Update on the
GPS III Laser Retroreflector Array

Dr. Linda M. Thomas, NRL
Dr. Stephen M. Merkowitz, NASA GSFC

October 26-31, 2014
“Celebrating 50 years of SLR”
Overview

- NASA-NRL Partnership
- GPS III SV Status
- LRA Status
- Mission support planning
NASA – NRL Partnership

• NASA GSFC – Space Geodesy Program
  – Principal Investigator/Project Management for the GPS III laser ranging project
  – Leads coordination among the user community

• NRL Naval Center for Space Technology
  – Design, build and test the GPS III laser retroreflector array
  – Provide support to NASA in the areas of laser ranging requirements, components, link budget analysis, and data collection optimization.
  – Leverage experience in active optical components, timing, orbit determination, modeling and simulation
GPS III Space Vehicle

- First GPS III launch scheduled for 2016
- LRAs will not be flown until a later launch, date to be determined
- NRL and NASA continue to engage the GPS III team

- Orbit: Six orbit planes at 55 degree inclination
- Altitude: 10,898 nautical miles
- Photo of the GPS III pathfinder Nonflight Satellite Testbed at Cape Canaveral, GPS World
Design Considerations

Tracking Mission
• Day/Night
• Elevation

Fundamental
• Velocity Aberration
• Link Budgets

Space Vehicle
• Interfaces
• Environment

LRA design driven by multiple sources
LRA Risk Reduction Work

- Designed a 7-aperture subarray
  - Incorporate mission, SLR, and vehicle requirements
- Fabricate and test subarray
  - Evaluate mechanical performance
  - Validate assembly methods
  - Ensure EMI/EMC compatibility
Flight Array and Modeled Cross Section

<table>
<thead>
<tr>
<th>Cubes</th>
<th>Wavelength</th>
<th>Orientation</th>
<th>Polarization</th>
<th>Cross Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>48 x 1.6”</td>
<td>532nm</td>
<td>0 deg</td>
<td>Horizontal</td>
<td>140MSM</td>
</tr>
<tr>
<td>48 x 1.6”</td>
<td>532nm</td>
<td>12 deg</td>
<td>Horizontal</td>
<td>105MSM</td>
</tr>
</tbody>
</table>

- Cube selection supports ILRS GNSS cross section specification
- FFDPs validated in Zemax
- On and off-axis performance evaluated

Rendering of flight model
Ongoing Work

- GPS III EQM Hardware:
  - Risk reduction work completed
  - Engineering Qualification Model integration and test underway
  - Flight check with SV integrator planned in 2015
  - Launch of first vehicle equipped with GPS III LRA no earlier than 2019
- NASA, NRL, and USAF continue to work together to solidify GPS III LRA integration plan
- NASA and NRL continue to participate in ILRS LARGE working group
  - Consider GPS timelines in the development of a unified GNSS tracking strategy
  - Assess any pilot tracking project results; make recommendations as they pertain to GPS III
- Complete optical modeling of GPS III EQM
- Expect delivery of EQM to NASA in early 2015
LRA and Mission Planning Information

• Mission support request information will be addressed prior to launch
  – Location of SV center of mass before launch
  – Location of the LRA on the SV
  – Optical phase center to CoM
  – Corner cube specification (DAO, flatness, etc)
  – Corner cube material
  – Coating specification

• Given the large number of LRA-equipped GPS satellites and to ensure maximum data utility, all tracking will be pre-coordinated with NASA
Thank you!