Title: **Instrument Testing on PLM EQM Level**

CI-No:

Prepared by:	S. Idler	Date: 22.05.02
Checked by:	C. Schlosser	27.05.02
Product Assurance:	R. Stritter	27.05.02
Configuration Control:	A. v. Ivády	270502
Project Management:	W. Rühe	27.05.02

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1 Scope

This plan defines the instrument tests to be performed on PLM level during the Herschel EQM programme. This includes the instrument incoming inspections after delivery to ASED, the activities and interface tests planned for the instrument integration on the PLM EQM and the instrument related tests to be performed during the various PLM EQM 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 PLM EQM test 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 PLM EQM 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 PLM EQM AIT programme. Furthermore this document serves as reference document for the higher level PLM EQM AIT Plan (AD 6), 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 PLM EQM 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’).

It is intended to establish a similar document for the PLM and S/C PFM AIT programme and the launch campaign.

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-0022	Herschel PLM EQM AIT Plan	Issue 1, 12.03.2002

2.2 Reference Documents

RD 1	HP-2-ASED-RP-0028	EQM Design Description	
RD 2	HP-2-ASED-TN-0041	HERSCHEL EQM Thermal Model and Analysis	Issue 2

3 Objective of PLM EQM AIT Programme

3.1 PLM EQM AIT Programme General Objectives

The main objective of the EQM test program on PLM EQM level is to verify the mechanical, electrical, electromagnetic and thermal compatibility of the instruments with the PLM in flight representative cryogenic conditions.

Another important objective is to validate the instrument integration, alignment and test procedures and the PLM test set-up as far as possible and to gain experience in operating the PLM and GSE for the PFM programme.

The EQM AIT programme uses the ISO QM cryostat which has especially been modified in some areas to represent as much as possible the Herschel cryostat.

There will be no satellite level EQM programme.

3.2 Instrument Test Definitions and Objectives

The following table gives an overview of the instrument tests to be carried out on PLM EQM 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).	All	Check will be performed in warm and cold conditions

Test	Test Objectives	Conditions	Remarks
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).
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).
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.
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).

Table 3-1: Instrument related Tests on PLM EQM Level

4 PLM EQM AIT Flow

4.1 Activities Overview

Figure 4-1 gives an overview of the tasks which are planned to be performed during the PLM EQM AIT programme (for details see AD 6).

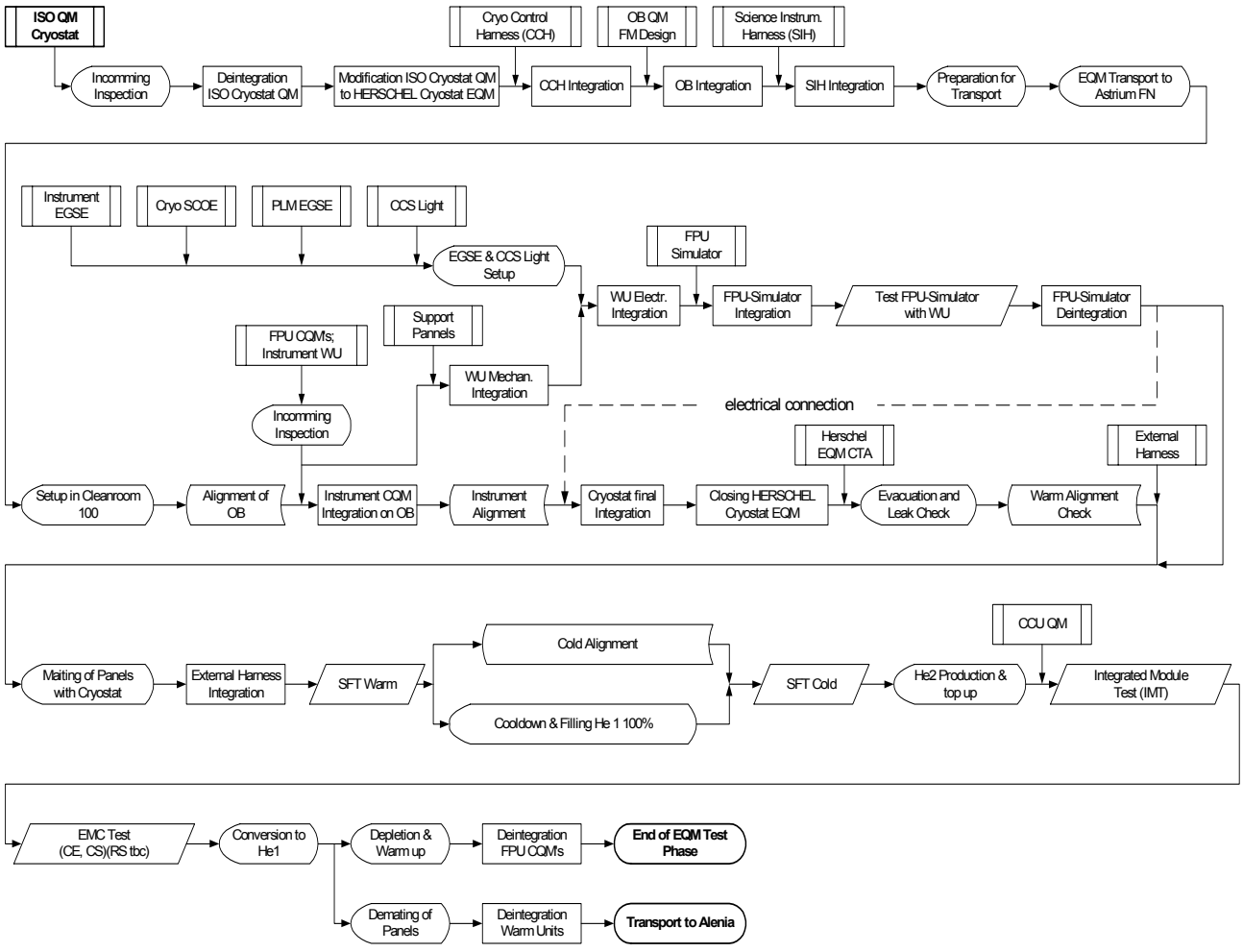

Figure 4-1: EQM AIT Flow

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 EPLM, 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.

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 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.

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

The short functional test is a tool to verify the instruments main functions in short time (few hours). It is preferred that the test evaluation can be based on housekeeping data only. It is further preferred that the test does not require specific conditions of the EPLM (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

The specific performance tests are tools to verify the instrument performance on EPLM level. The tests are based on the instrument level tests in order to allow an easy performance assessment by comparing the PLM level test results with the instrument level test results, assuming that the environmental conditions are comparable.

The performance tests 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 1.

The following specific performance tests 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 proposed 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)

The IMT is a sequence of tests which allows a full assessment of the functional and measurement performance of the integrated instrument, as far as it is possible on this level.

The IMT sequence for HIFI covers the following two objectives

- 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.

For PACS the IMT sequence comprises the check of the instrument function and the verification of the performance at representative background conditions (Astronomical Observation Template Tests).

The SPIRE IMT sequence is 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.

The testing of the SPIRE instrument has to be based around the recycling of the 300 mK cooler.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. In the IMT two full cooler recycle periods are foreseen.

During the IMT 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 1.

Figure 4-2 shows the activities to be performed during the IMT.

	Integrated Module Test																					
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
HIFI	Off	SFT HeII	IF Properties	Receiver Tuning	Radiometry	Reduced Standing Wave Test	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off
PACS	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	SFT HeII	PACS Cooler Recycle (TBC)	PACS/SPIRE Parallel Mode	Short Functional test	AOT Tests	Off
SPIRE	Off	Off	Off	Off	Off	Off	SFT HeII	Cooler Recycle #1	Ambient Background Verification test	Photometer Chopped Mode Test	Wait for Cooler Exhaustion	Cooler Recycle #2	Ambient Background Verification test	Spectrometer Mode Test	Photometer Operation	Switch between Spectrometer and	Standby	Standby	PACS/SPIRE Parallel Mode	Wait for Cooler Exhaustion	Off	Off
PLM Position	No requirement	No requirement	No requirement	No requirement	No requirement	No requirement	No requirement	20° to +y	No requirement	No requirement	No requirement	20° to +y	No requirement	No requirement	90° to +y	90° to +y	No requirement	20° to +y	No requirement	No requirement	No requirement	No requirement
Duration	0	1 day	1 day	3 days	1 day	3 days	6 h	3 h	1 h	3 h	about 40 h from last cooler recycle	3h	1 h	3 h	3 h	TBD	TBD	TBD	TBD	about 40 h from last cooler recycle	TBD	0
Remarks																						

Figure 4-2: IMT Activity Flow

4.2.8 EMC Test

The EMC test comprises measurements of the conducted emission per instrument (CE test) and the verification of the functional performance of each instrument under conducted and radiated electromagnetic distortions (CS and RS test). During the conducted emission measurements the instruments are switched in a mode with maximum generation of electrical distortion on the electrical lines. 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 1.

Figure 4-3 describes the instrument tests and modes to be performed within the EMC test.

	EMC Test																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
HIFI	Off	Measurement Mode (Band 3 H)	Measurement Mode (Band 3 V)	Measurement Mode (most noisiest)	Measurement Mode (Band 3 H)	Measurement Mode (Band 3 V)	Measurement Mode (Band 3 H)	Measurement Mode (Band 3 V)	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off
PACS	Off	Off	Off	Off	Off	Off	Off	Off	Cooler Recycle	TBD Mode/measurements	Measurement Mode (most noisiest)	TBD Mode/measurements	TBD Mode/measurements	Off	Off	Off	Off	Off	Off
SPIRE	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Off	Cooler Recycle	Photometer Mode	Measurement Mode (most noisiest)	Photometer Mode	Photometer Mode	Off
PLM Position	No requirement	No requirement	No requirement	No requirement	No requirement	No requirement	No requirement	No requirement	20° to +y	No requirement	No requirement	No requirement	No requirement	20° to +y	No requirement	No requirement	No requirement	No requirement	No requirement
Duration	0	2 days (TBC)							2 days (TBC)					TBD					0
Remarks		Reference test		CE	CS		RS			Reference test	CE	CS	RS		Reference test	CE	CS	RS	

Figure 4-3: EMC Test Activities Flow

5 Instrument Configurations

5.1 Delivered Instrument Flight Hardware Items

5.1.1 HIFI EQM Deliverables

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

Unit	Model	Remarks
FPU	QM	Band 3 only
LOU	QM	Band 3 only
FCU	DM	No redundancy, as PFM but with commercial parts
LSU	DM	No redundancy, as PFM but with commercial parts
LCU	QM	No redundancy
HRI	QM	Horizontal polarisation only
HRH	QM	
HRV	-	Not delivered
WEH	QM	
WEV	-	Not delivered
WOH	QM	
WOV	-	Not delivered
ICU	QM	No redundancy
WIH		Test harness (SVM harness)

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

Table 5-1: HIFI Instrument Hardware Items

5.1.2 PACS EQM Deliverables

The PACS instrument delivery configuration for the PLM EQM programme is as per Note: Cryoharness will be provided by ASED.

Table 5-2.

Unit	Model	Remarks
FPU	CQM	nearly PFM representative (not all Ge detector arrays are complete, but minimum 50%)
DPU	AVM	no redundancy
SPU	AVM	no redundancy, at present not PFM form representative
DECMEC	EM	no redundancy,

Unit	Model	Remarks
		at present not PFM form representative; delivery of an upgraded representative QM is tentative
BOLC	QM1	QM1 used during first phase of ILT, eventually replaced by QM2 later, QM1 has no internal PSU
BOLA	QM1	QM1 used during first phase of ILT, BOLA + BOLG provided, QM1 eventually replaced by QM2 later
WIH	AVM	-

Note: Cryoharness will be provided by ASED.

Table 5-2: PACS Instrument Hardware Items

5.1.3 SPIRE EQM Deliverables

The SPIRE instrument delivery configuration for the PLM EQM programme is as per Note: Cryoharness will be provided by ASED.

Table 5-3.

Unit: HSFPU

Subsystem /component	Delivered CQM Form/Capability
Structure/baffles/wiring standoffs etc	Flight Representative
Mirrors	Flight Representative
Filters	Flight representative
Beam steering mirror	Form and fit compliant Functionally representative in at least one axis No redundancy Electrical interfaces compliant Thermal conduction flight representative Thermal dissipation may not be flight representative
3He Fridge/thermal straps	Form and fit compliant Functionally fully flight representative All parts flight build standard except thermometers and heaters will be commercial/industrial grade
300 mK Thermal control system	None
Photometer LW array	Flight representative
Photometer MW array	Form and fit compliant Resistors used to represent detectors. Temperature monitors functionally representative (TBC)
Photometer SW array	Ditto
SMEC	Form and fit compliant

Subsystem /component	Delivered CQM Form/Capability
	Functionally representative – mirror travel TBD Electrical interfaces must be compliant Thermal conduction flight representative Thermal dissipation may not be flight representative
Spectrometer SW array	As P/MW and P/SW arrays
Photometer LW array	Flight representative
Photometer Calibrator	Form and fit compliant Functionally representative Electrical interfaces compliant Thermal interfaces compliant No redundancy (TBC)
Spectrometer Calibrator	Form and fit compliant Functionally representative Electrical interfaces compliant Thermal interfaces compliant No redundancy (TBC)
Shutter	Form and fit compliant Functionally representative Electrical interfaces compliant
JFET Enclosures	Flight Representative
JFET Modules and JFET box RF filter modules	Form and fit compliant Functionally representative Electrical interfaces compliant Thermal interfaces compliant Only JFETs for “live” detector channels will be provided Resistors for thermal dissipation in other channels will be provided (TBC)
FPU RF Filters	Flight representative
Thermometry	Flight representative
FPU internal harnesses	Flight representative
Harnesses between FPU-JFET (Photometer) and FPU-JFET (Spectrometer)	TBC

Unit: HSDCU

Subsystem /component	Delivered CQM Form/Capability
External structure/mechanical interfaces	Flight representative
Electrical Interfaces	Prime interfaces flight representative No redundant interfaces implemented
Functionality	Near flight performance on prime side No redundant side implemented

Electrical Component Level	Commercial/industrial level parts with near flight performance

Unit: HSFCU

Subsystem /component	Delivered CQM Form/Capability
External structure/mechanical interfaces	TBC – it is possible that some of the sub-units will not be housed within the FCU flight envelope
Electrical Interfaces	Prime interfaces flight representative No redundant interfaces implemented
Functionality	Near flight performance on prime side No redundant side implemented
Electrical Component Level	Commercial/industrial level parts with near flight performance

Unit: HSDPU (this unit will also be used for the AVM)

Subsystem /component	Delivered CQM Form/Capability
External structure/mechanical interfaces	Flight Representative
Electrical Interfaces	Prime interfaces flight representative No redundant interfaces implemented
Functionality	Near flight performance on prime side No redundant side implemented
Electrical Component Level	Commercial/industrial level parts with near flight performance

Unit: HSWIH (warm interconnect harness)

Subsystem /component	Delivered CQM Form/Capability
External structure/mechanical interfaces	Flight representative
Electrical Interfaces	Flight representative
Functionality	Near flight performance
Electrical Component Level	Commercial/industrial level parts with near flight performance

Note: Cryoharness will be provided by ASED.

Table 5-3: SPIRE Instrument Hardware Items

5.2 Delivered Instrument GSE Items

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

Instrument	GSE	Remarks
HIFI	CW test signal source	
	LO beam splitter	
	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	
	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	
	Shutter EGSE	
	SPIRE Test Facility Control System (TFCS)	
	SPIRE EGSE Router	
	EGSE to perform electrical interface checks on the FPU at ambient.	TBC

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 EQM 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.

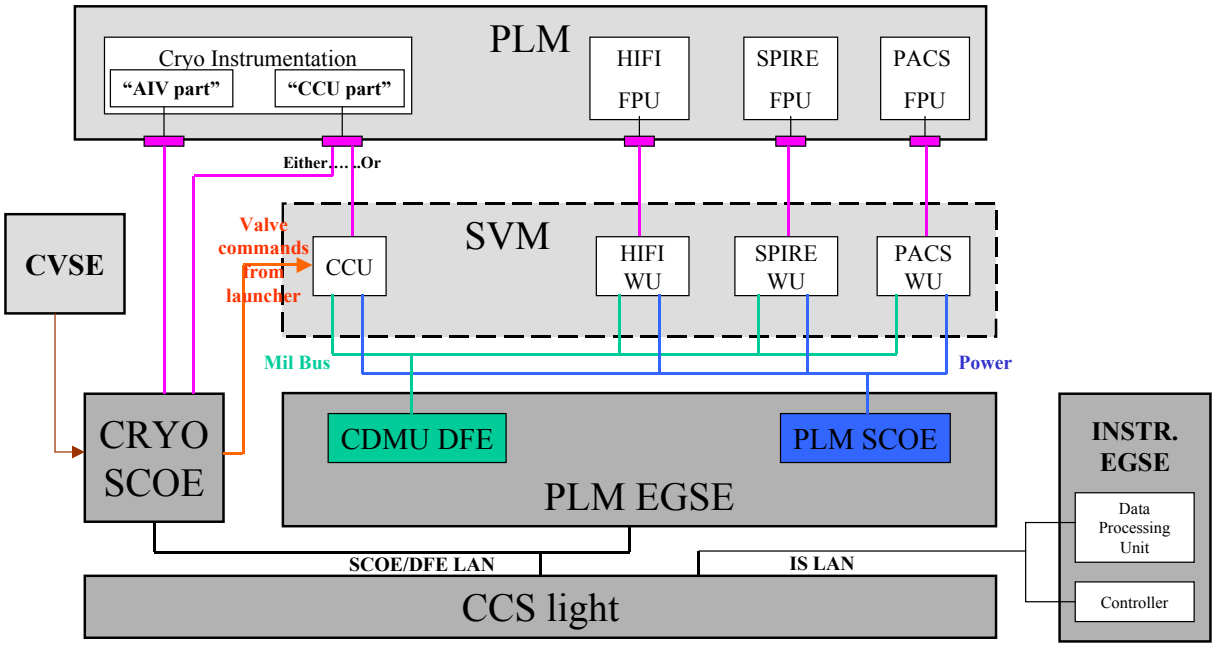

Figure 6-1: Principle EGSE Set-up for EQM Tests

The specific test set-up which have to be implemented for the PLM EQM level instrument tests is shown in Figure 6-2, Figure 6-3 and Figure 6-4.

[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 6-2: 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 6-3: Specific PACS Test Set-up

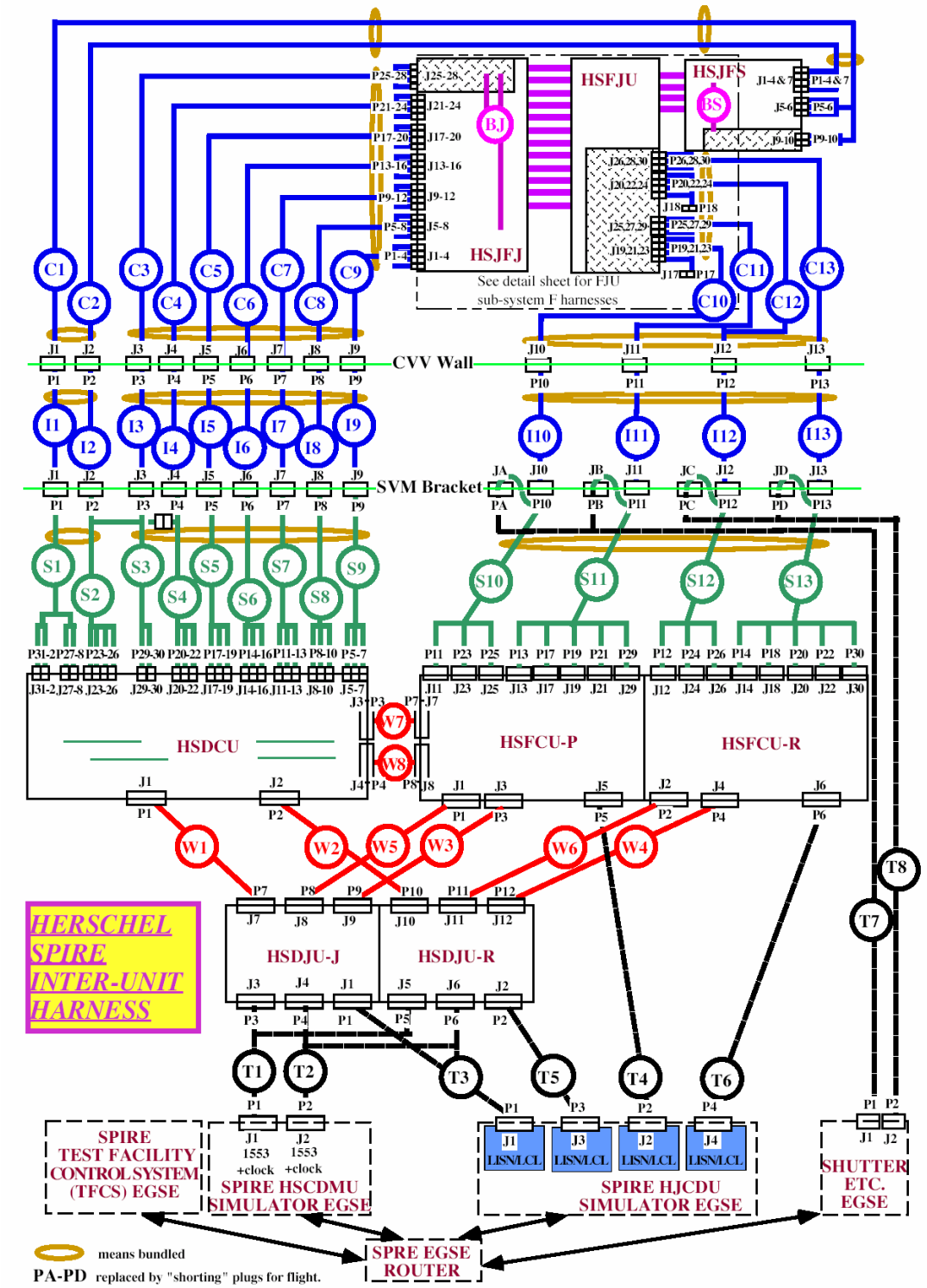

Figure 6-4: Specific SPIRE Test Set-up for the Instrument Electrical Integration Check (TBC)

6.2 Test Facility

The tests (incl. EMC test) will take place in a cleanroom class 100 000 in a test facility at Astrium. The layout of the test facilities is shown in Figure 6-5. For details see AD 06.

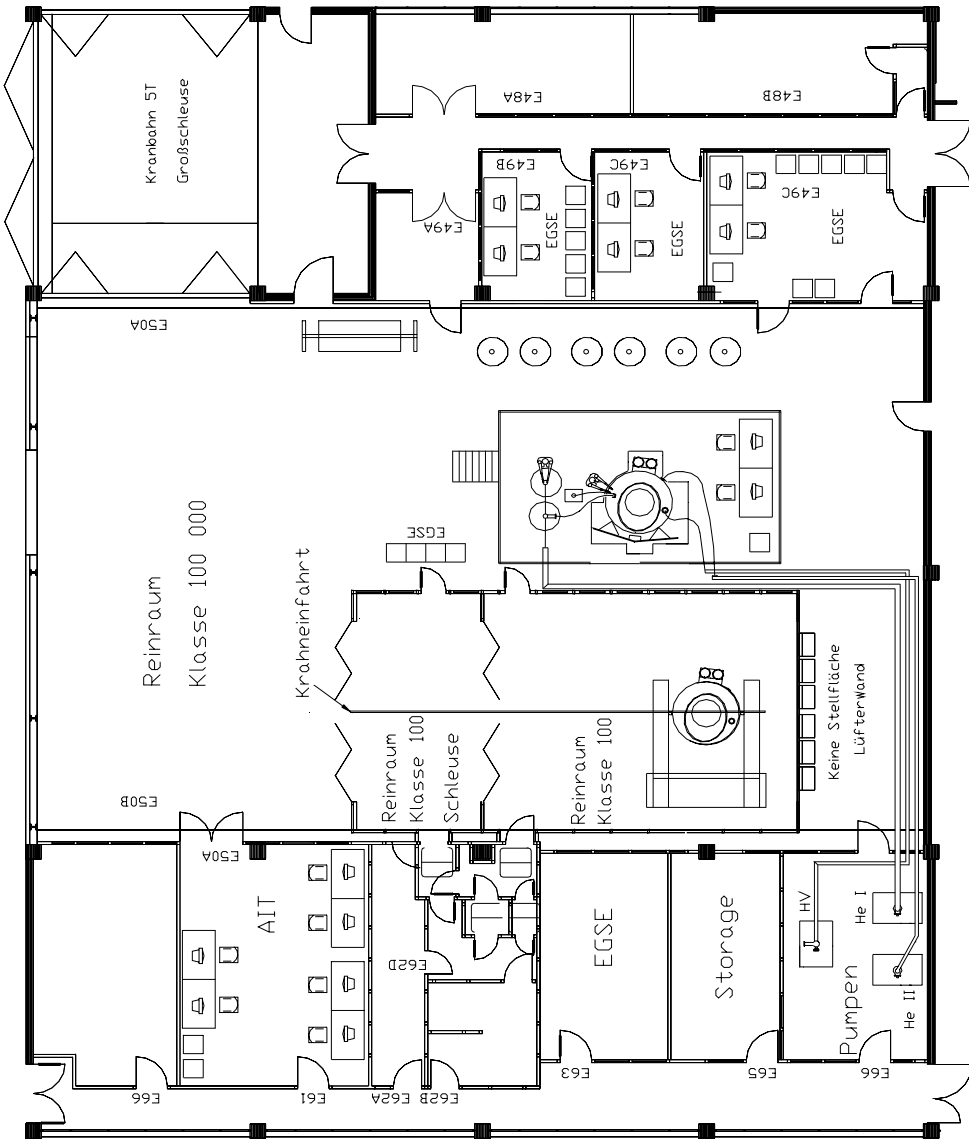

Figure 6-5: Layout of Test Facility

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 EQM 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 1):

TBD

7.3 Temperature Ranges

The L0, L1 and L2 temperature levels provided by the EQM cryostat (ISO) 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 2.

	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 EQM Cryostat (ISO)

8 Instrument Test Activity Descriptions

This sections describes the individual test activities per instrument which will be performed on PLM EQM 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 EQM level tests the test procedures developed for and validated at the instrument 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:*
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 EQM

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:
The delivered units are as per Table 5-1, packed in separate transport boxes (TBC).

Specific Requirements on PLM:
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 EQM

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:*
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 EQM

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:*
As per Table 5-4.	None.

Particular Environmental Constraints:
None.

Success Criteria:
TBD

Duration:	*Applicable:*
TBD	PLM EQM

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:*
As per Table 5-4.	None.

Particular Environmental Constraints:
None.

Success Criteria:
TBD

Duration:	*Applicable:*
TBD	PLM EQM

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:*
As per Table 5-4.	None.

Particular Environmental Constraints:
None.

Success Criteria:
TBD

Duration:	*Applicable:*
TBD	PLM EQM

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:*
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 EQM

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:*
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 EQM

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:*
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 EQM

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. With this check also the alignment of the optical bench with respect to the CVV is covered. Another objective is the validation of the alignment procedure (as far as possible).

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 and after cool down.

Instrument Configuration:	*Specific Requirements on PLM:*
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 EQM

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:*
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 EQM

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:*
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 EQM

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:*
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 EQM

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:*
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 EQM

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:*
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 EQM

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:*
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 EQM

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:*
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 EQM

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:*
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 EQM

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:*
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 EQM

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:*
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 EQM

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:*
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 EQM

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:*
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 EQM

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:*
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 EQM

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 EQM 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:*
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 EQM

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:*
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 EQM

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:*
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 EQM

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:*
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 EQM

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:*
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 EQM

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:*
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 EQM

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 EQM 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:*
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 EQM

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:*
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 EQM

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:* 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 EQM

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:*
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 EQM

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:*
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 EQM

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:*
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 EQM

8.10 EMC Tests

8.10.1 HIFI EMC Test

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

Objectives:
Check of instrument functional performance in its most sensitive mode under electromagnetic worst case conditions (conducted and radiated EMC).

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:*
As per Table 5-1 and Table 5-4 including a harmonic generator with beam splitter mounted between the LOU and CVV window.	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 EQM

8.10.2 PACS EMC Test

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

Objectives:
Check of instrument functional performance in its most sensitive mode under electromagnetic worst case conditions (conducted and radiated EMC).

Test Description:
During ILT, two specific EMC test sequences will be developed. During EQM, performance of these sequences will allow verification of certain EMC requirements in addition to the results from specified test set-ups. Note: EQM 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:*
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 EQM

8.10.3 SPIRE EMC Test

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

Objectives:
Check of instrument functional performance in its most sensitive mode (Photometer Standby) under electromagnetic worst case conditions (conducted and radiated EMC).

Test Description:
The EQM 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:*
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 EQM

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			