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

CI-No: 150 000

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Issue	Date	Sheet	Description of Change	Release
Draft	30.04.02	all	Draft for review and comments	
Issue 1	22.05.02	all	Initial issue	
Issue 2	06.06.03	all	Complete revision of issue 1, reflecting the development of the programme and taking into account related comments from the instrument contractors.	
Issue 3	20.07.04	all	Complete revision of issue 2 in the frame of the Herschel CDR, reflecting the development of the programme and taking into account related comments from the instrument contractors. Insertion of a new paragraph covering the instruments mechanical and electrical integration.	
Issue 3.1 draft	09.11.04	all	Incorporation of comments raised during the instrument AIT meetings (HP-2-ASED-MN-0753, -0762 and -0780) plus updates reflecting the development of the program.	

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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 in 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 document is the central document for the compilation of information concerning the instrument testing. It serves as reference document for the higher level Satellite 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 the PLM 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’).

The document provides the baseline for the instrument related PLM EQM test procedures.

Note:

The current issue 3.1 draft reflects the status as per 30.10.2004 and is for review by ESA, Alcatel and the Instrument Contractors. All information available by that date has been included. Open items are indicated by TBDs or TBCs. This draft version will become a final issue as soon as the comments from ESA, Alcatel and the Instrument Contractors have been received and incorporated.

2 Documents

2.1 Applicable Documents

AD 1	SCI-PT-IIDA-04624	Herschel/Planck Instrument Interface Document, Part A	Issue 3.3
AD 2	SCI-PT-IIDB/SPIRE-02124	Herschel/Planck Instrument Interface Document, Part B, Instrument “SPIRE”	Issue 3.2
AD 3	SCI-PT-IIDB/HIFI-02125	Herschel/Planck Instrument Interface Document, Part B, Instrument “HIFI”	Issue 3.2
AD 4	SCI-PT-IIDB/PACS-02126	Herschel/Planck Instrument Interface Document, Part B, Instrument “PACS”	Issue 3.2
AD 5	HP-1-ASPI-SP-0008	H-EPLM AIV and Herschel Satellite AIT Requirements Specification	Issue 4.2
AD 6	HP-2-ASED-PL-0022	Herschel PLM EQM AIT Plan	Issue 2.1
AD 7	HP-2-ASED-PL-0007	Herschel PA Plan	Issue 2.1
AD 8	HP-2-ASED-PL-0023	Herschel Contamination Control Plan	Issue 2
AD 9	H-P-ASP-PL-0225	Herschel/Planck Verification Program Plan	Issue 2

2.2 Reference Documents

RD 1	empty	-	
RD 2	HP-2-ASED-TN-0076	Optical Configuration and Straylight during Ground Testing	Issue 2
RD 3	H-P-1-ASPI-IS-0121	EGSE Interface Requirements Specification	Issue 4
RD 4	HP-2-ASED-TN-0011	HERSCHEL EQM Thermal Model and Analysis	Issue 4
RD 5	HP-2-ASED-TN-0097	Herschel Alignment Methods, Plan and results	Issue 1

2.2.1 HIFI Reference Documents

In this section all documents issued by HIFI for the HIFI PLM EQM level AIT activities are listed.

RH 1	SRON-U/HIFI/UM/2004-001	HIFI User Manual	Issue 1
RH 2	FPSS-00603	Handling Procedure HIFI FPU Transport Container	Draft 01
RH 3	FPSS-00444	FPU-Herschel Optical Bench Mounting Procedure	Issue 1

2.2.2 PACS Reference Documents

In this section all documents issued by PACS for the PACS PLM EQM level AIT activities are listed.

RP 1	PACS-ME-PL-015	PACS EMC/ESD Control Plan and Procedure	Issue 1.1
RP 2	PACS-KT-PR-024	User Manual	Issue 2

2.2.3 SPIRE Reference Documents

In this section all documents issued by SPIRE for the SPIRE PLM EQM level AIT activities are listed.

RS 1	SPIRE-RAL-PRC-001923	SPIRE FPU Handling and Integration Procedure	Issue 1, 20.05.04
RS 2	SPIRE-RAL-DOC-001905	SPIRE EQM Test Plan	Issue 1.0, 19.12.03
RS 3	SPIRE-RAL-DOC-000768	Operating the SPIRE Instrument	Issue Draft, 31.05.2003
RS 4	SPIRE-RAL-DOC-001652	SPIRE Functional Test Specification	Issue 1.0, 05.12.2003
RS 5	SPIRE-RAL-NOT-000983	Definition of SPIRE CQM Delivered for	Issue 3.0, 19.12.03

		System Level Testing	
RS 6	SPIRE-RAL-DOC-001049	SPIRE CQM Instrument Level Test Plan	Issue 1.0, 15.05.02

3 Objective of PLM EQM AIT Programme

3.1 PLM EQM Test Programme General Objectives

The main objective of the EQM test program on PLM EQM level is to check the mechanical, electrical, electromagnetic and thermal compatibility of the instruments with the PLM and the PLM environment.

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 been refurbished and modified in some areas to provide as much as possible the Herschel cryostat environmental conditions.

3.2 Instrument Specific 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 EGSE Validation	Check of Instrument EGSE function (self-test). Check of Instrument EGSE interfaces to CCS.	Ambient	Prior to start PLM level instrument test programme.
Instrument Alignment Check	Check of instrument alignment and validation of alignment procedure (as far as possible).	All	In warm and cold conditions.
Instrument Short Functional Test (SFT)	Instrument switch on and functional verification of instrument interfaces. Evaluation should preferably be based on housekeeping data. Two different types of instrument SFTs: warm and cold.	SFT warm: Ambient SFT cold: Tank temperature 4.2 K (He1) or 1.7 K (He2)	SFT warm: Before cool down of the cryostat. SFT cold: After cool down (He1) and after He2 production..

Test	Test Objectives	Conditions	Remarks
Instrument Specific Performance Test (SPT)	Verification of dedicated aspects of the performance of the integrated instrument. Tests may require a specific spacecraft configuration.	Tank temperature: 1.7 K	Scheduling depending on test set-up requirements.
Integrated Module Test (IMT)	Verification of the functional performance of the integrated instrument in all possible modes. Check of the instrument performance as far as possible with PLM configuration.	Tank temperature: 1.7 K	
EMC Test	Check of functional performance of the integrated instrument under electromagnetic worst case conditions (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).

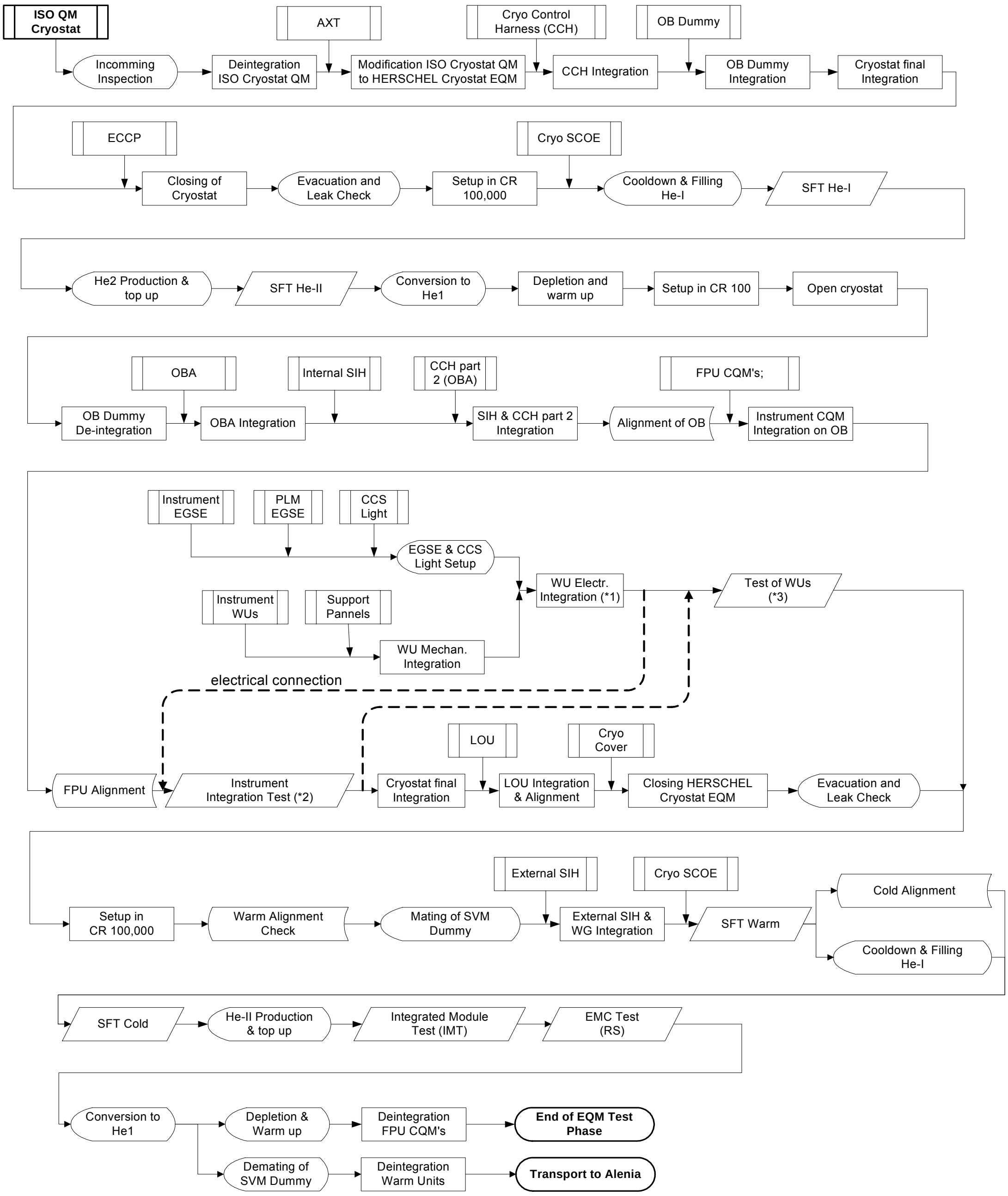

Figure 4-1: EQM AIT Flow

5 Instrument Integration

5.1 Incoming Inspection

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

The incoming inspection covers the visual inspection of the hardware, the cleanliness control and the check of the documentation.

The following items will be verified:

Packing undamaged

- Seals and straps intact
- Correct labelling

Transportation container, inner packing

- Correct identification (see heading)
- Equipment correctly and safely packed
- Equipment hermetically sealed
- Packed with desiccant
- Packed with humidity-indicators
- Packed with shock-indicators
- Packed with temperature-indicators
- Container reusable and stackable

Equipment

- Identification correct
- Screw sealing not broken
- Surface finish undamaged and clean
- Connector identification correct
- Connector with protective caps
- Connector pins clean and undamaged
- Mounting area clean and undamaged
- Accessories, bonding points, covers, red-tags

Documentation

- Shipping documentation
- Log sheets / historical records

- Handling, packing, transport procedures
- End Item Data Package
- Other Documentation

Other notable defects

5.2 Pre-Integration Tests

5.2.1 General

In addition to the incoming inspection as described above a series of stand-alone tests will be conducted by the instrument personnel prior to integration in the PLM in order to ensure that no damage has occurred during transit. The pre-integration tests will take place in a cleanroom class 100 (for the FPU) and 100000 (for the Warm Units) in the test facility at Astrium (Ottobrunn). The layout of the test facilities is shown in Figure 8-3. For details see AD 06. The spacecraft EGSE is not required with the exception of the SPIRE Warm Units test. The testing on the FPU is limited to continuity and isolation tests only. Limited function testing can be carried out on the warm electronics. Any equipment required for these tests (e. g. IEGSE, test harness, CDMS simulator, FPU simulator) will be supplied by the instruments.

5.2.2 HIFI Pre-Integration Tests

TBD by HIFI.

5.2.3 PACS Pre-Integration Tests

The following tests will be performed

- Electrical continuity check of FPU. Cleanroom class 100 required.
- Functional check of Warm Units with ILT EGSE, including FPU simulator.

5.2.4 SPIRE Pre-Integration Tests

5.2.4.1 FPU Testing

In addition to visual inspection continuity and isolation tests will be performed. The following equipment will be required (supplied by SPIRE):

- FPU and JFETs
- Test leads
- Breakout boxes

FPU (incl. JFETs) tests will be performed in cleanroom class 100 conditions (see AD 2, § 5.15.2.2 and RS 1). Any test equipment will be provided by SPIRE and is compatible to cleanroom class 100 conditions.

Expected duration: 1/2 day.

5.2.4.2 Warm Units Testing

Limited function tests will be carried out on the Warm Units. The tests will be performed in cleanroom class 100000 conditions. The following equipment will be required and supplied by SPIRE:

- DPU AVM
- DCU QM1
- FCU QM1
- DRCU separate Power Supply
- IEGSE (already at ASED)
- CDMS simulator
- FPU simulator
- WIH (test harness)
- Test Harness

Warm Units pre-integration test on instrument level:

- SPIRE DRCU Integration Test
- SPIRE warm short functional test (subset of full warm functional test) (see RD TBD by SPIRE)

Expected duration: 4 h.

Warm Units pre-integration test with Spacecraft EGSE:

- SPIRE Warm Units will be connected to the Spacecraft EGSE
- Repeat Warm Units pre-integration test on instrument level

Expected duration: 4 h.

5.3 Mechanical Integration

5.3.1 HIFI Mechanical Integration

Staggered delivery (TBC):

1. FPU, FCU, FCU SCOE to operate FCU, test harness to connect FCU and FPU and FCU SCOE, FPU simulator
2. LOU, LCU, LSU, LCU/LSU SCOE, test harness/waveguides to connect LOU with LCU and LSU and LCU/LSU SCOE
3. Remaining Warm Units

Flow and procedures TBD by HIFI.

Notes

- The FPU shims are sized by HIFI.
- HIFI will deliver the tool to fix the screws for the FPU front feet. No specific tools are needed for the fixation of the thermal compensators.
- The FPU transport container can stay with the FPU EQM (separate container available for FPU PFM).
- HIFI will deliver an LSU simulator instead of the LSU DM. It is currently not planned by HIFI to deliver the LSU DM at a later time. The LSU simulator shall be connected to LOU via the ASED waveguides plus flexible waveguide extensions (to be furnished by HIFI). HIFI will define the maximum possible length of the flexible waveguides between LSU simulator and ASED waveguides. The LSU simulator will not be operated during SFT.

5.3.2 PACS Mechanical Integration

The FPU trolley has wheels and cannot go in cleanroom class 100. Hence the FPU will be packed in a plastic bag (cover) inside the cylindrical container. The eyelets on the FPU will be pre-installed, in order to allow the lift of the (protected) FPU in the airlock, before moving it to cleanroom class 100.

All operators and the FPU shall be grounded during handling. Grounding connector will be be connected to ground

All operators and FPU will be grounded during handling. Grounding connector will be connected to ground.

PACS lifting devices have to be installed on the FPU feet to protect the FPU pins from shock during mounting on the OBA (ref sheet 7 of FPU ICD).

Level 0 strap connections to FPU will be performed by CEA.

The PACS transport container needs to be returned to PACS for FPU PFM.

For details see RP 2.

5.3.3 SPIRE Mechanical Integration

5.3.3.1 FPU and JFETs

Caution

- The bipod legs on two corners of the instrument are very thin section and easily damaged. Care must be taken at all times not to put side loads into these items. These are at risk, when not attached to a rigid plate.
- The FPU is supplied with the alignment cube fitted, and should be left in place until all alignment activities are complete.
- The FPU aperture cover (red tag item) is fitted and shall be removed prior to installation of the instrument shields and the closure of the cryostat.
- Interface surfaces of L0 straps are flat and soft gold plated, these surfaces can easily be damaged and the thermal performance of the instrument may suffer as a result.

Pre-conditions

- The detector L0 thermal strap will be removed before integration of the OBP.
- A specific lifting gear (MGSE) is supplied for the integration of SPIRE FPU and JFET assembly on the OBP.
- When delivered, the JFET units will be fitted with shorting connectors and/covers to protect the detectors. These should be left in place during the mechanical integration.
- The FPU is supplied attached to a baseplate together with the JFETs and the JFET harness already integrated. I. e. the JFETs will be fitted to the spacecraft together with the FPU.

Major integration steps

- Fix the FPU cone to the Optical Bench Plate.
- Fix the Spectrometer JFET studs (2 off) to the Optical Bench Plate.
- Lift the FPU and JFETs using the lifting gear from the SPIRE transportation baseplate onto the Herschel Optical Bench Plate.
- Flexible ends of the L0 straps are unsupported at this stage and need to be guided by hand.
- Note: The cone is very this walled section and large moments can be applied if the FPU is not lowered with its interface plane parallel to the HOB.

- When all units are rested on the HOB fit the attachment screws to the bipod feet as fothe cone mount.
- L0 cooler and evaporator straps are fitted to the L0 S/C pod interfaces.
- The L0 detector strap is fitted to the FPU according the SPIRE provided procedure (see RD6) and fitted to L0 S/C pod interface.
- The two L1 thermal strap interfaces are fitted to the FPU.
- Fit the two L3 straps to the JFETs.
- Perform an isolation test.

For details see RS 1.

5.3.3.2 Warm Units

The SPIRE Warm Units for the EQM consist of the DPU AVM and the DRCU QM1. An engineering model of the warm interconnect harness will be used.

A separate power supply will be installed in dedicated rack connected to the DRCU via a SPIRE provided harness.

The major integration steps for the SPIRE Warm Units are:

- TBD by SPIRE

The SPIRE Warm Units will be integrated on the SMV Simulator according to the Warm Electronics Integration Plan (see RS TBD by SPIRE).

5.4 Electrical Integration

5.4.1 General

The instrument electrical integration comprises the integration and check of

- The Warm Units internal interconnections.
- The connection of the Warm Units to the PLM EGSE.
- The connection between the FPU/LOU and the Warm Units.

<u>Warm Units internal connections and connection of Warm Units to PLM EGSE</u>

After mechanical integration of the Warm Units on the SVM simulator the interconnection harness will be connected to the Warm Units. The standard ESD requirements will be respected.

Then the Warm Units will be connected to the PLM EGSE (harness to be provided by TBD). Prior to connection with the Warm Units the PLM EGSE lines (primary power interface, 1553 data bus interface) will be electrically checked (polarity, voltages, measured at the harness connector to the Warm Units).

The Warm Units internal interconnections and the connection of the Warm Units to the PLM EGSE will be checked in their entity, using the instrument provided external FPU simulators (HIFI) or built-in FPU simulators (PACS). The check consists of an instrument functional test TBD by HIFI/PACS/SPIRE. The FPU simulators (HIFI, SPIRE) will be connected to the Warm Units with the instrument provided test harness. PACS uses an internal FPU simulator.

This test includes also the validation of the instrument test procedures which will run during the IMT and EMC test.

The warm units will be operated by the PLM EGSE.

Connection between the FPU/LOU and the Warm Units

Prior to the instrument electrical integration the cryoharness will be separately checked in the following way:

1. Check of the cryoharness electrical design versus the instrument test harness.
   This check will be performed by automatic pin-to-pin measurements of the instrument test harness and the cryoharness and an automatic comparison of the measurement results (consistency check). This will be accomplished by a computer supported data acquisition system (IDAS) using the cryoharness manufacturing database. The measurement of the instrument test harness versus the database will be performed at the instrument premises prior to the start of the cryoharness integration (as far as possible) in order to detect potential database errors.
2. Continuity check of the integrated cryoharness.
   Before connecting the cryoharness to instrument FPU/LOU and/or Warm Units a continuity check of the integrated cryoharness will be done. This check will also be performed by automatic pin-to-pin measurements with the IDAS using the validated database.

Note 1: The check of the HIFI cryoharness coax cables will be manually performed using a network analyser or an equivalent device.

Note 2: Measurements of electrical characteristics of FPU/LOU or Warm Units input/output lines are not planned.

Note 3: The check of the integrated cryoharness will be performed section by section, since the complete cryoharness is not yet available at the CVV closure (see sequence below).

General electrical integration sequence

1. Integration of CVV internal cryoharness.
2. Verification of CVV internal cryoharness by test with IDAS against validated EICD.
3. FPU mechanical integration.
4. Connection to CVV internal cryoharness to FPU.
5. Limited test of FPU via CVV feed through connectors (as far as possible).

6. WU mechanical integration.
7. WU electrical integration.
8. Integration of CVV external cryoharness.
9. Verification of CVV external cryoharness by test with IDAS against EICD.
10. Verification of complete cryoharness by analysis.
11. Connection of external cryoharness with WU and feed through connectors.
12. Instrument integration test.

<u>CVV internal cryoharness integration</u>

1. Routing and fixation of CVV internal cryoharness from CVV feed through connector to FPUs.
2. Continuity test of wires and shields between CVV feed through connector side and FPU side of cryoharness.
3. 100 V insulation tests of all wires to spacecraft structure (NOT pin to pin insulation!!).
4. Discharge of each wire by use of a short circuit plug.

<u>Connection of CVV internal cryoharness to instrument FPUs</u>

1. Connection of a short circuit plug (with all lines connected to ground) according integration sequence to (external side of) CVV feed through connector Jx1.
2. Disconnection of FPU ESD connector.
3. Connection of related cryoharness plug to FPU.
4. Disconnection of circuit plug from CVV feed through connector Jx1 which will be covered by an EMI protection cap.
5. Repeat steps 1 to 4 with the next CVV feed through connector Jx2, etc. until the complete FPU cryoharness is connected.

Note:

- During all connection activities personnel will be grounded via ESD-wrist bands.
- There is only one short circuit plug available for each type of feed through (128, 100 pin) which will be used sequentially. After disconnection of short circuit plug the feed through connector is closed by an EMI protection cap. This is not valid for PACS were dedicated short circuit plug will be connected on the feed through connectors until final mating with the Warm Units.

CVV external cryoharness integration

1. Routing and fixation of external cryoharness along CVV.
2. Continuity test of external cryoharness and shields between CVV feed through connector side and Warm Units side of cryoharness.
3. 100 V insulation tests of all wires to spacecraft structure (NOT pin to pin insulation!!).
4. Discharge of each wire by use of a short circuit plug.

Connection of CVV internal cryoharness to CVV feed through connectors

1. Connect a short circuit plug to SVM I/F-CB connector Jx1.
2. Disconnect from CVV feed through connector Jx1 the EMI protection cap.
3. Connect the CVV external cryoharness plug to CVV feed through connector Jx1.
4. Disconnect the short circuit plug from SVM I/F-CB connector Jx1.
5. Repeat steps 1 to 4 with the next SVM I/F-CB and CVV feed through connector Jx2, etc. until the complete FPU cryoharness is connected.

Connection of CVV external cryoharness to SVM cryoharness (final mating)

The SVM croyharness will be mated first with the Warm Units. Afterwards, in staggered way, the single SVM cryoharness connector will be mated to the CVV external cryoharness.

Before coupling of SVM cryoharness Pxx with CVV external cryoharness Jxx , both the CVV external and the SVM cryoharness Pxx connectors will be discharged by use of short circuit plugs, one connected on Jxx and another one connected on Pxx. Afterwards both short circuit plugs will be disconnected and the SVM cryoharness Pxx connector mated to the CVV externalcryoharness connector Jxx (final mating).

After the final mating a functional check (warm) of the complete instruments will be performed. Details TBD by HIFI/PACS/SPIRE.

5.4.2 HIFI Electrical Integration

The following deviations to the standard procedure defined in section 5.4.1 exist:

1) Cryoharness configuration

The cryoharness EQM is flight representative with the exception that for the cryoharness between the LOU and LCU the following 2 bundles are provided:

- SIH-IH/SH-07 from LOU P05/P07 to LCU P09/P10 via SVM-CB J03/P03
- SIH-IH/SH-11 from LOU P06/P08 to LCU P16/P17 via SVM-CB J01/P01

The connections for the not available LOU channels 1, 2, 5, 6 and 7 and the heaters to the LCU are not implemented. The LOU and LCU provides dummy connectors (at flight representative position) for the not available LOU channel 4 (P07 and P08 on LOU and P10 and P17 on LCU), with all returns and shields being grounded.

The FCU and FPU EQMs are assumed to be identical to the PFMs as regards form and fit (e. g. identical connector type/position).

Notes

- The warm check of the FPU includes a continuity check (measurement of noise level) of the IF output signal (a functional test is only possible when the FPU is at operating temperature). This check needs the connection of the SCOE to the ends of the cryoharness coax cables (at the position of the up-converters). The test coax cables will be provided by HIFI. For the EQM only 2 output signals need to be checked.
- The electrical integration test for the LOU is TBD by HIFI.

5.4.3 PACS Electrical Integration

Details TBD by PACS.

During entire integration all open PACS FPU cryoharness lines will be grounded using short circuit plugs on CVV feed through connectors.

After electrical integration of Warm Units on SVM simulator a functional check of the Warm Units including FPU simulator will be performed. The instrument is controlled by the PLM EGSE. This check includes the validation of all PACS test procedures (SFT, IMT, EMC test modes).

5.4.4 SPIRE Electrical Integration

The following deviations and/or amendments to the standard procedure defined in section 5.4.1 exist:

Caution

- Several subsystems with the SPIRE FPU are ESD sensitive and especially vulnerable during the integration process. All normal precautions shall be taken when handling the FPU especially when open connectors are present.

Preconditions

- Note: Only a subset of the spacecraft cryoharness branches is installed in the EQM. The non-used connectors on the FPU and JFETs will be fitted with EMI caps which will be provided by ASED (TBC).
- Note: During electrical integration the FPU is grounded via the temporary ground strap!

Major Integration steps

- Grounding verification (check that FPU Faraday shield is isolated from the chassis of the CVV/SVM).
- Connect cryoharness to FPU, JFETS, FCU and DCU following predefined sequence.
- Remove the temporary ground strap from the FPU.
- On the DCU and FCU cryoharness connectors, break all the connections between the FPU Faraday Shield Link and the EMC backshells.
- Measure and record the isolation resistance between the FPU Faraday Shield links and the chassis of the DCU.
- Reconnect all the links between the FPU Faraday Shield Links and the Cryoharness EMC backshells.
- Note: Above mentioned grounding verification with connections between FPU Faraday Shield and cryoharness backshells separated is TBC by ASED.
- Saving plugs shall be fitted to the connected CVV feed through connectors, when the intermediate cryoharness is not installed.
- Saving plugs shall be fitted to the connected SVM CB connectors, when the SVM cryoharness is not installed.

Check after Connection of CVV internal cryoharness to SPIRE FPU

- SPIRE will perform a bench test with the integrated FPU via break-out-box connected to the CVV feedthrough connector (I. e. resistance measurements). The break-out-box will be provided by ASED.
- For details concerning the electrical integration see RS 1.

Check after final mating

- A full warm functional test according to RD 9 will be performed when the FPU is integrated into the cryostat, the cryostat is closed, the complete cryoharness is installed and the SPIRE Warm Units are integrated, but before cool down of the cryostat.
- These tests will take approximately 1 day.

5.5 Instrument De-Integration

5.5.1 HIFI De-Integration

TBD by HIFI.

5.5.2 PACS De-Integration

TBD by PACS.

5.5.3 SPIRE De-Integration

5.5.3.1 Electrical Disconnection

Disconnection is the reverse of connection.

For details see RS 1.

5.5.3.2 Removal from spacecraft

<u>Caution</u>

- The bipod legs on two corners of the instrument are very thin section and easily damaged. Care must be taken at all times not to put side loads into these items. These are at risk, when not attached to a rigid plate.

For details see RS 1.

6 Instrument Specific Test Activities

6.1 Instrument EGSE Validation

The Instrument EGSE validation will comprise a stand-alone test of the Instrument EGSE (self-test).

Secondly, after connection to the CCS lite, an interface check will be performed (PIPE protocol).

Its objective is to check the proper electrical EGSE – CCS connections and the correct functioning of the EGSE – CCS interface drivers.

Note: This test does not substitute the principle verification of the Instrument EGSE – CCS interface which is part of the Instrument EGSE and CCS AIT programme.

For specific check-out equipment (e. g. HIFI test signal source) dedicated validation tests will be performed, as required.

Related test activity descriptions per instrument section 11.1.

6.2 Alignment Check

The main objectives of the alignment checks are:

- Validation of the instrument alignment procedure.
- Determination of the impact of the CVV pressure change and cool down on the instrument alignment.
- Alignment of HIFI LOU versus HIFI FPU.

The determination of the shift and rotation of the OB after cryostat evacuation and cool down will be performed in two steps. 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 shift and rotation will be determined by measurements of HIFI FPU alignment versus the HIFI LOU with a dedicated alignment camera system.

The alignment camera system consists of two alignment cameras which will be mounted on the LOU support plate, allowing monitoring simultaneously shift and rotation (two cameras are needed to determine the rotation about the y axis). A distance measurement in y direction is also possible, however, with reduced accuracy (TBC).

The correct alignment of the HIFI LOU versus HIFI FPU is required to allow reasonable instrument functional performance verification.

Note: To support these measurements the instruments FPU CQM is equipped with alignment references equal to the FPU PFM.

Details see RD 05.

6.3 Short Functional Test (SFT)

The principle objective of the SFT is the check of the electrical integrity and operability (command and control) of the PLM. As regards the instruments the SFT covers the instrument switch-on and the functional verification of the electrical instrument interfaces.

The SFT does not require any specific PLM configuration/condition (e. g. cryostat orientation) or specific instrument GSE. The test duration is in the range of 1 hour per instrument. During these tests the instrument will be controlled via the spacecraft and its associated EGSE. The test evaluation is based on housekeeping data, i. e. no need of science data evaluation.

Two different types of SFTs exist, depending on the helium tank temperature conditions:

- SFT warm (tank without helium)
- SFT cold (tank with normal boiling or supra fluid helium)

The related instrument SFT procedures are adapted to these specific thermal environmental conditions for the FPUs.

Related test activity descriptions per instrument see section 11.2.

6.3.1 HIFI SFT

HIFI provides one test sequence for SFT warm and SFT cold with different sets of nominal values (configuration files).

6.3.2 PACS SFT

TBD by PACS.

6.3.3 SPIRE SFT

6.3.3.1 SPIRE SFT Warm Test

A subset of the full warm functional test according to RS 4 will be performed.

Details TBD by SPIRE.

6.3.3.2 SPIRE SFT Cold Test

<u>SPIRE SFT Cold Test (He I)</u>:

A subset of the full cold functional test will be carried out (see RS 4).

Details TBD by SPIRE.

The test duration is 1 hour.

SPIRE SFT Cold Test (He II):

Full cold functional test will be carried out as specified in RS 4.

The test will take 1 hour.

6.4 Specific Performance Test (SPT)

Objective of the SPT is to verify dedicated aspects of the instruments performance. This may require a specific spacecraft configuration.

I. e. SPTs are a tools to verify the instrument performance on PLM level. The tests are strongly based on the instrument level tests in order to allow a quick and reliable performance assessment by comparing the PLM level test results with the instrument level test results (no degradation with respect to instrument level test results, assuming that the environmental conditions are similar).

The SPTs will be conducted with in-orbit representative thermal conditions inside the cryostat and as regards the detector back ground. This will be achieved by specific cryogenic means (e. g. cryo cover as described in RD 2). The SPTs of the PACS and SPIRE instrument include the verification of the hold time of the 300 mK cooler.

Related test activity descriptions per instrument see section 11.3.

Note: The SPTs will be conducted as subsets of the IMT.

6.4.1 HIFI SPT

The following SPTs are defined for HIFI (see also section 11.3 of this document):

- Functional Test
  This test consiss of test modes FT_unpumped and FT_pumped.
- Radiometry Test (using the internal calibration source)
  This test will be reduced. Since HIFI does not have available an LSU during the ILT test and first phase of IST, a less sophisticated LSU simulator will be used. It does not allow easy and safe operation of the LOU. That is why only one or two frequencies will be used in stead of stepping through band 3. It is not foreseen that more frequencies will be added when in a late phase the LSU simulator can be replaced by the QM LSU. Use of LSU simulator would degrade EMC test.
- LO Beam Standing Wave Test [1)]

[1)] The test comprises the impact verification of the standing waves on the LO Beam between LOU and FPU.

Test details TBD by HIFI.

6.4.2 PACS SPT

The following SPTs are defined for PACS (see also section 11.3 of this document):

- Cooler Recycle / Hold Time
- Full Functional Test
- Short Performance Test [1)]
- Astronomical Observation Template (AOT) Tests
- PACS/SPIRE Parallel Mode Test

Test details TBD by PACS.

6.4.3 SPIRE SPT

The SPIRE SPTs will include the following Flight Operations Thermal Balance Tests:

- Cooler Recycle / Hold Time
- Ambient Background Verification Test
- Photometer Chop Mode Test

Test details TBD by SPIRE.The case forms are contained in Section 11.3 of this document

Note: Need to use BOB to drive SMEC and BSM during chop test (BOB solution

with a T-connector preferred). Details TBD by SPIRE.

6.5 Integrated Module Test (IMT)

The superior objective of the IMT is the verification of the correct operation of the fully integrated PLM in a series of representative mission modes. This includes the verification of the functional performance of the integrated instruments and their measurement performance, as far as it is possible on that level.

On PLM EQM level only one IMT is planned. This IMT will comprise instrument SFTs and specific operational scenarios to determine the related temperature transients.

Figure 6-1 shows the activities to be performed during the IMT.

IMT Flow (EQM)						
Step	**HIFI**	**PACS**	**SPIRE**	**EPLM Position**	**Duration**	**Remarks**
1	Off	Off	Off	No requirement	-	
2	SFT Cold	Safe Mode	Ready Mode	No requirement	1 h	
3	Functional Test	Safe Mode	Ready Mode	No requirement	1 h	SPT
4	Radiometry Test	Safe Mode	Ready Mode		1 day	SPT
5	LOBeam Standing Wave Test	Safe Mode	Ready Mode	No requirement	1 day	SPT
6	Stand-By	Safe Mode	SFT Cold	No requirement	1 h	
7	Stand-By	Safe Mode	Cooler Recycle	23° to 30° to +y	2 h	
8	Stand-By	Safe Mode	Ambient Background Verification Test	No requirement	1 h	SPT
9	Stand-By	Safe Mode	Photometer Chop Mode	No requirement	1 h	SPT
10	Stand-By	Cooler Recycle	Ready Mode	23° to 30° to +y	2 h	
11	Stand-By	SFT Cold	Ready Mode	No requirement	1 h	
12	Stand-By	PACS/SPIRE Parallel Mode	PACS/SPIRE Parallel Mode	No requirement	TBD	SPT
13	Stand-By	Full Functional Test	Wait for Cooler Exhaustion	No requirement	TBD	SPT
14	Stand-By	Short Performance Test	Wait for Cooler Exhaustion	No requirement	TBD	SPT
15	Stand-By	AOT Tests	Wait for Cooler Exhaustion	No requirement	TBD	SPT
16	Stand-By	Wait for Cooler Exhaustion	Wait for Cooler Exhaustion	No requirement	TBD	Check of max. cooler hold time
17	Off	Off	Off	No requirement	-	

Figure 6-1: IMT Activity Flow (proposal TBC by HIFI/PACS/SPIRE)

The IMT includes the verification of the hold time of the 300 mK cooler, i. e. in the IMT a full cooler recycle period is foreseen for PACS and SPIRE

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 2.

Further details of the instrument test sequences still TBD by HIFI/PACS/SPIRE.

Timing of cooler recycling for both instruments TBD by PACS/SPIRE.

Related test activity descriptions per instrument see section 11.4.

6.6 EMC Test

The general objective of the instrument PLM EQM level EMC test programme is to demonstrate that the instruments are compatible with the Herschel PLM electro-magnetic environment.

The EMC tests comprise a radiated susceptibility (RS) test.

Conducted emission (CE) and conducted susceptibility (CS) tests on primary power side are not planned because of the limited representativity of the AVM primary power interfaces and the unavailability of the PCDU. Instead, for the CE and CS performance it shall be referred to the instruments level test results.

Also CE and CS tests on secondary power and on cryoharness are not planned. The CS test objectives on the cryoharness are in principle covered by the RS test.

During the RS 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.

Prior to the EMC tests a reference test will be made to determine the performance under nominal conditions.

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

The EQM EMC tests will be performed in a standard integration facility at Astrium (i. e. no anechoic chamber). In order to be allowed to perform the RS test outside the anechoic chamber the radio regulation community have formally to be requested for permission at least 6 months prior to test.

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

Figure 6-2 describes the instrument tests and modes to be performed within the EMC test.

EMC Test Flow (EQM)						
Step	**Test Type**	**HIFI**	**PACS**	**SPIRE**	**EPLM Position**	**Duration**
1	-	Off	Off	Off	No requirement	-
2	Reference test	Most sensitive mode	Off	Off	No requirement	5 days
4	RS	Most sensitive mode	Off	Off	No requirement	
6	-	Off	Cooler Recycle	Off	23° to 30° to +y	5 days
7	Reference test	Off	Most sensitive mode	Off	No requirement	
8	RS	Off	Most sensitive mode	Off	No requirement	
9	-	Off	Off	Cooler Recycle	23° to 30° to +y	5 days
10	Reference test	Off	Off	Most sensitive mode	No requirement	
11	RS	Off	Off	Most sensitive mode	No requirement	
12	-	Off	Off	Off	No requirement	-

Note: Most sensitive/noisiest modes during EMC tests TBD by HIFI/PACS/SPIRE.

Figure 6-2: EMC Test Activities Flow

The following principle test flow is applied for the susceptibility test:

- Powering of instrument
- Commanding of instrument into most sensitive mode
- Application of instrument stimuli (HIFI)
- HK data monitoring
- Analysis of the scientific data (quick look).

The following parameters are monitored during the susceptibility tests:

HIFI:

- TBD by HIFI

PACS

- TBD by PACS

SPIRE

- TBD by PACS

Related test activity descriptions per instrument see section 11.5.

Note

The satellite housekeeping data is sampled on-board every 1 second but transmitted only every 4 seconds. Therefore, instead of continuous sweeping a step-wise frequency adjustment will be applied for susceptibility testing. A minimum exposure time of 8 seconds is recommended for each frequency step. The data transmission sampling rate could be increased to 1 Hz for single parameters, on the expense of the number of parameters which can be monitored. Therefore, an increase of the sampling rate will be considered only for those parameters, which already showed susceptibility during unit level test. Such specific parameters together with the frequency bands where susceptibility exists are TBD by HIFI,/PACS/SPIRE.

Warning

The instrument interconnection harness shall not have any open lines, i. e. lines which are specified in the IID-B but which not used for the instrument EQM (e. g. due to missing redundancies, etc.) are assumed to be properly terminated inside the affected instrument units.

6.6.1 HIFI EMC Test

Note

During the HIFI EMC test an external test source will be used (positioned on the LOU baseplate bottom side).

Instrument Mode

PRIMARY

- LO frequency 850 GHz (tbc)
- HRS mode: High resolution
- HRS band centre frequency
- For the 4 – 6 GHz range: 4.25 GHz, 4.75 GHz, 5.25 GHz, 5.75 GHz
- For the 6 – 8 GHz Range. 6.25 GHz, 6.75 GHz, 7.25 GHz, 7.75 GHz
- WBS: On
- Observing mode: Total power
- Integration time: 1 s
- Chopper: cold source

Test Sequence

The susceptibility tests shall be performed first for the 4 – 6 GHz range and repeated for the 6 – 8 GHz range. During the tests the external source shall be switched on.

Due to the fact that the integration time is relatively short in comparison with PACS and SPIRE, it was decided to apply some kind of ‘’synchronised by call’’ automatic-EMC-stepwise sweep.

At the beginning of the test day a reference test will be performed in order to prove for proper functioning and performance of HIFI. This test may last several minutes (30 min maximum) and could be repeated during the normal test, e.g. during EMC set-up changes.

Then, the stepwise increase of the RS frequencies (set by the law using a fixed frequency multiplying factor, e.g. f1 = n x fo, f2 = n x f1, f3 = n x f2, etc.), shall be started simultaneously with the continuous performance data acquisition of HIFI. Every frequency step shall be active for exact 10 seconds enabling the synchronisation of the performance data with the RS frequency by time reference, time tags must be available in the performance data stream. One test session should not exceed 10 min (TBC by HIFI), in order to avoid loss of the synchronisation for the case that the time of 10 second cannot exactly be adjusted or for the case of ‘’dead times’’ between the setting from one frequency to the other.

The performance data will be evaluated offline and may give a rough order of magnitude estimation about the quantitative amount of exceeding (if any).

The number of step frequencies shall be about 160 (TBC) for the RS E-field test and about 70 for the RS H-field test

6.6.2 PACS EMC Test

RP 1 describes the most sensitive mode for the Photometer as well as for the Spectrometer. In the Photometer Mode cooler recycle is required every day and will take about 2 h.

The complete campaign shall be started with a reference test, in Spectrometer Mode and Photometer Mode respectively. The integration time is about 30 seconds for each frequency and the data can be checked by the PACS QLA (Quick Look Analysis). The results will be stored after every frequency step. The QLA will take about 2 minutes and will therefore be performed offline.

The following general test sequence is proposed:

1. Reference test and QLA – H-field steps in Spectrometer Mode for the 3 antenna positions – H-field test in Photometer Mode for all 3 antenna positions and cooler recycle every morning.

2. Reference test and QLA – E-field steps in Spectrometer Mode for the 3 antenna positions – E-field test in Photometer Mode for all 3 antenna positions and cooler recycle every morning.

6.6.3 SPIRE EMC Test

Susceptibility Levels

Susceptibility levels defined in the detector chain noise budget (~5nV/rt(Hz) referred to detector). In general the signal needs to be integrated for ~180 (1σ) seconds integration time to detect this level of noise. This means that a comprehensive (i.e. all frequencies, polarisations, antenna positions etc.) RS test would be very long.

Signal Monitoring

RS can manifest itself as either excess noise on the output from the analogue signal amplifiers, or ohmic heating of the detectors.

In either case, EMI in the detection chain can be monitored in quasi-real time with the SPIRE QLA (Quick Look Analysis). Results from early part of test will possibly be used to set levels and frequencies later on in the test.

Instrument Mode

The SPIRE instrument will be set in the most sensitive mode to allow the effects of EMI to be verified: Photometer Chop Mode. The detector sampling frequency is set to the maximum (about 80 Hz).

Cooler recycle (2h) is required every 24 h with a subsequent reference test in order to check for stabilisation (about 4 h maximum). The cooler recycle and set-up of the instrument will be done outside of the normal test time, quite early in the morning or after a test day, TBD by SPIRE.

Reference Condition

Instrument thermal transients will manifest themselves as 1/f noise hence after cooler recycle, need to wait for the bulk of the transients to settle before commencing testing. Dark noise measurements provide the reference noise levels for comparison with noise levels under test. The reference test will have to be repeated at TBD intervals to remove thermal instability "noise".

Test Sequence

A sweep at the beginning will verify for the potential susceptible frequencies. This sweep over the range from 14 kHz to 18 GHz shall not last longer than about 3 hours. The performance data retrieved during this sweep shall be stored together with a time tag in order to get the reference to the RS frequency. After evaluation of the retrieved data, the detected critical frequencies will be reinvestigated applying spot frequency test.

Maximum 60 spot frequencies shall be tested for E-field and maximum 30 for H-field RS test.

Exposure time for each frequency shall be 3 minutes. After about 6 spots a reference dark noise test shall be performed (in Photometer Chop Mode).

After each spot a QLA analysis will be performed in parallel to the continuation to the next spot frequency. The result of the QLA will be available quite soon and stored on the disk for further analysis purposes, etc. with designation of the respective spot frequency.

The test sequence is shown in Figure 6-3 and Figure 6-4.

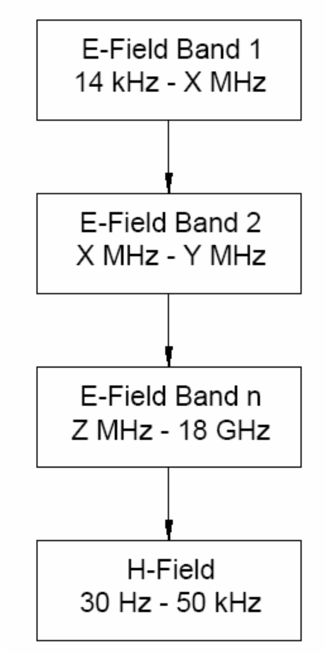

Figure 6-3: SPIRE Level 1 RS Test Sequence

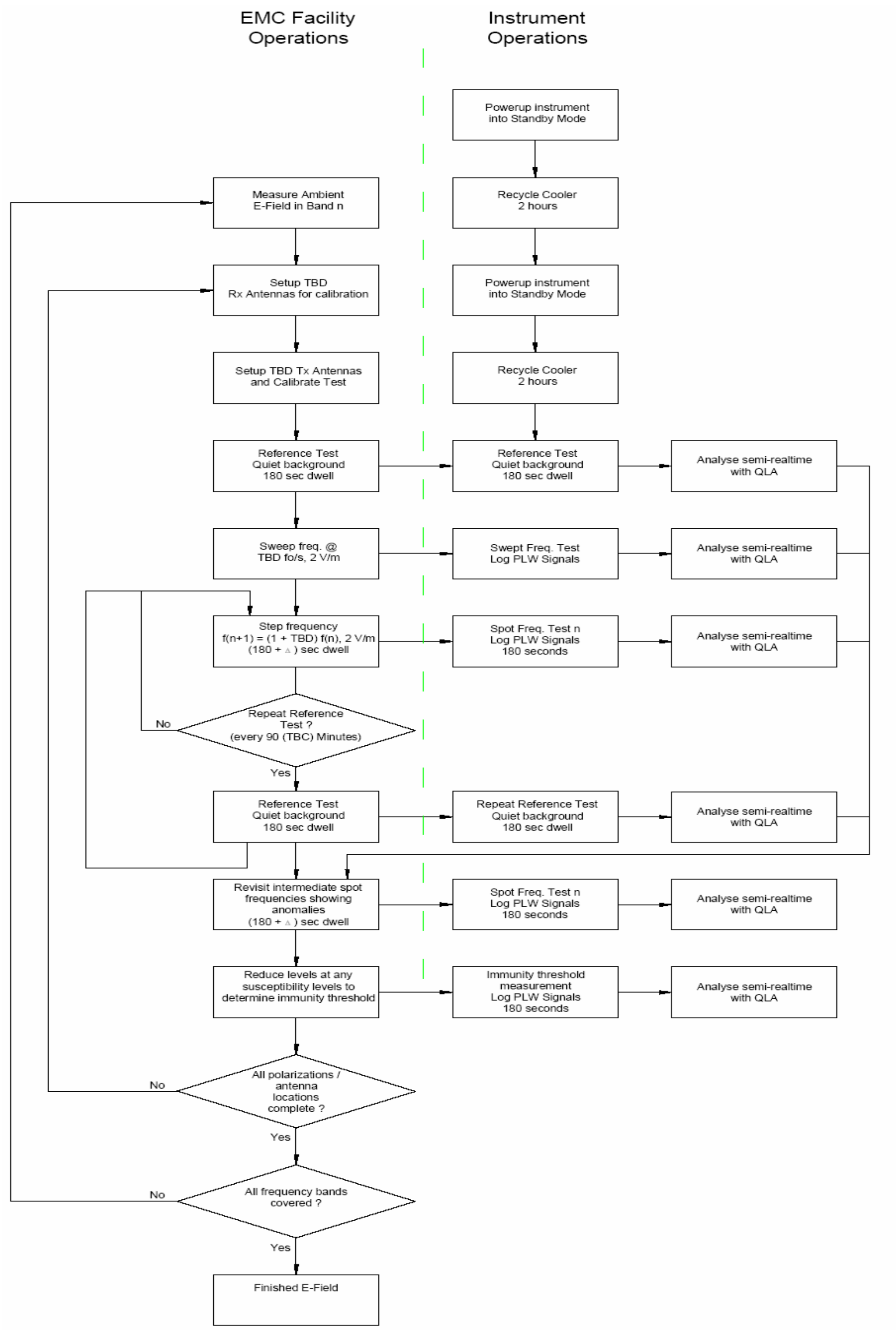

Figure 6-4: SPIRE Level 2 RS Test Sequence

7 Test Configuration

7.1 PLM EQM Hardware Configuration

The PLM hardware comprises the refurbished and modified ISO cryostat QM plus a newly developed SVM simulator.

The ISO cryostat is identical to the Herschel cryostat PFM as regards the

- optical bench with its mechanical and thermal interfaces to the FPUs
- instrument shield with LO beam baffles
- cryoharness with its electrical interfaces to the FPUs, LOU and Warm Units
- LOU support structure with its mechanical interfaces to the LOU

The cryostat provides an actively cooled cover with specific mirrors on the inside to simulate the in flight background conditions. The cover can be actively cooled.

The cryostat provides the following major limitations which are relevant for the instrument testing

- Line of sight of LO beam between HIFI LOU and HIFI FPU is obstructed by the CVV window borders since it is not possible to move the optical bench such that the FPU LOS matches the window axes. Note: the EQM upper bulkhead design is identical to the PFM, i. e. designed to match the window axes at in flight conditions.

The SVM simulator consists of a platform with a support frame and provides all mechanical interfaces to support the warm unit EQMs/AVMs. The arrangement of the Warm Units on the SVM simulator is identical to the SVM PFM as far as the Warm Units are flight representative with respect to their interfaces.

For instrument testing the cryostat together with SVM simulator can be tilted around z-axis.

For details of the PLM EQM hardware configuration see AD 6, section 4.

7.2 Instrument Hardware Configuration

7.2.1 HIFI EQM Configuration

The delivered HIFI instrument hardware for the PLM EQM programme is configured as per Table 7-1. In addition this table indicates the unit test histories prior to shipment to ESA.

Unit	**Built Standard**	**Form**	**Fit**	**Function**	**EMC**	**TC/TV**	**Vibration**	**Remarks**
FPU	QM	FM	FM	Only band 3 active [2)]	Yes	Yes	Yes	

Unit	Built Standard	Form	Fit	Function	EMC	TC/TV	Vibration	Remarks
FCU[4)]	DM	FM	FM	No redundancy	Yes	No	No	
LOU	QM	[1)]	FM	Only band 3	Yes	Yes	Yes	
LCU	DM	FM	FM	No redundancy	Yes	No	No	
LSU[3)]	DM	FM	FM	No redundancy	Yes	No	No	
WEH	QM	FM	FM	FM	Yes	Yes	Yes	
WEV	Not delivered							
WOH	QM	FM	FM	FM	Yes	Yes	Yes	
WOV	Not delivered							
HRH	QM	FM	FM	FM	Yes	Yes	Yes	
HRV	Not delivered							
ICU	QM	FM	FM	No redundancy	Yes	Yes	Yes	

[1)] LOU consists of the LOA for band 3a/3b plus a connector bracket with connectors to simulate the electrical interfaces of LOA for band 4a/4b plus two penta prisms, all mounted on the LOU dummy base plate with flight representative interface to the CVV side support plate.

[2)] The FPU QM contains heaters to simulate the FPU thermal load.

[3)] For the first activities only a LSU simulator will be delivered. The LSU DM will be delivered later (TBC by HIFI).

[4)] The FCU DM will be delivered with external power supply.

Table 7-1: HIFI EQM Hardware Built Standards

7.2.2 PACS EQM Configuration

The delivered PACS instrument hardware for the PLM EQM programme is configured as per Table 7-2.

Unit	Built Standard	Form	Fit	Function	Remarks
DPU		FM	FM	FM	No redundancy foreseen for AVM
SPU		Delivered as rack, mountable on SVM TBC	FM	FM	No redundancy foreseen for AVM
DECMEC		Delivered as rack, mountable on SVM TBC	FM	FM	No redundancy foreseen for AVM
BOLC		Delivered as rack, mountable on SVM TBC	FM	Delivered without power supply	No redundancy foreseen for AVM
WIH		FM	FM	FM	Identical with PFM harness; back shells to be discussed
FPU		FM	FM	Full optics. All mechanisms complete. Both photo-conductor arrays working, but only 2x12 modules integrated instead of 2x25. Both bolometer arrays completely equipped, but only 50% in each array with full IR performance.	Same redundancy as PFM

Table 7-2: PACS EQM Hardware Built Standards

7.2.3 SPIRE EQM Configuration

The delivered SPIRE instrument hardware for the PLM EQM programme is configured as per Table 7-3). For details see AD 2.

Unit	Built Standard	Form	Fit	Function	Remarks
FPU and JFETs	CQM	FM	FM	limited	
DCU	CQM	FM	FM	FM	Resistors for thermal dissipation are provided
FCU	CQM	Within flight envelope	Not FM compliant	Near flight performance	External power supply
DPU	CQM	FM	Prime interfaces flight representative, no redundant interfaces implemented	Near flight performance	No redundant side implemented
WIH	CQM	FM	FM	Near flight performance	

Table 7-3: SPIRE EQM Hardware Built Standards

The following additional hardware is delivered

- EGSE WIH harness for secondary power supply. Cable length, expected routing, etc. TBC by SPIRE

7.3 Instrument GSE Configuration

7.3.1 Instrument EGSE Configuration

The delivered Instrument EGSE for the PLM EQM level instrument test programme is as per Table 7-4.

Instrument	GSE	Remarks
HIFI/PACS/SPIRE	2 Instrument EGSE Stations for all 3 instruments	One EGSE Station operated in real time, the other one used as backup or for post processing tasks
HIFI	FPU simulator	For stand-alone tests after incoming inspection
HIFI	CW test signal source with LO beam splitter	For EMC tests Equipment will be located between LOU and CVV windows (LOU chain 3 beam)
PACS	TBD by PACS	For stand-alone tests after incoming inspection
SPIRE	CDMS simulator	Loan for stand alone integration checks only
SPIRE	Test harness	
SPIRE	FPU simulator	Loan for stand alone warm electronics checkout only. This unit does NOT interface to the cryoharness
SPIRE	Cross talk unit	Stand alone cross talk unit for checkout of Astrium detector side harness

Table 7-4: Instrument EGSE Items

The Instrument EGSE Station is composed by the following items:

- SCOS workstation – used primarily to run the SCOS-2000 software. This will be a PC running Linux with a dual display card driving two displays.
- Analysis workstation – used to run the instrument analysis software (QLA/IA/PCSS). This will be a PC running Linux with a dual display card driving two displays.
- Data Server – used primarily to run the HCSS software. This will be a PC running Linux with a single display and large disk drives with backup facility (to tape/CD TBD).
- Colour laser printer.

- LAN switch - protects the Operational System from the Analysis System allowing access to the external internet from the Analysis System.
- Laptops – used to run instrument specific analysis tools. These are not provided as part of the EGSE but may be used by instrument experts as necessary during testing.

7.3.2 Instrument MGSE Configuration

All instrument hardware will be delivered in appropriate containers including shock indicators, temperature monitoring as well as cleanliness provisions. For each FPU and the HIFI LOU appropriate lifting devices will be delivered with the units. Details TBD by HIFI and PACS.

7.3.2.1 Delivered MGSE

<u>HIFI</u>

HIFI will provide

- FPU Lifting device
- Tool to fix the screws for the FPU front feet.

<u>PACS</u>

TBD by PACS

<u>SPIRE</u>

SPIRE will provide a MGSE and lifting equipment according to RS 1, Annex A, which includes as least the following:

- FPU/JFET baseplate lifting gear (for lifting out of and in the transport container).
- FPU and JFET handling frame (for installation on Herschel Optical Bench Plate)
- Temporary FPU Grounding Strap including M4 x 6mm fastener to connect to OBA
- Imperial tools (note: only metric tools are available at Astrium).

7.3.2.2 Customer Furnished MGSE

<u>HIFI</u>

TBD by HIFI

PACS

TBD by PACS

SPIRE

ASED will supply the following MGSE and tools:

- Crane, with 'Hydroset'
- Torque wrench
- Allan key, spanners, etc
- DVM for electrical isolation testing

7.4 Instrument Documentation

7.4.1 EIDP

For each instrument an EIDP will be provided.

7.4.2 Integration and Test Procedures

The following instrument spacecraft level integration and test procedures will be provided by HIFI/PACS/SPIRE:

Procedures	Instrument inputs (procedures) required by	First Issue
Instrument Incoming Inspection Procedures	Instrument delivery - 2 months	Instrument delivery - 1 month
Instrument Hoisting and Handling Procedures	"	"
Instrument FPU/LOU Integration Procedures	"	"
Instrument Warm Units Integration Procedures	"	"
Instrument EGSE Setup and Verification Procedures	"	"
Instrument Electrical Integration Procedures	"	"
Instrument SFT Procedures	Instrument delivery	Instrument delivery + 1 month
Instrument IMT/IST Procedures	"	"
Instrument SPT Procedures (if any)	"	"
Instrument TV Test Procedure	"	"
Instrument EMC Test Procedures	"	"

Table 7-5: List of Instrument Spacecraft Level Integration and Test Procedures

7.4.3 Test Sequences

The instrument test sequences to be applied on PLM level is a subset of the instrument level test sequences. They will be delivered by the instruments in CCS TOPE compatible format and include all telecommands to control and monitor the instruments during testing.

For PLM level purposes these sequences will be appropriately embedded in the PLM test sequences. A specific validation of the instrument provided test sequences is not planned.

The following test sequences will be delivered:

HIFI:

TBD by HIFI

PACS

TBD by PACS

SPIRE

TBD by SPIRE

8 Test Set-up

8.1 Principle PLM Test Set-up

The principle PLM EQM test set-up is shown in Figure 8-1.

PLM EQM is equipped with the 3 instrument FPU CQMs and an SVM dummy structure with the integrated instrument Warm Unit CQMs/AVMs. The CCS "light" serves as core and controls the PLM EGSE with the data and power front ends, the Cryo SCOE and the Instrument EGSE. The PLM EGSE provides flight representative interfaces to the instruments. The Instrument EGSE is common for all instruments. For details see AD 06.

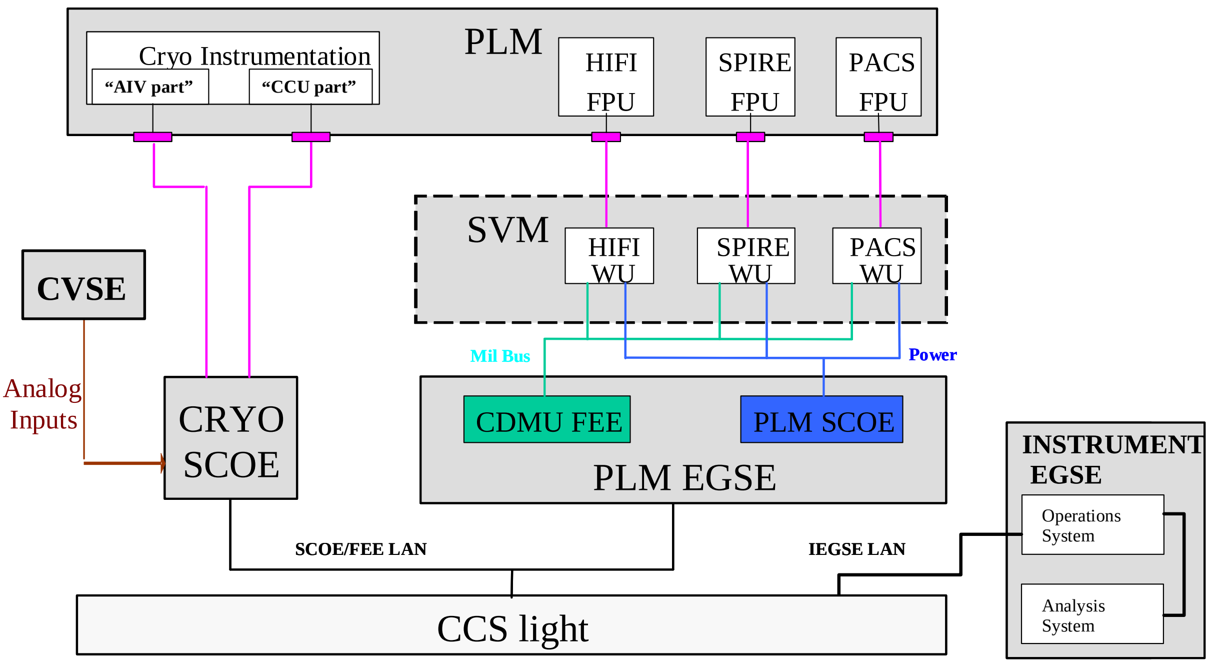

Figure 8-1: Principle Test Set-up for EQM Tests

Figure 8-2 shows the Instrument EGSE block diagram and provides an overview of the interface to the CCS.

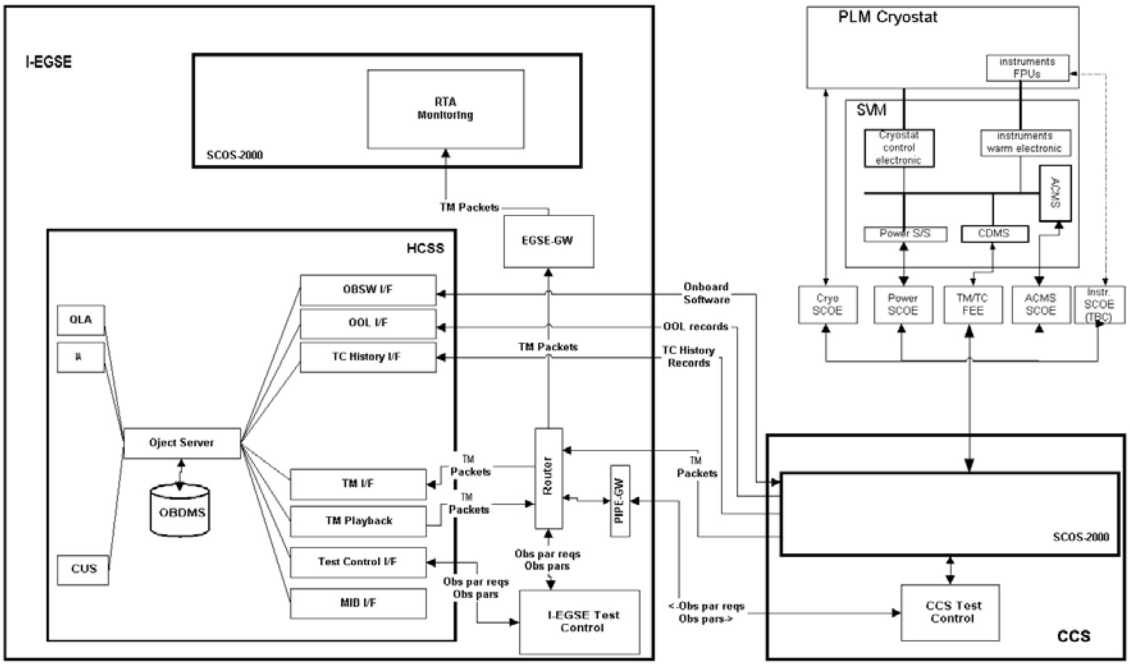

Figure 8-2: Data Exchange during PLM EQM Test

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

The CCS interfaces to the Instrument EGSE uses the PIPE protocol (for details see RD 3). The database is physically located in the IEGSE (HCSS).

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

FPU simulators and other instrument specific test equipment (e.g. HIFI stimuli equipment) have no interface to the CCS. I. e. such equipment will be controlled off-line.

The control of the FPU heaters and the HIFI CW test signal source during the EMC test is done manually (TBC by HIFI).

The SPIRE DPU AVM is powered by the PLM EGSE.

8.2 Test Facility

The tests (incl. EMC test) will take place in a clean room class 100 000 in a test facility at Astrium (Ottobrunn). The layout of the test facilities is shown in Figure 8-3. For details see AD 06.

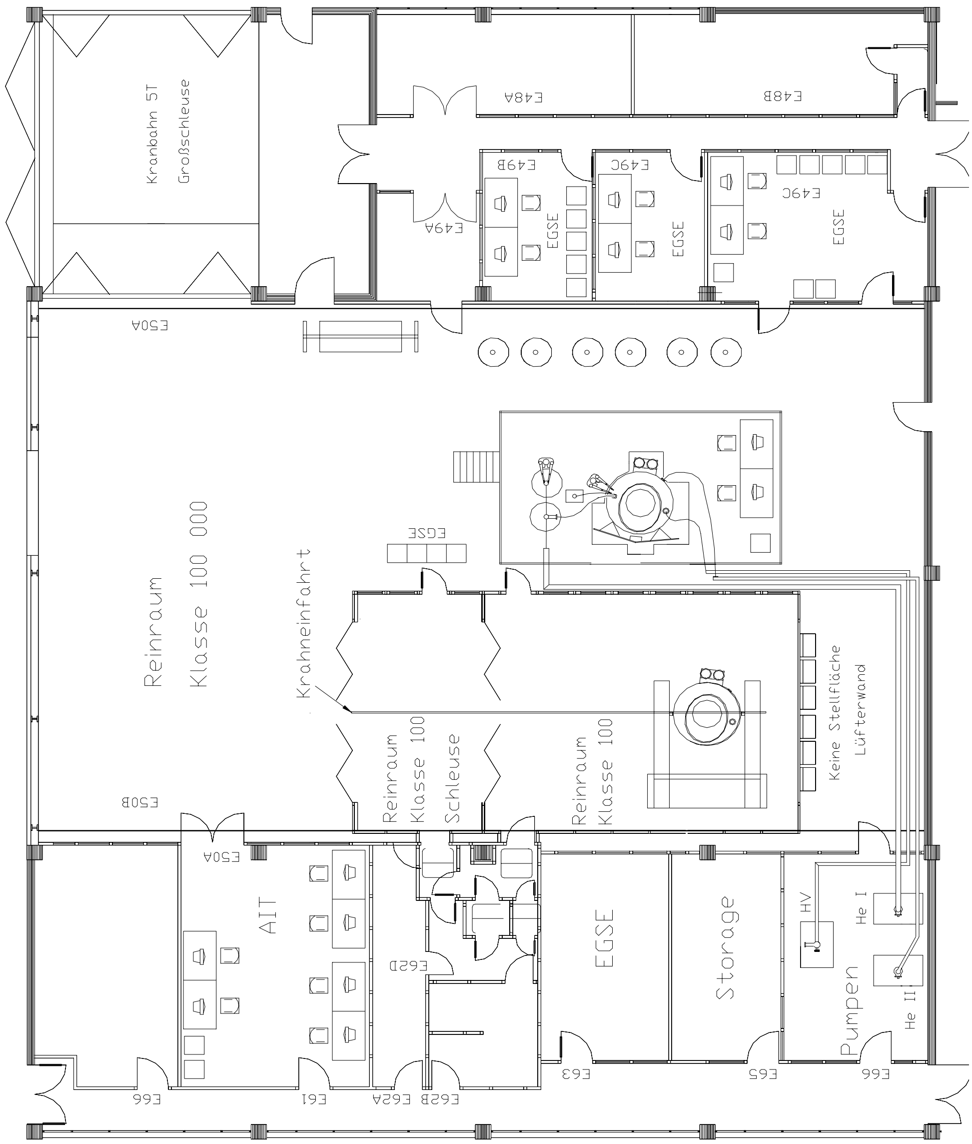

Figure 8-3: Layout of Test Facility

9 Instrument Specific Test Conditions and Constraints

9.1 Instrument Test Durations

In the following tables the nominal duration of the instrument test sequences are listed.

HIFI

Test	Duration	Remark
HIFI Incoming inspection	1 day	
HIFI Pre-integration Check	2 days	Done by HIFI
HIFI Mechanical Integration (FPU)	2 days	
HIFI Electrical Integration (FPU)	2 days	
HIFI Mechanical Integration (LOU)	2 days	
HIFI Electrical Integration (LOU)	1 day	
HIFI Alignment Test	2 days	
HIFI Mechanical Integration (WU)	2 days	Performed in parallel
HIFI Electrical Integration (WU)	1 day	Partly performed in parallel
HIFI SFT Warm	1 h	
HIFI SFT Cold	1 h	
HIFI Functional Test	2 h	Same in warm and cold
HIFI Radiometry	1 day	Cold
HIFI LO Beam Standing Wave Test	1 day (TBC)	Cold

HIFI Integrated Module Test	3 days (TBC)	Cold
HIFI EMC Test	5 day (TBC)	Cold

Note: In all cases the related test sequences have not been produced and tested.

Table 9-1: HIFI Test Duration

PACS

Table 9-2: PACS Test Duration (TBD by PACS)

SPIRE

Test	**Duration**	**Remark**
SPIRE Incoming inspection	1 day	
SPIRE Pre-Integration Tests	1.5 day	
SPIRE Mechanical Integration (FPU)	1 day	
SPIRE Mechanical Integration (Warm Units)	4 h	
SPIRE EGSE Check out	1/2 day	Common EGSE
SPIRE Electrical Integration	5 days (TBC)	
SPIRE SFT Warm	1 day	
SPIRE SFT Cold (He I)	1 h	
SPIRE SFT Test (He II)	6 h	
SPIRE SPT - Cooler Recycle Stand Alone Test	3 days	
SPIRE SPT - Ambient Background Verification	1 h (TBC)	

Test	**Duration**	**Remark**
Test		
SPIRE SPT - Photometer Chop Mode Thermal Balance Test	2 – 3 h	
SPIRE Integrated Module Test	2 days (TBC)	Full cooler cycle
SPIRE EMC Test	2 days (TBC)	

Table 9-3: SPIRE Test Duration

9.2 FPU/LOU Operational Constraints

This chapter defines the restrictions, constraints and limitations as regards the operation of the FPU /LOU during the PLM EQM level testing.

HIFI

System level constraints due to LSU simulator (LSU simulator will not be operated during SFT):

- Specific interfaces to SVM simulator needed.
- Manual operation necessary (by HIFI personnel).
- No command link between LCU and LSU simulator.
- Signal link between LSU simulator and spectrometers needed.
- For IMT sequence one break point needed.
- Cable length between LSU simulator and its support equipment is 60 cm.
- FPU EQM contains heaters to simulate the thermal load of "missing units". The heaters are powered via the cryoharness by external power supplies to be located outside the spacecraft. Interface via cryoharness T-adapter (provided by HIFI) in front of FCU connectors J17 and J27. Details TBD by HIFI.
- HIFI propose to perform a "thermal behaviour test" (dedicated SPT as part of the IMT) with the objective to define the FPU temperature transients during mode/submode switching. Measurements will be based on HIFI internal temperature sensors.
- FCU will be delivered with external power supply. Manual operation of FCU external power supply is required (see above). Details TBD by HIFI.
- HIFI will clarify whether instrument can be left unattended in Stand-by Mode during night.

- LSU simulator must be switched off prior to LOU switch off in order avoid damage of the LOU.
- Pperational constraints of LOU (e. g. monitoring/control of switch-off temperature, max. poweron
- duration at ambient) TBD by HIFI.

PACS

The following operational limitations exist pending the FPU L0/L1/L2 temperature:

IID-B specified operating temperatures are required for the following tests

- Achieve data as regards EMC sensitivity.
- Performance evaluation of bolometers and photometers.
- Calibration purposes using the buitlt in calibration sources.
- Cooler recycling.

For small exceedings (< 1 K) the following tests are possible

- Operation of blue detectors (photometers).
- Verification of mechanisms.

Impacts: reduction of He3-cooler hold-time.

For considerable exceedings (2K-5K) the possible tests are limited to

- Verification of mechanisms.
- Verification of read out electronic.

Impacts: Detector signals are in overload.

For exceedings > 5K only continuity checks are possible.

For the recording of one set of bolometer parameters the minimum required hold time of the sorption cooler is 6 h.

Cooler autonomy in EQM environment will have to be evaluated at the beginning of the test (cold functional test in HeII), and this duration shall be used as a constraint for (photometer) functional tests.

Cooler recycling will be part of the instrument test procedure

SPIRE

- No bake-out of FPU CQM is allowed in order not to invalidate the calibration of the Cernox thermistors (upper limit is 50°C. A bake-out of the EQM cryostat is not planned, but a flushing with nitrogen will be performed.
- During cool-down, after the Warm Functional Test, the instrument is to be left in the REDY Mode "DPU+DRCU-ON Thermometers ON Mode" to allow to monitor instrument temperatures. SPIRE in REDY Mode will allow the monitoring of the instrument temperatures.
- SPIRE requires break-out box between cryoharness and FCU to drive SMEC and BSM (STM). It only is connected during thermal balance test. ASED suggests using a T-adapter. Details TBD by SPIRE.

9.3 Spacecraft Orientation

The following spacecraft orientations will be adjusted:

- 0 deg for all tests excluding PACS and SPIRE cooler recycling.
- > 20 deg (30 deg to 35 deg (TBC)) in +y-direction during (duration about 2 h) PACS and SPIRE cooler recycling.
- Any orientation between +/- 90 deg during integration activities and SFT warm.

9.4 Sensor Background

The PLM EQM cryostat will provide far infrared background radiation levels for PACS and SPIRE comparable to those induced by the telescope. For HIFI no specific measures for that aspect have been implemented.

This will be accomplished by a specific design of cold plates (mirrors) which perform self-imaging of the PACS and SPIRE FPU entrance holes. Other contributions of thermal radiation are highly suppressed. The cold plate temperature is 80 K (adjustable to in-orbit telescope temperature by control of LHe flow). The goal for the cold plate emissivity is 0.015 (corresponding to the total telescope emissivity). For details see RD 2.

Note: Due to the limited accuracy in emissivity measurements the background radiation of the cover mirror can be fine tuned using the on-line signals of PACS and SPIRE which are assumed to be absolutely calibrated. The fine tuning will be performed prior to the instrument performance tests by appropriate adjustment of the cryo cover temperature (flow rate). When calculating the temperature it should be considered that a constant underlying stray light signal and/or constant instrument offset may be present.

9.5 Thermal Environment

The PLM EQM will provide the thermal environment to allow performance testing of the instruments. The interface temperature levels provided by the EQM cryostat (ISO) at the FPU thermal links are listed in Table 9-4.

	Interface	**I/F Requirement for in-orbit**		**EQM**
		Heat Load	**Temperature**	**Temperature**
Level 0	PACS Red Detector	0.8 mW	1.6 K … 1.75 K	<1.75 K
	PACS Blue Detector	2.0 mW	1.6 K … 2 K	<2 K
	PACS Cooler Pump	2.0 mW	1.6 K … 5 K	<2 K
		500 mW (peak)	1.6 K … 10 K	<10 K
	PACS Cooler Evapor.	15 mW	1.6 K … 1.85 K	<1.85 K
	SPIRE Detector	4 mW	< 2 K	<2 K
	SPIRE Cooler Pump	1 mW (goal)	< 1.71 K (goal)	<1.71 K
		2 mW	< 2 K	<2 K
	SPIRE Cooler Evapor.	500 mW (peak)	< 10 K (peak)	<10 K
		15 mW	< 1.85 K	<1.85 K
		15 mW (goal)	< 1.75 K (goal)	<1.75 K
	HIFI Detector	6.8 mW	< 2 K	<2 K
Level 1	PACS FPU	30 mW	2 K … 5 K	2-5 K*)
	SPIRE FPU	15 mW	< 5.5 K	<5.5 K*)
		13 mW (goal)	< 3.7 K (goal)	<3.7 K*)
	HIFI L1	15.5 mW	< 6 K	<6K
Level 2	OBP near PACS	0 mW	< 12 K	<16 K
	OBP near SPIRE	0 mW	< 12 K	<16 K
		0 mW (goal)	< 8K (goal)	
	Instr. Shield / SPIRE	0 mW	< 16 K	<20 K
	HIFI FPU	22 mW	< 20 K	<20 K
Level 3	SPIRE PM-JFET	50 mW	< 15 K	<20 K
	SPIRE SM-JFET	25 mW	< 15 K	<20 K
LOU	LOU (HIFI)	7000 mW	90 K …150 K	<300 K

Notes:

- The temperature values do not correspond to a similar helium mass flow rate as in orbit
- The AXT temperature will be adjusted to achieve Level 0 values

- The heat loads will be different compared to in orbit conditions due to higher Level 2 temperatures resulting from the CVV at room temperature (e.g. LOU windows)

*) The values apply to the Level 1I/F. The FPU housings itself might be warmer because they are directly related to the absorptivity/emissivity of the FPU outer surfaces, which is outside of the responsibility of ASED.

Table 9-4: Expected Interface Temperatures provided by the EQM Cryostat

Note

The EQM cryostat is a modified ISO cryostat and is different from the Herschel cryostat. The EQM cryostat is dedicated to simulate the orbital L2 environment (radiation and I/F temperatures) for the FPU's, whereas the Herschel cryostat has a different environment on ground, mainly because of a single vent line only and the CVV at room temperature with all the consequences. The optical bench (OB), including the optical bench shield and the interior (instruments,cooling loop, thermal links, etc.) are identical.

The large toroidal Helium tank (<2000 l volume) will be filled with helium at a pressure slightly above ambient (~4.2K). The evaporation of the helium will be controlled by heaters in order to cool the shielding around, which is similar to the Herschel cryostat. The FPU L1, L2 and L3 interfaces will not be cooled by this gas flow. Goal is to achieve the same constant temperature in the innermost shield (L2) as predicted in orbit. To achieve this a helium mass flow far above the nominal in-flight mass flow will be induced (about 100 mg/sec).

The auxiliary tank (AXT) is located below the OB, inside the toroidal Helium tank, connected with flight different thermal links to the respective FPU level 0 interfacess. The helium vent line from the AXT is connected to the OB cooling loop and further down stream to an interface at the vacuum vessel where a helium pump is connected. Temperature and mass flow will be controlled by the pumping speed together with heating on the AXT. There is a lot of flexibility in adjusting the AXT temperature (L0) and the mass flow.

One of the main differences to in-flight L2 conditions is the radiated heat load entering from the LOU windows at room temperature to the OB shield and HIFI itself, increasing the OB shield and plate temperature.

Another difference is the radiated heat from the entrance baffle connected to shield 2 and through all the remaining orifices in the isolation system. This could lead to a second approach for the innermost shield temperature (see above): reducing it to a value which gives a more similar OB shield/ plate/ L2 temperature.

It is assumed that the stability of the L0 temperature will not be similar to the Herschel cryostat (HTT), where it is pending on the passive phase separator (PPS) performance and helium mass inside the tank (continuously decreasing in 3.5 years). In the EQM cryostat the PPS will not be used and the mass inside the AXT is different. In general the stability can be increased by controlling the heater power on the AXT during sporadic dumping of energy e.g. for cooler recycling.

For details see RD 4.

9.6 Cleanliness

The following specific cleanliness provisions will be applied:

HIFI LOU

The LOU opening (Channel 3a/3b) will be protected against particles by covering the openings with TBD tape during the entire PLM EQM AIT programme with the exception for the IMT and the EMC susceptibility tests.

SPIRE

There is a restriction on the use of UV lamps. It has to be operated in low power in order not to damage the PDFE filters.

9.7 Purging

During the PLM EQM AIT no purging will be provided.

9.8 Grounding and ESD Protection

Instruments will be electrically integrated following the relevant ESA standards.

HIFI

Specific precautions are necessary during the electrical integration of the HIFI FPU and LOU (details TBD by HIFI).

PACS

All operators and FPU will be grounded during handling. Grounding connector will be connected to ground.

SPIRE

See Making SPIRE ESD Safe SPIRE-RALNOT-002028.

For unused connectors (due to cryoharness EQM simplification) ASED will use EMC caps.

9.9 Microvibration

In the test facility pumps may generate microvibrations (experience from ISO). Whenthe pups are stopped the mass flow will stop (ventline L1 and L3). The temperature will drift up consequently. No accelerometers are installed in the EQM cryostat.

This chapter defines restrictions as regards microvibrations during instrument performance tests at PLM EQM level.

Specific constraints TBD by HIFI/PACS/SPIRE.

9.10 Red/Green Tag Items

<u>HIFI</u>

TBD by HIFI.

<u>PACS</u>

TBD by PACS.

<u>SPIRE</u>

FPU - Red Tag Items

The following red tag items are fitted to the FPU when delivered:

- Aperture cover
- Alignment cube
- Temporary grounding strap
- Shorting plugs

The aperture cover is removed by unscrewing the four 2-56 UNC (imperial) cap head screws and the lifting the cover clear (TBC by ASED).

The alignment cube is removed by unscrewing the three fixing screws and lifting clear.

No green tagged items.

10 Logistics and Planning

10.1 Logistics

10.1.1 General

Delivery address

EADS Astrium

attn. Mr. Paul Mack

Ludwig-Boelkow-Allee

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85521 Ottobrunn

Germany

Contact persons at Ottobrunn

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Check in of visitors

Please send latest one day before your arrival at EADS-Astrium the names and nationalities of your team members in order to allow preparation of the badges.

10.1.2 HIFI

HIFI will support the mech. and el. integration and all HIFI instrument tests.

The tables below depict the HIFI estimated durations and the proposed personnel.

No	Task	Estimated Time	Required Personnel
1	Incoming inspection FP subsystem	1 day	KJW(?), PD
2	FCU SCOE set up and check out with FPU simulator	1day	PD, HS
3	Connection harness FCU - FPU	1 h	HS, PD
4	FT FP subsystem warm (post shipment test)	.5 day	PD, HS
5	Test cryoharness with FPU simulators and FCU/SCOE	1 day	HS, AN
6	Mechanical integration FPU on OB		Witness SRON?
7	RT FT of FPU and FCU/SCOE	2 h	PD, HS

No	Task	Estimated Time	Required Personnel
8	Incoming inspection LO	1 day	LO subsystem, NW
9	Incoming inspection LSU simulator	1 day	WJ
10	Set up (I)EGSE and interface check with router	1 wk?	LD
11	LCU SCOE set up and check out with LOU simulator	1 h (TBC)	LO subsystem
12	LSU SCOE set up and FT	1 h	WJ (back up AdJ or NB)
13	Connection harness LCU - LOU	1 h (TBC)	LO subsystem
14	Connection LSU simulator		WJ
15	FT LO subsystem warm (post shipment test)	1 h (TBC)	LO subsystem, WJ
16	FT LO subsystem warm with LSU simulator (post shipment test)	1 h	LO subsystem, WJ
17	Mechanical integration LOU on support		Witness SRON?
18	Connect waveguides (LSU simulator)		Witness SRON (NW)?
19	Alignment LOU/FPU (warm)		Witness SRON (RH)?
20	RT FT of LOU, LSU, LSU simulator and LCU/SCOE	2 h	LO subsystem, WJ
21	Incoming inspection WU and WIH	1 wk?	Subsystems,AN
22	Mechanical integration of WU's on panels, mount WIH, electrical test	1 wk	Witness SRON (AN)?
23	FT of warm units, WIH and (I)EGSE		LD, AN

Table 10-1: HIFI Integration Activities

No	Task	Estimated Time	Required Personnel
1	Install harness FCU - cryostat		Astium
2	Install harness LCU - LOU		Astrium
3	Functional Test cold (initalization, IF properties, tuning, etc.)	2h +	SRON operator
4	Functional test cold He2 (initialization, IF properties, tuning, etc.)	2h +	SRON operator
5	Thermal behavior test (option: with SCOE)	1 day	SRON operator, RR
6	Radiometry	1 day (TBC)	SRON operator, DT, evaluation at SRON
7	Reduced standing wave test	1 day	SRON operator, NW (or DT)
8	Other Integrated module test	TBD	TBD
9	EMC test	1 day (TBC)	SRON operator, NW and AN
10	Stand-by: upgrade OBS, MIB		LD

Table 10-2: HIFI Tests Activities after Cool Down of the Cryostat

10.1.3 PACS

PACS team will support the test as needed: during preparation of tests, execution, and near real time data-analysis.

In depth data analysis will be done at MPE.

Required office space

Room near the EGSE room for PACS instrument team (4 to 7 people).

Clean room equipments and suits.

10.1.4 SPIRE

Required office space

SPIRE will have not more then 4 people at the ASED site. Most of the time there will be 2. RAL will have at least one representative present during integration.

Connectivity to the out-side world is given via ISDN.

Clean Room tables, space required for testing in Clean Rooms

Only CR table required for FPU. The FPU simulator is cabinet (19 inch) to be placed in the CR100000. The Common Instrument EGSE will not be in the CR100000.

Power supply

ASED will provide the DPU power supply (part of PLM EGSE).

List of required tools, test adapters and measurement equipment

SPIRE will provide the packing list and may request some additional tools, if available at ASED (TBD by SPIRE)

SPIRE will bring imperial tools (spanners), as only metric ones are available at ASED.

Cleanroom class-100 clothing

ASED will provide clothing for 4 people.

10.2 Planning

Table 10-3 shows the planning of the instrument PLM EQM level integration activities where instrument attendance is needed. The planning is based on the agreed instruments delivery date of November, 15th 2004. This planning will be updated whenever major changes come up. The dates will be confirmed about two weeks in advance to manage potential late change in the schedule.

Activity	**Start**	**End**	**Remark**
SPIRE Delivery and bench test	15.11.04	19.11.04	
SPIRE FPU Integration onto OB	22.11.04	25.11.04	
PACS Delivery and bench test	22.11.04	26.11.04	
PACS FPU Integration onto OB	01.12.04	02.12.04	
HIFI Delivery and bench test	29.11.04	02.12.04	
HIFI FPU Integration onto OB	03.12.04	06.12.04	
SPIRE WU mech./electr. Integration	26.11.04	02.12.04	onto SVM simulator
SPIRE functional tests	03.12.04	10.12.04	WU + FPU simulator
PACS WU mech./electr. Integration	13.12.04	17.12.04	onto SVM simulator
PACS functional tests	20.12.04	11.01.05	WU + FPU simulator
HIFI WU mech./electr. Integration	11.01.05	17.01.05	onto SVM simulator
HIFI functional tests	17.01.05	24.01.05	WU + FPU simulator
Connection of internal SIH to FPU	25.01.05	03.02.05	PI support on demand
Fixation of cooling straps	31.01.05	03.02.05	support from PACS expected on 1-2 day(s)
SPIRE FPU test after integration	04.02.05	04.02.05	at CVV interface connector
PACS FPU test after integration	05.02.05	05.02.05	at CVV interface connector
HIFI FPU test after integration	06.02.05	06.02.05	at CVV interface connector

Table 10-3: Baseline Planning of Instrument PLM EQM Level Integration Activities

The further planning of instrument test activities is given in Table 10-4 below and for information only.

Activity	Start	End	Remark
Instrument warm functional test	18.04.05	21.04.05	
Cool-down and filling	29.04.05	05.05.05	instruments are invited to follow cool-down
Short functional test at He I temps.	04.05.05	10.05.05	
Short functional test at He II temps.	09.05.05	10.05.05	
IMT HIFI	12.05.05	19.05.05	detailed planning to be established
IMT PACS	19.05.05	25.05.05	- “ -
IMT SPIRE	25.05.05	01.06.05	- “ -

Activity	Start	End	Remark
IMT PACS/SPIRE	01.06.05	07.06.05	- " -
EMC Test SPIRE	07.06.05	13.06.05	- " -
EMC Test PACS	13.06.05	17.06.05	- " -
EMC Test HIFI	17.06.05	23.06.05	- " -
EMC Test PACS/SPIRE	23.06.05	29.06.06	- " -

Table 10-4: Baseline Planning of Instrument PLM EQM Level Test Activities

11 Instrument Test Activity Descriptions

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

The title of the activity sheet provides, as far as available, the reference number as defined in the Herschel/Planck Verification Program Plan (AD 9).

The objectives of the tests 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.

11.1 Instrument EGSE Validation

11.1.1 Instrument EGSE Validation

Title:	*Experiment:*
EGSE Validation	**HIFI/PACS/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:*
EGSE stand-alone, Instrument EGSE connected to CCS.	None.

Particular Environmental Constraints:
None.

Success Criteria:
TBD

Duration:	*Applicable:*
1 day	PLM EQM

11.2 Short Functional Test

11.2.1 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 7-1 and Table 7-4.	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:*
1 h	PLM EQM

11.2.2 HIFI Short Functional Test Cold

Title: **Short Functional Test Cold** **HP-VPP-VI-1900**	*Experiment:* **HIFI**

Objectives:
Confidence test to check electrical integrity and operability of instrument at cold conditions for the FPU (cryostat cooled down to He1 or He2 conditions). Evaluation will be based on housekeeping data; evaluation of science data is not foreseen. The tests at He1 and He 2 conditions may differ.

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. Measure power of mixer for minimum and maximum LO power settings.

Instrument Configuration: As per Table 7-1 and Table 7-4.	*Specific Requirements on PLM:* None.

Particular Environmental Constraints:
L0, L1 and L2 as per Table 9-4.

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

Duration: 1 h	*Applicable:* PLM EQM

11.2.3 PACS Short Functional Test Warm

Title:
Short Functional Test Warm

Experiment:
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:
As per Table 7-2 and
Table 7-4.

Specific Requirements on PLM:
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:
1 h

Applicable:
PLM EQM

11.2.4 PACS Short Functional Test Cold

Title: **Short Functional Test Cold** **HP-VPP-VI-2070**	*Experiment:* **PACS**

Objectives:
Confidence test to check electrical integrity and operability of instrument at cold conditions for the FPU (cryostat cooled down to He1 or He2 conditions). Evaluation will be based on housekeeping data; evaluation of science data is not foreseen. The tests at He1 and He 2 conditions may differ.

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: As per Table 7-2 and Table 7-4.	*Specific Requirements on PLM:* None.

Particular Environmental Constraints:
L0, L1 and L2 as per Table 9-4.

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

Duration: 1 h	*Applicable:* PLM EQM

11.2.5 SPIRE Short Functional Test Warm

Title: **Short Functional Test Warm**	*Experiment:* **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:
Perform switch on procedure.
Switch instrument to Ready Mode.
Commanded each sub-system as appropriate to verify its function (TBD).
Switched instrument back to READY.
The instrument may then be switched OFF or to another mode if further tests are planned.

Instrument Configuration: As per Table 7-3 and Table 7-4.	*Specific Requirements on PLM:* 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: 1 h	*Applicable:* PLM EQM

11.2.6 SPIRE Short Functional Test Cold

Title: **Short Functional Test Cold** **HP-VPP-VI-2220**	*Experiment:* **SPIRE**

Objectives:
Confidence test to check electrical integrity and operability of instrument at cold conditions for the FPU (cryostat cooled down to He1 or He2 conditions). Evaluation will be based on housekeeping data; evaluation of science data is not foreseen. The tests at He1 and He 2 conditions may differ.

Test Description:
Perform switch on procedure.
Switch instrument to Ready Mode.
Commanded each sub-system as appropriate to verify its function (TBD, different for He1 and He2 conditions).
Switched instrument back to READY.
The instrument may then be switched OFF or to another mode if further tests are planned.

Instrument Configuration: As per Table 7-3 and Table 7-4.	*Specific Requirements on PLM:* None.

Particular Environmental Constraints:
L0, L1 and L2 as per Table 9-4.

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

Duration: 1 h	*Applicable:* PLM EQM

11.3 Special Performance Tests

11.3.1 HIFI Functional test

Title:	*Experiment:*
Functional Test **HP-VPP-VI-1920**	**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). The measurements will be performed with 3 bias settings per mixer.

Instrument Configuration:	*Specific Requirements on PLM:*
As per Table 7-1 and Table 7-4.	None

Particular Environmental Constraints:
L0, L1 and L2 as per Table 9-4.

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

Duration:	*Applicable:*
1 h	PLM EQM

11.3.2 HIFI Radiometry

Title: **Radiometry** **HP-VPP-VI-1960**	*Experiment:* **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. In addition an LO power scan will be performed at each frequency setting as input for the calibration table for the receiver tuning.

Instrument Configuration: As per Table 7-1 and Table 7-4.	*Specific Requirements on PLM:* None

Particular Environmental Constraints:
L0, L1 and L2 as per Table 9-4.

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

Duration: 1 day	*Applicable:* PLM EQM

11.3.3 HIFI LO Beam Standing Wave Test

Title:
LO Beam Standing Wave Test
HP-VPP-VI-1980

Experiment:
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:

As per Table 7-1 and
Table 7-4.

Specific Requirements on PLM:
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:
L0, L1 and L2 as per Table 9-4.

Success Criteria:
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:
1 day

Applicable:
PLM EQM

11.3.4 PACS Cooler Recycle

Title:
Cooler Recycle

Experiment:
PACS

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

Test Description:
TBD

Instrument Configuration:
As per Table 7-1 and
Table 7-4.

Specific Requirements on PLM:
PLM tilted at least 23 deg around z-axis to +y. This operation can be carried out with the PLM rotated up to 90° in the same direction.

Particular Environmental Constraints:
L0, L1 and L2 as per Table 9-4.

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

Duration:
about 2 h

Applicable:
PLM EQM

11.3.5 PACS Full Functional Test

Title:
Full Functional Test

Experiment:
PACS

Objectives:
Validation of PACS switch-on procedure, including validation of connection between EGSE and instrument, memory load and dump. Validate function of DPU, function of SPU and data reduction/compression SW, validate function of DEC/MEC, validate function of BOLC/A, verify function of detectors, detector readouts, detector heaters and temperature sensors, verify function of mechanisms (grating, chopper and filter wheels), verify function of calibration sources, 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:
As per Table 7-2 and
Table 7-4.

Specific Requirements on PLM:
PLM tilted about 20° to +y during cooler recycle.

Particular Environmental Constraints:
L0, L1 and L2 as per Table 9-4.

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

Duration:
TBD

Applicable:
PLM EQM

11.3.6 PACS Short Performance Test

Title: **Short Performance Test**	*Experiment:* **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 7-2 and Table 7-4.	None.

Particular Environmental Constraints:
L0, L1 and L2 as per Table 9-4.
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

11.3.7 PACS Astronomical Observation Template (AOT) Tests

Title:
Astronomical Observation Template (AOT) Tests
HP-VPP-VI-2150

Experiment:
PACS

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

Test Description:
Prior to test the cooler has to be recycled / sufficient hold time has to be available.
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:
As per Table 7-2 and
Table 7-4.

Specific Requirements on PLM:
None.

Particular Environmental Constraints:
L0, L1 and L2 as per Table 9-4.
Sensor background TBD.

Success Criteria:
TBD.

Duration:
TBD day

Applicable:
PLM EQM

11.3.8 PACS PACS/SPIRE Parallel Mode

Title:
PACS/SPIRE Parallel Mode
HP-VPP-VI-2110

Experiment:
PACS

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

Test Description:
Prior to test the cooler has to be recycled / sufficient hold time has to be available.
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:

As per Table 7-2 and
Table 7-4.

Specific Requirements on PLM:
None.

Particular Environmental Constraints:
L0, L1 and L2 as per Table 9-4.
Sensor background TBD.

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

Duration:
TBD

Applicable:
PLM EQM

11.3.9 SPIRE Cooler Recycle

Title:	*Experiment:*
Cooler Recycle **HP-VPP-VI-2240**	**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 7-3 and Table 7-4.	PLM tilted at least 23 deg around z-axis to +y. This operation can be carried out with the PLM rotated up to 90° in the same direction.

Particular Environmental Constraints:

Mass flow rate: as close as possible to that expected in flight (limitations due to ambient temperature of CVV).

L0, L1 and L2 as per Table 9-4.

Success Criteria:

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

Duration:	*Applicable:*
about 2 h	PLM EQM

11.3.10 SPIRE Photometer Chop Mode

Title: **Photometer Chop Mode** **HP-VPP-VI-2260**	*Experiment:* **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 (limitations due to ambient temperature of CVV).
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 settling.
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: As per Table 7-3 and Table 7-4.	*Specific Requirements on PLM:* None

Particular Environmental Constraints:
Mass flow rate: as close as possible to that expected in flight (limitations due to ambient temperature of CVV).
L0, L1 and L2 as per Table 9-4.
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.

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: about 1 h	*Applicable:* PLM EQM

11.3.11 SPIRE Ambient Background Verification

Title:	Experiment:
Ambient Background Verification **HP-VPP-VI-2280**	**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 (limitations due to ambient temperature of CVV).
The SPIRE cooler has been recycled and the instrument is at nominal temperature.
The photometer JFETs are switched on and the instrument temperatures allowed settling.
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 7-3 and Table 7-4.	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

11.3.12 SPIRE PACS/SPIRE Parallel Mode

Title:
PACS/SPIRE Parallel Mode

Experiment:
SPIRE

Objectives:
TBD

Test Description:
The SPIRE cooler has been recycled and the instrument is at nominal temperature.
TBD.

Instrument Configuration:
As per Table 7-3 and
Table 7-4.

Specific Requirements on PLM:
None.

Particular Environmental Constraints:
Mass flow rate: as close as possible to that expected in flight (limitations due to ambient temperature of CVV).
L0, L1 and L2 as per Table 9-4.
Sensor background TBD.

Success Criteria:
TBD

Duration:
TBD day

Applicable:
PLM EQM

11.4 Integrated Module Tests

11.4.1 HIFI Integrated Module Test

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

Objectives:

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

Test Description:

The Integrated Module Test is composed by the following test steps: 1) Short Functional Test, 2) Functional Test, 3) Radiometry (for TBD receiver settings), 4) LO Beam Standing Wave Test, 5) Stability Test (TBC). For details to the single test steps see the related Test Activity Descriptions. The Stability Test is TBD.

Instrument Configuration: As per Table 7-1 and Table 7-4.	*Specific Requirements on PLM:* None.

Particular Environmental Constraints:

L0, L1 and L2 as per Table 9-4.

Success Criteria:

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

Duration: 3 days (TBC)	*Applicable:* PLM EQM

11.4.2 PACS Integrated Module Test

Title:
Integrated Module Test

Experiment:
PACS

Objectives:

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

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:

As per Table 7-2 and
Table 7-4.

Specific Requirements on PLM:
PLM tilted about 20° to +y during cooler recycle.

Particular Environmental Constraints:
L0, L1 and L2 as per Table 9-4.
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:
TBD

Applicable:
PLM EQM

11.4.3 SPIRE Integrated Module Test

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

Objectives:

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

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 7-3 and Table 7-4.	PLM tilted > 23 deg to +y during cooler recycle.

Particular Environmental Constraints:
Mass flow rate: as close as possible to that expected in flight (limitations due to ambient temperature of CVV).
L0, L1 and L2 as per Table 9-4.
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.

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

11.5 EMC Tests

11.5.1 HIFI EMC Test

Title: **EMC Test** **HP-VPP-VI-2000**	*Experiment:* **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: As per Table 7-1 and Table 7-4 including a harmonic generator with beam splitter mounted between the LOU and CVV window.	*Specific Requirements on PLM:* None.

Particular Environmental Constraints:
L0, L1 and L2 as per Table 9-4.

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

Duration: 5 days	*Applicable:* PLM EQM

11.5.2 PACS EMC Test

Title: **EMC Test** **HP-VPP-VI-2130**	*Experiment:* **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: As per Table 7-2 and Table 7-4.	*Specific Requirements on PLM:* PLM tilted > 23 deg to +y during cooler recycle.

Particular Environmental Constraints:
L0, L1 and L2 as per Table 9-4.
Sensor background TBD.

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

Duration: 5 days	*Applicable:* PLM EQM

11.5.3 SPIRE EMC Test

Title: **EMC Test** **HP-VPP-VI-2320**	*Experiment:* **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: As per Table 7-3 and Table 7-4.	*Specific Requirements on PLM:* PLM tilted > 23 deg to +y during cooler recycle.

Particular Environmental Constraints:
Mass flow rate: as close as possible to that expected in flight (limitations due to ambient temperature of CVV).
L0, L1 and L2 as per Table 9-4.
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.

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

Duration: 5 days	*Applicable:* PLM EQM

	Name	Dep./Comp.		Name	Dep./Comp.
	Alberti von Mathias Dr.	AOE22		Tenhaeff Dieter	AOE22
	Alo Hakan	OTN/TP 45		Thörmer Klaus-Horst Dr.	OTN/AED65
	Barlage Bernhard	AED11		Wagner Klaus	AOE23
x	Bayer Thomas	AET52	x	Wietbrock, Walter	AET12
x	Faas Horst	AEA65		Wöhler Hans	AOE22
	Fehringer Alexander	AOE13			
	Frey Albrecht	AED422			
	Gerner Willi	AED11			
	Grasl Andreas	OTN/AET52			
	Grasshoff Brigitte	AET12	x	Alcatel	ASP
x	Hauser Armin	AOE23	x	ESA/ESTEC	ESA
	Hinger Jürgen	AOE23			
x	Hohn Rüdiger	AET52		**Instruments:**	
	Huber Johann	AOA4	x	MPE (PACS)	MPE
	Hund Walter	ASE4A	x	RAL (SPIRE)	RAL
x	Idler Siegmund	AED432	x	SRON (HIFI)	SRON
	Ivády von András	FAE22			
	Jahn Gerd Dr.	AOE23		**Subcontractors:**	
x	Kalde Clemens	APE3		Air Liquide, Space Department	AIR
	Kameter Rudolf	OTN/AET52		Air Liquide, Space Department	AIRS
	Kettner Bernhard	AOE22		Air Liquide, Orbital System	AIRT
x	Knoblauch August	AET32		Alcatel Bell Space	ABSP
x	Koelle Markus	AET22		Astrium Sub-Subsyst. & Equipment	ASSE
x	Kroeker Jürgen	AED65		Austrian Aerospace	AAE
	Kunz Oliver Dr.	AOE23		Austrian Aerospace	AAEM
	Lamprecht Ernst	OTN/ASI21		APCO Technologies S. A.	APCO
x	Lang Jürgen	ASE4A		Bieri Engineering B. V.	BIER
	Langfermann Michael	AET52		BOC Edwards	BOCE
x	Mack Paul	OTN/AET52		Dutch Space Solar Arrays	DSSA
x	Muhl Eckhard	OTN/AET52		EADS CASA Espacio	CASA
x	Pastorino Michel	ASPI Resid.		EADS CASA Espacio	ECAS
	Peltz Heinz-Willi	AET42		EADS Space Transportation	ASIP
	Pietroboni Karin	AED65		Eurocopter	ECD
	Platzer Wilhelm	AED22		HTS AG Zürich	HTSZ
	Puttlitz Joachim	OTN/AET52		Linde	LIND
	Rebholz Reinhold	AET52		Patria New Technologies Oy	PANT
	Reuß Friedhelm	AED62		Phoenix, Volkmarsen	PHOE
x	Rühe Wolfgang	AED65		Prototech AS	PROT
	Runge Axel	OTN/AET52		QMC Instruments Ltd.	QMC
	Sachsse Bernt	AED21		Rembe, Brilon	REMB
x	Schink Dietmar	AED422		Rosemount Aerospace GmbH	ROSE
x	Schlosser Christian	OTN/AET52		RYMSA, Radiación y Microondas S.A.	RYM
	Schmidt Rudolf	FAE22		SENER Ingenieria SA	SEN
	Schweickert Gunn	AOE22		Stöhr, Königsbrunn	STOE
	Stauss Oliver	AOE13		Terma A/S, Herlev	TER
	Steininger Eric	AED422			
x	Stritter Rene	AED11			