

The status and plan of Chinese SLR network

Zhang Zhongping, Han Xinwei, Zhao Chunmei, Li Yuqiang, Guo Tangyong, Liu Weidong,
Wu Bin

(Chinese SLR network)

Corresponding author: zzp@shao.ac.cn

Abstract: The SLR stations in Chinese SLR network have been upgraded to kHz repetition rate laser ranging system and daytime tracking capability under the support of the state key project "Crustal Movement Observation Net-work of China" since 2011. Over last few years, these SLR stations have been focusing on daylight track to HEO satellites and short/long term bias stability, and extending research fields to extra-high repetition rate laser ranging. In three years, there are several one meter-level telescopes to be developed for SLR measurement and optical observation, and one new SLR station will be set up in Xinjiang Uygur Autonomous Region in the northwest China. The development of the compact SLR systems with the capability of observing MEO satellites is also being underway to increase the number of SLR sites with low cost and make Chinese SLR network more robust and co-location with VLBI and GNSS site to make contributions of GGOS..

Introduction

Chinese SLR network belongs to WPLTN of ILRS, formed in 1989 and now consists of seven fixed stations (Shanghai, Changchun, Wuhan, Kunming, Beijing, Xi'an, SanJuan in Argentina) and one mobile stations (Wuhan). The location of SLR stations and tracking telescopes can be seen from Fig 1.

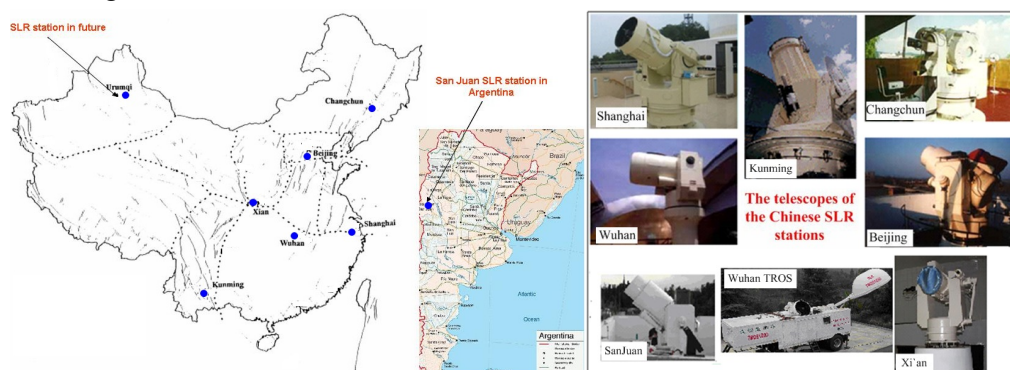


Fig. 1 Chinese SLR network

The update of Chinese SLR network

Since 2008, under the supports from the second stage of the state key project "Crustal Movement Observation Network of China", laser measurement system of SLR stations except for SanJuan in Chinese SLR network have been upgraded with the kHz repetition rate laser and daytime tracking capability. During the upgrade of SLR system, four sets of kHz repetition rate lasers from Photonics Industrial International Inc. of USA (Shanghai, Changchun, Kunming, and Wuhan), one set of kHz laser from High Quser Company of Austria at Beijing station, and two sets of kHz laser from domestic institutes have been utilized. The active lasers are showed in Fig2.



Fig.2 The kHz repetition rate lasers in Chinese SLR network

Up to now, laser measurement to ILRS satellites by using kHz SLR system at nighttime are routinely implemented for five stations and four ones have daylight tracking capability. San Juan SLR station will also implement kHz laser ranging and daylight tracking in 2015 by using the domestic kHz laser. The performances of Chinese SLR network are detailed in Table1.

Table 1 Performance of Chinese SLR Stations

Station	Shanghai	Changchun	Beijing	Wuhan	Kunming	San Juan	Wuhan TROS	Xi'an
Station ID	7821	7237	7249	7236	7820	7406	--	--
Receiving telescope	60 cm	60 cm	60 cm	60 cm	120 cm	60 cm	100 cm	35 cm
Aperture of Transmitter	21cm	21cm	10cm	10cm	120cm	10cm	15cm	10cm
Pulse Energy (532nm)	~1mJ	~1mJ	~1mJ	~1mJ	~1mJ	~20mJ	~1mJ	~1.5mJ
Pulse width	50ps	50ps	20ps	50ps	50ps	30ps	50ps	30ps
Repetition rate	1kHz	1kHz	1kHz	1kHz	1kHz	10Hz	1kHz	1kHz
Type of detector	CSPAD	CSPAD	CSPAD	CSPAD	CSPAD	CSPAD	CSPAD	CSPAD
Timer Interval Unit	Event timer	Event timer	Event timer	Event timer	Event timer	SR620	Event timer	Event timer

Routine SLR measurement of Chinese SLR network

Through upgrading kHz laser ranging system, the performance of Chinese SLR network has been greatly improved and provides lots of laser data compared to low repetition rate laser. Fig.3 shows total passes of laser data, RMS of calibration measurement and RMS of LAGEOS measurement obtained last year from global SLR stations. The passes of laser data from Changchun, Shanghai, San_Juan, Beijing and Kunming are over 1500 and Changchun SLR station ranked top two at the total passes and Shanghai station ranked sixth at the RMS of calibration measurement.

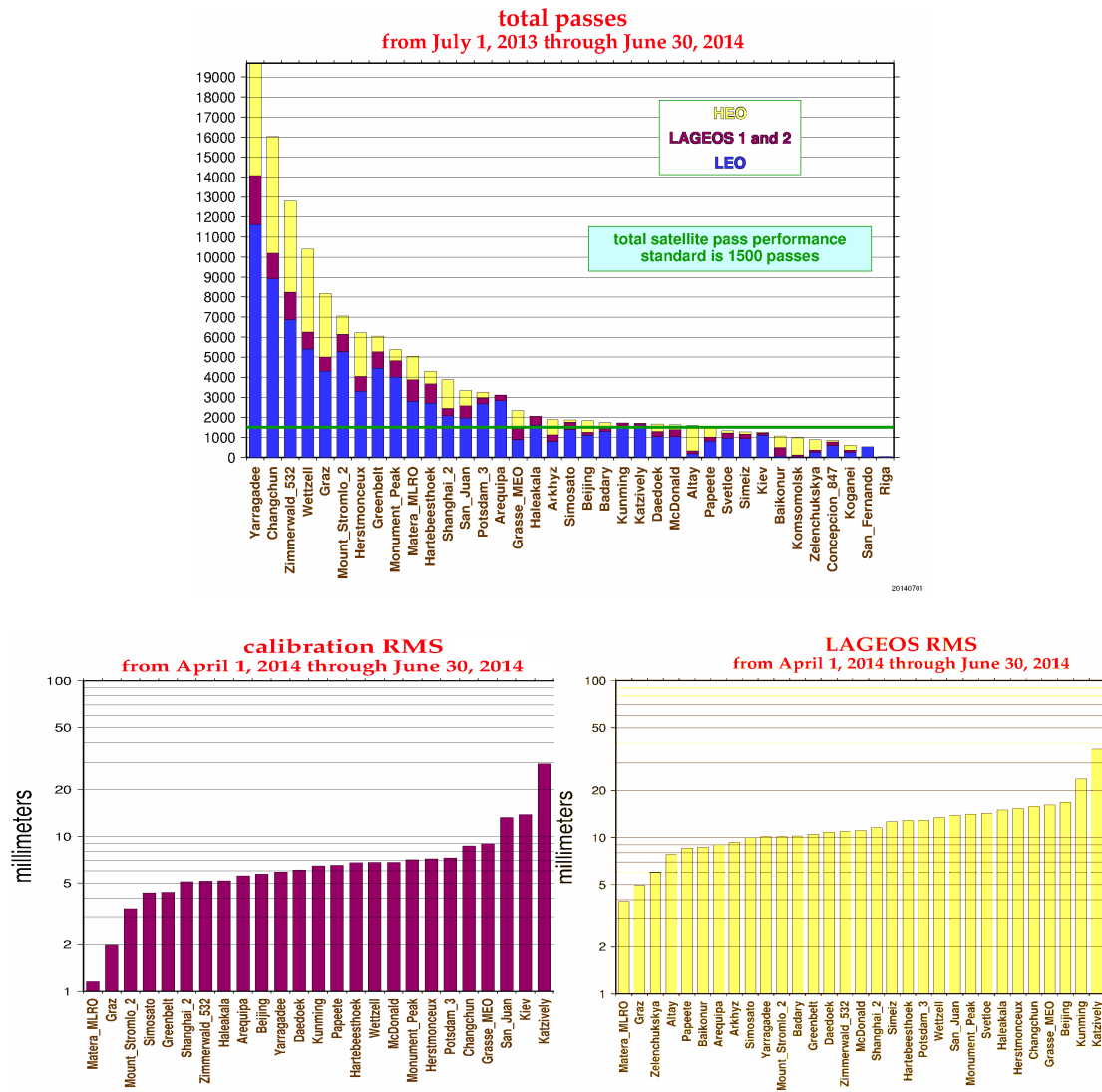


Fig.3 Routine SLR measurement for global stations last year

Development of daylight SLR measurement to HEO satellite

Among of improvements of SLR system, the realization of daylight laser measurement to LAGEOS with kHz repetition rate is one of important items. Shanghai, Changchun, Beijing and Kunming stations have realized the ability of daylight tracking satellites with kHz repetition rate. With the development of Satellites Navigation System (Compass, Glonass, Galileo), the daylight track to HEO satellites becomes the focus for Chinese SLR stations to support POD of navigation satellites. Through applying high-precision telescope pointing model, kHz laser beam monitor, narrow band filter and weak signal identified algorithm etc., Shanghai and Changchun stations

have successfully measured HEO satellites with distance up to 36000km (showed in Fig.4) in daytime and the corresponding work are also undergoing at the Beijing and Kunming stations to implement daylight laser measurement to support of POD of navigation satellites.

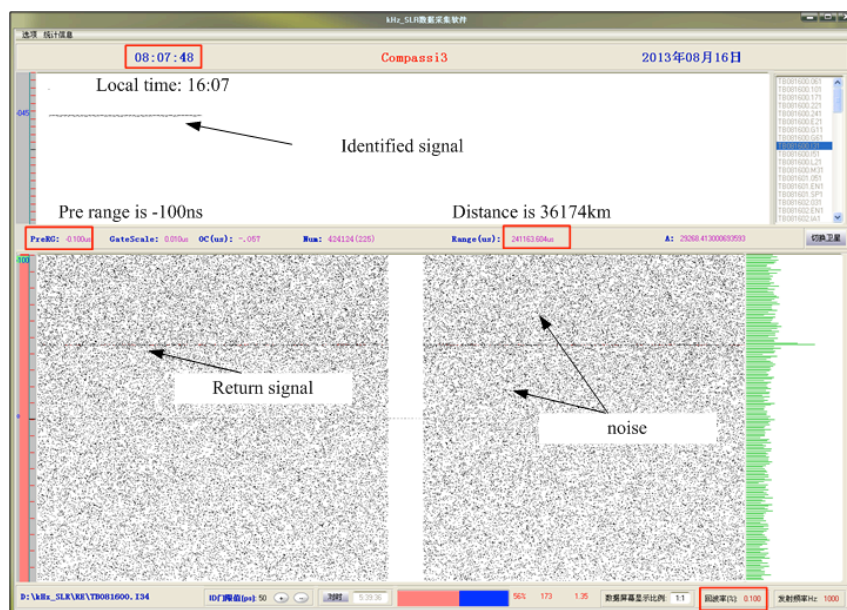


Fig.4 The results of daylight track to HEO satellites

Future development

Under the support of the national projects, two one-meter-level telescopes will be developed for SLR measurement in Changchun and Wuhan stations in two years and one new SLR station will be located at Xinjiang Uygur Autonomous Region in the northwest China in three or four years, they will participate in global SLR campaign and make great contributions to Chinese SLR network.

In addition, because of some advantages of low cost, maintenance, movable, co-location of VLBI, GNSS sites for space geodesy, compact SLR system have been developed firstly at Shanghai SLR station and the corresponding work is still underway in order to realize the laser measurement to MEO satellites.



Fig. 5 Compact SLR system

Through the widely applications of compact SLR systems, the number of SLR sites in china will be increased to make Chinese SLR network more robust and co-location with VLBI and GNSS sites to contribute to construct the sub-network of GGOS.

The great benefits of amount of laser data, precision of normal points and other applications have been made from 10Hz to 1k~2kHz SLR measurement. Shanghai SLR station has been developing 10 kHz SLR technology and the amount of laser data is increased several times than that from kHz SLR measurement and HEO satellites with distance of ~20000km in daylight and >36000km at night have been firstly measured respectively.

As the more attentions to space debris observation are paid with the development of space activities, the technology of laser measurement to space debris have been developed at Shanghai, Kunming and Changchun station and will participate in Space Debris Study Group of ILRS with collaborations with global SLR stations.

References

- [1] Zhang Z P, Zhang H F, Wu Z B, et al. kHz repetition Satellite Laser Ranging system with high precision and measuring results. Chinese Sci Bull, 2011, 56: 1177–1183
- [2] Wu Z B, Zhang H F, Li Pu, Chen J P, Zhang Z P. Report on Satellite Laser Ranging Observations at Shanghai Observatory in 2013, Annals of Shanghai Astronomical Observatory, 2014, 35:11-20
- [3] Wu Z B, Zhang Z P, Zhang H F, et al. The preliminary Results of SLR with 10kHz Laser System at Shanghai Station, 18th International Workshop on Laser Ranging, 2013, Fujiyoshida-City Japan