Title: **Summary Report of Instrument Testing on PLM EQM Level**

CI-No: 153 000

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Issue 1	01.02.06	All	Initial Issue

Table of Content

Table of Figures

List of Tables

1 Introduction

1.1 Scope of Document

This report provides an overview of the test activities carried out with the instruments on PLM EQM level.

This includes

- SFT warm and cold (He I and He II)
- IMT
- EMC test
- Instrument thermal behaviour and straylight test

In addition this report covers the tests related to the instruments electrical integration with the PLM EGSE (CDMU and power lines) and the SIH.

This summary recalls the test objectives and identifies the actual test configuration. Contained herein are the test flow and a cross references between the individual tests and the corresponding test documentation as e. g. reports, TRR/PTR minutes, etc.

A brief overview of the achieved test results is given.

A status list of all NCR's raised with references to the corresponding test is given. One section of this document is dedicated to major problems observed during the test campaign and their consequences to PFM.

Finally this report provides a conclusion of the test campaign.

The report does not include the mechanical integration activities which are covered by separate reports, also not included are instrument performance related aspects, but references to the relevant instrument analyses and reports are given, as far as available.

All test reports, data analyses and minutes referenced herein have been officially distributed.

2 Documents

2.1 Test Procedures

Here below all test procedures used during the instrument PLM EQM level testing are listed.

ASED

RD	HP-2-ASED-PR-0033	PLM EQM EMC Test Procedure	Issue 1
RD	HP-2-ASED-PR-0035	EGSE Set-up Procedure	Issue 4
RD	HP-2-ASED-PR-0039	Alignment Procedure	Issue 1
RD	HP-2-ASED-PR-0044	PLM EQM Demounting Procedure	Issue 1
RD	HP-2-ASED-PR-0051	Instrument PLM EQM Level Test Procedure	Issue 1.1
RD	HP-2-ASED-TP-0055	EQM-PACS Warm Units Integration with IDAS	Issue 1
RD	HP-2-ASED-TP-0057	EQM-SPIRE Warm Units Integration with IDAS	Issue 1
RD	HP-2-ASED-TP-0058	EQM-HIFI Warm Units Integration with IDAS	Issue 1
RD	HP-2-ASED-TP-0090	EQM AXT He II Production	Issue 1
RD	HP-2-ASED-TP-0091	EQM Cover Flushing	Issue 1
RD	HP-2-ASED-TP-0093	Procedure for Instrument Thermal Behaviour and Straylight Tests on PLM EQM Level	Issue 1
RD	HP-2-ASED-TP-0098	PLM EQM Warm Up	Issue 1

HIFI

RD	SRON-U-HIFI-PR-2004-007	HIFI Warm Units Electrical Interface Test Procedure	Issue 3
RD	SRON-G/HIFI/PR/2005-101	HIFI EQM IST & EMC Test Procedures	Issue 1.5
RD	SRON-U/HIFI/PR/2004-001	HIFI EMC Test Specification	Issue 1.4
RD	FPSS-00700	HIFI Electrical Integration FPU - FCU	Issue 2

		Procedure	
RD	SRON-U/HIFI/PR/2005-008	LSU simulator integration and test Procedure	Issue 1
RD	SRON-U/HIFI/PR/2005-011	ICU and IF Up-converter exchange procedure	Issue 1
RD	MPIfR/HIFI/PR/2005-561	Procedures for the LO-Cryoharness verification and LOU Health-Check at Astrium	Issue 1

PACS

RD	PACS-ME-TP-016	Test Procedure for PACS WE Tests with PACS EGSE and CCS	Issue 1.1
RD	PACS-ME-TP-017	PACS Short Functional Test Warm & Cold	Issue 1.3
RD	PACS-ME-TP-021	PACS IMT Procedure	Issue 1
RD	PACS-ME-TP-024	PACS/SPIRE Parallel Mode Test for EQM IMT	Issue 1.2
RD	PACS-ME-TP-025	PACS SIH Mating Procedure	Issue 2
RD	PACS-ME-TP-026	PACS Procedure for Non-Prime Operation during EQM IMT	Issue 1

SPIRE

RD	SPIRE-RAL-PRC-001923	SPIRE FPU Handling and Integration Procedure	Issue 4
RD	SPIRE -RAL-PRC-002422	SPIRE Warm Functional Test Procedures for the CCS	Issue 1.3
RD	SPIRE-RAL-PRC-002494	SPIRE Short Functional Test (SFT) Procedures for the CCS	Issue 1.3
RD	SPIRE-RAL-PRC-002512	SPIRE Integrated Module Test (IMT) Procedures for the CCS	Issue 1.1
RD	SPIRE-RAL-PRC-002545	SPIRE EMC	Issue 1

2.2 List of Activity Control Sheets

The following activity control sheets have been generated during the instrument PLM EQM level testing covering procedure variations or extra activities performed in the frame of NCR investigations.

RD	HP-2-ASED-SD-0025	HIFI INSTRUMENT OBSW UPLOAD TEST	ISSUE 1
RD	HP-2-ASED-SD-0026	HIFI Coax Cable Performance Verification	ISSUE 1
RD	HP-2-ASED-SD-0045	RYMSA WAVEGUIDE MODIFICATION	ISSUE 1
RD	HP-2-ASED-SD-0059	PACS COOLER RECYCLE INVESTIGATION	ISSUE 1
RD	HP-2-ASED-SD-0064	STRAYLIGHT INVESTIGATION	ISSUE 1
RD.	HP-2-ASED-SD-0066	INVESTIGATION OF FPU TEMP SENSORS	ISSUE 1
RD	HP-2-ASED-SD-0067	SPECIFIC STRAYLIGHT INVESTIGATION	ISSUE 1
RD	HP-2-ASED-SD-0068	GRATING PROBLEM INVESTIGATION	ISSUE 1
RD	HP-2-ASED-SD-0069	BOLOMETER GROUP 5 INVESTIGATION	ISSUE 1
RD	HP-2-ASED-SD-0070	BIAS SETTING INVESTIGATION	ISSUE 1
RD	HP-2-ASED-SD-0071	IF UP-CONVERTER VERIFICATION TEST	ISSUE 1
RD	HP-2-ASED-SD-0075	HIFI SWITCH-ON TRANSIENT STABILITY TEST	ISSUE 1
RD	HP-2-ASED-SD-0076	IFI EMC CS RETEST DUE TO TEST EQUIPMENT SOFTWARE ERROR	ISSUE 1
RD	HP-2-ASED-SD-0077	SPIRE Detector Chain Partial Failure	Issue 1
RD	HP-2-ASED-SD-0081	SPIRE EMC	
RD	HP-2-ASED-SD-0082	PACS MEMORY LOAD OF NEW SPU OBSW DUE TO PACS NCR	ISSUE 1

2.3 List of Test Reports

Below all test reports and analyses are listed which have been compiled in the frame of the instrument PLM EQM level testing.

ASP

RD	H-P-2-ASP-TR-1055	Herschel EQM Thermal – Straylight Tests - Report on Thermal Aspects	Issue 1

ASED

RD	HP-2-ASED-TR-0058	SPIRE WARM ELECTRONICS 2ND FUNCTIONAL TEST REPORT	ISSUE 1
RD	HP-2-ASED-TR-0059	Report for HIFI Warm Units Integration with IDAS	Issue 1
RD	HP-2-ASED-TR-0060	PACS WARM ELECTRONICS 2ND FUNCTIONAL TEST REPORT	ISSUE 1
RD	HP-2-ASED-TR-0061	HIFI WU 2ND FUNCTIONAL TEST REPORT	ISSUE 1
RD	HP-2-ASED-TR-0066	Test Report for Electrical Integration of EQM PACS Warm Units	Issue 1
RD	HP-2-ASED-TR-0067	Test Report for Electrical Integration of EQM SPIRE Warm Units	Issue 1
RD	HP-2-ASED-TR-0075	PACS INSTRUMENT 1ST SFT WARM REPORT	ISSUE 1
RD	HP-2-ASED-TR-0076	HIFI INSTRUMENT 1ST SFT WARM REPORT	ISSUE 1
RD	HP-2-ASED-TR-0077	SPIRE 3RD WARM FUNCTIONAL TEST REPORT	ISSUE 1
RD	HP-2-ASED-TR-0078	HIFI IF INTERFACE VERIFICATION TEST REPORT	ISSUE 1
RD	HP-2-ASED-TR-0079	PACS SPU DELTA VERIFICATION (2ND WFT) DUE TO NCR 1242	ISSUE 1
RD	HP-2-ASED-TR-0083	PACS SFT PRIOR TO COOLDOWN	ISSUE 1
RD	HP-2-ASED-TR-0084	SPIRE SFT PRIOR TO COOLDOWN	ISSUE 1

RD	HP-2-ASED-TR-0085	HIFI SFT PRIOR TO COOLDOWN	ISSUE 1
RD	HP-2-ASED-TR-0088	HIFI SFT AFTER LOU INTEGRATION	ISSUE 1
RD	HP-2-ASED-TR-0089	HIFI SFT COLD AT HE I	ISSUE 1
RD	HP-2-ASED-TR-0090	HIFI SFT COLD AT HE II	ISSUE 1
RD	HP-2-ASED-TR-0091	HIFI IMT	ISSUE 1
RD	HP-2-ASED-TR-0093	PACS IMT	ISSUE 1
RD	HP-2-ASED-TR-0095	SPIRE SFT COLD HE 2	ISSUE 1
RD	HP-2-ASED-TR-0096	SPIRE IMT	ISSUE 1
RD	HP-2-ASED-TR-0099	HIFI SFT WARM AFTER ICU EXCHANGE	ISSUE 1
RD	HP-2-ASED-TR-0102	PACS IMT PART 2	ISSUE 1
RD	HP-2-ASED-TR-0101	SPIRE IMT PART 2	ISSUE 1
RD	HP-2-ASED-TR-0103	EQM Alignment Measurement Report	Issue 1
RD	HP-2-ASED-TR-0104	PACS-SPIRE PARALLEL MODE IN EQM IMT	ISSUE 1
RD	HP-2-ASED-TR-0105	SFT DUE TO NCR 1603 (ICU FAILURE)	ISSUE 1
RD	HP-2-ASED-TR-0106	2ND SFT DUE TO NCR 1603 (ICU FAILURE)	ISSUE 1
RD	HP-2-ASED-TR-0114	PACS SFT He I	ISSUE 1
RD	HP-2-ASED-TR-0115	SPIRE SFT He I	ISSUE 1
RD	HP-2-ASED-TR-0118	EQM Cryo Operation Report	Issue 1
RD	HP-2-ASED-TR-0119	EMC Test Report	Issue 1
RD	HP-2-ASED-AN-0020	Explanations for Excessive EQM Straylight	Issue 1

HIFI

RD	SRON-U/HIFI/RP/2005-011	HIFI WU Electrical Integration	Issue 1
RD	MPIfR/HIFI/PR-2005-561	LO Cryoharness Verification test Report	Issue 1.1
RD	SRON-U/HIFI/RP/2005-	HIFI electrical integration FPU - FCU	Issue 1

	018	test report	
RD	SRON-U/HIFI/RP/2005-004	HIFI-QM Warm Units electrical integration report (first SVM integration)	Issue 1
RD	SRON-G/HIFI/AIV/2005-002	Report on integration of QM LSU Simulator with HIFI QM LOU	Issue 1
RD	SRON-G/HIFI/AIV/2005-006	HIFI-EQM Warm Units Test Report after LOU integration	Issue 1
RD	SRON-U/HIFI/RP/2005-086	HIFI ICU and IF Up-converter exchange report	Issue 1
RD	FPSS-00898	HIFI FPU CQM Thermal test at Astrium	Issue 1
RD	SRON-U/HIFI/RP/2005-00x	HIFI-QM EMC test report	not yet issued

PACS

RD	PACS-ME-TP-025	PACS FPU CQM Cryo Harness Connection for Integrated Module Test - Test Report	Issue 3
RD	PACS-ME-TR-048	PACS EQM BOLC-SIH Connection Report	Issue 1
RD	PACS-ME-TR-049	PACS EQM DMC-SIH Connection Report	Issue 1
RD	PACS-ME-TR-051	Testreport: Short Functional Test Warm 2nd run	Issue 1
RD-	PACS-ME-TR-059	Background Adjustment Measurement with PACS Spectrometer	Issue 1
RD-	PACS-ME-TR-060	Straylight Measurement with PACS	Issue 1
RD	PICC-MA-TR-001	Second Warm Short Functional Test of PACS Chopper and PACS Internal Calibration Sources during the EQM IMT – Test Report	Issue 1
RD	PACS-MA-TR-002	Third Warm Short Functional Test of PACS Chopper and PACS Internal Calibration Sources during the EQM IMT – Test Report	Issue 1
RD	PACS-ME-TR-053	Testreport: Short Functional Test	Issue 1

		Warm 2rd run	
	PACS-ME-TR-061	Short Functional Test at He I Temperatures	Issue 1
RD	PICC-KL-TR-003	PACS EQM Warm Functional Test: Grating & Phot Filter Wheel II	Issue 1
RD	PICC-KL-TR-004	PACS EQM Warm Functional Test: Grating & Phot Filter Wheel III	Issue 1
RD	PICC-KL-TR-007	PACS EQM IMT Grating	Issue 1
RD	PICC-MA-TR-007	PACS Chopper and Internal Calibration Sources during the PACS SFT He I	Issue 1

SPIRE

RD	SPIRE-RAL REP-002423	SPIRE SIH Electrical Integration Report	Issue 1
RD	SPIRE-RAL-REP-002471	SPIRE EQM Warm Functional Test Report	Issue 1
RD	SPIRE-RAL-NOT-000	SPIRE Straylight Testing during EQM	Issue 1

2.4 List of Test Review Minutes

Below the references of all test review minutes are listed which have been hold for the individual instrument tests in the frame of the instrument PLM EQM level test program.

RD	HP-2-ASED-MN-0997	PACS SIH Electrical Integration TRR
RD	HP-2-ASED-MN-1010	HIFI SIH Electrical Integration TRR
RD	HP-2-ASED-MN-1012	SPIRE SIH Electrical Integration TRR
RD	HP-2-ASED-MN-1014	HIFI SIH Electrical Integration PTR
RD	HP-2-ASED-MN-1018	SPIRE SIH Electrical Integration PTR
RD	HP-2-ASED-MN-1022	HIFI IF Interface Verification PTR
RD	HP-2-ASED-MN-1023	PACS SIH Electrical Integration PTR
RD	HP-2-ASED-MN-1032	TRR for Instruments Thermal Behaviour and Straylight Test
RD	HP-2-ASED-MN-1038	TRR for PACS SFT Warm
RD	HP-2-ASED-MN-1039	TRR for SPIRE SFT Warm

RD	HP-2-ASED-MN-1040	TRR-PTR for HIFI LOU Electrical Integration and HIFI SFT Warm
RD	HP-2-ASED-MN-1042	PLM EQM TRR prior to Cool-down
RD	HP-2-ASED-MN-1047	PTR for HIFI LOU-LSU Integration
RD	HP-2-ASED-MN-1055	Pre TRR for Instruments IMT
RD	HP-2-ASED-MN-1056	TRR for HIFI IMT
RD	HP-2-ASED-MN-1057	TRR for PACS IMT
RD	HP-2-ASED-MN-1058	PTR for HIFI IMT
RD	HP-2-ASED-MN-1061	TRR for SPIRE IMT
RD	HP-2-ASED-MN-1062	TRR for Instruments EMC Test
RD	HP-2-ASED-MN-1063	Interim PTR for PACS IMT
RD	HP-2-ASED-MN-1067	Interim PTR for SPIRE IMT
RD	HP-2-ASED-MN-1092	TRR-PTR for HIFI ICU Exchange
RD	HP-2-ASED-MN-1096	TRR for Restart of PACS IMT
RD	HP-2-ASED-MN-1100	EQM Test Phase Check Point Meeting
RD	HP-2-ASED-MN-1104	PTR for SPIRE IMT
RD	HP-2-ASED-MN-1106	TRR for PACS SPIRE Parallel Mode IMT
RD	HP-2-ASED-MN-1109	PTR for PACS IMT
RD	HP-2-ASED-MN-1112	PTR For PACS SPIRE Parallel Mode IMT
RD	HP-2-ASED-MN-1115	TRR for HIFI EMC Test
RD	HP-2-ASED-MN-1121	PTR for HIFI EMC Test
RD	HP-2-ASED-MN-1122	TRR for PACS EMC Test
RD	HP-2-ASED-MN-1125	PTR for PACS EMC Test
RD	HP-2-ASED-MN-1127	TRR for SPIRE EMC Test
RD	HP-2-ASED-MN-1130	EQM NCR Review
RD	HP-2-ASED-MN-1131	SPIRE EMC Test Status Meeting
RD	HP-2-ASED-MN-1132	TRR for Instruments Thermal Behaviour and Straylight Tests
RD	HP-2-ASED-MN-1134	PTR for Instruments Thermal Behaviour and Straylight Tests

RD	HP-2-ASED-MN-1137	PLM EQM TRR prior to Warm-up
RD	HP-2-ASED-MN-1140	PTR for SPIRE EMC Test

3 Objective of Test Program

The main objectives of the instrument testing on PLM EQM level were

- to verify the mechanical (fit check only), electrical and data interfaces between instruments and PLM.
- to verify the instruments operation in conjunction with the cryoharness.
- to verify the instruments operation and performance with the cryostat EQM serving as test bed.
- to identify any susceptibility of instruments to E- and H-fields within the specified frequency ranges.
- to train the on-ground operation of the PLM.
- to pre-validate the cryo operation, instrument integration, alignment and test procedures in view of the PFM program.

Additional objectives included later in the test program were

- to identify the cause of the measured excessive straylight level.
- to simulate a mission profile and determine the thermal interactions between the instruments.
- to observe HIFI FPU internal temperature behavior.

Points to be considered when assessing the test results

- Difference between EQM and PFM cryostat built standards: only limited representativity of EQM cryostat thermal performance with respect to prospected PFM in-orbit conditions (in particular as regards mass flow).
- Differences between instrument EQM and PFM built standards: limited FPU functions, no redundancy, some units replaced by simulators.

4 Test Configuration

4.1 Principle Test Set-up

The principle PLM EQM test set-up is shown in Figure 4-1.

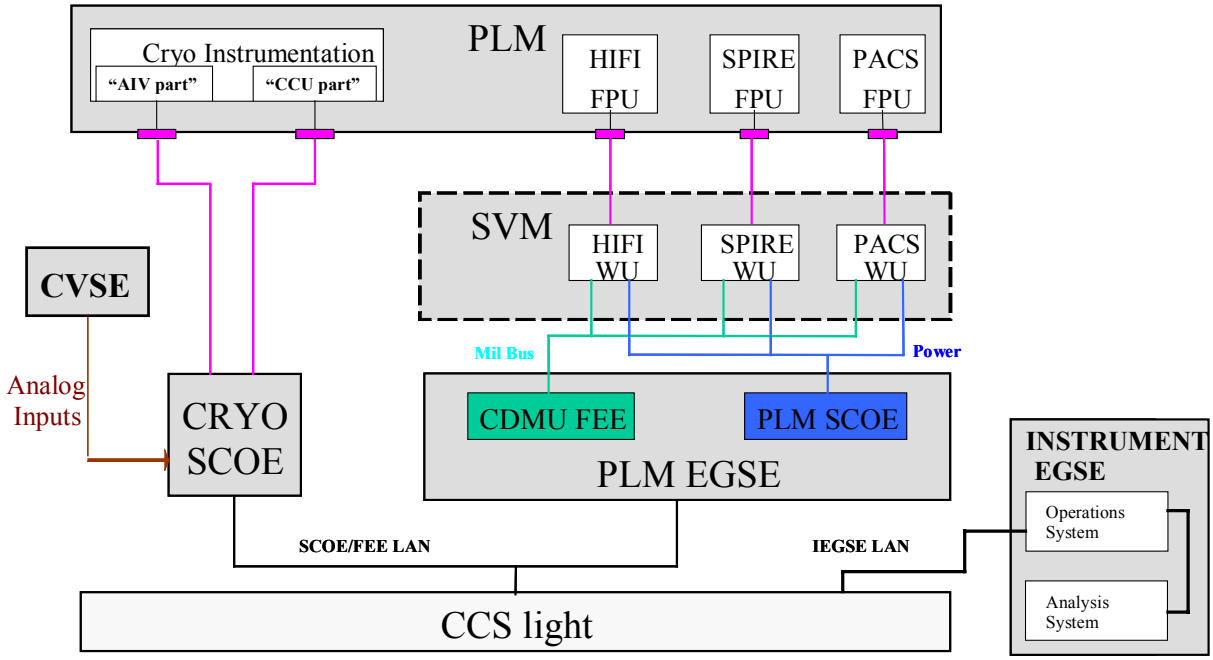


Figure 4-1: Principle Test Set-up for EQM Tests

4.2 PLM Configuration

At the start of this test programme the configuration of the PLM was

- HIFI/PACS/SPIRE FPU/JFETs integrated on OBA
- HIFI/PACS/SPIRE Warm Units integrated on SVM Simulator
- HIFI/PACS/SPIRE FPU and Warm Units bonding successfully verified by measurement
- HIFI/PACS/SPIRE WIH installed and mated
- HIFI/PACS/SPIRE Warm Units bench test (stand-alone test with instrument provided EGSE) performed
- CVV internal SIH integrated
- HIFI/PACS/SPIRE primary power and data bus harness integrated
- Shields, upper bulkhead and cryostat cover not yet integrated, OBA protected by dust cover

In the course of the integration and test program the following major PLM configuration changes have been performed:

- Completion of SIH integration (CVV external part and SVM part)
- Integration of cryostat upper shields and bulkhead
- HIFI LOU and waveguides mechanical integration
- Cryostat evacuation
- Integration of LOU SIH
- PACS SPU OBSW update
- Cryostat cool down
- HIFI LSU and BWG simulator integration
- Installation of PLM on test dolly and tilting of 23.5 deg to +y-direction.
- Temporary exchange of PACS DPU AVM by DPU CFM for repair.
- Cryostat repair and modification of cryostat thermal shields cooling in consequence of the helium leaking (ASED-NC-1495 and -1513).
- Exchange of HIFI ICU AVM with ICU CFM prior to EMC test.
- Temporary installation of EMC test source for HIFI EMC test.

Details of the actual configuration at the various test steps are provided in the corresponding TRR/PTR minutes and the test reports.

4.3 Major difference between EQM and PFM Built Standard

4.3.1 Cryostat

- Lower part of cryostat is ISO cryostat.
- Optical bench cooled by auxiliary tank (AXT).
- Thermal shields cooled by main tank, after helium leakage problem by external dewar. Mass flow adjustable independently from mass flow through L1/L2 ventline.
- CVV internal SIH not thermally connected to optical bench and inner heat shield.
- 6 of the 7 optical windows replaced by aluminium blind caps.
- Entrance baffle without aperture (instrument aperture existing).
- Reduced SIH for HIFI and SPIRE.

4.3.2 Instruments

<u>HIFI</u>

- FPU with only band 3 active, the other bands were thermally simulated, in addition heaters were implemented which were controlled via free lines of SIH.
- IFH replaced by bridge (prior to EMC test IFH has been integrated).

- LOU only band 3 (plus flight representative dummy connectors for band 4).
- LSU simulator instead of LSU.
- No redundant warm units, only one polarization.
- FCU powered by SCOE (power supply) (in conjunction with ICU AVM). Manual operation necessary.
- OBSW not final version

PACS

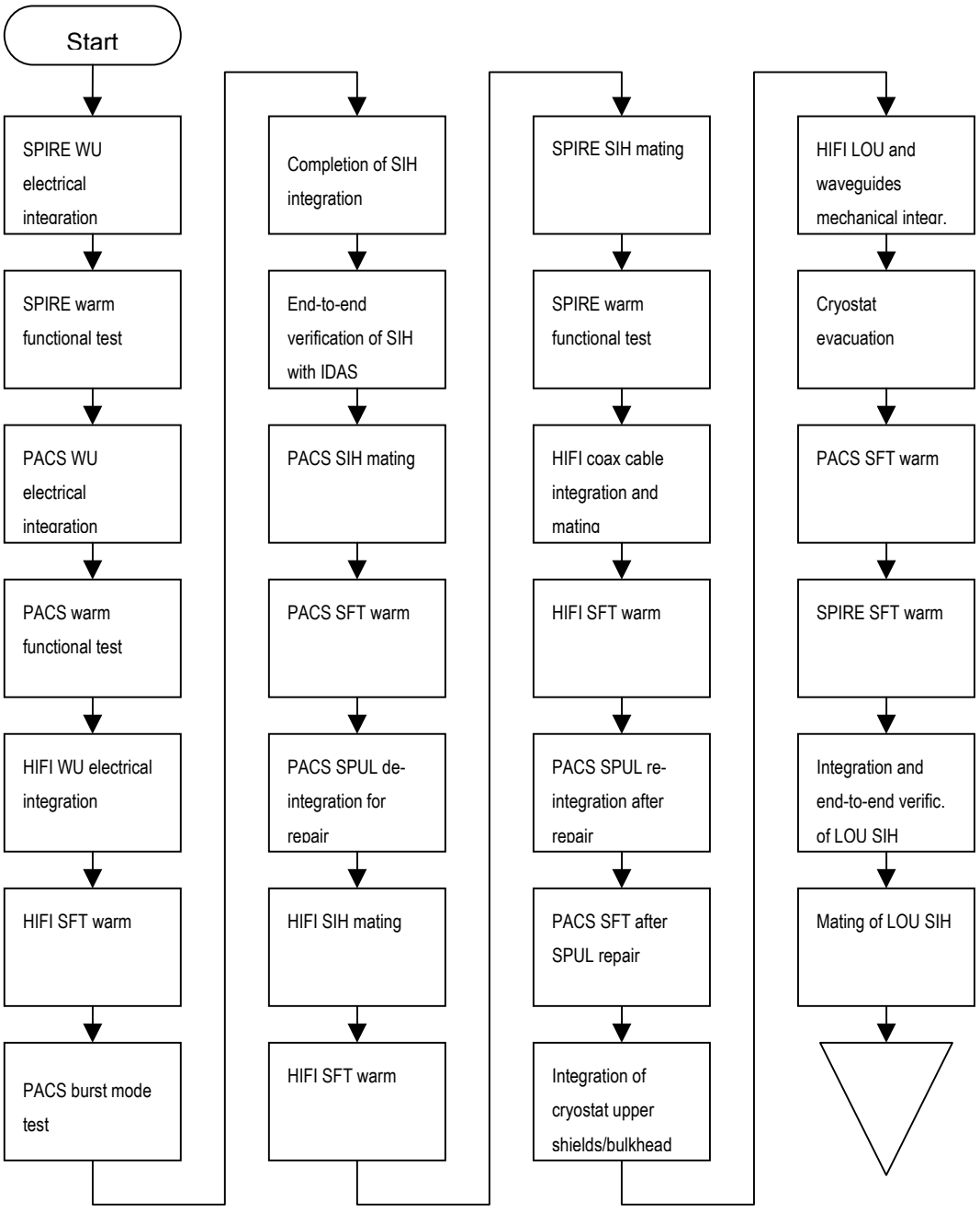
- FPU equipped with only half of the detectors for both, spectroscopy and photometry.
- No redundant warm units
- BOLC powered by SCOE (power supply which is controlled by PLM EGSE)
- OBSW not final version

SPIRE

- FPU with only 1 photometer array (LW), no spectrometer, no SMEC.
- JFET with only one 48 channel module flight representative.
- No redundant warm units.
- FCU and DCU powered by SCOE (SPIRE Power Bench). Manual operation necessary.
- OBSW not final version.

5 Test Flow

The following table illustrates the flow of the PLM EQM level instrument testing.



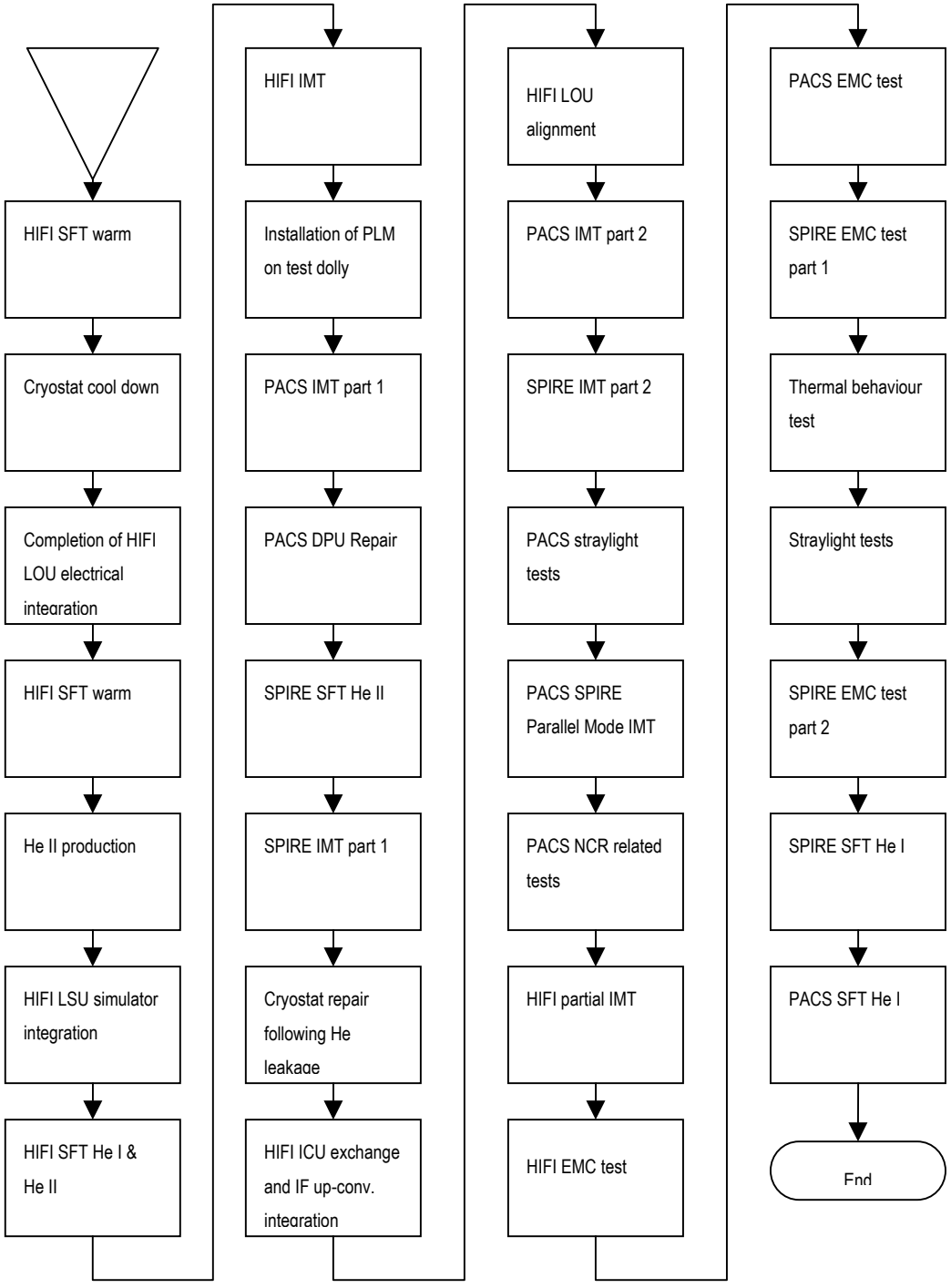


Table 5-1: Activities Flow

6 Test Documentation

The lead procedure for the instrument PLM EQM level test activities including the instruments electrical integration was the Instrument PLM EQM Level Test Procedure (HP-2-ASED-PR-0051).

This procedure calls up all lower level procedures executed in the frame the test program:

- The individual instrument test procedures (SFT, functional checks after harness integration, IMT).
- The EMC test procedure.

For the instrument thermal behaviour and straylight test which was introduced later a separate procedure was compiled (HP-2-ASED-TP-0093).

For the various integration and de-integration activities prior to and after the test campaign and for the cryo operations dedicated procedures were applicable.

For all tests individual reports (as-run procedures) have been generated by ASED covering the operational aspects. Performance related aspects are covered by separate analyses and reports from the instrument teams.

Some of the analyses and reports which need excessive post processing are still under compilation (e.g. performance analysis and EMC reports from instrument teams).

Prior to the start of each individual test a Test Readiness Review (TRR) took place and after its completion a Post Test Review (PTR) was held. All reviews were minuted.

Activity Control Sheets (ACS's) have been generated for any additional test steps which were either to be performed on instrument request or related to NCR's. An ACS serves as a procedure and after completion with the inclusion of the results as a report.

The following table gives references to all TRR and PTR minutes of meeting, test reports and ACS's established during the test program. In addition the start date of the individual tests is denoted.

No	Date	Activity	TRR	PTR	Reports	Comments
1	11.05.2005	SPIRE WU electrical integration test	ASED-MN-0955	ASED-MN-1012	ASED-TR-0067, ASED-TR-0058	
2	18.05.2005	PACS WU electrical integration test	ASED-MN-0963	ASED-MN-0997	ASED-TR-0066, ASED-TR-0060	
3	23.05.2005	HIFI WU electrical integration test	ASED-MN-0969 and ASED-MN-0971	ASED-MN-1010 (PTR combined with TRR for next test)	ASED-TR-0059, ASED-TR-0061	
4	30.05.2005	PACS burst mode investigation	ASED-MN-0976	ASED-MN-0976	Attached to ASED-MN-0976 and ASED-NC-0252	Test was done in the frame of ASED-NC-0252 investigation
5	07.07.2005	PACS SIH electrical integration test	ASED-MN-0997	ASED-MN-1023	ASED-TR-0075, PACS-ME-TR-048, PACS-ME-TR-049	SPU defect; de-integration and repair necessary (ASED-NC-1242)
6	13.07.2005	HIFI SIH electrical integration test	ASED-MN-1010	ASED-MN-1014	ASED-TR-0076, SRON-U/HIFI/RP/2005-018	SIH test report: ASED-TR-0074
7	18.07.2005	SPIRE SIH electrical integration test	ASED-MN-1012	ASED-MN-1018	ASED-TR-0077, SPIRE-RAL-REP-002423, SPIRE-RAL-REP-002471	SIH test report: ASED-TR-0073

No	Date	Activity	TRR	PTR	Reports	Comments
8	20.07.2005	HIFI IF interface verification test	ASED-MN-1010	ASED-MN-1022	ASED-SD-0026, ASED-TR-0078	Test was remainder of HIFI SIH electrical integration test
9	20.07.2005	PACS SFT after SPUL repair	ASED-MN-0997	ASED-MN-1023	ASED-TR-0079	
10	22.08.2005	PACS SFT warm	ASED-MN-1038	ASED-MN-1038	ASED-TR-0083	
11	22.08.2005	SPIRE SFT warm	ASED-MN-1039	ASED-MN-1039	ASED-TR-0084	
12	23.08.2005	HIFI LOU electrical integration and HIFI SFT Warm	ASED-MN-1040	ASED-MN-1040	ASED-TR-0085	Electrical LOU integration not successful (ASED-NC-1357)
13	01.09.2005	HIFI LOU electrical integration completion and HIFI SFT Warm	ASED-MN-1040	ASED-MN-1047	ASED-TR-0088	
14	08.09.2005	HIFI SFT I	ASED-MN-1047	ASED-MN-1056	ASED-TR-0089	
15	08.09.2005	HIFI LOU Alignment	ASED-MN-1047	ASED-MN-1056	ASED-TR-0103	
16	12.09.2005	HIFI SFT He II	ASED-MN-1056	ASED-MN-1058	ASED-TR-0090	
17	12.09.2005	HIFI IMT	ASED-MN-1056	ASED-MN-1058	ASED-TR-0091	Malfunction of WBS 3rd subband (ASED-NC-1798)
18	19.09.2005	PACS IMT	ASED-MN-1057	ASED-MN-1063	ASED-TR-0093	Cooler recycle failed due to cryostat helium leakage (ASED-NC-1495), DPU failure, (ASED-NC-1491)
19	26.09.2005	SPIRE SFT He II	ASED-MN-1061	ASED-MN-1067	ASED-TR-0095	

No	Date	Activity	TRR	PTR	Reports	Comments
20	26.09.2005	SPIRE IMT	ASED-MN-1061	ASED-MN-1067	ASED-TR-0096	Cooler recycle failed due to cryostat helium leakage (ASED-NC-1513)
21	17.10.2005	HIFI ICU exchange and IF up-converter integration and test	ASED-MN-1092	ASED-MN-1092	ASED-TR-0099, SRON-U/HIFI/RP/2005-086	Verification tests could not be completed on 17.10.2005 due to ICU problem, problem resolved on 14.11.2005 (ASED-NC-1603)
22	19.10.2005	PACS IMT 2nd part	ASED-MN-1096	ASED-MN-1109	ASED-TR-0102, PICC-KL-TR-007	Grating does not correctly work (ASED-NC-1666), high background radiation (ASED-NC-1675)
23	24.10.2005	SPIRE IMT 2nd part	ASP-MN-6975	ASED-MN-1104	ASED-TR-0101	High correlation between cryocover and L1 temperature observed (ASED-NC-1662)
24	07.11.2005	PACS SPIRE Parallel Mode IMT	ASED-MN-1106	ASED-MN-1112	ASED-TR-0104	
25	09.11.2005	PACS NCR investigation tests (ASED-NC-1687, -1675, -1666, -1663, -1665)	ASED-MN-1106	ASED-MN-1112	ASED-SD-0066, -0067, -0068, -0069, -0070	
26	14.11.2005	Completion of verification test resulting from ICU and IF up-converter exchange	ASED-MN-1115	ASED-MN-1121	ASED-TR-105, ASED-TR-106	ASED-NC-1603

No	Date	Activity	TRR	PTR	Reports	Comments
27	15.11.2005	HIFI EMC test	ASED-MN-1115	ASED-MN-1121	Not yet available	Susceptibility for E-fields from 3.9 - 8.1 GHz (ASED-NC-1733)
28	21.11.2005	PACS EMC test	ASED-MN-1122	ASED-MN-1125	Not yet available	Susceptibility for H-fields (ASED-NC-1772)
29	28.11.2005	SPIRE EMC test part 1	ASED-MN-1127	ASED-MN-1131	Not yet available	Susceptibility for H-fields (ASED-NC-1800), high susceptibility for E-fields (ASED-NC-1804)
30	05.12.2005	Thermal behaviour test	ASED-MN-1132	ASED-MN-1134	ASED-TR-112, FPSS-00898	
31	07.12.2005	Straylight test	ASED-MN-1132	ASED-MN-1134	ASED-TR-112	
32	12.12.2005	SPIRE EMC test part 2	ASED-MN-1127	ASED-MN-1140	Not yet available	High susceptibility for E-fields (ASED-NC-1804)
33	15.12.2005	PACS SFT He I	ASED-MN-1137	Covered by ASED-TR-0114	ASED-TR-0114, PACS-ME-TR-061, PICC-MA-TR-007	
34	15.12.2005	SPIRE SFT He I	ASED-MN-1137	Covered by ASED-TR-0115	ASED-TR-0115	

Table 6-1: List of Instrument PLM EQM Level Tests

7 Test Results Overview

7.1 Mechanical Interfaces

The mechanical interfaces between the instrument units and the PLM EQM were successfully verified as regards their fit. Some modifications to the thermal flex link interfaces were agreed and implemented during integration. The modifications were covered by relevant NCR's.

Verification as regards strength etc. (environmental testing) was not the objective of the EQM program but is performed on STM and PFM level.

7.2 Alignment

The main objectives of the PLM EQM alignment were

- Correct alignment between HIFI FPU and LOU. For this purpose the HIFI FPU is equipped with two alignment devices (AD's) and the LOU with two pentaprism blocks (PPB's) as optical references.
- Validation of the ASED alignment procedure which partly will also be applied for PFM.

The alignment comprised the following steps

- Elevation measurement of HIFI FPU (both AD's) with respect to theodolite levelling and azimuth measurement with respect to reference prism.
- Elevation measurement of HIFI LOU (both PPB's) with respect to theodolite levelling and azimuth measurement with respect to reference prism.
- Calculation of angular misalignment between FPU and LOU.
- Measurement of relative lateral and horizontal positions between FPU and LOU using the crosshairs on the AD's and PPB's as references.
- LOU adjustment to the required orientation and position under theodolite control
- Repetition of alignment measurement after LOU adjustment for final verification of correct alignment.

The following problems were observed:

- The required angular alignment between FPU and LOU could not be fully achieved (ASED-NC-1884). This was caused due to the high offset between the orientations of the two FPU AD's and due to the high offset between the orientations of the two LOU PPB's. The required lateral alignment (x and z direction) was within the specified values.
- The LOU adjustment caused bending of the LOU support plate due to different strut tensions during adjustment. For the PFM alignment a dedicated LOU alignment MGSE will be used (as

already done for STM) in order to avoid any bending loads on the LOU support plate by the struts.
- The reflexion from the FPU AD's was very faint for autocollimation. This needed darkening of clean room.

In spite of these problems the HIFI performance tests conducted during the HIFI IMT confirmed that the alignment was satisfactory.

Details can be found in the Alignment Procedure (HP-2-ASED-PR-0039) and the EQM Alignment Measurement Report (HP-2-ASED-TR-0103).

7.3 Electrical Interfaces

The various tests in the frame of the EQM campaign revealed that the electrical interfaces of the instruments with the PLM functioned correctly. This includes the instrument interfaces with the PLM EGSE (CDMU FEE, PLM SCOE) which simulated the SVM interfaces and the instrument interfaces with the SIH.

Prior to mating the instruments with the PLM EGSE both the power and the data interfaces had been verified by test. No anomalies were observed apart from a test setup problem (ASED-NC-1076, -1083, -1105).

Prior to mating the instruments with the SIH, the SIH had been end-to-end tested by automatic test equipment (IDAS). The applicable data base was identical to the one previously validated against the corresponding harness used during the ILT. The end-to-end test revealed some mistakes in the SIH which were corrected prior to mating, as far as necessary (details see HP-2-ASED-TR 0072, -0073 and -0074).

In addition manual SIH checks were performed as regards the multiple connections (HIFI) and the grounding (all instruments). Also here some mistakes were detected and corrected, as far as necessary (details see SRON-U/HIFI/RP/2005-018, PACS -ME-TR-048, PACS-ME-TR-049, SPIRE-RAL-REP-002423 and SPIRE-RAL-REP-002471).

After the SIH mating, the instruments were functionally tested with the FPU in warm conditions. Neither these tests nor the later tests in cold conditions revealed any malfunction of the SIH.

It is noted that EQM instruments have reduced hardware (e. g. limited number of channels, no redundancy). Therefore the EQM SIH was a partial build compared to the PFM.

7.4 Thermal Interfaces

During the test program all temperatures inside the cryostat have been continuously monitored and recorded. With the EQM cryostat as test bed the required L0, L1, L2 and L3 temperatures could be fully met. However, in order to achieve such temperature the mass flow through the OBA had to be adjusted by a factor of about 10 higher than the prospected in-orbit mass flow. This is assumed to be

mainly due to the higher heat load via the cryoharness which is for EQM not thermally connected to the heat shield and the optical bench as for PFM.

Due to the high mass flow the thermal behaviour observed during the PLM EQM tests must be appropriately scaled as regards L1 and L2 temperature time constants. The observed behaviour of L0 can be considered nearly flight representative.

During the IMT the following cooler hold times and evaporator temperatures were achieved:

- The cooler hold times were approx 40 h for both PACS and SPIRE.
- The cooler recycles are very reproducible and nearly similar for PACS and SPIRE
- The achieved min. evaporator temperature was 276 mK for PACS and 280 mK for SPIRE.
- PACS cooler operations were not affected by the SPIRE cooler recycling and theSPIRE cooler operations were also not affected by PACS cooler recycling.

To understand the thermal behaviour of the instruments when switching from one instrument to another a dedicated test has been introduced. This test comprised the following main steps:

- Instrument thermal behaviour test with the following switching sequence: HIFI - PACS - HIFI - SPIRE - HIFI.
- HIFI FPU thermal behaviour test with loading the HIFI FPU with predefined power (with heaters on HIFI FPU L1 bar) and switching between band 3 and a dummy band.

This test revealed the following findings

- A large effect of the HIFI operation to PACS and SPIRE L1 has been expected but the observed influence was very little. Reason is that the HIFI FPU EQM built standard deviates considerably from PFM.
- Influence of one instrument (incl. cooler recycle) to another is negligible. Influence of cooler recycle to L0 and L1 is as expected.
- The thermal tests on L1 showed that the system behaves as expected.

The impact of the cryocover temperature on the L0, L1 and L2 temperatures was nearly as predicted. The highest impact has been observed on the SPIRE L1 temperature.

Details can be found in the various thermal reports (H-P-2-ASP-TR-1055, FPSS-00898,…).

7.5 Straylight

During the PACS IMT higher than predicted straylight levels were observed (ASED-NC-1675). Also SPIRE reported higher straylight (SPIRE-RAL-NOT-000). To investigate the cause of the straylight a dedicated test was introduced which comprised the following main steps:

- Background radiation measurements with modulated radiation through the LO band 3 window using a torch light as heat source and a reflective metal plate as "cold source" in front of the window; and switching on and off the clean room lights. The measurements were done with PACS in photometry mode. The objective was to verify any potential straylight through the LO windows. Note: on PLM EQM only the LO band 3 window was equipped with a flight representative quartz glass, the other windows were closed by aluminium dummy plates.
- Background radiation measurements with different heat shield temperatures. Measurements was done with PACS in spectroscopy mode. The objective was to quantify the impact of the heat shield temperature on the measured straylight.
- Background radiation measurements prior and after cryocover heating up to 230 K with PACS in spectroscopy mode, in order to exclude potential straylight due to cryocover mirror contamination.
- Background radiation measurements with heated cryoharness. The supply lines to the Pt 1000 sensor T253 have been used as "heating lines". The supply current was 50 mA, the total line resistance was 560 Ohms leading to an injected power of 1.4 W. The measurements have been done with PACS in photometry mode. The objective was to see potential straylight from the cryoharness.

The following straylight impact was observed

- Modulated radiation through the LO band 3 window:
  None of the stimulation produced any effect in thermal or straylight. No visible variation of straylight through LO windows was observed. The straylight variation either was too small to be detected, or was hidden by larger contributions.
- Background radiation measurements with different heat shield temperatures:
  The shield temperatures were modified by variation of the flow through the shields. The temperature variation of the 2nd heat shield generated a large effect on the straylight measured by PACS. Variation of Thermal Shield 1 temperature (with 2nd heat shield temperature nearly constant) revealed only little straylight variation.
- Background radiation measurements prior and after cryocover decontamination:
  The cover temperature was changed from 20K to 220K and back to 20K again. No change in stray light was observed after this decontamination. It should be noted, however, that the CVV mirrors were at about 200 K already 3 days prior to that test, therefore only 3 days of water contamination can be accounted. The measured pressure inside the CVV was 2*10-8 mbar, which means that a maximum water layer of less than 1 µm thickness can have built up in this time, which most likely is too thin to have any effect. An outgasing effect of N2 and H2O has been observed on the isolation vacuum pressure. Also a clear effect on the L0, L1 and L2 temperatures could be observed.
- Background radiation measurements with heated cryoharness:
  No visible change of the straylight level was seen. The effect on L0, L1 and L2 temperatures could be clearly identified.

In addition to these tests the straylight analysis has been reconsidered with improved modelling, in particular as regards the mirror BRDF and taking into account the actually existing temperatures.

Following these investigations the measured high absolute straylight level can be explained most likely by one or several of the following scenarios:

- PACS: Much higher scattering of cryocover mirror (BRDF) compared to the model used for the original analysis HP-2-ASED-TN-0023. This, together with some improvements in the straylight model, and a higher temperature of thermal shield 2, accounts for most of the discrepancy for PACS. The factors in the discrepancy between calculation and measurement are reduced from a factor of 46 down to a factor of about 2 (preliminary value) for 88 microns wavelength. For 177 microns the remaining discrepancy is somewhat higher, about a factor of 4 (preliminary value). Because the BRDF can even be higher, this can be an explanation for the discrepancy in total for PACS. For the SPIRE wavelengths the BRDF assumed in the original analysis is realistic.
- SPIRE: Internal reflections on structural surfaces, because SPIRE structural surfaces are blank metallic and therefore high reflective. For SPIRE reflections mainly at the FPU internal walls are assumed to be much higher than expected leading to a lower off axis attenuation. Note that SPIRE has only its entrance section blackened; the other internal structural surfaces are high reflecting.
- Calculations have been performed for ideal alignment. Usual misalignment might cause additional 20 to 30% to the straylight.

Expected straylight for in flight conditions:

- PACS: provided that all excess straylight finally can be attributed to the excess scattering of the cryocover mirrors, the in flight straylight will be as predicted the original analysis HP-2-ASED-TN-0023, because the cryocover mirror BRDF does not contribute to in-flight straylight.
- SPIRE: The in flight straylight is expected to be about the same as on ground. The additional straylight from e.g. Sunshade and M1 baffle most likely will outweigh the less straylight from lower temperatures of Thermal Shield 2 and CVV. The only possibility to reduce this straylight is to make structural surfaces of SPIRE black.

For details see ASED analysis HP-2-ASED-AN-0020.

7.6 Operational Aspects

7.6.1 Instrument operation

For the verification of the instrument operation SFT's and IMT's have been defined and performed.

The instruments were operated from the CCS (see Figure 4-1), i. e., all commands were sent from the CSS and all telemetry and science data was received by the CCS.

The commanding of the instruments was done using TCL scripts generated by the instrument teams. These TCL scripts were derived from the instruments CUS scripts. Usually a limited validation on the CCS (dry run) was performed prior to "hot execution".

All data coming from the instruments (housekeeping, events, science packets) is displayed and archived on the CCS. The instrument packets are also forwarded to the IEGSE (Instrument EGSE) for real-time, online analysis of the housekeeping and science data by the instrument teams. On the IEGSE, the data is again stored for detailed offline analysis.

In general, the EQM test campaign proved that all three instruments could be operated in a very reliable way.

At the beginning of EQM test campaign the following problems were observed

- TCL script execution problems due to incorrect sequence of commands, too short wait times, incompatibility between TCL scripts and MIB (the TCL scripts use the data which are defined in the MIB),….
- Errors in the MIB (wrong limits,...). In particular the overwhelming amount of detected limit errors (up to 1 a second) made it impossible to detect any serious errors.
- Deficiencies in the CCS-IEGSE interface. Most of the TCL scripts do not contain all command parameters. During the script execution the missing parameters must be acquired from the IEGSE which is connected to the CCS.
- OBSW bugs.

The main reason behind these problems was that not all scripts and the MIB and the OBSW were fully validated on instrument level prior to delivery to ASED. Some inconsistencies were traced back to processing errors on HPSDB (early in the EQM tests). Others were traced to non- or partially-validated TCL scripts (later in the EQM tests).

When problems occurred during the execution of a TCL script, the script was usually stopped and manual single commands were send from the CCS to return to a safe and known situation. In the course of the test campaign most of the bugs could be resolved by script and/or MIB update or by appropriate workarounds. At the end of the test campaign the instrument operation was very reliable.

To avoid re-occurrence of the mentioned difficulties in the PFM test program, the following measures should be implemented

- Complete validation of TCL script and MIB on instrument level prior to delivery.
- In time delivery of TCL script and MIB files to ASED to allow proper pre-test validation.
- Definition of the limits of all parameters (MIB settings) taking into account the environmental conditions.
- Solving of bugs in the OBSW during ILT.

7.6.2 Cryostat operation

Cryostat was manually operated by means of the CRYO SCOE. Direct manual operations were the AXT heater and mass flows adjustments and dewar exchanges. Throughout the instrument tests these activities have been recorded in log sheets. All relevant telemetry (temperatures, mass flows, …) was acquired by the CCS via the CRYO SCOE.

The flow rate through the OBA which defined the L1, L2 and L3 temperatures was adjusted by appropriate AXT heating.

The temperature of the heat shields was controlled by the mass flow through the heat shields which originally was provided by the HTT. Later on, in order to resolve the helium leakage problem, the HTT was evacuated the shields were cooled by an external dewar.

The cover flushing was performed by an external dewar with a variable flow rate. The cover temperature was controlled by throttling at the transfer line valve and adjusting the dewar pressure.

During PACS and SPIRE performance tests the cover temperature was adjusted to lowest possible temperature in order to minimise straylight impact. The initially required mass flow was 300 mg/sec which could later on be optimised to about 100 mg/sec by appropriate throttling.

For HIFI no cover flushing was required.

Prior to PACS IMT the PLM EQM was hoisted on the multi purpose trolley and tilted by approx. 23.5 deg to +y-direction. This position was kept unchanged until the end of the test campaign.

The following major problems were observed:

- During SPIRE and PACS IMT it was identified that the cooler could not be recycled. Cause was established as being the already known helium leakages of the HTT and of the filling port interface. The following recovery measures were undertaken

    - The filling port interface to the CVV has been sealed to achieve an improved leak tightness with glue (RTV 691)
    - The HTT was depleted and evacuated and remained evacuated during the remaining tests. The heat shields were cooled instead by helium flushing from an external dewar with 150 mg/s to 250 mg/s.

    For details see related NCR's ASED-NC-1495 (PACS) and ASED-NC-1513 (SPIRE).
- The required mass flow to maintain the L1 and L2 temperatures at the required levels was about 25 mg/sec. This is by a factor of about 10 higher than the predicted in-orbit mass flow. See also section 7.4.
- During EMC test oscillations in the cryocover cooling loop were observed. Cause was the long vent line and bad isolation vacuum of the flushing line. By improving the isolation vacuum the oscillations could be suppressed.

The first two problems do not exist for PFM due to different cryostat design. The cover flushing needs to be optimised.

For details see the EQM Cryo Operation Report HP-2-ASED-TR-0118.

7.6.3 CCS

The CCS interfaces with the PLM EGSE, with the CRYO SCOE and with the IEGSE. The CCS controls and monitors the instruments via the PLM EGSE.

The CCS stores all data which it receives, it also keeps logs of all commands that have been sent and of all TCL scripts that have been executed, etc…. All this data can be retrieved, replayed and analysed.

The CCS is based on SCOS 2000, it has however some additional features like a plotting tool, etc….

In the course of the EQM test campaign the CCS turned out as a very stable test operation system.

The observed problems were not related to the CCS itself but mainly due to bugs in the MIB or the instrument OBSW.

7.6.4 PLM EGSE

The PLM EGSE comprises the CDMU DFE (with the 1553b bus interface to the instruments) and PLM SCOE (with the power outputs to the instruments) and is controlled by the CCS. For safety and traceability reasons the PLM EGSE configuration was performed automatically using dedicated TCL scripts compiled by ASED.

During the entire EQM test campaign the interface between CCS and CDMU DFE never showed any problem. No command or TM packets were detected which were lost in this interface for an unknown reason. It is however important that the correct bus profile is loaded. A bus profile allocates a certain part of the bus to a certain instrument.

Only some minor problems have been seen with the operation of the PLM EGSE, mainly related to burst mode operation and bus profiles. In the beginning of the EQM tests some difficulties were caused by a problem in the CDMU DFE when the first command to an instrument was not forwarded to the actual instrument. All problems detected during EQM on the PLM EGSE are resolved.

7.6.5 CRYO SCOE / CVSE

The CRYO SCOE monitors and controls the cryostat. The monitoring was done locally and via the CCS. The control was always done locally because the Cryo SCOE was next to the cryostat inside the cleanroom with good access by the cryo experts. The monitored parameters comprise cryostat temperatures, pressures, heater data and mass flows. This data was also forwarded to the IEGSE on request of the instrument teams to correlate their scientific data with events of the cryostat. Although the system was not designed to provide this data, the instrument teams had real-time access to all the cryostat sensor data.

The following problems were observed and should be resolved for PFM:

- Peaks in sensor data in ‘once-a-minute’ acquisition
- High noise in some temperature data
- Blocking of heater data acquisition in continuous mode
- Anomalous reset of heater output

7.6.6 Interface to IEGSE

The data exchange between the CCS and IEGSE comprised

- Transmission of instrument telemetry data acquired by the CCS to the IEGSE
- Transmission of parameters needed to compile telecommands from the IEGSE to the CSS. Most of the TCL scripts do not contain all command parameters. During the script execution the missing parameters must be acquired from the IEGSE which is connected to the CCS. The instrument TCL files executed on the CCS must be completed with data available on the IEGSE. In this data exchange, the TCL templates are completed with command parameter data available on the IEGSE.
- Transmission of CRYO SCOE data acquired by the CCS to the IEGSE

During EQM testing several problems were detected

- Because of a problem in SCOS 2000, the interpretation of IEGSE packets was not done correctly on the CCS. This is currently solved by a special script continuously running on the CCS.
- The IEGSE generates packets in TAI, while the CCS distributes UTC time. This 32 seconds difference caused data misinterpretations during operation and offline analysis. This problem is still open for PFM.
- During the IMT's it has been requested to forward also the CRYO SCOE data to the IEGSE. This was done by changing some settings on the CCS. Since these telemetry packets have no checksum inside the packet, the IEGSE creates error messages while handling them. For PFM the IEGSE software should be changed to avoid these problems in the future.
- The data exchange to build up the telecommands requires some definitions in the MIB files. HPSDB has however a limit of 1000 commands per element. This means in practise that TCL files could only contain 1000 commands. During several tests, this limit was exceeded and new TCL files needed to be generated.

7.6.7 MIB

The MIB is a data base which contains the definitions of TM/TC packets, calibrations, limit values, packet forwarding schemes, etc… The MIB, which is a collection of ASCII files is installed in the CCS.

The MIB files are developed by the instrument teams and SCOE operators, they are send/uploaded to the HPSDB (Alcatel). All the individual MIBs are loaded into the HPSDB (Herschel Planck Satellite DataBase) and from this combined database the CCS MIB files are generated.

The EQM tests revealed the following deficiencies

- The loading and generating of the MIB caused a lot of problems at the beginning of the EQM tests, mainly because of unclear SCOS 2000 definitions, HPSDB errors etc… The main problem was that the input provided by the instrument teams was not identical to the content of the CCS MIB files (also called bridge files). To overcome these problems, a meeting was held with all instrument teams, Alcatel and Astrium to discuss the HPSDB functioning. The outcome of this meeting should avoid major MIB problems in the future.
- The limits which are defined in the MIB files are not set in a consistent manner. This caused throughout the test campaign many false out of limit messages (1 error message per minute on average) so that it was nearly impossible to identify “real” errors. For PFM a clear guideline should be established how to use soft/hard limits, in particular the limit values should be set taking into account the on-ground conditions.
- During normal operations SSC (Source Sequence Counter) errors are reported by the CCS. This is due to the fact that packets arrive in a different order as they were generated. These errors are usually seen when type 1 packets arrive on the CCS. PACS already indicated that this is due to a problem in the OBSW and it will be solved in a new version of the OBSW.

7.7 EMC

The EMC test comprised radiation susceptibility tests with H- and E-fields. In addition specific Conducted emission and susceptibility tests were performed for HIFI.

The test was carried out in a standard clean room (no anechoic chamber). The PLM configuration was optimised for the EMC test (relocation of disturbing equipment apart from the cryostat as far as possible, additional shielding of cables from PLM EGSE by wrapping with aluminium foil, …).

HIFI

The HIFI EMC test comprised the following main tasks:

- RS H-field 30 Hz - 50 kHz (1 antenna position)
- RS E-field 0.1 MHz - 20.6478 MHz (2 antenna positions)
- RS E-field 35.0 MHz - 769.86 MHz photometry mode (2 antenna positions, 2 polarisations)
- RS E-field 1.1 GHz- 6.15891GHz photometry mode (2 antenna positions, 2 polarisations)
- RS E-field 6.6 GHz - 16.690921 GHz (2 antenna positions, 2 polarisations)

- polarisations)
- RS E-field notch 8.45 GHz / 8.475 GHz/ 8.5 GHz (2 antenna positions, 2 polarisations)
- CS DM sine wave on ICU power lines to 30 Hz - 50 KHz
- CS DM sine wave on LCU power lines to 30 Hz - 50 KHz
- CS DM sine wave on ICU power lines to 50 kHz - 50 MHz
- CS DM sine wave on LCU power lines to 50 kHz - 50 MHz
- CS CM sine wave on ICU power lines to 10 kHz - 50 MHz
- CS CM sine wave on LCU power lines to 10 kHz - 50 MHz
- CS CM transients on ICU power lines
- CS CM transients on LCU power lines
- CS DM transients on ICU power lines
- CS DM transients on LCU power lines

For the RS H-field test only 1 instead of 2 positions were used, since the risk estimated for HIFI with respect to H-field is low and since the illumination of the antenna was broad.

For the RS E-field test only 2 antenna positions were used instead of 3, because 2 positions were sufficient to illuminate the critical areas. An extra test was requested by HIFI illuminating the Warm Units. 1 antenna position with 1 polarisation was used for that test.

CS tests on signal lines were skipped since covered by the RS tests.

The preliminary conclusion from the tests is that HIFI is compliant with the requirements except for the E-field radiated susceptibility in the frequency interval from 3.9 GHz to 8.1 GHz (i.e. the IF band). The worst-case susceptibility level was 25mV/m at a frequency of 7.65GHz. As expected, the susceptible unit was the FPU. For details see ASED-NC-1733.

Given the expected interference level in the satellite and from the HIFI experience with the instrument, it is assumed that this susceptibility is acceptable for flight. Confirmation of this assumption should be done on PFM S/C level by RE measurements to define the margin between actual emission and the observed susceptibility.

PACS

The EMC test comprised the following main steps:

- RS H-field 30 Hz - 50 kHz photometry mode (3 antenna positions, 3rd antenna position only for threshold determination)
- RS H-field 30 Hz - 50 kHz spectroscopy mode (2 antenna positions)

- RS E-field 0.1 MHz - 20.6478 MHz photometry mode (2 antenna positions)
- RS E-field 0.1 MHz - 20.6478 MHz spectroscopy mode (2 antenna positions)
- RS E-field 35.0 MHz - 769.86 MHz photometry mode (2 antenna positions, 2 polarisations)
- RS E-field 35.0 MHz - 769.86 MHz spectroscopy mode (2 antenna positions, 2 polarisations)
- RS E-field 1.1 GHz- 6.15891GHz photometry mode (2 antenna positions, 2 polarisations)
- RS E-field 1.1 GHz - 6.15891GHz spectroscopy mode (2 antenna positions, 2 polarisations)
- RS E-field 6.6 GHz - 16.690921 GHz photometry mode (2 antenna positions, 2 polarisations)
- RS E-field 6.6 GHz - 16.690921 GHz spectroscopy mode (2 antenna positions, 2 polarisations)
- RS E-field notch 8.45 GHz / 8.475 GHz/ 8.5 GHz photometry mode (2 antenna positions, 2 polarisations)
- RS E-field notch 8.45 GHz / 8.475 GHz/ 8.5 GHz spectroscopy mode (2 antenna positions, 2 polarisations)

The tests revealed that the PACS photometer is very susceptible to magnetic fields of low frequency. An NCR has been raised (ASED-NC-1772). Dedicated sensitivity measurements showed that the overall susceptibility threshold is maximum 30dB below the test levels (120 dBpT from 30 Hz to 20 kHz and 110 dBpT from 20 kHz to 50 kHz). The error caused by the magnetic field is roughly proportional to the level of the applied magnetic field. This fact provides the possibility to estimate the susceptibility threshold more accurately after the off-line analysis of the recorded data. The final susceptibility threshold will be evaluated by comparing the deviations of the photometer signal during the irradiation with nominal level to the noise level of the photometer signal without magnetic field. The susceptible devices will be further investigated.

The E-field tests revealed no susceptibility.

A final assessment can be made only after post processing of the measurement data. The relevant report is under preparation.

SPIRE

The EMC test comprised the following main steps:

- RS H-field 30Hz to 50kHz: Sweep plus spot at 260, 366, 657, 1436, 2986, 20kHz, 48.17 and 50kHz
- RS E-field 14kHz-30MHz: Sweep
- RS E-field 30MHz-1GHz (horizontal polarisation): Sweep plus threshold estimation at many spot frequencies around the susceptibility peak plus detailed sweep for 200-600MHz and 30-40MHz

- RS E-field 30MHz-1GHz (vertical polarisation): Sweep plus threshold estimation at many spot frequencies around the susceptibility peak plus detailed sweep for 30-40MHz and 60-90MHz with different amplitudes
- RS E-field 1-18GHz (horizontal and vertical): Sweep (with two antenna positions)
- RS E-field 8.45 GHz / 8.475 GHz/ 8.5 GHz (horizontal and vertical): Spot with 10 V/m (with two antenna positions / two polarizations)
- Investigation of test configuration for major ~30MHz E-Field susceptibility incl. rough estimation of susceptibility threshold.

During the test specific test parameters as e. g. sweep speed, dwell time were optimised.

The only gross susceptibility was found in the E-Field in the 10s of MHz range (ASED-NC-1804). After the completion of the standard EMC test programme dedicated tests to investigate the reason of this susceptibility were carried out.

The investigations of this susceptibility revealed that:

- SPIRE has susceptibility at IID-A test levels in the 10s of MHz range (highest at around 30 MHz).
- The configuration of the test exacerbated the susceptibility. This was concluded after the following improvements in better simulating the flight environment:
    - The CCS Harness was rerouted;
    - The SPIRE Mechanism EGSE harness was removed;
    - The shielding of CCS harness was improved;
    - The ground wires dangling from SVM were stowed against SVM panel etc.
- The coupling mechanism into the instrument is probably via the SPIRE cryoharness.

A final assessment can be made only after post processing of the measurement data. The relevant report is under preparation.

7.8 Instrument Performance

During the IMT's, the EMC test and the thermal behaviour and straylight test many instrument performance data have been collected. The evaluation of these data and the presentation of the results is done by the instrument teams. References to the relevant instrument reports, as far as available, are given in Table 6-1.

Below the major findings are quoted.

HIFI

SFT successfully performed

IMT successfully performed. NCR's related to MIB and instrument hardware (3rd sub-band of WBS malfunction) (ASED-NC-1261, -1798).

PACS

SFT warm successfully performed with no NCR.

IMT was interrupted due to PACS DPU hardware failure (ASED-NC-1491) and because of cooler problems which later on turned out to be caused by cryostat helium leakage (ASED-NC-1495).

After DPU repair and cryostat repair the IMT has been resumed.

During the IMT a number of anomalies have been detected

- Grating position read back is too noisy (PACS-ME-NCR-158).
- Unexpected grating controller disable (PACS-ME-NCR-162, ASED-NCR-1666).
- Blue spectroscopy temperature sensors do not work (PACS NCR).
- Bias group 5 of bolometers show anomalous current (PACS NCR).
- DECMEC timing FPGA parameters for photometry caused a failure of the calibration sources (PACS NCR). Work around solution for EQM has been found and the test has been successfully repeated.
- Cooler hold time is 39 hours. During ILT 36 hours up to 52 hours hold time was achieved.
- Bias settings for the spectroscopy detectors failed some times (ASED-NC-1665 plus PACS NCR).
- Unexpectedly high straylight measured (ASED-NC-1675). See also section 7.5.

SPIRE

SFT successfully performed. It could be demonstrated that the SFT can run without IEGSE support.

IMT interrupted due to cryostat helium leakage which did not allow to achieve the required evaporator temperature needed for bolometer operation due to high heat load on the 300 mK hardware (probably via helium II film).

After cryostat repair the IMT has been resumed.

Quick look analysis of the noise test data gathered during IMT revealed a slightly higher noise (~30-40 nV/Hz1/2) cf (~20-30 nV/Hz1/2) that during dark CQM ILT conditions. The source of this “extra” noise is still under investigation with the rest of the test data gathered during the bolometer load curves.

The preliminary results of the performance test data analysed show no major discrepancies with the ILT behaviour although some aspects (background and its impact in the bolometer performance) are still to be investigated.

Some of the tests requiring a highly stable cryostat environment, noise tests in particular needed to be shortened due to the sometimes unstable thermal conditions as a result of cryo operation and flushing with dewar configuration. This situation was improved towards the end of the test.

During the IMT the SPIRE cooler recycle has been verified. The achieved hold time was approx. 40 h

No NCR's as regards operational aspects.

PACS SPIRE Parallel Mode

PACS cooler recycling has been started 30 min after SPIRE and no significant deviation from a stand-alone recycling could be detected in real time. The PACS tests with SPIRE in parallel have been successfully executed (thermal behaviour test, single band photometry test, dual band photometry test).

SPIRE performance during the parallel mode test appears nominal. SPIRE behaviour did not appear to be affected by PACS operations during the parallel mode portion of the testing.

No NCRs were raised as a result of this test.

The overlapped PACS and SPIRE cooler recycle has been verified. The achieved hold time was approx. 43 h for both, the PACS and the SPIRE cooler.

8 NCR Summary

ASED NCR's have been raised for

- Anomalies related to instrument and PLM EGSE operation.
- Anomalies related to instrument performance as far as visible during the test via quick lock analysis tools. Performance deficiencies detected later during the post processing will be tracked by instrument generated NCR's.
- Anomalies related to the cryostat operation and performance.

The table below lists all non-conformances generated during this test and gives their current status. Impact on the PFM test program is identified.

NCR Number and Title	Status	Cause	Effect on PFM
HP-111000-ASED-NC-0872, "Wrong ACK in HIFI forced boot command (HC000289)", "Test",Closed,"Soft","Database", 09-FEB-05, HIFI WU 1st Functional test	C	MIB settings corrected	None provided the recommendations and updated requirements from ASP as agreed at the data base meeting are implemented
HP-111000-ASED-NC-0873, "NEW OBSW release not burnt into ICU EEPROM", "Test",Closed,"Soft","Module", 09-FEB-05, HIFI WU 1st Functional test	C	Unit not sufficiently mature on delivery,.both HW and SW	Yes Only accept a mature and fully tested OBSW and unit
HP-111000-ASED-NC-0874, "Command Complete response missing for load Mem TC", "Test",Open,"Soft","Database", 09-FEB-05, HIFI WU 1st Functional test	Open	Open To be validated on PFM Use as is for EQM OBSW and MIB settings	Yes update to OBSW and MIB . Command completion is not yet implemented, which can be dangerous for critical commands
HP-111000-ASED-NC-0875, "IST_force_boot script not known by HIEGSE", "Test",Closed,"Soft","EGSE", 09-FEB-05, HIFI WU 1st Functional test	C	HIEGSE setup problem corrected on EQM	None

NCR Number and Title	Status	Cause	Effect on PFM
HP-111000-ASED-NC-0889, "RM packet number limitation to 1000", "Test",Open,"Soft","Database", 09-FEB-05, HIFI WU 1st Functional test	Open	MIB and TCL Scripts, Requirement not sufficiently defined and open to interpretation. Resolved at Data base Mt H-P-ASP-MN-6913	Yes MPE will update 'HIEGSE-CCS communication'
HP-111000-ASED-NC-0890, "Empty sco.dat, tcd.dat and tmd.dat files HPSDB", "Test",Closed,"Soft","Database", 09-FEB-05, HIFI WU 1st Functional test	C	MIB settings corrected	None
HP-111000-ASED-NC-1110, "HIFI WU Funct test: Limits of derived parameters have wrong type", "Test",Open,"Soft","Database", 24-MAY-05, HIFI WU 1st Functional test	Open	MIB settings of limits, should have been resolved at data base mt H-P-ASP-MN-6913	YES ASP to clarify implementation. Regular out of limits might result in a missed serious error.
HP-111000-ASED-NC-1258, "Faulty MIB definition of HIFI Parameter HU035197", "Test",Closed,"Soft","Database", 14-JUL-05, HIFI SIH Elec Int Test	C	MIB settings corrected	None
HP-111000-ASED-NC-1260, "Wrong limit values in procedure SRON-G/HIFI/PR/2005-101", "Test",Closed,"Soft","Documentation", 14-JUL-05, HIFI SIH Elec Int Test	C	Error in procedure corrected	None
HP-111000-ASED-NC-1261, "Not all limit values in MIB are correctly set ", "Test",Open,"Soft","Database", 14-JUL-05, HIFI SIH Elec Int Test	Open	Limit settings to be implemented in MIB. Clarify hot and cold test limits	YES Regular out of limits might result in a missed serious error.

NCR Number and Title	Status	Cause	Effect on PFM
HP-111000-ASED-NC-1262, "HIFI command completion confirmation not received.", "Test",Open,"Soft","Database", 14-JUL-05, HIFI SIH Elec Int Test	Open	Open HIFI Use as is EQM OBSW and MIB update If no complete response is implemented this can be dangerous for critical commands	YES OBSW Iss 3.3 to be validated New OBSW needs to be validated and regression tested prior to formal release and change history in SW release Note
HP-111000-ASED-NC-1263, "Boot from uploaded ICU OBSW failed", "Test",Closed,"Soft","Unit", 14-JUL-05, HIFI SIH Elec Int Test	C	Problem was caused by error in SW upload. This error was caused by HP-153300-ASED-NC-0251	None
HP-111000-ASED-NC-1275, "LCU Status in HK not correct", "Test",Open,"Soft","Unit", 20-JUL-05, HIFI IF I/F Verification Test	Open	Open for PFM HIFI to investigate off line Suspected OBSW problem	YES HIFI to investigate off line when WU returned HK should reflect actual situation
HP-111000-ASED-NC-1293, "Discrepancies found during multiple connections check", "Test",Open,"Cat4","Subsystem", 26-JUL-05, HIFI IF I/F Verification Test	C	Open for PFM Use as is for EQM Harness Build standard and Data base/EICD	TBD Confirmation of Harness configuration for PFM and Doc updates
HP-111000-ASED-NC-1357, "Wrong connection at EQM LOU Harness ", "Test",Closed,"Cat4","Unit", 19-AUG-05 HIFI LOU Elec Int / SFT Warm	C	Problem was with Test equipment Break out box configuration Harness Build standard and Data base/EICD were correct	None
HP-111000-ASED-NC-1455, "HIFI FCU power scoe computer not responding", "Test",Closed,"Cat1","Unit", 12-SEP-05 HIFI SFT He 2	C	Computer crash	None (power scoe not used anymore)
HP-111000-ASED-NC-1477, "HIFI FCU power SCOE PC failed", "Test",Closed,"Cat1","Unit",, 12-SEP-05 HIFI SFT He 2	C	Computer crash	None (power scoe not used anymore)

NCR Number and Title	Status	Cause	Effect on PFM
HP-111000-ASED-NC-1603, "Communication Link to HIFI ICU lost during test", "Test",Closed,"Soft","Unit", 17-OCT-05 HIFI ICU Exchange SFT	C	Error in OBSW. Solved with new OBSW	Yes New OBSW needs to be validated and regression tested prior to formal release and change history in SW release doc
HP-111000-ASED-NC-1733, "HIFI Radiated susceptibility in range 3.9GHz to 8.1GHz", "Test",Closed,"Cat1","Module", 16-NOV-05, HIFI EMC Test	C	Use as for EQM Expected from existing analysis. Results to be analysed by SRON	YES Possible RFW or HW mod
HP-111000-ASED-NC-1734, "HIFI EMC Measurement error in IABG Test equipment SW", "Test",Closed,"Soft","EGSE", 17-NOV-05, HIFI EMC Test	C	Test equipment SW implementation error	YES Validate TE SW prior to formal test
HP-111000-ASED-NC-1798, HIFI EQM the 3rd sub-band of the WBS did not behave as expected "Test",Open,"Cat4","Unit", 14-NOV-05, HIFI EMC Test	Open	Work around has been implemented (reconfiguration of HRS to cover the lost 3rd sub-band). Off line investigation at SRON after return of WU	TBD
HP-111000-ASED-NC-1873 HIFI ICU HK shows regular out of limits and error events Type 5_4 "Test",Open,"Soft","Unit", 13-Dec-05, HIFI EMC Test	open	TBD by HIFI	Yes HIFI to investigate and resolve for PFM
HP-111200-ASED-NC-1105, "HIFI: MIL bus functional behaviour out of requirement detected w. IDAS", "Test",Open,"Soft","EGSE", 23-MAY-05 , HIFI IDAS Check out	Open	IDAS measurement protocol	None IDAS measurement protocol to be validated on EQM CW 50

NCR Number and Title	Status	Cause	Effect on PFM
HP-111200-ASED-NC-1108, "HIFI WU Funct test: Usage of generic HPSDB items where possible", "Test",Closed,"Soft","Database", 24-MAY-05, HIFI WU FT	C	MIB settings corrected	None
HP-111200-ASED-NC-1109, "HIFI WU Funct test: HM314191 has no validity flag set", "Test",Open,"Soft","Database", 24-MAY-05, HIFI WU FT	Open	OBSW and MIB settings	YES New OBSW needs to be validated and regression tested prior to formal release and change history in SW release Note
HP-112000-ASED-NC-1042, "SPIRE Event Packet (5,2) could not be forwarded to IEGSE", "Test",Closed,"Soft","Database", 12-MAY-05, SPIRE WU FT	C	MIB settings corrected	None
HP-112000-ASED-NC-1248 SPIRE SIH PSW_JFETV Gnd open line Integration;Open;12-JUL-05 SPIRE Elec Integration	Open	Discrepancy between EICD and IID-B Use as is for EQM	NO RFW to be raised for PFM
HP-112000-ASED-NC-1269, "TMD.dat file not complete", "Test",Closed,"Soft","Database", 19-JUL-05, SPIRE WU/SIH Elec Int Test	C	MIB settings corrected	None
HP-112000-ASED-NC-1340 SPIRE FPU SIH Connectors not fully fixed Integration; Open; Cat 4; Unit	Open	Use as is for EQM	TBD Spire to supply sample of connector and fixing screws

NCR Number and Title	Status	Cause	Effect on PFM
HP-112000-ASED-NC-1375 "Source Sequence Counter Errors between instruments and CCS "Test",Open,"Soft","Unit", 22-AUG-05, SPIRE SFT Warm	Open	Open SPIRE to investigate Also seen on PACS and confirmed as OBSW fault. HIFI see smaller number of errors and SPIRE sees only a few. To be further investigated by Instruments	YES If not identified and resolved. Overflow of errors might result in a missed serious error.
HP-112000-ASED-NC-1376, "Initial Value of TM5N is wrong in procedure", "Test",Closed,"Soft","Documentation", 22-AUG-05 SPIRE SFT Warm	C	Error in procedure corrected	None
HP-112000-ASED-NC-1471, "TC's send too fast in Power On to STANDBY procedure", "Test",Closed,"Soft","Database", 13-SEP-05, HIFI IMT – SPIRE in standby	C	Procedure error. SPIRE bus profile to be used during power on. Instrument Time line test will be part of EQM Sys level test CW 49	None If correct Instrument Bus profiles are use
HP-112000-ASED-NC-1513, "SPIRE EQM Cooler recycling", "Test",Closed,"Cat4","System", 27-SEP-05, SPIRE IMT	C	Helium leak in cryostat	TBD Cryo operations and effect to be reviewed and analysed
HP-112000-ASED-NC-1662, "High correlation between cryo cover temp and SPIRE L1 temp ", "Test",Open,"Cat1","Subsystem", 25-OCT-05, SPIRE IMT Pt 2	Open	Open Way forward to be discussed at H-EPLM PM ESA will provide a Thermal model for EQM which can be used for further correlation.	TBD

NCR Number and Title	Status	Cause	Effect on PFM
HP-112000-ASED-NC-1688 ,"Evaporator temperature not correct wrt L0 temperature ","Test",Open,"Cat1","Unit", 07-NOV-05, PACS/SPIRE // Mode IMT	Open	Open SPIRE/ESA to Investigate. Possible calibration error (if so, then this should be solved in the MIB)	TBD
HP-112000-ASED-NC-1800 SPIRE EMC H-Field RS Test Results non conformances ","Test",Open,"Cat1","Module", 29-NOV-05 , SPIRE EMC test	Open	Open Spire to analyse results and see list of Harness related NCRs	TBD
HP-112000-ASED-NC-1804 SPIRE EMC E-Field RS test results non conformances ","Test",Open,"Cat1","Module", 30-NOV-05, SPIRE EMC Test	Open	Open SPIRE to analyse results and see list of harness related NCRs	TBD
HP-112000-ASED-NC-1812 SPIRE detector chain partial failure "Test",Open,"Soft","EGSE", 02-DEC-05 , SPIRE EMC Test	open	Open SPIRE QLA SW fault To be corrected by SPIRE	TBD
HP-112200-ASED-NC-1083, "SPIRE: MIL bus functional behaviour out of requirement detect. w. IDAS" "Test",Open,"Soft","EGSE", 18-MAY-05, SPIRE IDAS Check out	Open	IDAS measurement protocol	None IDAS measurement protocol to be validated on EQM CW 50
HP-113000-ASED-NC – 0210 PACS DPU anomalous behaviour during first test at ASED ,"Test",Closed,"Cat 4","Unit", 24-MAR-04, DBU I/F Test	C	NCR 0210 was fixed with a new OBSW issue This was done at MPE and not at ASTRIUM.	None
HP-113000-ASED-NC – 0251 Force Boot command has to be sent twice ,"Test",Closed,"Soft","Unit", 24-MAR-04, DBU I/F Test	C	CDMU DFE SW updated and validated	None

NCR Number and Title	Status	Cause	Effect on PFM
HP-113000-ASED-NC – 0252 SSC check failures when PACS DPU in Burst Mode ,"Test",Closed,"Soft","Unit", 24-MAR-04, DBU I/F Test	C	Was fixed by an update of the CDMU DFE software May 05. The problem was found to be the CDMU DFE SW after a dedicated PACS burst mode test. For this test SSBV were present.	None
HP-113000-ASED-NC-1242, "SHK data show that the 1355 link between DPU and SPUL does not work" ,"Test",Closed,"Soft","Unit", 08-JUL-05, PACS SIH Elec Int test	C	Instrument specific problem internal to units Unit was replaced and problem no longer present	None
HP-113000-ASED-NC-1247, "Source Sequence Counter Errors detected on PACS DPU during TC Ack", "Test",Open,"Soft","Unit", 08-JUL-05, PACS SIH Elec Int test	Open	PACS to investigate Probably OBSW problems (similar for all instruments)	YES New OBSW needs to be validated and regression tested prior to formal release and change history in SW release doc Overflow of errors might result in a missed serious error.
HP-113000-ASED-NC-1276, "PACS MIB Limit values not set correctly", "Test",Open,"Soft","Database", 20-JUL-05, PACS SFT Warm	Open	OPEN MIB settings correction and validation	YES Regular out of limits might result in a missed serious error.
HP-113000-ASED-NC-1482, "Wrong MIB definition of command PC162420", "Test",Open,"Soft","Database", 19-SEP-05 PACS IMT	Open	MIB settings	If solved in MIB, no influence on PFM
HP-113000-ASED-NC-1490, "DPU reboot during IMT testing..", "Test",Closed,"Cat4","Unit", 21-SEP-05, PACS IMT	C	Problem with DPU internal power electronics. DPU is fixed.	None
HP-113000-ASED-NC-1491, "PACS DPU power anomaly", "Test",Closed,"Cat4","Unit", 21-SEP-05, PACS IMT	C	Problem with DPU internal power electronics. DPU is fixed.	None

NCR Number and Title	Status	Cause	Effect on PFM
HP-113000-ASED-NC-1493, "CRC in HK not compliant with CRC in procedure (Memory Management Test)", "Test",Closed,"Soft","Documentation", 21-SEP-05, PACS IMT	C	Error in Procedure, corrected	None
HP-113000-ASED-NC-1494, "DEC/MEC got blocked and DEC/MEC - DPU comm link dead", "Test",Closed,"Cat1","Unit", 21-SEP-05, PACS IMT	C	Work around for EQM used PACS to investigate after return of WUs, Instrument specific problem internal communication of units	YES Should be solved for PFM. Restart of PACS necessary to recover.
HP-113000-ASED-NC-1495, "PACS: Cooler Recycle Failed", "Test",Closed,"Cat1","Unit", 20-SEP-05 , PACS IMT	C	Helium leak in cryostat	TBD Cryo operations and effect to be reviewed and analysed
HP-113000-ASED-NC-1496, "IMT TestID 516 should be run in Burst mode (SPEC_dark_current...tcl)", "Test",Closed,"Soft","Database", 20-SEP-05 , PACS IMT	C	Error in Procedure, corrected and validated	None
HP-113000-ASED-NC-1497, "DPU packets get corrupted (*bad packets*)", "Test",Open,"Soft","Unit", 21-SEP-05, PACS IMT	Open	Use as is EQM. PACS to investigate and resolve for PFM DPU OBSW problem	YES Should be solved for PFM. Single command recovers from problem. New OBSW needs to be validated and regression tested prior to formal release and change history in SW release Note
HP-113000-ASED-NC-1605, "DPU CFM communication link lost", "Test",Closed,"Cat4","Unit", 23-SEP-05, PACS IMT	C	Possible fault in CFM model and or OBSW error Unit exchanged	TBD OBSW

NCR Number and Title	Status	Cause	Effect on PFM
HP-113000-ASED-NC-1622, "PACS HK packets anomaly", "Test",Open,"Soft","Unit", 26-OCT-05 SPIRE IMT (PACS in standby)	Open	Open to be resolved by PACS DPU OBSW problem Restart of PACS necessary to recover.	TBD OBSW Should be solved for PFM. New OBSW needs to be validated and regression tested prior to formal release and change history in SW release Note
HP-113000-ASED-NC-1665, "Pacs Command to set bias fails sporadically", "Test",Open,"Soft","Unit", 02-NOV-05, PACS IMT Pt 2	Open	OPEN Instrument specific problem	TBD Bias setting is of major importance to PACS instrument
HP-113000-ASED-NC-1666, "PACS Grating does not work correct", "Test",Open,"Cat1","Unit", 02-NOV-05, PACS IMT Pt 2	Open	OPEN Instrument specific problem	TBD Grating is of major importance to PACS instrument
HP-113000-ASED-NC-1675, "Cryostat background radiation measured by PACS much higher than predicted", "Test",Open,"Cat1","System", 03-NOV-05, PACS IMT Pt 2	Open	OPEN Under investigation EQM Sys level test CW 49	TBD
HP-113000-ASED-NC-1687, "Reading of two temperature sensors inside FPU fails", "Test",Open,"Cat4","Unit", 03-NOV-05 PACS IMT Pt 2	Open	Probably cables problem, since 1 sensor worked again after diagnostic test on cables. Both sensors are physically there. ASED to check Harness continuity during de integration	TBD
HP-113000-ASED-NC-1743, "DPU anomality involving type 1_2 packet and lost DEC/MEC link", "Test",Open,"Soft","Unit", 21-NOV-05 , HIFI EMC (PACS in standby).	Open	OPEN Reason unknown, under investigation. Restart of PACS necessary to recover.	TBD Should be solved for PFM. Restart of PACS necessary to recover.

NCR Number and Title	Status	Cause	Effect on PFM
HP-113000-ASED-NC-1772 PACS EMC H-Field RS Test Results non conformances ","Test",Open,"Cat1","Module",, 22-NOV-05 , PACS EMC	Open	OPEN H-field susceptibility to be analysed off line by MPI See RFW MPI-RW-004	YES
HP-113000-ASED-NC-1831 DEC/MEC not responding to commands ","Test",Open,"Cat1","Module",, 09-DEC-05 ,Stray Light Test	Open	TBD PACS to Investigate	TBD
HP-113200-ASED-NC-1076, "PACS: MIL bus functional behaviour out of requirement detect. w. IDAS", "Test",Open,"Soft","EGSE", 18-MAY-05 , PACS WU Elec Int Test	Open	IDAS Measurement protocol	None IDAS measurement protocol to be validated on EQM CW 50
HP-140000-ASED-NC-1624, "MOIS reverse engineering tool not compatible to Herschel inst TCL", "Test",Open,"Soft","EGSE", 26-OCT-05 SPIRE IMT Pt 2	Open	TCL scripts are delivered to ASED in MOIS incompatible format (HIEGSE-CCS communication)	None RFW (HP-2-ASED-RW-0006) has been raised
HP-141210-ASED-NC-1081, "tmd.dat file does not contain the PACS Science packet PIDs", "Test",Closed,"Soft","Database", 18-MAY-05, PACS WU Elec Int Test.	C	MIB settings corrected	None
HP-141210-ASED-NC-1270, "CCS packet display problems", "Test",Closed,"Soft","EGSE", 19-JUL-05, SPIRE SIH Elec Int Test	C	CCS Performance limitations	None

NCR Number and Title	Status	Cause	Effect on PFM
HP-141210-ASED-NC-1440, "Repeated Occurence TOPE CORBA error / EXIF_TM1 crash on CCS", "Test",Closed,"Soft","EGSE", 08-SEP-05, HIFI LOU/SFT Warm Test	C	CCS SW bug	None
HP-141210-ASED-NC-1619, "Type 1 packets not forwarded to IEGSE", "Test",Open,"Soft","Database", 20-OCT-05, PACS IMT Pt 2	Open	OPEN CCS specification problem. Patch available, but not installed yet.	None provided patch is successful. Patch to be implemented and validated prior PFM testing
HP-142210-ASED-NC-1672, "CCS uses UTC instead of TAI time (32 seconds problem)", "Test",Open,"Soft","EGSE", 03-NOV-05 PACS/SPIRE // Mode IMT	Open	OPEN Specification problem. Alcatel to decide way forward.	YES Should be solved quickly since timing problems can provoke many secondary problems
HP-142220-ASED-NC-1322, "Cryo Scoe current limits not compatible with need for aged ISO valves", "Test",Closed,"Cat4","Subsystem", 02-AUG-05, ACS HP-2-ASED-SD-0027	C	SCOE current limits adjusted and operation of valves OK on EQM Cryo	None
HP-142220-ASED-NC-1422, "Disturbancies during Cryo Scoe Data acquisition" "Test",Closed,"Soft","EGSE", 02-SEP-05, EQM PLM Cooldown	C	CRYO SCOE SW problem, corrected	None
HP-142220-ASED-NC-1667, "EQM CRYO SCOE heater data block in 'continuous acquisition' mode", "Test",Open,"Soft","EGSE", 15-JUL-05 , HIFI SIH Elec Int Test	Open	OPEN EQM CRYO SCOE firmware bug. Could be solved with upgrade, but then SCOE is not available for some time. Upgrade will be done after EQM campaign	TBD SCOE sent to ABSP for firmware modified and validated off line

NCR Number and Title	Status	Cause	Effect on PFM
HP-142220-ASED-NC-1668, "EQM CRYO SCOE data shows regular peaks in 'once per minute' acquisition", "Test",Open,"Soft","EGSE", 15-JUL-05 , HIFI SIH Elec Int Test	Open	OPEN ABSP has no idea about the cause. It is SW related.	TBD SCOE sent to ABSP for modified and validated off line
HP-142220-ASED-NC-1673, "CRC in CRYO SCOE HK packets is not filled in", "Test",Open,"Soft","EGSE", 13-SEP-05 HIFI IMT	Open	OPEN Specification definition and clarification Check sum validation ASP to clarify with instruments	TBD
HP-142220-ASED-NC-1759, "CRYO SCOE Heater repeated blocking and disabling", "Test",Open,"Soft","EGSE", 22-NOV-05 , PACS EMC Test	Open	EQM CRYO SCOE firmware bug. Could be solved with upgrade, but then SCOE is not available for some time. Upgrade will be done after EQM campaign	TBD SCOE sent to ABSP for modified and validated off line
HP-142220-ASED-NC-1829 Very high noise on C100 sensors for EQM CRYO SCOE "Test",Open,"Soft","EGSE", 06-DEC-05, System Level test HIFI Thermal	Open	The fix for this is the same as was done for the PFM SCOE, i.e. replacing the capacitor in the external harness (between the harness screen and the connector chassis) with a short circuit.	TBD SCOE sent to ABSP for modified and validated off line
HP-142230-ASED-NC-1046, "Delay from CDMU DFE in forwarding HK packets to CCS", "Test",Closed,"Soft","EGSE", 12-MAY-05, SPIRE WU Elec Int Test	C	Bus profile problem corrected with updated bus profiles	None
HP-150000-ASED-NC-1484, "Temp. gradient requirement during Cooldown of cryostat partially exceeded", "Test",Closed,"Cat1","System", 18-SEP-05, EQM PLM Cooldown	C	Instrument revised requirements for cool down.	TBD

NCR Number and Title	Status	Cause	Effect on PFM
HP-150000-ASED-NC-1489, "Required tilting position of the cryostat via transport dolly not secured", "Test",Closed,"Cat1","Module", 21-SEP-05, Prep IMT/Cooldown	C	Tilting dolly operation not sufficiently robust to achieve and hold 30 degrees tilt. Manual workaround used	None PFM different configuration
HP-150000-ASED-NC-1683, "EQM L1 temperatures higher that expected", "Test",Closed,"Cat1","System", 07-NOV-05, PACS/SPIRE // Mode IMT	C	Caused by running out of He for flushing of AXT and shields and subsequent temperature transit	Yes Assess impact for different configuration for PFM
HP-150000-ASED-NC-1817 EQM mass flow through OBA from AXT higher that expected "Test",Open,"Cat4","System", 06-DEC-05, EQM System Level Test (HIFI Thermal)	Open	EQM effect to be analysed	YES Results of EQM analysis to be reviewed and considered
HP-151000-ASED-NC-0211, "Internal leakage of SV123 out of spec (ISO QM SV123)", "Test",Closed,"Cat4","Part", 06-APR-04,Pre Integration Test	C	ISO valve measurement results OOS	None New Herschel valves on PFM
HP-151000-ASED-NC-1319, "I/F CVV to fill./ vent tube of filling port is not He leaktight as req.", "Test",Closed,"Cat4","Module", 02-AUG-05, Cryo Integration Leak Test.	C	Filling port improved leak tightness by gluing I/F. Further I/F investigations to be performed in CW 50/51	YES Pending results of EQM FPA I/F investigation and test.
HP-151000-ASED-NC-1795 EQM Cryo cover temp instability "Test",Open,"Cat4","System", 28-NOV-05, SPIRE EMC Test	Open	EQM Cryo cover flushing circuit configuration to be reviewed and assessed	YES Procedure to be reviewed and assessed

NCR Number and Title	Status	Cause	Effect on PFM
HP-151240-ASED-NC-1415, "The SV121 plug remains not in safety valve position", "Test",Closed,"Cat4","System", 01-AUG-05, EQM PLM Cooldown	C	Use as is after the safety function was provided via connection to the SV 0622/ YO 621-2 line.	YES Same problem on PFM and workaround implemented.

Table 8-1: List of NCR's

9 Major Problems Observed and Consequences for PFM Program

The following table gives an overview of the major problems which have been observed during the instrument EQM level testing. It briefly describes the cause of the problem and provides a proposal how to resolve it for PFM.

9.1 Instrument Hardware and Software

Problem	Cause of Problem	Solution for EQM	Proposed Measures for PFM
Instrument hardware incomplete and not fully tested.	Programmatic reasons.	Late exchange of hardware, use of simulators and ext. power supplies, manual operations, etc.	Delivery of complete and fully tested instrument.
High offset between the orientations of the two FPU alignment devices, high offset between the orientations of the two LOU pentaprism blocks.	Not correctly adjusted/calibrated on unit level.	Averaging between the different orientations.	More precise adjustment/calibration of FPU alignment devices and LOU pentaprism blocks on unit level.
Test procedures partly late and not validated on instrument level.	Programmatic reasons.	On-line update of procedures and work arounds (on-line operation)	Validation of procedures on instrument level, delivery sufficiently prior to test.
Instrument OBSW failures	OBSW not sufficiently mature on delivery.	Work around (manual software uploads, software updates for PACS SPU, HIFI ICU).	Delivery of OBSW being fully debugged and verified on instrument level.

Table 9-1: Instruments Hardware and Software Major Problems Observed and Consequences for PFM Program

9.2 SIH

Problem	Cause of Problem	Solution for EQM	Proposed Measures for PFM
Few cryoharness hardware errors detected during integration.	EICD errors.	Hardware rework or use as is.	Update EICD (ongoing). Verify built standard.
Inconsistencies between EICD and IID-B.	Mistakes in EICD or IID-B.	Use as is.	EICD to be updated. RFW's to be raised. Verification of built standard against data base.

Table 9-1: SIH Major Problems Observed and Consequences for PFM Program

9.3 Cryostat

Problem	Cause of Problem	Solution for EQM	Proposed Measures for PFM
Cryostat helium leakage	Leaks in the filling port interface and leak in the main tank.	Tightening of interface. Evacuation of main tank and heat shield flushing via external dewar.	Verification of filling port leak tightness.
Cover temperature oscillation	Cover flushing oscillation due to long ventline and bad isolation vacuum of the flushing line.	Improving of isolation vacuum.	Optimise cover ventline.
Mass flow not representative	High heat load on L1 and L2 via SIH. SIH is not thermally connected to heat	Use as is.	None. TB/TV test demonstrated that in-orbit

Problem	Cause of Problem	Solution for EQM	Proposed Measures for PFM
	shield and optical bench as for PFM.		mass flow is as predicted.

Table 9-1: Cryostat Major Problems Observed and Consequences for PFM Program

9.4 EMC

Problem	Cause of Problem	Solution for EQM	Proposed Measures for PFM
HIFI radiated susceptibility to E-field 3.9 GHz to 8.1 GHz.	IF signal band. Susceptibility expected from existing analysis.	Use as is. Susceptibility levels have been determined.	Measure actual S/C emission level (by RE test) within relevant frequency band to determine the margin.
SPIRE higher than expected susceptibility on E-field	Not yet known.	Sensitivity measurements. Measurements with re-arranged harness bundles.	Instrument level EMC tests to define susceptibility of units. Reassessment of shielding concept.
PACS radiated susceptibility to H-fields.	Susceptibility expected from existing analysis.	Use as is. Susceptibility levels determined.	Recalculation of RE from solar array. Retest on S/C level with a value between susceptibility and emission level.

Table 9-1: EMC Major Problems Observed and Consequences for PFM Program

9.5 Straylight and Thermal

Problem	Cause of Problem	Solution for EQM	Proposed Measures for PFM
PACS measured background radiation higher than predicted.	Assumed main cause: Prediction did not correctly take into account the cover mirror BRDF.	Use as is. Dedicated test program performed to identify source.	Under investigation.
SPIRE measured background radiation higher than predicted.	Assumed main cause: SPIRE FPU entrance area not blackened (increased field of view).	Use as is. Dedicated test program performed to identify source.	Under investigation.

Table 9-1: Straylight and Thermal Major Problems Observed and Consequences for PFM Program

9.6 EGSE and Database

Problem	Cause of Problem	Solution for EQM	Proposed Measures for PFM
Many HK monitoring false alarms.	Monitoring limit values not properly set. Status of MIB not mature.	Ignore limit messages since too many. Identification of real alarm difficult.	Limit values should be adapted to on-ground environment (TB/TV test environment). 3 different sets for limit values required.
Time reference inconsistency between CCS and IEGSE provoking	CCS uses UTC, I-EGSE expects packet time stamps in TAI.	Use as is.	Select a single time base.

Problem	Cause of Problem	Solution for EQM	Proposed Measures for PFM
misinterpretation of measurement data.			
Test scripts execution on CCS failed.	Test scripts not validated during ILT.	Manual correction of scripts, retest, etc.	Test scripts to be properly validated during ILT.
Difficulties in quick evaluations of EMC effects	QLA partly limited.	Evaluations shifted to post processing.	Optimise QLA.
I-EGSE not configured for use for multiple instrument operation	MIB and bus profile and archiving not settled.	Work around.	Data archiving to be resolved prior to test
Noise and spikes on Cryo SCOE temperature data.	Cause of noise is grounding concept. Cause of spikes is considered to be a software problem.	Use as is.	Connect shield to chassis ground and to update FPGA's.

Table 9-1: EGSE Major Problems Observed and Consequences for PFM Program

10 Conclusion

The EQM test phase which started on May 11, 2005 with the electrical integration tests has been successfully completed on Dec 14, 2005. All planned tests have been carried out. Several additional tests have been performed covering specific requests or for NCR investigations. The specified test objectives have been fulfilled. No items have been identified which would need design changes as regard the interfaces to the instruments (preliminary assessment pending completion of evaluations as regards SPIRE EMC susceptibility and straylight).

The following major results have been achieved.

- The mechanical interfaces properly fit.
- The optical interface (transmission through windows) and the alignment between LOU and FPU could be proven during HIFI IMT. The FPU mixers received LOU signals.
- The thermal interfaces provide proper connection. The required interface temperatures (L0, L1 and L2) could be achieved.
- The electrical interfaces to the PLM EGSE and the connections via the SIH achieved the correct performance.
- The instrument on-ground operation via the CSS and PLM EGSE was successfully validated. The scripts and the MIB were finally working with a limited number of workarounds being implemented.
- Instrument function and performance within the PLM was validated, with the limitations of the EQM built standard.
- The instrument compatibility to H- and E-fields could be demonstrated; in case of detected susceptibilities the threshold levels could be identified.
- The cryo operations using the EQM cryostat as "test bed" were successfully performed. Arising problems could be recovered by appropriate workarounds.

The following points were observed which need to be resolved for PFM (lessons learnt)

- Procedures, scripts and MIB errors. For PFM properly and timely prepared procedures are required. Procedures, scripts and MIB shall be validated on instrument level. Limit values shall be adapted to on-ground conditions.
- Instrument software problems. For PFM the instruments software shall be properly debugged and tested on instrument level prior to delivery.
- Instrument hardware failures (PACS DPU and SPUL, PACS grating, HIFI WBS, etc). For PFM the instrument hardware shall be properly and sufficiently tested on instrument level, as required. Tests which can be done on instrument level shall not be shifted to PLM level.
- High sensibility of PACS and SPIRE 300 mK hardware to helium atmosphere. For PFM any potential helium leakage (filling port) must be excluded.

- High mass flow was necessary to achieve the required interface temperatures, mainly because of the heat load from the "warm" CVV via the SIH onto the FPU's. Note: For EQM the SIH was not thermally connected to the heat shield as is the case for PFM.
- Higher than predicted straylight levels, assumed mainly due to incorrect modelling of the cryo cover mirror (PACS) and the not blackened FPU entrance area (SPIRE). Evaluation is still ongoing (potential impact on PFM).
- Unexpected high E-field susceptibility of SPIRE. Investigation is still ongoing (potential impact on PFM). For HIFI and PACS no unexpected EMI behaviour. The already known susceptibilities to E-field (HIFI) and H-field (PACS) could be confirmed.

E N D O F D O C U M E N T

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	Barlage Bernhard	AED11	x	Schlosser Christian	OTN/AOA54
	Bayer Thomas	AOA52		Schmidt Rudolf	FAE22
	Brune Holger	AOA55		Schweickert Gunn	AOE22
	Fehringer Alexander	AOE13		Sonn Nico	AOE51
x	Fricke Wolfgang Dr.	AED 65		Steininger Eric	AED32
	Geiger Hermann	AOA52		Stritter Rene	AED11
	Gerner Willi	AED11		Suess Rudi	AOA54
	Grasl Andreas	OTN/AOA54		Thörmer Klaus-Horst Dr.	OTN/AED65
	Grasshoff Brigitte	AET12		Wagner Klaus	AOE22
	Hauser Armin	AOE22	x	Wietbrock Walter	AET12
x	Hendry David	Terma Resid.		Wöhler Hans	AOE22
	Hengstler Reinhold	AOA 5		Wössner Ulrich	ASE442
	Hinger Jürgen	AOE22	x	Alcatel	ASP
	Hofmann Rolf	ASE442	x	ESA/ESTEC	ESA
x	Hohn Rüdiger	AED65		**Instruments:**	
	Hölzle Edgar Dr.	AED44	x	MPE (PACS)	MPE
	Huber Johann	AOA52	x	RAL (SPIRE)	RAL
	Hund Walter	ASE442	x	SRON (HIFI)	SRON
x	Idler Siegmund	AED312		**Subcontractors:**	
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	Ivády von András	FAE22		Air Liquide, Space Department	AIRS
	Jahn Gerd Dr.	AOE22		Air Liquide, Orbital System	AIRT
	Kalde Clemens	APE3		Alcatel Bell Space	ABSP
	Kameter Rudolf	OTN/AOA54		Astrium Sub-Subsyst. & Equipment	ASSE
	Kettner Bernhard	AET42		Austrian Aerospace	AAE
	Knoblauch August	AET32		Austrian Aerospace	AAEM
	Koelle Markus	AOA53		APCO Technologies S. A.	APCO
	Koppe Axel	AED312		Bieri Engineering B. V.	BIER
x	Kroeker Jürgen	AED65		BOC Edwards	BOCE
	Kunz Oliver Dr.	AOE22		Dutch Space Solar Arrays	DSSA
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	Platzer Wilhelm	AED22		Rembe, Brilon	REMB
	Reichle Konrad	AOA52		Rosemount Aerospace GmbH	ROSE
	Reuß Friedhelm	AED62		RYMSA, Radiación y Microondas	RYM
	Rühe Wolfgang	AED6		SENER Ingenieria SA	SEN
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