ALCATEL SPACE

ANALYSES ET CHAINE FONCTIONELLE STRUCTURE

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HERSCHEL Local instrument vibro-acoustic analyses

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1. INTRODUCTION

This technical note presents the results of the local vibro acoustic analyses performed on the HERSCHEL satellite. The object of this is to estimate random vibration environment for the equipments located inside Herschel instrument in order to verify the random local responses obtained on the PDR S/C configuration.
The analysis basis is the PDR vibro acoustic analysis (ref AD1) with the current instrument dynamic behaviour (ref AD2, AD3, AD4 and AD5)

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2. REFERENCE DOCUMENTS

AD01: Herschel PLM Vibroacoustic Analyses
H-P-2-ASPI-AN-0354 is 1 dated 29/11/02.

AD02 : SPIRE instrument vibration test report STM qualification MSSL-tecnote-SPIRE-21 is1, October 2003 and Random Vibration SPIRE structure and detectors MSSL-technote-SPIRE-09, Issue 2.0 Sept 2002

AD03 : PACS FPU FEM, simplified model email Josef Schubert dated 03/05/04

AD04: HIFI e-mail Peter Van Leeuwen dated 10/03/04 ref doc FPSS 000546

AD05 : ESA mail Herschel vibro-acoustic load (Thijs van der Laan) dated 16/03/04

AD06 : HIFI e-mail Peter Van Leeuwen dated 07/06/04

3. METHODOLOGY

The local instrument responses have been calculated, based on the vibro acoustic analyses performed on the optical bench at the I/F instrument (ref AD01) with the current instrument dynamic behaviour.

The dynamic behaviour of PACS , SPIRE and HIFI instrument have been modelled in this way:
A mass/spring system has been put at the centre of gravity of the equipment linked to the interfaces with a RBE2 as seen on the following figure.

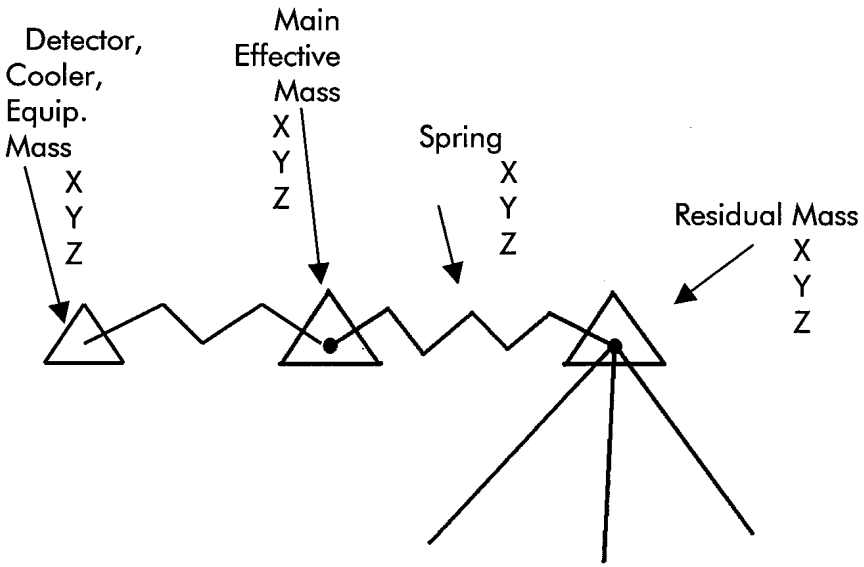

Figure 1: Dynamical behaviour modelisation for SPIRE, PACS and HIFI.

For SPIRE [reference in AD02]

Main modes

Mode Number	Freq. [Hz]	Effective Mass (kg)		
		X (launch)	Y (lateral)	Z (lateral)
1	122	0.00	31.72	0.00
2	137	0.00	0.00	33.41
3	176	19.46	0.00	0.00

Local modes (ref AD05):

Detectors, susp. mass =0.30 kg, X/Y/Z -freq. = 250Hz.
Mechanism, susp mass = 0.7 kg, X/Y/Z -freq. = 200Hz.

Cooler, susp. mass = 0.60 kg, X/Y/Z -freq= 400Hz.

Total Mass: 42.3 kg

A sensibility analysis has been made with the main modes at 189 Hz (X), 136 Hz (Y), 151 Hz (Z), the local detector modes at 224 Hz, mechanism mode at 189 Hz and cooler mode at 328 Hz.

For PACS [reference in AD03]

Main modes:

Mode Number	Freq [Hz]	Effective Mass (kg)		
		X (launch)	Y (lateral)	Z (lateral)
1	106.7	0.00	0.00	67.2
2	119.7	0.00	46.1	0.00
3	183.5	39.4	0.00	0.00
4	221.2	11.7	0.00	0.00
5	232.5	0.00	6.5	0.00

Local modes (ref AD05):

Detectors, susp. mass = 0.20 kg, X/Y/Z -freq. = 200Hz. To be conservative, the detector mode is modeled at 224 Hz
Cooler, susp. mass = 0.60 kg, X/Y/Z freq. = 400 Hz. To be conservative, the cooler mode is modeled at 350 Hz

Total mass: 72 kg

For HIFI [reference in AD04]

Main modes:

Mode Number	Freq [Hz]	Effective Mass (kg)		
		X (longi)	Y (lateral)	Z (lateral)
1	161.6	0	15.65	13.05
2	171.3	0	13.83	15.36
3	253.8	19.2	0	0

Local modes (ref AD05):

Mixers, susp. mass = 0.15 kg, X-freq.=400 Hz .
Chopper, mass =0.30 kg, X-freq. =300 Hz , Y/Z freq. = 160Hz.
Calib. unit, susp. mass = 0.45 kg,X/Y/Z freq. = 300Hz.

Total Mass : 41.3 Kg

4. RESULTS

All calculation hypotheses are described in the document ref AD1.
An uncertainty factor is taken into account to cover the shift in height between the instrument and the suspended mass location centre of gravity (excepted for the HIFI chopper and the PACS detector because their c.o.g. are close to the longitudinal instrument ones).

SPIRE:

			Case 1				Case 2			
	Dirrection	Mass (Kg)	Freq (Hz)	g (RMS)	internal Q	internal Freq. (Hz)	Freq (Hz)	g (RMS)	internal Q	internal Freq. (Hz)
SPIRE effective mass	X	19.46	189	2.0			189	2.0		
	Y	31.72	136	2.2			136	2.2		
	Z	33.41	151	1.7			151	1.7		
Detector, susp. Mass	X	0.3	224	9.5	107	174	250	11.3	63	204
	Y	0.3	224	6.8	69	132	250	6.4	61	130
	Z	0.3	224	6.4	82	146	250	4.9	67	144
Mechanim susp	X	0.7	224	9.5	107	174	189	9.7	153	170
	Y	0.7	224	6.8	69	132	189	6.9	85	130
	Z	0.7	224	6.4	82	146	189	5.6	107	144
Cooler, susp. Mass	X	0.6	328	7.4	59	174	400	4.7	37	168
	Y	0.6	328	7.4	54	132	400	5.0	50	130
	Z	0.6	328	4.4	59	146	400	3.6	52	144

			Case 3			
	Dirrection	Mass (Kg)	Freq (Hz)	g (RMS)	internal Q	internal Freq. (Hz)
SPIRE effective mass	X	19.46	176	2.4		
	Y	31.72	122	3.3		
	Z	33.41	137	2.5		
Detector, susp. Mass	X	0.3	224	9.7	95	164
	Y	0.3	224	9.0	71	118
	Z	0.3	224	7.8	73	132
Mechanim susp	X	0.7	224	9.7	95	164
	Y	0.7	224	9.0	71	118
	Z	0.7	224	7.8	73	132
Cooler, susp. Mass	X	0.6	328	7.3	59	164
	Y	0.6	328	8.5	59	118
	Z	0.6	328	6.0	57	132

PACS:

	Dirrection	Mass (Kg)	Freq (Hz)	g (RMS)	internal Q	internal Freq. (Hz)
PACS effective mass	X		183	1.8		
	Y		120	2.4		
	Z		107	1.6		
Cooler, susp. Mass	X	0.6	350	5.7	66	180
	Y	0.6	350	7.6	54	118
	Z	0.6	350	3.4	55	106
Detector, susp. Mass	X	0.2	224	6.6	100	204
	Y	0.2	224	13.4	82	204
	Z	0.2	224	2.1	32	106

HIFI:

	Dirrecti on	Mass (Kg)	Freq (Hz)	g (RMS)	internal Q	internal Freq. (Hz)
HIFI effective mass	X		254	2.3		
	Y		167	2.2		
	Z		168	2.6		
Chopper	X	0.3	300	4.3	59	240
	Y	0.3	160	12.6	130	154
	Z	0.3	160	22.7	127	154
Cal. Unit, susp. Mass	X	0.45	300	8.6	117	240
	Y	0.45	300	6.4	40	174
	Z	0.45	300	6.8	42	174
mixers	X	0.15	400	5.8	66	240

5. CONCLUSION

All local responses are calculated with the hypotheses defined in the § 3. These responses are validated if the local instrument Q factors are coherent with those presented § 4 (at the same internal frequency).

The HIFI chopper responses are important because this is a coupling between the main lateral modes (162 / 171 Hz) and the chopper lateral modes (160 Hz). But the HIFI contractor (ref. AD06) does not confirm these local modes (160 Hz). Apparently, the chopper lateral modes are at 750 Hz. In this case, the responses should be lower.