Definition of SPIRE testing for FM IST and TV/TB
B. Swinyard

0 Change notes

0.1 22 March 2006 Draft sent for discussion to Alcatel only basic IST sequence – EMC and TB/TV sequences to be added

1 Applicable and reference documents

AD1 SPIRE Functional Test Procedures for IST - SPIRE-RAL-PRC-00TBW
AD2 SPIRE Integrated System Test (IST) Procedures - SPIRE-RAL-PRC-00TBW

2 Scope

Describes basic tests required for PFM Integrated Satellite Tests (IST) once SPIRE has been integrated into the Herschel Extended Payload Module.

THIS IS A DRAFT and the contents are subject to change

3 Outline of Required Procedures/Configurations

SPIRE requires the following tests and instrument configurations during IST. Here we give acronyms to the test and instrument configurations that will be required during IST and the approximate durations. These acronyms will be used through this document and for the detailed descriptions of the individual procedures. The sequencing for the individual tests are given in section 3.

Name of test	Acronym (TBC)	Description	Approx. duration
Warm Functional Test	WFT	Full checkout of SPIRE functionality whilst the FPU is warm and either under vacuum or at atmospheric pressure. Requires use of the IGSE and presence of SPIRE personnel S/C y-axis must be vertical to allow operation of the spectrometer mechanism (SMEC) Test can be carried out in other orientations without SMEC test	2 hours
Cold Functional Test	CFT	Full checkout of SPIRE functionality once the FPU is cold and either under vacuum or at atmospheric pressure. Requires use of the IGSE and presence of SPIRE personnel S/C y-axis must be vertical to allow operation of the spectrometer mechanism (SMEC) Test can be carried out in other orientations without SMEC test	3 hours
Short Functional Test - warm	SFTW	Rapid check of SPIRE functionality to be carried out at key inspection points during integration with the FPU warm either under vacuum or at atmospheric pressure.. Does not require the IGSE and can be carried out in the absence of SPIRE personnel Places no requirements on the S/C orientation	<30 mins

Name of test	Acronym (TBC)	Description	Approx. duration
Short Functional Test - cold	SFTC	Rapid check of SPIRE functionality to be carried out at key inspection points during test with the FPU cold and at operating temperature. Does not require the IGSE and can be carried out in the absence of SPIRE personnel Places no requirements on the S/C orientation	<30 mins
SPIRE Ready Mode	REDY	This is the default mode that SPIRE will in when not prime instrument. Only temperature sensors are switched on and housekeeping is collected. Does not require the IGSE and can be carried out in the absence of SPIRE personnel Places no requirements on the S/C orientation	N/A
Cooler Pump Regulation Test	CPMP	Test of the power required to heat the pump to a given temperature. To be carried out with the FPU cold before the first cooler recycle. Requires use of the IGSE; manual intervention from operator and presence of SPIRE personnel Places no requirement on the S/C orientation	2 hours (TBC)
Cooler Recycle - Manual	CRECM	First time the cooler is recycled under new thermal conditions we require knowledge of the detailed responses – carrying out this procedure manually the first time ensure success. S/C must be inclined at, at least, 20 degrees around z-axis in +y direction	2 hours
Cooler Recycle	CREC	Once we have established the correct operating parameters for the cooler we can use an automatic procedure – this will be the standard procedure for the majority of the IST. Does not require the use of IGSE or the presence of SPIRE personnel. S/C must be inclined at, at least, 20 degrees around z-axis in +y direction	2 hours
Ambient background verification	ABVP ABVS	We need to test the straylight environment within the cryostat. To do this we take loadcurves and calibrator flashes with the cryocover set to a number of different conditions. Done once with photometer (ABVP) and once with spectrometer (ABVS). Requires the use of IGSE; offline analysis and the presence of SPIRE personnel. No requirement on S/C orientation; the cover will need to be set to a number (TBD) of different temperatures from coldest to ~80 K.	Depends on the stability of the cryocover
Photometer Standby	PHOT STBY	Sets the instrument to be ready to go into one of the photometer observation modes. This instrument setting will be used many times during IST both in transitions between test configurations and as a default condition. Requires use of the IGSE and presence of SPIRE personnel Places no requirements on the S/C orientation	N/A

Name of test	Acronym (TBC)	Description	Approx. duration
Photometer Scan Mode	POF5	This sets the SPIRE instrument to its nominal scan mode AOT configuration. We plan using this mode for thermal testing and operations checkout. Requires use of the IGSE and presence of SPIRE personnel We expect spacecraft data to be generated to simulate SCAN spacecraft operation Places no requirements on the S/C orientation	N/A
Photometer 7-Point jiggle/chop with nodding	POF2	This sets the SPIRE instrument to its nominal chop and jiggle mode AOT configuration. We plan using this mode for thermal testing and operations checkout. Requires use of the IGSE and presence of SPIRE personnel We expect spacecraft data to be generated to simulate NOD spacecraft operation. Places no requirements on the S/C orientation	N/A
Spectrometer Standby	SPEC STBY	Sets the instrument to be ready to go into one of the spectrometer observation modes. Requires use of the IGSE and presence of SPIRE personnel S/C y-axis must be vertical to allow operation of the spectrometer mechanism (SMEC)	N/A
Spectrometer high resolution spectrum	SOF1	This sets the SPIRE instrument to its spectrometer mode AOT configuration where the SMEC is scanned over its full operating range. We plan using this mode for thermal testing and operations checkout. Requires use of the IGSE and presence of SPIRE personnel S/C y-axis must be vertical to allow operation of the spectrometer mechanism (SMEC)	N/A
Spectrometer mechanism micro vibration test	MICV	SPIRE set to spectrometer mode with the SMEC continuously scanning. During the test the S/C reaction wheels are activated and taken through a range of rotation speeds while the SMEC performance is monitored for interference Requires use of the IGSE and presence of SPIRE personnel S/C y-axis must be vertical to allow operation of the spectrometer mechanism (SMEC) Requires S/C reaction wheels to be operated	4 hours
Photometer EMC Tests	EMCP	SPIRE set to most sensitive photometer mode during RS tests as specified by IID-A Requires use of the IGSE and presence of SPIRE personnel Places no requirements on the S/C orientation	5 days

Name of test	Acronym (TBC)	Description	Approx. duration
Spectrometer EMC Tests (TBC)	EMCS	SPIRE set to most sensitive spectrometer mode during RS tests as specified by IID-A Requires use of the IGSE and presence of SPIRE personnel Places no requirements on the S/C orientation	5 days
Detector temperature regulation test	PTCV	With the instrument in PHOT STBY the photometer thermal control system will be activated to verify thermal stabilisation performance. Requires use of the IGSE and presence of SPIRE personnel Cryostat temperatures and mass flow to be close to flight - carried out during thermal vacuum test only (TBC)	4 hours

This table describes the overarching tests for the thermal verification of SPIRE within the context of the IST and TV/TB testing.

Thermal verification cooler hold time test	*THRC*	*SPIRE set to worst case thermal dissipation – Spectrometer high resolution (SOF1 – see above) and left until cooler is exhausted – could be done in conjunction with MICV* *Requires use of the IGSE and presence of SPIRE personnel* *S/C y-axis must be vertical to allow operation of the spectrometer mechanism (SMEC)*	*48 Hours*
Thermal verification dynamic stability test	*THRS*	*SPIRE switched between modes during S/C thermal vacuum test to look test stability performance simulating flight conditions as closely as possible* *Requires use of the IGSE and presence of SPIRE personnel* *Ideally S/C should have y-axis vertical – recognised that this is not possible during TV – therefore no special constraint on S/C orientation as long as cooler can be recycled*	*48 Hours*

4 Test Sequence

The tables in this section detail the proposed sequence for the IST including the setup requirement. This does not include the TV/TB testing or the EMC testing. These will be the subject of a later version of this note or a separate note. We plan on ~10 hour days with SPIRE allocated 5 days for testing. We have planned in detail four days as this naturally matches with our cooler hold time, keeping the fifth for contingency or for PACS/SPIRE parallel mode testing.

SPIRE Cold Test Day 1
Overview:

Cryostat configuration:
Flow rate at “ground nominal” : i.e. whatever is required to get stable temperatures
Temperatures:

SPIRE Detector box strap interface <1.8 K
SPIRE Cooler pump strap interface <1.8 K
SPIRE Cooler evaporator strap interface <1.8 K
SPIRE Optical Bench L1 interface <~5.5 K
S/C y-axis must be vertical with +y downwards to allow operation of the spectrometer mechanism and cooler recycling

Cryocover cooled to lowest possible temperature (<10 K)

Aims of test:

1. Check SPIRE is functional when cold
2. Check system level noise
3. Recycle cooler “manually” and characterise response of cryostat to set up “automatic” cooler recycle sequence
4. Characterise ambient background within the cryostat

Step-No.	Test-Step-Description	Remarks/Results	P	N
4.1.1	**SPIRE commissioning**			
.1	Cold Functional Test CFT See AD1 for detailed test sequence	Approx 3 hours		
.2	Cooler Pump Test CPMP See AD2 for detailed test sequence	Approx 2 hours		

Step-No.	Test-Step-Description	Remarks/Results	P	N
4.1.1.1 Cooler recycle				
.3	Cooler recycle manual CRECM See AD2 for detailed test sequence	Approx 2 Hours		
.4	Switch to photometer Standby PHOT STBY See AD2 for detailed test sequence	10 minutes		
4.1.1.2 Photometer Ambient Background verification				
.5	Wait for stable temperature conditions	TBD		
.6	Carry out dark ambient background verification ABVP See AD2 for detailed test sequence	First part of ambient background verification with cryostat as dark as possible Approx 1 hour		
.7	Switch to phot standby for overnight noise tests PHOT STBY See AD2 for detailed test sequence			

SPIRE Cold Test Day 2

Overview:

Cryostat configuration:
Flow rate at “ground nominal” : i.e. whatever is required to get stable temperatures
Temperatures:

SPIRE Detector box strap interface <1.8 K
SPIRE Cooler pump strap interface <1.8 K
SPIRE Cooler evaporator strap interface <1.8 K
SPIRE Optical Bench L1 interface <~5.5 K
S/C y-axis must be vertical with +y downwards to allow operation of the spectrometer mechanism and cooler recycling

Cryocover at nominal flight temperature (range acceptable 70 – 90 K) and stable to within 1K/hour drift

Aims of test:

1. Characterise photometer ambient background within the cryostat
2. Check SPIRE photometer mode operations
3. Characterise Spectrometer ambient background and noise performance.

Step-No.	Test-Step-Description	Remarks/Results	P	N
4.1.1.3	**Photometer Ambient background verification test (ctd)**			
.8	Wait for stable temperature conditions	TBD		
.9	Carry out dark ambient background verification ABVP See AD2 for detailed test sequence	Approx 2 hours		
.10	Switch to PHOT STBY	10 minutes		
4.1.1.4	**Photometer mode tests**			
.11	Photometer scan mode POF5 See AD2 for detailed test sequence	2 hours		
.12	Photometer chop/jiggle mode POF2 See AD2 for detailed test sequence	2 hours		

Step-No.	Test-Step-Description	Remarks/Results	P	N
.13	Switch to PHOT STBY	10 minutes		
4.1.1.5 Spectrometer Ambient background verification test				
.14	Switch to SPEC STBY	30 minutes		
.15	Wait for stable temperature conditions	TBD		
.16	Carry out dark ambient background verification ABVS See AD2 for detailed test sequence	2 hours		
.17	Switch to SPEC STBY for overnight noise tests	The cooler will run out at some point during the night		

SPIRE Cold Test Day 3

Overview:

Cryostat configuration:
Flow rate at “ground nominal” : i.e. whatever is required to get stable temperatures
Temperatures:

- SPIRE Detector box strap interface <1.8 K
- SPIRE Cooler pump strap interface <1.8 K
- SPIRE Cooler evaporator strap interface <1.8 K
- SPIRE Optical Bench L1 interface <~5.5 K
- S/C y-axis must be vertical with +y downwards to allow operation of the spectrometer mechanism and cooler recycling
- S/C reaction wheels running

Cryocover cooled to lowest possible temperature (<10 K)

Aims of test:

1. Test automatic cooler recycle and set for hold time test
2. Complete characterisation of cryostat ambient conditions
3. Initial check of spectrometer mode operations
4. Check SPIRE response to microvibrations

Step-No.	Test-Step-Description	Remarks/Results	P	N
4.1.1.6 Cooler recycle				
.18	Switch to REDY mode from SPEC STBY	10 minutes		
.19	Automatic cooler recycle CREC See AD2 for detailed test sequence	2 hours		
.20	Switch to SPEC STBY			
4.1.1.7 Spectrometer Ambient background verification test (ctd)				
.21	Wait for stable temperature conditions	TBD		

Step-No.	Test-Step-Description	Remarks/Results	P	N
.22	Carry out dark ambient background verification ABVS See AD2 for detailed test sequence	2 hours		
.23	Switch to SPEC STDBY	10 minutes		
4.1.1.8 Spectrometer Mode Test				
.24	Switch to SPEC high resolution mode SOF1 See AD2 for detailed test sequence	Short test to assess system performance under quiescent conditions – low SCAL temperatures 1 hour		
4.1.1.9 Spectrometer Microvibration Test				
.25	Continuous SPEC high resolution mode while reaction wheels are exercised MICV See AD2 for detailed test sequence	Assessment of spectrometer performance in presence of microvibration disturbance ~4 hours		
.26	Switch to SPEC STBY for overnight noise tests	10 minutes		

SPIRE Cold Test Day 4
Overview:

Cryostat configuration:
Flow rate at “ground nominal” : i.e. whatever is required to get stable temperatures
Temperatures:

SPIRE Detector box strap interface <1.8 K
SPIRE Cooler pump strap interface <1.8 K
SPIRE Cooler evaporator strap interface <1.8 K
SPIRE Optical Bench L1 interface <~5.5 K

S/C y-axis must be vertical with +y downwards to allow operation of the spectrometer mechanism and cooler recycling

Cryocover at nominal flight temperature (range acceptable 70 – 90 K) and stable to within 1K/hour drift

Aims of test:

1. Complete characterisation of cryostat ambient conditions
2. Complete checkout of spectrometer mode operations
3. Spectrometer to Photometer mode switch checkout
4. Photometer detector thermal control check

Step-No.	Test-Step-Description	Remarks/Results	P	N
4.1.1.10 Spectrometer Mode Tests				
.27	Wait for stable temperature conditions	TBD		
.28	Switch to spectrometer high resolution mode SCAL null check See AD2 for detailed test sequence	Set SCAL temperature incrementally to null background from cryocover ~2 hours		
.29	Spectrometer high resolution mode SOF1 See AD2 for detailed test sequence	~1 hour		

Step-No.	Test-Step-Description	Remarks/Results	P	N
.30	Switch to SPEC STBY	10 minutes		
4.1.1.11 Spectrometer to Photometer Mode Switch				
.31	Switch from SPEC STBY to PHOT STBY	20 minutes		
.32	Wait for temperatures to stabilise	TBD		
4.1.1.12 Photometer Thermal Control Verification				
.33	Carry out photometer thermal control characterisation test PTCV See AD2 for detailed test sequence	Test procedure TBW depending on the results from the ILT – should not take longer than 4 hours		
.34	Switch to Photometer STBY – wait for cooler exhaustion	Completes the hold time test		