HERSCHEL / PLANCK

Planck PFM AIT Plan

H-P-3-ASPI-PL-0208

Product Code : 200000

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ENREGISTREMENT DES EVOLUTIONS / *CHANGE RECORD*

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,	JP. HAYET

Issue. Revision	DATE	§ : CHANGE RECORD	AUTHOR
		and 2 TV tests instead of 1) §3.8.1: sine vibration/acoustic noise/shock test 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

TABLE OF CONTENTS

LIST OF FIGURES AND TABLES

1. INTRODUCTION

1.1 FOREWORD

This document describes the assembly, integration and test activities to be performed by ALCATEL as AIT Contractor on Planck PFM.

All the Planck activities planned before the satellite launch cab be splinted in four major parts:

1.1.1 CQM (Cryo Qualification Model) activities:

Refer to [RD15]

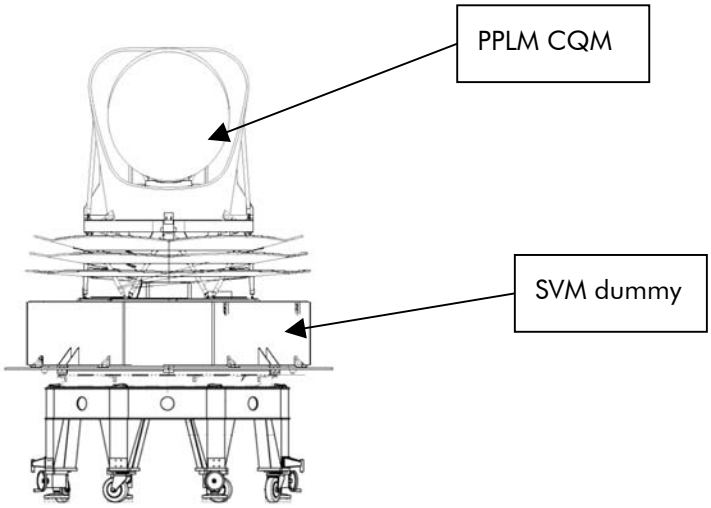


Figure 1: Satellite CQM configuration

→ perform an early acoustic testing of the Planck PLM 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.

→ Perform a PPLM thermal balance to :

- ✓ validate the passive cooling
- ✓ validate the active cooling (0.1K, 4K, 20K)
- ✓ validate the HFI detection chain
- ✓ validate the non-impact of the μ-vibration environment
- ✓ measure conducted EMC at HFI instrument level

1.1.2 RFQM (Radio Frequency Qualification Model) activities:

refer to [RD8]

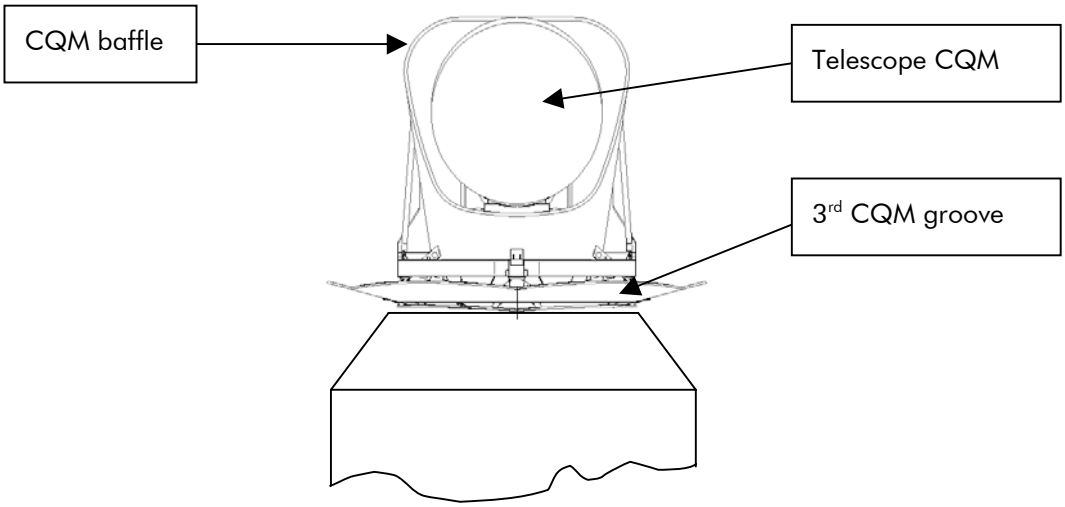


Figure 2: PPLM RF QM configuration

→ 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

1.1.3 AVM (Avionique Model) activities:

Refer to [RD11]

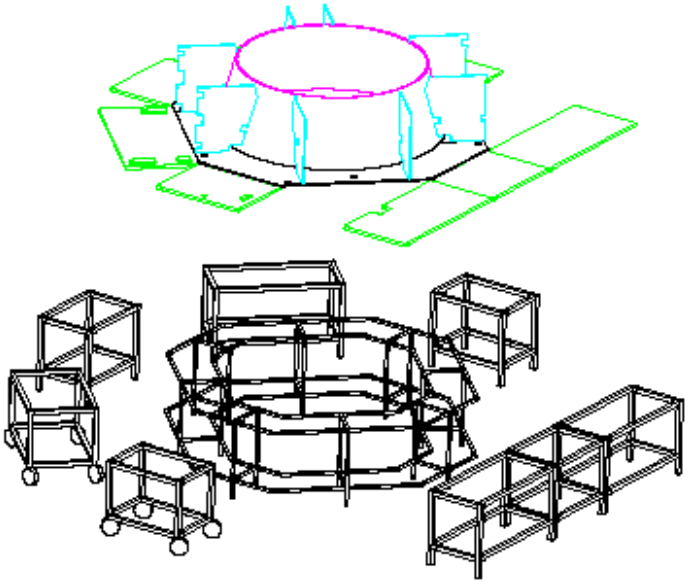


Figure 3: AVM configuration

The AVM model will be made with fixed table + two wheels table (to ease the swap between Herschel and Planck). The different panels as well as the harness will be set on these table.

→ The aim of the AVM is the validation of the functional chains at system level

1.1.4 Satellite PFM (Proto Flight Model) activities:

Refer to this document

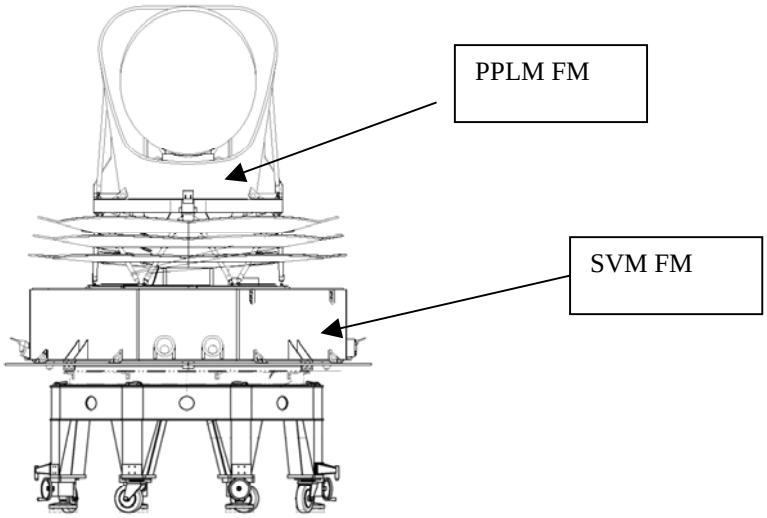


Figure 4: Planck satellite configuration

→ 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.

1.1.5 Top overview of the four main parts:

1.1.5.1 PPLM CQM / RFQM logic

This logic diagram is simplified. This document will deal with the detailed PFM activities in next chapter. [RD8] will deal with the detailed RFQM activities. [RD15] will deal with the detailed CQM activities.

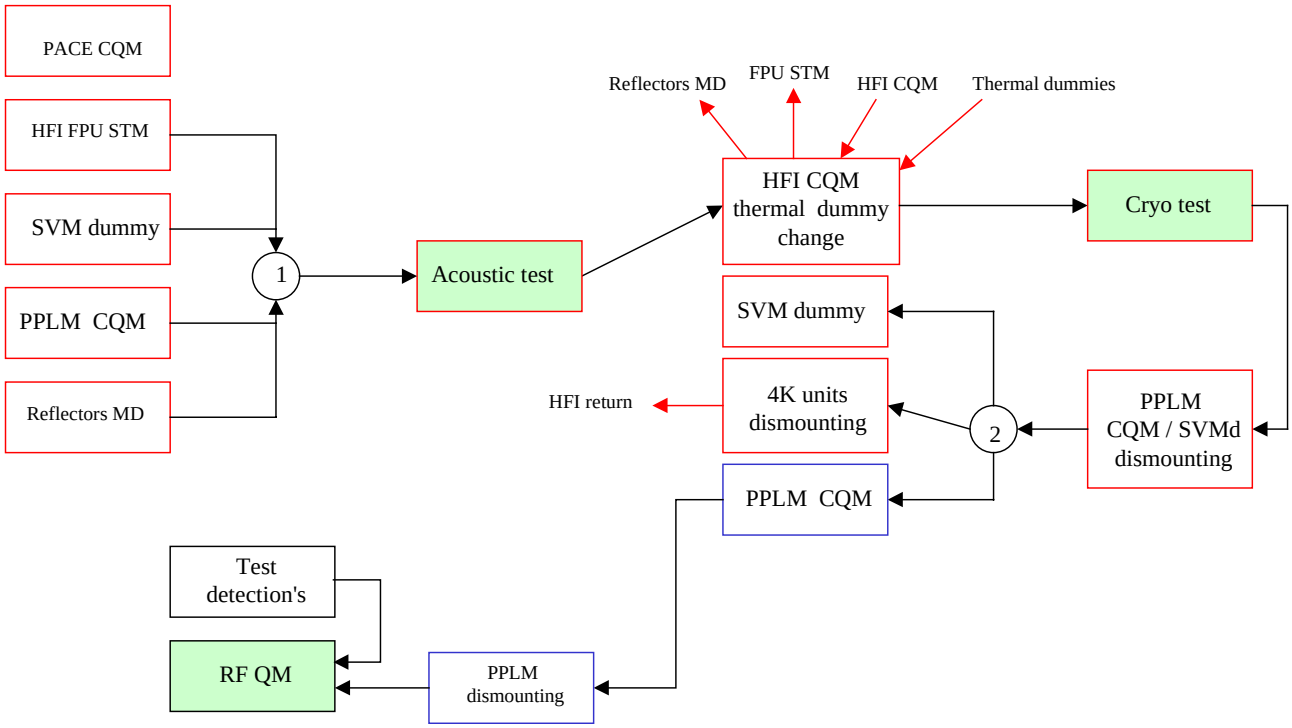


Figure 5: CQM / RF QM logic

1.1.5.2 AVM logic

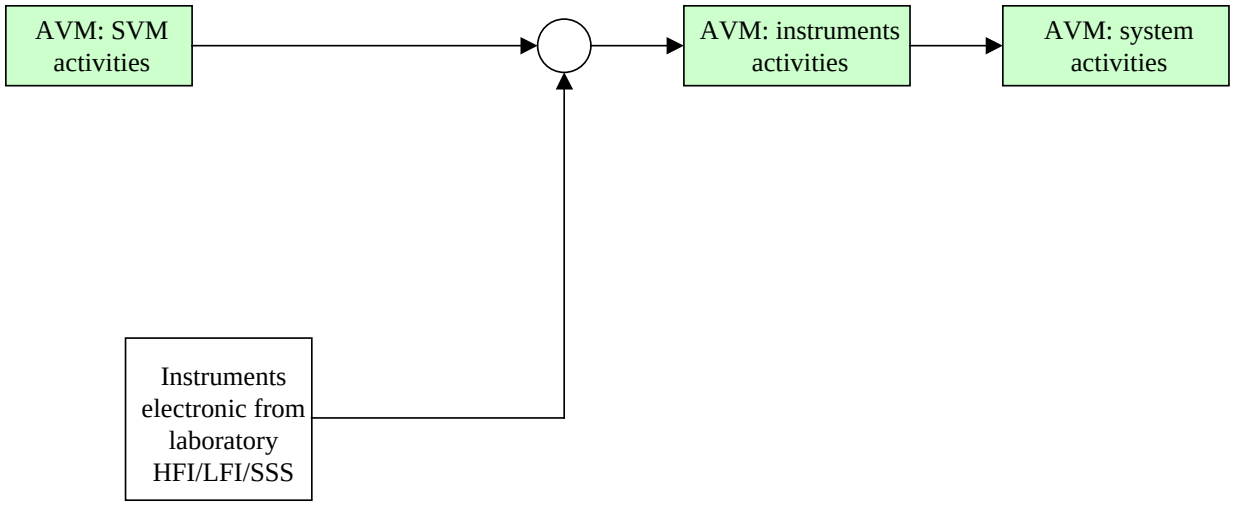
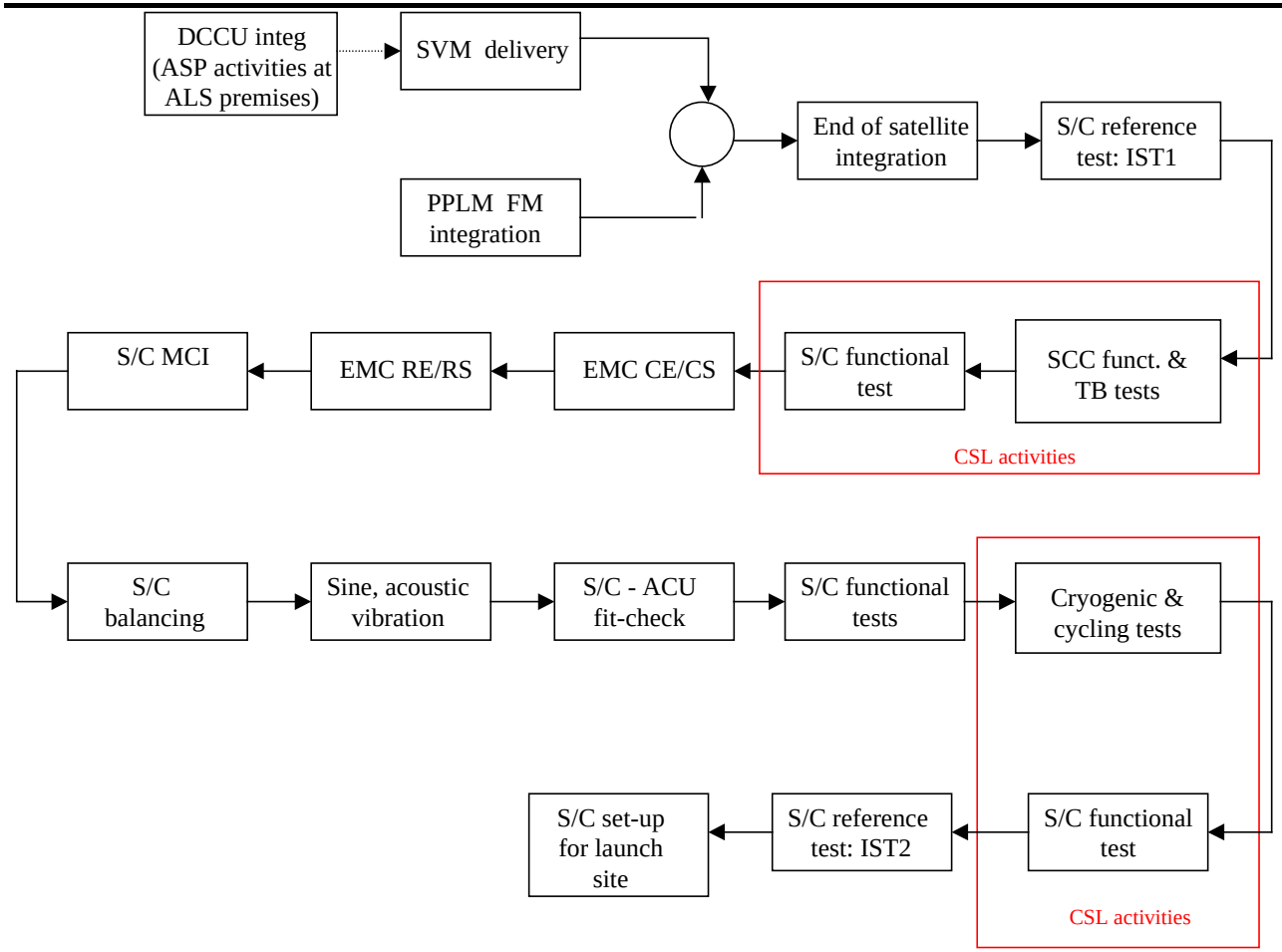


Figure 6: AVM logic

1.1.5.3 PFM logic



Note: SVT1 can be planned at any moment until the first S/C reference test and the second reference test

Figure 7: satellite logic

1.2 SCOPE

The objective of this plan is to define :

- an AIT programme in accordance with the system level AIV requirements
- the relevant organisation, necessary to carry out all tasks identified in the AIT programme
- the utilisation of GSE dedicated to this programme
- 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 programme schedule and the major milestones
- the integration and test sequences.

This document deals only with the 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	N/A
RD8	Planck RFQM AIT plan Document n° H-P-3-ASP-PL-0669
RD9	N/A
RD10	Planck SVM dummy structure specification Document n° H-P-3-ASP-SP-0545
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 Cryogenic Test Operation Plan Document n° H-P-3-ASP-PL-0502

RD15	Planck CQM AIT Plan Document n° H-P-3-SP-0668
RD16	CQM technical description Document n° H-P-3-ASP-TN-0671
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	Planck Electrical Integration Sequence Doc n° H-P-3-ASP-TN-0611
RD 21	Planck CQM EMC Test Specification Doc n° H-P-3-ASP-TS-0650

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 :

- RFQM [RD8]: RF Demonstration Model and RF Qualification Model ; PLANCK RF qualification done at subsystem level
- CQM [RD15]: Cryo. Qualification Model ; PLANCK satellite thermal and cryo. qualification
- AVM [RD11]: AVionic Model ; PLANCK functional and performances qualification (done by ALENIA at SVM level, by Alcatel at Satellite level)
- PFM : Proto Fligth Model ; PLANCK satellite

This document describes the PFM Assembly, integration & test until the avionics panels delivery from ALS.

The respective start of integration & test campaign of CQM, AVM, RFQM, PFM models will follow System Design & Development plan [AD9], reflected in the reference baseline schedule included in the AIT plan.

3.2 MODELS DEFINITION

3.2.1 Satellite CQM (Structural Cryo. Qualification Model)

The aim of the CQM is the validation at system level of thermal and cryogenic concepts and of the associated mathematical models. Before the cryo test, an early acoustic testing shall be 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.

3.2.1.1 Acoustic test

The model has been designed to be representative of the satellite for acoustic test.

It can be splited in two main parts:

- PPLM CQM: incluing the following functionality's:
  - FPU structural model (HFI STM+ LFI MTD)
  - Mass dummies to simulate the missing units
  - Telescope CQM with reflectors mass dummies

- Cryo structure CQM
- PACE CQM

- SVM dummy
  - Design to support the PPLM
  - No others functionality needs for the acoustic test

3.2.1.2 Cryo test

The model has been designed to be representative of the satellite for cryo tests. For the power simulated dissipation of the missing units, heaters have been installed; SVM dummy is not fully representative of the thermal aspect, only the interface with the PPLM is representative in order to not disturb the performances of the cryo subsystem.

It can be splited in two main parts:

- PPLM CQM: incluing the following functionality's:
  - complete HFI detection chain
  - 0.1K, 4K and PACE cooler chains
  - cryo sensors acquisition (test sensors + flight sensors)
  - heaters for power simulated dissipation
  - telescope CQM without reflectors QM
  - cryo structure CQM
- SVM dummy: incluing the following functionality's:
  - Structural aspect to support the PPLM
  - Thermal representive aspect on the PPLM / SVM dummy interface area.
  - Complete HFI detection chain (electronic units: WU)
  - 4K cooler chains
  - 0.1K and 20K cooler chains are not representative ; PGSE have been designed to simulate them

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.

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. Refer to [RD11]

3.2.4 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.

3.3 INCOMING

Before integration, verification is performed on each delivered unit to control the quality of the hardware to be integrated.

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
- mass.

3.4 ASSEMBLY

The S/C will be 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 QA coverage will perform all these activities. Only members of this group will be authorised 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
- mass of unit
- integration procedure reference (with issue/rev) with the record of:
    - torquing of fixing screws
    - 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 authorised 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/demating 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:
  - harness connector to saver
  - unit connector to saver
  - harness connector to unit connector
  - torquing of fixing screws
  - marking (or eventually sticking) of fixing screws

QC will manage 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 subco documents.
- after suppression of break-out boxes/tee adapter, final connection of each harness connector and torquing 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)

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)

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)
- Environmental tests (ENV)

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 [RD13]. 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.

3.7.1.2 SFT (Short Functional Test)

The SFT is an abridged IST. The software sequences and software modules which compose the SFT programme 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 mechanical test sequence and before the Thermal vacuum test. These tests may be run during preparation of TV test in open chamber configuration in order to optimise the AIT sequence.

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.

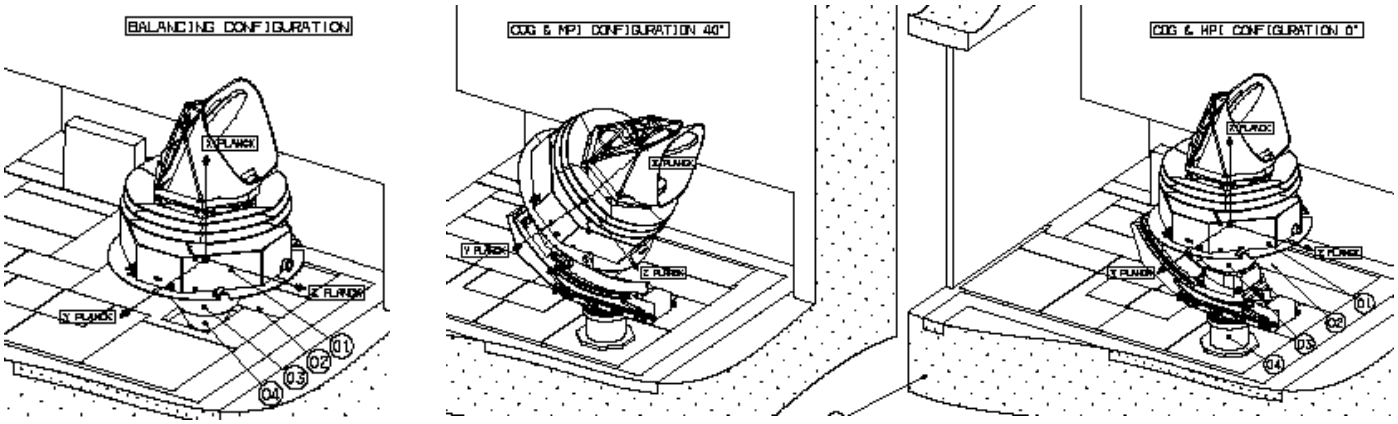
For these tests the satellite is motionless and EGSE simulations will be used with representative configurations. They will be detailed in a dedicated system tests plan .

3.7.1.4 Physical properties & mechanical spin test

The parameters weight, centre of gravity and moment of inertia are needed to predict spacecraft performance during attitude manoeuvres 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 . This measurement will be performed on rotating table available in Cannes facilities.



3.7.1.5 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 will be used first 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.
- 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.

3.7.1.6 Fluidic/Pneumatic Tests

RCS purposes:

- The detailed RCS testing are defined in the corresponding test matrix.
- A RCS global leak test is performed (inside the satellite transport container suited for this purpose) in order to check and demonstrate that the leak rate remains within specified values after the test sequence in Europe.
- Tanking Ground Support Equipment (TGSE) will be used:
  - for filling/draining of the tanks with simulation liquids when performing sine vibration and acoustic noise tests.
  - for filling and pressurisation operation on the launch site.

0.1K and 4K coolers:

- Concerning 0.1 and 4 K coolers, a proof test will be performed after assembly on satellite, and leak tests are performed in order to check the integrity of each line after environmental tests .
- TF (tank filling) PGSE will be used (under HFI responsibility) for filling and pressurisation operations of the Helium isotopes tanks at ASP 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 (under HFI responsibility) for isotopes exhaust during cryogenic test at CSL.
- 0.1K and 4K cooler Pneumatic Ground Support Equipments (PGSE) will be used (under HFI responsibility) to purge cooler lines, perform proof and leak tests.

20K cooler:

- Leak tests are TBD.

3.7.2 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 programme, 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 Alcatel 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 Alenia 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 Alcatel 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.

3.7.3 Specific Performance Test

3.7.3.1 RF qualification tests

The qualification tests will be performed with a RFQM [RD8]. This Radio Frequency Qualification Model will be very close to the flight design. The model includes:

- CQM reflectors
- CQM telescope
- CQM baffle
- CQM 3rd groove and the CQM cryo struts.

During these tests, the main lobes and the far out sides lobes will be measured from 30 Ghz up to at least 545 Ghz for the main lobe.

3.7.3.2 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 30 GHz RF testing. The satellite will be rotated by the CATR positioner so as to construct the pattern

3.8 ENVIRONMENTAL TESTS

3.8.1 Sine Vibration/Acoustic Noise/Shock tests

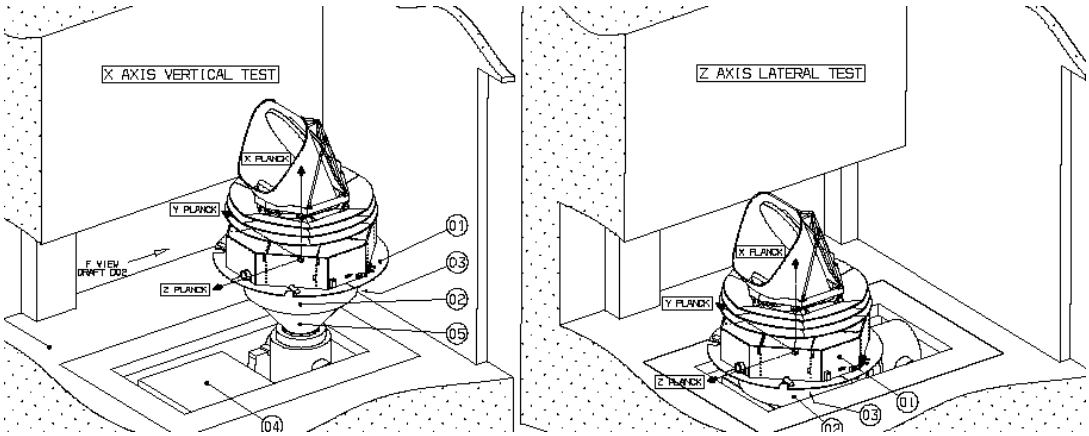
- The objective of these tests is to qualify the complete structure with respect to the environment caused by the launch of the spacecraft and to confirm the mechanical environment specified at subsystem and units levels.
- Vibration and acoustic noise levels and duration are chosen so as to demonstrate that the system design provides sufficient margins (based on the result of coupled load analyses with the launcher)

These levels (qualification or acceptance) are shown in [AD3].

3.8.1.1 Sine Vibration

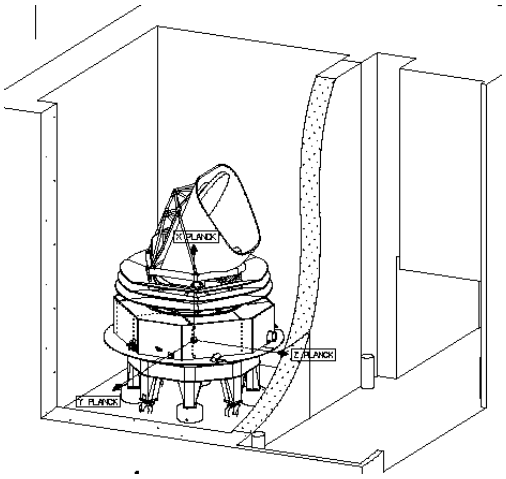
- The PFM will be tested through sine vibration and acoustic noise test. This test consists of:
  - low level sine vibration test to verify the coupled analysis and to search the resonance frequencies (modal test survey).
  - high level sine vibration test for the qualification of the mechanical system, 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:
  - low level run
  - determination of notching factors according to measured amplification factors
  - intermediate level run (to confirm the notching factors)
  - qualification level run
  - 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:
  - to perform this test, RCS tanks will be filled with simulation liquids.
  - to perform this test, Helium tanks will be pressurised to 150 bars (TBC).
  - To perform this test, battery will be charged.
  - the satellite will be installed on the shaker with a specific vibration test adapter.
  - 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.



3.8.1.2 Acoustic noise

- Acoustic noise test. The main objectives are:
  - demonstration of the satellite structure characteristics (primary and secondary)
  - verification of the compliance with the relevant analytical model parameters
  - verification of the system integrity under acoustic noise and alignment stability after test.
  - verification that the structural/mechanical components units meet the requirements for system acceptance, and comply with launch vehicle requirements.
- Test set-up and conditions:
  - To perform this test, RCS tanks will be filled with simulation liquids.
  - to perform this test, Helium tanks will be pressurised to 150 bars (TBC).
  - To perform this test, battery will be charged.
  - The satellite will be fixed on the VIS inside the acoustic chamber
  - 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:
  - low level run for satellite signature
  - qualification level run (an intermediate level could be run if necessary)
  - low-level verification run for comparison to initial satellite signature.



3.8.1.3 ACU Fit check and clamp-band release

- to realise a mechanical and electrical I/F fit check between the satellite ARIANE adapter (ACU) and the satellite

- 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 .

3.8.1.4 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 .

3.8.2 Thermal vacuum Tests

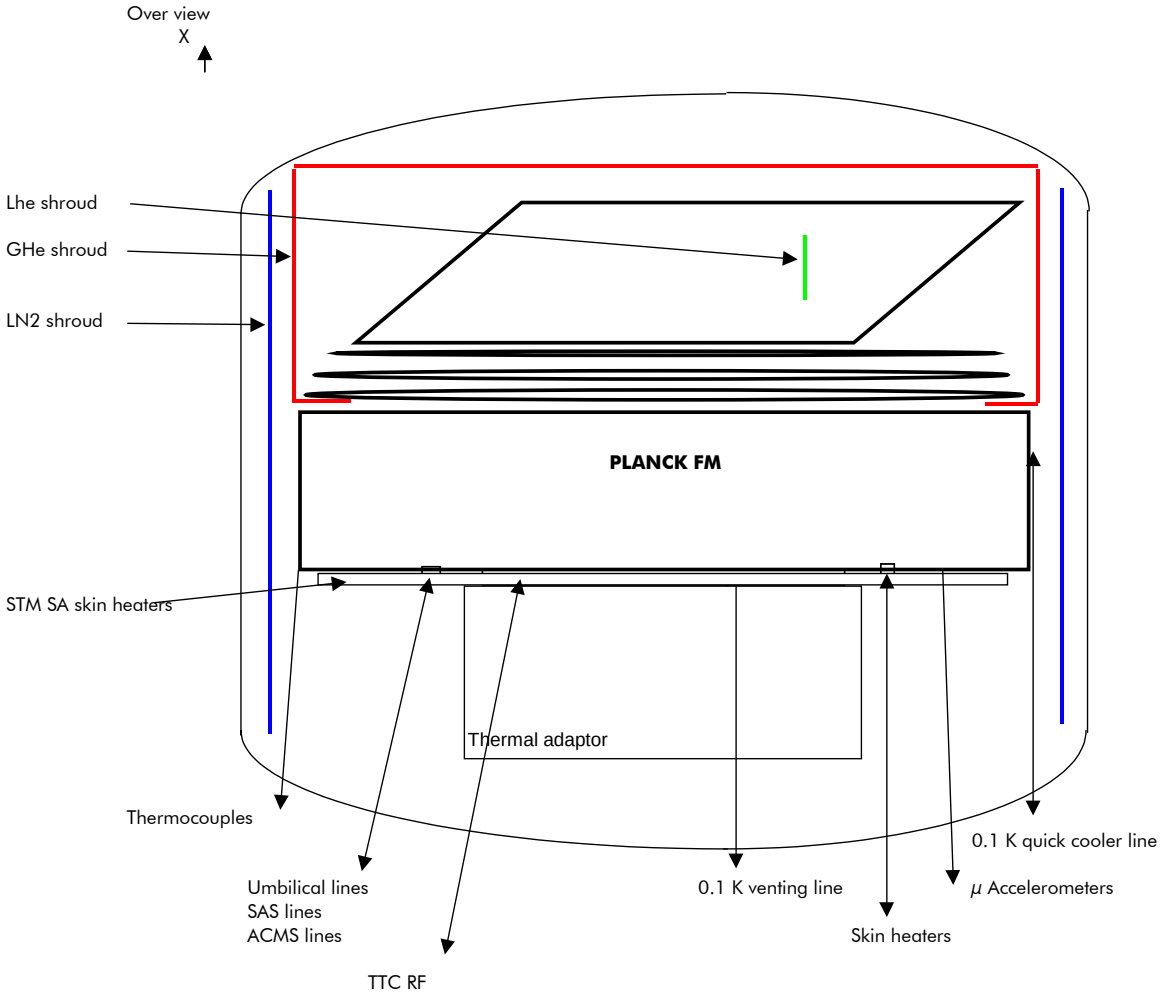
These tests will be performed in the FOCAL5 in CSL facility and are performed in two steps.

The first step concerns SCC functional test and thermal balance in order to qualify thermal performance of the SC.

The second step concerns cryogenic test(using the second SCC) 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 at 100 bars in He ¾ (TBC) .



3.8.3 EMC

3.8.3.1 At CQM level:

EMC CE/CS measurements will be performed on the HFI acquisition chain to check the marge at cryogenic temperature. As the need is to check that there are not disturbance on the performances of the chains, these measurements will be done during the cryo tests.

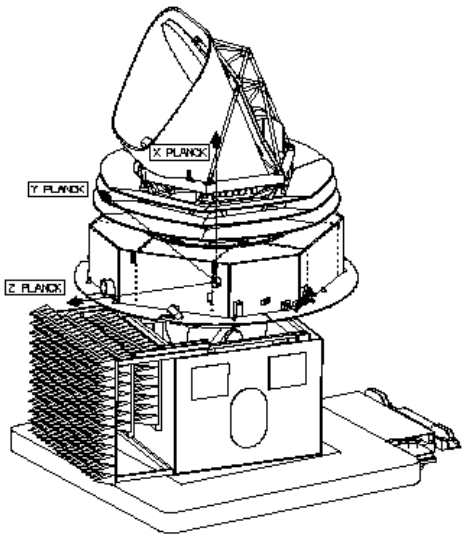
EMC sensors will be set on the power lines between the EGSE and the WU, outside the chamber. Refer to [RD21] for information about EMC plan.

3.8.3.2 At PFM level

Conventional EMC qualification programme will be applied on the PFM at ambient temperature. It will comprise RS, RE, CS and CE measurements.

- 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. 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.



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. For the QM model, these witness will be mounted on the LFI main frame and between the groove 2 and groove 3. They will be mounted for the cryogenic campaign, i.e. after the acoustic test.

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 have to be developed.

This nominal cleaning concerns only the external parts of the structure including the grooves, not the reflectors neither the FPU (they are always protected except during the thermal vacuum test).

4.2 SPECIFIC PROTECTIONS

To limit particulate contamination during AIT, several types of covers are necessary . These covers will be dismounted for some performances and environmental tests .

Skin protections 1, 2 and 3 are provided by ASP-AIT, CONTRAVES will provide covers 4, HFI will provide cover 5.

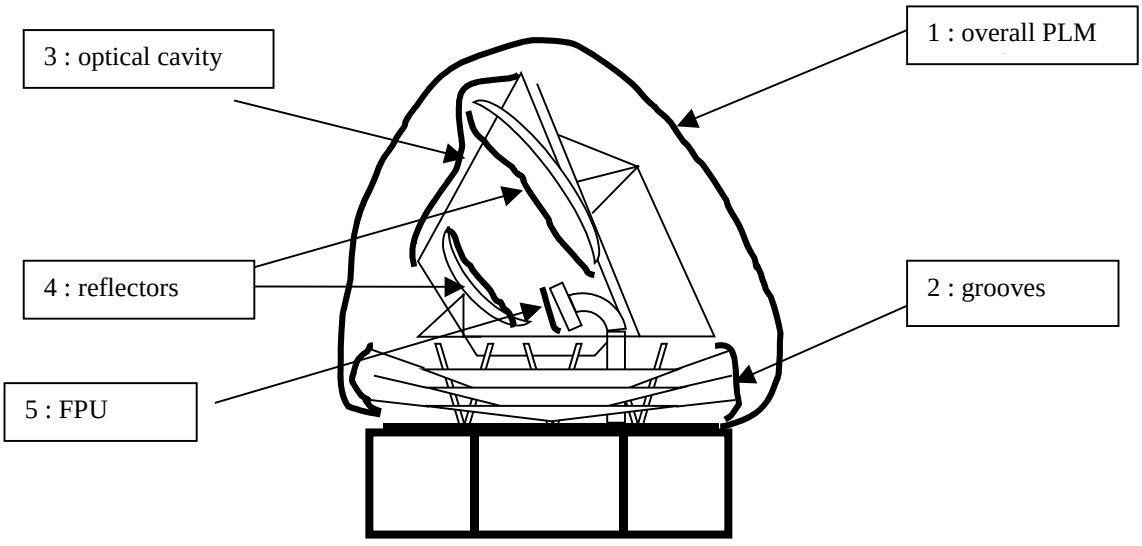


Figure 8: PPLM protections set

The mounting / dismounting of all these protections are explained in [AD12].

SVM will be protected according to [AD10].

4.3 PURGING

The FPU will be purged (requirement to be confirmed and clarified with LFI) with dry air (or nitrogen) during AIT sequence, but not during performance and environmental tests.

0.1 K cooler line will be purged periodically during AIT sequence with pure Helium during one week (TBD).

5. AIT SEQUENCES

This chapter describes the AIT activities at PFM level, from unit/subsystem assembly to system delivery.

ASP takes the assumption that the SVM will be delivered in 2 batches:

- batch 1: WU panels equipped with WU/SVM harness
  - +Y-Z panel (SCS)
  - -Z panel (SCE)
  - -Y-Z panel (SCS)
  - heat pipes for SCS panels
  - +Y panel (HFI: 4K, REU)
  - SVM subplatform
- batch 2: SVM core equipped with TCS + avionic panels
  - → ALS responsibility
    - RCS fully equipped
    - SVM harness set on the lower platform (core harness)
    - -Y panel (TTC)
    - -Y+Z panel (power & CDMS & ACMS)
    - all ACMS units
    - upper panel
  - → ASP responsibility at ALS premises
    - +Y+Z panel integration (HFI & LFI: DCCU & REBA's)
    - 4 helium tanks integration and associated pipes

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 programme and the rearrangements will be proposed and discussed thoroughly.

All operations will be performed at one location at ASP (Cannes), except what concerns the thermal vacuum to be performed at CSL.

The following flow charts describe for each model the main activities of the system level satellite AIT plan.

5.1 PFM assembly, integration and tests

5.1.1 Assembly, Integration and Test logic

The further chapter explains how will be performed the Planck PLM integration. After the delivery from ALS of the SVM core, the PPLM will be set on the cone. The WU panels (already integrated on the EPT) will be mounted and HFI/LFI electrical integration, UFT, SIT will be performed afterwards.

Taken into account the delivery from ASP of the batch 1, and after batch 2, the integration logic of the PPLM is the following:

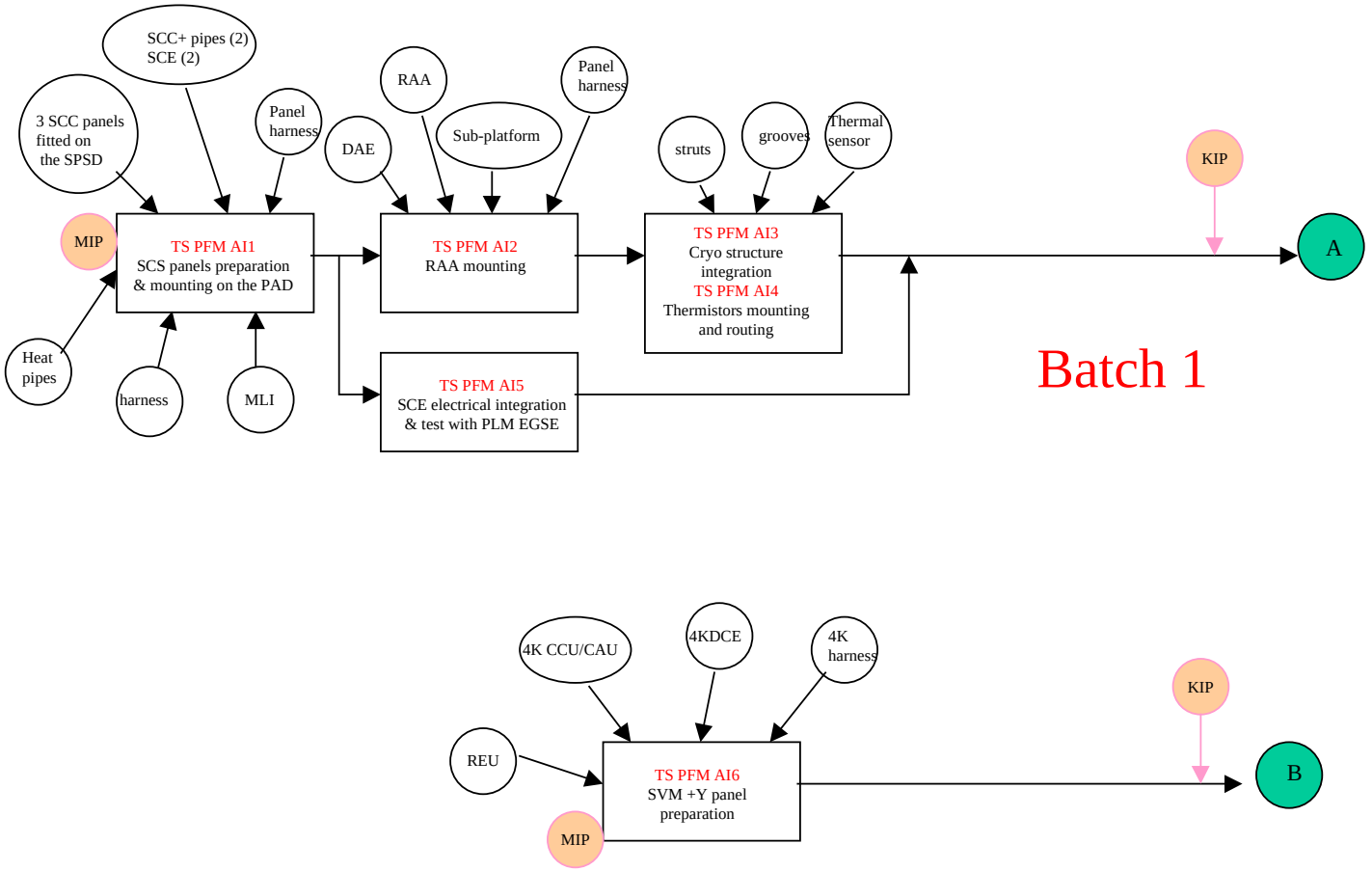
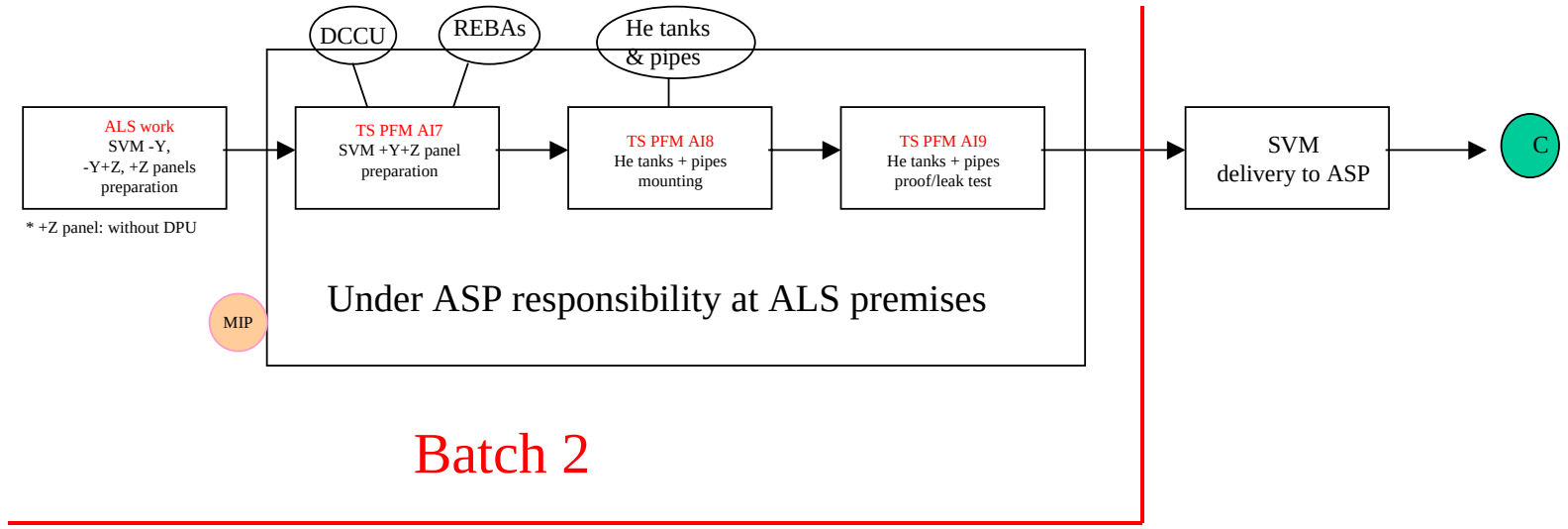
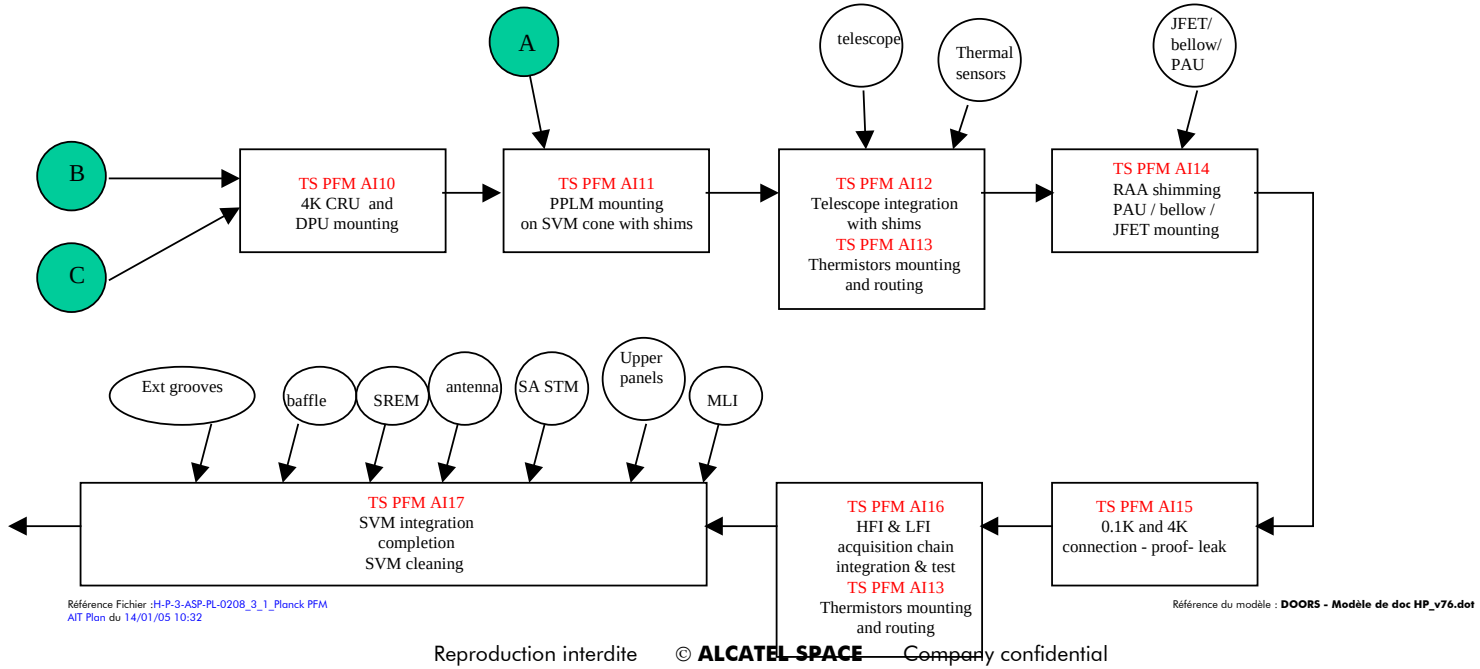


Figure 9: PFM detailed logic





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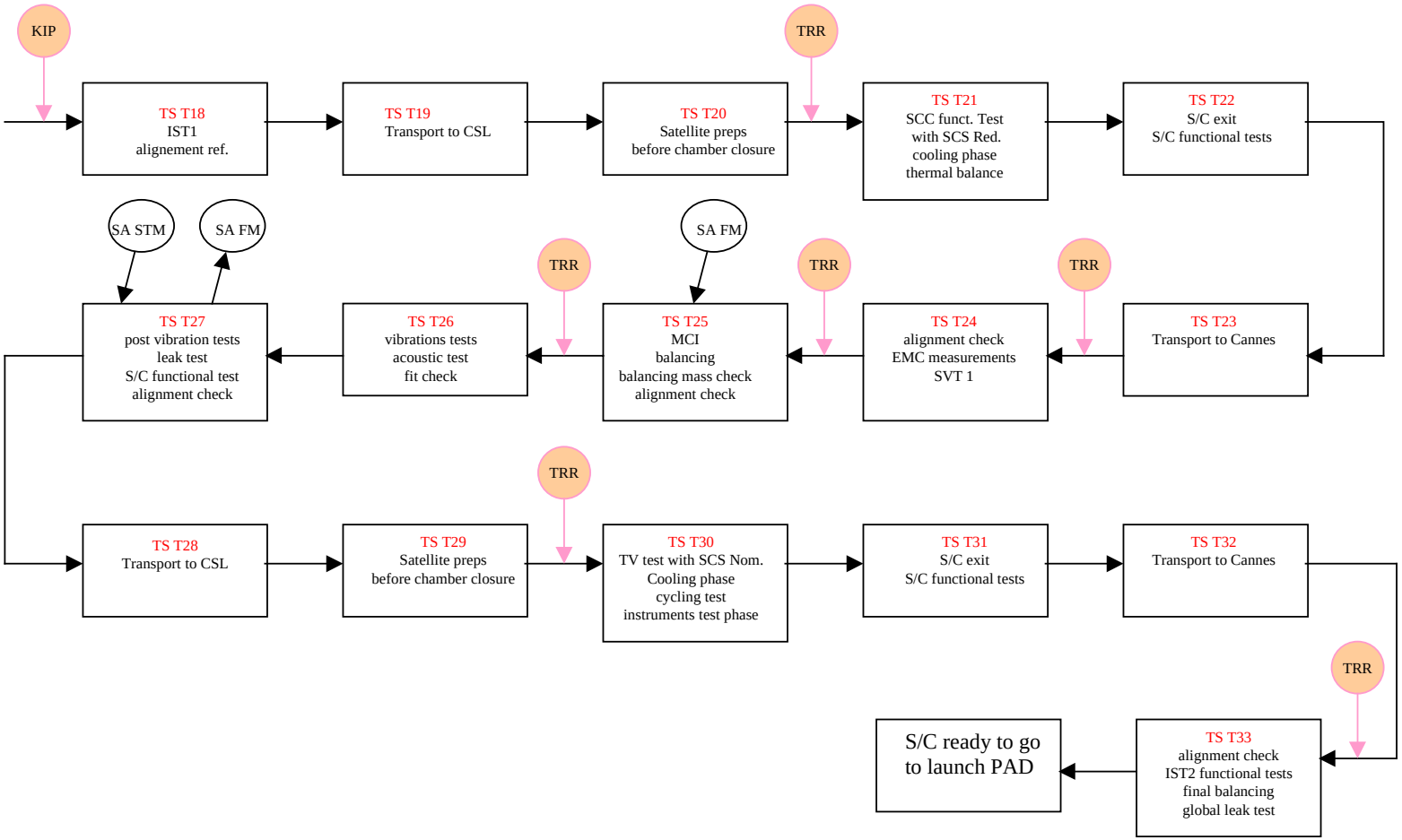


5.1.2 PFM EGSE configuration

5.1.2.1 PPLM integration (batch 1)

As there are neither the power panel nor the CDMS panel, the electronic units will be powered and controlled with the PLM EGSE.

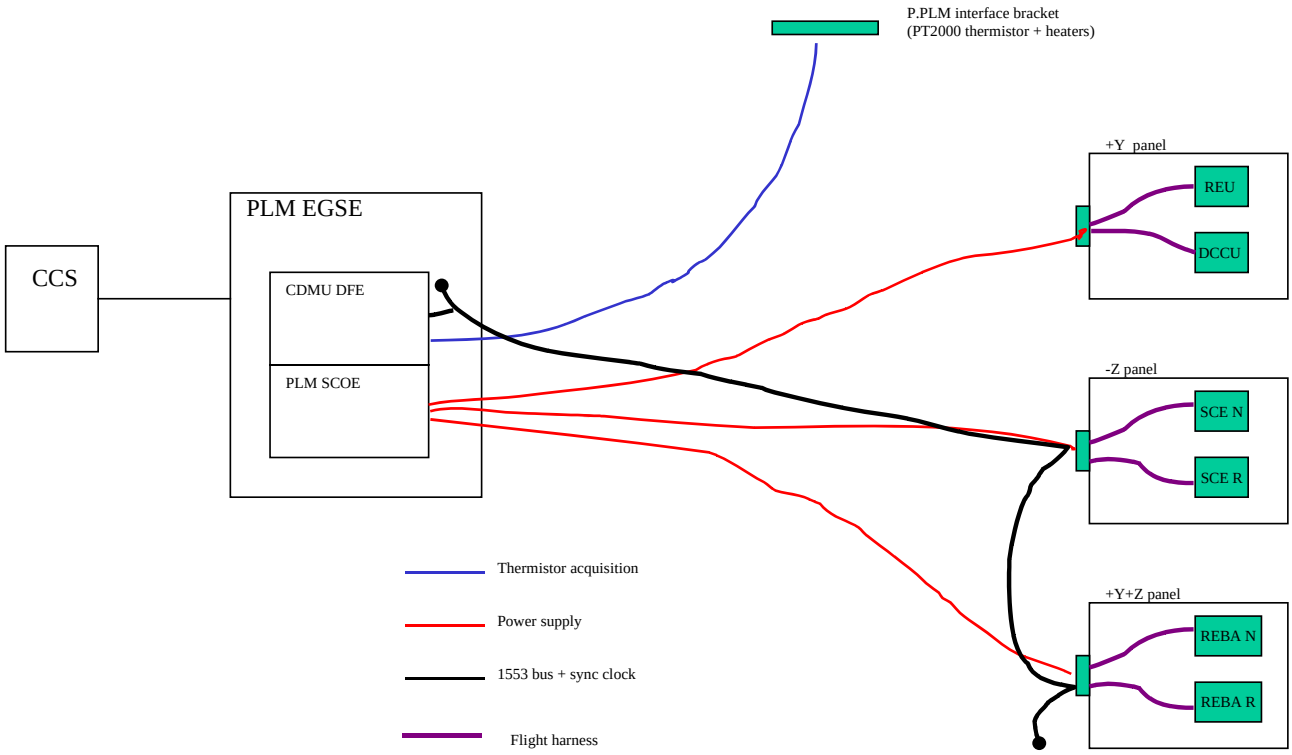
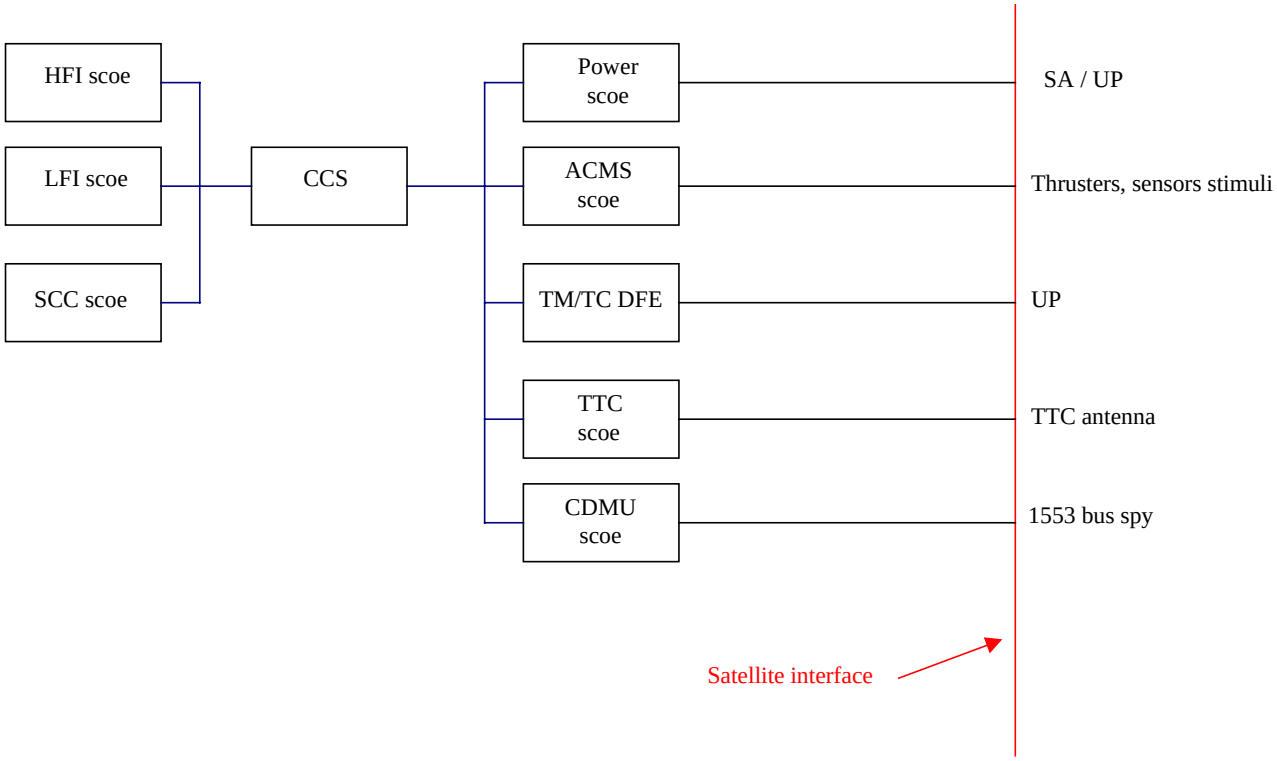


Figure 10: EGSE configuration for batch 1

5.1.2.2 End of integration (batch 2 + satellite testing)



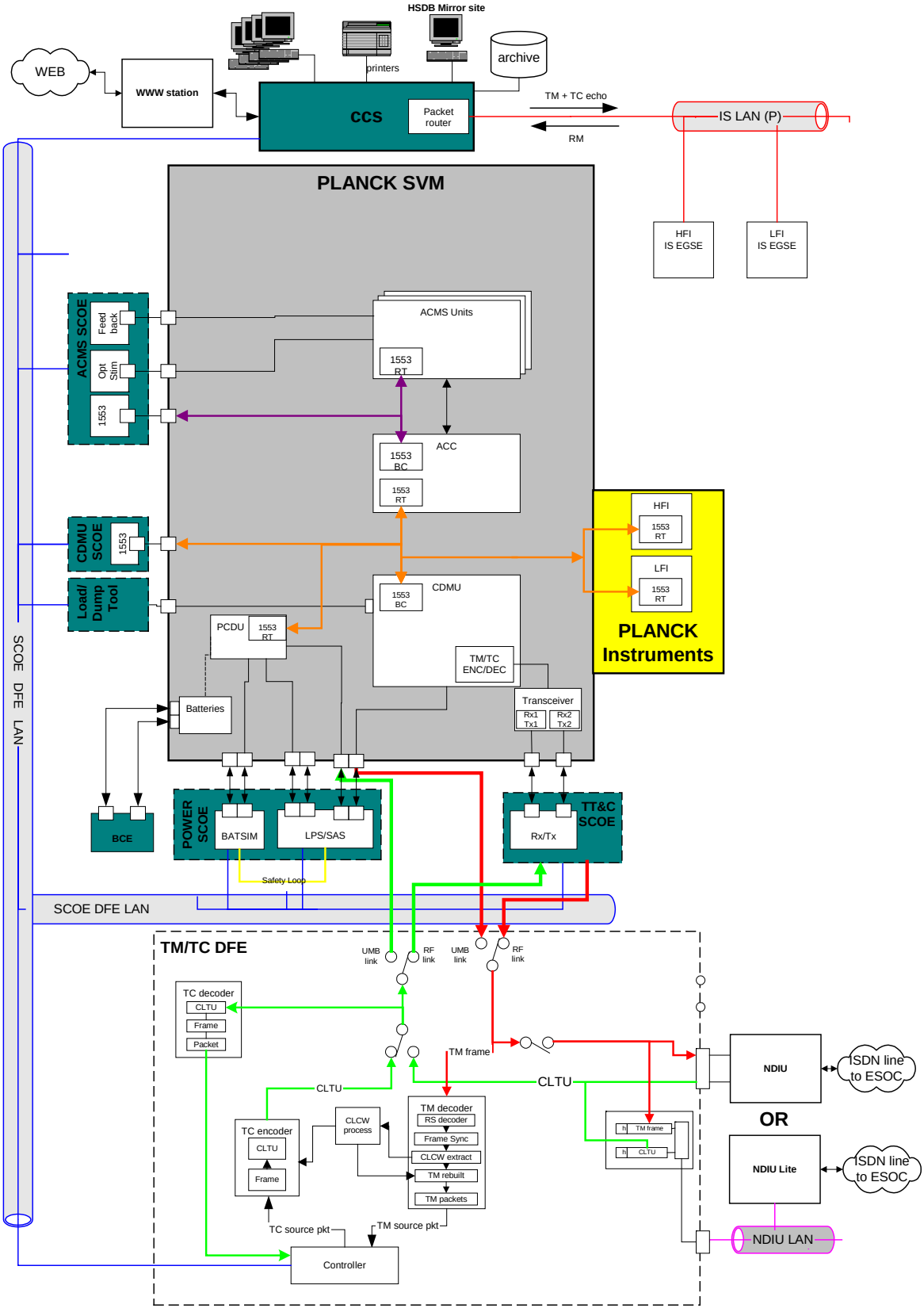


Figure 11: EGSE configuration for batch 2 and satellite level

5.2 PFM task sheets

TS PFM AI 1 : SCS panels preparation & mounting on the PAD	PFM
Duration	Refer to schedule on chapter §5.4
Ambience	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 :
  - SCC WU panels (3) are on SCC Panels Stiffener device (from ALENIA)
  - Heat pipes are in theirs transport stands (from ALENIA)
  - SCE / SCC harness (LFI delivery)
  - SCS panels harness
  - SCC (2) and SCE (2)
  - Hoisting device to integrate the SCC, the three panels
  - SPSD MGSE
  - SID MGSE

- Electrical configuration / EGSE required :
  - N/A

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)
- SCEs mounting on panel
- Harness connection between SCEs and SCCs (LFI responsibility)
- 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

TS PFM AI 2 : RAA mounting	PFM
Duration	Refer to schedule on chapter §5.4
Ambience	Class 100000

Goal :
To mount the RAA on the SVM subplatform

Specimen configuration :

- Mechanical configuration / MGSE required :
  - PAD
  - SVM subplatform
  - RAA hoisting device
  - 3 SCS panels mounted on the PAD.
  - RAA mounted on FPU support stand (from LFI) (0.1K and 4K pipes are connected on FPU side)
  - DAE control box
  - PAU-REU harness
  - BEU-REBA harness
  - BEU-DAE harness

- Electrical configuration / EGSE required :
  - N/A

Activity :

- SVM subplatform set on the PAD.
- PAU-REU harness routing.
- BEU-REBA harness routing.
- BEU-DAE harness routing.
- DAE control box mounting.
- RAA mounting on the subplatform

TS PFM AI 3 : cryo structure integration	PFM
Duration	Refer to schedule on chapter §5.4
Ambience	Class 100000

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

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Three SCS panels mounted
  - Subplatform mounted
  - RAA mounted (not shimmed)
  - 0.1K & 4K pipes integrated, connected on FPU side
  - Grooves
  - struts
  - SCS pipes connected to the SCC
  - Groove supporting tools (from CONTRAVES)
  - Groove hoisting device (from CONTRAVES)
  - Struts supporting tool (from CONTRAVES)
  - DAE control box

- Electrical configuration / EGSE required :
  - 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 fastening on grooves

In parallel with these activities, thermistors sensors activities will be performed (TS PFM AI13)

- Thermal sensors gluing.
- Thermal sensors wires routing to the thermal control bracket (sub platform)
- Thermal sensors continuity, insulation and addressing

TS PFM AI 4: Thermistors installation and routing	PFM
Duration	Refer to schedule on chapter §5.4
Ambience	Class 100000

Goal :
Thermistors gluing on the PPLM (cryo-structure).
Thermistors wires routing and connecting to the bracket located on the subplatform.
Thermistors addressing check.

Specimen configuration :

- Mechanical configuration / MGSE required :
  - This activity will be donein parallel with the PPLM assembly
  - SVM on the VIS
  -
- Electrical configuration / EGSE required :
  - PLM EGSE
  - CCS

Activity:

- Thermistors gluing on the PPLM (cryo-structure, telescope).
- Thermistors wires routing and connecting to the bracket located on the subplatform.
- Thermistors addressing check.

TS PFM AI 5 : SCE electrical integration & test	PFM
Duration	Refer to schedule on chapter §5.4
Ambience	Class 100000

Goal :
Perform the electrical integration of the SCE
Perform UFT.

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Three SCS panels mounted and completely integrated
  - SCC/SCE connected
- Electrical configuration / EGSE required :
  - PLM EGSE
  - CCS
  - I.EGSE

Activity :

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

TS PFM AI 6 : SVM +Y panel preparation (4K + REU)	PFM
Duration	Refer to schedule on chapter §5.4
Ambience	Class 100000

Goal :
4 K + REU panel preparation on EPT

Specimen configuration :

- Mechanical configuration / MGSE required :
  - (+Y) panel on EPT
  - 4K harness between
    - → 4K cooler electronic unit and 4K cooler compressor unit
    - → 4K cooler electronic unit and 4K cooler ancillary unit
  - 4K CCU/CAU unit
  - 4K CDE unit
  - REU unit
  - +Y panel harness

- Electrical configuration / EGSE required :
  - N/A

Activity :

- 4K CDE unit mounting
- 4K CCU/CAU unit mounting
  - harness connection between 4K CDE and 4K CCU/CAU
  - EMC shield mounting
- REU unit mounting
- +Y panel harness connexion
- 4K CDE electrical integration
- 4K CAU/CCU electrical integration

TS PFM AI 7 : SVM +Y+Z panel preparation (0.1K)	PFM
Duration	Refer to schedule on chapter §5.4
Ambience	Class 100000

These activities will take place in ALS premises

Goal :
0.1K panel preparation on EPT
0.1K pipes mounting

Specimen configuration :

- Mechanical configuration / MGSE required :
  - SVM cone equipped with (-Y) and (-Y+Z) panels
  - 0.1K panel (+Z+Y) on EPT
  - DCCE
  - 0.1K filling & venting panel
  - 0.1K panel (+Z+Y) equipped with all the units on EPT
  - CRU
  - REBA (2)
  -
- Electrical configuration / EGSE required :
  - N/A

Activity :

- DCCU mounting on (+Z+Y) panel
- CRU, REBA (2) mounting, with instruments harness
- (+Y+Z) panel transfer from EPT to PTT
- 0.1K filling & venting panel mounting on (+Z+Y) panel
- (+Y+Z) panel harness connection

TS PFM AI 8 : Helium tanks + pipes mouting	PFM
Duration	Refer to schedule on chapter §5.4
Ambience	Class 100000

These activities will take place in ALS premises

Goal :
Perform the complete Helium pipes/tanks integration in the SVM.

Specimen configuration :

- Mechanical configuration / MGSE required :
  - 0.1K pipe & harness
  - 0.1K pipes
  - PGSE
  - He tanks (4)
  - SVM core with (-Y) and (-Y+Z) panels integrated
  - PTT, VIS
  -

- Electrical configuration / EGSE required :
  - N/A

Activity :

- SVM core is on the VIS
- He tanks mounting (4)
- 0.1K pipe connection
- He tanks harness connection to DCCU
- 0.1K pipe connection
- harness connection between tanks and DCCE
- harness REBA/BEU mouting & connection at REBA side
- Inter cryo-harness connection at DCCE side (between DCCE and FPU)

TS PFM AI 9 : Helium pipes proof/leak test	PFM
Duration	Refer to schedule on chapter §5.4
Ambience	Class 100000 TBC by ALS

These activities are under HFI team responsibility and will take place in AMS premises

Goal :

After the complete helium pipes/tanks integration, perform leak check to validate the He circuits..

Specimen configuration :

- Mechanical configuration / MGSE required :
  - SVM core assembly with (-Y) and (-Y+Z) panels
  - 0.1K pipes/tanks completely integrated on DCCU
  - MPT or VIS
  - TF-PGSE & purge/proof /leak gas
- Electrical configuration / EGSE required :
  - N/A

Activity :

- 0.1K pipes proof test **(Hazardous operations)**
- 0.1K pipes leak test

TS PFM AI 10: +Z WU panel preparation (DPU)	PFM
Duration	Refer to schedule on chapter §5.4
Ambience	Class 100000

Goal :
(+Z) WUs panel preparation on EPT

Specimen configuration :

- Mechanical configuration / MGSE required :
  - (+Z) panel on EPT
  - DPU (2)
  - +Z panel harness already integrated by ALS (STR is on the +Z panel)
  - STR already integrated by ALS

- Electrical configuration / EGSE required :
  - N/A

Activity :

- DPU's mounting on the (+Z) panel

TS PFM AI 11 : PPLM mounting on SVM cone	PFM
Duration	Refer to schedule on chapter §5.4
Ambience	Class 100000

Goal :
Payload mating on the SVM.

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Equipped cone on VIS + THA
  - Cryo structure mounted on the subplatform
  - 4K panel integrated
  - 0.1K panel integrated
  - (+Z) panel integrated
  - CRU integrated
  - (-Y) and (-Y+Z) panels integrated

- Electrical configuration / EGSE required :
  - N/A

Activity:

- PPLM vertical hoisting device mating on payload
- PPLM transfer to the SVM
- SVM/subplatform fixation
- SVM/SCS panels fixation
- SVM/4K panel fixation
- 0.1K pipes connection between subplatform interface and the DCCU
- 0.1K and 4K leak tests (HFI responsibility)
- 4K pipes proof tests (HFI responsibility)
- 0.1K cryo harness connection at subplatform interface
- 4K CRU integration

TS PFM AI 12 : Telescope integration	PFM
Duration	Refer to schedule on chapter §5.4
Ambience	Class 100000

Goal :
Telescope integration on the SVM.

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Cryo structure mounted on SVM
  - SVM on the VIS
  - Telescope in its container

- Electrical configuration / EGSE required :
  - N/A

Activity:

- Telescope set outside its container
- Telescope vertical hoisting device mating on telescope
- Telescope transfer on the cryo structure
- Telescope/Cryostructure shimming
- MLI/SLI installation inside the optical cavity

In parallel with these activities, thermistors sensors activities will be performed (TS PFM AI18)

- Thermal sensors gluing.
- Thermal sensors wires routing to the thermal control bracket (sub platform)
- Thermal sensors continuity, insulation and addressing

TS PFM AI 13 : Thermistors mounting and routing	PFM
Duration	Refer to schedule on chapter §5.4
Ambience	Class 100000

Goal :

Thermistors gluing on the PPLM (cryo-structure, telescope).
Thermistors wires routing and connecting to the bracket located on the subplatform.
Thermistors addressing check.

Specimen configuration :

- Mechanical configuration / MGSE required :
  - This activity will be donein parallel with the PPLM assembly
  - SVM on the VIS
  -
- Electrical configuration / EGSE required :
  - PLM EGSE
  - CCS

Activity:

- Thermistors gluing on the PPLM (cryo-structure, telescope).
- Thermistors wires routing and connecting to the bracket located on the subplatform.
- Thermistors addressing check.

TS PFM AI 14 : RAA shimming, PAU/bellow/JFET mounting	PFM
Duration	Refer to schedule on chapter §5.4
Ambience	Class 100000

Goal :
RAA final mating
Baffle mounting
Last connections

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Telescope & cryo structure mounted on SVM
  - All cryo harness connected
  - SVM on the VIS
  - RAA hoisting device
  - JFET/Bellow/PAU mounted on dedicated MGSE (HFI)
  - 4K CRU

- Electrical configuration / EGSE required :
  - PLM EGSE
  - CSS

Activity:

- RAA hoisting device set on the RAA
- RAA shimming
  - Telescope/FPUs shims
  - BEU/subplatform shims
  - RAA Secondary structure/PLM
- RAA hoisting device disassembly and RAA MGSE removal
- 0.1 K & 4 K , 20K pipes fixation at FPU side (and shimming on groove 3)
- JFET/Bellow/PAU mounting and connecting (with HFI support)
- HFI FPU bellow connection to JFET (HFI responsibility TBC)
- PAU connection
- REU connection
- BEU/DAE control box connection
- REBA/BEU harness connection at BEU side
- Panel closure
- SLI mounting
- PPLM cleaning
- Protection cover installation on the baffle
- Protection cover installation on the groove
- Over PPLM protection cover installation
- MLI installation on subplatform

TS PFM AI 15 : 0.1K and 4K connection	PFM
Duration	Refer to schedule on chapter §5.4
Ambience	Class 100000

Goal :
Pipes connection finalisation

Specimen configuration :

- Mechanical configuration / MGSE required :
  - PPLM mounted on the SVM
  - All kateral panels connected
  - TF-PGSE & gaz
  - 4 K PGSE & gas
  - 20 K PGSE & gas (TBC)

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

Activity :

- 0.1K pipes connection at PPLM/SVM interface
- 4K pipes connection at PPLM/SVM interface
- 20K, 0.1K, 4K pipes leak test (HFI responsibility)
- 0.1K, 4K pipes purges test (HFI responsibility)
-

TS PFM AI 16 : HFI & LFI acquisition chain acquisition chain: I&T	PFM
Duration	Refer to schedule on chapter §5.4
Ambience	Class 100000

Goal :
Perform LFI/HFI instruments electrical integration
Perform LFI/HFI instruments UFT

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Satellite on the MPT
  - REBA, BEU mechanically integrated
  - DPU, REU, PAU, JFET mechanically integrated
  - 0.1K DCCU mechanically integrated
  - 4K CDE mechanically integrated
  - 4K cooler & CAU mechanically integrated

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

Activity:

- REBA, BEU electrical integration & UFT
- DPU, REU, PAU electrical integration & UFT
- 0.1K DCCU electrical integration & UFT
- 4K CDE electrical integration & UFT
- 4K cooler & CAU electrical integration & UFT
- LFI acquisition chain SIT
- HFI acquisition chain SIT
- 20K cooler chain SIT
- 4K cooler chain SIT
- 0.1K cooler chain SIT

TS PFM AI 17 : SVM integration completion – SVM cleaning	PFM
Duration	Refer to schedule on chapter §5.4
Ambience	Class 100000

Goal :
Complete the satellite integration

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Satellite on the VIS or MPT

- Electrical configuration / EGSE required :
  - N/A

Activity:

- MLI mounting
- STM solar array (central part) mounting
- Upper panels closure
- Antenna, SREM mounting
- External solar array fit-check
- PPLM cleaning
- Baffle mounting
- External grooves mounting
- SLI mounting
- Protective cover installation

TS PFM T 18 : IST1 before thermal test - alignment check	PFM
Duration	Refer to schedule on chapter §5.4
Ambience	Class 100000

Goal :
Perform functionality test on all the different chains of Planck PLM

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Satellite completely integrated on the MPT or VIS
  - Theodolites

- Electrical configuration / EGSE required :
  - N/A

Activity:

- First integrated system test after satellite integration completion
- Alignment reference
  - SC axis determination
  - ACMS equipments reference position
  - Thrusters alignments (orientation adjustment)
  - Telescope/FPUs/Reflectors reference positions
- Final external SVM MLI
-

TS PFM T 19 : Transport to CSL	PFM
Duration	Refer to schedule on chapter §5.4
Ambience	Class 100000

Goal :
Satellite preparation before transport.
Satellite transport from Cannes to CSL

Specimen configuration :

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

- Electrical configuration / EGSE required :
  - N/A

Activity:

- S/C preparation before transport
  - 4K cooler lock (20 K cooler TBC)
- 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

TS PFM T 20 : Satellite preps before chamber closure	PFM
Duration	Refer to schedule on chapter §5.4
Ambience	Class 100000

Goal :
Preparation of the satellite inside the thermal vacuum chamber

Specimen configuration :

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

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

Activity:

- EGSE/MGSE unpacking
- EGSE validation
- Thermocouples installation & routing
- STM SA external part mounting
- 4K compressor unlocked (20 K TBC)
- thermal configuration outside the chamber (MLI, test heaters……)
- battery charge
- 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

TS PFM T 21 : TV test with SCS Red.	PFM
Duration	Refer to schedule on chapter §5.4
Ambience	Class 100000

Goal :

This test will permit to validate the SCS early in the AIT test phase. The 20K temperature at FPU side will be checked. This first thermal vacuum test can be split in 2 parts:

→ SCS functional test (redundant one)
→ Thermal balance

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Satellite inside the chamber
  -
- Electrical configuration / EGSE required :
  - Power scoe
  - TM/TC DFE
  - TTC RF scoe
  - CDMU scoe
  - ACMS scoe
  - I.EGSE
  - CCS

Activity:

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

TS PFM T 22 : S/C exit – S/C functional tests	PFM
Duration	Refer to schedule on chapter §5.4
Ambience	Class 100000

Goal :
Satellite exit from the chamber.
Satellite functional tests

Specimen configuration :

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

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

Activity:

- All test equipment disconnection
- Thermocouples dismounting
- Shrouds dismounting
- Tests MLI & STM SA external part removal
- Satellite transfer to the MPT
- Protective cover installation
- Upper panel dismounting
- All test equipment reconnection
- Satellite functional tests (SFT)
-

TS PFM T 23 : Transport to Cannes	PFM
Duration	Refer to schedule on chapter §5.4
Ambience	Class 100000

Goal :
Satellite preparation before transport
Satellite transport from CSL to Cannes

Specimen configuration :

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

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

Activity:

- S/C preparation before transport
  - 4K cooler lock (20 K cooler TBC)
- 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
-
-

TS PFM T 24 : alignment check, EMC measurements, SVT1	PFM
Duration	Refer to schedule on chapter §5.4
Ambience	Class 100000

Goal :

Perform alignment measurement and compare with IST1 (task T18)
Perform EMC tests and ambient RF test
Perform SVT1

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Satellite on MPT with protective covers
  -
- Electrical configuration / EGSE required :
  - Power scoe
  - TM/TC DFE
  - TTC RF scoe (TBC)
  - ACMS scoe
  - CDMU scoe
  - NDIU for SVT1 (under ESA responsibility)
  - I.EGSE
  - CCS
  -

Activity:

- alignment check
- EMC CE/CS measurements at ambient temperature
- Transfer to compact range
- EMC RE/RS measurements at ambient temperature
- Transfer/alignment on the positioner of the CATR
- RF measurement : main lobe and far out side lobe measurements, by spherical cuts
- Transfer to clean room
- SVT1
-

TS PFM T 25 : MCI, balancing, balancing mass check	PFM
Duration	Refer to schedule on chapter §5.4
Ambience	Class 100000

Goal :
Perform mechanical system test

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Satellite completely integrated
  - MCI MGSE
  - Rotation table
  - Specific MGSE for balancing test

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

Activity:

- solar array FM mounting
- Mass, centre of gravity, inertial axes measurements

Balancing (and masses balancing mounting)

TS PFM T 26 : vibration tests, acoustic test, fit check and clamp band release Preliminary electrical fit-check with ACU harness	PFM
Duration	Refer to schedule on chapter §5.4
Ambience	Class 100000

Goal :
Perform vibration tests and launch adapter fit-check

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Satellite completely integrated
  - All accelerometer instrumentation done & check
  - RCS TGSE & simulation propellant & gas
  - TF-PGSE & gas
  - μvibration shaker
  - Flight ACU and clamp-band to be provided by Arianespace with dedicated GSE
  - ACU umbilical harness , SLOT to be provided by Arianespace

- Electrical configuration / EGSE required :
  - Power scoe
  - TM/TC DFE
  - CCS
  - COTE/cables A & C/SLOT and SC FE simulator

Activity:

- 0.1K pipes/tanks pressurisation
- RCS filing & pressurisation
- μ-vibration test
- Sinus vibration test (qualification level)
- Acoustic test (qualification level)
- RCS draining, drying
- ACU Mechanical & electrical fit-check
- Clamp band release
- In parallel, preliminary electrical fit-check is performed using ACU umbilical harness

TS PFM T 27 : post vibration tests, leak test, S/C functional test, alignment check	PFM
Duration	Refer to schedule on chapter §5.4
Ambience	Class 100000

Goal :
Perform functionality test after vibration check.
Perform pipes & propulsion health check

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Satellite completely integrated
  - TF-PGSE & gas
  - 20 & 4 K PGSE (TBD)
  - RCS TGSE
  -

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

Activity:

- 0.1K & 4K leak test (HFI responsibility)
- RCS leak test
- Satellite functional test (SFT)
- Alignment check
- FM SA dismounting (for flasher test in stand alone)
- STM SA central part mounting

TS PFM T 28 : Transport to CSL	PFM
Duration	Refer to schedule on chapter §5.4
Ambience	Class 100000

Goal :
Satellite preparation before transport.
Satellite transport from Cannes to CSL

Specimen configuration :

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

- Electrical configuration / EGSE required :
  - N/A

Activity:

- S/C preparation before transport
  - 4 K cooler lock (20 K cooler TBC)
- 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

TS PFM T 29 : Satellite preps before chamber closure	PFM
Duration	Refer to schedule on chapter §5.4
Ambience	Class 100000

Goal :
Preparation of the satellite inside the thermal vacuum chamber

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Satellite on the MPT
  - TF-PGSE and He ¾
  -

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

Activity:

- EGSE/MGSE unpacking
- EGSE validation
- Thermocouples installation & routing
- STM SA external part mounting
- 4K compressor unlocked (20 K cooler TBC)
- thermal configuration outside the chamber (MLI, test heaters……)
- battery charge
- He ¾ tanks filling
- STM SA external parts mounting
- 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

TS PFM T 30: TV test with SCS Nom	PFM
Duration	Refer to schedule on chapter §5.4
Ambience	Class 100000

Goal :

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

→ Cryogenic test – detection chains end to end test
→ Thermal cycling test

Specimen configuration :

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

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

Activity:

- Vacuum phase
- Cooling phase
- Thermal cycling phase
- Instruments test phase
- Chamber pressurisation
- Chamber opening
- Chamber inspection
-

TS PFM T 31 : S/C exit – S/C functional tests	PFM
Duration	Refer to schedule on chapter §5.4
Ambience	Class 100000

Goal :
Satellite exit from the chamber.
Satellite functional tests

Specimen configuration :

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

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

Activity:

- All test equipment disconnection
- Thermocouples dismounting
- Shrouds dismounting
- Tests MLI & STM SA external part removal
- Satellite transfer to the MPT
- Protective cover installation
- Upper panel dismounting
- All test equipment reconnection
- Satellite functional tests (SFT)
-

TS PFM T 32 : Transport to Cannes	PFM
Duration	Refer to schedule on chapter §5.4
Ambience	Class 100000

Goal :
Satellite preparation before transport
Satellite transport from CSL to Cannes

Specimen configuration :

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

TS PFM T 33 : alignment check, IST2 functional tests, final balancing, global leak test	PFM
Duration	Refer to schedule on chapter §5.4
Ambience	Class 100000

Goal :
Perform final performances tests before satellite delivery

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Satellite completely integrated
  - RCS TGSE & specific gas
  - SC container

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

Activity:

- Satellite transfer to MPT
- Alignment check
- IST2 functional tests
- Protection cover removal
- FM SA mounting
- Final balancing
- Protection cover installation
- External FM SA removal
- Satellite into its container
- Global leak test

5.3 Tests Matrix

Chapter to be updated accordingly with AD 1

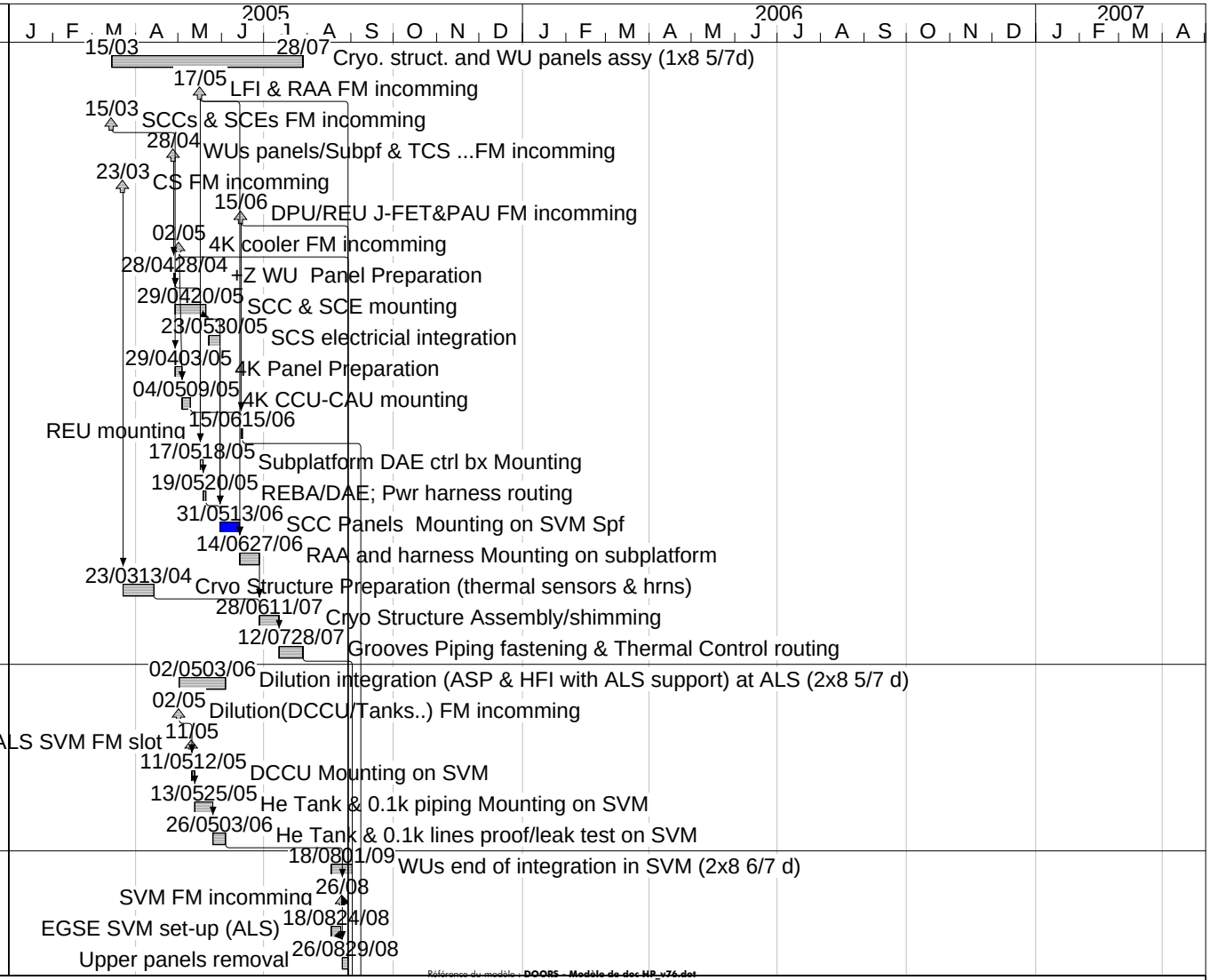
5.4 Schedule

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

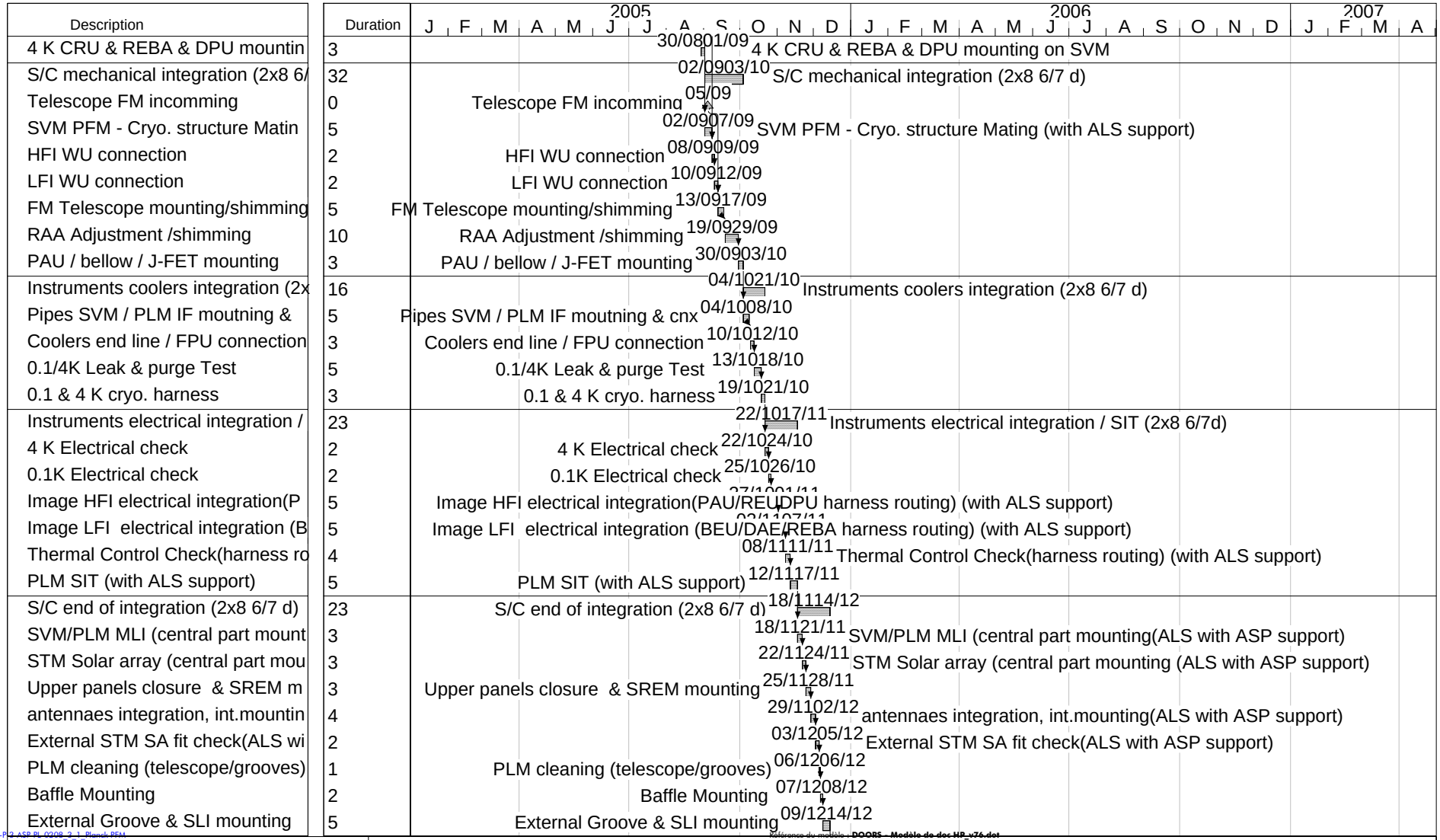
Planck FM

22JUL04

Description	Duration
Cryo. struct. and WU panels assy	95
LFI & RAA FM incomming	0
SCCs & SCEs FM incomming	0
WUs panels/Subpf & TCS ...FM in	0
CS FM incomming	0
DPU/REU J-FET&PAU FM incom	0
4K cooler FM incomming	0
+Z WU Panel Preparation	1
SCC & SCE mounting	15
SCS electricial integration	6
4K Panel Preparation	3
4K CCU-CAU mounting	4
REU mounting	1
Subplatform DAE ctrl bx Mounting	2
REBA/DAE; Pwr harness routing	2
SCC Panels Mounting on SVM S	10
RAA and harness Mounting on su	10
Cryo Structure Preparation (therm	15
Cryo Structure Assembly/shimmin	10
Grooves Piping fastening & Therm	12
Dilution integration (ASP & HFI wit	24
Dilution(DCCU/Tanks..) FM incom	0
ALS SVM FM slot	0
DCCU Mounting on SVM	2
He Tank & 0.1k piping Mounting o	8
He Tank & 0.1k lines proof/leak te	7
WUs end of integration in SVM (2	15
SVM FM incomming	0
EGSE SVM set-up (ALS)	5
Upper panels removal	3



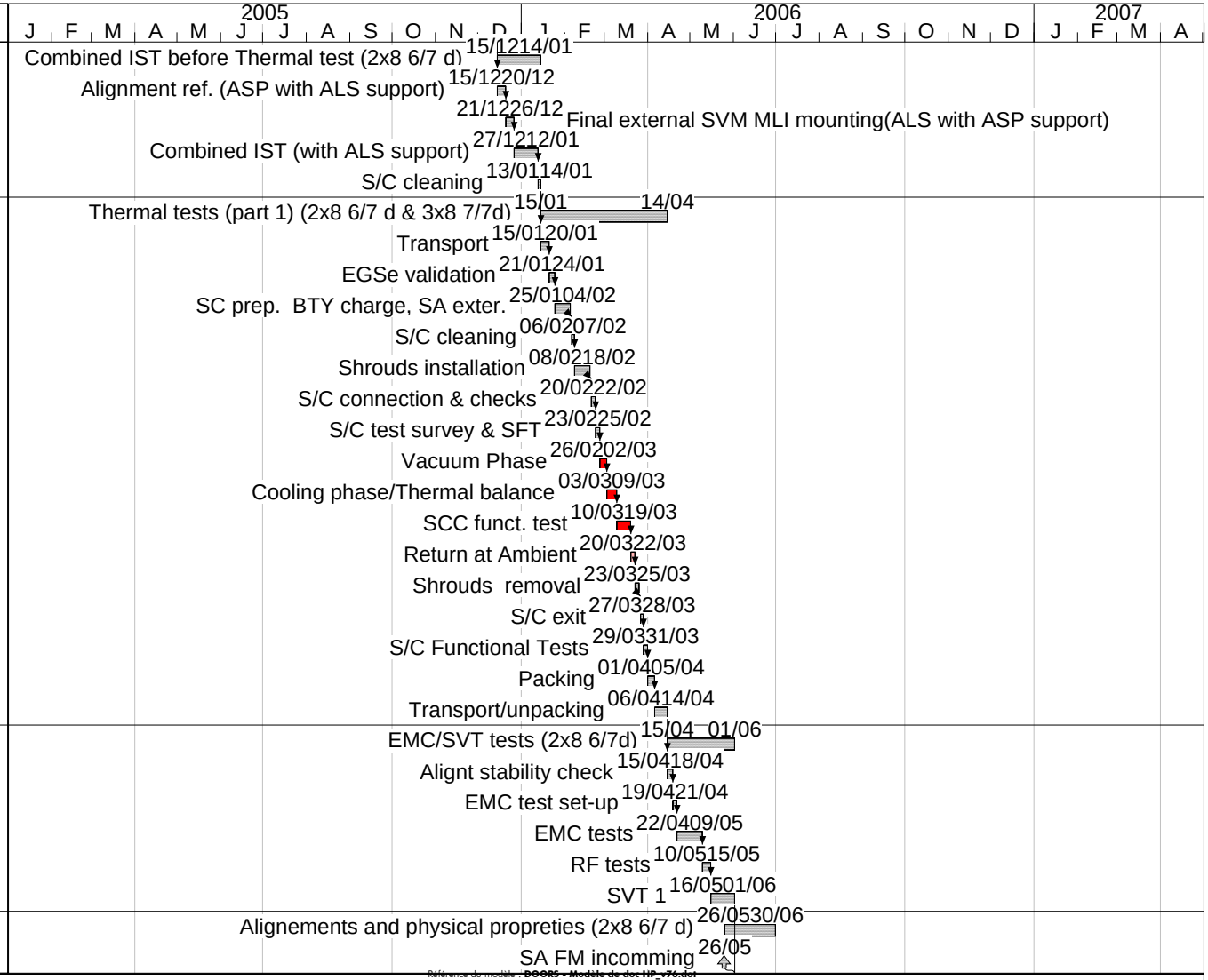
Planck FM



Planck FM

10DEC04

Description	Duration
Combined IST before Thermal test	27
Alignment ref. (ASP with ALS sup	5
Final external SVM MLI mounting(	5
Combined IST (with ALS support)	15
S/C cleaning	2
Thermal tests (part 1) (2x8 6/7 d &	90
Transport	6
EGSe validation	3
SC prep. BTY charge, SA exter.	10
S/C cleaning	2
Shrouds installation	10
S/C connection & checks	3
S/C test survey & SFT	3
Vacuum Phase	5
Cooling phase/Thermal balance	7
SCC funct. test	10
Return at Ambient	3
Shrouds removal	3
S/C exit	2
S/C Functional Tests	3
Packing	4
Transport/unpacking	9
EMC/SVT tests (2x8 6/7d)	41
Alignt stability check	3
EMC test set-up	3
EMC tests	15
RF tests	5
SVT 1	15
Alignements and physical propreti	36
SA FM incomming	0

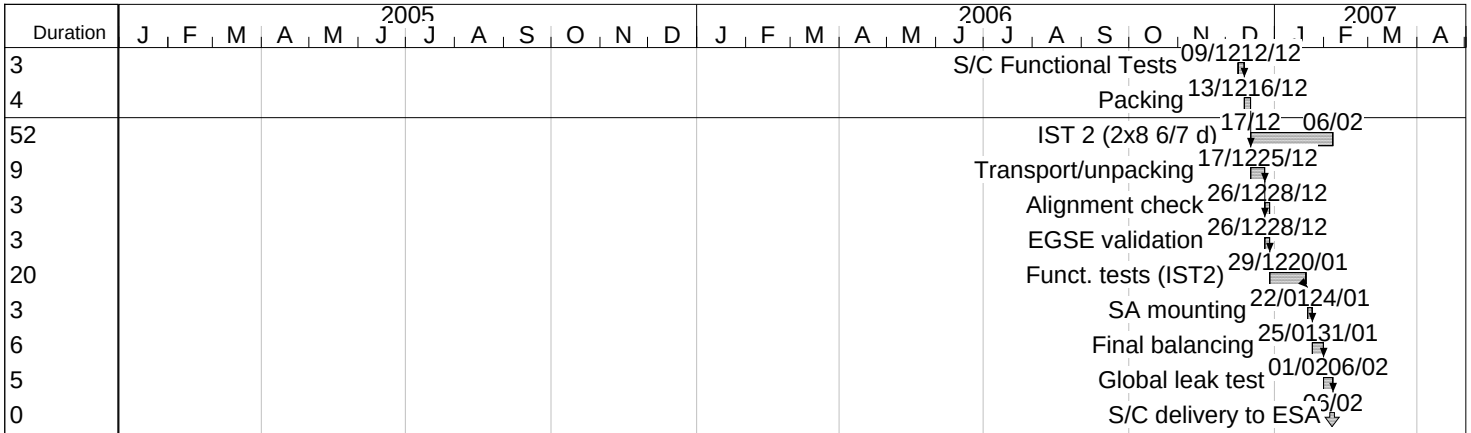


Planck FM

10DEC04

Description	Duration	Start	Finish
SA FM mounting	4	02/06	06/06
MCI	8	07/06	15/06
Balancing	6	16/06	22/06
Balancing mass & Alignment chec	7	23/06	30/06
Vibrations tests (1 & 2x8 6/7 d)	31	01/07	05/08
Vibrations set up (instrum.)/0.1 K l	5	01/07	06/07
RCS filing	3	07/07	10/07
µvib	3	11/07	13/07
Vibration & Acoustic	20	14/07	05/08
Post Virations tests (2x8 6/7 d)	25	07/08	04/09
Leak Test 0,1K; 4K	3	07/08	09/08
RCS Draining & Drying & Leak Te	5	10/08	15/08
Mecha & elect. Fit check	2	16/08	17/08
S/CFunctional Tests	7	18/08	25/08
Alignment check	3	18/08	21/08
FM SA dismount., Instrum. replac	8	26/08	04/09
Thermal tests (part 2) (2x8 6/7 d 3	103	05/09	16/12
Transport	6	05/09	10/09
EGSe validation	3	11/09	13/09
SC prep. BTY charge, SA exter.,	14	14/09	29/09
S/C cleaning	2	30/09	02/10
Shrouds installation	10	03/10	13/10
S/C connection & SFT	6	14/10	20/10
Cooling leak tests	2	21/10	23/10
Vacuum Phase	5	24/10	28/10
Cooling phase/Thermal balance	7	29/10	04/11
Instruments test phase	25	05/11	29/11
Return at Ambient	3	30/11	02/12
Shrouds removal	3	04/12	06/12
S/C exit	2	07/12	08/12

Planck FM



6. MANAGEMENT AND ORGANISATION

6.1 AIT TASKS

ALCATEL 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 ALCATEL will use an AIT team raising specialists of different engineering specialities already involved to the maximum extent in subsystem or module level testing in ALCATEL 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 ALCATEL AIT responsible supported by Test engineers.

6.2.1.1 Preliminary phase

This concerns the AIT activities to be performed early in the AIT programme, 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.

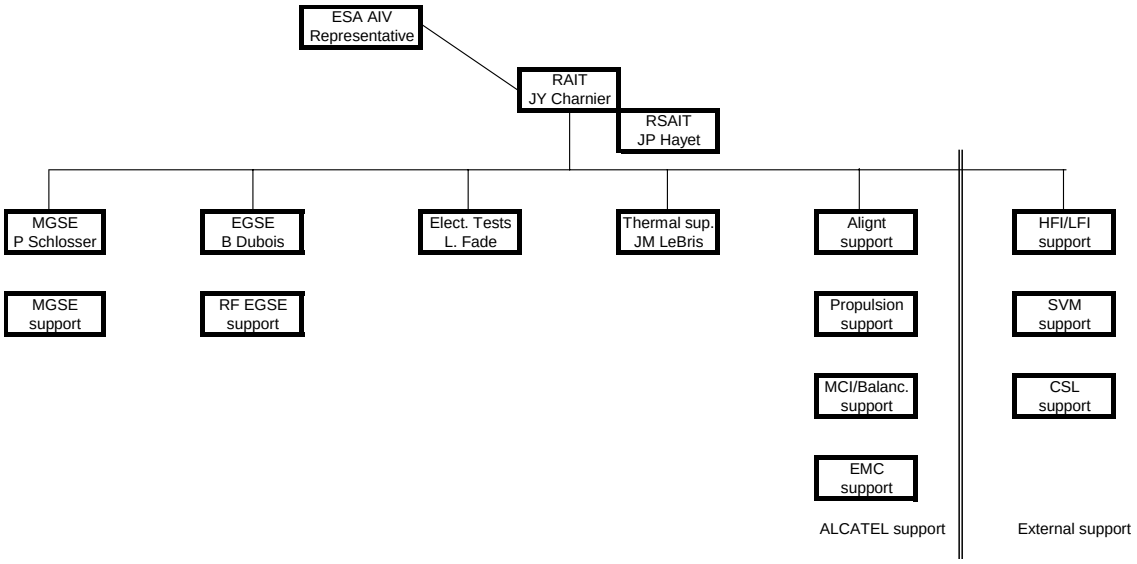


Figure 12: AIT team organisation for preliminary phase

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 ALCATEL (and by incorporation of personnel coming from other Contractors in PLANCK system

test activities). This integrated team will be under the authority of the ALCATEL 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 responsibles. 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

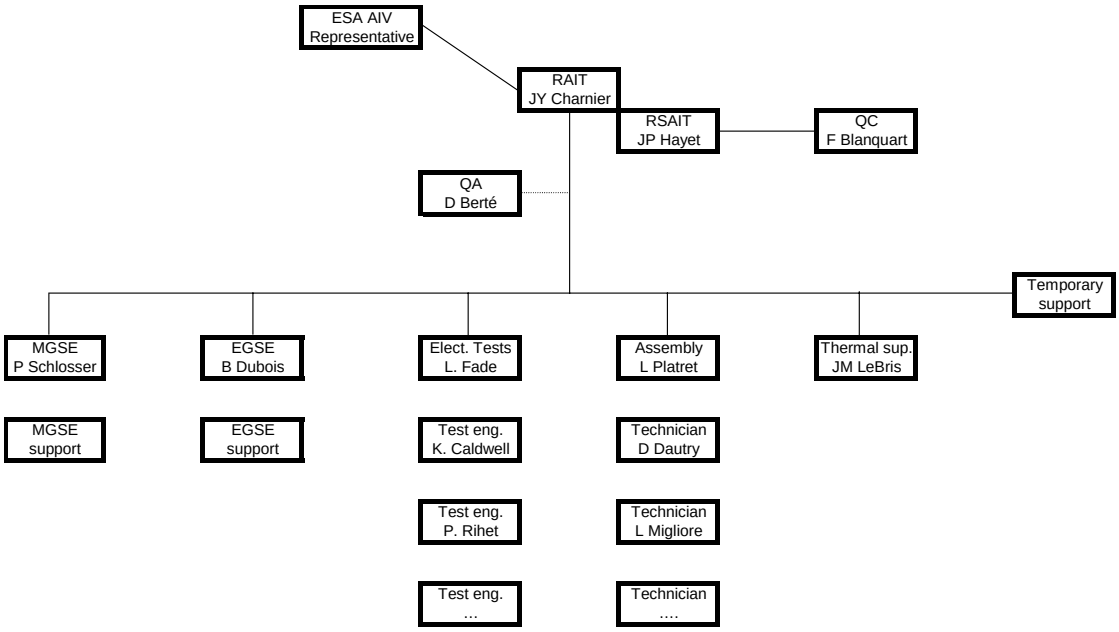


Figure 13: ALCATEL AIT core team

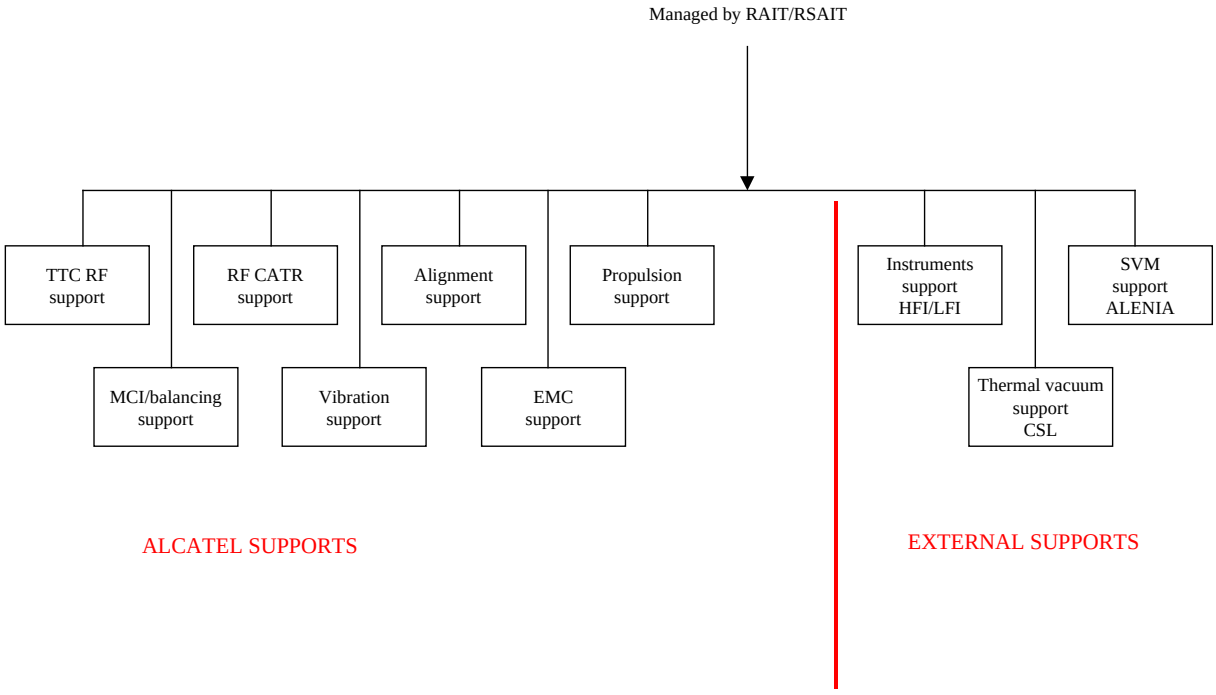


Figure 14: AIT temporary support

6.2.2 AIT responsibility

The ALCATEL 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 ALCATEL AIT responsible directly reports to the ALCATEL Project Manager.

He has to organise and co-ordinate the necessary manpower effort such as the engineering support of ALCATEL 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 ALCATEL 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).
- All HFI and LFI MIB files delivery for HPSDB populating.
- ASP help for the test requirement sheets writing.
- Cryo harness connection support around the FPU (TBC)
- Pipes proof, leak and purge test on 4K and 0.1K

- 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.
- He tanks filling with He3 and He4.

6.2.4 Interfaces with the ESA project team

As responsible for system level AIT the ALCATEL 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 logsheets 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 Alcatel
- 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:

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

- During test operations

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

- all test operations are conducted only according to approved procedures and in the presence of a QC representative
- operations to be performed are confirmed at a daily briefing, normally held each morning before starting the daily activities
- access to test areas is restricted only to a limited number of authorised personnel
- 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
- any non conformance has to be immediately raised and analysed before authorising proceeding with testing
- 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:

- verification that all required tasks have been performed and that results are approved and signed by the responsible engineer
- collection and archiving of all test results
- analysis of deviations, schedule impacts, work around solutions to be presented at the next daily briefing
- 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:
  - AIT weekly planning and report
  - AIT log sheet
  - Test procedures (Red line working copy As run procedure)
  - All AIT forms used for change recording during tests
  - Test reports.

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

The diagram of operational utilisation of different AIT forms :

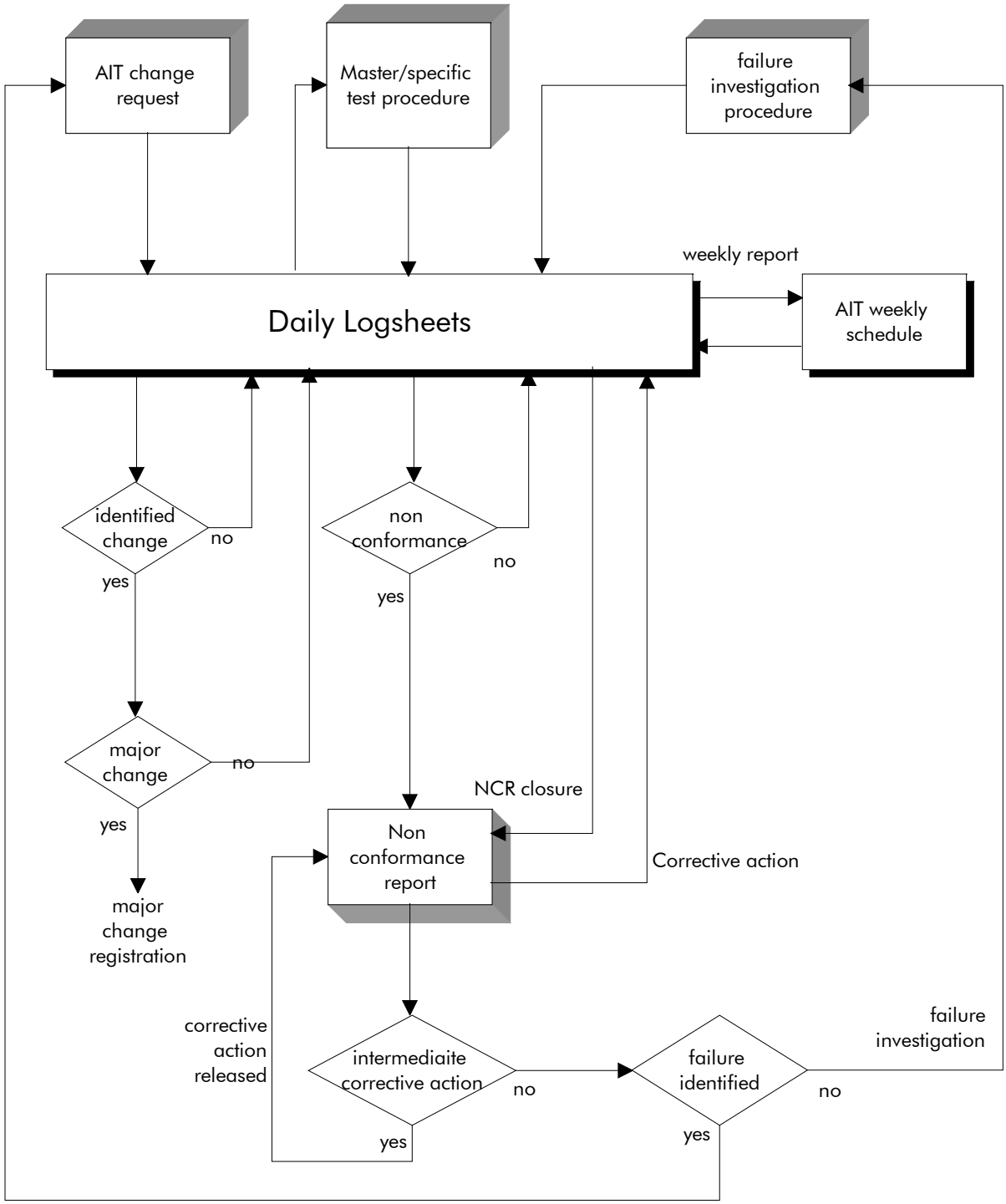


Figure 15: operational diagram - use of different AIT forms

- 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:

  - proposed immediate corrective action

  - elements of decision for the current test

  - 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 logsheets allow to keep track day by day all operations performed on the model. The necessary cross coupling between the logsheets 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 plannings 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 logsheet, 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 logsheets

- Definition

As already explained before, the daily logsheet 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 logsheets 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-FIP...)

The column "remarks" will give complementary informations 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 logsheet and attests in particular the closure of all NCR's issued in the framework of this logsheet and the configuration status when concerned.

When filled out, the logsheet shall contain the following informations:

- task definition
- test procedure (Nr, Issue, Rev.) or classed as document (ACR, FIP)
- test conductor and operators identification
- starting and ending time
- identification of units to be integrated if any (type, serial number)
- status of RCS/coolers if concerned (pressure, gas...)
- clear identification of hazardous operations
- mention of tasks for which a special care has to be paid (QA attendance, special process, critical points, SPF...)
- non conformances (NCR's)
- open works
- AIT change requests
- informations 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, STM, and 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 - ALCATEL 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 logsheet) 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:
  - when the stated event needs a failure analysis and/or a failure investigation (see corresponding form)
  - 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.

6.3.6.3 Failure Investigation Procedure (FIP)

The FIP has the effect to hold the current procedure and to start another procedure with a completely different objective, so it can be considered as a major modification of test.

Such a decision requires, as for the ACR, the formal agreement of a board where engineering, AIT and QA have to be represented.

The FIP is issued after issuing a NCR when the failure needs complementary investigations to be characterised, located, explained, and sometimes corrected. So the FIP is referenced to the NCR and after a short identification of failure, and a definition of investigation objective (given in § failure analysis) has to be worded as a step by step procedure.

When the FIP has been run it becomes possible to take appropriate action concerning the test: restart - continue - hold - delete - delay...

A FIP gives rise to a specific test report, which could be included in the NCR file.

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 programme. 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.

ALCATEL is responsible to call the TRR or PTR, upon completion of the relevant prerequisite activities; ALCATEL is chairing the TRR/PTR, ALCATEL 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 responsibilitie
- 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 16: TRR check list

7.3.2 TRB objectives

The objectives of the Test Review Board 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 17: TRB 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 programme 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 (STM 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:
  - handling and integration
  - transportation and storage
  - test
  - RCS & Tanking support ground equipment;
  - 0.1 K / 4 K PGSE.
  - solar array MGSE (container)

- MGSE are decomposed in several parts:

- common Herschel and Planck MGSE for SVM purpose. Alenia is in charge of the manufacturing of these MGSE. Refer to Herschel/Planck SVM SOW: H-P-WS-AI-0006 for more information's.
- Planck MGSE for satellite and CQM purpose. Alcatel is in charge of the manufacturing of these MGSE. Refer to Planck SOW: H-P-3-ASPI-SW-0168
- 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:

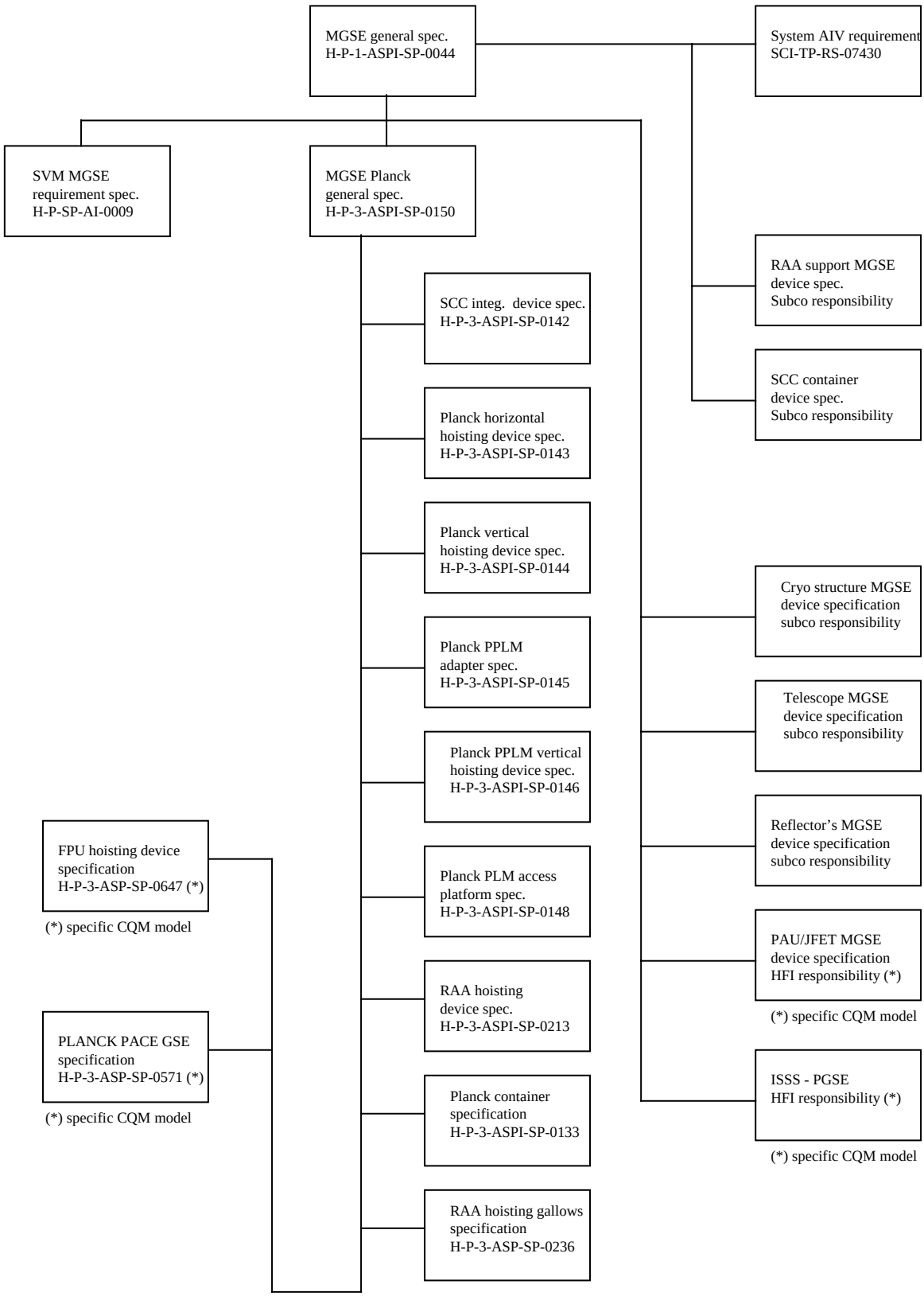


Figure 18: "main MGSE" specification tree

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
  - Power functions testing: Power SCOE used on FM model
  - ACMS functions testing: ACSM SCOE used on FM model
  - RCS functions testing: ACMS SCOE used on FM model
  - CDMS functions testing: CDMU DFE (CQM model and PFM model before batch 3 delivery), CDMU SCOE (FM model)
  - Specific launch area functions: Launch Power Supply (part of the Power SCOE) used on FM model
  - S/C simulator for interfaces testing used on FM model
  - RF functions testing: TTC RF SCOE used on FM model
  - HFI functions testing used on CQM and FM model
  - LFI, SCC functions testing used on FM model
  - 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
  - Thermal regulation functions: Thermal regulation EGSE used on CQM and FM models
- some special equipment
  - cabling (for standard 100 000 clean room, for thermal vacuum tests)
  - 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:

8.3.1.2.1 PFM model (batches 1 and 2)

As the number of electrical functionality's is very limited on the PFM model with only batches 1 and 2, the EGSE configuration is simple. The only EGSE's involved are:

- CCS (central check-out system) in light configuration (light for hardware purpose, all the software applications will be included)
- PLM EGSE
  - PCDU simulation for the powering of the equipment's
  - CDMS simulation for the control/command of the equipment's (1553 bus management) and the PPLM thermistors acquisition

8.3.1.2.2 FM completed model

- 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:

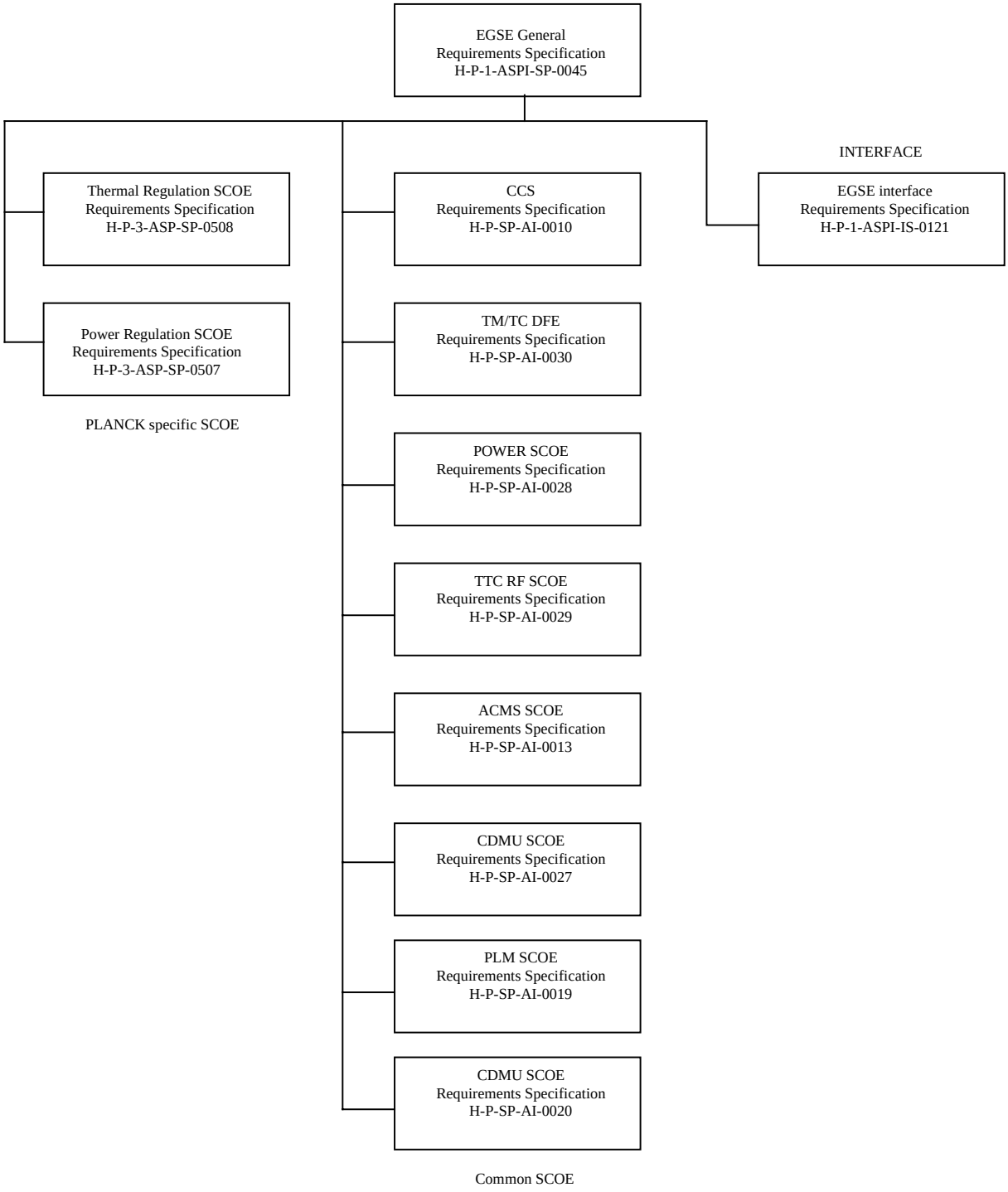


Figure 19: EGSE SPECIFICATION TREE

8.4 GSE DEVELOPMENT PLAN

Taking into account the commonality of the two satellites, several sets of GSE will be manufactured. It's summarised in the following documentation

- MGSE and TGSE parts:: see RD6
- EGSE parts: see RD5
- Specific GSE will be manufactured:
  - Thermal Regulation EGSE for the temperature inputs regulation (ASP responsibility)
  - 0.1K pipes PGSE (called ISSS) for the 0.1K pipes management (HFI team responsibility)
  - HFI I.EGSE for the scientific data processing of HFI acquisition chain (HFI team responsibility)
  - LFI I.EGSE for the scientific data processing of LFI acquisition chain (LFI team responsibility)

9. FACILITIES AND TRANSPORTATION PLAN

9.1 FACILITY AND TRANSPORTATION PLAN

All the AIT activities will be performed at ALCATEL/Cannes except the thermal balance vacuum test on CQM and PFM that will be performed at CSL.

Transportation between Cannes and CSL will be done with the satellite in its container (see container specification: H-P-3-ASPI-SP-0133). Two transports are foreseen today: one with the CQM model, another with the PFM model.

Transportation to Kourou should be done by sea with Herschel satellite.

All the transportation will include all EGSE and MGSE necessary for satellite testing purpose.

9.2 SATELLITE TO TEST FACILITY 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 m^2
- M01 area: 520 m^2
- M99 area: 280 m^2

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 20: crane characteristics in ASP premises

9.2.2 Compact Antenna Test Range facility

The Alcatel Space Industries Compact Antenna Test Range (CATR) is a dual reflector antenna facility designed for adjustment and measurement of satellite antenna and RF payloads in a clean room (class 100 000) environment.

The dimensions and specifications of the CATR are the following :

- Compact antenna test range model : dual shaped compensated Cassegrain reflector system.
- Surface accuracy of the large iron reflectors is better than 17 μm r.m.s.
- Range of validated frequencies: from 1.5 to 40 GHz with test satisfactorily performed at 100 Ghz
- Linear and circular polarisation's
- Anechoïc chamber dimensions : 14.32 x 36.17 x 11.15 meters (W x L x H).
- Central quiet zone: 5.5 x 5 x 6 meters (L x H x P).
- West door dimensions : 4.55x 5.2 meters (W x H).
- Plane wave quality (average values *) :

- Amplitude ripple = ± 0.3 dB
- Amplitude taper = 2 dB maximum
- Phase ripple = ± 4°

- measurement Accuracy (gain, EIRP, GT) : ± 0.25 dB
  - *This characteristic is dependent on the chosen illuminator.*

The shielding of the CATR has the following minimum attenuation characteristics :

- Magnetic fields 200 kHz : 61 dB
- Electric fields 10 MHz : 100 dB
- Planes Waves 1 GHz: 76 dB
- External Isolation (Faraday cage) : 100 dB (characteristic)
- Internal Isolation (absorbers) > 50 dB one way (in Ku band)
- Absorbers: M2 type

9.2.3 Vibration facilities

Three shakers are available at Alcatel Space: C210, C220, LDS V994 "ATLAS"

9.2.3.1 C210 characteristics:

- Sine and random vibrations
- Maximum strength vector: 124 kN
- Frequency range: from 5 to 2000 Hz
- 128 acquisition ways in real time
- shaker is working only in vertical position.

9.2.3.2 C220 characteristics:

- Sine and random vibrations
- Maximum strength vector: 155 kN
- Frequency range: from 5 to 2000 Hz
- 256 acquisition ways in real time

9.2.3.3 LDS V994 "ATLAS":

- 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)

9.2.3.4 Acoustic chamber characteristics:

One acoustic chamber is available at Alcatel Space. It's located in M10 area, its volume is 250 m^3

- Type: reflect chamber
- 6 nitrogen sirens:
  - 2 for high frequency: 6 kW LING EPT 943
  - 4 for low frequency: 20 kW LING EPT 1094
- size: (L x l x h) 6,3 x 5 x 7,93 m (h x l of the door): 7,9 x 4,5 m)
- height under hook: 6,9 m
- gas supplying:
  - nitrogen under pressure: 6 tanks (193 m3 at 150 bars)
  - flew rate: 54 m3 / min
  - liquid nitrogen: 10 000 l
  - autonomy: 20 min
  - filling duration: 2 hours
  - electrical modulators: 2 GEARING & WATSON DSA 1

- acoustic drivers:
  - spectrum and noise generation: NORSONIC type 731
  - 8 microphones Bruel & Kjaer type 4134
  - 2 microphones Bruel & Kjaer type 4136
  - spectrum analysis 2 ways: SD 375 octave – 1/3 octave – PSD / 400 lines
  - signals analyser: HP 35665 A
  - recorder: RACAL
  - 2 voltmeters RMS
  - 128 acquisitions ways in real time

- technical characteristics:

- reflect duration: 12 seconds at 500 Hz
- maximum global level: 156 dB (chamber empty)
- spectrum: octave bandwidth from 31.5 Hz to 8 kHz
- acoustic power: 48 kW

- safety aspect:
  - acoustic insulation
  - nitrogen extractor
  - nitrogen detector
  - wait before door opening: 20 min

9.2.4 Spin test facilities

One spin test machine is available at Alcatel Space Cannes.

- Machine SCHENCK M50
  - Maximum mass: 1400 kg
  - Rotate speed: 30 to 300 tr/min
  - 100 rotating contacts.

9.2.5 MCI facilities

The MCI measurements are performed in M95 area

- Mass measurement:
  - Measure is done with steelyards: (one 5 ton steelyard range, one 10 ton steelyard range)
  - Maximum mass of the specimen: 6000 kg (satellite empty)
  - Accuracy: +/- 0,1 %

- Gravity centre measurement:
  - Measure is done with three strength sensors (three sensors range 1000 kg each, 3 sensors range 5000 kg each)
  - Maximum mass of the specimen: 3200 kg (satellite empty)
  - Accuracy: +/- 1 mm in X and Y axis, +/- 5 mm in Z axis

- Inertia measurement:
  - Two facilities allow to perform this measurement:
  - oscillating table SCHENCK M7 or oscillate table SCHENCK M7S

- Table Schenck M7:

One specific tool in addition to the M7S table allows to measure inertia products.

  - Maximum mass: 10 000 kg (satellite + tools)
  - Maximum inertia: 15 000 m^2 .kg
  - Maximum static balance: 100 m.kg
  - Accuracy: +/- 1%

- Table Schenck M7S:
  - Maximum mass: 10 000 kg (satellite + tools)
  - Maximum inertia: 15 000 m^2 .kg
  - Maximum static balance: 350 m.kg
  - Accuracy: +/- 1%

END OF DOCUMENT