SPIRE

SUBJECT: **INSTRUCTMENT AIV PLAN**

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Change Record

ISSUE	DATE	
Draft	19/05/2000	First draft for comment
1	20/05/2000	Detailed changes to wording on description of DPU and DRCU QM capabilities. Version issued for Delta PDR
2.0		First draft of issue 2 to reflect new model philosophy with STM
2.1	29/03/2001	Comments from Berend Winter incorporated – slight changes to deliverables list; description of STM and testing changed

Table of Contents

Glossary

ADP	Acceptance Delivery Package
AIV	Assembly Integration and Verification
AOCS	Attitude and Orbit Control System
ASIC	Application Specific Integrated Circuit
AVM	Avionics Model
BSM	Beam Steering Mechanism
CDMS	Command and Data Management System (on Spacecraft)
CQM	Cryogenic Qualification Model
CVV	Cryostat Vacuum Vessel
DCRU	Detector Control and Readout Unit
DPU	Digital Processing Unit
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
FINDAS	FIRST Integrated Network and Data Archive System
FOV	Field of View
FPU	Focal Plane Unit
FS	Flight Spare
FTS	Fourier Transform Spectrometer
IID-A	Instrument Interface Document part A
IID-B	Instrument Interface Document part B
JFET	Junction Field Effect Transistor
MGSE	Mechanical Ground Support Equipment
NEP	Noise Equivalent Power
OBDH	On Board Data Handling (on Spacecraft)
OGSE	Optical Ground Support Equipment
OPD	Optical Path Difference
PDU	Power Distribution Unit (on spacecraft)
PFM	Proto-Flight Model
PLM	Payload Module
QLF	Quick Look Facility
S/C	Space Craft
SMEC	Spectrometer MEChanism
SPIRE	Spectral and Photometric Imaging REceiver
SRD	Science Requirements Document
SVM	Service Module
TBC	To Be Confirmed
TBD	To Be Determined

References

Applicable Documents

Document Reference	Name	Number/version/date
AD1	Instrument Requirements Document	SPIRE/RAL/N/0034 issue .31 25 May 2000
AD2	FIRST/PLANCK Operations Interface Requirements Document (FOIRD)	SCI-PT-RS-07360 Draft 5 03 May 2000 SPIRE-ESA-DOC-000188
AD3	SPIRE Instrument Product Tree	
AD4	SPIRE Calibration Requirements Document (TBW)	
AD5	SPIRE Operations Requirements Document (TBW)	
AD6	SPIRE Instrument Development Plan	
AD7	SPIRE PA Plan	

Table B: Applicable Documents

The abbreviations in brackets are used throughout the present document.

Reference Documents

RD1	Instrument Design Description Document	
RD2	FIRST/Planck - SPIRE AVM Definition	SPIRE-RAL-COM-000387.1
RD3	SPIRE Instrument STM Requirements	
RD4	SPIRE Instrument CQM Requirements	SPIRE-RAL-NOT-000389.1
RD5	FIRST SPIRE: Optical alignment verification plan	LOOM.KD.SPIRE.2000.001-1
RD6	Operating Modes for the SPIRE Instrument	SPIRE-RAL-DOC-000320.21
RD7	SPIRE Science Requirements Document	SPIRE-UCF-DOC-000064 *(Check version)*
RD8	EGSE Requirements document	

1. INTRODUCTION

1.1 Scope

This document describes the sequence of events and procedures leading from the delivery of the instrument sub-systems to the final delivery to ESA of each of the deliverable models of the SPIRE instrument.

1.2 Requirements on the Instrument AIV

The instrument is described in the *Instrument Design Description* (RD1) and the requirements the instrument performance and verification are detailed in the *Instrument Requirements Document* (AD1) and the *Instrument Verification Requirements Document* (AD?). The primary purpose of the SPIRE AIV is to verify that the Proto-Flight Model of the instrument delivered to ESA is compatible with the requirements of the Herschel (previously called FIRST) mission (launch and operational environment etc) and is capable of carrying out the scientific mission as described in the *SPIRE Science Requirements Document* (RD6).

The AIV of the instrument is also required to provide certain data tables that will enable the operation of the instrument in flight. It is also required to test the procedures to be used to operate the instrument in flight and during system level testing after integration in the satellite – the requirements on these are given in the *FIRST/Planck Operations Interface Requirements Document* (AD2) and the *SPIRE Operations Requirements Document* (AD5). Finally the AIV of the instrument should test the observing modes to be used to take scientific data and provide the calibration tables required to process the data on the ground – the requirements on these come from the *Calibration Requirements Document* (AD4) and the *Operating Modes for the SPIRE Document* (RD5).

This is the second version of this document to be formally released. The AIV plan has been modified to take into account the change of the instrument model philosophy following the delta-PDR in July 2000. In this release the first cross reference between the IRD requirements and the tests in the AIV plan is included

2. DELIVERABLE MODELS

The deliverable models of the SPIRE instrument are described in AD2. The descriptions are repeated here for information purposes.

***AVM – Avionics Model**. This is an electrical model of the SPIRE instrument and will consist of the AVM DPU and a DRCU simulator. It will allow the electrical and software interfaces between the SPIRE instrument and the spacecraft to be validated. This will include the capability of testing the SPIRE autonomy functions and any exchange of information required between the spacecraft and SPIRE for any SPIRE operational mode. This model is delivered to ESA.*

***STM – Structural Thermal Model**. This is a model of the cold FPU and JFET boxes that will be used to verify the vibration levels that will be experienced by the cold sub-systems during launch and to verify that the thermal design of the instrument meets the instrument level performance requirements. This model will also be used to qualify the design of the SPIRE structure. It will consist of the CQM structure, thermal hardware and optics, the CQM cooler and mass/thermal* *models of the cold sub-systems. In order to test the real vibration levels and thermal environment that will be experienced at the sub-system interfaces it will be necessary to have some of the sub-system STMs as mechanically representative as possible although there is no requirement that they should actually function. The FPU harnesses for the cold sub-systems and between the JFET boxes and the FPU should also be present to allow early test of the integration procedures and environmental robustness of the harness design. This model will be vibrated to full qualification levels at ambient temperature and, if possible, at cryogenic temperature. The model will be placed in the instrument test cryostat and full thermal characterisation will be carried out. This model is not delivered to ESA.*

***CQM - Cryogenic Qualification Model**. This is a model of the instrument that will be used to characterise and verify the instrument scientific performance with functionally representative cold sub-systems and warm electronics units. The structure, optics, cooler and FPU harnesses will be those used for the STM. All other cold FPU units need to function and have close to the expected flight performance, but do not need to be capable of withstanding the launch environment; have the full reliability and redundancy or necessarily be flight like in terms of power dissipation or speed of response. The purpose of the CQM is to verify that the design of the PFM will be capable of meeting the instrument level performance requirements and that the instrument is compatible with integration into the Herschel satellite. The requirements on the SPIRE CQM sub-systems will be judged against these criteria on a case by case basis.*
This model is delivered to ESA.

***PFM – Proto-Flight Model**. This will be the instrument model that is intended for flight. It will be built to full flight quality. It will be the only fully integrated instrument model that has the full flight like performance characteristics. The PFM cold FPU and JFET boxes will therefore undergo environmental test to qualification levels for acceptance times (TBD). The SPIRE warm electronics units will have full qualification models built and tested, therefore the PFM warm electronics units will only undergo acceptance testing.*
This model is delivered to ESA.

***FS – Flight Spare**. The flight spare cold FPU and JFET boxes will be constructed from the refurbished CQM (TBC). The flight spare warm electronics will consist of spare electronics cards. Whether this model is fully integrated and tested is TBD as is whether it is delivered to ESA.*

The requirements on the AVM are discussed in more detail in RD2; the requirements on the STM in RD3 and the requirements on the CQM in RD4.

3. Instrument Deliverables

The SPIRE instrument will consist of two basic components – the cold unit and the warm electronics. The cold unit is further sub-divided into the cold Focal Plane Unit (FPU) which contains all the optical elements; detectors and mechanisms and two JFET boxes containing the pre-amplifiers for the photometer (JFP) and spectrometer (JFS) bolometer arrays respectively. The FTB's are connected to the FPU by means of an external interconnect harness. Harnesses also run from the sub-systems within the cold FPU to the outside of the FPU via RF filter modules mounted on the FPU structure.

Figures 3-5 through 3-7 are graphical representations of the deliverable items that are required for the instrument integration for the STM; CQM and PFM cold FPU and JFET boxes. The details for the production of these deliverables are given in the appropriate sub-system and development plans and the Instrument Development Plan (AD6) and are not discussed further in the present document. The responsible institutes for each sub-system are detailed in the Instrument Product Tree – AD3.

3.1 Warm electronics

The warm electronics will consist of a Digital Processing Unit (DPU), which is a single physical unit containing the on board processing unit and data storage, and the Detector Read Out and Control Unit (DRCU) which consists of two physical units – the Detector Control Unit (DCU) which contains the analogue amplification for all the bolometer arrays and the FPU Control Unit (FCU) which contains the drive electronics for both flight mechanisms; the power supply and distribution unit and the electronics for the cooler, calibrators and thermometers for the cold FPU. Interconnect harnesses will run between the DPU and the DCU and the FCU and between the DCU and the FCU. These are termed the warm interconnect harnesses. It is assumed that the DCU and FCU will be integrated before delivery to RAL and can be treated as a single unit – the DRCU – thereafter.

Figure 3-1 shows the deliverables required for the avionics model of the DPU which will be used both for the testing of the CQM FPU and will be delivered to ESA as part of the instrument AVM together with a DRCU simulator and a set of EGSE. Figure 3-2 shows the deliverables for the electronics to be used to test the CQM FPU – note here that the simulators and EGSE systems are delivered only once and are presumed to be used again for the electronics for the PFM and FS. Figure 3-3 shows the deliverables for the electronics to be used to test the PFM FPU. These will initially consist of the QM versions of the DRCU, the interconnect harness and the DPU. At a later stage, and before instrument calibration can commence, the PFM versions of the warm electronics must be delivered. Figure 3.4 shows the deliverables for the electronics to be used to test the FS instrument. It is anticipated that these will consist of cards built to flight standards inserted into the QM boxes and backplanes.

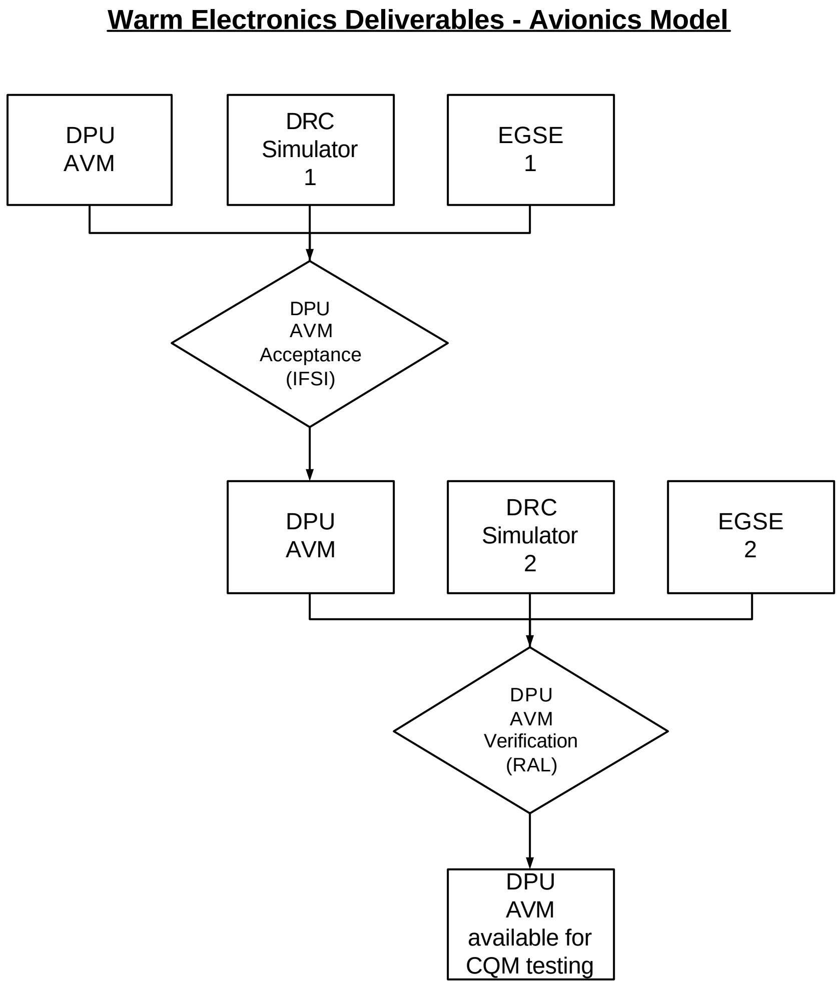

Figure 3-1: Deliverable sub-systems for the Avionics Model AIV.

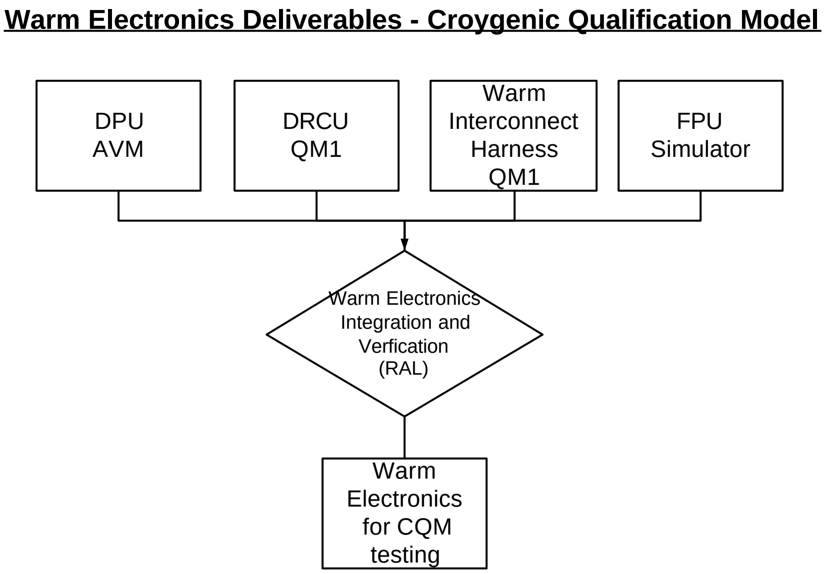

Figure 3-2: Deliverable sub-systems for the warm electronics for CQM AIV

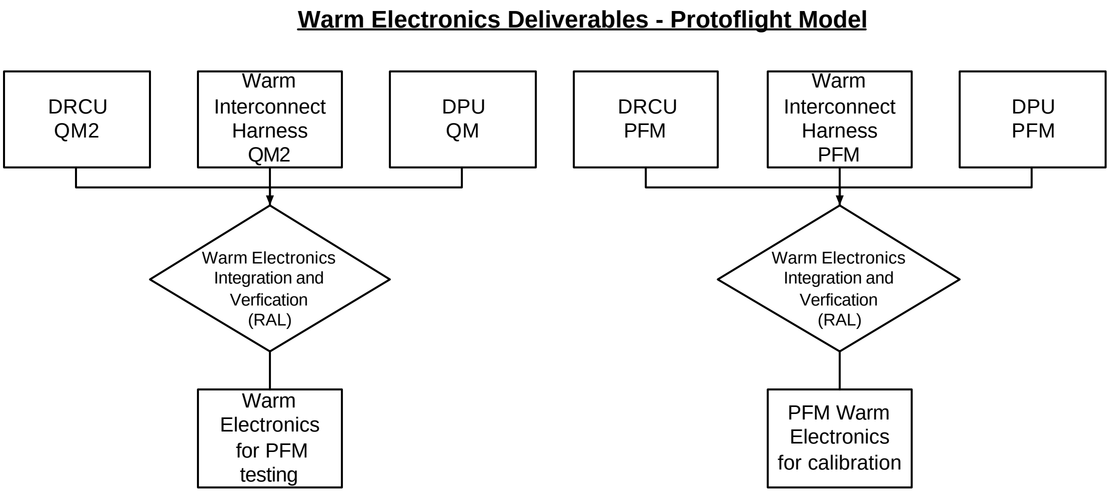

Figure 3-3: Deliverable sub-systems for the warm electronics for PFM AIV

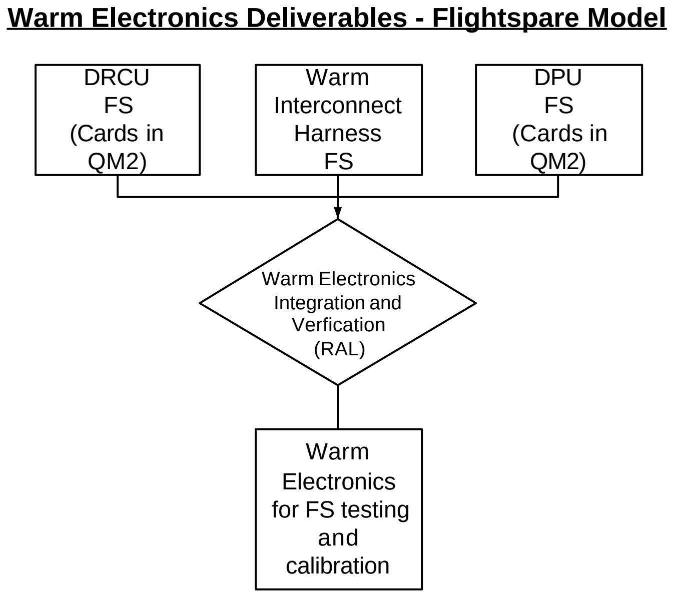

Figure 3-4: Deliverable sub-systems for the warm electronics for FS AIV

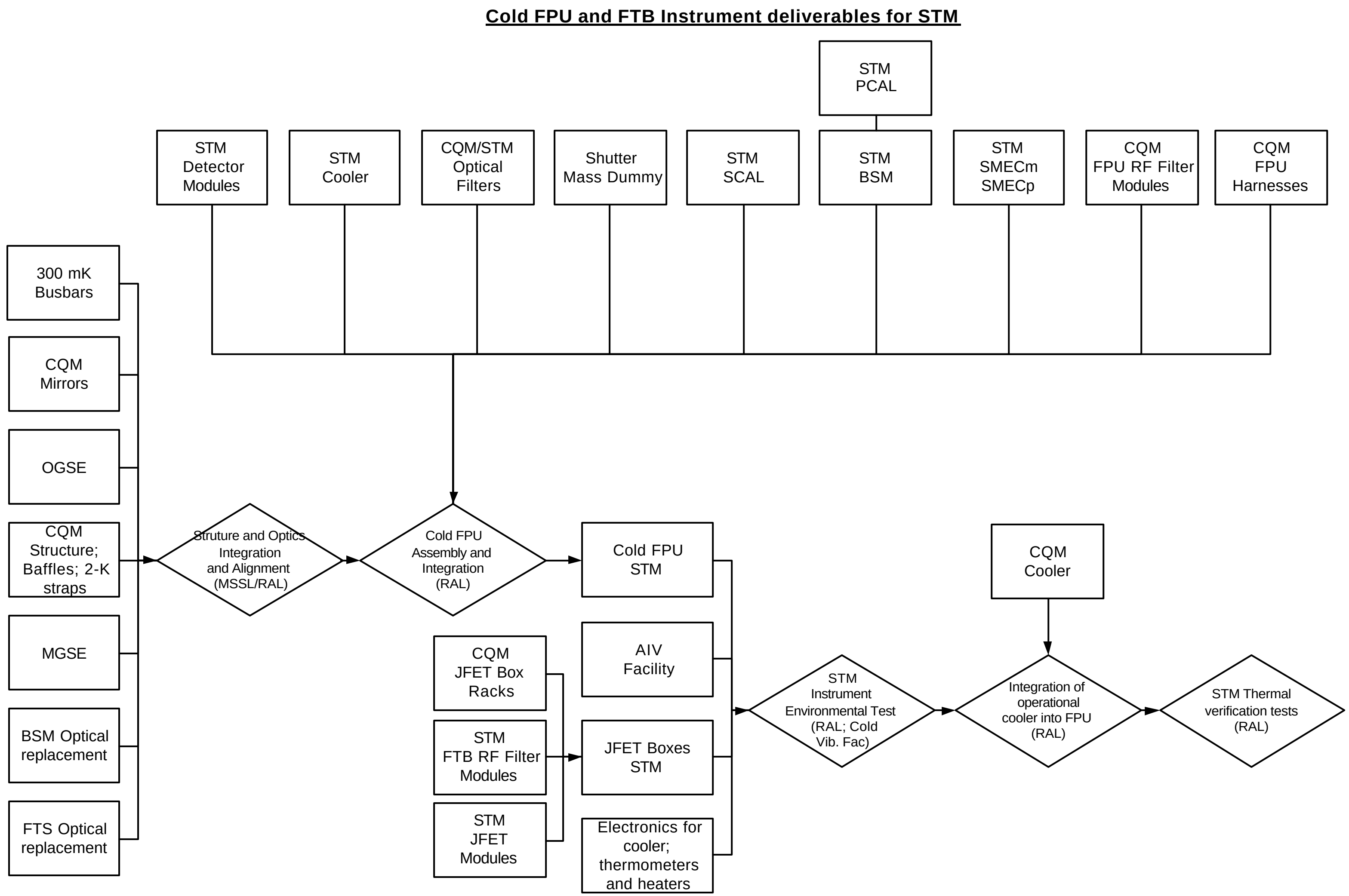

Figure 3-5: Deliverables for the SPIRE instrument structural thermal model (STM)

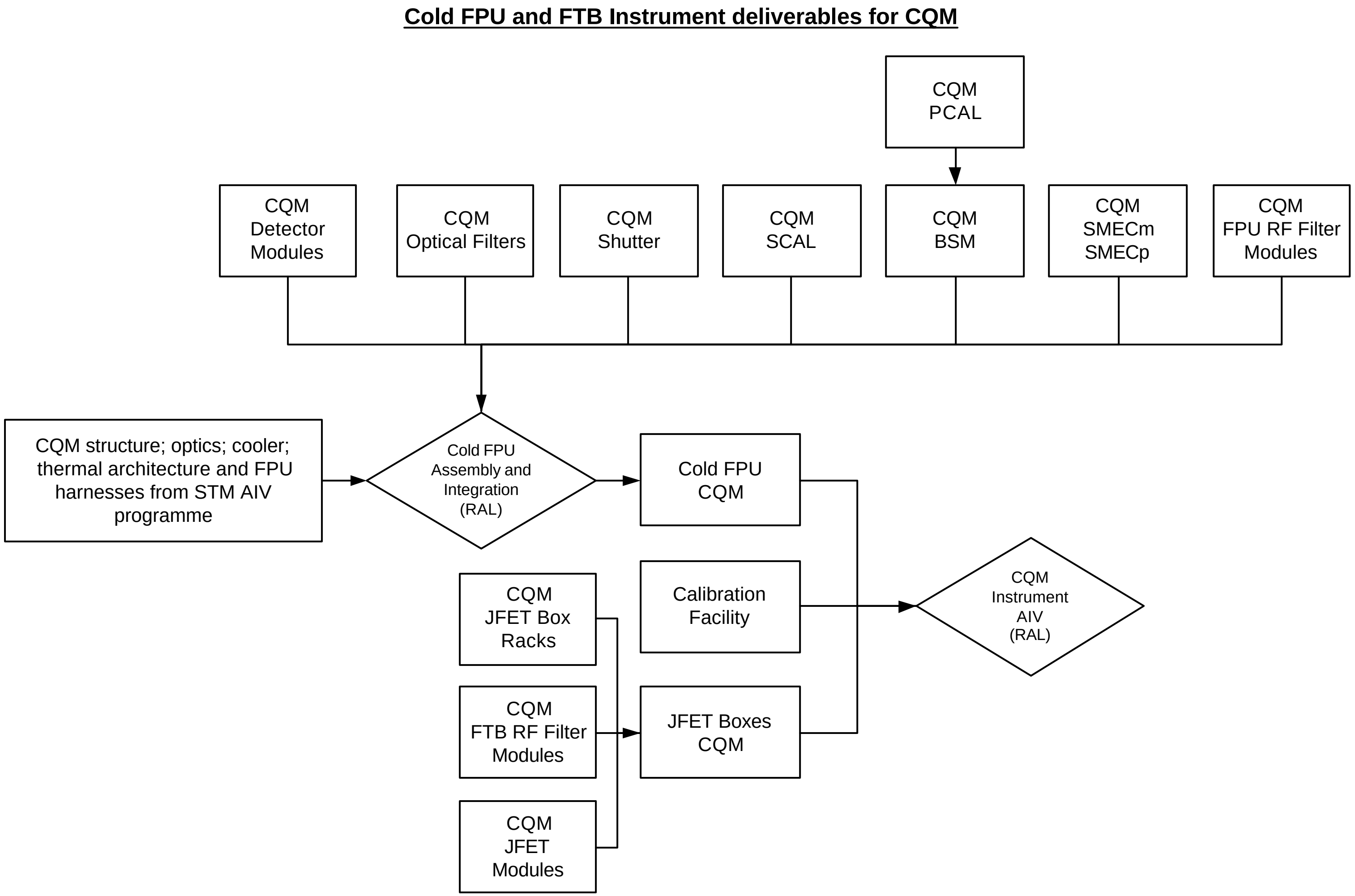

Figure 3-6: Deliverables for the SPIRE instrument cryogenic qualification model (CQM)

Cold FPU and FTB Instrument deliverables for PFM

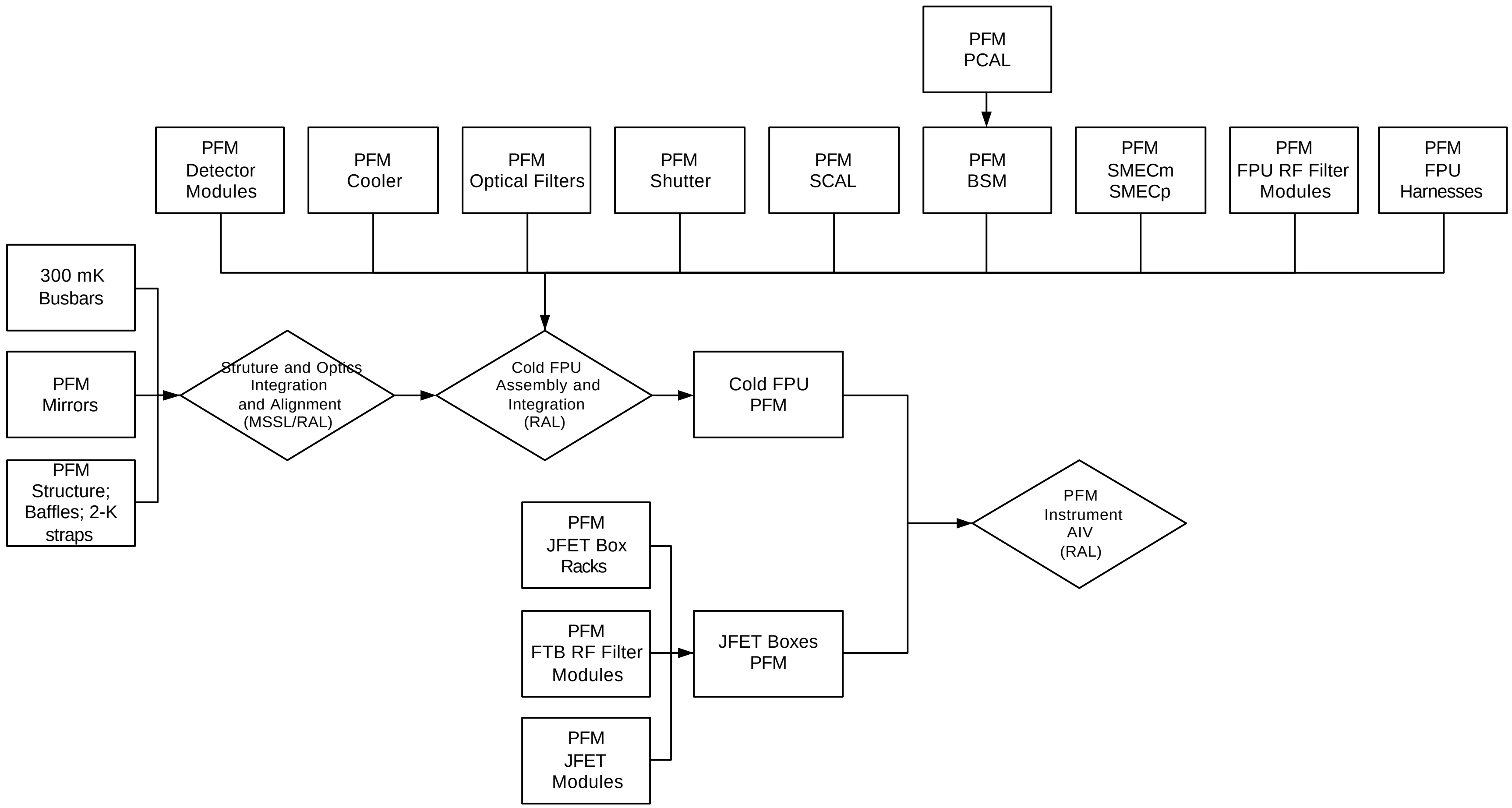

Figure 3-7: Deliverables for the SPIRE instrument proto flight model (PFM)

4. Outline Instrument AIV Sequence for Pre-Flight Models

The verification of the flight design of SPIRE will be done using the STM and CQM instrument models and the qualification models of the SPIRE sub-systems. In this section an overview of the "pre-flight" instrument model AIV programme is given together with an indication of the system level issues that are addressed at each stage of the sequence. This is intended as a guide only – the detailed sequencing of the integration and test of the instrument models is given in subsequent sections.

Figures 4-1 through 4-3 show an outline integration and test sequence for the instrument models. Given alongside the activities for each model are the systems issues that will be verified on each model. Some of these appear in more than one place indicating that different aspects of the systems design will be tested on different instrument and sub-system models.

Once the STM testing has been completed, the QM sub-systems can use any results necessary from the STM testing in their development programme which, it is assumed, will largely overlap the instrument level STM/CQM programme leading to a CDR at the end of the CQM programme. At this point all the system and sub-system design issues must have been addressed and the final design for the PFM can be confirmed. In fact it will be possible to confirm the design for some sub-systems, the structure (except for straylight concerns); the cooler and the mirrors, at the end of the STM programme.

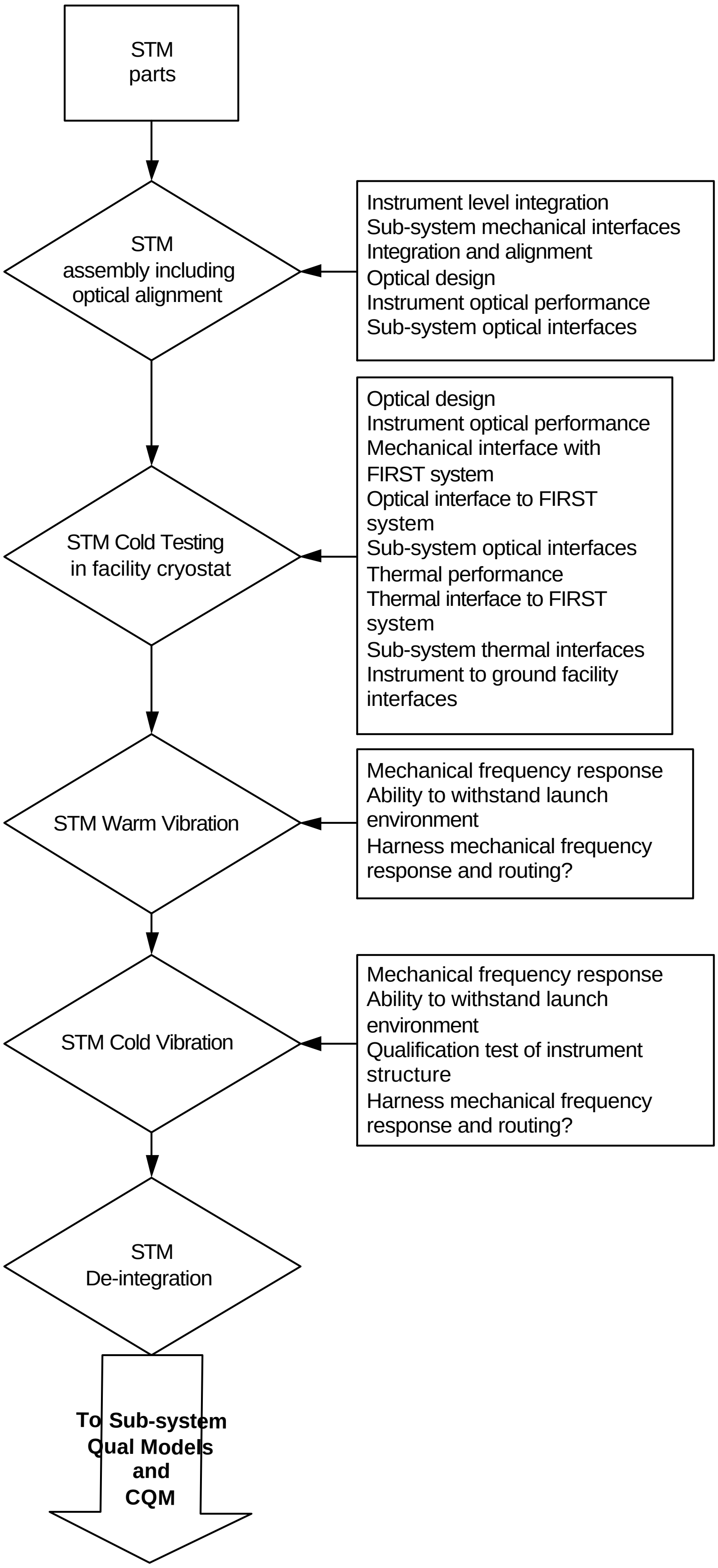

Figure 4-1: Outline STM integration and test sequence showing which system level issues are addressed at each stage.

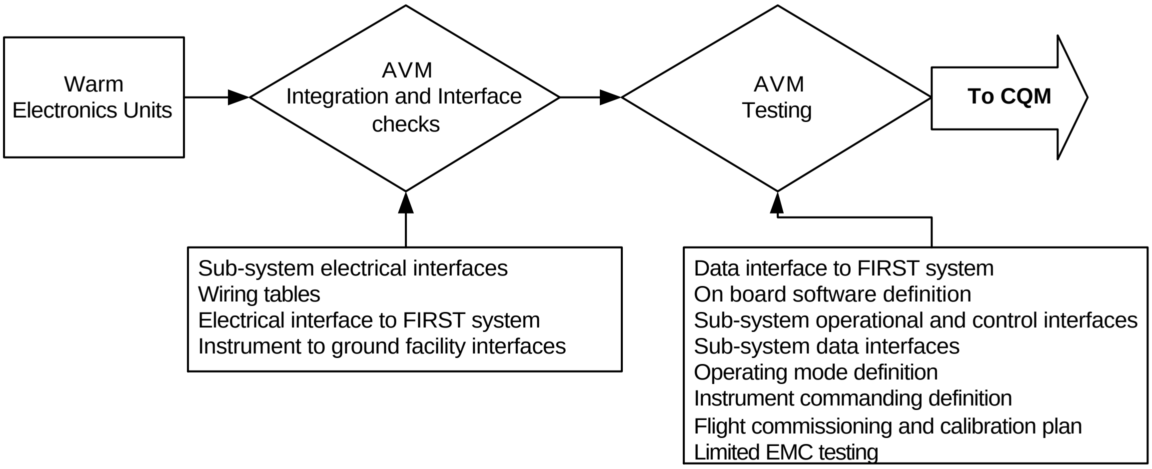

Figure 4-2: Outline AVM/QM1 warm electronics units integration and test sequence showing which systems issues are addressed at each stage.

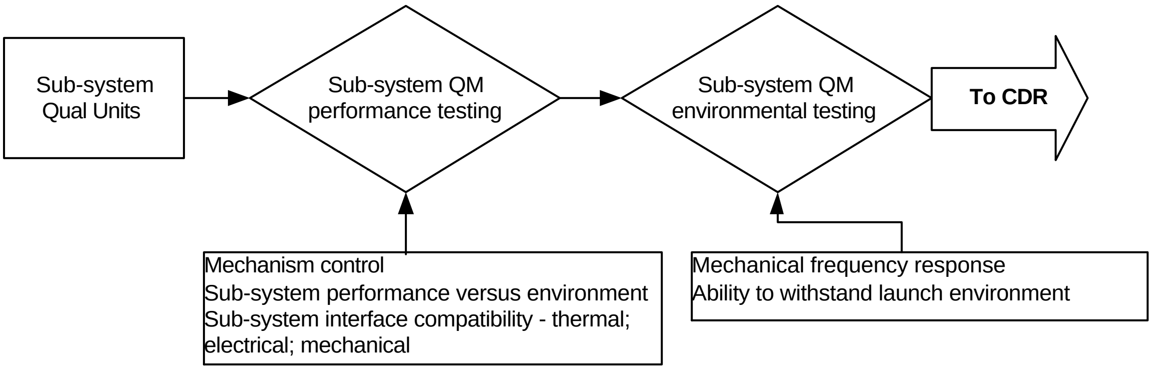

Figure 4-3: Outline sub-system qualification model integration and test sequence showing which systems issues are addressed at each stage. Not all the systems issues are appropriate for all sub-systems.

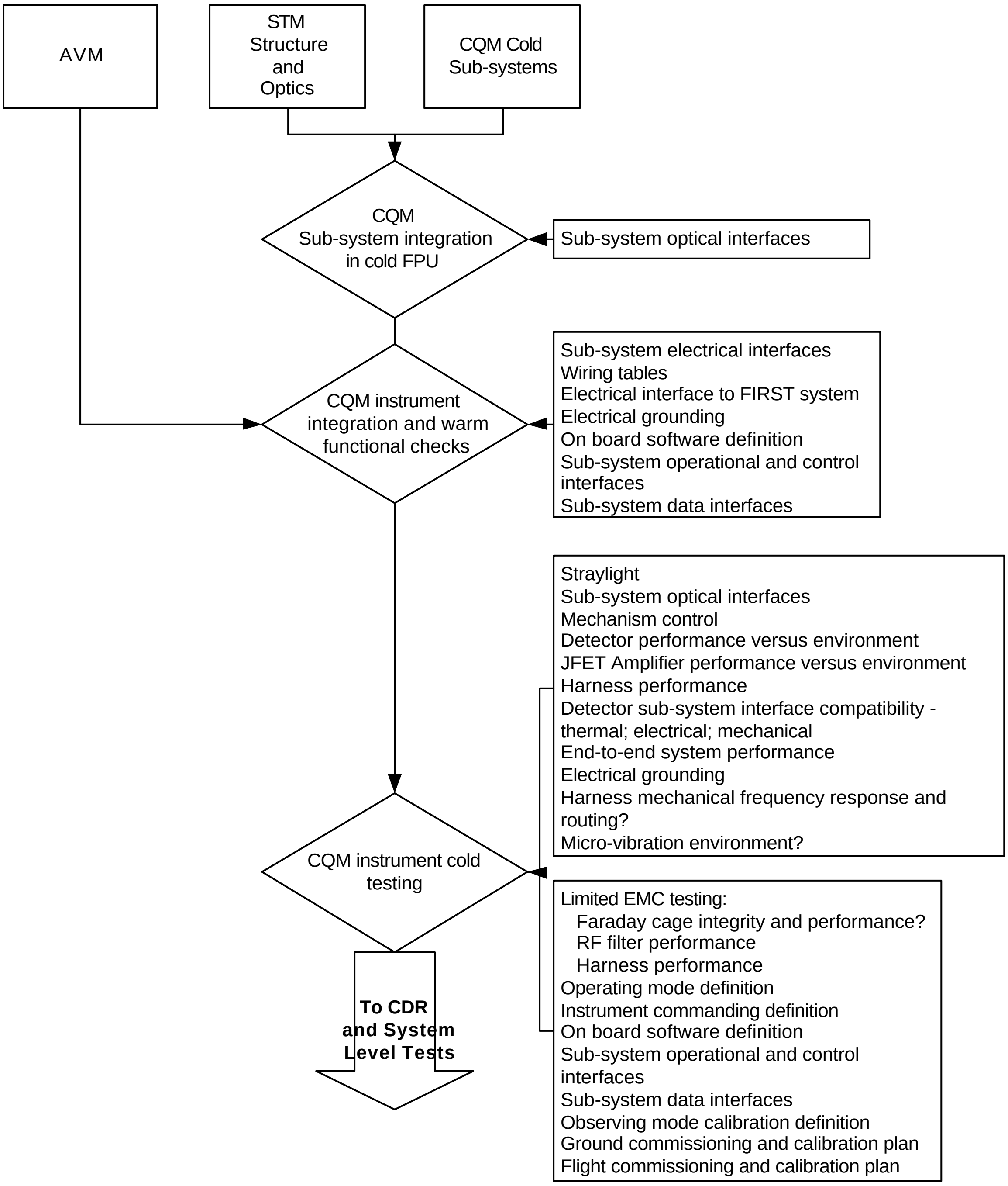

Figure 4-4: CQM outline integration and test sequence showing which systems issues are addressed at each stage.

5. WARM ELECTRONICS AIV

5.1 Overview

Production of the warm electronics units for SPIRE is phased differently to the cold FPU and JFET Box production. This is dictated by the resources available and complex nature of the interfaces between the sub-systems and the warm electronics. In this section we describe the assembly and integration of the units that go to make up the warm electronics used to test each instrument model and those which will be delivered to ESA.

Each step of the AIV sequence is numbered and the tests are named in bold throughout the section. Whilst an indication of the types of tests that will be carried is given, the detailed procedures for each test are the subject of documents covering each test. The correspondence between each test named here and the instrument requirements that are verified in each test is given in the appendices. The correspondence between sub-system specifications and tests is dealt with in the subsystem AIV plans.

5.2 AVM Warm Electronics

5.2.1 Capabilities

The AVM warm electronics consists of the AVM model of the DPU and a simulator of the DRCU and cold FPU. It is intended that these will be delivered to ESA.

The DPU will have the full functionality of the flight version but it will be built with commercial grade parts and will not have redundant systems fitted. It will be identical in external form and fit to the flight unit. This unit will also be used for the testing of the CQM cold FPU and JFET box.

The DRCU simulator will be a computer with interface cards to the DPU that is capable of receiving commands from the DPU and returning realistic data to mimic the operation of the DRCU; cold FPU and JFET box. Several DRCU simulators will be required at different institutes.

The functionality of the EGSE to be delivered with the AVM is discussed in RD8.

5.2.2 Outline Integration and Verification

Figure 3-1 shows the indicative order of assembly, integration and verification of the instrument AVM and associated EGSE. More detail on the tests to be carried out is given here.

5.2.2.1 DPU Acceptance Tests at IFSI

These will be designed to test the specifications written out in the DPU Specification Document (RD9) and the OBS URD (RD10). Some of the specifications reflect higher level requirements in the Instrument Requirements Document and, therefore, these tests form part of the instrument level verification. In outline the tests are:

> Test low-level interface between the DPU and the CDMS conforms to the appropriate interface definition

Test high-level interface protocol to S/C (Packet protocols etc)
Test high and low speed interfaces between DPU and DRCU – again both hardware and protocols as given in ICD
Static OBS Functionality – acceptance of commands; TM generation; OBS performance requirements
OBS Management functions as given in the DPU specification document.

We wish to discover from these tests whether the DPU/OBS can "run" the instrument in all its operating modes with the correct data collection; extraction of real time parameters (if necessary); algorithm execution and real time commanding and execution of a command queue from the S/C to simulate instrument operation – again with correct data collection; TM formatting and transmission to CDMS.

We also need to test the response of the OBS/DPU to various failure conditions both in the DRCU (failure to initialise; PSU failure; interface failure etc) and within one of the sub-systems (loss of SMEC position sensor; loss of drive coils etc). We will also test the autonomy functions of the OBS – that is switching to SAFE mode in the event of DRCU/sub-system failure of OFF in the event of DPU failure.

In summary the AIV sequence at IFSI will be as follows -:

HS_WE_AIV_1. AVM DPU and OBS acceptance testing at IFSI

1.1. The DPU is assembled and integrated at IFSI
1.2. The DRCU simulator #1 is delivered to IFSI from Stockholm
1.3. The EGSE #1 is delivered to IFSI from RAL (TBC)
1.4. The units are connected and basic interface checks are carried out to ensure compatibility between the DPU; DRCU simulator and the EGSE
1.5. The DPU acceptance procedure is carried out to ensure the compatibility of the unit as delivered from the manufacturer with the SPIRE instrument requirements and interface specification (this is the AVM **DPU_ACCEPT** test)
1.6. The On board Software acceptance procedure is carries out to ensure the compliance of the DPU and OBS with the OBS user requirements (this is the AVM **OBS_ACCEPT** test)
1.7. Following the acceptance of the DPU and OBS the DPU is prepared and shipped to RAL. The DRCU simulator #1 and the EGSE #1 remain at IFSI

5.2.2.2 DPU Integration at RAL

At RAL the AVM integration and functional test will be a repeat of a subset of the acceptance tests carried out at IFSI plus a test of running simulated instrument operations .

In summary the AIV sequence at RAL will be:

HS_WE_AIV_2. DPU integration at RAL

2.1. The DRCU simulator #2 is delivered to RAL from Stockholm
2.2. EGSE#2 is already at RAL
2.3. The DPU is received from IFSI
2.4. The DPU is integrated with the EGSE and DRCU simulator and basic interface checks are carried out.
2.5. The AVM functional test procedure is carried out. (this is the **AVM_FUNC** test)

2.6. The DPU AVM is now available for use with the warm electronics to be used with the instrument CQM.

5.2.2.3 AVM verification following CQM programme

This AVM DPU will be delivered to ESA together with the DRCU simulator #3 and the EGSE#3 to form the Instrument AVM. This delivery will occur at the end of the instrument CQM programme. Before the Instrument AVM can be delivered it has to be integrated and the AVM verification procedures carried out to ensure that any changes to the OBS; the DRCU simulator and/or the EGSE do not affect the performance of the integrated unit.

In summary the AIV sequence at RAL will be:

HS_AVM_AIV_1. DPU integration at RAL

1.1. The DRCU simulator #3 is delivered to RAL from Stockholm
1.2. EGSE#3 is already at RAL
1.3. The DPU is integrated with the EGSE and DRCU simulator and basic interface checks are carried out.
1.4. The AVM verification test procedure is carried out. (this is the **AVM_VER** test)

5.3 Warm Electronics for instrument CQM Testing

5.3.1 Capabilities

The warm electronics for the CQM testing consist of the DPU AVM and a qualification model of the DRCU that has full flight functionality but will be built with commercial grade parts and will not have any redundancy. The QM1 DRCU will be identical in external form and fit to the flight unit. An engineering model of the warm interconnect harness will also be used. Again this will have external form and fit identical to the flight unit but will be built with commercial grade parts. In order to verify the function of the warm electronics for the CQM testing a simulator of the cold FPU and JFET box is required to give realistic responses to the DRCU in the absence of the real sub-systems. This FPU simulator is intended to be as passive as possible, i.e. resistors in place of JFETs; coils; thermistors etc. Only the output from the SMEC position encoder may have to provide some active return in the form of a sinusoidal signal.

5.3.2 Outline Integration

Figure 3-2 shows the indicative order of assembly and integration tests for the AVM DPU; the QM1 DRCU; the QM1 warm interconnect harness and the associated EGSE and FPU simulator. More detail on the steps to be followed is given here.

HS_WE_AIV_3. CQM Warm electronics integration at RAL

3.1. The FPU simulator; the DRCU and the warm interconnect harness will be delivered to RAL from CEA
3.2. The FPU simulator; the DRCU and the warm interconnect harness will be integrated with the DPU AVM and EGSE#2 and basic interface checks carried out

3.3. The warm electronics integration procedures will be carried out (this is the CQM **WE_INTG** test)
3.4. The warm electronics is now available for integration with the cold FPU and JFET box.
3.5. This set of electronics, including the FPU simulator, will be delivered to ESA as part of the instrument CQM.

5.4 Warm Electronics Qualification Model

5.4.1 Capabilities

The QM electronics consists of the qualification model DPU; the second qualification model DRCU and the second qualification model warm interconnect harness. These are identical in function; form and fit to the flight units. They will be built to flight standards with some parts in both the DPU and DRCU being "extended range" or commercial grade rather than flight grade. The DPU QM will undergo full environmental and EMC (TBC) testing at IFSI before delivery. The DRCU QM2 will undergo full environmental and EMC testing at CEA before delivery. As the QM FPU simulator has been delivered to ESA as part of the instrument CQM, another one is required for testing this set of electronics. This set of electronics will be used to carry out the majority of instrument PFM tests, however they are not intended for flight and will not be delivered to ESA.

5.4.2 Outline Integration

Figure 3-3 shows the indicative order of assembly and integration for the QM DPU; the QM2 DRCU and the QM2 warm interconnect harness and the associated EGSE and FPU simulator. More detail on the steps to be followed is given here.

HS_WE_AIV_4. QM Warm electronics integration at RAL

4.1. The FPU simulator; the DRCU and the warm interconnect harness will be delivered to RAL from CEA
4.2. The DPU will be delivered to RAL from IFSI
4.3. The FPU simulator; the DRCU and the warm interconnect harness will be integrated with the DPU and EGSE#2 and basic interface checks carried out
4.4. The warm electronics integration procedures will be carried out (this is the QM **WE_INTG** test)
4.5. The warm electronics is now available for integration with the cold FPU and JFET box.

5.5 PFM Warm Electronics

5.5.1 Capabilities

The PFM electronics consist of the flight models of the DRCU; the warm interconnect harness and the DPU. These are the units intended for flight and have, naturally all the functions required including redundancy and are fully compliant with the satellite interface requirements. The DRCU; warm interconnect harness and the DPU will have been through environmental acceptance testing before delivery to RAL.

5.5.2 Outline Integration

Figure 3-3 shows the indicative order of assembly and integration for the FM DPU; the FM DRCU and the FM warm interconnect harness and the associated EGSE and FPU simulator. More detail on the steps to be followed is given here. This set of electronics will be used to carry out the calibration and functional performance tests on the PFM instrument. They will be delivered to ESA as part of the PFM instrument.

HS_WE_AIV_5. PFM Warm electronics integration at RAL

5.1. The DRCU and the warm interconnect harness will be delivered to RAL from CEA
5.2. The DPU will be delivered to RAL from IFSI
5.3. The FPU simulator; the DRCU and the warm interconnect harness will be integrated with the DPU and EGSE#2 and basic interface checks carried out
5.4. The warm electronics integration procedures will be carried out (this is the PFM **WE_INTG** test)
5.5. The warm electronics is now available for integration with the cold FPU and JFET box.

5.6 FS Warm Electronics

5.6.1 Capabilities

It is intended to provide flight spare electronics at board level only. In order to test the electronics the boards will be assembled into the qualification model DRCU and QM DPU frames (QM2 and QM respectively). Once assembled into the appropriate frames that FS boards will have fully flight like function and external form and fit. The QM2 warm interconnect harness will be used for flight spare testing and there will be no FS warm interconnect harness. The boards will undergo environmental acceptance testing in the qualification model boxes. It is assumed that the QM2 harness remains at RAL. This set of electronics will be used to carry out the calibration and functional performance tests on the FS instrument. The boards within the electronics will be available to replace PFM boards in the PFM instrument in the event of failures during system level AIV.

5.6.2 Outline Integration

Figure 3-4 shows the indicative order of assembly, integration and verification for the QM DPU; the QM2 DRCU and the QM2 warm interconnect harness and the associated EGSE and FPU simulator. More detail on the steps to be followed is given here.

HS_WE_AIV_6. FS Warm electronics integration at RAL

6.1. The DRCU boards assembled into the QM2 frame will be delivered to RAL from CEA
6.2. The DPU boards assembled into the QM frame will be delivered to RAL from IFSI
6.3. The FPU simulator; the DRCU and the warm interconnect harness will be integrated with the DPU and EGSE#2 and basic interface checks carried out
6.4. The warm electronics integration procedures will be carried out (this is the FS **WE_INTG** test)

6.5. The warm electronics is now available for integration with the cold FPU and JFET box.

6. STM AIV

6.1 Capabilities

The requirements and consequent capabilities of the STM instrument are discussed in RD3. The STM not an entirely separate model of the instrument as it will consist of the CQM structure; optics and, for part of the programme, cooler. Mass dummies or engineering models will be used for the other sub-systems. The STM is designed to allow for a verification of the structural and thermal design by conducting a warm vibration test; a cool down and cryogenic thermal test and a cold vibration early on in the instrument AIV programme. The possibility of a radiated EMC susceptibility test on the structure has also been allowed for in the schedule.

Note – as some parts of the STM will be used for both the CQM and, later, for refurbishment into the flight spare, the STM instrument will be subject to the PA/QA procedures detailed in the SPIRE PA Plan (AD7).

6.2 Test Programme

The following system level design issues will be addressed during the STM AIV programme (repeated here from RD3):

Mechanical interface with Herschel system
The FPU and JFET boxes will have the same form and fit as the PFM and will be interfaced to a mock up of the Herschel optical bench. The ability to accurately place the SPIRE instrument on the Herschel optical bench and its alignment stability when cooled will be verified.

Optical interface to Herschel system
The optics fitted to the STM will be of near flight quality. Optical light tests will be carried out to verify the performance of the optical system with respect to the Herschel telescope optical design.

Thermal interface to Herschel system
The STM will be placed in a thermal environment in the SPIRE instrument test cryostat that is as close to the Herschel cryostat as possible. The same temperature levels will be present although the heat capacity of the various stages may be different. The sorption cooler will be capable of being recycled and these tests will give an indication of whether the specified thermal interface (loads; required conductance etc) is correctly specified.

Instrument level integration and alignment
The STM will give the first opportunity to test and refine the instrument level integration and optical alignment procedures for the subsequent models.

Optical design and instrument optical performance
The optical light test programme will be designed to verify the geometrical optical model of the instrument and, therefore, to give confidence that the instrument optical performance will meet the requirements.

Instrument thermal performance

The instrument thermal balance will be simulated for each operating mode and further diagnostic tests will be devised to allow the instrument Thermal Mathematical Model to be verified. Heaters will be placed at strategic points in the STM to allow this testing. Of especial importance to the ultimate performance of the SPIRE instrument will be the behaviour of the 300 mK temperature stage. The STM cooler and 300 mK architecture and all the interfaces between the cooler and the detectors will be fully flight representative in this respect and there will be at least one thermally representative detector module.

Instrument to ground facility interfaces
This will be the first opportunity to check all the physical interfaces between the cold FPU and the instrument ground facility. This will include checking the form and fit of the test facility cryoharness with respect to the FPU and JFET boxes.

Instrument mechanical frequency response and ability to withstand launch environment
A programme of warm vibration will be conducted on the integrated FPU and JFET boxes that will check for mechanical resonance and gradually lead to a full qualification level vibration test. If the warm vibration programme shows no problems, it is expected that a cold vibration of the integrated FPU and JFET boxes will be carried out.

Harness mechanical frequency response and routing
The internal routing of the sub-system harnesses can be confirmed. The routing and support of the FPU to JFET boxes harnesses can be verified both thermally and with respect to the launch environment. It may be possible to devise a test programme during the warm vibration that will test the mechanical resonance of the detector harness assembly (?)

Sub-system mechanical interfaces
The sub-system STMs will be form and fit compliant and will include representative connectors.

Sub-system optical interfaces
Any sub-system with an optical interface to the SPIRE instrument will provide a suitable piece of OGSE (that may be removable) or will be compliant with the specified interface.

Sub-system thermal interfaces
All sub-systems that dissipate significant power in the cold FPU or JFET boxes must provide STMs with the same or similar thermal characteristics and an ability to replicate their expected thermal dissipation under nominal operating conditions.

6.3 Assembly, Integration and Verification Sequence

Figure 3-5 shows the indicative order of assembly and integration of the STM. In this section the outline sequence for the AIV programme to be done on the STM FPU and JFET boxes is discussed. This is intimately connected to the structure integration procedure and the alignment plan and is subject to revision as detailed design of the structure evolves.

HS_WE_AIV_1. Structural Thermal Model

1.1. STM FPU Subsystem deliveries

- **1.1.1.** CQM Structure; MGSE and transport container delivery
- **1.1.2.** CQM Mirrors delivery

1.1.3. STM Filter delivery
1.1.4. STM Cooler Delivery
1.1.5. CQM Cooler Delivery
1.1.6. STM/CQM Harness Deliveries for each sub-system
1.1.7. OGSE Delivery
1.1.8. STM FPU RF Filter Modules Delivery
1.1.9. BSM Optical dummy delivery
1.1.10. SMECm Optical Dummy Delivery
1.1.11. STM BDAs Delivery
1.1.12. STM Shutter Delivery
1.1.13. STM SCAL Delivery
1.1.14. STM BSM Delivery
1.1.15. STM SMECm Delivery

1.2. STM FPU Alignment 43.5d

The first task in the STM programme is to integrate the mirrors into the structure and to verify the performance of the optical design using visible light both warm and cold. The FPU structure – notably the optical bench – will require support during integration and alignment. Specialised MGSE will be provided for this task and is considered to be part of the structure delivery. This part of the STM programme is the STM **INT_ALIGN** test – see RD6

1.2.1. 3-D Metrology 11d

Here the partially assembled structure with some OGSE fitted is placed into a mechanical 3-D metrology machine and the positions of the mirror interfaces are verified and recorded. This is part of the STM **ILT_ALIGN** test – see RD5

1.2.2. Alignment during integration 20d

After mechanical metrology the mirrors and other OGSE items are assembled into the structure and their alignment verified optically using visible light. Integration of the mirrors may involve some re-machining of the mirror mounts – this has been allowed for in the scheduling. Various optical tests are carried out on the integrated structure and optics to verify the performance of the optical design. This is part of the STM **INT_ALIGN** test – see RD6

1.2.3. Cold Alignment Verification 12.5d

Once the optical alignment and performance has been verified warm, it must also be verified cold. The integrated structure; optics and OGSE is placed onto the Herschel optical bench simulator and thence into the facility cryostat. The optical alignment of the instrument with respect to the Herschel optical bench and the internal alignment of the instrument will then be verified cold. This is part of the STM **INT_ALIGN** test – see RD6

1.3. STM Warm Environmental Test 21d

Once the mirrors have been integrated and the optical alignment and performance has been verified both warm and cold using visible light the OGSE can be removed and the sub-system STMs can be integrated into the structure before the instrument is vibrated warm. The warm vibration test is carried out to verify overall mechanical responses; to give a reference level for the cold vibration check and to give realistic vibration levels at the interface locations of the sub-systems. The structure will be instrumented to allow this to happen. This test is part of the STM **ILT_VIB** test.

1.3.1. Preparation of STM 14d

The OGSE is removed and the sub-system STMs fitted. At this time further harnesses will also be fitted and the JFET boxes will be integrated and both the FPU and JFET boxes will be fitted to the vibration jig and the FPU to JFET harnesses installed. At the end of the integration activities an STM Warm Vibration Test Readiness Review will be held.

1.3.2. STM Warm Vibration 5d

The integrated instrument is vibrated warm in three axes. The vibration programme will be designed to build up towards full qualification levels with suitable checking by resonance searches as the level is increased. This is part of the STM **ILT_VIB** test.

1.3.3. Post vibration test 5d

Once the vibration has been carried out there will be a series of post vibration checks on the optical alignment and the structural integrity. These are part of the STM **ILT_ALIGN** test and the **ILT_VIB** test

1.3.4. STM Interim Review 3d

Once the STM warm vibration has been carried out the optical and the gross structural performance can be assessed and any design changes required can be initiated. If none are required then this can form part of the structure CDR and the go ahead given for the production of the long lead item flight model structural components. This will be a formal review to which ESA and prime contractor representatives will be invited.

1.4. STM Cold thermal verification 22d

The FPU will contain the STM cooler at this time. A fully functioning CQM version of the cooler will also be available. In order to proceed with the thermal verification of the FPU design this will be fitted into the STM structure and, if not already fitted, the thermal optical filter at the entrance to the FPU will also now be fitted. The re-integrated FPU will be placed onto the Herschel optical bench simulator together with the JFET boxes and the harnesses between the FPU and JFET boxes connected. The instrument will at this time also have extra thermistors temporally installed to allow more detailed monitoring of the FPU temperature during the thermal verification testing. At the end of the integration activities an STM Cold Thermal Test Readiness Review will be held. The instrument will then be cooled in the facility cryostat, once cold the STM thermal verification test (STM **ILT_THERM**) will be carried out.

1.5. STM EMC Testing 16d

A radiated susceptibility test on the STM structure together with the JFET boxes and harnesses is a desirable test to verify the integrity of the Faraday cage. This could be carried out at this time by placing an aerial at, or close, to the location of one or more of the detectors. This would involve some de-integration and re-integration of the FPU and will only be done if time allows and after a full risk assessment. This is part of the STM **ILT_EMC** test

1.6. STM Cold vibration campaign 25d

Following the EMC test and the re-integration of the STM FPU this instrument is now ready for a cold (<10 K) vibration test at the Herschel common cold vibration facility. The instrument will be prepared; packed and transported to the facility. Before the instrument is shipped an STM Cold Vibration Test Readiness Review will be held. After instrument has reached the facility and been prepared the three axis vibration test will be done and the instrument returned to RAL for further testing. Note that this test can only be done at this time if no severe problems were identified during the warm vibration testing – this is especially true for the cooler as the instrument will contain a working cooler at this time. This test verifies the mathematical model of the structure and is the qualification test for the SPIRE instrument structure mechanical design. This is part of the STM **ILT_VIB** test.

1.7. STM Cold verification test 15.5d

Following the cold vibration test the instrument thermal performance will be tested once more in the facility cryostat. The instrument will be unpacked; integrated onto the Herschel optical bench simulator and placed into the test cryostat. The thermal verification test will be repeated and some form of optical alignment test (TBD) will also be carried out. This is part of the STM **ILT_THERM** and **ILT_ALIGN** tests.

1.8. STM De-Integration 6d

Following the completion of the cold vibration and final cold verification the STM AIV programme is complete. The sub-system STMs can now be removed and the structure; optics and cooler be made available for use on the CQM.

1.9. STM Post Test Review 6d

At the conclusion of the STM programme a review of the instrument performance thus far will be conducted. Any design changes necessary for the flight model will be identified and initiated. This will be the CDR for the cooler; the thermal design of the instrument and the completion of the CDR for the structural design of the instrument. This will be a formal review to which ESA and prime contractor representatives will be invited.

7. CQM AIV

7.1 Capabilities

The full capabilities required of the instrument CQM are discussed in RD4. The instrument level CQM programme is designed to allow the performance and functionality of the instrument design to be fully explored and characterised ahead of the flight model. It is not intended that the CQM be used for environmental verification (i.e. it will not be subjected to vibration tests) and therefore the sub-systems provided for the CQM need not have full flight representation in terms of flight quality components, although they must conform as closely as possibly to the performance specifications.

Note – as some parts of the CQM will be used for refurbishment into the flight spare, the CQM instrument will be subject to the PA/QA procedures detailed in the SPIRE PA Plan (AD7).

7.2 Test Programme

The following system level design issues will be addressed during the CQM AIV programme (repeated here from RD4):

Electrical interface to Herschel satellite
The cryoharness for the instrument test facility will simulate the Herschel cryoharness as closely as possible. The CQM test programme will test all aspects of the electrical interfaces between the SPIRE cold units and the cryoharness. The CQM warm electronics units will be entirely flight representative bar the use of flight quality components and the presence of cold redundant circuitry. The electrical interfaces between SPIRE and the Herschel satellite will be verified in a more realistic operating situation compared to the tests carried out on the AVM (see AVM Requirements Document)

Electrical grounding
The CQM will offer the first opportunity to have an all up test of the instrument grounding scheme under realistic operating conditions. Any excess noise in the detection system can be quickly identified and trouble shooting undertaken.

Limited EMC testing:
The CQM will enable us to determine whether the proposed method providing the Faraday cage offers sufficient protection against radiated EMI in the laboratory environment. Although it will be very difficult to be quantitative in this, because the test cryostat environment is very different from the Herschel cryostat, it may be possible to have some dedicated qualitative tests to probe for sensitivity at particular frequencies. It will be possible to do some conducted susceptibility tests to check the performance of the RF filtering and the cryoharness.

Operations and Software
The CQM will have all the cold sub-systems operational. Although they may not be fully flight representative in terms of thermal dissipation or ability to withstand vibration, they will have a scientific performance equivalent or nearly equivalent tot he flight sub-systems. This will allow us to test and characterise the behaviour of the instrument and give much better definition to the instrument commanding scheme and the real-time control aspects of the on board software. We will also be able

to start to define better the operating modes for the instrument and the methods of calibration that will be employed during observations.

Having an operational instrument will also allow the finalisation the ground commissioning and calibration plans and procedures and a start to be made on the in-flight commissioning and calibration plan.

Optical
The CQM will be capable of allowing the far infrared and sub-mm optical performance of the instrument to be characterised to some extent and the straylight performance of the instrument *in toto* to be evaluated. This will complete the instrument optical alignment plan.

End-to-end system performance
The scientific capabilities of the instrument will be tested for the first time. This end-to-end testing will be the most important feature of the CQM test programme as it will tell us what the real capabilities of the flight instrument will be for the first time and, if things are wrong, allow us to adjust the PFM final design.

Electromechanical System
As it is not required that the mechanisms are completely flight compatible only a limited amount of realistic testing on the two mechanisms may be possible. However things that can be verified will be whether there is any exported micro-vibration that will trouble the detectors; whether the shutter design works reliably and whether the control of the BSM and SMEC is really sufficient for the scientific performance of the instrument.

Radiation Detection System
This will be the first time that representative detector arrays have been integrated with the cooler and 300 mK hardware with all the correct temperature stages present. Extensive testing of the array performance under realistic operating conditions (including mimicking the background loading from the telescope) will be carried out to fully characterise the behaviour of the radiation detection system. Tests will also be conducted to characterise the performance of the various elements of the radiation detection system (arrays; JFETs; warm electronics etc) under different environmental conditions – we will be able to change the loading on the detectors and the temperatures of the various stages.

Also all the detector sub-system interfaces will be able to be verified and we will gain some indication that the cryoharness specification is adequate.

Instrument Thermal Performance
Although the STM will have tested most of the thermal performance aspects of the SPIRE instrument, the fact that the CQM has real operation mechanisms; detectors; JFET amplifiers and the correct optical filtering scheme, means that the thermal performance of the instrument can be evaluated in a more realistic environment. In particular, the performance of the 300 mK temperature stage will be much more critically examined as there will be real bolometers present.

Sub-system interfaces
The CQM will give final verification of the sub-system optical; electrical; operational; control and data interface definitions.

7.3 Assembly, Integration and Verification Sequence

HS_INST_AIV_2: Cryogenic Qualification Model

2.1. CQM FPU Subsystem Deliveries

It is assumed that the de-integrated STM instrument will already contain the optics; the cooler and 300 mK thermal system and most if not all of the sub-system electrical harnesses. The following units are required for the CQM instrument.

2.1.1. CQM SMECm Delivery
2.1.2. CQM BDAs Delivery
2.1.3. CQM SCAL Delivery
2.1.4. CQM Filters, Dichroics and Beamsplitters Delivery
2.1.5. CQM FPU RF Filter Modules Delivery *(it is possible that these were delivered for the STM and that, therefore, there are no STM FPU RF Filters)*
2.1.6. CQM Shutter Delivery
2.1.7. CQM BSMm Delivery

2.2. CQM FPU Integration

The design of the SPIRE instrument is such that the units mounted from the two detector boxes need to be integrated and the connections to the 300 mK busbars made before that boxes are mounted into the structure. At this time the alignment of the detector arrays with respect to the detector boxes will also be verified and the dichroics and filters will be mounted. As with the STM, all FPU integration will take place in a clean area and will require specialised MGSE. The MGSE for holding the structure during integration is the same as that used for the STM. Any further MGSE required for sub-system integration is considered to be part of the sub-system delivery.

2.2.1. Photometer Detector Box Integration 4d

A fully functional photometer long wavelength array will be fitted and two thermally and mechanically representative BDAs will be fitted into the medium wavelength and short wavelength locations. The dichroics will be fitted even though their alignment cannot be verified; the total spectral bandpass of the instrument needs to be representative.

2.2.2. Spectrometer Detector Box Integration 3d

A fully functional spectrometer long wavelength array will be fitted and a thermally and mechanically representative BDA fitted to the short wavelength channel. The filters will be fitted in both locations.

2.2.3. Detector Box Integration onto Structure 7.5d

To verify the detector box alignment after mounting onto the structure the BSM and SMECm optical dummies may have to be present. It is possible that the alignment of the boxes can be done using reference cubes; if this is the case then the BSM and SMECm optical dummies may not need to be integrated. Once the detector boxes are physically mounted the detector harnesses can be routed and affixed to the detector boxes. This must be done carefully to ensure good thermal contact and to avoid the possibility of microphonic interference.

2.2.4. Sub-system integration 9d

With the detector boxes in place the other sub-systems; any straylight baffles and the rest of the optical filters can be integrated onto the SPIRE optical bench. The order of the integration and the alignment verification procedures are TBD. Once the sub-systems have been integrated and their harnesses connected a warm functional test may be carried out to ensure electrical integrity before the instrument covers can be fitted. This is part of the CQM **ILT_INTG** test.

2.3. CQM FTB Integration — 8d

In parallel with the integration of the FPU the JFET modules; JFET box RF filter units and the back harness can be integrated into the JFET box structures to form the FTB units: FTBp and FTBs. The back harness and structures are re-used from the STM programme. It may be that some if not all of the JFET modules used for the STM programme are fully functioning. Be that as it may the JFET modules to be integrated into the CQM FTB's must be fully functioning to allow the complete check out of the CQM warm electronics units. Following assembly of the FTB's a warm functional check will be done to ensure electrical integrity – this is part of the CQM **ILT_INTG** test.

2.4. FPU/FTB Integration with FOB Sim. — 2d

With both the FPU and FTB's now integrated they can be mounted onto the plate that forms the Herschel Optical Bench simulator. The alignment between the FPU and the Herschel optical bench simulator is verified using the alignment references. The harnesses between the FPU and the FTB's are connected and affixed to the mounting points on the FTB's. A warm functional test may be carried out (?) to verify electrical integrity – this would form part of the CQM **ILT_INTG** test.

2.5. CQM Warm Electronics Integration (HS_WE_AIV_3)

In parallel to the FPU/FTB integration the CQM warm electronics will be integrated and functionally checked as discussed in section 5.3.

2.6. CQM Verification

2.6.1. Instrument integration into Cryostat I — 4d

The cold units mounted on the Herschel optical bench simulator will be integrated into the facility cryostat and the harnesses attached. The external harness will be attached to the warm electronics units. A warm functional test will be conducted to ensure the electrical and operational integrity of the integrated CQM instrument. This is the CQM **ILT_WFT** test.

2.6.2. CQM Test Readiness Review — 3d

A review will be held prior to the commencement of the instrument cooldown to confirm that all systems are functioning correctly and that the test plan and procedures are correctly established. This will be a formal review to which ESA and prime contractors will be invited.

2.6.3. Instrument Cold Test I — 14d

Assuming no major deficiencies are identified in the integration or test readiness the cryostat will be evacuated and the cold instrument units cooled to their operating temperature. One the operating temperature has been reached a cold functional test will be conducted followed by a thermal verification test. This will be more detailed than the one done for the STM as the instrument now contains working sub-systems. During the thermal verification test the cooler will be recycled and it will be possible to start operation of the detectors. A cold functional test of the detectors will then be carried out. Assuming all is well with the detector operation the final part of the instrument alignment verification can be completed using far infrared and sub-millimetre radiation via the telescope simulator. These tests are the CQM **ILT_CFT** test; the CQM **ILT_THER** test and the CQM **ILT_ALIGN** test.

2.6.4. Detector Swap Warmup — 21d

Provision is made in the CQM schedule to bring the cold units back to ambient temperature at this stage. This is primarily to allow the flightspare spectrometer short wavelength BDA to be integrated to allow the performance of the FTS to be fully evaluated. However even is this unit were not available it is felt prudent to plan for a second warmup and cool cycle to allow any integration or operation problems that might have arisen to be solved. The cryostat will be warmed up; the cold units removed (still attached to the Herschel optical bench simulator) and the FPU removed from optical bench simulator and partially de-integrated to allow the spectrometer short wavelength BDA to be installed. The instrument will then be re-assembled and integrated back onto the optical bench simulator and with the FTB's. A warm functional test may be carried out (?) to verify electrical integrity – this would form part of the CQM **ILT_INTG** test.

2.6.5. Instrument integration into Cryostat II 3.5d

The cold units on the optical bench simulator will be placed back into the facility cryostat and the warm functional test repeated. A brief review will be held before the cooldown commences to ensure that all aspects of the instrument integration are nominal. This will be a repeat of the CQM **ILT_WFT** test

2.6.6. Instrument cooldown 5d

If all is well the cold units will be cooled to operating temperature and a cold functional test conducted to ensure no problems have occurred. This is a repeat of the CQM **ILT_CFT** test

2.6.7. Instrument Cold Verification 32d

Assuming no problems have arisen, the CQM instrument should now be fully functioning and its basic optical; electrical and thermal functionality will have been verified. We are now in a position to carry out more extensive performance and operational characterisation tests. The indicative order of the tests to be carried out is: to verify the performance of each sub-system against a set prescription from the sub-system providers; to run a set of instrument level performance and characterisation tests and finally to run a set of tests to verify and explore the optimum observing mode strategies for the SPIRE instrument. Before warm up commences the standard cold functional test will be carried out as a final cold health check on the instrument before delivery to ESA. Once the instrument is warm a warm functional test will be done as a final warm health check before delivery to ESA. The cold units will then be removed from the cryostat. The tests carried out will be the CQM **ILT_PERF**; the **ILT_OPS**; the **ILT_CFT** and the **ILT_WFT.**

2.7. Critical Design Reviews 2d

The instrument level test and verification procedures on the CQM instrument are now complete. In parallel to the instrument level testing the sub-systems have tested their Qualification Models. The results of all qualification testing will be available at this time and the SPIRE Critical Design Review will be help. This will be a formal review to which ESA and Prime Contractor representatives will be invited.

2.8. CQM Delivery Preparation 10d

The instrument will be prepared for shipment to ESA and the Acceptance Delivery Package (ADP) prepared. At this time any items needed for flight spare use (i.e. the spectrometer short wavelength array) will be removed from the instrument and replaced by STM's or QM's.

2.9. CQM Readiness Review 2d

Before shipment to ESA a readiness review will be help to check the instrument status and to review the contents of the ADP.

2.10. Delivery of CQM to ESA 0d

8. PFM AIV

8.1 Capabilities

The PFM FPU and JFET Boxes must be fully compliant with the Instrument Requirements Document. The electronics used to test the PFM FPU and JFET Boxes are initially the Qualification Models of the DRCU and DPU. However, in order to fully calibrate the instrument prior to integration in the satellite the PFM electronics units must be integrated with the FPU and JFET boxes and the calibration procedures carried out with the full proto-flight instrument.

8.2 Test Programme

Most of the design requirements on the SPIRE instrument will have been verified on the AVM; STM and CQM instruments and at unit level on the sub-system QM's. The test programme for the PFM will be designed to verify that the instrument is capable of meeting its performance requirements and will be capable carry out the defined observing modes. In addition, and most importantly, the AIV programme for the PFM instrument is geared towards carry out the instrument calibration tests that will fulfil the requirements set out in the Instrument Calibration Requirements Document.

8.3 Assembly and Integration and Verification Sequence

HS_INST_AIV_3: Proto-Flight Model

3.1. PFM FPU Deliveries

- 3.1.1. PFM Structure; MGSE and transport container Delivery
- 3.1.2. PFM Thermal Straps Delivery
- 3.1.3. PFM Mirrors Delivery
- 3.1.4. PFM Cooler Delivery
- 3.1.5. PFM Filters, Dichroics and Beamsplitters Delivery
- 3.1.6. PFM BSMm Delivery
- 3.1.7. PFM SMECm Delivery
- 3.1.8. PFM BDAs Delivery
- 3.1.9. PFM SCAL Delivery
- 3.1.10. PFM Shutter Delivery
- 3.1.11. PFM FPU RF Filter Modules Delivery

3.2. 3-D Metrology **11d**

This is a repeat of the process carried out on the STM. Here the partially assembled structure with some OGSE fitted is placed into a mechanical 3-D metrology machine and the positions of the mirror interfaces are verified and recorded. This is part of the PFM **ILT_ALIGN** test – see RD5

- 3.2.1. Preparation 2d
- 3.2.2. Fit OGSE into detector boxes 1d
- 3.2.3. Fit and align detector mirrors and dichroic mounts 2d
- 3.2.4. Fit detector boxes into structure 1d
- 3.2.5. 3-D metrology 5d

3.3. Alignment during integration **29d**

After mechanical metrology the mirrors and other OGSE items are assembled into the structure and their alignment verified optically using visible light. Integration of the mirrors may involve some re-machining of the mirror mounts – this has been allowed for in the scheduling. Various optical tests are carried out on the integrated structure and optics to verify the performance of the optical design. At this time the FPU RF filter modules and sub-system harnesses can be integrated and the PFM cooler will also be integrated to allow basic thermal checks to be carried during the cold alignment verification. This is part of the PFM **INT_ALIGN** test – see RD6

3.3.1.	Structure into GSE and fit OGSE	2d
3.3.2.	Fit and align mirrors	10d
3.3.3.	External alignment verification	1d
3.3.4.	Pupil Quality Verification	1d
3.3.5.	Image Quality Verification	1d
3.3.6.	RF Filter Modules and sub-system harness integration	3d
3.3.7.	Cooler Integration	2d
3.3.8.	Fit covers and mount on FOB	2d
3.3.9.	Alignment of SOR wrt FOR	1d
3.3.10.	Verify image quality and stability	2d

3.4. Cold Alignment and Thermal Checks — 20d

Once the optical alignment and performance has been verified warm, it must also be verified cold. The integrated structure; optics and OGSE which is now integrated onto the Herschel optical bench simulator is placed into the facility cryostat. The optical alignment of the instrument with respect to the Herschel optical bench and the internal alignment of the instrument will then be verified cold. While the partially integrated FPU is cold basic thermal balamce checks can be carried out and the cooler recycling checked out. This is part of the PFM **INT_ALIGN** and **ILT_THER** tests

3.4.1.	Integration into Cryostat	2d
3.4.2.	Cooldown	4d
3.4.3.	Cold optical alignment checks	5d
3.4.4.	Thermal Performance Checks	5d
3.4.5.	Warmup	3d

3.5. Completion of FPU Integration — 27d

Assuming no problems are identified with either the optical alignment or basic thermal performance of the instrument, the rest of the cold sub-systems can be integrated into the structure. All remaining sub-systems are integrated at this time.

3.5.1.	De-integrate optical/mass dummies	3d
3.5.2.	BDAs Integration and Alignment	8d
3.5.3.	SCAL Integration and Alignment	2d
3.5.4.	SMECm Integration and Alignment	3d
3.5.5.	BSMm Integration and Alignment	3d
3.5.6.	Shutter Integration	2d
3.5.7.	Filters, Dichroics and Beamsplitters Integration	2d
3.5.8.	Structure Final Integration	1d

3.6. PFM Instrument Bakeout — 5d

It is anticipated that the FPU will be baked out at this time in accordance with Herschel/Planck PA plan requirements.

3.7. PFM FTB Integration — 8d

In parallel with the integration of the FPU the JFET modules; JFET box RF filter units and the back harness can be integrated into the JFET box structures to form the FTB units: FTBp and FTBs. Following assembly of the FTB's a warm functional check will be done to ensure electrical integrity – this is part of the PFM **ILT_INTG** test.

3.8. FPU/FTB Integration with FOB Sim. — 2d

With both the FPU and FTB's now integrated they can be mounted onto the plate that forms the Herschel Optical Bench simulator. The alignment between the FPU and the Herschel optical bench simulator is verified using the alignment references. The harnesses between the FPU and the FTB's are connected and affixed to the mounting points on the FTB's. A warm functional test may be carried out (?) to verify electrical integrity – this would form part of the PFM **ILT_INTG** test.

3.9. QM Warm Electronics Integration (HS_WE_AIV_4)

In parallel to the FPU/FTB integration the QM warm electronics will be integrated and functionally checked as discussed in section 5.4.

3.10. PFM Verification 82d

3.10.1. Instrument Integration into Cryostat I 4d

The cold units mounted on the Herschel optical bench simulator will be integrated into the facility cryostat and the harnesses attached. The external harness will be attached to the warm electronics units. A warm functional test will be conducted to ensure the electrical and operational integrity of the integrated PFM instrument. This is the PFM **ILT_WFT** test.

3.10.2. PFM Test Readiness Review 3d

A review will be held prior to the commencement of the instrument cooldown to confirm that all systems are functioning correctly and that the test plan and procedures are correctly established. This will be a formal review to which ESA and prime contractors will be invited.

3.10.3. PFM Instrument Cold Tests I 21d

Assuming no problems are identified with the instrument integration, the cold units will be cooled down to operating temperature and the first set of PFM cold tests will be conducted. These will consist of the standard instrument cold functional test and a standard instrument basic performance test to give a baseline set of performance figures for comparison after the cold vibration test. Extra time is given to the standard performance test before vibration to allow for any debugging or characterisation of the integrated instrument. The cold units of the instrument will be warmed up following the standard instrument test and a warm functional test conducted to give a baseline for comparison after the cold vibration. These are the PFM **ILT_CFT**; part of the **ILT_PERF** and the **ILT_WFT** tests.

3.10.3.1.	Cool down	4d
3.10.3.2.	Cold Functional Tests I	3d
3.10.3.3.	Pre-vibration Performance Tests	10d
3.10.3.4.	Warm Up	3d
3.10.3.5.	Warm Functional Tests II	1d

3.10.4. PFM Cold Vibration 37d

After the instrument has been warmed up it will be prepared and packed for delivery to the cold vibration facility. The cold vibration will be conducted and the instrument returned to RAL. After return to RAL the cold units will be re-integrated with the Herschel optical bench simulator and the external alignment verified. This is the PFM **ILT_VIB** test.

3.10.4.1.	FPU/FTB Packing and preparation	5d
3.10.4.2.	Ship FPU/FTB to Cold Vibration Facility	2d
3.10.4.3.	Instrument Cold Vibration Campaign	21d
3.10.4.4.	FPU/FTB Packing and preparation	5d
3.10.4.5.	Ship FPU/FTB to RAL	2d
3.10.4.6.	Integrate FPU/FTB onto optical bench sim.	2d

3.10.5. Instrument Integration into Cryostat II — 4d

The cold units mounted on the Herschel optical bench simulator will be integrated into the facility cryostat and the harnesses attached. The external harness will be attached to the warm electronics units. A warm functional test will be conducted to ensure the electrical and operational integrity of the integrated PFM instrument after vibration. This is the PFM **ILT_WFT** test.

3.10.6. PFM Instrument Cold Tests II — 11d

The cold units will be cooled down to operating temperature and the second set of PFM cold tests will be conducted. These will consist of the standard instrument cold functional test and a standard instrument basic performance test to compare to the tests conducted before the cold vibration test. The standard performance test will be shorter this time. Following these tests the instrument will be left cold in preparation for the performance and calibration tests. These are the PFM **ILT_CFT**; part of the **ILT_PERF** and the

3.10.6.1.	Cool Down	4d
3.10.6.2.	Cold Functional Tests II	3d
3.10.6.3.	Post-vibration Performance Tests	5d

3.10.7. PFM Post Test Review — 2d

The environmental verification of the PFM is now complete and a review of the results will now be held to verify that the instrument is capable of withstanding launch. This will be a formal review to ESA and Prime Contractor representatives will be invited.

3.11. PFM Warm Electronics Integration (HS_WE_AIV_5)

In parallel to the PFM verification programme the PFM warm electronics will be delivered and integrated and functionally checked as discussed in section 5.5.

3.12. PFM Instrument Calibration — 45d

The PFM instrument is now fully integrated and the performance characterisation and calibration of the flight configuration can be carried out. The first test will be a repeat of the instrument cold functional test to give a baseline characterisation of the instrument functions. The warm electronics units will then be placed in a thermally controlled environment to allow the performance of the instrument to be characterised with the warm electronics operating over the expected temperature range of the SVM. Once this has been done an extensive series of instrument performance and calibration tests will be carried out. Finally a cold functional test will be conducted before the instrument is warmed up to give a baseline for comparison after integration in the Herschel cryostat. After the cold units have been warmed up a warm functional test will be carried to give a warm characterisation baseline. These are the PFM **ILT_CFT**; the **ILT_PERF**; the **ILT_CAL** and the **ILT_WFT**.

3.12.1.	Cold Functional Tests III	3d
3.12.2.	Warm Electronics Thermal Range Tests	5d
3.12.3.	Calibration and performance verification	30d
3.12.4.	Cold Functional Test IV	3d
3.12.5.	Warm Up	3d
3.12.6.	Warm Functional Test III	1d

3.13. PFM Delivery Preparation — 14d

Once the cold units have been warmed up and removed from the cryostat the instrument will be prepared and packed ready for shipment to ESA. The ADP will also be compiled at this time.

3.13.1.	De-integrtaion of FPU and FTB from optical bench sim	2d
3.13.2.	Mass properties Measurement	2d

3.13.3. Packing and shipment 10d

3.13.4. Preparation of Delivery Data Package 10d

3.14. PFM Readiness Review **2d**

The instrument level AIV sequence for the SPIRE PFM is now complete. A delivery readiness review will be held to examine the performance and calibration status of the instrument and the contents of the ADP prior to delivery to ESA. This will be a formal review to which ESA and Prime Contractor representatives will be invited.

3.15. Delivery of PFM to ESA **0d**

9. FS AIV

9.1 Capabilities

The FS FPU and JFET Box will be identical to the PFM. The electronics used to test the FS FPU and JFET Box consist of boards the are identical to the PFM electronics assembled into the qualification model frames.

9.2 Outline Assembly and Integration and Verification

The FS AIV will be identical to the PFM AIV except steps 3.10.4 where we plan only a warm vibration and step 3.11 which is not required as the calibration and functional characterisation will be carried out with the electronics that will ultimately be used with the flightspare.

10. APPENDIX: REQUIREMENTS MATRIX

Cross reference matrix between instrument requirements; qualification requirements and the test that will be carried out on each model – this is held as tables in an MS Access database.

Reference	Description	Verification Method	Mode l 1	Mode l 2	Mode l 3	Mode l 4	Test ID1	Test ID2	Test ID3	Test ID4	Test ID5
IRD-AUT-R01	The SPIRE instrument shall have a defined safe mode.	Design analysis	N/A				N/A				
IRD-AUT-R02	The SPIRE instrument shall define housekeeping parameters to be used for autonomous health and safety monitoring	Design analysis	N/A				N/A				
IRD-AUT-R03	The SPIRE instrument shall provide a method of monitoring the defined housekeeping parameters and taking appropriate action in the case of error or failure.	Design analysis AVM functional tests	AVM				AVM_FUNC				
IRD-AUT-R04	The SPIRE instrument shall provide a method of alerting the S/C CDMS of any failure requiring the instrument to be controlled by the CDMS (e.g. switched off).	Design analysis AVM functional tests	AVM				AVM_FUNC				
IRD-AUT-R05	The instrument shall continuously monitor the integrity of the on-board software and take appropriate action in case of error.	Design analysis AVM functional tests	AVM				AVM_FUNC				
IRD-AUT-R06	The instrument shall monitor the operational status of the	Design analysis AVM functional tests	AVM				AVM_FUNC				

Reference	Description	Verification Method	Mode l 1	Mode l 2	Mode l 3	Mode l 4	Test ID1	Test ID2	Test ID3	Test ID4	Test ID5
	instrument on-board computers and take appropriate action in case of error.										
IRD-BSMP-R01	Maximum throw in chop axis	Design analysis Instrument level performance tests	CQM	PFM			ILT_PERF				
IRD-BSMP-R02	Maximum throw in jiggle axis	Design analysis Instrument level performance tests	CQM	PFM			ILT_PERF				
IRD-BSMP-R03	Minimum step in both axis	Design analysis Instrument level performance tests	CQM	PFM			ILT_PERF				
IRD-BSMP-R04	Frequency of chop	Design analysis Instrument level performance tests	CQM	PFM			ILT_PERF				
IRD-BSMP-R05	Holding Position	Design analysis Instrument level performance tests	CQM	PFM			ILT_PERF				
IRD-BSMP-R06	Stability	Design analysis Instrument level performance tests	CQM	PFM			ILT_PERF				
IRD-BSMP-R07	Position Measurement	Design analysis Instrument level performance tests	CQM	PFM			ILT_PERF				
IRD-BSMP-R08	Duty Cycle	Design analysis Instrument level performance tests	CQM	PFM			ILT_PERF				
IRD-BSMP-R09	Volume envelope	Design analysis Instrument level integration verification Subsystem acceptance data package	STM	CQM			ILT_INTG				
IRD-BSMP-R10	Operating temperature	Design analysis Instrument level warm functional test Instrument level cold functional tests	CQM	PFM			ILT_WFT	ILT_CFT			
IRD-BSMP-R11	Thermal isolation	Design analysis Instrument level thermal verification Instrument level performance tests	STM	CQM			ILT_THER	ILT_PERF			
IRD-BSMP-R12	Cold power dissipation	Design analysis Instrument level cold functional test	CQM	PFM			ILT_CFT				
IRD-CALP-R01	Nominal operating output	Design Analysis Instrument level performance tests	CQM	PFM			ILT_PERF				
IRD-CALP-R02	Operating range	Design Analysis Instrument level	CQM	PFM			ILT_PERF				

Reference	Description	Verification Method	Mode I 1	Mode I 2	Mode I 3	Mode I 4	Test ID1	Test ID2	Test ID3	Test ID4	Test ID5
		performance tests									
IRD-CALP-R03	Equivalent obscuration of aperture through BSM mirror	Design Analysis Instrument level performance tests	CQM	PFM			ILT_PERF				
IRD-CALP-R04	Speed of response	Design Analysis Instrument level performance tests	CQM	PFM			ILT_PERF				
IRD-CALP-R05	Repeatability	Design Analysis Instrument level performance tests	CQM	PFM			ILT_PERF				
IRD-CALP-R06	Operation	Design analysis Instrument level operations tests	CQM	PFM			ILT_OPS				
IRD-CALP-R07	Frequency	Design analysis Instrument level operations tests	CQM	PFM			ILT_OPS				
IRD-CALP-R08	Interface	Design analysis	N/A				N/A				
IRD-CALP-R09	Volume envelope	Design analysis Instrument level integration verification Subsystem acceptance data package	STM	CQM			ILT_INTG				
IRD-CALP-R10	Thermal isolation	Design analysis Instrument level thermal verification Instrument level cold functional test	STM	CQM	PFM		ILT_THER	ILT_CFT			
IRD-CALP-R11	Operating temperature	Design analysis Instrument level cold functional test	CQM	PFM			ILT_CFT				
IRD-CALP-R12	Cold power dissipation	Design analysis Instrument level cold functional test Instrument level operations tests	CQM	PFM			ILT_CFT	ILT_OPS			
IRD-CALP-R14	Operating voltage	Design analysis	N/A				N/A				
IRD-CALP-R15	Redundancy	Design analysis (FMECA)	N/A				N/A				
IRD-CALS-R01	Radiated spectrum:	Design analysis Instrument level performance tests	CQM	PFM			ILT_PERF				
IRD-CALS-R02	Beam pattern	Design analysis Instrument level performance tests	CQM	PFM			ILT_PERF				
IRD-CALS-R03	Adjustability:	Design analysis Instrument level cold functional tests Instrument level performance tests	CQM	PFM			ILT_CFT	ILT_PERF			
IRD-CALS-R04	Uniformity	Design analysis Instrument level	CQM	PFM			ILT_PERF				

Reference	Description	Verification Method	Mode l 1	Mode l 2	Mode l 3	Mode l 4	Test ID1	Test ID2	Test ID3	Test ID4	Test ID5
		performance tests									
IRD-CALS-R05	Repeatability and drift	Design analysis Instrument level performance tests	CQM	PFM			ILT_PERF				
IRD-CALS-R06	Operation	Design analysis Instrument level operations tests	CQM	PFM			ILT_OPS				
IRD-CALS-R07	Number of operations	Design analysis Subsystem acceptance data package	N/A				N/A				
IRD-CALS-R08	Operating Voltage	Design analysis	N/A				N/A				
IRD-CALS-R09	Power dissipation in the focal plane	Design analysis Instrument level cold functional test Instrument level operations tests	CQM	PFM			ILT_CFT	ILT_OPS			
IRD-CALS-R11	Envelope	Design analysis Instrument level integration verification Subsystem delivery data package	STM	CQM			ILT_INTG				
IRD-CALS-R12	Thermal Isolation	Design analysis Instrument level thermal verification Instrument level cold functional test	STM	CQM	PFM		ILT_THER	ILT_CFT			
IRD-CALS-R13	Operating Temperature	Design analysis Instrument level cold functional test	CQM	PFM			ILT_CFT				
IRD-CALS-R14	Redundancy	Design analysis (FMECA)	N/A				N/A				
IRD-CALS-R15	Thermometry	Design analysis	N/A				N/A				
IRD-CMD-R01	The instrument shall be capable of accepting telecommand packets from the CDMS at speeds up to the maximum rate delivered by the CDMS without loss.	Design analysis AVM functional tests	AVM				AVM_FUNC				
IRD-CMD-R02	The instrument shall validate each telecommand packet as it is received.	Design analysis AVM functional tests	AVM				AVM_FUNC				
IRD-CMD-R03	The instrument shall verify execution of the telecommands in each packet.	Design analysis AVM functional tests	AVM				AVM_FUNC				

Reference	Description	Verification Method	Mode l 1	Mode l 2	Mode l 3	Mode l 4	Test ID1	Test ID2	Test ID3	Test ID4	Test ID5
IRD-CMD-R04	The instrument shall report the result of all telecommand validation/verification in telemetry	Design analysis AVM functional tests	AVM				AVM_FUNC				
IRD-CMD-R05	The instrument shall provide commands to allow control of all individual devices (e.g. switch or latch) within the instrument.	Design analysis AVM functional tests	AVM				AVM_FUNC				
IRD-CMD-R06	All commands to individual devices shall explicitly set the state of the device	Design analysis AVM functional tests	AVM				AVM_FUNC				
IRD-CMD-R07	The action of all commands affecting an individual device shall be verifiable by an independent parameter available in the nominal housekeeping packet.	Design analysis AVM functional tests	AVM				AVM_FUNC				
IRD-CMD-R08	The instrument shall provide commands to execute the functions required to implement the instrument operating modes	Design analysis AVM functional tests Instrument level operations tests	AVM	CQM	PFM	FS	AVM_FUNC	ILT_OPS			
IRD-CMD-R09	The instrument shall provide the facility to define and execute procedure commands.	Design analysis AVM functional tests	AVM				AVM_FUNC				
IRD-CMD-R10	The instrument shall provide commands to modify the execution sequence of commands.	Design analysis AVM functional tests	AVM				AVM_FUNC				
IRD-CMD-R11	The instrument shall provide commands to allow identification of the steps within an observation.	Design analysis AVM functional tests Instrument level operations tests	AVM	CQM	PFM	FS	AVM_FUNC	ILT_OPS			
IRD-CMD-R12	The instrument shall provide commands to modify data	Design analysis AVM functional tests	AVM				AVM_FUNC				

Reference	Description	Verification Method	Model 1	Model 2	Model 3	Model 4	Test ID1	Test ID2	Test ID3	Test ID4	Test ID5
	values/tables held in the instrument memory.										
IRD-CMD-R13	The instrument shall provide commands to enable on-board software maintenance	Design analysis AVM functional tests	AVM				AVM_FUNC				
IRD-COOL-R01	Temperature at the detectors	Design analysis Instrument level thermal verification	STM	CQM	PFM		ILT_THER				
IRD-COOL-R02	Operating temperature control	Design analysis Instrument level thermal verification	STM	CQM	PFM		ILT_THER				
IRD-COOL-R03	Temperature drop across thermal link between detectors and evaporator cold tip	Design analysis Instrument level thermal verification	STM	CQM	PFM		ILT_THER				
IRD-COOL-R04	Temperature drift	Design analysis Instrument level thermal verification	STM	CQM	PFM		ILT_THER				
IRD-COOL-R05	Temperature fluctuations at the evaporator cold tip	Design analysis Instrument level thermal verification	STM	CQM	PFM		ILT_THER				
IRD-COOL-R06	System low frequency temperature stability	Design analysis Instrument level thermal verification	STM	CQM	PFM		ILT_THER				
IRD-COOL-R07	Heat lift at evaporator cold tip	Design analysis Instrument level thermal verification	STM	CQM	PFM		ILT_THER				
IRD-COOL-R08	Hold time	Design analysis Instrument level thermal verification	STM	CQM	PFM		ILT_THER				
IRD-COOL-R09	Recycle time	Design analysis Instrument level thermal verification	STM	CQM	PFM		ILT_THER				
IRD-COOL-R10	Mechanical interface	Design analysis Instrument level integration verification	STM				ILT_INTG				
IRD-COOL-R11	Thermal Interface with Herschel cryostat	Design analysis Instrument level thermal verification	STM	CQM	PFM		ILT_THER				
IRD-COOL-R12	Parasitic thermal load onto He bath during cold operation	Design analysis Instrument level thermal verification	STM	CQM	PFM		ILT_THER				
IRD-COOL-R13	Time averaged thermal load onto He bath for 48 hour cycle	Design analysis Instrument level thermal verification	STM	CQM	PFM		ILT_THER				
IRD-COOL-R15	Maximum envelope	Design analysis Instrument level	STM				ILT_INTG				

Reference	Description	Verification Method	Mode l 1	Mode l 2	Mode l 3	Mode l 4	Test ID1	Test ID2	Test ID3	Test ID4	Test ID5
		integration verification Subsystem acceptance data package									
IRD-COOL-R18	Thermometers	Design analysis	N/A				N/A				
IRD-COOL-R19	Gas gap heat switches	Design analysis (FMECA)	N/A				N/A				
IRD-COOL-R20	Ground Operation	Subsystem verification programme	N/A				N/A				
IRD-DATA-R01	All data transferred between the CDMS and the instrument shall be contained in packets conforming to the ESA Packet Utilisation Standard (RD4)	Design analysis AVM functional tests	AVM				AVM_FUN C				
IRD-DATA-R02	The instrument shall provide all mandatory packet handling services defined for the mission.	Design analysis AVM functional tests	AVM				AVM_FUN C				
IRD-DATA-R03	The instrument shall be capable of buffering data generated during an observation.	Design analysis AVM functional tests	AVM				AVM_FUN C				
IRD-DATA-R04	The instrument shall be capable of reducing the average data rate to the CDMS to 20kbps.	Design analysis AVM functional tests	AVM				AVM_FUN C				
IRD-DATA-R05	The packing of science data into science data packets shall minimise loss of information if packet is lost or corrupted.	Design analysis AVM functional tests Instrument level operations tests	AVM	CQM	PFM	FS	AVM_FUN C	ILT_OPS			
IRD-DETP-R01	Detective Quantum Efficiency at 2 Hz at nominal incident power levels	Design analysis Instrument level performance tests	CQM	PFM			ILT_PERF				
IRD-DETP-R02	Time constant	Design analysis Instrument level performance tests	CQM	PFM			ILT_PERF				
IRD-DETP-R03	Uniformity	Design analysis Instrument level performance tests	CQM	PFM			ILT_PERF				
IRD-DETP-R04	Yield (good pixels)	Design analysis Subsystem acceptance data package	N/A				N/A				

Reference	Description	Verification Method	Mode I 1	Mode I 2	Mode I 3	Mode I 4	Test ID1	Test ID2	Test ID3	Test ID4	Test ID5
IRD-DETP-R05	Electrical crosstalk for near neighbour pixels.	Design analysis Instrument level cold functional tests Instrument level performance tests	CQM	PFM			ILT_CFT	ILT_PERF			
IRD-DETP-R06	Electrical crosstalk any pair of pixels	Design analysis Instrument level cold functional tests Instrument level performance tests	CQM	PFM			ILT_CFT	ILT_PERF			
IRD-DETP-R07	Detector angular response	Design analysis Subsystem acceptance data package	N/A				N/A				
IRD-DETP-R08	Spectral response	Design analysis Instrument level performance tests	CQM	PFM			ILT_PERF				
IRD-DETP-R09	Microphonic susceptibility	Design analysis Instrument level performance tests	CQM	PFM			ILT_PERF				
IRD-DETP-R10	EMI susceptibility	Design analysis Instrument level EMC tests Instrument level performance tests	CQM	PFM			ILT_EMC	ILT_PERF			
IRD-DETP-R11	Sensitivity to ionising radiation	Design analysis Subsystem verification programme	N/A				N/A				
IRD-DETP-R12	Volume envelope	Design analysis Instrument level integration verification Subsystem acceptance data package	STM	CQM			ILT_INTG				
IRD-DETP-R13	300 mK thermal load	Design analysis Instrument level thermal verification	STM	CQM	PFM		ILT_THER				
IRD-DETP-R14	Mechanical interface	Design analysis Instrument level integration verification Subsystem acceptance data package	STM	CQM			ILT_INTG				
IRD-DETP-R15	Eigenfrequency of the detector array structure	Design analysis Subsystem verification programme Subsystem acceptance data package	N/A				N/A				
IRD-DETP-R16	Eigenfrequency of the detector array structure	Design analysis Subsystem verification programme Subsystem acceptance data package	N/A				N/A				

Reference	Description	Verification Method	Mode I 1	Mode I 2	Mode I 3	Mode I 4	Test ID1	Test ID2	Test ID3	Test ID4	Test ID5
IRD-DETS-R01	Detective Quantum Efficiency at 20 Hz at nominal incident power levels	Design analysis Instrument level performance tests	CQM	PFM			ILT_PERF				
IRD-DETS-R02	Time constant	Design analysis Instrument level performance tests	CQM	PFM			ILT_PERF				
IRD-DETS-R03	Uniformity	Design analysis Instrument level performance tests	CQM	PFM			ILT_PERF				
IRD-DETS-R04	Yield (good pixels)	Design analysis Subsystem acceptance data package	N/A				N/A				
IRD-DETS-R05	Electrical crosstalk for near neighbour pixels.	Design analysis Instrument level cold functional tests Instrument level performance tests	CQM	PFM			ILT_CFT	ILT_PERF			
IRD-DETS-R06	Electrical crosstalk any pair of pixels	Design analysis Instrument level cold functional tests Instrument level performance tests	CQM	PFM			ILT_CFT	ILT_PERF			
IRD-DETS-R07	Detector angular response	Design analysis Subsystem acceptance data package	N/A				N/A				
IRD-DETS-R08	Spectral response	Design analysis Instrument level performance tests	CQM	PFM			ILT_PERF				
IRD-DETS-R09	Sampling frequency	Design analysis Instrument level warm functional tests Instrument level performance tests	CQM	PFM			ILT_WFT	ILT_PERF			
IRD-DETS-R10	Microphonic susceptibility	Design analysis Instrument level performance tests	CQM	PFM			ILT_PERF				
IRD-DETS-R11	EMI susceptibility	Design analysis Instrument level EMC tests Instrument level performance tests	CQM	PFM			ILT_EMC	ILT_PERF			
IRD-DETS-R12	Sensitivity to ionising radiation	Design analysis Subsystem verification programme	N/A				N/A				
IRD-DETS-R13	Volume envelope	Design analysis Instrument level integration verification Subsystem acceptance data package	STM	CQM			ILT_INTG				
IRD-DETS-R14	300 mK thermal load	Design analysis Instrument level	STM	CQM	PFM		ILT_THER				

Reference	Description	Verification Method	Mode I 1	Mode I 2	Mode I 3	Mode I 4	Test ID1	Test ID2	Test ID3	Test ID4	Test ID5
		thermal verification									
IRD-DETS-R15	Mechanical interface	Design analysis Instrument level integration verification Subsystem acceptance data package	STM	CQM			ILT_INTG				
IRD-DSIM-R01	Function	Design analysis Instrument level integration verification AVM functional tests	AVM				ILT_INTG	AVM_FUNC			
IRD-DSIM-R02	Outputs	Design analysis Instrument level integration verification AVM functional tests	AVM				ILT_INTG	AVM_FUNC			
IRD-DSIM-R03	Harness	Design analysis	N/A				N/A				
IRD-DSIM-R04	Prime and Redundant Interfaces	Design analysis Instrument level integration verification Instrument level warm functional tests	PFM				ILT_INTG	ILT_WFT			
IRD-FPHR-R01	Detector harness capacitance	Design analysis Instrument level cold functional test Instrument level performance test	CQM	PFM			ILT_CFT	ILT_PERF			
IRD-FPHR-R02	Detector harness mechanical support	Design analysis Instrument level performance tests	CQM	PFM			ILT_PERF				
IRD-FPHR-R03	Generic implementation	Design analysis	N/A				N/A				
IRD-FSIM-R01	Function	Design analysis Instrument level integration verification Instrument level warm functional tests	CQM				ILT_INTG	ILT_WFT			
IRD-FSIM-R02	Analogue Outputs	Design analysis Instrument level integration verification Instrument level warm functional tests	CQM				ILT_INTG	ILT_WFT			
IRD-FSIM-R03	Control loops	Design analysis Instrument level integration verification Instrument level warm functional tests	CQM				ILT_INTG	ILT_WFT			
IRD-FSIM-R04	Harness	Design analysis	N/A				N/A				
IRD-FSIM-R05	Prime and Redundant Interfaces	Design analysis Instrument level integration verification Instrument level warm functional tests	PFM				ILT_INTG	ILT_WFT			

Reference	Description	Verification Method	Mode l 1	Mode l 2	Mode l 3	Mode l 4	Test ID1	Test ID2	Test ID3	Test ID4	Test ID5
IRD-FTB-R01	Amplifier noise	Design analysis Instrument level cold functional test Instrument level performance test	CQM	PFM			ILT_CFT	ILT_PERF			
IRD-FTB-R02	RF rejection	Design analysis Instrument level EMC tests Instrument level performance test	CQM	PFM			ILT_EMC	ILT_PERF			
IRD-FTB-R04	Envelope	Design analysis Instrument level integration verification Subsystem acceptance data package	STM	CQM	PFM		ILT_INTG				
IRD-FTB-R05	Dissipation	Design analysis Instrument level thermal verification Instrument level cold functional test Instrument level operations tests	STM	CQM	PFM		ILT_THER	ILT_CFT	ILT_OPS		
IRD-FTB-R06	Operating temperature range	Design analysis Instrument level performance tests	CQM	PFM			ILT_PERF				
IRD-FTB-R07	Mechanical Interface	Design analysis	N/A				N/A				
IRD-FTB-R08	Nominal operating temperature	Design analysis Instrument level cold functional test	CQM	PFM			ILT_CFT				
IRD-FTB-R09	First natural frequency	Design analysis Instrument level vibration tests	STM	PFM			ILT_VIB				
IRD-FTB-R10	Thermometers	Design analysis	N/A				N/A				
IRD-INST-R14	The SPIRE instrument shall provide the instrument models as specified	Design analysis	N/A				N/A				
IRD-INST-R15	The instrument units are required to undergo an environmental test programme that demonstrates the design and build standard of the flight model is compatible with the launch and operational environment of the Herschel satellite.	Design analysis Instrument level vibration tests Instrument level EMC tests Instrument level thermal verification tests	STM	CQM	PFM		ILT_VIB	ILT_EMC	ILT_THER		

Reference	Description	Verification Method	Mode l 1	Mode l 2	Mode l 3	Mode l 4	Test ID1	Test ID2	Test ID3	Test ID4	Test ID5
IRD-MODE-R01	The instrument shall be capable executing all operating modes described in the SPIRE Operating Modes Document (RD8)	Design Analysis Instrument level operations tests	CQM	PFM	FS		ILT_OPS				
IRD-OPS-R01	It shall be possible to calculate the execution time of an instrument command to within 1 sec (TBC).	Design Analysis AVM functional tests	AVM				AVM_FUNC				
IRD-OPS-R02	The instrument shall be capable of limiting the average data rate to the CDMS during a 24hr period to 100kbps (TBC)	Design Analysis AVM functional tests	AVM				AVM_FUNC				
IRD-OPS-R03	The SPIRE instrument shall be identified as a single subsystem within the satellite.	Design Analysis	N/A				N/A				
IRD-OPS-R04	The photometer observing modes should provide a mechanism for telemetering undifferenced samples to the ground	Design Analysis	N/A				N/A				
IRD-OPS-R05	The photometer should have an observing mode that permits accurate measurement of the point spread function	Design Analysis Instrument level operations tests	CQM	PFM	FS		ILT_OPS				
IRD-OPS-R06	The SPIRE photometer shall have an observing mode capable of implementing a 64-point jiggle map to produce a fully sampled image of a 4x4 arc minute region	Design Analysis Instrument level operations tests	CQM	PFM	FS		ILT_OPS				
IRD-OPS-R07	The photometer observing modes shall include provision for 5-point or 7-point jiggle maps for	Design Analysis Instrument level operations tests	CQM	PFM	FS		ILT_OPS				

Reference	Description	Verification Method	Mode I 1	Mode I 2	Mode I 3	Mode I 4	Test ID1	Test ID2	Test ID3	Test ID4	Test ID5
	accurate point source photomometry										
IRD-OPS-R08	The photometer shall have a "peak-up" observing mode capable of being implemented without using satellite pointing	Design Analysis Instrument level operations tests	CQM	PFM	FS		ILT_OPS				
IRD-OPTP-R00	Compatibility with Herschel telescope	Design analysis Instrument level alignment verification Instrument level performance tests	STM	CQM			ILT_ALIGN	ILT_PERF			
IRD-OPTP-R01	Nominal final focal ratio	Design analysis	N/A				N/A				
IRD-OPTP-R02	Variation in focal ratio	Design analysis Instrument level alignment verification Instrument level performance tests	STM	CQM	PFM		ILT_ALIGN	ILT_PERF			
IRD-OPTP-R03	Distortion	Design analysis Instrument level alignment verification Instrument level performance tests	STM	CQM	PFM		ILT_ALIGN	ILT_PERF			
IRD-OPTP-R04	Anamorphism	Design analysis Instrument level alignment verification Instrument level performance tests	STM	CQM	PFM		ILT_ALIGN	ILT_PERF			
IRD-OPTP-R05	Throughput	Design analysis Instrument level alignment verification Instrument level performance tests	STM	CQM	PFM		ILT_ALIGN	ILT_PERF			
IRD-OPTP-R06	Image quality	Design analysis Instrument level alignment verification Instrument level performance tests	STM	CQM	PFM		ILT_ALIGN	ILT_PERF			
IRD-OPTP-R07	Out of band radiation	Design analysis Instrument level performance tests	CQM	PFM			ILT_PERF				
IRD-OPTP-R08	In-band straylight	Design analysis Instrument level performance tests	CQM	PFM			ILT_PERF				
IRD-OPTS-R01	Nominal final focal ratio	Design analysis	N/A				N/A				
IRD-OPTS-R02	Variation in focal ratio	Design analysis Instrument level alignment verification Instrument level performance tests	STM	CQM	PFM		ILT_ALIGN	ILT_PERF			

Reference	Description	Verification Method	Mode I 1	Mode I 2	Mode I 3	Mode I 4	Test ID1	Test ID2	Test ID3	Test ID4	Test ID5
IRD-OPTS-R03	Distortion	Design analysis Instrument level alignment verification Instrument level performance tests	STM	CQM	PFM		ILT_ALIGN	ILT_PERF			
IRD-OPTS-R04	Anamorphism	Design analysis Instrument level alignment verification Instrument level performance tests	STM	CQM	PFM		ILT_ALIGN	ILT_PERF			
IRD-OPTS-R05	Theoretical throughput	Design analysis Instrument level alignment verification Instrument level performance tests	STM	CQM	PFM		ILT_ALIGN	ILT_PERF			
IRD-OPTS-R06	Image quality	Design analysis Instrument level alignment verification Instrument level performance tests	STM	CQM	PFM		ILT_ALIGN	ILT_PERF			
IRD-OPTS-R07	Balancing of ports	Design analysis Instrument level performance tests	CQM	PFM			ILT_PERF				
IRD-OPTS-R08	Out of band radiation	Design analysis Instrument level performance tests	CQM	PFM			ILT_PERF				
IRD-OPTS-R09	In band straylight	Design analysis Instrument level performance tests	CQM	PFM			ILT_PERF				
IRD-OPTS-R10	Off axis resolution	Design analysis Instrument level performance tests	CQM	PFM			ILT_PERF				
IRD-PHOT-R01	Nominal passband	Design analysis Instrument level performance test	CQM	PFM			ILT_PERF				
IRD-PHOT-R02	Field of View	Design analysis Instrument level performance test	CQM	PFM			ILT_PERF				
IRD-PHOT-R03	Beam FWHM (Arcsec)	Design analysis Instrument level performance test	CQM	PFM			ILT_PERF				
IRD-PHOT-R04	Point source sensitivity	Design analysis Instrument level performance test	CQM	PFM			ILT_PERF				
IRD-PHOT-R05	Mapping sensitivity for one FOV	Design analysis Instrument level performance test	CQM	PFM			ILT_PERF				
IRD-PHOT-R06	Maximising 'mapping speed' at which confusion limit is reached over a large area of sky is the	Design analysis	N/A				N/A				

Reference	Description	Verification Method	Mode l 1	Mode l 2	Mode l 3	Mode l 4	Test ID1	Test ID2	Test ID3	Test ID4	Test ID5
	primary science driver. This means maximising sensitivity and field-of-view (FOV) but NOT at the expense of spatial resolution.										
IRD-PHOT-R10	Field distortion must be <10% across the FOV	Design analysis Instrument level performance test	CQM	PFM			ILT_PERF				
IRD-PHOT-R11	Electrical crosstalk should be <1% (goal 0.5%) between nearest-neighbour pixels and <0.1 % (gaol 0.05%) between all other pixels in the same array.	Design analysis Instrument level warm functional tests Instrument level performance test	CQM	PFM			ILT_WFT	ILT_PERF			
IRD-PHOT-R12	NEP variation should be < 20% across each array.	Design analysis Instrument level performance tests	CQM	PFM			ILT_PERF				
IRD-PHOT-R13	The photometer dynamic range for astronomical signals shall be > 12 bits.	Design analysis Instrument level warm functional tests	CQM				ILT_WFT				
IRD-PHOT-R14	Absolute photometric accuracy should be <15% at all wavelengths with a goal of <10%	Design analysis Instrument level calibration	PFM				ILT_CAL				
IRD-PHOT-R15	The relative photometric accuracy shall be <10% with a gaol of <5%	Design analysis Instrument level calibration	PFM				ILT_CAL				
IRD-PHOT-R16	The three arrays need to be co-aligned to within 1 arcsecond.	Design analysis Instrument alignment verification Instrument level performance tests	CQM	PFM			ILT_ALIGN	ILT_PERF			
IRD-PHOT-R17	The maximum available chop throw shall be at least 4 arcminutes; the minimum shall be 10 arcsecs or less	Design analysis Instrument level performance tests	CQM	PFM			ILT_PERF				
IRD-PHOT-R18	SPIRE Photometric measurements shall be linear to 5% over a dynamic range of 4000 for astronomical signals	Design analysis Instrument level performance tests	CQM	PFM			ILT_PERF				

Reference	Description	Verification Method	Mode l 1	Mode l 2	Mode l 3	Mode l 4	Test ID1	Test ID2	Test ID3	Test ID4	Test ID5
IRD-REL-R01	As far as possible the total failure of a single sub-system shall not lead to the total loss of instrument operations.	Design analysis (FMECA)	N/A				N/A				
IRD-REL-R02	Backup modes of operation should be available for all nominal observing modes. These shall be designed to allow the continued use of that mode albeit with degraded performance or efficiency.	Design analysis Instrument level warm functional tests Instrument level cold functional tests Instrument level operations tests	CQM	PFM			ILT_WFT	ILT_CFT	ILT_OPS		
IRD-REL-R03	Cold redundant hardware shall be provided wherever practicable within the instrument design.	Design analysis	N/A				N/A				
IRD-REL-R04	As far as possible all control loops shall be implemented through the use of on-board software.	Design analysis	N/A				N/A				
IRD-REL-R05	It shall be possible to break all control loops implemented in hardware.	Design analysis	N/A				N/A				
IRD-RFM-R01	RF rejection	Design analysis Instrument level EMC tests	CQM	PFM			ILT_EMC				
IRD-RFM-R02	Envelope	Design analysis Instrument level integration verification Subsystem acceptance data package	STM	CQM	PFM		ILT_INTG				
IRD-RFM-R03	Dissipation	Design analysis Instrument level cold functional test	CQM	PFM			ILT_CFT				
IRD-RFM-R04	Operating temperature range	Design analysis Instrument level performance test	CQM	PFM			ILT_PERF				
IRD-RFM-R05	Nominal operating temperature	Design analysis Instrument level cold functional test	CQM	PFM			ILT_CFT				
IRD-RFM-R06	Mechanical interface	Design analysis	N/A				N/A				

Reference	Description	Verification Method	Mode I 1	Mode I 2	Mode I 3	Mode I 4	Test ID1	Test ID2	Test ID3	Test ID4	Test ID5
IRD-RFM-R07	First natural frequency	Design analysis Subsystem verification programme Subsystem acceptance data package	N/A				N/A				
IRD-SAFE-R01	During all mission phases there shall be no requirement for commands to be sent from the ground to the instrument with an immediate response time (i.e. less than 2 minutes TBC).	Design analysis	N/A				N/A				
IRD-SAFE-R02	Situations which require response from the ground within a short time (i.e. less than 30 mins) shall be reduced to a minimum be well identified and agreed by ESA	Design analysis	N/A				N/A				
IRD-SAFE-R03	Situations which require response from the ground within a short time (i.e. less than 30 mins) shall be unambiguously recognisable in the instrument housekeeping telemetry without complex processing	Design analysis	N/A				N/A				
IRD-SAFE-R04	Housekeeping telemetry shall be generated during all nominal modes of the instrument.	Design analysis AVM functional tests Instrument level operations tests	AVM	CQM	PFM	FS	AVM_FUNC	ILT_OPS			
IRD-SAFE-R05	The instrument shall be able to accept all telecommand packets sent to it at the nominal transfer rate from the CDMS	Design analysis AVM functional tests	AVM				AVM_FUNC				
IRD-SAFE-R06	It shall not be possible by command or lack of command to place the instrument into a	Design analysis AVM functional tests?	AVM				AVM_FUNC				

Reference	Description	Verification Method	Mode l 1	Mode l 2	Mode l 3	Mode l 4	Test ID1	Test ID2	Test ID3	Test ID4	Test ID5
	configuration that will or is likely to cause damage to any subsystem										
IRD-SAFE-R07	All telecommands received by the instrument shall be checked to be correctly formatted and complete before execution. Incorrect telecommands will be rejected by the instrument	Design analysis AVM functional tests	AVM				AVM_FUNC				
IRD-SAFE-R08	Failure of any sub-system or one of its components shall not affect the health of any other subsystem the instrument or the interface with the satellite.	Design analysis (FMECA)	N/A				N/A				
IRD-SAFE-R09	Failure of any component in a subsystem shall not damage any redundant or backup component designed to replace that component in the subsystem	Design analysis (FMECA)	N/A				N/A				
IRD-SAFE-R10	No electronics sub-unit shall be capable of affecting instrument operations until it is in a defined state. This state shall be confirmed in the housekeeping telemetry.	Design analysis AVM functional tests	AVM				AVM_FUNC				
IRD-SAFE-R11	No commands shall be sent to an electronics sub-unit until they are in a defined state confirmed by the on-board software	Design analysis AVM functional tests	AVM				AVM_FUNC				
IRD-SHUT-R01	Beam blanking	Design analysis Instrument level performance test	CQM	PFM			ILT_PERF				
IRD-SHUT-R02	Vane emission	Design analysis Instrument level performance test	CQM	PFM			ILT_PERF				

Reference	Description	Verification Method	Mode l 1	Mode l 2	Mode l 3	Mode l 4	Test ID1	Test ID2	Test ID3	Test ID4	Test ID5
IRD-SHUT-R03	Vane states	Design analysis Instrument level warm functional test Instrument cold functional test	CQM	PFM			ILT_WFT	ILT_CFT			
IRD-SHUT-R04	Failure mode	Design analysis (FMECA) Instrument level warm functional test Instrument level cold functional test	CQM	PFM			ILT_WFT	ILT_CFT			
IRD-SHUT-R05	Operating temperature	Design analysis Instrument level warm functional test Instrument level cold functional test	CQM	PFM			ILT_WFT	ILT_CFT			
IRD-SHUT-R06	Operating Orientation	Design analysis Instrument level warm functional test Instrument level cold functional test	CQM	PFM			ILT_WFT	ILT_CFT			
IRD-SHUT-R07	Actuator envelope	Design analysis Instrument level integration verification Subsystem acceptance data package	STM	CQM			ILT_INTG				
IRD-SHUT-R08	Eigenfrequency	Design analysis Subsystem verification programme Subsystem acceptance data package	N/A				N/A				
IRD-SHUT-R09	Materials	Design analysis Subsystem acceptance data package	N/A				N/A				
IRD-SHUT-R10	Transition time	Design analysis Instrument level cold functional test	CQM	PFM			ILT_CFT				
IRD-SHUT-R11	Thermal stabilisation time	Design analysis Instrument level performance tests	CQM	PFM			ILT_PERF				
IRD-SHUT-R12	Thermometry	Design analysis	N/A				N/A				
IRD-SHUT-R13	Thermal dissipation	Design analysis Instrument level thermal verification	CQM				ILT_THER				
IRD-SHUT-R14	Cryoharness thermal dissipation	Design analysis Instrument level thermal verification	CQM				ILT_THER				
IRD-SMEC-R01	Linear Travel	Design analysis Instrument level cold functional test Instrument	CQM	PFM			ILT_CFT	ILT_PERF			

Reference	Description	Verification Method	Mode I 1	Mode I 2	Mode I 3	Mode I 4	Test ID1	Test ID2	Test ID3	Test ID4	Test ID5
		level performance test									
IRD-SMEC-R02	Minimum movement sampling interval	Design analysis Instrument level cold functional test Instrument level performance test	CQM	PFM			ILT_CFT	ILT_PERF			
IRD-SMEC-R03	Sampling step control	Design analysis Instrument level cold functional test Instrument level performance test	CQM	PFM			ILT_CFT	ILT_PERF			
IRD-SMEC-R04	Scan length	Design analysis Instrument level cold functional test Instrument level operations tests	CQM	PFM			ILT_CFT	ILT_OPS			
IRD-SMEC-R05	Dead-time	Design analysis Instrument level cold functional test Instrument level performance test	CQM	PFM			ILT_CFT	ILT_PERF			
IRD-SMEC-R06	Mirror velocity	Design analysis Instrument level cold functional test Instrument level performance test	CQM	PFM			ILT_CFT	ILT_PERF			
IRD-SMEC-R07	Velocity control	Design analysis Instrument level cold functional test Instrument level performance test	CQM	PFM			ILT_CFT	ILT_PERF			
IRD-SMEC-R08	Velocity stability	Design analysis Instrument level cold functional test Instrument level performance test	CQM	PFM			ILT_CFT	ILT_PERF			
IRD-SMEC-R09	Position measurement	Design analysis Instrument level cold functional test Instrument level performance test	CQM	PFM			ILT_CFT	ILT_PERF			
IRD-SMEC-R10	Sampling frequency	Design analysis Instrument level cold functional test Instrument level performance test	CQM	PFM			ILT_CFT	ILT_PERF			
IRD-SMEC-R11	Maximum thermal load onto level 1 during cold operation - mechanism and cold position measurement system.	Design analysis Instrument level thermal verification Instrument level cold functional test Instrument level operations tests	STM	CQM	PFM		ILT_THER	ILT_OPS			
IRD-SMEC-R12	Maximum envelope	Design analysis Instrument level	STM	CQM			ILT_INTG				

Reference	Description	Verification Method	Mode l 1	Mode l 2	Mode l 3	Mode l 4	Test ID1	Test ID2	Test ID3	Test ID4	Test ID5
		integration verification Subsystem acceptance data package									
IRD-SMEC-R13	Thermometers	Design Analysis	N/A				N/A				
IRD-SMEC-R14	Ground Operation	Design analysis Instrument level cold functional tests	CQM	PFM			ILT_CFT				
IRD-SPEC-R01	Wavelength range	Design analysis Instrument level performance tests	CQM	PFM			ILT_PERF				
IRD-SPEC-R02	Maximum Resolution	Design Analysis Instrument level performance test	CQM	PFM			ILT_PERF				
IRD-SPEC-R03	Minimum Resolution	Design Analysis Instrument level performance test	CQM	PFM			ILT_PERF				
IRD-SPEC-R04	Field of View (Arcmin)	Design analysis Instrument level performance tests	CQM	PFM			ILT_PERF				
IRD-SPEC-R05	Beam FWHM (Arcsec)	Design analysis Instrument level performance test	CQM	PFM			ILT_PERF				
IRD-SPEC-R06	Point source continuum sensitivity Point source unresolved line sensitivity	Design analysis Instrument level performance test	CQM	PFM			ILT_PERF				
IRD-SPEC-R07	Map continuum sensitivity Map line sensitivity	Design analysis Instrument level performance test	CQM	PFM			ILT_PERF				
IRD-SPEC-R08	The spectrometer design shall be optimised for sensitivity to point sources	Design analysis	N/A				N/A				
IRD-SPEC-R11	The width of the FTS instrument response function shall be uniform to within 10% across the FOV for resolution <0.4 cm-1	Design analysis Instrument level performance test	CQM	PFM			ILT_PERF				
IRD-SPEC-R14	Fringe contrast shall be greater than 80% for any point in the field of view for a resolution of 0.4 cm-1.	Design analysis Instrument level performance test	CQM	PFM			ILT_PERF				
IRD-SPEC-R15	The spectrometer dynamic range for astronomical signals shall be	Design analysis Instrument level warm functional tests	CQM				ILT_WFT				

Reference	Description	Verification Method	Mode l 1	Mode l 2	Mode l 3	Mode l 4	Test ID1	Test ID2	Test ID3	Test ID4	Test ID5
	12 bits or higher										
IRD-SPEC-R16	The FTS absolute photometric accuracy at the required resolution shall <15% at all wavelengths with a goal of <10%	Design analysis Instrument level calibration	PFM				ILT_CAL				
IRD-SPEC-R17	The sensitivity of the FTS at any spectral resolution up to the goal value shall be limited by the photon noise from the Herschel telescope within the chosen passband	Design analysis Instrument level performance tests	CQM	PFM			ILT_CAL				
IRD-STRC-R01	Alignment of the instrument w.r.t. the Herschel optical axis	Design analysis Instrument alignment verification	STM	CQM	PFM		ILT_ALIGN				
IRD-STRC-R02	Attenuation of RF by Common Structure covers	Design analysis Instrument level EMC tests	STM				ILT_EMC				
IRD-STRC-R03	Items requiring support from the Common Structure	Design analysis	N/A				N/A				
IRD-STRC-R04	Optics and associated sub-system alignment	Design analysis Instrument alignment verification	STM	CQM	PFM		ILT_ALIGN				
IRD-STRC-R05	Surface finish of the Common Structure cover	Design analysis Instrument level thermal verification	STM				ILT_THER				
IRD-STRC-R06	Pumping port	Design analysis Instrument level integration verification	STM				ILT_INTG				
IRD-STRC-R07	Thermometry	Design analysis	N/A				N/A				
IRD-STRC-R08	Attenuation of radiation from cryostat environment	Design analysis Instrument level performance tests	CQM				ILT_PERF				
IRD-STRC-R09	First natural frequency of the instrument assembly	Design analysis Instrument level vibration tests	STM	PFM			ILT_VIB				
IRD-STRC-R10	Instrument mechanical interface	Design analysis	N/A				N/A				
IRD-STRC-R12	Grounding	Design analysis Instrument level integration verification	STM	CQM	PFM		ILT_INTG				
IRD-STRC-R13	Electrical isolation from Herschel	Design analysis Instrument level integration verification	STM	CQM	PFM		ILT_INTG				

Reference	Description	Verification Method	Mode l 1	Mode l 2	Mode l 3	Mode l 4	Test ID1	Test ID2	Test ID3	Test ID4	Test ID5
IRD-STRC-R14	Thermal isolation	Design analysis Instrument level thermal verification	STM	CQM	PFM		ILT_THER				
IRD-STRP-R01	Items requiring support	Design analysis	N/A				N/A				
IRD-STRP-R02	Optics and filters alignment	Design analysis Instrument alignment verification	STM	CQM	PFM		ILT_ALIGN				
IRD-STRP-R03	Array module alignment	Design analysis Instrument alignment verification	STM	CQM	PFM		ILT_ALIGN				
IRD-STRP-R04	Surface finish	Design analysis Instrument level thermal verification	STM				ILT_THER				
IRD-STRP-R05	Pumping port	Design analysis Instrument level integration verification	STM				ILT_INTG				
IRD-STRP-R06	Attenuation of radiation from common structure environment	Design analysis Instrument level performance tests	CQM				ILT_PERF				
IRD-STRP-R07	First natural frequency	Design analysis Instrument level vibration tests	STM	PFM			ILT_VIB				
IRD-STRP-R09	Thermal isolation	Design analysis Instrument level thermal verification	STM	CQM	PFM		ILT_THER				
IRD-STRS-R01	Items requiring support	Design analysis	N/A				N/A				
IRD-STRS-R02	Optics alignment requirements	Design analysis Instrument alignment verification	STM	CQM	PFM		ILT_ALIGN				
IRD-STRS-R03	Array module alignment	Design analysis Instrument alignment verification	STM	CQM	PFM		ILT_ALIGN				
IRD-STRS-R04	Surface finish	Design analysis Instrument level thermal verification	STM				ILT_THER				
IRD-STRS-R05	Pumping port	Design analysis Instrument level integration verification	STM				ILT_INTG				
IRD-STRS-R06	Attenuation of radiation from 4-K environment	Design analysis Instrument level performance tests	CQM				ILT_PERF				
IRD-STRS-R07	First natural frequency	Design analysis Instrument level vibration tests	STM	PFM			ILT_VIB				
IRD-STRS-R08	Thermal isolation	Design analysis Instrument level thermal verification	STM	CQM	PFM		ILT_THER				
IRD-SUBS-R01	All subsystems are required to	Subsystems verification	N/A				N/A				

Reference	Description	Verification Method	Mode l 1	Mode l 2	Mode l 3	Mode l 4	Test ID1	Test ID2	Test ID3	Test ID4	Test ID5
	undergo an environmental test programme that demonstrates the design and build standard of the sub-system models will be compatible with the environmental test programme to be carried out on the appropriate integrated instrument model.	programme									
IRD-SUBS-R02	All sub-systems are required to demonstrate that they will operate successfully over the 4.25 years of expected mission operations following launch.	Subsystems verification programme	N/A				N/A				
IRD-SUBS-R03	All subsystems are required to be within the mass allocation given in RD8	Subsystems acceptance data package	N/A				N/A				
IRD-TLM-R01	The instrument shall be capable of transferring telemetry packets to the CDMS (or simulator) at up to the maximum rate allowed by the telemetry interface.	Design analysis AVM functional tests	AVM				AVM_FUN C				
IRD-TLM-R02	The instrument shall be able to buffer telemetry packets until they are requested by the CDMS	Design analysis AVM functional tests	AVM				AVM_FUN C				
IRD-TLM-R03	It shall be possible to validate the content of each telemetry packet.	Design analysis AVM functional tests	AVM				AVM_FUN C				
IRD-TLM-R04	All telemetry packets shall contain information identifying the observation/step being executed.	Design analysis AVM functional tests	AVM				AVM_FUN C				
IRD-TLM-R05	The instrument shall generate housekeeping data packets in all operating modes.	Design analysis AVM functional tests	AVM				AVM_FUN C				

Reference	Description	Verification Method	Mode l 1	Mode l 2	Mode l 3	Mode l 4	Test ID1	Test ID2	Test ID3	Test ID4	Test ID5
IRD-TLM-R06	It shall be possible to define TBC alternative housekeeping packet structures with different rates of generation.	Design analysis AVM functional tests	AVM				AVM_FUNC				
IRD-TLM-R07	The instrument shall generate science data packets in all observing modes.	Design analysis AVM functional tests	AVM				AVM_FUNC				
IRD-TLM-R07	It shall be possible to define TBC alternative science data packets structures.	Design analysis AVM functional tests	AVM				AVM_FUNC				
IRD-TLM-R08	The instrument shall generate event packets in all operating modes.	Design analysis AVM functional tests Instrument level operations tests	AVM	CQM	PFM	FS	AVM_FUNC	ILT_OPS			
IRD-VER-01	The STM verification testing shall demonstrate that the proposed structure design is capable of meeting the mechanical environmental conditions specified for the Herschel launch. The STM vibration shall be used to verify the stiffness and strength of the structure and verify the mechanical and thermal transfer functions between the various parts of the cold focal plane units and the Herschel satellite.	Instrument level vibration tests Instrument level thermal verificationtests	STM				ILT_VIB	ILT_THER			
IRD-VER-R02	The AVM verification testing shall demonstrate that the instrument will fulfil the requirements on the following: Communication between the satellite CDMS and the DPU. Correct transfer and receipt of instrument commands	AVM functional tests	AVM				AVM_FUNC				

Reference	Description	Verification Method	Mode l 1	Mode l 2	Mode l 3	Mode l 4	Test ID1	Test ID2	Test ID3	Test ID4	Test ID5
	from the satellite Correct transfer and receipt of instrument data packets form the instrument to the satellite Correct execution of instrument commands Correct transfer of instrument data from the FPU simulator to the DPU Correct execution of DPU on-board software for any data compression algorithms and packet generation for all instrument data packet types.										
IRD-VER-R03	The CQM verification testing shall demonstrate that the following conditions are met or are likely to be met on the PFM: Correct operation of all FPU sub-systems at cryogenic temperatures for all instrument operation modes for both prime and redundant systems. The instrument cold FPU and JFET box thermal dissipation is within requirements for all instrument operation modes. The warm electronics thermal dissipation at room temperature is within requirements. Correct operation of all on-board software. The instrument straylight environment is within requirements The instrument optics performance is within requirements The performance of the instrument	Instrument level warm functional tests Instrument level cold functional tests Instrument level performance tests	CQM				ILT_WFT	ILT_CFT	ILT_PERF		

Reference	Description	Verification Method	Mode I 1	Mode I 2	Mode I 3	Mode I 4	Test ID1	Test ID2	Test ID3	Test ID4	Test ID5
	meets the scientific requirements expected for the CQM for all instrument observing modes Development and test of all functional test sequences required for Integrated Systems Testing (IST) at satellite level. The correct functioning of the instrument for all observing modes and calibration sequences. Development and test of all in-flight functional and performance test sequences										
IRD-VER-R04	The PFM verification testing shall in addition to the requirements on the CQM and AVM verification demonstrate the following: The performance of the flight instrument meets the scientific requirements for all instrument observing modes. Correct operation of flight version of all on-board software. The characterisation of the PFM instrument performance for all instrument observing modes - including generation of data for instrument calibration and functional testing both during IST and in-flight. The characterisation of the instrument performance with the warm electronics operating over a range of temperatures Final test of all	Instrument level warm functional tests Instrument level cold functional tests Instrument level performance tests Instrument level operations tests Instrument level calibration	PFM	FS			ILT_WFT	ILT_CFT	ILT_PERF	ILT_OPS	ILT_CAL

Reference	Description	Verification Method	Mode l 1	Mode l 2	Mode l 3	Mode l 4	Test ID1	Test ID2	Test ID3	Test ID4	Test ID5
	functional test sequences for IST. Final test of all observing modes Final test of all in-flight functional and performance test sequences.										
IRD-WE-R01	Packet Services	Design analysis AVM functional tests Warm electronics accptance tests Instrument level warm functional tests	AVM	CQM	PFM		AVM_FUNC	ILT_WFT			
IRD-WE-R02	Telecommands	Design analysis AVM functional tests Instrument level warm functional tests	AVM	CQM	PFM		AVM_FUNC	ILT_WFT			
IRD-WE-R03	Telemetry	Design analysis AVM functional tests Instrument level warm functional tests	AVM	CQM	PFM		AVM_FUNC	ILT_WFT			
IRD-WE-R04	Housekeeping	Design analysis AVM functional tests Instrument level warm functional tests	AVM	CQM	PFM		AVM_FUNC	ILT_WFT			
IRD-WE-R05	Operating Modes	Design analysis AVM functional tests Instrument level warm functional tests Instrument level operations tests	AVM	CQM	PFM		AVM_FUNC	ILT_WFT	ILT_OPS		
IRD-WE-R06	Command Services	Design analysis AVM functional tests Instrument level warm functional tests	AVM	CQM	PFM		AVM_FUNC	ILT_WFT			
IRD-WE-R07	Data Handling	Design analysis AVM functional tests Instrument level warm functional tests Instrument level operations tests	AVM	CQM	PFM		AVM_FUNC	ILT_WFT	ILT_OPS		
IRD-WE-R08	Photometer detector readout	Design analysis AVM functional test Instrument level cold functional tests Instrument performance tests	AVM	CQM	PFM		AVM_FUNC	ILT_CFT	ILT_PERF		

Reference	Description	Verification Method	Mode l 1	Mode l 2	Mode l 3	Mode l 4	Test ID1	Test ID2	Test ID3	Test ID4	Test ID5
IRD-WE-R09	Spectrometer detector readout	Design analysis AVM functional test Instrument level cold functional tests Instrument performance tests	AVM	CQM	PFM		AVM_FUNC	ILT_CFT	ILT_PERF		
IRD-WE-R10	Spectrometer Position Readout	Design analysis AVM functional test Instrument level cold functional tests Instrument performance tests	AVM	CQM	PFM		AVM_FUNC	ILT_CFT	ILT_PERF		
IRD-WE-R11	FTS Control	Design analysis AVM functional test Instrument level cold functional tests	AVM	CQM	PFM		AVM_FUNC	ILT_CFT			
IRD-WE-R12	BSM Control	Design analysis AVM functional test Instrument level cold functional tests	AVM	CQM	PFM		AVM_FUNC	ILT_CFT			
IRD-WE-R13	PCAL Control	Design analysis AVM functional test Instrument level cold functional tests	AVM	CQM	PFM		AVM_FUNC	ILT_CFT			
IRD-WE-R14	SCAL Control	Design analysis AVM functional test Instrument level cold functional tests	AVM	CQM	PFM		AVM_FUNC	ILT_CFT			
IRD-WE-R15	Cooler Control	Design analysis AVM functional test Instrument level cold functional tests	AVM	CQM	PFM		AVM_FUNC	ILT_CFT			
IRD-WE-R16	Shutter Control	Design analysis Instrument level cold functional tests	CQM	PFM			ILT_CFT				
IRD-WE-R17	Housekeeping	Design analysis AVM functional test Instrument level cold functional tests	AVM	CQM	PFM		AVM_FUNC	ILT_CFT			
IRD-WE-R18	S/C Interface	Design analysis AVM functional test Instrument level integration verification Instrument level warm functional tests	AVM	CQM	PFM		AVM_FUNC	ILT_INTG	ILT_WFT		
IRD-WE-R19	Subsystem Interface	Design analysis AVM functional	AVM	CQM	PFM		AVM_FUN	ILT_INTG	ILT_WFT		

Reference	Description	Verification Method	Mode l 1	Mode l 2	Mode l 3	Mode l 4	Test ID1	Test ID2	Test ID3	Test ID4	Test ID5
		test Instrument level integration verification Instrument level warm functional tests					C				
IRD-WE-R20	Subsystem Control Loops	Design analysis AVM Functional test Instrument level warm functional test Instrument level cold functional test	AVM	CQM	PFM		AVM_FUNC	ILT_WFT	ILT_CFT		
IRD-WE-R21	Subsystem Data Acquisition	Design analysis AVM Functional test Instrument level warm functional test Instrument level cold functional test Instrument level operations tests	AVM	CQM	PFM		AVM_FUNC	ILT_WFT	ILT_CFT	ILT_OPS	
IRD-WE-R22	Data Processing	Design analysis AVM Functional test Instrument level warm functional test Instrument level cold functional test Instrument level operations tests	AVM	CQM	PFM		AVM_FUNC	ILT_WFT	ILT_CFT	ILT_OPS	
IRD-WE-R23	Communication	Design analysis AVM Functional test Instrument level warm functional test Instrument level cold functional test Instrument level operations tests	AVM	CQM	PFM		AVM_FUNC	ILT_WFT	ILT_CFT	ILT_OPS	
IRD-WE-R24	WE anomalies	Design analysis AVM Functional test Instrument level warm functional test Instrument level cold functional test Instrument level operations tests	AVM	CQM	PFM		AVM_FUNC	ILT_WFT	ILT_CFT	ILT_OPS	
IRD-WE-R25	Subsystem anomalies	Design analysis AVM Functional test Instrument level warm functional test Instrument level cold functional test Instrument level operations tests	AVM	CQM	PFM		AVM_FUNC	ILT_WFT	ILT_CFT	ILT_OPS	
IRD-WE-R26	Anomaly Management	Design analysis AVM Functional	AVM	CQM	PFM		AVM_FUN	ILT_WFT	ILT_CFT	ILT_OPS	

Reference	Description	Verification Method	Mode I 1	Mode I 2	Mode I 3	Mode I 4	Test ID1	Test ID2	Test ID3	Test ID4	Test ID5
		test Instrument level warm functional test Instrument level cold functional test Instrument level operations tests					C				
IRD-WE-R27	Failure resiliance	Design analysis (FMECA)	N/A				N/A				
IRD-WE-R28	Lifetime	Design analysis	N/A				N/A				
IRD-WE-R29	External Stress	Design analysis (FMECA)	N/A				N/A				
IRD-WE-R30	S/C Safety	Design analysis (FMECA)	N/A				N/A				
IRD-WE-R31	Instrument Safety	Design analysis (FMECA)	N/A				N/A				
IRD-WE-R32	Failure Propagation	Design analysis (FMECA)	N/A				N/A				
IRD-WE-R33	Mass	Design analysis Subsystem acceptance data package	N/A				N/A				
IRD-WE-R34	Volume	Design analysis Subsystem acceptance data package	N/A				N/A				
IRD-WE-R35	Power	Design analysis AVM Functional test Instrument level warm functional test Instrument level cold functional test Instrument level operations tests	AVM	CQM	PFM		AVM_FUNC	ILT_WFT	ILT_CFT	ILT_OPS	
IRD-WE-R36	EMC	Design analysis Instrument level EMC tests	CQM	PFM			ILT_EMC				
IRD-WE-R37	Quality Plan	Design analysis Subsystem acceptance data package	N/A				N/A				
VRD-01	Mechanical frequency response	Design analysis Instrument level vibration tests Subsystem verification programme	STM				ILT_VIB				
VRD-02	Ability to withstand launch environment	Design analysis Instrument level vibration tests Subsystem verification programme	STM				ILT_VIB				
VRD-03	Mechanical interface with Herschel system	Design analysis Instrument level integration verification	STM	CQM			ILT_INTG				
VRD-04	Instrument level integration	Design analysis Instrument level acceptance data package	STM	AVM	CQM		AVM_FUNC	ILT_INTG	ILT_WFT		

Reference	Description	Verification Method	Mode I 1	Mode I 2	Mode I 3	Mode I 4	Test ID1	Test ID2	Test ID3	Test ID4	Test ID5
		Instrument level integration verification AVM functional test Instrument level warm functional test									
VRD-05	Sub-system mechanical interfaces	Design analysis Subsystem acceptance data package Instrument level integration verification	STM	CQM			ILT_INTG				
VRD-06	Optical design	Design analysis Instrument level alignment verification Instrument level performance tests	STM	CQM			ILT_ALIGN	ILT_PERF			
VRD-07	Optical interface to Herschel system	Design analysis Instrument level acceptance data package Instrument level alignment verification Instrument level performance tests	STM	CQM			ILT_ALIGN	ILT_PERF			
VRD-08	Straylight	Design analysis Instrument level alignment verification Instrument level performance tests	CQM				ILT_ALIGN	ILT_PERF			
VRD-09	Instrument optical performance	Design analysis Instrument level alignment verification Instrument level performance tests	CQM				ILT_ALIGN	ILT_PERF			
VRD-10	Integration and alignment	Design analysis Instrument level acceptance data package Instrument level integration verification Instrument level alignment verification	STM	CQM			ILT_INTG	ILT_ALIGN			
VRD-11	Sub-system optical interfaces	Design analysis Subsystem acceptance data package Instrument level alignment verification Instrument level performance verification	STM	CQM			ILT_ALIGN	ILT_PERF			
VRD-12	Thermal performance	Design analysis Subsystem	STM	CQM			ILT_THER	ILT_CFT	ILT_PERF		

Reference	Description	Verification Method	Mode I 1	Mode I 2	Mode I 3	Mode I 4	Test ID1	Test ID2	Test ID3	Test ID4	Test ID5
		verification programme Subsystem acceptance data package Instrument level thermal verification Instrument level cold functional test Instrument level performance tests									
VRD-13	Thermal interface to Herschel system	Design analysis Instrument level acceptance data package Instrument level thermal verification	STM	CQM			ILT_THER				
VRD-14	Sub-system thermal interfaces	Design analysis Subsystem verification programme Subsystem acceptance data package Instrument level thermal verification	STM	CQM			ILT_THER				
VRD-15	Micro-vibration environment	Subsystem verification programme Subsystem acceptance data package Instrument level performance tests	CQM				ILT_PERF				
VRD-16	Mechanism control	Design analysis Subsystem verification programme Subsystem acceptance data package AVM functional test Instrument level cold functional tests Instrument level performance tests	AVM	CQM			AVM_FUNC	ILT_CFT	ILT_PERF		
VRD-17	Harness mechanical frequency response and routing	Design analysis Instrument level acceptance data package Instrument level integration verification Instrument level cold functional tests Instrument level performance tests	STM	CQM			ILT_INTG	ILT_CFT	ILT_PERF		

Reference	Description	Verification Method	Mode l 1	Mode l 2	Mode l 3	Mode l 4	Test ID1	Test ID2	Test ID3	Test ID4	Test ID5
VRD-18	Detector performance versus environment	Design analysis Subsystem verification programme Subsystem acceptance data package Instrument level performance tests	CQM				ILT_PERF				
VRD-19	JFET Amplifier performance versus environment	Design analysis Subsystem verification programme Subsystem acceptance data package Instrument level performance tests	CQM				ILT_PERF				
VRD-20	Detector Harness performance	Design analysis Subsystem verification programme Subsystem acceptance data package Instrument level performance tests	CQM				ILT_PERF				
VRD-21	Detector sub-system interface compatibility - thermal electrical mechanical	Design analysis Subsystem acceptance data package Instrument level integration verification AVM functional test Instrument level warm functional tests Instrument level cold functional tests	STM	AVM	CQM		ILT_INTG	AVM_FUNC	ILT_WFT	ILT_CFT	
VRD-22	End-to-end system performance	Design analysis Instrument level performance tests	CQM				ILT_PERF				
VRD-23	EMC susceptibility and emission radiated/conducted	Design analysis Subsystem verification programme Subsystem acceptance data package Instrument level EMC tests	CQM				ILT_EMC				
VRD-24	Electrical grounding	Design analysis Instrument level warm functional tests Instrument level cold functional tests Instrument level performance	CQM				ILT_WFT	ILT_CFT	ILT_PERF		

Reference	Description	Verification Method	Mode l 1	Mode l 2	Mode l 3	Mode l 4	Test ID1	Test ID2	Test ID3	Test ID4	Test ID5
		tests									
VRD-25	Faraday cage integrity and performance	Design analysis Instrument EMC tests Instrument level performance tests	STM	CQM			ILT_EMC	ILT_PERF			
VRD-26	RF filter performance	Design analysis Subsystem acceptance data package Instrument level EMC tests	CQM				ILT_EMC				
VRD-27	Non-detector Harness performance	Design analysis AVM functional test Instrument level warm functional test Instrument level cold functional test Instrument level performance test	AVM	CQM			AVM_FUNC	ILT_WFT	ILT_CFT	ILT_PERF	
VRD-28	Power supply cleanliness	Design analysis AVM functional test Instrument level warm functional test Instrument level cold functional test Instrument level performance test	AVM	CQM			AVM_FUNC	ILT_WFT	ILT_CFT	ILT_PERF	
VRD-29	Digital/analogue separation	Design analysis AVM functional test Instrument level warm functional test Instrument level cold functional test Instrument level performance test	AVM	CQM			AVM_FUNC	ILT_WFT	ILT_CFT	ILT_PERF	
VRD-30	Electrical interface to Herschel system	Design analysis Instrument level acceptance data package Instrument level integration verification AVM functional test Instrument level warm functional test Instrument level cold functional test Instrument level performance test	AVM	CQM			ILT_INTG	AVM_FUNC	ILT_WFT	ILT_CFT	ILT_PERF
VRD-31	Power supply distribution and control	Design analysis AVM functional test Instrument level warm functional test	AVM	CQM			AVM_FUNC	ILT_WFT			

Reference	Description	Verification Method	Mode l 1	Mode l 2	Mode l 3	Mode l 4	Test ID1	Test ID2	Test ID3	Test ID4	Test ID5
VRD-32	Sub-system electrical interfaces	Design analysis Subsystem acceptance data package Instrument level integration verification AVM functional test Instrument level warm functional test Instrument level cold functional test	AVM	CQM			ILT_INTG	AVM_FUNC	ILT_WFT	ILT_CFT	
VRD-33	Wiring tables	Design analysis Subsystem acceptance data package Instrument level integration verification AVM functional test Instrument level warm functional test Instrument level cold functional test	AVM	CQM			ILT_INTG	AVM_FUNC	ILT_WFT	ILT_CFT	
VRD-34	Analogue to digital interfaces	Design analysis Subsystem acceptance data package Instrument level integration verification AVM functional test Instrument level warm functional test Instrument level cold functional test	AVM	CQM			ILT_INTG	AVM_FUNC	ILT_WFT	ILT_CFT	
VRD-35	Digital to digital interfaces	Design analysis Subsystem acceptance data package Instrument level integration verification AVM functional test Instrument level warm functional test	AVM	CQM			ILT_INTG	AVM_FUNC	ILT_WFT		
VRD-36	Data interface to Herschel system	Design analysis Instrument level acceptance data package Instrument level integration verification AVM functional test Instrument level warm functional test	AVM	CQM			ILT_INTG	AVM_FUNC	ILT_WFT		
VRD-37	Operating mode definition	Design analysis Instrument level	AVM	CQM			AVM_FUN	ILT_WFT	ILT_CFT	ILT_OPS	

Reference	Description	Verification Method	Mode l 1	Mode l 2	Mode l 3	Mode l 4	Test ID1	Test ID2	Test ID3	Test ID4	Test ID5
		acceptance data package AVM functional test Instrument level warm functional test Instrument level cold functional test Instrument level operations tests					C				
VRD-38	Instrument commanding definition	Design analysis Instrument level acceptance data package AVM functional test Instrument level warm functional test Instrument level cold functional test Instrument level operations tests	AVM	CQM			AVM_FUNC	ILT_WFT	ILT_CFT	ILT_OPS	
VRD-39	On board software definition	Design analysis Instrument level acceptance data package AVM functional test Instrument level warm functional test Instrument level cold functional test Instrument level performance tests Instrument level operations tests	AVM	CQM			AVM_FUNC	ILT_WFT	ILT_CFT	ILT_PERF	ILT_OPS
VRD-40	Sub-system operational and control interfaces	Design analysis Subsystem verification programme Subsystem acceptance data package AVM functional tests Instrument level warm functional tests Instrument level cold functional tests	AVM	CQM			AVM_FUNC	ILT_WFT	ILT_CFT		
VRD-41	Sub-system data interfaces	Design analysis Subsystem acceptance data package AVM functional tests Instrument level warm functional tests Instrument level cold functional tests	AVM	CQM			AVM_FUNC	ILT_WFT	ILT_CFT		
VRD-42	Interfaces to the ICC	Design analysis Instrument level acceptance data package Instrument level integration	AVM				ILT_INTG	AVM_FUNC			

Reference	Description	Verification Method	Mode l 1	Mode l 2	Mode l 3	Mode l 4	Test ID1	Test ID2	Test ID3	Test ID4	Test ID5
		verification AVM functional test									
VRD-43	Data product definition	Design analysis Instrument level acceptance data package Instrument level operations tests Instrument level calibration	CQM				ILT_OPS	ILT_CAL			
VRD-44	Data processing definition	Design analysis Instrument level acceptance data package Instrument level operations tests Instrument level calibration	CQM				ILT_OPS	ILT_CAL			
VRD-45	Sub-system data processing interfaces	Design analysis Subsystem acceptance data package Instrument level operations tests Instrument level calibration	CQM				ILT_OPS	ILT_CAL			
VRD-46	Observing mode data processing interfaces	Design analysis Instrument level acceptance data package Instrument level operations tests Instrument level calibration	CQM				ILT_OPS	ILT_CAL			
VRD-47	Observing mode calibration definition	Design analysis Instrument level acceptance data package Instrument level operations tests Instrument level calibration	CQM				ILT_OPS	ILT_CAL			
VRD-48	Ground commissioning and calibration plan	Design analysis Instrument level acceptance data package AVM functional test Instrument level warm functional test Instrument level cold functional test Instrument level operations tests Instrument level calibration	AVM	CQM			AVM_FUNC	ILT_WFT	ILT_CFT	ILT_OPS	ILT_CAL
VRD-49	Flight commissioning and calibration plan	Design analysis Instrument level acceptance data package Instrument level cold functional test Instrument level operations tests Instrument level calibration	CQM				ILT_CFT	ILT_OPS	ILT_CAL		

Reference	Description	Verification Method	Model 1	Model 2	Model 3	Model 4	Test ID1	Test ID2	Test ID3	Test ID4	Test ID5
VRD-50	Instrument to ground facility interfaces	Design analysis Instrument level integration verification Instrument level alignment verification AVM functional test Instrument level warm functional test Instrument level cold functional test	STM	AVM	CQM		ILT_INTG	ILT_ALIGN	AVM_FUNC	ILT_WFT	ILT_CFT