detectors during operations.

Duration:	*Applicable:*
about 1 h	PLM PFM and satellite

8.8.11 SPIRE Ambient Background Verification

Title:	*Experiment:*
Ambient Background Verification	**SPIRE**

Objectives:
To check the photon background on the photometer detectors after cooler recycle and before all other tests.

Test Description:
The PFM cryostat will be placed in a condition that as nearly as possible replicates the expected flight conditions, i.e. the mass flow rate and shield temperatures must be those expected in flight.
The SPIRE cooler has been recycled and the instrument is at nominal temperature.
The photometer JFETs are switched on and the instrument temperatures allowed to settle.
The SPIRE shutter may be closed (TBD).
Load curves are taken on the photometer detectors by varying the bias voltage.

Instrument Configuration:	*Specific Requirements on PLM and/or satellite:*
As per Table 5-1 and Table 5-4.	None

Particular Environmental Constraints:
Mass flow rate: 2.2 mg/s.
L0: TBD, L1: TBD and L2: TBD.
Sensor background TBD.

Success Criteria:
Data analysed in real time to calculate the background flux on the detectors. Background should be within limits defined for the follow on test.

Duration:	*Applicable:*
about 1 h	PLM PFM and satellite

8.8.12 SPIRE Spectrometer Mode

Title:	*Experiment:*
Spectrometer Mode	**SPIRE**

Objectives:
To verify the temperature stability and balance of the SPIRE instrument during spectrometer mode operations.

Test Description:
The cryostat will be placed in a condition that as nearly as possible replicates the expected flight conditions i.e. the mass flow rate and shield temperatures must be those expected in flight.
The ambient background in the instrument is such as to allow meaningful signals from the detectors to be seen. This will be verified by a dedicated test.
The SPIRE cooler has been recycled and the instrument is at nominal temperature.
The spectrometer JFETs are switched on and the instrument temperatures allowed to settle.
The spectrometer calibrator is switched on.
A simulated spectrometer chop observation is carried out – this will include operation of the photometer calibrator and beam steering mirror.
The results will be compared to the ILT and the SPIRE ITMM.

Instrument Configuration:	*Specific Requirements on PLM and/or satellite:*
As per Table 5-1 and Table 5-4.	PLM tilted at least 85° around z-axis to either +y or -y direction.

Particular Environmental Constraints:
Mass flow rate: 2.2 mg/s.
L0: TBD, L1: TBD and L2: TBD.
Photon background on the detector in the 420-580 μm band within x5 (TBC) of that expected in flight – this equivalent to a blackbody of <~ 20 K in the beam of SPIRE.
This may be achieved using the SPIRE shutter (TBD).

Success Criteria:
The instrument temperatures stay within pre-defined limits as predicted by the SPIRE ITMM.
No excess background is seen on the detectors during operations.

Duration:	*Applicable:*
about 1 h	PLM PFM and satellite

8.8.13 SPIRE PACS/SPIRE Parallel Mode

Title:	*Experiment:* **SPIRE**

Objectives:
TBD

Test Description:
TBD.

Instrument Configuration: As per Table 5-1 and Table 5-4.	*Specific Requirements on PLM and/or satellite:* PLM tilted about 20° to +y during PACS cooler recycling. PLM tilted at least 17° around z-axis to +y during SPIRE cooler recycle.

Particular Environmental Constraints:
Mass flow rate: 2.2 mg/s.
L0: TBD, L1: TBD and L2: TBD.
Sensor background TBD.

Success Criteria:
TBD

Duration: TBD day	*Applicable:* PLM PFM and satellite

8.9 Integrated Module Tests

8.9.1 HIFI Integrated Module Test

Title:	*Experiment:*
Integrated Module Test	**HIFI**

Objectives:

TBD Verification of the functional performance of the integrated instrument in all modes. Check of the instrument performance as far as possible.

Test Description:

The Integrated Module Test is composed by the following test steps: 1) Short Functional Test, 2) IF Properties, 3) Receiver Tuning, 4) Radiometry (for TBD receiver settings), 5) Standing Wave Test (test steps to be repeated for all available channels) (TBC). For details to the single test steps see the related Test Activity Descriptions.

Instrument Configuration:	*Specific Requirements on PLM and/or satellite:*
As per Table 5-1 and Table 5-4.	None.

Particular Environmental Constraints:

Mass flow rate: 2.2 mg/s.
L0: TBD, L1: TBD and L2: TBD.
Sensor background TBD.

Success Criteria:

Housekeeping values within pre-defined limits. Correct execution of commands. No performance degradation with respect to instrument level test results.

Duration:	*Applicable:*
6 days (TBC)	PLM PFM

8.9.2 PACS Integrated Module Test

Title:	*Experiment:*
Integrated Module Test	**PACS**

Objectives:

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

Test Description:

The Integrated Module Test is composed by the following test steps: TBD. For details to the single test steps see the related Test Activity Descriptions.

Instrument Configuration:	*Specific Requirements on PLM and/or satellite:*
As per Table 5-1 and Table 5-4.	PLM tilted about 20° to +y during cooler recycle.

Particular Environmental Constraints:

Mass flow rate: 2.2 mg/s.
L0: TBD, L1: TBD and L2: TBD.
Sensor background TBD.

Success Criteria:

Housekeeping values within pre-defined limits. Correct execution of commands. No performance degradation with respect to instrument level test results.

Duration:	*Applicable:*
TBD	PLM PFM

8.9.3 SPIRE Integrated Module Test

Title:	*Experiment:*
Integrated Module Test	**SPIRE**

Objectives:

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

Test Description:

The Integrated Module Test is composed by the following test steps: (TBD). For details to the single test steps see the related Test Activity Descriptions.

Instrument Configuration:	*Specific Requirements on PLM and/or satellite:*
As per Table 5-1 and Table 5-4.	PLM tilted at least 17° around z-axis to +y during cooler recycle.

Particular Environmental Constraints:

Mass flow rate: 2.2 mg/s.
L0: TBD, L1: TBD and L2: TBD.
Photon background on the detector in the 420-580 μm band within x5 (TBC) of that expected in flight – this equivalent to a blackbody of <~ 20 K in the beam of SPIRE.
This may be achieved using the SPIRE shutter (TBD).

Success Criteria:

Housekeeping values within pre-defined limits. Correct execution of commands. No performance degradation with respect to instrument level test results.

Duration:	*Applicable:*
TBD	PLM PFM

8.10 Integrated System Tests

8.10.1 HIFI Integrated System Test

Title:	*Experiment:*
Integrated System Test	**HIFI**

Objectives:

TBD Verification of the functional performance of the integrated instrument in all modes. Check of the instrument performance as far as possible.

Test Description:

The Integrated System Test is composed by the following test steps: 1) Short Functional Test, 2) IF Properties, 3) Receiver Tuning, 4) Radiometry (for TBD receiver settings), 5) Standing Wave Test (test steps to be repeated for all available channels) (TBC). For details to the single test steps see the related Test Activity Descriptions.

Instrument Configuration:	*Specific Requirements on PLM and/or satellite:*
As per Table 5-1 and Table 5-4.	None.

Particular Environmental Constraints:

Mass flow rate: 2.2 mg/s.
L0: TBD, L1: TBD and L2: TBD.
Sensor background TBD.

Success Criteria:

Housekeeping values within pre-defined limits. Correct execution of commands. No performance degradation with respect to instrument level test results.

Duration:	*Applicable:*
6 days (TBC)	Satellite

8.10.2 PACS Integrated System Test

Title:	*Experiment:*
Integrated System Test	**PACS**

Objectives:

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

Test Description:

The Integrated System Test is composed by the following test steps: TBD. For details to the single test steps see the related Test Activity Descriptions.

Instrument Configuration:	*Specific Requirements on PLM and/or satellite:*
As per Table 5-1 and Table 5-4.	PLM tilted about 20° to +y during cooler recycle.

Particular Environmental Constraints:

Mass flow rate: 2.2 mg/s.
L0: TBD, L1: TBD and L2: TBD.
Sensor background TBD.

Success Criteria:

Housekeeping values within pre-defined limits. Correct execution of commands. No performance degradation with respect to instrument level test results.

Duration:	*Applicable:*
TBD	Satellite

8.10.3 SPIRE Integrated System Test

Title:	*Experiment:*
Integrated System Test	**SPIRE**

Objectives:

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

Test Description:

The Integrated System Test is composed by the following test steps: (TBD). For details to the single test steps see the related Test Activity Descriptions.

Instrument Configuration:	*Specific Requirements on PLM and/or satellite:*
As per Table 5-1 and Table 5-4.	PLM tilted at least 17° around z-axis to +y during cooler recycle.

Particular Environmental Constraints:

Mass flow rate: 2.2 mg/s.
L0: TBD, L1: TBD and L2: TBD.
Photon background on the detector in the 420-580 μm band within x5 (TBC) of that expected in flight – this equivalent to a blackbody of <~ 20 K in the beam of SPIRE.
This may be achieved using the SPIRE shutter (TBD).

Success Criteria:

Housekeeping values within pre-defined limits. Correct execution of commands. No performance degradation with respect to instrument level test results.

Duration:	*Applicable:*
TBD	Satellite

8.11 EMC Tests

8.11.1 HIFI EMC Test

Title:	*Experiment:*
EMC Test	**HIFI**

Objectives:
Check of instrument conducted and radiated electromagnetic emission (CE and RE) and functional performance in its most sensitive mode under electromagnetic worst case conditions (conducted and radiated susceptibility) (CS and RS).

Test Description:
During this test the EMC susceptibility of HIFI in a representative environment will be assessed. Susceptibility will be measured in terms of changes in performance parameters like noise temperature, but also in terms of spectral information (spurious responses). The RF bands will be fully tested on performance for a TBD number of receiver settings. The internal calibration source will be used as the stimuli for the performance test and to search for EMI of the IF chain. For verification of the absence of EMI of the LO an external line test source, comprising a harmonic generator driven by a microwave synthesiser, will be required. This test signal will be injected with a beamsplitter between the LOU and the CVV window. IF properties might be separately tested under simulated EMC environment again as part of this EMC test.

Instrument Configuration:	*Specific Requirements on PLM and/or satellite:*
As per Table 5-1 and Table 5-4 including a harmonic generator with beam splitter mounted between the LOU and CVV window (TBC).	Representative spacecraft configuration, representative configuration of LO windows and beam path, representative cryoharness, representative ground impedance between SVM and PLM.

Particular Environmental Constraints:
Mass flow rate: 2.2 mg/s.
L0: TBD, L1: TBD and L2: TBD.
Sensor background TBD.

Success Criteria:
Deviations from measurement results obtained during HIFI DM ILT are within TBD % or understood.

Duration:	*Applicable:*
2 days	PLM PFM and satellite

8.11.2 PACS EMC Test

Title:	*Experiment:*
EMC Test	**PACS**

Objectives:
Check of instrument conducted and radiated electromagnetic emission (CE and RE) and functional performance in its most sensitive mode under electromagnetic worst case conditions (conducted and radiated susceptibility) (CS and RS).

Test Description:
During ILT, two specific EMC test sequences will be developed. During PFM, performance of these sequences will allow verification of certain EMC requirements in addition to the results from specified test set-ups. Note: PFM EMC testing might very likely require conducted and radiated emission and conducted and radiated susceptibility measurements (details still TBD).
PACS activation including cooler recycling,
PACS in "most noisy" mode(s) (all actuators ON, etc.),
PACS in "most sensitive" mode(s) (all mechanisms quiet except chopper, all detector read-outs in most sensitive status, etc.),
PACS deactivation.

Instrument Configuration:	*Specific Requirements on PLM and/or satellite:*
As per Table 5-1 and Table 5-4.	PLM tilted about 20° to +y during cooler recycle.

Particular Environmental Constraints:
Mass flow rate: 2.2 mg/s.
L0: TBD, L1: TBD and L2: TBD.
Sensor background TBD.

Success Criteria:
Deviations from measurement results obtained during HIFI DM ILT are within TBD % or understood.

Duration:	*Applicable:*
2 days	PLM PFM and satellite

8.11.3 SPIRE EMC Test

Title:	*Experiment:*
EMC Test	**SPIRE**

Objectives:
Check of instrument conducted and radiated electromagnetic emission (CE and RE) and functional performance in its most sensitive mode under electromagnetic worst case conditions (conducted and radiated susceptibility) (CS and RS).

Test Description:
The PFM cryostat will be placed in a condition that as nearly as possible replicates the expected flight conditions i.e. the mass flow rate and shield temperatures must be those expected in flight.
The ambient photon background in the instrument is low enough such that meaningful noise measurements can be made on the detectors. The background will be verified by a dedicated test.
The SPIRE cooler has been recycled and the instrument is at nominal temperature.
The photometer JFETs are switched on and the instrument temperatures allowed to settle.
Noise traces are taken from the detectors at the highest data sampling frequency allowed by the electronics before and during conducted and radiated EM testing.
The results will be compared to the ILT and the SPIRE EMC model.

Instrument Configuration:	*Specific Requirements on PLM and/or satellite:*
As per Table 5-1 and Table 5-4.	

Particular Environmental Constraints:
Mass flow rate: 2.2 mg/s.
L0: TBD, L1: TBD and L2: TBD.
Photon background on the detector in the 420-580 μm band within x5 (TBC) of that expected in flight – this equivalent to a blackbody of <~ 20 K in the beam of SPIRE.
This may be achieved using the SPIRE shutter (TBD).

Success Criteria:
No excess noise on the detectors. Deviations from measurement results obtained during HIFI DM ILT are within TBD % or understood.

Duration:	*Applicable:*
TBD	PLM PFM and satellite

8.12 TB/TV Tests

8.12.1 HIFI TB/TV Test

Title:	*Experiment:*
TB/TV Test	**HIFI**

Objectives:

Check of temperatures and temperature transient of performance critical HIFI elements under nearly flight conditions.
Verification of instrument performance in nearly flight conditions.

Test Description:

Monitoring of temperature levels on the following HIFI FPU elements: IF box, mixers and IF amplifiers, diplexer mechanisms, chopper and calibration source and on the LOU power amplifiers and multiplier stages.
Performance measurements.

Instrument Configuration:	*Specific Requirements on PLM and/or satellite:*
As per Table 5-1 and Table 5-4.	Satellite in TV chamber.

Particular Environmental Constraints:

Mass flow rate: 2.2 mg/s.
L0: TBD, L1: TBD and L2: TBD.
Sensor background TBD.

Success Criteria:

Deviations from measurement results obtained during HIFI DM ILT are within TBD % or understood.

Duration:	*Applicable:*
2 days	Satellite

8.12.2 PACS TB/TV Test

Title:	*Experiment:*
TB/TV Test	**PACS**

Objectives:

Check of temperatures and temperature transient of performance critical PACS elements under nearly flight conditions.

Verification of instrument performance in nearly flight conditions.

Test Description:
TBD

Instrument Configuration:	*Specific Requirements on PLM and/or satellite:*
As per Table 5-1 and Table 5-4.	Satellite in TV chamber. PLM tilted about 20° to +y during cooler recycle.

Particular Environmental Constraints:
Mass flow rate: 2.2 mg/s.
L0: TBD, L1: TBD and L2: TBD.
Sensor background TBD.

Success Criteria:
Deviations from measurement results obtained during HIFI DM ILT are within TBD % or understood.

Duration:	*Applicable:*
2 days	Satellite

8.12.3 SPIRE TB/TV Test

Title:	*Experiment:*
TB/TV Test	**SPIRE**

Objectives:

Check of temperatures and temperature transient of performance critical SPIRE elements under nearly flight conditions.
Verification of instrument performance in nearly flight conditions.

Test Description:
TBD

Instrument Configuration:	*Specific Requirements on PLM and/or satellite:*
As per Table 5-1 and Table 5-4.	Satellite in TV chamber. PLM tilted about 20° to +y during cooler recycle.

Particular Environmental Constraints:
Mass flow rate: 2.2 mg/s.
L0: TBD, L1: TBD and L2: TBD.
Photon background on the detector in the 420-580 μm band within x5 (TBC) of that expected in flight – this equivalent to a blackbody of <~ 20 K in the beam of SPIRE.
This may be achieved using the SPIRE shutter (TBD).

Success Criteria:
No excess noise on the detectors. Deviations from measurement results obtained during HIFI DM ILT are within TBD % or understood.

Duration:	*Applicable:*
TBD	Satellite

8.13 SVT Tests

8.13.1 HIFI SVT Test

Title:	*Experiment:*
SVT Test	**HIFI**

Objectives:
Verification of instrument commanding, telemetry and science data from/to the control centre.

Test Description:
TBD

Instrument Configuration:	*Specific Requirements on PLM and/or satellite:*
As per Table 5-1 and Table 5-4.	Satellite in flight configuration.

Particular Environmental Constraints:
Mass flow rate: 2.2 mg/s.
L0: TBD, L1: TBD and L2: TBD.
Sensor background TBD.

Success Criteria:
Deviations from measurement results obtained during HIFI DM ILT are within TBD % or understood.

Duration:	*Applicable:*
2 days	Satellite

8.13.2 PACS SVT Test

Title: **SVT Test**	*Experiment:* **PACS**

Objectives:
Verification of instrument commanding, telemetry and science data from/to the control centre.

Test Description:
TBD

Instrument Configuration: As per Table 5-1 and Table 5-4.	*Specific Requirements on PLM and/or satellite:* Satellite in flight configuration. PLM tilted about 20° to +y during cooler recycle.

Particular Environmental Constraints:
Mass flow rate: 2.2 mg/s.
L0: TBD, L1: TBD and L2: TBD.
Sensor background TBD.

Success Criteria:
Deviations from measurement results obtained during HIFI DM ILT are within TBD % or understood.

Duration: 2 days	*Applicable:* Satellite

8.13.3 SPIRE SVT Test

Title:	*Experiment:*
SVT Test	**SPIRE**

Objectives:
Verification of instrument commanding, telemetry and science data from/to the control centre.

Test Description:
TBD

Instrument Configuration:	*Specific Requirements on PLM and/or satellite:*
As per Table 5-1 and Table 5-4.	Satellite in flight configuration. PLM tilted about 20° to +y during cooler recycle.

Particular Environmental Constraints:
Mass flow rate: 2.2 mg/s.
L0: TBD, L1: TBD and L2: TBD.
Photon background on the detector in the 420-580 μm band within x5 (TBC) of that expected in flight – this equivalent to a blackbody of <~ 20 K in the beam of SPIRE.
This may be achieved using the SPIRE shutter (TBD).

Success Criteria:
No excess noise on the detectors. Deviations from measurement results obtained during HIFI DM ILT are within TBD % or understood.

Duration:	*Applicable:*
TBD	Satellite

Quantity	Name	Dep./Comp.	Quantity	Name	Dep./Comp.
	Alberti von Mathias Dr.	ED 544		Reuß Friedhelm	ED 71
	Barlage Bernhard	ED 62	X	Rühe Wolfgang	ED 3
X	Bayer Thomas	ED 532		Runge Axel	OTN/TN 94
X	Faas Horst	ED 516		Sachsse Bernt	EC 34
	Grasl Andreas	OTN/TN 64	X	Sagner Udo	OTN/TN 64
	Grasshoff Brigitte	ED 511		Schäffler Johannes	OTN/TN 64
	Hartmann Hans Dr.	ED 172	X	Schink Dietmar	ED 522
	Hauser Armin	ED 541	X	Schlosser Christian	OTN/TN 64
	Hinger Jürgen	ED 541	X	Schwabbauer Paul Dr.	OTN/ED 171
	Hohn Rüdiger	ED 531		Schweickert Gunn	ED 544
X	Hölzle Edgar	ED 171		Steininger Eric	ED 522
	Huber Johann	ED 532	X	Stritter Rene	ED 61
	Hund Walter	ED 556		Suttner Klaus	ED 542
X	Idler Siegmund	ED 521		Tenhaeff Dieter	ED 544
	Ivády von András	EC 32		Thörmer Klaus-Horst Dr.	OTN/ED 37
	Jahn Gerd Dr.	ED 541		Wagner Adalbert	OTN/IP 35
	Kalde Clemens	ED 513		Wagner Klaus	ED 541
	Kameter Rudolf	OTN/TN 64		Wietbrock, Walter	ED 511
	Knoblauch August	ED 51		Wöhler Hans	ED 544
X	Koelle Markus	ED 533		Zipf Ludwig	EC 32
	Kreeb Helmut	ED 541			
	Kroeker Jürgen	ED 515			
	Kunz Oliver	ED 541			
	Lamprecht Ernst	OTN/TN 72			
X	Lang Jürgen	ED 556	X	Pastorino Michel	ASPI Resid.
	Langfermann Michael	ED 531			
	Mack Paul	OTN/TN 64	X	Alcatel (on FTP-Server)	
	Maier Hans-Ulrich	ED 61	X	ESTEC (on FTP-Server)	
	Mauch Alfred	ED 544			
	Moritz Konrad Dr.	ED 37			
	Müller Lutz	OTN/TN 64		APCO	
	Muhl Eckhard	OTN/TN 64	X	MPE (on FTP-Server)	
X	Peitzker Helmut	ED 37	X	RAL (on FTP-Server)	
	Peltz Heinz-Willi	ED 515	X	SRON (on FTP-Server)	
	Peters, Gerhard	ED 533			
	Pietroboni Karin	ED 37			
	Puttlitz Joachim	OTN/ED 37			
	Raupp Helmut	ED 543			
	Rebholz Reinhold	ED 531			