300-mK Strap Development Team
Discussion Document and Proposed Plan

TO: Bruce Swinyard, Matt Griffin, Berend Winter, Sam Heys, Peter Hargrave, Iris Ditschuns,
CC: Tom Bradshaw, Jamie Bock, Dustin Crumb, Lionel Duband, Tony Richards, John Delderfield, Eric Sawyer, Judy Long.
FROM: Doug Griffin
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Introduction

One of the critical technical issues in SPIRE still requiring development work is the 300-mK strap from the cooler to the BDAs. The following core team is to be drawn up to speed up and assist the development of this piece of hardware:

Person	**Responsibility**
Doug Griffin	Facilitator, mechanical and thermal design
Bruce Swinyard	Instrument overview
Matt Griffin	Instrument overview
Berend Winter	Mechanical and thermal design / mechanical testing
Sam Heys	Thermal design expert / instrument and system thermal issues
Peter Hargrave	Thermal test / thermal and mechanical design
Iris Ditschuns	Thermal test / thermal and mechanical design

The following people will also be called upon on either a formal or an informal basis for their expert advice / experience:

Person	**Responsibility/Expertise**
Tom Bradshaw	Cryogenic engineering
Jamie Bock	Cryogenic engineering / BDA / 300-mK Thermal Control interfaces
Dustin Crumb	Cryogenic engineering / BDA / 300-mK Thermal Control interfaces
Lionel Duband	Cryogenic engineering / SCO interfaces (Lionel – I know these have already been frozen but I am sure that you would like to see what will be bolted to your fridge).
Tony Richards	Review of stray light baffle design

Scope

According to the established SPIRE MoMs, MSSL has responsibility for the delivery of the 300-mK strap. The formation of this team does not change this.

The group will work together with these institutions, to help deliver the following hardware items:

1. Cooler - Photometer strap (MSSL)
2. Cooler – Spectrometer strap (MSSL)
3. Spectrometer box light baffle (MSSL)
4. Photometer box light baffle (MSSL)

Provision is to be made for the incorporation of temperature control hardware into the system to stabilise the temperature of the BDAs. JPL is to provide this hardware and the relevant interface information if temperature control is necessary.

In the development of the 300-mK strap, the following Interfaces need to be managed:

- 1.0 Mechanical
  - 1.1 Cooler
  - 1.2 SPIRE Optical Bench
  - 1.3 Photometer box
  - 1.4 Spectrometer box
  - 1.5 Temperature control
- 2.0 Thermal
  - 2.1 Cooler
  - 2.2 SPIRE optical bench
  - 2.3 Photometer box
  - 2.4 Spectrometer box
  - 2.5 Temperature control

Development Plan

The proposed development plan is as follows:

Phase One: Clearly establish a set of design requirements for the system.
Phase Two: Establish a set of design goals for design trade-offs and ranking.
Phase Three: Develop and test a range of prototype design solutions.
Phase Four: Evaluate each candidate solution according to the design requirements and goals.
Phase Five: Down-select a single design solution for eventual inclusion in the instrument.

There will also be two other tasks that will proceed in parallel with Phases One-Four.

Task One: Collection of generic background data. For example conductivity of interfaces, bulk material properties, annealing effectiveness, workshops equipped to carry out specialised processes, suppliers.
Task Two: Manufacture of a test rig for the mechanical and/or thermal testing of the candidate solutions.

A Gantt chart has been drawn up in Figure 1.

Table 1 contains a set of proposed requirements that are to be discussed by the group as part of Phase One. Once these requirements are agreed by all parties, they can be included in the relevant project documentation.

Table 1 - 300-mK system requirements.

Requirement ID	**Description**	**Requirement**	**Location**
TBD	300-mK thermal busbar first Eigen-frequency	The first mode of vibration of the photometer and the spectrometer 300-mK straps and associated stray light baffles shall all be greater than TBD Hz (Goal > TBD Hz)	Structure SSSD
TBD	300-mK thermal busbar quasi-static acceleration loads	The photometer and the spectrometer 300-mK straps and associated stray light baffles shall be able to withstand quasi-static acceleration loads of greater than TBD g.	Structure SSSD or Structure ICD
IRD-STRP-R06	300-mK bus bar stray light baffle effectiveness	The aperture in the detector boxes for the 300-mK busbar feed-through shall incorporate a stray light baffle. This baffle is to provide at least four reflections for the shortest optical path between the Level 1 environment outside the detector box and the Level 0 environment inside the detector box.	IRD
	300-mK parasitic heat load	The total parasitic heat load to the 300-mK straps shall be less than 1.51μW.	IRD taken from Thermal configuration document
IRD-COOL-R03	Thermal conductance	The thermal conductance between the sorption cooler interface (i.e. cold tip temperature) and each of the spectrometer and photometer BDA interfaces (i.e. BDA temperature) shall be sufficient to provide a temperature drop of no more than 20mK at normal operating conditions as contained in the SPIRE Thermal Configuration Document.	IRD taken from Thermal configuration document
	Accommodation	The space interface requirements between the beams and the structure are not violated within the detector box	Structure ICD
	Mass	The mass of the spectrometer and photometer 300-mK straps and the associated stray light baffles shall be less than 235g (TBC)	Structure ICD

Table 2 contains a set of proposed design goals. They are in no particular order and many are subjective. Priority levels for each of these goals have been assigned. These range from One to Three. One being highly desirable or high benefit to Three being slightly favourable or of marginal benefit.

Table 2 - Design goals and design drivers.

Goal	Description / Comments	Priority
Maximising of the ease of integration	Includes such considerations as alignment criticality/tolerances. Complicated Kevlar pre-tensioning systems. High preload Kevlar suspension systems.	One
Minimisation of the parasitic heat load	Results in longer cooler hold times and/or increased detector mapping efficiency due to lower detector temperature. It could also provide us with the required temperature margin for operation of active TC of the BDAs.	Two
Maximum Simplicity	This is to increase reliability.	Two
Minimisation of loss in tension due to creep	It would be desirable to avoid the need for re-tensioning of the mounting system after initial installation as this could introduce long delays in the AIV schedule.	One
Maximisation of the mechanical failure safety margin	Any contact between the 300-mK hardware and the Level 0 structure would create a thermal short that could potentially cause failure of the entire instrument. Designs that allow failure of a single thread without failure of the entire assembly are to be favoured.	One
Maximisation of thermal conductance	Results in increased detector mapping efficiency.	One
Maximisation of the mechanical robustness	In the context of the entire instrument AIV, it is desirable that the design be sufficiently robust to avoid inadvertent damage.	Two
Minimising the suspended mass	Reduction of the mass below the budget values would be marginally beneficial.	Three
Maximising the structural response	Achieved by making the first and subsequent Eigen frequencies higher	Three
Minimising manufacturing cost and time	Important, but must be considered in the light of the system performance trade-off. Science vs. Pounds.	Two

Kick-off meeting

I am circulating this document for comment prior to the kick-off telecon on Friday 28 September, 2001 at 11:00am (TBC by email). The dial in number will be circulated when the attendance is confirmed. The main aim of the telecon will be to agree and amend as necessary to the plan outlined above. At the moment, only Matt, Bruce, Doug, Peter, Berend and Iris are to be involved in the meeting. **If you want to participate and are not on this list, please let me know ASAP.**

The agenda will roughly follow the material presented in this document; viz.:

- Discussion of the scope of the group.
    - The best way of including the interface with the JPL thermal control hardware. I propose that information be sought from JPL as to what they need for the interface, keep them in the loop with the design selection process and include them in the down select process.
    - The acceptability of the inclusion of the 300-mK stray light baffle in the scope? I think this is required due to the integral nature of the two pieces of equipment.
    - I propose that the thermal strap will be treated as a separate system in the MSSL documentation. The interfaces with the cooler, structure and BDAs will be managed in the structure ICD.
- Discussion of the requirements.
    - Fill in TBDs, add extra requirements
- Discussion of the goals
    - Discuss and amend as necessary
- Discussion of the programme
    - Is the proposed schedule reasonable? Does it need to be condensed?
    - We will need to make up at least a dummy Photometer box so that we can test candidate solutions. Do we want a dummy Spectrometer, SPIRE optical bench and Sorption Cooler?
    - We need the dimensions of the locations of the various interfaces and the space envelope for the system (MSSL).
    - We need to make a list of the generic data we need.
    - We need to determine who/where the prototypes will be manufactured. (RAL/MSSL/UWC/Contract). What are the expected typical lead times in the various workshops.
    - Confirmation that the mechanical testing of different solutions will be carried out at MSSL. Availability of Hardware?
    - Program would probably not allow for any design iterations. Do we want to include this possibility?
- AOB

Doug Griffin
Tuesday, 25 September 2001

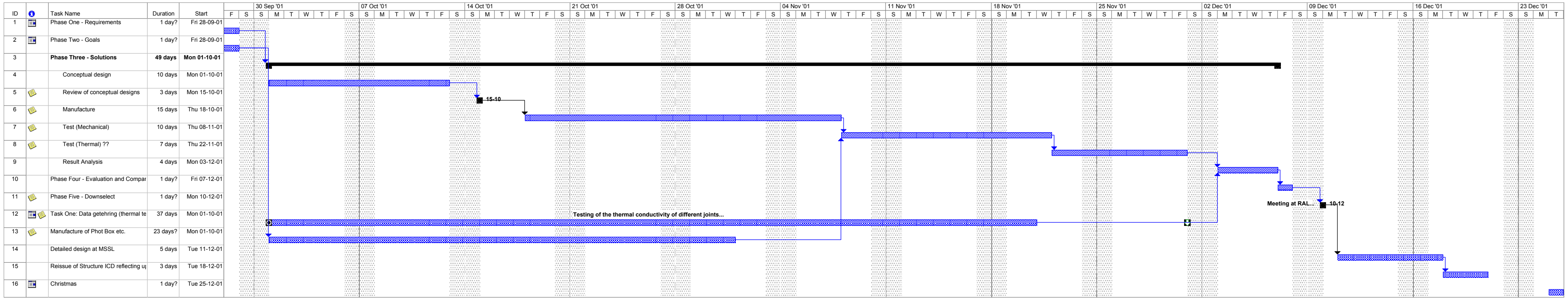

Figure 1 - Proposed Gannt chart for the 300-mK strap development

Notes:
ID 1: To be concluded during meeting on Friday 28 September.
ID 2: To be concluded during meeting on Friday 28 September.
ID 4: MSSL, RAL, UWC to brainstorm and produce candidate solutions and circulate among the group.
ID 5: Meeting to review candidate designs and decide which ones are to be manufactured.
ID 6 Manufacture of the candidate solutions.
ID 7: Mechanical / Integration testing of solutions at MSSL.
ID 8: Thermal testing of candidate solutions at Cardiff.
ID 9: The results are circulated around the various groups involved in the project. (Lionel, JPL, Cardiff, RAL, MSSL)
ID 10: Results to be collated into a single document for general review prior to the down select meeting.
ID 11: A one day (or less) down select meeting. (Official end of the Development Team's remit)
ID 12: The ongoing collection of data
ID 13: Manufacture of a test rig of at least the photometer box and possibly the spectrometer box, SPIRE Optical Bench and Cooler interface.
ID 14: Detailed drawings of hardware at MSSL
ID 15: Reissue Structure ICD reflecting updates arising from strap design