Herschel SPIRE Beam Steering Mirror PFM End Item Data Pack

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Document Approved By:	Gary Rae / Colin Cunningham	Signature and Date:	
Document Approved By:	Gillian Wright	Signature and Date:	
Document Released By:	Philip Parr-Burman	Signature and Date:	

Herschel SPIRE Beam Steering Mirror PFM End Item Data Pack

v 1.0

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* indicates master copy

Version Control

Date	Index	Remarks
19 Mar 04	1.0	Creation of the document

Contents

1. OVERVIEW

1.1 Introduction

The end goal of the ATC's PA plan is to

provide a level of traceability and assurance to the customer of overall quality levels,

- provide a specific assurance that the product is fit for purpose in the space environment.

In addition to retained in-house records, the end deliverable of the PA plan is the End Item Data Package (EIDP) - *this document* - which accompanies the delivered hardware to the customer.

1.2 Scope

The Beam Steering Mirror Prototype Flight Model (PFM) is a deliverable model of flight standard suitable for use on the SPIRE Instrument.

1.3 Applicable documents

Applicable documents are project specific and may be assumed to apply fully to the BSM, unless stated otherwise

Ref	Title	Author	Reference	Ver	Date
AD 1	SPIRE Beam Steering Mirror Subsystem Specification	P. Parr-Burman	SPIRE-ATC-PRJ-000460	3.7	11 Sep 03
AD 2	SPIRE Beam Steering Mirror Subsystem Development plan	I Pain	SPIRE-ATC-PRJ-0466	5.1	30.Jan.02
AD 3	SPIRE Beam Steering Mirror Design Description	I Pain	SPIRE-ATC-PRJ-000466	4.1	20.Feb.02
AD 4	SPIRE BSM Product Assurance Plan	B. Graham	SPIRE-ATC-PRJ-000711	1.5	09 Jun 03

1.4 Reference documents

Reference documents are generic and may only apply in part to the project, or may be for information or reference only.

Ref	Title	Author	Reference	Ver	Date
RD 1	SPIRE AIV plan	B.Swinyard	SPIRE-RAL-DOC-000410	2.0	23.Feb.01
RD 2	Airborne particulate cleanliness classes in clean rooms and clean zones		FED-STD-209 E	-	
RD 3	SPIRE BSM Declared Process List	B. Graham	SPI-BSM-PRJ-0708	1.4	27/10/03
RD 4	SPIRE BSM Declared Components List	B. Graham	SPI-BSM-PRJ-0709	1.1	12/08/02
RD 5	SPIRE BSM Declared Materials List	B. Graham	SPI-BSM-PRJ-0710	1.3	21/10/02
RD 6	SPIRE BSM Interface Control Document	P. Parr-Burman	SPI-BSM-PRJ-0713	3.1	26/11/03
RD 7	Preparation and Torque Tightening of fasteners	I.Pain	SPI-BSM-NOT-0018	1.1	27/8/02
RD 8	Contamination and Cleanliness Control	ECSS	ESA-PSS-01-201	Issue 1	
RD 9	BSM Subsystem Test Plan	D. McNeil	SPIRE-ATC-PRJ-000736	4.0	10/11/03

1.5 Glossary

AD	Applicable Document	MCU	Mechanism Control Unit
ADP	Acceptance Data Package	MIP	Mandatory Inspection Point
ARB	Acceptance Review Board	MGSE	Mechanical Ground Support Equipment
BSM	Beam Steering Mirror	MSSL	Mullard Space Science Laboratory
BSMe	Beam Steering Mirror electronics	NA	Not Applicable
CoG	Centre of Gravity	NCR	Non Conformance Report
CIL	Critical Items List	NCRP	Non Conformance Review Panel
CoC	Certificate of Conformance	OGSE	Optical Ground Support Equipment
CQM	Cryogenic Qualification Model	PA	Product Assurance
CTD	Change to Drawing/Document	PFM	Proto Flight Model
DCL	Declared Components List	PPARC	Particle Physics and Astronomy Research Council
DM	Development Model	PI	Principal Investigator
DML	Declared Materials List	QA	Quality Assurance
DPA	Destructive Physical Analysis	RAL	Rutherford Appleton Laboratory
DRB	Delivery Review Board	RAL SSD	RAL Space Science Department
ECSS	European Cooperation for Space Standardisation	RD	Reference Document
EGSE	Electrical Ground Support Equipment	SMEC	Spectrometer Mechanism
EIDP	End Item Data Pack	SPIRE	Spectral and Photometric Imaging REceiver
ESA	European Space Agency	STM	Structural & Thermal Model
FPU	Focal Plane Unit	TBC	To Be Confirmed
FSM	Flight Spare model	TBD	To Be Defined
GSE	Ground Support Equipment	TBW	To Be Written
HoS	Head of Specialism	UK ATC	United Kingdom Astronomy Technology Centre
Herschel	ESA Mission name (formerly FIRST)	UK SPO	UK SPIRE Project Office
IBDR	Instrument Baseline Design Review	WE	Warm Electronics
KIP	Key Inspection Point		
LAM	Laboratoire d'Astrophysique de Marseille		
LAT	Lot Acceptance Tests		

1.6 ACCEPTANCE AND DELIVERY PROCESS

Upon completion of final tests and inspection and before shipment of a deliverable item to LAM or RAL a review will be held covering all deliverable documentation, hardware and software items. The object of this Delivery Review is to establish that there is adequate documentary evidence to demonstrate that the product satisfies all the requirements applicable at that stage. The Delivery Review Board (DRB) shall comprise the following (or nominated representatives):

- ATC Project Manager, PA manager
- Representatives of the SPIRE project office
- Additional staff as required.

The DRB shall cover the following points under the headings:

- End Item Data Pack
- Hardware, including GSE

Project Team - Contact List

Contact	Role	Details
		Telephone numbers are 0131 668-8xxx Email addresses are user@roe.ac.uk
Dr Gillian Wright	Local Co-I, Project Scientist	Tel ext: 248 Email: gsw
Philip Parr-Burman,	Project Manager, Lead/Mechanical Engineer, Product Assurance Manager	Tel ext: 431 Email: ppb
Colin Cunningham,	Director, Technology Development, SPIRE systems engineer, BSM consultant	Tel ext: 223 Email: crc
Brian Stobie,	Electronics & Controls engineer	Tel ext: 261 Email: bstobie
Tom Paul,	Mechanical Design Engineer	Tel ext: 259 Email: tap
Brenda Graham	Electronics Engineer	Tel ext: 266 Email: bg
Tom Baillie	Project Technicians	Tel ext: 209 Email: tecb
Vivienne Bon	Project Assistant, Documentation	Tel ext: 252 Email: vcb

2. END ITEM DATA PACK CONTENTS

EIDP Section	Contents	Req'd	Comments
3.1	Shipping Documents	Yes	
3.2	Procedures for Transport Handling & Installation	Yes	
3.3	Certificate of Conformance/Delivery Review board MOM AI Lists	Yes	
3.4	Qualification Status/Test Matrix	Yes	
3.5	Top Level Drawings incl. Family Tree	Yes	
3.6	Interface Drawings	Yes	
3.7	Functional Diagrams (Block Diagram)	No	
3.8	Electrical Circuit Diagrams	Yes	
3.9	As built configuration lists	Yes	Incl. drawing numbers & issues, mod sheets and manufacturing NCR's
3.10	Serialised Components List	Yes	Electronics parts & Mechanical per ATC serial number logbook
3.11	List of Waivers	Yes	
3.12	Copies of Waivers	Yes	
3.13	Operation Manual	Yes	Use of STM as alignment OGSE
3.14	Historical Record	Yes	Linear log of assembly & test activities
3.15	Logbook/Diary of Events	No	Not deliverable. Available as required, but not delivered
3.16	Operating Time/Cycle Record	N/A	See section of EIDP
3.17	Connector Mating Record	Yes	
3.18	Blank		Not used
3.19	Pressure Vessel Test Record	N/A	No pressure testing carried out
3.20	Calibration Data record	Yes	
3.21	Temporary Installation Record	Yes	Shipping locks, Red Tag (remove before use), Green Tag (insert before use) Items
3.22	Open Work / Deferred Work / Open Tests	Yes	
3.23	List of Non-Conformance reports (NCR's)	Yes	
3.24	Copies of Non-Conformance reports (NCR's)	Yes	Includes manuf. NCR's & fault logs
3.25	Test Reports	Yes	
3.26	Blank		Not used
3.27	Mass records / Power Budgets	Yes	
3.28	Cleanliness Statement	Yes	
3.29	Compliance Matrix	Yes	
3.30	Photographs	Yes	

3. THE END ITEM DATA PACK

3.1 Shipping Documents

Delivered Items

- Item 1 : The BSM PFM, packed in grey plastic transit case, contents
    1. The BSM PFM (Double bagged, Dry Nitrogen purged)
- Item 2: The End Item Data Pack.

Items Not included,

- Item 3: Photometer calibrator PFM (PCAL) - UoC,W supply to RAL
- Item 4: Mounting bolts to optical bench, and location bushes - MSSL supply
- Item 5: Thermistors – Provision by RAL. Fitted at RAL

3.2 Procedures for Transport Handling & Installation

Handling,

The BSM PFM is a small unit with mass < 1kg. It has no sharp edges.

No lifting or handling equipment is required, other than :

- use of clean room gloves
- standard M4 allen keys (with torque readout) for attachment to alignment shoe
- standard UNC type allen keys for attachment to optical bench (MSSL supply)

Storage, Packaging ,Transportation

The PFM has been clean room assembled and double bagged at ATC, in air-tight bags with dry Nitrogen gas purge of the bags. A desiccant and humidity indicators is placed between the inner and outer bags. The bagged unit will be despatched in a standard plastic tooling case, foam packed (standard commercial grey foam) via accompanied surface transport to RAL.

CAUTIONS!

1. **"clean room grade contents" - see instructions on unpacking**
2. **"exposed optical surface " - do not touch mirror.**
3. **"magnets" fitted on internal components.**

Take care in using magnetic tools inside the BSM baffle (eg inspection mirrors)

Do not expose BSM to areas contaminated with metal swarf or filings.

Upon receipt:

The case is combination locked - the code will be provided to RAL PA staff.

Remove from transit case outside full clean room .

Remove outer bag in 'grey' area of clean room.

Take PFM through to clean room. Remove inner bag.

The PFM must be handled with appropriate precautions taken to prevent contamination or damage, in particular to the mirror surface. (Refer to RD 8)

Marking and Labelling

The BMS and BSM components are generally marked with an etched serial. Sub-assemblies are not marked, to avoid multiple numbers appearing on components. Traceability for assemblies is via assembly logs.

3.3 Certificate of Conformance

The Beam Steering Mirror Prototype Flight Model complies with the requirements of the SPIRE Project, as outlined in the applicable documents, i.e.

- Beam Steering Mirror Subsystem Specification AD 1
- SPIRE BSM Product Assurance Plan AD4

Signed: ………………………. Philip Parr Burman: Project Manager, BSM

Date: …..……..……………..

Signed: ………………………. Brenda Graham: Product Assurance Manager, BSM.

Date: …..……..……………..

Minutes of Delivery Review Board: Attachment

Waivers/Deviations	See section 3.11 of EIDP
Open NCRs	See section 3.23 of EIDP

Certificates of Conformance

• Flex Pivots	Attached
• Mirror	Attached
• Motor Coils	Attached
• Magnet	Attached

GOODRICH

Goodrich Corporation
104 Otis Street
Rome, NY 13441

September 9, 2003

To UK Astronomy Technology Centre
Edinburgh, United Kingdom

Certificate of Compliance

[X] This is to certify that parts, components and/or assemblies have been inspected and meet the quality assurance requirements of applicable specifications. Quality Control procedures provide for maintenance of adequate records for acceptance of raw material used in fabrication of all units processed. These records are on file and available for review at any reasonable time.

[ ] Equipment listed below has been 100% functionally tested and meets all requirements of applicable specifications. These results are on file and available for review at any reasonable time.

Sales order no. S030300000
Purchase order no. 032515
Shipper no. S030300000001
Shop order no. 074956

Goodrich part no. 2479594
Description Flexural Pivots
Quantity 6

Ed Kirsten

Quality Control Representative

C-FLEX
104 Industrial Drive
Frankfort, NY 13340 USA
TEL: 315-895-7454
FAX: 315-895-7268
e-mail: cflex@c-flex.com
Web Site: www.c-flex.com
BEARING CO., INC.

04/24/02

C-FLEX BEARING CO., INC.
E-10 BeCU Pivot Performance Results

UK Astronomy Technology Centre

Results based upon actual testing of finished parts completed on April 23, 2002.

Spring/Sleeve/Quadrant Materials:

NGK 17200 BeCu Alloy

Chemical Composition:	1.85% BE
	.25% Co
	Balance Cu

Physical Properties: (age hardened at 600 deg. F for 2 hours)

Tensile Strength:	182,800 psi
Yield Strength:	162,400 psi
Modulus of Elasticity:	18.5 KSI
Fatigue Strength:	48.7 KSI
Hardness:	36 Rc

Frictionless Bearings
-No Lubrication - Low Hysteresis - Easy Installation - Custom Design

THE BEARING SOLUTION

04/24/2002
C-FLEX BEARING CO., INC.
E-10 BeCU Pivot Performance Results
UK Astronomy Technology Centre
Page 2

Load Testing:

Four parts out of the same batch as the 16 serialized units, were load tested to 5.2 lbs and reviewed for performance or geometry changes. There were no noted changes, therefore, the maximum load rating may be established at 5.2 lbs, well above the required 3.5 lb requirement.

Brazing:

Several pivots were destructively tested, and although some minor voids were noted on some parts, in no case did the voids exceed 10% of the potential contact area. This will result in a core/spring, and core/sleeve joint strength which will greatly exceed performance requirements.

04/24/2002
C-FLEX BEARING CO., INC.
E-10 BeCU Pivot Performance Results
UK Astronomy Technology Centre
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INSPECTION RESULTS

Serial No.	Length(Inches) 0.500+/-0.003	Diameter(Inches) 0.3125 +0/-0.0005	TSR Lb*In/Degree cw	ccw
1	.500	.3121	0.0033	0.0033
2	.501	.3121	0.0033	0.0033
3	.499	.3125	0.0033	0.0033
4	.501	.3121	0.0034	0.0034
5	.500	.3121	0.0033	0.0033
6	.500	.3122	0.0033	0.0033
7	.500	.3122	0.0033	0.0033
8	.501	.3122	0.0033	0.0033
9	.503	.3123	0.0033	0.0033
10	.501	.3121	0.0035	0.0035
11	.500	.3121	0.0033	0.0033
12	.500	.3121	0.0034	0.0034
13	.501	.3121	0.0034	0.0034
14	.501	.3122	0.0034	0.0034
15	.503	.3122	0.0033	0.0033
16	.499	.3122	0.0033	0.0033

NGK BERYLCO

NGK Metals Corporation

150 Tuckerton Road P.O. Box 13367 Reading, PA 19612-3367 610 921-5000 Fax 610 921-5358 C#

CERTIFICATE OF TESTS

CUSTOMER P.O. NUMBER	CUSTOMER ORDER DATE	SPECIFICATION(S)
P02-017B	02/05/02	ASTM B194-96

CFL100
C-FLEX BEARING CO
104 INDUSTRIAL DR

FRANKFORT NY 13340

Robert W. Hagin
Robert W. Hagin
Manager, Servicenter Q(
02/07/02
913165-A1

NGK ORDER NUMBER	DESCRIPTION	UNIT	UNITS SHIPPED
614547-A	FORM : STRIP GAUGE : .02260(+.00100)(-.00100) WIDTH : 6.31200(+.06200)(-.06200) TEMPER: ANNEAL TB00 ALLOY : C17200 BERYLCO 25		14

HEAT NO. : JE193
MSTR COIL: 1

Be	1.8350
Si	.0120
Co	.2450
Fe	.0240
Al	.0260
Ni	.0040
Cu	Balance

MECHANICAL/PHYSICAL PROPERTIES

AS SHIPPED

TENSILE STR.	(PSI)	71,000 - 71,600
YIELD STR.	(PSI)	29,100 - 29,300
ELONGATION	(%)	42 - 46
HARDNESS	(DPH)	136 - 146

AGE HARDENED PROPERTIES
3.00 HOURS AT 600 F

TENSILE STR.	(PSI)	184,700 - 185,200
YIELD STR.	(PSI)	152,000 - 154,200
ELONGATION	(%)	4 - 8
HARDNESS	(DPH)	385 - 389

VE CERTIFY THAT THE MATERIAL DESCRIBED ABOVE HAS BEEN PRODUCED, TESTED, AND INSPECTED IN ACCORDACE WITH THE REFERENCED P.O. AND SPECIFICATION REQUIREMENTS DURING THE MANUFACTURING, TESTING, AND INSPECTION PROCESSES, THE SUPPLIES OFFERED HAVE NOT COME IN DIRECT CONTACT WITH MERCURY OR ANY CHEMICALLY OR THERMALLY UNSTABLE MERCURY CONTAINING COMPOUND OR WITH ANY MERCURY CONTAINING DEVICES WHICH PROVIDE ONLY A SINGLE BARRIER SEAL AGAINST BREAKAGE, SPILLAGE AND RELEASE OF THE ELEMENTAL MERCURY. THE INFORMATION RECORDED IN THIS DOCUMENT COULD AFFECT THE NATIONAL SECURITY OF THE UNITED STATES. IT IS FREE OF FALSE, FICTITIOUS, OR FRAUDULENT INFORMATION WHICH COULD BE IN VIOLATION OF FEDERAL LAW, TITLE 18, CHAPTER 47

ORM 101 AUG 97

NGK BERYLCO

NGK Metals Corporation

150 Tuckerton Road P.O. Box 13367 Reading, PA 19612-3367 610 921-5000 Fax 610 921-5358

CH 1

CERTIFICATE OF TESTS

CUSTOMER P.O. NUMBER	CUSTOMER ORDER DATE	SPECIFICATION(S)
?02-025B	03/04/02	ASTM B196-95A

:FL100
:-FLEX BEARING CO
104 INDUSTRIAL DR

FRANKFORT NY 13340

3-6-02
David W. Britt
Quality Engineer
03/06/02
-G

NGK ORDER NUMBER	DESCRIPTION	UNIT	UNITS SHIPPED
509073-A	FORM : ROD - ROUND O.D. : .37500(+.00300)(-.00300) LENGTH: 51.00000 - 63.43750 TEMPER: ANNEAL TB00 ALLOY : C17200 BERYLCO 25		

HEAT NO. : LC827 MECHANICAL/PHYSICAL PROPERTIES

Be	1.8400	AS SHIPPED
Si	.0100	TENSILE STR.(PSI): 78,700 - 78,700
Co	.2400	YIELD STR. (PSI): 52,000 - 52,000
Fe	.0280	ELONGATION (%): 40 - 40
Al	.0210	
Ni	.0050	AGE HARDENED PROPERTIES
Pb	.0010	3.00 HOURS AT 600 F
Cu	Balance	TENSILE STR.(PSI): 189,400 - 189,400
		YIELD STR. (PSI): 169,500 - 169,500
		ELONGATION (%): 10 - 10

E- sleeve Material

WE CERTIFY THAT THE MATERIAL DESCRIBED ABOVE HAS BEEN PRODUCED, TESTED, AND INSPECTED IN ACCORDACE WITH THE REFERENCED P.O. AND SPECIFICATION REQUIREMENTS DURING THE MANUFACTURING, TESTING, AND INSPECTION PROCESSES, THE SUPPLIES OFFERED HAVE NOT COME IN DIRECT CONTACT WITH MERCURY OR ANY CHEMICALLY OR THERMALL UNSTABLE MERCURY CONTAINING COMPOUND OR WITH ANY MERCURY CONTAINING DEVICES WHICH PROVIDE ONLY A SINGLE BARRIER SEAL AGAINST BREAKAGE, SPILLAGE AND RELEAS OF THE ELEMENTAL MERCURY. THE INFORMATION RECORDED IN THIS DOCUMENT COULD AFFECT THE NATIONAL SECURITY OF THE UNITED STATES. IT IS FREE OF FALSE, FICTITIOUS, O FRAUDULENT INFORMATION WHICH COULD BE IN VIOLATION OF FEDERAL LAW, TITLE 18, CHAPTER 47

FORM 101 AUG 97

NGK BERYLCO

NGK Metals Corporation

150 Tuckerton Road P.O. Box 13367 Reading, PA 19612-3367 610 921-5000 Fax 610 921-5358

CERTIFICATE OF TESTS

CUSTOMER P.O. NUMBER	CUSTOMER ORDER DATE	SPECIFICATION(S)
P02-001	01/08/02	PS-1-001 REV 3

CFL100
C-FLEX BEARING CO
104 INDUSTRIAL DR

FRANKFORT NY 13340

Robert W. Hagin
Manager, Servicenter QC
01/14/02
913265-A

NGK ORDER NUMBER	DESCRIPTION	UNIT	UNITS SHIPPED
614314-A	FORM : STRIP GAUGE : .00370(+.00015)(-.00015) WIDTH : 8.18700(+.06000)(-.06000) TEMPER: 1/4 H TD01 ALLOY : C17200 BERYLCO 25		16

HEAT NO. : KF061
MSTR COIL: 5

Be	1.8670
Si	.0140
Co	.2410
Fe	.0230
Al	.0220
Ni	.0040
Cu	Balance

MECHANICAL/PHYSICAL PROPERTIES

AS SHIPPED

TENSILE STR.	(PSI):	80,700	-	80,900
YIELD STR.	(PSI):	70,400	-	71,200
ELONGATION	(%):	12	-	15
GRAIN SIZE	(MM):	.006	-	.007

AGE HARDENED PROPERTIES
2.00 HOURS AT 600 F

TENSILE STR.	(PSI):	182,800	-	185,100
YIELD STR.	(PSI):	162,400	-	164,000
ELONGATION	(%):	3	-	3

WE CERTIFY THAT THE MATERIAL DESCRIBED ABOVE HAS BEEN PRODUCED, TESTED, AND INSPECTED IN ACCORDACE WITH THE REFERENCED P.O. AND SPECIFICATION REQUIREMENT: DURING THE MANUFACTURING, TESTING, AND INSPECTION PROCESSES, THE SUPPLIES OFFERED HAVE NOT COME IN DIRECT CONTACT WITH MERCURY OR ANY CHEMICALLY OR THERMALL UNSTABLE MERCURY CONTAINING COMPOUND OR WITH ANY MERCURY CONTAINING DEVICES WHICH PROVIDE ONLY A SINGLE BARRIER SEAL AGAINST BREAKAGE, SPILLAGE AND RELEAS OF THE ELEMENTAL MERCURY. THE INFORMATION RECORDED IN THIS DOCUMENT COULD AFFECT THE NATIONAL SECURITY OF THE UNITED STATES. IT IS FREE OF FALSE, FICTITIOUS, O FRAUDULENT INFORMATION WHICH COULD BE IN VIOLATION OF FEDERAL LAW, TITLE 18, CHAPTER 47

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G 500000

SYMONS MIRROR TECHNOLOGY LTD.

39 Wedgwood Way, Stevenage, Herts, SG1 4QT., U.K.
Tel: +44 (0) 01438 745022 Fax: +44 (0) 01438 361646.

CERTIFICATE OF CONFORMITY

UK Astronomy Technology Centre
Royal Observatory, Edinburgh
Blackford Hill
Edinburgh
EH9 3HJ
Scotland

Our ref. No: 8525
Your ref. No: 032526
M.O.D Contract No: N/A

Date: September 22, 2003

Delivery note no.	Qty.	Description or Specification
3483	3-Off	Mirror to drawing No. 023-004-001 Rev. 3.

CONDITION OF MATERIALS AS DESPATCHED

DETAILED RECOMMENDATIONS FOR SUBSEQUENT HEAT TREATMENT(S) WHERE SUCH IS NOT STIPULATED IN THE RELEVANT SPECIFICATION

DEVIATIONS (E.G. MAJOR CONCESSIONS OR PRODUCTION PERMITS)

CERTIFIED THAT THE WHOLE OF THE SUPPLIES DETAILED HEREON HAVE BEEN INSPECTED TESTED AND UNLESS OTHERWISE STATED ABOVE CONFORM IN ALL RESPECTS WITH THE REQUIREMENTS OF THE CONTRACT OR ORDER.

SIGNED G P Allbeeley **POSITION Quality Manager**

S.M.T. QA 1 INSPECTED

FOR AND ON BEHALF OF SYMONS MIRROR TECHNOLOGY LTD.

copy

Service-Center Oberkochen

Carl Zeiss 73446 Oberkochen

UK Astronomy Technology Centre
Royal Observatory, Edinburgh
Blackford Hill
EDINBURGH
EH9 3HJ
GROSSBRITANNIEN

Delivery note

Please always indicate:
Division/Number/Date
80/1030677385/30.07.2003

Contact
Ulrich Hahn
Phone / Fax
07364-202815 / 07364-202072
e-mail
u.hahn@zeiss.de
Customer No.
515044

Order confirmation: 80 / 1020609664 of 13.02.2003

Your order 030316 from 12.02.2003
Orderer: Elaine Robertson
Ian Pain
Daniel Duff

Item.	PH	Article-No. / Quantity	Description
000030	80	000000-0239-500	**Coils for PACS-Project**
		Country of origin: Germany	Commodity code: 90019090
		10 PC	Serial No. 28,32,33,34,35,36,38,39,41,42
			1 Dummy free of charge Serial No. 37

Terms of delivery: Ex works oberkochen (INCOTERMS 2000)
Dispatch route: Standard terms

Carl Zeiss
Carl-Zeiss-Strasse 22

Banken:
Deutsche Bank AG Heidenheim
Dresdner Bank Aalen

ZEISS

PACS-COIL | L 28

	F/Hz	T=295K 14µA < I < 33 µA L/mH R/Ω	T=77K 16µA < I < 85 µA L/mH R/ Ω	T=4,2K 16µA < I < 100 µA L/mH R/ Ω
Coil-Wire Alu 99,999% Ø d: 100 µm Isolation Polyimid Ø D:110 µm n: ca 1100 **Core** Cryoperm	**20**	**L=46,9** **R=214**	**L=48,4** **R=17,9**	**L=48,4** **R=0,419**
	50	**L=64,9** **R=211**	**L=48,6** **R=17,9**	**L=48,4** **R=0,438**
	100	**L=53,9** **R=212**	**L=48,7** **R=17,9**	**L=48,3** **R=0,493**
	500	**L=48,9** **R=214**	**L=48,6** **R=18,6**	**L=48,2** **R=1,13**
	2 000	**L=49,2** **R=220**	**L=48,7** **R=24,9**	**L=48,2** **R=8,30**

Operator: A. Binder; H. Ballmer 28.07.03

ZEISS	PACS-COIL	L 32

	F/Hz	T=295K 14µA < I < 33 µA L/mH R/Ω	T=77K 16µA < I < 85 µA L/mH R/ Ω	T=4,2K 16µA < I < 100 µA L/mH R/ Ω
Coil-Wire Alu 99,999% Ø d: 100 µm Isolation Polyimid Ø D:110 µm n: ca 1100 **Core** Cryoperm	20	L=48,2 R=208	L=48,3 R=17,9	L=48,2 R=0,425
	50	L=50,0 R=206	L=48,5 R=17,9	L=48,1 R=0,435
	100	L=53,0 R=210	L=48,4 R=17,9	L=48,0 R=0,498
	500	L=48,4 R=212	L=48,3 R=18,6	L=47,9 R=1,21
	2 000	L=49,1 R=228	L=48,5 R=25,5	L=48,8 R=8,90

Operator: A. Binder; H. Ballmer 28.07.03

ZEISS PACS-COIL L 33

	F/Hz	T=295K 14µA < I < 33 µA L/mH R/Ω	T=77K 16µA < I < 85 µA L/mH R/ Ω	T=4,2K 16µA < I < 100 µA L/mH R/ Ω
Coil-Wire Alu 99,999% Ø d: 100 µm Isolation Polyimid Ø D:110 µm n: ca 1100 **Core** Cryoperm	20	L=45,4 R=215	L=48,7 R=18,0	L=48,6 R=0,443
	50	L=55,8 R=214	L=49,0 R=17,9	L=48,4 R=0,480
	100	L=48,7 R=214	L=48,9 R=18,0	L=48,3 R=0,592
	500	L=48,9 R=213	L=48,9 R=19,1	L=48,0 R=1,43
	2 000	L=49,5 R=239	L=48,9 R=28,4	L=48,1 R=9,44

Operator: A. Binder; H. Ballmer 28.07.03

ZEISS

PACS-COIL | L 34

	F/Hz	T=295K 14µA < I < 33 µA L/mH R/Ω	T=77K 16µA < I < 85 µA L/mH R/ Ω	T=4,2K 16µA < I < 100 µA L/mH R/ Ω
Coil-Wire Alu 99,999% Ø d: 100 µm Isolation Polyimid Ø D:110 µm n: ca 1100 **Core** Cryoperm	**20**	**L=46,0** **R=214**	**L=48,3** **R=17,9**	**L=48,4** **R=0,419**
	50	**L=48,0** **R=215**	**L=48,6** **R=17,9**	**L=48,4** **R=0,440**
	100	**L=48,5** **R=210**	**L=48,6** **R=17,9**	**L=48,3** **R=0,498**
	500	**L=48,5** **R=214**	**L=48,5** **R=18,7**	**L=48,2** **R=1,25**
	2 000	**L=49,3** **R=228**	**L=48,7** **R=25,6**	**L=48,2** **R=9,60**

Operator: A. Binder; H. Ballmer 28.07.03

ZEISS PACS-COIL L 35

	F/Hz	T=295K 14µA < I < 33 µA L/mH R/Ω	T=77K 16µA < I < 85 µA L/mH R/ Ω	T=4,2K 16µA < I < 100 µA L/mH R/ Ω
Coil-Wire Alu 99,999% Ø d: 100 µm Isolation Polyimid Ø D:110 µm n: ca 1100 **Core** Cryoperm	20	L=43,4 R=212	L=47,7 R=17,7	L=47,6 R=0,420
	50	L=35,0 R=217	L=47,9 R=17,7	L=47,6 R=0,450
	100	L=47,0 R=206	L=47,9 R=17,8	L=47,5 R=0,510
	500	L=47,8 R=210	L=47,8 R=18,8	L=47,4 R=1,25
	2 000	L=48,4 R=225	L=47,9 R=26,3	L=47,5 R=9,20

Operator: A. Binder; H. Ballmer 28.07.03

ZEISS	PACS-COIL	L 36

	F/Hz	T=295K 14µA < I < 33 µA L/mH R/Ω	T=77K 16µA < I < 85 µA L/mH R/ Ω	T=4,2K 16µA < I < 100 µA L/mH R/ Ω
Coil-Wire Alu 99,999% Ø d: 100 µm Isolation Polyimid Ø D:110 µm n: ca 1100 **Core** Cryoperm	**20**	**L=46,0** **R=214**	**L=48,1** **R=17,9**	**L=47,0** **R=0,415**
	50	**L=47,0** **R=214**	**L=48,3** **R=17,9**	**L=47,9** **R=0,470**
	100	**L=44,0** **R=214**	**L=48,3** **R=17,9**	**L=47,8** **R=0,560**
	500	**L=47,6** **R=215**	**L=48,3** **R=18,8**	**L=47,6** **R=1,48**
	2 000	**L=49,1** **R=230**	**L=48,3** **R=27,5**	**L=47,6** **R=9,90**

Operator: A. Binder; H. Ballmer 28.07.03

ZEISS

PACS-COIL | L 38

	F/Hz	T=295K 14µA < I < 33 µA L/mH R/Ω	T=77K 16µA < I < 85 µA L/mH R/ Ω	T=4,2K 16µA < I < 100 µA L/mH R/ Ω
Coil-Wire Alu 99,999% Ø d: 100 µm Isolation Polyimid Ø D:110 µm n: ca 1100 **Core** Cryoperm	20	L=44,8 R=212	L=47,5 R=17,8	L=47,5 R=0,424
	50	L=46,7 R=211	L=47,9 R=17,7	L=47,4 R=0,464
	100	L=47,4 R=212	L=47,8 R=17,8	L=47,3 R=0,546
	500	L=47,8 R=213	L=47,8 R=18,7	L=47,1 R=1,10
	2 000	L=48,5 R=226	L=47,8 R=27,8	L=47,1 R=9,00

Operator: A. Binder; H. Ballmer 28.07.03

ZEISS	PACS-COIL	L 39

	F/Hz	T=295K 14µA < I < 33 µA L/mH R/Ω	T=77K 16µA < I < 85 µA L/mH R/ Ω	T=4,2K 16µA < I < 100 µA L/mH R/ Ω
Coil-Wire Alu 99,999% Ø d: 100 µm Isolation Polyimid Ø D:110 µm n: ca 1100 **Core** Cryoperm	**20**	**L=45,0** **R=213**	**L=48,4** **R=18,1**	**L=48,5** **R=0,415**
	50	**L=48,7** **R=214**	**L=48,7** **R=18,0**	**L=48,4** **R=0,441**
	100	**L=48,4** **R=214**	**L=48,8** **R=18,0**	**L=48,4** **R=0,504**
	500	**L=48,6** **R=215**	**L=48,6** **R=19,4**	**L=48,3** **R=1,25**
	2 000	**L=49,4** **R=231**	**L=48,4** **R=31,2**	**L=48,3** **R=9,70**

Operator: A. Binder; H. Ballmer 28.07.03

Qualification Status/Test Matrix

Applicability Of PA Requirements To The PFM/OGSE

The BSM model philosophy is described in AD 2 and AD4. The PA requirements for PFM are:

PA REQUIREMENTS	PFM
PA Management	**A**
Material and Process Selection and Approval	**A**
EEE Parts Selection and Control	**A**
Cleanliness and Contamination Control	**A**
Reliability Assurance	**A**
Safety	**A**
Quality Assurance Procurement Control Manufacturing Control Integration and Test Control Handling, Storage, Packaging Non-conformance Control Alerts Acceptance and Delivery	 **A** **A** **A** **A** **A** **N** **A**
Software PA	**N**

A = Applicable; P= Partially Applicable; N = Non-Applicable

Verification requirements

The BSM Subsystem Specification Document (AD 1) contains more detail on the actual tests to be carried out on the BSM, including a verification matrix defining how each parameter is to be verified.

Spire BSM Verification Summary

Changes from SSSD v 3.7 highlighted in yellow

17th March 2004

SSSD Para	SSSD Reqt No	Title	Requirement	PFM	FS	Notes	Ref to Compliance	RFW / NCR
4.1.1	R1	Angular Travel - Chop Axis	Angular range +/- 2.53 deg	T	T			
4.1.1	R2	Angular Travel - Chop Axis	Min chop throw 0.1 deg	T	T			
4.1.1	R3	Angular Travel - Chop Axis	Chop to at least 132 arcsec	T	T			
4.1.2	R4	Angular Travel - Jiggle Axis	Angular range +/- 0.573 deg	T	T			
4.1.3	R5	Minimum Step Size	0.038 deg jiggle, 0.039 deg chop	T	T			
4.1.4	R6	Chop Frequency	Up to 2 Hz	T	T			
4.1.4	R7	Chop Frequency	Goal up to 5 Hz, with degraded power and settling time	X	X			
4.1.5	R8	Jiggle Frequency	Up to 0.5 Hz	T	T			
4.1.5	R9	Jiggle Frequency	Goal up to 1 Hz, with degraded power and settling time	X	X			
4.1.6	R10	Holding position	Any position to 0.004 deg rms for up to 4 hrs	T	T			
4.1.7	R11	Stability	0.2 arcsec sky (0.0038 deg) over 60 sec incl at 0.03 - 25 Hz	T	T			
4.1.8	R12	Position Measurement	Knowledge of mirror pos to 0.00049 deg	T	T			
4.1.9	R13	Settling Time	Both axes within 0.019 deg in less than 20 ms from chop demand	T	T			

Spire BSM Verification Summary

Changes from SSSD v 3.7 highlighted in yellow

17th March 2004

4.1.9	R14	Settling Time	Both axes within 0.019 deg in less than 100 ms from jiggle demand	T	T			
4.1.9	R15	Settling Time	Goal: Within 0.019 deg in less than 50 ms from jiggle demand	X	X			
4.1.10	R16	Chop repeatability	0.004 deg over 4 hrs	T	T			
4.2.1	R17	Mechanical Dimensions	Within 130x130x30 mm exc mounting	A	A		SPIRE (Model Ref) Inspection Report Folder	
4.2.1	R18	Mechanical Dimensions	Within 132x95x120 inc mounting	A	A		SPIRE (Model Ref) Inspection Report Folder	
4.2.1	R19	Mechanical Dimensions	Ref ICD	M	M	From part inspection reports		
4.2.2	R20	Operating Temperature	4K (3.5 to 6)	T	T	By implication since performance parameters measured at this temperature		
4.2.2	R21	Operating Temperature	Capable of reduced perf at up to 300K	T	T	Check for basic function		
4.2.3	R22	Thermal Isolation	part vis to optical path < 1K above structure	A	A	Previous test on proto		
4.2.4	R23	Cold Power Dissipation	<4mW average	T	T			
4.2.6	R24	Mirror Surface Dims (& Form)	Clear diam 32 mm	M	M	On part insp report	Mirror C of C	
4.2.6	R25	Mirror Surface Dims (& Form)	Central hole 2.8 +/- 0.1mm	M	M	On part insp report	Mirror C of C	
4.2.6	R26	Mirror Surface Dims (& Form)	Goal: central aperture up to 8mm	X	X	On part insp report	Mirror C of C	
4.2.6	R27	Mirror Surface Dims (& Form)	Ellipse 30 x 32 mm	M	M	On part insp report	Mirror C of C	
4.2.6	R28	Mirror Surface Dims (& Form)	Flat to < 1 um	T	T	Ref cold mirror test results	Mirror C of C	

Spire BSM Verification Summary

Changes from SSSD v 3.7 highlighted in yellow

17th March 2004

4.2.7	R29	Mirror Surface Finish	Surface roughness < 10nm rms	I/M	I/M	Component measurement	Mirror C of C	
4.2.7	R30	Mirror Surface Finish	Obscuration due to defects <0.1%	I/M	I/M	Component measurement	Mirror C of C	
4.2.8	R31	Mirror Surface Reflectivity	99% at 200-670 microns	A	A	Standard values for diamond turned aluminium		
4.2.9	R32	Mirror Surface Emissivity	<1% at 200-670 microns	X	X	Complement of 4.2.11 & 4.2.8		
4.2.10	R33	Baffle	Must pass 20% oversized beam with 0.5mm margin	M	M	Measurement will be against part drawings. Tests only performed on integration at RAL		
4.2.11	R34	Position of Rotation Axes	Establish to 0.5mm, 0.5 deg	A	A	Design tolerances		
4.2.11	R35	Position of Rotation Axes	Shoe m/c'g to allow integration to 0.25mm, 0.05 deg	A	A	Process of machining shoe		
4.2.11	R36	Position of Rotation Axes	Repositionable on bench to 0.05mm, 0.05 deg	A	A	Test procedure relies on it		
4.2.11	R37	Position of Rotation Axes	ATC Goal: lateral decentre < 10 um	X	X			
4.2.11	R38	Position of Rotation Axes	ATC Goal: Assy of mirror jiggle to < 0.5mm	X	X			
4.2.11	R39	Position of Rotation Axes	ATC Goal: Assy of mirror chop to < 0.3mm	X	X			
4.2.12	R40	Orthogonality of Rotation Axes	ATC Goal: Orthogonality to 0.15 deg	X	X			
4.2.13	R41	Fail Safe (No Drive Signal) Position	Pos with no drive to nominal 0 within 0.18 deg	T	T			
4.2.14	R42	Fail Safe (Mechanical Failure) Posn	If flex pivots fail mirror can be returned to nominal within +0.573 jiggle, -2.53 deg chop	A	A	Design restrains mirror to operating range	Design Description	
4.2.15	R43	Mass	BSMm and BSMs (exc PCAL) <	M	M			

Spire BSM Verification Summary

Changes from SSSD v 3.7 highlighted in yellow

17th March 2004

			1100g					
4.2.16	R44	Cool-down time	Reach 4K within 15 hrs	A	A	Cooldown times will be dependent on cryostat configuration.		
4.2.17	R45	Reliability	Failure of a subsystem shall not lead to loss of instrument ops	A(h)	A(h)	(h) demonstrated by DM programme and by design/analysis		
4.2.17	R46	Reliability	Backup modes for nom observing modes	A(h)	A(h)	(h) demonstrated by DM programme and by design/analysis		
4.2.17	R47	Reliability	Cold redundant h/w shall be provided where practicable	A(h)	A(h)	(h) demonstrated by DM programme and by design/analysis		
4.2.18	R48	Failure Modes	Failure of subsystem shall not affect health of others subsysts, or the i/f	A(j)	A(j)	(j) demonstrated by DM programme and by design/analysis		
4.2.18	R49	Failure Modes	Failure of component shall not damage redundant or backup component designed to replace it	A(j)	A(j)	(j) demonstrated by DM programme and by design/analysis		
4.2.18	R50	Failure Modes	No elec sub unit shall affect inst ops until in a defined state	A(j)	A(j)	(j) demonstrated by DM programme and by design/analysis		
4.3.1	R51	Operational Safety	Shall operate safely	A	A	Demonstrated by analysis/design/risk assessment		

Spire BSM Verification Summary

Changes from SSSD v 3.7 highlighted in yellow

17th March 2004

4.3.2	R52	Lifetime	Capable of operation for periods > 1/6th of normal mission lifetime	A(k)	A(k)	(k) demonstrated by DM programme and confirmation that the design is comparable		
4.3.2	R53	Lifetime	Will operate over 4.25 yrs	A(k)	A(k)	(k) demonstrated by DM programme and confirmation that the design is comparable		
4.3.2	R54	Lifetime	Lifetime tests will use 1.25x multiplier on orbit and 4x for ground test	A(k)	A(k)	(k) demonstrated by DM programme and confirmation that the design is comparable		
4.3.3	R55	Operating modes	Jiggle: small angular steps	A	A	By test of other parameters		
4.3.3	R56	Operating modes	Chopping	A	A	By test of other parameters		
4.3.3	R57	Operating modes	Scan mapping: combined jiggle and chop	A	A	By test of other parameters		
4.3.3	R58	Operating modes	Holding stare	A	A	By test of other parameters		
4.3.8	R59	Degraded modes	Capable of driving from DC up to freq limit	A	A	By implication from other tests		
4.3.8	R60	Degraded modes	Current demand algorithms devised to operate chop open loop	T	T	Report actual values		
4.3.8	R61	Degraded modes	Each axis must operate in absence of the other	T	T	Basic function check		
4.3.9	R62	Combinations of Modes	1: Chop and jiggle	T	T	X coupling will be tested		
			2: Removal of x coupling during chop only or jiggle only					
4.4.1	R63	Data Outputs	Chop axis posn	S	S			

Spire BSM Verification Summary

Changes from SSSD v 3.7 highlighted in yellow

17th March 2004

4.4.1	R64	Data Outputs	Jiggle axis posn	S	S			
4.4.1	R65	Data Outputs	Eng / trace data (eg motor volts / current)	S	S			
4.4.3	R66	Exported vibration	Torque reaction < 25 x10^-6 Nm average over chop rise	S	S	On integration to SPIRE at RAL		
4.4.3	R67	Exported vibration	Torque reaction < 20 x10^-6 Nm average over jiggle rise	S	S	On integration to SPIRE at RAL		
4.4.4	R68	Stray Magnetic fields	Not susceptible to spurious signal generation under field < 0.01mT	S	S	On integration to SPIRE at RAL		
4.4.5	R69	Electro-Magnetic Compatibility	Grounding, isolation, H field radiated emission, Narrow band elec fields	S	S	On integration to SPIRE at RAL		
4.4.6		ICD's (No ref. no.)	Must interface to the other subsystems as defined in the ICD	A	A			
4.6.2	R70	Electronics Card Format	On double eurocards	I	I	Inspection of LAM deliverables		
4.6.3.1	R71	Mirror Flatness	Surface shape error < 1 um	A	A	Cold measurement. See above		
4.6.3.2	R72	Mirror Reflectivity	> 80% at 633 nm by design	A	A	(n) X if STM has no mirror		
4.6.3.3	R73	Cleanliness	Particulate < 440 ppm general, < 125 ppm mirror	A	A	Compliance indicated in ADP		
			Molecular contamination < 1x10^-4 g/cm^2					
4.6.3.4	R74	Material selection	Structure 6082 Al. Mirror 6061 Al	A	A	Compliance indicated in ADP	SPI-BSM-PRJ-0710 rev 1.3	
4.6.3.4	R75	Material selection	Fasteners cryo grade s/s….	A	A	Compliance indicated in ADP	SPI-BSM-PRJ-0710 rev 1.4	
4.6.3.5	R76	Storage	Up to 5 yrs in dry N without degradation	A	A	Compliance indicated in ADP		

Spire BSM Verification Summary

Changes from SSSD v 3.7 highlighted in yellow

17th March 2004

4.7.1.2	R77	Quasi Static Loads	25g x, 14g y, 14g z	A(o)	A(o)	(o) demonstrated by DM programme and confirmation that the design is comparable		
4.7.1.3	R78	Sine Vibration	25g x, 25g y,z	A(p)	A(p)	(p) demonstrated by DM programme and confirmation that the design is comparable		
4.7.1.4	R79	Random Vibration	0.185g^2/Hz x, 0.117 y,z	A(q)	A(q)	(q) demonstrated by DM programme and confirmation that the design is comparable		
4.7.1.5	R80	Vacuum Level	<10^-4 Pa	A	A	By implication from other tests		
4.7.1.6	R81	Vacuum Outgassing	Materials TML<1%, VCM < 0.1%	A	A	Demonstrated via materials selection and Compliance indicated in DML		
4.7.1.7	R82	Temperature	Within spec at operating, reduced perf at 300K	T	T	Specific performance tests done at operating temp. No specific tests at 300K, since no performance specified, but set up process relies on operation at 300K		
4.7.1.9	R83	Survival Temperature	Up to 80 deg C	A	A	Demonstrated by bakeout of components at		

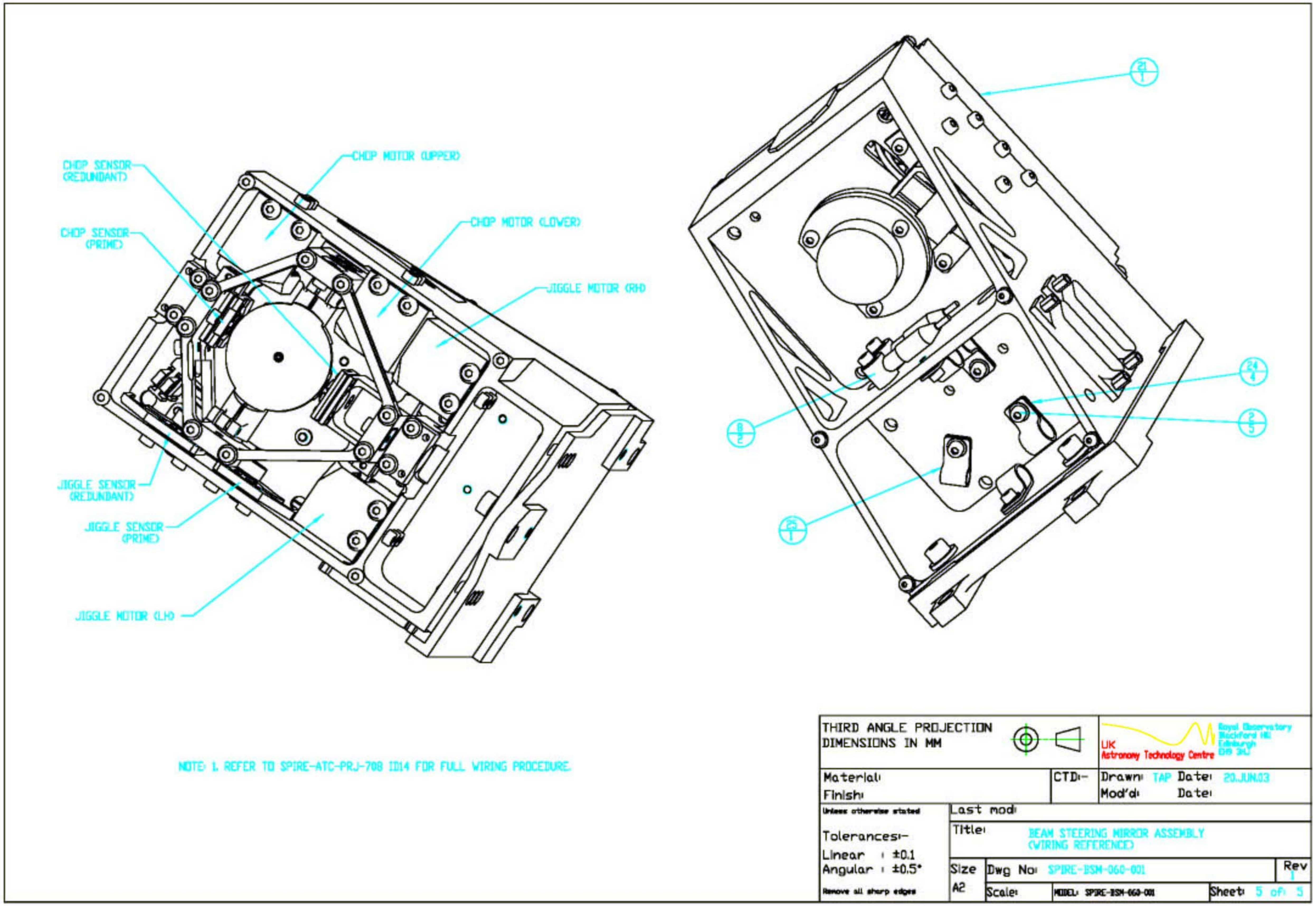
Spire BSM Verification Summary

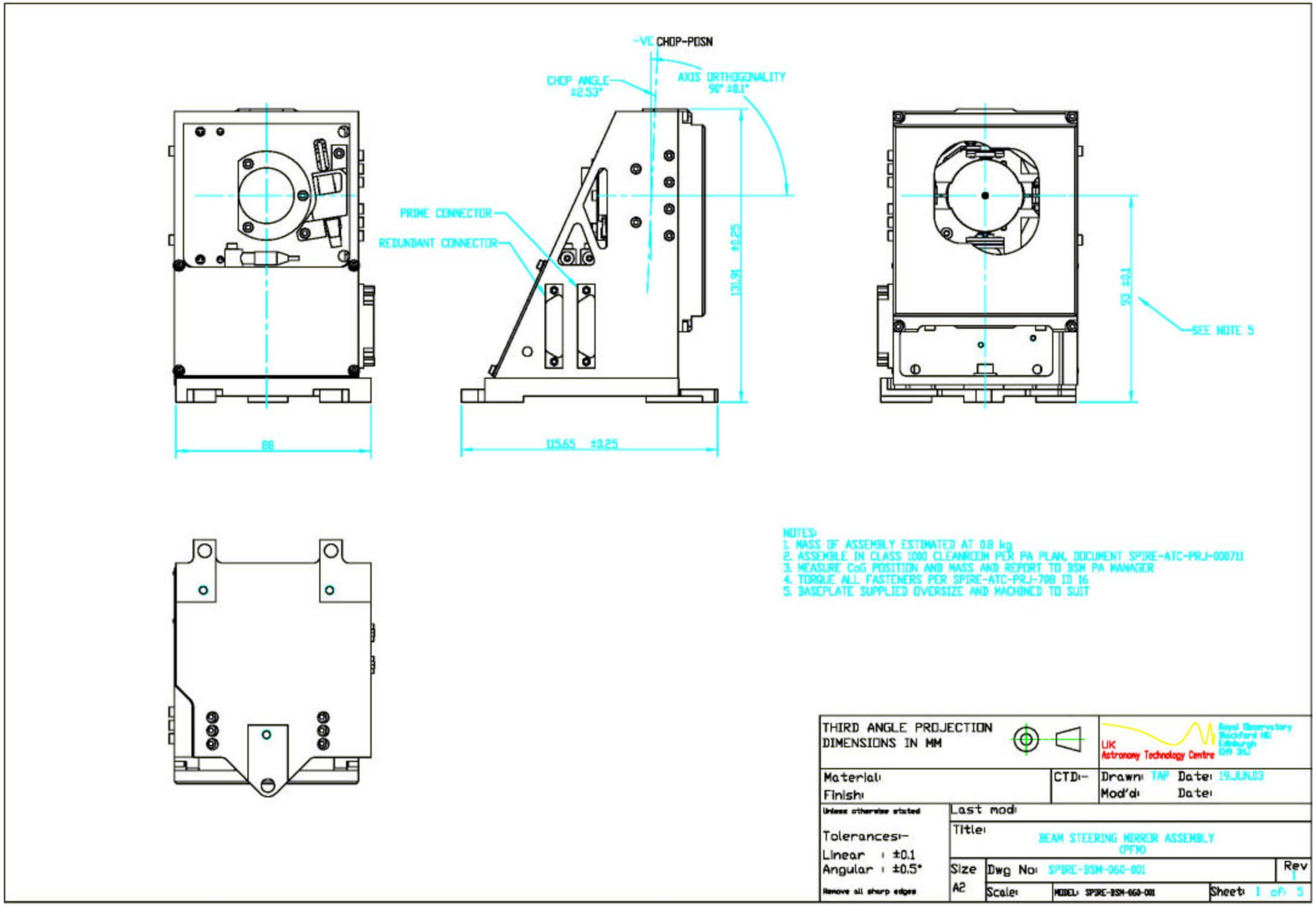
Changes from SSSD v 3.7 highlighted in yellow

17th March 2004

						ATC in the course of assembly & test		
4.7.1.10	R84	Radiation environment	Integrated dose	A	A	By approval of DML	SPI-BSM-PRJ-0710 rev 1.3	
4.7.1.10	R85	Radiation environment	Non ionizing energy	A	A	By approval of DML	SPI-BSM-PRJ-0710 rev 1.4	
4.7.1.10	R86	Radiation environment	ionizing radiation	A	A	By approval of DML	SPI-BSM-PRJ-0710 rev 1.5	

3.4 Top Level Drawings incl. Family Tree

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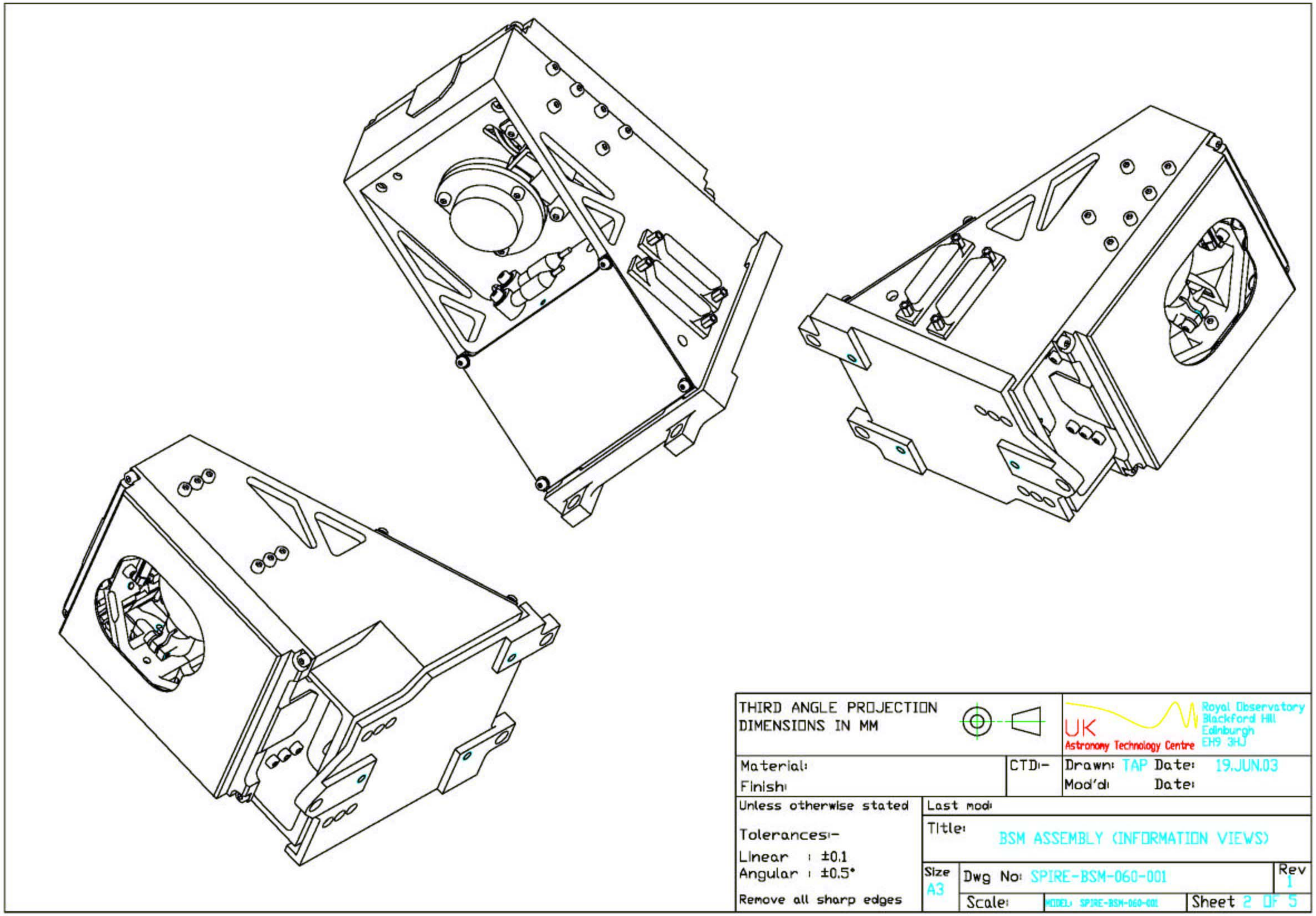
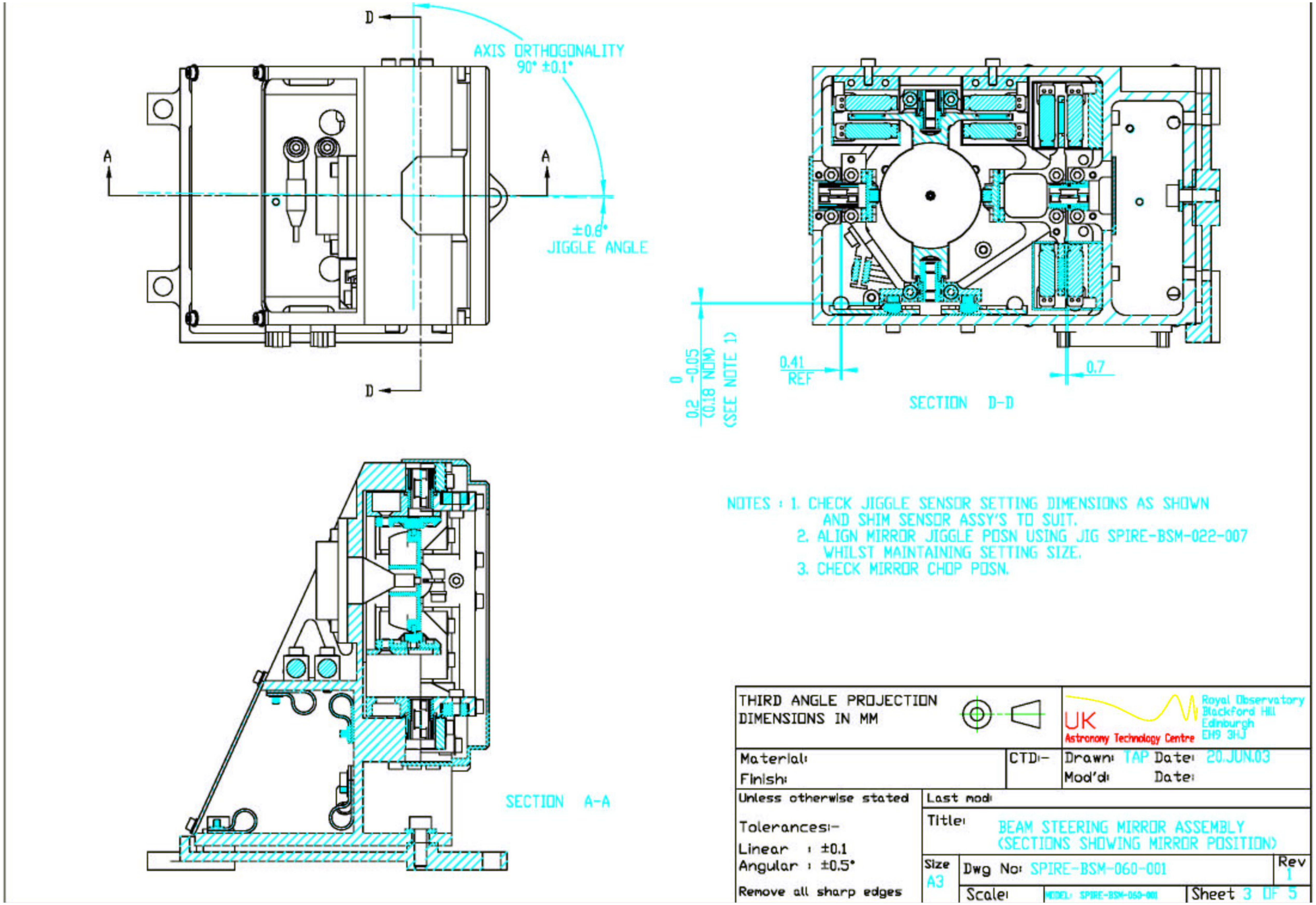
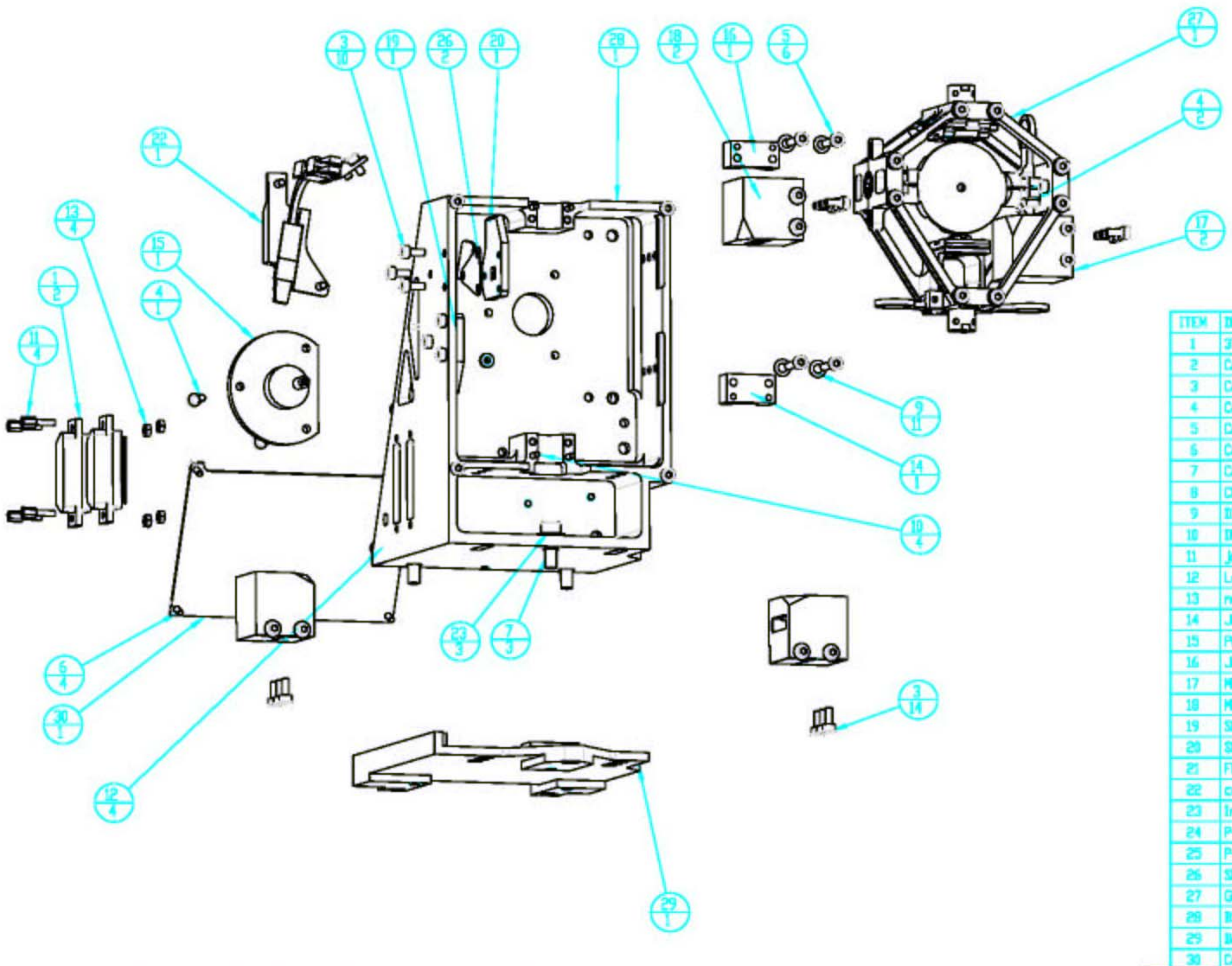
CHOP ANGLE ±2.53°
AXIS ORTHOGONALITY 90° ±0.1°
PRIME CONNECTOR
REDUNDANT CONNECTOR
131.91 ±0.25
93 ±0.1
SEE NOTE 5
88
115.65 ±0.25
NOTES:
1. MASS OF ASSEMBLY ESTIMATED AT 0.8 kg
2. ASSEMBLE IN CLASS 1000 CLEANROOM PER PA PLAN, DOCUMENT SPIRE-ATC-PRJ-000711
3. MEASURE CoG POSITION AND MASS AND REPORT TO BSM PA MANAGER
4. TORQUE ALL FASTENERS PER SPIRE-ATC-PRJ-708 ID 16
5. BASEPLATE SUPPLIED OVERSIZE AND MACHINED TO SUIT
THIRD ANGLE PROJECTION
DIMENSIONS IN MM
UK Astronomy Technology Centre
Material:
Finish:
CTD:-
Drawn: TAP
Date: 19.JUN.03
Mod'd:
Date:
Unless otherwise stated
Last mod:
Tolerances:-
Linear : ±0.1
Angular : ±0.5°
Title: BEAM STEERING MIRROR ASSEMBLY (PFM)
Size A2
Dwg No: SPIRE-BSM-060-001
Rev
Scale:
MODEL: SPIRE-BSM-060-001
Sheet: 1 of 5
Remove all sharp edges


THIRD ANGLE PROJECTION
DIMENSIONS IN MM
UK
Astronomy Technology Centre
Royal Observatory
Blackford Hill
Edinburgh
EH9 3HJ
Material:
Finish:
CTD:-
Drawn: TAP Date: 19.JUN.03
Mod'd: Date:
Unless otherwise stated
Last mod:
Tolerances:-
Linear : ±0.1
Angular : ±0.5°
Remove all sharp edges
Title: BSM ASSEMBLY (INFORMATION VIEWS)
Size A3
Dwg No: SPIRE-BSM-060-001
Rev 1
Scale:
MODEL: SPIRE-BSM-060-001
Sheet 2 OF 5


D
AXIS ORTHOGONALITY
90° ±0.1°
A
A
±0.6°
JIGGLE ANGLE
D
0
0.2 -0.05
(0.18 NOM)
(SEE NOTE 1)
0.41
REF
0.7
SECTION D-D
NOTES : 1. CHECK JIGGLE SENSOR SETTING DIMENSIONS AS SHOWN
AND SHIM SENSOR ASSY'S TO SUIT.
2. ALIGN MIRROR JIGGLE POSN USING JIG SPIRE-BSM-022-007
WHILST MAINTAINING SETTING SIZE.
3. CHECK MIRROR CHOP POSN.
SECTION A-A
THIRD ANGLE PROJECTION
DIMENSIONS IN MM
UK Astronomy Technology Centre
Royal Observatory
Blackford Hill
Edinburgh
EH9 3HJ
Material:
Finish:
CTD:-
Drawn: TAP Date: 20.JUN.03
Mod'd: Date:
Unless otherwise stated
Tolerances:-
Linear : ±0.1
Angular : ±0.5°
Remove all sharp edges
Last mod:
Title: BEAM STEERING MIRROR ASSEMBLY
(SECTIONS SHOWING MIRROR POSITION)
Size A3
Dwg No: SPIRE-BSM-060-001
Rev 1
Scale:
MODEL: SPIRE-BSM-060-001
Sheet 3 OF 5



ITEM	DESCRIPTION	QUANTITY	FILENAME	REV.
1	37 pin connector MDM	2	37WAY_CONN	1
2	CAP HD SCREW SS M2.5 X 5mm	5	CAP-HD-SCREW-SS-M2-5X5	1
3	CAP HD SCREW SS M2.5 x 6mm	24	CAP-HD-SCREW-SS-M2-5X6	1
4	CAP HD SCREW SS M2.5X8MM	3	CAP-HD-SCREW-SS-M2-5X8	1
5	CAP HD SCREW SS M2x12	6	CAP-HD-SCREW-SS-M2-5X12	1
6	CAP HD SCREW SS M2X6	4	CAP-HD-SCREW-SS-M2X6	1
7	CAP HD SCREW SS M4x12	3	CAP-HD-SCREW-SS-M4X12	1
8	CERNOX THERMISTOR (MOUNTED)	2	CX-1030-MOUNT-PRT	1
9	DISC SPRING SS 3.2mm ID	11	DISC-SPRING-ID-3_2	1
10	DOWEL SS 2mm dia x 8mm lg.	4	DOWEL_8X2	1
11	Jacknut	4	JACKNUT	1
12	Lockwasher m2	4	LOCK-WASHER-M2	1
13	nut_2-56	4	NUT-2-56	1
14	Jiggle axis flexure clamp lower	1	SPIRE-BSM-020-001-003	3
15	PCAL SPACE ENVELOPE	1	SPIRE-BSM-020-001-004	1
16	Jiggle axis flexure clamp upper	1	SPIRE-BSM-020-001-005	3
17	MOTOR ASSEMBLY (LH)	2	SPIRE-BSM-023-005	4
18	MOTOR ASSEMBLY (RH)	2	SPIRE-BSM-023-006	4
19	SENSOR ASSY LH (PRIME)	1	SPIRE-BSM-023-017	1
20	SENSOR ASSY RH (REDUN)	1	SPIRE-BSM-023-018	1
21	FRONT BAFFLE	1	SPIRE-BSM-023-001-009	2
22	connector_retainer	1	SPIRE-BSM-023-001-011	4
23	Invar washer	3	SPIRE-BSM-023-001-014	1
24	P-clip (6.25 dia)	4	SPIRE-BSM-023-001-017	1
25	P-clip (4 dia)	1	SPIRE-BSM-023-001-018	1
26	Shim	2	SPIRE-BSM-023-007-002	1
27	Gimbal Assembly (Jiggle + Chop stages)	1	SPIRE-BSM-060-003	2
28	BSM Structural Interface	1	SPIRE-BSM-060-001-001	1
29	BASEPLATE	1	SPIRE-BSM-060-001-002	2
30	Cover plate	1	SPIRE-BSM-060-001-010	2

NOTES: 1. MOTOR ASSEMBLIES (INCLUDING LOWER CHOP WITHIN GIMBAL ASSY) LOOSELY PACKAGED WHILE ASSEMBLING INTO MAIN STRUCTURE. ENSURE MOTORS LOCATED ONTO DATUM LEDGE BEFORE TIGHTENING.
2. FRONT BAFFLE OMITTED FOR CLARITY

THIRD ANGLE PROJECTION
DIMENSIONS IN MM

UK Astronomy Technology Centre
Royal Observatory
Blackford Hill
Edinburgh
EH9 3HJ

Material:
Finish:
CTD:-
Drawn: TAP Date: 20.JUN.03
Mod'd: Date:
Unless otherwise stated
Last mod:
Tolerances:-
Linear : ±0.1
Angular : ±0.5°
Remove all sharp edges
Title: BEAM STEERING MIRROR ASSEMBLY (PFM)
Size A2
Dwg No: SPIRE-BSM-060-001
Rev 1
Scale:
MODEL: SPIRE-BSM-060-001
Sheet: 4 of: 5

Interface Drawings
Ref ICD (RD 6)

3.5 *Functional Diagrams (Block Diagram)*

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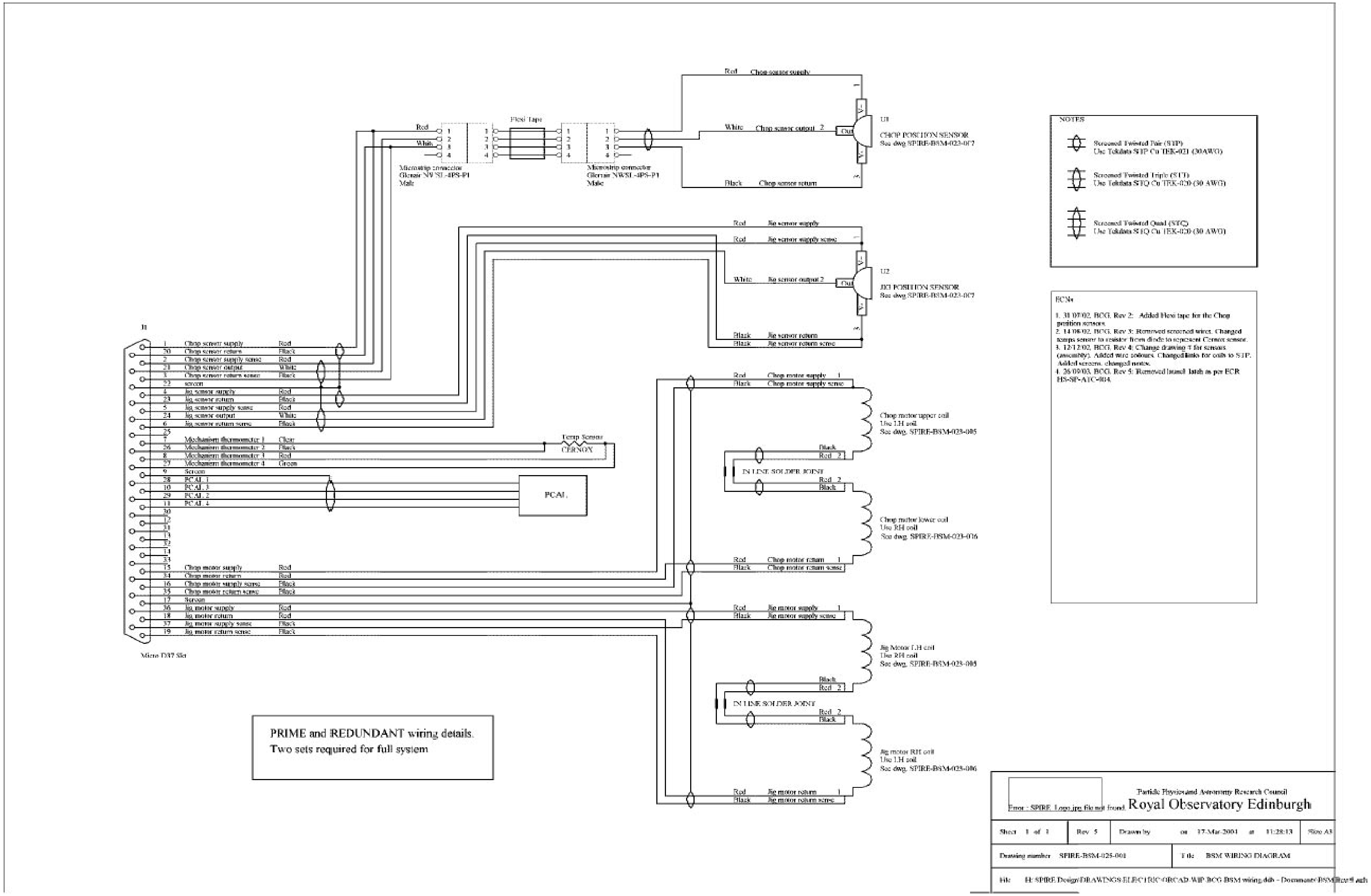
3.6 Electrical Circuit Diagrams



3.7 *As built configuration lists*

SPIRE-BSM-060-001

Top Level	Assembly	Sub Assy	Drawing/Model Name	Type Name	Description*	Revision	Version	Call Out Quantity	Serial no	Notes
SPIRE-BSM-060-001										
	atc-brg-flex-001 Lucas flex pivot 5010-600	-	atc-brg-flex-001.asm	Assembly	Lucas flex pivot 5010-600	1	14	1		
		-	atc-brg-flex-001-001.prt	Part	Sleeve	1	8	2		
		-	atc-brg-flex-001-002.prt	Part	Core	1	8	1		
		-	atc-brg-flex-001-003.prt	Part	Outer flexure	1	9	2		
		-	atc-brg-flex-001-005.prt	Part	Core	1	7	1		
		-	atc_brg_flex-001-004.prt	Part	centre flexure	1	8	1		
	atc-brg-flex-003 C-Flex pivot E-10	-	atc-brg-flex-003.asm	Assembly	C-Flex pivot E-10	1	3	1		
		-	atc-brg-flex-003-001.prt	Part	Sleeve	1	3	2		
		-	atc-brg-flex-003-002.prt	Part	Core	1	3	1		
		-	atc-brg-flex-003-003.prt	Part	Outer flexure	1	3	2		
		-	atc-brg-flex-003-004.prt	Part	centre flexure	1	3	1		
		-	atc-brg-flex-003-005.prt	Part	Core	1	3	1		
	spire-bsm-020-008 Shielded flexure assy (jiggle top)	-	atc-brg-flex-001.asm	Assembly	Lucas flex pivot 5010-600	1	14	1		
		-	spire-bsm-020-008.asm	Assembly	Shielded flexure assy (jiggle top)	2	1	1		
		-	atc-brg-flex-001-001.prt	Part	Sleeve	1	8	2		
		-	atc-brg-flex-001-002.prt	Part	Core	1	8	1		
		-	atc-brg-flex-001-003.prt	Part	Outer flexure	1	9	2		
		-	atc-brg-flex-001-005.prt	Part	Core	1	7	1		
		-	atc_brg_flex-001-004.prt	Part	centre flexure	1	8	1		
		-	spire-bsm-020-008-001.prt	Part	Flex Pivot Protective Shield	1	8	1		
	spire-bsm-020-012 Shielded flexure assy (jiggle bot)	-	atc-brg-flex-001.asm	Assembly	Lucas flex pivot 5010-600	1	14	1		
		-	spire-bsm-020-012.asm	Assembly	Shielded flexure assy (jiggle bot)	2	1	1		
		-	atc-brg-flex-001-001.prt	Part	Sleeve	1	8	2		
		-	atc-brg-flex-001-002.prt	Part	Core	1	8	1		
		-	atc-brg-flex-001-003.prt	Part	Outer flexure	1	9	2		
		-	atc-brg-flex-001-005.prt	Part	Core	1	7	1		
		-	atc_brg_flex-001-004.prt	Part	centre flexure	1	8	1		
		-	spire-bsm-020-008-001.prt	Part	Flex Pivot Protective Shield	1	8	1		
	spire-bsm-023-004 BSM chop axis assembly	-	atc-brg-flex-003.asm	Assembly	C-Flex pivot E-10	1	3	2		
		-	spire-bsm-023-004.asm	Assembly	BSM chop axis assembly	1	8	1		
		-	spire-bsm-023-015.asm	Assembly	Shielded flexure assy (chop LH)	1	3	1		
		-	spire-bsm-023-016.asm	Assembly	Shielded flexure assy (chop RH)	2	1	1		
		-	atc-brg-flex-003-001.prt	Part	Sleeve	1	3	4		
			atc-brg-flex-003-002.prt	Part	Core	1	3	2		
			atc-brg-flex-003-003.prt	Part	Outer flexure	1	3	4		
			atc-brg-flex-003-004.prt	Part	centre flexure	1	3	2		
			atc-brg-flex-003-005.prt	Part	Core	1	3	2		

SPIRE-BSM-060-001										
Top Level	**Assembly**	**Sub Assy**	**Drawing/Model Name**	**Type Name**	**Description***	**Revision**	**Version**	**Call Out Quantity**	**Serial no**	**Notes**
			cap-hd-screw-ss-m2-5x8.prt	Part	CAP HD SCREW SS M2.5X8MM	1	3	2		
			spire-bsm-020-003-003.prt	Part	PACS slim magnet	1	10	2		
			spire-bsm-020-004-004.prt	Part	sensor actuator	2	3	2		
			spire-bsm-020-008-001.prt	Part	Flex Pivot Protective Shield	1	8	2		
			spire-bsm-023-004-001.prt	Part	Chop Stage	3	2	1		
			spire-bsm-023-004-003.prt	Part	Balance spacer	1	1	2		
	spire-bsm-023-005 MOTOR ASSEMBLY (LH)		spire-bsm-023-005.asm	Assembly	MOTOR ASSEMBLY (LH)	4	1	1		
			cap-hd-screw-ss-m2-5x8.prt	Part	CAP HD SCREW SS M2.5X8MM	1	3	2		
			disc-spring-id-3_2.prt	Part	DISC SPRING SS 3.2mm ID	1	4	2		
			spire-bsm-023-005-001.prt	Part	COIL BRACKET (LH)	3	1	2	0100 0101	
			spire-bsm-023-005-002.prt	Part	COIL RETAINER (LH)	3	1	2	0102 0103	
			spire-bsm-023-005-003.prt	Part	COIL	1	4	2		
			spire-bsm-023-005-005.prt	Part	HEAT SHIELD (LH)	1	5	2	0127 0128	
	spire-bsm-023-006 MOTOR ASSEMBLY (RH)		spire-bsm-023-006.asm	Assembly	MOTOR ASSEMBLY (RH)	4	1	1		
			cap-hd-screw-ss-m2-5x8.prt	Part	CAP HD SCREW SS M2.5X8MM	1	3	2		
			disc-spring-id-3_2.prt	Part	DISC SPRING SS 3.2mm ID	1	4	2		
			spire-bsm-023-005-003.prt	Part	COIL	1	4	2		
			spire-bsm-023-006-001.prt	Part	COIL BRACKET (RH)	3	1	2	0104 0105	
			spire-bsm-023-006-002.prt	Part	COIL RETAINER (RH)	3	1	2	0107 0108	
			spire-bsm-023-006-005.prt	Part	HEAT SHIELD (RH)	1	4	2	0125 0126	
	spire-bsm-023-007 SENSOR ASSY CHOP TOP (PRIME)		spire-bsm-023-007.asm	Assembly	SENSOR ASSY CHOP TOP (PRIME)	2	3	1		
			spire-bsm-020-006-002.prt	Part	SENSOR	1	1	1		
			spire-bsm-023-007-001.prt	Part	SENSOR HOUSING	2	0	1		
	spire-bsm-023-015 Shielded flexure assy (chop LH)		atc-brg-flex-003.asm	Assembly	C-Flex pivot E-10	1	3	1		
			spire-bsm-023-015.asm	Assembly	Shielded flexure assy (chop LH)	1	3	1		
			atc-brg-flex-003-001.prt	Part	Sleeve	1	3	2		
			atc-brg-flex-003-002.prt	Part	Core	1	3	1		
			atc-brg-flex-003-003.prt	Part	Outer flexure	1	3	2		
			atc-brg-flex-003-004.prt	Part	centre flexure	1	3	1		
			atc-brg-flex-003-005.prt	Part	Core	1	3	1		
			spire-bsm-020-008-001.prt	Part	Flex Pivot Protective Shield	1	8	1		
	spire-bsm-023-016 Shielded flexure assy (chop RH)		atc-brg-flex-003.asm	Assembly	C-Flex pivot E-10	1	3	1		
			spire-bsm-023-016.asm	Assembly	Shielded flexure assy (chop RH)	2	1	1		
			atc-brg-flex-003-001.prt	Part	Sleeve	1	3	2		

SPIRE-BSM-060-001										
Top Level	**Assembly**	**Sub Assy**	**Drawing/Model Name**	**Type Name**	**Description***	**Revision**	**Version**	**Call Out Quantity**	**Serial no**	**Notes**
			atc-brg-flex-003-002.prt	Part	Core	1	3	1		
			atc-brg-flex-003-003.prt	Part	Outer flexure	1	3	2		
			atc-brg-flex-003-004.prt	Part	centre flexure	1	3	1		
			atc-brg-flex-003-005.prt	Part	Core	1	3	1		
			spire-bsm-020-008-001.prt	Part	Flex Pivot Protective Shield	1	8	1		
	spire-bsm-023-017 SENSOR ASSY LH (PRIME)		spire-bsm-023-017.asm	Assembly	SENSOR ASSY LH (PRIME)	1	2	1		
			spire-bsm-020-006-002.prt	Part	SENSOR	1	1	1		
			spire-bsm-023-017-001.prt	Part	SENSOR HOUSING	1	2	1		
	spire-bsm-023-018 SENSOR ASSY RH (REDUN)		spire-bsm-023-018.asm	Assembly	SENSOR ASSY RH (REDUN)	1	2	1		
			spire-bsm-020-006-002.prt	Part	SENSOR	1	1	1		
			spire-bsm-023-018-001.prt	Part	SENSOR HOUSING	1	2	1		
	spire-bsm-060-003 Gimbal Assembly (Jiggle + Chop stages)		atc-brg-flex-001.asm	Assembly	Lucas flex pivot 5010-600	1	14	2		
			atc-brg-flex-003.asm	Assembly	C-Flex pivot E-10	1	3	2		
			spire-bsm-020-008.asm	Assembly	Shielded flexure assy (jiggle top)	2	1	1		
			spire-bsm-020-012.asm	Assembly	Shielded flexure assy (jiggle bot)	2	1	1		
			spire-bsm-023-004.asm	Assembly	BSM chop axis assembly	1	8	1		
			spire-bsm-023-007.asm	Assembly	SENSOR ASSY CHOP TOP (PRIME)	2	3	1		
			spire-bsm-023-015.asm	Assembly	Shielded flexure assy (chop LH)	1	3	1		
			spire-bsm-023-016.asm	Assembly	Shielded flexure assy (chop RH)	2	1	1		
			spire-bsm-060-003.asm	Assembly	Gimbal Assembly (Jiggle + Chop stages)	2	0	1		
			spire-bsm-060-007.asm	Assembly	SENSOR ASSY CHOP BOT (REDUN)	1	2	1		
			atc-brg-flex-001-001.prt	Part	Sleeve	1	8	4		
			atc-brg-flex-001-002.prt	Part	Core	1	8	2		
			atc-brg-flex-001-003.prt	Part	Outer flexure	1	9	4		
			atc-brg-flex-001-005.prt	Part	Core	1	7	2		
			atc-brg-flex-003-001.prt	Part	Sleeve	1	3	4		
			atc-brg-flex-003-002.prt	Part	Core	1	3	2		
			atc-brg-flex-003-003.prt	Part	Outer flexure	1	3	4		
			atc-brg-flex-003-004.prt	Part	centre flexure	1	3	2		
			atc-brg-flex-003-005.prt	Part	Core	1	3	2		
			atc_brg_flex-001-004.prt	Part	centre flexure	1	8	2		
			cap-hd-screw-ss-m2-5x25.prt	Part	CAP HD SCREW SS M2.5x25mm	1	0	8		
			cap-hd-screw-ss-m2-5x5.prt	Part	CAP HD SCREW SS M2.5 X 5mm	1	3	2		
			cap-hd-screw-ss-m2-5x6.prt	Part	CAP HD SCREW SS M2.5 x 6mm	1	1	4		
			cap-hd-screw-ss-m2-5x8.prt	Part	CAP HD SCREW SS M2.5X8MM	1	3	2		
			csk-hd-screw-ss-m2-5x5.prt	Part	CSK HD SCREW SS M2.5X5	1	1	6		
			disc-spring-id-3_2.prt	Part	DISC SPRING SS 3.2mm ID	1	4	8		

SPIRE-BSM-060-001										
Top Level	**Assembly**	**Sub Assy**	**Drawing/Model Name**	**Type Name**	**Description***	**Revision**	**Version**	**Call Out Quantity**	**Serial no**	**Notes**
			dowel_8x2.prt	Part	DOWEL SS 2mm dia x 8mm lg.	1	2	2		
			microstrip_conn.prt	Part	microstrip_connector	1	5	4		
			microstrip_flex.prt	Part	flexible_cable_outer	1	0	1		
			microstrip_flex_b.prt	Part	flexible_cable_inner	1	0	1		
			spire-bsm-020-003-003.prt	Part	PACS slim magnet	1	10	4		
			spire-bsm-020-004-004.prt	Part	sensor actuator	2	3	4		
			spire-bsm-020-006-002.prt	Part	SENSOR	1	1	2		
			spire-bsm-020-008-001.prt	Part	Flex Pivot Protective Shield	1	8	4		
			spire-bsm-023-001-012.prt	Part	microstrip_brkt_bot	1	4	1		
			spire-bsm-023-001-013.prt	Part	microstrip_brkt_top	1	4	1		
			spire-bsm-023-003-003.prt	Part	Balance (side)	2	1	2		
			spire-bsm-023-003-004.prt	Part	Balance (top)	3	1	2		
			spire-bsm-023-004-001.prt	Part	Chop Stage	3	2	1		
			spire-bsm-023-004-003.prt	Part	Balance spacer	1	1	2		
			spire-bsm-023-007-001.prt	Part	SENSOR HOUSING	2	0	1		
			spire-bsm-023-007-002.prt	Part	Shim	1	2	2		
			spire-bsm-060-003-001.prt	Part	Jiggle Frame Bottom	2	0	1	0094	
			spire-bsm-060-003-002.prt	Part	Jiggle Frame Top	2	0	1	0093	
			spire-bsm-060-007-001.prt	Part	SENSOR HOUSING	2	0	1		
	spire-bsm-060-007 SENSOR ASSY CHOP BOT (REDUN)		spire-bsm-060-007.asm	Assembly	SENSOR ASSY CHOP BOT (REDUN)	1	2	1		
			spire-bsm-020-006-002.prt	Part	SENSOR	1	1	1		
			spire-bsm-060-007-001.prt	Part	SENSOR HOUSING	2	0	1		
			spire-bsm-023-004-001		Mirror	3		1	0089	
			spire-bsm-060-011		Structure	1		1	0096	
			spire-bsm-020-001-005		Clamp upper	3		1	0121	
			spire-bsm-020-001-003		Clamp lower	3		1	0122	
			spire-bsm-023-001-009		Front baffle	2		1	0098	
			spire-bsm-023-018-001		Sensor holder	1		4	0111 0113 0115 0118	
			spire-bsm-023-001-009		Cover	2		1	0098	
			spire-bsm-060-001-002		Base	2		1	0143	
			spire-bsm-023-001-009							
			spire-bsm-023-001-012		micro strip bracket bottom	1		2	0059 0061	
			spire-bsm-023-001-011		Connector Retainer	4		1	0109	

3.8 Serialised Components List

As above

3.9 List of Waivers

Waiver Number	ATC doc number	Title

3.10 Copies of Waivers

PROJECT: Herschel SPIRE	Request for Waiver/Deviation
[1] Title (Max 25 Spaces): **Angular travel – jiggle axis.**	RFW-Nr.SPIRE-ATC-BSM_NOT_0028 Issue/Rev.: Date:19/03/04 Page 53 of 1
	Related NCR (if any)

[2] End Item(s) affected (hardware, software):

Name:	CI-Number	Model(s)
BSMm	**060**	**PFM**

[3] Requirement/Interface Documents affected:

Specification/Drawing Title	Number	Issue	Date	Appl. Paragr.
SSSD	**SPIRE-ATC-PRJ-000460**	**3.7**	**11/09/03**	**4.1.2**

[4] Description of Deviation/Discrepancy/Non-Conformance:

Angular Travel – Jiggle Axis.

See following page

[5] Other Items or Requirements (potentially) Affected

None

[6] Need for RFW and Rationale for Acceptance:

With increased current supply the specification is close to being met..

[7] Originator:	Sign:	Attachments: **Description of test**
P. Parr-Burman	Date:	

[8] Approvals:

	Engineering Name/Date	Product Assurance Name/Date		CCB Chairman Name/Date
Prin. Investigator	[ ] Appr [ ] Rej	[ ] Appr [ ] Rej	[ ] Appr [ ] Rej	[ ] Appr [ ] Rej
Co-Investigator	[ ] Appr [ ] Rej	[ ] Appr [ ] Rej	[ ] Appr [ ] Rej	[ ] Appr [ ] Rej
	[ ] Appr [ ] Rej	[ ] Appr [ ] Rej	[ ] Appr [ ] Rej	[ ] Appr [ ] Rej
Prime Contractor	[ ] Appr [ ] Rej	[ ] Appr [ ] Rej	[ ] Appr[[ ] Rej	[ ] Appr [ ] Rej
ESA Project Office	[ ] Appr [ ] Rej	[ ] Appr [ ] Rej	[ ] Appr [ ] Rej	[ ] Appr [ ] Rej

Axis	Chop	Jiggle
Spec	+/- 2.53 deg	+/- 0.573 deg
Travel at 50 mA		
Travel at 60 mA		

PROJECT: Herschel SPIRE	Request for Waiver/Deviation
[1] Title (Max 25 Spaces): Angular travel – jiggle axis.	RFW-Nr. Issue/Rev.: Date:19/03/04 Page 54 of 1 Related NCR (if any)

[2] End Item(s) affected (hardware, software):

Name:	CI-Number	Model(s)
BSMm	060	PFM

[3] Requirement/Interface Documents affected:

Specification/Drawing Title	Number	Issue	Date	Appl. Paragr.
SSSD	SPIRE-ATC-PRJ-000460	3.7	11/09/03	4.1.2

[4] Description of Deviation/Discrepancy/Non-Conformance:
Angular Travel – Jiggle Axis.
See following page

[5] Other Items or Requirements (potentially) Affected
None

[6] Need for RFW and Rationale for Acceptance:
With increased current supply the specification is close to being met..

[7] Originator: P. Parr-Burman	Sign: Date:	Attachments: Description of test

[8] Approvals:

	Engineering Name/Date	Product Assurance Name/Date		CCB Chairman Name/Date
Prin. Investigator	[ ] Appr [ ] Rej	[ ] Appr [ ] Rej	[ ] Appr [ ] Rej	[ ] Appr [ ] Rej
Co-Investigator	[ ] Appr [ ] Rej	[ ] Appr [ ] Rej	[ ] Appr [ ] Rej	[ ] Appr [ ] Rej
	[ ] Appr [ ] Rej	[ ] Appr [ ] Rej	[ ] Appr [ ] Rej	[ ] Appr [ ] Rej
Prime Contractor	[ ] Appr [ ] Rej	[ ] Appr [ ] Rej	[ ] Appr[[ ] Rej	[ ] Appr [ ] Rej
ESA Project Office	[ ] Appr [ ] Rej	[ ] Appr [ ] Rej	[ ] Appr [ ] Rej	[ ] Appr [ ] Rej

Axis	Chop	Jiggle
Spec	+/- 2.53 deg	+/- 0.573 deg
Travel at 50 mA		
Travel at 60 mA		

PROJECT: Herschel SPIRE	**Request for Waiver/Deviation**
[1] Title (Max 25 Spaces): **Fail Safe Position.**	RFW-Nr. Issue/Rev.: Date:19/03/04 Page 55 of 1 Related NCR (if any)

[2] End Item(s) affected (hardware, software):

Name:	CI-Number	Model(s)
BSMm	**060**	**PFM**

[3] Requirement/Interface Documents affected:

Specification/Drawing Title	Number	Issue	Date	Appl. Paragr.
SSSD	**SPIRE-ATC-PRJ-000460**	**3.7**	**11/09/03**	**4.2.13**

[4] Description of Deviation/Discrepancy/Non-Conformance:

Fail Safe Position. **In chop the mirror is at 0.246 deg from the nominal (i.e. electrical zero) compared to spec of 0.18 deg.**

(In jiggle the mirror is at 0.083 deg from nominal. Therefore within spec.)

[5] Other Items or Requirements (potentially) Affected

None

[6] Need for RFW and Rationale for Acceptance:

RFW needed to allow testing to continue. To rectify the discrepancy by adjustment of the mirror at the unit directly would involve risk to the mechanism.

Propose that the difference is taken out by adjustment of the orientation on the Spire Optical Bench.

[7] Originator: **P. Parr-Burman**	Sign: Date:	Attachments: **Description of test**

[8] Approvals:

	Engineering Name/Date	Product Assurance Name/Date		CCB Chairman Name/Date
Prin. Investigator	[ ] Appr [ ] Rej	[ ] Appr [ ] Rej	[ ] Appr [ ] Rej	[ ] Appr [ ] Rej
Co-Investigator	[ ] Appr [ ] Rej	[ ] Appr [ ] Rej	[ ] Appr [ ] Rej	[ ] Appr [ ] Rej
	[ ] Appr [ ] Rej	[ ] Appr [ ] Rej	[ ] Appr [ ] Rej	[ ] Appr [ ] Rej
Prime Contractor	[ ] Appr [ ] Rej	[ ] Appr [ ] Rej	[ ] Appr[[ ] Rej	[ ] Appr [ ] Rej
ESA Project Office	[ ] Appr [ ] Rej	[ ] Appr [ ] Rej	[ ] Appr [ ] Rej	[ ] Appr [ ] Rej

3.11 Operation Manual

A Manual is not supplied.

The unit is to be fitted to the Spire optical bench in accordance with procedures defined and controlled by RAL.

Operation is via the Mechanism Control Unit, supplied separately to RAL, the interfaces for which are defined in the Interface Control Document (RD6).

3.12 Historical Record

Historical Record (Logbook)

The equipment logbooks are established for all operations and tests starting with the final inspection of the hardware after the manufacturing / assembly phase. They include:

- historical record sheets (an index to the diary of events); with:
  - dates of operation / test / transport
  - name of operation / test / transport from / to
  - applicable procedure and / or report
  - responsible organisation and signature for entry
  - remarks e.g. on NCR's or unplanned events
- Diary (ATC lab book)
  - chronological logbook for recording the details and progress or otherwise of all activities .
  - Note that for Prototype/DM/STM a single lab book is in place.
  - When future action is required a note of the action shall be made in the diary and flagged for easy identification and raised in the Fault logging system.
- Connector Mate / Demate Log
  - Every mate or demate of a flight or flight spare connector shall be logged. operating time/cycle record for limited life items, age sensitive items, temporary installations

The log sheets shall accompany the hardware whenever it is placed under the custody of another organisation and this organisation shall update and maintain these records.

The instrument log book is retained at the UK ATC.

3.13 Logbook/Diary of Events

To be updated just before issue

DESCRIPTION OF ACTIVITY / EVENT	REMARKS/ REF. DOC.	OPERATING TIME	DATE	SIGNATURE
Shielded flexure assembly built in clean room (PFM)			25/9/03	
BSM Chop assembly built in clean room			25/9/03	
Gimbal assembly built in clean room			30/9/03	
Microstrip bonded to brackets in clean room			24/10/03	
Motor assemblies built in clean room			24/10/03	
Wires attached to motor assemblies – clean room			29/10/03	
Wires potted and motor assemblies completed – clean room			30/10/03	
BSM assembled in clean room			12/11/03	
Wiring of BSM completed – clean room			01/12/03	
Covers fitted to BSM – clean room			11/12/03	
PFM transferred to vacuum oven in clean room and baked for one hour at 80˚C				
Mass tests performed in clean room				
Install alignment mirror onto BSM PCal mount				
PFM installed into cryostat in clean room			12/12/03	
Warm test performed to verify correct motion – FAIL wiring error				
BMS wiring corrected				
PFM transferred to vacuum oven in clean room and baked for one hour at 80˚C			12/01/04	
Mass test in clean room			13/01/04	
Install alignment mirror onto BSM PCal mount			13/01/04	
PFM installed into cryostat in clean room			13/01/04	
Tested warm for correct motion – PASS			13/01/04	
Pump down			14/01/04	

DESCRIPTION OF ACTIVITY / EVENT	REMARKS/ REF. DOC.	OPERATING TIME	DATE	SIGNATURE
Cooled from room temperature to 5.8K and performed quick, rough check of rest position alignment. From this check, BSM fails spec			15/01/04	
Cooled PFM from 113K to 7.2K. Performed “Fail Safe (no drive signal) position” Alignment test 4.2 : Failed spec. 0.23 deg instead of worst case 0.18 deg.			16/01/04	
Cooled PFM from room temp to 9.2K. Retake alignment test 4.2 to check for repeatability of mirror position on re-cool. Same position to within 10%			19/01/04	
Cooled from 150K to 5.9K. Tested maximum prime and redundant throw on both axes with 50mA. FAIL			20/01/04	
Kept PFM at 77K			21/01/04	
Cooled from 270K to 77K			22/01/04	
Heat PFM from 77K to 128K then cooled to 4K. Testing for maximum jiggle angles at same current (50mA) but different temperatures			23/01/04	
PFM at room temperature. PFM removed from cryostat and test performed to determine stiffness of jiggle pivots, lacing tape obstruction removed.			26/01/04	
PFM installed in cryostat and pumped down			28/01/04	
Cooled from room temperature to 5.9K. Test performed to determine maximum angles after lacing tape removed.			29/01/04	
Cooled to 4K to soak			03/02/04	
Cooled from 52K to 5.9K. Tested angular throw once soaked at under 10K for 3.5 hours			04/02/04	
Cryostat on Vacuum pump.			09/02/04	
Cool to 5.8 K for basic Calibration and control tests.			10/02/04	
Cooled from 61K to 5.9K for control tests.			11/02/04	
Cooled from 80 to 5.9K for Control tests.			12/02/04	
Cooled from 53 to 5.9K for Control tests.			13/02/04	
Cooled from 292 to 78K.			16/02/04	

DESCRIPTION OF ACTIVITY / EVENT	REMARKS/ REF. DOC.	OPERATING TIME	DATE	SIGNATURE
Cooled from 77 to 5.9K for Control tests.			17/02/04	
Cooled from 44 to 5.9K for Control tests.			18/02/04	
Cryostat left to warm up from 40K			19/02/04	
Remove PFM from Cryostat and Make ready PFM for Transporting to RAL for shake.			26/02/04	
PFM shaken at RAL.			27/02/04	
Removed baffle and EMC cover for inspection.			01/03/04	
Removed P-clips from emc cavity for later replacement with better Heat-shrink protection.			02/03/04	
Install PFM in cryostat, test for functional wiring and begin to vacuum pump.			08/03/04	
Cool cryostat from room temperature.			09/03/04	
Testing Fail Safe (No Drive) Position (Test 4.2). 5.5 – 6.5 K.			10/03/04	
Testing for Angular Travel (Test 4.5). 5.5 – 6.5 K.			11/03/04 to 16/03/04	

3.14 Operating Time/Cycle Record

Testing of the BSM involves minimal cycling compared to the >>10^6 cycles carried out for the cold life test (qualification test carried out on a separate model). For this reason a separate record has not been kept.

3.15 Connector Mating Record

CONNECTOR MATE / DEMATE LOG									
PROJECT SPIRE				**EXPERIMENT**					
S / SYSTEM BSM			**UNIT PFM**			**IDENT NO. PRIME FLEXI FRAME**			
ID		**ID**		**ID**		**ID**		**ID**	
Mate Date **B.Wilson** **27/11/03**	**Demate Date**	**Mate Date**	**Demate Date**	**Mate Date**	**Demate Date**	**Mate Date**	**Demate Date**	**Mate Date**	**Demate Date**
AFTER 5 CYCLES CARRY OUT VISUAL INSPECTION (RECORD RESULT BELOW)									

CONNECT I/D	DEBRIS	BENT PINS	REMARKS	PASS	FAIL	SIGNATURE

Mate Date	**Demate Date**	**Mate Date**	**Demate Date**	**Mate Date**	**Demate Date**	**Mate Date**	**Demate Date**	**Mate Date**	**Demate Date**
AFTER 10 CYCLES VISUAL INSPECTION WITH MAGNIFICATION (RECORD RESULTS BELOW)									

CONNECT I/D	DEBRIS	BENT PINS	PIN HTS	REMARKS	PASS	FAIL	SIGNATURE
NB: IN CASE OF FAILURE AN NCR IS REQUIRED, INFORM PA Manager							

CONNECTOR MATE / DEMATE LOG									
PROJECT SPIRE				**EXPERIMENT**					
S / SYSTEM BSM			**UNIT PFM**			**IDENT NO. REDUNDANT FLEXI FRAME**			
ID		**ID**		**ID**		**ID**		**ID**	
Mate Date **B.Wilson** **27/11/03**	**Demate Date**	**Mate Date**	**Demate Date**	**Mate Date**	**Demate Date**	**Mate Date**	**Demate Date**	**Mate Date**	**Demate Date**

AFTER 5 CYCLES CARRY OUT VISUAL INSPECTION (RECORD RESULT BELOW)						
CONNECT I/D	DEBRIS	BENT PINS	REMARKS	PASS	FAIL	SIGNATURE

Mate Date	**Demate Date**	**Mate Date**	**Demate Date**	**Mate Date**	**Demate Date**	**Mate Date**	**Demate Date**	**Mate Date**	**Demate Date**

AFTER 10 CYCLES VISUAL INSPECTION WITH MAGNIFICATION (RECORD RESULTS BELOW)							
CONNECT I/D	DEBRIS	BENT PINS	PIN HTS	REMARKS	PASS	FAIL	SIGNATURE
NB: IN CASE OF FAILURE AN NCR IS REQUIRED, INFORM PA Manager							

CONNECTOR MATE / DEMATE LOG									
PROJECT SPIRE				**EXPERIMENT**					
S / SYSTEM BSM				**UNIT PFM**		**IDENT NO. REDUNDANT FLEXI BASE**			
ID		**ID**		**ID**		**ID**		**ID**	
Mate Date **B.Wilson 27/11/03**	**Demate Date**	**Mate Date**	**Demate Date**	**Mate Date**	**Demate Date**	**Mate Date**	**Demate Date**	**Mate Date**	**Demate Date**
AFTER 5 CYCLES CARRY OUT VISUAL INSPECTION (RECORD RESULT BELOW)									

CONNECT I/D	DEBRIS	BENT PINS	REMARKS	PASS	FAIL	SIGNATURE

Mate Date	**Demate Date**	**Mate Date**	**Demate Date**	**Mate Date**	**Demate Date**	**Mate Date**	**Demate Date**	**Mate Date**	**Demate Date**
AFTER 10 CYCLES VISUAL INSPECTION WITH MAGNIFICATION (RECORD RESULTS BELOW)									

CONNECT I/D	DEBRIS	BENT PINS	PIN HTS	REMARKS	PASS	FAIL	SIGNATURE
NB: IN CASE OF FAILURE AN NCR IS REQUIRED, INFORM PA Manager							

CONNECTOR MATE / DEMATE LOG

PROJECT **SPIRE** | **EXPERIMENT**

S / SYSTEM **BSM** **UNIT** **PFM** **IDENT NO. PRIME FLEXI BASE**

ID		**ID**		**ID**		**ID**		**ID**	
Mate Date	**Demate Date**	**Mate Date**	**Demate Date**	**Mate Date**	**Demate Date**	**Mate Date**	**Demate Date**	**Mate Date**	**Demate Date**
B.Wilson 27/11/03									

AFTER 5 CYCLES CARRY OUT VISUAL INSPECTION (RECORD RESULT BELOW)

CONNECT I/D	DEBRIS	BENT PINS	REMARKS	PASS	FAIL	SIGNATURE

Mate Date	**Demate Date**	**Mate Date**	**Demate Date**	**Mate Date**	**Demate Date**	**Mate Date**	**Demate Date**	**Mate Date**	**Demate Date**

AFTER 10 CYCLES VISUAL INSPECTION WITH MAGNIFICATION (RECORD RESULTS BELOW)

CONNECT I/D	DEBRIS	BENT PINS	PIN HTS	REMARKS	PASS	FAIL	SIGNATURE

NB: IN CASE OF FAILURE AN NCR IS REQUIRED, INFORM PA Manager

CONNECTOR MATE / DEMATE LOG

PROJECT **SPIRE** | **EXPERIMENT**

S / SYSTEM **BSM** **UNIT** **PFM** **IDENT NO. PRIME**

ID		**ID**		**ID**		**ID**		**ID**	
Mate Date	**Demate Date**	**Mate Date**	**Demate Date**	**Mate Date**	**Demate Date**	**Mate Date**	**Demate Date**	**Mate Date**	**Demate Date**
D.McN **12/12/03**	**D. McN** **15/12/03**	**D. McN** **13 Jan 2004**	**D. McN** **26 Feb 2004**	**D. McN** **8 Mar 2004**					

AFTER 5 CYCLES CARRY OUT VISUAL INSPECTION (RECORD RESULT BELOW)

CONNECT I/D	DEBRIS	BENT PINS	REMARKS	PASS	FAIL	SIGNATURE

Mate Date	**Demate Date**	**Mate Date**	**Demate Date**	**Mate Date**	**Demate Date**	**Mate Date**	**Demate Date**	**Mate Date**	**Demate Date**

AFTER 10 CYCLES VISUAL INSPECTION WITH MAGNIFICATION (RECORD RESULTS BELOW)

CONNECT I/D	DEBRIS	BENT PINS	PIN HTS	REMARKS	PASS	FAIL	SIGNATURE

NB: IN CASE OF FAILURE AN NCR IS REQUIRED, INFORM PA Manager

CONNECTOR MATE / DEMATE LOG									
PROJECT SPIRE				**EXPERIMENT**					
S / SYSTEM BSM			**UNIT PFM**			**IDENT NO. REDUNDANT**			
ID		**ID**		**ID**		**ID**		**ID**	
Mate Date	**Demate Date**	**Mate Date**	**Demate Date**	**Mate Date**	**Demate Date**	**Mate Date**	**Demate Date**	**Mate Date**	**Demate Date**
D.McN 12/12/03	**D. McN 15/12/03**	**D. McN 13 Jan 2004**	**D. McN 26 Feb 2004**	**D. McN 8 Mar 2004**					

AFTER 5 CYCLES CARRY OUT VISUAL INSPECTION (RECORD RESULT BELOW)						
CONNECT I/D	DEBRIS	BENT PINS	REMARKS	PASS	FAIL	SIGNATURE

Mate Date	**Demate Date**	**Mate Date**	**Demate Date**	**Mate Date**	**Demate Date**	**Mate Date**	**Demate Date**	**Mate Date**	**Demate Date**

AFTER 10 CYCLES VISUAL INSPECTION WITH MAGNIFICATION (RECORD RESULTS BELOW)							
CONNECT I/D	DEBRIS	BENT PINS	PIN HTS	REMARKS	PASS	FAIL	SIGNATURE
NB: IN CASE OF FAILURE AN NCR IS REQUIRED, INFORM PA Manager							

3.16 BLANK

This section not used (retained for compatibility of numbering sequence with RAL ADP)

3.17 Pressure Vessel Test Record

Not supplied

3.18 Calibration Data record

To come BS

3.19 Temporary Installation Record

Red Tag Items: (remove before integration)

1. BSM connector cover caps : 2 off. Remove before bake-out or before fitting mating connectors.

Green Tag Items: (insert before integration)

None.

3.20 Open Work / Deferred Work / Open Tests

Additional tests ….

Additional staking of wiring	To done after testing has been completed and before shipping
Staking of tie wrap knots	To done after testing has been completed and before shipping
Fitting of PCAL	To be carried out at RAL
Fitting of Thermistors	To be carried out at RAL

3.21 List of Non-Conformance reports (NCR's)

No.	Non-Conformance Details	Status	Raised Date
SPI-BSM-NCR-000	This is a blank NCR raised to commence a numbering scheme for the BSM. SPI = SPIRE BSM = Beam steering Mirror NCR = Non Conformance Report 000 = unique number for NCR	CLOSED	25/09/2001
SPI-BSM-NCR-002	JIGGLE FRAME holes B tapped through, not tapped to depth MANUFACTURE FOR 2 AXIS PROTOTYPE. drg no. 01a05a.	CLOSED	28/09/2001
SPI-BSM-NCR-003	JIGGLE FRAME - tool dig on bore and one face Drg No 01a05a	CLOSED	28/09/2001
SPI-BSM-NCR-005	INTERFACE PLATE DRG SPIRE-BSM-020-001-001 REV 2 M4 INSERTS FITTED AS NON-LOCKING TYPES NOT TO HAND	CLOSED	25/04/2002
SPI-BSM-NCR-006	BSM STRUCTURAL INTERFACE. Drg. No. SPIRE-BSM-020-001-001 issue 3 Jiggle axis bore is off centre by 0.3mm. Towards datum. (41.2mm)	CLOSED	30/04/2002
SPI-BSM-NCR-007	JIGGLE FRAME BOTTOM. Drg. No. SPIRE-BSM-020-003-001 issue 3 1. Pocket oversize. 2. Height in jiggle axis out of tolerance, should be 15.25mm, actual 15.0mm	CLOSED	30/04/2002
SPI-BSM-NCR-008	BSM ASSEMBLY MODEL. DM-1 Drg. No.SPIRE-BSM-020-001 See notes from inspection record. 1. Jiggle sensor helicoils stripping out & and protrude from base of G10 component. 3. Jiggle clamp bottom right bolt found to be <20 Ncm. May not have been torqued? 7. Chop pivot bore in the jiggle frame has witness marks from sleeve adhesive holes. May be that chop sleeve had some trace adhesive around holes.	CLOSED	30/04/2002
SPI-BSM-NCR-009	NON CONFIGURED DOCUMENTS BEING USED FOR MANUFACTURE. Noted in the workshop that for the Jiggle frame (SPIRE-BSM-003-001 & -002) there are 3D views of the part being used for information during machining. These are not configuration controlled and are bad practice akin to handwritten auxiliary instructions.	CLOSED	09/05/2002
SPI-BSM-NCR-011	FRONT BAFFLE Drg No.SPIRE-BSM-020-001-009 version 1 #0002. 2 Holes added to front face of baffle. This was to allow clearence for jiggle frame bolts. Washers used for balance caused bolt heads to hit cover.	CLOSED	08/07/2002
SPI-BSM-NCR-012	DURING RE-ASSY OF DM-1 AS STM ONE OF THE JIGGLE FRAME CAP SCREWS FAILED WHEN BEING TORQUED TO THE SPECIFIED VALUE OF 920Nmm	PENDING	08/08/2002
SPI-BSM-NCR-015	Bolt positions on assembly drawing (SPIRE-BSM-020-003 sht.1&2 SPIRE-BSM-020-004) do not correspond with clearance holes on machining drawing (SPIRE-BSM-020-004-001)	CLOSED	02/09/2002

No.	Non-Conformance Details	Status	Raised Date
SPI-BSM-NCR-016	"E" Holes in Structural Interface (Drg. No. SPIRE-BSM-020-001-001) do not line up with "B" holes in BSM Base Plate (Drg. No. SPIRE-BSM-020-001-002). Due to machining allowance on base plate.	CLOSED	09/09/2002
SPI-BSM-NCR-019	STM : PCAL INTERFACE LACK TAPPED HOLES (DRG SPIRE-BSM-020-001-001 REV 3).	CLOSED	21/10/2002
SPI-BSM-NCR-022	DM2 motor cover serial no # 0041 foul on wires during assy.	CLOSED	01/11/2002
SPI-BSM-NCR-023	DM2 motor ser No. 0040 middle mounting helicoil has been replaced and first half turn is not supported by thread in al. alloy body.	CLOSED	08/11/2002
SPI-BSM-NCR-024	M2.5 nut used to hold launch latch on to structure is not traceable	CLOSED	04/12/2002
SPI-BSM-NCR-025	Solder joints not conforming to ECSS-Q-70-08A, excessive solder and solder spikes.	CLOSED	16/12/2002
SPI-BSM-NCR-026	baffle - spire-bsm-023-001-009 dos not have 5mmx45deg chamfer in 4 places.	CLOSED	31/01/2003
SPI-BSM-NCR-030	Screw removed from middle fixing hole on motor 0038 has damage at one point on the thread.	CLOSED	20/03/2003
SPI-BSM-NCR-031	DM-2 tayco flexi tape : clamp design does not fully retain the outer connector on thr BSM structure	CLOSED	03/04/2003
SPI-BSM-NCR-032	JIGGLE AXIS BORE MISALIGNMENT	CLOSED	10/10/2003
SPI-BSM-NCR-033	Wires for motor packages sitting slightly proud fowling on the motor cover	CLOSED	10/12/2003
SPI-BSM-NCR-034	Fail safe rest position (i.e. power off position of mirror) measured (16/01/04) at 0.23 deg chop (specification 0.18 deg). Note the value for jiggle is within spec. at 0.09 deg. The rest position was set within specification when warm (at 0.10 deg in jiggle, almost 0 in chop) but on cooldown has shifted.	OPEN	19/01/2004
SPI-BSM-NCR-035	Heatshrink debris found after shake test. Heatshrink on P-clips torn.	PENDING	02/03/2004
SPI-BSM-NCR-036	Mirror does not give full range of movement.	OPEN	03/03/2004
SPI-BSM-NCR-038	Wiring of motor coils incorrect. Labels had fallen off before wiring completed and wires got swapped over.	CLOSED	12/03/2004

3.22 Copies of Non-Conformance reports (NCR's)

EXTERNAL AUDIT

Non-Conformance Details

Number
SPI-BSM-NCR-019

Printed on 19/03/2004

Source EXTERNAL AUDIT	**Project/Support Area** SPIRE	**Process**
Audit Title	**Procedure**	
Department / Supplier MECHANICAL	**Cause / Reason** DOCUMENTATION /INCORRECT	
Raised By SPIRE CUST	**Severity** MAJ	**Date** 21/10/2002

Non-Conformance Details
STM : PCAL INTERFACE LACK TAPPED HOLES (DRG SPIRE-BSM-020-001-001 REV 3).

Product / Service SPIRE /SPIRE-STM	**Filename**

Corrective Action

Target CA Date	Actual CA Date	Cost	Supporting Actions	Responsible for CA
04/11/2002	07/11/2002		2	PAIN, IAN

Corrective Action
1. DRAWING NEEDS TO BE UPDATED TO INCLUDE TAPPED HOLES
2. TAP HOLES AND FIT INSERTS. NOTE! IF THIS RE-WORK CAN BE DONE IN CLEAN ROOM CONDITIONS IT WILL SAVE SIGNIFICANT EXTRA COST OF DIS/RE/ASSEMBLY

Preventive Action

PA Required	Target PA Date	Actual PA Date	Responsible for PA
No			

Preventive Action

Follow Up/Verification

Resolution	Responsible for Follow-up Action
REWORK	BAILLIE,, TOM

Follow-Up / Verification
re-worked and inspected by TECB. required a strip down to ensure no swarf ingress. Re-assemled afterwards.

Status	Actual Close Date	Approver
CLOSED	07/11/2002	PAIN, IAN

CONCESSION

Non-Conformance Details

Number	
SPI-BSM-NCR-032	Printed on 19/03/2004

Source	Project/Support Area	Process
CONCESSION	SPIRE	DESIGN AND DEVELOPMENT

Audit Title	Procedure

Department / Supplier	Cause / Reason
MECHANICAL	

Raised By	Severity	Date
PAUL, TOM	MAJ	10/10/2003

Non-Conformance Details
JIGGLE AXIS BORE MISALIGNMENT

Product / Service	Filename
SPIRE-SPIRE-FSM	

Corrective Action

Target CA Date	Actual CA Date	Cost	Supporting Actions	Responsible for CA
15/10/2003	11/12/2003		0	PAUL, TOM

Corrective Action
A RECOVERY PROCEDURE WAS DEVISED IN THAT IF THE JIGGLE AXIS BORES WERE MACHINED OVERSIZE AT THE CORRECT ANGLE THEN WE COULD SLEEVE THE FLEX-PIVOTS TO BRING BACK TO THE NEW DIA. THIS NEW DIA WOULD BE THE SAME AS THE EXISTING FLEX PIVOT PROTECTION SLEEVE DIA. AS THIS PROCESS HAS ALREADY BEEN PROVEN AND THE TOLERANCES CALCULATED.

Preventive Action

PA Required	Target PA Date	Actual PA Date	Responsible for PA
No			

Preventive Action

Follow Up/Verification

Resolution	Responsible for Follow-up Action
ACCEPT AS IS /WITHOUT WAIVER	PAUL, TOM

Follow-Up / Verification

CTD 03-11 RAISED

Status	Actual Close Date	Approver
CLOSED	11/12/2003	PAUL, TOM

CONCESSION

Non-Conformance Details

Number	
SPI-BSM-NCR-034	Printed on 19/03/2004

Source	**Project/Support Area**	**Process**
CONCESSION	SPIRE	DESIGN AND DEVELOPMENT

Audit Title	**Procedure**	
Department / Supplier PROJECT MANAGEMENT	**Cause / Reason** PROCESS /AMBIGUOUS	
Raised By	**Severity** MAJ	**Date** 19/01/2004

Non-Conformance Details
Fail safe rest position (i.e. power off position of mirror) measured (16/01/04) at 0.23 deg chop (specification 0.18 deg). Note the value for jiggle is within spec. at 0.09 deg.
The rest position was set within specification when warm (at 0.10 deg in jiggle, almost 0 in chop) but on cooldown has shifted.

Product / Service	**Filename**
SPIRE-SPIRE-PFM	SPI-BSM-OTH-0012

Corrective Action

Target CA Date	**Actual CA Date**	**Cost**	**Supporting Actions**	**Responsible for CA**
19/01/2004			0	MCNEILL, DAVID

Corrective Action
Corrective action proposed is to accept as is and continue with test programme. The zero datum used by the servo will be made to correspond to the fail-safe position, by offsetting the linearisation curve. This assumes that on the Spire Optical Bench the BSM will be aligned to this same point using the shoe and/or other alignment mirrors. (To bring BSM within spec. means a warm up, partial strip down and putting the appropriate offset in the warm position. This operation is believed to be too risky.)

Preventive Action

PA Required	**Target PA Date**	**Actual PA Date**	**Responsible for PA**
No			

Preventive Action

Follow Up/Verification

Resolution	**Responsible for Follow-up Action**
ACCEPT AS IS /WITH WAIVER	

Follow-Up / Verification
Spire project indicate acceptance likely provided an angular offset is made in only one axis. This will be the case since it is within spec in jiggle.

Status	**Actual Close Date**	**Approver**
OPEN		PARR-BURMAN, PHIL

CONCESSION

Non-Conformance Details

Number
SPI-BSM-NCR-036

Printed on 19/03/2004

Source	**Project/Support Area**	**Process**
CONCESSION	SPIRE	

Audit Title	**Procedure**

Department / Supplier	**Cause / Reason**
WORKSHOP	CAUSE UNKNOWN, NEEDS INVESTIGATION

Raised By	**Severity**	**Date**
	MAJ	03/03/2004

Non-Conformance Details
Mirror does not give full range of movement.

Product / Service	**Filename**
SPIRE-SPIRE-PFM	Brian Stobie Tech Note - number ???

Corrective Action

Target CA Date	**Actual CA Date**	**Cost**	**Supporting Actions**	**Responsible for CA**
			0	STOBIE, BRIAN

Corrective Action
For PFM: Leave unit as is. Raise RFW once the final values for range of movement with 50mA and with 60mA are known.
For FSM: Fit alternative magnets with higher thermal resistance.

Preventive Action

PA Required	**Target PA Date**	**Actual PA Date**	**Responsible for PA**
No			

Preventive Action

Follow Up/Verification

Resolution	**Responsible for Follow-up Action**

Follow-Up / Verification
Test report has the range of motion values. SPI-BSM-NOT-0728

Status	**Actual Close Date**	**Approver**
OPEN		

SPIRE Technical Note – Motor Magnets

Author :	Brian Stobie
Date:	23-Feb-04
Version:	1.0

Distribution LIST:

SPIRE-Project	Doug Griffin	
	Eric Clark	
UK ATC	Colin Cunningham	
	Gillian Wright	
	Phil Parr Burman	
	Tom Baillie	
	Brian Stobie	
	Tom Paul	
	Ian Laidlaw	
	Gary Rae	
	Derek Ives	
	Ian Bryson	

Version Control

Date	Index	Remarks
23-Feb-04	1.0	New release

Table of Contents

BACKGROUND

The SPIRE Beam-Steering Mirror (BSM) uses linear motors composed of two parallel coils and a disc magnet between them. The angular position of the BSM axis is dependant on the strength of axis flex joints, which act like rotational springs, and the motor force, which is in turn dependant on the product of the motor coil current and the magnetic field at the coil windings.

Each axis has 2 coil pairs and 2 magnets, with only 1 coil from each pair being used at a time. The other coils from the pairs are used as the 'Redundant' backup in the event of failure.

DESCRIPTION OF PROBLEM(S)

The motor coil design is fixed by the requirements of the PACS contract, as we just obtain PACS coils with no input to the design. However, the magnet material and shape is under our control (within mechanical constraints). To keep design heritage with the PACS motors, we decided to use the same magnet material type, Neodymium-Iron-Boron (NdFeB – specifically VACODYM 344) - however a UK-based magnet supplier (Magnetsales UK) was selected for reasons of price and delivery, i.e. they were cheaper and quicker than the PACS supplier, Vacuumschmeltze. As the PACS paper (1) also indicated a reduction of motor torque of only 2% between 300 and 4 degK, this magnet material seemed suitable for use.

The flex joint spring scale factor has been determined by the minimum required mechanical robustness to launch vibrations. Considerations of basic material properties predict increases in the spring scale factor of about 5% from 300 to 4 degK for the Jiggle axis, and 10% for the Chop axis.

The maximum coil current is limited by the BSM power dissipation requirements, the design of the power amplifier, and now system limitations imposed by the 'frozen' state of the design at this time, or rather the difficulty in changing requirements at this stage in the contract.

It was found that during development the balance between obtainable motor torque and required flex joint spring torque was resulting in a system that had a small design margin of approximately 10% in terms of available angle compared to specification requirements, therefore the maximum available current was requested to be increased from 40mA to 50mA.

Model DM2 had about 10% margin in maximum angles using currents of 50mA.

Due to shortages of motor coils from the manufacturer (Zeiss), previous models built (such as DM2) had solid iron cores in place of the Redundant, normally unused, coils.

The latest model built (the PFM model) is the first one to have all motor coils in place.

From considering the effects of moving magnets on conducting materials, it was considered that eddy currents would be produced in the dummy iron core, so that replacing the solid core with a laminated real core would result in better dynamic performance.

This dynamic performance has yet to be confirmed, but what has definitely been found on the PFM model is a further reduction in the available angles. It was postulated that the dummy core had been actually increasing the magnetic field at the coil, and this was confirmed during discussions with a magnetics consultant brought in to investigate the problem.

In addition, due to a wiring error, the PFM model had to be baked again to remove volatile compounds after re-potting, so another possible source of its poor performance could have been thermal effects on the magnets. The magnet material used had a specification maximum operating temperature of 80 degC, and the BSM was baked at 83 degC, but the thermostat in the oven could allow the temperature to rise to 85 degC for short periods.

To enable investigation of the problem, a Gaussmeter was purchased to measure magnet strength.

On testing using 6 spare magnets, the local magnetic field at a short distance from the magnet faces was found to decrease by 40% after baking for 30 minutes (Appendix A).

Further baking had little effect.

The magnet suppliers suggested that the 'form factor' (i.e. shape of the magnet with respect to the magnetic axis) was having an effect on the temperature capabilities.

Additionally, it had been clear from BSM testing that a reduction in maximum available angle occurred between 300 and 4 degK. Some causes were postulated to be:

- A reduction in magnet strength
- A reduction in available current
- An increase in flex joint spring scale factor
- Some unknown magnetic effect such as permeability change in the cores

some combination of the above

From angle tests using a basic power supply and meter, and combined with load resistance and measurements of voltage, item b) was discounted. In passing, these tests also indicated that an increase in the available current from 50mA to 60mA would enable the PFM to meet its angle specifications and get back to about 9% design margin.

After an internet search, a paper was found (2) that suggested a theoretical drop of about 14% due to temperature effects in NdFeB material, and the supporting graph (from another paper quoted in (2)) shows reductions of over 20% between 300 and 4 degK. Of particular interest to PFM test results (discussed later) is a rise in the graph of magnet strength peaking at around 150 degK from the value of 300 degK.

Note that in common with other materials and components; in general there is little information available about the cryogenic properties of magnets.

After some consideration, samples of higher operating temperature (120 degC) NdFeB magnets and also Samarium-Cobalt (SmCo) magnets were obtained from our UK supplier.

SmCo usually has lower room-temperature strength than NdFeB but higher operating temperature, and smaller low-temperature effects. The end result at 4 degK is very similar for typically available magnet grades. In passing it is noted that ISOPHOT and SMEC use SmCo magnets.

After applying exactly the same bakeout tests as had been done previously to the '80 degC' magnets, it was found that these magnet samples were essentially unaffected (Appendix B).

Tests on the PFM model (Appendix C) indicated that the Chop flex joint spring scale increase on cooling (300 to 4 degK) was about 3.9%, and the net change in the magnet strength was about -5.1% excluding the bakeout effect. The magnet strength increase noted in paper[1] was also confirmed, but this effect appears larger than the values suggested by the paper. However, it should be noted that some of the tests were done at basically unknown magnet temperatures due to the large thermal time constants between the magnets and the BSM base where the temperature sensors are. This might explain the disparity between these results and the paper[2] and previous tests on the Jiggle axis indicating an angle reduction due to temperature of about 17%.

As previously noted, the flex joint material properties suggest an increase of 10% for the Chop axis spring scale factor, so this test result is also inconsistent with theory, but in our favour for a change.

PROPOSED SOLUTION

Discussions with the magnetics consultant had also confirmed a belief that using thicker magnets would also produce a higher field at the coils, therefore the design solution proposed is to use slightly thicker magnets (2.5mm instead of 2.0mm) and use a higher-temperature NdFeB magnet grade.

Conceptually we should gain at least 40% on magnet strength by avoiding the bake-out problems we currently have.

There is a slight design risk from the reduced magnet-coil gap due to mechanical shifts, particularly with launch vibration, and perhaps thermal shrinkage.

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[1] Group Arnold Technote TN 0302, 'Using Permanent Magnets at Low Temperatures', (Stanley Trout).

[2] Krause, Lemke, Grozinger, Bohm,Baumeister and Rohloff, 'A Cold Focal Plane Chopper for the PACS Instrument of the FIRST satellite – Tests of an Advanced Prototype'

Additionally, NdFeB magnets are to be obtained from Vacuumschmelze as a backup in case the Magnetsales products prove unsuitable after testing. A 7-day bake-out needs to be performed to replicate the system level bake-out that RAL will perform at a later stage in the program.

The plan is to ‘upgrade’ the Flight Spare to the stronger, thicker magnets and ask RAL for the 60mA as well, thus allowing the PFM to be tested and delivered without having to replace its magnets. At some later date, the Flight Spare would become the launch item.

APPENDIX A

SPIRE BSM LAB TESTS LOG SHEET.

Date: 10 / 2 / 04 SPIRE Model: Magnets for Flight Models Tester: D. McNeill

Test 1

Testing the rest of the batch of magnets (24 off) that the ones in the PFM model are from. Testing for Spread of strength- variability between magnets in same batch. See '090204 Magnets testing Method.doc' for test of apparatus and method.

Test 2

PFM was baked twice at 80 deg C, the second time the temperature rose to 85 degrees C. Hence, to see the effect of this, bake 6 magnets (from same batch as that of test 1) at 80 deg C, baking once; then bake three of them again. Take note of magnet strengths at each point, before and after baking. Baking time is 30 minutes in normal oven (not vacuum oven).

First bake, have temperature reach 86 deg C since the PFM was baked out at a peak of 85: Hence we can see the effect of that temperature on the magnets.

Nb. During the second bake in test 2, where 3 magnets are being baked for the second time, include another 2 fresh, non-baked magnets, and bake this time to a peak of 80 degrees and no higher, so we can see any difference in effect of baking at 80 degrees than at 86 (specification temperature limit of these magnets is 80 deg C).

Since the Flight models, and their magnets will be baked out a number of times at 80 deg C, bake some again at 80 C, testing for changes in strength after repeated bakes. Test these again at 90 to investigate changes in strength at higher temperatures.

Test 3

Cool magnets to 77K and test for strength as they warm up to room temperature.

Apparatus used:

GM04 Gaussmeter	Ser. No: GM1166
With Transverse probe S/N:	PT3373
Magnets MSS	Part No. NIDC 01177/N
Batch No. 33/02	
Small Oven: Genlab Model N6C	Ser. No 93D004

Notes on Test 1:

Testing 2mm magnets in white tub- rest of PFM batch for variability.

Magnet #	Magnet Strength +ve side (mT)	Magnet Strength –ve side (mT)
1	178.5	-189.7
2	180.2	-189.7
3	174.3	-191.2
4	180.7	-181.5
5	191.6	-173.8
6	187.7	-184.5
7	173.5	-189.9
8	192.4	-174.7
9	179.8	-164.3
10	187.2	-186.3
11	186.6	-181.5
12	193.2	-173.2
13	191.6	-178.4
14	176.4	-181.9
15	190.1	-177.5
16	181.9	-187.0
17	188.8	-180.8
18	186.3	-179.9
19	188.3	-178.8
20	191.9	-170.0
21	169.4	-193.2
22	179.5	-190.3
23	179.2	-189.8
24	196.6	-174.2

Observations:

Mean of moduli of both sides: 183.08mT

Range: 32.3mT

Std. Deviation: 7.46mT

Conclusion of Test 1.

Magnets are quite similar in strength: there is not a large spread of strengths.

Notes on Test 2:

Magnets used: 1, 5, 11, 15, 19, 22. Bake 1 is at 86 deg C peak, bake 2 is at 80 deg C peak.

For bake-out records, see Appendix 1.

Magnet No.	Strength Before bake 1 (mT)	Strength After bake 1 (mT) * 86 deg C	Strength After bake 2 (mT). ** 80 deg C	Strength After bake 3 (mT). ** 80 deg C	Strength After bake 4 (mT). ** 90 deg C
1	179.5, -191.7	110.8, -121.5	110.2, -123.4	111.5, -123.5	Results available after measurement
		109.6, -120.8	110.8, -122.9	111.4, -122.6	
		111.4, -123.4			
		111.8, -123.0			
5	188.3, -172.2	121.0, -106.5			
		121.5, -105.8			
		121.4, -107.4			
		119.7, -106.6			
11	186.3, -183.5	107.5, -103.1	106.6, -103.7	108.5, -104.7	“
		106.7, -103.6	105.8, -103.4	107.7, -103.5	
		107.5, -105.1			
		108.0, -104.2			
15	190.6, -180.2	123.3, -114.8			
		124.0, -115.0			
		125.6, -115.2			
		122.9, -115.0			
19	191.2, -175.8	112.8, -102.9			
		111.9, -99.9			
		112.4, -99.9			
		112.1, -99.6			
22	178.5, -189.7	109.4, -117.7	108.6, -117.4	108.8, -115.1	“
		109.0, -116.4	108.7, -116.8	109.1, -115.9	
		110.1, -118.8			
		108.5, -118.4			

* The first 4 readings for each magnet in this column are taken 10+ minutes after removal from oven. The second 4 readings for each magnet are taken the following morning, approximately 17 hours after baking.

** These readings taken >= 1 hour after baking.

Magnet #	Before bake 1 strength mT (average)	After bake 1 strength mT (average)	After bake 2 strength mT (average)		After bake 1, fraction decrease	After bake 2, fraction decrease from before bake 1
1	185.6	116.54	116.83		0.62790948	0.62947198
5	180.25	113.74			0.63101248	
11	184.9	105.71	104.88		0.57171444	0.56722553
15	185.4	119.48			0.64444444	

19	183.5	106.44			0.5800545	
22	184.1	113.54	112.88		0.61673004	0.61314503
averages:	183.9583333	112.575	111.53		0.61197756	0.60328085

Two magnets baked to 80 deg C (peak temp) for first time, baked with the magnets 22, 1, 11 which are being baked for the second time, as described in test description.

Magnet No.	Strength before bake (bake 2) (mT)	Strength ~20 mins after bake to 80 deg peak (mT)
6	188.5, -182.3	114.0, -112.0
	187.3, -185.4	114.8, -110.3
10	191.0, -192.4	114.8, -119.6
	190.8, -191.3	115.0, -115.9

Two magnets cooled to 77K and tested for strength as they warm up, as described in the test description. Testing one that has been baked once to 80 deg, and one magnet that has not been previously baked.

Magnet #	Strength before cooling	Strength straight after	30 secs after	1 min after	2 min after	4 min after	6 min after	10 min after	20 min after
2	178.1,	202.0,	185.8,	181.7,	177.2,	175.0,	173.4	174.1,	176.1
	-192.6	-213.4	-205.0	-201.0	-197.5	-195.0	-193.9	-195.8	-194.2
6	114.7,	129.5,	124.2	121.1	118.0	115.8	115.8	114.5,	N/A
	-112.0	-127.0	-121.0	-117.8	-114.0	-113.2	-111.2	-111.0	

Magnets were measured by re-immersing after the first 4 readings after cooling. This is to keep readings dependable: turning magnets over to measure other side takes too long and heats them up.

Results:

Conclusion:

Appendix 1

Record of baking:

Bake 1.

Time in oven	Temp (deg C)
0 min	70
5 min	73
12 min	78
16 min	81
20 min	82.5
22 min 30	83.5
25 min	86
27 min 30	84
30 min	80

Bake 2.

Time in oven	Oven Temp (deg C)
0 min	76
2 min 30	70
5 min	71
7 min 30	72.5
10 min	74
12 min 30	76
15 min	78
17 min 30	79
20 min	80
23 min 30	80
25 min	79
27 min 30	78
30 min	77.5

Bake 3.

Time in oven	Oven Temp (deg C)
0 min	76
2 min 30	72.5
9 min	77.5
12 min 30	79
17 min 30	80
24 min	80
27 min 30	79.5
30 min	79

Bake 4

Time in oven	Oven Temp (deg C)
0 min	77
2 min 30	72.5
7 min 30	80
12 min 30	86
18 min 30	89.5
22 min 30	91
27 min 30	90
30 min	89

APPENDIX B

(D.MacNeill)

The following are results for the 35 minute bake at 80.5 deg C (max) of the new 'Magnet Sales' magnets:

In summary, neither of these magnets shows any decrease in performance as a result of the bake.

SmCo rated for use at 300 deg C with no fall in strength;
NdFeB rated for use at 120 deg C with no fall in strength.

Magnet strength before (mT):

SmCo 189.4, -185.7; 189.2, -185.8.	Average strength: | 187.5 |
NdFeB 194.8, -183.0; 194.9, -180.5	Average strength: | 188.3 |

Magnet strength after (mT):
(Test >15 minutes after to allow time to cool)

SmCo 188.7, -182.7; 187.8, -184.2	Average strength: | 185.9 |
NdFeB 200.0, -178.4; 195.8, -182.7	Average strength: | 189.2 |

APPENDIX C

The PFM Chop axis was moved to the position where maximum current of 50mA existed, then released to settle at its rest position.

From figure 1, showing the results at various temperatures, it can be noted that :

Temperature (degK)	Amplitude (arbitrary units)	Period (arbitrary units)
294	62.0	7.85
225	66.1	7.85
4	56.6	7.7

(The smallest amplitude shows the oscillation frequency at 294 degK, but is not marked as such on the graph. The '62.0' amplitude measured above was done separately using a power supply to force the 50mA through the motor.)

The frequency of oscillation of a linear spring-inertia system is given by sqrt(Ks/J), where:

Ks = spring constant (force per angle)

J = Inertia

As the inertia is essentially fixed for the experiment, it means that any change in oscillation frequency must be due to changes in spring constant. The actual change in spring stiffness will be proportional to the square of the frequency change.

The angle achieved is proportional to the ratio of the spring scale factor and the motor force. However at a fixed current, the motor force is just proportional to the magnet field strength, therefore the angle is proportional to Fm/Ks, and where Fm is the magnet strength and Ks is the spring scale factor.

We can then construct the following table of results (changes from 294 degK):

Temp (degK)	delta Angle	delta Oscillation Frequency	delta Spring Const.	delta Magnet Force
294	(at 62.0)	(at 1/7.85)	n/a	n/a
225	66.1/62.0 = 1.066 = + 6.6%	no measurable change	0	+6.6%
4	56.6/62.0 = 0.913 = -8.7%	0.12987/0.12739 =1.0195	1.0195^2 = 1.0393 = +3.9%	0.913*1.0393 = 0.949 = - 5.1%

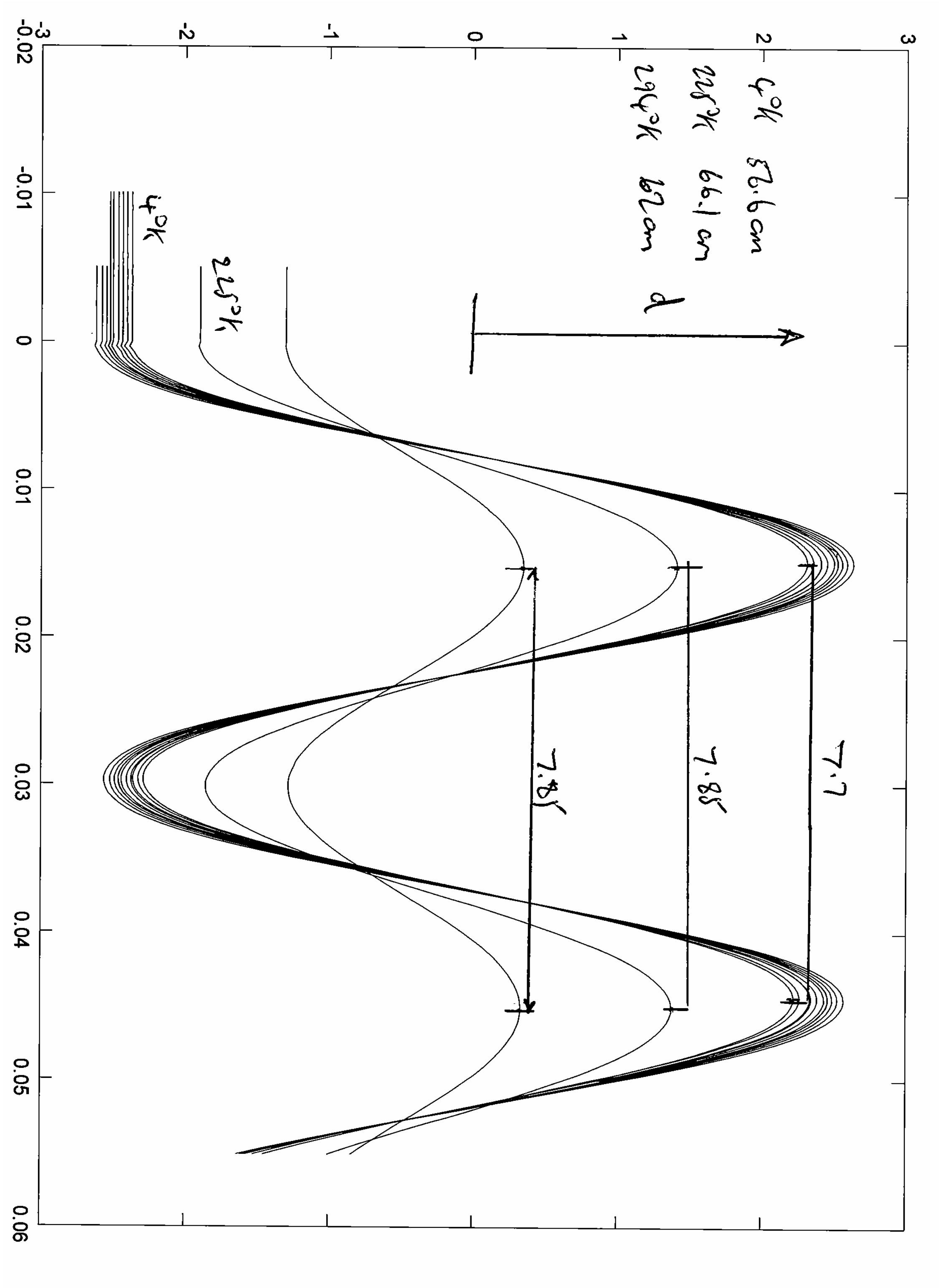

-3
-2
-1
0
1
2
3
-0.02
-0.01
0
0.01
0.02
0.03
0.04
0.05
0.06
4°K 57.6cm
228°K 66.1 cm
294°K 62cm
d
4°K
225°K
7.7
7.85
7.85

FIGURE 1

PROCESS

Non-Conformance Details

Number	
SPI-BSM-NCR-038	Printed on 19/03/2004

Source	Project/Support Area	Process
PROCESS	SPIRE	

Audit Title	Procedure

Department / Supplier	Cause / Reason
WORKSHOP	PROCESS /AMBIGUOUS

Raised By	Severity	Date
GRAHAM, BRENDA	MAJ	12/03/2004

Non-Conformance Details
Wiring of motor coils incorrect. Labels had fallen off before wiring completed and wires got swapped over.

Product / Service	Filename
SPIRE-SPIRE-PFM	

Corrective Action

Target CA Date	Actual CA Date	Cost	Supporting Actions	Responsible for CA
07/01/2004	12/03/2004		0	WILSON,, BRIAN

Corrective Action
Removed potting on motor housing to identify wires and re-wire BSM

Preventive Action

PA Required	Target PA Date	Actual PA Date	Responsible for PA
No			

Preventive Action

Follow Up/Verification

Resolution	Responsible for Follow-up Action

Follow-Up / Verification

Status	Actual Close Date	Approver
CLOSED	12/03/2004	GRAHAM, BRENDA

Test Reports

Spacecraft / Project	***Herschel***
Instrument / Model	***SPIRE***
Sub System / Serial No.	***BSMm***

Type of Test	Functional testing
AIV Facility Test No.	
Date(s) of Testing	10/03/04 (start date)
Applicable Test Specification *(Document No. & Issue)*	**SPIRE-ATC-PRJ-000736 Iss 4.0**
Applicable Test Procedure *(Document No. & Issue)*	**SPIRE-ATC-PRJ-000736 Iss 4.0**

Assignment of Personnel

Function	**Name**	**Contact number**
Test Director	David McNeil	
Project Manager	Philip Parr-Burman	
AIV Facility Manager		
Safety Officer		
Product Assurance	Brenda Graham	

Documentation / Inspection Status

Test Documentation available:

- AIV Facility Test Plan (if applicable?)
- Verification Procedures

Inspection Status and Records:

Cleanliness	BSM built in class 1000 clean room handled with gloves.
Unit/Item Bagged	Item installed into the Cryostat in the clean room.
Screws Locked	Screws locked apart from connector to be staked down after testing NCR raised. Wires also require to be staked down after testing.
Connector Savers	Connector savers installed for Prime and redundant connectors.
Hazards Identified	Liquid nitrogen and helium used to cool cryostat, test engineer trained in use of cryogenic liquids. Oxygen monitoring in lab.
Other	

CONTINUATION SHEET

As Built Status (Will the following have an Impact on the test performance / results?)	
Outstanding "NCR's"	No
Outstanding "Waiver's"	
"Open Work"	No
Other	

HARDWARE COMMENTS/ OBSERVATIONS:

Decision for test continuation		
Company	**Name**	**Signature**

3.23 BLANK

This section not used (retained for compatibility of numbering sequence with RAL EIDP)

3.24 Mass records / Power Budgets

Mass measurement contained in Test Report
Power budgets: See calibration data record

3.25 CLEANLINESS STATEMENT

Statement

The PFM has been cleaned, assembled and tested within a class 1000 clean room to meet the requirements of AD4.

Signed …………….. Brenda Graham, Product Assurance Manager, BSM.

Date ……………..

Information

A clean room is available at ATC premises, from range 100 to 1 000. Cleanliness has been checked and logged on a regular (approx weekly) basis.

For cooldown tests the PFM was integrated to the ATC test dewar within the clean room.

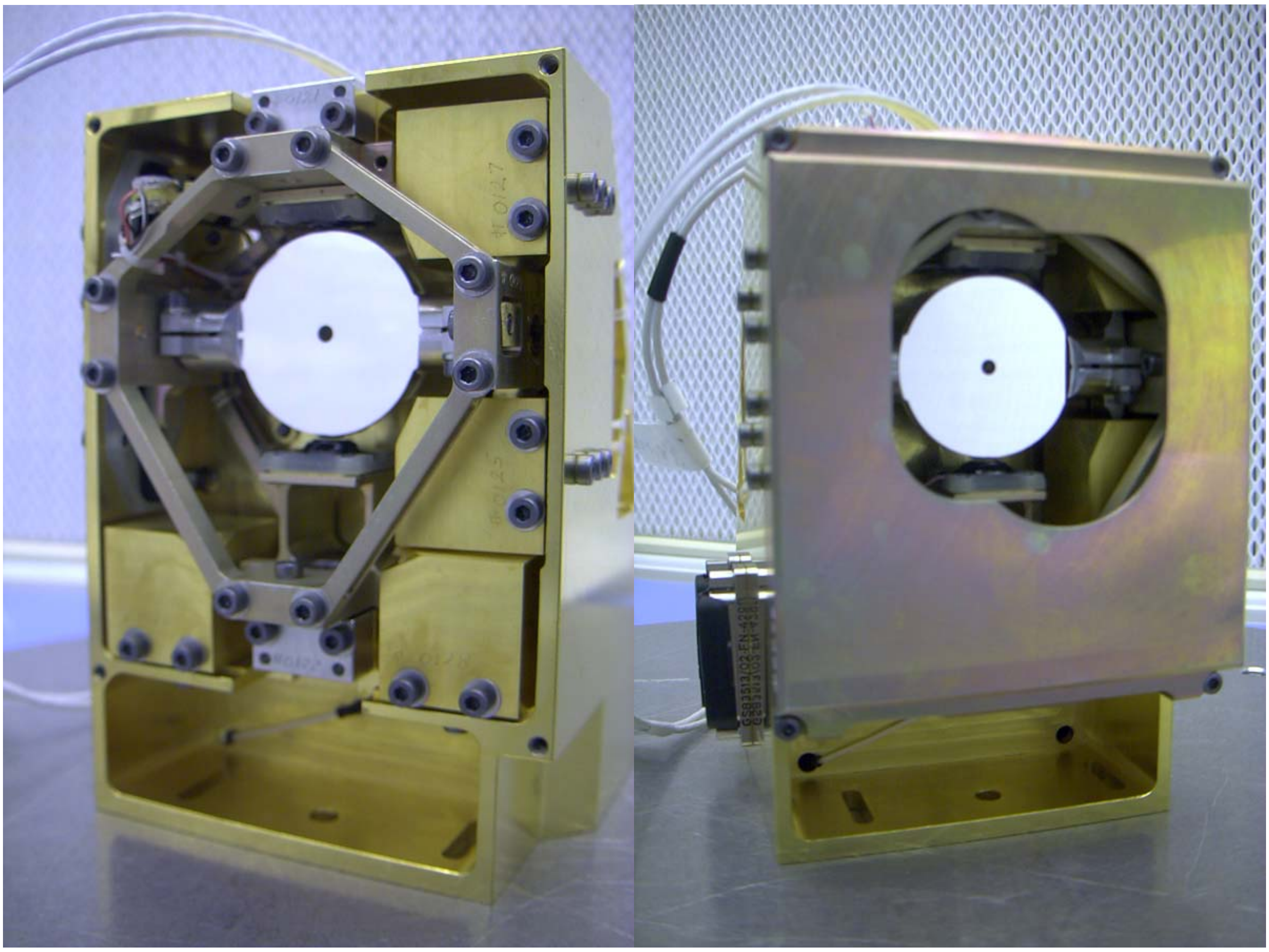
For Vibration test the PFM was transported using the Transport and handling procedure section 3.2. At RAL the PFM was bagged in an air tight back under a laminar flow before vibration testing.

For QMM measurements the PFM was placed in a bag in the clean room, this was then back filled with N2.

3.26 Compliance Matrix

This is contained in the SSSD (AD1) and the test report.

3.27 Photographs



Spire BSM PFM: Without and with Baffle: Dec 15th 2003