NGST Thermal Analysis

Quarterly Review

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Agenda

- Overview Of Thermal Analysis
- Thermal Trade Studies For Sunshade

Overview Of Thermal Analysis

- GSFC
  - Sunshade Trade Studies
  - Cooling Detectors In ISIM
  - Heat Conduction From SSM To ISIM Through Isolation Truss, Wires And Cryocooler Pipes
- MSFC
  - Detailed Study Of OTA

Overview Of Thermal Analysis Continued

- **FEMAP/TRASYS**
  - Converts NASTRAN Finite Element Model To TRASYS Format
  - Run TRASYS To Obtain Environmental Heat Fluxes And Radiation Couplings
  - Run SINDA
  - Facilitates Feedback Of Temperatures For Thermal Structural Analysis

Overview Of Thermal Analysis Continued

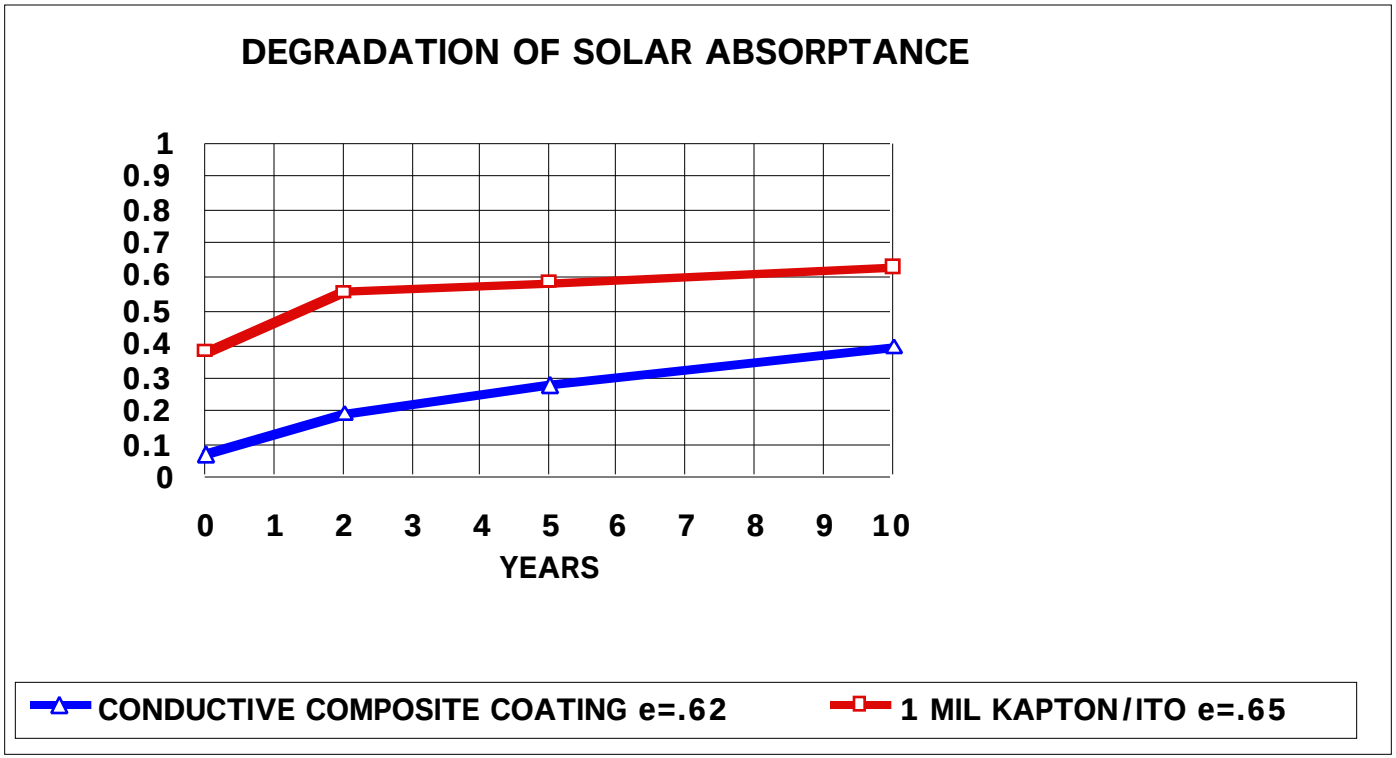
- TRASYS
  - Manually Generated Geometrical Mathematical Model
  - Not Good For Specular Radiation
- TSS
  - Manually Generated Geometrical Mathematical Model
  - Good For Specular Radiation
- Ultimate Goal Is To Use FEMAP Only

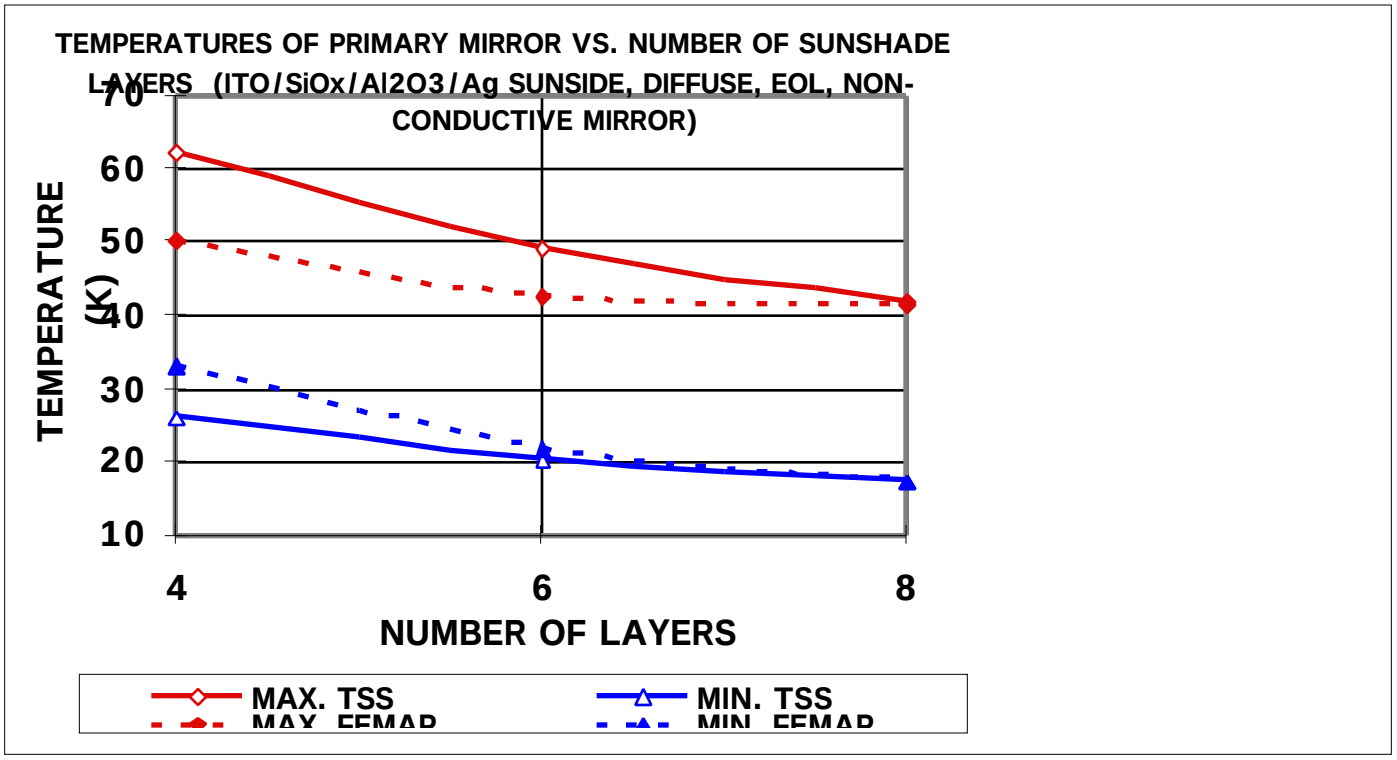
Sunshade Trade Studies

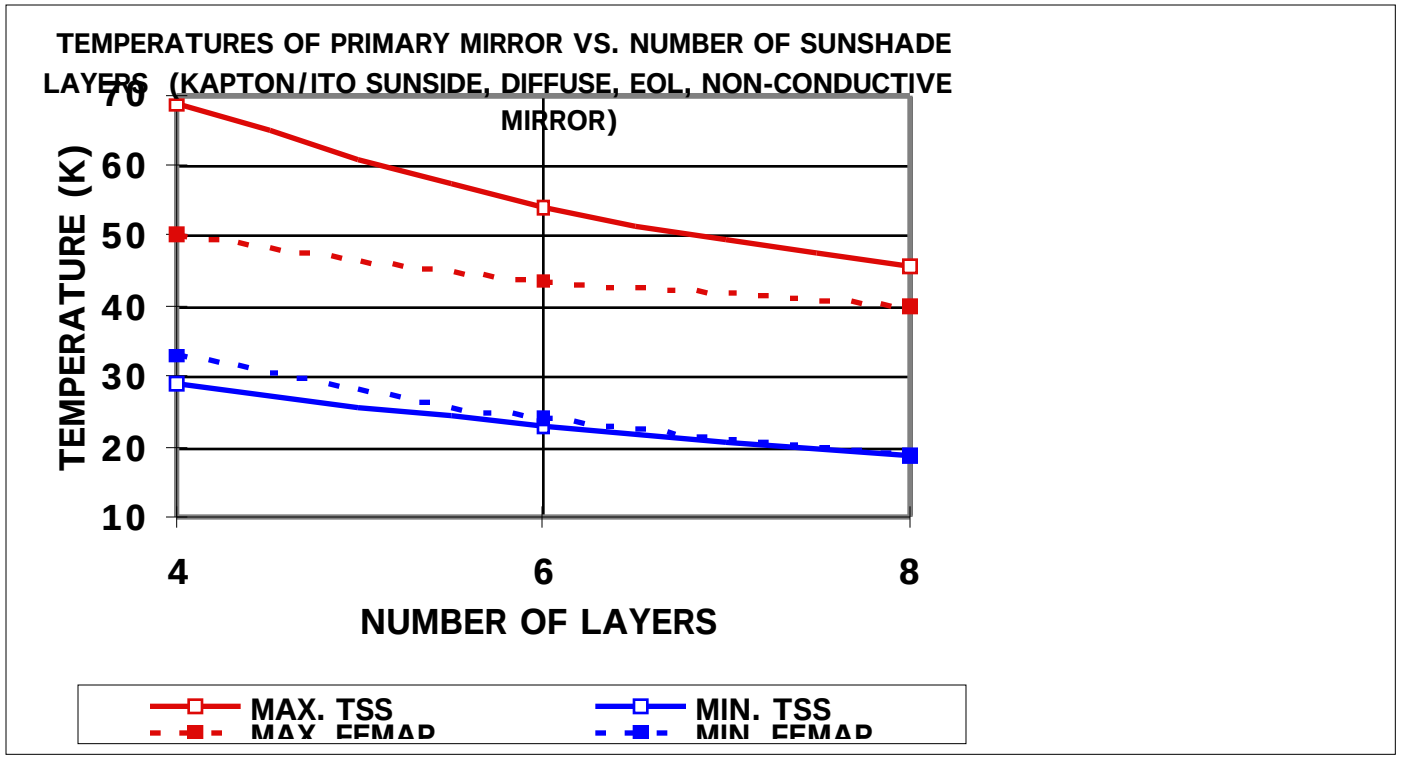
- Number Of Sunshade Layers
- Thermal Coating On Sunside
- Coating On Inner Sunshade Facing OTA
- V-Groove Angle
- Conductive Vs. Non-Conductive Primary Mirror
- High e Vs. Low e For Reaction Structure
- Diffuse Vs. Specular Radiation

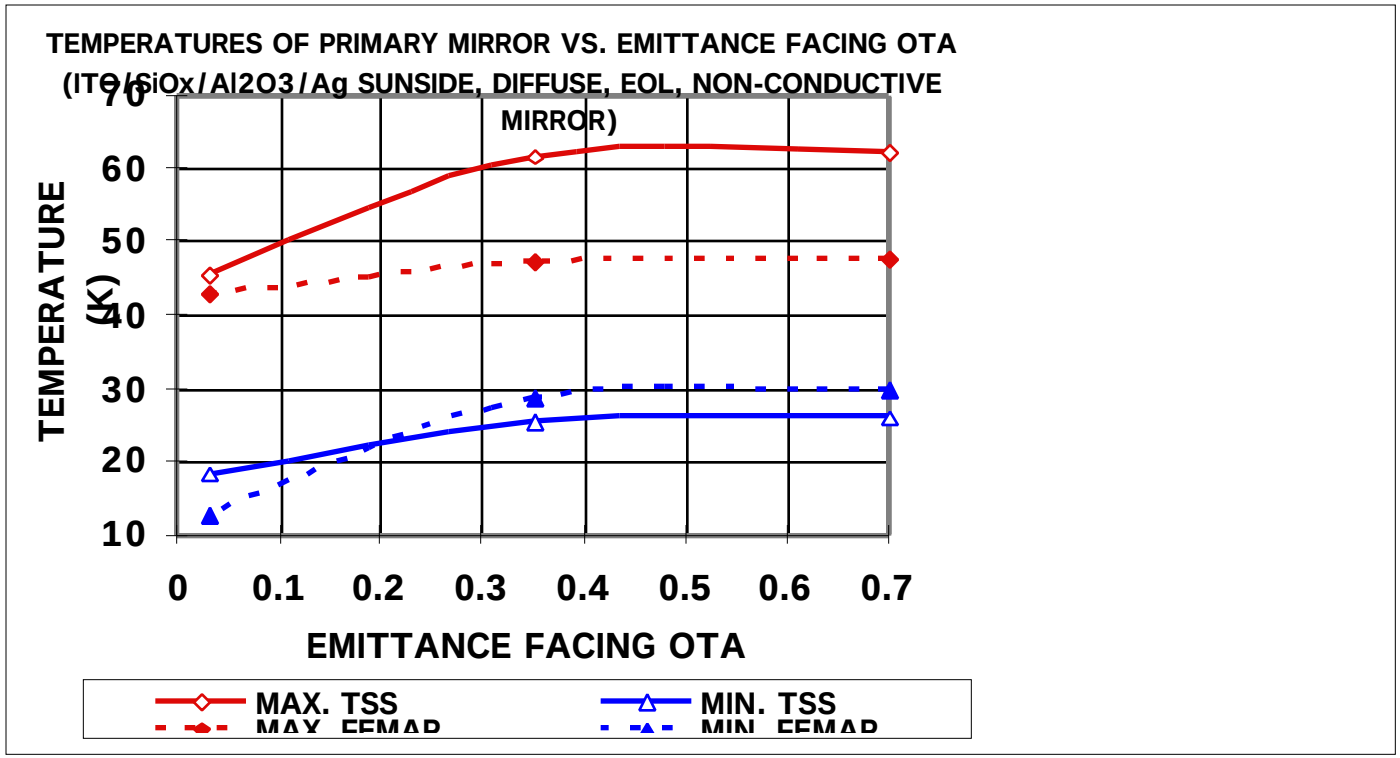
Sunshade Trade Studies Continued

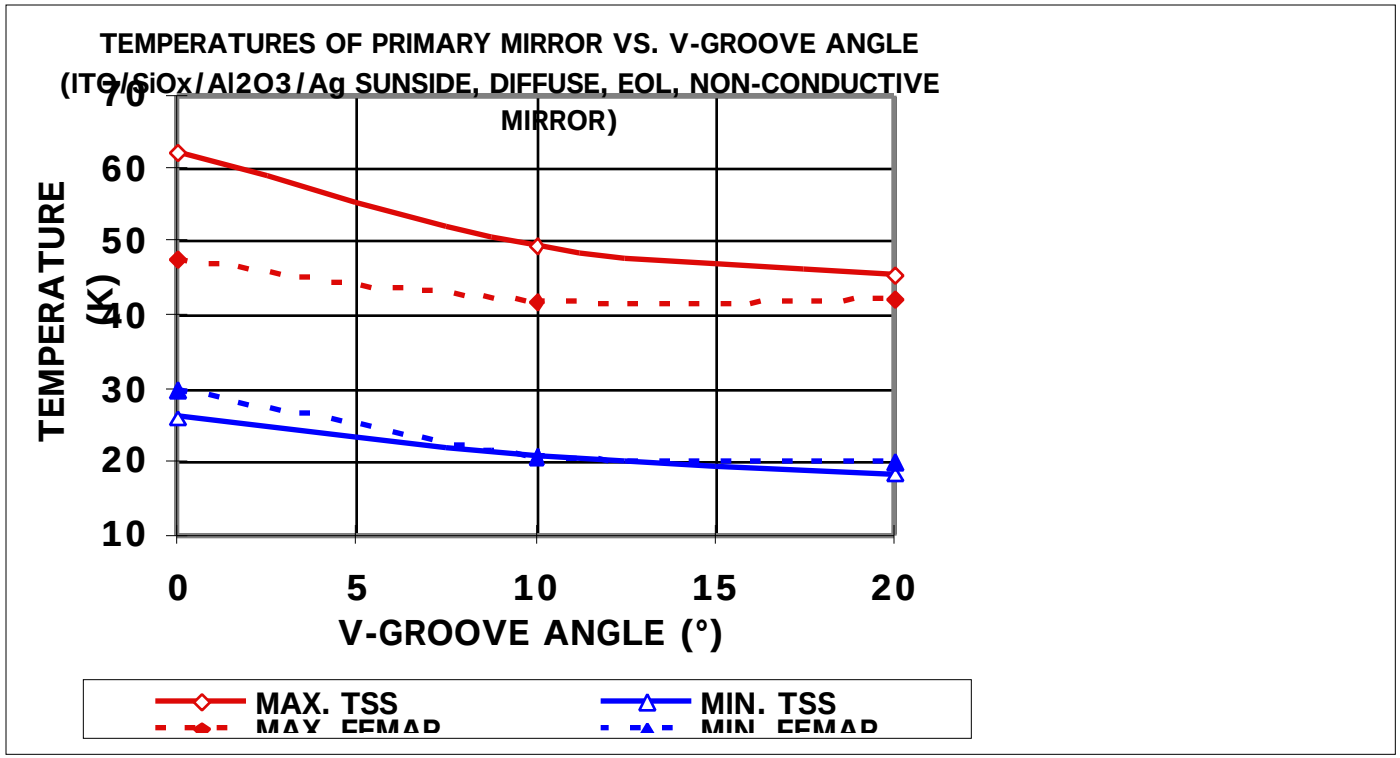
- Effect Of On-Orbit Degradation of Solar Absorptance
- Effect Of Rip Stop Threads
- Effect Of Pitch Angle

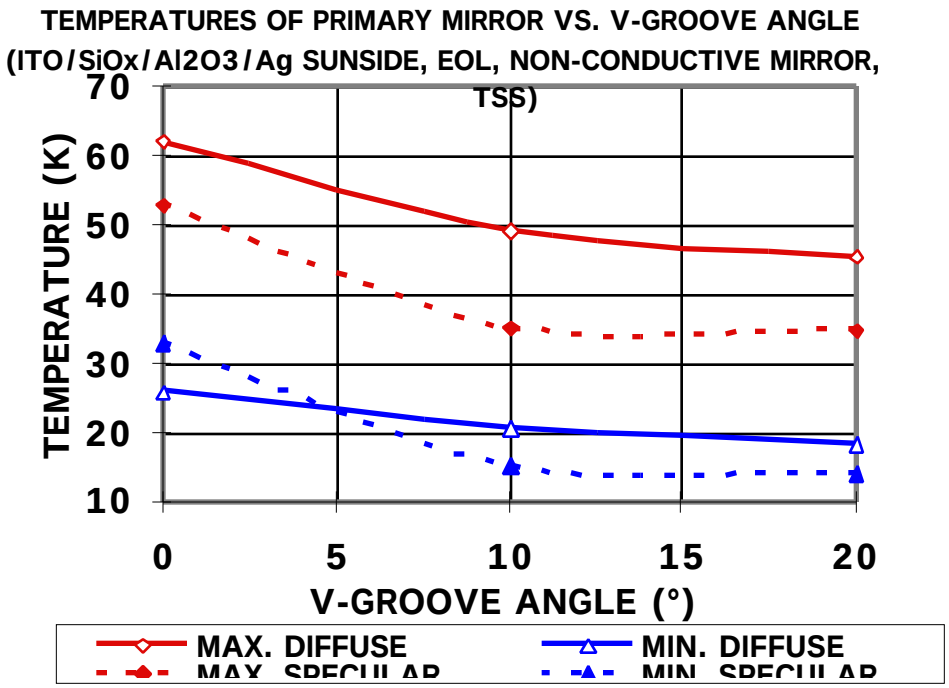

DEGRADATION OF SOLAR ABSORPTANCE
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0 1 2 3 4 5 6 7 8 9 10
YEARS
CONDUCTIVE COMPOSITE COATING e=.62
1 MIL KAPTON/ITO e=.65

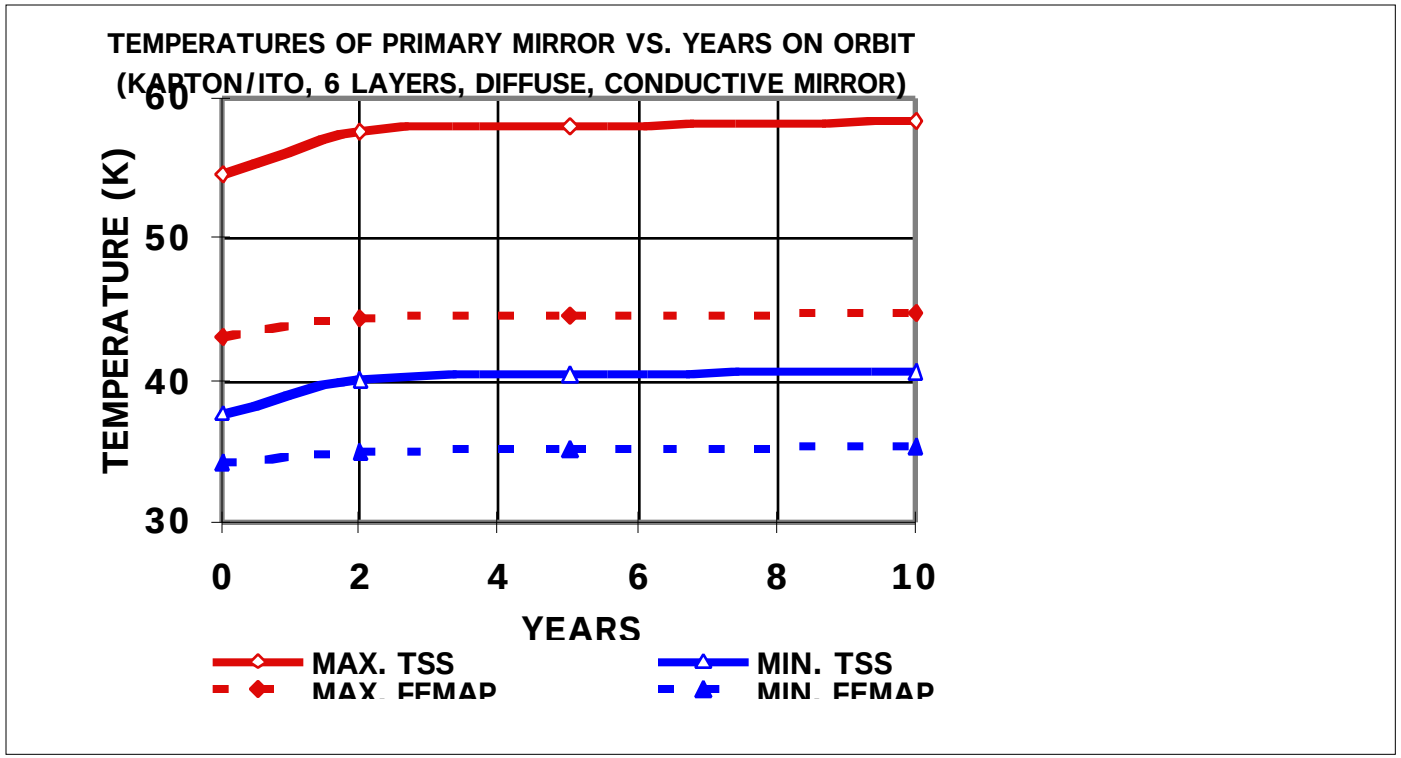

TEMPERATURES OF PRIMARY MIRROR VS. NUMBER OF SUNSHADE LAYERS (ITO/SiOx/Al2O3/Ag SUNSIDE, DIFFUSE, EOL, NON-CONDUCTIVE MIRROR)
TEMPERATURE (K)
70
60
50
40
30
20
10
4
6
8
NUMBER OF LAYERS
MAX. TSS
MIN. TSS

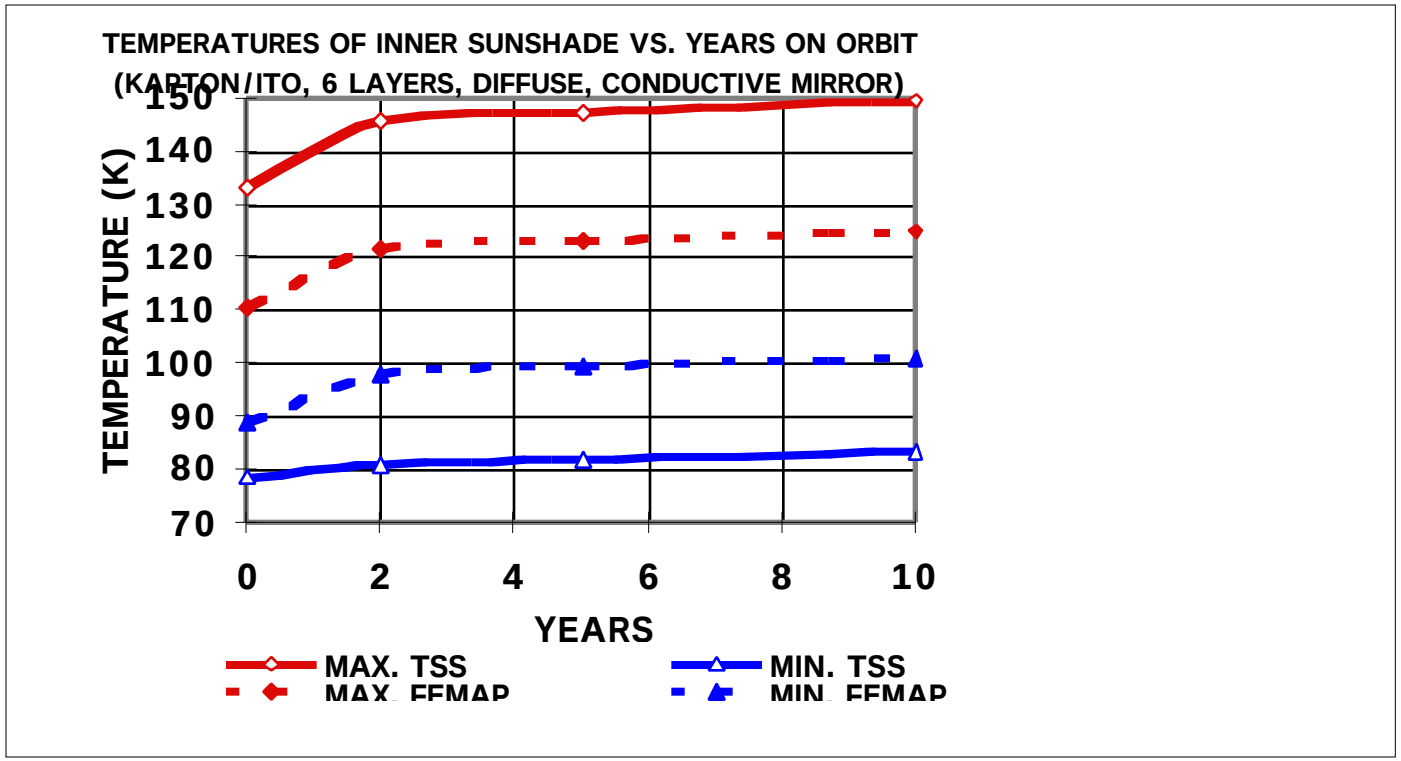

TEMPERATURES OF PRIMARY MIRROR VS. NUMBER OF SUNSHADE LAYERS (KAPTON/ITO SUNSIDE, DIFFUSE, EOL, NON-CONDUCTIVE MIRROR)
TEMPERATURE (K)
70
60
50
40
30
20
10
4
6
8
NUMBER OF LAYERS
MAX. TSS
MIN. TSS

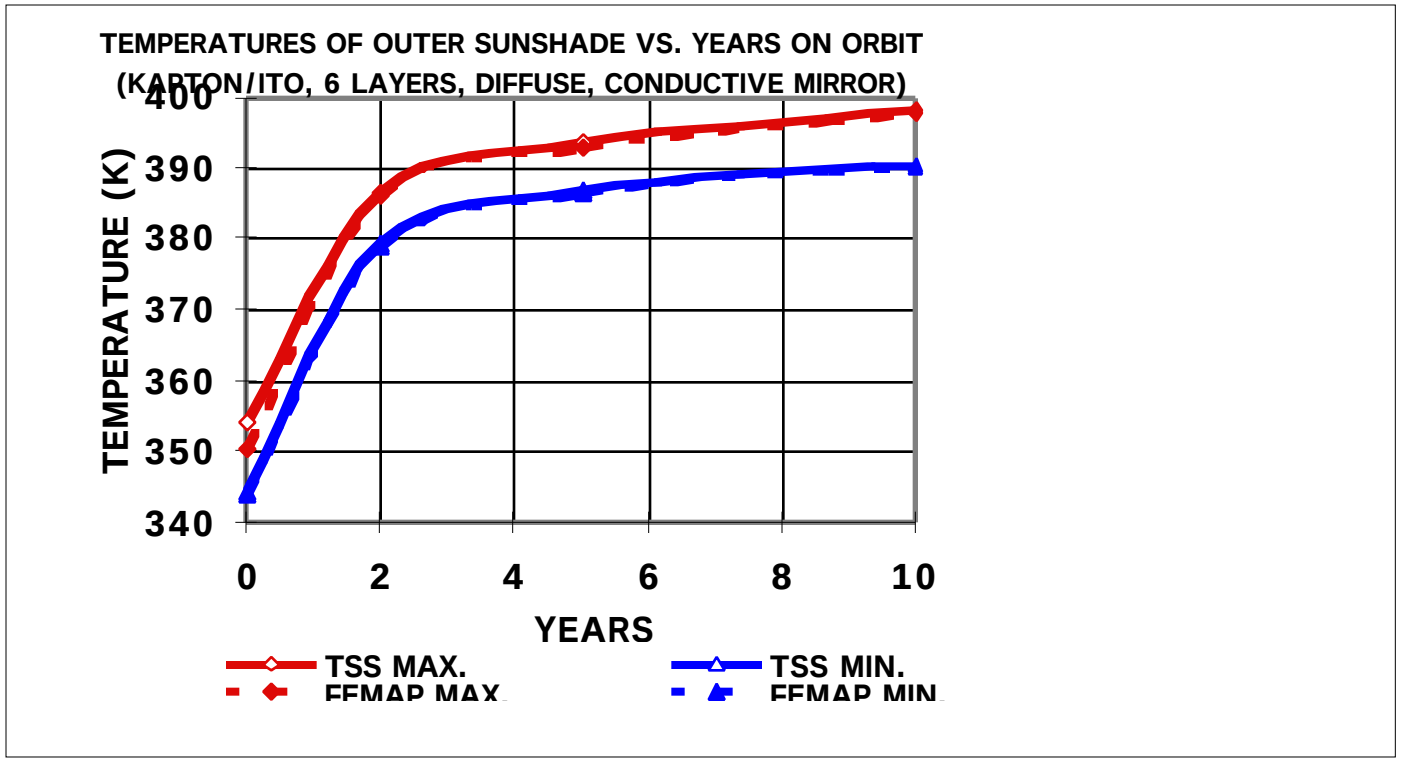

TEMPERATURES OF PRIMARY MIRROR VS. EMITTANCE FACING OTA
(ITO/SiOx/Al2O3/Ag SUNSIDE, DIFFUSE, EOL, NON-CONDUCTIVE MIRROR)
TEMPERATURE (K)
70
60
50
40
30
20
10
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
EMITTANCE FACING OTA
MAX. TSS
MIN. TSS


TEMPERATURES OF PRIMARY MIRROR VS. V-GROOVE ANGLE
(ITO/SiOx/Al2O3/Ag SUNSIDE, DIFFUSE, EOL, NON-CONDUCTIVE MIRROR)
TEMPERATURE (K)
70
60
50
40
30
20
10
0
5
10
15
20
V-GROOVE ANGLE (°)
MAX. TSS
MIN. TSS


TEMPERATURES OF PRIMARY MIRROR VS. V-GROOVE ANGLE
(ITO/SiOx/Al2O3/Ag SUNSIDE, EOL, NON-CONDUCTIVE MIRROR, TSS)
TEMPERATURE (K)
70
60
50
40
30
20
10
0
5
10
15
20
V-GROOVE ANGLE (°)
MAX. DIFFUSE
MIN. DIFFUSE


TEMPERATURES OF PRIMARY MIRROR VS. YEARS ON ORBIT
(KAPTON/ITO, 6 LAYERS, DIFFUSE, CONDUCTIVE MIRROR)
TEMPERATURE (K)
60
50
40
30
0
2
4
6
8
10
YEARS
MAX. TSS
MIN. TSS


TEMPERATURES OF INNER SUNSHADE VS. YEARS ON ORBIT
(KAPTON/ITO, 6 LAYERS, DIFFUSE, CONDUCTIVE MIRROR)
TEMPERATURE (K)
150
140
130
120
110
100
90
80
70
0
2
4
6
8
10
YEARS
MAX. TSS
MIN. TSS


TEMPERATURES OF OUTER SUNSHADE VS. YEARS ON ORBIT
(KAPTON/ITO, 6 LAYERS, DIFFUSE, CONDUCTIVE MIRROR)
TEMPERATURE (K)
400
390
380
370
360
350
340
0
2
4
6
8
10
YEARS
TSS MAX.
TSS MIN.

Temperature Predictions With Conductive Vs. Non-Conductive Primary Mirror (K)

	Non-Conductive Mirror		Conductive Mirror (4 mm, 120 W/m-K @40 K)	
	FEMAP	TSS	FEMAP	TSS
Min./Max. Primary Mirror	30/48	26/62	48.7/49	44/57
Min./Max. Sunshade Layer #1	353/362	353/362	353/362	353/362
Min./Max. Sunshade Layer #4	65/82	46/82	65/82	46/82

Temperature Predictions With e Of .05 Vs. e Of .03 For VDA On Sunshade Layers #1 And #4 (K)

	e Of .03	e Of .05 (Effect Of Rip Stop Threads)
Min./Max. Primary Mirror	26/62	29/68
Min./Max. Sunshade Layer #1	353/362	352/362
Min./Max. Sunshade Layer #4	46/82	51/89

Temperature Predictions With High e Vs. Low e For Reaction Structure (K)

	Low e (.03)		High e (.7)	
	FEMAP	TSS	FEMAP	TSS
Min./Max. Primary Mirror	30/48	26/62	37/59	32/62
Min./Max. Sunshade Layer #1	353/362	353/362	353/362	353/362
Min./Max. Sunshade Layer #4	65/82	46/82	65/82	46/82

Temperature Predictions For 2 Sunshade Layers 0.254 cm Apart And Effective Emittance Of .01 (K)

	TSS	FEMAP
Min./Max. Inner Sunshade	123.6/128.3	122.4/126.5

Temperature Predictions For 2 Sunshade Layers 0.254 cm Apart, Effective Emittance Of .01 And With OTA (K)

	TSS	FEMAP
Min./Max. Primary Mirror	66/96	58/85
Min./Max. Inner Sunshad	281/289	277/280

New Baseline Thermal Design

- **Sunshade**
  - 6 Layers
  - Sunside Thermal Coating Is Kapton/ITO
  - Coating On Layer #6 Facing OTA Is VDA
  - Rip Stop Threads On Layers #1 And #6
  - No V-Groove
- **Primary Mirror**
  - Beryllium
  - Both Sides Of Reaction Structure Are Black
- **Diffuse Radiation For Conservatism**