SPIRE

SUBJECT:	**ICD 1.1/1.3 Structure/Cooler**		
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Change Record

ISSUE	DATE	
0.1	14/Jan/2000	Draft issue
0.2	May 2000	Draft issue, updated with minor changes, indicated in the margin, block diagram updated, thermal block diagram added
0.3	June 2000	Draft issue, updated with minor changes, indicated in the margin
1.0	13 June	I/F drawing added, first official issue, removed wrong conduction and heatflow figures. These still need to be included. Update expected within weeks.

Table of Contents

Glossary

CSTR1	Level 0 cooler thermal strap 1
CSTR2	Level 0 cooler thermal strap 2
DRCU	Detector Readout and Control Unit
n.a.	Not Applicable
PSW	Photometer detector Short Wave
PMW	Photometer detector Medium Wave
PLW	Photometer detector Long Wave
SOB	Spire Optical Bench
SSW	Spectrometer detector Short Wave
SLW	Spectrometer detector Long Lave
SPIRE	Spectral and Photometric Imaging Receiver
TBC	To be confirmed
TBD	To be defined

References

Reference Documents

Throughout the document the applicable documents will be referred to as ADXX where XX is the number listed below.

RD1	SCI-PT/IFI/07222, d.d. 05/Nov./1999 FIRST PLM interface with instruments (fax)
RD2	Instrument Requirements Document, SPIRE/RAL/N/0034, issue 0.30, May 2000

Applicable Documents

Drawings

DR1	A2-5264-908, issue 1 Cooler – Optical bench interface drawing

1. INTRODUCTION

1.1 Purpose of Document

The purpose of this document is to define the interface between the SPIRE structure and the ^{3}He sorption cooler (hereafter referred to as cooler). Within this document the mechanical, thermal and harness routing requirements are given. For completeness all thermal straps + conduction to and from the cooler are added. That is the level 0 straps and the straps to the detectors.

1.2 SCOPE

Throughout this document the temperatures will be referred to as Level 0, 1 or 2. These temperatures are the result of the various parts of the SPIRE instrument being connected to the various temperature stages of the cryostat via thermal straps. The interface temperatures (outside the SPIRE instrument) are given inRD2, section 2.1.3.2. The temperatures inside the instrument are the result of the thermal balance taking into account these thermal interfaces, the thermal properties of the instrument itself and the working of the cooler. As a result the temperatures listed in the document have an uncertainty due to the design phase of the instrument. As a rule of thumb the uncertainty is assumed to be in the range of 10% to 15% (indicated by ~).

The structure of the cooler is mounted on the SPIRE optical bench panel (SOB) at ~4 K. The cooler interfaces via 2 thermal straps with the level 0 thermal sink inside the FIRST cryostat. The cold finger of the cooler interfaces via thermal straps with all detectors (3 photometer detectors and 2 spectrometer detectors). The cooler harness interfaces with the DRCU outside the SPIRE structure the RF-filter box mounted inside the structure.

In this document the requirements with respect to the mechanical and thermal interface are listed together with the routing of the harness. No requirements with respect to signals running through the harness are listed. The interface drawings and the thermal conduction requirements are listed in this document.

The following interfaces are considered

- SOB – Cooler (mounting)
- PSW – Cooler (thermal strap)*
- PMW – Cooler (thermal strap)*
- PLW – Cooler (thermal strap)*
- SLB – Cooler (thermal strap)*
- SHB – Cooler (thermal strap)*
- Cooler – level 0 heat sink (two different straps)
- Harness routing (from cooler via structure to RF-filter boxes)

*It should be noted that the interface between the detectors and the cooler, is it is currently foreseen, will run via a thermal busbar. Strictly speaking there will be in this case no (direct) interface between the cooler and the detectors.

2. FUNCTIONAL INTERFACE

2.1 Functional Description and Block Diagram

The cooler's purpose is to provide for the cooling of the sensors within the detectors down to ~.3 K. For this the cooler needs to be able to dump excess heat during its recycling and operating phase, via 2 straps to the level 0 heat sink within the cryostat. During operation and recycling different parts within the cooler will be connected to the level 0 heat sink This will be done using heat switches, which are located inside the cooler itself. The (support) structure of the cooler will be interfacing with the optical bench panel only (at level 1).

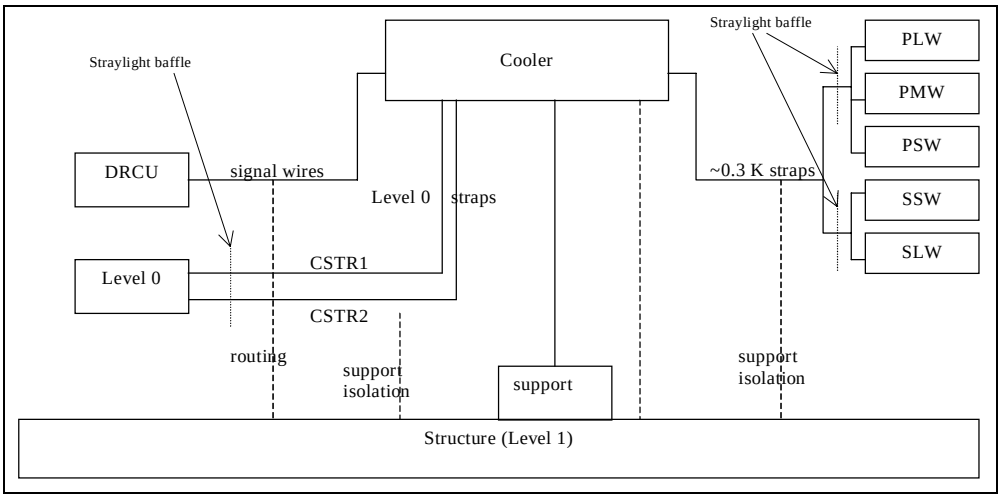


Figure 2.1-1: Block diagram

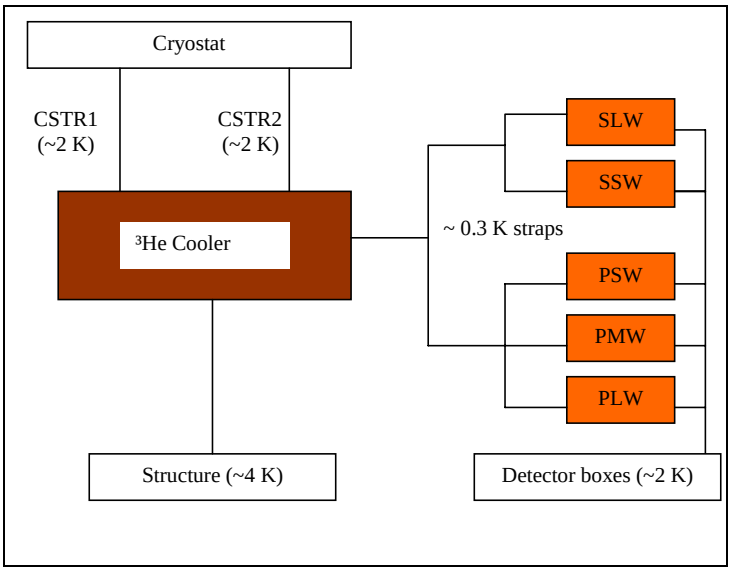


Figure 2.1-2: Thermal straps, conductive paths

2.2 Inputs

mounting interface structure (SOB)
Two separate straps, connected with level 0 heat sink
control wiring (routing towards RF-filter box)
Heat flow from level 1 towards cooler
Heat flow from cooler into Level 0

2.3 Outputs

Strap to the thermal busbar between both detector boxes
Heat flow from detectors into cooler

3. MECHANICAL, THERMAL AND OPTICAL INTERFACES

3.1 Mechanical and thermal interface data sheets

Mechanical environment

The sine and random input at the interfaces considered in this document will be updated after the coupled analysis. The input spectra hold for all interfaces.

Quasi-Static

The qualification levels are **provisiona**l, copied from the qualification loads of ISO. Since they are less severe than the specified sine loads, the requirement is covered by these sine vibration loads. (RD1)

Quasi Static levels	Case 1	Case 2	Case 3	Case 4
x-direction	22.5 g (TBC)	22.5 g (TBC)	-	-
y-direction	3 g (TBC)	-	6 (TBC)	-
z-direction	-	3 g (TBC)	-	6 (TBC)

Table 3.1-1: Qualification levels for quasi static vibration

Sine

The qualification levels are derived from the coupled analysis with the instrument structure with the input at base of the instrument following the requirements stated in AD01. These levels include the required qualification margin (factor 1.5) for the cooler. They do not include any further margin for the cooler.

Sine vibration levels	Frequency range	Input at base (QUAL)
X-direction	5-18 Hz 18-100 Hz	22 mm (peak-peak) 30 g
Y-direction	5-18 Hz 18-100 Hz	22 mm (peak-peak) 40 g
Z-direction	5-18 Hz 18-100 Hz	22 mm (peak-peak) 40 g

Table 3.1-2: Qualification levels for sine vibration

Random

The qualification levels are **provisional**, copied from the qualification loads of ISO.

Random vibration levels	Frequency range	Input at base (QUAL.)
X-direction	5 – 150 Hz 150-700 Hz 700 – 2000 Hz	+6 dB Hz 1.44 g^2/Hz -3 dB
Y-direction	5 – 150 Hz 150-700 Hz 700 – 2000 Hz	+6 dB Hz 1.44 g^2/Hz -3 dB
Z-direction	5 – 150 Hz 150-700 Hz 700 – 2000 Hz	+6 dB Hz 1.44 g^2/Hz -3 dB

Table 3.1-3: Qualification levels for random vibration (45 g_{rms})

INTERFACE DATA SHEET

SUBSYSTEM: ^{3}He Cooler	UNIT CODE:

UNIT DESIGNATION
TOTAL NUMBER: 1 IN OPERATION: IN REDUNDANCY:

MECHANICAL CHARACTERISTICS

DIMENSIONS(mm): L : 100 W : 100 H : 200

MASS (kg): 0.75 + 0.150 contingency, including fastners

C.G.LOCATION (mm) (wrt reference hole R)

X: Y: Z:

INERTIA (m^2kg): Ixx: Iyy: Izz:

MATERIAL OF HOUSING: Ti

SURFACE FINISH: n.a.

TOTAL CONTACT AREA: more than 200 mm^2

SURFACE ROUGHNESS OF CONTACT AREA: TBD

EIGEN FREQUENCY: Mounted on a rigid interface the first natural frequency > 300 Hz

FOOT THICKNESS: TBD

MECHANICAL INTERFACE CONTROL DRAWING

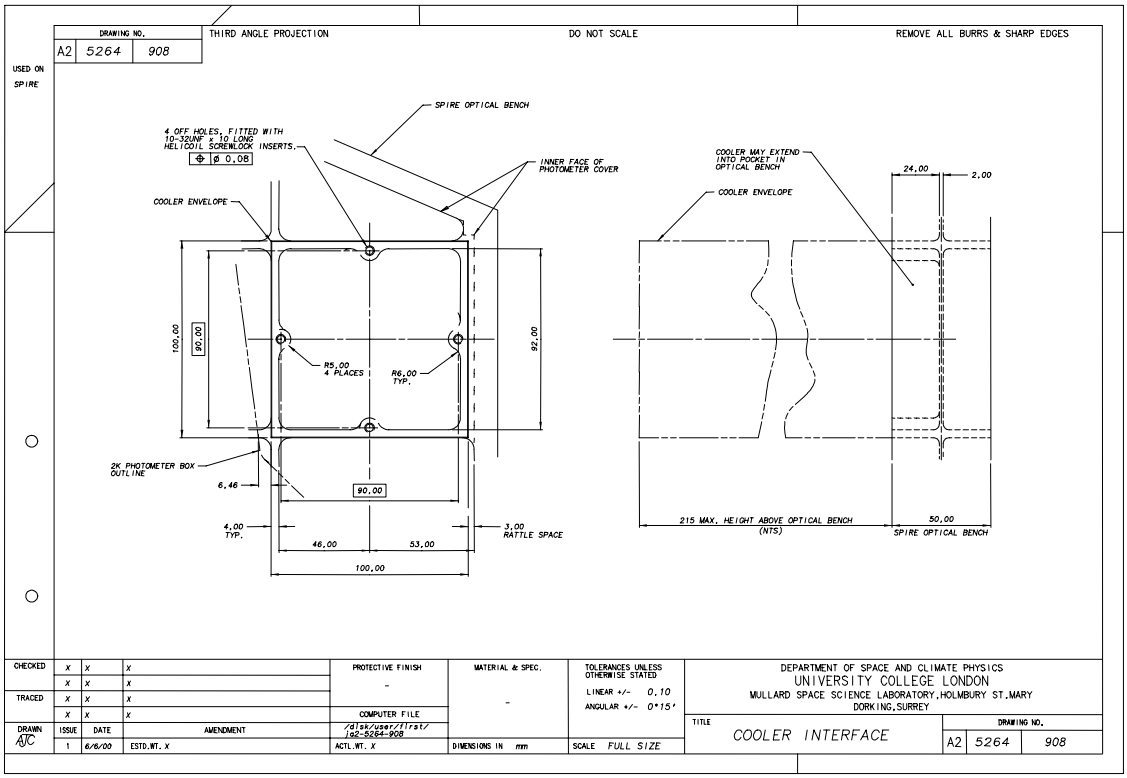
Change control sheet		
Drawing Number TBD		
Issue	Date	Change
A		

SUBSYSTEM:	UNIT CODE:

MECHANICAL INTERFACE CONTROL DRAWING

Drawing xxx gives details of the structure: SOB - ^{3}He cooler mechanical interface.

In the sketch hereafter the provisional interface definition is given. The cooler interfaces with 4 holes. The holes are located on the SOB. The interface plane is perpendicular to the longitudinal axis of the cooler. Currently the side-lengths are 100 mm



Interface drawing for cooler mounting (DR1)

TBD

Interface drawing for cold finger / 0.3 K thermal strap

TBD

Interface drawing for level 0 thermal straps (~2 K)

3.2 Harness interface data sheets

SUBSYSTEM:	UNIT CODE:

HARNESS LAYOUT

Change control sheet		
Drawing Number TBD		
Issue	Date	Change
A		New issue

SUBSYSTEM:	UNIT CODE:

Currently two 37 pin connectors are baseline. The wiring is routed through the instrument to the RF-filter box. Total length for the leads 800 mm (TBC).

3.3 Optical interface data sheets

n.a.

3.4 Thermal interface data sheets

SUBSYSTEM: 1.1 – 1.3 (Structure – cooler)	UNIT CODE:

THERMAL CHARACTERISTICS

FOOT MATERIAL AND THICKNESS:
n.a.

SURFACE PROPERTIES: #
n.a.

Table 3.4-1: Thermal characteristics

QUALIFICATION TEMPERATURE LIMIT (°C)

GROUND STORAGE &TRANS		OPERATING MODE		NON OPERATING MODE		START UP
MIN	MAX	MIN	MAX	MIN	MAX	MIN
Any	+80 °C	-273	-270.5	any	+80 °C	-270.5 °C

Table 3.4-2 Qualification temperatures

Interface/mode	AVERAGE	MIN	MAX
Cooler- Structure/OFF	TBD	TBD	TBD
Cooler- Structure /STAND-BY	TBD	TBD	TBD
Cooler- Structure /OPERATING	TBD	TBD	TBD

Table 3.4-3: Heat dissipation (µW) from cooler to structure (~4 K).

Interface/mode	AVERAGE	MIN	MAX
Cooler- CSTR1/OFF	TBD	TBD	TBD
Cooler- CSTR1/STAND-BY	TBD	TBD	TBD
Cooler- CSTR1/OPERATING	TBD	TBD	TBD
Cooler- CSTR2/OFF	TBD	TBD	TBD
Cooler- CSTR2/STAND-BY	TBD	TBD	TBD
Cooler- CSTR2/OPERATING	TBD	TBD	TBD

Table 3.4-4: Heat dissipation (μW) from cooler to level 0 (~2 K).

Interface/mode	AVERAGE	MIN	MAX
Cooler-PSW/OFF	TBD	TBD	TBD
Cooler-PSW/STAND-BY	TBD	TBD	TBD
Cooler-PSW/OPERATING	TBD	TBD	TBD
Cooler-PMW/OFF	TBD	TBD	TBD
Cooler-PMW/STAND-BY	TBD	TBD	TBD
Cooler-PMW/OPERATING	TBD	TBD	TBD
Cooler-PLW/OFF	TBD	TBD	TBD
Cooler-PLW/STAND-BY	TBD	TBD	TBD
Cooler-PLW/OPERATING	TBD	TBD	TBD

Table 3.4-5: Heat dissipation (μW) from cooler to detectors (~0.3 K).

Interface	AVERAGE	MIN	MAX
Cooler- CSTR1 (switch-on)	TBD	TBD	TBD
Cooler- CSTR2 (switch-on)	TBD	TBD	TBD
Cooler- CSTR1 (switch-off)	TBD	TBD	TBD
Cooler- CSTR2 (switch-off)	TBD	TBD	TBD
Cooler-PDSW	TBD	TBD	TBD
Cooler-PDMW	TBD	TBD	TBD
Cooler-PDLW	TBD	TBD	TBD
Cooler-SDLB	TBD	TBD	TBD
Cooler-SDHB	TBD	TBD	TBD

Table 3.4-6: Heat conductance (W/K) table cooler – detectors (See also fig. 2.1-2)

4. ELECTRICAL INTERFACES.

Grounding for the thermal straps….

5. DATA INTERFACES

n.a.