FS Testing Overview
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Scope
The aims of the SPIRE Flight Spare instrument level test programme are briefly stated and a top level description of the test programme is given.

The SPIRE Flight Spare Instrument
The FS build standard is as follows:

FPU	Flight quality for all sub-systems with the following caveats: SMEC – no redundant side optical encoder (operation failure) JFETs – x out 15 units are non-flight quality (attrition)
DRCU	QM2 is used – no redundancy on SCU
DPU	CFM
OBS	?

Flight Spare testing rationale
The basic purpose of the FS was to provide an FPU capable of being swapped for the PFM if there is a major problem during system level AIV. This aim is compromised by the failure of the FS SMEC redundant side encoder and the incomplete set of flight quality JFETS. The FS therefore provides a set of parts that can be swapped into the PFM in the event of a major failure.

The secondary aim of building the FS is to provide a test bed for the easy and rapid evaluation of on-board software upgrades; in-flight operations validation and trouble shooting of problems found on the flight unit, either during ground testing or once in flight.

The FS instrument level test campaign must therefore show that the sub-systems, as integrated into the instrument, perform as intended and are capable of being flown if necessary. To this end the test plan outlined here provides for the basic functional and performance testing of the instrument with, initially , little detailed characterisation, as the first priority. The second priority will be the validation of in-flight procedures and on-board software and the lowest priority is given to detailed performance characterisation.

Whether a vibration test is to be carried out on the FPU is to be decided dependent largely on schedule considerations. This is not discussed further here except to state that the basic function and performance test will be conducted before and after any vibration campaign.

Outline Test Procedure
Functional Test
General procedure is contained in SPIRE-RAL-PRJ-001652 – specific procedures carried out before (PFM4 and PFM5) are as follows.

The standard warm functional test (SPIRE-RAL-PRC-002322) will be carried out before and after installation into the test cryostat.

The standard cool functional test (SPIRE-RAL-PRC-002584) will be carried out at LN temperature

The standard cold functional test (SPIRE-RAL-REP-002585 see also SPIRE-RAL-PRC-002398) will be carried out once the instrument reaches operational temperature

Operation and Performance Verification
In order to check the basic operation and performance of the instrument the following set of tests is mandatory:

Proc ID	Description	Tests Used
FS-1.	Cooler recycling	CREC
FS-2.	Detector noise P – basic check for gross problems – includes phasing	ILT-PERF-VSS ILT-PERF-DPH ILT-PERF-DNA
FS-3.	Detector noise S – basic check for gross problems – includes phasing	ILT-PERF-VSS ILT-PERF-DPH ILT-PERF-DNA
FS-4.	Instrument throughput P – CBB – loadcurves vs T_{CBB}	ILT-PERF-DAB ILT-PERF-DAL
FS-5.	Instrument throughput S – CBB – loadcurves vs T_{CBB}	ILT-PERF-DAB ILT-PERF-DAL
FS-6.	Optical alignment P – centre of field/overlapping pixels	ILT-PERF-FOC ILT-PERF-PKI ILT-PERF-PKB
FS-7.	Optical alignment S – centre of field/overlapping pixels	ILT-PERF-PKI ILT-PERF-PKB
FS-8.	BSM performance and tuning	ILT-PERF-BSM ILT-PERF-BCT
FS-9.	SMEC performance and tuning	ILT-PERF-SMC
FS-10	Band pass P – TFTS centre of field	ILT-PERF-DSR
FS-11	Band pass S – to CBB	ILT-PERF-SSC
FS-12	Instrument throughput S – SCAL	ILT-PERF-DAB ILT-PERF-DAL
FS-13	Band pass S – to SCAL	ILT-PERF-CSS
FS-14	PCAL operation and response P	ILT-PERF-CPT ILT-PERF-CPS
FS-15	PCAL operation and response S	ILT-PERF-CPT ILT-PERF-CPS

In-flight operations validation

We wish to test that the procedures used for the commissioning, calibration and routine flight operations operate correctly when carried out with a real instrument. In particular the upgraded on board software, which includes the Failure Detection Isolation and Recovery procedures, needs to be tested in a "live" environment in order to debug it ahead of deployment on the flight system. The following procedures are proposed for the flight spare test campaign – some details need to be worked through.

Commissioning phase run through
AOT Testing using latest logic
PTC tuning algorithm and in flight tuning methodology
FDIR validation and operation

Characterisation of performance

If time permits further useful tests can be carried on the FS these are aimed at providing data for testing the pipeline and characterising the instrument performance.

Long simulated observations using AOTs to provide data for pipeline testing.
Detector characteristics as function of bias frequency (gain/bias/noise dependence)
Spectrometer performance testing – checks on nulling with small area SCAL; spectral response at more wavelengths
More pixel characterisation (bandpass/psf/FoV)

Proposed schedule for performance tests

Based on the outline schedule for PFM4 – here is a possible sequence for approximately the first two of performance testing – only 8 days are shown but with single shift working and allowing for things to go wrong this will probably take 3 elapsed weeks.

Schedule week starting #

Day 1	ID	Test description
	FS-1	Cooler recycle
	FS-2	Photometer - Phase up 130 Hz
	FS-4	Photometer dark load curve
	FS-2	Photometer standard noise test
	FS-14	Photometer PCAL level and standard flash test
	FS-3	Spectrometer - Phase up 160 Hz
	FS-5	Spectrometer dark load curve
	FS-3	Spectrometer standard noise test
	FS-15	Spectrometer PCAL level and standard flash test
	FS-2	Photometer overnight noise test
Day 2		
	FS-6	Photometer initial focus test using hot black body
	FS-6	Photometer peak-ups using hot black body
	FS-10	Photometer TFTS Scans
	FS-2	Photometer overnight noise test
Day 3		
	FS-7	Spectrometer initial focus test using hot black body
	FS-7	Spectrometer peak-ups using hot black body
	FS-9	SMEC tuning and scan checks – laser line scans SSW + SLW lines
	FS-1	Cooler recycle
Day 4		
	FS-4	Photometer dark loadcurve
	FS-4	Photometer loadcurves versus CBB temp (8.7,11,13,15,20 K TBC)
	FS-2	Photometer overnight noise test
Day 5		
	FS-5	Spectrometer dark loadcurve
	FS-5 FS-11	Spectrometer loadcurves and SMEC scans versus CBB (no SCAL) (off 8.7,11,13,15,20 K TBC)
	FS-3	Spectrometer overnight noise test
Day 6		
	FS-1	Cooler recycle
	FS-4	Photometer dark loadcurve
	FS-4	Photometer room loadcurve
	FS-8	BSM pixel finding
	FS-8	BSM tuning
	FS-6	Photometer beam shape using BSM
	FS-2	Photometer overnight noise test
Day 7		
	FS-12	Spectrometer dark loadcurve
	FS-12	SCAL-4 operation and tuning

	FS-12 FS-13	Spectrometer SCAL-4 tests load curves plus scans
	FS-3	Spectrometer overnight noise tests
Day 8		
	FS-12	Spectrometer dark loadcurve
	FS-12	SCAL-2 operation and tuning
	FS-12 FS-13	Spectrometer SCAL-2 tests load curves plus scans