HERSCHEL / Planck Project

date	09 December 2001	reference	SCI-PT/9798	page	1/17
meeting date	10-11/09/2001	meeting place	RAL ref: SPIRE-ESA-MOM-000867		
chairman	J. Bruston/ESA				

participants	K. King/RAL E.Sawyer/RAL B.Swyniard/RAL J.Delderfield/RAL P.Oldeman/ESA	copy	Cardiff University: M. Griffin ASPI: J.-J. Juillet B. Collaudin ASED: K.Moritz E. Hoelzle ESA: G. Crone T.Passvogel A.Heske Herschel Planck Project Team

subject **Herschel SPIRE meeting - Schedule - Mass budget**

The objectives and agenda are given as annex 1

1. General

ESA explained the delegation of part of its responsibility, regarding the instruments, to Industry:
Alcatel has the responsibility for day-to-day management of the interfaces, technical and programmatic wise..
ESA retains the responsibility for understanding and monitoring the details of the instruments schedules, at system and subsystem level.
Alcatel is only concerned with the top-level schedule and the delivery dates for the required instrument models.

2. SPIRE Model philosophy

The STM program was put in place to provide early feedback to the S/S that couldn't deliver early enough to start with CQM. One of its main objectives is to vibration test the structure early to provide levels to S/S, as vibration is seen as a high risk issue on some S/S (BDA, SMEC). Hence, most S/S STM are dummies, but the structure must be CQM .

3. SPIRE Schedule

The status of SPIRE schedule is unchanged, with a CQM delivery to ESA on 15 July 2003 versus a need date 1 April 2003. FM delivery is as required.

Project monitoring and reporting:

SPIRE reported that:
A monitoring system is being put in place by SPIRE. It consist of a milestones list including all deliverables between the different groups, and major milestones for S/S. These milestones are monitored on a monthly basis (Annex 2). Milestone list will be updated to issue 1.3 and placed under config. control. Numbers to be added.

- Milestones list is a formal commitment (S/Ss to SPIRE)
- Internally, the S/S should have more defined milestones and report on it.
- Monthly progress report will include reported deviations to the mil. list.

The schedule critical path is well understood. The schedule for the SPIRE Structure (SPIRE Optical bench, shells, mounting units) is the main driver of the SPIRE schedule.

All other S/S have margin (>2 months) with respect to due date. The mirrors delivery has 40 days margin, it is not on the critical path.

Structure schedule

On analysis of the structure S/S schedule, it appeared that it may be possible to optimize the fabrication with regards to integration, although earlier attempts to shorten it have failed. This was due to resource and manufacture logistics. Also, the structure schedule is driven by S/S interface closure and design drawing

Going from a sequential fabrication work to parallel work (fabrication is outsourced), and substituting the order of fabrication as a function of need sequence, it may be possible to gain a few weeks on the delivery date of the structure, hence of the STM completion and CQM delivery.

As the detector box is undergoing redesign (due to vibration level), MSSL needs to update their schedule anyway.

SPIRE to update the MSSL S/S schedule and address delivery date issue. The	AI-H-S-100901-001

results of this action shall be presented at the TM on 25th Sept.	Due 25th Sept.

It is to be noted that there is no system level Schedule margin. SPIRE "realistic" delivery date is several month later than "scheduled", as the schedule is success oriented. Realistic QM delivery date (with system margin) is 01oct03.

If the structure schedule is successfully updated (i.e. with a delivery date of April 2003), the test cryostat may become the next critical item as latest info revealed a possible 3 months slippage of the cryostat delivery.

Other S/S status:

- Detector deliveries are subcritical. CQM BDAs are ready 42 days before need date.
- BSM delivery to LAM is part of another subcritical path (via CEA to RAL)

WBS/PT

Lack of correlation between PT , WBS and schedule has been explained by SPIRE. They are used primarily for MOU and commitments between groups, although were originally made for schedule. They are considered to be now mostly obsolete and not used for project control. ESA agreed that since the schedule is very detailed and realistic, there is no need to re-issue the docs in this stage.

4. Mass Budget

The total S/S estimate + contingency is currently above allocation by 8kg.
7.3 kg are on the SVM, most from DRCU. The current contingency on both the FPU and DCU are thought to be realistic.

For the DRCU, there is no existing design for basing the estimate. The SPIRE perception is that it could still be underestimated and might come in at worst case value.
SPIRE needs to review the way DRCU did its estimate to find out its criticality.

SPIRE to review DRCU mass estimate.	AI-H-S-100901-002 Due: 25th Sept

5. Microvibration

The former10microg figure indicated by SPIRE was their first estimate of the requirements coming from the detectors, and are not valid anymore. It is now believed that the primary requirement shall come from the FTS mechanism. Currently, a level of 100 ug is the most recent estimate. A Technical Note (see annex 3) was provided with the Freq. Response. 20 Hz is freq. Resp of SMEC structure, controle loop is ~kHz. A TN is to be issued on the microvibration requirements from the detectors.

ESA and ASPI shall comment the two TNs for microvibration requirement for the FTS mechanism and detectors. Based on the assessed criticality, ESA, ASPI and SPIRE to discuss actions to solve the issue.

6. Thermal interface

SPIRE to deliver ESARAD model by end of September TBC by RAL

SPIRE requested the following items from ESA:

- a formal boil off rate to be in IID-B for their thermal analysis.
- a thermal dissipation break down between the instruments on the FPU, in order for them to control their thermal model after analysis.
- a thermal budget from cryo-harness.

This will be assessed and followed up in a separate forum, after consolidation of the Herschel cryostat thermal model.

7. Reviews

SPIRE wishes to combine their system DDR with the ESA IBDR. ESA and SPIRE will iterate on the review objectives and needed documentation. The last SPIRE S/S DDR should be held by end of the year, hence a February/March IBDR should be possible.

8. Cleanliness issues.

SPIRE will provide a complete DML by the IBDR, after iteration with ESA.
The new issue of FMECA will be provided by SPIRE by end of October 2001 after iteration with ESA.

Annex 1: Meeting Agenda

SPIRE Meeting, 10/09/01 and 11/09/01

Meeting objectives

1. Review the instrument development and delivery Schedule
   - Evaluate schedule reliability
   - Define required actions to ensure reliability as necessary
   - Identify critical path/items
   - Identify possible recovery actions for delivery dates

2. Review the instrument mass budget
   - Review of current budget
   - Review of plan for mass reduction/control

3. Check the status on
   - MicroVibration level definition
   - Thermal model update (geometrical model)
   - Relationship w/ industry

4. Discuss EQM

5. Discuss Cryoharness

Agenda

Chair: ESA

1. Introduction (ESA)

2. Schedule

Presentation: Critical developments and critical path (SPIRE)
Assessment of SPIRE Schedule (ESA)
Discussion and agreement on: (all)
    Schedule reliability
    Recovery goals
    Recovery actions

3. Mass Budget

Mass and Power budget (SPIRE)
Margin philosophy and critical developments (SPIRE)

Mass reduction exercise and control plan (SPIRE)
Agreement on next steps (all)

4. MicroVibration level definition

Status of work (SPIRE)

5. Thermal Design, Model and Interfaces

Current status at ESA
Clarification of open points (all)

6. Open discussion (as necessary) (all)

EQM test
Cryoharness
Relationship w/ industry
Review: IBDR

7. AOB

Annex 2: SPIRE Milestones list

SPIRE

SUBJECT: **SPIRE Major Milestone List**

PREPARED BY: **K.J. King**

DOCUMENT No: **SPIRE-RAL-PRJ-000455**

ISSUE: **1.2 Draft 2** **Date:** **12th April 2001**

CHECKED BY: **…………………………………. Date: ………………………….**

APPROVED BY: **…………………………………. Date: ………………………….**

Distribution

Instrument Development Manager
Local Project managers

Change Record

ISSUE	DATE	
Issue 1.0	17th July 2000	Initial Issue for Delta PDR
Issue 1.1 (Draft1)	2nd August 2000	Includes milestones for revised model philosophy
Issue 1.2 Draft1	25th February 2001	Updated Milestones following MSSL delivery schedule
Issue 1.2 Draft 2	12th April 2001	Updated following consolidation of Subsystem Schedules

Glossary

AVM	Avionics Model
BDA	Bolometer Detector Array(s)
BSM	Beam Steering Mirror
CQM	Cryogenic Qualification Model
DM	Development Model
DPU	Digital Processing Unit
DRCU	Detector Readout and Control Unit
EGSE	Electrical Ground Support Equipment
FS	Flight Spare (Model)
FTB	FET Box
FPU	Focal Plane Unit
MCU	Mechanisms Control Unit
OGSE	Optical Ground Support Equipment
PCAL	Photometer Calibrator
PFM	Proto-Flight Model
QM	Qualification Model
SCAL	Spectrometer Calibrator
SMEC	Spectrometer MEChanism
SPIRE	Spectral and Photometric Imaging REceiver
STM	Structural Thermal Model
TBD	To Be Determined
WE	Warm Electronics
WIH	Warm Interconnect Harness

References

1. INTRODUCTION

This document provides a list of the Major SPIRE milestones. This includes all delivery dates to ESA, all internal review dates and all delivery dates between SPIRE Responsible Organisations.

Once agreed this document will be the controlling document for the SPIRE instrument schedule and will be updated in line with agreed changes to the schedule.

1.1 Applicable Documents

1.2 Reference Documents

RD1 Structure Subsystem Development Plan (SPIRE-MSS-PRJ-000426) Issue 1.2
RD2 SPIRE Mirrors and Alignment Tools Development Plan (LAM.PJT.SPI.not.20000603 IND 3)
RD3 SPIRE BSM Development Plan (SPIRE-ATC-PRJ-003) v 4.0
RD4 JPL Receivables/Deliverables List 23/02/01
RD5 Filters Subsystem Development Plan (SPIRE-QMW-PRJ-000453) 11 Jan 2001
RD6 Calibrators Subsystem Development Plan (SPIRE-QMW-PRJ-000453) 12 Jan 2001
RD7 Spectrometer Mirror Mechanism Subsystem Development Plan (LAM.PJT.SPI.NOT.200001 IND 9)
RD8 SPIRE and PACS Sorption Cooler Development Plan (SPIRE-SBT-PRJ-000468) Issue 2.1
RD9 SPIRE Shutter Development Plan (SPIRE-USK-DOC-000001) Draft 0.2
RD10 DPU/ICU Subsystem Development Plan (IFSI/ICU/PL/2000-001) Issue 1.2
RD11 Detector Readout Control Unit and Warm Interconnect Harness Development Plan (Sap-SPIRE-JLA-xxxx-00) Issue 2.0, 15 Dec 2001
RD12 CEA Product Tree (Sap-SPIRE-JLA-xxxx-00) Issue 1.0, 14 Dec 2001
RD13 Development Plan for the DRCU Simulator (SO-2000-12-21)
RD14 SPIRE AIV Facilities Development Plan (SPIRE-RAL-PRJ-000477) Issue 1.0

MILESTONES

1.3 Development programme

Milestone	Responsible	Need Date	Planned Date	Margin (days)	Comments
Detector Array Selection	**SPIRE**		**01/02/00**		**Complete**
Delta PDR	**SPIRE**		**26/06/00**		**Complete**
BSM Simulink Model Delivery to LAM	ATC	11/08/00			Complete
BSM Analogue Board Design Delivery to LAM	ATC	11/08/00			Complete
Instrument Interface Review	**SPIRE**		**30/11/00**		**Complete**
ISVR	**ESA**		**30/11/00**		**Complete**
BSM Analogue Board Detailed Design Delivery to LAM	ATC	01/01/01			Complete
IIDR	**ESA**		**23/04/01**		
SMEC, BSM Detailed Design Review	**SPIRE**	**31/01/01**	**May 01**		
Structure, Optics, Cooler Detailed Design Review	**SPIRE**	**19/03/01**	**May 01**		
EGSE#1 Delivery to IFSI	RAL	01/06/01	01/05/01	1 month	
DRCU Simulator#1 Delivery to IFSI	SO	01/06/01	01/06/01		(21/12/00) SO-2000-12-21, margin TBD
BDAs Detailed Design Review	**SPIRE**		**18/06/01**		
SMECm Simulator Delivery to Sap	LAM	09/07/01			
IBDR	**ESA**		**Nov 01**		

1.4 STM Programme

Milestone	Responsible	Need Date	Planned Date	Margin	Comments
Test Facility Available	RAL	16/08/02	30/06/02	1.5 months	(10/04/01) Issue 3 Rev 0
CQM Structure and MGSE Delivery to RAL	MSSL	01/07/02	27/06/02	4 days	(19/03/01) Issue 1.2
CQM Thermal Straps Delivery to RAL	MSSL	01/07/02	27/06/02	4 days	(19/03/01) Issue 1.2
CQM Mirrors + OGSE Delivery to RAL	LAM	01/07/02	01/07/02	40 days	(30/03/01) v20010330
STM Filters, Dichroics, Beamsplitters and OGSE Delivery to RAL	QMW	01/07/02	21/11/01	7 months	Status Report March 01
STM BSMm Delivery to RAL	ATC	01/07/02	01/07/02		(08/04/01) V 4.0, margin TBD
CQM BSMm Harness Delivery to RAL	ATC	01/07/02	01/07/02		(08/04/01) V 4.0 Agreed in email 23/02/01, margin TBD
Optical Dummy SMECm Delivery to RAL	LAM	01/07/02	01/07/02	5.5 months	(30/03/01) v20010330 - CCA tools
FOB Simulator Available	RAL	01/07/02	27/07/01	11 months	Dev. Plan & Schedule Issue 3 Rev 0 - 'Support Frame'
STM Cooler Delivery to RAL	Grenoble	01/08/02	22/02/02	5 months	Dev. Plan (SBT/CT/2000-19 Issue 2 Rev 1)
CQM Cooler Harness Delivery to RAL	Sap	01/08/02			(15/12/00) Issue 2.0 Identified in Product Tree, but not in schedule
STM BDAs Delivery to RAL	JPL	01/08/02	01/04/02	4 months	Rec/Del List (23/02/01)
CQM BDAs Harness Delivery to RAL	JPL	01/08/02	01/10/02		Rec/Del List (23/02/01) Agreed at teleconf 23/02/01 - date/margin TBD
STM Shutter Delivery to RAL	USK	01/08/02	05/03/02	5 months	Dev. Plan Draft 0.2 (15/06/2000) Assumes CQM usable as STM (TBC)
CQM Shutter Harness Delivery to RAL	USK	01/08/02	05/03/02	5 months	Dev. Plan Draft 0.2 (15/06/2000) Assumes CQM usable as STM (TBC)
STM SCAL Delivery to RAL	QMW	01/08/02	27/03/02	4 months	(29/03/01) Issue 2.0
STM SCAL Harness Delivery to RAL	QMW	01/08/02	27/03/02	4 months	(29/03/01) Issue 2.0 Assumes STM includes harness (TBC)
STM SMECm Delivery to RAL	LAM	01/08/02	01/08/02	3 months	(10/04/01) v20010410
STM SMECm Harness Delivery	LAM	01/08/02	01/08/02	3 months	(10/04/01) v20010410
CQM FPU RF Filter Modules Delivery	JPL	01/08/02	01/10/02		Rec/Del List (23/02/01) Agreed at teleconf 23/02/01 - date/margin TBD
CQM Cooler Delivery to RAL	Grenoble	01/09/02	22/02/02	6 months	Dev. Plan (SBT/CT/2000-19 Issue 2 Rev 1)

Milestone	Responsible	Need Date	Planned Date	Margin	Comments
CQM FTB Enclosure Delivery to RAL	MSSL	01/08/02			(19/03/01) Issue 1.2 Not in schedule - agreed at teleconf 26/02/01, Date TBC, Margin TBD
STM JFET Modules Delivery to RAL	JPL	01/08/02	01/04/02	4 months	(23/02/01)
STM FTB RF Filter Modules Delivery to RAL	JPL	01/08/02	01/04/02	4 months	(23/02/01)
STM Interim Review			**09/10/02**		
Cold Vibration Campaign Starts	**ESA**		**28/11/02**		
STM Review			**14/02/03**		
CQM Structure and FTBs available			**17/02/03**		

1.5 CQM Programme

Milestone	Responsible	Need Date	Planned Date	Margin	Comments
CQM Cold Filters Delivery to JPL	QMW	01/02/02			(11/01/01) Issue 2.0 - not in QMW schedule
CQM PCAL Delivery to ATC	QMW	01/07/02	22/03/02	3 months	(11/01/01) Issue 2.0
CQM BSMm Delivery to LAM	ATC	01/09/02	23/08/02	7 days	(08/02/01)
CQM Filters Dichroics and Beamsplitters Delivery to RAL	QMW	11/01/03	01/10/02	3 months	(29/03/01) Issue 2.0
CQM BDAs Delivery to RAL	JPL	11/01/03	01/10/02	3 months	(23/02/01)
CQM SMECm Delivery to RAL	LAM	11/01/03	11/01/03	2 months	(10/04/01) v20010410
CQM SCAL Delivery to RAL	QMW	11/01/03	01/10/02	3 months	(29/03/01) Issue 2.0
CQM Shutter Delivery to RAL	USK	11/01/03	05/03/02	10 months	(15/06/2000) Issue 0.2 D
CQM BSMm Delivery to RAL	LAM	11/01/03	11/01/03	2 months	(10/04/01) v20010410
CQM FPU RF Filter Moduless Delivery to RAL	JPL	11/01/03	01/10/02	2 months	(23/02/01)
CQM JFET Modules Delivered to RAL	JPL	01/02/03	01/10/02	4 months	(23/02/01)
CQM FTB RF Filter Modules Delivered to RAL	JPL	01/02/03	01/10/02	4 months	(23/02/01)
QM1 MCU delivery to SAp	LAM	12/06/02	12/06/02	2 months	(10/04/01) v20010410, Margin TBC
DRCU-FPU Test Harness Delivery to SAp	RAL	12/06/02			To be purchased by SAp
AVM DPU Delivery to RAL	IFSI	01/06/02	02/04/02	2 months	(02/04/00) Issue 1.2
DRCU Simulator#2 Delivery to RAL	SO	01/06/02	01/06/02		(21/12/00) SO-2000-12-21, margin TBD
EGSE#2 Available	RAL	01/06/02	01/06/02		
QM1 DRCU Delivery to RAL	SAp	01/12/02	15/10/02	1.5 months	(19/01/01) v1.0, adjusted
QM1 WIH Delivery to RAL	SAp	01/12/02	15/10/02	1.5 months	(10/01/01) v1.0, adjusted
FPU Simulator#1 Delivery to RAL	SAp	01/12/02	01/11/02	1 month	(10/01/01) v1.0
EGSE#3 Available	RAL	01/12/02	01/12/02		
CQM Test Readiness Review			**21/03/03**		
CQM Interim Review			**22/04/03**		
PFM BDA (SSW) Delivery to RAL	JPL	01/04/03	01/02/03	2 months	(23/02/01) Agreed at teleconf 23/02/01 - date/margin TBC
Critical Design Review			**27/06/03**		
CQM Delivery to ESA	**RAL**	**01/04/03**	**15/07/03**		**Realistic Delivery Date 1st Oct 03**

1.6 AVM Programme

Milestone	Responsible	Need Date	Planned Date	Margin	Comments
AVM DPU Delivery to RAL	IFSI	01/06/02	02/04/02	2 months	(02/04/00) Issue 1.2
EGSE#4 Available	RAL	01/02/03	01/09/02		
DRCU Simulator#3 Delivery to RAL	SO	01/02/03			(21/12/00) SO-2000-12-21 Not in schedule, Date, Margin TBD
AVM Delivery to ESA	**RAL**	**01/04/03**	**25/03/03**		**Realistic Delivery Date 1st Jun 03**

1.7 QM Warm Electronics Programme

Milestone	Responsible	Required Date	Planned Date	Revised Need Date	Comments
QM2 MCU Delivery to SAp	LAM	01/11/02	10/09/02	1.5 months	(10/04/01) v20010410
QM DPU Delivery to RAL	IFSI	01/02/03	02/01/03	1 month	(02/04/00) Issue 1.2
QM2 DRCU Delivery to RAL	SAp	01/06/03	01/06/03		(19/01/01) v1.0, Margin TBD
QM2 WIH Delivery to RAL	SAp	01/06/03	01/06/03		(19/01/01) v1.0, Margin TBD
FPU Simulator#2 Delivery to RAL	SAp	01/06/03			(19/01/01) v1.0 Not in plan, Date, Margin TBD
WE Critical Design Review			**02/07/03**		

1.8 PFM Programme

Milestone	Responsible	Need Date	Planned Date	Margin	Comments
PFM Cold Filters Delivery to JPL	QMW	03/02/03			(11/01/01) Issue 2.0 - not in QMW schedule
PFM PCAL Delivery to ATC	QMW	01/09/03	14/05/03	2.5 months	(11/01/01) Issue 2.0
PFM BSMm Delivery to LAM	ATC	15/07/03	03/06/03	5 weeks	(08/04/01)
PFM Structure Delivery to RAL	MSSL	15/07/03	10/06/03	7 weeks	(19/03/01) Issue 1.2
PFM Thermal Straps Delivery to RAL	MSSL	15/07/03	10/06/03	7 weeks	(19/03/01) Issue 1.2
PFM Mirrors Delivery to RAL	LAM	15/07/03	15/06/03	2.5 months	(30/03/01) v20010330
PFM Filters Dichroics and Beamsplitters Delivery to RAL	QMW	01/08/03	15/05/03	2.5 months	(11/01/01)
PFM BSMm Delivery to RAL	LAM	01/10/03	01/10/03	1 month	(10/04/01) v20010410
PFM Cooler Delivery to RAL	Grenoble	01/08/03	01/03/03	5 months	01/2001 (SBT/CT/2000-19 Issue 2 Rev 1)
PFM BDAs Delivery to RAL	JPL	01/10/03	22/09/03	8 days	(23/02/01), margin TBC
PFM Shutter Delivery to RAL	USK	01/10/03	03/11/03		(15/06/2000) Issue 0.2 D, Date TBD
PFM SCAL Delivery to RAL	QMW	01/10/03	01/10/03	1 month	(11/01/01) Issue 2.0
PFM SMECm Delivery to RAL	LAM	01/10/03	01/09/03	1 month	(10/04/01) v20010410
PFM FPU RF Filter Modules Delivery to RAL	JPL	22/10/03	22/10/03		(23/02/01), Margin TBD
PFM FTB Enclosure Delivery to RAL	MSSL	22/10/03			(19/03/01) Issue 1.2 Not in schedule, Date TBC, Margin TBD
PFM JFET Modules Delivered to RAL	JPL	22/10/03	22/10/03		(23/02/01), Margin TBD
PFM FTB RF Filter Modules Delivery to RAL	JPL	22/10/03	22/10/03		(23/02/01), Margin TBD
PFM DPU Delivery to RAL	IFSI	01/03/04	01/03/04	1 month	(02/04/00) Issue 1.2, Margin TBC
PFM MCU Delivery to SAp	LAM	07/08/03	07/08/03	1 month	(30/03/01) v20010330, Margin TBC
PFM DRCU Delivery to RAL	SAp	16/03/04	16/03/04		(19/01/01) v1.0, Margin TBD
PFM WIH Delivery to RAL	SAp	16/03/04	16/03/04		(19/01/01) v1.0, Margin TBD
Delivery of PFM FPU to Cold Vibration Facility	**RAL**		**27/01/04**		
Delivery of Cold-Vibrated PFM FPU to RAL	**RAL**		**24/02/04**		
PFM Test Readiness Review			**09/12/03**		
PFM Delivery to ESA	**RAL**	**01/06/04**	**15/06/04**		**Realistic Delivery Date 1st Sep 04**

1.9 FS Programme

Milestone	Responsible	Need Date	Planned Date	Margin	Comments
FS Cold Filters Delivery to JPL	QMW	TBD			(11/01/01) Issue 2.0 - not in QMW schedule
FS PCAL Delivery to ATC	QMW	01/01/04	03/09/03	4 months	(11/01/01) Issue 2.0
FS BSMm Delivery to LAM	ATC	01/03/04	22/01/04	5 weeks	(08/04/01)
Return of CQM from ESA	**ESA**	**01/06/04**			**9 months after delivery to ESA**
FS Structure Available for Integration	MSSL	10/01/05	10/01/05	1 month	(19/03/01) Issue 1.2, adjusted 7 months refurbishment
FS Thermal Straps for Integration	MSSL	10/01/05	10/01/05	1 month	(19/03/01) Issue 1.2, adjusted 7 months refurbishment
FS Mirrors Delivery to RAL	LAM	10/01/05	10/01/05	18 months	
FS BDAs Delivery to RAL	JPL	10/01/05			Date TBD
FS Filters Dichroics and Beamsplitters Delivery to RAL	QMW	10/01/05			Date TBD
FS RF Filter Modules Delivery to RAL	JPL	10/01/05			Date TBD
FS SCAL Delivery to RAL	QMW	10/01/05	09/12/03	13 months	(11/01/01) Issue 2.0
FS SMECm Delivery to RAL	LAM	10/01/05	10/11/04	8 months	(10/04/01) v20010410
FS BSMm Delivery to RAL	LAM	10/01/05	10/11/04	8 months	(10/04/01) v20010410
FS Cooler Delivery to RAL	Grenoble	10/01/05	01/06/03	18 months	01/2001 (SBT/CT/2000-19 Issue 2 Rev 1) Only one cooler for SPIRE & PACS
FS Shutter Delivery to RAL	USK	10/01/05	01/11/04	2 months	(15/06/2000) Issue 0.2 D
FS FTB Enclosure Delivery to RAL	MSSL	10/01/05			(19/03/01) Issue 1.2 Not in schedule, Date TBC, Margin TBD Refurbished from CQM
FS JFET Modules Delivery to RAL	JPL	10/01/05			Date TBD
FS MCU Delivery to SAp	LAM	TBD	09/09/03		(10/04/01) v20010410
FS DRCU Delivery to RAL	SAp	10/01/05			Date TBD
FS WIH Delivery to RAL	SAp	10/01/05			Date TBD
Delivery of FS FPU to Cold Vibration Facility	**RAL**		**10/07/05**		
Delivery of Cold-Vibrated FS FPU to RAL	**RAL**		**10/08/05**		
FS Test Readiness Review			**06/06/05**		
FS Available to ESA	**RAL**	**01/07/05**	**29/11/05**		**Realistic Date 1st Jan 06**

Annex 3: TN: Herschel SPIRE control system – Micro Vibration Requirements

HERSCHEL SPIRE CONTROL SYSTEM

MICRO VIBRATIONS REQUIREMENTS

July, 17th 2001
D.FERRAND

Introduction

The SMEC control system performance requirements will strongly depend on disturbances characteristics. In an ideal case, the rejection of external disturbances will be optimal for an infinite servo control bandwidth. In fact the control will be limited in term of performances by the first mechanical parasitic mode due to its uncontrollability (the modes are not stable), unless a robust control or an adaptive control shows a better efficiency. Up to now, the closed loop shall have a limited bandwidth of 10-20 Hz, i.e. shall counteract disturbances up to this frequency only.
This study deals with the maximum external micro vibrations that can be accepted depending on the control loop bandwidth.

Disturbance model

We consider that external vibrations will apply as a position oscillation on the structure, and that the structure is monolithic between the optical train, the SMEC base plate and the detector mount.

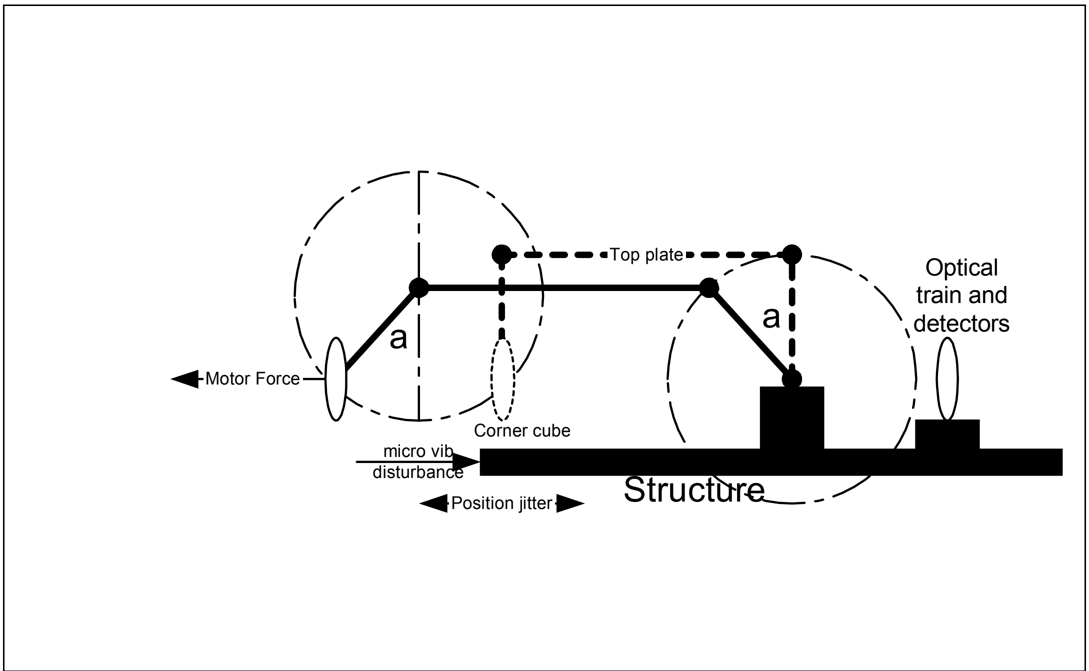


Figure 1: SMECm on the structure and micro vibrations

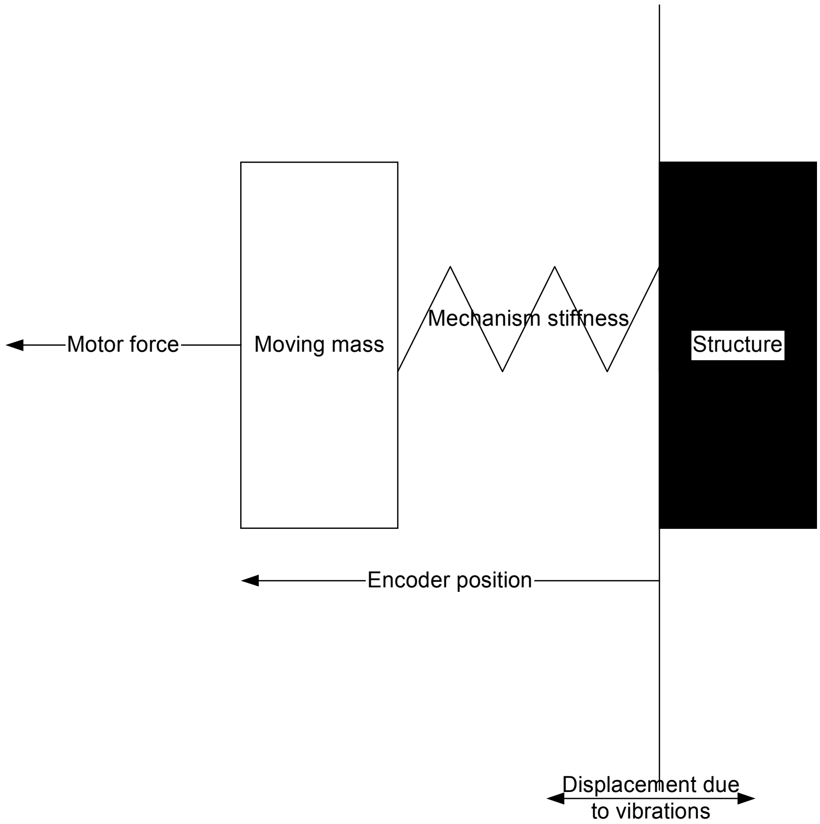


Figure 2: mass-spring model

Closing the loop

Matlab model used for simulations

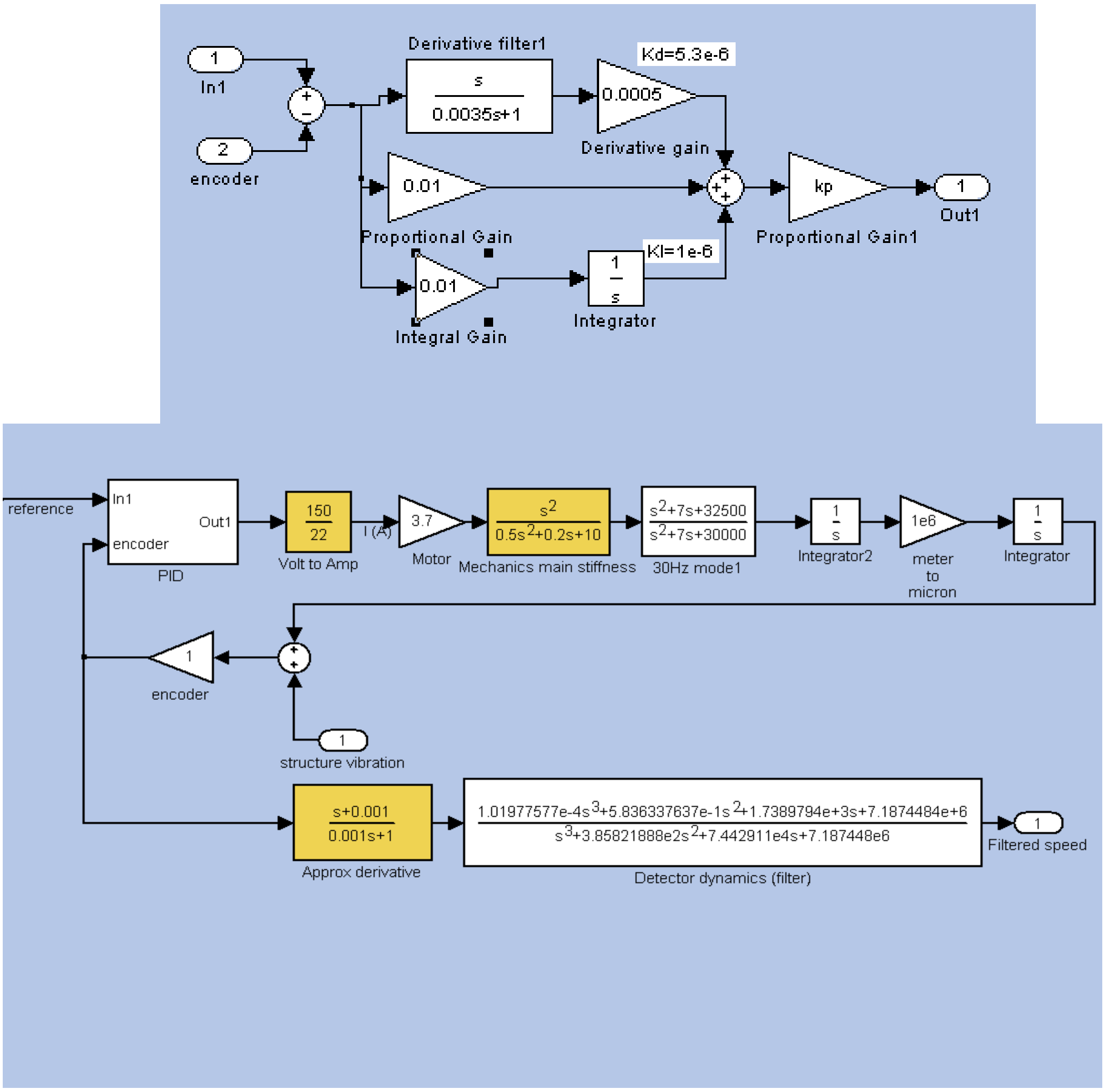


Figure 3:modele simulink mgesiml30

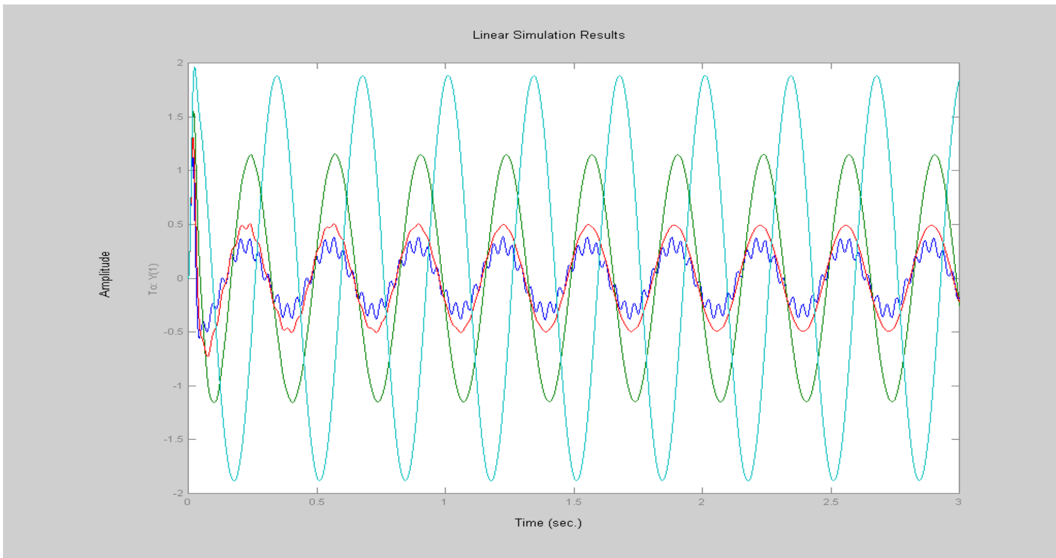
Closed loop tuning

Depending on the first parasitic mode tuned to 30, 50 and 70 Hz, the control in closed to the maximum admissible bandwidth. The mechanical damping is an important factor since the bandwidth shall be limited by the resonance level . The study shall take into account the conservative case of a first mode @30Hz . For a 30 Hz mode, the control bandwidth can be tuned around 10Hz (next figure).

Figure 4: closed loop bandwidth

Disturbance rejection if the first resonance is @ 30hz

The next two figures (figures 5 and 6) show the filtered speed oscillations (micron/sec) when applying a 0.1 µm 3Hz and 20Hz sinus on the structure, for various values for the proportional gain (0,1^e-3,2^e-3,3^e-3). For the 3Hz case, without closed loop, the velocity oscillation is about 2 um/s, corresponding to 0.1µm*2π*3 (Aω). When the closed loop is operating, the velocity oscillation is reduced by a factor 4 (12 dB). For the 20Hz case, the velocity fluctuation is about 13 um/s ie. 0.1*2*π*20 . At 20Hz and after, the control loop



cannot counteract the micro-vibrations. The complete disturbance rejection of a structure position oscillation is shown figure 7.

Figure 5: velocity oscillation for a 0.1 um @3hz position disturbance

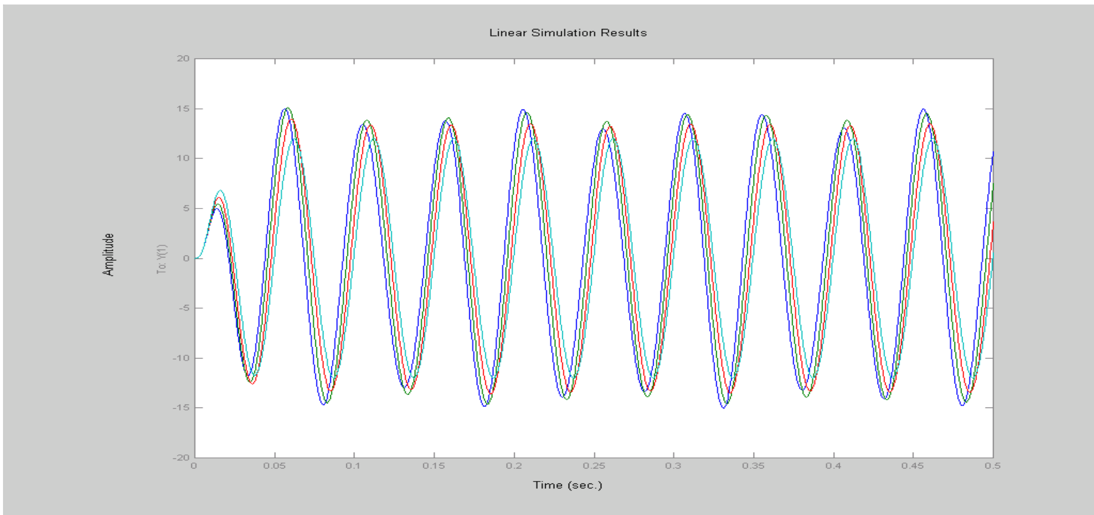


Figure 6: velocity oscillation for a 0.1 um @20hz position disturbance

The following figure shows the position disturbance rejection performed by the closed loop:

At about 10 Hz, there is no more rejection (0 dB)., i.e a 0.1 micron position jitter is not filtered by the closed loop. At 1 hz the position rejection is about 40 dB, that is an attenuation of factor 100. At 3hz the position rejection is only 12 dB (attenuation by a factor 4).

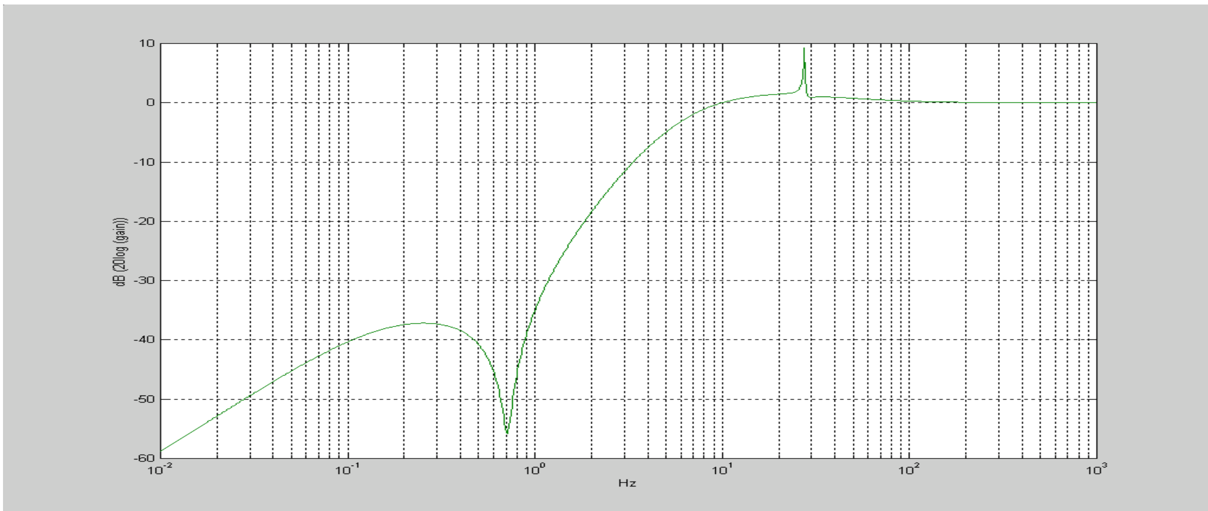


Figure 7: position jitter rejection by the control

The figure 8 shows the related deduced velocity rejection:

at 10 Hz the rejection is 40 dB (factor 00) ie a 0.1 um position jitter shall induce a 10 um/sec velocity jitter At 1 Hz, the rejection is –20dB (factor 0.1), ie a 0.1 um position jitter shall induce a velocity jitter of 0.01um/sec. The following figure shows the filtered speed jitter vs the acceleration level.

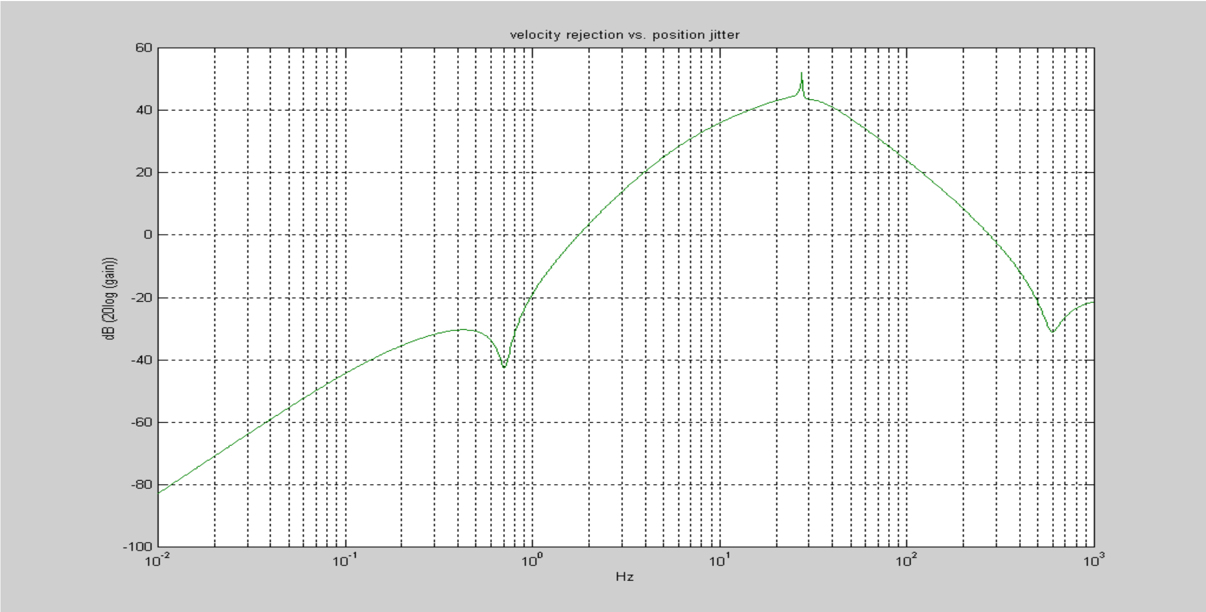


Figure 8: velocity rejection vs position jitter

The related transfer function between an acceleration jitter and the velocity is shown figure 9
Globally there is a rejection of –35 dB (decay of factor 56), i.e. a sine acceleration of 1000 micron/sec2 shall induce a velocity jitter of 1000/56= 17 micron/sec. It corresponds to the order of magnitude of an acceleration of 0.1mg.

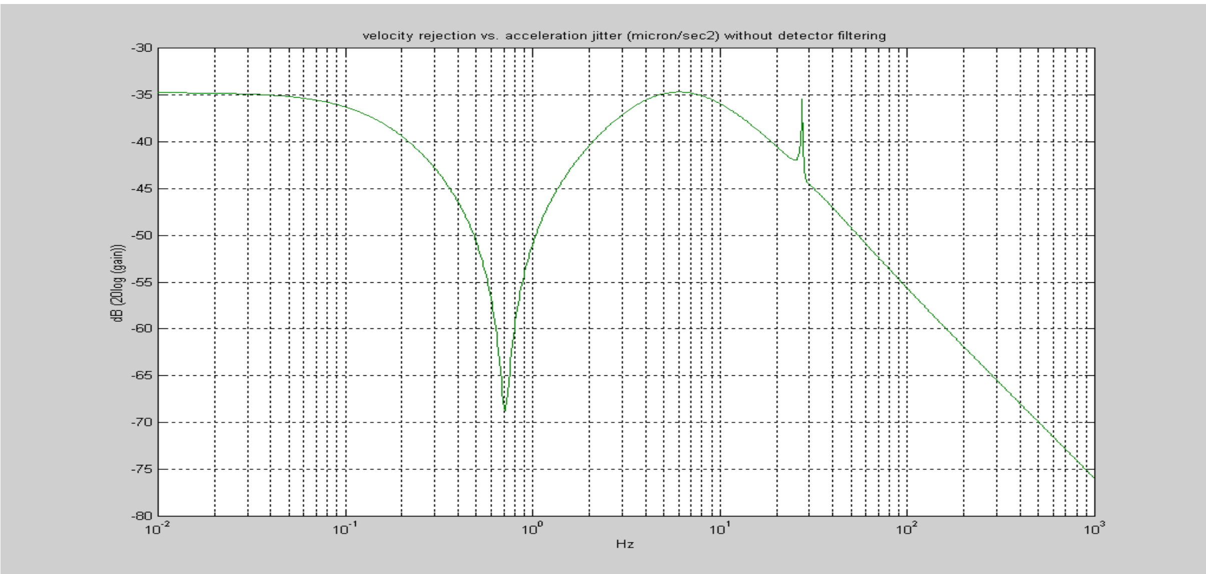


Figure 9: velocity (um/sec) vs acceleration jitter (um/sec2)

Figure 10 is the same transfer function but with the detector filtering.

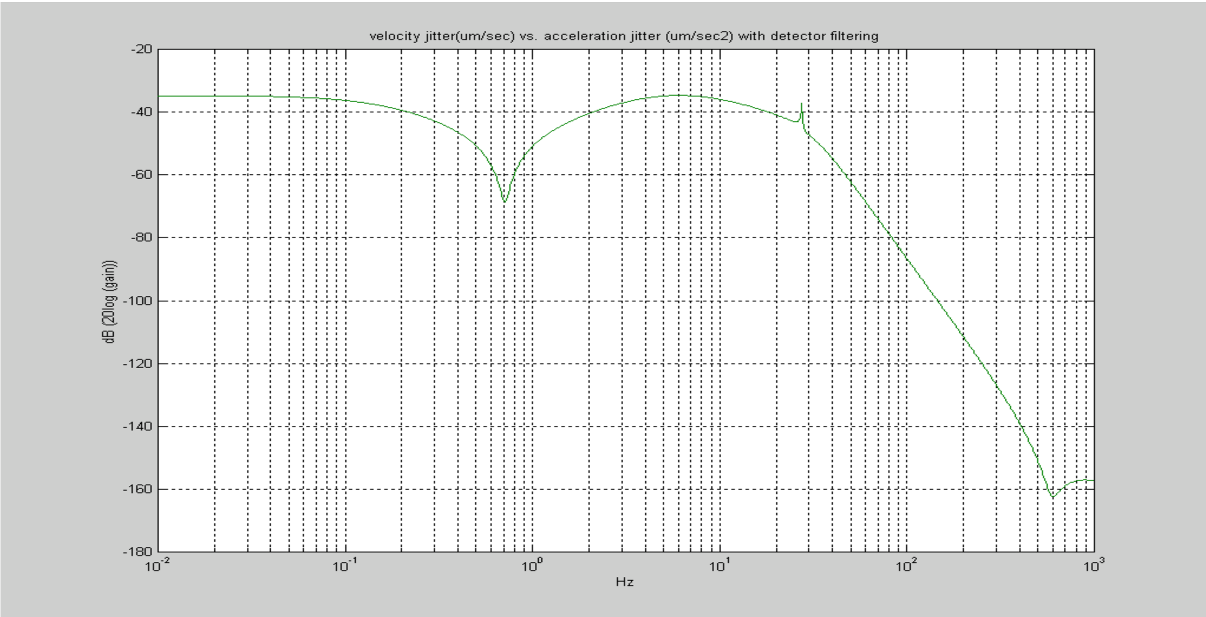
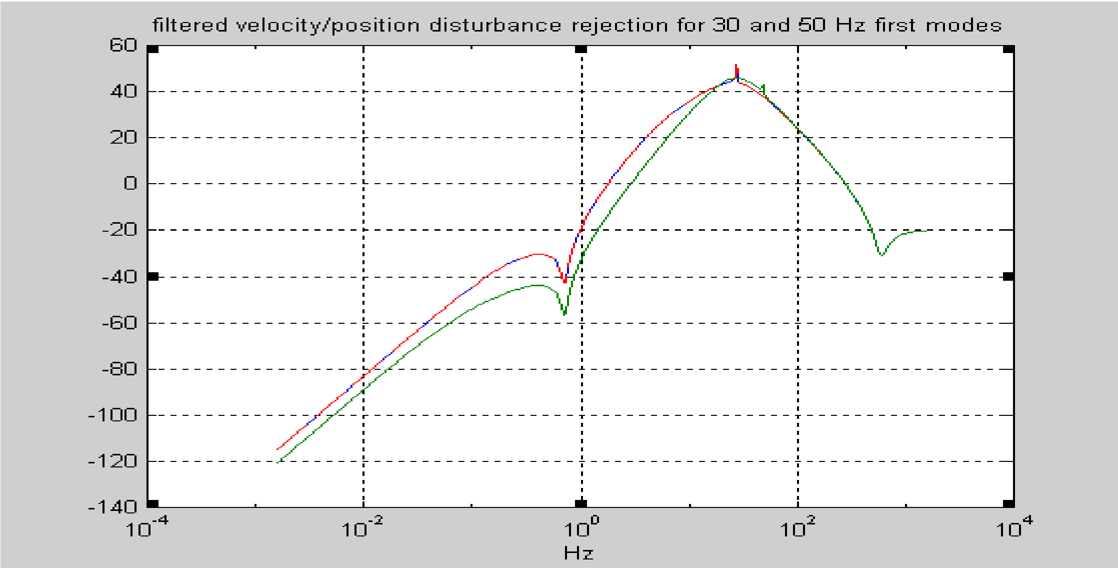


Figure 10: velocity vs acceleration jitter with detector filtering

Comparison between the disturbance rejection for loose and tighter bandwidth.

When applying a tighter control thanks to a further parasitic mode, we see a better rejection in the low frequencies and a shift of the resonant mode in the detector band filtering. On the other hand, there is no significant improvement in the frequencies around the bandwidth (10-20 Hz) in the rejection level.



Conclusion

The last figure shows the effect on the velocity when apply an acceleration of 1mg. To cope with the 10um/sec velocity jitter requirement (10micron/sec rms), given the capability to the closed loop the filter the jitter up to 10-20 Hz (depending on the final mechanical stiffness), the max acceleration level in the band 0-30 Hz shall not exceed the order of magnitude of 0.1 mg. This does not include the capability of the detector to filter the velocity jitter.

Generally speaking, the study deduces acceleration levels, but the study is based **on a position jitter** of the structure. Since the control loop acts as a filter that rejects the external disturbances, the micro vibrations should be rather expressed in term of position jitter on the structure of the SMEC. The general requirement should be to avoid any vibration that exceeds the level of 0.1 micron between the corner cube and the SMEC baseplate structure. The correspondence between position jitter and acceleration depending on frequency is given by:

$$\text{acceleration level (um/sec}^2\text{)=position jitter(um)*(2*pi*frequency)}^2$$

and

$$\text{1mg= 10000 um/sec}^2$$