esa

MINUTES OF MEETING

Herschel/Planck Project

	reference SCI-PT/9243	page	1/
meeting date 19/06/01	meeting place ESA - ESTEC		
chairman	D. de Chambure / G. Pilbratt		
copy			

subject HERSCHEL OPTICAL SYSTEM WG MEETING - 1

participants:

Name:	Affiliation:	Signature:
D. de Chambure	ESA - ESTEC	
DOMINIC DOYLE	" "	
NORBERT GEIS	MPE - PACS	
Dirk Kumpf	Kayser-Threde	
Patrick ASTROC	ALCATEL	
Philippe MARIN	ALCATEL	
Jackie Fischer	NRL	
Göran Pilbratt	ESA	
Edgar Hölzle	Astrium-D	
Tony Richards	CLRC-RAL	
Kiehl Döhler	LAM	
Douwe Brantema	SRON	
Volker Kirschner	ESTEC	

ESTEC
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description	action	due date

1/ Agenda see annex 1 (2 pages)

2/ Introduction see annex 2 (7 pages)
ESA - D. de Chambure

3/ Telescope design and manufacturing
Astrium. F - F. Safa see annex 3 ( )

→ Coating for M1 and M2 will be either Ni or Al. M2 mirror will be cleanable ie bare Al + protective layer on Ni (the telescope will be most of the time upside down collecting particulate contamination on M2) the robot particulate size versus mirror size is much larger and critical for M2 than M1). Ni 200 nm layer thickness (tbc)
Al 150 nm

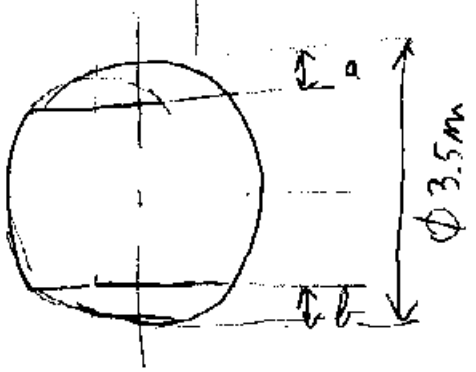
→ M1 thickness of optical surface will be determined to limit the quilting between cells (1 μm)
Trade-off to be done between
"thick" optical surface (≥ 3mm)
"thin" optical surface with rib (≥ 2.5mm)

description	action	due date
→ The Primary Mirror M1 will be gravity compensated during polishing / integration with 9 actuators - Various checks (- g + action on single actuator) will be done to check that the compensation applied is correct.		
→ WFE budget presented by Astrium is almost complete and is OK with the exception of the Telescope / PLM I/F which is not yet defined (Ti bipods)		
→ Optical, mechanical, thermal, stray light interfaces shall be frozen by October 2001 (MTR) and confirmed in March 2002 (CDR).	statement ESA / Astrium.	
→ Reflectivity and emissivity measurements on sample basis ~~LEMTA (Norway)~~ could be done		

at the following facilities:

- LEMTA (Nancy - F)
- JPL (California - USA)
- University of Massachusetts (Lowell - USA) → Dr. D. Doyle
- NPL (UK)

description	action	due date
Measurement accuracy < 1% Preferably at cryo temperature. Date of tests required : Jan / Feb 2002. JPL and Uof Massachussets look to have the higher precision.		
→ <u>Contamination levels</u> need to be revised and reviewed by according to Astrium_F. Astrium_F will review the MoM of last meeting and make possible counter proposals (according to scientific needs and their possibilities).	Astrium ESA Ac (1)	Sept 01 + MTR
→ <u>Brazing oven volume impacting on M1 mirror size</u>. M1 mirror edges could be possibly cut by 10-20mm on both sides to accommodate it inside the oven. Instrument teams to check whether it is acceptable to them, what could be the maximum edges reduction (in size) and which direction the cut edges shall be oriented.	Instrument team Ac (2)	End August 01



description	action	due date
→ Sunshield emissivity and temperature values to be defined by mid-July 01 (in particular shield lower panel whose temperature is currently 250K)	Alcatel / Astrium-D Ac (3)	15/7/01
→ Mechanical / thermal interface meeting for Herschel telescope ESA - Alcatel - Astrium F+D 4 September 01	-	
→ Telescope central hole (M1) design. Larger central hole minimises diffraction effect for instrument but larger obscuration (loss of effective area). Preliminary trade-offs done by Astrium-F		
→ M2 central area neutralization (meridional effect) HIFI to clarify their needs (Nick Whyborn) Returned light level / orientation etc...	HIFI Ac (4)	31/8/01

description	action	due date
4) Stray light analysis		
→ Alcatel / Astrium GmbH to refine detailed planning for stray light analysis. First objective is to obtain a preliminary analysis of the complete optical system by Feb. March 2002 at telescope COR.	Alcatel / Astrium - D Ac (4)	15/7/01
→ Overall stray light analysis remains the responsibility of Alcatel / Astrium GmbH	Statement ESA	
→ Presentation of Tony Richards (RAL) Annex 4 - 9 pages.		
Major critical issues for SPIRE are: - M2 edge - M1 central hole size and edge definition.		
→ Astrium GmbH (E. Hoelzle) Annex 5 - 8 pages		
Definition of requirements for stray light analysis → model in ASAP for all instruments and telescope and EPLM.		

description	action	due date
→ SPIRE stray light complete model will be delivered by July 01 in ASAP format	SPIRE team 31/7/01. Ac(6)	
→ PACS stray light optical model (top optics) is ready and it is not complete as it doesn't include the external surfaces in ASAP format	PACS team 31/7/01 Ac(7)	
→ HIFI shall deliver the physical description of their instrument box and ESA expert will built an ASAP model from the description	HIFI / ESA expert V. Kirchner. 31/7/01 Ac(8)	
→ Telescope model will be ready at MTR (Herschel Telescope)	Astrium F 15/10/01 Ac(9)	
→ Cryostat stray light model (preliminary) will be delivered end of July 01.	Astrium. D 31/7/01. Ac(10)	
→ Nonconus effect for HIFI Astrium . F (F. Sofa) presentation Annex 6 6 pages		

description	action	due date

4] Alignment Concept

Astrium presentation. Annex 7 - 7 pages

Alignment Concept:

Ambient temperature

- Alignment of instrument wrt optical bench
- — of optical bench wrt cryostat (with Primary alignment device on CVV outside)
- — of LOU wrt HIFI

CVV upper part is mounted then telescope

- — of telescope wrt CVV

Use of alignment cubes with reticules on all instruments + telescope + CVV (typically reflective for autocollimation / size 25mm)

End to end test (verification at cryo temp)

- Alignment check via LOU window

Astrium to revise alignment plan taking into account pupil alignment of instruments and telescope

(target ± 2 arcmin at focus (given by PACS) (to be checked wrt specification) (not agreed by ESA yet)

SRR action Ac (11) 23/7/01

description	action	due date
The document (plan) shall include the requirement for alignment device for all instrument / telescope and subsystem (alignment size / reflectivity / retical etc..)		

Daniel de Chambure

05/23/01 09:50 AM

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Subject: Herschel Optical System Working Group Meeting - 19 June 2001 - Estec - room Af 205 (Noordwijk - The Netherlands)

Mesdams, Sirs

Please find herebelow the agenda for the Herschel Optical System Working Group meeting. The meeting agenda will be concentrated mainly on telescope design aspects and manufacturing; Herschel stray light analysis and Herschel payload alignment. Main objectives of the meeting are to get a proper and common understanding of the optical system of Herschel and to identify the open points with clear actions to tackle them. Please note that the meeting initialy foressen for 2 days has been reduced to one (heavy) day 19 June 2001 (starting at 9:00) to save time for everybody. The date was moved back from June 20 to June 19, in order to allow some people to participate to the HST, taking place in Groningen on June 20-22.

June 19 starting at 9:00 in room Af 205

1. 9:00 - 9:15 Introduction - ESA - 15 min
2. 9:15 - 10:45 Teloscope design and manufacturing - Astrium -F - 90 min
   with emphasis on open issues
   - general aspects on teloscope design (30 min)
   - telescope manufacturing and planning with details on properties of SiC (20 min)
   - open issues (40 min) :
     - optical issues: diamoter central hole; tripod shape; M2 central obscuration, definition of volume below the telescope,
       M1 cut-out, coating
     - system issues : thermal interface; mechanical interface; electrical interface
3. 10:45 - 11:00 Coffe break - 15 min
4. 11: 00 - 12:30 Stray light analysis - 90 min
   - Reminder of requirements and system analysis approach - ESA - 10 min
   - Presentation of stray light analysis work carried out until now (SPIRE team) - 30 min
   - Presentation of stray light analysis work to be carried out - Alcatel/ Astrium-D - 30 min
   - Definition of tasks and actions to be performed - all - 20 min
   - NB: For that meeting, it would be nice that all instrument teams provide their updated stray light model and analysis if this has not already been done !
5. 12:30 - 13:45 Lunch break
6. 13:45 - 15:00 Alignment - 75 min
   - Alignment approach - ESA - 15 min
   - Alignment approach - Alcatel/Astrium-D - 30 min
   - Definition of tasks and actions to be performed - all - 30 min
7. 15:00 - 15:30 Conclusions and review of actions - 30 min

In order to be able to prepare your access to Estec, we will be grateful to get well in advance the list of your participants by company/ consortium. Please let us know whether you need hotel arrangement

Annex 1 - (1/2)

Thanks and regards

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Annex 1 - (2/2)

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Herschel Optical System Working Group Meeting

Estec -June 19,01

Daniel de Chambure
Herschel/Planck Telescope Responsible
ESA - ESTEC

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Agenda

Introduction
- Organisation and responsibilities
- Herschel/ Planck program situation
- Herschel telescope situation
- Planning
- Documentation and specification

Telescope Design and Manufacturing (Astrium)

Coffee break

Stray light analysis (SPIRE; Alcatel-Astrium-D)

Lunch break

Alignment (Alcatel; Astrium-D)

Conclusions

Annex 2
(total nb of pages)

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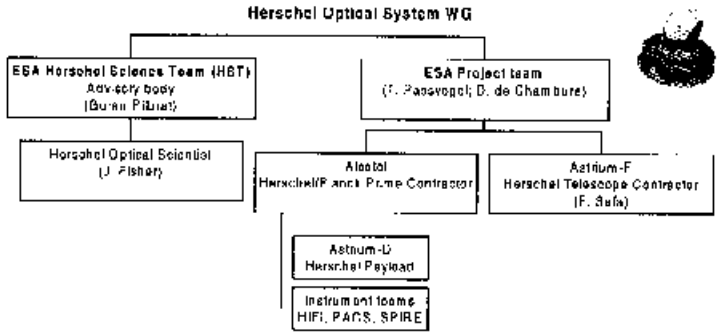
Herschel Optical System WG Organisation & Function

Provides input and recommendations to ESA Herschel/ Planck Project team and its industrial partners for the design and the development of the Herschel telescope (incl interfaces to the cryostat and the instruments, stray light and alignment)



- *Organised by ESA Herschel/ Planck Project Team - 3/4 meetings per year*
- *Includes experts from ESA, Instrument teams and our industrial contractors*

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Herschel/Planck Meeting Goals for Today

- Get a proper and common understanding of all major aspects of the Herschel optical system (telescope; stray light; alignment)
- Identify open points with clear actions
- Organise the work for the future

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Herschel/Planck Program planning

Phase B : started in April 2001and lasting until May 2002 with System Requirement Review (SRR) foreseen for September 01 - Build up of the complete Industrial Team and achieve final design of both spacecraft.

Phase C/D : starting in June 2002, up to September 2006 . Manufacture, assembly, integration, testing and verification of both spacecraft.

Phase E1 : Launch campaign starting in October 2006 leading up to launch in February 2007 and subsequent in-orbit commissioning of both satellites.

Phase E2 : Scientific operations of 15 months for Planck and minimum 36 months for Herschel.

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Herschel telescope situation (in SiC=now baseline solution)

- Successful development of a 1.35 m demonstration model (1999-2000) with optical tests at cryogenic temperature and with flight representative mechanical tests
- Successful manufacturing of a full size SiC demonstration petal (i.e. pie shaped element of Primary Mirror - 1/12 of total surface) mid-May 2001
- IPC approval for procurement of SiC telescope (May 11, 01) following NASA withdrawal for financial reasons
- Release of RFQ for SiC telescope procurement (beg June 01)
- Proposal preparation by Astrium-F
- Expected KOM in July 01
- NB: Herschel telescope is an **ESA CFE** to Alcatel/ Astrium GmbH

Herschel Optical System Planning

- Herschel telescope Mid-Term Review (end October 2001)
- Herschel telescope Critical Design Review (end February 2002) with Herschel stray light preliminary analysis
- Herschel Telescope Qualification Readiness Review (in 2003)
- Delivery of PFM telescope 1st quarter of 2005
- Delivery of FS telescope 4th quarter of 2005

Documentation

- Herschel Telescope Specification (SCI-PT-RS-04671, Is 4/0)
- IID-A (SCI-PT-IIDA-04624, Is 2/0) and IID-Bs
- FIRST/Planck System Specification (SCI-PT-RS-05991, Is 1/0)

Herschel telescope specification

- **Specification has been updated by ESA, since release for ITT, last year**
- Optical design is frozen: Cassegrain design (following agreement with instrument team) with definition of conic constant for M1, M2 and the focal surface
- Dry-out temperature requirement less stringent (SiC instead of CFRP)
- Major open issues: mechanical and thermal interface requirement to be clarified with ALCATEL/Astrium GmbH

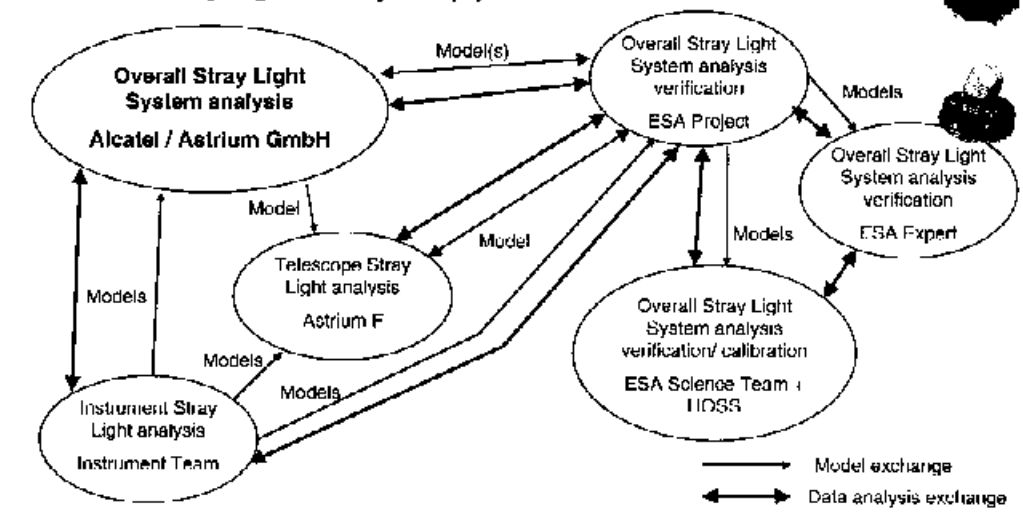
Contamination aspects for Herschel telescope

- Requirements at delivery of telescope to Alcatel:
  300 ppm and 2.10^{-7} g/cm²
  Requirements before encapsulation (in Kourou)
  1500 ppm and 10^{-6} g/cm² (values to be checked)
- No cleaning of reflective surface as baseline: the reflector surface shall be protected with covers as much as possible during their ground life (manufacturing; testing; launch campaign and launch)
- Telescope contamination risk during launch campaign inside the fairing (ground activities and flight) --> work with Arianespace
  - assessment and improvement of fairing cleanliness
  - technical solutions under study (protective foil)?

Herschel stray light analysis (1)

- Requirements given in system and in telescope specifications
- Some work done until now except for SPIRE, PACS and for the telescope
  - Model ready by SPIRE
  - Simplified ASAP model available for PACS
  - Preliminary analysis carried out on JPL telescope identifying some important impact on the design (central obscuration of M2; detailed design of central hole of M1 and of tripod)
- All analysis to be led and combined by industrial Prime Contractor Alcatel (or sub-co Astrium GmbH) with support of experts (ESA and instruments)
- Work, type of model and need dates are under definition between Alcatel / instrument team and telescope

Herschel stray light analysis (2)



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Herschel telescope alignment activities (1)

- ***Alignment activities to be initiated***
  --> creation of Alignment Working Group with telescope supplier and instrument teams to be led by Alcatel (and/or sub-co)
  --> review of alignment approach and alignment (verification) plan presented in the specification and in the proposal (Astrium GmbH) covering telescope, PLM and satellite
  --> Most critical alignment parameters:
  - alignment precision of LOU wrt HIFI: <0.75 mm and <0.038 deg
  - stability alignment stability of LOU wrt FPU (3 μm/ 100 sec) --> system aspect FPU tilt (vignetting risk of instrument)
- --> Constraints:
  - Access to OGSE elements on optical bench and on telescope during alignment activities
  - No optical window on cryostat door

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Herschel telescope alignment activities (2)

- Alignment device requirement definition for instruments and telescope

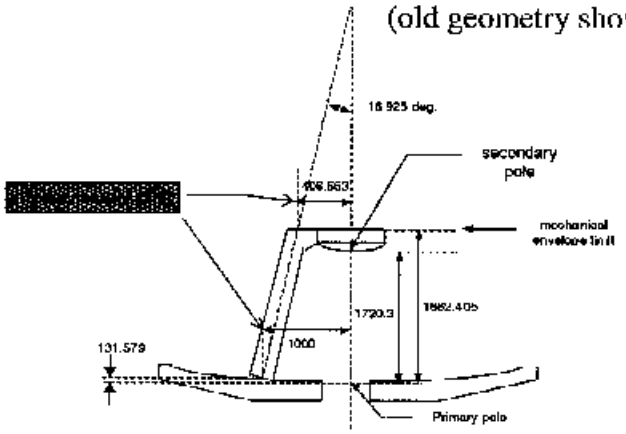
Main Telescope/PLM Geometry changes

M1-M2 spacing	1587.998	(was 1720.3)
Back-focal distance	1050.00	(was 975)
M1 - Fixation plane	250	(was 125)
M1 thickness at hole	100(TBC)	(was 100)
SPIRE cover upper surface location above best focus	243.52	(was 164.4)
Cryostat base shield (above best focus)	244+?	(was 244)

Forced Geometry changes(1)

Tripod leg length responds to new M1-M2 spacing

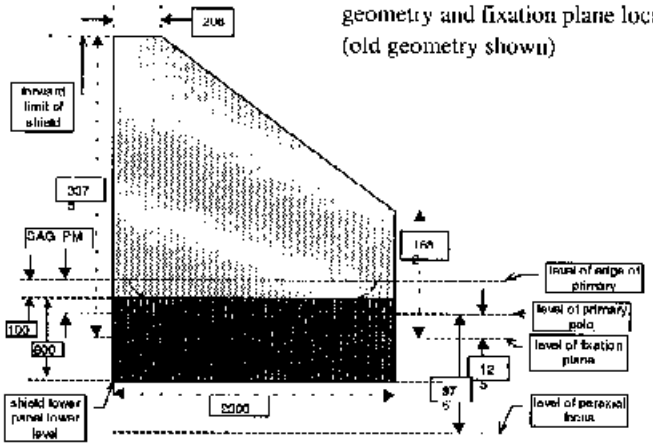
(old geometry shown)



Annex 4
(total nb of pages 9)

Forced Geometry changes(2)

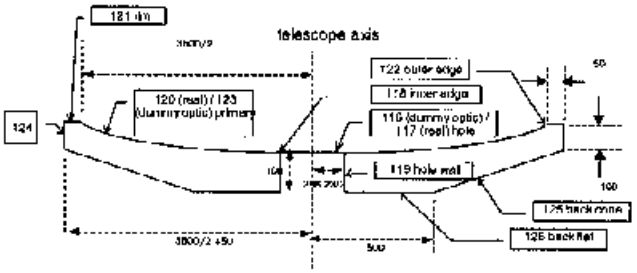
Sun shield geometry responds to M1-M2 spacing, M2 size and strut geometry and fixation plane location (old geometry shown)



Forced Geometry changes(3)

M1 thickness responds to new structure

M1 hole size responds to new structure

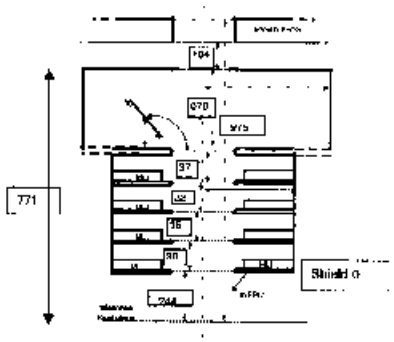


Forced Geometry changes(4)

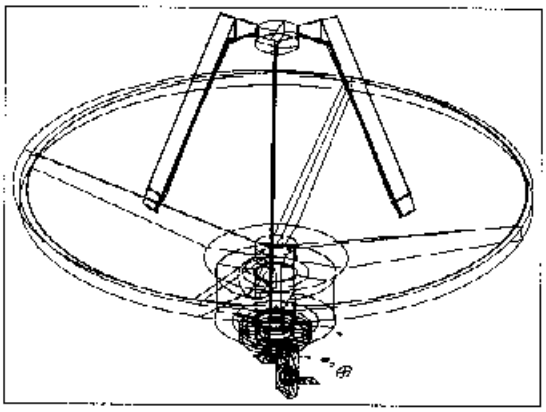
Cryostat base shield (above best focus) 244+65(TBC) (was 244)

Overall Cryostat length base shield to entrance port responds to cryostat redesign

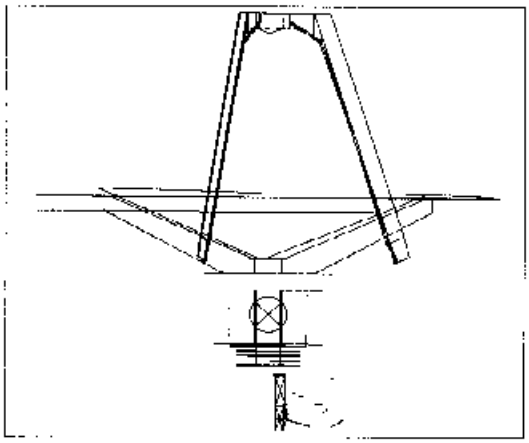
(old geometry shown)



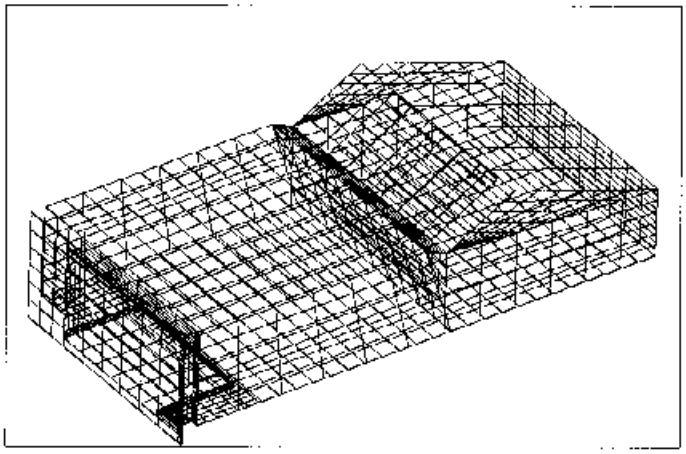
New Telescope / SPIRE Geometry(1)



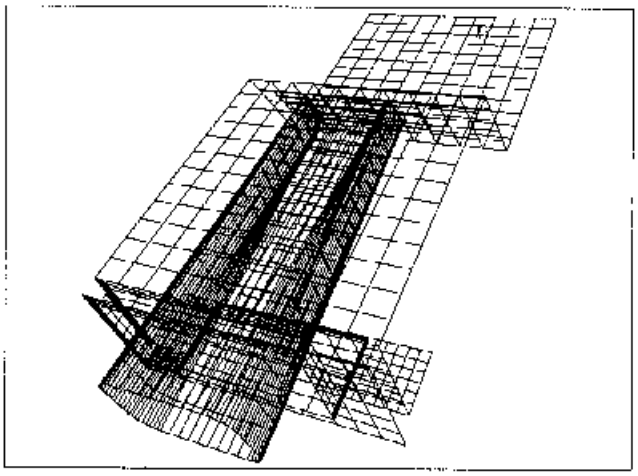
New Telescope / SPIRE Geometry(2)



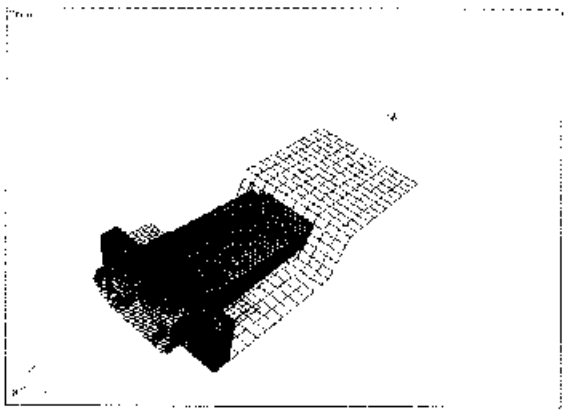
New SPIRE Geometry(1)



New SPIRE Geometry(2)

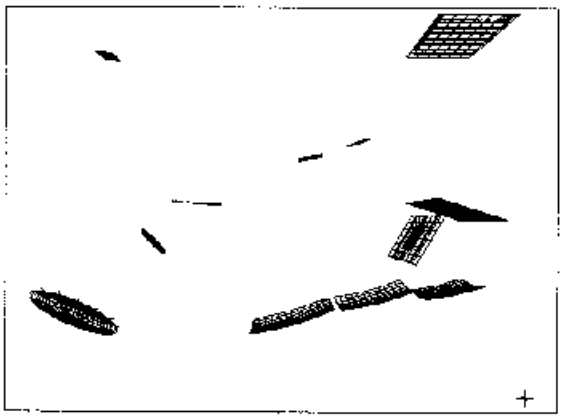


New SPIRE Geometry(3)



Chopped views and shutter/aperture geometry

New SPIRE Geometry(4)



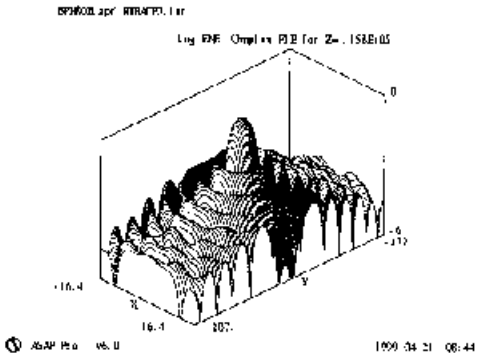
APART model of SPIRE Photometer optics

Beam shape effects.

- Important for (a) Stray-light (beam wings on optics surround) (b) Point spread function.
- Interested in clipping down to < 1 %, & beam is a **truncated** gaussian.
- Use full description: Beam patterns of smooth-wall circular horns, sized for $1/e^2$ clip at cold stops.
- Tested optics sizing for Worst-case: λ=0.5mm, single-moded.
- Clipping found to be : < 1 % throughout instrument, fore-optics chopping TBC.
- But more severe clipping in telescope ...

HERSCHEL meeting, APART Straylight Model June 18 ESTEC

SPIRE LW beam (λ=0.5mm) at Herschel Focal surface, centre of Phot. field



Airy pattern intensity (log scale) versus position in mm.

Clipped by instrument rectangular field stop, effective size at FP : X ,Y = 32.8 , 65 mm.

pupil-imaging is poor due to large f-number : 2600mm/X , 2600mm/Y = 80 , 40 .

Draft APART Model Update SPIHEFPU

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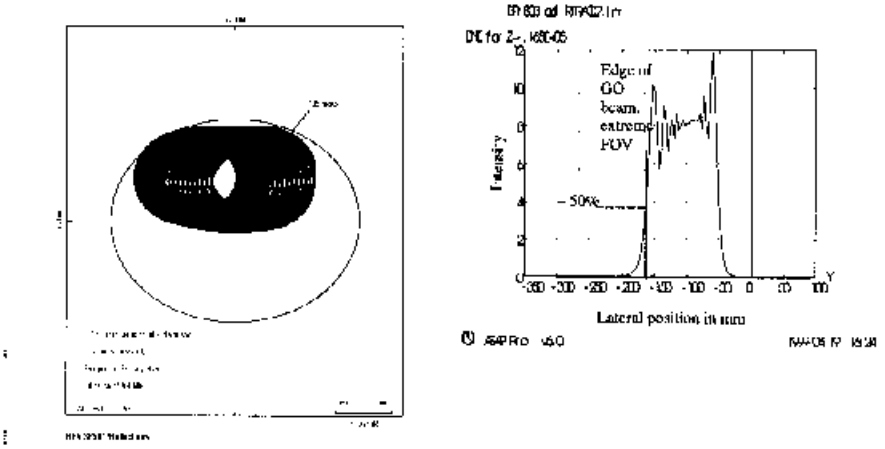
SPIRE LW beam at M1 cut-out



Draft APART Model Update SPIREFPU

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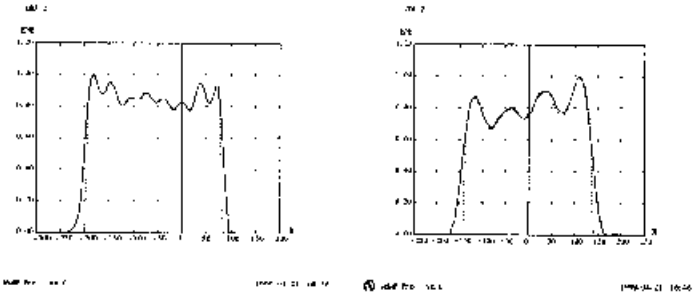
SPIRE LW beam at M2



•Intensity plots in 2 sections.

•Approx. edge of M2 shown in blue dots, over-spill mainly on to cold space, & spider

•Number of ripples ~ no. of Airy rings across field stop.

•Edge diffraction blur diameter ≈ $2.F_{fs}.\lambda$ ~ $60.\lambda$ = 60mm (average of X & Y directions).

• - applies also to M2 central cone, preventing efficient blocking of this by the instrument.

Draft APART Model Update SPIREPPU

HERSCHEL meeting, APART Straylight Model June 18 ESTEC

Telescope diffractive stray-light: Summary

$$Stray\ Light\ fraction = \frac{\text{power from surround}}{\text{power from M1 \& M2}} = \frac{\varepsilon_s.P(T_s).\Omega_s}{2\varepsilon_m.P(T_m).}$$

P = Planck function

ε_s, T_s surround emissivity, temp.

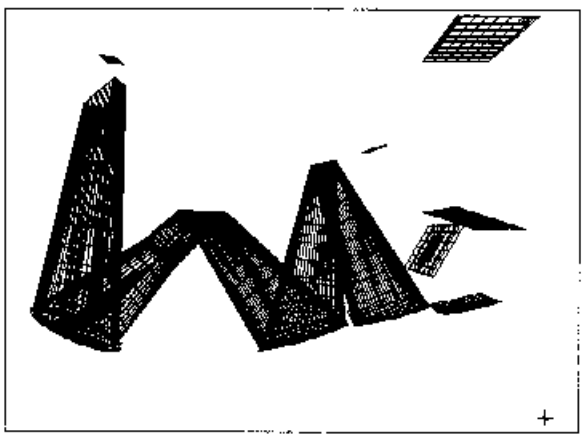
ε_m mirrors emissivity, temp

Telescope component & surround	Beam fraction Ω_s	emissivity ε_S	Source temp. T	Background level SL fraction	Ref
M1 cut-out, edge of FOV	0.02	0.15 (cryostat)	80 K	0.15	Fig.13
M2 surround: Non-spider, (space viewing)	0.13	1	Cold space	0	Fig.14
M2 surround : Spider	0.13x 1/16	0.02	Telescope 76 K	0.01	"
M2 surround: Centre conc	~ 0.01	0.02	76 K	0.01	
M1 surround Sun-shield, edge of FOV	2E-4	0.04	160 K	2e-3	Ref.9

Draft APART Model Update SPIREPPU

HERSCHEL meeting, APART Straylight Model June 18 ESTEC

New SPIRE Geometry(5)



APART model of SPIRE Photometer optics, with CODEV beam envelopes

Draft APART Model Update SPIREFPU

Instrument & Telescope Interfaces

Straylight Analysis: Verification of Straylight Levels at Detectors

Required Input:

1. Telescope Straylight Model:

- shall be written in ASAP
- shall contain telescope geometry, including
  - exact shape of the telescope mirrors (primary and secondary)
  - shape of the telescope struts
  - rear side of telescope and central hole.
- coordinates shall be given as defined in e.g. FIRST Extended Payload Module and Satellite AIT, Volume II, Part 1 page 5-312
- shall contain (preliminary) surface properties such as reflectivities, scattering properties in the different wavelength bands (70-700 μm)
- shall contain (preliminary) surface temperatures and surface emissivities in the different wavelength bands.

Annex 5 11/8

Instrument & Telescope Interfaces

Straylight Analysis / Required input cont.

2. Experiment Straylight Models:

- **shall be written in ASAP**
- **shall contain all straylight relevant experiment geometry**
- **coordinates shall be given as system coordinates, as defined in e.g. FIRST Extended Payload Module and Satellite AIT, Volume II, Part 1 page 5-312.**
- **shall contain (preliminary) surface properties such as reflectivities, scattering properties in the different wavelength bands (70-700 μm) for all straylight relevant surfaces**
- **shall contain (preliminary) surface temperatures and surface emissivities in the different wavelength bands for all straylight relevant surfaces.**

Instrument & Telescope Interfaces

Preliminary Schedule for Straylight calculations

Establish and verify Cryostat Straylight Model (including Sunshade/Sunshield and some preliminary Telescope data)	**up to end of Aug. 2001**
Telescope Straylight Model from ESTEC/Alcatel	**end of Sep. 2001**
Experiment Straylight Models from ESTEC/Alcatel	**end of Aug. 2001**
Integration of Telescope- and Experiment Models	**Sep./Oct. 2001**
Preliminary system straylight results	**end of Oct. 2001**

Update of these results:

- **as per more data on surface properties and actual geometry are available**
- **as per update of Telescope and Instrument Straylight Models from ESTEC / Alcatel**

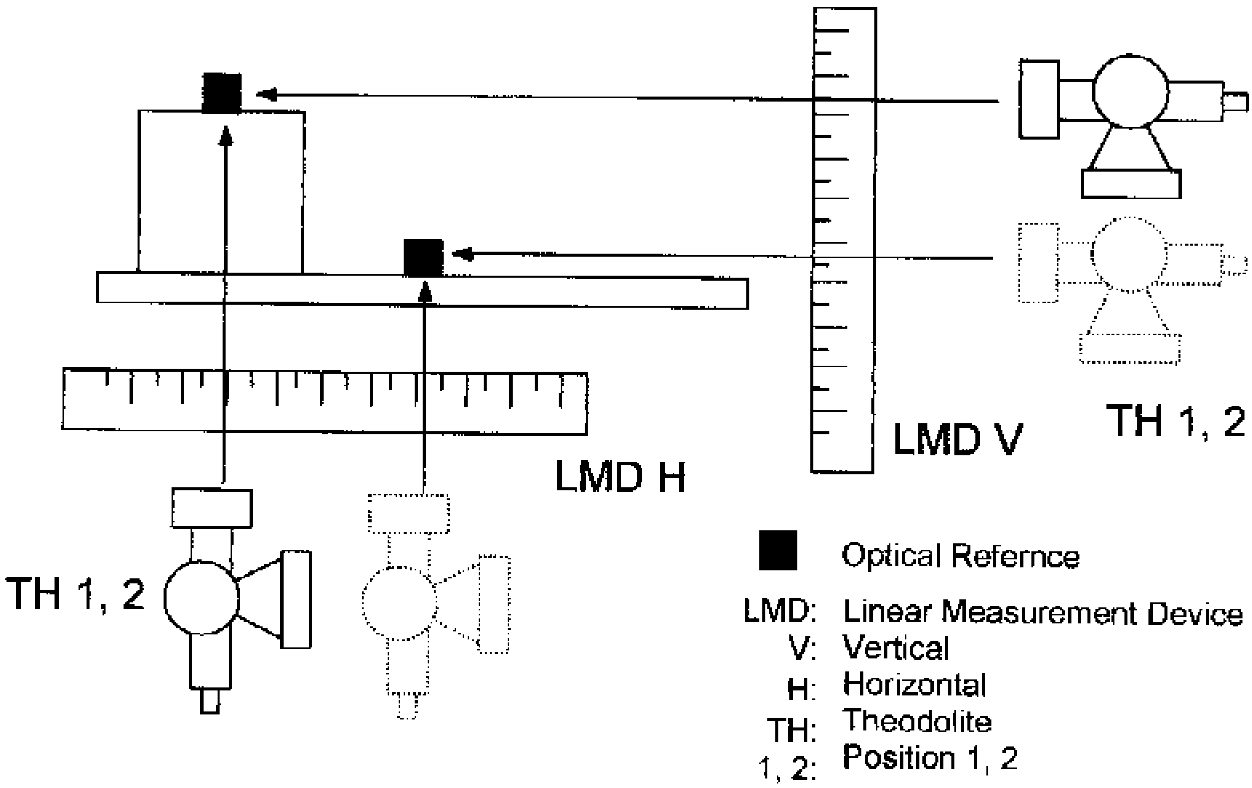
AS 3/8

Instrument & Telescope Interfaces

Open Issues

- **Instrument straylight models not yet available:**
  Need date: End Aug. 2001
- **Telescope straylight model not yet available:**
  Need date: End Sep. 2001

AS 418


LMD V
TH 1, 2
LMD H
TH 1, 2
Optical Refernce
LMD: Linear Measurement Device
V: Vertical
H: Horizontal
TH: Theodolite
1, 2: Position 1, 2

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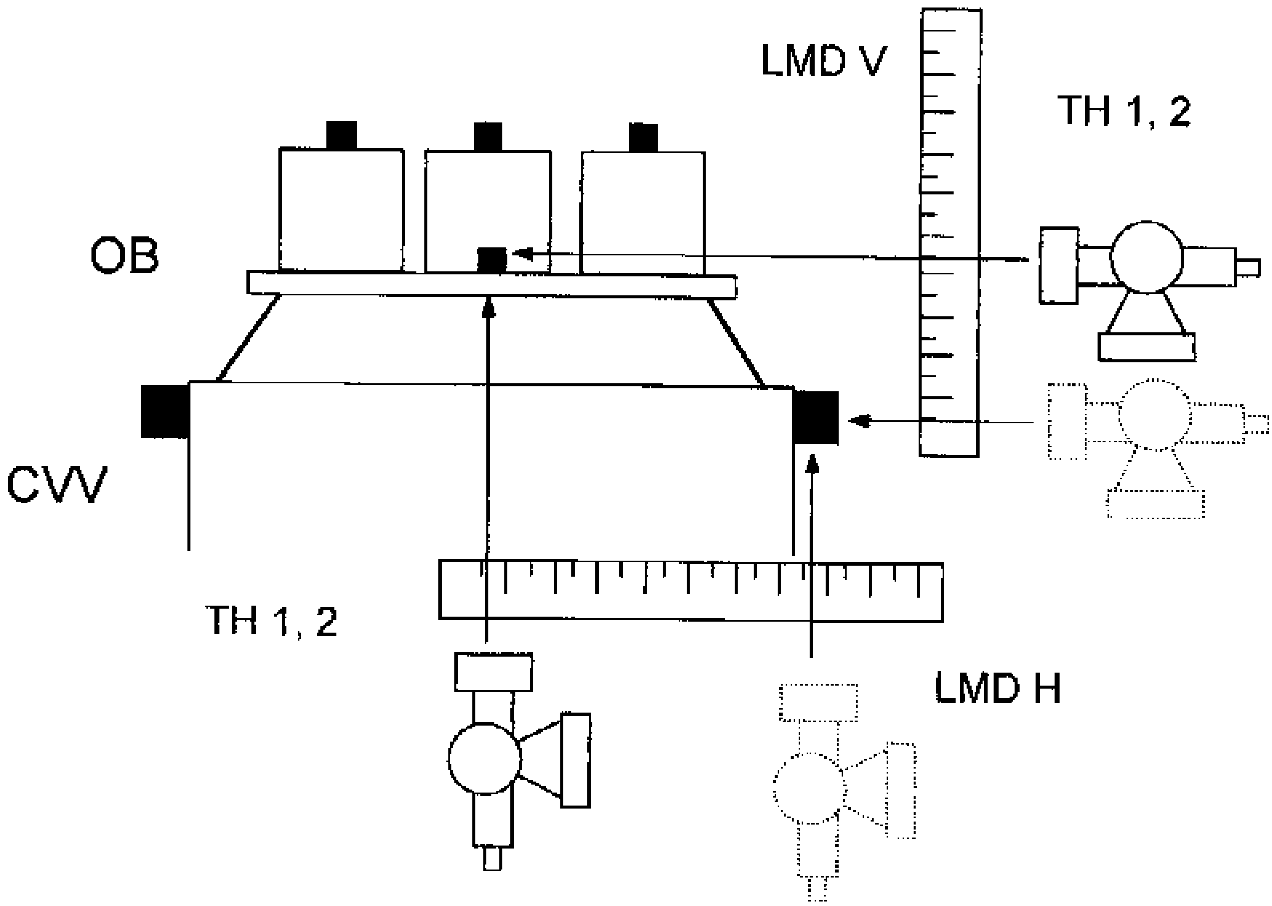
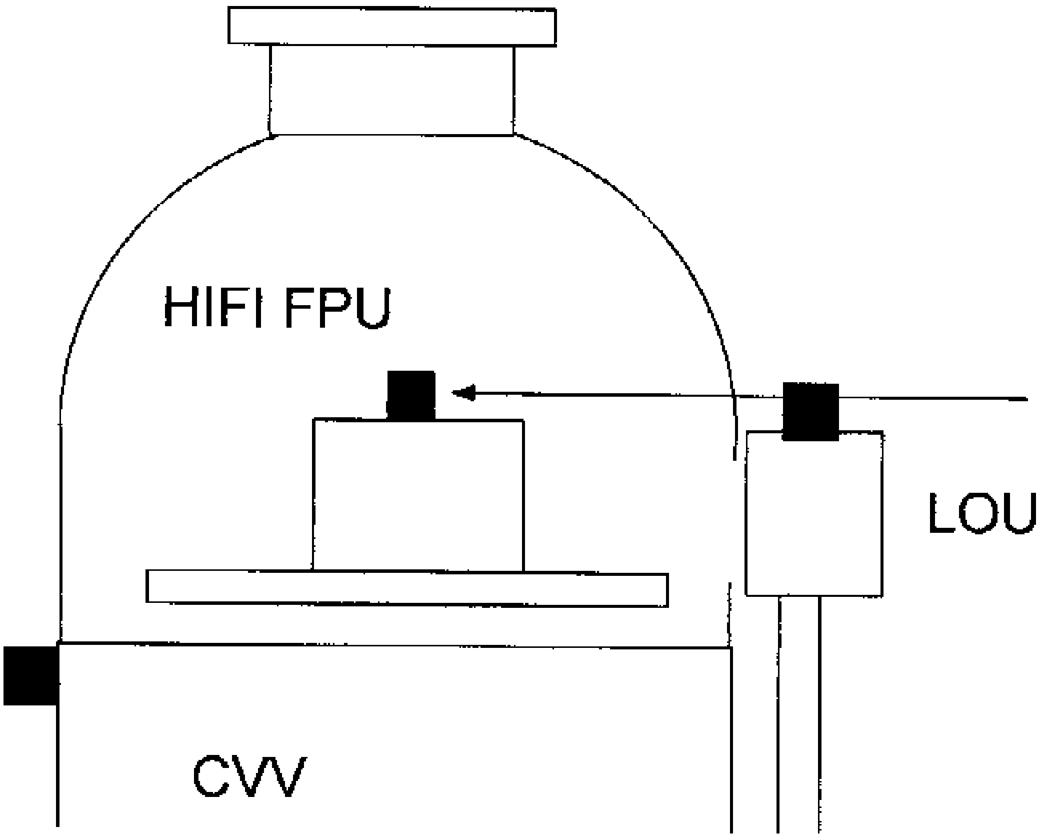
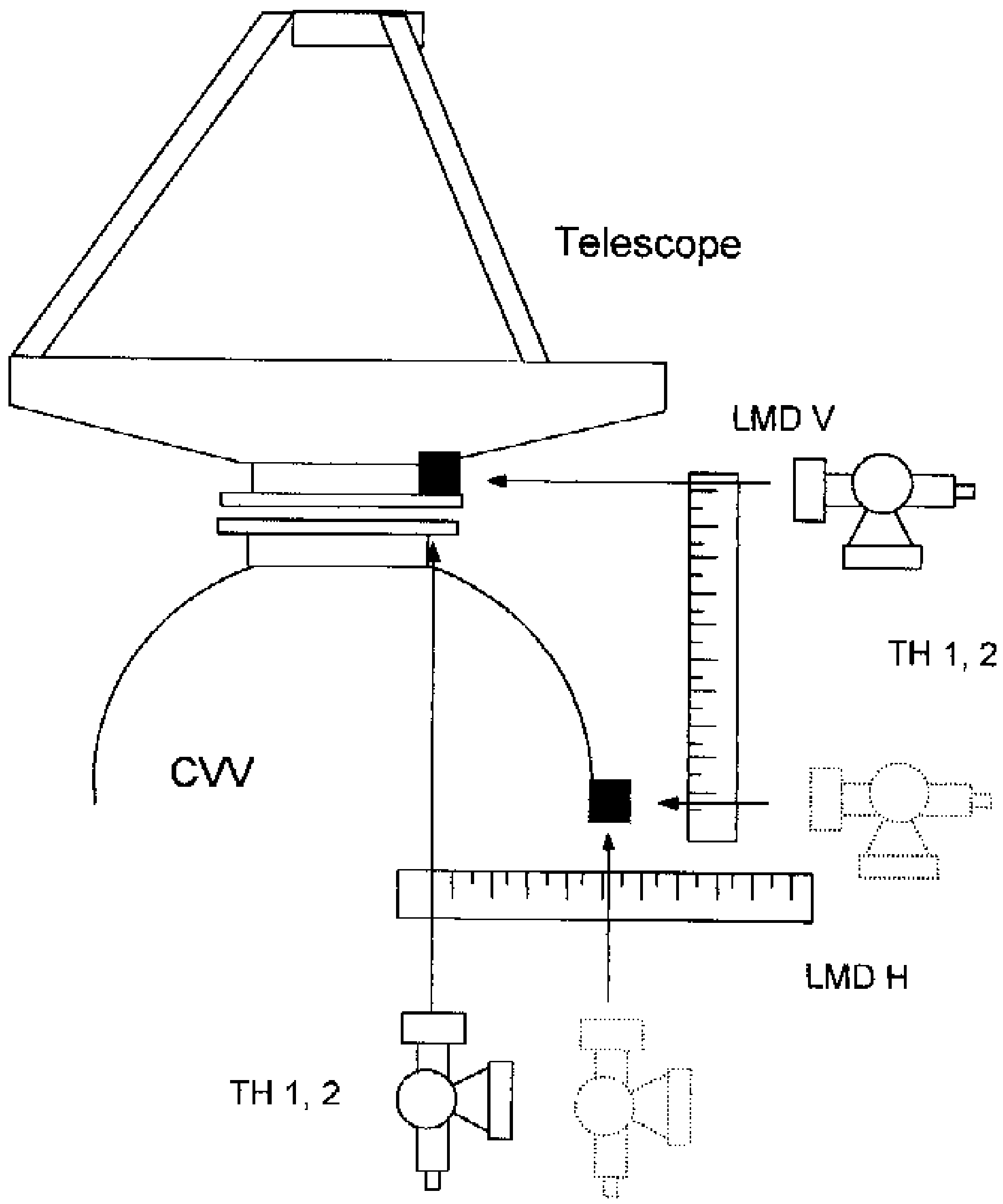


■ Optical Refernce

LMD: Linear Measurement Device
V: Vertical
H: Horizontal
TH: Theodolite
1, 2: Position 1, 2


HIFI FPU
LOU
CVV


Telescope
LMD V
TH 1, 2
CVV
LMD H
TH 1, 2

Instrument & Telescope Interfaces

EPLM Alignment Concept

The PLM Alignment will copmrise 3 main steps

STEP 1. Alignment of instruments wrt. Optical Bench

STEP 2. Alignment of Optical Bench wrt. Cryo-Vacuum Vessel

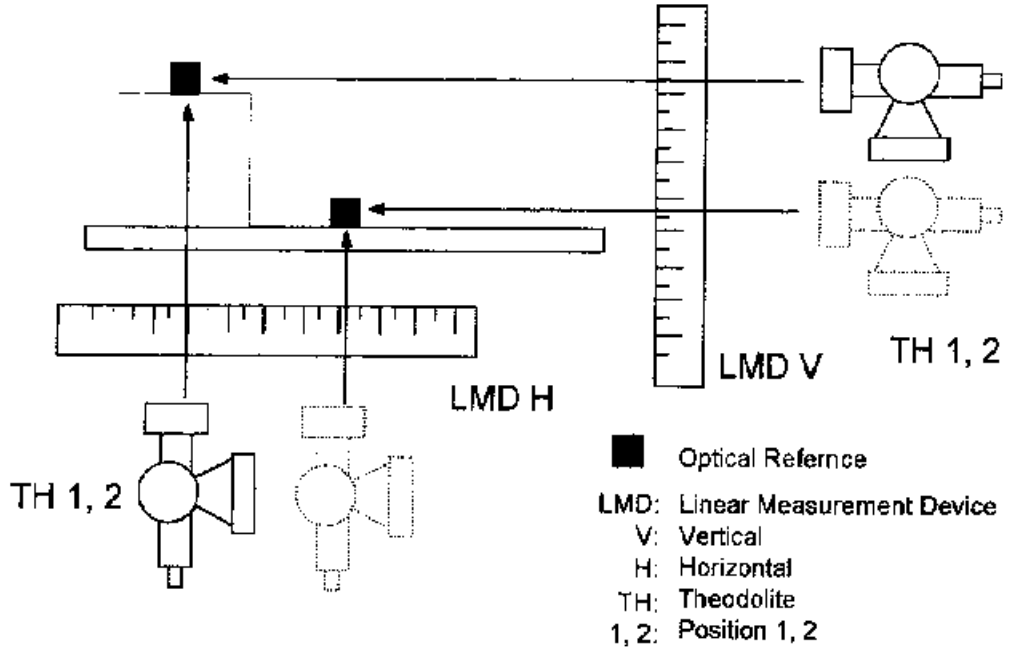
STEP 3. Alignment of Telescope wrt. Cryo-Vacuum Vessel

Annex 7 1/1

Instrument & Telescope Interfaces

1. Alignment of instruments wrt. Optical Bench

In STEP 1, the instruments will be aligned wrt. an optical reference on the OB via dedicated instrument reference(s). Environment: Ambient

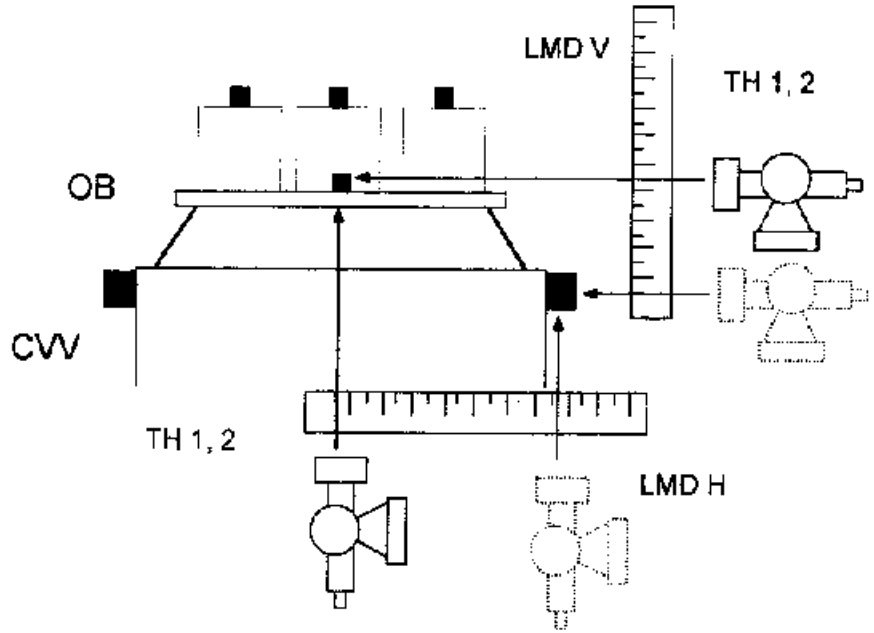


Annex 1 2/7

Instrument & Telescope Interfaces

2. Alignment of Optical Bench wrt. Cryo-Vacuum Vessel

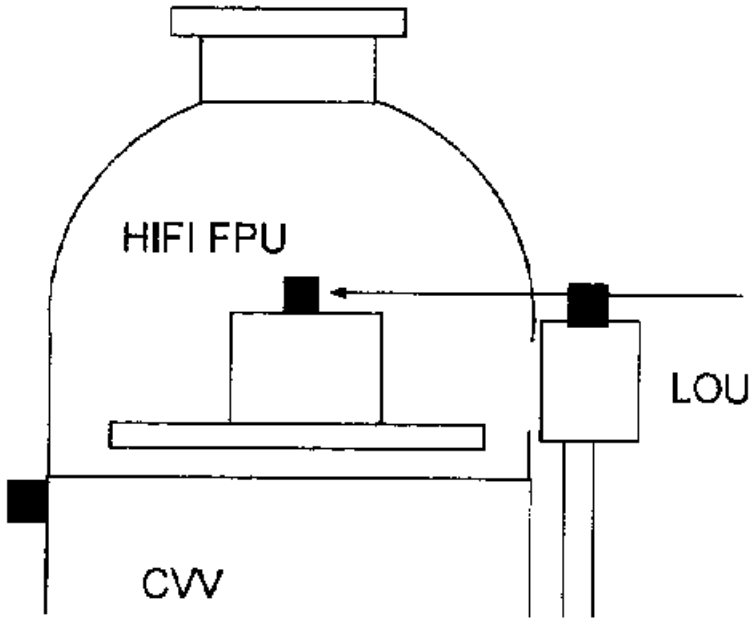
In STEP 2 the OB will be adjusted wrt. the CVV via OB reference and dedicated reference(s) on the CVV.). Environment: Ambient



Instrument & Telescope Interfaces

2a. Alignment LOU wrt. HIFI

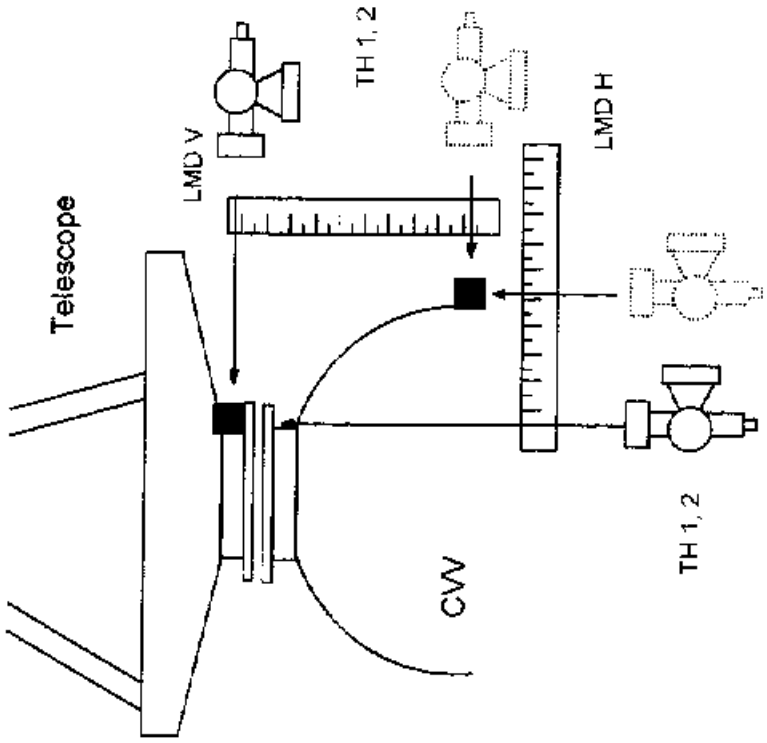
Step 2a is an intermediate step aligning HIFI on the OB with its LOU mounted on the outer CVV.). Environment: Ambient



Instrument & Telescope Interfaces

3. Alignment of Telescope wrt. Cryo-Vacuum Vessel

The Herschel Telescope will be aligned wrt. the CVV as one integral unit.



Instrument & Telescope Interfaces

Accuracy of Alignment Method Involving Linear Measurement Device LMD)

The LMD was used during the XMM Project.

Reproducibility of distance measurements over lengths of ~1.5 m:
≤ 0.3 mm

Therefore, distance measurements

between FPUs	**≤ 0.3 mm**
between OB and CVV	**≤ 0.5 mm**
between CVV and Telescope	**≤ 0.5 mm**

Instrument & Telescope Interfaces

Alignment Control

No real end-to-end alignment test seems possible during testing.

Therefore: It is assumed, that HIFI will represent the alignment behaviour of OB and FPUs.

- **Observing HIFI with dedicated HIFI Alignment Device (cameras) within test chamber will yield alignment stability of overall configuration.**
- **Switching on LOU and determining signal strength at HIFI FPU will verify correct alignment HIFI/LOU.**