Introduction:
This document outlines the SPIRE instrument requirements on the detector cooling system. The cooling system comprises the ^{3}He sorption cooler; the thermal links between the cooler cold tip and the detectors; the associated thermometry and any active temperature control circuitry. Most, but not all, of the requirements apply to the cooler.

The requirements set out here come from discussions between B. Swinyard, L. Duband, B. Collaudin and M. Griffin. Any comments or queries should be addressed to B. Swinyard (B.M.Swinyard@rl.ac.uk)

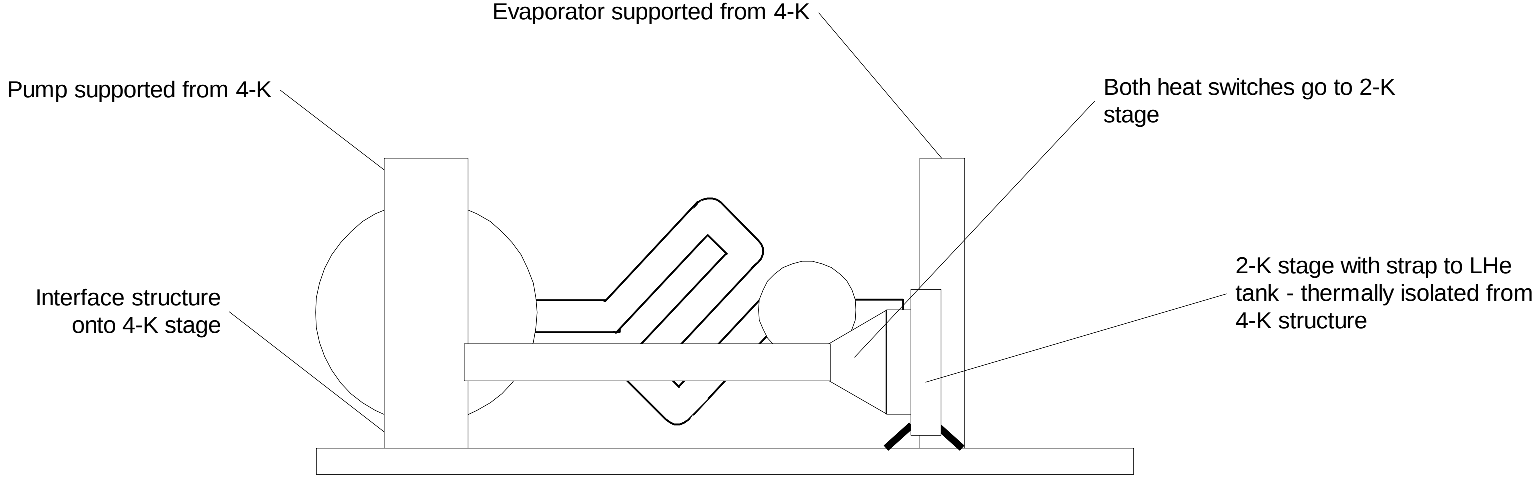
Provisional Instrument Requirements:

Temperature at the detectors	Nominal 300 mK
Operating temperature control	Desirable to be able to vary the temperature of the detectors up to 320 mK and below 300 mK *if this is permitted by the temperature drop across the thermal link.* The evaporator cold tip temperature can be varied by heating the sorption cooler. Electronic control shall be provided to do this in the flight electronics.
Temperature drop across thermal link between detectors and evaporator cold tip	Maximum of 25 mK
Temperature drift	The temperature of the evaporator cold tip should not drift by more than 10 mK/h
Temperature fluctuations at the evaporator cold tip	No more than 150 nK $Hz^{-1/2}$ in a frequency band from 0.1-100 Hz.
System low frequency temperature stability with active temperature control	TBD nK at 0.015 Hz at a maximum power dissipation of TBD μW
Heat lift at detectors	Minimum of 10 μW at 300 mK
Hold time	Minimum 46 hours
Recycle time	Maximum 2 hours
Thermal interface	Pumped liquid helium tank at 1.8 K for both sorption pump and evaporator
Thermal load onto He bath during cold operation	Maximum 1 mW
Time averaged thermal load onto He bath for 48 hour cycle	Maximum 3 mW (includes 20% margin)
Mass – including support structure	0.6 kg (includes 20%) margin (this will be revisited if more mass is required to mount the cooler from 4-K)
Maximum envelope	200x100x100 mm
Mechanical interface	Preferred interface is with the instrument 4-K structure – sketches below indicate how this might be achieved.
Preferred orientation	Horizontal with long axis along S/C Y-axis and evaporator at –Y end (see sketch)
Thermometers	Thermometers shall be provided on the cooler as set out in the table below. The absolute temperature measurement on the evaporator cold tip shall be 0.5% (<1.5 mK) with a resolution

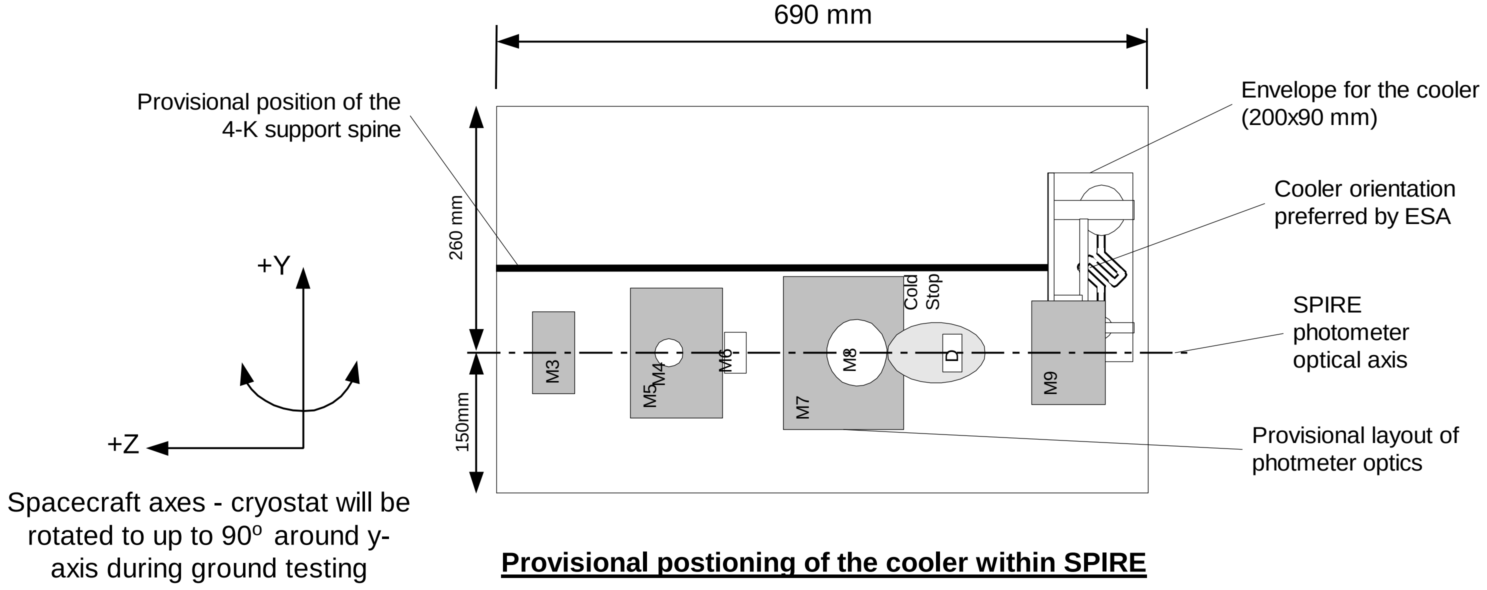
	of TBD mK. Thermometers of the same specification shall also be provided on each detector array.
Sorption pump heater	The baseline design has a heater resistance of 400 Ω implying a current of up to 20 mA for recycling. It is desirable that this heater resistance is increased so that the allowable resistance of the cryo-harness wiring can, in turn, be increased. The maximum resistance of the heater that can be driven by 28 V is about 5 kΩ.
Gas gap heat switches	It is noted that these are a potential single point failure in the instrument operation. Provision of some redundancy (i.e. doubling them up) is desirable *but not at the expense of severe limitations on the cooler performance.*
Ground Operation	The cooler must be capable of full operation on the ground, including recycling, when the instrument is in its normal orientation i.e. +Y horizontal and +X vertical and pointing skyward. Further it must be capable of operating with the instrument rotated to up to 90^{o} about the S/C Y-axis (see sketch)

ID	Instrument: SPIRE 4.3-K to 300-K interface Signal definition	Name	No. of Cond.	No. of shields	Max. allowed Res. (Ω)	Current (A)	Duty Cycle (t*T)	Max. Line Volt (V)	Remarks
14	Pump heater (main)	PH_M	2	0	10 TBC	1.4E-2	0.014	TBD	Br. AWG38
15	Pump heater (red.)	PH_R	2	0	10 TBC	0.0E+0	0	TBD	Br. AWG38
16	Pump therm. (main)	PT_M	4	1	1000	1.0E-5	1	TBD	SST AWG38
17	Pump therm. (red.)	PT_R	4	1	1000	1.0E-5	1	TBD	SST AWG38
18	Evap. therm. (main)	ET_M	4	1	1000	1.0E-5	1	TBD	SST AWG38
19	Evap. therm. (red.)	ET_R	4	1	1000	1.0E-5	1	TBD	SST AWG38
20	Pump heat SW heater (main)	PHSWH_M	2	0	10 TBC	2.0E-3	0.96	TBD	Br. AWG38
21	Pump heat SW heater (red.)	PHSWH_R	2	0	10 TBC	0.0E+0	0	TBD	Br. AWG38
22	Evap. heat SW heater (main)	EHSWH_M	2	0	10 TBC	2.0E-3	0.04	TBD	Br. AWG38
23	Evap. heat SW heater (red.)	EHSWH_R	2	0	10 TBC	0.0E+0	0	TBD	Br. AWG38
24	Pump heat SW therm. (main)	PHSWT_M	4	1	1000	1.0E-5	1	TBD	SST AWG38
25	Pump heat SW therm. (red.)	PHSWT_R	4	1	1000	1.0E-5	1	TBD	SST AWG38
26	Evap. heat SW therm. (main)	EHSWT_M	4	1	1000	1.0E-5	1	TBD	SST AWG38
27	Evap. heat SW therm. (red.)	EHSWT_R	4	1	1000	1.0E-5	1	TBD	SST AWG38
	TOTAL		44	8					

Wiring table from IID-B



Arrangement for mounting cooler from 4-K stage



Provisional postioning of the cooler within SPIRE