5 INTERFACE WITH SATELLITE

Spacecraft resource allocations, as specified for the scientific instruments in the IID-A, are based on present knowledge.

5.1 IDENTIFICATION AND LABELLING

Each individual instrument unit is allocated two unique identification codes:

- a project code which is the normal reference used for routine identification in correspondence and technical descriptive material.
- a spacecraft code allocated by the spacecraft contractor in accordance with the computerised configuration control system to be implemented, and used in particular for connector and harness identification purposes. The project code is part of the spacecraft code. (See IID-A section 5.1)

The project codes allocated to this instrument are:

Project code	Instrument unit
FSFPU	Cold Focal Plane Unit (FPU)
FSJFS	Spectrometer JFET box (JFS)
FSJFP	Photometer JFET box (JFP)
FSDRU	Detector Read-out Unit (DRU)
FSICU	Instrument Control Unit (ICU)
FSDPU	Digital Processing Unit (DPU)
FSWIH	Warm interconnect harnesses (HARNESS)

5.2 COORDINATE SYSTEM

The unit specific definitions are shown in the External Configuration Drawings. (section 5.4)

5.3 LOCATION AND ALIGNMENT

Figures 5.3-1 and 5.3-2 show the concept of the location of the three Focal Plane Units (FPUs) on the Optical Bench (OB) inside the cryostat and the concept of the location of the HIFI Local Oscillator Unit (FHLOU) external to the cryostat.

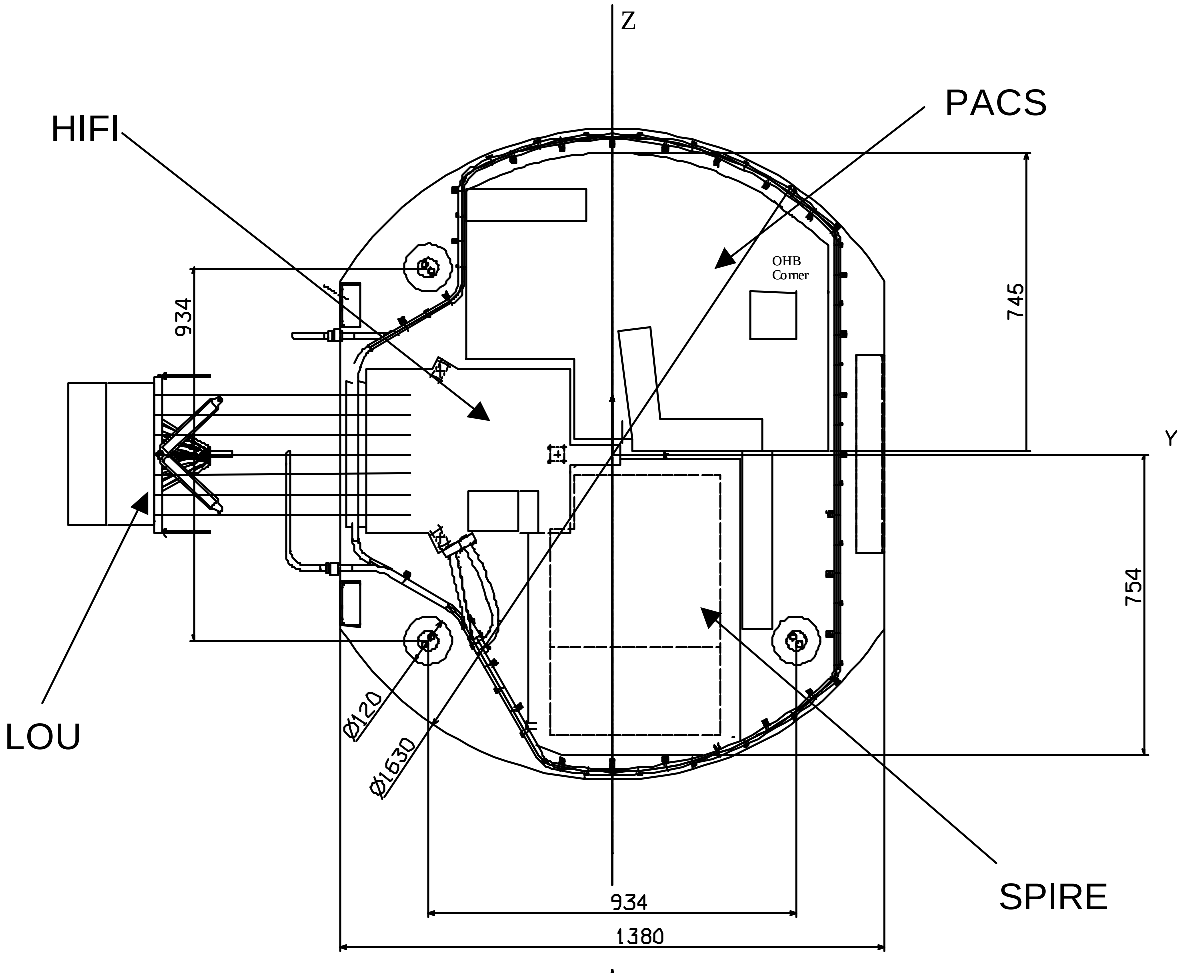


Figure 5.3-1: The FIRST Focal Plane, top view towards -X

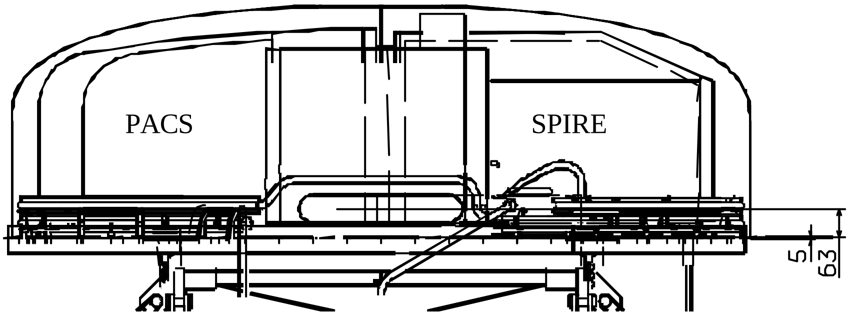


Figure 5.3-2: The FIRST Focal Plane, side view towards +Y

5.3.1 Instrument Location

The locations of the SPIRE units are as follows:

Project code	Instrument location
FSFPU	On FIRST optical bench inside cryostat
FSJFS	On FIRST optical bench inside cryostat
FSJFP	On FIRST optical bench inside cryostat
FSDRU	On SVM
FSICU	On SVM
FSDPU	On SVM
FSWIH	Between SPIRE units on SVM

5.3.1.1 Inside cryostat

As shown in figure 5.4-1

5.3.1.2 Outside cryostat

No SPIRE units are located on the outside of the cryostat

5.3.1.3 On SVM

There are no location requirements for units on the SVM. It is expected that the FSDRC and the FSDPU are located close to each other.

5.3.1.4 On Planck module

NA

5.3.2 Instrument Alignment

There are no alignment and/or alignment stability requirements except for the focal plane unit, the FSFPU.

5.3.2.1 Absolute Requirements

The absolute alignment requirements of the FSFPU to the Optical Bench at operating conditions are TBC. However the SPIRE instrument places the following general requirement on the alignment of the instrument on the optical bench and the FIRST telescope with optical bench.

The optical alignment for the SPIRE instrument will be designed to control the degree of undersize required on the instrument cold stop to prevent the instrument viewing undesirable parts of the telescope structure (TBD). The present SPIRE optical alignment plan (in preparation) gives an undersize of 4.1%. The SPIRE instrument requires that the contribution of the alignment of the instrument on the FIRST optical bench and the FIRST telescope with the optical bench contributes no more than 6% to the required cold stop undersize i.e. the contribution from misalignment of the instrument and telescope is not significantly different to that from the instrument itself.

The telescope alignment plan (reference) calls for the instruments to be placed on the FIRST optical bench with no adjustment thereafter and for the FIRST telescope to be aligned to within TBD mm. This actual value is critically dependent on the telescope optical design. For a 308 mm secondary mirror the 6% requirement equates to a **total** positional accuracy of +/- 5 mm (TBC) *(see SPIRE Optical Error Budgets – add to RD list)*.

There are no alignment requirements on the SPIRE JFET boxes.

5.3.2.2 Stability Requirements

The alignment stability requirements at operating conditions are TBD

5.4 EXTERNAL CONFIGURATION DRAWINGS

5.4.1 FSFPU

Figure 5.4-1a shows a drawing for the FSFPU inside the cryostat and its relationship to the telescope focal plane, the cryostat radiation shield and the diameter of the OB. Figure 5.4-1b shows the indicative size and location of the HSJFP and HSJFS units in relation to the HSFPU. The location of the JFET boxes is not final and is subject to approval by ESA.

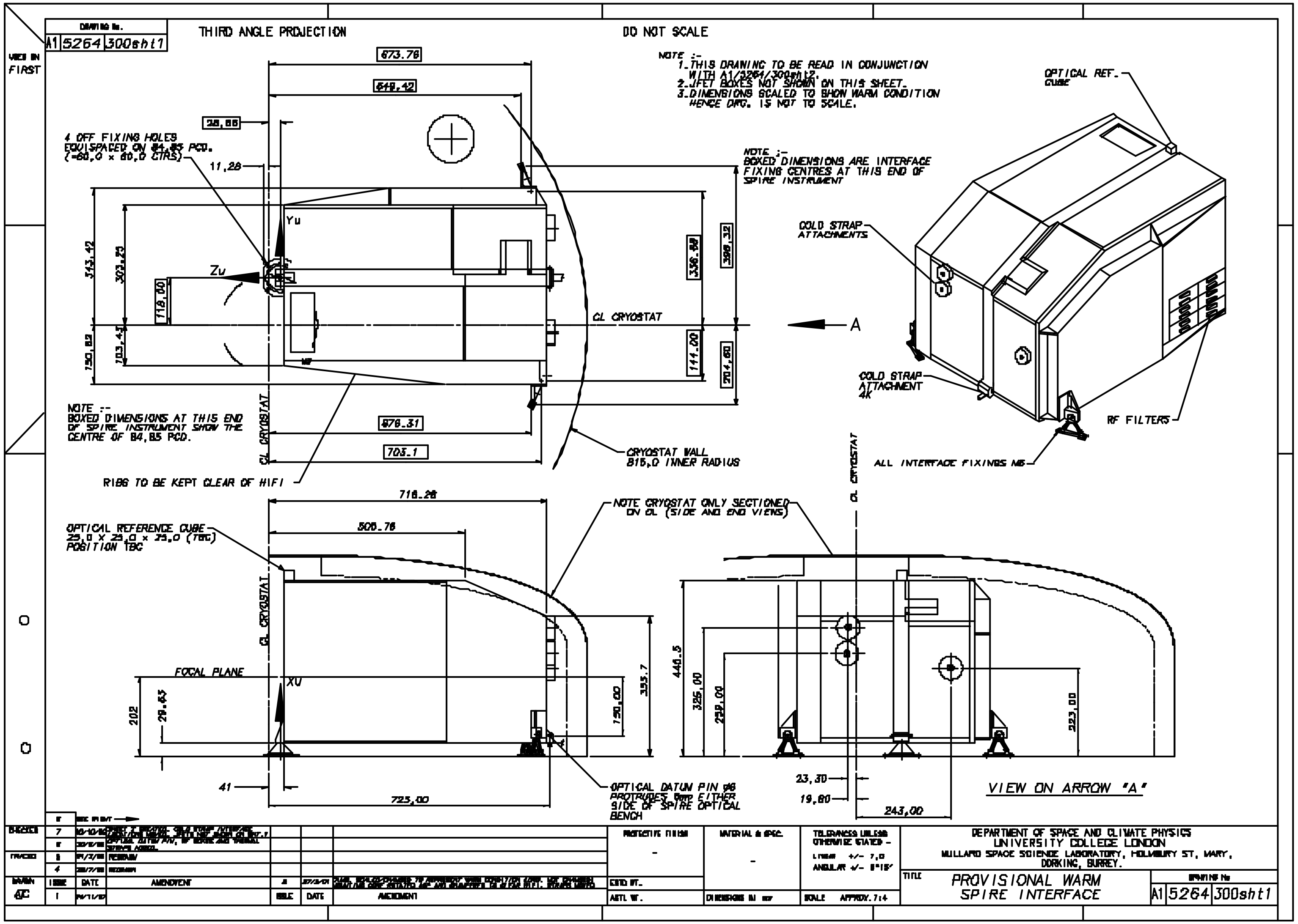
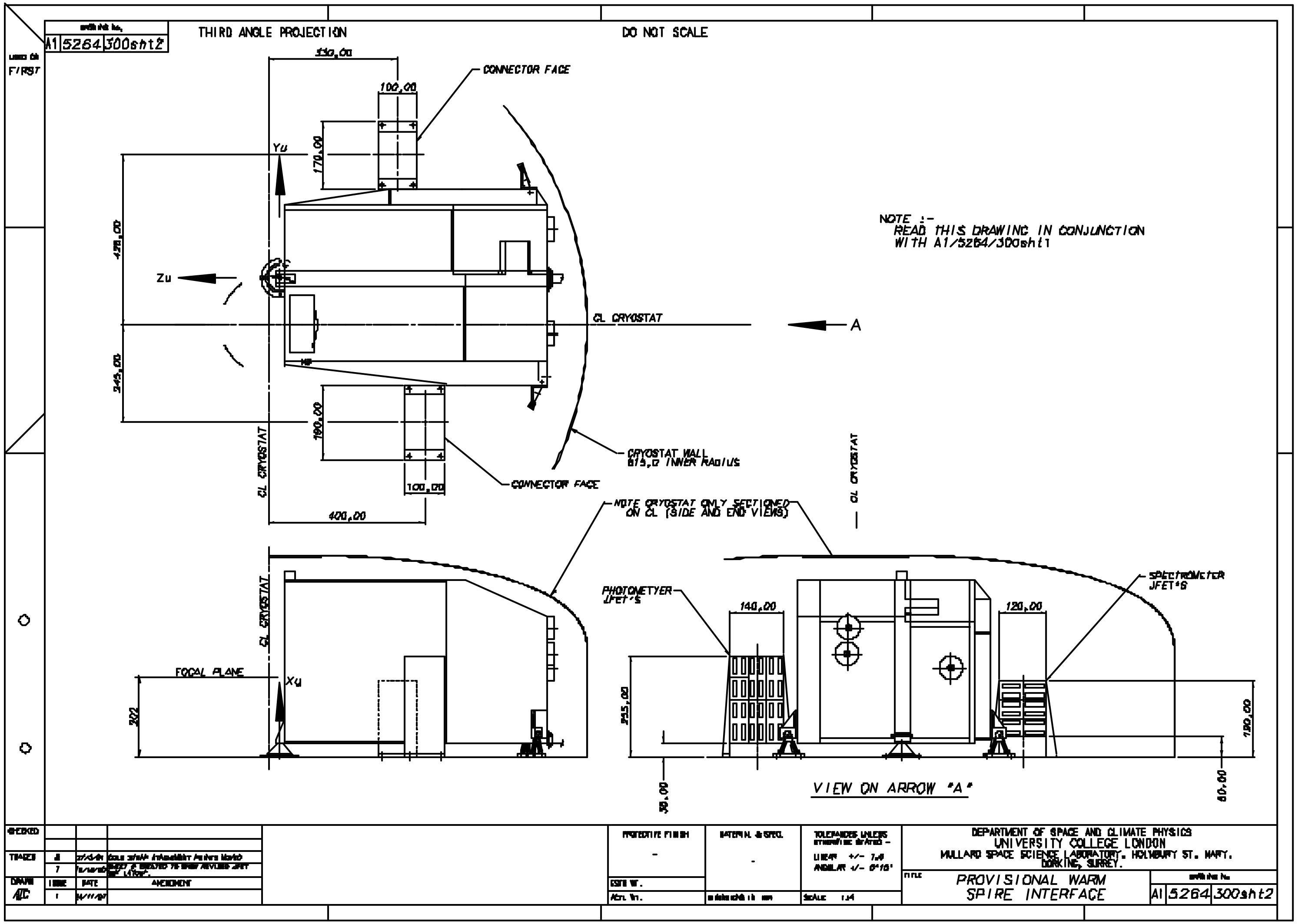


Figure 5.4-1a: SPIRE Focal Plane Unit. interface locations with the Herschel optical bench.



5.4-1b: SPIRE Focal Plane Unit showing indicative positions of the JFET boxes

5.4.2 FSJFS

Figure 5.4-2 shows the external configuration drawing for the SPIRE Spectrometer JFET box (TBW).

5.4.3 FSJFP

Figure 5.4-2 shows the external configuration drawing for the SPIRE Photometer JFET box (TBW).

5.4.4 FSDRC

Figure 5.4-4 shows the external configuration drawing for the SPIRE Detector Readout UNIT (TBW).

5.4.5 FSICU

Figure 5.4-4 shows the external configuration drawing for the SPIRE Instrument Control UNIT (TBW).

5.4.6 FSDPU

Figure 5.4-5 shows the external configuration drawing for the SPIRE data processing unit (TBW).

5.4.7 FSWIH

Figure 5.4-6 shows the external configuration drawing for the dimensions, routing and securing of the SPIRE warm electronics interconnect harness (TBW).

5.5 SIZES AND MASS PROPERTIES

The table below shows for each unit its size, mass and the number of units:

Project code	Instrument unit	# of	Dimensions (mm) *	Nominal Mass (kg)
HSFPU	Cold Focal Plane Unit (FPU)	1	750 x 650 x 455 Irregular shape	45.7
HSJFP	Photometer JFET box	1	100x190x255 (TBC)	5.2
HSJFS	Spectrometer JFET box	1	100x170x190 (TBC)	1.8
HSDCU	Detector Control Unit (DCU)	1	TBD	23 (total)
HSFCU	FPU Control Unit (FCU)	1	TBD	
HSDPU	Digital Processing Unit (DPU)	1	240 x 218 x 194	6.7
HSWIH	Warm interconnect harnesses: HSDRC-HSDPU	1	< 2000	2

Project code	**Instrument unit**	**# of**	**Dimensions (mm) ***	**Nominal Mass (kg)**
TOTAL				84.4

* Dimensions are given as Length x Width x Height. Length and Width define the fixation baseplate.

Note : Harnesses from the HSJFP; HSJFS and the HSFPU to the HSDRC will be ESA responsibility.

5.6 MECHANICAL INTERFACES

5.6.1 Inside cryostat

The Focal Plane Unit, the HSFPU, will have 3 support interfaces to the Optical Bench. One of these interfaces is the reference, as marked in the External Configuration Drawing. The interface will be such as to allow unit alignment and alignment-stability requirements to be fulfilled.

The JFET boxes will also mechanically interface directly to the Optical Bench, although with electrical insulation (TBC). The number and location of the interfaces for fixation are 4 (TBC). There is no accurate alignment requirement for these units.

The SMEC and the BSM are sensitive to μ-vibrations. SPIRE will define the required maximum level and bandwidth at the optical bench interface.

5.6.2 Outside Cryostat

NA

5.6.3 On SVM

Units mounted on the SVM will have 6 attachment points for fixation to the equipment platform, as shown in figure (5.5-4).

The SPIRE warm electronics interconnect harness will attach to the SVM via TBD straps

5.6.4 On Planck Payload Module

NA

5.6.5 Cooler valves and piping

NA

5.7 THERMAL INTERFACES

5.7.1 Inside cryostat

The various instrument stages require 3 different temperatures. This will be achieved by strapping the stages to various “cold” parts of the cryostat.
These cryostat parts are:

Level 0:	The He II tank for temperatures at the 1.7 K level
Level 1:	Strap to the He ventline at about 4K
Level 2:	Strap to the He-ventline at about 10 K

The table below shows the required operating temperatures at the interface of the instrument unit with the cryostat or parts thereof:

Project code	**Operating**		**Start-up**	**Switch-off**	**Non-operating**	
	Min. K	Max. K	^{0}C	^{0}C	Min. ^{0}C	Max. ^{0}C
HSFPU (Level 1 enclosure)	N/A	6	TBD***	TBD***	TBD	+ 60* + 80 **
HSFPU Dedicated ^{3}He cooler strap	N/A	2****	TBD***	TBD***	TBD	+ 60* + 80 **
HSFPU Level 0 Enclosure	N/A	2	TBD***	TBD***	TBD	+ 60* + 80 **
HSJFP/HSJFP	N/A	15	TBD***	TBD***	TBD	+ 60* + 80 **

* Continuous temperature limit.

** Short-duration temperature limit for bake-out during a maximum of 72 hours.

*** Certain sub-systems may not be able to be operated above 20 K.

**** For sorption cooler recycling see 5.7.1.1

5.7.1.1 Thermal Straps for ^{3}He Cooler

The operation of the ^{3}He cooler requires that it is recycled by heating the sorption pump to ~40-K whilst the evaporator is kept at 1.7-K, thus condensing the ^{3}He into the evaporator. At the end of the condensation phase the heat switch on the sorption pump is turned ON as the switch on the evaporator is turned OFF. Then there is a substantial peak power from the sorption pump to the bath via the strap. This peak power and associated energy will not have any significant impact on the bath – the cryostat LHe tank. However it will have a substantial impact on the thermal gradient along the strap.

The strap from the cooler to the LHe tank is actually split into two straps, one for the pump and one for the evaporator, it is required that the attachment points of each strap on the helium tank are separated. In this way the temperature of the evaporator strap will remain at $T_{bath}+\Delta T$ (as small as possible), leading to a good condensation efficiency and less ^{3}He lost during the cooldown from 1.7 K to 0.3 K. The sorption pump will still operate properly even if the "hot" end of its strap rises momentarily to as much as 10 K. The temperature of the evaporator during condensation is critical to the efficiency of the cooler. Therefore it is also highly desirable that the connection between the evaporator and the LHe tank is direct as possible – i.e. not via any internal structure in the SPIRE instrument which may impose parasitic loads leading to a higher temperature.

For these reasons SPIRE will provide two Level 0 thermal strap interfaces to the ^{3}He cooler which must be taken to the LHe tank via separate straps at separate locations on the tank.

The SPIRE instrument will provide a third, separate, Level 0 strap interface for the internal structure of the instrument. The required thermal conductance is defined by the maximum temperature allowed at the interface, i.e. for cooler recycling up to 10 K.

5.7.2 Outside Cryostat

NA

5.7.3 On SVM

The table below shows the required operating temperatures at the interface of the instrument unit with a mounting platform or parts thereof:

Project code	**Operating**		**Start-up**	**Switch-off**	**Non-operating**	
	Min. ^{0}C	Max. ^{0}C	^{0}C	^{0}C	Min. ^{0}C	Max. ^{0}C
HSDCU	- 15	+ 45	- 30	+ 50	- 35	+ 80
HSFCU	- 15	+ 45	- 30	+ 50	- 35	+ 80
HSDPU	- 15	+ 45	- 30	+ 50	- 35	+ 80

Note:
Acceptance temperature is 5 ^{0} below min. and 5 ^{0} above max. operating temp.
Qualification temperature is 10 ^{0} below min. and 10 ^{0} above max. operating temp.

5.7.4 On Planck Payload Module

NA

5.7.5 Temperature channels

5.7.5.1 Instrument Temperature Sensors

The table below shows information relevant to the measurement of instrument temperatures. These are available unless otherwise indicated via either of the prime and redundant sides of the SPIRE electronics.

Unit	Location	Acronym	Sensor Type	Nominal Temp. Range	Required Resolution over Range	Prime /Redundant
HSFPU	PHOT Level 0 box	T_PL0_1	CX-1050	1 K>10 K	2 mK	P
HSFPU	SPEC Level 0 box	T_SL0_1	CX-1050	1 K>10 K	2 mK	R
HSFPU	FPU SOB/BSM I/F	T_SOB_1	CX-1070	3 K>300 K	100 mK	P
HSFPU	FPU SOB/BSM I/F	T_SOB_2	CX-1070	3 K>300 K	100 mK	R
HSFPU	Optics sub-bench	T_SUB_1	CX-1050	3 K-50 K	10 mK	P
HSFPU	Optics sub-bench	T_SUB_2	CX-1050	3 K-50 K	10 mK	R
HSFPU	Input Baffle	T_BAF_1	CX1050	3 K-50 K	10 mK	P
HSFPU	Input Baffle	T_BAF_2	CX1050	3 K-50 K	10 mK	R
HSFPU	SMEC Mechanism	T_FTS_1	CX-1050	3 K>50 K	10 mK	P
HSFPU	SMEC Mechanism	T_FTS_2	CX-1050	3 K>50 K	10 mK	R
HSFPU	SMEC/SOB Interface	T_FTS_3	CX-1070	3 K>300 K	100 mK	P
HSFPU	SMEC/SOB Interface	T_FTS_4	CX-1070	3 K>300 K	100 mK	R
HSFPU	SPEC Calibrator	T_SCAL_1	CX-1070	10 K>80 K	5 mK	P
HSFPU	SPEC Calibrator	T_SCAL_2	CX-1070	10 K>80 K	5 mK	R
HSFPU	SPEC Calibrator Structure	T_SCST_1	CX-1070	10 K>80 K	25 mK	P
HSFPU	SPEC Calibrator Structure	T_SCST_2	CX-1070	10 K>80 K	25 mK	R
HSFPU	Cooler Pump	T_CPMP_1	CX-1050	3 K>100 K	25 mK	P
HSFPU	Cooler Pump	T_CPMP_2	CX-1050	3 K>100 K	25 mK	R
HSFPU	Cooler Evaporator	T_CEV_1	CX-1030	0.2 K>5 K	1 mK	P
HSFPU	Cooler Evaporator	T_CEV_1	CX-1030	0.2 K>5 K	1 mK	R

Unit	Location	Acronym	Sensor Type	Nominal Temp. Range	Required Resolution over Range	Prime /Redundant
HSFPU	Cooler Pump heat switch	T_CPHS_1	CX-1050	1 K>50 K	10 mK	P
HSFPU	Cooler Pump heat switch	T_CPHS_2	CX-1050	1 K>50 K	10 mK	R
HSFPU	Cooler Evap. Heat switch	T_CEHS_1	CX-1050	1 K>50 K	10 mK	P
HSFPU	Cooler Evap. Heat switch	T_CEHS_2	CX-1050	1 K>50 K	10 mK	R
HSFPU	Cooler Shunt	T_CSHT_1	CX-1030	0.2 K>5 K	1 mK	P
HSFPU	Cooler Shunt	T_CSHT_2	CX-1030	0.2 K>5 K	1 mK	R
HSFPU	BSM Mechanism	T_BSM_1	CX-1050	3 K>20 K	10 mK	P
HSFPU	BSM Mechanism	T_BSM_2	CX-1050	3 K>20 K	10 mK	R
HSJFS	SPEC JFET box	T_FTBS_1	CX-1070	3 K>100 K	25 mK	P
HSJFS	SPEC JFET box	T_FTBS_2	CX-1070	3 K>100 K	25 mK	R
HSJFP	PHOT JFET box	T_FTBP_1	CX-1070	3 K>100 K	25 mK	P
HSJFP	PHOT JFET box	T_FTBP_2	CX-1070	3 K>100 K	25 mK	R
These temperature sensors are readout by the FCU and the values appear in the instrument housekeeping telemetry.						

Unit	Location	Acronym	Sensor Type	Temp. Range	TM ref.
		(all TBC)		(all TBC)	
HSFPU	200 µm array	T_PSW_1	TBD	0.2 K>5 K	TBD
HSFPU	200 µm array	T_PSW_2	TBD	0.2 K>5 K	TBD
HSFPU	350 µm array	T_PMW_1	TBD	0.2 K>5 K	TBD
HSFPU	350 µm array	T_PMW_2	TBD	0.2 K>5 K	TBD
HSFPU	500 µm array	T_PLW_1	TBD	0.2 K>5 K	TBD
HSFPU	500 µm array	T_PLW_2	TBD	0.2 K>5 K	TBD
HSFPU	FTS array 1	T_SSW_1	TBD	0.2 K>5 K	TBD

Unit	Location	Acronym	Sensor Type	Temp. Range	TM ref.
		(all TBC)		(all TBC)	
HSFPU	FTS array 1	T_SSW_2	TBD	0.2 K>5 K	TBD
HSFPU	FTS array 2	T_SLW_1	TBD	0.2 K>5 K	TBD
HSFPU	FTS array 2	T_SLW_2	TBD	0.2 K>5 K	TBD
Temperature sensors on the BDAs are read out in the same manner as the detectors. The values are telemetered by default in the science data					

5.7.5.2 Satellite Temperature sensors

In addition to the instrument temperature channel, SPIRE requires that the satellite monitors the temperatures of certain parts of the cryostat and SVM independently to ensure the safety of the instrument when it is not operating. These are given in the table below.

Location	Acronym	Sensor Type	Temp. Range	TM ref.
	(all TBD)	(All TBD)	(all TBC)	(All TBD)
Level 0 Strap to cooler			1.5K - 90°C	
Level 0 Strap to FSFPU enclosure			1.5K - 90°C	
Level 1 strap to FSFPU			1.5K - 90°C	
Level 2 strap to FSFTB			1.5K - 90°C	
Optical bench at FSFPU mechanical interfaces (number TBD)			1.5K - 90°C	
SVM at FSICU mechanical interface			-80 + 90°c	
SVM at FSDRU mechanical interface			-80 + 90°c	
SVM at FSDPU mechanical interface			-80 + 90°c	

5.8 OPTICAL INTERFACES

Figures 5.8-1, 5.8-2, 5.8-3,5.8-4 and 5.8-5 show the SPIRE optical beam envelope at various places through the path from the telescope focal plane to the hole in the FIRST primary mirror. No structure or other material is allowed within the envelope defined by these “footprints”.

The footprints are subject to revision as the optical design of the telescope, and thus of the SPIRE instrument, is refined. Note that with the present design the 130 mm radius hole in the cryostat is barely large enough for the beam to pass through un-vignetted and the hole in the primary is required to be at least 135 mm radius. In fact these are sized for the geometrical footprints only, when the effects of diffraction are taken into account there is certain to be some vignetting at some parts of the FOV for some beam steering mirror positions.

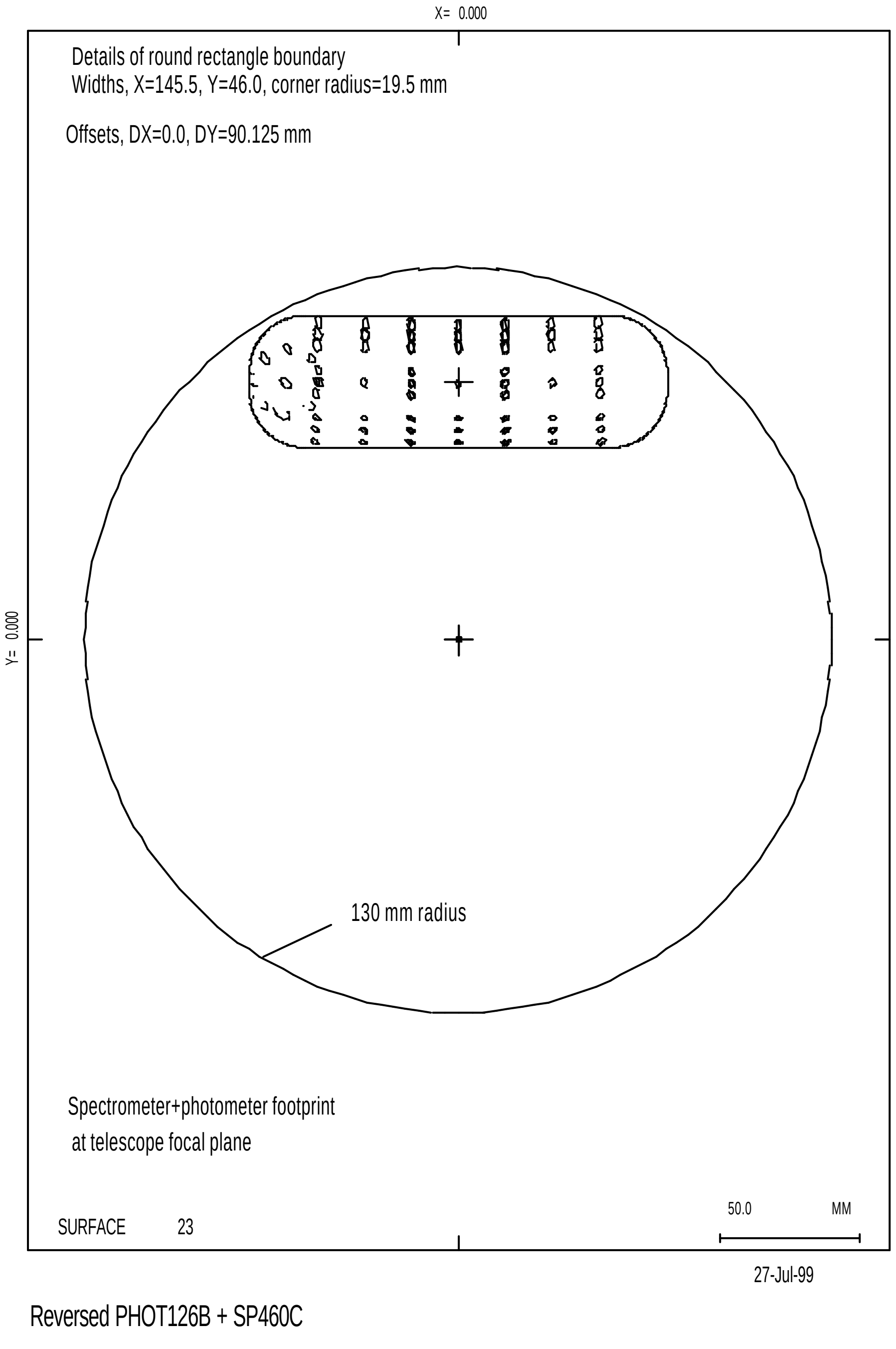


Figure 5.8-1 SPIRE optical beam envelope at the telescope focal plane.

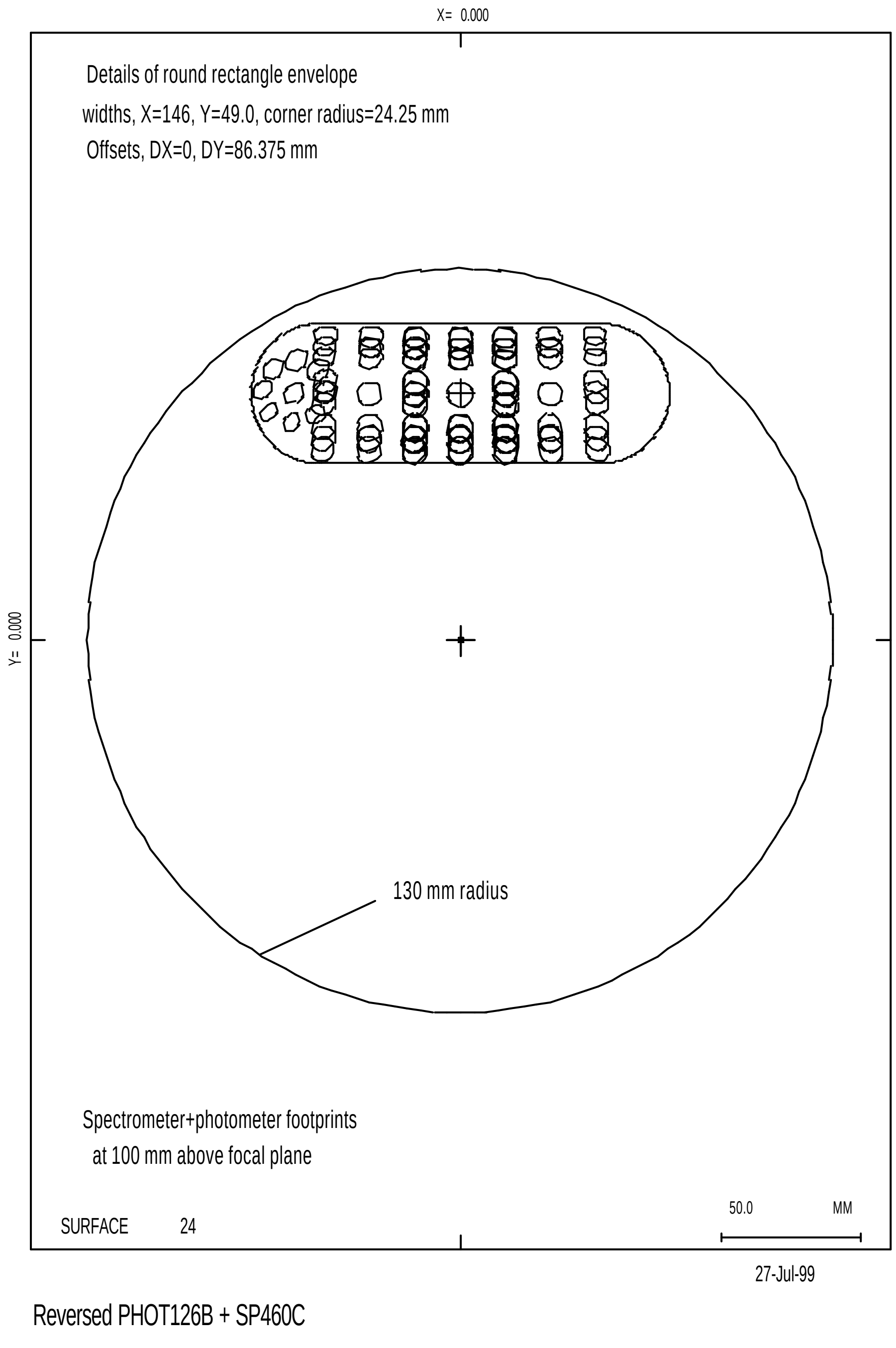


Figure 5.8-2 SPIRE optical beam envelope at 100 mm above telescope focal plane.

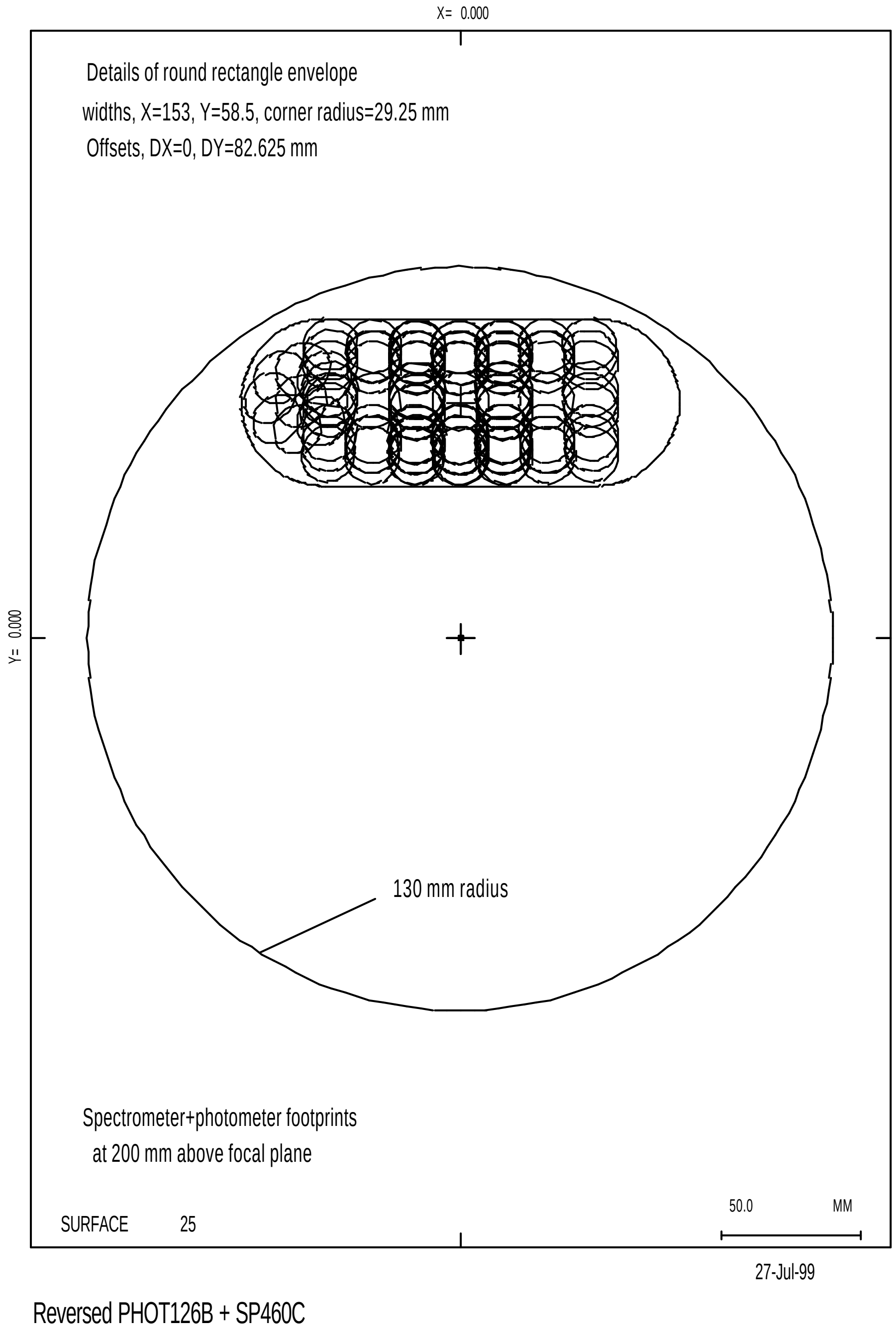


Figure 5.8-3 SPIRE optical beam envelope at 200 mm above telescope focal plane.

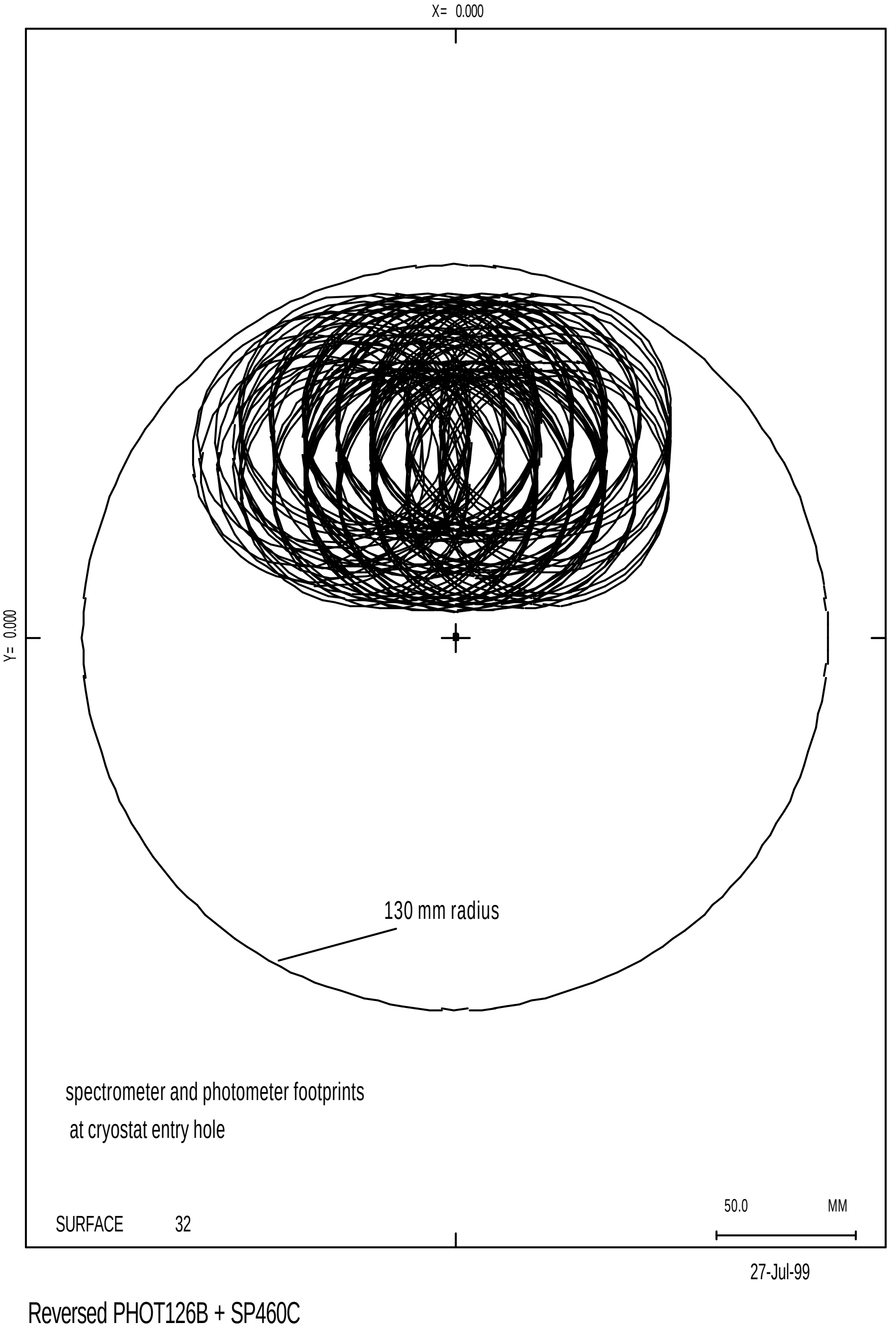


Figure 5.8-4 SPIRE optical beam envelope at the exit hole from the FIRST cryostat.

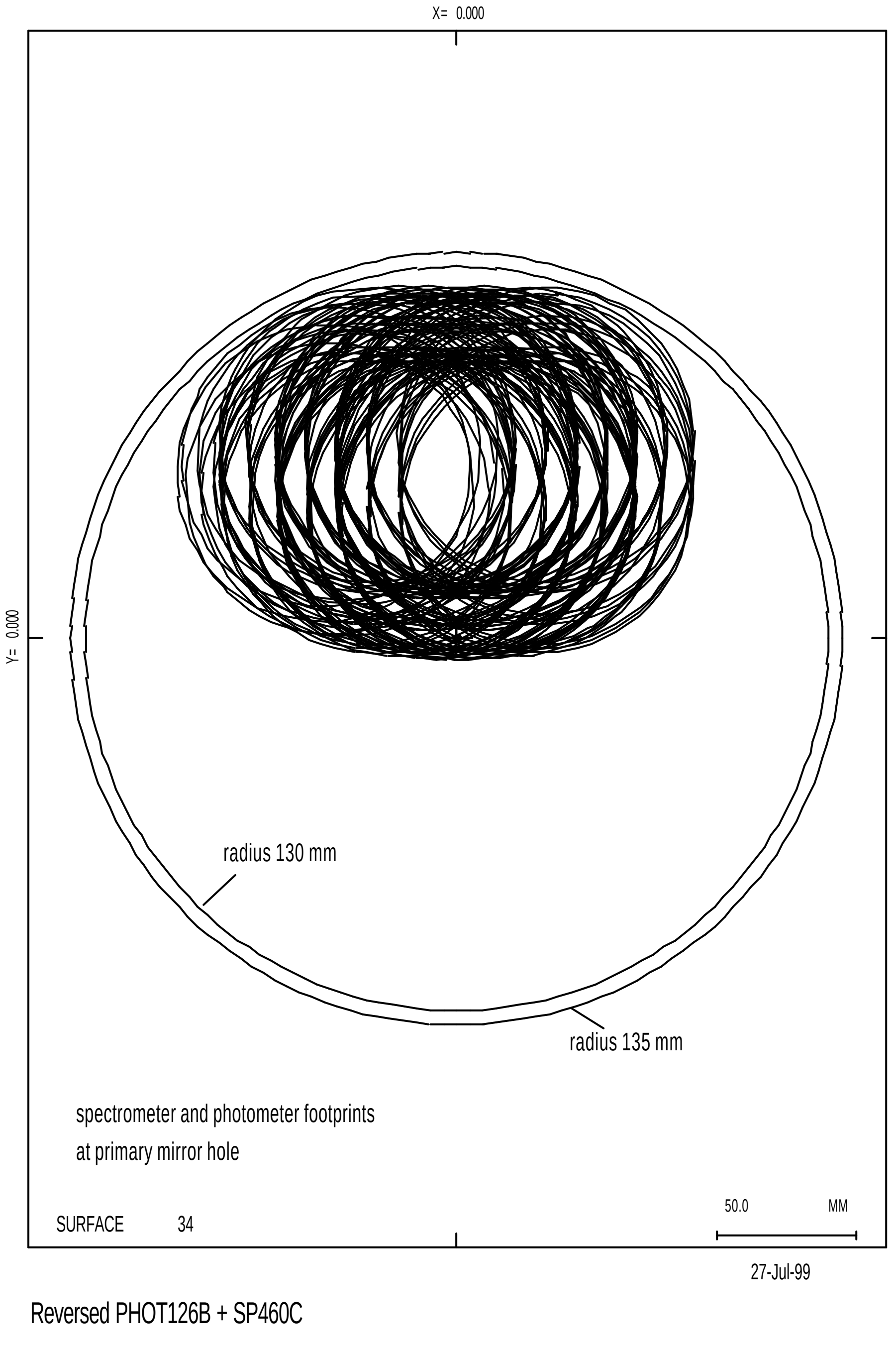


Figure 5.8-5 SPIRE optical beam envelope at the hole in the FIRST telescope primary mirror.

5.8.1 Straylight

Instrument straylight model is described in RD1: Caldwell. M; Richards. A; Swinyard. B. Straylight Analysis – SPIRE/RAL/N0044 Descriptions of CodeV and APART models of FIRST-SPIRE.

5.9 POWER

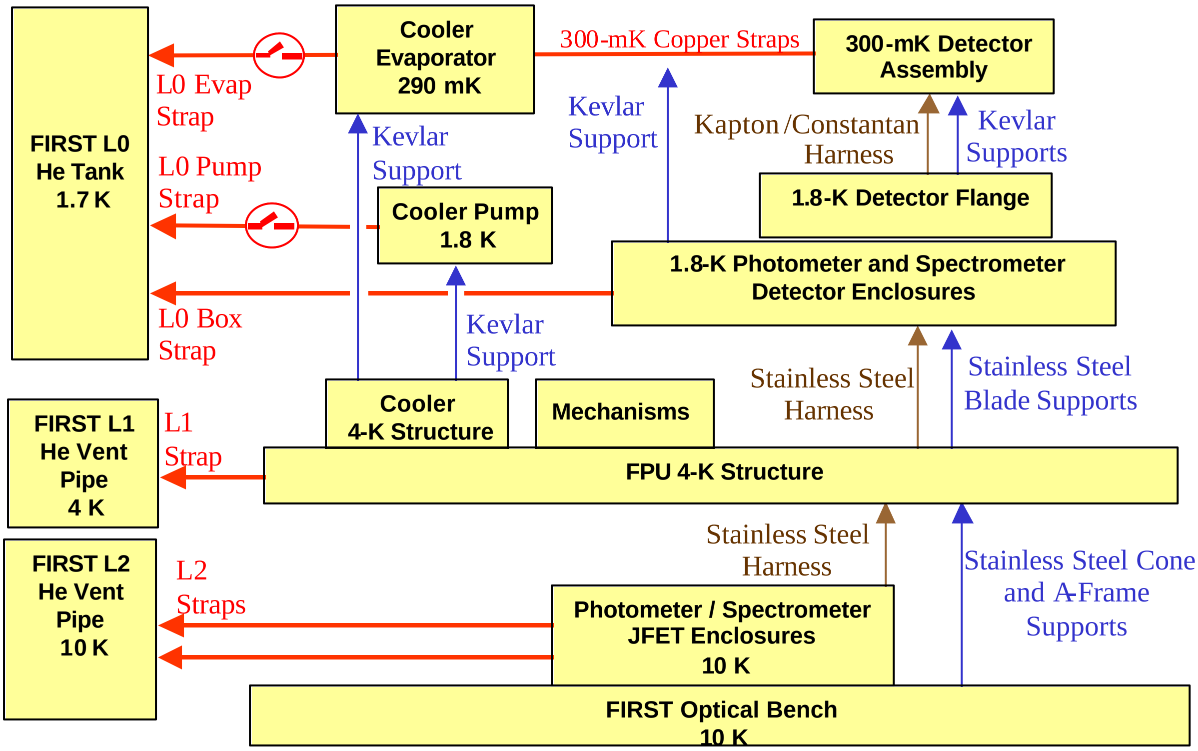
5.9.1 Inside cryostat

The tables and models below show the heat dissipation of the units mounted inside the cryostat:

Project code	Instrument unit	Power Dissipation (W)
FSFPU	Cold Focal Plane Unit	See: Thermal Model and Thermal Table

5.9.1.1 Thermal model FSFPU

Please note that this diagram is for information purposes only, budget values are given in the thermal tables. All pertinent information on thermal budgets is held in RD3.



5.9.1.2 Thermal table FSFPU

Refer to RD3 for latest information

Temp. Stage	Item	Loads in mW (All TBC)			
		Standby	OFF	PHOT	SPEC
Level 2	JFET Box				
Level 1	Wires				
	Radiation				
	Mechanisms				

	& calibrators				
	Structure				
	Total				
Level 0	Wires				
	Dissipation				
	Cooler***				
	Structure				
	Total				

Either Photometer or Spectrometer JFETS are switched on in STANDBY mode, and switched off in OFF mode. Average power in OBSERVING mode can be calculated assuming JFETS for photometer can be turned off when spectrometer is in operation, and vice versa.

5.9.2 Outside Cryostat

NA

5.9.3 On SVM

The table below shows the heat dissipation of the units mounted on the SVM:

Project code	**Instrument unit**	**Power (W)**
FSDRC	Detector Read-out and Control Unit	71
FSDPU	Digital Processing Unit	15
FSWIH	Warm Interconnect Harness	0
TOTAL		86

5.9.4 On Planck Payload Module

NA

5.9.5 Instrument Operating Modes

The table below shows the status of the instrument subsystems in the various instrument modes. (It is the idea to link this, at a later stage, to para 5.9.1 through 5.9.4 for the purpose of power dissipation calculations inside and outside the cryostat).

Unit	**Subsystem**	**Recycle**	**Off**	**On**	**Standby/ Parallel/ Serendipity**	**Observe**	
						PHOT	**SPEC**
FSFPU	Detector Bias	OFF	OFF	OFF	ON	ON	ON
	Photometer Cal Source	OFF	OFF	OFF	OFF	X	OFF
	Spect Cal Source	OFF	OFF	OFF	OFF	OFF	ON
	Cooler	ON	OFF	OFF	ON	ON	ON
	BSM	OFF	OFF	OFF	ON	ON	ON
	FTS Mechanism	OFF	OFF	OFF	OFF	OFF	ON
FSFTB	JFET amplifiers	ON	OFF	OFF	ON	ON	ON
FSDRC	Read-out electronics &	ON			ON	ON	ON

	Mechanism drive Electronics		OFF	OFF			
FSDPU	Digital Processing Unit	ON	OFF	ON	ON	ON	ON

ON =	Operational;
OFF =	Inactive;
X =	Either ON or OFF depending on instrument configuration.

5.9.6 Supply voltages

5.9.6.1 28 Volt main-bus

5.9.6.1.1 Load on main-bus

The power load on the 28V. main-bus for the instrument is as follows:

Operating mode	Average BOL (beginning of life) (W)	Average EOL (end of life) (W)	Peak (W)
Observe	86 W	TBD	TBD
Parallel	86 W	TBD	TBD
Serendipity	86 W	TBD	TBD
Standby	86 W	TBD	TBD
Cooler Recycle	86 W	TBD	TBD
On	15 W	TBD	TBD
Off	0	0	0

5.9.6.1.2 Interface circuit

There will be two 28 V lines plus redundancy into the SPIRE instrument. One to the FSDPU and one to the FSDRC.

5.9.6.2 Keep Alive Line (KAL)

Because the instrument will not be switched-on/off frequently, the implementation of a KAL is not envisaged.

5.10 CONNECTORS, HARNESS, GROUNDING, BONDING

5.10.1 Connectors

Compliant with section 5.10 of IID-A.

5.10.2 Harness

5.10.2.1 S/C Harness

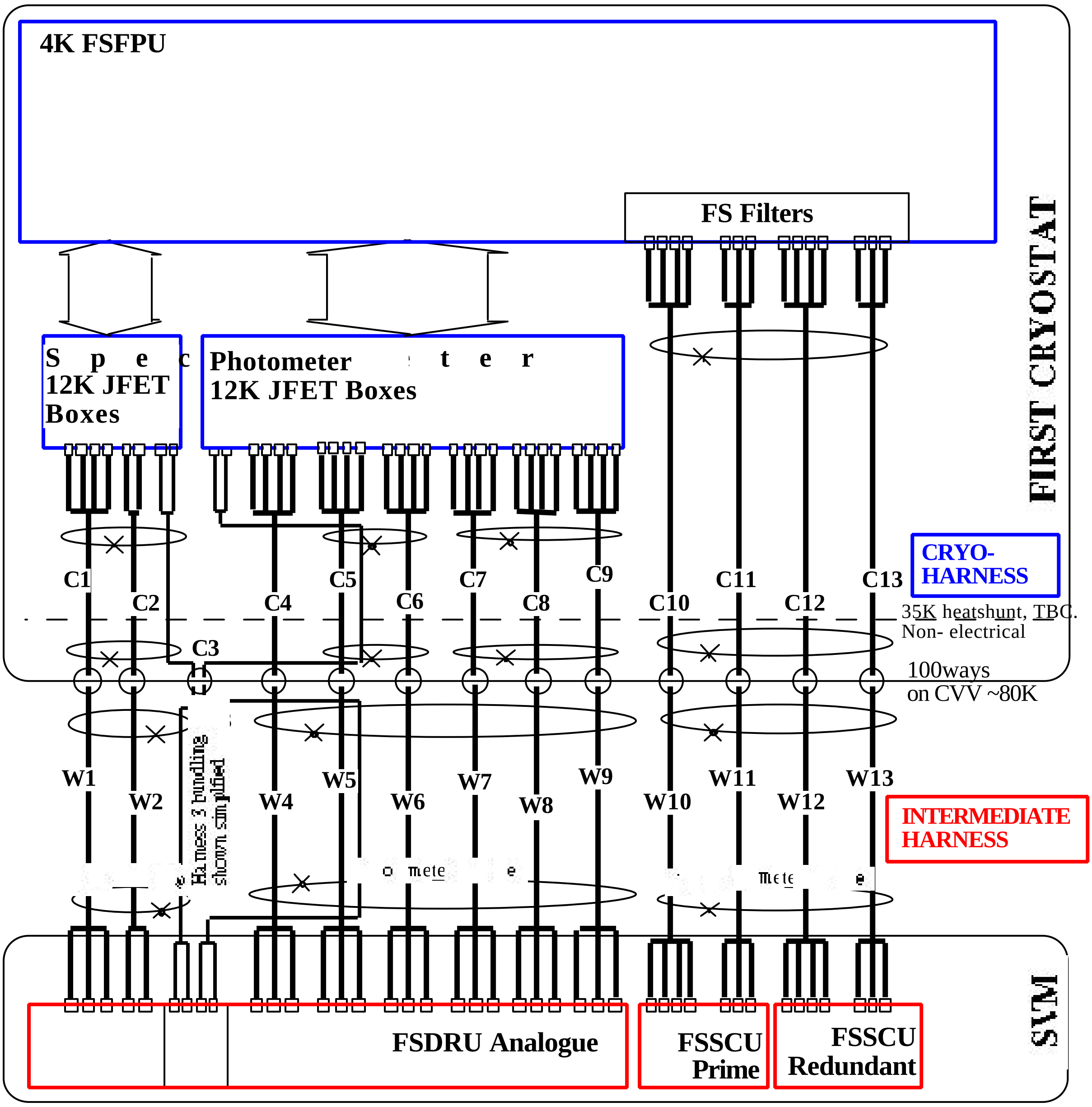
The S/C harness provides the interconnection between the instrument and two other subsystems i.e. the Power subsystem and the Command and Data Management System.
The harness is supplied through the S/C Contractor.
On the instrument side, pin functions are specified in Annex A to this document.

5.10.2.2 Instrument Harness

The “warm” harness i.e. the interconnect harness between the FSDRC and FSDPU will be delivered by the instrument team, manufactured to agreed requirements as specified in the IID-A section 5.10.2.2
Pin functions and wiring characteristics are specified in Annex A to this document.
The Contractor will specify length and routing as soon as an SVM lay-out is available. A Configuration Drawing will be included under item 5.4 of the IID-B.

5.10.2.2.1 Cryo-harness Harness Layout

A **cryo-harness** connects the 4K FSFPU and the 12K FSJFETS to the CVV connector panel, whence an **intermediate harness** continues to the ~260K SPIRE units mounted on the SVM. Note that the cryo-harness needs to be well supported up the struts to the FIRST optics' baseplate and then mates directly to SPIRE units rather than going via an extra connector panel. The S/C Contractor will deliver these harnesses for use with the flight cryostat, manufactured to at least the requirements given herein. The following block diagram outlines their configuration.



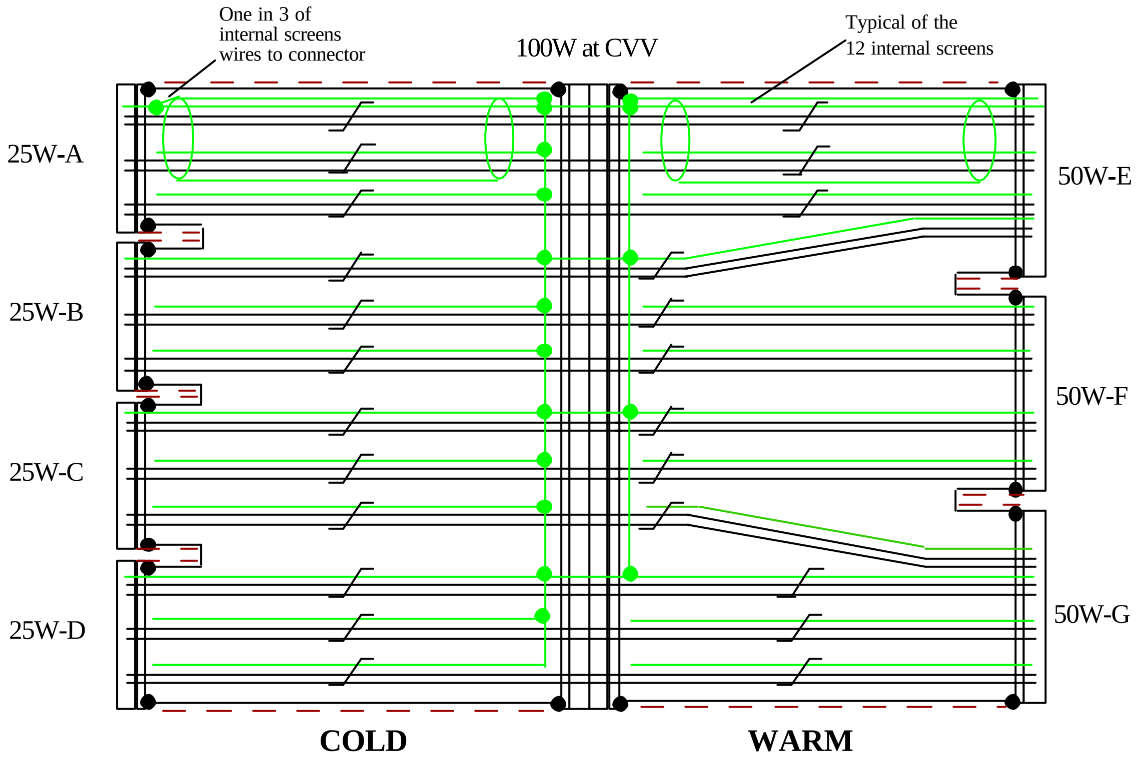
For SPIRE testing at instrument level, a replica harness to the above shall be instrument provided, any differences from the flight item being well quantified, analysed and approved. For instance, to be used with the SVM mounted units running in air, the warm test harness will need to be split by one further set of connectors.

5.10.2.2.2 CryoHarness Details

5.10.2.2.2.1 Bolometer Signal Harnesses

SPIRE harnesses **C/W 1 and 4-9** are electrically identical, differing only slightly in length if essential for routing/ installation. The baseline is to make **C/W 2** identically and leave one connector tied out each end, TBC. This level of commonality suggests making a spare to keep the programme running if one fault should develop.

The harness layout is as follows:



48 channels as twisted triples, grouped in fours as "12-ax", each with its own insulated screen. So there are three 12-ax to each 25 way changing to four for each 50way connector.

All of the signal grounds in the triples pass through the 50 way connectors, but only 4 can pass throug the 100 ways, the rest being NC at that point. The four that pass shall correspond to the 4 single grounds that pass the 25 way connectors. A signal ground wire ring on each side of the 100 way shall be supported on the 4 ground contacts that pass through it. The signal grounds in triples in the cold harness shall be NC at the JFET end and made-off to one of these rings.

All 12 internal screens in both the warm and cold harnesses shall be made off to these rings. The four at each 50way shall pass doubled-up on the 2 spare pins through each. If it is practical, because the braid is much lower impedance than the cores, one should be spliced on to the ground contact though each 25W, leaving the other two NC.

All of this harness is enclosed in outer r.f. screen, EMC sealed to connector boots, overwrapped with double-wound insulation.

Connector Types

Label	Type	Number
25WayA	MicroD MDM	TBD
25WayB	MicroD MDM	TBD
25WayB	MicroD MDM	TBD
25WayD	MicroD MDM	TBD
100way	Round hermetic	TBD
50WayE	R.F. "fingered" DxMA	TBD
50WayF	R.F. "fingered" DxMA	TBD
50WayG	R.F. "fingered" DxMA	TBD

Note that at IIDB interface level the contacts are named as "channels 1-48 on Hx" end-end, and mapping to specific detector position is only maintained internal to the instrument.

Name	25way A	25way B	25Way C	25way D	100Way	50way E	50way F	50way G
Channel 1 +	1				TBD	1		
Channel 1 -	14				TBD	18		
Channel 1gnd	NC				XXX	34		
Channel 2 +	2				TBD	2		
Channel 2 -	15				TBD	19		
Channel 2gnd	NC				XXX	35		
Channel 3 +	3				TBD	3		
Channel 3 -	16				TBD	20		
Channel 3gnd	NC				XXX	36		
Channel 4 +	4				TBD	4		
Channel 4 -	17				TBD	21		
Channel 4gnd	NC				XXX	37		
Channel 5 +	5				TBD	5		
Channel 5 -	18				TBD	22		
Channel 5gnd	NC				XXX	38		
Channel 6 +	6				TBD	6		
Channel 6 -	19				TBD	23		
Channel 6gnd	NC				XXX	39		
Channel 7 +	7				TBD	7		
Channel 7 -	20				TBD	24		
Channel 7gnd	NC				XXX	40		
Channel 8 +	8				TBD	8		
Channel 8 -	21				TBD	25		
Channel 8gnd	NC				XXX	41		
12ax braid ch1-4	NC				On Bars	9		
12ax braid ch5-8	NC				On Bars	9		
12ax braid ch9-12	13				On Bars	42		
12ax braid ch13-16		NC			On Bars	42		
Channel 9 +	9				TBD	10		
Channel 9 -	22				TBD	26		
Channel 9gnd	NC				XXX	43		
Channel 10 +	10				TBD	11		
Channel 10 -	23				TBD	27		
Channel 10gnd	NC				XXX	44		
Channel 11 +	11				TBD	12		
Channel 11 -	24				TBD	28		
Channel 11gnd	NC				XXX	45		
Channel 12 +	12				TBD	13		
Channel 12 -	25				TBD	29		
Channel 12gnd	13				TBD	46		
Channel 13 +		1			TBD	14		
Channel 13 -		14			TBD	30		
Channel 1gnd		NC			XXX	47		
Channel 14 +		2			TBD	15		
Channel 14 -		15			TBD	31		
Channel 1gnd		NC			XXX	48		
Channel 15 +		3			TBD	16		
Channel 15 -		16			TBD	32		
Channel 15gnd		NC			XXX	49		
Channel 16 +		4			TBD	17		
Channel 16 -		17			TBD	33		
Channel 16gnd		NC			XXX	50		
Channel 17 +		5			TBD		1	
Channel 17 -		18			TBD		18	
Channel 17gnd		NC			XXX		34	

Name	**25way A**	**25way B**	**25Way C**	**25way D**	**100Way**	**50way E**	**50way F**	**50way G**
Channel 18 +		6			TBD		2	
Channel 18 -		19			TBD		19	
Channel 18gnd		NC			XXX		35	
Channel 19 +		7			TBD		3	
Channel 19 -		20			TBD		20	
Channel 19gnd		NC			XXX		36	
Channel 20 +		8			TBD		4	
Channel 20 -		21			TBD		21	
Channel 1gnd		NC			XXX		37	
Channel 21 +		9			TBD		5	
Channel 21 -		22			TBD		22	
Channel 21gnd		NC			XXX		38	
Channel 22 +		10			TBD		6	
Channel 22 -		23			TBD		23	
Channel 22gnd		NC			XXX		39	
Channel 23 +		11			TBD		7	
Channel 23 -		24			TBD		24	
Channel 23gnd		NC			XXX		40	
Channel 24 +		12			TBD		8	
Channel 24 -		25			TBD		25	
Channel 24gnd		13			TBD		41	
12ax braid ch17-20		NC			On Bars		9	
12ax braid ch21-24		13			On Bars		9	
12ax braid ch25-28			NC		On Bars		42	
12ax braid ch29-32			NC		On Bars		42	
Channel 25 +			1		TBD		10	
Channel 25 -			14		TBD		26	
Channel 25gnd			NC		XXX		43	
Channel 26 +			2		TBD		11	
Channel 26 -			15		TBD		27	
Channel 26gnd			NC		XXX		44	
Channel 27 +			3		TBD		12	
Channel 27 -			16		TBD		28	
Channel 27gnd			NC		XXX		45	
Channel 28 +			4		TBD		13	
Channel 28 -			17		TBD		29	
Channel 28gnd			NC		XXX		46	
Channel 29 +			5		TBD		14	
Channel 29 -			18		TBD		30	
Channel 29gnd			NC		XXX		47	
Channel 30 +			6		TBD		15	
Channel 30 -			19		TBD		31	
Channel 30gnd			NC		XXX		48	
Channel 31 +			7		TBD		16	
Channel 31 -			20		TBD		32	
Channel 31gnd			NC		XXX		49	
Channel 32 +			8		TBD		17	
Channel 32 -			21		TBD		33	
Channel 32gnd			NC		XXX		50	
Channel 33 +			9		TBD			1
Channel 33 -			22		TBD			18
Channel 33gnd			NC		XXX			34
Channel 34 +			10		TBD			2
Channel 34 -			23		TBD			19
Channel 34gnd			NC		XXX			35

Name	**25way A**	**25way B**	**25Way C**	**25way D**	**100Way**	**50way E**	**50way F**	**50way G**
Channel 35 +			11		TBD			3
Channel 35 -			24		TBD			20
Channel 35gnd			NC		XXX			36
Channel 36 +			12		TBD			4
Channel 36 -			25		TBD			21
Channel 36gnd			13		TBD			37
Channel 37 +				1	TBD			5
Channel 37 -				14	TBD			22
Channel 37gnd				NC	XXX			38
Channel 38 +				2	TBD			6
Channel 38 -				15	TBD			23
Channel 38gnd				NC	XXX			39
Channel 39 +				3	TBD			7
Channel 39 -				16	TBD			24
Channel 39gnd				NC	XXX			40
Channel 40 +				4	TBD			8
Channel 40 -				17	TBD			25
Channel 40gnd				NC	XXX			41
12ax braid ch33-36			13		On Bars			9
12ax braid ch37-40				NC	On Bars			9
12ax braid ch41-44				NC	On Bars			42
12ax braid ch44-48				13	On Bars			42
Channel 41 +				5	TBD			10
Channel 41 -				18	TBD			26
Channel 41gnd				NC	XXX			43
Channel 42 +				6	TBD			11
Channel 42 -				19	TBD			27
Channel 42gnd					XXX			44
Channel 43 +				7	TBD			12
Channel 43 -				20	TBD			28
Channel 43gnd					XXX			45
Channel 44 +				8	TBD			13
Channel 44 -				21	TBD			29
Channel 44gnd				NC	XXX			46
Channel 45 +				9	TBD			14
Channel 45 -				22	TBD			30
Channel 45gnd				NC	XXX			47
Channel 46 +				10	TBD			15
Channel 46 -				23	TBD			31
Channel 46gnd				NC	XXX			48
Channel 47 +				11	TBD			16
Channel 47 -				24	TBD			32
Channel 47gnd				NC	XXX			49
Channel 48 +				12	TBD			17
Channel 48 -				25	TBD			33
Channel 48gnd				13	TBD			50

XXX= on bar cold side. NC warm side.

Although not every single channel is used in all harnesses, all wires should be installed.

The current taken along all these wires is minimal, so wire sections can be minimised provided the impedance of each line end-to-end at the operating temperature is <100 Ohms with <1000pF between twisted pairs. We assume that “operational temperature” for the cryostat harness will be as if it were all at 45K and for the warm 190 K. This suggests using 38AWG (stranded) stainless for the cold harness and 38AWG (stranded) brass for the intermediate.

5.10.3 Bolometer Signal/Supply Harness

This is harness **C/W 3**
More instrument design details are needed before this can be specified fully.

5.10.4 Non Bolometer Harnesses

These are harness **C/W 10-13**. **C/W 10-11** are prime and **C/W 12-13** redundant. **C/W 12** is identical to **C/W 10** and **C/W 13** is identical to **C/W 11**, save any small length differences ESA requires for their neat accommodation.

All these harnesses are "simple" in that although they have outer r.f. screens between back-shells, all other contacts including screens are wired one-contact-to-one-contact.

In the "Remarks" column is shown the suggested material for the cryo-harness. It would be expected that the longer warm harness would be constructed solely with brass conductors.

5.10.4.1.1.1 C/W 10 and 12…Signals

To be refined later, the present level of definition covers just the contact use because screens. layout etc. are according to standard design practises.

SIGNALS **Function definition**	No. of Cond.	No. of shields	Max.allowed Res.(Ohms)	Current (A)/group	Remarks	Cernox Type
Spect JFET chassis therm.	4	1	1000	2.50E-09	SST AWG38	CX-1070
Phot JFET chassis therm.	4	1	1000	2.50E-09	SST AWG38	CX-1070
FSFPU chassis therm.	4	1	1000	2.50E-09	SST AWG38	CX-1070
Photometer 2K box	4	1	1000	2.50E-09	SST AWG38	CX-1050
Spectrometer 2K box	4	1	1000	2.50E-09	SST AWG38	CX-1050
M3,5,7 Optical Subench	4	1	1000	2.50E-09	SST AWG38	CX-1050
37 way connector for 30 pins	24	6				
FTS BB stimulus heat	4	0	10	3.00E-03	Br. AWG38	
FTS BB thermA	4	1	1000	2.50E-09	SST AWG38	CX-1050
FTS BB thermB	4	1	1000	2.50E-09	SST AWG38	CX-1050
15 way connector for 14 pins	12	2				
Pump heater	4	0	10 TBC	3.00E-02	Br. AWG38	
Pump therm.	4	1	1000	2.50E-09	SST AWG38	CX-1050
Evap. diag. heater	2	0	10 TBC	0.00E+00	Br. AWG38	
Evap. therm.	4	1	1000	2.50E-09	SST AWG38	CX-1030
Shunt therm.	4	1	1000	2.50E-09	SST AWG38	CX-1030
Pump heat SW heater	4	0	10 TBC	1.60E-03	Br. AWG38	
Evap. heat SW heater	4	0	10 TBC	1.60E-03	Br. AWG38	
Pump heat SW therm.	4	1	1000	2.50E-09	SST AWG38	CX-1050
Evap. heat SWtherm.	4	1	1000	2.50E-09	SST AWG38	CX-1050
50* way connector for 39 pins	34	5				
Phot BB Heat	2	0	10 TBC	3.00E-03	Br. AWG38	
Phot BB thermA	4	1	1000	2.50E-09	SST AWG38	CX-1050
Phot BB thermB	4	1	1000	2.50E-09	SST AWG38	CX-1050

BSM/SOB I/F	4	1	1000	2.50E-09	SST AWG38	CX-1070
25 way connector for 17 pins	14	3				

* Unless common a couple of grounds and use 37 way, TBD.

5.10.4.1.1.2C/W 11 and 13….Drives

To be refined later, the present level of definition covers just the contact use because screens. layout etc. are according to standard design practises.

DRIVES **Function definition**	No. of Cond.	No. of shields	Max.allowed Res.(Ohms)	Current (A)/group	Remarks	Cernox Type
SMEC Mechanism	4	1	1000	2.50E-09	SST AWG38	CX-1050
SMEC /SOB I/F	4	1	1000	2.50E-09	SST AWG38	CX-1070
SMEC posn sensors	16	1	1000	1.00E-04	SST AWG38	
SMEC drive coils	2	1	5	8.00E-03	Br. AWG38	
SMEC drive coil volts	2	1	1000	2.50E-09	SST AWG38	
SMEC home/limit switches	12	1	1000	1.00E-03	SST AWG38	
SMEC Launch Latch	2	0	10		Br. AWG38	
50 way connector for 48 pins	42	6				
BSM chop drive coil	4	1	10 TBC	2.50E-03	Br. AWG38	
BSM jiggle drive coil	4	1	10 TBC	2.50E-03	Br. AWG38	
BSM chop posn. sense coil	5	1	100	2.50E-03	Br. AWG38	
BSM jiggle posn. sense coil	5	1	100	2.50E-03	Br. AWG38	
BSM therm	4	1	1000	2.50E-09	SST AWG38	CX-1050
BSM Launch Latch	2	0	10		Br. AWG38	
BSM Launch Latch sensor	2	0	1000		SST AWG38	
37 way connector for 31 pins	26	5				
Shutter Actuator	2	0	10 TBC		Br. AWG38	
Shutter Heater	2	0	10 TBC		Br. AWG38	
Shutter Vane Therm	4	1	1000	2.50E-09	SST AWG38	CX-1070
Shutter Actuator Therm	4	1	1000	2.50E-09	SST AWG38	CX-1070
Input Baffle Therm	4	1	1000	2.50E-09	SST AWG38	CX-1050
25 way connector for 19 pins	16	3				

Notes:
Allowed resistance values are at “operational temperatures” and assume that the cryostat harness will be at an average temperature of 45 K and the external harness at an average temperature of 190 K.
In column Duty cycle t= part of T in which signal is active; T= time for which SPIRE is in observe mode.
STP = Shielded Twisted Pair
From the instrument or OB connector to the CVV connector distance~2 m
From CVV to SVM distance between 3 and 5 m
Shields could be joined at the CVV feedthroughs in agreement with SPIRE.

5.10.5 Grounding

The grounding scheme is TBD.

5.10.6 Bonding

TBD

5.11 DATA HANDLING

5.11.1 Telemetry

5.11.1.1 Telemetry rate

The instrument produced “raw” housekeeping and science data rates, given for information purposes, are as follows:

Description	Data rate (kbps) (All TBC)
Housekeeping data rate (non-prime)	2.1
Housekeeping data rate (prime)	4.2
Science data rate: Photometer only	87
Science data rate: Spectrometer only	92
Science data rate: Parallel mode	10 (TBC)
Science data rate: Serendipity mode	87 (TBC)

Any increase in telemetry rate would have science benefits, as the detector frame rate could be increased making SPIRE more immune from any systematic 1/f noise.

5.11.1.2 Data-bus rate

For the purpose of possible (short duration) higher instrument data-rates the bus interconnecting the instrument and the Data-handling subsystem shall have the capability of handling a telemetry rate of > 200 kbps. This will allow for the rapid emptying of SPIRE on-board data storage units at the end of each observation, thus keeping overheads due to data transfer to a minimum.

5.11.1.3 Data Packets

The instrument is capable to buffer 10 seconds of data. In order to prevent data overflow in the SPIRE on-board data storage units, the S/C CDMS subsystem shall request packets at intervals of no more than 10 seconds (TBC).

5.11.2 S/C housekeeping

The S/C should be capable of monitoring the following instrument parameters every TBD minutes and provide a data packet with the results.

Voltages to instrument
Currents to instrument
Power status – i.e. which SPIRE units are on i.e. FSDPU and FSDRC.
Requested temperatures in Section 5.7.5.2.

5.11.3 Timing and synchronisation signals

The S/C shall provide SPIRE with a timing synchronisation at least once per 24 hours to allow synchronisation of the SPIRE and spacecraft clocks.

When using the telescope scan mode, the SPIRE instrument will require a “start of scan” indication to be sent be included in the telemetry with a timing precision of better than 5 milliseconds. This is required so that the SPIRE data can be correctly processed it is not required for the operation of the SPIRE instrument.

5.11.4 Telecommand

It is assumed that the observation schedule for each 24 hour period will be uplinked during the data transfer and commanding phase (DTCP). It is further assumed that the correct receipt of all SPIRE commands is verified by the S/C during the DTCP.

The maximum rate of sending command packets from the CDMS to the SPIRE instrument is less than 10 per second.

The maximum telecommand packet length is 256 octets.

5.11.5 Interface circuits

The interface between the SPIRE instrument DPU and the CDMS shall conform to MIL-STD-1553B.

The high-level packet transfer protocol is TBD.

5.12 ATTITUDE AND ORBIT CONTROL/POINTING

5.12.1 Attitude and orbit control

The SPIRE instrument has the following pointing modes:

- Peak up mode. The ACMS pointing ability quoted in the IID-A (3.7 arcsec APE – see also section 5.12.2) will not be good enough to prevent unacceptable signal loss when observing point sources with the photometer or spectrometer.

  The SPIRE beam steering mirror will be used to perform a cruciform raster over the observation target and the offset between the required pointing and the actual pointing of the telescope will be provided via an ACMS Data Packet from the SPIRE instrument to the S/C. The S/C will then adjust the pointing accordingly.

- Nodding mode. If the telescope temperature stability time constant proves to be short compared with a typical pointed observation with SPIRE; then the telescope must be capable of being pointed to another fixed position on the sky between 10 arcsec and 4 arcmin from the original pointing in an arbitrary direction with respect to the spacecraft axes. The settling time at each re-pointing must be less than 10 seconds

- Line scan mode. To map large areas of the sky, the telescope must be capable of being scanned up to 20 degrees at a constant rate in an arbitrary orientation with respect to the spacecraft axes. The rate of scan must be variable between 0.1 arcsec/sec and 60 arcsec per second. It is expected that the RPE will be maintained in the orthogonal direction during the scan. The S/C must be capable of reaching any scan speed up to the maximum within 20 seconds of the observation commencing.

- Raster mode. To finely sample the SPIRE FOV the instrument beam steering mirror will be used to step the FOV across the sky in an arbitrary direction. The step size will be between 1.7 arcsec and 30 arcsec. The beam steering mirror can also be used to chop a portion of the SPIRE FOV at a rate up to 2 Hz.

  In the event of a failure in this sub-system the S/C will be used in raster mode to sample the FOV. This is acknowledged to be much less efficient than using the internal beam steering mirror. The spacecraft must, nevertheless, be capable of providing a rectangular raster with steps of between 1.7 and 30 arcsec in any arbitrary orientation with respect to the S/C axes.

  To map extended regions using the spectrometer, the SPIRE instrument will use the telescope Normal Raster Mode. The instrument may perform fine sampling of each raster pointing using the internal beam steering mirror.

5.12.2 Pointing

The SPIRE instrument requires an absolute pointing error of better than 1.5 arcsec r.m.s. (TBC), and a relative pointing error of better than 0.3 arcsec r.m.s. per minute. This is achieved by the peak up mode in case the pointing goal values are not fully achieved by the S/C.

5.12.3 On-Target Flag (OTF)

For pointed observations it is assumed that an on target flag will be provided through the telemetry with a timing precision of better than 0.1 seconds (TBC). This is required for the correct processing of the SPIRE data on the ground, it is not required for SPIRE operations.
(Note: inconsistent with IID-A)

5.13 ON-BOARD HARDWARE/SOFTWARE AND AUTONOMY FUNCTIONS

5.13.1 On-board hardware

There is a single on-board computer in the SPIRE HSDPU. Only the HSDPU has on-board software.

5.13.2 On-board software

It is assumed that the SPIRE warm electronics will be left on during all operational phases. The instrument on-board software will thus be preserved in the HSDPU. If the FSDPU is switched off for any reason on-board software must be reloaded during the DTCP before SPIRE operations can recommence.

No single instrument command nor any sequence of instrument commands will constitute a hazard for the instrument

5.13.3 Autonomy functions

The S/C must be capable of automatic monitoring all SPIRE Spacecraft Housekeeping parameters, i.e. the parameters listed in section 5.11.2, when the S/C is not in ground contact.

The S/C must also be capable of monitoring certain SPIRE Instrument Housekeeping parameters provided to it via “Housekeeping Data” packets from the SPIRE DPU – see 5.13.4.

The S/C must be capable of taking predefined action – e.g. switching off the power to the SPIRE instrument – when an error or hard limit is detected in either the SPIRE S/C Housekeeping or the SPIRE Instrument Autonomous Housekeeping parameters.

The S/C must be capable of receiving and interpreting SPIRE “Event Data” packets that will alert the S/C of errors or hard limits detected by the SPIRE DPU autonomy monitoring software. Again the S/C must be capable of taking the appropriate pre-defined action on detecting an error alert in the SPIRE Event Data.

5.13.4 Instrument Autonomy Housekeeping Packet Definition

TBD

5.13.5 Instrument Event Packet Definition

TBD

5.14 EMC

5.14.1 Conducted Emission/Susceptibility

TBD

5.14.2 Radiated Emission/Susceptibility

TBD

5.14.3 Frequency Plan

TBD

5.15 Transport and Handling Provisions

5.15.1 Focal Plane Unit

5.15.1.1 Transport Container

The SPIRE FPU (HSFPU) will be transported in a clean hermetically sealed container to be opened only in class 100 clean conditions (TBC) with less than 50% humidity (TBC).

The maximum shock the HSFPU can sustain in any direction is (TBD). The transport container is fitted with shock recorders and internal humidity monitors. The FSFPU transport container is shown in figure TBD.

5.15.1.2 Cooling and Pumping restrictions

During cryostat warm-up or cool-down phases the rate of temperature change dT/dt shall not exceed 10 K/hour (TBC). The rate of depressurisation/pressurisation dP/dt shall not exceed 50 mBar/minute (TBC).

5.15.1.3 Mechanism positions

For reasons of possible damage caused by vibration during transport, environmental testing and launch, mechanisms shall be placed in the TBD position. This position is shown in table TBD.

5.15.1.4 Unpacking Procedure

The procedure for removing and installing the HSFPU from its transport container is given in document TBW

5.15.2 JFET Boxes

5.15.2.1 Transport Container

The SPIRE JFET/Filter Boxes will be transported in clean hermetically sealed containers to be opened only in class 100 clean conditions (TBC) with less than 50% humidity (TBC).

The maximum shock the HSJFS and HSJFP can sustain in any direction is (TBD). The transport container is fitted with shock recorders and internal humidity monitors. The HSJFP and HSJFP transport container is shown in figure TBD.

5.15.2.2 Unpacking Procedure

The procedure for removing and installing the HSJFS and HSJFP from their transport container is given in document TBW

5.15.3 Electronics Units

5.15.3.1 Transport Container

The SPIRE warm electronics units (FSDRC; FSDPU; FSWIH) will be transported in clean hermetically sealed containers to be opened only in class 10000 clean conditions (TBC) with less than 75% humidity (TBC).

The maximum shock any of the warm electronics units can sustain in any direction is (TBD). The transport containers are fitted with shock recorders and internal humidity monitors. The SPIRE warm electronics transport containers are shown in figure TBD.

5.15.3.2 Unpacking Procedure

The procedures for removing and installing the SPIRE from warm electronics units their transport containers are given in document TBW

5.16 DELIVERABLE ITEMS

5.16.1 Instrument Models

The model philosophy to be adopted for the AIV of the FIRST bolometer instrument will be in accordance with the requirements of the FIRST IID part A. The instrument models to be produced are:

AVM – Avionics Model. "…to validate electronics and software for its interface with the S/C, including anything that exchanges information with, for example, the AOCS. In addition all tasks relevant to SPIRE autonomy shall be verified."

We have interpreted this as being a DPU plus a simulator of the DRCU and cold FPU – this is termed the DRCU Simulator. As the schedule demands that this model will be delivered almost simultaneously with the CQM we intend using the CQM DPU plus a DRCU simulator as the AVM.

CQM - Cryogenic Qualification Model. For both the cold FPU and the warm electronics it is assumed that this is built to flight standards, but not necessarily using flight quality electronic components. The performance capabilities of the instrument may be less than the proto-flight model - i.e. fewer pixels in the focal plane arrays, but it will mimic as exactly as possible the thermal, electrical and mechanical properties of the flight instrument and will be capable of under going the full environmental qualification programme

PFM – Proto-Flight Model. This will be the instrument model that is intended for flight. It will be built to full flight standards and will only have minor differences in thermal, electrical and mechanical properties to the CQM. It will have the same mechanical, thermal and electrical interfaces to the satellite as the CQM but, may, however, have minor internal design changes compared to the CQM. For instance the bolometer arrays may have many more pixels. The PFM will therefore undergo environmental test to qualification levels for acceptance times (**TBD**) - this applies to both the warm electronics boxes and the cold FPU

FS – Flight Spare. The flight spare cold FPU will be made from the refurbished CQM (TBC). The flight spare warm electronics will consist of spare electronics cards.

5.16.2 Electrical Ground Support Equipment (EGSE)

Electrical Ground Support Equipment (EGSE) will be needed to provide SPIRE instrument level monitoring during instrument integration with the S/C and system level testing.

Deliverables:

- FPU electrical simulator, including simulation of the FSFTB, to enable integration of the FSDRC; FSDPU and FSWIH
- TBD EGSE for integration of the FSFPU
- Quick Look Facility to enable testing of the instrument at system level. This will interface to the S/C test environment via FINDAS.

5.16.3 Mechanical Ground Support Equipment (MGSE)

MGSE is required to ensure safe handling of all instrument components during assembly integration and test procedures.

Deliverables:

- Transport containers
- Instrument to cryostat integration jigs/equipment
- Plus TBD

5.16.4 Optical Ground Support Equipment (OGSE)

OGSE is required to carry out alignment procedures with the telescope.

Deliverables:
- Instrument optics primary alignment and alignment verification jigs/equipment
- Plus TBD

5.16.5 System Test Software

Will be based on the Quick Look Facility - computers and software that allow the monitoring in near real time of the instrument housekeeping parameters and instrument data. This is the basic facility to be used for the ICC operations monitoring for the monitoring of the instrument in-orbit. The same facility with enhanced capabilities will be used for the ground tests and in-orbit check out of the instrument.

5.16.6 Hardware for the Observatory Ground Segment

Quick Look Facility for the Mission Operations Centre for instrument in-flight commissioning. This will consist of TBD workstations etc….and is identical to the system used for system level testing.

5.16.7 Software for the Observatory Ground Segment

The software for the Quick Look Facility will be delivered to the MOC for instrument in-flight commissioning.

Plus TBD.

5.16.8 Instrument Software Simulator

TBD

5.16.9 Test Reference Data

The SPIRE instrument test reference data will be delivered via FINDAS in the TBD form generated during instrument and system level testing.

5.16.10 Instrument Characterisation Data

The SPIRE instrument characterisation data will be delivered via FINDAS in the TBD form generated during instrument and system level testing.

5.16.11 Technical Documentation

The following documents will be delivered:

- Instrument User Manual following the requirements laid down in the OIRD (AD2)
- Instrument database – this will be delivered via FINDAS in the TBD form generated during instrument and system level testing.
- Each instrument model will be delivered with an Acceptance Data Package consisting of TBD.