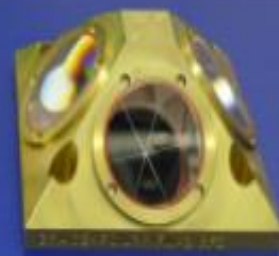
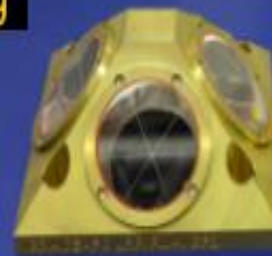


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Improvements of Changchun SLR Station

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Changchun Observatory, NAO, Chinese Academy of Science

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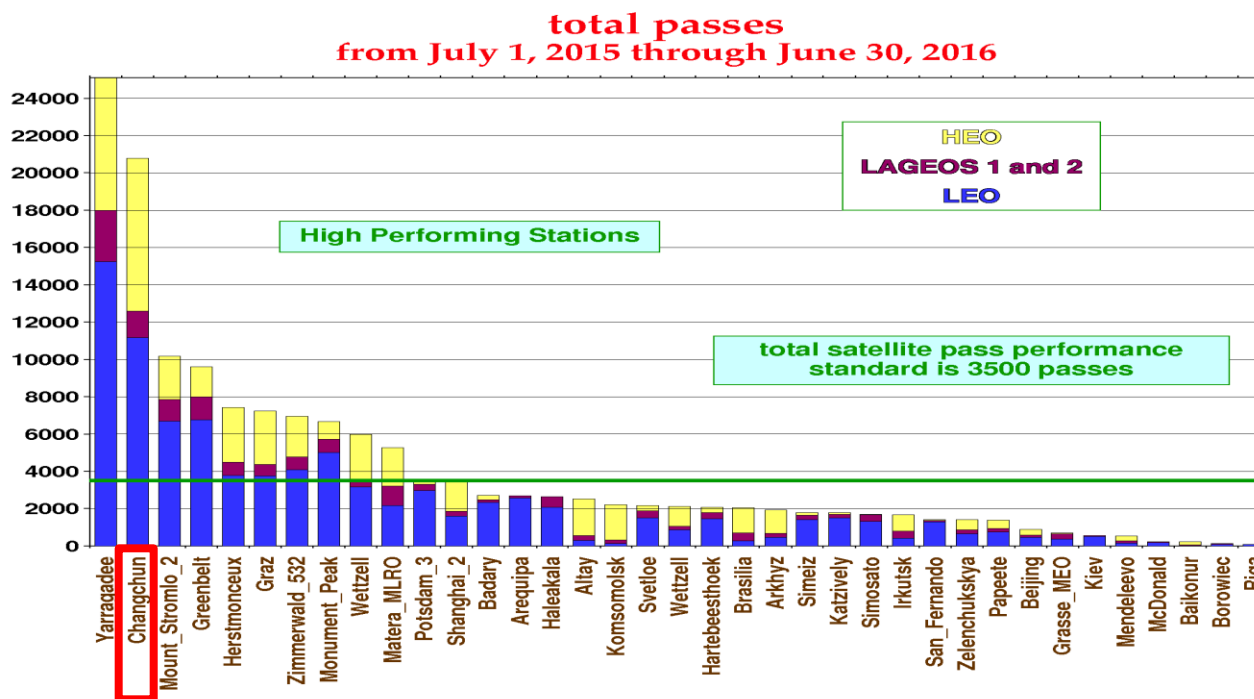
Outline

- **The problem of Changchun SLR station**
- **Analysis of short term stability issue**
- **Measures taken**
- **Conclusion**



The Problem of Changchun SLR station

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

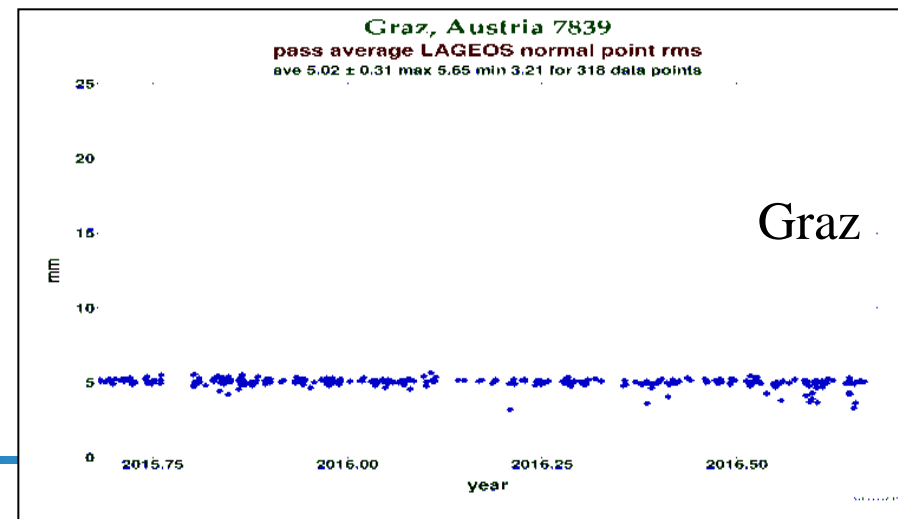
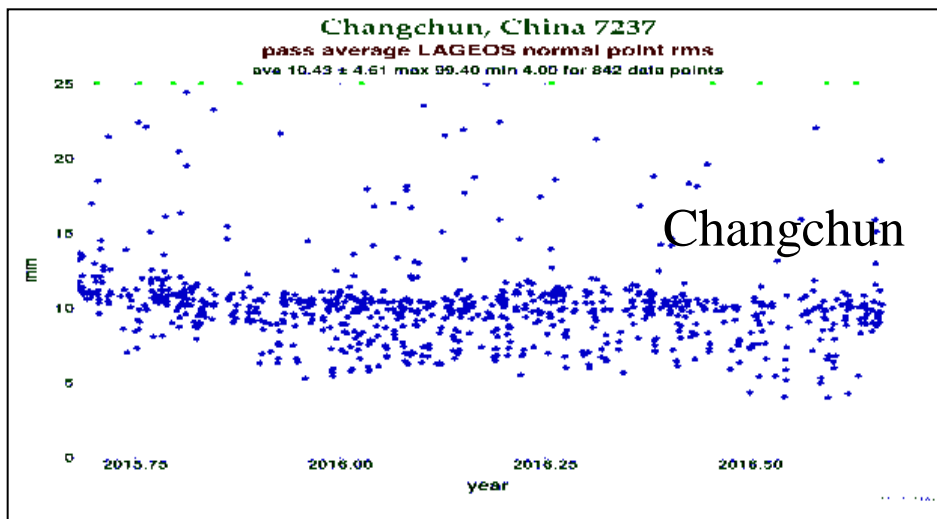




The Problem of Changchun SLR station

However, the short term bias stability is not improved as the system. So we began trying to improve the short term stability at July 2015.

The RMS (Root Mean Square) of Changchun LAGEOS normal points is larger compared to other station (such as 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.**



Analysis of Short Term Stability Issue

Several factors that affect system short term bias:

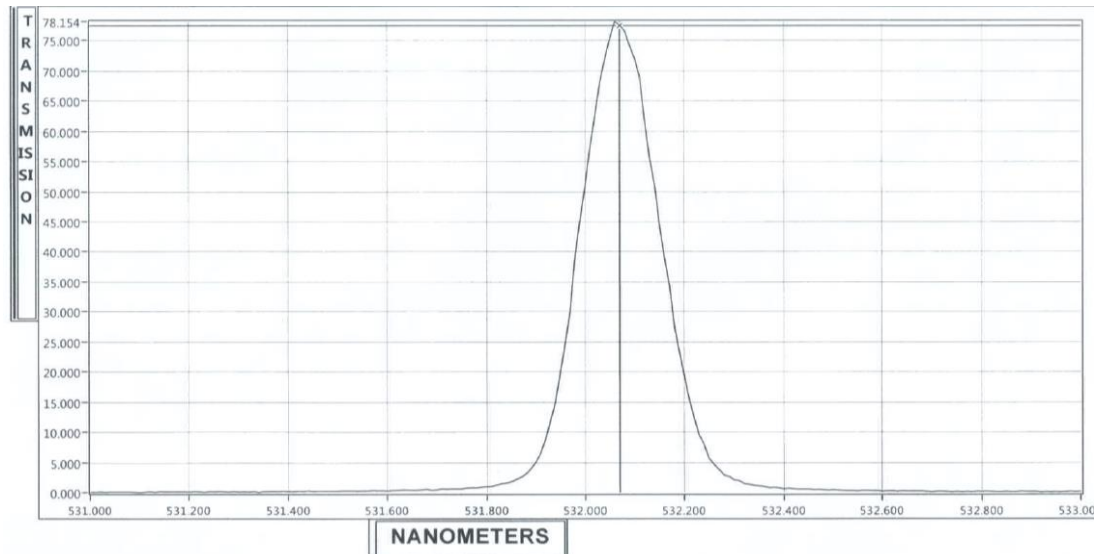
- **Laser intensity:** The variation of laser intensity may cause different response time for detector, leading to jitter of system delay.
- **The pass duration and echoes number in each NP bin are not regulated as recommended, which are also related to short term bias.**



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.





Measures Taken

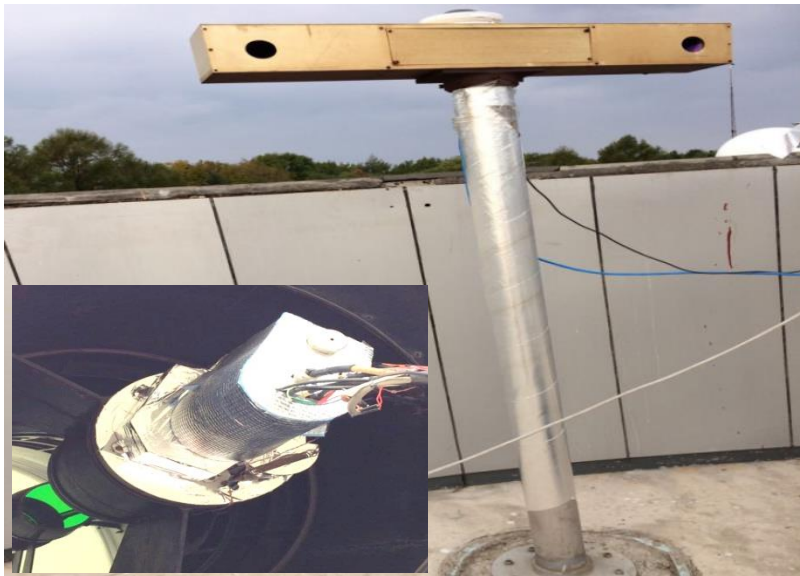
- A thermostatic housing for detector was installed to keep the temperature around detector stable, so as to avoid temperature drift effect.





Measures Taken

- 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.





Measures Taken

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





Measures Taken

- **The echo rate, pass duration and elevation were regulated according to technical recommendations.**
 - Both ascending and descending branches being tracked
 - Min. 10-minutes session duration for LAGEOS or HEOs
 - Min. 4 NP per one pass
 - 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-1

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, higher accuracy GPS receiver and so on.



Conclusion-2

After taking the above measures, the short term bias stability is expected to improve. Other measures for short term bias problem is 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.



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Thank You

for your attention!

