

The Performance Of Changchun SLR Station

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Abstract: This paper introduces the performance and observation summary of the SLR system at Changchun Observatory, Chinese Academy of Sciences. The performance of the SLR system has been greatly improved since August 1997. The single shot precision reaches 1-2cm from 5-7cm and the normal point precision reaches 4-7mm. The long term stability is better than 1cm. The amount of observation has been increased from about 1000 passes to about more than 4000 passes.

TECHNICAL IMPROVEMENT

1. Laser System. An active-passive mode-locked Nd:YAG laser is used to generate a 532 nm harmonic with 200 ps width optical pulses. They have energy of 100 mj per pulse and 1,2,4,5,8 and 10 pulses repetition rate per second. The laser firing is controlled by real-time tracking software, typically 4 and 8 pps repetition rate adopted. In recent years, we improve the laser room's environment and apply the high precision power and some new pieces for laser system, so the stability and reliability of laser system have been greatly improved, and now it can completely satisfy the routine observation.
2. Controlling system. All of the operations in Changchun SLR system are completely controlled by a Pentium 586 industrial computer. Its main functions include laser firing, rang gate controlling, telescope real-time tracking, data gathering and recording.
3. Receiving System. The C-SPAD with time walk compensation circuit and the temperature control shell was adopted as photo-electronic detector instead of the old photo-multiplier tube. The features of C-SPAD are high quantum efficiency, small time walk, automatic compensation and low working voltage. So it decreases the

system ranging bias caused by the variation of return signal amplitude and has larger dynamic range. It has been shown in the test that the timing error of the C-SPAD is 43ps, so better observation accuracy can be obtained.

4. Timing System. HP58503A GPS time frequency receiver supplies 10MHz signal and the second pulse that is synchronized to GPS time to the control system and receiving system. The tracking software is improved to synchronize time automatically every pass so as to reduce time walk and enhance the stability of time system.

5. 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.

6. Satellite Prediction and Pre-processing Software. 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 ranging gate and reduce 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.

SUMMARY

In recent years, the data quality of the Changchun SLR Station has been greatly improved and the data volume has been doubled. In 2003, we got total 4463 passes. Table 1 shows the data volume and quality of Changchun Station during January 1,

2003 through December 31, 2003. The long and short term stability has also been upgraded. The long-term stability reaches 1 cm or better and the short term stability reaches 2 cm. Table 2 shows the orbital analysis results of Changchun Station from CSR, MCC, Delft and CRL. In a word, Changchun Station has become an important station in the international SLR Network. Now Changchun Observatory is developing the daylight tracking capability, research on data analysis and applications. More high quality data and some application results will be obtained.

Table 1 Data Volume and Quality (January 1, 2003 through December 31, 2003)

Data Volume									Data Quality		
LEO Totals	LAGEOS Totals	High Tot	Total passes	LEO NP Total	LAGEOS NP Total	High NP Total	Total NP	Minutes of Track	Cal. RMS	ERS RMS	LAG RMS
3578	493	392	4463	54595	4930	2694	62219	40056	11.5	12.7	13.9

Table 2 Orbital Analysis Results of Changchun Station

Quarry	NP RMS	Short Term (mm)	Long Term (mm)	% of good LAGEOS NP
CSR	6.8	18.8	7.2	97.6
MCC	4.9	13.0	17.4	81.2
Delft	7.4	18.8	6.0	100.0
CRL	6.5	22.1	5.4	100.0