

Improvements of Changchun SLR Station

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Introduction

Changchun observatory tried every effort to improve short term bias stability. A thermostatic apparatus for Narrow Filter (NF) was set to keep relatively constant temperature to avoid temperature drift effect. The observe duration and elevation was limited strictly according to the observe priority. Also, some work was done according to the daylight observation: the silver paper covered over the telescope base, the near target and detector so as to reduce the effect of sunlight on the mechanical structure of telescope during daylight observation; the Fish Eye Camera used to monitor weather variations in the whole sky. Some other improvements will also be introduced in this presentation.

The problem of Changchun SLR system

The data quantity and detection ability of Changchun SLR station kept improving since KHz upgrade, making it easy to acquire data.

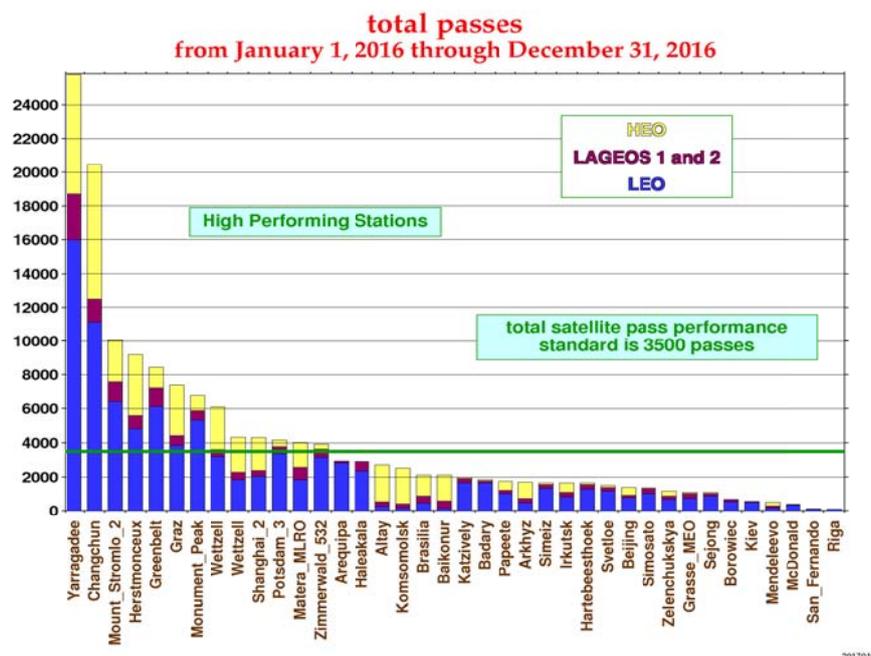


Figure 1: The total passes from Jan. 1, 2016 through Dec. 31, 2016

However, the short term bias stability is not improved as the system. So we began trying to improve the short term stability at the beginning of 2016. The RMS (Root Mean Square) of Changchun LAGEOS normal points is larger compared to other station (such as Graz).

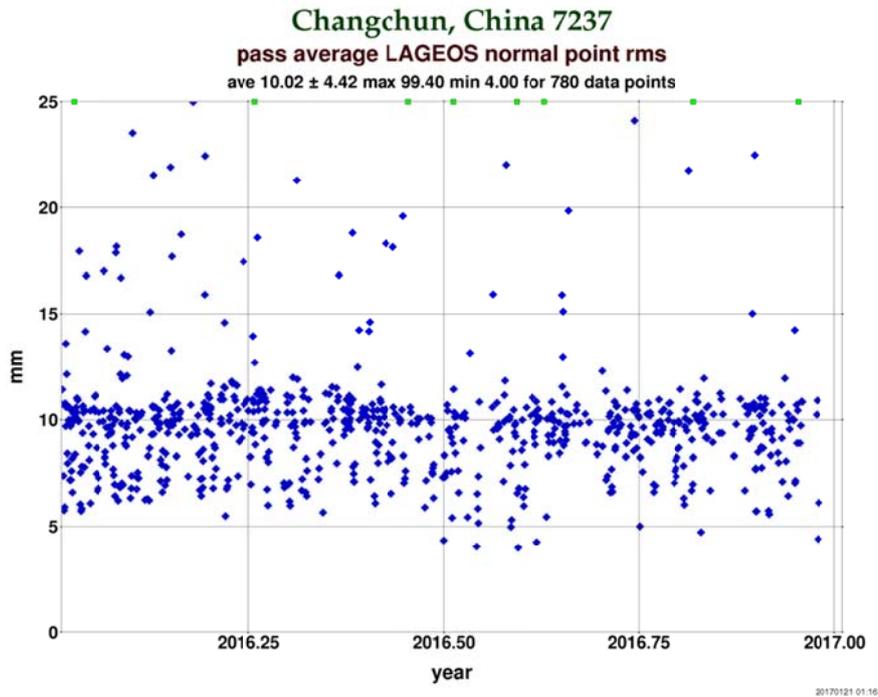


Figure 2: Pass average LAGEOS normal point RMS for Changchun

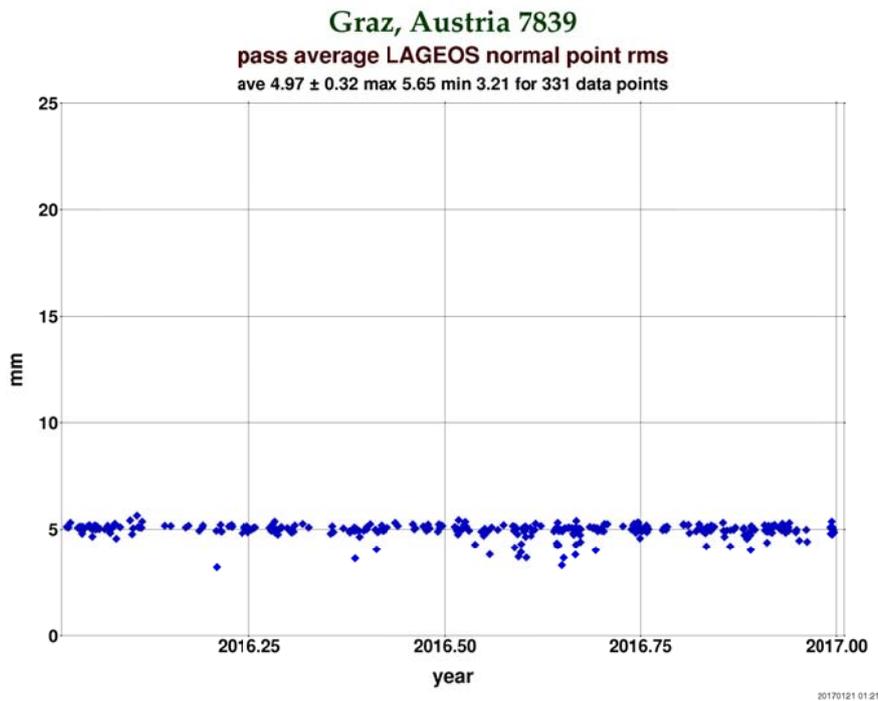


Figure 3: Pass average LAGEOS normal point RMS for Graz

Analysis of Short Term Stability Issue

Several factors affect system short term bias:

- Detector temperature: Changchun uses C-SPAD as the detector, which was installed in the front side of telescope. 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.
- Laser intensity: The variation of laser intensity may cause different response time for detector, leading to jitter of system delay.
- Other reasons: The pass duration and echoes number in each NP bin are not regulated as recommended, which are also related to short term bias.

Measures Taken

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 operations, in order to control the echo signal strength received.

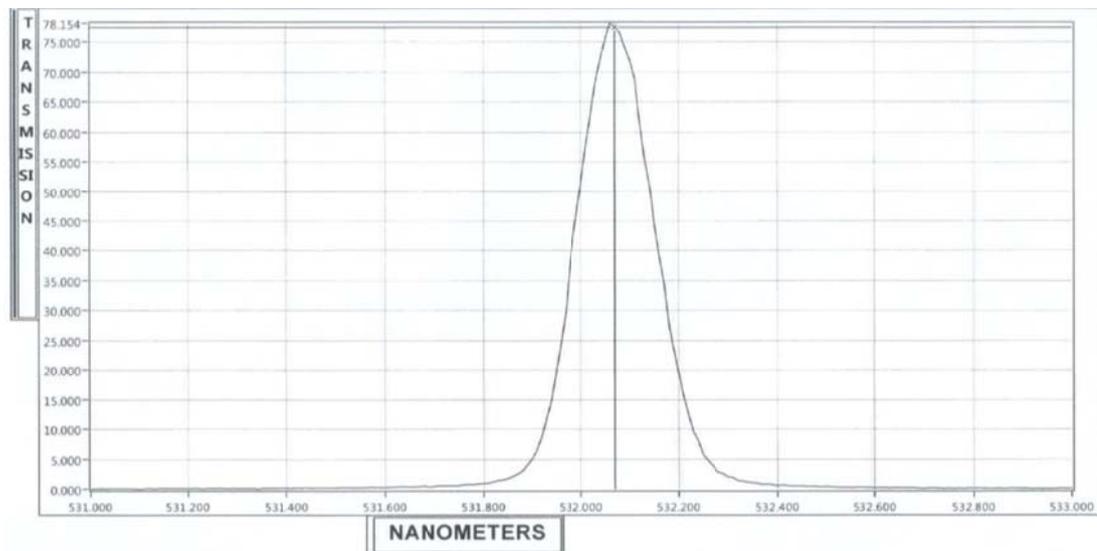


Figure 4: Narrow Band Filter (band width 0.18nm)

- A thermostatic housing for detector was installed to keep the temperature around detector stable, so as to avoid temperature drift effect.

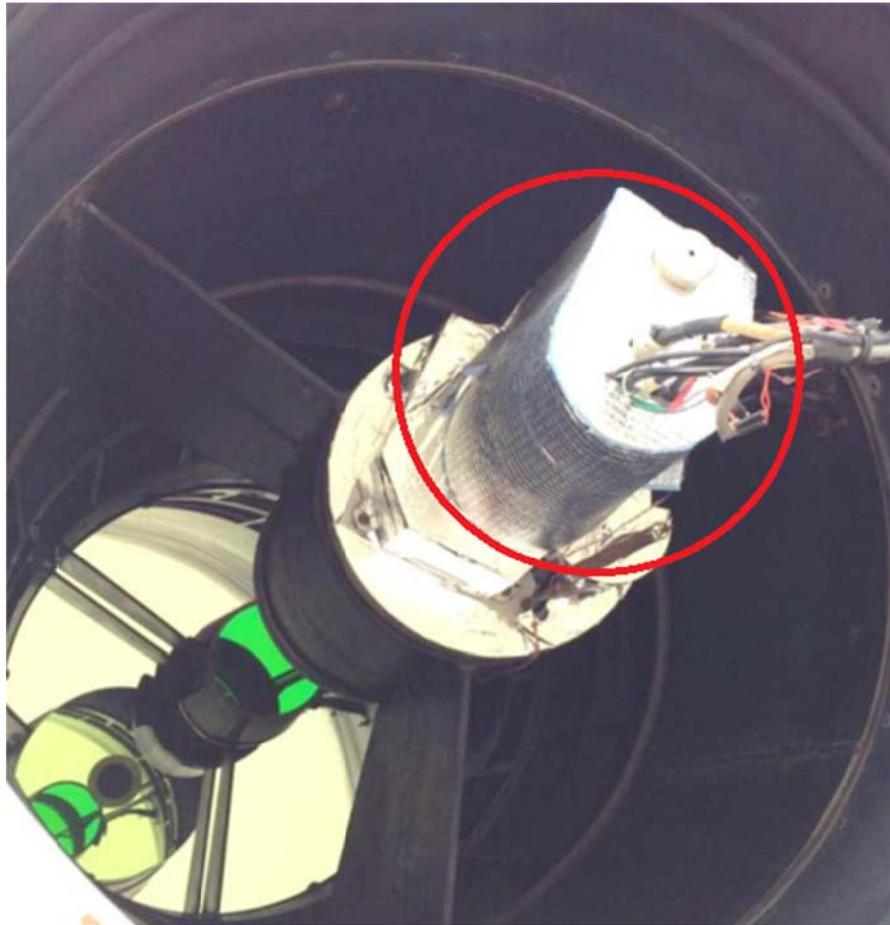


Figure 5: Thermostatic housing for detector

- Reflective covers are applied on the ground target, detector housing and part of the optical path so as to reduce the effect of sunlight on the mechanical structures and detector circuitry during daytime observation. A fish-eye camera was used to monitor weather in real-time.



Figure 6: Near target in SLR system



Figure 7: Fish-eye camera was used to monitor weather

- A new End Run GPS receiver was adopted to provide time. Thermostatic housing for clock, timer and control units is also underway.



Figure 8: End Run GPS Timer

- The echo rate, pass duration and elevation were regulated according to technical recommendations.
 - a) Both ascending and descending branches being tracked
 - b) Min. 10-minutes session duration for LAGEOS or HEOs
 - c) Min. 4 NP per one pass
 - d) Min. 20 degree elevation
- KHz calibration is now automated and more frequently done. We use 5000 returns per calibration, and guide RG automatics, the RG for C-SPAD before return arrives from 65 ns (as Graz) to 100ns.

Conclusion

Normal point numbers increase due to longer pass duration, especially for LAGEOS and HEOs. System delay variation reduces due to thermostatic control, echo intensity control, tracking regulation, software improvement, high accuracy GPS receiver and so on.

After taking the above measures, the short term bias stability is expected to improve. Other measures for short term bias problem are still under research. The Changchun KHz system capability is far from exhausted. With optimized scheduling and regulations, both quantity and quality of data can be achieved.

References

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