HERSCHEL / PLANCK

Planck CQM AIT Plan

H-P-3-ASP-PL-0668

Product Code : 200000

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1.0	26/03/2004	First issue	JP.HAYET
1.1	01/07/04	Update taking into account RIDs CDR (PAIV 10903, 10908, 10927, 10964, 10904) and STM deletion,model	JY Charnier

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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 CQM.

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

1.1.1 CQM (Cryo Qualification Model) activities:

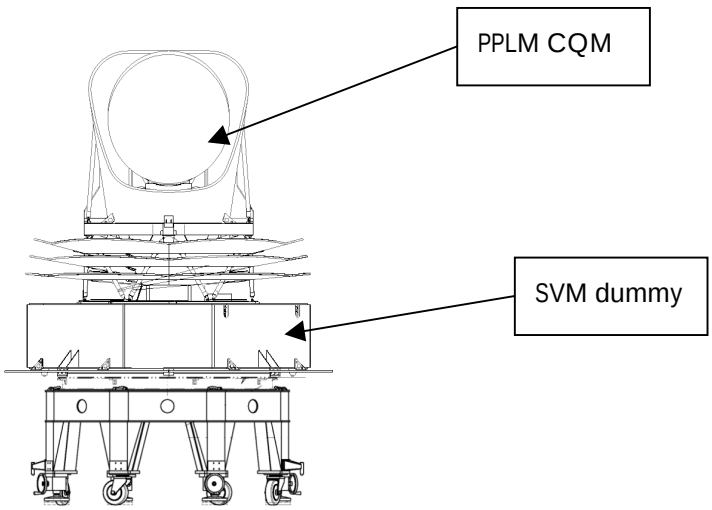


Figure 1: Satellite CQM configuration

- à 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.
- à Perform a PPLM thermal balance to :
  - ü validate the passive cooling
  - ü validate the active cooling (0.1K, 4K, 20K)
  - ü validate the HFI detection chain
  - ü validate the non-impact of the µ-vibration environment
  - ü measure conducted EMC at HFI instrument level

1.1.2 RFQM (Radio Frequency Qualification Model) activities:

refer to [RD8]

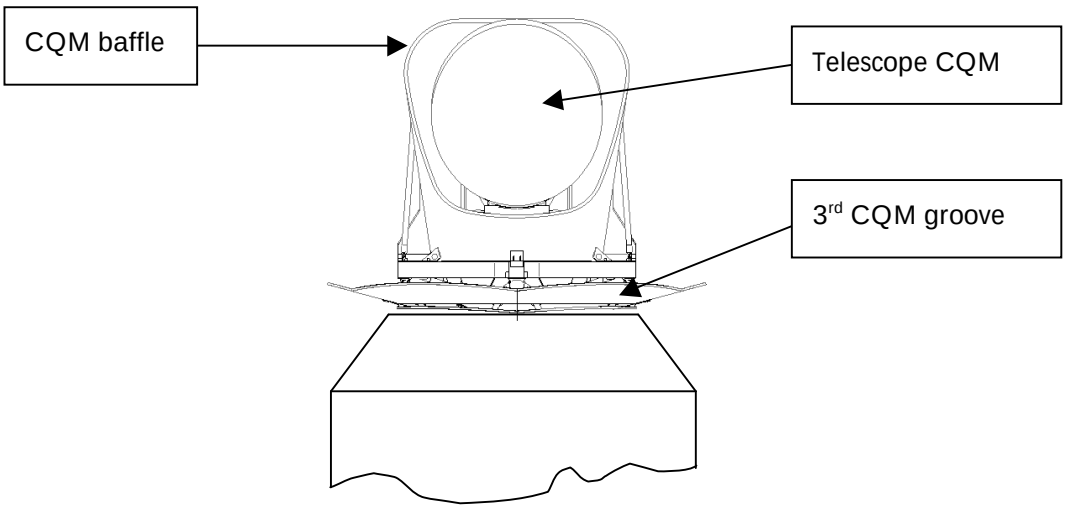


Figure 3: PPLM RF QM configuration

- 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]

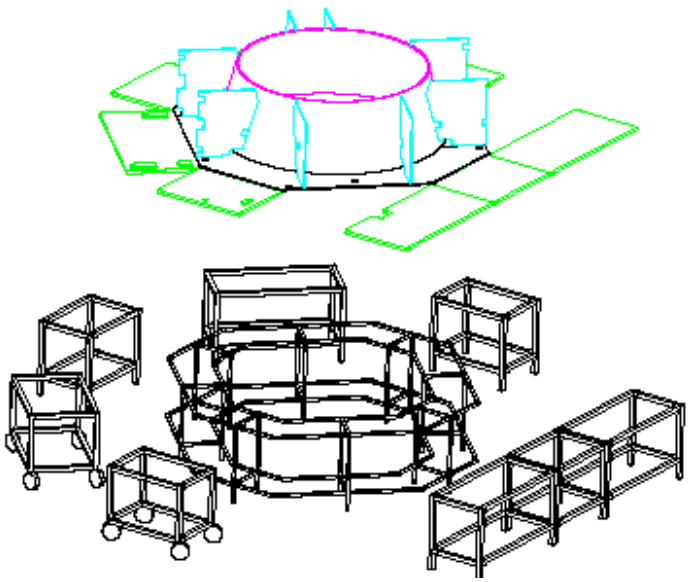


Figure 4: AVM configuration

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.

à 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 [RD7]

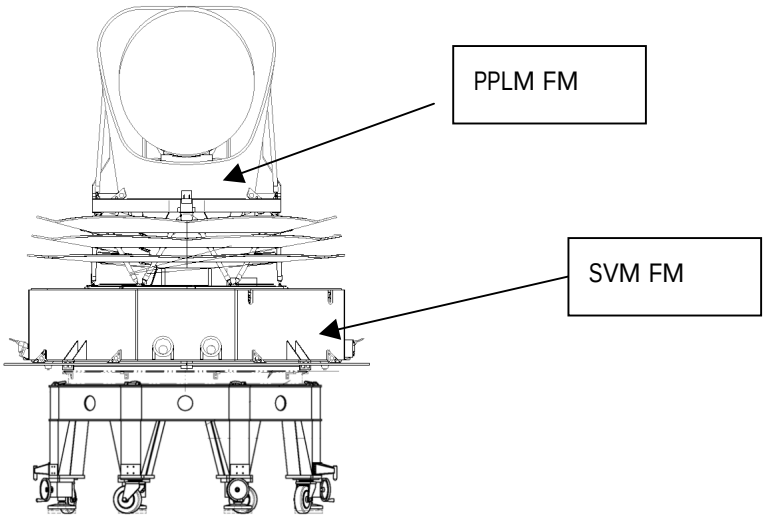


Figure 5: Planck satellite configuration

à The aim of the satellite is the verification of the overall satellite functioning and performances. The PFM is submitted to qualification levels during environmental tests.

1.1.5 Top overview of the five main parts:

1.1.5.1 PPLM CQM / RFQM logic

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

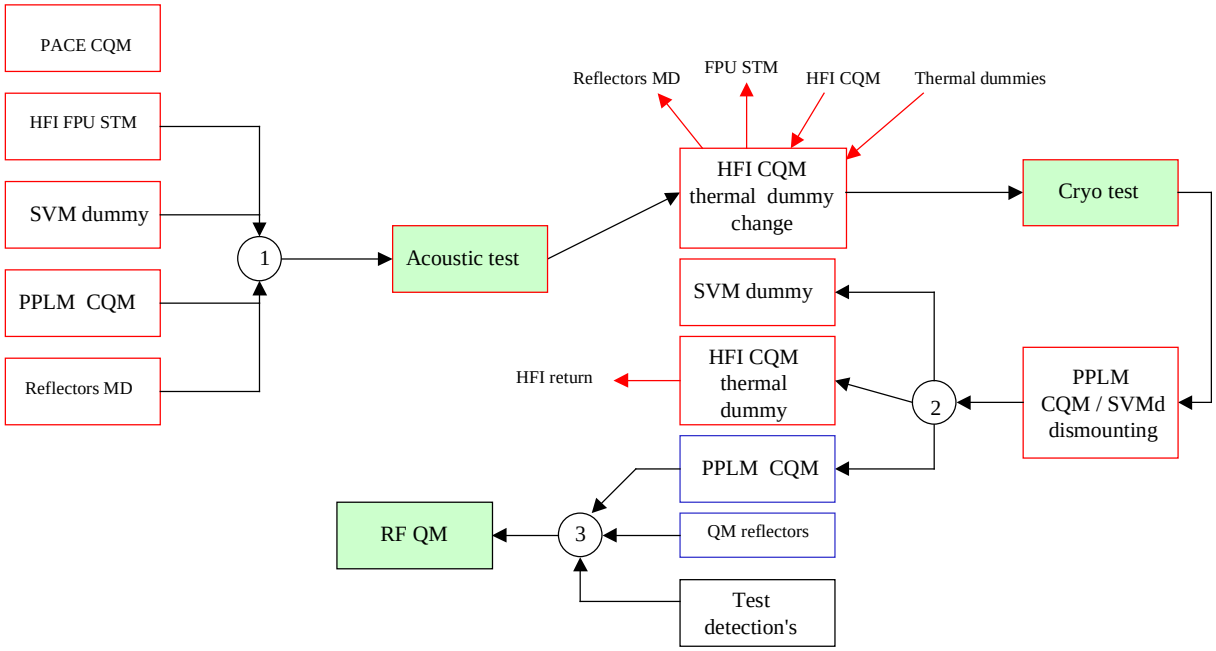
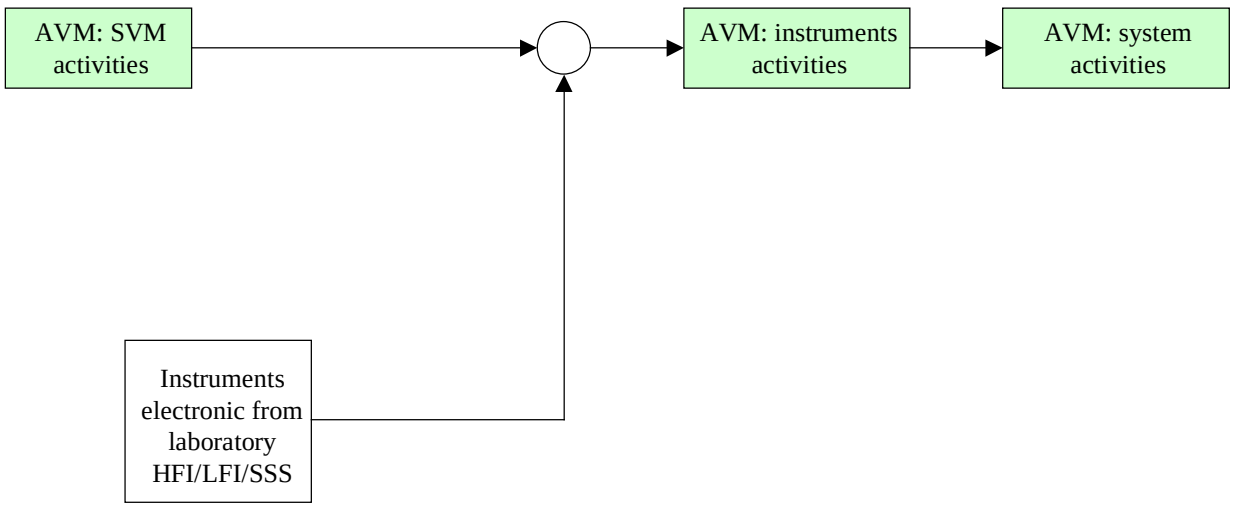


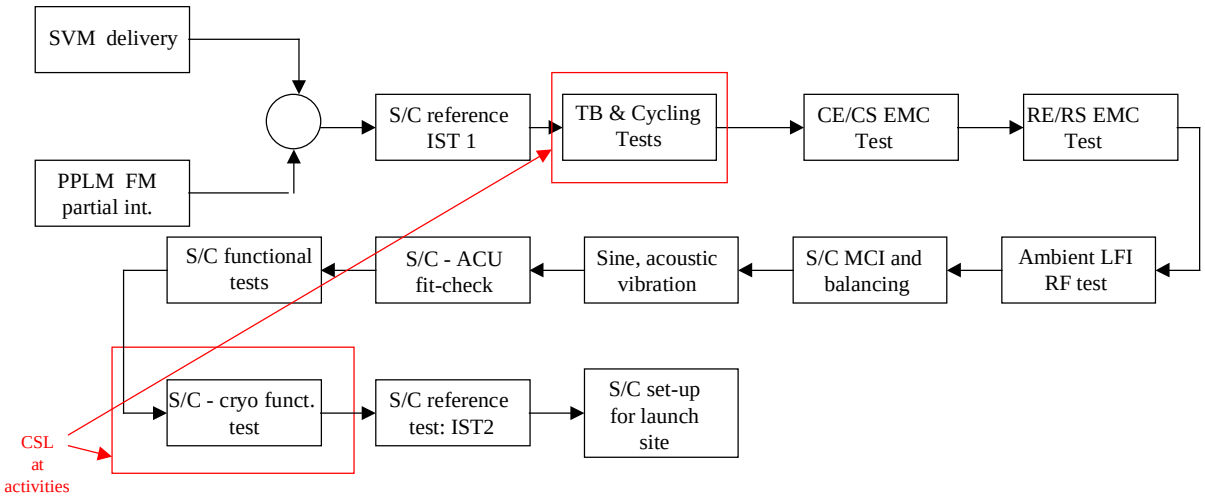
Figure 6: CQM / STM / RF QM logic



1.1.5.2 AVM logic

Figure 7: 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

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Figure 8: 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 CQM 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	N/A
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	N/A
AD 14	N/A

2.2 REFERENCE DOCUMENTS

RD1	EGSE General Requirements Specification Document n° H-P-1-ASPI-SP-0048
RD2	MGSE General Requirements Specification Document n° H-P-1-ASPI- SP-0044
RD3	EGSE Interface Requirements Document n° H-P-1-ASPI- IS-0121
RD4	MGSE Interface Requirements Document n° H-P-1-ASPI- IS-0120
RD5	EGSE Deployment Plan Document n° H-P-1-ASPI-PL-0220
RD6	MGSE Deployment Plan Document n° H-P-1-ASPI-LI-0119
RD7	Planck PFM AIT plan Document n° H-P-3-ASPI-PL-0208
RD8	Planck RFQM AIT plan Document n° H-P-3-ASP-PL-0669
RD9	Planck Satellite STM AIT plan (Mechanical test) Document n° H-P-3-ASP-PL-0670
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	N/A
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

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
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: 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 [RD7] : Proto Fligth Model ; PLANCK satellite

This document describes the CQM Assembly, integration & test.

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:
  - Ø FPU structural model (HFI STM+ LFI MTD)
  - Ø Mass dummies to simulate the missing units
  - Ø Telescope CQM with reflectors mass dummies
  - Ø Cryo structure CQM
  - Ø PACE CQM

- SVM dummy
  - Ø Design to support the PPLM
  - Ø 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:
  - Ø complete HFI detection chain
  - Ø 0.1K, 4K and PACE cooler chains
  - Ø cryo sensors acquisition (test sensors + partial flight sensors)
  - Ø heaters for power simulated dissipation
  - Ø telescope CQM without reflectors QM
  - Ø cryo structure CQM
- SVM dummy: incluing the following functionality's:
  - Ø Structural aspect to support the PPLM
  - Ø Thermal representive aspect on the PPLM / SVM dummy interface area.
  - Ø Complete HFI detection chain (electronic units: WU)
  - Ø 4K cooler chains
  - Ø 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:
  - Ø torquing of fixing screws
  - Ø marking (or eventually sticking) of fixing screws

3.5.3 Handling

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

Only 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:
  - Ø harness connector to saver
  - Ø 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

This section (and the next ones) concerns the electrical integration of the following P.PLM 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/ JPL) 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. All not conductive materials are prohibited on and near the satellite. If needed, a risk analysis will be held (For CQM purposes, a study will be done with HFI team), Alcatel standard instruction could be apply (RTE-ASPI-PN-33-F for sensitive element (class 0), and RTE-ASPI-PN-30-F for the others .

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 compatibilities .

3.7 TESTS AT SYSTEM LEVEL

During the sequence of the system tests the satellite has to be checked in an automated and reproductible 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)

Note: IST will be performed at CQM level

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 .(for PFM 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, each Model 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)

Note: SFT will not be performed at CQM level

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

Note: System tests & S/W compatibility will not be performed at CQM level

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

N/A for CQM model

3.7.1.5 Alignment measurements

The necessity to know accurately the PPLM stability during the cryo vacuum test, alignment measurements will be done at PPLM level before and after the cryo test.

The general alignment method consists in identifying the PPLM mechanical reference and in measuring the telescope, the HFI FPU and LFI FPU (main frame) versus to the reference axes system on the SVM dummy.

3.7.1.6 Fluidic/Pneumatic Tests

Concerning 0.1K and 4 K coolers, pipes leak tests will be performed in order to check the integrity of each line before cryo tests under HFI responsibility.

Concerning 20K cooler, the first PACE leak test will be performed after the reception of it in ASP premises. JPL person will be in charge of this test with JPL procedure and will train ASP team. All the other leak test foresee during the CQM campaign will be done by ASP. These leak tests will take place before and after the acoustic, before the cryo test.

3.7.2 SVT (System Verification Test)

N/A for CQM model

3.7.3 Specific Performance Test

N/A for CQM model

3.8 ENVIRONMENTAL TESTS

3.8.1 Acoustic Noise

The aim of the early acoustic test of the Planck PLM is:

- to obtain advanced and reliable data supporting the validation of some instruments – mainly the FPU's and PACE.
- to check that the acoustic levels at FPU / telescope (upper panel) interface comply with the specified levels.

The satellite will be set in the acoustic chamber on the VIS (Vertical Integration Stand). Microphones will do measurements of sound pressure level. Power spectral density response will be given by accelerometers.

The sequence of events for the test will be defined in a test requirement sheet.

3.8.2 Thermal vacuum Test

The test will be performed in the FOCAL 5 chamber in CSL facility.

The objectives of this test on the CQM are, as baseline:

- to demonstrate that the cryogenic structure can achieve 60K on the third groove interface.
- to demonstrate that the cryogenic chains of instruments can achieve 0.1 K temperature in HFI FPU area .
- to perform HFI detection chain and end to end test.

Transient test will be performed to check the satellite thermal characteristic stability.

The test will be performed in a vacuum chamber, which provides shrouds at 20K and 4 K. The GSE will be connected to the model through the interface brackets located on the SVM dummy back side.

The CQM model will be as close as possible thermally representative of the flight model. For this, thermal dummies will simulate the missing units in the PPLM, heaters in the SVM dummy will simulate the thermal aspect of the SVM at the PPLM interface (SVM sub platform) and will avoid thermal-elastic phenomena to protect the cryo-structure. The model will be mounted with a specific thermal adapter in order to thermally isolate the model to the cryo set-up.

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. 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 between the REU and the PAU.

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.

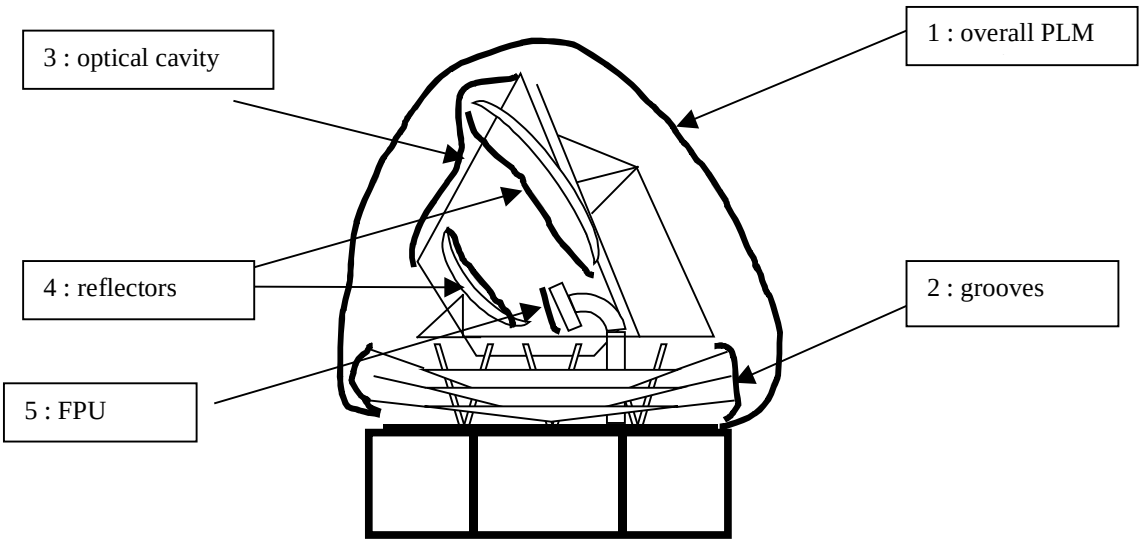


Figure 9: PPLM protections set

Note: protections 4 don't exist on the CQM model because the reflectors are missing.

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

4.3 PURGING

N/A for CQM model

4.4 4K compressor

During transportation or satellite moving (transfer from one dolly to an other, transfer from one area to an other); it's required that the 4K compressor is blocked.

It is blocked either by sending a telecommand when the satellite is switched "ON" or by cabling a short-circuit between two pins in a test connector when the satellite is not switched "ON".

Of course, during all the mechanical operations; the second solution will be chosen. A plug "called skin connector" will be installed to block the compressor, will be dismounted to switch the compressor "ON".

4.5 PACE pipes

As recommended in JPL documentation's, execpt for operational configuration during the cryogenic test, the PACE-CQM is under vacuum ..

5. AIT SEQUENCES

This chapter describes the AIT activities at CQM level, from unit/subsystem assembly

to the end of the CQM cryo test (CQM back to France).

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 ALCATEL/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.

Pre assembly operations are presented for information in the overall sequence.

5.1 CQM assembly, integration and tests

5.1.1 Assembly, Integration and Test logic

CQM model can be split in two parts:

- For acoustic test, the main part of the model will be:
  - à SVM dummy
  - à PAU and BEU MTD
  - à CQM cryo structure
  - à CQM telescope
  - à reflectors mass dummies
  - à CQM baffle
  - à CQM PACE redundant
  - à HFI and LFI FPU mass dummies
  - à Others secondary missing masses in the PPLM will be simulated by mass dummies.

Accelerometers and constraint gauges will be set on the model according to the acoustic requirement test sheet.

At the end of the acoustic tests, the model will be partially dismounted in order to prepare the cryo test model.

- For cryo test, the main part of the model will be:
  - à SVM dummy

- à BEU MTD
- à CQM cryo structure
- à CQM telescope
- à CQM baffle
- à CQM PACE redundant
- à LFI FPU mass dummies
- à HFI FPU CQM with its bellow
- à JFET/bellow/PAU CQM
- à 4K CQM CRU, CDE, CAU/CCU
- à 0.1K CQM DCCU
- à CQM DPU
- à CQM REU
- à Thermal dummies in order to simulate power dissipation of the missing units in the PPLM.

The integration logic of the CQM (acoustic + cryo tests) is the following:

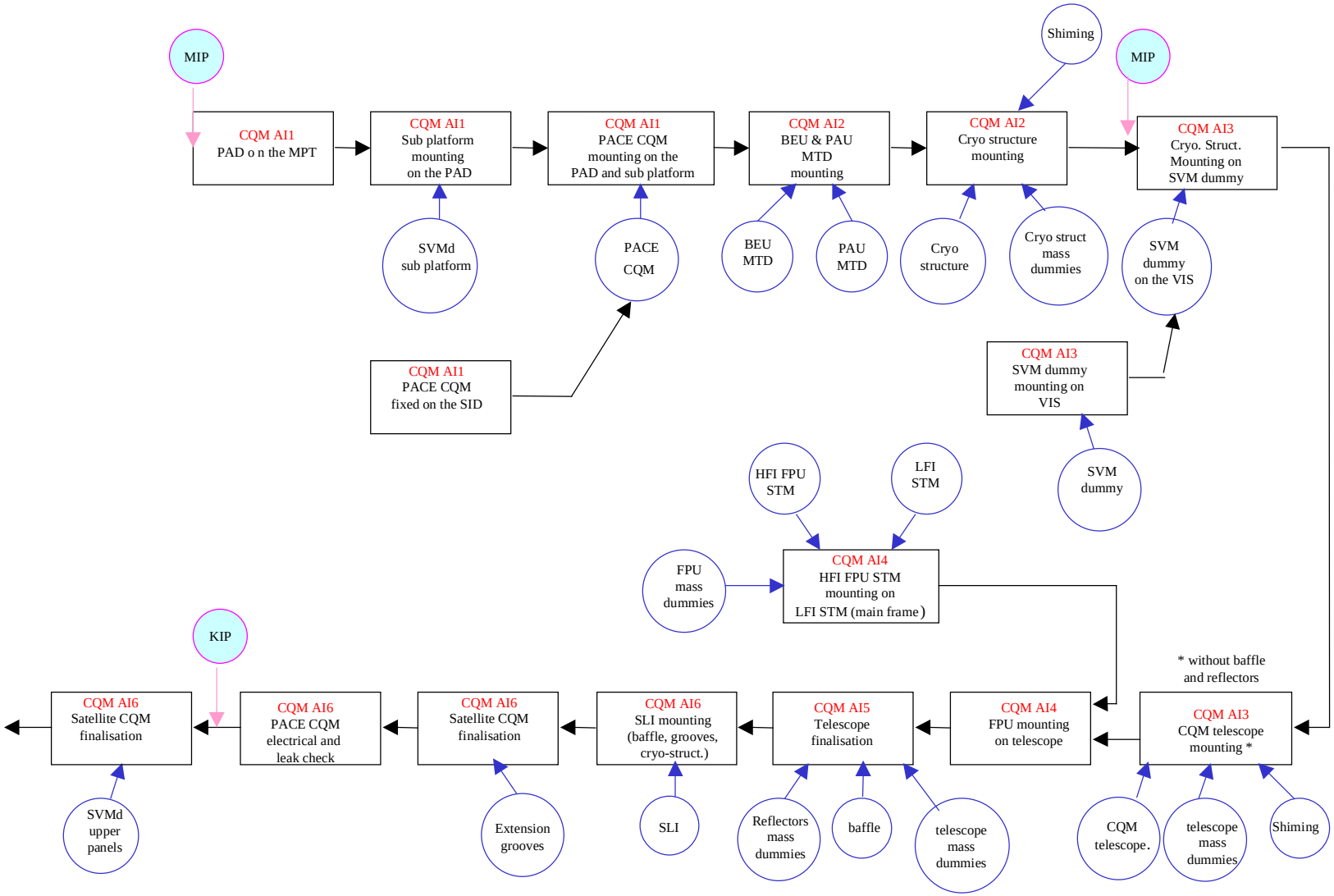
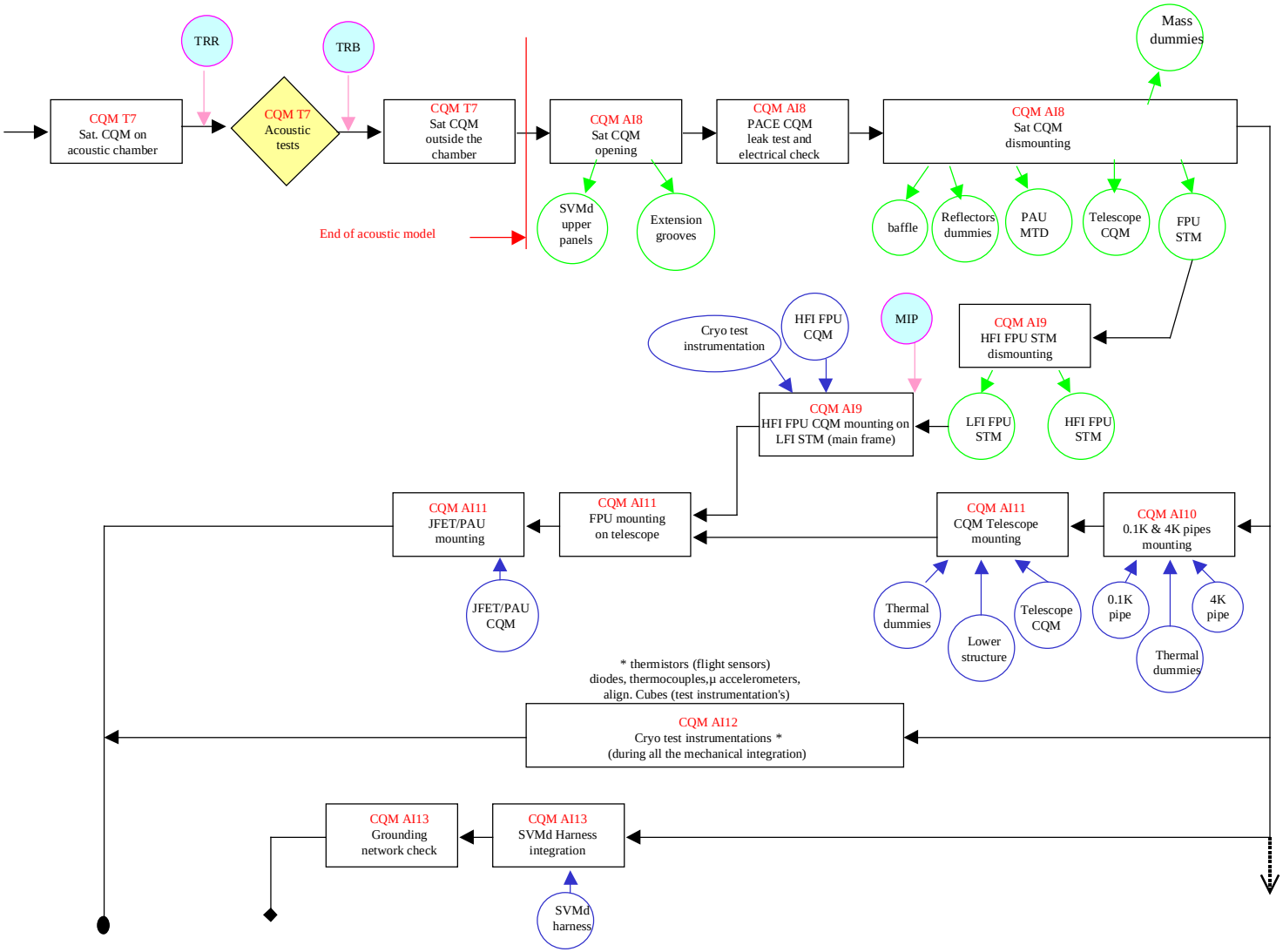
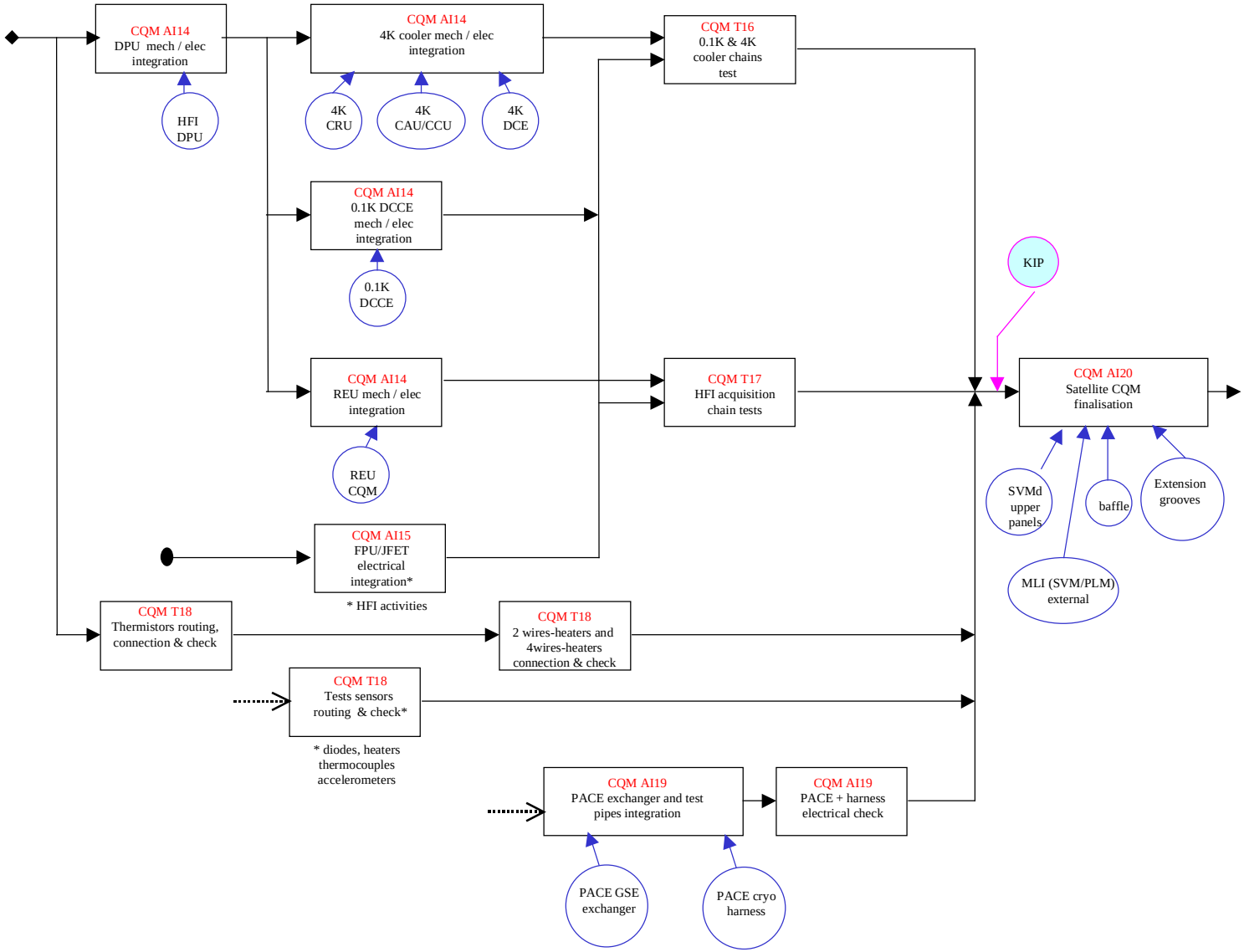
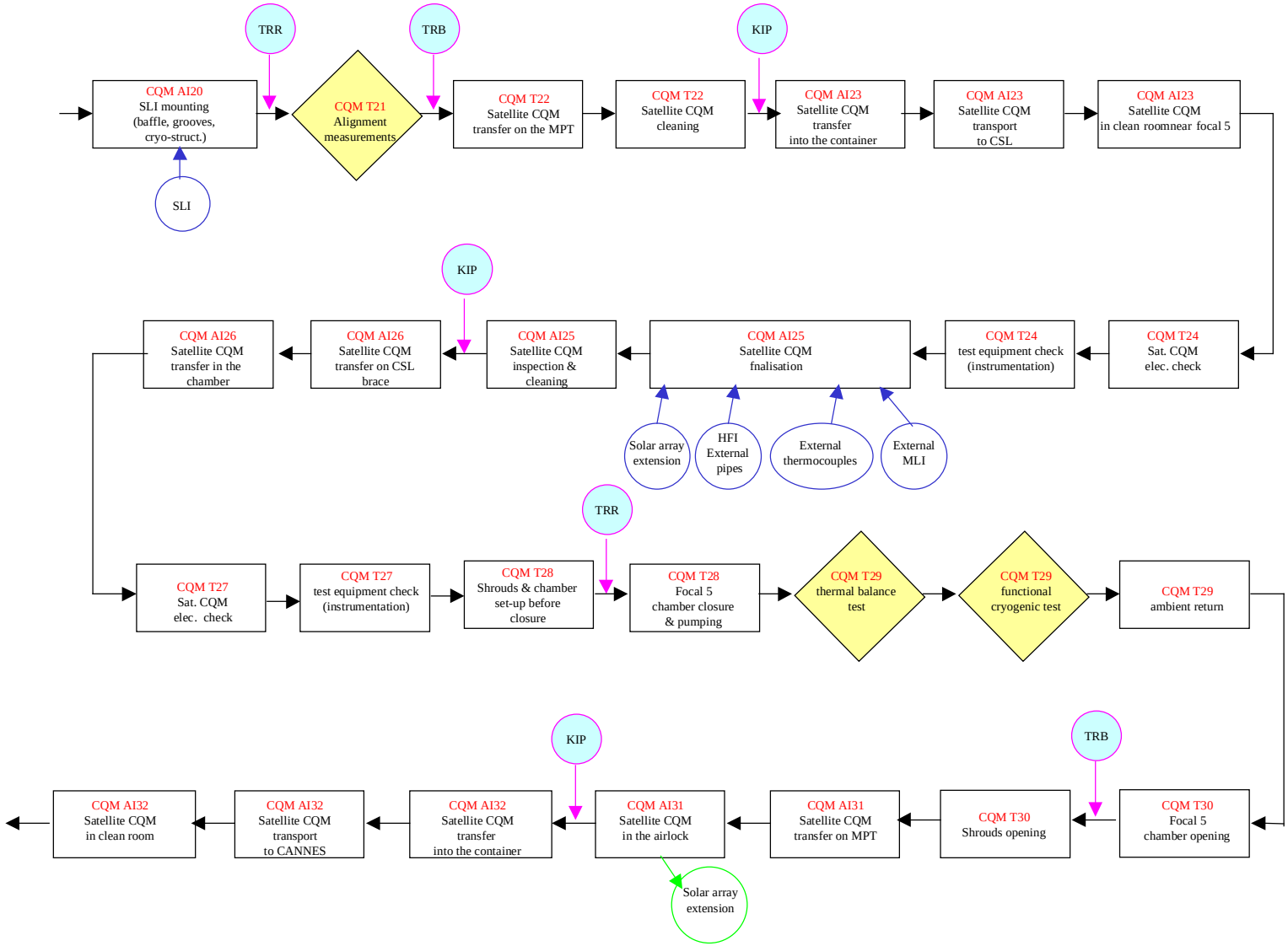
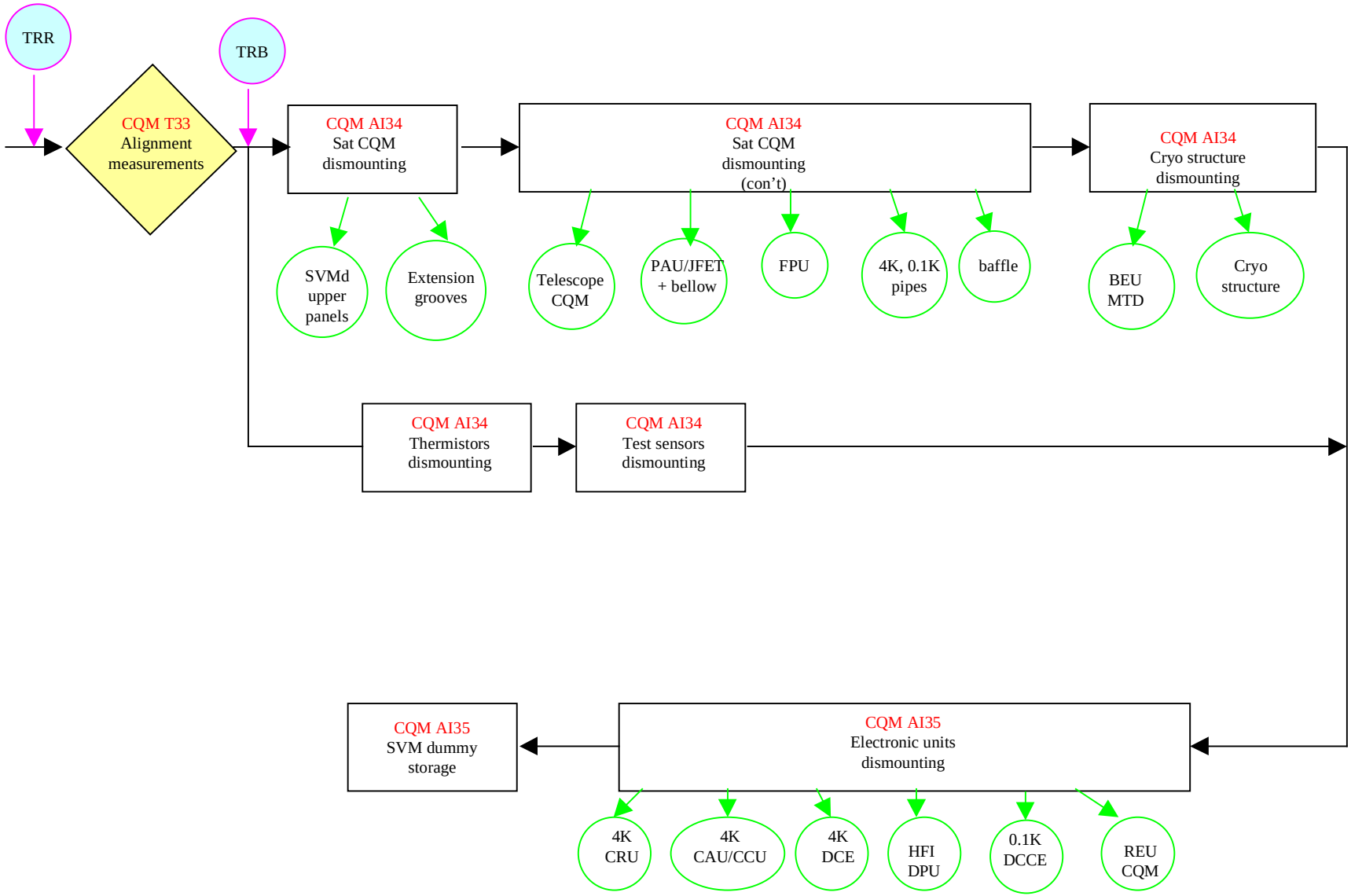


Figure 10: CQM detailed logic









5.1.2 CQM EGSE configuration

5.1.2.1 Acoustic model

- The acoustic test model includes only mechanical parts. There is not needs of EGSE.

5.1.2.2 Cryogenic model

- The cryogenic test model includes several electrical and fluidic functionality's:
  - Ø HFI detection chain
  - Ø Coolers chains (20K, 4K, 0.1K)
  - Ø SVM dummy heating in order that the interface between the SVM dummy and the PPLM is thermally representative of the SVM flight model
  - Ø SVM dummy heating in order to avoid structural damage of the cryo structure du to thermal-elastic phenomena.
  - Ø PPLM thermal dummies heating in order the simulate power dissipation of the missing units in the PPLM.
  - Ø PACE CQM: heaters powering, thermal regulation of the cold end, hydrogen powering
  - Ø 0.1K pipes CQM: Helium isotopes, pre-cooling management
- For all these functionality's, EGSE will be used:
  - Ø PLM EGSE: PLM scoe part
    - à To power the electronic units (DPU, REU, 0.1K DCCE, 4K CRU, 4K CAU/CCU, 4K DCE).
  - Ø PLM EGSE: CDMU DFE part
    - à To manage the 1553 bus with the DPU
    - à To acquire the thermistors of the PPLM (the flight representative thermal sensor)
  - Ø CCS
    - à To manage all the electronic units (TC sending to EGSE and CQM, TM receiving from EGSE and CQM)
  - Ø IEGSE (instrument EGSE)
    - à To analyse the HFI data acquired through the CCS (telemetry coming from HFI DPU units)
  - Ø Thermal EGSE
    - à Thermal regulation EGSE: to regulate the temperature inside the SVM dummy.

à Power regulation EGSE: to simulate precise power dissipation on the PPLM

5.1.3 CQM PGSE configuration

5.1.3.1 Acoustic model

N/A

5.1.3.2 Cryogenic model (only at CSL)

Two kinds of PGSE will be used for the cryogenic test.

- PACE PGSE: management of the 20K PACE pipes to power the pipes with hydrogen, to power the heaters.
- ISSS GSE: management of the 0.1K pipes to power the pipes with isotope He3 and He4 (HFI will be in charge of this equipment).

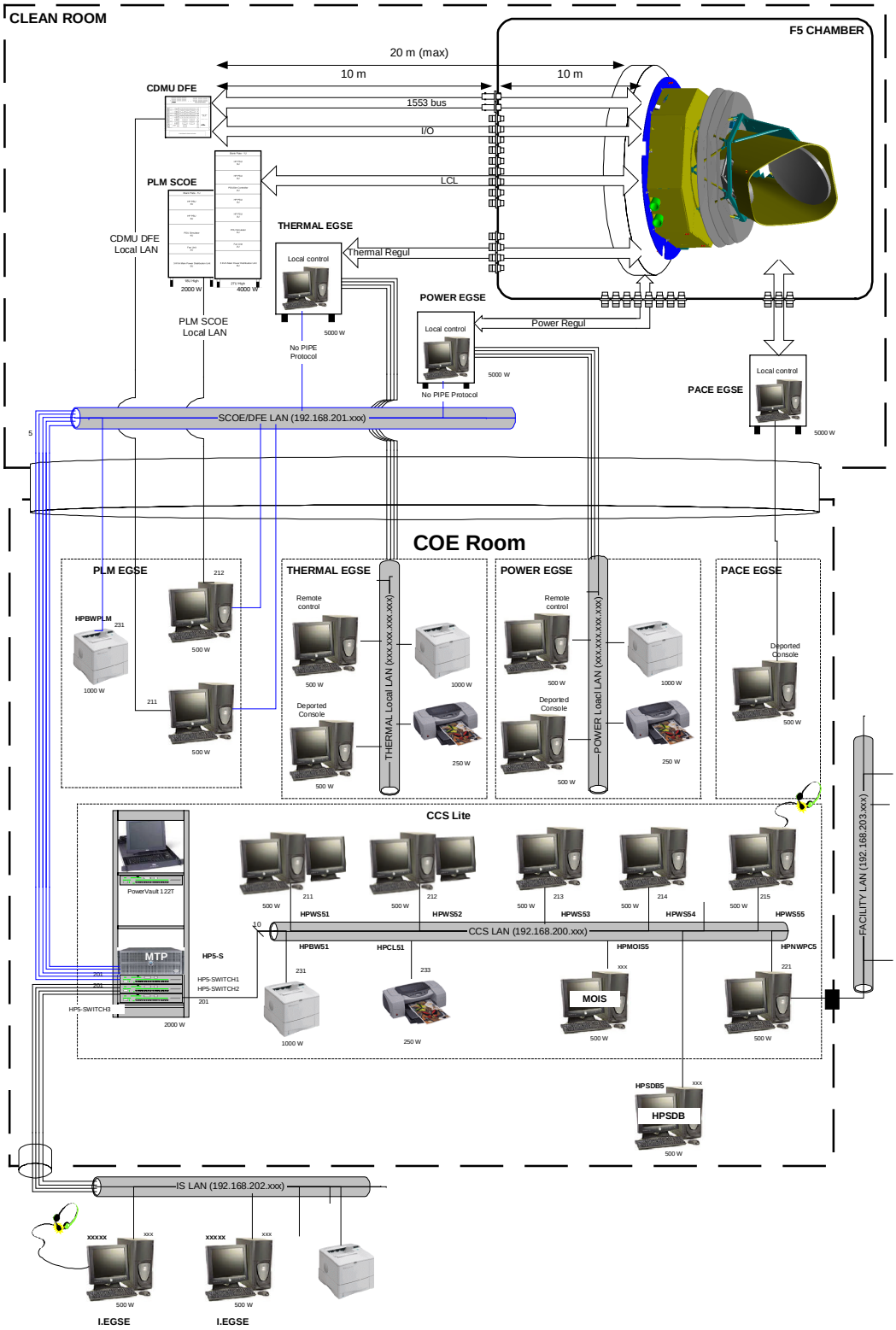


Figure 11: detailed EGSE configuration for CQM model

5.1.4 CQM test sensors

5.1.4.1 Acoustic model

There will have only accelerometers and constraints gauges set in this model. The only test equipment will be the acquisition system of these accelerometers (standard equipment used in ASP premises).

5.1.4.2 Cryogenic model

Several kinds of test sensors will be used during the cryogenic test.

- ASP units
  - Ø In order to check the micro-vibration
    - à induced by the 4K cooler compressor, accelerometers will be set on a foot of the LFI main frame, at the interface between HFI and LFI FPU (on the LFI main frame), near the 4K cooler compressor on the sub-platform. At PPLM level, these µ-accelerometers will be cryo accelerometers.
    - à induced by the ground on the SVM dummy interface with the MGSE.

    Theses µ-accelerometers will be acquired by units provided by ASP.
  - Ø EMC CE/CS measurements will be done in the HFI detection chain, between the REU and the PAU units. Tools will be set inside the SVM dummy and measurement equipment's outside the chamber will be provided by ASP
- CSL units
  - Ø Thermocouples, Lakeshore diodes and PT100 thermistors will be acquired with CSL units.

5.1.5 CQM test equipment's overview

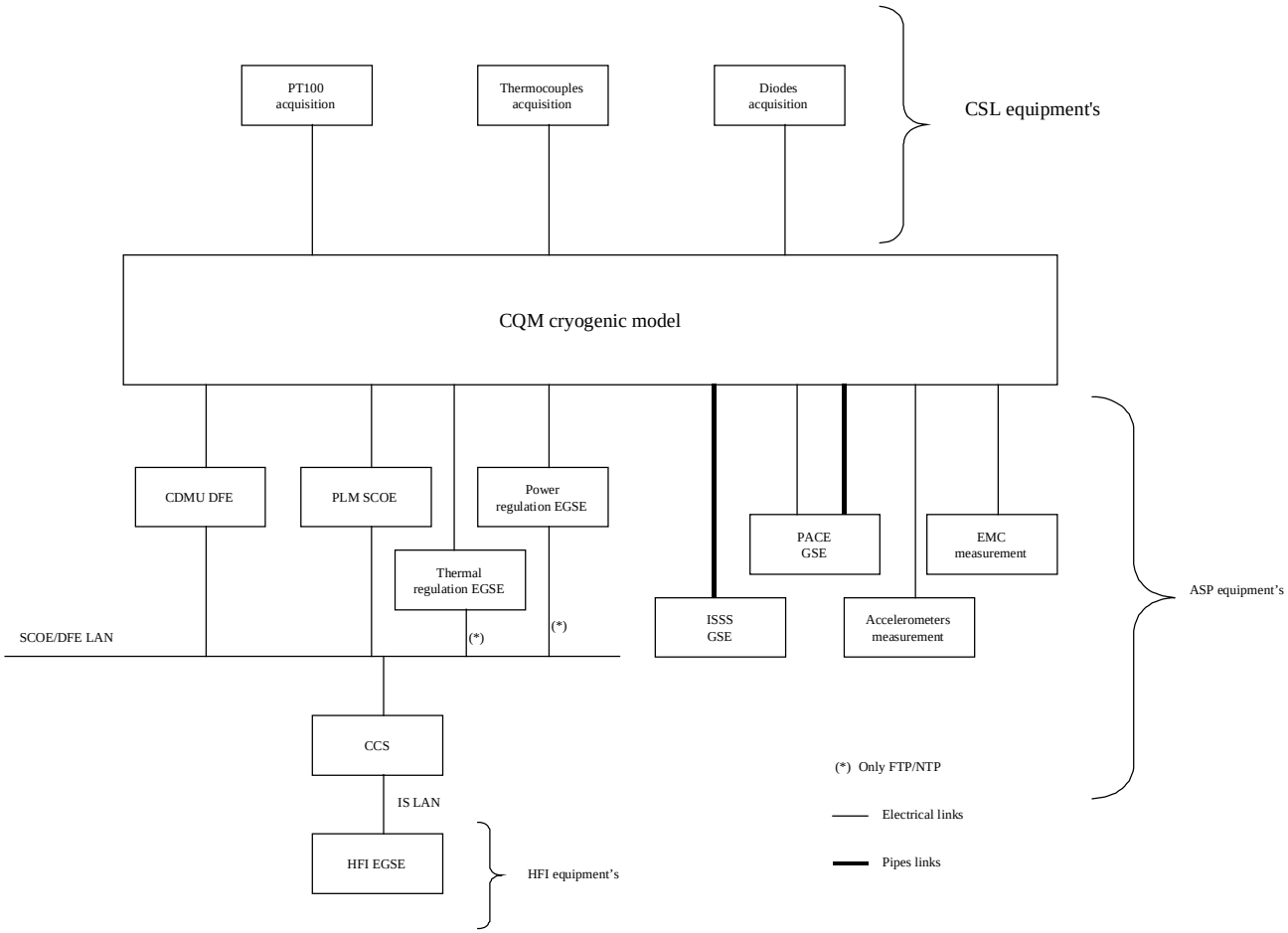


Figure 12: test equipment's overview

5.2 CQM task sheets

TS CQM AI1: PACE CQM mounting on the sub platform	CQM acoustic model
Duration	3 days
Ambience	Class 100000

Goal :

Start the mechanical integration of the CQM acoustic model. Prepare the model to receive the PACE CQM.

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø First tasks, i.e. no equipment already integrated.
  - Ø MGSE needs: MPT, PAD, SID
- Electrical configuration / EGSE required :
  - Ø N/A

Activity :

- Set-up of the PAD on the MPT.
- Integration of the SVM dummy sub platform on the PAD.
- PACE CQM fixation on the SID.
- PACE CQM and SID mounting on the sub platform.

TS CQM AI2: cryo structure mounting	CQM acoustic model
Duration	3 days
Ambience	Class 100000

Goal :

To mount the cryo structure on the sub platform

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø Sub platform mounted on the PAD. PACE CQM fixed on the sub platform with the SID.
  - Ø MGSE needs: MPT, PAD, SID, PAP (PAP is a complex scaffolding, required to be prepared several days before the activity.

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

Activity :

- Mounting of the three grooves on the sub platform.
- Mounting of the cryo structure struts.
- Mounting of the BEU and PAU MTD.
- Mounting of mass dummies on the three grooves.
- Shiming between the cryo structure structs and the sub platform.
- Depending where the accelerometers needed for the acoustic test are, accelerometers bonding.
- According to the groove integration, SID can be disassemble.

TS CQM AI3: cryo structure & telescope mounting on the SVM dummy	CQM acoustic model
Duration	5 days
Ambience	Class 100000

Goal :

To mount the cryo structure and the telescope on the SVM dummy

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø Cryo structure integration done on the sub platform (set on the MPT)
  - Ø MGSE needs: MPT, PAD, VIS, PVHD, PAP, Telescope handling jig.

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

Activity :

- Mounting of the SVM dummy on the VIS.
- Mounting of cryo structure on the SVM dummy with the PVHD.
- Mounting of the mass dummies on the telescope.
- Mounting of the telescope CQM on the cryo structure (without the baffle and the reflectors).
- Shimming cryostructure/telescope.
- Depending where the accelerometers needed for the acoustic test are, accelerometers bonding.

TS CQM AI4: FPU mounting on telescope	CQM acoustic model
Duration	7 days
Ambience	Class 100000

Goal :

To mount the FPU STM inside the telescope

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø Cryo structure and telescope (without the baffle and the reflectors) mounted on the SVM dummy.
  - Ø MGSE needs: VIS, PAP, FHD.

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

Activity :

- On the table, mounting of the HFI FPU STM inside the LFI FPU main frame.
- Mounting of the HFI & LFI FPU mass dummies.
- Integration of the FPU inside the telescope with the FHD.
- Depending where the accelerometers needed for the acoustic test are, accelerometers bonding.

TS CQM AI5: Telescope finalisation	CQM acoustic model
Duration	2 days
Ambience	Class 100000

Goal :

To finalise the telescope

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø Cryo structure and telescope (without the baffle and the reflectors) mounted on the SVM dummy.
  - Ø MGSE needs: VIS, PAP, baffle lifting device.

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

Activity :

- Mounting of the telescope mass dummies.
- Mounting of the reflectors mass dummies.
- Mounting of the baffle.
- Depending where the accelerometers needed for the acoustic test are, accelerometers bonding.

TS CQM AI6: Satellite CQM finalisation	CQM acoustic model
Duration	7 days
Ambience	Class 100000

Goal :

To finalise the satellite CQM

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø Telescope, cryo structure completely mounted on the SVM dummy.
  - Ø MGSE needs: VIS, PAP.
  - Ø Equipment's needs: dry pump, ASM 122D, helium, standard leaks (ASP furniture)

- Electrical configuration / EGSE required :
  - Ø multimeter

Activity :

- SLI mounting around the baffle, the grooves, the cryo-structure.
- Extension grooves mounting.
- PACE CQM electrical check (insulation and continuity).
- PACE CQM leak test.
- Inspection before closure.
- SVM dummy closure (upper panels mounting, lateral panels closure).
- Depending where the accelerometers needed for the acoustic test are, accelerometers bonding.
- Constraint gauges wires routing.

TS CQM T7: acoustic test	CQM acoustic model
Duration	8 days
Ambience	Class 100000

Goal :

To perform acoustic

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø Acoustic model completed, on the VIS.
  - Ø MGSE needs: VIS with a lead plate between the model and the VIS.
  - Ø Acoustic chamber.

- Electrical configuration / EGSE required :
  - Ø Accelerometers acquisition system

Activity :

- Satellite CQM moved inside the acoustic chamber.
- Measurement unit's set in the chamber (accelerometers/gauges connection, microphone set and connection).
- Inspection before test.
- Acoustic run according to the test requirement sheet.
- Inspection after test.
- Measurement unit's disconnection.
- Satellite CQM moved outside the acoustic chamber.

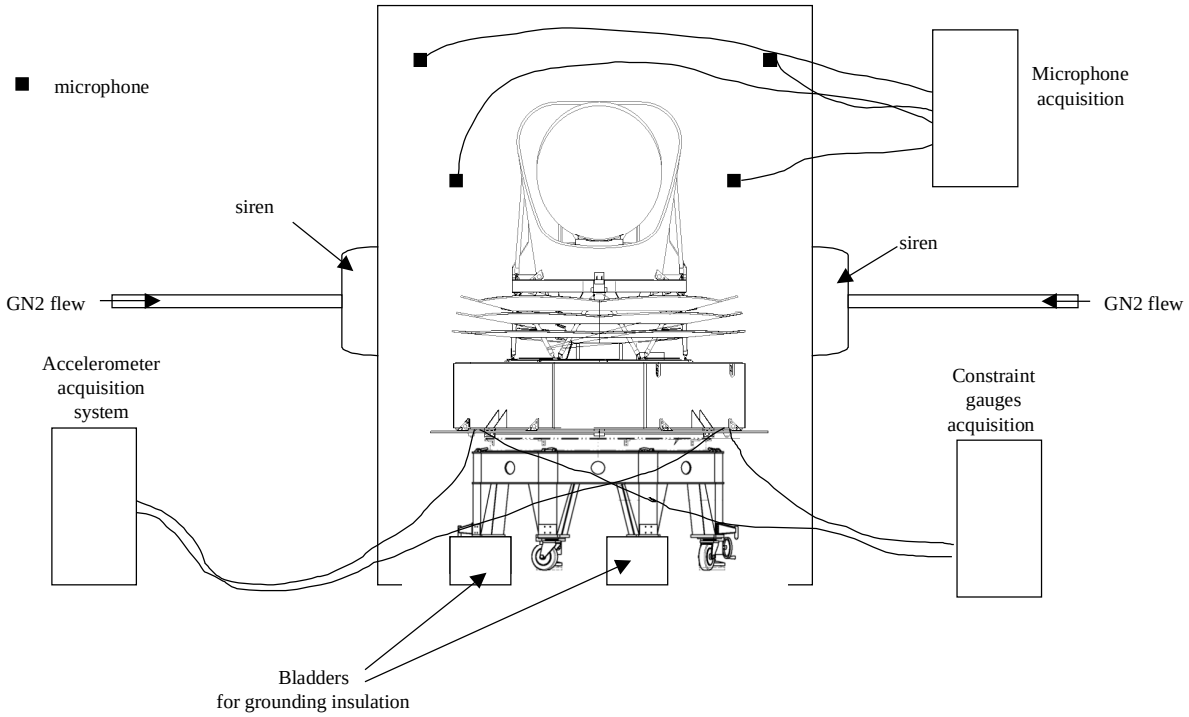


Figure 13: CQM configuration for acoustic test

TS CQM AI8: Satellite CQM dismounting	CQM acoustic model
Duration	10 days
Ambience	Class 100000

Goal :

To dismount the acoustic model in order to prepare the cryogenic model

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø Acoustic model completed, on the VIS.
  - Ø Acoustic tests completed.
  - Ø MGSE needs: VIS, PAP, FHD, telescope handling jig, baffle lifting device.
  - Ø Equipment's needs: dry pump, ASM 122D, helium, standard leaks (ASP furniture)

- Electrical configuration / EGSE required :
  - Ø Multimeter

Activity :

- SVM dummy upper panels dismounting.
- SVM dummy lateral panels opening.
- Extension grooves dismounting.
- PACE CQM leak test.
- PACE CQM electrical check (insulation and continuity).
- Baffle, reflector dummies, FPU STM, telescope CQM dismounting.
- PAU MTD dismounting.
- Mass dummies dismounting (on the telescope, on the grooves)

TS CQM AI9: FPU preparation for cryo test	CQM cryogenic model
Duration	5 days
Ambience	Class 100000

Goal :

To prepare the FPU model for the cryogenic test (on the table)

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø FPU STM dismounted from the acoustic model, set on the table.
  - Ø HFI FPU CQM on the table with its bellow (bellow between the FPU and the JFET).
  - Ø MGSE needs: FHD.

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

Activity :

- HFI FPU STM dismounting.
- µ-accelerometers mounting under the main frame, on the foot of the main frame (interface between the telescope and the main frame).
- Cryo tests sensors bonding in the FPU (LFI main frame).
- Cleanliness witness mounting on the main frame.
- Alignment cube mounting on the main frame.
- HFI FPU CQM mounting in the LFI main frame.

TS CQM AI10: 0.1K and 4K pipes mounting	CQM cryogenic model
Duration	6 days
Ambience	Class 100000

Goal :

To mount the 0.1K and the 4K pipes in the PPLM

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø Baffle, FPU, telescope, reflectors, extension grooves dismounted.
  - Ø Satellite CQM model is on the VIS, with the cryo structure mounted.
  - Ø MGSE needs: VIS, PAP.

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

Activity :

- 0.1K pipes integration through the grooves.
- 4K pipes integration through the grooves.
- Thermal dummies mounting and connection.
- PACE CQM constraint gauges dismounting.

TS CQM AI11: telescope mounting on the SVM dummy, PPLM integration	CQM cryogenic model
Duration	8 days
Ambience	Class 100000

Goal :

To mount the telescope on the cryo structure

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø Cryo structure completely mounted on the SVM dummy.
  - Ø 0.1K and 4K pipes mounted through the grooves.
  - Ø MGSE needs: VIS, PAP, FHD, JFET/PAU lifting device.

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

Activity :

- Mounting of the telescope on the cryo structure (except the baffle).
- Mounting of the FPU CQM on the telescope (.
- Pipes connection on FPU side (20K, 4K, 0.1K).
- Mounting of the JFET/PAU on the PPLM (JFET/bellow/PAU are received already connected together).
- JFET/PAU bellow routing through the cryo structure.
- Thermal dummies mounting and connection.

TS CQM AI12: cryo test instrumentation's mounting	CQM cryogenic model
Duration	7 days
Ambience	Class 100000

Goal :

To bond, connect, the test sensors located all around and inside the PPLM.
To route the harness from the sensors to the brackets located on the top of the SVM dummy plate-form.
To connect the harness on connector at sub plate-form level.

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø CQM cryo model mounted on the SVM dummy.
  - Ø MGSE needs: VIS, PAP.

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

Activity :

- Bonding, connection of the test sensors: thermocouples, Lakeshore diodes, thermistors.
- Thermal dummies mounting and connection (4-wires heaters).
- Routing of thermocouples, Lakeshore diodes cables from the sensors to the SVM dummy. The harness will go inside the SVM dummy through the holes around the sub platform and the upper panels.
- Routing of thermistors, 4-wires heaters cables from the sensors/heaters to the brackets located on the top of the sub plate form.
- Connection of the thermistors and heaters on the brackets (cables pinning + mechanical mounting on the bracket).

TS CQM AI13: SVM dummy integration	CQM cryogenic model
Duration	7 days
Ambience	Class 100000

Goal :

To install and route the harness inside the SVM dummy.
To check the grounding network.
To check the power polarity before electronic equipment connection.

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø CQM cryo model mounted on the SVM dummy.
  - Ø Lateral panels of the SVM dummy open.
  - Ø Upper panels of the SVM dummy dismounted.
  - Ø MGSE needs: VIS, PAP.

- Electrical configuration / EGSE required :
  - Ø Multimeter.
  - Ø PLM EGSE (PLM scoe part).
  - Ø CCS.

Activity :

- SVM dummy harness mechanical installation.
- Instrument harness installation (REU/PAU).
- Instrument pipes installation (DCCU, 4K).
- grounding network check.
- power polarity check.

TS CQM AI14: electronic mechanical & electrical integration	CQM cryogenic model
Duration	8 days
Ambience	Class 100000

Goal :

To integrate mechanically and electrically the DPU, 4K CRU, 4K CAU/CCU, 4K DCE , 0.1K DCCE, REU.

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø Lateral panels of the SVM dummy open.
  - Ø Upper panels of the SVM dummy dismounted.
  - Ø SVM dummy harness installed.
  - Ø MGSE needs: VIS, PAP.

- Electrical configuration / EGSE required :
  - Ø PLM EGSE (PLM scoe and CDMU DFE).
  - Ø CCS .

Activity :

- DPU, 4K CRU, 4K CAU/CCU, 0.1K DCCE, REU mechanical integration and grounding.
- Grounding check between the units and the SVM dummy structure.
- DPU, 4K CRU, 4K CAU/CCU, 0.1K DCCE, REU electrical integration. Harness connection. Units switch 'ON' with the PLM EGSE.
- DPU, 4K CRU, 4K CAU/CCU, 0.1K DCCE, REU Unit Function Check.
  - Ø Consumption check (with the PLM EGSE).
  - Ø 1553 bus acquisition.
  - Ø telemetry check (house-keeping telemetry).

TS CQM AI15: FPU/JFET electrical integration	CQM cryogenic model
Duration	4 days
Ambience	Class 100000

Goal :

To connect the HFP FPU bellow to the JFET. This task is under HFI team responsability.
To check the HFI acquisition chain after connection.

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø Lateral panels of the SVM dummy open.
  - Ø Upper panels of the SVM dummy dismounted.
  - Ø SVM dummy harness installed.
  - Ø MGSE needs: VIS, PAP.

- Electrical configuration / EGSE required :
  - Ø PLM EGSE.
  - Ø CCS .

Activity :

- HFI FPU cryo harness connection to the JFET.
- FPU/JFET/PAU/REU Unit Function Check.
  - Ø Consumption check (with the PLM EGSE).
  - Ø 1553 bus acquisition.
  - Ø telemetry check (house-keeping telemetry).
- MLI installation between sub-platform and PPLM.
- SVM dummy: 4K panel closure

TS CQM T16: 0.1K and 4K cooler chain test	CQM cryogenic model
Duration	2 days
Ambience	Class 100000

Goal :

To perform 0.1K and 4K cooler System Integrated Test after the electronic units integration and UFT.

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø Lateral panels of the SVM dummy open.
  - Ø Upper panels of the SVM dummy dismounted.
  - Ø SVM dummy harness installed.
  - Ø MGSE needs: VIS, PAP.

- Electrical configuration / EGSE required :
  - Ø PLM EGSE (PLM scoe and CDMU DFE).
  - Ø CCS .

Activity :

- 0.1K cooler chain System Integrated Test.
- 4K cooler chain System Integrated Test.
- 0.1K and 4K pipes purging and leak test.

TS CQM T17: HFI acquisition chain test	CQM cryogenic model
Duration	2 days
Ambience	Class 100000

Goal :

To perform HFI acquisition System Integrated Test after the electronic units integration and UFT.

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø Lateral panels of the SVM dummy open (except 4K panel).
  - Ø Upper panels of the SVM dummy dismounted.
  - Ø SVM dummy harness installed.
  - Ø MGSE needs: VIS, PAP.

- Electrical configuration / EGSE required :
  - Ø PLM EGSE (PLM scoe and CDMU DFE).
  - Ø CCS .

Activity :

- HFI acquisition chain system integrated test.

TS CQM T18: test sensors routing and connection	CQM cryogenic model
Duration	5 days
Ambience	Class 100000

Goal :

To complete the routing and the connection of the tests sensors/ heaters used for the cryo tests.

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø Lateral panels of the SVM dummy open.
  - Ø Upper panels of the SVM dummy dismounted.
  - Ø Test sensors already routed from the sensors on the PPLM to the SVM dummy (thermocouples, Lakeshore diodes, accelerometers).
  - Ø Tests sensors already routed and connected on the top of the SVM dummy plate-form (thermistors, 4-wires heaters).
  - Ø MGSE needs: VIS, PAP.

- Electrical configuration / EGSE required :
  - Ø PLM EGSE (PLM scoe and CDMU DFE).
  - Ø CCS .
  - Ø Test aids

Activity :

- SVM dummy heaters bonding.
- SVM dummy thermocouples bonding.
- EMC probes set on the cables between the REU and the PAU.
- SVM dummy accelerometers bonding.
- Thermocouples (PPLM and SVM dummy) harness routing outside the SVM dummy (at –X side) and connection to CSL connectors.
- Lakeshore diode harness routing outside the SVM dummy (at –X side) and connection to CSL connectors.
- Accelerometers coax (PPLM and SVM dummy) routing outside the SVM dummy (at –X side).
- EMC probes coax routing outside the SVM dummy (at –X side).
- 2-wires harness connection at SVM dummy (at –X side) level.
- Addressing check of the thermistors, 2-wires heaters, 4-wires heaters.
- Visual check of the right addressing of the thermocouples, Lakeshore diodes.

TS CQM AI19: PACE CQM exchanger, harness integration and check.	CQM cryogenic model
Duration	5 days
Ambience	Class 100000

Goal :

To mount the PACE exchanger and fix the PACE CQM to the SVM dummy.
To connect the test pipe to the PACE pipes.
To connect and check the SVM harness to the PACE harness

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø Lateral panels of the SVM dummy open.
  - Ø Upper panels of the SVM dummy dismounted.
  - Ø PACE test pipe.
  - Ø MGSE needs: VIS, PAP, dry pump, helium (high purity) (ASP), filter (Air Liquid).

- Electrical configuration / EGSE required :
  - Ø PLM EGSE (PLM scoe and CDMU DFE).
  - Ø CCS .

Activity :

- PACE test pipes connection from the PACE CQM to the bracket outside the SVM dummy.
- PACE test pipes cleaning, purging, under vacuum.
- PACE valves opening.
- PACE harness connection to the SVM harness.
- Connection of the cryo harness between the PACE harness and the SVM dummy (PACE CQM connectors J21 and J22).
- Check the PACE harness (continuity, sensors value reading, insulation).

TS CQM AI20: Satellite CQM finalisation.	CQM cryogenic model
Duration	6 days
Ambience	Class 100000

Goal :

To finalise the CQM model before the alignment check and the cryo test.

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø Lateral panels of the SVM dummy open.
  - Ø Upper panels of the SVM dummy dismounted.
  - Ø MGSE needs: VIS, PAP, baffle lifting device.

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

Activity :

- To mount the baffle on the top of the telescope.
- To install the cleanliness witness between the groove 2 and 3.
- To mount the extension groove.
- To inspect the CQM model before SVM dummy closure .
- To close the SVM dummy lateral panels.
- To mount the SVM dummy upper panels.
- To inspect the CQM model after SVM dummy closure.
- To partially mount the MLI (SVM, PPLM, external) (alignment cubes need to stay visible in order to do TS CQM T21).
- To mount the SLI (baffle, grooves, cryo-structure).
- To install cleanliness witness in optical cavity.

TS CQM T21: alignment measurements.	CQM cryogenic model
Duration	1 day
Ambience	Class 100000

Goal :

To perform the PPLM alignment measurements. The cubes are located on the FPU, on the main frame, on the telescope bottom frame, on the sub plate-form.

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø Satellite cryogenic CQM model completely integrated.
  - Ø MGSE needs: VIS, PAP.

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

Activity :

- To measure the location of the different parts of the PPLM (with cubes and balls) before the cryogenic tests with regards to the referential plane: PPLM sub plate-form.
- To complete the MLI installation.

TS CQM T22: Satellite preparation before transfer to CSL.	CQM cryogenic model
Duration	2 days
Ambience	Class 100000

Goal :

To prepare and finalise the satellite CQM before transfer to CSL.

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø Satellite cryogenic CQM model completely integrated.
  - Ø MGSE needs: VIS, MPT, VHD.

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

Activity :

- Transfer the Satellite CQM model from the VIS to the MPT.
- Satellite cleaning.
- Satellite cleanliness protection installation.
- Inspection before Satellite CQM transfer to the transportation container.

TS CQM AI23: Satellite transfer to CSL.	CQM cryogenic model
Duration	11 days
Ambience	Class 100000 in Cannes, 10000 in CSL

Goal :

To transfer the Satellite CQM model from Cannes to Liege (Belgium) for the cryogenic tests. The transfer will be done by road.

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø Satellite cryogenic CQM model completely integrated.
  - Ø MGSE needs: MPT, HHD, satellite container.

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

Activity :

- Container preparation: cleanliness witness, accelerometers, temperature/humidity recorder installation.
- Transfer the Satellite CQM model from the MPT to the container brace.
- Transfer the satellite CQM into the container.
- Inspection before closure.
- Container closure.
- Container transportation by road.
- Container cleaning closed to the CSL airlock.
- Container opening.
- Transfer the satellite CQM into the CSL airlock.
- Satellite CQM inspection.
- Satellite cleaning into the CSL airlock.
- Satellite transfer into the clean room.
- Satellite transfer from the container brace to the MPT.
- Satellite moving closed to the focal 5 chamber.

For details, refer to [RD14]

TS CQM T24: Satellite CQM electrical test.	CQM cryogenic model
Duration	3 days
Ambience	Class 10000

Goal :

To perform sub system SIT.
To check all the test sensors/heaters connection.

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø Satellite cryogenic CQM model completely integrated.
  - Ø Satellite CQM closed to the focal 5 chamber.
  - Ø MGSE needs: MPT.

- Electrical configuration / EGSE required :
  - Ø PLM EGSE
  - Ø CCS
  - Ø EMC measurement equipment's
  - Ø Accelerometers acquisition equipment's

Activity :

- EGSE cables connection.
- 4K cooler chain SIT.
- 0.1K cooler chain SIT.
- HFI data acquisition chain SIT.
- Tests sensors/heaters check before satellite transfer into the chamber (partial check because they are not connected to the facilities).
- EGSE cables disconnection.

For details, refer to [RD14]

TS CQM AI25: Satellite CQM finalisation and inspection.	CQM cryogenic model
Duration	3 days
Ambience	Class 10000

Goal :

To mount the last equipment before closure.
To clean and inspect the satellite.

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø Satellite cryogenic CQM model completely integrated.
  - Ø Satellite CQM closed to the focal 5 chamber.
  - Ø MGSE needs: MPT.

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

Activity :

- Solar extension mounting.
- HFI external pipes mounting.
- External thermocouples bonding and routing.
- External MLI mounting.
- Satellite CQM cleaning.
- Satellite CQM inspection.

For details, refer to [RD14]

TS CQM AI26: Satellite CQM transfer in the chamber.	CQM cryogenic model
Duration	10 days
Ambience	Class 10000

Goal :

To transfer the Satellite CQM into the chamber.

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø Satellite cryogenic CQM model completely integrated.
  - Ø Satellite CQM closed to the focal 5 chamber.
  - Ø MGSE needs: MPT, HHD.

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

Activity :

- Satellite CQM transfer on CSL brace.
- Satellite CQM transfer into the chamber.

For details, refer to [RD14]

TS CQM T27: Satellite CQM electrical check	CQM cryogenic model
Duration	2 days
Ambience	Class 10000

Goal :

To transfer the Satellite CQM into the chamber.

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø Satellite cryogenic CQM model completely integrated.
  - Ø Satellite CQM inside the chamber.
  - Ø MGSE needs: N/A.

- Electrical configuration / EGSE required :
  - Ø PLM EGSE.
  - Ø CCS.
  - Ø Power regulation EGSE.
  - Ø Thermal regulation EGSE.

Activity :

- EGSE cables connection.
- 4K cooler chain SIT.
- 0.1K cooler chain SIT.
- HFI data acquisition chain SIT.
- Tests sensors/heaters check into the chamber.
- EMC probes check.
- Accelerometers acquisition chain check.
- Thermocouples, Lakeshore diode, Pt100 connection and check (CSL activities).

For details, refer to [RD14]

TS CQM T28: Shrouds & chamber set-up before closure.	CQM cryogenic model
Duration	3 days
Ambience	Class 10000

Goal :

To finalise the chamber before closure.

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø Satellite cryogenic CQM model completely integrated.
  - Ø Satellite CQM inside the chamber.
  - Ø MGSE needs: 20K and 0.1K PGSE.

- Electrical configuration / EGSE required :
  - Ø PLM EGSE.
  - Ø CCS.
  - Ø Power regulation EGSE.
  - Ø Thermal regulation EGSE.
  - Ø CSL facilities.

Activity :

- 20K and 0.1K PGSE purging, leak test and set in operational mode.
- Molecular and particular witnesses set-up inside the chamber.
- Baffle protection removal.
- Shrouds cover installation.
- Optical shield installation.
- MLI installation around the test cables, around the satellite CQM model.
- Final piping connection: LN2, He, H2 and leak check.
- Chamber cleaning
- Chamber closure.

For details, refer to [RD14]

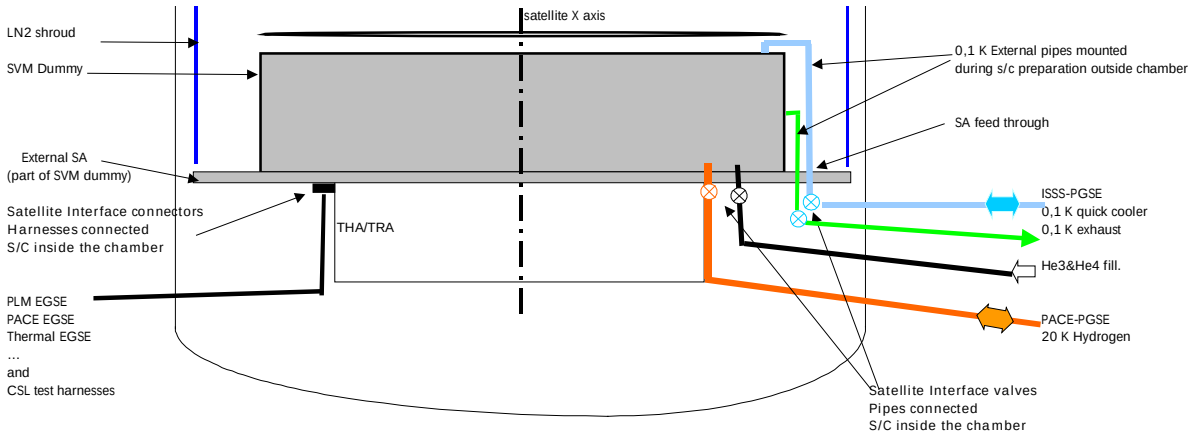


Figure 14: interface between the chamber and the test facilities

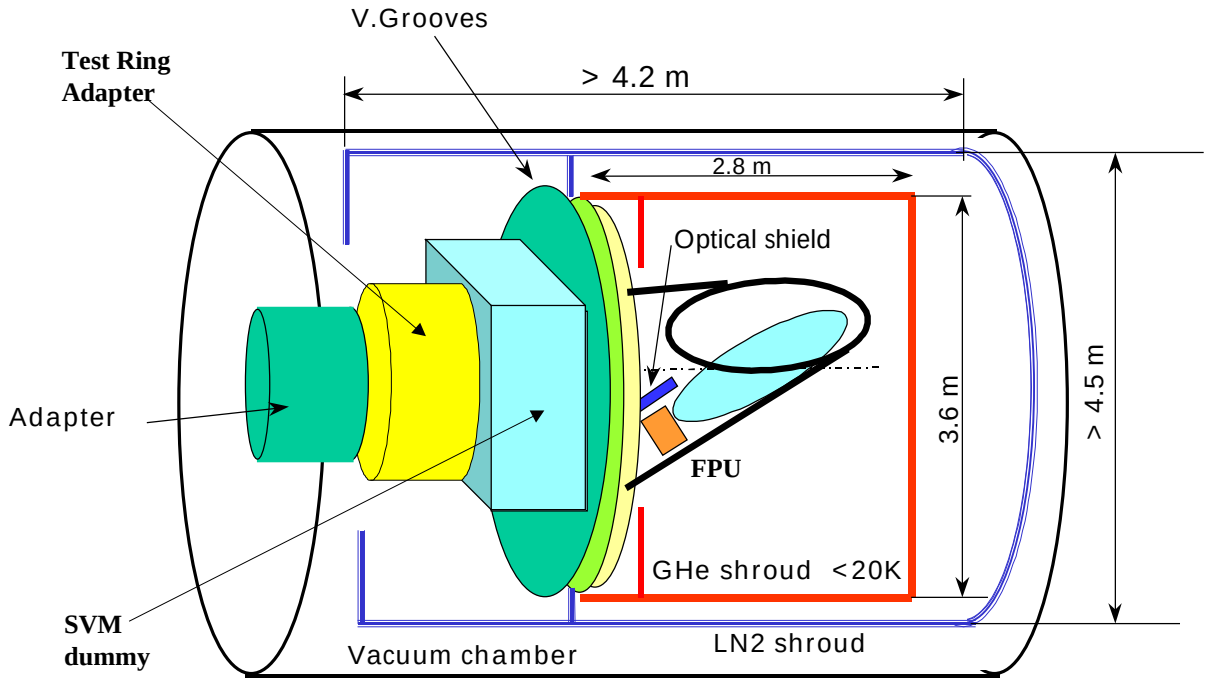


Figure 15: CQM configuration in chamber

TS CQM T29: thermal balance & functional cryogenic test.	CQM cryogenic model
Duration	41 days
Ambience	Class 10000

Goal :

To perform the cryogenic test.

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø Satellite CQM inside the chamber.
  - Ø MGSE needs: N/A.

- Electrical configuration / EGSE required :
  - Ø PLM EGSE.
  - Ø CCS.
  - Ø Power regulation EGSE.
  - Ø Thermal regulation EGSE.
  - Ø CSL facilities.

Activity :

- Satellite CQM power-up.
- Facility pump down (decontamination/out-gassing phase).
- Leaks and µ.vibrations checks.
- Thermal balance test.
- Functional Cryogenic test.
- Ambient return.

For details, refer to [RD14]

TS CQM T30: Chamber & shrouds opening.	CQM cryogenic model
Duration	6 days
Ambience	Class 10000

Goal :

To open the chamber and the shrouds after the cryogenic test.

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø Satellite CQM inside the chamber.
  - Ø MGSE needs: N/A.

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

Activity :

- Chamber opening.
- Baffle protection installation.
- Molecular and particular witnesses removal.
- piping disconnection: LN2, He, H2, 0.1K, 20K.
- MLI dismounting around the test cables, around the satellite CQM model.
- Shrouds cover dismounting.
- Electrical cables disconnection.
- Satellite CQM moved outside the chamber.

For details, refer to [RD14]

TS CQM AI31: Satellite CQM transfer in the airlock.	CQM cryogenic model
Duration	3 days
Ambience	Class 10000

Goal :

To prepare the satellite CQM transport from CSL to Cannes. Satellite CQM moved in the airlock.

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø Satellite CQM closed to the chamber, on the CSL brace.
  - Ø MGSE needs: MPT, HHD.

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

Activity :

- Satellite CQM transfer on the MPT.
- Solar array extension dismounting.
- Grooves protection installation.
- Satellite CQM moved in the airlock.

For details, refer to [RD14]

TS CQM AI32: Satellite CQM transfer to Cannes.	CQM cryogenic model
Duration	15 days
Ambience	Class 10000 in CSL, 100000 in Canness

Goal :

To prepare the satellite CQM transport from CSL to Cannes. Satellite CQM moved in the airlock.

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø Satellite CQM closed to the chamber, on the CSL brace.
  - Ø MGSE needs: MPT, HHD.

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

Activity :

- Container preparation: cleanliness witness, accelerometers, temperature/humidity recorder installation.
- Transfer the Satellite CQM model from the MPT to the container brace.
- Transfer the satellite CQM into the container.
- Inspection before closure.
- Container closure.
- Container transportation by road.
- Container cleaning closed to the ASP airlock.
- Container transfer in the airlock.
- Container opening.
- Satellite CQM inspection.
- Satellite transfer into the clean room.
- Satellite transfer from the container brace to the MPT.

For details, refer to [RD14]

TS CQM T33: alignment measurements.	CQM cryogenic model
Duration	1 day
Ambience	Class 100000

Goal :

To perform the PPLM alignment measurements. The cubes are located on the FPU, on the main frame, on the telescope bottom frame, on the sub plate-form. The aim of these measurements is to verify the PPLM cryo structure stability during the cryo test. The results will be compared to the ones performed before the cryogenic test (Task Sheet T21)

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø Satellite cryogenic CQM model completely integrated, on the MPT.
  - Ø MGSE needs: MPT, PAP.

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

Activity :

- To measure the location of the different parts of the PPLM (with cubes and balls) after the cryogenic tests with regards to the referential plane: PPLM sub plate-form.

TS CQM AI34: Satellite CQM and cryo structure dismounting.	CQM cryogenic model
Duration	13 days
Ambience	Class 100000

Goal :

As the Satellite CQM activities are completed, dismounting of all the units in order to prepare the STM model, to send back units to HFI laboratory.

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø Satellite cryogenic CQM model completely integrated.
  - Ø MGSE needs: MPT, PAP, baffle lifting device, telescope handling jig, FHD, PAU/JFET HD, SID.

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

Activity :

- To dismount the SVM dummy lateral panels.
- To dismount the extension grooves.
- To dismount the baffle.
- To dismount the FPU.
- To dismount the PAU/Bellow/JFET.
- To dismount the telescope CQM.
- To dismount the 0.1K and 4K pipes.
- To dismount the BEU MTD.
- To dismount the cryo structure and mount the SID to maintain to PACE CQM .
- To dismount the thermistors, the test sensors, the heaters.

TS CQM AI35: SVM dummy dismounting.	CQM cryogenic model
Duration	2 days
Ambience	Class 100000

Goal :

As the Satellite CQM activities are completed, dismounting of all the units in order to prepare the STM model, to send back units to HFI laboratory.

Specimen configuration :

- Mechanical configuration / MGSE required :
  - Ø PPLM completely dismounted.
  - Ø MGSE needs: MPT.
- Electrical configuration / EGSE required :
  - Ø N/A

Activity :

- To dismount the 4K CRU.
- To dismount the 4K CAU/CCU.
- To dismount the 4K DCE.
- To dismount the HFI DPU.
- To dismount the 0.1K DCCE.
- To dismount the REU CQM.
- To dismount the PACE CQM and the SID.
- To dismount the thermistors, the test sensors.
- To store the SVM dummy.

5.3 Tests Matrix

Test designation	acoustic test	HFI DPU electrical integration (*)	HFI DPU UFT	4K CRU electrical integration (*)	4K CDE electrical integration (*)	4K CAU/CCU electrical integration (*)	4K CAU/CCU UFT	REU electrical integration (*)	REU UFT	0.1K DCE electrical integration (*)	0.1K DCE UFT	PACE leak check	PACE electrical check	4K cooler chain SIT	0.1K cooler SIT	HFI data acquisition chain SIT	0.1K leak check	4K leak check	0.1K pipes purging	4K pipes purging	PACE setting in operational mode	0.1K pipes setting in operational mode	EMC CE/CS measurements	µ.vibrations measurements
Test requirement sheet number																								
acoustic test	X											X	X											
Satellite CQM integration		X		X	X	X		X		X														
Unit Functional Test			X				X		X		X													
electrical and pneumatic check												X	X				X	X	X	X				
System Integrated Test														X	X	X								
Pre thermal tests														X	X	X	X	X			X	X		
Thermal/cryo tests														X	X	X					X	X	X	X

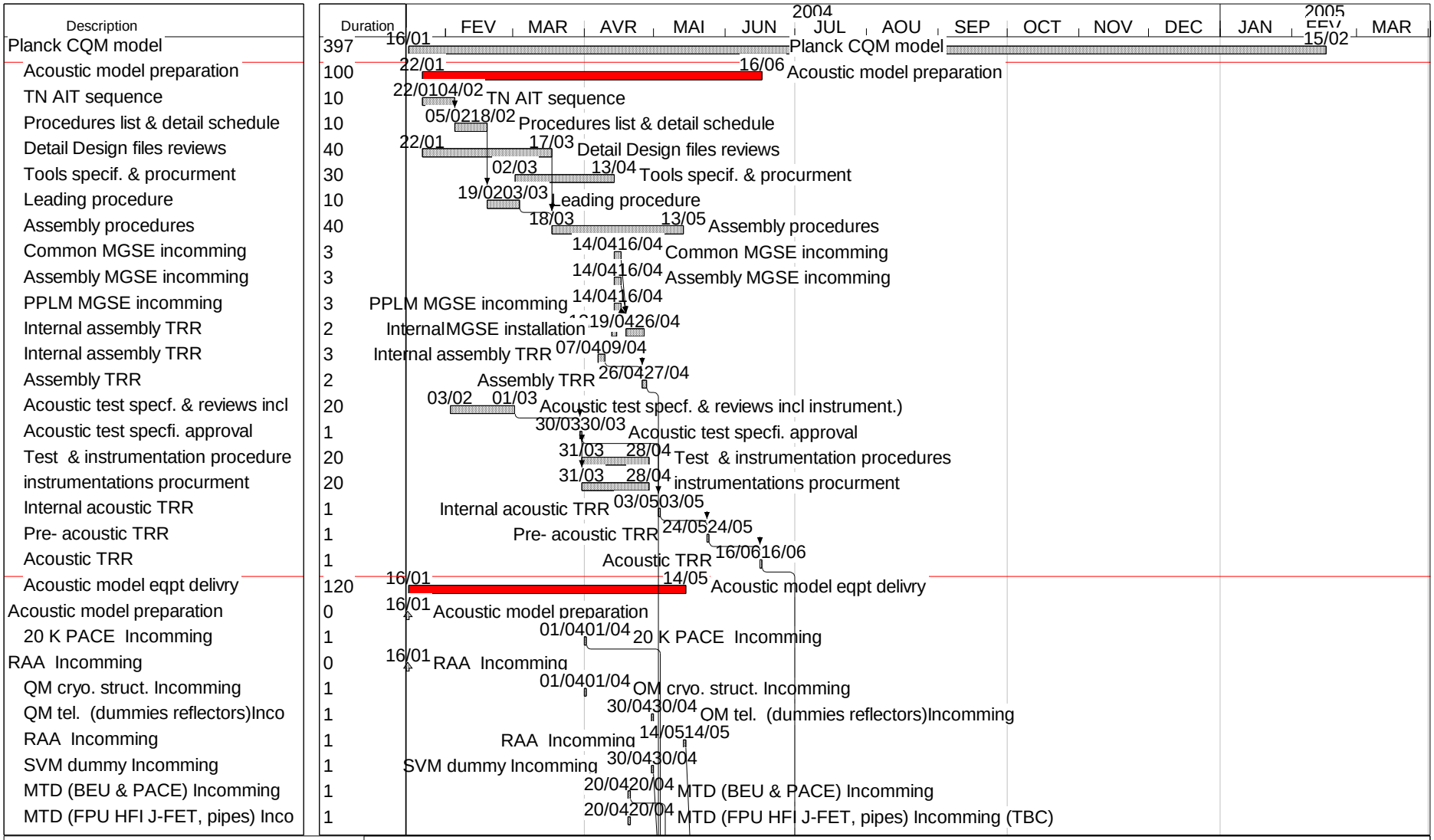
(*) electrical integration included critical signals checking

5.4 Schedule

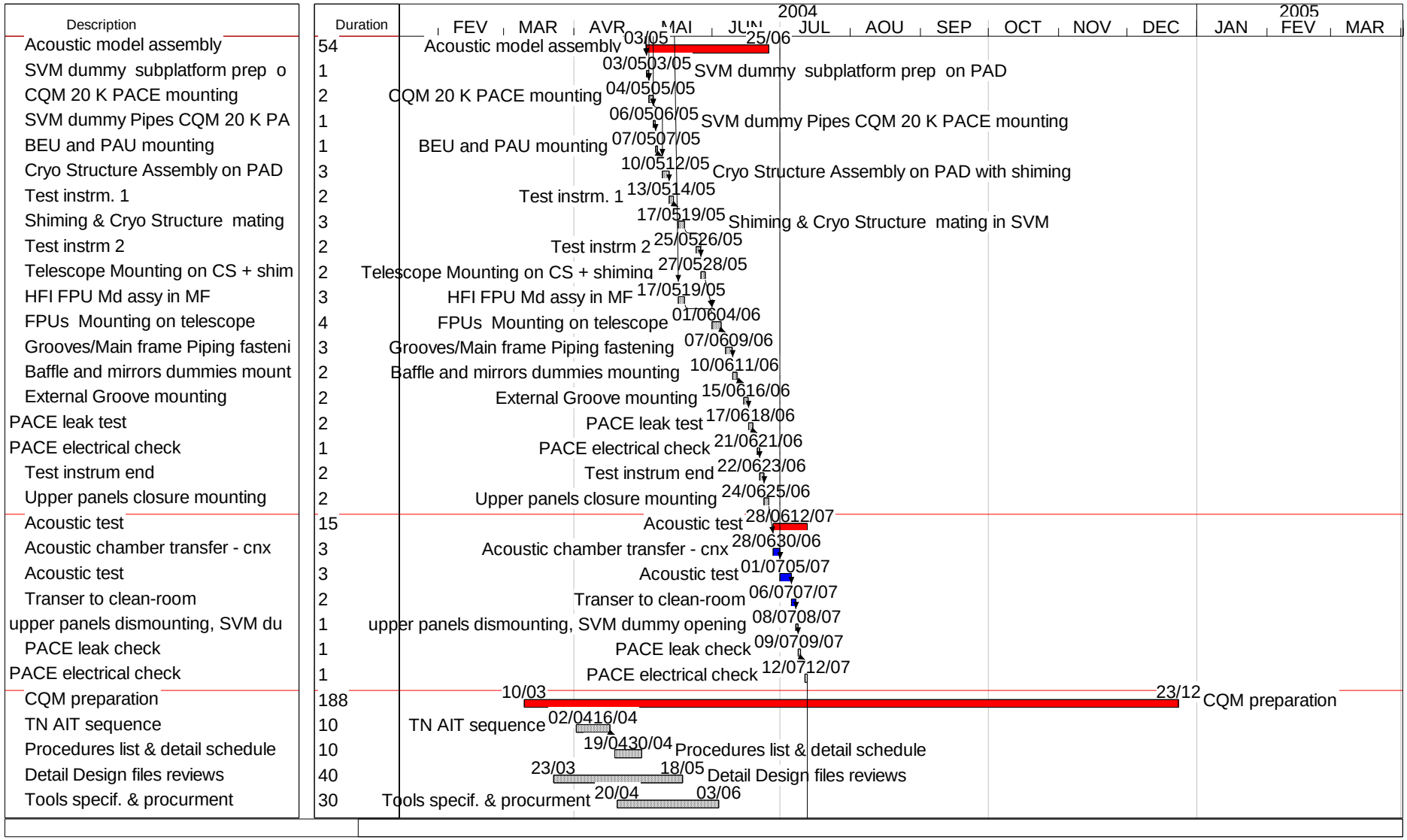
Schedule is given only for information, showing a logic flow and typical duration activity.

Planck - CQM model
acoustic and cryogenic tests

25MAR04



Planck - CQM model
acoustic and cryogenic tests



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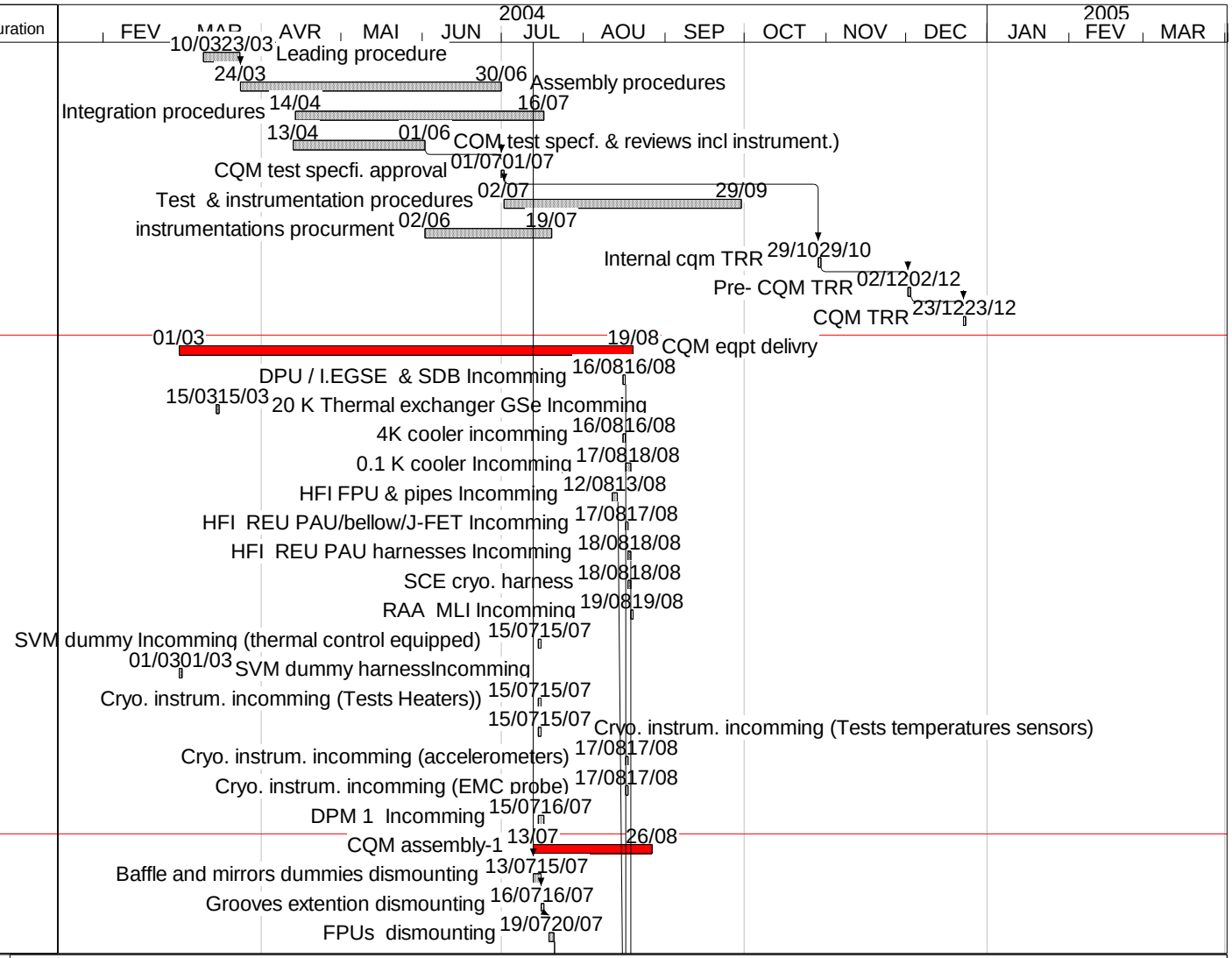
Planck - CQM model acoustic and cryogenic tests

Description	Duration
Leading procedure	10
Assembly procedures	66
Integration procedures	63
CQM test specf. & reviews incl ins	33
CQM test specfi. approval	1
Test & instrumentation procedure	53
instrumentations procurment	32
Internal cqm TRR	1
Pre- CQM TRR	1
CQM TRR	1
CQM eqpt delivry	172
DPU / I.EGSE & SDB Incomming	1
20 K Thermal exchanger GSe Inco	1
4K cooler incomming	1
0.1 K cooler Incomming	2
HFI FPU & pipes Incomming	2
HFI REU PAU/bellow/J-FET Inco	1
HFI REU PAU harnesses Incomm	1
SCE cryo. harness	1
RAA MLI Incomming	1
SVM dummy Incomming (thermal	1
SVM dummy harnessIncomming	1
Cryo. instrum. incomming (Tests	1
Cryo. instrum. incomming (Tests t	1
Cryo. instrum. incomming (acceler	1
Cryo. instrum. incomming (EMC p	1
DPM 1 Incomming	2
CQM assembly-1	45
Baffle and mirrors dummies dismo	2
Grooves extention dismounting	1
FPUs dismounting	2



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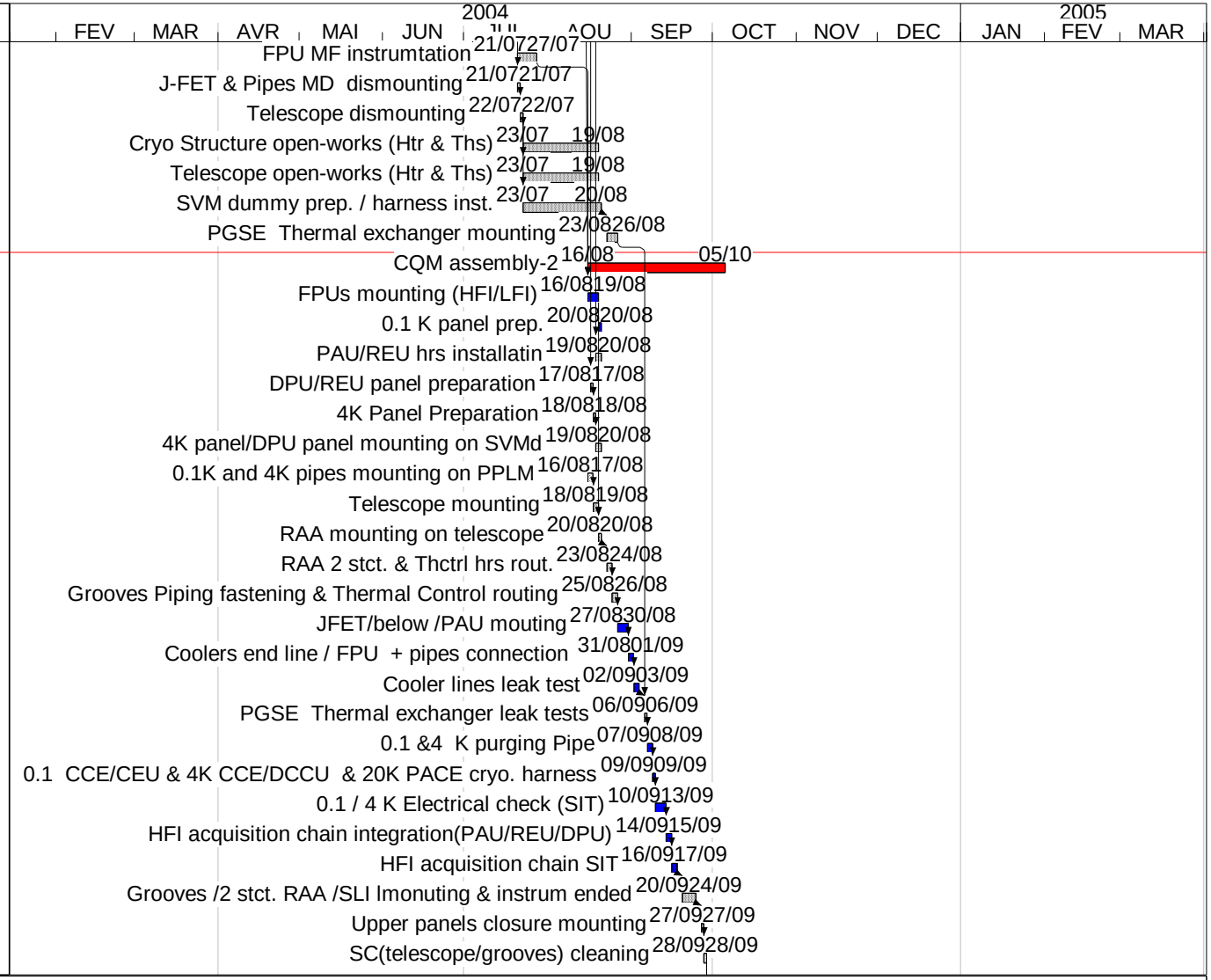
Planck - CQM model acoustic and cryogenic tests

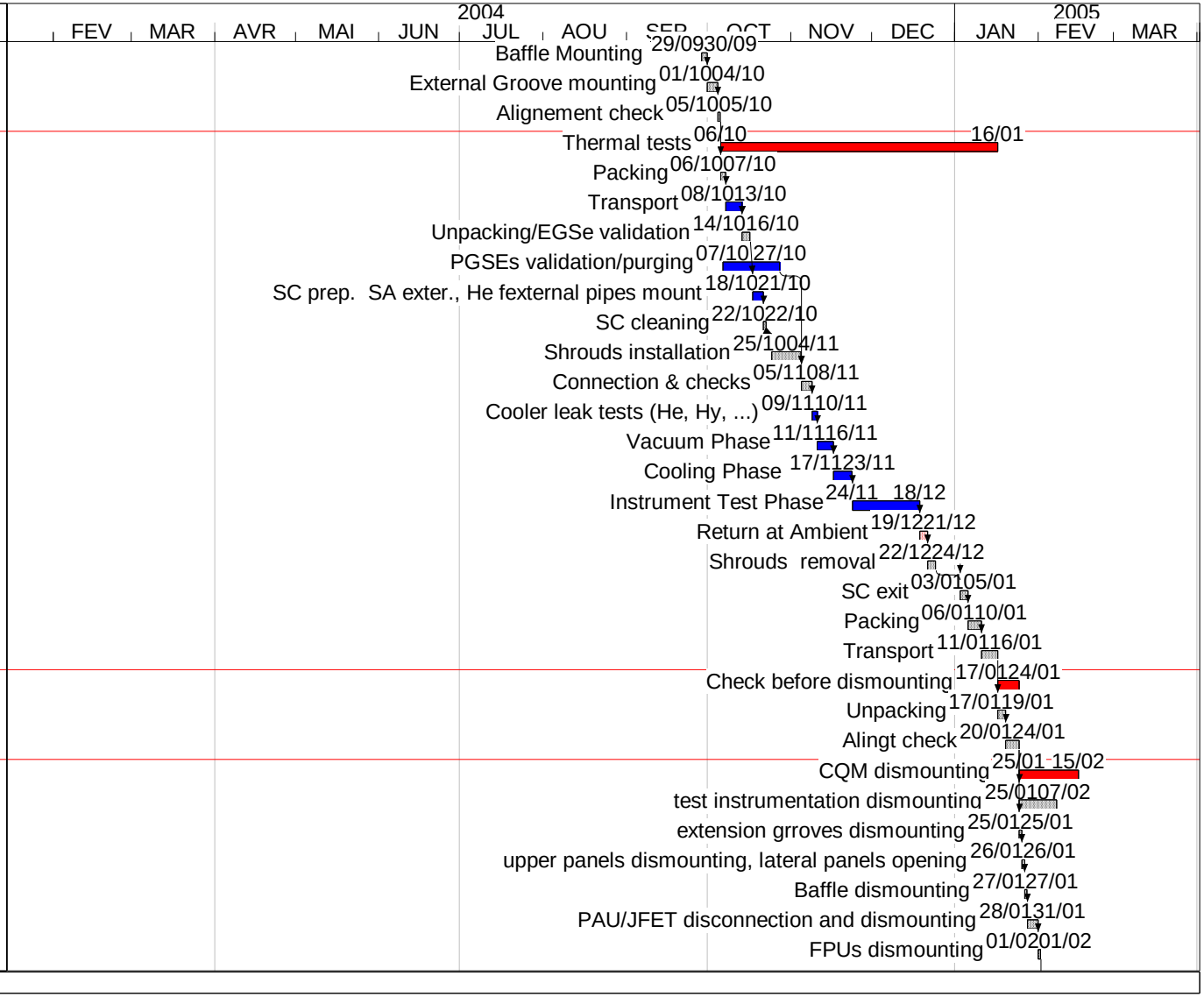
Description	Duration
FPU MF instrumtation	5
J-FET & Pipes MD dismounting	1
Telescope dismounting	1
Cryo Structure open-works (Htr &	10
Telescope open-works (Htr & Ths)	10
SVM dummy prep. / harness inst.	11
PGSE Thermal exchanger mounti	4
CQM assembly-2	51
FPUs mounting (HFI/LFI)	4
0.1 K panel prep.	1
PAU/REU hrs installatin	2
DPU/REU panel preparation	1
4K Panel Preparation	1
4K panel/DPU panel mounting on	2
0.1K and 4K pipes mounting on P	2
Telescope mounting	2
RAA mounting on telescope	1
RAA 2 stct. & Thctrl hrs rout.	2
Grooves Piping fastening & Therm	2
JFET/below /PAU mouting	2
Coolers end line / FPU + pipes co	2
Cooler lines leak test	2
PGSE Thermal exchanger leak te	1
0.1 &4 K purging Pipe	2
0.1 CCE/CEU & 4K CCE/DCCU	1
0.1 / 4 K Electrical check (SIT)	2
HFI acquisition chain integration(P	2
HFI acquisition chain SIT	2
Grooves /2 stct. RAA /SLI lmonuti	5
Upper panels closure mounting	1
SC(telescope/grooves) cleaning	1



Planck - CQM model
acoustic and cryogenic tests

25MAR04

Description	Duration
Baffle Mounting	2
External Groove mounting	2
Alignement check	1
Thermal tests	103
Packing	2
Transport	6
Unpacking/EGSe validation	3
PGSEs validation/purging	15
SC prep. SA exter., He fexternal	4
SC cleaning	1
Shrouds installation	9
Connection & checks	2
Cooler leak tests (He, Hy, ...)	2
Vacuum Phase	6
Cooling Phase	7
Instrument Test Phase	25
Return at Ambient	3
Shrouds removal	3
SC exit	3
Packing	3
Transport	6
Check before dismounting	6
Unpacking	3
Alingt check	3
CQM dismounting	22
test instrumentation dismounting	10
extension grroves dismounting	1
upper panels dismounting, lateral pa	1
Baffle dismounting	1
PAU/JFET disconnection and dismo	2
FPUs dismounting	1



Planck - CQM model acoustic and cryogenic tests

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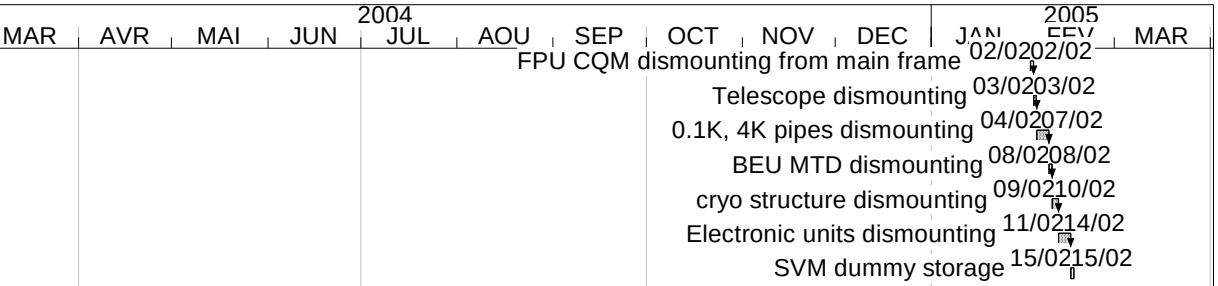
Description	Duration
FPU CQM dismounting from main fr	1
Telescope dismounting	1
0.1K, 4K pipes dismounting	2
BEU MTD dismounting	1
cryo structure dismounting	2
Electronic units dismounting	2
SVM dummy storage	1



6. MANAGEMENT AND ORGANISATION

6.1 AIT TASKS

ALCATEL is in charge of system level AIT and the RFQM.

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.

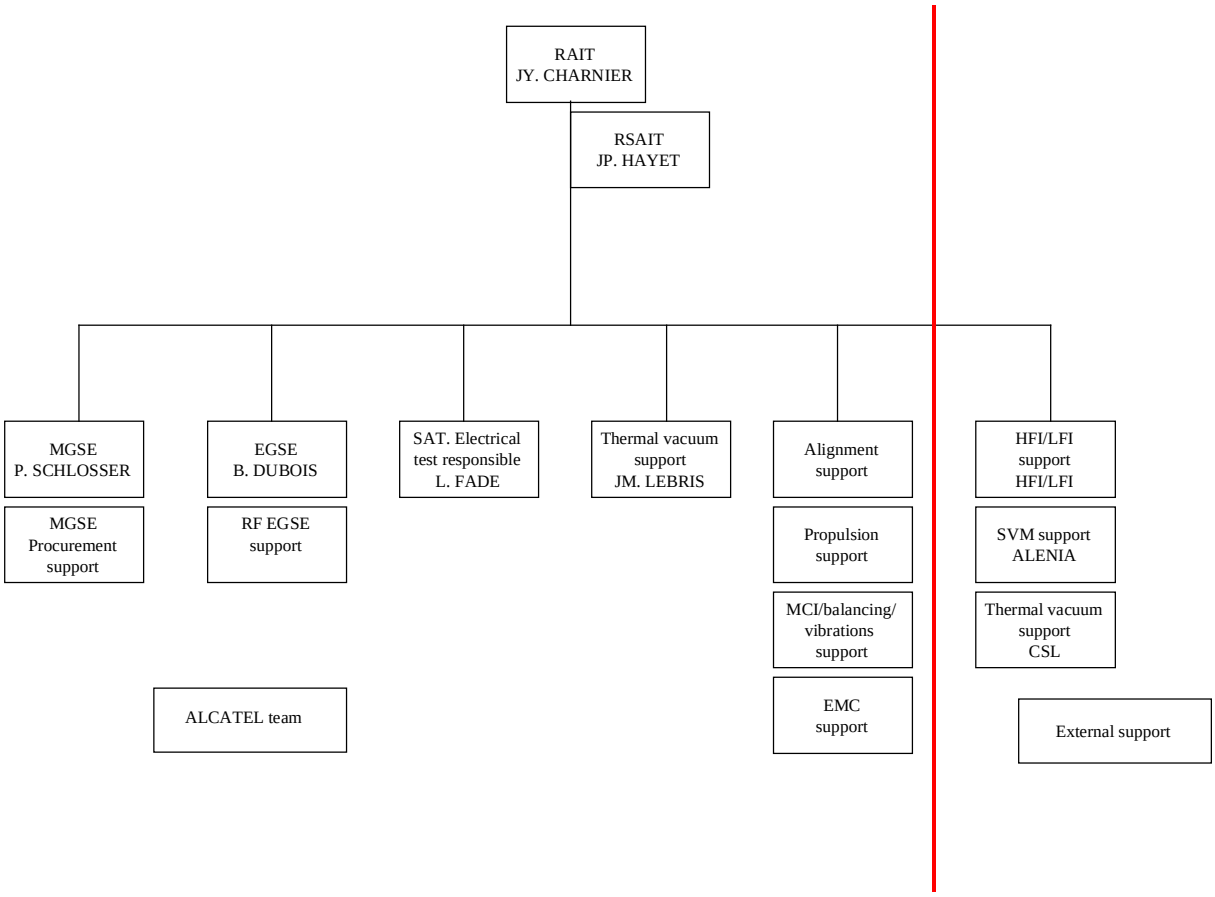


Figure 16: AIT team organisation for preliminary phase

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

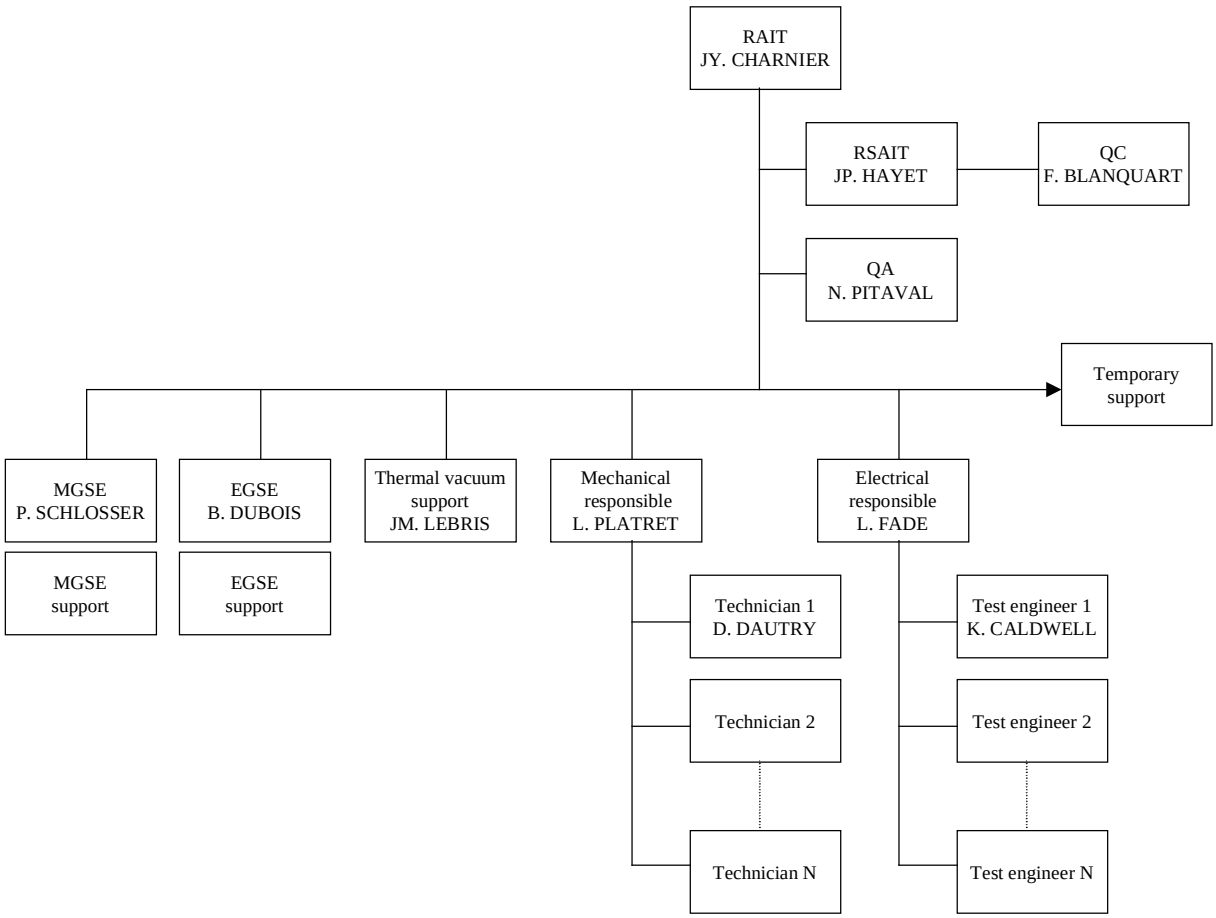


Figure 17: ALCATEL AIT core team

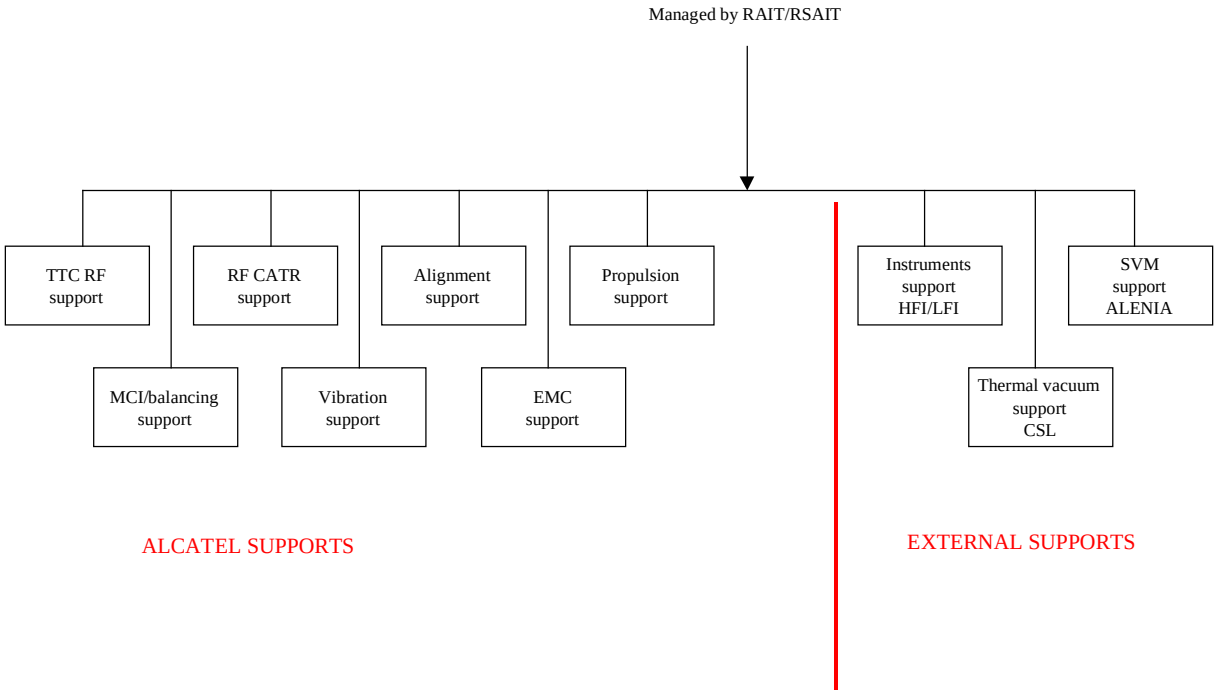


Figure 18: AIT temporary support

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 responsibility

For the CQM model, HFI will be the alone laboratory involved in the AIT phases. HFI team will be in charge of:

- Delivery of all documentation needed for AIT (ICD, user's manual, data sheets, task sheets, procedures).
- All HFI MIB files for HPSDB populating.
- ASP help for the test requirement sheets writing.
- Cryo harness connection (FPU bellow to JFET).
- Pipes connection at 18K stage.
- Pipes purging & leak test on 4K and 0.1K
- Sub system test: JFET/PAU test before integration on the CQM.
- Sub system test: PAU/REU test before integration on the CQM (incluing the harness).
- Test follow-up when HFI unit's are involved.
- HFI I.EGSE set-up before test.
- The data process after UFT, IST.
- 0.1K PGSE (ISSS) for pipes check (cleaning, set under vacuum, leak check).
- 0.1K PGSE (ISSS) for set the pipes in operational mode (cryogenic test).

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:

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

- During test operations

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

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

- Conclusion of test operations

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

- Ø verification that all required tasks have been performed and that results are approved and signed by the responsible engineer
- Ø collection and archiving of all test results
- Ø analysis of deviations, schedule impacts, work around solutions to be presented at the next daily briefing
- Ø at the end of the working day, the EGSE and flight hardware are set in a known and safe configuration, unattended operation is not allowed on the flight hardware.

6.3.2 Supervision of AIT tasks through the AIT documents

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

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

- Ø Test reports.

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

The diagram of operational utilisation of different AIT forms :

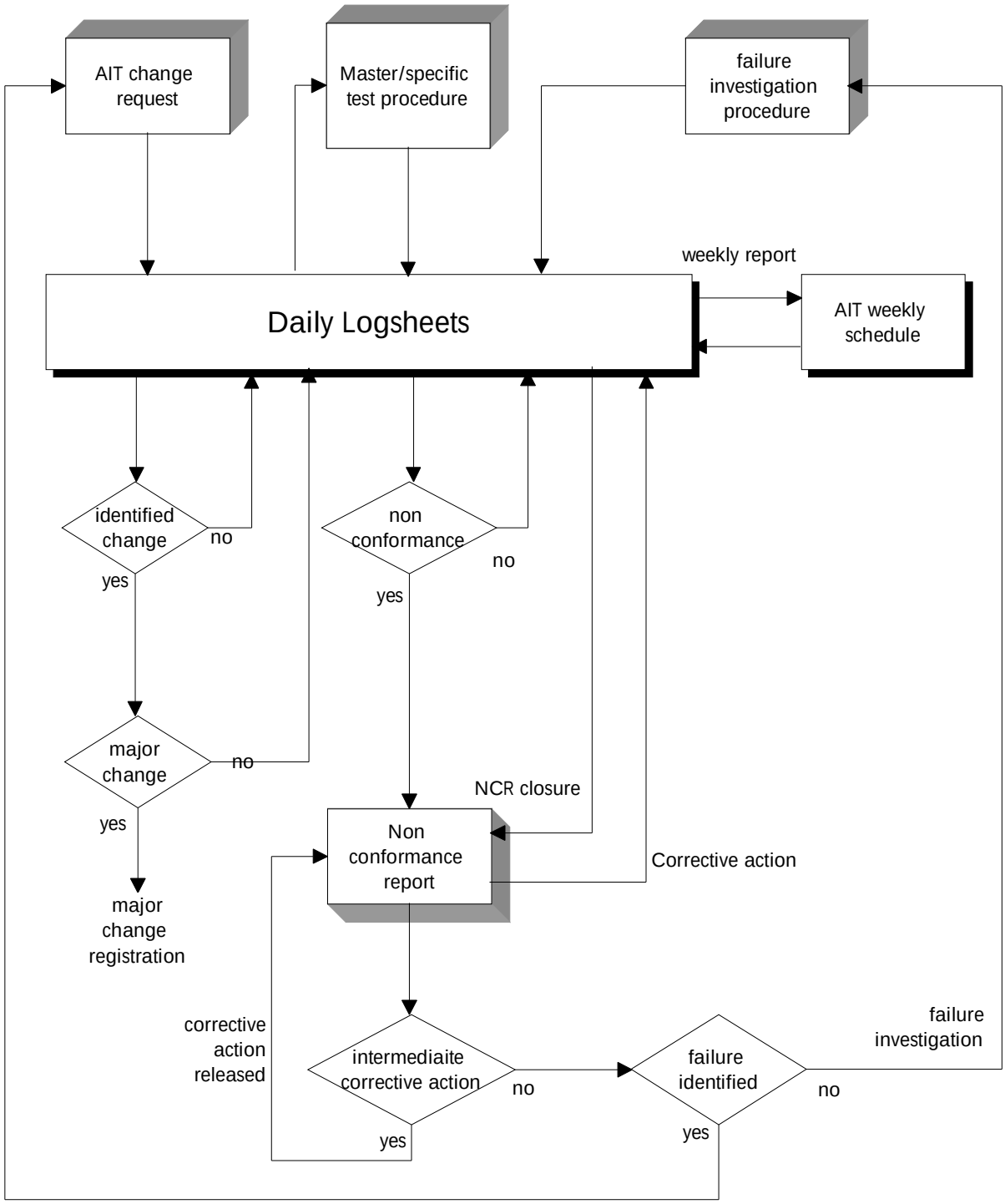


Figure 19: operational diagram - use of different AIT forms

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

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

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

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

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

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

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

  - Ø proposed immediate corrective action
  - Ø elements of decision for the current test
  - Ø failure investigation.

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

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

- The 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:

- Ø task definition
- Ø test procedure (Nr, Issue, Rev.) or classed as document (ACR, FIP)
- Ø test conductor and operators identification
- Ø starting and ending time
- Ø identification of units to be integrated if any (type, serial number)
- Ø status of RCS/coolers if concerned (pressure, gas...)
- Ø clear identification of hazardous operations
- Ø mention of tasks for which a special care has to be paid (QA attendance, special process, critical points, SPF...)
- Ø non conformances (NCR's)
- Ø open works
- Ø AIT change requests
- Ø 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:
  - Ø when the stated event needs a failure analysis and/or a failure investigation (see corresponding form)
  - Ø when the non conformance is considered as level 1 according to the criteria defined in PLANCK PA requirements (AD 5).
- The internal "anomaly sheet" can be used as official NCR form (incoming inspection - EGSE incident...). The use of NCR form will be restricted to AIT sequence when any non-conformance, which is officially stated, has to be considered as major. In this case a formal MRB is requested.

6.3.6 Technical management of “as performed” operations

6.3.6.1 Test procedure change registration

To supervise the progress of a test, procedure is performed through its official working copy, which is filled in as the test proceeds by the test conductor or the test engineer and is verified and countersigned by the QA engineer.

This working copy will be taken as reference for the test report under the name of "as run procedure"

The test procedure can be run nominally, it can be improved (with approval) or modified (with approval) during the test, it can be also aborted whatever the reason is and the test be cancelled or postponed. All changes to test procedure are recorded on ACR forms. Nevertheless three cases can be identified:

1. The minor changes: (defined and agreed by the AIT manager or his representative) and AIT QA engineer, they will be directly red lined in the working copy of test procedure itself which will be included in test report (as run procedure). This kind of change does not require any interruption in the procedure running. Nevertheless these minor changes shall be summarised in a change record sheet, part of a recapitulative ACR, and reviewed each day

2. The major changes: they will be recorded using the AIT Change Request. This form can be initiated before starting the procedure or during its progress. In this case the procedure execution has to be interrupted until an agreement is reached on the ACR content.

3. The procedure interruption for failure analysis: this is considered as a specific major change which needs a Failure Investigation Procedure. The test continuation depends on the results of the FIP.

6.3.6.2 AIT Change Request (ACR)

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

- specimen configuration

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

The ACR is the only authorised way to improve or modify a test procedure when it has been approved by competent authority and already been validated. All major changes will be justified and agreed prior to application. ACR's are subject to configuration control regardless of acceptance or rejection. ACR's will be approved at the same authority level in the organisation as it was the case for the test procedure.

The ACR has to identify if it means::

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

An ACR can be the consequence of:

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

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

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

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 20: 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 21: 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. The ISSS will also be able to power with He3/4 the 0.1K pipes for thermal environmental testing purpose (CQM). This PGSE is under HFI responsibility.
- 20K Pneumatic Ground Support Equipment called PACE GSE as a part of the MGSE used on the cryogenic test facilities for the CQM. The PACE GSE will be able to power with Hydrogen the PACE CQM, to manage the PACE CQM heaters and thermistors.
- 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:
  - Ø handling and integration
  - Ø transportation and storage
  - Ø test
  - Ø RCS & Tanking support ground equipment; 0.1 K PGSE , PACE GSE, RCS
  - Ø solar array MGSE (container)

- MGSE are decomposed in several parts:
  - Ø 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.
  - Ø 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
  - Ø Instruments MGSE. Each company is in charge of this own MGSE (LABEN for LFI…..)

8.2.2 MGSE specification documentation

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

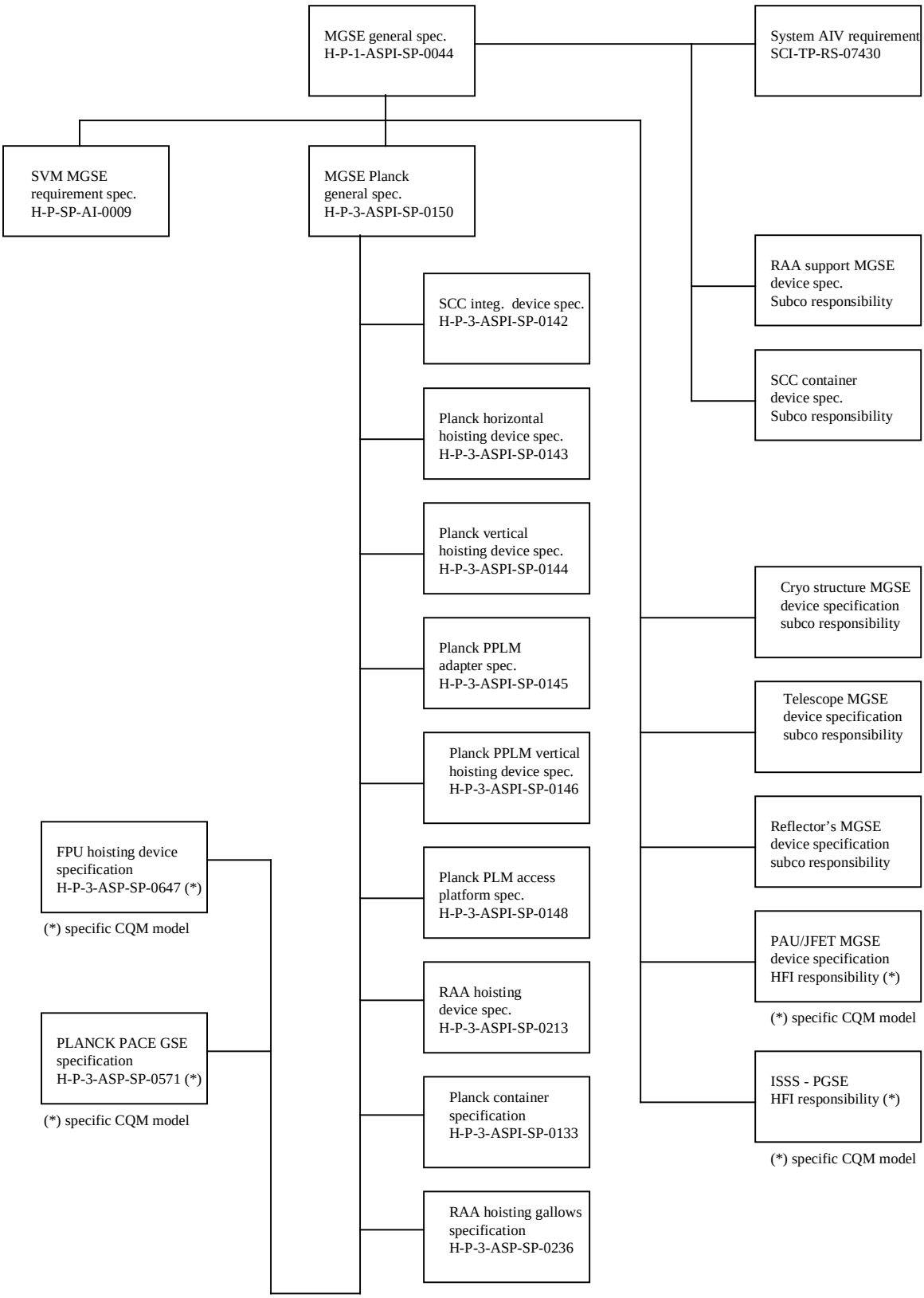


Figure 22: "main MGSE" specification tree

8.3 EGSE

8.3.1 EGSE system design

8.3.1.1 Introduction

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

This equipment includes:

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

All these specific SCOE's will be powered through an insulation transformer

The EGSE is designed to support satellite testing during all phases of integration and test.

The following section gives a general description of EGSE by presenting decomposition into functional components.

8.3.1.2 System decomposition

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

8.3.1.2.1 CQM model

As the number of electrical functionality's is very limited on the CQM model, 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
  - Ø PCDU simulation for the powering of the equipment's
  - Ø CDMS simulation for the control/command of the equipment's (1553 bus management) and the PPLM thermistors acquisition
- Thermal regulation EGSE (only for the cryogenic test): manage the temperature inside the SVM dummy and at the interface between the PPLM and the SVM dummy
- Power regulation EGSE (only for the cryogenic test): manage the simulation of the power dissipation of the missing equipment's inside the PPLM.

8.3.1.2.2 FM 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:

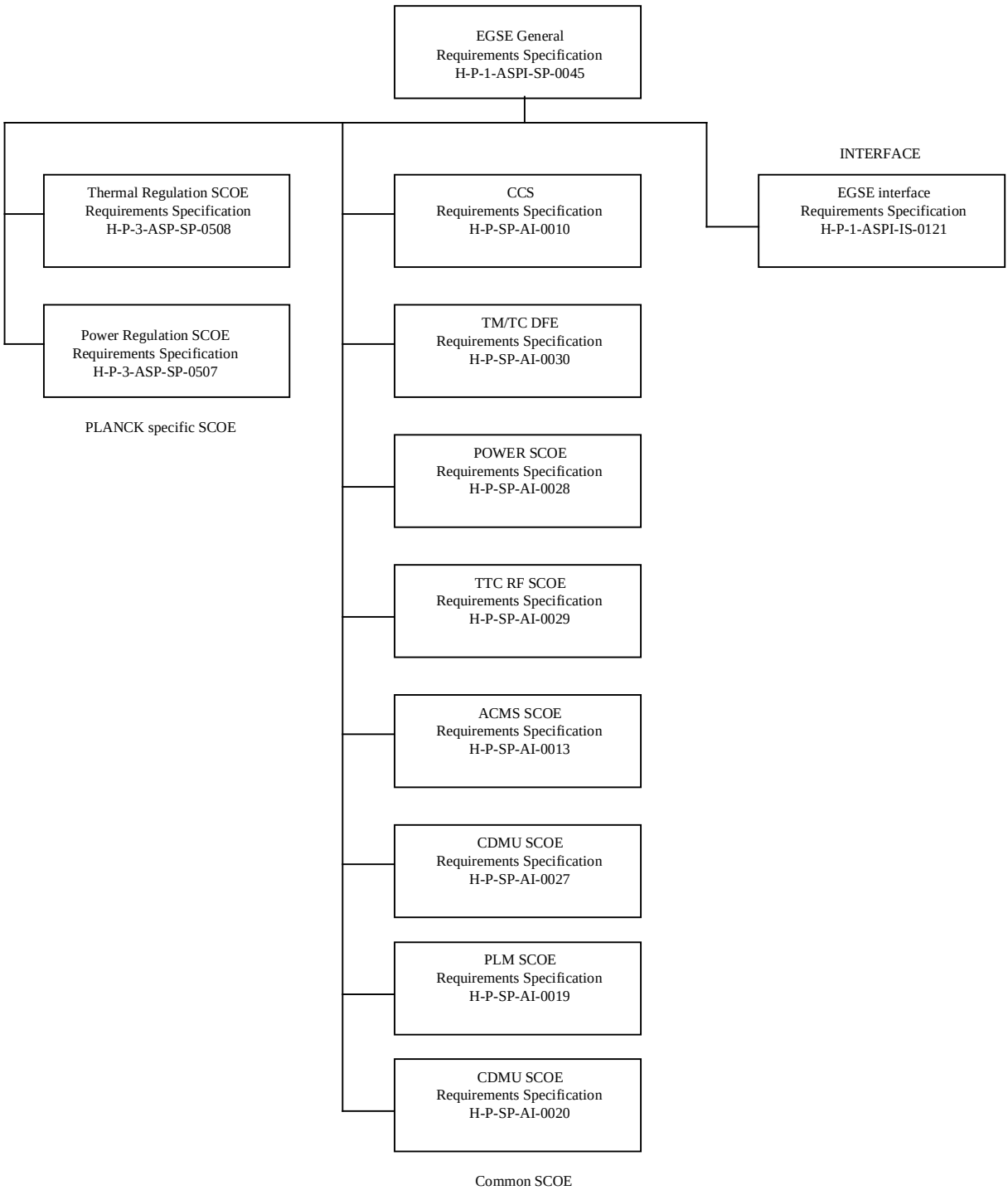


Figure 23: EGSE SPECIFICATION TREE

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

For CQM purpose, specific GSE will be manufactured either under ASP responsibility or under HFI responsibility.

- Under ASP responsibility:
  - Ø PACE GSE for the PACE CQM management (pneumatic and electrical)
  - Ø Thermal Regulation EGSE for the SVM dummy temperature management
  - Ø Power Regulation EGSE for the simulation of the unit's dissipation inside the P.PLM
- Under HFI responsibility
  - Ø 0.1K pipes PGSE (called ISSS) for the 0.1K pipes management
  - Ø HFI I.EGSE for the scientific data processing

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 and eventually the RFQM following ITT process completion.

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 m²
- M01 area: 520 m²
- M99 area: 280 m²

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

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

Figure 24: crane characteristics in ASP premises

9.2.2 Thermal facilities

9.2.2.1 Chamber characteristics :

The characteristics of the chamber are:

- Diameter: 7,54 m
- Length: 8,05 m
- Maximum satellite weight: 3 tonnes
- Vacuum level: < 10^{-6} mbar, time duration pumping from atmospheric pressure to 10^{-5} mbar: about 6 hours.
- Pumping system:
  - Ø primary pumping:
    - à 2 palets with pumping speed = 630 m^3/h (Alcatel 3631 B)
    - à 4 roots: two with a pumping speed = 1250 m^3/h (Alcatel RHV 1000), two with a pumping speed = 5000 m^3/h (Alcatel RHV 4000)
    - à 1 LN2 trap

Ø secondary pumping:

- à 2 turbo-molecular pumps:, one = 5000 l/s (Balzers TPH 5000),
  one = 2200 l/s (Balzers TPH 2200)
- à 2 cryogenic pumps (with gas helium in closed loop for cooling aspect). pumping speed = 50 000 l/s (Balzers TPH 1250 Z2)
- à 1 cryogenic static pump (with liquid helium). Pumping speed = 100 000 l/s.
- à 1 cryo panel liquid N_2: 8m²

9.2.2.2 Thermal environment:

Thermal environment is simulated with a cold skin in stainless steel (black painted). This envelope completely surrounds the satellite (emissivity > 0,9).

This envelope is cooled with boiling nitrogen . The reached temperature is above –180 °C.

9.2.2.3 Acquisition data system & temperature control system:

The acquisition data includes 3 HP 3852A . This system allows :

- to acquire temperature
- to trace in real time specific curves (asked by the user)
- to trace in real time data and warning
- to store data

The data acquisition includes 2000 data acquisition tracks.

9.2.3 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 *) :
  - Ø Amplitude ripple = ± 0.3 dB
  - Ø Amplitude taper = 2 dB maximum
  - Ø Phase ripple = ± 4°
- measurement Accuracy (gain, EIRP, GT) : ± 0.25 dB
  - Ø 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

9.2.4 Vibration facilities

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

9.2.4.1 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.

9.2.4.2 C220 characteristics:

- Sine and random vibrations
- Maximum strength vector: 155 kN
- Frequency range: from 5 to 2000 Hz

- 256 acquisition ways in real time

9.2.4.3 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)

9.2.4.4 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:
  - Ø 2 for high frequency: 6 kW LING EPT 943
  - Ø 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:
  - Ø nitrogen under pressure: 6 tanks (193 m3 at 150 bars)
  - Ø flew rate: 54 m3 / min
  - Ø liquid nitrogen: 10 000 l
  - Ø autonomy: 20 min
  - Ø filling duration: 2 hours
  - Ø electrical modulators: 2 GEARING & WATSON DSA 1

- acoustic drivers:
  - Ø spectrum and noise generation: NORSONIC type 731
  - Ø 8 microphones Bruel & Kjaer type 4134
  - Ø 2 microphones Bruel & Kjaer type 4136
  - Ø spectrum analysis 2 ways: SD 375 octave – 1/3 octave – PSD / 400 lines
  - Ø signals analyser: HP 35665 A

- Ø recorder: RACAL
- Ø 2 voltmeters RMS
- Ø 128 acquisitions ways in real time

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

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

9.2.5 Spin test facilities

One spin test machine is available at Alcatel Space Cannes.

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

9.2.6 MCI facilities

The MCI measurements are performed in M95 area

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

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

- Inertia measurement:
  - Ø Two facilities allow to perform this measurement:
  - Ø 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.

- Ø Maximum mass: 10 000 kg (satellite + tools)
- Ø Maximum inertia: 15 000 m² .kg
- Ø Maximum static balance: 100 m.kg
- Ø Accuracy: +/- 1%

- Table Schenck M7S:
  - Ø Maximum mass: 10 000 kg (satellite + tools)
  - Ø Maximum inertia: 15 000 m² .kg
  - Ø Maximum static balance: 350 m.kg
  - Ø Accuracy: +/- 1%

END OF DOCUMENT