Development of Transportable Cabin-Based SLR system with 60cm aperture telescope

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Abstract

This presentation gives the overview of one set of Transportable Cabin-Based SLR system with 60cm aperture telescope which is being developed (2018-2019) by Shanghai Astronomical Observatory (SHAO), including the transportable cabin, tracking telescope, laser system and SLR control system. The planned sites where the SLR system will run in future are also considered.

1. Introduction

SLR is an acknowledged high precise space geodesy observation technology and plays a significant important role in the satellite orbit determination, astrodynamic research and the origin and scale of Global Terrestrial Reference Frame, and so on. As the development of Chinese space industry, there are more and more Chinese satellites in space and the requirements of high precise measuring orbit have been put forward. Currently there are only a few SLR stations which can be used for routinely tracking satellites, locating at city of Shanghai, Changchun, Beijing, Wuhan and Kunming in the partial regions of China. To promote the development of Chinese SLR network, SHAO is developing one set of the transportable cabin-based SLR system.

2. Structure of Transportable Cabin-Based SLR system

The SLR system is built based on the cabin. The heavy duty fixtures are mounted in a movable case with size of 8000×2438×2750 mm^3 shown in figure 1. The top and side of cabin is designed to be movable and can be open to ensure tracking satellites above the elevation of 25 degree, and also against rain, wind and dust when it is close.

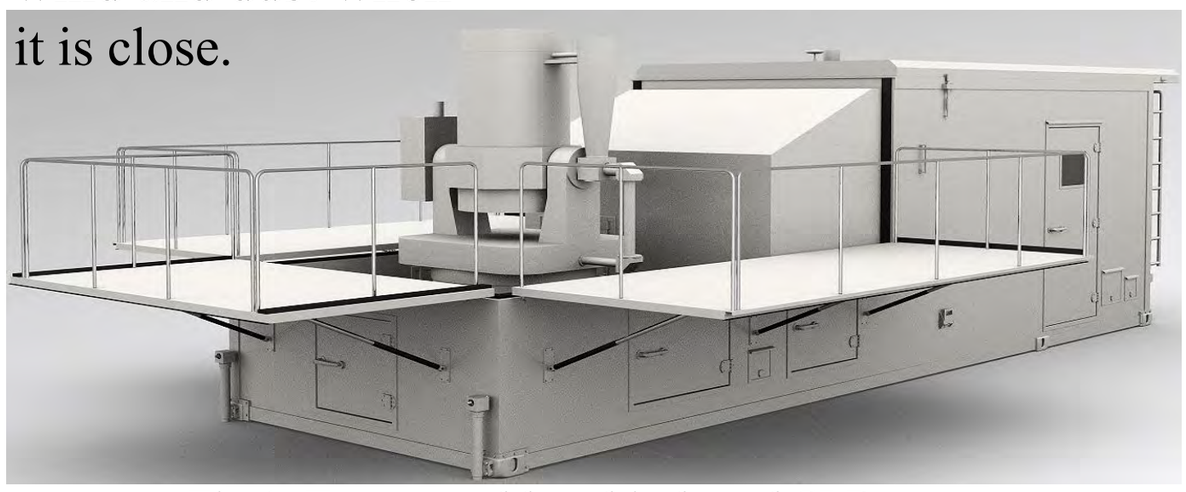


Fig.1 Transportable cabin-based SLR system

The cabin is divided into three units, telescope room, laser room and SLR control room shown in figure 2. It is equipped with a workbench, air conditioner, air cleaner and the interface of installation of telescope mount, which are all stored in the cabin during the transportation.

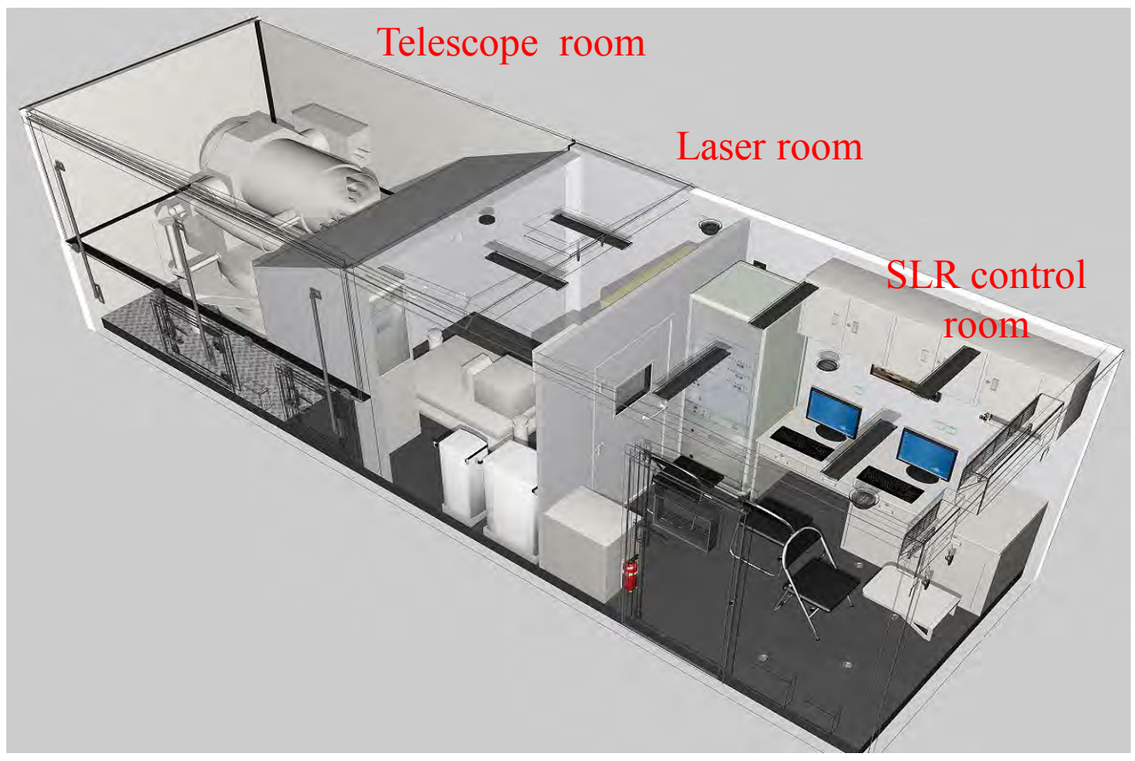


Fig. 2 The inner structure of cabin

The main parts of this system are following:

- Cabin-mounted 60cm-optical-telescope with its control unit;
- KHz repetition rate pulse laser;
- Self-developed high precise timer;
- SLR control system.

1) Optical tracking telescope

The tracking telescope is designed to be the cabin-mounted type and sustained by using the three electrical-control legs with the mount level of 5″.

- Mount type: Az-El;
- Receiving aperture: 600mm;
- Transmitting aperture: 100mm;
- Tracking accuracy: 1″ (RMS);
- Pointing accuracy: 5″ (RMS);
- Tracking speed: 4°/s;
- Azimuth axis rotation range: ±270°

The telescope mount is realized by using steel metal jointing. The mass of the telescope system is about 2500 kg. The four shock absorber are installed and the cross chain are connect between the cabin and mount to against the vertical and horizontal shock while the transportation.

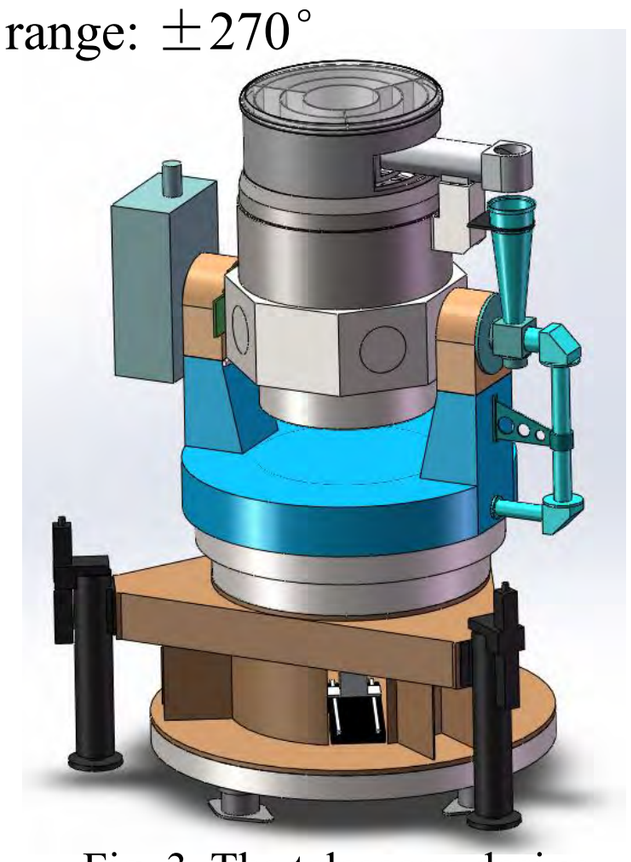


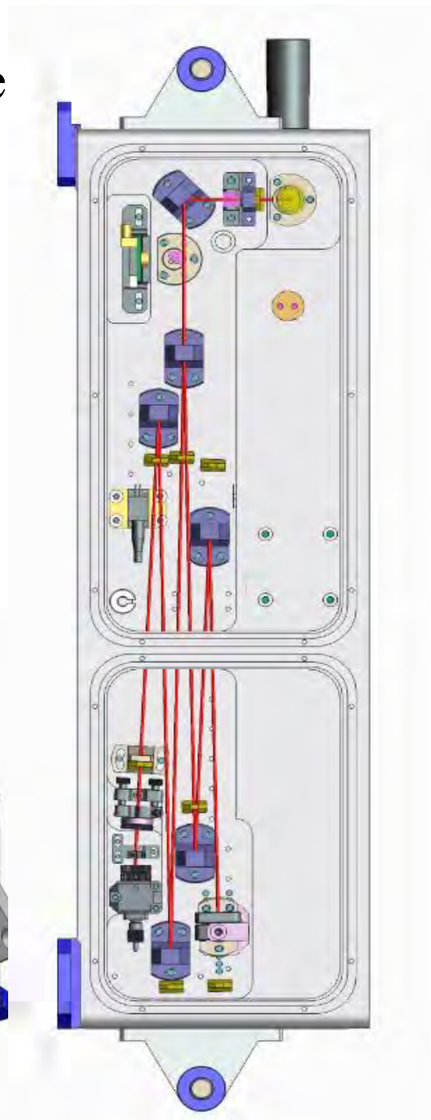
Fig. 3 The telescope design

2) Laser system

The seed pulses with a repetition rate of 80MHz are generated from a Nd:YVO4 mode locked laser with a SESAM and pumped by a laser diode (LD).A pocket cell in the regenerative amplifier (RA) is used to choose 1000 pulses per second from the seed pulses. The seed pulse energy is increased to milli-joule through the RA. A green laser is obtained with LBO frequency doubling. The laser pulses are guided through the optical link between telescope room and laser room.

The parameters of laser system are

- Wavelength 532nm;
- repetition rate 1 kHz;
- pulse energy ≥1.2mJ;
- Output power ≥1.2W;
- Beam quality M^2<1.3;
- Pulse width ≤ 50ps;
- Divergence angle ≤ 0.6mrad.



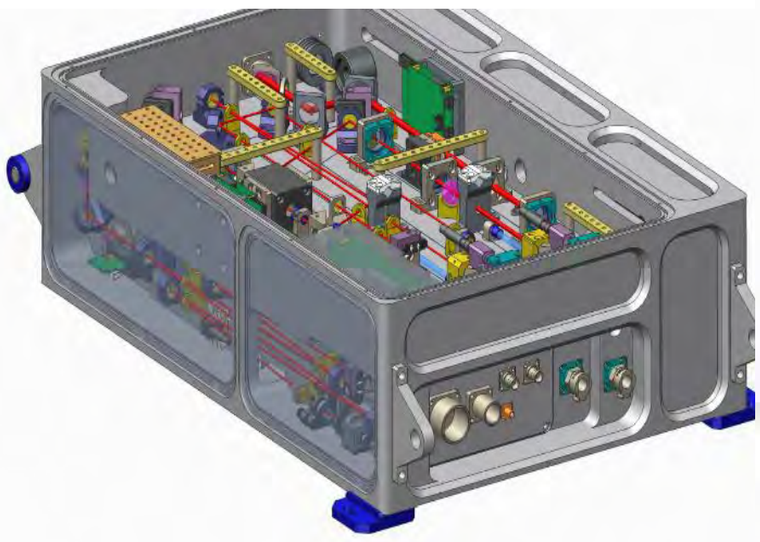
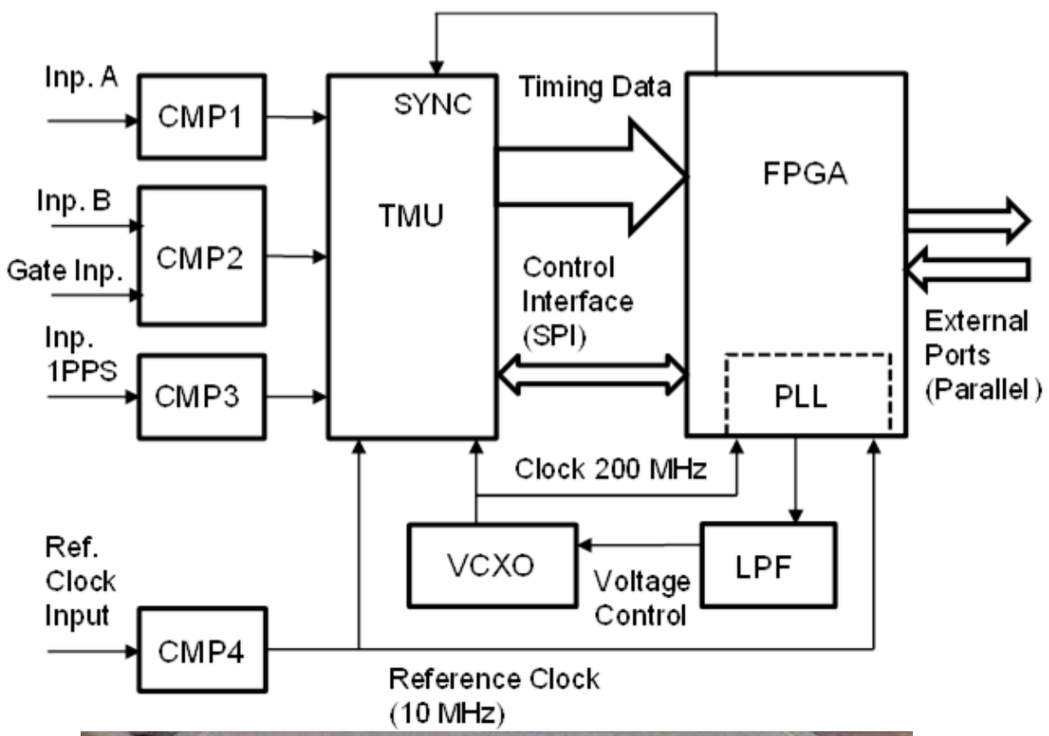


Fig. 4 The structure of semiconductor pumped picosecond laser system

3) The laser detection and event timer

The receiving terminal locates at the third focus of telescope and the standard C-SPAD will be used to detect the laser signal. The iris with size of 0.5mm-5mm and the spectral filter with bandwidth of 0.15~0.3nm is adopted for daylight laser detection. The TDC+FPGA event timer is developed (figure 5) to measure the start and stop events with a precision of 10 ps. The interface to the host computer is performed as a standard parallel port.



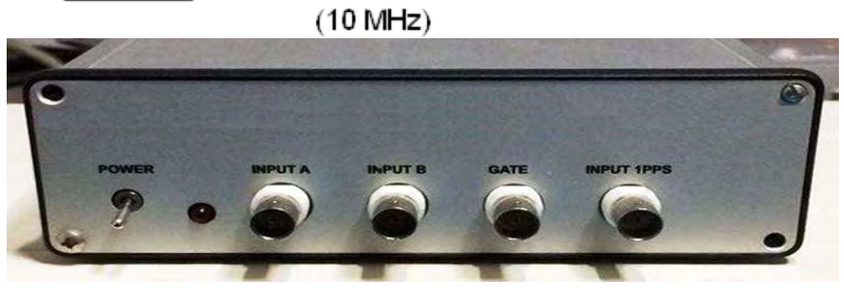


Fig. 5 The diagram of Event Timer

4) The SLR control and operation

There are three PC monitors on the console platform using for SLR operator interface, tracking and pointing guide, video monitor. The routine SLR operations are performed on the single-person seated in the front of console platform.

Fig. 6 The SLR console

The SLR control software is running in SLR operator PC and executes following tasks:

- Computations of the satellite orbit predictions;
- Adjustments of telescope tracking, optical unit and the range gate generator for measurements;
- Post-processing the measured data to evaluate data quality and produce the normal points.

3. The planned working sites

The current SLR sites in China are in the Shanghai, Changchun, Beijing, Wuhan, Kunming (☆). In order to make the well distribution of Chinese SLR network, the planned sites for this cabin-based SLR system will be in the middle, western China (✦).

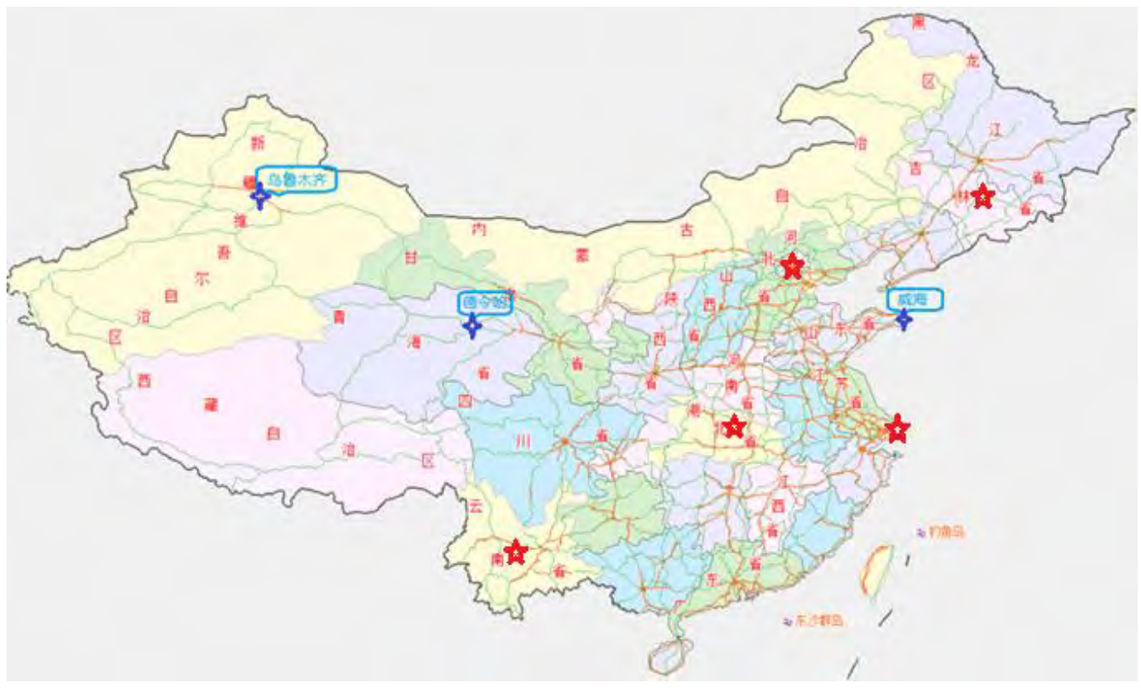


Fig. 7 The distribution of Chinese SLR network

4. Summary

The Transportable Cabin-Based SLR system with 60cm aperture telescope is being developed in SHAO and will be finished at the end of 2019. The future working sites will be located in the current astronomical observation sites in the middle and western of China. Combinations of the current fixed SLR stations, the satellites tracking campaign will be performed, which will make very significant contributions for improving the satellite orbit and promoting the development of Chinese SLR network.