



## SPIRE Report

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PIRE CQM Verification Matrix Report  
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This note contains a report from the SPIRE CQM Verification Matrix covering those requirements for the Instrument Requirements Document (SPIRE-RAL-PRJ-00034) and Qualification Requirements Document (SPIRE-RAL-PRJ-00592) tested during the SPIRE CQM test campaign.

The tables are set out in the following order:

- Requirements verified by Integration Procedures
- Requirements verified by Warm Functional Test
- Requirements verified by Cold Functional Test
- Requirements verified by Vibration Test
- Requirements verified by Thermal Test
- Requirements verified by EMC Test
- Requirements verified by Performance Test



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## VERIFIED DURING FPU AND INSTRUMENT INTEGRATION

Requirement Name	Description	Procedure	Report	NCRs	Status/Comments
IRD-EMC-R01	The SPIRE instrument grounding shall comply with the SPIRE Instrument Grounding Philosophy Document	MSSL/SPIRE/SP011 SPIRE-RAL-DOC-1888 SPIRE-RAL-DOC-2108	SPIRE-RAL-LOG-1625	HR-SP-RAL-NCR-82 HR-SP-RAL-NCR-83 Raise NCR for FPU/cryostat integration procedure	Implementation issues to be addressed on PFM
IRD-STRC-R06	Pumping port	By Analysis			No evidence of problems during pump down
IRD-STRC-R12	Grounding	MSSL/SPIRE/SP011	SPIRE-RAL-LOG-1625		Compliant
IRD-STRC-R13	Electrical isolation from Herschel	MSSL/SPIRE/SP011 SPIRE-RAL-DOC-1888 SPIRE-RAL-DOC-2108	SPIRE-RAL-LOG-1625	HR-SP-RAL-NCR-81 Raise NCR for FPU/cryostat integration procedure	Implementation issues to be addressed on PFM
IRD-STRP-R05	Pumping port	By Analysis			No evidence of problems during pump down
IRD-STRS-R05	Pumping port	By Analysis			No evidence of problems during pump down
IRD-COOL-R10	Mechanical interface	MSSL/SPIRE/SP011	SPIRE-RAL-LOG-1625		Compliant – no issues for PFM
IRD-DETP-R12	Volume envelope	By Analysis			Compliant - No issues with fitting
IRD-DETP-R14	Mechanical interface	MSSL/SPIRE/SP011	SPIRE-RAL-LOG-1625		Compliant - No issues with fitting
IRD-DETS-R13	Volume envelope	By Analysis			Compliant - No issues with fitting
IRD-DETS-R15	Mechanical interface	MSSL/SPIRE/SP011	SPIRE-RAL-LOG-1625		Compliant - No issues with fitting
IRD-CALP-R09	Volume envelope	By Analysis			Compliant - No issues with fitting
IRD-FTB-R04	Envelope	By Analysis			Compliant - No issues with fitting
IRD-RFM-R02	Envelope	By Analysis			Compliant - No issues with fitting
IRD-WE-R18	S/C Interface	SPIRE-RAL-DOC-1799	SPIRE-RAL-MOM-1815		Not fully tested – no LCL test



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## VERIFIED DURING FPU AND INSTRUMENT INTEGRATION

Requirement Name	Description	Procedure	Report	NCRs	Status/Comments
			SPIRE-RAL-REP-2084		
IRD-WE-R19	Subsystem Interface	Electrical integration procedure	SPIRE-RAL-MOM-1815 SPIRE-RAL-REP-2084		MCU not tested on CQM
IRD-FSIM-R01	Function	N/A			Not tested on CQM – to be tested on AVM
IRD-FSIM-R02	Analogue Outputs	N/A			Not tested on CQM – to be tested on AVM
IRD-FSIM-R03	Control loops	N/A			Not tested on CQM – to be tested on AVM
VRD-03	Mechanical interface with FIRST system	MSSL/SPIRE/SP011 SPIRE-RAL-PRC-1923	SPIRE-RAL-DOC-2166		To be completed during EQM
VRD-05	Sub-system mechanical interfaces	MSSL/SPIRE/SP011	SPIRE-RAL-LOG-1625		All issues now addressed for PFM
VRD-10	Integration and alignment	MSSL/SPIRE/SP011	SPIRE-RAL-LOG-1625		Compliant see SM/AM verification matrix
VRD-17	Harness mechanical frequency response and routing	MSSL/SPIRE/SP011	SPIRE-RAL-LOG-1625		Compliant except SMEC to be done of PFM1
VRD-21	Detector sub-system interface compatibility - thermal electrical mechanical	MSSL/SPIRE/SP011	SPIRE-RAL-LOG-1625		Mechanical Compliant for Photometer
VRD-30	Electrical interface to Herschel system	SPIRE-RAL-DOC-1799	SPIRE-RAL-MOM-1815 SPIRE-RAL-REP-2084		Not fully tested on CQM no LCL test
VRD-32	Sub-system electrical interfaces	SPIRE-RAL-DOC-1799	SPIRE-RAL-MOM-1815 SPIRE-RAL-REP-2084		Not fully tested on CQM no MCU test
VRD-33	Wiring tables	SPIRE-RAL-DOC-1799	SPIRE-RAL-MOM-1815 SPIRE-RAL-REP-2084		Not fully tested on CQM no MCU test
VRD-34	Analogue to digital interfaces	SPIRE-RAL-DOC-1799	SPIRE-RAL-MOM-1815 SPIRE-RAL-REP-2084		Not fully tested on CQM no MCU test
VRD-35	Digital to digital interfaces	SPIRE-RAL-DOC-1799	SPIRE-RAL-MOM-1815 SPIRE-RAL-REP-2084		See WFT
VRD-36	Data interface to Herschel system	SPIRE-RAL-REP-1886	SPIRE-RAL-REP-1886		See WFT



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## VERIFIED DURING FPU AND INSTRUMENT INTEGRATION

Requirement Name	Description	Procedure	Report	NCRs	Status/Comments
VRD-50	Instrument to ground facility interfaces	SPIRE-RAL-REP-1886 SPIRE-RAL-NOT-1651 SPIRE-RAL-DOC-1888 SPIRE-RAL-DOC-2108 SPIRE-RAL-PRC-2122	SPIRE-RAL-REP-1886	Raise NCR for FPU/cryostat integration procedure	Compliant – procedure needed for FPU/Cryostat integration



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## VERIFIED BY WARM FUNCTIONAL TEST

Requirement Name	Description	Procedure In	Test Report Section	NCRs	Status/Comments
IRD-VER-R03	The CQM verification testing shall demonstrate that the following conditions are met or are likely to be met on the PFM: Correct operation of all FPU sub-systems at cryogenic temperatures for all instrument operation modes for both prime and redundant systems. The instrument cold FPU and JFET box thermal dissipation is within requirements for all instrument operation modes. The warm electronics thermal dissipation at room temperature is within requirements. Correct operation of all on-board software. The instrument straylight environment is within requirements The instrument optics performance is within requirements The performance of the instrument meets the scientific requirements expected for the CQM for all instrument observing modes Development and test of all functional test sequences required for Integrated Systems Testing (IST) at satellite level. The correct functioning of the instrument for all observing modes and calibration sequences. Development and test of all in-flight functional and performance test sequences	SPIRE-RAL-DOC-001888 SPIRE-RAL-DOC-001652	SPIRE-RAL-REP-002084		Warm electronics units used for CQM model have not been thermally cycled and do not have full functional capability.  CQM has only verified performance of photometer optics and PLW detector.
IRD-PHOT-R11	Electrical crosstalk should be <1% (goal 0.5%) between nearest-neighbour pixels and <0.1 % (goal 0.05%) between all other pixels in the same array.	Electrical Crosstalk Test Procedure – ref ?			Covered by performance tests
IRD-PHOT-R13	The photometer dynamic range for astronomical signals shall be > 12 bits.	SPIRE-RAL-DOC-001652 FUNC-DCU-03	SPIRE-RAL-REP-002084		
IRD-WE-R01	Packet Services	SPIRE-RAL-DOC-001652 FUNC-DCU-11 FUNC-SCU-01	SPIRE-RAL-REP-002084 §4, 7 §7		Science data generation ok



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## VERIFIED BY WARM FUNCTIONAL TEST

Requirement Name	Description	Procedure In	Test Report Section	NCRs	Status/Comments
		FUNC-MCU-02	§7		
IRD-WE-R02	Telecommands	SPIRE-RAL-DOC-001652	SPIRE-RAL-REP-002084	SPIRE-OBS SPR-0288	Some commands failed to execute All commands that did execute produced the expected response
IRD-WE-R03	Telemetry	SPIRE-RAL-DOC-001652	SPIRE-RAL-REP-002084		Telemetry as expected
IRD-WE-R04	Housekeeping	SPIRE-RAL-DOC-001652	SPIRE-RAL-REP-002084		Telemetry as expected
IRD-WE-R05	Operating Modes	SPIRE-RAL-DOC-001652	SPIRE-RAL-REP-002084		SPIRE into DRCU ON, INIT, REDY & STANDBY
IRD-WE-R06	Command Services	SPIRE-RAL-DOC-001652	SPIRE-RAL-REP-002084	SPIRE-OBS SPR-0288	Occasional loss of commands
IRD-WE-R07	Data Handling	SPIRE-RAL-DOC-001652	SPIRE-RAL-REP-002084		Telemetry and housekeeping as expected
IRD-WE-R18	S/C Interface	SPIRE-RAL-DOC-001652	SPIRE-RAL-REP-002084		Tested using SPIRE EGSE (CDMS Simulator)
IRD-WE-R19	Subsystem Interface	SPIRE-RAL-DOC-001652	SPIRE-RAL-REP-002084		Commands executed as expected
IRD-WE-R20	Subsystem Control Loops	N/A	N/A		Not tested at room temperature
IRD-WE-R21	Subsystem Data Acquisition	SPIRE-RAL-DOC-001652	SPIRE-RAL-REP-002084		All subsystems functioned as expected at room temperature
IRD-WE-R22	Data Processing	N/A	N/A		No on-board data processing
IRD-WE-R23	Communication	SPIRE-RAL-DOC-001652	SPIRE-RAL-REP-002084		Telecommand, Telemetry, Housekeeping and Science packets being sent/received
IRD-WE-R24	WE anomalies	SPIRE-RAL-DOC-001652	SPIRE-RAL-REP-002084	NCR-MCU-123  SPIRE-OBS SPR-0288	Over current limited triggered preventing MCU from switching on – to be fixed for MCU-QM1  Occasional Tele-Command drop-out.
IRD-WE-R25	Subsystem anomalies	SPIRE-RAL-DOC-001652	SPIRE-RAL-REP-002084		None
IRD-WE-R26	Anomaly Management	Not Tested	Not Tested		Not tested at room temperature



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## VERIFIED BY WARM FUNCTIONAL TEST

Requirement Name	Description	Procedure In	Test Report Section	NCRs	Status/Comments
IRD-WE-R35	Power	SPIRE-RAL-DOC-001652	SPIRE-RAL-REP-002084	NCR-MCU-123	Over current limited triggered preventing MCU from switching on – to be fixed for MCU-QM1
IRD-FSIM-R01	Function	SPIRE-RAL-DOC-001652	SPIRE-RAL-REP-002084		All subsystems functioned as expected during WFT
IRD-FSIM-R02	Analogue Outputs	SPIRE-RAL-DOC-001652	SPIRE-RAL-REP-002084		All subsystems functioned as expected during WFT Limited test
IRD-FSIM-R03	Control loops	N/A	N/A		Not Tested during WFT
VRD-21	Detector sub-system interface compatibility - thermal electrical mechanical	SPIRE-RAL-DOC-001652			Electrical checkout during integration Functional tests showed that there were no problems due to electrical interfaces
VRD-24	Electrical grounding	SPIRE-RAL-DOC-001652			Checked during integration Functional tests showed that there were no problems due to grounding loops
VRD-27	Non-detector Harness performance	SPIRE-RAL-DOC-001652			
VRD-28	Power supply cleanliness	SPIRE-RAL-DOC-001652			Noise within acceptable levels
VRD-29	Digital/analogue separation	?	?		
VRD-30	Electrical interface to Herschel system	SPIRE-RAL-DOC-001652	SPIRE-RAL-REP-002084		Tested using SPIRE EGSE
VRD-31	Power supply distribution and control				Tested using SPIRE EGSE
VRD-32	Sub-system electrical interfaces	SPIRE-RAL-DOC-001652	SPIRE-RAL-REP-002084		Functional tests demonstrate that internal interfaces were ok
VRD-33	Wiring tables	SPIRE-RAL-DOC-001652	SPIRE-RAL-REP-002084		Limited test at warm temperatures show indirectly that subsystems were wired as per harness definition.
VRD-34	Analogue to digital interfaces	SPIRE-RAL-DOC-001652	SPIRE-RAL-REP-002084		Limited tests at warm temperatures show that all A2D circuits were ok.



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## VERIFIED BY WARM FUNCTIONAL TEST

Requirement Name	Description	Procedure In	Test Report Section	NCRs	Status/Comments
VRD-35	Digital to digital interfaces	SPIRE-RAL-DOC-001652	SPIRE-RAL-REP-002084		Some problems with assignment of parameters as signed or unsigned integers – otherwise numbers coming out as expected
VRD-36	Data interface to Herschel system	SPIRE-RAL-DOC-001652	SPIRE-RAL-REP-002084		Tested using SPIRE EGSE (CDMS Simulator)
VRD-37	Operating mode definition	SPIRE-RAL-DOC-001652	SPIRE-RAL-REP-002084		SPIRE into DRCU ON, INIT, REDY & STANDBY
VRD-38	Instrument commanding definition	SPIRE-RAL-DOC-001652	SPIRE-RAL-REP-002084		All commands that did execute produced the expected response
VRD-39	On board software definition	SPIRE-RAL-DOC-001652	SPIRE-RAL-REP-002084	SPIRE-OBS SPR-0288	OBS rejecting some commands at random Otherwise on board software behaved as expected
VRD-40	Sub-system operational and control interfaces	SPIRE-RAL-DOC-001652	SPIRE-RAL-REP-002084		Commands executed as expected
VRD-41	Sub-system data interfaces	SPIRE-RAL-DOC-001652	SPIRE-RAL-REP-002084		Telemetry as expected
VRD-48	Ground commissioning and calibration plan	SPIRE-RAL-DOC-001652	SPIRE-RAL-REP-002084		Functional tests performed will be used for in-flight verification and ISTs
VRD-50	Instrument to ground facility interfaces	SPIRE-RAL-DOC-001652	SPIRE-RAL-REP-002084		Instrument tested with full EGSE system including storage of telemetry inside HCSS database, SCOS, QLA





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## Verified by Cold functional test

Requirement Name	Description	Procedure In	Test Report Section	NCRs	Status/Comments
IRD-VER-R03	<p>The CQM verification testing shall demonstrate that the following conditions are met or are likely to be met on the PFM: Correct operation of all FPU sub-systems at cryogenic temperatures for all instrument operation modes for both prime and redundant systems.</p> <p>The instrument cold FPU and JFET box thermal dissipation is within requirements for all instrument operation modes.</p> <p>The warm electronics thermal dissipation at room temperature is within requirements.</p> <p>Correct operation of all on-board software.</p> <p>The instrument straylight environment is within requirements</p> <p>The instrument optics performance is within requirements</p> <p>The performance of the instrument meets the scientific requirements expected for the CQM for all instrument observing modes</p> <p>Development and test of all functional test sequences required for Integrated Systems Testing (IST) at satellite level. The correct functioning of the instrument for all observing modes and calibration sequences.</p> <p>Development and test of all in-flight functional and performance test sequences</p>	<p>SPIRE-RAL-DOC-001888</p> <p>SPIRE-RAL-DOC-001652</p>	SPIRE-RAL-REP-002084		<p>Warm electronics units used for CQM model have not been thermally cycled and do not have full functional capability.</p> <p>CQM has only verified performance of photometer optics and PLW detector.</p>
IRD-FPHR-R01	Detector harness capacitance				Covered by performance tests
IRD-DETP-R05	Electrical crosstalk for near neighbour pixels.				Covered by performance tests
IRD-DETP-R06	Electrical crosstalk any pair of pixels				Covered by performance tests
IRD-CALP-R10	Thermal isolation	<p>SPIRE-RAL-DOC-001652</p> <p>FUNC-SCU-03</p> <p>FUNC-SCU-06</p>	SPIRE-RAL-REP-002084		Instrument reached operating temperatures and remained stable.
IRD-CALP-R11	Operating temperature	<p>SPIRE-RAL-DOC-001652</p> <p>FUNC-SCU-03</p> <p>FUNC-SCU-06</p>	SPIRE-RAL-REP-002084		Calibrated temperatures showing sensible values except BSM thermometer.



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## Verified by Cold functional test

Requirement Name	Description	Procedure In	Test Report Section	NCRs	Status/Comments
IRD-CALP-R12	Cold power dissipation	SPIRE-RAL-DOC-001652 FUNC-SCU-07	SPIRE-RAL-REP-002084	HR-SP-RAL-NCR-62	Cooler recycling OK Heat switch took too long to close
IRD-CALS-R12	Thermal Isolation	SPIRE-RAL-DOC-001652 FUNC-SCU-03 FUNC-SCU-06	SPIRE-RAL-REP-002084		Instrument reached operating temperatures and remained stable.
IRD-CALS-R13	Operating Temperature	SPIRE-RAL-DOC-001652 FUNC-SCU-03 FUNC-SCU-06	SPIRE-RAL-REP-002084		Instrument reached operating temperatures and remained stable.
IRD-FTB-R01	Amplifier noise	SPIRE-RAL-DOC-001652 FUNC-DCU-11	SPIRE-RAL-DOC-002084		Noise not measured directly?
IRD-FTB-R05	Dissipation	SPIRE-RAL-DOC-001652 FUNC-DCU-11	SPIRE-RAL-REP-002084		PLW array only Temperatures measured by TFCS were sensible and stable when powered on.
IRD-FTB-R08	Nominal operating temperature	SPIRE-RAL-DOC-001652 FUNC-DCU-11	SPIRE-RAL-REP-002084		PLW array only Temperatures measured by TFCS were sensible and stable when powered on.
IRD-RFM-R03	Dissipation	SPIRE-RAL-DOC-001652	SPIRE-RAL-REP-002084		Temperatures measured during test were sensible
IRD-RFM-R05	Nominal operating temperature	SPIRE-RAL-DOC-001652	SPIRE-RAL-REP-002084		Temperatures measured during test were sensible
IRD-WE-R08	Photometer detector readout	SPIRE-RAL-DOC-001652 FUNC-DCU-11	SPIRE-RAL-REP-002084		PLW Array only
IRD-WE-R13	PCAL Control	SPIRE-RAL-DOC-001652 FUNC-SCU-04 FUNC-PCAL-01	SPIRE-RAL-REP-002084		
IRD-WE-R14	SCAL Control	SPIRE-RAL-DOC-001652 FUNC-SCU-05 FUNC-SCAL-01	SPIRE-RAL-REP-002084	HR-SP-RAL-NCR-64	SCAL 4% failed at operating temperatures
IRD-WE-R15	Cooler Control	SPIRE-RAL-DOC-001652 FUNC-SCU-07	SPIRE-RAL-REP-002084	HR-SP-RAL-NCR-62 HR-SP-RAL-NCR-63	Heat switch took too long to close Pump and evaporator heat switch commands were in



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## Verified by Cold functional test

Requirement Name	Description	Procedure In	Test Report Section	NCRs	Status/Comments
		Cooler Recycling			wrong order
IRD-WE-R17	Housekeeping	SPIRE-RAL-DOC-001652	SPIRE-RAL-REP-002084		Telemetry acquisition as expected
IRD-WE-R20	Subsystem Control Loops	N/A	N/A		Not tested
IRD-WE-R21	Subsystem Data Acquisition	SPIRE-RAL-DOC-001652	SPIRE-RAL-REP-002084		Telemetry acquisition as expected
IRD-WE-R22	Data Processing	N/A	N/A		No on-board data processing
IRD-WE-R23	Communication	SPIRE-RAL-DOC-001652	SPIRE-RAL-REP-002084		Telecommand, Telemetry, Housekeeping and Science packets being sent/received
IRD-WE-R24	WE anomalies	SPIRE-RAL-DOC-001652	SPIRE-RAL-REP-002084	NCR-MCU-123  NCR-  SPIRE-OBS SPR-0288	Over current limited triggered preventing MCU from switching on – to be fixed for MCU-QM1  MCU went into oscillation when powered on causing instrument temperatures to escalate – should be fixed for MCU-QM1  Occasional Tele-Command drop-out.
IRD-WE-R25	Subsystem anomalies	SPIRE-RAL-DOC-001652	SPIRE-RAL-REP-002084	HR-SP-RAL-NCR-64	SCAL 4% failed at operating temperatures
IRD-WE-R26	Anomaly Management	SPIRE-RAL-DOC-001652	SPIRE-RAL-REP-002084	HR-SP-RAL-NCR-61	Illegal command not rejected by DRCU and not sending an exception report.
IRD-WE-R35	Power	SPIRE-RAL-DOC-001652	SPIRE-RAL-REP-002084	NCR-MCU-123  NCR-	Over current limited triggered preventing MCU from switching on – to be fixed for MCU-QM1  MCU went into oscillation when powered on causing instrument temperatures to escalate – should be fixed for MCU-QM1
VRD-12	Thermal performance	SPIRE-RAL-DOC-001652	SPIRE-RAL-REP-002084		Temperatures measured during test were sensible
VRD-17	Harness mechanical frequency response and routing	SPIRE-RAL-DOC-001652	SPIRE-RAL-REP-002084		
VRD-21	Detector sub-system interface compatibility -	SPIRE-RAL-DOC-001652			Electrical checkout during integration



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## Verified by Cold functional test

Requirement Name	Description	Procedure In	Test Report Section	NCRs	Status/Comments
	thermal electrical mechanical				Functional tests showed that there were no problems due to electrical interfaces
VRD-24	Electrical grounding	SPIRE-RAL-DOC-001652			Checked during integration Functional tests showed that there were no problems due to grounding loops
VRD-27	Non-detector Harness performance	SPIRE-RAL-DOC-001652		HR-SP-RAL-NCR-63	Pump and evaporator heat switch commands were in wrong order – solution was to update the harness definition and the DRCU/DPU ICD.
VRD-28	Power supply cleanliness	SPIRE-RAL-DOC-001652			Noise within acceptable levels
VRD-29	Digital/analogue separation	?	?		
VRD-30	Electrical interface to Herschel system	SPIRE-RAL-DOC-001652	SPIRE-RAL-REP-002084		Tested using SPIRE EGSE
VRD-32	Sub-system electrical interfaces				Tested using SPIRE EGSE
VRD-33	Wiring tables	SPIRE-RAL-DOC-001652	SPIRE-RAL-REP-002084	HR-SP-RAL-NCR-63	Pump and evaporator heat switch commands were in wrong order – solution was to update the harness definition and the DRCU/DPU ICD.
VRD-34	Analogue to digital interfaces	SPIRE-RAL-DOC-001652	SPIRE-RAL-REP-002084		Test results show that A2D circuits were OK
VRD-37	Operating mode definition	SPIRE-RAL-DOC-001652	SPIRE-RAL-REP-002084		SPIRE in DRCU ON, REDY, PHOT STANDBY
VRD-38	Instrument commanding definition	SPIRE-RAL-DOC-001652	SPIRE-RAL-REP-002084		All commands that did execute produced the expected response
VRD-39	On board software definition	SPIRE-RAL-DOC-001652	SPIRE-RAL-REP-002084	SPIRE-OBS SPR-0288	OBS rejecting some commands at random Otherwise on board software behaved as expected
VRD-40	Sub-system operational and control interfaces	SPIRE-RAL-DOC-001652	SPIRE-RAL-REP-002084		Commands executed as expected
VRD-41	Sub-system data interfaces	SPIRE-RAL-DOC-001652	SPIRE-RAL-REP-002084		Telemetry as expected
VRD-48	Ground commissioning and calibration plan	SPIRE-RAL-DOC-001652	SPIRE-RAL-REP-002084		Functional tests performed will be used for all ground testing, in-flight verification and ISTs
VRD-49	Flight commissioning and calibration plan	SPIRE-RAL-DOC-001652	SPIRE-RAL-REP-002084		Functional tests performed will be used for in-flight



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## Verified by Cold functional test

Requirement Name	Description	Procedure In	Test Report Section	NCRs	Status/Comments
					verification and ISTs
VRD-50	Instrument to ground facility interfaces	SPIRE-RAL-DOC-001652	SPIRE-RAL-REP-002084		Instrument tested with full EGSE system including storage of telemetry inside HCSS database, SCOS, QLA



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## VERIFIED BY VIBRATION TEST

Requirement Name	Description	Procedures	Test Reports	NCRs	Status/Comment
IRD-INST-R15	The instrument units are required to undergo an environmental test programme that demonstrates the design and build standard of the flight model is compatible with the launch and operational environment of the Herschel satellite.	SPIRE-RAL-PRC-001956 SPIRE-RAL-NOT-001681	SPIRE-MSS-REP-002049		CQM tested stainless steel supports only. PFM will have CFRP supports
IRD-STRC-R09	First natural frequency of the instrument assembly	SPIRE-RAL-PRC-001956	SPIRE-MSS-REP-002049		CQM tested stainless steel supports only. PFM will have CFRP supports
IRD-STRP-R07	First natural frequency	SPIRE-RAL-PRC-001956	SPIRE-MSS-REP-002049		CQM tested stainless steel supports only. PFM will have CFRP supports
IRD-STRS-R07	First natural frequency	SPIRE-RAL-PRC-001956	SPIRE-MSS-REP-002049		CQM tested stainless steel supports only. PFM will have CFRP supports
IRD-FTB-R09	First natural frequency	SPIRE-RAL-PRC-001956 Post vibe inspection procedure	SPIRE-MSS-REP-002049 SPIRE-RAL-REP-002007		Qualification complete



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## VERIFIED BY THERMAL TEST

Requirement Name	Description	Procedure In SPIRE-RAL-DOC-00207 Draft 4.6	Test Report Section in SPIRE-RAL-REP-002078 Issue 1	NCRs	Status/Comments
IRD-INST-R15	The instrument units are required to undergo an environmental test programme that demonstrates the design and build standard of the flight model is compatible with the launch and operational environment of the Herschel satellite.	ALL	All sections		All tests defined in the test specification have been carried out.
IRD-VER-R03	The CQM verification testing shall demonstrate that the following conditions are met or are likely to be met on the PFM: Correct operation of all FPU sub-systems at cryogenic temperatures for all instrument operation modes for both prime and redundant systems. The instrument cold FPU and JFET box thermal dissipation is within requirements for all instrument operation modes. The warm electronics thermal dissipation at room temperature is within requirements. Correct operation of all on-board software. The instrument straylight environment is within requirements The instrument optics performance is within requirements The performance of the instrument meets the scientific requirements expected for the CQM for all instrument observing modes Development and test of all functional test sequences required for Integrated Systems Testing (IST) at satellite level. The correct functioning of the instrument for all observing modes and calibration sequences. Development and test of all in-flight functional and performance test sequences	ALL	All Sections		Test Restrictions:  BSM, SMEC and JFETs were STM so operating power dissipation could not be verified (see test report at sub-system levels for information).  SCAL and PCAL operation will be checked at EQM level as no correlation was possible for the level1 load on CQM (defective temperature sensors).
IRD-STRC-R05	Surface finish of the Common Structure cover	N/A			Will be validated by analysis at EQM level
IRD-STRC-R14	Thermal isolation	Procedure TBT2, TBT3	Sections 5.2.5.2, 5.2.5.3		Test Restrictions:



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Requirement Name	Description	Procedure In SPIRE-RAL-DOC-00207 Draft 4.6	Test Report Section in SPIRE-RAL-REP-002078 Issue 1	NCRs	Status/Comments
					Conductance from L2 to L1 was non-flight representative at CQM level, will be tested at EQM and PFM2 level
IRD-STRP-R04	Surface finish				By inspection.
IRD-STRP-R09	Thermal isolation	Procedure TBT2, TBT3	Sections 5.2.5.2, 5.2.5.3		Test Restrictions: Conductance from L1 to L0 photo was non-representative at CQM level, will be tested at EQM and PFM2 level
IRD-STRS-R04	Surface finish				By inspection.
IRD-STRS-R08	Thermal isolation	Procedure TBT2, TBT3	Sections 5.2.5.2, 5.2.5.3		Test Restrictions: Conductance from L1 to L0 spectro was non-representative at CQM level, will be tested at EQM and PFM2 level
IRD-COOL-R01	Temperature at the detectors	Procedure F-I	Section 5.2.4.3.2	NCRxxx	300-mK Busbar needs re-manufacturing with higher purity copper and will be tested at PFM2 level
IRD-COOL-R02	Operating temperature control	N/A			PTC will be implemented at PFM2 level
IRD-COOL-R03	Temperature drop across thermal link between detectors and evaporator cold tip	Procedure F-I	Section 5.2.4.3.2	NCRxxx	Non-compliant as measured temperature drop is about 33mK
IRD-COOL-R04	Temperature drift	Procedure TBT2, TBT3	Sections 5.2.5.2, 5.2.5.3		Test Restrictions: The cooler cold tip temperature drift has been tested but without active control as the PTC will be implemented at PFM2 level
IRD-COOL-R05	Temperature fluctuations at the evaporator cold tip				See previous requirement.
IRD-COOL-R06	System low frequency temperature stability				N/A anymore thermal control circuit will be used for this Test anyway restricted by cryostat stability





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Requirement Name	Description	Procedure In SPIRE-RAL-DOC-00207 Draft 4.6	Test Report Section in SPIRE-RAL-REP-002078 Issue 1	NCRs	Status/Comments
IRD-COOL-R07	Heat lift at evaporator cold tip	Procedure F-I	Section 5.2.4.3.2		Test Restrictions:  4 STM BDA  Will be tested at PFM2 Level.
IRD-COOL-R08	Hold time	Procedure TBT2, TBT3	Sections 5.2.5.2, 5.2.5.3		Test Restrictions:  L1/L0 Isolation Supports non-flight representative,  L0 straps non-flight representative,  4 STM BDA.  Will be tested at PFM2 Level.
IRD-COOL-R09	Recycle time	Procedure Appendix D	Section 5.2.2.3		Test Restrictions:  The L0 straps were not flight representative  Will be tested at EQM/PFM2 level
IRD-COOL-R11	Thermal Interface with Herschel cryostat				Will be tested at EQM with flight-representative L0 straps
IRD-COOL-R12	Parasitic thermal load onto He bath during cold operation	Procedure F-I	Section 5.2.4.3.2		Test Restrictions:  The L0 straps and isolation supports were not flight representative  Will be tested at EQM/PFM2 level.
IRD-COOL-R13	Time averaged thermal load onto He bath for 48 hour cycle				Will be tested at PFM2 Level



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## VERIFIED BY THERMAL TEST

Requirement Name	Description	Procedure In SPIRE-RAL-DOC-00207 Draft 4.6	Test Report Section in SPIRE-RAL-REP-002078 Issue 1	NCRs	Status/Comments
IRD-DETP-R13	300 mK thermal load	Procedure F-I	Section 5.2.4.3.2		Test Restrictions:  4 STM BDA  Will be tested at PFM2 level
IRD-DETS-R14	300 mK thermal load	Procedure F-I	Section 5.2.4.3.2		Test Restrictions:  4 STM BDA  Will be tested at PFM2 level
IRD-CALP-R10	Thermal isolation		Section 4.2.3		Test Restrictions:  An acceptable warm-up has been measured when the SCAL2 was operated. Need to check SCAL4.
IRD-CALS-R12	Thermal Isolation		Cardiff test report		Subsystem Level test
IRD-FTB-R05	Dissipation	Procedure G-I	Section 5.2.3		Test Restrictions:  The impact of the JFET temperature on the FPU performances has been assessed but STM JFET modules were used  Will be tested at PFM2 level
VRD-12	Thermal performance	All	All sections		
VRD-13	Thermal interface to Herschel system				Tested at EQM
VRD-14	Sub-system thermal interfaces	All	All sections		



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## VERIFIED BY EMC TEST

Requirement Name	Description	Procedure	Test Report (Section)	NCRs	Status/Comments
IRD-INST-R15	The instrument units are required to undergo an environmental test programme that demonstrates the design and build standard of the flight model is compatible with the launch and operational environment of the Herschel satellite.	SPIRE-RAL-NOT-001681	SPIRE-RAL-REP-2167		Compliance not fully tested on CQM
IRD-STRC-R02	Attenuation of RF by Common Structure covers	SPIRE-RAL-NOT-001681	SPIRE-RAL-REP-2167		Compliance not fully tested on CQM See also ILT_PERF Noise Tests
IRD-DETP-R10	EMI susceptibility	SPIRE-RAL-NOT-001681	SPIRE-RAL-REP-2167		Compliance not fully tested on CQM
IRD-FTB-R02	RF rejection	SPIRE-RAL-NOT-001681	SPIRE-RAL-REP-2167		Compliance not fully tested on CQM See also ILT_PERF Noise Tests
IRD-RFM-R01	RF rejection	SPIRE-RAL-NOT-001681	SPIRE-RAL-REP-2167		Compliance not fully tested on CQM See also ILT_PERF Noise Tests
IRD-WE-R36	EMC	SPIRE-RAL-NOT-001681	SPIRE-RAL-REP-2167		Compliance not fully tested on CQM
VRD-23	EMC susceptibility and emission radiated/conducted	SPIRE-RAL-NOT-001681	SPIRE-RAL-REP-2167		Compliance not fully tested on CQM1
VRD-25	Faraday cage integrity and performance	SPIRE-RAL-NOT-001681	SPIRE-RAL-REP-2167		Compliance not fully tested on CQM See also ILT_PERF Noise Tests
VRD-26	RF filter performance	SPIRE-RAL-NOT-001681	SPIRE-RAL-REP-2167		Compliance not fully tested on CQM See also ILT_PERF Noise Tests



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## VERIFIED BY PERFORMANCE TEST

Requirement Name	Description	Procedure(s) In SPIRE-RAL-NOT-1850	Test Report Section in SPIRE-RAL-REP-2083	NCRs	Status/comment
IRD-VER-R03	<p>The CQM verification testing shall demonstrate that the following conditions are met or are likely to be met on the PFM: Correct operation of all FPU sub-systems at cryogenic temperatures for all instrument operation modes for both prime and redundant systems. The instrument cold FPU and JFET box thermal dissipation is within requirements for all instrument operation modes. The warm electronics thermal dissipation at room temperature is within requirements. Correct operation of all on-board software. The instrument straylight environment is within requirements. The instrument optics performance is within requirements. The performance of the instrument meets the scientific requirements expected for the CQM for all instrument observing modes. Development and test of all functional test sequences required for Integrated Systems Testing (IST) at satellite level. The correct functioning of the instrument for all observing modes and calibration sequences. Development and test of all in-flight functional and performance test sequences.</p>	All	All		<p>Only photometer fitted to CQM – no spectrometer or BSM tests</p> <p>JFET supplied is not flight performance wrt dissipation</p> <p>DPU o.k. DRCU not flight build</p> <p>OBS testing as part of development Tested for photometer</p> <p>Tested for photometer</p> <p>Tested for photometer without BSM</p> <p>All functional tests carried out see functional test report</p> <p>No mode tests for CQM1</p>



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## VERIFIED BY PERFORMANCE TEST

Requirement Name	Description	Procedure(s) In SPIRE-RAL-NOT-1850	Test Report Section in SPIRE-RAL-REP-2083	NCRs	Status/comment
					Testing carried out as part of OBS and procedure development
IRD-PHOT-R01	Nominal passband	Spectral Response	3.5		CQM1 test inconclusive – to be repeated. Facility level test also required
IRD-PHOT-R02	Field of View	Pixel Centre Pupil Test	3.2, 3.4		CQM1 test inconclusive – to be repeated. Facility level test also required
IRD-PHOT-R03	Beam FWHM (Arcsec)	PSF Test	3.3		Tested
IRD-PHOT-R04	Point source sensitivity	Optical Efficiency	2.3		Tested
IRD-PHOT-R05	Mapping sensitivity for one FOV	Optical Efficiency Pixel Centre	2.3		Tested
IRD-PHOT-R10	Field distortion must be <10% across the FOV	Pixel Centre	NoReport		Tested
IRD-PHOT-R11	Electrical crosstalk should be <1% (goal 0.5%) between nearest-neighbour pixels and <0.1 % (goal 0.05%) between all other pixels in the same array.	Optical Cross Talk Test	3.1		CQM1 test inconclusive – to be repeated.
IRD-PHOT-R12	NEP variation should be < 20% across each array.	Optical Efficiency	2.3		CQM PLW array does not meet requirement. Instrument throughput tested.
IRD-PHOT-R16	The three arrays need to be co-aligned to within 1 arcsecond.	Pixel Centre	3.2		No test really possible.
IRD-PHOT-R18	SPIRE Photometric measurements shall be linear to 5% over a dynamic range of 4000 for astronomical signals	Linearity Test	2.5		Tested
IRD-STRC-R01	Alignment of the instrument w.r.t. the FIRST optical axis	Pupil Test	3.4		CQM1 test inconclusive – to be repeated. Facility level test also required
IRD-STRC-R02	Attenuation of RF by Common Structure covers	Dark Noise Loadcurve	2.1.2, 2.2		Tested
IRD-STRC-R04	Optics and associated sub-system alignment	Pupil Test	3.4		CQM1 test inconclusive – to be repeated. Facility level test also required
IRD-STRC-R08	Attenuation of radiation from cryostat	Dark Noise	2.1.2, 2.2		Tested



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## VERIFIED BY PERFORMANCE TEST

Requirement Name	Description	Procedure(s) In SPIRE-RAL-NOT-1850	Test Report Section in SPIRE-RAL-REP-2083	NCRs	Status/comment
	environment	Loadcurve			
IRD-STRP-R02	Optics and filters alignment	Optical Cross Talk Test PSF Test Pupil Test	3.1, 3.3, 3.4		Tested except Pupil Test where CQM1 test inconclusive – to be repeated. Facility level test also required
IRD-STRP-R03	Array module alignment	Pixel Centre	3.2		Tested
IRD-STRP-R06	Attenuation of radiation from common structure environment	Loadcurve Laser Straylight Test Pupil Test	2.2, 3.6, 3.4		Tested except Pupil Test where CQM1 test inconclusive – to be repeated. Facility level test also required
IRD-STRS-R06	Attenuation of radiation from 4-K environment	Loadcurve	2.2		Tested
IRD-FPHR-R01	Detector harness capacitance	Loadcurve Harness Test	2.2, 5.2		Tested
IRD-FPHR-R02	Detector harness mechanical support	Microphonics Test	5.1		Tested
IRD-OPTP-R00	Compatibility with Herschel telescope	Focus Test	3.7		Tested
IRD-OPTP-R02	Variation in focal ratio	PSF Test	3.3		Tested on one pixel only – to be repeated
IRD-OPTP-R03	Distortion	Pixel Centre	3.2		Tested
IRD-OPTP-R04	Anamorphism	PSF Test	3.3		Tested
IRD-OPTP-R05	Throughput	Optical Efficiency Spectral Response	2.3, 3.5		CQM1 test inconclusive – to be repeated. Facility level test also required
IRD-OPTP-R06	Image quality	PSF Test	3.3		Tested
IRD-OPTP-R07	Out of band radiation	Spectral Response Out of Band Test	3.5		Not tested
IRD-OPTP-R08	In-band straylight	Loadcurve	2.2		Tested
IRD-DETP-R01	Detective Quantum Efficiency at 2 Hz at nominal incident power levels	Noise Tests Optical Efficiency Frequency Response Test	2.1, 2.3, 2.4		Tested
IRD-DETP-R02	Time constant	Frequency	2.4		Tested



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## VERIFIED BY PERFORMANCE TEST

Requirement Name	Description	Procedure(s) In SPIRE-RAL-NOT-1850	Test Report Section in SPIRE-RAL-REP-2083	NCRs	Status/comment
		Response Test			
IRD-DETP-R03	Uniformity	Optical Efficiency	2.3		CQM PLW array does not meet requirement.
IRD-DETP-R05	Electrical crosstalk for near neighbour pixels.	Optical Cross Talk Test	3.1		CQM1 test inconclusive – to be repeated.
IRD-DETP-R06	Electrical crosstalk any pair of pixels	Optical Cross Talk Test	3.1		CQM1 test inconclusive – to be repeated.
IRD-DETP-R08	Spectral response	Spectral Response	3.5		CQM1 test inconclusive – to be repeated. Facility level test also required
IRD-DETP-R09	Microphonic susceptibility	Microphonics Test	5.1		Tested
IRD-DETP-R10	EMI susceptibility	Noise Tests	2.1		Tested as much as possible QM1 electronics not flight quality. Further tests to be carried out during CQM2
IRD-CALP-R01	Nominal operating output	PCAL Level Response	4.1		Tested
IRD-CALP-R02	Operating range	PCAL Level Response	4.1		Tested
IRD-CALP-R03	Equivalent obscuration of aperture through BSM mirror		Analysis		By analysis?
IRD-CALP-R04	Speed of response	PCAL Frequency Response	4.2		CQM PCAL does not meet flight requirement.
IRD-CALP-R05	Repeatability	PCAL Level Response	4.1		?
IRD-FTB-R01	Amplifier noise	Noise Tests	2.1.1		Tested
IRD-FTB-R02	RF rejection	Noise Tests	2.1.1		Tested
IRD-FTB-R06	Operating temperature range	Noise Tests	2.1.1		Tested
IRD-RFM-R04	Operating temperature range	Noise Tests	2.1.1		Tested
IRD-WE-R08	Photometer detector readout	All	NoReport		For all tests carried out on photometer timing accuracy is sufficient



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## VERIFIED BY PERFORMANCE TEST

Requirement Name	Description	Procedure(s) In SPIRE-RAL-NOT-1850	Test Report Section in SPIRE-RAL-REP-2083	NCRs	Status/comment
					PFM1 will test spectrometer.
VRD-06	Optical design	Optical Tests	3		Tested
VRD-07	Optical interface to FIRST system	Optical Tests	3		Tested
VRD-08	Straylight	Straylight Test	3		Tested
VRD-09	Instrument optical performance	Optical Tests	3		Tested
VRD-11	Sub-system optical interfaces	PSF Tests Pupil Scan Test Pixel Centre	3.2, 3.3		Tested for photometer LW channel only
VRD-12	Thermal performance	Loadcurve	2.2		CQM1 build standard non-flight – to be repeated.
VRD-15	Micro-vibration environment	Microphonics Test	5.1		Partly tested – to be repeated with higher fidelity test
VRD-17	Harness mechanical frequency response and routing	Microphonics Test	5.1		Partly tested – to be repeated with higher fidelity test
VRD-18	Detector performance versus environment	Noise Tests	2.1		Tested
VRD-19	JFET Amplifier performance versus environment	Noise Tests	2.1		Tested
VRD-20	Detector Harness performance	Noise Tests	2.1		Tested
VRD-22	End-to-end system performance	Noise Tests Optical Efficiency	2.1, 2.3		Tested
VRD-24	Electrical grounding	Noise Tests	2.1		Tested
VRD-25	Faraday cage integrity and performance	Noise Tests	2.1		Tested
VRD-27	Non-detector Harness performance	PCAL Level	4.1		Not tested for SMEC or BSM
VRD-28	Power supply cleanliness	Noise Tests	NoReport		Not tested for flight configuration – GSE power supply.
VRD-29	Digital/analogue separation	Noise Tests	2.1		Tested
VRD-30	Electrical interface to Herschel system	Noise Tests	NoReport		Tested for DPU only





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## VERIFIED BY PERFORMANCE TEST

Requirement Name	Description	Procedure(s) In SPIRE-RAL- NOT-1850	Test Report Section in SPIRE-RAL-REP-2083	NCRs	Status/comment
VRD-39	On board software definition	All	All		Tested as part of OBS development



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