Preliminary results of SLR measurement with 1.56m astrometry telescope as a receiver and the laser transmitter on the 60cm SLR system

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Abstract: Detecting ability of laser ranging system is proportional to the area of the receiving telescope, so it is helpful to receive weak signal by using telescope with large aperture. Using 1.56m telescope as the laser signal receiver nearby station 7821 of 60cm SLR system at Shanghai Observatory is a good chance to improve the laser measuring ability for the space targets with less laser returns. This paper introduces the improvements of 1.56m telescope, including receiver terminal and servo controlling system, and the experiments to satellites with retro-reflectors by using 1.56m telescope as receiver and 60cm SLR as a transmitter are also presented. The laser measurements for 1.5m receiving telescope are implemented successfully to lay the foundations for future space debris laser ranging, lunar laser ranging.

1. Introduction

The 1.56m astrometry telescope designed and established by Shanghai Astronomical Observatory in 1987 was one of the large apertures of optical telescopes in China. The main parameters are following:

- Receiving optical system: R-C mode
- Second mirror: 30cm
- Focus length: 15 meter
- Receiving optical effectivity: less than 10% @ 532nm
- Equatorial mounted
- Tracking RMS: <3″

Shanghai SLR station with 60cm SLR telescope was located nearby the 1.56m telescope as shown in Fig 1. The specifications of 60cm SLR system as follows:

- Transmitting telescope: 21cm
- Receive telescope: 60cm
- Laser: ~1 W@1kHz(532nm), 20ps
  ~7 W@10Hz (532nm), 10ns
- Laser beam divergence: 7~8″ @kHz, 10~12″ @10Hz
- Transmitting efficiency: 0.5~0.6

- Tracking RMS: 1″

To take full advantage of the receiving ability of 1.56m telescope for the future applications in the uncooperative space objects, lunar ranging experiments etc, the modifications were successfully performed for preliminary laser measurement experiments with 60cm SLR system in 2012.

Fig 1 The two telescopes with the aperture of 1.5m and 60cm in Shanghai Observatory

The main upgrading for 1.56m telescope system including

- Modifications of receiving terminal for SLR
- Setting up the laser echo signal timing and data processing system
- Range gate control and servo control synchronization for two systems
- Upgrading for dome controlling

2. Measurement results

After the SLR system with laser emitted from the 60cm SLR system and laser echo signal received by 1.56m telescope was established, laser ranging experiment was successfully carried out in March and August of 2012.

Laser measurements to Ajisai, Lageos, BeaconC by using pico-second pulse-width kHz laser (~1W) and using nano-second pulse-width laser (~7W) for Glonass, Compass satellites because of low optical reflective ability were successfully performed. The measuring experiments verify that the 1.56m telescope has the ability

of laser measurement. The results are showed in Fig2.

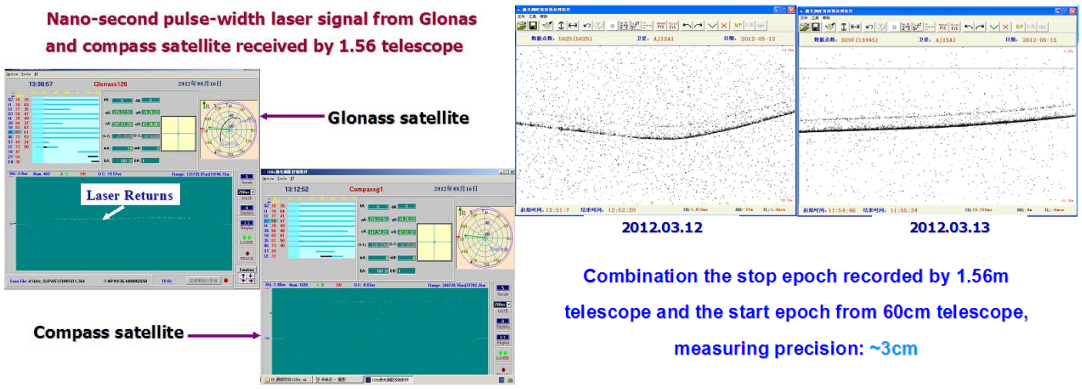

Fig.2 The results of laser ranging experiment by using 1.56m and 60cm telescope

3. Summary

The laser measurement experimental system based on 1.56m telescope as the receiver and laser transmitter at the 60cm SLR telescope by SHAO was established. Laser measurements to several satellites were successfully carried out in March and August of 2012, which preliminarily validated that the 1.56m telescope system could receive the laser echo signal to provide the opportunities for the new applications of 1.56m telescope system. Now the primary mirror and second mirror were sent to recoat for obtaining high optical reflectivity for 532nm wavelength and the improvements of tracking capability for low orbit satellite at the level of 1″ is under way.