International Earth Science Constellation
Mission Operations Working Group (MOWG)
December 3-5, 2019
Aura Fall 2019 IAM Results and Spring 2020 Planning
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Mission Operations Working Group
Dec. 3-5, 2019

Agenda

• Recap Aura Fall 2019 Inclination Adjust Maneuver (IAM) Campaign
  – Series Summary
  – Maneuver Results
• Aura’s IAM Performance Trends
• 2020 IAM Campaign Dates and Planning
• Aura Latest Lifetime MLT Predictions
Aura performed an inclination maneuver, IAM#63, on October 3\textsuperscript{rd}

As in the Spring, Aura’s Reaction Wheel Assembly (RWA) was successfully utilized to slew to the desired angle for the inclination maneuver

With very few maneuvers utilizing this new slewing method, the Flight Dynamics System (FDS) team has not developed trending equations for them
  – For the Spring, the results from the previous maneuver were used for inputs into the next maneuver
  – The final maneuver of the Spring, IAM#62, was out of family of the first three of the series in terms of achieved attitude during the burn
  – For the Fall, results from IAM#61 were used as predictions

The delta-inclination from IAM#63 was very close to predictions and the maneuver was 0.33\% cold
  – Achieved similar attitude offsets to IAM#62
### Results

<table>
<thead>
<tr>
<th>Inc #</th>
<th>Date</th>
<th>Burn Dur (sec)</th>
<th>Commanded Yaw (deg)</th>
<th>Achieved Yaw (deg)</th>
<th>Delta Inclination (deg)</th>
<th>Delta RAAN* (deg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Predicted</td>
<td>Definitive</td>
<td>Predicted</td>
<td>Definitive</td>
</tr>
<tr>
<td>63</td>
<td>Oct 3</td>
<td>425.0</td>
<td>-77.5</td>
<td>-76.02</td>
<td>-77.63</td>
<td>-0.00769</td>
</tr>
</tbody>
</table>

*Right Ascension of the Ascending Node (RAAN)

Total: -0.00767

- Aura’s achieved delta-inclination for the maneuver was 0.33% COLD, based on the Constellation Coordinated Plan
• The roll and pitch attitude errors during the burn have continued the trend of previous maneuvers
• As we observed in the last IAM of the Spring series, the yaw offset has flipped signs from previous maneuvers
  – More negative semi-major axis change was achieved than predicted due to the different yaw offset
• The delta-inclination efficiency of the Fall IAM was in family with the Spring series
RWA slewed IAMs have two values for yaw offset, the yaw error from telemetry (grey) and calibrated yaw (red). The calibrated yaw is the angle necessary to achieve the delta-SMA observed. Both yaw offsets for the fall IAM were similar to IAM#62 and have flipped signs from negative offset to positive.
As with the Spring 2019 series, the delta-inclination efficiency has increased compared to thruster slewed maneuvers.
The Aura Spring 2020 IAM plan consists of 4 inclination maneuvers
  - Continue using RWA to slew

Aura’s predicted ideal burn date occurs March 12, 2020
  - Since burn can be centered on node with RWA slewed maneuvers, the ideal date is no longer a factor in efficiency

Proposed plan has 2 maneuvers occurring before the ideal burn date, and 2 after
  - March 4 (IAM #64)
  - March 11 (IAM #65)
  - March 18 (IAM #66)
  - March 25 (IAM #67)

Dates are set so Aura maneuvers a day before Aqua
**Proposed Aqua/Aura 2020 Maneuver Schedule**

<table>
<thead>
<tr>
<th>Sunday</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
<th>Saturday</th>
</tr>
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<tbody>
<tr>
<td>February 23</td>
<td>24</td>
<td>25</td>
<td>26</td>
<td>27</td>
<td>28</td>
<td>29</td>
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<tr>
<td><strong>March 1</strong></td>
<td>2</td>
<td>3</td>
<td>Aura IAM#64</td>
<td>4</td>
<td>Aqua IAM#67</td>
<td>5</td>
</tr>
<tr>
<td>8</td>
<td>9</td>
<td>10</td>
<td>Aura IAM#65</td>
<td>11</td>
<td>Aqua IAM#68</td>
<td>12 *</td>
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<tr>
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<td>16</td>
<td>17</td>
<td>Aura IAM#66</td>
<td>18</td>
<td>Aqua IAM#69</td>
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<tr>
<td>22</td>
<td>23</td>
<td>24</td>
<td>Aura IAM#67</td>
<td>25</td>
<td>Aqua IAM#70</td>
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<td>29</td>
<td>30</td>
<td>31</td>
<td>April 1</td>
<td>Aura Back-up</td>
<td>2</td>
<td>Aqua Back-up</td>
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<tr>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>11</td>
</tr>
</tbody>
</table>

*Aura Ideal Date on March 12
**Spring Equinox on March 20
Note: Golden Week in Japan starts April 29
The following predictions are based on maintaining phasing with the nominal Aqua plan:
- Results from IAM#63 used in predictions

<table>
<thead>
<tr>
<th>Inc #</th>
<th>Date</th>
<th>Commanded Yaw* (deg)</th>
<th>Duration (sec)</th>
<th>Delta SMA** (m)</th>
<th>Delta Inc (deg)</th>
<th>Delta RAAN (deg)</th>
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</thead>
<tbody>
<tr>
<td>64</td>
<td>Mar 04</td>
<td>-75.0</td>
<td>375.0</td>
<td>13.26</td>
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<td>65</td>
<td>Mar 11</td>
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<td>-0.00669</td>
<td>-0.00001</td>
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<tr>
<td>66</td>
<td>Mar 18</td>
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<td>-1.28</td>
<td>-0.00667</td>
<td>-0.00001</td>
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<td>67</td>
<td>Mar 25</td>
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<td>-1.27</td>
<td>-0.00665</td>
<td>-0.00001</td>
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<td><strong>Total:</strong></td>
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</tr>
</tbody>
</table>

*Preliminary angles  
**Semi-Major Axis (SMA)
Aura will maintain MLT phasing with Aqua near the middle of the targeted range through next Fall.
Summary

- Similar to the Spring series, Aura used the RWA to slew to the necessary angle for IAM#63
- While the delta-inclination performance was close to predictions, the yaw error during the burn was more negative than predicted
- The Spring 2020 IAM series will have 4 maneuvers and is predicted to keep Aura near the middle of the MLT phasing control box prior to the Fall 2020 series