ALCATEL SPACE

SPIRE-ALC-MOM-001330

		REF. : H-P-ASPI-MN-1725
		DATE : ~~23~~ 23-24/07/02 — PAGE : 1/
COMPTE RENDU DE REUNION / *MINUTES OF MEETING*		LIEU / *PLACE :*
OBJET / *PURPOSE :* SPIRE		CLASSIFICATION :

PARTICIPANTS *ATTENDEES*	SOCIETE *FIRM*	SIGNATURE *SIGNATURE*	PARTICIPANTS *ATTENDEES*	SOCIETE *FIRM*	SIGNATURE *SIGNATURE*
G. LUND	ALCATEL		B. SWINYARD	RAL	
H. FAAS	ASTRIUM		S. HEYS	RAL	
J. DELDERFIELD	RAL		B. WINTER	MSSL	
G. CRONE	ESA				
E. SAWYER	RAL				
K. KING	RAL				
REDACTEUR / *WRITTEN BY* :	G. LUND				

CONCLUSION :

DISTRIBUTION : PARTICIPANTS / *ATTENDEES*	POUR ACTION : *FOR FURTHER ACTION*
	POUR INFORMATION : *FOR INFORMATION*

APPROUVE PAR / *APPROVED BY*

NOM / *NAME*				
SIGNATURE / *SIGNATURE*				

SPIRE STATUS

Presentation by B. Swinyard (see annexed electronic file).

- S/C interfaces
- Grounding scheme
- Vibration Levels
- μvibrations
- Subsystems ....
  * Shutter deletion.

main areas needing clarification.

- Major concerns with: delivery calendar (no margins)
  funding.

- SPIRE Shutter is removed. The instrument will rely on the CTA for EQM and PFM testing.

  SPIRE wants a black (ε ≥ 0.8) rather than gold/aluminised cover shield. Astrium wishes to use one of the black paints qualified for the instruments. (PACS, "Cardiff Black").

- 300 mK Thermal Straps.
  Electrical Break is needed
  Rupture of Kevlar support tensioner during vibration testing. (due to small radius of curvature imposed on Kevlar).
- Thermal interface testing / on-going at Cardiff.

SMEC
- prototypes built
- launch latch testing in July.
- SMEC Flex-pivots: current design would resist ~ 4 x less than this.
  • Cannot resist the random (66g peak) vibration levels.
  • Propose to negotiate notching, following STM tests

Internal GROUNDING SCHEME (analogue / detectors).

Redesign may be needed, with grounding point shifted to the cold end
=> in this case, some design of DCU / FCU could be needed.

DRCU DDR Phase-2 completed in September, but technical agreement (internal to SPIRE) needed beforehand.

^{3}He Cooler STM/CQM Vibration tests : - pbs with Kevlar straps - wear on pulley
(Can be traded (via thicker straps) for higher thermal loads).

Random vibration levels generate strong problems with the following:

- ^{3}He cooler (can be solved with thicker Kevlar cables, -> higher heat load).
- 300 mK thermal straps
- SMEC
- Detector arrays

SPIRE would like to know whether the T.N. (HP-2-ASPI-AN-0112 - 15/03/02) will be refined in the near future, * URGENT confirmation, refinement needed of the predicted vibration levels.

SPIRE points out that the IIDA specified levels are ~10x higher than predicted levels (at FPU). Further refinement of this should be available from B. Winter by early september.

AI ASPI 31-07-02

VIBRATION LEVELS

B. Winter to analyse the situation and come up with an Instrument level input that satisfies the subsystem requirements.

AI-MSSR 31/08/02

Beam Steering Mechanism

- Testing "successful" so far.
- Funding problems (additional K£100).
- One development model deleted.

FPU - Structure

STM/CQM Structure is already being manufactured, in order to keep to schedule.
However, Astrium has not yet reached agreement with SPIRE on all external interfaces - various details of the current drawings remain to be clarified.

DCU

- Boards being built at Caltech. (EM)
- QM1 is form + Fit, but Power supply will be separate.

RAL Test Cryostat

- has now been built, problem with the door fitting.
- Should be delivered, with door pb fixed, early september.

AIV facility is progressing well.

(M. Griffin). - Major Concerns.

- Funding situation
  - reduction in manpower (system)
  - Some activities on-hold.
  - transfer of effort to sub-systems for next 6-months (away from system level).

→ Low level of PA activity
→ lack of conf. ctrl on subsystems
→ System level FMECA lacking.

- DRCU design is not mature (on critical path).
- Too many tests pushed back to FM level.
- BDA development / testing (all testing is 'serial').
- SMEC pivot vibration survival.

MICROVIBRATIONS

SPIRE sensitivity - between ~ 100 mHz and 25 Hz.

- SMEC has been redesigned to improve sloppiness at ~ 20 Hz.
- Previously feared sensitivity at detector level can probably be worked around.
- SPIRE has produced a tech Note, with proposed μ-vibration requirements. — See Annex.

MECHANICAL STATUS (B. Winter).

No major pb. with on-going manufacturing.

Discussion of ECRs / Status

- Agreement for ASPI to maintain a spreadsheet database (Excel) of all current / proposed updates, corrections, changes to the IIDB, similarly to the system used for IIDA updates.
- All further change requests (including interface drawing updates) shall be first approved by SPIRE internal CCB, and then sent out to Alcatel / ESA by Eric Sawyer.

ECR N°s

5, 6, 7 } closed

10 – Covered by IIDB 2.2

11 – Closed / rejected

12 – closed by IIDB 2.2

14 ~~Open?~~ Approved by ESA CCB : – Should be implemented into an annex of the IIDB
SPIRE will reformulate this ECR, in order to replace Sections 9.3 – 9.7 by an appropriate annex to the IIDB.

29 (v. 2) – issued 10/05/02. Updated Cryoharness definition.
SPIRE will supply suitably reduced Excel files with the harness data, in V. 3 of this ECR.

30 (20-06-02) – Temperature Sensor updates / refinements. Closed out. However, some ~~issue (v.3) of this ECR~~ (telemetry) ref. names are changed. ESA also wishes to review the overall temperature Sensor situation. Minor updates to be clarified with Astrium (H.F.).

32 – Shutter Removal.

31 – Ref. N° only.

33 – Release of updated views ('3D') of FPU, JFET boxes, ..., block diagrams.

FPU Interface drawings

- Next delivery expected by August 2002.
- Future updates (via ECR) shall provide associated drawing reference N°, and Step File reference.

JFET Interface Drawings

- Issue versions 350-"C" (Photometer) and 360-"E" (Spectrometer) via ECR.

DPU

IFSI should supply drawings with correctly updated R.f. nos, to ease configuration control of these. • AI-SPIRE 15-09-02

Current IIDB Version is dated 10/02/02

FCU & DCU

Recently sent 'updates' are considered for information only.
SPIRE will request SAP to provide unambiguous dates on all further issues. Then shall be sent to industry via ECR. • AI-SPIRE 15-09-02

- Thermal capacity shall be indicated.

Spectrometer JFET – location on OBA

Fixation points changed in latest issue (without CR). Astrium has adopted these changed positions (without CR) into their design, and will inform SPIRE of the updated coordinates for their location on the OBA.

FPU Feet locations

SPIRE is updating foot position to reduce foot encroachment by 2.5 mm (wrt previous 0.7 mm violation of PACS envelope). This will be included in next issue of interface drawings (late August 2002).

Level-0 Straps

Presentation of Astrium design, with flexible Al. straps.
SPIRE's instrument design does not provide any support of the Level-0 straps.
Further iterations are needed to find an acceptable design.

MSSL to provide a proposed interface design, taking into account the ~~th~~ currently proposed stiff cone concept of Astrium. — AI - SPIRE 31-07-02

Alignment cube – no problems. (SPIRE shutter now removed).

Level 1 Straps

Astrium foresees the use of 2 straps (at different points on the ventline), however these shall be attached to a single fixation point on SPIRE (tbc). These need electrical isolation.
SPIRE to send the design the used on ISO, to Astrium. — AI - SPIRE 31-07-02

Fixation to HOB

Astrium to clarify details of the fixation bolts to be used to fasten the FPU feet to the HOB. Design to take into account the use of ~~a~~ 1mm Vespel washers.

W.U. – Other mechanical details from Alenia

- SPIRE still needs details of '~~painting~~ finish mask' for location of warm & cryo. harness lugs.
- W/H mass ≤ 1.5 kg, length ~ 1m (power cables) from DCU - FCU
- SPIRE to provide ~~Astrium~~ Alcatel with linear mass of the other serial link cables. — AI - SPIRE 15/09/02

THERMAL INTERFACES

- Electrical isolation for L1 and JFET boxes

L1 Astrium has assumed this is provided by the instrument, whereas SPIRE assumes the opposite. No clear statement is made in the IIDA or IIDB.

JFET boxes

No need for the standoff insulation to be better than that of the JFET harness.

Current design from Astrium uses thermal link to L3 (end of the ventline). (Need to provide electrical isolation for this link.) which passes down through the OB.

Thermal Modeling

- SPIRE is currently updating their FPU / JFET TMMs, to bring them in line with updated design. (Completion ~ 20/08/02).
- Astrium reduced model will be communicated to the instruments within ~ the next week. (awaiting OK for release from Alcatel).
- (Goal only): SPIRE/Astrium would aim to meet to discuss/evaluate thermal performance of SPIRE, with above updated models, by end of September.* Ideally, preliminary O/P would be ready in time for the PDR co-location. * Proposed date: 24/09/02
- Need for SPIRE to update the timeline behaviour of SPIRE

AI-SPIRE
31-08-02

STRAYLIGHT

Model should be released ~ sept./oct. by Astrium. Design of the baffles, should also be consolidated by this time. (incl. emissivity).

"SPIRE Optical Design – Diffraction Analysis" (SPIRE-RAL-DOC-000441) should be referred to, in order to understand the diffraction behaviour of the instrument.

ELECTRICAL

Specific grounding requirements on cryoharness: These are described in the SPIRE harness document, which is an RD, (not AD). SPIRE will generate a new ECR to specifically request such requirements to be be reflected in the IIDB.

- Astrium to provide SPIRE with proposed routing between cold and warm units, for comment. — AI - Astrium 30/09/02

Cryoharness can be attached to SPIRE W.U.s, provided the proposed attachment points are communicated and approved by SPIRE.

SPIRE wishes to reiterate its belief that an internal overshield is absolutely necessary, and that without it their instrument may not work to spec. Their comments, related to (to §5.14.2.9) ~~to~~ the IIDA document, have not been taken into account.

RAL stated that No adequate RF tests seem to have been foreseen, in order to evaluate the influence of EM fields inside the cryostat on the SPIRE signals. Antenna inside EQM Cryostat is not foreseen for RS test.

SPIRE to review "Scientific Instrument Harness - General Overview" sheet handed over during meeting, and forward their comments to Astrium.

AIV Issues

SPIRE integration procedure should be written by ~ Dec. 2002. This should then be sent to Astrium for their system integration procedure.

Old A.I.'s

HP-2-ASED-MN-0107 - AI-9 : Closed, according to data provided in ECR-030.

HP-2-ASED-MN-0112 - AI-1 : Still open. (I/F drawing details)
New due date 31.08.02

HP-2-ASED-MN-0112 - AI-2 : Update harness data w.r.t. cooler recycling
Closed. V. 0.9 has been sent by email.

IIDB Comments

I/P has been provided by JD, Astrium and Alcatel.
=> Excel database, as provided to ESA before CCD in June.

- New comments sent by JD last week (Word format) will be integrated into same database.
- Need to add sequential numbers (additional column) to all comments.

Specific comments

§5.7.1.3 - Alcatel to clarify bake-out requirements.

§5.8.1. - SPIRE to update.

§5.9.7. - Delete comment.

§5.10.4.3 - Needs to be re-amended, following removal of the shutter.
- Check latest edition with BH.

§6.2. - Besides IIDB comments already raised, implementation of the EGSE does not seem to be consistent with what has been agreed in this section. Negotiation is needed, with ESA, to rectify this situation.

SPIRE Interface Meeting of 23-24/07/02 : actions / status on 25/07/02

Action n°	Meeting	Ref	Date	Origin	Responsible	Description	Due	Status
1	SPIRE Interface Meeting	HP-ASPI-MN-**1725**	23-juil-02	SPIRE	ALCATEL	Provide feedback to SPIRE on current status of (launch) random vibration levels expected at FPU level (last known data is from HP-2-ASPI-AN-0112, of 15/03/02). See also p. 23 of attached 'status' presentation of SPIRE.	31/07/02	OPEN
2	SPIRE Interface Meeting	HP-ASPI-MN-**1725**	23-juil-02	SPIRE	MSSL	B. Winter to analyse the current instrument design, and provide instrument-level (random) vibrational inputs compatible with the (FPU) sub-system requirements.	31/08/02	OPEN
3	SPIRE Interface Meeting	HP-ASPI-MN-**1725**	23-juil-02	ALCATEL	SPIRE	SPIRE to request IFSI to provide DPU interface drawings containing correctly updated reference numbers and dates. The drawings shall include the unit's estimated thermal capacity. SPIRE to then submit these drawings to industry in the form of an ECR.	15/09/02	OPEN
4	SPIRE Interface Meeting	HP-ASPI-MN-**1725**	23-juil-02	ALCATEL	SPIRE	SPIRE to request SAP to re-issue latest FCU & DCU interface drawings, with unambiguous dates. The drawings shall include estimated thermal capacities. SPIRE to then submit these drawings to industry in the form of an ECR.	15/09/02	OPEN
5	SPIRE Interface Meeting	HP-ASPI-MN-**1725**	23-juil-02	ASTRIUM	SPIRE	MSSL to propose an L0 thermal strap interface design, taking into account the currently proposed "stiff-cone" (attached to the tank) concept of Astrium.	31/07/02	OPEN
6	SPIRE Interface Meeting	HP-ASPI-MN-**1725**	23-juil-02	ASTRIUM	SPIRE	SPIRE to provide Astrium with the design used on ISO for thermal strap connections with (sapphire-plate) electrical isolation.	31/07/02	OPEN
7	SPIRE Interface Meeting	HP-ASPI-MN-**1725**	23-juil-02	ALCATEL	SPIRE	Provide Alcatel with the linear mass of its internal (serial link) harnesses used on the SVM.	15/09/02	OPEN
8	SPIRE Interface Meeting	HP-ASPI-MN-**1725**	23-juil-02	ASTRIUM	SPIRE	Update the timeline behaviour of the SPIRE FPU taking into account all design modifications of the instrument.	31/08/02	OPEN
9	SPIRE Interface Meeting	HP-ASPI-MN-**1725**	23-juil-02	SPIRE	ASTRIUM	Provide proposed routing of the cryoharness between the HOB and the SPIRE WU's, for comment.	30/09/02	OPEN

CR Ref	Date of CR	Origin	Doc to be modified	Issue	Date of Doc.	IID Chapter	Change summary	Core team resp. for analysis	Included in version	Status
HP-SP-RAL-ECR-005	19/11/01	SPIRE	SCI-PT-IIDB-SPIRE-02124	2.0	31/07/01	§ 5.6.1.2	Definition of support & responsibility thereof, of thermal straps.	Alenia Astrium	2.1	closed
HP-SP-RAL-ECR-005	19/11/01	SPIRE	SCI-PT-IIDB-SPIRE-02124	2.0	31/07/01	§ 5.7.5.1	Definition of various thermistor types / temperature range / resolution / accuracy	Alenia Astrium	2.1	closed
HP-SP-RAL-ECR-005	19/11/01	SPIRE	SCI-PT-IIDB-SPIRE-02124	2.0	31/07/01	§ 5.7.5.3	Definition of various thermistor accuracy requirements	Alenia Astrium	2.1	closed
HP-SP-RAL-ECR-005	19/11/01	SPIRE	SCI-PT-IIDB-SPIRE-02124	2.0	31/07/01	§ 5.8	Definition of SPIRE beam size / geometry	Alenia Astrium	2.1	closed
HP-SP-RAL-ECR-005	19/11/01	SPIRE	SCI-PT-IIDB-SPIRE-02124	2.0	31/07/01	§ 5.9.3	Update of thermal dissipations of WUs on the SVM.	Alenia Astrium	2.1	closed
HP-SP-RAL-ECR-005	19/11/01	SPIRE	SCI-PT-IIDB-SPIRE-02124	2.0	31/07/01	§ 5.9.6.1	Update / clarification of mean BOL / EOL, and Peak power demands in all operational modes.	Alenia Astrium	2.1	closed
HP-SP-RAL-ECR-005	19/11/01	SPIRE	SCI-PT-IIDB-SPIRE-02124	2.0	31/07/01	§ 5.9.6.3	Clarification of I/F circuit and LCL current resolution requirements.	Alenia Astrium	2.1	closed
HP-SP-RAL-ECR-005	19/11/01	SPIRE	SCI-PT-IIDB-SPIRE-02124	2.0	31/07/01	§ 5.11.3	Clarification of timing accuracy requirement.	Alenia Astrium	2.1	closed
HP-SP-RAL-ECR-005	19/11/01	SPIRE	SCI-PT-IIDB-SPIRE-02124	2.0	31/07/01	§ 5.13.1	Clarification of 1553 bus address requirements.	Alenia Astrium	2.1	closed
HP-SP-RAL-ECR-005	19/11/01	SPIRE	SCI-PT-IIDB-SPIRE-02124	2.0	31/07/01	§ 5.15.3	Addition of "launch-latch" requirement during transport.	Alenia Astrium	2.1	closed
HP-SP-RAL-ECR-005	19/11/01	SPIRE	SCI-PT-IIDB-SPIRE-02124	2.0	31/07/01	All Sections	Replacement of "FIRST" by "Herschel", and "F" by "H", in acronyms where appropriate.	Alenia Astrium	2.1	closed

HP-SP-RAL-ECR-006	19/11/01	SPIRE	SCI-PT-IIDB-SPIRE-02124	2.0	31/07/01	§ 5.5	Update of SPIRE mass and dimensional properties.	Alenia Astrium	2.1	closed
HP-SP-RAL-ECR-006	19/11/01	SPIRE	SCI-PT-IIDB-SPIRE-02124	2.0	31/07/01	§ 5.4.2	Inclusion of Spectrometer JFET box drawings	Alenia Astrium	2.1	closed
HP-SP-RAL-ECR-006	19/11/01	SPIRE	SCI-PT-IIDB-SPIRE-02124	2.0	31/07/01	§ 5.4.3	Inclusion of Photometer JFET box drawings	Alenia Astrium	2.1	closed
HP-SP-RAL-ECR-006	19/11/01	SPIRE	SCI-PT-IIDB-SPIRE-02124	2.0	31/07/01	§ 5.4	Update of external Interface Drawings of SPIRE FPU.	Alenia Astrium	2.1	closed
HP-SP-RAL-ECR-006	19/11/01	SPIRE	SCI-PT-IIDB-SPIRE-02124	2.0	31/07/01	§ 5.4.4.2	Update of external Interface Drawings of SPIRE DCU.	Alenia Astrium	2.1	closed
HP-SP-RAL-ECR-006	19/11/01	SPIRE	SCI-PT-IIDB-SPIRE-02124	2.0	31/07/01	§ 5.4.4.3	Update of external Interface Drawings of SPIRE FCU.	Alenia Astrium	2.1	closed
HP-SP-RAL-ECR-007	19/11/01	SPIRE	SCI-PT-IIDB-SPIRE-02124	2.0	31/07/01	§ 5.6.1.1	Update of requirements in terms of microvibrations at FPU level.	Alcatel	2.1	closed

HP-SP-RAL-ECR-009	19/11/01	SPIRE	SCI-PT-IIDB-SPIRE-02124	2.0	31/07/01	§ 5.7.1	Update of text, to reflect current definition of cryostat interfaces.	Astrium	3.0 - TBD	open
HP-SP-RAL-ECR-009	19/11/01	SPIRE	SCI-PT-IIDB-SPIRE-02124	2.0	31/07/01	§ 5.7.1.1	Update of interface requirements of SPIRE 300 mK Sorption cooler. Update of thermal loads on Levels 0, 1 & 2.	Astrium	2.2	open
HP-SP-RAL-ECR-010	19/11/01	SPIRE	SCI-PT-IIDB-SPIRE-02124	2.0	31/07/01	§ 5.2	Update of electrical interface darwings.	Astrium	2.2	Covered by IIDB 2.2
HP-SP-RAL-ECR-010	19/11/01	SPIRE	SCI-PT-IIDB-SPIRE-02124	2.0	31/07/01	§ 5.10.2	Update of electrical grounding scheme diagramme.	Astrium	2.2	Covered by IIDB 2.2
HP-SP-RAL-ECR-010	19/11/01	SPIRE	SCI-PT-IIDB-SPIRE-02124	2.0	31/07/01	§ 5.3	Addition of new external interface drawing of FPU showing preferred harness routing.	Astrium	2.2	Covered by IIDB 2.2
HP-SP-RAL-ECR-010	19/11/01	SPIRE	SCI-PT-IIDB-SPIRE-02124	2.0	31/07/01	§ 5.10.1	Addition of new isometric view of FPU, showing preferred harness routing.	Astrium	2.2	Covered by IIDB 2.2
HP-SP-RAL-ECR-011	19/11/01	SPIRE	SCI-PT-IIDB-SPIRE-02124	2.0	31/07/01	§ 5.7.1.2	CR Received LATE (after CCB-4)	Astrium	obsolete	closed
HP-SP-RAL-ECR-011	19/11/01	SPIRE	SCI-PT-IIDB-SPIRE-02124	2.0	31/07/01	§ 5.10.2	Electrical isolation of L0 cooling strap	Astrium	obsolete	closed

HP-SP-RAL-ECR-012	19/11/01	SPIRE	SCI-PT-IIDB-SPIRE-02124	2.0	31/07/01	§ 5.3.1	New requirement on length of internal harness on SVM.	Alenia	obsolete	Covered by IIDB 2.2
HP-SP-RAL-ECR-014	19/11/01	SPIRE	SCI-PT-IIDB-SPIRE-02124	2.0	31/07/01	§ 9.3	Addition of new Reference Doc. For definition of verification requirements.	Alcatel	3.0	Approved by ESA CCB : - include as annex in IIDB 3.0
HP-SP-RAL-ECR-014	19/11/01	SPIRE	SCI-PT-IIDB-SPIRE-02124	2.0	31/07/01	§ 9.4	Addition of new Reference Doc. For definition of verification requirements.	Alcatel	3.0	Approved by ESA CCB : - include as annex in IIDB 3.0
HP-SP-RAL-ECR-014	19/11/01	SPIRE	SCI-PT-IIDB-SPIRE-02124	2.0	31/07/01	§ 9.5	Addition of new Reference Doc. For definition of verification requirements.	Alcatel	3.0	Approved by ESA CCB : - include as annex in IIDB 3.0
HP-SP-RAL-ECR-014	19/11/01	SPIRE	SCI-PT-IIDB-SPIRE-02124	2.0	31/07/01	§ 9.6	Addition of new Reference Doc. For definition of verification requirements.	Alcatel	3.0	Approved by ESA CCB : - include as annex in IIDB 3.0
HP-SP-RAL-ECR-014	22/11/01	SPIRE	SCI-PT-IIDB-SPIRE-02124	2.0	31/07/01	§ 9.7	Addition of new Reference Doc. For definition of verification requirements.	Alcatel	3.0	Approved by ESA CCB : - include as annex in IIDB 3.0
HP-ASPI-CR-0029 v.2	18/07/02	SPIRE	SCI-PT-IIDB-SPIRE-02124	2.2	01/07/02	§ 5.10	Harness update, including impact of shutter removal.	Astrium		OPEN
HP-ASPI-CR-0030 v.2	20/06/02	SPIRE	SCI-PT-IIDB-SPIRE-02124	2.2	01/07/02	§ 5.7.5	Temperature sensor updates.	Astrium		OPEN
HP-ASPI-CR-0032	TBD	SPIRE	SCI-PT-IIDB-SPIRE-02124	2.2	01/07/02	§ 5.7.5 § 5.10 § 7.2.1 Annex 2.	Removal of shutter from instrument design.	Alcatel		OPEN
HP-ASPI-CR-0033	20/07/02	SPIRE	SCI-PT-IIDB-SPIRE-02124	2.2	01/07/02	§ 4, § 5.	Release of updated 3D views.	Alcatel		OPEN

SPIRE STATUS - PRESENTATION

SPIRE Status

Bruce Swinyard

(pp Matt Griffin)

Instrument Design/Development Status

- Systems issues
  - **Non-frozen S/C and PLM interfaces (for discussion here)**
  - **Grounding scheme**
  - **Vibration Levels**
  - **Micro-vibrations**
- Sub-systems Status
  - **Shutter**
  - **300 mK Strap**
  - **Structure**
  - **Optics**
  - **Cooler**
  - **BDAs**
  - **SMEC**
  - **BSM**
  - **DRCU**
  - **DPU/OBS**
  - **Cal Facility**
  - **EGSE**

ESA/Industry Programme and Schedule

- **Revised Instrument Delivery Dates (announced by ESA to Industry on 2 June)**
- **Industry schedule for PDR will be based on these dates**

	Previous	New	SPIRE (at IBDR)
AVM	Apr. 2003	Oct. 2003	June 2003
CQM	Apr. 2003	Oct. 2003	Oct. 2003
PFM	July 2004	Jan. 2005	Oct. 2004
FS	July 2005	Jan. 2006	Jan. 2006

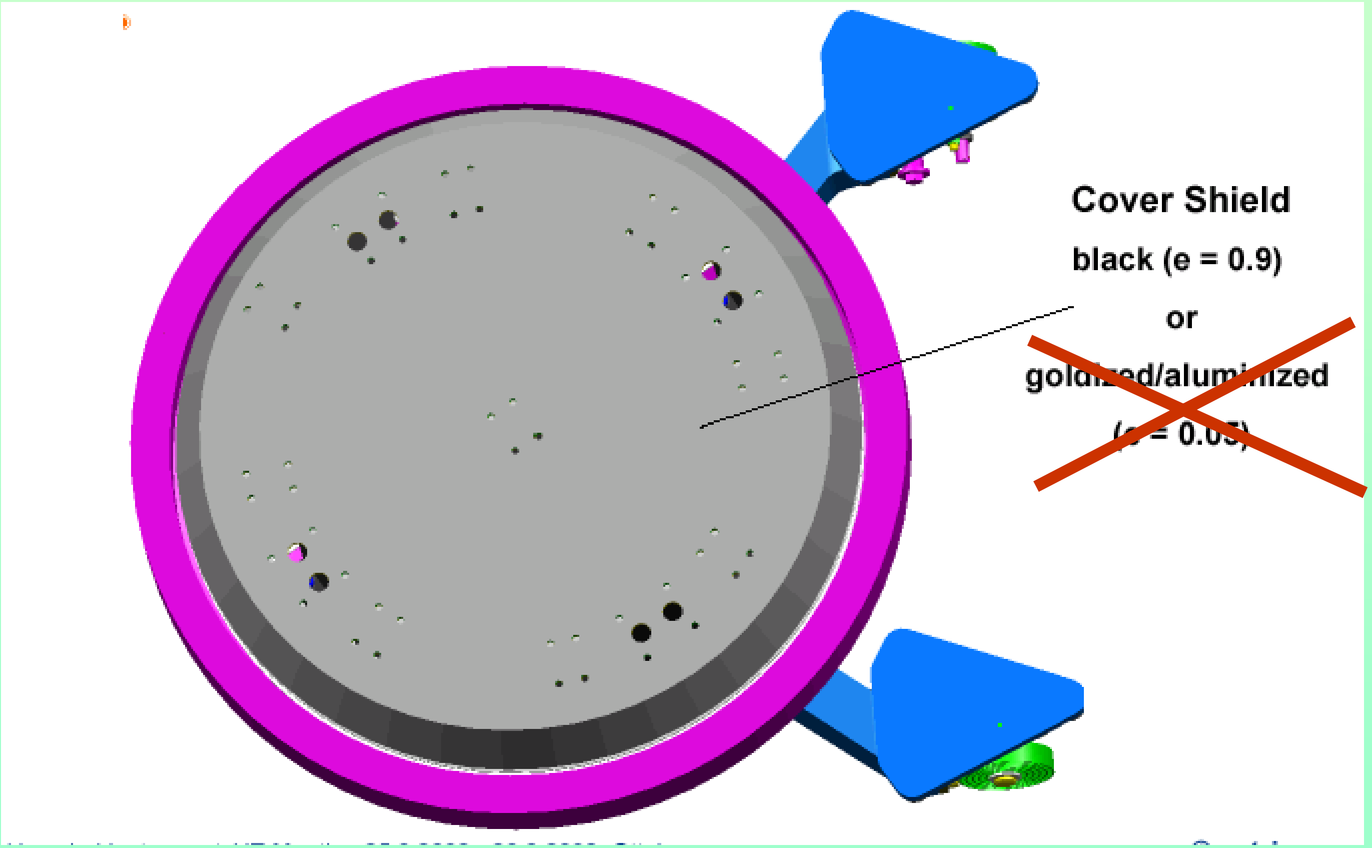
Programmatic Summary

- **SPIRE is (barely) compatible with the new instrument delivery dates**
- **Main schedule problems:**
  - US: Detector array delivery
  - France: Delays on warm electronics and optics
- **CPP payment scheme (over)solves French and Italian problems but no effect on UK**

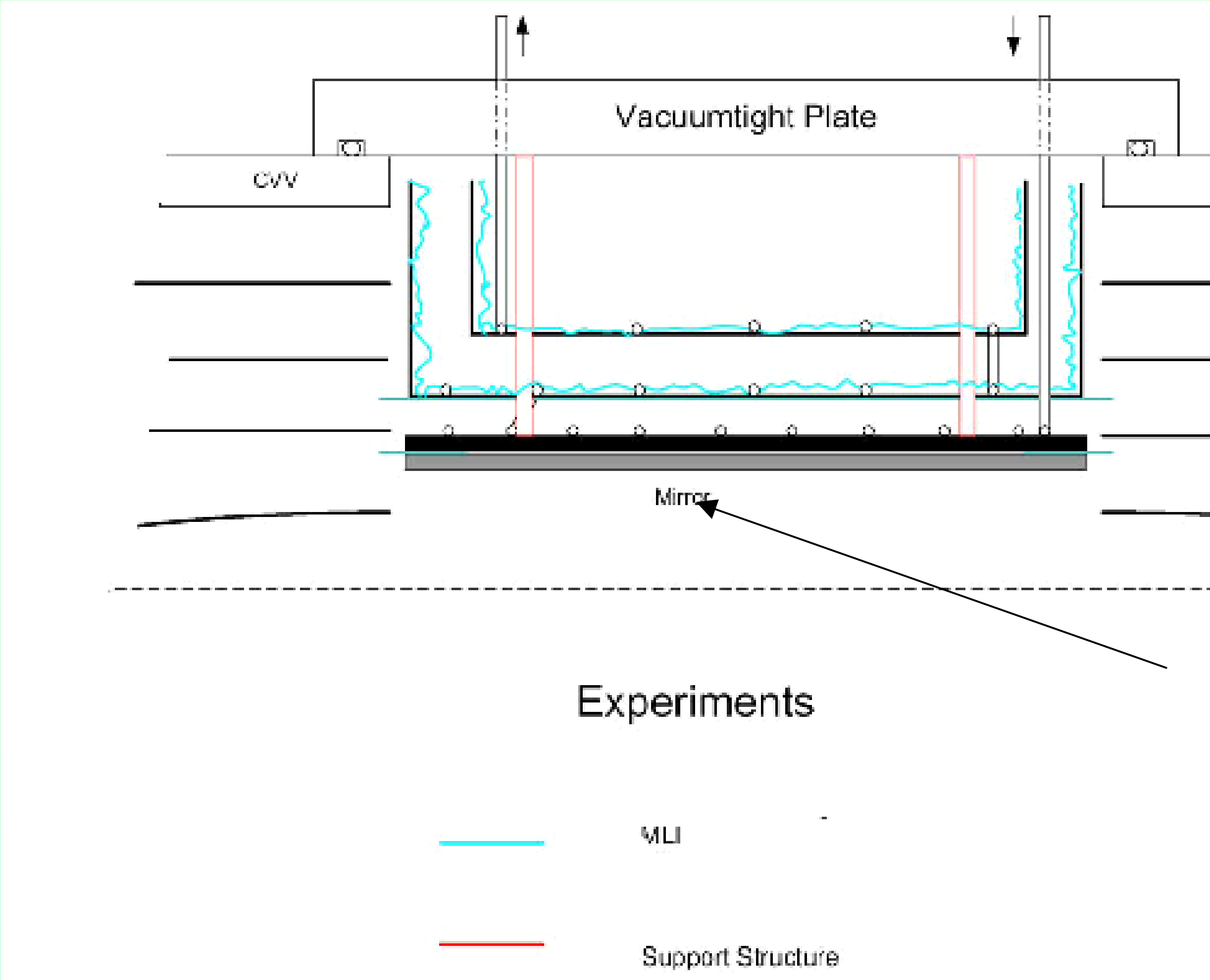
Shutter Deletion

- Purpose of Shutter: Allow detector sensitivity to be verified in the Herschel cryostat by replicating the correct photon background.
- PACS did not have a shutter but have concluded that they need the same capability
- Industry are now required to provide a Cryogenic Test Adapter (CTA) for both the EQM tests and the PFM (flight) cryostat
- Performance not likely to be as good as the SPIRE Shutter – but good enough
- Shutter therefore deleted. Alternative Canadian participation through substantial AIV and ICC support is being discussed

CTA Design – Flight Cryostat

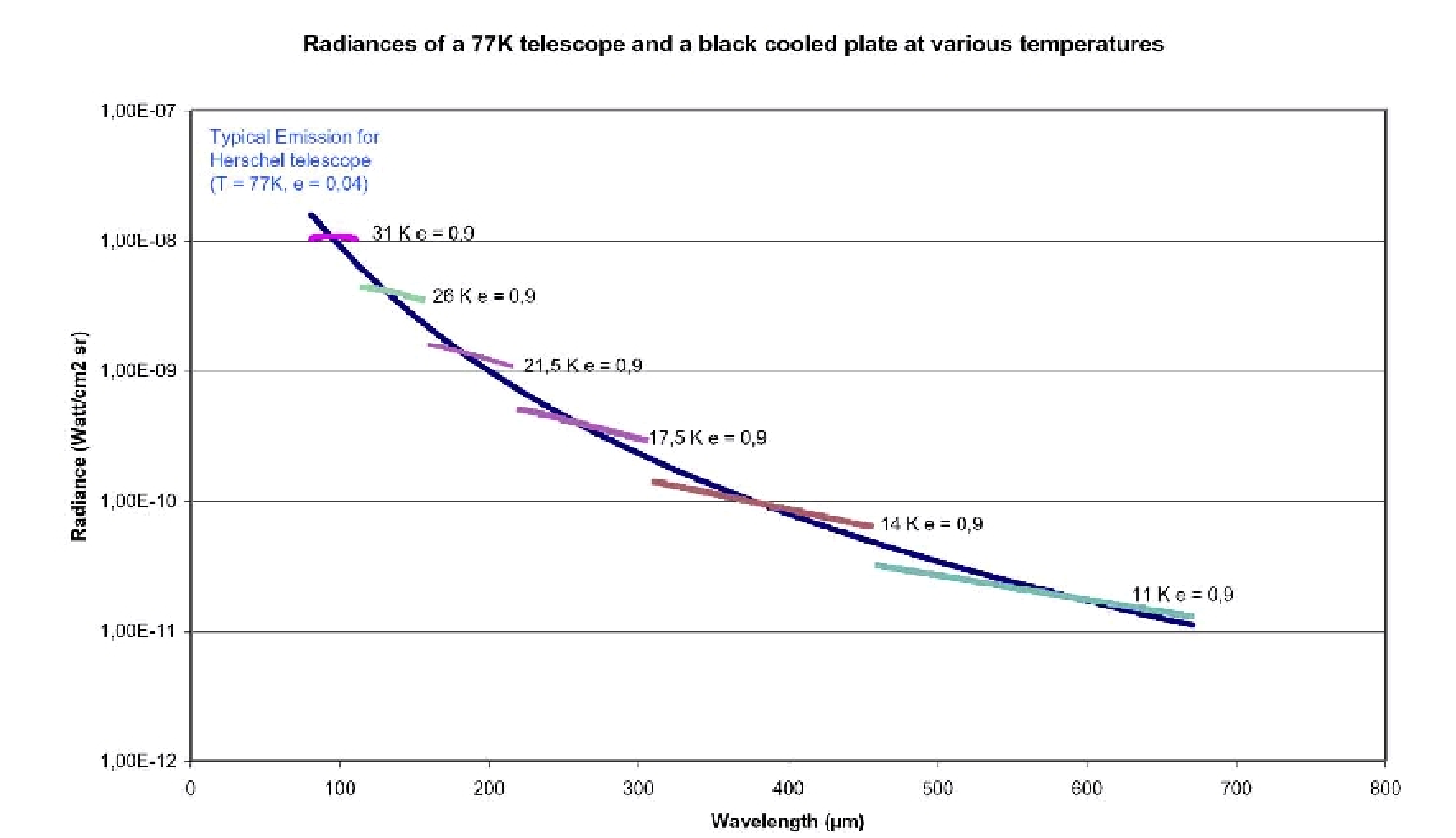


CTA Design – EQM Cryostat



No – black please

Why a Black Plate?

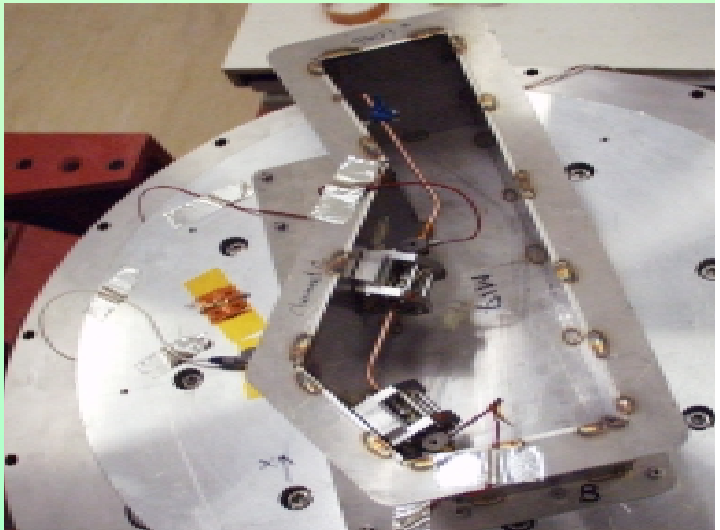


300-mK Thermal Straps

- Working Team (MSSL, RAL, Cardiff) led by Doug Griffin set up in October 2001:
  - Devise and evaluate thermal strap support concepts (thermal and mechanical modelling)
  - Build and test prototypes (cryogenic thermal and room-temp. vibration testing)
  - Select optimum design
  - Formulate implementation plan
- Three designs were evaluated
- Review in February selected concept for implementation
- Working Group continues to operate
  - Design and fabrication: Cardiff and MSSL
  - Coordination, management, and System Engineering: RAL
- DDR held July 10

300-mK Thermal Straps
Requirements and Constraints

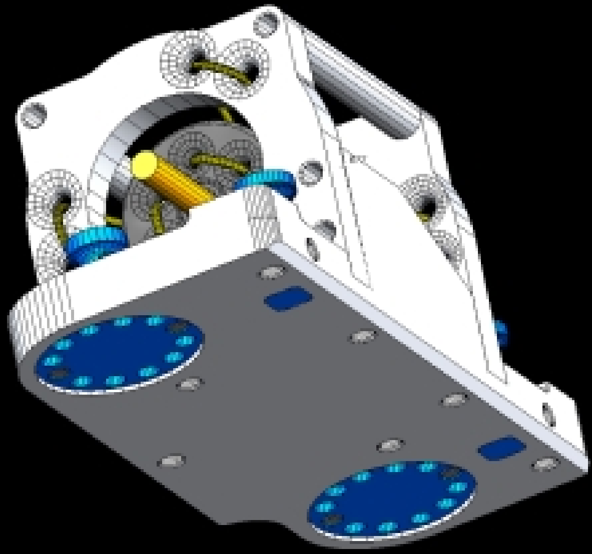
- $2\mu W$ thermal budget for whole system
- Two light-tight entry points to 2-K detector boxes
- Compliant links to BDAs and cooler tip
- ΔT between cooler tip and BDAs < 20 mK
- Small space envelope (20x60x60 mm^3 for each support)

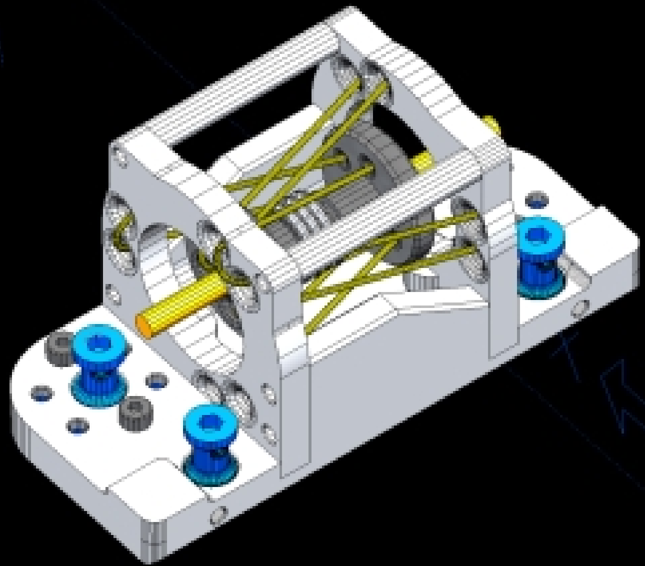


Thermal strap system mock-up

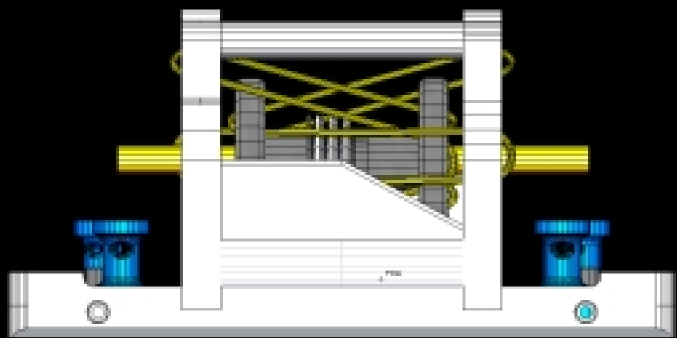
- **Electrical break between photometer and Spectrometer BDAs (separate grounds)**
- **Minimal deformation of the detector box**
- **Low mass**
- **Simple integration**
- **Modularity**
- **Accommodation of thermal control hardware if needed**

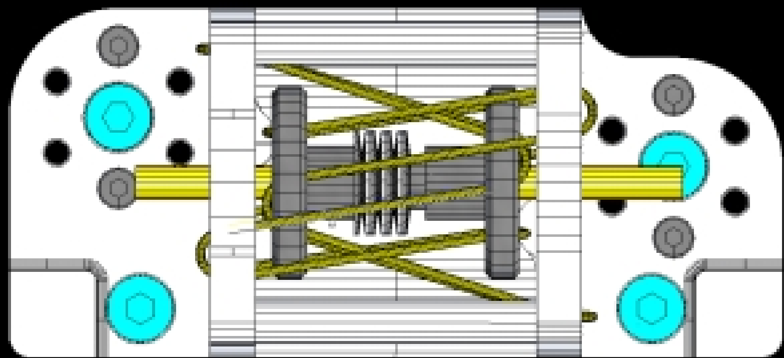
300-mK Support Module MK3





- Modular units
- Kevlar under tension
- Self tensioning compensates for creep/expansion
- Kevlar passes over polished radii





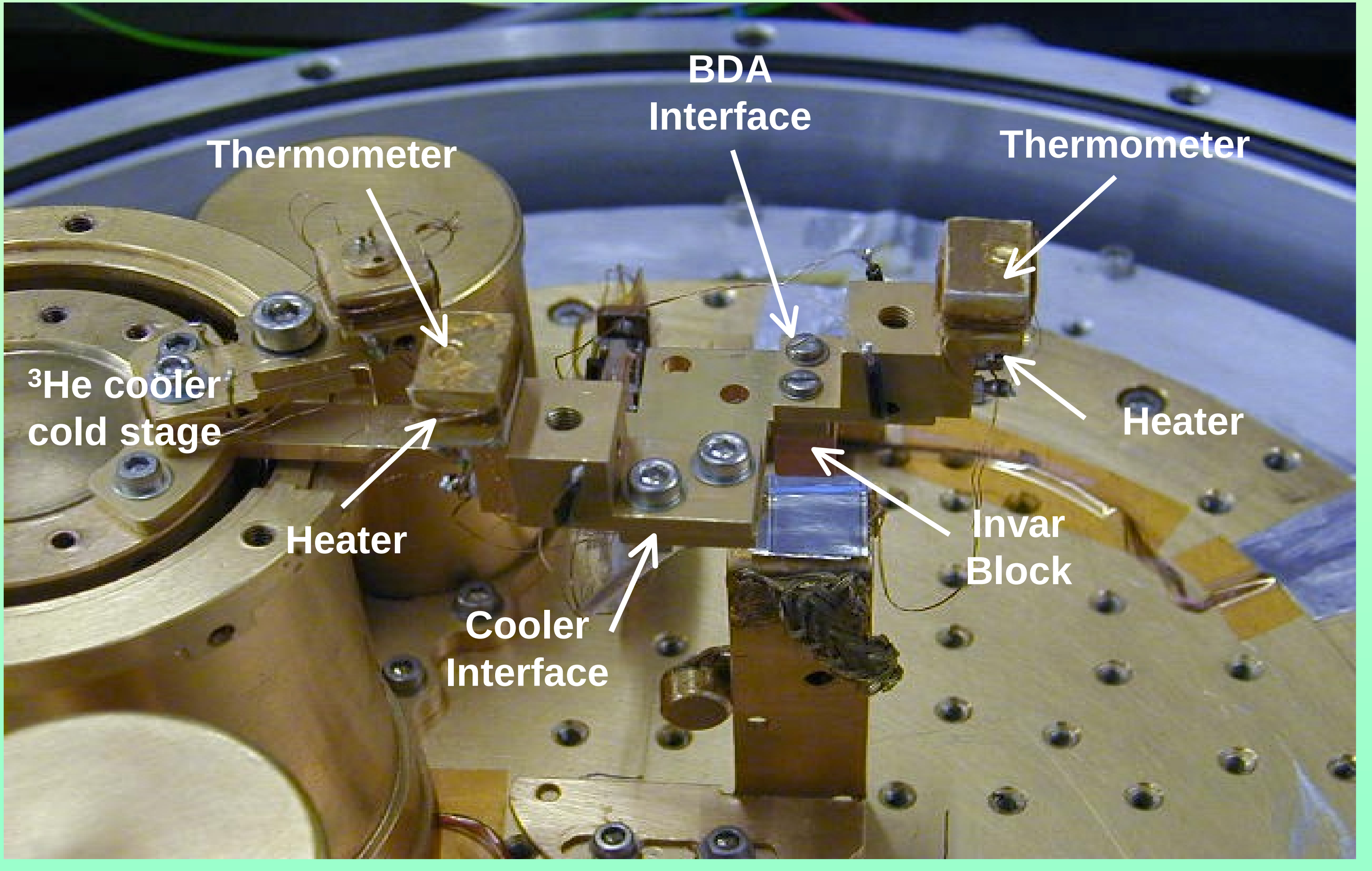
Thermal Analysis

- 2 supports in photometer box – 2 x 12 wires
- 2 light baffles – 2 x 12 wires
- 30 mm Kevlar thread length

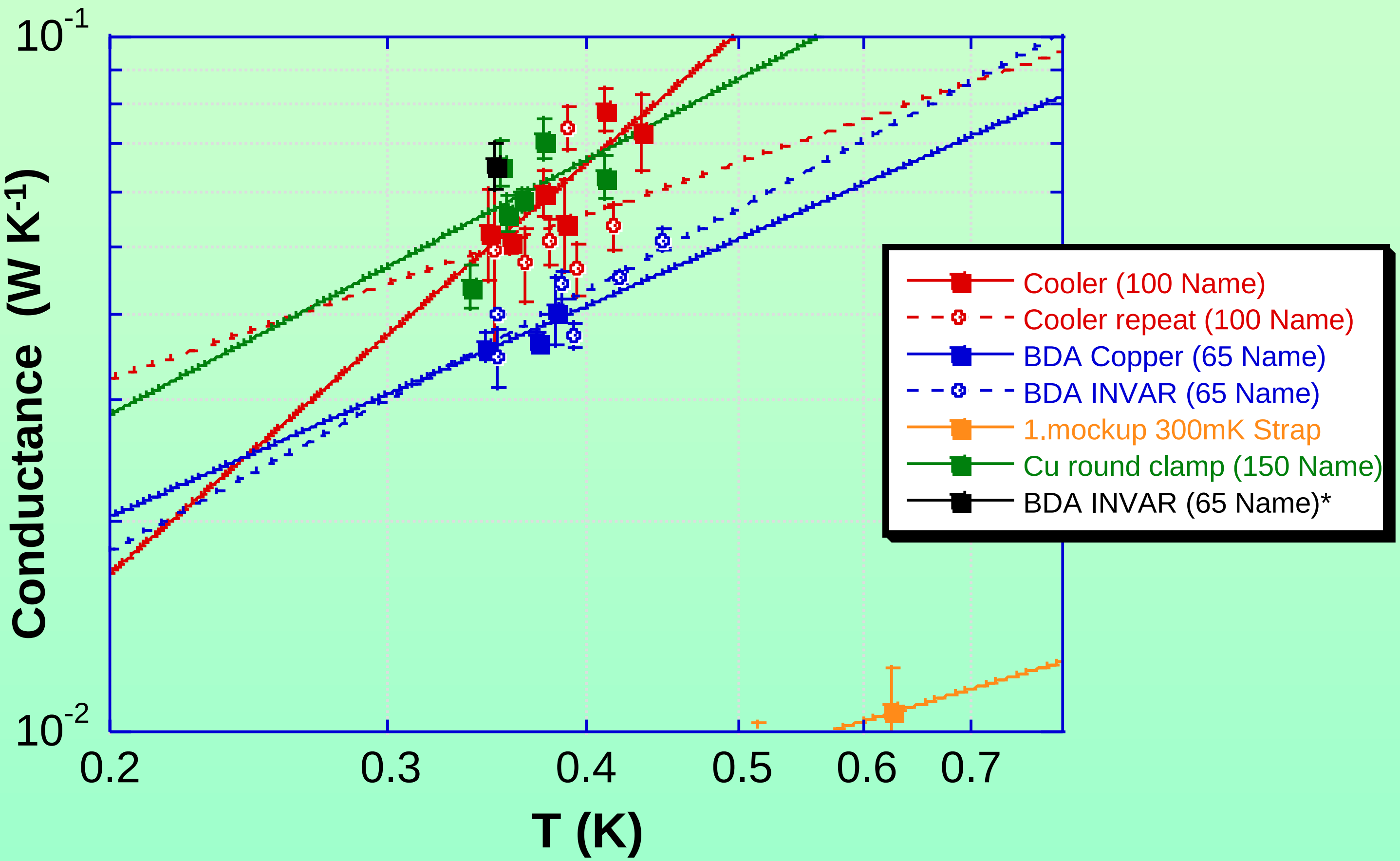
Tex	44	167	790
Strands	0.018x120	0.012x1000	0.012x5000
Load from 2 K	0.4μW	1.2 μW	6.5 μW

- Some margin on 2-K thermal budget – may change to braided Kevlar for ease of assembly

Thermal Interface Testing

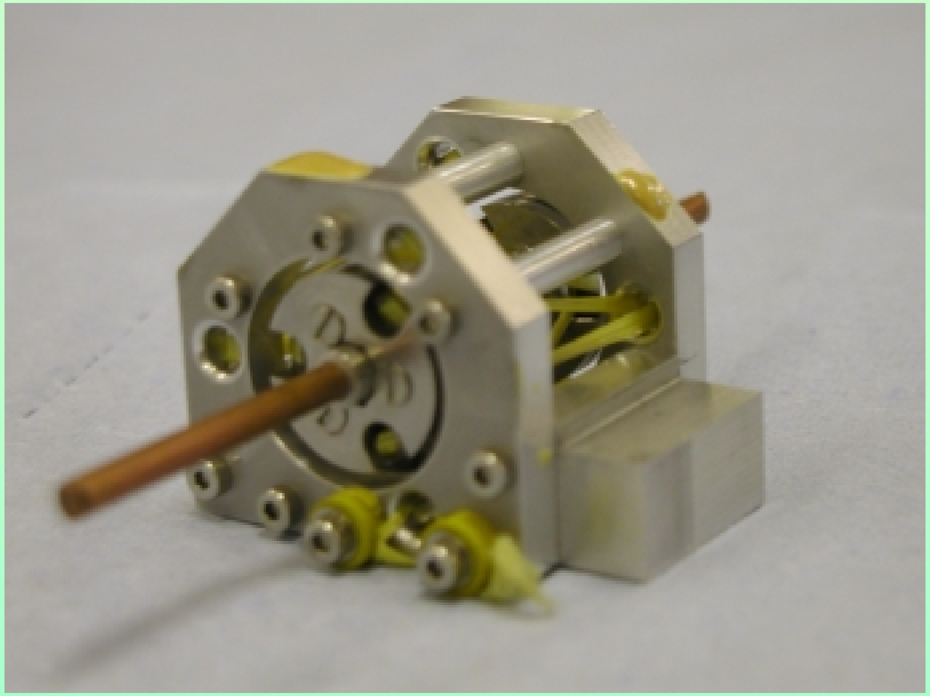


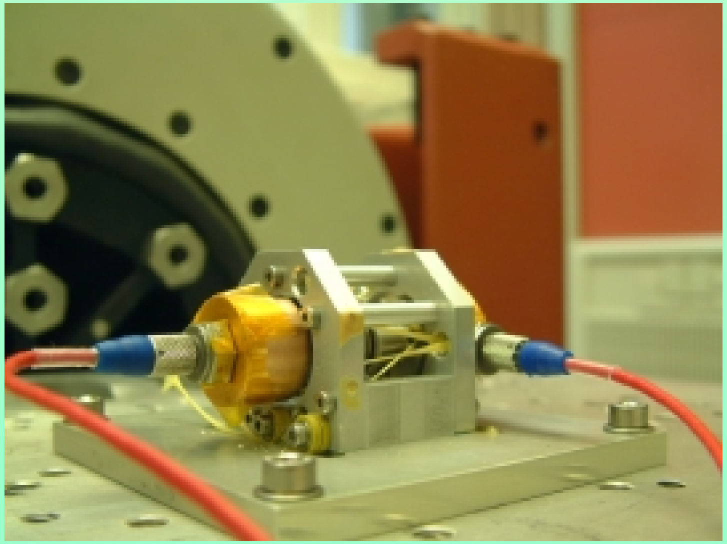
Thermal Interface Conductance



- **Thermal strap and cooler interface: typ 25 mW K^{-1}**
- **BDA interface typ. 40 mW K^{-1}**
- **Envisaged ΔT from cooler to BDA interface ~ 2 mK**

Thermal Strap Support Module MK2

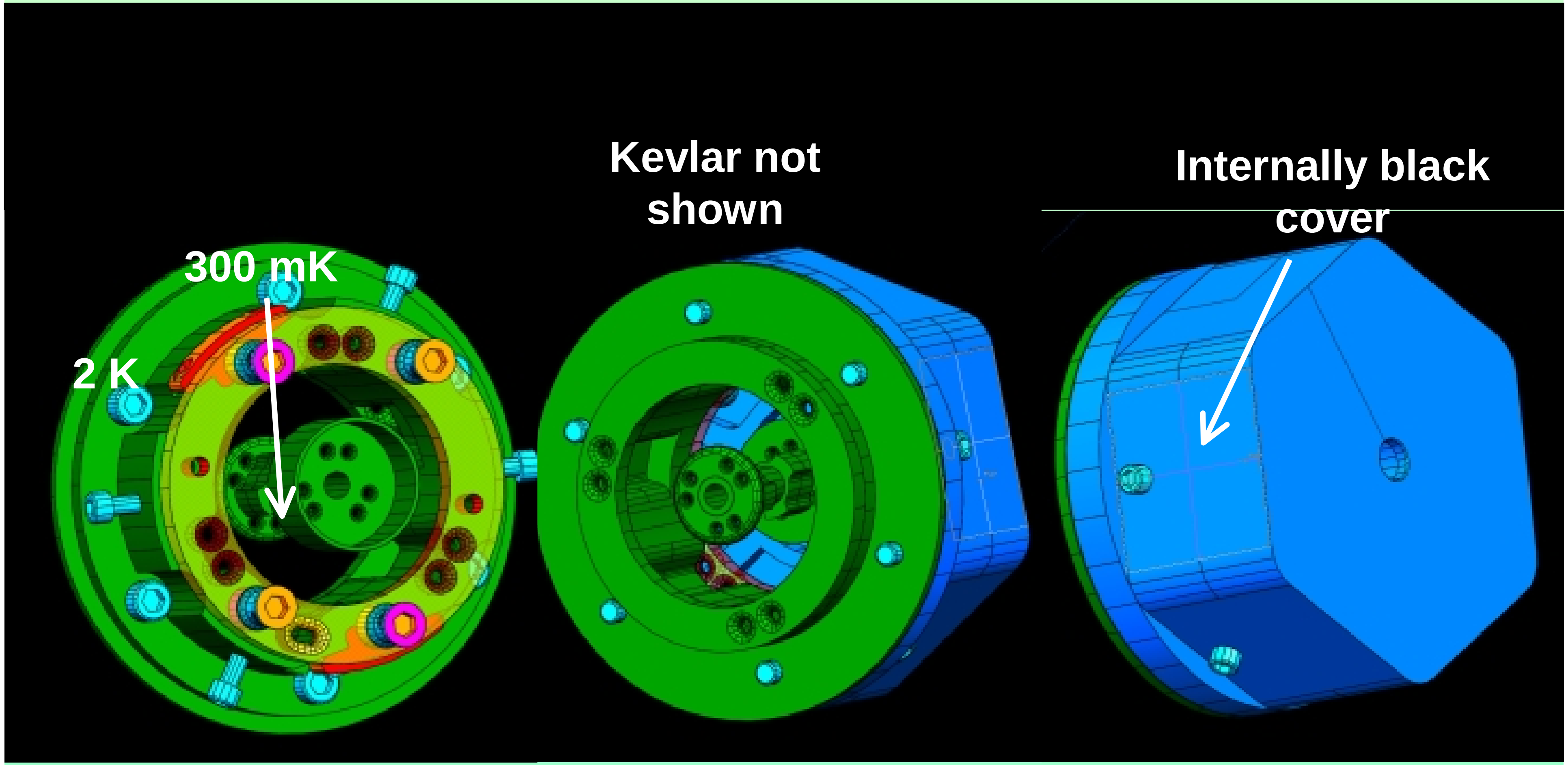




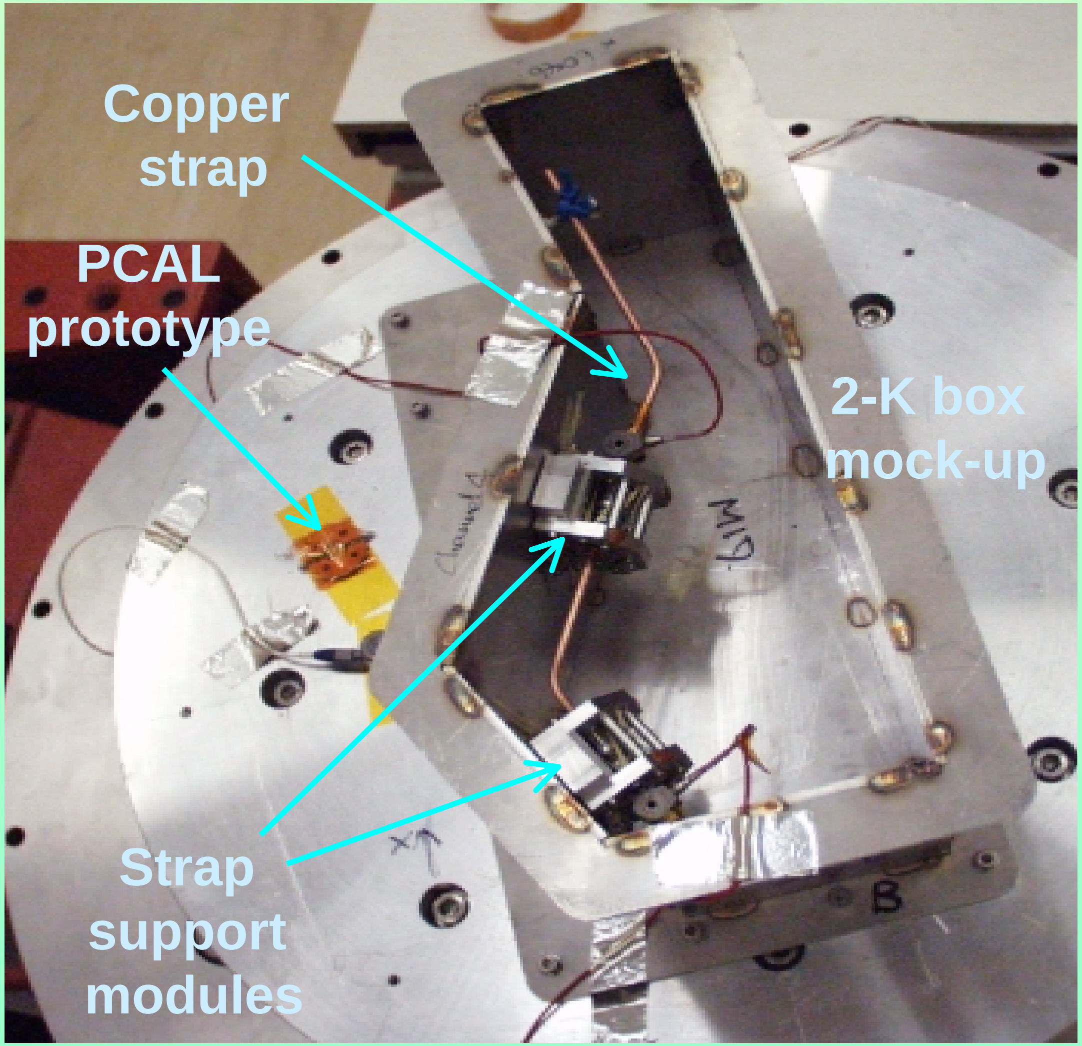
Resonant frequencies:

Axial	**1120 Hz**
Transverse	**365 Hz**

300-mK Strap Support/2-K Box Light Baffle



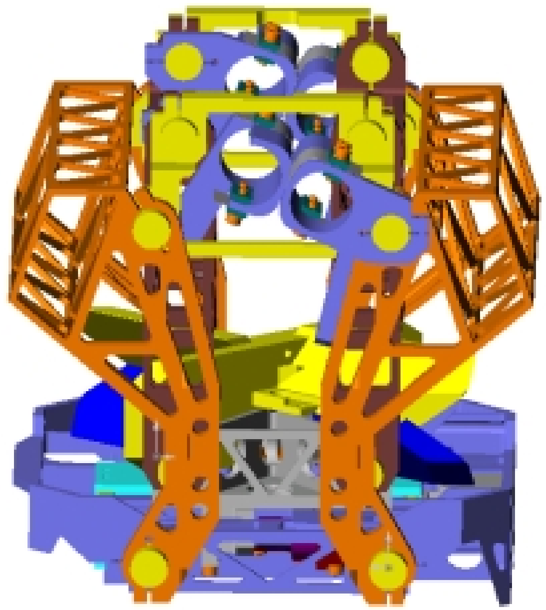
Thermal Strap System MK2 Vibration Tests



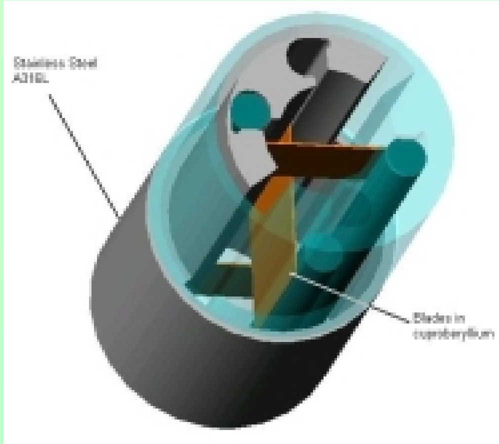
- Test sequence:
  - Sine sweep
    40g, 5 Hz - 110 Hz
  - Random
    18g rms, 5 Hz - 2 kHz
- Failure under random test – but due to Kevlar fraying at a machining burr

SMEC status

- **SMECm STM and CQM structures being built**
- **Actuator prototypes built and tested**
- **Launch latch being built. To be tested in July.**
- **MCU development model built and tests nearly completed**



SMEC Flex Pivots



BE System Pivot

- **Problem with random vibrations levels has arisen after IBDR**

- **Design levels (66g peak) are 4 times higher than the level the pivots can bear.**

- **Proposed LAM approach**

  1- Measure real levels, frequencies, damping factors with dummy SMEC in the STM

  2- Negotiate notches with ESA depending on these results

  3- Design a way to protect the pivots during launch: sleeves to limit displacement (but small allowable clearance (10µm) before irreversible buckling of the pivot blades)

SMEC: Other Technical Issues

- Launch latch
  - Thermal contraction between 300 K and 4 K: same small clearance as for the pivots sleeves. Careful choice of materials and possible adjustments. Will be checked on the SMECm CQM.

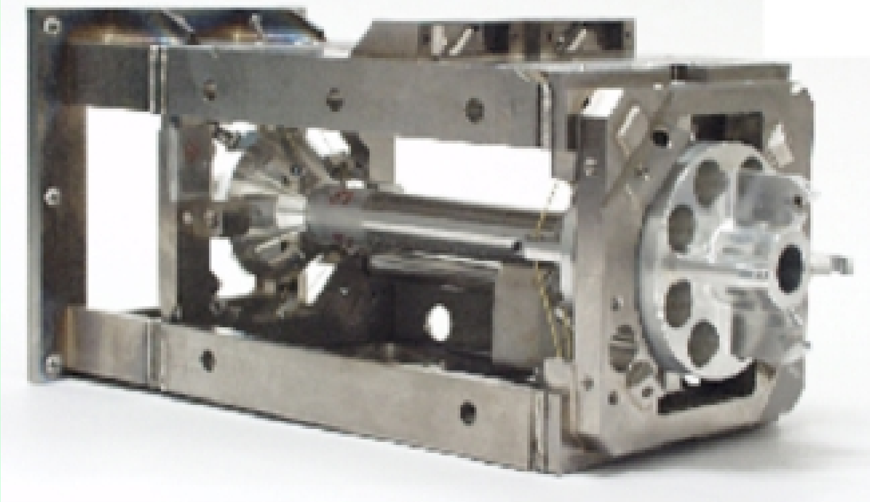
- Warm electronics thermal dissipation:
  - DRCU/MCU interface qualification temperature level is approx. 75°C => internal component temperature above 105°C (85 °C is max acceptable).
  - Cooling or revision of interfaces between MCU board and DRCU or between DRCU and satellite.

Grounding Scheme

- **Requirement: system design with single point ground at either warm or cold end - to be selected after EMC analysis and CQM tests**
- **Current SAp DRCU design forces ground point to be at the warm end**
- **Design changes would be needed in DRCU to make cold-end grounding possible**
- **JPL/CEA/Project Team currently studying the options with regular telecons**
- **Technical agreement not yet achieved**
- **Solution to be be decided in preparation for DRCU Technical DDR**
- **DRCU DDR Phase-2 (development plan and schedule) to be completed in September**

STM/CQM ^{3}He Cooler Vibration Tests

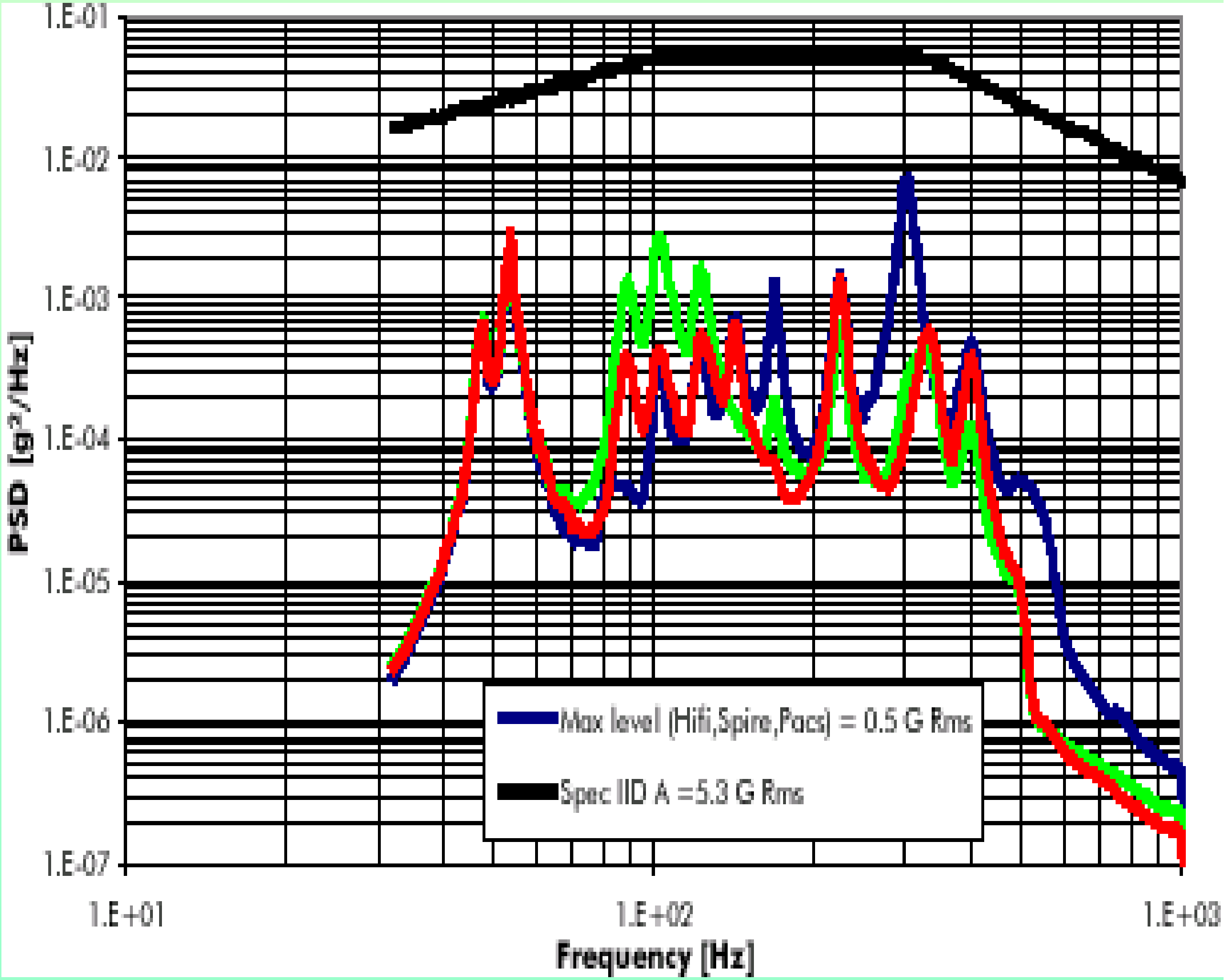
- **Kevlar cords diameter for the evaporator support changed in late 2000 from 0.5 mm dia. to to 0.3 mm dia. to increase the margins and net heat lift**
- **Modelled performance acceptable, but assumes no slipping on pulleys**



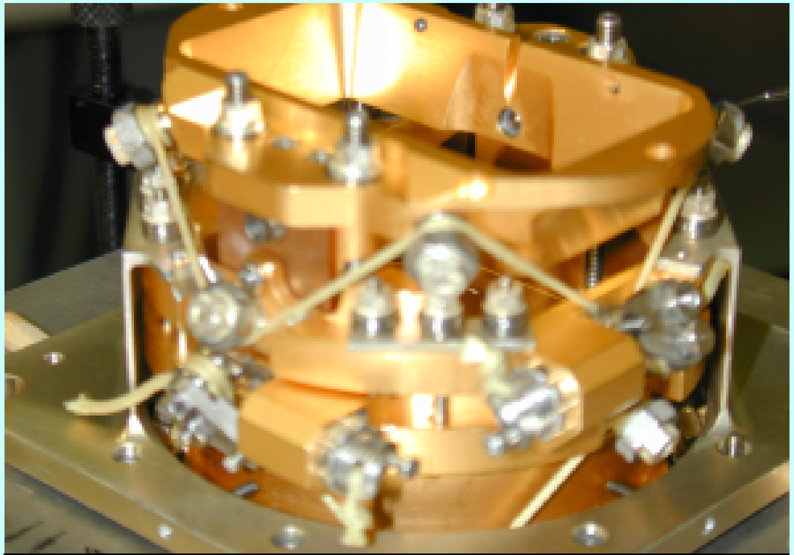
- **Warm vibration tests: sine (40 g 0-100 Hz); random (14 g rms)**
- **Cooler survived but inspection showed some damage to a Kevlar cord due to slipping on a pulley**
- **40 g acceleration was enough to move the evaporator slightly and induce rubbing between the cord and the pulleys**
- **Impact on cooler hold time to be studied**
  - **Preliminary conclusion: may use up most margin wrt 48-hr requirement and/or BDA thermal load on 300 mK**
  - **Depends strongly on the Level-1 temperature**

Random Vibration Levels

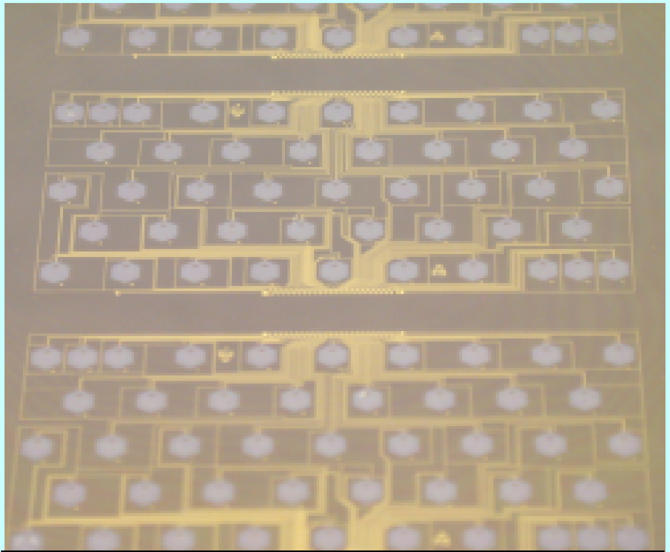
- Alcatel analysis shows factor of 10 margin between modelled levels at FPU and qualification levels specified in IID-A
- Design, cost, risk, schedule of several SPIRE subsystems is currently driven by the mechanical/thermal trade-off
  - –^{3}He cooler
  - –300-mK thermal straps
  - –SMEC
  - –Detector Arrays
- SPIRE is preparing formal request for reduction in the levels



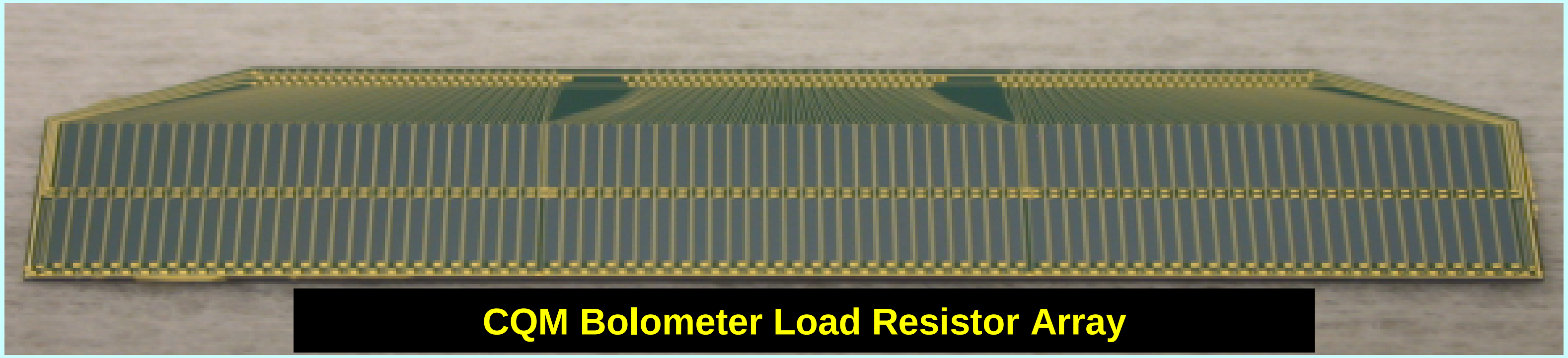
Bolometer Arrays



BDA Mechanical Qualification unit



P/LW CQM wafer

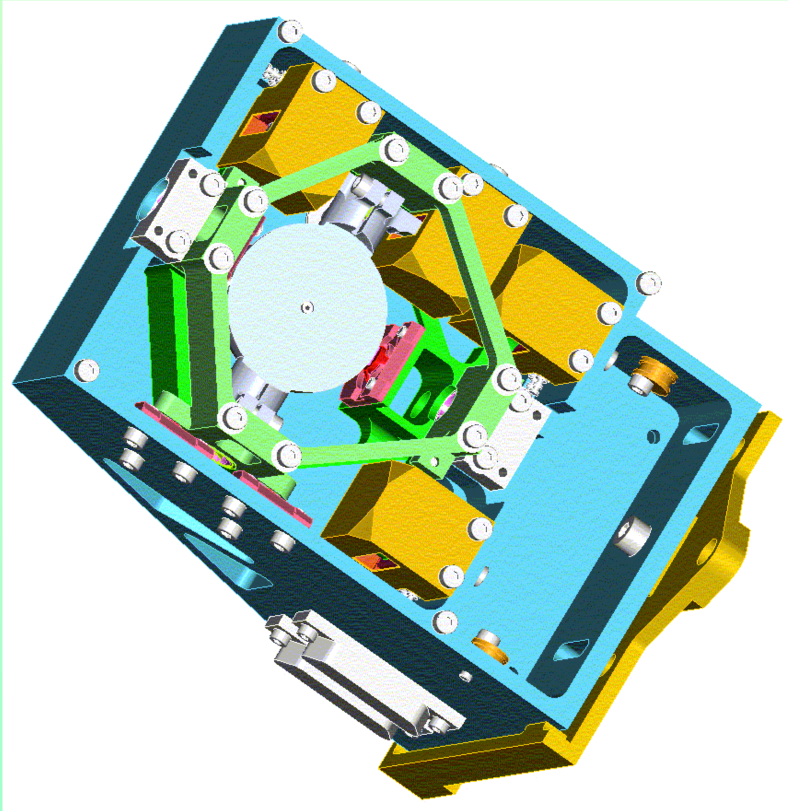


CQM Bolometer Load Resistor Array

Beam Steering Mechanism

- De-scope of BSM development model philosophy already being implemented (dev. model 1 will be delivered for STM)
- Proposal not to integrate FS (not accepted by SPIRE Project)
- Descope to single axis will save very little at this stage
- No margin for any setbacks
- De-scope of the test programme or deletion of the mechanism are high risks

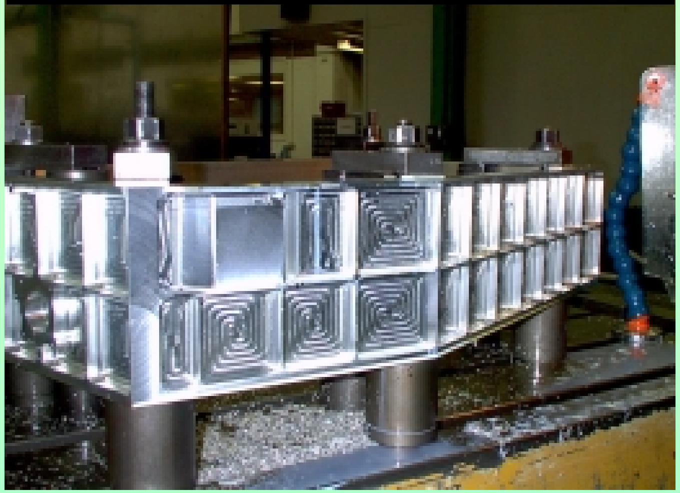
- Observing modes that allow degraded operation without the BSM exist – but major penalty to science



STM/CQM Structure

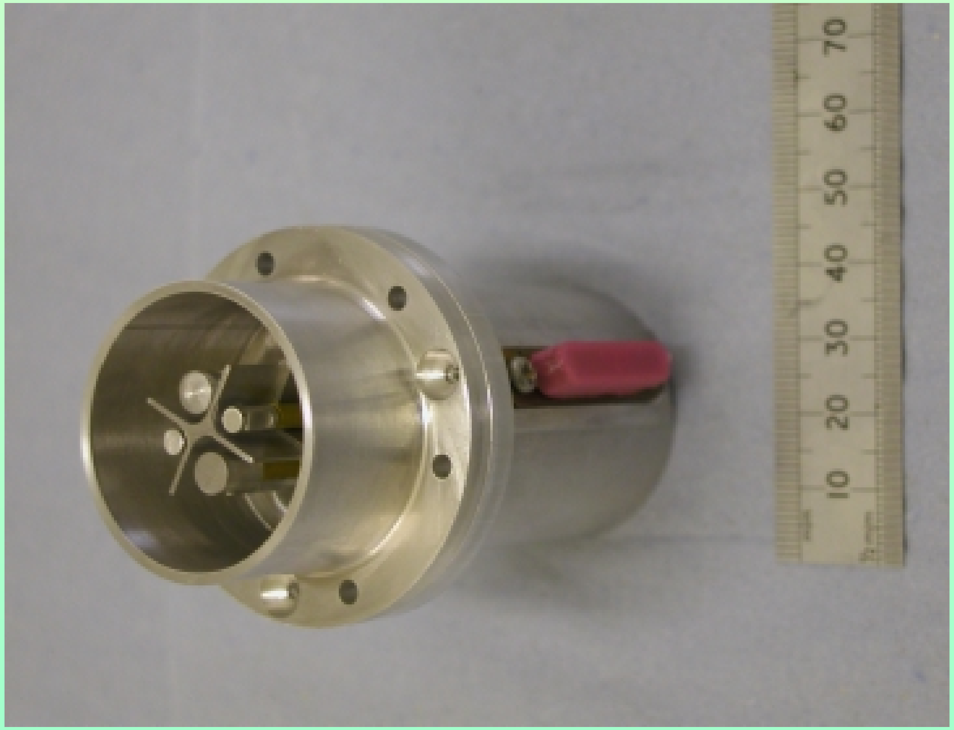
Photometer 2-K enclosure

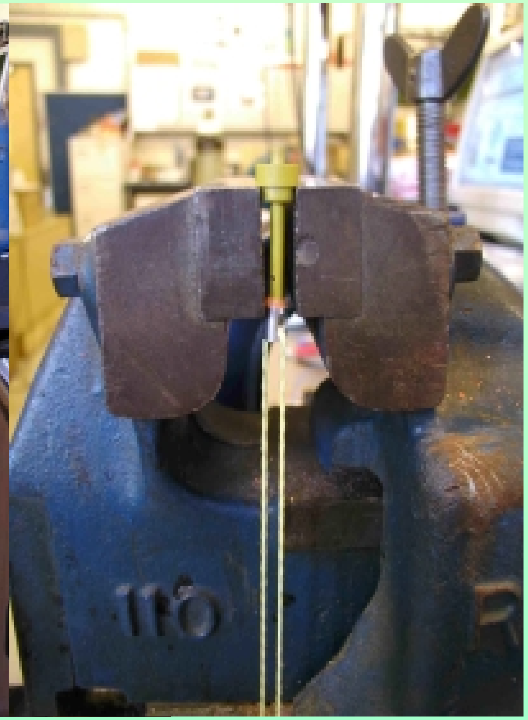
FTS-Side FPU Cover



2-K Enclosure Covers

STM SCAL Source

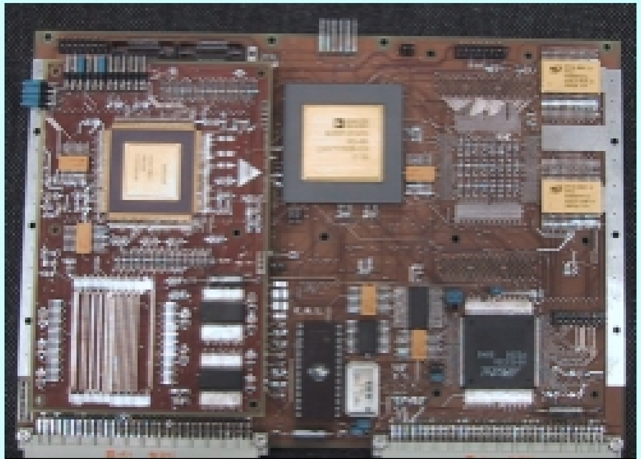




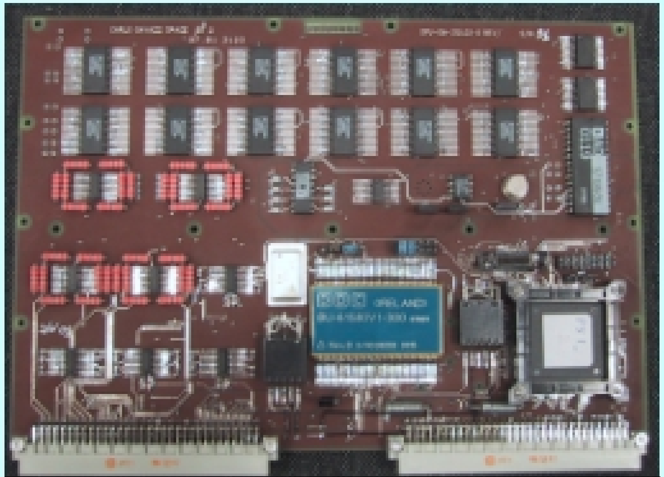
DRCU

- QM1 DCU is being built at Caltech
- Reaches CEA in October/November
- Documentation for DDR has been received – (DDR will be in September)
- PSU is not specified and procurement has not started – grounding scheme is the holding item.

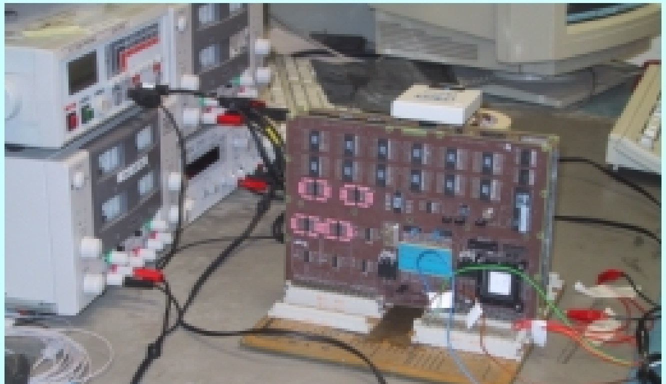
DPU Boards



CPU Board



I/F Board

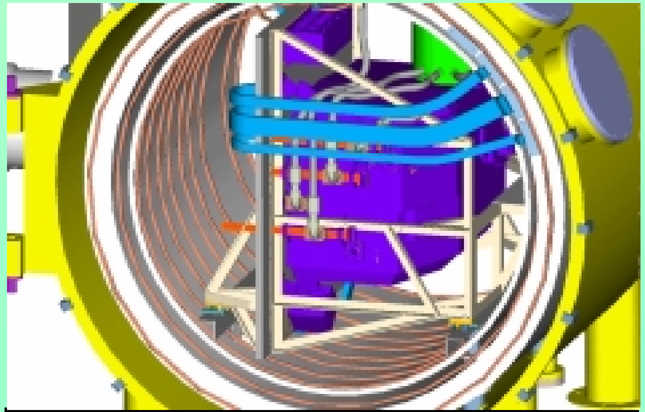


CPU + I/F + Motherboard Testing

SPIRE AIV Facility

Instrument Test Cryostat

FIR laser and telescope simulator



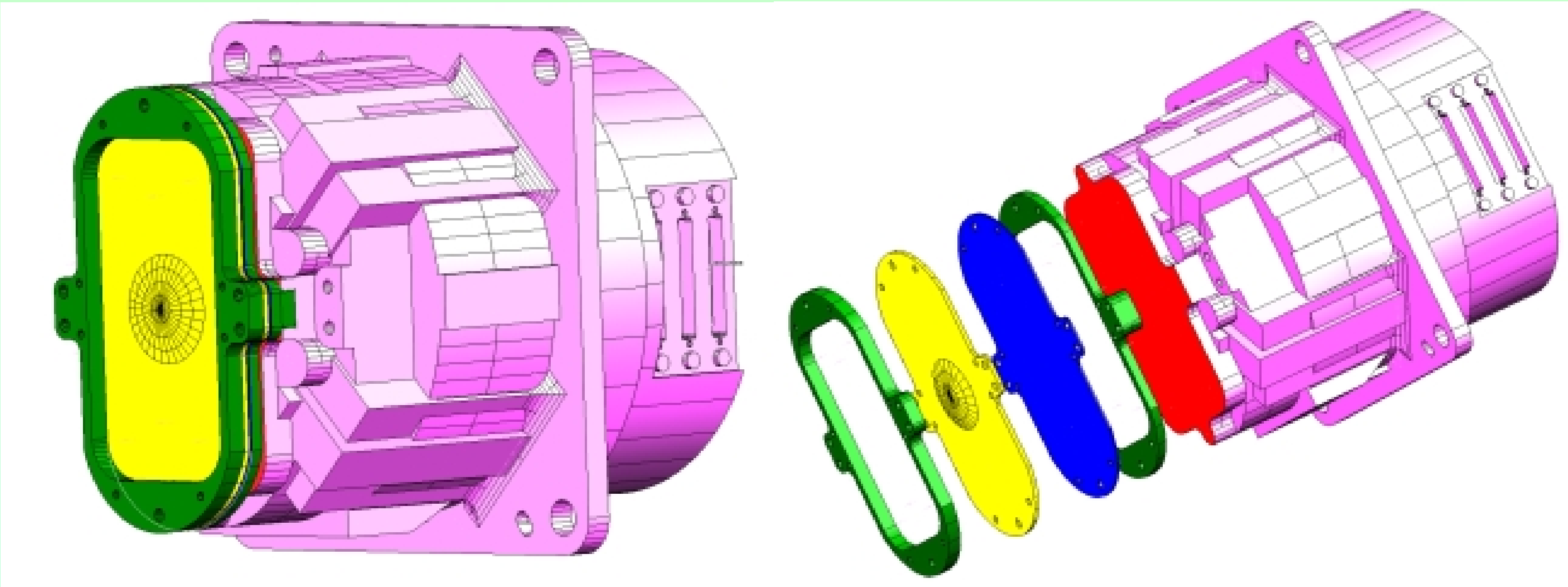
Instrument in cryostat

Vacuum system

EGSE

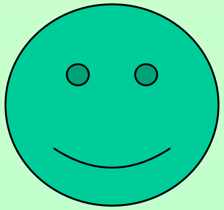
- CDMS Simulator built and integrated at IFSI with DPU
- SCOS first version received and waiting “official” version in August
- HCSS – available and waiting SCOS for testing
- QLA – prototype has been built and development ongoing.
- TFCS – under development
- H/W due for delivery in September
- Problem will occur because the I/f to the CCS will cause extra work

FTS BDA with Lens and Filter Stack

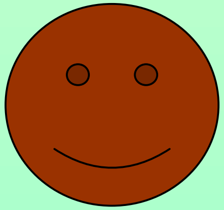


IBDR Review Board Report

Progress, Overall Status, Programmatics



- Good progress made since the IIDR, visible from documentation, presentations and recent test results
- Most issues raised at IIDR closed or close to being solved

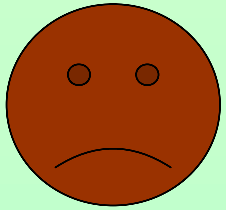


Major concerns

- Funding situation for SPIRE
  - Reduction of Project Team to very low level of manpower, while the resources are stretched already.
  - Some activities reported to be on hold, although they need to be addressed urgently.
- Schedule
  - Main driver for all SPIRE activities; de-scoping in the AIV programme has already taken place.
  - Absence of appropriate margins

IBDR Review Board Report

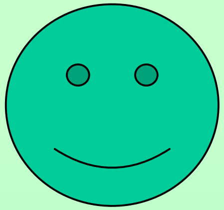
Product Assurance and System Engineering



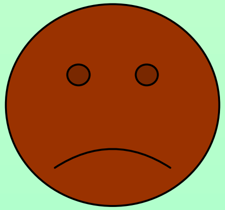
Other Concerns

- Lack of planning and coordination of future PA activities
- Lack of configuration control, especially at Subsystem level
- Full system-level FMECA is still lacking.
- Delay in completing FDIR and H/W-S/W Interaction analyses due to lack of manpower at RAL

IBDR Review Board Report
Instrument Design and Subsystems



- System and subsystem design and definition of internal interfaces are well advanced.
- Clear way forward on mitigating microvibration risk



- Lack of visibility of Bolometers status (ITAR problems noted)
- 300-mK thermal strap status
- Harness routing to and from the BDAs still open
- FTS mechanism design not fully consolidated; lifetime tests are late in the programme
- DRCU design is not yet mature
- Too many tests being pushed into FM programme

IBDR Review Board Report Recommendations

1. **Extreme concern that funding-driven slow-down of SPIRE Project Team activities seems to be unavoidable: impacts should be assessed and priorities proposed**
2. **Schedule must be urgently consolidated. Clarify planning of DRCU, Thermal straps, AIV/AIT plan.**
3. **Advance the status of the DRCU and thermal straps to a level equivalent with the rest of the instrument**
4. **Freeze the outstanding interfaces with the spacecraft, both thermal and stray light**
5. **PA activities need appropriate planning and resources**

IBDR Review Board Report Recommendations

6. Configuration control must be improved at system and subsystem levels.

7. Special care shall be given to early testing of high-risk items, such as the SMEC, the BDA, microphonics.

8. A software development and verification plan shall be made available.

Critical Issues Listed by SPIRE at IBDR

RED: More concerned

Blue: Less concerned

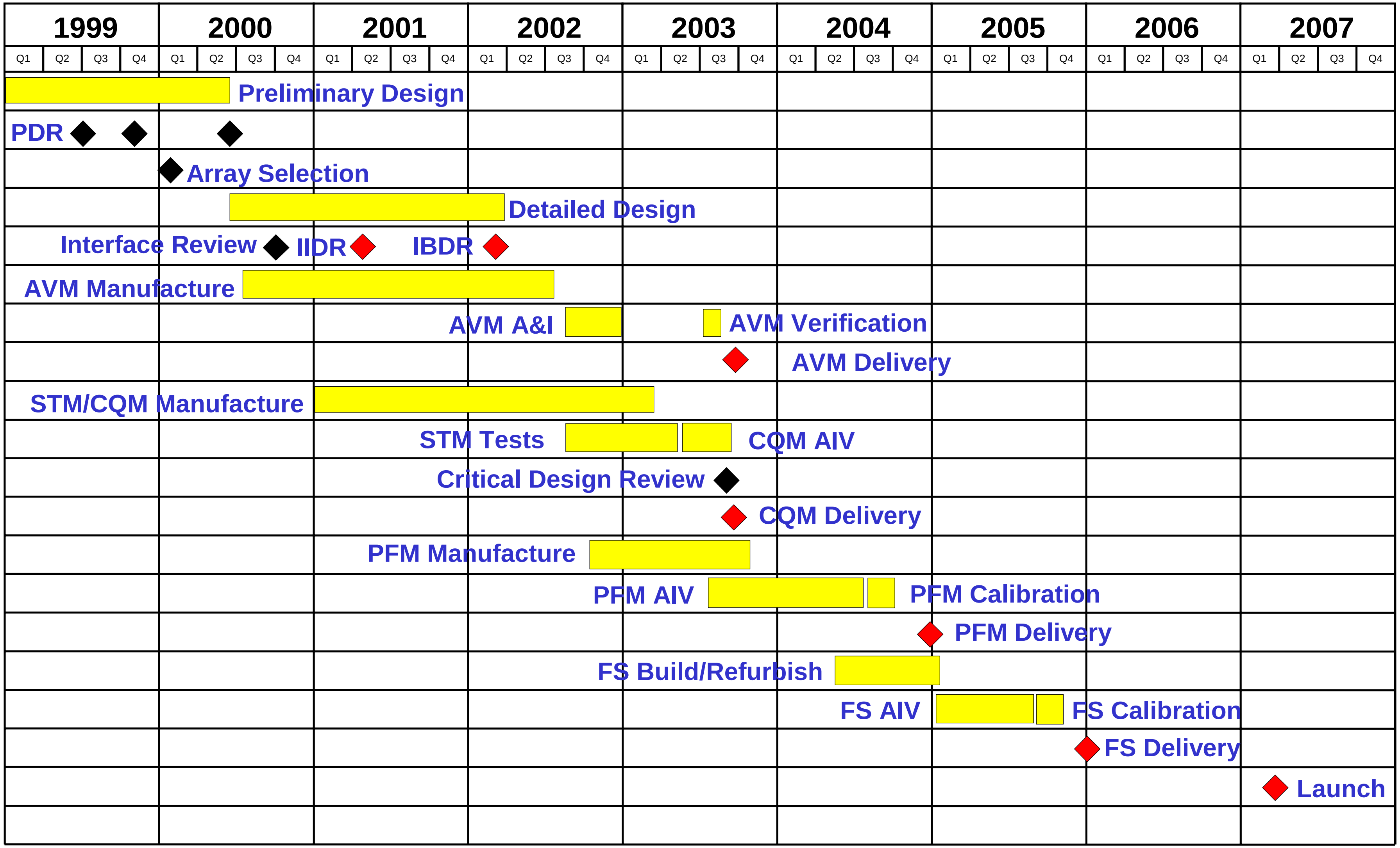
Black: Same

1. Spacecraft interfaces (IID-A & IID-B)
2. BDAs
   - Development Plan
   - BDA vibration levels
3. 300-mK thermal straps
4. FPU Structure schedule
5. Microvibrations
6. DRCU Dev. Plan and Schedule
7. DRCU mass
8. EMC
9. BSM Development Plan
10. UK Project Team Costs
11. OBS effort at IFSI
12. Shutter programme
13. AIV Facility
14. FMECA/FDIR

<u>New ones . . .</u>

- DRCU design and overall grounding scheme
- DRCU delay
- Optics delay
- SMEC pivots vibration survival
- ^{3}He Cooler Kevlar supports

Schedule Overview (new instrument delivery dates)



SPIRE – DRAFT NOTE ON MICROVIBRATION REQUIREMENTS

1 Introduction

The SPIRE project systems team is concerned that the instrument meets its requirements in operation when it is vibrated by the spacecraft mechanical systems, particularly the reaction wheels. The concern arises from experience of ground-based bolometer instruments, which often have been sensitive to vibrations from the local environment. We also need to ensure that the two SPIRE mechanisms can cope with vibrational perturbations and keep within specification. An arbitrary level of 10 μg_{rms} was specified on the spacecraft/instrument interface, to provide a basis for discussion. It is apparent that this would be impossible to achieve. This paper provides a rationale for a more realisable specification.

2 Summary of effect of vibrations on similar bolometer system

Two papers by Ravinder Bhatia et al. show results from vibrating a bolometer of similar type to those used in SPIRE (reference 1 & 2). The bolometer was a germanium spider-web Planck prototype with electrical NEP of 2×10^{-18} W $Hz^{-1/2}$ and a time constant of 25 ms, and an operating impedance of about 10MΩ. A dummy load resistor was also tested. Both were mounted on torlon supports at 100 mK. The readout system was an ac-excited differential circuit, similar to SPIRE, but modulated at 446 Hz. Uniaxial accelerometers were mounted on the 100mK and 4K stages, and the cryostat vibrated on axis with the accelerometers. When excited at 32 Hz at a level of 22 mg_{rms} on the 100mK stage signals were generated at the fundamental frequency signal level and harmonics, but there was no effect on the noise floor away from the vibration frequency and its harmonics for either the bolometer or the dummy. When the vibration was increased to 37 mg_{rms} the bolometer showed an increased noise floor across the spectrum, whereas the dummy's output was unchanged.

The detectors were biased at 136Hz, with a bandwidth of around 5Hz, so only the fourth harmonic of the 37mgrms excitation at 32Hz was detected, resulting in a signal at 6.5 Hz after demodulation (~132-4*32). Amplitude of this signal after demodulation was about 30 times above the noise floor of 20 nV/rtHz. We do not know how much lower the fourth harmonic response is than the fundamental, so can only make a rough estimate of the sensitivity of this system. If the fundamental is ten times higher than the fourth harmonic, and we want to keep the response at the noise floor, the amplitude we can tolerate is 37/10/30, or about 100 μgrms. This can only be regarded as an order of magnitude estimate, as the bolometers, wiring and support structure were all very different from SPIRE. The way vibration signals appear in the signal spectrum as it is processed by the modulation and demodulation process is discussed later.

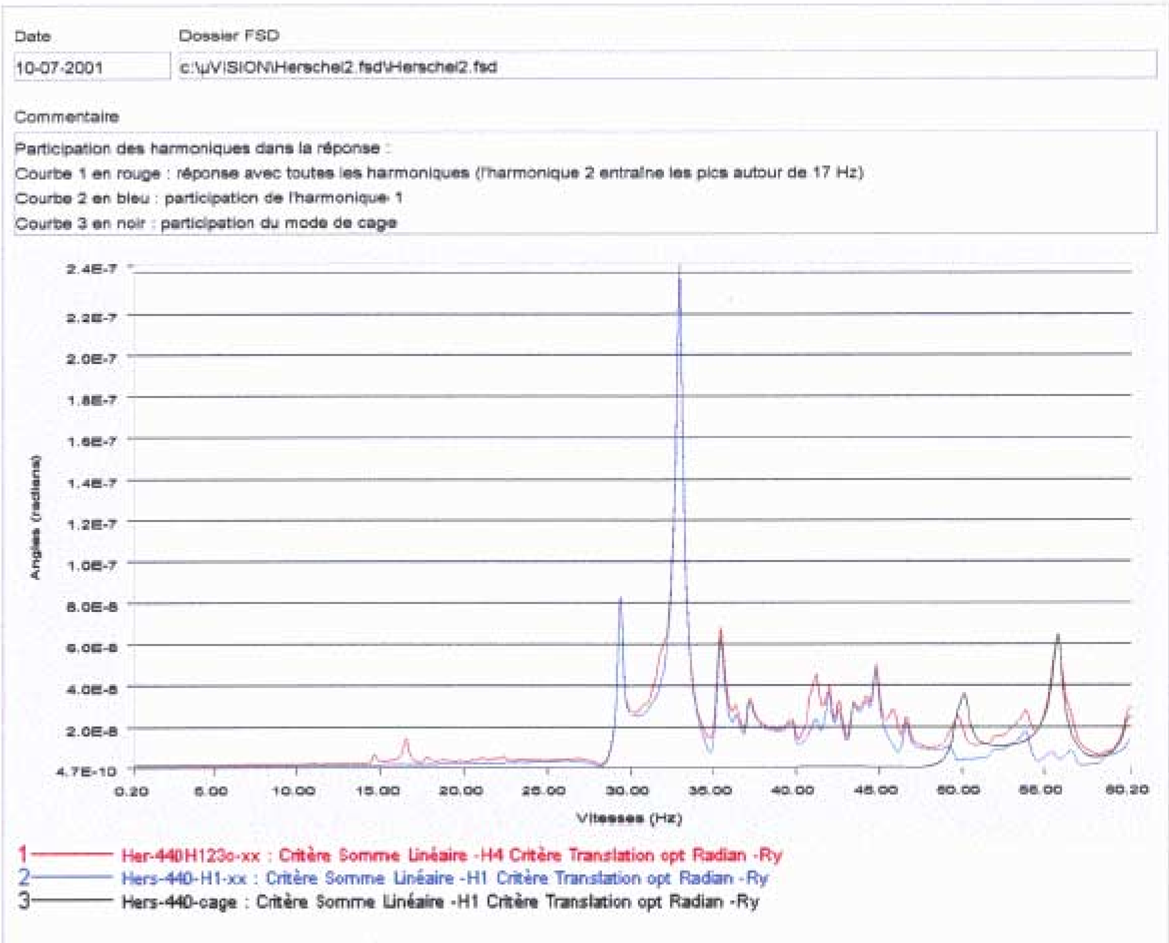
These measurements are indicative of two different mechanisms for transduction of vibration into signal. Where a similar level of sensitivity was seen by both the bolometer and dummy resistor, it is likely that the signals are generated by modulation of the wiring capacitance 'seen' by the bolometer or dummy. There will be a substantial rejection of this effect due to the differential amplifier, but the wiring cannot be perfectly matched electrically and mechanically, so some unbalanced signal is produced – although at much lower levels than in single-ended systems as used on the SCUBA instrument.

In principle, signals generated at the frequency and harmonics of the vibration can be dealt with by tuning modulation frequency, or by post processing, so the increase in noise floor seen at the higher level of vibration is more serious. This effect was only seen with the bolometer not the dummy resistor, suggesting a thermal mechanism, such as the tribo-electrically generated currents causing heating of the bolometer. It is essential that levels are kept well below those which increase this noise floor.

3 Expected spectrum of vibration from the spacecraft

Analysis by Alcatel shows predicted level at the HOB of below 5 mg at a range of frequencies 0-60 Hz, with a peak of 7.7 mg at 60 Hz. . This is a peak amplitude level, so rms will be 0.707 times this, or 5.4 mg. There is a deal of uncertainty in the assumptions on damping factors of the structural resonances of the spacecraft.

The methodology used to model microvibrations of the spacecraft consisted of computing transfer functions between an excitation source an a sensitive element and then multiplying this transfer function by the excitation spectrum. For the reaction wheels we an excitation spectrum in amplitude which means that the predicted microvibration levels are also in amplitude.



4 Factors to allow for variations from test system

We can only use the values from Ravider's work as a rough estimate for sensitivity of SPIRE bolometers for the following reasons:

4.1 Bolometer sensitivity

The most sensitive SPIRE bolometers will have an optical NEP of better than 6 x 10^{-17} W $Hz^{-1/2}$. Even allowing for a factor of 2 between optical and electrical NEP, the bolometer used in the above test is more than 10 times more sensitive.

4.2 Bolometer speed

The SPIRE bolometers have a minimum time constant of 3.4 ms compared with 25ms for the tested bolometer. Without knowing the precise process of conversion of vibrations to bolometer output, we cannot say exactly what the effect of this thermal time constant will have on sensitivity to microvibrations.

4.3 Structural response

The test set-up had eigenmodes at about 50 and 250 Hz, so the 32 Hz excitation was well away from resonance. The SPIRE structure is expected to have little if any amplification in the range x-y frequency, but we will assume a maximum of 1.5.

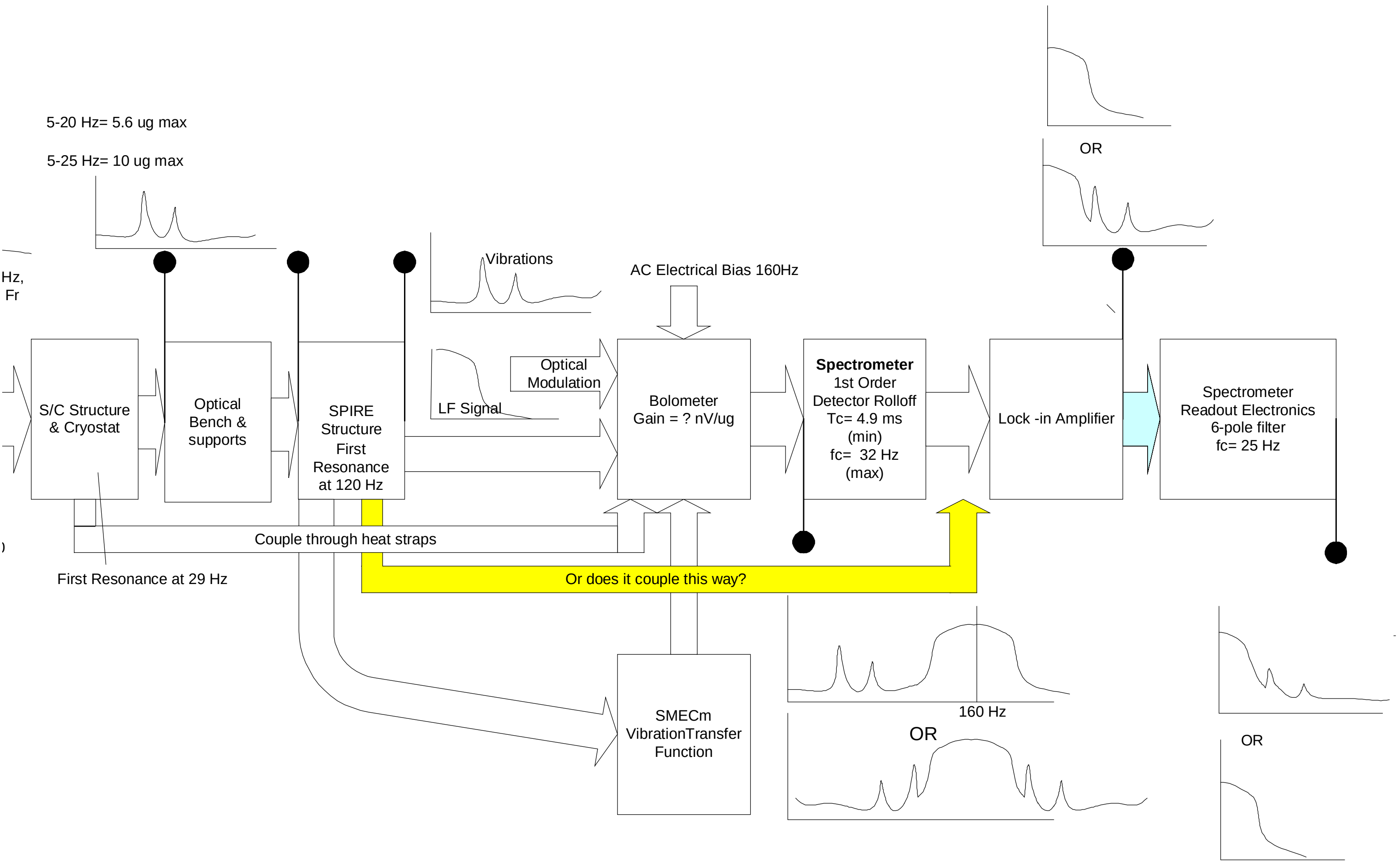
4.4 Cable type

Tests were carried out Stainless steel conductors & shield, twisted shielded pair, 32 AWG conductor, Cooner wire company part no. AS 636-2SS, nominal diameter over shield 0.044 inches. This is close enough to the wire type that makes up the SPIRE ribbon cable between the bolometers and JFETS.

4.5 Length of cable

Test used 200mm cable length, compared with 500 for SPIRE. The wires were taped to the Torlon legs. We will assume that this makes the SPIRE bolometer system 2.5 times more sensitive.

5 Block Diagram

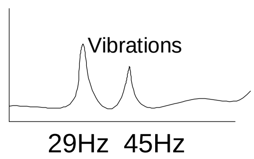


The rotating reaction wheel generates vibrations at the frequency of revolution, and the ball-bearings generate signals at a frequency of 0.59 times that. These vibrations pass through the spacecraft structure to the Herschel Optical Bench, and are modified in amplitude by the spacecraft transfer function. Of course, the reactions wheels change speed (up to 3600 rpm) as the spacecraft attitude is modified, so the instrument can be excited by a range of fundamental frequencies from 0-60 Hz. The Alcatel analysis shows resonances at 29 and 45 Hz.
The vibrations then pass through the SPIRE structure, which has a first resonance at 120 Hz, so there will be very little amplification: no more than 1.2 at 45 Hz.
These vibrations then couple into the three subsystems where we are concerned about susceptibility: the Beam Steering Mirror, the Spectrometer Mechanism and the Bolometer Modules.

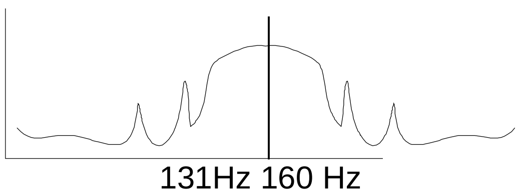
6 Bolometer Response

To understand how vibrations can couple into bolometer signals, we need to consider the signal processing involved as the vibrations couple into the bolometer system. There are two main methods of coupling. First we will look at the effect of capacitance modulation:

6.1 Impedance modulation



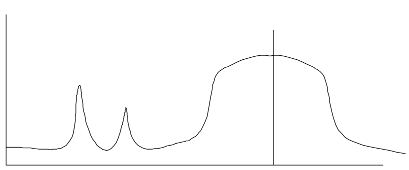
If the vibration input to the bolometer module is like this, with peaks at 29 and 45 Hz, and it causes a modulation of impedance by changing capacitance of leads, then this will result in side bands on either side of the bolometer modulation frequency of say 160Hz:



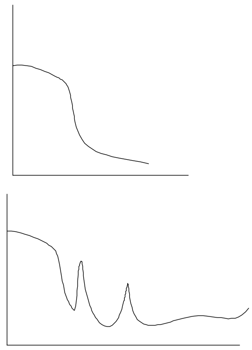
Note the roll-off of the bolometer optical signal due to the thermal time constant of the bolometer.

6.2 Interference

If the coupling is through direct electrical interference, it will couple at the original 29 and 45 Hz frequencies:



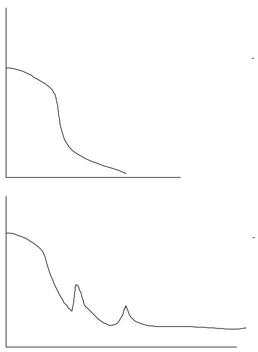
6.3 Lock-in Amplifier



When demodulated by the lock-in amplifier, the output for the interference coupled case will be as in the upper plot, and for impedance modulation it would be as in the lower plot. IN other words, the modulation-demodulation process effectively rejects low frequency interference, but not impedance modulation.

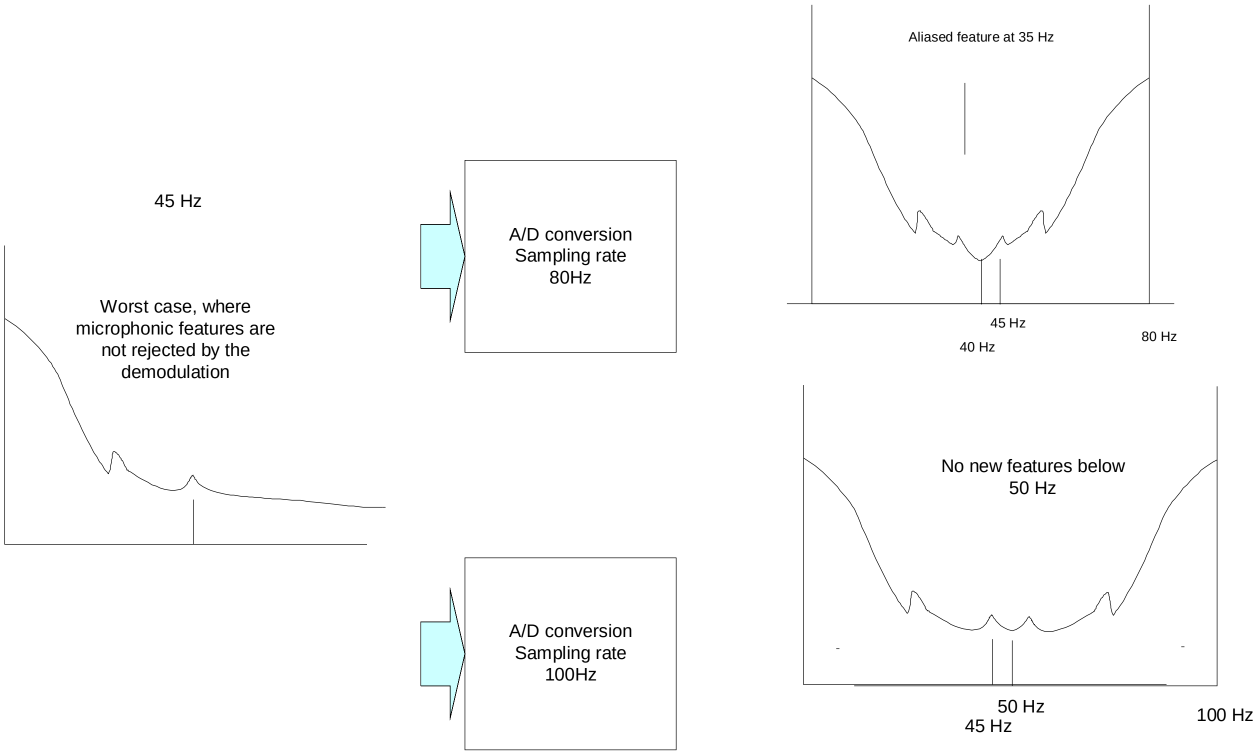
6.4 Filtering

6-pole Anti-alias filtering will further attenuate vibration signals:



It should be possible to use this difference in spectral response to determine which type of vibration coupling is present.

6.5 Aliasing



A further signal processing step is introduced by the analog to digital conversion. As we see here, if the sampling frequency is too low, the 45 Hx vibration signal could be aliased down into the signal band – 35 Hz in this example.

7 Summary of effect of vibrations on FTS mechanism and control system

Analysis (ref 4) shows a sensitivity of 0.1 mg from 20 – 30 Hz. It is not clear if this is peak rms level, but it is noted that this is 'an order of magnitude' estimate, so it will need confirmation.

8 Summary of effect of vibrations on BSM

Analysis (Ref 5) of the BSM vibrated at its chop axis resonance of 15Hz by 10mg, with 1 g.cm out of balance shows that the resulting movement would almost 43 times below the angular noise specification, in the active control mode. Balancing to such a level should be easy. However, this analysis assumes that the vibration is linearly applied, whereas the structure may introduce rotational vibrations. Allowing for a factor of safety of 10, and amplification through the SPIRE structure of 1.5, the BSM's requirement is that the microvibration at the HOB is less than 30 mg_{rms} over 0 –60 Hz range.

9 Specification for maximum microvibration level at Herschel Optical Bench Interface

The above shows that the most critical subsystems in SPIRE are the FTS mechanism and the bolometer modules. Therefore this drives the specification for the spacecraft to produce less than 0.1 mg at the Herschel Optical Bench. We need to confirm this in order to firm up the specification, as there are very large uncertainties in the bolometer sensitivity estimates.

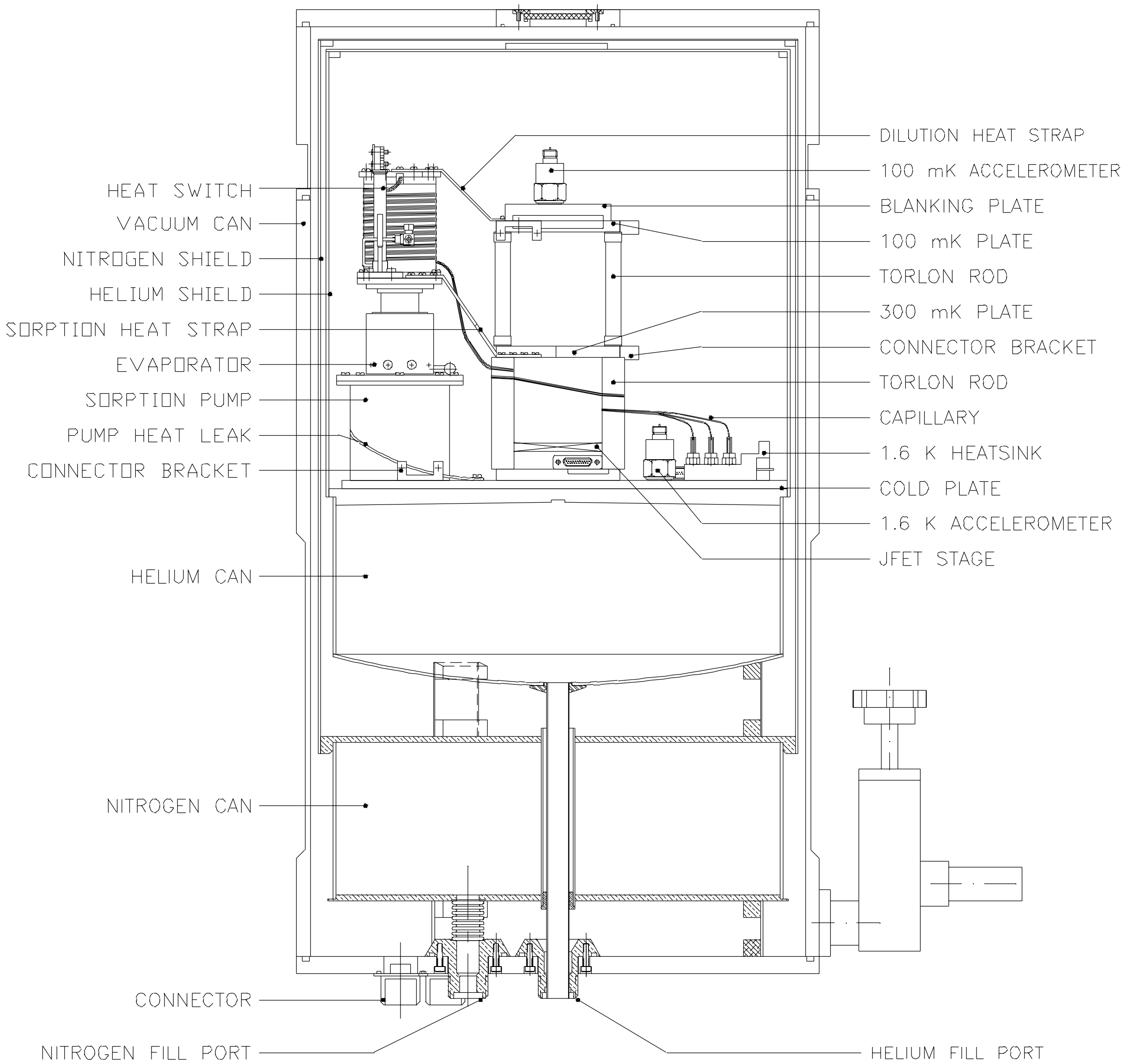
			Spectrometer Mech	BSM	Bolometers
Frequency	Amplitude (peak)	Amplitude (peak)	Tolerated vibes	Tolerated vibes	Tolerated vibes
Hz	microg	microg	ug	ug	ug rms
	(at CVV)	(at HOB)			
20	5.6	8.9	160	1000	100
25	10	28		1000	100
29		300	380	1000	100
35	-	-		1000	100
45		320		1000	100
50			990		

10 Verification

There are large uncertainties in all the estimates of effects of microvibration on these SPIRE subsystems, so it is sensible to carry out tests of susceptibility on development models.

10.1 Bolometers

Tests must be done at operating temperature, because we have seen that the predominant effect is likely to be thermal. We should test the SPIRE bolometer modules in a similar way to Ravinder's test, using a test cryostat, external vibration source and an accelerometer mounted on the 2K interface plate- see figure below. A series of bolometer noise spectra should be taken with vibration excitation from 5 to 100 Hz to cover the range of expected microvibrations from the spacecraft. If this is not possible at subsystem level, the test should certainly be carried out on the complete CQM instrument model.


DILUTION HEAT STRAP
100 mK ACCELEROMETER
BLANKING PLATE
100 mK PLATE
TORLON ROD
300 mK PLATE
CONNECTOR BRACKET
TORLON ROD
CAPILLARY
1.6 K HEATSINK
COLD PLATE
1.6 K ACCELEROMETER
JFET STAGE
HEAT SWITCH
VACUUM CAN
NITROGEN SHIELD
HELIUM SHIELD
SORPTION HEAT STRAP
EVAPORATOR
SORPTION PUMP
PUMP HEAT LEAK
CONNECTOR BRACKET
HELIUM CAN
NITROGEN CAN
CONNECTOR
NITROGEN FILL PORT
HELIUM FILL PORT

10.2 FTS Mechanism

It should be possible to model microvibrations effects at room temperature, and then confirm this model with a room temperature test. It would be valid to then use a model using parameters for the cold system to verify sensitivity. However, since initial analysis shows a potential problem with the Alcatel spec, it would be prudent to confirm with a cryogenic test.

10.3 Beam Steering Mechanism

By a similar argument, but noting the low sensitivity, a room temperature test will be adequate.

References

1 Bhatia R.S., P.A.R. Ade, T.W. Bradshaw, M.R. Crook, M.J. Griffin and A.H. Orlowska, 'The Effects of Cryocooler Microphonics, EMI and Temperature Variations on Bolometric Detectors', accepted by Cryogenics (2001)

2 Bhatia, R.S., J.J. Bock, P.A.R. Ade, A. Benoit, T.W. Bradshaw, B.P. Crill, M.J. Griffin, I.D. Hepburn, V.V. Hristov, A.E. Lange, P.V. Mason, A.G. Murray, A.H. Orlowska and A.D.Turner, 'The Susceptibility of Incoherent Detector Systems to Cryocooler Microphonics' Cryogenics 39 8, 701-715 (1999)

3 Poutrel,S, Micro vibration analysis concerning optical instruments of Herschel spacecraft. Alcatel Document HP-ASPI-MO-218 (August 10th 2001)

4 Ferrand, D., Herschel Spire Control System: Microvibration Requirements July 17th 2001

5 Stobie, B.S., SPIRE BSM Sensitivity to Vibration V 1.0, ATC Internal Note: SPIRE-BSM-NOT-0005, Aug 27th 2001