REMOTE OPERATION OF GUTS-SLR

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Abstract
The GUTS-SLR is operated by remote control from the Tsukuba Space Center (TKSC). The approximate distance between TKSC and SLR station is 1100km.
In this paper, we present the overview of the remote control and the function of system for supporting remote operation.

1. System overview

Japan Aerospace Exploration Agency's (JAXA) Satellite Laser Ranging system, which is called "GUTS-SLR" (GMSL, Tanegashima), has been completed in the spring of 2004. We are now in the training phase. The GUTS-SLR is located in Tanegashima Island, where the Japanese launch site is also located.
The GUTS-SLR is operated by remote control from the Tsukuba Space Center (TKSC). The approximate distance between TKSC and the SLR station is an approximate1100km. A 512-kbps communication line between the SLR station and TKSC is used for transmission of data such as system status data, operational parameters and observation data. For the transmission of surveillance monitor image, a 256-kbps line is used. JAXA will contribute to the ILRS in daylight and night using this system. The configuration of GUTS-SLR is shown in Fig.1-1.

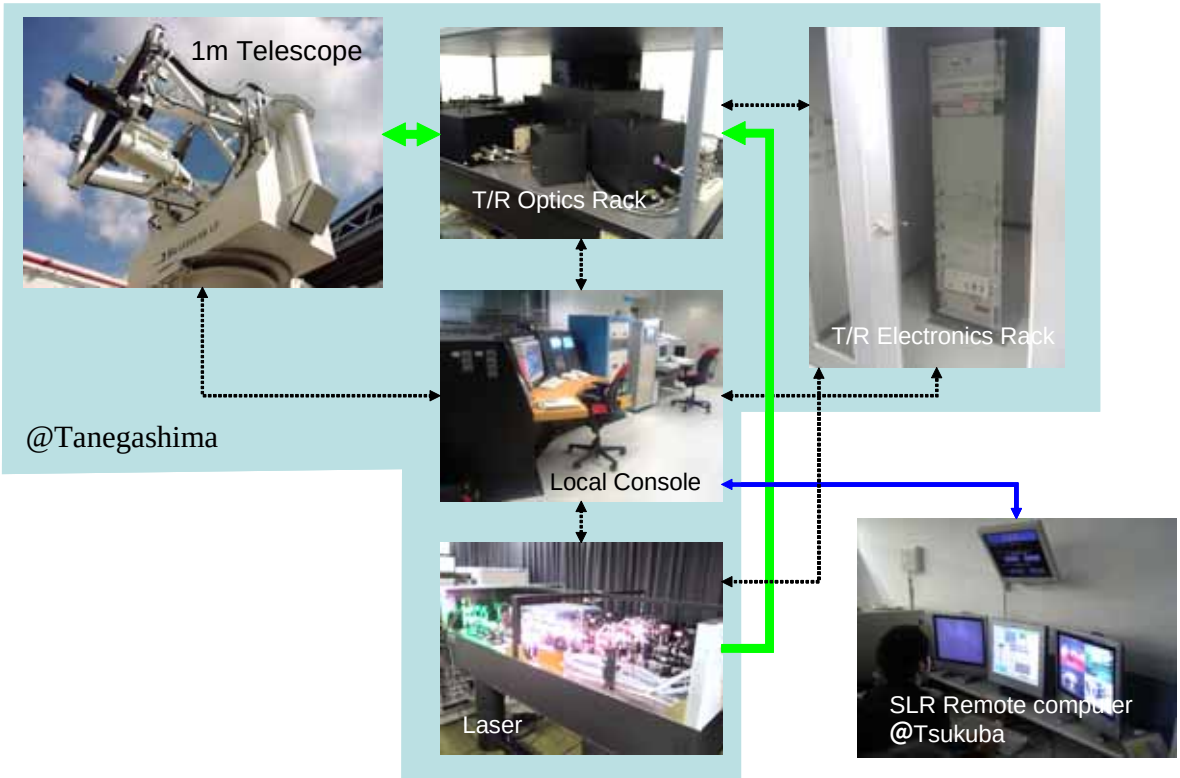

Fig.1-1 GUTS-SLR system configuration

2. Functions for remote control

The GUTS-SLR system has the following functions for remote control.

Fig.2-1 Weather Monitoring system

(1) Weather monitoring system

In order to monitor the weather condition of SLR station, the weather monitoring system has a wind direction/anemometer and the raindrop sensor, but the weather in Tanegashima can't be grasped precisely at TKSC at this present. We use the weather information such as the conditions of the present sky and weather forecast on the Internet at present. We will develop the all sky monitoring system with infrared camera in near future to solve this problem.

(2) Station Monitoring System

The ITV camera is installed in order that a safe surveillance system can always monitor the SLR observation building and its surroundings from the TKSC. There are two monitor screens at TKSC. One is a four-split screen to monitor the station environment. The other is used to monitor optical tracking and the laser beam profile.
Moreover, the door sensor is attached to detect an intrusion into the SLR building, etc., and the signal of the sensor is interfaced to the Laser interlock equipment directly. Fig.2-2 shows the appearance of operation console at TKSC.

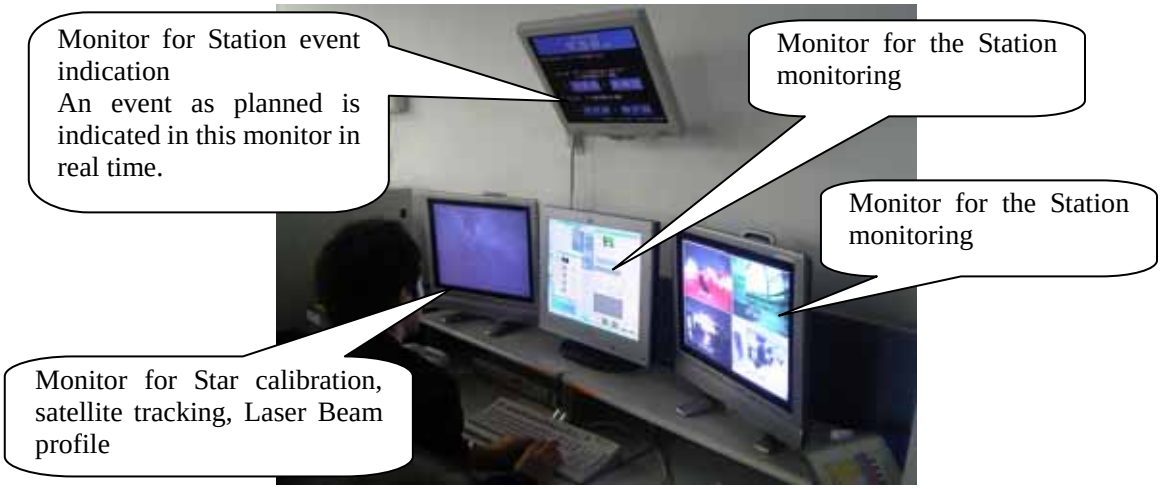

Fig.2-2 Station control system in Tsukuba

(3) Aircraft Surveillance Radar

In order to avoid laser hazard to aircraft such as airplanes, hang gliders and paragliders, we installed the aircraft surveillance radar, which follows the telescope, and also installed the wide-view camera as the backup. The appearance of Radar and wide-view camera is shown in Fig.2-3 (a) and (b)

(4) Sun Exposure Avoidance

In order to protect the mirror from being damaged by the direct sunlight in SLR daylight operation, the telescope system automatically avoid the sun exposure using software and hardware such as the sunlight sensor. The computer of telescope system calculates the sunlight direction and automatically closes and opens the mirror cover. The operator can

be applied without being conscious of interference with the sun. The photograph of sun sensor is shown in Fig.2-3(c).

(a) Aircraft Surveillance Radar (b) Wide-view Camera (c) Sun Sensor

Fig.2-3 Appearance of Safety System

(5) Communication Outage

In case of anomalies such as a communication outage between TKSC and SLR station, SLR station's computer detects the communication outage and stops laser radiation, stows a telescope, closes the dome shutter, then sets the whole subsystem to the standby mode until the restoration of communication line.

(6) Star Calibration and Satellite Tracking

This system has a video tracker function. This function is to assist an operator in the star calibration operation. It also facilitates the acquisition of flashing satellites. The Fig.2-4 is a screen shot of the video tracker image. The video tracker captures the flashing target and aims the telescope at the target automatically.

Fig.2-4 Video Tracker monitor

(7) Operation planning

The tracking schedule of SLR is automatically generated considering sunlight direction, satellite priority and satellite elevation angle (>20deg).

If these functions work properly, the operator checks the weather conditions, confirms the

daily schedule, the dome open/close, the primary mirror cover open/close and Laser firing.

Fig.2-5 shows an example of a tracking schedule at Tanegashima. We plan a tracking schedule over 20 degrees elevation. The figure shows the visibility information for each satellite with AOS/LOS time, Maximum elevation angle, information about the sunlight, and daylight or night. The planning software can automatically create a tracking schedule for 2 weeks period (Maximum) according to a predetermined priority list.

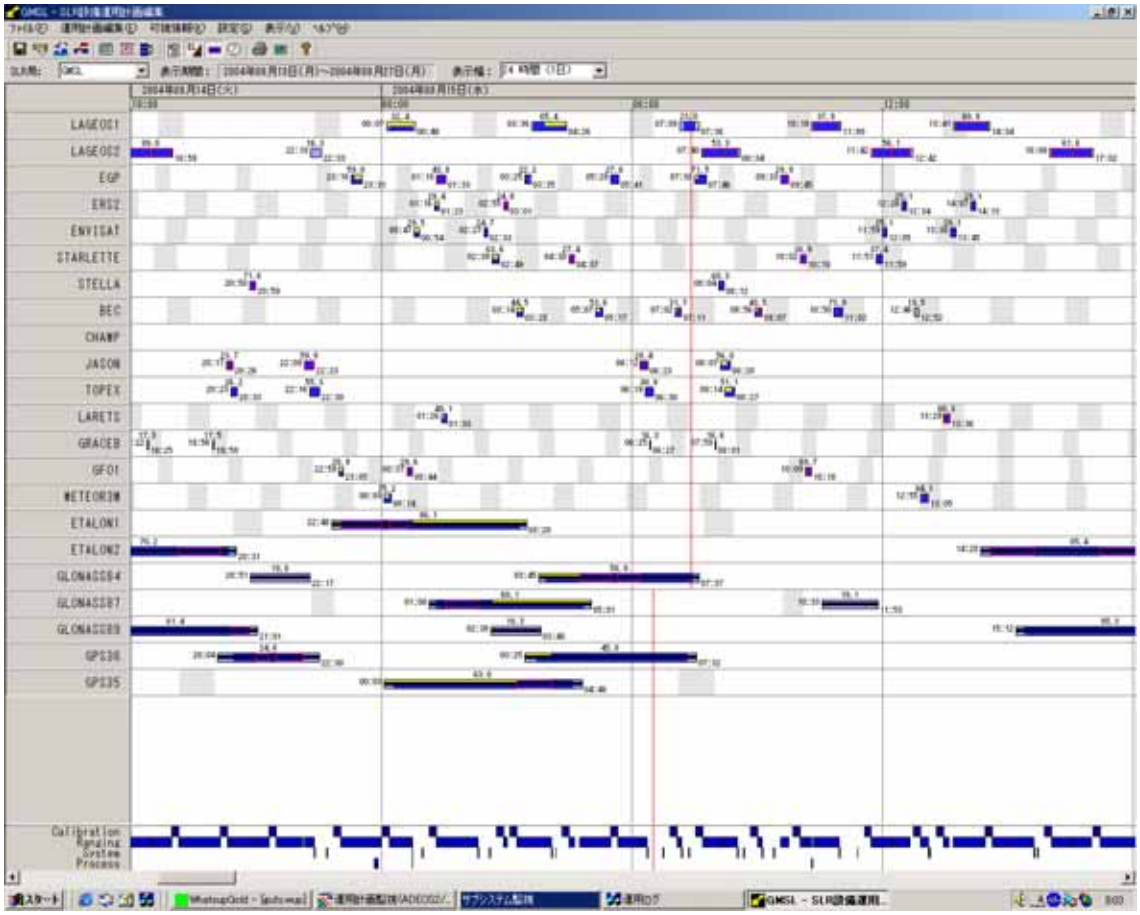

Fig.2-5 Example of tracking schedule

3. Conclusions

This would be the first experience ever in the world with such a long distance for routine SLR remote operation.