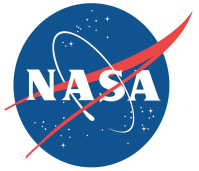
LRO Operations at the MLRS



Jerry R. Wiant
Randall L. Ricklefs
Peter J. Shelus

Center for Space Research and
McDonald Observatory
The University of Texas at Austin

Introduction

- The Lunar Reconnaissance Orbiter (LRO) will perform laser altimetry of the moon and improve lunar gravity field modelling.
- To augment orbital accuracy for lunar gravity field mapping, one-way laser ranging is needed to provide several-cm position accuracy.
- MLRS is one of the primary laser stations that will track LRO.
- MLRS pointing, tracking, beam-divergence, software, and procedural issues must be resolved prior to the early-2009 launch.

Hardware Issues - 1

- Pointing and tracking
  - LRO will not be visible in the MLRS telescope, so accurate blind pointing is required.
  - Absolute pointing of the MLRS telescope is around 10 arcsec. Pointing to LRO will be improved (to 1-2 arcsec) by offsetting from lunar features, possibly using the XY stage.
  - MLRS can hands-off track high satellites to a few arcseconds over 15 minutes. Observer will re-center with lunar features as needed for 60 minute LRO “passes.”

Hardware Issues - 2

- Energy delivered to spacecraft
  - Critical to safety of LOLA detectors
  - Depends on laser energy, seeing, and beam divergence
  - Beam divergence (controlled by defocus of MLRS telescope) has been **poorly known**
  - Ranging high satellites (Glonass) using high laser energy and high detector amplification while manually scan through the laser beam along track and cross track gives us beam divergence.

Hardware Issues - 3

- Energy delivered to spacecraft (cont.)
  - Tests with collimated beam showed beam-width at the space craft matches seeing estimate.
  - Tests with LAGEOS-level defocussed beam, showed a beam divergence of xx arcsec.
  - Tests with LEO defocussing gave yy arcsec.
  - Using LEO beam divergence and LEO power will deliver proper power at LRO. [TBD for sure]

Hardware Issues - 4

- Optimal fire rate for LRO is 28Hz, synchronized with the satellite. However, MLRS will fire at 10 Hz as usual.
- The ranging detector will be used during LRO ranging to gather internal calibration data and the firing time.
- Laser wavelength tests have confirmed compatibility with LRO/LOLA detector.

Acquisition System Software Tasks

- Allow any target to be treated like an LLR or SLR target through a set-up file (to allow lunar feature offset pointing for LRO). **Done**.
- Pass CPF file “target type” (slr, llr, xponder) through raw data to trigger transponder processing in reduction software. **Done**.
- Read and act on LRO go/no-go flag. **Done**.

Reduction System Software Tasks

- Download and process LRO predictions and schedule. **Done**.
- Recognize LRO by “target type” in raw data. **Done**.
- Apply one-way calibrations. Investigating.
- Convert LRO data to CRD. **Done** as part of CRD conversion.
- Send LRO data to HTSI. **No change**.

Procedure Changes

- Check integrated target schedule for LRO availability (1 hour out of every 2 while moon is above horizon).
- Manually set laser power and focus to LRO values.
- Use LRO website for operator pointing feedback, as there are no returns from LRO.

Conclusion

- Our build-up to LRO tracking has required addressing lingering questions about MLRS's pointing, tracking, and beam divergence
- Once these questions were/are answered, LRO tracking mainly impacts software and procedures