Title: **Satellite AIT Plan**
Part 2: EPLM & S/C-PFM Acceptance Phase

CI-No: **120.000**

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Issue	Date	Sheet	Description of Change	Release
1	30.5.02		first issue	
2	15.4.04		complete update for CDR - update of AIT flow to reflect modified model and test philosophy - update of AIT schedule - more detailed information about GSE used - update and rearrangement of activity sheets following the AIT flow	
2.1	10.09.04	11, 12, 38, 39, 40, 52, 57, 60, 81, 82, 108, 123, 124, 125, 134	Changes as requested during the H-EPLM CDR (ref. to RID-numbers 11047, 10993, 11210, 11216, 11221, 11223 and 11353): - SVM AIT plan as new reference document - additional task sheet for bake-out - changes according EMC test philosophy discussed during HAIV panel - MIP, KIP, TRR: TRRs will be hold instead of the deleted MIPs or KIPs. As expressed in chapter 6.3.2 test readiness reviews will be held before each test. A dedicated list of TRRs is not needed and will therefore not be provided. KIP F2 has been changed to MIP F2 - SVM specific safety aspects implemented as given in SVM AIT plan - change STRA integration according SVM AIT plan	
2.2	01.03.05		Changes as requested during System CDR (ref. to RID DAIV-1115) and changes due to project progress: - § 1.1: AIT schedule removed from AIT plan - § 3: no cryogenic qualification in EQM program - fig. 3-1 & fig. 3-2: adaptation of the AIT flow to the agreed test configuration - § 4.1.1: editorial - tab. 4-1: update of thermal requirements of instruments	

Issue	Date	Sheet	Description of Change	Release
			- § 4.1.2: no BOLA - § 4.1.4: correction of HSS and Telescope built standard - $ 5.1.8.1: no alignment verification on EQM - § 5.1.9.1: refer to STM phase instead of EQM phase - § 5.1.9.2: refer to STM phase instead of EQM phase - § 5.1.10: editorial - fig. 5-2: updated - fig. 5-3 … fig 5.5 updated according scenario 4 - § 5.3.1: updated according to scenrario 4 agreements - § 5.3.2: updated according to scenrario 4 agreements - § 5.4: updated according to scenrario 4 agreements - § 5.4.2.4: updated according inputs taken from ASP document - § 5.4.2.5: updated according internal review - § 5.4.2.6: updated according agreements in TB/TV test preparation - § 5.4.2.7: EMC test updated according CDR agreements - § 6.1: reviews will be organised by PA - § 6.2: updated according new ASED organisation - § 6.4.3: editorial - § 10: deleted in favour of up to date schedule reports - § A 1,2: editorial changes - § A 1.2: table reworked according scenario 4 - additional task F.020.065: “disconnection of WUs from FPUs” - delete tasks F.030.010 and F.030.020 according to scenario 4 - tasks F.040.050 and F.040.060 moved to F.050.005 and F.050.006 according to scenario 4 - PLM / SVM Mating moved from F.070.010 … 030 to F.045.000 according to scenario 4 - New task sheet F.070.090 for satellite completion - IST 1 moved from F.080.000 to F.050.060 and	

Issue	Date	Sheet	Description of Change	Release
			combined with IMT according to scenario 4 - F.110.080 and F.110.090, SFT and alignment after vibration, removed according to scenario 4 - Facility changed in task sheets for PLM and satellite integration from Astrium to ESTEC according to scenario 4 - Editorial changes in the task sheets	

Table of Content

List of Figures

List of Tables

Abbreviations (complete list see RD 02)

ABCL	As Built Configuration List
ACMS	Attitude Control and Monitoring Subsystem
ACR	AIT Change Request
AIT	Assembly, Integration and Test
AIV	Assembly, Integration and Verification
AN	Acoustic Noise
~~BOLA~~	~~Bolometer Amplifier Unit~~
CB	Cryostat Baffle
CC	Cryostat Cover
CCH	Cryo-Control Harness
CCP	Contamination Control Plan
CCS	Central Checkout System
CCU	Cryostat Control Unit
CE	Conducted Emission
CFE	Customer Furnished Equipment
CFRP	Carbon Fibre Reinforced Plastic
CIDL	Configuration Item Data List
COG	Centre of Gravity
CR	Change Request
CR	Cleanroom
CS	Conducted Susceptibility
CVSE	Cryogenic and Vacuum Servicing Equipment
CVV	Cryostat Vacuum Vessel
DDP	Design and Development Plan
DRB	Delivery Review Board
EGSE	Electrical Ground Support Equipment
EMC	Electromagnetic Compatibility
EPLM	Extended Payload Module
EQM	Engineering Qualification Model
ESD	Electrostatic Discharge
FM	Flight Model
FN	Friedrichshafen, Astrium Site in Germany
FPU	Focal Plane Units
GHe	Gaseous Helium
GSE	Ground Support Equipment
HOT	He-I Tank
HSS	Herschel Solar array/Sunshade
HTT	He-II Tank
ICD	Interface Control Document/Drawing
IMT	Integrated Module Test
ISO	Infrared Space Observatory
IST	Integrated System Test
KIP	Key Inspection Point
LOU	Local Oscillator Unit
LVA	Launch Vehicle Adapter
MD	Mass Dummy
MGSE	Mechanical Ground Support Equipment
MIP	Mandatory Inspection Point
MLI	Multi Layer Insulation
MPT	Multi Purpose Trolley
MTD	Mass & Thermal Dummy = STM Equipm.
NA	Not Applicable
NCR	Non Conformance Report
OBA	Optical Bench Assembly
OGSE	Optical Ground Support Equipment
OSR	Optical Surface Reflectors
OTN	Ottobrunn, Astrium Site in Germany
PA	Product Assurance
PFM	Protoflight Model
PLM	Payload Module
PTR	Post Test Review
PVA	Photo-voltaic assembly
QA	Quality Assurance
RE	Radiated Emission
RS	Radiated Susceptibility
S/S	Subsystem
SCOE	Special Checkout Equipment
SFPT	System Functional Performance Test
SFT	Short Functional Test
SFW	Spatial Framework
SIH	Scientific Instrument Harness
STM	Structural and Thermal Model
STR	Star Tracker
SVM	Service Module
SVT	System Validation Test
TB	Thermal Balance
TD	Thermal Dummy
TGSE	Tanking Ground Support Equipment
TMM	Thermal Mathematical Model
TSMU	Transport Stimuli & Monitoring Unit
TRR	Test Readiness Review
TTA	Thermal Test Adapter
TV	Thermal Vacuum
VPP	Verification Program Plan
WU	Warm Unit

1 INTRODUCTION

The Herschel Satellite AIT programme is divided into two main consecutive sections:

- the STM qualification phase where basically the satellite will be thermally and structurally qualified
- the PFM acceptance phase where the satellite functional and EMC qualification will be completed as well as the acceptance for flight

Major elements of the PFM EPLM, i.e. the cryostat, consisting of Cryostat Vacuum Vessel (CVV), thermal ~~radiation~~ shields, He-II tank (HTT), He-I tank (HOT), and optical bench assembly (OBA), will be used for both sections.

This 2nd part of the AIT Plan describes the assembly, integration and qualification test activities to be performed by Astrium GmbH as payload module and satellite AIT contractor on

- the refurbishment and upgrade of the PFM EPLM with FM instruments (FPUs, JFETs and LOU) and Solar array &~~,~~ Sunshade and
- the final integration of the PFM satellite with PFM SVM (incl. instrument WUs and CCU) and Telescope and
- the subsequent satellite level tests for completion of qualification and flight acceptance

The first EPLM integration and subsequent Satellite STM qualification campaign are described in the 1st part of the AIT plan, see RD 05.

The PLM EQM AIT programme is also described in a separate document, RD 04.

Details about the Herschel payload and satellite model philosophy can be found in chapter 3 below.

1.1 OBJECTIVE

The objective of this second part of the AIT plan is to define:

- a PLM and satellite level integration and acceptance test programme in accordance with the system level AIV/AIT requirements per AD 02
- the relevant organisation, necessary to carry out all tasks of the AIT programme
- the definition and utilisation of GSE and facilities dedicated to this programme
- the required integration/test documentation
- the integration and test sequences
- detailed test steps and operations to be performed within the identified sequence
- the general company rules, PA and safety procedures to be followed throughout the AIT activities
- ~~the AIT programme schedule and the major milestones like MIP, KIP, TRR, PTR~~
- major handling and transportation activities

2 DOCUMENTS

2.1 APPLICABLE DOCUMENTS

The following documents of issue as valid at the issue date of this document, if not otherwise stated below, form a part of this plan and are applicable to the extent specified in the text of this plan.

AD #	Document Title	Document Identifier
AD 01	HERSCHEL/PLANCK Verification Programme Plan (VPP)	HP-1-ASPI-PL-0225
AD 02	HERSCHEL EPLM AIV and HERSCHEL Satellite AIT Requirements Specification	HP-1-ASPI-SP-0008
AD 03	H-EPLM Requirements Specification	HP-2-ASP-SP-0250
AD 04	EMC Requirements Specification	HP-1-ASPI-SP-0037
AD 05	Contamination Control Plan	HP-2-ASED-PL-0023
AD 06	PA Plan	HP-2-ASED-PL-0007
AD 07	Herschel/Plank DDP	HP-1-ASPI-PL-0009
AD 08	Instrument Interface Document IID – part B, HIFI	SCI-PT-IIDB/HIFI-02125
AD 09	Instrument Interface Document IID – part B, PACS	SCI-PT-IIDB/PACS-02126
AD 10	Instrument Interface Document IID – part B, SPIRE	SCI-PT-IIDB/SPIRE-02124
AD 11	HERSCHEL EPLM Verification Programme Plan	HP-2-ASED-PL-0033
AD 12	Herschel/Planck System Requirement Specification	SCI-PT-RS-05991
AD 13	Instrument Interface Document IID- part A	SCI-PT-IIDA-04624

2.2 REFERENCE DOCUMENTS

RD #	Document Title	Document Identifier
RD 01	Facility and Transportation Plan	HP-2-ASED-PL-0014
RD 02	List of Acronyms	HP-1-ASPI-LI-0077
RD 03	Alignment Method, Plan and Results	HP-2-ASED-TN-0097
RD 04	Herschel PLM/EQM AIT Plan	HP-2-ASED-PL-0022
RD 05	Herschel Satellite AIT Plan, Part 1: STM Satellite Qualification Phase	HP-2 ASED-PL-0025
RD 06	EGSE General Requirement Specification	HP-1-ASPI-SP-0045
RD 07	HERSCHEL MGSE Requirement Specification	HP-2-ASED-SP-0019
RD 08	HERSCHEL CVSE Requirement Specification	HP-2-ASED-SP-0012
RD 09	Handling and Transportation during Qualification Test Phase Technical Note	HP-2-ASED-TN0024

RD #	Document Title	Document Identifier
RD 10	Instrument Testing on PLM and Satellite PFM level	HP-2-ASED-PL-0031
RD 11	Herschel Product/Configuration Item Tree	HP-2-ASED-PT-0001
RD 12	CVSE Setup Description	HP-2-ASED-TN-0094
RD 13	Helium Subsystem Specification	HP-2-ASED-SP-0015
RD 14	Herschel/Planck Service Module AIT Plan	HP-4-AI-PL-0004

3 MODEL PHILOSOPHY

The Herschel Satellite AIT sequence and planning is based on the following satellite models:

- a Structural and Thermal Model (STM) for structural and thermal qualification
- a Proto-flight Model (PFM) for qualification completion and final flight acceptance

These models are completed by the following PLM models:

- an Engineering Qualification Model (EQM) for instrument compatibility tests in a Herschel PLM representative ~~cryogenic qualification of the PLM~~environment based on the ISO QM, of which the AIT programme is defined in RD 04.
- a Proto-Flight Model (PFM) of the PLM (together with ~~STM/MTDs~~thermal and/or mechanical dummies of instruments, telescope, solar array and sunshade to be used in the Satellite STM test campaign and, after refurbishment and replacement of STM/MTD equipment by PFM units, for the Herschel PFM Satellite

These models are completed by the following SVM models

- a Structural and Thermal Model of the SVM to be used in the Satellite STM test campaign
- a Proto-Flight Model of the SVM to be used for the PFM Satellite

The main objectives of each model are given hereafter:

- Satellite STM:
  - development & qualification model for structure lay-out and certification
  - development & qualification model for thermal control certification (on EPLM level)
  - confirmation of mechanical and thermal environment at satellite level before satellite flight model testing.
- Satellite PFM
  - qualification completion in areas where this qualification has not been completely achieved with the other models
  - acceptance for flight.
- PLM EQM
  - development model for instrument compatibility, functional and EMC tests at cryogenic temperature.
- PLM PFM
  - Thermal qualification on EPLM STM, mechanical qualification at Satellite STM level
  - qualification completion at PLM and satellite level in areas where this qualification has not been completely achieved with the other models
  - acceptance on PLM and satellite level for flight.

For illustration of how the different models come together during AIT sequence a simplified PLM and Satellite STM and PFM AIT flow is shown in the following figures, together with reference to the respective part of the AIT plan. The associated schedule is presented in chapter 10.

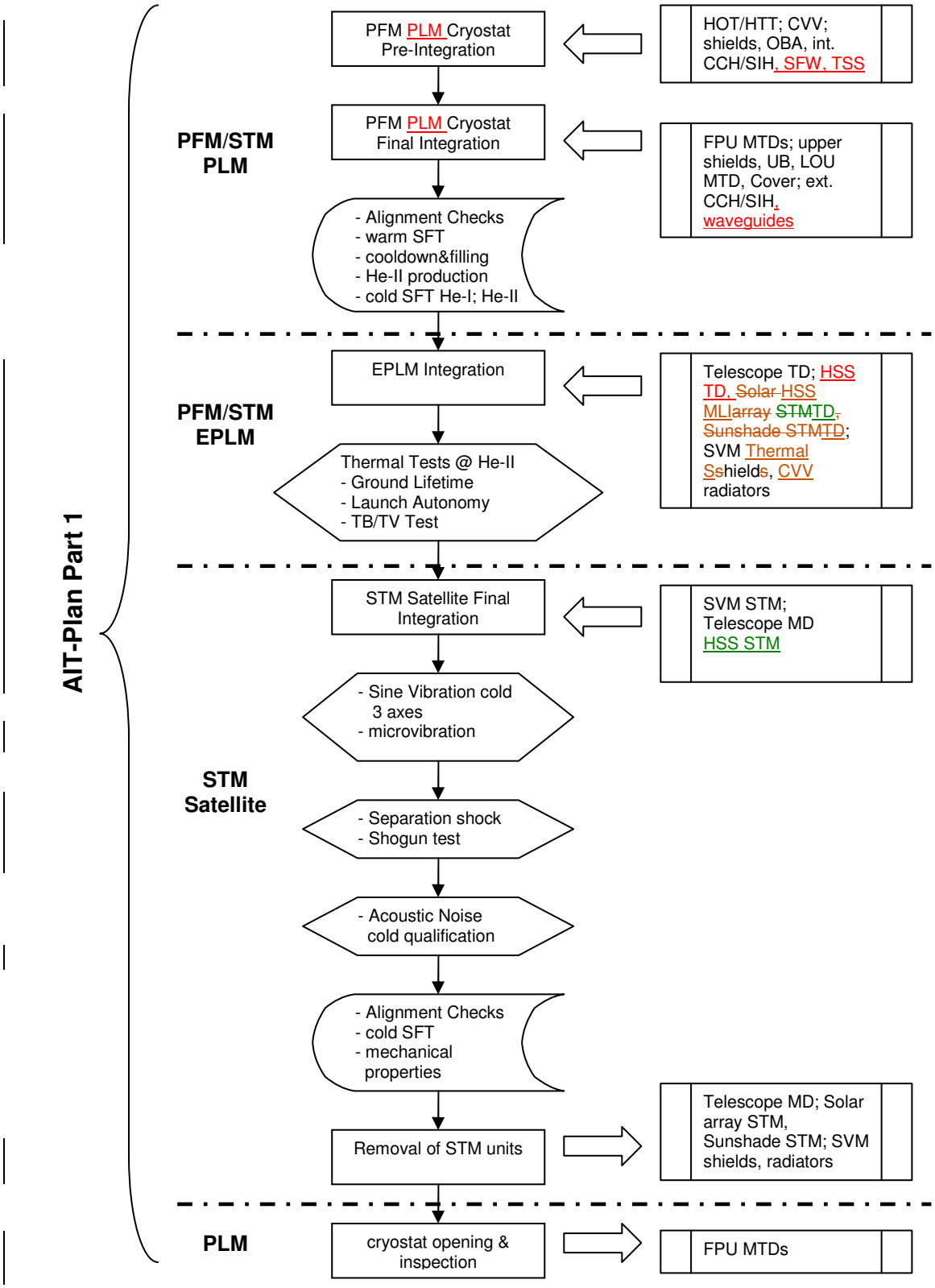


Fig. 3-1: Simplified PLM and Satellite STM AIT Flow

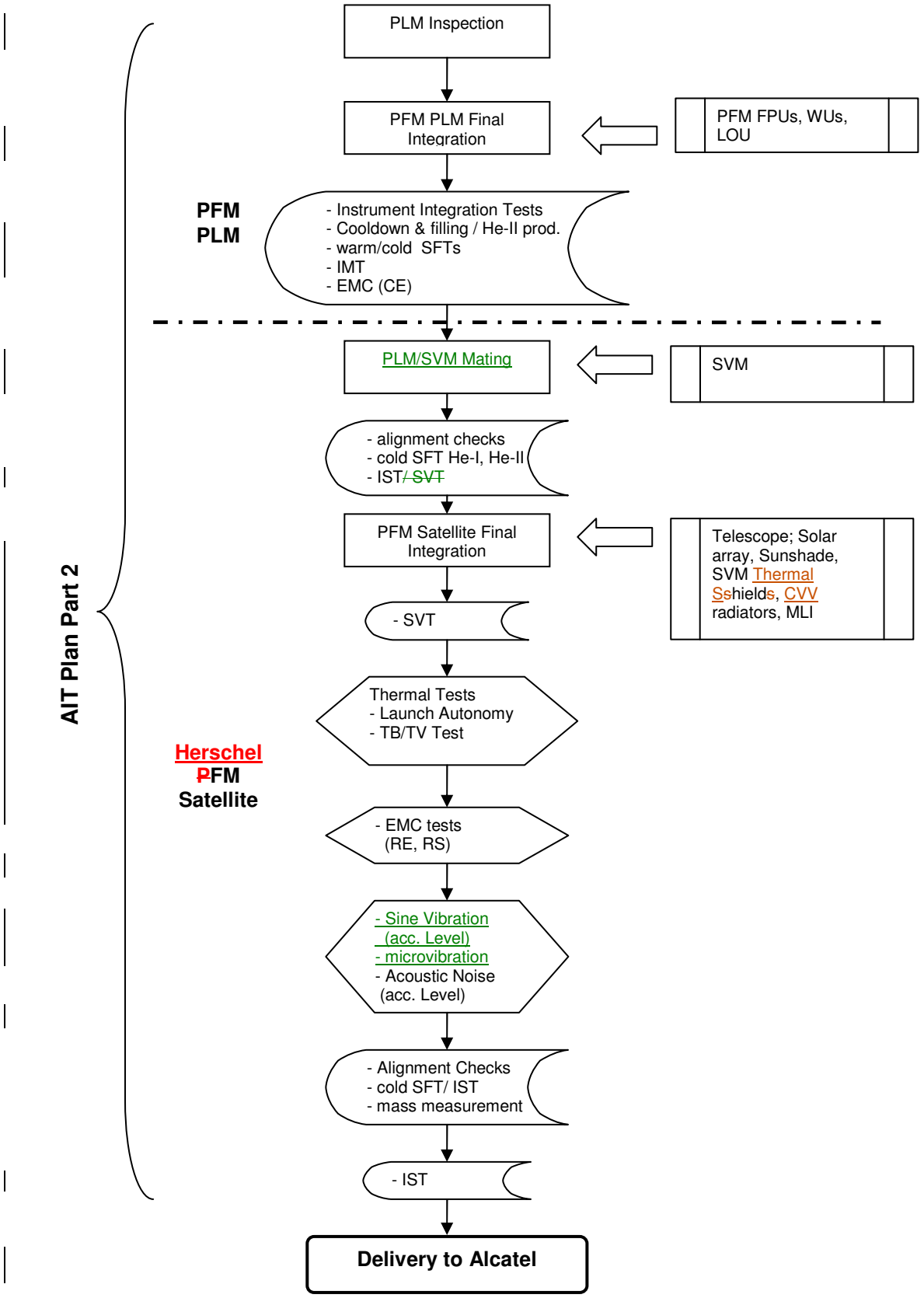


Fig. 3-2: Simplified PLM and Satellite PFM AIT Flow

4 CONFIGURATION AND DESIGN DESCRIPTION

4.1 EXTENDED PAYLOAD MODULE

4.1.1 EPLM OVERALL CONFIGURATION

The main parts of the EPLM are the:

- Cryostat with CVV, thermal shields, ~~He-I~~Helium One Tank (HOT), ~~He-II tank~~Helium Two Tank (HTT) and Optical Bench Assembly (OBA)
- The scientific instruments inside and outside the cryostat (incl. LOU Radiator and Waveguides)
- CCU and instrument warm units inside the SVM
- 3.5 m Telescope with its support structure
- Solar Array and Sunshade
~~with sunshield~~
~~Sunshade~~
- PLM/SVM interface ~~structure~~ structure
- SVM Thermal Shield
- Scientific and Cryo Control Harness (SIH and CCH)

The following figure gives an overview on the EPLM configuration.

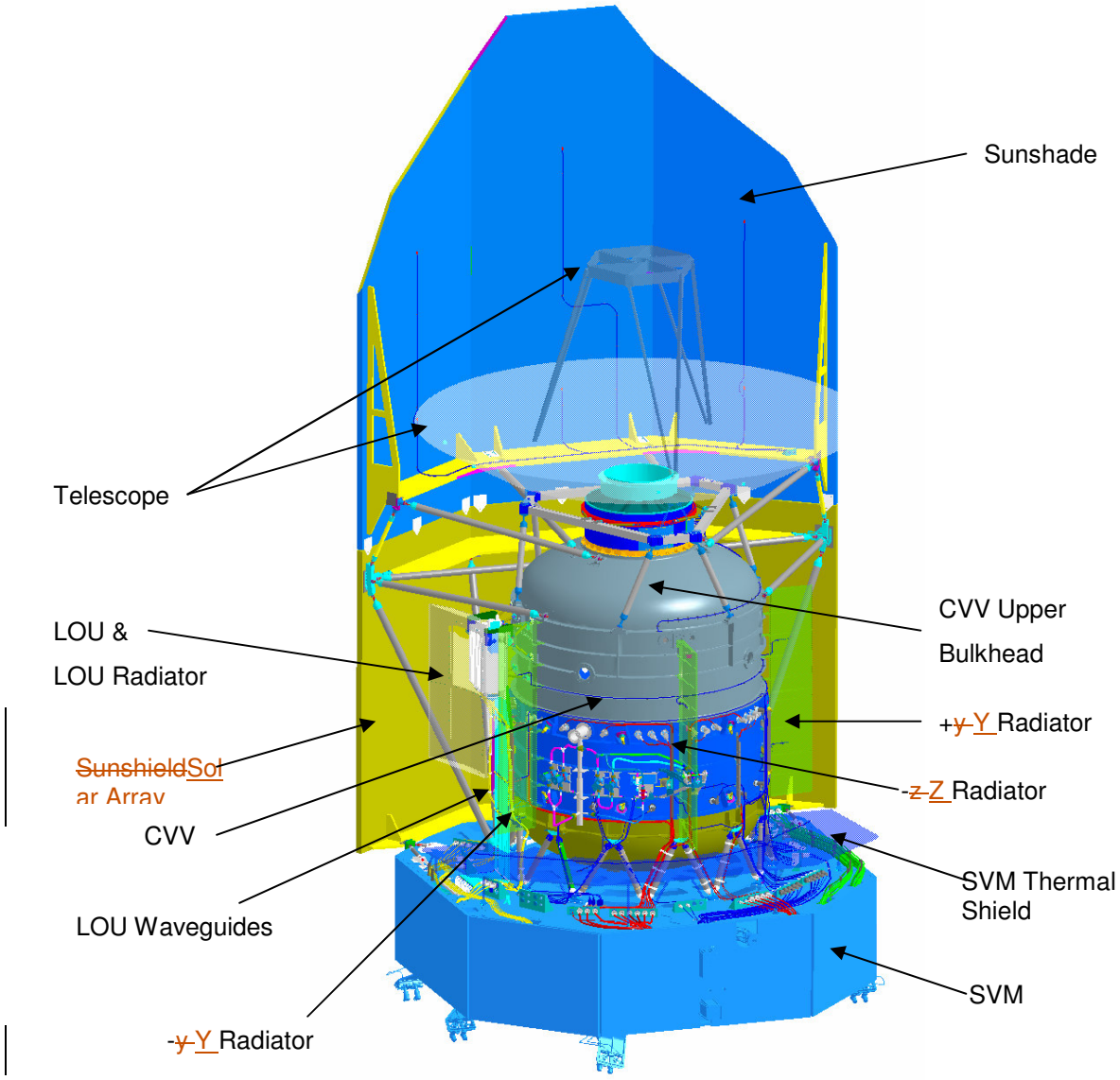


Fig. 4-1: EPLM External View

The EPLM is mounted on top of the SVM via 24 GFRP-struts.

On the outside of the Cryostat Vacuum Vessel (CVV) the Local Oscillator Unit (LOU) as part of the HIFI instrument ~~HIFI~~ is installed. The –Z side~~rear~~ of the CVV is used as a radiator to space and is ~~therefore~~ equipped with 3 additional radiators (±Y and –Z Radiator~~nose~~) to improve the radiator performance.

The two individual units Sunshade and Solar ~~array~~ Array are bolted together to form one integral unit. This composed unit requires no frame for lateral stability and is supported via a set of lateral and vertical struts to the CVV and the SVM.

The Sunshade unit consists of 3 different sub panels. The individual panel shape is generated by the Ariane 5 Fairing dimensions, and to provide full Telescope shadowing.

The panels are bonded together by the use of additional doublers and are attached to the Solar ~~array~~ Array via bolts and brackets to allow separate production and verification. The front of the Sunshade is covered with OSRs.

The Solar ~~array~~ Array consists of 3 unique panels of 2.5m x 1.6m each carrying the solar array assembly.

The integrated Solar A~~a~~rray/Sunshade assembly is~~re~~ supported by means of GFRP struts ~~made of GFRP and are~~ connected to the cryostat and by CFRP~~. The lower~~ struts ~~are~~ directly connected to the SVM. The whole rear area of the unit is covered with ~~high-efficient~~ MLI.

The Telescope is mounted upon the CVV on 3 CFRP bipods.

The CVV provides the vacuum for the He S/S and the instruments on ground. A cover closes it during ground operations and launch.

The segmented He-II main tank (HTT) is arranged inside the cryostat. The tank equipment (valves, phase separator, safety devices, sensors, heaters etc.) are similar to the ISO PLM equipment. 16 tank support straps, which are connected to the Upper and Lower Spatial Framework, suspend the tank. The tank support straps consist each of 4 GFRP and 2 CFRP chain loops. Steel bolts, which also act as thermal anchors connect them, and mechanical support of the three GHe cooled thermal radiation shields. The tank support straps are pre-tensioned by 16 tank support strap tensioning devices on the outside of the CVV.

A lens-shaped auxiliary LHe (He-I) tank (HOT) for launch autonomy cooling is mounted to the lower spatial framework.

The Optical Bench, which supports the scientific instruments, is mounted on top of the upper spatial framework. A common instrument protection shield surrounds the instruments on the Optical Bench. To provide the cooling level 0 of the instruments, they are connected via straps directly to the He-II tank. The He vent gas leaving the He-II tank is used for the provision of cooling levels 1, 2, and 3 (Spire only) of the instruments (by connection to the ventline surrounding the instruments) and is then used for cooling of the three cryostat ~~radiation~~ thermal shields. On top of the cryostat a baffle is mounted to suppress stray~~-~~light incidence.

The thermal requirements for the three different levels as taken from AD 13 are compiled in the table below.

	Max. I/F Temp. @ max. Heat Load			Description
	HIFI	**PACS**	**SPIRE**	
Level 0	2 K @ 6.8 mW stability: 6 mK/100s	1.75 K @ 0,8 mW 2 K @ 2 mW 5 K @ 2 mW 10K @ 500 mW peak	2 K @ 4 mW (1.71 K @ 1 mW goal) 2 K @ 2 mW 10K @ 500 mW peak 1.85 K @ 15 mW (1.75 K @ 15 mW goal)	Thermal Interface to the He-II tank Sorption coolers pump & evaporator, PACS red & blue photo-detectors, SPIRE detector enclosure, HIFI mixers
Level 1	~~0 K ...~~ 6 K @ 15.5 mW stability: 6 mK/100s	5 K @ ~~10~~ 30 mW	~~3.7~~5.5 K @ ~~13~~ 15 mW (3.7 K @ 13 mW goal)	First thermal interface to the He-II vent-lines. PACS and SPIRE FPU enclosure. FIFI mixer (4K box)
Level 2	~~0 K ...~~ 20 K @ 22 mW stability: 15 mK/100s	12 K @ no load	~~8~~ 12 K @ no load (8 K @ no load goal) 16 K @ no load	Level 2 vent line is bolted to the Optical bench. HIFI FPU enclosure. PACS & SPIRE insulated by carbon fivre compound feet
Level 3	n.a.	n.a	15 K @ 25 mW 15 K @ 50 mW	Level 3 added for SPIRE JFET boxes (P&S), now thermally insulated from OBA, to allow a reduction of the temperature of the Optical Bench

Tab. 4-1: Thermal Requirements of FPUs as taken from IID-B's

An internal view of the cryostat is given in Fig. 4-2.

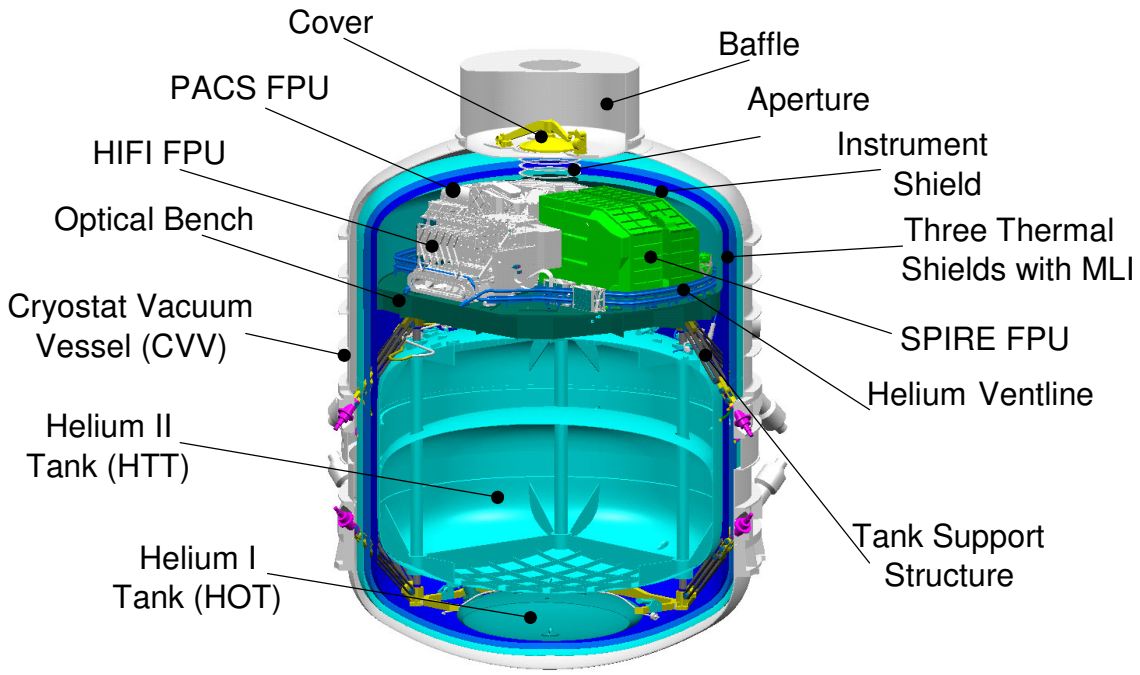


Fig. 4-2: Inner View of Herschel PLM Cryostat

4.1.2 EPLM SUBSYSTEMS

The **PLM** consists of the following subsystems

- Cryostat Structure Subsystem
- Cryostat Helium Subsystem
- Cryostat Insulation Subsystem
- Cryostat Electrical Subsystem
- Instrument Secondary Structure
- Instrument FPUs and ~~WUs (~~LOU~~ & BOLA)~~ mounted on CVV

The **EPLM** is completed by

- Solar Array/Sunshade (HSS)
- Telescope
- SVM Thermal Shield
- remaining Instrument WUs mounted on SVM panels

together with their corresponding support structure

The main components of these **EPLM Subsystems** are:

- Cryostat Structure S/S
  - Cryostat Vacuum Vessel (CVV) with three radiators, Cryostat Cover and Entrance Baffle, Tank Support and Spatial Framework, Optical Bench for instrument FPUs incl. Instrument Thermal Connectors (cooling straps), Optical Feedthroughs,
- Cryostat Helium S/S:
  - He-II tank, He-I tank, Liquid Helium Valves, Helium System Tubing, other Helium System Equipment, (passive phase separator, DLCM; safety valves)
- Cryostat Insulation S/S:
  - Cylinder Thermal Shields, Lower and Upper Bulkhead Thermal Shields, Optical Bench and Beam Pattern Shield, Cryostat MLI
- Cryostat Electrical S/S:
  - Cryostat Control Unit, Cryostat Control Instrumentation, Cryostat Control Harness; scientific instrument harness
- Scientific Instruments (CFE)
  - HIFI, PACS & SPIRE Focal Plane Units, ~~BOLA,~~ LOU, Instrument WUs
- Instrument Secondary Structure:
  - LOU Support Structure, Optical Windows and associated Support Frame, LOU Waveguide Mounting Structure, and CVV & Optical Bench Alignment References
- Solar Array/Sunshade
  - Solar Array/Sunshade Structure, Solar Array Photo-Voltaic Assembly (PVA), MLI, Sunshade radiator; Support Structure
- Telescope
  - Telescope, Telescope Support Structure, Alignment references
- SVM Thermal Shield~~s~~
  - Thermal Shield~~s~~, Support Structure, MLI

4.1.3 EPLM FUNCTIONAL DESCRIPTION

The overall function of the EPLM is to provide a suitable environment for the scientific instruments and the telescope on ground, during launch and in orbit, for the required lifetime.

The cryostat structure S/S comprises mainly the CVV and OB and provides the mounting base for the scientific instruments, the telescope and the solar array/sunshade. It supports the He S/S (He-II tank, ventline), the Insulation S/S (radiation shields and MLI) and the instrumentation and harness of the Electrical S/S. The CVV provides the insulation vacuum for the He S/S during ground operations and early phase after launch. It is equipped with a cryostat cover which is opened in orbit to provide the instruments with the telescope beam.

The Cryostat Helium S/S provides the cooling of the scientific instruments inside the CVV on ground, during launch and in orbit. The He-II tank is the reservoir that provides the cooling over the lifetime of the H-PLM in orbit and for ground testing. The He-I tank is used as a cooling reservoir during launch preparation for launch autonomy.

The Cryostat Insulation S/S (radiation shields and MLI) enables the cryostat to provide the required temperatures and the lifetime. It protects the CVV from external radiative heat input (e.g. from SVM and Solar array) and the He-II tank from radiative heat input from the CVV.

The Cryostat Control Unit, Instrumentation and the Cryostat Control Harness of the Cryostat Electrical S/S enable the proper function of the cryostat on ground, during launch and in orbit (housekeeping data). The scientific instrument harness provides the electrical connection between the instrument cold units inside the cryostat and the instrument warm units outside the cryostat and in the SVM.

The Solar array/Sunshade ~~shadow~~shadows the Cryostat and the Telescope from sun illumination. The solar generator provides the electrical power for operation of the satellite.

The SVM Thermal S~~s~~hield shadows the CVV radiator area from the warm SVM MLI and reflects heat to space via the so called ~~v~~V-groove effect.

A flow schematic of the PLM Helium Subsystem is presented in the following figure.

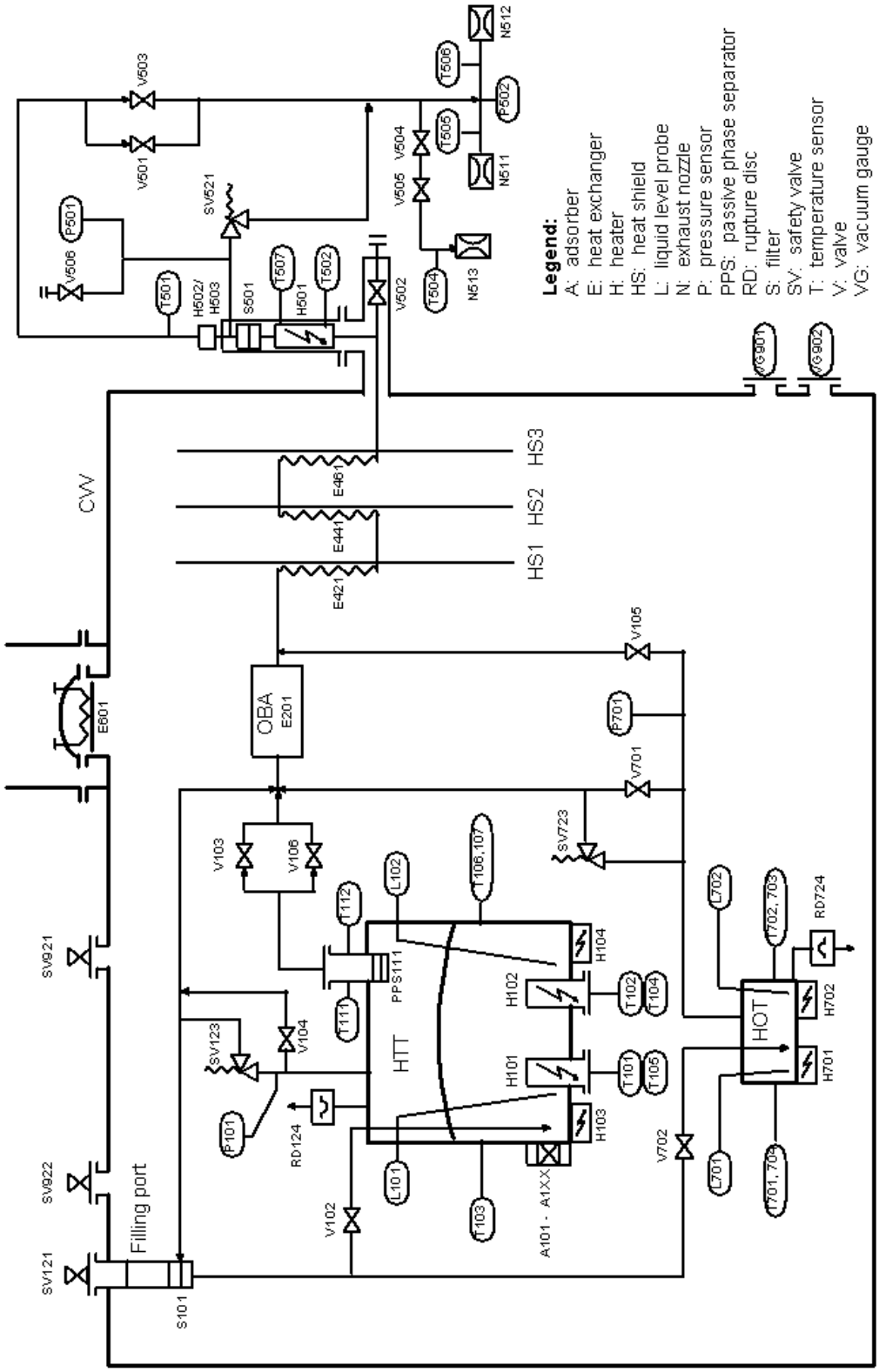


Fig. 4-3: Helium Subsystem Flow Schematic

4.1.4 EPLM FOR STM SATELLITE QUALIFICATION TEST PHASE

For the first PLM/EPLM test sequence and the subsequent STM satellite qualification test sequence the ~~configuration~~ built standard of the elements is as listed below.

- Cryostat	PFM
~~- CCU~~	~~STM~~
- Scientific Instruments (FPU & LOU)	STM (=MTDs)
- LOU Radiator	PFM
- Sunshade, Solar array	Thermal Dummy / STM
- Telescope	~~STM (~~Mass Dummy/ Thermal Dummy~~)~~
- SVM Thermal Shield~~s~~	PFM ~~(tbc)~~

4.1.5 EPLM FOR PFM SATELLITE ACCEPTANCE TEST PHASE

After completion of the STM qualification test sequence the STM/MTD type units and subsystems are removed and replaced by PFM respectively FM type units.

4.2 SATELLITE

Fig. 4-4 below provides ~~an~~a HERSCHEL satellite overall view. Two different satellite model configurations can be distinguished:

- STM Satellite for Qualification Test Phase
- PFM Satellite for Acceptance Test Phase

4.2.1 STM SATELLITE FOR QUALIFICATION TEST PHASE

The STM satellite model consists of the EPLM in a configuration as described in chapter 4.1.4 above plus the STM SVM which includes the instrument WU and the CCU.

4.2.2 PFM SATELLITE FOR ACCEPTANCE TEST PHASE

The PFM satellite will basically consist of the EPLM in a configuration as described in chapter 4.1.5 above plus the PFM SVM.

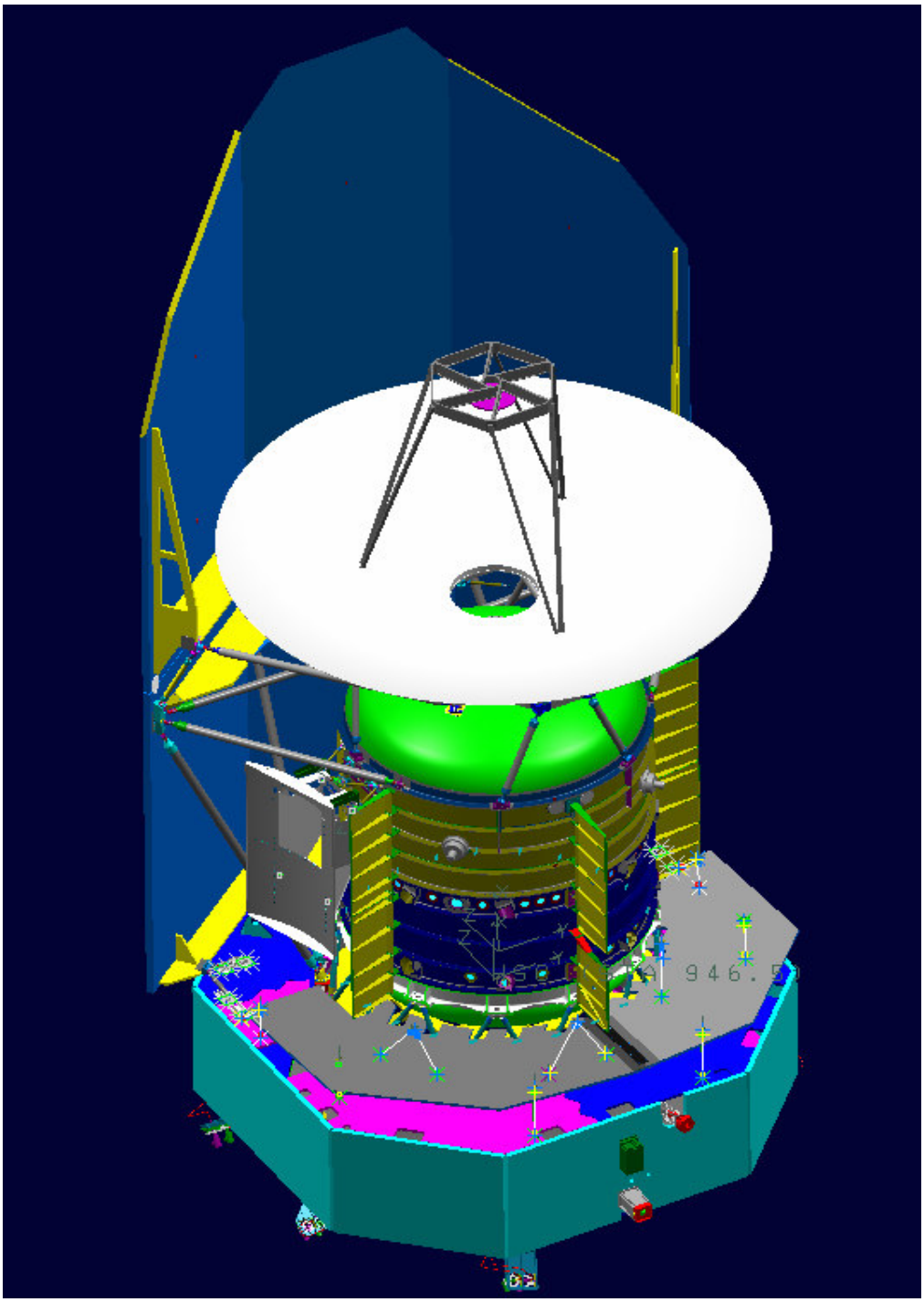


Fig. 4-4: HERSCHEL Satellite Global View

4.2.3 SATELLITE AXIS CONVENTION

The HERSCHEL Satellite reference frame (O, Xs, Ys, Zs), see Fig. 4-4, is a right-handed Cartesian system with:

- its origin O is located at the point of intersection of the longitudinal launcher and the satellite/launcher separation plane; the origin coincides with the centre of the satellite/launcher separation plane
- Positive Xs-axis is oriented towards the target source.; the Xs-axis coincides with the X- axis of the SVM and the launcher. However, the PLM X-axis and the telescope nominal optical axis have an offset of 60 mm (towards -Z) relative to the satellite Xs-axis.
- Zs is in the plane normal to Xs-axis, such that nominally the Sun will lay in the (Xs, Zs) plane (zero Roll angle with respect to Sun). Positive Zs-axis is oriented towards the Sun
- Ys completes the right handed orthogonal reference frame.

4.3 EPLM AND SATELLITE PRODUCT TREE

An overview of the elements of the Herschel EPLM and Satellite and their logical order is presented in the product/configuration item tree, as given in RD 11.

5 INTEGRATION & TEST RULES AND LOGIC

5.1 BASIC INTEGRATION RULES

5.1.1 PRE-INTEGRATION INSPECTION AND H/W RELEASE

Before starting any integration activity an incoming inspection will be performed on each delivered item to control the quality of the hardware to be integrated.

As a minimum, the following controls/measurements will be performed:

- control of data package according to the shipping list
- completeness of H/W according to shipment documentation
- visual inspection (no obvious damage or degradation)
- cleanliness inspection
- conformity of identification markings and serial numbers to the configuration status
- fit check (if possible)
- functional health checks (where appropriate)

Release of hardware for integration will be controlled. Parts required for a particular integration activity will be kited to reflect the requirements of the governing integration procedure and the parts lists prior to the need date.

5.1.2 HARDWARE AS BUILT CONFIGURATION STATUS LIST

Through an official record (ABCL) the hardware “as built status” will be traced during the AIT activities.

The list will include:

- name of hardware
- identity tag number
- drawing references
- integrated hardware part identification and serial number
- integration date

5.1.3 HANDLING

All handling activities of module and system hardware, in the various integration and test facilities will only be carried out using the dedicated MGSE and by trained personnel having the necessary experience.

In particular, overhead cranes will be operated by authorised crane operators.

5.1.4 HARNESS AND WAVEGUIDES INTEGRATION

Harness and waveguides will be handled and installed only by experienced and authorised personnel.

All electrical interfaces will be protected by connector savers during integration, so mating/demating will be made by breaking non flight hardware interfaces. Through an official record, all flight connector mating/demating steps will be traced during the AIT activities. This record shall state:

- unit and harness connectors identification: reference and type
- mating/demating date for:
  - harness connector to saver
  - unit connector to saver
  - harness connector to unit connector (tightening of fixing screws)

Electrical integration of harness will be completed by execution of detailed functional checks/tests. Open ends of the waveguides will be protected by adequate caps.

5.1.5 ELECTRONIC UNITS INTEGRATION

The general approach is a sequential assembling and testing. Each unit shall be reasonable functionally tested within existing constraints as far as possible before further units are added. The philosophy shall allow the identification of problems as clear and early as possible.

After unit mechanical integration and fixing bolt torque, a bonding measurement (or isolation as required) between unit housing and structure reference grounding point will be performed.

Electrical integration of units and subsystems will be completed by execution of detailed functional checks and tests, see below.

In particular, prior to cryostat final closure and evacuation a health check of the FPUs and associated inner harness will be performed with corresponding unit testers.

Precautions and limitations as prescribed by the instrument suppliers will be strictly observed.

The system integration (electrical connection of SVM to PLM) will be performed according to the same principles: electrical interface verification completed by functional checks during and after final connection as explained hereafter.

5.1.6 ELECTRICAL INTERFACE CHECKS

Electrical checks will be automated as far as practicable. This will ensure systematic control of all interfaces of a unit to be integrated. Before and after connection of a harness to its dedicated unit connector, all electrical interfaces will be tested using an Integration Data Acquisition System. The following checks will be performed to verify the electrical interface compatibility, to avoid any degradation of flight units:

- grounding plan verification through grounding measurements at unit and harness connector level
- safety verification of output signals by measurement at emitter unit level in unloaded configuration before harness connection. Such a verification will be restricted to high level signals (power supply – high level commands) and to signals for which a specific measurement is required due to the risk encountered by receiver units
- harness verification by performing the same kind of measurements at harness connector level before connection to the receiver unit
- signal characteristics measurement in loaded configuration (harness connected at emitter and receiver unit level) through break-out boxes and T-adapters

After removal of break-out boxes and T-adapters, final connection of each harness connector and tightening of fixation screws (plus marking where required) will be performed.

5.1.7 FUNCTIONAL CHECKS

Electrical integration of units, instruments and subsystems will be completed by execution of detailed functional tests. Test equipment and procedures will be reused as elements of subsequent SFT, IMT or IST. The environmental test will be accomplished by short functional test at ambient, He-I, or He-II conditions.

Functional checks of integrated units before continuing the next unit integration operations. These kind of functional checks are restricted to the minimum and allow only verifying that the unit can be powered, commanded, and monitored.

5.1.8 ALIGNMENTS

5.1.8.1 ALIGNMENT PLAN

This chapter defines the alignment philosophy and the measurements which will be performed during the various steps of integration and testing with the PFM PLM and Satellite. During the on-ground alignment two constraints must be taken into account:

1. The alignment requirements are valid for in-orbit conditions
2. The alignment requirements are specified for operational conditions, whereas the alignment can only be performed at ambient conditions.

The following environmental conditions will change between on-ground alignment and in-orbit operation:

- Gravity from 1g to zero g
- Atmospheric pressure from 1bar to 0 bar
- Outer CVV temperature

These effects must be determined and have to be pre-compensated by a corresponding offset on-ground. The experience gained with theoretical determination of this offset ~~and its confirmation during testing with EQM PLM~~ will support the PFM PLM activities.

Also the effects due to internal temperature and pressure changes ~~being confirmed during on-ground testing of EQM~~ shall be considered, however, the effect on alignment of outer CVV temperature change can only accurately be verified during TB/TV testing, and the gravity release effect can only be determined theoretically. Restrictions must also be made for the testing of the temperature change.

Alignment of the Herschel elements has to be performed in multiple steps and can be divided in three main areas.

5.1.8.2 PLM ALIGNMENT

The instrument alignments are achieved by multiple measurements during PLM re-integration integration and test

- alignment of optical bench (OB) versus CVV before FPU integration
- alignment measurement of FPUs versus OB after FPU integration
- alignment of LOU versus OB (HIFI) after LOU integration through open cover and/or optical window using a theodolite or the alignment camera
- alignment check HIFI FPU vs. LOU after CVV evacuation (warm) through optical windows
- alignment check HIFI FPU vs. LOU during/after cool down, filling and final adjustment of strap pretension

5.1.8.3 SVM ALIGNMENT

The SVM alignments i.e. ACMS and RCS sensors, actuators, and thrusters are performed by ALENIA during module integration versus a SVM master reference cube.

5.1.8.4 SATELLITE SYSTEM ALIGNMENT

During satellite final integration, the system alignment consists of the following main steps:

- alignment of Startracker (STR) vs. CVV (to be performed by Alenia)
- alignment of telescope versus CVV
- Helium vent nozzles alignment
- measurement of the PLM reference cube vs. SVM reference cube

The STR allignment steps will be done in parallel to the STR integration and SVM mating.

During the various steps of PLM refurbishment and reintegration after STM test completion, PFM satellite integration and testing, these measurements are repeated at appropriate steps, as indicated in chapter 5.2 below.

Alignment verification of the telescope v~~x.~~ersus LOU at CVV low temperatures will be done by videogrammetry during TB/TV tests.

5.1.9 CRYO OPERATIONS

In order to allow instrument testing in the required thermal environment, the cryostat will be cooled down and the tanks filled with LHe. Instrument cool down requirements will be respected.

5.1.9.1 COOLDOWN & FILLING

The cooldown and filling will be performed according dedicated procedures, based on existing and verified ISO documents and Herschel ~~EQM~~ PLM documents, established and verified during the STM phase, ~~and~~ using a CVSE based on the refurbished ISO CVSE units. Constraints to be regarded during cooldown and filling are described in the He S/S specification, RD12.

Cooldown and filling will start after successfully performed leak test of the internal Helium S/S ~~to the cryostat isolation vacuum and isolation vacuum to ambient~~and of the CVV. After filling of the HTT with LHe-I, a cold leak test will be performed.

A cold leak test of the He-S/S has already been performed in the STM phase. The He S/S will not be opened inbetween both phases (e.g. for instrument integration). Therefore and due to the installed adsorbers, a cold leak test is not planned in the PFM phase.

Similar procedures will be used for filling the HOT with He-I. Cooldown and filling will be performed with x-axis in vertical direction only. The principal set-up for cooldown and filling operations is described in detail in the CVSE Setup description (RD 11) and shown in the following figure.

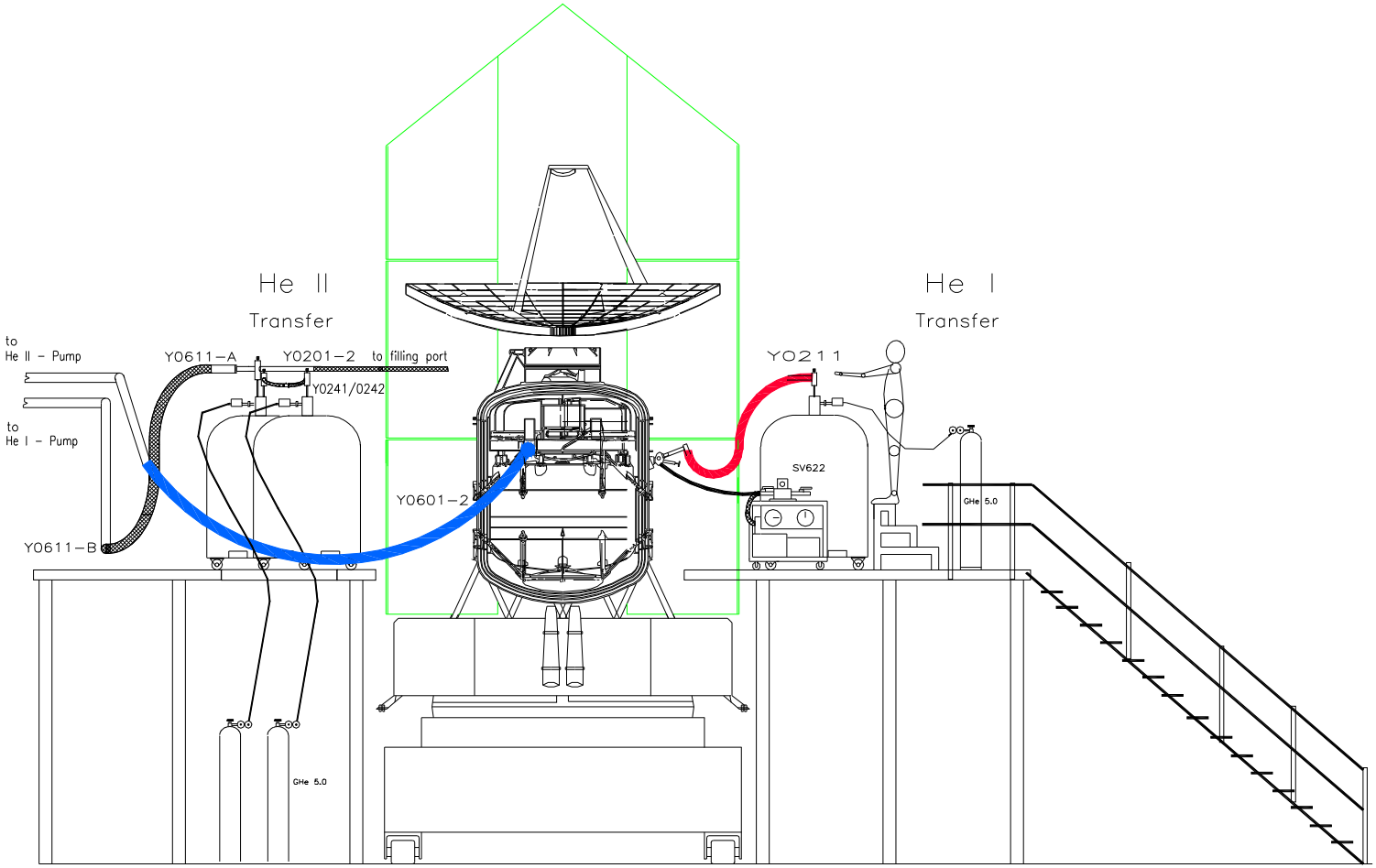


Fig. 5-1: Set-up for cooldown, helium filling (He-I) and He-II production operations

5.1.9.2 HELIUM II PRODUCTION AND TOP-UP

The Helium II production and top up will be performed according dedicated procedures also based on verified ISO and Herschel ~~EQM~~ PLM documents, established and verified during the STM phase, ~~and~~ using the CVSE based on refurbished ISO CVSE units.

He-II production and top up will be performed with x-axis in vertical direction only.

Specific constraints, e.g. thermal gradient limits for instruments are described in the He-S/S specification (RD13) and will be strictly observed.

Principal test set-up is operations is described in detail in the CVSE Setup description (RD 12) and shown in Fig. 5-1 above.

5.1.9.3 DEPLETION AND WARM UP

Depletion and warm-up activities will be performed according dedicated procedures also based on verified ISO and Herschel EQM PLM documents and using the CVSE. Solely the internal heaters of the HTT and HOT will be used.

During the nominal PFM integration and test sequence no depletion and warm up is foreseen.

5.1.10 HANDLING AND TRANSPORTATION

Detailed requirements regarding handling and transportation activities of the PLM and the satellite shall be covered in dedicated handling and transportation procedures.

An overview of the necessary handling and transportation activities is given in RD 09.

A description of the major facilities and GSE needed and the major transportation steps are shown in chapters 8 and 9 below.

If a transport of the PLM or satellite in cold conditions ~~needs be transported in its container (with the x-axis horizontally)~~is necessary, e.g. between ~~facilities~~ Astrium and ESTEC~~see the figure below~~, then this transport will be with the PLM or satellite in its container and with the x-axis horizontal. In this case the HTT will be filled to no more than about 50% ~~for that purpose~~.

The Transportation Stimuli & Monitoring Unit (TSMU) will be attached to the transportation container and activated during transportation.

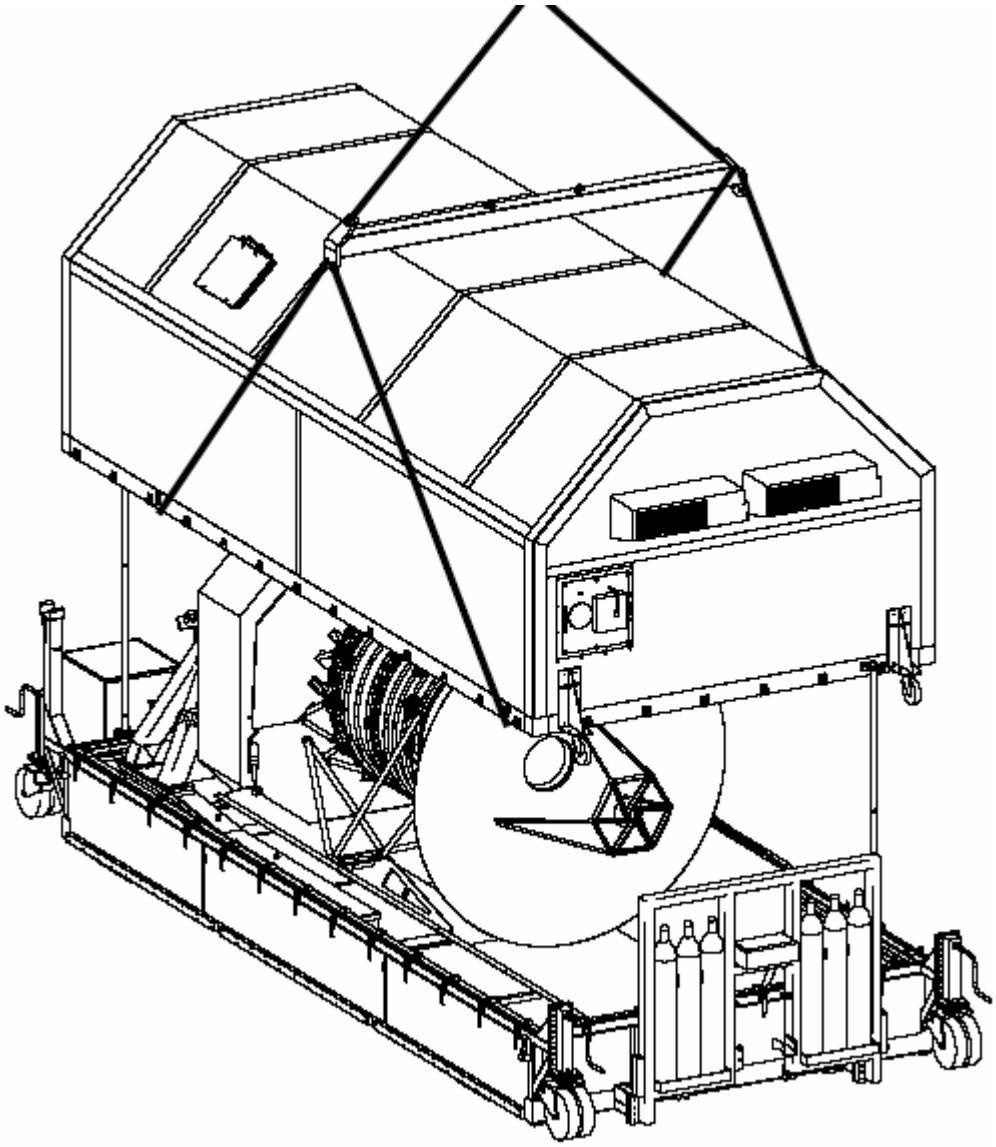


Fig. 5-2: PLM/Satellite Transportation

This figure is a schematic only, thus the transport will be done in the Transport and Storage Container for Spacecraft (H-TSC)

5.2 AIT LOGIC FLOW

The PFM PLM and Satellite integration flows are given in fig. 5.3 and fig. 5.4.

The PFM Satellite test flow is presented in fig. 5.5.

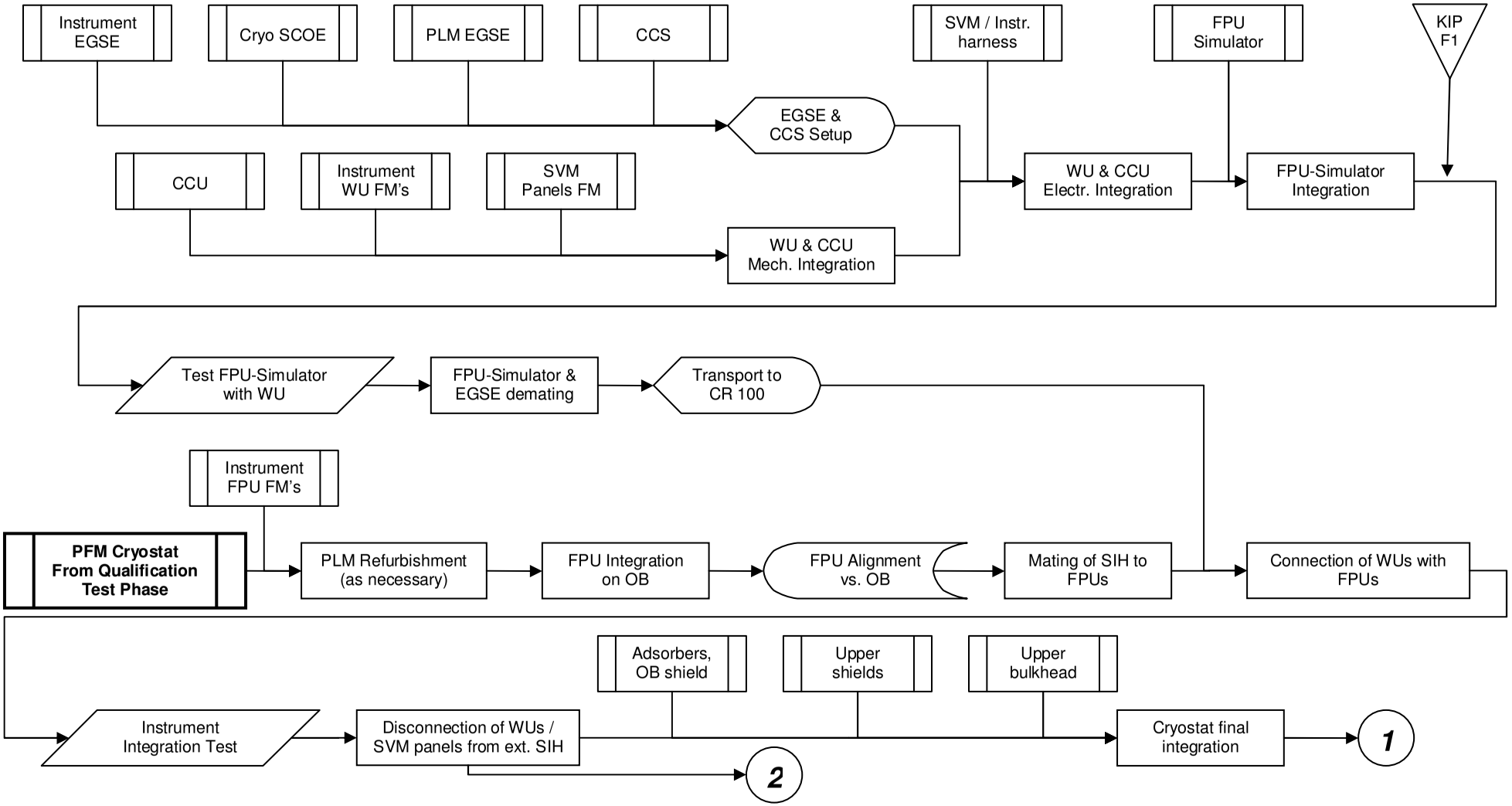


Fig. 5-3: PFM PLM integration flow in CR 100

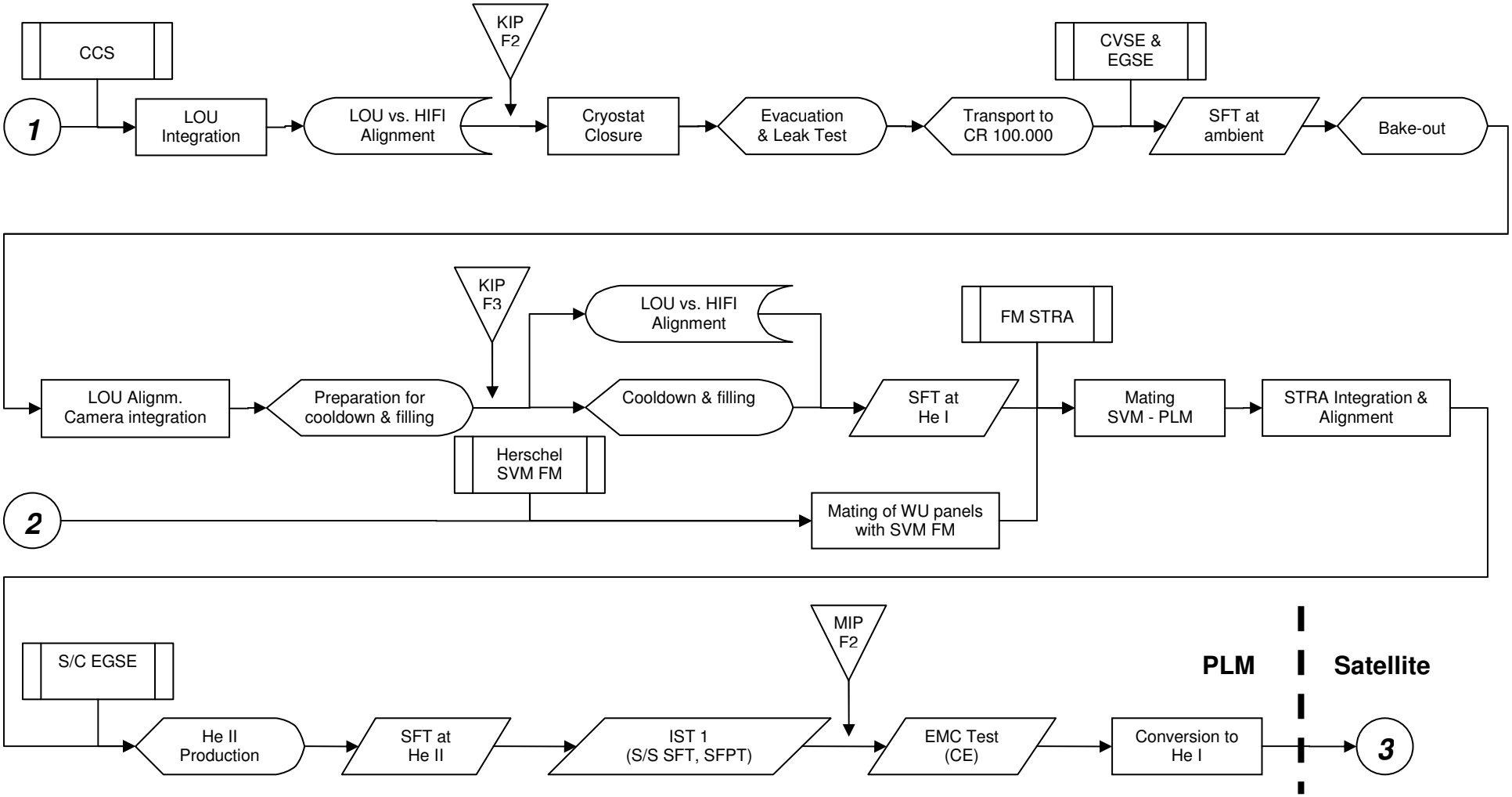


Fig. 5-4: PFM PLM and Satellite Integration flow in CR 100,000

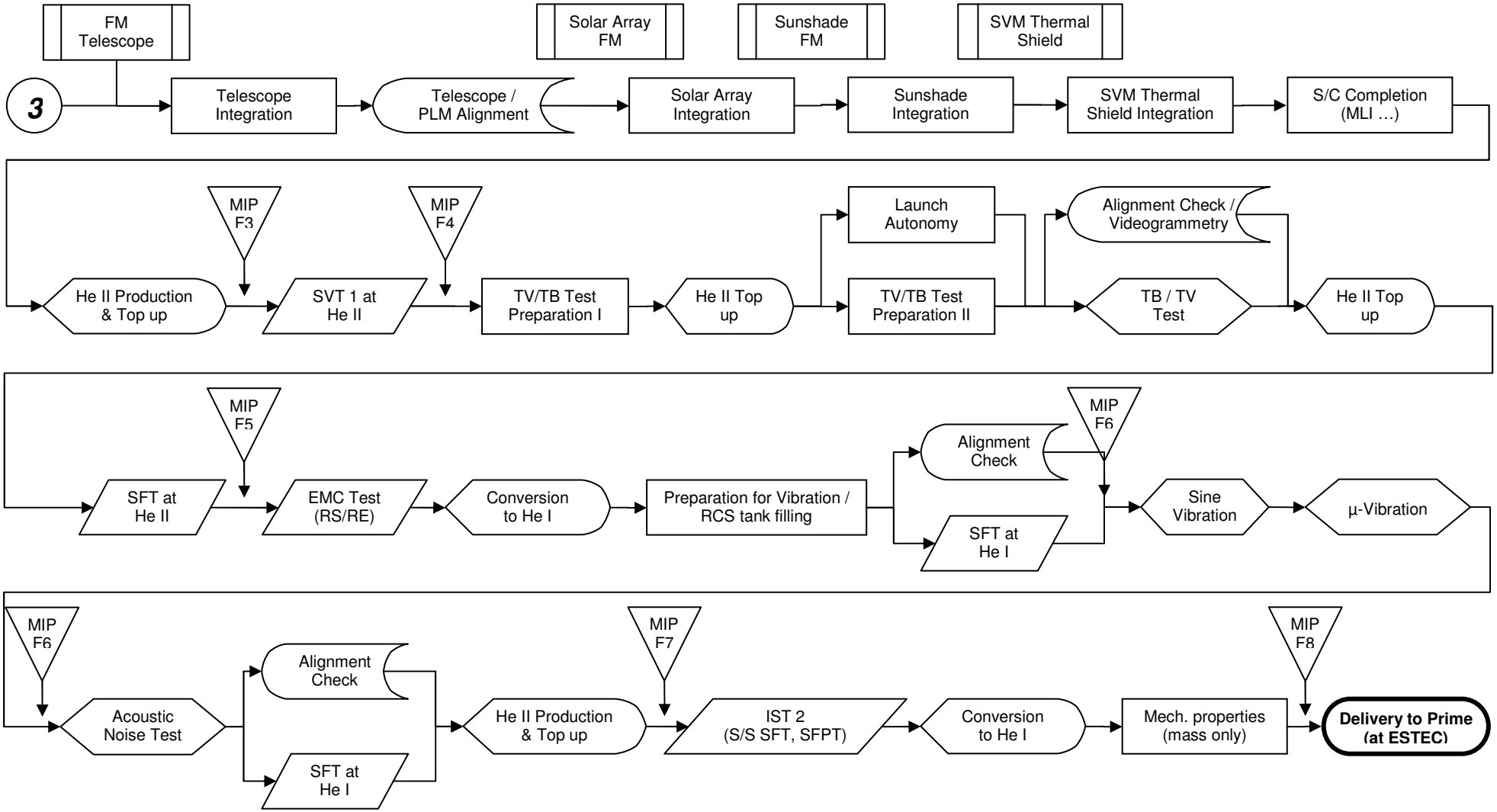


Fig. 5-5: PFM Satellite qualification and acceptance test flow

5.3 PLM LEVEL INTEGRATION AND TESTING

5.3.1 PLM REFURBISHMENT AND INTEGRATION

Based upon final inspection results after completion of STM satellite qualification test campaign and subsequent partial de-integration of the PLM, necessary and agreed refurbishment activities will be completed.

Thereafter the PFM PLM will be re-integrated. In this frame the following items that had been STM units respectivelly Mass and Thermal Dummies for the STM satellite will be replaced by PFM/FM units:

- Instrument FPUs for PACS, HIFI, and SPIRE
- LOU incl. support structure
- CCU (installed during satellite integration)

During the FPU electrical integration the STM SVM being still mated to the PLM during that period will be populated with the equipped FM WU panels for first integration tests and health checks.

Mechanical and electrical assembly and integration will be performed according to formal step-by-step procedures only. ~~All activities will be given there in correct timely order.~~

All integration activities on the PFM cryostat will be performed in cleanroom class 100 environment up to and including final closure of the cryostat and evacuation.

The handling and integration activities of PFM hardware will be carried out using dedicated MGSE as described in chapter 9 below. It will be done by trained authorised personnel only with the necessary experience (e.g. ISO heritage).

The major activities during the PFM PLM re-integration are summarised as follows:

- **Instrument Warm Units and SVM panel preparation**
  - EGSE/CCS preparation and set-up
  - Integration of SVM CCH and SIH
  - Mechanical integration of WUs on SVM Panels
  - Electrical Integration of WUs and associated WIH & SVM harness
  - Connection of WU's with PLM EGSE
  - Connection of WU's with FPU simulator
  - Functional tests of WU's
  - Disconnection of EGSE and FPU simulators
  - Cleaning & Transport of WUs on SVM panels to CR 100

- **Integration and alignment of FM Instrument FPUs**
  - Mechanical/thermal Integration FPUs onto OB
  - FPU Alignment vs. OB and OB vs. CVV
  - connection of SIH to FPUs & electrical interface check

- **Instrument Integration Test**
  - Connection of external SIH to WUs via SVM SIH
  - Connection to instrument EGSE

- Instrument Integration Test
- Disconnection from instrument EGSE
- Disconnection of WU panels from SIH

- **PFM Cryostat Final Integration**
  - Integration of adsorbers
  - Integration of OBA shield incl. instrumentation
  - Integration upper shields incl. LOU and entrance baffle with MLI and instrumentation
  - Integration of upper bulkhead
  - Connection of filling port SV121 & leak test
  - Integration and alignment of LOU with OBA / CVV
  - Evacuation & leak check

- **Transport to clean room 100,000**
- **PLM external completion**
  - Mechanical integration of SVM panels onto STM SVM
  - Integration of external vent line, heater, valves, nozzles
  - Connection of SIH to WU's
  - Connection of waveguides to WU's
  - Integration of LOU alignment camera (HACS)
  - Connection of CVSE and EGSE
  - Short Functional Test (SFT) warm

The PLM integration sequence is completed with the first short functional test.

Details about the flow and the actual schedule are given in chapter 5.2 and chapter 10 respectively.

5.3.2 PLM TESTING

~~Before~~ After the PLM is finally mated with the FM SVM and and before other elements will be integrated to become the PFM satellite the PLM/SVM assembly it is submitted to the following test and further preparation steps:

- Cooldown & filling with He-I
- Alignment measurement & adjustment during cooldown
- Short functional test of Instruments (SFT), He-I
- De-integration of SVM STM and WU panels from PLM
- Remove STR sunshade, Star Tracker, STR platform and associated items as the thermal closure (the struts remain integrated)
- PLM FM / SVM FM mating
- integration of STRA
- Integration and alignment of STR
- Integration of WU panels to SVM
- Connection of SVM harness (CCH & SIH) and waveguides

- He-II production & top-up
- Short Functional Test cryostat and instruments (SFT), He-II
- Integrated ~~Module~~ Satellite Tests (~~IMT~~IST) incl. operational programme
  - S/S Functional Tests
  - Cryostat Tests (CCU & Instrumentation)
  - Integrated Module ~~HIFI~~ Tests (HIFI, PACS, SPIRE, PACS/SPIRE Parallel Mode)
  - ~~PACS Tests~~System Functional Performance Tests

  ~~SPIRE Tests~~

  ~~PACS/SPIRE Tests (parallel mode)~~
- EMC tests (CE only)
- Conversion to He-I

Details about the flow and the actual schedule are given in chapter 5.2 and chapter 10 respectively.

The SFT, the IMT and the EMC tests are briefly described in the following chapters.

5.3.2.1 SHORT FUNCTIONAL TEST (SFT)

The SFT is foreseen to verify the correct functioning of units or the complete module, in order to validate a specific installation or to check the system health after dedicated integration or test steps (e.g. cooldown, He-II production).

This test is performed by setting the system in defined operational configurations and checking that all elements under test are working properly.

During the PLM integration and test phase the Cryo-Control Subsystem (CCS) and the instruments are concerned. Evaluation will preferably be based on housekeeping (HK) data rather than scientific data.

Further details for instrument related SFT can be found in RD 10.

5.3.2.2 INTEGRATED MODULE TEST (IMT)

The IMT shall be a sequence of tests which allow a full assessment of the functional and measurement performance of the integrated instrument in conjunction with the spacecraft, as far as it is possible on this level and with the thermal environmental constraints. The IMT is part of the Integrated System Test (IST)

The IMT sequence for HIFI shall cover the following two objectives

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

For PACS the IMT sequence comprises the check of the instrument function and the verification of the performance at simulated background conditions.

The SPIRE IMT sequence is based on need to look at the following aspects:

- Recovery from cooler recyclinge.
- Settling time for photometer mode switch on.
- Switching from photometer to spectrometer mode.
- Test of spectrometer mode with PLM axis horizontal

- Switching from SPIRE prime to PACS/SPIRE parallel.
- Total cooler hold time during nominal operations (at ground conditions)

The testing of the SPIRE instrument has to be based around the recycling of the 300 mK cooler. At least one full operational cycle of the cooler (nominal 48 hours) is required in order to evaluate the hold time of the cooler under nominal in flight operating conditions.

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

Further details for instrument related IMT can be found in RD 10.

5.3.2.3 INTEGRATED SYSTEM TEST (IST)

The full IST is the reference system performance test. It will be run twice:

- after system integration phase, i.e. after PLM and SVM mating to verify the performance of the overall satellite system at start of environmental test
- after the environmental test sequence (i.e. after Acoustic Noise) to verify that no intolerable performance drift or degradation happened during the mechanical and thermal tests.

The IST is a combination of tests developed from unit, subsystem, or module level test sequences.

It consists of

- subsystem performance measurements at system level, i.e. the most complete possible verification of performance and characteristics of each PLM and SVM subsystem with regard to its specifications, when integrated in the actual system environment instead of a simulated one.
- system functional performance measurements incl. scientific instruments for verifying where possible the system specification.

Measurements to be performed are identified in the test matrices provided in AD 01, AD 11, and RD 10.

~~5.3.2.3~~5.3.2.4 EMC TEST

The EMC test applicable for the PLM comprises measurements of the conducted emission (CE) per instrument on the primary power lines towards PCDU. This test can be done with the PLM EGSE representing the PCDU, or later when the PCDU is available, i.e. during/after mating of the PLM with the SVM.

During these measurements the instruments are switched in a mode with maximum generation of electrical distortion on the electrical lines.

The instruments are tested individually, i. e. the EMC test configurations and sweeps have to be repeated for each instrument. During the EMC test the constraints of the PLM tilting angle during PACS and SPIRE cooler recycles have to be considered.

Details for instrument related EMC tests can be found in RD 10.

The following table summarizes ~~the~~ all EMC tests performed within the Herschel programme (EQM and PFM):

	CE	CS	RE-H	RS-H	RE-E	RS-E
Equipment level	Y	Y	N	N	N	N
EQM	not possible	N	N	Y	N	Y
H-EPLM FM	Y	N	N	N	N	N
S/C FM	Y	N	N	Y	Y	Y

Table 5-1: List of EMC tests

5.4 PFM SATELLITE INTEGRATION AND TESTING

5.4.1 PFM SATELLITE FINAL INTEGRATION

To complete the EPLM and finally the PFM satellite, the steps listed below will be undertaken to assemble the remaining elements and modules to the PLM. The PLM remains in He-I condition during this period.

- ~~De-integration of SVM STM and WU panels from PLM~~
- ~~Remove STR sunshade, Star Tracker, STR platform and associated items as the thermal closure (the struts remain integrated)~~
- ~~Integration of SVM to PLM and alignment~~
- ~~integration of STRA~~
- ~~Integration and alignment of STR~~
- ~~Integration of WU panels to SVM~~
- ~~Connection of SVM harness (CCH & SIH) and waveguides~~
- Integration and alignment of Telescope incl. mounting structure
- Integration of Solar Array and Sunshade including support structure
- ~~Integration of Sun Shade including support structure~~
- Integration of SVM Thermal S~~s~~hield~~s~~
- Integration & closure of remaining external MLI

5.4.2 PFM SATELLITE TESTS

To complete the qualification and to accomplish acceptance for flight the following main test and inspection steps are foreseen on the integrated PFM satellite.

- He-I top up; He-II production & top-up

- ~~Integrated System Test (IST1) (S/S SFTs & SFPT) including EMC test (CE only)~~
- ~~Conversion to He-I~~
- ~~Preparation for tansportation~~
- ~~Transportation to Test Facility (ESTEC)~~
- ~~Unpacking and setup of the Satellite at ESTEC~~
- ~~Short Functional Test (SFT), He-I~~
- ~~He-II production and top-up~~
- System Validation Test (SVT1) @~~,~~ He-II
- Launch autonomy verification (as well needed to support TB/TV preparation) incl. evacuation of HOT
- Thermal balance and thermal vacuum test including alignment checks, He-II
- Short functional test of cryostat (SFT), He-II
- EMC Tests (RE, RS)
- Conversion to He-I

- preparation for vibration test including short functional test (SFT)
- Sine vibration acceptance level, 3 axis, He-I
- Microvibration measurement by activating the reaction wheels
- alignment check & short functional test (SFTx), He-I
- Acoustic Noise Test (acceptance level)
- SFT and alignment check, He-I
- He-II production and top up
- Integrated System Test (IST2), He-II (S/S SFT, SFPT)
- Conversion to He-I
- Mechanical properties measurement (mass only)
- Satellite Delivery to Prime

The main test activities are briefly described in the following chapters.

5.4.2.1 INTEGRATED SYSTEM TEST (IST)

The full IST is the reference system performance test. It will be run twice:

- after system integration phase, i.e. after PLM and SVM mating to verify the performance of the overall satellite system at start of environmental test
- after the environmental test sequence (i.e. after Acoustic Noise) to verify that no intolerable performance drift or degradation happened during the mechanical and thermal tests.

The IST is a combination of tests developed from unit, subsystem, or module level test sequences.

It consists of

- subsystem performance measurements at system level, i.e. the most complete possible verification of performance and characteristics of each PLM and SVM subsystem with regard to its specifications, when integrated in the actual system environment instead of a simulated one.
- system functional performance measurements incl. scientific instruments for verifying where possible the system specification.

Measurements to be performed are identified in the test matrices provided in AD 01, AD 11, and RD 10.

5.4.2.2 SHORT FUNCTIONAL TEST (SFT)

The SFT consists of a subset of the IST sequence and is foreseen to verify system electrical integrity following transportation of the satellite or in-between /during environmental test steps. The instrument part of this test is basically limited to a switch on and a functional verification of the interfaces.

Measurements to be performed during a SFT are identified in the test matrices provided in AD 01, AD 11, and RD 10.

5.4.2.3 SINE VIBRATION TEST

The PFM sine vibration test consists of the following steps in the three orthogonal main satellite axes:

- low level sine vibration run to verify the structural and coupled load analysis and to identify/confirm the major Eigenfrequencies and to agree upon necessary notching for the acceptance level test

- intermediate level run for determination of final notching levels (tbc)
- acceptance level sine vibration for verification of the workmanship of the mechanical system, the verification of the alignment requirements, and the demonstration that the thermal insulation and its support elements can withstand the environmental loads.
- low level run for comparison of previous satellite signature

Notching of levels applied to the satellite will be made at the resonance frequencies of the main structural elements in order not to over-stress the satellite. These notching criteria will be determined in accordance with launcher regulations.

Finally the microvibrations created by activating the reaction wheels will be verified.

5.4.2.3.1 TEST SET-UP AND CONDITIONS

The sine vibration test will be performed ~~with the PLM~~ in cold (He-I) condition.

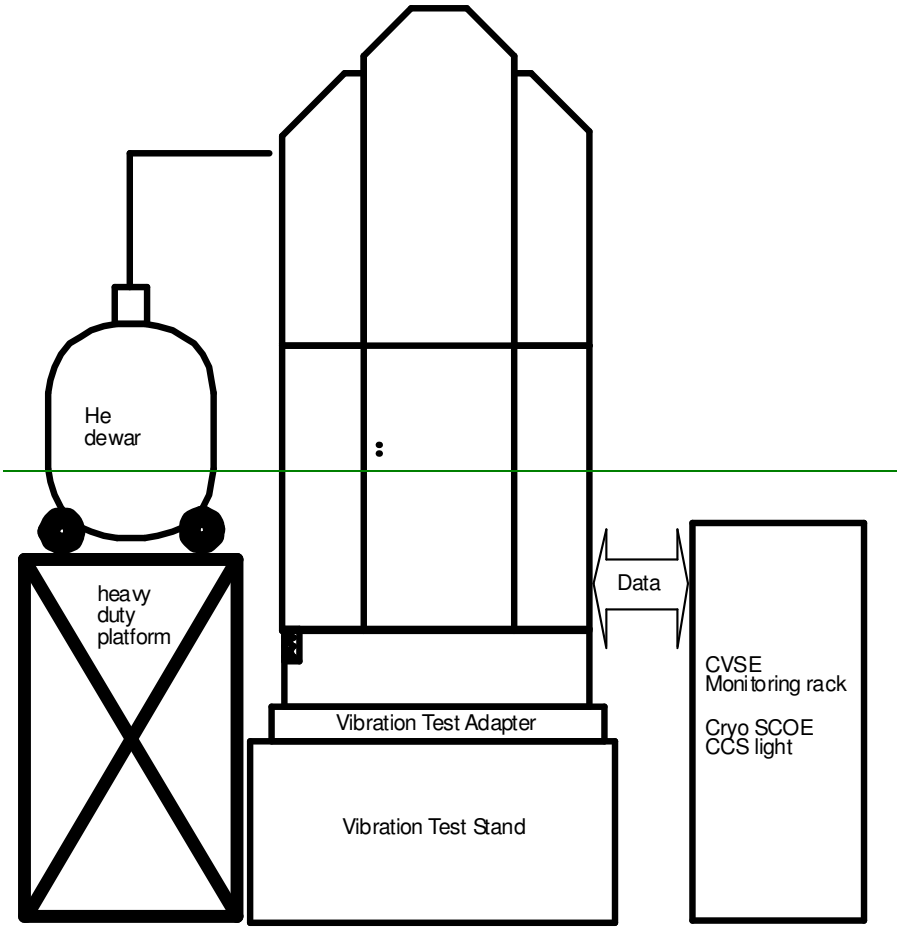
As for launch the HTT will be filled (≥ 98%) however ~~with~~ in He-I instead of He II conditions. ~~This~~ The ~~condition~~ filling level will be verified~~/achieved~~ before each test run and the HTT will be refilled if necessary. The PLM auxiliary helium tank will be empty.

The SVM propellant tank will be filled with simulation fluid (de-ionised water) and pressurised.

The satellite will be installed on the shaker with the vibration test adapter representative of the launcher interface. The clamp band will be mechanically identical to a flight one.

Protective covers for e.g. Sun shield, OSRs, thrusters, sensors etc. with the exception of the telescope cover will be removed before and reinstalled immediately after test to minimise exposure of sensitive surfaces to potential contamination.

The telescope cover will be lifted during each test run. ~~The figure below shows the principal vibration set-up.~~



~~Fig. 5-6: PFM Satellite sine vibration test set-up~~

Test accelerometers will be installed on the satellite at pre-defined locations, in order to be able to compare test results with previous structural mathematical models and to monitor the vibration levels applied to particular equipment and interfaces.

5.4.2.4 SYSTEM VALIDATION TEST (SVT)

The System Validation Test (SVT) consists of a system level compatibility test with the ground segment. For this purpose the PLM cryostat will be at He-II conditions.

The test objectives are

- to verify the compatibility between the control centre data base and the command and telemetry data base used during the AIT sequence
- to validate the control centre mission operation software

Currently there is one SVT foreseen in the PFM acceptance test sequence.

The SVT will include ACMS closed loop test (tbc) amongst those already performed at subsystem level. The validation of ~~these test~~these tests will be done during the SVM integration phase (tbc by SVM supplier). A special test harness may need to be installed.

~~The system level compatibility will be proven by command and data flow tests involving the satellite, the system EGSE, and the control centre (this includes the satellite control centre and the scientific operation~~

~~centre)~~The satellite MOC interfaces will be verified for all telemetry formats and telecommands. It will be done with the satellite linked via a Network Data Interface Unit (NDIU) to the MOC. The SVT procedure will be written taking into account ESTEC/ESOC requirements.

~~To assist ESOC in development of the mission operation software it may be required to supply ESOC with satellite telemetry data during or after certain testing phases (e.g. TB/TV tests) on a non-interference basis.~~

5.4.2.5 GROUND LIFETIME AND LAUNCH AUTONOMY VERIFICATION

The ground lifetime and launch autonomy verification has already be done during the qualification test phase. The launch autonomy verification ~~test will~~could be combined with the preparation of the subsequent TB/TV tests.

The objectives of the ground lifetime and launch autonomy verification are:

- to obtain a set of temperature parameters and He mass flow for near ground equilibrium conditions for comparison with the model prediction
- to verify the Cryostat Helium Subsystem correct behaviour during launch preparation and start phase.

The test sequence of the launch autonomy verification in the frame of the TB/TV test preparation will be as follows:

- He-II production and top up
- closing of HTT
- Disconnect of He Pumping Unit I and II
- Filling of HOT with He-I
- Refilling of HOT with He-I after two days according preliminary launch time line and recording of HTT temperature profile
- Depletion of HOT, just before start of the TB/TV test and evacuation of the HOT and tubing
- Heating up of the HOT and a launch abort will not be simulated in order to optimize start conditions for the following TB/TV tests.

5.4.2.6 TB/TV TEST

The PFM satellite will be submitted to the following thermal vacuum tests (tbc):

- Thermal Vacuum (step 1)
- Thermal Balance (step 2)
- Thermal Vacuum Cycle~~s~~ (one hot and one cold case for SVM)

Step 1 will be performed for ~~acceptance of the He S/S, MLI workmanship~~a full scientific payload test with all sensors operational, for a complete system level qualification/acceptance test and for alignment measurements at close to in orbit conditions. During this phase the CVV outer surface will be ~~actively~~ passively cooled ~~with LN2~~to about 105 K.

~~It serves to support instrument testing in realistic conditions.~~

~~step~~ Step 2 and the subsequent thermal vacuum cycles serves for the the thermal balance test of the SVM.

Details will be given in the test specification provided by the prime.

5.4.2.6.1 THERMAL VACUUM TEST (STEP 1)

The first part of the TB/TV test covers the test of cryogenic equipment and subsystem, including the stabilisation period (from pre-launch autonomy to cryo cover opening in orbit) in order to verify

- PLM thermal mathematical model correlation (already done during qualification test phase)

- launch transient temperatures~~, however with different starting conditions (see above)~~
- internal temperature distribution
- External vent line performances (delta p, nozzle)

Alignment verification of LOU vs. HIFI will be done with the alignment camera.

Alignment verification of the telescope vs. LOU will be done by videogrammetry.

5.4.2.6.2 THERMAL BALANCE TEST (STEP 2)

The TB test covers the following objectives

- the test of the ~~warm~~ SVM units to be tested together in flight conditions in order to mainly verify
  - SVM mathematical thermal model correlation
  - SVM global thermal performances
  - performance verification of active and passive thermal control subsystem in flight representative conditions
  - performance verification of the satellite system in flight representative conditions

5.4.2.6.3 THERMAL VACUUM CYCLING TEST

Thermal vacuum cycling is foreseen to complete acceptance of FM electronic equipment. Due to the absence of a system Qualification Model, it will also serve to qualify the complete system in thermal vacuum environment.

This thermal cycling test will allow accepting the FM electrical performances of the following equipment at extreme temperature with hot and cold soaks:

- all warm electronic units of the PLM (instrument WUs, CCU)
- all SVM subsystems
  - the data handling subsystem
  - the RF subsystem
  - the power conditioning subsystem
  - the Attitude Control and Monitoring Subsystem
  - the Reaction Control Subsystem

Test Conditions and Sequence:

Hot soak conditions:

- the temperature of equipment to be accepted will be obtained by heater power adjustments
- the criteria for starting of system testing is reached when the unit temperatures are equal to (or near to) hot soak predicted temperature
- unit temperatures have to remain below upper acceptance limit

Cold soak conditions:

- the temperature of equipment to be accepted will be obtained by heater power adjustments
- if necessary some units will be turned off to cool down the whole satellite
- criteria for staring of system testing is reached when main unit temperatures are equal or below cold soak predicted temperature
- unit temperatures have to remain above lower acceptance limit

- during system testing unit temperatures are stabilised by turning on/off internal units and external heat fluxes of solar simulator

Transition phase

- hot soak -> cold soak
- the change will be done by switching off of dissipating units, by solar power adjustments until cold soak criteria are obtained
- cold soak -> hot soak
- the change will be done by switching on of dissipating units, by solar power adjustments until hot soak criteria are obtained

5.4.2.6.4 TB/TV TEST SET-UP

The test set-up is principally shown in the figure below. Objective is to test the satellite in completely integrated configuration, i.e. with Telescope, Sun Shield and Sun Shade, and SVM Thermal Shields.

Before actual test the GSE/CVSE (i.e. He dewar and platform) will be removed from the TV chamber.

Protective covers of telescope, solar array, OSRs, thrusters, sensors etc. will be removed as necessary before and reinstalled immediately after test to minimise exposure of sensitive surfaces to potential contamination.

The HTT will be filled with He-II completely ~~(≥~~(~98%); the auxiliary tank will be ~~empty, after completion of launch autonomy test~~emptied just before beginning of the TB/TV test.

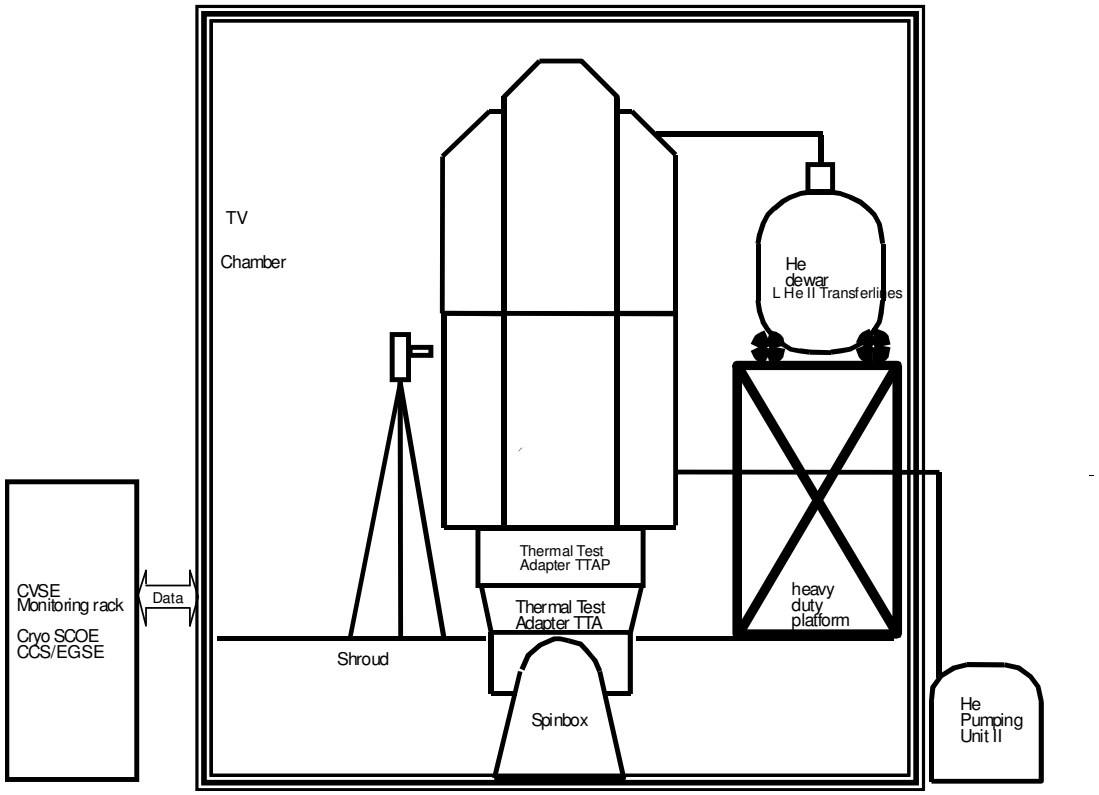


Fig. 5-6: TB/TV test set-up (No shroud in test, to be removed from sketch)

5.4.2.7 EMC TEST

The EMC test shall demonstrate the ability of the satellite system to operate during any phase without suffering or causing unacceptable performance degradation du to electromagnetic interferences (EMI). This definition includes interferences with its own system (auto-compatibility) as well as interferences with other systems (e.g. launcher – EGSE...).

The satellite will be placed in ~~a clean room with anechoic walls~~an anechoic chamber, where the ambient noise is at least 6dB below the test level in all required frequency ranges.

For tested operational configurations, refer to EMC test specification to be established. For instrument related tests refer to RD 10.

It is assumed that all monitoring of the satellite, particularly concerning the instruments, is performed via telemetry and practically in real time.

The constraints of the PLM tilting angle during PACS and SPIRE cooler recycles will be considered during EMC testing if it is required by the instruments.

Tests will be done in HeII conditions. For this reason, the He pumping units will be installed in side the LEMC chamber but behind adsorber walls.

Following measurements will be performed:

~~a)~~**~~Conducted Emission~~**

~~Conducted emission shall be measured on the primary power lines and to be selected signal lines as well as the voltage ripple between the SVM and PLM structure. These tests shall be performed during the integration of the PLM together with the SVM, if not already performed on PLM level with PLM EGSE simulating the PCDU. Details will be given in the relevant test procedures~~

~~b)~~a) **Radiated Emission**

to demonstrate the compliance with the launch vehicle requirements, narrow band E-filed emissions will be measured at LVA plane, using standard calibrated antennas in the required frequency range.

For this test the satellite will be set in pre-launch and launch configuration externally powered or powered by internal batteries.

To determine the compatibility of the overall platform with the scientific instruments, the narrow band E-field emissions will be measured at three different locations around the cryostat with calibrated antennas set at predefined distance toward the PLM.

~~c)~~b) **Radiated Susceptibility**

The satellite shall not exhibit any malfunction or degradation of performance when subject to E-field and H-field with levels and characteristics as defined in AD 04.

This will be verified by emitting radiated EMI toward the satellite and scientific instruments. Radiating antennas will be set at predefined location around the PLM.

5.4.2.8 ACOUSTIC NOISE TEST

Main objectives of this acoustic noise test are

- final demonstration of the satellite structure characteristics and workmanship
- verification of compliance with the relevant analytical model parameters
- verification of the system integrity and alignment stability after acoustic noise

The satellite will be submitted to acceptance level noise spectrum.

The sequence of tests will be as follows:

- low level run (for preliminary adjusting of individual sound pressure levels)

- intermediate level run, duration as short as possible (for final adjustment of individual sound pressure levels)
- acceptance level run
- low level run

5.4.2.8.1 TEST SET-UP AND CONDITIONS

The acoustic noise test will be performed with the PLM in cold (He-I) condition.

The HTT will be filled (>98%) with He-I. The HOT will be empty.

The SVM RCS propellant tanks will be filled with simulation fluid (de-ionised water) and pressurised (tbc by SVM contractor).

The satellite will be installed in the chamber on a dedicated acoustic noise test adapter. The clamp band interface will be mechanically identical to a flight one.

The CVSE and GSE will be removed from the acoustic noise chamber before the actual tests.

Protective covers will be removed as necessary before and reinstalled immediately after test to minimise exposure of sensitive surfaces to potential contamination.

Measurement of sound pressure levels will be done by microphones. Power spectral density response will be given by accelerometers and strain gauges (if necessary).

The figure below shows the principal acoustic noise test set-up.

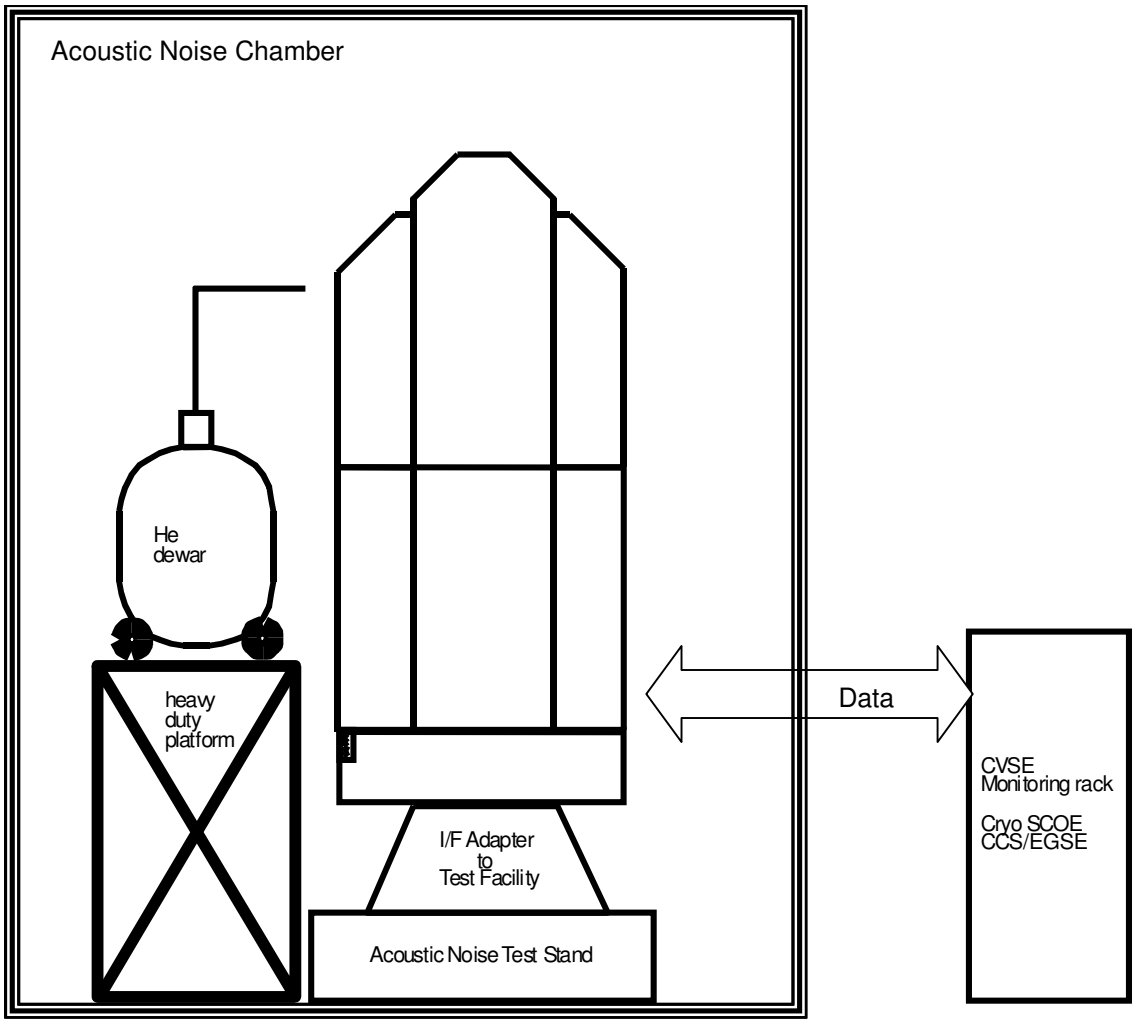


Fig. 5-7: Acoustic noise test set-up

6 ORGANISATION AND MANAGEMENT

6.1 AIT TASKS

EADS Astrium GmbH is in charge of system level AIT which includes the operations on the following models: PFM PLM, satellite STM, Satellite PFM.

The main tasks to be performed under the AIT organisation are the following:

- detailed planning of AIT activities
- ~~definition and~~ sequencing of tests and operations as defined by the prime and as far as in line with SoW
- preparation of integration and test
- co-ordination and preparation of test facilities
- preparation of test set-up
- ~~organisation~~ participation in~~of~~ test reviews organised by PA
- execution of AIT operations
- reporting of AIT operations
- determination and on site management of AIT team and technical support.

In order to fulfil these tasks, the following general rules will need to be respected:

- Prior to the start of any integration or test activity:
  - KIP/MIP or TRR has to be held as agreed in the AIT flow
  - relevant procedures are available, reviewed and approved
  - test configuration is defined, established and verified by Product Assurance
  - necessary GSE, test instrumentation and facility is available and accepted for use
  - safe working conditions for personnel and hardware have been established and verified by safety
  - designated personnel is specially distinguished in the integration and test area

- During any integration and test activity:
  - all activities proceed according to approved procedures only
  - anomalies or discrepancies with the procedure shall be reflected in a non-conformance report immediately raised

- Conclusion of integration or test activity:
  - all activities are successfully completed
  - declaration sheets to verify completion are signed by the responsible engineers
  - appropriate action is taken on all non-conformance reports raised during the activity
  - an integration or test report is issued within an adequate time interval

6.2 AIT ORGANISATION AND PERSONNEL

The AIT team will be recruited of a number of people from different disciplines. The team will be sized according to the manpower required during the various integration and test steps.

An AIT manager will be responsible for the overall co-ordination of the team.

Only trained personnel, familiar with special requirements of class 100,000/100 clean-rooms will work with the various H/W.

The AIT team will be supported as appropriate by optical engineering, mechanical engineering, thermal engineering and various supports from manufacturing departments. The necessary engineering support from the different disciplines will be provided according to the AIT program requirements.

For instrument and SVM related tests, adequate engineering and AIT support from respective suppliers is anticipated.

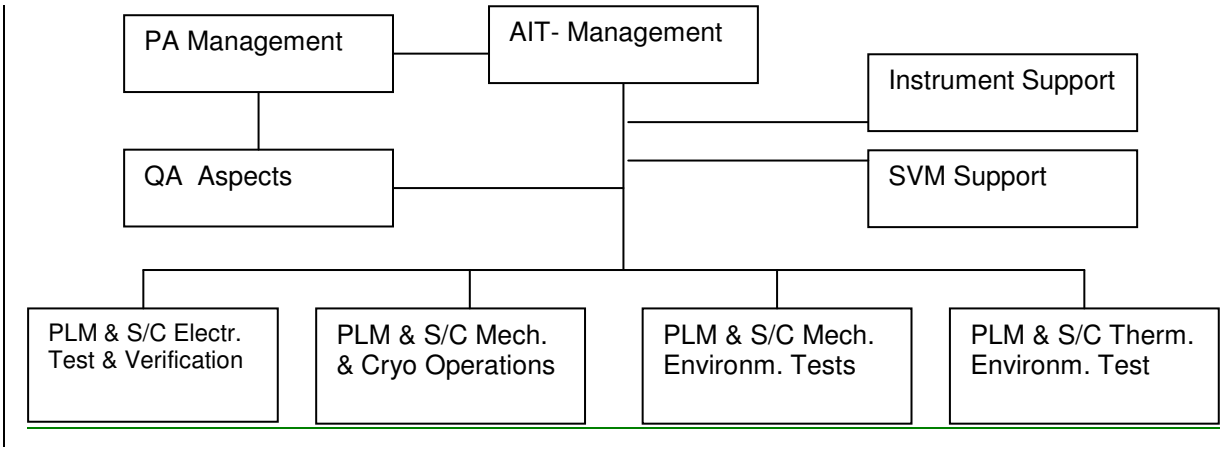


Fig. 6-1: AIT Team Organisation

6.3 AIT MEETINGS AND REVIEWS

In the following a short overview of meetings and reviews including their objectives is provided.

Further reviews, as the Qualification Review and Delivery Review Board (DRB) are no AIT specific reviews; however corresponding inputs will be delivered from AIT.

6.3.1 AIT INTERNAL MEETINGS

Regular internal meetings (daily, weekly,.. as necessary) will accompany the AIT process. The meetings are used to discuss the status of AIT, further AIT activities with the corresponding members of the engineering team and PA.

6.3.2 TEST READINESS REVIEW (TRR)

A test readiness review is associated with major operations and test (e.g. PLM tests, satellite environmental tests). The TRR will be called by Astrium and chaired by the respective test conductor and PA. The customer and ESA will be invited.

The objective of a TRR is to determine if the test or test sequence under review may start. To achieve this, the following must be declared/ certified:

- that the hardware status is known, compliant and properly documented (CIDL/ABCL)

- that it is in a fit state to be tested (open works and NCR's closed or not affecting the tests)
- that the test facilities to be used are available and validated
- that all appropriate test objectives and the associated test procedures are agreed and approved
- the supporting documentation is available
- that all supporting equipment (hardware and software) is available and validated
- that the team exists and is sufficiently briefed, also in term of responsibility
- that the test schedule is available and agreed
- that all safety aspects have been properly addressed

The TRR shall ensure a successful performance of the envisaged test. Test readiness reviews are announced at a suitable period prior to begin of corresponding tests.

6.3.3 POST TEST REVIEW (PTR)

This review is to confirm that the corresponding test was carried out according to the applicable test procedure, to review the result and to release the hardware configuration for the next step or to decide on the course of action where non-conformances occurred.

6.3.4 NON CONFORMANCE REVIEW BOARD (NRB)

A review board will be established if non-conformances within integration or test program are encountered. This board has to decide upon corrective actions to be taken and therefore defines how to proceed in the program. The rules to be followed are described in the PA Plan, AD 06.

6.3.5 KIP/MIP

Key Inspection Points and Mandatory Inspection Points (KIP/MIP) will be implemented in the integration and test flow to be performed in accordance with the PA plan (AD 06). The following KIP's and MIP's are planned:

Key Inspection Points:

- KIP F1: after WU mechanical and electrical integration on SVM panels before test with FPU simulators
-
- KIP F2: after mating of PLM with SVM and before Telescope and SSH/SSD integration

Mandatory Inspection Points:

- MIP F1: after PLM evacuation and leak check and before transport to CR 100,000
- MIP F2: after LOU alignment and before closing of cryostat
- MIP F3: after completion of PLM tests and demating of SVM STM and before mating of PLM with PFM SVM
- MIP F4: after completion of PFM satellite integration and alignment and before IST at He-II
- MIP F5: after arrival at ESTEC and before SVT and TB/TV tests
- MIP F6: after completion of satellite acceptance sequence and before delivery to Prime at ESTEC

6.4 AIT DOCUMENTATION

The integration and test documentation comprises different types of documents:

- documents used for definition of AIT activities:
  AIT plans and other applicable documents called therein
- documents used for performing the AIT activities defined above:
  integration and test procedures
- documents used for reporting AIT activities:
  integration and test reports
- documents for controlling the AIT:
  log books and AIT forms like ACR

The logical relationship of this documentation with the overall design and verification is shown in the following figure.

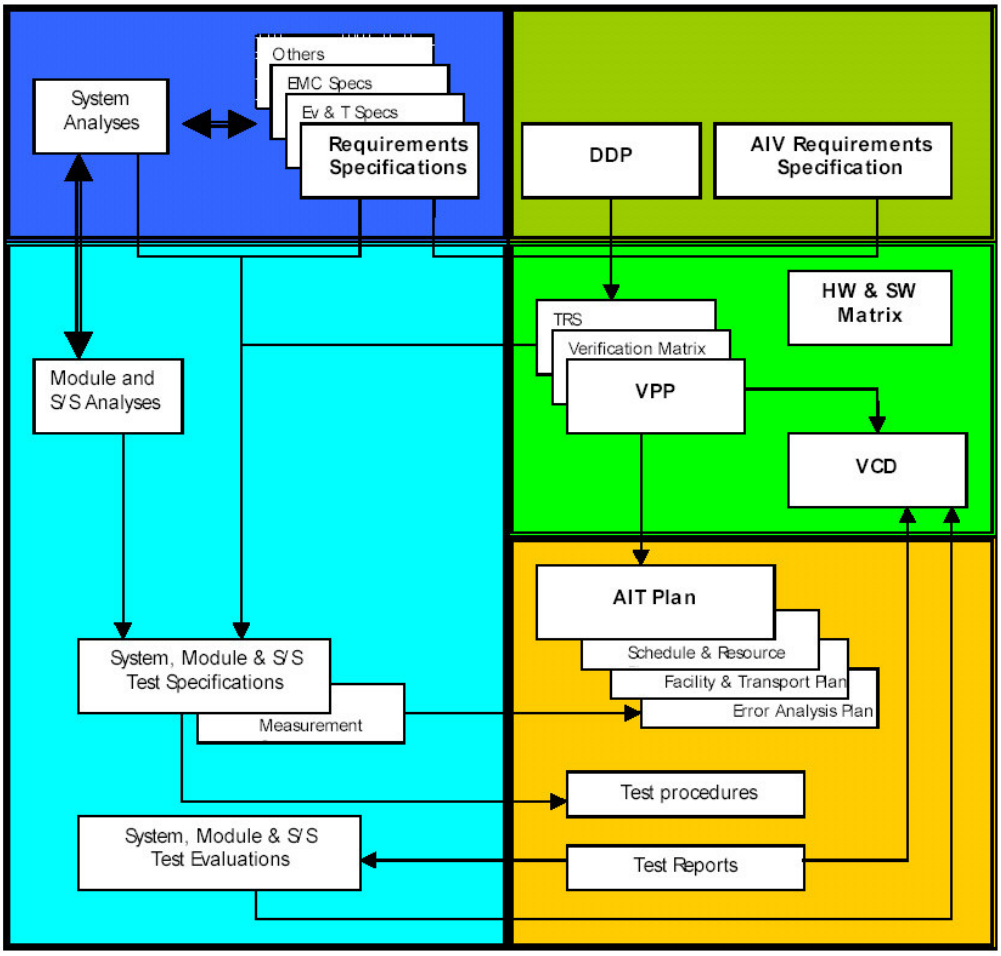


Fig. 6-2: Verification logic and links

6.4.1 INTEGRATION AND TEST PROCEDURES

Integration and Test Procedures will be written for all major AIT activities. This documentation will provide detailed step-by-step instructions to the dedicated teams conducting these activities.

Each procedure corresponds to a dedicated phase (CVV integration, vibration test, SFT etc) defined between two milestones, so running an Integration or Test procedure will typically have a duration of several days to several weeks.

The procedures take into account the mechanical and electrical setting of the satellite, define how integration steps and tests hang together in sequence, describe the elementary operations and tests which have to be carried out to complete the described integration or test phase. The sequencing shall be followed up when logical criteria lay down their order, nevertheless the AIT manager can modify the sequence in certain cases when circumstances require according to availability of material, personnel or facilities. So the actual planning of AIT activities is done on a daily/weekly basis by the AIT manager by reference to the different procedure paragraphs.

The integration and test procedures can integrate in their step by step operation section all operations to be performed from beginning to end of the related phase, but they can also call up specific test procedures for precisely defined operations and tests. These specific procedures are usually issued at each time that a test or operation can be run identically in different contexts, or when it is more convenient to isolate a coherent activity that my require specific support equipment or a specialised team. For automatic test sequences test procedures will be written in a specific test language.

Integration and test procedures shall contain the following information:

- General view**:**

- Describing the activity objective, item to be integrated or tested, references, methods and success criteria
- List of applicable and reference documents
- Facilities description, listing of GSE items, tooling required, personnel functions and other equipment

- Instructions**:**

- Provision of general set-up instructions including cleanliness and safety, environmental conditions, hazards and precautions
- Step-by-step operation sequences, including an operational flow diagram where required

  In this section all measurements will be recorded against the required schedule, including check out sequences to be executed in case of test configurations (description of activity set-up) and pass/fail criteria

- Necessary documentation and data sheets:

- Identification of test result data to be delivered by the corresponding GSE
- Data sheets to be prepared by the operator
- declaration sheet to verify completion is signed by the responsible engineers.

6.4.2 INTEGRATION AND TEST REPORTS

Integration reports shall be established during the actual integration process. They shall consist of the filled-out working copies of the respective integration procedure.

For each test, a test report containing the actually performed operations and the detailed test results shall be generated.

Parts of the test report start as soon as the test itself is running. As the test proceeds the information, documents, lists, data sheets, records etc. are incorporated in the corresponding sections up to the test

completion. Finalising the test report require to analyse the results with respect to success criteria and to draw the test conclusion.

The major sections of the test report are as follows:

- Scope and the test report digest (one page for major test data including summary)
- Relevant pages of the filled-in/ as-run procedure including performed operations, test period
- Detailed test results and analysis where applicable
- Pass / fail information for success criteria
- Configuration status w.r.t. specimen configuration during operation, GSE configuration, test set-up
- NCR status including a list of non-conformances issued during operations
- Time record, which lists the actual operation sequence. Raw data sheets if applicable like log sheets, minutes, data recording
- Procedure Variation Sheet

6.4.3 LOG BOOKS AND AIT FORMS

Log documentation:

A logbook will be established at the beginning of AIT activities and will be maintained up to date until delivery. It will contain log sheets that will be used to document all planned and unplanned events, supporting documentation will be added as necessary. In addition, a configuration list will be kept current to reflect the as-built status (ABCL) at any point of time.

The logbook will provide a complete traceability for all items being integrated or under test.

AIT change request (ACR)

The ACR is the only authorised way to significantly improve or modify an integration/test procedure when competent authority has already approved this one and there is not enough time to prepare a new issue. All changes will be justified and agreed prior to the event. ACRs will be approved at the same authority level in the organisation as it is the case for the integration/test procedure. ACRs will formally be handled via Document Change Requests (HP-2-ASED-DC-xxxx).

The ACR has to identify following issues:

- adding a new task
  The corresponding test sequence (step-by-step section) shall be included into the ACR file with clear definition sequencing
- suppressing a planned task
  The ACR shall clearly identify the test sequence of the current procedure to be cancelled.
- modifying a task already clearly defined

The ACR shall include the new issue of the test sequence to be updated.

The ACR can be the consequence of:

- change in test plan
- calculation, prediction analysis, thermal or mechanical models processing etc.
- analysis of preliminary result (coming form another test or processed during the test itself)
- unavailability of unit, test equipment, facility etc.
- unexpected limitation in capability of test equipment or test facilities
- non conformance and failure.

The ACR modifies an integration/test procedure and after agreement it becomes a part of this one, so the ACR does not justify to issue a specific test report, but it will be automatically included in the test report of the corresponding procedure.

Non-conformance reporting and control will be performed on any article or material which fails to meet the requirements of the contract as interpreted through drawings, technical specifications and integration/test procedures.

NOTE: Procedure variations will be covered by the procedure variation sheets, part of the working copy of each procedure.

6.5 PRODUCT ASSURANCE AND SAFETY

6.5.1 PRODUCT ASSURANCE

The product assurance requirements and responsibilities to be accomplished in order to build and ascertain an adequate quality level during all AIT operations performed on Herschel hardware are defined in AD 06.

6.5.2 QUALITY ASSURANCE GENERAL ACTIVITIES

In accordance with AD 06 a QA engineer shall be in charge ~~or~~ of AIT activities supervision from quality control point of view. His responsibilities include

- consideration of PA requirements in AIT documentation
- approval of integration and test procedures and test reports
- control of cleanliness and environmental conditions within AIT facilities
- inspection of qualification and flight hardware before integration
- verification of GSE status and test set-up
- verification of calibration validity of measurement equipment
- supervision of assembly and integration processes
- control of electrical mating and demating steps during the integration process
- visual inspections and reporting during all AIT activities including test phases and transportation including MIPs and KIPs
- control and management of module and system configuration and as-built status through the AIT sequence
- issuing of module and system logbooks
- participation in test meetings and reviews as defined in chapter 6.3
- approval of changes to the existing procedures
- initiation and processing of non-conformance reports
- organisation of Non-conformance Review Boards (NRB)

6.5.3 INSPECTION PROCEDURES AND REPORTS

Visual inspections are necessary to verify the satellite hardware status e.g. before and after each main integration and test phase. These inspections are to be considered as part of the general verification plan and shall be performed all along the AIT sequence. In order to systematically accomplish this tasks inspections shall be performed based on written procedures. These can be self-standing documents or integral parts of the integration and test procedures.

Each detailed inspection shall be reported in a specific inspection report. This report can be issued separately or incorporated in the corresponding integration or test report.

6.5.4 SAFETY

Safety requirements as defined in chapters 5 and 10 of AD 06 shall be followed as general rule.

The implementation of safety rules is made through dedicated emergency procedures (to be issued). These procedures shall define the emergency cases and the corresponding instructions to protect the satellite and the personnel at any time.

The implemented safety systems are mainly related to the following hazards:

- cryogenic temperatures, pressure and temperature within
  - HTT
  - HOT
  - CVV

  The HTT and HOT are protected with a staged safety system enabling to release pressure at different thresholds. The CVV is equipped with safety valves.

  Details about the Cryostat safety sysem are given the He-S/S specification and in the safety data package (HP-2-2ASED-DP-0001)

- toxicity of propellants, pressure in RCS

  Dedicated safety rules will be followed during RCS tank filling, draining and leak-test. These safety rules are defined by the SVM contractor who is responsible for the related tasks.

7 CLEANLINESS AND CONTAMINATION CONTROL

The detailed requirements on cleanliness and contamination control for Herschel EPLM and satellite AIT are comprised in the Contamination Control Plan, AD 05.

This chapter outlines only the major relevant requirements to be respected during Herschel AIT.

7.1 CLEANLINESS REQUIREMENTS

Cleaning and Cleanliness inspection for any Hardware entering the clean room class 100 is mandatory following approved procedures**.**

7.2 CLEANLINESS MONITORING ACTIVITIES

The following paragraphs list some of the cleanliness control measurements which are suitable and which shall be implemented in an appropriate manner.

- Standard-Cleanliness Monitoring

  Particulate and molecular cleanliness monitoring shall be performed during all phases of AIT, starting from the point of arrival of the hardware at the AIT site until launch.

- Witness Samples

  Witness samples have to accompany cleanliness sensitive surfaces and components. Samples have to be located close to critical surfaces or surfaces which are representative with respect to overall contamination.

  The witness samples have to be exchanged periodically in certain time intervals according to the contamination control plan. The samples will be tested by special laboratories with regard to particle fall-out and molecular contamination.

7.3 SPECIAL PROTECTIONS TO PREVENT CONTAMINATION

If special protections are necessary to prevent or limit contamination on sensitive optical surfaces and other equipment the associated requirements shall be respected and implemented for the detailed planning of AIT procedures with high priority.

Sensitive items include:

- Solar Array front surface (PVA)
- Optical Surface Reflectors on SVM and Sunshade
- RCS Thrusters and fill/drain ports
- ACMS sensors
- FPUs
- Optical Windows
- Telescope Reflector
- all inner surfaces of the Cryostat and the Helium Subsystem

8 FACILITIES AND TRANSPORTATION

8.1 INTEGRATION FACILITIES

The main integration facilities at Astrium GmbH sites used within the Herschel PLM and Satellite AIT program are:

- Clean room class 100 used for
  - PLM refurbishment after completion of STM test campaign and subsequent deintegration
  - mechanical and electrical integration and alignment of the PLM up to closure and evacuation of the CVV
  - first functional tests of FPUs with WUs mounted on SVM panels
- Clean room class 100,000 used for
  - incoming inspection of components
  - pre-integration of Hardware incl. functional testing
  - provision and cleanliness inspection of all PLM and SVM H/W before entering the class 100 area
  - final integration of EPLM and satellite
  - He-I filling and He-II production
  - functional testing on EPLM and satellite before transportation to test facility

These integration facilities are standard for AIT of optical space payloads and satellites.

The main dimensions and capabilities for the integration facility at Astrium GmbH in FN are as follows:

Facility FN	Data	Remarks
Cleanroom Class 100	17.5 x 10 x 12 m (LxWxH)	
Cleanroom Class 100,000	36.5x17.5x12 m (LxWxH)	
Crane capacity	Two cranes : 50 000 N 100,000 N	Enables the handling with two cranes
Crane height (under hook)	10 m	In class 100 and In class 100,000
Seismic mass	5 000 kg Size 2.6 x 3.6 m	For optical alignment
Illumination	Additional halogen floodlight	Prevents electro magnetic disturbances and ionisation of dust particles
Air supply	particle and active carbon filters	

Tab. 8-1: Main Dimensions and capabilities of Astrium integration facility in FN

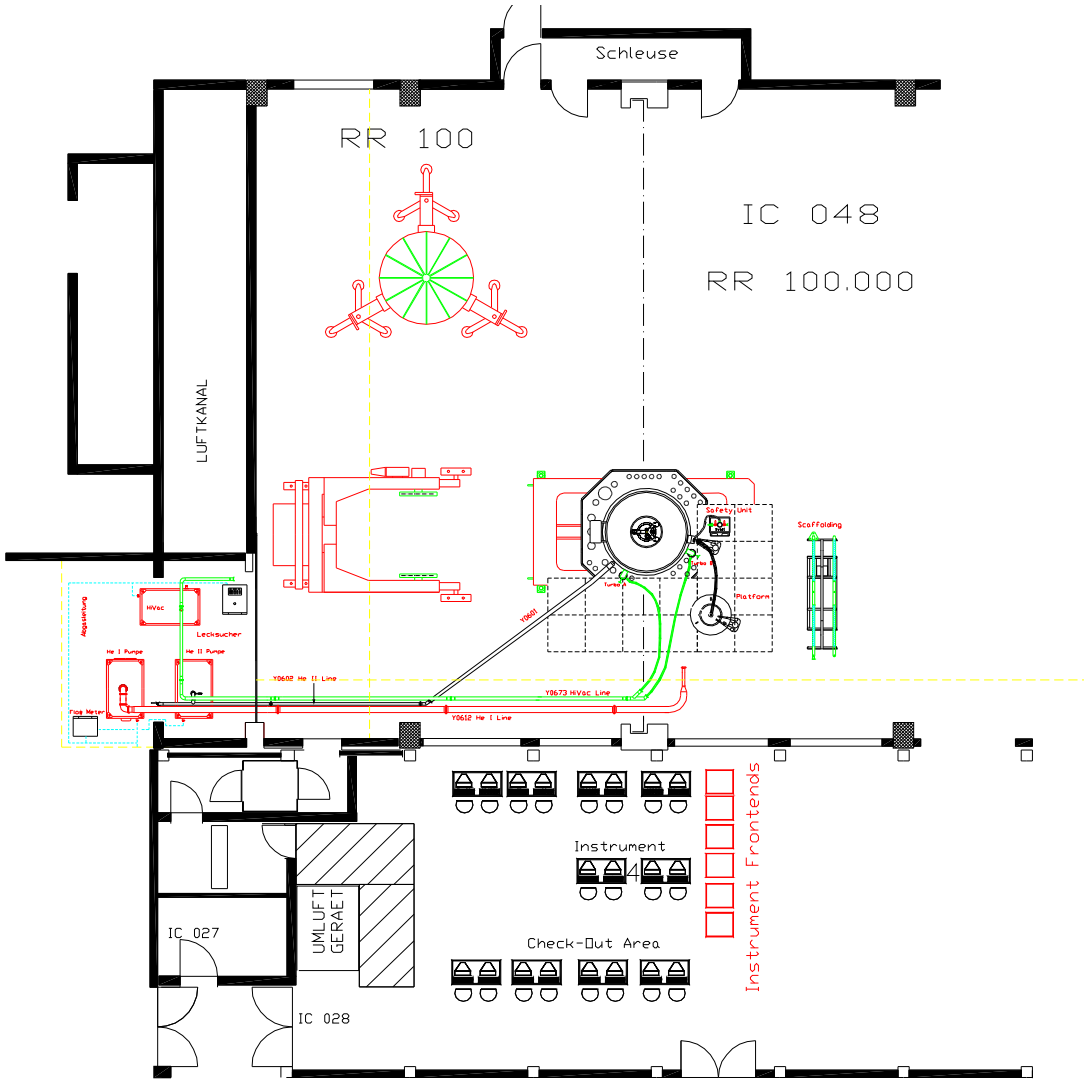


Fig. 8-1: Integration facility at Astrium FN

8.2 TEST FACILITIES

In addition to the integration facilities the following test facilities at ESTEC will be used for the PFM test campaign.

- Shaker for PFM Satellite Acceptance Level Sine Vibration Tests — ESTEC HYDRA Shaker
- Acoustic Noise Chamber for PFM Satellite Acceptance Level Test — ESTEC LEAF
- Anechoic Chamber for PFM Satellite EMC tests — ESTEC LEMC
- Thermal Vacuum Chamber for PFM Satellite TB/TV test — ESTEC LSS
- Weighing Machine for Mass Determination — ESTEC

8.3 TRANSPORTATION

The following major transport and movement activities are foreseen in the PFM PLM and Satellite AIT sequence prior to shipment of the qualified and accepted satellite to the launch site.

- The PFM SVM will be transported from ALENIA to the ASTRIUM Satellite AIT facility for mating with the PLM
- After completion of satellite integration and subsequent first functional tests the satellite will be transported from the ASTRIUM AIT facility to the Environmental Test Site at ESTEC for completion of qualification and acceptance environmental testing
- Within the Environmental Test Site the satellite will be moved between different environmental test facilities and the corresponding preparation areas.

All transportation and movement will be under AIT and QA supervision.

9 GROUND SUPPORT EQUIPMENT (GSE)

The purpose of GSE is to support the Herschel PLM and Satellite AIT activities as non flight equipment's. The GSE ensures that the function of

- integration and handling
- transportation
- optical alignment
- testing and verification

of the Hardware and Software in their intended environment are fully supported and carried out easily and safely (refer also to chapter 13 of the PA Plan AD 06).

All measurement equipment foreseen to be used for qualification, acceptance or performance verification tests will be subject to agreed calibration process. It will be ensured that these items are within the normal calibration periods at the time of tests.

Utilisation of GSE elements during the various integration and test steps are described in the detailed activity sheets in annex 1.

9.1 MECHANICAL GROUND SUPPORT EQUIPMENT (MGSE)

The following MGSE will be used during the various phases of PLM and satellite AIT:

MGSE reused from ISO		
Item	**No.**	**Reference**
ISO PLM Integration dolly	1	ISO-VV-ZYYR-SP-0043
ISO Hoisting equipment SN02 / SN 01	1	ISO-VV-ZYYY-SP-0048141121
ISO Test dolly SN02	1	ISO-VV-ZYYX-SP-0473
ISO Test dolly (enlarged) SN03	1	-
Heavy duty working platform	1	-
Load cells with strap pretension gauge	16	-
Small overhead crane (CR 100)	1	142127

Tab. 9-1: MGSE Equipment reused from ISO

HERSCHEL PLM and Spacecraft MGSE		
Item	**No.**	**Reference**
Transport Container H-TSC	1	141110
Vertical Lifting Device VLD	1	142122
Horizontal Lifting Device (beams) HLDB	1	142124
General Purpose hoisting Device GPHD	1	142125
Hoisting sling set HSL	2	142126
Support Trolley for Rotary Table STR	1	142140

HERSCHEL PLM and Spacecraft MGSE		
Item	**No.**	**Reference**
Mobile Access Platform MAP	1	142115
Handling and Transport Adapter for PLM I/F ADA	1	142133
Vibration Adapter for S/C I/F VAS	1	141130
Thermal test Adapter for PLM I/F TTAP	1	142135
Thermal test Adapter for S/C I/F TTAS	1	141140
Alignment Adapter PLM I/F for Rotary Table AAP	1	142137
Alignment Adapter S/C I/F for Rotary Table AAS	1	141150
Movable Cabinets/Handcarts for:	Tbd	
• MGSE items HCM 1+2	2	142152-01+02
• Flight H/W items HCH 1+2	2	142152-03+04
• Break Out Boxes and adapter cables HCB 1+2	2	142152-05+06
• MLI parts HCML 1+2	2	142152-07
• Vacuum circuit items HCV 1+2	2	142152-08
Mass Dummy for MGSE purpose	1	142139
Rotary Table RT	1	142116

Tab. 9-2: HERSCHEL PLM and S/C MGSE items

HERSCHEL SVM MGSE		
Item	**No.**	**Reference**
Equipment Panel Trolley EPT	1-8	
Panel Tilting Trolley PTT	1+2	
Equipment Panel Lifting Device ELD	1	
SVM Stiffener Set SSS	1	
Multi Purpose Trolley MPT	1+3	
Vertical Integration Stand VIS	1+3	
SVM Lifting Device SLD	1+3	
Transport and Handling Adapter THA	1+3	
Handling Clamp Band CB	1+3	
Test Clamp Band TCB	1+3	
RCS Loading Equipment PPLE	1+2	

HERSCHEL SVM MGSE		
Item	**No.**	**Reference**
Ground Half Coupling GHC	1+2	
Simulate Loading Equipment	1+2	
Leak Test Equipment	1+2	
Pump purge Equipment PPE	1+2	
ACMS Sensor protective covers	1+2	
Thruster protective covers	1+2	
OSR protective covers	1+2	
SVM Container TSCS	1	
Equipment Drive Unit EDU	1	

Tab. 9-3: HERSCHEL SVM MGSE items

HERSCHEL EPLM Subsystem and Equipment MGSE		
Item	**No.**	**Reference**
SSH/SSD Container	**1**	
SSD Protective Devices		
HERSCHEL Telescope Container	1	
HERSCHEL Telescope Protective Cover	1	
Optical Bench Transport Container	1	
Instruments Transport Container (HIFI, PACS and SPIRE)	1 each	

Tab. 9-4: HERSCHEL EPLM Subsystem and Equipment MGSE

MGSE Items from XMM project		
Item	**No.**	**Reference**
Multi Purpose Trolley MPT (already at APCO for refurbishment)	1	142111
Leveling Jacks for MPT (already at APCO for refurbishment)	1	142111
Equipment Drive Unit EDU (already at APCO for refurbishment)	1	142151
I/F support to LEAF ISL	1	From ETS at ESTEC 141180
Mech. Test Adapter for acoustic noise test MTA-B	1	From ETS at ESTEC 141170
Pump Purge Equipment for ISL pressurization PPE-C	1	
Vertical Support Stand VSS	1	142112
Handling and Transport Adapter HTA.D (---)	1	142131
Clamping Band CB-A ( )	1	
Clamping Band CB-B (for test)	1	
Scaffolding AP-D	1	142114
Thermal Test Adapter TTA	1	141160
Horizontal Lifting Device HLD	1	142123
Weight plates for HLD		142123
Mass Property Adapter MPA-B	1	At ESTEC
Integration and Alignment Adapter IAA	1	
Pump Purge Equipment for Instrument purging PPE-B	1	

Tab. 9-5: MGSE Items reused from XMM (provided by ESTEC)

9.2 ELECTRICAL GROUND SUPPORT EQUIPMENT (EGSE)

The following EPLM (Tab. 9-6) and Satellite (Tab. 9-7) specific electrical ground support equipment is required for the PFM EPLM and PFM satellite integration and test sequence.

A schematic of the PFM PLM and PFM Satellite EGSE is shown in Fig. 9-1 and ig. 9-2.

Equipment		No.	Reference
Instrument EGSE	(from EQM)	1	PTI No. 111520
Backup Instrument EGSE	from EQM	1	PTI No. 1125...
Central Checkout System (CCS) light	from EQM	1	PTI No. 142210 (EPLM)
Cryo SCOE	new	1	PTI No. 142220 (EPLM)
CDMU Front End	from EQM	1	PTI No. 142230 (EPLM)
PLM SCOE	from EQM	1	PTI No. 142240 (EPLM)
Test cabling	from EQM (?)	1	PTI No. 142250 (EPLM)
Brake out Boxes (BOB) and savers set	from EQM (?)	1	
IDAS		1	
Set of standard measurement equipment		1	

Tab. 9-6: EPLM PFM EGSE Items

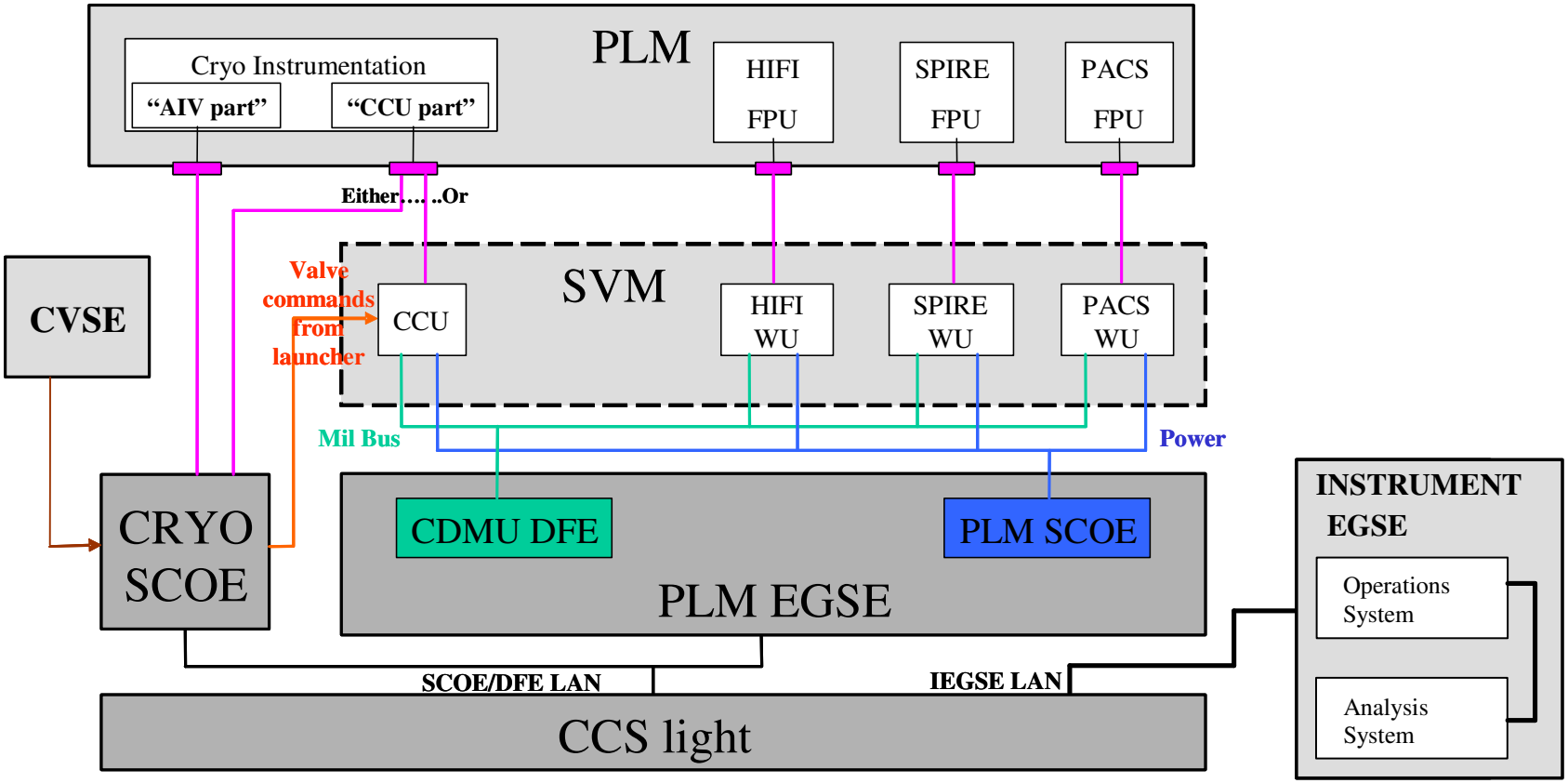


Fig. 9-1: PFM PLM EGSE Configuration

Equipment		No.	Reference
Instrument EGSE	from PLM PFM	1	PTI No. 111520
Backup Instrument EGSE	from PLM PFM	1	PTI No. 1125…
Cryo SCOE	from PLM PFM	1	PTI No. 142220 (EPLM)
Central Checkout System (CCS)	from Alenia	1	PTI No. 141210
CDMU SCOE	from Alenia	1	PTI No. 141220
Power SCOE	from Alenia	1	PTI No. 141230
ACMS SCOE	from Alenia	1	PTI No. 141240
TT&C SCOE	from Alenia	1	PTI No. 141250
TM/TC FEE	from Alenia	1	PTI No. 141260
Cables (set)	from Alenia	1	ASPI PTI No. 3A218
BOB and savers (set)	from Alenia	1	ASPI PTI No. 3A219
IDAS		1	
Set of standard measurement equipment		1	

Tab. 9-7: PFM Satellite EGSE Items

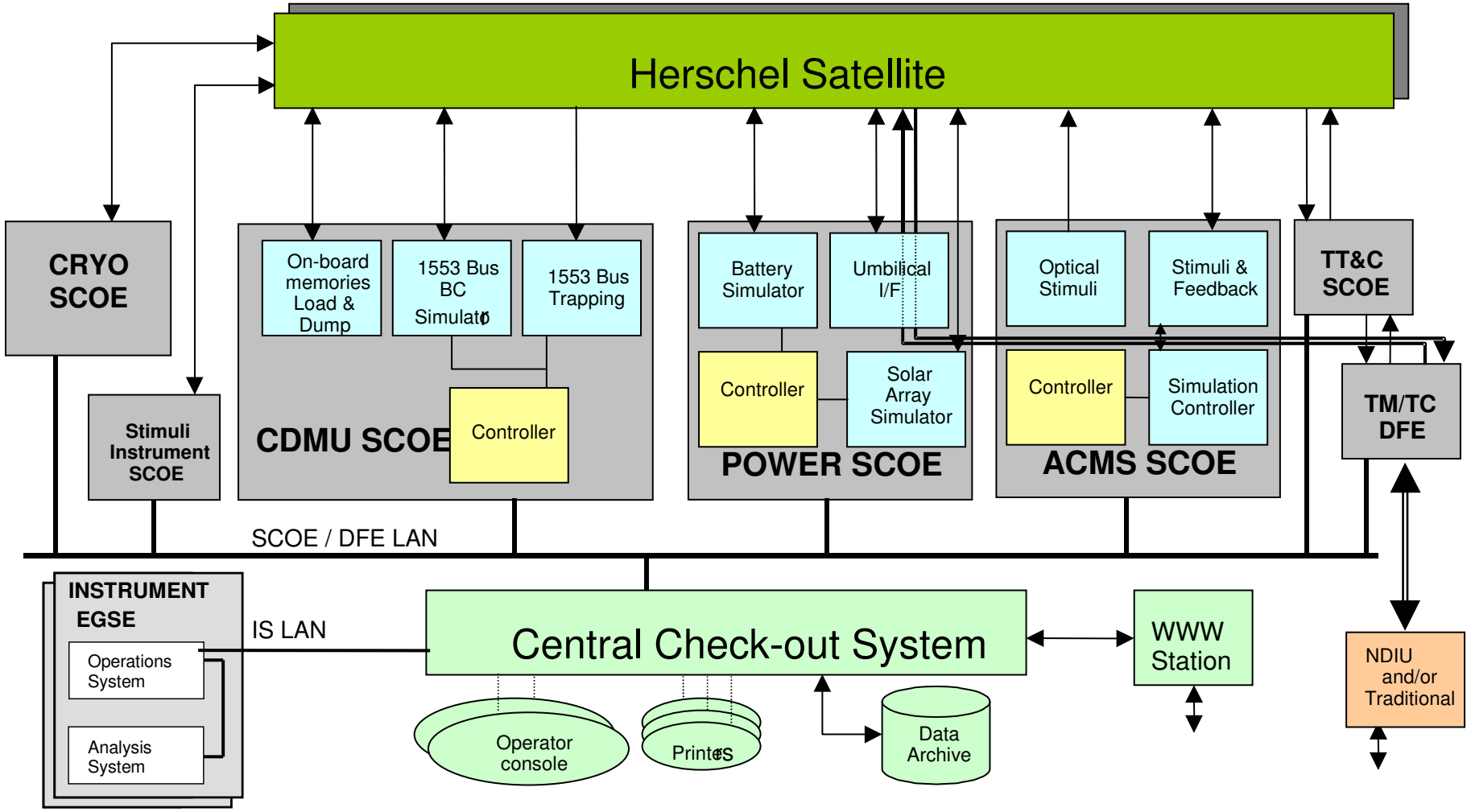


Fig. 9-2: PFM Spacecraft EGSE Configuration

9.3 CRYO VACUUM SERVICE EQUIPMENT (CVSE)

The CVSE is used to support all vacuum and cryogenic ground activities for both, the Herschel EPLM and Satellite.

The CVSE shall ensure that the function of the Herschel Cryo/vacuum system in its intended environment is fully supported and carried out easily and safely. The CVSE must be able to cover the Herschel EPLM-He S/S requirements starting with the EPLM integration and ending with the launch campaign of the Herschel flight model.

The CVSE will allow the following basic operations with the Herschel EPLM and Satellite:

- Global and local leak checks of the cryogenic system and its elements
- Evacuation and leak check of the cryostat isolation system
- Cool-down of the auxiliary He-I tank (HOT) and the He-II tank (HTT) from ambient to Lhe temperatures
- Filling of the HOT and HTT with He-I with the X-axis in vertical orientation
- Production and refilling (top up) of He-II in HTT
- conversion to He-I
- Warm up of the HTT and HOT from Lhe temperatures to ambient temperature
- Cooling of the cryostat cover by flushing to T(Lhe)
- Bake-out of the cryostat by flushing of the He subsystem with gaseous, warm (350 K) nitrogen

A list of major CVSE equipment and installations is given in the following Tab. 9-8. The complete list can be found in RD11.

CVSE Item No.	Item	Main Function	Amount	Reference	Remarks
C-01-01	Lhe Service Vacuum Pumping Unit I	Lhe II production and Lhe II top-up	2	NSB 301000	
C-01-02	Lhe Service Vacuum Pumping Unit II	Obtain Lhe II conditions during operation and testing	2	NSB 302000	
C-01-03	Main High vacuum Pump Unit	Insulation vacuum for CVV	1	NSB 303000	Connection I/F by two Turbo Pumps
C-01-04	Mobile High Vacuum Pump Unit	Insulation vacuum for CVV	1	NSB 304000	Connection I/F by own Turbo Pump
C-01-05	Turbo Pumping Unit	Insulation vacuum for CVV	3	NSB 305000	Turbo Molecular Pump
C-01-09	Remote unit	Pump control and check out equipment	2	NSB 305000	
C-03-01	Leak – detector	leak-test of CVV and tubing / transfer-lines/ piping etc.	2	D154-81-880	
C-01-02-B	Flow meter / He II	Measurement of Helium flow through OBA during tests in He II condition	1		Mounted on exhaust of He II pump unit
C-01-07	Laboratory pump	Safety Unit and transfer-lines prep. Bench	2	NSB 306000/tbd	One ex proofed
	Evacuate ports	Pumping I/F for generation/ maintenance of the isolation vacuum	4	Stöhr DW 26-234	Connected to P921/922 I/F and turbo pumps
C-02-01	Lhe supply dewars 450 L	Transport and storage of liquid helium, during cooling down and filling and during He II operations	10		2 dewars are property of Herschel 8 dewars reserved for Herschel

CVSE Item No.	Item	Main Function	Amount	Reference	Remarks
C-03-02	Flow meter unit	He I outlet or exhaust / 0-5g	1		With different measurement ranges of the flow meters
C-04-02-A/B	Safety unit	Supported the installation of transfer lines inside the He sup-system	2		Included C-01-07 Laboratory pump and P0623 / SV 0623 (one ex proof)
C-05-xx	He-I/He-II transfer lines	He I cool-down and/or filling He II production & top-up Transfer from dewar to dewar	6		Different length
C-05-03	Y0301-1 He I Flushing – line	Cooling of cover	1	TBD	cover flushing
C-05-04-A/B/C	Pumping – lines	Interface to V502, He exhaust or pumping line; Interface to He II transfer line and He II pump	5		
C-06-01	Heater unit	Bake out of He S/S	1		
C-07-01-A	Scaffolding	Preparation bench for He I and He II transfer – lines	1		Included C-01-07 Laboratory pump
	Filling airlock	I/F to CVV for Lhe operations	2	HP-2-ASED-ID-0009.01-0A	
	Miscellaneous vacuum parts	Support for cryogenics and vacuum operation	1 set		

Tab. 9-8: CVSE Equipment List

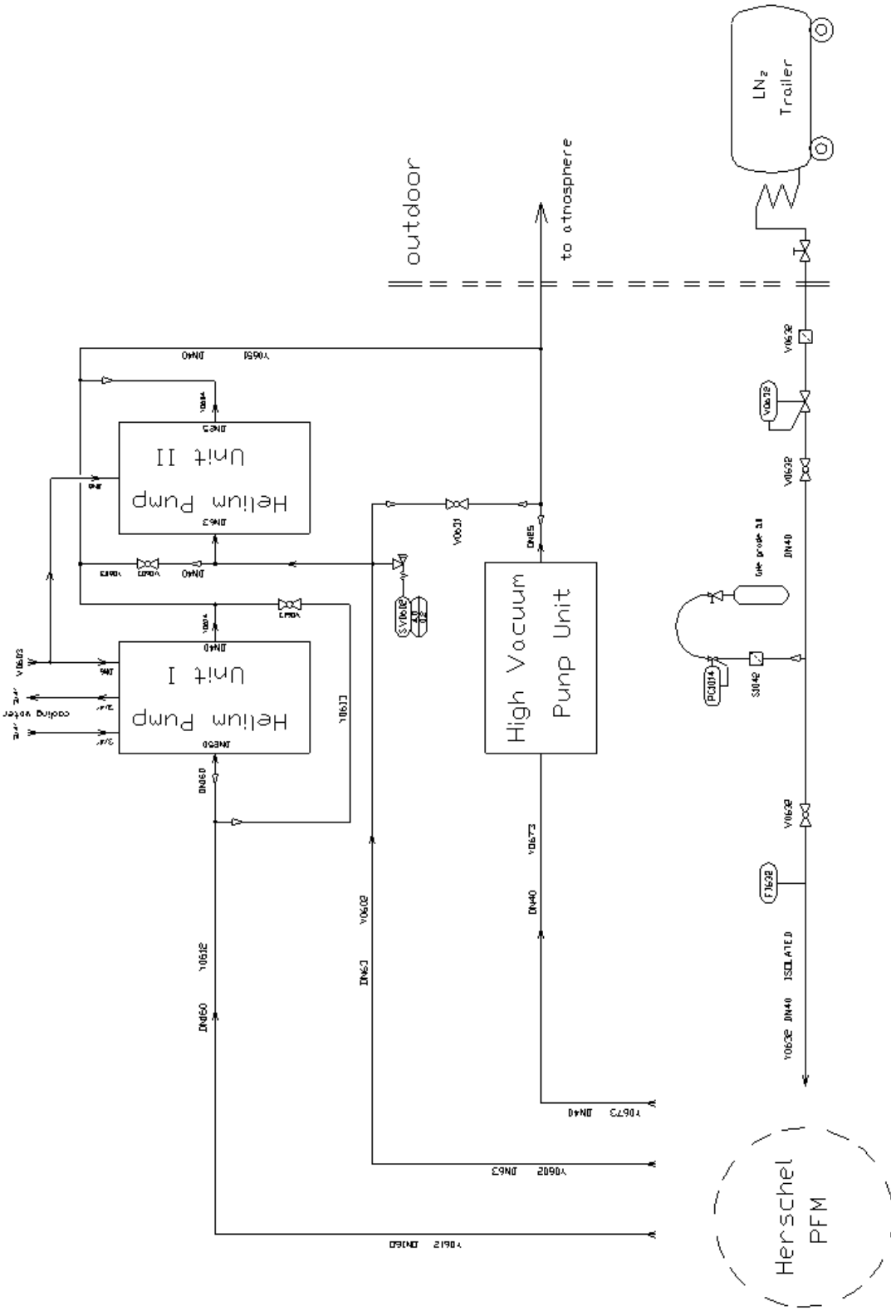


Fig. 9-3: CVSE Flow Schematic

The test set-up for helium filling and He production activities is shown in Fig. 5-1 of chapter 5.1.9.1. CVSE set-up for instrument tests is shown in the figure below.

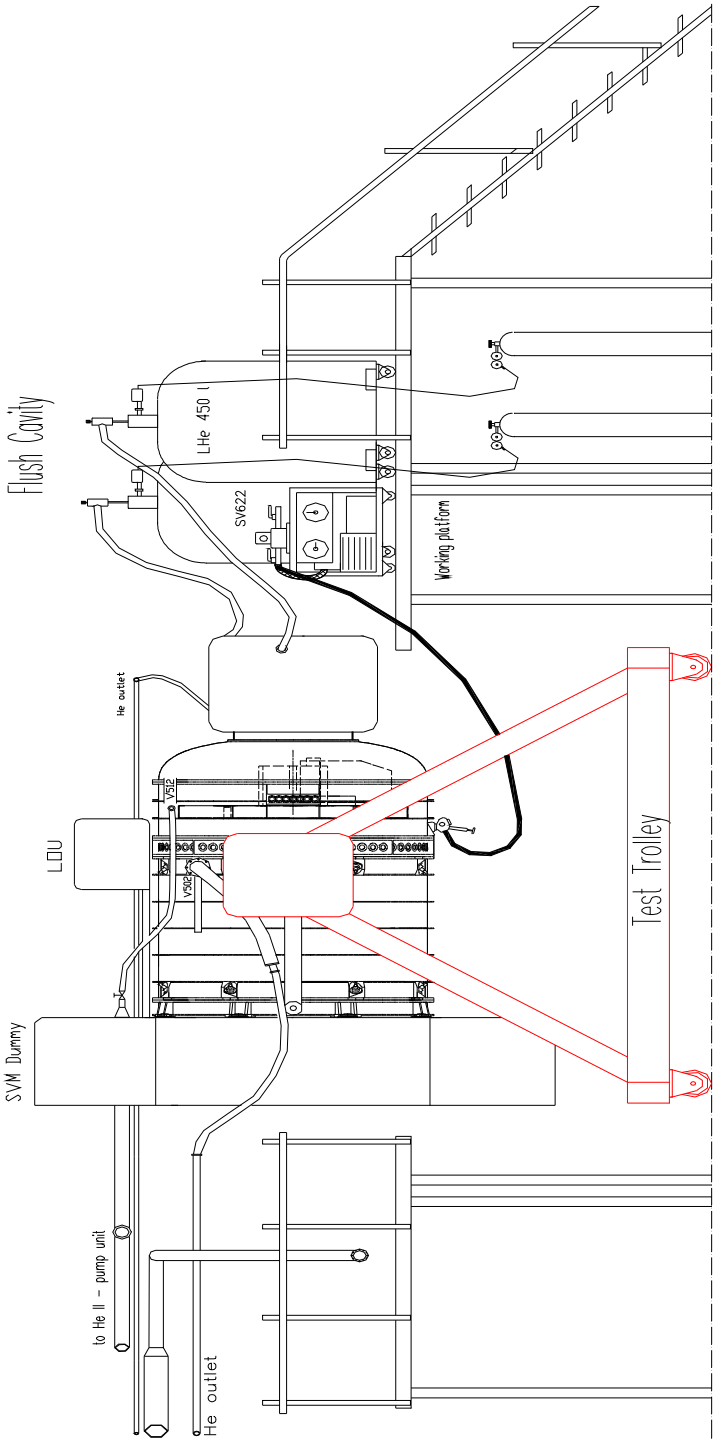


Fig. 9-4: Test Set-up for Instrument and Integrated Module Tests (IMT)

9.4 OPTICAL GROUND SUPPORT EQUIPMENT (OGSE)

The alignment concept proposed for Herschel is chosen such that standard laboratory products can be used to a large extend for the OGSE. Most of the equipment is already available at Astrium, but some may need to be adapted for Herschel. In the following table the main equipment needed for Herschel system level alignment activities is shown.

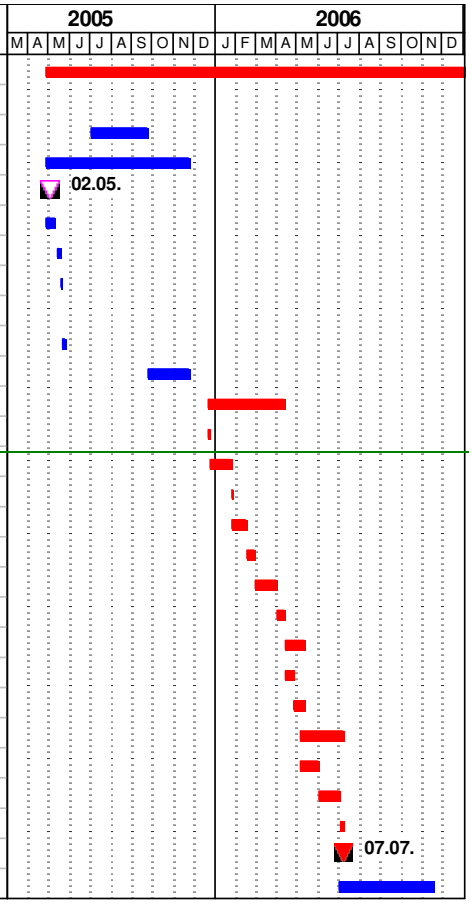
No.	Qty	Equipment	Description/Reference
1	2	Theodolite	Wild T2000 S or equivalent
2	1	Linear Measurement Device	For axial and lateral distance measurements
3	2	Angular Transfer Prism	As reference for azimuth
4	2	LOU Alignment Camera	LOU alignment and alignment monitoring
5	tbd	Alignment reference cubes	For OB, CVV.....
6	1	Support Structure for LMD	For vertical and horizontal measurements
7	1	Tripod	For Theodolite Height appr. 7m
8	1	Adjustable support for PLM or use of a rotary table	For precise levelling of the PLM
9	1	Adapter	For SVM I/F
10	1	Adapter	For PLM I/F
11	1	Cherry Picker	

Tab. 9-9: OGSE / Alignment Equipment List

10 AIT SCHEDULE

~~Fig. 10-1 and Fig. 10-3 show the actual planning status of the EPLM PFM and satellite PFM AIT activities, as described in this plan. Please note that these bar charts are given for information only. They will not necessarily be kept up to date for each programme planning evolution. Valid schedule information can be found in the official programme master schedule at mutually any time.~~The AIT schedule is given in the schedule report HP-2-ASED-RP-0142, updated on a regular basis.

Nr.	Task Name	Start	End
1	**PFM Acceptance Phase Major Milestones**	**Mo 25.04.05**	**Do 12.07.07**
14	Integration need Dates for PFM Acceptance Phase	Mo 18.04.05	Mo 07.08.06
28	**Receive PFM Instruments**	**Fr 01.07.05**	**Do 22.09.05**
35	**PFM Warm Units Integration (CR 100.000)**	**Mo 25.04.05**	**Di 22.11.05**
36	*Delivery FM SVM Support Panels - current*	*Mo 02.05.05*	*Mo 02.05.05*
37	**EGSE & CCS Setup**	**Mo 25.04.05**	**Mo 09.05.05**
41	preparation of SVM FM panels in CR 100.000	Do 12.05.05	Di 17.05.05
42	integration of harness support brackets etc.	Mi 18.05.05	Mi 18.05.05
43	*FM CCU Delivery*	*Mi 15.09.04*	*Mi 15.09.04*
44	**Integration PFM CCU**	**Do 19.05.05**	**Mi 25.05.05**
47	**Integration Instruments Warm Units**	**Fr 23.09.05**	**Di 22.11.05**
55	**PLM PFM Integration in CR 100**	**Mo 19.12.05**	**Mi 12.04.06**
56	**Preparation of PLM**	**Mo 19.12.05**	**Fr 23.12.05**
61	**Opening of Cryostat**	**Fr 23.12.05**	**Mo 23.01.06**
75	***Inspection PLM PFM***	Di 24.01.06	Di 24.01.06
76	**Instrument FPU integration**	**Mi 25.01.06**	**Mi 15.02.06**
85	**Instrument Integration Test**	**Do 16.02.06**	**Mo 27.02.06**
92	**Cryostat Closure**	**Mo 27.02.06**	**Do 30.03.06**
107	**Evacuation & leak test**	**Do 30.03.06**	**Mi 12.04.06**
114	**PLM PFM Integration in CR 100.000**	**Mi 12.04.06**	**Do 11.05.06**
115	**Integration of SVM panels**	**Mi 12.04.06**	**Mo 24.04.06**
118	**PLM PFM external completion**	**Mo 24.04.06**	**Do 11.05.06**
128	**PLM PFM Testphase at ASED**	**Fr 05.05.06**	**Fr 07.07.06**
129	**Cooldown & Filling, Cold SFT's**	**Fr 05.05.06**	**Di 30.05.06**
139	**Integrated Module Test**	**Mi 31.05.06**	**Mo 03.07.06**
145	**EMC test (CE only)**	**Di 04.07.06**	**Fr 07.07.06**
150	conversion to He I	Fr 07.07.06	Fr 07.07.06
151	**SAT PFM Testphase at ASED**	**Fr 30.06.06**	**Fr 17.11.06**



~~Fig. 10-1: PFM PLM integration and test schedule~~

Nr.	Task Name	Start	End
151	**SAT PFM Testphase at ASED**	**Fr 30.06.06**	**Fr 17.11.06**
152	**Preparation SVM/PLM mating**	**Mo 10.07.06**	**Fr 21.07.06**
164	**SVM/PLM mating**	**Fr 30.06.06**	**Mi 16.08.06**
177	**Satellite Integration**	**Mi 16.08.06**	**Mo 11.09.06**
178	integration of thermal test and vibration test instrui	Mi 16.08.06	Mi 23.08.06
179	transfer from MPT to rotary table	Mi 16.08.06	Do 17.08.06
180	integration of telescope mounting structure	Do 17.08.06	Fr 18.08.06
181	alignment of TMS	Mo 21.08.06	Mo 21.08.06
182	integration of telescope FM	Mo 21.08.06	Mi 23.08.06
183	alignment of telescope	Mi 23.08.06	Fr 25.08.06
184	transfer from rotary table to MPT	Fr 25.08.06	Mo 28.08.06
185	integration of telescope instrumentation	Mo 28.08.06	Mo 28.08.06
186	integration of telescope harness	Di 29.08.06	Di 29.08.06
187	integration of telescope MLI	Di 29.08.06	Mi 30.08.06
188	*Delivery PFM HSS - current*	*Mi 16.11.05*	*Mi 16.11.05*
189	preintegration of 3 solar array panels with instrum	Mo 21.08.06	Mo 28.08.06
190	integration of solar array assembly with struts to C	Mi 30.08.06	Fr 01.09.06
191	integration of instrumentation and harness	Fr 01.09.06	Fr 01.09.06
192	closure of MLI	Mo 04.09.06	Mo 04.09.06
193	integration of sunshade assembly with struts to C'	Di 05.09.06	Mi 06.09.06
194	integration of instrumentation and harness	Do 07.09.06	Do 07.09.06
195	closure of MLI	Do 07.09.06	Fr 08.09.06
196	integration of SVM thermal shield	Fr 08.09.06	Mo 11.09.06
197	**He II Production & top up**	**Mo 11.09.06**	**Di 19.09.06**
203	**Integrated System Test 1**	**Do 14.09.06**	**Mo 30.10.06**
204	IST 1 - S/S SFT's	Do 14.09.06	Mo 16.10.06
205	System Functional Performance Tests	Mo 16.10.06	Mo 30.10.06
206	Conversion to He I	Mo 30.10.06	Mo 30.10.06
207	Disconnection SVM EGSE	Mo 30.10.06	Mo 30.10.06
208	**Preparation & Transport to ESTEC**	**Di 31.10.06**	**Fr 17.11.06**
209	Preparation for transport	Di 31.10.06	Do 02.11.06
210	refilling/depletion to 50% for transport to ESTEC	Di 31.10.06	Mi 01.11.06
211	Disconnection CVSE	Do 02.11.06	Do 02.11.06
212	disconnection Cryo SCOE	Do 02.11.06	Do 02.11.06
213	transfer from MPT to transport container	Fr 03.11.06	Fr 03.11.06
214	Connection of TSMU	Fr 03.11.06	Fr 03.11.06
215	packing and transport to ESTEC	Mo 06.11.06	Fr 17.11.06
216	**SAT PFM Testphase at ESTEC**	**Mo 20.11.06**	**Do 12.07.07**

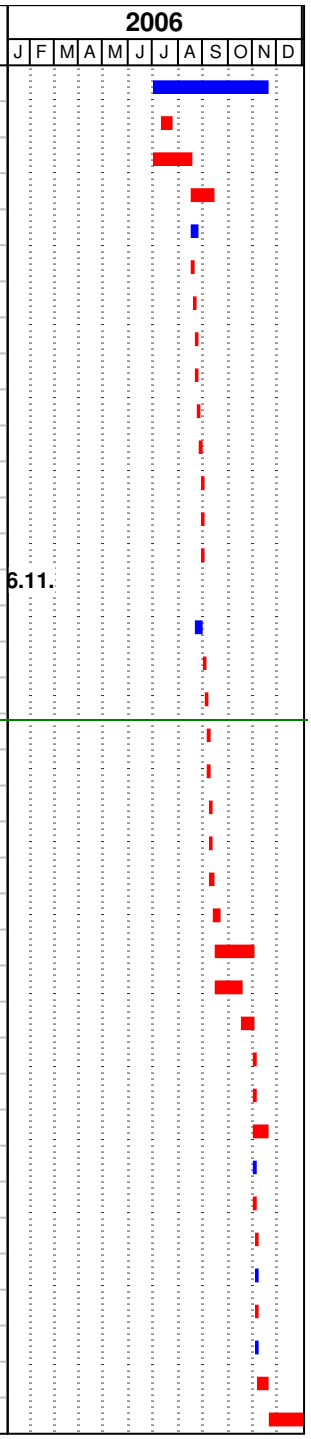


Fig. 10-2: PFM Satellite Integration and test schedule at Astrium

Nr.	Task Name	Start	End
216	**SAT PFM Testphase at ESTEC**	**Mo 20.11.06**	**Do 12.07.07**
217	**Setup at ESTEC**	**Mo 20.11.06**	**Fr 24.11.06**
227	**System Validation Test (SVT1)**	**Fr 24.11.06**	**Mi 10.01.07**
232	**Preparation for TB/TV test**	**Fr 01.12.06**	**Sa 13.01.07**
239	**Set-up in LSS**	**Mi 10.01.07**	**Fr 26.01.07**
253	**TB/TV test**	**Sa 27.01.07**	**So 25.02.07**
254	chamber closure	Sa 27.01.07	Sa 27.01.07
255	pumping	Sa 27.01.07	Sa 27.01.07
256	cooldown of shrouds / CVV	Sa 27.01.07	Sa 27.01.07
257	TB/TV test (phases tbd)	So 28.01.07	So 25.02.07
258	tilting of S/C on request (PPS test, instrument test	So 25.02.07	So 25.02.07
259	alignment with alignment camera, videogrammetr	So 28.01.07	So 25.02.07
260	**Post test activities**	**Mo 26.02.07**	**Mo 12.03.07**
277	**EMC test**	**Di 13.03.07**	**Di 27.03.07**
278	HOT filling for transport to EMC chamber	Di 13.03.07	Di 13.03.07
279	moving of S/C into EMC chamber	Di 13.03.07	Mi 14.03.07
280	connection of EGSE and CVSE	Mi 14.03.07	Do 15.03.07
281	EMC test (RS, RE)	Do 15.03.07	Di 27.03.07
282	conversion to He I	Di 27.03.07	Di 27.03.07
283	disconnect EGSE and CVSE	Di 27.03.07	Di 27.03.07
284	**Preparation for Vibration**	**Mi 28.03.07**	**Do 05.04.07**
293	**Vibration Test**	**Di 03.04.07**	**Mi 09.05.07**
294	integration of vibration adapter onto HYDRA	Di 03.04.07	Mi 04.04.07
295	transfer of S/C to HYDRA	Di 10.04.07	Di 10.04.07
296	connection of EGSE, vibration instrumentation	Mi 11.04.07	Mi 11.04.07
297	preparation of setup for refilling (connection of CV	Do 12.04.07	Do 12.04.07
298	final HTT topping	Do 12.04.07	Do 12.04.07
299	SFT 15 - short functional test - cold	Fr 13.04.07	Fr 13.04.07
300	vibration 3 axis (incl. HTT topping)	Mo 16.04.07	Do 26.04.07
301	microvibration measurement by activating the rea	Fr 27.04.07	Fr 27.04.07
302	SFT 16 - short functional test - cold	Mi 02.05.07	Mi 02.05.07
303	disconnection of test harness and EGSE	Do 03.05.07	Do 03.05.07
304	transfer from HYDRA to rotary table	Do 03.05.07	Do 03.05.07
305	alignment check	Fr 04.05.07	Fr 04.05.07
306	transfer from rotary table to MPT	Mo 07.05.07	Mo 07.05.07
307	moving of S/C to LEAF	Di 08.05.07	Di 08.05.07
308	connection of test harness	Mi 09.05.07	Mi 09.05.07
309	**Acoustic noise test**	**Do 10.05.07**	**Mi 30.05.07**
323	**Integrated System Test (IST2)**	**Do 24.05.07**	**Di 10.07.07**
330	**Physical properties**	**Mi 11.07.07**	**Do 12.07.07**
331	transfer to physical property area	Mi 11.07.07	Mi 11.07.07
332	mass measurement	Do 12.07.07	Do 12.07.07
333	***S/C delivery to Alcatel***	***Do 12.07.07***	***Do 12.07.07***

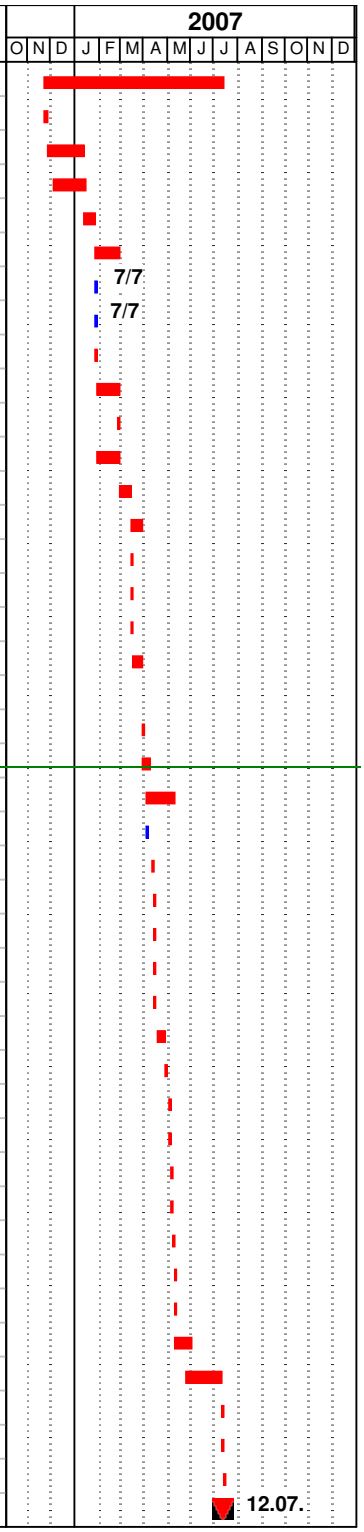


Fig. 10-3: PFM Satellite Integration and test schedule at ESTEC

ANNEX 1 ACTIVITY SHEETS

A1.1 CONTENTS OF ACTIVITY SHEETS

The individual activities presented in the detailed AIT flow, see chapter 5.2, are described in the AIT activity sheets. These sheets present the following information:

- Activity identification (ID)
- Duration (in working days)
- Activity Name (accordance to AIT sequence)
- Objective
- Requirements to be verified
- Environment
- Specimen configuration (at the beginning of the task)
- Activity breakdown
- Applicable documents
- GSE required
- Facility / Instrumentation
- Personnel (AIT and QA)
- Safety Precautions Special Notes
- Special Notes

A1.2 LIST OF ACTIVITY SHEETS

Number	Activity/Definition	Remark
	Start of PFM- Acceptance Test Phase	
F.010.000	**Instrument WU and SVM panel preparation (parallel to F.020.000)**	
F.010.010	Preparation of EGSE and CCS set- up	
F.010.020	Mechanical Integration of WUs on SVM panel	
F.010.030	Electrical Integration of WUs on SVM panel	
F.010.040	FPU Simulator integration	
F.010.050	Functional Tests of WUs	
F.010.060	FPU simulator & EGSE de-integration	
F.010.070	Cleaning & Transport of ~~WUs on~~ SVM panels to CR100	
F.020.000	**PFM Cryostat Integration in CR 100**	
F.020.010	PLM Refurbishment activities	
F.020.020	Mechanical/ thermal integration of FM FPUs on OB	
F.020.030	Alignment of instruments versus OB/CVV	
F.020.040	Connection of SIH to FPUs and I/F checks	
F.020.050	Connection of WUs with FPUs ~~to SVM brackets~~	
F.020.060	Instrument Integration Test	
F.020.065	Disconnection of WUs from FPUs	
F.020.070	Integration of adsorbers	
F.020.080	Integration of OBA shield incl. instrumentation	
F.020.090	Assembly of pre-integrated upper shields	
F.020.100	Integrate upper bulkhead, connect airlock, leak test of FP & SV121	
F.020.110	Integration & Alignment of LOU	
F.020.120	Integration of cryostat cover and cryostat baffle	
F.020.130	Install vacuum pumps, evacuation and leak check	
F.020.140	Transport to Cleanroom 100,000	
F.030.000	**PLM external Completion**	
~~F.030.010~~	~~Mechanical integration of SVM panels onto STM SVM~~	
~~F.030.020~~	~~Connection of SIH, CCH & waveguides to Wus~~	

Number	Activity/Definition	Remark
F.030.030	Connect EGSE and perform Short Functional Test warm	
F.030.035	Bake-out	
F.030.040	Integration of LOU alignment camera	
F.040.000	**He-I ~~and He-II~~ Activities**	
F.040.010	Preparation for cool down and filling	
F.040.020	Cooldown and filling of HTT	
F.040.030	alignment verification and adjustments during cool down	
F.040.040	SFT at He-I (cryostat & instruments)	
~~F.040.050~~	~~Production of He-II and top up~~	
~~F.040.060~~	~~SFT at He-II (cryostat & instruments)~~	
F.045.000	**PLM / SVM Mating**	
F.045.010	Mating of instrument panels with SVM FM (offline activity)	
F.045.020	De-mating of SVM STM from PLM; removal of STM Star Tracker	
F.045.030	Preparation & Mating of PFM SVM and PLM	
F.045.040	Integration & Alignment of Star Tracker	
F.045.050	Connection of SIH, CCH and Waveguides to WUs	
F.045.050	Preparation and connection of S/C EGSE	
F.050.000	**Integrated ~~Module~~ System Test (~~IMT~~IST 1)**	
F.050.005	Production of He-II and top up	
F.050.006	SFT at He-II (cryostat & instruments)	
F.050.010	Cryostat tests (CCU & instrumentation)	
F.050.020	HIFI tests (IMT)	
F.050.030	PACS tests (IMT)	
F.050.040	SPIRE tests (IMT)	
F.050.050	PACS / SPIRE ~~tests (~~parallel mode (IMT)	
F.050.060	Integrated system test 1 (S/S- SFTs & SFPT)	
F.060.000	**EMC- Test**	
F.060.010	EMC test CE at He-II	
F.060.020	Conversion to He-I	

Number	Activity/Definition	Remark
F.070.000	**PFM Satellite Integration**	
~~F.070.010~~	~~De-mating of SVM STM and WU; removal of STM Star Tracker~~	
~~F.070.020~~	~~Preparation & Mating of PFM SVM and PLM~~	
~~F.070.030~~	~~Integration & Alignment of Star Tracker~~	
~~F.070.040~~	~~integration of WU panels to SVM~~	
F.070.050	Integration and alignment of telescope	
F.070.060	Integration of solar array incl. support structure	
F.070.070	Integration of sunshade incl. support structure	
F.070.080	Integration of SVM Thermal Shield	
F.070.090	Satellite Completion	
~~**F.080.000**~~	~~**Integrated System Test 1 (IST)**~~	
	~~Preparation and connection of CVSE and GSE~~	
~~F.080.010~~	~~He-I top up; He-II production and top up~~	
~~F.080.020~~	~~Integrated system test 1 (S/S- SFTs & SFPT)~~	
~~F.080.025~~	~~EMC Test (CE)~~	
~~F.080.030~~	~~Conversion to He-I~~	
~~F.080.040~~	~~Transport to ESTEC~~	
F.090.000	**TB / TV Test including System Validation Tests**	
F.090.010	Preparation and connection of CVSE and EGSE	
F.090.020	SFT at He-I	
F.090.030	He-I top up; He-II production and top up	
F.090.040	System validation test 1 (SVT)	
F.090.050	Integration of LOU and specific CVV radiators	
F.090.060	Installation and set-up of S/C in LSS	
F.090.065	He II top up and HOT filling	
F.090.070	Launch autonomy verification	
F.090.080	TB / TV test	
F.090.090	Alignment check during TB/TV test	
F.090.100	Removal from test chamber and transfer to integration area	
F.100,000	**EMC test**	
F.100.010	Transport to EMC chamber and preparation (HOT filling)	

Number	Activity/Definition	Remark
F.100.020	EMC test (RE & RS)	
F.100.030	Conversion to He-I	
F110.000	**PFM Satellite Sine Vibration Test**	
F110.010	RCS tank filling	
F110.020	Transport to vibration test facility & preparation for test	
F110.030	Alignment check before vibration test	
F110.040	He-I top up	
F110.050	SFT at He-I before vibration test	
F110.060	Sine Vibration in three axes incl. HTT topping	
F110.070	Microvibration	
~~F110.080~~	~~SFT at He-I after vibration test~~	
~~F.110.090~~	~~Alignment check after vibration test~~	
F.120.000	**Acoustic Noise Test**	
F.120.010	Transport to LEAF	
F.120.020	He-I top up	
F.120.030	Acoustic noise test	
F.120.040	Alignment check after AN test	
F.120.050	SFT at He-I after AN test	
F.130.000	**Integrated System Test 2 (IST)**	
F.130.010	He-I top up; He-II production and top up	
F.130.020	Integrated system test 2 (S/S- SFTs & SFPT)	
F.130.030	Conversion to He-I	
F.140.000	**Mechanical Properties**	
F.140.010	Determination of mass	
	End of Herschel PFM Acceptance Test Phase	

A1.3 DETAILED ACTIVITY SHEETS

A1.3.1 Instrument WU and SVM Panel Preparation (F.010.000)

Activity Number:	F.010.010	**Duration:**	tbd
Activity Name:	**Preparation of EGSE and CCS set-up**	**Model:**	NA

Objective:

- Preparation of the GSE and CCS set-up for integration of WUs and test with the FPU simulator

Requirements to be verified:

- NA

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100,000

Configuration:

- released EGSE for integration activities

Activity Breakdown:

- prepare the instrument EGSE, Cryo SCOE, PLM EGSE and CCS for test of Warm Units
- provide the EGSE parts at the defined test area

Applicable Documents:

- EGSE requirement specification
- ~~PFM PLM integration procedure~~
- Contamination control plan
- Warm unit user manuals

GSE required:

- Instrument EGSE
- PLM EGSE
- CCS light

Facility / Instrumentation:

- ~~Astrium AIT facility; clean room class 100,000~~ESTEC test facility; Herschel preparation area
- check out area

Personnel:

EGSE operators

electrical engineer

AIT engineer

AIT technician

QA engineer

Safety Precautions:

- ESD requirements for integration of WUs

Special Notes:

- NA

Activity Number:	F.010.020	**Duration:**	tbd
Activity Name:	**Mechanical Integration of WUs on SVM Panels**	**Model:**	WU/SVM PFM

Objective:

- Mechanical integration of Instrument Warm Units on SVM panels

Requirements to be verified:

- According to ~~WUs integration procedure~~IID-Bs

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100 000

Configuration:

- SVM panels fixed on tables (or support structure)
- WUs released for integration

Activity Breakdown:

- clean the I/F area of WUs
- provide thermal filler, bonding straps, bonding washers etc.
- mount WUs on Panels
- integrate bonding straps
- check screw torque and screw locking
- measure bonding resistance

Applicable Documents:

- WUs integration procedure
- SVM handling procedure

GSE required:

- panel support structure
- Bonding measurement device
- Standard integration tools

Facility / Instrumentation:

- ~~Astrium AIT facility; clean room class 100,000~~ESTEC test facility; Herschel preparation area
- Cleaning equipment

Personnel:

AIT engineer

AIT mech. technician

AIT electr. technician

QA engineer

Safety Precautions:

- ESD requirements

Special Notes:

- NA

Activity Number:	F.010.030	**Duration:**	tbd
Activity Name:	**Electrical Integration of WUs on SVM panel**	**Model:**	WU/SVM

Objective:

Electrical integration of Instrument WUs on SVM panels

Requirements to be verified:

According to integration procedure of WUs

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100 000

Configuration:

- Instrument WUs mechanically integrated on SVM panels

Activity Breakdown:

- prepare EGSE and CCS
- Prepare WU Interconnect Harness (WIH)
- Check electrical Interfaces with IDAS
- Mate WIH with WUs
- Connect PLM EGSE with WUs via B/O boxes and T-adapters
- Verify power and CDMU interfaces (supported by IDAS)

Applicable Documents:

- WUs integration procedures

GSE required:

- PLM EGSE and CCS light
- IDAS

Facility / Instrumentation:

- ~~Astrium AIT facility; clean room class 100,000~~ESTEC test facility; Herschel preparation area

Personnel:

AIT engineer

EGSE operators

AIT electr. technician

QA engineer

Instrument representatives

Safety Precautions:

- ESD requirements

Special Notes:

- NA

Activity Number:	F.010.040	**Duration:**	tbd
Activity Name:	**FPU Simulator integration**	**Model:**	WU/SVM

Objective:

- Connection of FPU simulator to WUs

Requirements to be verified:

- tbd

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100,000

Configuration:

- WUs mechanically and electrically integrated on SVM panels

Activity Breakdown:

- prepare FPU simulator
- attach FPU simulator to instrument WUs

Applicable Documents:

- integration procedure for WUs
- WUs pre- test procedure (with FPU simulator)

GSE required:

- panel support structure (tables)
- Bonding measurement device
- Standard integration tool
- PLM EGSE and CCS light

Facility / Instrumentation:

- ~~Astrium AIT facility; clean room class 100,000~~ESTEC test facility; Herschel preparation area

Personnel:

AIT engineer

EGSE operators

AIT electr. technician

QA engineer

Instrument representatives

Safety Precautions:

- NA

Special Notes:

- the cleanliness requirements have to be applied

Activity Number:	F.010.050	**Duration:**	tbd
Activity Name:	**Functional Test of WUs**	**Model:**	WU/SVM PFM

Objective:

- Debugging of Instrument WUs with FPU simulator

Requirements to be verified:

- According to WU test procedure with FPU simulator

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100,000

Configuration:

- WUs and FPU simulator connected

Activity Breakdown:

- Perform functional tests of HIFI WUs including FPU simulator
- Perform functional tests of PACS WUs including FPU simulator
- Perform functional tests of SPIRE WUs including FPU simulator

Applicable Documents:

- Procedure for functional tests of Instrument WU
- Manual of FPU simulators

GSE required:

- SVM panel support structure (tables)
- PLM EGSE and CCS light
- FPU simulator

Facility / Instrumentation:

- ~~Astrium AIT facility; clean room class 100,000~~ESTEC test facility; Herschel preparation area

Personnel:

AIT engineer

EGSE operators

AIT electr. technicians

QA engineer

Instrument representatives

Safety Precautions:

- ESD requirements

Special Notes:

- NA

Activity Number:	F.010.060	**Duration:**	tbd
Activity Name:	**FPU simulator & EGSE de-integration**	**Model:**	WU/SVM PFM

Objective:

De-integration of the FPU simulator

Requirements to be verified:

- According to user manual of FPU simulator

Environment:

- temperature: 22 ± 3 ºC
- humidity: 40% < RH < 60%
- cleanliness: clean class 100

Configuration:

- FPU simulator connected to WUs mounted on SVM panels for debugging of WU
- EGSE connected

Activity Breakdown:

- Demating of FPU simulator from WUs
- Demating of EGSE from WUs

Applicable Documents:

- FPU simulator integration procedure
- Manual for FPU simulator

GSE required:

- SVM panel support structure (tables)
- PLM EGSE/CCS light
- FPU simulator

Facility / Instrumentation:

- ~~Astrium AIT facility; clean room class 100,000~~ESTEC test facility; Herschel preparation area

Personnel:

AIT engineer

EGSE operator

AIT technicians

QA engineer

Instrument representatives

Safety Precautions:

- ESD requirements

Special Notes:

- NA

Activity Number:	F.010.070	**Duration:**	tbd
Activity Name:	**Cleaning & Transport of SVM panels to CR100**	**Model:**	WU/SVM PFM

Objective:

- Cleaning, Cleanliness Verification and Transport of SVM panels including WUs to CR100

Requirements to be verified:

- According to Contamination Control Plan (AD05)

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100,000/ 100

Configuration:

- WUs integrated on SVM panels

Activity Breakdown:

- Transport of SVM panels in the airlock of Clean Room 100
- Clean and/or cover SVM panels including WUs for clean class 100
- Verify cleanliness
- Locate the panels including WUs inside of cleanroom class 100 for SFT with PLM

Applicable Documents:

- PFM PLM integration procedure
- Contamination Control Plan
- cleaning and cleanliness verification procedure

GSE required:

- Support structure for SVM panels
- Cleaning equipment
- Cleanliness verification equipment
- standard hoisting device

Facility / Instrumentation:

- ~~Astrium AIT facility; clean room class 100,000~~ESTEC test facility; Herschel preparation area & 100 and airlock
- overhead crane

Personnel:

AIT engineer

AIT technician

QA engineer

Safety Precautions:

- ESD requirements

Special Notes:

the cleanliness requirements have to be applied

A1.3.2 PFM Cryostat Integration in CR 100 (F.020.000)

Activity Number:	F.020.010	**Duration:**	tbd
Activity Name:	**PLM Refurbishment activities**	**Model:**	PLM PFM

Objective:

- conduct the defined (at the end of qualification phase) refurbishment activities on the PLM

Requirements to be verified:

- ~~According to PLM integration procedure~~none

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100

Configuration:

- PLM mounted in the integration dolly in CR 100
- OBA integrated including connected tubing
- Cryostat at ambient temperature
- STM units removed
- Inspection and definition of refurbishment completed

Activity Breakdown:

- remove items that need to be replaced
- install replacement items
- repair damaged items as agreed

Applicable Documents:

- PFM PLM integration procedure
- PLM refurbishment procedure
- Contamination Control Plan (AD05)

GSE required:

- PLM Integration dolly
- Working platform

Facility / Instrumentation:

- ~~Astrium AIT facility; clean room class 100~~ESTEC test facility; class 100 tent
- overhead crane

Personnel:

- tbd

Safety Precautions:

- Standard safety precautions for crane operations
- tbd

Special Notes:

- the cleanliness requirements have to be applied
- nominally no time is allocated for refurbishment activities

Activity Number:	F.020.020	**Duration:**	tbd
Activity Name:	**Mechanical/ thermal integration of FM FPUs on OB**	**Model:**	PLM PFM

Objective:

- Mechanical and thermal integration of FM Focal Plane Units on Optical Bench

Requirements to be verified:

- Integration according to drawings and integration procedure

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100

Configuration:

- PLM mounted in the integration dolly
- integrated and aligned OBA (w/o shield)

Activity Breakdown:

- final cleaning and inspection of FM FPUs
- mechanical integration of FM FPUs
- install cooling straps to FPUs
- install grounding straps
- check of screw torque and marking
- measure bonding values

Applicable Documents:

- PFM PLM integration procedure
- Contamination Control Plan
- FPU integration procedure

GSE required:

- PLM Integration dolly
- scaffolding
- instrument lifting device
- bonding meter

Facility / Instrumentation:

- ~~Astrium AIT facility; clean room class 100~~ESTEC test facility; class 100 tent
- Facility crane, standard hoisting slings

Personnel:

- crane operator / technician
- AIT engineer
- QA engineer
- Instrument representatives

Safety Precautions:

- Standard safety precautions for crane operations
- ESD precautions

Special Notes:

- the cleanliness requirements have to be applied

Activity Number:	F.020.030	**Duration:**	tbd
Activity Name:	**Alignment of instruments versus OB/CVV**	**Model:**	PLM PFM

Objective:

- alignment verification of instrument FPUs versus OB
- Alignment measurements OB versus CVV

Requirements to be verified:

- Alignments requirements of instrument FPUs and OBA vs. CVV

Environment:

- temperature: 22 ± 3 ºC
- humidity: 40% < RH < 60%
- cleanliness: clean class 100

Configuration:

- PLM mounted in the integration dolly
- integrated OB including FPUs

Activity Breakdown:

- Transfer the PLM form integration dolly to rotary table
- install alignment equipment
- shimming and / or adjustment of instruments to fulfil the alignment requirements
- final torque of screws and check of screw locking
- measure and record the final alignment values FPUs versus OB and from OB to CVV reference cube

Applicable Documents:

- PLM integration procedure
- instrument alignment procedure
- Contamination Control Plan

GSE required:

- PLM Integration dolly
- Rotary table
- scaffolding
- PLM alignment equipment/ OGSE

Facility / Instrumentation:

- ~~Astrium AIT facility; clean room class 100~~ESTEC test facility; class 100 tent

Personnel:

AIT engineer

AIT technicians

optical engineers

QA Engineer

Safety Precautions:

- ESD requirements

Special Notes:

- the cleanliness requirements have to be applied

Activity Number:	F.020.040	**Duration:**	tbd
Activity Name:	**Connection of SIH to FPUs & I/F checks**	**Model:**	PLM PFM

Objective:

- Final routing of SIH on OBA & mating with FPUs
- check of electrical interfaces

Requirements to be verified:

- resistance values, pin allocation etc.

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100

Configuration:

- PLM mounted in the integration dolly
- FPUs mounted and aligned on OBA

Activity Breakdown:

- If harness was affected by refurbishment:
  - Integration of SIH connectors to CVV
  - Perform leak test of feedthrough connectors
  - Routing of harness from CVV inner side to OB via straps
  - Verify SIH with IDAS
- Else
  - Connect the SIH to the FPUs
  - finalise SIH routing on OBA
  - perform electrical check from vacuum feedthrough to FPUs ~~with integration data acquisition system (tbc)~~by instrument EGSE (instrument task)

Applicable Documents:

- PFM PLM integration procedure
- SIH integration and test procedure

GSE required:

- PLM Integration dolly
- scaffolding
- IDAS
- Instrument EGSE

Facility / Instrumentation:

- ~~Astrium AIT facility; clean room class 100~~ESTEC test facility; class 100 tent

Personnel:

- AIT engineer
- electrical engineer
- electrical technician
- QA engineer
- Instrument representative

Safety Precautions:

- ESD requirements have to be applied

Special Notes:

- the cleanliness requirements have to be applied

Activity Number:	F.020.050	**Duration:**	tbd
Activity Name:	**connection of WUs ~~to SVM brackets~~with FPUs**	**Model:**	PLM PFM

Objective:

- connection of instrument warm units mounted on SVM brackets to the FPUs via external SIH connectors mounted on brackets on the STM SVM

Requirements to be verified:

- According to PFM PLM integration procedure
- According to PFM PLM harness specification

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100

Configuration:

- PLM mounted in the integration dolly
- external CCH and SIH pre-integrated (from STM campaign)
- STM SVM still attached to PLM

Activity Breakdown:

- position the WU panels close to their foreseen location on the SVM
- connect SVM harness to corresponding WUs (tbc)
- connect SVM harness to the external SIH via brackets on the SVM top panels respectivelly connect specific instrument SCOE to SVM brackets
- check out of electrical interfaces

Applicable Documents:

- PLM integration procedure
- external SIH integration procedure

GSE required:

- PLM Integration dolly
- Scaffolding
- SVM panel support structures
- IDAS
- Instrument SCOE (if applicable)

Facility / Instrumentation:

- ~~Astrium AIT facility; clean room class 100~~ESTEC test facility; class 100 tent

Personnel:

- AIT engineer
- AIT/ electrical engineer
- electrical technician
- QA engineer
- Instrument representative

Safety Precautions:

- ESD requirements

Special Notes:

- the cleanliness requirements have to be applied

Activity Number:	F.020.060	**Duration:**	tbd
Activity Name:	**Instrument Integration Test**	**Model:**	PLM PFM

Objective:

- conduct short functional test of instruments to verify integrity after installation

Requirements to be verified:

- According to instrument requirement specification

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100

Configuration:

- PLM mounted in the integration dolly
- FPUs integrated on OBA and connected to SIH
- SVM panels with Wus connected to external SIH

Activity Breakdown:

- prepare and connect ~~instrument~~ PLM EGSE
- Perform instrument integration test
- Disconnect EGSE
- Disconnect Warm units from SVM brackets
- Remove SVM panels with WUs from CR100

Applicable Documents:

- PFM PLM integration procedure
- Instrument Integration test procedure

GSE required:

- PLM Integration dolly
- Scaffolding
- PLM EGSE & CCS light
- Instrument EGSE

Facility / Instrumentation:

- ~~Astrium AIT facility; clean room class 100~~ESTEC test facility; class 100 tent and 100,000

Personnel:

- AIT engineer
- check out operators
- electrical technicians
- QA engineer
- Instrument representative

Safety Precautions:

- NA

Special Notes:

- NA

Activity Number: F.020.065 **Duration:** tbd

Activity Name: **Dis-connection of WUs from FPUs** **Model:** PLM PFM

Objective:

- Dis-connection of instrument warm units mounted on SVM brackets from the FPUs and removal of SVM panels from CR 100

Requirements to be verified:

- none

Environment:

temperature: 22 ± 3 ºC

humidity: 40% < RH < 60%

cleanliness: clean class 100

Configuration:

- PLM mounted in the integration dolly
- STM SVM still attached to PLM
- SVM panels attached to SVM and WUs connected to FPUs

Activity Breakdown:

- Disconnect PLM EGSE
- disconnect SVM harness from external SIH
- disconnect SVM panels from SVM
- remove SVM panels from CR 100

Applicable Documents:

- PLM integration procedure
- SVM panel handling procedure

GSE required:

- PLM Integration dolly
- Scaffolding
- SVM panel support structures
- PLM EGSE

Facility / Instrumentation:

- ESTEC test facility; class 100 tent

Personnel:

- AIT engineer
- AIT/ electrical engineer
- electrical technician
- QA engineer
- Instrument representative

Safety Precautions:

- ESD requirements

Special Notes:

- the cleanliness requirements have to be applied

Activity Number:	F.020.070	**Duration:**	tbd
Activity Name:	**Integration of adsorbers**	**Model:**	PLM PFM

Objective:

- Integration of adsorbers

Requirements to be verified:

- NA

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100

Configuration:

- PLM with SVM STM installed in the integration dolly
- OB including FPUs integrated

Activity Breakdown:

- Install adsorbers

Applicable Documents:

- PLM integration procedure
- Contamination Control Plan

GSE required:

- PLM Integration dolly
- scaffolding

Facility / Instrumentation:

- ~~Astrium AIT facility; clean room class 100~~ESTEC test facility; class 100 tent

Personnel:

- AIT engineer
- AIT mechanical technician
- QA engineer

Safety Precautions:

- NA
-

Special Notes:

- the cleanliness requirements have to be applied

Activity Number:	F.020.080	**Duration:**	tbd
Activity Name:	**Integration of OBA Shield incl. instrumentation**	**Model:**	PLM PFM

Objective:

- Integration of OBA shield and related temperature sensors

Requirements to be verified:

- straylight requirements

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100

Configuration:

- PLM with SVM STM mounted in the integration dolly
- FPUs integrated and aligned on OBA

Activity Breakdown:

- final cleaning and inspection of OB shield
- mechanical installation of OB shield,
- connect sensor harness and perform electrical check
- verify straylight tightness
- check of screw torque and locking

Applicable Documents:

- PLM integration procedure
- Contamination Control Plan

GSE required:

- PLM Integration dolly
- scaffolding
- OB lifting device
- multimeter for grounding resistance measurement
- IDAS

Facility / Instrumentation:

- ~~Astrium AIT facility; clean room class 100~~ESTEC test facility; class 100 tent

Personnel:

- crane operator / technician
- AIT engineer
- AIT mechanical technician
- AIT electrical technician
- QA engineer
- Optical engineer

Safety Precautions:

- Standard safety precautions for crane operations
-

Special Notes:

- the cleanliness requirements have to be applied

Activity Number:	F.020.090	**Duration:**	tbd
Activity Name:	**Assembly of pre-integrated upper shields**	**Model:**	PLM PFM

Objective:

- Integration of upper bulkhead thermal shields

Requirements to be verified:

- grounding, bonding

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100

Configuration:

- PLM with SVM STM mounted in the integration dolly
- OBA shield integrated on OBA

Activity Breakdown:

- successive mechanical integration of upper bulkhead thermal shields 1,2 and 3
- integration of entrance and LOU baffle (after shield 2 integration)
- successive closure of MLI between cylindrical and upper shield MLI
- connect electrical sensors to the CCH
- perform functional check after sensor connection of every shield
- check the grounding of MLI

Applicable Documents:

- PFM PLM integration procedure
- Contamination Control Plan
- PLM instrumentation list
- MLI integration procedure

GSE required:

- PLM Integration dolly
- scaffolding
- shield lifting device
- temperature sensor measurement equipment
- IDAS

Facility / Instrumentation:

- ~~Astrium AIT facility; clean room class 100~~ESTEC test facility; class 100 tent

Personnel:

- crane operator
- AIT engineer
- AIT technician
- harness technician
- MLI specialists
- QA engineer

Safety Precautions:

- Standard safety precautions for crane operations are applicable.

Special Notes:

- the cleanliness requirements have to be applied

Activity Number:	F.020.100	**Duration:**	tbd
Activity Name:	**Integrate upper bulkhead, connect airlock port, leak test of filling port & SV121**	**Model:**	PLM PFM

Objective:

- Assembly of cryostat upper bulkhead
- Connect filling port including airlock and SV121
- Perform leak check of filling port/CVV interface and of SV121

Requirements to be verified:

- According to PLM integration procedure
- tightness of interfaces

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100

Configuration:

- PLM mounted in the integration dolly
- Upper bulkhead pre-integrated with valves and LOU windows, w/o cover
- upper shield group including MLI and sensors already integrated

Activity Breakdown:

- install sealing of cylindrical CVV I/F
- install sealing for filling port I/F
- lower upper bulkhead to cylindrical CVV
- Position upper bulkhead such that filling port fits to the bulkhead opening
- mount filling port to upper bulkhead
- perform leak test of filling port tube I/F to CVV
- mount Airlock to CVV Filling Port interface
- perform leak test of Filling Port I/F to CVV
- install the safety valve SV121
- install airlock for SV121
- perform leak test of SV121
- fix upper bulkhead with CVV cyclindrical part

Applicable Documents:

- PLM integration procedure
- Contamination Control Plan

GSE required:

- PLM Integration dolly
- scaffolding
- upper bulkhead lifting device
- leak test equipment
- airlock for filling port

Facility / Instrumentation:

- ~~Astrium AIT facility; clean room class 100~~ESTEC test facility; class 100 tent

Personnel:

- crane operator
- AIT engineer
- AIT / CVSE technicians
- QA engineer

Safety Precautions:

- Standard safety precautions for crane operations

Special Notes:

- the cleanliness requirements have to be applied

Activity Number:	F.020.110	**Duration:**	tbd
Activity Name:	**Integration & alignment of LOU**	**Model:**	PLM PFM

Objective:

Integration of LOU support structure and LOU onto CVV.

Alignment of LOU vs. OBA (HIFI)

Requirements to be verified:

- alignment requirements between LOU and HIFI

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100

Configuration:

- PLM mounted in the integration dolly
- PLM internally fully integrated

Activity Breakdown:

- Transfer of PLM from integration dolly to rotary table
- integrate LOU support structure
- mechanically integrate LOU
- electrically integrate LOU
- attach wave guides to LOU
- install alignment equipment
- perform alignment of LOU w.r.t HIFI FPU

Applicable Documents:

- PLM integration procedure
- Instrument alignment procedure
- Contamination Control Plan
- LOU handling manual

GSE required:

- PLM Integration dolly
- Rotary table
- scaffolding
- LOU lifting device
- PLM alignment equipment/OGSE

Facility / Instrumentation:

- ~~Astrium AIT facility; clean room class 100~~ESTEC test facility; class 100 tent
- overhead crane

Personnel:

AIT engineer

AIT technician

crane operator

high frequency specialist

QA engineer

Alignment engineer

Safety Precautions:

- Standard safety precautions for crane operations

Special Notes:

- the cleanliness requirements have to be applied

Activity Number:	F.020.120	**Duration:**	tbd
Activity Name:	**Integration of cryostat baffle**	**Model:**	PLM PFM

Objective:

- Integrate FM cryostat cover and cryostat baffle to close the cryostat

Requirements to be verified:

- NA

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100

Configuration:

- PLM with SVM STM mounted on the rotary table

Activity Breakdown:

- install sealing for cover I/F
- integrate cryostat cover components
- integration of cryostat baffle
- installation of cover harness including I/F bracket (on upper bulkhead)
- electrical check of integrated harness

Applicable Documents:

- PLM integration procedure
- Contamination Control Plan

GSE required:

- rotary table
- scaffolding
- electrical checkout system (IDAS)
- lifting device for cover and baffle

Facility / Instrumentation:

- ~~Astrium AIT facility; clean room class 100~~ESTEC test facility; class 100 tent

Personnel:

- crane operator / technicians
- AIT engineer
- IDAS operator
- QA engineer

Safety Precautions:

- Standard safety precautions for crane operations

Special Notes:

- the cleanliness requirements have to be applied

Activity Number:	F.020.130	**Duration:**	tbd
Activity Name:	**Install vacuum pumps, evacuation and leak check**	**Model:**	PLM PFM

Objective:

- check of pumping units, provide the evacuation line to CVV and installation of vacuum gauges
- evacuate CVV and perform leak checks

Requirements to be verified:

~~-according to CVSE Specification~~

- ~~cleanliness of evacuation line~~leak rate requirements

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100 /100,000

Configuration:

- PLM with SVM STM mounted on rotary table
- all PLM apertures (e.g. cover, windows) closed

Activity Breakdown:

- check the proper working of the pumping systems
- check the cleanliness status of all evaluation tubes and parts
- install the evacuation line to CVV
- perform leak check of evacuation line
- start evacuation of the vacuum vessel (controlled Δp/ min to avoid MLI damages) by the high vacuum pumping unit – low stage
- after having reached specified vacuum value ($p<1x10^{-2}$ mbar) start turbo-pumps and continue evacuation
- perform integral leak check of Cryostat Helium S/S
- perform local leak checks of CVV O-rings
  - upper bulkhead
  - cryostat cover
- perform local leak checks of:
  - filling port I/F to upper bulkhead
  - safety valves SV 921 and SV 922 to upper bulkhead
  - all tubing I/F to CVV
  - all strap pretension device I/F to CVV
  - all electrical feedthroughs

Applicable Documents:

- PLM integration procedure
- Leak test procedure
- Contamination Control Plan

GSE required:

- rotary table
- Scaffolding
- CVSE – High vacuum pumping unit with 2 turbo pumps
- Leak test equipment

Facility / Instrumentation:

- ~~Astrium AIT facility; clean room class 100~~ESTEC test facility; class 100 tent

Personnel:

Test conductor (AIT engineer)

CVSE / AIT technician

QA Engineer

Safety Precautions:

- NA

Special Notes:

- the cleanliness requirements have to be applied
- max. pressure gradient to be observed

Activity Number:	F.020.140	**Duration:**	tbd
Activity Name:	**Transport to Cleanroom 100,000**	**Model:**	PLM PFM

Objective:

- PLM removal from rotary ~~table and movement to cleanroom class 100,000 by hoisting equipment and crane~~
- installation of PLM with SVM STM in Vertical Integration Stand
- opening of CR 100 curtain

Requirements to be verified:

- NA

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100 / 100,000

Configuration:

- CVV evacuated and leak tested
- PLM with SVM STM mounted on rotary table

Activity Breakdown:

~~- release for transport~~
- disconnect evacuation lines from PLM
- connect PLM hoisting equipment
- dismount PLM from rotary table
- tramsport to CR 100,000 (by opening of CR100 doors
- install PLM with SVM STM on VIS

Applicable Documents:

- PLM integration procedure
- Manual for rotary table and VIS

GSE required:

- rotary table
- VIS
- Working platform
- hoisting equipment

Facility / Instrumentation:

- ~~Astrium AIT facility; clean room class 100~~ESTEC test facility; class 100 tent and class 100,000

Personnel:

- crane operator
- AIT engineer
- AIT technician
- QA engineer

Safety Precautions:

- Standard safety precautions for crane operations

Special Notes:

- NA

A1.3.3 PLM External Completion (F.030.000)

Activity Number:	F.030.010	**Duration:**	tbd
Activity Name:	**Integration of SVM panels to SVM STM**	**Model:**	PLM PFM

Objective:

- Mechanical integration of SVM panel to the SVM STM

Requirements to be verified:

- According to PFM PLM integration procedure

Environment:

temperature: 22 ± 3 ºC
humidity: 40% < RH < 60%
cleanliness: clean class 100

Configuration:

- PLM mounted on the VIS
- SVM STM is attached to PLM

Activity Breakdown:

- mount SVM panels including instrument WUs to SVM STM
- final torque of screws and check of screw locking

Applicable Documents:

- PFM PLM integration procedure
- Contamination Control Plan

GSE required:

- VIS
- Working platform
- MGSE for panel integration

Facility / Instrumentation:

- Astrium AIT facility; clean room class 100
- overhead crane

Personnel:

AIT engineer
AIT technician
crane operator
QA engineer

Safety Precautions:

- ESD requirements

Special Notes:

- the cleanliness requirements have to be applied

Activity Number: F.030.020 **Duration:** tbd

Activity Name: **connection of SIH, CCH & Waveguides to WUs** **Model:** PLM PFM

Objective:

- connection of instrument warm units mounted on SVM brackets to the FPUs via external SIH connectors mounted on brackets on the STM SVM
- connection of CCU to external CCH via SVM connector brackets
- connection of LOU waveguides to HIFI WUs

Requirements to be verified:

- According to PFM PLM integration procedure
- According to PFM PLM harness specification

Environment:

temperature: 22 ± 3 ºC

humidity: 40% < RH < 60%

cleanliness: clean class 100

Configuration:

- PLM with SVM mounted on VIS
- external CCH and SIH pre-integrated
- SVM panels attached to SVM STM

Activity Breakdown:

- connect SVM harness to the external SIH/CCH via brackets on the SVM top panels
- check out of electrical interfaces
- connect waveguides to HIFI WU
- transfer PLM from VIS to MPT

Applicable Documents:

- PLM integration procedure
- external SIH/CCH integration procedure

GSE required:

- VIS/ MPT
- IDAS

Facility / Instrumentation:

- Astrium AIT facility; clean room class 100,000
- Overhead crane

Personnel:

- AIT engineer
- AIT/ electrical engineer
- electrical technician
- QA engineer

Safety Precautions:

- ESD requirements
- Standard safety precautions for crane operations

Special Notes:

- NA

Activity Number:	F.030.030	**Duration:**	tbd
Activity Name:	**Connect EGSE and perform SFT warm**	**Model:**	PLM PFM

Objective:

- Connect the Cryo SCOE
- perform SFT warm before bake-out, cooldown and filling

Requirements to be verified:

- proper functional and required values of the cryostat instrumentation ~~according to PLM requirement specification (AD ..)~~

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100,000

Configuration:

- PLM with SVM STM mounted on MPT
- external harness integrated
- Instrument Wus integrated

Activity Breakdown:

- connect ~~check out equipment (PLM EGSE and~~ Cryo SCOE to cryostat instrumentation~~)~~
- perform SFT warm (cryostat)

Applicable Documents:

~~PLM integration procedure~~

- short functional test procedure

GSE required:

- MPT
- Working platform
- ~~PLM EGSE~~CCS and Cryo SCOE

Facility / Instrumentation:

- ~~Astrium AIT facility; clean room class 100,000~~ESTEC test facility; Herschel preparation area
- Check out area

Personnel:

AIT engineer

check out operators

Cryo Engineer

QA engineer

Safety Precautions:

- NA

Special Notes:

- NA

Activity Number: F.030.035 **Duration:** tbd

Activity Name: **Bake out** **Model:** PLM PFM

Objective:

- Bake out of the cryostat Helium S/S to improve the isolation vacuum and support the outgassing process

Requirements to be verified:

- According to H-EPLM Requirement Specification

Environment:

temperature:	22 ± 3 º C
humidity:	40% < RH < 60%
cleanliness:	clean class 100,000

Configuration:

- PLM mounted with SVM STM on MPT
- CVSE is installed
- Cryo SCOE is connected

Activity Breakdown:

- Re-install turbo pumps and connect the evacuation lines to the high vacuum pumping unit
- install the flexible, heatable tubing for bake out
- connect bake out equipment to GN2 supply
- Check of the complete set up
- Perform bake out according procedure (72 h @ 80 K)
- Perform mass spectrometer measurement

Applicable Documents:

- bake out test procedure
- Contamination Control Plan

GSE required:

- MPT
- scaffolding
- measurement device for bake out equipment
- CVSE
- Cryo SCOE
- Bake out equipment
- Mass spectrometer
- High vacuum pumping unit

Facility / Instrumentation:

- ~~Astrium AIT facility; clean room class 100,000~~ESTEC test facility; Herschel preparation area

Personnel:

- AIT engineer / test conductor
- SCOE operators
- AIT / CVSE technicians
- Cryo engineer
- QA engineer
- Mass spectrometer operator

Safety Precautions:

- the GN2 for bake out will be heated to 80°C maximum

Special Notes:

- the cleanliness requirements have to be strongly applied for the bake out equipment (GN2 flow through the cryostat Helium S/S)

Activity Number:	F.030.040	**Duration:**	tbd
Activity Name:	**Integration of LOU alignment camera**	**Model:**	PLM PFM

Objective:

- Install LOU alignment camera to allow FPU alignment verification through optical windows

Requirements to be verified:

NA

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100,000

Configuration:

- PLM with SVM STM mounted on MPT

Activity Breakdown:

- mount alignment camera to LOU support structure
- align camera to LOU

Applicable Documents:

- LOU alignment procedure
- HACS integration procedure

GSE required:

- MPT
- Working platform
- Alignment equipment (OGSE)

Facility / Instrumentation:

- ~~Astrium AIT facility; clean room class 100,000~~ESTEC test facility; Herschel preparation area
- Check out area

Personnel:

AIT engineer

AIT technicians

Alignment engineer

QA engineer

Safety Precautions:

- NA

Special Notes:

- NA

A1.3.4 He-I ~~and He-II~~ Activities (F.040.000)

Activity Number:	F.040.010	**Duration:**	tbd
Activity Name:	**Preparation for cool down and filling**	**Model:**	PLM PFM

Objective:

- preparation of CVSE for cool down and filling activities

Requirements to be verified:

- according to cool down and filling procedure

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100,000

Configuration:

- PLM with SVM mounted on MPT
- evacuation port already installed and leak tested
- evacuation lines installed and leak tested
- CVV evacuated until required vacuum pressure (VG901 and VG902)

Activity Breakdown:

- Re-install turbo pumps and connect the evacuation lines to the high vacuum pumping unit
- Continue evacuation of the CVV
- Requirement for start of cooldown: $p < 1x10^{-5}$ mbar
- install working platform (also used for filled LHe dewar)
- Connect ventline
- Installation and leak test of filling port airlock
- Prepare LHe transfer line
- Provide LHe supply dewars
- connect strap pretension measurement equipment

Applicable Documents:

- cool down and filling procedure

GSE required:

- MPT
- scaffolding
- working platform for additional load (LHe dewar etc.)
- leak test equipment
- strap pretension measurement equipment
- CVSE for filling (transfer lines, venting lines, dewars, flowmeters,…)

Facility / Instrumentation:

- ~~Astrium AIT facility, cleanroom class 100,000;~~ ESTEC test facility, Herschel preparation area

Personnel:

AIT engineer / test conductor

CVSE technician

Cryo/mech. team

QA engineer

Safety Precautions:

- Standard precautions for crane operations
- Standard precautions for cryo operations

Special Notes:

- cleanliness requirements for LHe transfer lines shall be applied

Activity Number:	F.040.020	**Duration:**	tbd
Activity Name:	**Cooling and filling of HTT**	**Model:**	PLM PFM

Objective:

- cool down and filling of Helium II tank (HTT) with He-I

Requirements to be verified:

- according to cool down & filling procedure

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100,000

Configuration:

- PLM with SVM STM mounted on MPT
- CVV is evacuated down to required values and turbo pumps in operation
- EGSE is connected and in operational condition
- filling port airlock is installed and leak tested
- strap pretension measurement device is installed

Activity Breakdown:

- install transfer line in supply dewar and PLM filling port
- Start cool down of HTT w.r.t. temperature gradients
- During cool down adjust the pretension to the required values w.r.t. OB alignment too
- Start filling of HTT when temperatures T101 /102 ≤ 4.2 K
- Continue filling until liquid level ≥ 98 %
- Prepare final configuration after filling (e.g. CVV evacuation, oscillation damper, valve status, filling port, transfer lines etc.)

Remark:

- alignment measurements shall be performed in parallel to cool down and filling activities (see next activity sheet

Applicable Documents:

- cool down and filling procedure
- procedure for preparation of transfer lines
- procedure for mounting and dismounting of oscillation damper

GSE required:

- MPT
- Scaffolding
- heavy platform
- evacuation equipment
- strap pretension measurement equipment
- CVSE for filling operations
- checkout equipment (CCS and Cryo SCOE)

Facility / Instrumentation:

- ~~Astrium AIT facility, cleanroom class 100,000;~~ ESTEC test facility; Herschel preparation area
- overhead crane, standard hoisting slings

Personnel: (double shift)

- AIT engineer / test conductor
- cryo operation manager
- check out operator
- cryo/mech. team
- CVSE technician
- QA engineer

Safety Precautions:

- Standard precautions for crane and cryo operations

Special Notes:

- cleanliness requirements for LHe transfer lines shall be applied

Activity Number:	F.040.030	**Duration:**	tbd
Activity Name:	**alignment verification and adjustments during cool down**	**Model:**	PLM PFM

Objective:

- alignment measurements through the LOU windows" during cool down using the Alignment camera
- readjustment of straps

Requirements to be verified:

- according PLM requirement specification

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100,000

Configuration:

- PLM with SVM STM mounted on MPT
- cool down & filling activities are running

Activity Breakdown:

- install alignment equipment
- Cool down and filling activities in parallel
- perform alignment measurement LOU vs. HIFI FPU with alignment camera
- correct allignment as necessary by adjusting strap pretension

Applicable Documents:

- Herschel alignment concept
- Alignment procedure
- HACS user manual

GSE required:

- MPT
- strap pretension measurement equipment
- alignment camera

Facility / Instrumentation:

- ~~Astrium AIT facility, cleanroom class 100,000;~~ESTEC test facility; Herschel preparation area

Personnel:

- AIT engineer / test conductor
- alignment technicians / engineers
- QA engineer

Safety Precautions:

- standard precautions for cryo operations

Special Notes:

- NA

Activity Number:	F.040.040	**Duration:**	tbd
Activity Name:	**SFT at He-I (cryostat & instruments)**	**Model:**	PLM PFM

Objective:

- perform a short functional test of the cryostat ~~and scientific instruments~~ after cool down & filling activities ~~and before He-II production~~

Requirements to be verified:

- proper functional and required values of the cryostat instrumentation according to H-EPLM requirement specification (AD 03)

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100,000

Configuration:

- PLM with SVM STM mounted on MPT
- PLM at He-I conditions

Activity Breakdown:

- prepare check out equipment (CCS, PLM EGSE and Cryo SCOE)
- perform SFT of cryostat
- ~~perform SFT of instruments~~

Applicable Documents:

- short functional test procedure

GSE required:

- MPT
- scaffolding
- checkout equipment (CCS, PLM EGSE and Cryo SCOE)

Facility / Instrumentation:

- ~~Astrium AIT facility, cleanroom class 100,000;~~ESTEC test facility; Herschel preparation area check out area

Personnel:

- test conductor
- AIT engineer
- checkout operators
- cryo/mech. Team
- ~~instrument representatives~~
- QA engineer

Safety Precautions:

- standard precautions for cryo operations

Special Notes:

- NA

Activity Number: F.040.050 **Duration:** tbd

Activity Name: **Production of He-II and top up** **Model:** PLM PFM

Objective:

- execute the transfer activities from He-I to He-II

Requirements to be verified:

- according to H-EPLM requirement specification (AD 03)
- according to He-II production and top up procedure

Environment:

temperature: 22 ± 3 ºC

humidity: 40% < RH < 60%

cleanliness: clean class 100,000

Configuration:

- PLM with SVM STM mounted on MPT
- HTT in He-I conditions, any HTT filling level
- vent line is connected
- filling port airlock is mounted

Activity Breakdown:

- Check PLM status (liquid level of HTT, valve status, CVSE; Cryo SCOE)
- Preparation activities (if mounted remove oscillation damper; prepare MGSE, install aux. lines, prepare and install transfer lines, install supply and transport dewar)
- refilling of HTT with He-I if needed
- Prepare He-I and He-II pumping units
- Prepare and connect He-I and He-II pumping units to SV 121 respectively to V502
- Start He-II production (valve status according to He-II production and top procedure)
- After completion of He-II production prepare final configuration (check valve status, retract transfer line and close filling port, stop He pumping unit I, remove supply and transport dewar, continue pumping with He pumping unit II)

Applicable Documents:

- He-II production and top up procedure
- procedure for preparation of transfer lines
- procedure for mounting and dismounting of oscillation damper

GSE required:

- MPT
- scaffolding
- heavy duty working platform
- checkout equipment (CCS/PLM EGSE and Cryo SCOE)
- CVSE for filling operations (He vacuum pumping unit I and II, Transfer lines, LHe supply dewars)
- safety line to filling port

Facility / Instrumentation:

- Astrium AIT facility, cleanroom class 100,000;
- overhead crane, standard hoisting slings

Personnel:

- AIT engineer / test conductor
- cryo operation manager
- check out operator
- cryo/mech. team
- CVSE technician
- QA engineer

Safety Precautions:

- Standard precautions for crane and cryo operations

Special Notes:

cleanliness requirements for LHe transfer lines shall be applied

Activity Number:	F.040.060	**Duration:**	tbd
Activity Name:	**SFT at He-II (cryostat & instruments)**	**Model:**	PLM PFM

Objective:

- perform a short functional test of the cryostat and the instruments after He-II production

Requirements to be verified:

- proper functional and required values of the cryostat instrumentation according to H-EPLM requirement specification (AD 03)

Environment:

temperature: 22 ± 3 ºC

humidity: 40% < RH < 60%

cleanliness: clean class 100,000

Configuration:

- PLM with SVM STM mounted on MPT
- HTT in He-II conditions

Activity Breakdown:

- prepare check out equipment (CCS, PLM EGSE and Cryo SCOE)
- perform SFT of cryostat
- perform SFT of instruments

Applicable Documents:

- short functional test procedure

GSE required:

- MPT
- scaffolding
- checkout equipment (CCS, PLM EGSE & Cryo SCOE)
- CVSE

Facility / Instrumentation:

- Astrium AIT facility, cleanroom class 100,000; check out area

Personnel:

- test conductor
- AIT engineer
- check out operators
- cryo/mech. Team
- instrument representatives
- QA engineer

Safety Precautions:

- Standard precautions for cryo operations

Special Notes:

- NA

A1.3.5 PLM /SVM Mating (F.045.000)

Activity Number:	F.045.010	**Duration:**	tbd
Activity Name:	**Mating of instrument panels with SVM FM**	**Model:**	SVM FM

Objective:

- Mechanical integration of SVM instrument panels to the SVM FM

Requirements to be verified:

- none

Environment:

temperature: 22 ± 3 ºC

humidity: 40% < RH < 60%

cleanliness: clean class 100 000

Configuration:

- SVM FM on VIS

Activity Breakdown:

- mount SVM panels including instrument WUs to SVM FM
- final torque of screws and check of screw locking
- check of bonding / isolation

Applicable Documents:

- SVM integration procedure
- Contamination Control Plan

GSE required:

- VIS
- Working platform
- MGSE for panel integration

Facility / Instrumentation:

- ESTEC test facility; Herschel preparation area
- overhead crane

Personnel:

AIT engineer

AIT technician

crane operator

QA engineer

SVM contractor support

Safety Precautions:

- ESD requirements

Special Notes:

- Offline activity

Activity Number:	F.045.020	**Duration:**	tbd
Activity Name:	**De-mating of SVM STM and WUs**	**Model:**	PLM SAT

Objective:

removal of SVM STM.

Removal of STM STR and associated support structure

Requirements to be verified:

- according to HERSCHEL EPLM AIV and HERSCHEL Satellite AIT Requirements Specification (AD02)
- according to STRA integration procedure

Environment:

temperature: 22 ± 3 ºC

humidity: 40% < RH < 60%

cleanliness: clean class 100 000

Configuration:

- PLM with SVM STM mounted on MPT
- HTT in He-I conditions

Activity Breakdown:

- disconnect SVM harness (SIH/CCH) from SVM brackets
- transfer of PLM/SVM from MPT to satellite VIS
- remove Star Tracker Assembly (STRA) and central part of subplatform (except STR platform struts) – ALS task
- unscrew SVM backets and secure brackets and external SIH/CCH on CVV
- unscrew waveguides from SVM (or remove waveguides)
- attach PLM hoisting device
- decouple PLM and SVM and transfer of PLM to PLM VIS (with adapter)
- transfer SVM STM to transport container

Applicable Documents:

- PLM /SVM uncoupling procedure
- STRA demating procedur (provided by ALS)

GSE required:

- MPT
- S/C VIS
- PLM VIS
- SVM transport container
- miscellaneous integration tools

Facility / Instrumentation:

- ESTEC test facility; Herschel preparation area;
- overhead crane

Personnel:

- AIT engineer
- AIT technicians
- QA engineer
- SVM support (ALS)
- STRA specialists (ALS)

Safety Precautions:

- standard safety precautions for crane and cryo operations

Special Notes:

- NA

Activity Number: F.045.030 **Duration:** tbd

Activity Name: **Preparation & Mating of PFM SVM and PLM** **Model:** PFM SAT

Objective:

- Preparation & Mating of PLM with PFM SVM
-

Requirements to be verified:

- according to HERSCHEL EPLM AIV and Satellite AIT Requirements Specification (AD02)
- according to PLM/SVM mating procedure

Environment:

temperature: 22 ± 3 ºC

humidity: 40% < RH < 60%

cleanliness: clean class 100,000

Configuration:

- PLM mounted in test dolly
- PLM HTT in He-I conditions
- SVM mounted on VIS

Activity Breakdown:

- Preparation of PFM SVM on VIS
- lifting of PLM with vertical lifting device
- mechanical mating of SVM to PLM
- shimming and alignment of PLM/SVM I/F in axial and lateral direction
- STRA Integration in parallel (see F.0445.040)

Applicable Documents:

- PLM/SVM mating procedure
- Satellite Alignment procedure

GSE required:

- PLM VIS
- S/C VIS
- Rotary table
- PLM vertical lifting device
- SVM hoisting equipment
- Hydraset
- working platform
- checkout equipment (CCS and Cryo SCOE)
- alignment equipment (OGSE)

Facility / Instrumentation:

- ESTEC test facility; Herschel preparation area
- check out area
- overhead crane

Personnel:

- Integration/ test manager
- AIT engineer
- AIT technicians
- check out operators
- Alignment engineer
- SVM support (ALS)
- QA engineer

Safety Precautions:

- standard precautions for crane and cryo operations

Special Notes:

NA

Activity Number: S.045.040 **Duration:** tbd

Activity Name: **Integration & alignment of Star Tracker** **Model:** PFM SAT

Objective:

Mechanical and electrical integration of the Star Tracker (ALS task)

Requirements to be verified:

- according to STR integration procedure

Environment:

temperature: 22 ± 3 ºC

humidity: 40% < RH < 60%

cleanliness: clean class 100,000

Configuration:

- PLM with SVM mounted on VIS
- PLM HTT in He-I conditions

Activity Breakdown:

- installation of central part of subplatform
- mechanical integration of the STR platform
- sunshade structure integration and harness routing finalization
- MLI finalization
- mechanical and electrical integration of the STR
- STR sunshade MLI integration and thermal closure installation on SVM
- secondary baffle integration
- transfer of PLM/SVM from VIS to rotary table
- alignment of STR to CVV/ S/C axes

Applicable Documents:

- Star Tracker integration procedure (provided by ALS)

GSE required:

- Rotary table
- working platform
- S/C VIS
- alignment equipment (OGSE)

Facility / Instrumentation:

- ESTEC test facility; Herschel preparation area

Personnel:

- AIT engineer
- AIT technicians
- MLI technicians
- STRA AIT Team (ALS)
- Alignement engineer
- QA engineer

Safety Precautions:

- standard safety precautions for cryo operations

Special Notes:

- integration of STRA is an ALS task (with ASED support)

Activity Number: F.045.050 **Duration:** tbd

Activity Name: **Connection of SIH, CCH & Waveguides to WUs** **Model:** PLM SAT

Objective:

- connection of instrument warm units mounted on SVM brackets to the FPUs via external SIH connectors mounted on brackets on the STM SVM
- connection of CCU to external CCH via SVM connector brackets
- connection of LOU waveguides to HIFI WUs

Requirements to be verified:

- According to PFM PLM integration procedure

Environment:

temperature: 22 ± 3 ºC

humidity: 40% < RH < 60%

cleanliness: clean class 100

Configuration:

- PLM with SVM mounted on VIS
- external CCH and SIH pre-integrated
- SVM instrument panels mated with SVM FM

Activity Breakdown:

- connect SVM harness to the external SIH/CCH via brackets on the SVM top panels
- check out of electrical interfaces
- connect waveguides to HIFI WU
- transfer PLM/SVM assembly from VIS to MPT

Applicable Documents:

- PLM/SVM mating procedure
- external SIH/CCH integration procedure

GSE required:

- VIS/ MPT
- IDAS

Facility / Instrumentation:

- ESTEC test facility; Herschel preparation area
- Overhead crane

Personnel:

- AIT engineer
- AIT/ electrical engineer
- electrical technician
- QA engineer

Safety Precautions:

- ESD requirements
- Standard safety precautions for crane operations

Special Notes:

- NA

Activity Number: F.045.060 **Duration:** tbd

Activity Name: **Preparation and connection of S/C EGSE** **Model:** PFM SAT

Objective:

- Preparation and connection of EGSE/CCS after PLM/SVM mating
- SFT SVM and instruments

Requirements to be verified:

- according to EGSE requirement specifications
- according SFT procedures

Environment:

temperature: 22 ± 3 ºC

humidity: 40% < RH < 60%

cleanliness: clean class 100,000

Configuration:

- PLM and SVM FM mounted on MPT
- HTT at He-I temperature, any filling level
- HOT empty
- RCS empty and dry

Activity Breakdown:

- install working platform
- connect S/C EGSE (TMTC SCOE, AOCS SCOE, CDMU SCOE etc.) to the SVM
- connect CCS with S/C EGSE
- perform a short functional test of the SVM
- perform a short functional test of the instruments

Applicable Documents:

- EGSE set-up and connection procedure
- Short functional test procedure SVM
- Short functional test procedure at He I instruments

GSE required:

- MPT
- working platform
- S/C hoisting device
- checkout equipment (CCS, S/C EGSE incl. Cryo SCOE)

Facility / Instrumentation:

- ESTEC test facility; Herschel preparation area
- overhead crane
- EGSE area

Personnel:

- Test Manager
- AIT Test conductor
- Cryo manager
- EGSE operators
- AIT / CVSE technicians
- SVM experts (ALS)
- Instrument representatives
- QA engineer

Safety Precautions:

- standard safety precautions for crane and cryo operations

Special Notes:

- NA

~~A1.3.5~~A1.3.6Integrated ~~Module~~ System Tests (~~IMT~~IST 1) (F.050.000)

Activity Number:	F.050.005	**Duration:**	tbd
Activity Name:	**Production of He-II and top up**	**Model:**	PLM SAT

Objective:

- Perform He II production and top up in preparation of the IST/IMT

Requirements to be verified:

- according to H-EPLM requirement specification (AD 03)
- according to He-II production and top up procedure

Environment:

temperature: 22 ± 3 ºC

humidity: 40% < RH < 60%

cleanliness: clean class 100,000

Configuration:

- PLM with SVM FM mounted on MPT
- HTT in He-I conditions, any HTT filling level
- vent line is connected
- filling port airlock is mounted

Activity Breakdown:

- Check PLM status (liquid level of HTT, valve status, CVSE; Cryo SCOE)
- Preparation activities (if mounted remove oscillation damper; prepare MGSE, install aux. lines, prepare and install transfer lines, install supply and transport dewar)
- refilling of HTT with He-I if needed
- Prepare He-I and He-II pumping units
- Prepare and connect He-I and He-II pumping units to SV 121 respectively to V502
- Start He-II production (valve status according to He-II production and top procedure)
- After completion of He-II production prepare final configuration (check valve status, retract transfer line and close filling port, stop He pumping unit I, remove supply and transport dewar, continue pumping with He pumping unit II)

Applicable Documents:

- He-II production and top up procedure
- procedure for preparation of transfer lines
- procedure for mounting and dismounting of oscillation damper

GSE required:

- MPT
- scaffolding
- heavy duty working platform
- checkout equipment (CCS/Satellite EGSE and Cryo SCOE)
- CVSE for filling operations (He vacuum pumping unit I and II, Transfer lines, LHe supply dewars)
- safety line to filling port

Facility / Instrumentation:

- ESTEC test facility; Herschel preparation area
- overhead crane, standard hoisting slings

Personnel:

- AIT engineer / test conductor
- cryo operation manager
- check out operator
- cryo/mech. team
- CVSE technician
- QA engineer

Safety Precautions:

- Standard precautions for crane and cryo operations

Special Notes:

cleanliness requirements for LHe transfer lines shall be applied

Activity Number:	F.045.006	**Duration:**	tbd
Activity Name:	**SFT at He-II (cryostat & instruments)**	**Model:**	PLM SAT

Objective:

- perform a short functional test of the cryostat and the instruments after He-II production

Requirements to be verified:

- proper functional and required values of the cryostat instrumentation according to H-EPLM requirement specification (AD 03)

Environment:

temperature: 22 ± 3 ºC

humidity: 40% < RH < 60%

cleanliness: clean class 100,000

Configuration:

- PLM with SVM FM mounted on MPT
- PLM in He-II conditions

Activity Breakdown:

- prepare check out equipment (CCS, S/C EGSE and Cryo SCOE)
- perform SFT of cryostat
- perform SFT of instruments

Applicable Documents:

- short functional test procedure

GSE required:

- MPT
- scaffolding
- checkout equipment (CCS, S/C EGSE & Cryo SCOE)
- CVSE

Facility / Instrumentation:

- ESTEC test facility; Herschel preparation area check out area

Personnel:

- test conductor
- AIT engineer
- check out operators
- cryo/mech. Team
- instrument representatives
- QA engineer

Safety Precautions:

- Standard precautions for cryo operations

Special Notes:

- NA

Activity Number:	F.050.010	**Duration:**	tbd
Activity Name:	**Cryostat tests (CCU and instrumentation)**	**Model:**	PLM SAT~~PLM PFM~~

Objective:

- verify that the CCU and the cryostat are working correctly

Requirements to be verified:

- according to H-EPLM requirement specification (AD03)
- according to Instrument Test Procedure on PLM PFM level

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100,000

Configuration:

- PLM with SVM ~~STM~~ FM mounted on MPT
- SFT at He-II has been performed
- HTT at He-II condition

Activity Breakdown:

- Perform self-test of ~~instrument EGSE~~Cryo SCOE
- Check ~~instrument EGSE~~Cryo SCOE interfaces to ~~System EGSE (~~CCS~~)~~
- perform IMT of cryostat (flight instrumentation operated by CCU ~~and instrumentation~~)

Applicable Documents:

- Integrated Module Test Procedures

GSE required:

- MPT
- ~~PLM~~ S/C EGSE, Cryo SCOE, CCS

Facility / Instrumentation:

- ~~Astrium AIT facility, cleanroom class 100,000;~~ESTEC test facility; Herschel preparation area
- Check out area

Personnel:

- AIT engineer / test conductor
- Cryo manager
- EGSE operators
- Cryo/mech. Team

~~Instrument representatives~~

- QA engineer

Safety Precautions:

- Standard safety precautions for cryo operations

Special Notes:

- NA

Activity Number:	F.050.020	**Duration:**	tbd
Activity Name:	**HIFI Tests (IMT)**	**Model:**	PLM SAT~~PLM PFM~~

Objective:

- Functional and performance verification of HIFI

Requirements to be verified:

- According to functional and performance test procedure for HIFI

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100,000

Configuration:

- PLM with SVM ~~STM~~ FM mounted on MPT
- HTT in He-II conditions, HTT closed
- EGSE set-up installed & completely tested
- HOT filled with He-I, boiling through shields

Activity Breakdown:

- Perform functional performance test as defined by HIFI

~~- Perform reduced standing wave test~~

- Evaluate results, release for next instrument test

Applicable Documents:

- functional and performance test procedure for HIFI

GSE required:

- MPT
- checkout equipment (CCS, ~~PLM~~ S/C EGSE, Cryo SCOE, instrument EGSE)

Facility / Instrumentation:

- ~~Astrium AIT facility, cleanroom class 100,000;~~ESTEC test facility; Herschel preparation area check out area

Personnel:

- AIT engineer / test conductor
- Cryo manager
- representatives of instruments
- EGSE operators
- instrument operators
- cryo/mech. Team
- CVSE operator
- QA engineer

Safety Precautions:

- Standard safety precautions for cryo operations

Special Notes:

- NA

Activity Number:	F.050.030	**Duration:**	tbd
Activity Name:	**PACS Tests (IMT)**	**Model:**	PLM SAT~~PLM PFM~~

Objective:

- Functional and performance verification of PACS

Requirements to be verified:

- According to functional and performance test procedure for PACS

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100,000

Configuration:

- PLM with SVM ~~STM~~ FM mounted on MPT
- HTT in He-II conditions, HTT closed
- EGSE set-up installed & completely tested
- HOT filled with He-I, boiling through shields

Activity Breakdown:

- Perform functional performance test as defined by PACS
- Evaluate results, release for next instrument test

Applicable Documents:

- functional and performance test procedure for PACS

GSE required:

- MPT
- checkout equipment (CCS, ~~PLM~~ S/C EGSE, Cryo SCOE, instrument EGSE)

Facility / Instrumentation:

- ~~Astrium AIT facility, cleanroom class 100,000;~~ESTEC test facility; Herschel preparation area check out area

Personnel:

- AIT engineer / test conductor
- Cryo manager
- representatives of instruments
- EGSE operators
- Cryo/mech. Team
- CVSE operator
- instrument operators
- QA engineer

Safety Precautions:

- Standard safety precautions for cryo operations

Special Notes:

Tiliting of PLM necessary

Cover flushing tbd

Activity Number:	F.050.040	**Duration:**	tbd
Activity Name:	**SPIRE Tests (IMT)**	**Model:**	PLM SAT~~PLM PFM~~

Objective:

- Functional and performance verification of SPIRE incl. cooler recycling

Requirements to be verified:

- According to functional and performance test procedure for SPIRE

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100,000

Configuration:

- PLM with SVM ~~STM~~ FM mounted on MPT
- HTT in He-II conditions, HTT closed
- EGSE set-up installed & completely tested
- HOT filled with He-I, boiling through shields

Activity Breakdown:

- Perform functional performance test as defined by SPIRE
- Evaluate results, release for next instrument test

Applicable Documents:

- functional and performance test procedure for SPIRE

GSE required:

- MPT
- checkout equipment (CCS, ~~PLM~~ S/C EGSE, Cryo SCOE, instrument EGSE)

Facility / Instrumentation:

- ~~Astrium AIT facility, cleanroom class 100,000;~~ESTEC test facility; Herschel preparation area check out area

Personnel:

- AIT engineer / test conductor
- Cryo manager
- representatives of instruments
- EGSE operators
- Cryo/mech. Team
- CVSE operator
- instrument operators
- QA engineer

Safety Precautions:

- Standard safety precautions for cryo operations

Special Notes:

- Tilting of PLM necessary
- Cover flushing tbd

Activity Number:	F.050.050	**Duration:**	tbd
Activity Name:	**PACS / SPIRE ~~tests (~~parallel mode (IMT)**	**Model:**	PLM SAT~~PLM PFM~~

Objective:

- Test of parallel mode for PACS / SPIRE

Requirements to be verified:

- According to test procedure for PACS / SPIRE in parallel mode

Environment:

temperature: 22 ± 3 ºC

humidity: 40% < RH < 60%

cleanliness: clean class 100,000

Configuration:

- PLM with SVM ~~STM~~ FM mounted on MPT
- HTT in He-II conditions, HTT closed
- EGSE set-up installed & completely tested
- HOT filled with He-I, boiling through shields

Activity Breakdown:

- Execute the parallel mode of PACS / SPIRE
- Evaluate results

Applicable Documents:

- functional and performance test procedure for PACS and SPIRE

GSE required:

- MPT
- checkout equipment (CCS, ~~PLM~~ S/C EGSE, Cryo SCOE, instrument EGSE)

Facility / Instrumentation:

- ~~Astrium AIT facility, cleanroom class 100,000;~~ESTEC test facility; Herschel preparation area check out area

Personnel:

- AIT engineer / test conductor
- Cryo manager
- representatives of instruments
- EGSE operators
- Cryo/mech. Team
- CVSE operator
- instrument operators
- QA engineer

Safety Precautions:

- Standard safety precautions for cryo operations

Special Notes:

- Tilting of PLM necessary
- Cover flushing tbd

Activity Number: F.050.060 **Duration:** tbd

Activity Name: **IST 1 (S/S SFTs & SFPT)** **Model:** PFM SAT

Objective:

Verify overall satellite performance after integration by:

- Subsystem performance measurements
- Scientific Instruments performance at He-II temp.
- Overall system performance measurement

Requirements to be verified:

- according to Satellite requirement specification
- according to H-EPLM requirement specification

Environment:

temperature: 22 ± 3 ºC

humidity: 40% < RH < 60%

cleanliness: clean class 100,000

Configuration:

- PLM and SVM FM mounted on MPT
- HTT at He-II temperature
- CVSE, S/C EGSE and CCS available and connected

Activity Breakdown:

- conduct subsystem performance tests (SVM and PLM S/S)
- conduct instrument performance tests
- conduct end-to-end system performance test

Applicable Documents:

- Integrated System Test procedure

GSE required:

- MPT
- scaffolding
- CVSE
- CCS & S/C EGSE incl. Cryo SCOE

Facility / Instrumentation:

- ESTEC test facility; Herschel preparation area

Personnel:

- Test Conductor
- electrical AIT engineers
- CVSE operator
- EGSE/CCS Operators
- Instrument test support team
- SVM test support team
- Cryo/mech. Team
- Instrument representatives
- QA engineer

Safety Precautions:

- standard safety precautions for cryo operations

Special Notes:

- tilting of S/C for some instrument tests required
- HTT closed, HOT filled with He-I and boiling through shields during instrument testing

~~A1.3.6~~A1.3.7EMC Tests (F.060.000)

Activity Number:	F.060.010	**Duration:**	tbd
Activity Name:	**EMC test CE at He-II**	**Model:**	PLM SAT~~PLM PFM~~

Objective:

- EMC test on ~~PLM~~ S/C level (CE)

Requirements to be verified:

- EMC requirement specification AD 04
- EMC test specification

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100,000

Configuration:

- PLM with SVM ~~STM~~ FM mounted on MPT
- HTT in He-II conditions, HTT closed
- EGSE set-up installed & completely tested
- HOT filled with He-I, boiling through shields

Activity Breakdown:

- verify EGSE/CCS set-up for EMC testing
- install and calibrate EMC test set-up
- Perform EMC test (CE only)
  - HIFI Tests
  - PACS Tests
  - SPIRE Tests
  - PACS/SPIRE Tests (parallel mode)

Applicable Documents:

- EMC test specification
- PLM EMC test procedure

GSE required:

- MPT
- checkout equipment (CCS/PLM EGSE, Instrument EGSE and Cryo SCOE)
- CVSE
- EMC (CE) test equipment

Facility / Instrumentation:

- ~~Astrium AIT facility, cleanroom class 100,000~~ESTEC test facility; Herschel preparation area
- Check out area

Personnel:

- AIT Test conductor
- EMC measurement team
- Cryo manager
- EGSE / CCS operators
- Cryo/mech. team
- AIT / CVSE technician
- QA engineer

Safety Precautions:

- standard safety precautions for cryo operations
- standard precautions for EMI

Special Notes:

As an option, this test could also be performed after mating the PLM with the PFM SVM

- Tilting of PLM necessary
- Cover flushing tbd

Activity Number:	F.060.020	**Duration:**	tbd
Activity Name:	**Conversion to He-I**	**Model:**	~~PLM PFM~~PFM SAT

Objective:

- Conversion of HTT from He-II to He-I condition

Requirements to be verified:

- none

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100,000

Configuration:

- PLM with SVM FM mounted on MPT
- HTT in He-II conditions
- ventline attached to V502
- CVSE and CCS connected
- He pumping unit II connected and running

Activity Breakdown:

- Shut- off helium ventline by closing V501/503 and 502
- Stop He pumping unit II and disconnect
- shut-off HTT by closing V104
- activate heaters H103/104 to heat up HTT to 4.2K and 1050mbar
- monitor HTT pressure and temperature
- When He-I conditions are achieved, open V104 and subsequently V502 or 501/503 to allow helium vent flow through either ventline or exhaust nozzles

Applicable Documents:

- ~~PLM Depletion and warm up~~Conversion to He I procedure

GSE required:

- MPT
- scaffolding
- checkout equipment (CCS,~~/PLM~~ S/C EGSE and Cryo SCOE)
- CVSE

Facility / Instrumentation:

- ~~Astrium AIT facility, cleanroom class 100,000;~~ESTEC test facility; Herschel preparation area check out area

Personnel:

- AIT engineer
- CVSE operator
- EGSE operator
- CVSE technicians
- Cryo engineer
- QA engineer

Safety Precautions:

- standard safety precautions for cryo operations

Special Notes:

- secure He S/S at any time to prevent backflow of air into He-Subsystem

~~A1.3.7~~A1.3.8PFM Satellite Integration (F.070.000)

~~Activity Number:~~	~~F.070.010~~	**~~Duration:~~**	~~tbd~~
~~Activity Name:~~	**~~De-mating of SVM STM and WUs~~**	**~~Model:~~**	~~PFM PLM~~

~~Objective:~~

~~removal of SVM STM.~~

~~Removal of WU panels from SVM STM~~

~~Removal of STM STR and associated support structure~~

~~Requirements to be verified:~~

- ~~according to HERSCHEL EPLM AIV and HERSCHEL Satellite AIT Requirements Specification (AD02)~~
- ~~according to PLM integration procedure~~

~~Environment:~~

~~temperature: 22 ± 3 ºC~~

~~humidity: 40% < RH < 60%~~

~~cleanliness: clean class 100 000~~

~~Configuration:~~

- ~~PLM with SVM STM mounted on MPT~~
- ~~HTT in He-I conditions~~

~~Activity Breakdown:~~

- ~~disconnect SVM harness (SIH/CCH) from SVM brackets~~
- ~~dismount WU panels from SVM STM~~
- ~~transfer of PLM/SVM from MPT to satellite VIS~~
- ~~remove Star Tracker Assembly (STRA) and central part of subplatform (except STR platform struts) – ALS task~~
- ~~unscrew SVM backets and secure brackets and external SIH/CCH on CVV~~
- ~~unscrew waveguides from SVM (or remove waveguides)~~
- ~~attach PLM hoisting device~~
- ~~decouple PLM and SVM and transfer of PLM to PLM VIS (with adapter)~~
- ~~transfer SVM STM to transport container~~

~~Applicable Documents:~~

- ~~PLM /SVM uncoupling procedure~~
- ~~STR demating procedur~~

~~GSE required:~~

- ~~MPT~~
- ~~S/C VIS~~
- ~~PLM VIS~~
- ~~SVM transport container~~
- ~~miscellaneous integration tools~~

~~Facility / Instrumentation:~~

- ~~Astrium AIT facility, cleanroom class 100,000;~~
- ~~overhead crane~~

~~Personnel:~~

- ~~AIT engineer~~
- ~~AIT technicians~~
- ~~QA engineer~~
- ~~STR specialists (ALS)~~

~~Safety Precautions:~~

- ~~standard safety precautions for crane and cryo operations~~

~~Special Notes:~~

- ~~NA~~

Activity Number: F.070.020 **Duration:** tbd

Activity Name: **Preparation & Mating of PFM SVM and PLM** **Model:** PFM SAT

Objective:

- Preparation & Mating of PLM with PFM SVM

Requirements to be verified:

- according to HERSCHEL-EPLM-AIV and Satellite AIT Requirements Specification (AD02)
- according to PFM satellite integration procedure

Environment:

temperature: 22 ± 3 ºC

humidity: 40% < RH < 60%

cleanliness: clean class 100,000

Configuration:

- PLM mounted in test dolly
- PLM HTT in He-I conditions
- SVM mounted in the MPT

Activity Breakdown:

- Preparation of PFM SVM on VIS
- lifting of PLM with vertical lifting device
- mechanical and electrical mating of SVM to PLM
- shimming and alignment of PLM/SVM I/F in axial and lateral direction

Applicable Documents:

- PFM satellite integration procedure
- Satellite Alignment procedure

GSE required:

- PLM VIS
- Rotary table
- PLM vertical lifting device
- SVM hoisting equipment
- Hydraset
- working platform
- checkout equipment (CCS and Cryo SCOE)
- alignment equipment (OGSE)

Facility / Instrumentation:

- Astrium AIT facility, cleanroom class 100,000
- check-out area
- overhead crane

Personnel:

- Integration/ test manager
- AIT engineer
- AIT technicians
- check-out operators
- Alignment engineer
- QA engineer

Safety Precautions:

- standard precautions for crane and cryo operations

Special Notes:

NA

Activity Number: S.070.030 **Duration:** tbd

Activity Name: **Integration & alignment of Star Tracker** **Model:** PFM SAT

Objective:

Mechanical and electrical integration of the Star Tracker

Requirements to be verified:

- according to STR integration procedure

Environment:

temperature: 22 ± 3 ºC

humidity: 40% < RH < 60%

cleanliness: clean class 100,000

Configuration:

- PLM with SVM mounted on VIS
- PLM HTT in He-I conditions

Activity Breakdown:

- installation of central part of subplatform
- mechanical integration of the STR platform
- sunshade structure integration and harness routing finalization
- MLI finalization
- mechanical and electrical integration of the STR
- STR sunshade MLI integration and thermal closure installation on SVM
- secondary baffle integration
- transfer of PLM/SVM from VIS to rotary table
- alignment of STR to CVV/ S/C axes

Applicable Documents:

- Star Tracker integration procedure

GSE required:

- Rotary table
- working platform
- alignment equipment (OGSE)

Facility / Instrumentation:

- Astrium AIT facility, cleanroom class 100,000

Personnel:

- AIT engineer
- AIT technicians
- MLI technicians
- STR specialists (ALS)
- Alignement engineer
- QA engineer

Safety Precautions:

- standard safety precautions for cryo operations

Special Notes:

- integration of STRA is an ALS task (with ASED support)

Activity Number: F.070.040 **Duration:** tbd

Activity Name: **integration of WU panels to SVM** **Model:** PFM SAT

Objective:

- Integration of WU panels to FM SVM

Requirements to be verified:

- according to PFM S/C integration procedure

Environment:

temperature: 22 ± 3 ºC

humidity: 40% < RH < 60%

cleanliness: clean class 100,000

Configuration:

- PFM PLM and SVM mated and mounted on rotary table
- HTT in He-I conditions
- SVM panel including WUs prepared for integration to FM SVM

Activity Breakdown:

- Transfer of S/C from rotary table to VIS
- Mechanical integration of SVM panels including WUs
- integration of SVM brackets with attached external SIH/CCH to SVM top panels
- Transfer of satellite from VIS to MPT
- Connection of SVM harness (SIH/CCH) to SVM brackets
- Integration of/ connection of waveguides to WU panel
- Electrical integration of WU panels with SVM (supported by IDAS)

Applicable Documents:

- PFM satellite integration procedure
- PFM SVM integration procedure

GSE required:

- rotary table
- Satellite VIS
- Satellite MPT
- working platform
- checkout equipment (CCS, SAT EGSE incl. Cryo SCOE)
- IDAS

Facility / Instrumentation:

- Astrium AIT facility, cleanroom class 100,000 check-out area
- overhead crane

Personnel:

- AIT engineer
- AIT technicians
- check-out operators
- AIT electrical technicians
- QA engineer

Safety Precautions:

- standard precautions for crane and cryo operations

Special Notes:

ESD requirements have to be applied

Activity Number:	F.070.050	**Duration:**	tbd
Activity Name:	**Integration & alignment of telescope**	**Model:**	PFM SAT

Objective:

- Integration and alignment of FM Telescope

Requirements to be verified:

- according to FM S/C integration procedure
-

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100,000

Configuration:

- PLM with SVM mounted on MPT
- HTT in He-I conditions

Activity Breakdown:

- Transfer S/C from MPT to rotary table
- integrate telescope mounting structure
- align telescope mounting structure
- mechanically integrate telescope
- align telescope
- install telescope instrumentation
- route and connect telescope instrumentation harness
- integrate telescope MLI
- protect the telescope critical surface

Applicable Documents:

- PFM satellite integration procedure
- FM telescope handling procedure

GSE required:

- MPT
- Rotary table
- telescope lifting device
- Hydra-set
- Telescope protection cover
- working platform
- alignment equipment (OGSE)

Facility / Instrumentation:

- ~~Astrium AIT facility, cleanroom class 100,000;~~ESTEC test facility; Herschel preparation area check out area
- overhead crane

Personnel:

- AIT PLM engineer
- AIT technician
- check out operators
- QA engineer
- Alignment engineer
- Telescope support team

Safety Precautions:

- standard precautions for crane and cryo operations

Special Notes:

- cleanliness precautions for telescope handling due to its sensitive surfaces

Activity Number:	F.070.050	**Duration:**	tbd
Activity Name:	**Alignment telescope to CVV**	**Model:**	PFM SAT

Objective:

- Final alignment of telescope to CVV

Requirements to be verified:

- according to PFM S/C integration procedure
- according to telescope alignment procedure

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100,000

Configuration:

- PLM and SVM mated and aligned onto rotary table
- PLM main tank in He-I conditions
- telescope integrated onto EPLM

Activity Breakdown:

- preparation of alignment equipment
- install working platform
- install / check the mirror cubes for alignment measurements
- final shimming and alignment of telescope
- check the final screw torque an locking
- document the obscuration status
- protect the telescope critical surface
- transfer form rotary table to MPT

Applicable Documents:

- telescope alignment procedure
- according to PFM S/C integration procedure

GSE required:

- SVM Multi Purpose Trolley (MPT)
- Rotary table
- working platform
- alignment equipment
- special integration tools for shimming

Facility / Instrumentation:

- ~~Astrium AIT facility, cleanroom class 100,000~~ESTEC test facility; Herschel preparation area
- Check out area
- overhead crane

Personnel:

AIT S/C integration engineer

AIT technician

alignment technician / engineers

QA engineer

Safety Precautions:

- standard safety precautions for crane and cryo operations

Special Notes:

- apply precautions for telescope handling due to its sensitive surfaces

Activity Number:	F.070.060	**Duration:**	tbd
Activity Name:	**Integration of solar array incl. support structure**	**Model:**	PFM SAT

Objective:

- Mechanical, electrical and thermal integration of FM solar array including its support structure

Requirements to be verified:

- according to PFM S/C integration procedure
- according to solar array integration procedure

Environment:

- temperature: 22 ± 3 ºC
- humidity: 40% < RH < 60%
- cleanliness: clean class 100,000

Configuration:

- PLM and SVM mated and aligned onto MPT
- HTT in He-I conditions
- telescope integrated and aligned to CVV
- solar array released for integration

Activity Breakdown:

- preparation of solar array for integration
- provide working platform
- provide struts for solar array integration
- integrate the struts to SVM and PLM
- mechanical integration of the solar array
- electrical integration and check of the S/A harness
- integrate solar array instrumentation and harness
- integrate/complete the solar array MLI
- protect the solar array outer surface (PVA)

Applicable Documents:

- PFM S/C integration procedure
- Solar array integration procedure including electrical checkout of S/A
- solar array handling procedure

GSE required:

- MPT
- scaffolding
- solar array surface protection parts
- solar array hoisting equipment
- Hydra-set
- digital multimeter

Facility / Instrumentation:

- ~~Astrium AIT facility, cleanroom class 100,000~~ESTEC test facility; Herschel preparation area
- overhead crane

Personnel:

- AIT engineer
- mechanical technicians
- electrician technicians
- MLI technician
- QA engineer

Safety Precautions:

- standard safety precautions for crane and cryo operations

Special Notes:

- apply precautions for solar array handling due to its sensitive surfaces

Activity Number:	F.070.070	**Duration:**	tbd
Activity Name:	**Integration of sunshade incl. support structure**	**Model:**	PFM SAT

Objective:

- Mechanical and thermal integration of sunshade incl. its support structure

Requirements to be verified:

- according to PFM S/C integration procedure

Environment:

- temperature: 22 ± 3 ºC
- humidity: 40% < RH < 60%
- cleanliness: clean class 100,000

Configuration:

- PLM and SVM mated and aligned onto MPT
- HTT in He-I conditions
- telescope integrated and aligned to CVV
- solar array integrated
- sunshade released for integration

Activity Breakdown:

- preparation of sunshade elements for integration
- provide working platform
- provide I/F brackets for sunshade integration
- integrate the I/F brackets to solar arrays
- mechanical integration of the sunshade incl. support structure
- integrate sunshade instrumentation and harness
- integrate/close the sunshade MLI

Applicable Documents:

- PFM S/C integration procedure

GSE required:

- MPT
- scaffolding
- sunshade hoisting equipment
- Hydraset

Facility / Instrumentation:

- ~~Astrium AIT facility, cleanroom class 100,000~~ESTEC test facility; Herschel preparation area
- Check out area
- overhead crane

Personnel:

- AIT S/C integration engineer
- AIT technician
- MLI technician
- QA engineer

Safety Precautions:

- standard safety precautions for crane and cryo operations

Special Notes:

- NA

Activity Number:	S.070.080	**Duration:**	tbd
Activity Name:	**Integration of SVM thermal shield**	**Model:**	PFM SAT

Objective:

Mechanical and thermal integration of SVM Thermal Shield including its support structure

Requirements to be verified:

- according to PFM S/C integration procedure

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100,000

Configuration:

- PLM and SVM mated and aligned onto MPT
- HTT in He-I conditions
- Telescope integrated and aligned
- solar array integrated
- sunshade integrated

Activity Breakdown:

- preparation of SVM shield for integration
- provide working platform
- provide I/F brackets for SVM thermal shield integration
- integrate the I/F brackets to CVV/SVM
- mechanical integration of the thermal shield incl. support structure
- integrate instrumentation and harness
- integrate/close the thermal shield MLI

Applicable Documents:

- PFM SAT integration procedure

GSE required:

- MPT
- scaffolding
- SVM thermal shield hoisting equipment

Facility / Instrumentation:

- ~~Astrium AIT facility, cleanroom class 100,000~~ESTEC test facility; Herschel preparation area
- overhead crane

Personnel:

- AIT engineer
- AIT technicians
- MLI technicians
- QA - engineer

Safety Precautions:

- standard safety precautions for crane and cryo operations

Special Notes:

-
- NA

Activity Number: S.070.090 **Duration:** tbd

Activity Name: **Satellite Completion** **Model:** PFM SAT

Objective:

Completion of satellite integration

Requirements to be verified:

- according to PFM S/C integration procedure

Environment:

temperature: 22 ± 3 ºC

humidity: 40% < RH < 60%

cleanliness: clean class 100,000

Configuration:

- PLM and SVM mated and aligned onto MPT
- HTT in He-I conditions
- Telescope integrated and aligned
- solar array integrated
- sunshade integrated
- SVM shield integrated

Activity Breakdown:

- Integrate CVV radiators
- Check completion of mechanical integration
- Complete external MLI

Applicable Documents:

- PFM SAT integration procedure

GSE required:

- MPT
- scaffolding

Facility / Instrumentation:

- ESTEC test facility; Herschel preparation area
- overhead crane

Personnel:

- AIT engineer
- AIT technicians
- MLI technicians
- QA - engineer

Safety Precautions:

- standard safety precautions for crane and cryo operations

Special Notes:

-
- NA

A1.3.9Integrated System Test 1 (IST) (F.080.000)

Activity Number:	F.080.010	**Duration:**	tbd
Activity Name:	**He-I top up; He-II production and top up**	**Model:**	PFM SAT

Objective:

perform the He-II production and top up before IST

Requirements to be verified:

- according to He-II production and top up procedure

Environment:

temperature: 22 ± 3 ºC

humidity: 40% < RH < 60%

cleanliness: clean class 100,000

Configuration:

- PFM Satellite mounted on MPT
- HTT at He-I temperature, any filling level
- HOT empty

Activity Breakdown:

- Check PLM status (liquid level of HTT, valve status Cryo EGSE etc.)
- Mount airlock to filling port
- Connect EGSE (TMTC SCOE, AOCS SCOE, CDMU SCOE etc.)
- Preparation activities (if mounted remove oscillation damper; prepare MGSE, install aux. lines, prepare and install transfer lines, install supply and transport dewar)
- Top up of HTT with He-I
- Prepare He-I and He-II pump units
- Prepare and connect He-I and He-II pumping units to Filling port SV 121 respectively to V502
- Start He-II production in HTT
- After completion of He-II production prepare final configuration (check valve status, retract transfer line and close filling port, stop He pumping unit I, remove supply and transport dewar, continue pumping with He pumping unit II)

Applicable Documents:

- He-II production and top up procedure

GSE required:

- MPT
- heavy duty working platform
- checkout equipment (CCS, SAT EGSE and Cryo SCOE)
- CVSE for filling operations (He vacuum pumping unit I and II, Transfer lines, LHe supply dewars)
- safety line to filling port

Facility / Instrumentation:

- Astrium AIT facility, cleanroom class 100,000
- overhead crane

Personnel: (2-shift)

- AIT engineer / test conductor
- cryo operation manager
- check out operators
- CVSE technicians
- Cryo/mech. team
- QA engineer

Safety Precautions:

- standard safety precautions for cryo and crane operations

Special Notes:

- NA

Activity Number: F.080.020 **Duration:** tbd

Activity Name: **IST 1 (S/S SFTs & SFPT)** **Model:** PFM SAT

Objective:

Verify overall satellite performance after integration by:

- Subsystem performance measurements
- Scientific Instruments performance at He-II temp.
- Overall system performance measurement

Requirements to be verified:

- according to Satellite requirement specification
- according to H-EPLM requirement specification

Environment:

temperature: 22 ± 3 ºC

humidity: 40% < RH < 60%

cleanliness: clean class 100,000

Configuration:

- Satellite mounted on MPT
- HTT at He-II temperature
- CVSE and CCS/EGSE available and connected

Activity Breakdown:

- conduct subsystem performance tests (SVM and PLM S/S)
- conduct instrument performance tests
- conduct end-to-end system performance test

Applicable Documents:

- Integrated System Test procedure

GSE required:

- MPT
- scaffolding
- CVSE
- CCS/EGSE incl. Cryo SCOE

Facility / Instrumentation:

- Astrium AIT facility, cleanroom class 100,000

Personnel:

- Test Conductor
- electrical AIT engineers
- CVSE operator
- EGSE/CCS Operators
- Instrument test support team
- SVM test support team
- Cryo/mech. team
- QA engineer

Safety Precautions:

- standard safety precautions for cryo operations

Special Notes:

- tilting of S/C for some instrument tests required
- HTT closed, HOT filled with He-I and boiling through shields during instrument testing

Activity Number: F.080.025 **Duration:** tbd

Activity Name: **EMC test CE at He-II** **Model:** PFM SAT

Objective:

- EMC test on S/C level (CE)

Requirements to be verified:

- EMC requirement specification AD 04
- EMC test specification

Environment:

temperature: 22 ± 3 ºC

humidity: 40% < RH < 60%

cleanliness: clean class 100,000

Configuration:

- Satellite mounted on MPT
- HTT in He-II conditions, HTT closed
- EGSE set-up installed & completely tested
- HOT filled with He-I, boiling through shields

Activity Breakdown:

- verify EGSE/CCS set-up for EMC testing
- install and calibrate EMC test set-up
- Perform EMC test (CE only)
  - HIFI Tests
  - PACS Tests
  - SPIRE Tests

Applicable Documents:

- EMC test specification
- Satellite EMC test procedure

GSE required:

- MPT
- checkout equipment (CCS/Satellite EGSE, Instrument EGSE and Cryo SCOE)
- CVSE
- EMC (CE) test equipment

Facility / Instrumentation:

- Astrium AIT facility, cleanroom class 100,000
- Check out area

Personnel:

- AIT Test conductor
- EMC measurement team
- Cryo manager
- EGSE / CCS operators
- Cryo/mech. team
- AIT / CVSE technician
- QA engineer

Safety Precautions:

- standard safety precautions for cryo operations
- standard precautions for EMI

Special Notes:

- Tilting of PLM necessary
- Cover flushing tbd

Activity Number: F.080.030 **Duration:** tbd

Activity Name: **Conversion to He-I** **Model:** PFM SAT

Objective:

- Conversion of HTT from He-II to He-I condition before transportation to ESTEC

Requirements to be verified:

- none

Environment:

temperature: 22 ± 3 ºC

humidity: 40% < RH < 60%

cleanliness: clean class 100,000

Configuration:

- PFM Satellite mounted on MPT in AIT facility
- HTT at He-II temperature
- ventline attached to V502
- CVSE and CCS connected
- He pumping unit II connected and running

Activity Breakdown:

- Shut-off helium ventline by closing V502
- Stop He pumping unit II and disconnect
- shut-off HTT by closing V104
- activate heaters H103/104 to heat up HTT to 4.2K and 1050mbar
- monitor HTT pressure and temperature
- When He-I conditions are achieved, open V104 and subsequently V502 or 501/503 to allow helium vent flow through either ventline or exhaust nozzles

Applicable Documents:

- Helium depletion and warm-up procedure

GSE required:

- MPT
- Scaffolding
- Cryo SCOE; CCS
- CVSE

Facility / Instrumentation:

- Astrium AIT facility, cleanroom class 100,000

Personnel:

- AIT engineer
- Cryo Engineer
- EGSE operator
- CVSE technicians
- QA engineer

Safety Precautions:

- standard safety precautions for cryo operations

Special Notes:

- secure HE S/S at any time in ventline to prevent backflow of air into He-Subsystem

Activity Number: F.080.040 **Duration:** tbd

Activity Name: **Transport to ESTEC** **Model:** PFM SAT

Objective:

Transport of PFM satellite and associated GSE from Astrium GmbH AIT site to environmental test site at ESTEC

Requirements to be verified:

- according to PFM satellite handling and transportation procedure

Environment:

temperature: 22 ± 3 ºC

humidity: 40% < RH < 60%

cleanliness: clean class 100,000

Configuration:

- PFM satellite mounted on MPT
- HTT in He-I conditions;
- HOT empty

Activity Breakdown:

- Make sure that HTT is filled to about 50%
- remove working platform
- disconnect checkout equipment and CVSE
- prepare the transport container
- move the satellite with lifting device to the prepared container (S/C x-axis horizontally)
- install and activate the transport stimuli & monitoring Unit (TSMU)
- transport of satellite to environmental test site
- transport of GSE to test site (in parallel)
- open satellite container and lift satellite with lifting device onto MPT
- perform incoming inspection and disconnect TSMU

Applicable Documents:

- PFM satellite handling and transportation procedure

GSE required:

- MPT
- working platform
- satellite lifting device
- checkout equipment during transport
- Satellite transport container incl. TSMU

Facility / Instrumentation:

- Astrium AIT Facility, cleanroom class 100,000
- ESTEC test facility; preparation area
- overhead crane

Personnel:

- AIT Test conductor
- AIT technician
- EGSE operator
- transport team
- QA engineer

Safety Precautions:

- standard safety precautions for crane and cryo operations

Special Notes:

- NA

A1.3.9 TB/TV Test including System Validation Tests (F.090.000)

Activity Number:	F.090.010	**Duration:**	tbd
Activity Name:	**Preparation and connection of CVSE and GSE**	**Model:**	PFM SAT

Objective:

Preparation of EGSE/CCS and CVSE at TB/TV facility

Requirements to be verified:

- according to EGSE and CVSE requirement specifications

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100,000

Configuration:

- PFM Satellite mounted on MPT
- HTT at He-I temperature, any filling level
- HOT empty
- RCS empty and dry

Activity Breakdown:

- install working platform
- connect checkout equipment (CCS/EGSE incl. Cryo SCOE) to the satellite
- ~~install CVSE incl. filling port airlock~~

Applicable Documents:

- He-I filling and top up procedure
- He-II production and top up procedure
- TB/TV test procedure

GSE required:

- MPT
- working platform
- S/C hoisting device
- checkout equipment (CCS/EGSE incl. Cryo SCOE)
- CVSE for He-I top up, He-II production and TB/TV testing

Facility / Instrumentation:

- ESTEC test facility; Herschel preparation area
- overhead crane
- EGSE area

Personnel:

- Test Manager
- AIT Test conductor
- Cryo manager
- EGSE operators
- AIT / CVSE technicians
- QA engineer

Safety Precautions:

- standard safety precautions for crane and cryo operations

Special Notes:

- NA

Activity Number:	F.090.020	**Duration:**	tbd
Activity Name:	**SFT at He-I (cryostat & instruments)**	**Model:**	PFM SAT

Objective:

- perform a short functional test of the cryostat and scientific instruments ~~after transportation to ESTEC and~~ before He-II production and subsequent TB/TV test

Requirements to be verified:

- proper functional and required values of the cryostat instrumentation according to H-EPLM requirement specification (AD 03)

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100,000

Configuration:

- PFM Satellite mounted on MPT
- HTT at He-I temperature, any filling level

Activity Breakdown:

- perform SFT of cryostat
- perform SFT of instruments

Applicable Documents:

- short functional test procedures

GSE required:

- MPT
- scaffolding
- checkout equipment (CCS, SAT EGSE and Cryo SCOE)

Facility / Instrumentation:

- ESTEC facility, cleanroom class 100,000; check out area

Personnel:

- test conductor
- AIT engineer
- checkout operators
- cryo/mech. team
- QA engineer

Safety Precautions:

- standard precautions for cryo operations

Special Notes:

- NA

Activity Number:	F.090.030	**Duration:**	tbd
Activity Name:	**He-II production and top up**	**Model:**	PFM SAT

Objective:

perform the He-II production and top up before SVT and TB/TV tests

Requirements to be verified:

- according to He-II production and top up procedure

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100,000

Configuration:

- PFM Satellite mounted on MPT
- HTT at He-I temperature, any filling level
- HOT empty
- RCS empty

Activity Breakdown:

- Check PLM status (liquid level of HTT, valve status Cryo EGSE etc.)
- Preparation activities (if mounted remove oscillation damper; prepare MGSE, install aux. lines, prepare and install transfer lines, install supply and transport dewar)
- refilling of HTT with He-I if needed
- Prepare He-I and He-II pumping units
- Prepare and connect He-I and He-II pumping units to Filling port SV 121 respectively to V502
- Start He-II production (valve status according to He-II production and top procedure)
- After completion of He-II production prepare final configuration (check valve status, retract transfer line and close filling port, stop He pumping unit I, remove supply and transport dewar, continue pumping with He pumping unit II)

Applicable Documents:

- He-II production and top up procedure

GSE required:

- Multi Purpose Trolley (MPT)
- heavy duty access working platform
- checkout equipment (CCS/EGSE and Cryo SCOE)
- CVSE for filling operations (He vacuum pumping unit I and II, Transfer lines, LHe supply dewars)
- safety line to filling port

Facility / Instrumentation:

- ESTEC test facility, cleanroom class 100,000;
- preparation area in front of TB/ TV chamber
- overhead crane

Personnel:

- AIT Test conductor
- Cryo operations manager
- check out operators
- AIT / CVSE technicians
- QA engineer

Safety Precautions:

- standard safety precautions for cryo and crane operations

Special Notes:

- NA

Activity Number:	F.090.040	**Duration:**	tbd
Activity Name:	**System validation test 1 (SVT)**	**Model:**	PFM SAT

Objective:

to demonstrate compatibility between the Herschel satellite and the satellite control centre at ESOC

Requirements to be verified:

- according to satellite performance requirement specification

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100,000

Configuration:

- PFM SAT mounted on MPT
- HTT at He-II conditions; any filling level
- HOT empty
- RCS empty
- CVSE and CCS/EGSE connected

Activity Breakdown:

- setting of CCS/EGSE in SVT configuration
- connect ESOC interface equipment and modems
- perform SVT (details to be defined with ESOC support)

Applicable Documents:

- SVT procedure

GSE required:

- satellite Multi Purpose Trolley
- checkout equipment (CCS/EGSE and Cryo SCOE)
- NDIU
- He pump units I and II

Facility / Instrumentation:

- ESTEC test facility
- EGSE area

Personnel:

- Test manager
- Test conductor
- Cryo engineer
- EGSE operators
- AIT / CVSE technicians
- SVM support team (ALS)
- ESOC operations team
- Instrument representatives
- QA engineer

Safety Precautions:

- standard safety precautions for cryo operations

Special Notes:

- It may be required to perform some ACMS closed loop test cases. It may be necessary therefore to install special ACMS test cabling at an earlier stage during AIT

Activity Number:	S.090.050	**Duration:**	tbd
Activity Name:	**Integration of LOU ~~and specific CVV radiators~~**	**Model:**	PFM SAT

Objective:

Mechanical integration of LOU radiator ~~and specific CVV radiators for CVV active cooling~~

Requirements to be verified:

- according to PFM satellite integration procedure

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100,000

Configuration:

- PFM SAT mounted on MPT
- HTT at He-II conditions; any filling level
- HOT empty
- RCS empty
- CVSE and CCS/EGSE connected

Activity Breakdown:

- preparation of radiators for integration
- provide working platform
- mechanical integration of the LOU radiator incl. support structure
- ~~mechanical integration of the specific CVV radiators~~
- integrate test instrumentation and harness
- closure of MLI

Applicable Documents:

- PFM satellite integration procedure

GSE required:

- MPT
- working platform
- Radiators hoisting equipment

Facility / Instrumentation:

- ESTEC facility, cleanroom class 100,000
- overhead crane

Personnel:

- AIT engineer
- AIT technicians
- MLI technicians
- QA - engineer

Safety Precautions:

- standard safety precautions for crane and cryo operations

Special Notes:

- NA

Activity Number:	F.090.060	**Duration:**	tbd
Activity Name:	**Launch autonomy verification**	**Model:**	PFM SAT

Objective:

perform launch autonomy verification during/after installation into the LSS to

- to simulate the conditions on the launcher during final launch preparations and launch and to verify acceptable temperatures and filling level in HTT at begin of mission
- launch autonomy phases neded to support set-up in LSS

Requirements to be verified:

- according to satellite AIT requirement specification
- according to Satellite performance requirement specification

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100,000

Configuration:

- satellite installed in vertical direction on thermal test adapter inside the open TV chamber
- HTT at He-II temperature
- HOT empty
- CVSE and CCS attached to satellite
- RCS empty

Activity Breakdown:

- perform He-II top up
- verify launch autonomy
  - closing of HTT
  - Disconnect of He Pumping Unit I and II
  - Filling of HOT with He-I
  - Refilling of HOT with He-I every other day (tbc) and recording of the He-II tank temperature profile
- connect He pumping unit II in LSS basement
- depletion and evacuation of HOT at end of launch autonomy test (after LSS closure)
- opening of HTT
- remove scaffolding and other GSE from LSS

Applicable Documents:

- PFM launch autonomy test procedure

GSE required:

- working platform
- checkout equipment (CCS SAT EGSE and Cryo SCOE)
- CVSE set 1 and set 2 for launch autonomy test and TB/TV test

Facility / Instrumentation:

- ESTEC test facility; LSS
- Preparation area in front of LSS
- EGSE area

Personnel:

- Test conductor
- Cryo manager
- EGSE operators
- AIT / CVSE technicians
- QA engineer

Safety Precautions:

- standard safety precautions for cryo and crane operations

Special Notes:

- NA

Activity Number:	F.090.070	**Duration:**	tbd
Activity Name:	**Installation and set-up of S/C in LSS**	**Model:**	PFM SAT

Objective:

Installation of the satellite including GSE/CVSE in TV chamber

Requirements to be verified:

- according to satellite AIT requirement specification
- according to PFM satellite TB/TV test ~~procedure~~specification

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100,000

Configuration:

- PFM Satellite mounted on MPT
- HTT at He-II conditions, HTT closed
- HOT filled with He-I, boiling through shields
- RCS empty
- Radiators installed

Activity Breakdown:

- check the cleanliness status of LSS
- preparation of LSS ~~and bake out~~
~~preparation of active cooling of CVV~~
- Install S/C in the TV chamber including thermal adapter and thermal shields
- install internal and external CVSE
- install test harnesses and connect to ~~CCS~~S/C EGSE
- perform leak tests of installed tubing
- complete the MLI installation at S/C and thermal adapter
- remove protective covers from contamination sensitive surfaces
- integration of ~~IR rig~~HSS thermal control rig
- install samples for contamination control

Applicable Documents:

- PFM Satellite TB/TV Test Procedure

GSE required:

- Satellite vertical lifting device
- samples for particle and molecular contamination verification
- thermal test adapters (~~TTAP~~ TTAS and TTA)
- checkout equipment (CCS, ~~/~~ S/CEGSE and Cryo SCOE)
- He pump units I and II on top of basement
- He pump units set 2 in basement of LSS
- LSS data acquisition
- LSS pump units
- safety equipment

Facility / Instrumentation:

- ESTEC test facility; LSS area
~~TV chamber~~
- overhead crane
- EGSE area

Personnel:

Test Manager
AIT Test conductor
Cryo engineer
EGSE operators
AIT / CVSE technicians
TV chamber operation team
technical support for SVM activities
QA engineer

Safety Precautions:

- standard safety precautions for crane and cryo operations
- precautions due to pressure in RCS
- safety equipment during TB/TV test shall be provided

Special Notes:

- the cleanliness requirements shall be strongly applied

- intermediate HOT filling required

Activity Number:	F.090.080	**Duration:**	tbd
Activity Name:	**TB / TV test**	**Model:**	PFM SAT

Objective:

- final qualification of thermal design
- validation of mathematical model to predict temperatures on flight and life time
- verification of alignment (HIFI vs. LOU)
- identification of proper system functional aspects
- verification of MLI workmanship

Requirements to be verified:

- according to satellite AIT requirement specification
- according to TB/TV test ~~procedure~~specification

Environment:

as per TB/TV test procedure

Configuration:

- satellite installed in vertical direction on thermal test adapter inside the open LSS
- HTT at He-II temperature
- CVV active cooling attached
- RCS filled and pressurised to tbd bar

Activity Breakdown:

See TB/TV test specification for details

- close LSS
- depletion of HOT
- evacuation and cool down of LSS shrouds
- simulation of launch phase pressure gradients
- the shroud temperature shall be below 100k, the vacuum pressure inside the chamber shall be below 1x10 –5 mbar tbc.

- Step 1
  - Actively cool down of CVV until 70 K tbc
  - tilting of satellite according PPS needs (maximal 30 degrees)
  - check of cryostat internal balance
  - alignment measurements (see F.100.080)
- Step 2
  - perform thermal balance test
  - perform thermal cycling test incl. hot and cold soak and transition phase
  - ~~perform µ-vibration measurements during reaction wheel operation~~

Applicable Documents:

- PFM Satellite TB/TV Test Procedure

GSE required:

- checkout equipment (CCS, SAT EGSE, Cryo SCOE)
- He pump units ~~I~~ set 2 in basement of LSS
- thermal test adapters
- Special cooling equipment for CVV
- LSS data acquisition
- LSS pump units
- safety equipment
- ~~IR rig~~HSS thermal control rig

Facility / Instrumentation:

- ESTEC test facility; LSS
- EGSE area

Personnel: (3-shift during test)

- Test Manager
- AIT Test conductor
- Cryo manager
- EGSE operators
- AIT / CVSE technicians
- chamber operation team
- SVM support team
- QA engineer

Safety Precautions:

- standard safety precautions for cryo operations

Special Notes:

- the cleanliness requirements shall be strongly applied

Activity Number:	F.090.090	**Duration:**	tbd
Activity Name:	**Alignment check during TB/TV test**	**Model:**	PFM SAT

Objective:

- Check alignment requirements of HIFI FPU versus LOU during TB/TV test
- Perform videogrammetry

Requirements to be verified:

- alignment requirements for LOU/HIFI

Environment:

- as per TB/TV test procedure

Configuration:

- PFM Satellite mounted on Thermal Test Adapter in LSS
- TB/TV test running
- HTT at He-II temperature

Activity Breakdown:

- Continuous alignment measurement of HIFI FPU reference to outer CVV (LOU) through LOU optical window with alignment camera
- Alignment check of telescope vs. LOU with videogrammetry system in LSS at begin (warm CVV) and at end of TB/TV test (CVV cold)

Applicable Documents:

- PFM satellite TB/TV test procedure
- PFM satellite alignment verification procedure
- Videogrammetry measurement procedure

GSE required:

- as for TV/TB test (F.090.080)
- alignment camera
- Video grammetry system

Facility / Instrumentation:

- ESTEC test facility; LSS

Personnel:

- AIT engineer
- alignment engineer
- video grammetry team (ESTEC)
- QA engineer

Safety Precautions:

- standard safety precautions for cryo operations

Special Notes:

- NA

Activity Number:	F.090.100	**Duration:**	tbd
Activity Name:	**Removal from test chamber and transfer to integration area**	**Model:**	PFM SAT

Objective:

Remove PFM satellite and associated GSE from LSS

Transfer of satellite and GSE to integration area

Requirements to be verified:

- none

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100,000

Configuration:

- PFM Satellite mounted on Thermal Test Adapter installed in TV test chamber
- HTT at He-II temperature

Activity Breakdown:

- Warm up of shrouds
- Pressurize LSS
- Open LSS
- Install telescope protection
- Installation of scaffolding
- Disconnect test harness

~~disconnect active CVV cooling piping~~

- reinstall protective covers to contamination sensitive items
- close HTT; stop pumping
- lift satellite out of TV test chamber
- remove thermal test adapter
- install satellite on MPT
- transfer satellite to integration area
- reconnect CVSE and Cryo SCOE
- re-open HTT
- He-II top up
- short functional test cryostat
- removal of test instrumentation

~~removal of specific CVV radiators~~

~~installation of CVV radiators~~

Applicable Documents:

- TB/TV test procedure
- PFM satellite handling and transportation procedure

GSE required:

- Satellite vertical lifting device
- Hydraset
- MPT
- Thermal Test Adapter
- CVSE
- Cryo SCOE, CCS, SAT EGSE

Facility / Instrumentation:

- ESTEC test facility; LSS; preparation area
- overhead crane

Personnel:

Test conductor

AIT engineer

AIT technicians

CVSE operator

EGSE/CCS Operators

QA engineer

Safety Precautions:

- standard safety precautions for cryo and crane operations
- safety precautions due to pressure in RCS

Special Notes:

- limited time to remove satellite from LSS, re-installation on MPT and transfer to integration area due to closed HTT

A1.3.10 EMC Test (F.100.000)

Activity Number:	F.100.010	**Duration:**	tbd
Activity Name:	**Transport to EMC chamber and preparation**	**Model:**	PFM SAT

Objective:

Transport of PFM satellite and associated GSE to the EMC chamber and preparation ofsatellite for RE/RS test

Requirements to be verified:

- according to PFM satellite handling and transportation procedure

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100,000

Configuration:

- PFM satellite mounted on MPT in integration area
- HTT in He-II conditions;
- HOT empty

Activity Breakdown:

- Close HTT
- HOT filling with He-I
- remove working platform
- disconnect checkout equipment and CVSE
- move the satellite into the EMC chamber
- install working platform
- install pumping units in EMC chamber behind absorber wall
- install pumping units at LEMC
- re-connection of CVSE and EGSE

Applicable Documents:

- PFM satellite handling and transportation procedure
- HOT filling procedure
- CVSE setup procedure
- EGSE setup and connection procedure

GSE required:

- MPT
- working platform
- EGSE/CVSE
- He-I and II pumping units

Facility / Instrumentation:

- ESTEC Test Facility, integration area
- ESTEC test facility; EMC chamber

Personnel:

- AIT Test conductor
- AIT technician
- EGSE operator
- CVSE operator
- QA engineer

Safety Precautions:

- standard safety precautions for cryo operations

Special Notes:

- NA

Activity Number:	F.100.020	**Duration:**	tbd
Activity Name:	**EMC test Satellite level (RE & RS)**	**Model:**	PFM SAT

Objective:

- Demonstration of compliance with launch vehicle EMC requirements
- demonstration of margin on power lines at interfaces between SVM and PLM
- demonstration of compatibility of scientific instruments in specified environment in flight configuration

Requirements to be verified:

- EMC requirement specification AD 04
- EMC test specification

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100,000

Configuration:

- Satellite mounted on MPT in EMC chamber
- HTT at He-II temperature
- RCS filled and pressurised (tbc)
- CVSE and CCS connected

Activity Breakdown:

- install and calibrate EMC test set-up
- Perform EMC test (RE, RS)
- Perform PTR F10

Applicable Documents:

- EMC test specification
- EMC test procedure

GSE required:

- MPT
- working platform
- CVSE
- EGSE/CCS

Facility / Instrumentation:

- ESTEC test facility; EMC Test chamber
- EMC probes and measurement equipment

Personnel:

- Test conductor
- AIT engineer
- CVSE operator
- EGSE/CCS Operators
- SVM test engineers
- EMC facility and measurement team (ESTEC)
- crane operator
- QA engineer
- Instrument support team

Safety Precautions:

- standard safety precautions for cryo operations
- safety precautions due to pressure in RCS
- standard precautions for EMI

Special Notes:

- NA

Activity Number:	F.100.030	**Duration:**	tbd
Activity Name:	**Conversion to He-I**	**Model:**	PFM SAT

Objective:

- Conversion of HTT from He-II to He-I condition

Requirements to be verified:

- none

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100,000

Configuration:

- PFM Satellite mounted on MPT in EMC chamber
- HTT at He-II temperature
- ventline attached to V502
- CVSE and CCS connected
- He pumping unit II connected and running
- RCS filled and pressurised (tbc)

Activity Breakdown:

- Shut- off helium ventline by closing V502
- Stop He pumping unit II and disconnect
- shut-off HTT by closing V104
- activate heaters H103/104 to heat up HTT to 4.2K and 1050mbar
- monitor HTT pressure and temperature
- When He-I conditions are achieved, open V104 and subsequently V502 or 501/503 to allow helium vent flow through either ventline or exhaust nozzles

Applicable Documents:

- Helium depletion and warm-up procedure

GSE required:

- MPT
- Scaffolding
- Cryo SCOE; CCS
- CVSE

Facility / Instrumentation:

- ESTEC test facility; EMC Test chamber; preparation area

Personnel:

- AIT engineer
- CVSE operator
- EGSE operator
- CVSE technicians
- Cryo/mech. team
- QA engineer

Safety Precautions:

- standard safety precautions for cryo operations
- safety precautions due to pressure in RCS

Special Notes:

- secure HE S/S at any time in ventline to prevent backflow of air into He-Subsystem

A1.3.11 PFM Sine Vibration Test (F.110.000)

Activity Number:	F.110.010	**Duration:**	tbd
Activity Name:	**RCS tank filling**	**Model:**	PFM SAT

Objective:

Prepare SVM for sine vibration tests and subsequent acoustic noise tests

Note: this activity is obsolete, if RCS tanks have been filled before (e.g. before TB/TV tests)

Requirements to be verified:

- NA

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100,000

Configuration:

- PFM Satellite mounted on MPT
- HHT at He-I temperature;
- RCS empty and at ambient (tbc) pressure

Activity Breakdown:

- Move S/C on MPT to LEAF for RCS tank filling
- perform internal and external leak check on RCS
- perform functional check of RCS units (valves, sensors)
- fill propellant tank with simulation fluid
- pressurise RCS to tbd bar

Applicable Documents:

- RCS filling and pressurisation procedure
- RCS leak test procedure

GSE required:

- MPT
- CVSE
- EGSE/CCS
- RCS Loading Equipment PPLE
- RCS Ground Half Coupling GHC
- SVM Simulate Loading Equipment
- SVM Leak Test Equipment
- SVM Pump purge Equipment PPE

Facility / Instrumentation:

- ESTEC test facility; preparation area

Personnel:

- AIT engineer
- EGSE operator
- CVSE technician
- AIT technicians
- Cryo/mech. team
- SVM support team
- RCS filling team
- QA engineer

Safety Precautions:

- standard safety precautions for cryo operations
- safety precautions due to pressure in RCS

Special Notes:

- NA

Activity Number:	S.110.020	**Duration:**	tbd
Activity Name:	**Transport to Test Facility & preparation for test**	**Model:**	PFM SAT

Objective:

Transport of PFM satellite to sine vibration test area

Prepare satellite for vibration test

Requirements to be verified:

- none

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100,000

Configuration:

- STM satellite mounted on MPT

Activity Breakdown:

- Integration of vibration adapter onto HYDRA
- move the satellite mounted on MPT to the HYDRA area
- install instrumentation for vibration test

Applicable Documents:

- PFM satellite handling and transportation procedure

GSE required:

- MPT
- Vibration adapter

Facility / Instrumentation:

- ESTEC test facility

Personnel:

- AIT engineer
- AIT technicians
- QA engineer

Safety Precautions:

- standard safety precautions for cryo operations
- safety precautions due to pressure in RCS

Special Notes:

NA

Activity Number:	F.110.030	**Duration:**	tbd
Activity Name:	**Alignment check before Sine Vibration test**	**Model:**	PFM SAT

Objective:

- check satellite mechanical axes stability
- verify ACMS/RCS sensor/actuator alignment stability
- verify telescope alignment stability w.r.t CVV
- verify LOU vs. HIFI alignment

before sine vibration test

Requirements to be verified:

- alignment requirements for telescope, HIFI/LOU, ACMS/RCS sensors and actuators and satellite main axes

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100,000

Configuration:

- PFM Satellite mounted on MPT
- HTT in He-I condition; any filling level
- HOT empty
- RCS filled with simulation fluid and pressurised to tbd bar
- OGSE available and set-up

Activity Breakdown:

- lift satellite and install on rotary table
- verify alignment of LOU vs. HIFI FPU with alignment camera
- verify alignment of telescope versus CVV
- verify alignment of SVM axes versus CVV
- verify alignment of ACMS/RCS units vs. SVM
- transfer of satellite from rotary table to HYDRA

Applicable Documents:

- PFM satellite alignment verification procedure

GSE required:

- MPT / Rotary Table
- Satellite lifting device
- Hydraset
- OGSE
- HIFI Alignment camera

Facility / Instrumentation:

- ESTEC test facility; preparation area
- overhead crane

Personnel:

- Test conductor
- AIT engineer
- AIT technician
- crane operator
- alignment technician / engineers
- QA engineer

Safety Precautions:

- standard safety precautions for crane and cryo operations
- safety precautions due to pressure in RCS

Special Notes:

- NA

Activity Number: F.110.040 **Duration:** tbd

Activity Name: **He-I Top Up** **Model:** PFM SAT

Objective:

Perform top up of He-I in HTT before Satellite Sine Vibration Test to achieve launch representative conditions

Requirements to be verified:

according He-I filling and top up procedure

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100,000

Configuration:

- PFM Satellite mounted on HYDRA
- HTT at He-I temperature
- HOT empty
- RCS filled with simulation fluid and pressurised to tbd bar

Activity Breakdown:

- prepare He-I supply and transfer equipment
- install He-I supply and transfer equipment
- install the exhaust line
- fill up HTT until filling level of >98% achieved

Applicable Documents:

- He-I filling and top up procedure

GSE required:

- Rotary table
- working platform
- checkout equipment (CCS and Cryo SCOE)
- CVSE for He-I top up
- He-I supply and transfer equipment

Facility / Instrumentation:

- ESTEC test facility; shaker area

Personnel:

- Test Manager
- AIT Test conductor
- Cryo engineer
- EGSE operators
- AIT / CVSE technicians
- QA engineer

Safety Precautions:

- standard safety precautions for cryo operations
- safety precautions due to pressure in RCS

Special Notes:

- NA

Activity Number:	F.110.050	**Duration:**	tbd
Activity Name:	**SFT at He-I before vibration test**	**Model:**	PFM SAT

Objective:

- perform Satellite Short Functional Test before Sine Vibration Test to verify good functioning of the complete satellite system

Requirements to be verified:

- as per SFT procedure

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100,000

Configuration:

- Satellite mounted on HYDRA
- HTT at He-I temperature, top up running
- RCS filled with simulation fluid and pressurised to tbd bar

Activity Breakdown:

- prepare and connect check out system (CCS/EGSE and Cryo SCOE)
- perform SFT of cryostat
- perform SFT of instruments

Applicable Documents:

- Satellite short functional test procedure

GSE required:

- Rotary table
- Working platform
- Check-out System (CCS/EGSE incl. Cryo SCOE)
- CVSE

Facility / Instrumentation:

- ESTEC test facility; shaker area

Personnel:

Test Manager

AIT Test conductor

Cryo manager

EGSE operators

AIT / CVSE technicians

QA engineer

Safety Precautions:

- standard safety precautions for cryo operations
- precautions against explosion due to pressure in RCS

Special Notes:

- NA

Activity Number:	F.110.060	**Duration:**	tbd
Activity Name:	**Sine Vibration in three axes incl. HTT topping**	**Model:**	PFM SAT

Objective:

Perform acceptance level sine vibration test in three axis to verify structural and functional integrity of complete PFM satellite

Requirements to be verified:

- according to Environmental Requirement Specification

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100,000

Configuration:

- Satellite mounted on HYDRA
- HTT at He-I temperature;
- HOT empty
- RCS filled with simulation fluid and pressurised to tbd bar

Activity Breakdown:

- install / connect all remaining vibration sensors
- remove protective covers from all items
- conduct vibration test
  - low level (resonance search)
  - intermediate level
  - low level
  - acceptance level
  - low level
- for all three (X, Y, Z) satellite axes
- perform He-I top up as necessary before each vibration run; minimum He-level >98%

Applicable Documents:

- PFM satellite sine vibration test procedure

GSE required:

- vibration test adapter
- Scaffolding
- Mobile Access Platform
- Protective Covers
- CVSE
- Cryo SCOE, CCS /EGSE

Facility / Instrumentation:

- ESTEC test facility; HYDRA shaker

Personnel:

- AIT engineer
- AIT technicians
- shaker facility operation team
- EGSE operators
- Cryo Engineer
- CVSE technicians
- QA engineer

Safety Precautions:

- standard safety precautions for crane and cryo operations
- safety precautions due to pressure in RCS

Special Notes:

- telescope protection cover to be lifted during test runs

Activity Number:	F.110.070	**Duration:**	tbd
Activity Name:	**Microvibration**	**Model:**	PFM SAT

Objective:

Activate the reaction wheels for

- Characterisation of the transfer functions from wheel panel on the SVM to the instruments on the optical bench,
- FEM model correlation. It shall validate the unit micro vibration environment specifications.

Requirements to be verified:

- ~~Tbd~~according TRS H-SAT-MEC-4

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100,000

Configuration:

- Satellite mounted on HYDRA
- HTT at He-I temperature;
- HOT empty
- RCS filled with simulation fluid and pressurised to tbd bar

Activity Breakdown:

- Suspend satellite over HYDRA shaker
- Activate reaction wheels
- Measure response at instrument level

Applicable Documents:

- PFM satellite microvibration test procedure

GSE required:

- vibration test adapter
- ~~Scaffolding~~
- ~~Mobile Access Platform~~Vertical Lifting Device
- CVSE
- Cryo SCOE, CCS /EGSE

Facility / Instrumentation:

- ESTEC test facility; hydra shaker

Personnel:

- AIT engineer
- AIT technicians
- shaker facility operation team
- EGSE operators
- Cryo Engineer
- CVSE technicians
- QA engineer

Safety Precautions:

- standard safety precautions for crane and cryo operations
- safety precautions due to pressure in RCS

Special Notes:

- NA

Activity Number: F.110.080 **Duration:** tbd

Activity Name: **SFT at He-I after sine vibration test** **Model:** PFM SAT

Objective:

- perform Satellite Short Functional Test after Sine Vibration Test to verify good functioning of the complete satellite system

Requirements to be verified:

- as per SFT procedure

Environment:

temperature: 22 ± 3 ºC

humidity: 40% < RH < 60%

cleanliness: clean class 100,000

Configuration:

- Satellite mounted on HYDRA
- HTT at He-I temperature
- RCS filled with simulation fluid and pressurised to tbd bar

Activity Breakdown:

- prepare and connect check out system (CCS/EGSE and Cryo SCOE)
- perform SFT of cryostat
- perform SFT of instruments

Applicable Documents:

- Satellite short functional test procedure

GSE required:

- Working platform
- Check-out System (CCS/EGSE incl. Cryo SCOE)
- CVSE

Facility / Instrumentation:

- ESTEC test facility; HYDRA shaker

Personnel:

- Test Manager
- AIT Test conductor
- Cryo manager
- EGSE operators
- AIT / CVSE technicians
- QA engineer

Safety Precautions:

- standard safety precautions for cryo operations
- safety precautions due to pressure in RCS

Special Notes:

- NA

Activity Number: F.110.090 **Duration:** tbd

Activity Name: **Alignment check after sine vibration test** **Model:** PFM SAT

Objective:

- check satellite mechanical axes stability
- verify ACMS/RCS sensor/actuator alignment stability
- verify telescope alignment w.r.t. CVV
- verify LOU vs. HIFI alignment

after Sine Vibration test

Requirements to be verified:

- alignment requirements for telescope, HIFI/LOU, ACMS/RCS sensors and actuators and satellite main axes

Environment:

temperature: 22 ± 3 ºC

humidity: 40% < RH < 60%

cleanliness: clean class 100,000

Configuration:

- PFM Satellite mounted on HYDRA shaker
- HTT in He I condition;
- RCS filled with simulation fluid and pressurised to tbd bar
- OGSE available and set-up

Activity Breakdown:

- Disconnect test harness & EGSE
- lift satellite and install on rotary table
- verify alignment of LOU vs. HIFI FPU with alignment camera
- verify alignment of telescope versus CVV
- verify alignment of SVM axes versus CVV
- verify alignment of ACMS/RCS units vs. SVM
- reinstall satellite on MPT

Applicable Documents:

- PFM satellite alignment verification procedure

GSE required:

- Rotary table
- MPT
- Satellite lifting device
- OGSE/ HIFI alignment camera

Facility / Instrumentation:

- ESTEC test facility; shaker area
- overhead crane

Personnel:

- Test conductor
- AIT engineer
- AIT technicians
- crane operator
- alignment technician / engineers
- QA engineer

Safety Precautions:

- standard safety precautions for crane and cryo operations
- safety precautions due to pressure in RCS

Special Notes:

- NA

A1.3.12 Acoustic Noise Test (F.120.000)

Activity Number:	F.120.010	**Duration:**	tbd
Activity Name:	**Transport to LEAF**	**Model:**	PFM SAT

Objective:

~~Transport of~~Transport of ~~ST~~PFM satellite from vibration to Acoustic Noise test facility

Requirements to be verified:

- none

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100,000

Configuration:

- PFM satellite mounted on MPT
- vibration tests and subsequent alignment verification completed
- HTT at He-I temperature
- RCS filled and pressurised

Activity Breakdown:

- move the satellite mounted on MPT to the AN test facility
- installation of test instrumentation and harness
- transfer of satellite with lifting device to LEAF adapter

Applicable Documents:

- PFM satellite handling and transportation procedure
- PFM satellite AN test procedure

GSE required:

- MPT
- satellite vertical lifting device; Hydraset
- working platform
- AN test adapter
- test clamp band

Facility / Instrumentation:

- ESTEC test facility; AN test chamber
- overhead crane

Personnel:

crane operator

AIT engineer

AIT technicians

CVSE technician

EGSE operator

QA engineer

Safety Precautions:

- standard safety precautions for cryo and crane operations
- safety precautions due to high pressure in RCS

Special Notes:

- NA

Activity Number:	F.120.020	**Duration:**	tbd
Activity Name:	**He-I top up**	**Model:**	PFM SAT

Objective:

Perform top up of He-I in HTT before Satellite Acoustic Noise Test to achieve launch representative conditions

Requirements to be verified:

according He-I filling and top up procedure

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100,000

Configuration:

- PFM Satellite mounted on Acoustic Noise Test Adapter in AN chamber
- HTT at He-I temperature;

Activity Breakdown:

- prepare He-I supply and transfer equipment
- install He-I supply and transfer equipment
- install the exhaust line
- fill up HTT until filling level of >98% achieved

Applicable Documents:

- He-I filling and top up procedure

GSE required:

- Acoustic Noise Test Adapter
- working platform
- checkout equipment (CCS and Cryo SCOE)
- CVSE for He-I top up
- He-I supply and transfer equipment

Facility / Instrumentation:

- ESTEC test facility; Acoustic Noise Chamber

Personnel:

- Test Manager
- AIT Test conductor
- Cryo engineer
- EGSE operators
- AIT / CVSE technician
- QA engineer

Safety Precautions:

- standard safety precautions for cryo operations
- safety precautions due to high pressure in RCS

Special Notes:

NA

Activity Number:	F.120.030	**Duration:**	tbd
Activity Name:	**Acoustic noise test**	**Model:**	PFM SAT

Objective:

Perform Acoustic Noise test to verify structural and functional integrity during/after submission to acoustic launch environment

Requirements to be verified:

- Acoustic noise spectrum per Environmental Specification

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100,000

Configuration:

- PFM Satellite mounted on Acoustic Noise Test Stand in Acoustic Noise test chamber
- HTT at He-I temperature, filling level >98%
- CVSE and CCS connected
- RCS filled with simulation fluid and pressurised

Activity Breakdown:

- remove CVSE and other GSE from test chamber
- remove protective covers from sensitive items as necessary
- perform Acoustic Noise test at low, intermediate, acceptance and final low level
- perform He-I top up between runs if necessary
- perform visual inspection of satellite
- disconnect test harness and EGSE
- remove satellite from test chamber and re-install on MPT
- deplete and depressurise RCS

Applicable Documents:

- PFM satellite Acoustic Noise test procedure
- He-I filling and top-up procedure
- PPLE operations manual

GSE required:

- working platform
- AN test adapter
- test clamp band
- CVSE
- Cryo SCOE, CCS
- PPLE

Facility / Instrumentation:

- ESTEC test facility; AN test chamber

Personnel:

- Test Conductor
- AIT engineer
- AIT technicians
- CVSE technician
- EGSE operator
- QA engineer
- SVM support
- TGSE operator
- AN facility team (ESTEC)

Safety Precautions:

- standard safety precautions for cryo operations
- precautions against explosion due to high pressure in RCS

Special Notes:

Telescope protection cover will stay in place during test

Activity Number:	F.120.040	**Duration:**	tbd
Activity Name:	**Alignment check after AN test**	**Model:**	PFM SAT

Objective:

- check satellite mechanical axes stability
- verify ACMS/RCS sensor/actuator alignment stability
- verify telescope alignment w.r.t. CVV
- verify LOU vs. HIFI FPU alignment

after Acoustic Noise test

Requirements to be verified:

- alignment requirements for thrusters, telescope, and satellite main axes

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100,000

Configuration:

- PFM Satellite mounted on MPT
- HTT in He-I condition; any filling level
- OGSE available and set-up

Activity Breakdown:

- Move satellite on MPT to integration area
- lift satellite and install on rotary table
- verify alignment of LOU vs. HIFI FPU with alignment camera
- verify alignment of telescope versus CVV
- verify alignment of SVM axes versus CVV
- verify alignment of ACMS/RCS units vs. SVM

Applicable Documents:

- PFM satellite alignment verification procedure

GSE required:

- MPT
- Rotary table
- Satellite lifting device
- Hydraset
- OGSE/ HIFI alignment camera

Facility / Instrumentation:

- ESTEC test facility; integration area
- overhead crane

Personnel:

- Test conductor
- AIT engineer
- AIT technicians
- crane operator
- alignment technician / engineers
- QA engineer

Safety Precautions:

- standard safety precautions for crane and cryo operations

Special Notes:

- NA

Activity Number:	F.120.050	**Duration:**	tbd
Activity Name:	**SFT at He-I after Acoustic Noise test**	**Model:**	PFM SAT

Objective:

- perform Satellite Short Functional Test after Acoustic Noise Test to verify good functioning of the complete satellite system

Requirements to be verified:

- as per SFT procedure

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100,000

Configuration:

- Satellite mounted on rotary table
- HTT at He-I temperature,

Activity Breakdown:

- prepare and connect check out system (CCS, SAT EGSE and Cryo SCOE)
- perform SFT of cryostat
- perform SFT of instruments

Applicable Documents:

- Satellite short functional test procedure

GSE required:

- rotary table
- Working platform
- Check-out System (CCS, SAT EGSE incl. Cryo SCOE)
- CVSE

Facility / Instrumentation:

- ESTEC test facility; integration area

Personnel:

Test Manager

- AIT Test conductor
- Cryo manager
- EGSE operators
- AIT / CVSE technician
- QA engineer

Safety Precautions:

- standard safety precautions for cryo operations

Special Notes:

- NA

A1.3.13 Integrated System Test 2 (F.130.000)

Activity Number:	F.130.010	**Duration:**	tbd
Activity Name:	**He-I top up; He-II production and top up**	**Model:**	PFM SAT

Objective:

perform the He-II production and top up before IST

Requirements to be verified:

- according to He-II production and top up procedure

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100,000

Configuration:

- PFM Satellite mounted on rotary table
- HTT at He-I temperature, any filling level
- HOT empty

Activity Breakdown:

- Check PLM status (liquid level of HTT, valve status Cryo EGSE etc.)
- Mount airlock to filling port
- Connect EGSE (TMTC SCOE, AOCS SCOE, CDMU SCOE etc.)
- Preparation activities (if mounted remove oscillation damper; prepare MGSE, install aux. lines, prepare and install transfer lines, install supply and transport dewar)
- Top up of HTT with He-I
- Prepare He-I and He-II pump units
- Prepare and connect He-I and He-II pumping units to Filling port SV 121 respectively to V502
- Start He-II production in HTT
- After completion of He-II production prepare final configuration (check valve status, retract transfer line and close filling port, stop He pumping unit I, remove supply and transport dewar, continue pumping with He pumping unit II)
- Close HTT
- Fill HOT with He-I

Applicable Documents:

- He-II production and top up procedure

GSE required:

- MPT
- heavy duty working platform
- CCS/EGSE and Cryo SCOE
- CVSE for filling operations (He vacuum pumping unit I and II, Transfer lines, LHe supply dewars)
- safety line to filling port

Facility / Instrumentation:

- ESTEC test facility, integration area
- overhead crane

Personnel: (2-shift)

- AIT engineer / test conductor
- cryo operation manager
- check out operators
- CVSE technicians
- Cryo/mech. team
- QA engineer

Safety Precautions:

- standard safety precautions for cryo and crane operations

Special Notes:

- NA

Activity Number:	F.130.020	**Duration:**	tbd
Activity Name:	**IST 2 (S/S SFTs & SFPT)**	**Model:**	PFM SAT

Objective:

Verify overall satellite performance after integration by:

- Subsystem performance measurements
- Scientific Instruments performance at He-II temp.
- Overall system performance measurement

Requirements to be verified:

- according to Satellite requirement specification
- according to H-EPLM requirement specification

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100,000

Configuration:

- Satellite mounted on MPT
- HTT at He-II temperature, HTT closed
- HOT filled with He-I, boiling throuhg shields
- CVSE and CCS/EGSE available and connected

Activity Breakdown:

- conduct subsystem performance tests (SVM and PLM S/S)
- conduct instrument performance tests
- conduct end-to-end system performance test

Applicable Documents:

- Integrated System Test procedure

GSE required:

- MPT/ rotary table
- scaffolding
- CVSE
- CCS/EGSE incl. Cryo SCOE

Facility / Instrumentation:

- ESTEC test facility, integration area

Personnel:

- Test Conductor
- electrical AIT engineers
- CVSE operator
- EGSE/CCS Operators
- Instrument test support team
- Cryo/mech. team
- SVM test support team
- QA engineer

Safety Precautions:

- standard safety precautions for cryo operations

Special Notes:

- tilting of S/C for some instrument tests required
- HTT closed, HOT filled with He-I and boiling through shields during instrument testing

Activity Number:	F.130.030	**Duration:**	tbd
Activity Name:	**Conversion to He-I**	**Model:**	PFM SAT

Objective:

- Conversion of HTT from He-II to He-I condition before transfer to physical property area

Requirements to be verified:

- none

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100,000

Configuration:

- PFM Satellite mounted on MPT
- HTT at He-II temperature
- ventline attached to V502
- CVSE and CCS connected
- He pumping unit II connected and running

Activity Breakdown:

- Shut- off helium ventline by closing V501/503 and 502
- Stop He pumping unit II and disconnect
- shut-off HTT by closing V104/103/106
- activate heaters H103/104 to heat up HTT to 4.2K and 1050mbar
- monitor HTT pressure and temperature
- When He-I conditions are achieved, open V104 and subsequently V502 or 501/503 to allow helium vent flow through either ventline or exhaust nozzles

Applicable Documents:

- Conversion to He-I procedure

GSE required:

- MPT
- Scaffolding
- Cryo SCOE; CCS
- CVSE

Facility / Instrumentation:

- ESTEC test facility, integration area

Personnel:

- AIT engineer
- Cryo Engineer
- EGSE operator
- CVSE technicians
- QA engineer

Safety Precautions:

- standard safety precautions for cryo operations

Special Notes:

- secure He S/St at any time in ventline to prevent backflow of air into He-Subsystem

A1.3.14 Mechanical Properties (F.140.000)

Activity Number:	F.140.010	**Duration:**	tbd
Activity Name:	**Determination of Satellite mass**	**Model:**	PFM SAT

Objective:

mass determination of satellite after completion of acceptance test phase and before delivery to launch site

Requirements to be verified:

- Satellite mass requirements

Environment:

temperature:	22 ± 3 ºC
humidity:	40% < RH < 60%
cleanliness:	clean class 100,000

Configuration:

- PFM satellite fully integrated and mounted on MPT
- Cryostat at He-I temperature, HTT filling level tbd
- RCS tanks empty and at ambient (tbc) pressure

Activity Breakdown:

- removal of protective covers of solar array, sunshade, etc as necessary
- Determination of HTT filling level
- lifting of satellite with crane and mass measurement with load cell
- lifting of satellite with crane back onto MPT
- re-installation of protective covers

Applicable Documents:

- PFM Satellite mechanical properties determination procedure

GSE required:

- MPT
- Satellite Vertical Lifting Device
- Test clamp band
- Mechanical Test Adapter
- Mobile Access Platform

Facility / Instrumentation:

- ESTEC test facility; physical property area
- Overhead crane; Hydraset
- weighing machine (load cell)

Personnel:

- mechanical test engineer
- mechanical AIT technicians
- Cryo Operator
- QA engineer
- Mass Measurement Team (ESTEC)

Safety Precautions:

- standard safety precautions for cryo and crane operations

Special Notes:

- NA

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	Barlage Bernhard	AED11		Wöhler Hans	AOE22
X	Bayer Thomas	AOA52			
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	Grasl Andreas	OTN/AOA54			
	Grasshoff Brigitte	AET12			
X	Hauser Armin	AOE22			
	Hendry David	Terma Resid.	X	Alcatel	ASP
X	Hinger Jürgen	AOE22	X	ESA/ESTEC	ESA
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X	Idler Siegmund	AED432		RAL (SPIRE)	RAL
X	Ivády von András	FAE22		SRON (HIFI)	SRON
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X	Kalde Clemens	APE3		**Subcontractors:**	
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	Kettner Bernhard	AET42		Air Liquide, Space Department	AIRS
X	Knoblauch August	AET32		Air Liquide, Orbital System	AIRT
X	Koelle Markus	AOA53		Alcatel Bell Space	ABSP
X	Kroeker Jürgen	AED65		Astrium Sub-Subsyst. & Equipment	ASSE
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	Sachsse Bernt	AED21		Prototech AS	PROT
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