System Stability Improvement of Changchun SLR

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Abstract: The paper presents some work done in Changchun station to keep and improve the SLR system stability since the system upgrade in 1997, such as the laser improvement, new encoder and servo system, and control system. These work brings and keeps Changchun SLR system to an high level in data quantity and quality during the past several years, and makes the station to be one of the standard and important stations in ILRS.
Keywords: Satellite Laser Ranging, Laser, improvement

1. Introduction

Changchun station has updated its satellite laser ranging (SLR) system since 1997, including satellite orbit prediction, tracking, data collection, data preprocessing and data delivery. After the system update, the single-shot precision is improved from 5-7cm to 1-2cm for satellites and less than 1cm for ground target. The normal point precision reaches 4-7mm. In recent years, the amount of observation data has been increased dramatically. Each year, more than 2000 passes data can be obtained[1,2,3,4]. In addition, the system stability has been improved greatly. According the report issued by International Laser Ranging Service (ILRS), the long-term and shot-term stability of the SLR system become better and better. The long-term stability reaches 1cm or better from 4cm and the short-term stability reaches 2 cm from 6cm[5].
Now Changchun SLR has become an important one in the international SLR Network.

2. Ways to keep the system stability

(1) Laser System
The Laser system is eighty's generation domestic product: the Nd:YAG active and passive mode-lock laser system. Because of the restriction of the parts of the apparatus and technique at that time, the laser output unsteady, energy rise and falling largely, repeating frequency lowly, breaking down rate highly, so it is very difficult to keep the system steady. In the last several years we have improved the system continuously, and chosen the new pieces for the system, and make it more stable and reliable.
a. Improvement of the laser room's environment
Installed an air conditioner and wet-cleaning machine in the laser room in order to keep the temperature and humidity stable. To clean the laser room periodically.
b. The application of high precision power supply insures the stability of the laser system.
For the pulse switch driven by avalanche transistor driver, it should be very care to choose each avalanche transistor in order to make them have the almost same avalanche electric voltage(<±1V), trigger delay time(±1ns) and avalanche point electric current(±1A), so that that can make the driver leading edge well, jitter low, longevity. Otherwise, we choose the high voltage power supply with high precision and high stability to power pulse switch driven by avalanche transistor. Now, the rate of the single pulse selection reaches almost 100%.
Following are the photos of the power supply for laser system and pulse selection switch.

Fig.1 power supply for laser system

Fig.2 power supply for pulse selection switch

c. The improvement and application of the new pieces for laser system.
We use new pulse xenon lamp pump and cavity for the oscillator of the laser system.
To minish the valid thickness of dyestuff box in order to narrow the pulse width, we renew the laser dyestuff circulatory system so as to solve the defects of dyestuff aqua change and produced scatter particles. The result is the dyestuff can be used longer and need to be replaced only once a month.
After the continuous improvement during the past several years, the stability and reliability of the laser system have been greatly improved, and can completely satisfy the normal observation.

(2) Servo System and Encoder Electronics.

A new servo system for the mount was built. As some microprocessors substitute for the old relays, the stability becomes better. The servo system adopts IGBT, its tracking ability for low orbit satellite boost up, and the tracking error for high orbit satellite is apparently diminished. The new encoder electronics uses a circuit with 23 bit (0.155_resolution), and the output signal becomes better. Also, the output signal of encoder is less affected by the intensity variation of encoder light. So the encoder is more stable.

(3) Satellite Prediction and Pre-processing Software and control system.

A new prediction software for satellites was introduced, and the accuracy of prediction for position and range of satellite is improved. The prediction accuracy of range for low orbit satellite reaches 20m and is better for LAGEOS. The accurate position prediction can increase the return rate from satellite. The accurate ranging prediction is in favor of narrowing range gate and reduces interference of background noise. The data pre-processing software picks up the useful data from large numbers of the raw observation data and generates normal point data for precise determination of orbit and other applications. In addition, sometimes the laser produces two pulses at one firing, which might cause ranging bias for this pass. We compiled special software for dealing with two pulses, and the availability of observation data has been increased. Fig.3 is the tracking control system screen for multi-satellites, same as Shanghai station [6].

Fig.3 tracking control system screen

3. Summary

Now after several years improvement work on the SLR system, the observation of Changchun station keeps a good record in data quality and yield. Following table 1 is a chart showing the passes during the past years in Changchun station, and it shows a very impressive steady increase. The precision of single shot and normal point, the long and short system stability are all in a standard region. Now Changchun Observatory is developing the daylight tracking capability, and researching on data analysis and applications. More high quality data and some application results will be obtained.

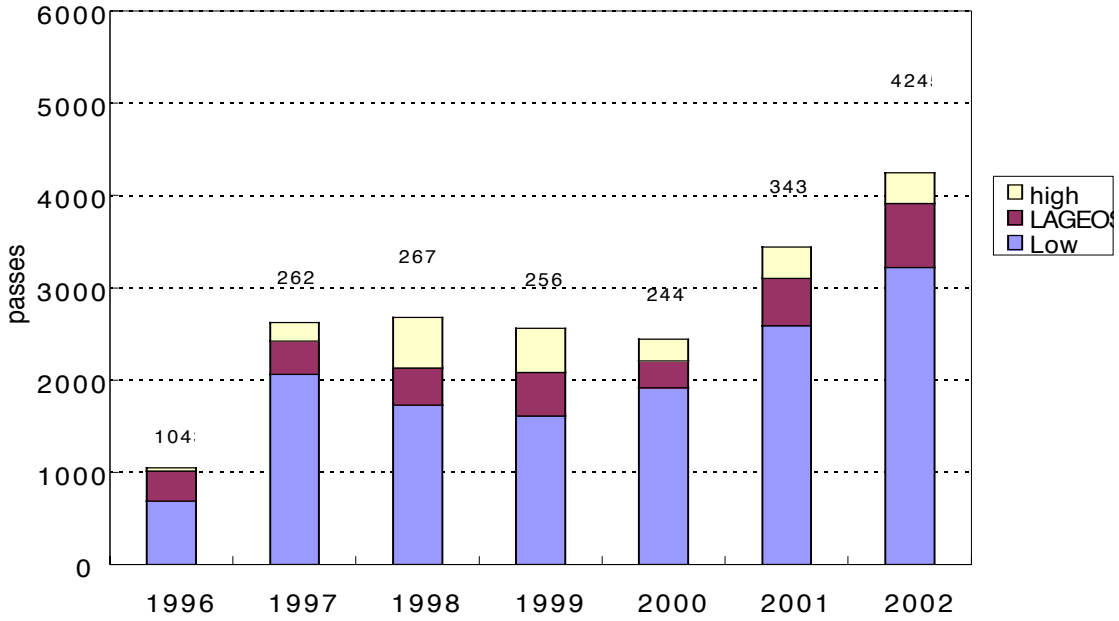

Table 1. Passes from 1996 to 2002

References

1. Zhao You_Upgrade of Changchun SLR System_ Proceedings of 11th International Workshop on Laser Ranging, Deggendorf, Germany, Sep. 1998_188_196
2. Zhao You, Zhang Jun-rong, CUI Dou-xing_The improvement of changchun satellite laser ranging system_ in Optical Remote Sensing of the Atmosphere and Clouds, Jinxue Wang, Beiying Wu, Editors, Proceedings of SPIE Vol. 3501, Beijing, China, 1998 _453_460
3. Liu Chengzhi, Zhao You, FAN Cunbo, Cui Douxing, Han Xingwei, Yang Fumin_Performance and observation summary of Changchun Satellite Laser Ranging Station_ Chinese Science Bulletin_ Vol_47_No_13_July 2002_1070—1072
4. Zhao You, Kunimori H., Hamal K., Prochazka I._PCS in Changchun Station_ Proceedings of 11th International Workshop on Laser Ranging, Deggendorf, Germany, Sep. 1998_174_180
5. Van Husson. Performance Report Card 2001, 2001
6. Yang Fumin, Xiao Zhikun, Chen Wanzhen, et al. Design and Observations of the Satellite Laser Ranging System for Daylight Tracking at Shanghai Observatory, SCIENCE IN CHINA_Series A_Vol.42, No.2, 1999. 198~206