Satellite Laser Ranging Station “Lviv-1831” in Lviv, Ukraine. Status Report.

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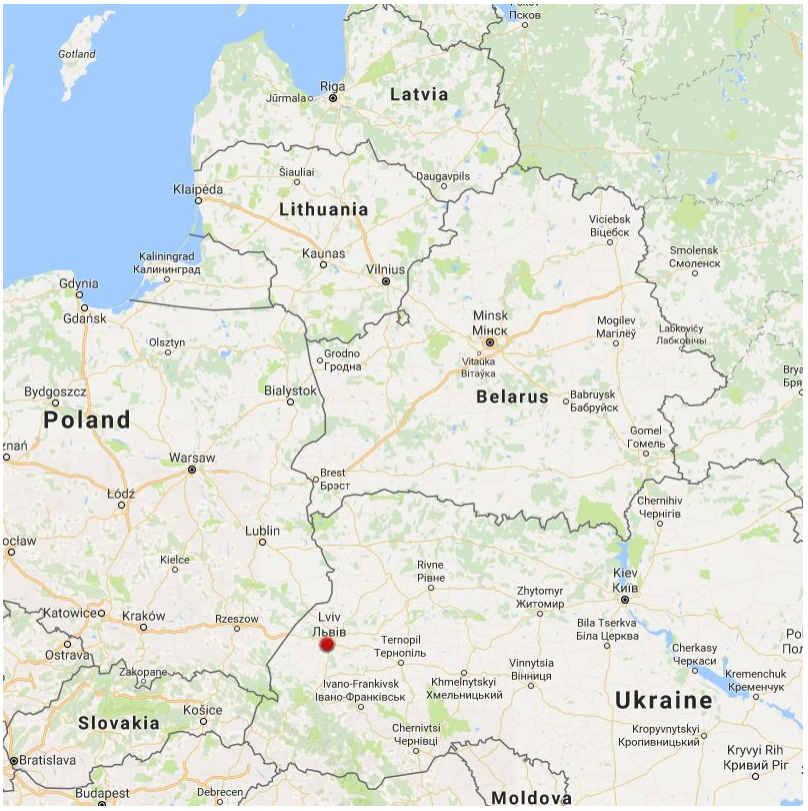
About the station

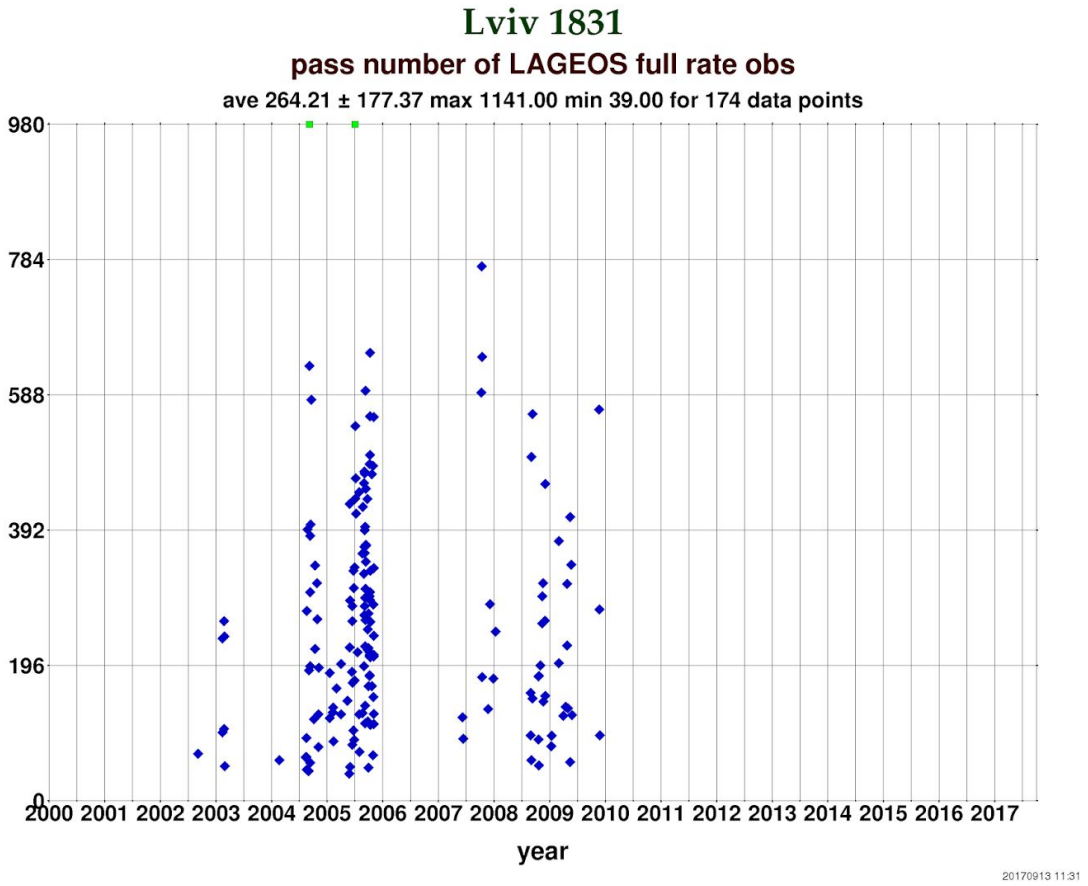
The station was founded in 1998.

In 2002 it was registered in ILRS as “LVIV-1831” with SOD number 18318501, DOMES 12368S001. Also, it participates in observations held within the network of UCEOP (Ukrainian Center for Earth Orientation Parameters).
The equipment is hosted in special building in Bryukhovychi village, on the site of suburban station of Astronomical Observatory of Ivan Franko National University of Lviv.
In 2009 this research facility is registered as National Property of Ukraine.
The station corresponds to the third generation of SLR according to the international classification.

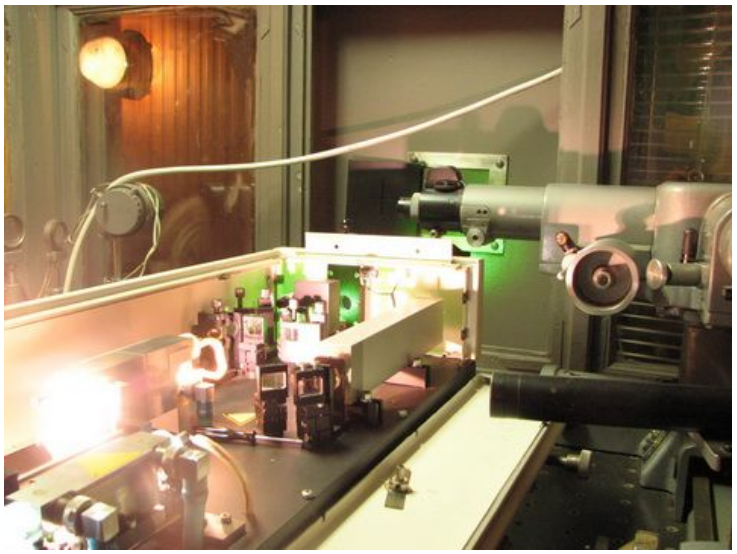


Team	
Yaroslav Blahodyr	coordination/management, optics, observations
Andrii Bilinskyi	software, observations, optics
Kostyantyn Martynyuk-Lototskyy	hardware/software, observations
Sofiya Apunevych	observations, coordination/management
Stepan Apunevych	software, coordination/management
Natalia Virun	observations

History



Laser

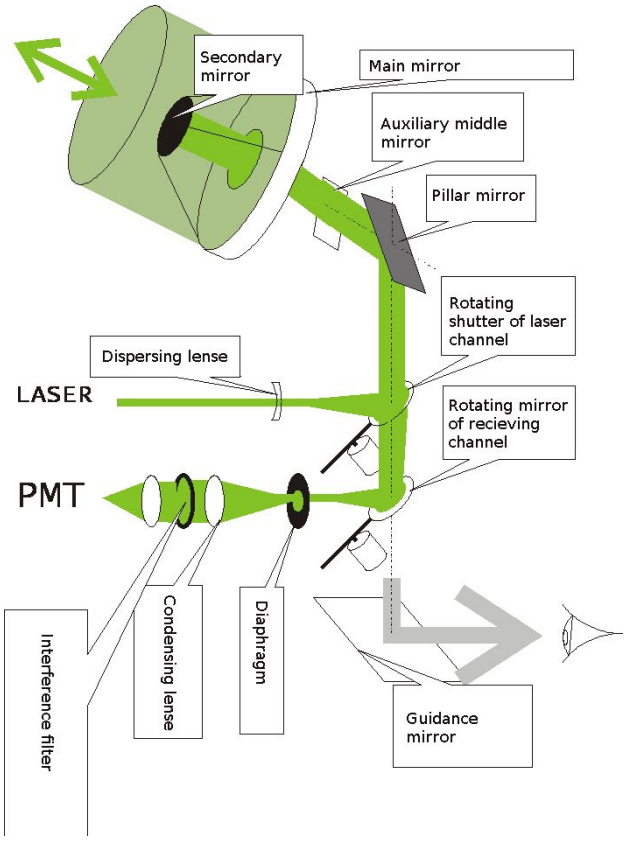


Laser-pulse transmitter SL-212 with secondary max energy of 130 mJ and pulse width 150 ps.
At the end of 2009, the water got freezed in cooling system of laser SL-212 due the unexpected blackout. As of May of 2013, with assistance of Medvedskiy (SLR station Kyiv-1824) new quantrons were installed and laser aligned. The control of cooling system was enforced by Atmega8-based controller with DS1820 sensors, connected to PC via UART (or TWI, SPI).

To-do:

- Ensure regular replacement of pumping lamps (1 for generator and 2 for amplifier), for example “Verre et Quartz” (France);
- The control of output stability is done visually. We need proper measuring device.

Optics



Telescope TPL-1M with 1000 mm main mirror. Mirrors were re-coated and realigned in 2013. Also, we have installed the interference filter (Edmund Optics, 532nm CWL, 1nm bandwidth) into optical path to improve the S/N ratio, and developed the thermostabilization control unit for it.
To-do:

- Complete the developmental (stand) testing of thermostabilization control unit for filter;
- Standard system of modulating mirrors imposes the limitations on measurements of time-delays less than 5.5 ms. Upgrade of this subsystem is under way, to the one developed at SIC “Orion” (Alchevsk, Ukraine)

Guiding and pointing

The guidance system does not meet the requirements of ILRS, both mechanics and control subsystems are obsolete.

- The system can be operated even in current state;
- Power supply stabilization is implemented.

To-do:

- abandon ISA-card/PC-based solution in favour of one based on industrial computers and/or microcomputers, as we have experience with RaspberryPI and similar ARM-based platforms;
- implement electronic guiding with PLIS, provide precise real time;
- reuse our experience with LD-2;
- look forward implementing absolute positioning system.

Detection and data acquisition system

The unique development of Latvian Institute of Electronics, providing the precision of picoseconds; time and frequency standards and meteorological instrumentation.
Also, the frequency standard and mechanical modulator were replaced or upgraded.
Currently PMTs FEU 79 and FEU 136 are used as receivers.

- photoelectric modules Hamamatsu H6780-20 have been purchased;
- the new shutter was designed and implemented with Atmega8 controller to protect from scattered light;
- digital oscillograph Agilent DSO6104L 1 GHz has been recently purchased to explore the signals with front 1-0.5 ns;
- as the event timer Comtis was getting older, the failures persisted. New oscillograph with MSO extension pack allowed us to repair our own Comtis, and help with that in Alchevsk.
- New frequency standard CH-5832 is installed;

To-do:

- developmental testing of the shutter and frequency subsystem;
- We need new amplifier with bandwidth of >1 GHz along with proper balancing system to install the H6780-20 into receiver path of telescope;
- Look forward total substitution of Comtis with another system;

Software

We have developed a number of software components since 1998. The platform of our choice is open-source (libre) software stack, C, C++, Perl etc.

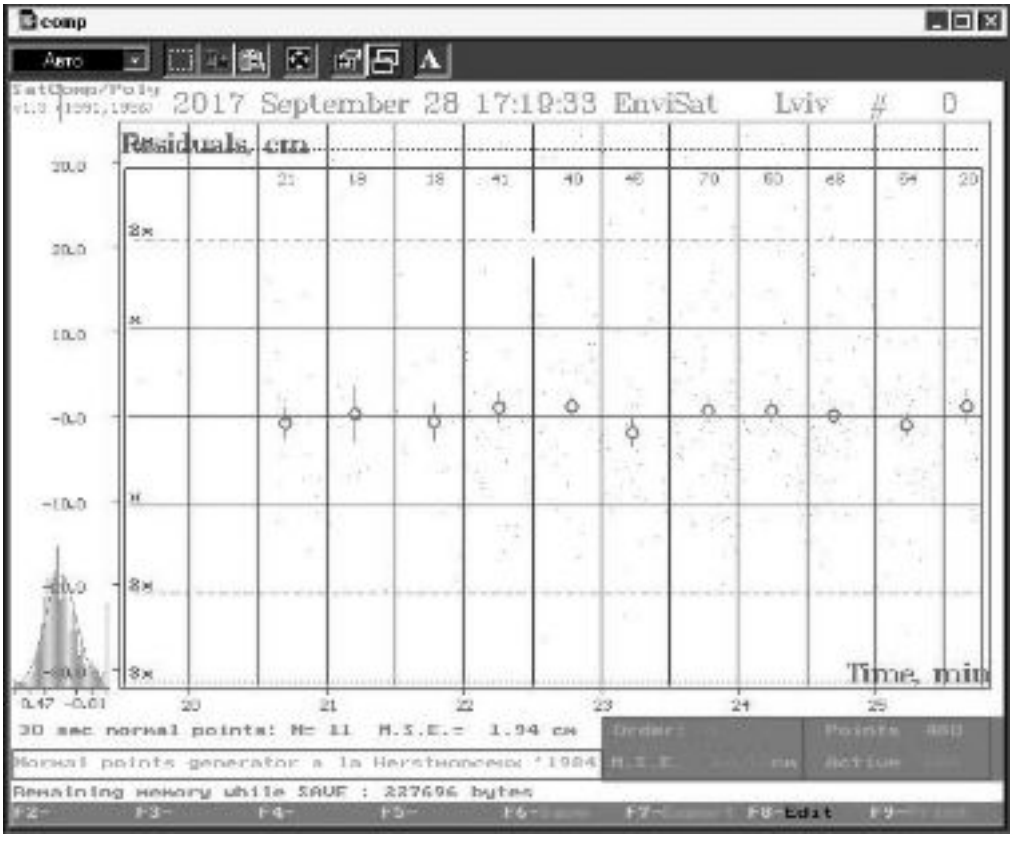
- Control of guiding subsystem;
- Re-implementation of new formats CPF, CRD;
- Herstmonceux algorithm for post-processing and normal points production;
- Automation with remote access;

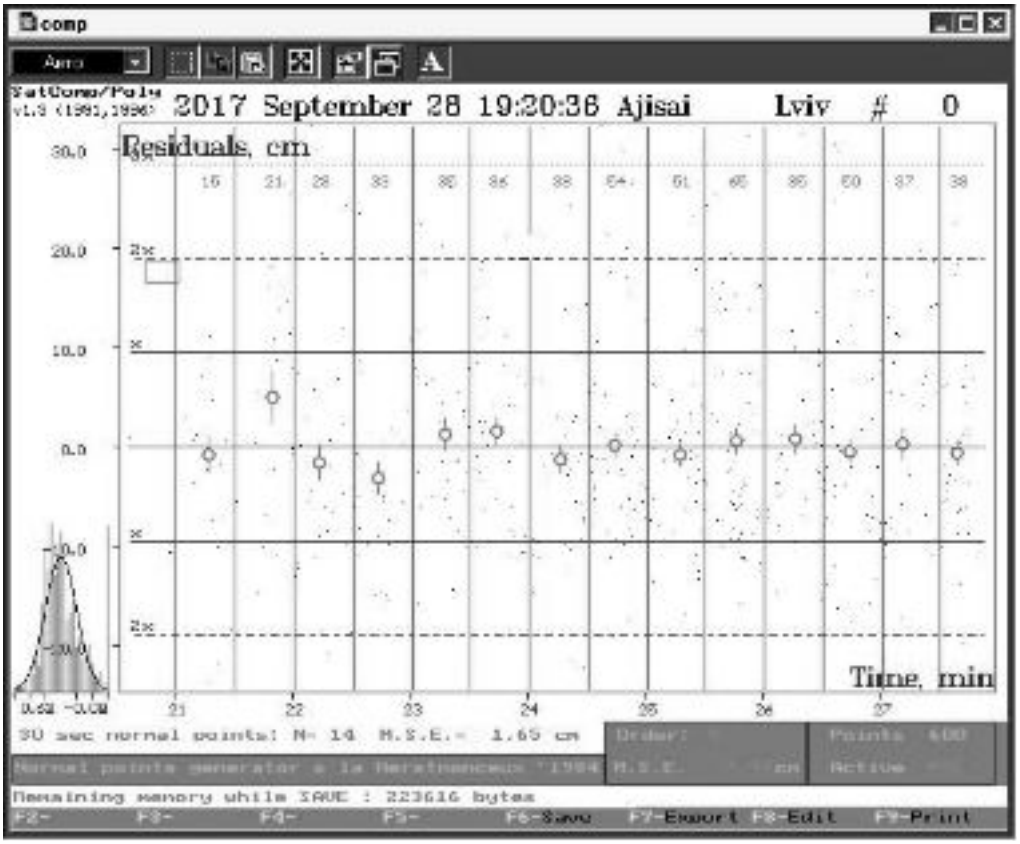
To-do:

- Fill the gaps in functionality;
- Finalize and test the all abovementioned basic components;
- Integrate the components, test and publish the code;

Experimental observations

Normal points in CRD format: dates from 2013-06-19 till 2014-04-03, 33 transits of 8 satellites (Ajisai, Beacon-C, Jason-2, LARES, Saral, Starlette, Stella, Swarm-C). The precision seems to be the same as before. Latest observations:





To-do:

- Finalize the precision estimation, locate the bugs if any, realign and fine-tune;
- Renew regular observations;

Other activities

Besides for SLR we use laser “Ekspla SL-212” to conduct research in optics. For example, we have examined non-linear refraction of ZnO thin films the emission of second harmonic λ=532 nm. Maintenance of this station includes regular re-examination of interference filter with respect to temperature dependence of transmitted spectral band. According to our result the best temperature for transparency is 38ºC.

Conclusions

Yet many things to be done. The guidance system does not meet the requirements of ILRS, both mechanics and control subsystems are obsolete. As “Comtis” event timer is getting older, the failures persist. We are on the way of upgrade, however, the system can be operated even in current state, so we are looking forward renewing regular observations.