Fig. 1.—Cutaway view of the Spitzer flight hardware. The observatory is approximately 4.5 m high and 2.1 m in diameter. In this figure the dust cover is shown prior to its ejection approximately 5 days after launch.
Spitzer Space Telescope Cryogenics

- 337 liters of superfluid LHe
- Warm launch. Radiative cooling of telescope to 30K.
  - Tremendous savings in cryogen/mass requirements.
- Telescope operating temperature 5.6K
  - Temperature reached 41 days after launch.
  - Raised to 9.5K during “warm” MIPS campaigns (sacrificing 160um sensitivity but conserving cryogen)
- Heat load onto Helium is 5.6 mW
  - 5.3 year lifetime – 0.935 MW total power dissipation.

- On-orbit Cryogenic Performance (Finley et al. SPIE 5487, 26)
- In-orbit Checkout Document
- "Warm" MIPS Campaign Evaluation Document
- Cryogenic Telescope Assembly (CTA) Gallery
Thermal Contraction

- Materials decrease in length with decreasing temperature.
  - From room temperature to 80K the thermal contraction exceeds the yield strain for most materials!
  - Dis-similar metal junctions will experience significant stress.
  - Most contraction occurs before reaching 100K
- Metals contract more than glasses and other optical materials (with potential damaging consequences)
- “Plastics” contract substantially more than metals

Fig. 4.5  Thermal contraction of some commonly used materials.
Thermal Contraction Application

- Consider an 0.750” O.D bearing press fit into Aluminum at room temperature cooled to 70K.
  - The bearing, made of stainless steel, will contract by 0.3%
    - \(0.750 \times 0.0030 = 0.0023”\)
  - The aluminum hole will contract to a diameter
    - \(0.750 \times 0.0041 = 0.0031”\)
  - The hole becomes about 0.001” smaller than the bearing it holds.
    - Sounds small, but bearings have such tight tolerances that this compression will bind up the bearing so that it will not turn.

Fig. 4.5 Thermal contraction of some commonly used materials.
Thermal Contraction Application

Lens Retention

**Radial Lens Retention** -
@77K - 3 Point Fit to 6061-T6 housing
MMC (min clearance) .001 decenter
LMC (max clearance) .002 decenter
@293K – 3 point radial contact to athermalized delrin pins
(Adjusted to “Fit”)

**Axial Lens Retention** - Canted coil springs retain optics ~2.2 lb/in at circumference
Delrin spacers distribute loads

Ref. Relief Zone