System Bias Analysis of 1.2m Telescope Satellite Laser Ranging

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Outline

• 1.2m telescope laser ranging system and some experiments
  kHz SLR, Space Debris LR, SSPD

• Parts of system are upgrading now
  laser (adding 1064nm output), telescope servo control system

• System bias and reasons finding
  set the nearer ground target: ~1.78m (near the second mirror), ~202.5m
  measure reference signal stability
  update station coordinate in time
  monitor the laser energy stability

• Summary
1.2m telescope laser ranging system---kHz system

Telescope Diameter: ~ 1.2m
Optical Path common
kHz SLR Established 2009

wavelength 532nm
repetition 1kHz
energy 0.8mJ/pulse
Pulse width 100ps
1.2m telescope laser ranging system—kHz uncooperate LR system

Satellite

Receiving system

53cm binoculars transmitting telescope

Experimental details, please see our poster—Laser Ranging Experiment with 1.2m Co-optics Telescope Reception of Laser Emitting from 53cm Binocular
1.2m telescope: **space debris LR**

- Repetition: 1000Hz
- Pulse width: 750ps
- Energy: 40mW/pulse
1.2m telescope: **SSPD LR**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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<tr>
<td>QE@532nm</td>
<td>~10%*</td>
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<tr>
<td>Dead time</td>
<td>20 ns</td>
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<tr>
<td>Dark count</td>
<td>&lt;100 cps</td>
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<td>temperature</td>
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April to May, 2015
1.2m telescope: SSPD LR(19km)
1.2m telescope: **SSPD LR**

- Many laser ranging satellites (such as Ajisai) and space debris laser ranging experiments have also been done, but no returns are distinguished.
- Why?
  - large tracking error (10arcsec),
  - little tracking FOV (5arcsec),
  - small fiber diameter (62.5um),
  - QE is low for SSPD at 532nm (~10%), ....
- Upgrade system!
  - do the SSPD test again
Parts of system are upgrading

- 10Hz(1.2m) & 1000Hz(53cm) lasers add 1064nm output, SSPD will be higher QE at 1064nm than 532nm
- Telescope servo-control system upgrade to improve tracking accuracy (better than 10")
- ......
System Bias and reasons finding

LAGEOS 1 & LAGEOS 2

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<th>PREC EST [mm]</th>
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Before 2015.04.08------Evaluated by E.C.Pavlis & M.Kuzmizc-Cieslak
reference stability measure

1pps signal period measurement

10MHz signal frequency measurement
station coordinate

LAGEOS 1 & LAGEOS 2

NEW as of May 26, 2015

Before 2015.05.26------Evaluated by E.C.Pavlis & M.Kuzmizc-Cieslak
laser energy stability

Laser → PIN Diode

Transmitted Time epoch with $\Delta t$ error (≈ cm)

Event Timer

Discriminator (Threshold=1.88V)
sumary

Main system biases: station coordinate, laser stability, system calibration

Weather: from 28th May to now, this year, it’s raining or cloudy (with strong lighten and thunder), ~half a year

Next step:

to optimize our kHz SLR continuously (to observe GNSS satellites), and to do DLR observation, and so on.
• Thanks for your attention!
• Thanks to those people who have been helping us!
• Enjoy all of you to give us some advices and welcome to our station.