New SLR System with 1m aperture telescope in Wuhan Jiufeng Station

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Abstract

A new SLR system with 1m aperture telescope is designed and developed in Wuhan Jiufeng Station, and it will replace the original 60cm SLR telescope system by the end of 2016. The original 60cm SLR system didn't work for several years because of controlling circuit module of telescope mechanical structure and laser transmission module. The design and processing of laser transmitting and receiving module, mechanical structure and electronical controlling circuit have been finished, and the ranging system including the telescope is in assembling and debugging now. The SLR system will work normally next year with the performance of daytime ranging with 1kHz repetition frequency at the precision of cm. The SLR system will be planned to range satellites, detect space debris and research some other SLR technologies.

Introduction

The satellite laser ranging technology is every important for satellite orbit determinations, space debris detection, geodesy, geophysics, astrometry and astro-geodynamics. There are five fixed SLR observation stations in China, and Wuhan Jiufeng SLR station is one of the fixed stations. The Jiufeng station is approved by the Chinese Academy of Sciences in 1986, and the station worked normally since 1996. There are gravity observation station, SLR station, GPS station, DORIS station and so on in the Jiufeng station of the Institute of Geodesy and Geophysics, CAS now. Because of controlling circuit module of telescope mechanical structure and laser transmission module, the 60cm aperture SLR station didn't work for several years. However, the renovation project of SLR station was approved by National Ministry of Finance last year. A new SLR system with 1 aperture telescope is designed and developed in Jiufeng station now, and the SLR system will work normally next year.

Fig.1 The original 60cm SLR telescope observation station

Design and Development of New SLR System

The new SLR system consists of 1m aperture telescope, telescope mount, servo-controlling module, laser transmitting and receiving module, time and frequency module, event counter and computer controlling module, and the block diagram of the SLR system is shown in Fig.2. The satellite orbit prediction and laser ranging data processing are carried out in computer control module. C-SPAD with the performances of single photon detecting sensitivity, high quantum efficiency, time drift compensation and time resolution is used to detect echoes and generate "STOP" signal of event counter, and Latvia A033 event counter is used to measure the time interval between the laser launching moment and photon echoes receiving moment. In order to realize daytime ranging, the narrow-band optical filter and powerful light protector are added in conventional echoes receiving system.

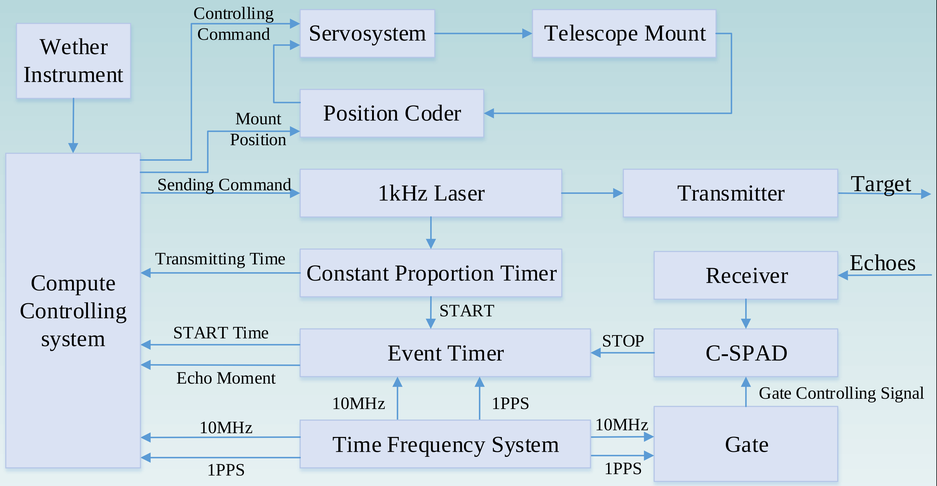

Fig.2 The block program of the new SLR system with 1 aperture telescope

Multilayer dielectric filming of the 1m aperture telescope, machining of telescope mount, processing of laser transmitting and receiving module have finished, and the SLR system including the telescope is assembling and debugging now. The preliminary assembly of telescope mount is shown in Fig.3. The coated combination surface precision of 1m aperture primary mirror and 235mm aperture secondary mirror is measured by Panasonic 4D interferometer, and the interferogram is shown in Fig.4. The fixed trestle of secondary mirror keeps out test laser leading upper part of the interferogram missing. The RMS and peak-to-peak value of surface precision are 0.06λ and 0.6λ respectively, and the test wavelength λ is 632.8nm.

The new SLR system with 1m aperture telescope will replace the original 60cm SLR system and work normally at the precision of centimeter (cm) next year. The key designed performances of the new SLR system is described as following:

- The capacity of daytime ranging with 1kHz repetition frequency, powerful light protector and different CCDs assist for night and daytime ranging.;
- Laser ranging distance from 300km to 40000km;
- Tracking precision is about 2'' for LEO target and 1'' for MEO and GEO targets;
- Maximum tracking speed and acceleration are 5^0/s and 1^0/s^2 in orientation and 2^0/s and 0.5^0/s^2 in pitch.

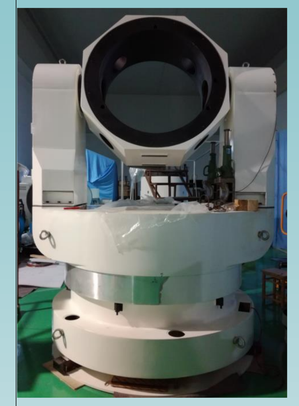

Fig.3 The preliminary assembly of telescope mount

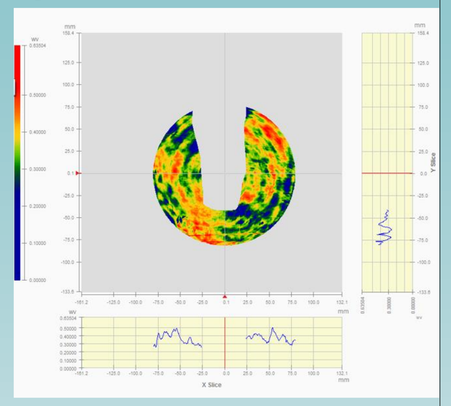

Fig.4 The interferogram of combination test of 1m and 20cm aperture coating mirrors

Laser ranging plan in Wuhan SLR station

The original 60cm SLR observation station is one of ILRS stations, however, it hasn't worked for several years. The new SLR system will work normally with the performance of daytime ranging next year. The future research plan of the new SLR system is as following:

- finish ILRS routine observation missions and providing ranging data for ILRS;
- detecting uncooperative space target;
- carrying out joint observations with some other SLR station in China, such as Shanghai SLR station, Fangshan SLR station in Beijing, Changchun SLR station;
- researching some new SLR technologies, for example, remote automatic controlling of SLR station, laser time two-way transfer and sub-centimeter laser ranging.

Summary

The new SLR system with 1m aperture telescope is designed and developed in Wuhan Jiufeng station. Compared with the original 60cm SLR system, it has higher repetition frequency, higher laser ranging precision and larger effective receiving area. The new SLR system will carry out IRLS routine laser ranging missions next year, and it also will be used to detect uncooperative target and research some new SLR technologies.