BSM AIV & Compliance

Ian Pain

AIV Overview

» *Doc Pack section 2, 13.1-13.7*

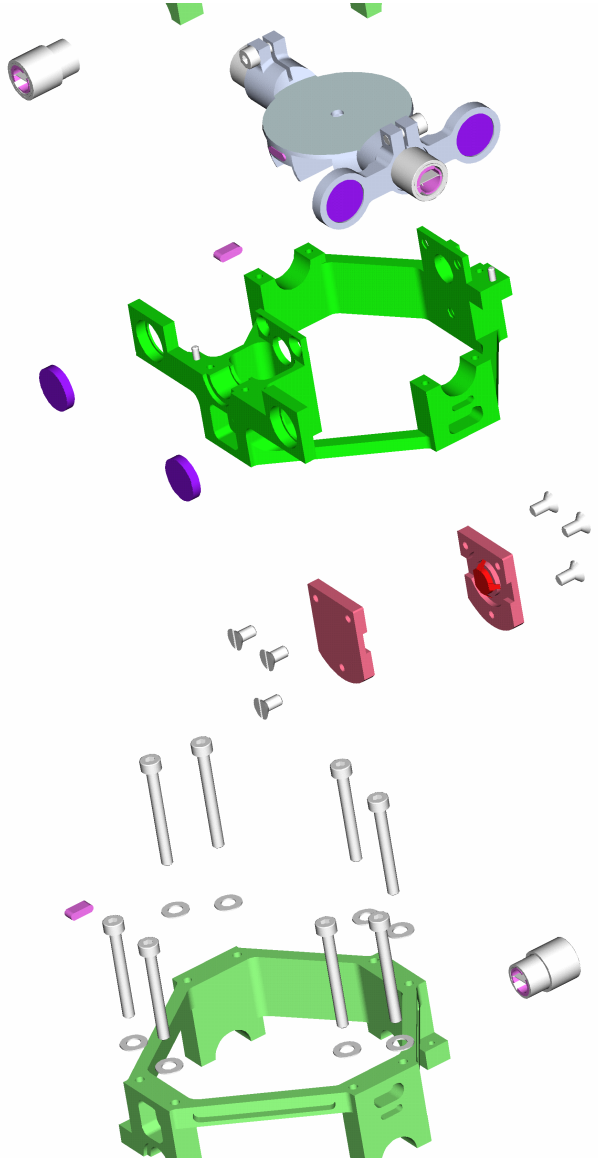
- **Assembly:**
  - Clean room assembly
  - Interface Control
  - Build Configuration control
- **Integration**
  - plan for BSMm, BSMs, BSMe test as units
  - plan for mechanism integration: BSMm+BSMe,
  - plan for sub-system integration: BSM + MCU
- **Verification**
  - test plan

AIV design implications

- **AIV requirements are primarily programmatic, and met through the product assurance plan, test plan, etc.**
- **Some design implications are:**
  - **Design compatible with cleanliness : class 1000 or better**
  - **Parts are fully traceable**
    - for build configuration control on deliverable models and where test data forms part of the qualification process
    - Drawing tree to reflect model evolution through various builds.
    - traceability will be by marked drawing number, revision and a unique serial number, on all components (except fasteners)

Assembly

- **Key areas**
  - **flex pivots**
  - **motor air gaps/clearances**
  - **mirror alignment**
  - **wiring**
- **Solutions**
  - **Mirror alignment & motor coils jigged for repeatability & accuracy**
  - **harness routing conceptually OK, will be developed on 2 axis prototype & DM**
  - **Flex pivot handing important : explanatory drawing issued.**



Test Matrix

See BSM Subsystem Specification	doc pack section 7, p32
Test	T
Measurement	M
Analysis, Reference to calculations and previous tests, assumption	A
Inspection	I
Not Applicable	X

4.8.1 Performance Requirements

Reference	Requirement	STM	CQM	PFM	FS	Notes
4.1.1	Angular Travel - Chop Axis	X	T	T	T	
4.1.2	Angular Travel - Jiggle Axis	X	T	T	T	
4.1.3	Minimum Step Size	X	T	T	T	
4.1.4	Chop Frequency	X	T	T	T	
4.1.5	Jiggle Frequency	X	T	T	T	
4.1.6	Holding position	X	T	T	T	
4.1.7	Stability	X	T	T	T	
4.1.8	Position Measurement	X	T	T	T	
4.1.9	Settling Time	X	T	T	T	
4.1.10	Chop repeatability	X	T	T	T	

4.8.2 System Requirements

Reference	Requirement	STM	CQM	PFM	FS	Notes
4.2.1	Mechanical Dimensions	M	M	M	M	
4.2.2	Operating Temperature	T	T	T	T	
4.2.3	Thermal Isolation	T	T	T	T	
4.2.4	Cold Power Dissipation	X	T (a)	T	T	(a) Cold power dissipation of the CQM may not be compliant if non-space rated components are used for motor coils
4.2.5	Warm Electronics Power Dissipation	X	T	T	T	
4.2.6	Mirror Surface Dimensions	M (b)	M	M	M	(b) X if STM has no mirror
4.2.7	Mirror Surface Finish	I/M (c)	I/M	I/M	I/M	(c) X if STM has no mirror
4.2.11 & 4.2.8	Mirror Surface Reflectivity	A(d)	A	A	A	(d) X if STM has no mirror
4.2.9	Mirror Surface Emissivity	X	X	X	X	Complement of 4.2.11 & 4.2.8
4.2.10	Baffle	X	M/T	M/T	M/T	Measurement will be against design drawings. Tests only performed on integration at RAL
4.2.11	Position of Rotation Axes	M/I (e)	M/I	M/I	M/I	(e) X if STM has no mirror
4.2.12	Orthogonality of Rotation Axes	X	T	T	T	
4.2.13	Fail Safe (No Drive Signal) Position	X	T/A(f)	T/A(f)	T/A(f)	(f) May require supporting analysis of rest position in 1 g field is not (0,0)
4.2.14	Fail Safe (Mechanical Failure) Position	X	X	T/A(g)	T/A(g)	(g) Demonstrated on tests on QM or DM
4.2.15	Mass	M	M	M	M	
4.2.16	Cool-down time	T	T	T	T	Cooldown times will be dependent on cryostat configuration.
4.2.17	Reliability	X	X	A(h)	A(h)	(h) demonstrated by QM programme and by design/analysis
4.2.18	Failure Modes	X	X	A(j)	A(j)	(j) demonstrated by QM programme and by design/analysis

4.8.3 Operational Specification

Reference	Requirement	STM	CQM	PFM	FS	Notes
4.3.1	Operational Safety	A	A	A	A	Demonstrated by analysis/design/risk assessment
4.3.2	Lifetime	X	X	A(k)	A(k)	(k) demonstrated by QM programme
4.3.3	Operating modes	X	T(l)	T	T	(l) CQM will not have redundant modes
4.3.4	Jiggle Mode	X	T	T	T	
4.3.5	Chopping Mode	X	T	T	T	
4.3.6	Scan mapping	X	X	X	X	Only applicable on spacecraft
4.3.7	Stare or 'holding' mode	X	T	T	T	
4.3.8	Combinations of Modes	X	T	T	T	

4.8.4 Interface requirements

Reference	Requirement	STM	CQM	PFM	FS	Notes
4.4.1	Data Outputs	X	T	T	T	Fully demonstrated only on integration at LAM/ RAL. ATC tests will demonstrate compliance to ICD
4.4.2	Data Inputs	X	T	T	T	Fully demonstrated only on integration at LAM/ RAL. ATC tests will demonstrate compliance to ICD
4.4.3	Exported vibration	X	T	T	T	On integration to SPIRE at RAL
4.4.4	Stray Magnetic fields	X	T	T	T	On integration to SPIRE at RAL
4.4.5	Electro-Magnetic Compatibility	X	A/T	T	T	On integration to SPIRE at RAL
4.4.6	ICD's	I/M/T	I/M/T	I/M/T	I/M/T	

4.8.5 Design, manufacture and test requirements

Reference	Requirement	STM	CQM	PFM	FS	Notes
4.6.1	Design requirements	A	A	A	A	Compliance indicated in ADP
4.6.2	Electronics Card Format	X	I	I	I	Inspection of LAM deliverables
4.6.3.1	Mirror Flatness	M(m)	M	M	M	(m) X if STM has no mirror
4.6.3.2	Mirror Reflectivity	A(n)	A	A	A	(n) X if STM has no mirror
4.6.3.3	Cleanliness	I	I	I	I	Compliance determined by TBC
4.6.3.4	Material selection	I	I	I	I	Compliance indicated in ADP
4.6.3.5	Storage	A	A	A	A	Compliance indicated in ADP

4.8.6 Environmental requirements

Reference	Requirement	STM	CQM	PFM	FS	Notes
4.7.1.1	Shock	X	X	X	X	No requirement
4.7.1.2	Quasi Static Loads	T	X	A(o)	A(o)	(o) demonstrated by QM programme
4.7.1.3	Sine Vibration	T	X	A(p)	A(p)	(p) demonstrated by QM programme
4.7.1.4	Random Vibration	T	X	A(q)	A(q)	(q) demonstrated by QM programme
4.7.1.5	Vacuum Level	T	T	T	T	
4.7.1.6	Vacuum Outgassing	A	A	A	A	Demonstrated via materials selection and Compliance indicated in ADP
4.7.1.7	Temperature	T	T	T	T	
4.7.1.8	Magnetic Fields	X	TBD	TBD	TBD	EMC tests performed when integrated at RAL. Tests to be determined once specification exists
4.7.1.9	Survival Temperature	T	T	T	T	
4.7.1.10	Radiation environment	X	X	TBD	TBD	EMC tests performed when integrated at RAL. Tests TBD

BSM Compliance

Doc Pack sec.5, appendix 11

UK Astronomy Technology Centre

Known Issues

ID	Issue	Plan to resolve
1.	Motor corners clip the 20% oversize optical beam	Chamfer corners and shields - work in hand as at 20.Jul.01
2.	Chop sensor assembly edge clip the 20% oversize optical beam	Chamfer corners, move sensor back slightly
3.	Chop sensor is G10 and emisivity/cooling needs to be modelled	Consider material change.
4.	Baffle design is TBC	Liaise with RAL, Confirm before IBDR
5.	Random vibration regime remains a challenge	Liaise with MSSL. DM vibration test
6.	Jiggle flex pivots inconel survivability data needs updating in discussions with TRW	Resolve with TRW
7.	Harness cut-outs and securing to the BSM structure interface need to be determined	Mock up harness on 2 axis prototype and make design changes
8.	Harness layout to be optimized to allow overlay of prime on redundant.	
9.	MPIA motor space envelope is TBC after Zeiss optimization	Liaise with MPIA/Zeiss
10.	Parts list needs update after LAM finalize MCU parts list	Liaise with LAM. Update at SMEC/MCU DDR
11.	Warm electronics do not have baseline motor coil damping	
12.	Minimum step size & position measurement need more depth in design description	work in hand as at 20.Jul.01
13.	Model damping due to redundant motors, and evaluate need for cross-switching	Liaise with LAM, MPIA
14.	Plan & cost qualification of Infineon position sensors	Update by IBDR

UK Astronomy Technology Centre

Known Issues

ID	Issue	Plan to resolve
15.	Flex pivot costing requires programmatic solution	Solve by IBDR
16.	Model harness & RF Filters for cross-talk & EMC	
17.	Show how connections are made to motors, particularly if aluminium wires are specified by Zeiss	Liaise with MPIA/Zeiss
18.	EMC not specified - stray magnetic fields etc	Measure BSM magnetic fields and communicate to systems team.
19.	Data I/O has TBC's	Liaise with LAM. Update at SMEC/MCU DDR
20.	Warm power dissipation is TBD	Liaise with LAM. Update at MCU DDR
21.	Bake out temperature is TBC	Perform bake out tests on 2 axis prototype
22.	Hysterisis, backlash etc need to be considered	Analyze before IBDR
23.	Chatter & impact on end-stops	Consider compliant end stops, possibly as part of motor design
24.	Cryo-Harness mechanical layout is not included in ATC drawing pack	Incorporate backshells & cable harness in ICD to structure – ensure avoidance of optical beams
25.	No detailed design for flexible wiring to chop axis position sensors	Outline design before IBDR
26.	Drawing pack is incomplete	Complete by IBDR.

Compliance

Requirement	Met by baseline design	Design description reference	Supporting test data	Notes
Angular Travel - Chop Axis	Yes	Drawing SPIRE-BSM-020-001		By design - no fouls at max travel
Angular Travel - Jiggle Axis	Yes	Drawing SPIRE-BSM-020-001		By design - no fouls at max travel
Minimum Step Size	TBC	Not covered		By design - limit will in digitization & noise
Chop Frequency	Yes	10.5.1, 7.2.2.3	partial	Power dissipation modeled at specified frequency. 1-AP chops OK at 2 Hz sine and square wave.
Jiggle Frequency	Yes	10.5.1, 7.2.2.3		Power dissipation modeled at specified frequency.
Holding position	Yes	10.5.3	see appendix 9	
Stability	Yes	10.5.3	see appendix 9	
Position Measurement	TBC	10.5.3 (partial)	see appendix 9	
Settling Time	Yes	10.5.2	see appendix 9	
Chop repeatability	TBC	Not covered		Hysterisis, backlash etc need to be considered

UK Astronomy Technology Centre

Compliance

Requirement	Met by baseline design	Design description reference	Supporting test data	Notes
Mechanical Dimensions	Yes	Mech ICD	partial	2 axis prototype does not have baffle
Operating Temperature	Yes	8.1.2	Single axis : see appendix 8	Cooldown data supports modelling. Mechanism functions cold
Thermal Isolation	Yes	8.1.2, 8.1.3	Single axis : see appendix 8	Cooldown data supports modelling. Mechanism functions cold
Cold Power Dissipation	Yes	10.5.1	TBC	Tests in hand on 1-AP
Warm Electronics Power Dissipation	TBD	N/A	N/A	LAM
Mirror Surface Dimensions	Yes	SPIRE-BSM-020-004-001	Yes	2 axis prototype mirror is correct size
Mirror Surface Finish	Yes	9.2		
Mirror Surface Reflectivity	Yes	9.2		
Mirror Surface Emissivity	N/A	N/A		
Baffle	TBC	9.3		Beam profile currently has minor foul from motor & sensor (see 7.3.1, Fig 14)
Position of Rotation Axes	Yes	Drawing SPIRE-BSM-020-001		Assembly jig designs required
Orthogonality of Rotation Axes	Yes	Drawing SPIRE-BSM-020-001		Assembly jig designs required
Fail Safe (No Drive Signal) Position	Yes	13.2, Drawing SPIRE-BSM-020-001		Assembly jig designs required
Fail Safe (Mechanical Failure) Position	Yes	7.2.4.2-4		
Mass	Yes	8.5		

UK Astronomy Technology Centre

Compliance

Requirement	Met by baseline design	Design description reference	Supporting test data	Notes
Cool-down time	Yes	8.1.2, 8.1.3	Single axis : see appendix 8	Cooldown data supports modelling. Mechanism functions cold
Reliability	Yes	11		Non-quantitative spec
Failure Modes	Yes	11		
Operational Safety	Yes	N/A		ATC safety risk assessment performed
Lifetime	Yes	7.2.4.1 (flex pivots)		Motors & sensor life TBC, but as PACS, ISOPhot
Operating modes	Yes	10.8.2, 10.8.3		
Jiggle Mode	Yes	10.8.2, 10.8.3		
Chopping Mode	Yes	10.8.2, 10.8.3		
Scan mapping	Yes	10.8.2, 10.8.3		
Stare or 'holding' mode	Yes	10.8.2, 10.8.3		
Combinations of Modes	Yes	10.8.2, 10.8.3		
Data Outputs	TBC	10.6.1 (overview only)		Spec is TBC with LAM
Data Inputs	TBC	10.6.1 (overview only)		Spec is TBC with LAM
Exported vibration	Yes	7.3.7		
Stray Magnetic fields	TBC	8.1.4		No externally imposed spec
Electro-Magnetic Compatibility	TBC	8.1.4, 10.6.7		No externally imposed spec
ICD's	Yes	12		
Design requirements	Yes	AD3, 13.1		PA Plan - configuration control etc

UK Astronomy Technology Centre

Compliance

Requirement	Met by baseline design	Design description reference	Supporting test data	Notes
Electronics Card Format	Yes	Not covered		
Mirror Flatness (optical alignment)	Yes	9.2		
Mirror Reflectivity (optical alignment)	Yes	9.2		
Cleanliness	Yes	AD3, 13.1		
Material selection	Yes	7.4.4, AD3		
Storage	Yes	13.5		
Shock	N/A	N/A		No shock spec.
Quasi Static Loads	Yes	7.1, 7.2.4.1, 7.3.2		
Sine Vibration	Yes	7.1, 7.2.4.1, 7.3.2		
Random Vibration	TBC	7.1, 7.2.4.1, 7.3.2		Margins lower than ideal
Vacuum Level	Yes	Not covered	partial	Lab book notes, material choice
Vacuum Outgassing	Yes	Not covered		Covered by material selection
Temperature	Yes	8.1.2, 8.1.3	Single axis : see appendix 8	Cooldown data supports modelling. Mechanism functions cold
Magnetic Fields	TBC	TBC		No externally imposed spec
Survival Temperature	TBC	Not covered		Magnets limited to 80 deg C
Radiation environment	TBC	Not covered		Infineon sensor requires rating. LAM to rate BSMe