astrium GmbH   **Technical Note**   **Herschel**

Title: **Description of Reduced H-EPLM Thermal Model for Instruments**

CI-No:

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Issue	Date	Sheet	Description of Change	Release
1	23.07.02	all	Initial Issue	

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1   Scope

This document gives a short description of the H-EPLM reduced Thermal Mathematical Model (TMM) intended to be used by the instruments as interface model. The TMM reflects the status 07th June 2002 that is used as working baseline for the Herschel PDR thermal analyses. Section 4 contains all the comments and notes from ASPI, ESA and ASED to the reduced H-EPLM TMM. Finally, the results obtained with the reduced TMM are compared to the detailed TMM results.

2   Reference Documents

RD 1   H-EPLM Thermal Model and Analysis, HP-2-ASED-RP-0011, Issue 2, dated 17.06.02

RD 2   He System Description, HP-2-ASED-RP-0034, Issue 1

RD 3   H-EPLM Design Description; Doc.No.: HP-2-ASED-RP-0003, Issue 2

3   Description of Reduced TMM

3.1   Performed Reduction of Detailed TMM

The reduced H-EPLM TMM is based on the Herschel PDR version of the detailed H-EPLM Thermal Model described in RD 1. The main modifications performed to achieve the reduced TMM are listed hereafter:

- Sunshield/Sunshade structure removed

- Sunshield MLI removed

- Sunshade MLI nodes merged to 3 nodes and set to boundary temperature

- SVM incl. MLI removed

- SVM shield incl. MLI removed

- SVM struts removed

- Telescope M1 MLI removed

- Telescope set to boundary temperature

- CVV MLI and Cryostat Baffle MLI removed

- CVV structure nodes merged to one single node and set to boundary temperature

- +Z and +/-Y radiators removed (incl. MLI)

- LOU, LOU Waveguides & BOLA removed

- CVV internal: Pretension devices merged to 1 node

- CVV internal: Heat Shield 3 MLI merged to 4 nodes

Thus, the amount of nodes is reduced from 557 to 276 (without FPU submodels).

3.2 Description of Interface Nodes

Instrument Interface	Temp. Level	Instr. Node	EPLM I/F	EPLM Node	Temp. uncertainty of Instr. Node acc. to sensitivity analysis (see RD 1)
FPFPU Red Detector	L0	760	Thermal link to HTT	10	±0.025K
FPFPU Blue Detector	L0	765	Thermal link to HTT	10	±0.025K
Cooler Pump	L0	781	Thermal link to HTT	10	±0.025K
Cooler Evaporator	L0	781	Thermal link to HTT	10	±0.025K
PACS FPU	L1	720 725 730	Cooling straps to L1 ventline	332 327 322	+ 0.1K* ±0.18K
PACS FPU	L1	791 792 793	CFRP mounting feet to OBP (Level 2)	376 371 376	+ 0.1K* ±0.18K
PACS FPU	L1	720	Harness	9101 9121 9141 9161 376	+ 0.1K* ±0.18K

*) see Note 4, Sect. 4

Table 3.2-1:   PACS Conductive Interfaces to EPLM TMM

Instrument Interface	Temp. Level	Instr. Node	EPLM Interface	EPLM Node	Temp. uncertainty of Instr. Node acc. to sensitivity analysis (see RD 1)
Enclosure	L0	811	Thermal link to HTT	10	±0.025K
Cooler Pump	L0	819	Thermal link to HTT	10	±0.025K
Cooler Evaporator	L0	820	Thermal link to HTT	10	±0.025K
SPIRE FPU	L1	803	Cooling strap to L1 ventline	338	+0.1K* ±0.35K
SPIRE FPU	L1	803	Stainless Steel mounting feet to OBP (Level 2)	376 381	
SPIRE FPU	L1	804	Harness	9301 376	
PM-JFETs	L2	801	direct mounted on OBP (L2)	378 379	±0.5K
PM-JFETs	L2	801	Harness	376	±0.5K
SM-JFET	L2	802	direct mounted on OBP (L2)	379 380	±0.5K
SM-JFET	L2	802	Harness	376	±0.5K

*) see Note 4, Sect. 4

Table 3.2-2:   SPIRE Conductive Interfaces to EPLM TMM

Instrument Interface	Temp. Level	Instr. Node	EPLM I/F	EPLM Node	Temp. uncertainty of Instr. Node acc. to sensitivity analysis (see RD 1)
FHFPU	L0	912	Thermal link to HTT	10	±0.035K
HIFI L1	L1	913	Cooling strap to L1 ventline	344	+0.1K* ±0.32K
HIFI FPU	L2	910	direct mounted on OBP (L2)	375 376	±0.5K
HIFI FPU	L2	910	Cooling strap to OBP	375	±0.5K
HIFI FPU	L2	910	Harness	9401 9421 9441 9461 9481 376	±0.5K

*) see Note 4, Sect. 4

Table 3.2-3:   HIFI Conductive Interfaces to EPLM TMM

EPLM Item	EPLM Node	Set point in TMM (hot case)	Expected range at L2 (hot/cold case)	Predicted uncertainty (sensitivity analysis, see RD 1)
Telescope	8000	79.3 K	75.8 K $\pm$ 3.5 K	+4K / -5K
SSD center panel MLI	7150	192 K	175 K $\pm$ 17 K	+15K / -26K
SSD side panels MLI	7151 7152	180 K	162 K $\pm$ 18 K	+15K / -24K
CVV	4000	67.9 K	67 K $\pm$ 1 K	$\pm$ 3 K
CVV connector bracket	9000	68.3 K	67.4 K $\pm$ 1 K	$\pm$ 3 K
Cryostat Baffle	4070	68.1 K	67.2 K $\pm$ 1 K	$\pm$ 3 K
LOU window	4090	68.1 K	67.2 K $\pm$ 1 K	$\pm$ 3 K
HTT	10	1.7 K	1.65 K $\pm$ 0.05 K	1.65 K $\pm$ 0.05 K
Space	99999	3 K	0	0
mass flow	5900	2.2 mg/s	$\pm$ 0.1 mg/s	

Table 3.2-4:   EPLM Boundary Nodes

3.3   Model Architecture

For this latest model version a submodel structure has been introduced. The actual submodel tree is shown below:

```
                    HERSCRED
                       *
                       *
                    EPLMNTRM
                       *
                       *
        * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
        *                      *                      *
        *                      *                      *
    PACSNTRM             SPIRENTRM              HIFINTRM
```
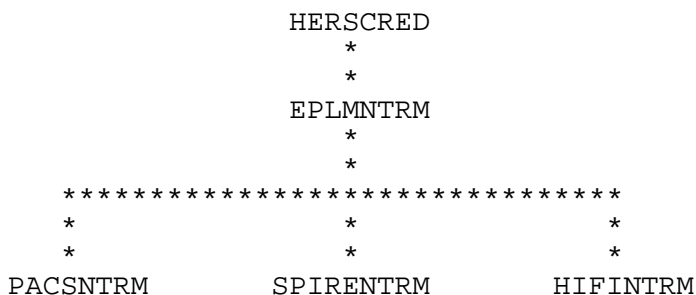
The following file system has been installed:

Folder	Contents
"ESARAD-OUTPUTS"	includes the ESARAD output files (cover open and cover closed conditions)
"GENERIC"	comprises all ESATAN source files
"ORBIT"	all orbit case calculations shall be performed in this folder
"GROUND"	all ground case calculations shall be performed in this folder

3.4   Model Operation

Both ESATAN and ESARAD models are provided with a Makefile, a tool to facilitate TMM handling.

For ESATAN, the command

> make

> automatically preprocesses all submodels and then starts the calculation. The command shall be executed either in the folder "ORBIT" or "GROUND" to generate the corresponding results.

The instrument modes for in-orbit calculations can be adjusted in the control-file "control.ctl" (-1: all Instruments Off, 0: Average Mode, 1-6: Modes 1-6).

For ESARAD, the command

> make

      initiates a model update in the ESARAD database.

The command

> make calc

      starts a kernel run.

The command

> make esatan

      extracts the ESATAN input file.

3.5   Structure of TMM Files

For delivery, the model files are packed in two tar-archives named "ESARAD.tar.gz" and ESATAN.tar.gz", including the directory structure described in Section 3.3.

Contents of

ESARAD.tar.gz:

- pacsngrm.erg
- spirengrm.erg
- hifingrm.erg
- eplmngrm.erg
- HERSCHEL_EOLred.erg
- HERSCHEL_EOLred.erk
- HERSCHEL_EOLred.ere
- Makefile

ESATAN.tar.gz:

- /GENERIC: herscred.d
                     eplmntrm.d
                     pacsntrm.d
                     spirentrm.d
                     hifintrm.d
                     matdattab.d
                     matdatfun.d
                     USRLIB. DAT
                     calcmd.f
                     Makefile

- /ESARAD-OUTPUTS/COVER_OPEN-EOL: herschel_grred.d
                                         eplm_grred.d
                                         spire_gr.d

- /ESARAD-OUTPUTS/COVER_CLOSED-BOL: herschel_gr_cclred.d
                                         eplm_gr_cclred.d
                                         spire_gr_ccl.d

- /ORBIT: control.ctl
                     symbolic links to files in /GENERIC and /ESARAD-OUTPUTS
                     /COVER_OPEN-EOL

- /GROUND: control.ctl
                     symbolic links to files in /GENERIC and /ESARAD-OUTPUTS
                     /COVER_CLOSED-BOL

4   Restrictions and Notes

The following Notes/Warnings concerning the usage of the H-EPLM thermal reduced model (PDR status) shall be taken into account:

Note 1:
****

The current thermal design is based on the H-EPLM PDR status. Note that there will be ongoing design refinements that might have an impact on the FPUs thermal behaviour. Currently a modification of the cryostat baffle design is under investigation.

Note 2:
****

For the dissipation Modes 1-6 a fixed mass flow of 2.2 mg/s is programmed. Please check after each calculation run on instrument level also the total heat input into the He II tank (dumped with node 5951 in mW) to get an indication for the lifetime impact. In the Average Mode the heat flow into the He II tank currently is 53 mW, please note that higher heat flows will reduce lifetime.

The massflow rate of 2.2 mg/sec is a design goal and not the result of the model. There will be a variation of ±0.1 mg/sec in L2 due to the different environmental conditions (hot / cold case).

Note 3:
****

For the transient case (subcase that can be selected in $EXECUTION of HERSCRED) a floating mass flow is programmed. Please keep in mind, that the Passive Phase Separator is not finally selected and that the variations in mass flow can be larger than currently calculated in the TMM.

Note, that the overall instrument timeline is based on ASED assumptions up to now and therefore is defined within HERSCRED. Especially, the timelines of the PACS and SPIRE sorption cooler are based on an average value and need to be replaced by a better description. For updating/defining other instrument timelines please consider, that HERSCRED may overwrite timelines defined in the submodels. In this case the timeline defined in HERSCRED needs to be modified.

Note 4:
****

Detailed investigations of the ventline modeling revealed slightly higher Level 1 temperatures than calculated with the current H-EPLM TMM (PDR status). The maximum difference is 0.1 K. Therefore, 0.1 K has to be added to all Level 1 instrument interface temperatures when using the current H-EPLM TMM.

Note 5:
****

Makefiles are included and can be used to automatically pre-process all submodels and start the calculations. It might be that the makefiles need to be changed depending on the OS/computer and

ESATAN/ESARAD versions used. In case of problems ASED can give support in adapting the makefiles.

Of course, model operation is also possible "by hand" without using a Makefile, considering ESATAN and ESARAD specific rules for handling submodels.

Note 6 (ESA comment):
****

For future versions, the following needs to be considered:

▪ The dissipation of the Photometer JFETS in mode 3 and mode 6 is 49 mW and not 30 mW.

▪ For the sorption coolers the following dissipations should be considered:

- sorption cooler off: 0 mW (SPIRE is modelling the parasitics, PACS should do the same in the next version, parasitics ~0.5 mW).

- sorption cooler recycling: 164J / 1h (cooler evaporator) releasing the He3 from the pump (by heating the pump) and liquefy it in the bath.

- sorption cooler cool-down: 290J / 1h (cooler pump) pumping down the He3 bath from 1.8 K to 0.3 K.

- sorption cooler operation: 314J / 46h (cooler pump) operate the cooler at 0.3 K by continuous pumping.

5 Comparison of Reduced and Detailed TMM Results

The deviation of the instrument I/F temperatures are less than 0.28%. Except for Mode 5, where it is 0.6% (for HIFI Level 1). Detailed temperature listings are shown in the Annex.
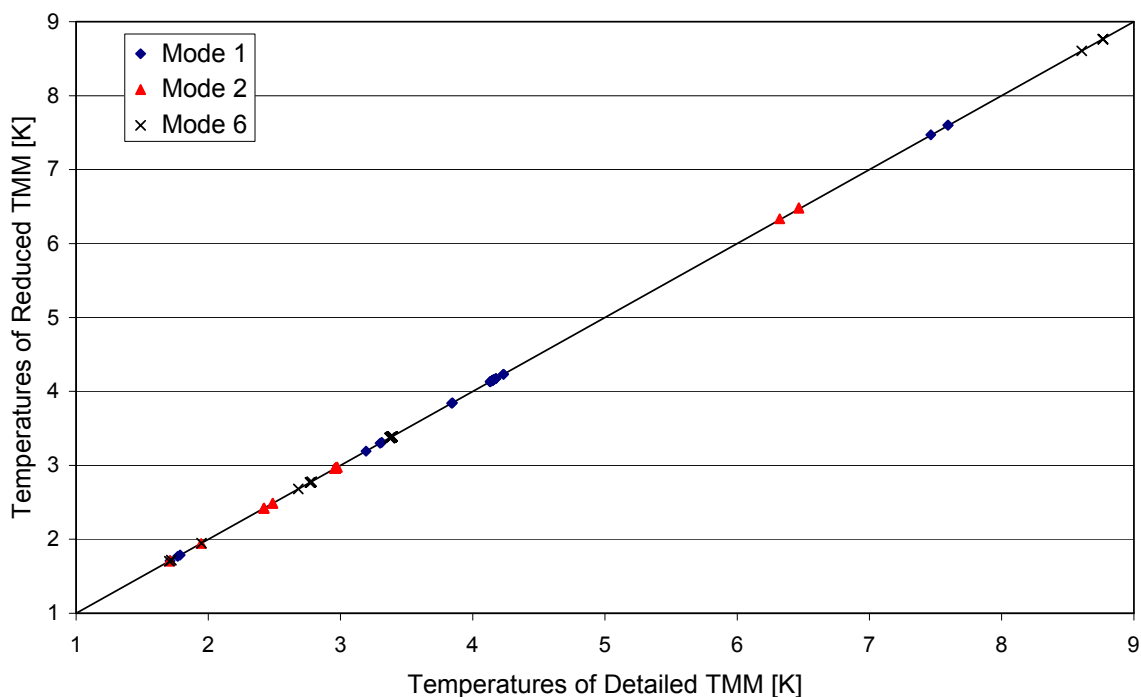

Figure 3.5-1:   PACS Temperatures – Reduced versus Detailed TMM Results
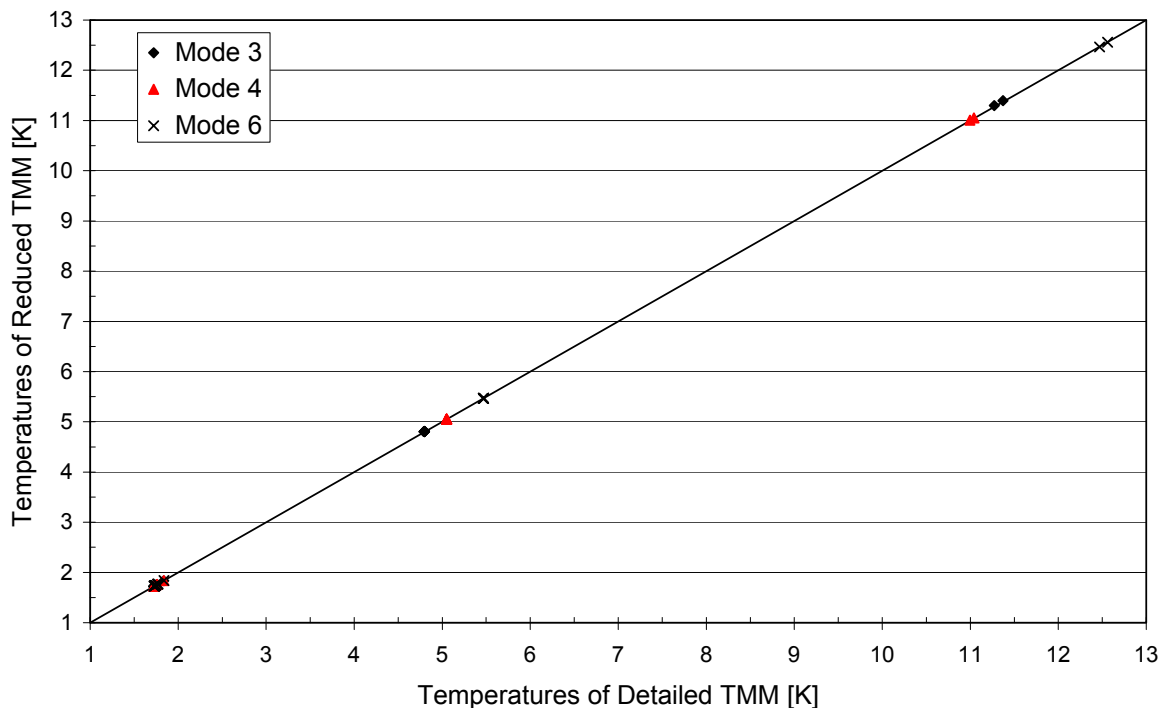
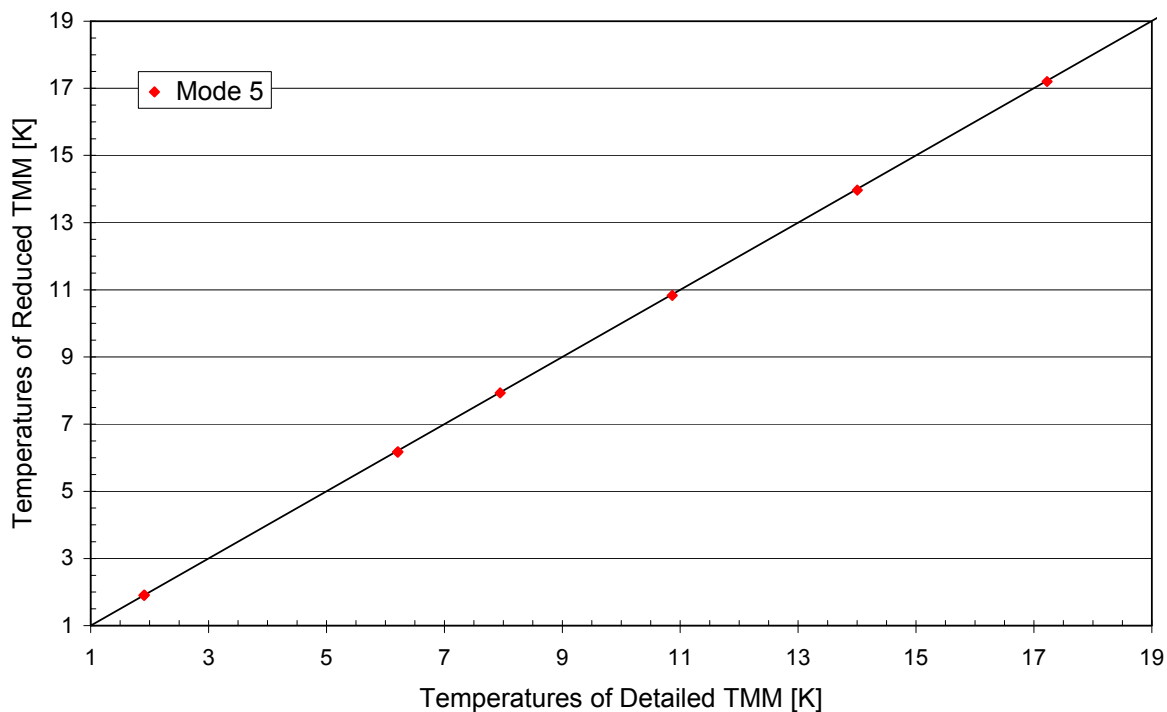Figure 3.5-2:   SPIRE Temperatures – Reduced versus Detailed TMM Results

Figure 3.5-3:   HIFI Temperatures – Reduced versus Detailed TMM Results

ANNEX: Temperature Listings

	Mode 1: PACS Spectrometer			
Node	Detailed TMM	Reduced TMM	Deviation (T det. - T red.)	
	[K]	[K]	absolute [K]	relative [%]
710	4.14805	4.14803	2E-05	0.00048%
720	4.1525	4.15249	1E-05	0.00024%
725	4.14272	4.1427	2E-05	0.00048%
730	4.13117	4.13116	1E-05	0.00024%
735	4.14875	4.14874	1E-05	0.00024%
740	4.14716	4.14715	1E-05	0.00024%
750	4.17275	4.17274	1E-05	0.00024%
755	4.17573	4.17572	1E-05	0.00024%
760	1.71113	1.71113	0	0.00000%
761	4.23325	4.23324	1E-05	0.00024%
765	1.7876	1.7876	0	0.00000%
766	4.23351	4.2335	1E-05	0.00024%
770	4.15286	4.15285	1E-05	0.00024%
771	4.13153	4.13152	1E-05	0.00024%
775	4.1621	4.16209	1E-05	0.00024%
776	4.15765	4.15763	2E-05	0.00048%
780	4.14279	4.14277	2E-05	0.00048%
781	1.76822	1.76822	0	0.00000%
791	7.59438	7.59976	-0.00538	-0.07084%
792	7.46397	7.46935	-0.00538	-0.07208%
793	7.59404	7.59942	-0.00538	-0.07085%
794	3.29975	3.29975	0	0.00000%
795	3.31112	3.31112	0	0.00000%
796	3.84008	3.84007	1E-05	0.00026%
797	3.84722	3.84722	0	0.00000%
798	3.19223	3.19223	0	0.00000%
801	10.30108	10.31006	-0.00898	-0.08718%
802	10.29391	10.30269	-0.00878	-0.08529%
803	4.85164	4.85325	-0.00161	-0.03318%
804	4.85292	4.85453	-0.00161	-0.03318%
805	4.85164	4.85325	-0.00161	-0.03318%
806	4.85164	4.85325	-0.00161	-0.03318%
807	4.85164	4.85325	-0.00161	-0.03318%
808	4.85164	4.85325	-0.00161	-0.03318%
809	4.85164	4.85325	-0.00161	-0.03318%
810	1.75445	1.75449	-4E-05	-0.00228%
811	1.73394	1.73397	-3E-05	-0.00173%
812	1.72875	1.72876	-1E-05	-0.00058%
813	1.72869	1.72871	-2E-05	-0.00116%
816	1.82897	1.82898	-1E-05	-0.00055%
817	1.72247	1.72248	-1E-05	-0.00058%
818	1.72869	1.72871	-2E-05	-0.00116%
819	1.75309	1.7531	-1E-05	-0.00057%
820	1.72232	1.72233	-1E-05	-0.00058%
900	1.82568	1.82572	-4E-05	-0.00219%
905	3.90363	3.89974	0.00389	0.09965%
910	10.2648	10.27348	-0.00868	-0.08456%
912	1.82165	1.8217	-5E-05	-0.00274%
913	5.21071	5.20477	0.00594	0.11400%
914	8.13424	8.13785	-0.00361	-0.04438%
915	8.12106	8.12456	-0.0035	-0.04310%
920	5.21443	5.20852	0.00591	0.11334%
Deviation:	all Levels:	max:	0.00594 K	0.11400%
		min:	-0.00898 K	-0.08718%
	L0 only:	max:	0 K	0.00000%
		min:	-5E-05 K	-0.00274%
	L1 only:	max:	0.00594 K	0.11400%
		min:	-0.00538 K	-0.07208%
	L2 only:	max:	-0.00868 K	-0.08456%
		min:	-0.00898 K	-0.08718%

	Mode 2: PACS Photometer			
Node	Detailed TMM	Reduced TMM	Deviation (T det. - T red.)	
	[K]	[K]	absolute [K]	relative [%]
710	2.96427	2.96595	-0.00168	-0.05667%
720	2.96533	2.96702	-0.00169	-0.05699%
725	2.95886	2.96054	-0.00168	-0.05678%
730	2.95685	2.95853	-0.00168	-0.05682%
735	2.96217	2.96385	-0.00168	-0.05672%
740	2.96258	2.96427	-0.00169	-0.05704%
750	2.96217	2.96385	-0.00168	-0.05672%
755	2.96051	2.9622	-0.00169	-0.05708%
760	1.70341	1.70342	-1E-05	-0.00059%
761	2.96147	2.96316	-0.00169	-0.05707%
765	1.71244	1.71247	-3E-05	-0.00175%
766	2.96149	2.96318	-0.00169	-0.05707%
770	2.96533	2.96702	-0.00169	-0.05699%
771	2.95685	2.95853	-0.00168	-0.05682%
775	2.97493	2.97662	-0.00169	-0.05681%
776	2.97387	2.97555	-0.00168	-0.05649%
780	2.96004	2.96172	-0.00168	-0.05676%
781	1.9454	1.94541	-1E-05	-0.00051%
791	6.46655	6.48133	-0.01478	-0.22856%
792	6.32049	6.3352	-0.01471	-0.23274%
793	6.46591	6.48069	-0.01478	-0.22858%
794	2.48529	2.48643	-0.00114	-0.04587%
795	2.48729	2.48843	-0.00114	-0.04583%
796	2.4201	2.42114	-0.00104	-0.04297%
797	2.42323	2.42428	-0.00105	-0.04333%
798	2.41916	2.4202	-0.00104	-0.04299%
801	9.23869	9.26146	-0.02277	-0.24646%
802	9.22978	9.25233	-0.02255	-0.24432%
803	3.80735	3.81373	-0.00638	-0.16757%
804	3.80842	3.8148	-0.00638	-0.16752%
805	3.80735	3.81373	-0.00638	-0.16757%
806	3.80735	3.81373	-0.00638	-0.16757%
807	3.80735	3.81373	-0.00638	-0.16757%
808	3.80735	3.81373	-0.00638	-0.16757%
809	3.80735	3.81373	-0.00638	-0.16757%
810	1.73075	1.73088	-0.00013	-0.00751%
811	1.71913	1.71921	-8E-05	-0.00465%
812	1.71809	1.71815	-6E-05	-0.00349%
813	1.71807	1.71813	-6E-05	-0.00349%
816	1.82235	1.82239	-4E-05	-0.00219%
817	1.71519	1.71524	-5E-05	-0.00292%
818	1.71807	1.71813	-6E-05	-0.00349%
819	1.74647	1.74651	-4E-05	-0.00229%
820	1.71505	1.71509	-4E-05	-0.00233%
900	1.80029	1.80059	-0.0003	-0.01666%
905	3.17466	3.17608	-0.00142	-0.04473%
910	9.19971	9.22209	-0.02238	-0.24327%
912	1.79801	1.79831	-0.0003	-0.01669%
913	4.10695	4.10896	-0.00201	-0.04894%
914	7.11451	7.1295	-0.01499	-0.21070%
915	7.09806	7.11298	-0.01492	-0.21020%
920	4.11133	4.11336	-0.00203	-0.04938%
Deviation:	all Levels:	max:	-1E-05 K	-0.00051%
		min:	-0.02277 K	-0.24646%
	L0 only:	max:	-1E-05 K	-0.00051%
		min:	-0.0003 K	-0.01669%
	L1 only:	max:	-0.00104 K	-0.04297%
		min:	-0.01499 K	-0.23274%
	L2 only:	max:	-0.02238 K	-0.24327%
		min:	-0.02277 K	-0.24646%

Mode 3: SPIRE Photometer			Deviation (T det. - T red.)	
Node	Detailed TMM	Reduced TMM	absolute [K]	relative [%]
	[K]	[K]		
710	2.83883	2.84156	-0.00273	-0.09617%
720	2.83699	2.83973	-0.00274	-0.09658%
725	2.83368	2.83641	-0.00273	-0.09634%
730	2.83326	2.83598	-0.00272	-0.09600%
735	2.8367	2.83943	-0.00273	-0.09624%
740	2.83697	2.8397	-0.00273	-0.09623%
750	2.8367	2.83943	-0.00273	-0.09624%
755	2.83519	2.83792	-0.00273	-0.09629%
760	1.70293	1.70294	-1E-05	-0.00059%
761	2.83359	2.83632	-0.00273	-0.09634%
765	1.7107	1.71073	-3E-05	-0.00175%
766	2.83361	2.83634	-0.00273	-0.09634%
770	2.83699	2.83973	-0.00274	-0.09658%
771	2.83326	2.83598	-0.00272	-0.09600%
775	2.83699	2.83973	-0.00274	-0.09658%
776	2.83883	2.84156	-0.00273	-0.09617%
780	2.83457	2.8373	-0.00273	-0.09631%
781	1.75581	1.75583	-2E-05	-0.00114%
791	7.72642	7.74378	-0.01736	-0.22468%
792	7.57739	7.5949	-0.01751	-0.23108%
793	7.72579	7.74315	-0.01736	-0.22470%
794	2.39922	2.40105	-0.00183	-0.07627%
795	2.40105	2.40288	-0.00183	-0.07622%
796	2.34138	2.34305	-0.00167	-0.07133%
797	2.34416	2.34584	-0.00168	-0.07167%
798	2.34067	2.34234	-0.00167	-0.07135%
801	11.37103	11.39554	-0.02451	-0.21555%
802	11.27373	11.29845	-0.02472	-0.21927%
803	4.79503	4.80367	-0.00864	-0.18019%
804	4.79676	4.80541	-0.00865	-0.18033%
805	4.79995	4.80859	-0.00864	-0.18000%
806	4.79503	4.80367	-0.00864	-0.18019%
807	4.80007	4.80871	-0.00864	-0.18000%
808	4.79503	4.80367	-0.00864	-0.18019%
809	4.79503	4.80367	-0.00864	-0.18019%
810	1.75303	1.75324	-0.00021	-0.01198%
811	1.73305	1.73318	-0.00013	-0.00750%
812	1.72835	1.72845	-1E-04	-0.00579%
813	1.7283	1.72839	-9E-05	-0.00521%
816	1.83498	1.83503	-5E-05	-0.00272%
817	1.72237	1.72243	-6E-05	-0.00348%
818	1.7283	1.72839	-9E-05	-0.00521%
819	1.75913	1.75919	-6E-05	-0.00341%
820	1.72212	1.72218	-6E-05	-0.00348%
900	1.83584	1.83617	-0.00033	-0.01798%
905	3.76826	3.76842	-0.00016	-0.00425%
910	11.21894	11.24369	-0.02475	-0.22061%
912	1.83221	1.83254	-0.00033	-0.01801%
913	4.9996	4.99968	-8E-05	-0.00160%
914	8.69937	8.71626	-0.01689	-0.19415%
915	8.66665	8.68284	-0.01619	-0.18681%
920	5.00528	5.0054	-0.00012	-0.00240%

Deviation:	all Levels:	max:	-1E-05 K	-0.00059%
		min:	-0.02475 K	-0.23108%
	L0 only:	max:	-1E-05 K	-0.00059%
		min:	-0.00033 K	-0.01801%
	L1 only:	max:	-8E-05 K	-0.00160%
		min:	-0.01751 K	-0.23108%
	L2 only:	max:	-0.02451 K	-0.21555%
		min:	-0.02475 K	-0.22061%

Mode 4: SPIRE Photometer				
Node	Detailed TMM	Reduced TMM	Deviation (T det. - T red.)	
	[K]	[K]	absolute [K]	relative [%]
710	2.80334	2.80393	-0.00059	-0.02105%
720	2.8015	2.8021	-0.0006	-0.02142%
725	2.79835	2.79895	-0.0006	-0.02144%
730	2.79795	2.79854	-0.00059	-0.02109%
735	2.80127	2.80186	-0.00059	-0.02106%
740	2.80152	2.80212	-0.0006	-0.02142%
750	2.80127	2.80186	-0.00059	-0.02106%
755	2.79981	2.8004	-0.00059	-0.02107%
760	1.7028	1.7028	0	0.00000%
761	2.79823	2.79883	-0.0006	-0.02144%
765	1.71023	1.71024	-1E-05	-0.00058%
766	2.79825	2.79884	-0.00059	-0.02108%
770	2.8015	2.8021	-0.0006	-0.02142%
771	2.79795	2.79854	-0.00059	-0.02109%
775	2.8015	2.8021	-0.0006	-0.02142%
776	2.80334	2.80393	-0.00059	-0.02105%
780	2.79923	2.79982	-0.00059	-0.02108%
781	1.75554	1.75554	0	0.00000%
791	7.53904	7.54717	-0.00813	-0.10784%
792	7.39411	7.40229	-0.00818	-0.11063%
793	7.53841	7.54655	-0.00814	-0.10798%
794	2.37554	2.37594	-0.0004	-0.01684%
795	2.37731	2.37771	-0.0004	-0.01683%
796	2.31977	2.32014	-0.00037	-0.01595%
797	2.32246	2.32283	-0.00037	-0.01593%
798	2.31913	2.3195	-0.00037	-0.01595%
801	10.99579	11.00811	-0.01232	-0.11204%
802	11.04059	11.0526	-0.01201	-0.10878%
803	5.04881	5.05186	-0.00305	-0.06041%
804	5.05258	5.05564	-0.00306	-0.06056%
805	5.05001	5.05306	-0.00305	-0.06040%
806	5.05169	5.05474	-0.00305	-0.06038%
807	5.05001	5.05306	-0.00305	-0.06040%
808	30.64881	30.65186	-0.00305	-0.00995%
809	5.04881	5.05186	-0.00305	-0.06041%
810	1.75954	1.75962	-8E-05	-0.00455%
811	1.73713	1.73718	-5E-05	-0.00288%
812	1.73111	1.73114	-3E-05	-0.00173%
813	1.73105	1.73108	-3E-05	-0.00173%
816	1.83658	1.8366	-2E-05	-0.00109%
817	1.72413	1.72415	-2E-05	-0.00116%
818	1.73105	1.73108	-3E-05	-0.00173%
819	1.76073	1.76075	-2E-05	-0.00114%
820	1.72388	1.7239	-2E-05	-0.00116%
900	1.83302	1.83311	-9E-05	-0.00491%
905	3.81835	3.81466	0.00369	0.09664%
910	10.94107	10.95314	-0.01207	-0.11032%
912	1.82925	1.82935	-1E-04	-0.00547%
913	5.07738	5.07173	0.00565	0.11128%
914	8.53477	8.54115	-0.00638	-0.07475%
915	8.50973	8.51579	-0.00606	-0.07121%
920	5.08242	5.07679	0.00563	0.11077%
Deviation:	all Levels:	max:	0.00565 K	0.11128%
		min:	-0.01232 K	-0.11204%
	L0 only:	max:	0 K	0.00000%
		min:	-1E-04 K	-0.00547%
	L1 only:	max:	0.00565 K	0.11128%
		min:	-0.00818 K	-0.11063%
	L2 only:	max:	-0.01201 K	-0.10878%
		min:	-0.01232 K	-0.11204%

	Mode 5:　HIFI on			
Node	Detailed TMM	Reduced TMM	Deviation (T det. - T red.)	
	[K]	[K]	absolute [K]	relative [%]
710	3.28018	3.27247	0.00771	0.23505%
720	3.27816	3.27047	0.00769	0.23458%
725	3.27296	3.26529	0.00767	0.23434%
730	3.27221	3.26455	0.00766	0.23409%
735	3.27725	3.26956	0.00769	0.23465%
740	3.27766	3.26997	0.00769	0.23462%
750	3.27725	3.26956	0.00769	0.23465%
755	3.2751	3.26742	0.00768	0.23450%
760	1.70471	1.70467	4E-05	0.00235%
761	3.2731	3.26543	0.00767	0.23433%
765	1.71716	1.71704	0.00012	0.00699%
766	3.27312	3.26546	0.00766	0.23403%
770	3.27816	3.27047	0.00769	0.23458%
771	3.27221	3.26455	0.00766	0.23409%
775	3.27816	3.27047	0.00769	0.23458%
776	3.28018	3.27247	0.00771	0.23505%
780	3.27399	3.26632	0.00767	0.23427%
781	1.75948	1.75941	7E-05	0.00398%
791	9.89439	9.86575	0.02864	0.28946%
792	9.72171	9.69284	0.02887	0.29696%
793	9.89362	9.86498	0.02864	0.28948%
794	2.69728	2.69203	0.00525	0.19464%
795	2.69968	2.69442	0.00526	0.19484%
796	2.61529	2.61044	0.00485	0.18545%
797	2.61928	2.61441	0.00487	0.18593%
798	2.61387	2.60903	0.00484	0.18517%
801	13.97669	13.9426	0.03409	0.24391%
802	13.96057	13.92629	0.03428	0.24555%
803	5.47922	5.45941	0.01981	0.36155%
804	5.48184	5.46202	0.01982	0.36156%
805	5.47922	5.45941	0.01981	0.36155%
806	5.47922	5.45941	0.01981	0.36155%
807	5.47922	5.45941	0.01981	0.36155%
808	5.47922	5.45941	0.01981	0.36155%
809	5.47922	5.45941	0.01981	0.36155%
810	1.77133	1.77076	0.00057	0.03218%
811	1.74452	1.74417	0.00035	0.02006%
812	1.73573	1.7355	0.00023	0.01325%
813	1.73566	1.73543	0.00023	0.01325%
816	1.83294	1.83281	0.00013	0.00709%
817	1.72683	1.7267	0.00013	0.00753%
818	1.73565	1.73543	0.00022	0.01268%
819	1.75706	1.75693	0.00013	0.00740%
820	1.72668	1.72654	0.00014	0.00811%
900	1.91031	1.90926	0.00105	0.05496%
905	7.94471	7.92923	0.01548	0.19485%
910	14.00435	13.97022	0.03413	0.24371%
912	1.90139	1.90042	0.00097	0.05102%
913	6.204	6.16488	0.03912	0.63056%
914	17.22388	17.20502	0.01886	0.10950%
915	10.86438	10.83045	0.03393	0.31230%
920	6.21283	6.17376	0.03907	0.62886%
Deviation:	**all Levels:**	max:	**0.03912 K**	**0.63056%**
		min:	**4E-05 K**	**0.00235%**
	L0 only:	max:	**0.00105 K**	**0.05496%**
		min:	**4E-05 K**	**0.00235%**
	L1 only:	max:	**0.03912 K**	**0.63056%**
		min:	**0.00484 K**	**0.10950%**
	L2 only:	max:	**0.03428 K**	**0.24555%**
		min:	**0.03409 K**	**0.24371%**

Mode 6: PACS Photometer and SPIRE Photometer Parallel				
Node	Detailed TMM	Reduced TMM	Deviation (T det. - T red.)	
	[K]	[K]	absolute [K]	relative [%]
710	3.38295	3.38151	0.00144	0.04257%
720	3.38393	3.3825	0.00143	0.04226%
725	3.37556	3.37414	0.00142	0.04207%
730	3.37322	3.37181	0.00141	0.04180%
735	3.38009	3.37867	0.00142	0.04201%
740	3.38066	3.37923	0.00143	0.04230%
750	3.38009	3.37867	0.00142	0.04201%
755	3.37783	3.3764	0.00143	0.04233%
760	1.70538	1.70537	1E-05	0.00059%
761	3.37778	3.37638	0.0014	0.04145%
765	1.71964	1.7196	4E-05	0.00233%
766	3.37779	3.37639	0.0014	0.04145%
770	3.38393	3.3825	0.00143	0.04226%
771	3.37322	3.37181	0.00141	0.04180%
775	3.39353	3.3921	0.00143	0.04214%
776	3.39255	3.39111	0.00144	0.04245%
780	3.37685	3.37543	0.00142	0.04205%
781	1.9487	1.94869	1E-05	0.00051%
791	8.7667	8.76422	0.00248	0.02829%
792	8.60599	8.60355	0.00244	0.02835%
793	8.76592	8.76344	0.00248	0.02829%
794	2.76953	2.76855	0.00098	0.03539%
795	2.77217	2.77119	0.00098	0.03535%
796	2.77377	2.77029	0.00348	0.12546%
797	2.78139	2.77801	0.00338	0.12152%
798	2.6809	2.67999	0.00091	0.03394%
801	12.56116	12.55846	0.0027	0.02149%
802	12.46933	12.46672	0.00261	0.02093%
803	5.4671	5.46426	0.00284	0.05195%
804	5.46919	5.46635	0.00284	0.05193%
805	5.4719	5.46906	0.00284	0.05190%
806	5.4671	5.46426	0.00284	0.05195%
807	5.4719	5.46906	0.00284	0.05190%
808	5.4671	5.46426	0.00284	0.05195%
809	5.4671	5.46426	0.00284	0.05195%
810	1.77098	1.7709	8E-05	0.00452%
811	1.7443	1.74425	5E-05	0.00287%
812	1.73581	1.73577	4E-05	0.00230%
813	1.73573	1.7357	3E-05	0.00173%
816	1.83922	1.8392	2E-05	0.00109%
817	1.72704	1.72702	2E-05	0.00116%
818	1.73573	1.7357	3E-05	0.00173%
819	1.76337	1.76335	2E-05	0.00113%
820	1.72679	1.72677	2E-05	0.00116%
900	1.86161	1.86136	0.00025	0.01343%
905	4.28679	4.27601	0.01078	0.25147%
910	12.42047	12.41785	0.00262	0.02109%
912	1.85659	1.85638	0.00021	0.01131%
913	5.7739	5.75777	0.01613	0.27936%
914	9.76012	9.75346	0.00666	0.06824%
915	9.68821	9.68156	0.00665	0.06864%
920	5.77985	5.76375	0.0161	0.27855%
Deviation:	**all Levels:**	max:	**0.01613 K**	**0.27936%**
		min:	**1E-05 K**	**0.00051%**
	L0 only:	max:	**0.00025 K**	**0.01343%**
		min:	**1E-05 K**	**0.00051%**
	L1 only:	max:	**0.01613 K**	**0.27936%**
		min:	**0.00091 K**	**0.02829%**
	L2 only:	max:	**0.0027 K**	**0.02149%**
		min:	**0.00261 K**	**0.02093%**

END OF DOCUMENT

Quantity	Name	Dep./Comp.	Quantity	Name	Dep./Comp.
	Alberti von Mathias Dr.	ED 544		Reuß Friedhelm	ED 71
	Barlage Bernhard	ED 62	X	Rühe Wolfgang	ED 3
	Bayer Thomas	ED 532		Runge Axel	OTN/TN 94
X	Faas Horst	ED 516		Sachsse Bernt	EC 34
	Grasl Andreas	OTN/TN 64		Schäffler Johannes	OTN/TN 64
	Grasshoff Brigitte	ED 511	X	Schink Dietmar	ED 522
	Hartmann Hans Dr.	ED 172	X	Schlosser Christian	OTN/TN 64
X	Hauser Armin	ED 541		Schwabbauer Paul Dr.	OTN/ED 171
X	Hinger Jürgen	ED 541		Schweickert Gunn	ED 544
X	Hohn Rüdiger	ED 531		Steininger Eric	ED 522
X	Hölzle Edgar	ED 171	X	Stritter Rene	ED 61
	Huber Johann	ED 532		Suttner Klaus	ED 542
	Hund Walter	ED 556		Tenhaeff Dieter	ED 544
X	Idler Siegmund	ED 521		Thörmer Klaus-Horst Dr.	OTN/ED 37
	Ivády von András	EC 32		Wagner Adalbert	OTN/IP 35
	Jahn Gerd Dr.	ED 541	X	Wagner Klaus	ED 541
	Kalde Clemens	ED 513	X	Wietbrock, Walter	ED 511
	Kameter Rudolf	OTN/TN 64		Wöhler Hans	ED 544
	Kersting Stefan	OTN/TN 63		Zipf Ludwig	EC 32
	Knoblauch August	ED 51			
	Koelle Markus	ED 533			
X	Kroeker Jürgen	ED 515	X	Pastorino Michel	ASPI Resid.
	Kunz Oliver	ED 541			
	Lamprecht Ernst	OTN/TN 72	X	Alcatel	ASPI
	Lang Jürgen	ED 556	X	ESA/ESTEC	ESA
	Langfermann Michael	ED 531			
	Mack Paul	OTN/TN 64		Instruments	
	Maier Hans-Ulrich	ED 61	X	MPE (PACS)	MPE
	Mauch Alfred	ED 544	X	RAL (SPIRE)	RAL
X	Moritz Konrad Dr.	ED 37	X	SRON (HIFI)	SRON
	Müller Lutz	OTN/TN 64			
	Muhl Eckhard	OTN/TN 64		Subcontractors:	
	Peitzker Helmut	ED 37		Air Liquide	AIR
	Peltz Heinz-Willi	ED 515		APCO Technologies S. A.	APCO
	Peters, Gerhard	ED 533		Astrium GmbH Space Infrastr.	ASIP
	Pietroboni Karin	ED 37		BOC Edwards	BOCE
	Puttlitz Joachim	OTN/ED 37		HTS AG Zürich	HTSZ
	Raupp Helmut	ED 543		Linde	LIND
	Rebholz Reinhold	ED 531			