WFIRST Telescope Study Preliminary Analysis

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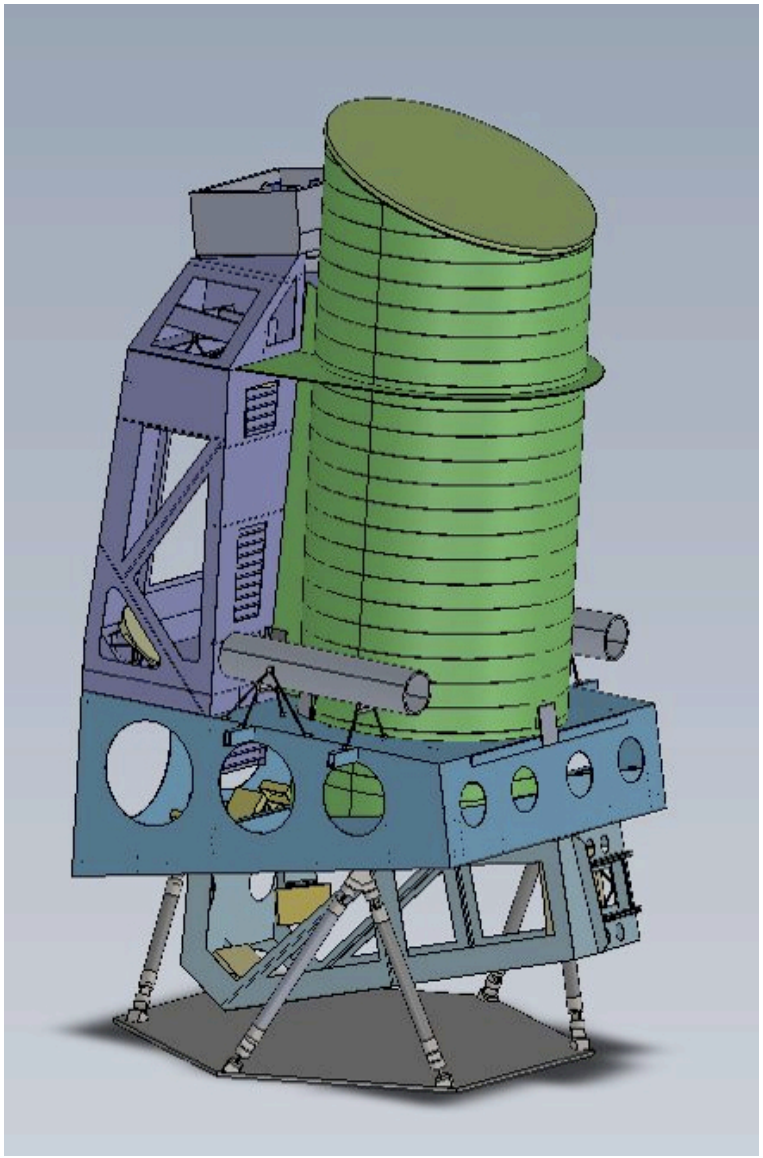
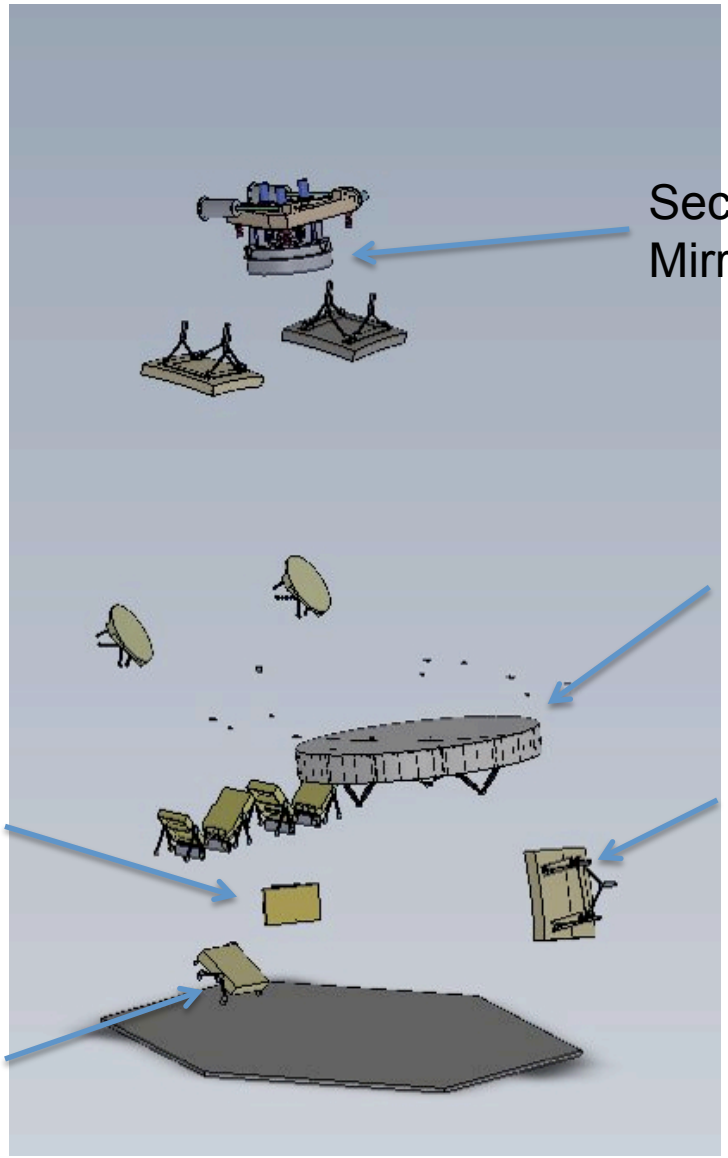
in collaboration with the Goddard team

Telescope Modeling Status

- Completed detailed CAD model.
- Completed Thermal model.
- Completed Finite element model.
- Competed Optical Tolerancing model.
- Modeled Ground Alignment of Telescope:
  - Requires 5 DoF on SM and tip/tilt of ImC Fold mirror
  - Requires tip/tilt of SpC F2 and tip/tilt/piston of SpC TM
- Modeled Ground to On-orbit Gravity shift:
  - Gravity shift can be taken out by the SM mechanism 5 DoF.

Telescope CAD model

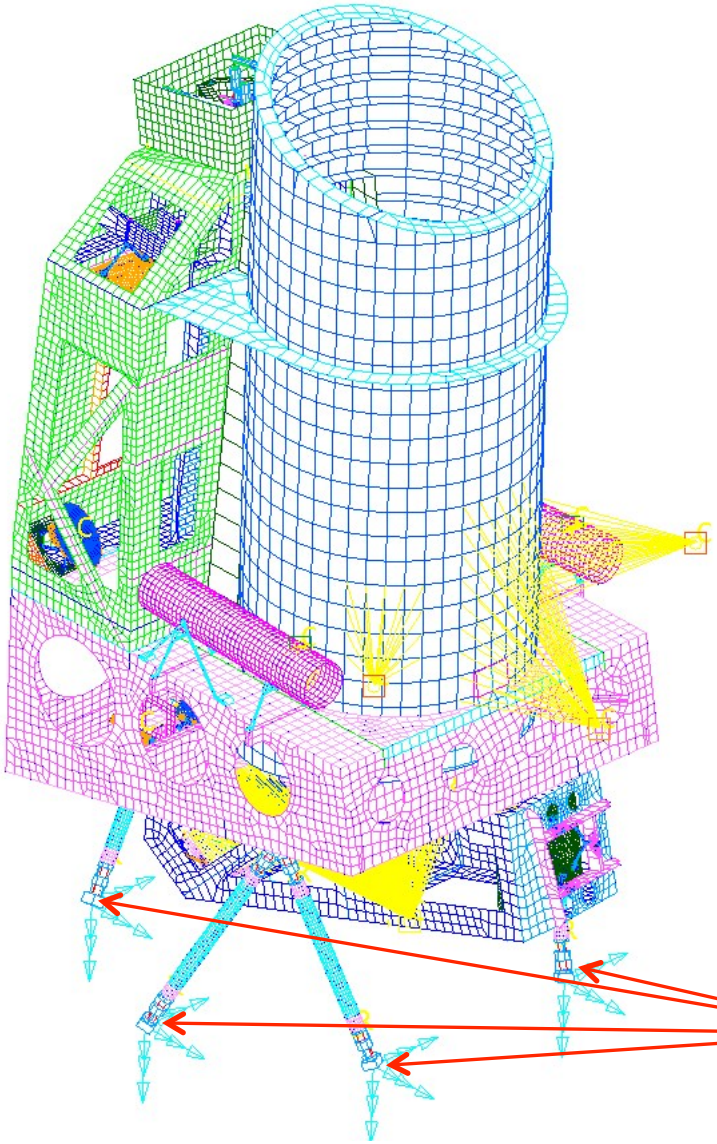




Telescope Mass Breakdown

OTA Mass Breakdown by material:	kg
M55J (composite structures, tubes)	375.3
Titanium (mirror mounts)	21.8
Stops and cans (Aluminum)	2.8
OTA mount	53.6
ULE (mirrors)	127.4
Mechanical (mechanisms)	18.8
MLI (thermal blankets)	19.8
kapton (heaters)	13.9
PRTs (thermal sensors)	0.7
Telescope electronics (chassis+boards)	16.4
Cabling	39.0
Instruments	154.3
Radiators	34.3
Contingency	282.3
TOTAL (including 21.3kg electronics)	1160.2

Telescope Finite Element Model



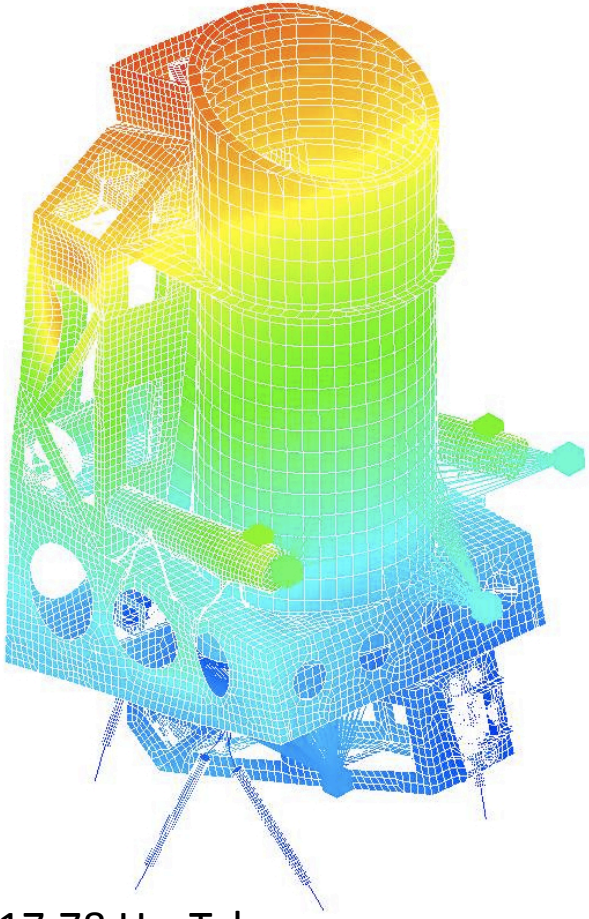
Node count: 103,219
Element count: 209,748
Mass: 1,139.0 kg

Element type:
- CBAR: 305
- CHEXA: 16,776
- CONM2: 14
- CPENTA: 6,798
- CQUAD4: 91,648
- CTETRA: 81,790
- CTRIA3: 12,115
- CTRIA6: 202
- RBAR: 8
- RBE2: 69
- RBE3: 23

Boundary conditions:
Ends of the 3 bipods fixed

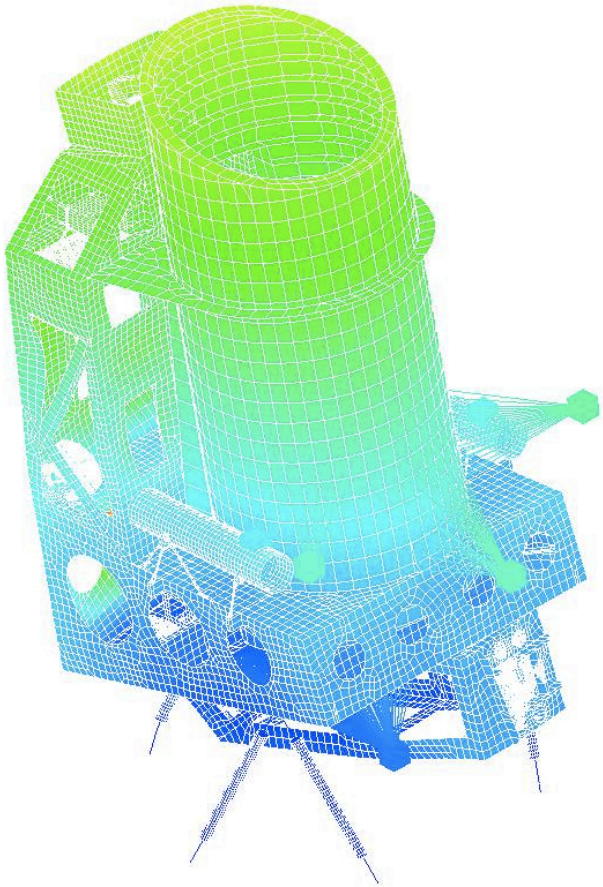
Telescope First Mode

Mode 1



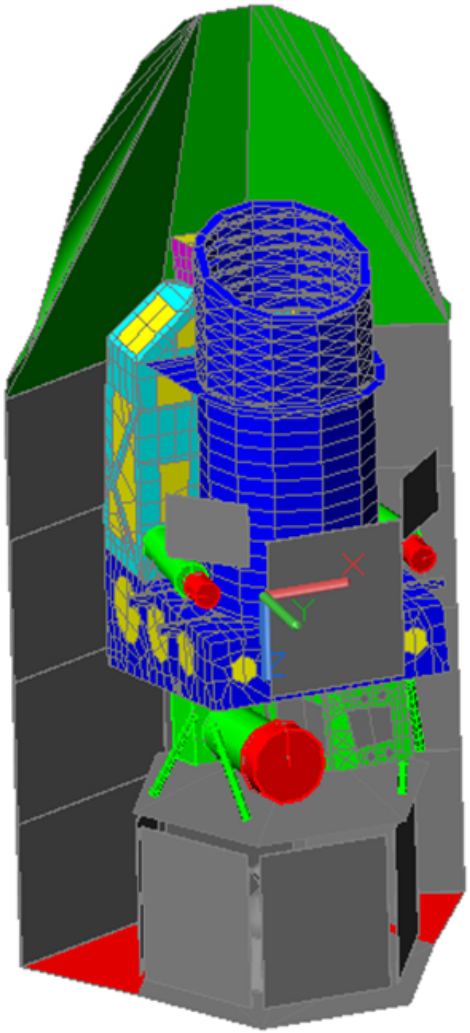
17.78 Hz, Telescope moves from side to side

Mode 2



18.77 Hz, Telescope moves from front to back

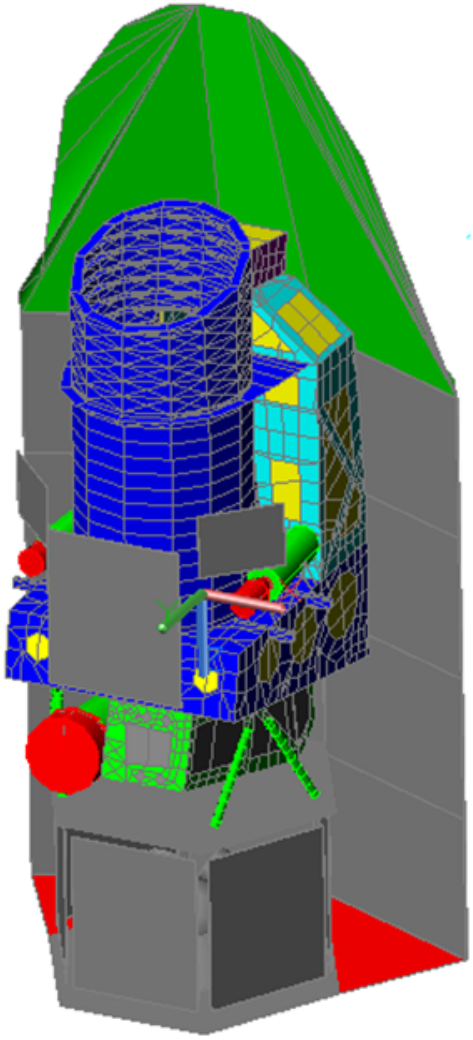
WFIRST Thermal Model



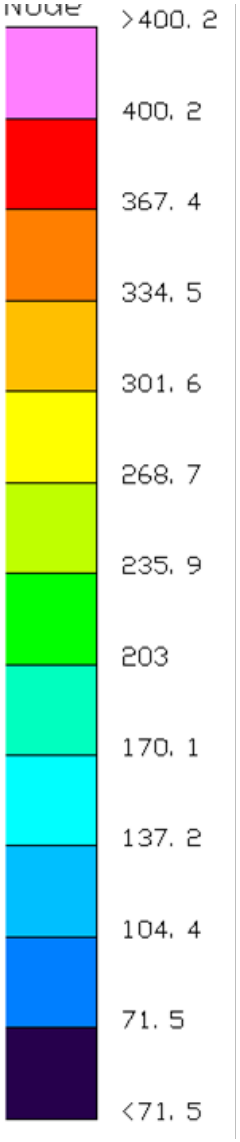
9006 TD/RC Nodes
23 User Nodes
8 boundary (SC at 313.2K)
3538 MLI (non graphical)

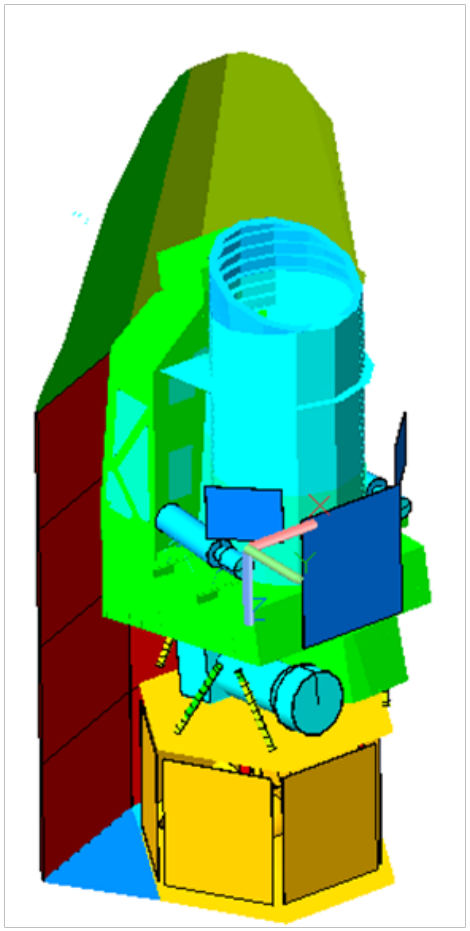
Surfaces
8675 planar elements
413 surfaces

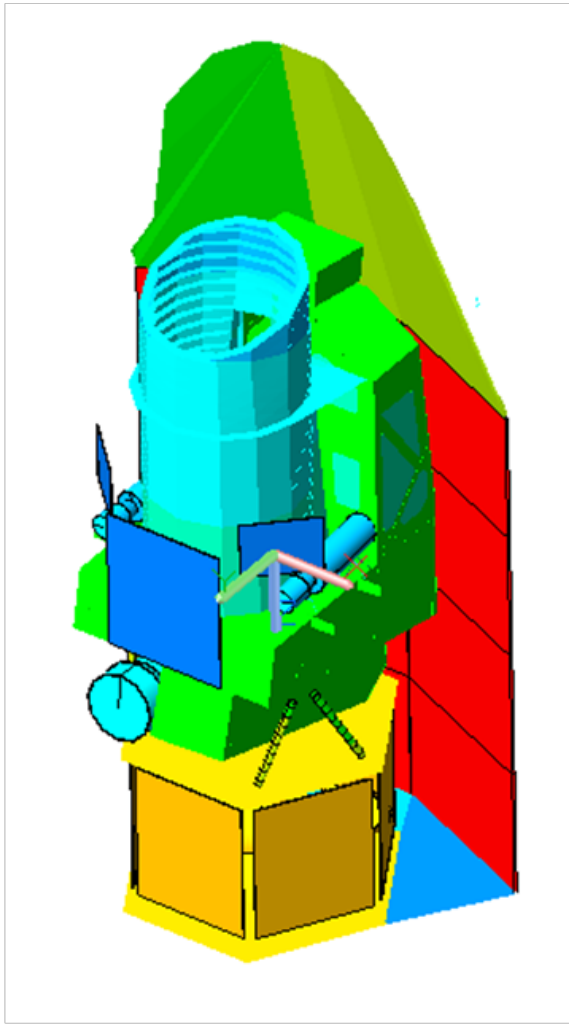
50 heaters



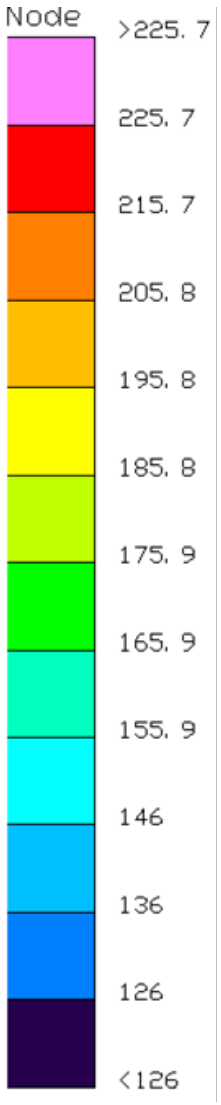
Temperature Plot
(at Nominal orientation)

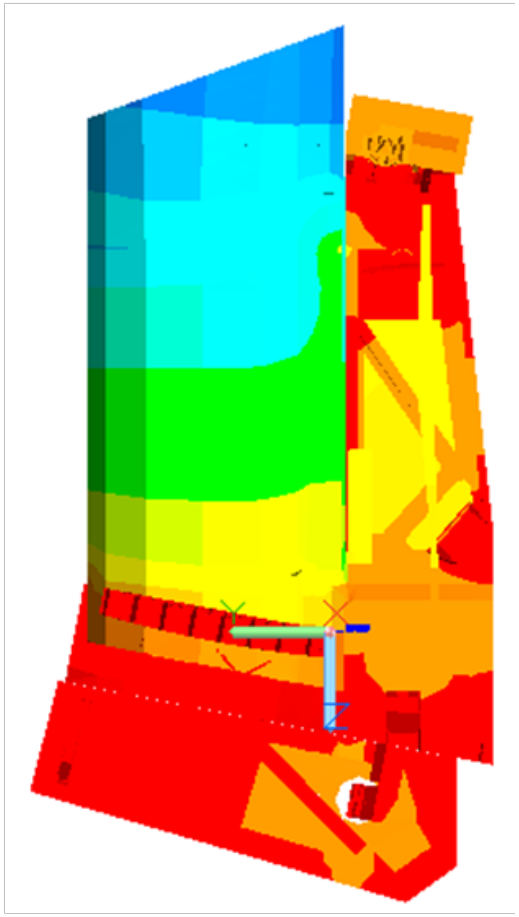


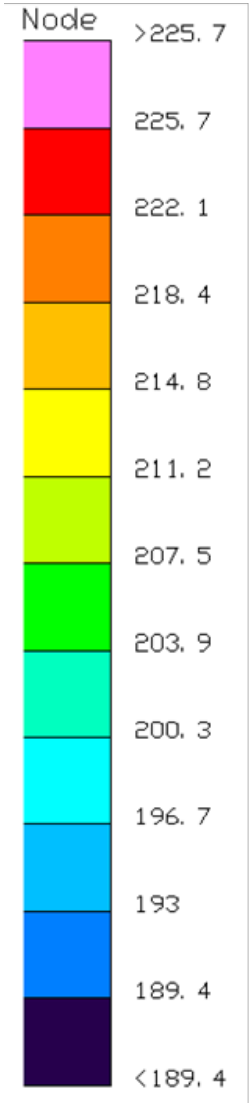


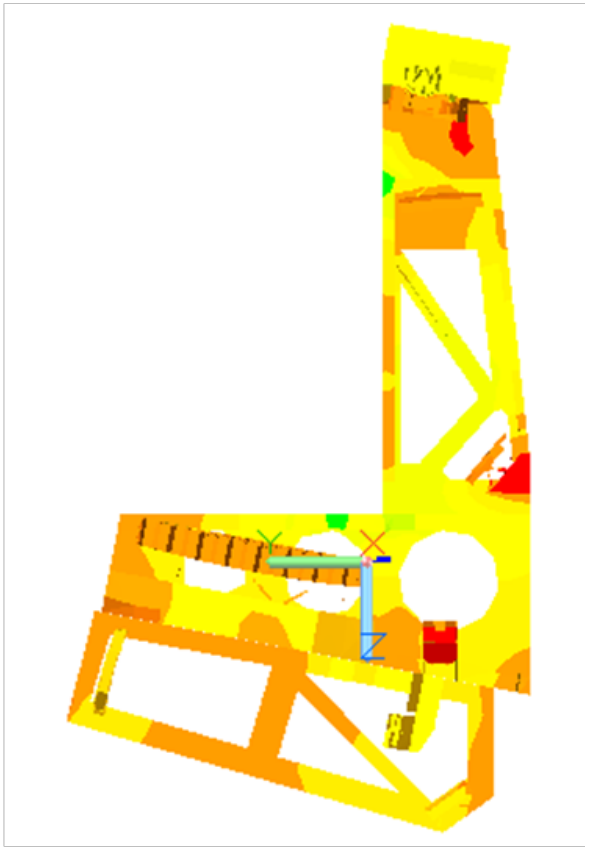


Thermal Model - Cutout view

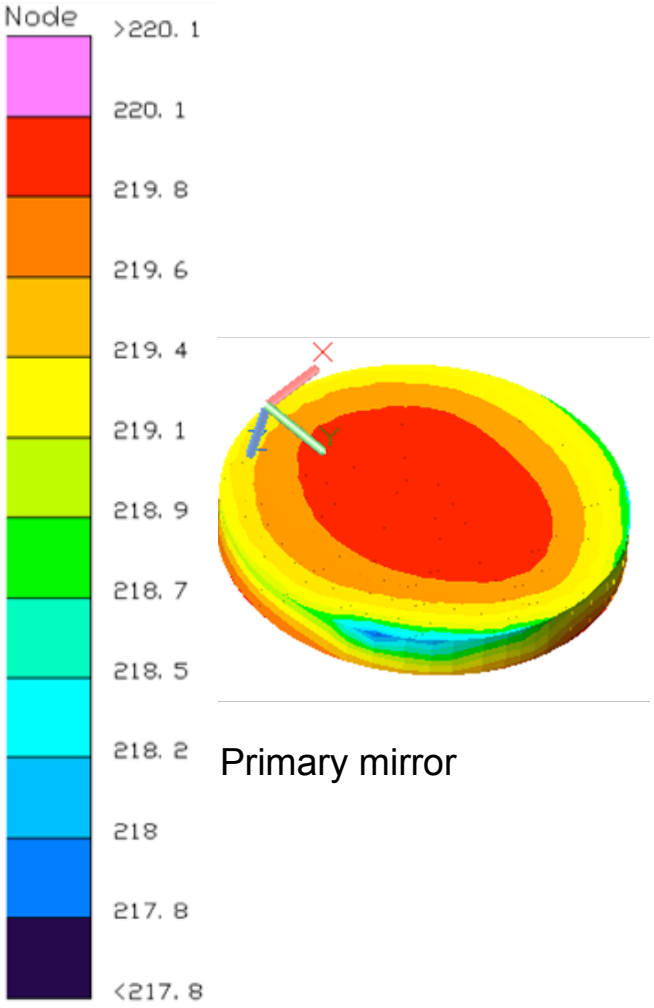




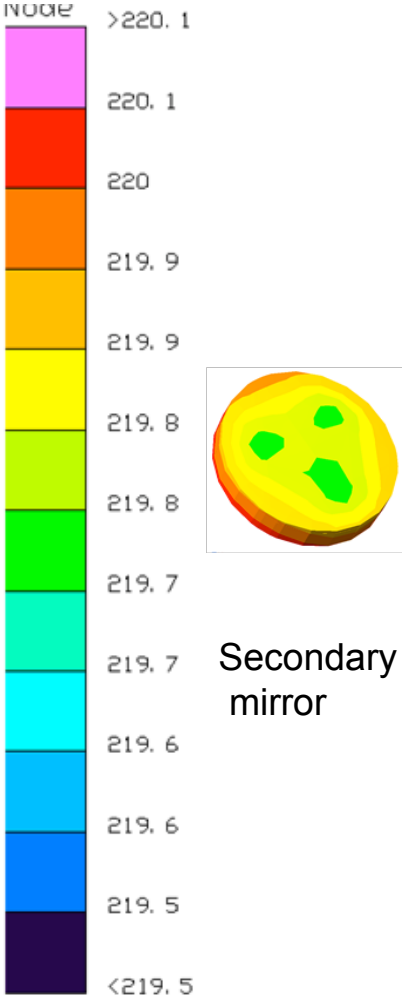




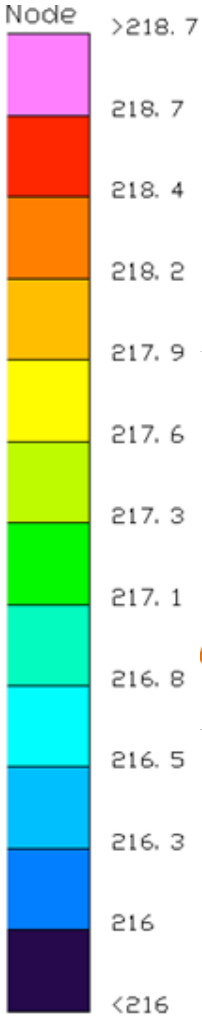
Primary, Secondary and Fold Mirrors (Nominal)

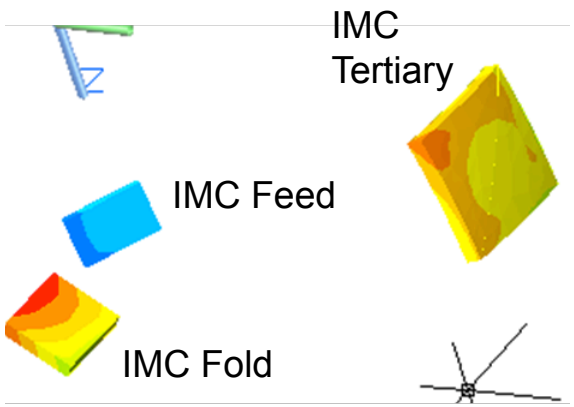


Primary mirror

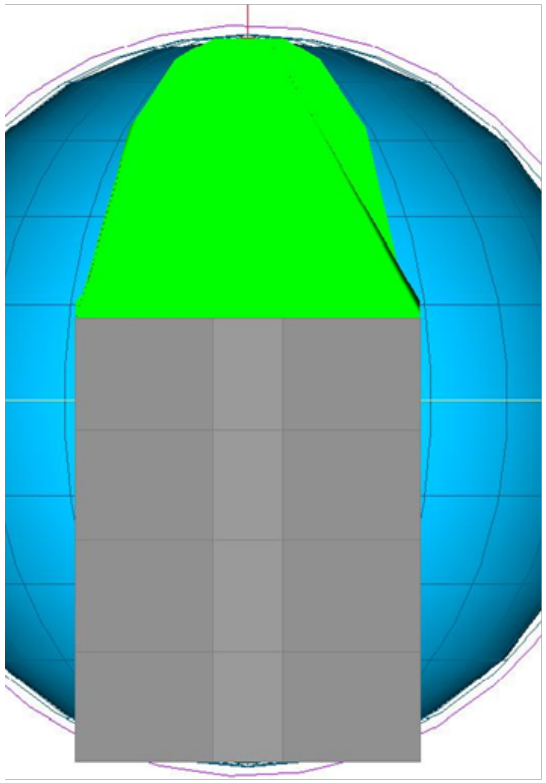


Secondary mirror

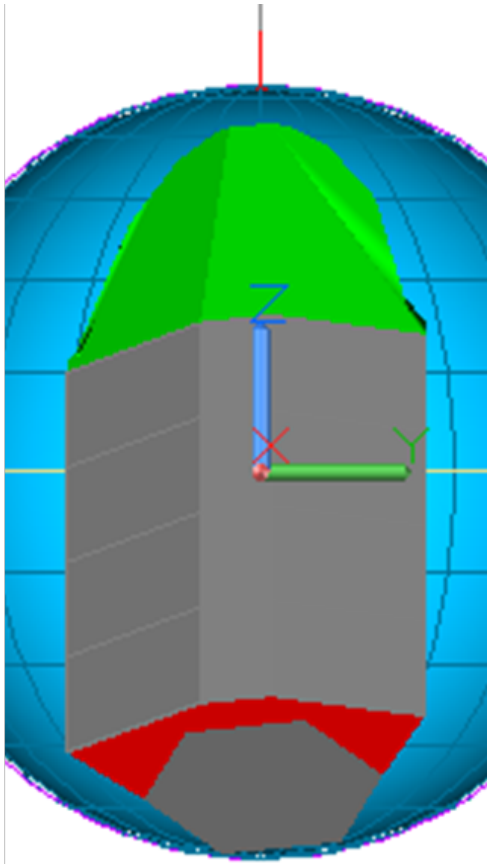




Spacecraft Orientation (View From the Sun)



Nominal



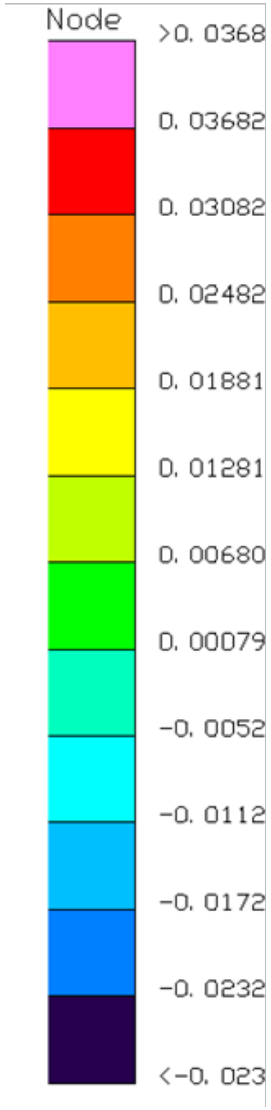
Roll 10 deg, Pitch 36 deg

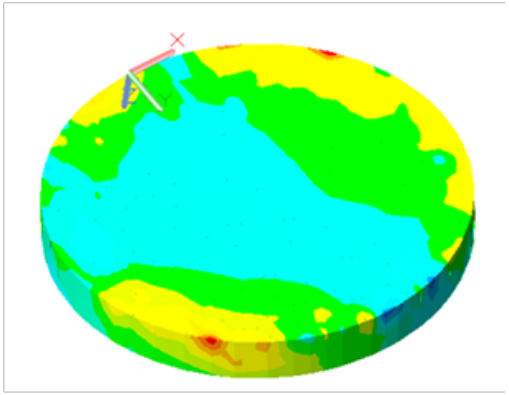
Thermal Results Summary

Component	Nominal				Roll 10, Pitch 36			
	Max. T, °K	Min. T, °K	Avg. T, °K	Heater Power at 220K, W	Max. T, °K	Min. T, °K	Avg. T, °K	Heater Power at 220K, W
Baffle	215.8	126.0	163.4	--	215.8	123.8	162.5	--
Primary mirror	220.1	217.8	219.8	27.2	220.1	217.7	219.8	27.5
Rear Encl.	226.0	189.4	215.9	73.3	226.2	188.9	215.7	71.2
Secondary mirror	220.1	219.5	219.9	4.2	220.1	219.5	219.9	4.2
Tertiary 1	220.1	217.9	219.3	0.9	220.1	217.9	219.3	0.9
Tertiary 2	220.1	218.0	219.4	0.9	220.1	218.0	219.4	0.9
Fold mirror 1	220.0	218.7	219.4	7.0	220.0	218.7	219.4	7.3
Fold mirror 2	220.0	218.8	219.3	7.5	220.0	218.8	219.3	7.7
Strongback	222.8	197.2	216.1	58.1	222.7	196.9	216.0	64.6
Rooftop mirror 1	220.1	219.0	219.5	0.4	220.1	219.0	219.5	0.4
Rooftop mirror 2	220.1	218.4	219.4	0.5	220.1	218.4	219.4	0.5
Rooftop mirror 3	220.2	218.5	219.5	0.5	220.1	218.4	219.5	0.5
Rooftop mirror 4	220.0	219.1	219.5	0.4	220.0	219.0	219.5	0.4
Feed Structure	220.4	215.2	218.5	24.5	220.4	215.1	218.4	25.2
Imager mirror	216.5	216.0	216.3	--	216.4	215.8	216.1	--
Imager tertiary	218.4	217.4	217.8	--	218.4	217.4	217.8	--
Imager fold mirror	218.7	217.5	218.1	--	218.7	217.4	218.1	--
			Total	205.4			**Total**	211.7

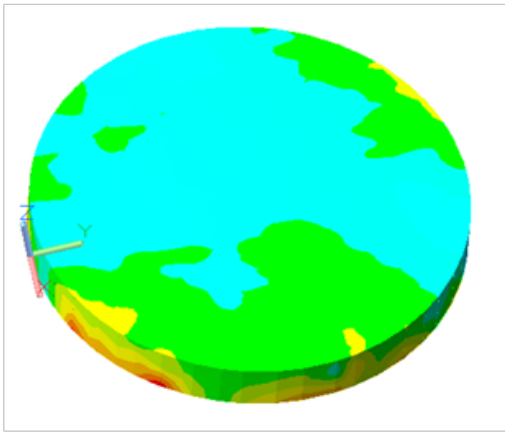
Temperature Change vs. Orientation

Delta_T (T_nominal – T_ Roll 10 pitch 36)



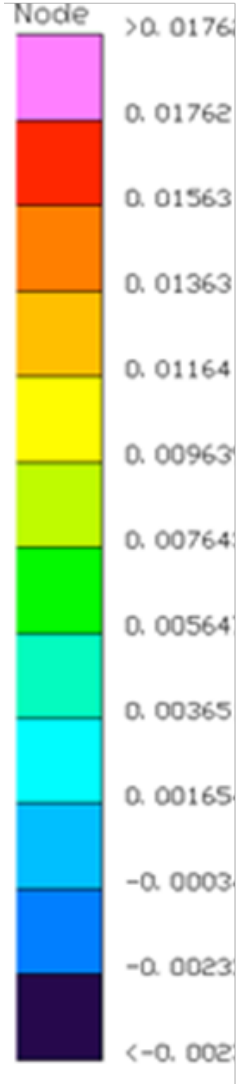


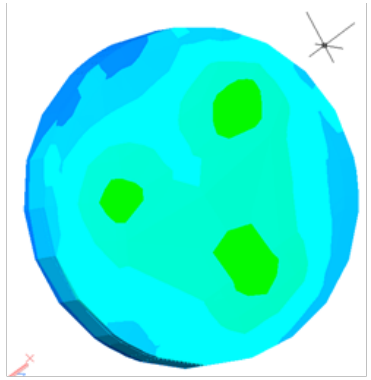
Front

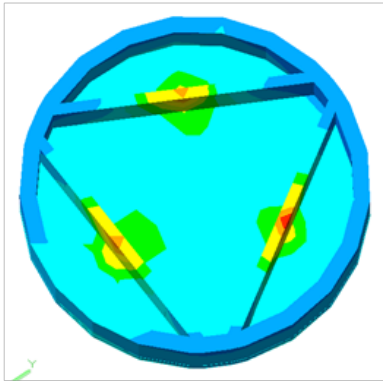


Back

Primary mirror



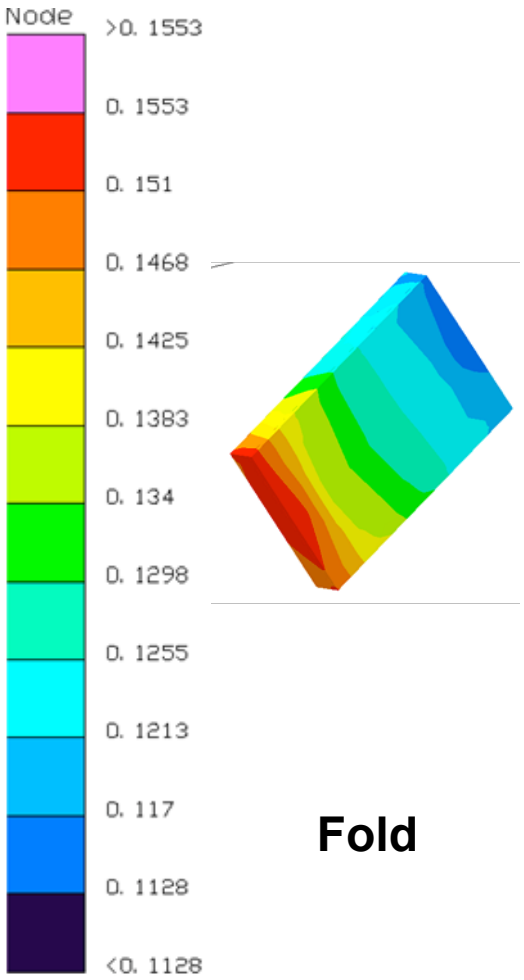




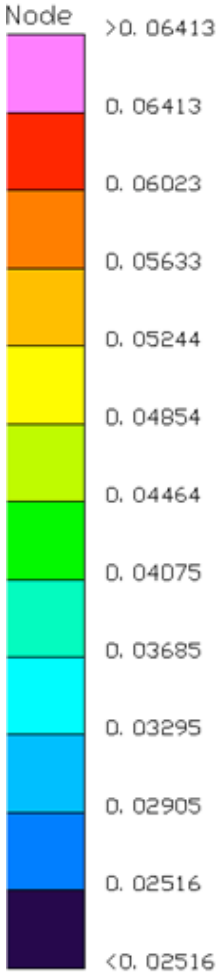
Secondary mirror

Temperature Change vs. Orientation

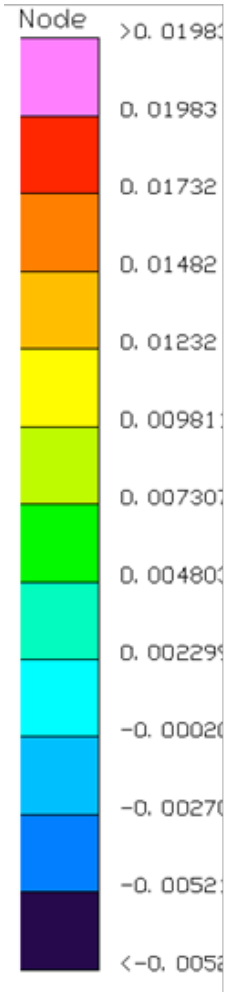
Delta_T (T_nominal – T_ Roll 10 pitch 36)

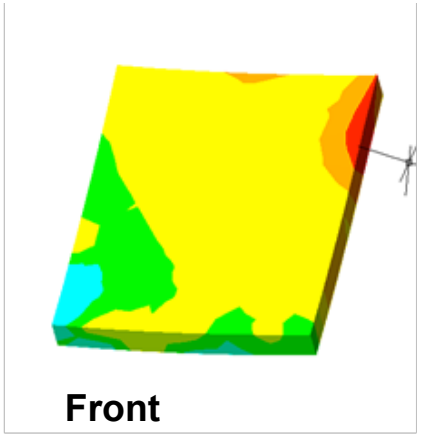


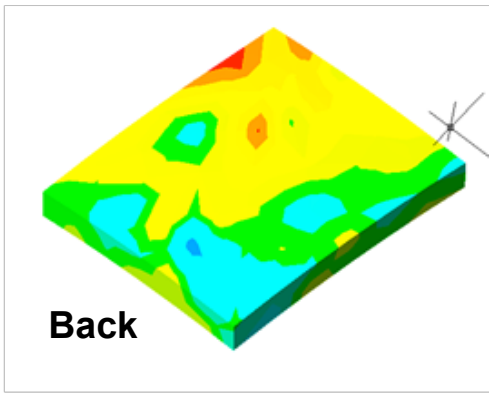
Fold



Imager





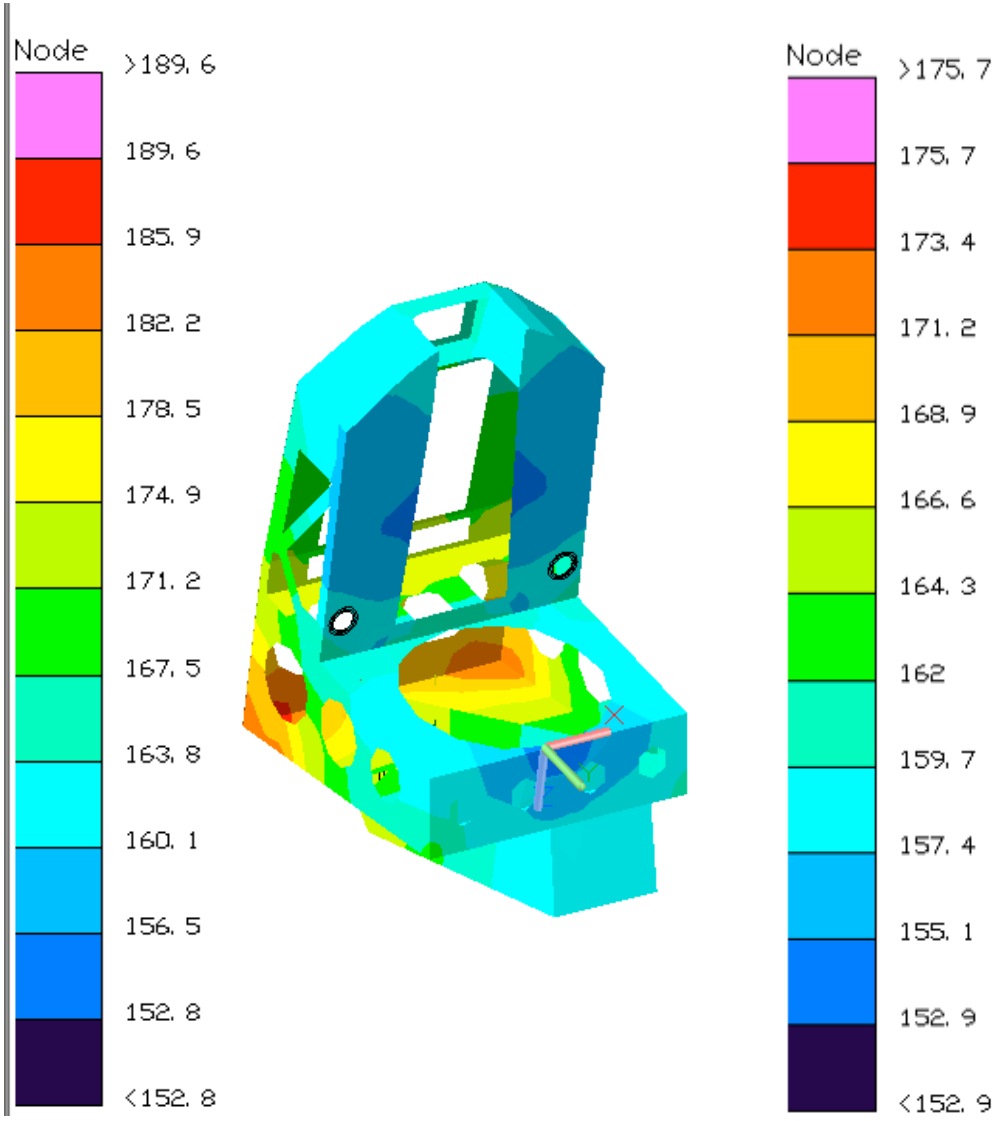


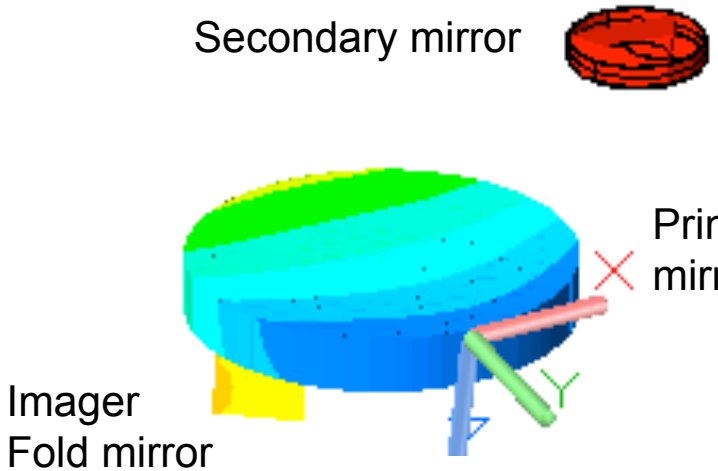
Tertiary

Next Steps

- Apply temperatures to the Finite Element Model.
- Calculate wavefront error stability using optical modal.
- Reduce temperature to 200K.
- Calculate wavefront error stability.
- Turn off thermal control (160-180K).
- Calculate wavefront error stability.

Heaters off: Telescope Temperature





Component	Case 3			
	Max. T, °C	Min. T, °C	Avg. T, °C	Heater Power at 220K, W
Feed Structure	185.3	160.7	169.4	Heater Off
Rear Encl.	174.5	152.8	164.7	
Strongback	189.6	152.8	169.0	
Tube	157.8	114.7	132.9	
Imager mirror	168.9	168.4	168.7	
Primary mirror	165.2	152.9	158.9	
Secondary mirror	175.7	175.6	175.6	
Fold mirrors	160.9	160.6	160.8	
			Total	--