Herschel/SPIRE

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SPIRE – MECHANICAL I/F

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Change Record

Issue	Date	Brief description of change
0.1	November 2000	New document
0.2	February 2001	Update, updated topology, updated I/F drawings and cable lengths
1.0	April 2001	Update
1.1	November 2001	Update, updated I/F drawings and random qualification levels

Table of Contents

Glossary

All terms are listed in the CIDL.

Documents

All documents are listed in Figure 3.2 of the CIDL.

1. Introduction

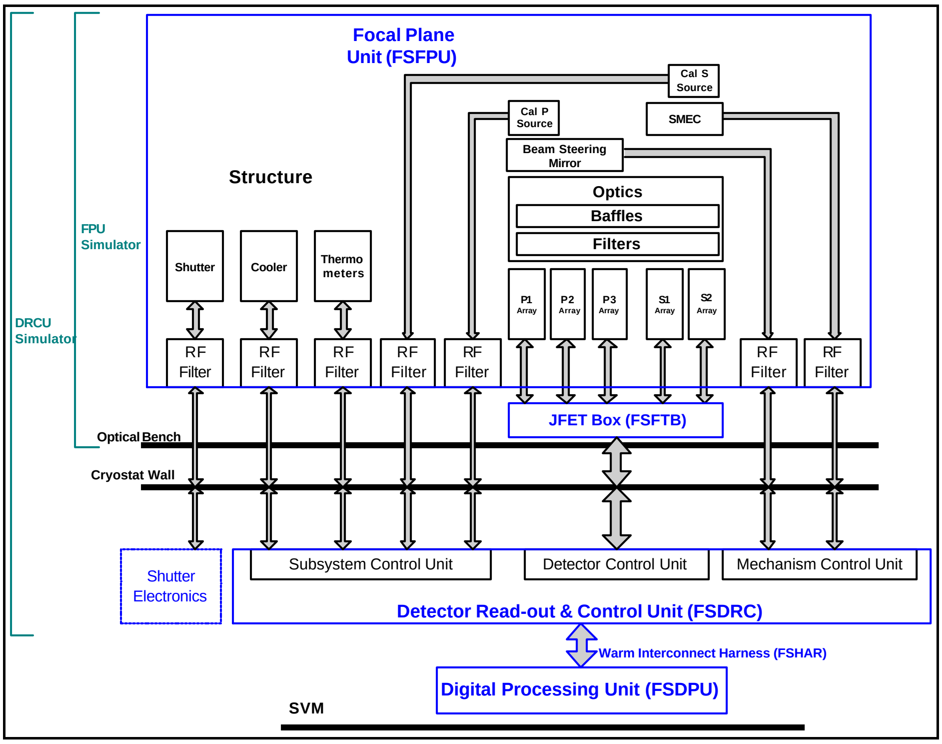
1.1 Purpose of Document

The purpose of this document is to define the interface between the SPIRE structure and all the sub-systems. Within this document the mechanical and thermal requirements, with respect to these interfaces are given. The mechanical interface requirements are related to the actual interface (interface drawing), CoG, MoI and input spectra. The thermal interface requirements deal with contact area, surface finishes, thermal mass and cross sectional areas.

During the final design process the definitions may be refined and possibly changed. This must be done following a formal change procedure, agreed by all parties involved in the design of a sub-system linked to that particular interface requirement.

The design of the instrument and its subsystems obeys the requirements as stated in AD05 of the CIDL.

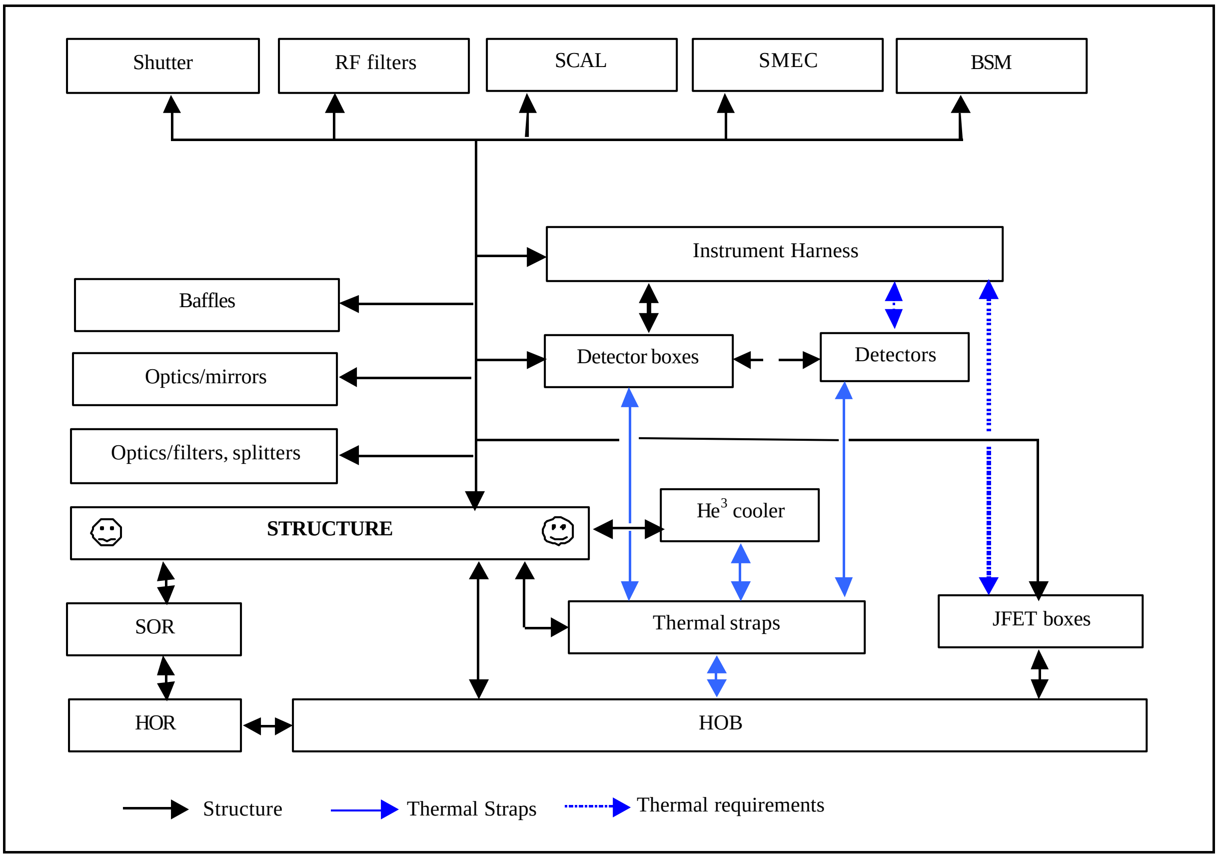
An overview in block diagram format of all the sub-systems and their relation ships is given hereafter in block diagram: 1.1-1.



Block diagram: 1.1-1: SPIRE system

1.2 SCOPE

The interfaces between the structure and the other subsystems are divided into the mechanical and thermal. For each interface the relevant requirements are listed. The interfaces considered are between the SPIRE structure and the relevant subsystems. Block diagram 1.2-1 gives a graphical interpretation of the interfaces defined, including the mechanical and thermal requirements, in this document.



Block diagram: 1.2-1: Connections, mechanical and thermal, between the subsystems

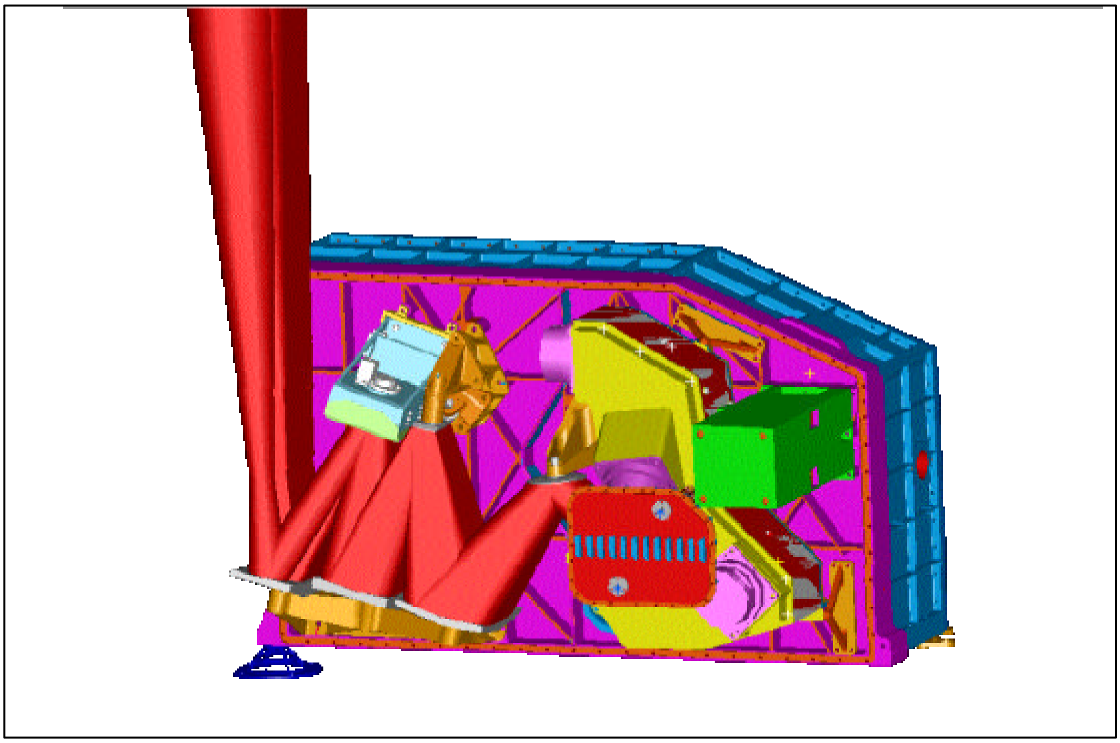


Figure 1.2-1: View of the inside of the instrument – photometer side, cover taken off

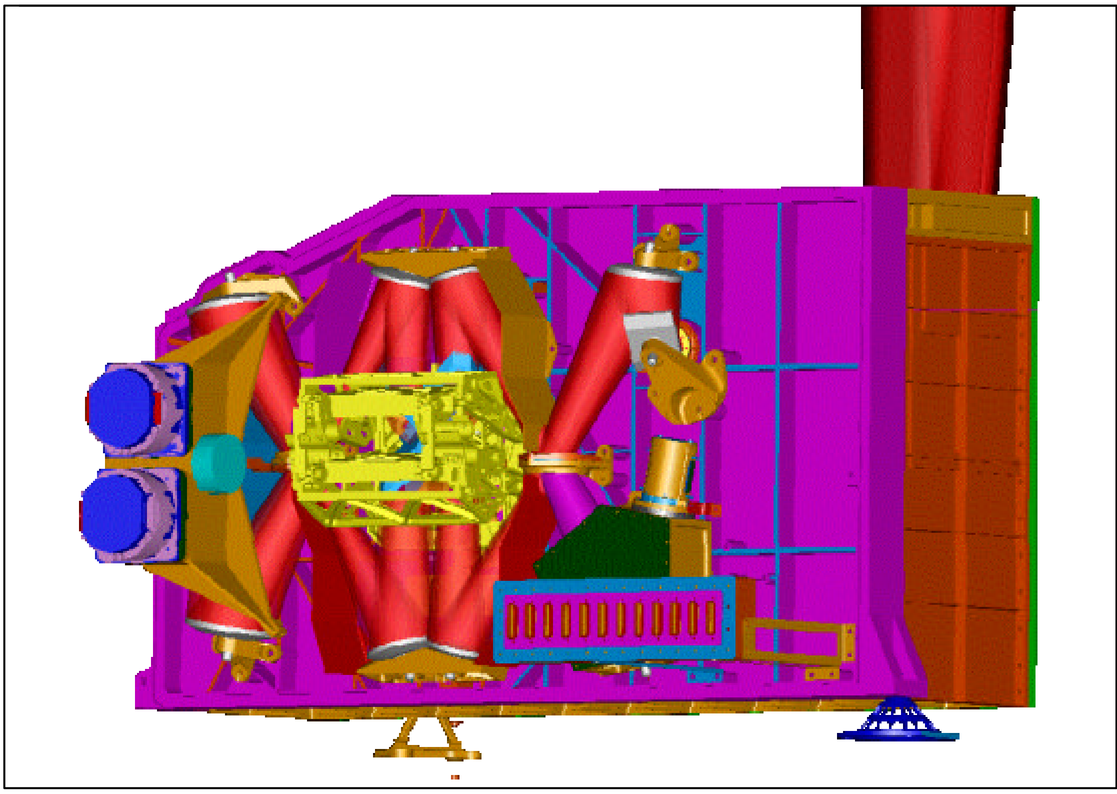


Figure 1.2-2: View of the inside of the instrument – spectrometer side, cover taken off

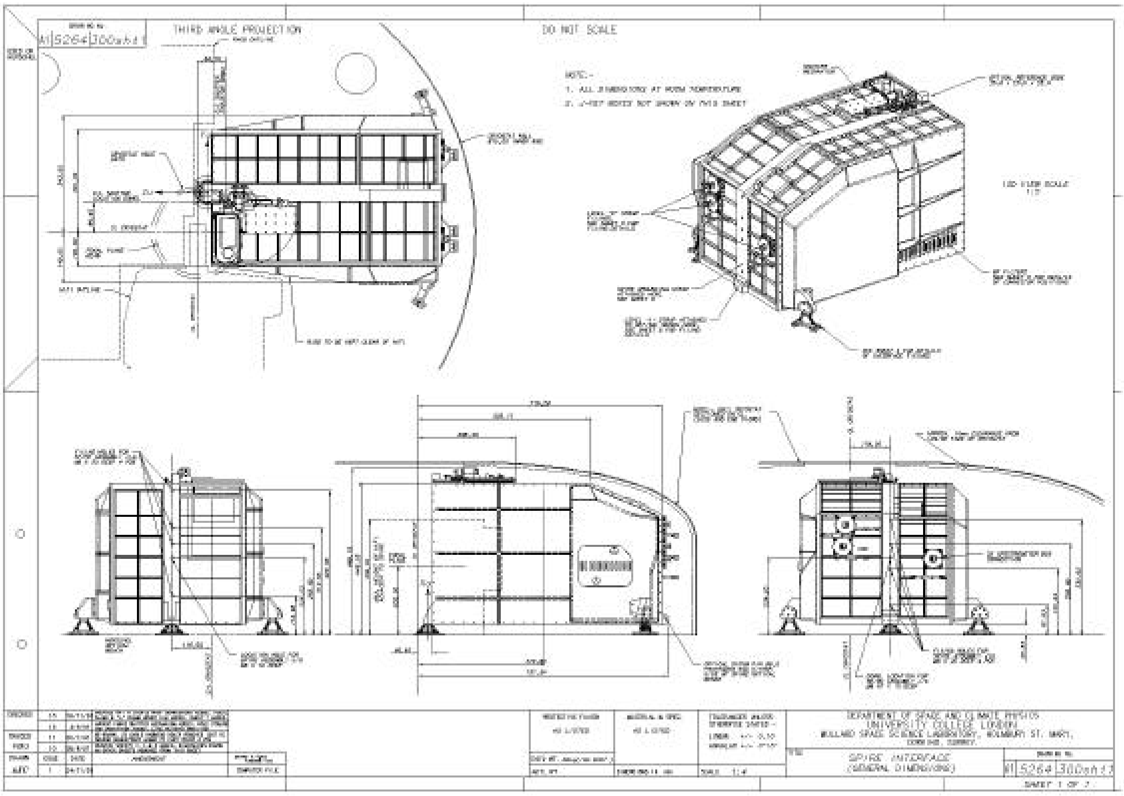


Figure 1.2-3: Interface drawing between structure and HOB-1 (Sheet 1 Issue 13)

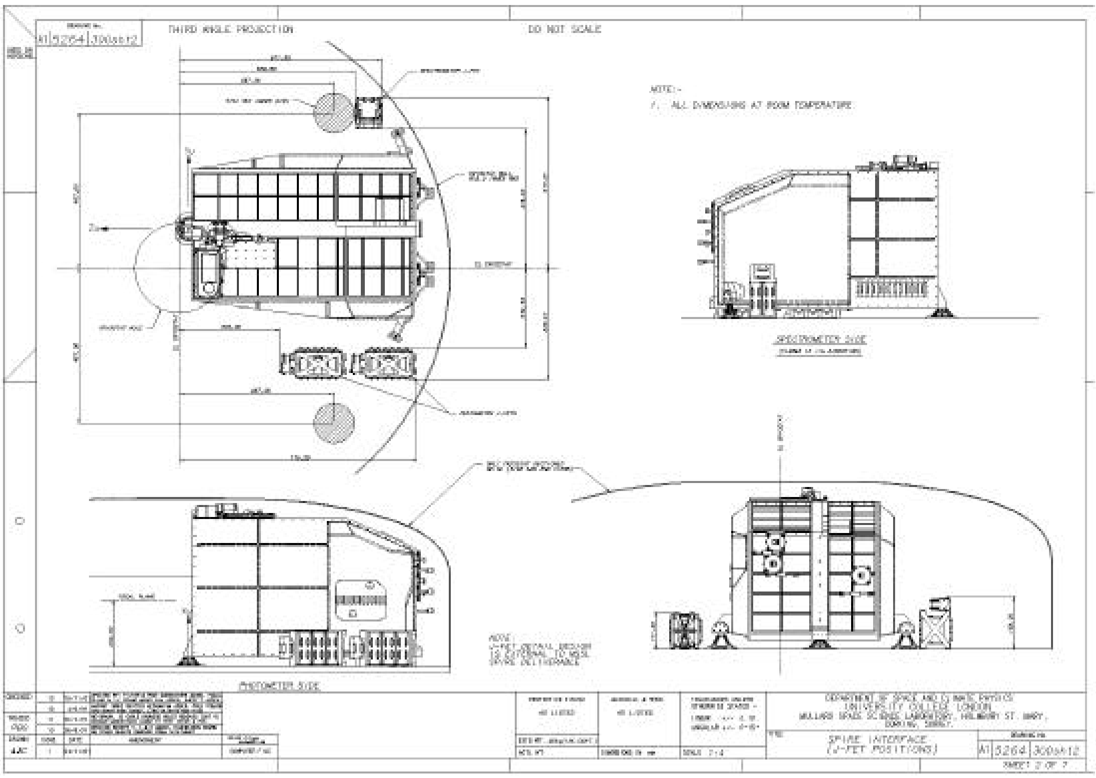


Figure 1.2-4: Interface drawing between structure and HOB-2 (Sheet 2 Issue 13)

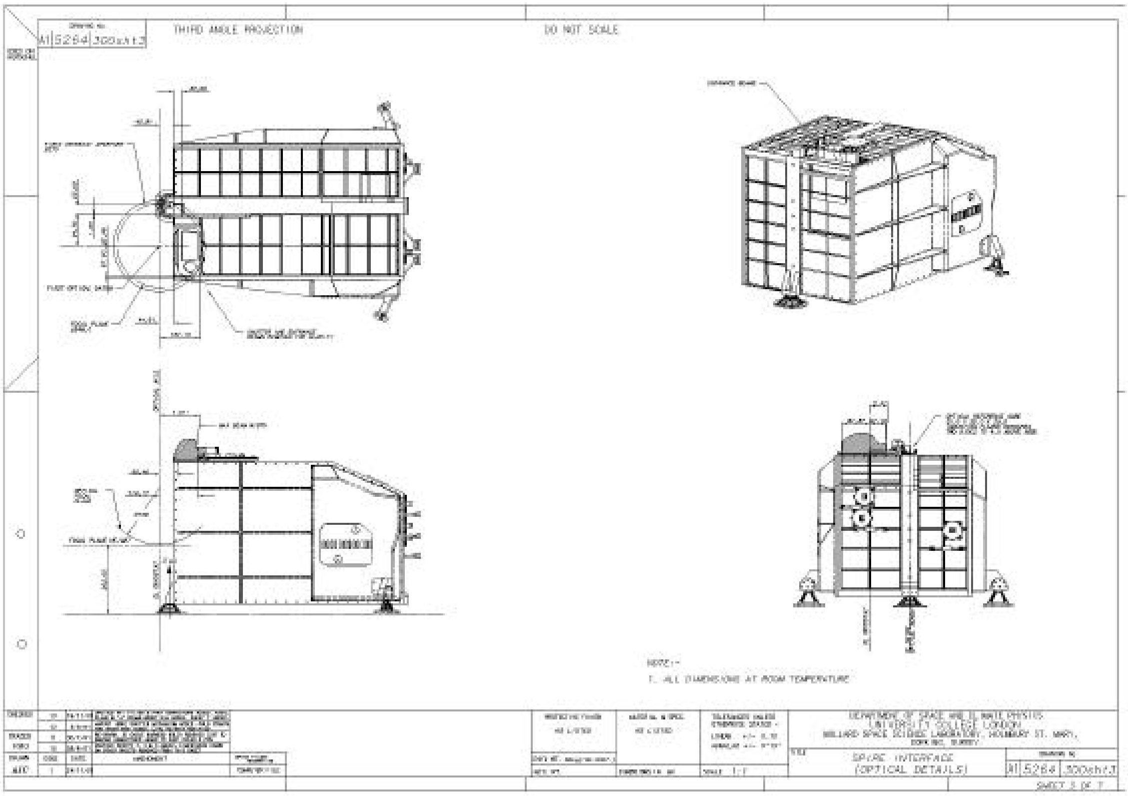


Figure 1.2-5: Interface drawing between structure and HOB-3 (Sheet 3 Issue 13)

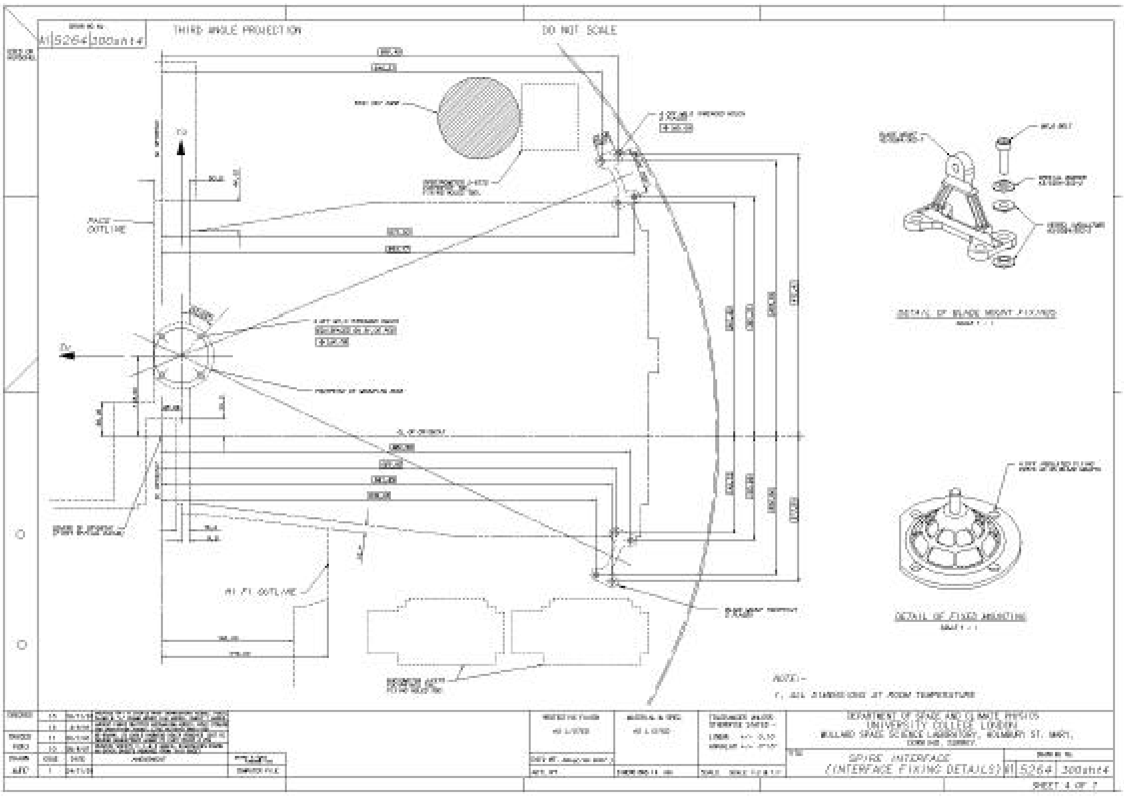


Figure 1.2-6: Interface drawing between structure and HOB-4 (Sheet 4 Issue 13)

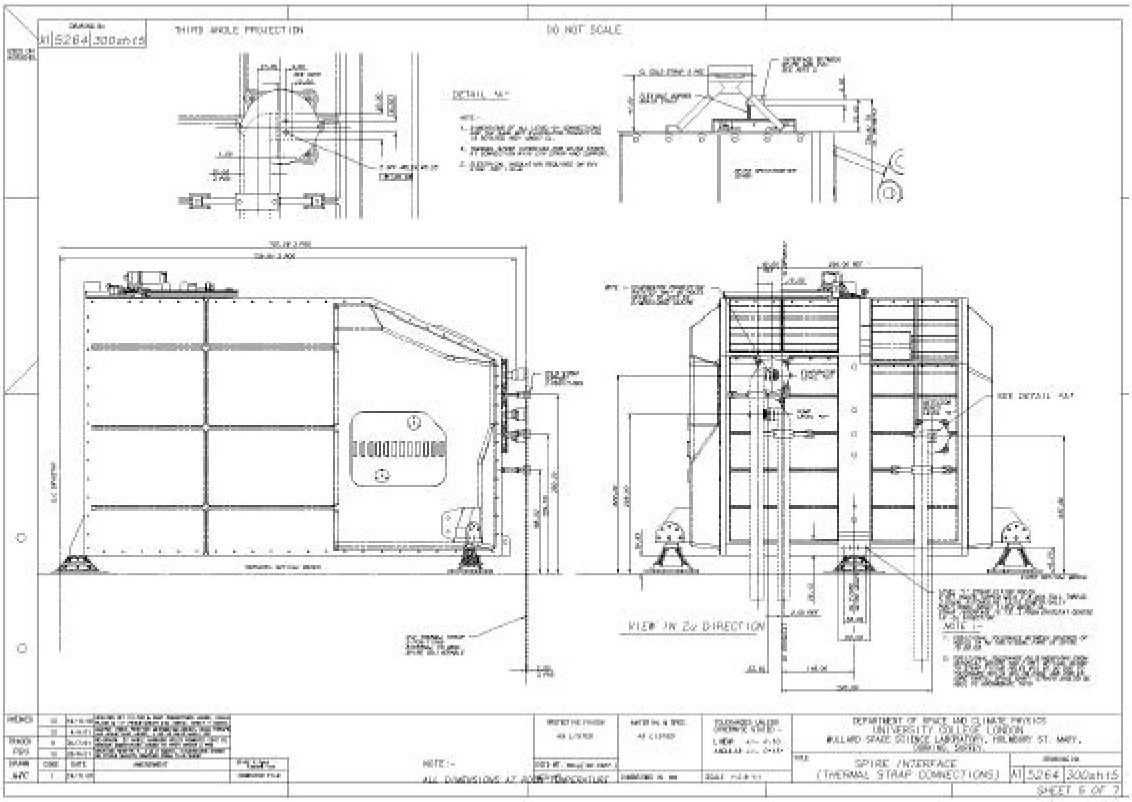


Figure 1.2-7: Interface drawing between structure and HOB-5 (Sheet 5 Issue 13)

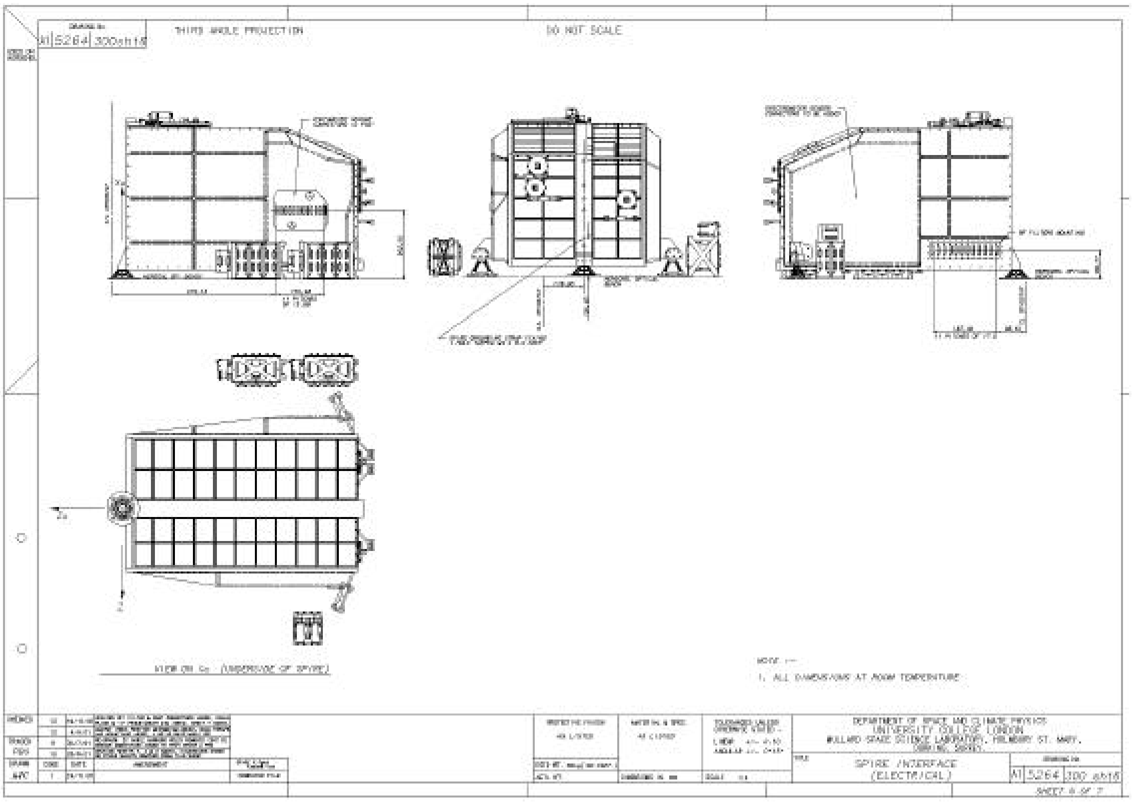


Figure 1.2-8: Interface drawing between structure and HOB-6 (Sheet 6 Issue 13)

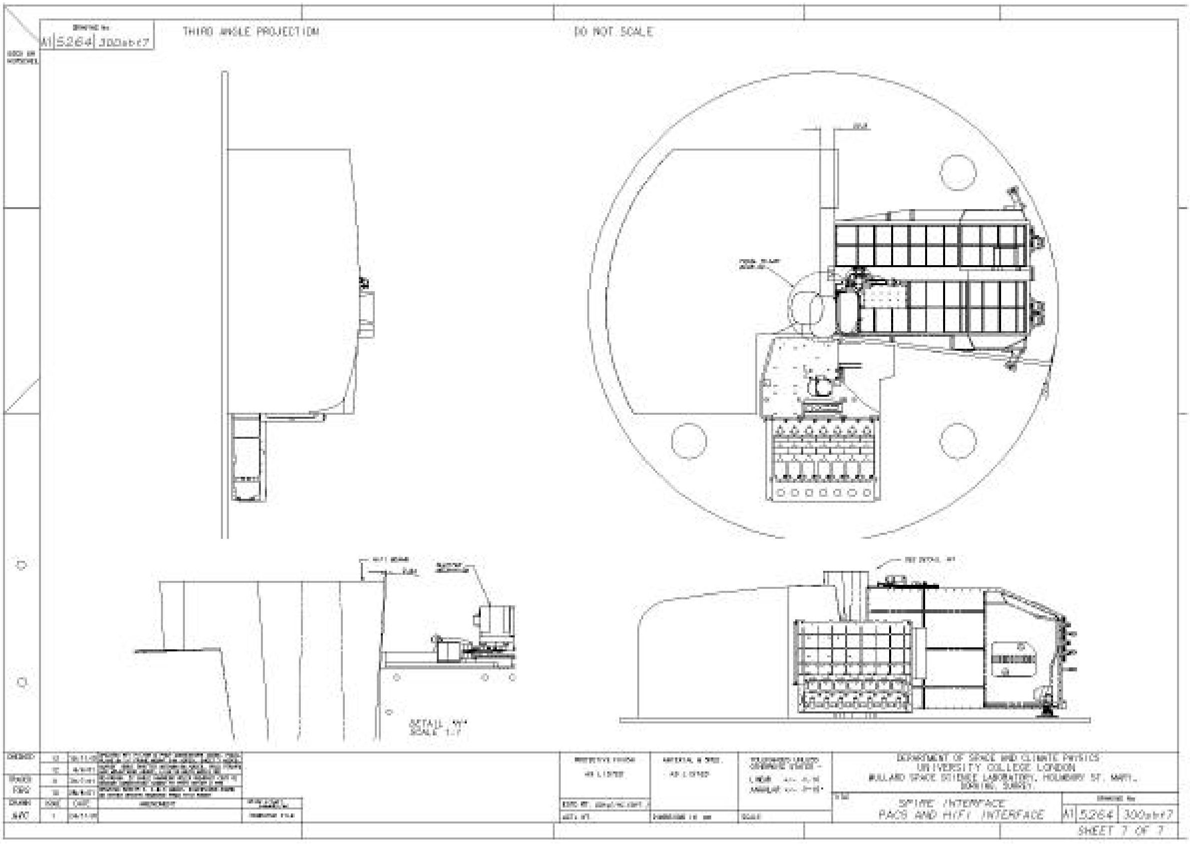
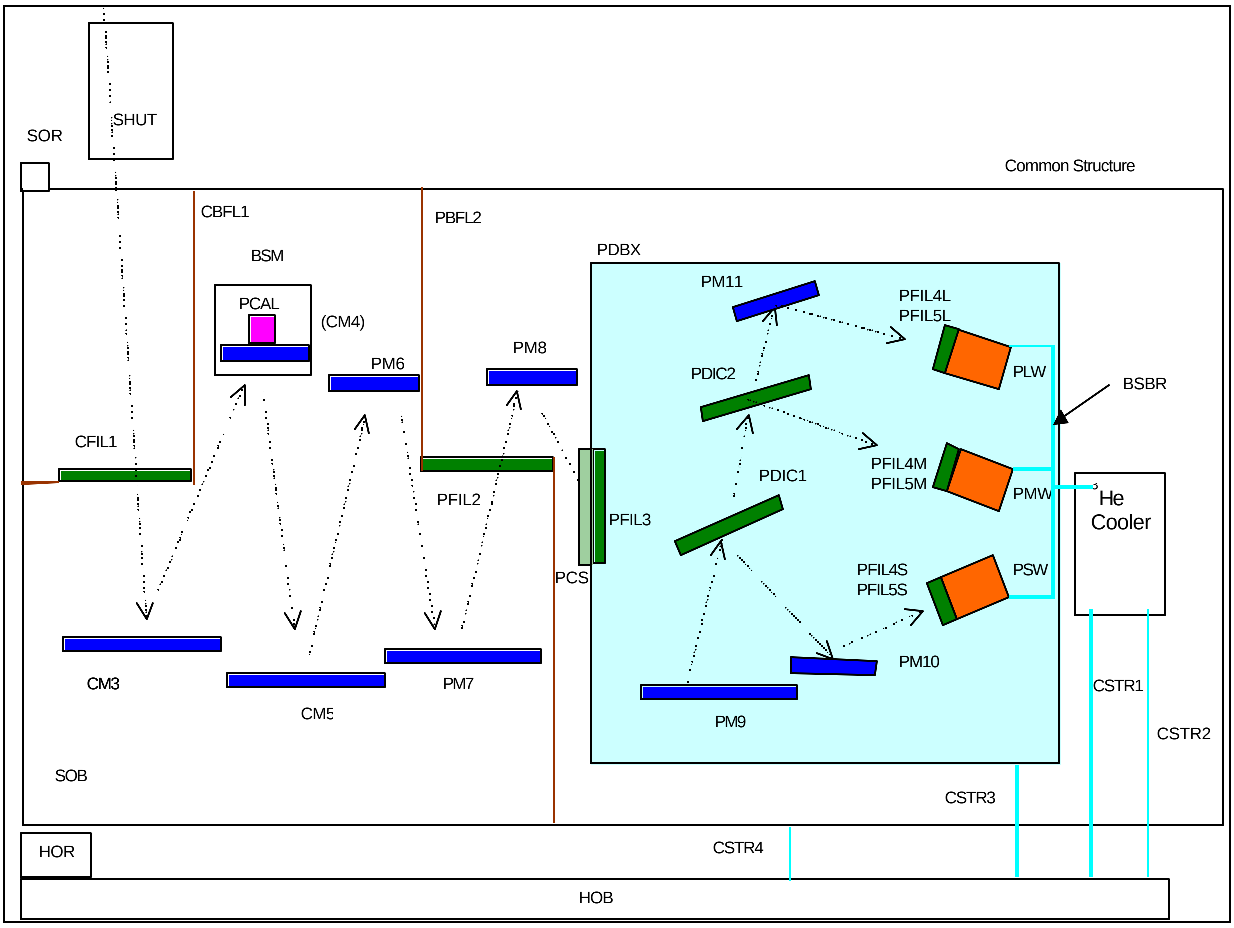


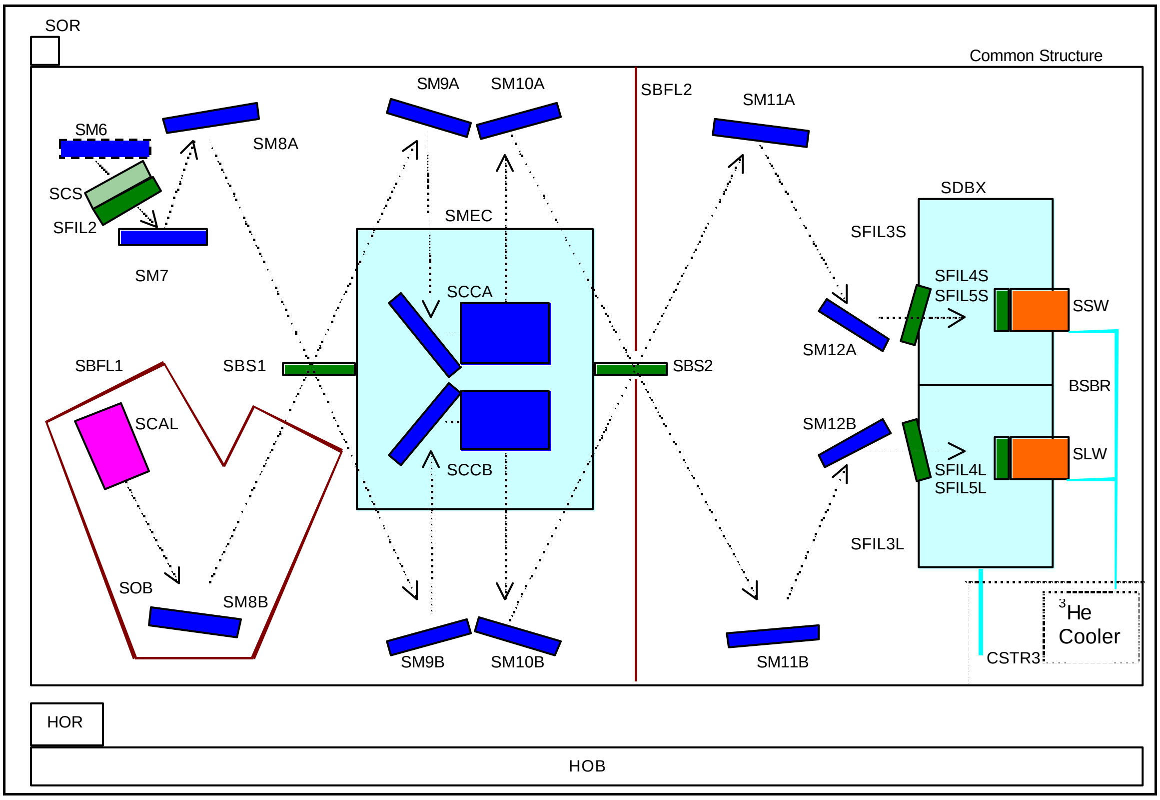
Figure 1.2-9: Interface drawing between structure and HOB-7 (Sheet 7 Issue 13)

1.3 The sub-system requirements listed (mechanical and thermal)



Block diagram 1.3-1: Photometer side of the instrument

BSBR	Thermal BuSBaR between cooler and detectors
BSM	Beam Steering Mechanism
CBFL1	Common BaFfLe1
CFIL1	Common FILter 1 (entry 4 K enclosure)
CM3-5	Common Mirror 3-5
CSTR1	Cold STRap 1 (level 0, Cryostat to base evaporator heat switch)
CSTR2	Cold STRap 2 (level 0, Cryostat to base sorption pump heat switch)
CSTR3	Cold STRap 3 (level 0, Cryostat to photometer detector box)
CSTR4	Cold STRap 4 (level 1, Vent line to optical bench)
HOB	HERSCHEL Optical Bench
HOR	HERSCHEL Optical Reference
[3]He Cooler	[3]He cooler (located in photometer side of the instrument)
PBFL2	Photometer BaFle2
PCAL	Photometer CALibration source
PCS	Photometer Cold Stop
PDBX	Photometer Detector BoX
PDIC1	Photometer DIChroic 1
PDIC2	Photometer DIChroic 2
PFIL2	Photometer FILter (entrance PDBX)
PFIL3	Photometer FILter 2 (4 K-2 K enclosure)
PFIL4L/5L	Photometer FILter 4 and 5 at nose PLW
PFIL4M/5M	Photometer FILter 4 and 5 at nose PMW
PFIL4S/5S	Photometer FILter 4 and 5 at nose PSW
PLW	Photometer Long Wave detector
PM6-11	Photometer Mirror 6 to 11
PMW	Photometer Medium Wave detector
PSW	Photometer Short Wave detector
SHUT	SHUTter mechanism
SOB	Spire Optical Bench Panel
SOR	SPIRE Optical Reference



Block diagram 1.3-2: Spectrometer side of the instrument

CSTR3	Cold STRap 3 (Level 0, cryostat base to SDBX, via PDBX)	SDBX	Spectrometer Detector BoX
HOB	HERSCHEL Optical Bench	SFIL2	Spectrometer FILter 2 (4 K - 2 K enclosure)
HOR	HERSCHEL Optical Reference	SFIL3L	Spectrometer FILter 3 (long wave)
^{3}He Cooler	^{3}He cooler (located in photometer side of the instrument)	SFIL3S	Spectrometer FILter 3 (short wave)
		SFIL4L/5L	Spectrometer FILter at nose SLW
SBFL1	Spectrometer BaFfLe 1	SFIL4S/5S	Spectrometer FILter at nose SSW
SBFL2	Spectrometer BaFfLe 2	SM6-7	Spectrometer Mirror6-7
SBS1	Spectrometer Beam Splitter 1	SM8A-12A	Spectrometer Mirror 8-12 +X chain
SBS2	Spectrometer Beam Splitter 2	SM8B-12B	Spectrometer Mirror 8-12 –X chain
SCAL	Spectrometer CALibration source	SMEC	Spectrometer MEChanism
SCCA	Spectrometer Corner Cube +X	SOB	Spire Optical Bench Panel
SCCB	Spectrometer Corner Cube –X	SOR	Spire Optical Reference
SCS	Spectrometer Cold Stop		

For the schematic location in the instrument, see block diagrams 1.3-1 and 1.3-2.

Sub system ID	Description	Acronim	Section
1.2	Mirrors	CM3-CM5 PM6-PM11 SM6-SM12	2.1
1.2.1	Filters	CFIL1, PFIL2, PFIL3, SFIL2, SFIL3L, SFIL3L	2.2
1.2.1	Beam splitters	SBS1, SBS2	2.3
1.2.1	Dichroics	PDIC1, PDIC2	2.4
1.2.2	Straylight attenuation (Baffles and QMW-black)	PBFL1, PBFL2, SBFL1, SBFL2	2.5
1.3	He^3 Cooler		2.6
1.4.1-1	Photometer detectors	PSW,PMW, PLW	2.7
1.4.1-2	Spectrometer detectors	SSW,SLW	2.8
1.5.1	Beam steering mechanism	BSM	2.9
1.5.2	Spectrometer mechanism	SMEC-m	2.10
1.5.3	Shutter mechanism	SHUT	2.11
1.6.1	Calibration source Photometer	PCAL	part of the BSM
1.6.2	Calibration source Spectrometer	SCAL	2.12
-	Thermal straps	CSTR1-4 BSBR	2.13
-	JFET box	JFBX	2.14
-	RF-filters		2.15

Table 1.3-1: Subsystems interfaces listed in this document

1.4 General requirements

Mechanical environment

AD01 of the CIDL states the following with regard to the mechanical environment and testing. (General requirements for design and analysis on system level: section 9.4 AD01). The mechanical environment as defined in AD01 will change. So the values listed hereafter are provisional.

Safety factors and Sizing factors (9.4.1.2.3, AD01)

Item	Yield SF	Ultimate SF	Buckling SF
Conventional Metallic Materials	1.1	1.5	2.0
Unconventional Materials	1.4	2.0	2.0
Inserts and Joints	1.5	2.0	NA

For the SPIRE instrument as a whole the following flight limit load are given:

Quasi-Static

AD01, section 9.4.1.2.4:

Quasi Static levels	Case 1	Case 2	Case 3
x-direction	20 g	-	-
y-direction	-	14 g	-
z-direction	-	-	14 g

Table 1.4-1: Instrument qualification levels for quasi-static vibration

All subsystems will be subjected to the same environment as defined above. The accelerations, as defined in Table 1.4-1, are very important for limiting interface loads for the various sub-systems subjected to either sine, random or shock loads. At no point during these tests, the interface load between two subsystems is allowed to exceed the quasi-static interface load. This is the baseline for notching during these tests. For an accurate analysis of the interface loads reduced models of all subsystems are required. These models should give an accurate approximation of the first eigenmode and mass in all three orthogonal directions. There is one condition to be allowed a notch based upon this quasi-static interface load. The condition is that the subsystem is only allowed a notch at a given frequency band, if that system has significant effective mass in that frequency band in the excitation direction.

Sine

AD01, section 9.5.3.3.2, gives the following as the requirement for the sine vibration test (instrument level) and input .for the SPIRE instrument mounted on the HERSCHEL optical bench:

Sweep rate: 2 oct/min

Sine vibration levels	Frequency range	Input at base (QUAL)
X - Axis	5-40 Hz 40-100 Hz	20 g 10 g
Y - Axis	5-100 Hz	14 g
Z - Axis	5-100 Hz	14 g

Table 1.4-2: Instrument qualification levels for sine vibration (2 oct/min)

Due to mechanical amplification of the instrument itself, subjected to these levels, the subsystems within the instrument will see a different environment. This has been analysed using FEA. The results of this analysis are translated into sine level specifications for subsystems individually. This will be done taking the following into account:

- Frequency uncertainty: The instrument is designed to meet the frequency requirement including a uncertainty of 10%. To meet the frequency uncertainty requirement the above listed levels are extended to 110 Hz.
- Analysis uncertainty: A analysis uncertainty of 20% will be take into account. The analysed amplification is multiplied with the analysis uncertainty factor of 1.2. The latter is assumed to be sufficient since the influence of structural damping is minimal. The input spectrum for each subsystem is analysed (and given) at its interface plane with the instrument structure.

Random

AD01, section 9.5.3.4, gives the following requirements for the SPIRE instrument.

The test duration is 120 seconds per axis.

Random vibration levels	Frequency range	Input at base (QUAL.)	RMS
X – Axis	20 – 100 Hz 100 - 300 Hz 300 – 2000 Hz	+6 dB Hz/Oct 0.05 g²/Hz -6 dB/Oct	5.27g RMS
Y – Axis	20 – 80 Hz 80 - 300 Hz 300 – 2000 Hz	+6 dB Hz/Oct 0.05 g²/Hz -6 dB/Oct	5.27 g RMS
Z – Axis	20 – 80 Hz 80 - 300 Hz 300 – 2000 Hz	+6 dB Hz/Oct 0.05 g²/Hz -6 dB/Oct	5.27 g RMS

Table 1.4-3: Instrument levels for random vibration (qualification levels)

Due to mechanical amplification of the instrument itself, subjected to these levels, the subsystems within the instrument will see a different environment. This has been analysed using FEA. The results of this analysis are translated into random level specifications for subsystems individually. This will be done taking the following into account:

- damping of 3% between 20 and 200 Hz
- damping of 4% between 200 and 300 Hz
- damping of 3% above 300 Hz

I/F Drawing

The dimensions on the interface drawings, unless specified otherwise, refer to the design at room temperature. To arrive at dimensions at cyrogenic temperatures, one should take thermal contraction into account. The default for the structure is 0.415% (aluminium).

2. MECHANICAL AND THERMAL INTERFACE REQUIREMENTS PER SUBSYSTEM

In the sections here after, some of the requirements that are listed are for information only, since they are defined in higher level documents. The listed requirements, for information only, are:

1. Mass, reference document: AD4 of the CIDL Systems budgets

The sections per interface are divided into 9 different sub-sections. The first subsection deals with overall information to give something of a background (briefly) to the function of the subsystem. A block diagram is included for some systems, to clarify the inter-relations between the different parts/interfaces.

The second and third sub-section deals with possible inputs and outputs. For a mechanical interface this consists, if applicable, of a definition of input micro-vibrations and output micro-vibrations.

The fourth sub-section gives the interface drawings. One set defining the interface on the instrument side and one set defining the interface on the subsystem side. The drawings in this document itself are not the official drawings. They serve as an illustration only. Proper (A1 or A2) interface drawings will be exchanged between the parties concerned. It is the responsibility of each side of the interface to provide the other side with their interface drawing. The interface drawing should contain a reference hole. This reference hole will be tightly toleranced at both sides. In case of mounting on the SOB, it is the responsibility of the subsystem, mounting on this bench, not to introduce additional stress to the optical bench during and after integration. That is no other than the loads induced through the mechanical environment. Copies of these interface drawings can be found in the appendix at the end of this document.

The fifth sub-section gives the mass properties. As stated before, the mass is given for information only as each mass is detailed in the subsystems' own ICD. Together with the mass, the centre of gravity and the moments of inertia around the CoG are also given. The mass properties listed should contain all mass of the subsystem mounted on this interface. Since the listed mass, in accordance with AD04, will serve as input for the overall CoG and MoI figures for the instrument. According to AD01, the mass properties have to be measured within the following tolerances:

- CoG +/- 1%
- MoI +/- 5%

These margins are the same for the actual mass properties and predictions of both the CQM and the PFM model.

The sixth sub-section gives the mechanical environment. The mechanical environment defines the analysed interface levels as a result of the required input for the instrument as a whole. In effect it is the translation of the ESA requirements at the base of the instrument to responses at the interfaces as outlined in section 1.4. For this analysis the qualification levels for the instrument are used. For the qualification of the subsystems, an extra qualification factor of 1.5 is needed. For the latest environmental specification, refer to ESA Instrument Interface Document IID-A (SCI-PT-IIDA-04624).

The seventh sub-section deals with the mechanical implementation of thermal interface requirements. That is, there could be a need for thermal insulation (like the structure support of thermal straps). Or there could be a need for maximised thermal conductance, as in the case of the calibration sources where the generated heat needs to be diffused inside the optical bench.

Sub-section eight deals with the harness routing. The number of connectors involved for each interface, allowable curvature of wiring, cable length, screening requirements. For further details please see the Harness ICD for the IF wiring diagram.

Sub-section nine deals with alignment requirements if applicable.

2.1 Mirrors

2.1.1 Functional Description and Block Diagram

The following holds for all interfaces considered in section 2.1 unless otherwise specified.

Allowable interface loads

The mechanical interface should provide for sufficient stiffness, such that the mechanical loads on the mirrors are minimised. The mounting of the mirror will not add significantly to the rigid body inertia's of the mirrors themselves. That is the eigenfrequency of the mirrors shall be higher than 600 Hz against a rigid interface. With a mount, mounted against a rigid interface shall be higher than 400 Hz.

Interface drawing

Since the mirrors interface both with their mounting and the infra red beams, which they reflect, the relative position of the mounting in the instrument depends both on the interface with the mirror mount as well as the thickness of the mirror. The baseline is two different mirror thicknesses. The mounting spigot will be the same for all the mirrors. As a result of this there are only two different interface drawings required. Hereafter these drawings are presented and the datasheet for each mirror will refer to one of these drawings. The dimensions in the drawing are for the design at room temperature. In the drawings the dimension H-height refers to the thickness of the mirror at its mounting interface. This is either 15 or 7 mm. In principle each mirror has a rotational degree of freedom, since each mirror mounting spigot is rotationally symmetrical. This degree of freedom will be suppressed by means of a dowel pin. The location of this pin, indicated on each drawing, is between the mirror mount spigot and the mirror mount bracket interface with the structure. If in case of possible confusion, the position of the dowel pin will be defined explicitly. See section 2.1.4 and AD20 (Structure/Optics ICD).

No block diagram

2.1.2 Inputs

N.A.

2.1.3 Outputs

N.A.

2.1.4 I/F drawing

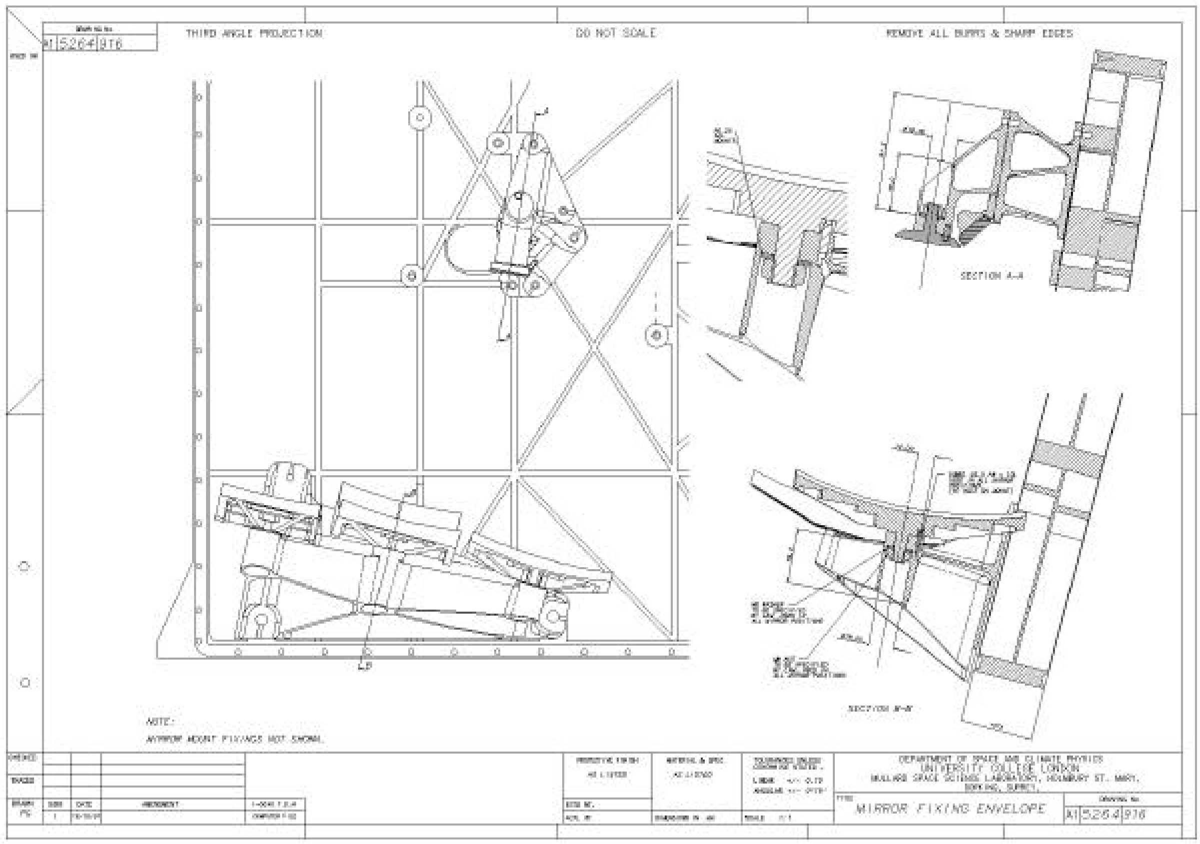


Figure 2.1.4-1: Interface drawing.

2.1.5 Mass Properties

Hereafter for each mirror the CoG and the MoI are listed with respect to the co-ordinate system listed in figure 2.1-2. The Z axis is pointing away from the mirror surface. The Y axis is pointing away from the SOB.

The mass budget for the mirrors is 1720 +1100 gr (AD04 and AD25, excluding contingency)

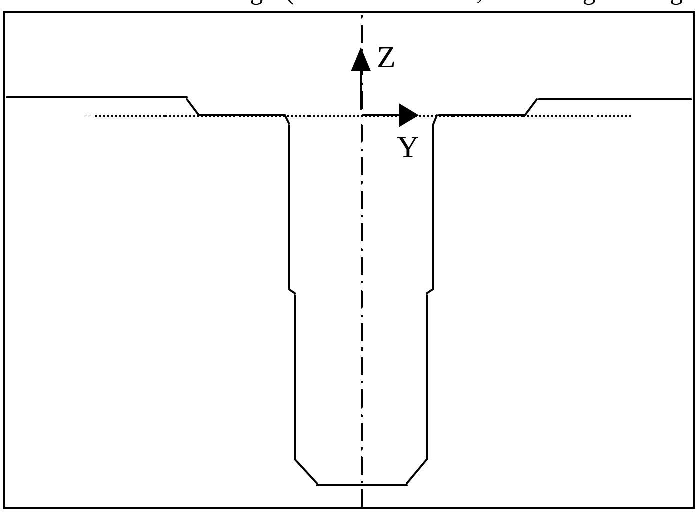


Figure 2.1-2: CoG location reference co-ordinate system for mirrors (Y pointing away form SOB)

ID	L	W	Thick -ness	Mass nominal	CoG [m]	Ixx	Iyy	Izz
	[mm]	[mm]	[mm]	[gr]	[mm]	[grmm^2]	[grmm^2]	[grmm^2]
CM3	132	54	15	250				
CM5	161	85	15	362				
PM6	46	27	7	23+nut				
PM7	118	101	15	254+nut				
PM8	60	60	7	40+nut	2.8			
PM9	112	112	15	201+nut				
PM10	78	40	7	51+nut				
PM11	56	53	7	48+nut				
SM6	29	51	7	13+nut				
SM7	40	57	7	38+nut				
SM8	60	60	7	108+nut				
SM9	50	50	7	68+nut				
SM10	60	60	7	92+nut				
SM11	74	74	7	160+nut				
SM12	21	16	7	50+nut				

Table 2.1.5-1: Mass properties of the mirrors (Reference RD08)

2.1.6 Mechanical Environment

Assuming a first natural frequency, mounted against a rigid interface above 170 Hz.
As specified in 1.4, including the qualification factor of 1.5, the provisional sine spec is:

Sine vibration levels	Frequency range	Input at base (QUAL)
X-direction	5-30 Hz 30-100 Hz	11 mm (0-peak) 40 g
Y-direction	5-30 Hz 30-100 Hz	11 mm (0-peak) 25 g
Z-direction	5-30 Hz 30-100 Hz	11 mm (0-peak) 25 g

Table 2.1.6-1 Qualification sine input (2 oct/min)

As specified in 1.4, including the qualification factor of 1.5. The random spec is:
The test duration is 120 seconds per axis.

Axis (S/C)	ramp up	plateau	ramp down	g-rms
X	+6 dB/oct 20-100 Hz	0.35 g^2/Hz 100 - 400 Hz	-6 dB/oct 300-2000 Hz	~16
Y	+6 dB/oct 20-100 Hz	0.35 g^2/Hz 100 - 400 Hz	-6 dB/oct 300-2000 Hz	~16
Z	+6 dB/oct 20-100 Hz	0.35 g^2/Hz 100 - 400 Hz	-6 dB/oct 300-2000 Hz	~16

Table 2.1.6-2 Instrument levels for random vibration (qualification levels)

2.1.7 Thermal Interface

When cooling down the instrument, the mirrors with their overall significant thermal mass, should not lag behind in temperature significantly (time wise). Therefore a significant thermal conductance should exist between the mirrors, through the mirror mounts to the optical bench. Since the contact area between mirror and mirror mount is significant, the mirror mounts themselves are significant and thus no problem is expected. The mirror mounts are mounted with three interface bolts on the optical bench.

Between mirror and mirror mount:

Total contact area: between 100 and 250 mm^2 (TBC)

Surface roughness of contact area: Ra=1.5 (TBC).

2.1.8 Harness Routing

N.A.

2.1.9 Alignment

The following requirements hold for the alignment of the I/F plane between the mirror mounts and the structure.

- Off centre 0.1 mm all directions simultaneously
- Longitudinal +/-0.5 mm
- Tilt +/-1 arcminute.
- Roll +/-2 arcminute (TBC)

2.2 Filters

2.2.1 Functional Description and Block Diagram

The first filters in the chain, situated on the 4-K box, should reflect back to the sky as much unwanted high frequency radiation as possible. Filters on lower temperature shields should then reject radiation to higher temperature boxes and shields. Strategic placement of filters will enable us to:

- Define the spectral passbands.
- Minimise the thermal loading on the ^{3}He fridge, 2-K, and 4-K stages by rejecting short wavelength thermal energy.
- Minimise stray light getting to the detectors.
- Maximise the in-band spectral transmission.

The sequence of filters starts with the two common 4-K filters at the input to the instrument. They minimise the radiation from T > 4-K from entering the instrument. The filters at the entrance of the detector boxes minimise the transmission of radiation from T > 2-K. The 0.3 K filters at the nose of the detectors are not discussed in this document since they interface only with the detectors.

The filters are clamped against the structure using a light tight clamp ring. The function of the OBP (reviewing the interface between the OBP and the filters) is to support the beam splitters and their mounts. The mechanical interface should provide for a precise defined and accurately machined mounting surface. The mechanical interface should provide for sufficient stiffness, such that the mechanical loads on the filters are minimised.

There is no block diagram.

2.2.2 Inputs

N.A.

2.2.3 Outputs

N.A.

2.2.4 I/F drawing

TBD

As a guide the filters will be sized to the envelope the 20% oversized beam at the mounting location. At this location the filters closes an aperture and the area around it, if possible, will be covered with the Cardiff black.

2.2.5 Mass Properties

The mass budget for the filters is 450 gr (AD2, excluding contingency)

ID	Mass	CoG	Ixx	Iyy	Izz
	[gr]	[mm]	[grmm^2]	[grmm^2]	[grmm^2]
CFIL1	5	TBD	TBD	TBD	TBD
PFIL2	3	TBD	TBD	TBD	TBD
PFIL3	3	TBD	TBD	TBD	TBD
SFIL2	1	TBD	TBD	TBD	TBD
SFIL3S	1	TBD	TBD	TBD	TBD
SFIL3L	1	TBD	TBD	TBD	TBD

Table 2.2.5-1: Mass properties table, I with regard to CoG

2.2.6 Mechanical Environment

Assuming a first natural frequency mounted against a rigid interface above 170 Hz.
As specified in 1.4, including the qualification factor of 1.5. The sine spec is:

Sine vibration levels	Frequency range	Input at base (QUAL)
X-direction	5-30 Hz 30-110 Hz	22 mm (0-peak) 40 g
Y-direction	5-30 Hz 30-110 Hz	22 mm (0-peak) 25 g
Z-direction	5-30 Hz 30-110 Hz	22 mm (0-peak) 25 g

Table 2.2.6-1 Qualification sine input (2 oct/min)

As specified in 1.4, including the qualification factor of 1.5. The random spec is:
The test duration is 120 seconds per axis.

Axis (S/C)	ramp up	plateau	ramp down	g-rms
X	+6 dB/oct 20-100 Hz	0.8 g^2/Hz 100 - 300 Hz	-6 dB/oct 300-2000 Hz	
Y	+6 dB/oct 20-100 Hz	0.8 g^2/Hz 100 - 300 Hz	-6 dB/oct 300-2000 Hz	
Z	+6 dB/oct 20-100 Hz	0.8 g^2/Hz 100 - 300 Hz	-6 dB/oct 300-2000 Hz	

Table 2.2.6-2: Instrument levels for random vibration (qualification levels)

2.2.7 Thermal Interface

TBD

2.2.8 Harness Routing

N.A.

Note some filters may need to be part of the Faraday filters.

2.2.9 Alignment

The following requirements hold for the alignment of the I/F plane between the filter mounts and the structure. RD2

- Off centre 1 mm all directions simultaneously (TBC).

2.3 Beam Splitters

2.3.1 Functional Description and Block Diagram

The beam splitters in the FTS part of the instrument reflect >49% and pass >49% of the incident radiation virtually independently of frequency across the entire SPIRE band.

2.3.2 Inputs

N.A.

2.3.3 Outputs

N.A.

2.3.4 I/F drawing

The outer diameter of the beam splitter is TBD mm.

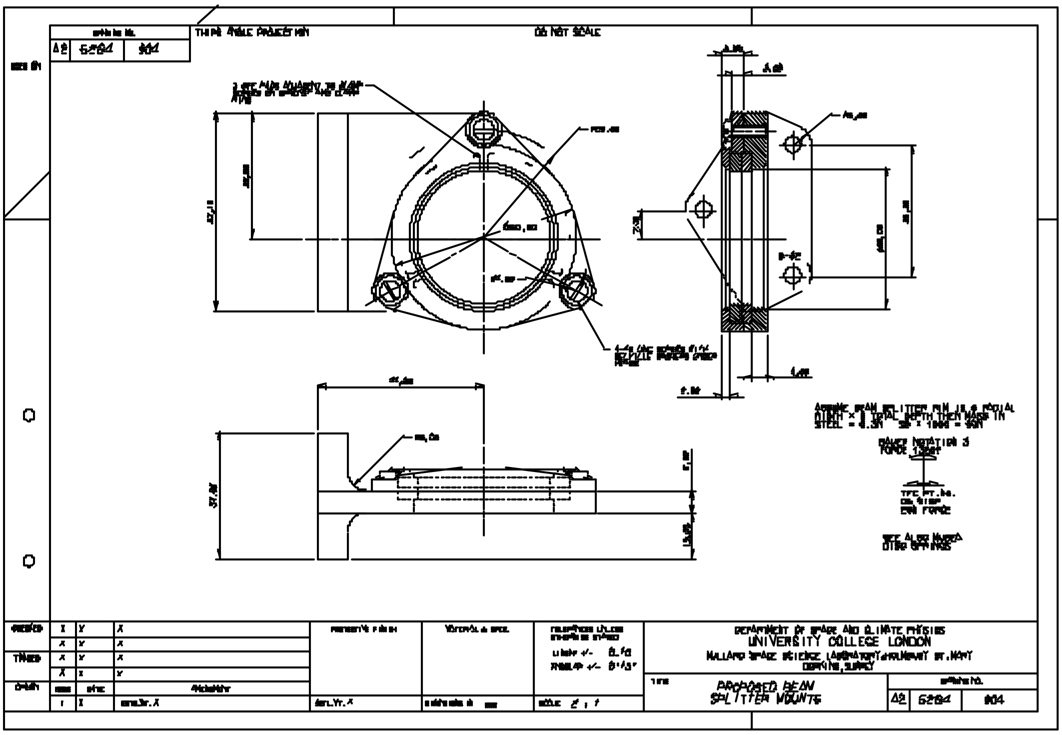


Figure 2.3.4-1 Beam Splitter Interface Drawing (Sheet 1Issue 1)

2.3.5 Mass Properties

The mass budget for the splitters is 100 gr (AD04, excluding contingency) (This is based upon 100 gr taken from mass for the spectrometer filters) This is the splitter itself, without mount.

ID	Mass	CoG	Ixx	Iyy	Izz
	[gr]	[mm]	[grmm^2]	[grmm^2]	[grmm^2]
SBS1	32	TBD	TBD	TBD	TBD
SBS2	32	TBD	TBD	TBD	TBD

Table 2.3.5-1: Mass properties table, I with regard to CoG

2.3.6 Mechanical Environment

Assuming a first natural frequency mounted against a rigid interface above 170 Hz.
As specified in 1.4, including the qualification factor of 1.5. The sine spec is:

Sine vibration levels	Frequency range	Input at base (QUAL)
X-direction	5-30 Hz 30-110 Hz	22 mm (0-peak) 40 g
Y-direction	5-30 Hz 30-110 Hz	22 mm (0-peak) 25 g
Z-direction	5-30 Hz 30-110 Hz	22 mm (0-peak) 25 g

Table 2.3.6-1 Qualification sine input (2 oct/min)

As specified in 1.4, including the qualification factor of 1.5. The random spec is:
The test duration is 120 seconds per axis.

Axis (S/C)	ramp up	plateau	ramp down	g-rms
X	+6 dB/oct 20-100 Hz	0.35 g^2/Hz 100 - 400 Hz	-6 dB/oct 300-2000 Hz	~16
Y	+6 dB/oct 20-100 Hz	0.35 g^2/Hz 100 - 400 Hz	-6 dB/oct 300-2000 Hz	~16
Z	+6 dB/oct 20-100 Hz	0.35 g^2/Hz 100 - 400 Hz	-6 dB/oct 300-2000 Hz	~16

Table 2.3.6-2: Instrument levels for random vibration (qualification levels)

2.3.7 Thermal Interface

N.A.

2.3.8 Harness Routing

N.A.

2.3.9 Alignment

TBD

2.4 Dichroics

2.4.1 Functional Description and Block Diagram

The dichroics within the PDBX reflect high frequencies and pass low frequencies and hence aid definition of the SPIRE photometer channels. The mechanical interface should provide for sufficient stiffness, such that the mechanical loads on the detector boxes and the dichroics are minimised. The dichroics and beam splitters are sensitive to warping, and this is considered in the design of the mounts for these components.

The maximum warping of the dichroics induced by the structure is TBD. Tilt 1 arcminute (TBC)

2.4.2 Inputs

N.A.

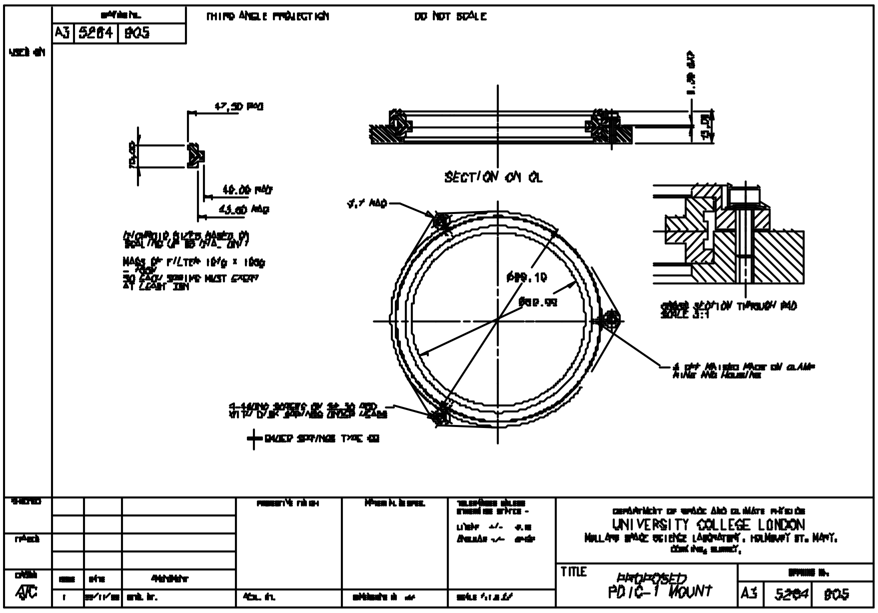
2.4.3 Outputs

N.A.

2.4.4 I/F drawing

The outer dimension of the dichroics are:

PDIC1: TBD mm
PDIC2: TBD mm



2.4.5 Mass Properties

The mass budget for the dichroics is 100 gr (AD04, excluding contingency) (This is based upon 100 gr taken from mass for the spectrometer filters)

ID	Mass	Ixx	Iyy	Izz
PDIC1	287	TBD	TBD	TBD
PDIC2	250	TBD	TBD	TBD

Table 2.4.5-1: Mass properties table, I with regard to CoG

2.4.6 Mechanical Environment

Assuming a first natural frequency mounted against a rigid interface above 170 Hz.

As specified in 1.4, including the qualification factor of 1.5. The sine spec is:

Sine vibration levels	Frequency range	Input at base (QUAL)
X-direction	5-30 Hz 30-110 Hz	22 mm (0-peak) 40 g
Y-direction	5-30 Hz 30-110 Hz	22 mm (0-peak) 25 g
Z-direction	5-30 Hz 30-110 Hz	22 mm (0-peak) 25 g

Table 2.4.6-1 Qualification sine input (2 oct/min)

As specified in 1.4, including the qualification factor of 1.5. The random spec is:

The test duration is 120 seconds per axis.

Axis (S/C)	ramp up	plateau	ramp down	g-rms
X	+6 dB/oct 20-100 Hz	0.8 g^2/Hz 100 - 300 Hz	-6 dB/oct 300-2000 Hz	
Y	+6 dB/oct 20-100 Hz	0.8 g^2/Hz 100 - 300 Hz	-6 dB/oct 300-2000 Hz	
Z	+6 dB/oct 20-100 Hz	0.8 g^2/Hz 100 - 300 Hz	-6 dB/oct 300-2000 Hz	

Table 2.4.6-2: Instrument levels for random vibration (qualification levels)

2.4.7 Thermal Interface

N.A.

2.4.8 Harness Routing

N.A.

2.4.9 Alignment

The following requirements hold for the alignment of the I/F plane between the mirror mounts and the structure.

- Off centre 0.1 mm all directions simultaneously
- Longitudinal +/-0.5 mm
- Tilt +/-1 arcminute.
- Roll +/-2 arcminute (TBC)

2.5 Straylight Baffles and Cardiff black

2.5.1 Functional Description and Block Diagram

The straylight baffles reflect and partially attenuate straylight at various locations in the optical chain. At present two baffles are foreseen. The first baffle is located inside the instrument at the entrance of the IR-beam into the instrument, located between the secondary mirror and CM3. It encloses together with the photometer side walls the shutter mechanism. The second one is located between PM7 and PM8, separating the common environment from the photometer and effectively enclosing the photometer detector box. Inside the spectrometer detector box, an enclosure is mounted, which holds the SCAL and SM8B. They split the spectrometer into three zones, each at the beam splitter where the two spectrometer optical chains cross.

The block diagram is shown in 1.3-1 and 1.3-2.

2.5.2 Inputs

N.A.

2.5.3 Outputs

N.A.

2.5.4 I/F drawing

TBD

2.5.5 Mass Properties

The mass budget for the straylight baffles is 2.42 kg (AD04, excluding contingency).

2.5.6 Mechanical Environment

Assuming a first natural frequency, mounted against a rigid interface above 170 Hz.
As specified in 1.4, including the qualification factor of 1.5. The provisional sine spec is:

Sine vibration levels	Frequency range	Input at base (QUAL)
X-direction	5-30 Hz 30-100 Hz	11 mm (0-peak) 40 g
Y-direction	5-30 Hz 30-100 Hz	11 mm (0-peak) 25 g
Z-direction	5-30 Hz 30-100 Hz	11 mm (0-peak) 25 g

Table 2.5.6-1 Qualification sine input (2 oct/min)

2.5.7 Thermal Interface

N.A.

2.5.8 Harness Routing

N.A.

2.5.9 Alignment

The opening in the straylight baffles will be sufficient to allow the 20% oversized beam to cross it with a positive margin of no more than 0.5 mm.

2.6 ^{3}He Cooler

2.6.1 Functional Description and Block Diagram

The structure of the cooler is mounted on the SPIRE optical bench panel (SOB) at ~4 K. The cooler interfaces via two thermal straps with the level 0 thermal sink (~1.8 K) inside the HERSCHEL cryostat. The cold finger of the cooler interfaces via a thermal busbar with all detectors (3 photometer detectors and 2 spectrometer detectors). The cooler harness interfaces with the DRCU outside the SPIRE structure via the RF-filter box mounted inside the structure.

- 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 via a thermal busbar. Strictly speaking there is no (direct) interface between the cooler and the detectors.

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).

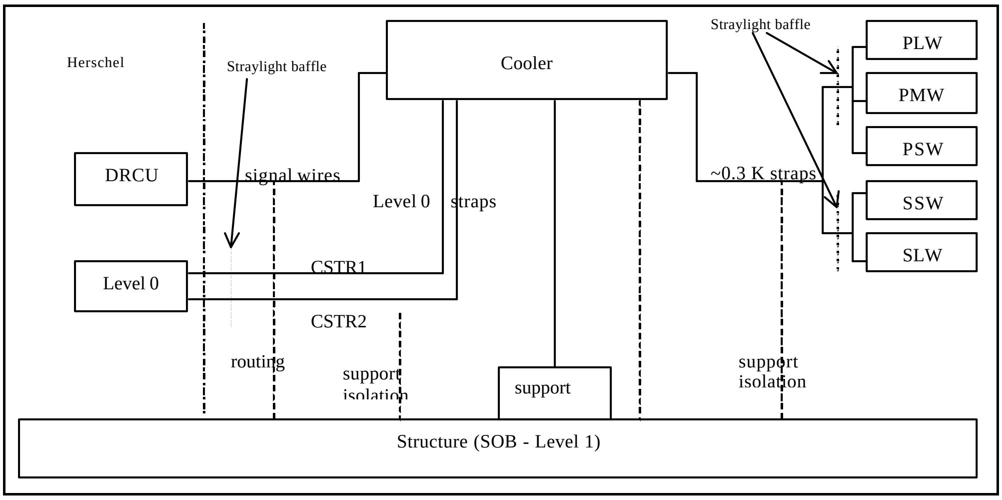


Figure 2.6.1-1: Block diagram

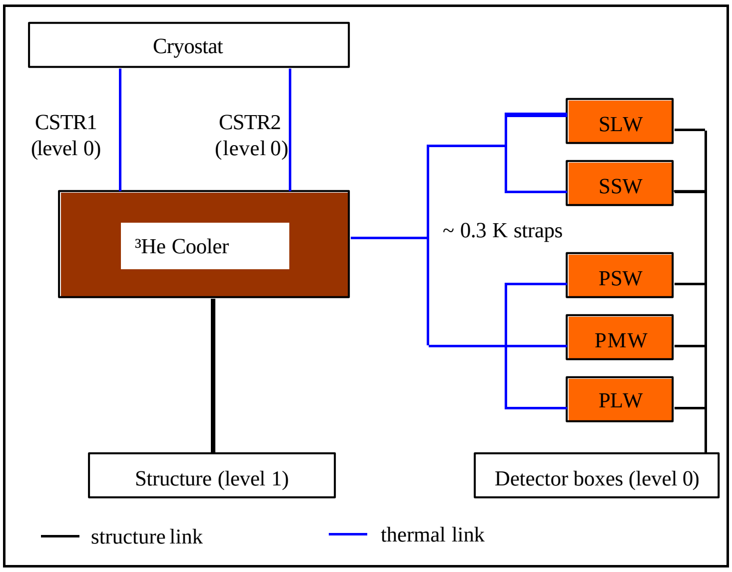


Figure 2.6.1-2: Thermal straps, conductive paths

2.6.2 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

- Micro vibration N.A.

- *To be specified*: allowable interface load for the thermal strap-interface (CSTR1 and CSTR2)
- *To be specified*: stiffness for the thermal strap interface.

2.6.3 Outputs

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

- Micro vibration N.A.

2.6.4 I/F drawing

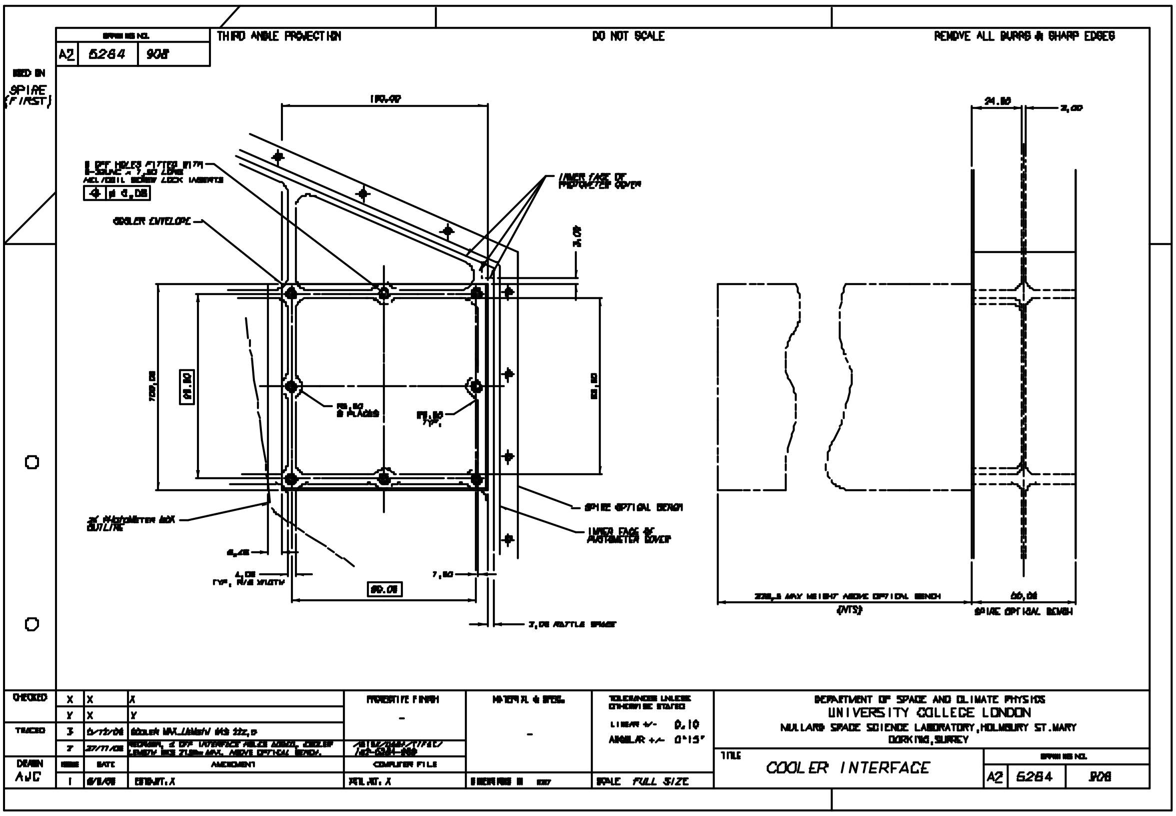


Figure 2.6.4-1: Outdated interface drawing, current I/F has 8 I/F holes, indicated with dotted circles

2.6.5 Mass Properties

Current mass budget for the cooler is 1.65 kg + 10% contingency, see AD04.
COG and MoI to be defined.

2.6.6 Mechanical Environment

Assuming a first natural frequency, mounted against a rigid interface above 170 Hz.
As specified in 1.4, including the qualification factor of 1.5. The provisional sine spec is:

Sine vibration levels	Frequency range	Input at base (QUAL)
X-direction	5-30 Hz 30-100 Hz	11 mm (0-peak) 40 g
Y-direction	5-30 Hz 30-100 Hz	11 mm (0-peak) 25 g
Z-direction	5-30 Hz 30-100 Hz	11 mm (0-peak) 25 g

Table 2.6.6-1 Qualification sine input (2 oct/min)

Axis (S/C)	ramp up	plateau	ramp down	g-rms
X	+6 dB/oct 20-100 Hz	0.2 g^2/Hz 100 – 300 Hz	-6 dB/oct 300-2000 Hz	~10.2
Y	+6 dB/oct 20-100 Hz	0.4 g^2/Hz 100 – 200 Hz 0.1 g^2/Hz 200 – 400 Hz	-6 dB/oct 400-2000 Hz	~11.3
Z	+6 dB/oct 20-100 Hz	0.3 g^2/Hz 100 – 200 Hz	-6 dB/oct 200-2000 Hz	~9.9

Table 2.6.6-3 2 Instrument levels for random vibration (qualification levels)

2.6.7 Thermal Interface

See AD26 (Thermal Configuration Control Document) for the budgets.

CSTR1

minimal thermal resistance between structure and CSTR1 support is TBD W/K

CSTR2

minimal thermal resistance between structure and CSTR2 support is TBD W/K

Thermal Busbar

maximal heat leak from structure into the busbar is 1 micro-W (TBC)

2.6.8 Harness Routing

There are two connectors on cooler housing and interconnect harness, between the cooler and RF-filter box. The connectors are 37 pins. Two of them are located on the outside of the cooler housing. The provisional location indicated on cooler design, as of 25 October 2000, is still to be included in the I/F drawing.

Harness length: Cooler RF-filter box 845 ± 170 mm

The harness length from the cooler to the RF-filter boxes is: TBD mm

2.6.9 Alignment

There are no strict alignment requirements on the cooler. The thermal straps attached to the cooler need to be able to sustain 0.5 mm (TBC) differential motion between the interface with the structure and the cooler. This does not take into account differential thermal contraction.

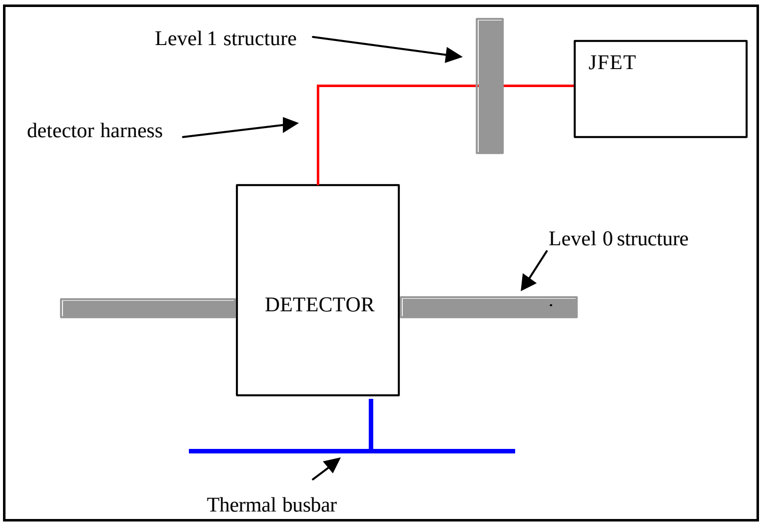
2.7 Photometer Detectors

2.7.1 Functional Description and Block Diagram

The photometer detectors consist of a set of three detectors PSW, PMW and PLW. The detectors are mounted on the photometer detector box. Inside the box the detectors interface with the thermal busbar and outside the box with the harness routing towards the JFET modules outside the structure.

The structure interface shall provide compensation of position of the BDA by 1 mm in x and y, 1mm in z and by 2 degrees (TBC).

The BDA shall be housed in a RF-tight shield. All electrical, optical and thermal penetrations into the shield will be RF blocked or attenuated. It shall be possible to electrically isolate the RF shield from the optical bench.



Block diagram 2.7.1-1:

2.7.2 Inputs

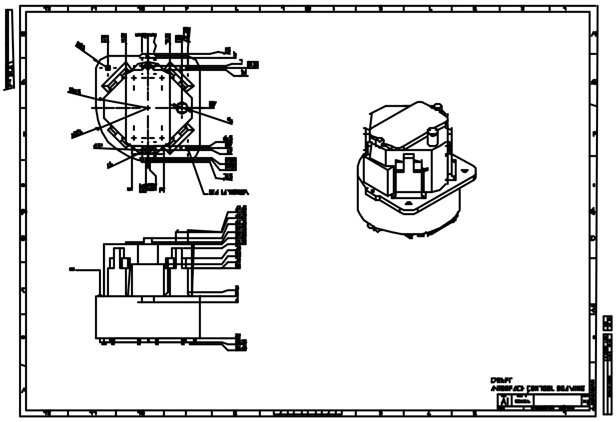
N.A.

2.7.3 Outputs

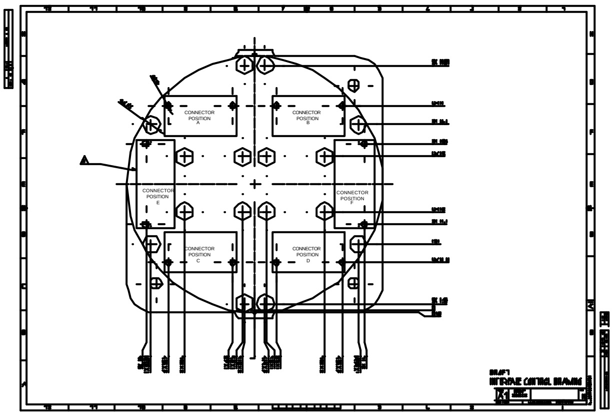
N.A.

2.7.4 I/F drawing

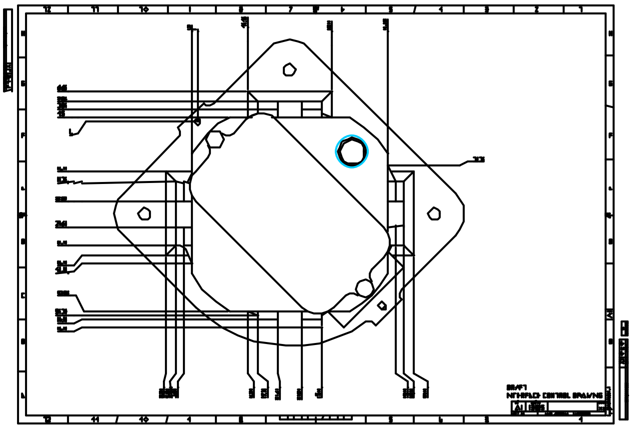
The listed drawings hereafter are draft versions. The current design has 4 interface bolt-holes.



2.7.4-1: Overview of the detector



2.7.4-2: Back of the detector with 6 possible connector positions



2.7.4.-3 Front of the detector with filter. Thermal interface indicated in blue

2.7.5 Mass Properties

On average the mass (for all five detectors) of the detector is 1500 gr excluding contingency, see AD04.

ID	Mass	CoG	Ixx	Iyy	Izz
	[gr]	[mm]	[grmm^2]	[grmm^2]	[grmm^2]
PLW	TBD	TBD	TBD	TBD	TBD
PMW	TBD	TBD	TBD	TBD	TBD
PSW	TBD	TBD	TBD	TBD	TBD
SSW	TBD	TBD	TBD	TBD	TBD
SLW	TBD	TBD	TBD	TBD	TBD

2.7.6 Mechanical Environment

Assuming a first natural frequency, mounted against a rigid interface above 170 Hz.
As specified in 1.4, including the qualification factor of 1.5. The provisional sine spec is:

Sine vibration levels	Frequency range	Input at base (QUAL)
X-direction	5-30 Hz 30-100 Hz	11 mm (0-peak) 40 g
Y-direction	5-30 Hz 30-100 Hz	11 mm (0-peak) 25 g
Z-direction	5-30 Hz 30-100 Hz	11 mm (0-peak) 25 g

Table 2.7.6-1 Qualification sine input (2 oct/min)

As specified in 1.4, including the qualification factor of 1.5. The random spec is:
The test duration is 120 seconds per axis.

Axis (S/C)	ramp up	plateau	ramp down	g-rms
X	+6 dB/oct 20-100 Hz	0.8 g^2/Hz 100 - 300 Hz	-6 dB/oct 300-2000 Hz	
Y	+6 dB/oct 20-100 Hz	0.8 g^2/Hz 100 - 300 Hz	-6 dB/oct 300-2000 Hz	
Z	+6 dB/oct 20-100 Hz	0.8 g^2/Hz 100 - 300 Hz	-6 dB/oct 300-2000 Hz	

Table 2.7.6-2: Instrument levels for random vibration (qualification levels)

The input to the BDA is allowed to be notched at resonance to a level equal in g-rms to 100g (for suspended mass), taking into account a 4 sigma variation of the measured rms-signal. This is in order not to exceed a quasi-static equivalent loading of the BDA of 100g.

The notch-width is not allowed to exceed 1/3 octave bandwidth.

In future the levels may be relaxed, taking into account responses of individual detectors. A detailed analysis will be performed after reworking the FEM.

2.7.7 Thermal Interface

The detectors interface with the 0.3 K thermal busbar inside the photometer detector box. The connection will be made at the nose of the detector, as outlined in the draft interface drawing. The detector structure will be supported by the 2 K detector box.

The thermal requirements for the 0.3 K busbar are listed in the appropriate section of the thermal ICD.

2.7.8 Harness Routing

The requirements for the harness routing are:

1. Firmly connected to (support) structure to minimise microphonics by strapping every 10mm
2. Baseline routing is from the back of the detector down to the detector box routed along the spigots on top of the detector box.
3. PLW to connector panel: 1200 mm TBC
4. PMW to connector panel: 1000 mm TBC
5. PSW to connector panel: 1100 mm TBC
6. Connector panel to JFET modules: 200 mm TBC
7. The cables routed inside the structure shall be affixed to have a mechanical resonant frequency >1kHz TBC

From AD08, the following notes were obtained:

1. The cables should be kept short. We wish to achieve a capacitance of 50 pF between signal lines, including all sources of capacitance. Please give us a rough length so we can investigate cable capacitance per unit length.
2. The minimum mechanical frequency of the cables should be 1 kHz. The cables must not be disturbed during servicing of the instrument.
3. Minimum bend radius is 5 mm with an ideal radius of 10mm.

2.7.9 Alignment

2.8 Spectrometer Detectors

2.8.1 Functional Description and Block Diagram

For the spectrometer detectors the same hold as for the photometer detectors, unless specified otherwise.

2.8.2 Inputs

See 2.7.

2.8.3 Outputs

See 2.7.

2.8.4 I/F drawing

See 2.7.

2.8.5 Mass Properties

See 2.7.

2.8.6 Mechanical Environment

See 2.7.

2.8.7 Thermal Interface

See 2.7.

2.8.8 Harness routing

See 2.7.

The harness lengths are:

1. SLW to connector panel 600 mm TBC
2. SLW to connector panel 700 mm TBC
3. Connector panel to JFET modules: 200 mmTBC

2.8.9 Alignment

See 2.7.

2.9 Beam Steering Mechanism

2.9.1 Functional Description and Block Diagram

The BSM is used to steer the optical beam of the SPIRE photometer channel over the detector arrays.

The BSM comprises a flat mirror mounted on a pivot system which system allows precise angular motion of the mirror over a small range of angular travel in two orthogonal axes. Electrical actuators are used to provide motion of the mirror. Electrical transducers are used to measure the mirror position to allow control of the mirror position.

The BSM also provides an aperture through which the Photometer Calibration Source is directed towards the detector arrays. The Photometer Calibration Source is mounted behind the BSM.

The BSM comprises 3 main parts; the cryogenic mechanism (BSMm), the structural support (BSMs), and the warm electronics (BSMe). The structural support may be integral to the BSMm housing, or attached as a distinct entity (TBD). This document only deals with the interface between the BSM support and the SOB.

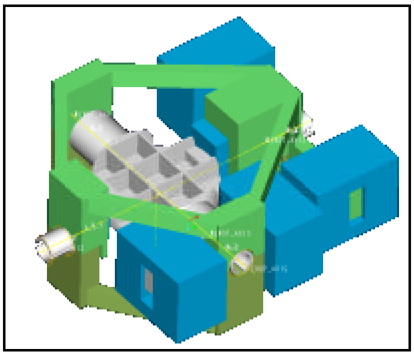


Figure 2.9.1-1: BSM mechanism, green-support structure, blue-actuators, grey-bottom view mirror RD3

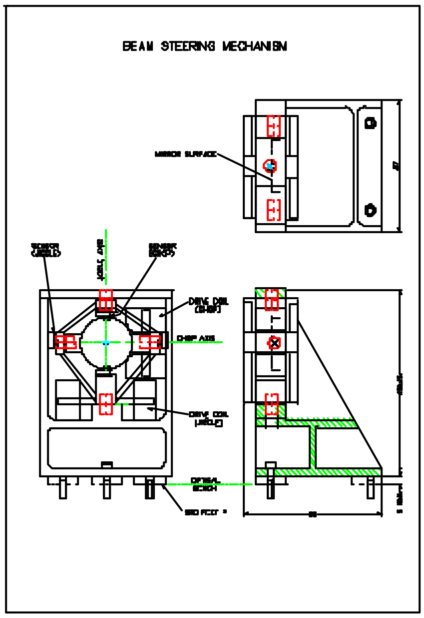


Figure 2.9.1-2: Sketch of the BSM support with BSM and Calibration source RD3

The support structure mounts the beam steering mirror mechanism from the SPIRE optical bench and is a machined stiff aluminium alloy mount. Note that there will be a baffle incorporated to minimise straylight and emission into the optical beam. Electrical wiring and connectors are not shown. The photometer calibration source will also be mounted on this structure, and its wiring incorporated into the BSM harness. The outline design shown here is at present non-optimised, and will be further refined following FEA.

No block diagram

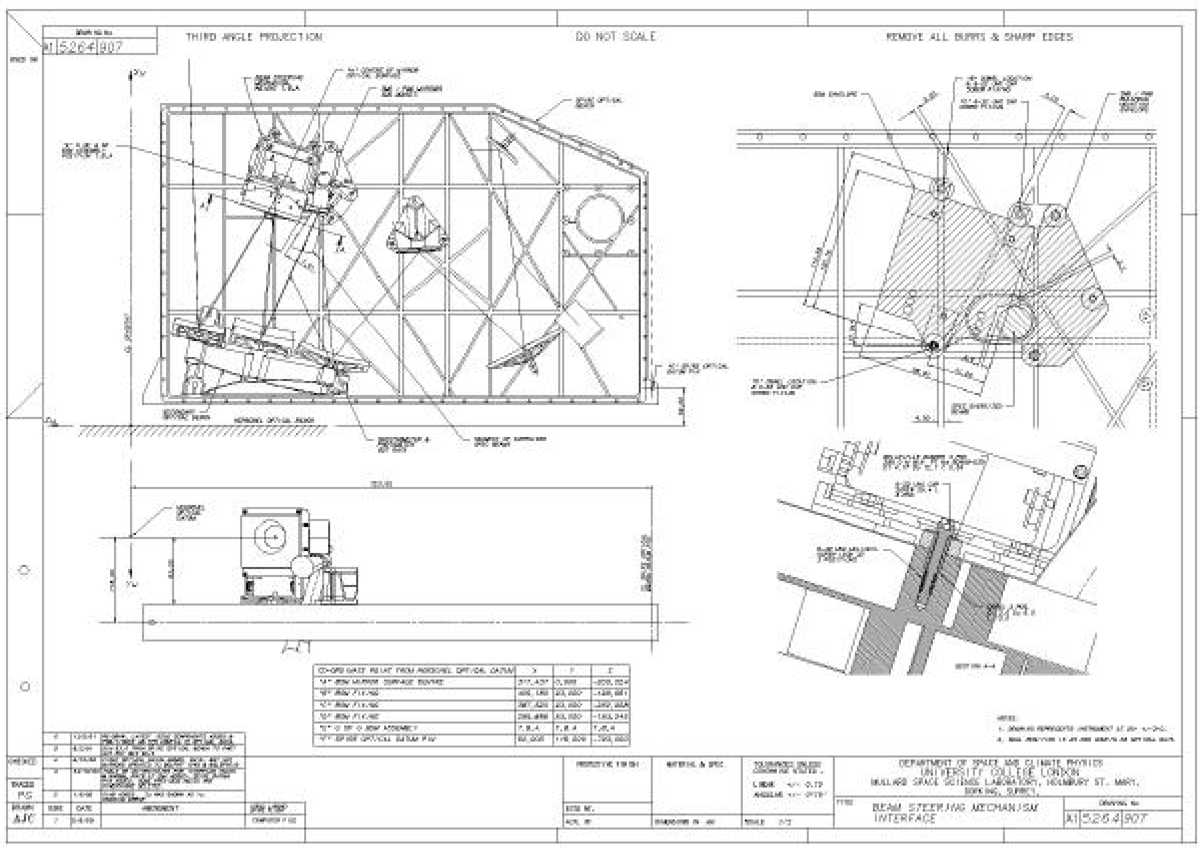
2.9.2 Inputs

Micro vibrations: TBD

2.9.3 Outputs

Micro vibrations: TBD

2.9.4 I/F drawing



2.9.5 Mass Properties

The mass budget for the BSM is 909 gr including harness. (AD04, excluding contingency) excluding calibrator.

CoG and MoI TBD

2.9.6 Mechanical Environment

As specified in 1.4, including the qualification factor of 1.5. The provisional sine spec is:

Sine vibration levels	Frequency range	Input at base (QUAL)
X-direction	5-30 Hz 30-100 Hz	11 mm (0-peak) 40 g
Y-direction	5-30 Hz 30-100 Hz	11 mm (0-peak) 25 g
Z-direction	5-30 Hz 30-100 Hz	11 mm (0-peak) 25 g

Table 2.9.6-1 Qualification sine input (2 oct/min)

As specified in 1.4, including the qualification factor of 1.5. The random spec is:

The test duration is 120 seconds per axis.

Axis (S/C)	ramp up	plateau	ramp down	g-rms
X	+6 dB/oct 20-100 Hz	0.2 g^2/Hz 100 - 300 Hz	-6 dB/oct 300-2000 Hz	~10.2
Y	+6 dB/oct 20-100 Hz	0.7 g^2/Hz 100 - 200 Hz 0.1 g^2/Hz 200 - 400 Hz	-6 dB/oct 400-2000 Hz	~11.3
Z	+6 dB/oct 20-100 Hz	0.3 g^2/Hz 100 - 200 Hz	-6 dB/oct 200-2000 Hz	~9.9

Table 2.9.6-2 Instrument levels for random vibration (qualification levels)

2.9.7 Thermal Interface

This interface needs to dissipate heat generated by the photometer calibration source into the SOB. This could be via the currently defined interface or via a thermal strap. In the last case we need to specify a thermal strap bolt hole.

2.9.8 Harness Routing

- Harness will be connected to the RF-filter boxes and routed over the SOB.
- The harness length form the BSM connectors to the RF-filter boxes is 415 mm ±90 mm

2.9.9 Alignment

2.10 Spectrometer Mechanism

2.10.1 Functional Description and Block Diagram

The SMEC holds the central corner cube mirror's of the FTS part of the HERSCHEL/SPIRE instrument. These mirrors need to travel between the two ray paths within the spectromter, shortening one ray path and simultaneously lengthen the other. The total required travel is 32 mm in +X direction and 3.2 mm in –X direction (AD1, IRD-SMEC-R01) (Where +X is the launch direction). There will be an over-travel on top of this which still needs to be specified. It is expected that the overall total travel will be about something like 40 mm.

Mechanism Interface with other components

- Spire optical bench (SOB)
- Optics
- RF-filter boxes, via the harness

The function of the SOB (reviewing the interface between the SOB and the SMEC) is to support the mechanism. The mechanical interface should provide for a precise, defined and accurately machined mounting surface. The mechanical interface should provide for sufficient stiffness, such that the mechanical loads on the SMEC are minimised.

There is no block diagram

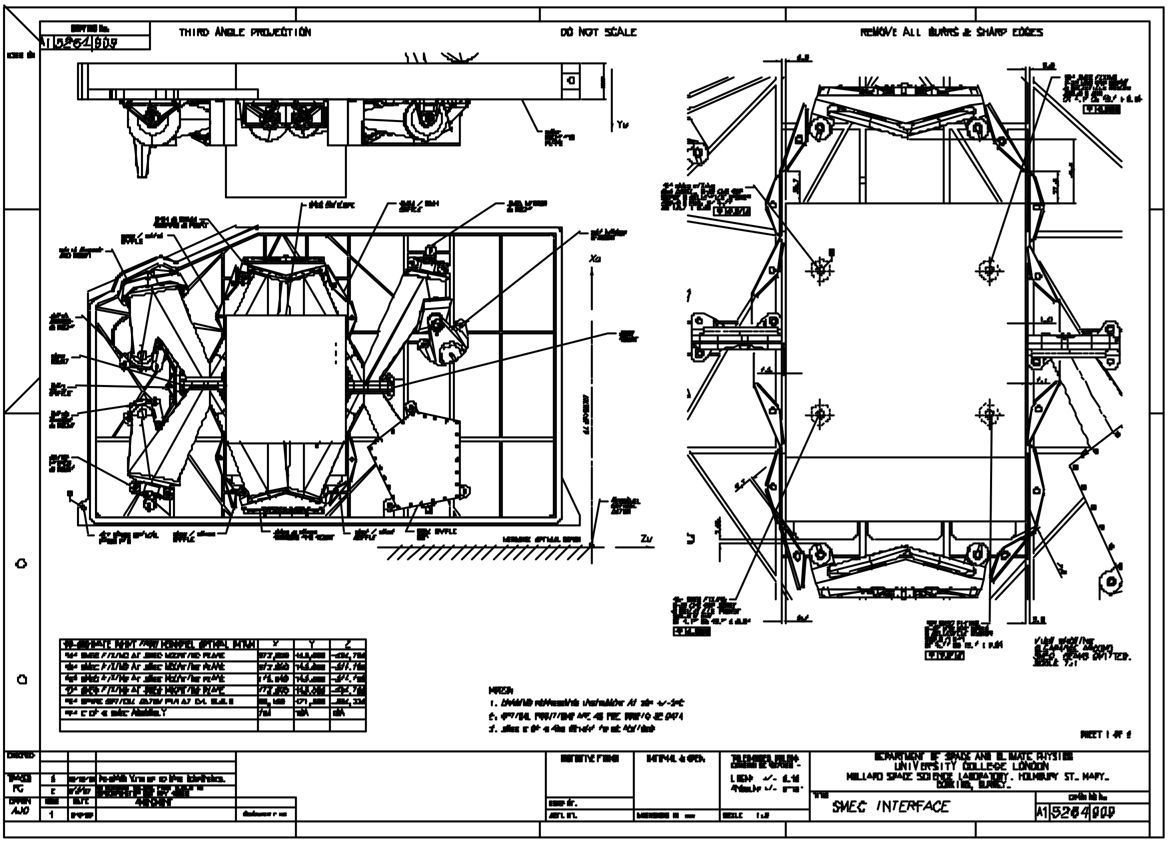
2.10.2 Inputs

Micro-vibrations coming from the SOB TBS

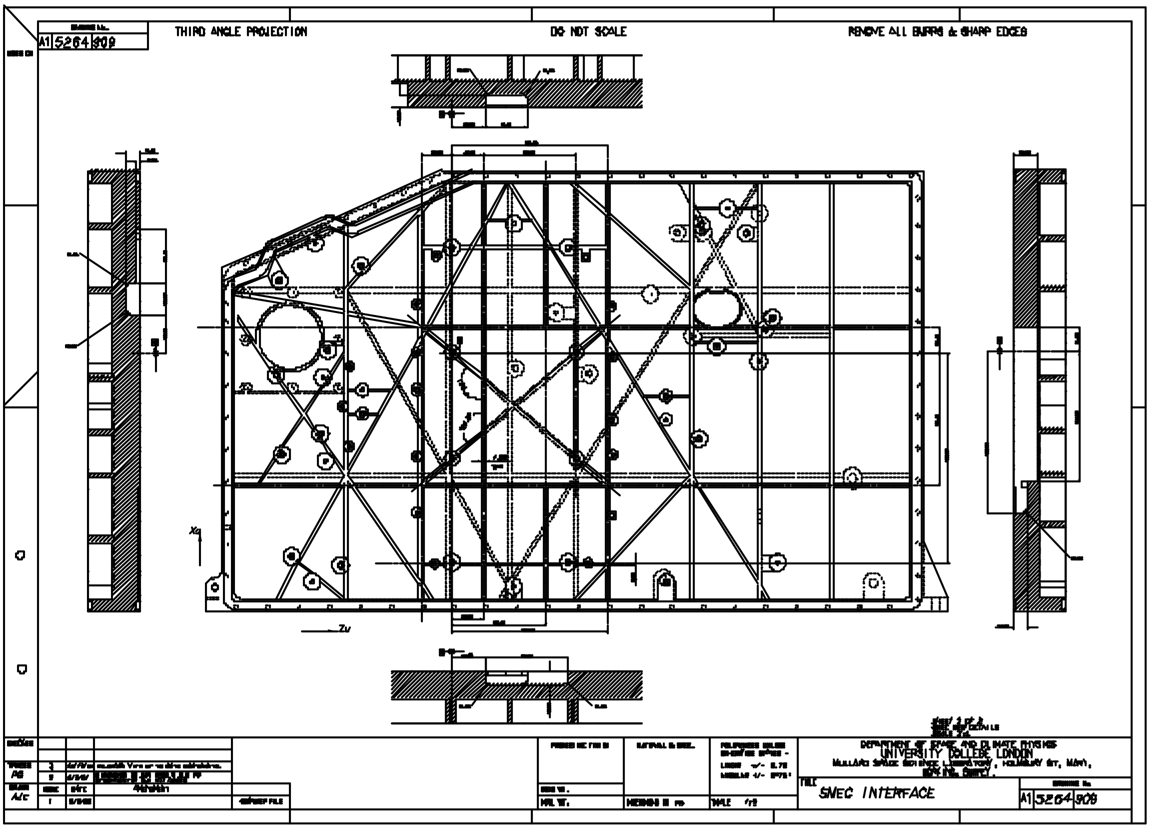
2.10.3 Outputs

Micro-vibrations going into the SOB TBS

2.10.4 I/F drawing



2.10.4-1: Interface Drawing Sheet 1



2.10.4-2 :Interface Drawing Sheet 2, the interface bolt hole pattern is indicated on the inside of the optical bench within the area enclosed by the collimating mirrors and the beam splitters..

2.10.5 Mass Properties

The current mass budget for the SMEC is 1.647 kg + 10% contingency, with mirrors and with harness. See AD04.

2.10.6 Mechanical Environment

Assuming a first natural frequency, mounted against a rigid interface above 170 Hz.
As specified in 1.4, including the qualification factor of 1.5. The provisional sine spec is:

Sine vibration levels	Frequency range	Input at base (QUAL)
X-direction	5-30 Hz 30-100 Hz	11 mm (0-peak) 40 g
Y-direction	5-30 Hz 30-100 Hz	11 mm (0-peak) 25 g
Z-direction	5-30 Hz 30-100 Hz	11 mm (0-peak) 25 g

Table 2.10.6-1 Qualification sine input (2 oct/min)

As specified in 1.4, including the qualification factor of 1.5. The random spec is:
The test duration is 120 seconds per axis.

Axis (S/C)	ramp up	plateau	ramp down	g-rms
X	+6 dB/oct 20-100 Hz	0.2 g^2/Hz 100 – 300 Hz	-6 dB/oct 300-2000 Hz	~10.2
Y	+6 dB/oct 20-100 Hz	0.4 g^2/Hz 100 – 200 Hz 0.1 g^2/Hz 200 – 400 Hz	-6 dB/oct 400-2000 Hz	~11.3
Z	+6 dB/oct 20-100 Hz	0.3 g^2/Hz 100 – 200 Hz	-6 dB/oct 200-2000 Hz	~9.9

Table 2.10.6-2 2 Instrument levels for random vibration (qualification levels)

2.10.7 Thermal Interface

2.10.8 Harness Routing

One Connector on SMEC interface and harness between connector and RF-filter boxes.
The harness length form the SMEC connectors to the RF-filter boxes is 425 ± 85 mm (TBC)

2.10.9 Alignment

The overall alignment of the interface plane dictates that the planarity stays within 0.1 mm, the interface bolt holes are located within +/- 0.1 mm. TBC.

2.11 Shutter Mechanism

2.11.1 Functional Description and Block Diagram

Hereafter the latest concept for mounting the shutter vane is pictured. The position of the shutter moved from the inside of the instrument (located at entry filter) to the outside (located at instrument beam entry opening).

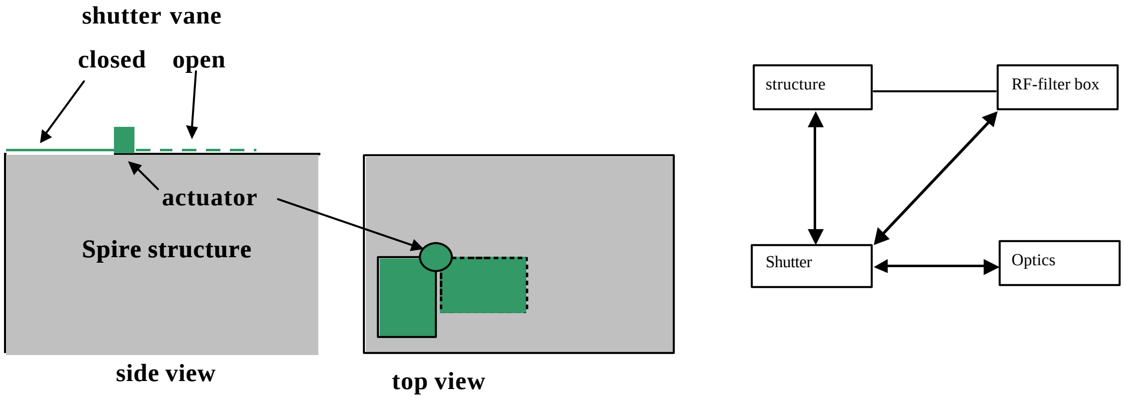


Figure 2.11.1-1: Block diagram

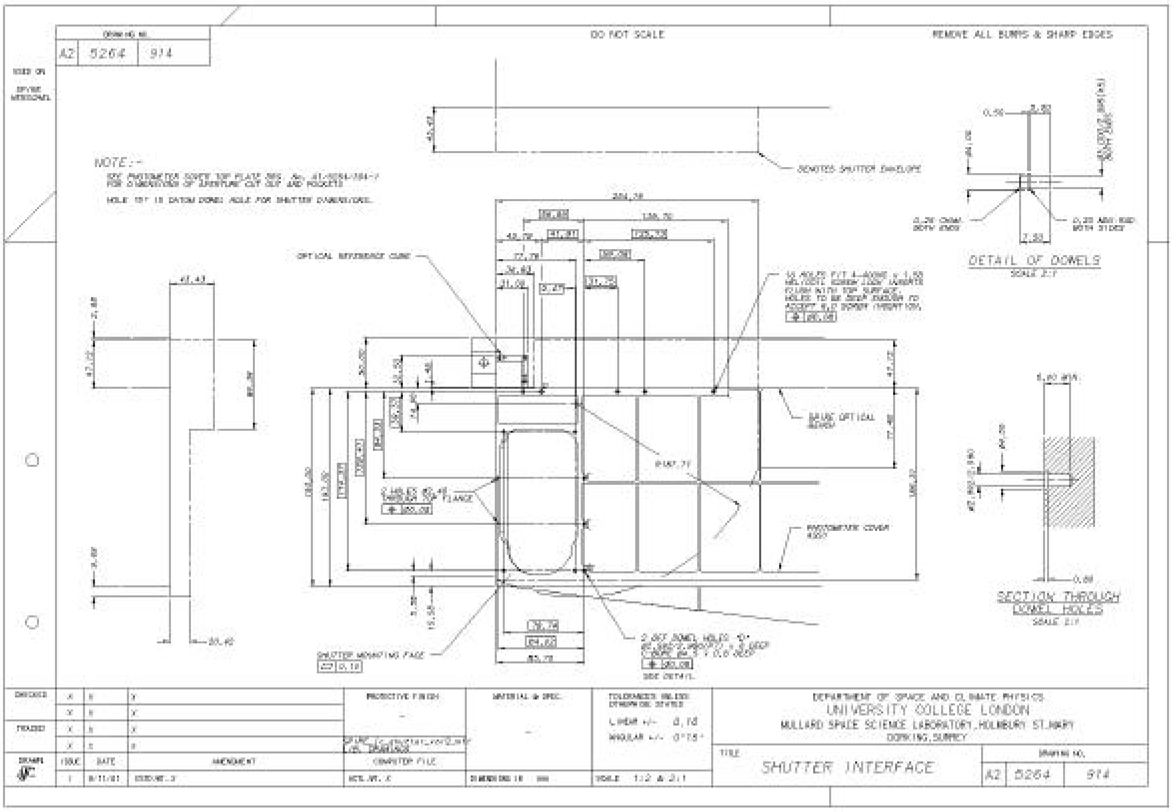
2.11.2 Inputs

N.A.

2.11.3 Outputs

N.A.

2.11.4 I/F drawing



2.11.5 Mass Properties

See AD04, 592 gr without contingency.

2.11.6 Mechanical Environment

Assuming a first natural frequency, mounted against a rigid interface above 170 Hz.

As specified in 1.4, including the qualification factor of 1.5. The provisional sine spec is:

Sine vibration levels	Frequency range	Input at base (QUAL)
X-direction	5-30 Hz 30-100 Hz	11 mm (0-peak) 40 g
Y-direction	5-30 Hz 30-100 Hz	11 mm (0-peak) 25 g
Z-direction	5-30 Hz 30-100 Hz	11 mm (0-peak) 25 g

Table 2.11.6-1 Qualification sine input (2 oct/min)

As specified in 1.4, including the qualification factor of 1.5. The random spec is:
The test duration is 120 seconds per axis.

Axis (S/C)	ramp up	plateau	ramp down	g-rms
X	+9 dB/oct 20-150 Hz	0.25 g^2/Hz 150 – 300 Hz	-9 dB/oct 300-2000 Hz	~8
Y	+9 dB/oct 20-100 Hz	0.8 g^2/Hz 100 – 200 Hz	-9 dB/oct 200-2000 Hz	~14
Z	+9 dB/oct 20-100 Hz	0.5 g^2/Hz 100 – 200 Hz	-9 dB/oct 200-2000 Hz	~11

Table 2.11.6-2: Instrument levels for random vibration (qualification levels)

2.11.7 Thermal Interface

Maximum allowed heat load on the SOB is 1 mW during operation of the vane (telescope broadband background simulation). TBD/TBC RAL. This does not include latching and short term events. These peak events will not exceed an influx of more than 0.01 J (?) into the instrument

2.11.8 Harness Routing

The harness will be routed along the outside of the instrument.

2.12 Spectrometer Calibration Source

2.12.1 Functional Description and Block Diagram

The spectrometer calibration source provides for a reference channel for the Fourier Transform Spectrometer. It consists of a heated black body inside a cavity. The heat generated inside the housing needs to be diffused in the optical bench. It is mounted with four bolts. The available envelope is 50 x 50 x 100 mm possibly extendable to 60 x 60 x 100 mm.

No block diagram

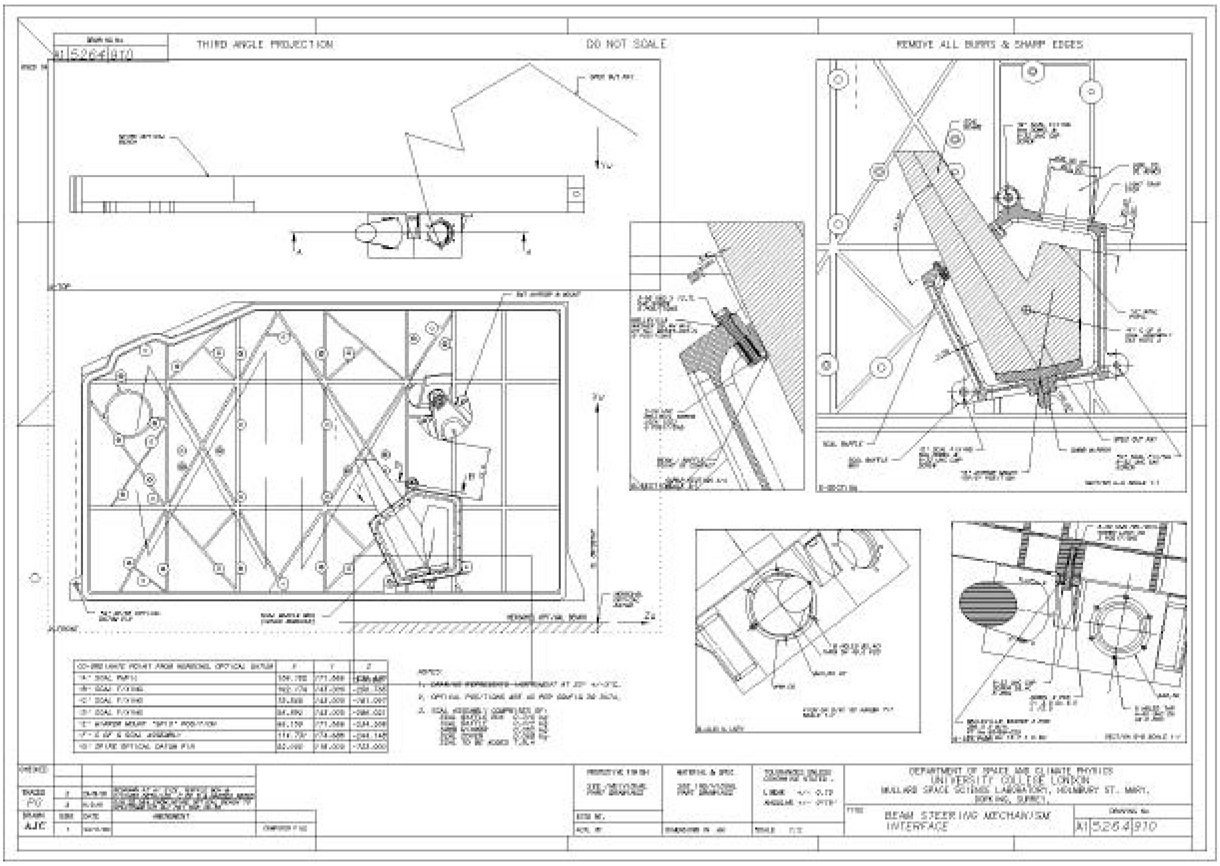
2.12.2 Inputs

N.A.

2.12.3 Outputs

N.A.

2.12.4 I/F drawing



2.12.5 Mass Properties

The mass allocated to the SCAL and mount is 200 gr with 20% contingency, including harness. See AD04

2.12.6 Mechanical Environment

Assuming a first natural frequency mounted against a rigid interface above 170 Hz.

As specified in 1.4, including the qualification factor of 1.5. The sine spec is:

Sine vibration levels	Frequency range	Input at base (QUAL)
X-direction	5-30 Hz 30-110 Hz	22 mm (0-peak) 40 g
Y-direction	5-30 Hz 30-110 Hz	22 mm (0-peak) 25 g
Z-direction	5-30 Hz 30-110 Hz	22 mm (0-peak) 25 g

Table 2.12.6-1 Qualification sine input (2 oct/min)

As specified in 1.4, including the qualification factor of 1.5. The random spec is:

The test duration is 120 seconds per axis.

Axis (S/C)	ramp up	plateau	ramp down	g-rms
X	+6 dB/oct 20-100 Hz	0.08 g^2/Hz 100 – 400 Hz	-6 dB/oct 400-2000 Hz	
Y	+6 dB/oct 20-100 Hz	0.08 g^2/Hz 100 – 400 Hz	-6 dB/oct 400-2000 Hz	
Z	+6 dB/oct 20-100 Hz	0.08 g^2/Hz 100 – 400 Hz	-6 dB/oct 400-2000 Hz	

Table 2.12.6-2: Instrument levels for random vibration (qualification levels)

2.12.7 Thermal Interface

The connection with the SOB should allow for thermal conductance in order to dissipate the heat generated by the SCAL sufficiently.

2.12.8 Harness Routing

The harness is routed via the SOB to the RF-filter boxes. The harness routing will be part of the I/F drawing, likely on a separate sheet(s).

The length of the harness from the SCAL to the RF-filter boxes will be 325±65 mm.

2.12.9 Alignment

The overall alignment of the interface plane dictates that the planarity stays within 0.1 mm, the interface bolt holes are located within +/- 0.1 mm. TBC.

2.13 Thermal Straps

2.13.1 Functional Description and Block Diagram

SPIRE has several different temperature stages. In order to diffuse excess heat to the cryostat, various components of the instrument are connected directly or indirectly to the cryostat. The straps are made of copper.

Level 0 straps.

There are three level 0 straps attached to the instrument. Two of them are connected to the cooler and one connected to the photometer detector box and the spectrometer detector box. The level 0 thermal straps are directly connected with the cryostat. There nominal temperature is between 1.7 and 1.8 Kelvin.

Level 1 strap

There is one level 1 strap attached to the structure. It is routed from the vent line, running around the FOB to the optical bench.

Thermal busbar

The thermal busbar runs from the cold end of the cooler to the photometer detector box and the spectrometer detector box. It branches off inside these boxes and runs along the detectors. At each detector interface a copper strap branches off and is connected to the thermal interface with the detector.

2.13.2 Inputs

N.A.

2.13.3 Outputs

N.A.

2.13.4 I/F drawing

TBD

2.13.5 Mass Properties

The mass budget for the thermal straps is 285 gr with 20% contingency (AD04).

2.13.6 Mechanical Environment

Assuming a first natural frequency, mounted against a rigid interface above 170 Hz.

As specified in 1.4, including the qualification factor of 1.5. The provisional sine spec is:

Sine vibration levels	Frequency range	Input at base (QUAL)
X-direction	5-30 Hz 30-100 Hz	11 mm (0-peak) 40 g
Y-direction	5-30 Hz 30-100 Hz	11 mm (0-peak) 25 g
Z-direction	5-30 Hz 30-100 Hz	11 mm (0-peak) 25 g

Table 2.13.6-1 Qualification sine input (2 oct/min)

As specified in 1.4, including the qualification factor of 1.5. The random spec is:
The test duration is 120 seconds per axis.

Axis (S/C)	ramp up	plateau	ramp down	g-rms
X	+6 dB/oct 20-100 Hz	0.2 g^2/Hz 100 – 300 Hz	-6 dB/oct 300-2000 Hz	~10.2
Y	+6 dB/oct 20-100 Hz	0.4 g^2/Hz 100 – 200 Hz 0.1 g^2/Hz 200 – 400 Hz	-6 dB/oct 400-2000 Hz	~11.3
Z	+6 dB/oct 20-100 Hz	0.3 g^2/Hz 100 – 200 Hz	-6 dB/oct 200-2000 Hz	~9.9

Table 2.13.6-2: Instrument levels for random vibration (qualification levels)

2.13.7 Thermal Interface

ID	Maximum parasitic load from the structure	Boundary temperatures	
CSTR1	TBD	4.0 K	2.0 K
CSTR2	TBD	4.0 K	2.0 K
CSTR3	TBD	4.0 K	2.0 K
CSTR4	N.A.	4.0 K	4.0 K
Thermal busbar	1 micro-W	1.7 K	0.3 K

Table 2.13.7:

Add bolt patterns (I/F drawing) + torques + surface finish

2.13.8 Harness Routing

N.A.

2.14 RF-Filters

2.14.1 Functional Description and Block Diagram

Currently **five** units with 2 25 way connectors are foreseen..

2.14.2 Inputs

N.A.

2.14.3 Outputs

N.A.

2.14.4 I/F drawing

TBD

2.14.5 Mass Properties

TBD

2.14.6 Mechanical Environment

TBD

2.14.7 Thermal Interface

TBD

2.14.8 Harness routing

TBD

2.14.9 Alignment

TBD

2.15 Thermometry harness

2.15.1 Functional Description and Block Diagram

For the structure there will only be two flight thermometers on the detector boxes (+ redundant thermometers TBC) and possibly a extra thermometer on the secondary optical bench for ground testing purposes.

2.15.2 Inputs

N.A.

2.15.3 Outputs

N.A.

2.15.4 I/F drawing

TBD

2.15.5 Mass Properties

TBD

2.15.6 Mechanical Environment

TBD

2.15.7 Thermal Interface

TBD

2.15.8 Harness routing

TBD

2.15.9 Alignment

TBD

2.16 Cold Stops

2.16.1 Functional Description and Block Diagram

The cold stops define the field of view within the instrument
There is no block diagram.

2.16.2 Inputs

N.A.

2.16.3 Outputs

N.A.

2.16.4 I/F drawing

TBI

2.16.5 Mass Properties

The mass budget for the cold stops is 450 gr (AD2, excluding contingency)

2.16.6 Mechanical Environment

2.16.7 Thermal Interface

TBD

2.16.8 Harness Routing

N.A.

2.16.9 Alignment

The following requirements hold for the alignment of the I/F plane between the cold stop mounts and the structure. RD2

- Off centre 1 mm all directions simultaneously (TBC).
- The flatness of the mounting surface for the cold stops is NA.