SPIRE PFM Critical Design Review

Review Board Report

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1. Introduction

This report on the SPIRE CDR is designed as a working document that can be used by the Project Team to help in the planning and management of the SPIRE programme in the coming months.

2. Review Objectives

The objectives of the CDR, as listed in the review plan, are listed below, with the Review Boards conclusions in each case.

A. To assess of the test programme carried out on SM, AM, AVM and CQM instrument models prior to the "official" start of PFM programme.

The SM and AM programmes have been successfully completed.

The CQM programme is currently underway, with a largely successful first cold test campaign followed by cold vibration. Modification to the FPU prior to post-vibration cold testing constitutes a calculated risk on the part of the Project Team to allow a more representative CQM to be tested and delivered while avoiding the need for an additional cool-down.

Both the AVM and the EQM programme is in need of clarification with Industry, particularly the definition of the system-level test programme. This should be clarified in appropriate meetings and interactions between SPIRE and Industry.

B. To confirm final approval of interfaces between instrument and system and between sub-systems and instrument.

This aspect of the review was not explicitly covered in detail during the presentations. The Board expects that it shall be completed by the Project Team through final review and sign-off of all relevant interface documents in the course of normal work following the review. A list of open items should be compiled and used to ensure that all interfaces are fully closed out prior to the IQR.

C. To review the sub-system PFM designs and their qualification status.

The Review Board considers this to have been achieved in all cases, but with variable rigour and quality. A list of particular items which should be addressed is given in Section 4. This list is based on discussions during the review meeting, and is certain to be incomplete. The Board recommends that the Project Team uses and adds appropriate items to this list as a method of ensuring that all aspects of the subsystem design

and qualification are properly covered.

D. To prepare for the formal ESA Instrument Qualification Review (IQR) to be held in November

Provided it is suitably followed up, this CDR will have been very good preparation for some aspects of the IQR. The documentation and agenda for the IQR will include an explicit summary of the status of the recommendations given in this report.

The IHDR close-out is considered adequate in most aspects, with additional work needed in particular on the OBS programme and PA.

3. General conclusions and recommendations

3.1 Instrument Development Plan and Model Programme

The current model philosophy and instrument test plan are not ideal and have been devised as an adaptation of the original (more straightforward) plan as a reaction to various circumstances. The Review Board considers the plan as it stands to be appropriate under the circumstances, and recognises the excellent technical work and progress at both subsystem and instrument level that is evident from the success of the CQM programme so far. But the Board considers the PFM plan to involve a high level of schedule and technical risk. Major concerns are:

- No instrument level cryo-mechanical tests (on the SMEC and BSM) have been done so far. The earliest possible verification of the BSM and SMEC should be given high priority in the ILT plan.

- Thermal margins are small or non-existent. Careful test and analysis will continue to be essential until the thermal system has been verified at H-EPLM and at system level.

- The baseline plan to deliver the flight DRCU for integration on the spacecraft is recognised by all parties as extremely risky. The Project Team should consider an extension of PFM2 test period to allow proper instrument-level tests with the flight DRCU should the schedule evolution allow this.

- Any risk to the BDA spares provision will have significant implications for the Herschel spares philosophy, and will need to be discussed with ESA.

- A good deal of PA responsibility is devolved to the subsystems – the Project Team should monitor this carefully to ensure that the appropriate standards are observed.

3.2 Schedule

The PFM schedule is critically success oriented dependent on subsystem deliveries and trouble-free cool-downs. Every effort must be made by the subsystem teams to eliminate any avoidable delays. “Surprises” concerning subsystem schedules should be avoided by maintaining close and regular contact between the Project Team and all key subsystem managers. To ensure that subsystems are delivered on time, the subsystem groups will need to have appropriate support from their institutes and agencies.

There is a strong possibility that additional cool-downs will be needed, and the Project Team should develop back-up scenarios accordingly.

It will be important to maintain the PFM calibration programme in the face of schedule pressure. Options of round-the-clock working in the latter stages of the ILT programme should be developed (and will require enough trained personnel to be available).

4. List of recommendations

4.1 Top-level recommendations as noted above

No.	Recommendation
1	Both the AVM and the EQM programme is in need of clarification with Industry, particularly the definition of the system-level test programme. This should be clarified in appropriate meetings and interactions between SPIRE and Industry.
2	Final review and sign-off of all relevant interface documents should be covered with high priority in the course of normal work following the review. A list of open items should be compiled and used to ensure that all interfaces are fully closed out prior to the IQR start in November.
3	No instrument-level cryo-mechanical tests (on the SMEC and BSM) have been done so far. The earliest possible verification of the BSM and SMEC should be given high priority in the ILT plan.
4	Thermal margins are small or non-existent. Careful test and analysis will be essential until the thermal system has been verified at system level.
5	The baseline plan to deliver the flight DRCU for integration on the spacecraft is recognised by all parties as extremely risky. The Project Team should consider an extension of PFM 2 test period to allow proper instrument-level tests with the flight DRCU should the schedule evolution allow this.
6	Any risk to the BDA spares provision will have significant implications for the Herschel spares philosophy, and will need to be discussed with ESA. A meeting/telecon between ESA, SPIRE and JPL to consider all aspects of spares philosophy should be convened as a matter of urgency.
7	A good deal of PA responsibility is devolved to the subsystems – the Project Team should monitor this carefully to ensure that the appropriate standards are observed.
8	Every effort must be maid by the subsystem teams to eliminate any avoidable delays, and very close contact must be maintained between the Project Team and the schedule critical subsystems.
9	It is possible that additional cool-downs will be needed, and the Project Team should develop back-up scenarios accordingly.
10	It will be important to maintain the PFM calibration programme in the face of schedule pressure. Options of round-the-clock working in the latter stages of the ILT programme should be developed (and will require enough trained personnel to be available).

4.2 Technical and programmatic recommendations/actions

The table below lists recommendations and actions which should be followed up by the appropriate people. Some of them are on subsystem teams, but only Project Team members are listed here (as responsible for liasing with the subsystems to address the points appropriately).

No.	Item	Recommendation	PT member responsible
11	Model programme	There could be differences in the mechanical properties of the L-0 strap material depending on purity and annealing. This should be assessed. Careful efforts must be made to ensure that differences in performance of CQM 2 vs. CQM 1 can be attributed to changes to the system or possible consequences of cold vibration.	Eric S. Bruce
12		PFM: Some information has been sent from Astrium on the LOU baffle, and needs to be assessed to see if SPIRE is concerned bout the stray light rejection.	Bruce
13	Thermal testing and modelling	Assess whether carbon fibre would be a better option for the L-0 strap supports (same design, different material). *Note: current model is worst case, with no allowance for additional isolation due to imperfect conduction across the interface*	Eric

14	CQM tests	Investigate feasibility of checking the integrated out-of-band leakage using a drilled-plate filter	Bruce
15		Consider testing the system for ability to cope with a sudden complete loss of electrical power (check whether this is in the IID-A as a mandatory test already)	Bruce
16		Define and carry out whatever tests or analysis are needed to tell you whether a chicken wire filter is needed at the SPIRE FPU input aperture.	Bruce
17		Consider raster scanning across the array (e.g., with the BSM) to check stray light performance	Bruce
18	SMEC	Quantify the micro-vibration levels to which the SMEC is sensitive.	Bruce
19		Assess whether special measures will be needed during spectrometer testing in the AIV facility to reduce micro-vibrations	Bruce
20		Thoroughly assess status wrt matching of SMEC drive electronics to harness properties by determining the range of likely harness properties for flight and ground test environments and by analysing the range of harness impedance values that can be accommodated by the MCU. Assess need for MCU adjustment/calibration when DRCU QM2 will be exchanged versus FM (Is there a need to open the box?) *Note: LAM actioned to produce a technote on this issue*	Doug
21		Assess whether any special cleanliness requirements must be adhered to during SMEC handling and integration	Eric
22		Assess LAM documentation to verify that SMEC life-test at room temperature is worst case.	Doug
23	SMEC/MCU	The planned sequence of deliveries and exchanges of hardware between LAM and SAp should be optimised in consultation with the SPIRE Hardware Programme Manager	Eric
24		The SMEC PFM delivery in March 2005 is too late to match the instrument test and deliver schedule. The Project Team and LAM must examine schedule recovery options.	Eric
25	Photometer Thermal Control	Carry out modelling and analysis to assess the performance and optimisation of the PTC system	Doug
26		Measure the time constant of the 300-mK thermal system when the PTC is installed.	Doug
27		Assess the need for thermal control assuming that linear drifts can be calibrated out	Bruce
28	DRCU	Define success/failure criteria for PFM 1 ILT validation of the MCU design, and define the procedure and timetable for this validation	Bruce
29		Definition of the specification for the WIH (to be delivered to RAL Oct. 2005) is urgently needed from Industry	Eric
30		QM2 was baselined to include a flight representative power supply (down to component level). Clarify the build standard (redundancy?) of the EM PSU (are savers needed) and provide interface drawing and potential adapters needed for system level integration. Assess EMC representativity	Doug
31		Assess whether the FPGA programming problem will be fully solved by the reprogramming method recommended by Actel (high-speed board techniques might need to be incorporated into the design).	Bruce
32		Close out Some PAD approval process for DRCU (some PADS are outstanding even as manufacture is going ahead).	Eric C.
33	DPU	CGS are now responsible for implementation of the DPU	Ken

		hardware. They should therefore be required to present the status of the design, qualification, performance testing, verification matrix, schedule, etc. at the IQR.	
34	OBS	Review the OBS verification matrix and provide feedback to IFSI	Ken
35	BSM	ATC to submit RFW for BSM 2 chop throw/settling time non-compliance, and the Project Team to consider and decide on how the system should be optimised.	Bruce/Matt
36	Filters etc.	Investigate possibility of a warm spectral measurement of the entire stacked filter chain as part of diagnosis of why the overall instrument response differs from the calculated stacked response of the filter chain.	Bruce/Matt
37		Derive a flatness spec. for the dichroics from the optical model and indicate how it is to be verified	Bruce
38		Institute a rigorous qualification and review process for the anti-reflection coated 300-mK lenses for the spectrometer BDAs, including cold vibration.	Bruce
39	L-0 thermal straps	Check whether the capacitance of the new inter-box strap design is within spec.	Doug
40	All thermal straps and FPU supports	Arrange for separate reviews of the 300-mK thermal strap system, L-0 strap system and the CFRP feet, with a specific reduced EIDP (including verification matrix) and a dedicated DRB convened in each case (over and above any individual DRBs dealing with parts of the systems).	Eric
41	CFRP supports	Assess the impact on the qualification programme of changes in resonances introduced by changing the feet from stainless steel to CFRP.	Eric
42	Radiation environment	Clarify whether the figure to assume is 10 or 3 kRad *Note: closed by Carsten in subsequent e-mail confirming that the requirement is 10 kRad.*	*ESA*