SC-5 Telescope Structural / Thermal

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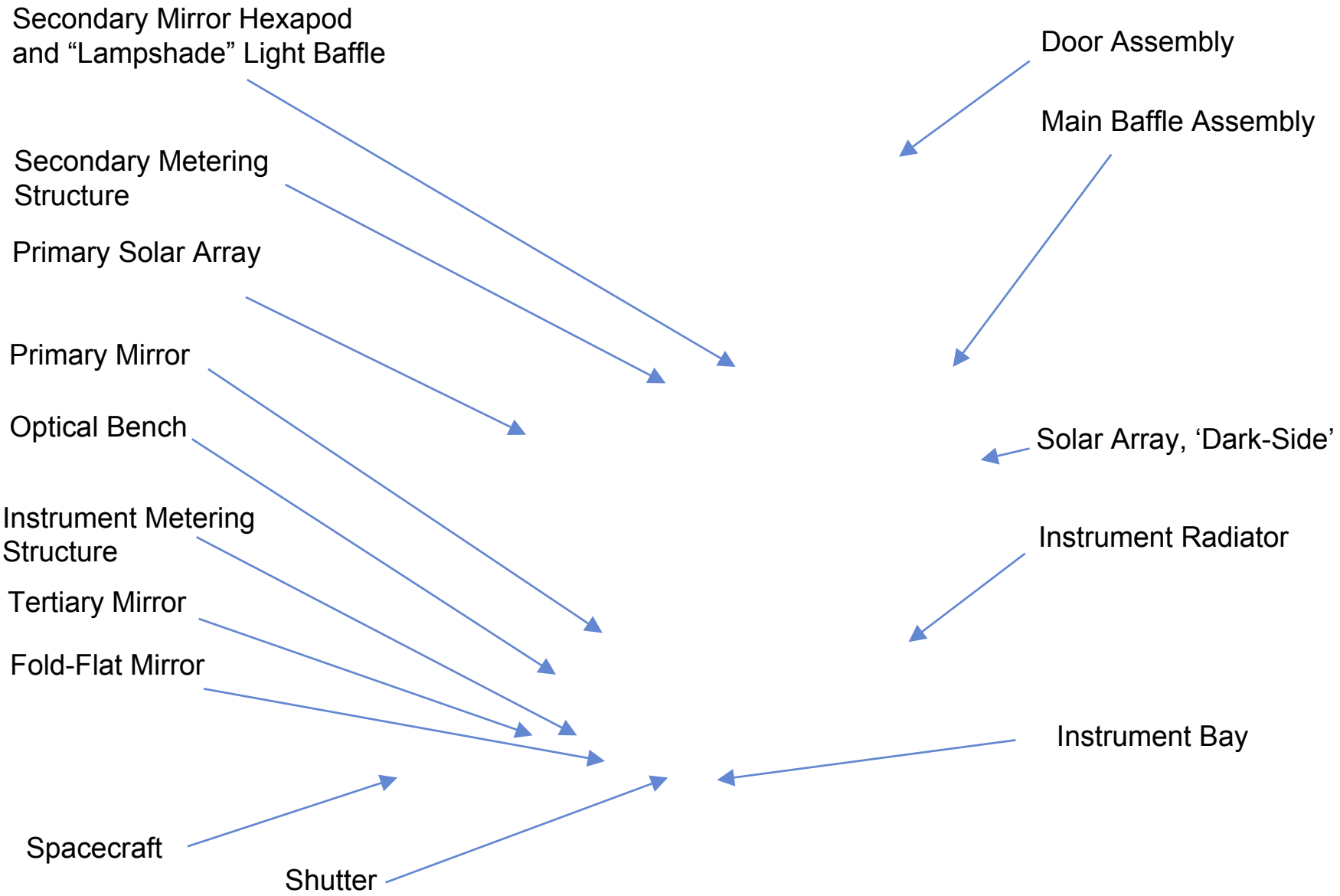
Current Telescope Evolution

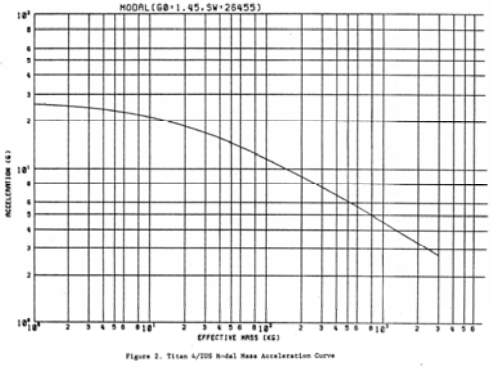


MECHANICAL REQUIREMENTS

- **Launch Environments (Delta IV)**
  - Stiffness: > 25 Hz (axial) > 10 Hz (lateral)
  - Strength: 6.5 Gs Axial; 2.0 Gs Lateral
  - Minimum Required Safety Factors
    - Two for 'Ordinary' Engineering Materials
    - Four for Composite Materials
    - Ten for Glass & Ceramic Materials
  - Vibro-Acoustics: *mostly for Boxes*

MASS ACCELERATION CURVE
FOR SPACECRAFT STRUCTURAL DESIGN
JPL Document: JPL D-5882
by: Marc Trubert dated Nov 1, 1989

10Gs



100 kg

- **Mission Environments**
  - Stiffness > 5 Hz to Minimize ACS Interactions
  - ~ ppm Optics Path Stability, periodic Focus is acceptable
  - Low Outgassing; Low Water Absorption; Low *(particulate)* Contamination

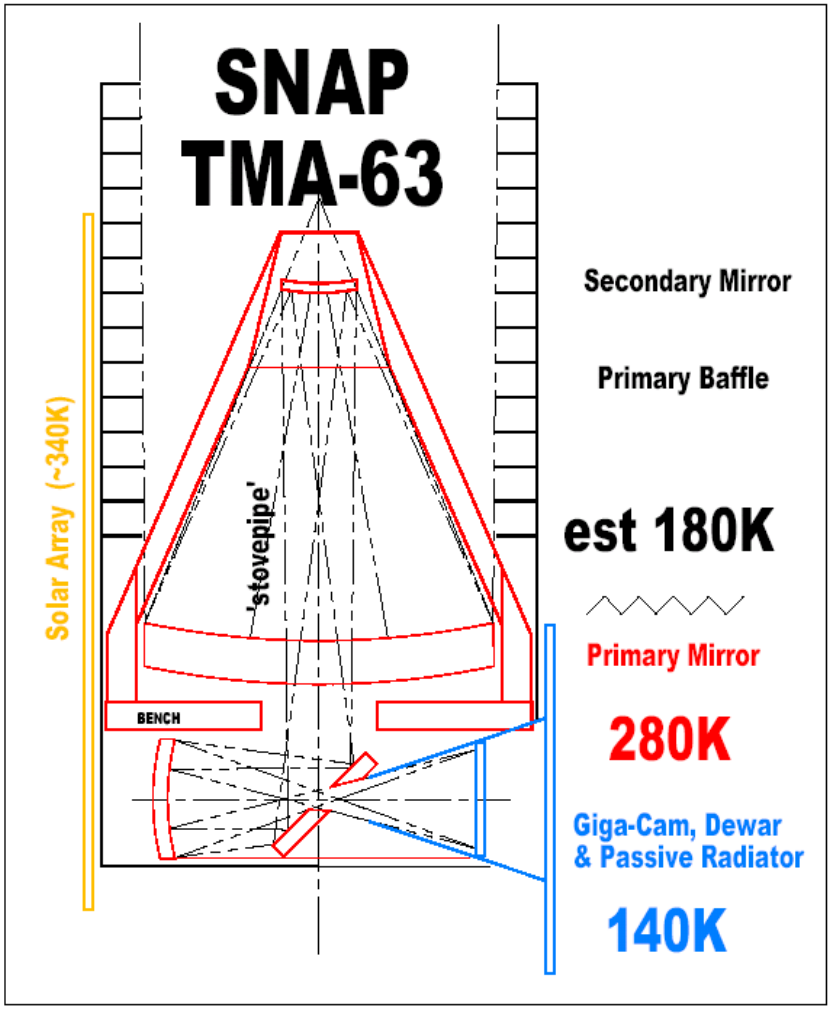
- **Integration & Test Environments**
  - Handling Fixture Accommodation on OTA
  - Needed (Large) Inventory of Handling Fixtures

TELESCOPE THERMAL

OPTICS: Build,Test, & Fly Warm… like Hubble !

KEY DESIGN FEATURES

- High Earth orbit (HEO) to minimize IR Earth-glow loading
- GaAs cell - OSR striping of the (hot) solar array panels
  - — Front surface heat rejection OK
  - — Optical Solar Reflectors are back silvered Quartz tiles (α ~ 8%, ε ~ 80%)
- Low emissivity silvered mirrors
- Thermal Isolation mounting and MLI blanketing



OTA WARM OPTICS THERMAL BUDGET

LARGE STRAY LIGHT BAFFLE (~180K)

478 w	Absorbed Sunlight if MLI covered (α^* ~ 2%)
100 w	Telescope Internal Parasitics and 5m^2 Solar Array coupling (MLI behind)
< 62w>	Radiant Loss from Baffle Outer Cylinder (ε^* ~ 2%)
<480w>	Radiant Loss from Baffle Open BB End (*large axial Temp gradient*)

PRIMARY MIRROR HEATER LOAD AT 280K

< 6w>	Radiant Loss to Space (ε ~ *2%*)
<14w>	Radiant Face Loss to 180K Baffle (ε ~ *2%*)
< 4w>	Radiant MLI covered Edge Loss to 180K Baffle (ε^* ~ *1%*)
< 1w>	Radiant Loss from Central MLI Stovepipe BB hole

SECONDARY MIRROR HEATER LOAD AT 280K

<10w>	Radiant and Conductive Losses to Baffle and Structure (Est.)

TBS	HEATED SECONDARY STRUCTURE (black MLI covered)

Cool Optics means cool figuring and testing – possible but a cost & schedule driver

Hubble budgeted 63w for heaters – now may be higher

OTA CAMERA THERMAL ROM

PASSIVE GIGA-CAM 140K DEWAR THERMAL BUDGET

32 w	Radiating Capacity from $2m^2$ unobstructed 130K Radiator to Space
< 4w>	Radiator Thermal Isolation Mounts & MLI behind

RADIANT COUPLING LOSSES

< 6w>	CONICAL Cosmic Ray Shield - MLI outside (ε^* ~ 1%)
< 4w>	Open End CONE Blackbody Loss to warm Coffin Cavity

CONDUCTIVE COUPLING LOSSES

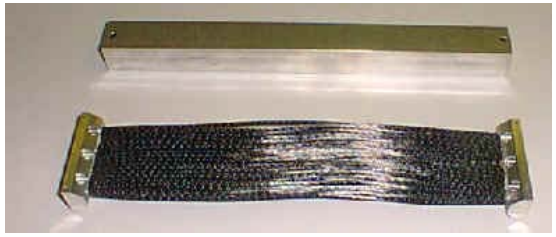
< 1w>	Giga-Cam Thermal Isolation Mounts
< 2w>	Dewar Thermal Isolation Mounts and Cold Plate Gaskets
< 1w>	Electrical “Flex-Print” (~ 5800 traces)
< 8w>	Average Electrical Power Dissipated in HgCdTe & CCD’s
~ 6w	CURRENT MARGIN (ROM)
~10°C	Gradient allocated for Cold Plate, Radiator, and Flex-Links

OTA THERMAL

SOME “KEY ITEM” THERMAL HARDWARE EXAMPLES

HESSI Sapphire & S-LINK
High Conductivity Thermal Strap
~ 700 layers Al Foil

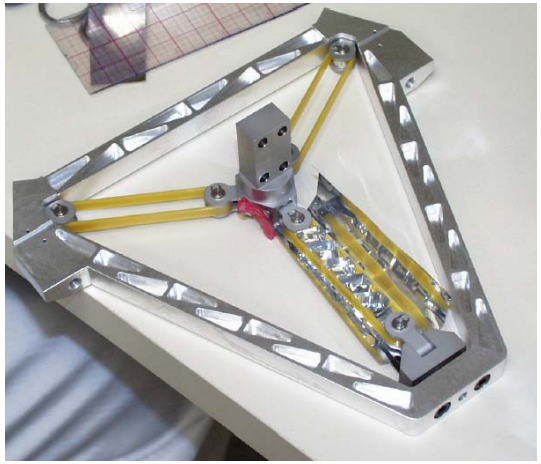
8x higher Conductivity Graphite Fiber based Thermal Strap Assembly



Mariner 6&7 (Mars ‘69)
IR Spectrometer
Joule-Thompson Cryostat
Thermal Isolation Mount

OTA THERMAL

SOME RECENT THERMAL HARDWARE EXAMPLES



HESSI S-Glass Thermal Isolation Strap Assembly
~140mW loss for the set at 200°ΔT

HESSI COLD PLATE ASSEMBLY
supports 38 kg Ge Detector Assembly under Vacuum

HESSI DETECTOR ASSEMBLY
Extensive Thermal Isolation used to achieve 75K with only ~3W of active cooling

OTA THERMAL +

SOLUTIONS FOR COMMON CONTAMINATION CONCERNS

- **Moisture or Frost is a Primary Culprit**
  - — FEP Teflon MLI Blanketing is a Stock Item (0.005% hygroscopic)
  - — Cyanate Ester Resins Absorb ~7ppm Water vs ~70 ppm for Epoxies
  - — Concentric Gold Plated Cans Tend to be Heavy & More Conductive

- **“Structured” Cool-down Approach**
  - — Focal Plane Camera will be the Last Item to Cool-Down in LEO
  - — Residual Moisture can be Frozen into Structure & Blankets

- **Preferred Vent Paths & Cover Strategies are Frequently Used**