Response of SPIRE Consortium to July 1999 PDR Review Board Report

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Introduction

We find the Review Board report to be a very useful analysis of the present state of the project. In this document we address each of the points made in the Board's report.

I. Capability of SPIRE to meet its science requirements/goals

1. Effect of pointing errors on scanning mode observations and need for simulations of FTS observations: Simulations of scanning-mode observations have been started. At present, the emphasis is on comparing the different detector options. Although in the first iteration, spacecraft pointing noise is not included, it will be straightforward to do this at the next stage in such a way as to evaluate the effect of varying kinds and degrees of pointing errors on the final science data. We regard this as an important part of the simulation work. Once the detector selection has been made, detailed simulations of the complete instrument chosen option will be started.

Extraction of astronomical spectra from FTS data: The imaging nature of the FTS will allow for sky subtraction, but this will need to be carefully calibrated. Detailed simulations of FTS observations have not yet started, and will be given priority as soon as the FTS design is clarified (later in 99). The telescope spectrum will not be perfectly matched by the calibration source, so the astronomical spectrum will have to be calibrated using known astronomical sources (as with most astronomical observations). We are also studying a backup "step and integrate" operating mode, using the BSM to provide spatial modulation at each position. This naturally nulls the telescope background but may lead to degraded performance compared to the rapid-scan mode as it would require a much longer scan time.

2. Stray light modelling: We are in complete agreement with the Review Board. Stray light minimisation is critical to achieving the required sensitivity for SPIRE, particularly for filled array detectors. An increasingly detailed APART model of the instrument will be built up to optimise the optics, internal blackening and baffling. The BACUS array test facility, while not replicating the SPIRE optics exactly, will be used to test the efficacy of stray light minimisation techniques. We will also examine the possibility of building up the instrument calibration facility early in the project, and using it to carry out tests on the detector array modules at subsystem level with representative optics.

3. Data rate: We will continue to study this as the detailed design of the instrument and its operating modes progresses over the next six months. Our aim is to avoid any on-board averaging if possible. While there may be some opportunities for more lossless compression, working within the 100 kbs limit is likely to require a combination of strategies involving some compromises (e.g., not using the whole FTS field of view for some observations, increasing the downlink time, slowing down the scan mirror, etc.). We will need to study the optimum strategies.

4. FTS design status: We share the Review Board's concern about the urgent need to make progress on the FTS design. A meeting of the Optics/FTS Group was held in early September, at which a number of design parameters were frozen, the GSFC carriage design and the Moiré fringe position readout were adopted as the baseline, and plans made for a programme of design and testing leading up to a full PDR in March 2000. At this meeting we also analysed the technical and cost implications of designing for the goal of maximum resolution = 0.04 cm^{-1} and concluded that the impact is minimal.

It is also true that we must avoid a disproportionate amount of consortium effort being devoted to the FTS, which is of lower priority scientifically than the photometer. Should design compromises be necessary in order to reduce overall cost and risk, they will be made. The distribution of work within the consortium will need to be re-examined after detector array selection in early 2000, and we will then review the instrument and consortium resources available for the FTS.

5. ^{3}He cooler redundancy: We recognise the importance of this issue. Implementing redundancy in the cooler system would have significant implications for cost and spacecraft resources, and these need to be studied. We have set up an *ad hoc* group to examine the whole issue, comprising the following people: Bruce Swinyard (Chair), Lionel Duband, Berend Winter, Matt Griffin. Bernard Collaudin of ESA is also participating. This group is already working by e-mail on a failure modes analysis and studying the options for redundancy. It will meet as necessary by e-mail/telecon and perhaps face-to-face as the work progresses, and it will produce a detailed report by the end of 1999 covering the technical, schedule and cost impact of all viable options. The results will form the basis of SPIRE's proposal to ensure and verify the reliability of the cooler system.

II. Compatibility with the FIRST mission

We will continue to work within the consortium and with ESA to address these issues (thermal loads, pointing requirements, and EMI) and others.

III. Development Plan

1. Structural design: We anticipate making significant progress on this over the next six months. Much will depend on the forthcoming industrial study of the cryostat interfaces. Issues such as accessibility and alignment will be given particular attention in the detailed definition of the subsystem interfaces, the FPU internal layout and the structure. We note the potential advantages of the blade-type mount and are studying this in detail at present. CFRP materials testing will start soon and the results will be used for the final trade-off in choosing the for the support concept for the SPIRE FPU. An Instrument Alignment Plan is currently being drawn up and the mechanical design will be made compatible with the needs for alignment and access.

2. FTS design an development plan: Agreed - see above.

3. Beam Steering Mirror: A much more detailed preliminary design for the BSM will be developed and presented at the PDR in March 2000. The design of the control system will be presented at the November Warm Electronics Review.

4. Thermal design: A full thermal model incorporating all instrument thermal loads and their time dependencies will be devised. It will be necessary to use this in conjunction with a model of the cryostat and its instrument interfaces to examine the achieved temperatures, their stabilities and the influence of instrument power dissipation.

5. Shutter: The shutter design cannot start in detail until the workpackage has been accepted and funded. At present the only option is for it to be done in Canada, and we are still awaiting the outcome of a funding proposal to the CSA. We agree that the study of a low-background lid for the cryostat should also go ahead. This question is presumably also an important one for PACS.

6. Detector selection: We are in complete agreement with the panel. The date for detector array selection cannot be delayed. The spacecraft and consortium resource requirements of all of the options will be taken into account in the selection.