Improvements of System Stability at Changchun Observatory

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Abstract:
Changchun Station (7237)'s routinely KHz SLR operation since July 2009 has undergone a lot of improvement on system stability. A new near target was installed for system calibration. Auto-Gate-Identification was applied to enhance the detect probability of return pulse signal. The A032-ET was replaced with A033-ET to increase timing precision. Also an additional delay cable was connected to A033-ET channel B in order to adjust measured delay from near target. The correlation between the detector operation temperature and system delay was particularly analyzed.

Key Words: System stability, Near target, Calibration

1. Introduction

Changchun Station's routinely KHz SLR operation since July 2009 has undergone a lot of improvement on system stability. The atmospheric environment was found influence the far target obviously, which was built 1.2Km away from the station. In order to resolve this problem, Changchun SLR group decided to install a new near target in the dome, and also, the event timer was replaced by a new one to improve the precision.

2. Near Target

2.1 Structure:

The near target was installed in the dome about 3m away from telescope. The position was : Azimuth: 225°, Altitude: >0°. Vibration isolation was added to ensure its stability. See the Structure and appearance of near target in Fig.1 and Fig. 2. Tie-strut to ensure the altitude when observation, while M1 and M2 reflector to weak the return pulse.

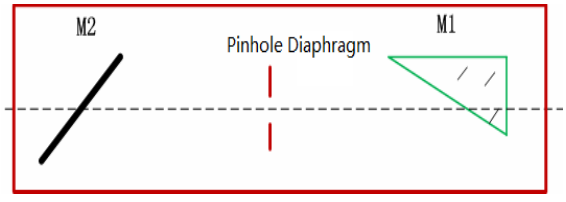


Fig.1 Structure of near target

Fig.2 Appearance of near target

2.2 Material:

Prism M1: Anti-reflective coating, R<0.1%@532nm, with Wedge shape

Prism M2: diffuse reflection plate, with black color.

2.3 Measurement

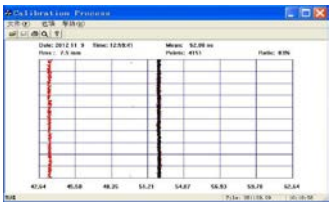
The mean value is 3.699m, single distance.

The actual location:

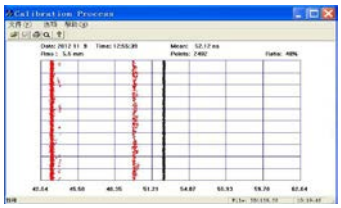
— Azimuth: 228° 56′ 10″

— Altitude: 0° 24′ 27″

The return pulse with different pinhole diaphragm: the smaller the better.



3.5mm



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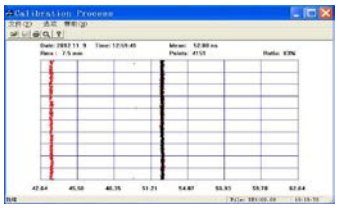

1mm

2.4 Add ND Filter on the Pinhole Diaphragm: the return pulse could be found clearly.

Fig.3 ND Filter on PD

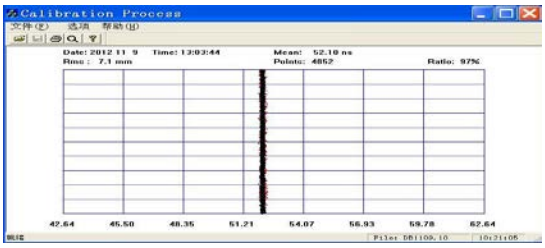

Fig.4 Detection result with ND

3. Event Timer Replacing

A032 was replaced with A033 to increase timing precision, an additional delay cable was connected to A033-ET channel B. The main performances of A032 and A033 are listed in the table below.

Fig.5 Appearance of A033-ET

Table 1 Table of A032 and A033 performances

Performances	A032-ET	A033-ET
Single-shot RMS resolution	<10ps	3.5-4ps, 5ps max.
Dead time	60ns	50ns
Interval non-linearity	< 1ps	+/- 0.5ps

The shortest intervals for A032 it is 60 ns and for A033 it is 50 ns. These intervals will be registered in any cases and independent on inputs. RMS for short intervals <100 ns is worse than for longer intervals. This impact can (not obligatory) increase the RMS by about 2ps. While the measurement of target is about 52ns before cable was connected to A033 channel B, nearby “dead time”, so an additional cable was added. See Fig.6.

Fig.6 30m cable added to A033-B

4. Auto-Gate-Identification

Auto-gate-identification method was used in Tracking Software to identify return pulse through a self-adjusting gate. The gate was calculated by satellite prediction at this moment, the return pulse received right now, and the gate advance period. Auto-gate-identification was used particularly in daytime tracking.

5. Analyzation

5.1 Change of System Delay

After the improvement of SLR calibration, the change of Changchun SLR system delay is much lower, about 8-10cm for near target, while 3-15cm for far target. See Fig.7 and Fig.8 (From Multi-Satellite Bias Analysis Report).

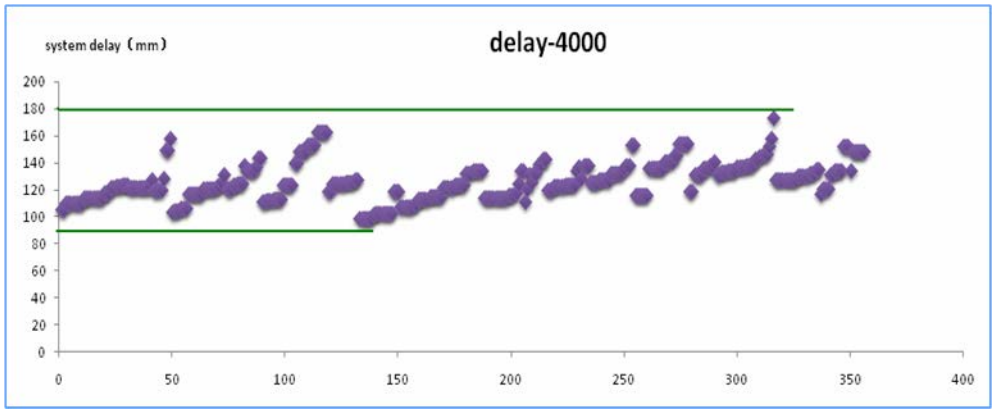

Fig.7 System delay of near target

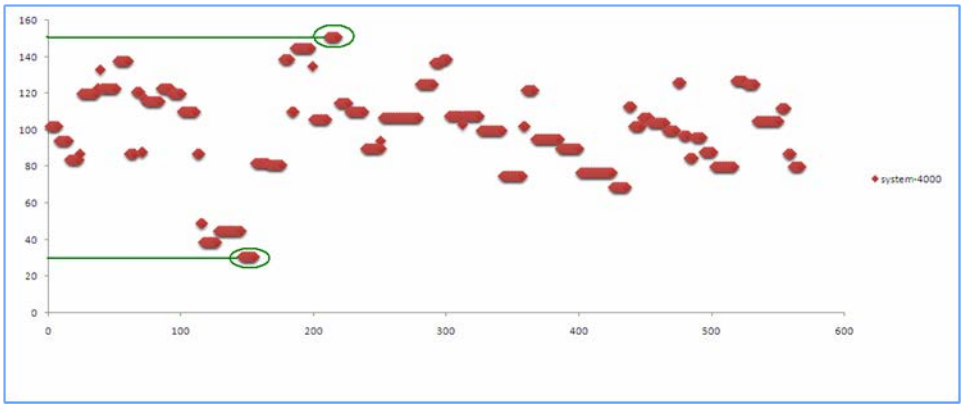

Fig.8 System delay of far target

5.2 Co-relation with environment

The meteorological environment influence the target measurement: pressure contribute irregular, temperature contribute linear influence (See Fig.9). As for this analysis, the MET3's center was rose the same as telescope (See Fig.10).

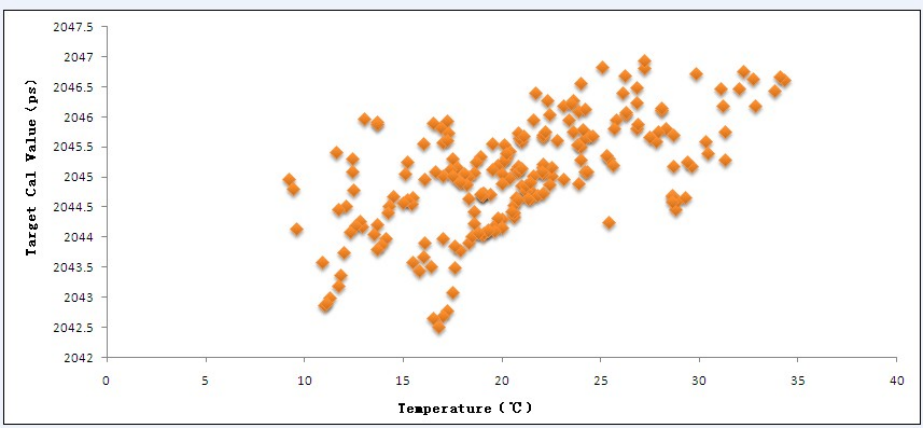

Fig.9 Co-relation of System delay and temperature

Fig.10 MET3’ center was rose

6. Summary

Near target was used in Changchun for a few months, it works well during this period. While the short term stability of SLR system is still not expected for us. Maybe partly because of the bad temperature stability of C-SPAD, and partly because of some other

questions which we didn’t consider about. After all, more work should be done for system stability.

Reference

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