Minutes of Meeting

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Herschel

Date:	10/04/02		
Doc.-No.:	HP-2-ASED-MN-0107		
Meeting place:	ASED, Friedrichshafen	Chairman:	Edgar Hölzle
Date/Time:	10/04/02 / 09h00	Secretary	Horst Faas
Agenda dated:	25/03/02 (fax: ASED-0190)	Close of Meeting:	Close of Meeting

Subject: Instrument Thermal Interface Meeting

Participants:	SRON: R. Huisman, R. Roelfsema MPE: R. Katterloher, J. Schubert, L. Morgenroth RAL: J. Delderfield (p/t) ESA: G. Crone, J. Bruston, M. Linder, C. Jewel, A. Heske ASPI: B. Collaudin, G. Lund, M. Cornut, M. Pastorino ASED: E. Hölzle, A. Hauser, D. Schink, S. Idler, M. Langfermann, G. Jahn, J. Hinger, R. Hohn, J. Kroeker, P. Schwabbauer, W. Rühe (p/t)	Additional Distribution:	Dr. Moritz, W. Rühe, R. Stritter

Page: 1 of 3 Page(s)

☐ Brief-Minutes (except following sheets) ☐ Summary of Results of Sheets 2 till

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Reference	Results	Remarks
	Agenda Item 1: Introduction	
Annex 1 (Page 2)	E. Hölzle opened the meeting and introduced the objectives and the agenda (see Annex 1).	
	Agenda Item 2: Current cryogenic s/s baseline and constraints	
Annex 1 (starting page 4)	M. Langfermann presented the HEPLM cryogenic subsystem and constraints (Annex 1). It was clarified that the instruments are connected to the He Control system via the E201 (Herschel Optical Bench). Contamination: ASED presented the vacuum environment (see Page 5 of cryogenic subsystem presentation). PACS clarified that they have issued a TN covering the maximum allowable contamination on the PACS mirrors. ASPI clarified that contamination requirements exist and that the current system is compliant. Ground Test Environment: ASED clarified that the option of actively cooling the cover is still an option. This option is yet not fully analysed by ASED. He tank temperature: The system is designed that the nozzles dominate the pressure drop.	
	Agenda Item 3: HPLM Thermal Design	
Annex 1 (starting page 11)	A. Hauser presented the Herschel PLM Thermal Design baseline. ASED clarified that the interface heat flow calculations (page 20ff) have been performed with flexible He mass flow rate. ASED clarified that in mode 5 the requirement for the HIFI level 1 temperature is only fulfilled with a He flow rate of minimum 2.1mg/s. ASED asked, if the HIFI Level 1 temperature could be relaxed in Mode 5 (page 24) from 6K to, for instance, 7K. This would give more flexibility in thermal design and/or might gain overall mission lifetime. The presentation of the SPIRE specific viewgraphs was postponed until the presence of the SPIRE representative.	
	Agenda Item 4: Potential Design Improvements ASED presented 12 options to reduce the L1 and L2 temperatures. ASED asked PACS and SPIRE concerning the	Action #1: ASED will provide the gain in temperature, if the FPUs are coated with low

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Reference	Results	Remarks
	thermo-optical characteristics of the FPU surfaces. Initially SPIRE had an emissivity of 0.1. This was recently changed to 0.26. ASED would recommend that the FPUs are coated with low emissivity material. A further option to be investigated could be that the FPU are covered with e.g a goldplated Kapton foil.	emissivity material. Action #2: HIFI, PACS and SPIRE: Look into the possibility to reduce the IR emissivity of the FPU outer surfaces (based on the result of AI#1). Options identified to be distributed between instruments
Annex 2	**Agenda Item 5: Instrument Thermal Design and Critical Areas** R. Roelfsema presented the HIFI thermal design and critical areas. The SIS mixers (connected to Level 0) need incidentally (low DC) to be at a temperature of 9 to 15K on ground to de-trap magnetic flux. This is currently not foreseen in space, but maybe foreseen as contingency. The material of the straps will be high purity Al (99.999%). Thermal contact conductance (Al/Al) measurements are currently performed and first results have been presented.. HIFI performed thermal calculations, but they are based on lower I/F temperatures for Level 1 and no radiation input to Level 2. The following attention point /critical areas were identified: • Contact resistance in mixer units • Thermal contact conductance • Substrap support design • Distinction between SIS and HEB mixers • Thermal contact between 1^{st} /2^{nd} stage ampl. and FPU structure	
	PACS asked if the LOU windows could impact the other instruments (e.g. thermal load and straylight) during the on-ground testing. ASED clarified that the LOU windows are included in the HPLM thermal model. ASPI checked if HIFI has already a timeline for a typical observation period (e.g. for a 24 or 48 observation period), to be the basis for the transient calculations.	Action 3: HIFI to provide a typical timeline for nominal HIFI operations over a observation period of 24 to 48 hours. Action 4: HIFI to check the sensitivity of the L2

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Reference	Results	Remarks
Annex 3	ASED asked if the Level 1 temperature HIFI to check the sensitivity of the L2 temperature for 6K and 7K (instead of 4.3K currently assumed). MPE (J. Schubert) presented in PACS thermal design and critical areas. The mechanical L0 load requirements were presented and the responsibility between ASED and PACS need to be clarified (check with ASED/D. Schink). ASPI clarified that it is not acceptable that the straps are directly mounted to the heat switch. ASPI and ESA have defined a standard L0 interface to which PACS have to comply to. The following critical areas were presented: see PACS viewgraphs ASPI and ASED stated that it is urgent to clarify the L0 thermal strap interface. It is recommended that PACS provides an additional support, as agreed with ESA on 13/02/02 at the ESTEC meeting. L. Morgenroth presented the PACS thermal model (Annex 4). The harness baseline is in line with the IID-B, Issue 2.0 and the proposed changes. ASED would recommend not to use Alodine inside the cryostat, due to potential contamination problems. ASED clarified that the parasitic radtiative heat load to the PACS FPU is in the order of about 5mW. This should be considered in the PACS model.	temperature for 6K and 7K (instead of 4.3K currently assumed).
Annex 4 (PACS thermal model presentation)	PACS performed a worst case analysis considering the IID-A temperature requirements, i.e. L0 temperature: 1.75K, L1: 5K and L2: 15K (see page 7 of the thermal model presentation). PACS concluded that those temperatures are ok for L0, but the housing temperature (L1) may be slightly too high (5.47 to 5.67K) instead of 5K. It needs to be clarified if those temperatures have an impact on the operations and the lifetime of the Sorption Cooler. This will be performed on instrument level using the reduced HPLM TMM.	

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Reference	Results	Remarks
Annex 1	PACS clarified that the ASED Thermal Report (issued in Dec. 2001) was only received 4 weeks ago by MPE. The temperatures for the 3 L1 straps are assumed to be the same for all three I/F. **Afternoon Session:** J. Hinger /ASED presented the thermal analysis results based on the updated SPIRE L0-interfaces given in ECR009-V2 (see Annex 1, Page 30-35). A. Hauser presented the conclusions (see Annex, page 35). All requirements of the SPIRE ECR#009, Version 2 are fulfilled, except the L1 temperature of 4.5K. ASPI stated that the new I/F temperature could not be provided without a reduction of the L1 dissipation. This was apparently agreed at the Change Request Close out meeting on 13/02/02 (see ECR#009). SPIRE / JD clarified that such a lower dissipation had resulted firm thermal analysis, not design change, and as such was not an agreement, but a reflection of present analysis done with unsecure boundaries. **Agenda Item 6: clarification of I/F temperature requirements** PACS confirmed that the instrument will work with the current IID-A requirements. HIFI is compliant with the IID-B temperature requirements. SPIRE will have new thermal analysis results available on 16 April. They should be discussed in the telecon between ASED and SPIRE. SPIRE will update the Change Request ECR#009, Version 2 after the delivery of the HPLM reduced TMM. This reduced model will be run with the detailed SPIRE instrument model.	
Annex 5	**Agenda Item 7: Selection of promising concepts** The 12 options to improve the thermal design were discussed once more. ASED presented the entrance baffle baseline design and the associated orbit and ground temperatures of	

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Reference	Results	Remarks
	the Instrument Shield, Heat Shield 1, 2 and 3, etc. . **Option 1:** not followed up at this stage. **Option 2:** less effective and lifetime loss rather large, **Option 3a and 3b**: 3a has the largest impact on temperature and has the advantage that lifetime is not affected. SPIRE stated that the structure is on the critical path and from a management point of view this option 3a will not be preferred. ASED will investigate the gains of Option 3b **Option 4**: see option 1 and 3 **Option 5, 6 and 7**: ASED provided the results in the presentation. **Option 8**: see AI#2 and 3 SPIRE stated that gold coating may be difficult at cryo-temperature. **Option 9** makes the I/F too complex and is therefore rejected. **Option 10**: not followed-up at this stage **Option 11**: Reduce harness coupling to OB will be investigated by ASED. **Option 12**: This covers two parts, i.e. the JFET Isolation and additional cooling of the JFET with L2 ventline (e.g. providing approx. 12K). ASED will check the gain in temperature for this option. Following the results a technical implementation may be investigated. RAL will check the feasibility on the instrument side. **Agenda Item 8: Preliminary definition of reference timeline** Covered in Agenda Item 10 and AI#7 and AI#8. **Agenda Item 9:** ASED presented the minimal temperature achievable on ground (see Annex 1, page 6). The high flow rate would provide a stable environment for approx. 5 hours. SPIRE stated that in the Case P (1000mg/s) the absorption cooler could operate. But it is not clear if SPIRE could handle the cryo-cover shield of 232K, even with closed shutter. SPIRE will need to investigate this using missing geometry information. The geometry drawing of the top part of the cryostat is attached as Annex 6 (provided by ASED). PACS stated that they could also live, in princple, with Case P (1000mg/s). The PACS instrument could perform a functional check, but the detector would be	Action #5: ASED to investigate the temperature gains of Option 3b. Action#6: ASED to evaluate the impact of Option 12 on L1 and L2 temperatures. Action#6a: SPIRE to make preliminary estimate of its shutter temperature, based on this geometry information.

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Reference	Results	Remarks
	saturated. With a cooled cryo-cover (80K) further test could possibly be performed. HIFI also require the geometry model to investigate, before the impact on HIFI from the heat loads from the cryocover is determined. Instrument teams should check that they are able to validate that the thermal sensors are covering the correct range under this operations conditions.	
Annex 6	**Agenda Item 10: H-EPLM TMM and Instrument TMMs** SPIRE may produce another version of the SPIRE reduced model for inclusion in the HPLM TMM. This will be discussed. SPIRE will update the available rough timeline. This will be provided as part reduced model delivery. PACS will provide a reduced instrument TMM, which shall be capable of representing the steady state dissipation modes and in a later addendum also the detailed timeline (representing 72 hours).	
	HIFI and ESA will work together to update the current HIFI reduced TMM which shall be capable of respresenting the steady state dissipation modes and the detailed timeline. Cut-off date- input to the HPLM TMM (Issue 2 for PDR): 30 April 2002. Possible HPLM Reduced TMM delivery date to Instrument Teams is mid June 2002.	Action#9: HIFI, PACS and SPIRE to check that they are able to validate that the thermal sensors are covering the correct range under this operations conditions
	The defintion of the reduced HPLM TMM is as Annex 1, Page 39-40 **Agenda Item AOB:** P. Schwabbauer presented the Cryogenic Test Adapter (CTA) for EQM status (Annex 7). ASED informed the Instrument Teams that ESA and ASPI informed ASED that no radiated susceptibility test shall be foreseen. The current baseline does not include a Standing Wave test. ASED stated that the CTA procurement is on the critical path for the EQM programme. ESA/ASPI will invite for a dedicated CTA meeting on	Action #7: PACS to provide updated Instrument TMM (due: 30 April) Action #7a: Delivery of the timeline (10 May) Action #8: HIFI/ESA to provide updated Instrument TMM (due: 30 April)

Reference	Results	Remarks
Annex 7	26/04/02.	

Meeting:
Title
Date:

Action Item List

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No.:	Description:	Due Date	Originator Comp./Pers.	Actionee Comp./Pers.	Source	Completion
#1	Action #1: ASED will provide the gain in temperature, if the FPUs are coated with low emissivity material.	19/04/02	ASPI	ASED/Hauser		
#2	Action #2: HIFI, PACS and SPIRE: Look into the possibility to reduce the IR emissivity of the FPU outer surfaces (based on the result of AI#1). Options identified to be distributed between instruments	26/04/02	ASED	HIFI PACS SPIRE		
#3	Action 3: HIFI to provide a typical timeline for nominal HIFI operations over a observation period of 24 to 48 hours.	30/04/02	ASED	HIFI		
#4	Action 4: HIFI to check the sensitivity of the L1 temperature for 6K and 7K (instead of 4.3K currently assumed).	19/04/02	ASED/Hauser	HIFI		
#5	Action #5: ASED to investigate the temperature gains of Option 3b.	25/04/02	ESA	ASED/Hauser		
#6	Action#6: ASED to evaluate the impact of Option 12 on L1 and L2 temperatures.	25/04/02	ESA	ASED/Hauser		
#6a	Action#6a: SPIRE to make preliminary estimate of its shutter temperature, based on this geometry information.	19/04/02	ASED	SPIRE		
#7	Action #7: PACS to provide updated Instrument TMM (due: 30 April)	30/04/02	ASED	PACS/Morgenroth		
#7a	Action #7a: Delivery of the timeline (10 May)	10/05/02	ASED	PACS		
#8	Action #8: HIFI/ESA to provide updated Instrument TMM (due: 30 April)	30/04/02	ASED	HIFI/ESA(Linder)		
	Action#9: HIFI, PACS and SPIRE to check that they are able to validate that the thermal sensors are covering the correct range under this operations conditions	30/04/02	ASED/G.Lund	HIFI PACS SPIRE		
#9	Action #1: ASED will provide an estimate of loss in lifetime, if the cooler recycling period is reduced from 48 h to 24 h.	25/04/02	ASPI	ASED/Hauser		

Annex 1

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Instrument Thermal I/F Meeting

10. April 2002

Introduction

Agenda

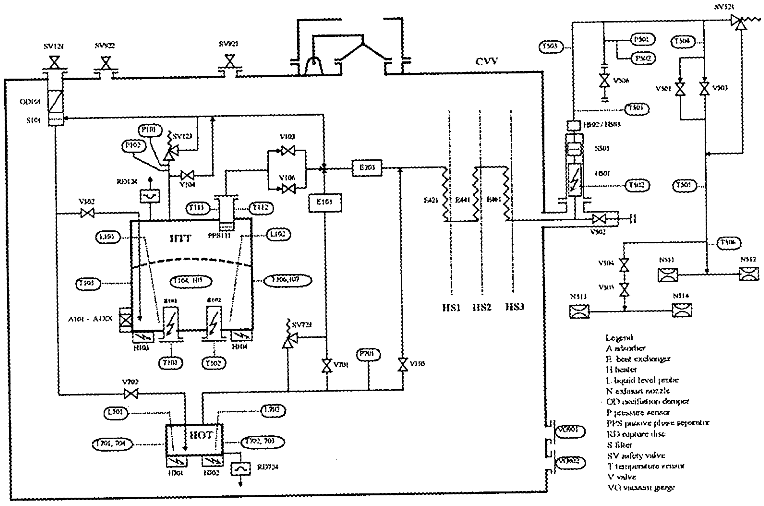
1.	Introduction	(ASPI/ASED)	09:00 – 09:15
2.	Cryogenic S/S baseline and constraints	M. Langfermann	09:15 – 09:40
3.	HPLM thermal design baseline and constraints	A. Hauser	09:40 – 10:10
4.	Potential design improvements	A. Hauser	10:10 – 10:35
	Coffee Break		10:35 – 10:50
5.	Instrument Thermal Design and Critical Areas (20 min. each)	PACS SPIRE HIFI	10:50 – 11:50
6.	Clarification of I/F Temperature Requirements and Goals	(all)	11:50 – 12:30
	Lunch Break		12:30 – 13:45
7.	Selection of promising concepts to be implemented in HPLM PDR design	(all)	13:45 – 14:20
8.	Reference Instrument Operating Timeline	M. Linder (ESTEC)	14:20 – 15:00
9.	Requirements for Instrument Functional Check (PFM) on Ground	(all)	15:00 – 15:30
	Coffee Break		15:30 – 15:45
10.	HPLM TMM and Instrument TMM's ⇒Planned (available) update of PACS, SPIRE; HIFI I/F TMM's ⇒H-EPLM TMM update planned for Herschel PDR ⇒H-PLM (reduced) TMM for Instrument transient analyses		15:45 – 17:00

Cryogenic Subsystem and Constraints

Agenda

- **Helium control system description**
- **Vacuum environment on ground**
- **Thermal environment on ground**
  - **Minimal temperatures**
  - **TB/TV test**
- **Thermal environment in orbit**
  - **Tank temperature**
  - **Temperature and mass flow variations**

Herschel helium control system



Vacuum environment

The Herschel cryostat vacuum vessel (CVV) is sealed with synthetic material (viton), which is not really gas tight.

The amount of air entering the cryostat due to permeation is ~0.008 grams per day.

Due to the cryostats geometry most of this air will condense at the focal plane and the LOU openings of HIFI because of cryo-pumping with an rough estimate of:
0.029 grams per m^2 and day

More than 200 days in cold conditions are planned before launch.

Details are given in the technical note: HP-2-ASED-TN-0034

Minimal temperatures on ground

Node	Level	Label	Temperature [K] Case G 21 mg/s	Case P 60mg/s	Case P 100mg/s	Case P 1000mg/s	P 100mg/s cover cooled	PI 100mg/s cover cooled
811	0	SPIRE SM Detector en	2.06	1.86	1.84	1.80	1.73	1.88
819	0	SPIRE Cooler pump HS	1.82	1.75	1.75	1.74	1.72	1.91
820	0	SPIRE Cooler evap HS	1.83	1.76	1.75	1.74	1.72	1.87
760	0	PACS-Red Detector	1.76	1.74	1.74	1.73	1.71	1.86
765	0	PACS-Blue Detector	1.91	1.86	1.84	1.82	1.74	1.90
781	0	PACS-Photometer CooPu	1.78	1.76	1.75	1.75	1.72	1.94
912	0	HIFI L0 boundary node	2.05	1.79	1.77	1.75	1.73	1.90
803	1	SPIRE Optical Bench	14.73	10.25	9.54	8.14	4.38	4.66
720	1	PACS-Spectrometer	7.69	6.76	6.48	6.07	4.27	4.36
725	1	PACS-Collimator	7.69	6.76	6.48	6.08	4.27	4.36
730	1	PACS-Photometer Optic	7.69	6.76	6.48	6.08	4.27	4.36
913	1	HIFI L1 boundary node	7.81	5.07	4.71	4.27	4.22	4.27
801	2	SPIRE PM JFET ENCL	22.04	7.35	6.63	5.71	5.00	5.27
802	2	SPIRE SM JFET ENCL	21.83	7.21	6.52	5.60	4.95	5.18
910	2	HIFI FPU Structure	21.69	7.53	6.84	5.96	5.14	5.41
10		HTT	1.70	1.70	1.70	1.70	1.70	1.85
376		Opt. Bench centre	21.61	7.40	6.72	5.84	5.06	5.30
311		Instr. Shield Top	23.94	9.48	8.82	8.12	5.61	5.81
4061		Cryostat Cover Shield	233.94	232.43	232.25	232.19	80.00	80.00

Cases Legend:
- G GHe mass flow from HTT, Instruments off
- P GHe mass flow from HOT, Instruments off
- PI GHe mass flow from HOT, Instruments in average dissipation mode

out of limits for known change requests
out of limits for applicable IID-A Iss. 1

➔ Flight representative I/F temperatures can only be reached by subcooling of shields and cooling of cover.

Thermal environment on ground

Due to the location of the level 0 I/F to the tank Helium II is not wetting (cooling) the adjacent tank surface in vertical position.

EQM testing will be done in horizontal position

PFM has to be tilted for each instrument separately

Thermal environment in orbit

Helium tank temperature

Tank temperature is given with the corresponding helium vapour pressure and is defining the Level 0 temperatures.
The in orbit vapour pressure will be adjusted with a pair of nozzles as a result of a prediction, based on the TMM and the extrapolated ground measurements of the whole vent line temperature and pressure drop behavior.
The Level 0 requirements from PACS IIDB are min 1.6 and max 1.75. Due to the uncertainties in the thermal straps connection this dictates a tank temperature of 1.625 - 1.725 K (8.3 - 12.4 mbar)
For comparison the requirement for ISO was 1.7 - 1.9 K (11.3 - 23.0 mbar) and 1.725 K was achieved.

Thermal environment in orbit

Temperature and mass flow variations

Variations in the heat flux to the tank, like cooler recycling, will be controlled by a passive phase separator (PPS)
A PPS has a hysteresis in mass flow against temperature, this is under investigation in a pre-development phase.

The on orbit behaviors of COBE and ISO show transients.

Mass flow and tank temperature will vary with time constants depending on instrument operation timelines and helium content.

Herschel cryostat is required to be a passive system

Cryogenic Subsystem and Constraints

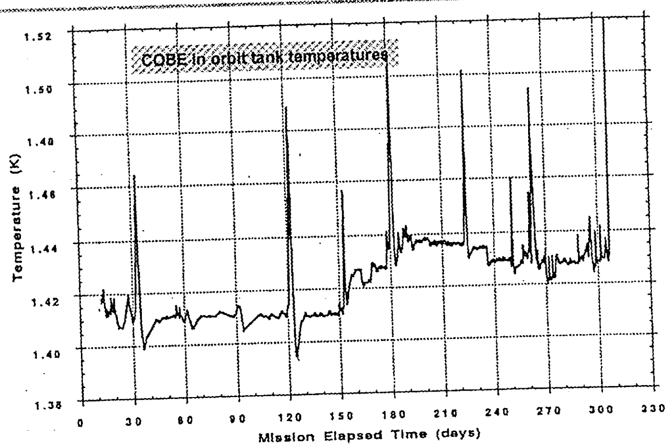


Figure 2: Dewar helium bath on-orbit operating temperature.

89 kg helium at launch, peaks from calibration with 1 - 10 kJ in 1 - 3 days

HPLM Thermal Design Baseline

Temperature Requirements for the HPLM

Temperature Requirements acc. to IIDA

- Level 0 : < 1.75 K for PACS, < 2 K for SPIRE, < 2 K for HIFI, max. dissipation: 10 mW
- Level 1 : < 5 K for PACS, < 6 K for SPIRE, < 6 K for HIFI max. dissipation: 25 mW
- Level 2 : < n.a. for PACS, <15 K for SPIRE, <20 K for HIFI max. dissipation: 50 mW

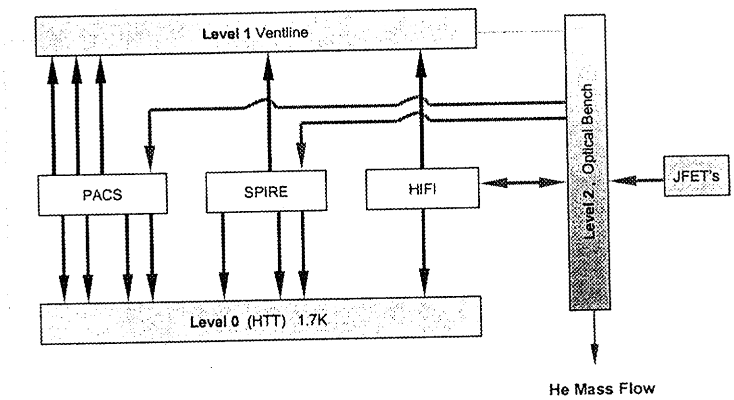
⇒ **Temperature requirements verified by thermal analysis using Instrument Interface TMM's provided by ESA, Ref.: SCI-PT/09948, dated 04.10.01**

Temperature Requirements acc. to SPIRE Change Request (HR-SP-RAL-ECR-009-V2):

• Level 0 strap, detector enclosure:	1.8K for 5 mW I/F heat flow
• Level 0 strap, cooler pump:	1.8K for 2 mW I/F heat flow
• Level 0 strap, cooler evaporator:	1.8K for 1 mW I/F heat flow
• Level 1 strap:	4.5K for 13 mW I/F heat flow
• HOB Level 2, FPU feet:	12 K for -10 mW I/F heat flow
• HOB Level 2, JFET rack feet:	12 K for 50 mW I/F heat flow

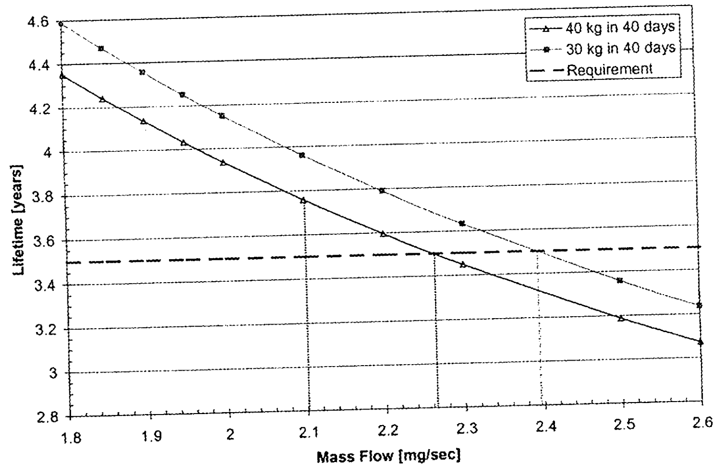
HPLM Thermal Design Baseline

Instrument - HPLM Thermal Interfaces



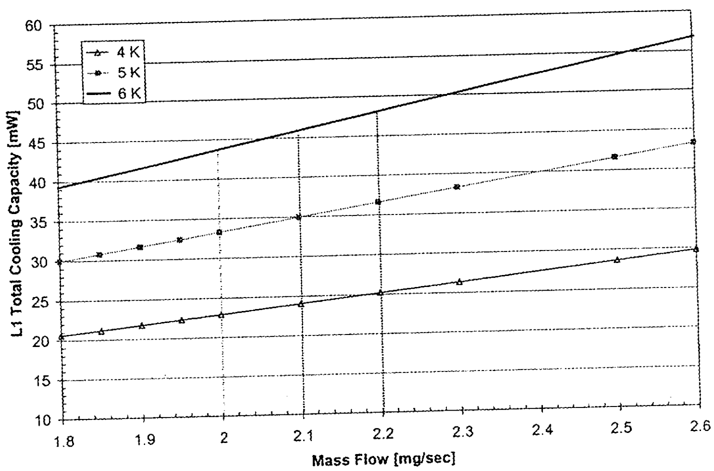
HPLM Thermal Design Baseline and Constraints

Lifetime versus He Mass Flow



HPLM Thermal Design Baseline and Constraints

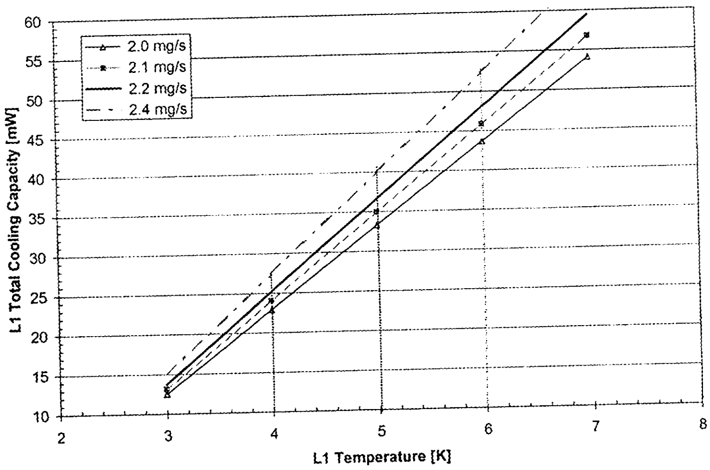
L1 Total Cooling Capacity versus He Mass Flow



HTT at 1.7 K

HPLM Thermal Design Baseline and Constraints

L1 Total Cooling Capacity versus L1 Temperature



HTT at 1.7 K

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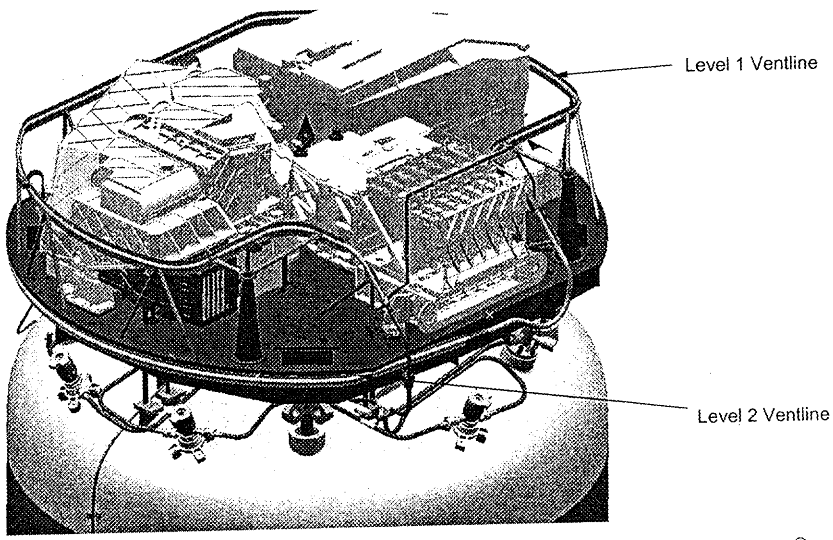
HPLM Thermal Design Baseline



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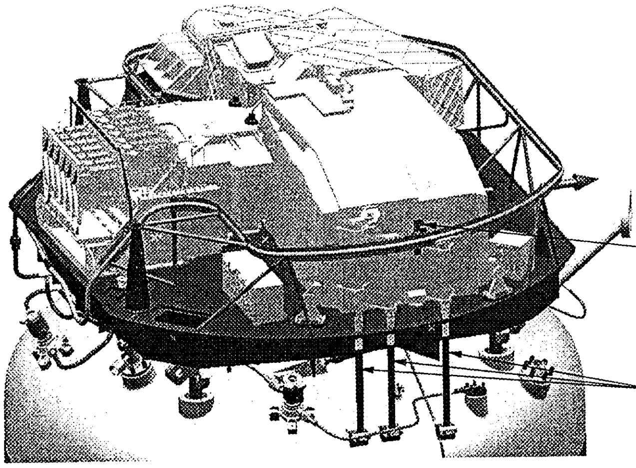
HPLM Thermal Design Baseline



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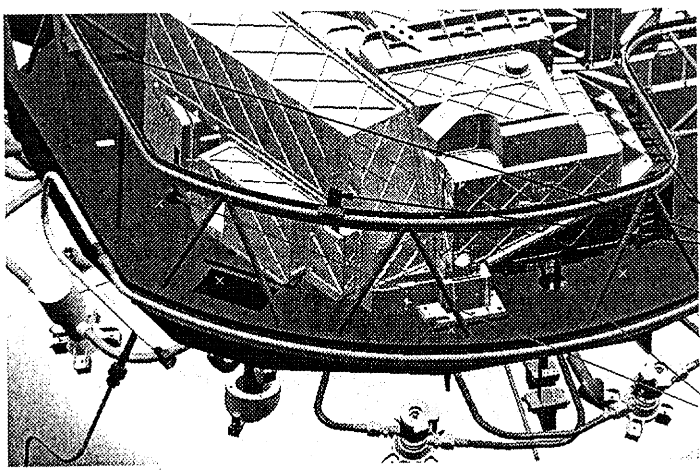
HPLM Thermal Design Baseline



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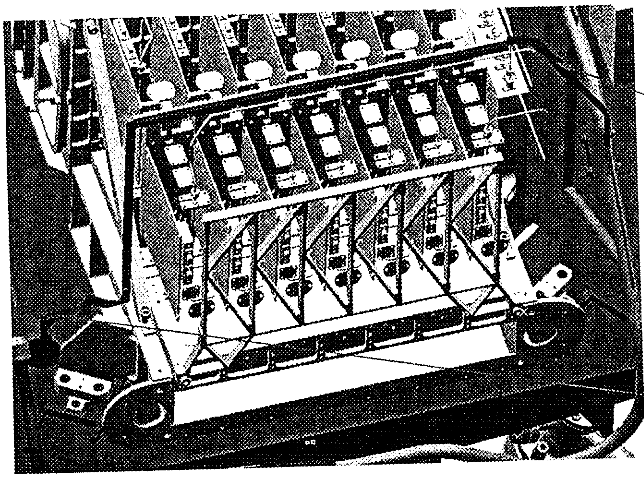
HPLM Thermal Design Baseline



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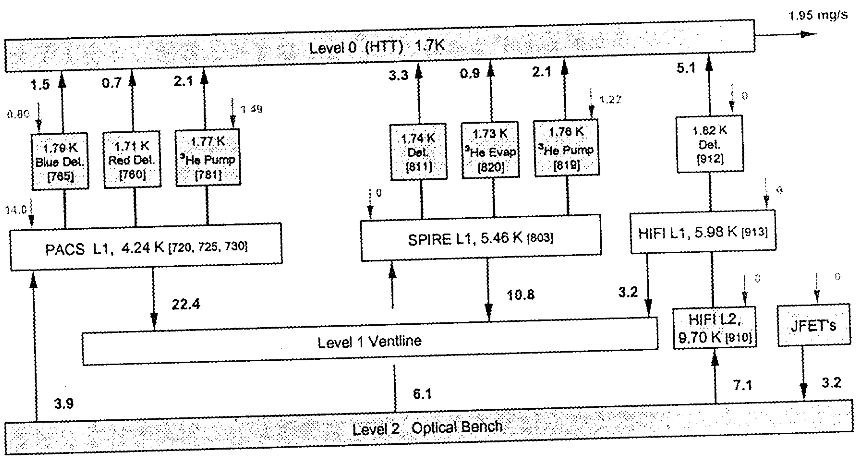
HPLM Thermal Design Baseline

Interface Heat Flows in [mW] for Mode 1: PACS Spectrometer



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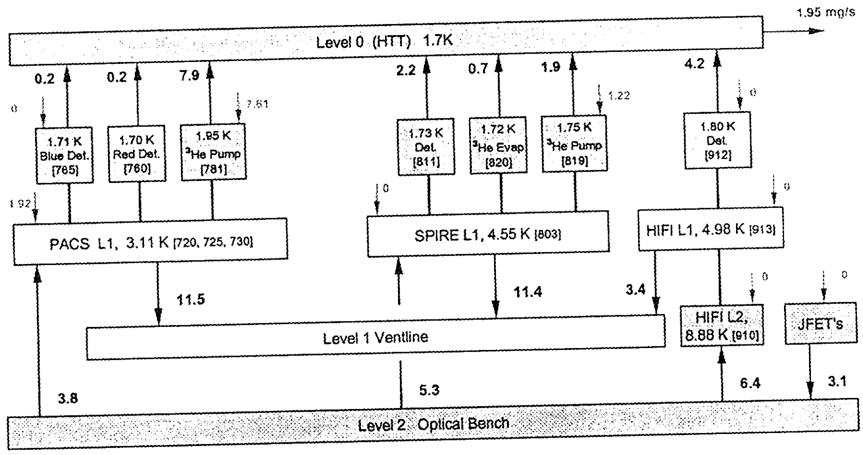
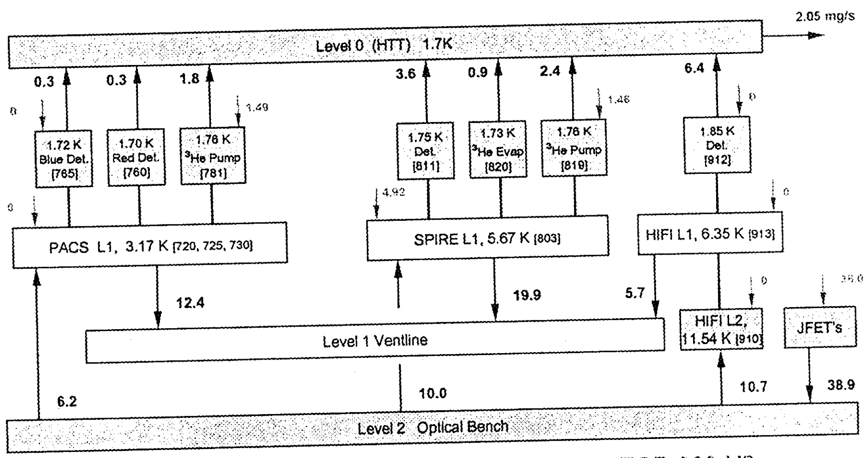
HPLM Thermal Design Baseline

Interface Heat Flows in [mW] for Mode 2: PACS Photometer



HPLM Thermal Design Baseline

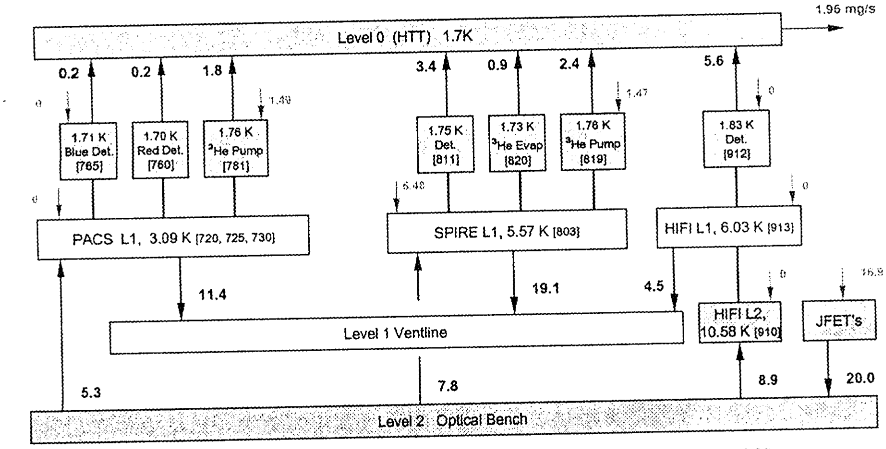
Interface Heat Flows in [mW] for Mode 3: SPIRE Photometer



⇒ SPIRE L1 temperature not compatible with ECR-009-V2

HPLM Thermal Design Baseline

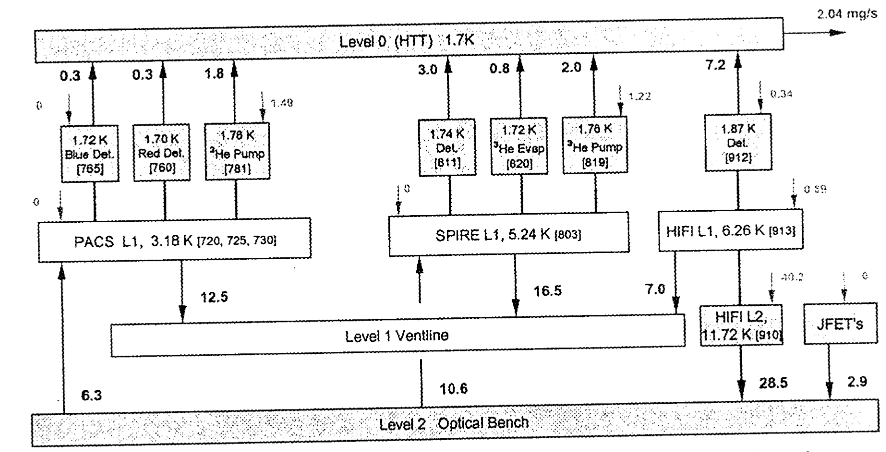
Interface Heat Flows in [mW] for Mode 4: SPIRE Spectrometer



⇒ SPIRE L1 temperature not compatible with ECR-009-V2

HPLM Thermal Design Baseline

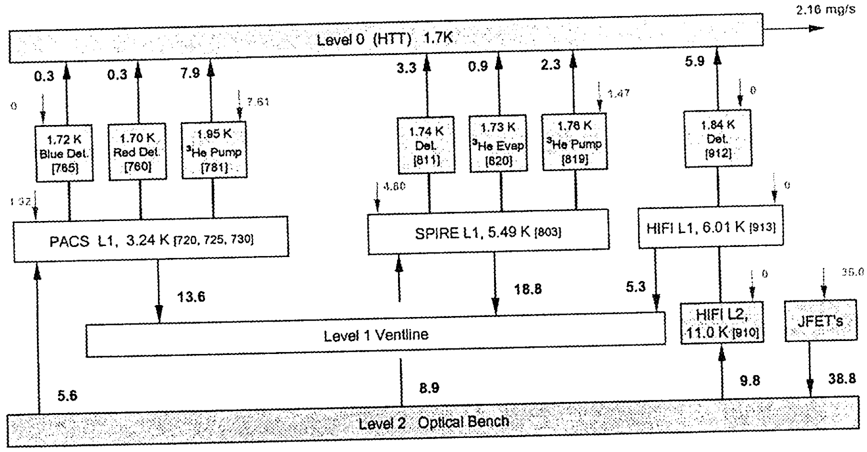
Interface Heat Flows in [mW] for Mode 5: HIFI



⇒ HIFI L1 temperature not compatible with IID-A for 2.04 mg/s

HPLM Thermal Design Baseline

Interface Heat Flows in [mW] for Mode 6: PACS + SPIRE Photometer



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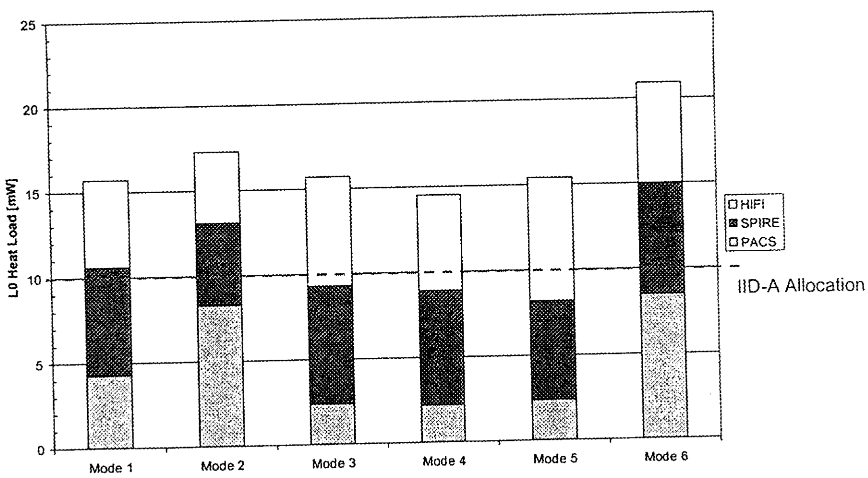
HPLM Thermal Design Baseline

Summary of Instrument Interface Heat Flows to Level 0



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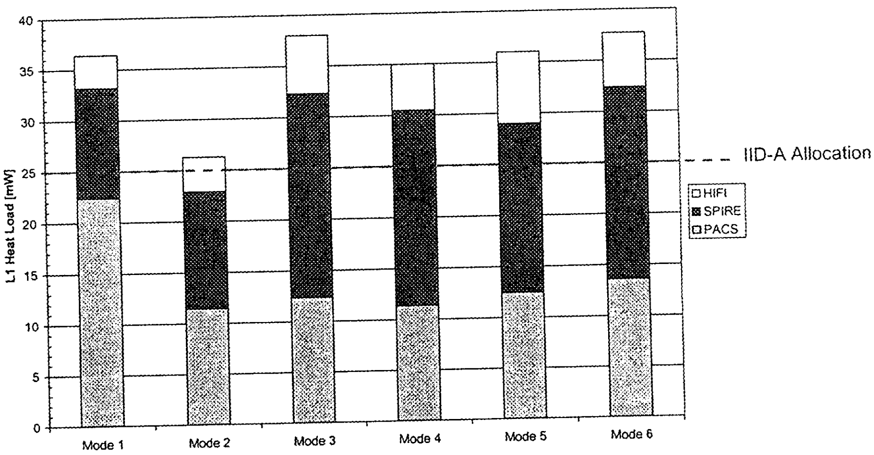
HPLM Thermal Design Baseline

Summary of Instrument Interface Heat Flows to Level 1



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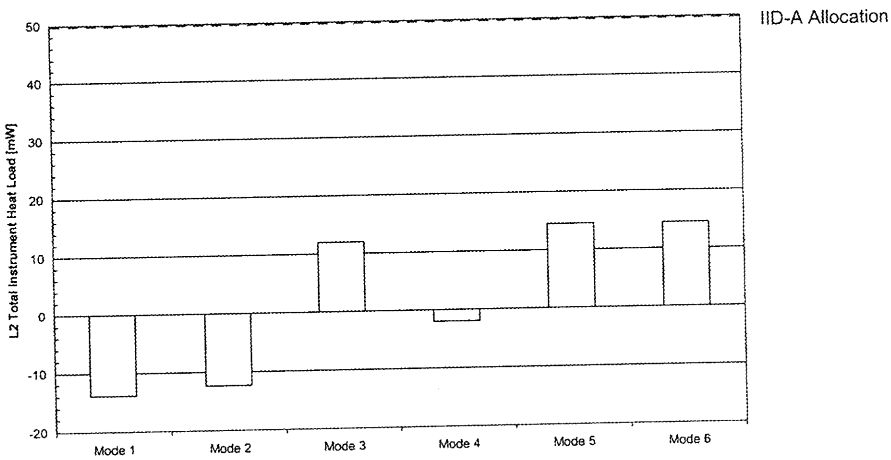
HPLM Thermal Design Baseline

Summary of Instrument Interface Heat Flows to Level 2



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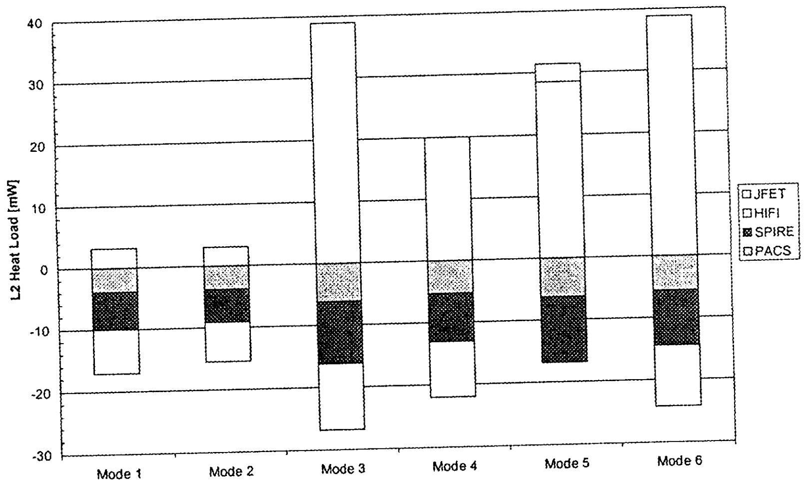
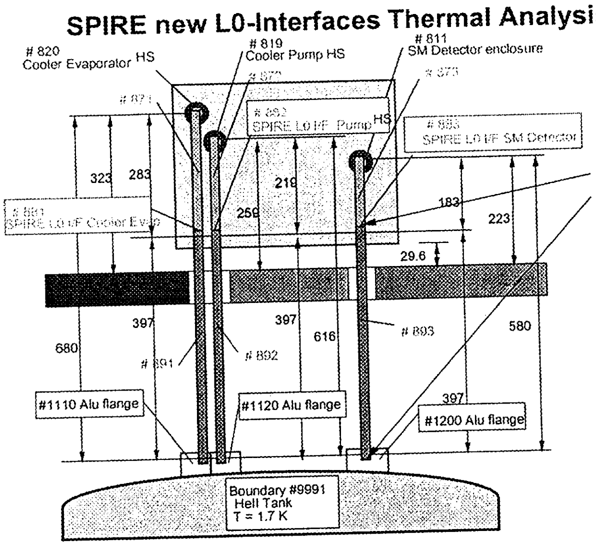
HPLM Thermal Design Baseline

Summary of Instrument Interface Heat Flows to Level 2



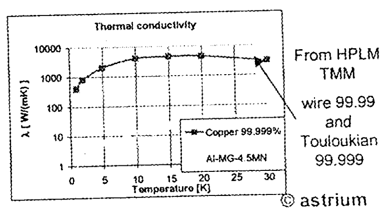
HPLM Thermal Design Baseline and Constraints

SPIRE new L0-Interfaces Thermal Analysis with detailed TMM



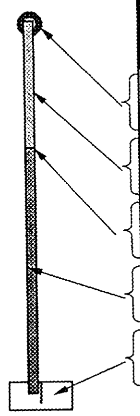
Assumptions

- Strap width 20 mm for all three straps
- Contact film coefficient 2000 W/(m²K) from ISO-heritage
- Contact area at instrument I/F: 4 cm²
- Contact area at tank bracket I/F: 3 cm²
- Strap supports (made of VESPEL etc.) not yet considered in the TMM. Thermal conductance across strap supports neglected.
- Radiation from environment not considered (goldized straps)



HPLM Thermal Design Baseline and Constraints

Instrument I/F



NODE	LABEL	QI (W)	T (K)	T (K)	T (K)
	Cooler pump strap thickness		*2 mm*	*2 mm*	*2 mm*
	cooler evaporator strap thickness		*2 mm*	*2 mm*	*2 mm*
	Detector strap thickness		*2 mm*	*3 mm*	*5 mm*
811	SPIRE SM Detector en	0.005	1.86	1.83	1.80
819	SPIRE Cooler pump HS	0.002	1.78	1.78	1.78
820	SPIRE Cooler evap HS	0.001	1.75	1.75	1.75
871	Evaporator Strap up	0	1.74	1.74	1.74
872	Cooler pump Strap up	0	1.77	1.77	1.77
873	SM Det. Strap up	0	1.84	1.81	1.79
881	**SPIRE L0 I/F cooler evap**	0	**1.73**	**1.73**	**1.73**
882	**SPIRE L0 I/F pump**	0	**1.76**	**1.76**	**1.76**
883	**SPIRE L0 I/F SM Detec**	0	1.82	**1.79**	**1.77**
891	Evaporator Strap low	0	1.73	1.73	1.73
892	Cooler pump Strap low	0	1.74	1.74	1.74
893	SM Det. Strap low	0	1.78	1.77	1.76
1110	Alu flange 1	0	1.72	1.72	1.72
1120	Alu flange 1	0	1.72	1.72	1.72
1200	Alu flange 2	0	1.74	1.74	1.74
9991	Tank vessel	0	1.70	1.70	1.70

Tank I/F

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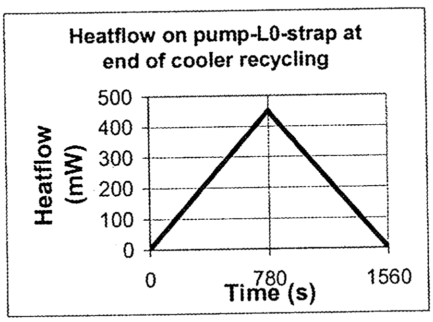
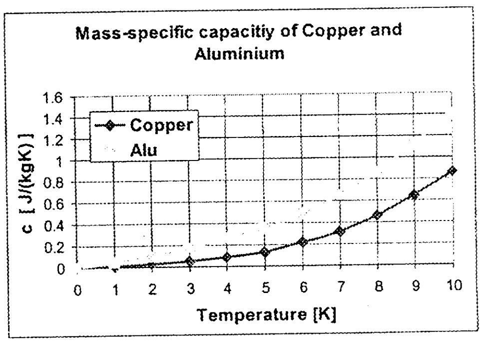
HPLM Thermal Design Baseline and Constraints

SPIRE transient Thermal Analysis after Cooler Recycling

Cooler pump strap thickness	***2 mm***
cooler evaporator strap thickness	***2 mm***
Detector strap thickness	***5 mm***





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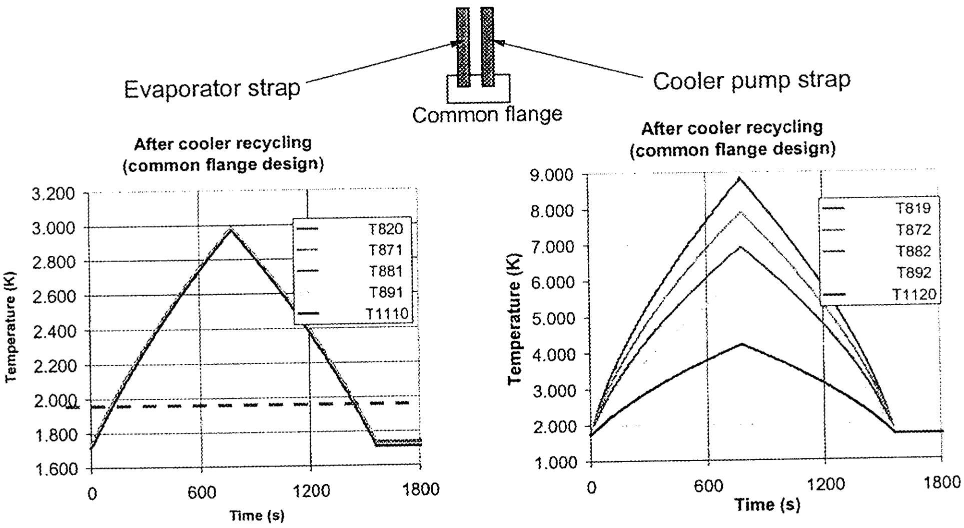
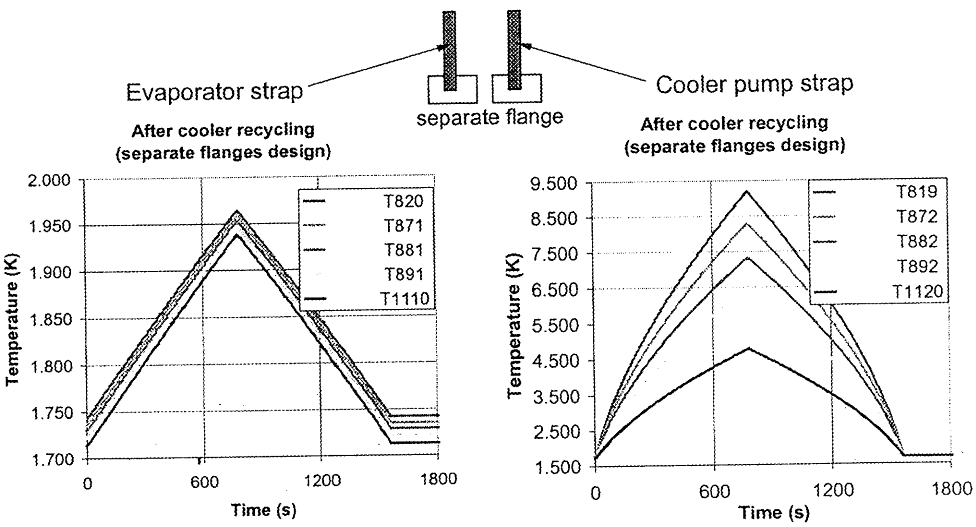
HPLM Thermal Design Baseline and Constraints



HPLM Thermal Design Baseline and Constraints



HPLM Thermal Design Baseline and Constraints

Conclusions:

- Temperature Requirements acc. to IID-A can be met with a He mass flow of minimum 2.1 mg/s
- L0 Temperature Requirements of ECR009-V2 are feasible from thermal point of view (Mechanical compatibility to be investigated).
- L0 Temperature Requirements during sorption cooler recycling can be fulfilled
- L1 Temperature Requirement of ECR009-V2 is **not feasible** with current design

Potential Design Improvements

Potential Improvements to reduce SPIRE L1 Temperature

Baseline for 2.1 mg/s: 5.4 K and 19.2 mW I/F heat flow in Mode 3, 4.1 K for PACS (Mode 1),
6.0 K for HIFI (Mode 5)

(Option 1: Shift SPIRE prior to PACS on Level 1 vent line
→ **4.64 K** and **20.3 mW** I/F heat flow in Mode 3
→ in Mode 1: PACS L1 I/F go up to 4.93 K, SPIRE heat input to L1 is 12.7mW)

Option 2: Increase He mass flow to 2.2 mg/s.
→ **5.14 K** and **17.9 mW** I/F heat flow
→ loss of 60 days lifetime

Option 3a: Improve SPIRE thermal decoupling from HOB similar to the PACS one, i.e. 20 mm CFRP T300 cross-section to length ratio.
→ **4.97 K** and **15.5 mW** I/F heat flow
→ Level 2 heat flow to SPIRE FPU is reduced from 8.2 mW to 4.4 mW

Option 3b: Improve SPIRE thermal decoupling from HOB similar to the PACS one by inserting thermal washers

Potential Design Improvements

Potential Improvements to reduce L1 and L2 Temperature

Option 4: Option 1 AND Option 3
→ **4.23 K** and **17.2 mW** I/F heat flow in Mode 3.
→ Mode 1: PACS L1 I/F go up to 4.83 K, SPIRE heat input to L1 is 11.3 mW

Option 5: Low emissive lower HOB surface (e.g. goldized Kapton Foil with eps = 0.03)
→ **- 0.3 K at L2, - 0.04 K at PACS L1, - 0.1 K SPIRE L1, but - 6 days lifetime**

Option 6: HOB Thermal decoupling with CFRP blades instead titanium blades (factor 11)
→ **- 0.2 K at L2, - 0.02 K at PACS L1, - 0.05 K SPIRE L1, but - 6 days lifetime**

Option 7: Low emissive Instrument Shield: eps =0.03 instead 0.05
→ **no improvement**

Option 8: Low emissive PACS, SPIRE FPU surfaces:

Option 9: Use L1 thermal I/F also as mechanical I/F

Option 10: Use HeII filled tube for SPIRE L0 I/F

Option 11: Reduce harness coupling to OB

Option 12: J-FETs insulated from HOB and coupled to L2-ventline
==> HOB temp. will be decreased

Potential Design Improvements

Conclusions:

- Increase of He mass flow is less effective, see option 2
- at least Option 3 should become baseline to reduce L1 temperature

H-EPLM TMM and Instrument TMM's

H-PLM (reduced) TMM for Instrument transient analyses

- Reduced HPLM TMM with ~100 nodes (ESATAN)
- Reduced HPLM Geometry model, cover closed/open (ESARAD)
- CVV at boundary: 70 K ± 3 K
- Constant He mass flow: 2.1 mg/s ± 0.1 mg/s
- HTT at boundary: 1.65 K ± 0.05K

H-EPLM TMM and Instrument TMM's

Reduced Instrument TMM's for H-PLM analysis

- Reduced Instrument Interface TMM's (ESATAN) with tbd nodes with following node number ranges:

#700 to 799	PACS
#800 to 899	SPIRE, incl. JFET's
#900 to 999	HIFI

- Models including different operating modes
- Reduced Instrument Geometry models (ESARAD), considering also different Orbit/Ground conditions (e. g. shutter open/closed)
- Models organized such to be used as sub-models on H-PLM level

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ISIRON

HIFI

HIFI-FPU Thermal Design

Ronald Roelfsema

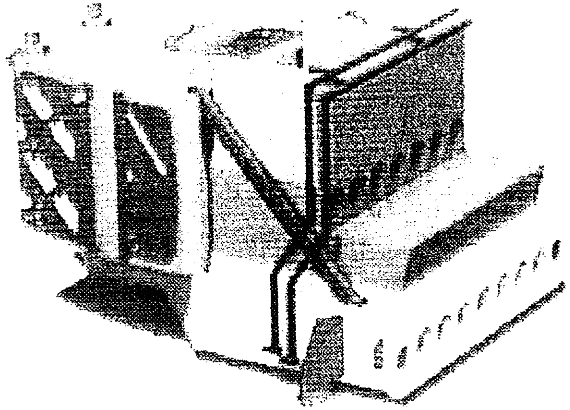
Robert Huisman

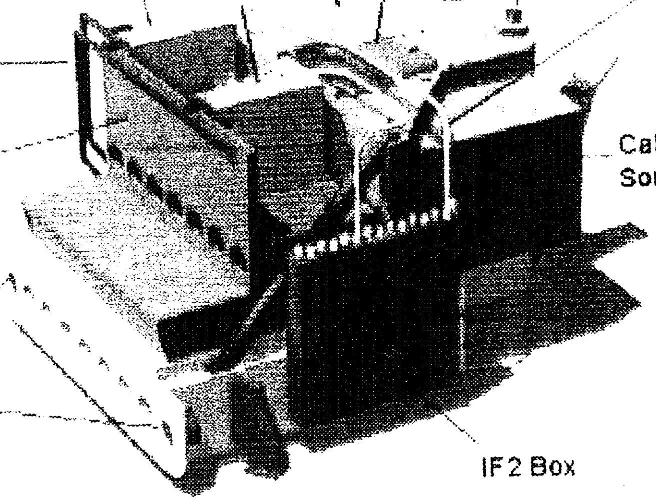
Klaas Wildeman

Annex 2

FPU

DM - FPU final configuration





ISIRON

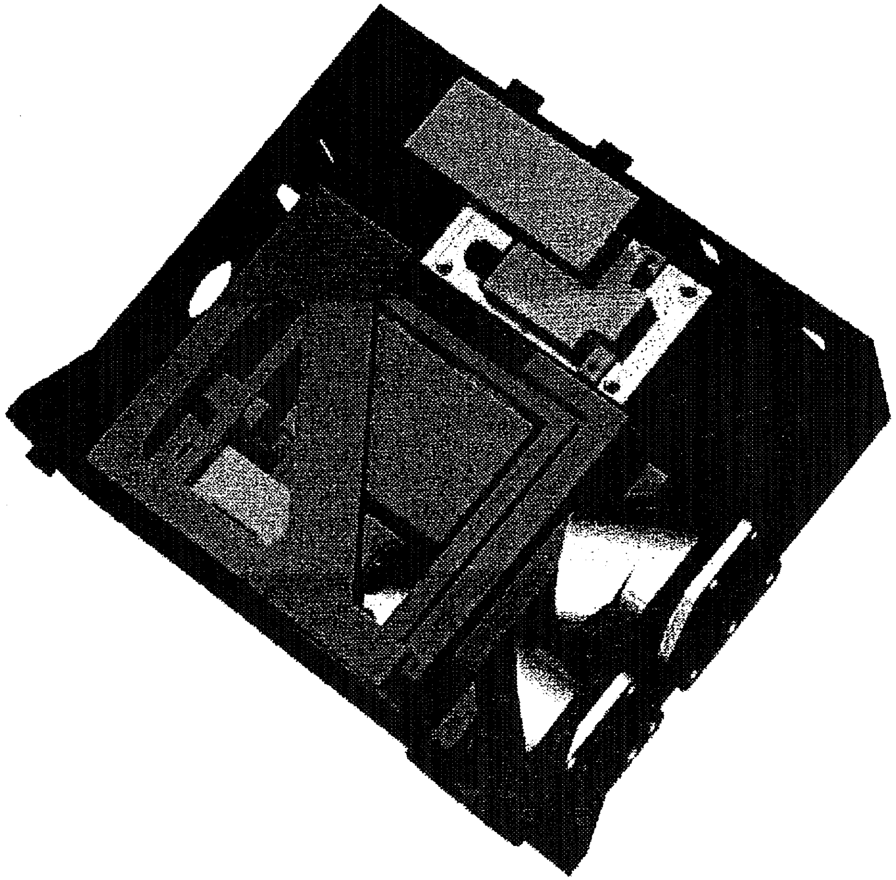
Mixer Bands

HIFI

Band	1	2	3	4	5	6L	6H
Mixers	SIS[1]	SIS[1]	SIS[1]	SIS[1]	SIS[1]	HEB[2]	HEB[2]
Coupling	beam-splitter unit[3]	beam-splitter unit[3]	diplexer unit[4]	diplexer unit[4]	diplexer unit[4]	diplexer unit[4]	diplexer unit[4]

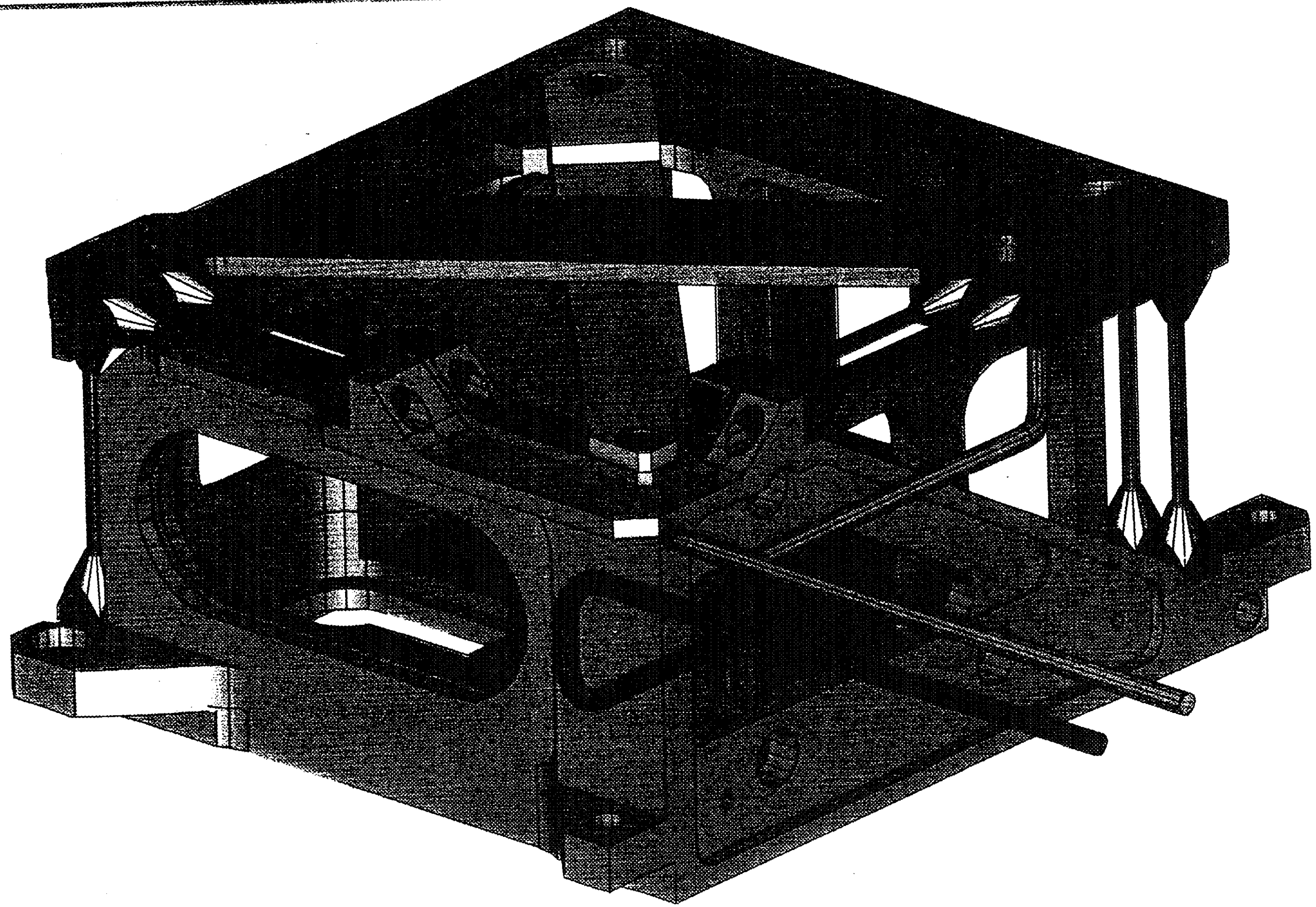
1) DC-wiring for mixer bias, heater, magnet and temperature sensor
2) DC-wiring for mixer bias and temperature sensor
3) Contains no mechanisms
4) Contains mechanisms

ISIRON **MSA** **HIFI**



Instrument Thermal Interface Meeting Astrium, Friedrichshafen, 10 April 2002

Mixer Console



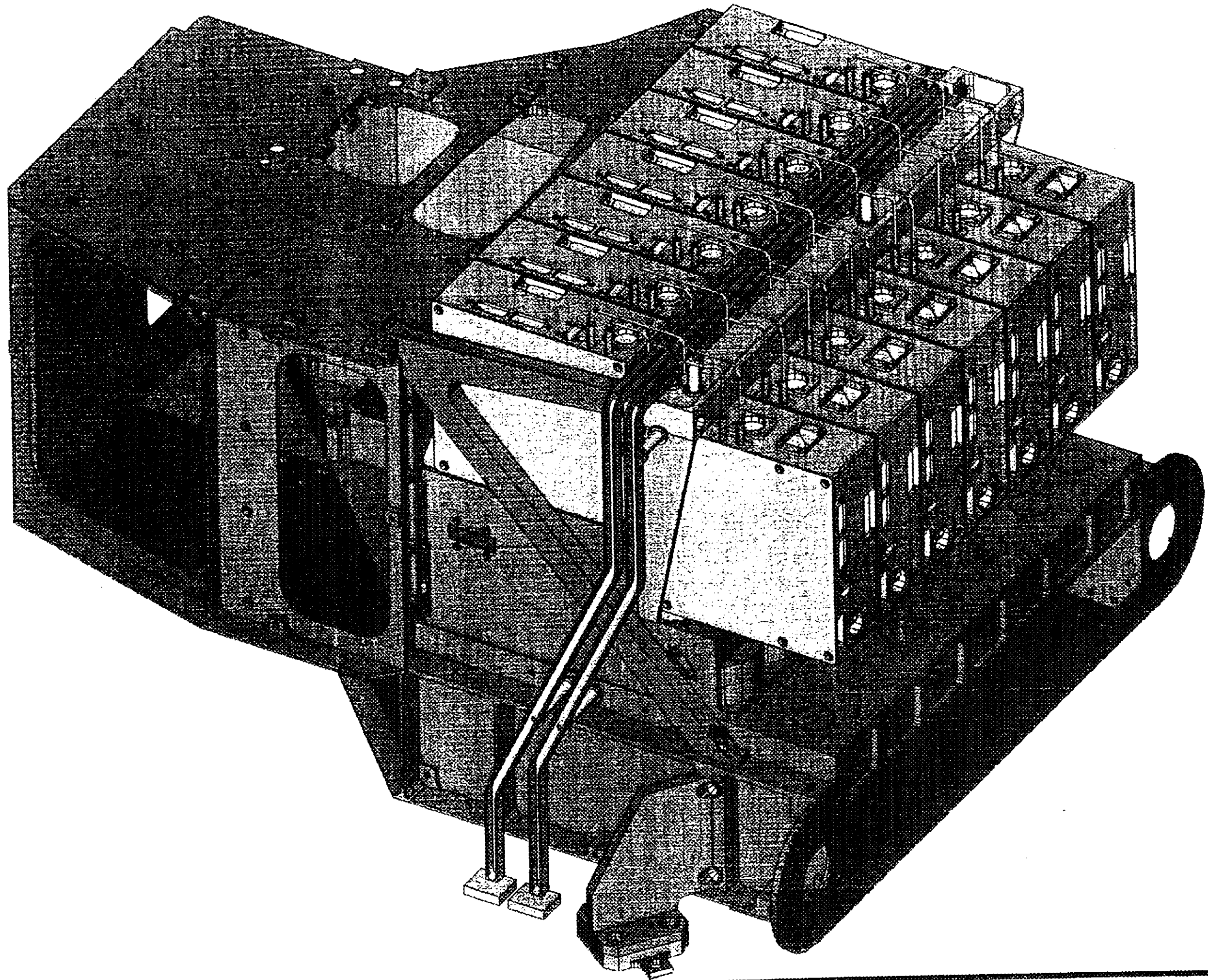
FPU

- FPU contains 7 bands, 2 mixer units each
- The 2 mixer units operate simultaneously
- Only one band is active

SIRON

FPU Thermal Strapping

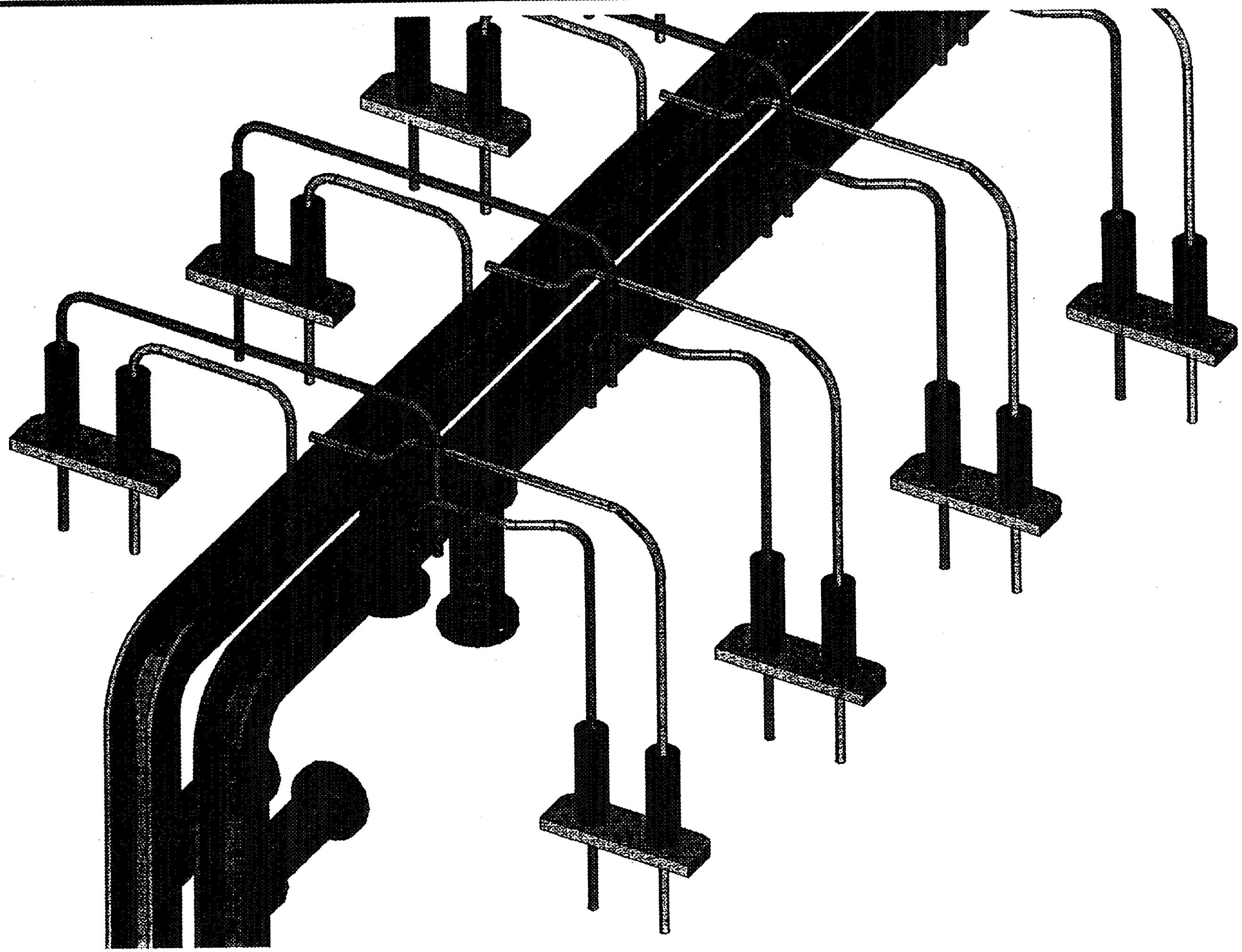
HIFI



ISIRON

Strapping

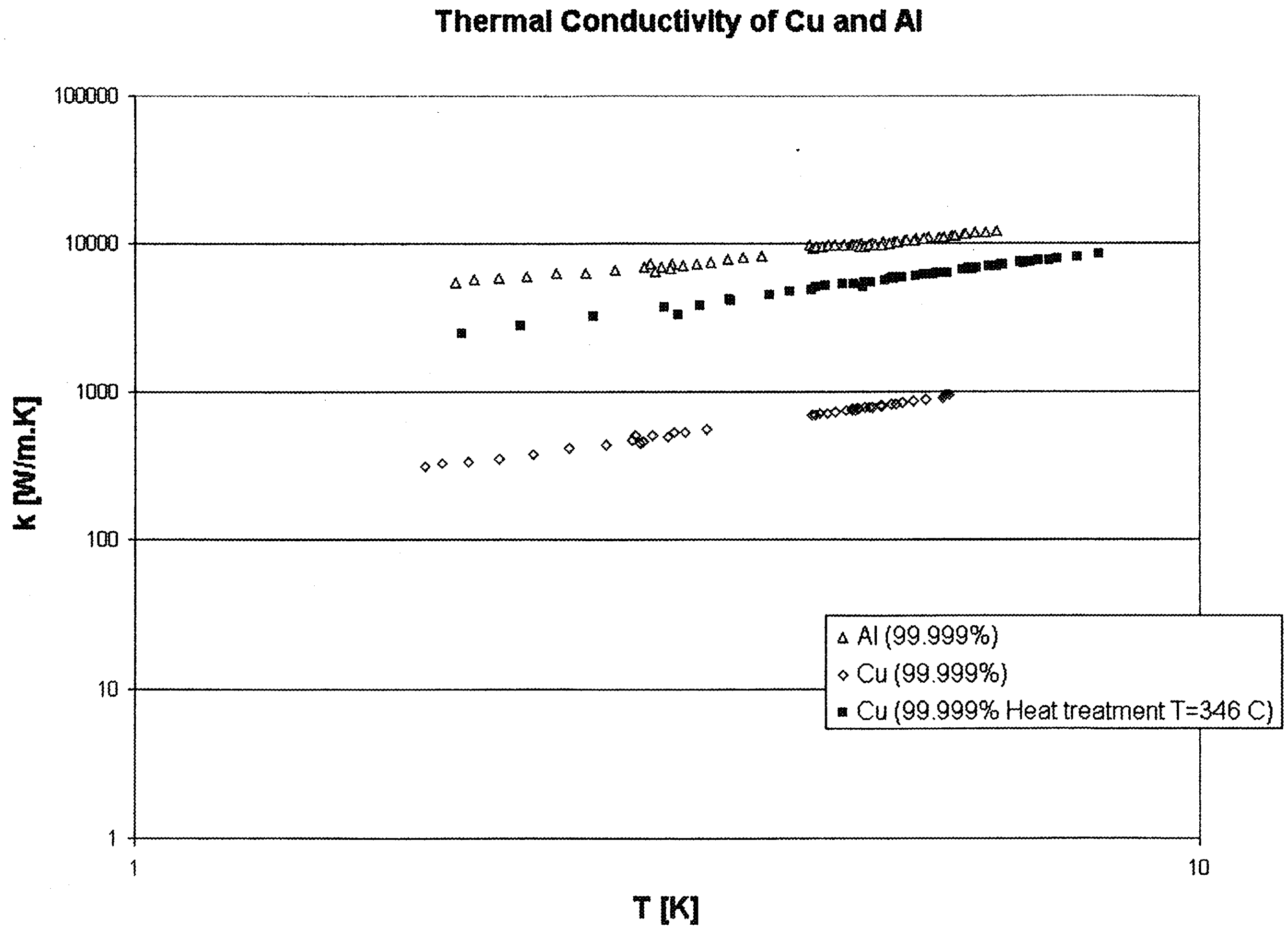
HIFI



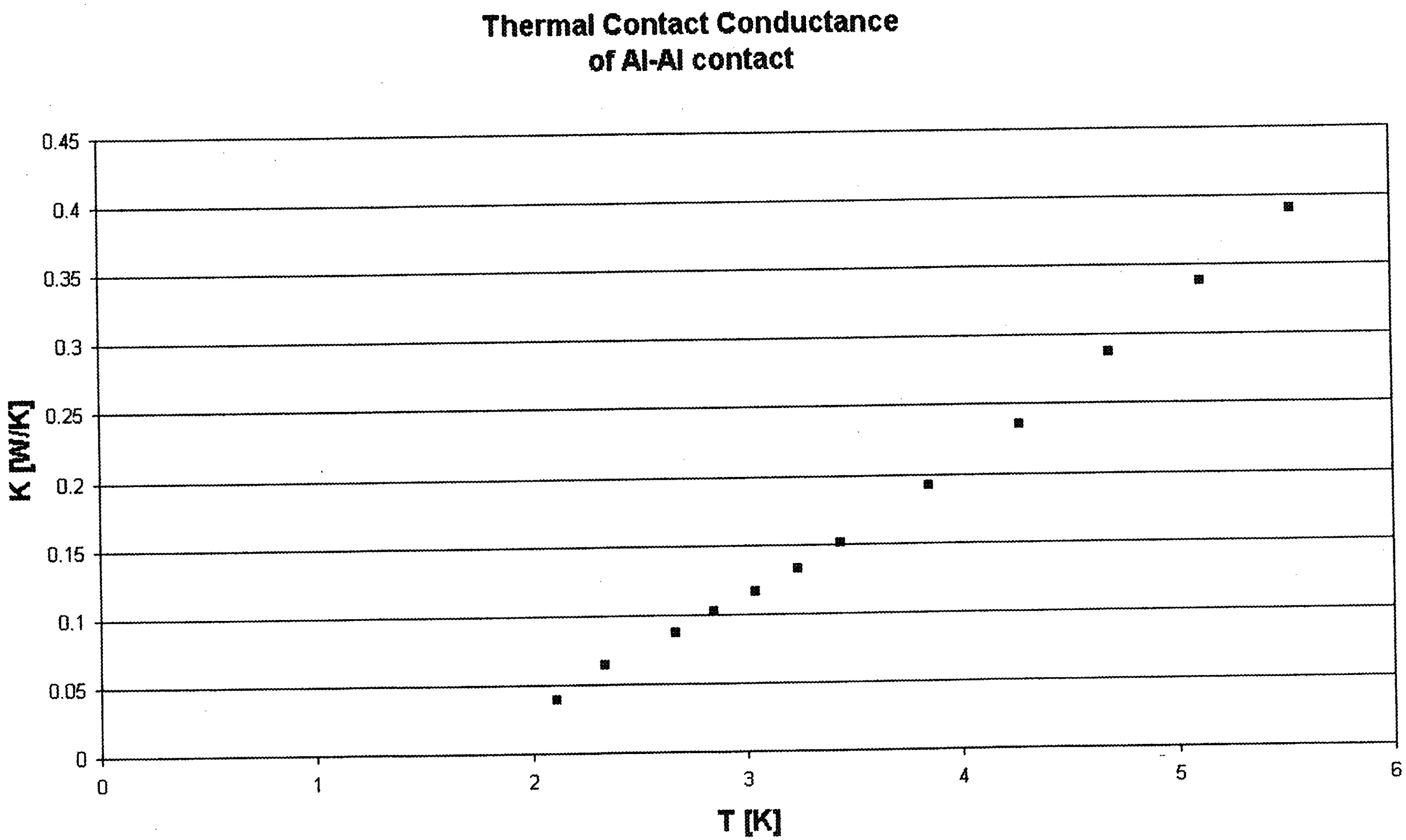
ISIRON

Thermal Conductivity (Experimental Results)

HIFI



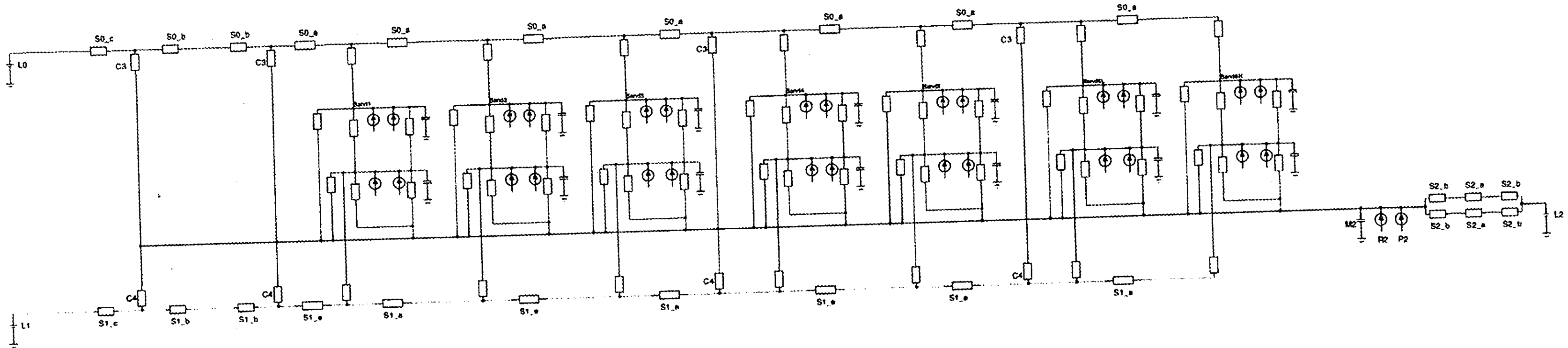
ISIRON **Thermal Contact Conduction** **HIFI**

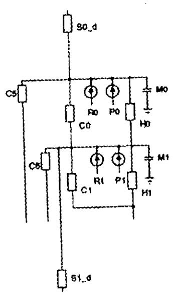


ISIRON

Thermal Model

HIFI





Heat Loads On S/C Cryostat

	Temp. level (K)
L0 S/C cryostat level0	1.9
L1 S/C cryostat level1	4.3
L2 S/C cryostat level2	10.0
	Thermal mass (J/K)
M0 Thermal mass level0	0.25
M1 Thermal mass level1	0.11
M2 Thermal mass level2	70.00
	Supports cond. (mW)
C0 Console support level0	0.43
C1 Console support level1	3.01
C2 FPU-OB mechanical feet[1)]	0 (TBC)
C3 Strap support level0[2)]	2.14
C4 Strap support level1[2)]	1.83
	Harness cond. (mW)
H0 Harness level0-level1[5, 10)]	0.78
H1 Harness level1-level2[5, 10)]	2.95
	Average power (mW)
P0 Dissipation level0[6)]	0.36
P1 Dissipation level1	0.02
P2 Dissipation level2	35.44
	Average Power (mW)
R0 Radiation level0[8)]	0.11 (TBC)
R1 Radiation level1[8)]	0 (TBC)
R2 Radiation level2[8)]	TBD

Heat loads on S/C cryostat[9)]	S0 (mW)	S1 (mW)	S2 (mW)
FPU primary mode	3.81	6.64	25.48
FPU off mode	3.45	6.58	-9.93

Attention Points

- Contact resistance in mixer units
- Thermal contact conductance
  - Al(99.999%)-al(99.999%)
  - Al(99.999%)-al(6061_t6)
  - Al(99.999%)-cu(99.999%)
- Substrap support design
- Distinction between SIS and HEB mixers
- Thermal contact between 1st/2nd stage ampl. and FPU structure

Annex ?

PACS Thermal Spacecraft Interface

MPE
J. Schubert

Summary

- Requirements to thermal I/F
- Mechanical IF to the Level 0 and Level 1 cooling straps
  - Location
  - Types and Design of the I/Fs
  - Design proposal for the cooler level 0 - I/F
- Critical Areas

Requirements

- FPU requires two temperature levels
  - level 0 at 1.7K
  - level 1 around 4K
- Other temperatures inside the FPU are produced autonomously (2.5K / 300mK)
- Thermal coupling to level 0 via 4 independent heat straps
- Thermal coupling to level 1 via 3 heat strap
- FPU is thermally decoupled from OB

FPU Temperature Requirements

Project code	Operating		
FPFPU	Min / [K]*	Max / [K]*	Nominal / [K]
Optics /Structure	3	5	4
Ge:Ga Detector Ass.	1.65	1.75	1.7
Cooler	1.65	2.2	1.9
Bolometer Ass.	1.65	3.5	2.6

*) Acc. IID-B, Issue 2

FPU Mechanical Level 0 IF Requirements

The mechanical loads arising from the level 0 cooling straps to the fixation points of the cooling straps must be limited to the following values (CR: H-P-PACS-CR-0008)

	Level 0 I/F	Lateral [N]	Axial [N]	Torque [Nm]
Static loads	sGe:Ga detectors (KT-Type)	106	2680 (static)	1.8
	Cooler pump switch and Cooler evaporation switch (CEA-Type)	50	TBD	TBD

	Level 0 I/F	dynamic mass
Dynamic loads	sGe:Ga detectors (KT-Type)	200 grams assuming 50 grms (included in the handling load)
	Cooler pump switch and Cooler evaporation switch (CEA-Type)	In addition 50 grams to the static load providing 20.8 grms random spec

Location of the FPU Thermal I/Fs to the S/C (I)

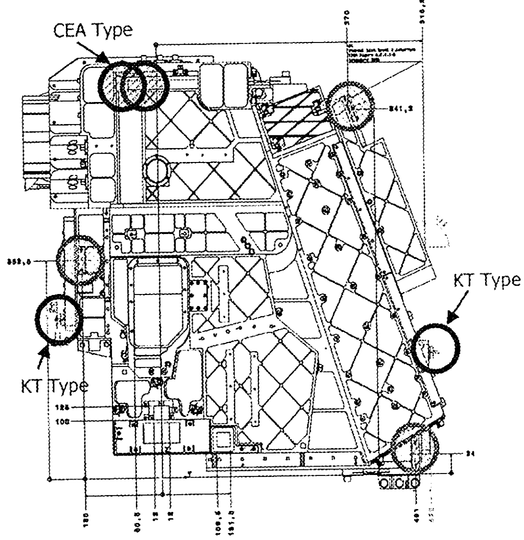
Four independent cooling straps to **level 0**

- Two to the sGe:Ga detectors (KT-Type)
- Two to the Cooler (CEA-Type)

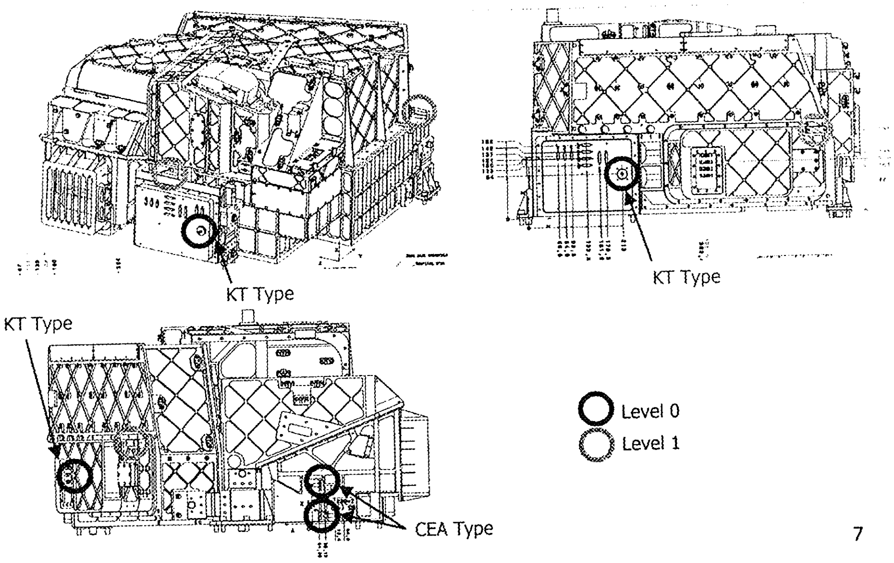
Three cooling straps to level 1

acc. IID-A, Fig.: 5.7.1.1-2 (ISO standard)

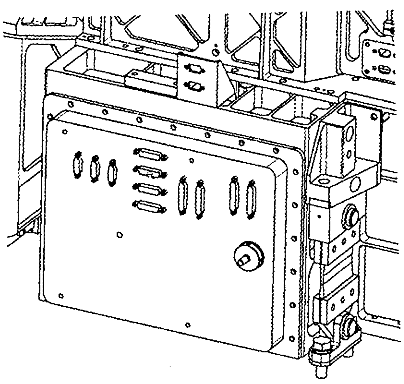
Level 0
Level 1

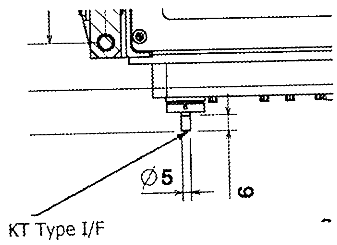


Location of the FPU Thermal I/Fs to the S/C (II)



Level 0 I/F
(KT Type)



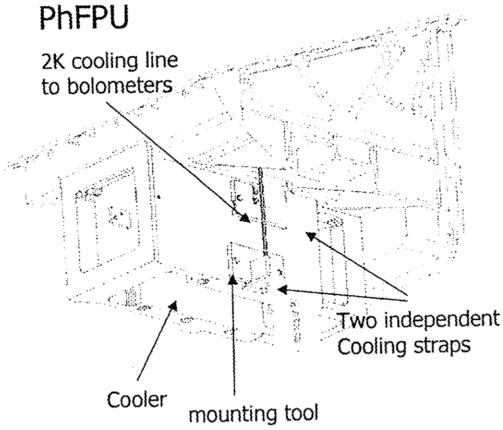


Level 0 Cooling Straps (CEA-Type)

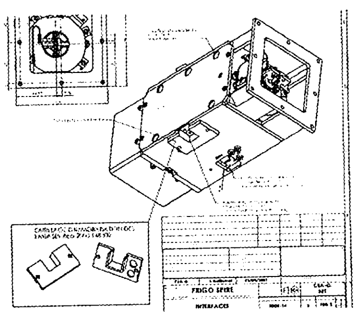
- Two gas gap heat switches
- Each switch interfaces with a thermal 2K strap (connected to Level 0)
- Mechanical I/F : copper plate gold plated 16 mm x 16 mm featuring two M3 holes
- To prevent any excessive torque to the heat switch a **mounting tool**, designed for screwing the strap, **will be supplied**

Proposal for the Level 0 Cooling Straps set up (I) (CEA-Type)

PhFPU



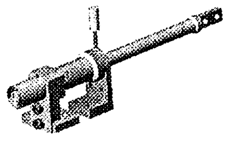
Cooler

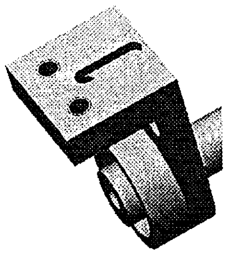


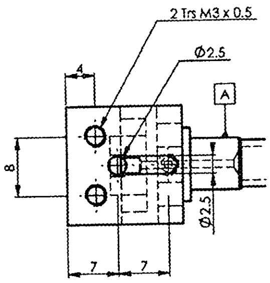
Mounting Tool

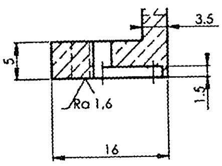
THERMAL INTERFACE TO CRYOSTAT (SPIRE & PACS)

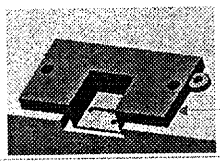
Mounting : Gold Plated Copper - Two M3 holes





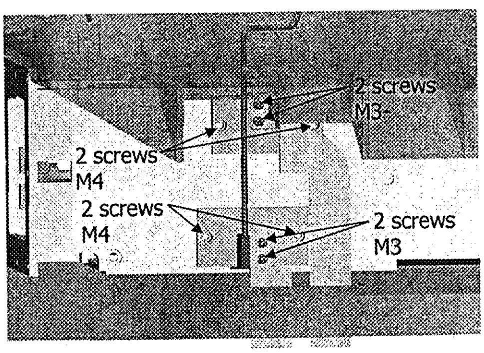


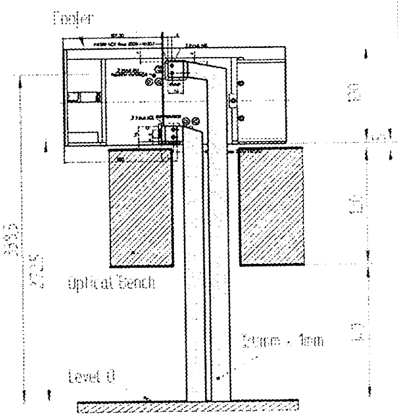




Mounting tool

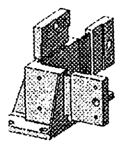
Proposal for the Level 0 Cooling Straps set up (II) (CEA-Type)



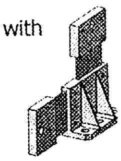


FPU Suspension

- Isostatic mounting of the FPU housing
- Thermal decoupling of the instrument from the optical bench



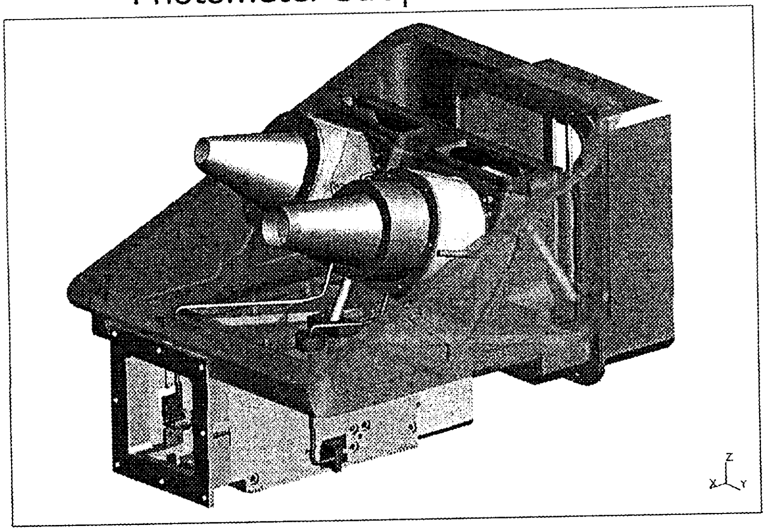
Material:	CFRP T300
Struts length:	70 mm
Cross section:	50 mm²
I/F to external H/W:	Aluminum fittings with 10 x M8 screw holes (tbc)
I/F fitting / strut:	bolted



Critical Areas

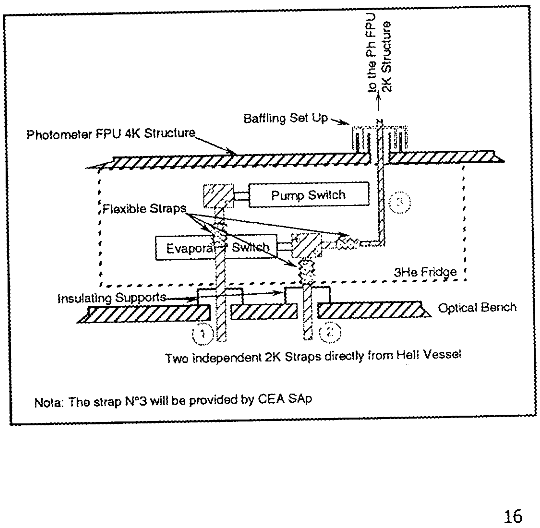
- Freezing of mech. I/Fs to cooling straps overdue
  - Mechanical I/F to level 0 cooler switches not agreed
  - Mechanical load requirements to level 0 cooler I/F not agreed
- Increasing OB temperature and impact to the cooler/bolometer- operation/recycling
- BOLA operation at 72K still questionable
- Missing Cryostat-TMM for thermal transient calculations (e.g. design verification, SPIRE-PACS parallel mode)

Photometer Strap Location I



Thermal Strap Proposal

- Photometer
- suspension set up on each strap
- strap a flexible part between the fixation cooler I/F and the suspension level on the OB



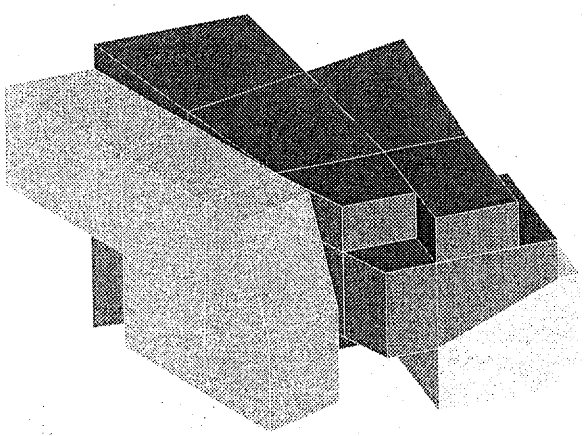
Annex 4

PACS Thermal Analysis

Dr. L. Morgenroth
CASE GmbH

Herschel Thermal I/F-Meeting 10. April 2002

PACS Thermal Model



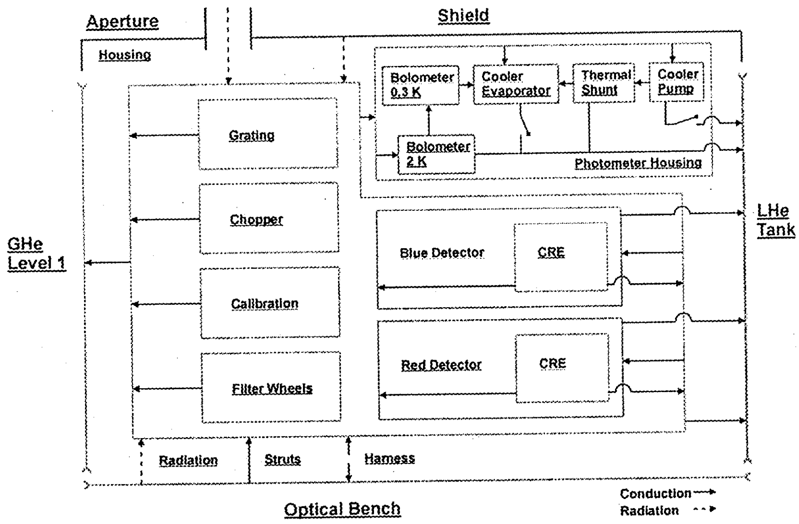
PACS TMM:

7 Boundary Nodes
185 Diffusion Nodes

Model includes:
- all Mechanisms
- all Harness
- Radiation Environment

Model excludes:
- Cryostat TMM

PACS Thermal Model: Schematic View



Requirements on a Cryostat TMM

- PACS needs to check temperature limits (transient)
- Possibility to calculate transient temperatures of Level 1, Optical Bench, Shield
- Minimum Input:
  Heat Loads from SPIRE/HIFI to different Temperature-Levels
- Preferably:
  reduced TMM of SPIRE/HIFI
  since Heat Loads depend on "Boundary" Temperatures - and vice versa

PACS Thermal I/F to S/C

- Cu-Cooling Straps

  4 Straps l = 400 mm A = 4 x 20 mm² to Level 0

  3 Straps l = 300 mm A = 3 x 20 mm² to Level 1

- CFRP Suspension Struts (PACS to Optical Bench)

  6 Struts l = 32 mm A = 6 x 100 to 200 mm² (transition)

- Harness (PACS to Optical Bench) Length 500 mm

  Steel 31.4 mm² Brass 4.35 mm² Teflon 307.3 mm²

- Radiative Coupling to Shield with Alodine (ε = 0.2)

- Radiative Coupling to "Aperture"

  Assumption: ε = 0.1 Ø = 50 mm T = 80 K

PACS Heat Dissipation (with 20 % margin)

	Temp. Level	Heat Dissipation [mW] for Operation Mode:					
		Spectrom. Operation	Photometer Operation (without recycling)	PACS off	Average Herschel	Pump Heating	Cooler Cool Down
Red Spectrometer	LHe Tank	--	--	--	--	--	--
Blue Spectrometer	LHe Tank	0.18	--	--	0.03	--	--
Spectrometer CREs	GHe Level 1	2 x 3.0	--	--	2 x 0.5	--	--
Photometer Housing	GHe Level 1	--	--	--	--	--	--
Photometer Buffer	LHe Tank	--	6.0	--	0.96	--	--
Photometer Cooler Pump	LHe Tank	--	1.49	--	0.81	50.4	146.4
Grating Assy	GHe Level 1	6.0	--	--	1.0	--	--
Chopper	GHe Level 1	4.8	4.8	--	1.57	--	--
Filter Wheels	GHe Level 1	0.036	0.036	--	2 x 0.012	--	--
Calibration Sources	GHe Level 1	2 x 1.33	2 x 1.33	--	2 x 0.43	--	--
Harness	Opt. Bench	2.9	2.0	--	0.81	--	--
TOTAL	LHe Tank	0.18	7.49	--	1.8	50.4	146.4
TOTAL	Level 1/O.B.	22.4	9.5	--	5.3	--	--

Sensitivity of PACS Temperatures
(to varying Boundary-Temperatures)

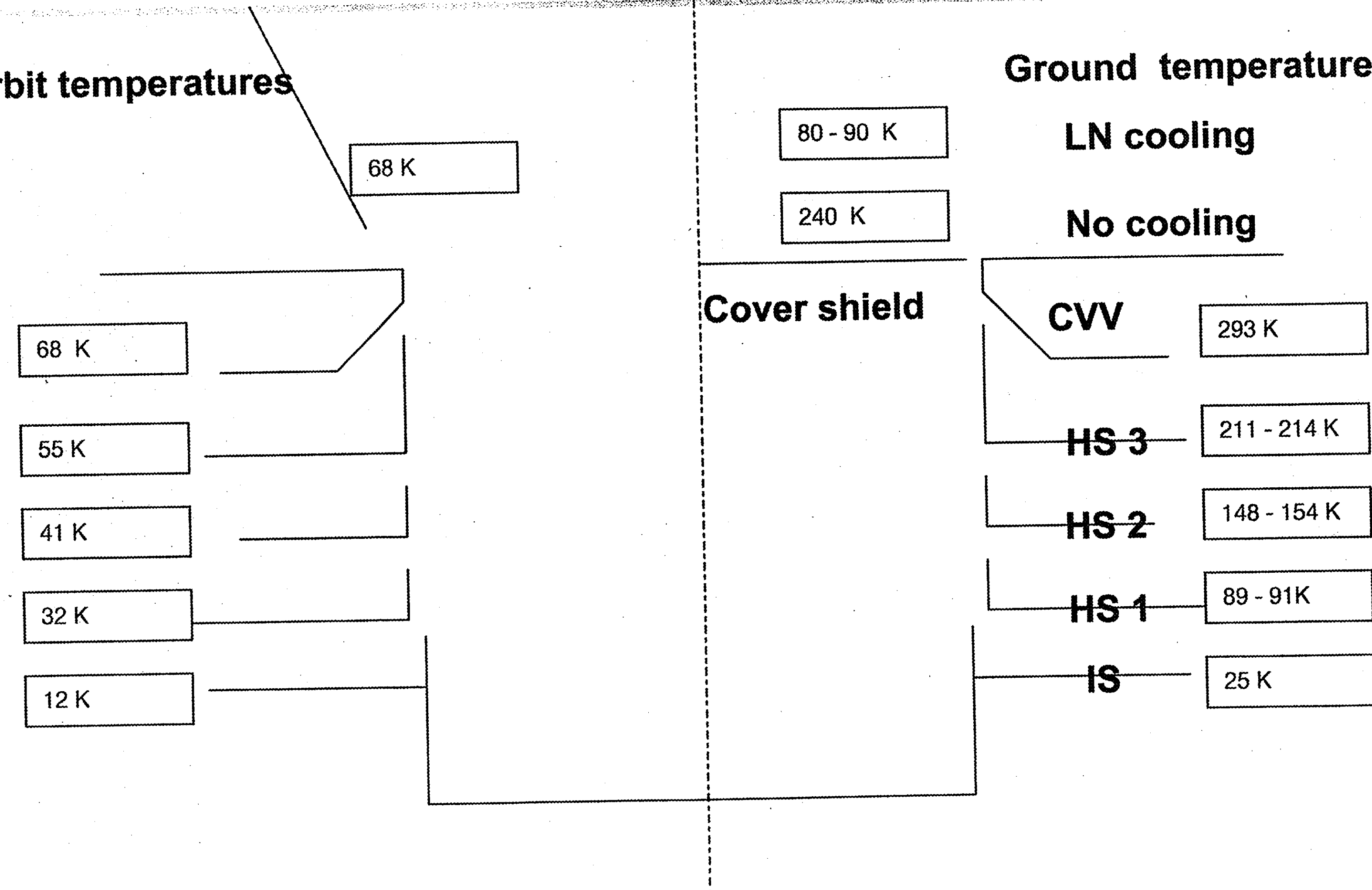
PACS-MODE:	new (21.03.2002)		old (13.02.2002)		increase	
	Spect.	Photo.	Spect.	Photo.	Spect.	Photo.
	[K]	[K]	[K]	[K]	[K]	[K]
Level 0	1.75	1.75	1.7	1.7	0.05	0.05
Level 1	5.0	5.0	3.5	2.5	1.5	2.5
Optical Bench	15.0	15.0	8.4	7.5	6.6	7.5
Shield	16.0	16.0	8.4	7.5	7.6	8.5
Housing Maximum Temperature	5.67	5.47	4.22	3.08	1.46	2.39
Blue Detector	2.95	2.83	2.50	1.94	0.45	0.89
Red Detector	1.83	1.81	1.74	1.71	0.09	0.10
Photometer (2K-Stage)	1.77	2.13	1.71	2.07	0.06	0.05
Photometer Cooler Pump	1.79	1.87				
Photometer Cooler Evaporator	1.78	1.84				
	[mW]	[mW]	[mW]	[mW]	[mW]	[mW]
Flux to LHe	4.4	11.3	2.4	8.4	2.0	3.0
Flux to Level 1	31.5	19.7	23.5	12.2	8.0	7.6
Flux from Optical Bench	12.5	13.1	2.8	3.1	9.7	10.1
Flux through Struts	11.6	11.7	3.6	3.5	7.9	8.2

Annex 5

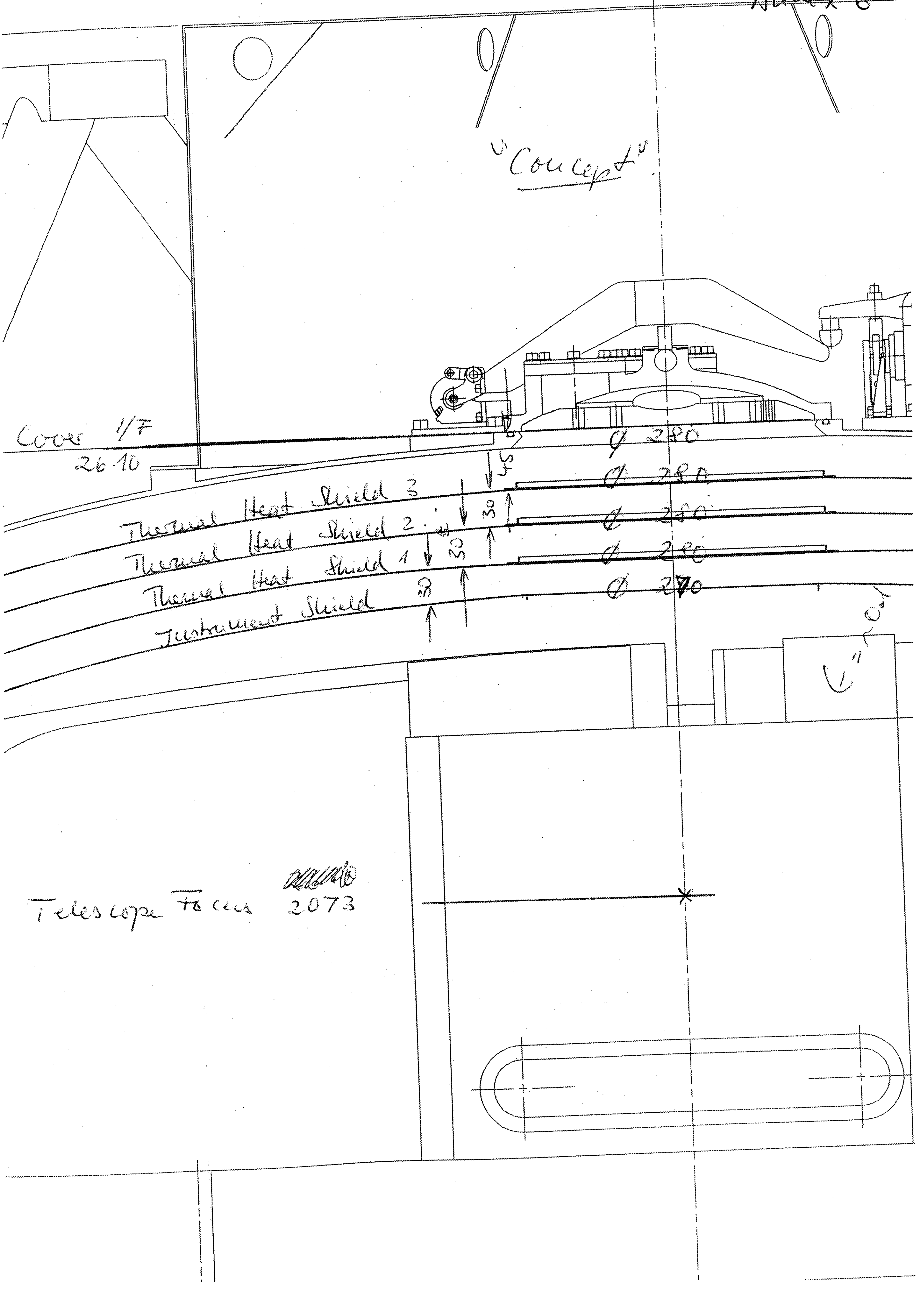
Entrance Baffle Baseline Design

- **Orbit temperatures**

Ground temperatures



Annex 5


"Concept"
Cover 1/7
26.10
45
Ø 280
Ø 280
Thermal Heat Shield 3
30
Ø 280
Thermal Heat Shield 2
30
Ø 280
Thermal Heat Shield 1
30
Ø 270
Instrument Shield
Telescope Focus 2073

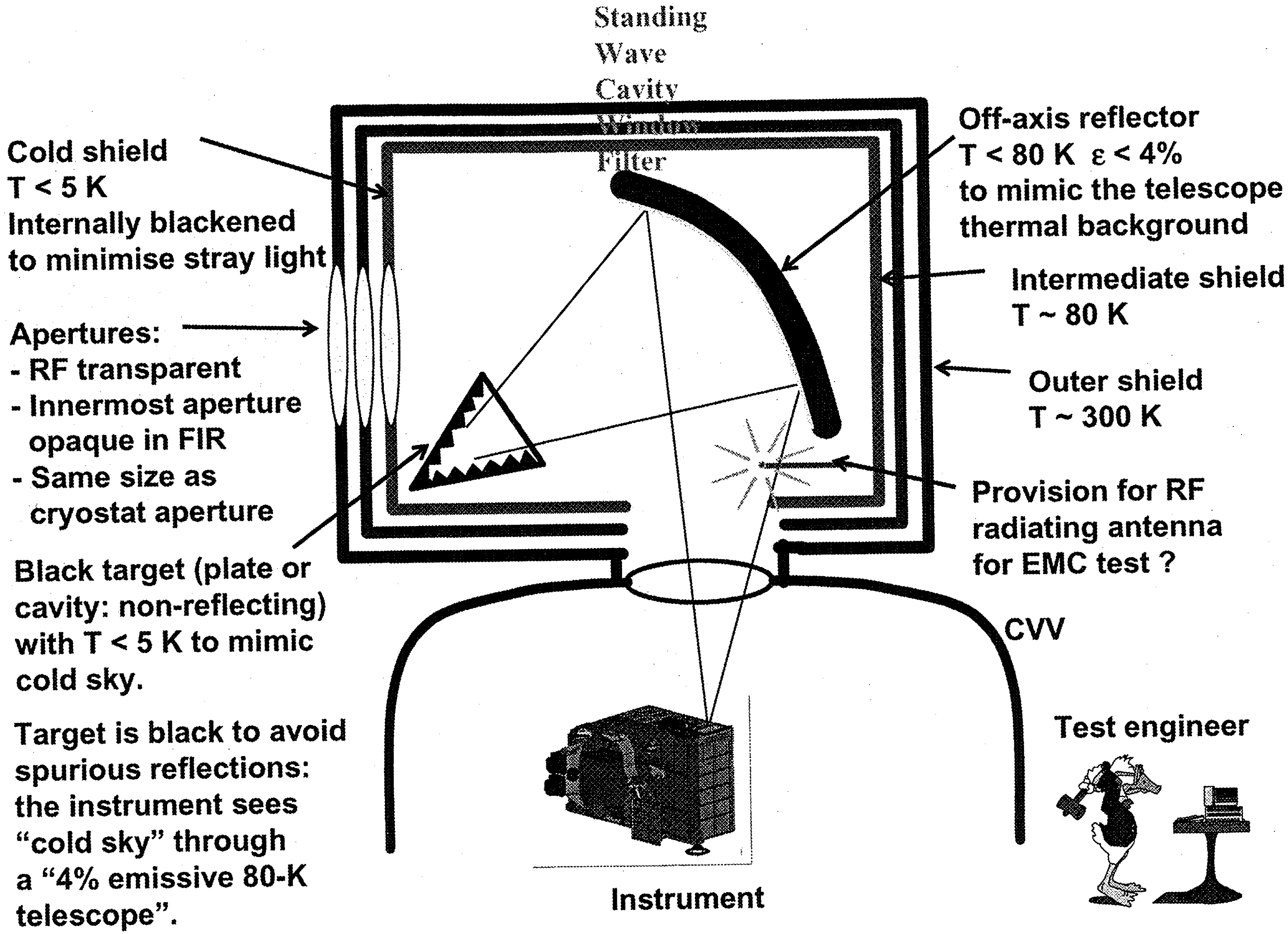
Herschel
Cryo Test Adapter

astrium

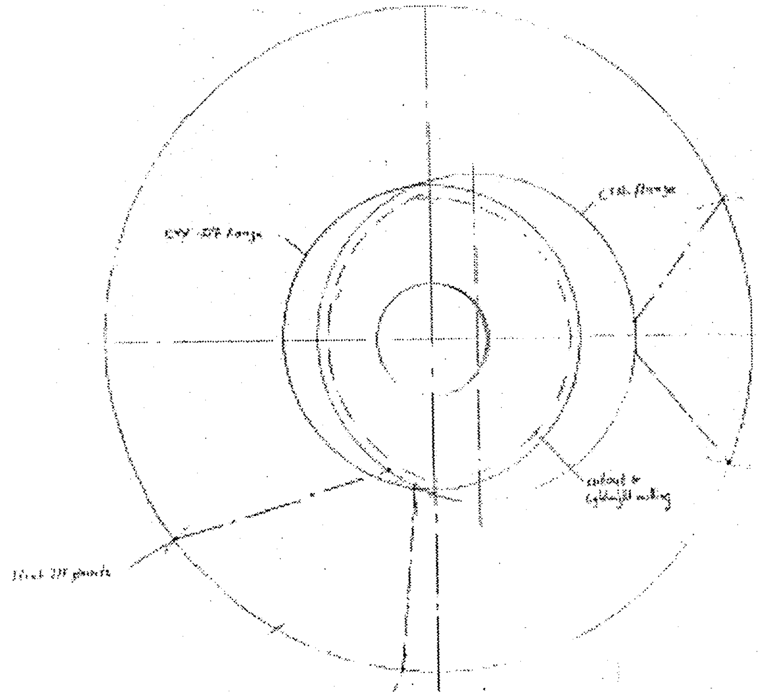
P.Schwabbauer
11/12.04.2002

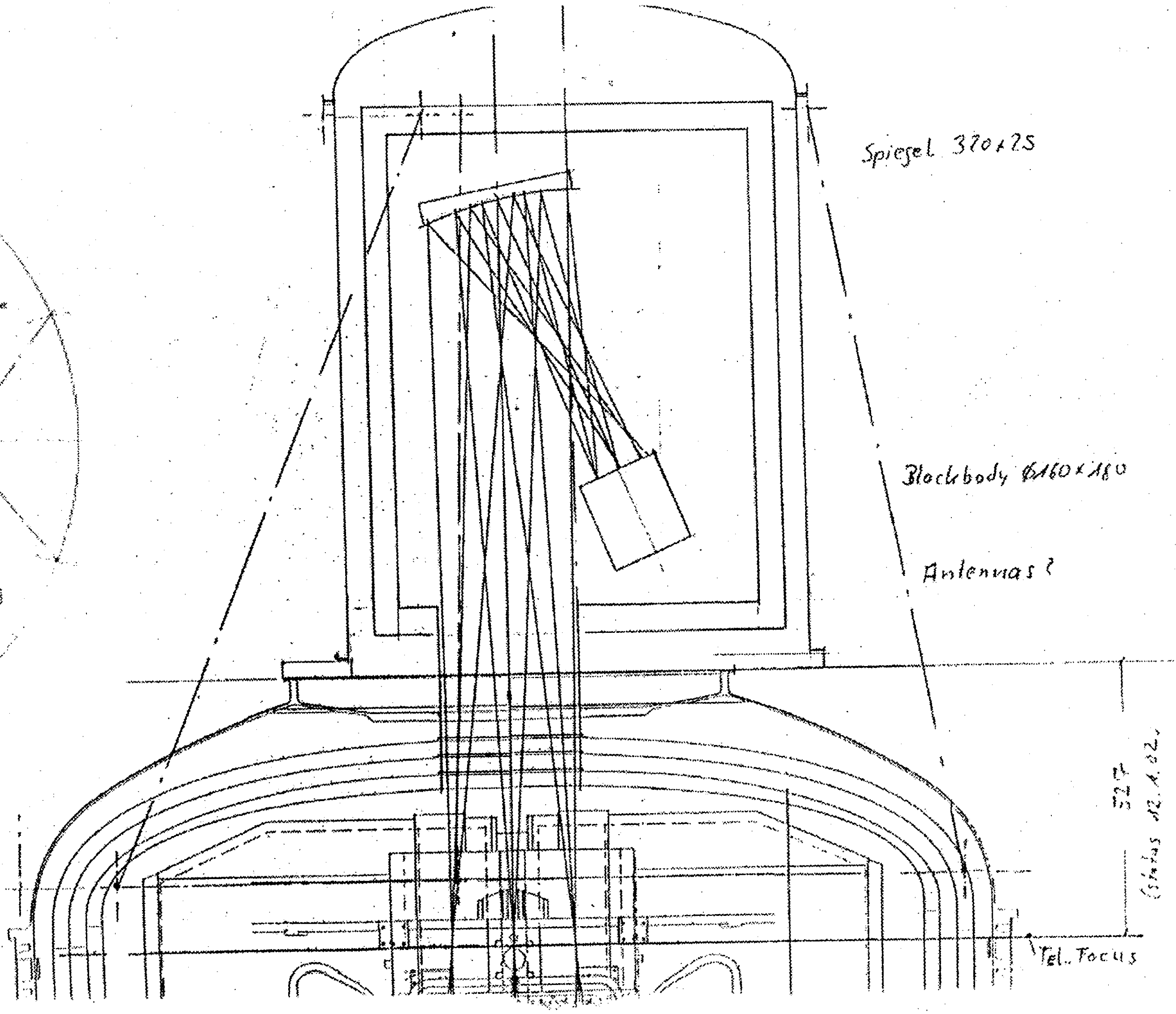
Annex 7

CTA for EQM: Concept proposed by SPIRE

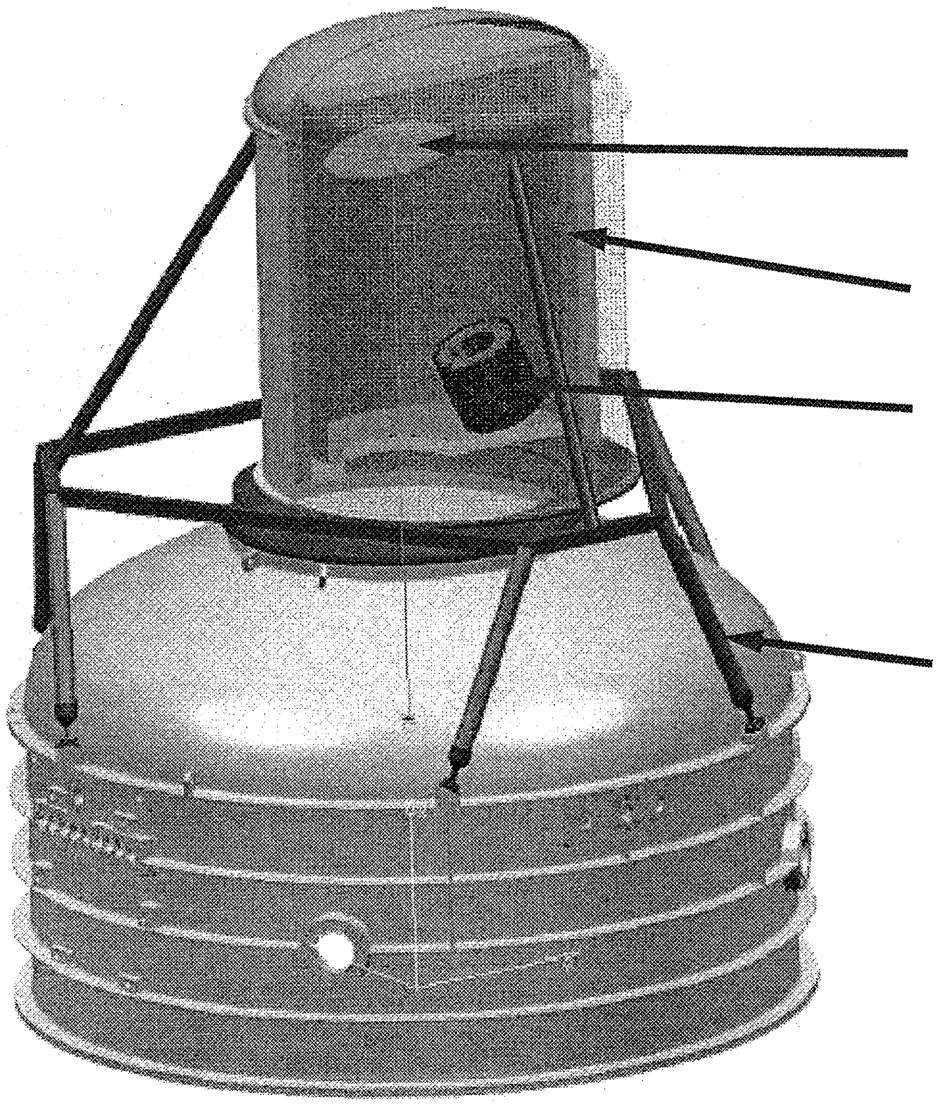


CTA for EQM – Conceptual design





CTA for EQM – Conceptual design



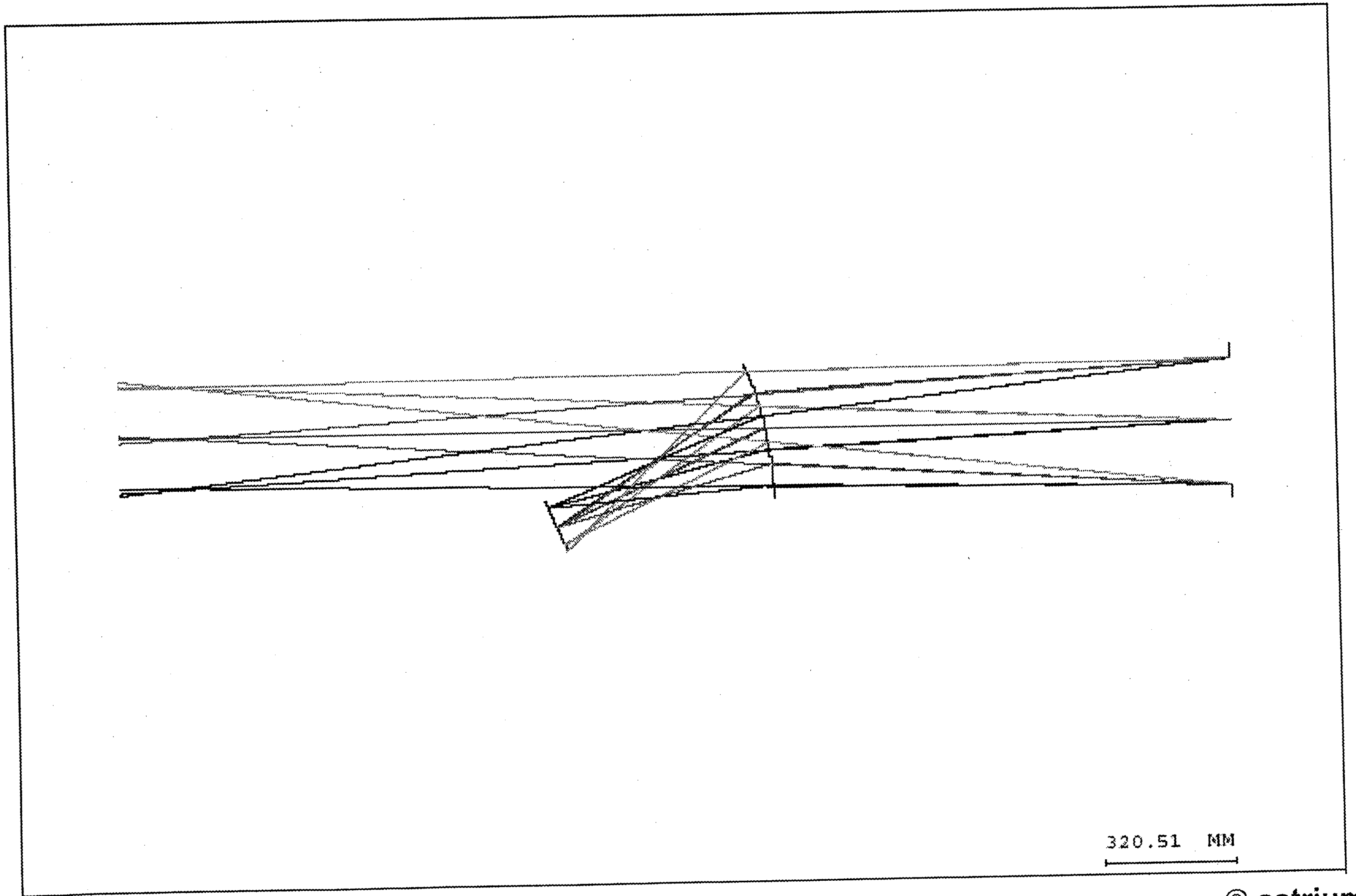
CTA for EQM - Status

- **Concept definition of CTA completed**
- **Procurement Spec and SoW under internal review**
- **Major Design features**
  - One off-axis spherical reflector (spherical, r~829 mm, tilt ~12 deg)
  - Black target of app. 105 mm x 120 mm
  - LHe continuous flow cryostat with 2 – 3 shields for background simulation; innermost shield intruding CVV to avoid straylight
  - 3 independent cooling cycles (cryostat, reflector and black target)
  - Expected mass: 200 - 250 kg
  - Expected temperature levels inside CTA:

Inner shield temperature	**4,5 - 5,3 K**
Mirror temperature with respective heater power	**21 – 90 K** **0 – 50 mW**
Black target	**< 5K**

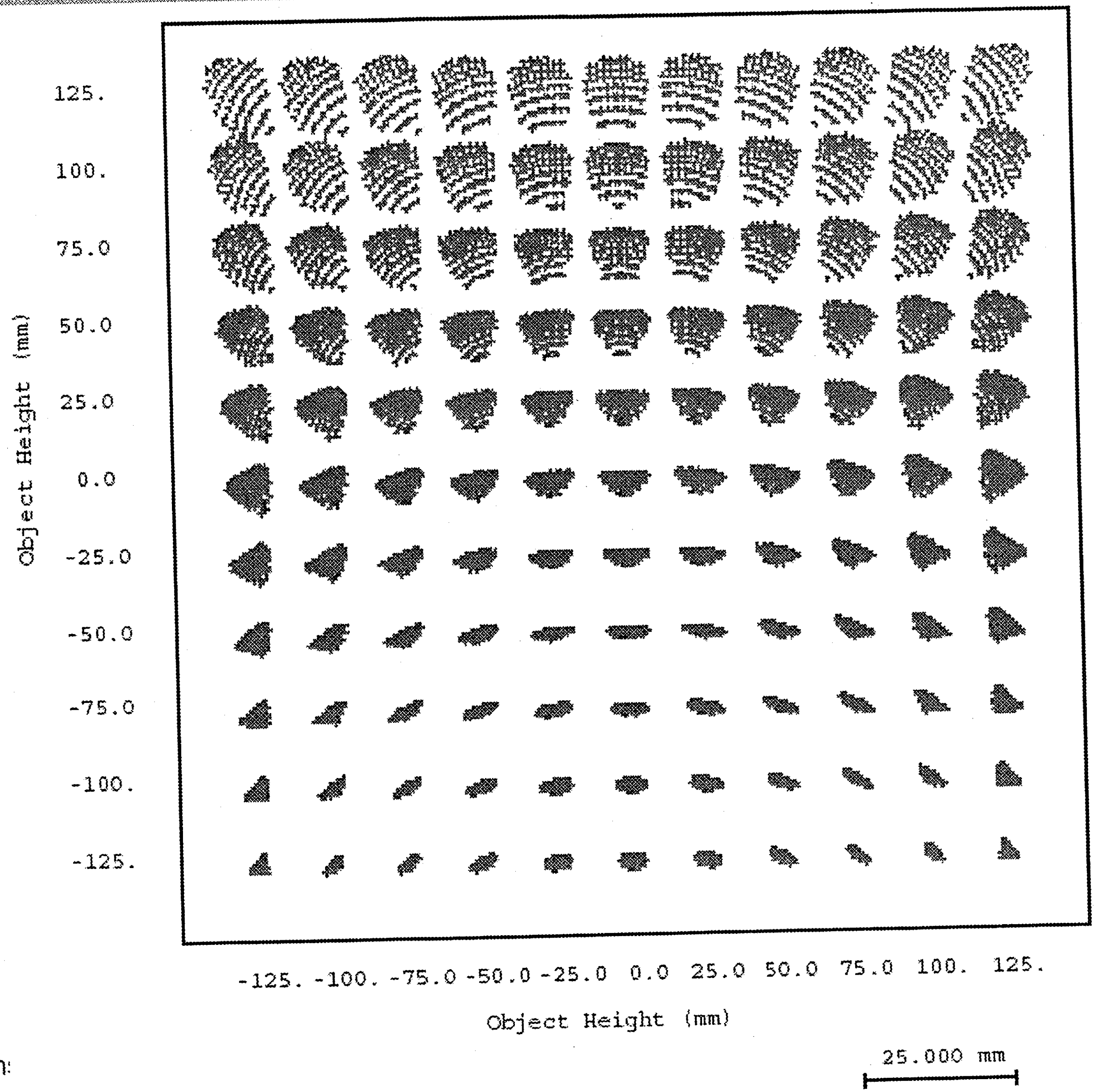
CTA for EQM – Optical design

Layout



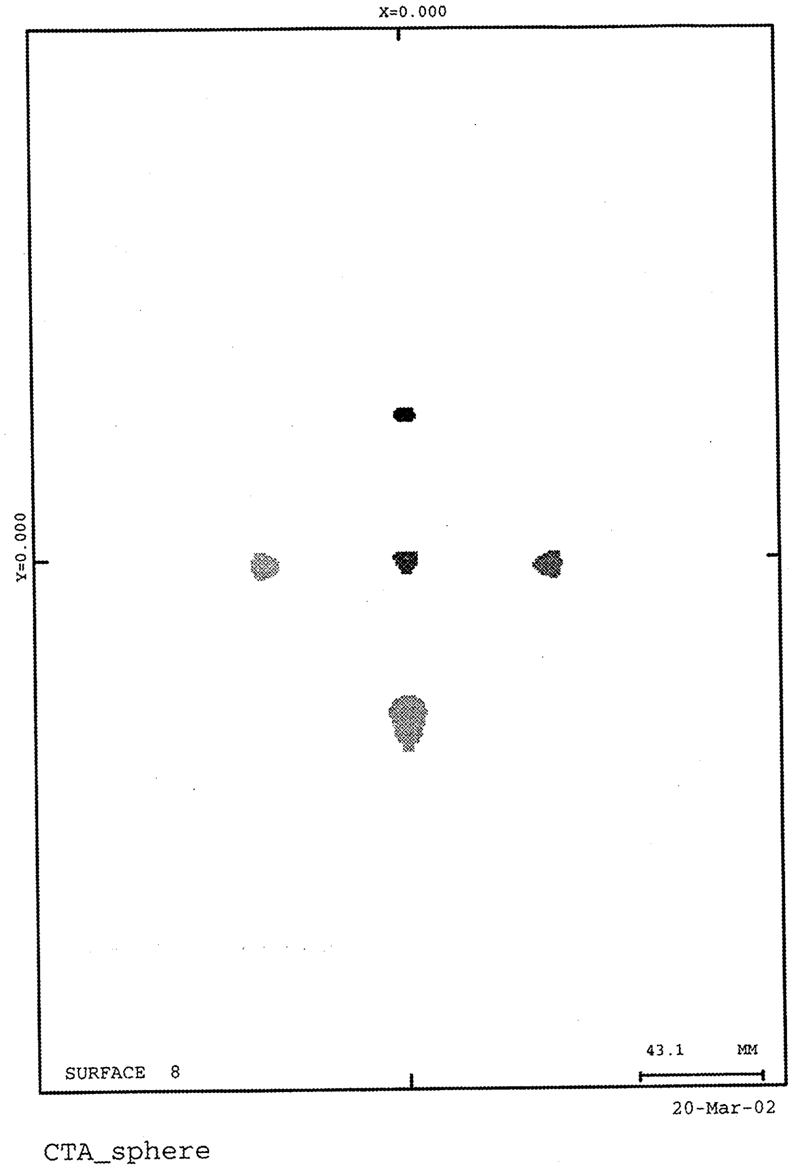
CTA for EQM – Optical design

Spot diagram



CTA for EQM – Optical design

Foot print



CTA for EQM - Optical requirements

- R-CTA-100 The Herschel telescope shall be simulated by one off-axis reflector.
- R-CTA-110 Emissivity of the reflector shall be between 2 % and 5 %. No specific coating or material for the reflector is required..
- R-CTA-120 The reflector shall have one focus on the optical axis. Distance reflector to focus shall be < 1450 mm. Second focus of the reflector shall be the black target.
- R-CTA-130 On the rear side in the center the reflector shall provide an alignment cube.
- R-CTA-140 Dark background shall be simulated by a black target with an emissivity of > 0,95. No specific coating or material for the black target is required.
- R-CTA-150 Reflector and black target shall cover the complete Field of View of Herschel EQM.
- R-CTA-160 Image quality of the optical subsystem is tbd under operational conditions.

CTA for EQM - Thermal requirements

- **R-CTA-200** **The CTA is to be used during ground operations on EQM only.**
- **R-CTA-210** **The cryo subsystem consists of three independent cooling cycles working according to the He continuous flow principle:**

  CTA – innermost shield

  Reflector

  Black target

  Specific requirements are:

[K]	Minimum operational temperature	Homogeneity	Accuracy	Stability
CTA (innermost shield)	≤ 5	+ 2 ≥ ΔT ≥ -0,5	Tbd	≤ 2
Reflector	40 – 90 adjustable	± 0,5	Tbd	≤ 1 over 5 minutes
Black Target	≤ 5,5	± 0,1	Tbd	tbd

CTA for EQM - Requirements

- **R-CTA-220** An optical support-structure (optical bench) inside the CTA shall be used to mount and adjust Reflector and Black target.
- **R-CTA-230** The CTA shall be connected vacuum-tight to the CVV without any additional adapter. The inner shield of the cryostat shall intrude the CVV with a minimum inner diameter of > 260 mm and a length of ~ 220 mm (baffle) in order to minimise straylight from warm parts of the CVV.
- **R-CTA-240** The CTA shall be supported isostatically by a dedicated framework (Mechanical Support Structure - MSS), which shall take all gravity loads resulting from a total mass of the CTA □ 300 kg (TBC) in each possible position.
- **R-CTA-250** It shall be possible to operate the CTA alone and on top of the EQM:

  S/C +x-axis pointing upwards, i.e. vertical EQM PLM position

  EQM PLM tilted around the z-axis between +90 degrees (i.e. +y-axis downwards) and –90 degrees (i.e. -y-axis downwards).The Filling port shall allow continuous flow operation for all cooling cycles in all positions.
- **R-CTA-260** Inner side of the innermost shield shall be blackened (tbc: from straylight assessment only shield behind reflector needs blackening).

CTA for EQM - Requirements

- R-CTA-270 CTA shall be equipped with heaters for warmup and thermistors for monitoring.

Heaters	Total number	Location	Power	Type
Cryo Subsystem	1 on each shield	tbd	10 W	tbd
Reflector	2	tbd	1 W	tbd
Black Target	2	rear side	1 W	tbd

Thermistors	Total number	Location	Range	Accuracy	Type
Cryo Subsystem	8	4 x innermost shield, 4x rest	4 – 370 K	≤ 20K: ± 0,1K > 20K: ± 1K	Innermost 3 x C100, rest PT 1000
Reflector	4	Tbd	4 – 100 K	± 0,1K	2 x C100, 2 x PT 1000
Black Target	4	rear side	4 – 100 K	± 0,1K	2 x C100, 2 x PT 1000

esa

FAX

Herschel / Planck Project

date	21 February 2002	reference	SCI-PT/011755	page	1/2
from	B. Jackson, T. Passvogel (SCI-PT)	extension	55962		
to	J.J. Juillet (Alcatel) W. Ruehe (Astrium) Th. de Graauw (SRON) Prof. M. Griffin A. Poglitsch (MPE)	n°fax	33 49292 3010 33 49292 3010 050 363 4033 44 29 2087 4056 49 89 3299 3292		
Copy	G. Crone, A. Elfving, O. Piersanti, A. Heske, J. Bruston, C. Jewell, F. Marliani, P. de Maagt				

Subject reference **Herschel EQM (ISO Cryostat) - Radiated EMC Test**

Dear all,

Please find below an assessment of the radiated EMC test discussed in the frame of the Herschel CQM (ISO QM) test sequence. As was discussed in the last meeting on that subject the idea was to perform a radiated test with an antenna directly facing the aperture of the cryostat.
Only this part of the CQM test is addressed below.

Our understanding of the objective of the test is to verify that radiation (RF) entering the cryostat from whatever source (e.g. spacecraft SVM) will not affect the instrument performance.

It has been proposed to perform a radiated susceptibility test on the instruments by placing a radiating test antenna either inside the cryostat or in a test adaptor at the cryostat aperture.

This method has several complications in implementation. Not only will it need to be done in an anechoic chamber but also it will require an accurate control of the electric field injected into the CVV. This is a difficult task. In fact, the electric field inside the cryostat will need to be measured and compared with the required levels at several locations inside the CVV. With standard EMC instrumentation this appears impracticable. In addition, even assuming this procedure is feasible, it would require a significant amount of time.

Since the susceptibility level to test the Instruments should be tailored to the S/C radiated emissions reaching the inside of the cryostat we have made a first cut of the level that can be expected to enter the cryostat via the aperture (or any other RF opening).

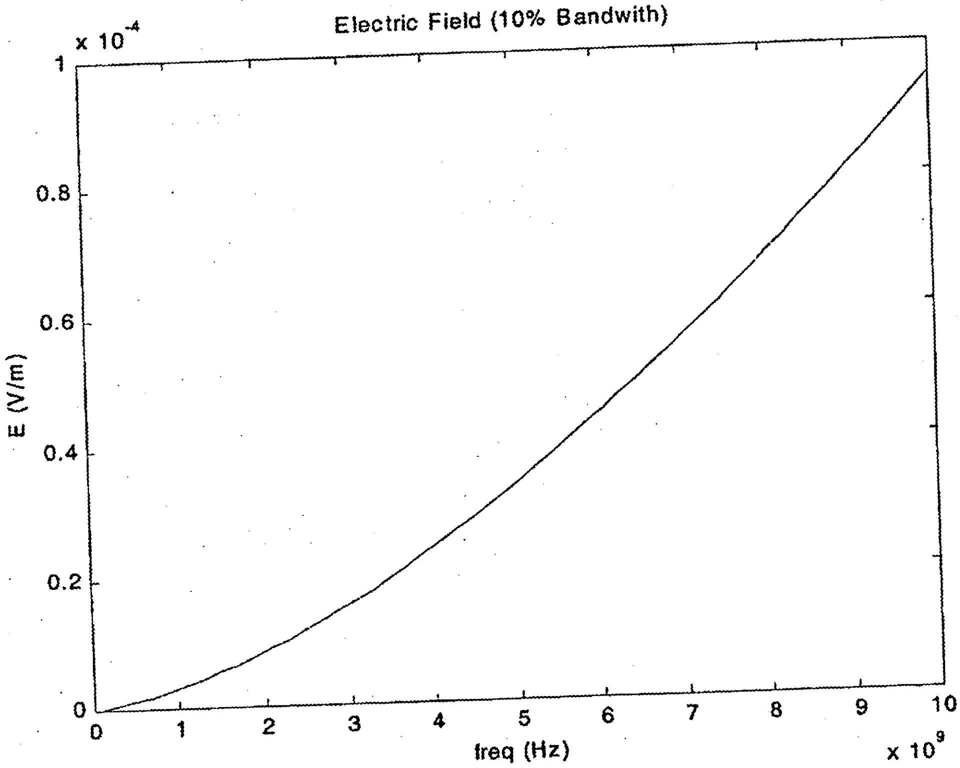
Using a typical SVM (ISO) emission spectrum in the range from 1 kHz to 1GHz, - and with the TX Off, there is nothing emitted of similar significance above this level,- and taking into account

CTA: 1 - 20 GHz

European Space Agency
Agence spatiale européenne
ESTEC
Keplerlaan 1 - NL 2201 AZ Noordwijk ZH - The Netherlands
Tel (31) 71 565 3473 · Fax (31) 71 565 5244 · http://sci.esa.int/home/herschel/ – http://sci.esa.int/planck

the minimum attenuation that is achieved by the cryostat (see ASPI-TN-0177) the level expected to enter the cryostat aperture is considered to be insignificant (below one microV/m).

In addition one can evaluate the level of radiation from the sun in the range from 1-100GHz that is diffracted at the edge of the sunshade and enters the cryostat as straylight noise (far above microV/m – see below figure) and finds this is higher than the levels "seen" from the SVM.



Based on the above, we believe a radiated test into the aperture of the cryostat is **not useful.** wi CTA

Could you review/comment the above ASAP and if you agree with the approach we would stop any further effort on the design of a cryogenic test adapter (CTA) for radiated EMC testing.

Best regards

T. Passvogel

ALCATEL SPACE

Alcatel Space Industries
Herschel Planck project office
OS/M/H
Fax + 33 4 92 92 30 10
Tel Secretary: + 33 4 92 92 30 85

FAX	Nb pages 1/1
Date	Référence
01/03/02	HP-ASPI-LT-1069

DE / FROM :
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A / TO (Dest, Soc/Comp.) :
B. JACKSON, T. PASSVOGEL
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COPY :
K. HIBBERD, P. COUZIN,
G. LUND, B. COLLAUDIN,
M. PASTORINO, P RIDEAU, J.J. JUILLET

HPLM EQM Radiated Susceptibility test

[Ref 1] SCI-PT/011755

Dear Sirs,

In response to your Fax [Ref 1], please find hereafter our comments.

Concerning the straylight resulting from the diffraction of the sun light at the edge of the sunshade in the range 1 – 100 GHz, note that this incoherent broadband noise cannot be compared as is (integrated in 10% bandwidth) to the radiated emission from the SVM, that will have a narrow band nature, being the reason why, for example, the telecommand signal from earth (minimun value ~ 20 µV/m at 7.2 GHz) will not be covered by the RF straylight from the sun.

We understand that your point is that the SVM radiated or HF conducted EMI coupling to the PLM sensitive electronics will mostly have the harness as coupling path.
At least between, roughly, 1 MHz and 1 GHz, as above 1 GHz (or a few GHz), the apertures may become the predominant coupling path (cf. the impact of bias cable presence on HIFI FPU components shielding efficiency, according to frequency, SRON-U/FPU/RP/2002-001).

However we think that, considering the SVM location, opposite to the cryostat top opening, other apertures should have at least as much impact as the cryostat top opening, e.g. the feed-through connectors (even closed by the backshells and overshieldings), and the LO optical windows.

In the end we agree with your approach :

- there is **no** need to equip the CTA with built-in antennas for RS testing, considering the above and the limitations and complications related to the installation and use of small antennas inside the CTA or inside the cryostat ;
- RS can be performed using standard external antennas, the cryostat top opening being closed by the CTA providing the appropriate background allowing to verify the EMI noise pick-up from the Instruments detection chains.

Best regards,

Laurent Trougnou J.J. Juillet

astrium

Telefax/Telecopy

Herschel

Datum/Date:	5.3. 2002		
An/To:	*+31 71 565 52 44* **ESTEC, Noordwijk, NL** T. Paßvogel, B. Jackson	Kopie an/ Copy to:	*+33 4 92 92 30 10* **ALCATEL, Cannes, F** J.J.Juillet *+31 30 254 0860* **SRON**, Th. De Graaw *+44 29 20 87 4056* **Uni. of Wales**, M. Griffin *+49 089 30 000 3272* **MPE**, A. Poglitsch

Abs./Sender: P.Schwabbauer
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E-Mail: Paul.Schwabbauer@astrium-space.com

Ref.: HP-ASED-150/02

Seite/Page: 1 von/of 1 Seiten/Pages

Betreff/Subj.: Herschel EQM – Radiated EMC Test

Reference:
1. ESTEC telefax SCI-PT/011755 of 21.02.2002
2. ASPI telefax HP-ASPI-LT-1069 of 01.03.2002
3. Herschel EQM #3 meeting of 20.11.2001, H-P-ASPI-MN-0597

Dear Sirs,

with regard to reference 1 telefax we have the following comments:
1) EMC test is critical to perform - therefore we intend to perform a calibration run with the CTA before adapting it to the EQM.
2) Field levels to be expected are significantly lower than the foreseen test levels of up to 2V/m – is already discussed in reference 2 telefax.

With the present CTA approach Astrium is following the recommendations as given during ref. 3 meeting. Because these recommendations have been proposed by the scientists, we are expecting their comments with the rationale for this approach.

In order not to delay the coming procurement activities we continue our present CTA activities (in accordance to ref.3 meeting) unless otherwise directed.

Kind regards
Astrium GmbH

i. V. W. Rühe

i. V. Dr. P.Schwabbauer

Schwabbauer, Paul

Von:	Schwabbauer, Paul
Gesendet:	Montag, 11. März 2002 11:45
An:	Ruehe, Wolfgang ED3; Kroeker, Juergen ED51; Hoelzle, Edgar ED171; Kalde, ED513; Schink, Dietmar ED172; Idler, Siegmund ED182; Faas, Horst ED516
Betreff:	EMC testing mit CTA

Liebe Kollegen,

anbei die Nachricht von SRON als Antwort auf das ESA fax SCI/PT011755 vom 21.02.02.

Gruß
PS

-----Ursprüngliche Nachricht-----
Von: Kees Wafelbakker [mailto:C.K.Wafelbakker@sron.nl]
Gesendet: Montag, 11. März 2002 10:37
An: Schwabbauer, Paul; jean.bruston@esa.int; thomas.passvogel@esa.int; bernard.collaudin@space.alcatel.fr; glenn.lund@space.alcatel.fr
Cc: matt.griffin@astro.cf.ac.uk; alpog@mpe.mpg.de; ohb@mpe.mpg.de; k.j.king@rl.ac.uk; thijsdg@sron.rug.nl
Betreff: EMC testing

Dear all,

With reference to SCI-PT/011755 of 210202 I note to my regret 1.That it does not give reasons ie. reference to calculation or test but merely asserts low field values. 2.That I do not understand it's relation to the ongoing discussion with Alcatel and Astrium who DO appear to give reason's ie. for example calculations by Laurent Trougnou.

Having discussed with my PI and my team the uniform request is to continue an appropriate discussion and prepare for the test.

Best greetings, C.K.Wafelbakker

Verlauf:

Empfänger		Übermittlung	Gelesen
Ruehe, Wolfgang	ED3	Übermittelt: 11.03.2002 11:45	Gelesen: 11.03.2002 11:49
Kroeker, Juergen	ED51	Übermittelt: 11.03.2002 11:45	Gelesen: 11.03.2002 13:10
Hoelzle, Edgar	ED171	Übermittelt: 11.03.2002 11:45	Gelesen: 12.03.2002 10:04
Kalde,	ED513	Übermittelt: 11.03.2002 11:45	Gelesen: 11.03.2002 11:56
Schink, Dietmar	ED172	Übermittelt: 11.03.2002 11:45	
Idler, Siegmund	ED182	Übermittelt: 11.03.2002 11:45	Gelesen: 13.03.2002 08:50
Faas, Horst	ED516	Übermittelt: 11.03.2002 11:45	Gelesen: 11.03.2002 12:53

CTA for EQM – Present baseline for RF test

- Performance of conducted susceptibility test under flight representative conditions;
- Performance of radiated susceptibility test under flight representative conditions i.e. field strength in the order of magnitude of 10^{-3} to 10^{-4} V/m;
- The radiated susceptibility test will make use of CTA-external antenna;
- No CTA-internal antenna or RF transparent windows will be used.

SRON

To : Nick Whyborn, Rudolf Schieder

From : W. Luinge
Date : 30 November 2001

Re : **Requirements for a Telescope Simulator For the HIFI Instrument Level Tests!!**

Goal of a Telescope Simulator

1. Verification of the FPU signal port to telescope standing wave design
2. Determine the effectiveness to subtract standing waves with the internal chopper.

This set up could be used as a test-bed for various sub-reflector shapes.

Requirements

Vacuum
2. Representative sub-reflector (including various shapes), distance, rotational symmetry
3. No generation of standing waves by the telescope simulator
4. Simple set up (regarding temperatures and alignment)
5. No adjustment for alignment
6. No simulation of primary mirror
7. Heat input of the telescope simulator must not lead to a significant change in impedance of the Mixer Unit
8. Heat input of the telescope simulator must not reduce the holding time of the baths of the test cryostat to less than a few hours
9. Set up must fit above the FPU test cryostat

Discussion of requirements

1. Vacuum: in order to be able to measure standing waves in all HIFI bands and not to depend on transmission windows in (humid) air. Even if this would not be a requirement, the need to reduce the heat load on the 10 K of the cryostat requires somehow cold surfaces, so vacuum is needed.

2. Representative means: (down) scaling with an order of magnitude is not allowed. A factor 2 is a compromise.
This piece of equipment can be used to determine the effectiveness of the central part of the sub reflector.

3. The simulator must be 'black' in the HIFI frequency bands in order to avoid resonant modes. This means that baffles have to be used absorbing material must be applied to the walls. Since it is assumed that absorption will not be complete for small angles we have to have a tube that is oversized. An analysis/trade-off is still to be made. This requirement cannot be maintained in full

since a heat filter has to be introduced (and/or window) between Telescope simulator and FPU test cryostat (see requirement 7, 8). A wedged filter/window can alleviate this problem. Absorber material will produce vapour that will deposit on the cold heat filter.

4. A Telescope Simulator at operational temperature would be most representative. It is not a real requirement to achieve the goals for the standing wave test, provided that a heat filter does not introduce standing waves that cannot be dis-entangled from the standing waves from the sub reflector. A special cryostat to get the operational temperatures is considered overdone (and would lead to extra test time). As mentioned under 3. a wedged filter inclined w.r.t. to the beam will reduce the effect. [An axial displacement of the sub reflector would enable us to identify the cause of the standing wave; it would complicate the set up; it is open for discussion].

5. For the time being it is considered that the exact position of the sub reflector w.r.t. to the FPU beam is not critical. Adjustment feed throughs are not required.

6. It is too complicated to take this into account and not required. The sub reflector standing waves are considered dominant. A standing wave due to the Herschel cryostat structure is more relevant.

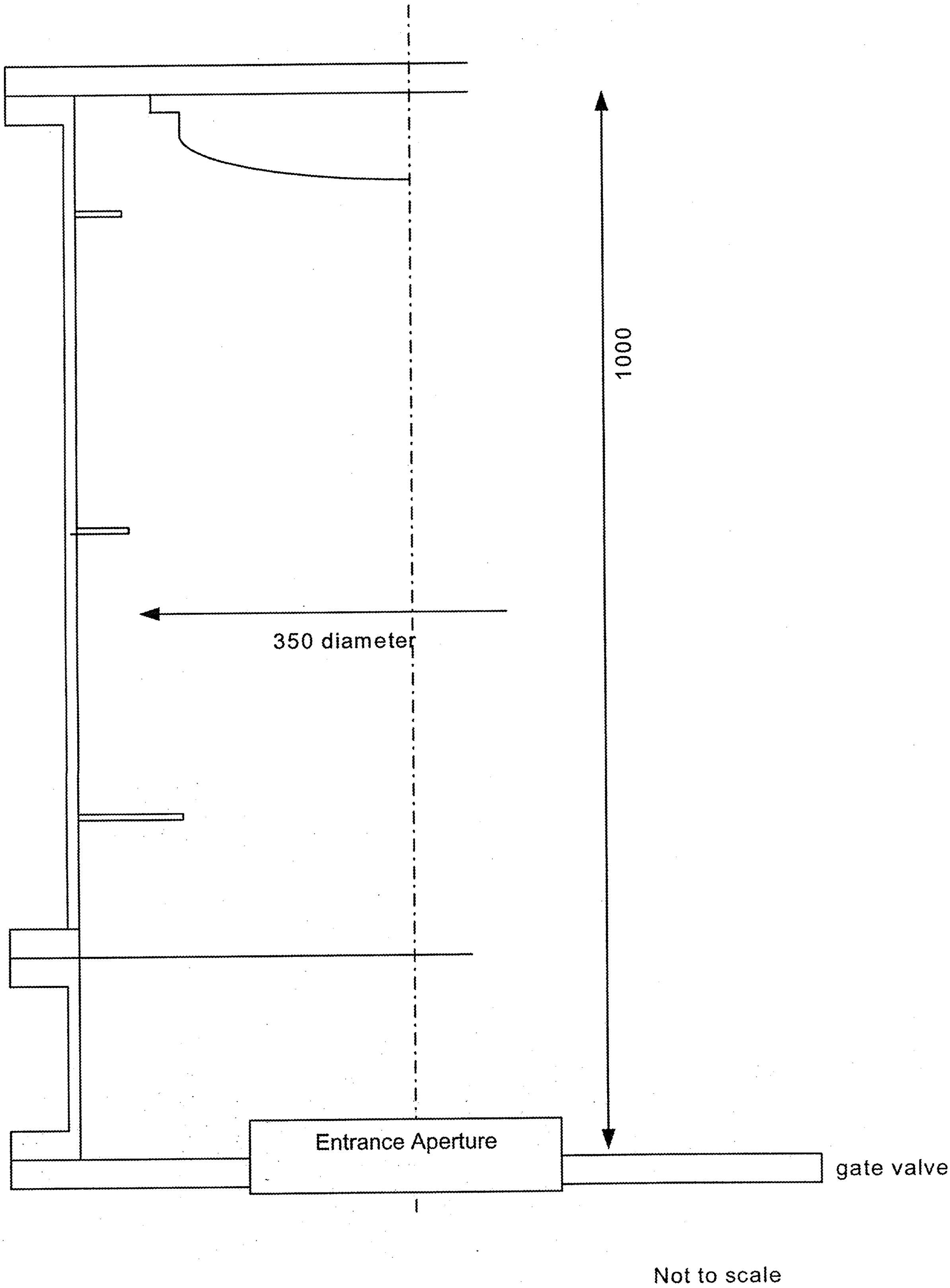
7. Heat input from the telescope simulator must not lead to a significant change in impedance of the MU's. It is assumed that a change in temperature of the MU's 1 - 4 will not effect the impedance. I am not too sure for QO and HEB receivers. NW: not true for present mixers

9. If the length of the telescope simulator exceeds 1.5 m we need a folding mirror (see attached figure for dimensions). So we have a trade off: complication of folding mirror or scaling with a factor 2 (see requirement 2). [I think a factor 2 does not really degrade the goal of the standing wave test]

In conclusion: it seems that the requirements on blackness and room temperature are the main issues for the design of the Telescope Simulator.

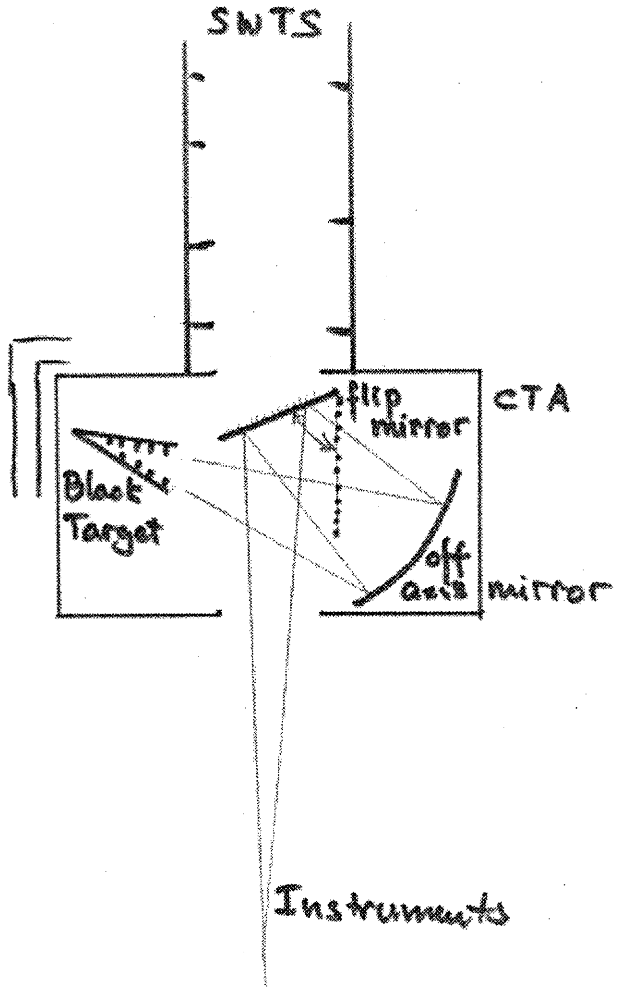
NW: The lower frequency bands are most sensitive & magnitude of reflection coupled to mixer is proportional to wavelength. ∴ concentrate on lower band(s).

Concept of telescope simulator (in mm)



CTA for EQM - Standing wave test

- Concept as proposed by HIFI on 18 February 02.



Quantity	Name	Dep./Comp.	Quantity	Name	Dep./Comp.
	Alberti von Mathias Dr.	ED 544	1	Rühe Wolfgang	ED 3
	Barlage Bernhard	ED 62		Runge Axel	OTN/TN 94
	Bayer Thomas	ED 532		Sachsse Bernt	EC 34
1	Faas Horst	ED 516		Sagner Udo	OTN/TN 64
	Grasl Andreas	OTN/TN 64		Schäffler Johannes	OTN/TN 64
	Grasshoff Brigitte	ED 511	1	Schink Dietmar	ED 522
	Hartmann Hans Dr.	ED 172	1	Schlosser Christian	OTN/TN 64
1	Hauser Armin	ED 541	1	Schwabbauer Paul Dr.	OTN/ED 171
1	Hinger Jürgen	ED 541		Schweickert Gunn	ED 544
1	Hohn Rüdiger	ED 531		Steininger Eric	ED 522
1	Hölzle Edgar	ED 171	1	Stritter Rene	ED 61
	Huber Johann	ED 532		Suttner Klaus	ED 542
	Hund Walter	ED 556		Tenhaeff Dieter	ED 544
1	Idler Siegmund	ED 521		Thörmer Klaus-Horst Dr.	OTN/ED 37
	Ivády von András	EC 32		Wagner Adalbert	OTN/IP 35
1	Jahn Gerd Dr.	ED 541	1	Wagner Klaus	ED 541
	Kalde Clemens	ED 513	1	Wietbrock, Walter	ED 511
	Kameter Rudolf	OTN/TN 64		Wilz Eberhard	OTN/ED 37
	Knoblauch August	ED 51		Wöhler Hans	ED 544
	Koelle Markus	ED 533		Zipf Ludwig	EC 32
	Kreeb Helmut	ED 541			
1	Kroeker Jürgen	ED 515			
	Lamprecht Ernst	OTN/TN 72			
	Lang Jürgen	ED 556			
1	Langfermann Michael	ED 531	1	Pastorino Michel	ASPI Resid.
	Mack Paul	OTN/TN 64			
	Maier Hans-Ulrich	ED 61	1	Alcatel (on FTP-Server)	
	Mauch Alfred	ED 544	1	ESTEC (on FTP-Server)	
1	Moritz Konrad Dr.	ED 37			
	Müller Lutz	OTN/TN 64			
	Muhl Eckhard	OTN/TN 64		APCO	
	Peitzker Helmut	ED 37	1	MPE	
	Peltz Heinz-Willi	ED 515	1	RAL	
	Peters, Gerhard	ED 533	1	SRON	
	Pietroboni Karin	ED 37			
	Puttlitz Joachim	OTN/ED 37			
	Raupp Helmut	ED 543			
	Rebholz Reinhold	ED 531			
	Reuß Friedhelm	ED 71			