1. INTRODUCTION

This note describes the tests to be carried out with the PFM1 instrument in order to simulate the operation of the SPIRE instrument during normal observing modes and generate data in a form able to be processed through the available data processing steps.

The goals of these tests are to:
- verify that the instrument can perform representative example observations
- provide example data (both with and without a simulated source) for use in testing and developing data reduction methods

The following observation types are executed:

- Point Source, high resolution, spectroscopy using continuous scanning (SOF1)
- Field mapping, medium resolution, spectroscopy, using continuous scanning (and raster) (SOF2)
- Point Source, low resolution, spectroscopy, using step and integrate scanning (SOF3)
- Point source photometry using chopping (and nodding) (POF1)
- Point source photometry using Jiggle Mapping (ie. 7 point Jiggle-map) (POF2)
- Photometric mapping with a fully sampled jiggle map (using a raster) (POF3)
- Mapping using scanning without chopping (POF5)

In all cases satellite pointing modes will be simulated as appropriate. For some of these tests (e.g. scanning) arranging a true simulated source might be rather difficult. Additionally, since only the spectrometer array is in place at this time, photometric observations will use the spectrometer detector arrays rather than the photometer array with the SMEC held at an appropriate position.

1.1 Reference Documents

RD01	Operation of the SPIRE FTS (SPIRE-RAl-NOT-002213)
RD02	Instrument User Manual

2. TEST SETUP

2.1 Prerequisites

2.1.1 Spectrometer mechanism positions

The start and end positions for FTS scans have to be determined from the measurement of the Zero Path Difference (ZPD) position before executing these tests.

Given the nominal position of the ZPD of 8000, the following positions are assumed for the FTS operations. Any change to ZPD should be reflected in an identical change to these values.

Position	Value	Description
ZPD	*8000 (nominal)*	Zero path difference
HOME	*5000 (Nominal)*	Home position

The nominal scan speed will be set to 0.5mm per second

Resolution	Scan range (mm)	Start Position	End Position	Scan Time (secs)
High	-3.4 mm to +34mm	**HRSTART** *(4600)*	**HREND** *(42000)*	74.8
Medium	-3.4 mm to +3.4 mm	**MRSTART** *(4600)*	**MREND** *(11400)*	13.6
Low	-1.0 mm to +1.0 mm	**LRSTART** *(7000)*	**LREND** *(9000)*	4.0

2.1.2 Pixel positions

The value of the chop and jiggle positions corresponding to the pixels used for chopping need to be determined

Pixel _ID	Chop Posn	Jiggle Posn	Description
On-source Position			
SSW-D4			SSW Central Pixel (on-source)
SLW-C3			SLW Central Pixel (on-source)
On-source position			Actual on-source position to be used
Off-source Position			
SLW-C4			SLW off-source
SSW-B3			SSW off-source
Off source Position			Actual off-source position to be used
Nod Position			
SSW-F3			SSW nod position

SLW-C2			SLW nod position
Nod Position			Actual nod position to be used

2.1.3 Raster positions

Rasters will be implemented by moving the telescope simulator to a set of positions corresponding to the raster positions. The raster array will be a 3 x 3 array at the following positions

Raster_ID	Pixel_ID	Chop Posn	Jiggle Posn	STEP
(0,0)	SSW-F1			0x0000
(0,1)	SSW-F1			0x0001
(0,2)	SSW-F1			0x0002
(1,2)	SSW-F1			0x0022
(1,1)	SSW-F1			0x0021
(1,0)	SSW-F1			0x0020
(2,0)	SSW-F1			0x0040
(2,1)	SSW-F1			0x0041
(2,2)	SSW-F1			0x0042

2.2 Configuration

In all cases the test will start, and end, with the instrument and test facility in the following configuration:

Instrument: In the SPEC_STBY mode (see RD02)
- SMEC is initialised, all trajectory parameters are set to their required values, the scan speed is set to its nominal value and the SMEC is held at the 'HOME' position
- The spectrometer JFETS are powered on, the detector bias set and sampling frequency set
- The BSM is powered on, and held in the 'HOME' position.
- MODE = 0x0400
- STEP = 0x0000
- Nominal Housekeeping sampling at 0.25 Hz

Facility:
- Cryostat window open

- Hot BB powered on (Temp TBD)
- Telescope simulator set to place the Hot BB on the central Spectrometer Pixels (SSW-D4, SLW-C3)
- Facility chopper out of beam

3. SPECTROMETER TESTS

3.1 Point Source Observation (SOF1)

This test will execute a set of 10 high resolution scans of the spectrometer.

3.1.1 Summary

Step	Building Block	Procedure	Description
1	A401-0000	**SCAN_CONF**	Set up the spectrometer for continuous scanning
		Set OBSID	Indicate Start of Observation BBID -> 0
		Set BBID to 0xA401	
		Set MODE to 0x1400	Indicate mode changing
		Set Nominal Hsk packets to 1 per second	Normal speed when SPIRE Prime
		Execute FTS_MOVE(HRSTART)	Move SMEC to start position ready to scan
		Switch on SCAL at required temperature	Currently no thermal control of SCAL is envisaged
		Wait for SMEC to reach HRSTART position and SCAL to settle	
		Set MODE to 0x0410	Indicate now in SOF1 mode
2	A410-0000	**SCAN**	Execute 4 scans
		Set BBID to 0xA410	
		Execute FTS_SCAN(HRSTART, HREND, 4)	Perform 4 FTS scans SMEC ends up back at START
3	A410-0001	**SCAN**	Execute 4 scans

		Set BBID to 0xA410	
		Execute FTS_SCAN (HRSTART, HREND, 4)	Perform 4 FTS scans SMEC ends up back at START
4	A410-0002	**SCAN**	Execute 2 scans
		Set BBID to 0xA410	
		Execute FTS_SCAN (HRSTART, HREND, 2)	Perform 2 FTS scans SMEC ends up back at START
5	A402-0000	**SCAN_END**	Return Spectrometer to SPEC_STBY mode
		Set BBID to 0xA402	
		Set MODE to 0x1410	Indicate mode changing
		Execute FTS_MOVE(HOME)	Move SMEC to 'home' position
		Switch off SCAL	
		Set Nominal Hsk packets to 0.25 per second	Normal speed when SPIRE in standby
		Set MODE to 0x0400	Indicate now in SPEC_STBY
		Set OBSID=0x00000000	Indicate end of observation BBID->0

3.1.2 Test Duration

Approximately 20 mins

3.2 Field Mapping Spectroscopy (SOF2)

This test will execute a set of 4 medium resolution scans of the spectrometer at a set of 9 'positions on the sky' (simulated by moving the telscope simulator)

3.2.1 Summary

Step	Building Block	Procedure	Description
1	A401-0000	**SCAN_CONF**	Set up the spectrometer for continuous scanning
		Set OBSID	Indicate Start of Observation BBID -> 0
		Set BBID to 0xA401	
		Set MODE to 0x1400	Indicate mode changing
		Set Nominal Hsk packets to 1 per second	Normal speed when SPIRE Prime
		Execute FTS_MOVE(MRSTART)	Move SMEC to start position ready to scan
		Switch on SCAL at required temperature	Currently no thermal control of SCAL is envisaged
		Wait for SMEC to reach START position and SCAL to settle	
		Set MODE to 0x0410	Indicate now in SOF1 mode
2	A380-0000	**PCAL_FLASH**	Execute PCAL calibration flash
		Set BBID to 0xA380	
		Execute PCAL_Flash	
3	A702-nnnn	**RASTER**	Move to raster position
		Set BBID to 0xA702	
		Move telescope simulator to raster position (see table 2.1.3)	
		Set STEP to value in table 2.1.3	

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4	A420-nnnn	**SCAN** **Set BBID to 0xA420** **Execute Scan_FTS(MRSTART, MREND, 4)**	Execute 4 scans Perform 4 FTS scans SMEC ends up back at START
5		**Repeat steps 3 and 4 for all raster positions in table 2.1.3**	
6	A380-0001	**PCAL_FLASH** **Set BBID to 0xA380** **Execute PCAL_Flash**	Execute PCAL calibration flash
7	A402-0000	**SCAN_END** **Set BBID to 0xA402** **Set MODE to 0x1420** **Execute FTS_MOVE(HOME)** **Switch off SCAL** **Set STEP to 0** **Set Nominal Hsk packets to 0.25 per second** **Set MODE to 0x0400** **Set OBSID=0x00000000**	Return Spectrometer to SPEC_STBY mode Indicate mode changing Move SMEC to 'home' position Normal speed when SPIRE in standby Indicate now in SPEC_STBY Indicate end of observation BBID->0
8		**Move telescope simulator to central pixel position**	

3.2.2 Test Duration

Approximately 60 mins, assuming 5 mins to peak up on each new raster position.

3.3 Point Source, low resolution, spectroscopy, using step and integrate scanning (SOF3)

This test will execute a medium resolution scan of the spectrometer.

3.3.1 Summary

Step	Building Block	Procedure	Description
1	A403-0000	**STEP_CONF**	Set up the spectrometer for step-and-look scanning
		Set OBSID	Indicate Start of Observation BBID -> 0
		Set BBID to 0xA403	
		Set MODE to 0x1400	Indicate mode changing
		Set Nominal Hsk packets to 1 per second	Normal speed when SPIRE Prime
		Execute FTS_MOVE(HRSTART)	Move SMEC to start position ready to scan
		Switch on SCAL at required temperature	Currently no thermal control of SCAL is envisaged
		Wait for SMEC to reach HRSTART position and SCAL to settle	
		Set MODE to 0x0430	Indicate now in SOF1 mode
2	A380-0000	**PCAL_FLASH**	Execute PCAL calibration flash
		Set BBID to 0xA380	
		Execute PCAL_Flash	
3	A430-nnnn	**CHOP**	
		Set BBID to 0xA430	
		Chop for 2 seconds	Chop between on and off source pixels.
4	A431-nnnn	**MOVE**	Move to next scan position

		Set BBID to 0xA431 **Execute FTS_MOVE (posn)**	
5		**Repeat steps 3 and 4 for positions MRSTART to MREND in steps of 10 (1600 steps)**	
6	A404-0000	**STEP_END** **Set BBID to 0xA404** **Set MODE to 0x1430** **Execute FTS_MOVE(HOME)** **Switch off SCAL** **Set Nominal Hsk packets to 0.25 per second** **Set MODE to 0x0400** **Set OBSID=0x00000000**	Return Spectrometer to SPEC_STBY mode Indicate mode changing Move SMEC to 'home' position Normal speed when SPIRE in standby Indicate now in SPEC_STBY Indicate end of observation BBID->0

3.3.2 Test Duration

Approximately 90 mins

4. PHOTOMETER TESTS

4.1 POF1: Point Source with Chop and no Nod

4.1.1 Summary

Step	Building Block	Procedure	Description
1	A301-0000	**CHOP_CONF** **Set OBSID** **Set BBID to 0xA301** **Set MODE to 0x1400** **Set Nominal Hsk packets to 1 per second** **Set MODE to 0x0310**	Set up instrument for photometer observations Indicate Start of Observation BBID -> 0 Indicate mode changing Normal speed when SPIRE Prime Indicate now in POF1 mode
2	A380-0000	**PCAL_FLASH** **Set BBID to 0xA380** **Execute PCAL_Flash**	Execute PCAL calibration flash
3	A310-0000	**CHOP** **Set BBID to 0xA310** **Chop for 120 seconds**	Chopping observation Chop between on and off source pixels.
4	A380-0001	**PCAL_FLASH** **Set BBID to 0xA380** **Execute PCAL_Flash**	Execute PCAL calibration flash
5	A302-0000	**CHOP_END**	Return Spectrometer to SPEC_STBY mode

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		Set BBID to 0xA302	
		Set MODE to 0x1310	Indicate mode changing
		Move BSM to HOLD position	
		Set STEP to 0	Normal speed when SPIRE in standby
		Set Nominal Hsk packets to 0.25 per second	Indicate now in SPEC_STBY
		Set MODE to 0x0400	Indicate end of observation BBID->0
		Set OBSID=0x00000000	

4.1.2 Test Duration

Approximately 8 mins

4.2 POF1: Point Source with Chop and Nodding

4.2.1 Summary

Step	Building Block	Procedure	Description
1	A301-0000	**CHOP_CONF** **Set OBSID** **Set BBID to 0xA301** **Set MODE to 0x1400** **Set Nominal Hsk packets to 1 per second** **Set MODE to 0x0310**	Set up instrument for photometer observations Indicate Start of Observation BBID -> 0 Indicate mode changing Normal speed when SPIRE Prime Indicate now in POF1 mode
2	A380-0000	**PCAL_FLASH** **Set BBID to 0xA380** **Execute PCAL_Flash**	Execute PCAL calibration flash
3	A310-0000	**CHOP** **Set BBID to 0xA310** **Chop for 120 seconds**	Chopping observation Chop between on and off source pixels.
4	A701-0000	**NOD** **Set BBID to 0xA701** **Move telescope simulator to NOD position** **Set STEP = 0x0001**	Move to nod position
5	A310-0001	**CHOP** **Set BBID to 0xA310**	Chopping observation

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			Chop for 120 seconds	Chop between on and off source pixels.
6	A700-0000		**POINT** **Set BBID to 0xA700** **Move telescope simulator to central pixel position** **Set STEP = 0x0000**	Move to central position
7	A310-0002		**CHOP** **Set BBID to 0xA310** **Chop for 120 seconds**	Chopping observation Chop between on and off source pixels.
8	A701-0001		**NOD** **Set BBID to 0xA701** **Move telescope simulator to NOD position** **Set STEP = 0x0001**	Move to nod position
9	A310-0003		**CHOP** **Set BBID to 0xA310** **Chop for 120 seconds**	Chopping observation Chop between on and off source pixels.
10	A700-0001		**POINT** **Set BBID to 0xA700** **Move telescope simulator to central pixel position** **Set STEP = 0x0000**	Move to central position
11	A380-0001		**PCAL_FLASH**	Execute PCAL calibration flash

		Set BBID to 0xA380 **Execute PCAL_Flash**	
12	A302-0000	**CHOP_END** **Set BBID to 0xA302** **Set MODE to 0x1310** **Move BSM to HOLD position** **Set STEP to 0** **Set Nominal Hsk packets to 0.25 per second** **Set MODE to 0x0400** **Set OBSID=0x00000000**	Return Spectrometer to SPEC_STBY mode Indicate mode changing Normal speed when SPIRE in standby Indicate now in SPEC_STBY Indicate end of observation BBID->0

4.2.2 Test Duration

Approximately 35 mins

4.3 POF2: Point Source with 7-point Jiggle with nodding

4.3.1 Summary

Step	Building Block	Procedure	Description
1	A303-0000	**J7_CONF**	Set up instrument for photometer observations
		Set OBSID	Indicate Start of Observation BBID -> 0
		Set BBID to 0xA303	
		Set MODE to 0x1400	Indicate mode changing
		Set Nominal Hsk packets to 1 per second	Normal speed when SPIRE Prime
		Set MODE to 0x032#0	Indicate now in POF1 mode
2	A380-0000	**PCAL_FLASH**	Execute PCAL calibration flash
		Set BBID to 0xA380	
		Execute PCAL_Flash	
3	A320-0000	**JIGGLE_7**	7-point jiggle operation
		Set BBID to 0xA320	
		Execute 7-point jiggle map	
4	A701-0000	**NOD**	Move to nod position
		Set BBID to 0xA701	
		Move telescope simulator to NOD position	
		Set STEP = 0x0001	
5	A320-0001	**JIGGLE_7**	7-point jiggle operation
		Set BBID to 0xA320	

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		Execute 7-point jiggle map	
6	A700-0000	**POINT** **Set BBID to 0xA700** **Move telescope simulator to central pixel position** **Set STEP = 0x0000**	Move to central position
7	A320-0002	**JIGGLE_7** **Set BBID to 0xA320** **Execute 7-point jiggle map**	7-point jiggle operation
8	A701-0001	**NOD** **Set BBID to 0xA701** **Move telescope simulator to NOD position** **Set STEP = 0x0001**	Move to nod position
7	A320-0003	**JIGGLE_7** **Set BBID to 0xA320** **Execute 7-point jiggle map**	7-point jiggle operation
10	A700-0001	**POINT** **Set BBID to 0xA700** **Move telescope simulator to central pixel position** **Set STEP = 0x0000**	Move to central position
11	A380-0001	**PCAL_FLASH**	Execute PCAL calibration flash

		Set BBID to 0xA380 Execute PCAL_Flash	
12	A304-0000	**J7_END**	Return Spectrometer to SPEC_STBY mode
		Set BBID to 0xA304	
		Set MODE to 0x1320	Indicate mode changing
		Move BSM to HOLD position	
		Set STEP to 0	Normal speed when SPIRE in standby
		Set Nominal Hsk packets to 0.25 per second	Indicate now in SPEC_STBY
		Set MODE to 0x0400	Indicate end of observation BBID->0
		Set OBSID=0x00000000	

4.3.2 Test Duration

Approximately 30 mins

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4.4 POF3: Point Source in Full Jiggle Map no Raster

4.4.1 Summary

Step	Building Block	Procedure	Description
1	A305-0000	**J64_CONF**	Set up instrument for photometer observations
		Set OBSID	Indicate Start of Observation BBID -> 0
		Set BBID to 0xA305	
		Set MODE to 0x1400	Indicate mode changing
		Set Nominal Hsk packets to 1 per second	Normal speed when SPIRE Prime
		Set MODE to 0x0330	Indicate now in POF1 mode
2	A380-0000	**PCAL_FLASH**	Execute PCAL calibration flash
		Set BBID to 0xA380	
		Execute PCAL_Flash	
3	A330-0000	**JIGGLE_64**	64-point jiggle operation
		Set BBID to 0xA330	
		Execute 64-point jiggle map	
4	A380-0001	**PCAL_FLASH**	Execute PCAL calibration flash
		Set BBID to 0xA380	
		Execute PCAL_Flash	
5	A306-0000	**J64_END**	Return Spectrometer to SPEC_STBY mode
		Set BBID to 0xA306	
		Set MODE to 0x1330	Indicate mode changing

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		Move BSM to HOLD position	
		Set STEP to 0	
		Set Nominal Hsk packets to 0.25 per second	Normal speed when SPIRE in standby
		Set MODE to 0x0400	Indicate now in SPEC_STBY
		Set OBSID=0x00000000	Indicate end of observation BBID->0

4.4.2 Test Duration

Approximately 10 mins

4.5 POF3: Point Source in Full Jiggle Map with Raster

4.5.1 Summary

Step	Building Block	Procedure	Description
1	A305-0000	**J64_CONF**	Set up instrument for photometer observations
		Set OBSID	Indicate Start of Observation BBID -> 0
		Set BBID to 0xA305	
		Set MODE to 0x1400	Indicate mode changing
		Set Nominal Hsk packets to 1 per second	Normal speed when SPIRE Prime
		Set MODE to 0x0330	Indicate now in POF1 mode
2	A380-0000	**PCAL_FLASH**	Execute PCAL calibration flash
		Set BBID to 0xA380	
		Execute PCAL_Flash	
3	A702-nnnn	**RASTER**	Move to raster position
		Set BBID to 0xA702	
		Move telescope simulator to raster position (see table 2.1.3)	
		Set STEP to value in table 2.1.3	
4	A330-nnnn	**JIGGLE_64**	64-point jiggle operation
		Set BBID to 0xA330	
		Execute 64-point jiggle map	
5		**Repeat steps 3 and 4 for each raster position in table 2.1.3**	

6	A380-0001	**PCAL_FLASH** **Set BBID to 0xA380** **Execute PCAL_Flash**	Execute PCAL calibration flash
7	A306-0000	**J64_END** **Set BBID to 0xA306** **Set MODE to 0x1330** **Move BSM to HOLD position** **Set STEP to 0** **Set Nominal Hsk packets to 0.25 per second** **Set MODE to 0x0400** **Set OBSID=0x00000000**	Return Spectrometer to SPEC_STBY mode Indicate mode changing Normal speed when SPIRE in standby Indicate now in SPEC_STBY Indicate end of observation BBID->0

4.5.2 Test Duration

Approximately 65 mins

4.6 POF5: Scanning without chopping

4.6.1 Summary

Step	Building Block	Procedure	Description
1	A307-0000	**PSCAN_CONF**	Set up instrument for photometer scanning observations
		Set OBSID	Indicate Start of Observation BBID -> 0
		Set BBID to 0xA307	
		Set MODE to 0x1400	Indicate mode changing
		Set Nominal Hsk packets to 1 per second	Normal speed when SPIRE Prime
		Set MODE to 0x0350	Indicate now in POF1 mode
2		**Insert signal attenuator into beam**	Effectively gives no signal for most of the observation
3	A380-0000	**PCAL_FLASH**	Execute PCAL calibration flash
		Set BBID to 0xA380	
		Execute PCAL_Flash	
4	A350-nnnn	**PSCAN**	Photometric scan
		Set BBID to 0xA350	
		Collect data for 60 seconds	
5		**Increment STEP**	Set new scan number
6		**Repeat steps 3-4 for 10 scans**	
		During scan 5 after 30 seconds remove signal attenuator for ~ 0.5 seconds	Puts a 'source' at the centre of the map
7	A380-0001	**PCAL_FLASH**	Execute PCAL calibration flash
		Set BBID to 0xA380	

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		Execute PCAL_Flash	
8	A308-0000	**PSCAN_END**	Return Spectrometer to SPEC_STBY mode
		Set BBID to 0xA308	
		Set MODE to 0x1350	Indicate mode changing
		Move BSM to HOLD position	
		Set STEP to 0	
		Set Nominal Hsk packets to 0.25 per second	Normal speed when SPIRE in standby
		Set MODE to 0x0400	Indicate now in SPEC_STBY
		Set OBSID=0x00000000	Indicate end of observation BBID->0

4.6.2 Test Duration

Approximately 15 mins