



Technical Note

PFM1 Performance Test Details

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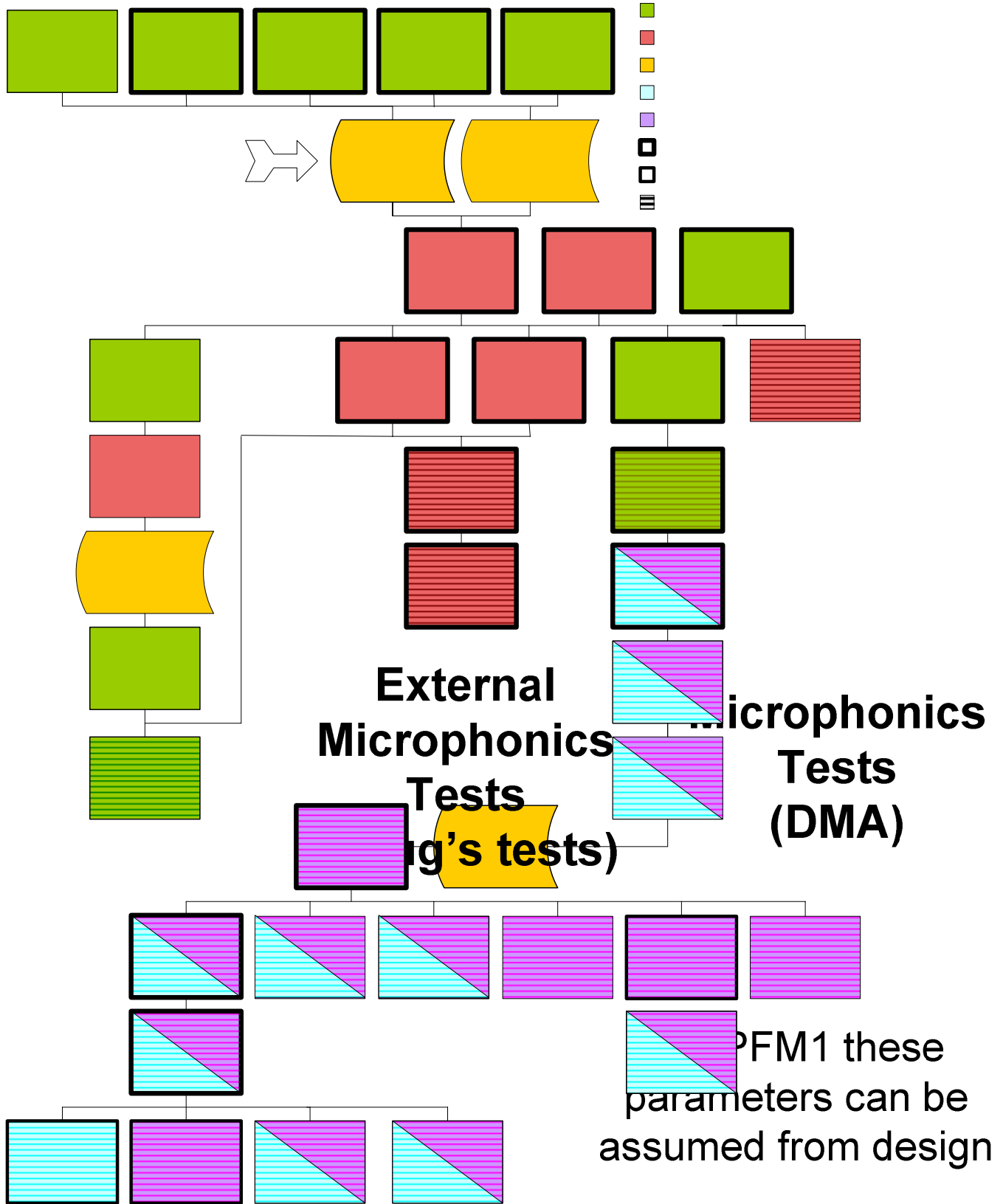
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1. TEST FLOW



PFM1

Performance Test



2. NOMINAL SETTINGS FOR THE DETECTORS

Bias frequency to 160 Hz,
Bias amplitude to 16 mV rms
Sample rate to 80 Hz
Phase to peaked up value

3. DETECTOR TESTS

3.1 Notes

- The max bias amplitude is not in the DRCU-DPU ICD. Bruce checked and it is the same as the photometer.
- It is assumed that 160 Hz is lowest usable bias frequency for the spectrometer as the lowest meaningful sample rate when scanning is 80 Hz and there is no apparent reason to sample slower.

3.2 DNA-S Noise Test with Lowest Possible Background

1. Check that the cold black body is off and conditions are stable
2. Check that the flip mirror set so that cold black body is in FOV
3. Check that the BSM is centred on middle pixel
4. Move the SMEC to home
5. Check that SCAL is switched off
6. Set bias frequency, bias amplitude, sample rate and phase to nominal values.
7. Request full spectrometer data
8. 5 bias amplitudes 0, 5, 10, 15, 30 mV rms 10 minutes each, setting offsets before taking data at each level
9. Repeat for bias frequencies 180, 200, 240, 260 Hz, note each bias frequency is a standalone test.

3.3 DNC-S Noise Test with Telescope Representative Background

1. Set the cold black body to 8 K (TBR)
2. Set the flip mirror so that cold black body is in FOV
3. Check that the BSM is centred on the middle pixel
4. Move the SMEC to home
5. Check that SCAL is switched off
6. Set bias frequency to 160 Hz, bias amplitude to 16 mV rms, sample rate to 80 Hz and phase to peaked up value for 160 Hz bias.
7. Request full spectrometer data
8. Wait 30 minutes
9. 5 bias amplitudes 0, 5, 10, 15, 30 mV rms 10 minutes each setting offsets before taking data at each level
10. Repeat for bias frequencies 180, 200, 240, 260 Hz, note each bias frequency is a standalone test.

3.4 DAB-S Dark Load Curves

1. Check that the cold black body is off and conditions are stable



2. Check that the flip mirror set so that cold black body is in the FOV
3. Check that the BSM is centred on the middle pixel
4. Move the SMEC to home
5. Check that SCAL is switched off
6. Set bias frequency to 160 Hz, sample rate to 80 Hz (divider = 1)
7. Set bias amplitude to zero
8. Set phase to peaked value
9. Set offsets
10. Wait 10 seconds
11. Request full spectrometer data (10 seconds)
12. Stop data generation
13. Set phase to -90
14. Set offsets
15. Wait 10 seconds
16. Request full spectrometer data (10 seconds)
17. Stop data generation
18. Set phase to +90
19. Set offsets
20. Wait 10 seconds
21. Request full spectrometer data (10 seconds)
22. Stop data generation
23. Repeat steps 3-18 for bias amplitudes 0-10 in steps of 1, 10-20 in steps of 2, 20-70 in steps of 5
24. Repeat load curve set for bias frequencies

(This was taken directly from the previous version of this. Given we didn't end up doing it this way but instead did the phases separately should I now write it up to do the phases separately?)

3.5 DAL-S Optical Load Curves

1. Flip mirror set so that cold black body is in FOV
2. Check that the BSM is centred on the middle pixel
3. Move the SMEC to home
4. Check that SCAL is switched off
5. Request full spectrometer data
6. Set bias frequency to 160 Hz, bias amplitude to 16 mV rms, sample rate to 80 Hz and phase to peaked up value for 160 Hz bias
7. Set cold black body to 8 K
8. Wait 30 minutes
9. Run procedure for DAB-P steps 8-22
10. Repeat for cold black body temperatures 9K and 11K, as separate runs of this test

3.6 DRB/L-S Time Response With The Hot Black Body or Laser

1. Flip mirror set so that the lab is in the FOV
2. Check that the BSM is centred on the middle pixel
3. Move the SMEC to home
4. Check that SCAL is switched off
5. Set bias frequency to 160 Hz, bias amplitude to 16 mV rms, and phase to peaked up value for 160 Hz bias
6. Set the detectors to the maximum sample rate for the nominal bias frequency (e.g. 160 Hz)
7. If possible request full spectrometer data, else request appropriate array data for pixel under study. (Given the problems we had jacking the sample rate up on PLW this may be an issue)



8. Check that the telescope simulator is centred on the pixel under study, and either the hot black body or laser is illuminating the selected pixel.
9. Set the chopper frequency to 2 Hz
10. Wait for 3 minutes
11. Repeat 4-5 for chop frequencies of 1,2,3,4,5,6,7,8,9,10, 15, 20, 25,30,35,40 Hz
12. Repeat for other pixels as separate runs of this test

3.7 DLA-S Beam Attenuation Using The Laser

1. Flip mirror set so that the lab is in the FOV
2. Check that the BSM is centred on the middle pixel
3. Move the SMEC to home
4. Check that SCAL is switched off
5. Set bias frequency to 160 Hz, bias amplitude to 16 mV rms, sample rate to 80 Hz and phase to peaked up value for 160 Hz bias
6. Check that the telescope simulator is centred on the pixel under study, and the laser is illuminating the selected pixel.
7. Set chop frequency to 2Hz
8. Wait 3 minutes
9. Place known attenuation in beam (eg one sheet of paper)
10. Wait 3 minutes
11. Place another attenuator in beam (now two sheets of paper)
12. Wait 3 minutes
13. Repeat until unable to get signal from hot black body

4. PCAL TESTS

*These tests should be done with SCAL switched off i.e. to get maximum signal on the detectors plus possibly with SCAL switched on to mimic possible operational conditions in flight.

4.1 CPC-S PCAL Static Characterisation

1. Flip mirror set so that cold black body is in FOV and the cold blackbody is off.
2. Check that the BSM is centred on the middle pixel
3. Move the SMEC to home
4. Check that SCAL is switched off
5. Set bias frequency to 160 Hz, bias amplitude to 16 mV rms, and phase to peaked up value for 160 Hz bias
6. Request full spectrometer data
7. Set PCAL bias to 0.5 mA
8. Wait for 0.5 minutes
9. Set PCAL bias to zero
10. Wait for 0.5 minutes
11. Repeat for PCAL settings 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0, 5.5, 6.0, 6.5 and 7.0 mA

4.2 CPT-S PCAL Dark Frequency Characterisation

1. Flip mirror set so that cold black body is in FOV and the cold blackbody is off.
2. Check that the BSM is centred on the middle pixel
3. Move the SMEC to home
4. Check that SCAL is switched off



5. Set bias frequency to 160 Hz, bias amplitude to 16 mV rms, and phase to peaked up value for 160 Hz bias
6. Request full spectrometer data
7. Set PCAL bias to 7 mA
8. Wait for 0.125 seconds
9. Set PCAL to 0 mA
10. Wait for 0.125 seconds
11. Repeat 5-8 1200 times (i.e giving 10 minutes of data)
12. Repeat for PCAL bias settings of 2 Hz, 1 Hz, 0.5 Hz, 0.25 Hz (10 minutes each)
13. Repeat for bias values 0-3.5, 3.5-7.0, 1.75-5.25

4.3 CPF-S PCAL Loaded Frequency Characterisation

1. Set flip mirror to put cold black body in the FOV
2. Check that the BSM is centred on the middle pixel
3. Move the SMEC to home
4. Check that SCAL is switched off
5. Set bias frequency to 160 Hz, bias amplitude to 16 mV rms, and phase to peaked up value for 160 Hz bias
6. Request full spectrometer data
7. Cold black body is set to 8 K (TBR)
8. Wait 30 minutes
9. Run PCAL between two 0-3,5 mA levels at nominal flash frequency (0.25 Hz) for 1 minute
10. Run PCAL between level pairs, 3.5-7.0 mA, 0-1mA and 0-2 mA.
11. Repeat at TBD black body temperatures as separate runs of this test

4.4 CPS-S PCAL Standard Flash

1. Set flip mirror to put cold black body in the FOV and that the cold blackbody is off
2. Check that the BSM is centred on the middle pixel
3. Move the SMEC to home
4. Check that SCAL is switched off
5. Set bias frequency to 160 Hz, bias amplitude to 16 mV rms, and phase to peaked up value for 160 Hz bias
6. Request full spectrometer data
7. Set PCAL bias to 3.5 mA
8. Wait for 2 seconds
9. Set PCAL to 0 mA
10. Wait for 2 seconds
11. Repeat 5-8 10 times (i.e giving 40 seconds of data)
12. Repeat for wait of 1 second, 20 times

5. OPTICAL TESTS

5.1 PKB/L-S Peak-Up Using T/S With The Hot Blackbody or Laser

- I'm assuming the pixel diameters are 18" and 35" as these are the figures in the science requirements.
- I'm also assuming that even for the co-aligned pixels we may have to peak-up separately.
- This test is written for the SLW pixels, for SSW pixels the distance is 9" and the step size 2.25".

- There is no reason not to request full spectrometer data for this test even though the test is only applicable to one pixel on one array.
1. Cold black body is off, hot black body is on at 1000 °C
 2. External chopper is running at 2Hz
 3. Set flip mirror to put the window in the FOV
 4. SMEC is set to home
 5. The spectrometer calibrator is off
 6. BSM is set to centre of the array (i.e. pixel is located by the T/S not by the BSM)
 7. Request full spectrometer data
 8. Set bias frequency, sample rate and amplitude to nominal
 9. Set telescope simulator to position beam at nominal centre of central pixels
 10. Wait for QLA to determine if source is detected
 11. Move source to centre of central pixel
 12. Check QLA to determine if source on central pixel and adjust again if necessary
 13. Move telescope simulator -18 arcseconds in the Z direction (figure 2 position 1)
 14. Wait for 2 minutes
 15. Move the telescope simulator +4.5 arcseconds in the Z direction (figure 2 position 2)
 16. Wait for 2 minutes
 17. Repeat for all positions in figure 2
 18. Determine nominal centre of the SSW pixel from the peak-up data
 19. Repeat steps 10-14
 20. Make any further adjustment if necessary

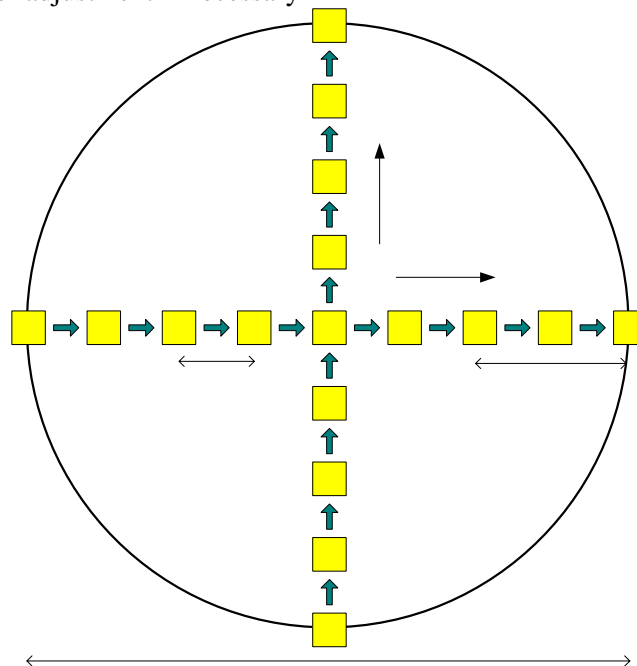


Figure 1: Raster Pattern For SLW Peak-Up

5.2 PKI-S - Peak-Up Using The BSM With The Hot Blackbody or Laser

* I'm assuming the centre of array position for the BSM is known while the centre of array position for the T/S is not. Therefore the T/S peakup will need to have been done before the BSM peakup mode can

be exercised. However if the nominal central position of the BSM is not aligned with the array centre we may need to bootstrap these tests somehow.

1. Cold black body is off, hot black body is on at 1000 °C
2. External chopper is running at 2Hz
3. Set flip mirror to put the window in the FOV
4. SMEC is set to home
5. The spectrometer calibrator is off
6. T/S is set to centre of array
7. BSM is set to centre of the pixel tested (i.e. pixel is located by the T/S not by the BSM)
8. Request full spectrometer data
9. Set bias frequency, sample rate and amplitude to nominal
10. Perform raster shown in figure 1 using the BSM instead of the telescope simulator to move the source, note the size of the raster is dependant on the pixel tested.

5.3 OSB/L-S Beam Scan Using The T/S With The Hot Blackbody or Laser – Type 1

* For SSW pixels all distance parameters should be halved.

1. Run PKU
2. Move source to centre of the central pixel
3. Move telescope simulator + 36 arcseconds in the +Y direction
4. Wait for 3 minutes
5. Move the telescope simulator 4.5 arcseconds in the -Y direction and 9.0 arcseconds in the -Z direction (position 2 in figure 3), wait for 3 minutes
6. Move to the remaining pixels in turn as indicated in figure 3 (see table 1), waiting 3 minutes at each.

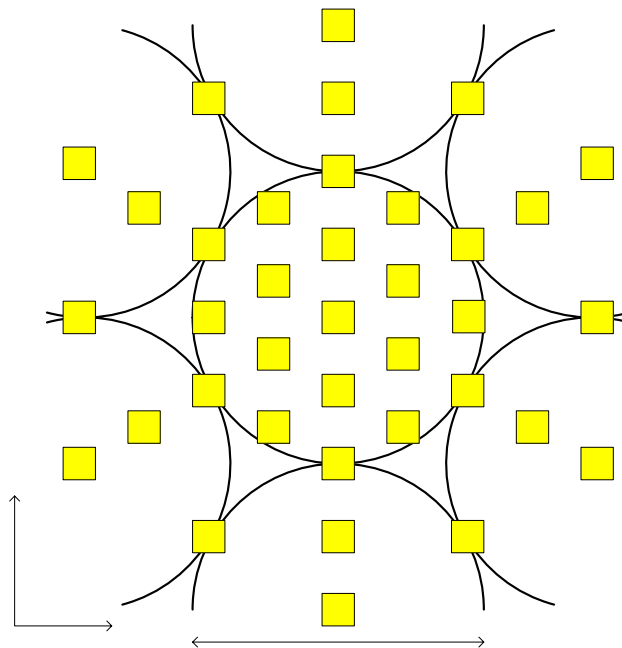


Figure 3: Beam Scan Raster Pattern

5.4 OSB/L-S Beam Scan Using The T/S With The Hot Blackbody or Laser – Type 2

* For SSW pixels all distance parameters should be halved.

1. Run PKU
2. Move source to centre of the central pixel
3. Offset to first raster position
4. Wait 1 minute
5. Repeat for all raster positions

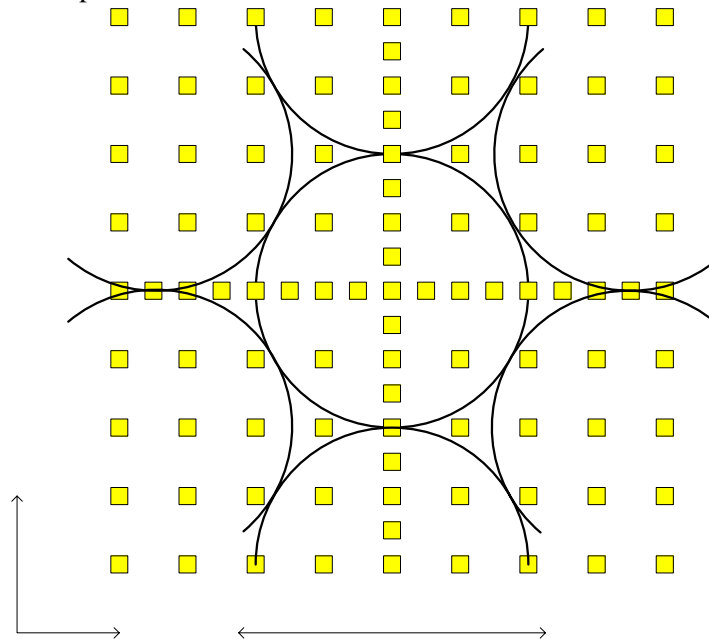


Figure 4: Square Beam Scan Raster Pattern

5.5 OSB/L-S Beam Scan Using The T/S With The Hot Blackbody or Laser – Type 3

* For SSW pixels all distance parameters should be halved.

1. Run PKU
2. Move source to centre of the central pixel
3. Offset to first raster position
4. Wait 1 minute
5. Repeat for all raster positions

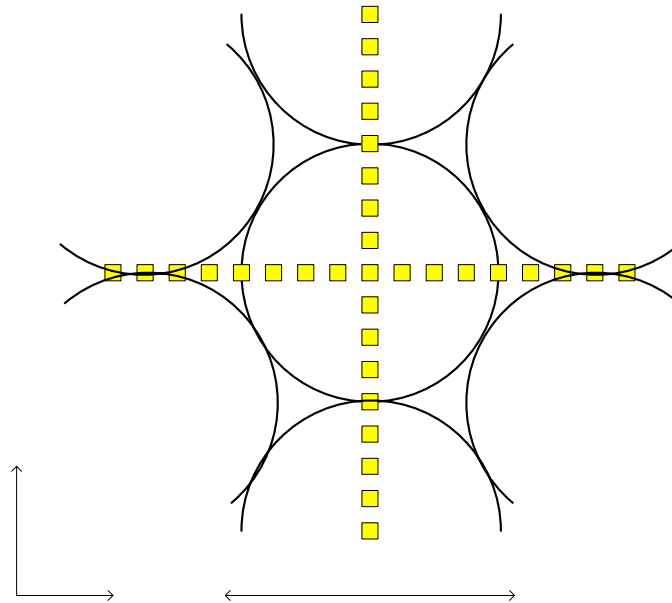


Figure 5: Cross Beam Raster Pattern

5.6 OPB-S Beam Scan Using The BSM

1. Configure lab to put hot black body in beam
2. External chopper is running at 2Hz
3. Set flip mirror to put the window in the FOV
4. SMEC is set to home
5. The spectrometer calibrator is off
6. T/S is set to centre of array
7. BSM is set to centre of the pixel tested (i.e. pixel is located by the T/S not by the BSM)
8. Request full spectrometer data
9. Run one of the OSB/L rasters using the BSM to perform the raster scan instead of the telescope simulator. Again, the size of this raster will depend on whether a SSW or SLW pixel is tested.

5.7 OPI-S Pupil Scan

* To be updated by Samuel

10. Reconfigure lab to put hot black body in beam at pupil
11. Set the telescope simulator to the position of the central pixel
12. Chopper is running at 2Hz (TBR may depend on nominal sample rate)
13. Move the source to the edge of the pupil
14. Wait 5 minutes
15. Move the source 5% of the distance across the pupil
16. Wait for 5 minutes
17. Repeat until source scanned across pupil

5.8 OBL-S Out of Band Rejection Using OOB Laser Lines

1. Cold black body is off, laser is on with brightest in band line
2. SMEC is at home
3. The spectrometer calibrator is off
4. BSM at centre of array



5. Request full spectrometer data
6. Set bias frequency, sample rate and amplitude to nominal
7. Chopper is running at 2Hz
8. Wait 3 minutes
9. Change laser line to out of band line
10. Wait 10 minutes
11. Repeat for four more lines

5.9 DPB-S Polarisation With The Black Body or Laser

1. Cold black body is off, hot black body is on at maximum setting, chopper is running at 2 Hz
2. Set flip mirror to put hot black body in the beam
3. SMEC is at home
4. The spectrometer calibrator is off
5. BSM at centre of array
6. Request full spectrometer data
7. Set bias frequency, sample rate, phase and amplitude to nominal
8. Set telescope simulator at centre of central pixel (previous peak-up prerequisite)
9. Wait for 3 minutes
10. Place polariser in beam and note setting
11. Wait for 5 minutes
12. Move polariser 60 degrees
13. Wait for 5 minutes
14. Move polariser another 60 degrees
15. Wait for 5 minutes
16. Remove polariser from beam
17. Wait for 3 minutes

6. BSM CHARACTERISATION

6.1 BSM-S BSM Characterisation

* Not sure how to approach this, the centre of the non-central pixels may have been found previously by peak-up but it is unlikely we will have time to peak-up on all of them, especially for the SSW array. Without this, this test could act as a coarse test checking that we see the chopped signal in the right pixel and that the signal amplitude is such that we know that the BSM is reasonably centred.

1. The hot black body is placed at the input of the telescope simulator and set to a 1200°C
2. The chopper is placed in the beam and set to 2 Hz
3. Place the SMEC at home
4. The spectrometer calibrator is off
5. Request full spectrometer data
6. Set bias frequency, sample rate, phase and amplitude to nominal
7. Set up the T/S to be centred on the central pixels
8. Place the BSM at the centre of the central pixels
9. Point the BSM at each pixel of the pixels in the array in turn
10. Check that the position reached is correct for that pixel.
11. Repeat for the other array

6.2 BCT-S BSM Chop Throw

1. The hot black body is placed at the input of the telescope simulator and set to a 1200°C



2. The chopper is placed in the beam and set to 2 Hz
3. Place the SMEC at home
4. The spectrometer calibrator is off
5. Request full spectrometer data
6. Set bias frequency, sample rate, phase and amplitude to nominal
7. Set up the T/S to be centred on the central pixels
8. Place the BSM at the centre of the central pixels
9. Use the BSM to chop between the centre pixel and an adjacent one
10. Vary the chop frequency, 0.25, 0.5, 1, 1.5, 2 Hz
11. Select pixel pairs so that the full range of amplitudes and directions are tested, each pixel pair can be a separate run of this test

Define BSM chopping command definition

7. SPECTROMETER SPECIFIC TESTS

7.1 SZP ZPD Position

1. The cold black body is placed in the sky port of the FTS and is switched off and stable
2. The spectrometer calibrator is set to a nominal value and allowed to stabilise.
3. The detectors are set to nominal, phase, bias frequency, sample rate and bias amplitude.
4. The SMEC is set to home (I'm assuming this position is always known)
5. The SMEC is moved 0.2 mm in the ZPD direction. * It is not clear from the DPU-DRCU ICD how the position is set therefore I'm not sure if this is possible.
6. Wait 5 seconds
7. The SMEC is moved back to home
8. Wait 5 seconds
9. The SMEC is moved to the next position (another 0.2mm to 0.4 mm) and back again until sufficient range of the SMEC has been covered to find the ZPD (This should be about 4-5 mm).
10. The test may be repeated with finer steps around the ZPD.
11. The test should be repeated with the calibration source cold and the external black body set to a known temperature to ensure that the ZPD position is the same in both paths through the spectrometer.

7.2 OBP Balancing of Ports

1. The cold black body is placed in the sky port of the FTS and is switched off and stable
2. The spectrometer calibrator is set to maximum output and allowed to stabilise.
3. The detectors are set to nominal, phase, bias frequency, sample rate and bias amplitude.
4. Request full spectrometer data
5. The SMEC is set to home
6. The SMEC is scanned maximum distance 20 times and the detector output is read.
7. The test is repeated as a separate obsid with the cold black body on and the SCAL off.

7.3 SFC Fringe Contrast and Spectral Response While Scanning

1. A laser line is focussed and peaked up onto a single spectrometer pixel using the telescope simulator.
2. The BSM is set to the nominal centre of the array.
3. The spectrometer calibrator is not used.



4. The detectors are set to nominal, phase, bias frequency, sample rate and bias amplitude.
5. Request full spectrometer data
6. Allow conditions to stabilise while continuing to readout the detectors
7. The SMEC is scanned over its full range of movement 20 times.
8. The test is repeated over the 100 resolution (-3.2mm to +3.2mm) and 10 resolution scan ranges.
9. The test is repeated for all possible laser lines.
10. The test is repeated for as many pixels in the spectrometer arrays as practicable

7.4 SFL Fringe Contrast and Spectral Response Step and Look

* If we only use step and look for low resolution mode this test is probably not necessary

1. A laser line is focussed and peaked up onto a single spectrometer pixel using the telescope simulator.
2. The SMEC is moved to home.
3. The BSM is commanded to start chopping at nominal frequency (2Hz?) and chop throw (adjacent co-aligned pixel?).
4. The detectors are read out for 10 seconds (or should this be N chop cycles?).
5. The SMEC is moved to the next position (TBD) in the step and look sequence and the 10s readout is repeated.
6. This is repeated until the SMEC range is covered
7. The test is repeated for all possible laser lines.
8. The test is repeated for as many pixels in the spectrometer arrays as practicable

7.5 SMC Mirror Carriage Characterisation While Scanning

1. The cold black body source set to 15K is used
2. The BSM is set to the nominal centre of the arrays
3. The spectrometer calibrator is off
4. The SMEC position is set to home.
5. The detectors are set to nominal, phase, bias frequency, sample rate and bias amplitude.
6. Request full spectrometer data
7. The SMEC is scanned over its full range.
8. Repeat for resolution 10 and 100 SMEC ranges
9. Repeat for different speeds

7.6 SML Mirror Carriage Characterisation Step and Look

1. The hot black body is placed in the sky port of the spectrometer and centred on the central pixel.
2. The spectrometer calibrator is off
3. The SMEC position is set to home.
4. The BSM is commanded to start chopping at nominal frequency (2Hz?) and chop throw (adjacent co-aligned pixel?).
5. The detectors are read out for 10s (or should this be N chop cycles?).
6. The SMEC is moved to the next position (TBD) in the step and look sequence.
7. The detectors are read out for 10s (or number of chop cycles) then the SMEC is moved to the next position etc until the step and look scan is completed.

7.7 OBS Out of Band Radiation Using the SMEC

1. The laser is used, initially with an in-band line.
2. The BSM is set to the nominal centre of the arrays



3. The spectrometer calibrator is off
4. The detectors are set to nominal, phase, bias frequency, sample rate and bias amplitude.
5. Request full spectrometer data
6. The SMEC position is set to home.
7. Scan the SMEC over its full range.
8. Repeat with the laser set up with out of band lines

7.8 CSC Spectrometer Calibrator Characterisation

1. The cold blackbody is placed in the sky port of the FTS and set to nominal temperature.
2. One of the spectrometer calibrators is selected and set to its first operating point.
3. The detectors are set to nominal, phase, bias frequency, sample rate and bias amplitude.
4. Request full spectrometer data
5. The SMEC is scanned 20 times over a short range about the ZPD.
6. The spectrometer calibrator is set to the next operating point and the scans are repeated.
7. This is repeated until the TBD ranges of operating points have been tested.
8. The test is repeated using all operating points for various black body temperatures.

Define PID characteristics for SCAL – measure time constants of SCAL – Ken could write a VM that does the PID control

7.9 CSR Room Temperature Nulling

1. The sky port of the FTS is open to the room.
2. One of the spectrometer calibrators is selected and set to its first operating point.
3. The detectors are set to nominal, phase, bias frequency, sample rate and bias amplitude.
4. Request full spectrometer data
5. The SMEC is scanned 20 times over a short range about the ZPD.
6. The spectrometer calibrator is set to the next operating point and the scans are repeated.
7. This is repeated until the TBD range of operating points have been tested.

7.10 CST Spectrometer Calibrator Performance With Time

1. A blackbody is placed in the sky port of the FTS and set to a nominal temperature probably about 8K
2. Set the spectrometer calibrator to the nulling value
3. The detectors are set to nominal, phase, bias frequency, sample rate and bias amplitude.
4. Request full spectrometer data
5. PCAL is cycled.
6. The SMEC is scanned 20 times over a short range about the ZPD.
7. PCAL is cycled again to check for responsivity changes.
8. Repeat the PCAL cycles and SMEC scans for about 2 hours