SUBJECT: SPIRE PV Phase Plan

PREPARED BY: Tanya Lim & Sarah Leeks

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Distribution

Jean-Paul Baluteau	LAM
George Bendo	IC
Dominique Benielli	LAM
Jamie Bock	JPL
Luca Conversi	ESA
Peter Davis	Lethbridge
Marc Ferlet	RAL
Trevor Fulton	Lethbridge
Matt Griffin	Cardiff University
Steve Guest	RAL
Pete Hargrave	Cardiff University
Ken King	RAL
Tanya Lim	RAL
Nanyao Lu	IPAC
David Naylor	Lethbridge
Hien Nguyen	JPL
Pasquale Panuzzo	CEA
Michael Pohlen	Cardiff University
Chris Pearson	RAL
Edward Polehampton	RAL
Bernhard Schulz	IPAC
David Shupe	IPAC
Sunil Sidher	RAL
Bruce Swinyard	RAL
Markos Trichas	IC
Ivan Valtchanov	ESA
Kevin Xu	IPAC
HCalSG c/o Tony Marston	

Change Record

ISSUE	DATE	Changes
Draft 0.1		First Draft
Version 1.0	06/08/2008	Put into SPIRE document template. Updated to reflect the calibration products needed for the empirical pipeline and to include the new uplink calibration files. Updated to reflect the astronomer AOTs. Observation Priorities included in 4.2 and 4.3. Updated observations. Included parallel mode. Typos. Updated ADs and RDs. Removed (most) items that belong in the commissioning plan. Updated section 3.2.1. Updated section 5. Section 6: Added in Test flowcharts and gantt chart to section 6. Section 7, partially updated with changes to section 5. Section 9 written for HGSRR.
Version 1.1	24/10/2008	Working version, released for ICC Readiness Review. Made in line with Commissioning Plan (RD1) version 1. Acronym list. Updated to AD3 version draft 1.0 (note PV only 2.5 months not 3). Section 4.1 updated stating back-up modes won't be validated unless we find out that we need to use them (and updated Sections 4.2, 5.1.3, 5.1.15 and 7 accordingly). Removed downlink table SCalSpecInstModeMask as this is not needed. Added assumption that VMs are checked out and working properly at the end of ComP. Added SLW Nominal Settings (5.1.12) and SSW Nominal Settings (5.1.13) and to table in Section 4.2. Other updates to table in Section 4.2. Numerous updates to most calibration table sections (*uplink*). Added appendix reference to spreadsheet of observations.
Version 1.2	28/11/2008	Added in Bruce's comments. Updated section 3.2.5
Version 1.3	27/03/2009	Matt's comments/corrections/changes. Significant changes are shown in blue and red (rather than change bars) and include: • Updating sections 2.1, 3.1.2, 3.2.3 ***on section 5.1.11***

	Also added the following – preamble to Section 5. Updates following Jean-Paul's comments to sections: 3.2.7(2b finished), 5.1.14, 5.1.15, 5.1.16, 5.2.21, 5.2.22, 5.2.23, 5.2.27 Added SIAM matrix to end of the uplink section 5.1 and the pointing calibration observations. Updated distribution list. Incorporated new BSM/PCAL measurement (lid closed measurement) into section 5.2.7 Updated section 5.2.12 on TempDriftCorr following discussion with Kevin. Section 3.2.3 scheduling observations responsiblities. Updates to my notes in the box below.
Comments to self and things to do	Include references to Calibration Responsibles documents that describe the analysis of the data. Make sure that these documents are also available from the products page. Include ref to George's flux cal doc. Include reference to Ivan's dark sky doc. To be included somewhere appropriate: Overlaps the fact that we will do – scan map in spire, pacs and pmode all on the same source (for several different types of source). Also we will do spectrometer and photometer observations of these sources using all the different AOTs. Add in detailed beam maps of selected pixels using square grids. LCs on Planets for throughput. New uplink tables for expert PV tests. Need some more work on absolute calibration. Load curves on a few pixels for phot and spec on known sources and PCAL.

Throughput calibration sources with variable size.
Straylight map (this should be handled by the new straylight working group)
Thing about using asteroids as modulated sources or binary stars.
Use Mars for straylight.

Make sure all IA calibration data is included.
Still to work on the downlink side.

Update the pointing calibrations with the tests as given in the pointing plan.

Include peak up
Include bright source settings.
Should spectrometer extended sources be validated during PV? Goal or requirement or neither?

Include serendipity and PCAL (except in noise tests) in all PV non-standard observations.

List of all the data reduction tasks, when they are, the duration available and the person responsible.

Update uplink tables following CUS code review

Need to make sure I have all the uplink and other tables. – Ken/Sunil. Michael/Sunil for Michael's tables..which tables have det settings for after being turned on? Multi level noise tests – where to put them in this doc (should only be ComP). Thermal Stab (PV only). LCs. Need to make sure that all tests from Tanya's flowchart are somewhere.

Observe photometer cal sources also with the spectrometer (low res).
Check relevant things with moving and fixed targets.
Noise measurements.
Backgrounds when observing moving targets.
Use scanning planet across array –i.e. through PSF- to get first k values?

Need to ensure that all relevant prerequisites are covered by ComPlan (where they aren't we do PV phase obs in ComP as fillers of ComP gaps).

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Glossary

AOT	Astronomical Observation Template
BSM	Beam Steering Mirror
CCB	Configuration and Control Board
DTCP	Daily Telecommunication Period
HCSS	
HK	Housekeeping
ICC	Instrument Control Centre
ILT	Instrument Level Test
LEOP	Launch and Early Orbit Phase
LVDT	Linear Voltage Displacement Transducer
MTL	Mission Timeline
OD	Operational Day
OE	Optical Encoder
OPD	Optical Path Difference
PCAL	
PI	
PID	Proportional, Integral & Differential (control parameters)
PTC	Photometer Thermal Control
PV	Performance Verification
RSRF	Relative Spectral Response Function
SCAL	Spectrometer Calibration Sources (SCAL2 and SCAL4)
SIAM	Spacecraft/Instrument Alignment Matrices
SMEC	Spectrometer Mechanism
SPIRE	Spectral and Photometric Imaging REceiver
TBC	To Be Confirmed
TBD	To Be Determined
TBS	To Be Specified
TM	Telemetry
ZPD	Zero Path Difference

INTRODUCTION

This document defines the PV Phase for SPIRE. It does not give the observations carried out during Commissioning Phase (RD1) or the observations that are needed to be carried out to check the calibration of SPIRE though routine phase (see RD2).

1.1 Scope

1.2 Structure of Document

This document is the top level PV Phase plan for SPIRE. It starts in section 4 by laying out the objectives and top level requirements of PV Phase and science demonstration phase. The working framework is then detailed in section 5. An approach to prioritisation is stated in section 6. Section 7 then describes how each calibration table will be populated in flight.

1.3 Documents

1.3.1 Applicable Documents

AD1	Herschel/Planck Commissioning and Performance Verification Plan	H-P-1-ASP-TN-1383
AD2	SPIRE Calibration Requirements Document	SPIRE-RAL-PRJ-1064
AD3	Herschel Performance Verification Phase Overview (Draft 1.0)	HERSCHEL-HSC-DOC-1012
AD4	SPIRE Operating Modes	SPIRE-RAL-DOC-000320
AD5	SPIRE Uplink Calibration Data	SPIRE-RAL-DOC-002947
AD6	SPIRE AOTs in HSPOT: Entry of Observations and Return of Time and Sensitivity Information	SPIRE-UCF-DOC-002554
AD7	SPIRE Pipeline Description	SPIRE-RAL-DOC-002437

1.3.2 Reference Documents

RD1	SPIRE Commissioning Phase Plan	SPIRE-RAL-PRJ-003018
RD2	SPIRE Routine Phase Calibration Plan	SPIRE-RAL-DOC-003131
RD3	SPIRE Calibration Observation Definitions	SPIRE-RAL-DOC-000000
RD4	SPIRE Astronomical Calibration Sources for Herschel-SPIRE	SPIRE-UCF-NOT-003016
RD5	Calculation of Important Parameters for SPIRE Scan Map Observations	SPIRE-UCF-NOT-00
RD6	Herschel Pointing Calibration Plan – Calibration Plan for Commissioning and PV Phases	HERSCHEL-HSC-DOC-1139
RD7	SPIRE FTS Mapping Modes	SPIRE-RAL-NOT-002801
RD8	CREC Command List Specification	SPIRE-RAL-NOT-002771
RD9	SPIRE Spacecraft-Instrument Alignment Matrix (SIAM)	SPIRE-RAL-NOT-002881

2. OBJECTIVES OF PV PHASE AND SCIENCE DEMONSTRATION PHASE

2.1 General Objectives of PV Phase

The main objectives of PV Phase are:

- characterisation of in-flight instrument performance and comparison with predictions;
- population, with initial values, of all calibration files which require in-flight data;
- verification of instrument operating modes;
- validation and optimisation of AOTs;
- generation of data sets required to update instrument sensitivity estimates.

The main objectives of Science Demonstration Phase are:

- verification of the scientific performance of each AOT, including verification of instrument sensitivity via observations of faint sources;
- assessment of capabilities of the observatory to carry out, and achieve the scientific goals of, the approved Key Programmes;
- generation of results for PR purposes.

2.2 SPIRE Requirements

(This section contains the specific requirements on the SPIRE instrument team – to be updated and expanded in future versions)

To meet these requirements the SPIRE instrument team must:

- be able to execute AOTs during PV Phase with different parameters;
- by the end of PV phase, be able to quote first-cut as-measured sensitivities for each mode and provide information for HSpot updates;
- provide first-cut astronomical/instrument calibration both for uplink and data processing purposes;
- have an adaptable plan to ensure that PV is used effectively.

3. OPERATIONAL FRAMEWORK/ASSUMPTIONS

3.1 Spacecraft Operations

This section is mainly based on the information provided in the Herschel/Planck Commissioning and Performance Verification Plan (AD1). Where information is not yet available assumptions are made and stated here.

3.1.1 Overall Timeline

The overall mission timeline after launch consists of the following phases:

1. Launch and Early Orbit Phase (L – 8 hours to L + 12 days (AD3))
2. Commissioning Phase (L + 0.5 months to L + 1.5 month (AD3))

   a. Decontamination complete, telescope cooldown starts at L + 3 weeks (AD1)
   b. Cryo-cover opening at L + one month (AD1) (TBD)
3. PV Phase (from L + 1.5 months, 2.5 months in duration (AD3))
4. Science Demonstration Phase (from L + 4 months, 2.0 months in duration (AD3))
5. Routine Operations Phase (remainder of the mission from L + 6 months)

AD1 states 'End of commissioning 1 month after launch with opened cryo-cover'. Therefore it is assumed that the activity of establishing the focal plane geometry, which is a commissioning activity and requires the lid to be off, will take place early in the PV Phase. Similarly, some instrument performance verification activities may be performed with the cryo-cover closed, i.e. in the Commissioning Phase. However RD3 states 'CoP does not end with cryo-cover ejection'

The definition of PV Phase used in this document is the set of activities which meet the requirements given in Section 2.2 irrespective of the mission phase (time) in which they are performed. It should be noted that this covers confirmation of instrument performance, baseline calibration and basic validation/optimisation of AOTs operation and standard data processing. i.e. it is noted that PV Phase observations may be carried out before the cryo-lid is opened and that once PV Phase proper starts CoP observations may still be carried out (although it practice these observations are pre-requisites to PV observations). Note that (from AD3) we will begin PV Phase scientific operations while still en-route to L2. The expected time to reach the nominal orbit about L2 is approximately four months (although for all practical purposes, we are conducting the PV Phase with the spacecraft location and attitude constraints equivalent to those in its final operational orbit [AD3]).

AD3: By the end of PV Phase the Commissioning of the overall ground segment that started in the previous phases will be completed and the spacecraft, payload and Ground Segment will be considered operational. The following major activities are therefore planned during the PV phase:

- the recommendations of the Pointing Calibration Plan [AD 10] as they pertain to the PV Phase, will be implemented;
- comprehensive initial instrument calibration and basic performance verification as defined in the ICC PV Phase Plans;
- AOT verification: functional and scientific aspects as defined in the ICC PV Phase Plans;
- full observatory verification, i.e. verifying that the SGS (with its facilities and teams) is ready to support the routine scientific operations.

Science Demonstration phase is the phase where the data processing pipelines are verified and optimised and scientific products and publicity images produced. This demonstrates the baseline calibration and a reasonably mature data processing pipeline. AD3 lists the following objectives:

- demonstrate the actual scientific capabilities of the Observatory;
- determine whether the scientific objectives of the mission can be met;

- generate publicity material for the mission;

3.1.2 Commissioning Phase Outcome

The SPIRE Commissioning Phase Plan is given in RD1. The status at the end of the Commissioning Phase is assumed to be as follows:

- the instrument successfully functionally tested
- instrument parameters that do not require astronomical observations established (e.g. we would re-tune the BSM and SMEC during commissioning phase).
- all VMs checked out and be working.

The status of the observatory at the end of Commissioning Phase is assumed to be as follows:

- pointing accuracy good enough for SPIRE PV Phase measurements (To Be Specified (TBS));
- spacecraft able to slew along a specified axis at a specified rate with good (TBS) pointing accuracy [update to RD6***];
- straylight performance established (this can only be finally established once the telescope has reached its operating temperature and the instruments have been operationally optimised).

3.1.3 Ground Contact

AD1 (on page 17) states 'During the commissioning, the visibility for both satellites [Herschel and Planck] is fully 24h/24h using the three available stations (Kourou, New Norcia and Villafranca (TBC)). Considering shared visibility, each Satellite is in ground contact about 12h per day (TBC)'. However AD3 states 'During Commissioning and PV Phases 10 hours of ground station coverage per day will be available, shared between Herschel and Planck in two contiguous blocks of five hours. The 5-hour PV Phase DTCP is not obligatory in the sense that either mission can waive some of that time to recover time in the Science Window. If HSC/ICCs find that a full 5-hour DTCP is not needed at any point during PV Phase then the shorter Routine Phase DTCP duration of 3 hours (or even less) could be adopted.'

We assume that SPIRE PV Phase observations will be uploaded for autonomous execution and so will not require ground contact and that we therefore prefer minimal DTCP periods, as during DTCP the sky visibility is very restricted. AD3 notes that real-time manual commanding of the instruments during the PV Phase can have duration of approximately four hours.

3.1.4 Division of Operational Time between the Instruments in PV

The division of operational time between instruments is TBD. For SPIRE a two day rotation through the three instruments is preferred: i.e. SPIRE operational for two days then non-operational for four days. This would allow flexibility in planning and scheduling observations taking into account the results of earlier tests and would maximise the efficiency with respect to the use of the cooler.

3.1.5 Telescope Cooldown

This is out of date – see RD1 version 1.3 for the most up to date information.
Figure 3-1 shows the telescope cooldown curve provided by Thales Alenia Space. AD3 says that at about 3 weeks after launch the cryo-cover will be opened and the telescope decontamination heaters will be switched off; however AD1 proposes that the cryo-cover be opened 30 days after launch. For observations performed during the ensuing two weeks the telescope temperature will be relatively high (100-120 K) compared to its nominal value, and this will be taken into account in planning and scheduling such observations.. The cooldown starts at L + 3 weeks following a period during which the telescope is maintained at ~320 K to allow decontamination. From this plot, at the end of commissioning phase (L + 30 days, also the start of PV phase) the telescope temperature is at about 125 K. The curve is not given for the end of PV Phase (assumed to be launch plus 120 days) but it appears from the trend shown that the temperature reached will be around 90 K and this is adopted as the assumed end of PV Phase temperature for this plan. AD3 implies that the telescope will not be close to the operational temperature before L + 42 days, which matches the beginning of the PV Phase around L + 45 days.

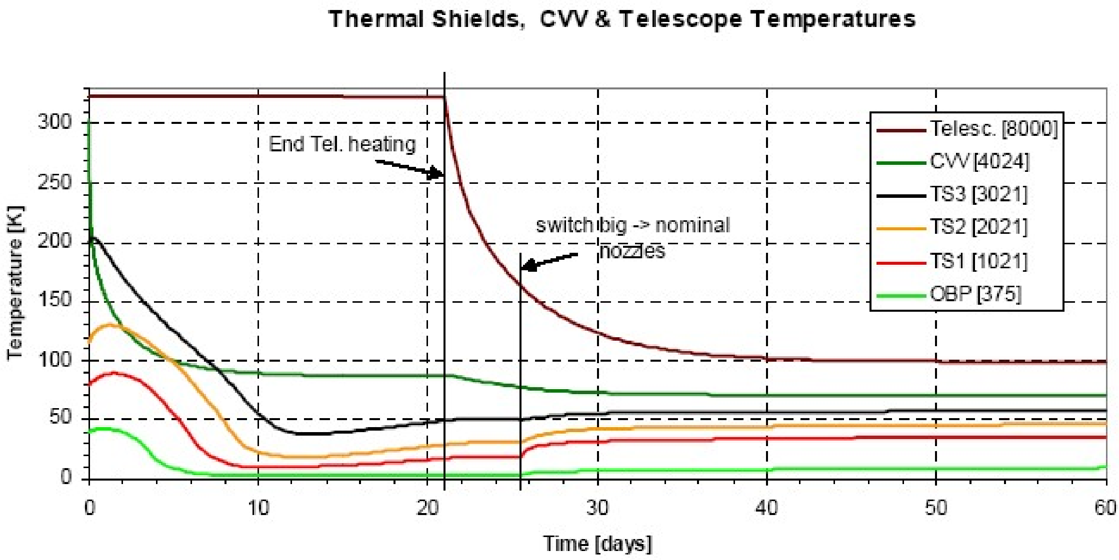


Figure 3-1: Modelled telescope cooldown provided by Thales Alenia Space

SPIRE can not complete the PV Phase activities until the telescope has reached its final operating temperature with TBS stability.

3.2 SPIRE Operations

3.2.1 Documentation

The governing documents for SPIRE Operations are the SPIRE Calibration Requirements Document (AD2), the Herschel Performance Verification Phase Plan & Detailed Timeline (AD3), and the SPIRE Operating Modes document (AD4). This PV Phase Plan document also needs to be updated if the following documents are updated as they state which calibration files are needed: SPIRE Pipeline Description (AD5), SPIRE Uplink Calibration Data (AD6), SPIRE AOTs in HSPOT: Entry of Observations and Return of Time and Sensitivity Information (AD7)

The PV Phase Plan then describes how these will be implemented. It should be used in conjunction with the SPIRE Calibration Observation Definitions (RD3) which gives the procedures to be carried out and with SPIRE Astronomical Calibration Sources for Herschel-SPIRE (RD4) which gives the sources to be used for calibration observations.

PV Phase will require flexibility in planning. An initial detailed plan scheduling the observations is listed in Appendix 1, and this will be maintained and updated regularly following each daily meeting in the PV Phase.

3.2.2 Assumed Mission Management during Commissioning and PV Phase

During Commissioning Phase, the Herschel-Planck Project is responsible for the planning and execution of the Spacecraft Commissioning Phase (AD3). At the conclusion of the satellite Commissioning Phase overall responsibility for the Mission passes from the Project Manager within the ESA Science Projects Department to the Mission Manager within the ESA Science Operations Department at ESAC (AD3). Under this arrangement, SPIRE will initially report to a Project-led planning team, then to the HSC led planning team. It is important the managerial arrangements during Commissioning and PV Phases are clearly defined and understood by all parties (see AD3 for more details).

3.2.3 SPIRE Team Management during PV

The SPIRE ICC operational team management structure during PV Phase will be similar to the ICC development team structure. Overall responsibility is held by the PI with the ICC Manager and Instrument Scientist as his deputies, but the day-to-day coordination and planning of PV Phase activities will be the responsibility of the Calibration Scientist.

The execution of the PV Phase activities will be carried out by the ICC teams under the control of the ICC Manager.

- The Operations Team will be responsible for: instrument health monitoring; data retrieval and processing; ensuring the data are available at RAL for use by the other teams; and delivery of updated calibration information for the Herschel planning and data processing systems.
- The Data Processing and Software Team will be responsible for validation of the implementation, operation, and scientific performance of the AOTs
- The Calibration Team will be responsible for: scheduling PV Phase observations and entering these into the mission planning system; analysing the data and feeding the results back into the PV Phase planning; producing updated calibration information both for uplink and downlink purposes; and providing information for updating the sensitivity estimates.

These teams map on to the currently existing ICC Operations, Software and Calibration teams respectively and will be led by the team leaders. During commissioning and PV, these teams, which have overlapping membership, will operate in a highly integrated way.

3.2.4 Availability of Data

It is assumed that all data from an observation will be available at RAL for ICC use within six hours of the end of the DTCP (the requirement stated in AD3 is two hours: “During Commissioning and PV phases ICC@ICC can access the consolidated Science TM not later than 2 hours after the last bit of this data for the consolidation period has been received by the MOC.”).

3.2.5 Locations of People

3.2.5.1 ESOC

It is not expected that any SPIRE ICC staff will be located at ESOC as no real time operation is required during PV Phase (TBC).

3.2.5.2 ESAC

On the assumption that data will be made available promptly from ESOC to RAL (via ESAC), we do not envisage SPIRE staff co-location at ESAC over and above the two ESA liaison staff.

3.2.5.3 RAL

It is currently assumed that all three ICC teams will work one shift per day, seven days per week, and that all shifts will be in office hours.

All key personnel will normally be co-located at RAL, these include:

- the PI;
- the existing RAL team, including the ICC manager, the Instrument Scientist, and the Calibration Scientist;
- the ICC Team Leaders;
- consortium experts who will participate in performance analysis activities (these include experts from CEA, (SBT and SAP), JPL, IPAC, LAM, Lethbridge and Cardiff)
- ICC members who will be part of the Operations and Calibration teams and who may participate in data analysis activities (these will include experts from Imperial College, Lethbridge, CEA, IPAC and Cardiff);
- the ESAC ICSs, who will be co-located at RAL for 60-90% of PV Phase between them.

Various people who will not be co-located will still be expected to participate in data analysis and may be able to attend the daily meetings via video link.

3.2.6 Staffing and Meetings

Seven day week working is assumed with individual team members working for 5 of each 7 days.

3.2.6.1 *External Meetings*

SPIRE will attend HSC-chaired Ground Segment meetings. It is expected that this will usually be via telecon or videoconference (preferred) and will require a minimal number of SPIRE personnel. These meetings include:

- daily schedule/planning meetings: a (de-)briefing meeting at 16:30 CET (TBC); and, at 17:30 CET (TBC), a daily telecon to review the events of the preceding Operational Day and to preview the events of upcoming days;
- CCBs.

In addition it is expected that at least one scientific review meeting will be held to evaluate the status of the scientific verification and performance of the satellite.

At the daily (de)-briefing meeting it is expected (AD3) that the ICCs report on their activities in the preceding shift, noting objectives, outcome, problems experienced, and anomalies observed, and will provide look-ahead to the planned activities in their area in the following shift. The ICC representatives will also brief the meeting on the status of their instruments.

3.2.6.2 *Internal ICC meetings*

A daily SPIRE planning meeting will be held which will be chaired by the PI, Instrument Scientist or Calibration Scientist, depending on availability. The purposes of this meeting will be to

- assess current state of instrument (from health checks);
- assess observations carried out with respect to the plan;
- assess data analysis results and implications;
- review planned observations.

A standard agenda will be used to format each meeting. All available SPIRE personnel will be expected to attend and each team must be represented by either the team leader or a designated deputy. Minutes will be posted onto the SPIRE twiki page.

We will also hold a data analysis review meeting once every six days (based on the assumed instrument rotation).

3.2.7 Planning Tools

PV Phase will, as far as possible, be executed from a mission timeline (MTL) entered into the expert version of HSpot and scheduled through the HCSS Mission Planning System (AD3). The Mission Planning System (MPS) is the system used by the HSC to plan all science observations, and will be used by the ICCs to timeline the observations of their PV Phase Operational Days (ODs). The ICC-prepared schedules will be delivered to the HSC where the HSC Mission Planners will run the ICC output through the HSC Proposal Handling System (PHS) to generate POS files for delivery to the MOC.

At the start of PV Phase it is assumed that the entire phase has been fully scheduled and that this schedule will be run as default. We assume that the results of data analysis will require some schedule changes, and that the SPIRE Calibration Team may make changes as agreed at daily meetings. It is further assumed they may do so relatively close to the schedule being uplinked: e.g. up to 24 hours before. The system must allow previously planned PV Phase ODs to be rescheduled on a time scale of 3 - 4 days to take account of the exploratory character of the PV Phase (AD3).

For this to be done effectively, the mission planning tool has been made available to the ICC Calibration Team to allow them to schedule the SPIRE observations. This planning tool will enable the SPIRE operations team to produce a complete schedule for their allocated time period. Once the SPIRE operations team has produced a schedule it is assumed that this will be checked by the HSC before uplink.

(AD3) The pre-planned PV Phase timeline will have to be adjusted after launch to take account of the visibility of celestial targets during the actual PV Phase, which can only be known once the precise launch time is known. This adaptation of the pre-launch "model" PV Phase timeline will be completed by the HSC and ICCs between launch and the start of the PV Phase and schedule will be followed as closely as possible. It will be modified when analysis of the ongoing observations shows that changes are required to adapt to the characteristics of the instruments in-flight.

Each observation will have a priority which is derived from the purpose of the observation and the priorities as laid out in section 4.1.

The timescale for the modifications be very short (min <1/2 day analysis of data before replanning if we want to feedback information learnt from a test in one OD into the next pair of ODs). However the aim is that most of the time we will be working to feedback into the pair after next of ODs which gives about 6 days for data analysis before the replanning. ****give example like Ken's vg

Outputs of PV Phase**
Report, mid term review.. (AD3)…

4. PV PHASE PRIORITIES

4.1 Overview

The goal of PV Phase is to have a complete set of observing modes ready for routine operations. However, given time constraints, visibility constraints and the need for flexibility, it may be necessary to restrict the number of modes validated by the nominal end of the phase. Therefore observations carried out during PV Phase will be assigned a priority (high, medium or low) which will determine, in general, the order in which the relevant observations will be executed and the corresponding data sets analysed. This priority will be based on a combination of considerations detailed here.

The priority order is governed by the need to release AOTs. The following set of priorities is adopted (1 is higher priority than 5):

1. Point Source Photometry
2. Scan Map and Parallel Mode
3. Jiggle Map
4. FTS Point Source
5. FTS Map

Note that only those modes offered in HSpot will be validated. Back-up modes will not be validated unless in-flight we find out that we need to use them.

For each AOT the following general priority order is adopted:

i. calibration files required for uplink of an AOT (e.g. BSM position vs. angle on sky);
ii. setup of an AOT (e.g. for point source photometry this would include optimum jiggle offset, or for scan map it would include the scan speed);
iii. calibration files required for data processing but not needed for uplink (e.g. spectral response function).

All calibration files are also categorised as follows:

A. has to be populated at the start of PV;
B. is dependent on being done at a certain time;
C. has to be properly populated definitively at end of PV;
D. must be populated but not definitively at end of PV;
E. could be populated later via routine calibration.

Category A files relate to detector setup - e.g. we will have to adopt a nominal in-flight JFET Vss from commissioning phase. Most category A files will be populated in Commissioning Phase but some may be populated early in PV Phase.

Category B files include parameters derived from data which is time specific. The main example of this is the characterisation of the SCAL port which is planned to be done by carrying out SMEC scans with the telescope at different temperatures as it is cooling.

Category C includes all uplink files associated with a particular AOT.

Category D files include all information which must be obtained via special PV observations and generally includes most of the calibration information required for data processing.

Category E files are similar to category D files but are considered as lower priority due to the ability to use ground calibration or routine phase calibration data to improve them. An example of a category E file is the spectrometer RSRF which has been well established on the ground and will be confirmed in PV phase. Routine observations of a well known source such as Uranus will then be used to refine file produced at the end of PV phase.

The priority of an observation is derived according to these three criteria, and an observation priority column in included in the following tables listing these priorities.

4.2 Uplink Files

This section includes a list of uplink files, the information contained and attached priorities. It is intended to be a summary table with the next section covering the gory details. Note parallel mode is explicitly listed where appropriate. The uplink files are HSpot (CUS) calibration data, On-Board Software internal tables (which can only be updated once an OD) or Operational Procedures.

Filename	Description	Use	Populated In PV	AOTs	Priority	Observation Priority
BSM Configuration	Minimum Power dissipation position	HSpot	No, Commissioning	All, Parallel	High	
BMS Nominal Settings	BSM initialisation parameters	HSpot	Updated plus Commissioning	All, Parallel	High	
Chopping Configuration	Observing parameters when chopping	HSpot	Updated plus Commissioning	Phot Point Source, Phot Small Map	High	1,3,ii,C
Command Lists	VM table locations	HSpot	No, ground	N/A	N/A	N/A
Flash	PCAL Flash Parameters	HSpot	Updated plus Commissioning	All, Parallel	High	1-5,i/ii,C
Instrument Configurations	MODE HK parameters	HSpot	No, ground	N/A	N/A	N/A
PLW Nominal Settings	PLW detector switch on parameters	HSpot	Updated plus commissioning	All photometer, Parallel	High	1-5,i,A
PMW	PMW detector	HSpot	Updated plus	All	High	1-5,i,A

Nominal Settings	switch on parameters		commissioning	photometer, Parallel		
PSW Nominal Settings	PSW detector switch on parameters	HSpot	Updated plus commissioning	All photometer, Parallel	High	1-5,i,A
PTC Nominal Settings	PTC parameters	HSpot	Updated plus commissioning	TBC, Scan, Parallel		
Photometer Sensitivities	Photometer sensitivities	HSpot	Updated	All photometer, Parallel	High	1-3,iii,C
SLW Nominal Settings	SLW detector switch on parameters	HSpot	Updated plus commissioning	All spectrometer	High	1-5,i,A
SSW Nominal Settings	SSW detector switch on parameters	HSpot	Updated plus commissioning	All spectrometer	High	1-5,i,A
SMEC	SMEC switch on parameters	HSpot	No, Commissioning	Spectrometer		
Spectrometer Sensitivities	Spectrometer sensitivities	HSpot	Updated	All spectrometer	High	4-5,iii,C
Spectrometer Configuration	Scan parameters	HSpot	Updated	All spectrometer scanning	High	4-5,ii,C
SPIRE Configuration	Observing parameters, time between flashes etc	HSpot	Updated?	All, Parallel	High	1-5,ii,C
Operations	Fundamental Observing parameters	HSpot	Updated	All, Parallel	High	1-5,ii,C
7-Point Jiggle Map Positions	7-Point Jiggle Map Positions	OBS	Updated	Phot Point Source,	High	1(3),ii, C
64-Point Jiggle Map Positions	64-Point Jiggle Map Positions	OBS	Updated	Phot Small Map	High	3(1),ii, C
Spectrometer Sparse Sampling	BSM Position for Sparse Sampling	OBS	Same as BSM Configuration?	Sparse Spatial Sampling	High	4,ii,C

Spectrometer Intermediate Sampling	BSM Positions for Intermediate Sampling (4 point jiggle)	OBS	Updated	Intermediate Spatial Sampling	Medium	5,ii,C
Spectrometer Full Sampling	BSM Positions for High Sampling (16 point jiggle)	OBS	Updated	Full Spatial Sampling	Medium	5,ii,C
CREC Operations	Parameters required to do a cooler recycle	Operational Procedures parameters	No, Commissioning	None	N/A	
PTC Control	Parameters required to control the PTC	Operational Procedures parameters	TBD, mostly done in commissioning	Scan Map Only? Parallel? TBC	High	2,ii,A
SCAL Control	Parameters required to control SCAL	Operational Procedures parameters	Mostly Commissioning	All Spectrometer AOTs	N/A	
SpireTable_PhotSourceMode	Normal and Bright Source detector settings	Expert HSpot	Commissioning and updated PV	Expert modes	High	
SpireTable_PhotMultiLevelNoiseLevels	List of all possible bias frequencies with a set of bias amplitudes and their associated bias phases.	Expert HSpot	Commissioning and updated in PV	Expert modes	High	

4.3 Data Processing Files

The table below contains a list of pipeline calibration files. For each file it is indicated whether it needs to be populated with PV Phase data, which AOTs require it to be populated, and the priority. Where high priority is assigned it is because the information used to produce this file is also required for uplink. Medium priority is assigned to files which are populated for the first time with PV data, and low priority is assigned to the remainder. (Placeholder priorities, this needs a group discussion). Note that parallel mode is explicitly listed where appropriate.

Filename	Description	Populated In PV	AOTs	Priority	Observation Priority
Photometer					
Files Not Populated in PV Phase					
SCalPhotChanNum	Channel Number Table	No, ground	N/A	N/A	N/A
SCalPhotChanTimeOff	Pixel Readout Time Offsets	No, ground	N/A	N/A	N/A
SCalPhotChanGain	Electronic Gain Table	No, ground	N/A	N/A	N/A
SCalPhotLpfPar	Electronic Parameter Table	No, ground	N/A	N/A	N/A
SCalPhotRsrf	RSRF	No, ground	N/A	N/A	N/A
Files Populated Continuously					
SCalResetHist	DPU Counter Reset History File (common with spec)	Yes	N/A	N/A	N/A
SCalPhotOffsetHist	Offset History File	Yes	N/A	N/A	N/A
SCalPhotPcal	PCAL History	Yes	N/A	N/A	N/A
Files (Re-) Populated In PV Phase					
SCalPhotChanMask	Bad Channel Table	Updated	All, Parallel	High	1-3,iii,E
SCalPhotInstModeMask	Instrument Mode mask	Updated (if chop params change)	Point, Small Map		1,3,iii,E/D
SCalPhotBolPar	Bolometer Parameters	Updated	All, Parallel	Low[1]	1-3,
SCalPhotChanNomRes The known phase should be used instead of this resistance.	Blank Sky Measurement (Rd-nom)	Update	All, Parallel		1-3,iii,
SCalPhotBsmPos	BSM Position vs Angle Table	Updated	Point Source, Small Map	High	1,3,i,C
SCalPhotBsmOps	BSM Operations	Updated	All, Parallel	High	1,3,i,C

	Table				
SCalPhotDetAngOff	Pixel Offset Table	Updated	All, Parallel	Low	1-3,iii,
SCalPhotGlitchWavelet This isn't a true calibration, no specific observations will be made for glitches	Pixel Glitch Table	Updated	All, Parallel	Low	1-3,iii,E/D
SCalPhotGlitchThreshOne (Name TBC) This isn't a true calibration, no specific observations will be made for glitches	Glitch Threshold Table		All, Parallel		
SCalPhotElecCross	Electrical Crosstalk	Updated	All, Parallel	Low	1-3,iii,E
SCalPhotFluxConv	Conversion to Astronomical Units and non-linearity correction	Updated	All, Parallel	Medium	1-3,iii,D/E
SCalPhotTempDriftCorr	Temperature Drift Correction Coefficients	Updated	Scan, Parallel All???		2,iii
SCalPhotChanTimeConst	Pixel and Electronic Time Constants	Updated	All, Parallel	Low	1-3,iii,
SCalPhotOptCross	Optical Crosstalk	New	All, Parallel	Medium	1-3,iii,D/E
SCalPhotChanNoise	Detector Noise Spectrum				iii
SCalPhotGlitchThreshTwo (Name TBC) This isn't a true calibration, no specific observations will be made for glitches	Second Level Glitch Threshold Table				
SCalPhotBeamProf	Beam Profiles	Updated	All (TBR), Parallel	Low	1-3,iii
SCalPhotSpecIndex	Spectral Index Conversion	No	N/A	N/A	
SCalPhotPcalPar	PCAL Input Parameters				1-3, i/ii

Spectrometer					
Files Not Populated in PV Phase					
SCalSpecChanNum	Channel Number Table	No	N/A	N/A	N/A
SCalSpecChanTimeOff	Pixel Readout Time Offsets	No	N/A	N/A	N/A
SCalSpecChanGain	Electronic Gain Table	No	N/A	N/A	N/A
SCalSpecLpfPar	Electronic Parameter Table	No	N/A	N/A	N/A
Files Populated Continuously					
SCalResetHist	DPU Counter Reset History File (common with phot)	Yes	N/A	N/A	N/A
SCalSpecOffsetHist	Offset History File	Yes	N/A	N/A	N/A
SCalSpecPcal	PCAL History	Yes	N/A	N/A	N/A
Files (Re-) Populated In PV Phase					
SCalSpecChanMask	Bad Channel Table	Updated	All	High	4-5,iii,E
SCalSpecBolPar	Bolometer Parameters	Updated	All	Low[1]	4-5
SCalSpecChanNomRes The known phase should be used instead of this resistance.	Blank Sky Measuremen t (Rd-nom)				4-5,iii
SCalSpecBsmPos	BSM Position vs Angle Table	Updated	Intermediate , full/All	High	5,i,C
SCalSpecBsmOps	BSM Operations Table	Updated	All	High	5,i,C
SCalSpecDetAngOff	Pixel Offset Table	Updated	All	Low	4-5,iii
SCalSpecGlitchWavelet This isn't a true calibration, no specific observations will be made for glitches	Pixel Glitch Table	Updated	All	Low	4-5,iii,E/D

SCalSpecElecCross	Electrical Crosstalk	Updated	All	Low	4-5.iii,E
SCalSpecGlitchThreshTwo (Name TBC) This isn't a true calibration, no specific observations will be made for glitches	Second Level Glitch Threshold Table				
SCalSpecOptCross	Optical Crosstalk	New	All	Medium	4-5,iii,D/E
SCalSpecChanTimeConst	Pixel and Electronic Time Constants	Updated	All	Low	4-5,iii,
SCalSpecNonLinCorr	Non-Linearity Correction	New	All	Medium	4-5,iii
SCalSpecTempDriftCorr	Temperature Drift Correction				iii
SCalSpecSmecZpd	ZPD Position	Updated	All	Low	4-5,iii,
SCalSpecSmecStepFactor	Conversion MPD to OPD				4-5,iii
SCalSpecModEff	Modulation Efficiency	Updated	All	Low	4-5,iii,
SCalSpecScalBlankSky (InterRef)	Standard Interferogram	New	All	Medium	4-5,iii
SCalSpecBandEdge	Spectral Band Edge	Updated	All	Low	4-5,iii
SCalSpecNlp	Non-Linear Phase	Updated	All	Low	4-5,iii
SCalSpecRsrf	RSRF	Updated	All	Low	4-5,iii
SCalSpecIls	Instrumental Line Shape	Updated	All	Low	4-5,iii
SCalSpecBeamProf	Beam Profiles	Updated	All	Low	4-5,iii
SCalSpecPcalPar	PCAL Input Parameters				4-5,i/ii

1. This file has a low priority for DP because the empirical scheme is adopted; however the load curve data taken to populate it will need to be analysed with high priority as this impacts the predicted sensitivity to be entered into HSpot.

5. Calibration Files to be Populated from PV Data

The calibration files listed in the previous section are discussed in detail in this section: the uplink files in Section 5.1 and the Downlink files in Section 5.2. For each of the calibration files the following points are addressed:

- a description of the information contained in the file,
- a list of the parameters within the file.
- the templates to be used to make observations that will allow the parameters in the file to be updated
- a list of AOTs for which the calibration file is relevant
- observations that are planned to be carried out in order to update the parameters in the file
- data analysis that will be performed on the data resulting from the observations in order to update the parameters of the file.

Note that under the 'AOTs Using This Table' heading

- Parallel Mode is listed explicitly although usually it will be only checked individually on the scan map. Parallel mode will be checked out as a complete AOT.
- The Spectrometer two resolution mode, 'H+L' isn't explicitly stated, the way the scans are performed are like their single resolution observations, hence assume that all values determined from separate High resolution and low resolution observations are equally valid for H+L mode.

5.1 Uplink Files

These are described in SPIRE Uplink Calibration Data (AD5) and AD6 says how the sensitivity values are derived.

.

5.1.1 BSM Configuration

Determined during Commissioning

Description

This file defines the positions of the BSM for different stable configurations. It is determined during Commissioning phase.

Hold Minimum power dissipation position

Table Parameters

For each configuration the following parameters are given:

ChopPosn Commanded Chop position for minimum power dissipation
JigglePosn Commanded Jiggle position for minimum power dissipation

Templates

Commissioning Test

AOTs Using This Table

Will be used in all AOTs, Parallel.

Observations

See commissioning plan

Analysis

See commissioning plan
Note that the boresights of SPIRE will be relative to this BSM position.

5.1.2 BSM Nominal Settings

Determined during Commissioning

Description
This file is used during BSM initialisation for optimum feed forward offset, gain and PID parameters.

Table Parameters
```
…chop_ff_offset   chop_ff_gain   chop_kd   chop_kp   chop_ki   chop_rl
chop_0_I   chop_filt1   jigg_ff_gain   jigg_kd   jigg_kp   jigg_ki
```

Templates
Commissioning Test (BSM PID Tuning)

AOTs Using This Table
Will be used in all AOTs, Parallel.

Observations
See commissioning plan for initial observations.
Note that we will need to do final BSM PID tuning as when this is done during commissioning we won't have verified the best chop throws (where the pixels are) and chop frequencies so if they turn out to be different we will have to tune the BSM again for those new settings.

Analysis
See commissioning plan (RD1)

5.1.3 Chopping Configuration

Description
This file defines the parameters for each of the SPIRE chopped observing modes. These modes are: POF2, POF3.

Table Parameters
For each mode:
Period Period of chop cycle (microsecs)
DcuFrame DCU Sample Mode
DcuFreq BIAS Frequency divider - gives DCU sample frequency
DcuSamples Number of DCU Samples per chop position
DcuDelay Delay to start of DCU sampling (microsecs)
BsmFreq BSM Sampling Frequency
BsmSamples Number of BSM samples per chop position

Note: many values in this file are dependant on the detector bias frequency, which is defined in the SPIRE Parameters table

AOTs Using This Table
The photometer AOTs using this table are:
AOT – Point Source (POF2)
AOT – Small Map (POF3)
AOT – Peakup Mode?

Templates Required

Period	The chop 'Period' is the governing parameter of this table and is the entity tested
DcuFrame	Indicates whether taking full array (i.e. all the arrays) or just an individual array. Will always take full array data for normal observations (see DcuFreq). No testing required.
DcuFreq	The bias frequency will be established in commissioning phase (see commissioning plan RD1, multi-level noise tests) this gives the DCU freq (via the divider). This should be such that we can use full arrays via the DcuFrame parameter, although we might want to test frequencies that only allow the use of one array at a time. This parameter is independent of the Period.
DcuSamples	The Period combined with the DcuFreq constrains the DcuSamples parameter; e.g. for 1 Hz chopping and 18 Hz detector sampling we have 9 samples per chop position. Doesn't need standalone testing.
DcuDelay	This parameter is the delay time to the first sample. The baseline is to put the last sample at the end of the chop cycle. [*Is this correct? Does it not need to be delayed as specified in the Photometer Pipeline documents?], therefore this delay accounts for the remainder after n dcu samples are subtracted from the chop period. Test this*
BsmFreq	BsmFreq while variable is expected to remain at the ground (and design) value

	of 80Hz and therefore is considered to be constant at this value for both the photometer and spectrometer. Doesn't need testing.
BSMSamples	The BsmFreq combined with the period constrains the BsmSamples parameter e.g. for 1 Hz chopping there will be 80 samples per second or 40 samples per chop position. Doesn't need standalone testing.

Expert 'Point Source' AOTs will be tested with different chop periods. These will utilise POF2. Also need to test the Small Map AOT (POF3) as chop throw is different.

Pre-Requisites

The BSM will need to have been tuned for the frequencies tested (BSM PID tuning).
As the tuning depends on chop throw the nominal chop throw will need to have been established.
The nominal chop throw is established from the BSM FOV scanning (BSM Angle Calibration).
The nominal bias frequency and sample rate is also required to have been established.

Observations

The source requirements for all observations are a stable bright point source which is isolated.

Source Type	Mode	S/N	Jiggle Offset	Spectral Resolution	Chop Frequency
Point source	POF2	TBD	Nominal, as established from offset set up tests, currently 6"	N/A	2.0 Hz
Point source	POF3	TBD	Nominal positions	N/A	2.0 Hz
Point source	POF2	TBD	Nominal, as established from offset set up tests	N/A	1.5 Hz
Point source	POF3	TBD	Nominal positions	N/A	1.5 Hz
Point source	POF2	TBD	Nominal, as established from offset set up tests	N/A	1.0 Hz
Point source	POF3	TBD	Nominal positions	N/A	1.0 Hz

Analysis
The standard demodulation scheme will be applied to data from each position in the 7-point jiggle. The positions will then be combined to recover the source flux.
The chopping scheme that then most accurately recovers the source flux in the minimal time taken should then be adopted for all AOTs.

5.1.4 Command Lists

Does Not Require an Update In-Flight

Description
This file defines the VM Table location and parameters for executing a particular Command List. These command lists are: Flash, Chop, JiggleMap, BSMMove

Table Parameters
Id VM Table number
Index VM Start address
Nparms Number of parameters to the VM Table

5.1.5 Flash

Description
This file defines the parameters for a PCAL flash in the following instrument modes: Photometer (including Parallel), Spectrometer. Only one flash type is currently available per sub-instrument (but will use the same flash for them both).

Table Parameters

LowBias	PCAL low current
HighBias	PCAL high current
Cycles	number of cycles
Period	period of cycle (µsec)
DcuFrame	DCU data mode (0 = Full Photometer, 4 = Full Spectrometer)
DcuSamples	number of DCU sampled per half cycle
DcuDelay	delay (µsec) from start of cycle to first DCU sample
ScuMode	SCU data mode (0 = 80Hz sampling)
ScuSamples	number of SCU samples per half cycle (should always be set to 0 - continuous data)

Note: some values in this file are dependant on the detector bias frequency, which is defined in the SPIRE Parameters table.

AOTs Using This Table
All AOTs including Parallel will use the same parameters for PCAL (for cross calibration between them) but may have varying DCU parameters.

Templates Required

LowBias	This is the low value of the PCAL current to use. From ground testing zero has always been used. No other values will be tested in-flight.
HighBias	This is the high value of the PCAL current to use. This will be established with a dedicated PCAL level test during commissioning. TBC if we want to repeat this once everything else (det parameters, telescope stable, strong source settings) is finalised.
Cycles	The number of cycles currently used is 16, it is assumed this will remain the baseline parameter unless there is a large degradation in S/N, therefore no specific tests are planned for this. If the period increases then we might want to reduce the number of cycles. No specific tests are needed for this (just use the first PCAL flashes of a longer stream and check that the data analysis works ok on it).
Period	This parameter will be tested via a dedicated test.
DcuFrame	Indicates whether taking full array or just an individual array. Always set to full array unless we want really high frequency data for a special test. Therefore no testing will be performed.
DcuSamples	The Period combined with the DcuFreq constrains the DcuSamples parameter

	e.g. for 1 Hz flashing and 18 Hz sampling we have 9 samples per flash half cycle. Test via the period.
DcuDelay	*This parameter is the delay time to the first sample, the baseline is to put the last sample at the end of the flash cycle, therefore this delay accounts for the remainder after n dcu samples are subtracted from the flash period. Maybe test this?
ScuMode	The PCAL sample rate ground value of 80Hz will continue to be used without further testing.
ScuSamples	The ground value of zero (=continuous sampling) will continue to be used.

Several templates feed in to this:
Phot (and Spec) PCAL Level Check – determines the PCAL high level to use, this test will be done at different PCAL flash frequencies (done (first) in commissioning). We are likely to just go with the values used in ILT if they work well. If we use different values we'd do some ILT PCAL flashes for comparisons.
Phot (and Spec) Standard PCAL Flash – we will use the longer ground sequence to compare on-ground and in-flight instrument reaction, this is considered to be a supporting test for the flashes (commissioning mostly). Useful do this whenever testing PCAL flashes?
Phot (and Spec) PCAL AOT Flash – standalone AOT for PCALs. Use this to work out the parameters such as period (or do in PCAL level check) as it is standalone (for normal AOT testing we don't want to be trying out the PCAL flashes in the same AOR). Note that those used within AOTs and those for standalone use will have the same parameters (which is why we can use the standalone version for the tests).

Pre-Requisites

The nominal detector settings (Vss, bias frequency, bias amplitude and associated phase) have been established.

Observations

Template	Source Type	Inst	Flash Frequency
PCAL Level Check	Dark Sky?	Phot	0.125 Hz
PCAL Level Check	Dark Sky?	Phot	0.25 Hz
PCAL Level Check	Dark Sky?	Phot	0.5 Hz
PCAL Level Check	Dark Sky?	Phot	0.125 Hz
PCAL Level Check	Dark Sky?	Spec	0.25 Hz
PCAL Level	Dark Sky?	Spec	0.5 Hz

Check			

Add a test at lower frequency also – 0.125 Hz.

1. These levels are hardcoded into the test which uses the full range.

Analysis

The minimum level which gives good (TBD) S/N will be adopted.
***Period.

5.1.6 Instrument Configurations

This Table Does Not Require an Update In-Flight therefore this section is not filled out

Description
Values to setup the MODE HK parameter when operating the instrument (a value is given per configuration).

5.1.7 PLW Nominal Settings

Description
PLW detector values set during BDA switch on.

Table Parameters
(For each model (QM, PFM, FM etc)) biasmode mclkdiv biasdiv plw_bias plw_phase plw_vss1 plw_vss2= bias mode, dividers, bias, phase and Vss values for each JFET module. Note values are from 0 to 255. NOTE biasFreq* (master clock divider - gives the bias frequency) is defined in spireParams table

Templates
Phase Up

AOTs Using This Table
Will be used in all photometer AOTs, Parallel.

Pre-Requisites
For those done in PV Phase, cryostat lid open – and telescope down to stable temperature***TBC
Do before or after the telescope down to temperature standard load curve?

Observations
See commissioning plan for observations to get initial settings with the lid shut at 2 different temperatures (via Vss and *** phase up* tests). Plus we will get the values again (phases using phase up) when the cryostat lid is open (using a dark patch of sky), repeating as the telescope cools and when the telescope is down to temperature.

The bias amplitude and freq (bias divider) will be optimised by a repeat of the standard LCs (or full LC - mutli-level noise*) once the telescope is down to temperature.* Source= dark sky.

Repeat multi-level noise test (once telescope cold and have other detector parameters) with a strong source (extended) to find the noise under loaded conditions?

Analysis
See commissioning plan plus TBW. This gives the nominal phase that should be used instead of R nom. (Matt's doc section 3.5.2). [No change should be made here unless and until the Photometer Pipeline doc. has been formally updated.]

5.1.8 PMW Nominal Settings (as PLW section but parameters for PMW)

Description
PMW detector values set during BDA switch on.

Table Parameters
biasmode mclkdiv biasdiv pmw_bias pmw_phase pmw_vss1 pmw_vss2 pmw_vss3 pmw_vss4

Templates
See PLW Nominal Settings

AOTs Using This Table
Will be used in all photometer AOTs, Parallel.

Observations
See PLW Nominal Settings. Note that no additional observations need to be performed as the data for all the arrays are gathered from each observation.

Analysis
See PLW Nominal Settings

5.1.9 PSW Nominal Settings (as PLW section but parameters for PSW)

Description
PSW detector values set during BDA switch on.

Table Parameters
biasmode mclkdiv biasdiv psw_bias psw_phase psw_vss1 psw_vss2 psw_vss3 psw_vss4 psw_vss5 psw_vss6

Templates
See PLW Nominal Settings

AOTs Using This Table
Will be used in all photometer AOTs, Parallel.

Observations
See PLW Nominal Settings. Note that no additional observations need to be performed as the data for all the arrays are gathered from each observation.

Analysis
See PLW Nominal Settings

5.1.10 PTC Nominal Settings

Description
PTC values set during BDA switch on.

Table Parameters
….. biasmode mclkdiv biasdiv ptc_bias ptc_phase ptc_vss

Templates
TBW

AOTs Using This Table
Will be used in all photometer AOTs, Parallel.

Observations
See PLW Nominal Settings. Note that no additional observations need to be performed as the data for all the arrays are gathered from each observation.
*need to decide which PV tests we do with PTC and which without.. probably have to decide during PV…

Analysis
See commissioning plan and TBW

5.1.11 Photometer Sensitivities

Description

This table defines the sensitivity information for each of the SPIRE photometric observing modes. This information is defined in SPIRE-UCF-DOC-002554 (AD6).

Photometric observing modes included are:
(back up mode POF1,) POF2, POF3,
POF5_F_scana, POF5_F_scanb, POF5_F_scanab
POF5_S_scana, POF5_S_scanb, POF5_S_scanab
Par_F_N, Par_F_O, Par_S_N, Par_S_O

Table Parameters

For each of the above observing modes the following parameters are required:

PSWTeff	Effective integration time for unit speed per repetition for PSW band
PMWTeff	Effective integration time for unit speed per repetition for PMS band
PLWTeff	Effective integration time for unit speed per repetition for PLS band
PSWFLuxUnc	flux density uncertainties (1sigma, 1sec) in mJy for PSW Band
PMWFLuxUnc	flux density uncertainties (1sigma, 1sec) in mJy for PMW Band
PLWFLuxUnc	flux density uncertainties (1sigma, 1sec) in mJy for PLW Band
PSWBrightUnc	surface brightness uncertainties (1sigma, 1sec) in MJy/sr for PSW Band
PMWBrightUnc	surface brightness uncertainties (1sigma, 1sec) in MJy/sr for PMW Band
PLWBrightUnc	surface brightness uncertainties (1sigma, 1sec) in MJy/sr for PLW Band

[PSWConfLim Confusion Limit in the PSW Band] these are not used now, the confusion noise estimator of HSpot is now used
[PMWConfLim Confusion Limit in the PSW Band]
[PLWConfLim Confusion Limit in the PSW Band]

AOTs Using This Table

All Phot including Parallel, but not all the modes use all the parameters:
Teff is for POF5 and Par.
FluxUnc is for all.
BrightUnc isn't for point source observations (i.e. only used for POF3, POF5, Par)
ConfLim is no longer used.

Flux calibration (Section 5.2.11 approx p.80): Establishment of the K-parameters will have set the flux density scale, so the uncertainty will be easily determined by the noise level. Further discussion needed on detailed approach and plan. Action: Matt, Bruce, Darren, Sarah to confer and propose detailed scheme.

Templates Required

Teff	This parameter is derived from the adopted scan rate and scan angle, therefore depends on the AOTs used to establish scan rate (and scan angle) (see RD5). These scan parameters are contained in table Operations hence observations

	are listed under there. This will use the normal AOTs
FluxUnc	Observe a faintish source in the various modes. Needs to be in a "clean" area of sky. [Asteroids; quasars – maybe better as out of galactic plane.]
BrightUnc	Scan map of a well modelled extended source at nominal rate will be used to check ground derived values. Also do a small map to confirm its sensitivity. This will use the normal AOTs. This can be determined from FluxUnc and knowledge of the beam profile. But scans of an extended source of known brightness distribution will be valuable as a check.
ConfLim (not used)	Scan map of dark patch of sky will be used to confirm predicted values in HSpot (TBC). This will use the normal AOTs. This is not needed for PV – will be in important issue for SD – via science analysis of scan maps on dark regions.

Load curves on Jupiter, Mars, Uranus

Pre-Requisites
TBD

Observations
Teff depends on scan speed and scan angle; the observations to determine this are listed in 5.1.18 Operations

Source Type	Mode	S/N
Point sources	POF2	TBD
Point source(s)	POF3	TBD
Point source(s)	POF5	TBD
Extended source(s)	POF3	TBD
Extended source(s)	POF5	TBD

Do one scan map with known point and extended sources? Not likely to be feasible.

Does doing a small map add anything other than sanity check? Useful as a check.

Analysis
TBD. Its really tricky do to this with observations. [??? – it can only be done with observations.] Maybe use models in the first instance and then use Science Demo phase for the rest? [No – establishment of sensitivity is a key objective of PV]. Low priority for PV? [High priority for PV] [Although need to provide updated sensitivities in HSpot for planning of the Sci Demo observations]

Best approach: Need to establish sensitivities separately for each mode, because the systematics are likely to be different.

Scan-map: Carry out deep scan map observations of a well-known dark field, going below the confusion limit. Process using scan-map pipeline. Analyse carefully and in detail to determine basic sensitivity level.

Point source and jiggle-map: Observations of a range of brightesses – e.g.; faintish asteroid (~ 10 Jy); star (few hundred mJy) or quasars (few 100 mJy – few Jy).

5.1.12 SLW Nominal Settings (as PLW section but parameters for SLW)

Description
SLW detector values set during BDA switch on.

Table Parameters
biasmode mclkdiv biasdiv slw_bias slw_phase slw_vss1 slw_vss2 slw_vss3 slw_vss4 slw_vss5 slw_vss6

[confirm parameters when table is implemented]

Templates
See PLW Nominal Settings

AOTs Using This Table
Will be used in all spectrometer AOTs.

Observations
See PLW Nominal Settings

Analysis
See PLW Nominal Settings

5.1.13 SSW Nominal Settings (as PLW section but parameters for SSW)

Description
SSW detector values set during BDA switch on.

Table Parameters
biasmode mclkdiv biasdiv ssw_bias ssw_phase ssw_vss1 ssw_vss2 ssw_vss3 ssw_vss4 ssw_vss5 ssw_vss6

[confirm parameters when table is implemented]

Templates
See PLW Nominal Settings

AOTs Using This Table
Will be used in all spectrometer AOTs.

Observations
See PLW/SLW Nominal Settings

Analysis
See PLW/SLW Nominal Settings

5.1.14 SMEC (Commissioning)

Description
Used to setup nominal SMEC parameters during switch ON and initialisation – i.e. it says where HOME is.

Note Home is defined in 5.1.16Spectrometer Configuration too, however they are different places/parameters. In this file it is the default place the SMEC sits at the start and end of an observation and in between observations.
In the other file it is the place to go back to at the end of each scan before starting the next scan (here we don't want to waste time going further than necessary).

Table Parameters
ivalue says where to put SMEC.

Templates
See commissioning

AOTs Using This Table
Will be used in all spectrometer AOTs

Observations
See commissioning plan

Analysis
See commissioning plan

5.1.15 Spectrometer Sensitivities

This table defines the sensitivity information for each of the SPIRE spectrometric observing modes. Values are defined at a set of fixed wavelengths (mostly in 5 µm sampling steps) – the values at other wavelengths are interpolated (linearly) from these. This information is defined in SPIRE-UCF-DOC-002554 (AD6). Note that the data are for the central pixel. If the other (key) pixels are much/very different further information in the future should be provided to the HSpot user possibly via documentation.

Table Parameters

HLineUnc	line flux uncertainty (10^-17 W/m^2) for high resolution scans
MLineUnc	line flux uncertainty (10^-17 W/m^2) for medium resolution scans
HContUncJ	continuum uncertainty (Jy) for high resolution scans
MContUncJ	continuum uncertainty (Jy) for medium resolution scans
LContUncJ	continuum uncertainty (Jy) for low resolution scans
HContUncW	continuum uncertainty (Wm-2µm-1) for high resolution scans
MContUncW	continuum uncertainty (Wm-2µm-1) for medium resolution scans
LContUncW	continuum uncertainty (Wm-2µm-1) for low resolution scans

AOTs Using This Table

All Spec

Templates Required

LineUnc	Observations of a set of standard line sources with well modelled line fluxes will be used to establish this. This will use the normal AOTs
ContUnc	Observations of a set of standard sources with well modelled fluxes will be used to establish this. This will use the normal AOTs
ContUncW	This is just ContUnc but with different units. Derive Jy values and then convert.

Note, need to get the values for each resolution. For really long observations might have to consider doing one observation with scanStart at MR value and scanned at HR value. Otherwise I prefer to do an observation for each resolution.

Pre-Requisites
TBD

Observations
TBD. Observations of different strength point-like sources (see list). Need also to get the information at each resolution (either separate observations or reduce these data to LR and MR).

Analysis
TBD. This is very tricky.

Action: Matt + others (Bruce, David Naylor, Jean-Paul Baluteau) to review this section and propose detailed scheme. Important to cross-calibrate with HIFI.

5.1.16 Spectrometer Configuration

Description

This table defines the instrument-wide parameters for SPIRE spectrometer operations for each spectral resolution.

Spectral resolutions available are:

H High resolution
M Medium resolution
L Low resolution

Table Parameters

Home	HOME position to use for while scanning
Osit	on-source integration time per scan (secs)
ScanTime	time taken to execute a single scan (secs)
Resolution	Expected spectral resolution (cm-1)
ScanStart	Scan Start position
ScanEnd	Scan End Position
ScanFSpeed	Scan Forward Speed
ScanRSpeed	Scan Reverse Speed
ScanFCmd	Scan Forward Speed command parameter
ScanRCmd	Scan Reverse Speed command parameter
Waveform	Scan Waveform (TRIANGULAR (we shouldn't need to use the SAWTOOTH))

Note "Home" is defined in the calibration table SMEC too. In this file, it is the position to which the SMEC returns at(after*) the end of each scan before starting the next scan (here we don't want to waste time going further than necessary). In the SMEC file it is the position at which the SMEC sits at when an observation is not taking place. They are currently set to the same value and always will be.

AOTs Using This Table

All Spec

Templates Required

TBW need to confirm that happy with the resolution – which determines the scanStart/End distance and the scanTime and the Osit. Do we experiment with scan speed [yes – we should test nominal speed + significantly slower and faster (e.g.; 30% faster; 50% slower] (also affects the times)? Use triangular waveform for continuous scanning. Do this with normal AOTs in expert mode.

Pre-Requisites

TBD final-ish detector, SCAL and telescope settings

Observations
TBW. To be done at each resolution see list. In practice probably use the same speed for each resolution, but need to confirm the start and end positions and maybe also confirm that the speed is ok. Do with the standard line flux sources.

Analysis
TBW

5.1.17 Spire Configuration

Description
This table defines the instrument-wide parameters for SPIRE observations for each mode. The available modes in the table are:

POF2, POF3,
POF5_F_scana, POF5_F_scanb, POF5_F_scanab
POF5_S_scana, POF5_S_scanb, POF5_S_scanab
Par_F_N, Par_F_O, Par_S_N, Par_S_O
SOF1, SOF2, SOF2_int, (and back up modes POF1, POF4, POF6, SOF3, SOF4, SOF4_int)

Only the nominal modes are planned to be verified in PV Phase.

Table Parameters

TSerendipity	minimum time required in a slew for a serendipity observation to be inserted
InitFlash	true if PCAL flashes always inserted during initialisation
EndFlash	true if PCAL flashes always inserted at end of observation
Flashtime	minimum time (in seconds) between PCAL Flashes
CalTime	minimum time (in seconds) between Gyro calibrations
BiasFreq	master clock divider - gives the bias frequency

Note BiasFreq is defined in Nominal Settings too

AOTs Using This Table
All including Parallel

Templates Required

TSerendipity	This is currently set to be the minimum time possible as dictated by a slew of sufficient length to take one sample. There is no obvious reason to change this in flight therefore no specific tests will be done. It is assumed that PV Phase will be done with serendipity mode enabled. * therefore the slew data will be analysed and an assessment can be made as to whether this one sample minimum should be increased. [We have always regarded Serendipity mode as unsupported as far as analysis is concerned, and therefore no analysis is baselined – could say that it will be looked at on a best efforts basis, but it’s going to be a very low priority]. None required.
InitFlash	The baseline is that this will remain true while we continue with a scheme of flashing PCAL before and after each observation. None required
EndFlash	The baseline is that this will remain true while we continue with a scheme of flashing PCAL before and after each observation. None required
Flashtime	This parameter should be derived from analysis of long duration scan map observations and long spectrometer observations (or day’s worth of normal observations). Note with the current scheme of doing flashes at the start and

	end of observations this is only important for long observations (longer than the required flash time)
CalTime	It is assumed the spacecraft value will be reflected in the SPIRE calibration file therefore specific no observations are needed in this PV Phase plan as this (and the time needed at the position) is “to be determined during ACMS commissioning” (which is also documented in RD6)
BiasFreq	This parameter will be established in commissioning phase and is mode dependent. (might be updated with final detector settings)

Above assume PCal flashes at start and end of each observation – probably too much.

The Scan Map AOT can be used, an expert mode is not required.

Pre-Requisites
TBW settle on Scan Map AOT parameters especially scan speed (not necessarily? Detector parameters should be determined though).

Observations
TBW Long duration scan maps to determine flash time.

Analysis
TBW

5.1.18 Operations

Description

This table defines the instrument-wide parameters for SPIRE operations for each mode. The available modes are:

POF2, POF3,
POF5_F_scana, POF5_F_scanb, POF5_F_scanab
POF5_S_scana, POF5_S_scanb, POF5_S_scanab
Par_F_N, Par_F_O, Par_S_N, Par_S_O
SOF1, SOF2, SOF2_int, (and back up modes POF1, POF4, POF6, SOF3, SOF4, SOF4_int)

Only the nominal modes are planned to be verified in PV Phase.

A value of -1, -1.0 or --- indicates that this parameter is not used in a particular mode

Table Parameters

Boresight	instrument boresight
DeltaY	offset to pixel centre from instrument boresight in Y direction (arcsecs)
DeltaZ	offset to pixel centre from instrument boresight in Z direction (arcsecs)
TableID	Jiggle Position Table number
TableSize	number of jiggle positions in Position Table (must be a multiple of NJiggs)
NChops	number of chop cycles per jiggle position
MinScans	minimum number of FTS scans to be taken
NHScans	number of FTS High Res scans (taken as a unit or per jiggle posn)
NMScans	number of FTS Medium Res scans (taken as a unit or per jiggle posn)
NLScans	number of FTS Low Res scans (taken as a unit or per jiggle posn)
NJiggs	number of jiggle positions per nod position
NNodInts	number of times to repeat Njigg jiggles at each nod position
NNodPosns	number of nod positions in a nod cycle
NNodCycles	number of nod cycles in a repetition
NMaps	number of times to repeat each small map in a raster, or each scan map in a repetition
Fixed	pattern angle definition
Patt	direction of telescope movement in D1 direction (degrees)
D1	distance between raster points or nod positions (arcsecs)
D2	distance between raster/scan lines (arcsecs)
HLoss	lost map height: Observed map height = (D2 * (No of Lines - 1)) + HLoss
LLoss	lost map length: Observed map length = (scan length - LLoss)
XRepeat	Number of times to repeat the cross scan map per nominal map
ScanRate	telescope scan rate (arcsec/sec)
SrcTime	effective on source integration time per unit of operation (nod cycle, map, scan)

Parameters related to Spectrometer raster mapping – see RD7

YShiftUnit	Units used to define steps in the Y direction (arcsecs)

ZShiftUnit	Units used to define steps in the Z direction (arcsecs)
YStep	step in Y direction between raster points (YShiftUnits)
ZStep	step in Z direction between raster points (ZShiftUnits)
YRowSep	separation in Y direction between raster rows (YShiftUnits)
ZRowSep	separation in Z direction between raster rows (ZShiftUnits)

AOTs Using This Table
All including Parallel (note not all parameters are used by all AOTs/Observing Modes)

Templates Required
Probably use the normal AOTs for most of these and just try with different values, some require more than that (pointing).
(For RD3 Need to decide if change these things in calibration file or whether to make them all parameters of expert observation.) See pointing plan RD6.

Boresight	See pointing plan (RD6). Also use AOTs to confirm that each has a suitable boresight.
DeltaY	This would only be used if for some reason we want to offset the 'centre' of the observation from the centre of a channel defined in the SIAM. In it not planned to test this unless we find we need it. No new script would be required (the calibration file could be updated).
DeltaZ	This would only be used if for some reason we want to offset the 'centre' of the observation from the centre of a channel defined in the SIAM. In it not planned to test this unless we find we need it. No new script would be required (the calibration file could be updated).
TableID	This is defined by definition and doesn't need testing. However it is necessary to confirm the best the positions. This is covered via the calibration table sections on jiggle positions below (7-Point Jiggle Map Positions, 64-Point Jiggle Map Positions, Spectrometer Sparse Sampling, Spectrometer Intermediate Sampling, Spectrometer Full Sampling,).
TableSize	Defined by sections on jiggle positions below. Might need more positions to take into account dead pixels.
NChops	Need to make sure that we are performing number of chop cycles per jiggle position in the most optimum way. Use normal AOTs in expert mode to do this. Probably stay at default unless see any reason to change how we planned to do it.
MinScans	This will depend on the effect of glitches in space and how well we can get rid of them. Use normal AOTs in expert mode to do this. This is also somewhat dependent on the glitch removal algorithm. No need for separate observations, use a few scans of long observation.
N(HML)Scans	The baseline is always to do a forward and a backward scan pair. There won't be specific observations for this but need to check that there isn't some reason to change it to something else/stay the default unless see reason to change.
NJiggs	This depends on stability and glitches. Will make observations trying different values using normal AOTs in expert mode. Stay at default unless

	see reason to change.
NNodInts	As above (these are all interdependent if we want to keep basic obs time to be the same).
NNodPosns	As above (these are all interdependent if we want to keep basic obs time to be the same).
NNodCycles	As above (these are all interdependent if we want to keep basic obs time to be the same).
NMaps	As above (these are all interdependent if we want to keep basic obs time to be the same).
Fixed	This says whether pattern is fixed wrt the sky (true) or false, whether relative to the instrument boresight. This is almost by definition, we want maps relative to the array not to the sky. So don't need observation or a script.
Patt	Need to change this if arrays not aligned with S/C arrays. Checked during pointing observations (RD6). See that doc. Also used to specify the scan angle, need to try observations with different angles. using normal AOTs in expert mode. For a value of Patt, D2, HLoss and LLoss can be calculated.
D1	For point and small map, need to confirm the nod (chop) distance. For spectrometer rastering, need to confirm the spacings of the raster points.
D2	Need to confirm the best overlap between scan, see Patt. For spectrometer rastering, need to confirm the spacings of the raster points.
HLoss	Need to confirm the values for mapping. See Patt
LLoss	Need to confirm the values for mapping. See Patt
XRepeat	not currently used
ScanRate	Need to check that we are using the best value as nominal speed. Need to confirm that the high speed is giving sensible data.
SrcTime	Calculate from things like NJigg above so only changes if they change.
YShiftUnit	Need to confirm that all these are still the best values, are the overlaps ok, do we do anything about dead pixels etc.
ZShiftUnit	See YShiftUnit
YStep	See YShiftUnit
ZStep	See YShiftUnit
YRowSep	See YShiftUnit
ZRowSep	See YShiftUnit

Pre-Requisites
Detector settings, PCAL, pointing, PTC, SCAL

Observations
TBW. Testing the AOTs.

Boresight	See pointing plan (RD6). Also for each AOT check that the most suitable boresight is being used. i.e are we using the best detector pairs for chop and nod. Do we need to move the Spectrometer boresight for intermediate and full spatial resolution due to dead pixels. The default values will be checked during AOT testing. For chop nod we should confirm which set of coaligned pixels to use (which probably we control via Patt). For parallel mode need to

	make sure that both instruments cover the user area which means getting the boresight right.
DeltaY	The default is that we shouldn't need this parameter (although it could be used for moving the Spectrometer boresight for intermediate and full spatial resolution due to dead pixels if we want to place it somewhere that isn't a pixel centre.)
DeltaZ	The default is that we shouldn't need this parameter. (Although it could be used for moving the Spectrometer boresight for intermediate and full spatial resolution due to dead pixels if we want to place it somewhere that isn't a pixel centre.)
TableID	None.
TableSize	None. See jiggle position tables
NChops	Probably stay at default (no point to make basic observations shorter as overheads will dominate) unless see any reason to change how we planned to do it. Reasons to change may be if there are more glitches than expected and they effect subsequent data, or if we find we can do few nods then we'd want to put that integration time in more chops per jiggle (or go around the jiggle again).
MinScans	No need for separate observations, use a few scans of long observation.
N(HML)Scans	No specific tests. Just confirm that forward and backward scans are ok.
NJiggs	Stay at default unless see reason to change. See also NChops
NNodInts	As above (these are all interdependent if we want to keep basic obs time to be the same).
NNodPosns	As above (these are all interdependent if we want to keep basic obs time to be the same).
NNodCycles	As above (these are all interdependent if we want to keep basic obs time to be the same).
NMaps	As above (these are all interdependent if we want to keep basic obs time to be the same).
Fixed	None
Patt	Need to change this if arrays not aligned with S/C arrays. Checked during pointing observations (RD6). See that doc. Also used to specify the scan angle, need to try observations with different angles. using normal AOTs in expert mode (this will be valid for parallel too). For a value of Patt, D2, HLoss and LLoss can be calculated. Also for nodding observations need to decide which set to use (see boresight observations). How used for spectrometer?
D1	For point and small map, need to confirm the nod (chop) distance. For spectrometer rastering, need to confirm the spacings of the raster points.
D2	Need to confirm the best overlap between scan, see Patt. For spectrometer rastering, need to confirm the spacings of the raster points.
HLoss	Need to confirm the values for mapping. See Patt
LLoss	Need to confirm the values for mapping. See Patt
XRepeat	not currently used
ScanRate	Perform scan maps at 5, 20, 30 and 45 "/s. Do on "blank" field.

	Also map at the fastest rate (60”/s). Do maps of the same area of sky. Source TBD. Maybe do extended source and point source type areas (one to cover both). Also do for parallel mode (different data rate), 15, 20, 25 and max speed (60”/s). Need to make sure that parallel mode map and spire only give same results.
SrcTime	None
YShiftUnit	Need to confirm that all these are still the best values, are the overlaps ok, do we do anything about dead pixels etc. So the default is to perform raster observations at each spatial resolution and to confirm the values.
ZShiftUnit	See YShiftUnit
YStep	See YShiftUnit
ZStep	See YShiftUnit
YRowSep	See YShiftUnit
ZRowSep	See YShiftUnit

Analysis
TBW

5.1.19 7-Point Jiggle Map Positions

In order to perform a 7-point jiggle map (POF2) the BSM is commanded to 8 positions (the last is a repeat of the first). At each of these the BSM chops between two positions, designated the on- and off-source positions. Thus 14 values are required defining these positions.

[This terminology is different to that used in the Pipeline document, which designates the beams as L and R (left and right). In one half of the nod cycle the L beam is on-source, and in the other half the R beam is on-source. We'll change terminology from L/R to YP/YN in the pipeline docs.]

Each 32 bit value corresponds to a single BSM position and contains the Jiggle axis position in the most significant 16 bits and the Chop axis position in the least significant 16 bits.

JM7_01_On BSM position for position 1, on-source
JM7_01_Off BSM position for position 1, off-source
JM7_02_On BSM position for position 2, on-source
JM7_02_Off BSM position for position 2, off-source
:::::::::::::::::::: ::
JM7_06_On BSM position for position 6, on-source
JM7_06_Off BSM position for position 6, off-source
JM7_07_On BSM position for position 7, on-source
JM7_07_Off BSM position for position 7, off-source

AOTs Using This Table
Photometer Point Source

Templates Required
An expert AOT for 7-point jiggle map will be required.

Pre-Requisites
The logical sequence to establish this is to do a BSM FOV scan, then tune the nominal chop throw found, then test the AOT with different angular offsets as established by the FOV scan. Here only the AOT testing is described as the BSM FOV scanning and tuning is dealt with elsewhere in this plan.

Observations

Source Type	Position of Source	Chop Freq	Chop Throw	Angular Offset (arcsecs)
Point Source	Centre	Nominal	Nominal	5
Point Source	Centre	Nominal	Nominal	6
Point Source	Centre	Nominal	Nominal	7
Point Source	2" offset	Nominal	Nominal	5
Point Source	2" offset	Nominal	Nominal	6
Point Source	2" offset	Nominal	Nominal	7

Note the pointing is very unlikely to be good enough to be able to put a source at a position of 2 arcsec offset, however we could try it via peaking up on the source to be sure we have the source centred but then apply a Y/Z offset to pointing pattern (via the pointing mode) [this would need extra parameters in our scripts***].

[What's the purpose of this sequence with the source offset? Why 2"?]
[The range of 7-point offsets checked: 4, 6, 9"]
[Range of telescope pointing offset positions to be checked: 4", 8"]
[Useful test: Revisit the same source multiple times to check for consistency – could eb done in CP?]
Do this on Brightish source (10 Jy or more or a quasar) and faint source (~ 200 mJy) and really faint (50-100 mJy – e.g., a star, to push the ultimate performance).

It is TBD whether we additionally vary the number of chop cycles and/or the chopping parameters.

The angular offset (BSM position) will be implemented in a version of the VM table (and selected via a parameter in Expert HSpot)

Analysis
The observations will be processed through the standard pipeline if possible and the point source reconstruction will be checked. The positions the BSM went to will be checked. The angular offset which best recovers the source flux will be adopted. [The optimum offset depends on the pointing accuracy, which may change as the mission progresses.]

5.1.20 64-Point Jiggle Map Positions

In order to perform a 64-point jiggle map (POF3) the BSM is commanded to 64 positions. At each of these the BSM chops between two positions, designated the on- and off-source positions. Thus 128 values are required defining these positions.

[As noted above, this terminology is inconsistent with the pipeline document, and potentially confusing since the beams are switched by nodding.]

Each 32 bit value corresponds to a single BSM position and contains the Jiggle axis position in the most significant 16 bits and the Chop axis position in the least significant 16 bits.

JM64_01_On BSM position for position 1, on-source
JM64_01_Off BSM position for position 1, off-source
JM64_02_On BSM position for position 2, on-source
JM64_02_Off BSM position for position 2, off-source
:::::::::::::::::::: ::
JM64_63_On BSM position for position 63, on-source
JM64_63_Off BSM position for position 63, off-source
JM64_64_On BSM position for position 64, on-source
JM64_64_Off BSM position for position 64, off-source

AOTs Using This Table
Only the photometer small map AOT uses this table.

Templates Required
As the 64 points jiggle-map produces a fully sampled image it does not make sense to vary the offsets. While not planned we may anticipate the need to change the chop parameters i.e. number of cycles and chop frequency. Note the sequence that the 64 points are done in is not planned to be changed but if a need is identified to test this, it only implies a change to the position order in this table.

Pre-Requisites
As with the 7-point jiggle map, the logical sequence to establish this is to do a BSM FOV scan, then tune the nominal chop throw found, then test the AOT with different angular offsets as established by the FOV scan. Here only the AOT testing is described as the BSM FOV scanning and tuning is dealt with elsewhere in this plan.

Observations

Source Type	Position of Source	Chop Throw
Point Source	Centre	Nominal
Point Source	5” offset in Y	Nominal
Point Source	5” offset in Z	Nominal
Point Source	9” offset in Y	Nominal
Point Source	9” offset in Z	Nominal

Small Extended Source	Centre	Nominal

What are we learning from these different offsets?**
We could try it via peaking up on the source to be sure we have the source centred but then apply a Y/Z offset to pointing pattern (via the pointing mode) [this would need extra parameters in our scripts***].

It is TBD whether we additionally vary the number of chop cycles and/or the chopping parameters.

The extended source should be a size less than 4x4'.

[Maybe use dual sources (see Pete's calib. source doc.]

Analysis
The observations will be processed through the standard pipeline if possible. The positions the BSM went to will be checked. The recovery of the source will be checked.

5.1.21 Spectrometer Sparse Sampling

This parameter gives the BSM chop and Jiggle commanded positions for the spectrometer sparse sampling observations (SOF1). The 32 bit value corresponds to the BSM position and contains the Jiggle axis position in the most significant 16 bits and the Chop axis position in the least significant 16 bits.

SP_Sparse BSM sparse position e.g. 0x986B9270

AOTs Using This Table
Spectrometer single pointing (sparse sampling)
Spectrometer raster (sparse sampling)

Templates Required
This parameter is the BSM minimum current position which will be derived in commissioning phase.

Pre-Requisites
None

Observations
Normal observation with point source (should use source that was used for the photometer point source observation). Note that the instrument boresight needs to be established (or at least confirmed) with the BSM at this position (confirm in commissioning/pointing RD1/RD6).

Analysis
The BSM jiggle and chop positions where the current is the minimum value will be adopted. Confirm that the point source at known RA and Dec is seen on central pixel.

5.1.22 Spectrometer Intermediate Sampling

These parameters give the BSM chop and Jiggle commanded positions for the spectrometer observations with intermediate spatial sampling (SOF2_int). There are currently 4 positions which are given in RD7.

Each 32 bit value corresponds to a single BSM position and contains the Jiggle axis position in the most significant 16 bits and the Chop axis position in the least significant 16 bits.

SP_Int_01 BSM position for intermediate position 1
SP_Int_02 BSM position for intermediate position 2
SP_Int_03 BSM position for intermediate position 3
SP_Int_04 BSM position for intermediate position 4

AOTs Using This Table
Single pointing (Intermediate Sampling)
Raster (Intermediate Sampling)

Templates Required
The AOTs can be used without the need for expert templates. Although can alter the position of the source using DeltaY and DeltaZ parameters (expert template/cal file). (This means that the boresight is moved from the central pixel, rather than putting some 'target off by offset' on the central pixel – the effect should be the same.)

Pre-Requisites
The BSM FOV mapping will establish the positions to use for this table.

Observations

AOT	Source Type	Position of Source	Spectral Resolution
Point Source	Point Source	Centre	High
Point Source	Point Source	5 and 12" offset in Y	Medium
Point Source	Point Source	5" and 12" offset in Z	Medium
Point Source	Small Extended Source	Centre	High

In the case that there are new dead pixels and we want to compensate for them then other observations will be needed (similar to those mentioned earlier elsewhere…). However this plan is optimistic and so doesn't give them. This comment applies to the full sampling too and the photometer 7 and 64 point maps. See comments in photometer 7 and 64 point.

Analysis

The observations will be processed, through the standard pipeline if possible. The positions the BSM went to will be checked. The recovery of the source will be checked.

5.1.23 Spectrometer Full Sampling

Description
These parameters give the BSM chop and Jiggle commanded positions for the spectrometer observations with full spatial sampling (SOF2). There are currently 16 positions which are given in RD7.

Each 32 bit value corresponds to a single BSM position and contains the Jiggle axis position in the most significant 16 bits and the Chop axis position in the least significant 16 bits.

SP_Full_01 BSM position for full position 1
SP_Full_02 BSM position for full position 2
:::::::::: ::::::::::::::::::::::::::::::::::::::
SP_Full_15 BSM position for full position 15
SP_Full_16 BSM position for full position 16

AOTs Using This Table
Single pointing (Full Sampling)
Raster (Full Sampling)

Templates Required
The AOTs can be used without the need for expert templates. Although can alter the position of the source using DeltaY and DeltaZ parameters (expert template/cal file). (This means that the boresight is moved from the central pixel, rather than putting some 'target off by offset' on the central pixel – the effect should be the same)

Pre-Requisites
The BSM FOV mapping will establish the positions to use for this table.

Observations

AOT	Source Type	Position of Source	Spectral Resolution
Point Source	Point Source	Centre	Medium
Point Source	Point Source	5" offset in Y	Low
Point Source	Point Source	5" offset in Z	Low
Point Source	Point Source	12" offset in Y	Low
Point Source	Point Source	12" offset in Z	Low
Point Source	Small Extended Source	Centre	Medium

Analysis

The observations will be processed, through the standard pipeline if possible. The positions the BSM went to will be checked. The recovery of the source will be checked. See comments in photometer 7 and 64 point.

5.1.24 CREC Operations (Commissioning Phase)

Description

These parameters define the operational characteristics of the Cooler Recycle command list (See RD8). The ground values will be retained for in-flight operations these will be checked/determined via manual cooler recycles early in the mission (see RD1).

Table Parameters

All parameters are provided in raw ADU, if not otherwise defined

CREC_A	Heat Switch ON current (during Recycling)
CREC_B	Heat Switch OFF current
CREC_C	Pump Heat Switch Actuation Temperature
CREC_D	Pump Heater Dissipation 1
CREC_E	Pump Condensation Temperature 1
CREC_F	Pump Heater Dissipation 2
CREC_G	Pump Condensation Temperature 2
CREC_H	Pump Heater Dissipation 3
CREC_I	Pump Heater Dissipation 4
CREC_J	Pump Condensation Temperature Threshold
CREC_K	Evaporator Condensation Temperature
CREC_L	Evaporator Heat Switch Actuation Temperature
CREC_M	Pump Threshold Temperature
CREC_N	Heat Switch ON current
CREC_O	Sampling Interval (sec)
CREC_P	Heatswitch Timeout (min)
CREC_Q	Pump Heating Timeout 1 (min)
CREC_R	Pump Heating Timeout 2 (min)
CREC_S	Evaporator Timeout (min)
CREC_T	Pump Cooling Timeout (min)
CREC_U	Global Timeout (min)

AOTs Using This Table

None

Templates Required

None

Pre-Requisites

TBD

Observations

None

Analysis

Handled by RD1

5.1.25 PTC Control (Commissioning Phase)

Description

These parameters define the operational characteristics of the PTC Control command list. It is assumed the ground values will be retained for in-flight operations and that these will be checked early in the mission.

Table Parameters

All parameters are provided in raw ADU, if not otherwise defined

PTC_00	Required Temperature (ADC Units) - int
PTC_01	PTC Temp Cmd - command to get the controlling temperature This can be a direct DRCU GET command or the SDEX entry for the detector channel required: PSW T1 = 0x00040000 TC1 = 0x83CF001A PSW T2 = 0x001C0000 TC2 = 0x83CF001C PMW T1 = 0x00C30000 TC3 = 0x83CF001E PMW T2 = 0x00DC0000 PLW T1 = 0x009E0000 PLW T2 = 0x00B50000
PTC_02	Loop Period (us) - int
PTC_03	Kp (PID parameter) - float
PTC_04	Ki (PID parameter) - float
PTC_05	Kd (PID parameter) - float
PTC_06	Ki Limit - float
PTC_07	Low pass filter Gain - float
PTC_08	Low pass filer coefficient b1 - float
PTC_09	Low pass filer coefficient b2 - float
PTC_10	DAC constant offset - float
PTC_11	Maximum DAC value allowed - int
PTC_12	PWM flag - if non-zero, Pulse width modulation is used
PTC_13	TM flag – if non-zero, TM packets containing a copy of the data storage area are generated
PTC_14	Additional initialisation count – if non-zero, this additional number of values will be read into the signal registers before starting the PID

AOTs Using This Table

TBD – The most likely AOT needing the PTC is scan map. If adopted the PTC may also be used for the other two photometer AOTs, small map and point source.

Templates Required

PTC Tuning

Pre-Requisites

TBD

Observations
TBD – It is expected that any PTC tuning will take place in commissioning phase. The open question remaining is does the PTC require any re-tuning one the telescope is cold?

Analysis
TBW

5.1.26 SCAL Control (mostly Commissioning Phase)

Description
These parameters define the operational characteristics of the SCAL Control command list. They will be checked in Commissioning Phase. However the required temperature (parameter SCAL_00) needs to be determined for PV when we start using the spectrometer AOTs and again when the telescope settles (and maybe in between too as it cools). The tuning parameters should not need retuning once the telescope is cold (but this should be confirmed in flight).

Table Parameters
All parameters are provided in raw ADU, if not otherwise defined

SCAL_00	Required Temperature (ADC Units) - int
SCAL_01	SCAL Temp Cmd - DRCU command to get the SCAL temperature
SCAL_02	SCAL Htr Cmd – DRCU command to set the SCAL Heater voltage. Only the command ID should be set
SCAL_03	Loop Period (us) - int
SCAL_04	Kp (PID parameter) - float
SCAL_05	Ki (PID parameter) - float
SCAL_06	Kd (PID parameter) - float
SCAL_07	Ki Limit - float
SCAL_08	Low pass filter Gain - float
SCAL_09	Low pass filer coefficient b1 - float
SCAL_10	Low pass filer coefficient b2 - float
SCAL_11	Maximum DAC value allowed - int
SCAL_12	PWM flag - if non-zero, Pulse width modulation is used
SCAL_13	TM flag – if non-zero, TM packets containing a copy of the data storage area are generated
SCAL_14	Additional initialisation count – if non-zero, this additional number of values will be read into the signal registers before starting the PID

AOTs Using This Table
Spectrometer AOTs

Templates Required
TBW

Pre-Requisites
TBD

Observations
TBW

Analysis
TBW

5.1.27 SpireTable_PhotSourceMode (mostly Commissioning Phase)

Description

Table Parameters

AOTs Using This Table
AOTs

Templates Required
TBW

Pre-Requisites
TBD

Observations
TBW

Analysis
TBW

5.1.28 SpireTable_PhotMultiLevelNoiseLevels (mostly Commissioning Phase)

Description

Table Parameters

AOTs Using This Table
AOTs

Templates Required
TBW

Pre-Requisites
TBD

Observations
TBW

Analysis
TBW

5.1.29 SIAM Matrix

Description
This uplink table gives the orientation of the SPIRE apertures with respect to the spacecraft control reference (it also contains the information for PACS and HIFI). The SIAM (Spacecraft/Instrument Alignment Matrices) is used to determine the pointing of the telescope boresight in order that the reflected light from the telescope secondary enters the appropriate instrument aperture. See RD6 for more information on Herschel Pointing Calibration, the SIAM etc and RD3 for more detail on the SPIRE observations.

Table Parameters
There is one matrix per aperture defined, there are around 77 apertures defined for SPIRE. Key AOT apertures are S_14 (for photometer AOTs, PSW central pixel E8), S_24 (for spectrometer AOTs, SSW central pixel D4) and S_55 (for parallel mode, half way between SPIRE and PACS photometer centres). See RD6 Appendix A for full list of SPIRE apertures or RD9 for the most up to date positions.

AOTs Using This Table
All AOTs

Templates Required
See below under each test required

Pre-Requisites
PACS coarse measurement of primary instrument aperture (and check of SIAM update)… some more things in ComP
See below under each test required for the detailed pre-requisites for each test.

Observations
See below under each test required

Analysis
See below under each test required

Details
The SPIRE pointing procedures are split into three parts.
First, an initial pointing calibration is done in COMMISSIONING to accurately determine the position of several primary apertures, both for the photometer and the spectrometer. After this activity we determine the whole focal plane geometry for all arrays by establishing the relative positions of all pixels. These two activities will enable updates to the SPIRE SIAM.
Sources are then able to be placed on any given pixel.
Finally, we will calibrate the BSM to be able to move the source across the arrays using only the BSM. This last procedure is an internal SPIRE activity not associated with the determination of the apertures directly. The following descriptions are a synopsis of the

procedures outlined in the two reference documents RD15 and RD16, which should be always consulted to get the latest version.

Initial Photometer Pointing (THIS IS UNDER COMMISSIONING)

ESA_ID: *SPIRE_Initpoint_PHOT*

Templates Required
Phot Focal Plane Geometry (Initial Pointing) (RD3 section 6.1.7)

Pre-Requisites
 'PACS_SIAM_search' successfully completed
 A coarse SIAM implemented as defined in "PACS_SIAM_Search" with pointing accuracy to within 10".
 BSM PID tuning has been successfully completed
 SPIRE cold functional tests completed
 Gyro propagation (reconstruction) available

Observations
Suitable bright point source available (> 50Jy) drive a point source along several 5 by 5 rasters **(concatenated AORs)** across the primary SPIRE apertures of the photometer. Neptune preferred, bright asteroid a possible alternative.
Duration 2.5 hours.

Analysis
This produces a data set that SPIRE will analyse to fit the offsets of the source with respect to the detector beam on the sky (Δy, Δz). In addition, we will get the relative positions of a set of pixels on each array to check for the alignment of the array's YZ axes with the satellite's YZ axes and for distortions of the array footprints on the sky with respect to predictions from ground tests. Analysis time: 7ODs.

Goal/requirement: Obtain the apertures of 5 fiducial pixels in the SPIRE photometer array to a positional accuracy of at least 1.0" with a goal of 0.5".

Initial Spectrometer Pointing (THIS IS UNDER COMMISSIONING)

As for Photometer but uses the ***Spec Focal Plane Geometry (Initial Pointing) (RD3 section 6.2.**)*** and the duration is 2 hours.

Focal Plane Geometry Photometer Scan (PV)

ESA_ID: *SPIRE_FPGscan_PHOT*

Templates Required
Phot FOV Mapping Line Scan (FPG scan) *(RD3 section 6.1.8)*

Pre-Requisites
- *Successful completion of SPIRE_Initpoint_PHOT*
- *BSM PID tuning has been successfully completed*
- *Gyro propagation (pointing reconstruction) available*
- *Scan accuracy – speed and direction* ***(TBD)***

Observations
A point source is scanned along each line of the SPIRE photometer array
Suitable bright point source available (> 50Jy)
Duration ~1 hour

Analysis
This produces a series of beam profile cuts with peaks separated by a time interval corresponding to the pixel separation along the scan axis. SPIRE will analyse this data to derive the relative positions along the scan direction of all pixels on the arrays with respect to a fiducial pixel (nominally the central pixel). Pixels along the two lines containing this pixel will be related to it directly, pixels not on that line, indirectly.
The relative pointing shift throughout the measurement should be small (< 0".5') and measurable with on-ground gyro reconstruction. The method is insensitive to a pointing error perpendicular to the scan axis, but the scan axis and the line of detectors are required to be accurately aligned with an accuracy similar to the normal line scan mode.
The scan direction is also required to be uniform (straight, i.e. no “wobbling”, and with constant speed) along the scan to an accuracy of **TBD**. An initial estimate of the scan accuracy comes from *PACS_SRPE_scan.*
Analysis time: 2ODs

Goal/requirement: Obtain the apertures of all pixels on the SPIRE photometer array to a positional accuracy of 1.0 "

Focal Plane Geometry Spectrometer Scan (PV)

ESA_ID: *SPIRE_FPGscan_SPEC*

Templates Required
Spec FOV Mapping Line Scan (FPG scan) *(RD3 section 6.2.***9)*

Pre-Requisites
- *Successful completion of SPIRE_Initpoint_SPEC*
- *BSM PID tuning has been successfully completed*
- *Gyro propagation (pointing reconstruction) available*
- *Scan accuracy – speed and direction* ***(TBD)***

Observations
A point source is scanned along each line of the SPIRE spectrometer array
Suitable bright point source available (> 50Jy)
Duration ~0.5 hour

Analysis
Similar to Photometer version
Analysis time: 2ODs

Goal/requirement: Obtain the apertures of all pixels on the SPIRE photometer array to a positional accuracy of 1.0 "

5.2 Data Processing Files

Note that Parallel Mode is listed explicitly although usually it will be only checked individually on the scan map. Parallel mode will be checked out as a whole AOT (so it may not be so relevant to mention parallel mode explicitly but at least then it isn't forgotten).

5.2.1 SCalPhotChanMask and SCalSpecChanMask

Description
This file provides a set of masking parameters. Each masking parameter is in the form of an integer mask i.e. a 1 or 0. Currently dead pixel, noisy and chopped out masks are defined although the file structure is flexible enough to allow other masks to be added.

Table Parameters
Table containing three columns, channelName, isDead and isNoisy

AOTs Using This Table
All including Parallel

Templates Required
None – The dead pixels will be apparent from commissioning phase observations
The noisy pixels will be confirmed from commissioning phase and PV Phase observations.

Pre-Requisites
None

Observations
No specific observations are required, the dead pixels will show up in all of them.

Analysis
Dead pixels are apparent from load curves. As the bias amplitude changes, the signal level on the channel does not.

5.2.2 SCalPhotInstModeMask

Description
This file provides a set of masking parameters that are related to the instrument mode. Each masking parameter is in the form of an integer mask i.e. a 1 or 0. Currently the chopped out mask is defined although the file structure is flexible enough to allow other masks to be added.

Table Parameters
Table containing two columns, pixel id and integer mask

AOTs Using This Table
Photometer point source
Photometer small map

Templates Required
None –
The chopped out masks need to be confirmed from AOT observations

Pre-Requisites
That the chopping is set up properly

Observations
No specific observations are required, the chopped out masks will be confirmed from AOT observations.

Analysis
TBW

5.2.3 SCalPhotBolPar and SCalSpecBolPar

Description
This table contains the fundamental bolometer parameters. Only the load resistors are important for the empirical pipeline, however the other parameter values are used to populate other tables.

Table Parameters (to be updated, include optical efficiency?)

TempT0	T_0 : reference Temperature for Bolometer Thermal Conductivity.
channelName	Unique name for each channel. For example optical pixel C5 on the PLW array would be 'PLWC5'.
loadResPos	R_{load}^{+}: load resistance on positive bias side of bolometer.
loadResNeg	R_{load}^{-}: load resistance on negative bias side of bolometer.
resR0	R_0: constant resistance parameter used to calculate bolometer temperature from R_{bolo}: the resistance at temperature Δ
Delta	Δ: parameter used to calculate bolometer temperature from R_{bolo}: the reference temperature for the bolometer resistance (in units of K).
Capac	C: electrical cable capacitance, used to calculate the RC roll off correction.
CondG0	G_0 : bolometer thermal conductivity at temperature T_0
Beta	β: the power law index for relationship between thermal conductance and temperature.

[These parameters are not currently used in the pipeline]

AOTs Using This Table
All AOTs including Parallel

Templates Required
TBD

Pre-Requisites
TBD

Observations
None

Analysis
TBD

5.2.4 SCalPhotBolParSky and SCalSpecBolParSky

Description
The phase should be used instead of the nominal resistance. [This is not yet confirmed – Bruce needs to document the proposed change to the PPD, which then needs to be reviewed (by Matt, Darren and Pasquale.]

Table Parameters (to be updated)
Table containing phase values per detector.
[Note can these uplink data be propagated to the downlink without having to make a copy of the information into a downlink file?]

AOTs Using This Table
All including Parallel
Confirm re spectrometer, not in pipeline doc.

Templates Required
Phase up

Pre-Requisites
Populate with initial values from commissioning phase ups. Will need to be re-done a final time with the bias values we settle on and the telescope background at stable value.

Observations
Phase up of dark sky.

Template	Source Type	Position	Integration Time
Phot Phase Up	Dark Sky	PSW E8	
Spec Phase Up	Dark Sky	PSW E8	

Maybe phase up on different source strengths and biases to determine the harness capacitance, *C*.

Analysis
TBW

5.2.5 SCalPhotBsmPos and SCalSpecBsmPos

Description
This table provides the calibration between BSM sensor signal in raw units (in chop and jiggle directions) and angular distance on the sky from its zero position (in spacecraft Y, Z coordinates).

Table Parameters

chopSens	Sensor signal in chop direction
jiggSens	Sensor signal in jiggle direction
yangle	Angle in spacecraft Y direction
yangleError	Error in Y angle
zangle	Angle in spacecraft Z direction
zangleError	Error in Z angle

AOTs Using This Table
Photometer Point Source
Photometer Small Map
Photometer Scan Map (to check rest position only)
Photometer Parallel Mode (to check rest position only)
Spectrometer Single Pointing (sparse [minimum power position], intermediate and full)
Spectrometer Raster (sparse [minimum power position], intermediate and full)

Templates Required
This is established via FOV scanning with the BSM (BSM Angle Calibration).

Pre-Requisites
The effective chop and jiggle ranges will need to have been established. This will either be done in commissioning phase or the ground values will be adopted.

Observations

Template	Source Type	Position	Direction	Step Size	Integration Tme
BSM FOV Scan	Point Source	PSW E8	Chop	0x100	10 s
BSM FOV Scan	Point Source	PSW E8	Jiggle	0x200	10 s
BSM FOV Scan	Point Source	PMW D6	Jiggle	0x200	10 s
BSM FOV Scan	Point Source	PMW D7	Jiggle	0x200	10 s
BSM FOV Scan	Point Source	SSW D4	Chop	0x100	10 s
BSM FOV Scan	Point Source	SSW D4	Jiggle	0x200	10 s

Analysis
The data produced by the template observations will be analysed in the following steps:
1. For Each Scan
2. For Each Pixel
    a. Demodulate the data obtained at each BSM position

   b. Plot demodulated signal vs BSM position
   c. Fit a Gaussian to find FWHM of beam in BSM position units and BSM position for centre of the beam
3. Plot beam centre positions vs pixel offset angle on the sky for all scans
4. Fit this plot to obtain Angle vs position calibration
5. Repeat using the BSM chop/jiggsenssig parameter instead of chop/jiggpos.

5.2.6 SCalPhotBsmOps and SCalSpecBsmOps

Description

This file gives all the BSM positions required for each observing mode, (single pointing,-this one isn't used or implemented) photometer 7-point jiggle, photometer 64 point jiggle, spectrometer intermediate sampling (4 point jiggle), spectrometer full sampling (16 point jiggle). These are equivalent to the uplink files described in sections (7-point) 5.1.19, (64-point) 5.1.20, [(sparse) 5.1.21], (intermediate) 5.1.22, and (full) 5.1.23. Note that for Scan and Parallel the rest position is used.

Table Parameters

chopBeamId	Chop beam identifier
jiggId	Jiggle position identifier
chopSens	Sensor signal in chop direction
chopLoTol	Negative tolerance in the sensor signal in the chop direction
chopHiTol	Positive tolerance in the sensor signal in the chop direction
jiggSens	Sensor signal in jiggle direction
jiggLoTol	Negative tolerance in the sensor signal in the jiggle direction
jiggHiTol	Positive tolerance in the sensor signal in the jiggle direction

Templates

None

AOTs Using This Table

Photometer Point Source
Photometer Small Map
Photometer Scan Map (to check rest position only)
Photometer Parallel Mode (to check rest position only)
Spectrometer Single Pointing (sparse (to check rest position?), intermediate and full)
Spectrometer Raster (sparse (to check rest position?), intermediate and full)

Pre-Requisites

Two main steps are required to establish this table, the first is the establishment of the BSM angle calibration and the other is the finalisation of the uplink tables which determine which positions are used. The only further step required here is an understanding of the relationship between commanded position and the position given by the sensor signal. Effectively the angle calibration has to be done for both the commanded position and for the sensor signal although the same observations can be used.

Observations

The observations described in section 5.2.5 (for the angle calibration) and in sections 5.1.19, 5.1.20, 5.1.21, 5.1.22, and 5.1.23 (for the AOT positions).

Analysis

The angular calibration is first established. For the 7-point jiggle, this is used to derive the BSM positions for the angular offsets tested for the AOT uplink tables. For the remainder of the AOTs the offset positions can be fed into the tables directly. Once the angular offset is established, the downlink table described here can then be populated with the equivalent angle in sensor signal (rather than commanded position as used for the uplink tables).

5.2.7 SCalPhotDetAngOff and SCalSpecDetAngOff

Description
This table gives the angular offset of each pixel from the SPIRE boresight.

Table Parameters

pixelName	Unique name for each optical pixel. For example pixel C5 on the PLW array would be 'PLWC5'.
zangle	Angular offset of pixel from SPIRE boresight in instrument coordinates: Z direction (arcseconds).
zangleError	Error on pixel angular offset in Z direction (arcseconds).
yangle	Angular offset of pixel from SPIRE boresight in instrument coordinates: Y direction (arcseconds).
yangleError	Error on pixel angular offset in Y direction (arcseconds).

AOTs Using This Table
All AOTs including Parallel

Templates Required
UPDATE with info from pointing plan. See also the SIAM section.
This is set up initially with the Focal Plane Geometry observations. It is TBD how to do this, one alternative is to scan the telescope across a point source and check the pointing when the source crosses a particular pixel compared with when the source crosses the boresight. [This is the baseline as I understand it.] Another alternative is to use the telescope to place a source where a pixel is expected to be then to do a cross raster with either the telescope or the BSM to locate the pixel centre. [Problematic because of the telescope pointing error.] For the photometer the BSM will be required to modulate the signal. For the spectrometer low resolution scans can be used.

The only update to this is via the telescope putting a point source on various pixels and noting the positions of maximum signal. This will only be done as a dedicated test for a few pixels but the normal surveys provide plenty of secondary data to confirm relative positions. [What about observations scanning along detector lines?].

PcalBsm test with lid on. Modelling of the cryocover by M. Ferlet has shown that for the photometer the PCAL signal is focused into a line along the jiggle axis, by moving the BSM the PCAL signal can be moved along the chop axis to give initial information of the pixels relative to each other.

Pre-Requisites
TBD

Observations

TBD – See Templates

Analysis
The angular offset obtained for each pixel in chop and jiggle separately will be put into the file.

5.2.8 SCalPhotGlitch and SCalSpecGlitch

Description
This file is not yet defined but if it is a calibration table it is intended to contain any parameters necessary for deglitching.

Table Parameters
TBD

AOTs Using This Table
All including Parallel

Templates Required
None.

Pre-Requisites
None

Observations
No specific observations are required (data from all observations can be used).

Analysis
TBD. Glitches seen in any SPIRE data will be used to work out the best parameters that allow the majority of glitches to be removed by the pipeline.

5.2.9 SCalPhotGlitchThreshOne

Description
Note that even though this is not a calibration file (the deglitching parameters are inputs to the software) this is left for completeness as we will make sure that these parameters are updated according to in flight data.

Table Parameters
TBW

AOTs Using This Table
Photometer Point Source
Photometer Small Map
(not in scan(parallel) pipeline)

Templates Required
None

Pre-Requisites
None

Observations
No specific observations are required (data from all observations can be used).

Analysis
TBW. See SCalPhotGlitch and SCalSpecGlitch

5.2.10 SCalPhotElecCross and SCalSpecElecCross

Description
This file gives the electrical crosstalk matrix. It contains an *N*x*N* matrix for each array, where *N* is the number of detectors in the array. The diagonal elements should be unity, and for zero crosstalk correction the non-diagonal elements would be zero.

Table Parameters
See above description

AOTs Using This Table
All including Parallel

Templates Required
None – The parameters to derive this table will be derived from glitch data.

Pre-Requisites
None

Observations
None

Analysis
For details see George's Procedure. From ground data and in flight, data will be sifted to find a set of glitches for each pixel. The response of all other pixels to those glitches will be determined and recorded in the calibration file. The final matrix should be re-derived at the end of the mission when we have as full picture as possible.

5.2.11 SCalPhotFluxConv

Description
This file applies a conversion between the volts out of the detector and astronomical units for the photometer. The non-linearity correction is included in this calibration. The product contains the coefficients of the conversion and the reference voltage measured on blank sky. The units adopted are Janskys and a power law spectrum is assumed. There needs to be information for both bias settings (to be implemented in calibration product).

Templates Required
The standard Point Source AOT will be used.***

Pre-Requisites
The AOT does not need to have been fully commissioned but as a minimum the BSM calibration needs to have been established and the 7-Point Jiggle uplink table updated.

Observations –Source names to be replaced with Jy/Power requirements so that the plan is independent of launch date (which sources are available)

Template	Source Type
Point Source	Uranus
Point Source	Neptune
Point Source	Ceres or equivalent
Point Source	Vesta or equivalent
Point Source	Juno or equivalent
Point Source	Arcturus or equivalent
Point Source	Aldebaran equivalent

Add Mars and Jupiter and load curves.
Need steep and flat spectrum sources to act as a crude check on colour correction.

Flux calibration (Section 5.2.11 approx p.80): Establishment of the K-parameters will have set the flux density scale, so the uncertainty will be easily determined by the noise level. This is detailed in a note by George that will be released in a week or two.

Analysis
The detector outputs will be compared with the modelled signals, and the K-parameters derived as described in the PPD. [In addition we need a selection of bright sources to be pointed at (telescope pointing fixed and BSM stationary) and PCAL flashes implemented. Is this included in the plan?]

5.2.12 SCalPhotTempDriftCorr and SCalSpecTempDriftCorr

Description
This is used to subtract low frequency noise caused by variations of the detector array bath temperature.

Table Parameters
This file provides for each bias, the nominal detector array thermistor signal V_{T0} for all 6 thermistors (for high voltage use the dark pixels instead) and the parameters of the correction formula.

For each of the two bias settings, there should be two sets of tables, one for T1 and the other for T2. Altogether, there shall be four sets of tables (2 bias × 2 Ts).
(i) One table per array, one row per detector with fitting coefficients
(ii) column 1: Detector number
(iii) column 2: Polynomial Constant for Thermistor 1 (aT1)
(iv) column 3: Polynomial linear multiplier for Thermistor 1 (bT1)
(v) column 4: Integral base voltage for Thermistor 1 (v0T1)
(vi) column 5: Polynomial Constant for Thermistor 2 (aT2)
(vii) column 6: Polynomial linear multiplier for Thermistor 2 (bT2)
(viii) column 4: Integral base voltage for Thermistor 2 (v0T2)

AOTs Using This Table
All AOTs including Parallel

Templates Required
None (TBC)

Pre-Requisites
TBW

Observations

These data depend on the flux calibration observations. The observations for this temp drift will be performed when the flux cal ones are. These observations will however first be done early in PV to check that the data coming from them are all that is needed to get the results for the calibration file.

Ideally there should be 2 or 3 campaigns to reduce the error and have some redundancy. There should be a few campaigns with nominal detector settings and a few with strong source settings. Any tests with the PTC on would just be for comparison. The actual data that will be used to generate the temperature drift calibration will be those around the time when the flux calibration observations are generated, therefore is it best to do those observations first for nominal settings and then for bright (rather than interspersing them).

Each campaign will cover a given cooler recycle period (~ 48 hours) and contain two different types of observations:

1. Nominal calibration observations. This shall be a chain of ~20 short observations (~ a few minutes) of the same optical load (e.g. pointing to a given dark sky background position near the ecliptic pole (?) for constant availability). These observations shall provide a sparse sampling of long term variation of the bath temperature, optimize the chance of capturing a large enough temperature range for the calibration of the detector/thermistor correlations. There is no strict requirement for the uniformity of the observations, as long as they are spread over the whole time span of 48 hours between two cooler recycles and not clustered together in a few hours period.

Do these observations with the PTC off, if we use PTC for scan maps we should check that it really does leave us stable otherwise we have to use this module still.

2. A 0.5 hour observation towards the end of the cooler recycling just before the temperature becomes stable. The array temperature will decline by ~30 mK (~10%) during this time. This will complement the above nominal observations carried out at relatively stable bath temperature, in case the temperature range is too small during the time when the nominal observations are carried out. This observation determines the slope of the temperature drift correction.

Template	Source Type
Thermal Stability ?? (PTC off) is the duration a variable?	Dark Sky

Analysis

The module and calibrations shall be tested using other data sets, for example those of calibration observations for noise characterizations.

[Has this been reviewed by Kevin? Yes, Kevin provided this information]

5.2.13 SCalPhotChanTimeConst and SCalSpecChanTimeConst

Description
This file contains the detector time constants.

Table Parameters
For photometer
- 3 x *N* table for each array
  - Column 1 : τ_{1-i}
    - Units: ms
    - Format: rational number specified to four significant figures
  - Column 2 : τ_{2-i}
    - Units: ms
    - Format: rational number specified to four significant figures
  - Column 3 : a_i
    - Units: dimensionless
    - Range: 0 - 1
    - Format: rational number specified to four significant figures

AOTs Using This Table
Phot Large map and Parallel

Templates Required
The Photometer Scan map AOT will be used in Expert Mode as we require different sky scan speed. The Spectrometer Sparse Map AOT will also be used in Expert Mode at different mechanism scan speeds.

Pre-Requisites
None

Observations

Template	Source Type	Resolution	Scan Speed
Photometer Scan Map	Point Source or Field with a number of point sources	N/A	60”/s
Photometer Scan Map	Point Source or Field with a number of point sources	N/A	45”/s
Photometer Scan Map	Point Source or Field with a number of point sources	N/A	30”/s
Spectrometer Sparse Map	Continuum Point Source	High	0.125 mm/s
Spectrometer Sparse Map	Continuum Point Source	High	0.7 mm/s
Spectrometer Sparse Map	Continuum Point Source	High	0.5 mm/s

Spectrometer Sparse Map	Continuum Point Source	High	0.25 mm/s

Analysis

See note by Andreas and Markos.

[The nominal time constants (τ_1) are already known. Determining or putting limits on the slow component time constants (τ_2) requires fast scanning (maybe faster than 60"/s) across a point source for each detector – need to scan along detector lines to visit each detector (so maybe use expert test rather than the AOT).]

This is tied up with the beam profiles.

The spectrometer is expected to not be sensitive to a slow component in the case of the FTS. Measurements will be performed to check and confirm this.

5.2.14 SCalPhotOptCross and SCalSpecOptCross

Description

This file gives the optical crosstalk matrix. It contains an *N*x*N* matrix for each array, where *N* is the number of detectors in the array. The diagonal elements should be unity, and for zero crosstalk correction the non-diagonal elements would be zero.

Table Parameters

TBD

AOTs Using This Table

All including Parallel

Templates Required

Expert Point Source AOT – To determine the optical cross talk for each pixel we need to put a very bright (well centred, point) source on that pixel and look at the reaction of all other pixels. This is slightly complicated by the need for a modulated signal, hence we are actually putting the signal on two pixels. To measure this in PV Phase we will setup an expert AOT which just does simple chopping between two pixels without jiggling. Because of chopping the difference in the background limits the level to which the cross talk can be detected.
Or without chopping modulate the signal by scanning and make a measurement by scanning a strong point source along the array lines. Do a Jiggle map to define strut diffraction features.
Optical cross talk might depend on BSM position.

Pre-Requisites

TBD – To some extent chopping will need to have been setup, for these purposes we will need to be able to place the BSM on particular pixels, therefore the FOV scanning will need to have been done. As we are only looking for relative signals, it may not be necessary for the BSM to be finely tuned.

Observations

TBD Use the flux calibration measurements

Analysis

We need to look for demodulated signals on each pixel, the amplitude and 'sign' of the signal on any other pixel will then show the crosstalk. This is tricky because there will be sources in the background.

5.2.15 SCalPhotChanNoise

Description
This product contains the noise power spectrum for each detector channel, to be used in the map making stage of the pipeline. There is one table dataset for each array. There will be several editions of this product for different detector bias frequency and amplitude settings.

Table Parameters
One table per array containing columns: frequency in Hz, and then one column per detector containing the noise spectrum for each.

AOTs Using This Table
Scan map and Parallel. TBC

Templates Required
None TBC

Pre-Requisites
TBW

Observations
Noise measurements. TBW. Phot Thermal Stability give 1/f knee and average noise****

Analysis
TBW

[Need to consult with Pierre and Darren.]

5.2.16 SCalPhotGlitchThreshTwo and SCalSpecGlitchThreshTwo

Description
Note that even though this is not a calibration file (the deglitching parameters are inputs to the software) this is left for completeness as we will make sure that these parameters are updated according to in flight data.

Table Parameters
None, software parameters to be listed here.

AOTs Using This Table
All but not Parallel or scan TBC

Templates Required
None

Pre-Requisites
None

Observations
No specific observations needed

Analysis
TBW. Glitches from all SPIRE data will be used.

5.2.17 SCalPhotBeamProf

Description
This file will contain the beam profiles of the photometer pixels. The file definition is not yet finalised but it is likely that we will adopt one beam profile per photometer array which is applicable to all pixels on the array. This should be stored as a 2-D beam profiles in the spacecraft Y and Z directions.

(i) Pre-launch 2-D beam maps for about 20% of photometer pixels. Beams will be measured in flight. Pre-flight we will use modelling for a broadband source with a ν^2 source spectrum In flight, beams will be down to at least 20 dB
(ii) Sampling grid 2”
(iii) Side: 4 x FWHM = 4 x (18, 25, 36)” = (72,100,144)”
(iv) N x N grid size = 362, 502, 722

Table Parameters
TBD

AOTs Using This Table
This file is not currently part of SPG as the mapping algorithms adopted do not require it. However it is required for astronomers who are analysing sources with complex structures and who may wish to use their own mapping algorithms. [It is also required for the 7-point flux density and position fitting, and for conversion of flux density to surface brightness. Any significant deviations from the expected values will influence choice of parameters for 7-point and 64-point jiggle.]

Templates Required
Detailed beam profiles will be obtained by doing 64 point jiggle maps with isolated point sources. Therefore the standard small map AOT is all that is required (Static Beam Profile). This hexagonal pattern can be difficult to analyse – consider square pattern.

[We should also measure beam profiles using bright sources in scan-map mode.]

Pre-Requisites
The positions of the pixels are known and the SPIRE apertures have been commissioned.
The 64 point jiggle map AOT is commissioned.

Observations

For these observations we require the telescope to place the point source on the pixel specified as the BSM does not have the range to offset to each pixel.

Template	Source Type	Source Position
Small Map	Point Source	PSW E8
Point Source	Point Source	PSW E6

Point Source	Point Source	PSW E10
Point Source	Point Source	PSW G8
Point Source	Point Source	PSW C8

[We need to check the beam profiles of a sample of pixels across the arrays to check for uniformity.]

Analysis

The beam profile is obtained directly from the maps.

5.2.18 SCalPhotSpecIndex

Description
This file will give correction factors to colour correct the in-band fluxes of the photometer. This file is not yet defined in detail. It is not a file used as part of SPG but is expected to be used by an astronomer processing data interactively.

Table Parameters
TBD

AOTs Using This Table
All Phot AOTs including Parallel

Templates Required
This file can be obtained by standard point source observations of sources with a known (modelled) spectral shape.

Pre-Requisites
There are no pre-requisites. The file is not critical for uplink and it is expected that an adequate version will be generated on the ground. The in-flight observations are only intended to confirm this is the case.

Observations
The sources are TBD depending on visibility but are likely to consist of the primary calibrator, Neptune, possibly Uranus, 2-3 asteroids, 2-3 stars.

[I don't think any specific PV observations are needed for this – checks can be done later using routine-phase calibration observations. These are small corrections (a couple of %) and fairly well defined by the RSRFs, so checking their accuracy means looking for effects well below 1% – we won't be working at that level in PV.]

Template	Source Type- specify index instead so plan is independent of source availability
Point Source	Uranus
Point Source	Neptune
Point Source	Ceres or equivalent
Point Source	Vesta or equivalent
Point Source	Juno or equivalent
Point Source	Arcturus or equivalent
Point Source	Aldebaran or equivalent

Analysis
Fluxes from these sources can be predicted by convolving the model fluxes with the spectral response profiles obtained on the ground. Therefore this file can be derived without observations. Observations of sources with known spectral shape will confirm this derivation.

5.2.19 SCalPhotPcalPar and SCalSpecPcalPar

Description
These should be no longer needed – the information is available in the trend analysis/uplink. However this is left here as we want to make sure that PCAL is setup and used in the best way.

Table Parameters
TBW

AOTs Using This Table
All including Parallel

Templates Required
TBW

Pre-Requisites
TBW

Observations
TBW

Analysis
TBW

5.2.20 SCalSpecNonLinCorr

Description
This table gives the coefficients required to correct for detector non-linearity. The file is not yet defined in detail.

Table Parameters
TBD

AOTs Using This Table
All Spectrometer AOTs

Templates Required
Spectrometer Sparse Map AOT with standard astronomical sources will be used for the spectrometer observations.

Pre-Requisites
The AOT's do not need to have been fully commissioned but a minimum for the photometer will be that the BSM calibration needs to have been established and the 7-Point Jiggle*** uplink table updated.

Observations
See Matt's phot pipeline doc section 7.
[This needs to be reviewed. Bruce has pointed out that the scheme used for the photometer is not appropriate for the FTS. In any case, a similar characterisation of the FTS detectors K-parameters could be done using the same kind of approach as for the photometer.]

Template	Source Type- change to flux/spectrum required	Resolution
Spectrometer Sparse Map	Uranus	High
Spectrometer Sparse Map	Neptune	High
Spectrometer Sparse Map	Ceres or equivalent	High
Spectrometer Sparse Map	Vesta or equivalent	High
Spectrometer Sparse Map	Juno or equivalent	High
Spectrometer Sparse Map	Arcturus or equivalent	High
Spectrometer Sparse Map	Aldebaran or equivalent	High

Analysis
The detector outputs will be compared with the modelled fluxes.

5.2.21 SCalSpecSmecZpd

Description
This file gives the lookup table for the zero path difference position both in terms of the optical encoder position and the LVDT position.

Table Parameters

names	Unique name for each optical pixel. For example pixel C5 on the PLW array would be 'PLWC5'.
optEnc	The optical encoder value at zero path difference.
optEncError	The error on the optical encoder value at zero path difference.
lvdt	The LVDT signal at zero path difference.
lvdtError	The error on the LVDT signal at zero path difference

AOTs Using This Table
All spectrometer AOTs

Templates Required
The expert AOT for sparse map is required

Pre-Requisites
TBD

Observations
In principle a normal scanning AOT can be used to determine this. By varying the scan speed we are better able to decouple effects of the detector time constants.

Template	Source Type	Scan Speed
Sparse Map	Continuum Point Source	Scan at 0.125 mm/s
Sparse Map	Continuum Point Source	Scan at 0.7 mm/s
Sparse Map	Continuum Point Source	Scan at 0.5 mm/s
Sparse Map	Continuum Point Source	Scan at 0.25 mm/s

It is expected that ZPD is independent of scan speed, these observations are done as a sanity check to confirm this. The observations are actually required also for SpecChanTimeConst and so no new observations are required for this calibration data.

Analysis
The ZPD is determined as the midway position between the forward and reverse scans.
Note this information can be derived from the actual observation that is being reduced.

5.2.22 SCalSpecSmecStepFactor

Description

This product provides the conversion factor between mechanical path difference (MPD) and optical path difference (OPD) as a function of channel, using the following equation, This is also effect is also known as obliquity.

$OPD=(MPD-ZPD)f_{pixel}$

This is needed because the conversion changes away from the central axis of the array. The numbers for this table are empirically derived from ILT data.

Table Parameters

names	Unique name for each optical pixel. For example pixel C5 on the PLW array would be 'PLWC5'.
factor	The factor used to convert between mechanical path difference and optical path difference for the SMEC. Nominally equaly to 4 on axis at the central pixel, but less than 4 away from the axis.

AOTs Using This Table
All spectrometer AOTs

Templates Required
TBW

Pre-Requisites
TBW

Observations
TBW see Ed’s note for sources *****

Analysis
TBW

5.2.23 SCalSpecModEff

Description

This table provides a correction for the modulation efficiency as the SMEC moves away from ZPD. Modulation efficiency is understood for this purpose as a purely multiplicative change to the interferogram modulation with OPD. Any change to the interferogram baseline due to the changing overlap between the telescope and SCAL beams is treated by the Baseline Correction Table calibration product. The data to fill this product are determined by fitting an apodised interferogram to measurements of sources with prominent line features (preferable a single line emitter).

Table Parameters

optEnc	Optical Encoder value.
optEncError	Error on Optical Encoder value.
effA1	The modulation efficiency at the given OE value for channel A1.
effA2	The modulation efficiency at the given OE value for channel A2.
eff##	The modulation efficiency at the given OE value for channel ##.spec
optEncError	Error on Optical Encoder value.
effErrorA1	The Error in modulation efficiency for channel A1.
effErrorA2	The Error in modulation efficiency for channel A2.
effError##	The Error in modulation efficiency for channel ##.

AOTs Using This Table

All spectrometer AOTs

Templates Required

The normal Spec Sparse Map AOT can be used

Pre-Requisites

Spec Sparse Map needs to have been commissioned

Observations

Template	Source Type	Scan Speed
Sparse Map	Source with as few as possible bright lines in SSW	Nominal Rate
Sparse Map	Source with as few as possible bright lines in SLW	Nominal Rate

State the resolutions to be done.

J-P: It is not expected to be of importance for LR and likely for MR too. Only valid for HR mode.

We will give priority to HR but will also make checks on MR and LR to confirm the expectations.

Analysis
A strong single line will give the modulation efficiency directly however we won’t find just a single line…. This will be tricky

5.2.24 SCalSpecScalBlankSky

Description
TBD. TBC Contains the interferogram of a blank sky measurement, i.e. the spectrum of SCAL, the Telescope and the beam splitter. One calibration interferogram per detector, per spectral resolution, per bias voltage (for strong sources). There may also be one interferogram per scan direction as it may be advantageous to ensure that systematics are not introduced due to SMEC scan direction.

Table Parameters
TBW

AOTs Using This Table
All Spectrometer AOTs

Templates Required
Will use normal AOT (single pointing, sparse) to get the 'final' information but will use Expert HSpot for the initial versions as this can do all resolutions in one go (via starting scans at the MR start position and ending them at the HR end stop).

(from before the telescope and cryostat are stablised).

Pre-Requisites
TBC that the spectrometer AOT is set up (which might require having this cal table populated, but in that case it would be done for less S/N than the 'final' version (we'll need some information to reduce the PV observations). The 'final' version will need to be done when the telescope is down to temperature and with the final SCAL level decided.

Observations
Dark patch should be in a place of high visibility (i.e. near ecliptic poles so is always visible). Initial observations to be relavtively short to give initial population of this table while the telescope and the cryostat are stabilising and therefore before we have finalised on the temperature to set SCAL too. Once SCAL settings are determined then we will spend a long time to measure the SCAL port and telescope interferogram on dark sky for each resolution. This dataset will be added to via future observations that will also be used to track whether anything has changed.

With the empirical approach the telescope and SCAL contributions are removed from the source spectrum using a standard blank sky result. This observation should be of a couple of dark patches of sky (a couple – 2 to check each other for any source contributions). These observations are needed at both settings. The data are needed with high S/N, contributing maybe 10% but definitely not more than 20% noise to the astronomer's observation, hence these are long observations.

Also want to make observations on the lid at different temperature and while telescope cools **very important that we get access for this. Also observe when telescope constant but while SCAL cooling. Also make observations with PCAL on. Some of this is covered by ComP.

Analysis

The pipeline will be run up to and including the create interferogram module. The output will be used to populate this module.**** Note also need to remove 2nd level glitches and average the interferograms (forward and back separately) . [Shouldn't need to baseline removal, phase corr, optical crosstalk etc as these are after this BlankSky data is used in the pipeline]

5.2.25 SCalSpecBandEdge

Description
This product provides the band limit edges for the SLW and SSW bands.

Table Parameters

pixelName	Unique name for each optical pixel. For example pixel C3 on the SLW array would be 'SLWC3'.
low	Wavenumber of the low frequency band edge for the specified pixel. This is defined as the 50% point of the in band transmission in the single mode region.
high	Wavenumber of the high frequency band edge for the specified pixel. This is defined as the 50% point of the in band transmission in the single mode region.

AOTs Using This Table
All Spectrometer AOTs

Templates Required
The template for the telescope backgrounds with different SCAL levels, including SCAL off, will be used.
The AOTs on standard sources will provide supporting data for one pixel

Pre-Requisites
As the results are not strongly dependent on scan speed; the nominal value from the ground can be adopted.

Observations

Template	Source Type- change to flux levels not actual sources.	Pixels	Scan Speed
Telescope Background With Different SCAL Levels	Dark Sky	All	Nominal Rate
Telescope Background With Different SCAL Levels	Dark Sky	All	Nominal Rate
Sparse Map	Uranus	SSWD4	Nominal Rate
Sparse Map	Neptune	SSWD4	Nominal Rate
Sparse Map	Ceres or Equivalent	SSWD4	Nominal Rate
Sparse Map	Vesta or Equivalent	SSWD4	Nominal Rate

Analysis

The temperatures of SCAL and the telescope will be inputs to model spectra used to derive the spectrometer RSRF and confirm transmission in flight. Once the RSRF is obtained the band edges can be found.

5.2.26 SCalSpecNlp

Description

This product contains the known non-linear optical phase as a function of wavenumber. It may be useful to have a high resolution and low resolution version of the product. The wavenumber grid should range from 0 to 200 cm-1. The wavenumber grid must be regularly spaced. The phase-error will be different depending on input and output port of the FTS, making it necessary to store four different phases.

Table Parameters this information comes out of the pipeline

resolutionSsw	The resolution of the calibration file wavenumber grid for SSW.
resolutionSlw	The resolution of the calibration file wavenumber grid for SLW.
wavenumber	Wavenumber grid for this sub-array.
telePhase	The amplitude of the phase correction for the telescope port.
teleError	The error in amplitude of the phase correction for the telescope port.
scalPhase	The amplitude of the phase correction for the SCAL port.
scalError	The error in amplitude of the phase correction for the SCAL port.

AOTs Using This Table

All Spectrometer AOTs

Templates Required

The template for the telescope backgrounds with different SCAL levels will be used.
The AOTs on standard sources will provide supporting data for one pixel.

Pre-Requisites

As the results are not strongly dependent on scan speed; the nominal value from the ground can be adopted

Observations

Template	Source Type – remove names, put source requirements	Pixels	Scan Speed
Telescope Background With Different SCAL Levels	Dark Sky	All	Nominal Rate
Telescope Background With Different SCAL Levels	Dark Sky	All	Nominal Rate
Sparse Map	Uranus	SSWD4	Nominal Rate
Sparse Map	Neptune	SSWD4	Nominal Rate
Sparse Map	Ceres or Equivalent	SSWD4	Nominal Rate
Sparse Map	Vesta or Equivalent	SSWD4	Nominal Rate

Analysis

In principle the non-linear phase can be obtained from any continuum source observation, as it is derived during processing. These observations are good to use because all pixels are illuminated.

5.2.27 SCalSpecRsrf

Description
This file will contain the relative spectral response function of the spectrometer. The format in which the file holds the data*** is not yet defined in detail. [There is a baseline as described in a note by Bruce.]

Table Parameters
TBD

AOTs Using This Table
All Spectrometer AOTs

Templates Required
To set up the RSRF the observation of the telescope with different SCAL levels, including SCAL off, during cooldown and again when cold will be used. This provides an extended source allowing derivation for all pixels. To check this for different scan rates, the sparse map AOT can be used, in expert mode.

Pre-Requisites
TBD5.2.27

Observations

Template	Source Type	Pixels	Scan Speed
Telescope Background With Different SCAL Levels	Dark Sky (Telescope cooling)	All	Nominal Rate
Telescope Background With Different SCAL Levels	Dark Sky (Telescope cold)	All	Nominal Rate
Sparse Map	Continuum Point Source	SSWD4	Scan at 0.125 mm/s
Sparse Map	Continuum Point Source	SSWD4	Scan at 0.7 mm/s
Sparse Map	Continuum Point Source	SSWD4	Scan at 0.5 mm/s
Sparse Map	Continuum Point Source	SSWD4	Scan at 0.25 mm/s

This will be done (with not too high S/N - i.e. not so long time) at different scan speeds to show(/sanity check) that the RSRF is independent of scan speed. If it is independent then great, we then know that and don't have to worry if we ever need to make observations for any reason at different scan speeds - we will know that the RSRF is still valid.

The RSRF made at nominal scan speed and at ~ the final telescope temperature will be made with high S/N.

We will also make observations on a key pixel (the central ones on each array) to see how the RSRF varies across the pixel. These will be done in medium resolution to see how the overall shape changes.

High resolution scans will be done on key pixels on sources such as asteroids to avoid having lines in the RSRF.

More details to be described.

Analysis
The RSRF is derived directly.

5.2.28 SCalSpecIls

Description
This file contains the instrumental line profile. The file does not yet have a detailed definition.

Table Parameters
TBD

AOTs Using This Table
TBD

Templates Required
To derive this, a high resolution scan of a line source is required, the standard sparse map AOT can be used.

Pre-Requisites
The sparse map AOT can be used without having been fully commissioned e.g. the adopted scan speed is not important although the scan range is.

Observations

Template	Source Type	Pixels	Scan Speed
Sparse Map AOT	Unresolved Line Source (preferably extended although a point source is also OK). Use a variety of source sizes.	SSWD4 + SLWC3	Nominal Rate

Wavelength calibration and ILS will change with source distribution.

[Does the line profile need to be checked on more pixels?]

Analysis
Providing the line is unresolved the line profile will be obtained directly after transform into the spectral domain.

5.2.29 ScalSpecBeamProf

Description

This file will contain the beam profiles of the spectrometer pixels. The file definition is not yet finalised but it is likely that we will adopt one beam profile per photometer array which is applicable to all pixels on the array. This is likely to be stored as a 2-D beam profiles in the spacecraft Y and Z directions.

Table Parameters

TBD

AOTs Using This Table

TBD – The re-gridding of spectral data during level 2 processing is not yet finalised therefore it is not yet know if the beam profiles will be used. It may be best to use a square grid for the observations.

Templates Required

Spec Fixed SMEC Beam Profile
Spec Scanned Beam Profile

Pre-Requisites

The BSM calibration must have been established.

Observations

Template	Source Type	Resolution	Pixels	Scan Speed
Spec Fixed SMEC Beam Profile	Point Source	N/A	SSWD4	Nominal Rate
Spec Scanned Beam Profile	Point Source	Low	SSWD4	Nominal Rate
Spec Fixed SMEC Beam Profile	Point Source	N/A	SLWC3	Nominal Rate
Spec Scanned Beam Profile	Point Source	Low	SLWC3	Nominal Rate
Fully Sampled Map	Point Source	High	SSWD4	Nominal Rate

Analysis

The Spec Fixed SMEC Beam Profile measurement will produce a broadband beam map. The Spec Scanned Beam Profile measurements will show the dependence on wavelength. The Full Map observation will confirm the profiles produced.

6. TEST FLOW

This is slightly out of date.

1. Requirements for ordering the tests (interdependence/pre-requisites)
   1.1. Master flow-chart of tests/analysis/test inputs/outputs

Figures 6-1 and 6-2 show the dependencies of the different tests to be carried out on the photometer and the spectrometer respectively. Figures 6-3 and 6-4 show these converted into Gantt charts for the photometer and the spectrometer respectively (again only showing each test once). For each test 1 (observing) day is allocated to the test (note this isn't the duration of the observation), 2 days for downlink and processing the data from the test, 5 days for data analysis and for the results to be fed back into CUS scripts and calibration files, 2 days to check the CUS scripts and calibration files and to update planned observations and observation day schedules, finally 2 days for providing this to the HSC and them being uplinked to the spacecraft. i.e. this is the turn around time between observations that are dependent on each other. The Gantt chart has been made to identify independent chains and to optimism PV. Note the first day is 1st Jan 2009 purely to enable a counting of days since the first observation.

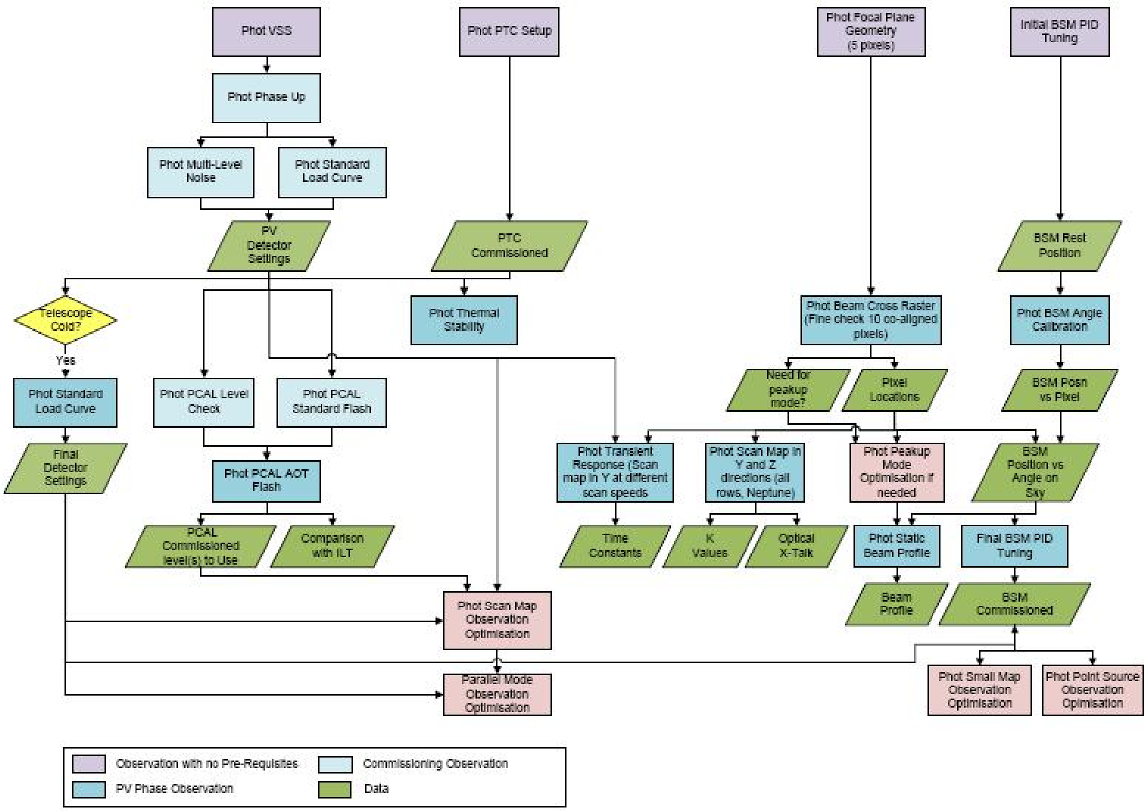


Figure 6-1: Flowchart of the order in which tests should be carried out for the photometer

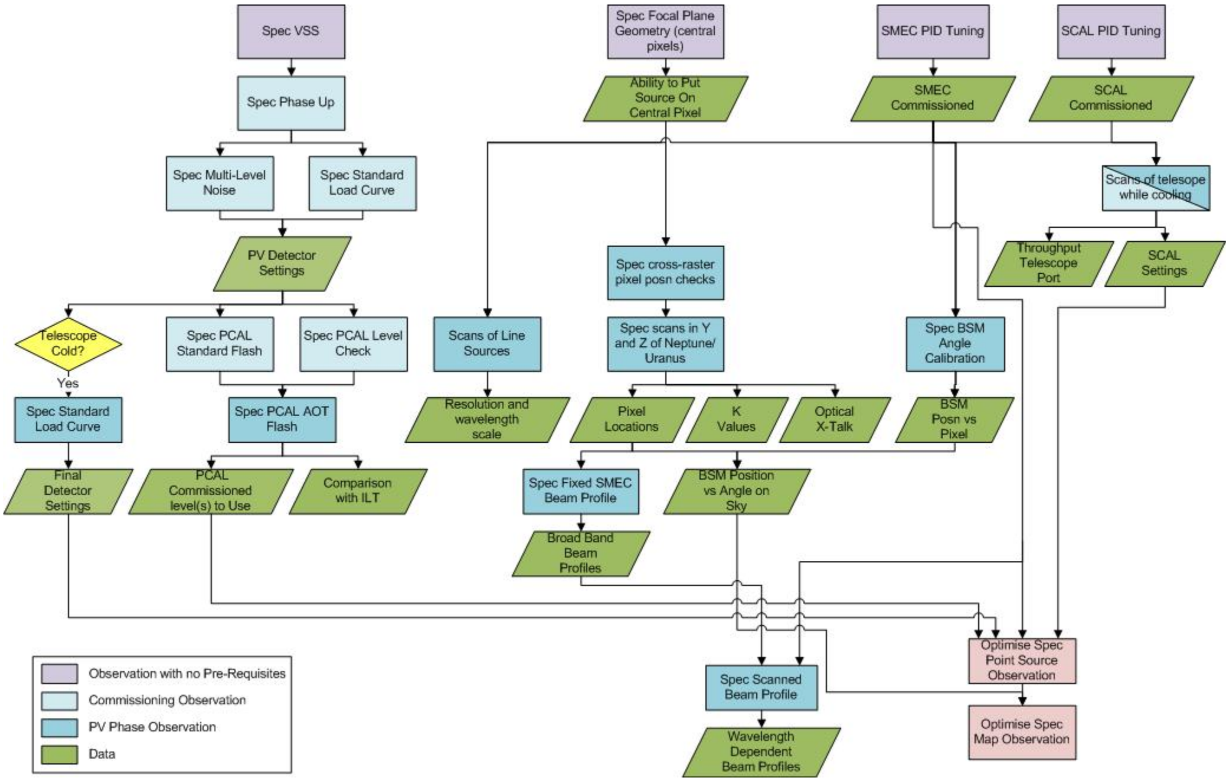


Figure 6-2: Flowchart of the order in which tests should be carried out for the spectrometer

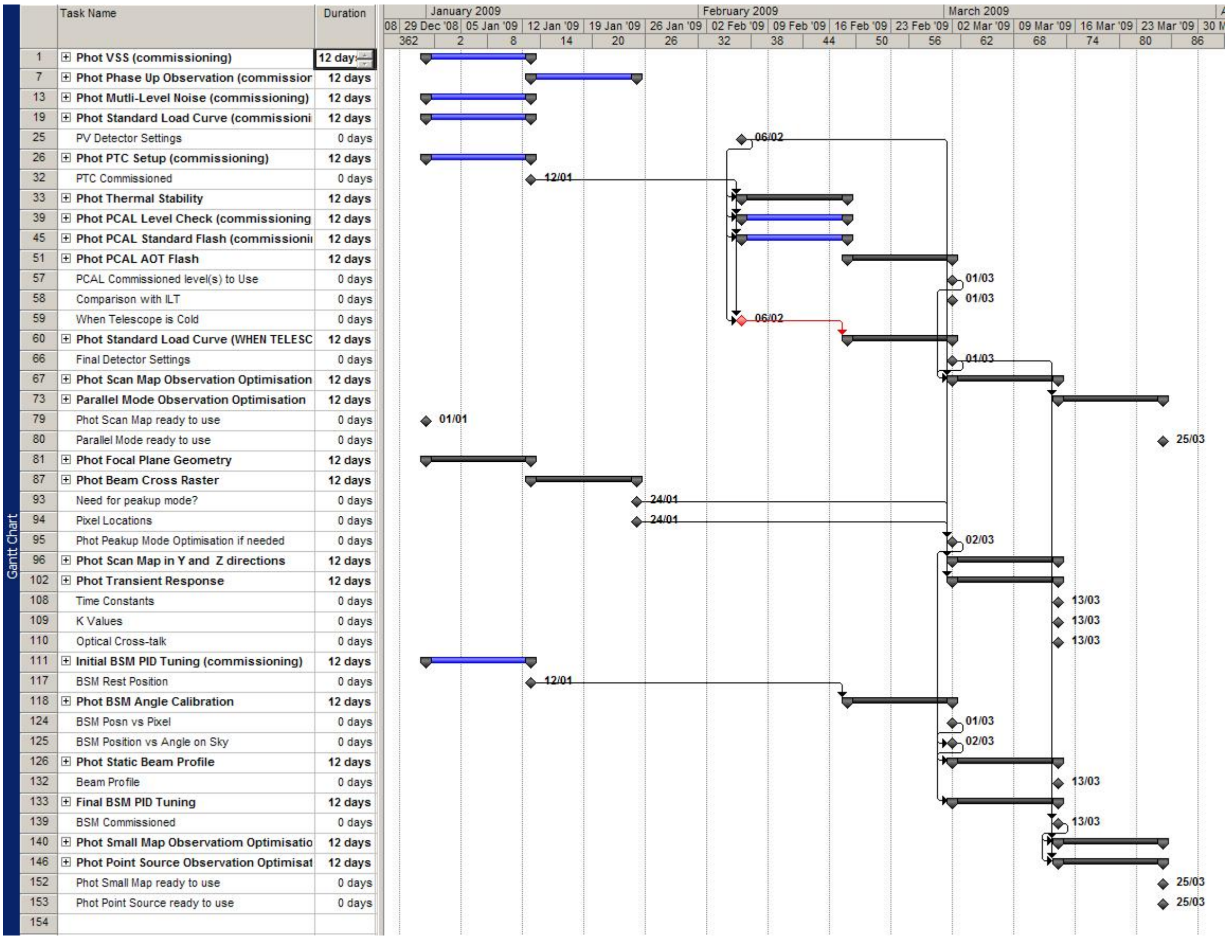
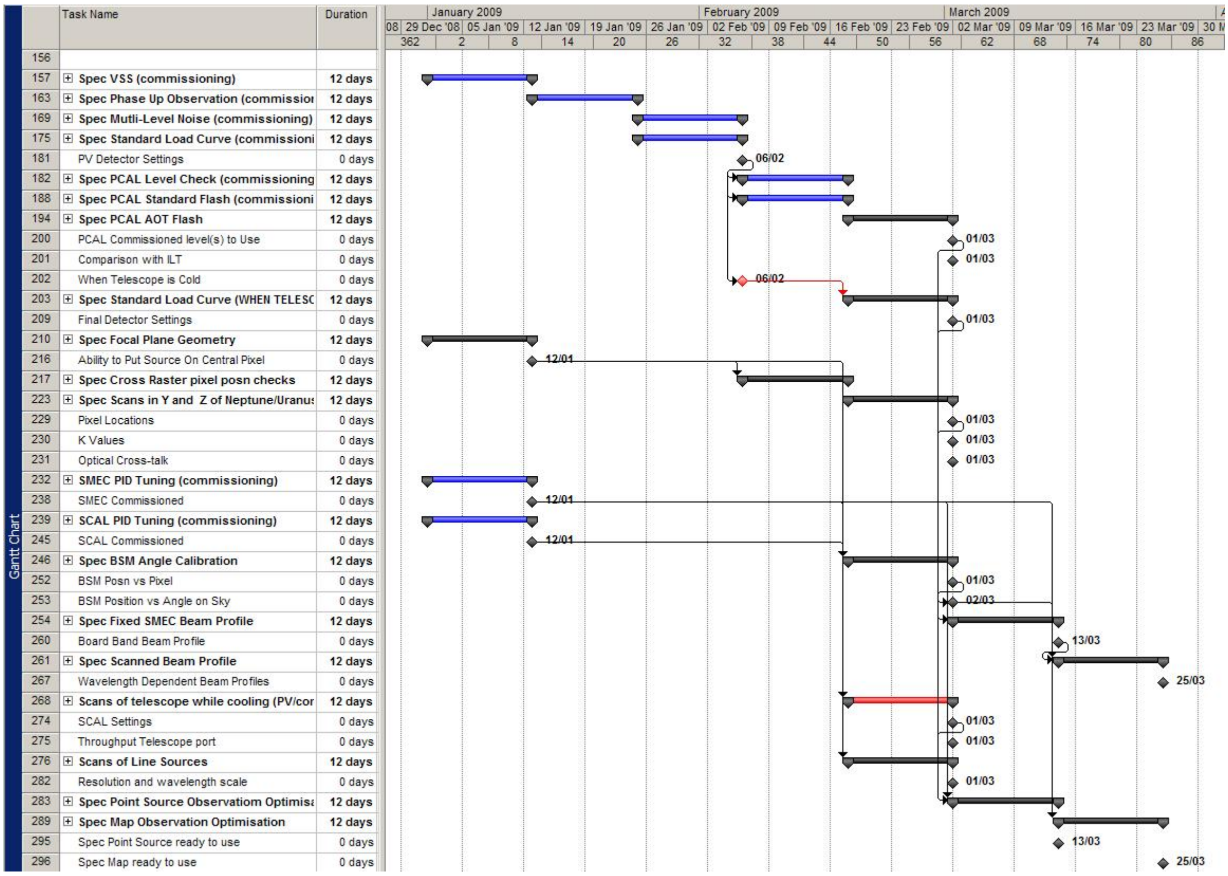


Figure 6-3 Schedule showing dependencies between tests for the Photometer



	Task Name	Duration
156		
157	Spec VSS (commissioning)	12 days
163	Spec Phase Up Observation (commissioi	12 days
169	Spec Mutli-Level Noise (commissioning)	12 days
175	Spec Standard Load Curve (commissioni	12 days
181	PV Detector Settings	0 days
182	Spec PCAL Level Check (commissioning	12 days
188	Spec PCAL Standard Flash (commissioni	12 days
194	Spec PCAL AOT Flash	12 days
200	PCAL Commissioned level(s) to Use	0 days
201	Comparison with ILT	0 days
202	When Telescope is Cold	0 days
203	Spec Standard Load Curve (WHEN TELESC	12 days
209	Final Detector Settings	0 days
210	Spec Focal Plane Geometry	12 days
216	Ability to Put Source On Central Pixel	0 days
217	Spec Cross Raster pixel posn checks	12 days
223	Spec Scans in Y and Z of Neptune/Uranus	12 days
229	Pixel Locations	0 days
230	K Values	0 days
231	Optical Cross-talk	0 days
232	SMEC PID Tuning (commissioning)	12 days
238	SMEC Commissioned	0 days
239	SCAL PID Tuning (commissioning)	12 days
245	SCAL Commissioned	0 days
246	Spec BSM Angle Calibration	12 days
252	BSM Posn vs Pixel	0 days
253	BSM Position vs Angle on Sky	0 days
254	Spec Fixed SMEC Beam Profile	12 days
260	Board Band Beam Profile	0 days
261	Spec Scanned Beam Profile	12 days
267	Wavelength Dependent Beam Profiles	0 days
268	Scans of telescope while cooling (PV/cor	12 days
274	SCAL Settings	0 days
275	Throughput Telescope port	0 days
276	Scans of Line Sources	12 days
282	Resolution and wavelength scale	0 days
283	Spec Point Source Observatiom Optimisa	12 days
289	Spec Map Observation Optimisation	12 days
295	Spec Point Source ready to use	0 days
296	Spec Map ready to use	0 days

Figure 6-4 Schedule showing dependencies between tests for the Spectrometer

7. DETAILED IMPLEMETATION (NEED TO ADD IN THE NEW CALIB FILES, UPDATED NAMES OF EXISTING ONES)

Jigg-POF2, need to check for overlapping observations (i.e one observation suiting several purposes). This is not a complete list of tests, it is an out of date subset. The full list of test will be contained in the PV spreadsheet.

Inst	Mode	Tests	Source	Table Name
Phot	Jigg	7-point jiggle, nominal offset, chopping 2.0 Hz	Point	Chopping Configuration
Phot	Jigg	7-point jiggle, nominal offset, chopping 1.5 Hz	Point	Chopping Configuration
Phot	Jigg	7-point jiggle, nominal offset, chopping 1.0 Hz	Point	Chopping Configuration
Phot	Jigg	64 point jiggle, nominal offset, chopping 2.0 Hz	Point	Chopping Configuration
Phot	Jigg	64 point jiggle, nominal offset, chopping 1.5 Hz	Point	Chopping Configuration
Phot	Jigg	64 point jiggle, nominal offset, chopping 1.0 Hz	Point	Chopping Configuration
Phot	Special	PCAL Level Check 0.25 Hz	Dark Sky	Flash
Phot	Special	PCAL Level Check 0.5 Hz	Dark Sky	Flash
Spec	Special	PCAL Level Check 0.25 Hz	Dark Sky	Flash
Spec	Special	PCAL Level Check 0.5 Hz	Dark Sky	Flash
Phot	Jigg	7-point jiggle, nominal settings, on Neptune	Neptune	Photometer Sensitivities, SCalPhotSpecIndex, SCalPhotFluxConv
Phot	Jigg	7-point jiggle on Uranus	Uranus	Photometer Sensitivities, SCalPhotSpecIndex, SCalPhotFluxConv
Phot	Jigg	7-point jiggle on Ceres	Ceres or equivalent	Photometer Sensitivities, SCalPhotSpecIndex, SCalPhotFluxConv
Phot	Jigg	7-point jiggle on Vesta [One strong asteroid will be enough here: Ceres, Juno, or Vesta. Likewise, one star will be enough to begin with.]	Vesta or equivalent	Photometer Sensitivities, SCalPhotSpecIndex, SCalPhotFluxConv
Phot	Jigg	7-point jiggle on Juno	Juno or equivalent	Photometer Sensitivities, SCalPhotSpecIndex, SCalPhotFluxConv
Phot	Jigg	7-point jiggle on Arcturus	Arcturus or equivalent	Photometer Sensitivities, SCalPhotSpecIndex, SCalPhotFluxConv
Phot	Jigg	7-point jiggle on Aldebaran	Aldebaran or equivalent	Photometer Sensitivities, SCalPhotSpecIndex, SCalPhotFluxConv
Phot	Scan	Scan map of known extended source at nominal rate	Known Extended	Photometer Sensitivities, Spire Configuration
Phot	Scan	Scan map of dark patch of sky	Dark Sky	Photometer Sensitivities

Spec	Point	High Resolution scan of a line source with known line fluxes in both bands	Line	Spectrometer Sensitivities
Spec	Point	Medium Resolution scan of a line source with known line fluxes in both bands	Line	Spectrometer Sensitivities
Spec	Point	High Resolution Spectrum of Uranus	Uranus	Spectrometer Sensitivities, SCalSpecNonLinCorr, SCalSpecBandEdge
Spec	Point	High Resolution Spectrum of Neptune	Neptune	Spectrometer Sensitivities, SCalSpecNonLinCorr, SCalSpecBandEdge
Spec	Point	High Resolution Spectrum of Ceres	Ceres or equivalent	Spectrometer Sensitivities, SCalSpecNonLinCorr, SCalSpecBandEdge
Spec	Point	High Resolution Spectrum of Vesta	Vesta or equivalent	Spectrometer Sensitivities, SCalSpecNonLinCorr, SCalSpecBandEdge
Spec	Point	High Resolution Spectrum of Juno	Juno or equivalent	Spectrometer Sensitivities, SCalSpecNonLinCorr, SCalSpecBandEdge
Spec	Point	High Resolution Spectrum of Arcturus	Arcturus or equivalent	Spectrometer Sensitivities, SCalSpecNonLinCorr, SCalSpecBandEdge
Spec	Point	High Resolution Spectrum of Aldebaran	Aldebaran or equivalent	Spectrometer Sensitivities, SCalSpecNonLinCorr, SCalSpecBandEdge
Spec	Point	Scan of Point Source at 1 mm/s High resolution	Point	Spectrometer Configuration, SCalSpecSmecZpd, SCalSpecChanTimeConst
Spec	Point	Scan of Point Source at 0.7 mm/s High resolution	Point	Spectrometer Configuration, SCalSpecSmecZpd, SCalSpecChanTimeConst
Spec	Point	Scan of Point Source at 0.5 mm/s High resolution	Point	Spectrometer Configuration, SCalSpecSmecZpd, SCalSpecChanTimeConst
Spec	Point	Scan of Point Source at 0.25 mm/s High resolution	Point	Spectrometer Configuration, SCalSpecSmecZpd, SCalSpecChanTimeConst
Spec	Point	Scan of Point Source at 1 mm/s Medium resolution	Point	Spectrometer Configuration, SCalSpecSmecZpd, SCalSpecChanTimeConst
Spec	Point	Scan of Point Source at 0.7 mm/s Medium resolution	Point	Spectrometer Configuration, SCalSpecSmecZpd, SCalSpecChanTimeConst

Spec	Point	Scan of Point Source at 0.5 mm/s Medium resolution	Point	Spectrometer Configuration, SCalSpecSmecZpd, SCalSpecChanTimeConst
Spec	Point	Scan of Point Source at 0.25 mm/s Medium resolution	Point	Spectrometer Configuration, SCalSpecSmecZpd, SCalSpecChanTimeConst
Spec	Point	Scan of Point Source at 1 mm/s Low resolution	Point	Spectrometer Configuration, SCalSpecSmecZpd, SCalSpecChanTimeConst
Spec	Point	Scan of Point Source at 0.7 mm/s Low resolution	Point	Spectrometer Configuration, SCalSpecSmecZpd, SCalSpecChanTimeConst
Spec	Point	Scan of Point Source at 0.5 mm/s Low resolution	Point	Spectrometer Configuration, SCalSpecSmecZpd, SCalSpecChanTimeConst
Spec	Point	Scan of Point Source at 0.25 mm/s Low resolution	Point	Spectrometer Configuration, SCalSpecSmecZpd, SCalSpecChanTimeConst
Phot	Scan	Telescope scan along chop axis with source at boresight, BSM at zero current position	Point	Operations
Phot	Scan	Telescope scan along jiggle axis with source at boresight, BSM at zero current position	Point	Operations
Phot	Scan	Telescope scan along jiggle axis with source at boresight, BSM offsetting source by approx +16" in chop	Point	Operations
Phot	Scan	Telescope scan along jiggle axis with source at boresight, BSM offsetting source by approx -16" in chop	Point	Operations
Spec	Scan	Telescope scan along chop axis with source at boresight, BSM at zero current position	Point	Operations
Spec	Scan	Telescope scan along chop axis with source at boresight, BSM offsetting source by approx +18" in jiggle	Point	Operations
Spec	Scan	Telescope scan along chop axis with source at boresight, BSM offseting source by approx -18" in jiggle	Point	Operations
Spec	Scan	Telescope scan along jiggle axis with source at boresight, BSM at zero current position	Point	Operations
Phot	Scan	Scan map at TBD angle 1 with appropriate step size (D2), HLoss, LLoss	Known Extended	Operations
Phot	Scan	Scan map at TBD angle 2 with appropriate step size (D2), HLoss, LLoss	Known Extended	Operations
Phot	Scan	Scan map at TBD angle 3 with appropriate step size (D2), HLoss, LLoss	Known Extended	Operations
Phot	Scan	Scan map at TBD angle 4 with appropriate step size (D2), HLoss, LLoss	Known Extende	Operations

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Phot	Scan	Scan map at TBD angle 5 with appropriate step size (D2), HLoss, LLoss	Known Extended	Operations
Phot	Scan	Scan map at TBD angle 6 with appropriate step size (D2), HLoss, LLoss	Known Extended	Operations
Phot	Scan	Scan map row 60"/s nominal speed, field with a number of sources	Known Extended	Operations, SCalPhotChanTimeConst
Phot	Scan	Scan map row 45"/s nominal speed, field with a number of sources	Known Extended	Operations, SCalPhotChanTimeConst
Phot	Scan	Scan map row 30"/s nominal speed, field with a number of sources	Known Extended	Operations, SCalPhotChanTimeConst
Phot	Scan	Scan map row 75"/s Not Possible nominal speed, field with a number of sources	Known Extended	Operations, SCalPhotChanTimeConst
Phot	Scan	Scan map row 90"/s not possible nominal speed, field with a number of sources	Known Extended	Operations, SCalPhotChanTimeConst
Phot	Jigg	7-point jiggle, 5" offset, source centre, nominal chop freq	Point	7-Point Jigglemap Positions
Phot	Jigg	7-point jiggle, 6" offset, source centre, nominal chop freq	Point	7-Point Jigglemap Positions
Phot	Jigg	7-point jiggle, 7" offset, source centre, nominal chop freq	Point	7-Point Jigglemap Positions
Phot	Jigg	7-point jiggle, 5" offset, source 2" offset, nominal chop freq	Point	7-Point Jigglemap Positions
Phot	Jigg	7-point jiggle, 6" offset, source 2" offset, nominal chop freq	Point	7-Point Jigglemap Positions
Phot	Jigg	7-point jiggle, 7" offset, source 2" offset, nominal chop freq	Point	7-Point Jigglemap Positions
Phot	Jigg	64 point jiggle, point source centred on pixel	Point	64-Point Jigglemap Positions
Phot	Jigg	64 point jiggle, point source 5" offset in Y	Point	64-Point Jigglemap Positions
Phot	Jigg	64 point jiggle, point source 5" offset in Z	Point	64-Point Jigglemap Positions
Phot	Jigg	64 point jiggle, point source 9" offset in Y	Point	64-Point Jigglemap Positions
Phot	Jigg	64 point jiggle, point source 9" offset in Z	Point	64-Point Jigglemap Positions
Phot	Jigg	64 point jiggle, small extended source	Known Extended	64-Point Jigglemap Positions
Spec	Intermediate	4 point raster High Res Scan, Point Source centre SSWD4	Point	Spectrometer Intermediate Sampling
Spec	Intermediate	4 point raster Medium Res Scan, Point Source offset 5" in Y SSWD4	Point	Spectrometer Intermediate Sampling
Spec	Intermediate	4 point raster Medium Res Scan, Point Source offset 5" in Z SSWD4	Point	Spectrometer Intermediate Sampling
Spec	Intermediate	4 point raster High Res Scan, Extended Source SSWD4	Known Extende	Spectrometer Intermediate Sampling

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Spec	Full	16 point raster Medium Res Scan, Point Source centre	Point	Spectrometer Full Sampling
Spec	Full	16 point raster Low Res Scan, Point Source offset 5" in Y	Point	Spectrometer Full Sampling
Spec	Full	16 point raster Low Res Scan, Point Source offset 5" in Z	Point	Spectrometer Full Sampling
Spec	Full	16 point raster Low Res Scan, Point Source offset 9" in Y	Point	Spectrometer Full Sampling
Spec	Full	16 point raster Low Res Scan, Point Source offset 9" in Z	Point	Spectrometer Full Sampling
Spec	Full	16 point raster Medium Res Scan, Extended Source	Known Extended	Spectrometer Full Sampling
Spec	Phase Up	Phase up with final detector settings and telescope at stable (final) value	Dark Sky	SCalSpecBolParSky
Phot	Phase Up	Phase up with final detector settings and telescope at stable (final) value	Dark Sky	SCalPhotBolParSky
Phot	Special	BSM FOV Scan in chop, Point source on PSWE8	Point	SCalPhotBsmPos
Spec	Special	BSM FOV Scan in chop, Point source on SSWD4	Point	SCalSpecBsmPos
Phot	Special	BSM FOV Scan in jiggle, Point source on PSWE8	Point	SCalPhotBsmPos
Phot	Special	BSM FOV Scan in jiggle, Point source on PMWD6	Point	SCalPhotBsmPos
Phot	Special	BSM FOV Scan in jiggle, Point source on PMWD7	Point	SCalPhotBsmPos
Spec	Special	BSM FOV Scan in jiggle, Point source on SSWD4	Point	SCalSpecBsmPos
Phot	Jigg	64 point jiggle map source centred in PSW E8	Point	SCalPhotBeamProf
Phot	Jigg	64 point jiggle map source centred in PSW E6	Point	SCalPhotBeamProf
Phot	Jigg	64 point jiggle map source centred in PSW E10	Point	SCalPhotBeamProf
Phot	Jigg	64 point jiggle map source centred in PSW C8	Point	SCalPhotBeamProf
Phot	Jigg	64 point jiggle map source centred in PSW G8	Point	SCalPhotBeamProf
Spec	Point	High Resolution Scan of a line source in SSW band	Line	SCalSpecModEff
Spec	Point	High Resolution Scan of a line source in SLW band	Line	SCalSpecModEff
Spec	Point	Low Resolution scan, source centred on SSW D4, with 16 point raster	Point	ScalSpecBeamProf

8. INDICATIVE DAY-BY-DAY SCHEDULE

See PV Spreadsheet
TBW……

1. Test implementation timeline
2. Analysis plan
    2.1. Include
        2.1.1. High-priority results that are required from the tests and the form in which they'll be reported
        2.1.2. Second-priority outputs
    2.2. Identification of the individuals/teams to be responsible for the analysis

9. OPEN ISSUES WISHES/RECOMMENDATIONS

This section is relevant to HGSRR version to assist with the review

Schedule for the PV Phase Plan: Next issue to be released mid September so can be used to prepare for the PV Phase simulations, which will feedback into the PV Phase plan. The updated PV Phase Plan will be reviewed internally in the first half of October, after which the PV Phase Plan will be updated further.

This document is a work in progress. The next issue include:

- The use of two bias levels (about to be implementated into the AOTs in HSpot)
- The recommendations from the HCalSG review of PV Phase plans.
- Sort out TBCs and TBWs
- Latest updates to the Pipeline Document (AD7)

It also needs more thorough thought to include further instances of observations that are needed to calibration SPIRE, including observations that need to be repeated when the telescope temperature has changed significantly.
It also needs to be compared with the Commissioning Phase Plan (RD1) and the Pointing Plan (RD6) to ensure there are no gaps and with RD3 to ensure that all necessary observations definitions have been included in that document.

In the future will need to address the time needed to analyse test data and produce results that may be relevant for future tests – should incorporate a flow-diagram outlining the test/analysis activity.

Appendix 1 – very detailed list of observations (PV spreadsheet)

[See excel spreadsheet ‘pv_observations’ - this is an old list that was copied into the PV spreadsheet and hence is superseded by the PV spreadsheet]