SPIRE

Instrument Intermediate Design Review

Board Report

23-24 April 2001 SPIRE-ESA-REP-000792

(Rutherford Appleton Laboratory, UK)

Board Members	*Signature*	*Date*
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G. Stacey **Cornell University**	**…………………………...**	**…………….**

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1. Introduction

The Instrument Intermediate Design Review (IIDR) of the Spectral and Photometric Imaging Receiver (SPIRE) was held in the Rutherford Appleton Laboratory, UK, on 23-24 April 2001.

This report provides the Review Board findings, recommendations and conclusions.

2. Review Objectives

The review objectives of the IIDR are defined in the ESA document “FIRST/Planck Instrument Reviews”, SCI-PT/FIN-06692, and are as follows:

It shall be demonstrated that:

- the instrument detailed system design has been finalised
- the instrument subsystem design has been finalised
- the detailed interface requirements have been finalised
- the design for the on-board software has been finalised
- the design of the necessary MGSE, EGSE and OGSE has been finalised.

In the framework of this review the Board asked SPIRE explicitly to:

- identify problem areas and potential solutions
- identify specific inputs and/or support required from ESA
- identify, scope, prioritise the work necessary to freeze the instrument design in order to start phase C/D

3. SPIRE Instrument Intermediate Design Review Board

Name	*Affiliation*	*Function*
P. Estaria	ESA	Chair
G. Pilbratt	ESA	Co-Chair
A. Heske	ESA	Secretary
O.H. Bauer	MPE	
P. Olivier	ESA	
G. Stacey	Cornell University	

The Board was supported by the following experts from ESTEC: J. Bruston, M. Linder, J. Marti Canales, N. Rando, and P. Falkner. In addition, R. Carvell (PPARC), B. Collaudin and G. Lund (both from ALCATEL) attended and participated in the Board deliberations.

4. Proceedings of the Review

4.1 Documentation reviewed

The list of documents reviewed is attached in Annex 1. The review documentation partly arrived sufficiently late to impair the review process.

4.2 Presentations

Presentations were given by various members of the SPIRE team on 23 and 24 April 2001 in RAL.

4.3 Panel Meetings

All Board members and experts, with the exception of M. Linder and P. Falkner (both excused), attended the presentations at RAL.

On behalf of all participants in the review the Review Board wants to thank the local organisers, and in particular Judy Long, for the efficient organisation of the review proceedings, and for taking us to a nice dinner in pleasant surroundings.

5. Board Findings

- The Board notes with satisfaction the amount of progress, which had been made since the SPIRE System Design Review, held in November 2000. In particular, the Board sees the recommendation given at that review well addressed, as is demonstrated in the documentation delivered and the presentations given - namely to resolve and consolidate with highest priority: the Design and Development Plan, the system and subsystem schedule and the model philosophy. However, the identified problems with schedule, model philosophy and Product Assurance could still not be resolved by SPIRE.

- The Board notes that significant progress has generally been made to identify the design drivers, the critical areas and the degree of criticality at system and subsystem level. However, the Board is concerned that the presentations did not address how to resolve the identified critical issues.

- Despite the overall progress made, the Board notes with concern that additional critical areas are still pending to be dealt with at system level. In addition, at subsystem level it was difficult for the Board to see where and to what extent progress had been made since the System Design Review.

- The Board is particularly concerned about the apparent absence of Product Assurance activities. Neither the documentation nor the presentations offered a detailed analysis.

Although an initial failure mode analysis was presented, this analysis lacks the systematic approach needed at this stage of the programme. The iterative nature of the process i.e. the fact that the results of the FMECA shall be used as input into the elaboration of the design (in particular redundancy aspects) seems not to be appreciated.

- The Board is highly concerned about the status of several aspects of the thermal design:
  - Although a detailed model was presented, the Board has serious doubts about the correctness of the basis and of the underlying assumptions for this model, especially with regard to the helium mass flow rates and related equilibrium temperatures for different SPIRE operating modes (i.e. different dissipations).
  - In addition, the present calculations show no margins with respect to the operation of the 3He cooler.
  - The JFET design has not been optimised to reduce its dissipation (increase from 33 to 55 mW). If the cryostat were to accommodate the present JFET dissipation figure and FPU design, and at the same time providing the desired focal plane temperatures, then the required helium mass flow would significantly reduce the mission lifetime.
  - The compliance of the temperature stability of the BDAs with respect to the instrument requirements is unclear. SPIRE indicated that with their current design (open loop control) it might be impossible to achieve the required stability requirements for the observation of extended sources. Should the provision of active temperature stabilisation prove necessary to meet the scientific requirements, a number of subsystems would be affected, including the warm electronics. To date such provisions have not been made, and the impact of having to do this at a later date must be established, including not only the subsystems themselves, but also at system level, including thermal modelling, testing/validation, and schedule.
  - The 300mK thermal strap programme is much less mature than it should be at this stage of the project. The thermal straps are a potential single-point failure and are schedule-critical for the STM.

- The Board notes with concern that the instrument development schedule and model programme are still very tight (several major items on the critical path), and that in particular:
  - the FPU structure could not yet be removed from the critical path,
  - the overall schedule is very ‘interlaced’, e.g. lack of adequate slack time between STM testing and CQM integration, and the CDR taking place after the manufacture of the PFM,
  - considering the long turnaround times involved in cryogenic testing the presented development schedule is too success oriented,
  - adequate time for properly characterising and calibrating the instrument on the ground may not be available under the currently highly compressed overall schedule.
  - There is little margin (1-2 months) in the envisaged delivery date of the cryo- vibration facility required to accommodate SPIRE STM.

- The Board notes with concern the status of the DRCU design, which appears to be lagging behind that of other subsystems (the DRCU has been now split into two boxes). The PSU procurement specs must be frozen as a matter of urgency because of administrative delays in the procurement. The DRCU will play a crucial role in future tests and assessment of instrument performance and if unavailable when needed could seriously jeopardise the overall instrument development schedule.

- Further on the instrument design the Board notes with concern that:

  - the definition of the cryo harness is still pending and becoming urgent,

  - the instrument specific part of the OBSW has not been properly addressed, in particular autonomy functions were not addressed at all.

- The Board notes that in the definition of interfaces – the IID-B – progress has been made, however a number of critical interfaces still need to be defined. In particular chapter 5 which has undergone a major update still contains many TBD's.

- The Board notes that the calibration requirements and resulting plan, from which detailed test procedures will be established, are still to be formulated.

- The Board notes that the bolometer design is crucially dependant on the incident power, this has implications at system level including the telescope design and operating temperature, PLM baffling, and instrument design.

- The Board notes the potential straylight impact of the optical encoder on the spectrometer.

- The Board notes that EMC issues are not yet adequately addressed, in particular analysis and modelling are not yet sufficiently mature. Some of the EMC activities currently considered do not seem realistic (e.g. testing of the FPU structure in a representative CVV environment at ESTEC). A comprehensive EMC Control Plan including the relevant logistical aspects must be generated.

- The Board is concerned about the apparent lack of a tight control over the system budgets and margins (e.g. JFET power dissipation) although significant efforts have been made in specific areas (e.g. FPU structure)

- The Board notes that internal reporting and monitoring of subsystem group's activities within the SPIRE consortium is still not satisfactory. Information flow and responses from institutes is sometimes slow introducing delays in the finalisation of designs. Attendance at weekly management telecons is often poor and the PM does not get a complete set of monthly reports from the institutes.

- The Board notes SPIRE's intention to 'optimise' the design of the instrument (small changes to the photometer and spectrometer bands). Despite claims that this optimisation will not require additional work nor have any impact on interfaces and schedule the Board urges SPIRE to focus its attention to the critical issues which need urgent resolution.

- The Board notes that SPIRE is potentially sensitive to microvibrations. This needs to be analysed and quantified (e.g. detector readout and FTS mechanism).

6. Board Recommendations

R1: The Board asks SPIRE with highest urgency to critically review their current thermal model and to produce a realistic model to be integrated into the overall optical bench model for Herschel. Part of this activity shall be to carry out an analysis of the thermal stability required and predicted at instrument level, in particular at the 0.3 K level. Thermal transients must be considered. SPIRE shall produce temporal power profiles for likely operational modes and transitions between the modes (e.g. switching from FTS to photometer)

R2: The Board urges SPIRE to start without delay PA activities and to carry out a systematic FMECA. The results of the FMECA shall be fed into the design process where this is still possible.

R3: The Board sees still shortcomings in the system approach and urges SPIRE to critically reassess and consolidate in particular the following issues:

- AIV programme test definition and test sequences at instrument subsystem and system level and at spacecraft system level in order to restore adequate schedule margins
- For all elements on the critical path generate schedules with a higher density of milestones. Monitor these milestones carefully
- Look at all possibilities for reducing JFET dissipation
- Thermal modelling of the FPU, in particular the JFETs and 3K strap definition
- EMC and grounding approach (generate an EMC Control Plan)
- Straylight and its impact on optical elements of the FPU
- Definition of interfaces
- Mass and power budget

R4: The Board asks SPIRE to strengthen the communication between system and subsystem teams and reporting to ensure proper information flow between these teams. The system team shall enforce a very strict control of the instrument budgets (especially mass and power) on all subsystems.

R5: The Board asks SPIRE, together with PACS and the Herschel Science Team, to provide a schedule showing how to settle the “parallel” mode and “serendipity” issues before the end of the year, identifying the (currently missing) knowledge required to make a decision.

R6: The Board asks SPIRE to ensure that the OBSW definition (in particular instrument-specific functionality) is addressed adequately. A mature ‘Software Specification Document’ shall be produced for the IBDR.

7. Board Conclusions

The Board notes with satisfaction that at both system and subsystem levels good progress has been made in the design and identification of critical areas and congratulates the SPIRE team for their efforts. However, the Board has noted that a way to resolve identified criticalities was not always presented, and points out a number of critical areas that need close attention urgently.

The Board is confident that with the implementation of its recommendations SPIRE will arrive at the required status for the next review (the Instrument Baseline Design Review - IBDR), which will mark the start of the instrument's detailed design and development phase.

Although the Board does not consider the Review objectives formally fully met, it considers that it would not be realistic to hold a delta IIDR prior to the IBDR, which shall take place before the end of the year.

The Board takes note of the responses by the SPIRE team to the recommendations of the Board of the System Design Review held in November 2000 at Cosener's House in Abingdon, UK. The Board is satisfied with the answers, with the exception of PA activities. It considers the System Design Review as formally closed out.

In order to allow a satisfactory review process the Board requests that for future reviews the data package is made available to the reviewers as a minimum 20 working days prior to the scheduled review date, as specified in the IID-A (section 10.8.2).

ANNEX 1

LIST OF DOCUMENTS REVIEWED

No.	Title	Comments
1	**Guide to IIDR Documentation**	This document
2	**IIDR Agenda**	Latest version
Design Description		
1	**Design Description Document Contents**	
2	**Design Description Document**	
3	**MCU Design Description**	
4	**BSM Design Description**	
IID Part B		
1	**IID-B Comments**	Comments by Instrument Scientist on the proposed changes to the IID Chapters
2	**IID-B Chapter 4**	Proposed new Chapter
3	**IID-B Chapter 5**	Proposed new Chapter
4	**IID-B Chapter 9**	Proposed new Chapter
AIV		
1	**AIV Plan**	
2	**AVM Definition**	
3	**STM Requirements**	
4	**CQM Requirements**	
5	**Alignment Tool Specification**	
6	**Optical Alignment Verification Plan**	
7	**SPIRE Alignment Sequence**	
8	**Integration Plan SPIRE Structure**	
Development Plan		
1	**Instrument Development Plan**	
2	**Product Tree**	
3	**WBS**	
4	**Qualification Requirements**	
5	**Milestone List**	
6	**Master schedule**	
7	**Subsystem Development Plans**	
	Development Plan for the DRCU Simulator (DRCU SIM)	
	JPL Receivables/Deliverables List	
	Spectrometer Mirror Mechanism Subsystem Development Plan	
	SPIRE & PACS Sorption Cooler Development Plan	
	SPIRE 300mK Straps Subsystem Development Plan	
	SPIRE AIV Facilities Development Plan	
	SPIRE BSM Development Plan	

	SPIRE Calibrators Subsystem Development Plan	
	SPIRE CEA Product Tree	
	SPIRE DPU/ICU Subsystem Development Plan	
	SPIRE DRCU and WIH Development Plan	
	SPIRE Filters Subsystem Development Plan	
	SPIRE JPL Array Test Dewar Development Plan	
	SPIRE Mirrors and Alignment Tools Development Plan	
	SPIRE Shutter Development Plan	
	SPIRE Structure Subsystem Development Plan	
Management		
1	**Management Plan**	
2	**PA Plan**	
3	**Configuration Management Plan**	
4	**Configurable Documents' Tree**	
Ground Support Equipment		
1	**MGSE**	Included in Instrument Integration Plan
2	**EGSE URD**	
3	**EGSE-ILT URD**	
4	**AIV Requirements Document**	
Requirements		
1	**SRD**	
2	**IRD**	Same version as provided at System Design Review
3	**OBS URD**	
4	**Operating Modes Document**	
5	**Calibrators Software Interface**	
6	**Calibrators Electrical Interface**	
Subsystem Specifications		
1	Structure	
2	Optics	
3	BSM	
4	SMEC	
5	Cooler	
6	BDAs	
7	Calibrators	
8	Filters	
9	DRCU	
10	DPU	
11	FPU Simulator	
Key ICDs		
1	FPU to Herschel interface drawing	
2	Structure Mechanical ICD	
3	DPU/DRCU ICD	
4	Harness Document	
5	Photometer Optics Configuration Control Spreadsheet	
6	Spectrometer Optics Configuration Control	

	Spreadsheet	
7	Thermal Configuration Control Document	
8	Optical Error Budgets	
9	Budget Control Spread Sheet	
10	Systems Budget	
11	Cooler I/F Drawing	
12	Instrument Block Diagram	
13	Provisional Warm Interface Drawing	

Technical Notes and Papers		
1	Technical notes and papers	Currently contains: • MJG SPIE paper –SPIE4013_10 • KD SPIE optics paper – SPIE_4013_31_05 • MC SPIE diffraction analysis paper – SPIE4013_12 • BMS SPIE FTS paper – SPIE4013_11 • Feedhorn Focus Positions - TN0566 • SPIRE Beam Sections – TN0586 • Focal Plane Plate Definition – TN0581 • SPIRE CM4 Hole Sizing – TN0576 • SPIRE Diffraction Analysis • Grounding Philosophy • Sensitivity Models • Criticality Analysis – updated from Nov. this is new issue. • Thermal Stability Requirements – TN000623 • TR Straylight model
Test Reports		
1	A-Frame Testing Final Report	
2	Horn Measurement Report	
3	SMEC Mechanism Control System	
4	Cryogenic Sorption Cooler Summary Report	

ANNEX 2

REVIEW ITEM DISCREPANCIES

1) SPIRE needs to critically review their current thermal model and to produce a realistic model to be integrated into the overall optical bench model for Herschel (see also recommendation 1).

2) SPIRE needs to perform temperature stability tests on the available sorption cooler prototypes in order to assess the expected temperature behaviour of the instrument BDAs. Tests should be complemented by any applicable thermal modelling. Design activity on active temperature control should also be given priority, establishing what modifications are required to include such a function in the instrument.

3) SPIRE needs to address the issue of microphonics induced by operating the internal mechanisms (SMEC and BSM). Adequate requirements should be defined, including maximum levels and bandwidth at the optical bench level.