SPIRE

SUBJECT: **SPIRE Commissioning Phase Plan**

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DOCUMENT No: **SPIRE-RAL-PRJ-003018**

ISSUE: **1.0** **Date:** **1st August 2008**

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Change Record

ISSUE	DATE	
Draft 0.1	6th December 2007	First Draft
Issue 1.0	1st August 2008	

Glossary

AOR	Astronomical Observation Request
AOT	Astronomical Observation Template
BSM	Beam Steering Mirror
CCB	Configuration and Control Board
DTCP	Daily Telecommunication Period
HK	Housekeeping
ICC	Instrument Control Centre
ILT	Instrument Level Test
IST	Integrated System Test
LEOP	Launch and Early Orbit Phase
LVDT	Linear Voltage Displacement Transducer
MOC	Mission Operations Centre
MOIS	Mission Operation Information System
MTL	Mission Time Line
OD	Operational Day
OE	Optical Encoder
OPD	Optical Path Difference
PCAL	Photometer Calibration Source
PHS	Proposal Handling System
PID	Proportional, Integral & Differential (control parameters)
PTC	Photometer Thermal Control
PV	Performance Verification
RT	Real Time
SCAL	Spectrometer Calibration Sources (SCAL2 and SCAL4)
SMEC	Spectrometer Mechanism
SPIRE	Spectral and Photometric Imaging Receiver
SPT	System Performance Test
SCOM	SpaceCraft Operations Manager
TBC	To Be Confirmed
TBD	To Be Determined
TBS	To Be Specified
TM	Telemetry
ZPD	Zero Path Difference

1. SCOPE

2. DOCUMENTS

2.1 Applicable Documents

AD1	Herschel/Planck Commissioning and Performance Verification Plan	H-P-1-ASP-TN-1383
AD2	SPIRE Operating Modes	SPIRE-RAL-DOC-000320, Issue 3.3, 24th June 2005

2.2 Reference Documents

RD1	SPIRE FM Cold Functional Test Procedures	SPIRE-RAL-PRC-002398, Issue 2.6, 10th July 2008
RD2	SPIRE IUM	SPIRE-RAL-PRJ-002395, Issue 1.3, 9th November 2007
RD3	SPIRE IST Specific Performance Test Procedures	SPIRE-RAL-PRC-002704, Issue 3.2, 19th June 2008
RD4	Herschel Pointing Calibration Plan	HERSCHEL-HSC-DOC-1139, Issue 0.92, 13th June 2008
RD5	SPIRE Calibration Observation Definitions	SPIRE-RAL-DOC-003104, Issue 1.0, 14th July 2008
RD6	SPIRE Functional Test Specification	SPIRE-RAL-DOC-001652, Issue 1.4, 22nd July 2005

3. INTRODUCTION

This document is the top level commissioning phase plan for SPIRE. General assumptions about this phase are listed in section 4 and section 5 highlights the objectives and top level requirements. The working framework is detailed in section 6 while section 7 describes each activity in details. Section 8 then gives a summary of the calibration tables which will be populated by the end of the commissioning phase.

4. ASSUMPTIONS

- There will be ~ 4 hours available for instrument activities during each DTCP for the duration of commissioning phase.
- ICC@MOC team will work two shifts per day (TBC), seven days a week to cover DTCPs
- ICC@ICC team responsible for offline analysis will work office hours
- Commissioning phase activities in this plan take place both during the Commissioning and PV periods

5. GENERAL OBJECTIVES OF COMMISSIONING PHASE

The main objectives of commissioning phase are:

- verification of the functional health of the instrument
- functional switch-on checks of the instrument and subsystems
- revision of nominal instrument settings for instrument operations during PV and routine phase
- determination of the location of instrument apertures with respect to the telescope boresight
- validation of the peak-up mode
- validation of the instrument mode transitions

5.1 Total Duration

The current estimate for the duration of all SPIRE commissioning phase activities is approximately 105-110 hours (TBC). **Note that this estimate only includes times for the first manual and automatic cooler recycle. Additional cooler recycles will be necessary to complete the commissioning phase activities, but these will depend on the overall schedule**.

5.2 *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 ICC@MOC team must:

- be able to execute tests manually from the MOC or from the MTL
- be able to repeat tests if necessary with a different set of command parameters

6. OPERATIONAL FRAMEWORK/ASSUMPTIONS

6.1 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.

6.1.1 Overall Timeline

The overall mission timeline after launch consists of

1. Launch and Early Orbit Phase (Launch to Launch plus 3 days (**AD1**))
2. Commissioning Phase (Launch plus 3 days to Launch plus 1 month (**AD1**))
    a. Decontamination complete, telescope cooldown starts at launch plus 3 weeks (**AD1**)
    b. Cryo-cover opening at launch plus one month (**AD1**)
3. PV Phase (assumed to be 3 months in duration)
4. Science Demonstration Phase (assumed to be one month in duration)
5. Routine Operations Phase (remainder of the mission)

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 cryo-cover 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.

6.1.2 Commissioning Outcome

The status of the instrument at the end of the Commissioning Phase is assumed to be:

- Functionally tested
- Instrument parameters which do not require astronomical observations established (e.g. we would re-tune the BSM and SMEC during commissioning phase).
- Cooler hold time established.

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

- Pointing accuracy must be good enough for SPIRE PV Phase measurements (TBS)
- The spacecraft must be able to slew along a specified axis at a specified rate with good (TBS) pointing accuracy
- The straylight performance has been established. This can only be finally established once the telescope has reached its operating temperature and the instruments have been operationally optimised.

6.1.3 Ground Contact

AD1 (on page 17) states 'During the commissioning, the visibility for both satellite 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)'.

It is therefore assumed that during commissioning the instrument teams will have ~ 10-12 hours of ground contact time available to them.

6.1.4 Telescope Cooldown

Figure 6-1 shows the telescope cooldown curve provided by Thales Alenia Space. The cooldown starts at Launch + 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 (Launch + 30 days, also the start of PV phase) the telescope temperature is at about 125 K.

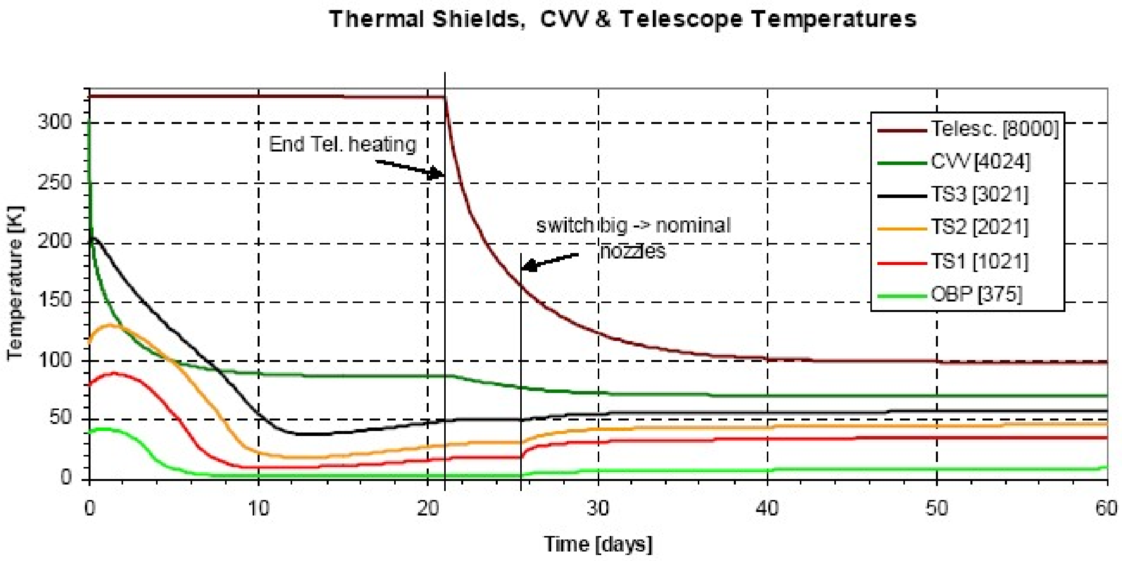

Figure 6-1: Modelled telescope cooldown provided by Thales Alenia Space

6.2 SPIRE Operations

6.2.1 Assumed Mission Management during Commissioning and PV Phase

We currently assume that, during Commissioning Phase, TAS (Thales Alenia Space) will have overall management of the mission planning, transitioning to full HSC/Project control by the start of PV phase. Under this arrangement, SPIRE will initially report to a TAS-led planning team, then to the HSC/Project (SCOM) led planning team. It is important the managerial arrangements during Commissioning and PV Phases are clearly defined and understood by all parties.

6.2.2 SPIRE Team Management during Commissioning Phase

The SPIRE ICC operational team management structure during commissioning phase will be similar to the ICC development team structure. Overall responsibility is held by the PI with the Instrument Scientist as his deputy, but the day-to-day coordination and planning commissioning phase activities will be the responsibility of the ICC@MOC.

The execution of the commissioning phase activities will be carried out by members of the following ICC teams under the control of the ICC Manager:

- The Operations Team – responsible for scheduling commissioning phase observations, where appropriate, and entering these into the mission planning system; instrument health monitoring; data retrieval, processing and ensuring the data is 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 – responsible for validation of the implementation, operation and scientific performance of the AOTs
- The Calibration Team – responsible for analysing the data and feeding the results into the PV phase planning; producing updated calibration information both for uplink and downlink purposes; and for updating the sensitivity estimate.

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 involve overlapping membership, will operate in a highly integrated way.

6.2.3 Availability of Data

It is assumed that the ICC@ICC will have real time access to data from the MOC.

6.2.4 Location of Personnel during Commissioning phase

6.2.4.1 ICC@MOC

It is assumed that two shifts per day covering the ground contact time are required at ESOC. Therefore a staffing level of 4-5 people (TBC) will be required. The SPIRE team members located at ESOC will have expertise in instrument commanding and instrument science as a result of their participation in all aspects of ILT and IST.

6.2.4.2 ESAC

No ICC staff are needed to be present at the HSC.

6.2.4.3 ICC@ICC

For Commissioning Phase no external consortium or ICC members need to be co-located at RAL as the data will be made available in the same way as for ILT/IST. The following experts will be required to help with data analysis:

- JPL/IPAC: detector noise data and load curves
- LAM: SMEC functionality
- UKATC: BSM functionality
- Cardiff: internal calibrators
- CEA and IFSI: Warm Electronics

It is assumed that the ESA instrument/calibration scientists will be located at ESAC during this period but will be available to help with instrument activities.

6.2.5 Staffing and Meetings

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

6.2.5.1 External Meetings

SPIRE will support 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
- 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

6.2.5.2 Internal ICC meetings

A daily planning meeting will be held which will be chaired by the PI, Instrument Scientist or Calibration Scientist, depending on availability. The aims 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 SPIRE personnel will be expected to attend and each team must be represented with either the team leader or designated deputy.

In order to maximise the efficiency of scheduling, it is important to note that the 6-day instrument rotation cycle is not applicable during the commissioning phase. Therefore we will hold data analysis review meetings as and when required.

6.2.6 Planning

A significant number of the commissioning phase tests will be performed during DTCP using MOIS procedures. However, whenever and wherever possible, every attempt will be made to perform these tests from the mission timeline (MTL). The tool to be used for this task is the Expert version HSPOT which allows the preparation and scheduling of these observations through the HCSS Mission Planning System. For this to be done effectively it is assumed that the mission planning tool will be made available to the ICC operations team which will allow them to schedule the SPIRE observations.

It is assumed that there will be some flexibility available to the ICC@MOC for modifying the previously scheduled observations before uplink e.g. up to TBC hours before.

7. COMMISSIONING PHASE ACTIVITIES

The commissioning phase activities described in this section are generally laid out in the order they are to be performed and their expected duration.

7.1 Cold Functional Tests

Nominally the commissioning phase will commence with the execution of these functional tests. Only the sequence of tests on the PRIME side of the instrument will be performed, unless an instrument anomaly occurs.

7.1.1 Purpose

To check the basic functional health of the instrument and its sub-systems

7.1.2 Preconditions

SPIRE is at nominal operating temperature and temperatures are as stable as possible.

7.1.3 Constraints

To be done during DTCP (see test sequence as outlined in section 7.1.6)

7.1.4 Execution Method

Default: MOIS procedures.

7.1.5 Duration

~ 12 hours, i.e. SPIRE will require 3 DTCPs to complete their functional tests.

7.1.6 Outline Sequence

The table below gives the sequence of the PRIME standard functional tests. The tests are to be executed in the order shown. It is essential that tests 1 and 2 are executed successfully before the subsequent tests can be performed.

Only in the event of an anomaly will the tests be executed for REDUNDANT side. After execution of this nominal test sequence SPIRE will be in the equivalent of REDY mode but with the nominal HK being generated at 1Hz rather than at 0.25Hz (see **RD2**).

Test #	Test Procedure Name	Purpose	Tests which need to be have been executed beforehand	Duration / min
1.	SPIRE-COLD-DPU-ON-P	DPU PRIME Power up and OBS start	-	10
2.	SPIRE-COLD-DRCU-ON-P	DRCU PRIME Power up	1	10
3.	SPIRE-COLD-FUNC-SCU-02-P	SCU Nominal Science Contents check PRIME	1-2	5
4.	SPIRE-COLD-FUNC-SCU-03-P	SCU DC Thermometry check PRIME	1-2	10
5.	SPIRE-COLD-FUNC-SCU-06-P	SCU AC Thermometry check PRIME	1-2	5
6.	SPIRE-COLD-FUNC-SCU-07-P	Sorption Cooler Heaters Check PRIME	1-2	10
7.	SPIRE-COLD-FUNC-PCAL-01-P	PCAL Characterisation Test PRIME	1-2	10
8.	SPIRE-COLD-FUNC-SCAL-01-P	SCAL Characterisation Test PRIME	1-2	20
9.	SPIRE-COLD-FUNC-MCU-01-P	MCU Boot Check PRIME	1-2	10
10.	SPIRE-COLD-FUNC-MCU-03-P	MCU Nom. Science Contents Check PRIME	1-2, 9	10
11.	SPIRE-COLD-FUNC-BSM-01-P	BSM Chop/Jiggle Sensors check PRIME	1-2, 9	10
12.	SPIRE-COLD-FUNC-BSM-03-P	BSM Open Loop Dynamics Check PRIME	1-2, 9, 11	10
13.	SPIRE-COLD-FUNC-BSM-05A-P	BSM Open Loop Chop Test PRIME	1-2, 9, 11	10
14.	SPIRE-COLD-BSM-INIT	BSM Initialisation Test PRIME	1-2, 9, 11	10
15.	SPIRE-COLD-FUNC-BSM-05B-P	BSM Close Loop Chop Test PRIME	1-2, 9, 11, 14	10
16.	SPIRE-COLD-FUNC-BSM-06-P	BSM Close Loop Operational Mode Chop Test PRIME	1-2, 9, 11, 14	10
17.	SPIRE-COLD-BSM-0FF-P	BSM switch OFF PRIME	1-2, 9	10
18.	SPIRE-COLD-FUNC-DCU-02-P	DCU Nominal Science Contents Check PRIME	1-2, 9	10
19.	SPIRE-COLD-FUNC-DCU-11-PHOT-P	Photometer BDAs Switch ON Check PRIME	1-2, 9	20
20.	SPIRE-COLD-FUNC-DCU-13-PHOT-P	Photometer BDAs Integrity Check PRIME	1-2, 9, 19	30
21.	SPIRE-COLD-	Photometer BDAs Noise Check	1-2, 9, 19-20	5

Test #	Test Procedure Name	Purpose	Tests which need to be have been executed beforehand	Duration / min
	FUNC-DCU-14-PHOT-P	PRIME		
22.	SPIRE-COLD-PHOT-VSS-P	Photometer BDAs Vss Test PRIME	1-2, 9, 19-20	45
23.	SPIRE-COLD-PDET-OFF-P	Photometer BDAs Switch OFF PRIME	1-2, 9, 19	10
24.	SPIRE-COLD-FUNC-DCU-11-SPEC-P	Spectrometer BDAs Switch ON Check PRIME	1-2, 9	20
25.	SPIRE-COLD-FUNC-DCU-13-SPEC-P	Spectrometer BDAs Integrity Check PRIME	1-2, 9, 24	30
26.	SPIRE-COLD-FUNC-DCU-14-SPEC-P	Spectrometer BDAs Noise Check PRIME	1-2, 9, 24-25	5
27.	SPIRE-COLD-SPEC-VSS-P	Spectrometer BDAs Vss Test PRIME	1-2, 9, 24-25	45
28.	SPIRE-COLD-SDET-OFF-P	Spectrometer BDAs switch OFF	1-2, 9, 24	10
29.	SPIRE-COLD-FUNC-SMEC-01-P	SMEC Encoder and LVDT check PRIME	1-2, 9	10
30.	SPIRE-COLD-FUNC-SMEC-03-P	SMEC Encoder Levels Check PRIME	1-2, 9	10
31.	SPIRE-COLD-FUNC-SMEC-02A-P	SMEC Open Launch Latch PRIME	1-2, 9, 29-30	30
32.	SPIRE-COLD-FUNC-SMEC-FFOFFSET-P	SMEC (PRIME) Open Loop Feed Forward Offset Test	1-2, 9, 29-31	90
33.	SPIRE-COLD-FUNC-SMEC-04A-P	SMEC Open Loop Position check PRIME	1-2, 9, 29-32	30
34.	SPIRE-COLD-FUNC-SMEC-09-P	SMEC Open Loop Scan check PRIME	1-2, 9, 29-32	20
35.	SPIRE-COLD-FUNC-SMEC-INIT-P	SMEC Initialisation Test PRIME	1-2, 9, 29-32, 34	60
36.	SPIRE-COLD-FUNC-SMEC-07-P	SMEC Close Loop Scan check PRIME	1-2, 9, 29-32, 34-35	30
37.	SPIRE-COLD-FUNC-SMEC-04B-P	SMEC Close Loop Position check PRIME	1-2, 9, 29-32, 34-35	30
38.	SPIRE-COLD-SMEC-OFF-P	SMEC switch OFF PRIME	1-2, 9, 29	10
39.	SPIRE-COLD-	Put SPIRE in REDY mode	1-2	10

Test #	Test Procedure Name	Purpose	Tests which need to be have been executed beforehand	Duration / min
	REDY-P			

7.1.7 TM Requirements

RT HK and Science TM required during test execution

7.1.8 Estimated Analysis Time

~4 ODs

7.2 BSM PID Tuning

7.2.1 Purpose

To establish the BSM PID control loop parameters. It is not necessary to have the cooler recycled for this test, i.e. it can be performed before the first cooler recycle..

7.2.2 Preconditions

BSM specific functional tests of the instrument have been successfully executed (see section 7.1.6)

7.2.3 Constraints

None

7.2.4 Execution Method

Default: MTL (AORs)

7.2.5 Test Outline

Tune the Kp, Ki and Kd parameters of the BSM for the nominal chop throw and chop frequency

7.2.6 Duration

~ **3 – 4 hours**

7.2.7 Estimated Analysis Time

1-2 ODs

7.3 SMEC PID Tuning

7.3.1 Purpose

To establish the SMEC PID control loop parameters. It is not necessary to have the cooler recycled for this test, i.e. it can be performed before the first cooler recycle.

7.3.2 Preconditions

- SMEC functional tests have been executed (see section 7.1.6)
- SPIRE is at nominal operating temperature and temperatures are as stable as possible

7.3.3 Constraints

4 ODs will be needed by the ICC to analyse the SMEC functional test data (see section 7.1.6) before this test can be executed (TBC).

7.3.4 Execution Method

Default: MOIS procedure

7.3.5 Output

Optimised SMEC PID control loop parameters

7.3.6 Pass/Fail Criteria

The SMEC can be operated in closed loop following this test.

7.3.7 Duration

~ **4 – 6 hours**

7.3.8 Estimated Analysis Time

2 ODs

7.4 SMEC LVDT Backup Mode Test

7.4.1 Purpose

This contingency procedure determines the SMEC control loop parameters for operating the SMEC in closed loop mode over the LVDT range. Nominally it should not be necessary to execute this test if the SMEC cold functional tests have been completed successfully. It will only be executed if the SMEC encoders fail during routine operations.

This test can be performed before the first cooler recycle.

7.4.2 Preconditions

- SMEC functional tests have been executed (see section 7.1.6)
- SPIRE is at nominal operating temperature and temperatures are as stable as possible

7.4.3 Constraints

Two days will be needed by the ICC to analyse the SMEC functional test data (see section 7.1.6) before this test can be executed (TBC).

7.4.4 Execution Method

Default: MOIS procedure

7.4.5 Output

Optimised SMEC LVDT control loop parameters

7.4.6 Pass/Fail Criteria

The SMEC can be operated in closed loop on the LVDT following this test.

7.4.7 Duration

~ **2 – 3 hours**

7.4.8 Estimated Analysis Time

3 ODs

7.5 Manual Cooler Recycle

7.5.1 Purpose

This test manually recycles the cooler to determine the command parameters for the subsequent automatic cooler recycles. It will only be repeated if the first run fails to establish the optimum parameters or for diagnostic purposes if, for example, the hold time is much shorter than expected.

7.5.2 Preconditions

- Functional tests of the instrument have been successfully executed (see section 7.1.6)
- Cryostat temperatures are at the required levels and stable

7.5.3 Constraints

Has to be performed manually during DTCP

7.5.4 Execution Method:

Default: MOIS procedure

7.5.5 Duration

~ **3.5 – 4 hours** (including stabilisation time)

7.5.6 Estimated Analysis Time

3-4 ODs

7.6 Photometer Phase-ups

7.6.1 Purpose

To perform photometer detector phase-ups

7.6.2 Preconditions

- Functional tests of the instrument have been successfully executed (see section 7.1.6)
- Cooler is recycled, the detector temperatures are at <300 mK and as stable as possible

7.6.3 Constraints

Should be done before ejection of the cryo-cover

7.6.4 Execution Method

Default: MTL (AORs)

7.6.5 Test Outline

- 3 bias frequencies
- 2 bias levels (nominal and strong source levels from IST)
- 21 points per phase up (10 points either side of central target phase from IST)
- ~60 seconds per phase step

7.6.6 Duration

3 (bias frequencies) x 2 (bias Levels) x 21 (points per phase up) x (1 min per phase step) =>> ~ **2-3 hours**.

7.6.7 Estimated Analysis Time

2 ODs

7.7 Photometer Dark Load Curves

7.7.1 Purpose

To perform photometer detector dark load curves for a number of bias frequencies. It is expected that this test will be performed twice at different cryo-cover temperatures as it should lead to a determination of the instrument throughput (TBC).

7.7.2 Preconditions

- Functional tests of the instrument have been successfully executed (see section 7.1.6)
- Cooler is recycled, the detector temperatures are at <300 mK and as stable as possible
- Photometer phase-up tests have been completed (see section 7.6)

7.7.3 Constraints

- Should be done in commissioning phase before ejection of the cryo-cover
- Should be repeated at two significantly different cryo-cover temperatures

7.7.4 Execution Method

Default: MTL (AORs)

7.7.5 Test Outline

- 2 cryo-cover temperatures
- Perform load curve at 3 bias frequencies
- Each load curve takes ~ 30 minutes

7.7.6 Duration

2 (cryo-cover temperatures) x 3 (bias frequencies) x 30 (minutes per load curve) =>> ~ **3 – 4 hours**

7.7.7 Estimated Analysis Time

3-4 ODs

7.8 Photometer Multi-Level Noise Tests

7.8.1 Purpose

To perform photometer noise measurements for a number of bias levels, with a PCAL flash at each bias level. It is expected that this test will be performed twice at different cryo-cover temperatures (TBC).

7.8.2 Preconditions

- Functional tests of the instrument have been successfully executed (see section 7.1.6)
- Cooler is recycled, the detector temperatures are at <300 mK and as stable as possible
- Photometer phase-up tests have been completed (see section 7.6)

7.8.3 Constraints

- Should be done before ejection of the cryo-cover
- Should be repeated at two significantly different cryo-cover temperatures

7.8.4 Execution Method

Default: MTL (AORs)

7.8.5 Test Outline

- 2 cryo-cover temperatures
- 3 bias frequencies
- 2 bias levels
- PCAL flashes at each bias level
- Each noise test should take ~ 45 minutes to ~1 hour

7.8.6 Duration

2 (cryo-cover temperatures) x 3 (bias frequencies) 2 (bias levels) x 45 (minutes per noise test)
=>> ~ **9 – 10 hours**

7.8.7 Estimated Analysis Time

3-4 ODs

7.9 Photometer PCAL Level Check

7.9.1 Purpose

To perform PCAL level checks for the Photometer. It is expected that this test will be performed twice at different cryo-cover temperatures (TBC).

7.9.2 Preconditions

- Functional tests of the instrument have been successfully executed (see section 7.1.6)
- Cooler is recycled, the detector temperatures are at <300 mK and as stable as possible
- Photometer phase-up tests have been completed (see section 7.6)

7.9.3 Constraints

- Should be done before ejection of the cryo-cover
- Should be repeated at two significantly different cryo-cover temperatures

7.9.4 Execution Method

Default: MTL (AORs)

7.9.5 Test Outline

- 2 cryo-cover temperatures
- 1 detector bias frequency
- 2 detector bias levels
- 20 PCAL bias current levels
- 15 flash cycles
- Perform PCAL level check at nominal bias frequency

7.9.6 Estimated Analysis Time

2-3 ODs

7.9.7 Duration

2 (cryo-cover temperatures) x 1 (detector bias frequency) x 2 (detector bias levels) x 30 (minutes per PCAL level check) =>> ~ **2 hours**

7.10 Spectrometer Phase-ups

7.10.1 Purpose

To perform spectrometer detector phase-ups

7.10.2 Preconditions

- Functional tests of the instrument have been successfully executed (see section 7.1.6)
- Cooler is recycled, the detector temperatures are at <300 mK and as stable as possible

7.10.3 Constraints

Should be done before ejection of the cryo-cover

7.10.4 Execution Method

Default: MTL (AORs)

7.10.5 Test Outline

3 bias frequencies
2 bias levels (nominal and strong source levels from IST)
21 points per phase up (10 points either side of central target phase from IST)
~60 seconds per phase step

7.10.6 Duration

3 (bias frequencies) x 2 (bias Levels) x 21 (points per phase up) x (1 min per phase step) =>> ~ **2-3 hours**.

7.10.7 Estimated Analysis Time

2 ODs

7.11 Spectrometer Dark Load Curves

7.11.1 Purpose

To perform spectrometer detector dark load curves for a number of bias frequencies. It is expected that this test will be performed twice at different cryo-cover temperatures as it should lead to a determination of the instrument throughput (TBC).

7.11.2 Preconditions

- Functional tests of the instrument have been successfully executed (see section 7.1.6)
- Cooler is recycled, the detector temperatures are at <300 mK and as stable as possible
- Spectrometer phase-up tests have been completed (see section 7.10)

7.11.3 Constraints

- Should be done in commissioning phase before ejection of the cryo-cover
- Should be repeated at two significantly different cryo-cover temperatures

7.11.4 Execution Method

Default: MTL (AORs)

7.11.5 Test Outline

- 2 cryo-cover temperatures
- Perform load curve at 3 bias frequencies
- Each load curve takes ~ 30 minutes

7.11.6 Duration

2 (cryo-cover temperatures) x 3 (bias frequencies) x 30 (minutes per load curve) =>> ~ **3 – 4 hours**

7.12 Spectrometer Multi-Level Noise Tests

7.12.1 Purpose

To perform spectrometer noise measurements for a number of bias levels. It is expected that this test will be performed twice at different cryo-cover temperatures (TBC).

7.12.2 Preconditions

- Functional tests of the instrument have been successfully executed (see section 7.1.6)
- Cooler is recycled, the detector temperatures are at <300 mK and as stable as possible
- Spectrometer phase-up tests have been completed (see section 7.10)

7.12.3 Constraints

- Should be done before ejection of the cryo-cover
- Should be repeated at two significantly different cryo-cover temperatures

7.12.4 Execution Method

Default: MTL (AORs)

7.12.5 Test Outline

- 2 cryo-cover temperatures
- 3 bias frequencies
- 2 bias levels
- PCAL flashes at each bias level
- Each noise test should take ~ 45 minutes to ~1 hour

7.12.6 Duration

2 (cryo-cover temperatures) x 3 (bias frequencies) x 2 (bias levels) x 45 (minutes per noise test) =>> ~ **9-10 hours**

7.12.7 Estimated Analysis Time

3-4 ODs

7.13 Spectrometer PCAL Level Check

7.13.1 Purpose

To perform PCAL level checks for the Spectrometer. It is expected that this test will be performed twice at different cryo-cover temperatures (TBC).

7.13.2 Preconditions

- Functional tests of the instrument have been successfully executed (see section 7.1.6)
- Cooler is recycled, the detector temperatures are at <300 mK and as stable as possible
- Spectrometer phase-up tests have been completed (see section 7.10)

7.13.3 Constraints

- Should be done before ejection of the cryo-cover
- Should be repeated at two significantly different cryo-cover temperatures

7.13.4 Execution Method

Default: MTL (AORs)

7.13.5 Test Outline

- 2 cryo-cover temperatures
- 1 detector bias frequency
- 2 detector bias levels
- 20 PCAL bias current levels
- 15 flash cycles
- Perform PCAL level check at nominal bias frequency

7.13.6 Duration

2 (cryo-cover temperatures) x 1 (detector bias frequency) x 2 (detector bias levels) x 30 (minutes per PCAL level check) =>> ~ **2 hours**

7.13.7 Estimated Analysis Time

2-3 ODs

7.14 Spectrometer SCAL PID Tuning

7.14.1 Purpose

To confirm the SCAL2 and SCAL4 Control loop PID parameters. It should not normally be necessary to perform this test but it is included here for contingency.

7.14.2 Preconditions

- Functional tests of the instrument have been successfully executed (see section 7.1.6)

7.14.3 Constraints

None

7.14.4 Execution Method

Default: MOIS procedure

7.14.5 Test Outline

- 2 temperatures (40K and 80K)
- 2 calibrators (SCAL2 and SCAL4)

7.14.6 Duration

2 (calibrator temperatures 40K and 80K) x 2 (calibrators SCAL2 and SCAL4) x 20 (minutes at each temperature) =>> ~ **2 hours**

7.14.7 Estimated Analysis Time

1-2 ODs

7.15 Photometer Thermal Control (PTC) PID Tuning

7.15.1 Purpose

To establish the PTC PID control loop parameters.

7.15.2 Preconditions

- Functional tests of the instrument have been successfully executed (see section 7.1.6)
- Detector nominal settings have been determined
- Cooler is recycled, the detector temperatures are at <300 mK and as stable as possible
- Photometer phase-up tests have been completed (see section 7.6)

7.15.3 Constraints

7.15.4 Execution Method

Default: MOIS procedure

7.15.5 Duration

~ **4 – 6 hours**

7.15.6 Estimated Analysis Time

~ 3-4 ODs

7.16 Photometer Thermal Control (PTC) Headroom Characterisation

7.16.1 Purpose

This test is to establish the PTC heater power characteristics for stable operation of photometer detectors. It should not normally be necessary to perform this test but, if required, it would be done towards the end of the commissioning phase.

7.16.2 Preconditions

- Functional tests of the instrument have been successfully executed (see section 7.1.6)
- Detector nominal settings have been determined
- Cooler is recycled

- Photometer phase-up tests have been completed (see section 7.6)

7.16.3 Constraints

None

7.16.4 Execution Method

Default: MTL (AORs)

7.16.5 Duration

~ **4 hours**

7.16.6 Estimated Analysis Time

3-4 ODs

7.17 SMEC scans of the cryo-cover

7.17.1 Purpose

To perform SMEC scans of the cryo-cover as its temperature changes in order to characterise the SCAL port. It is expected that this test will be performed twice at different cryo-cover temperatures (TBC).

7.17.2 Preconditions

- Functional tests of the instrument have been executed (see section 7.1.6)
- If required, based on result of the functional tests, SMEC PID Tuning test has been performed
- Cooler is recycled, the detector temperatures are at <300 mK and as stable as possible

7.17.3 Constraints

Should be done before ejection of the cryo-cover

7.17.4 Execution Method

Default: MTL (AORs)

7.17.5 Test Outline

- 2 cryo-cover temperatures
- Each test should take ~ 3-4 hours

7.17.6 Duration

~ **6 – 8 hours**

7.17.7 Estimated Analysis Time

3-4 ODs

7.18 Automatic Cooler Recycle

7.18.1 Purpose

To automatically recycle the cooler following the successful completion of a manual cooler recycle.

7.18.2 Preconditions

- Functional tests of the instrument have been successfully executed (see section 7.1.6)
- Cryostat temperatures are at the required levels and stable.
- Manual Cooler recycle has been successfully performed and the cooler hold time determined.

7.18.3 Constraints

None

7.18.4 Execution Method:

Default: MTL (AORs)

7.18.5 Duration

~ **3.5 – 4 hours**

7.18.6 Estimated Analysis Time

2-3 ODs

7.19 Initial Photometer Pointing

7.19.1 Purpose

This test is designed to accurately determine the position of several primary apertures for the photometer. Note that, although this is a commissioning phase activity, it can only be performed in the PV phase timeframe, i.e. after the cryo-cover has been ejected. As full details of this test can be found in the Herschel Pointing Calibration Plan, ESA_ID: SPIRE_Initpoint_PHOT in RD4, it is not elaborated here any further.

7.19.2 Preconditions

- Functional tests of the instrument have been successfully executed (see section 7.1.6)
- Cooler is recycled, the detector temperatures are at <300 mK and as stable as possible

- BSM PID Tuning test has been completed successfully
- The cryo-cover has been ejected
- The Herschel ACMS is fully functional and calibrated.
- Initial PACS Scan test (ESA_ID: PACS_SIAM_search) has been performed successfully (see RD04)
- Gyro propagation reconstruction is available.

7.19.3 Constraints

Can only be done after ejection of cryo-cover

7.19.4 Execution Method

Default: MTL (AORs)

7.19.5 Test Outline

See RD04

7.19.6 Duration

~ **3 – 4 hours (see RD04)**

7.20 Initial Spectrometer Pointing

7.20.1 Purpose

This test is designed to accurately determine the position of several primary apertures for the spectrometer. Note that, although this is a commissioning phase activity, it can only be performed in the PV phase timeframe, i.e. after the cryo-cover has been ejected. As full details of this test can be found in the Herschel Pointing Calibration Plan, ESA_ID: SPIRE_Initpoint_SPEC in RD4, it is not elaborated here any further.

7.20.2 Preconditions

- Functional tests of the instrument have been successfully executed (see section 7.1.6)
- Cooler is recycled, the detector temperatures are at <300 mK and as stable as possible
- BSM PID Tuning test has been completed successfully
- The cryo-cover has been ejected
- The Herschel ACMS is fully functional and calibrated.
- Initial PACS Scan test (ESA_ID: PACS_SIAM_search) has been performed successfully (see RD04)
- Gyro propagation reconstruction is available.

7.20.3 Constraints

Can only be done after ejection of cryo-cover

7.20.4 Execution Method

Default: MTL (AORs)

7.20.5 Test Outline

See RD04

7.20.6 Duration

~ 2-3 hours (see RD04)

7.21 Focal Plane Geometry Photometer Scan

7.21.1 Purpose

This test is designed to accurately determine the position of *all* apertures for the photometer. Note that, although this is a commissioning phase activity, it can only be performed in the PV phase timeframe, i.e. after the cryo-cover has been ejected. As full details of this test can be found in the Herschel Pointing Calibration Plan, ESA_ID: SPIRE_FPGscan_PHOT in RD4, it is not elaborated here any further.

7.21.2 Preconditions

- Functional tests of the instrument have been successfully executed (see section 7.1.6)
- Cooler is recycled, the detector temperatures are at <300 mK and as stable as possible
- BSM PID Tuning test has been completed successfully
- The cryo-cover has been ejected
- The Herschel ACMS is fully functional and calibrated.
- Test SPIRE_Initpoint_PHOT has been performed successfully (see RD04)
- Gyro propagation reconstruction is available.

7.21.3 Constraints

Can only be done after ejection of cryo-cover

7.21.4 Execution Method

Default: MTL (AORs)

7.21.5 Test Outline

See RD04

7.21.6 Duration

~ 1 – 2 hours (see RD04)

7.22 Focal Plane Geometry Spectrometer Scan

7.22.1 Purpose

This test is designed to accurately determine the position of *all* apertures for the spectrometer. Note that, although this is a commissioning phase activity, it can only be performed in the PV phase timeframe, i.e. after the cryo-cover has been ejected. As full details of this test can be found in the Herschel Pointing Calibration Plan, ESA_ID: SPIRE_FPGscan_SPEC in RD4, it is not elaborated here any further.

7.22.2 Preconditions

- Functional tests of the instrument have been successfully executed (see section 7.1.6)
- Cooler is recycled, the detector temperatures are at <300 mK and as stable as possible
- BSM PID Tuning test has been completed successfully
- The cryo-cover has been ejected
- The Herschel ACMS is fully functional and calibrated.
- Test SPIRE_Initpoint_SPEC has been performed successfully (see RD04)
- Gyro propagation reconstruction is available

7.22.3 Constraints

Can only be done after ejection of cryo-cover

7.22.4 Execution Method

Default: MTL (AORs)

7.22.5 Test Outline

- see RD04

7.22.6 Duration

~ **1 hour (see RD04)**

7.23 Peak-Up Mode

7.23.1 Purpose

This activity is to test, validate and verify the correct functioning of the Peak-Up Mode for SPIRE instrument. Note that, although this is a commissioning phase activity, it can only be performed in the PV phase timeframe, i.e. after the cryo-cover has been ejected.

7.23.2 Preconditions

- Functional tests of the instrument have been successfully executed
- Cooler is recycled, the detector temperatures are at <300 mK and as stable as possible
- BSM PID Tuning test has been completed successfully (if required)

- The cryo-cover has been ejected
- The Herschel ACMS is fully functional and calibrated

7.23.3 Constraints

Can only be done after ejection of cryo-cover

7.23.4 Execution Method

Default: MTL (AORs)

7.23.5 Test Outline

- Point the telescope at peak-up target
- Perform the SPIRE peak-up procedure using the BSM (9 x 9 Chop and Jiggle Cross Raster)
- SPIRE OBS calculates the angular offsets for the peak signal with respect to the current telescope pointing
- SPIRE OBS sends these angular offsets to the ACMS via a TM(5,1) event report
- The ACMS re-points the telescope and then performs the required observation - exactly how this mode is implemented in the PHS is TBD

7.23.6 Duration

~ **2 – 4 hours**

7.23.7 Estimated Analysis Time

3-4 ODs

8. Uplink Calibration Tables Resulting From Commissioning Phase Tests

This section gives a high level summary of the uplink calibration tables which are to be populated using the results of the commissioning phase tests.

Test	Table	Contents	Priority
SPIRE-COLD-PHOT-VSS-P	Photometer detector nominal settings	Optimum Vss settings	High
Photometer Phase Ups	Photometer detector nominal settings	Optimum phase for a given bias frequency	High
Photometer Dark Load Curves	Photometer detector nominal settings	Optimum bias level in dark conditions	High
Photometer Multi-Level Noise Tests	Photometer detector nominal settings	Optimum bias level and bias frequency	High
Photometer PCAL Level Check	PCAL flash nominal settings	Optimum PCAL current settings for Photometer	High

Test	Table	Contents	Priority
Photometer Thermal Control (PTC) PID Tuning	PTC nominal settings	Optimum settings for PTC	High
Photometer Thermal Control (PTC) Headroom Characterisation	PTC heater settings	Range of PTC heater settings	Medium
SPIRE-COLD-SPEC-VSS-P	Spectrometer detector nominal settings	Optimum Vss settings	High
Spectrometer Phase Ups	Spectrometer detector nominal settings	Optimum phase for a given bias frequency	High
Spectrometer Dark Load Curves	Spectrometer detector nominal settings	Optimum bias level in dark conditions	High
Spectrometer Multi-Level Noise Tests	Spectrometer detector nominal settings	Optimum bias level and bias frequency	High
Spectrometer PCAL Level Check	PCAL flash nominal settings	Optimum PCAL current settings for Spectrometer	High
Spectrometer SCAL PID Tuning	SCAL PID nominal settings	Optimum SCAL PID settings for Spectrometer	Medium
Manual Cooler Recycle	Cooler recycle settings	Optimum parameters for the automatic cooler recycle	High
BSM PID Tuning	BSM nominal settings	BSM PID control loop parameters	Medium
SPIRE-COLD-FUNC-SMEC-FFOFFSET-P	SMEC nominal settings	Optimum Feed Forward Offset	High
SPIRE-COLD-FUNC-SMEC-FFGAIN-P	SMEC nominal settings	Optimum Feed Forward Gain	High
SMEC PID Tuning	SMEC nominal settings	SMEC PID control loop parameters	High
SMEC LVDT Backup Mode Test	SMEC nominal settings	SMEC LVDT scale and offset settings	Medium
SMEC scans of the cryo-cover	SCAL port characterisation	SCAL settings as a function of telescope temperature	High
Instrument Apertures Determination	Photometer and Spectrometer aperture locations	Locations of Photometer and Spectrometer detector channels	High

9. DAILY SCHEDULE

The daily schedule of SPIRE commissioning phase activities following the cooler recycle will depend critically on the cooler hold time. It will therefore be critical to establish the cooler hold time from the manual cooler recycle test and then plan the subsequent activities accordingly.

9.1 Indicative Day-by-Day Schedule

The detailed day-by-day schedule will depend on the overall commissioning phase schedule and will be maintained separately in coordination with the Herschel Science Operations Working Group.

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