SLR for LEO Ranging

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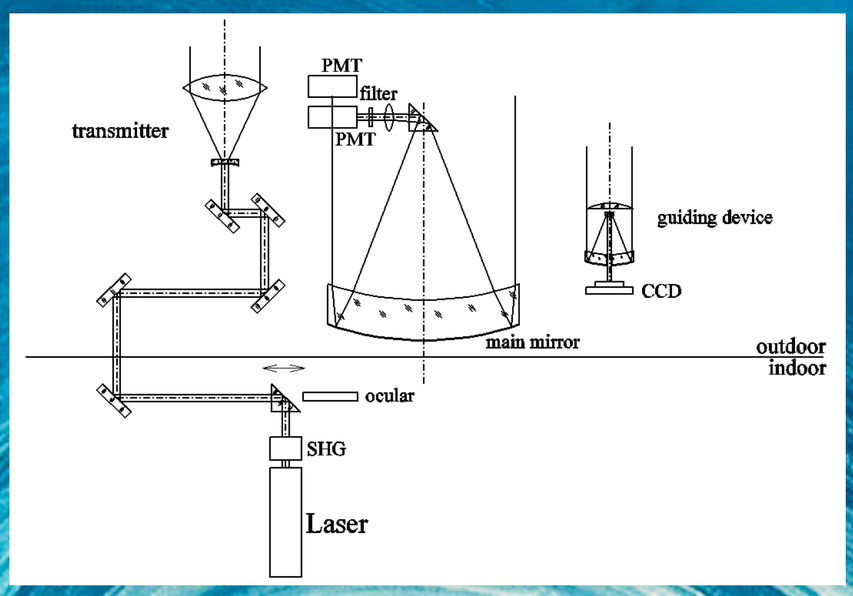
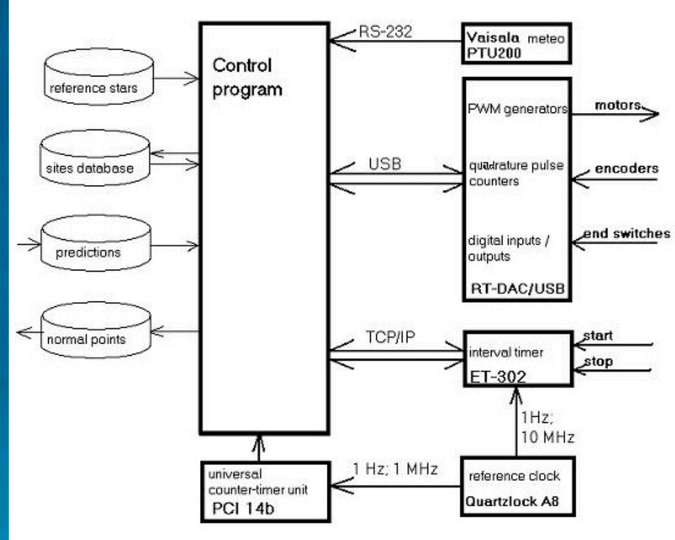
Already 2 years around since SLR for Low Earth Orbiters (LEO) ranging has been operational at the Institute of Geodesy and eoinformation (GGI). The test observations has approved the capability of SLR for LEO ranging, including LAGEOS, ERS2, ENVISAT, Ajisai and others. Regular observations has not been performed because of different social reasons. However, the SLR system is operational. The SLR hardware and control software is designed in GGI by additionally integrating advanced industrially produced hardware components. The experience gained by the SLR personnell in Riga and in Australia has been applied. There is an alt/alt original small size telescope mount, EKSPLA diode pumped 17 mJ laser used with a repetition rate 50 Hz and a 35 psec pulse width. A032-ET event timer and the Quartzlock (UK) GPS time service applied. Hamamatsu PMT used. SLR is placed on the roof of 150 years old 5 storey University building. The manual corrections for botrh the satellite tracking and the laser beam poining has been applied by using digital imagery on the screen of computer. The guiding corrections has been applied by watching the digital imagery of the sky on the co,puter screen which has been obtained using sensitive CCD matrix.



Laser beam pointing correction motors



SLR control software:
MS Windows based, communicates with external devices via USB, RS-232 and TCP/IP.
Includes:
- mount position control using encoders and stepper motors, tracking speed up to ~10 dg/s, tracking accuracy up to encoder resolution.
  Real-time mode implemented using Multimedia timer, up to 1 kHz control frequency,
  synchronization of events with external time reference provided by standard counter-timer extension PCB
- communication to time interval counter via TCP/IP, many stop events per each start, multi-pulse mode possible
- real-time visualization of ranging results with filtering and possibility to adjust prediction time delay,
- result processing and generation of normal points,
- mount error model and orientation subsystem, Hipparcos star catalog
- meteo subsystem.

Mount control hardware

- Compumotor S57-51P stepper motors,
- Heidenhain RON 200 incremental encoders: 72" divisions; interpolated to 0.7" per division,
- InTeCo RT-DAC USB data acquisition and contrunit:
  - - PWM generators (2.4 Hz ... 156 kHz),
  - – quadrature pulse counters,
  - – digital inputs/outputs for servo sensors
  - – timer-counters for position time acquisition.
- QuartzLock A8-B GPS-disciplined quartz frequency Standard,
- ET-302 event timer,
- Vaisala PTU200 meteo station.

The EUPOS-RIGA GNSS network is surrounding SLR site. The system has been developed in co-operation of Municipal surveying company "Rigas GeoMetrs" and GGI. It consists of a EUPOS-RIGA GNSS RTK five reference station network located at a distances from 20 m till 17 km to SLR. The GNSS chock ring antennas calibrated in Garbsen, Germany. The heights of antennas were additionally controlled by levelling to the 1-2 order levelling benchmarks. The analysis centre server's placement is at the Institute of Geodesy and Geoinformation close to the SLR control unit. The Geo++ network solution software GNSMART is used. EUPOS-RIGA is operational more than 5 years and its RTCM correction data has been used for the research control of the levelling network. In daily routine they has been used by solely land surveyors till now. However, all the collected GNSS observations has been stored for the further research. The computation of the time series of LATPOS and EUPOS-RIGA are in process now.

Recently the construction of the digital zenith camera for the studies of vertical deflection has been commenced in GGI.

Lageos

Calibration

Coordinate determination using GNSS

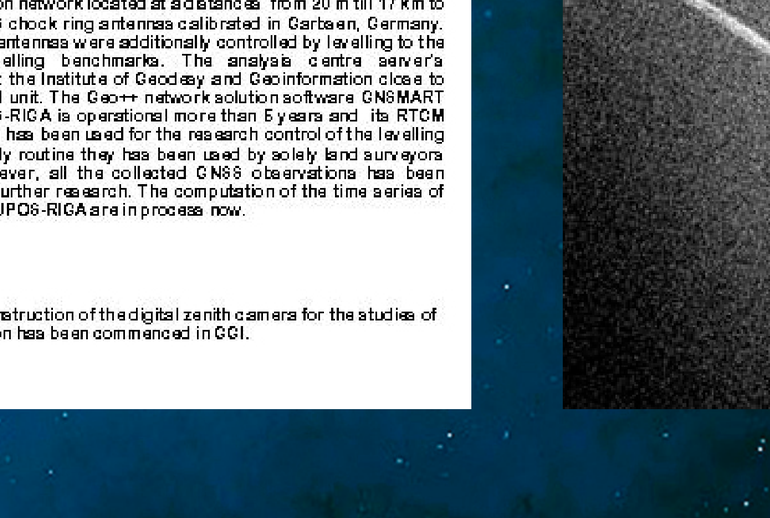


Table 1. SLR test results

	Date	Satellite	Points	RMS (cm)	NP	RMS (cm)
1	2009.04.13.	Ajisai	661	3.1	9	0.64
2	2009.04.16.	Jason2	752	4.0	9	0.54
3	2009.04.16.	Ajisai	631	4.7	6	0.62
4	2009.10.06.	Ajisai	1894	4.2	13	0.70
5	2009.10.06.	Jason1	9	1.7		
6	2010.04.13.	Lageos1	33	1.9	2	1.01
7	2010.04.19.	Lageos2	58	2.1	3	0.66
8	2010.04.19.	ERS2	368	2.7	11	1.0
9	2010.04.20.	Lageos1	97	3.4	2	0.54
10	2010.04.26.	ENVISAT	1212	2.7	16	0.70
11	2010.04.26.	ERS2	1539	2.3	17	0.41
12	2010.04.27.	Jason2	210	3.1	10	0.65