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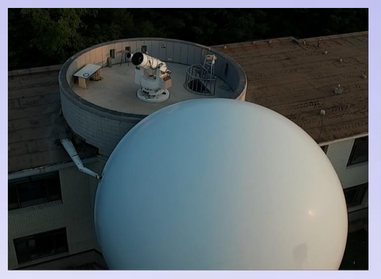

The Improvements on Data Quality of Changchun High Frequency Laser Ranging System

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Changchun Observatory has achieved the high frequency laser ranging and daylight laser ranging since 2009. The data quantity always ranked second in the world, but the data quality is not improved as the system. At present, we have done a serial of measurements on data quality stability and have proved to be very effective. In the upgrade of software, it includes data identification, auto time bias and range bias, auto gate control, the pass duration and echoes number control. In the upgrade of hardware, there are laser intensity control, target calibration improvements and detector housing. After taking the above methods, the long term bias is better than 3mm, short term bias is better than 20mm.

Introduction

Changchun Station's routinely KHz SLR operation since July 2009 has undergone a lot of improvement on system stability. The data quantity and detection ability of Changchun SLR station kept improving since KHz upgrade, making it easy to acquire data both in night and daylight. And the space debris observation succeeded since 2014. However, the stability was not improved as the system. A lot of methods have been done to improve the data quality of Changchun SLR system.

Software

◆Data identification:

The data identification used in real-time observation, so that we could ensure return signals in the daylight observation.

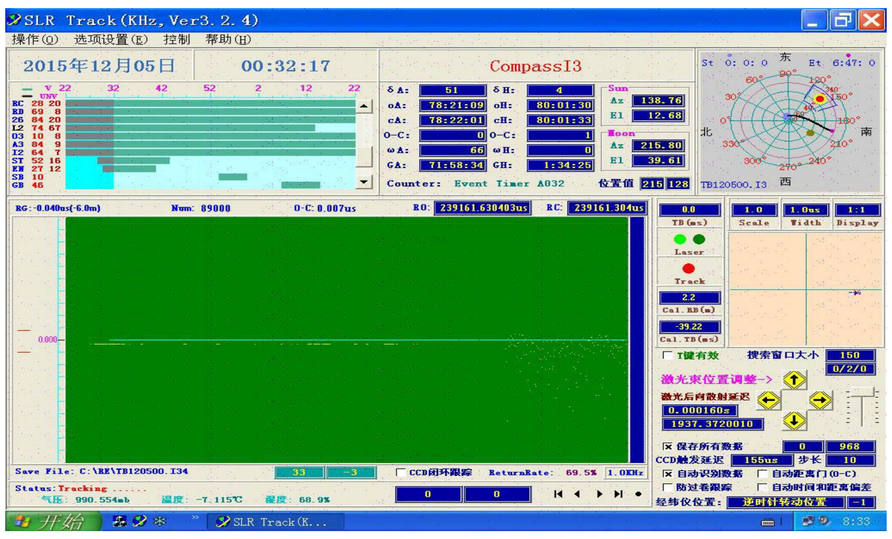

Fig.1 Appearance of SLR Tracking Interface

The data identification also used in data processing, the "return pulse" could easily be picked up from the flooding noise. The data identification is suitable for all the targets, even for TOPEX and space debris.

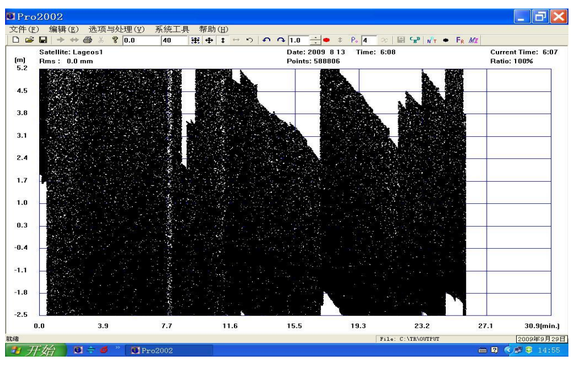

Fig.2a Data process without data identification

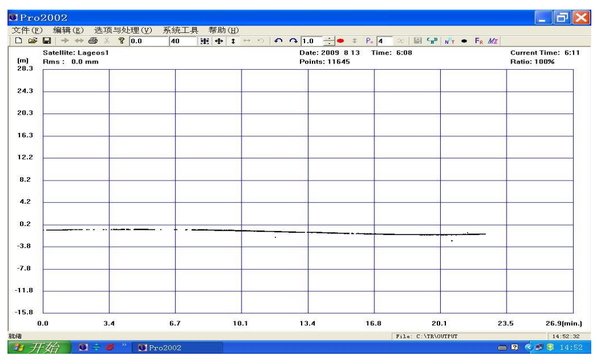

Fig.2b Data process with data identification

◆Auto Time Bias, Range Bias and Gate

The TB and RB are calculated in real-time during operation, and if they are applied into prediction in real-time, the "slope" of the data line will be made very small, which is very useful for data identification. It is used both for SLR and DLR. The TB fitting also used in process. We could acquire more data after adding TB before data process. The gate could also be auto-calculated in real-time.

◆The pass duration and echoes number control

The echo rate, pass duration and elevation were regulated according to technical recommendations. Calibration is now automated and more frequently done. We use 5000 returns per calibration session，and guide RG automatics，the RG for C-SPAD before return arrives is now tuned from 65 ns (as Graz) to 100ns.

Hardware

◆Laser Intensity:

The variation of laser intensity may cause different response time for detector, leading to jitter of system delay. To investigate the error source, part of system status is kept constant. The narrow band filter and iris are now used in both day and night observation, in order to keep consistency of the received signal strength.

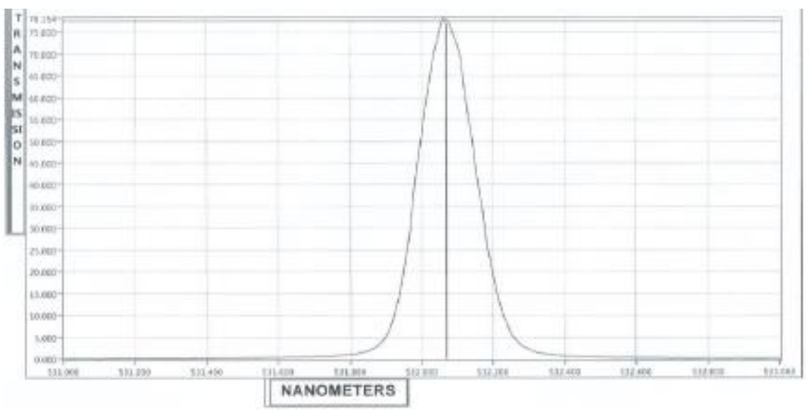

Fig. 3 Narrow Band Filter Spectrum

◆Target Calibration Improvements

Reflective covers are applied on the ground target, the detector housing and exposed part of the optical path so as to reduce the effect of sunlight on the mechanical structures and detector circuitry.

◆Detector Housing

The temperature do affect detector's response time according to our experiment. While during the daytime, the temperatures are quite different between the sunlight and shadow. This causes the SLR system delay to vary in one HEO pass. A thermostatic housing for detector was installed to keep the temperature detector stable, so as to avoid temperature drift effect.

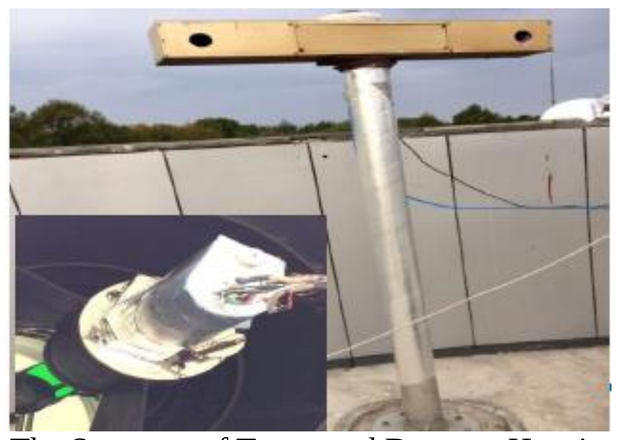

Fig. 4 The Structure of Target and Detector Housing

Data Quality

After taking the above methods, the long term bias is better than 3mm, short term bias is better than 20mm.

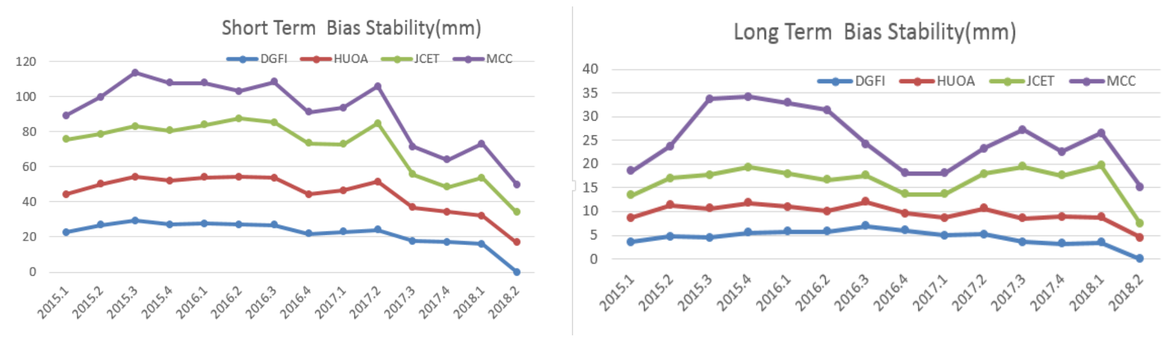

Fig. 5 Short Term and Long Term Bias Stability of Changchun Observatory