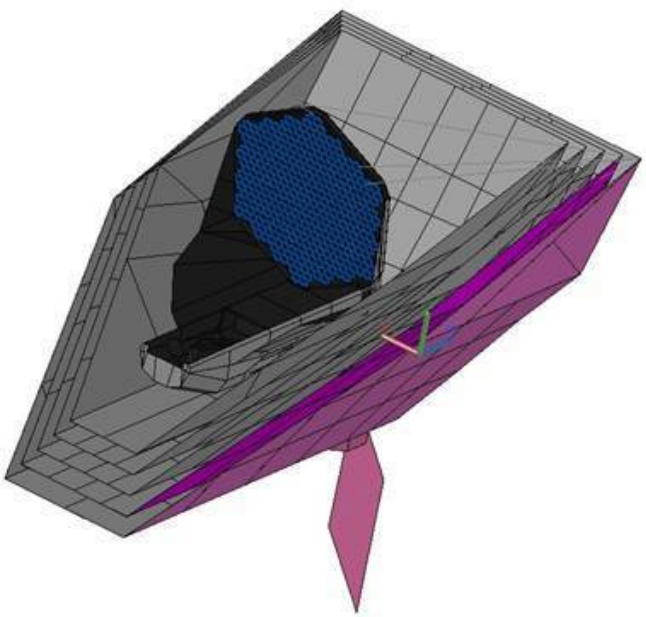
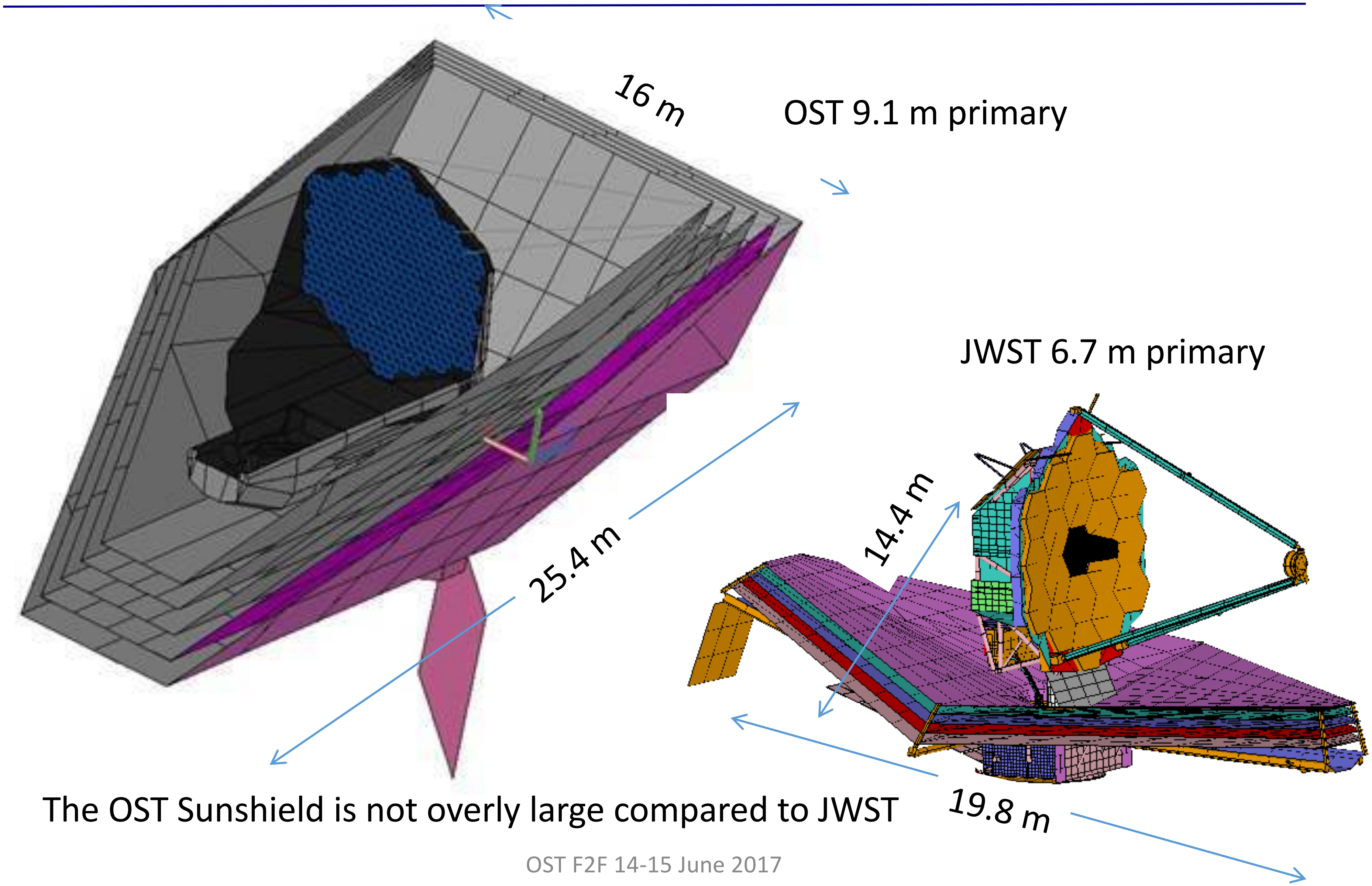
OST System Architecture



Mike DiPirro

14-15 June 2017

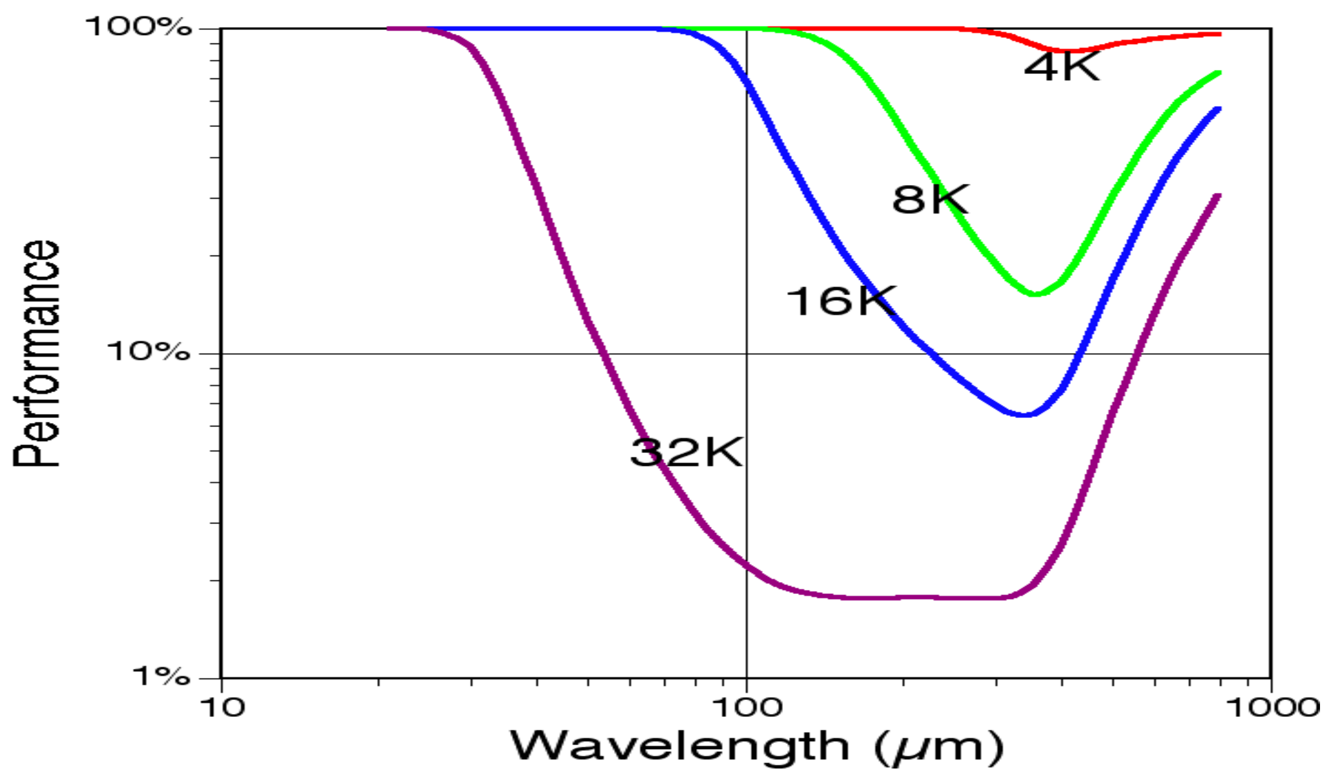
JWST and OST Compared



The OST Sunshield is not overly large compared to JWST

Basics

- The OST science is based on wavelengths from 6 to 600 µm
  - Longer wavelength have a background that is limited by telescope temperature
  - 4.0 K chosen for the telescope temperature



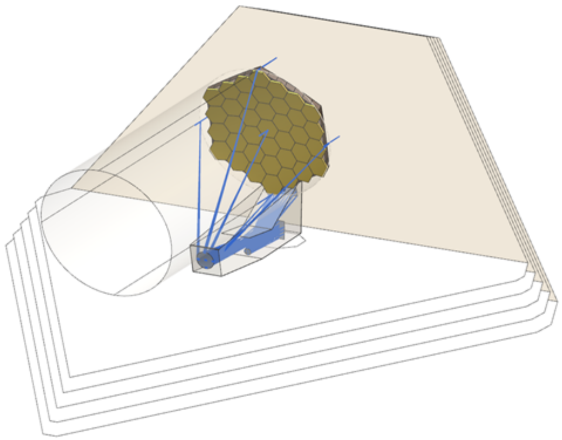
Active Cooling for 4 K

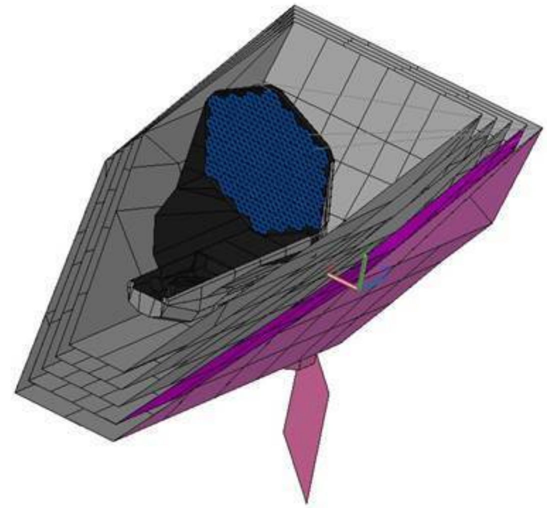
- Radiative cooling is not possible to achieve 4 K
  - Use mechanical cryocoolers of TRL 4+
- Staged cooling gives the most power efficient way of cooling to 4 K
  - Cryocooler as nominal 4K, 20 K and 70 K cooling stages
  - Layered sunshield provides radiative protection and cooling at higher temperatures
- 4 K baffle prevents stray light from sunshield from entering 4 K area
  - IAM and back of primary form part of 4 K baffle

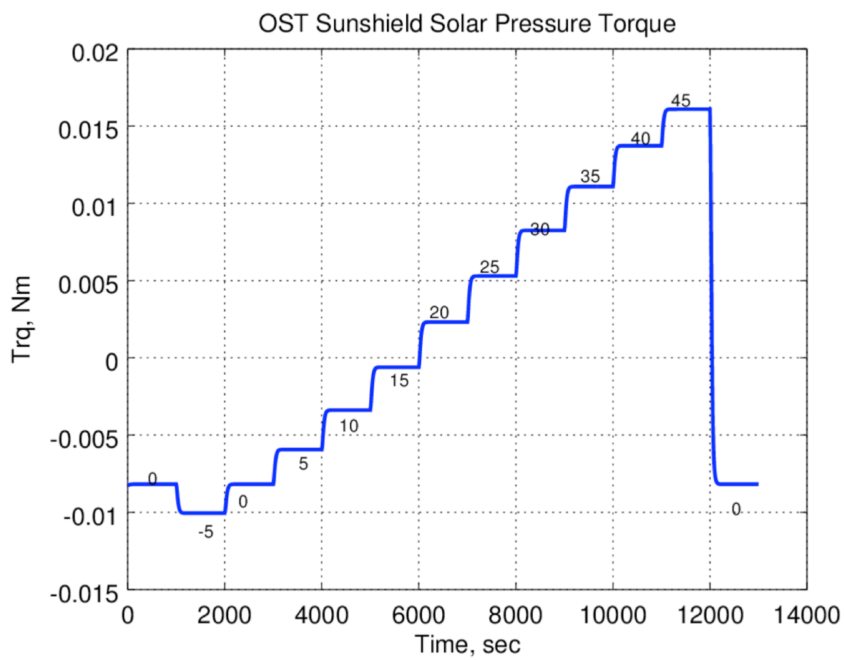
Sunshield

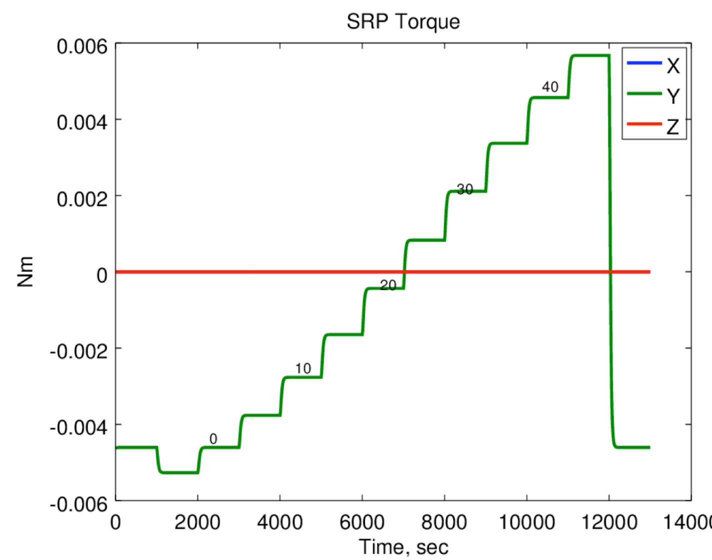
- Protection angle determined by the radius of the L2 orbit and the Field of Regard (instantaneous)
  - L2 orbit chosen as 4 x 10^5 km
    - Some moon shadow but not significant
  - FoR Pitch: +5/-45°, Roll +/- 5°, Yaw 360° (same as JWST)
- Center of Pressure is near Center of Mass
- Modeled as 5 parallel layers for now
  - Slight angle between layers will improve heat load

Solar Torque for Sunshield Configurations







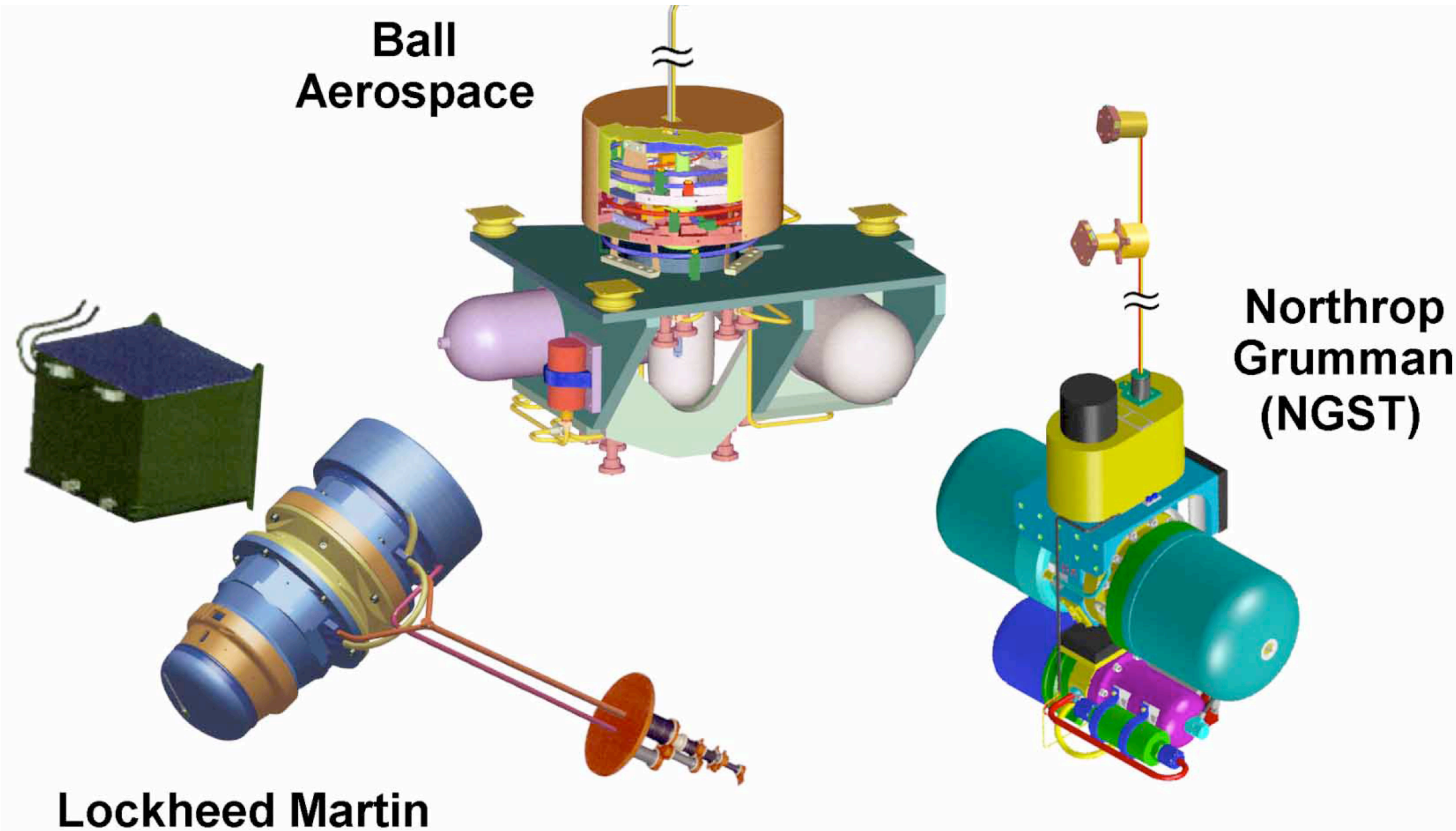


ORIGINS Space Telescope

Cryocoolers

- Several cryocoolers have been advanced to TRL 5 or higher by the NASA ACTDP program and other sources
  - Possible configurations include Stirling cycle precoolers and JT expanders, Pulse Tube precoolers and JT expanders, Multi-stage pulse tubes and independent circulators
  - Vibration levels are anticipated to be similar to the MIRI cryocooler on JWST
    - Note that the compressors and displacers are housed in the spacecraft

Advanced Cryocooler Technology Development Program (ACTDP) Cryocoolers



Instrument Accommodations

- Instruments located in Instrument Accommodation Module (IAM
- IAM provides 4 K boundary for instruments
  - Nothing inside is allowed to exceed 4 K except for transients
- Instruments may dissipate as much as 100 mW at 4 K combined
  - This cooling provided by observatory
    - 4 cryocoolers providing 50 mW of cooling each allowing factor of 2 margin
  - From early instrument studies it appears that only 2 instruments (MISC + one other) will be able to be on at any time
- Sub-Kelvin Coolers (for HRS, MRSS, and FIP)
  - SAT funded Continuous ADR provides up to 6 μW of cooling at 50 mK and intermediate cooling to intercept parasitic heat
- Warm electronics located in spacecraft up to 10 m away
- 20 K area provided for preamps for at least 4 of the five instruments
  - 200 mW combined + allowed in this area
    - This heat lift could be augmented if required

Preliminary heat load analysis

- 5 layer sunshield allows only 55 mW (TBD) to impact 4 K zone
- Structural conduction is estimated to be 20 mW
- Harness conduction is estimated to be 30 mW
- Instrument heat load estimated to be 100 mW max
- Total Heat Load = 55+20+30+100 = 205 mW
- Cryocoolers sized for double the estimated heat load (8 cryocoolers with 50 mW of cooling each)
  - Factor of 2 is consistent with Aerospace recommended factor at this stage of concept

Challenges

- Limit heat load
  - Sunshield, telescope and instrument details to be refined
- Deploy sunshield using simple, reliable, method
  - JWST is a basline, but we are searching for a simpler, lighter, and more reliable method
- Telescope and IAM deployment are also challenging
- Fit by volume and mass within a Vulcan-Aces launch vehicle
- Elevate our low TRL technologies to TRL 4 by 2019
  - Technology Roadmap, especially for detectors
- Keep OST cost reasonable
- Compelling science at a reasonable cost =

Selection by the Decadal Survey Panel