Thermal Control Subsystem
FAME

PRELIMINARY TEMPERATURE PREDICTIONS

- ASSUMPTIONS
- CASES
- RESULTS
- CONCLUSIONS
- FORWARD WORK
ASSUMPTIONS

• ALTITUDE = 19323.4 NM
• ENVIRONMENTAL CONSTANTS:
  SOLAR = 444 W/in²  ALBEDO = .28%  IR = 70 W/in²
• BLANKET $\alpha/\varepsilon = .37/.78$
• SCT $\alpha/\varepsilon = .10/.85$
• TRIM TABS:
  - TILTED 45° FROM SPIN AXIS.
  - SCT ON BOTH SIDES – NO BLANKETS.
• SHEET METAL SUN SHADE WITH SCT ON EXPOSED SIDES – DEPENDING ON CASE.
• SOLAR PANELS:
  - 24.72% SOLAR CELL COVERAGE IN NO PITCH CASE.
  - 34.9% SOLAR CELL COVERAGE IN 10° PITCH CASE.
  - UNPOPULATED/UNBLANKETED AREA IS SCT.
CASES

• PANELS NORMAL TO SPIN AXIS
• PANELS PITCHED 10° TOWARD INSTRUMENT
• PANELS AND SUNSHADE BLANKETED
• PANELS AND SUNSHADE UNBLANKETED
# Results

## Case Study: BUS MLI

<table>
<thead>
<tr>
<th>CASE STUDY</th>
<th>S/C</th>
<th>S/A</th>
<th>Sun Shield</th>
</tr>
</thead>
<tbody>
<tr>
<td>CASE 1 - NO PITCH w/ MLI</td>
<td>BUS MLI</td>
<td>Sun Side</td>
<td>Shade Side</td>
</tr>
<tr>
<td>Solar Cells Cover 24.72% of S/A</td>
<td>-165</td>
<td>-5</td>
<td>-142</td>
</tr>
<tr>
<td>Orbital Min/Max</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>CASE 2 - NO PITCH w/o MLI</td>
<td>BUS MLI</td>
<td>Sun Side</td>
<td>Shade Side</td>
</tr>
<tr>
<td>Solar Cells Cover 24.72% of S/A</td>
<td>-101</td>
<td>-40</td>
<td>-41</td>
</tr>
<tr>
<td>Orbital Min/Max</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>CASE 3 - 10° PITCH w/ MLI</td>
<td>BUS MLI</td>
<td>Sun Side</td>
<td>Shade Side</td>
</tr>
<tr>
<td>Solar Cells Cover 34.9% of S/A</td>
<td>-163</td>
<td>18</td>
<td>-132</td>
</tr>
<tr>
<td>Orbital Min/Max</td>
<td>n/a</td>
<td>19 / 17</td>
<td>n/a</td>
</tr>
<tr>
<td>CASE 4 - 10° PITCH w/o MLI</td>
<td>BUS MLI</td>
<td>Sun Side</td>
<td>Shade Side</td>
</tr>
<tr>
<td>Solar Cells Cover 34.9% of S/A</td>
<td>-90</td>
<td>-25</td>
<td>-26</td>
</tr>
<tr>
<td>Orbital Min/Max</td>
<td>n/a</td>
<td>-28 / -22</td>
<td>-29 / -23</td>
</tr>
</tbody>
</table>
Results
(2 of 6)

SOLAR PANEL REACTION TIME

HOURS

SOLAR PANEL - NO BLANKET
Results

(SOLAR PANEL REACTION TIME)

Blanket installed

SOLAR PANEL - SHADE SIDE

SOLAR PANEL - SUN SIDE

HOURS

C
Results

SUN SHADE REACTION TIME

10° Pitch

SUN SHIELD - NO BLANKET
Results
(5 of 6)

SUN SHADE REACTION TIME
Blanket installed / 10° Pitch
Results

AKM Cavity Reaction Time

11 12 13 14 15 16 17 18 19 20

-30 -28 -26 -24 -22 -20 -18 -16 -14 -12 -10 -8 -6 -4 -2 0

Hours
CONCLUSIONS

• Trim Tab temperature swing less severe when panels are blanketed.
  - May have biggest impact on instrument since temperature swing will be apparent over entire mission – view to instrument.

• About 3 hours for the vehicle temperature to return to pre-eclipse state (passively).
  - Vehicle stability an affected yet separate issue.

• Blankets on sun shield and panels cause more severe temperature changes during eclipse for those components.
  NO MLI / with MLI
  - 100 vs 113ºC ΔT for solar panels.
  - 90 vs 113ºC ΔT for sun shield.

• I have a lot of work to do..........(see next slide).
FORWARD WORK

(1 of 2)

• Begin running worst hot/cold cases.
  – Worst case environmental constants, blanket emissivities, BOL/EOL material properties, min/max line voltages.

• Size electronics deck radiator.
  – This will determine required Heater circuit dissipations /number of circuits.
  – Thermal time constant – Reaction time to regain stability.
  – Box layout on deck.

• Add detail to Instrument.
  – In order to attain Interface Heater/Conductance requirement.
  – Predict star tracker interface/heater requirement.
  – Get fluxes on Instrument apertures.
  – Antenna temperature prediction for required test limits.
FORWARD WORK
(2 of 2)

• Incorporate realistic solar cell layout.
• Geometry changes
  - Trim Tab/Bus size.
  - Box layout
• Verify all conductors/masses