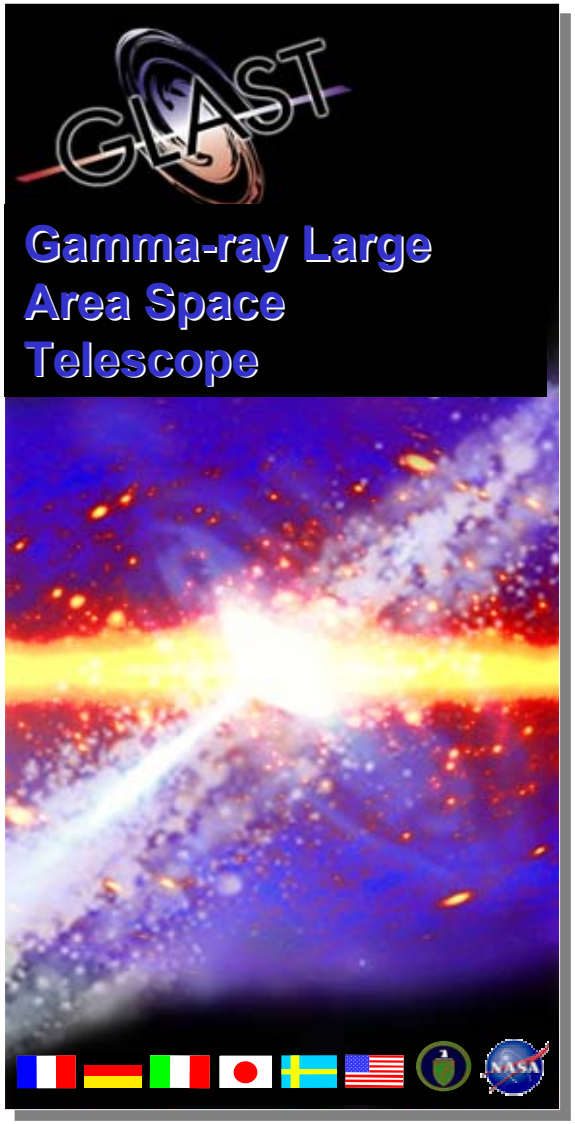

GLAST Large Area Telescope:

Anticoincidence Detector Thermal Subsystem

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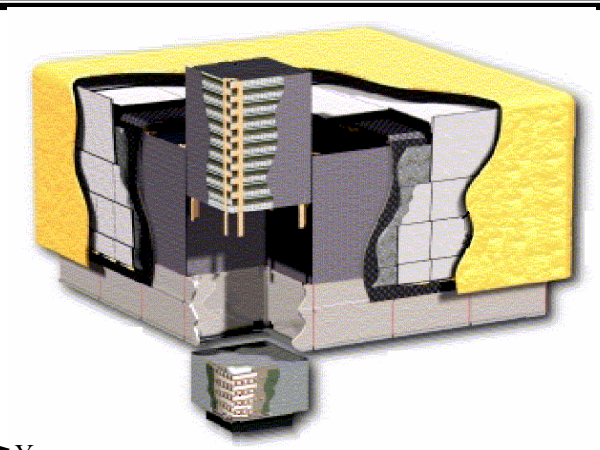
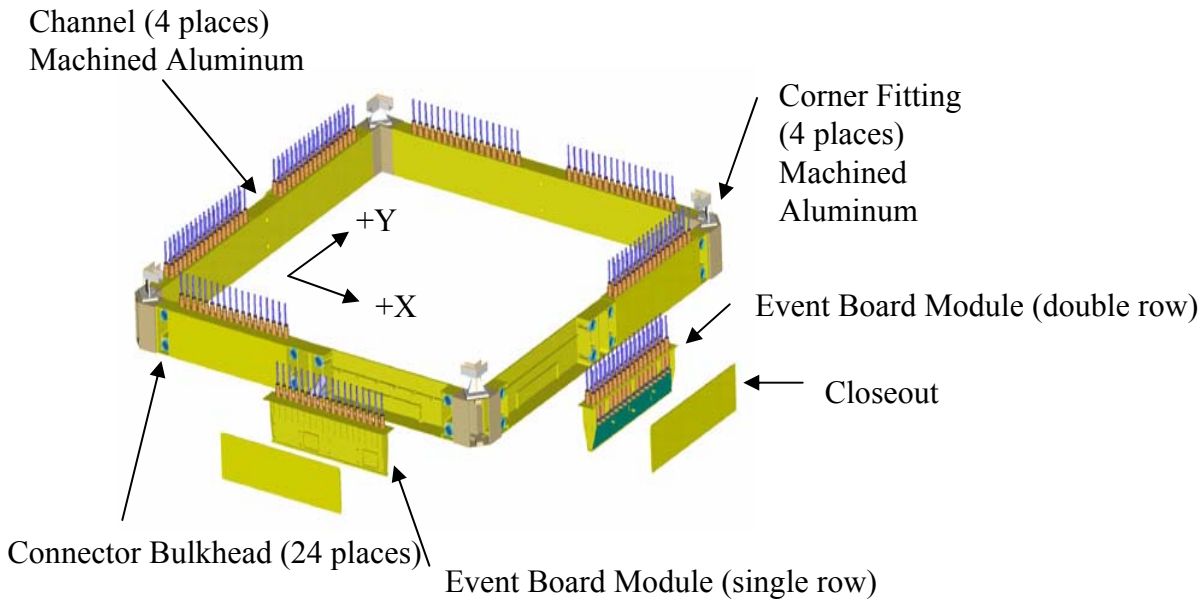
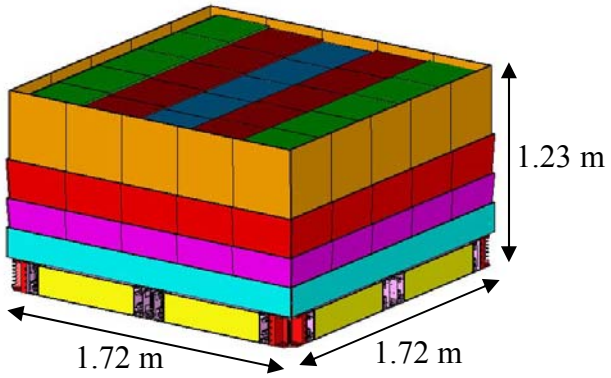
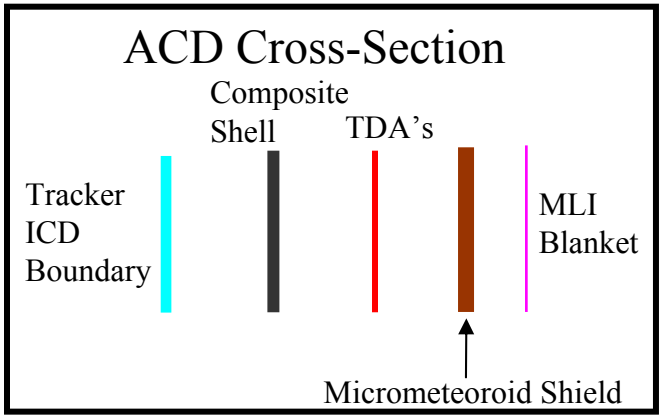


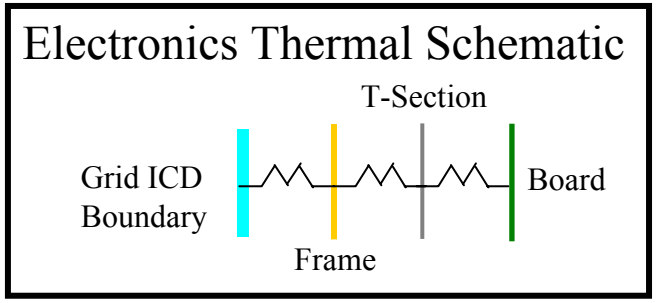


ACD Design Configuration

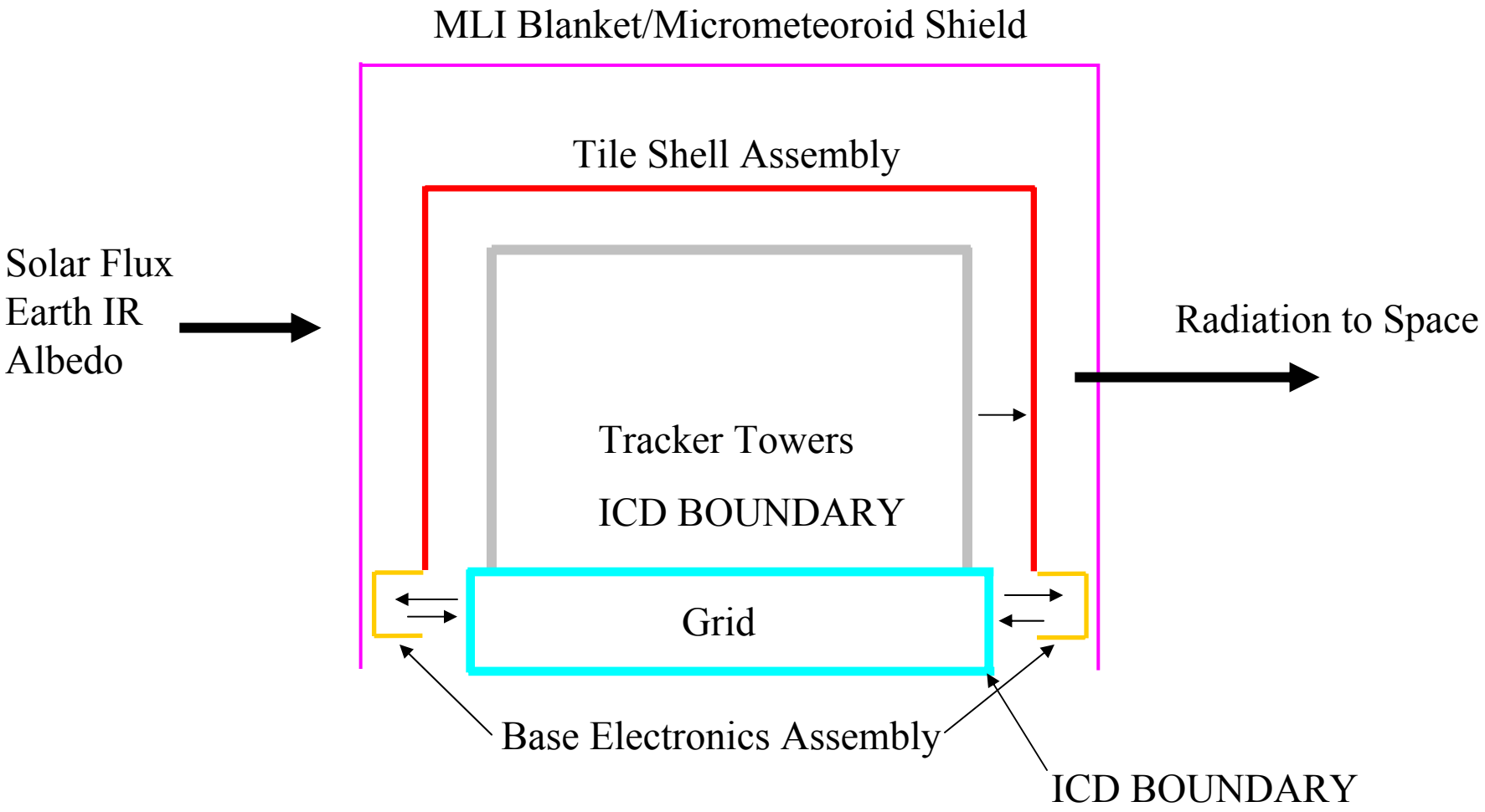
- Anticoincidence Detector covers all five external sides of the LAT
- External MLI Blanket has 5 mil Silver Teflon outer layer and is composed of 8-14 blanket layers
- Micrometeoroid shield includes approximately 3 cm of Solomide foam and Nextel layers
- Thin composite, low conductivity shell provides ACD structural support
- Low emittance tracker exterior surfaces mandated by LAT instrument team
- Electronics Boards mounted to BEA "T-section"
- No dedicated radiator
- BEA mounted to grid at the 4 corners via corner fittings and at the center of each side by mid-span connectors







ACD Design Configuration



ACD Thermal Requirements

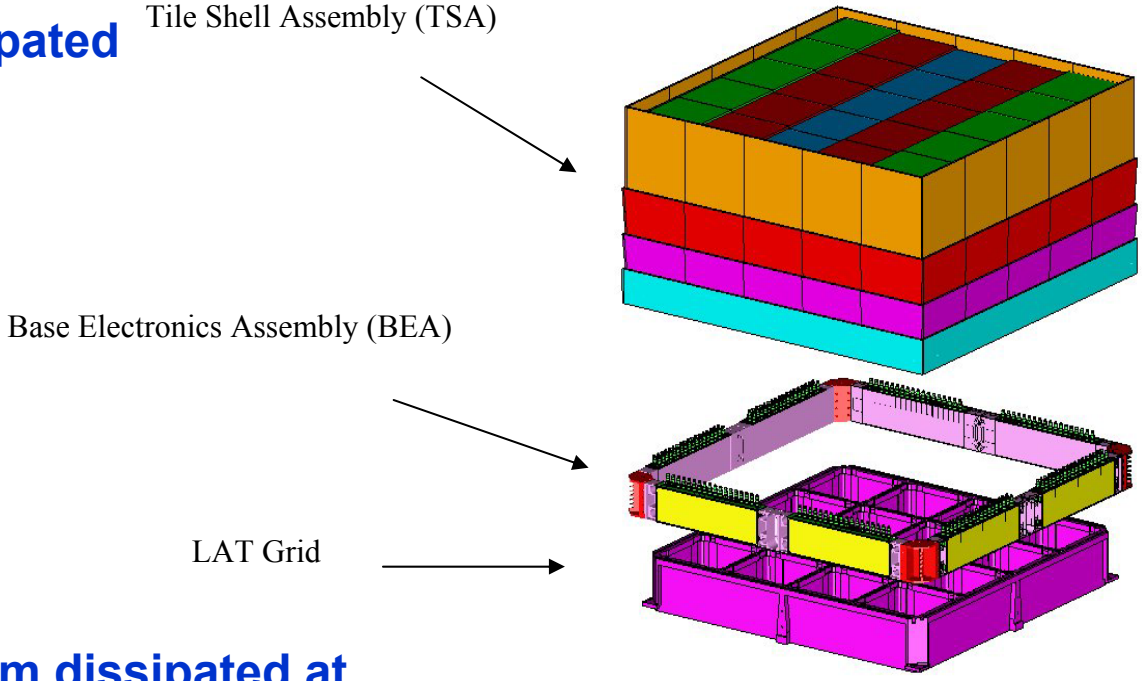
- **ACD TDA**
  - -50 to 40 C operating temperature requirement
  - -60 to 45 C survival temperature requirement
  - Requirement applicable at TDA external surface
  - Survival requirement driven by the optical epoxy adhesive

- **Electronics Interface**
  - -10 to 40 C operating temperature requirement
  - -40 to 45 C survival temperature requirement
  - Requirement applicable at board interface, the BEA “T-section”
  - Survival requirement driven by the PMT’s

ACD Power Dissipation

Tile Detector Assembly

- No power dissipated



Electronics

- 18 watts maximum dissipated at 12 board locations
- 1.5 watts per board

Thermal Design Approach

Tile Detector Assembly

- **Passive thermal design approach**
- **The following ACD characteristics argue for a thermal design approach based on local thermal environment considerations for any of the five sides:**
  - **LAT Point anywhere anytime viewing requirements**
  - **TDA's located on all five ACD exterior sides**
  - **Poor lateral thermal conduction characteristics through the ACD TDA structural support (low conductivity composite shell)**
  - **No dedicated radiator**
- **Hot case for any ACD exterior side occurs when the solar vector is normal to the ACD side with maximum earth infrared and albedo energy input.**
  - **25 C Tracker effective radiation sink environment**
- **Cold case for any ACD side occurs when an ACD side is shadowed from direct solar input and pointed in the zenith direction where earth infrared and reflected albedo solar input is minimum.**
  - **-10 C Tracker effective radiation sink environment**

Thermal Design Approach

Electronics Board Interface Temperatures

- Passive thermal design approach with survival heaters
- Electronics board interface temperatures are driven by the grid cold sink boundary temperature since heat transfer from the board interface to the grid is through a series conduction heat transfer path.

- Hot case occurs when grid ICD boundary temperature is maximum
  - Operational Grid Boundary = 25 C
  - Survival Grid Boundary = 40 C

- Operational Cold case occurs when grid ICD boundary temperature is minimum
  - Operational Grid Boundary = -10 C
  - Survival Grid Boundary = -20 C

Thermal Analyses Assumptions

Orbital Analysis

- **Thermal Environment Design Parameters**

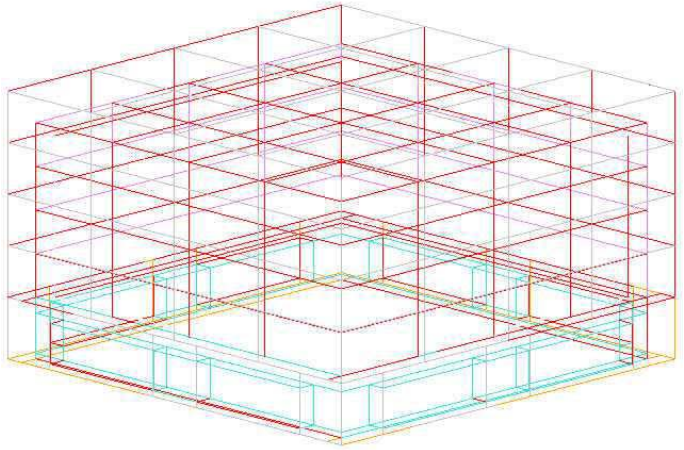
	COLD	HOT	UNITS
EARTH IR	66 208	84 265	Btu / Hr sq. ft Watts/ sq. meter
SOLAR CONSTANT	408 1287	450 1420	Btu / Hr sq. ft Watts/ sq. meter
SOLAR ALBEDO	0.25	0.40	Dimensionless

- **Optical properties**

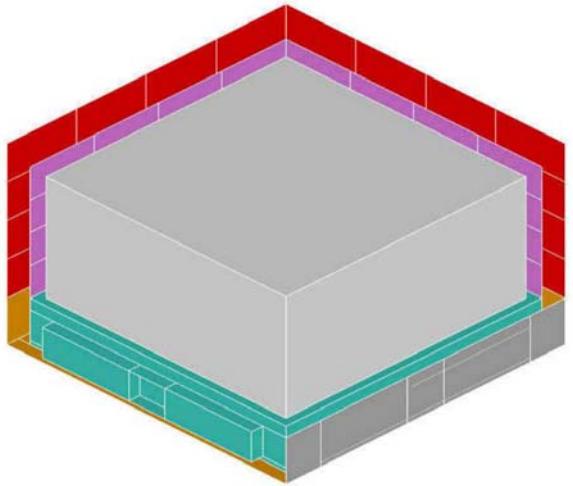
TSS Optics Name	Description	Emissivity (BOL)	Absorptivity (BOL)	Emissivity (EOL)	Absorptivity (EOL)
3_mil_Kapton	Interior Closeouts	0.79	*	0.75	*
5 mil Silver Teflon	Exterior MLI Blanket	0.78	0.08	0.74	0.13
Aluminum	Tracker Towers	0.10	*	0.10	*
Black Anodize	Grid Exterior and BEA	0.82	*	0.78	*
m46J/RS-3	ACD Shell	0.93	*	0.90	*

Thermal Model Description

- **TSS Geometric Math Model**
  - TSS Surface Model used to calculate view factors and orbital fluxes
  - 90 Surfaces with 411 active nodes
  - Used to calculate RADKS and heat rates



- **SINDA Thermal Math Model**
  - 512 total nodes



Thermal Design Results

Description	Cold Operating Temperature	Hot Operating Temperature	Cold Survival Temperature	Hot Survival Temperature	Operating Temperature Limits	Survival Temperature Limits
Grid Boundary	-10	25	-20	40	-	-
Trackers Boundary	-10	25	-20	40	-	-
ACD Composite Shell	-30	22	-39	36	-	-
Tile Detector Assembly	-32	21	-41	35	-50 to 40	-60 to 45
BEA +X T-section 1	-8	30	-20	40	-10 to 40	-40 to 45
BEA +Y T-section 1	-10	27	-21	39	-10 to 40	-40 to 45

- **All temperatures in ºC**

Summary

- Thermal design approach bounds worst case hot and cold possibilities
- TDA temperature requirements satisfied in design, external MLI effective emittance needs to be less than 0.05
- Tracker exterior surfaces can be high emittance so that TDA's are coupled to tracker temperatures rather than MLI temperatures
- Effective emittance of 0.03 or less can be achieved with 8-14 blanket layers
- ICD boundary conditions are driving the thermal design
- PMT survival temperature of 45 C cannot be exceeded in testing