



SUBJECT: **SPIRE FM Calibration and Performance Test Plan**

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Change Record

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Changes

First Draft

Added update to sections 4 and 5 for PFM4 testing, updated nominal settings table by including PFM3 values.

Added PTC PID tuning



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Glossary

FM	Flight Model
ILT	Instrument Level Testing
PFM3	Proto-Flight Model 3 – the final build of the flight model



1. INTRODUCTION

1.1 Scope

This document covers the high level specification of the both spire FM calibration programme and the FM post vibration final performance test programme. It covers all performance tests except EMC and Microphonics tests which are documented separately. At present it does not cover operations tests but these may be added at a later time.

This document shows the logical test flow for each sub-instrument then lists the tests to be carried out in each campaign.

The campaign overview defines the input parameters for each test e.g. A dark load curve at 130Hz bias frequency and 16.25 Hz sample rate or an optical load curve with the cold black body at 10 K, 130Hz bias frequency and 16.25 Hz sample rate. Both of these specifications call the same load curve procedure.

It is intended to specify the individual test procedures in sufficient detail to allow command scripts to be defined. They then act as templates with the inputs entered at the time the test is run. The required conditions specified when run and the pre-requisites are specified in each procedure.

An overview of the conditions selected for both the performance test campaign and calibration campaign are given. The detailed test by test daily planning will appear in a separate daily planning document.

1.2 Documents

1.2.1 Applicable Documents

AD1 SPIRE Calibration Plan

1.2.2 Reference Documents

1.3 Overview of the PFM3 Campaign

The PFM3 campaign, the last ILT campaign for the SPIRE flight model, will take place in spring and summer of 2006. The campaign is broken down into several cool down periods. At the start of the



campaign the instrument will be cooled to operating temperature then will be operated for about two weeks.

These first two weeks will be dedicated to performance verification, in-particular checking that no changes have taken place during vibration. As much as possible tests from the PFM1 campaign (spectrometer) and PFM2 campaign (mostly photometer) will be repeated. No new tests are expected.

Following this period will be a hold period of two weeks where the instrument is allowed to warm up to about 100 K (LN2 top up will be maintained). This allows for preliminary data analysis to be completed by the test team plus any changes to be made to the detailed planning of the calibration component of the campaign.

After two weeks of hold the instrument will again be cooled to operating temperature for the first calibration test period. The two weeks of test period followed by two weeks of hold will continue for at least three calibration test runs with the instrument warm up to ambient following the last calibration test period.

The calibration runs will include both calibration tests and operations tests interleaved in the detailed schedule. While all operating modes will be exercised, it is expected that the overall operations test time will form a small minority of the overall calibration test time.

It will be left to the detailed scheduling to determine how long each instrument is operated for at a time i.e. whether we schedule several days with the photometer then several days with the spectrometer or whether we interleave as convenient i.e. do all tests for both instruments for a single laser line.

1.4 Prioritisation and Scheduling

The test scheduling will follow a round robin approach where during each cool campaign all the tests will be attempted once and as early as possible during the campaign. This is in case the testing period is reduced for any reason.

The test order will in general follow the logical flow given in section 3, although nominal settings established in previous campaigns allow some deviation from this flow. There are exceptions to this e.g. the detector phase up must be established before further detector tests and the telescope simulator must be focussed before use. These exceptions are flagged in section 3.

The baseline assumption at the start of testing is that apart from the needs of the test flow, in general no test has priority over any other test i.e. there is no difference in priority between an SCAL load curve and a beam scan. There are exceptions to this:

- Mandatory tests e.g. load curves following cooler recycles, and calibrator flashes always have top priority.
- Higher priority will also be given to tests that can only be done on the ground, photometer RSRF is a clear example of this
- Tests which effectively act as alternate ways of getting information have a lower priority e.g. the out of band test using laser lines supplements information gained from spectral scans which cover out of band wavelengths.

As the test campaign develops it is expected that daily planning meetings will review progress and re-prioritise as necessary.



1.5 Structure of Document

The document is structured using a top down approach.

- The following section gives the cross reference with the calibration plan. This is the applicable document to the calibration campaign and is included to demonstrate how the calibration requirements have fed into the test planning.
- Section 3 shows the logical test flow including all tests which will be executed i.e. additional tests such as telescope simulator focus are needed during the test campaign but are not direct inputs to calibration. The test flow is shown for the two sub-instruments separately as the each campaign can be considered as two separate campaigns for the photometer and spectrometer separately.
- The tests performed in the two campaigns are then detailed separately in sections 4 and 5. These two sections form the high level definition for the two parts of the campaign. The information from sections 4 and 5 along with the test flow in section 3 will be used to produce the daily planning schedule which is documented separately for ease of update.
- Section 6 lists the currently understood nominal settings as these form the remaining inputs to the detailed test planning. It is likely the nominal detector settings will change following analysis of performance verification data from the first two weeks of testing.
- The individual test template procedures are documented in section 7. These feed directly into CUS scripts (plus manual procedures where necessary) which are then called with the parameters specified in sections 4, 5 and 6.



2. DERIVATION OF CALIBRATION TESTS

2.1 Approach

The calibration requirements are documented in AD1. In AD1 requirements have been gathered from 4 higher level sources, the calibration requirements document (CRD-PAR), the time estimator calibration files (TECR), the uplink calibration files (UPCR) and the data processing calibration files (DPCR). These have been combined into a single list of requirements (CALT).

The calibration information required is either derived directly from test or from a combination of tests and intermediate information levels e.g. nominal detector settings have to be derived in order that later tests can use those settings. The two summary cross reference matrices between calibration requirements and tests from AD1 are included here for ease of reference.

As there is a high interdependency between requirements and tests, the calibration scheme is also demonstrated via a calibration map (section 2.4). Note the calibration map only shows tests directly contributing information to the calibration and the overall ILT test flow showing all tests planned is detailed in section 3.

2.2 Cross Reference between Calibration Requirements and Tests

CALT Identifier	Description	Higher Level Requirements	Test/Lower Level Requirement
Telescope Operations			
Uplink Parameters			
CALT-01	Number of nod positions in a nod cycle	TECR-04	CALT-11
CALT-02	Number of nod cycles to complete a map	TECR-05	CALT-11
CALT-03	Number of times to repeat each map in a raster	TECR-06	CALT-11
CALT-04	Telescope scan rate (arsec/sec) during scan mapping	TECR-09	CALT-11
CALT-05	Number of times to repeat jiggles at each nod position	TECR-16	CALT-11
CALT-06	Direction of telescope movement in D1 direction (degrees) - optimum scan angle	TECR-08	ILT-PERF-OSBL
CALT-07	Distance between raster points or nod positions	TECR-03	ILT-PERF-OSBL
CALT-08	Number of jiggle positions per nod position	TECR-15	ILT-PERF-OSBL ILT-PERF-BSM
CALT-09	Distance between raster/scan lines (arcsecs)	TECR-07	ILT-PERF-OSBL
CALT-10	SIAM file – giving positions of SPIRE apertures	UPCR-03	ILT-PERF-OSBL ILT-PERF-BSM
Instrument Sensitivity			
CALT-11	Instrument Sensitivity	TECR-02	CALT-12-16 CALT-17 CALT-19
Detectors			
Detector Uplink Parameters			



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CALT-12	Optimum bias frequency	TECR-01, UPCR-04	FUNC-DCU-08 ILT-PERF-DNA ILT-PERF-DAB ILT-PERF-DAL
CALT-13	Optimum sample rate	UPCR-05	FUNC-DCU-08 ILT-PERF-DNA ILT-PERF-DAB ILT-PERF-DAL
CALT-14	Optimum bias amplitude	UPCR-06	FUNC-DCU-08 ILT-PERF-DNA ILT-PERF-DAB ILT-PERF-DAL
CALT-15	Optimum phase	UPCR-07	FUNC-DCU-08 ILT-PERF-DNA ILT-PERF-DAB ILT-PERF-DAL
CALT-16	Optimum Vss	UPCR-08	FUNC-DCU-07
Detector contribution to Instrument Sensitivity and Flux Determination			
CALT-17	Instrument Absolute Responsivity ($R_{inst} - V/W$) will be a function of temperature	CRD-PAR-2	PERF-DAL (also from CALT-18 plus CALT-36)
CALT-18	Detector Absolute Responsivity ($R_{det} - V/W$)	CRD-PAR-1	JPL Provided
CALT-19	Pixel Nominal Load Noise Map ($\delta V_{nom} - Volts$)	CRD-PAR-5	PERF-DNA
CALT-20	Dead pixel mask	DPCR-01	FUNC-DCU-11
CALT-21	LIA and JFET gains	DPCR-03	JPL Provided
CALT-22	Pixel readout time offsets from frame time	DPCR-06	CEA Provided
CALT-23	Glitch thresholds for each array	DPCR-09	PERF-DNA
CALT-24	R_{LOAD} , Capacitance, R_0 , Δ , G_0 , T_0 , β	DPCR-10	JPL Provided PERF-DAB confirms
CALT-25	Phase – Gain loss table for each bias frequency	DPCR-12	PERF-DAB
CALT-26	Pixel time constants	DPCR-18, CRD-PAR-13	CALT-12-16 PERF-DRBL
CALT-27	Detector Response Versus Input Power ($R_{linear} -$ no units)	CRD-PAR-12	PERF-DLA
PCAL			
CALT-28	PCAL low and high current values for a flash	TECR-17, UPCR-36	PERF-CPT
CALT-29	Number of PCAL cycles in a flash	TECR-18	PERF-CPT
CALT-30	Period of a PCAL flash	TECR-19	PERF-CPT
CALT-31	Number of DCU samples per flash half cycle	TECR-20	CALT-30 plus CALT-12-13
CALT-32	Number of SCU samples per flash half cycle	TECR-21	CALT-30
CALT-33	Maximum time (in seconds) between PCAL Flashes	TECR-22	PERF-CPS
CALT-34	PCAL History	DPCR-13	TBD
CALT-35	Calibrator Equivalent Power (CR – W per step)	CRD-PAR-16	CALT-24 PERF-CPT



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Optics			
CALT-36	Instrument Efficiency (η_{opt} – no units)	CRD-PAR-3	PERF-DAL
CALT-37	Pixel Relative Position Map ($(\alpha_{det}, \delta_{det})$ - arcsec)	CRD-PAR-10, DPCR-17	PERF-PKBL
CALT-38	Straylight Characterisation	DPCR-14	CALT-39 CALT-41
CALT-39	Instrument Throughput ($A\Omega_{inst}$ – cm ² steradian)	CRD-PAR-1	CALT-40 CALT-41
CALT-40	Beam Map	CRD-PAR-8, DPCR-19	PERF-OSBL
CALT-41	Telescope Pupil Illumination Function (PIF – no units)	CRD-PAR-9	PERF-OPI
CALT-42	Channel Equivalent Bandpass ($\Delta\lambda$ – microns)	CRD-PAR-4	PERF-DSR
CALT-43	Photometer RSRF	CRD-PAR-15, DPCR-20	PERF-DSR
CALT-44	Cross Talk Map (c_{ix}, c_{iy} - no units)	CRD-PAR-11, DPCR-15	PERF-OSBL PERF-BSM
CALT-45	Spatial Relative Responsivity (flatfield) (r_{xy} – no units)	CRD-PAR-14, DPCR-16	PERF-DAL
CALT-46	Point Source Coupling Efficiency (η_{point} – no units)	CRD-PAR-7	PERF-DVA
BSM Information			
Uplink PID Parameters			
CALT-47	Chop feed forward offset	UPCR-17	FUNC-BSM-03
CALT-48	Chop feed forward gain	UPCR-18	FUNC-BSM-03
CALT-49	Chop kd	UPCR-19	FUNC-BSM-03
CALT-50	Chop kp	UPCR-20	FUNC-BSM-03
CALT-51	Chop ki	UPCR-21	FUNC-BSM-03
CALT-52	Chop rl	UPCR-22	FUNC-BSM-03
CALT-53	Chop_0_l	UPCR-23	FUNC-BSM-03
CALT-54	Jigg feed forward gain	UPCR-24	FUNC-BSM-03
CALT-55	Jigg kd	UPCR-25	FUNC-BSM-03
CALT-56	Jigg kp	UPCR-26	FUNC-BSM-03
CALT-57	Jigg ki	UPCR-27	FUNC-BSM-03
CALT-58	Jigg rl	UPCR-28	FUNC-BSM-03
CALT-59	Jigg_0_l	UPCR-29	FUNC-BSM-03
Other Uplink Parameters			
CALT-60	BSM Position-Angle Calibration Table	DPCR-08	PERF-BSM
CALT-61	BSM chop mode hold, On Source and Off Source Positions	TECR-10	CALT-60
CALT-62	7 point jiggle map positions	UPCR-01	CALT-60
CALT-63	64 point jiggle map positions	UPCR-02	CALT-60
CALT-64	BSM Operations Table	DPCR-07	CALT-61 CALT-62 CALT-63
CALT-65	Number of DCU samples per chop position – derived from nominal sample rate of detectors	TECR-12	CALT-12-13 PERF-BCT



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CALT-66	BSM sampling frequency	TECR-13, TECR-11	FUNC-BSM-03 PERF-BCT
CALT-67	Number of BSM samples per chop position	TECR-13, TECR-11	FUNC-BSM-03 PERF-BCT
CALT-68	DCU delay	TECR-13, TECR-11	CALT-64 CALT-65
CALT-69	Number of chop cycles per jiggle position	TECR-14	CALT-11
Spectrometer Specific Information			
SMEC Uplink PID Parameters			
CALT-70	SMEC feed forward offset	UPCR-09	FUNC-SMEC-04
CALT-71	SMEC up feed forward gain	UPCR-10	FUNC-SMEC-04
CALT-72	SMEC down feed forward gain	UPCR-11	FUNC-SMEC-04
CALT-73	SMEC sig1 offset	UPCR-12	FUNC-SMEC-04
CALT-74	SMEC sig2 offset	UPCR-13	FUNC-SMEC-04
CALT-75	SMEC home position	UPCR-14	FUNC-SMEC-04
CALT-76	SMEC kd	UPCR-15	FUNC-SMEC-04
CALT-77	SMEC kp	UPCR-16	FUNC-SMEC-04
Other Spectrometer Uplink Parameters			
CALT-78	FTS High Res Scan Start	UPCR-30	PERF-SMC
CALT-79	FTS High Res Scan End	UPCR-31	PERF-SMC
CALT-80	FTS Medium Res Scan Start	UPCR-32	PERF-SMC
CALT-81	FTS Medium Res Scan End	UPCR-33	PERF-SMC
CALT-82	FTS Low Res Scan Start	UPCR-34	PERF-SMC
CALT-83	FTS Low Res Scan End	UPCR-35	PERF-SMC
CALT-84	Number of FTS scans (taken as a unit or per jiggle posn)	TECR-23	PERF-SMC CALT-11
CALT-85	SMEC positions for start of low, medium and high res scans	TECR-24	PERF-SMC
CALT-86	SMEC positions for end of low, medium and high res scans	TECR-25	PERF-SMC
CALT-87	SMEC position for standby	TECR-26	PERF-SMC
CALT-88	SMEC scan rate during scanning	TECR-27	PERF-SMC
SMEC Data Analysis			
CALT-89	SMEC Velocity Stability ($\delta V - \mu\text{m/s/rt(Hz)}$)	CRD-PAR-18	PERF-SMC
CALT-90	Spectrometer Calibrator Equivalent Power (SCR – W per step)	CRD-PAR-19	PERF-DAL
CALT-91	Fringe Contrast Map (FCM - no units)	CRD-PAR-20, DPCR-28	PERF-SFC
CALT-92	Spectral Response Function (SRF - no units))	CRD-PAR-21, DPCR-34	PERF-SMC
CALT-93	Time Domain Phase	DPCR-21	TBD
CALT-94	Bad Scan Mask	DPCR-22	From data TBC
CALT-95	Optical encoder position at ZPD for each spectrometer pixel	DPCR-23, CRD-PAR-17	PERF-SMC
CALT-96	LVDT position at ZPD for each spectrometer pixel	DPCR-24, CRD-PAR-17	PERF-SMC
CALT-97	Optical Encoder Position to OPD	DPCR-25	PERF-SMC
CALT-98	LVDT Position to OPD	DPCR-26	PERF-SMC



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CALT-99	Vignetting as a function of OPD	DPCR-27	CALT-97
CALT-101	SCAL Temporal Drift	DPCR-29	PERF-CPS
CALT-102	Telescope Emission	DPCR-30	TBD
CALT-103	Non-Linear Phase	DPCR-31	PERF-SMC
CALT-104	Spectrometer band edges	DPCR-32	PERF-SMC
CALT-105	Apodisation functions	DPCR-33	Lethbridge Provided
PTC			
CALT-106	PTC Set Point	UPCR-37	PERF-PTC
CALT-107	PTC Selection, 1,2 or 3	UPCR-38	PERF-PTC
CALT-108	PTC Loop Period	UPCR-39	PERF-PTC
CALT-109	PTC Kp	UPCR-40	PERF-PTC
CALT-110	PTC Ki	UPCR-41	PERF-PTC
CALT-111	PTC Kd	UPCR-42	PERF-PTC
CALT-112	PTC Ki Limit	UPCR-43	PERF-PTC
CALT-113	PTC Low Pass Filter Gain	UPCR-44	PERF-PTC
CALT-114	PTC Low Pass Filter Coefficient B1	UPCR-45	PERF-PTC
CALT-115	PTC Low Pass Filter Coefficient B2	UPCR-46	PERF-PTC
CALT-116	PTC Maximum allowable DAC value	UPCR-47	PERF-PTC
CALT-117	PTC Pulse Width Modulation Flag	UPCR-48	PERF-PTC
CALT-118	PTC Initialisation Count (number of cycles before control start)	UPCR-49	PERF-PTC

2.3 Cross Reference between Tests and Requirements

Test ID	Test	CALT Requirement
Functional Tests		
ILT-FUNC-BSM-03	PID Tuning	47,48,49,50,51,52,53,54,55,56,57,58,59,66,67
ILT-FUNC-SMEC-04	SMEC PID Tuning	70,71,72,73,74,75,76,77
ILT-FUNC-DCU-07	VSS Test	16
ILT-FUNC-DCU-08	Detector Phase Up	12,13,14,15
Detector Tests		
ILT-PERF-DNA	Noise Test	12,13,14,15,19,23
ILT-PERF-DAB	Dark Load Curves	12,13,14,15,24,25
ILT-PERF-DAL	Optical Load Curves	12,13,14,15,17,35,36,45,90
ILT-PERF-DRBL	Chopper Frequency Test	26
ILT-PERF-DLA	Beam Attenuation Test	27
ILT-PERF-DVA	Variable Aperture Test	46
ILT-PERF-DSR	Spectral Response	42,43
PCAL Tests		
ILT-PERF-CPT	PCAL Level Test	28,29,30,31,32,35
ILT-PERF-CPS	PCAL Standard Flash	33,101
Optical Tests		
ILT-PERF-PKBL	Peakup	37
ILT-PERF-OPI	Pupil Scan	38,39,41
ILT-PERF-OSBL	Beam Scan	06,07,08,09,10,39,40,44



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BSM Tests		
ILT-PERF-BSM	BSM FOV Scan	08,10,44,60,61,62,63,64,68
ILT-PERF-BCT	BSM Chopping Test	65,66,67,68
SMEC Tests		
ILT-PERF-SMC	SMEC Scanning	78,79,80,81,82,83,84,85,86,87,88,89,92,95,96,97,98,99,103,104
ILT-PERF-SFC	SMEC Fringe Contrast	91
PTC Tests		
ILT-PERF-PTC	PTC PID Tuning	106,107,108,109,110,111,112,113,114,115,116,117,118

2.4 Calibration Map

This map gives an overview of the calibration scheme and shows how the ILT tests feed into the calibration of the instrument. All types of calibration are included including information for uplink, time estimation and data processing. Tests are represented by oval boxes and information along with associated calibration requirement by the other boxes. More detail on the fulfilment of each requirement is given in AD1.

2.4.1 Photometer Map

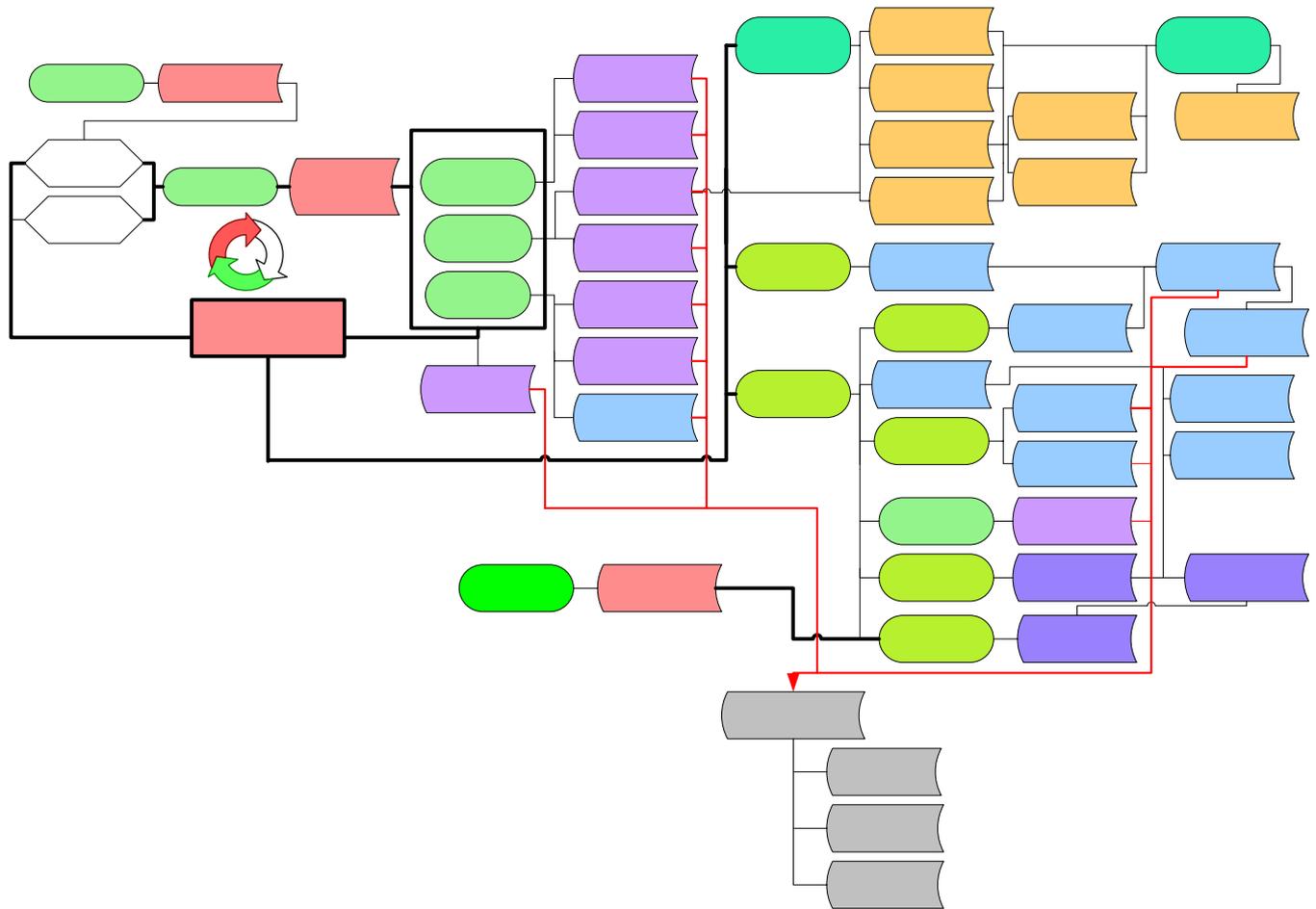


Figure 1: Calibration map for the photometer. Tests are shown in oval boxes. The red line shows requirements that act as inputs to the knowledge of the instrument sensitivity. Note for the detector tests the establishment of nominal settings is an iterative process.

2.4.2 Spectrometer Map

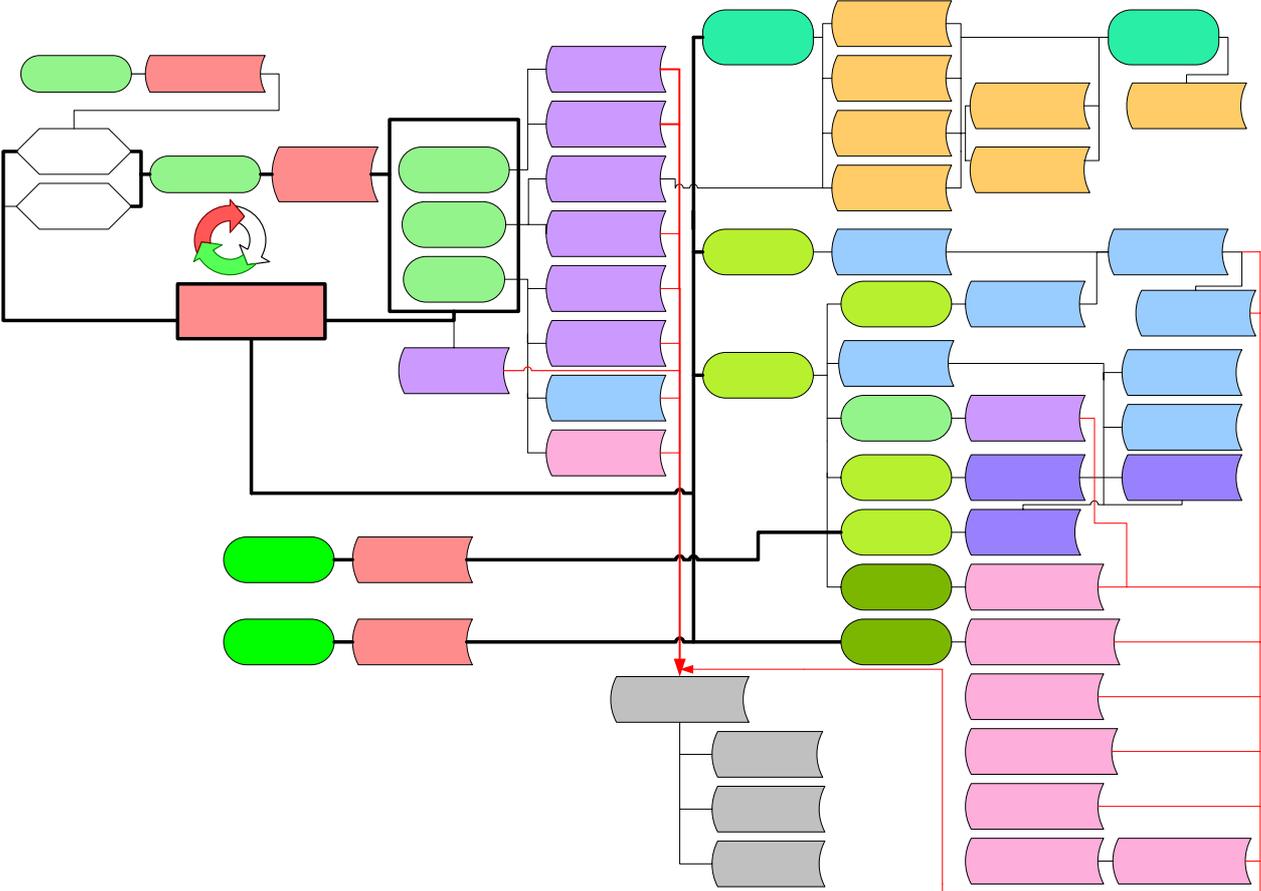


Figure 2: Calibration map for the spectrometer. Tests are shown in oval boxes. The red line shows requirements that act as inputs to the knowledge of the instrument's sensitivity.

FUNC-DCU-07
VSS Test
 Tested bias frequency
 Tested Sample rate
Optimum Vss
CALT-16
FUNC-DCU-08
 Phase Up

Nominal detector settings (CALT-12-

3. ILT TEST FLOW

3.1 Photometer Testing Scheme

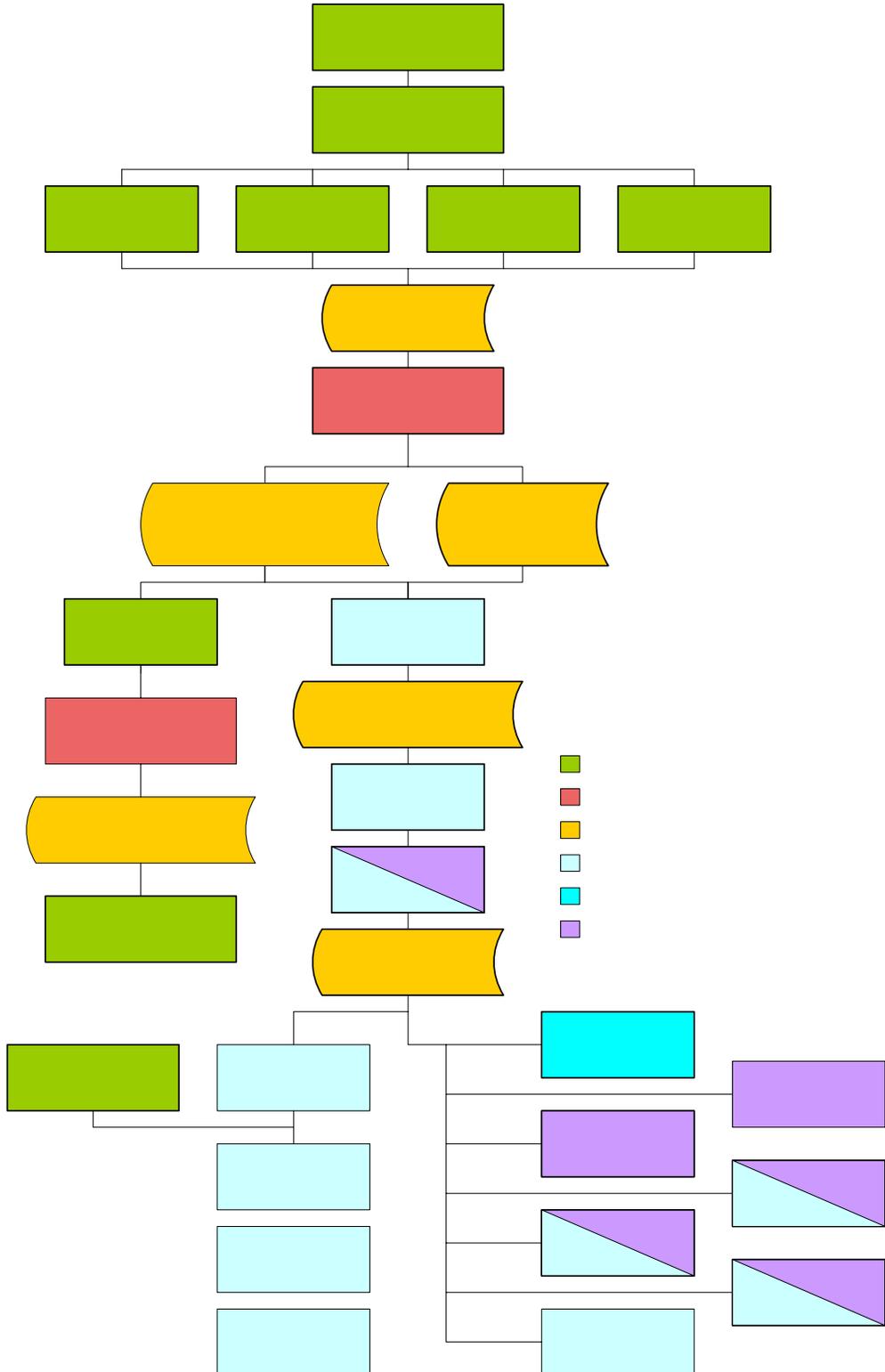




Figure 3 Photometer Test Flow

3.1.1 Overview

Figure 1 shows the logical test flow for the photometer tests.

The first part of the test flow concerns the detector testing and the setup of the nominal settings for the detectors. Before the first recycle the VSS tests checks the JFET noise. All other tests are done with the detectors at nominal temperature.

There are essentially three free parameters, bias frequency, sample rate and bias amplitude. The bias frequency is adjustable between 50 and 300 Hz. The spectrometer is designed such that the nominal bias frequency is about 160 Hz with 80 Hz sampling and the photometer nominal bias frequency about 130 Hz with 16 Hz sampling. The sampling frequency by definition in the electronics is an integer divider of the bias frequency. The optimal bias amplitude will depend on loading conditions and will be established via noise tests and load curves. For each bias amplitude selected for testing electronics phase up must first be done where the optimum phase for the LIAs is found. This must be done before any further set of tests with the given bias frequency and amplitude can take place. Once a set of bias frequencies and amplitudes have been tested a nominal value is selected for the remainder of the campaign.

At this point PCAL setup can be done which essentially consists of a level test both under dark and loaded conditions followed by the selection of a level for standard flashes. The flash frequency, established in earlier campaigns will not be re-established and the previous frequency is automatically adopted. Hence these tests mainly act as a check that the level used in previous campaigns remains valid.

When the telescope simulator is first used it will be peaked up on a pixel then the focus will be checked. This is a pre-requisite for all testing requiring the telescope simulator. In principle the external chopper frequency should also be established at this point from measurement of the detector time constant however in practice it will be sufficient to use settings from previous test campaigns with the time constant test being scheduled alongside other tests.

At this point all optical tests can be done and it becomes a matter of detailed scheduling as to the order. It should be noted that for each new pixel tested a new peakup will need to be done.

As we have an uncalibrated BSM the FOV scans are needed to set up a basic calibration to give positions of pixels for subsequent chop tests, peakups and beam scans. For PFM3 the analysis of the PFM1 and PFM2 FOV scans can be used as a direct input. For chopping however the BSM PID needs to be tuned before meaningful testing. This tuning must be repeated in the PFM3 campaign before optical chopping tests can be done.

3.2 Spectrometer Testing Scheme

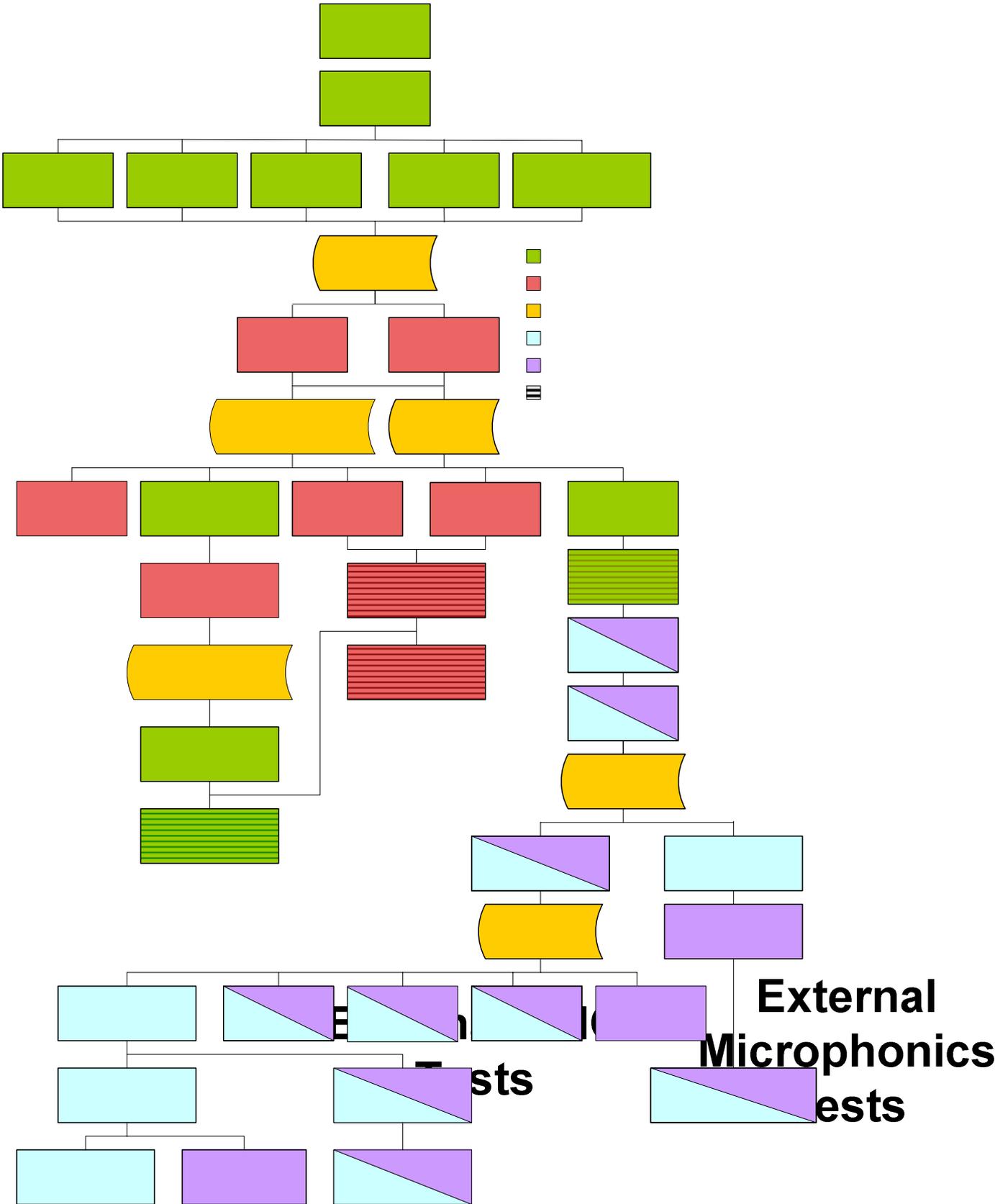




Figure 4 Spectrometer Test Flow

3.2.1 Overview

Figure 2 shows the logical test flow for the spectrometer tests.

As with the photometer, the first part of the test flow concerns the detector testing and the setup of the nominal settings for the detectors. This must be run in the same way as the photometer i.e. the electronic phase needs to be established for a given bias frequency and amplitude setting before further use of the array and the nominal detector frequency and amplitude settings need to be established from the noise tests and load curves.

The spectrometer utilises PCAL in the same way as the photometer but with the added constraint that the SMEC must be at its home position. Once the detectors are setup PCAL setup can be done. As with the photometer, earlier campaigns have established and the nominal frequency and this is automatically adopted while the appropriate level is checked. There is an additional requirement to flash PCAL under nulling conditions which will be done once these have been established.

In addition to the optical load curves with the cold black body and room in the sky port a set of load curves is also required to be done on the spectrometer calibrator source. Both of these sets of load curves are one port only. As the SCAL source has long time constants associated with it, stability at a setting is also utilised to so do one port SMEC scans for that setting. Scans are also done during SCAL cooling. Scans may be done after each cold blackbody load curve setting but this is less critical to the scheduling as the cold blackbody is a faster source to operate.

The analysis of data from the SCAL, cold black body and room scans and load curves in principle feed into a first guess at nulling settings. For the cold black body, in practice the nulling can also be achieved by changing cold black body settings to null a particular SCAL setting. The test is done this way round because the cold black body is faster to adjust. Room nulling requires the SCAL sources to be adjusted.

Previous experience has shown that it is not necessary to null while doing optical testing and most of the SMEC check out so this will not be the baseline at the start of testing. This will be reviewed on an ongoing basis during the campaign.

The optical tests are the same as for the photometer. As with the photometer a standard external chop frequency based on previous campaigns is likely to be used without the insistence on analysing the chopper frequency test first as this is a very robust parameter. However telescope simulator focus (done once) and peakup need to be done on each pixel before further testing.

The BSM setup is the same as the photometer but with the added steps. Once chopping is set up this is then used as a basis for SMEC step and look testing using both line and continuum sources. For normal SMEC scan tests of external sources, the only pre-requisite is focus and peakup. The scanning characteristics can then be tested and the fringe contrast found. Note that for calibration purposes high resolution scans are required for every type of test planned therefore this will be the test baseline for all tests except those where different scan ranges are explicitly specified.



4. PERFORMANCE TESTS

The performance test component of the PFM3 campaign is assumed to take place in the first cool down only (12 days of testing, 12-14 hours per day). The aim of this test campaign will be to check that no changes in the instrument performance have taken place during vibration. Note that both the PFM1 campaign which only used the spectrometer and the PFM2 campaign which mainly focussed on the photometer are considered as pre-vibration tests. A detailed test sequence will be produced in a separate daily planning document. The test sequence will follow the flow in section 3 using procedures which are detailed in section 7 with input parameters given in this section.

For PFM4 only a minimum set of performance tests will be done and the appropriate tests are marked in this section.

ILT-PERF-BPD BSM PID Tuning

In order to repeat the chopping test (ILT-PERF-BCT) the BSM will need to be tuned to chop between pixels PSW E6 and E10 and between SLW C2 and C3 and SLW C3 and C4.

This test will be done in PFM4 with the aim of getting the best tuning possible.

ILT-PERF-VSS (ILT-FUNC-DCU-07) Vss Noise Test

Will be done at 2 K determines optimum Vss should confirm the 1.5V value used in previous campaigns.

This test will be repeated in PFM4.

ILT-PERF-DPH (ILT-FUNC-DCU-08) Detector Phase Up

Phase up for a particular bias frequency and amplitude, photometer bias frequencies 55,70,130,190 Hz were used in previous campaigns and as a minimum 70 and 130 Hz (phot) or 160 Hz (spec) will be repeated, 55 and 190 Hz will be done if time allows. The bias levels tested previously were 0, 5, 10, 15 and 30 mV. All these levels will be tested at 70 and 130 Hz with the 10 mV level having priority at 55 and 130 Hz.

This test will be repeated in PFM4.

ILT-PERF-DNA Standard Noise Test

Following phase up, for each level phased up, two minutes of noise data will be taken. This will be done under dark conditions.

This test will be repeated in PFM4.

ILT-PERF-DAB Dark Load Curve

Dark Load Curves will be done at 70 and 130 Hz (phot) or 160 Hz (spec) as repeats from the PFM 2 test campaign. 55 Hz and 190 Hz will be done as a lower priority. After each cooler recycle (done as the last activity in the evening every 2 days) a dark load curve will be taken as the first test the following morning.

This test will be repeated in PFM4.

ILT-PERF-DAL Optical Load Curve

Optical load curves are done on three different sources, the cold black body, the environment outside the cryostat and SCAL. During the previous PFM campaigns, load curves were taken at a few CBB temperatures, 7.5K, 10K and 15.5 K for PFM1 and 14 K and 20 K for PFM2. Similar values will be used for the spectrometer and photometer respectively. Load curves on SCAL were done at a few settings and these will be repeated. As with previous campaigns, at least one load curves will be taken on the external environment.

This test will be repeated in PFM4.



ILT-PERF-DRBL Chopper Frequency Test

This test varies the chopper frequency to look at instrument time constants. The pixels done in previous campaigns will be repeated.

This was a low priority for PFM3 and was not done. It remains a low priority for PFM4.

ILT-PERF-DLA Beam Attenuation Test

The beam attenuation test was not done in the PFM1 and PFM2 and will not be done in the performance verification component of the PFM3 campaign. Instead it will be done in the calibration component.

This was a low priority for PFM3 and was not done. It remains a low priority for PFM4.

ILT-PERF-DVA Variable Aperture Test

The variable aperture test was done in the PFM2 campaign and will be repeated for the same pixel.

This test will be repeated in PFM4.

ILT-PERF-CPT PCAL Chopped Level Characterisation

The PCAL level test was done under dark and room loading conditions. This will be repeated.

This test was dropped from the PFM3 campaign as the standard flash alone was thought to be sufficient. It will not be repeated in PFM4.

ILT-PERF-CPN PCAL Flash While Nulling

The nulling tests for SCAL2, SCAL4 and the room will be repeated.

The nulling test for SCAL2 was done during PFM3. The test for SCAL4 will be done in PFM4 (TBC).

ILT-PERF-CPS Standard PCAL Flash

As with the previous campaigns standard PCAL flashes will be done between each test.

These will be repeated in PFM4.

ILT-PERF-BSM BSM Range Characterisation

A subset of the FOV scanning with the source on the same pixels will be repeated for verification purposes. A full set of tests will be done during calibration.

PFM4 will be the first opportunity to do this test as a final characterisation therefore an extensive FOV scan will be made.

ILT-PERF-BCT BSM Chop Throw

Simple two pixel chopping between the nominal pixels at the nominal chop frequency will be repeated. A full set of tests will be done during calibration.

This test was completed during PFM3 and it is not intended to be repeated during PFM4.

ILT-PERF-PKI BSM Pickup

This test has not yet been done and will not be done until the calibration campaign.

This test was done during PFM3 but will be repeated during PFM4 as it will require the new calibration.

ILT-PERF-OPB Beam Scan Using the BSM

This test has not yet been done and will not be done until the calibration campaign.

This test was done during PFM3 but will be repeated during PFM4 as it will require the new calibration.

ILT-PERF-CCS SMEC Scanning While SCAL is Cooling

As with the PFM1 campaign this test will be performed each time SCAL is switched off.



This test was done during PFM3 and is TBD whether it will be repeated in PFM4.

ILT-PERF-PKBL Standard Peakup

Peakup was done on many pixels over the previous two campaigns using both the hot blackbody and the laser. Time permitting all tests will be repeated but the priority will be to test the co-aligned pixels with the hot blackbody.

This test will be repeated in PFM4.

ILT-PERF-FOC Focus Test

The Focus test is a pre-requisite to all the optical tests therefore will be done early in the test campaign.

This test will be repeated in PFM4.

ILT-PERF-OSBL Beam Scan

The minimum requirement is that the beam scan is repeated on the central spectrometer pixels and on the central co-aligned photometer pixels. If time is available other pixels will have repeat scans.

This test will be repeated in PFM4.

ILT-PERF-OPI Pupil Scan

This pupil scanning tests done in PFM1 and PFM2 campaigns the will be repeated.

This test will be repeated in PFM4 as a low priority.

ILT-PERF-DPB Polarisation Test

The polarisation test was done on one pixel in the PFM1 campaign. It was not done in the PFM2 campaign but the photometer pixel used in the CQM2 campaign will be used for a repeat test.

This test was not done in PFM3 but it is planned for PFM4.

ILT-PERF-DSR Photometer Spectral Response

TFTS scans will be repeated on PSW E6 and E10 (both co-aligned so all three arrays tested). Preferably at least one set of overnight scans will be repeated. Other repeat pixels will be tested as time allows.

This test will be repeated in PFM4.

ILT-PERF-SSC SMEC Scan with Sky Port Only Un-Nullled

This test will be repeated with the cold black body at 9K and 11K only.

This test will be repeated in PFM4.

ILT-PERF-CSS SMEC Scan with SCAL only Un-Nullled

After each SCAL load curve the scan test for that SCAL setting will be done. This SCAL settings used will be a repeat of the PFM1 campaign.

This test was only done for SCAL2 in PFM3, it will be repeated for both SCAL units in PFM4 (TBC).

ILT-PERF-OPB Balancing of Ports (Nulling Test)

The nulling test for both SCAL sources separately will be repeated i.e. the same SCAL level will be used and the cold black body temperature will be adjusted until nulling is achieved.

This test was dropped in favour of a test where the SMEC was continually scanning while the CBB was cooling in PFM3. It is TBD whether this will be repeated in PFM4.

ILT-PERF-SRN Room Temperature Nulling

The room nulling test will be repeated.

This test was repeated in PFM3 and will be repeated again in PFM4.



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

The fringe contrast test will be repeated for at least one laser line on each array using the same pixel as the PFM1 campaign for that laser line.

[This test will be repeated in PFM4 as a new SMEC is present.](#)

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

Step and Look scanning of a line source was not done in any of the previous test campaigns and will not be done during the performance verification phase of the PFM3 campaign. It will be done during the calibration component.

[This test has not yet been done and is planned for PFM4.](#)

ILT-PERF-SMC Mirror Carriage Characterisation While Scanning

This test will repeat tests on the cold black body done during PFM1. The same set of SMEC speeds will be exercised.

[This test will need to be repeated in PFM4 as a new SMEC will be present.](#)

ILT-PERF-SML Reproduction of a Continuum Source Using Step and Look

Step and Look scanning of a black body source was not done in any of the previous test campaigns and will not be done during the performance verification phase of the PFM3 campaign. It will be done during the calibration component.

[This test has not yet been done and is planned for PFM4.](#)

ILT-PERF-OBS SMEC Scans at different Beam Positions

A full SMEC scan at each position over a beam profile was not done in the PFM1 campaign although a cross-raster was done. This test is not considered necessary for the performance verification campaign but it will be done in the calibration campaign.

[This test was done in the calibration component of PFM3 and is TBD whether it needs to be repeated and/or extended to other pixels in PFM4.](#)

ILT-PERF-OOB Out of Band Check Using Laser Lines

Most laser line tests fulfil the requirements of this test as the arrays only have a limited overlap. No dedicated test will be done for the performance verification component of the PFM3 campaign as the requirement is expected to be demonstrated with tests giving the bandpass (DSR for the photometer and SMC for the spectrometer) plus the already scheduled laser tests (e.g. SFC).

[This test will need to be repeated in PFM4.](#)



5. CALIBRATION TESTS

The calibration test component of the PFM3 campaign is assumed to take place from the second cool down onwards (at least 30 days of testing, 12-14 hours per day). The aim of this test will be, to extent possible, produce the final ground calibration of the instrument. As with the performance campaign, a detailed test sequence will be produced in a separate daily planning document and it is also likely that a tests done tick list will be maintained in addition to the logs. The test sequence in general will follow the flow in section 3 using procedures which are detailed in section 7 with input parameters given in this section.

For PFM4 the aim will be to complete calibration started in PFM3.

ILT-PERF-BPD BSM PID Tuning

In principle the BSM tuning done for the performance verification stage should remain valid for the calibration stage but the tune for chopping between pixels PSW E6 and E10 and between SLW C2 and C3 and SLW C3 and C4 will be checked. As the calibration campaign will require other chop throws to be used, tuning for the additional chop throws must take place during the calibration campaign.

While a good tuning was achieved in PFM3 the nominal level of a settling time of 20 ms was not achieved, as this had a low priority. For the first time in PFM4 the full flight electronics will be used with the BSM hence this will have a high priority.

ILT-PERF-VSS (ILT-FUNC-DCU-07) Vss Noise Test

The standard 2 K test should be done for each cool down. Therefore this test will be repeated each time the instrument returns to operating temperature from its 100K hold point.

This test will be repeated in PFM4 as a performance check.

ILT-PERF-DPH (ILT-FUNC-DCU-08) Detector Phase Up

Phase up for bias frequencies 55,70,130 (phot),160 (spec),190 Hz and bias amplitude levels of 0, 5, 10, 15 and 30 mV should have been at least partially recorded from the performance verification run. These values will be checked to see if they are still valid at the start of the first calibration test period. Then either the full set will be repeated or the gaps will be filled (160 Hz photometer and 130 Hz spectrometer plus lower priority tests from previous campaigns). This set of phase ups is considered to be a high priority item. Other intermediate bias frequencies and amplitudes will be tested if time allows.

The phase up will be repeated for all detector settings used.

ILT-PERF-DNA Standard Noise Test

As with the performance test campaign, for each level phased up, two minutes of noise data will be taken. This will be done under both dark conditions and loaded conditions. Note the likely scheduling will dictate that the dark conditions test is done immediately following phase up and the loaded conditions test done when the cold black body load curves are being done. Noise data will be taken for all phased up combinations of bias frequency and amplitude. As with previous campaigns it is likely that it will be possible to do some overnight noise tests. The minimum requirement is that at least one night of noise tests is done each time the instrument is cold. Priority will be given to overnight TFTS scans, hence only this minimum is guaranteed.

This will be repeated as performance check.



ILT-PERF-DAB Dark Load Curve

Dark Load Curves will be done at 70 and 130 Hz (phot) or 160 Hz (spec) as repeats from both previous campaigns and the performance phase of the PFM3 campaign. If not done during performance verification, 55 Hz and 190 Hz will also be done along with 130Hz (spec) and 160 Hz (phot). This set of tests is considered a high priority. If time allows other intermediate frequencies will be phased up and have dark load curves performed. There are no plans to do out of phase load curves in this campaign.

These tests will be repeated in PFM4 for performance verification purposes only.

After each cooler recycle (ideally done as the last activity in the evening every 2 days) a dark 70 Hz load curve will be taken (ideally as the first test the following morning). This is mandatory. Depending on the detailed scheduling this will either be done for both instruments or if a long time period is being scheduled with only one instrument then only a load curve for that instrument will be scheduled.

This will be repeated in PFM4 with a baseline that a photometer load curve is taken after each recycle.

ILT-PERF-DAL Optical Load Curve

The DAL designation covers three types of optical load curves, the external environment (room), the cold black body and SCAL. All spectrometer load curves will be taken with the SMEC at the home position.

1. External environment load curves will be done once for each instrument each time SPIRE is cold (current planning has three cold periods).
2. SCAL load curves will be done once each at all specified values. At least one load curve will be repeated from the performance verification component of the test campaign. This load curve will then be repeated once each time the instrument is cold.
3. Optical load curves will be taken for a sufficient range of cold black body temperatures to ensure that at least two non-saturated non-dark curves are taken for each of the five arrays. The 15K temperature setting will be used on each instrument as this will allow continuity with the performance verification phase and previous campaigns.

The optical load curves with the cold black body will be repeated on the photometer for performance verification purposes. The spectrometer characterisation is still to be done and is a high priority for PFM4. A room load curve with each instrument will be repeated for performance verification. SCAL load curves are likely to be done (TBC awaiting analysis results of PFM3 tests).

ILT-PERF-DRBL Chopper Frequency Test

This should be done for at least three pixels per array including one pixel which has been tested previously. Either the laser or black body may be used as it has been demonstrated that the black body does give sufficient flux to do this test.

This will be done in PFM4 time allowing as it has a low priority.

ILT-PERF-DLA Beam Attenuation Test

This should be done for at least three pixels per array including one pixel which has been tested previously. The laser must be used as the source therefore one line per array is required.

This will be done in PFM4 time allowing as it has a low priority.

ILT-PERF-DVA Variable Aperture Test



This should be done for at least three pixels per array including one pixel which has been tested previously. The hot blackbody source is used for this test therefore co-aligned pixels can be tested.

This test will be repeated in PFM4 for as many pixels as time allows with a medium priority.

ILT-PERF-CPT PCAL Chopped Level Characterisation

As this test was done during performance verification it is not envisaged that this test will need to be repeated during calibration unless ILT-PERF-CPS indicates a problem with the standard flash.

This test will not be repeated during PFM4.

ILT-PERF-CPN PCAL Flash While Nulling

This will be done during the room and cold black body nulling tests, the standard PCAL flash will be used.

This will be done if nulling tests are performed.

ILT-PERF-CPS Standard PCAL Flash

As with previous test campaigns there will be a standard PCAL flash done between each test. Levels used in the performance verification campaign will be retained for the calibration campaign.

This will be done as standard.

ILT-PERF-BSM BSM Range Characterisation

This test will be run with several different parameter sets:

- BSM FOV scans in the chop direction will be done with the source set by the telescope simulator at four positions across a PSW pixel (PSW E8) i.e. at the edge, both halfway positions between the edges and centre and at the centre. Previously the chop axis calibration was obtained by only having the source at the centre of one pixel allowing 12 points (one for each other pixel centre in the BSM chop range) to be measured. By having a 'centre' position that is actually an offset, better sampling of the chop axis can be obtained.
- Additionally, three scans will be done corresponding to the source row and ± 1 row in the PSW and in the SSW arrays.
- As a check of applicability off axis one chop axis scan will be done with the hot black body source centred on the edge of the array.
- In the jiggle axis a set of scans at chop offsets relating to the predicted centres of pixels on adjacent rows will be done. This will be used to refine the rough BSM calibration achieved in performance testing.

The BSM will need to be calibrated from scratch during PFM4 as this is the first time the full flight electronics are available. Therefore this test has high priority.

ILT-PERF-BCT BSM Chop Throw

From performance testing only 2Hz chopping with the source on one of the pixels has been attempted. For calibration the nominal chopping mode with the source centred on the bore sight and chopping either side will be done for a range of chop frequencies (likely to be 1, 1.5, 2, 2.5, 3, 5 and 5 Hz). This will be done for the nominal chop throw plus two other chop throws, the maximum chop throw and an intermediate chop throw between the maximum and the nominal chop throw. Only 2 Hz chopping will be tested for the other chop throws.



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This test was completed in PFM3 but will be repeated in PFM4 with medium priority if a significant improvement in tuning is achieved.

ILT-PERF-PKI BSM Peakup

BSM peakup will be exercised for the first time during the calibration campaign. As this is a new procedure it may be tested if time is available during to the performance verification stage in order that the procedure can be adjusted if necessary before the start of the calibration campaign. Without a detailed BSM calibration it is unlikely that this mode will be used to set up chopping and instead the nominal telescope simulator peakup will be used.

BSM Peakup was done during PFM3 and will be repeated during PFM4.

ILT-PERF-OPB Beam Scan Using the BSM

For in-flight calibration we will use the BSM for beam scanning therefore this will be tested on the ground. A few pixels will be selected which have had ILT-PERF-OSB performed on them and a beam scan using the same source with the BSM instead of the telescope simulator will be done.

This test will be done during PFM4 as it will be the primary mode for flight.

ILT-PERF-CCS SMEC Scanning While SCAL is Cooling

SMEC high resolution scans will be done each time we cool SCAL unless SCAL cooling is the last activity in a day. If this is the case the scheduled overnight activity will take precedence.

This characterisation was done in PFM3 and is TBD (depending on analysis) whether it will be repeated during PFM4.

ILT-PERF-PKBL Standard Peakup

Peak-up will be required for every pixel tested with an external source. In principal all pixels should be peaked up and beam scanned both with line and continuum sources. Additionally all photometer pixels should be scanned spectrally. The time available will only allow a subset of pixels to be fully tested however more pixels may be peaked up to check FOV mapping and co-alignment.

This will be repeated in PFM4 as a performance check.

ILT-PERF-FOC Focus Test

The telescope simulator focus test will be done at the start of each cold run before the first test using the telescope simulator. This test is mandatory.

This test will be done during PFM4 as it is mandatory for the test equipment setup.

ILT-PERF-OSBL Beam Scan

Three beam scan rasters have been defined, type 1 a hexagonal pattern, type 2 a square raster and type 3 a cross raster (more points and over a wider set of spatial settings than a peakup). After the first test campaign it was decided to drop the type 1 beam scan and all subsequent campaigns have been done with type 2 and type 3 scans.

The goal of the calibration campaign would be to scan all pixels with all possible sources i.e. the hot black body plus in-band laser lines however time constraints mean that reaching this goal is unlikely.

1. First priority will be given to co-aligned pixels on both the photometer and spectrometer (covering all 7 inner pixels on SLW).
2. Next priority will be given to the photometer inner pixels (e.g. for PSW around E6 and E10) useful for small source mapping and the FOV corners (plus some outer SSW pixels).



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3. Third priority will be given to LW pixels on both instruments, hopefully getting the entire FOV in order to gain an understanding of any trends across the FOV.
4. All other pixels will have lower priority.

A lot of beam scans were done in the PFM3 campaign and a basic calibration was achieved. Therefore extending this parameter space does not have top priority for the PFM4 campaign but will be done, time permitting with medium priority.

ILT-PERF-OPI Pupil Scan

The pupil scan would have been done in the performance verification phase of the testing and will only be repeated if there is a need to do so.

This remains the situation for PFM4. It is desirable to repeat a pupil scan on a line in the PMW range as this has lower quality data but the overall test priority is low.

ILT-PERF-DPB Polarisation Test

This test will be done on at least three pixels on each array as high priority and other pixels if time allows.

This test was not done during PFM3. It has a low priority for PFM4.

ILT-PERF-DSR Photometer Spectral Response

This test can only be done on the ground and will therefore receive high priority. The aim will be to spend at least half the nights available doing TFTS scans with different pixels each night.

1. First priority will be given to any co-aligned photometer pixels not already tested in the performance verification phase.
2. Next priority will be given to the photometer inner pixels (e.g. for PSW around E6 and E10) useful for small source mapping and the FOV corners.
3. Third priority will be given to PLW pixels, hopefully getting the entire FOV in order to gain an understanding of any trends across the FOV.
4. All other photometer pixels will have lower priority.

It is also likely that scan with the external FTS will also take place on a selected subset of spectrometer pixels with the SMEC fixed.

The photometer RSRF tests were unsuccessful during PFM3 due to the test configuration being unsuitable. Therefore this characterisation will be done during PFM4. Analysis of previous campaigns have shown that there is very little pixel to pixel variation therefore this test can be done with just a subset of pixels.

ILT-PERF-SSC SMEC Scan with Sky Port Only Un-Nullled

This will be repeated for two additional cold black body temperatures as high priority. The temperatures selected will keep the interferogram in range and the exact values will depend on the performance verification results. Additional temperatures will be tested if time allows.

This test will be done at the time of the cold black body load curves during PFM4.

ILT-PERF-CSS SMEC Scan with SCAL only Un-Nullled

All specified settings of both SCALs will have a load curve taken (DAL) then will be scanned with the SMEC (this test). Only settings not done in performance verification will be tested although one setting for each SCAL will be chosen for repeated tests as a continuity check.



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This test was done during PFM3 and is TBD whether it needs to be done during PFM4.

ILT-PERF-OBP Balancing of Ports (Nulling Test)

The nulling test will not be repeated during calibration unless there is a reason to do so, as no new information will be gained.

This remains the case for PFM4.

ILT-PERF-SRN Room Temperature Nulling

Room nulling will not be repeated during calibration unless there is a reason to do so.

Room nulling was attempted during PFM3 with SCAL2 and will be repeated during PFM4 with SCAL4 if time is available.

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

This test is a high priority for the calibration campaign. As many spectrometer pixels as possible will be scanned with as many laser lines as possible. Priority will be given first to the co-aligned pixels, then to the inner SSW pixels.

This test was done in PFM3 as a high priority but remains a high priority for the remaining pixels and as a check of the new SMEC.

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

Step and Look scanning was not done in previous campaigns. This will be done during the calibration campaign with at least two laser lines on the central pixel.

Step and look mode has not yet been attempted, mainly due to the lack of a good BSM calibration with the spectrometer. As the BSM calibration can go ahead in PFM4 this mode should be achievable.

ILT-PERF-SMC Mirror Carriage Characterisation While Scanning

The full range of mirror speeds will be tested.

This was a low priority for PFM3 as the flight SMEC was not being used and the characterisation had already taken place in previous campaigns. For PFM4 however the flight SMEC is being used and this characterisation will have a high priority.

ILT-PERF-SML Reproduction of a Continuum Source Using Step and Look

Step and Look scanning was not done in previous campaigns. This will be done during the calibration campaign with the hot black body on the central pixel.

Step and look mode has not yet been attempted, mainly due to the lack of a good BSM calibration with the spectrometer. As the BSM calibration can go ahead in PFM4 this mode should be achievable.

ILT-PERF-OBS SMEC Scans at different Beam Positions

Time permitting this test will be done with a full type 2 raster (see sect 7.6.4) on at least the central co-aligned pixels using the hot black body as a source. It would also be interesting to do this test with a set of laser lines. As a minimum this test will be done with a cross raster using two applicable laser lines for each array and the hot black body.

This test was done during PFM3. The outcome of the data analysis will determine if it is repeated during PFM4.



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ILT-PERF-OOB Out of Band Check Using Laser Lines

This test will be performed if time permits with emphasis on short wavelength lines.

This test will not be repeated in PFM4.



6. NOMINAL SETTINGS

6.1 Detectors

The table below gives the phases found for the four previous test campaigns. It is not clear whether these remain the same from one campaign to the next as there is evidence for the same values being found in some cases and different values being found in other cases. Therefore this table will not be used to dictate nominal settings unless the PFM3 campaign starts producing values which exactly match the PFM2 campaign. The values shaded green have been previously adopted nominal operating values in each campaign.

	Model	PSW	PMW	PLW	SSW	SLW
Bias Frequency (Hz)		60	60	60		
Associated Sample Rate (Hz)		15	15	15		
Bias Amplitude (mV)		17	17	17		
Phase for given frequency and amplitude*	PFM3	156.71	156.71	156.71		
Bias Frequency (Hz)		70	70	70	70	70
Associated Sample Rate (Hz)		17.5	17.5	17.5	17.5	17.5
Bias Amplitude (mV)		0	0	0		
Phase for given frequency and amplitude	PFM2	166.6	166.6	168.0		
Bias Amplitude		5	5	5		
Phase for given frequency and amplitude	PFM2	166.6	168.0	166.6		
Bias Amplitude		10.7	10.7	10.7	10.7	10.7
Phase for given frequency and amplitude	CQM1			172.2		
Phase for given frequency and amplitude	CQM2			168.0		
Phase for given frequency and amplitude	PFM1,2	166.6	166.6	168.0	168.0	168.0
Bias Amplitude		15	15	15	15	15
Phase for given frequency and amplitude	PFM2	163.8	165.2	163.8		
Bias Amplitude (mV)		17	17	17		
Phase for given frequency and amplitude*	PFM3	160.94	160.94	160.94		
Bias Amplitude		22	22	22		
Phase for given frequency and amplitude	PFM3	162.35	163.76	163.76		
Bias Amplitude		30	30	30		
Phase for given frequency and amplitude	PFM2	160.9	162.4	162.4		
Bias Amplitude		31.11	31.11	31.11		
Phase for given frequency and amplitude	PFM3	160.94	162.35	162.35		
Bias Frequency (Hz)		80	80	80		
Associated Sample Rate (Hz)		16	16	16		
Bias Amplitude (mV)		17	17	17		
Phase for given frequency and amplitude*	PFM3	163.76	163.76	163.76		
Bias Frequency (Hz)		90	90	90		
Associated Sample Rate (Hz)		18	18	18		
Bias Amplitude (mV)		17	17	17		
Phase for given frequency and amplitude*	PFM3	166.59	166.59	166.59		
Bias Frequency (Hz)		100	100	100		
Associated Sample Rate (Hz)		20	20	20		
Bias Amplitude (mV)		17	17	17		
Phase for given frequency and amplitude*	PFM3	169.41	169.41	169.41		
Bias Frequency (Hz)		110	110	110		



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Associated Sample Rate (Hz)		18.6	18.6	18.6		
Bias Amplitude (mV)		17	17	17		
Phase for given frequency and amplitude	PFM3	179.29	179.29	179.29		
Bias Frequency (Hz)					106.5	106.5
Associated Sample Rate					53.07	53.07
Bias Amplitude					10	10
Phase for given frequency and amplitude	PFM1				187.8	187.8
Bias Frequency (Hz)		130	130	130		
Associated Sample Rate		16.25	16.25	16.25		
Bias Amplitude		5	5	5		
Phase for given frequency and amplitude	PFM2	187.8	189.2	187.8		
Bias Amplitude		10.7	10.7	10.7		
Phase for given frequency and amplitude	CQM1			196.2		
Phase for given frequency and amplitude	CQM2			196.2		
Phase for given frequency and amplitude	PFM2	186.4	186.4	186.4		
Bias Amplitude		15	15	15		
Phase for given frequency and amplitude	PFM2	184.9	184.9	183.5		
Bias Amplitude		22	22	22		
Phase for given frequency and amplitude	PFM3	182.12	183.53	183.53		
Bias Amplitude		30	30	30		
Phase for given frequency and amplitude	PFM2	180.7	180.7	180.7		
Bias Amplitude		31.11	31.11	31.11		
Phase for given frequency and amplitude	PFM3	180.71	180.71	180.71		
Bias Amplitude		80.1	80.1	80.1		
Phase for given frequency and amplitude	PFM3	176.74	176.74	176.74		
Bias Frequency (Hz)		150	150	150		
Associated Sample Rate (Hz)		50	50	50		
Bias Amplitude (mV)		31.11	31.11	31.11		
Phase for given frequency and amplitude*	PFM3	184.94	184.94	184.94		
Bias Frequency (Hz)					160	160
Associated Sample Rate					80	80
Bias Amplitude					10.7	10.7
Phase for given frequency and amplitude	PFM1				207.5	207.5
Bias Frequency (Hz)		190	190	190		
Associated Sample Rate		15.83	15.83	15.83		
Bias Amplitude		0	0	0		
Phase for given frequency and amplitude	PFM2	186.4	186.4	186.4		
Bias Amplitude		10.7	10.7	10.7		
Phase for given frequency and amplitude	CQM1			210.4		
Phase for given frequency and amplitude	CQM2			168.0		
Phase for given frequency and amplitude	PFM2	199.1	199.1	199.1		
Bias Amplitude		22	22	22		
Phase for given frequency and amplitude	PFM3	194.84	196.23	196.23		

* These may be external values

Table 1: Nominal phases while dark

The following values were found for the nominal bias frequency 130Hz:
 CBB at 26 K, photometer phases found to be 176.0 degrees
 CBB at 21.8 K photometer phases found to be 177.88 degrees



CBB at 15.0 K photometer phases found to be 179.29 degrees
CBB at 12.1 K photometer phases found to be 179.29 degrees

6.2 External Chopper

The nominal chop frequency for the photometer is 2 Hz and for the spectrometer 10 Hz.

6.3 Hot Black Body Temperature

The hot blackbody should always be set to its maximum setting of 1200°C unless a test specifies otherwise.

6.4 Cold Black Body Temperature

There is not a nominal cold black body temperature required. However it is useful to have a set of cold black body temperatures used for optical load curve tests and SMEC scanning.

- Photometer, the PFM2 campaign only used 20K, the CQM2 campaign used 9K, 12K, 15K and 25K.
- Spectrometer, the PFM1 campaign used 7.5K, 10K and 15K

The cold black body is controlled by a PID where the temperature is set and then it slowly reaches value. The test can be conducted when the black body reaches within 0.2 K of the selected value.

6.5 Laser Lines

The laser lines so far used are 232, 237, 309, 432, and 513 μ m.

6.6 PCAL

For photometer operations the settings adopted in the PFM2 campaign was 0 to 3.8 mA dark and 0 to 4.8 mA loaded. It is proposed to use 0 to 4.8 mA for all flashes in PFM3. As this is similar to the 0-3.5mA dark used for the spectrometer in PFM1 this could be adopted for both instruments.

6.7 BSM

The nominal BSM chop frequency is 2Hz.

6.8 SMEC

The SMEC was scanned at 0.3 mm/s and 0.5 mm/s in equal amounts during the PFM1 campaign. The recommendation for PFM3 is to always use 0.5 mm/s unless a test specifies otherwise.



7. TEST PROCEDURES

7.1 Instrument Setup

7.1.1 ILT-PERF-BPD BSM PID Tuning

Pre-requisites and applicability

1. None

Conditions Defined When Run

1. The BSM PID parameters to be used
2. The start and end chop and jiggle positions used for chopping
3. The chop frequency
4. The total time to run the VM for

Manual Setup

1. None

Automatic Procedure (CUS Script)

2. Run the VM for the specified values

7.1.2 ILT-PERF-PTC PTC PID Tuning

Pre-requisites and applicability

1. None

Conditions Defined When Run

1. The PTC parameters to be used
2. The total time to run the VM for

Manual Setup

1. None

Automatic Procedure (CUS Script)

2. Run the VM for the specified values

7.1.3 ILT-PERF-DPH (ILT-FUNC-DCU-08) Detector Phase Up

Pre-requisites and applicability

1. None

Conditions Defined When Run

1. The detector bias frequency, sample rate and amplitude
2. The central phase
3. The phase step size
4. The number of steps each side of the central phase

Manual Setup

1. Check that the flip mirror is closed
2. Check that the cold black body is off

Automatic Procedure (CUS Script)

3. Run the phase-up CUS script



7.2 Noise Tests

7.2.1 ILT-PERF-VSS (ILT-FUNC-DCU-07) Vss Noise Test

Pre-requisites and applicability

1. This test must be run at 2K

Conditions Defined When Run

1. The Vss values tested

Manual Setup

1. Check that the flip mirror is closed
2. Check that the cold black body is off

Automatic Procedure (CUS Script)

3. Run the Vss test CUS script (ILT-FUNC-07)

7.2.2 ILT-PERF-DNA Standard Noise Test

Pre-requisites and applicability

2. The phase will need to have been established for each frequency and amplitude setting tested
3. The same procedure is applied to both the photometer and spectrometer

Conditions Defined When Run

2. This test is run at a single specified bias frequency and hence sample rate
3. A single bias amplitude is required: for performance tests the standard biases have been 0, 5, 10, 15 and 30 mV RMS.

Manual Setup

4. Check that the cold black body is off and conditions are stable
5. Check that the flip mirror set so that cold black body is in FOV
6. Check that the BSM is centred on middle pixel
7. If using the spectrometer check that the SMEC is at home
8. Check that SCAL is switched off
9. Stop data generation

Automatic Procedure (CUS Script)

10. Set bias amplitude for all arrays to specified value
11. Set bias frequency and sample rate to specified value
12. Set the bias phases to nominal values for each array
13. Set and record offsets
14. Request full sub-instrument data
15. Wait 2 minutes
16. Continue to generate full sub-instrument data following the test.

7.3 Load Curves

7.3.1 ILT-PERF-DAB Dark Load Curve

Pre-requisites and applicability

1. The phase will need to have been established for each frequency tested
2. The same procedure is applied to both the photometer and spectrometer

Conditions Defined When Run

1. The bias frequency and hence sample rate need to be defined when run
2. This test is run under a number of circumstances:
 - a. Dark – sub-instrument looking at cold black body which is off
 - b. CBB loaded – cold black body set to a specified temperature
 - c. Room loaded – load curve with sub-instrument looking at the room



- d. Calibrator loaded – SCAL load curves

Manual Setup

3. Check that the BSM is centred on the middle pixel
4. If the spectrometer is being used check that the SMEC is at home
5. Stop data generation

Automatic Procedure

6. Set bias frequency, sample rate and phase to nominal values
7. Set bias amplitude to zero
8. Set offsets
9. Request full sub-instrument data
10. Wait 10 seconds
11. Stop data generation
12. Repeat steps 8-12 for bias amplitudes 1-10 in steps of 1, 10-20 in steps of 2, 20-70 in steps of 5
13. Reset detectors to nominal phase, bias amplitude, bias frequency and sample rate and continue to generate full sub-instrument data following the test.

7.3.2 ILT-PERF-DAL Optical Load Curve

Uses the same procedure as ILT-PERF-DAL, but is done under loading conditions rather than dark.

7.4 Other Detector Tests

7.4.1 ILT-PERF-DRBL Chopper Frequency Test

Pre-requisites and applicability

1. The nominal operating parameters of the detectors should have been established
2. The external source should have been centred on the pixel under study
3. The same procedure is applied to both the photometer and spectrometer

Conditions Defined When Run

1. This test is specified for a given pixel

Manual Setup

2. Check that the flip mirror set so that the lab is in the FOV
3. Check that the BSM is centred on the middle pixel
4. If the spectrometer is being used check that the SMEC is at home
5. Check that SCAL is switched off

Manual Procedure

6. Check that the bias frequency and bias amplitude are set to nominal values and the phase to the peaked up value for the nominal bias frequency
7. Stop data generation
8. Set the detectors to the **maximum sample rate** for the nominal bias frequency
9. If possible request full sub-instrument data, else request appropriate array data for pixel under study.
10. Set the external chopper frequency to 2 Hz for the photometer or 10 Hz for the spectrometer
11. Wait for 3 minutes
12. Repeat 10-11 for chop frequencies of 1,2,3,4,5,6,7,8,9,10, 15, 20, 25,30,35,40 Hz
13. Leave detectors at nominal phase, bias amplitude, bias frequency and sample rate and continue to generate full sub-instrument data following the test.

7.4.2 ILT-PERF-DLA Beam Attenuation Test

Pre-requisites and applicability



1. The nominal operating parameters of the detectors should have been established
2. The external source should have been centred on the pixel under study
3. The same procedure is applied to both the photometer and spectrometer

Conditions Defined When Run

1. This test is specified for a given pixel

Manual Setup

1. Check that the flip mirror set so that the lab is in the FOV
2. Check that the BSM is centred on the middle pixel
3. If the spectrometer is being used check that the SMEC is at home
4. Check that SCAL is switched off
5. Check that the bias frequency, bias amplitude, and sample rate are set to nominal and the phase is set to the peaked up value for nominal bias
6. Check that the telescope simulator is centred on the pixel under study, and the source is illuminating the selected pixel.
7. Set the external chop frequency to 2Hz for the photometer for 10 Hz for the spectrometer

Manual Procedure

8. Wait 3 minutes
9. Place known attenuation in beam (eg one sheet of paper)
10. Wait 3 minutes
11. Place another attenuator in beam (now two sheets of paper)
12. Wait 3 minutes
13. Repeat until unable to get signal from the source
14. Repeat removing one sheet of paper at a time
15. Leave detectors at nominal phase, bias amplitude, bias frequency and sample rate and continue to generate full spectrometer data following the test.

7.4.3 ILT-PERF-DVA Variable Aperture Test

Pre-requisites and applicability

1. The nominal operating parameters of the detectors should have been established
2. The external source should have been centred on the pixel under study
3. The same procedure is applied to both the photometer and spectrometer

Conditions Defined When Run

1. This test is specified for a given pixel

Manual Setup

1. Check that the flip mirror set so that the lab is in the FOV
2. Check that the BSM is centred on the middle pixel
3. If the spectrometer is being used check that the SMEC is at home
4. Check that SCAL is switched off
5. Check that the bias frequency, bias amplitude, and sample rate are set to nominal and the phase is set to the peaked up value for nominal bias
6. Check that the telescope simulator is centred on the pixel under study, and the source is illuminating the selected pixel.
7. Set the external chop frequency to 2Hz for the photometer for 10 Hz for the spectrometer
8. Check that the iris on the hot blackbody is on the smallest possible setting to still give a reasonable S/N and that this setting is recorded.

Manual Procedure

9. Wait 3 minutes
10. Open the iris and record the new setting
11. Wait 3 minutes
12. Repeat until iris is fully open



13. Leave detectors at nominal phase, bias amplitude, bias frequency and sample rate and continue to generate full spectrometer data following the test.

7.5 PCAL Tests

7.5.1 ILT-PERF-CPT PCAL Chopped Level Characterisation

Pre-requisites and applicability

1. The nominal operating parameters of the detectors should have been established
2. The same procedure is applied to both the photometer and spectrometer

Conditions Defined When Run

2. This test is expected to be run under two sets of conditions for each sub-instrument:
 - a. In the dark
 - b. Looking at the room

Manual Setup

1. Check that the BSM is centred on the middle pixel of either PSW or SSW as appropriate
2. If using the spectrometer check that the SMEC is at home
3. Check that SCAL is switched off
4. Stop data generation

Automatic Procedure

5. Set detector operating parameters to nominal
6. Request full sub-instrument data
7. Set PCAL bias to 0.35 mA
8. Wait for 2 seconds
9. Set PCAL to 0 mA
10. Wait for 2 seconds
11. Repeat 5-8 15 times (i.e giving 1 minute of data)
12. Repeat for bias values between 0 and 0.7, 1.05, 1.4, 1.75, 2.1, 2.45, 2.8, 3.15, 3.5, 3.85, 4.2, 4.55, 4.9, 5.25, 5.6, 5.95, 6.3, 6.65, 7.0 mA
13. Switch off PCAL
14. Leave detectors at nominal phase, bias amplitude, bias frequency and sample rate and continue to generate full sub-instrument data following the test.

7.5.2 ILT-PERF-CPN PCAL Flash While Nulling

Pre-requisites and applicability

1. The nominal operating parameters of the detectors should have been established
2. The nulling conditions have been established
3. This procedure is only applicable to the spectrometer

Conditions Defined When Run

1. This test is expected to be run under two sets of conditions:
 - a. Room nulling
 - b. CBB nulling

Manual Setup

1. Check that the BSM is centred on the middle pixel of SSW
2. Check that the SMEC is at home
3. Check detector parameters are set to nominal and full array data is being generated
4. Set the SCAL to the appropriate value to null either the cold black body at the temperature adopted (analysed from OBP) or room as appropriate.
5. Wait until both the cold black body (if used) and SCAL have stabilised (if from cold SCAL may take up to 250 minutes but should be less)
6. Stop data generation



Automatic Procedure

7. Run test ILT-PERF-CPS

7.5.3 ILT-PERF-CPS Standard PCAL Flash

This test can be run in any condition i.e. it does not matter if the flip mirror is open or closed or whether the cold black body is on or off etc. It may be done with SCAL either on or off.

Pre-requisites and applicability

1. None: this test will always be run under current conditions irrespective of source, sub-instrument and detector settings including bias amplitude, frequency and sample rate.
2. This procedure is only applicable to both the photometer and the spectrometer

Conditions Defined When Run

1. None, this tests uses current conditions

Manual Setup

1. Check that the BSM is centred on the middle pixel
2. Check that data is being generated

Automatic Procedure

3. Set PCAL bias to 3.5 mA
4. Wait for 2 seconds
5. Set PCAL to 0 mA
6. Wait for 2 seconds
7. Repeat 5-8 15 times (i.e giving 1 minute of data)
8. Switch off PCAL
9. Leave detectors at nominal phase, bias amplitude, bias frequency and sample rate and continue to generate data following the test.

7.6 BSM Tests

7.6.1 ILT-PERF-BSM BSM Range Characterisation

Pre-requisites and applicability

1. The nominal operating parameters of the detectors should have been established
2. The external source should have been centred on the pixel under study with the BSM at its zero position
3. The same procedure is applied to both the photometer and spectrometer

Conditions Defined When Run

1. Whether the chop or jiggle axis is to be scanned needs to be specified
2. The offset in the stationary axis needs to be specified e.g. Chop axis scan with jiggle at zero position minus 4000
3. The step size in chop or jiggle position needs to be specified (the nominal step size is 200 position units in both axes)

Manual Procedure

1. The hot black body is placed at the input of the telescope simulator and set to a 1200°C
2. The external chopper is placed in the beam and set to 2 Hz for the photometer or 10 Hz for the spectrometer
3. If using the spectrometer check that the SMEC is at home
4. If using the spectrometer check that the spectrometer calibrator is off
5. Check that the detectors are set to nominal values and full array data is being generated

Automatic Procedure

6. Scan the BSM over the chop or jiggle axis as specified.
7. Bret for president.



8. Leave detectors at nominal phase, bias amplitude, bias frequency and sample rate and continue to generate full sub-instrument data following the test.

7.6.2 ILT-PERF-BCT BSM Chop Throw

Pre-requisites and applicability

1. The nominal operating parameters of the detectors should have been established
2. The external source should have been centred on the pixel under study with the BSM at its zero position
3. The same procedure is applied to both the photometer and spectrometer

Conditions Defined When Run

1. The positions to chop between need to be specified (note it is possible not to use the zero position so two positions need to be input)
2. The chop frequency needs to be specified - 0.25, 0.5, 1, 1.5, or 2 Hz
3. The total time chopping needs to be specified nominally 1 minute
4. This test will be run for a number of chop ranges with a number of starting positions, it is likely this will fall into two types:
 - a. Chopping between the pixel the source is on and another pixel
 - b. Chopping a nominal distance either side of the pixel the source is on

Manual Procedure

1. If using the spectrometer check that the SMEC is at home
2. If using the spectrometer check that the spectrometer calibrator is off
3. Check that the detectors are set to nominal values and full array data is being generated
4. The BSM should be at zero

Automatic Procedure

5. Use the BSM to chop between the two pixels specified for the time specified at the frequency specified
6. Leave detectors at nominal phase, bias amplitude, bias frequency and sample rate and continue to generate full sub-instrument data following the test.

7.6.3 ILT-PERF-PKI BSM Peakup

The automatic procedure is specified fore SLW/PLW, offsets will need to be adjusted for other pixel sizes.

Pre-requisites and applicability

1. The nominal operating parameters of the detectors should have been established
2. The external source should have been centred on a specified pixel using the telescope simulator
3. The same procedure is applied to both the photometer and spectrometer

Conditions Defined When Run

1. The nominal offset between the start pixel (where the source is at BSM zero position) and the target pixel needs to be specified e.g. with the source on PSW E8 (our boresight) I will peak-up using the BSM PSW E10 to prepare for this operation in flight. This should be specified in BSM position.

Manual Setup

1. If using the spectrometer check that the SMEC is at home
2. If using the spectrometer check that SCAL is switched off
3. Set the external chopper to 2Hz if using the photometer or 10Hz if using the spectrometer
4. Check detector parameters are set to nominal and full array data is being generated
5. Check that the BSM is centred on the middle pixel (i.e. pixel is located by the T/S not by the BSM)
6. Offset the BSM the specified distance (or set to the specified position)

7. Stop data generation

Automatic Procedure

8. Request full sub-instrument data generation
9. Move BSM -18 arcseconds in the Z direction (figure 2 position 1)
10. Wait for 2 minutes
11. Move the BSM +4.5 arcseconds in the Z direction (figure 2 position 2)
12. Wait for 2 minutes
13. Repeat for all positions in figure 1
14. Leave detectors at nominal phase, bias amplitude, bias frequency and sample rate and continue to generate full sub-instrument data following the test.

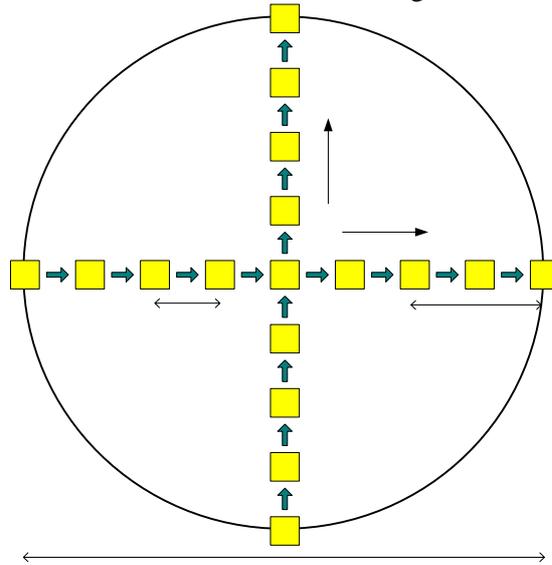


Figure 5 Raster Pattern For SLW or PLW Peak-Up

7.6.4 ILT-PERF-OPB Beam Scan Using The BSM Type 2

The automatic procedure is specified fore SLW/PLW, offsets will need to be adjusted for other pixel sizes.

Pre-requisites and applicability

1. The nominal operating parameters of the detectors should have been established
2. The external source should have been centred on a specified pixel using the telescope simulator
3. The same procedure is applied to both the photometer and spectrometer

Conditions Defined When Run

1. Different ranges will be required for different pixel sizes
2. The nominal offset between the start pixel (where the source is at BSM zero position) and the target pixel needs to be specified e.g. with the source on PSW E8 (our boresight) I will peak-up using the BSM PSW E10 to prepare for this operation in flight. This should be specified in BSM position.

Manual Setup

1. If using the spectrometer check that the SMEC is at home
2. If using the spectrometer check that SCAL is switched off
3. Set the external chopper running at 2Hz for the photometer or 10 Hz for the spectrometer
4. Check that the BSM is centred on the middle pixel (i.e. pixel is located by the T/S not by the BSM)
5. Set the BSM to the centre of the pixel under study using the specified offsets

6. Stop data generation

Automatic Procedure

1. Request full sub-instrument data
2. Wait specified time (nominally one minute)
3. Lowe should go
4. Offset the BSM to the first raster position top left of figure 4 (for SSW this is an offset of 36 arcsec in +Y, -Z and for SLW this is an offset of 50 arcsec in + Y-Z)
5. Wait specified time
6. Repeat for all raster positions (e.g raster position 2 should be +36 arcsec in Y and -27 arcsec in Z for SSW)
7. Return BSM to zero position
8. Leave detectors at nominal phase, bias amplitude, bias frequency and sample rate and continue to generate full spectrometer data following the test.

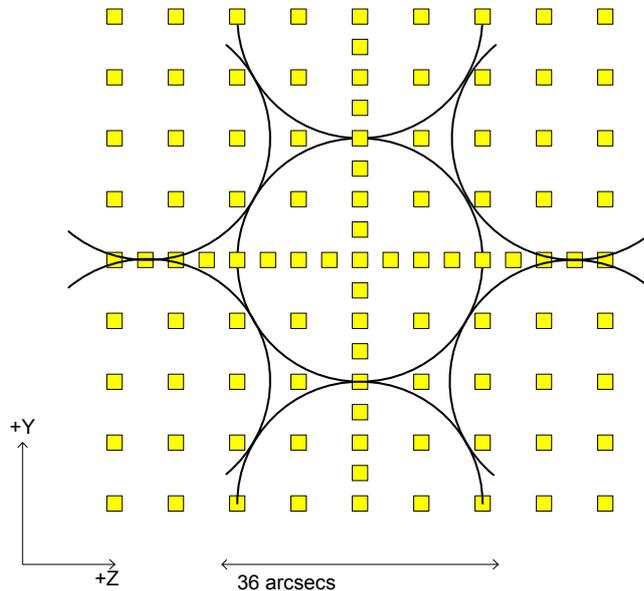


Figure 6 Square Beam Scan Raster Pattern

7.6.5 ILT-PERF-OPB Beam Scan Using The BSM Type 3

The automatic procedure is specified fore SLW/PLW, offsets will need to be adjusted for other pixel sizes.

Pre-requisites and applicability

1. As for previous test

Conditions Defined When Run

1. As for previous test

Manual Setup

1. As for previous test

Automatic Procedure

2. As for previous test but using raster in Figure 7

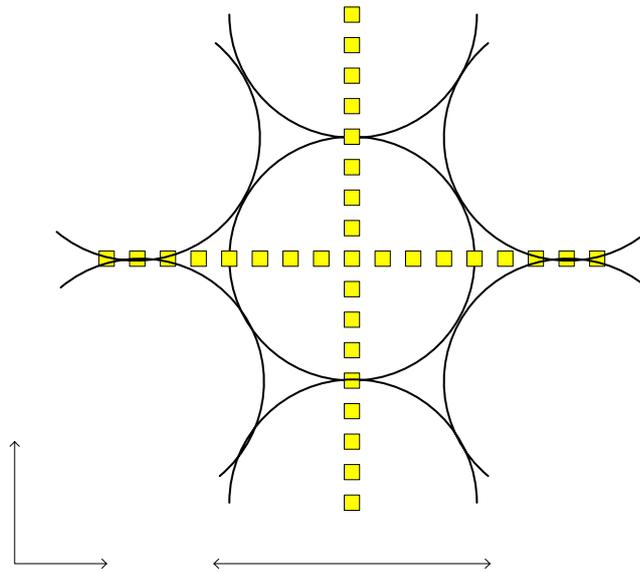


Figure 7 Cross Beam Raster Pattern

7.7 SCAL Tests

7.7.1 ILT-PERF-CCS SMEC Scanning While SCAL is Cooling

Pre-requisites and applicability

1. SCAL is on, there is no pre-requisite as to the level
2. This test is spectrometer specific

Conditions Defined When Run

1. SMEC speed
2. SMEC scan range
3. Number of scans (assumption is that these will not be completed but stopped manually when SCAL is cold) – nominally about 2 hours worth
4. This test is expected to be run under several conditions
 - a. Looking at the cold blackbody (on or off)
 - b. Looking at the room (with or without a source)

Manual Setup

1. SCAL is on and stable
2. Stop data generation

Automatic Procedure

3. Set detector operating parameters to nominal
4. Request full array spectrometer data
5. The SMEC is set to the start point of the specified scan range
6. Start a set of the specified number of scans at the specified resolution and the specified speed
7. Switch off SCAL

Manual Procedure

8. After the specified time check that the SCAL temperature has reached the value that is to be expected when SCAL is off.
9. If necessary perform another set of scans (Total duration TBD at time of test depending on SCAL level)
10. After the test the detectors should left producing data at nominal settings.



7.8 Optical Tests

7.8.1 ILT-PERF-PKB Standard Peakup

Pre-requisites and applicability

3. This test is applicable to both the photometer and spectrometer

Conditions Defined When Run

5. The pixel to be peaked up

Manual Setup

1. Check that the cold black body is off, and the hot black body is on at maximum temperature (1200°C) or that a laser line is illuminating the FOV
2. Check that the flip mirror set so that the lab is in the FOV
3. If using the spectrometer check that the SMEC is at home
4. If using the spectrometer check that SCAL is switched off
5. Set the external chopper running at 2Hz for the photometer or 10Hz for the spectrometer
6. Check that the BSM is at its zero position (i.e. pixel is located by the T/S not by the BSM)
7. Set the T/S is set to the rough centre of the specified pixel
8. Stop data generation

Automatic Procedure

9. Set detector operating parameters to nominal
10. Request full sub-instrument data
11. Perform raster shown in figure 1 using the telescope simulator to move the source, note the size of the raster is dependant on the pixel tested (*note this raster is specified for SSW, for SLW offset is 25 arcsec and steps 6.25 arcsec*).
12. Leave detectors at nominal phase, bias amplitude, bias frequency and sample rate and continue to generate full spectrometer data following the test.

7.8.2 ILT-PERF-FOC Focus Test

Pre-requisites and applicability

1. A source already centred on a pixel by peakup
2. This test is applicable to both the photometer and spectrometer although it is expected that it will only be run on the photometer as it is a test of the facility rather than the instrument

Conditions Defined When Run

1. Focus level of the telescope simulator

Manual Setup

1. If using the spectrometer check that the SMEC is at home
2. If using the spectrometer check that SCAL is switched off
3. Check that the external chopper is running at 2Hz for the photometer or 10Hz for the spectrometer
4. Check that the BSM is at its zero position (i.e. pixel is located by the T/S not by the BSM)
5. Set the telescope simulator to the specified focus
6. Stop data generation

Automatic Procedure

7. Run automatic procedure for ILT-PERF-OSB type 3

7.8.3 ILT-PERF-OSB Beam Scan Type 2

Pre-requisites and applicability

1. A source already centred on a pixel by peakup



2. This test is applicable to both the photometer and spectrometer

Conditions Defined When Run

1. Time per step, nominally 30 seconds

Manual Setup

1. Check that the cold black body is off, and the hot black body is on at maximum temperature (1200°C) or that a laser line is illuminating the FOV
2. Check that the flip mirror set so that the lab is in the FOV
3. If using the spectrometer check that the SMEC is at home
4. If using the spectrometer check that SCAL is switched off
5. Set the external chopper running at 2Hz for the photometer or 10 Hz for the spectrometer
6. Check that the BSM is at its zero position (i.e. pixel is located by the T/S not by the BSM)
7. Stop data generation

Automatic Procedure

9. Set detector operating parameters to nominal
10. Request full sub-instrument data
11. Wait the specified time
12. Offset the telescope simulator to the first raster position top left of figure 4 (*for SSW this is an offset of 36 arcsec in +Y, -Z and for SLW this is an offset of 50 arcsec in + Y-Z*)
13. Wait the specified time
14. Repeat for all raster positions (*e.g raster position 2 should be +36 arcsec in Y and -27 arcsec in Z for SSW*)
15. Return to centre of pixel under study
16. Leave detectors at nominal phase, bias amplitude, bias frequency and sample rate and continue to generate full spectrometer data following the test.

7.8.4 ILT-PERF-OSB Beam Scan Type 3

The automatic procedure is specified fore SLW/PLW, offsets will need to be adjusted for other pixel sizes.

Pre-requisites and applicability

3. As for previous test

Conditions Defined When Run

2. As for previous test

Manual Setup

2. As for previous test

Automatic Procedure

4. As for previous test but using raster in figure 4

7.8.5 ILT-PERF-OPI Pupil Scan

Pre-requisites and applicability

1. This test is applicable to both the photometer and spectrometer

Conditions Defined When Run

1. None – the procedure is self contained

Manual Procedure

1. Check that the detectors are set to nominal values and full array data is being generated.
2. Reconfigure lab to put FIR laser in the beam (c.f.SPIRE-RAL-PRC-001921)
3. Set the telescope simulator to the position of the central pixel
4. Set the chopper running at 2Hz for the photometer or 10 Hz for the spectrometer
5. Place the sheet of Ecosorb with the 20mm hole against the mask's mount, centred on the central obstruction
6. Remove pupil mask



1. Send actuators A1, A2, A3 and A4 to the first position of the scan: (-7.8, 0, -10.9, 0 respectively for the scan across the middle of the pupil)
2. Run procedure from SCOS for the pupil scan using T/S actuators with a 30 sec “time at each position”.
3. Leave detectors at nominal phase, bias amplitude, bias frequency and sample rate and continue to generate full spectrometer data following the test.

7.8.6 ILT-PERF-DPB Polarisation Test

Pre-requisites and applicability

1. A source already centred on a pixel by pickup
2. This test is applicable to both the photometer and spectrometer

Conditions Defined When Run

1. None – the procedure is self contained

Manual Procedure

1. Check that the detectors are set to nominal values and full array data is being generated.
2. Check that the cold black body is off
3. Check that the flip mirror set so that the lab is in the FOV
4. Set the chopper running at 2 Hz for the photometer or 10 Hz for the spectrometer
5. If using the spectrometer check that the SMEC is at home
6. If using the spectrometer check that the spectrometer calibrator is off
7. Check that the BSM is at its zero position
8. Set telescope simulator at centre of the peaked up pixel (previous peak-up prerequisite)
9. Wait for 3 minutes
10. Place polariser in beam and note setting
11. Wait for 5 minutes
12. Move polariser 60 degrees
13. Wait for 5 minutes
14. Move polariser another 60 degrees
15. Wait for 5 minutes
16. Remove polariser from beam
17. Wait for 3 minutes
18. Leave detectors at nominal phase, bias amplitude, bias frequency and sample rate and continue to generate full spectrometer data following the test.

7.9 Photometer Tests

7.9.1 ILT-PERF-DSR Photometer Spectral Response

Pre-requisites and applicability

1. The hot blackbody source is already centred on a pixel by pickup
2. This test is actually applicable to both the photometer and spectrometer although its concept was photometer only

Conditions Defined When Run

1. The test FTS scan range needs to be specified (20 cm maximum)
2. The test FTS scan speed needs to be specified (nominally 1 mm/s)
3. The test FTS sampling frequency needs to be specified (nominally 25um)
4. The number of scans needs to be specified (nominally 10)

Manual Procedure

1. Check that Cold black body is off, hot black body is on at 1200°C
2. Check that the flip mirror set so that the lab is in the FOV
3. Stop data generation



Automatic Procedure

4. Request photometer data
5. Set bias frequency, sample rate and amplitude to nominal (assuming 200Hz, 15.3 and 100 mV for now)
6. Set the test FTS to scan the specified range
7. Set the test FTS scan speed
8. Set the test FTS sampling frequency to the specified value
9. Scan the test FTS the specified number of times
10. Leave detectors at nominal phase, bias amplitude, bias frequency and sample rate and continue to generate full spectrometer data following the test.

7.10 SMEC Tests

7.10.1 ILT-PERF-SSC SMEC Scan with Sky Port Only Un-Nullled

Pre-requisites and applicability

1. This test is only applicable to the spectrometer

Conditions Defined When Run

1. Temperature of the cold black body
2. Number of SMEC scans
3. SMEC velocity
4. SMEC resolution

Manual Setup

1. Set flip mirror to put cold black body in the FOV
2. Check that the BSM is centred on the middle pixel
3. Check that SCAL is switched off
4. Check that the detectors are set to nominal values and full array data is being generated
5. Cold black body is set to specified temperature
6. Wait 30 minutes
7. Stop data generation

Automatic Procedure

8. Set detector operating parameters to nominal
9. Request full spectrometer data
10. Move the SMEC to home
11. Scan SMEC at the specified resolution doing the specified number of scans at the specified velocity
12. Return the SMEC to home
13. Leave detectors at nominal phase, bias amplitude, bias frequency and sample rate and continue to generate full spectrometer data following the test

7.10.2 ILT-PERF-CSS SMEC Scan with SCAL only Un-Nullled

Pre-requisites and applicability

1. This test is only applicable to the spectrometer

Conditions Defined When Run

1. Temperature or power setting of SCAL
2. Number of SMEC scans
3. SMEC velocity
4. SMEC resolution

Manual Setup

1. Set flip mirror to put cold black body in the FOV
2. Check that the cold black body is switched off



3. Check that the BSM is centred on the middle pixel
4. Check that the detectors are set to nominal values and full array data is being generated
5. Set SCAL to the specified temperature
6. Wait until stable
7. Stop data generation

Automatic Procedure

8. Run ILT-PERF-SSC automatic procedure

7.10.3 ILT-PERF-OBP Balancing of Ports (Nulling Test)

Pre-requisites and applicability

1. This test is only applicable to the spectrometer
2. SCAL must be on and stable

Conditions Defined When Run

1. Temperature of the cold black body
2. Number of SMEC scans
3. SMEC velocity
4. SMEC resolution
5. This test will be repeated for a number of cold black body temperatures

Manual Setup

1. Set flip mirror to put cold black body in the FOV
2. Check that the BSM is centred on the middle pixel
3. Check that the detectors are set to nominal values and full array data is being generated
4. Set the cold black body to specified temperature
5. Wait for the black body to stabilise
6. Stop data generation

Automatic Procedure

7. Run ILT-PERF-SSC automatic procedure

7.10.4 ILT-PERF-SRN Room Temperature Nulling

Pre-requisites and applicability

1. This test is only applicable to the spectrometer
2. SCAL must be on and stable

Conditions Defined When Run

1. Number of SMEC scans
2. SMEC velocity
3. SMEC resolution

Manual Setup

1. The sky port of the FTS is open to the room.
2. The spectrometer calibrators are set to the estimated operating point (*as determined from analysis of room load curve plus SCAL load curves*).
3. Stop data generation

Automatic Procedure

1. Run ILT-PERF-SSC automatic procedure

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

It is TBD whether room nulling is required for this test. As currently defined, SCAL is left off and it is assumed nulling of the room is not needed. If nulling is found to be needed the SCAL will have to be on at the appropriate setting to null the room and must have stabilised before this test can commence

Pre-requisites and applicability



1. A laser line is focussed and peaked up onto a single spectrometer pixel using the telescope simulator
2. This test is only applicable to the spectrometer

Conditions Defined When Run

1. Number of SMEC scans (nominally 20)
2. SMEC velocity and nominal velocity (500 $\mu\text{m/s}$)
3. SMEC resolution (nominally high resolution = 1000 (range ~ 38000))

Manual Setup

2. Check that the BSM is centred on the middle pixel
3. The spectrometer calibrator is not used.
4. The external chopper is not used
5. Stop data generation

Automatic Procedure

6. Run ILT-PERF-SSC automatic procedure

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

Pre-requisites and applicability

1. A laser line is focussed and peaked up onto a single spectrometer pixel using the telescope simulator
2. The BSM has been peaked up on the other chop pixel
3. This test is only applicable to the spectrometer

Conditions Defined When Run

1. The time at each step and look position

Manual Setup

1. The SMEC is moved to home
2. The spectrometer calibrator is not used.
3. Stop data generation

Automatic Procedure

4. Set detector operating parameters to nominal
5. Request full array spectrometer data
6. The BSM is commanded to start chopping at 2 Hz and chop throw appropriate to send BSM to adjacent co-aligned pixel.
7. The BSM chops for the specified time
8. The SMEC is moved to the next position in the step and look sequence.
9. This is repeated until the SMEC range for 100 resolution is covered
10. Leave detectors at nominal phase, bias amplitude, bias frequency and sample rate and continue to generate full spectrometer data following the test.

7.10.7 ILT-PERF-SMC Mirror Carriage Characterisation While Scanning

Pre-requisites and applicability

1. This test is only applicable to the spectrometer

Conditions Defined When Run

1. The time at each step and look position

Manual Setup

1. The cold black body source set to 15K is used
2. The BSM is set to the nominal centre of the arrays
3. Check that the detectors are set to nominal values and full array data is being generated
4. The spectrometer calibrator is off
5. Stop data generation

Automatic Procedure



6. Set detector operating parameters to nominal
7. Request full array spectrometer data
8. The SMEC position is set to home.
9. The SMEC is scanned over its full range resolution 1000 at nominal velocity 500 $\mu\text{m/s}$ doing 20 scans.
10. Repeat for same resolution and number of scans at TBD scan velocities (This could be a separate OBSID or BBID. SMC is likely to be done as a single test.)
11. Leave detectors at nominal phase, bias amplitude, bias frequency and sample rate and continue to generate full spectrometer data following the test.

7.10.8 ILT-PERF-SML Reproduction of a Continuum Source Using Step and Look

For ease of operation there could be a variant of this test where we use the external chopper to modulate the signal instead of the BSM. Using the BSM allows a closer simulation of operations.

Pre-requisites and applicability

1. The hot black body is centred on a pixel and peaked up
2. The BSM has been peaked up on the other chop pixel
3. This test is only applicable to the spectrometer

Conditions Defined When Run

1. The time at each step and look position

Manual Setup

1. The hot black body is placed in the sky port of the spectrometer and centred on the central pixel.
2. The spectrometer calibrator is off
3. The external chopper is not used
4. Stop data generation

Automatic Procedure

5. Set detector operating parameters to nominal
6. Request full array spectrometer data
7. The SMEC position is set to home.
8. The BSM is commanded to start chopping at 2Hz and chop throw
9. The detectors are read out for the specified time
10. The SMEC is moved to the next position (TBD) in the step and look sequence
11. The detectors are read out for the specified time then the SMEC is moved to the next position etc until the step and look scan is completed
12. Leave detectors at nominal phase, bias amplitude, bias frequency and sample rate and continue to generate full spectrometer data following the test

7.10.9 ILT-PERF-OBS SMEC Scans at different Beam Positions

Pre-requisites and applicability

1. A laser line is focussed and peaked up onto a single spectrometer pixel using the telescope simulator
2. This test is only applicable to the spectrometer

Conditions Defined When Run

1. The number of scans at each position
2. The raster pattern to use

Manual Setup

1. The BSM is set to the nominal centre of the arrays
2. The external chopper is not used
3. The spectrometer calibrator is off



4. Stop data generation

Automatic Procedure

5. Set detector operating parameters to nominal
6. Request full array spectrometer data
7. Set the SMEC position to home.
8. Scan the SMEC over its full range for the specified number scans
9. Move the telescope simulator to the next position in raster (see figures, 3,4,5)
10. Repeat SMEC scans
11. Repeat until raster map is covered, returning to central location for last point
12. Leave detectors at nominal phase, bias amplitude, bias frequency and sample rate and continue to generate full spectrometer data following the test.

7.11 Out of Band Tests

7.11.1 ILT-PERF-OOB Out of Band Check Using Laser Lines

Pre-requisites and applicability

1. An out of band laser line is focussed and peaked up onto a single pixel using the telescope simulator
2. This test is only applicable to both the spectrometer and photometer

Conditions Defined When Run

1. The integration time

Manual Setup

1. The BSM is set to the nominal centre of the arrays
2. The external chopper is set to 2Hz for the photometer or 10 Hz for the spectrometer
3. The spectrometer calibrator is off
4. If using the spectrometer, the SMEC is at home
5. Stop data generation

Automatic Procedure

6. Set detector operating parameters to nominal
7. Request full array data
8. Wait the specified integration time
9. Leave detectors at nominal phase, bias amplitude, bias frequency and sample rate and continue to generate full spectrometer data following the test.