Cryogenic Technology for CMB-Pol

Stored Cryogens and Radiative Cooling

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CMB-Pol Needs

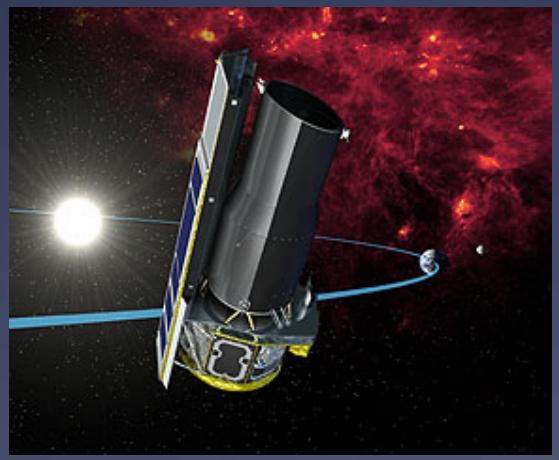
- Integrated Long Life, Low Mass, Low Power System with Operational Flexibility and High TRL
  - Consider Thermal Verfication Costs

Stored Cryogens' Long History

IRAS
1983

COBE, IRTS, ISO, …

Spitzer
2003



Herschel
2009

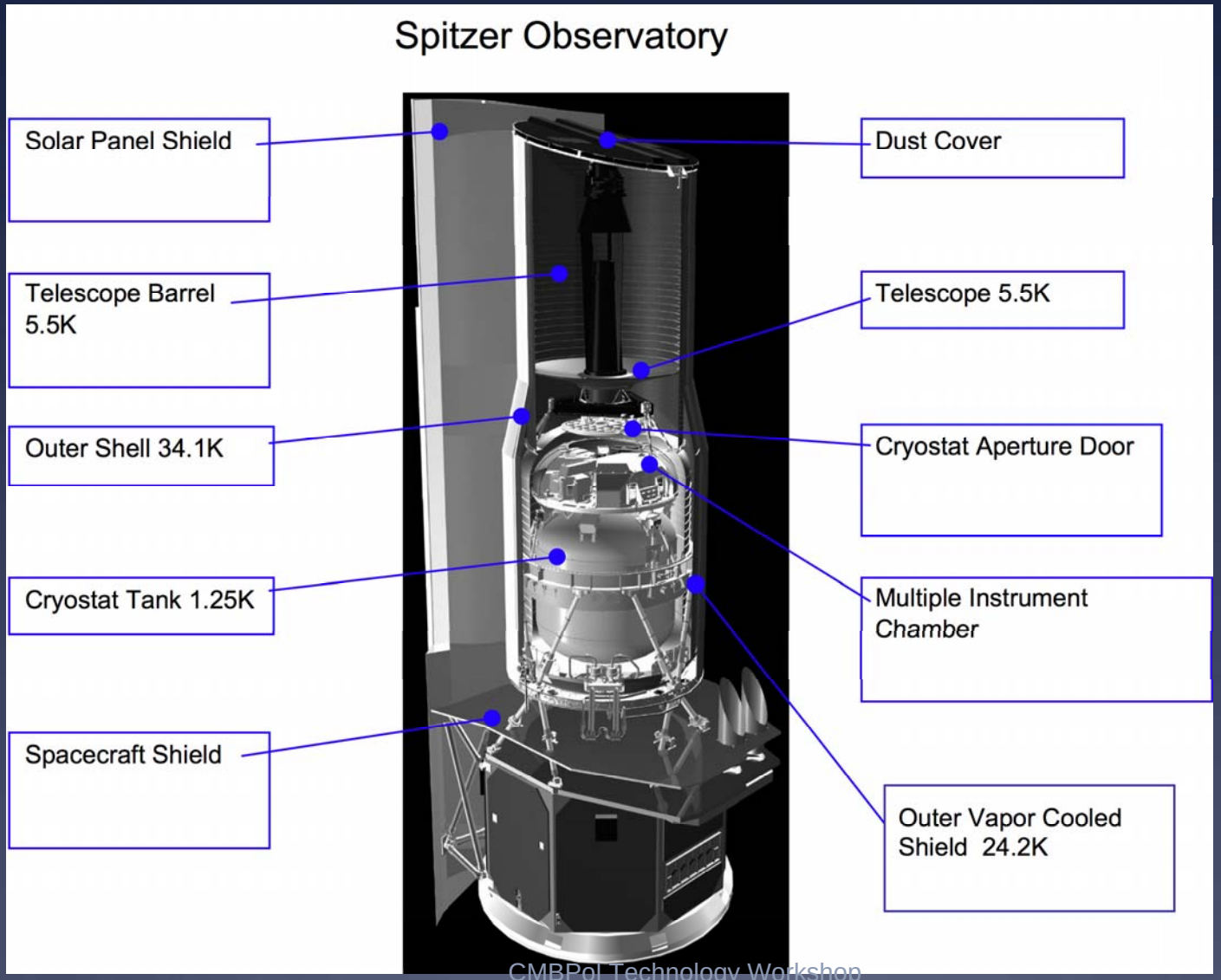
GP-B, Suzaku, Akari, …

Assessment of TRL - Stored Cryogens

* TRL 5 Because …

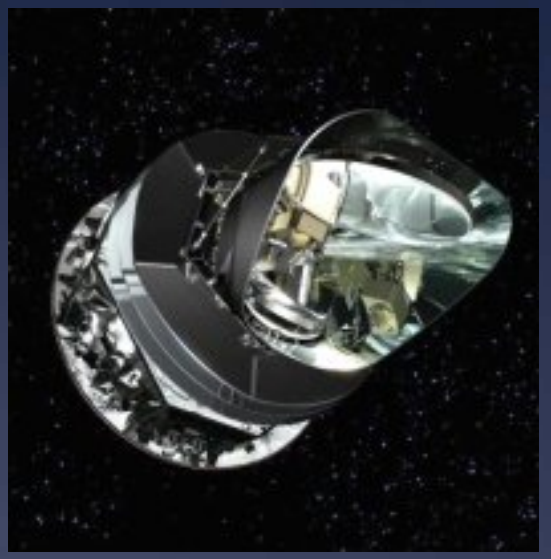
  Even a repeat build (COBE vs. IRAS dewars) had 50% drawings changed and had new issues

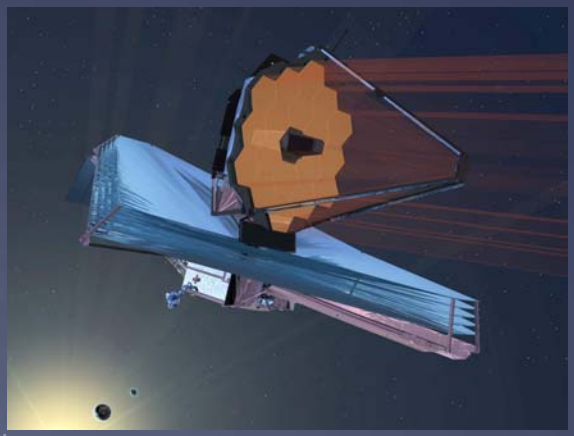
The State of the Art



Radiative Cooling to Low T

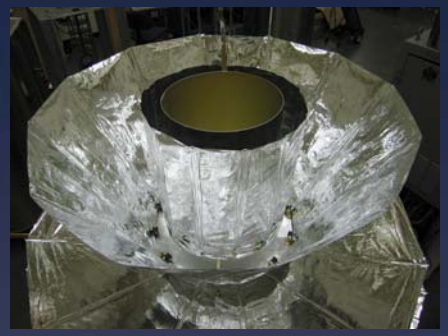
- Planck - V-Groove radiators
  - 50 K
- JWST 5 layer DAK sunshield plus BIRB coated radiators
  - 27 K

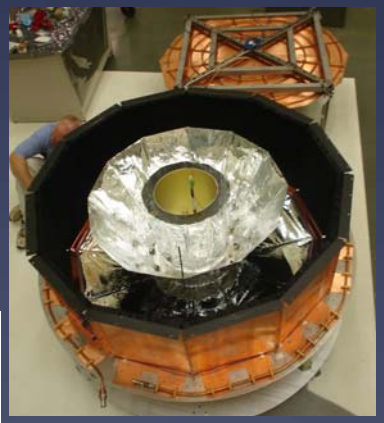


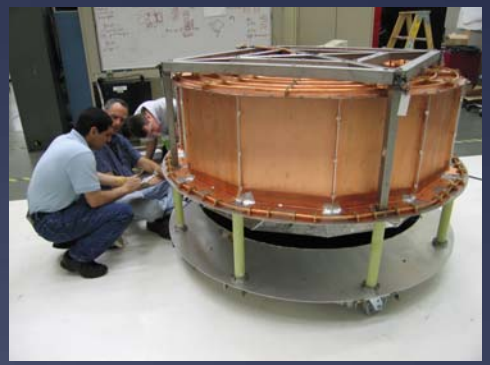


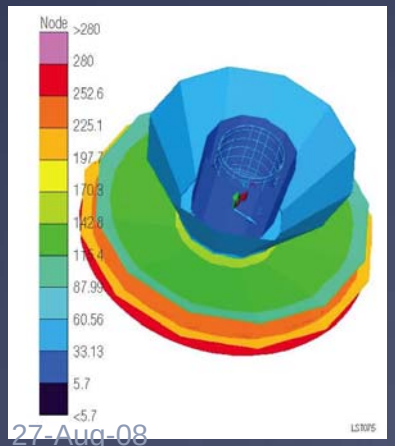
Thermal Performance Verification

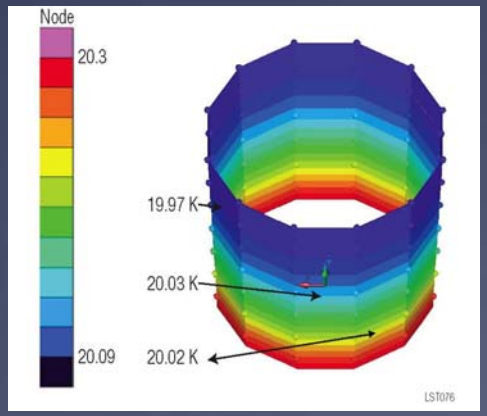
- High performance radiative cooling is difficult to verify before launch
- Large, cold, black facilities required
- Subscale testing
  - Shown is 18% model for 2 m telescope shield
  - Used cryocooler assist for lowest T (20K)
- Concentrate on model validation











Assessment of TRL - Radiators

- JWST sunshield and radiators are TRL 6
- Lower temperatures achievable on large shields with cooler assist on conductive loads
- Testing of even colder shields is shown to be feasible for reasonable cost
  - Subscale may be key

Stored Cryogens vs. Cryocoolers

- Extrapolating Spitzer to 3 m telescope would require 360 L -> 2600 L (6 mW vs. 42 mW)
  - MIRI Cryocooler has > 2x this cooling power
- The cases of NICMOS, WIRE and Astro-E2

The Special Case of Astro-H

- Uses both a SFHe Dewar and a 1.8 K JT Cooler
  - "redundant technology"
  - Cooler lifetime at issue
  - Very complex cryo system