HERSCHEL / PLANCK

Planck PFM AIT Plan
H-P-3-ASP-PL-0208
Product Code : 200000

Rédigé par/*Written by*	**Responsabilité-Service-Société** ***Responsibility-Office -Company***	**Date**	**Signature**
JY CHARNIER	PLANCK AIT RESPONSIBLE	1/02/2007	
Vérifié par/*Verified by*			
P. RIDEAU	PLANCK SYSTEM MANAGER	05/02/07	
T. GRASSIN	H/P PA MANAGER	06/02/07	
T. BANOS	PLANCK SATELLITE MANAGER	05/02/07	
Approbation/*Approved*			
JJ. JUILLET	H/P PROGRAM MANAGER	06/02/07	

Entité Emettrice : Alcatel Alenia Space - France
(détentrice de l'original) :

HERSCHEL/PLANCK	DISTRIBUTION RECORD

DOCUMENT NUMBER : H-P-3-ASP-PL-0208

Issue : 4
Date: 01/02/2007

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ENREGISTREMENT DES EVOLUTIONS / CHANGE RECORDS

Issue. Revision	DATE	§ : CHANGE RECORD	AUTHOR
1.0	27/06/2002	First issue	JY. CHARNIER
1.1	28/11/2002	Document updated to take into account the PDR RID AIV n° 15 &16 See § 5.3.1 Electrical configuration See § 5.4.5 System Test Task Sheets IST 1.3 EMC RE/RS IST 1.4 LFI RF test See § 5.4.7 Schedule FM Sheet 3, 4 and 5	JY. CHARNIER
2.0	09/04/2004	§1.1.1: different models presentation improvement §2.1: old AD10 (H-P-3-ASPI-TD-0054) and AD13 (H-P-3-ASPI-PL-0137) deleted §2.2: RD8 to RD20 added §3.2.1: Satellite CQM definition improvement §3.3 and 3.4: clarification between incoming and assembly activities §3.6.3: short functional test replaced unit integration test §3.7.1.6: fluidic/pneumatic tests explanation improvement §4.1: cleanliness – clean room condition added. §5 due to the fact that AIT plan has been splinted in several AIT plan (CQM, AVM, RFQM, STM, PFM) and that the PFM integration is now done after the delivery from ALS in three batches, all the paragraph 5 has been completely re-written §6.2.1.1: AIT team organisation figure improvement. §6.2.1.3: AIT core team improvement and AIT temporary support. §6.2.3: HFI and LFI teams responsibility paragraph added §8.2.2: MGSE specification tree improvement. §8.3.1: EGSE system design improvement. §8.3.1.2: system decomposition improvement. §8.3.1.2: overall EGSE synoptic deleted – not used for batches 1 & 2. §8.3.2: EGSE specification tree improvement §8.4: GSE development plan: specific EGSE added	JP. HAYET
3.0	19/07/2004	§1.1 / 2 / 3.1 /3.2 : STM activities deleted §1.1:FM activities updated according to new AIT philosophy (SVM delivered in 2 batches instead of 3, and 2 TV tests instead of 1) §3.8.1: sine vibration/acoustic noise/shock test	JP. HAYET

Issue. Revision	DATE	§ : CHANGE RECORD	AUTHOR
		philosophy changed due to STM deletion §3.8.2: thermal vacuum test: add of a second TV test with SCS functional test §3.8.3: EMC - reference to RD21 added. EMC probes location changed. §5 fully updated	
3.1	2/12/2004	Document updated to take into account the CDR RID DAIV n° 0106 (ESA representative IF with AIT) MTP n° 0033 (clamp band release, after STM deletion) MTP n° 0114 (µ-vibration test, after STM deletion) Ambient RF test re-introducing	JY Charnier
4	01/02/2007	Document updated for Satellite QR, main changes in chapter 3.7, 4 , 5 are : - AIT sequence cut in two step PFM1 and PFM - HFI coolers global leak before/after vibrations - Tests instrumentations flight compatible - IST 1 with OBSW AIV branch - End of AIT campaign at Estec, including : - RCS global leak (using krypton) under vacuum - Fine balancing under vacuum - ACU fit check at the end of AIT campaign chapter 5,3 Tests Matrixes creation chapter 5,4 Schedule	JY Charnier

TABLE OF CONTENTS

INTRODUCTION 8

1.1 FOREWORD 8
1.2 SCOPE 8

2. APPLICABLE AND REFERENCE DOCUMENTS 9

2.1 APPLICABLE DOCUMENTS 9
2.2 REFERENCE DOCUMENTS 10
2.3 ACRONYMS 12

3. MODEL PHILOSOPHY 16

3.1 GENERAL 16
3.2 MODELS DEFINITION 17
3.2.1 Satellite CQM (Cryogenic Qualification Model) 17
3.2.2 RFQM (RF Qualification Model) 18
3.2.3 AVM(Avionic Model) 19
3.2.4 Telescope FM activities: 20
3.2.5 Satellite PFM (Proto Flight Model) 21
3.2.6 PFM logic 25
3.3 INCOMING 27
3.4 ASSEMBLY 27
3.5 MECHANICAL INTEGRATION 27
3.5.1 Hardware release 27
3.5.2 Hardware "as built status" report 27
3.5.3 Handling 28
3.6 ELECTRICAL INTEGRATION 28
3.6.1 Electronic units 28
3.6.2 Integration task – Interface checks 28
3.6.3 Unit function checks (UFT) 29
3.6.4 System Integrated test (SIT) 29
3.7 TESTS AT SYSTEM LEVEL 30
3.7.1 Functional/Performance tests 30
3.7.2 Physical properties & mechanical spin test 32
3.7.3 Alignment measurements 33
3.7.4 ACU Fit check 33
3.7.5 Fluidic/Pneumatic Tests 33
3.7.6 SVT (System Verification Test) 34
3.7.7 Specific Performance Test 35
3.8 ENVIRONMENTAL TESTS 36
3.8.1 Sine Vibration/Acoustic Noise/Shock tests 36
3.8.2 Thermal vacuum Tests 38
3.8.3 EMC 40

4. SPECIFIC CONSTRAINTS 41

4.1 CLEANLINESS 41
4.2 SPECIFIC PROTECTIONS 41
4.3 PURGING 43
4.4 TESTS INSTRUMENTATIONS 43
4.5 FLIGHT UNITS REMOVAL DURING SATELLITE AIT CAMPAIGN 44

5. AIT SEQUENCES 45

5.1 PFM1 ASSEMBLY, INTEGRATION AND TESTS 46
5.1.1 Assembly, Integration and Test logic 46
5.1.2 EGSE Configuration 48
5.1.3 PFM1 task sheets 49
5.2 PFM TASK SHEETS 58
5.2.1 PPLM Integration 58
5.2.2 S/C AIT 70
5.3 TESTS MATRIXES 82
5.4 SCHEDULE 86

6. MANAGEMENT AND ORGANISATION 102

6.1 AIT TASKS 102
6.2 AIT ORGANISATION 102
6.2.1 AIT team 102
6.2.2 AIT responsibility 105
6.2.3 HFI and LFI teams responsibility 106
6.2.4 Interfaces with the ESA project team 107
6.2.5 QA responsibility 107
6.3 MANAGEMENT OF AIT TASKS 108
6.3.1 General AIT rules 108
6.3.2 Supervision of AIT tasks through the AIT documents 109
6.3.3 Time and task execution management 112
6.3.4 Configuration management 113
6.3.5 Control and management of non conformances 114
6.3.6 Technical management of "as performed" operations 115

7. REVIEWS 116

7.1 KIP/MIP 116
7.2 AIT REVIEWS 116
7.3 TEST READINESS REVIEWS AND TEST REVIEW BOARDS 117
7.3.1 TRR objectives 117
7.3.2 PTR objectives 118

8. GSE 118

8.1 IDENTIFICATION OF GSE 118
8.2 MGSE 119
8.2.1 MGSE System Design 119
8.2.2 MGSE specification documentation 119
8.3 EGSE 121
8.3.1 EGSE system design 121
8.3.2 EGSE specification documentation 122
8.4 GSE DEVELOPMENT PLAN 124

9. FACILITIES AND TRANSPORTATION PLAN 124

9.1 FACILITY AND TRANSPORTATION PLAN 124
9.2 SATELLITE TO AAS-F TEST FACILITIES INTERFACE SPECIFICATION 125
9.2.1 Clean room facilities class 100 000 US standard: 125
9.2.2 Compact Antenna Test Range facility 126
9.2.3 Vibrations tests facilities 127
9.2.4 MCI & Spin test facilities 128

TABLE OF ILLUSTRATIONS

FIGURE 1: SATELLITE CQM AT CSL READY FOR CRYOGENIC TEST 17
FIGURE 2: RFQM CONFIGURATION IN AAS-F CATR 18
FIGURE 3: AVM CONFIGURATION 19
FIGURE 4: TELESCOPE INTEGRATION CONFIGURATION 20
FIGURE 5: PLANCK SATELLITE PFM1 CONFIGURATION 21
FIGURE 6: PFM PLANCK PLM & INSTRUMENTS LAY-OUT 22
FIGURE 7: SCS & LFI BLOC DIAGRAM 23
FIGURE 8: HFI BLOC DIAGRAM 24
FIGURE 9: PFM1 SATELLITE LOGIC 25
FIGURE 10: PFM SATELLITE LOGIC 26
FIGURE 11: PFM CENTRING/INERTIA & AAS-F BALANCING CONFIGURATIONS 32
FIGURE 12: PFM SINE VIBRATIONS CONFIGURATION 37
FIGURE 13: PFM ACOUSTIC VIBRATIONS CONFIGURATION 38
FIGURE 14: PFM CRYOGENIC/THERMAL SET-UP CONFIGURATION 39
FIGURE 15: PFM CRYOGENIC GSE LINKS 40
FIGURE 16: PFM EMC RE/RS CONFIGURATION 41
FIGURE 17: PPLM PROTECTIONS SET 42
FIGURE 18: S/C PROTECTION DURING SINE VIBRATIONS 42
FIGURE 19: PPLM PROTECTIONS FOR S/C TRANSPORTATION (CQM) 43
FIGURE 20: S/C ENTRANCE INTO CATR CHAMBER 44
FIGURE 21: PFM 1 THERMAL CONFIGURATION INSIDE FOCAL 5 AT CSL 46
FIGURE 22: PFM1 INTEGRATION LOGIC 47
FIGURE 23: EGSE CONFIGURATION FOR PFM 1 AND PFM SATELLITE INTEGRATION 48
FIGURE 24: PPLM INTEGRATION LOGIC 59
FIGURE 28: MECHANICAL TESTS MATRIX 82
FIGURE 29: SYSTEM TESTS MATRIX 83
FIGURE 30: FUNCTIONAL TESTS MATRIX #1 84
FIGURE 31: FUNCTIONAL TESTS MATRIX #2 85
FIGURE 32: AIT TEAM ORGANISATION FOR PRELIMINARY PHASE 103
FIGURE 33: AAS-F AIT CORE TEAM 105
FIGURE 35: OPERATIONAL DIAGRAM - USE OF DIFFERENT AIT FORMS 110
FIGURE 36: TRR CHECK LIST 118
FIGURE 37: PTR CHECK LIST 118
FIGURE 38: "MAIN MGSE" SPECIFICATION TREE 120
FIGURE 39: EGSE SPECIFICATION TREE 123
FIGURE 40: CRANE CHARACTERISTICS IN AAS-F PREMISES 125
FIGURE 41: CATR CHAMBER 126
FIGURE 42: V 994 ATLAS SHAKER 127
FIGURE 43: 1000 ACOUSTIC CHAMBER 127
FIGURE 44: SCHENCK OSCILLATING TABLE 128
FIGURE 45: MPI TABLE 128
FIGURE 46: BALANCING TABLE 128

INTRODUCTION

1.1 FOREWORD

This document describes the assembly, integration and test activities to be performed by AAS-F as AIT Contractor on Planck satellite .
Telescopes & Satellites Planck AIT activities are declined in several models . For each model a dedicated AIT Plan is written . This document concernes Planck satellite PFM AIT .

1.2 SCOPE

The objective of this plan is to define :

- an AIT program in accordance with the system level AIV requirements
- the relevant organization, necessary to carry out all tasks identified in the AIT program
- the utilization of GSE dedicated to this program
- the required test documentation and test software
- all tests and operations to be performed within the identified tasks
- the general company rules, PA and safety procedures to be followed throughout the AIT operations
- the AIT program schedule and the major milestones
- the integration and test sequences.

This document deals only with the satellite PFM activities.

2. APPLICABLE AND REFERENCE DOCUMENTS

2.1 APPLICABLE DOCUMENTS

AD 1	System Verification Performance Plan Document n° H-P-1-ASPI-PL-0225
AD 2	Herschel/Planck system requirement specification Document n° SCI-PT-RS-05991
AD 3	Environment & Test Requirements Specification Document n° H-P-1-ASPI-SP-0030
AD 4	EMC/ESD Control Plan Document n° H-P-1-ASPI-PL-0038
AD 5	Herschel/Planck Product Assurance Requirement Document n° SCI-PT-RS-04683
AD 6	Cleanliness Requirements Specification Document n° H-P-1-ASPI-SP-0035
AD 7	General Design & Interface Requirement Document n° H-P-1-ASPI-SP-0027
AD 8	PA Plan Document n° H-P-1-ASPI-PL-0055
AD 9	Design and Development Plan Document n° H-P-1-ASPI-PL-0009
AD 10	SVM cleanliness and contamination control plan Document n° H-P-PL-AI-0011
AD 11	Planck Alignment Plan Document n° H-P-3-ASPI-PL-0078
AD 12	Planck Cleanliness Control Plan Document n° H-P-3-ASPI-PL-0253
AD 13	Planck Optical & RF verification test plan Document n° H-P-3-ASPI-PL-0137
AD 14	N/A

2.2 REFERENCE DOCUMENTS

RD1	EGSE General Requirements Specification Document n° H-P-1-ASPI-SP-0048
RD2	MGSE General Requirements Specification Document n° H-P-1-ASPI- SP-0044
RD3	EGSE Interface Requirements Document n° H-P-1-ASPI- IS-0121
RD4	MGSE Interface Requirements Document n° H-P-1-ASPI- IS-0120
RD5	EGSE Deployment Plan Document n° H-P-1-ASPI-PL-0220
RD6	MGSE Deployment Plan Document n° H-P-1-ASPI-LI-0119
RD7	Planck Electrical Integration Sequence Doc n° H-P-3-ASP-
RD8	Planck RFQM AIT plan Document n° H-P-3-ASP-PL-0669
RD9	Planck Telescope FM AIT Plan Document n° H-P-3-ASP-PL-1056
RD10	N/A
RD 11	Herschel / Planck Service Module AIT plan Document n° H-P-PL-AI-0012
RD 12	Specification of Facilities for Planck Cryogenic Test Sequence Document n° H-P-3-ASPI-TS-0051
RD 13	Satellite AIT software management plan Document n° H-P-1-ASP-PL-0420

RD14	Planck PFM1 Test Operation Plan Document n° H-P-1-ASP-PL-1071
RD15	N/A
RD16	N/A
RD17	Common ground support equipment maintenance Doc n° H-P-1-ASP-PL-0544
RD18	Planck deployment in clean room Doc n° H-P-3-ASPI-TN-0442
RD 19	Planck Assembly Sequence Doc n° H-P-3-ASP-TN-0521
RD 20	N/A
RD 21	N/A
RD 22	HP Launch Plan Document n° H-P-1-ASP-PL-0788

2.3 ACRONYMS

AC	Alternating Current
ACC	Attitude Control Computer
ACME	Attitude Control and Measurement Electronic
ACMS	Attitude Control and Measurement Subsystem
ACR	AIT Change Request
ACU	Adaptateur Charge Utile
ADP	Acceptance Data Package
AIT	Assembly, Integration and Test
AIV	Assembly, Integration and Verification
AVM	Avionics Verification Model
BEU	Back End Unit (LFI)
C/O	Check Out
CATR	Compact Antenna Test Range
CAU	Cooler Ancillary Unit
CCS	Control Check-out System
CCU	Cryostat Control Unit
CDMS	Command and Data Management Subsystem
CDMU	Central Data Management Unit
CE	Conducted Emission
CEU	Cryo Electronics Unit
CFRP	Carbon Fibre Reinforced Plastic
CLCW	Command List Control Word
CLTU	Command Link Transfer Unit
CoG	Centre of Gravity
CQM	Cryogenic Qualification Model
CS	Conducted Susceptibility
CSL	Centre Spatial de Liège
DAE	Data Acquisition Electronics (LFI)
DBS	Data Base System
DBMS	Data Base Management System
DC	Direct Current
DCCE	Dilution Cooler Control Equipment
DCCU	Dilution Cooler Control Unit
DCE	Dilution Cooler Equipment
DFE	Data Front End
DPU	Digital Processing Unit
EED	ElectroExplosive Device
EGSE	Electrical Ground Support Equipment
ELD	Equipment panel Lifting Device
EMC	ElectroMagnetic Compatibility
ENV	ENVironment
EPS	Electrical Power System
EPT	Equipment Panel Trolley
EQM	Engineering Qualification Model (of spacecraft)
ESA	European Space Agency
ESD	ElectroStatic Discharge
ESOC	European Space Operations Centre

FAR	Flight Acceptance Review
FIP	Failure Investigation Procedure
FOP	Flight Operations Plan
FPA	Focal Plane Assembly
FPU	Focal Plane Unit
GN2	Gaseous Nitrogen
GSE	Ground Support Equipment
H/W	HardWare
He	Helium
HFI	High Frequency Instrument (Planck)
HHD	Horizontal Hoisting device
HK	House Keeping
HPSDB	Herschel Planck System Data Base
HLC	High Level Command
HW	Hard Ware
ICD	Interface Control Document
I/F	Inter Face
IS	InStrument
ISDN	Integrated Service Digital Network
IST	Integrated Satellite Test
ITT	Invitation To Tender
JFET	Junction Field Effect Transistor
KIP	Key Inspection Point
LAN	Local Area Network
LFI	Low Frequency Instrument
LGA	Low Gain Antenna
LHe	Liquid Helium
LN2	Liquid Nitrogen
MCI	Masse, centring, Inertia
MGA	Medium Gain Antenna
MGSE	Mechanical Ground Support Equipment
MIP	Mandatory Inspection Point
MLI	MultiLayer Insulation
MOC	Mission Operations Centre
MPI	Masse, Product Inertia
MPT	Multi Propose Trolley
MTD	Mechanical & Thermal Dummy
MTL	Mission Time Line
N/A	Not Applicable
NA	Not Applicable
NCR	Non Conformance Report
NDIU	Network Data Interface Unit
OBCP	On-Board Control Procedure
OBSW	On-Board SoftWare
OBT	On-Board Time
PA	Product Assurance
PAD	PPLM Adaptet Device
PAP	PLM Access Platform
PAU	Power Amplifier Unit
PCDU	Power Conditioning & Distribution Unit

PFM	Proto-Flight Model
PGSE	Pneumatic Ground Support Equipment (HFI dilution)
PLM	Payload Module
PPLM	Planck Payload Module
PTR	Post Test Review
PTT	Panel Tilting Trolley
PVHD	PLM Vertical Hoisting Device
QA	Quality Assurance
QC	Quality Controller
QM	Qualification Model
QRS	Quarts Rate Sensor
RAA	Radiometry Array Assembly (LFI)
RAIT	Responsible AIT
RCS	Reaction Control System
RE	Radiated Emission
REBA	Radiometer Electronics Box Assembly (LFI)
REU	Read out Electronics Unit
RF	Radio Frequency
RFDM	Radio Frequency Development Model
RFQM	Radio Frequency Qualification Model
RFW	Request For Waiver
RMS	Root Mean Square
RS	Radiated Susceptibility
RSAIT	Responsible System AIT
S/C	SpaceCraft
SA	Solar Array
SC	SpaceCraft
SCC	Sorption Cooler Compressor (LFI)
SCE	Sorption Cooler Electronics (LFI)
SCOE	Special Check Out Equipment
SCS	Sorption Cooler Subsystem (LFI)
SFT	Short Functional Test
SID	SCC Integration Device
SIT	System Integration Test
SLI	Single Layer Insulation
SOW	Statement Of Work
SPF	Single Point Failure
SPSD	SCC Panels Stiffener Device
SPT	Specific Performance Test
SS	Subsystem
SREM	Standard Radiation Environment Monitor
STM	Structural/Thermal Model
STR	Star Tracker
SVM	SerVice Module
SVT	System Validation Test
SW	SoftWare
TBC	To Be Confirmed
TBD	To Be Defined
TC	TeleCommand
TFPU	Test Focal Plane Unit

TGSE	Tanking Ground Support Equipment
THA	Transport and Handling Adapter
TRR	Test Readiness Review
TRS	Test Requirement Sheet
TTC	Telemetry, Tracking & Command
TV	Thermal Vacuum
UFT	Unit Function Test
UIT	Unit Integration Test
UP	Umbilical Plug
US	United States
VHD	Vertical Hoisting Device
VIS	Vertical Integration Stand
VMC	Video Monitoring Camera
WU	Warm Unit

3. MODEL PHILOSOPHY

3.1 GENERAL

The PLANCK design and development plan deals with the following model philosophy :

- CQM [RD15]: Cryogenic Qualification Model
- RFQM [RD8]: RF Qualification Model
- AVM [RD11]: AVionic Model (functional and performances qualification) (done by AAS-I SVM level, by AAS-F at Satellite level)
- Telescope FM [RD9]: Assembly of the telescope and cold-videogrammetry measurement
- PFM1, then PFM : Satellite Proto Model satellite

This document describes the PFM Assembly, integration & test . Planck FM SVM AIT is describes in AAS-I AIT Plan.
The respective integration & test campaign of CQM, AVM, RFQM, PFM models follow System Design & Development plan [AD9], and are reflected in the reference baseline schedule. A detailed schedule is included in this AIT plan, for information only.

3.2 MODELS DEFINITION

3.2.1 Satellite CQM (Cryogenic Qualification Model)

The aim of the CQM is the validation at system level of thermal and cryogenic concepts and of the associated mathematical models.
This test validates passive cooling, active cooling (0,1/4/20 K), HFI detection chain, Conducted EMC and the test set-up (thermal, µ-vibration environment, mechanical interfaces….)

Before the cryo test, an early acoustic testing is performed so as to obtain advanced and reliable data supporting the validation of some instruments –mainly the FPU's- specified mechanical environment before FPU FM test campaign.

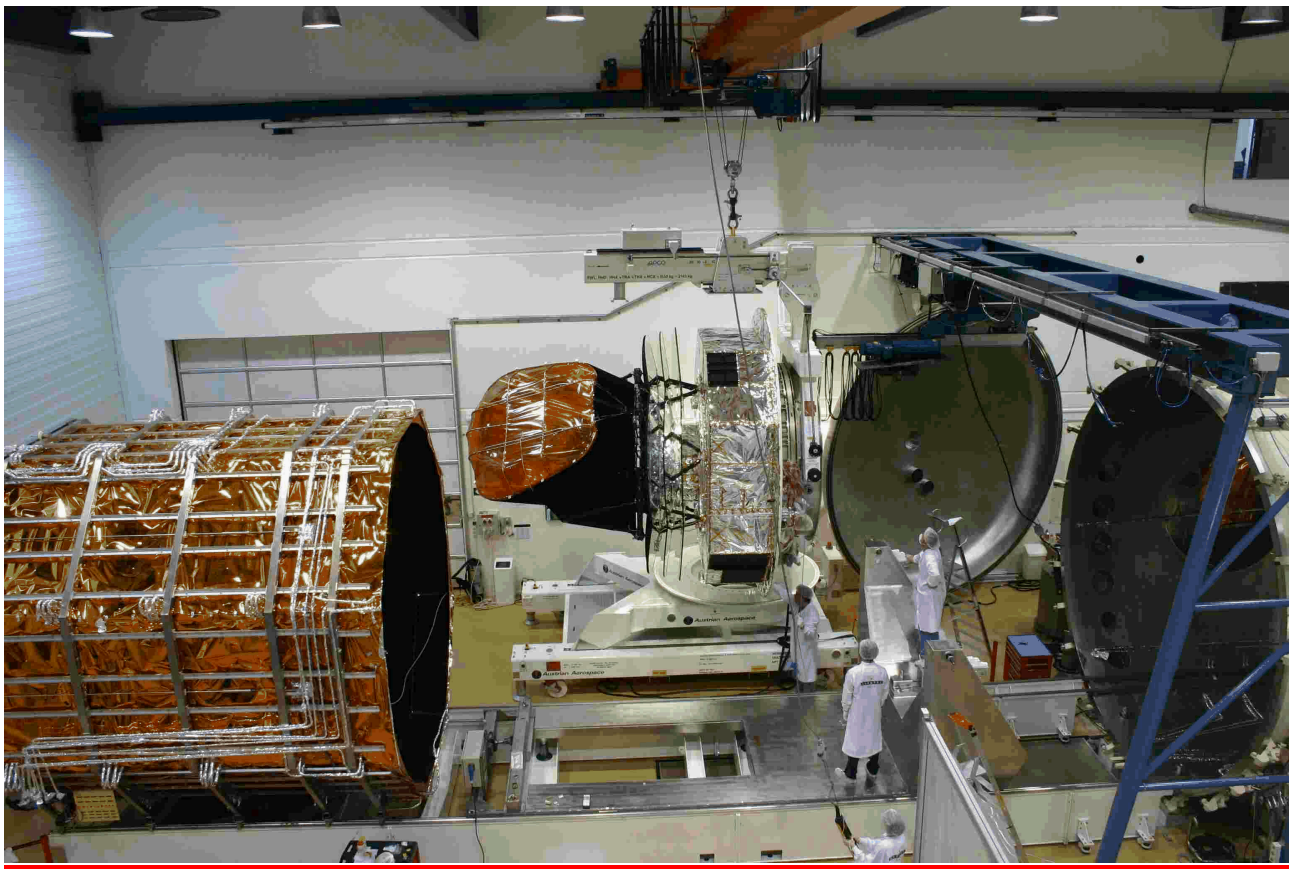


figure 1: Satellite CQM at CSL ready for cryogenic test

3.2.2 RFQM (RF Qualification Model)

The aim of the RFQM is the validation at PLM level of RF performances and of the associated mathematical models.
The model is representative of all the elements active in the RF performances (i.e telescope / baffle and the third groove of the cryo. structure) .
The telescope the baffle and the third groove are the CQM model ones.

Figure 2: RFQM configuration in AAS-F CATR

At the end of RFQM test campaign, a specific validation of the “reference test horn” is performed, in order to demonstrate the reference test horn at PFM level (i.e. FM telescope alignment check at ambient)

3.2.3 AVM(Avionic Model)

The aim of the AVM is the validation at system of functional chains.
The model is fully representative of electronics/software aspects, it includes flight representative units / bread board / simulator. (see AAS-I AIT Plan)

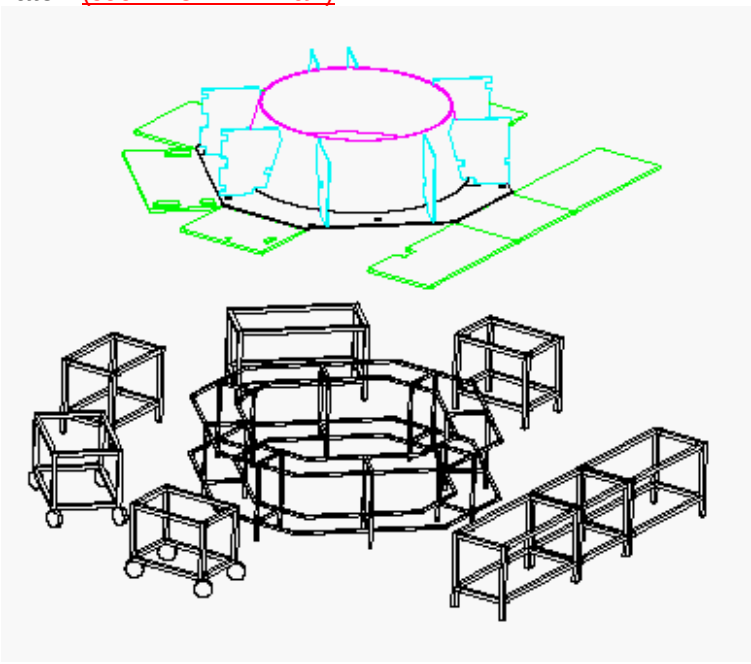


Figure 3: AVM configuration

3.2.4 Telescope FM activities:

The aim of the telescope FM cryo-videogrammetry test is the validation at PLM level of the associated mathematical models. The model is representative of all the elements actives in the performances (i.e. telescope)

Figure 4: Telescope integration configuration

3.2.5 Satellite PFM (Proto Flight Model)

The aim of the satellite is the verification of the overall satellite functioning and performances. The PFM is submitted to qualification levels during acceptance tests. The levels and the duration of the tests will be defined later in the “tests specifications” documents.

In first step a so call PFM1 model had been integrated in order to perform the thermal balance satellite qualification, including the full redundant SCC functional test .

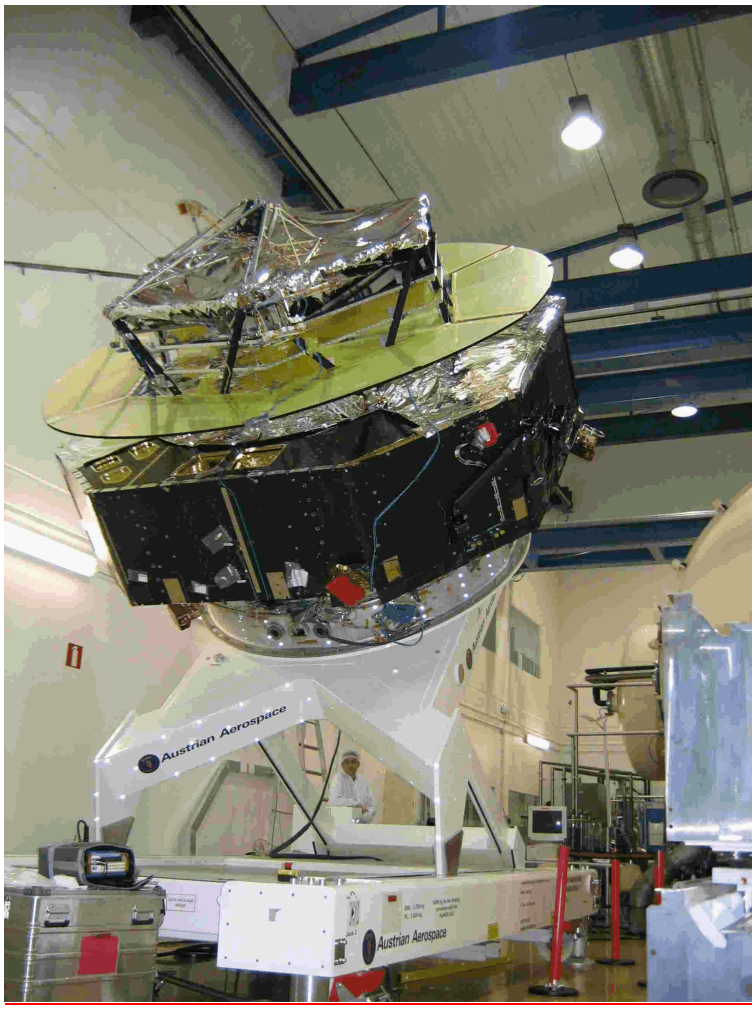


Figure 5: Planck satellite PFM1 configuration

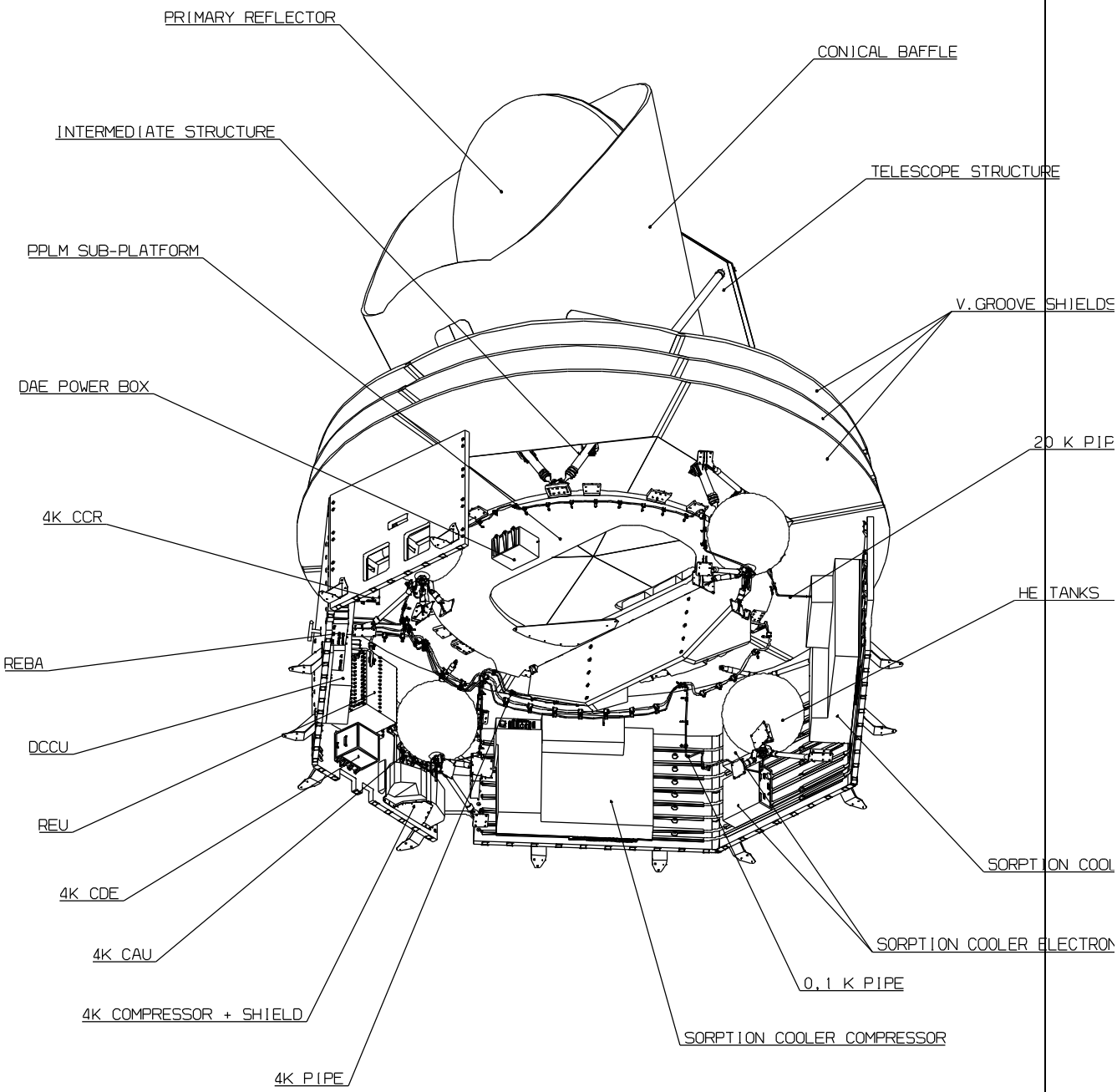


Figure 6: PFM Planck PLM & instruments lay-out

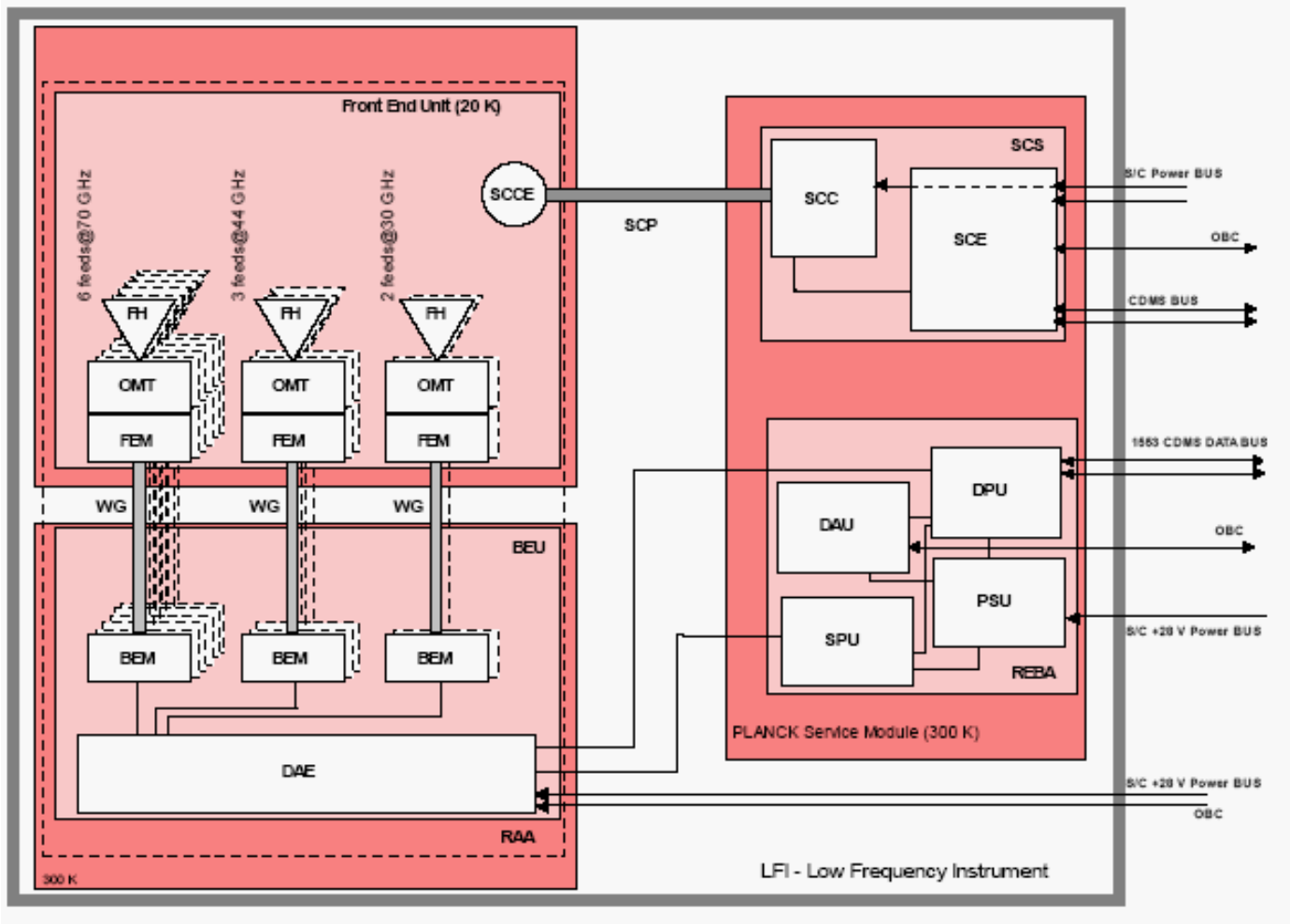


Figure 7: SCS & LFI bloc diagram

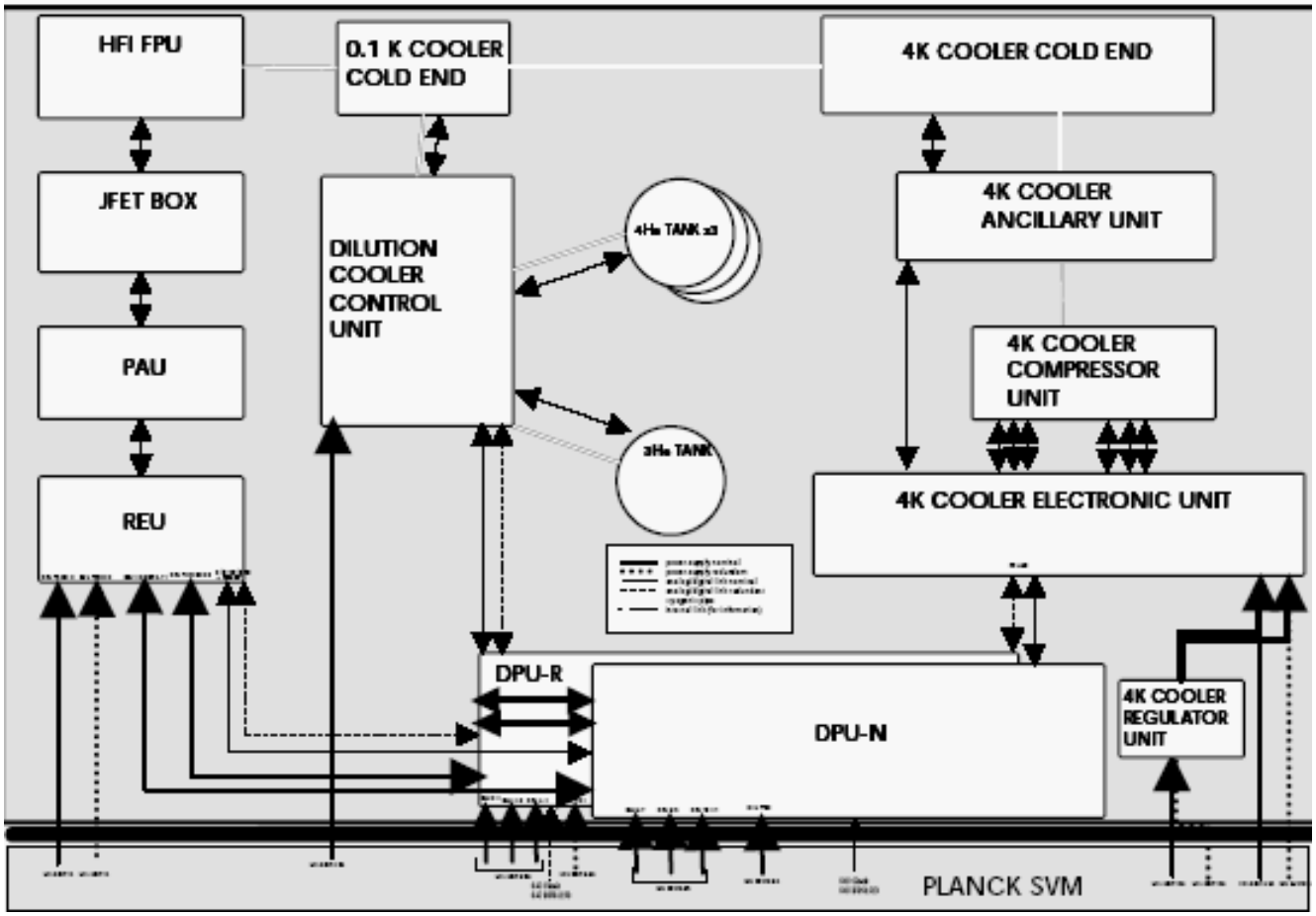


Figure 8: HFI bloc diagram

3.2.6 PFM logic

Due to the late availability of Instruments FM Hardware, an alternative so call PFM1 had been performed during Planck PFM Satellite AIT, the main objective of this PFM 1 were a earlier satellite thermal balance test, including particularly a full functional test on redundant SCC.

At end of the PFM 1 sequence (i.e. : thermal balance), the PFM1 had been dismounted (i.e. Telescope dummy, SVM / PLM, MTDs), in order to complete the SVM integration (RCS tanks integration) and PLM integration (RAA integration) and to start to the PFM integration sequence (WU in the SVM, RAA …)

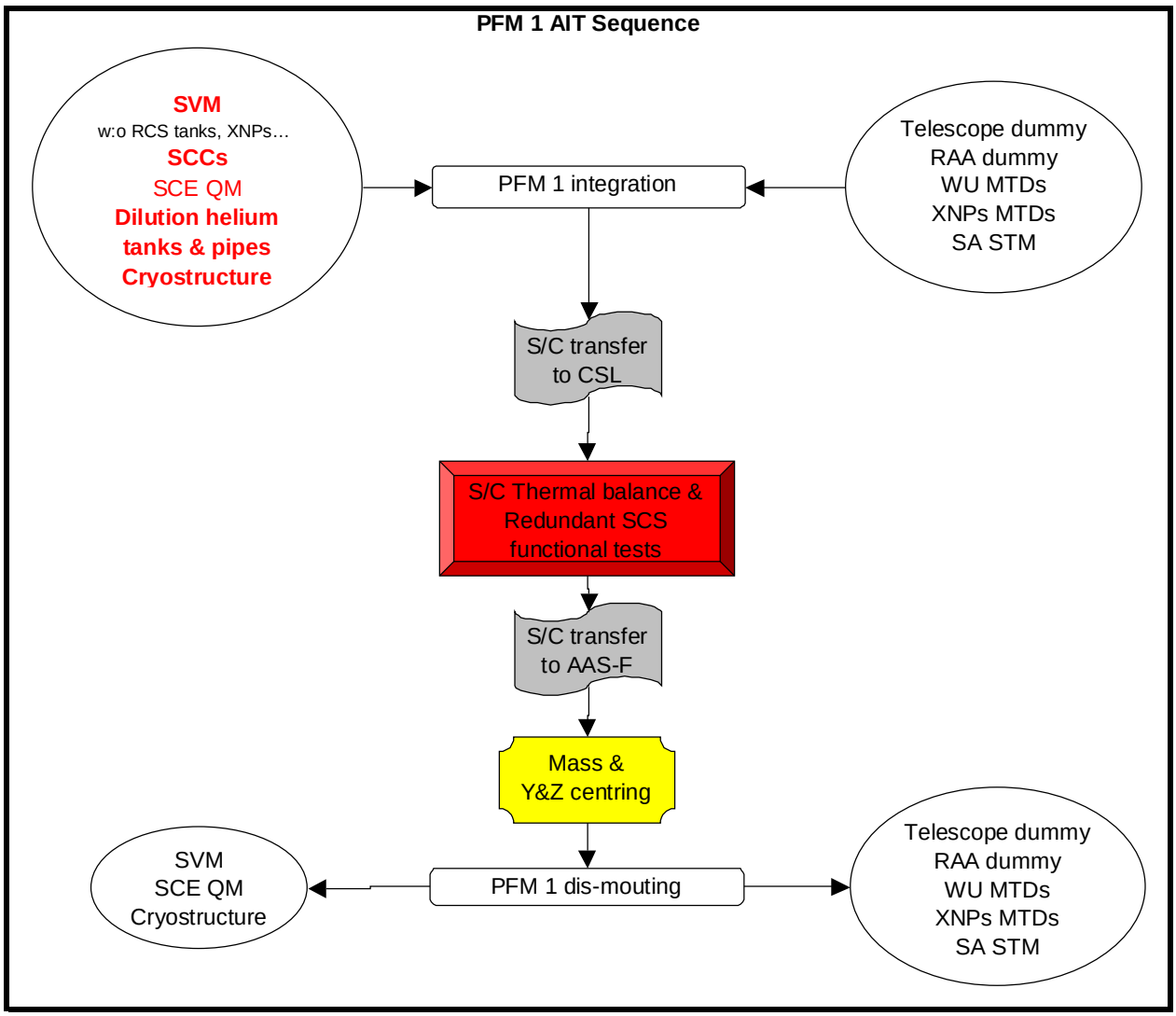


Figure 9: PFM1 satellite logic

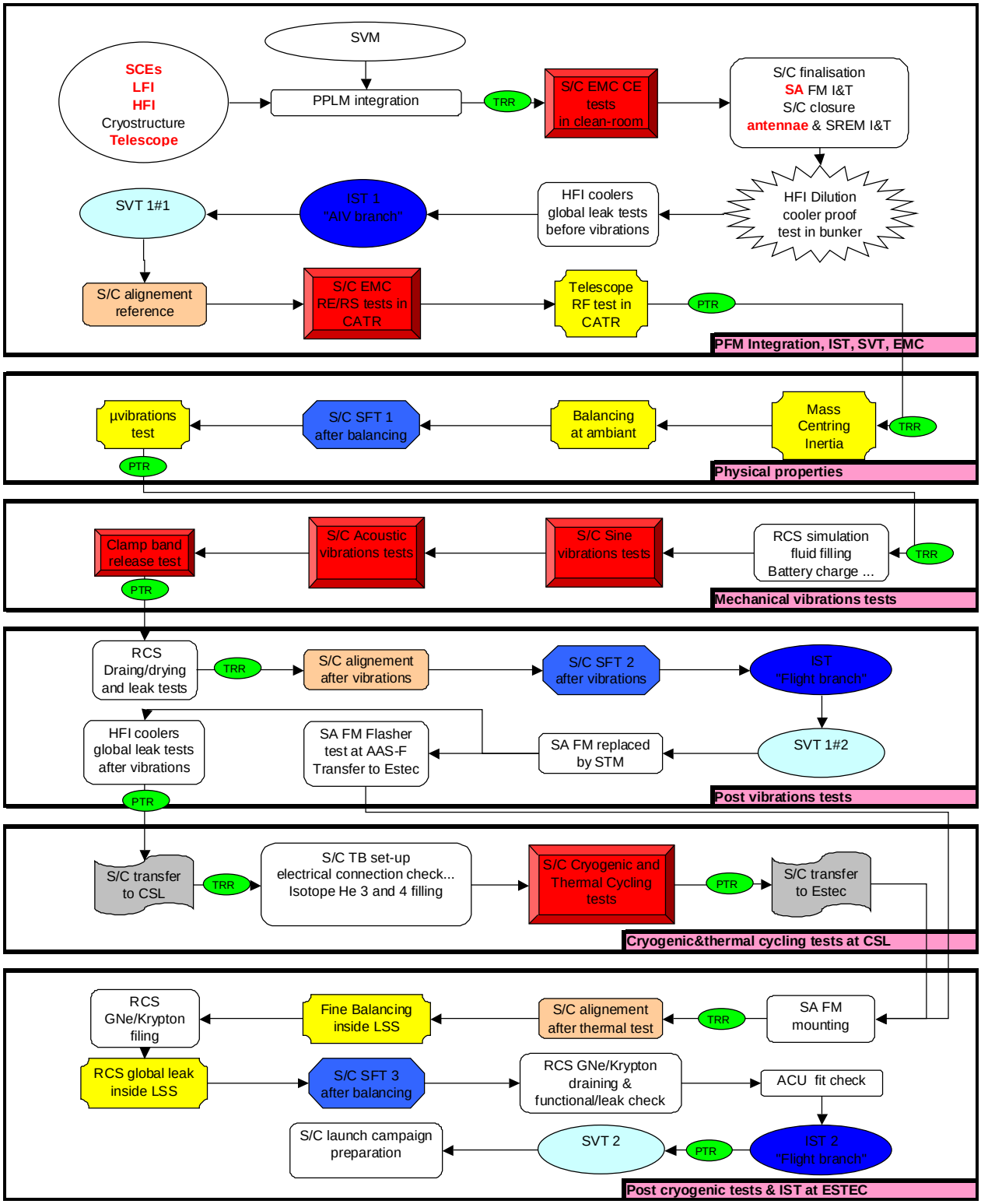


Figure 10: PFM satellite logic

3.3 INCOMING

Before integration, visual verification is performed on each delivered unit to control the quality of the hardware . As minimum, the following controls are performed :

- verification of data package according to the shipping list
- visual inspection
- conformity of identification markings and serial numbers to the configuration status
- planarity (if requested).
- mass (if requested).

3.4 ASSEMBLY

The S/C will is assembled in a class 100000 (US fed. Std) clean room.
Assembly methods and hardware will conform to the latest satellite design, drawings and procedures.
Afterwards it will be prepared on the table if required and then mounted on the structure in accordance with the respective procedure.
Bonding and grounding measurements will terminate the assembly.
A well-trained team with adequate QC coverage will perform all these activities.
Except for specific operations on HFI, only members of this group will be authorized to perform mechanical operations on the satellites or part of them.

3.5 MECHANICAL INTEGRATION

3.5.1 Hardware release

Hardware release for integration will be controlled. Parts required for a particular integration activity will be kited to reflect the requirements of the governing procedure prior to the need date. This kiting operation shall include an inspection according to the system/module assembly drawing and subsystem manufacturing drawings to ensure that all parts materials are available and that obvious anomalies are found prior to the beginning of integration activities.

3.5.2 Hardware “as built status” report

Through official records, the hardware "as built status" shall be traced during the AIT activities. The record shall state:

- integrated hardware part and serial number
- ADP reference
- integration date
- integration location when applicable
- module status
- subsystem
- integration procedure reference (with issue/rev) with the record of:
  - Ø torque of fixing screws
  - Ø marking (or eventually sticking) of fixing screws

3.5.3 Handling

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

Only authorized crane operators will operate in particular, overhead crane.

3.6 ELECTRICAL INTEGRATION

All electrical interfaces (flight connectors) will be protected by savers (on flight models only) during integration, so mating/de-mating will be made by breaking non-flight hardware interfaces. Through an official record all flight connector connections/disconnections shall be traced during the AIT activities. The record shall state :

- unit and harness connectors identification: reference and type
- connection/disconnection dates for:
  - Ø harness connector to saver
  - Ø unit connector to saver
  - Ø harness connector to unit connector
  - Ø torque of fixing screws
  - Ø marking (or eventually sticking) of fixing screws

QC will update this document.

3.6.1 Electronic units

There is no functional verification during incoming inspection. The verification of all the unit interfaces before box connection is done through the verification of the received unit data-package documentation : box interface data sheets w.r.t. harness list or measurements at harness side (power addressing).
After unit mechanical fitting and fixing bolts torque, a bonding measurement (or insulation as required) between unit case and structure reference grounding point is performed.
Then the electrical integration takes place to make sure that :

- the interfaces are compatible
- the unit, then the overall subsystem are working properly.

The system integration will be performed according to the same principles : electrical interface verification completed by functional checks after final connection as explained here under.

3.6.2 Integration task – Interface checks

Electrical integration will be automated to the maximum extend as is reasonable, and will systematically control all interfaces of a unit being integrated. Before and after connection of harness to dedicated unit connector, the electrical interfaces will be tested. The following tests will be performed to verify the electrical interface compatibility, avoiding any degradation of flight units:

- grounding verification through grounding measurements at unit and harness connector level

- safety hardware verification of output signals by measurement at emitter unit / harness connector level in unloaded configuration (or test loads) before harness connection to the receiver unit. Such a verification will be restricted to high level signal (power supply - high level command when mixed with other signals on the same connector) and to signals for which a specific measurement is required due to the risk encountered by receiver units and will be detailed in the dedicated subsystem test plans at system level
- standard interface verification of unit before connection to harness
- specific verifications will be detailed by instrument suppliers documents (HFI/ LFI) and sub-contrators documents.
- after suppression of break-out boxes/tee adapter, final connection of each harness connector and torque of fixation screws.

Special care will be taken for ESD purposes(in particular for HFI/LFI detection chains). All not conductive materials are prohibited on and near the satellite. If needed, a risk analysis will be held.

3.6.3 Unit function checks (UFT)

The detailed functional testing are defined in the corresponding test matrix.

Functional check of integrated unit before continuing the next unit integration operations. This kind of functional checks is restricted to the minimum and only allow to verify that the unit can be powered, commanded, and monitored in advance to the next IST.

3.6.4 System Integrated test (SIT)

The detailed functional testing are defined in the corresponding test matrix.

At electrical integration complexion, a global functional test is performed on each module (PLM and SVM) . Its aim is to demonstrate subsystem or functional chains compatibility's .

3.7 TESTS AT SYSTEM LEVEL

During the sequence of the system tests the satellite has to be checked in an automated and reproducible manner in the course or at the end of each test in order :

- to verify the functional performances
- to identify faults and anomalies
- to observe trends of the main parameters.

This will be ensured by the means of :

- Integrated System Test (IST)
- Short Functional Test (SFT)
- Specific Performance Test (SPT)
- Environnemental tests (ENV)

The detailed functional testing are defined in the corresponding test matrix.

To demonstrate the compatibility between Planck and the ground segment a series of system validation tests shall be performed: System Verification Test (SVT).

3.7.1 Functional/Performance tests

3.7.1.1 IST (Integrated System Test)

After assembly and integration completion, the satellite will be submitted to a first Integrated System Test (IST1). The objective is to verify the performances and the compatibility of all subsystems with each other in the configurations of the system which are representative of the mission (including the redundancies and cross-strapped configurations where applicable).
For this purpose the system will be powered as requested by the chosen configuration and the functions and performances will be tested in all modes (as far as feasible at system level) for all subsystems.
During the test of one subsystem the other subsystems will be continuously monitored and their status shall not be changed.
The functional and performance verifications of a subsystem will be done with automatic sequences built up in a modular way and using as much as possible the test software developed at unit or subsystem level [RD13].
As the experience of previous programs shows that automatic sequences can only be run correctly after intensive debugging of the test software, care will be taken to use the same tests sequence, the same synoptic than the ones used on the AVM model or CQM model. The use of the alone HPSDB for all models guarantees its validation before the IST, as well as the monitoring (included in the HPSDB).
Test S/W changes for the PFM will also be validated prior to start of IST 1. On completion of the environmental tests, the PFM will be submitted to a second Integrated System Test (IST2, identical to IST1). The objective is to verify that the performances have not been degraded during environmental exposure, by comparison with IST1 measured performances.
Since the OBSW is delivered in two steps (AIV & Flight branches), a IST with flight OBSW will be performed before cryogenic tests .

3.7.1.2 SFT (Short Functional Test)

The SFT is an abridged IST. The software sequences and software modules which compose the SFT program will be chosen among the test software tools developed for the testing at lower levels or at IST level in order to reduce time for validation testing and to provide results coherent between all levels. This will allow straightforward comparison and facilitate the trend analysis [RD13].
The SFT is foreseen after balancing tests and vibration tests, and after transport to the CSG.

3.7.1.3 SYSTEM tests & S/W compatibility

On PFM, system tests will be performed to check the operational configurations and verify the configuration changes (nominal and after failure detection) .
During these tests the functions of the on-board S/W are checked in order to test the compatibility of this S/W together with the operational environment. Taking into account the number of combinations of the built-in functions, only selected combinations will be chosen for each system test.
For these tests the satellite is motionless and EGSE simulations will be used with representative configurations. They will be detailed in a dedicated system tests plan .

3.7.2 Physical properties & mechanical spin test

The parameters weight, centre of gravity and moment of inertia are needed to predict spacecraft performance during attitude control and to verify that the maximum dry mass will not be exceeded. Moment of inertia measurements will be performed on Schenck oscillating tables available in Cannes facilities . A balancing will be performed to measure and adjust S/C spin axis .
In a first step, this measurement will be performed on rotating table available in Cannes facilities.. In a second step, a "fine" balancing with E5 rotating table will be performed under vacuum inside the LSS at ESTEC . This second step is performed in order to improve the balancing accuracy measurement avoiding air effect . A dedicated validation of the "fine" balancing test set-up will be done by ETS, before PFM measurement .

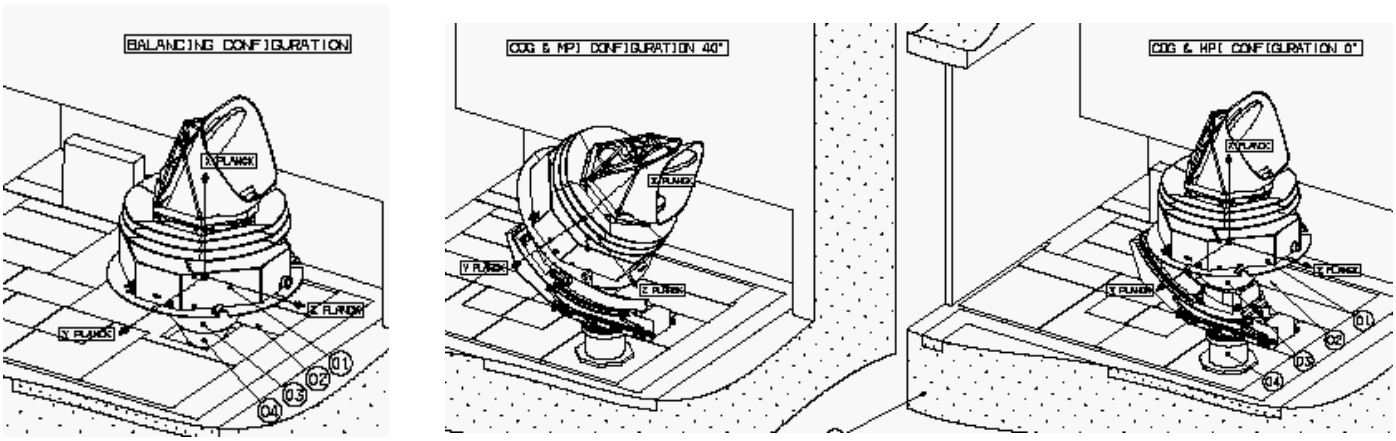


Figure 11: PFM Centring/Inertia & AAS-F Balancing Configurations

3.7.3 Alignment measurements

Refer to [AD11]

- The necessity to know accurately the sensors (STR, CRS ...) and thrusters positioning versus the telescope axis governs the control of the rotation (of the satellite) and therefore the image quality.
- The alignment measurement method had been used on the CQM to check the telescope stability during cryogenic test [RD15].
- At satellite level, the tests will be performed before and after satellite's environmental testing in order to check by trend analysis the system alignment status.
- During telescope & RAA mounting/adjustment an alignment by videogrammetry will be performed to check the telescope stability .

The general alignment method consists in identifying the satellite mechanical axes system and in measuring (and if necessary adjusting) sensors (STR, CRS), thrusters, telescope versus to the reference axes system.

AAS-F standard Alignment Ground Support Equipment will be used with in addition :

Ø A specific toolin ball & MGSE had been developed, in order to measure S/C axis reference. These tools had been validated during PFM 1 S/C axis reference determination .

3.7.4 ACU Fit check

- A dedicated mechanical and electrical fit check with the ARIANE adapter (ACU) will be done before the launch campaign .

3.7.5 Fluidic/Pneumatic Tests

3.7.5.1 For RCS purposes:

The functional check of RCS is a standard approach.
A RCS global leak test is performed at the end of AIT campaign.
Since the important concentration of helium around Herschel & Planck satellite during AIT activities, a classical global leak cannot be performed, so the ISO satellite solution had been re-adapted.
This test will be performed under vacuum inside the LSS. RCS is filled with a gas mixture (GN2 + Kr), the test is performed by the Krypton leak detection inside the vacuum chamber .
The validation of this process (mass spectrometer and Krypton standard leaks) had been validated in parallel with the telescope cold-videogrammetry test .

AAS-F standard Tanking Ground Support Equipment (TGSE) will be used with in addition :

Ø A specific system pump group for draining/drying, validated on Herschel SVM STM, in order to dry the simulation liquids (filling for vibrations tests) . To avoid safety constraints during vibrations tests , the simulation liquids will be demineralised water.

Ø for the filling/pressurisation of the tanks a new cart has to be developed in order to perform the fine equilibrium of the three tanks . This GSE so called (DPH/P) will be used for simulation liquids and hydrazine fillings .

3.7.5.2 For the Dilution (0,1 K) and 4 K coolers

Ø During S/C integration, after pipes and/or tank connections leak tests are performed (by HFI) on VCR
Ø For the 4K cooler proof/leak (by sniff) tests will be performed (by HFI) in clean-room (as CQM)
Ø For the dilution cooler,the proof test will be performed (by HFI with AAS-F support) after assembly of the satellite inside the AAS-F bunker(T05) for safety reason (max. pressure at 450 bars)
Ø Before/after satellite vibrations tests , a global leak test is performed(by HFI with AAS-F support) in order to check the integrity of the sub-systems . This test is done satellite inside the satellite transport container suited for this purpose. A sniff test along the PLM pipes can be done in clean-room.
Ø During the cryogenic test, leak measurements will be performed by CSL test facility, following cool down sequence as defined in the test specification

- TF (tank filing) PGSE will be used (byHFI) for filing and pressurization operations of the Helium isotopes tanks at AAS-F facilities for sine vibration, acoustic noise tests, at CSL for cryogenic test and at CSG for operation during the launch site operations. ISSS-GSE PGSE will be used (by HFI) for isotopes exhaust during cryogenic test at CSL (as for CQM).
- Isotope He3 will be filing only for at CSL for cryogenic test (as for CQM) and at CSG for operation during the launch site operations

0.1K and 4K cooler Pneumatic Ground Support Equipments (PGSE) will be used (by HFI) to purge cooler lines, perform proof and leak tests.

3.7.5.3 For the Sorption (20K) cooler:

No tests are foreseen during S/C integration and before/after mechanical environmental tests . During cryogenic test a partial pressure of hydrogen will be measured by CSL test facility.

3.7.6 SVT (System Verification Test)

To demonstrate the compatibility between Planck and the ground segment, a series of system validation tests shall be performed.
The MOC (Mission Operation Centre) should be validated as far as possible early in the program, with the aid of a dedicated spacecraft software simulator, using the telemetry data generated during satellite check-out tests, and supplemented by System Validation Tests (SVT) with the satellite hardware itself.
Nominally, three System Validation Tests (SVT-0, SVT-1, SVT-2) with the satellite are performed before launch by the operation team (ESOC) with the support of AAS-F Space.

- SVT-0 will be performed at AVM level. This test will be performed via a NDIU or similar interface to the MOC via communication network connection (i.e ISDN link). SVT-0 will be performed at AAS-I premises.

- SVT-1 is the principal full flight operational system test carried out with all the H/W & S/W elements required for the mission. The main objectives will be to verify the satellite – MOC interface for all telemetry formats and telecommand, the validation of the MOC TM & TC processing systems, the validation of MOC TM & TC data bases, characterisation of satellite spacecraft and payload) behaviour, e.g. power consumption, the confirmation of FOP data, and the validation of procedures.. SVT-1 will be performed at AAS-F premises.
- SVT-2 is the final verification of the integrated flight ground segment with the flight spacecraft interfaces and functional performances prior to launch. SVT-2 will be performed after FAR.

During all the SVT tests in ALS or ASP, the generated telemetry is sent through the MOC and via Telecom network to ESOC.

3.7.7 Specific Performance Test

3.7.7.1 Ambient RF performance test

PLANCK PFM will be tested using the simulated far field capability of the Compact Antennae Test Range (CATR).

The concept of compact range is based on the principle that a spherical wave coming from a source antenna is converted into a plane wave by means of two focusing precision reflectors.

CATR is selected as baseline for Telescope RF testing. The satellite will be rotated by the CATR positioner so as to construct the pattern.
The reference test horn to be performed on the RFQM, will validate the process .

3.7.7.2 µ Vibration test

Since Planck STM removal, a µ-vibration test is performed on Planck PFM. The aim of this test is to validate the transfer function between 4K cooler and FPU .
For this test S/C will be handled, two configuration could be done, one using a µshaker mounted on the external 4K panel, one using the “real” 4K compressor functioning .

3.8 ENVIRONMENTAL TESTS

3.8.1 Sine Vibration/Acoustic Noise/Shock tests

- The objective of these tests is to qualify the complete structure with respect to the environment caused by the launch of the spacecraft and to confirm the mechanical environment specified at subsystem and units levels.

Vibration and acoustic noise levels and duration are chosen so as to demonstrate that the system design provides sufficient margins (based on the result of coupled load analyses with the launcher)

3.8.1.1 Sine Vibration

- The PFM will be tested through sine vibration and acoustic noise test. This test consists of:
  - Ø low level sine vibration test to verify the coupled analysis and to search the resonance frequencies (modal test survey).
  - Ø high level sine vibration test for the qualification of the mechanical system, the verification of the alignment requirements and the demonstration that the thermal insulation and its support withstand the environmental loads.
- The sequence of events for each vibration axis will be as follows:
  - Ø low level run
  - Ø determination of notching factors according to measured amplification factors
  - Ø intermediate level run (to confirm the notching factors)
  - Ø qualification level run
  - Ø low-level verification run for comparison to initial satellite signature.
- Notching of levels applied to the satellite will be made at the resonant frequencies of the main structure in order not to over-stress the satellite. These notching criteria will be determined in accordance with launcher regulations.
- Test set-up and conditions:
  - Ø RCS tanks will be filled with simulation liquids.
  - Ø Helium tanks will be pressurised .
  - Ø Battery will be charged.
  - Ø the satellite will be installed on the shaker with a specific vibration test adapter, the Force Measurement Device from ETS will be located between the shaker and the test adaptor.
  - Ø Test accelerometers will be installed in the satellite at specific locations in order to be able to compare test results with previous structural mathematical model predictions and to monitor the vibration levels applied to particular equipment.

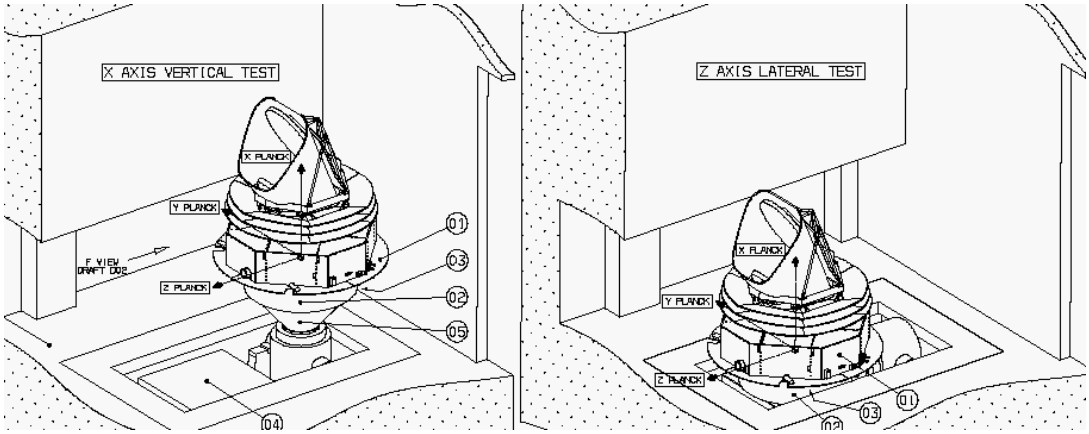


Figure 12: PFM Sine vibrations configuration

3.8.1.2 Acoustic noise

- Acoustic noise test. The main objectives are:
  - Ø demonstration of the satellite structure characteristics (primary and secondary)
  - Ø verification of the compliance with the relevant analytical model parameters
  - Ø verification of the system integrity under acoustic noise and alignment stability after test.
  - Ø verification that the structural/mechanical components units meet the requirements for system acceptance, and comply with launch vehicle requirements.
- Test set-up and conditions:
  - Ø The same as for sine vibrations for RCS & Helium and battery
  - Ø The satellite will be fixed on the VIS inside the acoustic chamber
  - Ø Microphones will do measurement of sound pressure level. Power spectral density response will be given by accelerometers
- The sequence of events for the test will be as follows:
  - Ø low level run for satellite signature
  - Ø intermediate level run
  - Ø qualification level run
  - Ø low-level verification run for comparison to initial satellite signature.

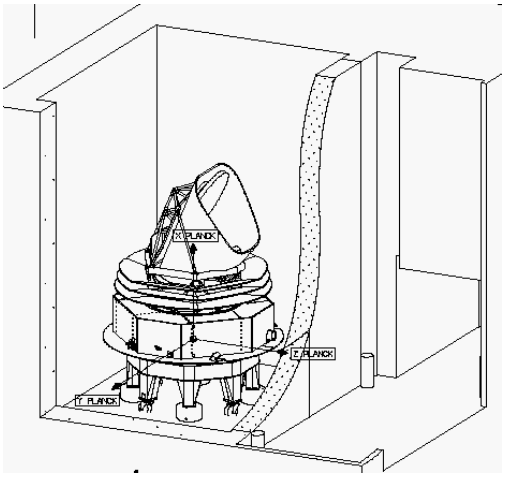


Figure 13: PFM Acoustic vibrations configuration

3.8.1.3 ACU clamp-band release

- Since Planck STM removal, a clamp-band release is performed on Planck PFM. The aim of this test is to validate the transfer functions obtained during Herschel STM campaign for Planck .

3.8.2 Thermal vacuum Tests

These tests will be performed in the FOCAL5 in CSL facility and are performed in two steps.
The first step concerns Redundant SCC functional and thermal balance tests in order to qualify thermal performance of the SC and demonstrate the SCS performance. This step had been performed during the PFM1 campaign .
The second step concerns cryogenic test, using the second SCC (Nominal one) and thermal cycling in order to verify the workmanship (at hot and cold equilibriums) and to perform an end to end HFI/LFI detection chains at cryogenic temperature .
The satellite is motionless and there is no sun simulation in such tests. The RCS tanks are empty.
For the cryogenic test, 0.1K Isotope Helium tanks will be filled in isotopes He3 and He4 .

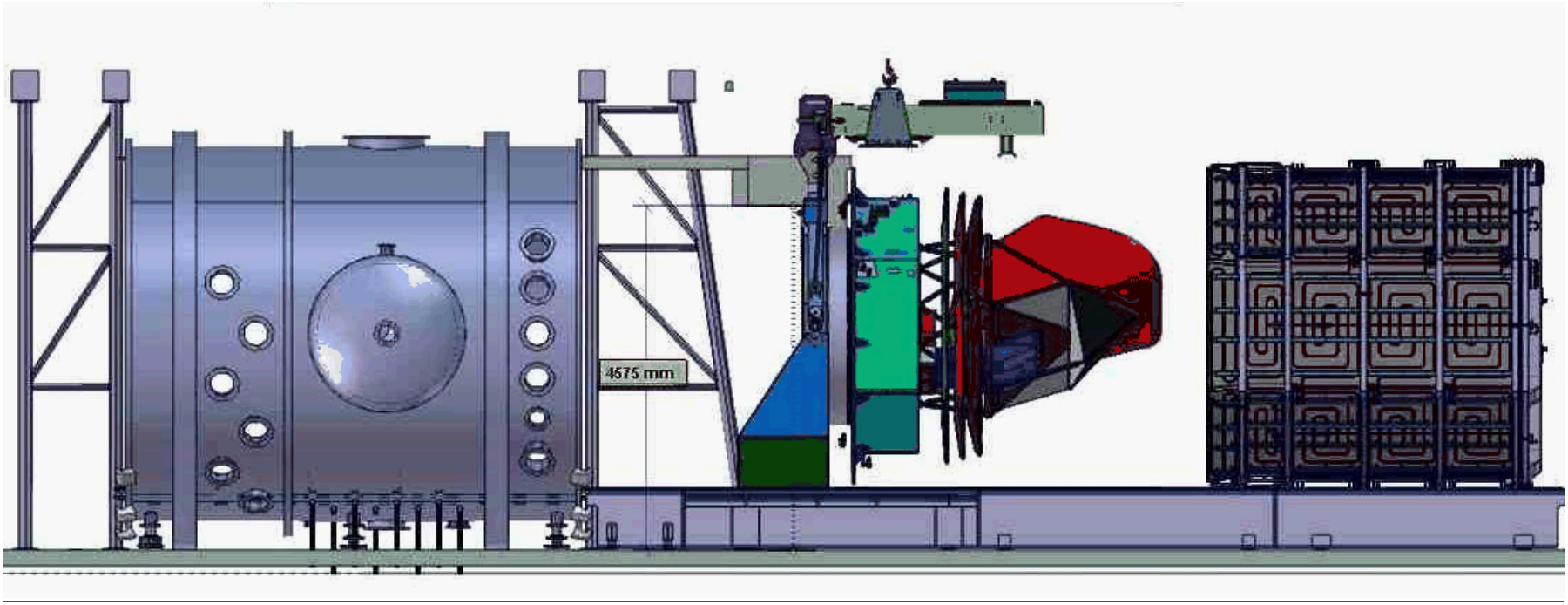


Figure 14: PFM Cryogenic/thermal set-up configuration

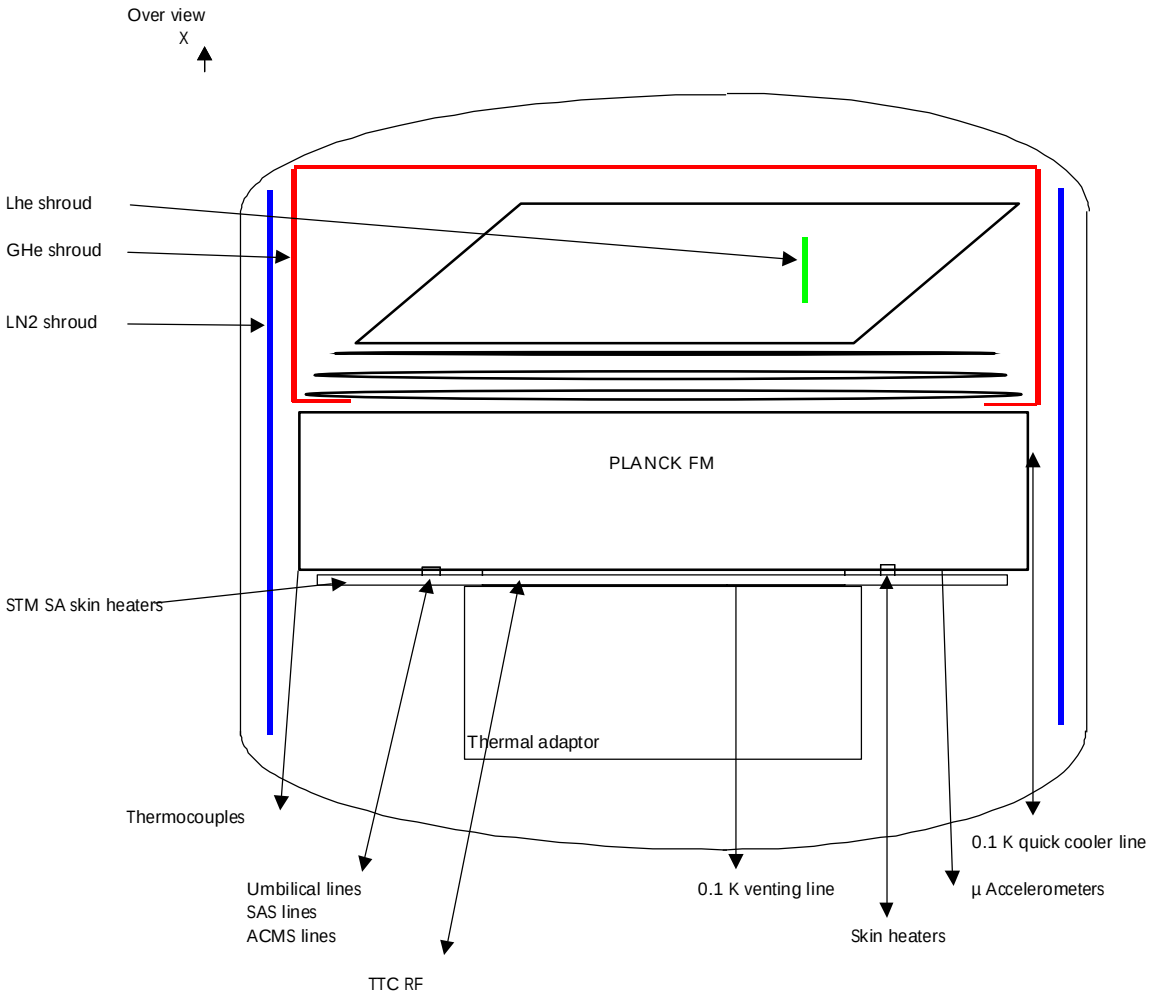


Figure 15: PFM Cryogenic GSE links

3.8.3 EMC

3.8.3.1 At PFM level

Conventional EMC qualification program will be applied on the PFM at ambient temperature.

- CE/CS measurements will be performed in clean room facilities. If needed, several specific savers will be connected in the main bus in order to connect “probe measurements”. In order to have access to the savers, satellite will be opened following list of measurements to be done.
- RE/RS measurements will be performed in an anechoic chamber (in AAS-F CATR). The satellite will be as close as possible to the flight configuration. Two major tests will be done: compatibility with Ariane 5 and satellite auto-compatibility. In order not to perturb the measurement, all the GSE will be set out of the chamber during the measurements.

For RE/RS purpose, special care will be taken for the MLI blankets installation in order to be as closed as possible to the flight configuration.

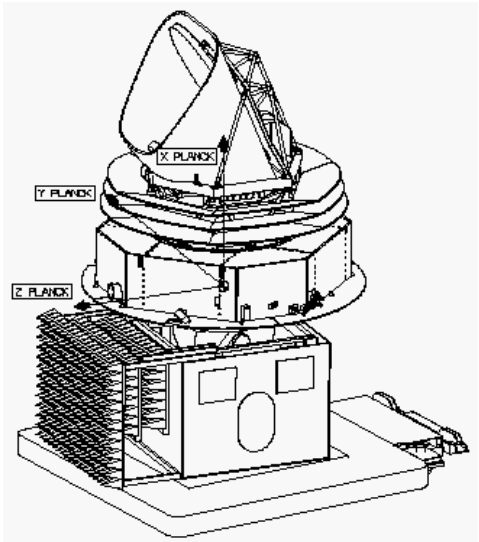


Figure 16: PFM EMC RE/RS Configuration

4. SPECIFIC CONSTRAINTS

4.1 CLEANLINESS

The requirements on cleanliness are recalled in [AD6].
Planck AIT is performed in a clean room class 100.000 of US Federal Std n° 209B. The clean rooms are in accordance with the following conditions:

- Temperature: 22°C +/- 3°C
- Relative humidity: 55% +/- 10%

During all the AIT, standard cleanliness monitoring is done on particulate and molecular witness samples. During AIT phase, there are several particulate cleaning periods of the satellite. These activities are summarise in [AD12]. The cleaning operation will be done by a vacuum cleaner, tools. Procedures had been developed on CQM model .
This nominal cleaning concerns only the external parts of the structure including the grooves, neither the reflectors neither the FPU.

4.2 SPECIFIC PROTECTIONS

To limit particulate contamination during AIT, several types of covers are necessary . These covers will be dismounted for some performances (ambient RF; balancing tests) and environmental tests (sine, acoustic & thermal tests) .
Skin protections 1, 2 and 3 are provided by ASP-AIT, ESA provide covers 4, HFI will provide cover 5.

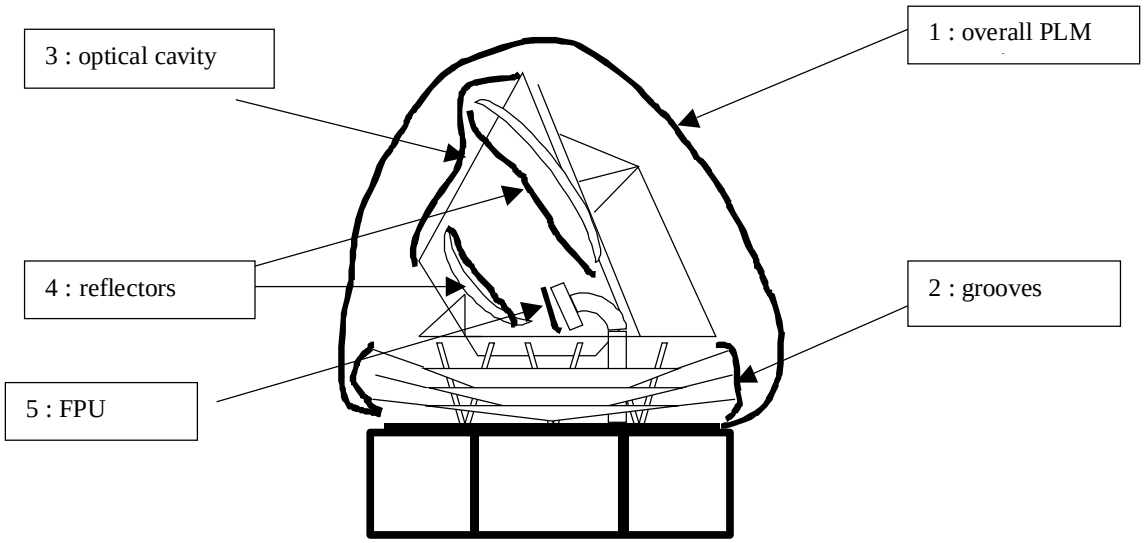


Figure 17: PPLM protections set

The mounting / dismounting of all these protections are explained in [AD12].
SVM will be protected according to [AD10].

During sine vibration tests, a dedicated protection tent will be used in order to remove all the protections.

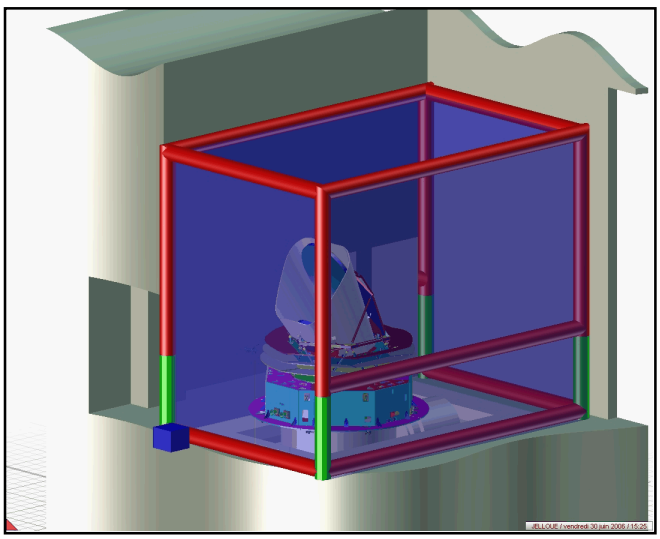


figure 18: S/C protection during sine vibrations

During S/C transport skin protection 1 & 2 are installed .

figure 19: PPLM protections for S/C transportation (CQM)

4.3 PURGING

The FPU will be purged with nitrogen during AIT sequence, including S/C transportation, except for some of performances (ambient RF, balancing, alignment, MCI…) and environmental tests.

4.4 Tests instrumentations

Inside the SVM, in order to avoid panels removal after environmental tests, the tests instrumentations (accelerometers, strain-gauges, thermocouples..) is defined to be flight compatible and will be grounded on the structure after tests.
Concerning the PPLM pending the accesses either instrumentation is grounded on the structure or pipe, either instrumentation is removed.

4.5 Flight units removal during satellite AIT campaign

During the AIT flow, due to ground constraints, some of units has to be removed .

For CATR accesses :
External solar panels are not compatible with CATR door. Thus they will be mounted inside CATR on Planck for RE/RS EMC test. Planck satellite will be entered Z axis downward (see in appendix drawing msmerf15310a) in order not to have protuberances close to the top of the door.
Due to low margins regarding walls, the MPT will be guided at the entrance by the same rails as for ASTRA. Fixation holes shall be done in the floor due to MPT width.

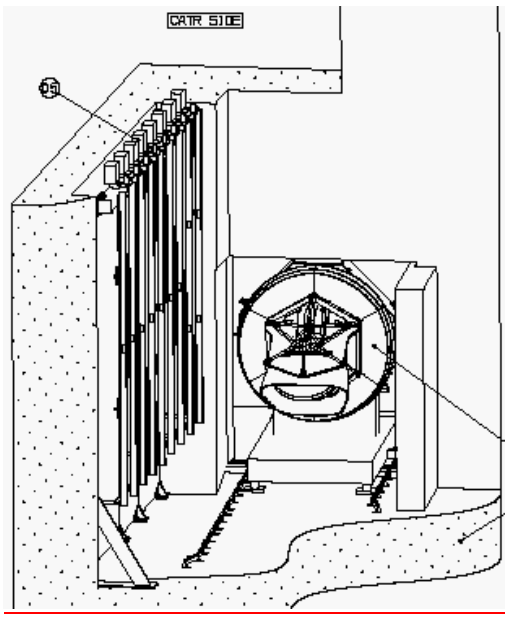


figure 20: S/C entrance into CATR chamber

For Vibrations instrumentation tests removal :
External Vgrooves (on –Z) will be dismounted after sine & acoustic tests, for test instrumentation removal accesses (accelerometer, strain-gauges ..)

For Thermal tests inside focal 5 at CSL
Lateral LGA (1 & 2), Solar array, Dilution “T” exhaust are dismounted for cryogenic test (pending the dimensions balancing masses could be removed)

For S/C Transportation :
External Solar array has to be dismounted for S/C transportation

5. AIT SEQUENCES

This chapter describes the AIT activities at PFM level, from unit/subsystem assembly to system delivery.
The sequences logic may be arranged in order to improve the schedule and reduce the costs without jeopardising the qualification or the health of the hardware. This point will be closely examined during early phase of the program and the rearrangements will be proposed and discussed thoroughly.
The following flow charts describe for each model the main activities of the system level satellite AIT plan.

5.1 PFM1 assembly, integration and tests

5.1.1 Assembly, Integration and Test logic

The further chapter explains the Planck PFM 1 integration.
Integration started by SCC assembly on vertical & horizontal heat-pipes its-self mounted on the SCS panels . QM SCE pre-electrical integration with Redundant SCC had been done in stand alone configuration with LPSC GSE . Then the Cryo-strucutre had been moutned in order to mate this partial PPLM onto the SVM .
Before the delivery from AAS-I of the SVM, helium tanks and WU MTDs had been mouted in AAS-I, After SVM mini IST test done by AAS-I, the PPLM had been mated on the SVM.
PFM 1 integration completion had been done by telescope & RAA dummies mounting and the mini IST, this functional test validating the thermal balance test sequence procedures

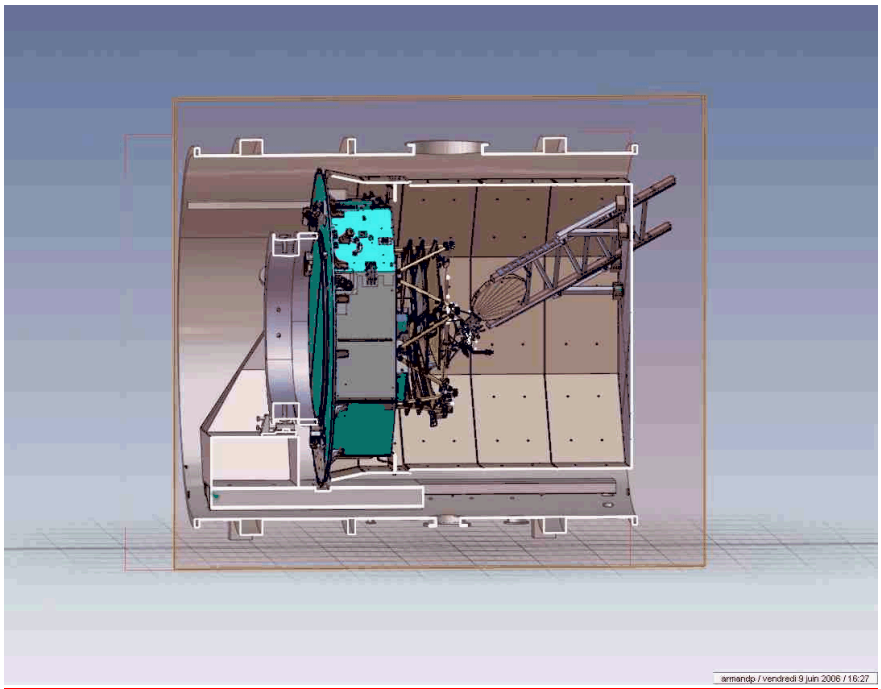


figure 21: PFM 1 thermal configuration inside Focal 5 at CSL

For the thermal configuration, a dedicated thermal drain had been developed to connect a cold point on the Vgroove 3 SCC pre-cooler .

In the PFM1 / PFM logic, Helium tanks and SCCs are definitively integrated and so are not removed after the PFM 1 test campaign. At the end of PFM1, the Cryo-structure is dismounted due to the non compatibility of RAA mounting during the PFM integration, and so the SVM is de-mated to perform a new Cryo-structure mounting . In addition the RCS tanks are mounted inside the SVM after PFM1.

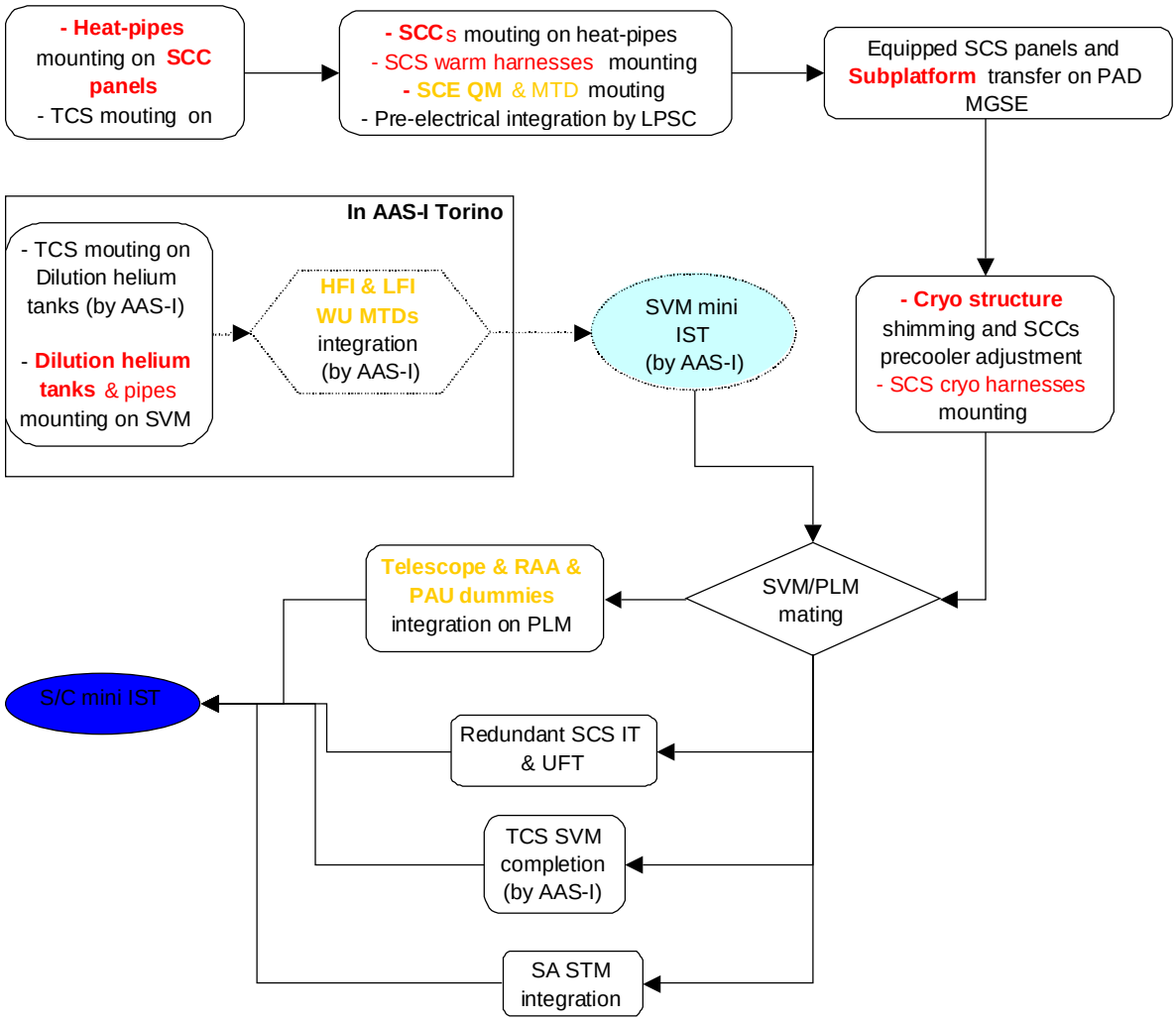


Figure 22: PFM1 Integration logic

5.1.2 EGSE Configuration

Instruments electrical integration will be performed with the SVM, using the nominal SVM EGSE (CCS / Pwr SCOE, TM/TC DFE)

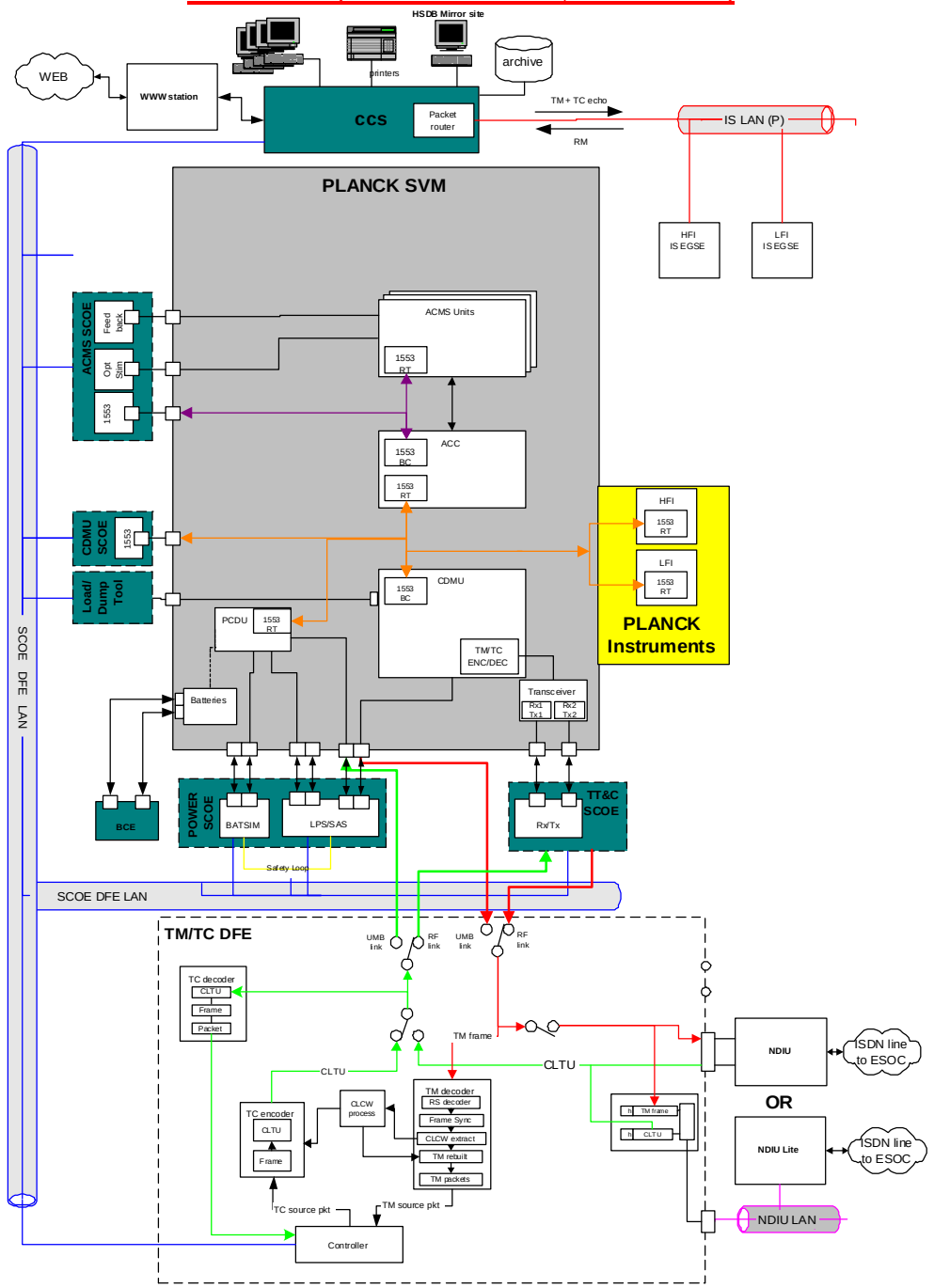


Figure 23: EGSE configuration for PFM 1 and PFM satellite integration

5.1.3 PFM1 task sheets

SCS panels preparation & mounting on the PAD Duration Ambience	PFM (SCC not removed for PFM) Refer to schedule on chapter §5.4 Class 100000

Goal : Mechanical and electrical integration of sorption coolers WUs on SVM panels installed on the SPSD. Transfer of the 3 integrated panels to the PAD.

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø SCC WU panels (3) are on SCC Panels Stiffener device (from AAS-I)
  - Ø Heat pipes are in theirs transport stands (from AAS-I)
  - Ø SCE / SCC harness (Instrument delivery)
  - Ø SCS panels harness
  - Ø SCC (2) and SCE QM model for PFM 1
  - Ø Hoisting device to integrate the SCC, the three panels
  - Ø SPSD MGSE
  - Ø SID MGSE

- Electrical configuration / EGSE required :
  - Ø LPSC EGSE in stand alone

Activity :

- SCC WU panels (3) positioning on the SPSD
- Thermal joints mounting on panels
- Horizontal heat pipes mounting on panels side
- Thermal joints mounting on SCC
- Vertical heat pipes mounting on SCCs side
- SCCs mounting on panels with the SID (SID has been designed in order to protect the pipes)
- SCE mounting on panel
- Harness connection between SCE and SCC (with pre-electrical integration by LPSC)
- Sorption coolers (the three panels) transfer, with SCC Panels Stiffener device, to the PAD
- Extended PPLM stiffener panels fastening on SCC WU panels and PPLM adapter

Cryo structure integration Duration Ambience	PFM 1 Refer to schedule on chapter §5.4 Class 100000

Goal : Cryo structure assembly (struts, grooves, piping)

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø Three SCS panels mounted
  - Ø SVM sub-platform
  - Ø Grooves
  - Ø struts
  - Ø Groove supporting tools
  - Ø Groove hoisting device
  - Ø Struts supporting tool

- configuration / EGSE required :
  - Ø N/A

Activity :

- SVM subplatform set on the PAD.
- Groove supporting tool installation around and on the top of the PAD
- Upper (n°3) to lower (n°1) grooves installation (due to 20K piping)
- Struts mounting and grooves fastening
- Groove supporting tool removal
- 20K Piping fastening on grooves

Helium tanks + pipes mounting Duration Ambience	PFM (He tanks not removed for PFM) Refer to schedule on chapter §5.4 Class 100000

These activities had been done in AAS-I premises
Goal : Perform the complete Helium pipes/tanks integration in the SVM.

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø 0.1K pipes
  - Ø He tanks (4)
  - Ø SVM cone
  - Ø PTT, VIS
- Electrical configuration / EGSE required :
  - Ø N/A

Activity :

- SVM cone is on the VIS
- TCS preparation on He tanks by AAS-I
- He tanks mounting (4)
- 0.1K pipe connection by HFI

PPLM mating on SVM cone Duration Ambience	PFM 1 Refer to schedule on chapter §5.4 Class 100000

Goal : Payload mating on the SVM.

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø Equipped cone on VIS + THA
  - Ø Cryo structure mounted on the sub-platform with SCS panels
  - Ø SVM cone with lateral panels removed
- Electrical configuration / EGSE required :
  - Ø N/A

Activity:

- PPLM vertical hoisting device mating on payload
- PPLM transfer to the SVM
- SVM/subplatform fixation
- SVM/SCS panels fixation

SCS integration & test Duration Ambience	PFM 1 Refer to schedule on chapter §5.4 Class 100000

Goal : Perform the electrical integration of the SCE, then the SCS UFT

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø Three SCS panels mounted and completely integrated
  - Ø SCC/SCE connected
- Electrical configuration / EGSE required :
  - Ø Pwr SCOE, TM/TC DFE
  - Ø CCS
  - Ø I.EGSE

Activity :

- SCE cryo harness mounting and connecting
- QM SCE/SVM electrical integration
- QM SCE/SCC electrical integration
- SCS UFT

- In parallel AAS-I completed the TCS SCS panels integration with the SVM .

Telescope & RAA dummies integration Duration Ambience	PFM 1 Refer to schedule on chapter §5.4 Class 100000

Goal : Telescope & RAA dummies integration on the S/C.

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø Cryo structure mounted on SVM
  - Ø SVM on the VIS
  - Ø Telescope & RAA dummies dismounted on tables

- Electrical configuration / EGSE required :
  - Ø Pwr SCOE, TM/TC DFE
  - Ø CCS
  - Ø I.EGSE

Activity:

- RAA dummies mounting (and electrical integration with AAS-I) on sub-platorm and cryo-structure BEU, DEA pwr box, RAA LSS (lower support structure) and PAU .
- Telescope dummy mounting on Cryostructure
- MLI/SLI installation

S/C integration completion Duration Ambience	PFM 1 Refer to schedule on chapter §5.4 Class 100000

Goal : Complete the satellite integration

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø Satellite on the VIS or MPT
- Electrical configuration / EGSE required :
  - Ø Pwr SCOE, TM/TC DFE
  - Ø CCS
  - Ø I.EGSE

Activity:

- Upper panels closure
- MLI mounting
- STM solar array (central part) mounting
- S/C mini IST
- Protective cover installation

Transport to CSL Duration Ambience	PFM 1 Refer to schedule on chapter §5.4 Class 100000

Goal : Satellite preparation and transport from Cannes to CSL

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø Satellite on MPT
  - Ø Satellite container
- Electrical configuration / EGSE required :
  - Ø N/A

Activity:

- Container and satellite instrumentation
- S/C transfer into its container
- S/C transport to CSL
- Container opening in airlock
- S/C transfer on MPT
- EGSE/MGSE packing

Satellite preps before chamber closure Duration Ambience	PFM 1 Refer to schedule on chapter §5.4 Class 100000

Goal : Preparation of the satellite inside the thermal vacuum chamber

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø Satellite on the MPT

- Electrical configuration / EGSE required :
  - Ø Power scoe
  - Ø TM/TC DFE
  - Ø TTC RF scoe
  - Ø CDMU scoe
  - Ø I.EGSE
  - Ø CCS

Activity:

- EGSE/MGSE unpacking
- EGSE validation
- Thermocouples installation & routing
- STM SA external part mounting
- thermal configuration outside the chamber (MLI, test heaters……)
- Satellite connection and check outside the chamber
- Satellite transfer to the thermal dolly
- Satellite survey test
- Shrouds installation
- Satellite connection and check inside the chamber
- Test MLI mounting
- Inspection before closure
- Chamber closure

Thermal balance & Functional Redundant SCS Duration Ambience	PFM 1 Refer to schedule on chapter §5.4 Class 100000

Goal : This test validated the SCS early in the AIT test phase. The 20K temperature at FPU side had been checked.

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø Satellite inside the chamber

- Electrical configuration / EGSE required :
  - Ø Power scoe
  - Ø TM/TC DFE
  - Ø CDMU scoe
  - Ø I.EGSE
  - Ø CCS

Activity:

- Vacuum phase
- PPLM cooling
- Thermal balance test
- SCC functional test (redundant one)
- Chamber pressurisation
- Chamber opening
- Chamber inspection

S/C exit Duration Ambience	PFM 1 Refer to schedule on chapter §5.4 Class 100000

Goal : Satellite exit from the chamber.

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø Satellite on the thermal dolly inside the chamber

- Electrical configuration / EGSE required :
  - Ø N/A

Activity:

- All test equipment disconnection
- Thermocouples dismounting
- Shrouds dismounting
- Tests MLI & STM SA external part removal
- Satellite transfer to the MPT
- Protective cover installation

Transport to Cannes Duration Ambience	PFM 1 Refer to schedule on chapter §5.4 Class 100000

Goal : Satellite preparation and transport from CSL to Cannes

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø Satellite on MPT
  - Ø Satellite container

- Electrical configuration / EGSE required :
  - Ø N/A

Activity:

- S/C preparation before transport
- Container and satellite instrumentation
- S/C transfer into its container
- S/C transport to CSL
- Container opening in airlock
- S/C transfer on MPT
- EGSE/MGSE packing

Mass and Y/Z centring measurement Duration Ambience	PFM 1 Refer to schedule on chapter §5.4 Class 100000

Goal : Perform centring measurement

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø Satellite completely integrated
  - Ø Vertical hoisting device
  - Ø MCI MGSE
  - Ø Alignment tools

- Electrical configuration / EGSE required :
  - Ø N/A

Activity:

- S/C Reference axis determination
- S/C mass measure
- S/C transfer on MPA
- Y & Z centre of gravity measurements

PFM1 dismounting Duration Ambience	PFM 1 Refer to schedule on chapter §5.4 Class 100000

Goal : Dismount the PFM1, to complete SVM and start PFM campaign with RAA FM .

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø Satellite integrated

- Electrical configuration / EGSE required :
  - Ø N/A

Activity:

- SA STM and telescope dummies removal
- Lateral panels removal
- RAA & PAU dummies removal
- SVM/PLM de-mating
- Instruments WU MTD removal > SVM ready for RCS tanks mounting
- Cryo-structure dis-mounting and storage .
- SCE QM & MTD removal

5.2 PFM task sheets

5.2.1 PPLM Integration

The further chapter explains how will be performed the Planck PLM integration. After the delivery from AAS-I of the SVM, the PPLM will be set on the cone. The WU panels will be mounted and HFI/LFI electrical & pneumatic integration, UFT, SIT will be performed afterwards.

The PFM Planck PPLM integration is a complex logic taking several constraints : mixed instrument lay-out, electrical, pneumatic, mechanical interfaces and accesses constraints . This logic is given here under .

The PPLM integration is cut in two major steps (SVM/PLM mating and telescope & RAA mounting/shimming).
After the cryo-structure mounting/shimming the SVM/PLM mating is done .

This step allows to starts the telescope mounting . This mounting is done with maximal thick shims Telescope/Cryo-structure shims (taking into account telescope planarity). The FPU is fixed on the telescope (with nominal shims), RAA/PLM gaps adjustments are measured in order to compute the shims Telescope/Cryostruture with nominal thick shims .
If necessary an iterative shimming will be performed around the RAA.
During the telescope shimming, telescope structure deflections monitoring will be done by video-grammetry measurement .
At the end of telescope/RAA shimming, the RAA MGSE will be removed and instruments end of integration will be completed .

KIP will be performed before SVM/PLM mating (on SCS cavity), and before SVM panels closures. For the rest of integration dedicated Key Point will be done before activities

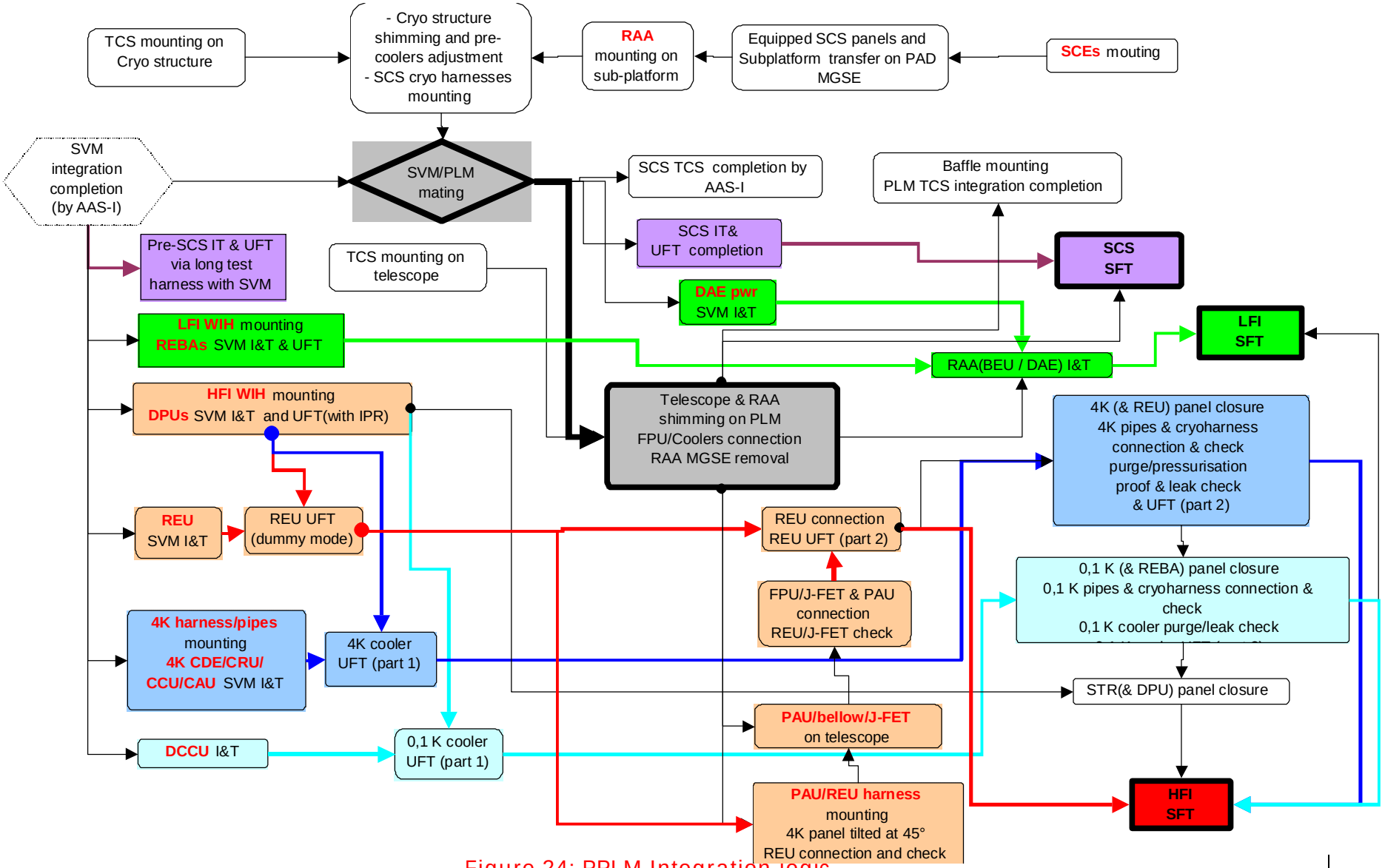


Figure 24: PPLM Integration logic

SCS pre-integration and RAA mounting Duration Ambience	PFM Refer to schedule on chapter §5.4 Class 100000

Goal :

FM SCEs mounting & pre-electrical integration with long harness to the SVM, before the SVM/PLM mating

RAA mounting on the SVM sub-platform

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø SCCs are on SCS panels
  - Ø SCE (2)
  - Ø SPSD MGSE
  - Ø SID MGSE
  - Ø SVM on VIS & sub-platform on PAD
  - Ø RAA hoisting device
  - Ø 3 SCS panels mounted on the PAD.
  - Ø RAA mounted on FPU support stand

- Electrical configuration / EGSE required :
  - Ø Power scoe
  - Ø TM/TC DFE
  - Ø CDMU scoe
  - Ø CCS

Activity :

- SCEs mounting on panel
- Harness connection between SCEs and SCCs
- SCE / SVM Pre-electrical integration with long harness up to SVM and UFT .
- RAA mounting on the sub-platform with tick tool shims
- Pre-coolers adjustments on cryo-structure & RAA for SVM/PLM mating

Thermal sensors installation and routing Duration Ambience	PFM Refer to schedule on chapter §5.4 Class 100000

Goal : Thermal sensors
- gluing on the PPLM : cryo-structure, telescope & baffle
- wires routing and connecting to the bracket located on the subplatform.
- addressing check.

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø This activity will be done in parallel with integration flow
  - Ø S/C on the VIS

- Electrical configuration / EGSE required :
  - Ø Power scoe
  - Ø TM/TC DFE
  - Ø CDMU scoe
  - Ø CCS

Activity:

- In advance (before assembly) :
  - thermal sensors are glued on the PPLM (cryo-structure, telescope & baffle).
- After integration :
  - wires routing and connecting to the bracket located on the subplatform.
  - addressing check.

Cryo structure integration Duration Ambience	PFM Refer to schedule on chapter §5.4 Class 100000

Goal : Cryo structure assembly (struts, grooves, 20 K pre-coolers fixing)

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø Three SCS panels mounted
  - Ø Sub-platform mounted
  - Ø RAA mounted (not shimmed)
  - Ø Grooves
  - Ø struts
  - Ø Groove supporting tools
  - Ø Groove hoisting device
  - Ø Struts supporting tool
- Electrical configuration / EGSE required :
  - Ø N/A

Activity :

- Groove supporting tool installation around and on the top of the PAD
- Upper (n°3) to lower (n°1) grooves installation (due to 20K piping)
- Struts mounting and grooves fastening
- Groove supporting tool removal
- 20K Piping(pre coolers) fastening on grooves
- RAA handled to the nominal tick tool shims
- Pre-coolers adjustments on cryo-structure & RAA for SVM/PLM mating

PPLM / SVM mating Duration Ambience	PFM Refer to schedule on chapter §5.4 Class 100000

Goal :
Payload mating on the SVM.

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø SVM cone on VIS + THA
  - Ø Cryo structure & RAA mounted on the subplatform

- Electrical configuration / EGSE required :
  - Ø N/A

Activity:

- PPLM vertical hoisting device mating on payload
- PPLM transfer to the SVM
- SVM/subplatform fixation
- SVM/SCS panels fixation
- SCS TCS completion by AAS-I

SCS electrical integration & test Duration Ambience	PFM Refer to schedule on chapter §5.4 Class 100000

Goal : Perform SCS electrical integration & UFT.

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø Three SCS panels mounted and completely integrated
  - Ø SCC/SCE connected
- Electrical configuration / EGSE required :
  - Ø Power scoe
  - Ø TM/TC DFE
  - Ø CDMU scoe
  - Ø CCS

Activity :

- SCE cryo harness mounting and connecting
- SCE/SCC's electrical integration
- SCE's UFT

LFI WU Integration Duration Ambience	PFM Refer to schedule on chapter §5.4 Class 100000

Goal : Perform LFI electrical integration & UFT after units mounting

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø Lateral panels on EPT
  - Ø S/C on VIS
  - Ø REBA (2), DEA power box, harness
- Electrical configuration / EGSE required :
  - Ø Power scoe
  - Ø TM/TC DFE
  - Ø CDMU scoe
  - Ø CCS
  - Ø I.EGSE

Activity :

- REBAs mounting, eletrical integration with SVM and UFT
- DEA powr box mounting, eletrical integration with SVM
- BEU-REBA harness mounting.
- BEU-DAE harness mounting.

HFI WU Integration Duration Ambience	PFM Refer to schedule on chapter §5.4 Class 100000

Goal : Perform electrical integration & UFT after units mounting

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø Lateral panels on EPT
  - Ø S/C on VIS
  - Ø DPU (2), REU, 4K CDE/CRU/CAU/CCU & 4 K harness, DCCU

- Electrical configuration / EGSE required :
  - Ø Power scoe
  - Ø TM/TC DFE
  - Ø CDMU scoe
  - Ø CCS
  - Ø I.EGSE

Activity :

- DPU's mounting, eletrical integration with SVM and UFT with IPR simulators
- REU mounting, eletrical integration with SVM and UFT in dummy mode
- 4K cooler mounting (CDE/CRU/CAU/CCU), harness connection, CCU EMC cover mounting, eletrical integration with SVM and UFT (partial with-out compressor stroke).
- DCCU, eletrical integration and UFT (partial with-out gaz flow).
- PAU-REU harness mounting

Telescope integration & RAA shimming Duration Ambience	PFM Refer to schedule on chapter §5.4 Class 100000

Goal : Telescope integration on the PPLM, then RAA final mating

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø Cryo structure mounted on SVM on the VIS
  - Ø Telescope
  - Ø RAA & MGSE

- Electrical configuration / EGSE required :
  - Ø N/A

Activity:

- Telescope vertical hoisting device mating on telescope
- Telescope transfer on the cryo structure, with video-grammetry stability check
- Telescope/Cryostructure planarity shimming with maximal thick , with video-grammetry stability check
- Telescope/FPU shims mounting, then RAA/PLM & SVM shims determination and manufacturing
- RAA shims mounting, with telescope video-grammetry stability check
  - Telescope/FPUs shims
  - BEU/subplatform shims
  - RAA Secondary structure/PLM
- RAA hoisting device disassembly and RAA MGSE removal
- SCCEs / FPUs fixing
- SLI installation around the FPU and between RAA and PPLM

HFI detection chain integration completion Including PAU /bellow/JFET mounting Duration Ambience	PFM Refer to schedule on chapter §5.4 Class 100000

Goal : Complete HFI dectection chain integration

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø S/C on the VIS
  - Ø JFET/Bellow/PAU mounted on dedicated MGSE

- Electrical configuration / EGSE required :
  - Ø Power scoe
  - Ø TM/TC DFE
  - Ø CDMU scoe
  - Ø CCS
  - Ø I.EGSE
  - Ø CESR EGSE

Activity:

- 4K panel tilting at 45°, REU connection (of PAU side)
- REU connection electrical check with CESR EGSE (by HFI)
- JFET/Bellow/PAU mounting and connecting (with HFI support)
- FPU / JFET and bellow/ PAU connections (by HFI)
- REU/PAU/J-FET electrical check with CESR EGSE (by HFI)
- REU/DPU final connection and UFT part 2

SCS & LFI detection chain integration completion Baffle mounting Duration Ambience	PFM Refer to schedule on chapter §5.4 Class 100000

Goal : Complete HFI dectection chain integration

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø S/C on the VIS
  - Ø Telescope baffle and hoisting device

- Electrical configuration / EGSE required :
  - Ø Power scoe
  - Ø TM/TC DFE
  - Ø CDMU scoe
  - Ø CCS
  - Ø I.EGSE

Activity:

- RAA / SVM electrical integration
- BEU/DAE control box connection
- REBA/BEU harness connection at BEU side
- LFI SFT
- 20 K cryo-harness connection
- 20K manual valves locking (by JPL)
- SCS SFT
- Baffle & SLI mounting
- Telescope cleaning and optical cavity protection mounting

HFI coolers integration completion & HFI SFT PLM SIT Duration Ambience	PFM Refer to schedule on chapter §5.4 Class 100000

Goal : Complete HFI dectection chain integration

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø S/C on the VIS
  - Ø HFI PGSEs & leak detector
  - Ø Helium

- Electrical configuration / EGSE required :
  - Ø Power scoe
  - Ø TM/TC DFE
  - Ø CDMU scoe
  - Ø CCS
  - Ø I.EGSE

Activity:

- 4K panel closure
- 4K pipes & cryo-harness connection (by HFI)
- 4K cooler purge, filling, proof and leak tests (by HFI); Manual valves locking (by HFI)
- 4K cooler UFT part 2
- 0,1K panel closure
- 0,1K pipes & cryo-harness connection (by HFI)
- 0,1K cooler purge, leak check (by HFI)
- 0,1K cooler UFT part 2
- STR panel closure
- HFI SFT
- SVM/PLM MLI mounting
- PPLM TCS electrical checks
- PLM SIT

5.2.2 S/C AIT

EMC CE; S/C finition ; IST & SVT # 1 Duration Ambience	PFM Refer to schedule on chapter §5.4 Class 100000

Goal : Perform EMC CE tests, then satellite closure,
then IST and SVT 1 before vibrations tests ((could be done after HFI dilution proof test)

Specimen configuration :

- AAS-F EMC test aids
- Mechanical configuration / MGSE required :
  - Ø Satellite on VIS
  - Ø S/C vertical hoisting
  - Ø FM SA central part
  - Ø SA MGSE stand and fixing tool

- Electrical configuration / EGSE required :
  - Ø Power scoe
  - Ø TM/TC DFE
  - Ø TTC RF scoe
  - Ø ACMS scoe
  - Ø CDMU scoe
  - Ø I.EGSE
  - Ø CCS
  - Ø NDIU for SVT1 (under ESA responsibility)

Activity:

- EMC CE measurements at ambient temperature
- Pending AAS-I alignment, Internal alignment equipments determination in masters cubes (CRS ..)
- Power & RF lateral panels closure and upper panels mounting
- ACMS SAS dis-connection
- S/C vertical hoisting, FM SA central part installation inside the VIS, mounting and SA MGSE removal
- FM SA central part flood test
- ACMS SAS reconnection & electrical check and LGA 3 & MGA antennae checks
- External MLI finalisation
- LGA 1 &2, SREM Integration and checks
- IST 1
- SVT 1#1

HFI Dilution cooler proof test and HFI coolers global leak tests Duration Ambience	PFM Refer to schedule on chapter §5.4 Class 100000

Goal : (could be done before IST & SVT test)
After the complete helium pipes/tanks integration, perform the proof test of high pressure part , then the HFI coolers reference global leak before vibrations tests .

Specimen configuration :

- AAS-F bunker facility
- Mechanical configuration / MGSE required :
  - Ø Satellite on MPT
  - Ø S/C hoisting device
  - Ø Satellite container
  - Ø TF-PGSE & helium (by HFI)
- Electrical configuration / EGSE required :
  - Ø N/A

Activity:

- S/C preparation before transport
  - 4K cooler lock , covers protection management ….
- Container and satellite instrumentation
- S/C transfer into its container
- S/C transfer to AAS-F bunker
- Dilution cooler high pressure sub-system proof test (Hazardous operation) by HFI
- S/C transfer to clean-room airlock
- Dilution cooler high pressure sub-system pressurisation at MEOP (by HFI)
- HFI coolers global leak tests
- Dilution cooler high pressure sub-system pressurisation at storage/vibration tests configuration (by HFI)
- Container opening in airlock
- S/C transfer in clean-room on MPT

S/C alignment, EMC RE/RS and Telescope RF test Duration Ambience	PFM Refer to schedule on chapter §5.4 Class 100000

Goal : Perform alignment before vibrations tests and thrusters adjustment if necessary, EMC RE/RS, then telescope RF tests inside AAS-F CATR .

Specimen configuration :

- AAS-F CATR test facility and EMC test aids
- Mechanical configuration / MGSE required :
  - Ø Satellite on MPT with protective covers
  - Ø S/C vertical hoisting device
  - Ø Theodolites and dedicated alignment tools
  - Ø EMC test aids
  - Ø Rails guides for EMC entrance
- Electrical configuration / EGSE required :
  - Ø Power scoe
  - Ø TM/TC DFE
  - Ø TTC RF scoe
  - Ø ACMS scoe
  - Ø CDMU scoe
  - Ø I.EGSE
  - Ø CCS

Activity:

- First integrated system test after satellite integration completion
- Alignment reference
  - S/C vertical hoisting, SC axis determination
  - ACMS equipments reference position
  - Thrusters alignments (orientation adjustment)
  - Telescope/FPUs/Reflectors reference positions
- Transfer to compact range
- External FM SA mounting
- EMC RE/RS measurements at ambient temperature, including RF auto-compatibility and launcher compatibility
- Transfer/alignment on the positioner of the CATR
- RF measurement : main lobe and far out side lobe measurements, by spherical cuts
- External FM SA dis-mounting
- Transfer to clean room

MCI, balancing at ambient , SFT#1, µvibrations tests Preliminary electrical fit-check with ACU harness Duration Ambience	PFM Refer to schedule on chapter §5.4 Class 100000

Goal : Perform physical characteristics and short functional test after balancing measurement

Specimen configuration :

- AAS-F MCI, balancing test facilities & µvibration generator
- Mechanical configuration / MGSE required :
  - Ø Satellite on MPT
  - Ø S/C vertical hoisting device
  - Ø MPA and BRA MGSE
  - Ø Masses balancing

- Electrical configuration / EGSE required (for SFT):
  - Ø Power scoe
  - Ø TM/TC DFE
  - Ø TTC RF scoe
  - Ø ACMS scoe
  - Ø CCS
  - Ø COTE/cables A & C/SLOT and SC FE simulator

Activity:

- S/C transfer to MCI area
- S/C mass measurement
- S/C preparation before centring, inertia & balancing tests
  - 4K cooler lock, covers protection management …
- Transfer on centring table : Y/Z centring measurement
- Transfer on inertia table : X centring and Inertia axes measurement
- Transfer on balancing table (3 runs) and masses adjustment
- Transfer on MPT and SFT S/C health-check (Antennae, SAS & AAD, CRS, FOG, SREM.. checks; SA flood test .
- µvibration generator mounting on lateral panel
- S/C vertical hoisting and µvibration measurement (with generator and with 4 K cooler)

In parallel, preliminary electrical fit-check is performed using ACU umbilical harness

Mechanical vibration tests (sine & acoustic) and clamp band release Preliminary electrical fit-check with ACU harness Duration Ambience	PFM Refer to schedule on chapter §5.4 Class 100000

Goal : Perform S/C mechanical qualification

Specimen configuration :

- AAS-F Vibrations sine (LDS V994 "ATLAS") & acoustic (1000 Acoustic chamber) tests facilities
- Mechanical configuration / MGSE required :
  - Ø Satellite on MPT
  - Ø S/C vertical hoisting device
  - Ø VAD MGSE and vibration test clamp-band
  - Ø RCS TGSE, DPH/P & simulation demineralised water & Nitrogen
  - Ø Clamp-band to be provided by Arianespace with dedicated GSE (EEDs ..)
  - Ø Dilution cooler sub-system is already configure (done at the end of HFI coolers global leak
- Electrical configuration / EGSE required :
  - Ø Power scoe
  - Ø TM/TC DFE
  - Ø BCE
  - Ø CCS

Activity:

- RCS filling & pressurisation (Hazardous operation)
- Battery charge and connection to S/C bus
- S/C transfer to the shaker
- Sinus vibrations tests (4 runs by axis)
  - S/C connection & launch configuration check & visual inspection
  - S/C transfer to each axis and accelerometer instrumentation checking after test facility connection
- S/C transfer to acoustic chamber
- Acoustic tests
  - S/C connection & launch configuration check & visual inspection
  - Accelerometer instrumentation checking after test facility connection
- S/C transfer to clean-room
- AE Clamp-band with EEDs mounting (by AE)
- S/C vertical hoisting
- Clamp-band release and shock recording with AE
- S/C transfer to MPT

Post vibration tests : RCS leak test, alignment check, SFT, IST & SVT and FM SA dis-mounting Duration Ambience	PFM Refer to schedule on chapter §5.4 Class 100000

Goal : Perform S/C alignment, functionality tests after vibration check.

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø Satellite on MPT with protective covers
  - Ø RCS TGSE Draining & drying, leak tools
  - Ø S/C vertical hoisting device
  - Ø Theodolites and dedicated alignment tools
  - Ø STM SA
  - Ø SA MGSE stand and fixing tool

- Electrical configuration / EGSE required :
  - Ø Power scoe
  - Ø TM/TC DFE
  - Ø ACMS scoe
  - Ø TTC RF scoe
  - Ø CDMU scoe
  - Ø I.EGSE
  - Ø CCS
  - Ø NDIU for SVT1#2 (under ESA responsibility)

Activity:

- RCS draining and drying
- RCS functional check and local leak test
- Alignment reference
  - S/C vertical hoisting, SC axis determination
  - ACMS equipments reference position
  - Thrusters position
  - Telescope/FPUs/Reflectors reference positions
- SFT S/C health-check (Antennae, SAS & AAD, CRS, FOG, SREM checks, SA flood test
- IST after OBSW "Flight branch" loading
- SVT 1#2
- S/C vertical hoisting, FM SA central part replace by STM one and SA MGSE removal
- ACMS SAS reconnection & electrical check and LGA 3 & MGA antennae checks
- External MLI finalisation

HFI coolers global leak after vibrations tests and S/C transfer to CSL SA Flasher test after vibrations tests Duration Ambience	PFM Refer to schedule on chapter §5.4 Class 100000

Goal : HFI coolers global leak after vibrations tests .
Satellite preparation and transport from Cannes to CSL

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø Satellite on MPT
  - Ø S/C hoisting device
  - Ø Satellite container
  - Ø TF-PGSE & helium (by HFI)

- Electrical configuration / EGSE required :
  - Ø N/A

Activity:

- S/C preparation before transport
  - 4 K cooler lock, covers protection management ….
- Container and satellite instrumentation
- S/C transfer into its container in the airlock
- Dilution cooler high pressure sub-system pressurisation at MEOP (by HFI)
- HFI coolers global leak tests
- Dilution cooler high pressure sub-system pressurisation at storage/vibration tests configuration (by HFI)
- S/C & GSEs transport to CSL
- Container opening in airlock
- S/C transfer on MPT
- EGSE/MGSE packing

- In parallel FM SA transfer to AAS-F flasher test facility
- FM SA Flasher test
- FM SA packing and transfer to Estec and storage

Satellite preps before chamber closure Duration Ambience	PFM Refer to schedule on chapter §5.4 Class 100000

Goal :

Preparation of the satellite before thermal vacuum chamber closure

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø Satellite on the MPT
  - Ø TF-PGSE and helium 3 and 4 isotopes (by HFI)
  - Ø ISSS-PGSE (HFI)

- Electrical configuration / EGSE required :
  - Ø Power scoe
  - Ø TM/TC DFE
  - Ø TTC RF scoe
  - Ø ACMS scoe
  - Ø CDMU scoe
  - Ø I.EGSE
  - Ø CCS

Activity:

- EGSE/MGSE unpacking
- EGSE validation
- Thermocouples installation & routing
- STM SA external part mounting
- 4K compressor unlocked and cover protection management
- thermal configuration outside the chamber (MLI, test heaters……),
- LGA 1 &2, dilution exhaust pipe dis-mounting ..
- battery charge
- Isotope He ¾ tanks filling (Hazardous operation) by HFI
- Satellite connection and check outside the chamber
- S/C cleaning
- Satellite transfer to the thermal dolly
- Satellite survey test
- Shrouds installation
- Satellite connection (electrical, dilution connection) and check inside the chamber
- Test instrumentation connection (thermocouples, test heaters, EMC probes) and check inside the chamber
- Test MLI mounting
- Inspection before closure
- Chamber closure

Cryogenic and Thermal Cycling tests (with nominal SCS) Duration Ambience	PFM Refer to schedule on chapter §5.4 Class 100000

Goal :

This test will permit to check the detection chains performance at cryogenic ambience.
In parallel the thermal cycling is done .

- à Cryogenic test – detection chains end to end test
- à Thermal cycling test

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø Satellite inside the chamber
  - Ø ISSS-GSE

- Electrical configuration / EGSE required :
  - Ø Power scoe
  - Ø TM/TC DFE
  - Ø TTC RF scoe
  - Ø CDMU scoe
  - Ø ACSM scoe
  - Ø I.EGSE
  - Ø CCS

Activity:

- Vacuum phase
- Cooling phase
- Thermal cycling phase
- Instruments test phase
- Chamber pressurisation
- Chamber opening
- Chamber inspection
- Satellite (SFT) before chamber exit

S/C exit Transport to Estec Duration Ambience	PFM Refer to schedule on chapter §5.4 Class 100000

Goal : Satellite exit from the chamber.
Satellite preparation before transport from CSL to Estec

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø Satellite on the thermal dolly inside the chamber
  - Ø MPT
  - Ø TF-PGSE and helium 3 and 4 isotopes (by HFI)
  - Ø ISSS-PGSE (HFI)

- Electrical configuration / EGSE required :
  - Ø N/A

Activity:

- All test equipment disconnection
- Thermocouples dismounting
- Shrouds dismounting
- Tests MLI & STM SA external part removal
- Satellite transfer to the MPT
- He ¾ tanks draining and storage configuration by HFI
- Protective cover installation
- All test equipment reconnection : LGA 1 &2, dilution exhaust pipe dis-mounting ..
- S/C preparation before transport
  - 4K cooler lock, covers protection management …
- Container and satellite instrumentation
- S/C transfer into its container
- S/C transport to CSL
- Container opening in airlock
- S/C transfer on MPT
- EGSE/MGSE packing

SA FM mounting / alignment check, Fine balancing & RCS global leak Duration Ambience	PFM Refer to schedule on chapter §5.4 Class 100000

Goal : Perform S/C final physical tests

Specimen configuration :

- LSS test facility and balancing E5 table
- Mechanical configuration / MGSE required :
  - Ø Satellite completely integrated on MTP
  - Ø S/C vertical hoisting device
  - Ø Masses balancing
  - Ø BRA
  - Ø RCS TGSE, leak tools, Krypton and Nitrogen
  - Ø Krypton reference leak and spectrometer
  - Ø Theodolites and dedicated alignment tools
  - Ø FM SA
  - Ø SA MGSE stand and fixing tool
- Electrical configuration / EGSE required (for SFT):
  - Ø N/A

Activity:

- External FM SA mounting
- Alignment reference
  - S/C vertical hoisting, SC axis determination
  - ACMS equipments reference position
  - Thrusters position
  - Telescope/FPUs/Reflectors reference positions
- S/C transfer inside the LSS
- S/C preparation before fine balancing runs
  - 4K cooler lock, covers protection management …
- Fine balancing measurement under vacuum and masses adjustment
- S/C transfer to clean-room
- S/C preparation before RCS global leak
  - RCS filling in Nitrogen & Krypton
  - 4K cooler lock, covers protection management …
- S/C transfer inside the LSS
- RCS global leak measurement
- S/C transfer to clean-room

SFT after balancing, RCS draining ACU electrical & mechanical fit check IST2 and SVT 2 S/C launch preparation Duration Ambience	PFM Refer to schedule on chapter §5.4 Class 100000

Goal : Perform final functional tests before satellite delivery

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø Satellite completely integrated on MPT
  - Ø RCS TGSE and leak tools
  - Ø S/C container
  - Ø S/C vertical hoisting device
  - Ø ACU from Arianespace with dedicated GSE

- Electrical configuration / EGSE required :
  - Ø Power scoe
  - Ø TM/TC DFE
  - Ø ACSM scoe
  - Ø TTC RF scoe
  - Ø CDMU scoe
  - Ø I.EGSE
  - Ø CCS
  - Ø NDIU for SVT1#2 (under ESA responsibility)

Activity:

- SFT S/C health-check (Antennae, SAS & AAD, CRS, FOG, SREM checks, SA flood test
- RCS draining and functional check after RCS global leak, including gas flow test
- S/C transfer on ACU for fit-check
- IST 2
- SVT 2
- S/C launch transport preparation
  - External SA dis-mounting
  - S/C cleaning
  - 4K cooler lock, covers protection management …
  - Container and satellite instrumentation
- S/C transfer into its container
- S/C transfer for launch campaign
- EGSE/MGSE packing & transfer for launch campaign

5.3 Tests Matrixes

This chapter details the list of tests specifications performed during the AIT sequence .
Some of tests are performed in continuous during the AIT Flow :

Satellite power On/Off	H-P-3-ASP-TS-xxxx
Equipments/components with limited cycle	H-P-3-ASP-TS-0987
S/C consumption trend analysis	H-P-3-ASP-TS-1005
Battery monitoring on ground	H-P-3-ASP-TS-0988
S/C Transport	H-P-3-ASP-TS-0980

		PFM1		PFM						
	Activity within phase	PFM1 integration	SCS R functional & Thermal balance tests	PFM integration, IST & SVT, EMC	Physical properties	Mechanical vibrations tests	Post vibrations/Pre-Cryogenic tests	Cryogenic & thermal cycling tests	Post cryogenic tests, IST	Launch campaign
Test description	Test Spec n°									
Mecha. Tests										
Alignement										
Thruster alignement	H-P-3-ASP-TS-0888			X	(if neces.)					
SC axes determination	H-P-3-ASP-TS-0880		X	X			X		X	
SC alignement check (includ. SA shadow check)	H-P-3-ASP-TS-0884			X			X		X	
Assembled telescope alignment check	H-P-ASP-TS-xxxx			X						
MCI & Balancing										
Mass, Centring, Inertia measurment	H-P-3-ASP-TS-0761		(mass, centring)		X					
Fine balancing test (under vac.)	H-P-3-ASP-TS-0761								X	
Balancing at ambiant test	H-P-3-ASP-TS-0761				X					
Vibrations tests										
Sine & acoustic & shock vibrations tests	H-P-3-ASP-TS-0890					X				
µ vibration test	H-P-3-ASP-TS-0890				X					

figure 28: Mechanical tests matrix

		PFM1		PFM						
	Activity within phase	PFM1 integration	SCS R functional & Thermal balance tests	PFM integration, IST & SVT, EMC	Physical properties	Mechanical vibrations tests	Post vibrations/Pre-Cryogenic tests	Cryogenic & thermal cycling tests	Post cryogenic tests, IST	Launch campaign
Test description	Test Spec n°									
System Tests										
Launcher I/F										
ACU Electricla & Mechanical fit check	H-P-3-ASP-TS-0864								X	
ACU harness Preliminary Electrical fit check	H-P-3-ASP-TS-0864			X						
EMC										
Conducted EMC test	H-P-3-ASP-TS-0820			X						
Radiated EMC test	H-P-3-ASP-TS-0820			X						
Autocomp. RF test (including LFI & TTC RF)	H-P-3-ASP-TS-0820			X						
Planck instrument IST/EMC specification	H-P-3-ASP-TS-1084			X			X		X	
Telescope RFambiant Test	H-P-3-ASP-TS-0896			X						
Thermal Tests										
Mini IST (PFM1)	H-P-SP-AI-0077	X	(X partial before)							
Functional check (PFM1)	H-P-3-ASP-TN-1076		X (before)							
SCS Functional test under vacuum	H-P-3-ASP-TS-xxxx		X							
Planck PFM#1 Thermal Test	H-P-3-ASP-TS-0883		X							
MLI emisivity control	H-P-3-ASP-TN-1042		X(before /after)					X(before /after)		
S/C Thermal cycling & Autocomp. & Cryogenic test	H-P-3-ASP-TS-0893							X		
Planck instruments TV test	H-P-3-ASP-TS-xxxx							X		
SC PFM1 Emergency Mode	H-P-3-ASP-TS-1067		X							
SC Emergency Mode	H-P-3-ASP-TS-xxxx							X		
Vibrations tests										
S/C launch config. (including 4K lock)	H-P-3-ASP-TS-xxxx					X			X	
IST										
IST S/C (modes checks, from launch to Science Observation, including reconfiguration, survival & FDIR)	H-P-3-ASP-TS-0881			X V			X V	X (partial)	X V	
Launch Phase, Launch Clean Run and Launch Sequence Robustness	ASP-06-AIT-AVIO-PL-0010xx ASP-06-AIT-AVIO-PL-0090xx ASP-06-AIT-AVIO-PL-0110xx			x			x		x	
Separation & Post Separation Activities	ASP-06-AIT-AVIO-PL-0010xx			x			x		x	
S/C Commissioning	ASP-06-AIT-AVIO-PL-0020xx						x		[2]	
Instrument Commissioning and Performance Verification	ASP-06-AIT-AVIO-PL-0030xx						x		x	
Mode Transition	ASP-06-AIT-AVIO-PL-0040xx			x			x		x	
S/C Reconfiguration	ASP-06-AIT-AVIO-PL-0050xx						x		x	
MTL Management	ASP-06-AIT-AVIO-PL-0060xx			x			x		x	
DTCP Worst Case Scenario	ASP-06-AIT-AVIO-PL-0070xx			x			x		x	
Routine Mission Scenario	ASP-06-AIT-AVIO-PL-0080xx			x			x		x	
Degraded Modes	ASP-06-AIT-AVIO-PL-0100xx						x		x	
Nominal Modes Robustness	ASP-06-AIT-AVIO-PL-0120xx			x			x		x	
SVT										
Listen-in test	ESOC	X		X >					>X	
SVT	ESOC	X		X					X	

figure 29: System tests matrix

		PFM1		PFM						
	Activity within phase	PFM1 integration	SCS R functional & Thermal balance tests	PFM integration, IST & SVT, EMC	Physical properties	Mechanical vibrations tests	Post vibrations/Pre-Cryogenic tests	Cryogenic & thermal cycling tests	Post cryogenic tests, IST	Launch campaign
Test description	Test Spec n°									
Functional Tests #1										
TTC-RF										
LGA connection (& switch) test	AAS-F			X	X		X	X	X	
MGA connection (& switch) test	AAS-F			X	X		X	X	X	
TM Frequency	AAS-I (TM/TC SIT)			(at svm level)			X		X	
TM power	AAS-I (TM/TC SIT)			(at svm level)					X	
TC lock maintenance	AAS-I (TM/TC SIT)			(at svm level)					X	
TM/TC operation (including MGA via MM)	AAS-I (SVM IST)			X(funct)	X(funct)		X(funct)	X(funct)	X	
Transponder Health Check	AAS-I (TM/TC SIT)			X	X	X(TM on)	X		X	
TWTA Health Check	AAS-I (TM/TC SIT)			X	X	X(TM on)	X		X	
TM near band spurious	AAS-I (TM/TC SIT)			(at svm level)					X	
ACMS	H-P-3-ASP-TN-1180									
ACC health test	AAS-I	X	X	X	X	X(TM on)	X		X	
STR health test	AAS-I	X	X	X	X		X		X	
AAD & SAS health test	AAS-I	X	X	X	X		X		X	
CRS health test	AAS-I	X	X	X	X	X(TM on)	X		X	
RCS health test	AAS-I	X	X	X	X		X		X	
RCS (fluidic)										
Pressure transducer calibration test	TN on RILAM procedure reusing			(at svm level)		(TM on)			(post GL)	
LV mechanical/electrical status	TN on RILAM procedure reusing			(at svm level)		(TM on)	X		(post GL)	
Valve (FDV, FVV, TP) leak test	TN on RILAM procedure reusing			(at svm level)		X (Post filling)	X (Post drying)		(post GL)	
Thrusters external leak test	TN on RILAM procedure reusing			(at svm level)			X (Post drying)		(post GL)	
Gaz flow test	TN on RILAM procedure reusing			(at svm level)			X (optional)		(post GL)	
Global Leak test	H-P-3-ASP-TS-0897								X	
Simulation liquid filling /pressurisation	H-P-1-ASP-TS-0892					X				
Tank drying & cleaning	H-P-3-ASP-TS-0889						X			
Safety test (in Kourou)	H-P-3-ASP-TS-xxxx									X
Hydrazine filling /pressurisation	H-P-3-ASP-TS-xxxx									X
Hydrazine unfilling	H-P-3-ASP-TS-xxxx									
TCS										
PLM ATC-SVM Electrical Integration Spec	H-P-3-ASP-TS-1169			X						
ATC health check (incldng PML & SVM)	H-P-3-ASP-TS-1172	X	X	X	X		X	X	X	
CDMS	HCT by AAS-I proc. or ST commisioning test									
CDMU health test	AAS-I	X	X	X	X	X(TM on)	X		X	
PCS										
BTY on ground operation	H-P-3-ASP-TS-xxxx					X				
SA flood test	H-P-3-ASP-TS-xxxx			X			X		X	
SA flasher tests	H-P-3-ASP-TS-xxxx						X			
Others										
FOG health test	SCI-PT/33527 included in ACMS SIT			X	X		X		X	
SREM health test	SCI-PT/35132 Iss 2	X	X	X	X		X		X	
MTDs electrical integration (PAU/BEU/DAE)	H-P-3-ASP-TS-0984	X								

figure 30: Functional tests matrix #1

		PFM1		PFM						
	Activity within phase	PFM1 integration	SCS R functional & Thermal balance tests	PFM integration, IST & SVT, EMC	Physical properties	Mechanical vibrations tests	Post vibrations/Pre-Cryogenic tests	Cryogenic & thermal cycling tests	Post cryogenic tests, IST	Launch campaign
Test description	Test Spec n°									
Functional Tests #2										
SCS										
PACE electrical check (connection)	H-P-3-ASP-TS-1183	X		X						
FM SVM - SCE Electrical integration	H-P-3-ASP-TS-1131	X		X						
SVM-SCE Electrical integration	H-P-3-ASP-TS-0981	X		X						
Functionnal test at Ambient (SFT)	H-P-3-ASP-TS-0983	X	X							
Sorption cooler Subsystem Health Test Requirement	H-P-3-ASP-TS-1126			X	X		X		X	
Leak measurment	H-P-3-ASP-TS-0883		X							
Leak measurment	H-P-3-ASP-TS-0893							X		
LFI										
Electrical integration REBA vs SVM I/F	H-P-3-ASP-TS-1112			X						
Electrical integration REBA UFT	PL-LFI-PST-PR-015									
LFI-DAE Power box -SVM Electrical Integration	H-P-3-ASP-TS-1220			X						
LFI short functional test	PL-LFI-PST-PR-018			X	X		X		X	
LFI full warm functional test	PL-LFI-PST-PR-017			X					X	
HFI Detection Chain										
Electrical integration DPU vs SVM I/F (& UFT)	H-P-3-ASP-TS-1113 PR-PH740-600334-IAS			X						
Electrical integration REU vs SVM I/F	H-P-3-ASP-TS-1201			X						
Electrical integration DPU with REU (& UFT)	PR-PHCB-600280-IAS			X						
Electrical check PAU/REU	PR-PH740-600817-IAS			X						
Electrical check REU vs PAU / J-FET & FPU	PR-PH740-600773-IAS			X						
Electrical check REU/ FPU	PR-PH740-600734-IAS			X						
HFI 0.1K Cooler										
Electrical integration DCE/DCCU vs SVM IF	H-P-3-ASP-TS-1204			X						
Electrical integration DPU/DCCU & 0.1K harness	PR-PH740-500557-IAS			X						
0.1K UFT/SFT				X	X		X		X	
0,1 K Fill & Purge (include pres. & depres.)	HFI			X						
Global leak test	HFI			X			X			
GSU Proof pressure test @ 442.5b	TP-PHEZVC-400553-AIRL			X						
Leak measurment	H-P-3-ASP-TS-0893							X		
Tank filling for Mechanical test & storage	HFI			X			X	X		
Isotopes Tank filling & presurisation	HFI							X		
Isotopes Tank de-presurisation	HFI							X		
HFI 4K Cooler										
Electrical int. CDE & CRU vs SVM I/F (& UFT)	H-P-3-ASP-TS-1149									
Elect. Int. DPU vs CDE /CAU / CRU + 4K harness	HFI									
Helium Fill and purge 4K	HFI									
4K cooler UFT / SFT	PR-PHD-600165-IAS			X	X		X		X	
Global leak test	HFI			X			X			
Leak measurment	H-P-3-ASP-TS-0893							X		
HFI										
HFI Warm Short/Full Functional Test (W-S/FFT)	PR-PH740-600718-IAS			X	X		X		X	

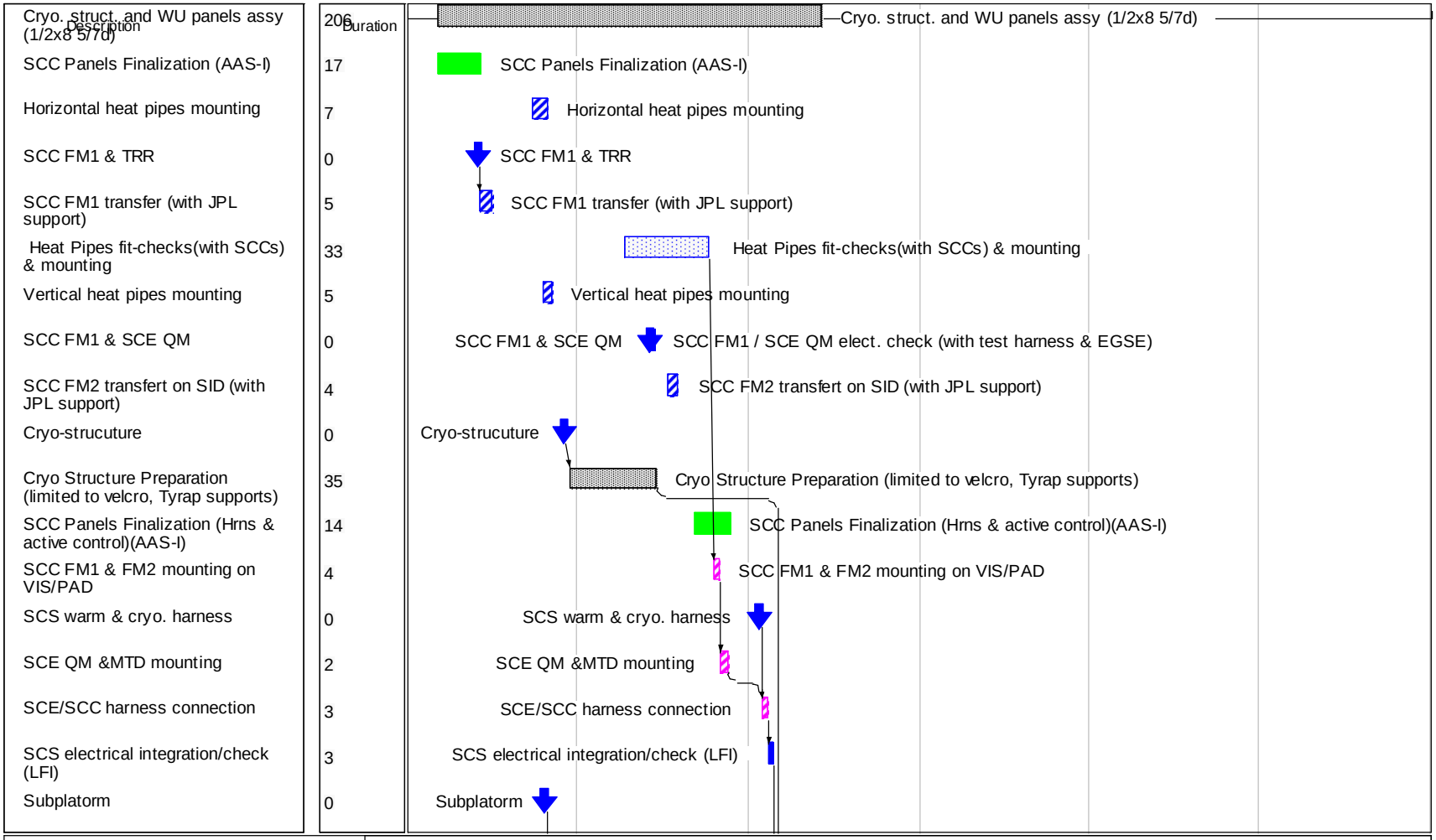
figure 31: Functional tests matrix #2

5.4 Schedule

Schedule is given only for information, showing a logic flow and typical duration activity.

Planck PFM 1

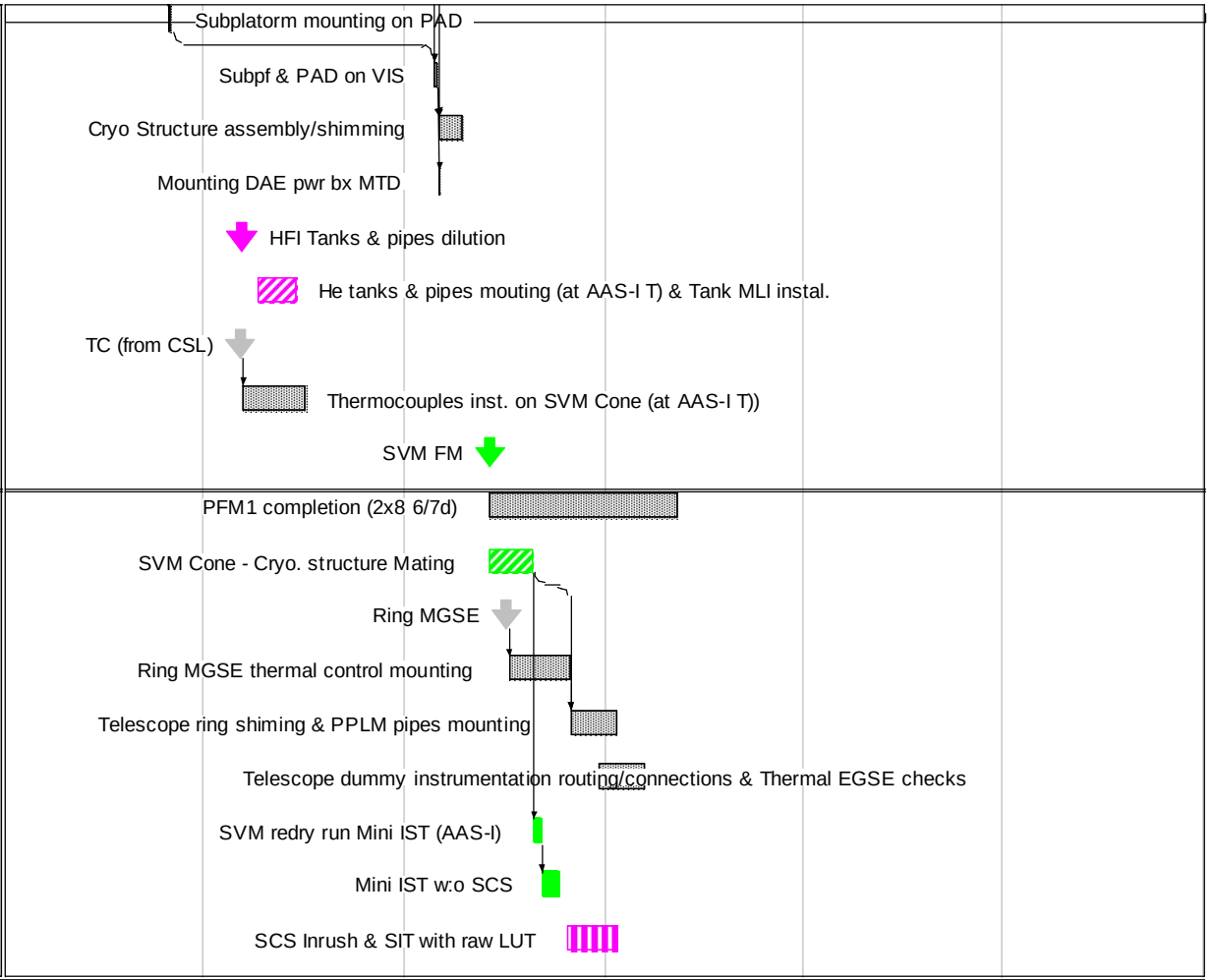
1



Planck PFM 1

2

Description	Duration
Subplatorm mounting on PAD	2
Subpf & PAD on VIS	1
Cryo Structure assembly/shimming	10
Mounting DAE pwr bx MTD	1
HFI Tanks & pipes dilution	0
He tanks & pipes mouting (at AAS-I T) & Tank MLI instal.	16
TC (from CSL)	0
Thermocouples inst. on SVM Cone (at AAS-I T))	25
SVM FM	0
PFM1 completion (2x8 6/7d)	86
SVM Cone - Cryo. structure Mating	16
Ring MGSE	0
Ring MGSE thermal control mounting	24
Telescope ring shiming & PPLM pipes mounting	13
Telescope dummy instrumentation routing/connections & Thermal EG	21
SVM redry run Mini IST (AAS-I)	4
Mini IST w:o SCS	7
SCS Inrush & SIT with raw LUT	14



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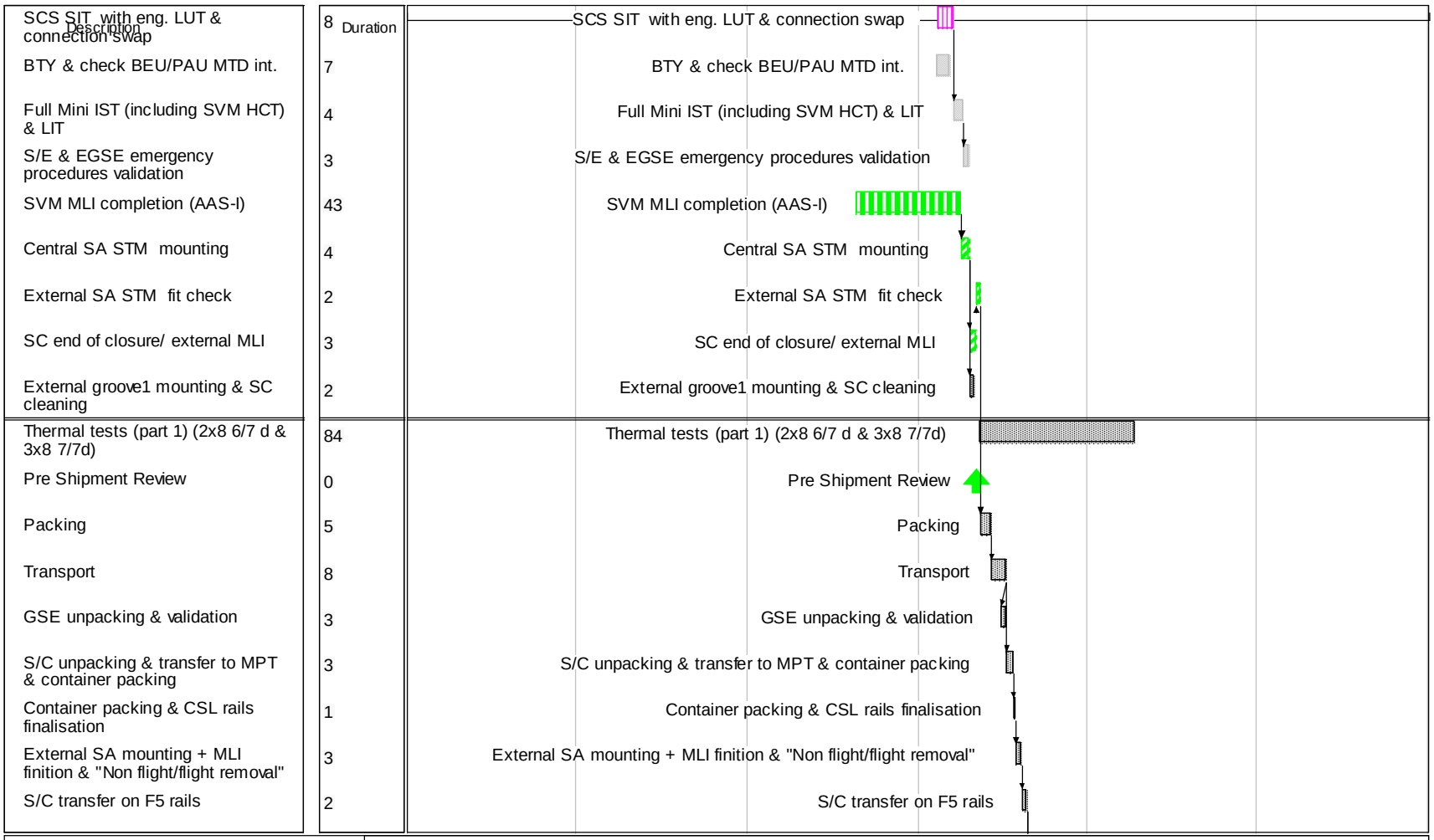
Référence du modèle : M023-3

Planck PFM 1

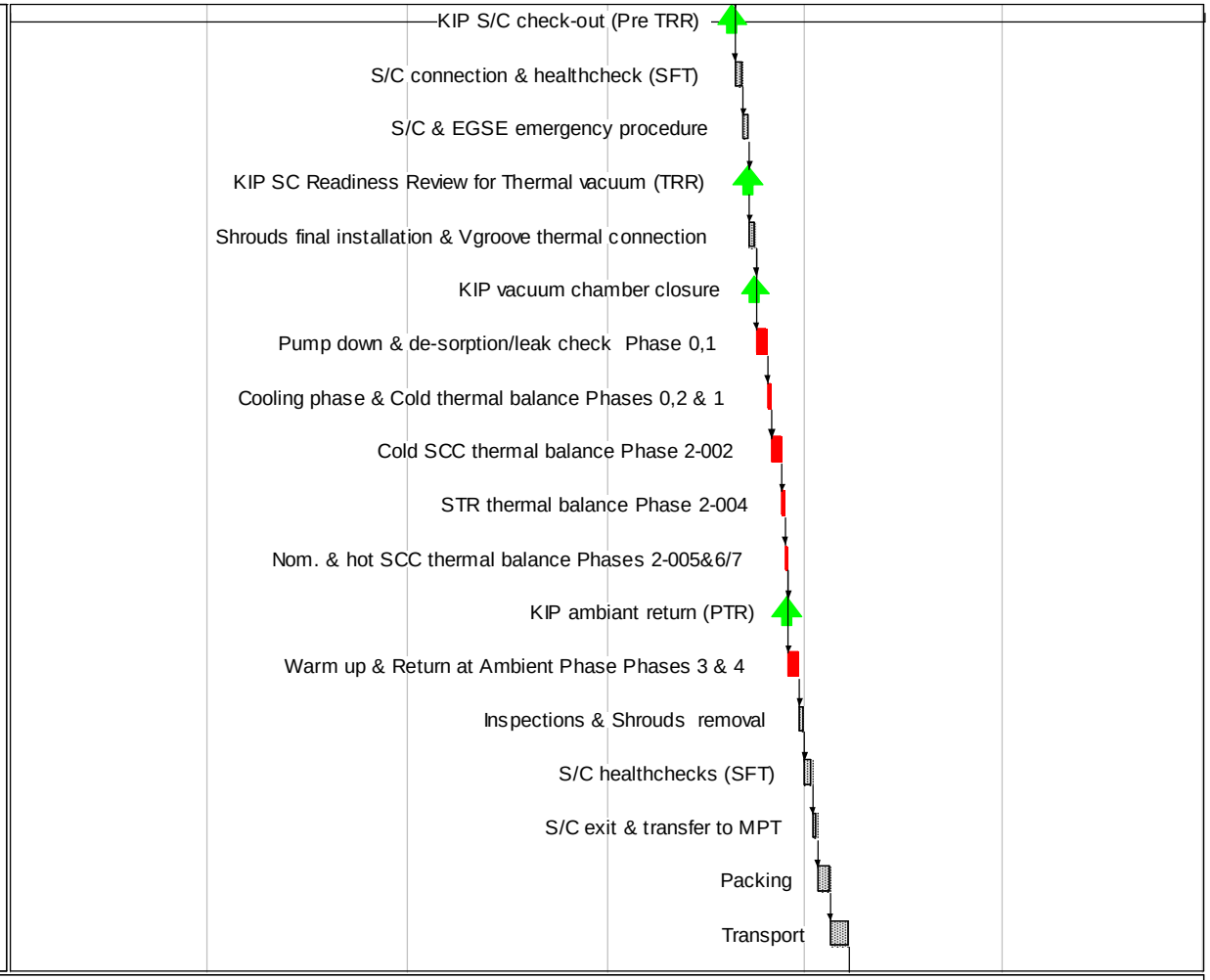
3



Planck PFM 1

4

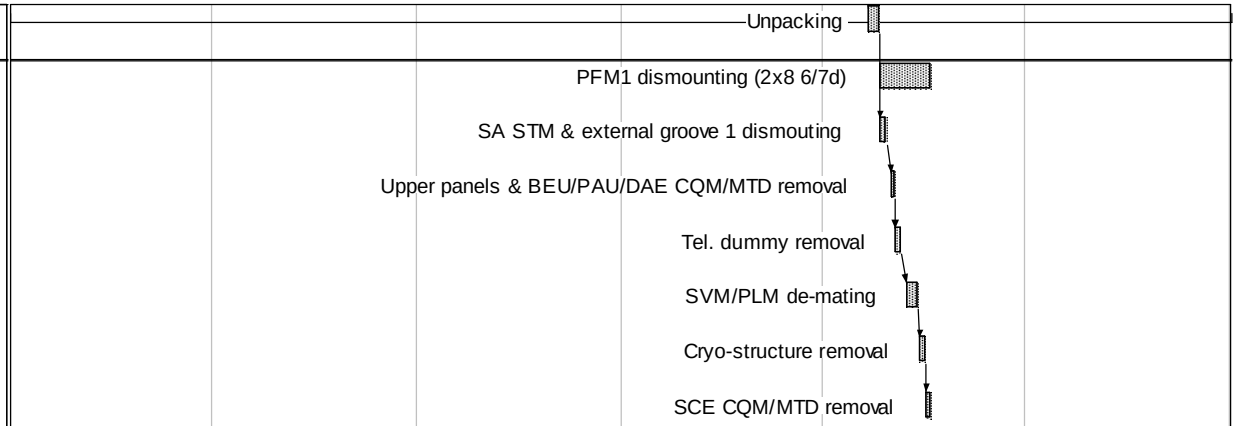
Description	Duration
KIP S/C check-out (Pre TRR)	0
S/C connection & healthcheck (SFT)	4
S/C & EGSE emergency procedure	2
KIP SC Readiness Review for Thermal vacuum (TRR)	0
Shrouds final installation & Vgroove thermal connection	3
KIP vacuum chamber closure	0
Pump down & de-sorption/leak check Phase 0,1	5
Cooling phase & Cold thermal balance Phases 0,2 & 1	2
Cold SCC thermal balance Phase 2-002	5
STR thermal balance Phase 2-004	1
Nom. & hot SCC thermal balance Phases 2-005&6/7	2
KIP ambiant return (PTR)	0
Warm up & Return at Ambient Phase Phases 3 & 4	5
Inspections & Shrouds removal	2
S/C healthchecks (SFT)	3
S/C exit & transfer to MPT	2
Packing	5
Transport	9



Planck PFM 1

5

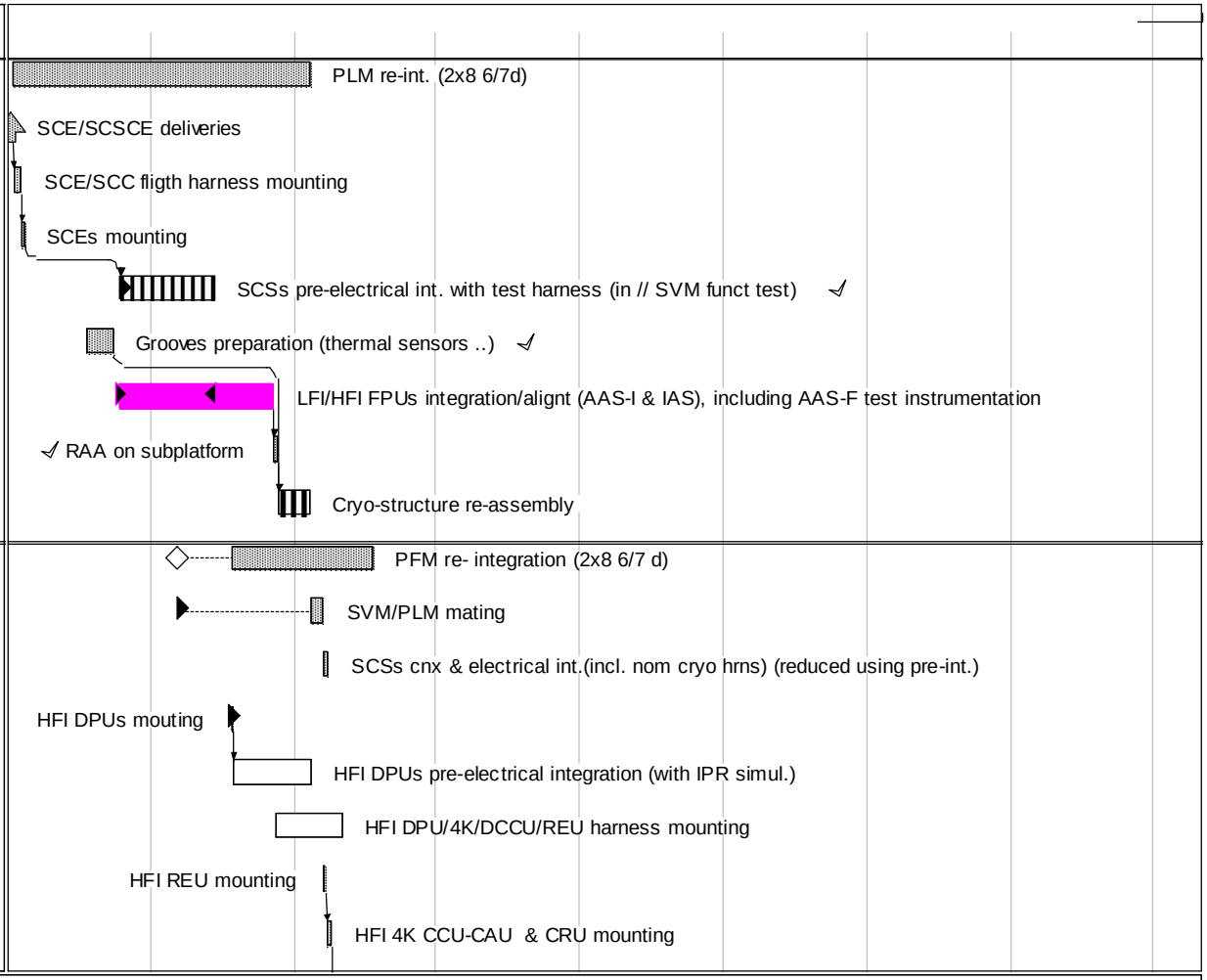
Description	Duration
Unpacking	4
PFM1 dismounting (2x8 6/7d)	18
SA STM & external groove 1 dismouting	3
Upper panels & BEU/PAU/DAE CQM/MTD removal	2
Tel. dummy removal	3
SVM/PLM de-mating	5
Cryo-structure removal	3
SCE CQM/MTD removal	2



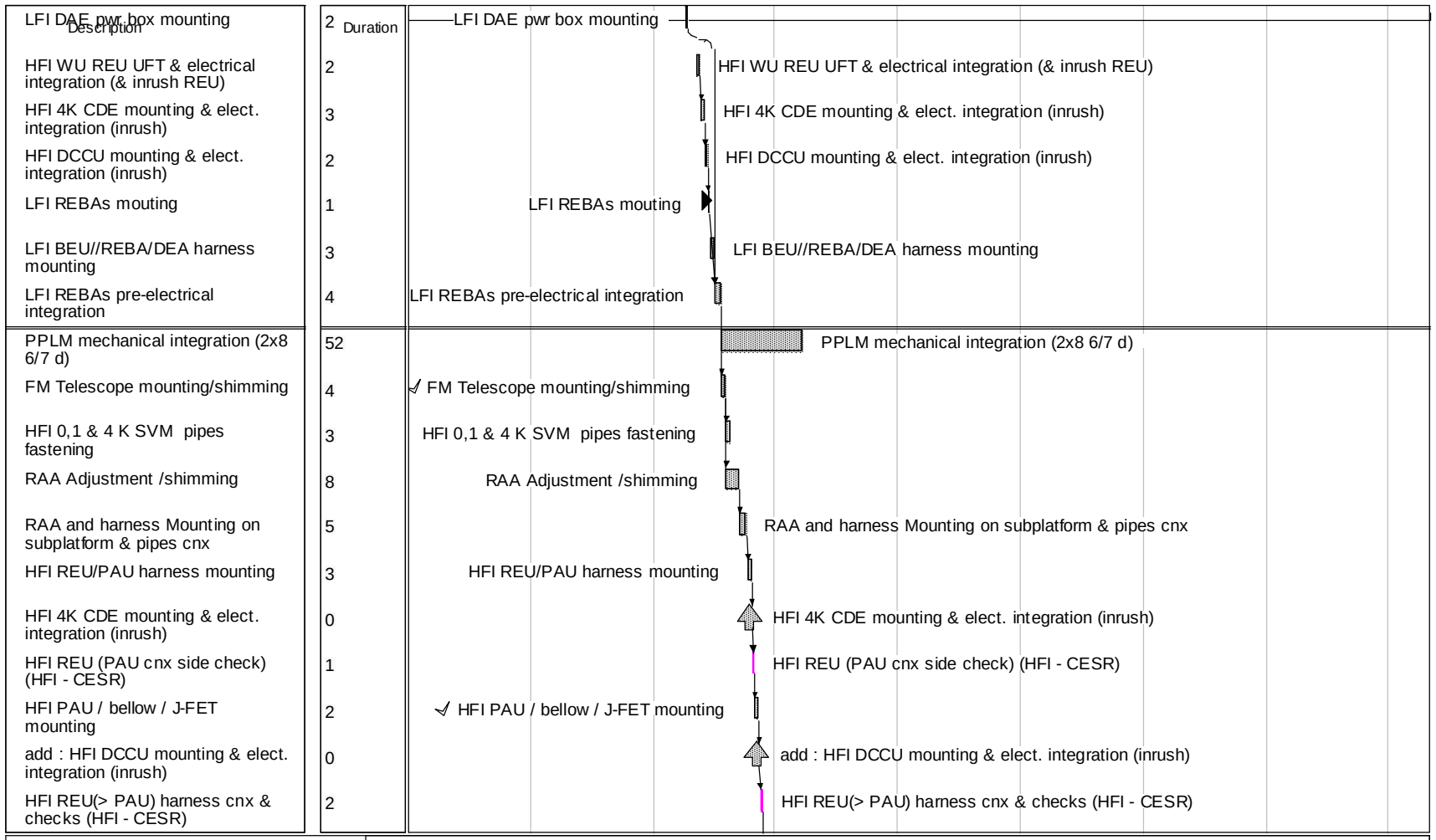
Planck PFM

1

Description	Duration
PLM re-int. (2x8 6/7d)	152
SCE/SCSCE deliveries	0
SCE/SCC fligth harness mounting	4
SCEs mounting	2
SCSs pre-electrical int. with test harness (in // SVM funct test)	51
Grooves preparation (thermal sensors ..)	15
LFI/HFI FPUs integration/alignt (AAS-I & IAS), including AAS-F te	83
RAA on subplatform	3
Cryo-structure re-assembly	10
PFM re- integration (2x8 6/7 d)	70
SVM/PLM mating	8
SCSs cnx & electrical int.(incl. nom cryo hrns) (reduced using pre	2
HFI DPUs mouting	1
HFI DPUs pre-electrical integration (with IPR simul.)	36
HFI DPU/4K/DCCU/REU harness mounting	30
HFI REU mounting	1
HFI 4K CCU-CAU & CRU mounting	3

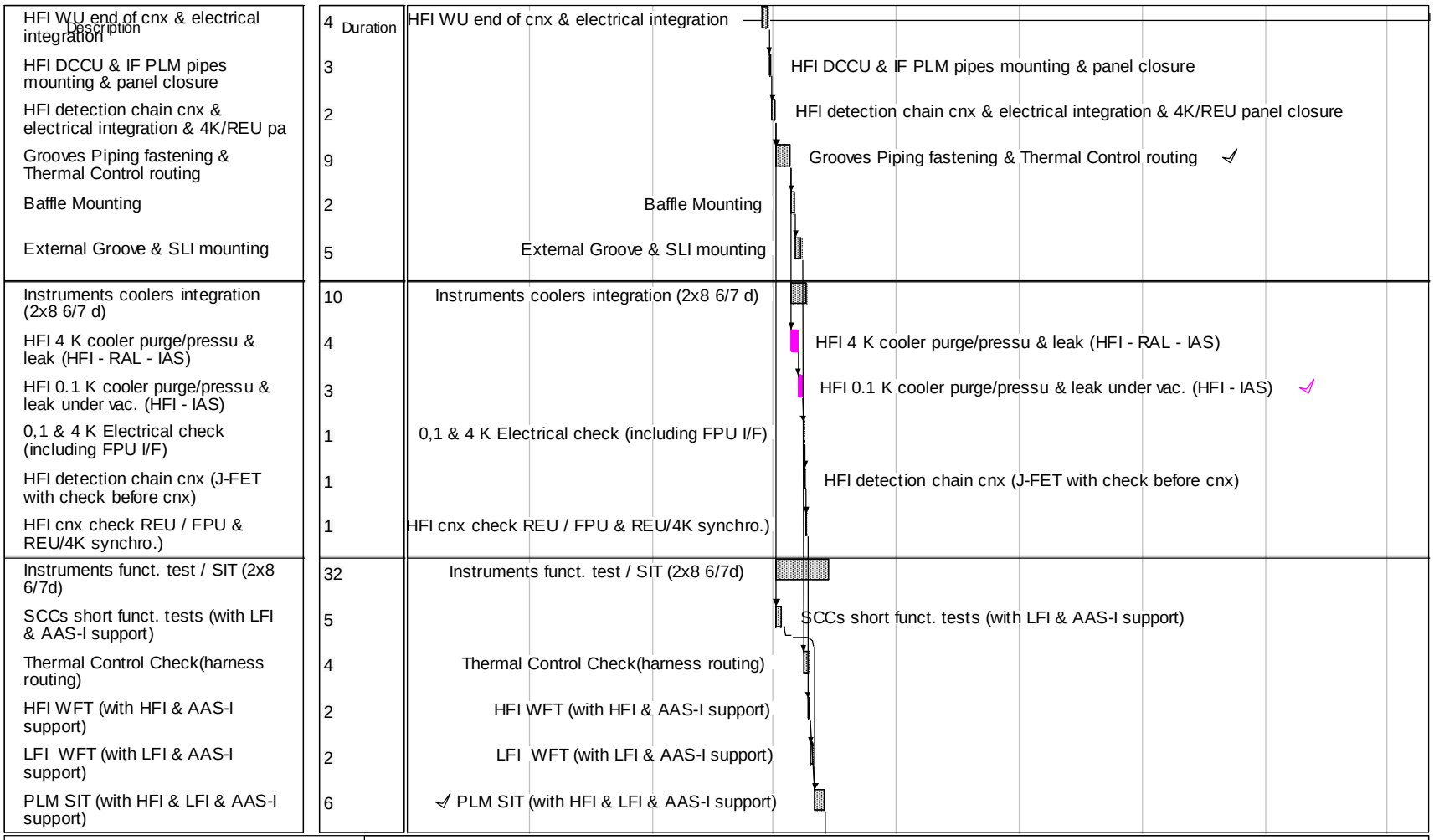


Planck PFM



Planck PFM

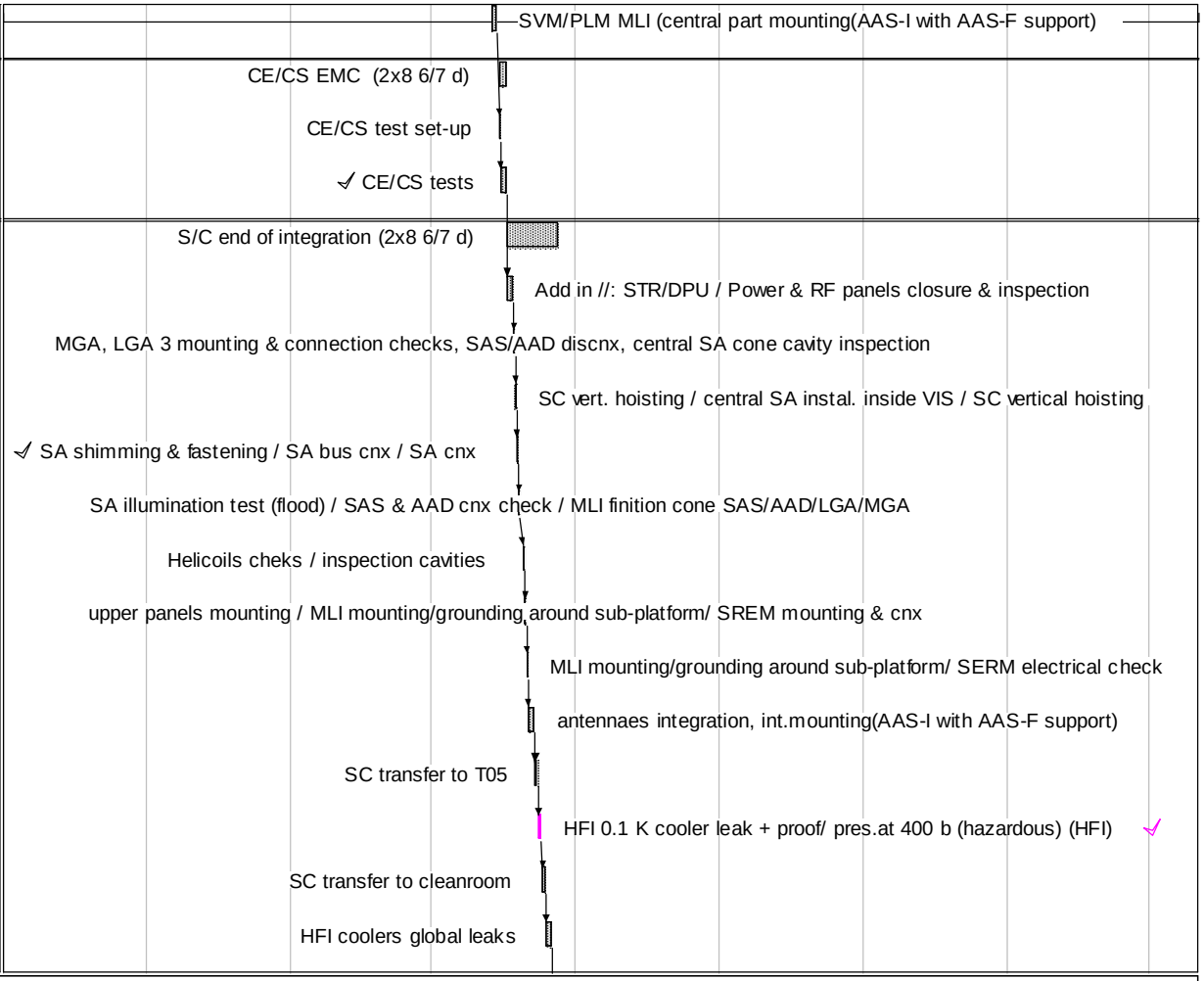
3



Planck PFM

4

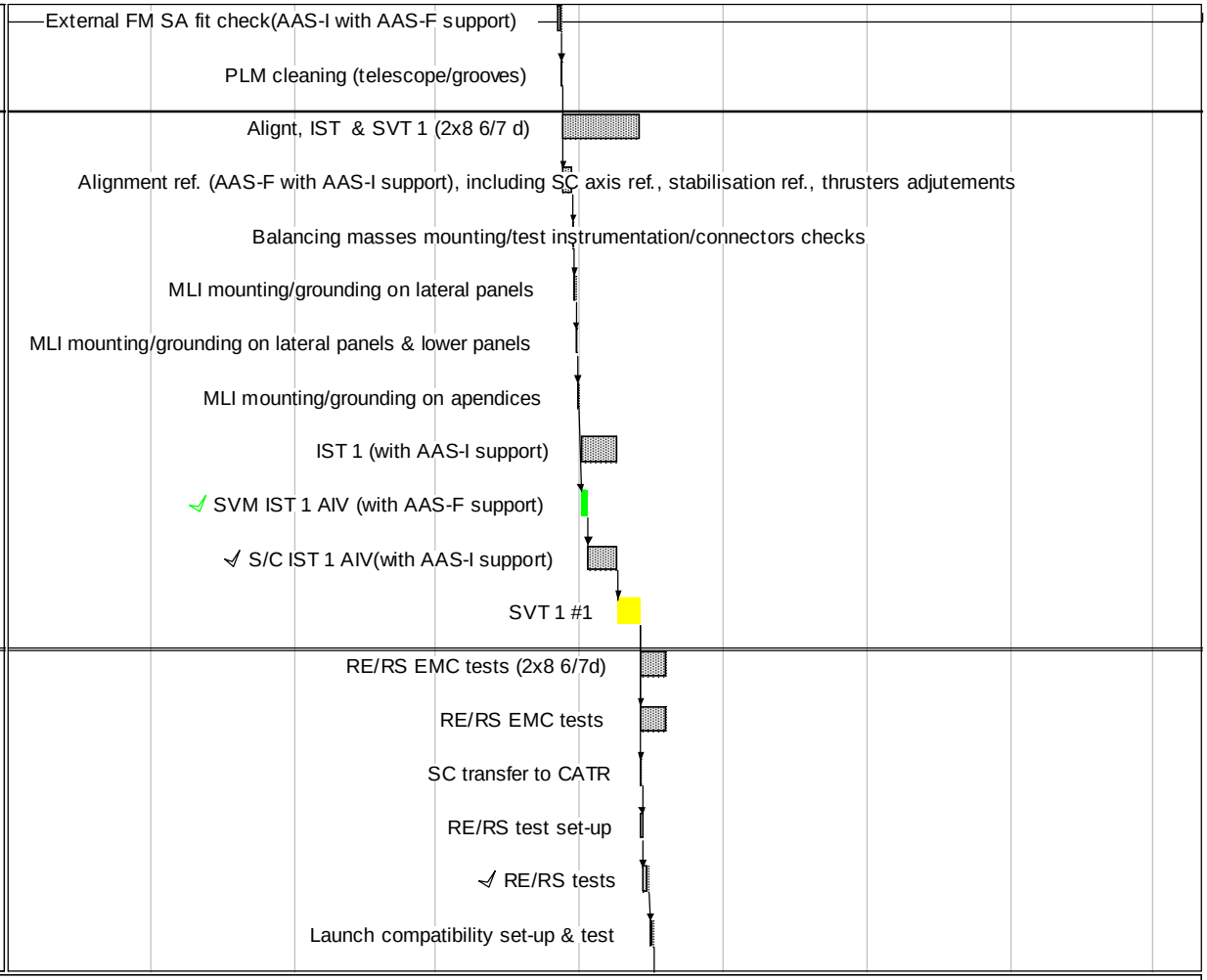
Description	Duration
SVM/PLM MLI (central part mounting(AAS-I with AAS-F supp	3
CE/CS EMC (2x8 6/7 d)	4
CE/CS test set-up	1
CE/CS tests	3
S/C end of integration (2x8 6/7 d)	27
Add in //: STR/DPU / Power & RF panels closure & inspection	3
MGA, LGA 3 mounting & connection checks, SAS/AAD dis	1
SC vert. hoisting / central SA instal. inside VIS / SC vertical hoi	1
SA shimming & fastening / SA bus cnx / SA cnx	1
SA illumination test (flood) / SAS & AAD cnx check / MLI finition co	1
Helicoils cheks / inspection cavities	1
upper panels mounting / MLI mounting/grounding around sub-pl	1
MLI mounting/grounding around sub-platform/ SERM electrical che	1
antennaes integration, int.mounting(AAS-I with AAS-F su	4
SC transfer to T05	2
HFI 0.1 K cooler leak + proof/ pres.at 400 b (hazardous) (HFI)	2
SC transfer to cleanroom	2
HFI coolers global leaks	4



Planck PFM

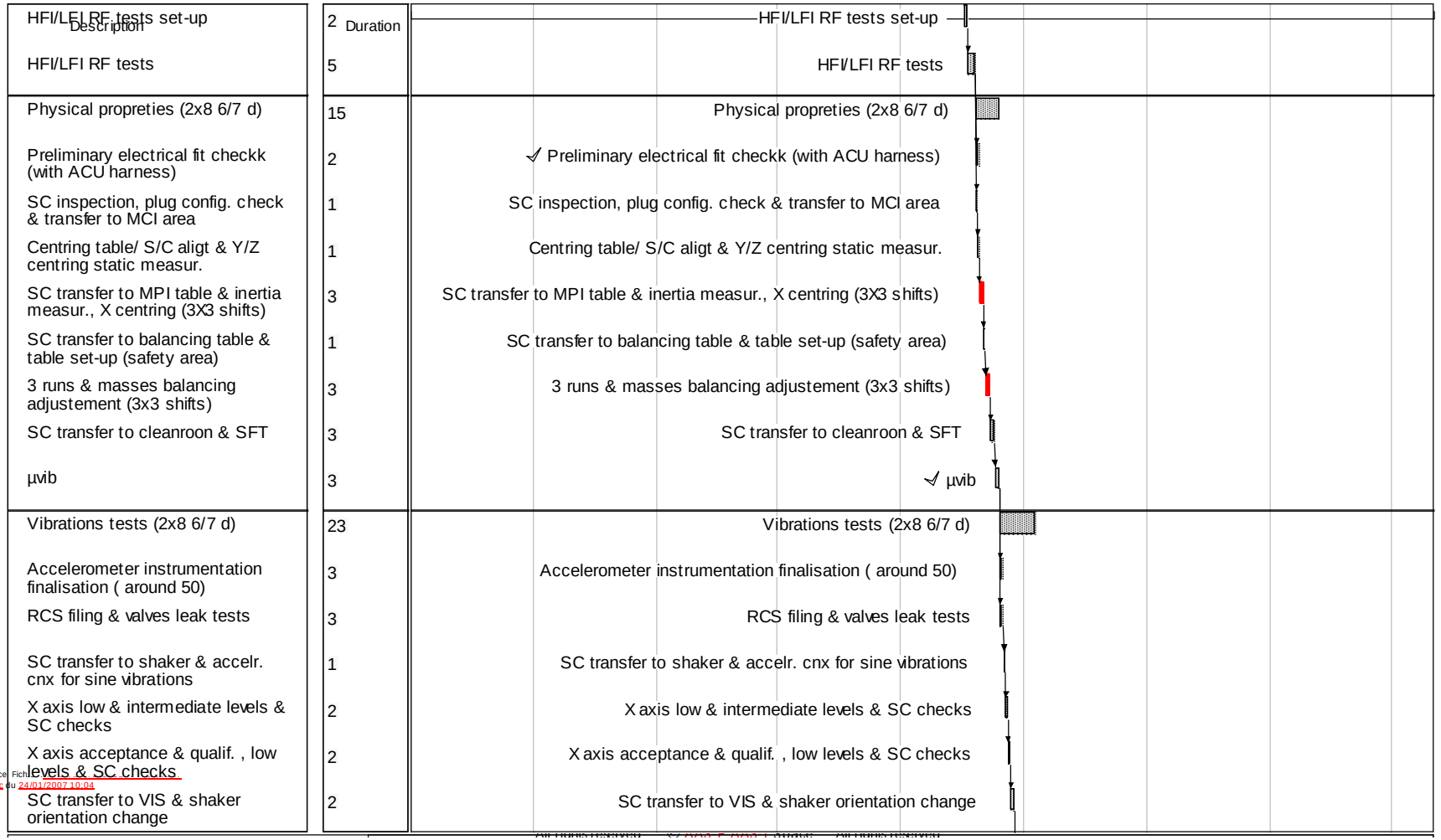
5

Description	Duration
External FM SA fit check(AAS-I with AAS-F support)	2
PLM cleaning (telescope/grooves)	1
Alignt, IST & SVT 1 (2x8 6/7 d)	49
Alignment ref. (AAS-F with AAS-I support), including SC axis ref., st	5
Balancing masses mounting/test instrumentation/connectors check	1
MLI mounting/grounding on lateral panels	1
MLI mounting/grounding on lateral panels & lower panels	1
MLI mounting/grounding on apendices	1
IST 1 (with AAS-I support)	20
SVM IST 1 AIV (with AAS-F support)	5
S/C IST 1 AIV(with AAS-I support)	15
SVT 1 #1	10
RE/RS EMC tests (2x8 6/7d)	14
RE/RS EMC tests	14
SC transfer to CATR	1
RE/RS test set-up	1
RE/RS tests	3
Launch compatibility set-up & test	2



Planck PFM

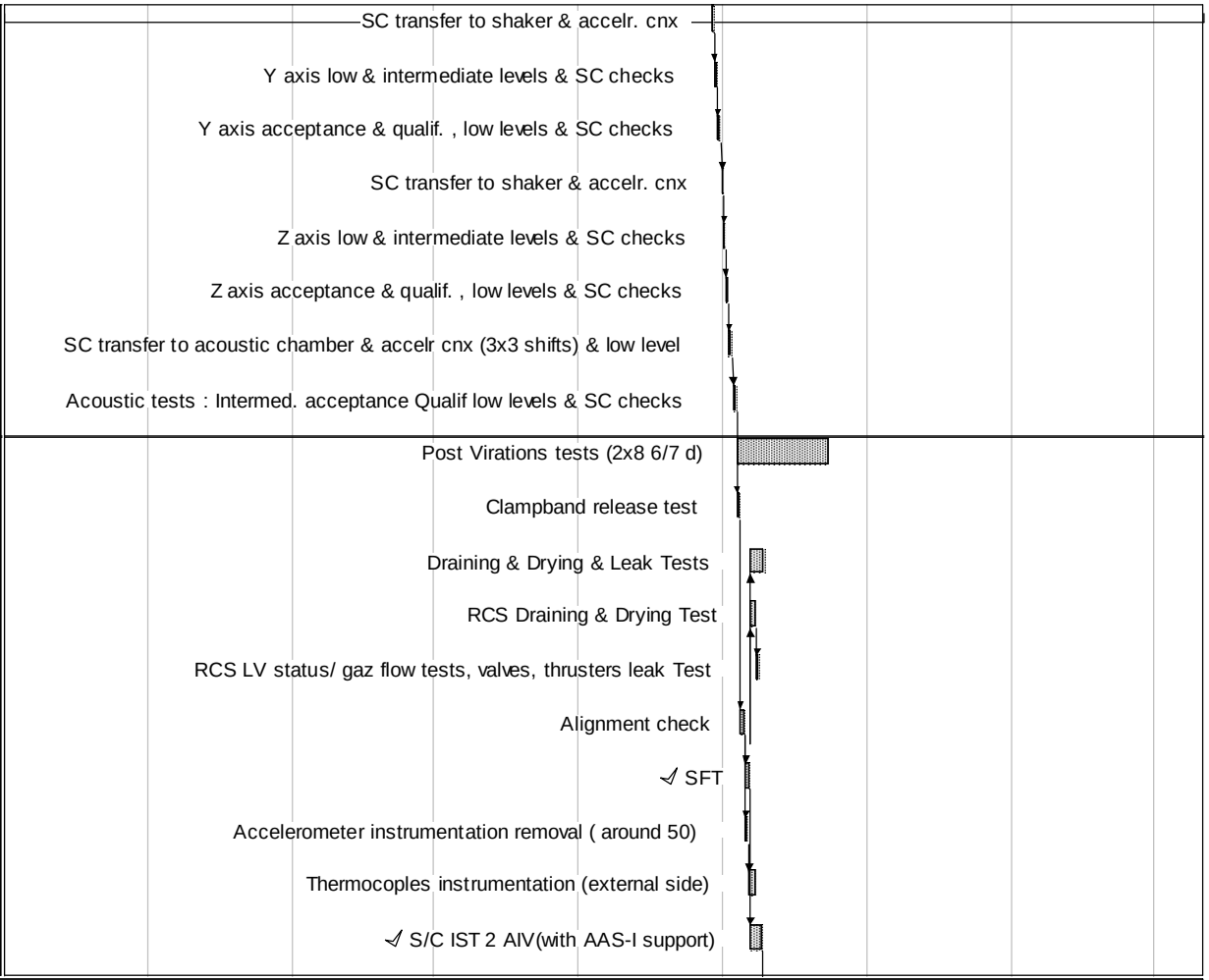
6



Planck PFM

7

Description	Duration
SC transfer to shaker & accelr. cnx	1
Y axis low & intermediate levels & SC checks	2
Y axis acceptance & qualif. , low levels & SC checks	2
SC transfer to shaker & accelr. cnx	1
Z axis low & intermediate levels & SC checks	1
Z axis acceptance & qualif. , low levels & SC checks	2
SC transfer to acoustic chamber & accelr cnx (3x3 shifts) & low lev	2
Acoustic tests : Intermed. acceptance Qualif low levels & SC	2
Post Virations tests (2x8 6/7 d)	59
Clampband release test	2
Draining & Drying & Leak Tests	8
RCS Draining & Drying Test	3
RCS LV status/ gaz flow tests, valves, thrusters leak Test	2
Alignment check	3
SFT	3
Accelerometer instrumentation removal (around 50)	2
Thermocoples instrumentation (external side)	4
S/C IST 2 AIV(with AAS-I support)	7



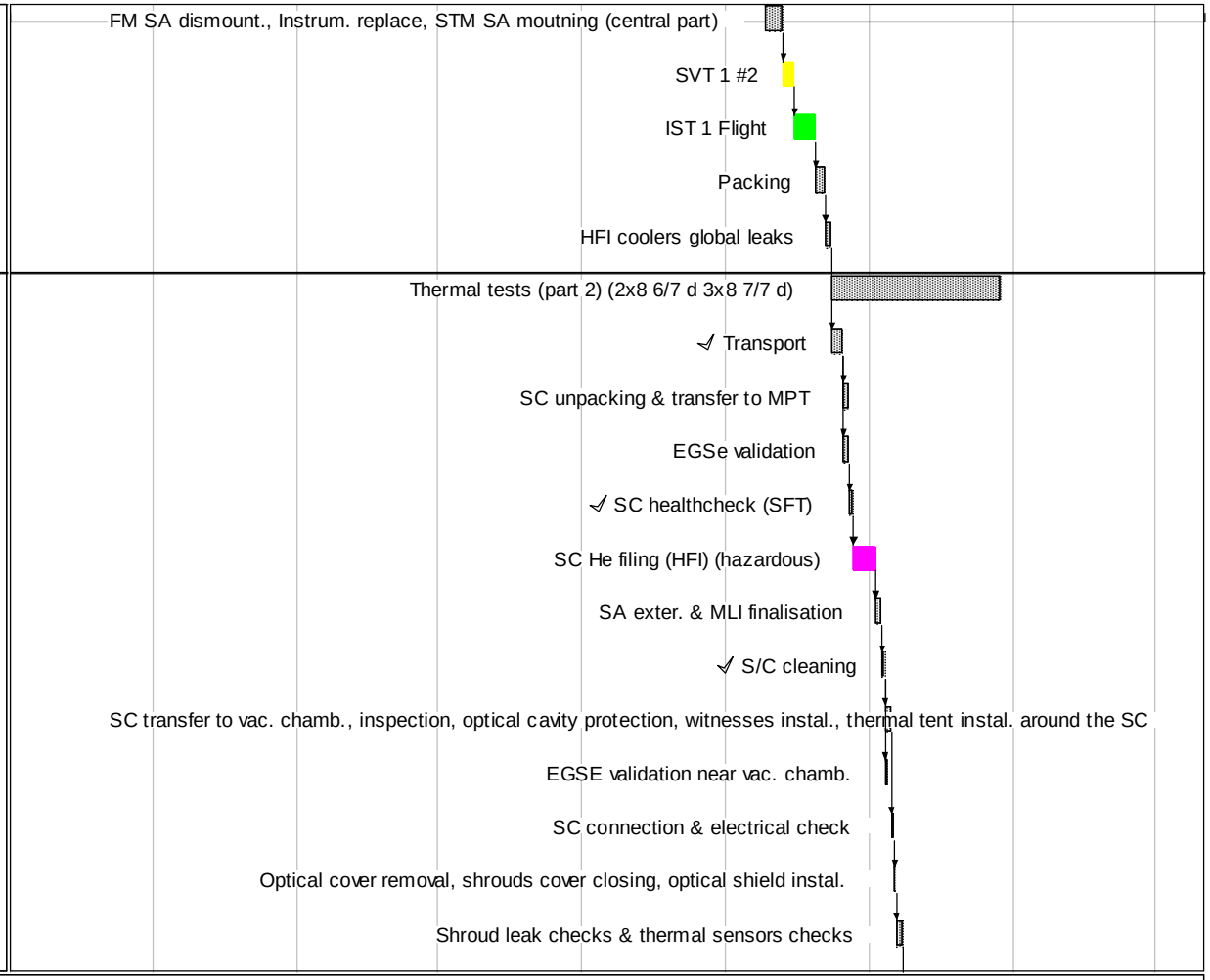
Référence Fichier :HP_3_ASP_PL_0208_4_Planck_AIT_Plan.mpp du 24/01/2007 10:04

Référence du modèle : M023-3

Planck PFM

8

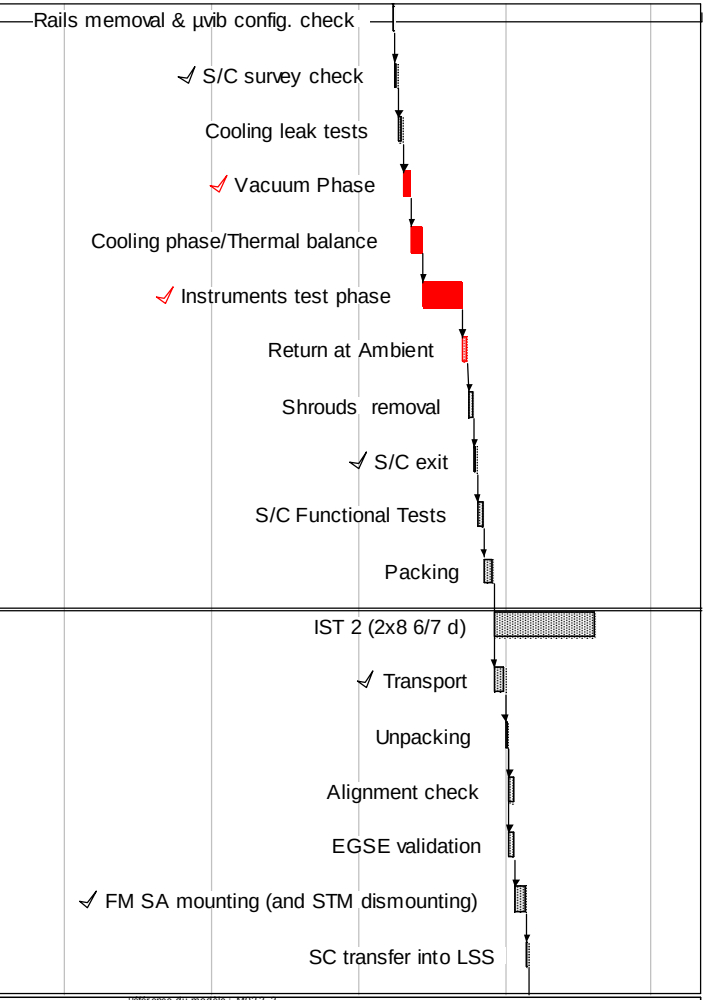
Description	Duration
FM SA dismount., Instrum. replace, STM SA moutning (centr	8
SVT 1 #2	5
IST 1 Flight	12
Packing	5
HFI coolers global leaks	4
Thermal tests (part 2) (2x8 6/7 d 3x8 7/7 d)	108
Transport	7
SC unpacking & transfer to MPT	3
EGSe validation	3
SC healthcheck (SFT)	3
SC He filing (HFI) (hazardous)	4
SA exter. & MLI finalisation	3
S/C cleaning	2
SC transfer to vac. chamb., inspection, optical cavity protectio	3
EGSE validation near vac. chamb.	2
SC connection & electrical check	2
Optical cover removal, shrouds cover closing, optical shield instal.	1
Shroud leak checks & thermal sensors checks	3



Planck PFM

9

Description	Duration
Rails memoval & µvib config. check	1
S/C survey check	3
Cooling leak tests	2
Vacuum Phase	5
Cooling phase/Thermal balance	7
Instruments test phase	25
Return at Ambient	3
Shrouds removal	3
S/C exit	2
S/C Functional Tests	3
Packing	5
IST 2 (2x8 6/7 d)	64
Transport	7
Unpacking	3
Alignment check	3
EGSE validation	3
FM SA mounting (and STM dismounting)	6
SC transfer into LSS	1



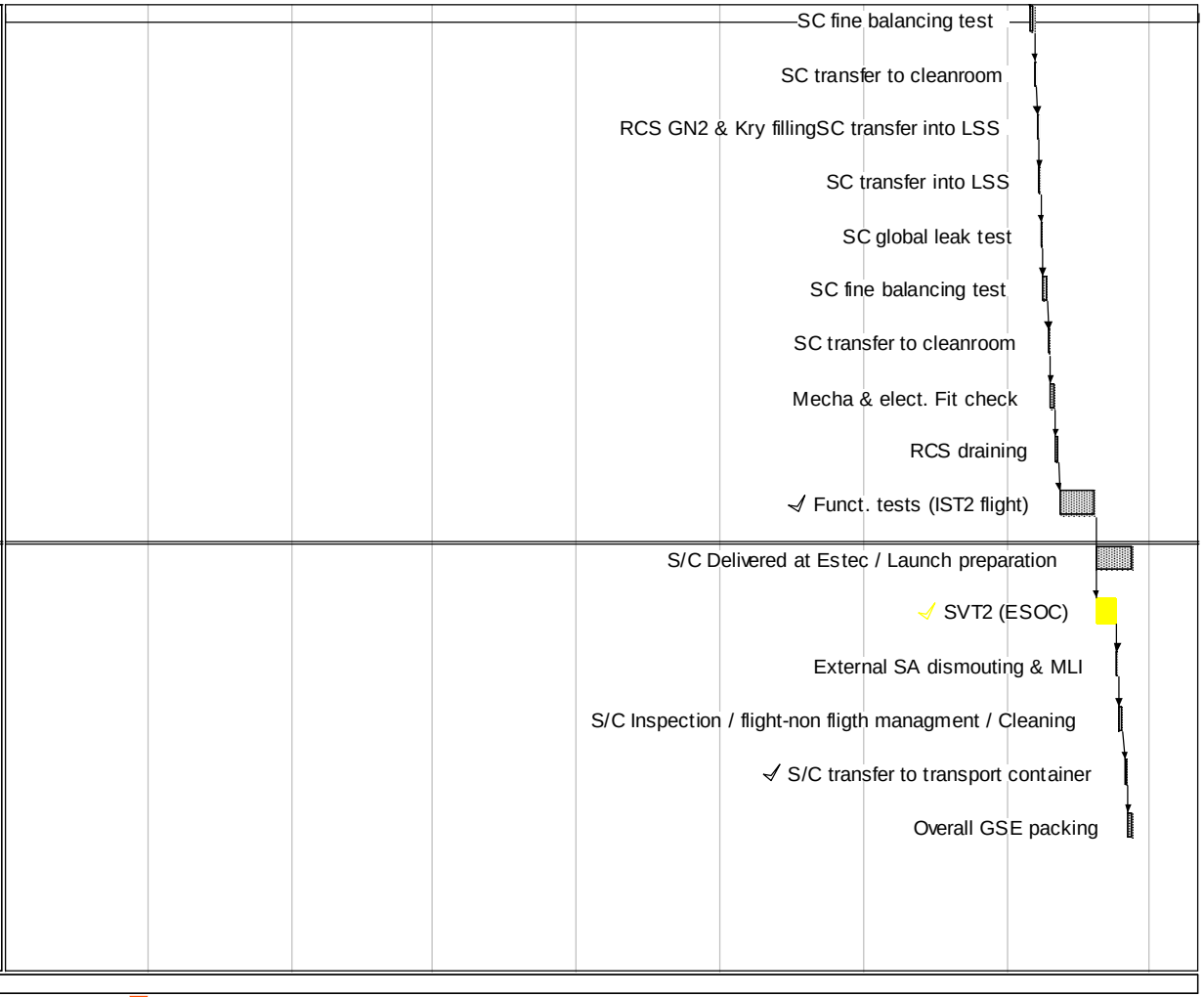
Référence Fichier : HP_3_ASP_PL_0208_4_Planck_AIT_Plan.doc du 24/01/2007 10:04

Référence du modèle : M023-3

Planck PFM

10

Description	Duration
SC fine balancing test	3
SC transfer to cleanroom	1
RCS GN2 & Kry fillingSC transfer into LSS	1
SC transfer into LSS	1
SC global leak test	1
SC fine balancing test	3
SC transfer to cleanroom	1
Mecha & elect. Fit check	3
RCS draining	2
Funct. tests (IST2 flight)	20
S/C Delivered at Estec / Launch preparation	24
SVT2 (ESOC)	10
External SA dismouting & MLI	1
S/C Inspection / flight-non fligth managment / Cleaning	3
S/C transfer to transport container	2
Overall GSE packing	3



6. MANAGEMENT AND ORGANISATION

6.1 AIT TASKS

AAS-F is in charge of system level AIT.
The main tasks to be performed under the AIT organisation are the following:

- definition and sequencing of system tests and operations
- detailed planning of AIT activities
- daily event scheduling and briefing
- determination of test methods
- specification of user's requirements of GSE and check-out software
- management and co-ordination of GSE and central check-out software development for P.PLM integration and Planck satellite tests.
- preparation of test procedures
- installation, validation, verification and maintenance of system level GSE
- co-ordination and preparation of test facilities
- preparation of test set-up
- organisation of test reviews
- execution of AIT operations
- reporting of AIT operations
- preparation and issue of test reports
- determination and on site management of AIT team and technical support.

6.2 AIT ORGANISATION

6.2.1 AIT team

For all these activities AAS-F will use an AIT team raising specialists of different engineering specialities already involved to the maximum extent in subsystem or module level testing in AAS-F and other companies. That means that the composition of AIT team will be modified according to the AIT phase in order to be always adequate to the task. A close attention will be paid to management and technical supervision tasks of GSE and Check-out software which will be carried-out by the EGSE and the MGSE Managers belonging from the beginning to the system AIT team.

The AIT team will be directed by the AAS-F AIT responsible supported by Test engineers.

6.2.1.1 Preliminary phase

This concerns the AIT activities to be performed early in the AIT program, before starting the module or system level operations:

- definition and sequencing of system tests and operations
- preparation of AIT plans and subsystem test plans
- supervision of GSE design and development
- interfaces.

During this phase, as the AIT team does not include any test engineer specifically responsible for each subsystem, the AIT manager will be able to call upon technical support of specialists in AIT Department on one side and PLANCK engineering team on the other side. So the AIT organised as described in Figure here under will be mainly restricted to GSE (MGSE, EGSE and software) engineers as permanent members.

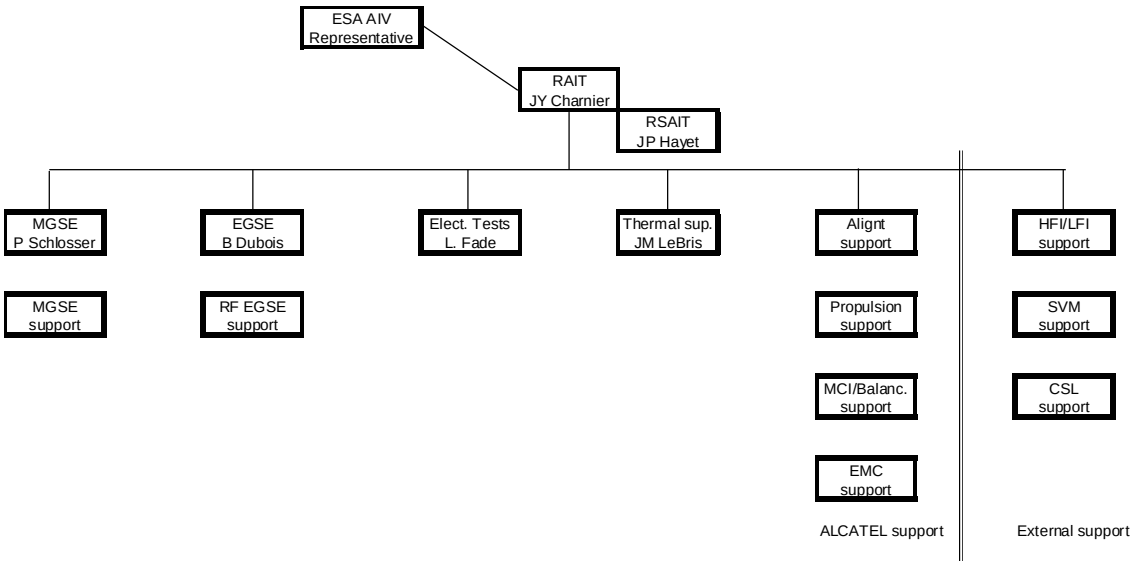


Figure 32: AIT team organisation for preliminary phase

6.2.1.2 Operational phase

The AIT team, will be charged with doing all preparation and adaptation tasks from module level to system level. So the AIT team constituted as defined previously for preliminary phase will be progressively increased by addition of operation personnel (operators, technicians, test engineers...) from AAS-F (and by incorporation of personnel coming from other Contractors in PLANCK system test activities). This integrated team will be under the authority of the AAS-F AIT Manager (RAIT / RSAIT)

6.2.1.3 Operational AIT team

The baseline hypothesis for the scheduled activities is that the work will be organised in one shift operation; some activities will be performed in double or triple shift (as thermal tests for example). This kind of organisation may be used for mechanical and electrical integration tasks, mechanical electrical or thermal preparation operations, functional and performance test phases, provided that no test engineers and operators other than the AIT team specialists are required. Of course, all the AIT team members are properly trained and authorise to do their works.

The team is managed by the RAIT / RSAIT with the helps of mechanical & electrical responsible. The team comprises mainly the electrical and mechanical operators required for performing general electrical and mechanical tasks (including EGSE operation). This team will be able to :

- switch on/off the satellite
- send commands and test sequences from the CCS
- receive and monitor TM and other parameters
- run test sequences and send stimuli from SCOE's
- connect/disconnect any on board cable
- mount/dismount any on board unit
- hoist and handle the flight hardware
- assemble/disassemble the modules and mechanical items.

According to the task to be performed the technical support of other test engineers could further increase the teams for the duration of the dedicated operation .

A typical operational team function included:

- test conductor (in charge of the test procedure execution) with the help of CCS conductor, if needed.
- mechanical engineer with the help of electrical and mechanical operators.
- quality controller.

During the nominal working timetable the complete management and technical AIT team is available, to support the operational team who is in charge of the satellite:

- AIT manager/test managers
- EGSE and test software engineers
- subsystem test engineers (not directly concerned by the test running)
- responsible for procedures
- AIT QA engineer

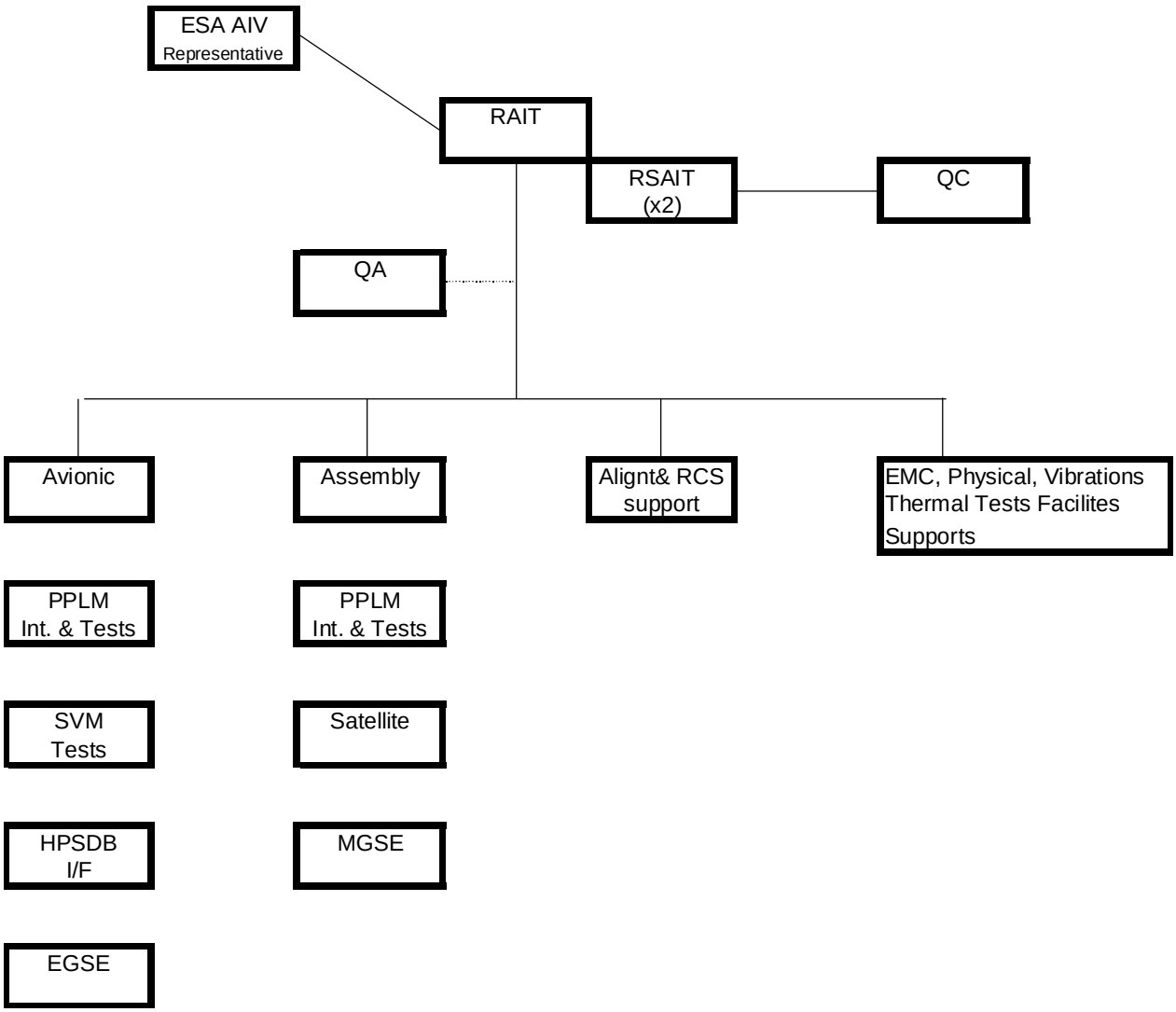


Figure 33: AAS-F AIT core team

6.2.2 AIT responsibility

The AAS-F AIT Manager is responsible for definition, organisation, preparation, execution and reporting of all system level AIT activities and associated tasks including GSE and C/O software management. The AAS-F AIT responsible directly reports to the AAS-F Project Manager.

He has to organise and co-ordinate the necessary manpower effort such as the engineering support of AAS-F and other companies. He co-ordinates the selection and use of test facilities.

He participates in planning, co-ordination and progress meetings as responsible for co-ordination and planning for system level AIT activities, related documentation and GSE.

He is supported for conduction of operational tasks (electrical, mechanical, and alignment operations) by Test Manager more specially in charge of technical aspects of testing.

He is assisted by an EGSE manager for system EGSE and C/O software management and by an MGSE Manager for MGSE and test facilities management.

They are responsible for maintenance, availability, readiness and verification of GSE, C/O software and test facilities for all planned activation within the domain of: electrical, mechanical operations.

For each specific test, a Test Conductor will be selected amongst the different test engineers, according to the test to be performed and taking into account their competences and technical specialities. For some particular testing phases (thermal test for instance) it will be necessary to nominate several test conductors for double shift (2 x 8) or triple shift (3 x 8) work. The test conductor will be responsible for operational test team management (other test engineers and operators) and for test execution, he will be answerable to the test manager and the AIT manager.

The test engineers and operators coming from other companies are considered as members of AIT team and are under complete supervision of AAS-F AIT manager. They have to execute any committed task (in the framework of their competency), to report results and incidents to the AIT manager/Test manager, to enforce all AIT rules, instructions and practices. They could be appointed test conductor for specific tasks, considered in certain cases as technical support, or integrated if necessary into operational teams.

6.2.3 HFI and LFI teams responsibility

For the PFM model, HFI and LFI teams will be involved in the AIT phases. HFI and LFI teams will be in charge of:

- Delivery of all documentation needed for AIT (ICD, user's manual, data sheets, task sheets, procedures). AAS-F help for the test requirement sheets writing.
- All HFI and LFI MIB files delivery for HPSDB populating.
- HFI will perform :
  - Cryo-harness (detection chains and coolers) connection
  - 0,1 & 4 K coolers pipes connection, leak, purge, filling tests and valves locking
  - HFI detection chain(REU/PAU/J-FET electrical checks
  - Helium tanks filling with He3 and/or He4
- JPL will perform SCC valves locking
- Test follow-up when HFI and LFI unit's are involved.
- HFI and LFI GSE set-up and using.
- The data process after UFT, IST, SIT, SFT, SVT.

6.2.4 Interfaces with the ESA project team

As responsible for system level AIT the AAS-F AIT Manager is in close communication with the ESA project representatives and is the only official authorised interface between them and the AIT team. In particular he maintains close contacts with the ESA AIT Manager, informs him of AIT schedules, activity flow and any deviation w.r.t. the planned operations.
The Test manager is in charge of the satellite during a delimited test phase (Electrical integration, Mechanical tests...) He acts on the authority of the AIT/manager for all technical aspects of the test phase which he is entrusted with. The test manager is responsible for supervision of tests performed under the direct responsibility of the test conductors, in particular he has to take steps to ensure that all AIT requirements are fulfilled and all quality requirements enforced.

He has to report during the daily meeting all technical aspects of the tests, the day by day organisation and all practical problems or unexpected events that could occur. He fills in the daily log sheets and the working copy of the Master test procedure.

6.2.5 QA responsibility

The QA engineer assures the compliance between the satellite and the definition files, the AIT plan, the test matrix. He is in charge of the Assurance Product of the GSE, he is in charge of the Assurance Quality of all the process's and all the test equipments used during the AIT phase.
His main functions are:

- to verify that AIT team is working following the quality rules defined by AAS-F
- to organise the TRR/PTR (with the RS AIT)
- to check the coherency between the definition files and the AIT procedure. He approves the procedures.
- to participate to the "risk analysis " meetings
- to manage the MIP, the KIP
- to check the compliance of the test results versus the expected results defined in the procedure
- to manage the satellite configuration
- to manage the NCR's, the open work's status

6.3 MANAGEMENT OF AIT TASKS

6.3.1 General AIT rules

The following is an outline of general rules, standard practices, procedures adopted throughout the whole integration and test activities to ensure a controlled and safe conduction of all tasks to be performed before, during and at the conclusion of AIT operations.

- Preparation activities

Before starting any AIT activity the following status shall be verified:

- Ø availability of all required test documentation of the last approved issue and distribution to all team members who have to make use of it
- Ø control of GSE installation and validation results, instruments calibration status, compliance with all required test configurations
- Ø preparation of daily activity planning, based on a master AIT procedure, with the identification of required personnel, task duration, data analysis
- Ø clear definition of task assignments to each member to the team with identification of responsibilities, autonomy and where decisions have to be deferred to higher level
- Ø availability and good knowledge of any applicable emergency procedure to be applied in case of hazardous situations for either personnel or flight hardware.
- Ø NCR's / open work status

- During test operations

Any AIT operation shall be performed in conformity with the following rules and practices:

- Ø all test operations are conducted only according to approved procedures and in the presence of a QC representative
- Ø operations to be performed are confirmed at a daily briefing, normally held each morning before starting the daily activities
- Ø access to test areas is restricted only to a limited number of authorised personnel
- Ø tests and operations are supervised by a Test Manager and performed by a Test Conductor appointed by the AIT Manager and nobody else is allowed to operate the satellite or ask deviations from the test sequence that have not been requested and approved during daily reviews
- Ø any non conformance has to be immediately raised and analysed before authorising proceeding with testing
- Ø any approved deviation from a baseline procedure is recorded on the daily activity log together with the justification for the change using the AIT change request (ACR).

- Conclusion of test operations

At the end of any AIT activity the following verifications and operations will be performed:

- Ø verification that all required tasks have been performed and that results are approved and signed by the responsible engineer

- Ø collection and archiving of all test results
- Ø analysis of deviations, schedule impacts, work around solutions to be presented at the next daily briefing
- Ø at the end of the working day, the EGSE and flight hardware are set in a known and safe configuration, unattended operation is not allowed on the flight hardware.

6.3.2 Supervision of AIT tasks through the AIT documents

Planning and supervision of AIT activities are done through a number of official documents sent to the customer or which can be examined on the site by his representative. The documents under AIT responsibility and those under QA responsibility are interdependent, therefore we will refer here to the two types of documentation.

- The control of AIT activities is done from documents under AIT responsibility:
  - Ø AIT weekly planning and report
  - Ø AIT log sheet
  - Ø Test procedures (Red line working copy As run procedure)
  - Ø All AIT forms used for change recording during tests
  - Ø Test reports.

- The configuration is normally followed up by means of documents under QA responsibility:
  - Ø "As built" register
  - Ø Electrical connection register
  - Ø Non conformance forms when issued.

The diagram of operational utilisation of different AIT forms :

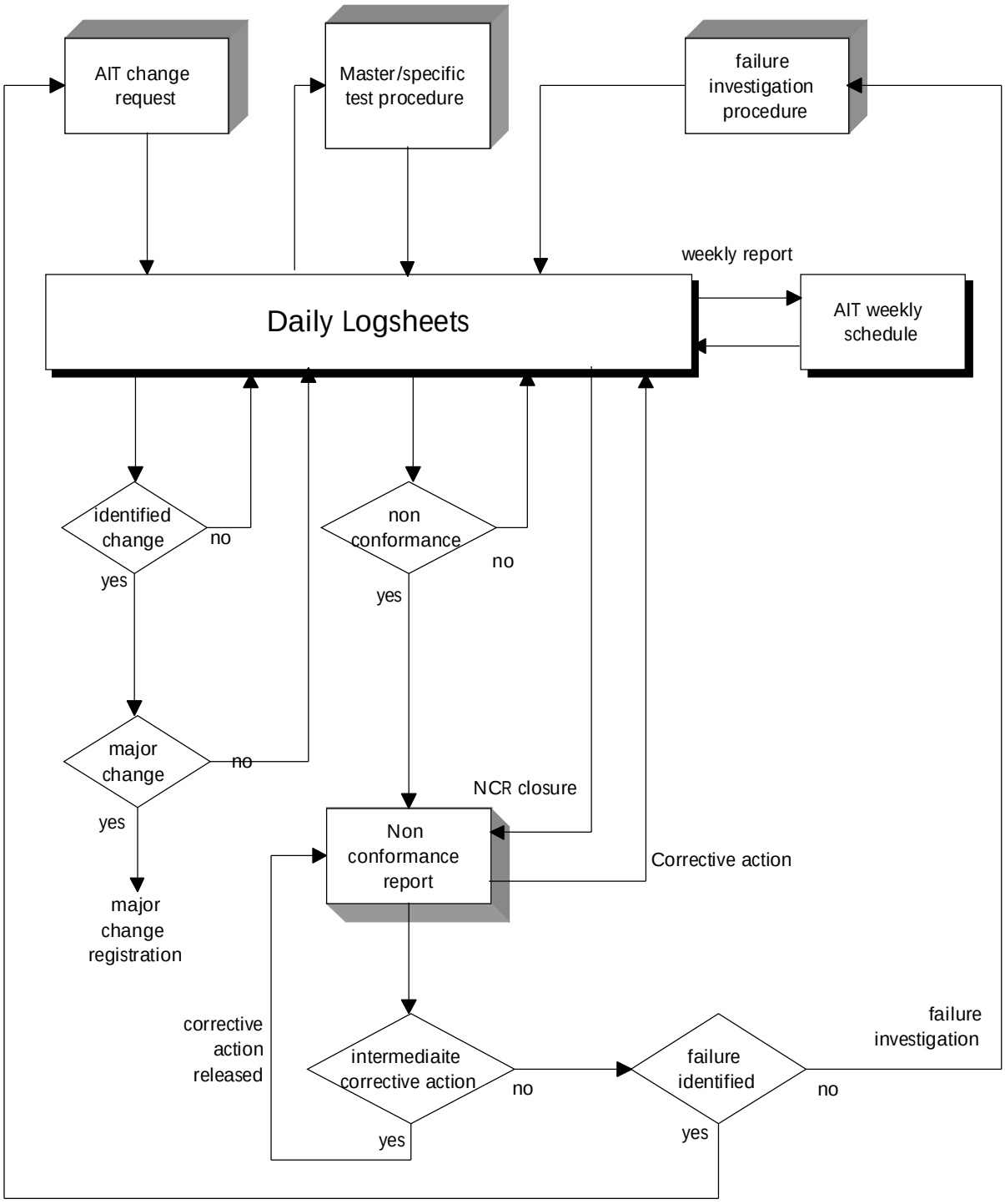


Figure 35: operational diagram - use of different AIT forms

- all AIT tasks are planned in the Log sheets from the AIT weekly planning and their execution is reported in the AIT weekly report. They are always referenced to a test procedure or classed as document.

- To plan the daily activities, a daily planning is introduced each daily meeting. Its takes into account the n-1 day activities and all the new discrepancy's if any.

- when the task is performed as planned without any non conformance nor modification, the task completion is recorded in the log sheet and the next task starts as foreseen.

- if the task cannot be performed nominally or the test procedure has to be modified, a NCR is opened and discussed (QA is in charge of the classification of the NCR's: major or minor). An AIT Change Request is issued and this is recorded in the log sheet. When accepted this ACR supersedes the corresponding steps of the current procedure and the task is performed accordingly.

- the minor changes to an approved (but not yet validated) procedure are red lined in the working copy and immediately applied, nevertheless these changes are recorded in a recapitulative sheet and submitted to approval immediately or at least at the daily meeting. These recapitulative sheets will constitute a global ACR, which will be formally reviewed to update the procedure

- if an unexpected event occurs, or if something seems wrong or suspicious, before, during or after the task execution, a NCR is issued under the test conductor responsibility.

- This NCR will be documented and analysed to define if possible the following points:

  Ø proposed immediate corrective action

  Ø elements of decision for the current test

  Ø failure investigation.

- This NCR is examined jointly by the AIT manager, the ESA AIT manager or his representative, the test manager and AIT QA engineer in order to determine if the current test must be continued, hold for complementary investigations or delayed according to the NCR importance. Whatever the decision is, the corresponding operations shall be recorded in the log sheet.

- The log sheet shall be always the reliable record file of any event occurred during the tests and will be incorporated into the module or system Logbook. This sheet has to be at the same time an execution order of planned activities and a record file of actual performed operations.

- The log sheets allow to keep track day by day all operations performed on the model. The necessary cross coupling between the log sheets and the others documents is made by means of the AIT record lists where are registered the AIT events through the dedicated

documents (Non conformances - Change request - Failure investigation - Test reports - Open works...). Another verification is also possible through the AIT weekly planning and reports.

6.3.3 Time and task execution management

6.3.3.1 AIT weekly planning and report

The report is done each week, it briefly analyses the last events and gives out a notice of work planned for next weeks, showing the modification of actual performed activities w.r.t. expected ones.
Several sheets of AIT weekly planning can be joined to this short comment: the previous week planning with comparison between planned and actual performed activities, and the next weeks actualised planning to take into account the evolutions (if any) from the last edition.

6.3.3.2 Daily progress meeting

A progress meeting will be held each day at suitable time taking into account the availability of the personnel, the nature of the tasks in progress, and the work organisation.

The objectives of this meeting are as follows:

- to report from the daily log sheet, the activities of the day before: actual performed, ACR's and red line summary of test procedure, problems and non conformances, open works, status of NCR's, ACR's,...
- to confirm the task planned for the current day and take if necessary all specific dispositions in case of unexpected event. This part of the meeting can be considered as a preliminary report, as the progress status of the current day will be reported during the next meeting
- to anticipate the activities which will be planned for the next day (verify procedure availability and approval, compatibility of tasks planned in parallel...).
- In order not to disturb the progress of the work, the number of participants will be restricted to necessary personnel.
- The planned activities are displayed on a board and a short briefing of the whole AIT team is held to inform everybody and to listen to their comments, answer their questions or record their problems.

6.3.3.3 AIT log sheets

- Definition

As already explained before, the daily log sheet allows to record on a daily basis the AIT operation as they proceed. This sheet is filled out under control of the Test manager:

- Emission

The AIT daily log sheets are filled out during the daily meeting, which convenes the AIT management team. It is established from the AIT weekly planning, the Master Test Procedure and the progress status of the previous day (through the corresponding log sheet).
The planned operations will be always referenced to a test procedure or classed as document (ACR-NCR-...)
The column "remarks" will give complementary information as for example: potential risks and precautions, attendance of QA when mandatory, identification of unit to be integrated SPF and critical points...

- Execution

The systematic recording of work progress and all events occurred during the task execution (non-conformances, changes, repairs...) is mandatory. The AIT QA engineer verifies the filled out log sheet and attests in particular the closure of all NCR's issued in the framework of this log sheet and the configuration status when concerned.
When filled out, the log sheet shall contain the following information:

- Ø task definition
- Ø test procedure (Nr, Issue, Rev.) or classed as document (ACR, FIP)
- Ø test conductor and operators identification
- Ø starting and ending time
- Ø identification of units to be integrated if any (type, serial number)
- Ø status of RCS/coolers if concerned (pressure, gas...)
- Ø clear identification of hazardous operations
- Ø mention of tasks for which a special care has to be paid (QA attendance, special process, critical points, SPF...)
- Ø non conformances (NCR's)
- Ø open works
- Ø AIT change requests
- Ø information on the progress status of planned tasks (completed, to be continued, interrupted...).

6.3.4 Configuration management

6.3.4.1 Task identification

The configuration management allows to know exactly at any time what is the configuration of the specimen under test. So all assembly and integration operations have to be recorded and controlled by reference to the design and any change or deviation has to be identified. This task is mainly under the responsibility of AIT QA engineer. He shall manage on one side the specific documents as explained hereunder and on the other side the non-conformances since they have an impact on the specimen definition. At last the AIT QA engineer will be responsible for System logbook management.

6.3.4.2 "as built" configuration register

The specimen configuration shall be precisely brought up to date by means of real time recording of all mounting/dismounting operations. The units or items installed on the model will be identified by their reference in a specific register.
This register will comprise a configuration summary sheet subsystem by subsystem where it will be easily possible to identify at any time what kind of equipment is installed (CQM, PFM) or what equipment is missing.
This register will be filled in by the Quality controller and so is set under QA responsibility.

6.3.4.3 Electrical connection register

All connection/disconnection of flight connectors shall be recorded in a specific document. This register is filled in by the technician who is only authorised to proceed to electrical connections/disconnection's. It has to be verified by the Quality controller who attests the validity of information mentioned is this document.
It allows to identify when the connections are provisional (presence of savers) or permanent, and to control the number of connections/disconnection's of flight connectors.

6.3.5 Control and management of non conformances

- The level of the NCR determines the processing (if level 1 a major NCR shall be issued), this level will be decided during the weekly meeting involving all parties: ESA - AAS-F AIT - QA - Engineering in order to streamline both the AIT schedule (minimise holds) and the NCR's treatment, the following rule applies:
- When a non-conformance (or supposed to be) is identified, a Non Conformance Report is filled in. When the AIT manager (or representative e.g. Test Manager) ESA AIT manager (or representative) and AIT QA engineer agree that there is no need to stop the activity, the work is continuing without waiting for the NCR treatment. In all other cases the current work is stopped either to immediately repair the defect (the corrective action is immediately defined, implemented and recorded on the log sheet) or to start another activity while the NCR is analysed.
- If there is no clear identification on the nature of the anomaly, its origin or its full consequences versus the system behaviour, a failure investigation can be decided.
- The NCR's are reviewed each day at the status meeting and final decision is made to issue or not a major NCR.
- The ESA AIT manager may have access to the testing area and participate to the activities with the AIT team when present on the spot, so he is immediately informed and consulted on the NCR treatment.

- A NCR status list will be issued, and at any time the NCR's themselves will be available on the spot.
- Anyhow an official major NCR shall be issued in all following cases:
  - Ø when the stated event needs a failure analysis and/or a failure investigation (see corresponding form)

Ø when the non conformance is considered as level 1 according to the criteria defined in PLANCK PA requirements (AD 5).

- The internal "anomaly sheet" can be used as official NCR form (incoming inspection - EGSE incident...). The use of NCR form will be restricted to AIT sequence when any non-conformance, which is officially stated, has to be considered as major. In this case a formal MRB is requested.

6.3.6 Technical management of "as performed" operations

6.3.6.1 Test procedure change registration

To supervise the progress of a test, procedure is performed through its official working copy, which is filled in as the test proceeds by the test conductor or the test engineer and is verified and countersigned by the QA engineer.
This working copy will be taken as reference for the test report under the name of "as run procedure"
The test procedure can be run nominally, it can be improved (with approval) or modified (with approval) during the test, it can be also aborted whatever the reason is and the test be cancelled or postponed. All changes to test procedure are recorded on ACR forms.
Nevertheless three cases can be identified:

1. The minor changes: (defined and agreed by the AIT manager or his representative) and AIT QA engineer, they will be directly red lined in the working copy of test procedure itself which will be included in test report (as run procedure). This kind of change does not require any interruption in the procedure running. Nevertheless these minor changes shall be summarised in a change record sheet, part of a recapitulative ACR, and reviewed each day
2. The major changes: they will be recorded using the AIT Change Request. This form can be initiated before starting the procedure or during its progress. In this case the procedure execution has to be interrupted until an agreement is reached on the ACR content.
3. The procedure interruption for failure analysis: this is considered as a specific major change which needs a Failure Investigation Procedure. The test continuation depends on the results of the FIP.

6.3.6.2 AIT Change Request (ACR)

The ACR is specially meant for changes concerning the test definition as for example:

- specimen configuration
- sequencing when significant
- test method
- test objective and success criteria
- addition, deleting, modification of test phase, verification phase or operation phase.

The ACR is the only authorised way to improve or modify a test procedure when it has been approved by competent authority and already been validated. All major changes will be justified and agreed prior to application. ACR's are subject to configuration control regardless

of acceptance or rejection. ACR's will be approved at the same authority level in the organisation as it was the case for the test procedure.
The ACR has to identify if it means::

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

An ACR can be the consequence of:

- change in test specification
- calculation, prediction analysis, thermal or mechanical models processing...
- analysis of preliminary result (coming from another test or processed during the test itself)
- rearrangement of schedule

- unavailability of unit test equipment, facility, personnel..
- unexpected limitation in capability of test equipment or test facilities
- non-conformance and failure.

The ACR modifies a test procedure and after agreement becomes a part of it, 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.

7. REVIEWS

7.1 KIP/MIP

Inspection points are implemented in the AIT sequence with the objectives to ensure that the activities are performed in compliance with the requirements, which are applicable on the program. These inspection points are :

- KIP: Key Inspection Point
- MIP: Mandatory Inspection Point

During these inspection points attention will be placed on the compliance of the hardware to its design, on the status of non conformance or waiver, on the availability of approved documentation (procedures , specifications), on the status of the GSE.

7.2 AIT reviews

Such reviews are associated with milestones in the AIT sequence.

AAS-F is responsible to call the TRR or PTR, upon completion of the relevant prerequisite activities; AAS-F is chairing the TRR/PTR, AAS-F is responsible to authorise the test start (TRR) and to close-out the test (PTR)

7.3 Test Readiness Reviews and Test Review Boards

Such reviews are associated with major operations and tests (e.g. integration, dynamic environment tests, thermal environment tests, etc...).
PLANCK Project representative, Product Assurance manager, Quality Assurance manager, AIT System manager & Test manager are part of the board; as well as specialists and contractors as appropriate.
ESA will participate with management or expert personnel as required.

7.3.1 TRR objectives

The objectives of the TRR are to determine if the test may start. To this end must be declared / certified that:

- the hardware configuration is known, compliant and documented
- it is in a fit state to be tested
- the test facilities to be used are validated
- all the appropriate test objectives and the associated test procedures are agreed and approved
- supporting documentation is available
- all supporting equipment (hardware and software is available and validated
- the team exists and is clearly briefed, also in term of responsibility
- the schedule is available and agreed
- all safety aspects have been properly addressed
- RMR status allows the test

The form of this meeting is ideally that of completing a checklist and not a detailed review of individual items which should precede the review proper.

TRR CHECK LIST	REQUIRED
0. TEST REQUIREMENTS	Approval
1. TEST PROCEDURE	Approval
2. TEST SEQUENCE (CCS)	Approval
3. HPSDB STATUS	Approval
4. SPECIMEN CONFIGURATION	Adequate definition - QA certification
5. GSE	Availability - QA certification and validation report
6. FACILITIES	Availability – validation report
7. SUPPORTING DOCUMENTATION	Availability
8. PERSONNEL	Organisation, responsibilities, availability, information
9. SAFETY & HAZARD	Covered by procedure - QA certification
10. NCR STATUS	Open NCR's without impact on the test validity
11. RFW STATUS	No RFW impact on the test results
12. OPEN WORKS	Completeness of all steps necessary prior to test

13. SCHEDULE	Detailed and agreed

Figure 36: TRR check list

7.3.2 PTR objectives

The objectives of the Post Test Review is to confirm that the activities were carried out according to the procedure, to review the results and to release the hardware configuration for the next activity or to decide on the course of action where unacceptable anomalies occurred.

PTR CHECK LIST	REQUIRED
1. TEST RESULTS & DATA ANALYSIS	Available and approved
2. "AS RUN" TEST PROCEDURE	Deviations agreed
3. SPECIMEN CONFIGURATION	Adequate definition - QA certification
4. GSE	Current status
5. FACILITIES	Current status
6. DOCUMENTATION	Current status
7. NCR STATUS	List of NCR's open during the test
8. OPEN WORKS	List of Open works closed during the test
9. CORRECTIVE ACTIONS	Detailed list available and agreed
10. SCHEDULE	Real schedule of all performed activities

Figure 37: PTR check list

8. GSE

The GSE requirements specifications documents will be the guideline for GSE Design and Development plans .

8.1 Identification of GSE

The execution of the AIT program at system level will require the following groups of GSE:

- Mechanical Ground Support Equipment (MGSE) which includes all equipment's identified and described during phase B studies
- Tanking Ground Support Equipment (TGSE) as a part of the MGSE used on the launch site for hazardous oxidiser and fuel sampling spacecraft loading operations and tanks pressurisation. The TGSE will also be able to fill/drain the tanks with simulation liquids for mechanical and thermal environmental testing purpose
- 0.1 K Pneumatic Ground Support Equipment (PGSE) called ISSS (ISotope Support Supply) as a part of the MGSE used on the launch site for He3/4 spacecraft loading operations and tanks pressurisation. This PGSE is under HFI responsibility.

- Electrical Ground Support Equipment and associated test S/W. EGSE can be split in several parts:: common EGSE (Planck and Herschel) for SVM, partially common EGSE for ACMS, own EGSE for instruments.

8.2 MGSE

8.2.1 MGSE System Design

The MGSE shall be designed and developed for the AIT operations to be performed on all PLANCK models (CQM and PFM). This includes assembly, integration, test activities and finally all tasks to be performed prior to launch. The MGSE will be used all along the different phases described in the development plan.

- The following groups of MGSE items are identified:
  - Ø handling and integration
  - Ø transportation and storage
  - Ø test
  - Ø RCS & Tanking support ground equipment;
  - Ø 0.1 K / 4 K PGSE.
  - Ø solar array MGSE (container)

- MGSE are decomposed in several parts:
  - Ø common Herschel and Planck MGSE for SVM purpose. AAS-I is in charge of the manufacturing of these MGSE. Refer to Herschel/Planck SVM SOW: H-P-WS-AI-0006 for more information's.
  - Ø Planck MGSE for satellite and CQM purpose. AAS-F is in charge of the manufacturing of these MGSE. Refer to Planck SOW: H-P-3-ASPI-SW-0168
  - Ø Instruments MGSE. Each company is in charge of this own MGSE (LABEN for LFI…..)

8.2.2 MGSE specification documentation

The definition and all the requirements of PLANCK-MGSE are given in the following reference documents:

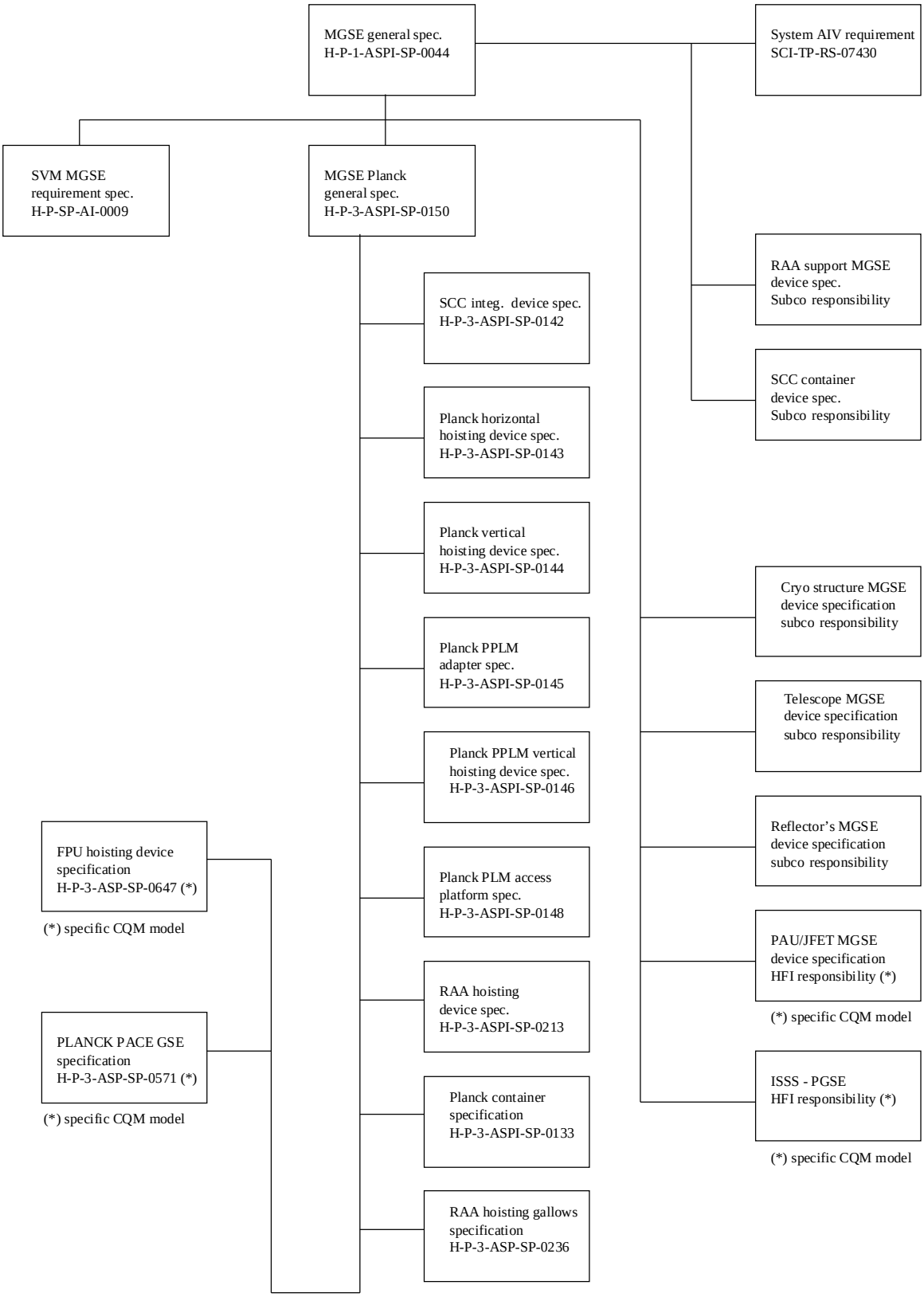


Figure 38: "main MGSE" specification tree

8.3 EGSE

8.3.1 EGSE system design

8.3.1.1 Introduction

The term EGSE (Electrical Ground Support Equipment) refers to the electrical and electronic equipment including associated software; which is needed to support the program during integration, functional testing, environmental testing, ground station compatibility and launch operations.
This equipment includes:

- the Overall Check Out Equipment (CCS) and associated software
- the Specific Check Out Equipment (SCOE) and associated software for
  - Ø Power functions testing: Power SCOE used on FM model
  - Ø ACMS functions testing: ACSM SCOE used on FM model
  - Ø RCS functions testing: ACMS SCOE used on FM model
  - Ø CDMS functions testing: CDMU DFE (CQM model and PFM model before batch 3 delivery), CDMU SCOE (FM model)
  - Ø Specific launch area functions: Launch Power Supply (part of the Power SCOE) used on FM model
  - Ø S/C simulator for interfaces testing used on FM model
  - Ø RF functions testing: TTC RF SCOE used on FM model
  - Ø HFI functions testing used on CQM and FM model
  - Ø LFI, SCC functions testing used on FM model
  - Ø Power and CDMS functions testing: PLM EGSE used on CQM model and PFM model before batch 3 delivery.
- Specific SCOE will be used for cryogenic test
  - Ø Thermal regulation functions: Thermal regulation EGSE used on CQM and FM models
- some special equipment
  - Ø cabling (for standard 100 000 clean room, for thermal vacuum tests)
  - Ø test equipment required to integrate and validate EGSE

All these specific SCOE's will be powered through an insulation transformer
The EGSE is designed to support satellite testing during all phases of integration and test.
The following section gives a general description of EGSE by presenting decomposition into functional components.

8.3.1.2 System decomposition

The EGSE for the PLANCK project is decomposed into following components:

- CCS (central check-out system)
- POWER SCOE (including Battery Simulator, Solar Arrays Simulator, launch power supply through umbilical plugs, Battery Charger)
- ACMS SCOE (including OGSE)
- RCS unit tester (part of the ACMS SCOE)
- TTC SCOE (RF test)
- TM/TC DFE
- COTE (Launch SCOE: part of the Power SCOE)
- S/C simulator

This decomposition reflects the functional decomposition which, in turn, reflects the structure of the onboard subsystems while concentrating related technologies in common components (e.g. all equipment related to electrical power is brought together in the POWER SCOE).

Basically EGSE functions which have the same test objectives belong to the same EGSE element. In order to obtain optimum EGSE, different functions are sometimes grouped in the same EGSE element because they use either same S/C SS interfaces or common EGSE main resource.

8.3.2 EGSE specification documentation

The specification requirements tree of PLANCK-EGSE is given in the following reference documents:

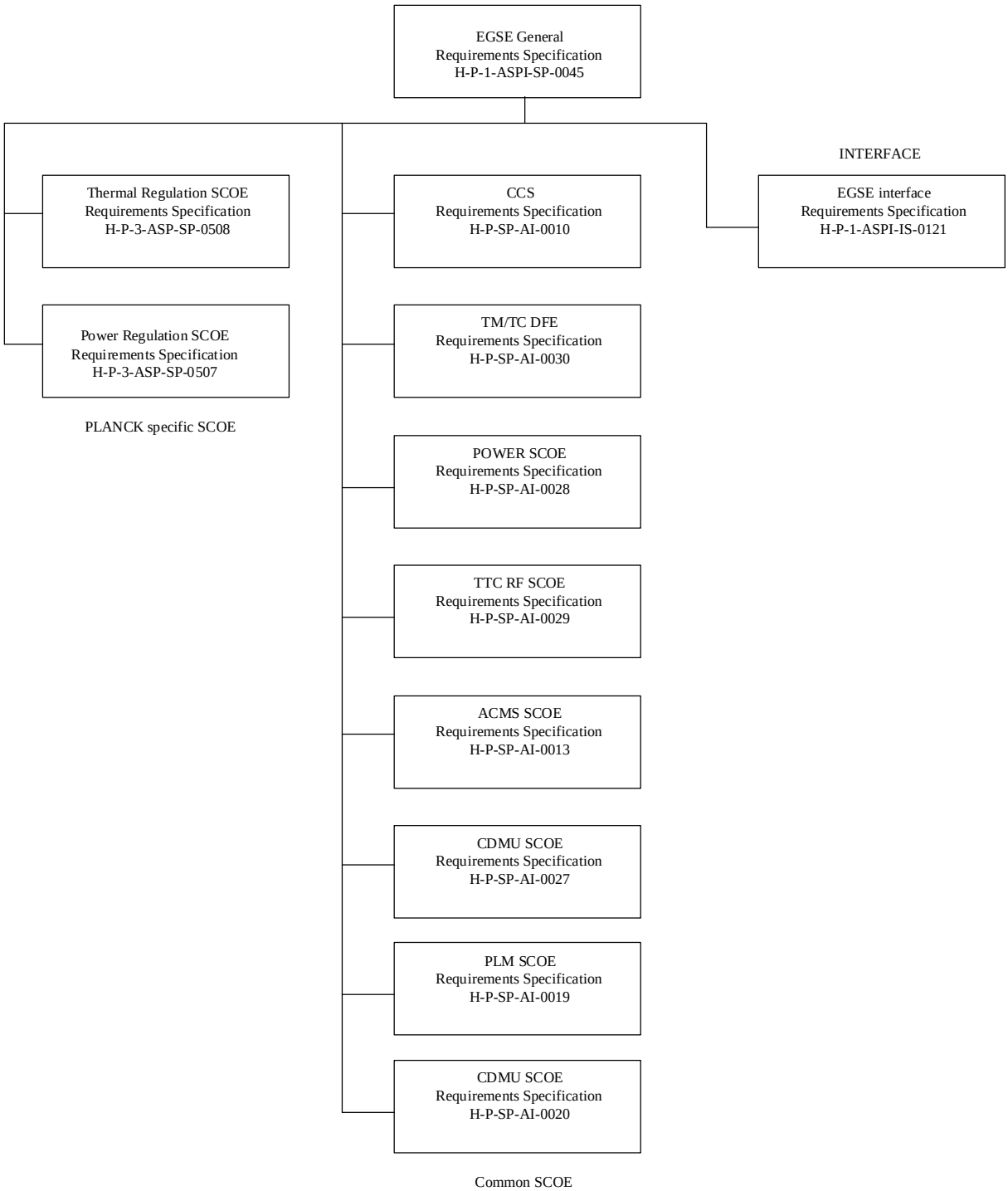


Figure 39: EGSE SPECIFICATION TREE

8.4 GSE DEVELOPMENT PLAN

Taking into account the commonality of the two satellites Herschel & Planck , several sets of GSE had been manufactured . It's summarised in the following documentation

- MGSE and TGSE parts:: see RD6
- EGSE parts: see RD5
- IGSE are under HFI/LFI responsibilities

The main overall GSE have been developed and validated during CQM, FM SVM and Satellite PFM 1 AIT campaign (Focal 5 thermal GSE adaptation at CSL, GSE for satellite integration, ISSS & TF PGSE from HFI …)

At the time being, development of some of GSE has to be completed (deliveries expected mid-2007)

- Ø The DPH&P ("Dispositif Pressurisation Herschel& Planck) concerning the fine filling/equilibrium of RCS tanks
- Ø MGSE adaptation to E6 balancing table, for fine balancing inside the LSS
- Ø Satellite transportation container potential adaptation for potential air shipment
- Ø Completion of the thermal vacuum test harnesses
- Ø Launch Support Equipment (used for links validation during the launch campaign)

9. FACILITIES AND TRANSPORTATION PLAN

9.1 FACILITY AND TRANSPORTATION PLAN

The main AIT activities will be performed at AAS-F/Cannes except :

- Ø the thermal balance vacuum test on PFM1 and PFM that will be performed at CSL.
- Ø End of AIT campaign at Estec, specially for fine balancing

Transportation between Cannes and CSL, then Estec will be done with the satellite in its container (see container specification: H-P-3-ASPI-SP-0133). Several transports are foreseen today: two with the PFM1 model(CSL / AAS-F), two with the PFM model (one to CSL, one to Estec)
Transportation to Kourou should be done by sea (or air) with Herschel satellite.
All the transportation will include all EGSE and MGSE necessary for satellite testing purpose.

9.2 SATELLITE TO AAS-F TEST FACILITIES INTERFACE SPECIFICATION

All the interfaces between the various PLANCK satellite models CQM and PFM plus associated GSE and all the AIT facilities are defined here after:

9.2.1 Clean room facilities class 100 000 US standard:

Refer to [RD18]

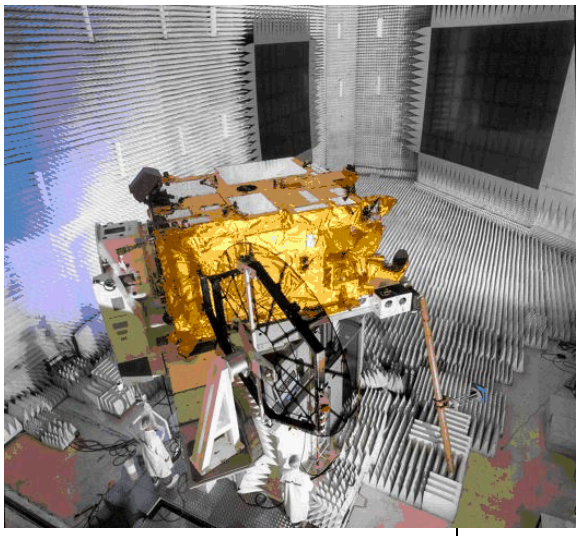
- M6/M10/M95 area: 440 m²
- M01 area: 520 m²
- M99 area: 280 m²

The height under hook and the capability of the crane depending on the clean room are:

Hall	Room	Height under hook (m)	Force (tons)
M10	M10–101	11	7,5
M9	M9-101	11	10
M95	M95-105	10,85	7,5
M95	M95-105	10,8	7,5
M95	M95-111 (airlock)	10,3	10
M99	M99-101	13,48	10
V01 north	V01-113	10,4	7,5
V01 south	V01-122	6,5	7,5
V01	V01-120 (airlock)	10,5	10
M01	airlock	12	25
	PLOTS South	11.33	10
	PLOT North	10.71	10

Figure 40: crane characteristics in AAS-F premises

9.2.2 Compact Antenna Test Range facility



The Cannes facility's Compact Antenna Test range (CATR) is a vast, entirely Faraday-shielded clean room isolated from spurious frequencies by RF-absorbing anechoic panelling. Housed within the class 100,000 permanent clean rooms building , the CATR and its entrance door accommodate the ARIANE 5-allowable payloads.
Tests are fully automated and results come in a plurality of formats. Both reflectors, the tray and the feed are mounted on special, ground-decoupled seismic blocks. The feed is housed in a dedicated area, and a wide opening enables transmission in CATR.
Reflectors' size and surface tolerance are selected against radiations' properties in the chamber and the minimal and maximal operating frequencies, respectively 1.2 GHz and 200 GHz.

Figure 41: CATR Chamber

- Useful size: 12 x 30 x 12 (W x L x H)
- Max weight of crane: 10 T with 10 m under crane
- Frequency range : 1.2 GHz and 200 GHz
- Class 100 000 compatible
- White painting (class M2)
- Maximum allowable load : 10 T
- External Faraday Shield insulation : attenuation by 100dB
- Reflectivity > 50 dB one way in Ku band, and 30 dB in UHF Band
- Absorbers: constructor Hyfral model APM 45 and 66
- Shielding minimum attenuation characteristics :
  - § Magnetic fields 200 KHz: 61 dB
  - § Electric fields 10 MHz: 90 dB
  - § External Isolation (Faraday cage) : 80-100 dB (characteristic)
- Ambient characteristics:
  - § Class 100 000 clean room
  - § Temperature 22° +/- 3°
  - § Humidity 55 % +/- 10 °
  - § These three parameters are continuously being recorded
- Access :
  - § 1 personal door
  - § 1 specimen door (4.55 meter x 5.2 meter)
- Mechanical I/F : 6 axis Platform

9.2.3 Vibrations tests facilities

Several shakers are available at AAS-F Space: C210, C220, LDS V994 "ATLAS"

Two acoustic chambers are available at AAS-F Space: 250 and 1000 m^3

LDS V994 "ATLAS" characteristics :

- Sine and random vibrations
- Maximum strength vector: 289 kN
- Specimen mass: < 5,8 tonnes
- Frequency range: from 5 to 2000 Hz
- 400 acquisition ways (256 in real time)

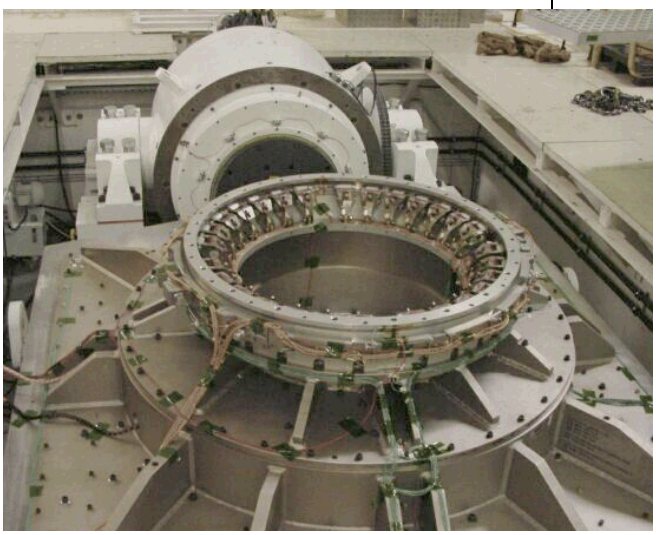


Figure 42: V 994 ATLAS shaker

1000 m^3 Acoustic chamber characteristics: :
Volume 1000 m3 (10 × 8 × 12.53 - L×l×H)
Niveau maximum global : 156 dB
Spectre : 31.5 – 8 000 Hz
3 main horns (25H, 50 Hz & 160 Hz)
Automatic control (8 microphones)

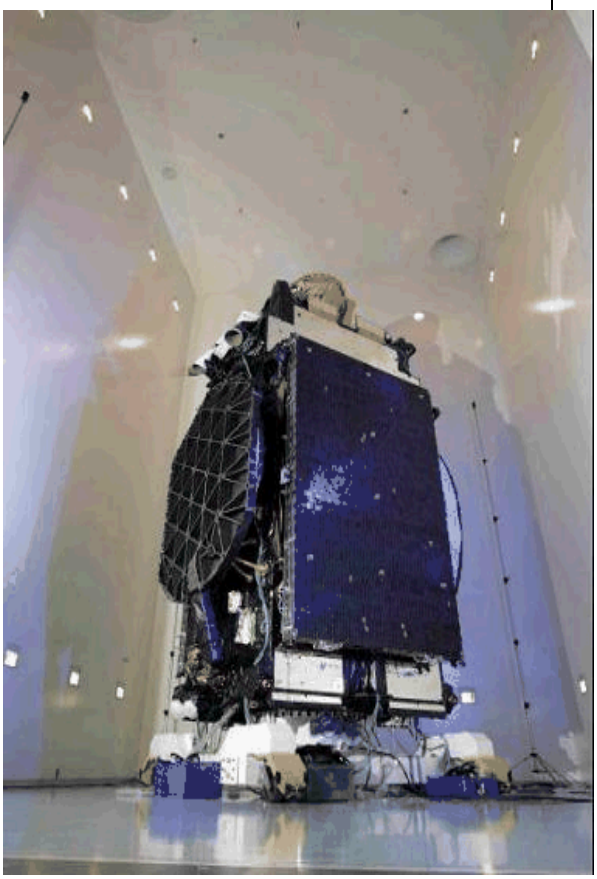


Figure 43: 1000 Acoustic chamber

9.2.4 MCI & Spin test facilities

- Inertia

  One SCHENK M7S oscillating table
  - § Max mass 1OT
  - § Max Inertia 15000 m^2.kg
  - § Max static imbalance 350 m.kg
  - § Measurement accuracy ±1%

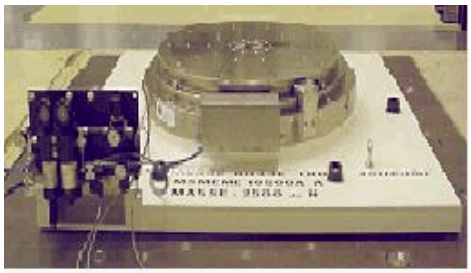


Figure 44: SCHENCK Oscillating table

- MPI
  - § Spacecraft from 800 kg to 3200 kg
  - § COG in Z ≤ 2500 mm
  - § Max inclination 40°
  - § Alignment accurracy
    - ± 0.1mm displacement
    - ± 0.02° angular

Figure 45: MPI table

- Balancing & operational spin
  - § Max mass 2500 kg
  - § Speed 30 to 300 rpm
  - § Max shearing force 200 daN

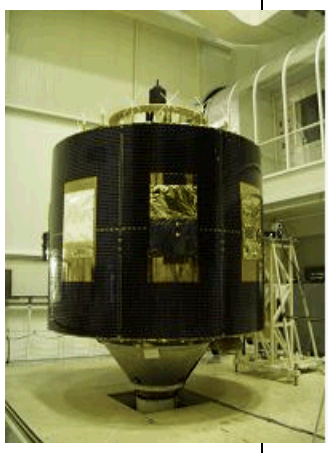


Figure 46: Balancing table

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