Engineering process of SLR for LEO orbiters

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Abstract

A ground based satellite laser ranging system has been developed at the Institute of Geodesy and Geoinformation (GGI), University of Latvia in cooperation with a Riga municipality surveying company, Rigas GeoMetrs SIA The original small size telescope mount is based on the 70 cm broad firewall of the 150 year old University building. The first satellite ranging test results of the completed SLR system were unsuccessful. The modification was completed in early 2009 The transmitting and receiving paths were separated. Optical efficiency of both was improved. Additionally, the GNSS 5 base station network is developed in an area covering Riga city. The central base station and analysis center are located close to the SLR site.

Introduction

The experience gained in Riga and Australia by the personnel of the University of Latvia (Abele et.al., 1994, Abele et.al., 1996) has been applied to design a new satellite laser ranging system (SLR). Initially it was designed for ranging to Low Earth Orbiters (LEO), particularly the European Space Agency's (ESA) mission GOCE. However, we understand now that observations of LAGEOS are required as well. The first satellite laser attempts were not successful. Although tracking was good, there were no ranging results. In late 2008, the optical system was simplified. By the end of February 2009, the modification process seems to be finished.

Figure 1. SLR before (left) and after optics modification (right)

SLR technical characteristics

The SLR hardware and software is designed in GGI by integrating advanced industrially produced components. The transmitter is an EKSPLA diode-pumped, 17 mJ laser with a repetition rate of 50Hz and a 35 psec pulse width. The range receiver uses an A032-ET event timer, and epoch time is provided by a GPS-steered Quartzlock (UK) timing unit. The detector is a Hamamatsu PMT. The SLR system is located on the roof of a 150 year old, 5 story University building, as illustrated in Figure 1.

The reasons for the poor observation test results were examined with the conclusion that the optical channels were too complicated and redundant (see Figure 2). A simplification was agreed to (Figure 3), and a modification of the station was performed.

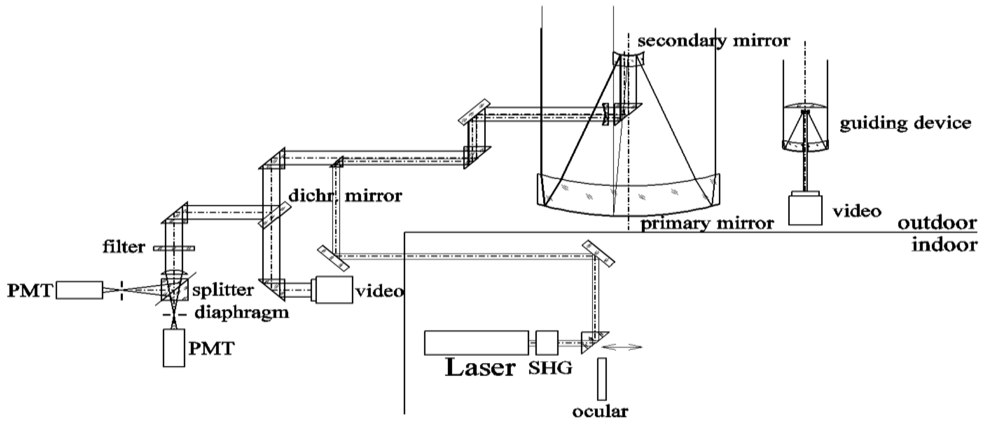

Figure 2. Initial optical scheme

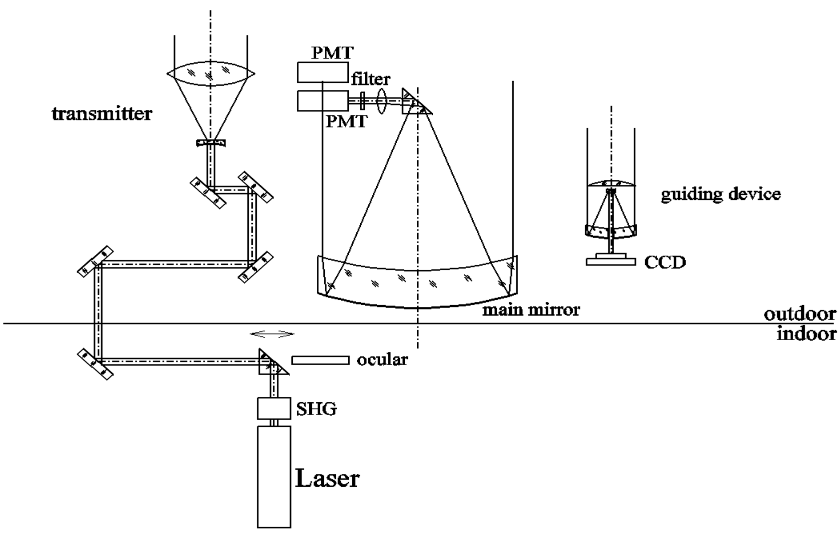

Figure 3. The modified optical scheme

The transmitter channel was separated from the receiver channel in the modified version. The number of reflecting surfaces in the receive channel was decreased significantly. The guiding telescope, supplied with a CCD camera, seems promising and aids the visual tracking and pointing quality. Currently, both the SLR reconstruction and modification are completed. Good weather conditions are needed now to validate the success of the modification. Unfortunately, in recent years, the sky in Latvia is cloudy most of the time.

EUPOS®-RIGA augmentation system

The joint system of both the GNSS network and SLR will be used for LEO satellite positioning. The system consists of a *EUPOS® -RIGA* GNSS RTK five reference station network and a satellite laser ranging system developed by both GGI and Rigas GeoMetrs SIA. The *EUPOS® -RIGA* is a small subnet of the *EUPOS®* network, which consists of 470 base stations covering a wide area in Eastern Europe, including the Ukraine and part of Russian Federation (Rosenthal, 2008). The *EUPOS® -RIGA* base stations are equipped with JAVAD sensors, capable of utilizing both GPS and GLONASS signals. The JAVAD GNSS chock ring antennas were calibrated in Garbsen, Germany. The coordinates of the SLR and *EUPOS® -RIGA* base station antennas are determined in different coordinate systems – ITRF2005, ETRS89, LKS92. Furthermore, the elevation is determined in the Baltic height system using geometric leveling methods. The analysis center's server is connected to the GGI and the GNSS receivers via optical cables. The signal from each receiver is received at GGI with a latency of 1-2 msec. The Geo++ network solution software GNSMART is used for analysis. *EUPOS®-RIGA* has been operational for over one year, and its RTCM correction data is widely used by land surveyors in Riga city. The central base station is located about 20 m from the SLR site. The analysis of multipath effect for *EUPOS®-RIGA* network antennas has been performed, and the results were reported at the International Symposium on Global Navigation Satellite Systems (Silabriedis, 2009). The Bernese 5.0 academic version software has been obtained from GGI and will be used for the further research work.

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