SPIRE

SUBJECT: **SPIRE CQM Performance Test Specification**

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Change Record

ISSUE	DATE	
Draft 0.1	15th February 2002	First draft
Draft 0.2	19th March 2002	Moved instrument requirements not covered by these tests to separate section, added test setup and outputs.
Draft 0.3	5th April 2002	Added OSL, DAN, DRL, CSR, SFL, SML, SHE and OBS
Draft 0.4	29th May 2002	Updated following JPL comments and to take JPL EGSE into account, also added performance test flow. Added EGSE to the test setup tables. Added DOT, DAB, DAL, DNA, DMM, DMA, OBE renamed DBC to DDB, DLC to DDL, DNC to DND, DMS to DMD

TABLE OF CONTENTS

FIGURES

TABLES

Glossary

AIV	Assembly Integration Verification
CCD	Charge Coupled Device
CQM	Cryogenic Qualification Model
FOV	Field of View
FWHM	Full Width Half Maximum
ILT	Instrument Level Tests
MAT	Micro Alignment Telescope
NEP	Noise Equivalent Power
PFM	Proto Flight Model
PSF	Point Spread Function
SLW	Spectrometer Long Wavelength (array)
SPIRE	Spectro Photometric Imaging REceiver
STM	Structural Thermal Model

1 SCOPE

This document expands on the part of the SPIRE test plan relating to performance and calibration related tests of the instrument. The steps in the test plan with an ILT-PERF identifier are expanded into an outline of each of the main tests that are needed for performance assessment and calibration. A cross matrix with the instrument requirements, calibration requirements and qualification requirements is then given to show how the test campaign will meet the performance requirements of the instrument.

2 DOCUMENTS

2.1 Applicable Documents

AD1	SPIRE Instrument Requirements	B. M. Swinyard	SPIRE-RAL-PRJ-000034	10 January 2002
AD2	SPIRE Calibration Requirements	B. M. Swinyard	SPIRE-RAL-PRJ-001064	3 January 2002
AD3	SPIRE Instrument AIV Plan	B.M. Swinyard	SPIRE-RAL-PRJ-000410	29 March 2001
AD4	SPIRE CQM Instrument Level Test Plan	D. L. Smith	SPIRE-RAL-DOC-001049	

2.2 Reference Documents

RD1	SPIRE Instrument Qualification Requirements	B. M. Swinyard	SPIRE-RAL-PRJ-000592	29 March 2001
RD2	SPIRE Optical Alignment Verification Plan	A. Origne	SPIRE-LAM-PRJ-000445	10 April 2001
RD3	SPIRE Thermal Test Plan	S. Heys	TBW	
RD4	SPIRE Systems Budgets	C. Cunningham	SPIRE-ATC-PRJ-000450	12 April 2001
RD5	SPIRE EMC Control Plan	D. Griffin	SPIRE-RAL-PRJ-000852	
RD6	SPIRE Sensitivity models	M. Griffin	SPIRE-QMW-PRJ-000559	24 November 2000
RD7	Test Facility Requirements Specification	D. Smith	SPIRE-RAL-PRJ-000463	10 April 2001

3 INTRODUCTION

This document is intended to give a high level outline specification of those tests on the SPIRE CQM which relate to instrument performance and it is intended to act as an intermediate level of documentation between the overall CQM test plan (AD4) and the detailed test scripts. The documentation where performance requirements are given is shown in figure 1. The following section shows the overall flow of tests, outlining the configuration of the cryloab (specified in RD7) for each group of tests.

Each test is then outlined in section 0 contains with each outline specifying the aim of the test, an outline of how the test will be performed, an outline of the data analysis and an indication as to which sub-instrument the test is being performed on. The aim also includes a list of those instrument requirements we expect to verify by doing the test. This programme is highly success oriented an no details are given of any action that will be taken if a test fails.

Section 7 contains a cross reference matrix between the instrument requirements (AD1), the calibration requirements (AD2) and each test and section 8 contains a cross reference matrix between each instrument requirement and each test.

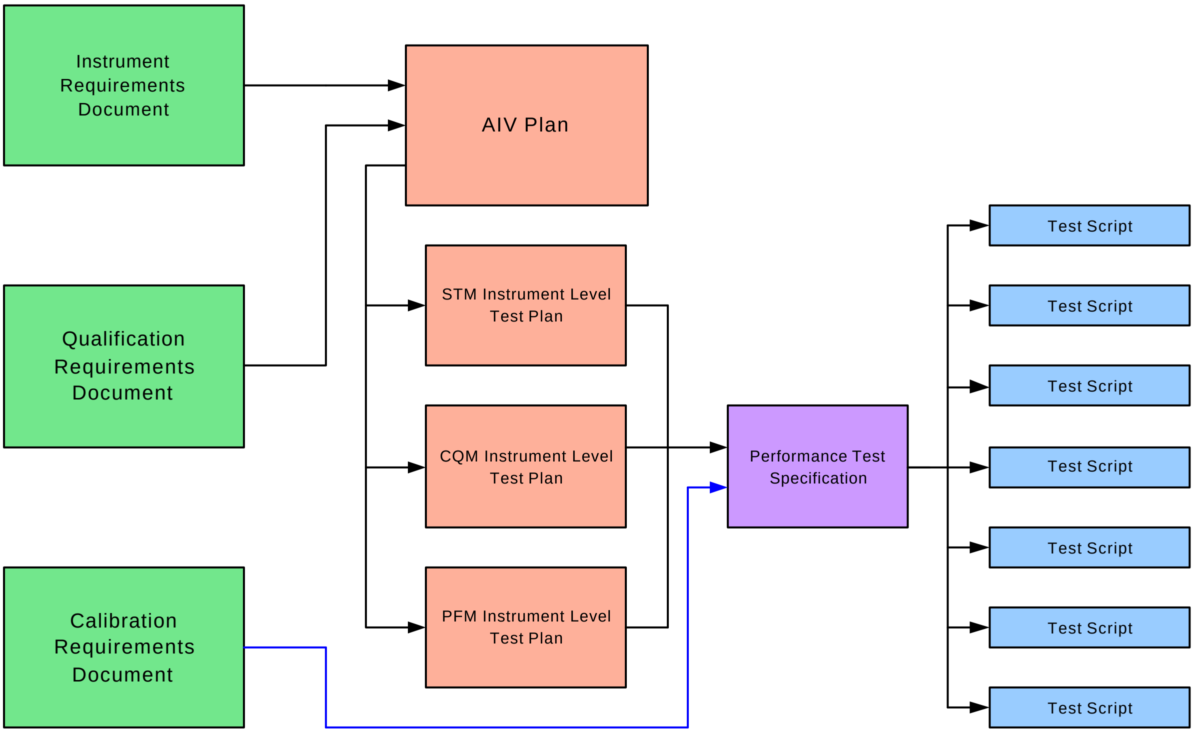


Figure 1: Test Document Tree

4 PERFORMANCE REQUIREMENTS MET BY OTHER TESTS

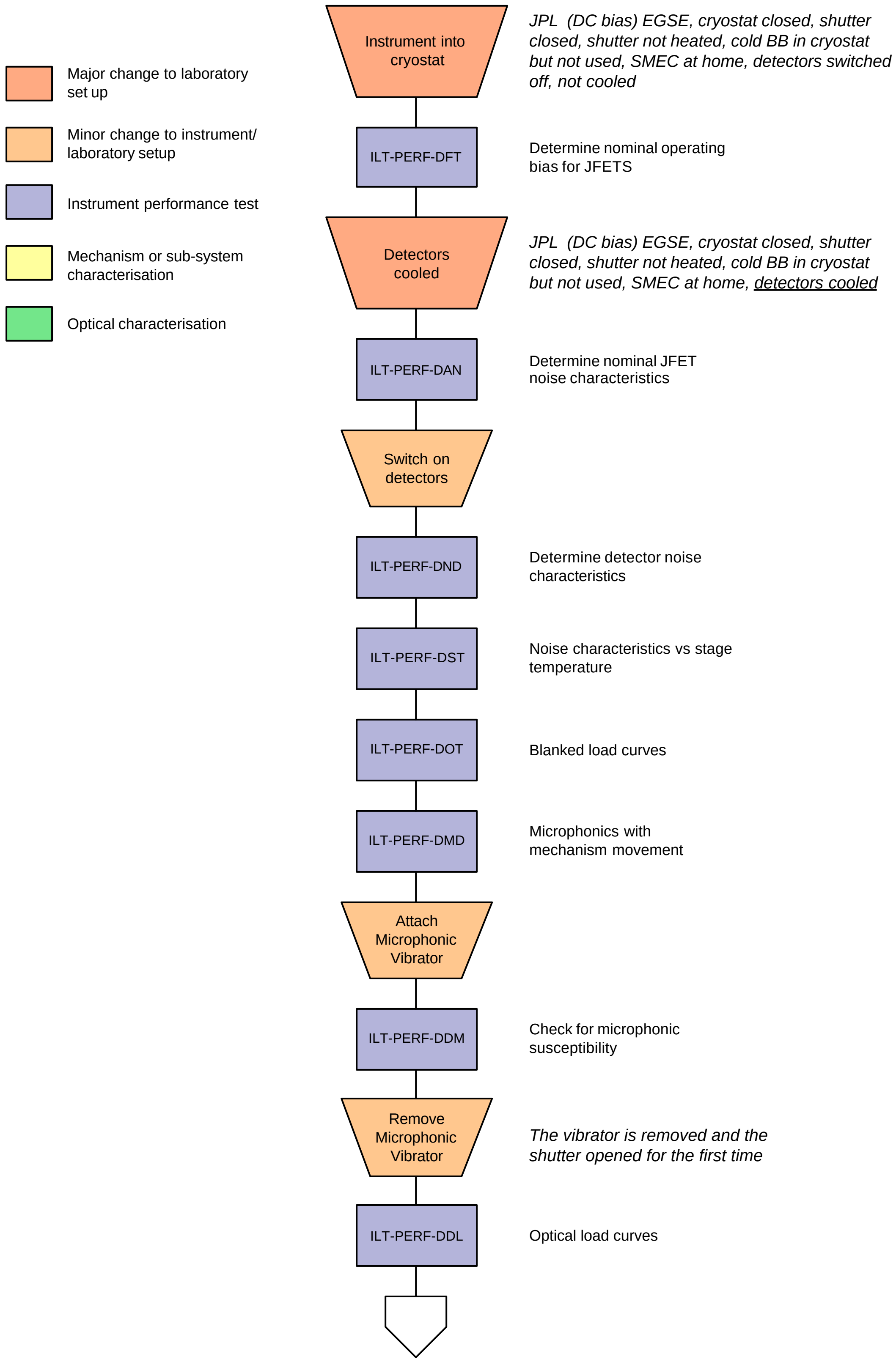
Some performance indicators are not determined by specific performance tests but are one of the products of a specific test or procedure covered elsewhere, either in the optical alignment plan (RD2), thermal test plan (RD3) or in the EMC control plan (RD5). The requirements met by these procedures are given here.

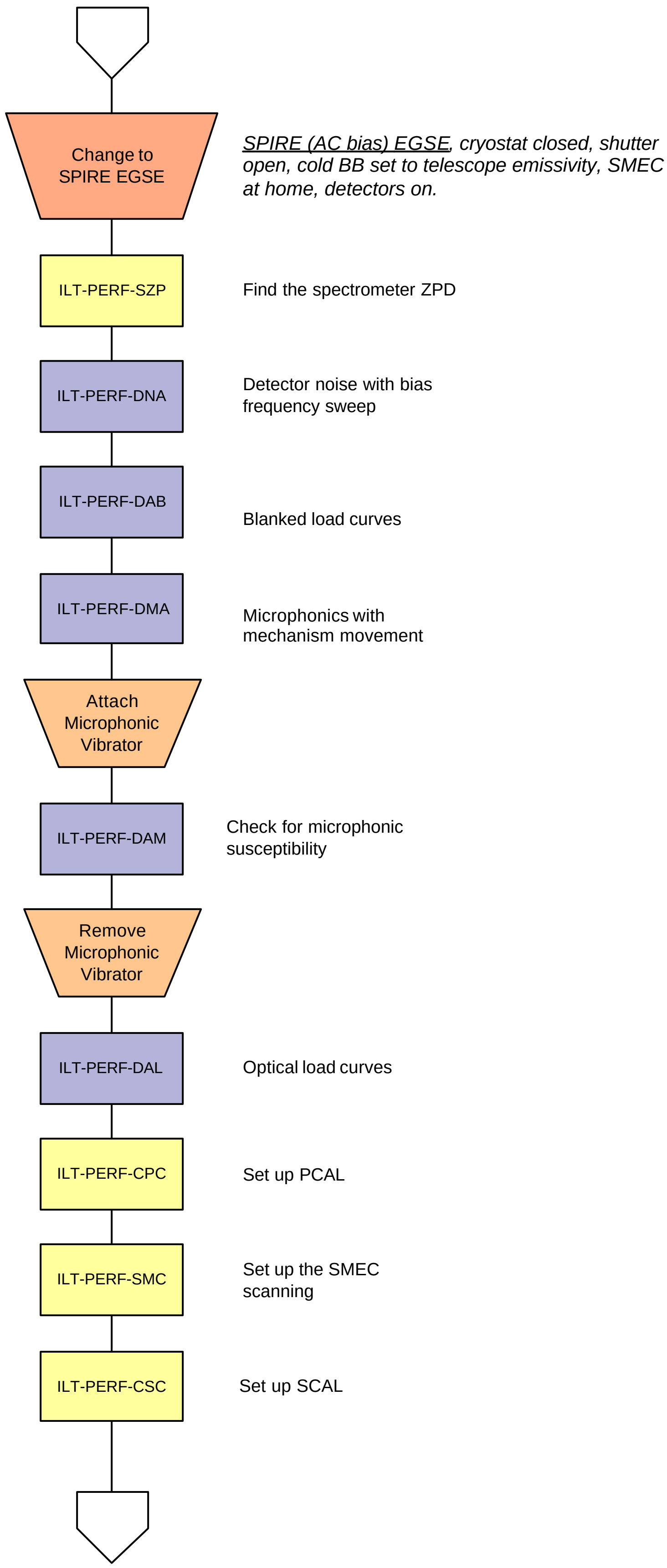
Instrument Requirement	Reference	Performance Requirement
IRD-OPTP-R03 IRD-OPTS-R03	RD2	The image of the telescope field of view is nominally rectangular. The position of any point within the image of the FOV at the detectors is within 10% (TBC) of the actual position of the point at the telescope focal plane.
IRD-OPTP-R04 IRD-OPTS-R04	RD2	The anamorphic ratio of the image of a point source at the detectors is no more than 6:5 (TBC) in any pair of orthogonal directions at any point in the FOV.
IRD-OPTP-R06 IRD-OPTS-R06	RD2	The Strehl ratio for both the photometer and spectrometer at 250 μm must be greater than 0.9 (TBC) over the full FOV at 250 μm including all losses due to alignment; mirror quality etc.
IRD-PHOT-R10	RD2	Field distortion must be <10% across the FOV
IRD-OPTP-R00	RD2	The optical design of the photometer fore-optics shall be compatible with the Herschel telescope optical design.
IRD-OPTP-R02 IRD-OPTS-R02	RD2	The focal ratio at any point in the FOV is within 20% of that of the on-axis point.
IRD-FTB-R05	RD3	The dissipation of JFET amplifiers shall be heat sunk to the level 2 cryostat stage. The dissipation shall be within the specification given in RD4.
IRD-DETP-R10 IRD-DETS-R11	RD5	The design of any harnesses associated with the detectors that form part of the instrument RF shield shall be such as to minimise the influence of any potential EMI. All metalwork surounding the detectors at 300mK is electrically isolated from local chassis ground due to its Kevlar suspension. So that it can be grounded, the 300-mK metalwork shall be wired to the 1.7K connector PCB through the 300mK to 1.7K harness. Here it shall be possible to connect it to Bias Ground and/or local chassis.
IRD-FTB-R02	RD5	The RF filters, as fitted in the box and with the correct harness, connectors and back-shells: shall reject all frequencies from 500 MHz to 10 GHz at –60 dB.
IRD-CALS-R09	RD3	The power dissipation in the focal plane is within the specification given in the SPIRE System Budgets document (RD4)

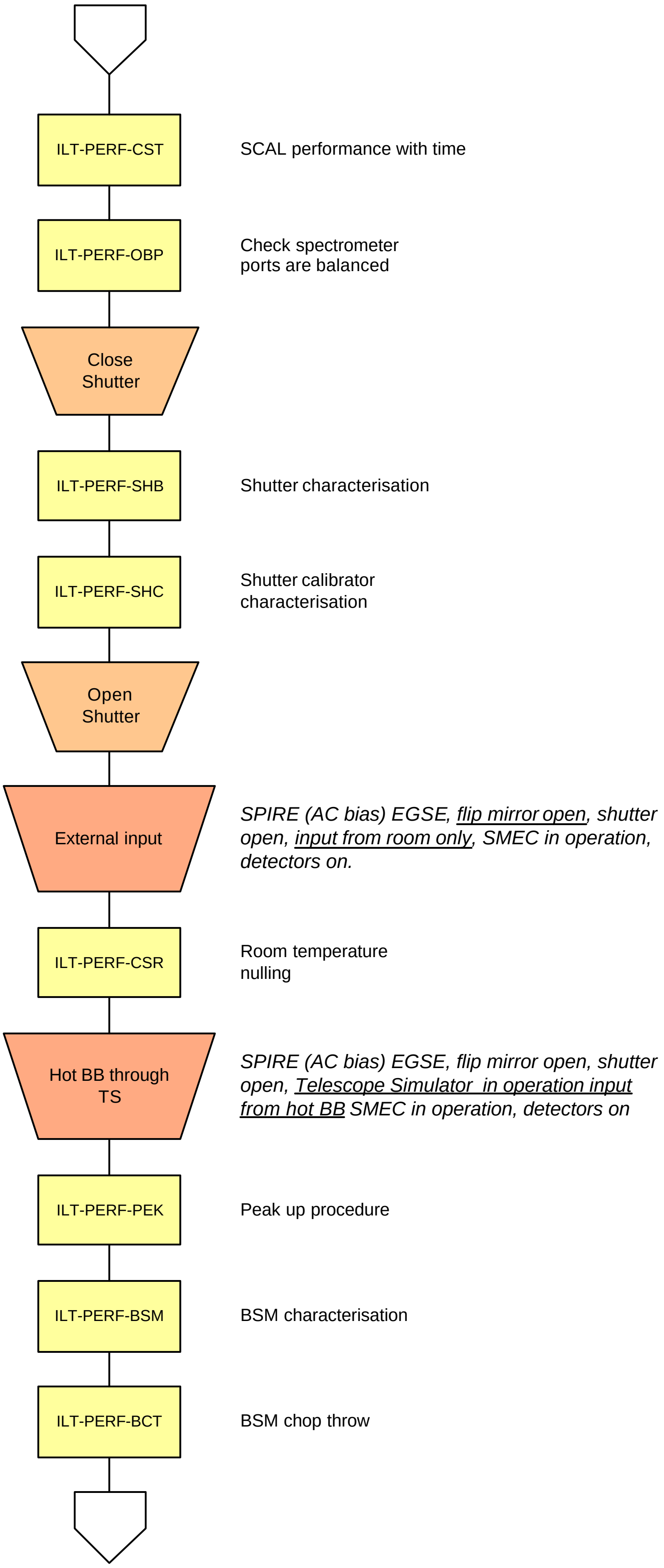
IRD-CALP-R03	By design	Equivalent obscuration of aperture through the BSM mirror. The outside envelope of the calibrator housing shall not foul on any part of the BSM for any operational angular position of the BSM.
IRD-FPHR-R01	Harness acceptance package	The wire-to-wire capacitance of the cables running from the detector arrays to the JFET modules is < 50 pF (TBC).
IRD-FPHR-R02	Harness acceptance package	The detector harness cables routed inside the structure shall be affixed to have a mechanical resonant frequency > 1kHz (TBC)

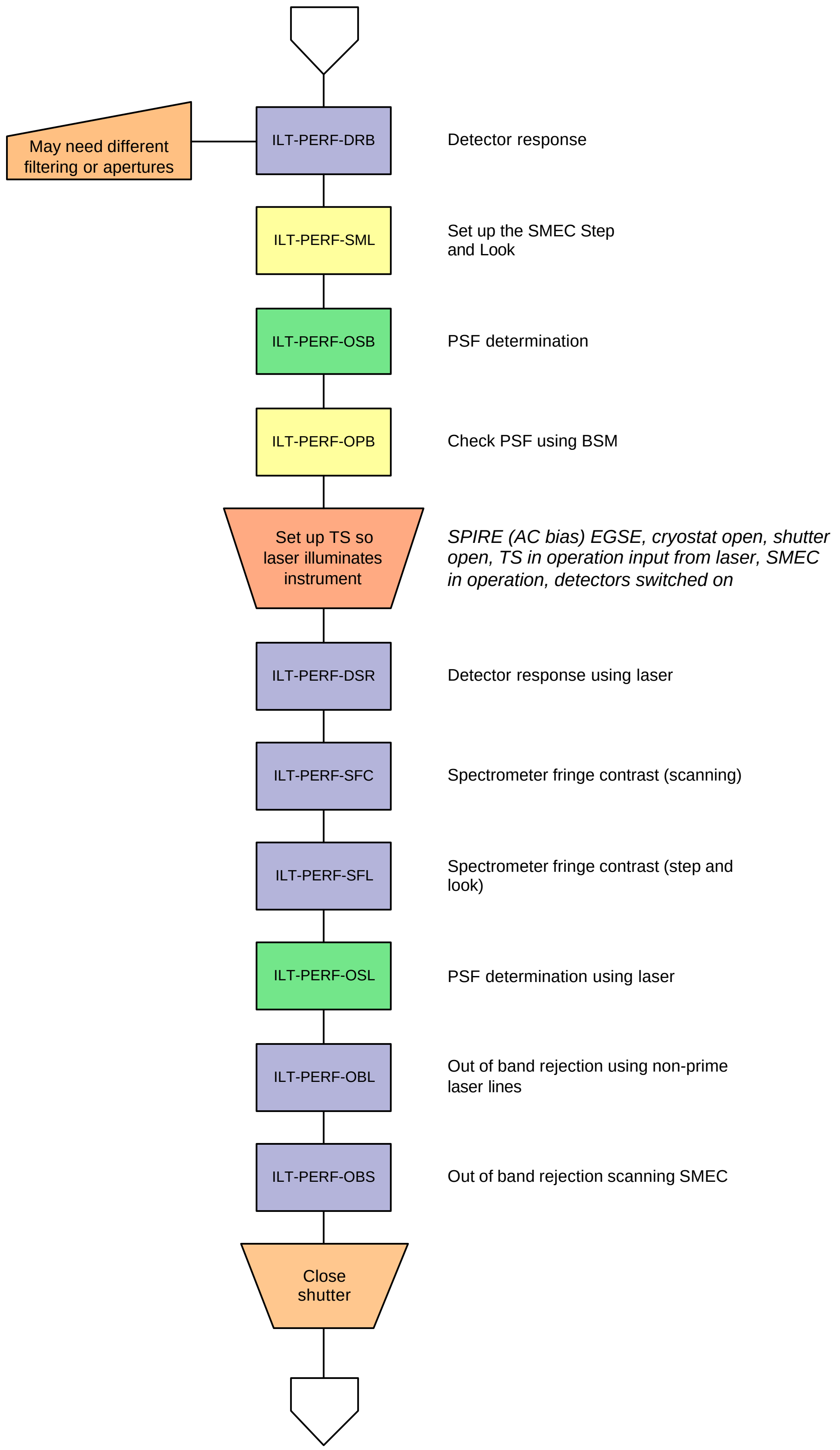
Table 1: Performance requirements coveredby procedures specified in other documents

5 PERFORMANCE TEST FLOW




Change to SPIRE EGSE
SPIRE (AC bias) EGSE, cryostat closed, shutter open, cold BB set to telescope emissivity, SMEC at home, detectors on.
ILT-PERF-SZP
Find the spectrometer ZPD
ILT-PERF-DNA
Detector noise with bias frequency sweep
ILT-PERF-DAB
Blanked load curves
ILT-PERF-DMA
Microphonics with mechanism movement
Attach Microphonic Vibrator
ILT-PERF-DAM
Check for microphonic susceptibility
Remove Microphonic Vibrator
ILT-PERF-DAL
Optical load curves
ILT-PERF-CPC
Set up PCAL
ILT-PERF-SMC
Set up the SMEC scanning
ILT-PERF-CSC
Set up SCAL


ILT-PERF-CST
SCAL performance with time
ILT-PERF-OBP
Check spectrometer ports are balanced
Close Shutter
ILT-PERF-SHB
Shutter characterisation
ILT-PERF-SHC
Shutter calibrator characterisation
Open Shutter
External input
SPIRE (AC bias) EGSE, flip mirror open, shutter open, input from room only, SMEC in operation, detectors on.
ILT-PERF-CSR
Room temperature nulling
Hot BB through TS
SPIRE (AC bias) EGSE, flip mirror open, shutter open, Telescope Simulator in operation input from hot BB SMEC in operation, detectors on
ILT-PERF-PEK
Peak up procedure
ILT-PERF-BSM
BSM characterisation
ILT-PERF-BCT
BSM chop throw


May need different filtering or apertures
ILT-PERF-DRB
Detector response
ILT-PERF-SML
Set up the SMEC Step and Look
ILT-PERF-OSB
PSF determination
ILT-PERF-OPB
Check PSF using BSM
Set up TS so laser illuminates instrument
SPIRE (AC bias) EGSE, cryostat open, shutter open, TS in operation input from laser, SMEC in operation, detectors switched on
ILT-PERF-DSR
Detector response using laser
ILT-PERF-SFC
Spectrometer fringe contrast (scanning)
ILT-PERF-SFL
Spectrometer fringe contrast (step and look)
ILT-PERF-OSL
PSF determination using laser
ILT-PERF-OBL
Out of band rejection using non-prime laser lines
ILT-PERF-OBS
Out of band rejection scanning SMEC
Close shutter

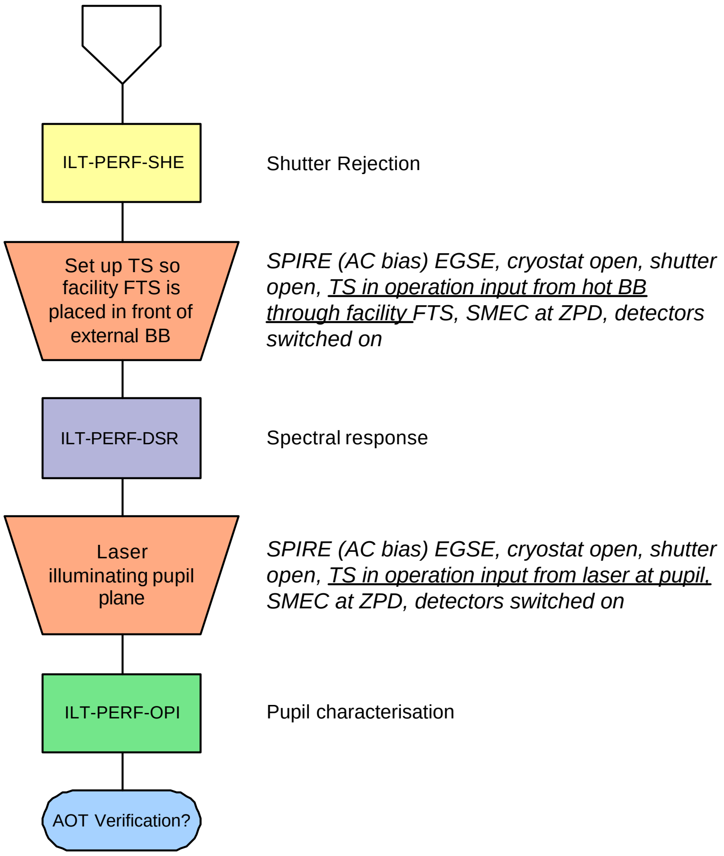


Figure 2: Performance Test Flow

6 PERFORMANCE TEST DESCRIPTIONS

6.1 Optical Tests

6.1.1 ILT-PERF-OPI - Telescope Pupil Illumination

Sub-inst:
Photometer + Spectrometer

Aim:
Determine relative response of a pixel as a function of position in the pupil plane of the telescope simulator (CRD-PAR-9). This will be used for determination of instrument throughput and point source coupling efficiency.

Test Setup:

EGSE	SPIRE
Source	Laser
Facility FTS	Not used
Flip mirror	Open
Shutter	Open
Telescope simulator	Used
External chopper	Used
PCAL	Off
SCAL	Off
BSM	Off
SMEC	Set at ZPD for each pixel

Will additional equipment be required?

Method:
TBW involves scanning a small source across the location of the image of the instrument cold stop with the telescope simulator.
Will be done for the photometer then spectrometer.

Output Parameters:
Voltage output from all possible detector arrays for active sub-instrument
Position of image in pupil plane
Source parameters e.g. temperature
Detector biases
TBD temperatures

Analysis:
All photometer pixels are measured with a single measurement.
Spectrometer pixels measured separately.

Comments/Open Issues:

The spectrometer measurement requires the ZPD to be set for each pixel separately.

6.1.2 ILT-PERF-OBP - Balancing of Ports

Sub-inst:
Spectrometer

Aim:
To verify that: In order that the two output ports shall have the same performance and to facilitate accurate compensation of the zero path difference maximum, the beam splitters shall have 2RT equal to R^2+T^2 to within 90% (TBC) over the waveband of the instrument (IRD-OPTS-R07).

Test Setup:

EGSE	SPIRE
Source	Internal black body
Facility FTS	Not Used
Flip mirror	Pointing at internal black body
Shutter	Open
Telescope simulator	Not used
External chopper	Not used
PCAL	Not used
SCAL	Off
BSM	Off
SMEC	On

Method:
1. At the start of the test the spectrometer is in standby mode, the SCAL source is switched off and the internal bla ck body set to a nominal temperature illuminates the spectrometer sky port.
2. The SMEC is scanned maximum distance TBD times and the detector output is read.
3. The internal source is switched off and the shutter is closed
4. The appropriate SCAL is switched on to a nominal value
5. The SMEC is scanned maximum distance TBD times and the detector output is read.

Output Parameters:
Voltage output from all detector arrays
Detector biases
SMEC position
SCAL temperature
TBD temperatures

Analysis:
The spectra from each of the two output ports are obtained.
The overlapping regions are compared, for each input port to check that the two ports give spectra of the same intensity.

Comments/Open Issues

The verification of this requirement will be done at component level. This test can act as a check in the overlap wavelength region between the ports, but we cannot do the full verification at instrument level.
ILT-PERF-CSC is a similar test to this one but is a low resolution test rather than this high resolution test.

6.1.3 ILT-PERF-OSL - Pixel Spatial Information Using The Laser

Sub-inst:
photometer + spectrometer

Aim:
To determine the relative response of a pixel as a function of near-beam position in the focal plane of the telescope simulator. This gives the point spread function of each pixel and also gives the relative position of the centre of the response of each pixel in each array in arcsec wrt the boresight, hence will be used to reconstruct the pointing of each pixel on the sky.
To verify the following instrument requirements:

- The photometer field of view for all three arrays: req. = 4x4, goal=4x8 (IRD-PHOT-R02)
- The photometer Beam FWHM (Arcsec) = 18 (250μm), 25 (350μm), 36 (500μm) all TBC (IRD-PHOT-R03)
- The photometer field distortion is <10% across the FOV (IRD-PHOT-R10)
- The three photometer arrays are co-aligned to within 1 arcsecond (IRD-PHOT-R16)*
- The spectrometer Field of view (arcmin) 2.6 diameter circular for feedhorns (IRD-SPEC-R04)
- The spectrometer Beam FWHM (arcsec) Band A (250 μm) 18 Band B (350 μm) 25 (IRD-SPEC-R05)
- The photometer mapping sensitivity for one FOV 1s – 1 hr (mJy) 1.4, 1.5, 1.9 (all TBC) (IRD-PHOT-R05)
- The spectrometer map continuum sensitivity (mJy 1σ 1 hr) Band A 200-300 μm 108 (TBC) Band B 300-400 μm 104 (TBC) Band B 400-700 μm TBD (IRD-SPEC-R07)

* This verification can only be made by this test and ILT-PERF-OSB on the PFM.

Test Setup:

EGSE	SPIRE
Source	Laser
Facility FTS	Not Used
Flip mirror	Open
Shutter	Open
Telescope simulator	In use
External chopper	In use
PCAL	Off
SCAL	Off
BSM	Off
SMEC	Set to ZPD position for each pixel tested

Method:
1. Place the laser at the input focal plane of the telescope simulator.
2. Use Telescope Simulator to scan the image over the position of the pixel, using fine steps, preferably in a raster pattern, otherwise in a cross pattern.
3. Repeat for each pixel

4. Full rasters on a few pixels plus cross patterns on a few pixels.

Output Parameters:
Voltage output from all possible detector arrays for active sub-instrument
Detector biases
TBD temperatures
Laser Line
TBD other laser parameters

Analysis:
Produce map of each pixel beam.
Produce a map of pixel central response.

Comments/Open Issues:
The central response should also be derived from ILT-PERF-DRB
The ZPD we will have to be determined for each pixel before the spectrometer can be tested.
This test will also check the anamorphism, distortion and variation of focal ratio across the array at FIR/Sub-mm wavelengths.
It is likely we will have to use two different lines for the spectrometer.
A suitable line will be chosen for the PLW array. When we repeat this test on the PFM we might have to use different lines for the different photometer arrays.

6.1.4 ILT-PERF-OSB - Pixel Spatial Information Using External Black Body

Sub-inst:
photometer + spectrometer

Aim:
To determine the relative response of a pixel as a function of near-beam position in the focal plane of the telescope simulator. This gives the point spread function of each pixel and also gives the relative position of the centre of the response of each pixel in each array in arcsec wrt the boresight, hence will be used to reconstruct the pointing of each pixel on the sky.
To verify the following instrument requirements:

- The photometer field of view for all three arrays: req. = 4x4, goal=4x8 (IRD-PHOT-R02)
- The photometer Beam FWHM (Arcsec) = 18 (250µm), 25 (350µm), 36 (500µm) all TBC (IRD-PHOT-R03)
- The photometer field distortion is <10% across the FOV (IRD-PHOT-R10)
- The three photometer arrays are co-aligned to within 1 arcsecond (IRD-PHOT-R16)*
- The spectrometer Field of view (arcmin) 2.6 diameter circular for feedhorns (IRD-SPEC-R04)
- The spectrometer Beam FWHM (arcsec) Band A (250 µm) 18 Band B (350 µm) 25 (IRD-SPEC-R05)
- The photometer mapping sensitivity for one FOV 1s – 1 hr (mJy) 1.4, 1.5, 1.9 (all TBC) (IRD-PHOT-R05)
- The spectrometer map continuum sensitivity (mJy 1σ 1 hr) Band A 200-300 µm 108 (TBC) Band B 300-400 µm 104 (TBC) Band B 400-700 µm TBD (IRD-SPEC-R07)

* This verification can only be made by this test and ILT-PERF-OSL on the PFM.

Test Setup:

EGSE	SPIRE
Source	External hot black body
Facility FTS	Not Used
Flip mirror	Open
Shutter	Open
Telescope simulator	In use
External chopper	In use
PCAL	Off
SCAL	Off
BSM	Off
SMEC	Set to ZPD position for each pixel tested.

Method:
1. Place the external black body at the input focal plane of the telescope simulator.
2. Use Telescope Simulator to scan the image over the position of the pixel, using fine steps, preferably in a raster pattern, otherwise in a cross pattern.
3. Repeat for each pixel

4. Full rasters on a few pixels plus cross patterns on a few pixels.

Output Parameters:
Voltage output from all possible detector arrays for active sub-instrument
Detector biases
TBD temperatures

Analysis:
Produce map of each pixel beam.
Produce a map of pixel central response.

Comments/Open Issues.
The central response should also be derived from ILT-PERF-DRB
The ZPD we will have to be determined for each pixel before the spectrometer can be tested.
This test will also check the anamorphism, distortion and variation of focal ratio across the array at FIR/Sub-mm wavelengths.
We will probably want full rasters on the co-aligned pixels for both sub-instruments.

6.1.5 ILT-PERF-OPB - Point Spread Function Check Using The BSM

Sub-inst:
photometer

Aim:
To verify that the photometer should have an observing mode that permits accurate measurement of the point spread function (IRD-OPS-R05)

Test Setup:

EGSE	SPIRE
Source	External hot black body
Facility FTS	Not Used
Flip mirror	Open
Shutter	Open
Telescope simulator	In use
External chopper	In use
PCAL	Off
SCAL	Off
BSM	On
SMEC	Off

Method
1. The external black body is placed at the input focal plane of the telescope simulator.
2. The BSM is used to scan the image over the position of the pixel, using fine steps, preferably in a raster pattern, otherwise in a cross pattern.
3. Repeat for a TBD set of pixels
4. Full rasters on a few pixels plus cross patterns on a few pixels.

Output Parameters:
Voltage output from all possible detector arrays for active sub-instrument
Detector biases
TBD temperatures
BSM position

Analysis
Produce map of each pixel beam.
Compare with ILT-PERF-OSF and ILT-PERF-OSL

Comments/Open Issues.
This test will have to be done after the BSM characterisation tests and is likely to be eventually used as a template for in-orbit PSF determination.
No more that a few pixels will be tested.

6.2 Detector Tests

6.2.1 ILT-PERF-DFT – Operating Temperature Range

Sub-inst:
Photometer + Spectrometer

Aim:
To verify that the JFET amplifiers and RF filters are capable of operating in with the temperature of the mounting point of the box in the range 4 to 300-K (IRD-FTB-R06, IRD-RFM-R04)
To characterise the performance of the JFET amplifiers over the range of level 2 (8K -15K (TBC)).

Test Setup:

EGSE	JPL
Source	None
Facility FTS	Not Used
Flip mirror	Pointing to internal black body?
Shutter	Closed
Telescope simulator	Not used
External chopper	Not used
PCAL	Off
SCAL	Off
BSM	Off
SMEC	Off

Method:
1. This test must be done before pumping the Helium and should be done with the JFET inputs shorted. The detectors must be sufficiently warm (4 K should do it). The detectors are switched off, the JFETs are set to nominal bias
2. Set the JFET bias Vss to –5V for all JFETS used in the sub-instrument
3. Set the JFET bias Vdd to 4V
4. Take a long time series of output voltage of detectors

Output Parameters:
Voltage output from all possible detector arrays for active sub-instrument
Detector biases
TBD temperatures

Analysis:
All pixels are illuminated.
Recover the output voltage of each the detector readout by removing instrument gains and offsets
Fourier transform time series
Check for microphonics
Determine position of 1/f knee
Compare with expected values.
Characterise noise performance with JFET temperature.

Comments/Open Issues:

- We should be able to characterise all JFETs in each sub-instrument simultaneously but we might want to consider doing this test on individual JFETs.
- The Vss range will be tested at subsystem level.
- We will not be able to cover all Vss values as at a certain point the JFETs will fall below the minimun operating temperature. It is not clear if this Vss value will be known before this test, hence we start on the maximum value.
- Can Vdd be varied in the range 0-4V or does it only take these two values?

6.2.2 ILT-PERF-DAN - Amplifier Noise

Sub-inst
Photometer + Spectrometer

Aim
The noise response of the amplifiers is measured by sitting at a single bias in dark conditions for up to 60 minutes.

Test Setup:

EGSE	JPL
Source	Internal cold black body
Facility FTS	Not Used
Flip mirror	Pointing to internal black body
Shutter	Closed
Telescope simulator	Not used
External chopper	Not used
PCAL	Off
SCAL	Off
BSM	Off
SMEC	Off

Method

1. At the start of the test the internal blackbody is in the instrument beam and the entire array is illuminated. The detectors are switched off, the JFETs are set to nominal bias
2. Set the blackbody to power setting to give an equivalent input power to the telescope.
3. Take a long time series of output offset and voltage from the instrument.
4. Repeat for a range of JFET biases by taking a shorter time series.

Output Parameters:
Voltage output from all possible channels for active sub-instrument
Detector biases
TBD temperatures

Analysis
Recover the output offset voltage of each channel by removing instrument gains
Fourier transform time series
Check for microphonics
Determine position of 1/f knee
Compare with expected values.

Comments/Open issues
None

6.2.3 ILT-PERF-DND - Detector Noise With Bias (DC Bias)

Sub-inst:
Photometer + Spectrometer

Aim:
The noise/frequency response of the detectors is measured by sitting at a single bias in dark conditions for up to 60 minutes. This is essentially a health check to make sure the 1/f knee is where it is expected and that there is no noise due to microphonics.
The test could also be done with different optical loads from the cold BB being used over its temperature range and the shutter still closed.

Test Setup:

EGSE	JPL
Source	None
Facility FTS	Not Used
Flip mirror	Pointing to internal black body
Shutter	Closed
Telescope simulator	Not used
External chopper	Not used
PCAL	Off
SCAL	Off
BSM	Off
SMEC	At home

Method:
1. Set the detector bias to the nominal value.
2. Take a long time series (>60 minutes) of output voltage of detectors.
3. Repeat for a range of biases by taking a shorter time series.

Output Parameters:
Voltage output from all possible detector arrays for active sub-instrument
Detector biases
TBD temperatures

Analysis:
All pixels are illuminated.
Recover the output voltage of each the detector readout by removing instrument gains and offsets
Fourier transform time series
Check for microphonics
Determine position of 1/f knee
Compare with expected values.
Cross correlation of one detector against another and with blank; fixed resistors and thermometer channels.

Comments/Open issues:
None

6.2.4 ILT-PERF-DST - Detector Noise With Sink Temperature (DC Bias)

Sub-inst:
Photometer + Spectrometer

Aim:
The noise/frequency response of the detectors is measured by sitting at a single bias in dark conditions for up to 60 minutes and its variation with sink temperature is found.

Test Setup:

EGSE	JPL
Source	None
Facility FTS	Not Used
Flip mirror	Pointing to internal black body
Shutter	Closed
Telescope simulator	Not used
External chopper	Not used
PCAL	Off
SCAL	Off
BSM	Off
SMEC	At home

Method:
1. Set the detector bias to the nominal value and the sink temperature to minimum value.
2. Take a long time series (>60 minutes) of output voltage of detectors.
3. Repeat for a range of bolometer operating temperatures (~287 – 400mK).

Output Parameters:
Voltage output from all possible detector arrays for active sub-instrument
Detector biases
TBD temperatures

Analysis:
All pixels are illuminated.
Recover the output voltage of each the detector readout by removing instrument gains and offsets
Fourier transform time series
Check for microphonics
Determine position of 1/f knee
Compare with expected values.
Cross correlation of one detector against another and with blank; fixed resistors and thermometer channels.

Comments/Open issues:
None

6.2.5 ILT-PERF-DOT - Bolometer Operating Temperature Characterisation

Sub-inst:
Photometer + Spectrometer

Aim:
To establish the behaviour of the detectors in the CQM 'dark' conditions
To verify the following instrument requirements:

- The background power falling on the photometer detectors with the optical beam blocked shall be no more than 5% (TBC) of the in-band background power from the telescope over the 200-300 µm band 5% (TBC) over the 300-400 µm band and 5% (TBC) over the 400-670 µm band (IRD-OPTP-R08).
- The background power falling on the spectrometer detectors with the optical beam blocked shall be no more than 5% (TBC) of the in band background power from the telescope over the 200-400µm band and 5% (TBC) over the 400-670 µm band (IRD-OPTS-R09)
- The attenuation of radiation from the cryostat environment <2 x 10^{-5} (TBC) (IRD-STRC-R08).
- The attenuation of radiation from common structure environment into the photometer is 5 x 10-7; (goal is 5 x 10-8 (TBC)) (IRD-STRP-R06)
- The attenuation of radiation from 4-K environment into the spectrometer is 5 x 10-7; (goal is 5 x 10-8 (TBC)) (IRD-STRS-R06)
- The amplifier noise is better than 10nV $Hz^{-1/2}$ over a bandwidth of 100 to 1400 Hz. (Goal 7 nV $Hz^{-1/2)}$ (IRD-FTB-R01).
- The photometer NEP variation is <20% across each array (IRD-PHOT-R12).

Test Setup:

EGSE	JPL
Source	None
Facility FTS	Not Used
Flip mirror	Pointing to internal black body?
Shutter	Closed
Telescope simulator	Not used
External chopper	Not used
PCAL	Off
SCAL	Off
BSM	Off position
SMEC	At home

Method:

1. At the start of the test, the instrument is in standby mode, the JPL EGSE is connected to the instrument, the temperatures are stable and the detectors are at their lowest (temperature) operating point possible and
2. Use the JPL EGSE set up to run through a TBD set of bias voltages and measure the output signal at each step.
3. The load curves are repeated over a range of sink temperatures from lowest to ~400 mK.

Output Parameters:
Offset and voltage output from all possible detector arrays for active sub-instrument

Detector biases
TBD temperatures
Flip mirror position

Analysis:
All arrays for p and s separately are read out simultaneously
Convert instrument output voltage to detector output voltage
(Can check the system gain using the fixed resistors)
Compare load curves obtained with those either theoretical load curves determined from supplied detector parameters or actual load curves supplied with the detector arrays.
Determine background loading.

Comments/Open issues:
Any significant spurious light falling on to the arrays will be found by this test and we assume success. If this test does show up any light leaks we will need to design further tests to determine the source.
This test will be the only test where the sink temperature will be varied and we will pick the expected flight temperature as the working point for all other tests.

6.2.6 ILT-PERF-DNA - Detector Noise (AC Bias)

Sub-inst
Photometer + Spectrometer

Aim
The noise/frequency response of the detectors is measured by sitting at a single bias in dark conditions for up to 60 minutes. This is essentially a health check to make sure the 1/f knee is where it is expected and that there is no noise due to microphonics.
We will probably want to repeat this test at different operating temperatures of the bolometers from as low as the cooler will take them (i.e. no lower than 287mK) to about 400mK.
The test could also be done with different optical loads from the cold BB being used over its temperature range and the shutter still closed.

Test Setup:

EGSE	SPIRE
Source	Internal cold black body
Facility FTS	Not Used
Flip mirror	Pointing to internal black body
Shutter	Open
Telescope simulator	Not used
External chopper	Not used
PCAL	Off
SCAL	Off
BSM	Off
SMEC	At ZPD

Method

1. At the start of the test the internal blackbody is in the instrument beam and the entire array is illuminated.
2. Set the blackbody to power setting to give an equivalent input power to the telescope.
3. Set the bias frequency to the minimum operating point
4. Take a long time series of output voltage of detectors.
5. Repeat by selecting bias frequencies at steps of 5Hz, keeping it fixed at each step, and dwelling for five minutes at each point.
6. Repeat for a range of black body temperatures by taking a shorter time series.
7. Repeat for a range of bolometer operating temperatures.

Output Parameters:
Voltage output from all possible detector arrays for active sub-instrument
Detector biases
TBD temperatures

Analysis
All pixels are illuminated.
Recover the output voltage of each the detector readout by removing instrument gains and offsets
Fourier transform time series

Check for microphonics
Determine position of 1/f knee
Compare with expected values.
Cross correlation of one detector against another and with blank; fixed resistors and thermometer channels.

Comments/Open issues
None frequency to find operating point – 5 Hz bandwudth – 40 points across full band

6.2.7 ILT-PERF-DDB - Blanked Load Curves (DC Bias)

Sub-inst:
Photometer + Spectrometer

Aim:
To establish the behaviour of the detectors in the CQM 'dark' conditions and compare with JPL values.

Test Setup:

EGSE	JPL
Source	None
Facility FTS	Not Used
Flip mirror	Pointing to internal black body?
Shutter	Closed
Telescope simulator	Not used
External chopper	Not used
PCAL	Off
SCAL	Off
BSM	Off position
SMEC	At home

Method:
1. At the start of the test, the instrument is in standby mode and the temperatures are stable and the detectors are at their nominal operating temperature and the JPL EGSE is connected to the instrument.
2. Use the JPL EGSE set up to run through a TBD set of bias voltages and measure the output signal at each step.

Output Parameters:
Offset and voltage output from all possible detector arrays for active sub-instrument
Detector biases
TBD temperatures
Flip mirror position

Analysis:
All arrays for p and s separately are read out simultaneously
Convert instrument output voltage to detector output voltage
(Can check the system gain using the fixed resistors)
Compare load curves obtained with those either theoretical load curves determined from supplied detector parameters or actual load curves supplied with the detector arrays.
Determine background loading.

Comments/Open issues:
Any significant spurious light falling on to the arrays will be found by this test and we assume success. If this test does show up any light leaks we will need to design further tests to determine the source.

This is a separate test to ILT-PERF-DOT in order to allow scheduling of a blanked load curve at only one sink temperature.

6.2.8 ILT-PERF-DAB - Blanked Load Curves (AC Bias)

Sub-inst:
Photometer + Spectrometer

Aim:
To check detector parameters with AC bias configuration.

Test Setup:

EGSE	SPIRE
Source	Internal cold black body
Facility FTS	Not Used
Flip mirror	Pointing to internal black body
Shutter	Closed
Telescope simulator	Not used
External chopper	Not used
PCAL	Off
SCAL	Off
BSM	Off
SMEC	At ZPD

Method:
1. At the start of the test the internal blackbody is in the instrument beam and the entire array is illuminated.
2. Set the blackbody to power setting to give an equivalent input power to the telescope.
3. Place instrument in standby mode and allow temperatures to settle.
4. Run through a TBD set of bias currents and measure output offset at each step.
5. We will want to repeat this test for a range of bolometer operating temperatures.

Output Parameters:
Offset and voltage output from all possible detector arrays for active sub-instrument
Detector biases
TBD temperatures
Flip mirror position

Analysis:
All arrays for p and s separately are read out simultaneously
Convert instrument output voltage to detector output voltage
(Can check the system gain using the fixed resistors)
Compare load curves obtained with those either theoretical load curves determined from supplied detector parameters or actual load curves supplied with the detector arrays.
Determine background loading.

Comments/Open issues:
Any significant spurious light falling on to the arrays will be found by this test and we assume success. If this test does show up any light leaks we will need to design further tests to determine the source.

6.2.9 ILT-PERF-DDL - Optical Load Curves (DC Bias)

Sub-inst:
Photometer + Spectrometer

Aim:
To determine the detectors DC responsivity and DC NEP referred to instrument input.
To verify the following instrument requirements:

- The responsivity variations are less than 10% across the array and calibrated to an accuracy of <1% for all arrays (IRD-DETP-R03, IRD-DETS-R03).
- The detective Quantum Efficiency at 2 Hz at nominal incident power levels for all arrays except SLW > 0.6, and is as large as possible for SLW (IRD-DETP-R01, IRD-DETS-R01).
- The photometer the throughput of the photometer mirrors, filters, dichroics and baffles is greater than 0.27 (TBC) over the instrument waveband. This includes losses due to manufacturing defects; surface finish and alignment tolerances (IRD-OPTP-R05).
- The spectrometer the theoretical throughput of the mirrors; filters; beam splitters and baffles is greater than 0.2 (TBC) over the total instrument waveband (TBC) including all losses due to manufacturing defects; surface finish and alignment tolerances (IRD-OPTS-R05).

Test Setup:

EGSE	JPL
Source	Internal cold black body
Facility FTS	Not Used
Flip mirror	Pointing to internal black body
Shutter	Open
Telescope simulator	Not used
External chopper	Not used
PCAL	Off
SCAL	Off
BSM	Off
SMEC	At home

Method:

1. At the start of the test the internal blackbody set to the minimum operating temperature is in the beam and the shutter is open.
2. Allow conditions to settle.
3. Run through a TBD set of bias currents (voltages) and measure output voltage at each step
4. Repeat VI curve measurement at various black body temperatures (0-40K)

Output Parameters:
Voltage offset from all possible detector arrays for active sub-instrument
Detector biases
Cold black body temperature
SMEC position during spectrometer tests
TBD other temperatures
Flip mirror position

Analysis:

All arrays for each sub-instrument are read out simultaneously
Convert instrument output voltage to detector output voltage
Determine DC responsivity of each detector from each load curve (S=dV/dQ)
Determine NEP from each load curve (NEP=dV/S)
Relative pixel to pixel DC is also then determined.
Relationship between DC responsivity and input flux determined
NEP as a function of position in FOV is determined
Optical efficiency know from temperatures of detectors how much power is falling on them as long as we know AΩ, we can work out the efficiency.

Comments/Open issues:

- The full range of black body temperatures should be tested. We would probably need 5-6 points to understand the relationship. 5K steps might therefore be appropriate.
- The detector properties in particular the DC response might be time varying, we could repeat a load curve under the same conditions to check for this. One way is to extend this test to stepping down in temperature after stepping up.
- In order to verify the detector quantum efficiency we only need to know the responsivity and NEP, we should be able to calculate the photon noise as we know the power coming in to the array from the cold black body. This should be of the order of a few pW and is specified in RD6.
- Finding the ZPD requires the SPIRE EGSE which has not yet been used at the time of doing this test, hence we will have to use home an hopefully we will understand the spectrometer transmission at the home position from later tests.

6.2.10 ILT-PERF-DAL - Optical Load Curves (AC bias)

Sub-inst:
Photometer + Spectrometer

Aim:
To determine the detectors DC responsivity and DC NEP referred to instrument input.
To verify the following instrument requirements:

- The responsivity variations are less than 10% across the array and calibrated to an accuracy of <1% for all arrays (IRD-DETP-R03, IRD-DETS-R03).
- The detective Quantum Efficiency at 2 Hz at nominal incident power levels for all arrays except SLW > 0.6, and is as large as possible for SLW (IRD-DETP-R01, IRD-DETS-R01).
- The photometer the throughput of the photometer mirrors, filters, dichroics and baffles is greater than 0.27 (TBC) over the instrument waveband. This includes losses due to manufacturing defects; surface finish and alignment tolerances (IRD-OPTP-R05).
- The spectrometer the theoretical throughput of the mirrors; filters; beam splitters and baffles is greater than 0.2 (TBC) over the total instrument waveband (TBC) including all losses due to manufacturing defects; surface finish and alignment tolerances (IRD-OPTS-R05).

Test Setup:

EGSE	SPIRE
Source	Internal cold black body
Facility FTS	Not Used
Flip mirror	Pointing to internal black body
Shutter	Open
Telescope simulator	Not used
External chopper	Not used
PCAL	Off
SCAL	Off
BSM	Off
SMEC	Set to ZPD position

Method:

1. At the start of the test the internal blackbody set to the minimum operating temperature is in the beam and the shutter is open.
2. Allow conditions to settle.
3. Run through a TBD set of bias currents (voltages) and measure output voltage at each step
4. Repeat VI curve measurement at various black body temperatures (0-40K)

Output Parameters:
Voltage offset from all possible detector arrays for active sub-instrument
Detector biases
Cold black body temperature
SMEC position during spectrometer tests
TBD other temperatures
Flip mirror position

Analysis:

All arrays are read out simultaneously
Convert instrument output voltage to detector output voltage
Determine DC responsivity of each detector from each load curve (S=dV/dQ)
Determine NEP from each load curve (NEP=dV/S)
Relative pixel to pixel DC is also then determined.
Relationship between DC responsivity and input flux determined
NEP as a function of position in FOV is determined
Optical efficiency know from temperatures of detectors how much power is falling on them as long as we know AΩ, we can work out the efficiency.

Comments/Open issues:

- The full range of black body temperatures should be tested. We would probably need 5-6 points to understand the relationship. 5K steps might therefore be appropriate.
- The detector properties in particular the DC response might be time varying, we could repeat a load curve under the same conditions to check for this. One way is to extend this test to stepping down in temperature after stepping up.
- The ZPD may be dependent on the position of the detector in the array, we should use the ZPD position for the central pixel. For the non-central spectrometer pixels a value will have to be applied to their output signal to adjust them to the expected value if they had been at the ZPD or we could check this correction by setting the SMEC position to the ZPD of some selected other pixels.
- In order to verify the detector quantum efficiency we only need to know the responsivity and NEP, we should be able to calculate the photon noise as we know the power coming in to the array from the cold black body. This should be of the order of a few pW and is specified in RD6.

6.2.11 ILT-PERF-DMD - Mechanism Microphonics (DC Bias)

Sub-inst
Photometer + Spectrometer

Aim
To check for microphonics during mechanism movement with the DC bias setup.

Test Setup:

EGSE	JPL
Source	None
Facility FTS	Not Used
Flip mirror	Pointing to internal black body
Shutter	Closed
Telescope simulator	Not used
External chopper	Not used
PCAL	Off
SCAL	Off
BSM	Off (except when scanning)
SMEC	Off (except when scanning)

Method
1. The instrument is blanked and the detector bias is set to the nominal value
2. Take a short time series of output voltage of detectors.
3. Take a longer time series of readouts (~1 hour) while moving the BSM
4. Take a longer series of readouts (~1 hour) while moving the SMEC
5. Repeat for a range of bolometer operating temperatures.
6. Both sub-instruments are tested separately.

Output Parameters:
Voltage output from all possible detector arrays for active sub-instrument
Detector biases
TBD temperatures
BSM position
SMEC position

Analysis
All pixels are illuminated.
Recover the output voltage of each the detector readout by removing instrument gains and offsets
Fourier transform time series
Check for microphonics
Determine position of 1/f knee
Compare with expected values.
Cross correlation of one detector against another and with blank; fixed resistors and thermometer channels.

Comments/Open issues
None

6.2.12 ILT-PERF-DMA - Mechanism Microphonics (AC Bias)

Sub-inst:
Photometer + Spectrometer

Aim:
To check for microphonics during mechanism movement with the AC bias setup.

Test Setup:

EGSE	SPIRE
Source	Internal cold black body
Facility FTS	Not Used
Flip mirror	Pointing to internal black body
Shutter	Open
Telescope simulator	Not used
External chopper	Not used
PCAL	Off
SCAL	Off
BSM	Off (except when scanning)
SMEC	Off (except when scanning)

Method:

1. At the start of the test the internal blackbody is in the instrument beam and the entire array is illuminated.
2. Set the blackbody to the power setting to give an equivalent input power to the telescope.
3. Set the detector bias to the nominal value
4. Take a short time series of output voltage of detectors.
5. Take a longer time series of readouts (~1 hour) while moving the BSM
6. Take a longer series of readouts (~1 hour) while moving the SMEC
7. Repeat for a range of bolometer operating temperatures.
8. Both sub-instruments are tested separately.

Output Parameters:
Voltage output from all possible detector arrays for active sub-instrument
Detector biases
TBD temperatures

Analysis
All pixels are illuminated.
Recover the output voltage of each the detector readout by removing instrument gains and offsets
Fourier transform time series
Check for microphonics
Determine position of 1/f knee
Compare with expected values.
Cross correlation of one detector against another and with blank; fixed resistors and thermometer channels.

Comments/Open issues

None

6.2.13 ILT-PERF-DDM - Microphonic Susceptibility (DC Bias)

Sub-inst:
Photometer + Spectrometer

Aim:
This test is a specific test for microphonics where microphonics are deliberately put into the system and the detectors susceptibility to this are recorded.

- To verify that the design of the detector structural support and the detector harnessing shall be such as to minimise the impact of any microvibration induced in the instrument by internal or external sources. (IRD-DETP-R09, IRD-DETS-R10)

Test Setup:

EGSE	JPL
Source	None
Facility FTS	Not Used
Flip mirror	Pointing to internal black body?
Shutter	Closed
Telescope simulator	Not used
External chopper	Not used
PCAL	Off
SCAL	Off
BSM	Off
SMEC	Off

A microphonic vibrator will need to be attached to one of the legs of the cryostat.

Method:

1. The instrument is blanked and the detector bias is set to the nominal value
2. The detectors are read out for a period of time (say 10 minutes)
3. The microphonic vibrator is switched on at a known frequency and vibration level
4. The detectors are read out for a period of time long enough to pick up microphonics at that frequency
5. The vibrator is stepped through various frequency and vibration levels and the test repeated.
6. Both sub-instruments are tested separately.

Output Parameters:
Voltage output from all possible detector arrays for active sub-instrument
Detector biases
TBD temperatures
Flip mirror position

Analysis:
All detectors on each sub-instrument are tested simultaneously.
Each time series is Fourier transformed to give the behaviour with frequency.
The initial readout under dark conditions checks for similar noise behaviour to the dedicated noise test.

Any microphonic signal will show up as a spike on this transform.

Comments/Open issues:
It is probably most sensible to run through this whole test with each sub-instrument separately although we might be able to switch between the photometer and spectrometer arrays at each vibration/frequency level.

6.2.14 ILT-PERF-DAM - Microphonic Susceptibility (AC Bias)

Sub-inst:
Photometer + Spectrometer

Aim:
This test is a specific test for microphonics where microphonics are deliberately put into the system and the detectors susceptibility to this are recorded.

- To verify that the design of the detector structural support and the detector harnessing shall be such as to minimise the impact of any microvibration induced in the instrument by internal or external sources. (IRD-DETP-R09, IRD-DETS-R10)

Test Setup:

EGSE	SPIRE
Source	Internal cold black body
Facility FTS	Not Used
Flip mirror	Pointing to internal black body
Shutter	Open
Telescope simulator	Not used
External chopper	Not used
PCAL	Off
SCAL	Off
BSM	Off
SMEC	Off

A microphonic vibrator will need to be attached to one of the legs of the cryostat.

Method:

1. At the start of the test the internal blackbody is in the instrument beam and the entire array is illuminated.
2. Set the blackbody to power setting to give an equivalent input power to the telescope.
3. The detectors are read out for a period of time (say 10 minutes)
4. The microphonic vibrator is switched on at a known frequency and vibration level
5. The detectors are read out for a period of time long enough to pick up microphonics at that frequency
6. The vibrator is stepped through various frequency and vibration levels and the test repeated.
7. The test is repeated at various bias frequencies.
8. Both sub-instruments are tested separately.

Output Parameters:
Voltage output from all possible detector arrays for active sub-instrument
Detector biases
TBD temperatures
Flip mirror position

Analysis:
All detectors on each sub-instrument are tested simultaneously.

Each time series is Fourier transformed to give the behaviour with frequency.
The initial readout under dark conditions checks for similar noise behaviour to the dedicated noise test.
Any microphonic signal will show up as a spike on this transform.

Comments/Open issues:
It is probably most sensible to run through this whole test with each sub-instrument separately although we might be able to switch between the photometer and spectrometer arrays at each vibration/frequency level.

6.2.15 ILT-PERF-DRL - Detector Relative Response vs Input Power Using the Laser

Sub-inst
Photometer + Spectrometer

Aim:
To verify the following instrument requirements:

- SPIRE Photometric measurements are linear to 5% over a dynamic range of 4000 for astronomical signals (IRD-PHOT-R18).
- The responsivity variations are less than 10% across the array and calibrated to an accuracy of <1% for all arrays (note this test covers the same requirement as the optical load test but for responsivity to a modulated signal) (IRD-DETP-R03, IRD-DETS-R03).
- Photometer: Electrical crosstalk for near neighbour pixels. Requirement is less than 1% with a goal to be less than the optical cross talk at the output of the cold JFET amplifiers (IRD-DETP-R05).
- Photometer: Electrical crosstalk for any pair of pixels. Requirement is less than 0.1% (TBC) at the output of the cold JFET preamplifiers. Goal is to be less than the optical cross talk (IRD-DETP-R06).
- Photometer: Electrical crosstalk should be <1% (goal 0.5%) between nearest-neighbour pixels and <0.1% (goal 0.05%) between all other pixels in the same array (IRD-PHOT-R11).
- The electrical crosstalk for near neighbour pixels in the Spectrometer is less than 1% at the output of the cold JFET amplifiers. The goal is less than the optical cross talk (IRD-DETS-R05)
- The spectrometer electrical crosstalk between any pair of pixels is less than 0.1% at the output of the cold JFET preamplifiers. The goal is to be less than the optical crosstalk (IRD-DETS-R06)
- The time constant for the photometer arrays is 16 milliseconds (Equivalent to 10 Hz) (IRD-DETP-R02).
- The spectrometer time constant is 8 milliseconds (Equivalent to 20 Hz) (IRD-DETS-R02).
- The photometer point source sensitivity 1s – 1 sec (mJy) is at least 34, 35, 41 (all TBC), and 1s -1 hr (mJy) is at least 0.6, 0.6, 0.7 (all TBC) (IRD-PHOT-R04)

Test Setup:

EGSE	SPIRE
Source	Laser
Facility FTS	Not Used
Flip mirror	Open
Shutter	Open
Telescope simulator	In use
External chopper	In use
PCAL	Off
SCAL	Off
BSM	Off
SMEC	Set to ZPD position of pixel

To vary the attenuation we will use ND filters.

Method:

1. The laser is placed at the input of the telescope simulator and set to a suitable line for the detector under test.
2. Place the chopper in the beam set to chop between room temperature and the laser
3. Set the detectors to nominal bias.
4. Peakup using the telescope simulator on the pixel under test
5. If necessary allow conditions to settle
6. Read out the detectors for a TBD time period
7. Repeat for various detector biases
8. Repeat for various chop frequencies
9. Repeat for various beam attenuations
10. Repeat for various laser lines
11. Repeat for all pixels

Output Parameters:
Voltage output from all possible detector arrays for active sub-instrument
Detector biases
Chopper frequency
Laser settings
Attenuation
SMEC position during spectrometer tests
TBD other temperatures
Flip mirror position if present

Analysis:
Only one pixel can be tested at a time
Determine output voltage of each detector in the array
For high input signals check surrounding pixels for crosstalk
The time constant can be determined if the full range of chop frequencies are tested. For the time constant the f_{3db} point is the frequency at which the signal falls to half the DC value. A frequency – signal curve is constructed for each pixel under each condition and the f_{3db} point determined from the fitted curve. The time constant is calculated $t=1/2pf_{3db}$.
Put output voltage, frequency and input signal in lookup table
This data can be used to verify the point source sensitivity, provided other TBD parameters are known.
Chopping between three temperature levels will also verify the dynamic range.

Comments/Open Issues:

- A huge parameter space is potentially covered by this test, we will need to give some consideration to how we optimise its coverage.
- This test will give us the responsivity to a known point source. In principle this is a check on the values obtained from the optical load curves. Knowing the time constant we can relate the AC responsivity to the DC responsivity i.e. $S(?)=S(1+?^2t^2)^{-1/2}$ and we can then either use the two results to derive the point source coupling or use the results from the point source coupling test as a check.
- Coupling efficiecy will either be directly derived by this measurement or may be derived using the pixel spatial information test.
- For optical crosstalk we may need to know the PSF but a properly centred point illumination we would expect optical crosstalk to show up evenly in each of the surrounding pixels. The detectors are wired in such a way so that each cable contains the wires from four bolometers. If one bolometer is illuminated the crosstalk should bring down the voltage in the other three but should affect both output wires in the same way,

hence would not be picked up by the detection system after the amplifier. If there is any effect we should be able to spot a different behaviour in the three other wires.

6.2.16 ILT-PERF-DRB - Detector Relative Response vs Input Power Using the External Black Body

Sub-inst:
Photometer + Spectrometer

Aim:
To verify the following instrument requirements:

- SPIRE Photometric measurements are linear to 5% over a dynamic range of 4000 for astronomical signals (IRD-PHOT-R18).
- The responsivity variations are less than 10% across the array and calibrated to an accuracy of <1% for all arrays (note this test covers the same requirement as the optical load test but for responsivity to a modulated signal) (IRD-DETP-R03, IRD-DETS-R03).
- Photometer: Electrical crosstalk for near neighbour pixels. Requirement is less than 1% with a goal to be less than the optical cross talk at the output of the cold JFET amplifiers (IRD-DETP-R05).
- Photometer: Electrical crosstalk for any pair of pixels. Requirement is less than 0.1% (TBC) at the output of the cold JFET preamplifiers. Goal is to be less than the optical cross talk (IRD-DETP-R06).
- Photometer: Electrical crosstalk should be <1% (goal 0.5%) between nearest-neighbour pixels and <0.1% (goal 0.05%) between all other pixels in the same array (IRD-PHOT-R11).
- The electrical crosstalk for near neighbour pixels in the Spectrometer is less than 1% at the output of the cold JFET amplifiers. The goal is less than the optical cross talk (IRD-DETS-R05)
- The spectrometer electrical crosstalk between any pair of pixels is less than 0.1% at the output of the cold JFET preamplifiers. The goal is to be less than the optical crosstalk (IRD-DETS-R06)
- The time constant for the photometer arrays is 16 milliseconds (Equivalent to 10 Hz) (IRD-DETP-R02).
- The spectrometer time constant is 8 milliseconds (Equivalent to 20 Hz) (IRD-DETS-R02).
- The photometer point source sensitivity 1s – 1 sec (mJy) is at least 34, 35, 41 (all TBC), and 1s -1 hr (mJy) is at least 0.6, 0.6, 0.7 (all TBC) (IRD-PHOT-R04)

Test Setup:

EGSE	SPIRE
Source	Hot black body
Facility FTS	Not Used
Flip mirror	Open
Shutter	Open
Telescope simulator	In use
External chopper	In use
PCAL	Off
SCAL	Off
BSM	Off
SMEC	Set to ZPD position

We will need a variable aperture in order to be able to attenuate the beam for this test.

We might want to consider not only chopping between room temperature and a hot black body but also between room temperature and a cold black body (77 K) and between the hot black body and a cold black body.

Method:
1. A hot blackbody is placed at the input of the telescope simulator
2. Place the chopper in the beam set to chop between room temperature and the hot black body
3. Place a variable aperture in the beam, at the start of the test allow the full beam to illuminate the instrument.
4. Set the detectors to nominal bias.
5. Peakup using the telescope simulator on the pixel under test
6. If necessary allow conditions to settle
7. Read out the detectors for a TBD time period
8. Repeat for various detector biases
9. Repeat for various chop frequencies
10. Repeat for various hot black body temperatures
11. Repeat for various beam attenuations
12. Repeat by chopping between hot and cold black body
13. Repeat by chopping between cold black body and room temperature
14. Repeat for all pixels

Output Parameters:
Voltage output from all possible detector arrays for active sub-instrument
Detector biases
Chopper frequency
Black body temperature(s)
Variable aperture setting
SMEC position during spectrometer tests
TBD other temperatures
Flip mirror position if present

Analysis:
Only one pixel can be tested at a time
Determine output voltage of each detector in the array
For high input signals check surrounding pixels for crosstalk
The time constant can be determined if the full range of chop frequencies are tested. For the time constant the f_{3db} point is the frequency at which the signal falls to half the DC value. A frequency – signal curve is constructed for each pixel under each condition and the f_{3db} point determined from the fitted curve. The time constant is calculated $t=1/2pf_{3db.}$
Put output voltage, frequency and input signal in lookup table
This data can be used to verify the point source sensitivity, provided other TBD parameters are known.
Chopping between three temperature levels will also verify the dynamic range.

Comments/Open Issues:
- A huge parameter space is potentially covered by this test, we will need to give some consideration to how we optimise its coverage.
- This test will give us the responsivity to a known point source. In principle this is a check on the values obtained from the optical load curves. Knowing the time constant we can relate the AC responsivity to the DC responsivity i.e. $S(?)=S(1+?^2t^2)^{-1/2}$ and we can then

either use the two results to derive the point source coupling or use the results from the point source coupling test as a check.

- Coupling efficiecy will either be directly derived by this measurement or may be derived using the pixel spatial information test.
- For optical crosstalk we may need to know the PSF but a properly centred point illumination we would expect optical crosstalk to show up evenly in each of the surrounding pixels. The detectors are wired in such a way so that each cable contains the wires from four bolometers. If one bolometer is illuminated the crosstalk should bring down the voltage in the other three but should affect both output wires in the same way, hence would not be picked up by the detection system after the amplifier. If there is any effect we should be able to spot a different behaviour in the three other wires.
- Can we change the aperture setting without the need to peakup again?

6.2.17 ILT-PERF-DSR - Spectral Response

Sub-inst:
Photometer + spectrometer

Aim:
Relative response of each pixel in each array as a function of wavelength. This is used to colour correct the measured fluxes of objects with known or assumed continuum spectra. It is also used to determine the equivalent width and central wavelength of each channel. In the spectrometer channels the spectral relative responsivity is used to spectrally "flat field" the measured source spectra. It is especially important that this parameter is accurately determined for each spectrometer pixel as all are used for taking astronomical spectra (CRD-PAR-4).
The effective spectral width of the end-to-end optics; filters and detectors on each of the three photometer channels – used to convert from detected power to power per unit frequency (wavelength) interval (CRD-PAR-15).

- Photometer spectral response ≥ 90% at the nominal edge frequencies of the appropriate passband, photometer nominal passband (?/??) for all three arrays = 3 (IRD-PHOT-R01) (IRD-DETP-R08)
- Spectrometer spectral Response SW 200-300 μm ≥ 90% LW 300-400 μm ≥ 90% LW>400 μm as large as possible (IRD-DETS-R08)
- Spectrometer wavelength range Band A 200-300 μm Band B 300-700 μm (IRD-SPEC-R01)

Test Setup:

EGSE	SPIRE
Source	Hot black body
Facility FTS	In use
Flip mirror	Open
Shutter	Open
Telescope simulator	In use
External chopper	Not in use
PCAL	Off
SCAL	Off??
BSM	Off
SMEC	Set to ZPD

Method:

1. A test spectrometer is used to feed the input focal plane of the telescope simulator.
2. Set detectors to nominal bias
3. Peakup the telescope simulator on the pixel under test
4. Allow conditions to settle recording detector output
5. The wavelength (or position if an FTS) scanned.
6. The scans are repeated until the desired S/N is reached.
7. Repeat for all pixels tested (see comments).

Output Parameters:
Voltage output from all possible detector arrays for active sub-instrument
Detector biases

Chopper frequency if used
Black body temperature
Facility spectrometer position (wavelength or OPD)
SMEC position during spectrometer tests
TBD other temperatures
Flip mirror position if present

Analysis:
Divide output spectrum by input spectrum, record response in a calibration file.

Comments/Open Issues:

- This measurement should be done at high (R~few hundred-thousand) resolution and with good s/n (~1000 per spectral bin) in order to accurately determine the relative spectral response function of the instrument.
- Each pixel in the spectrometer channel must be measured to high accuracy; only the overlap pixels in the photometer arrays need be measured with high accuracy. Other pixels maybe measured at low resolution if time allows.
- Its not clear whether we need the chopper for this test, if we are using an FTS then there will be a modulation in the input signal, if the input signal is a spectrum then we might also need to chop.
- To get the calibration file we might need to consider what the detector responsivity is doing, we could include some PCAL flashes in with the test to do this.
- We will also get a handle on the spectrometer spectral response from scanning the SMEC.

6.3 Calibrator Performance

6.3.1 ILT-PERF-CPC - Photometer Calibrator Characterisation

Sub-inst
Photometer + Spectrometer?

Aim
Characterise the PCAL behaviour. Determine photometer calibrator equivalent power.

- Verify that the nominal operating output Equivalent to eT=40 K for 200<?<700µm (IRD-CALP-R01)
- Verify that the operating range is commandable in 256 steps with at least 124 steps covering the range from zero output to eT=40K. (IRD-CALP-R02)
- Speed of response In response to a step change in applied electrical power, the 90% settling time of the radiant power output shall be less than 350ms (requirement); 70ms (goal). (IRD-CALP-R04)
- Repeatability RMS of output signal better than 1% over 20 cycles on to off during a calibration operation of less than 2 minutes. Drift less than 10% over lifetime of the mission. Repeatability of signal 1% for 12 calibration operations equi-spaced over a period of 12 hours, with uniform base temperature and drive current. (IRD-CALP-R05)
- Operation: Nominally once per hour for no more than 10 seconds. (IRD-CALP-R06)
- Frequency: continuously or pseudo continuously variable between 0 and 2 Hz (IRD-CALP-R07)

As the calibrator is needed to track the drift in responsivity it is needed to verify the following:

- Photometer Absolute photometric accuracy should be <15% at all wavelengths with a goal of <10% (IRD-PHOT-R14)
- Photometer The relative photometric accuracy shall be <10% with a goal of <5% (IRD-PHOT-R15)
- The FTS absolute photometric accuracy at the required resolution shall <15% at all wavelengths with a goal of <10% (IRD-SPEC-R16)

Test Setup:

EGSE	SPIRE
Source	Internal cold black body
Facility FTS	Not used
Flip mirror	Pointing to internal black body
Shutter	Open
Telescope simulator	Not used
External chopper	Not used
PCAL	On
SCAL	Off
BSM	Off
SMEC	ZPD of central pixel

Method

1. Place the black body in the beam

2. Set the detectors to nominal bias
3. Measure the detector output
4. Turn on PCAL at the pedestal step and nominal operating frequency
5. Wait for it to reach steady power
6. Measure the detector output during a TBD time period.
7. Repeat for 3-5 for a TBD set of PCAL temperature steps
8. Repeat for a TBD set of frequencys.
9. Repeat for a TBD set of waveforms
10. Repeat for a set of cold black body temperatures
11. Repeat for nominal operating conditions 12 hours later

Output Parameters:
Voltage output from all possible detector arrays for active sub-instrument
Detector biases
PCAL output power
TBD other PCAL parameters
Black body temperature
SMEC position if switched on during spectrometer tests
TBD other temperatures
Flip mirror position if present

Analysis
The detector parameters are known from the black body source. The signal when the calibrator is on can then be used to calculate eT
As each step is tested the eT for each step will be known.
The power output curve will enable us to verify the time constant.
The first part of the repeatability requirement can be verified by this test. Presumably a separate sub-system test will verify the mission lifetime requirement.

Comments/Open Issues
The characterisation done in this test will enable us to set up a test which will then be repeated often to monitor the detectors.
The time separation part of the test does not have to be done with the full test and could be encompassed in the daily measurement.
We will want to start with a pedestal, if we don't know what this is we could start with the maximum output and work down in power.

6.3.2 ILT-PERF-CSC - Spectrometer Calibrator Characterisation

Sub-inst:
Spectrometer

Aim:
To determine the equivalent flux from the SCAL output.

- To verify that the central maximum can be nulled to an accuracy of 5% (goal 2%)[TBC] (IRD-CALS-R01)
- To verify that the dilute spectrum of the telescope is replicated to an accuracy of better than 20% (goal 5%) [TBC] over 200-400 µm (IRD-CALS-R01)
- To verify that the adjustability is Zero – maximum in 256 steps (IRD-CALS-R03)
- To verify that the uniformity of the intensity from the calibration source across the field image at the detector shall be better than 5% (IRD-CALS-R04)

Test Setup:

EGSE	SPIRE
Source	Internal black body
Facility FTS	Not Used
Flip mirror	Pointing at black body
Shutter	Open
Telescope simulator	Not used
External chopper	Not used
PCAL	Off
SCAL	On
BSM	Off
SMEC	On

Method

1. A blackbody is placed in the sky port of the FTS
2. One of the spectrometer calibrators is selected and set to its first operating point.
3. The detectors are operated at nominal bias.
4. The SMEC is scanned (TBD times) over a short range about the ZPD.
5. The spectrometer calibrator is set to the next operating point and the scans are repeated.
6. This is repeated until the TBD range of operating points have been tested.
7. The test is repeated using different mirror scan velocities
8. The whole test is repeated using all operating points and scan velocities for various black body temperatures.

Output Parameters:
Voltage output from all possible detector arrays for active sub-instrument
Detector biases
Black body temperature
SCAL temperature
Other TBD SCAL parameters
SMEC position (both optical encoder and LVDT)
TBD other temperatures
Flip mirror position

Analysis:
When the spectrum is nulled the input power from the calibrator and external source are matched and hence the equivalent power of the calibrator can be found.
The accuracy of the nulling will also be determined.
This test will confirm that 256 step range is available
The uniformity can be determined as the detector parameters are known

Comments/Open Issues:
None

6.3.3 ILT-PERF-CSR - Room temperature nulling

Sub-inst:
Spectrometer

Aim:
To determine the setting of SCAL needed for room temperature nulling for spectrometer tests using external sources.

Test Setup:

EGSE	SPIRE
Source	None
Facility FTS	Not Used
Flip mirror	Open
Shutter	Open
Telescope simulator	Not used
External chopper	Not used
PCAL	Off
SCAL	On
BSM	Off
SMEC	On

Method
1. The sky port of the FTS is open to the room.
2. One of the spectrometer calibrators is selected and set to its first operating point.
3. The detectors are operated at nominal bias.
4. The SMEC is scanned (TBD times) over a short range about the ZPD.
5. The spectrometer calibrator is set to the next operating point and the scans are repeated.
6. This is repeated until the TBD range of operating points have been tested.

Output Parameters:
Voltage output from all possible detector arrays for active sub-instrument
Detector biases
SCAL temperature
Other TBD SCAL parameters
SMEC position (both optical encoder and LVDT)
TBD other temperatures
Flip mirror position

Analysis:
When the spectrum is nulled the input power from the calibrator and room are matched and hence the equivalent power of the calibrator can be found.

Comments/Open Issues:
None

6.3.4 ILT-PERF-CST - Spectrometer Calibrators Performance with Time

Sub-inst:
Spectrometer

Aim:
To check the performance of the spectrometer calibrators over time

- To verify that the output intensity of the calibration source shall drift is no more than 1% over one hour of continuous operation. The absolute change in the output intensity of the source shall be no more than 15% over the mission lifetime (IRD-CALS-R05).
- To verify that the calibration source shall be capable of continuous operation for periods of up to 2 hours with no loss of operational performance (IRD-CALS-R06).

Test Setup:

EGSE	SPIRE
Source	Internal cold black body
Facility FTS	Not Used
Flip mirror	Pointing at black body
Shutter	Open
Telescope simulator	Not used
External chopper	Not used
PCAL	On
SCAL	On
BSM	Off
SMEC	On

Method:
1. A blackbody is placed in the sky port of the FTS and set to a nominal temperature for the spectrometer calibrator.
2. One of the spectrometer calibrators set to its nominal operating point.
3. The detectors are operated at nominal bias.
4. PCAL is cycled.
5. The SMEC is scanned (TBD times) over a short range about the ZPD.
6. PCAL is cycled again to check for responsivity changes.
7. Repeat the PCAL cycles and SMEC scans for about 2 hours
8. Repeat for the other calibrator.

Output Parameters:
Voltage output from all possible detector arrays for active sub-instrument
Detector biases
Black body temperature
PCAL power (calculated from input current)
Other TBD PCAL parameters
SCAL temperature
Other TBD SCAL parameters
SMEC position (both optical encoder and LVDT)
TBD other temperatures
Flip mirror position

Analysis:
Check for changes in output spectrum

Comments/Open Issues:
We will use this characterisation to develop a standard test which will be repeated often during the CQM testing..

6.4 SMEC Tests

6.4.1 ILT-PERF-SZP - ZPD Position

Sub-inst:
Spectrometer

Aim:
To determine the position of the zero path difference (ZPD) i.e. the position in the SMEC scan range at which the path length in the two spectrometer arms is exactly the same. It should be the same in both spectrometer channels. It is used to determine where to set the SMEC for all photometric calibration measurements and so that the correct scan length can be input for each desired resolution.

- To verify that the system is capable of starting and stopping a scan from either side of the zero path difference position (IRD-SMEC-R04).

Test Setup:

EGSE	SPIRE
Source	Internal cold black body
Facility FTS	Not Used
Flip mirror	Pointing to internal black body
Shutter	Closed
Telescope simulator	Not used
External chopper	Not used
PCAL	Off
SCAL	Off
BSM	Off
SMEC	Off

Method:
1. A cold black body is placed in the sky port of the FTS.
2. The spectrometer calibrator is set to maximum output and allowed to stabilise.
3. The detectors are set to nominal bias. The data from the arrays is collected continuously at a high rate (16 Hz) during this operation
4. The SMEC is set a known position (home would be a reasonable start)
5. The SMEC is moved to another position in the known ZPD direction.
6. The SMEC is moved back to the starting point
7. The SMEC is moved to the next position and back again until the whole range of the SMEC has been covered.
8. The measurement should be repeated with the calibration source cold and the external black body set to a known temperature to ensure that the ZPD position is the same in both paths through the spectrometer.

Output Parameters:
Voltage output from all possible detector arrays for active sub-instrument
Detector biases
Black body temperature
SMEC position (both optical encoder and LVDT)

TBD other temperatures
Flip mirror position

Analysis:
The position of the ZPD is given by the peak in the output spectrum.

Comments/Open Issues:
This test could also be used to compare encoder and LVDT position. This should confirm the values from sub-system testing. If needed we would probably perform a finer step and look test to compare positions.
The stepping frequency should be at least 1 Hz, but this might need to be slower at the extreme range when the SMEC has to move furthest. This should be confirmed by sub-system testing.

6.4.2 ILT-PERF-SFC - Fringe Contrast and Spectral Response While Scanning

Sub-inst:
Spectrometer

Aim:
To characterise the behaviour of the spectrometer in relation to line measurements, the mirror carriage behaviour, the fringe contrast and the spectral response to a line showing that the FTS is capable of achieving the required sensitivity and minimum resolution.
This will also be used to determine the sensitivity of the instrument to spectral lines and will be used to deconvolve the instrument function from measured spectra. This test will verify the following instrument requirements:

- Maximum resolution (cm-1) Req. 0.4 cm-1 Goal 0.04 cm-1 (IRD-SPEC-R02)
- Minimum resolution (cm-1) Req 2 cm-1 Goal 4 cm-1 (IRD-SPEC-R03)
- Point source unresolved line sensitivity (W m-2; 1σ 1 hr) Band A 200-300 μm 5 x 10^{-18} (TBC) Band B 300-400 μm 5.1 x 10^{-18} (IRD-SPEC-R06)
- Spectrometer map line sensitivity (W m-2; 1 σ 1 hr) Band A 200-300 μm 1.3 x 10^{-17} (TBC) Band B 300-400 μm 1.3 x 10^{-17} (TBC) Band B 400-700 μm TBD (IRD-SPEC-R07)
- The width of the FTS instrument response shall be uniform to within 10% across the FOV for resolution <0.4cm-1 (IRD-SPEC-R11)
- Fringe contrast shall be greater than 80% for any point in the field of view for a resolution of 0.4 cm^{-1} (IRD-SPEC-R14)
- 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 chosen passband (IRD-SPEC-R17).
- The FWHM of the resolution element at any point in the FOV shall be no more than 10% greater than the on-axis value for a nominal resolution of 0.4 cm^{-1} (IRD-OPTS-R10).
- Linear Travel: *Assumed folding factor of 4 for baseline design and single sided interferograms with short travel beyond zero path difference for phase correction.* Total OPD required 14 cm. Maximum mirror travel required for goal resolution (wrt ZPD position): - 0.32 to +3.2 cm (IRD-SMEC-R01).
- Minimum movement sampling interval: Short wavelength band minimum measurement interval of 5 μm is required (equivalent to 20 μm OPD) For long wavelength band the requirement is 7.5 μm (equivalent to 30 μm OPD) (IRD-SMEC-R02).
- Sampling step control: The measurement interval must be variable between 5 and 25 μm (IRD-SMEC-R03).
- A goal is to have a dead-time of no more than 10% per scan when taking data at resolution 0.4 cm^{-1} (IRD-SMEC-R05).
- Mirror velocity: For assumed detector response of 20 Hz the maximum required rate change of the OPD is 0.4 cm s^{-1}. Required max. mirror velocity 0.1 cm s-1. A capability to have mirror velocity of 0.2 cm s^{-1} is desirable and is set as a goal (IRD-SMEC-R06).
- Velocity Control: The mirror velocity should be selectable from 0 to 0.1 cm s^{-1} – or 0.2 cm s^{-1} if the goal performance is achieved (IRD-SMEC-R07).
- Velocity stability: *The mirror velocity shall be within 10 μm/s r.m.s. within a band width of 0.03 to 25 Hz over the full range of movement of the mechanism* The velocity from scan to scan shall not vary by more than 1% over a period of 24 hours under nominal operating conditions (IRD-SMEC-R08).
- Position measurement: Required OPD position accuracy is 1/50 of the smallest step size. Simulation confirms that this adds minimal system noise to the resultant interferogram. Required mirror position measurement accuracy 0.1 μm over ± 0.32 scan range and 0.3 μm thereafter (IRD-SMEC-R09).

- Sample frequency: The position is sampled at the frequency required for the short wavelength array – i.e. (mirror velocity)/(measurement step size for short wavelength array) (IRD-SMEC-R10).
- To verify that the spectrometer bolometer pixels are capable of being readout at the rate required by the FTS mechanism and position control system – nominally 80 Hz (TBC) (IRD-DETS-R09).

Test Setup:

EGSE	SPIRE
Source	Laser
Facility FTS	Not Used
Flip mirror	Open
Shutter	Open
Telescope simulator	In use
External chopper	Not in use
PCAL	Off
SCAL	Off
BSM	Off
SMEC	At ZPD position

Method:

1. A laser line is focussed and peaked up onto a single spectrometer pixel, the spectrometer calibrator is not used.
2. Allow conditions to stabilise while continuing to readout the detectors
3. The SMEC is scanned over its full range of movement.
4. The scans are repeated until the desired S/N is reached
5. The test is repeated over various scan ranges.
6. The test is repeated for all possible laser lines.
7. The test is repeated for as many pixels in the spectrometer arrays as practicable

Output Parameters:

Voltage output from all possible detector arrays for active sub-instrument
Detector biases
Laser line used
Laser output
SMEC position (both optical encoder and LVDT)
TBD temperatures
Flip mirror position if used

Analysis:

The laser line acts as a delta function giving a cosine wave output
This converted spectrum of the full range allows the maximum achievable spectral resolution to be determined.

Comments/Open Issues:

The laser must be stable enough that the velocity instability can be distinguished from any source instability.

The fringe contrast on a delta function input spectrum may vary over the scan range of the mirror mechanism. A map of the variation in contrast will be used to correct the measured interferograms.
This test also verifies the wavelength vs position calibration.

6.4.3 ILT-PERF-SFL - Fringe Contrast and Spectral Response Step and Look

Sub-inst:
Spectrometer

Aim:
To characterise the behaviour of the spectrometer in relation to line measurements, the mirror carriage behaviour, the fringe contrast and the spectral response to a line showing that the FTS is capable of achieving the required sensitivity and minimum resolution.
This will also be used to determine the sensitivity of the instrument to spectral lines and will be used to deconvolve the instrument function from measured spectra. This test will verify the following instrument requirements:

- Maximum resolution (cm-1) Req. 0.4 cm-1 Goal 0.04 cm-1 (IRD-SPEC-R02)
- Minimum resolution (cm-1) Req 2 cm-1 Goal 4 cm-1 (IRD-SPEC-R03)
- Point source unresolved line sensitivity (W m-2; 1σ 1 hr) Band A 200-300 μm 5 x 10^{-18} (TBC) Band B 300-400 μm 5.1 x 10^{-18} (IRD-SPEC-R06)
- The width of the FTS instrument response shall be uniform to within 10% across the FOV for resolution <0.4cm-1 (IRD-SPEC-R11)
- Fringe contrast shall be greater than 80% for any point in the field of view for a resolution of 0.4 cm^{-1} (IRD-SPEC-R14)
- The FWHM of the resolution element at any point in the FOV shall be no more than 10% greater than the on-axis value for a nominal resolution of 0.4 cm^{-1} (IRD-OPTS-R10).
- Spectrometer map line sensitivity (W m-2; 1 σ 1 hr) Band A 200-300 μm 1.3 x 10^{-17} (TBC) Band B 300-400 μm 1.3 x 10^{-17} (TBC) Band B 400-700 μm TBD (IRD-SPEC-R07)
- Linear Travel: *Assumed folding factor of 4 for baseline design and single sided interferograms with short travel beyond zero path difference for phase correction.* Total OPD required 14 cm. Maximum mirror travel required for goal resolution (wrt ZPD position): - 0.32 to +3.2 cm (IRD-SMEC-R01).
- Minimum movement sampling interval: Short wavelength band minimum measurement interval of 5 μm is required (equivalent to 20 μm OPD) For long wavelength band the requirement is 7.5 μm (equivalent to 30 μm OPD) (IRD-SMEC-R02).
- Sampling step control: The measurement interval must be variable between 5 and 25 μm (IRD-SMEC-R03).
- A goal is to have a dead-time of no more than 10% per scan when taking data at resolution 0.4 cm^{-1} (IRD-SMEC-R05).
- 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 chosen passband (IRD-SPEC-R17).
- Position measurement: Required OPD position accuracy is 1/50 of the smallest step size. Simulation confirms that this adds minimal system noise to the resultant interferogram. Required mirror position measurement accuracy 0.1 μm over $\pm$ 0.32 scan range and 0.3 μm thereafter (IRD-SMEC-R09).
- Sample frequency: The position is sampled at the frequency required for the short wavelength array – i.e. (mirror velocity)/(measurement step size for short wavelength array) (IRD-SMEC-R10).
- To verify that the spectrometer bolometer pixels are capable of being readout at the rate required by the FTS mechanism and position control system – nominally 80 Hz (TBC) (IRD-DETS-R09).

Test Setup:

EGSE	SPIRE
Source	Laser
Facility FTS	Not Used
Flip mirror	Open
Shutter	Open
Telescope simulator	In use
External chopper	Not in use
PCAL	Off
SCAL	Off
BSM	On
SMEC	At ZPD position

Method:

1. The SMEC is set to the ZPD position of the pixel under test.
2. A laser line is focussed and peaked up with the telescope simulator onto the pixel.
3. The SMEC is moved to home.
4. The BSM is commanded to start chopping at nominal frequency and chop throw.
5. Allow conditions to stabilise while continuing to readout the detectors.
6. The SMEC is moved to the next position (TBD) in the step and look sequence.
7. The detectors are read out for a TBD time (or number of chop cycles) then the SMEC is moved to the next position etc until the step and look scan is completed.
8. The test is repeated for all possible laser lines.
9. The test is repeated for as many pixels in the spectrometer arrays as practicable

Output Parameters:

Voltage output from both detector arrays
Detector biases
Laser line used
Laser output
SMEC position (both optical encoder and LVDT)
TBD temperatures
Flip mirror position

Analysis:

The laser line acts as a delta function giving a cosine wave output
This converted spectrum of the full range allows the maximum achievable spectral resolution to be determined.

Comments/Open Issues:

The laser must be stable enough that the velocity instability can be distinguished from any source instability.
The fringe contrast on a delta function input spectrum may vary over the scan range of the mirror mechanism. A map of the variation in contrast will be used to correct the measured interferograms.
This test also verifies the wavelength vs position calibration.
The BSM characterisation will need to have taken place before this test can be done.

6.4.4 ILT-PERF-SMC - Mirror Carriage Characterisation While Scanning

Sub-inst:
Spectrometer

Aim:
To characterise the behaviour of the SMEC mechanism and to verify that the following performance requirements are met:

- Linear Travel: *Assumed folding factor of 4 for baseline design and single sided interferograms with short travel beyond zero path difference for phase correction.* Total OPD required 14 cm. Maximum mirror travel required for goal resolution (wrt ZPD position): - 0.32 to +3.2 cm (IRD-SMEC-R01).
- Minimum movement sampling interval: Short wavelength band minimum measurement interval of 5 µm is required (equivalent to 20 µm OPD) For long wavelength band the requirement is 7.5 µm (equivalent to 30 µm OPD) (IRD-SMEC-R02).
- Sampling step control: The measurement interval must be variable between 5 and 25 µm (IRD-SMEC-R03).
- A goal is to have a dead-time of no more than 10% per scan when taking data at resolution 0.4 cm^{-1} (IRD-SMEC-R05).
- Mirror velocity: For assumed detector response of 20 Hz the maximum required rate change of the OPD is 0.4 cm s^{-1}. Required max. mirror velocity 0.1 cm s-1. A capability to have mirror velocity of 0.2 cm s^{-1} is desirable and is set as a goal (IRD-SMEC-R06).
- Velocity Control: The mirror velocity should be selectable from 0 to 0.1 cm s^{-1} – or 0.2 cm s^{-1} if the goal performance is achieved (IRD-SMEC-R07).
- Velocity stability: *The mirror velocity shall be within 10 µm/s r.m.s. within a band width of 0.03 to 25 Hz over the full range of movement of the mechanism* The velocity from scan to scan shall not vary by more than 1% over a period of 24 hours under nominal operating conditions (IRD-SMEC-R08).
- 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 chosen passband (IRD-SPEC-R17).
- Position measurement: Required OPD position accuracy is 1/50 of the smallest step size. Simulation confirms that this adds minimal system noise to the resultant interferogram. Required mirror position measurement accuracy 0.1 µm over ± 0.32 scan range and 0.3 µm thereafter (IRD-SMEC-R09).
- Sample frequency: The position is sampled at the frequency required for the short wavelength array – i.e. (mirror velocity)/(measurement step size for short wavelength array) (IRD-SMEC-R10).
- To verify that the spectrometer bolometer pixels are capable of being readout at the rate required by the FTS mechanism and position control system – nominally 80 Hz (TBC) (IRD-DETS-R09).
- To verify that the spectrometer point source continuum sensitivity (mJy, 1σ-1hr; 0.4 cm-1 resolution), Band A 200-300 µm 47 (TBC), Band B 300-400 µm 43 (TBC), Band B 400-700 µm TBD (IRD-SPEC-R06)

Test Setup:

EGSE	SPIRE
Source	Internal cold black body
Facility FTS	Not Used
Flip mirror	Pointing to internal black

	body
Shutter	Open
Telescope simulator	Not used
External chopper	Not used
PCAL	Off
SCAL	Off
BSM	Off
SMEC	On

Method:

1. A black body source placed in the sky port of the FTS.
2. In this test the spectrometer calibrator is set to zero output.
3. The SMEC is scanned over its full range.
4. Repeat over a set of SMEC ranges
5. Repeat for different speeds
6. Repeat for a set of black body temperatures.

Output Parameters:

Voltage output from all possible detector arrays for active sub-instrument
Detector biases
Black body temperature
SMEC position (both optical encoder and LVDT)
TBD other temperatures
Flip mirror position

Analysis:

The re-constructed black body spectrum will be an indicator of the velocity stability of the SMEC.

Comments/open issues:

This test is a final verification following the detailed verification in ILT-PERF-SFC.

6.4.5 ILT-PERF-SML - Mirror Carriage Characterisation Step and Look

Sub-inst:
Spectrometer

Aim:
To characterise the behaviour of the SMEC mechanism and to verify that the following performance requirements are met:

- Linear Travel: *Assumed folding factor of 4 for baseline design and single sided interferograms with short travel beyond zero path difference for phase correction.* Total OPD required 14 cm. Maximum mirror travel required for goal resolution (wrt ZPD position): - 0.32 to +3.2 cm (IRD-SMEC-R01).
- Minimum movement sampling interval: Short wavelength band minimum measurement interval of 5 µm is required (equivalent to 20 µm OPD) For long wavelength band the requirement is 7.5 µm (equivalent to 30 µm OPD) (IRD-SMEC-R02).
- Sampling step control: The measurement interval must be variable between 5 and 25 µm (IRD-SMEC-R03).
- A goal is to have a dead-time of no more than 10% per scan when taking data at resolution 0.4 cm^{-1} (IRD-SMEC-R05).
- 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 chosen passband (IRD-SPEC-R17).
- Position measurement: Required OPD position accuracy is 1/50 of the smallest step size. Simulation confirms that this adds minimal system noise to the resultant interferogram. Required mirror position measurement accuracy 0.1 µm over ± 0.32 scan range and 0.3 µm thereafter (IRD-SMEC-R09).
- Sample frequency: The position is sampled at the frequency required for the short wavelength array – i.e. (mirror velocity)/(measurement step size for short wavelength array) (IRD-SMEC-R10).
- To verify that the spectrometer bolometer pixels are capable of being readout at the rate required by the FTS mechanism and position control system – nominally 80 Hz (TBC) (IRD-DETS-R09).
- To verify that the spectrometer point source continuum sensitivity (mJy, 1σ-1hr; 0.4 cm-1 resolution), Band A 200-300 µm 47 (TBC), Band B 300-400 µm 43 (TBC), Band B 400-700 µm TBD (IRD-SPEC-R06)

Test Setup:

EGSE	SPIRE
Source	Internal cold black body
Facility FTS	Not Used
Flip mirror	Pointing to internal black body
Shutter	Open
Telescope simulator	Not used
External chopper	Not used
PCAL	Off
SCAL	Off
BSM	On
SMEC	On

Method:
1. A black body is placed in the beam to the sky port of the spectrometer, the spectrometer calibrator is not used.
2. The SMEC position is set to home.
3. The BSM is commanded to start chopping at nominal frequency and chop throw.
4. The conditions are allowed to stabilise while the detectors continue to be read.
5. The SMEC is moved to the next position (TBD) in the step and look sequence.
6. The detectors are read out for a TBD time (or number of chop cycles) then the SMEC is moved to the next position etc until the step and look scan is completed.
7. The test is repeated for a TBD set of black body temperatures.
8. The test is repeated for as many pixels in the spectrometer arrays as practicable.

Output Parameters:
Voltage output from all possible detector arrays for active sub-instrument
Detector biases
Black body temperature
SMEC position (both optical encoder and LVDT)
TBD other temperatures
Flip mirror position

Analysis:
The re-constructed black body spectrum will be an indicator of the velocity stability of the SMEC.

Comments/open issues:
More details are needed on how each SMEC performance requirement will be verified.

6.5 BSM Tests

6.5.1 ILT-PERF-BSM - BSM Characterisation

Sub-inst:
Photometer + Spectrometer

Aim:
To characterise the BSM movement and stability of movement.

- The BSM shall be capable of moving to and holding indefinitely at any commanded position within its range of movement (IRD-BSMP-R05).
- The angle on the sky must not vary by more than 0.1 arcsec (TBC) over 60 sec at the commanded mirror position. The mirror position shall also have a stability equivalent to 0.2 arcsec rms in the 0.03 to 25 Hz frequency band (IRD-BSMP-R06).
- The knowledge of the mirror position shall be equivalent to a stability of 0.2 arcsec rms in the 0.03 to 25 Hz frequency band.. The absolute knowledge of the mirror position shall be equivalent to less than 0.01 arcsec (TBC) (IRD-BSMP-R07).
- The mirror shall settle to within 1 arcsec of its commanded position in less than 20 milliseconds (IRD-BSMP-R08).

Test Setup:

EGSE	SPIRE
Source	Hot black body
Facility FTS	Not Used
Flip mirror	Open
Shutter	Open
Telescope simulator	In use
External chopper	In use
PCAL	Off
SCAL	Off
BSM	On
SMEC	At ZPD position?

Method:

1. The hot black body is placed at the input of the telescope simulator and set to a suitable temperature.
2. The chopper is placed in the beam and set to a nominal value
3. Use a 7-point jiggle map to peak up on the initial the pixel under test
4. Point the BSM at each pixel of the pixels in the array in turn
5. Measure the BSM pointing and detector output until the desired S/N is reached.
6. Repeat to check for pointing stability.

Output Parameters:
Voltage output from all possible detector arrays for active sub-instrument
Detector biases
Black body temperature
Chopper frequency
BSM position

TBD temperatures
Flip mirror position if used

Analysis:
Look-up tables, will be needed for uplink

Comments/Open issues:
Assumes we know how to place the beam on a pixel with the BSM, we might need a separate test to characterise this or it might be covered by a functional test. The 7-point jiggle map should be available as an AOT. The T/S simulator can place the beam on any pixel so the 7-point jiggle map can be done on any pixel although there will be vignetting at the edges.

6.5.2 ILT-PERF-BCT - BSM Chop Throw

Sub-inst:
Photometer + Spectrometer

Aim:
To verify that the BSM chopping modes work as expected

- To verify that the BSM can move the imaged field of view of the detectors by a maximum of ± 130 arcsec on the sky in the ± Y axis of the satellite (IRD-BSMP-R01).
- To verify that the BSM can move the imaged field of view of the detectors by a maximum of ± 30 arcsec in the ± Z axis of the satellite (IRD-BSMP-R02)
- The minimum step size in either chop or jiggle axes shall be 2 arcsec (IRD-BSMP-R03)
- To verify that the chop frequency in either axis is continuously variable or selectable in 16 steps from 0 to 2 Hz for nominal operation and power dissipation. The chop frequency should be capable of reaching 5 Hz with increased power dissipation and settling time (IRD-BSMP-R04).
- To verify that the maximum available chop throw is at least 4 arcminutes: the minimum is 10 arcsecs or less (IRD-PHOT-R17).

Test Setup:

EGSE	SPIRE
Source	Internal cold black body
Facility FTS	Not Used
Flip mirror	Pointing to internal black body
Shutter	Open
Telescope simulator	Not used
External chopper	Not used
PCAL	Off
SCAL	Off
BSM	Off
SMEC	Off

Method:

1. Place a stable external source at the input of the telescope simulator
2. Use the BSM to chop between two pixels
3. Vary the chop frequency
4. Select pixel pairs so that the full range of amplitudes and directions are tested.

Output Parameters:
Voltage output from all possible detector arrays for active sub-instrument
Detector biases
Black body temperature
Chopper frequency
BSM position
TBD temperatures
Flip mirror position if used

Analysis:
Requirements will be verified and unusual behaviour notified

Comments/Open issues:
A description of this is also in the CRD, operations section.

6.6 Shutter Tests

6.6.1 ILT-PERF-SHB - Shutter Characterisation

Sub-inst:
Photometer + Spectrometer?

Aim:
Determine shutter characteristics. Calibrate shutter against internal calibrators. Calibrate shutter against a black body source.
To verify that the following instrument requirements are met:

- The seal of the shutter vane shall be designed so as to reduce stray light entering the instrument to an acceptable level. *Any straylight seal design is to be evaluated by the project team to assess its efficacy* (IRD-SHUT-R02).
- The emissivity of the instrument side of the vane shall be controllable over the range 9-25K (IRD-SHUT-R03).
- The temperature of the instrument side of the vane shall be uniform to within 2% (rms) (IRD-SHUT-R04).
- The temperature of the instrument side of the vane shall be controllable over the range 9-25 K (IRD-SHUT-R05)
- There shall be at least 16 set points over the temperature range specified in IRD-SHUT-R05 (IRD-SHUT-R06)
- The temperature of the instrument side of the vane shall be uniform to within 0.1K (rms) (IRD-SHUT-R07).
- The average temperature of the instrument side of the vane shall be repeatable to within <0.040K (IRD-SHUT-R08)
- The time required to increase the vane temperature by 5K and stabilize to within the repeatability in R1I, assuming that the vane is initially at its minimum (unpowered) temperature, shall be less than 10 minutes (IRD-SHUT-R16).

Test Setup:

EGSE	SPIRE
Source	Internal cold black body
Facility FTS	Not Used
Flip mirror	Pointin g to internal black body
Shutter	Open
Telescope simulator	Not used
External chopper	Not used
PCAL	Off
SCAL	Off
BSM	Off
SMEC	Off

Method:

1. Place the cold black body in the beam
2. Set to 9 K
3. Stabilise.
4. Measure the load curve

5. Close the shutter
6. Set the shutter temperature to 9K
7. Stabilise while measuring detector response
8. Measure the detector response to the shutter
9. Open the shutter so the detectors see the cold black body
10. Measure the detector response to the cold black body
11. Set the cold black body and shutter temperature to 10K
12. Repeat steps 3-11 for different shutter temperatures (9-25 K)

Output Parameters:
Voltage output from all possible detector arrays for active sub-instrument
Detector biases
Shutter temperature(s)
Black body temperature
TBD temperatures
Flip mirror position

Analysis:
All detectors are illuminated hence all arrays in each sub-instrument can be tested simultaneously.
Black body comparison allows us to know what temperature the detectors are seeing from the shutter.

Comments/Open Issues:
Another way to do this test could be to operate with the shutter half shut with half the FOV seeing the cold black body and the other half seeing the shutter. It is possible the black body could warm the shutter, if this is the case we may need to switch it off when taking readouts from the shutter. We are not modulating the signal, although drifts could be corrected if we open and shut the shutter several times. If the black body and the shutter are set to the same temperature we could open and shut the shutter and look for a differential on the detectors.

Another thing we might consider is whether we wish to characterise the shutter spectrally. Instead of just using the ZPD position we could scan the SMEC at selected shutter temperatures, this could be either done moving the black body in and out the beam as described here or could be done as a stand alone measurement.

6.6.2 ILT-PERF-SHE - Shutter Emissivity

Sub-inst:
Photometer + Spectrometer?

Aim:
To verify that the following instrument requirement is met:

- The shutter vane must physically prevent thermal radiation from the Herschel cryostat lid from directly entering the instrument (IRD-SHUT-R01).

Test Setup:

EGSE	SPIRE
Source	Laser
Facility FTS	Not Used
Flip mirror	Pointing to internal black body
Shutter	Chosed
Telescope simulator	Not used
External chopper	Used
PCAL	Off
SCAL	Off
BSM	Off
SMEC	Off

Method:
1. The laser is placed in the beam chopped at a nominal frequency with the external chopper
2. Stabilise.
3. The shutter is set to 9K
4. The detectors are readout for a TBD time period (or number of chop cycles)
5. The test is repeated for different shutter temperatures (9-25 K)

Output Parameters:
Voltage output from all possible detector arrays for active sub-instrument
Detector biases
Shutter temperature(s)
Black body temperature
TBD temperatures
Flip mirror position

Analysis:
All detectors are illuminated hence all arrays in each sub-instrument can be tested simultaneously.
Any modulation in the signal will indicate the shutter emission.

Comments/Open Issues:
None

6.6.3 ILT-PERF-SHC - Shutter Calibrator Characterisation

Sub-inst:
Photometer + Spectrometer?

Aim:
Determine shutter characteristics. Calibrate shutter against internal calibrators. Calibrate shutter against a black body source.
To verify that the following instrument requirements are met:

- The seal of the shutter vane shall be designed so as to reduce stray light entering the instrument to an acceptable level. *Any straylight seal design is to be evaluated by the project team to assess its efficacy* (IRD-SHUT-R02).
- The emissivity of the instrument side of the vane shall be controllable over the range 9-25K (IRD-SHUT-R03).
- The temperature of the instrument side of the vane shall be uniform to within 2% (rms) (IRD-SHUT-R04).
- The temperature of the instrument side of the vane shall be controllable over the range 9-25 K (IRD-SHUT-R05)
- There shall be at least 16 set points over the temperature range specified in IRD-SHUT-R05 (IRD-SHUT-R06)
- The temperature of the instrument side of the vane shall be uniform to within 0.1K (rms) (IRD-SHUT-R07).
- The average temperature of the instrument side of the vane shall be repeatable to within <0.040K (IRD-SHUT-R08)
- The time required to increase the vane temperature by 5K and stabilize to within the repeatability in R1I, assuming that the vane is initially at its minimum (unpowered) temperature, shall be less than 10 minutes (IRD-SHUT-R16).

Test Setup:

EGSE	SPIRE
Source	None
Facility FTS	Not Used
Flip mirror	Not used
Shutter	Closed
Telescope simulator	Not used
External chopper	Not used
PCAL	Off at start of test
SCAL	Off
BSM	Off
SMEC	Off

Method:

1. At the start of the test the shutter is closed.
2. Set the shutter temperature to 9 K
3. Wait for the shutter temperature to stabilise
4. Measure the detector response
5. Cycle PCAL at nominal frequency, number of cycles etc as determined by PCAL characterisation, measuring detector response during cycle

6. After PCAL cycle again measure detector response to the shutter
7. Set the temperature of the shutter to 10 K and repeat.

Output Parameters:
Voltage output from all possible detector arrays for active sub-instrument
Detector biases
Shutter temperature(s)
PCAL temperature
Other TBD PCAL parameters
TBD temperatures
Flip mirror position

Analysis:
The shutter illuminates the whole of each array, so all detectors are tested simultaneously. The response to the calibrator with the shutter in the beam is needed for IST when the cold black body will not be available.

Comments/Open Issues:
None

6.7 Other Tests

6.7.1 ILT-PERF-OBL - Out of Band Radiation Using a Set of Laser Lines

Sub-inst:
Photometer + Spectrometer

Aim:
To check that any out of band radiation reaching the detectors is within the requirement and to characterise what out of band radiation is being detected.

- The end to end filtering of the photometer shall control the out of band radiation to be no more than 10^{-3} for 40 cm^{-1} to 200 cm^{-1} 10^{-6} for 200 cm^{-1} to 1000 cm^{-1} 10^{-9} for 1000 cm^{-1} to 100000 cm^{-1} of the in-band telescope background radiation (IRD-OPTP-R07).
- The end-to-end filtering of the spectrometer shall control the out of band radiation to be no more than 10-3 for 40 cm-1 to 200 cm-1 10-6 for 200 cm-1 to 1000 cm-1 10-9 for 1000 cm-1 to 100000 cm-1 of the in band telescope background radiation (IRD-OPTS-R08).

Test Setup:

EGSE	SPIRE
Source	Laser
Facility FTS	Not Used
Flip mirror	Open
Shutter	Open
Telescope simulator	Used
External chopper	In use
PCAL	Off
SCAL	Off
BSM	Off
SMEC	Set at ZPD

Method:
1. At the start of the test the laser is illuminating the pixel under study with an in-band line and the external chopper chopping at a nominal frequency.
2. Peak-up the beam on the pixel under study using the telescope simulator
3. Put the laser on standby
4. Measure the detector output
5. Set up the laser with an out of band line
6. Measure the detector output
7. Put the laser on standby
8. Measure the detector output
9. Repeat steps 5-8 for other out of band lines
10. Repeat procedure for all pixels in both sub-instruments

Output Parameters:
Voltage output from all possible detector arrays for active sub-instrument
Detector biases
Laser line used
Laser output

SMEC position (both optical encoder and LVDT)
TBD temperatures
Flip mirror position if used
Chopper frequency

Analysis:
The two room measurements are used to establish a baseline. Any signal above this baseline when the laser is on is an out of band contribution.

Comments/Open Issues
The spectral bandpass determination will also give us some information on the out of band rejection.
Very bright lines must be used for this test.
As each spectrometer pixel is tested individually we can use the ZPD position for that pixel.
We might want to consider also scanning the SMEC but this may fall outside our time constraint.
Also we want to try to use the telescope simulator to shine light into the instrument at non-standard angles. The feasibility of this will need to be investigated.

6.7.2 ILT-PERF-OBS - Out of Band Radiation Using the SMEC

Sub-inst:
Spectrometer

Aim:
To check that any out of band radiation reaching the detectors is within the requirement and to characterise what out of band radiation is being detected.

- The end to end filtering of the photometer shall control the out of band radiation to be no more than 10^{-3} for 40 cm^{-1} to 200 cm^{-1} 10^{-6} for 200 cm^{-1} to 1000 cm^{-1} 10^{-9} for 1000 cm^{-1} to 100000 cm^{-1} of the in-band telescope background radiation (IRD-OPTP-R07).
- The end-to-end filtering of the spectrometer shall control the out of band radiation to be no more than 10-3 for 40 cm-1 to 200 cm-1 10-6 for 200 cm-1 to 1000 cm-1 10-9 for 1000 cm-1 to 100000 cm-1 of the in band telescope background radiation (IRD-OPTS-R08).

Test Setup:

EGSE	SPIRE
Source	Laser
Facility FTS	Not used
Flip mirror	Open
Shutter	Open
Telescope simulator	In use
External chopper	Not used
PCAL	Off
SCAL	Null value for room temperature?
BSM	Off
SMEC	Set at ZPD

Method:
1. At the start of the test the laser is illuminating the pixel under study with an in-band line and the SMEC is set the ZPD position of the pixel under study.
2. Peak-up the beam on the pixel under study using the telescope simulator
3. Scan the SMEC over its full range.
4. Repeat with the laser set up with out of band lines

Output Parameters:
Voltage output from all possible detector arrays for active sub-instrument
Detector biases
Laser line used
Laser output
SCAL temperature
SMEC position (both optical encoder and LVDT)
TBD other temperatures
Flip mirror position if used

Analysis:

Comments/Open Issues
None

6.7.3 ILT-PERF-OBE - Out of Band Radiation Using an Edge Filter

Sub-inst:
Spectrometer

Aim:
To check that any out of band radiation reaching the detectors is within the requirement and to characterise what out of band radiation is being detected.

- The end to end filtering of the photometer shall control the out of band radiation to be no more than 10^{-3} for 40 cm^{-1} to 200 cm^{-1} 10^{-6} for 200 cm^{-1} to 1000 cm^{-1} 10^{-9} for 1000 cm^{-1} to 100000 cm^{-1} of the in-band telescope background radiation (IRD-OPTP-R07).
- The end-to-end filtering of the spectrometer shall control the out of band radiation to be no more than 10-3 for 40 cm-1 to 200 cm-1 10-6 for 200 cm-1 to 1000 cm-1 10-9 for 1000 cm-1 to 100000 cm-1 of the in band telescope background radiation (IRD-OPTS-R08).

Test Setup:

EGSE	SPIRE
Source	Hot BB
Facility FTS	Not used
Flip mirror	Open
Shutter	Open
Telescope simulator	In use
External chopper	Used
PCAL	Off
SCAL	Null value for room temperature?
BSM	Off
SMEC	Set at ZPD

We will also need an edge filter that will allow mid-ir through but reject far-ir placed in the beam from the TS

Method:
1. At the start of the test the hot black body is illuminating the pixel under study and the SMEC is set at ZPD.
2. Peak-up the beam on the pixel under study using the telescope simulator
3. Scan the SMEC over its full range.
4. Repeat for other pixels
5. Repeat for photometer pixels, instead of scanning, take a time series.

Analysis:
Any OOB radiation will show in the spectrometer output spectrum. In the case of the photometer, the time series can be compared to the ILT-PERF-DRB test.

Output Parameters:
Voltage output from all possible detector arrays for active sub-instrument
Detector biases
Laser line used
Laser output
SCAL temperature

SMEC position (both optical encoder and LVDT)
TBD other temperatures
Flip mirror position if used

Comments/Open Issues:
The facility FTS could be used for the photometer test if OOB rejection is not found to be nominal

7 Cross Matrix Between Tests and Instrument and Calibration Requirements

7.1 Tests

Test	Identifier	Sub-Inst	Instrument Requirement(s)	Calibration Requirement
Requirements not covered by tests				
RD2		Both	IRD-OPTP-R00, R02, R03, R04, R06 IRD-OPTS-R02, R03, R04, R06 IRD-PHOT-R10	None
RD3		Both	IRD-FTB-R05, IRD-CALS-R09	None
RD5		Both	IRD-FTB-R02 IRD-DETP-R10 IRD-DETS-R11	None
By Design		Both	IRD-CALP-R03	None
Harness acceptance package		Both	IRD-FPHR-R01, R02	None
Optical Tests				
Telescope pupil illumination	ILT-PERF-OPI	Both	None	CRD-PAR-9
Balancing of Ports	ILT-PERF-OBP	FTS	IRD-OPTS-R07	None
Pixel Spatial Information using the laser	ILT-PERF-OSL	Both	IRD-PHOT-R02, R03, R05, R10, R16 IRD-SPEC-R04, R05, R07	CRD-PAR-8, CRD-PAR-10 CRD-PAR-14
Pixel Spatial Information using the external black body	ILT-PERF-OSB	Both	IRD-PHOT-R02, R03, R05, R10, R16 IRD-SPEC-R04, R05, R07	CRD-PAR-8, CRD-PAR-10 CRD-PAR-14
Point Spread Function Check Using The BSM	ILT-PERF-OPB	Both	IRD-OPS-R05	None
Detector Tests				
JFET Operating Temperature Range	ILT-PERF-DFT	Both	IRD-FTB-R06 IRD-RFM-R04	None
Amplifier noise	ILT-PERF-DAN	Both	None	None
Detector noise characterisation	ILT-PERF-DND	Both	None	CRD-PAR-5
Detector noise characterisation	ILT-PERF-DST	Both	None	CRD-PAR-5
Detector noise characterisation	ILT-PERF-DOT	Both	IRD-OPTP-R08, IRD-OPTS-R09 IRD-STRC-R08, IRD-STRP-R06 IRD-STRS-R06, IRD-FTB-R01 IRD-PHOT-R12	CRD-PAR-5
Detector noise characterisation	ILT-PERF-DNA	Both	None	CRD-PAR-5
Blanked Load Curves	ILT-PERF-DDB	Both	None	None
Blanked Load Curves	ILT-PERF-DAB	Both	None	None
Optical Load curves	ILT-PERF-DDL	Both	IRD-DETP-R01, R03 IRD-DETS-R01, R03 IRD-OPTP-R05 IRS-OPTS-R05	CRD-PAR-1?, CRD-PAR-2, CRD-PAR-3?
Optical Load curves	ILT-PERF-DAL	Both	IRD-DETP-R01, R03 IRD-DETS-R01, R03 IRD-OPTP-R05 IRS-OPTS-R05	CRD-PAR-1?, CRD-PAR-2, CRD-PAR-3?
Microphonic	ILT-PERF-DMD	Both	None	None

Susceptibility				
Microphonic Susceptibility	ILT-PERF-DMA	Both	None	None
Microphonic Susceptibility	ILT-PERF-DDM	Both	IRD-DETP-R09 IRD-DETS-R10	None
Microphonic Susceptibility	ILT-PERF-DAM	Both	IRD-DETP-R09 IRD-DETS-R10	None
Detector relative response vs input power using the laser	ILT-PERF-DRL	Both	IRD-DETP-R02, R03, R05, R06 IRD-DETS-R02, R03, R05, R06 IRD-PHOT-R04, R11, R18	CRD-PAR-11 CRD-PAR-12
Detector relative response vs input power using the external black body	ILT-PERF-DRB	Both	IRD-DETP-R02, R03, R05, R06 IRD-DETS-R02, R03, R05, R06 IRD-PHOT-R04, R11, R18	CRD-PAR-11 CRD-PAR-12
Spectral Response	ILT-PERF-DSR	Both	IRD-DETP-R08 IRD-DETS-R08 IRD-PHOT-R01 IRD-SPEC-R01	CRD-PAR-4, CRD-PAR-15
Calibrator Performance				
Photometer Calibrator Characterisation	ILT-PERF-CPC	Phot	IRD-CALP-R01, R02, R04, R05, R06, R07 IRD-PHOT-R14, R15 IRD-SPEC-R16	CRD-PAR-16
Spectrometer Calibrator Characterisation	ILT-PERF-CSC	FTS	IRD-CALS-R01, R03, R04	CRD-PAR-19
Room Temperature Nulling	ILT-PERF-CSR	FTS	None	None
Spectrometer Calibrators Performance with Time	ILT-PERF-CST	FTS	IRD-CALS-R05, R06	None
SMEC Tests				
ZPD Position	ILT-PERF-SZP	FTS	IRD-SMEC-R04	CRD-PAR-17
Fringe Contrast and Spectral Response While Scanning	ILT-PERF-SFC	FTS	IRD-OPTS-R10 IRD-SPEC-R02, R03, R06, R07, R11, R14, R17 IRD-SMEC-R01, R02 R03, R05, R06, R07, R08, R09, R10 IRD-DETS-R09	CRD-PAR-20, CRD-PAR-21 CRD-PAR-18
Fringe Contrast and Spectral Response Step and Look	ILT-PERF-SFL	FTS	IRD-OPTS-R10 IRD-SPEC-R02, R03, R06, R07, R11, R14, R17 IRD-SMEC-R01, R02 R03, R05, R09, R10 IRD-DETS-R09	CRD-PAR-20, CRD-PAR-21 CRD-PAR-18
Mirror Carriage Characterisation While Scanning	ILT-PERF-SMC	FTS	IRD-SMEC-R01, R02 R03, R05, R06, R07, R08, R09, R10 IRD-SPEC-R17 IRD-DETS-R09 IRD-SPEC-R06	None
Mirror Carriage Characterisation Step and Look	ILT-PERF-SML	FTS	IRD-SMEC-R01, R02 R03, R05, R09, R10 IRD-SPEC-R17 IRD-DETS-R09 IRD-SPEC-R06	None
BSM Tests				
BSM characterisation	ILT-PERF-BSM	Both	IRD-BSMP-R05, R06, R07, R08	None
BSM Chop Throw	ILT-PERF-BCT	Both	IRD-BSMP-R01, R02, R03, R04 IRD-PHOT-R17	None

Shutter Tests				
Shutter Characterisation	ILT-PERF-SHB	Phot	IRD-SHUT-R02, R03, R04, R05, R06, R07, R08, R16	None
Shutter Emissivity	ILT-PERF-SHE	Phot	IRD-SHUT-R01	None
Shutter Calibrator Characterisation	ILT-PERF-SHC	Phot	IRD-SHUT-R02, R03, R04, R05, R06, R07, R08, R16	None
Other Tests				
Out of Band Radiation Using a Set of Laser Lines	ILT-PERF-OBL	Both	IRD-OPTP-R07, IRD-OPTS-R08	None
Out of Band Radiation Using the SMEC	ILT-PERF-OBS	Both	IRD-OPTP-R07, IRD-OPTS-R08	None
Out of Band Radiation Using an Edge Filter	ILT-PERF-OBE	Both	IRD-OPTP-R07, IRD-OPTS-R08	None

7.2 Observatory Functions

Observing Mode	Identifier	Sub-inst	Brief Description	Instrument Requirement(s)
POF1	ILT-OBS-PO1	PHOT	Chop without jiggling	IRD-CMD-R08, IRD-CMD-R11, IRD-DATA-R05 IRD-MODE-R01, ILT-SAFE-R04, IRD-TLM-R09
POF2	ILT-OBS-PO2	PHOT	Seven point jiggle map	IRD-CMD-R08, IRD-CMD-R11, IRD-DATA-R05 IRD-MODE-R01, IRD-OPS-R07, ILT-SAFE-R04, IRD-TLM-R09
POF3	ILT-OBS-PO3	PHOT	N point jiggle map	IRD-CMD-R08, IRD-CMD-R11, IRD-DATA-R05 IRD-MODE-R01, IRD-OPS-R05, IRD-OPS-R06 ILT-SAFE-R04, IRD-TLM-R09
POF4	ILT-OBS-PO4	PHOT	Raster map	IRD-CMD-R08, IRD-CMD-R11, IRD-DATA-R05 IRD-MODE-R01 ILT-SAFE-R04, IRD-TLM-R09
POF5	ILT-OBS-PO5	PHOT	Scan map without chopping	IRD-CMD-R08, IRD-CMD-R11, IRD-DATA-R05 IRD-MODE-R01, ILT-SAFE-R04, IRD-TLM-R09
POF6	ILT-OBS-PO6	PHOT	Scan map with chopping	IRD-CMD-R08, IRD-CMD-R11, IRD-DATA-R05 IRD-MODE-R01, ILT-SAFE-R04, IRD-TLM-R09
POF7	ILT-OBS-PO7	PHOT	Photometer peak up	IRD-CMD-R08, IRD-CMD-R11, IRD-DATA-R05 IRD-MODE-R01, IRD-OPS-R08, ILT-SAFE-R04, IRD-TLM-R09
POF8	ILT-OBS-PO8	PHOT	Photometer calibrate	IRD-CMD-R08, IRD-CMD-R11, IRD-DATA-R05 IRD-MODE-R01, ILT-SAFE-R04, IRD-TLM-R09
SOF1	ILT-OBS-SO1	FTS	Point source spectrum	IRD-CMD-R08, IRD-CMD-R11, IRD-

				DATA-R05 IRD-MODE-R01, ILT-SAFE-R04, IRD-TLM-R09
SOF2	ILT-OBS-SO2	FTS	Fully sampled spectral map within FOV	IRD-CMD-R08, IRD-CMD-R11, IRD-DATA-R05 IRD-MODE-R01, ILT-SAFE-R04, IRD-TLM-R09
SOF3	ILT-OBS-S03	FTS	Point source spectrum (Step and Integrate)	IRD-CMD-R08, IRD-CMD-R11 IRD-DATA-R05 IRD-MODE-R01, ILT-SAFE-R04, IRD-TLM-R09
SOF4	ILT-OBS-S04	FTS	Fully sampled spectral map (Step and Integrate)	IRD-CMD-R08, IRD-CMD-R11 IRD-DATA-R05 IRD-MODE-R01, ILT-SAFE-R04, IRD-TLM-R09
Parallel/Serendipity Modes?	ILT-OBS-PPS	PHOT	parallel and serendipity mode operation	IRD-CMD-R08, IRD-CMD-R11, IRD-DATA-R05 IRD-MODE-R01, ILT-SAFE-R04, IRD-TLM-R09

7.3 Degraded Operations

Backup Mode	Identifier	Sub-inst	Brief Description	Instrument Requirement(s)
Automatic Cooler Recycling	ILT-BCR	Cooler	command cooler to recycle using DPU only	IRD-CMD-R08, IRD-CMD-R11, IRD-CMD-R05 IRD-MODE-R01, IRD-REL-R02, IRD-SAFE-R04, IRD-TLM-R08
Slow chop mode	ILT-BSC	PHOT FTS	re-assess use of AOTs with chopper driven slowly	IRD-CMD-R08, IRD-CMD-R11, IRD-CMD-R05 IRD-MODE-R01, IRD-REL-R02, IRD-SAFE-R04, IRD-TLM-R08
BSM open loop	ILT-BOF	BSM	failure of position sensor means the actuators are commanded directly	IRD-CMD-R08, IRD-CMD-R11, IRD-CMD-R05 IRD-MODE-R01, IRD-REL-R02, IRD-SAFE-R04, IRD-TLM-R08
Single axis BSM operation	ILT-BAF	BSM	characterise BSM operation with only one axis available	IRD-CMD-R08, IRD-CMD-R11, IRD-CMD-R05 IRD-MODE-R01, IRD-REL-R02, IRD-SAFE-R04, IRD-TLM-R08
FTS slow scanning	ILT-BFS	FTS	characterise a set of scan speeds to be used in case default speed is too high	IRD-CMD-R08, IRD-CMD-R11, IRD-CMD-R05 IRD-MODE-R01, IRD-REL-R02, IRD-SAFE-R04, IRD-TLM-R08
Open loop operation of FTS mechanism	ILT-BOL	FTS	characterise behaviour of FTS in open loop in case position sensor is lost	IRD-CMD-R08, IRD-CMD-R11, IRD-CMD-R05 IRD-MODE-R01, IRD-REL-R02, IRD-SAFE-R04, IRD-TLM-R08
Selection of pixels for telemetry	ILT-BTM	PHOTFTS	characterise how, and determine which, pixels to select if only a limited sub-set of pixels can be telemetered	IRD-CMD-R08, IRD-CMD-R11, IRD-CMD-R05 IRD-MODE-R01, IRD-REL-R02, IRD-SAFE-R04, IRD-TLM-R08
Spectrometer Operation without calibrator	ILT-BFC	FTS	Determine most effective way to operate FTS in case of the FTS calibrator failure	IRD-CMD-R08, IRD-CMD-R11, IRD-CMD-R05 IRD-MODE-R01, IRD-REL-R02, IRD-SAFE-R04, IRD-TLM-R08

8 Cross Matrix Between Instrument Requirements and Tests

Note: Recent changes to AD1 given in red, ops requirements are in blue, and cal requirements in green.

Reference	Verification Method	Model1	Test ID	Requirement	
IRD BSMP-R01	Design analysis Instrument level performance tests	CQM PFM	ILT_PERF	The BSM shall move the imaged field of view of the detectors by a maximum of ± 130 arcsec on the sky in the ± Y axis of the satellite.	ILT-PERF-BCT
IRD-BSMP-R02	Design analysis Instrument level performance tests	CQM PFM	ILT_PERF	The BSM shall move the imaged field of view of the detectors by a maximum of ± 30 arcsec in the ± Z axis of the satellite	ILT-PERF-BCT
IRD-BSMP-R03	Design analysis Instrument level performance tests	CQM PFM	ILT_PERF	The minimum step size in either chop or jiggle axes shall be 2 arcsec	ILT-PERF-BCT
IRD-BSMP-R04	Design analysis Instrument level performance tests	CQM PFM	ILT_PERF	The chop frequency in either axis shall be continuously variable or selectable in 16 steps from 0 to 2 Hz for nominal operation and power dissipation. The chop frequency should be capable of reaching 5 Hz with increased power dissipation and settling time.	ILT-PERF-BCT
IRD-BSMP-R05	Design analysis Instrument level performance tests	CQM PFM	ILT_PERF	The BSM shall be capable of moving to and holding indefinitely at any commanded position within its range of movement.	ILT-PERF-BSM
IRD-BSMP-R06	Design analysis Instrument level performance tests	CQM PFM	ILT_PERF	The angle on the sky must not vary by more than 0.1 arcsec (TBC) over 60 sec at the commanded mirror position. The mirror position shall also have a stability equivalent to 0.2 arcsec rms in the 0.03 to 25 Hz frequency band.	ILT-PERF-BSM
IRD-BSMP-R07	Design analysis Instrument level performance tests	CQM PFM	ILT_PERF	The knowledge of the mirror position shall be equivalent to a stability of 0.2 arcsec rms in the 0.03 to 25 Hz frequency band.. The absolute knowledge of the mirror position shall be equivalent to less than 0.01 arcsec (TBC).	ILT-PERF-BSM
IRD-BSMP-R08	Design analysis Instrument performance tests	CQM PFM	ILT_PERF	The mirror shall settle to within 1 arcsec of its commanded position in less than 20 milliseconds.	ILT-PERF-BSM
IRD-CALP-R01	Design Analysis Instrument level performance tests	CQM PFM	ILT_PERF	Niminal operating output Equivalent to eT=40 K for 200<?<700µm	ILT-PERF-CPC
IRD-CALP-R02	Design Analysis Instrument level performance tests	CQM PFM	ILT_PERF	Operating range Commandable in 256 steps with at least 124 steps covering the range from zero output to eT=40K.	ILT-PERF-CPC
IRD-CALP-R03	Design Analysis Instrument level performance tests	CQM PFM	ILT_PERF	Equivalent obscuration of aperture through the BSM mirror.The outside envelope of the calibrator housing shall not foul on any part of the BSM for any operational angular position of the BSM.	By design
IRD-CALP-R04	Design Analysis Instrument level performance tests	CQM PFM	ILT_PERF	Speed of response In response to a step change in applied electrical power, the 90% settling time of the radiant power output shall be less than 350ms (requirement); 70ms (goal).	ILT-PERF-CPC
IRD-CALP-R05	Design Analysis Instrument level performance tests	CQM PFM	ILT_PERF	Repeatability: RMS of output signal better than 1% over 20 cycles on to off during a calibration operation of less than 2 minutes. Drift less than 10% over lifetime of the	ILT-PERF-CPC

				mission. Repeatability of signal 1% for 12 calibration operations equi-spaced over a period of 12 hours, with uniform base temperature and drive current.	
IRD-CALP-R06	Design analysis Instrument level operations tests	CQM PFM	ILT_OPS	Operation: Nominally once per hour for no more than 10 seconds.	ILT-PERF-CPC
IRD-CALP-R07	Design analysis Instrument level operations tests	CQM PFM	ILT_OPS	Frequency: continuously or pseudo continuously variable between 0 and 2 Hz	ILT-PERF-CPC
IRD-CALS-R01	Design analysis Instrument level performance tests	CQM PFM	ILT_PERF	Radiated Spectrum: Null the central maximum to accuracy of 5% (goal 2%)[TBC] Replicate the dilute spectrum of the telescope to an accuracy of better than 20% (goal 5%) [TBC] over 200-400 µm	ILT-PERF-CSC
IRD-CALS-R02					*Deleted*
IRD-CALS-R03	Design analysis Instrument level cold functional tests Instrument level performance tests	CQM PFM	ILT_CFT ILT_PERF	Adjustability: Zero – maximum in 256 steps	ILT-PERF-CSC
IRD-CALS-R04	Design analysis Instrument level performance tests	CQM PFM	ILT_PERF	The uniformity of the intensity from the calibration source across the field image at the detector shall be better than 5%	ILT-PERF-CSC
IRD-CALS-R05	Design analysis Instrument level performance tests	CQM PFM	ILT_PERF	Repeatability and drift: The output intensity of the calibration source shall drift no more than 1% over one hour of continuous operation. The absolute change in the output intensity of the source shall be no more than 15% over the mission lifetime.	ILT-PERF-CST
IRD-CALS-R06	Design analysis Instrument level operations tests	CQM PFM	ILT_OPS	The calibration source shall be capable of continuous operation for periods of up to 2 hours with no loss of operational performance	ILT-PERF-CST
IRD-CALS-R09	Design analysis Instrument level cold functional test Instrument level operations tests	CQM PFM	ILT_CFT ILT_OPS	Power dissipation in the focal plane: Shall be within the specification given in the SPIRE System Budgets document (SPIRE-RAL-DOC-00410)	RD3
IRD-CMD-R08	Design analysis AVM functional tests Instrument level operations tests	AVM CQM PFM FS	ILT_FUNC ILT_OPS	The instrument shall provide commands to execute the functions required to implement the instrument operating modes.	ILT-PO(1-8) ILT-SO(1-2) All backup modes
IRD-CMD-R11	Design analysis AVM functional tests instrument level operations tests	AVM CQM PFM FS	AVM_FUNC ILT_OPS	The instrument shall provide commands to allow identification of the steps within an observation.	ILT-PO(1-8) ILT-SO(1-2) All backup modes
IRD-DATA-R05	Design analysis AVM functional tests instrument level operations tests	AVM CQM PFM FS	AVM_FUNC ILT_OPS	The packing of science data into science data packets shall minimise loss of information if packet is lost or corrupted.	ILT-PO(1-8) ILT-SO(1-2) All backup modes
IRD-DETP-R01	Design analysis Instrument level performance tests	CQM PFM	ILT_PERF	Detective Quantum Efficiency at 2 Hz at nominal incident power levels > 0.6	ILT-PERF-DDL ILT-PERF-DAL
IRD-DETP-R02	Design analysis Instrument level performance tests	CQM PFM	ILT_PERF	Time constant 16 milliseconds (Equivalent to 10 Hz)	ILT-PERF-DRL ILT-PERF-DRB
IRD-DETP-R03	Design analysis instrument level performance tests	CQM PFM	ILT_PERF	Uniformity NEP spec. shall be met over the whole array. Responsivity variations shall be less than 10% across the array and calibrated to an accuracy of <1%	ILT-PERF-DDL ILT-PERF-DAL ILT-PERF-DRL ILT-PERF-DRB
IRD-DETP-R05	Design analysis Instrument level cold functional tests Instrument level performance tests	CQM PFM	ILT_CFT ILT_PERF	Electrical crosstalk for near neighbour pixels. Requirement is less than 1% with a goal to be less than the optical cross talk at the output of the cold JFET amplifiers.	ILT-PERF-DRL ILT-PERF-DRB
IRD-DETP-R06	Design analysis Instrument level cold functional tests	CQM PFM	ILT_CFT ILT_PERF	Electrical crosstalk for any pair of pixels. Requirement is less than 0.1% (TBC) at the	ILT-PERF-DRL ILT-PERF-DRB

	Instrument level performance tests			output of the cold JFET preamplifiers. Goal is to be less than the optical cross talk.	
IRD-DETP-R08	Design analysis Instrument level performance tests	CQM PFM	ILT_PERF	Spectral response ≥ 90% at the nominal edge frequencies of the appropriate passband	ILT-PERF-DSR
IRD-DETP-R09	Design analysis Instrument level performance tests	CQM PFM	ILT_PERF	The design of the detector structural support and the detector harnessing shall be such as to minimise the impact of any microvibration induced in the instrument by internal or external sources.	ILT-PERF-DDM ILT-PERF-DAM
IRD-DETP-R10	Design analysis instrument level EMC tests instrument level performance tests	CQM PFM	ILT_EMC ILT_PERF	The design of any harnesses associated with the detectors that form part of the instrument RF shield shall be such as to minimise the influence of any potential EMI. All metalwork surounding the detectors at 300mK is electrically isolated from local chassis ground due to its Kevlar suspension. So that it can be grounded, the 300-mK metalwork shall be wired to the 1.7K connector PCB through the 300mK to 1.7K harness. Here it shall be possible to connect it to Bias Ground and/or local chassis.	RD5
IRD-DETS-R01	Design analysis Instrument level performance tests	CQM PFM	ILT_PERF	Detective Quantum Efficiency at 20 Hz at nominal incident power levels SW 200-300 µm > 0.6 LW 300-400 µm > 0.6 LW > 400 µm as large as possible	ILT-PERF-DDL ILT-PERF-DAL
IRD-DETS-R02	Design analysis instrument level performance tests	CQM PFM	ILT_PERF	Time constant 8 milliseconds (Equivalent to 20 Hz)	ILT-PERF-DRL ILT-PERF-DRB
IRD-DETS-R03	Design analysis instrument level performance tests	CQM PFM	ILT_PERF	Uniformity NEP spec. shall be met over the whole array Responsivity variations shall be less than 10% across the array and calibrated to an accuracy of <1%	ILT-PERF-DDL ILT-PERF-DAL ILT-PERF-DRL ILT-PERF-DRB
IRD-DETS-R05	Design analysis Instrument level cold functional tests Instrument level performance tests	CQM PFM	ILT_CFT ILT_PERF	Electrical crosstalk for near neighbour pixels: Requirement is less than 1% at the output of the cold JFET amplifiers. Goal of less than the optical cross talk.	ILT-PERF-DRL ILT-PERF-DRB
IRD-DETS-R06	Design analysis Instrument level cold functional tests Instrument level performance tests	CQM PFM	ILT_CFT ILT_PERF	Electrical crosstalk any pair of pixels: Requirement is less than 0.1% at the output of the cold JFET preamplifiers. Goal is to be less than the optical crosstalk.	ILT-PERF-DRL ILT-PERF-DRB
IRD-DETS-R08	Design analysis Instrument level performance tests	CQM PFM	ILT_PERF	Spectral Response SW 200-300 µm ≥ 90% LW 300-400 µm ≥ 90% LW>400 µm as large as possible	ILT-PERF-DSR
IRD-DETS-R09	Design analysis Instrument level warm functional tests instrument level performance tests	CQM PFM	ILT_WFT ILT_PERF	The spectrometer bolometer pixels shall be capable of being readout at the rate required by the FTS mechanism and position control system – nominally 80 Hz (TBC).	ILT-PERF-SFC ILT-PERF-SFL
IRD-DETS-R10	Design analysis Instrument level performance tests	CQM PFM	ILT_PERF	The design of the detector structural support and the detector harnessing shall be such as to minimise the impact of any microvibration induced in the instrument by internal or external sources.	ILT-PERF-DDM ILT-PERF-DAM
IRD-DETS-R11	Design analysis Instrument level EMC tests Instrument level performance tests	CQM PFM	ILT_EMC ILT_PERF	The design of any harnesses associated with the detectors that form part of the instrument RF shield shall be such as to minimise the influence of any potential EMI. All metalwork surounding the detectors at 300mK is electrically isolated from local chassis ground due to its Kevlar suspension.	RD5

				So that it can be grounded, the 300-mK metalwork shall be wired to the 1.7K connector PCB through the 300mK to 1.7K harness. Here it shall be possible to connect it to Bias Ground and/or local chassis.	
IRD-FPHR-R01	Design analysis Instrument level cold functional test Instrument level performance test	CQM PFM	ILT_CFT ILT_PERF	The wire-to-wire capacitance of the cables running from the detector arrays to the JFET modules will be < 50 pF (TBC).	Harness acceptance package
IRD-FPHR-R02	Design analysis instrument level performance tests	CQM PFM	ILT_PERF	The detector harness cables routed inside the structure shall be affixed to have a mechanical resonant frequency > 1kHz (TBC)	Harness acceptance package
IRD-FTB-R01	Design analysis Instrument level cold functional test Instrument level performance test	CQM PFM	ILT_CFT ILT_PERF	Amplifier noise. Requirement better than 10nV $Hz^{-1/2}$ over a bandwidth of 100 to 1400 Hz. Goal 7 nV $Hz^{-1/2}$.	ILT-PERF-DOT
IRD-FTB-R02	Design analysis Instrument level EMC test Instrument level performance test	CQM PFM	ILT_EMC ILT_PERF	The RF filters, as fitted in the box and with the correct harness, connectors and back-shells: shall reject all frequencies from 500 MHz to 10 GHz at –60 dB.	RD5
IRD-FTB-R05	Design analysis Instrument level thermal verification Instrument level cold functional test Instrument level operations tests	STM CQM PFM	ILT_THER ILT_CFT ILT_OPS	The dissipation of JFET amplifiers shall be heat sunk to the level 2 cryostat stage. The dissipation shall be within the specification given in RD8.	RD3
IRD-FTB-R06	Design analysis Instrument level performance tests	CQM PFM	ILT_PERF	The JFET amplifiers and RF filters shall be capable of operating in with the temperature of the mounting point of the box in the range 4 to 300-K	ILT-PERF-DFT
IRD-MODE-R01	Design analysis Instrument level operations tests	CQM PFM FS	ILT_OPS	The instrument shall be capable executing all operating modes described in the SPIRE Operating Modes Document (RD8)	ILT-PO(1-8) ILT-SO(1-2) All backup modes
IRD-OPS-R05	Design analysis Instrument level operations tests	CQM PFM FS	ILT_OPS	The photometer should have an observing mode that permits accurate measurement of the point spread function	ILT-PERF-OPB ILT-PO3
IRD-OPS-R06	Design analysis Instrument level operations tests	CQM PFM FS	ILT_OPS	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	ILT-PO3
IRD-OPS-R07	Design analysis Instrument level performance tests	CQM PFM FS	ILT_OPS	The photometer observing modes shall include provision for 5-point or 7-point jiggle maps for accurate point source photometry	ILT-PO2
IRD-OPS-R08	Design analysis Instrument level operations tests	CQM PFM FS	ILT_ALIGN ILT_OPS	The photometer shall have a "peak up" observing mode capable of being implemented without using satellite pointing	ILT-PO7
IRD-OPTP-R00	Design analysis Instrument level alignment verification Instrument level performance tests	STM CQM	ILT_ALIGN ILT_PERF	The optical design of the photometer fore-optics shall be compatable with the Herschel telescope optical design.	RD2
IRD-OPTP-R02	Design analysis Instrument level alignment verification Instrument level performance tests	STM CQM PFM	ILT_ALIGN ILT_PERF	The focal ratio at any point in the FOV must be within 20% (TBC) of that of the on-axis point.	RD2
IRD-OPTP-R03	Design analysis Instrument level alignment verification Instrument level performance tests	STM CQM PFM	ILT_ALIGN ILT_PERF	The image of the telescope field of view is nominally rectangular. The position of any point within the image of the FOV at the detectors must be within 10% (TBC) of the actual position of the point at the telescope focal plane.	RD2
IRD-OPTP-R04	Design analysis Instrument	STM	ILT_ALIGN	The anamorphic ratio of the image of a point	RD2

	level alignment verification Instrument level performance tests	CQM PFM	ILT_PERF	source at the detectors must be no more than 6:5 (TBC) in any pair of orthogonal directions at ant point in the FOV.	
IRD-OPTP-R05	Design analysis Instrument level alignment verification Instrument level performance tests	STM CQM PFM	ILT_ALIGN ILT_PERF	The throughput of the photometer mirrors, filters, dichroics and baffles shall be greater than 0.27 (TBC) over the instrument waveband. This includes losses due to manufacturing defects; surface finish and alignment tolerances.	ILT-PERF-DDL ILT-PERF-DAL
IRD-OPTP-R06	Design analysis Instrument level alignment verification Instrument level performance tests	STM CQM PFM	ILT_ALIGN ILT_PERF	The photometer optics shall give a Strehl ratio of greater than 0.9 (TBC) over the full FOV at 250 µm including all losses due to alignment; mirror quality etc.	RD2
IRD-OPTP-R07	Design analysis Instrument level performance tests	CQM PFM	ILT_ALIGN ILT_PERF	The end to end filtering of the photometer shall control the out of band radiation to be no more than 10^{-3} for 40 cm^{-1} to 200 cm-1 10^{-6} for 200 cm^{-1} to 1000 cm-1 10^{-9} for 1000 cm^{-1} to 100000 cm-1 of the in-band telescope background radiation.	ILT-PERF-OBL ILT-PERF-OBS ILT-PERF-OBE
IRD-OPTP-R08	Design analysis Instrument level performance tests	CQM PFM	ILT_PERF	The background power falling on the detectors with the optical beam blocked shall be no more than 5% (TBC) of the in-band background power from the telescope over the 200-300 µm band 5% (TBC) over the 300-400 µm band and 5% (TBC) over the 400-670 µm band.	ILT-PERF-DOT
IRD-OPTS-R02	Design analysis Instrument level alignment verification Instrument level performance tests	STM CQM PFM	ILT_ALIGN ILT_PERF	The focal ratio at any point in the FOV must be within 20% (TBC) of the on-axis point.	RD2
IRD-OPTS-R03	Design analysis Instrument level alignment verification Instrument level performance tests	STM CQM PFM	ILT_ALIGN ILT_PERF	The position of any point within the image of the FOV at the detectors must be within 10% (TBC) of the actual position of the point at the telescope focal plane.	RD2
IRD-OPTS-R04	Design analysis Instrument level alignment verification Instrument level performance tests	STM CQM PFM	ILT_ALIGN ILT_PERF	The anamorphic ratio of the image of a point source at the detectors must be no more than 6:5 (TBD) in any pair of orthogonal directions.	RD2
IRD-OPTS-R05	Design analysis Instrument level alignment verification Instrument level performance tests	STM CQM PFM	ILT_ALIGN ILT_PERF	The theoretical throughput of the spectrometer mirrors; filters; beam splitters and baffles shall be greater than 0.2 (TBC) over the total instrument waveband (TBC) including all losses due to manufacturing defects; surface finish and alignment tolerances.	ILT-PERF-DDL ILT-PERF-DAL
IRD-OPTS-R06	Design analysis Instrument level alignment verification Instrument level performance tests	STM CQM PFM	ILT_ALIGN ILT_PERF	The spectrometer optics shall give a Strehl ratio of greater than 0.9 (TBC) over the as much of the FOV as possible at 250 µm including all losses due to alignment; mirror quality etc.	RD2
IRD-OPTS-R07	Design analysis Instrument level performance tests	CQM PFM	ILT_PERF	In order that the two output ports shall have the same performance and to facilitate accurate compensation of the zero path difference maximum, the beam splitters shall have 2RT equal to R^2+T^2 to within 90% (TBC) over the waveband of the instrument.	ILT-PERF-OBP
IRD-OPTS-R08	Design analysis Instrument level performance tests	CQM PFM	ILT_PERF	The end-to-end filtering of the spectrometer shall control the out of band radiation to be no more than	ILT-PERF-OBL ILT-PERF-OBS ILT-PERF-OBE

				10-3 for 40 cm-1 to 200 cm-1 10-6 for 200 cm-1 to 1000 cm-1 10-9 for 1000 cm-1 to 100000 cm-1 of the in band telescope background radiation.	
IRD-OPTS-R09	Design analysis Instrument level performance tests	CQM PFM	ILT_PERF	The background power falling on the detectors with the optical beam blocked shall be no more than 5% (TBC) of the in band background power from the telescope over the 200-400µm band and 5% (TBC) over the 400-670 µm band.	ILT-PERF-DOT
IRD-OPTS-R10	Design analysis Instrument level performance tests	CQM PFM	ILT_PERF	The FWHM of the resolution element at any point in the FOV shall be no more than 10% greater than the on-axis value for a nominal resolution of 0.4 cm^{-1}.	ILT-PERF-SFC ILT-PERF-SFL
IRD-PHOT-R01	Design analysis Instrument level performance tests	CQM PFM	ILT_PERF	Nominal passband (?/??) for all three arrays = 3	ILT-PERF-DSR
IRD-PHOT-R02	Design analysis Instrument level performance tests	CQM PFM	ILT_PERF	Field of view for all three arrays: req. = 4x4, goal=4x8	ILT-PERF-OSL ILT-PERF-OSB
IRD-PHOT-R03	Design analysis Instrument level performance tests	CQM PFM	ILT_PERF	Beam FWHM (Arcsec) = 18 (250µm), 25 (350µm), 36 (500µm) all TBC	ILT-PERF-OSL ILT-PERF-OSB
IRD-PHOT-R04	Design analysis Instrument level performance tests	CQM PFM	ILT_PERF	Point source sensitivity 1s – 1 sec (mJy) = 34, 35, 41 (all TBC), 1s -1 hr (mJy) = 0.6, 0.6, 0.7 (all TBC)	ILT-PERF-DRL ILT-PERF-DRB
IRD-PHOT-R05	Design analysis Instrument level performance tests	CQM PFM	ILT_PERF	Mapping sensitivity for one FOV 1s – 1 hr (mJy) 1.4, 1.5, 1.9 (all TBC)	ILT-PERF-OSL ILT-PERF-OSB
IRD-PHOT-R10	Design analysis Instrument level performance tests	CQM PFM	ILT_PERF	Field distortion must be <10% across the FOV	ILT-PERF-OSL ILT-PERF-OSB
IRD-PHOT-R11	Design analysis Instrument level warm functional tests Instrument level performance tests	CQM PFM	ILT_WFT ILT_PERF	Electrical crosstalk should be <1% (goal 0.5%) between nearest-neighbour pixels and <0.1% (goal 0.05%) between all other pixels in the same array.	ILT-PERF-DRL ILT-PERF-DRB
IRD-PHOT-R12	Design analysis Instrument level performance tests	CQM PFM	ILT_PERF	NEP variation should be <20% across each array.	ILT-PERF-DOT
IRD-PHOT-R14	Design analysis Instrument level calibration	PFM	ILT_CAL	Absolute photometric accuracy should be <15% at all wavelengths with a goal of <10%	ILT-PERF-CPC
IRD-PHOT-R15	Design analysis Instrument level calibration	PFM	ILT_CAL	The relative photometric accuracy shall be <10% with a goal of <5%	ILT-PERF-CPC
IRD-PHOT-R16	Design analysis Instrument level performance tests	CQM PFM	ILT_ALIGN ILT_PERF	The three arrays need to be co-aligned to within 1 arcsecond	ILT-PERF-OSL ILT-PERF-OSB
IRD-PHOT-R17	Design analysis Instrument level performance tests	CQM PFM	ILT_PERF	The maximum available chop throw shall be at least 4 arcminutes: the minimum shall be 10 arcsecs or less.	ILT-PERF-BCT
IRD-PHOT-R18	Design analysis Instrument level performance tests	CQM PFM	ILT_PERF	SPIRE Photometric measurements shall be linear to 5% over a dynamic range of 4000 for astronomical signals.	ILT-PERF-DRL ILT-PERF-DRB
IRD-REL-R02	Design analysis Instrument level warm functional tests Instrument level cold functional tests Instrument level operations tests	CQM PFM	ILT_WFT ILT_CFT ILT_OPS	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 degraded performance or efficiency.	All Backup Modes
IRD-RFM-R04	Design analysis Instrument level performance tests	CQM PFM	ILT_PERF	The RF filters shall be capable of operating in with the temperature of the mounting point of the box in the range 4 to 300-K	ILT-PERF-DTR
ILT-SAFE-R04	Design analysis AVM functional tests Instrument level operations tests	AVM CQM PFM FS	AVM_FUNC ILT_OPS	Housekeeping telemetry shall be generated during all nominal modes of the instrument. This includes any instrument Safe Modes.	ILT-PO(1-8) ILT-SO(1-2) All backup modes
IRD-SHUT-R01	Design analysis Instrument level performance tests	CQM PFM	ILT_PERF	The shutter vane must physically prevent thermal radiation from the Herschel cryostat lid from directly entering the instrument.	ILT-PERF-SHE

IRD-SHUT-R02	Design analysis Instrument level performance tests			The seal of the shutter vane shall be designed so as to reduce stray light entering the instrument to an acceptable level. *Any straylight seal design is to be evaluated by the project team to assess its efficacy.*	ILT-PERF-SHC ILT-PERF-SHB
IRD-SHUT-R03				The emissivity of the instrument side of the vane shall be controllable over the range 9-25K.	ILT-PERF-SHC ILT-PERF-SHB
IRD-SHUT-R04				The emissivity of the instrument side of the vane shall be uniform to within 2% (rms).	ILT-PERF-SHC ILT-PERF-SHB
IRD-SHUT-R05				The temperature of the instrument side of the vane shall be controllable over the range 9-25K	ILT-PERF-SHC ILT-PERF-SHB
IDR-SHUT-R06				There shall be at least 16 set points over the temperature range specified in IRD-SHUT-R05	ILT-PERF-SHC ILT-PERF-SHB
IRD-SHUT-R07				The temperature of the instrument side of the vane shall be uniform to within 0.1K (rms).	ILT-PERF-SHC ILT-PERF-SHB
IRD-SHUT-R08				The average temperature of the instrument side of the vane shall be repeatable to within <0.040K	ILT-PERF-SHC ILT-PERF-SHB
IRD-SHUT-R16	Design analysis Instrument level performance tests	CQM PFM	ILT_PERF	The time required to increase the vane temperature by 5K and stabilize to within the repeatability in R1l, assuming that the vane is initially at its minimum (unpowered) temperature, shall be less than 10 minutes.	ILT-PERF-SHC ILT-PERF-SHB
IRD-SMEC-R01	Design analysis Instrument level cold functional tests Instrument level performance tests	CQM PFM	ILT_CFT ILT_PERF	Linear Travel*: Assumed folding factor of 4 for baseline design and single sided interferograms with short travel beyond zero path difference for phase correction.* Total OPD required 14 cm. Maximum mirror travel required for goal resolution (wrt ZPD position): - 0.32 to +3.2 cm.	ILT-PERF-SMC ILT-PERF-SML ILT-PERF-SFC ILT-PERF-SFL
IRD-SMEC-R02	Design analysis Instrument level cold functional tests Instrument level performance tests	CQM PFM	ILT_CFT ILT_PERF	Minimum movement sampling interval: Short wavelength band minimum measurement interval of 5 µm is required (equivalent to 20 µm OPD) For long wavelength band the requirement is 7.5 µm (equivalent to 30 µm OPD).	ILT-PERF-SMC ILT-PERF-SML ILT-PERF-SFC ILT-PERF-SFL
IRD-SMEC-R03	Design analysis Instrument level cold functional tests Instrument level performance tests	CQM PFM	ILT_CFT ILT_PERF	Sampling step control: The measurement interval must be variable between 5 and 25 µm.	ILT-PERF-SMC ILT-PERF-SML ILT-PERF-SFC ILT-PERF-SFL
IRD-SMEC-R04	Design analysis Instrument level cold functional tests Instrument level performance tests	CQM PFM	ILT_CFT ILT_OPS	The system shall be capable of starting and stopping a scan from either side of the zero path difference position.	ILT-PERF-SZP
IRD-SMEC-R05	Design analysis Instrument level cold functional tests Instrument level performance tests	CQM PFM	ILT_CFT ILT_PERF	A goal is to have a dead-time of no more than 10% per scan when taking data at resolution 0.4 cm^{-1}.	ILT-PERF-SMC ILT-PERF-SML ILT-PERF-SFC ILT-PERF-SFL
IRD-SMEC-R06	Design analysis Instrument level cold functional tests Instrument level performance tests	CQM PFM	ILT_CFT ILT_PERF	Mirror velocity: For assumed detector response of 20 Hz the maximum required rate change of the OPD is 0.4 cm s^{-1}. Required max. mirror velocity 0.1 cm s-1. A capability to have mirror velocity of 0.2 cm s^{-1} is desirable and is set as a goal.	ILT-PERF-SMC ILT-PERF-SFC
IRD-SMEC-R07	Design analysis Instrument level cold functional tests Instrument level performance	CQM PFM	ILT_CFT ILT_PERF	Velocity Control: The mirror velocity should be selectable from 0 to 0.1 cm s^{-1} – or 0.2 cm s^{-1} if the goal performance is achieved.	ILT-PERF-SMC ILT-PERF-SFC

	tests				
IRD-SMEC-R08	Design analysis Instrument level cold functional tests Instrument level performance tests	CQM PFM	ILT_CFT ILT_PERF	Velocity stability: *The mirror velocity shall be within 10 μm/s r.m.s. within a band width of 0.03 to 25 Hz over the full range of movement of the mechanism.* The velocity from scan to scan shall not vary by more than 1% over a period of 24 hours under nominal operating conditions.	ILT-PERF-SMC ILT-PERF-SFC
IRD-SMEC-R09	Design analysis Instrument level cold functional tests Instrument level performance tests	CQM PFM	ILT_CFT ILT_PERF	Position measurement: Required OPD position accuracy is 1/50 of the smallest step size. Simulation confirms that this adds minimal system noise to the resultant interferogram. Required mirror position measurement accuracy 0.1 μm over ± 0.32 scan range and 0.3 μm thereafter.	ILT-PERF-SFC ILT-PERF-SML ILT-PERF-SFC ILT-PERF-SFL
IRD-SMEC-R10	Design analysis Instrument level cold functional tests Instrument level performance tests	CQM PFM	ILT_CFT ILT_PERF	Sample frequency: The position is sampled at the frequency required for the short wavelength array – i.e. (mirror velocity)/(measurement step size for short wavelength array)	ILT-PERF-SFC ILT-PERF-SML ILT-PERF-SFC ILT-PERF-SFL
IRD-SMEC-R11	Design analysis Instrument level thermal verification cold functional tests Instrument level operations tests	STM CQM PFM	ILT_THER ILT_OPS	Dissipation shall be within the specification given in RD8.	Operating modes
IRD-SPEC-R01	Design analysis Instrument level performance tests	CQM PFM	ILT_PERF	Wavelength range Band A 200-300 μm Band B 300-700 μm	ILT-PERF-DSR
IRD-SPEC-R02	Design analysis Instrument level performance tests	CQM PFM	ILT_PERF	Maximum resolution (cm-1) Req. 0.4 cm-1 Goal 0.04 cm-1	ILT-PERF-SFC ILT-PERF-SFL
IRD-SPEC-R03	Design analysis Instrument level performance tests	CQM PFM	ILT_PERF	Minimum resolution (cm-1) Req 2 cm-1 Goal 4 cm-1	ILT-PERF-SFC ILT-PERF-SFL
IRD-SPEC-R04	Design analysis Instrument level performance tests	CQM PFM	ILT_PERF	Field of view (arcmin) 2.6 diameter circular for feedhorns	ILT-PERF-OSL ILT-PERF-OSB
IRD-SPEC-R05	Design analysis Instrument level performance tests	CQM PFM	ILT_PERF	Beam FWHM (arcsec) Band A (250 μm) 18 Band B (350 μm) 25	ILT-PERF-OSL ILT-PERF-OSB
IRD-SPEC-R06	Design analysis Instrument level performance tests	CQM PFM	ILT_PERF	Point source continuum sensitivity (mJy, 1σ-1hr; 0.4 cm-1 resolution) Band A 200-300 μm 47 (TBC) Band B 300-400 μm 43 (TBC) Band B 400-700 μm TBD Point source unresolved line sensitivity (W m-2; 1σ 1 hr) Band A 200-300 μm 5 x 10^{-18} (TBC) Band B 300-400 μm 5.1 x 10^{-18}	ILT-PERF-SFC ILT-PERF-SFL
IRD-SPEC-R07	Design analysis Instrument level performance tests	CQM PFM	ILT_PERF	Map continuum sensitivity (mJy 1σ 1 hr) Band A 200-300 μm 108 (TBC) Band B 300-400 μm 104 (TBC) Band B 400-700 μm TBD Map line sensitivity (W m-2; 1 σ 1 hr) Band A 200-300 μm 1.3 x 10^{-17} (TBC) Band B 300-400 μm 1.3 x 10^{-17} (TBC) Band B 400-700 μm TBD	ILT-PERF-OSL ILT-PERF-OSB
IRD-SPEC-R11	Design analysis Instrument level performance tests	CQM PFM	ILT_PERF	The width of the FTS instrument response shall be uniform to within 10% across the FOV for resolution <0.4cm-1	ILT-PERF-SFC ILT-PERF-SFL
IRD-SPEC-R14	Design analysis Instrument	CQM	ILT_PERF	Fringe contrast shall be greater than 80% for	ILT-PERF-SFC

	level performance tests	PFM		any point in the field of view for a resolution of 0.4 cm^{-1}	ILT-PERF-SFL
IRD-SPEC-R16	Design analysis Instrument level calibration	PFM	ILT_CAL	The FTS absolute photometric accuracy at the required resolution shall <15% at all wavelengths with a goal of <10%	ILT-PERF-CPC
IRD-SPEC-R17	Design analysis Instrument level performance tests	CQM PFM	ILT_CAL	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 chosen passband.	ILT-PERF-SFC ILT-PERF-SFL
IRD-STRC-R08	Design analysis Instrument level performance tests	CQM	ILT_PERF	Attenuation of radiation from the cryostat environment. Requirement <2 x 10^{-5} (TBC) To illustrate this, the requirement is the equivalent of a ~4 mm diameter hole in a total area of the box cover of 1 m^2 (TBC)	ILT-PERF-DOT
IRD-STRP-R06	Design analysis Instrument alignment verification	CQM	ILT_PERF	Attenuation of radiation from common structure environment. Requirement 5 x 10-7; goal is 5 x 10-8 (TBC) To illustrate this, the requirement is the equivalent of a 0.5 mm diameter hole in a total area of the box cover of 0,5 m^2. *This, of course, excludes the hole that lets the beams in.*	ILT-PERF-DOT
IRD-STRS-R06	Design analysis Instrument level performance tests	CQM	ILT_PERF	Attenuation of radiation from 4-K environment. Requirement 5 x 10-7; goal is 5 x 10-8 (TBC) To illustrate this, the requirement is the equivalent of a 0.5 mm diameter hole in a total area of the box cover of 0,5 m^2. *This, of course, excludes the hole that lets the beams in.*	ILT-PERF-DOT
IRD-TLM-R09	Design analysis AVM functional tests Instrument level operations tests	AVM CQM PFM FS	AVM_FUNC ILT_OPS	The instrument shall generate event packets in all operating modes. *These packets notify the CDMS and/or ground monitoring equipment of instrument anomalies and significant actions taken by the instrument. The ESA packet Utilisation Standard identifies many of these report packet types. These packets should identify the type of anomaly and the data used to identify it.*	ILT-PO(1-8) ILT-SO(1-2) All backup modes
IRD-VER-R03	Instrument level warm functional tests Instrument level cold functional tests Instrument level performance tests	CQM	ILT_WFT ILT_CFT ILT_PERF	The CQM verification testing shall demonstrate that the following conditions are met or are likely to be met on the PFM: 1. Correct operation of all the FPU sub-systems at cryogenic temperatures for all instrument operation modes for both prime and redundant sustems. 2. The instrument cold FPU and JFET box thermal dissipation is within requirements for all instrument operation modes. 3. The warm electronics thermal dissipation at room temperature is within requirements. 4. Correct operation of all on-board software. 5. The instrument straylight environment is within requirements. 6. The instrument optics performance is within requirements. 7. The performance of the instrument meets the scientific requirements expected for the CQM for all instrument observing modes. 8. Development and test of all functional	TBD

				test sequences required for Integrated Systems Testing (IST) at satellite level. 9. The correct functioning of the instrument for all observing modes and calibration sequences. 10. Development and test of all in-flight functional and performance test sequences.	
IRD-VER-R04	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	Thw PFM verification testing shall, in addition to the requirements on the CQM and AVM verification, demonstrate he following: 1. The performance of the flight instrument meets the scientific requirements for all instrument observing modes. 2. Correct operation of flight version of all on-board software. 3. The characterisation of the PFM instrument performance for all instrument observing modes – includinding generation of data for instrument calibration and functional testing both during IST and in-flight. 4. The characterisation of the instrument performance with the warm electronics operating over a range of temperatures. 5. Final test of all functional test sequences for IST. 6. Final test of all observing modes. 7. Final test of all in-flight functional and performance test sequences.	TBD
IRD-WE-R05	Design analysis AVM functional tests Instrument level warm functional tests Instrument level operations tests	AVM CQM PFM	AVM_FUM C ILT_WFT ILT_OPS	The warm electronics shall be able to execute all the instrument operating modes. These modes are described in 'Operating Modes of the SPIRE Instrument'	All tests
IRD-WE-R07	Design analysis AVM functional test Instrument level warm functional tests Instrument level operations tests	AVM CQM PFM	AVM_FUN C ILT_WFT ILT_OPS	The Warm Electronics shall manage the data handling requirements of the instrument. *This will include data buffering, manipulation and compression necessary to meet the instrument data requirements.*	All tests
IRD-WE-R08	Design analysis AVM functional test Instrument level cold functional tests Instrument level performance tests	AVM CQM PFM	AVM_FUN C ILT_CFT ILT_PERF	The Warm Electronics shall be able to read the data from the photometer detector arrays with the required time accuracy and synchronisation, and within the required accuracy and error. *This includes data from the detector subsystem (e.g. bias values and temperatures) necessary to the processing of the detector data.*	All tests
IRD-WE-R09	Design analysis AVM functional test Instrument level cold functional tests Instrument level performance tests	AVM CQM PFM	AVM_FUN C ILT_CFT ILT_PERF	The Warm Electronics shall be able to read the data from the spectrometer detector arrays with the required time accuracy and synchronisation, and within the required accuracy and error. *This includes data from the detector subsystem (e.g. bias values and temperatures) necessary for the processing of detector data.*	All tests
IRD-WE-R10	Design analysis AVM functional test Instrument level cold functional tests	AVM CQM PFM	AVM_FUN C ILT_CFT	The Warm Electronics shall be able to read the data from the spectrometer control circuitry with the required time accuracy and	All tests

	Instrument level performance tests		ILT_PERF	synchronisation, and within the required accuracy and error to allow the science data to be processed.	
IRD-WE-R21	Design analysis AVM Functional test Instrument level warm functi onal tests Instrument level cold functional tests Instrument level operations tests	AVM CQM PFM	AVM_FUN C ILT_WFT ILT_CFT ILT_OPS	The Warm Electronics shall be able to acquire subsystem data without loss or delay to the instrument operations.	All tests
IRD-WE-R22	Design analysis AVM Functional test Instrument level warm functional tests Instrument level cold functional tests Instrument level operations tests	AVM CQM PFM	AVM_FUN C ILT_WFT ILT_CFT ILT_OPS	The Warm electronics shall be able to process the instrument data without loss or delay to the instrument operations.	All tests
IRD-WE-R23	Design analysis AVM Functional test Instrument level warm functional tests Instrument level cold functional tests Instrument level operations tests	AVM CQM PFM	AVM_FUN C ILT_WFT ILT_CFT ILT_OPS	The Warm Electronics shall be able to meet the S/C communications constraints (telecommand acceptance and telemetry generation) without loss or delay to instrument poerations.	All tests
IRD-WE-R24	Design analysis AVM Functional testInstrument level warm functional test Instrument level cold functional test Instrument level operations tests	AVM CQM PFM	AVM_FUN C ILT_WFT ILT_CFT ILT_OPS	The Warm Electronics shall provide functions for determining its own health and safety. *Instrument telemetry should contain sufficient information to allow health and safety checking of the Warm Electronics by the Spacecraft.*	All tests
IRD-WE-R25	Design analysis AVM Functional tests Instrument level warm functional tests Instrument level cold functional tests Instrument level operations tests	AVM CQM PFM	AVM_FUN C ILT_WFT ILT_CFT ILT_OPS	The Warm Electronics shall handle subsystem anomalies. *The WE shall be able to recognise anomalies and take a predefined action based on the anomaly.*	All tests
IRD-WE-R26	Design analysis AVM Functional test Instrument level warm functional tests Instrument level cold functional tests Instrument level operations tests	AVM CQM PFM	AVM_FUN C ILT_WFT ILT_CFT ILT_OPS	The Warm Electronics shall provide facilities to manage the reporting and response to anomalies. The WE shall prevent multiple reporting of anomalies and provide for disabling of anomaly reporting and execution of response actions.	All tests
IRD-WE-R35	Design analysis AVM Functional test Instrument level warm functional tests Instrument level cold functional tests Instrument level operations tests	AVM CQM PFM	AVM_FUN C ILT_WFT ILT_CFT ILT_OPS	The warm electronics shall conform to the allocated power budget in RD8.	All tests
VRD-06	Design analysis Instrument level alignment verification Instrument level performance tests	STM CQM	ILT_ALIGN ILT_PERF		
VRD-07	Design analysis Instrument level acceptance data package Instrument level alignment verification Instrument level performance tests	STM CQM	ILT_ALIGN ILT_PERF		
VRD-08	Design analysis Instrument level alignment verification Instrument level performance tests	CQM	ILT_ALIGN ILT_PERF		
VRD-09	Design analysis Instrument level alignment verification Instrument level performance	CQM	ILT_ALIGN ILT_PERF		

	tests				
VRD-11	Design analysis Subsystem acceptance data package Instrument level alignment Instrument level performance tests	STM CQM	ILT_ALIGN ILT_PERF		
VRD-12	Design analysis Subsystem verification programme Subsystem acceptance data package Instrument level thermal verification Instrument level cold functional tests Instrument level performance tests	STM CQM	ILT_THER ILT_CFT ILT_PERF		
VRD-15	Subsystem verification programme Subsystem acceptance data package Instrument level performance tests	CQM	ILT_PERF		
VRD-16	Design analysis Subsystem verification programme Subsystem acceptance data package AVM functional test Instrument level cold functional tests Instrument level performance tests	AVM CQM	AVM_FUN C ILT_CFT ILT_PERF		
VRD-17	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		
VRD-18	Design analysis Subsystem verification programme Subsystem acceptance data package Instrument level performance tests	CQM	ILT_PERF		
VRD-19	Design analysis Subsystem verification programme Subsystem acceptance data package Instrument level performance tests	CQM	ILT_PERF		
VRD-20	Design analysis Subsystem verification programme Subsystem acceptance data package Instrument level performance tests	CQM	ILT_PERF		
VRD-22	Design analysis Instrument level performance tests	CQM	ILT_PERF		
VRD-24	Design analysis Instrument level warm functional tests Instrument level cold functional tests Instrument level performance tests	CQM	ILT_WFT ILT_CFT ILT_PERF		
VRD-25	Design analysis Instrument EMC tests Instrument level performance tests	STM CQM	ILT_EMC ILT_PERF		
VRD-27	Design analysis AVM functional test instrument level warm functional test	AVM CQM	AVM_FUN C ILT_WFT ILT_CFT		

	Instrument level cold functional test Instrument level performance test		ILT_PERF		
VRD-28	Design analysis AVM functional test Instrument level warm functional test Instrument level cold functional test Instrument level performance test	AVM CQM	AVM_FUN C ILT_WFT ILT_CFT ILT_PERF		
VRD-29	Design analysis AVM functional test instrument level warm functional test Instrument level cold functional test Instrument level performance test	AVM CQM	AVM_FUN C ILT_WFT ILT_CFT ILT_PERF		
VRD-30	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_FUN C ILT_WFT ILT_CFT ILT_PERF		
VRD-37	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_FUN C ILT_WFT ILT_CFT ILT_OPS		
VRD-38	Design analysis Instrument level acceptance test data package AVM functional test Instrument level warm functional test Instrument level cold functional test Instrument level operations tests	AVM CQM	AVM_FUN C ILT_WFT ILT_CFT ILT_OPS		
VRD-39	Design analysis Instrument level acceptance data package AVM functional test Instrument level warm functional test Instrument level cold functional test Instrument level performance tests.	AVM CQM	AVM_FUN C ILT_WFT ILT_CFT ILT_PERF ILT_OPS		
VRD-43	Design analysis Instrument level acceptance data package Instrument level operations tests Instrument level calibration	CQM	ILT_OPS ILT_CAL		
VRD-44	Design analysis Instrument level acceptance data package Instrument level operations tests Instrument level calibration	CQM	ILT_OPS ILT_CAL		
VRD-45	Design analysis Subsystem acceptance data package Instrument level operations tests Instrument level	CQM	ILT_OPS ILT_CAL		

	calibration				
VRD-46	Design analysis Subsystem acceptance data package Instrument level operations tests Instrument level calibration	CQM	ILT_OPS ILT_CAL		
VRD-47	Design analysis Instrument level acceptance data package Instrument level operations tests Instrument level calibration	CQM	ILT_OBS ILT_CAL		
VRD-48	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	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		