Notes on Meeting SPIRE-RAL-MOM-001720

SPIRE visit to SBT 19th June 2003.
Present: Lionel Duband, Chris Jewell, John Delderfield.

We paid several visits to the cooler test laboratory during the day, passing SBT's new cooler assembly clean room.

The PACS cooler was under test in the cryostat. Both test straps are 200mW/K from heatswitch I/F to cryostat endplate I/F, the cryostat having a good conducting substantial copper endplate.

We watched part of a re-cycling and noted that there were indeed convection effects which will not occur in orbit. Changing from 30˚ to 60˚ tilt these were very evident, but altering from 60˚ to 90˚ there was no obvious effect. It still remains to be established whether convection effects account for all the total energy performance shortfall observed in the PACS unit.

The heater power in the evaporator heatswitch was varied to see if the switch's sieve temperature was limiting recycling. It wasn't, but 600µW was already being used. This is higher than Spire knew about. Lionel will have discussions with CEA Paris. If this is a change in FCU requirements an ECR is needed.

There were interesting effects due to 1G on the main cryostat. It is pumped down from 4.2K to 1.6K and cannot be topped up. It thus starts off at 1.6K about half full. The pump heatswitch strap connects to the cryostat endplate well above half-way across, and when the tilt is 90˚ [the cylinder horizontal] this is above the He fill level. Even with a not insubstantial cryostat endplate, relying on metal conductivity not liquid He the strap end temperature is noticeably unstable in temperature as the pump switch is turned on and lifts from 1.65 to 1.91K. During Herschel ground test the effect will occur but is minimised because the internal pods should remain in contact with the superfuid helium.

The SPIRE CQM cooler could be seen undergoing clean-up bakeout in vacuo (5 days 80˚C). Apparently no Cernox offsets were induced by this process already carried out on the PACS cooler.

The Spire cooler had "passed" preliminary functional tests on 13th June, and also showed convective effects that looked like PACS'.

Back in the meeting room we ran through performance requirements + options…such as the latter are. These are summarised in the later table. Several points were clarified, possibly the most important outcome of the meeting:

a. Anneso's hold-time figures in the specific cases quoted at Freidrichshafen agreed well with what came out of Lionel's laptop, as did the holdtimes in H-P-PACS-ER-009 update December 2002.
b. Lionel's hold-times already take into account the not quite full recycling determined by the pump and evaporator temperatures AND the loss of available helium as it cools back to "300mK". Lionel and Chris both thought that with all the 3He in the evaporator its self specific heat would totally dominate the loss of available helium as it cools back to "300mK" as opposed to any heat capacity in the BDA+Plumbing… Anneso to confirm or challenge.
c. Not surprisingly, with all other conditions constant, gross power at 300mK x holdtime = Konst.
d. It follows, from this, that holdtime sensitivity to changes in load depends strongly on the starting point. For a Spire 32.9µW/45.5 hour load case the sensitivity is 1.4 hours per µW, but for a PACS 27.1µW /55.5 hour baseline the sensitivity is 2.1 hours per µW.
e. We have some E-mail problems and I need to recirculate the test suggestions sent round and put as note on Livelink since Lionel does not have the latest version. This may explain why he inadvertently mentioned a 10microwatt load being added to the 300mK by the instrument rather than 20 , i.e going back to before we changed from 4 litre to 6 litre coolers.

f. The biggest surprise to me, and one which really puts "the cat among the pigeons" such that Spire thermal specifications again no longer quite hold together is that the algorithm for calculating the recycling has as its input not evaporator cooler I/F temperature but raw helium temperature inside the evaporator. On the coolers as measured today there is about 150milliKelvin uplift from I/F temperature to evaporator cold-tip, never mind any small further increase to inside the evaporator. Whatever the history of who said what, this has now been worked through.

g. A slight compensation [but not enough] is that 30mW L0 evaporator strap design point at the end of recycling is too stringent. It is about 17 total, 15 from the shunt and 2 via the evaporator heatswitch.

h. JD pointed out that using 200mW/K straps for the present tests not only made them inapplicable to the rather low conductivity straps that ESA have presently agreed to but also made them unrepresentative of the case for which Spire has been negotiating based on Lionel's requirements for 100mW/K and 50mW/K.

We addressed schedule. It is packed up until after cold vibration at CSL 1st week in July. Second week in July will be spent confirming post-vibration performance and doing full 48 hour runs. Then Lionel comes to Spire review. Lionel kindly agreed to get the bits engineered to do a poor heatstrap runs in parallel with all this ongoing chaos. The possibility then exists, to be agreed at or before the Spire Review, for low conductance strap results to be carried out at SBT in Lionel's absense before Spire needs delivery on 21st July. This arises due to a difference of opinion. I consider it proven that Spire needs to achieve very full cooler recycling to achieve 46 hour run-times, and that this cannot happen with poorer straps than we were negotiating for…adjusted by point f., above. On the other hand, ESA would prefer to have a clear picture of the overall situation, including drivers, margins, errors and sensitivity before the Level 0,1,2,3 strap PDR at the end of July.

We noted that the difference between the evap. T and the switch base extends out for ages before becoming truly stable after a recycling. JD proposed that we define recycling to have finished (i.e Spire starts taking data again) when the cold tip temperature has got within a small number of mK of what would be its final temperature. This could be the point at which the Spire PTC hardware is set up during commissioning to "catch" the "300mK" temperature. Bruce and Anneso to assess, comment, and accept or qualify. My idea is that other instabilities in the instrument temperatures occur anyway after recycling and we will need to start observing periods with chopped modes to take out gain and offset drifts anyway. The idea is to give recycling a clear target to achieve in 2 hours.

<u>Specification logic:</u>

~300mK Tip temperature. In practise Spire will use temperature that results from having a load that corresponds to 46 hour hold-time and will seek to minimise the rise between the evaporator cold-tip and detectors (BDAs). The drivers on the 46 hour hold-time are as follows:

>46hour holdtime → Load

a. Detector/resistor dissipation and incoming radiation
b. Parasitic strays environment strays from L1 and LO +Conduction along tube from heatswitch + sensor wires
c. Convection losses inside pump….ground only
d. Heatswitch power losses
e. Any oscillation power losses…..possibly ground only

→ Mass of 3He at 300mK at T_0

a. Total charge of 3He which could be recycled
b. Temperature for recondensation + more weakly temperature of pump/shunt
c. Time to recondense
d. Use of liquid to cool from ~2K to 300mK

In the below, the second and third columns are temperature in Kelvin at the end of recycling, and the holdtimes are in hours.

Conditions	Temp Cooler I/F	Temp He Evap	PACS holdtime	Spire holdtime
L1 at 5K	1.6	1.8	50	44
Evap Sw. 1.8K	1.8	2	47	41.5
during operation	2.0	2.2	43.5	38.5
Supposed loads in microWatts			11.4Ext+18.6Int	20Ext+13.9Int

Note: Spire's 13.9 Internal includes 8.1μW by conduction along titanium tube to the shunt, 3.4 via the switch and 2.4μW via the Kevlar suspension.

Conditions	Temp Cooler I/F	Temp He Evap	PACS holdtime	Spire holdtime
L1 at 4.5K	1.6	1.8	53.5	45
Evap Sw. 1.8K	1.8	2	49.6	42
during operation	2.0	2.2	46	
Supposed loads in microWatts			11.4+17	20+13.4

Conditions	Temp Cooler I/F	Temp He Evap	PACS holdtime	Spire holdtime
L1 at 4.5K	1.6	1.8	55	46.5
Evap Sw. 1.72K	1.8	2	52	44
during operation	2.0	2.2		
Supposed loads in microWatts			11.4+15.7	20+12.1

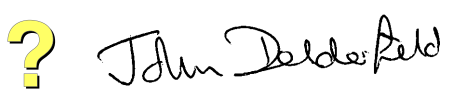
Conditions	Temp Cooler I/F	Temp He Evap	PACS holdtime	Spire holdtime
L1 at 4K	1.6	1.8	55.5	45.5
Evap Sw. 1.8K	1.8	2	52	43
during operation	2.0	2.2		
Supposed loads in microWatts			11.4+15.6	20+12.9

Conditions	Temp Cooler I/F	Temp He Evap	PACS holdtime	Spire holdtime
L1 at 4K	1.6	1.8	58	47.5
Evap Sw. 1.72K	1.8	2	54.5	44.5
during operation	2.0	2.2		
Supposed loads in microWatts			11.4+14.3	20+11.5

I also took an action to provide a breakdown of the Spire 300mK loads as per Anneso's 4^{Th} April presentation, both because they are a major for the holdtime driver and because Spire has understood for a long while that it needs to take all possible measures to minimise their values. All figures are Micro-Watts.

Internal to Cooler		**External to Cooler**	
Titanium Tube from Shunt	7.06	Photometer Detector Kevlar	6.04
Kevlar from L1	1.51	Photometer Detector Leads	5.02
Heatswitch offstate leakage	2.95	Photometer Light-trap Kevlar	0.66
Harness to sensors	0.1	Photometer bus bar support	1.24
Total Cooler Internal	**11.62**	Similarly Total Spectrometer	5.38
		Total	**18.34**

J.D.



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