SUBJECT: VIBRATION TEST SPECIFICATION STM QUALIFICATION

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CHANGE RECORD

ISSUE	SECTIONS	REASON FOR CHANGE
1.0	all	New issue
2.0	header, appendix A and somewhere else. Added report number, instrument mass and instrumentation pictures	

Table of Contents

1. SCOPE

This document specifies the qualification vibration test for the Herschel SPIRE instrument structural thermal model (STM).

The notching philosophy is outlined in Technote AD (2).

2. DOCUMENTS

AD (1)	Instrument Interface Document, part A	IID-A, issue 3
AD (2)	Technote 9 Random Vibration SPIRE February 2003 issue 3.doc	
AD (3)	Drawing of interface fixture for head expander	A1-5264-404-30
AD (4)	Drawing of interface ficutre for slip table	A1-5264-404-31

3. DEFINITIONS

3.1. ABBREVIATIONS

AD	Applicable Document
BSM	Beam steering mirror
EM	Engineering Model
FM	Flight Model
ICD	Interface Control Document
PFM	Proto-Flight Model
QFM	Quartz Filter Mechanism
STM	Structural Thermal Model
S/C	Spacecraft
TBC	To be confirmed
TBD	To be defined
TRB	Test Revieuw Board
TRR	Test Readiness Review
TML	Total Material Loss
VCD	Verification Control Document
VCM	Volatile Condensable Material

4. TEST PHILOSOPHY

The design of the STM of the SPIRE instrument is identical to the flight model except as stated in section 5. This model will be used to qualify the structural design of the SPIRE instrument.

5. BUILD STANDARD

The STM of the SPIRE instrument is identical to the PFM with the following exceptions:-

? Mass thermal dummies of the following subsystem are fitted in place of the Flight units:-
? Beam Steering Mirror (and support)
Spectrometer calibration source
? Spectrometer Mechanism (full structure but no electronics and dummy flex-pivots)
? Detectors (mass representative and internally suspended mass representative of the flight hardware with thermal interface for thermal busbar)
? Helium-3 cooler (mass dummy for the heater/evaporator, rest structure representative including suspention)
Filters are optical dummies

The interface to the spacecraft is identical to the flight unit. The mass of the STM model of the SPIRE instrument is 38.5 kg.

6. TEST OBJECTIVES

? To Qualify the structural design of the SPIRE instrument and to recover response spectra at critical internal interfaces between system structure and subsystem structures.
? To measure the input levels of the subsystems.
? The test sequence is such that a proper response signature of the instrument is identified both in sine and in random vibration. This will lead to extra reconfigurations of the test set-up and extra runs. In effect all the responses are measured for all excitation directions at levels lower than flight levels before the structure is subjected to qualification levels.

7. FIXTURE

For the X axis vibration (on the nose of the shaker) fixture to drawing AD (3)-A shall be used.
For the Y and Z axis vibration (on the slip table) fixture to drawing AD (4) shall be used.

8. TEST REQUIREMENTS

8.1. SUMMARY

Resonance search, sine vibration test and random vibration tests shall be carried out in three axis. Resonance searches and intermediate random tests shall be performed in all three axes before the instrument is subjected to qualification runs.

8.2. Fixture qualification runs

Runs on just the bare fixture will be carried out as necessary to prove that the fixture behaviour is suitable for the test. This can be carried out before the instrument is available for test.

8.3. Resonance search

A resonance search shall be conducted at approximately 0.5 g input between 5 and 2000 Hz to identify any changes in the primary resonance's. The will serve as the structure's health check. The sweep rate shall be 1 Oct/min The monitor accelerometers shall be located on the SPIRE vibration fixture near the mounting locations of the instrument. The resonance search will be performed prior and after a qualification run. No nuts or bolts should be tightened or loosend between these verification runs.

8.4. Sine vibration test

As stated in IID-A, AD (1) the qualification levels are:

X axis

Frequency Range Hz	Qualification level
5 - 20.1	+/- 11mm
20.1 - 100	18 g

Test sweep rate 2 Oct/min, the input will be limited to equivalent quasi static interface force.

Y and Z axis

Frequency Range Hz	Qualification level
5 - 13.5	+/- 11mm
13.5 - 100	8 g

Test sweep rate 2 Oct/min, the input will be limited to equivalent quasi static interface force.

8.5. Random vibration test

As stated in IID-A, AD (1) the qualification levels are:

Y and Z axis

Frequency Range Hz	Qualification level
20-100	+3dB/Oct
100-150	0.02 g^2/Hz
150-300	0.0125g^2/Hz
300-2000	-7 dB/Oct
Global	…. gRMS

Test duration 2 minutes in each axis

X axis

Frequency Range Hz	Qualification level
20-100	+3dB/Oct
100-150	0.05 g^2/Hz
150-300	0.02g^2/Hz
300-2000	-7 dB/Oct
Global	…. gRMS

Test duration 2 minutes

8.6. Measurement of subsystem levels

The instrumentation of the instrument should be sufficient to characterise the responses at critical locations and allow for the characterisation of the responses at the various subsystem interfaces. If needed runs will be repeated to cover all locations if the data acquisition doesn't allow for simultaneous measurement of all accelerometers at these locations.

Input levels at the following subsystems are required:-

Detectors (detector boxes)
Spectrometer mechanism
Helium cooler
Beam steering mirror (at base of the support structure)

8.7. TEST SEQUENCE

X Axis (on the nose of the shaker)

? Fixture qualification runs as required by the facility.
? Mount instrument on vibration fixture
? Visual inspection
? Resonance search
? Low level random
? Intermediate level random
? Resonance search
? Visual inspection

Change to Y axis.

Y axis (on the slip table)
? Fixture qualification runs as required by the facility.
? Mount instrument on vibration fixture
? Visual inspection
? Resonance search
? Low level random
? Intermediate level random
? Resonance search
? Visual inspection

Change to Z axis.

Z axis (on the slip table)
? Mount instrument on vibration fixture
? Visual inspection
? Resonance search
? Low level random

? Intermediate level random
? Resonance search
? Visual inspection
? Intermediate level sine
? Visual inspection
? Full level sine
? Resonance search
? Visual inspection
? Full level random (stepping up from -9dB to full level 30 seconds for each step before full le vel, retain measurement data for each step.
? Resonance search
? Visual inspection

Change to Y axis

? Mount instrument on vibration fixture
? Visual inspection
? Resonance search
? Intermediate level sine
? Visual inspection
? Full level sine
? Resonance search
? Visual inspection
? Full level random (stepping up from -9dB to full level 30 seconds for each step before full level, retain measurement data for each step.
? Resonance search
? Visual inspection

Change to X axis

? Fixture qualification runs as required by the facility.
? Mount instrument on vibration fixture
? Visual inspection
? Resonance search
? Intermediate level sine
? Visual inspection
? Full level sine
? Resonance search
? Visual inspection
? Full level random (stepping up from -9dB to full level 30 seconds for each step before full level, retain measurement data for each step.
? Resonance search
? Visual inspection

9. REJECTION AND RETEST

If a failure, malfunction or out of tolerance performance occurs during or after test as appropriate the test shall be discontinued. This also includes test equipment qualification. the deficiency, including any design defect, shall be corrected and the applicable procedures repeated until successfully completed. If the corrective action subsequently affects the significance of results of previously completed test in the sequence, such test shall be repeated.

10. DOCUMENTATION

A test report shall be produced logging all events and the results of the visual inspections. Also all main resonances shall be reported and the worst case responses at the subsystem interfaces. The rest report shall also contain the environmental measurement data (taken during the test) and the calibration/qualification certificates of the test facility.

11. PRODUCT ASSURANCE

Before a test can proceed a Test Readiness Review (TRR) shall be convened by the SPIRE project manager. All the relevant test and facility documentation will be made available. The TRR must give approval before the test can commence. The TRB will convene between each reconfiguration of the test set-up. The test set up can be dismanteled after the TRB convened and agrees.

The test review board will consist of the project manager, quality control manager, mechanical engineer responsible for the test and the test facility manager or their representatives.

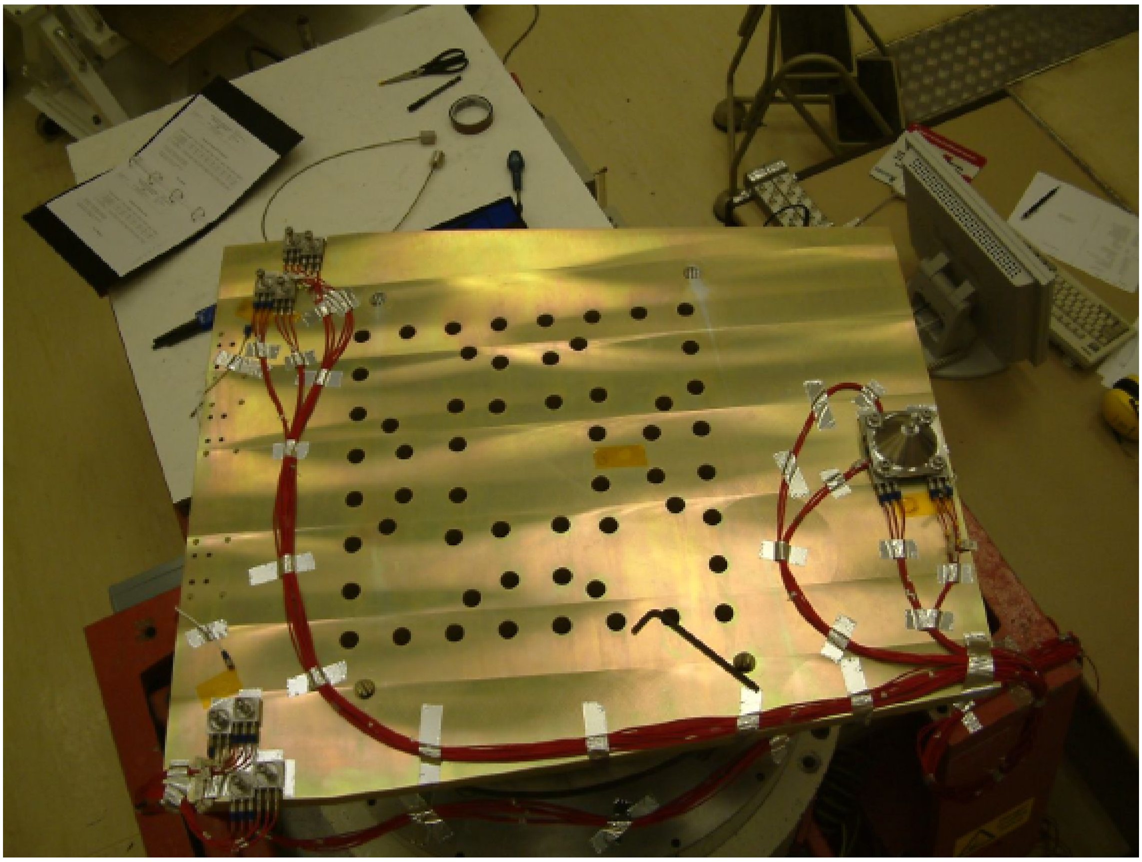
APPENIX A - INSTRUMENTATION SPECIFICATION

The instrumentation will consists, as a minimum of:

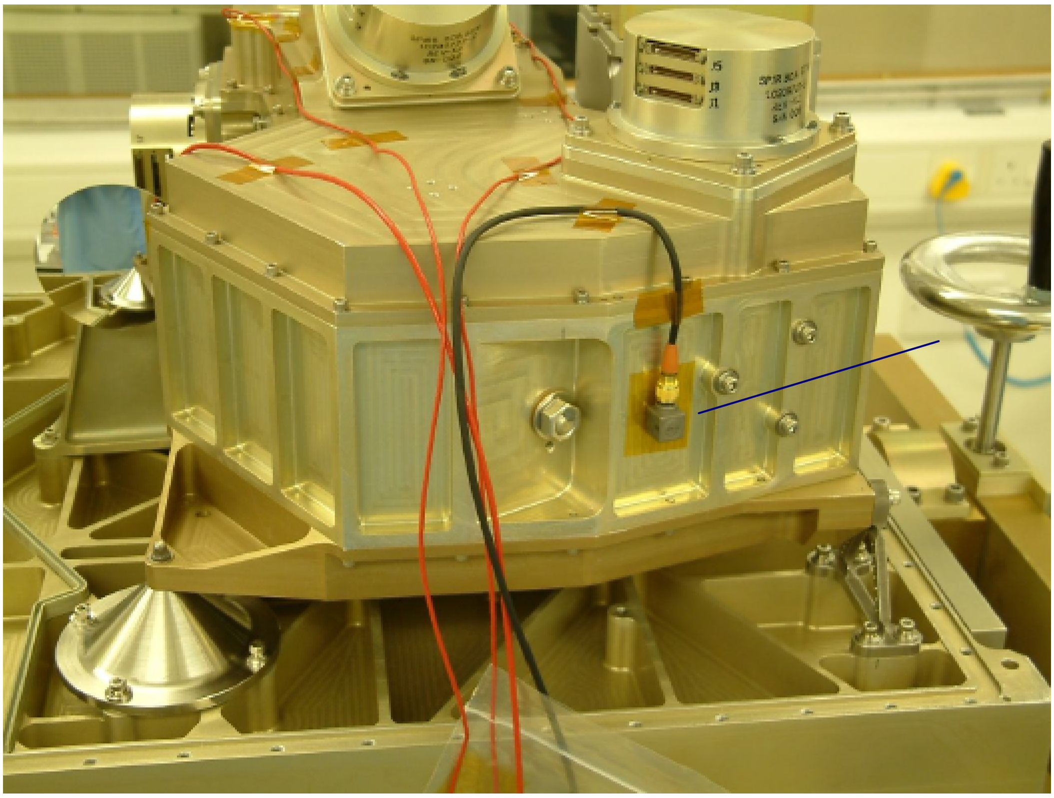
- At the monuting point of the instrument (interface with vibration fixture) tri axial for one, excitation direction for all (4 channels)
- Top of the optical bench in instrument coordinates: +X,+Z tri-axial or near that location. (3 channels)
- +X,-Z,-Y corner of the instrument, tri-axial (3 channels)
- Spectrometer detector box tri-axial (any suitable location) (3 channels)
- Photometer detectorbox 2 on extreme oposite ends measuring in Z direction (2 channels)
- Photometer detectorbox 2 on extreme oposite ends measuring in Y direction (2 channels)
- Photometer detectorbox 1 on any suitable location measuring in X direction (1 channel)
- At the foot of He3 cooler in Y direction (1 channel)
- At the foot of the SMec in Y direction (1 channel)
- At the foot of the BSM in Y direction (1 channel)
- Force in three axes (interface force) (3 channels)

The implemented instrumentation:

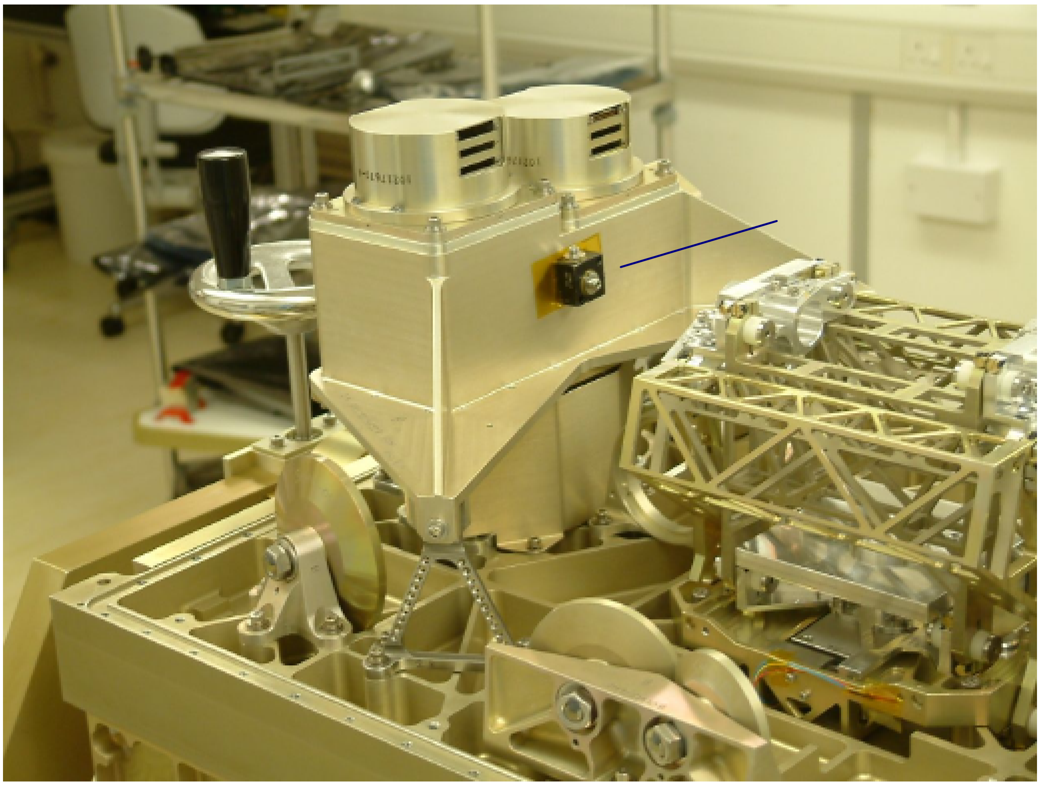
A-1:Control accelerometers



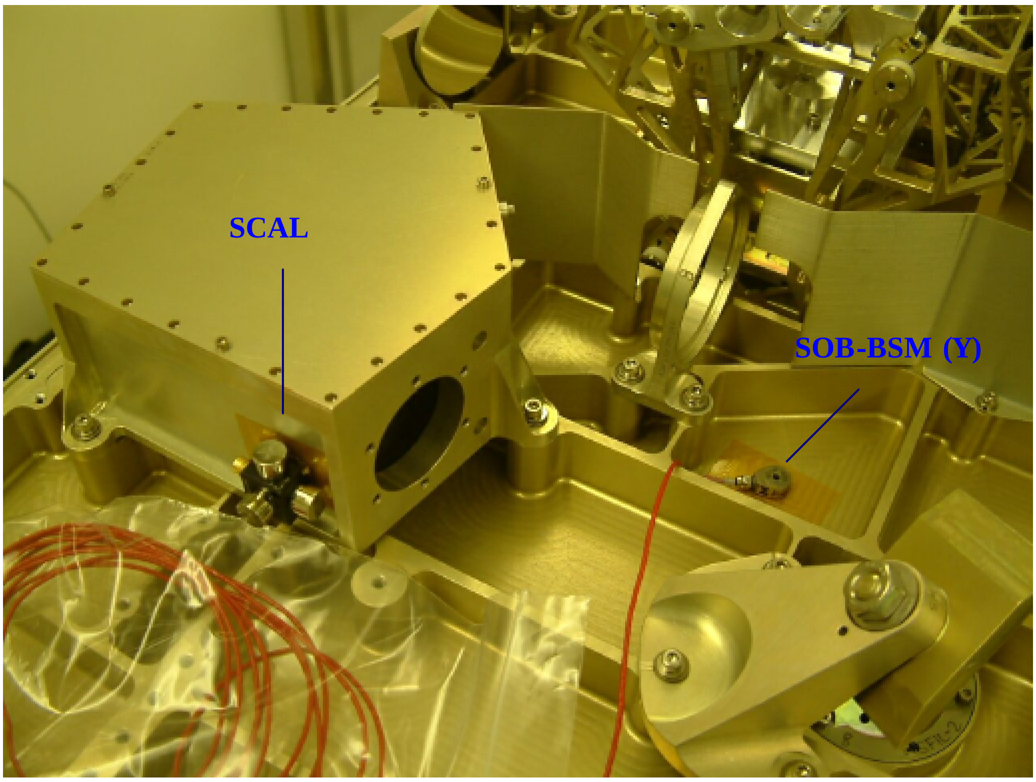
A-2:Force transducers at all interface bolts



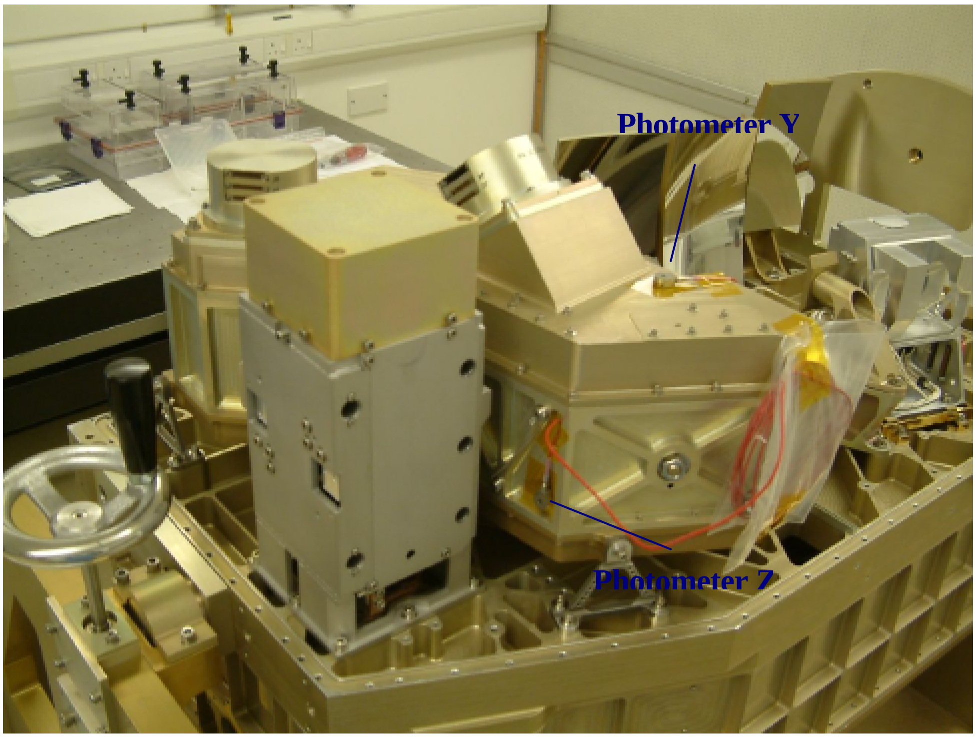
A-3: The triax on the photometer detector box



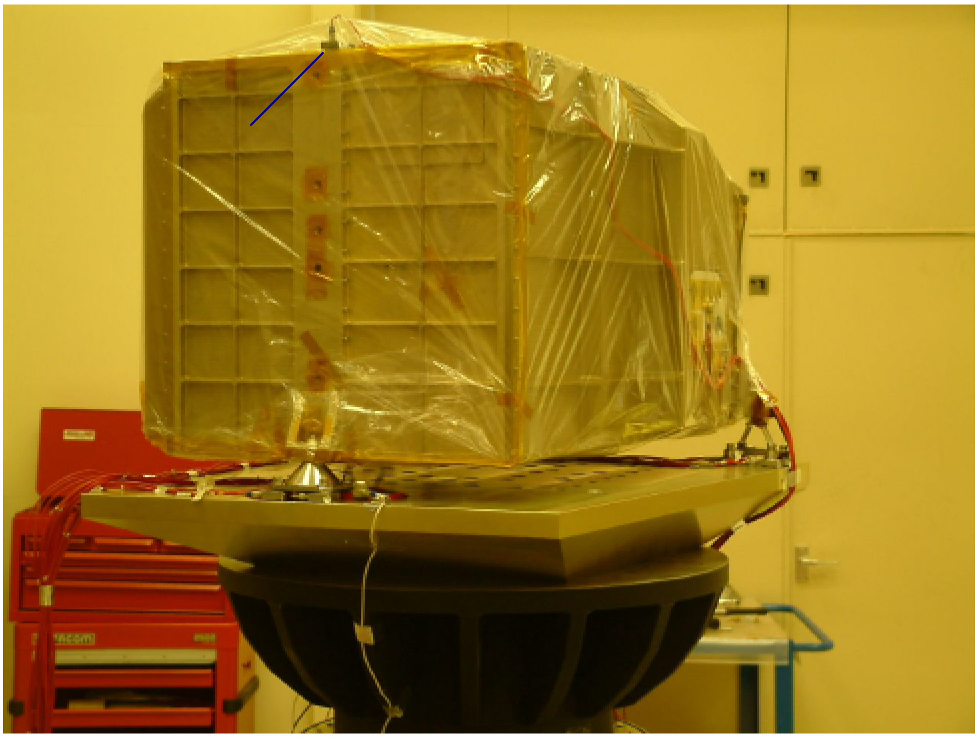
A-4: The trixax on the spectrometer detector box



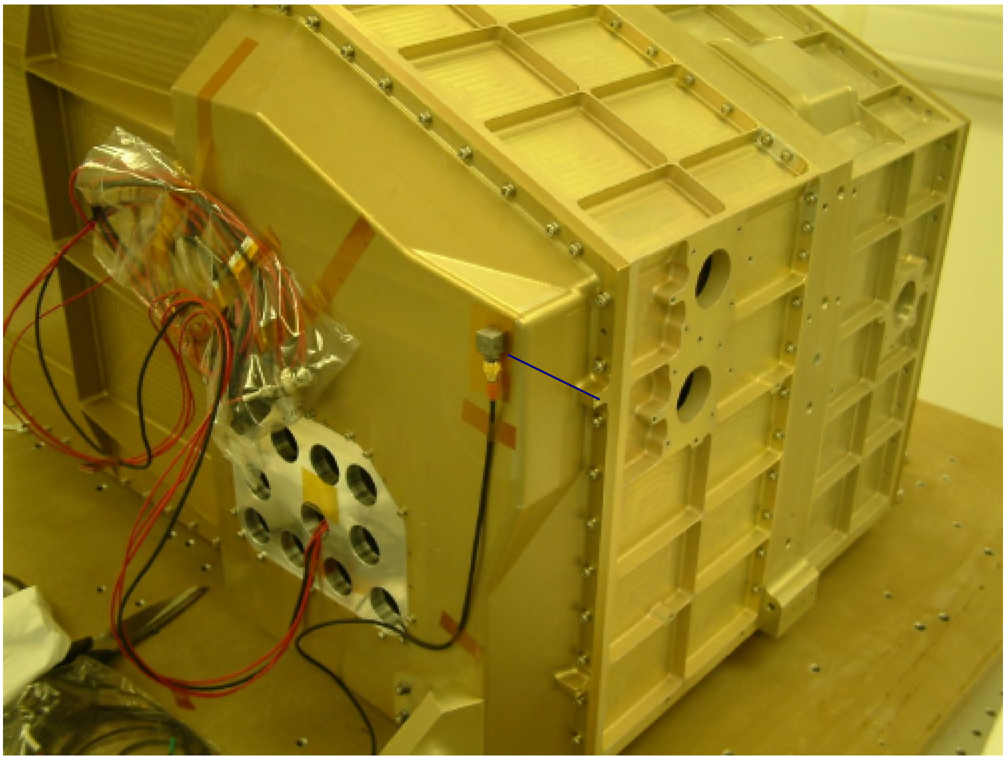
A-5: SCAL trixax and SOB-BSM location

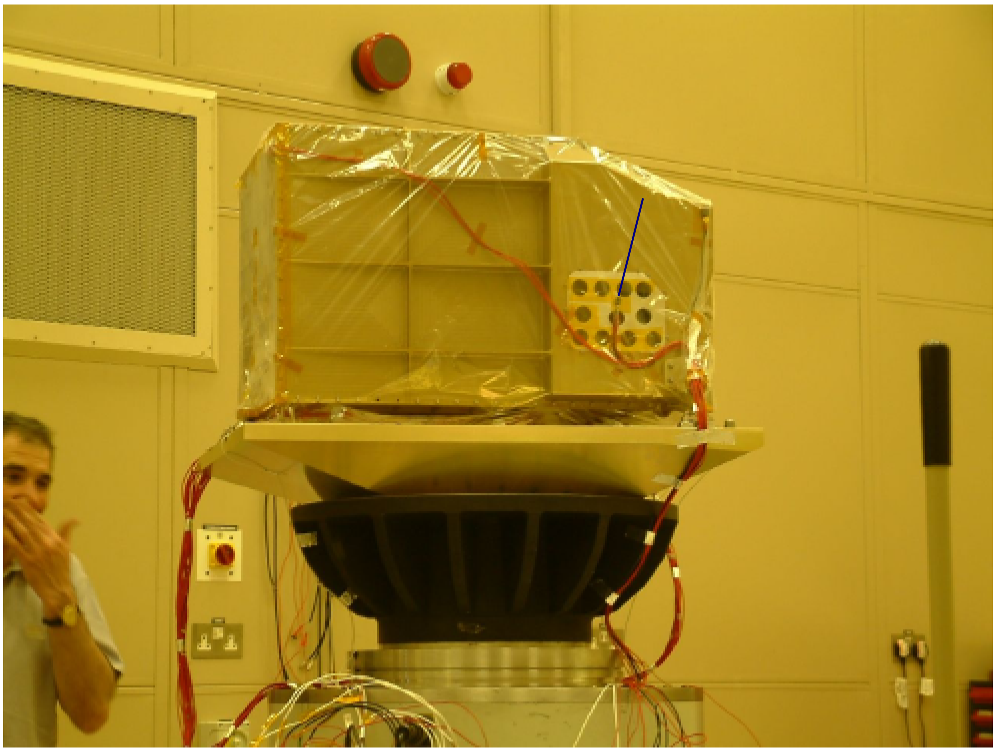


A-6: Photometer detectorbox (extra at extreme ends)



A-7: Tri-ax on SOB outside


A-8: Triax on photometer cover


A-9: Cover plate (Y)