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DAYLIGHT TRACKING OF GNSS IN THE CHANGCHUN SLR STATION

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ABSTRACT

The Changchun SLR station（CCSLR） has gained experience of tracking high orbiting satellites, and has upgraded to track GNSS satellites (GEO \ IGSO \ MEO) in daytime. The system uses an iris(0.23mm), a narrowband filter (~0.15nm@532nm) and a daytime camera system (PCO-1600) to capture and adjust the laser beam in daytime. With the dome open, the heating of sunlight affects telescope pointing and sensor temperature, introducing telescope pointing error. Experiments were taken on the error. The presentation will introduce the technical developments and the observation obtained.

Introduction

Daylight tracking GNSS satellites is difficult, the SNR（signal to noise ratio）is too low. It is hard to identify valid returns even in background noise .With the dome open, the heating of sunlight affects telescope pointing and sensor temperature, introducing telescope pointing error. We do a lot of experiments for taken on the error and improved. Upgrade control software for identify valid returns. The CCSLR had the capability to track GNSS during daytime.

GNSS Constellations

◆GPS

American global navigation satellite systems.
GPS-35:20195km
GPS-36:20030km

◆ GLONASS

Russian global navigation satellite systems.
Glonass-101—133: 19140km

◆ Galileo

European global navigation satellite systems.
Galileo-101,102,103,104:23220km
GIOVE-A:23916km

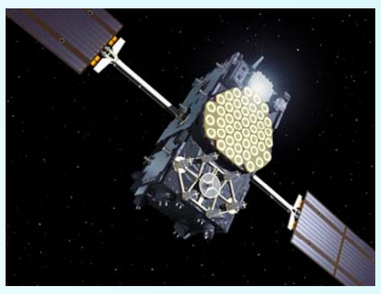

Fig.1 Galileo

◆ Bei Dou

Chinese global navigation satellite system (GEO/IGSO/MEO).
Compass-G1: 42164km
Compass-I3: 42161km
Compass-I5: 42161km
Compass-M3: 21528km

◆QZS: Japan, 32,000-40,000 km

◆IRNSS: Indian, 42164km

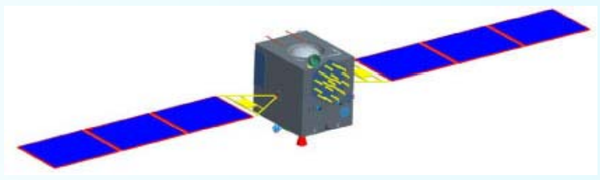

Fig.2 Compass

GNSS Tracking Improvements

◆ The smaller receiver field of view

In Changchun SLR System, we use spatial filtering to reduce the background noise. Remote control is used in the adjustable iris (0.2mm-7mm). The field of view is in a range of 23″-420″. The smaller receiver field of view is for daylight tracking to reduce the background noise in order to acquire the effective echo signals.

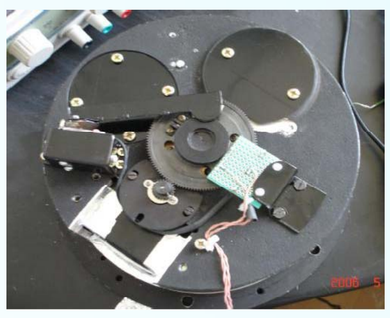

Fig.3The machine frame of the adjustable iris

◆ Spectral Filter

Another measure to reduce noise in the daylight background is application of narrowband interference filter in the receiver optical path.

Central Wavelength : 531.955nm
Transmission : >75%
Bandwidth : 0.15±0.1nm
Size : Φ25.0±0.25nm
Operating Temperature: 23℃

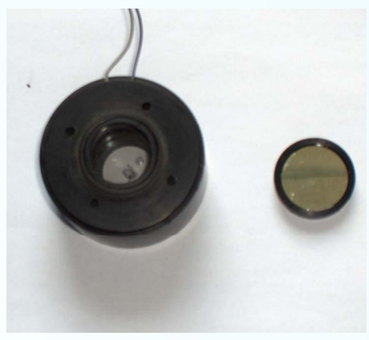

Fig.4 Spectrum filter in constant temperature box

◆ The CCD for Monitoring laser beam in daylight

A new CCD camera is installed to monitor transmit laser beam for laser beam pointing and divergence improvement. The background light is strong in the daytime, so it is difficult to obtain the daylight KHz laser beam image in real-time. We tried several methods in our experiment in order to take better image of the laser beam, such as spectral filtering, exposure superposition, adjusting exposure time and image processing.

Fig.5 The photo of CCD camera

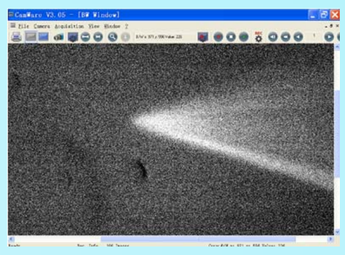

Fig.6 The laser beam in daylight

◆ Telescope Pointing Stability Improvement

With the dome open, the heating of sunlight affects telescope pointing and sensor temperature, introducing error.

- Change the telescope support to reduce the impact of structural design.
- Strengthen auxiliary support to improve telescope leveling.
- Use reflection membrane on the telescope.
- Close telescope tube to reduce thermal interference while not in use.
- Track stars in daytime to improve the telescope pointing stability.

GNSS Observation Results

◆ Observation Results (2014.1.1-2014.10.22)

Changchun SLR station has the ability to track GNSS satellites in daylight and acquired 5207 passes data in total from January to December 2014, of which 1063 passes in daytime.

Tab.1 Observation Results for GNSS (2014.1.1-2014.10.22)

Name	Daylight	Night	Total
Compass	62	397	459
Galileo	168	373	541
GLONASS	819	3136	3955
IRNSS	0	19	19
QZS	11	158	169
GPS	3	61	64
Total	1063	4144	5207

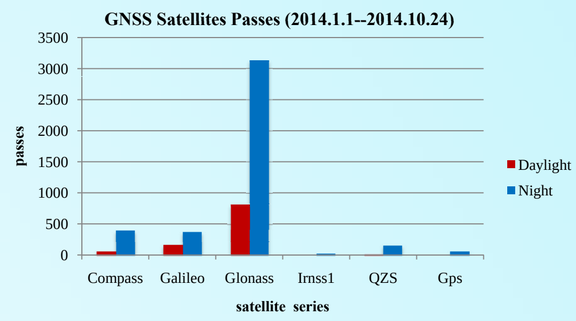

Fig.7 GNSS Satellites Passes (2014.1.1--2014.10.22)

Summary

The upgrade to GNSS satellites tracking of Changchun Observatory is successful. The CCSLR had the capability to track GNSS during daytime, Although this requires good weather conditions and the operator have the patience and experience.

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