

Development of the GPS III Laser Retroreflector Array (LRA)

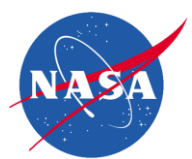
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Background

- NASA Administrator, committed the agency to the provision of Laser Retroreflector Arrays (LRA) for integration on the GPS III satellites in a June, 2010 letter to the Commander, Air Force Space Command (AFSPC).
- Commander of AFSPC instructed GPS Directorate to proceed with planning for integration of LRA's pending ongoing study. ICD for LRAs is being drafted with NASA, NGA, NRL, and AFPSC.
- GPS III Laser Ranging Mitigation Study underway to examine Materiel and non-Materiel Solutions. Recommendations to Senior Advisory Group Planned for late September.
- Final decision on GPS III LRA integration aboard SV 9+ is TBD:
 - Senior Advisory Group to advise Decision Makers in October, 2012
 - JCIDS to provide final resolution
 - Preparation of LRA designs and fabrication must begin now



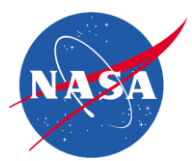
LRA Flight Production and Tracking Plan

- NASA will build, flight qualify, and deliver 24 (TBF) LRA to the AFSPC for placement on the GPS Block III space vehicles starting with Space Vehicle #09 (CY 2015).
- The LRA payload will be provided to the spacecraft contractor by the GPS Directorate as Government Furnished Equipment (GFE).
- The National Geospatial Intelligence Agency (NGA) will support the costs of integration of the LRA aboard the GPS III space vehicles with an estimated cost of ~\$20M.
- NASA's Space Geodesy Program will coordinate the ILRS tracking of the LRA equipped GPS III satellites and provide analysis of the data.
- These operations will involve the coordination and monitoring by the NASA SLR Data Operations Center at Goddard Space Flight Center as part of the Space Geodesy Program operations.



LRA Engineering Development Plan

- LRA development & production schedule is keyed to SV 9+ dPDR and dCDR schedules expected in the February-March , 2013.
- NASA will deliver one LRA Engineering Development Unit (EDU) to support testing activities at the GPS spacecraft contractor's facilities (Lockheed Martin) by the end of FY13.
- NRL, funded by NGA and NASA, is working with the AFSPC and the Spacecraft contractor (Lockheed Martin) to develop the Interface Requirement Document (IRD) and EDU.
- NASA will competitively select a Prime Contractor for production, performance testing, flight qualification and delivery of the flight units to the AFSPC in compliance with NRL developed Specification.
- Delivery of first Flight qualified LRA expected in FY15.



Back Up



GPS III Satellite Laser Ranging (SLR) - Background

- **April 2007:** The Geodetic Requirements for GPS III were formally submitted to the Air Force Space Command's (AFSPC) Global Positioning System Interagency Forum for Operational Requirements (GPS IFOR), which included:
 - An Analysis of Alternatives recommending that **Satellite Laser Ranging (SLR) retroreflectors be included on all future GPS III satellites.**
 - Formal letters from DOI, NASA, NGA, and NOAA to the IFOR in support of this proposal.
 - A supporting letter from the Global Geodetic Observing System (GGOS), the organization that maintains the International Terrestrial Reference Frame (ITRF),
- **Dec 2007:** Concerns raised by DoD regarding a secondary payload hosted on GPS
- **June 2010:** NASA Administrator C. Bolden in a memorandum to General Kehler (AFSPC) indicated the following. NASA would
 - **Provide SLR retroreflectors as GFE to meet the requirements set forth by the GPS III Capability Development Document as modified for the SLR retroreflectors.**
 - Work with the international laser ranging community, to provide tracking and analysis of the GPS III satellites position and performance to NGA
 - Work closely with NGA and the USNO to support GPS III orbit and clock determinations in order to provide for continuing improvement to system performance.



GPS III Satellite Laser Ranging (SLR) – Background

- **May 2011:** NGA Director L. Long submitted a letter to Gen Shelton (AFSPC) with NGA's commitment for:
 - Supporting the integration and installation of laser retroreflectors on GPS IIIB and GPS IIIC satellite
 - Setting up a funding profile up to \$18.4M through 2020
- **Jan. 11, 2012:** Deputy Associate Administrator, Badri Younes, and Policy and Strategic Communications Deputy Director, JJ Miller (SCaN) supported a NASA – USAF Space Command bilateral meeting between NASA Administrator and Deputy Administrator with Gen Shelton.
 - AFSPC agreed to move forward on the integration studies (\$19M funded by NGA) and NASA agreed to provide \$2.9M to support a 3-year Risk mitigation Study. SMD has already provided \$500K, HEOMD/SCaN to cover the remaining \$2.4M.
- **Feb. 23, 2012:** Follow-up DoD-NASA classified meeting at the Dept. of Commerce to discuss actions from Jan. 11, 2012 NASA-USAF bilateral.
 - Dr. John Labrecque (SMD), with support from HEOMD/SCaN/PSC, to co-chair the GPS SLR Risk Mitigation Study.
 - **NASA and AFSPC to co-chair the Senior Advisory Group (SAG) overseeing this effort**

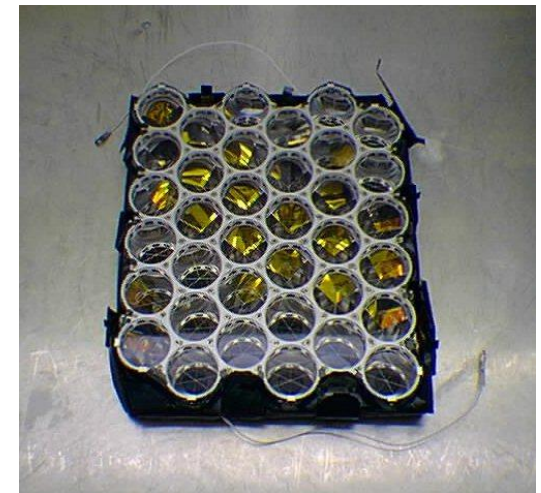


Laser Retroreflector Array

- LRAs are totally passive, and require no power or active control.
- LRAs are made up of arrays of corner-cube retroreflectors:
 - Solid quartz corner cube type reflectors are typically used for LRAs. They operate on the principle of Total Internal Reflection of the incoming laser pulse.
 - Light is re-directed to location of the source of light.
 - Material quality of the quartz is key for long lived applications, such as GNSS satellite installations.
 - Retroreflectors must be specified appropriately to support ground station tracking.



Individual solid corner cubes



**LRA (Honeywell's ETS-VIII)
10 in x 12 in x 2.5 in**



Milestones (to be updated *)

Event	Date
LRA System Requirements Review (SRR)	Aug 2012
SV9 delta PDR *	Sep 2012 Mar 2013
LRA Risk Reduction (RR) Unit 1 Ready	Oct 2012
PIM Testing on RR 1	Nov 2012
LRA Preliminary Design Review (PDR)	Jan 2013
LRA Risk Reduction (RR) Unit 2 Ready	Feb 2013
PIM Testing on RR 2	Mar 2013
LRA Qualification Model (QM) Ready	Jun 2013
LRA QM Testing at NRL Complete	Sep 2013
LRA Critical Design Review (CDR)	Sep 2013
RFP for Prime Contractor	Oct 2013
LRA QM Testing in Spacecraft Test Bed	Oct 2013
LRA Prime Contractor Selected	Feb 2014
LRA Production Readiness Review (PRR)	Jun 2014
SV9 delta CDR	Sep 2014
First LRA Test Readiness Review (TRR)	Jan 2015
First LRA Pre-Ship Review / GPS III Acceptance Review	Mar 2015
LRA Production	Mar 2015 +
SV9 Launch	2019