IFSI CNR	**Herschel DPU-ICU** **Vibration Test Procedure**	**Ref.:** CNR.IFSI.2002TR01 **Issue:** 1.1 **Date:** 9/12/02

Herschel

DPU-ICU Vibration

Test Procedure

Document Ref: CNR.IFSI.2002TR01

Issue 1.1

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Document Status Sheet

Issue	Revision	Date	Reason for Change
Issue 1		28 October 2002	First Issue
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Document Change Record

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Section	**Reason For Change**
Issue 1	ALL
Issue 1.1	Introduced sections 3.7 and 3.8 after HIFI ICU CDR

Acronyms

ASI	Agenzia Spaziale Italiana (Italian Space Agency)
AVM	AVionic Model
CDMS	Central Data Management System
CDMU	Central Data Management Unit
CE	Conducted Emission
CEDM	Conducted Emission Differential Mode
CECM	Conducted Emission Common Mode
CGS	Carlo Gavazzi Space
CM	Common Mode
COG	Centre Of Gravity
DM	Differential Mode
EEPROM	Electrically Erasable Programmable Read Only Memory
EGSE	Electrical Ground Support Equipment
EIDP	End Item Data Package
EMC	ElectroMagnetic Compatibility
ESD	Electro Static Discharge
EQM	Electrical Qualification Model
DPU	Digital Processing Unit
FIRST	Far Infra-Red and Sub-millimetre Telescope
FCU	Focal plane Control Unit
FM	Flight Model
FP S/S	Focal Plane sub-system
FPU	Focal Plane Unit
FS	Flight Spare
HIFI	Heterodyne Instrument for First
HK	House-Keeping
HRS	High Resolution Spectrometer
HRSU	High Resolution Spectrometer Unit
HW	HardWare
IC	Instrument Control
ICD	Interface Control Document
ICE	In Circuit Emulator
ICU	Instrument Control Unit
I/F	Interface

ILT	Instrument Level Test
LCU	Local oscillator Control Unit
LISN	Line Impedance Stabilization Network
LOA	Local Oscillator Assembly
LO S/S	Local Oscillator sub-system
LOU	Local Oscillator Unit
MOI	Moment Of Inertia
NA	Not Applicable
NB	Narrow Band
NCR	Non Conformance Report
OBS	On Board Software
PA	Product Assurance
PACS	Photoconductor Array Camera and Spectrometer
PFM	Proto Flight Model
PROM	Programmable Read Only memory
QA	Quality Assurance
QM	Qualification Model
RE	Radiated Emission
S/C	Spacecraft
S/S	Subsystem
SLE	Standard Laboratory Equipment
SPIRE	Spectral and Photometric Imaging Receiver
SW	SoftWare
TBC	To Be Confirmed
TBD	To Be Defined
TBW	To Be Written
TLP	Transfer Layer Protocol
TRB	Test Review Board
TRRB	Test Readiness Review Board
UR	User Requirement
URD	UR Document
VCD	Verification Control Document
WBS S/S	Wide Band Spectrometer sub-system
WBSU	Wide Band Spectrometer Unit

1 INTRODUCTION

1.1 General

The content of this procedure is based on the DPU-ICU (from now on "the unit") model philosophy and the unit subsystem specification (AD05-AD07), the unit product tree; it is consistent with the interface documents AD01 and AD02-AD04. This document specifies how **the vibration tests and the shock test** will be carried-out on the unit, to be sure that the unit fulfils its mechanical performances.

The subsystem that has to undergo the tests at unit level consists of an electronic box called DPU (for the PACS and SPIRE instruments) and ICU (for HIFI instrument) (dimensions: 274x258x194 mm^3) and of the On Board Software both appropriate for each of the delivered models.

1.2 Scope

This document describes the detailed procedure for the various vibration tests and the shock test. This procedure applies to the following deliverable models of the unit subsystem:

EQM subsystem
FM subsystem

The letters EQM and FM identify these models respectively.

1.3 Objectives

Verification by means of testing of the unit subsystem with respect to the subsystem specification, especially with reference to AD01, AD02-AD08.

2 DOCUMENTS

2.1 Applicable Documents

AD	Name
01	Herschel/Planck Instrument Interface Document, part A
02	Herschel/Planck Instrument Interface Document, part B-Instrument PACS
03	Herschel/Planck Instrument Interface Document, part B-Instrument HIFI
04	Herschel/Planck Instrument Interface Document, part B-Instrument SPIRE
05	Herschel PACS DPU Subsystem Specification Document
06	Herschel HIFI ICU Subsystem Specification Document
07	Herschel SPIRE DPU Subsystem Specification Document
08	DPU/ICU P.A. Plan

2.2 Reference Documents

RD	Title
01	PACS DPU HW User Manual
02	HIFI ICU HW User manual
03	SPIRE DPU HW User Manual

3 General Requirements (AD01)

3.1 Facility

The vibration test facility and procedure shall satisfy the following minimum requirements:

- the shaker shall have at least 20% margin with respect to the maximum expected interface load,
- the control equipment shall be able to maintain the specified tolerances,
- the data handling equipment shall be sized according to the requested instrumentation
- in case of unexpected incidents, smooth abort shall be programmed,
- all test incidents shall be reported and fully explained before going on with the test sequence,
- blank test using the item fixture is not mandatory but is strongly advised.

3.2 Test facility cleanliness

Every precaution shall be taken to avoid contamination by oils, greases... The test should take place in a class 100,000 clean room or better. A protection shall be used if needed.

3.3 Fixture requirement

The unit shall be hard mounted on a stiff fixture by all its spacecraft attachment points. IFSI will be responsible for the definition and procurement (via the testing firm TBC) of the test fixture. The design of the fixture shall guarantee that the major modes of the unit are not modified (as a typical value, frequency shifts should be less than 5 % on the lower frequency modes). In figure 3-1 the ICU (HIFI) box interface control drawing is shown.
There will be suitable 3-axes accelerometers (see section 4.5 below) to monitor the behaviour of the box, a possible set-up is indicated in the following figure 3-2 (the SPIRE DPU box is shown).

3.4 Configuration

The unit shall be vibrated in the launch configuration: connectors savers and connectors dust–cups shall be removed

3.5 Vibration and control equipment

To control the vibration level applied to the test specimen, at least 2 three-axis accelerometers shall be **rigidly** attached on the test fixture near the specimen/fixture interface and shall be aligned with the excitation axis.
Accelerometers shall be calibrated for frequency response in the range 5-2000 Hz.

3.6 Recording instrumentation

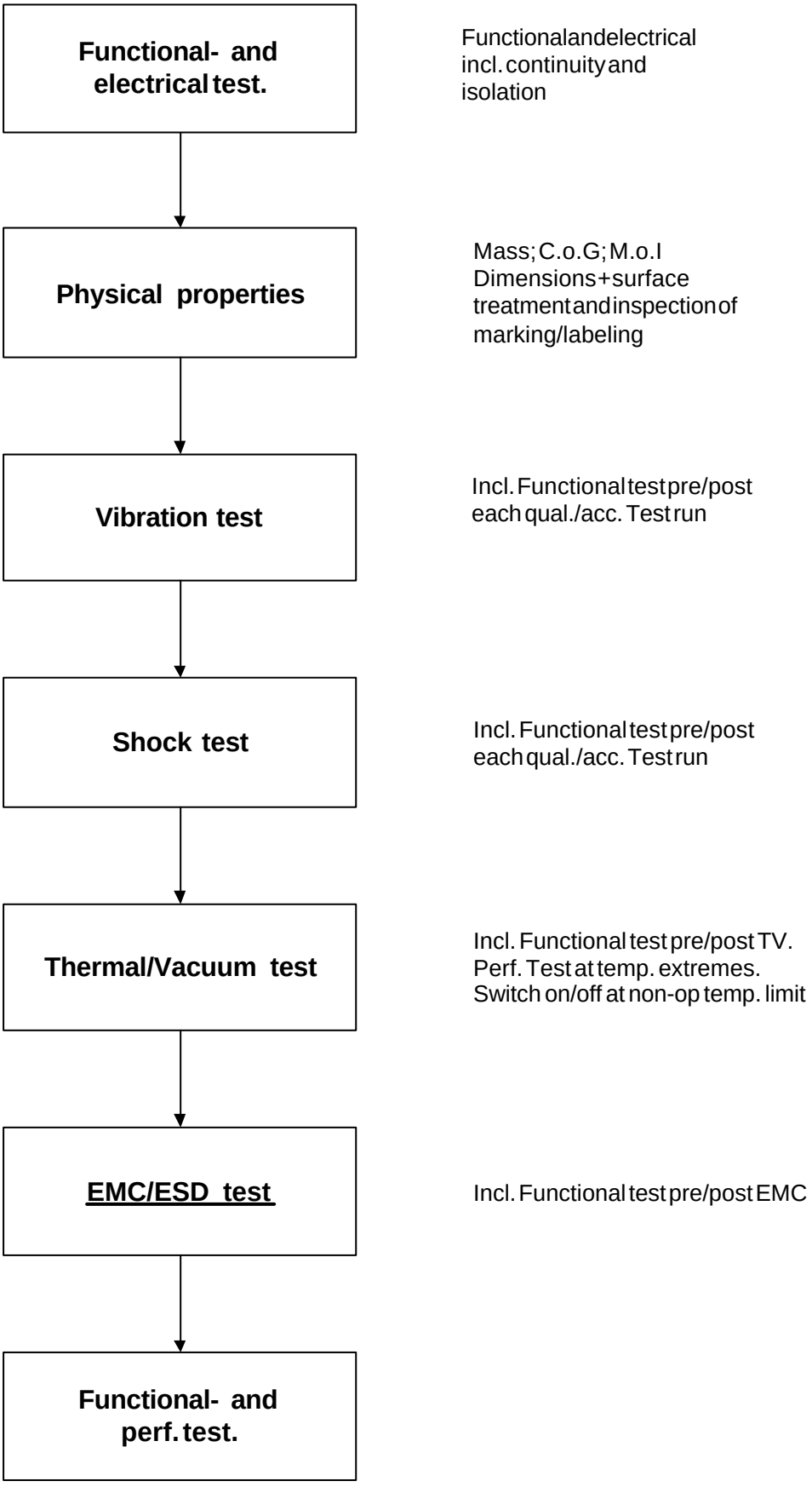
All tests shall be fully recorded and records be properly labeled. All accelerometers shall be calibrated and show linear response in the range 5-2000 HZ for amplitudes up to 1.25 times the maximum expected during the tests. Should the need arise, some carefully selected accelerometers will be used for automatic notching and abort in order to protect the unit.

3.7 Test sequence

The general tests sequence is shown in the following functional diagram. This sequence applies to both EQM and FM/FS tests.

3.8 Acceptance criteria

Before the vibration testing and after the vibration testing a short functional test has to be carried out. The results of the pre-vibration and post vibration tests have to be reported in the Log book and in the summary test report and the acceptance criterion will be based on the fact that there should be no performance difference in the above two functional tests.


Functional- and electrical test.
Functional and electrical incl. continuity and isolation
Physical properties
Mass; C.o.G; M.o.I Dimensions + surface treatment and inspection of marking/labeling
Vibration test
Incl. Functional test pre/post each qual./acc. Test run
Shock test
Incl. Functional test pre/post each qual./acc. Test run
Thermal/Vacuum test
Incl. Functional test pre/post TV. Perf. Test at temp. extremes. Switch on/off at non-op temp. limit
EMC/ESD test
Incl. Functional test pre/post EMC
Functional- and perf. test.

4 Sine Vibration Test Levels and Duration

Note: The values below have been derived from PDR system level frequency response analysis and are considered as the most suitable mechanical environment expected to be experienced by the instruments. Steps are initiated within Arianespace (Coupled Load Analysis with launcher) to further refine these values with the intention to reduce them whenever possible.

Qualification levels are specified in the table 1 below (Herschel SVM location for the DPU-ICU); sweep rate: 2 Oct./min

In figures 4 and 5 a general picture of the Herschel satellite and of the Service Module units allocations are shown. In figures 6, 7 and 8 the various preliminary warm units allocations are shown in order to identify the vibration axes.

Location		Axis	Frequency	Level (g)
Herschel	FPU	Longit/ Lat	5 –100 Hz	18 / 8
	LOU	Longit./ Lat	5 –100 Hz	14 / 8
	BOLA	Long / Lat	5 - 100 Hz	9 / 3
	SVM	Long / Lat	5 - 100 Hz	25 / 20
Planck	FPU			see below
	JFET			see below
	SCC	Long/Lat	5-80Hz 80-100Hz	25 / 25
	BEU	Long/Lat	5 – 100 Hz	25
	SVM	Long/Lat	5 – 100 Hz	25/20

Table 1 Sine Vibration Qualification Test Levels

Acceptance levels are to be derived by dividing the qualification levels by a factor 1.25. Acceptance sweep rate is 4 Oct./min.

Low level sine test shall be performed to determine resonance frequencies to evaluate the behaviour of the test fixture and item integrity. Resonance search shall be carried out before and after vibration test for each axis between 5 to 2000 Hz with a level of 0.5 g (sweep rate: 2 Oct/min).

5 Random Vibration Tests

Note: The values below have been derived from an early system level analysis and are considered conservative. Steps are initiated within the project to further evaluate these values with the intention to reduce them.

Qualification levels are specified in the table 2 below. Duration: 2 min. per axis.

Herschel					
Location		**Axis**	**Frequency Hz**	**Level (g^2/Hz)**	**g rms**
Warm Units in SVM	**PACS DPU**	Normal to fixation plane	100-300	0.2	9.88
		Other axes	100-300	0.1	6.99
	HIFI ICU	Normal to fixation plane	100-300	0.2	9.88
		Other axes	100-300	0.1	6.99

	SPIRE DPU	Normal to fixation plane	100-300	0.2	9.88
		Other axes	100-300	0.1	6.99

Table 2 Random Vibration Qualification Test Levels

Acceptance levels are to be derived by dividing the qualification levels by a factor 1.5625. Acceptance duration is 1 min. per axis.

Note: These Random levels are higher than those presented in the previous version. They correspond to the status of Mechanical analysis at PDR. A new evaluation is currently being performed with more accurate method, and we expect to revise them.

6 Shock Test Levels

The defined shock response spectrum is applicable to the Herschel instruments mounted inside the SVM. It is to be applied along all three axes.

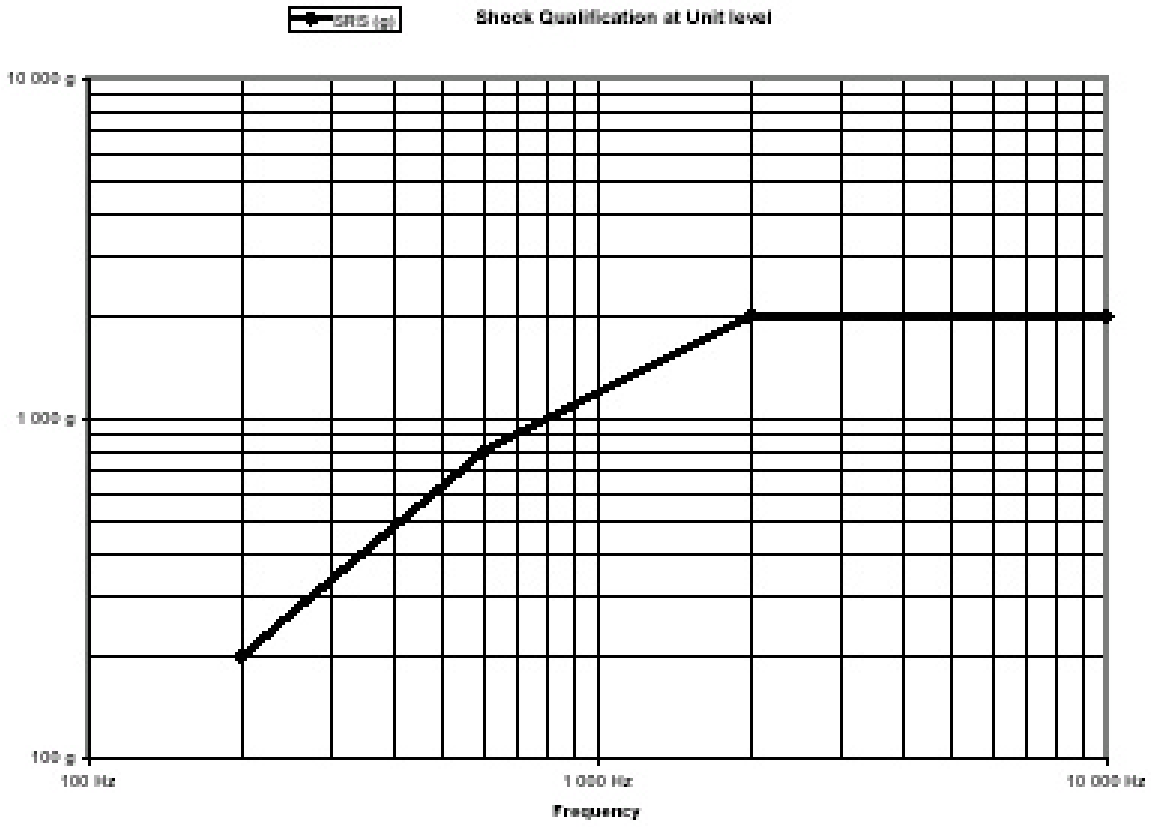


Figure 3-0 Shock Response Spectrum

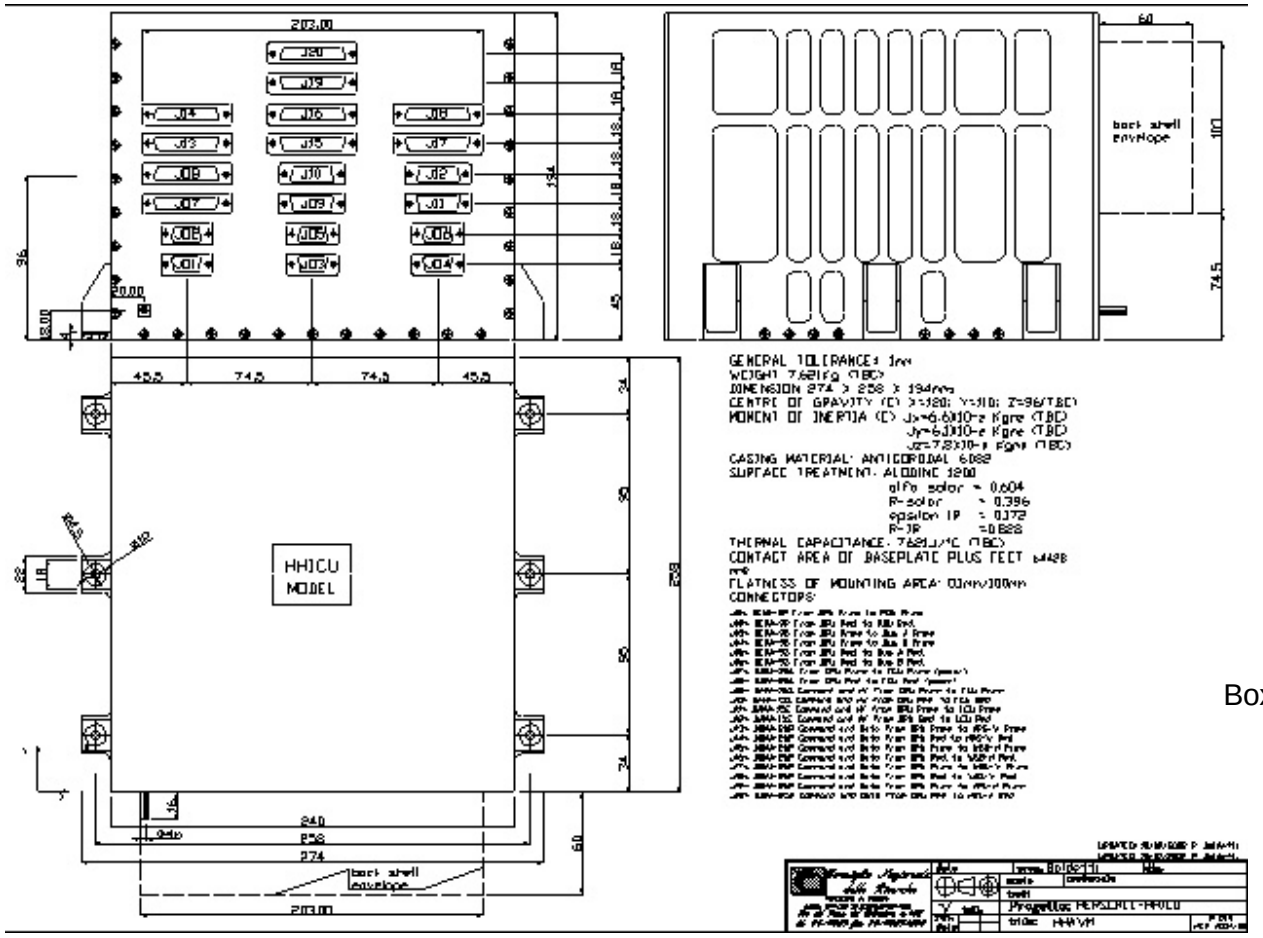


Figure 3-1
Box (HIFI) interface control drawing

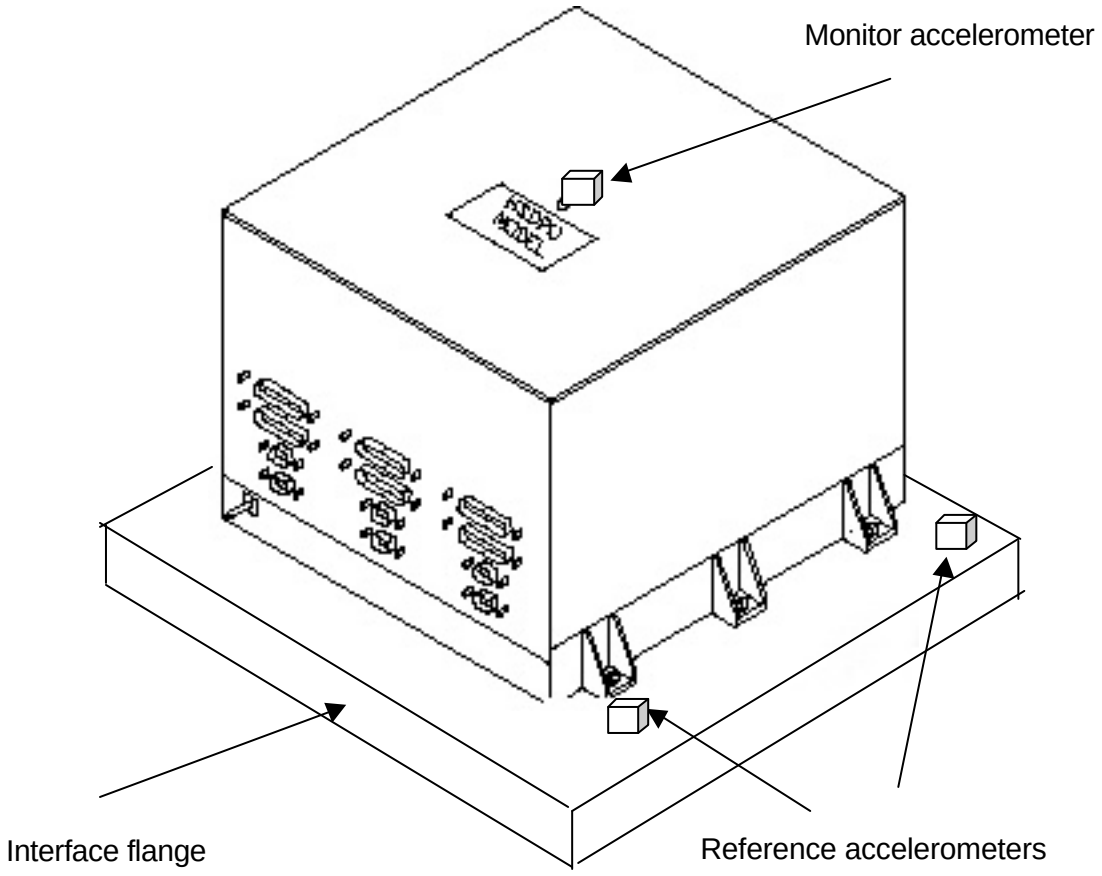


Figure 3-2 A possible Accelerometers set-up

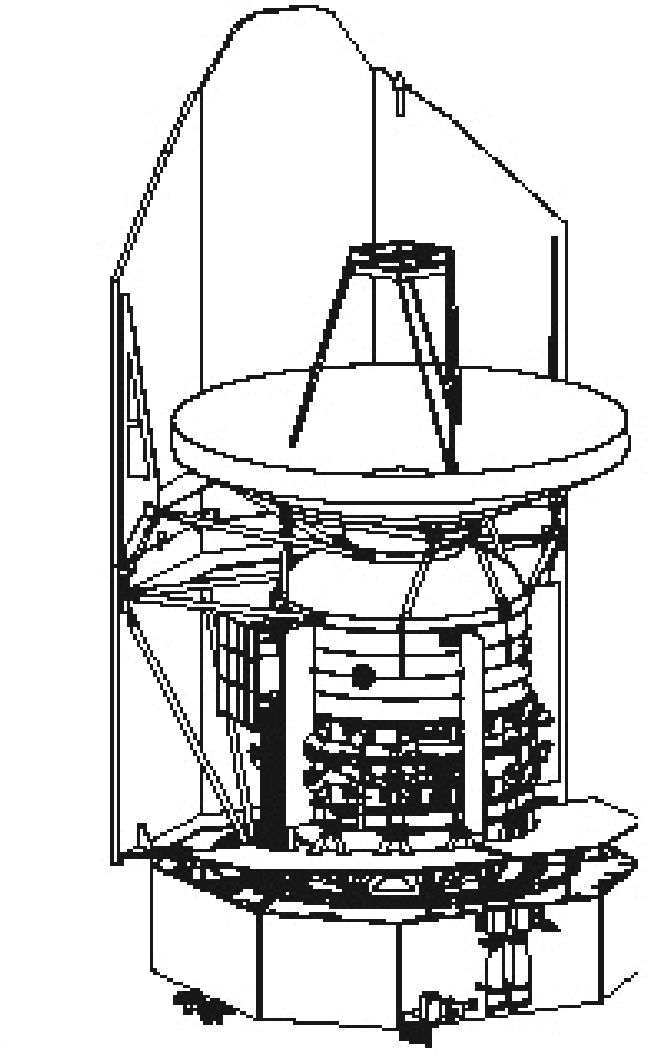


Figure 4 Herschel and the Service Module

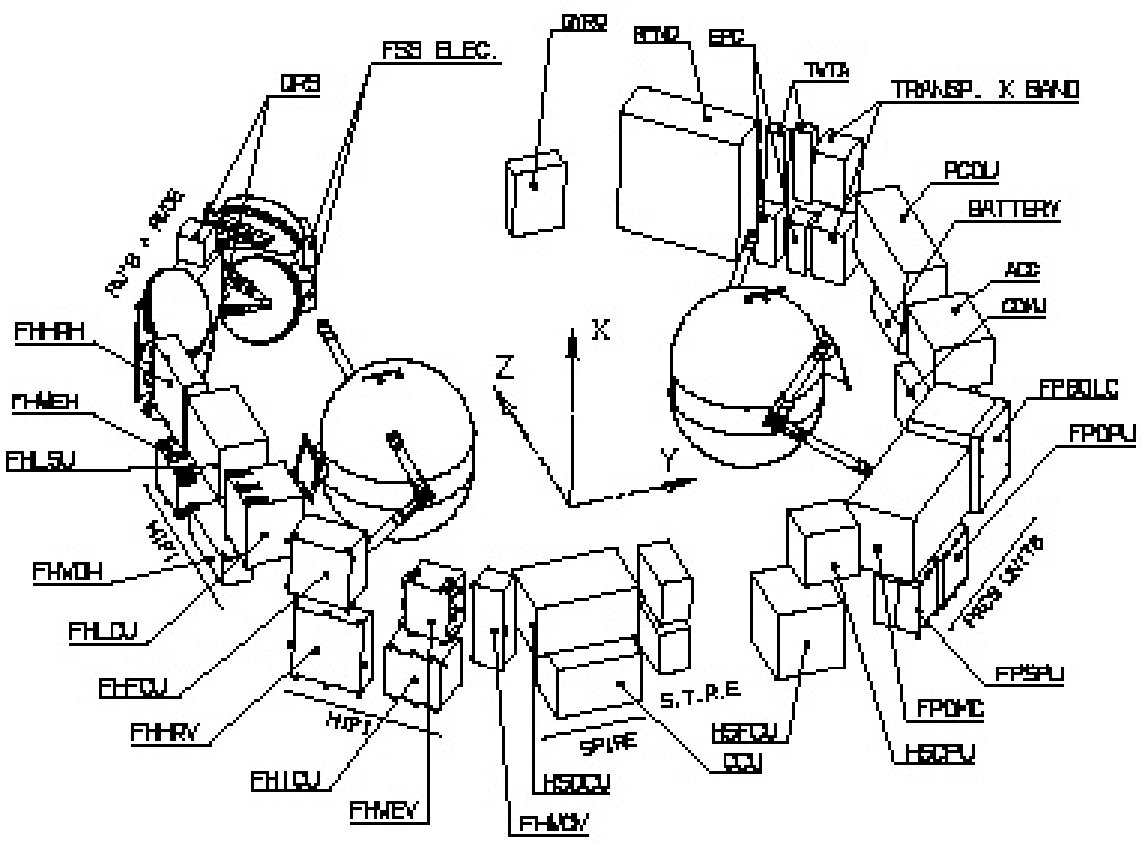


Figure 5 Warm Units Locations and orientations (PRELIMINARY)

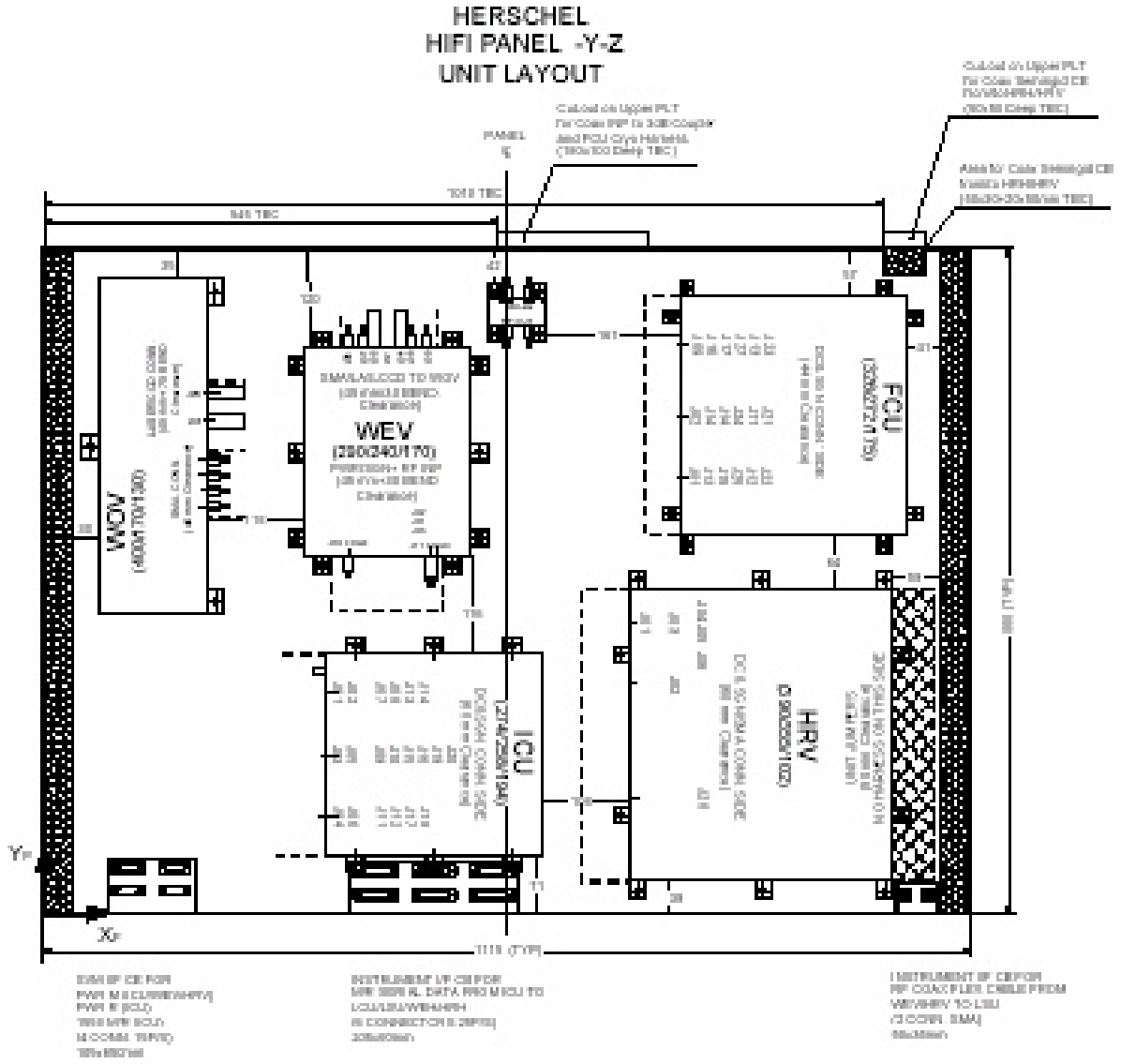


Figure 6 HIFI ICU Location and orientation (PRELIMINARY)

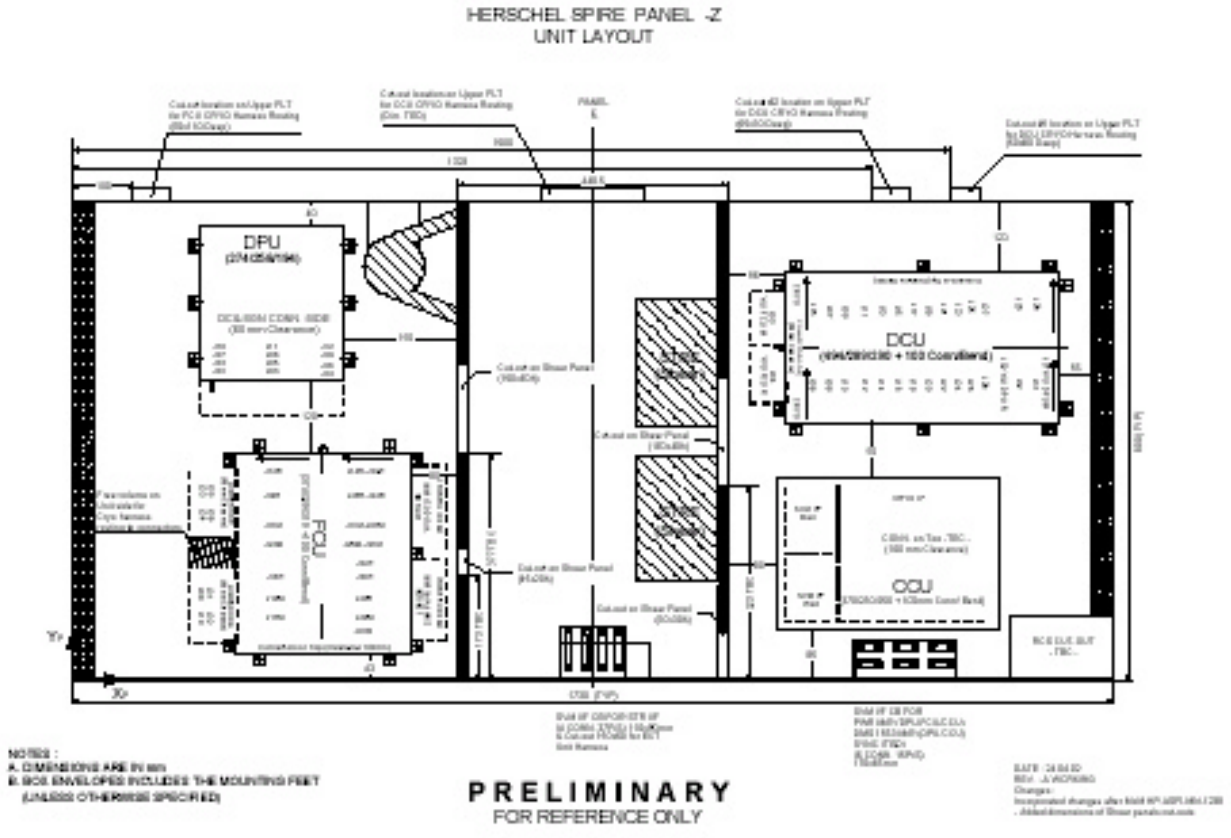


Figure 7 SPIRE DPU Location and orientation (PRELIMINARY)

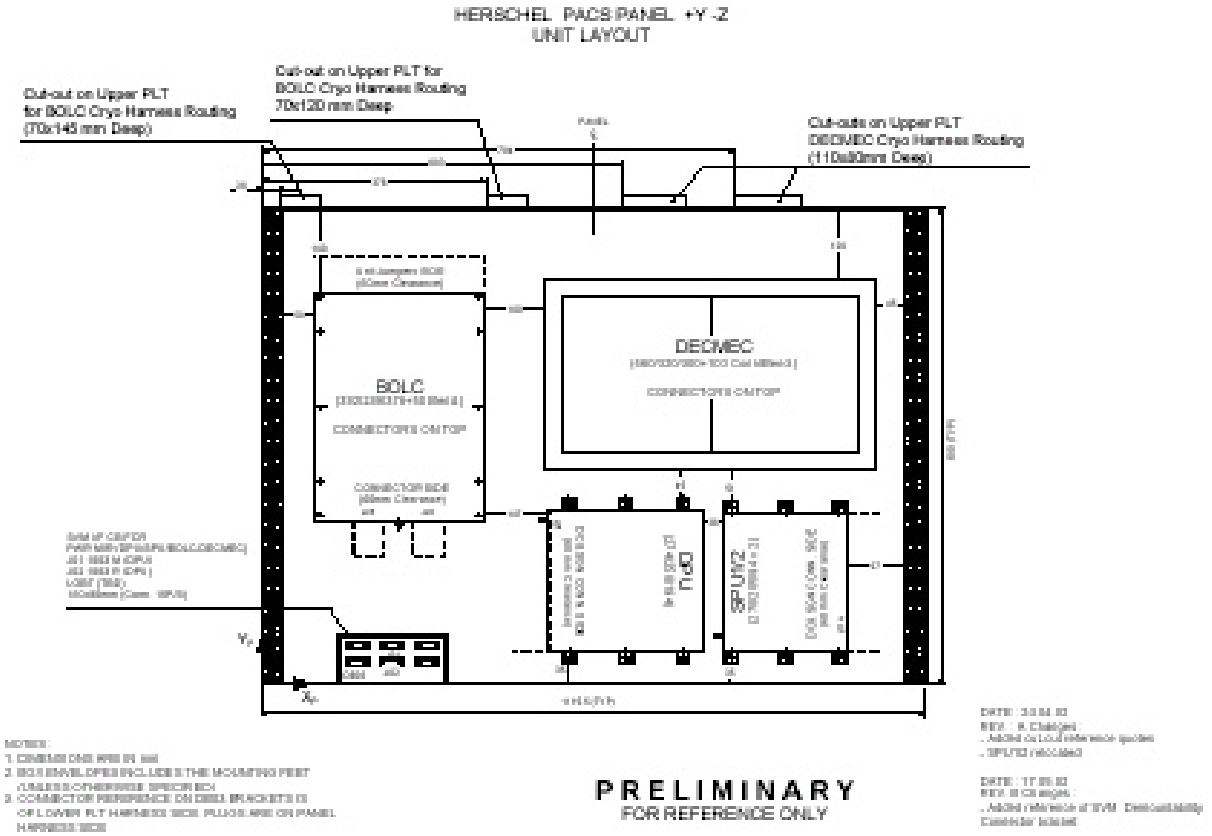


Figure 8 PACS DPU Location and orientation (PRELIMINARY)