	SPIRE Project Document	ATC Ref: SPI-BSM -MOM-0025 RAL Ref: SPIRE-ATC-MOM-000735 Issue: 1.0 Date: 23-Aug-01 Page: 1 of 7
	Meeting Summary ATC SPIRE BSM DDR Close out 23 August 2001	

BSM DDR Close Out MINUTES OF MEETING

Date: 23 August 2001

Location: Villas Meeting Room

Present:

Colin Cunningham	CRC	Ray Carvell	RC
Ian Pain	IP	Matt Griffin	MJG
Gillian Wright	GSW	Bruce Swinyard	BMS
Brian Stobie (p.m.)	BS		

1 Review BSM DDR Outcome (from Doug Griffin's Doc of 21 August 2001)

1.1 Motor winding material

- IP advised we consider that the baseline motor coil material is now Copper (as it appears Zeiss will not space qualify Aluminium). The design of BSM still the same. Item now closed.

1.2 Position telemetry rate:

- OK - no problem with sampling at 80 Hz.


ACTION: ATC TO ADD DIAGNOSIS/TRACE MODE TELEMETRY RATE TO THE SPEC. (AND LET DIDIER FERAND KNOW)

1.3 Stray light baffle:

- Beam clipping problem solved
- Need for conformal baffle not definitely indicated by the stray light model, and would cost about £3k per model
- Decision: it could be retrofitted so make provision for it and decide after CQM.
- Closed with caveat that all visible surfaces to be kept at 1degK above structure.

1.4 Flex pivot selection

- We have a workable technical solution, but have cost problems affording it.
- Stainless steel v Inconel? Known that 420 grade stainless steel should not be used a cryogenic material, with a risk that the welds or flexure blades would break. The fracture toughness (Charpy V notch) is about 5 times less for 420 series stainless than inconel grades. However, ISO have used the 420 series stainless flex pivots and got away with it. Acknowledged that there is a greater risk using this material – though lower cost.
- Cost breakdown – Went through options by IP –
 - Note on costs: Niru scheme importation of items for scientific use into UK – duty free? So can't assume that we will get VAT free – needs some investigation – possibly put all procurements through MSSS?


	SPIRE Project Document	ATC Ref: SPI-BSM -MOM-0025 RAL Ref: SPIRE-ATC-MOM-000735 Issue: 1.0 Date: 23-Aug-01 Page: 2 of 7
	Meeting Summary ATC SPIRE BSM DDR Close out 23 August 2001	

- all power budgets assumed chopping and jiggling at full rate
- Noted that Lucas do not cryo qualify pivots.
- \$50k batch cost per pivot type and unit costs of ~£640 per pivot. Tests are included in this cost.
- Option 3 – cost savings from dividing out costs pro rata. IP has discussed with SRON but collaboration with LAM, whilst still open appears unlikely.
- Option 5 –34.2k assumes 10k cost pre cold vibration unit cost for cryogenic test costs may be reduced, but needs confirmation from RAL? Buy more flex pivots from same batch, still pay for Lucas warm tests (spring rate, p [roof load, warm fatigue shake-down), but do some destructive analysis, extra warm vibration tests to reassure that vibration modes known. There is some published information to show that variations in damping rate can indicate problems, so anything not nominal throw away. Discussed whether NDT welds test would be possible. If went with this then need to spend time testing to see if work. Noted that if all fails and we revert to inconel we could be up to 6 months late on PFM delivery with the current project philosophy.
- Would ESA pay for or give a contribution to non-recurrent costs? SRON may join us on this – but not sure about LAM; gut feel is we would need a 3-nation cooperation to get ESA buy in.
- Option 9 - Could do full launch lock? Clamp in a couple of places. But would still have re-engineering costs and possible SPF no matter how we go about this.
- Option 10 - Hybrid solution will only work with jiggle pivot. FTS – temp of optical bench goes up – goes outside drift model.
- Option 11 – should read “requires 15% lightweight of jiggle frame”.
- Option 13 - Cu selected because spark errodable and good spring constant and nice thermal path.
- Need 20 of each kind as need 4 per model – so 5 or 6 models x 4. Minimum number needed is 12, but advised to buy more due to breakage etc.
- Option 15 (Maraging steel). – power figures other way around. Could be worth exploring. Looks like could meet the spec. Would two types be available? - Probably can't do specials. Geoff Beardmore = technical contact. Based in Cheltenham. No import duty.
. Smiths Industries would not sell us pivots directly, as they market at the gyroscope level only. Smiths had switched away from Lucas (Bendix) pivots in the late 70's as unsatisfied with technical performance and QA. IP talked to Geoff Beardmore (patent holder) one of the senior technical people at Smiths. Other notes: SRON and LAM may also be interested? Could we get Smiths to license design and get someone else to make? (Unlikely and could lose manufacturing expertise in doing so). Conclusion this option now looks very favourable and should be vigorously pursued.

ACTION: RC/IP TO CONTACT SMITHS ABOUT PIVOTS. RAY WILL SPEAK TO CONTACT AT DTI.

- General notes:

- If cost can be contained to £30k then the budget can be maintained (except for VAT costs)
- ISO-PHOT chopper used Be-Cu. SWS and LWS were 420 series stainless but mixed welded-brazed construction. Wim Alders does not recommend using SS again. IP noted Inconel has fracture toughness of around 25 Joules vs. around 6 Joules for SS. Most likely failure mode is at the weld in fatigue, or shear buckling of the flexure in vibration or overload.

	SPIRE Project Document	ATC Ref: SPI-BSM -MOM-0025 RAL Ref: SPIRE-ATC-MOM-000735 Issue: 1.0 Date: 23-Aug-01 Page: 3 of 7
	Meeting Summary ATC SPIRE BSM DDR Close out 23 August 2001	

- Most options comfortably within power budget even with copper coils.
- STM does not have to have a fully representative BSM
- Cost of 77-K vibration could be a lot lower than 4-K so could look at this in the overall model philosophy. SRON are commissioning a 77-K test facility capable of taking ~ 0.5 kg.
- IP: Latest fit-date of flex pivots for STM are June 02 so need to order from Lucas by Sept 01 - i.e., now. For QM, have until Dec 02 - extra 6 months. Would put stainless in the STM (or even a block of metal) - gives 6 months breathing space
- Could maybe batch-test cold in the RAL facility
- Neither Lucas nor Smiths Industries pivots are cryo-qualified
- COBE- need more information on capture sleeve efficacy - try Don Jennings?

ACTION: BMS/ERIC SAWYER TO PRODUCE DEFINITIVE COST FIGURES FOR RAL COLD VIBRATION (WITH SPECIAL EMPHASIS ON COST OF 77-K TESTING) Note, Ray and Sue

Horne have discussed vib. Costs already with Mike Sandford

Agreements:

Agreed to put stainless steel pivots in STM or nothing.

Agreed to go with stainless steel pivots if Smith's option a no-go; though this is a high-risk option.

Need to do cold/warm tests on stainless steel or Smith's pivots. Have six months to do this. If neither preferred option a go then need to go (reluctantly) with inconel pivots.

IP will order small batch of stainless steel pivots


Start up-screen programme for SS (77 K) and investigate Smiths Industries (i.e., adopt Option 5 as working baseline). ATC to design up-screening test equipment

1.5 RID

- May be using the wrong optical model? Up to FOT 26. Tony to provide results of CODE V tests. BMS: Optical configuration files on livelink should be used for optical design
- FoV – later one should be right – scale factor of 72: 1, but earlier email appears more definitive. Change in scaling requirement power a bit easier, stability a bit more difficult. Generally not a problem. BMS will trace down the scaling factor, and the RID will be closed out routinely either way.

ACTION: RAL (BMS) TO PROVIDE A TRACEABLE DOCUMENT WITH THE OPTICAL SCALING FACTOR.

ACTION ATC (IP): BSM SPECIFICATION DOCUMENT SHOULD BE BROUGHT UP TO DATE TO MEET CURRENT OPTICAL MODEL.

	SPIRE Project Document	ATC Ref: SPI-BSM -MOM-0025 RAL Ref: SPIRE-ATC-MOM-000735 Issue: 1.0 Date: 23-Aug-01 Page: 4 of 7
	Meeting Summary ATC SPIRE BSM DDR Close out 23 August 2001	

1.6 Sinusoidal chopping

- If detectors work as well as expected then will be chopping at 0.5 Hz.
- Calculated that power savings were less attractive than mooted at the DDR
- Given other systems issues, it was concluded that sinusoidal chopping was not open for consideration for the BSM.

1.7 Reduced max. chop throw vs. launch lock

- ATC find this option of interest as it eliminates need for deployable end stop. Difference in instantaneous field is factor of $3/4 = (3 \times 4) \text{ vs } (4 \times 4)$ arcminutes
- However, as at current design the electronics and space envelope are provided for.
- BSM Noted that protection needed only on the spectrometer side, which implies the FoV protection is NOT symmetrical (i.e. +x, -y, not +/- 1.5 degrees).
- Maximum chop throw discussed
+/- 2.4 degrees is max. Chop
2.4 degrees = 120" for 1 deg = 50"
So if 1 deg = 57" then it is possible to access other pairs of overlapping pixel sets should the nominal pair not be suitable.

ACTION: BMS TO CHECK SPEC ON FoV REQUIREMENTS (A FEW WEEKS FROM NOW). WILL DO THIS AS FORMAL CHANGE REQUEST TO THE IRD

ACTION: IP TO INVESTIGATE RELOCATING THE LAUNCH LOCK


- Decision: Keep launch lock in the plan/budget, but not to be implemented unless necessary. Launch Latch would have to be "up-selected" to be implemented. As last resort, setting the end stops could restrict field.

1.8 Deployable End Stop

- Keep end stops at >2.4: requested as much as 2.8. IP notes the baseline design is 2.4 plus 'enough' to ensure tolerance build up does not lead to encroachment of the design
- Discussed whether the baseline (centerline of mirror, to the left of PCAL) is this the only useable space envelope? Non-symmetrical FoV protection (Actually have +1.5 and -2.4 ...TBC). So should think again - this would allow relocation to behind one of the motor assemblies, pinning against a chop stage 'wing' where contact forces would be reduced.
- Have put in estimate of £10k.
- Need to look at/test broken flex pivots.
- Launch lock provided for – leave space but not baseline or undergo a minor descope on chop throw.

ACTION: RAL (BMS) TO CHECK SPECIFICATION ON FoV OF 126 ARC SECS IF + SOME NUMBER OTHER THAN WHAT WE HAVE.

ACTION: ATC (IP) TO CHECK LAUNCH LATCH AGAINST MOTOR ASSEMBLIES.

	SPIRE Project Document	ATC Ref: SPI-BSM -MOM-0025 RAL Ref: SPIRE-ATC-MOM-000735 Issue: 1.0 Date: 23-Aug-01 Page: 5 of 7
	Meeting Summary ATC SPIRE BSM DDR Close out 23 August 2001	

1.9 Damping

- Brian will be looking at the effect of cryoharness impedance
- It makes the redundancy/cross-linking very tricky
- Should be unnecessary anyway if very well balanced

ACTION ATC (BS) HIGH PRIORITY: TO DETERMINE DAMPING BEFORE MCU DDR.

ACTION ATC (IP) TO QUANTIFY HOW WELL BALANCED CAN GET BSM.

1.10 Microvibrations (Brian Stobie present for this)

- Micro-G discussed. Spacecraft reaction wheel rumble is defined in Alcatel tech note (on Livelink). Levels are around 10 mG.
- IP: Expect to export around 10 μ g during the transition (for max chop amplitude). CRC: the original SPIRE number was invented
- SMEC can only tolerate 100 μ g at 20 Hz. However, 10 mg should be no problem for the BSM though BS noted that sensitive to actual frequency.
- Noted no requirement on us if power fails, as this is more than a single point failure.

ACTION ATC (BS) CALCULATE MAXIMUM INPUT DISTURBANCE AT 15HZ AT MAX FREQUENCY WITH POWER ON.


ACTION: MJG/BMS TO REVISE MICROVIBRATION SUSCEPTIBILITY NUMBER (AT NEXT ALCATEL MEETING)

ACTION: ATC (BS) TO SPECIFY THE MAX INPUT DISTURBANCE THAT CAN BE WITHSTOOD AT THE RESONANT FREQ. (WHEN POWERED UP)

1.11 PCAL Interface

- 2-mm PCAL light pipe OD should be OK

ACTION: CARDIFF TO LOOK AT PUTTING THE END OF THE LIGHT PIPE BEHIND THE MIRROR TO ELIMINATE ANY POSSIBILITY OF FOULING ON THE BSM. OPTIONS FOR DELIVERY WITHIN COST

	SPIRE Project Document	ATC Ref: SPI-BSM -MOM-0025 RAL Ref: SPIRE-ATC-MOM-000735 Issue: 1.0 Date: 23-Aug-01 Page: 6 of 7
	Meeting Summary ATC SPIRE BSM DDR Close out 23 August 2001	

1.12 Budget

- £713k is baseline cost (MG dated Mar-01)
- At time of DDR, IP's estimate was £763k – with cost of £95k with Inconel flex pivots.
- No contingency cost is within SPIRE philosophy. IP to keep to £713k budget (try and work a contingency into this.) and try to make savings internally.
- Other than flex pivots, have saved £30k. This has come from deleted cold vibrations and supporting tests, we will also do some work in house. Cost of launch lock to stay in contingency.
- ATC will perform another internal review of budget since DDR as cost data changes. **IP agreed to continue to copy budget snapshot to MG and RC when updated.**
- MG/RC noted contingency funds are fully committed. Enormous budgetary pressure on whole project and any increase in costs will mean descopes. IP suggested travel should be kept to a minimum and looks at using telecons/videocons more often where appropriate.

1.13 Systems Engineering at ATC

- CRC finding it difficult to find the time to spend on this project. Time spent on Systems engineering down this year to ~9% compared to budgeted ~15%. Discussed effectiveness at this level and how much effort is actually needed. As the Budgets are to be handled by John from now on some load reduced. Agreed that he has experience from SCUBA and is contributing significantly by asking the "awkward questions".
- From practical point of view difficult for CRC to spend due to other commitments at ATC. At this level, this works out at half budget allocated over next FY and could make saving of ~£k40. (This would be kept in the ATC line and could be floated over and above the £k713 BSM budget). Concluded that we should not make any allocation adjustments this FY to budget and report an underspend.
- Agreed that

Routine systems responsibilities can be done by RAL.

CRC to act as systems roving "Devil's Advocate".

That a restricted systems telecom (~ 30 mins) every other week to discuss systems engineering would be beneficial.


Savings in ATC systems would remain inside ATC allocation

2 ATC ICC Programme

- Discussed offline.

3 ACTION Summary

- 1) **Action: ATC to add diagnosis/trace mode telemetry rate to the spec. (and let Didier Ferand know)**

	SPIRE Project Document	ATC Ref: SPI-BSM -MOM-0025 RAL Ref: SPIRE-ATC-MOM-000735 Issue: 1.0 Date: 23-Aug-01 Page: 7 of 7
	Meeting Summary ATC SPIRE BSM DDR Close out 23 August 2001	

- 2) **ACTION : RC/IP to contact Smiths about pivots. Ray will speaking to contact at DTI.**
- 3) **Action: RAL (BMS) to provide a traceable document with the optical scaling factor.**
- 4) **Action ATC (IP) : BSM Specification document should be brought up to date to meet current optical model.**
- 5) **Action: BMS to check spec. on FoV requirements (a few weeks from now). Will do this as formal change request to the IRD**
- 6) **Action: IP to investigate relocating the launch lock**
- 7) **ACTION : RAL (BMS) to check specification on FoV of 126 arc secs if + some number other than what we have.**
- 8) **ACTION : ATC(IP) to check launch latch against motor assemblies.**
- 9) **Action ATC (BS) High priority: to determine damping before MCU DDR.**
- 10) **Action ATC (IP) to quantify how well balanced can get BSM.**
- 11) **ACTION ATC (BS) Calculate maximum input disturbance at 15Hz at max frequency with power on.**
- 12) **Action: MJG/BMS to revise microvibration susceptibility number (at next Alcatel meeting)**
- 13) **Action: ATC (BS) to specify the max input disturbance that can be withstood at the resonant freq. (when powered up)**
- 14) **Action: Cardiff to look at putting the end of the light pipe behind the mirror to eliminate any possibility of fouling on the BSM.**

4 Agreement Summary

- 1) **Agreed to put stainless steel pivots in STM or nothing.**
- 2) **Agreed to go with stainless steel pivots if Smith's option a no-go; though this is a high risk option.**
- 3) **Need to do cold/warm tests on stainless steel or Smith's pivots. Have six months to do this. If neither preferred option a go then need to go (reluctantly) with inconel pivots.**
- 4) **IP will order small batch of stainless steel pivots**
- 5) **Start up-screen programme for SS (77 K) and investigate Smiths Industries (i.e., adopt Option 5 as working baseline). ATC to design up-screening test equipment**
- 6) **routine systems responsibilities can be done by RAL.**
- 7) **CRC to act as systems roving "Devil's Advocate".**
- 8) **that a restricted systems telecom (~ 30 mins) every other week to discuss systems engineering would be beneficial.**
- 9) **Savings in ATC systems would remain inside ATC allocation**

Author: Vivienne Bon Date:

Approved: Date