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FAX

FIRST/Planck Project

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subject **FIRST - Simplified Optical Bench Thermal Model**

reference

Please find below the promised simplified thermal model of the FIRST Optical Bench, that allows some estimation of the impact of variations of thermal loads of the Instrument Focal Plane Units.

It is a set of equations and has been derived from the detailed thermal model of the Payload Module of FIRST in line with the instrument definition as available during the System Optimisation Study.

The input parameters are those for the instrument heat load to the different thermal interface level, i.e. PPL0, PPL1, PPL2, SPL0, SPL1, SPL2, HPL0, HPL1 and HPL2.

Best regards

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Attachment: 2 pages

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Simplified Thermal Model of FIRST Optical Bench

Parameters

Power:
PACS to level 0: PPL0 [mW]
PACS to level 1: PPL1 [mW]
PACS to level 0: PPL2 [mW]

SPIRE to level 0: SPL0 [mW]
SPIRE to level 1: SPL1 [mW]
SPIRE to level 0: SPL2 [mW]

HIFI to level 0: HPL0 [mW]
HIFI to level 1: HPL1 [mW]
HIFI to level 0: HPL2 [mW]

Cryoharness dissipation to level 2: CHD2 [mW]
Cryoharness conduction to level 2: CHC2 [mW]

PLM structure and Radiation to level 0: PLM0 [mW]
PLM structure and Radiation to level 2: PLM2 [mW]
Total Heat load from PACS to level 1: THP1 [mW]
Total Heat load from SPIRE to level 1: THS1 [mW]
Total Heat load from HIFI to level 1: THH1 [mW]

Sum heat load to level 0: SHL0 [mW]
Sum heat load to level 2: SHL2 [mW]
Sum heat load to heat shield 1: SHH1 [mW]

Temperatures:
PACS at ventline part level 1: TPV1 [K]
PACS at instr. interface level 1: TPI1 [K]
SPIRE at ventline part level 1: TSV1 [K]
SPIRE at instr. interface level 1: TSI1 [K]
HIFI at ventline part level 1: THV1 [K]
HIFI at instr. interface level 1: THI1 [K]

PACS at ventline part level 2: TPV2 [K]

Heat shield 1: HS1 [K]
Optical Bench: OB [K]

Massflow:
Massflow: mdot [mg/sec]

Equations/Input Numbers:

PPL0 = 0.17 (var.)
PPL1 = 2.76 (var.)
PPL2 = 3.95 (var.)

SPL0 = 0.67 (var.)
SPL1 = 2.47 (var.)
SPL2 = 12.68 (var.)

HPL0 = 0.8 (var.)
HPL1 = 0.27 (var.)
HPL2 = 10.74 (var.)

CHD2 = 10.79
CHC2 = 17.831

PLM0 = 56.618 + (OB – 9.36) + 0.8 * (HS1 – 34.84) + 3
PLM2 = 45.829

THP1 = PPL1 + (TPV2 – TPI1)
THS1 = SPL1 + 1.6 * (TPV2 – TSI1)
THH1 = HPL1 + 0.2 * (TPV2 – THI1)
SHL0 = PPL0 + SPL0 + HPL0 + PLM0
SHL2 = PPL2 + SPL2 + HPL2 + CHD2 + CHC2 + PLM2
SHH1 = 350

TPV1 = THP1/1000/[mdot/1000000]/5200 + 1.7
TPI1 = THP1/1000 * 0.3/[200 * 0.00002] + TPV1
TSV1 = THS1/1000/[mdot/1000000]/5200 + TPV1
TSI1 = THS1/1000 * 0.3/[200 * 0.00002] + TSV1
THV1 = THH1/1000/[mdot/1000000]/5200 + TSV1
THI1 = THH1/1000 * 0.3/[200 * 0.00002] + THV1
TPV2 = [(SHL2 + 5.35 + 0.65 * (PPL1 + SPL1 + HPL1 – 5.35))/1000]/[(mdot/1000000)*5200] + 1.7
OB = TPV2
HS1 = (SHH1/1000/(mdot/1000000)/5200) + TPV2

mdot = SHL0/23.1864