



# SLR Observations at the “Quasar” Network Stations

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# SLR systems installation at the “Quasar” observatories

Observatory	Stage	2011							
		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Zelenchuk- skaya	Dome building	■							
	System installation		■						
	Testing		■	■	■				
Badary	Dome building			■					
	System installation				■				
	Testing					■	■		
Svetloe	Dome building						■		
	System installation							■	
	Testing								■

Observatory	Date of the first observations
Zelenchukskaya	18.05.2011
Badary	28.07.2011
Svetloe	25.10.2011

# “Sazhen-TM” SLR system



«Research-and-Production Corporation  
“Precision Systems and Instruments”»



## Main technical characteristics

Ranging distance:

day 400-6000 km

night 400-23000 km

Aperture 25 cm

Wavelength 532 nm

Beam divergence 12"

Laser pulse frequency 300 Hz

Laser pulse width 300 ps

Pulse energy 2.5 mJ

Mass 170 kg

Normal points precision 1 cm

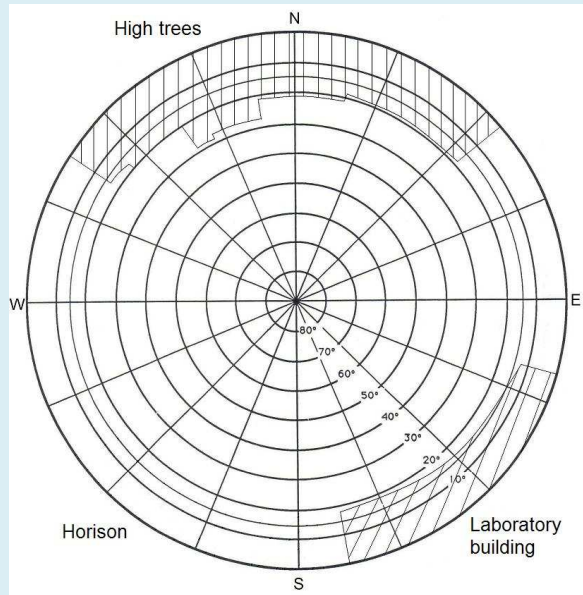
Angular precision 1-2"

# “Sazhen-TM” at Zelenchukskaya observatory

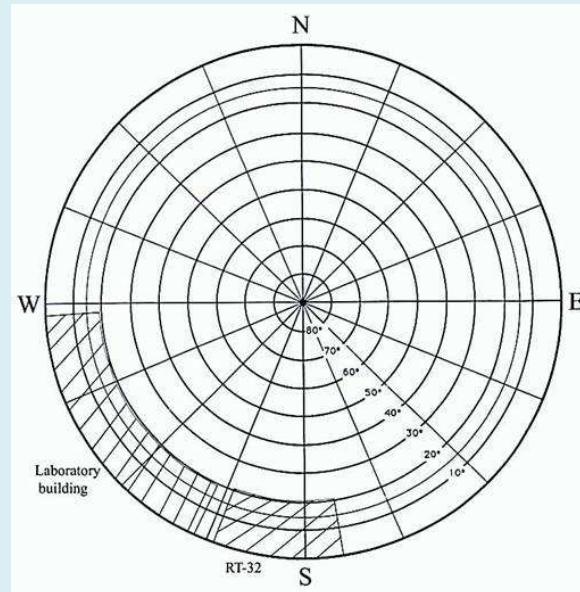


# Cut-off angles for SLR systems at the stations

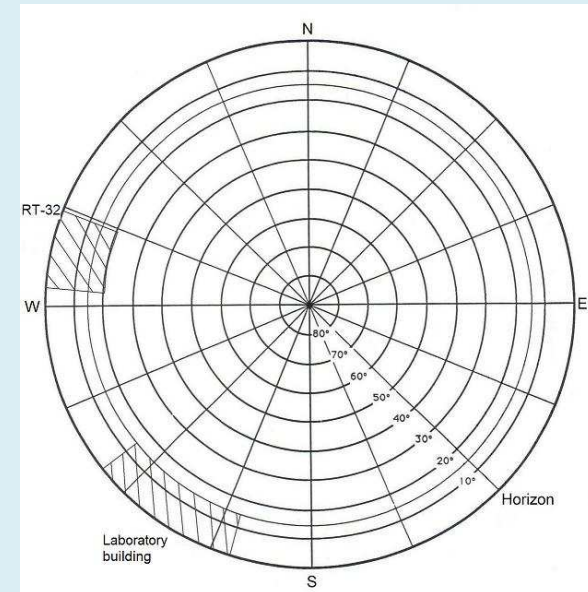
## SVEL (1888)



## ZELL (1889)



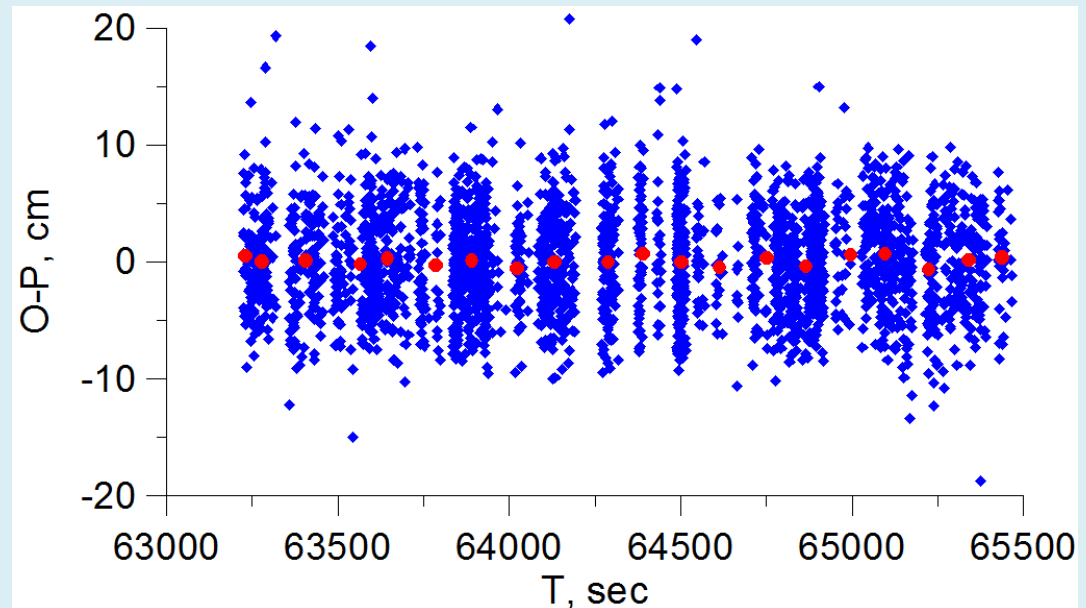
## BADL (1890)



# Observations

- The regular software of SLR system developed by the producer is used for preparing the observation sessions and their implementation
- The observational data from all stations in the initial format are collected at the Institute (IAA RAS)
- The special software has been developed for pre-analysis and reduction of observational data

BADL  
07 04 2012  
Lageos 1



# Statistics of observations

## January 1 - August 15, 2012

### All satellites

Station	Total number of passes	Number of processed passes	Number of registered pulses	Used for NPs	% of rejected	Number of NPs	RMS, mm
1888	254	206	683073	616431	9.8	1513	30.2
1889	384	364	1448739	1426928	1.5	2682	26.6
1890	512	456	3234719	3159425	2.3	6471	39.1

### Lageos 1 & Lageos 2 satellites

Station	Total number of passes	Number of processed passes	Number of registered pulses	Used for NPs	% of rejected	Number of NPs	RMS, mm
1888	87	73	48716	46775	4.0	382	30.8
1889	78	74	72492	71681	1.1	527	26.7
1890	86	81	139112	138125	0.7	896	39.9

# Program package for reduction of observations

## Main features:

- Statistical analysis of raw data
- Forming Normal Points according to ILRS recommendations
- Output normal point data in CSTG and CRD formats
- Full automation of data reduction
- Using the ILRS CRD\_check utility to verify the CRD files consistency

## Results:

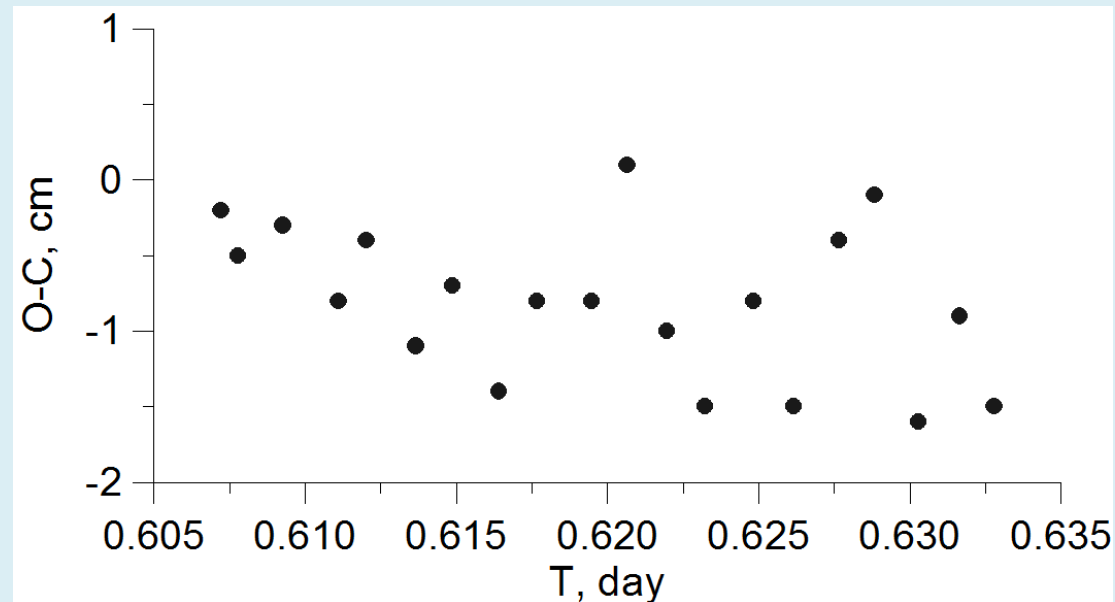
- Formal errors of normal points are about 5 mm.
- On the average 4 % of returned pulses are rejected when preprocessing the observational data
- Uploading the normal points in CRD format to EDC has been started in April 2012
- **Disturbing facts (errors in the first version of the program)**



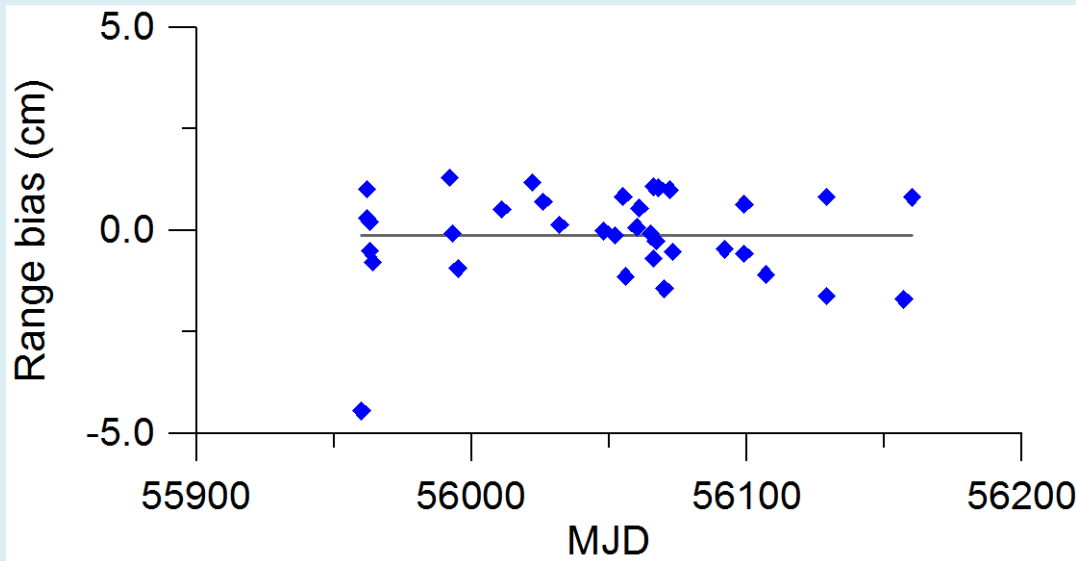
# Orbital analysis of L1&L2 observations

- The analysis of the observations quality is made now in the course of fitting to precise orbits of Lageos satellites which are derived from observations of global network stations
- Preliminary coordinates of reference points of the SLR systems, defined from local geodetic surveying with respect to GNSS antenna markers, are used

BADL  
56024 MJD  
Lageos 1

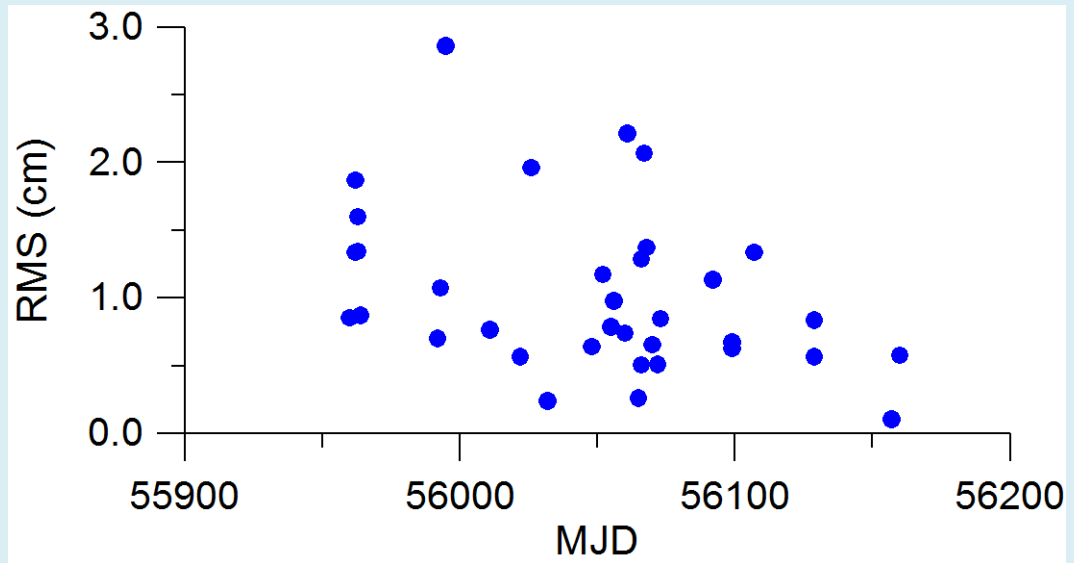


# 1888 (SVEL) L1&L2 observations

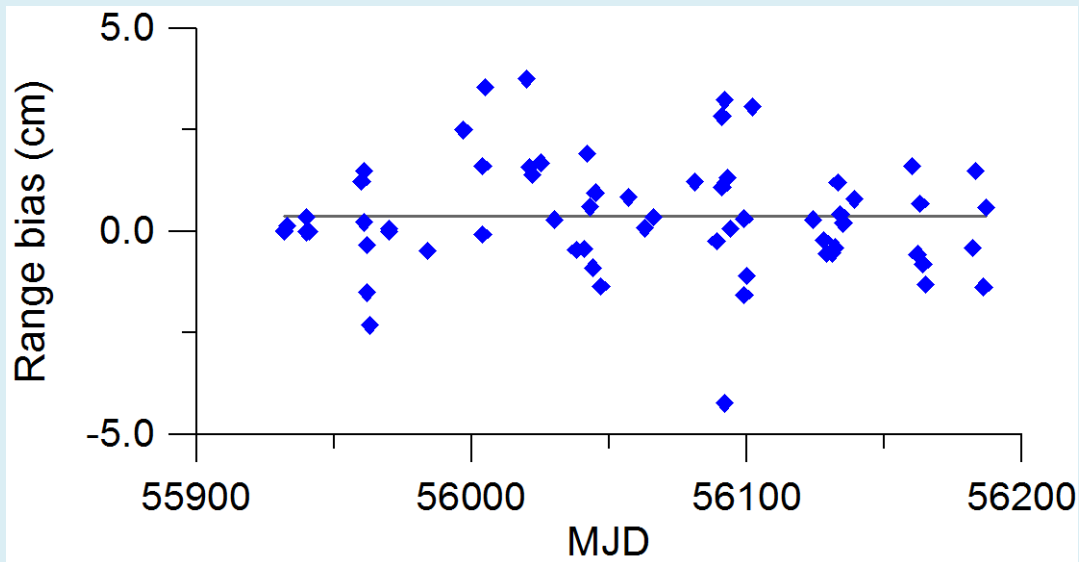


Mean = -0.12 cm

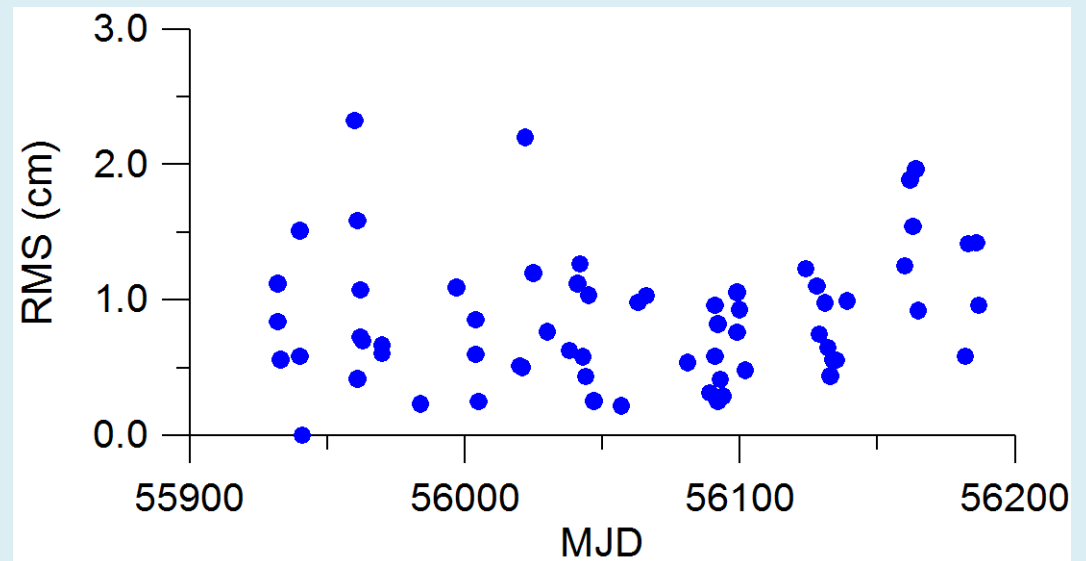
Mean RMS = 1.02 cm



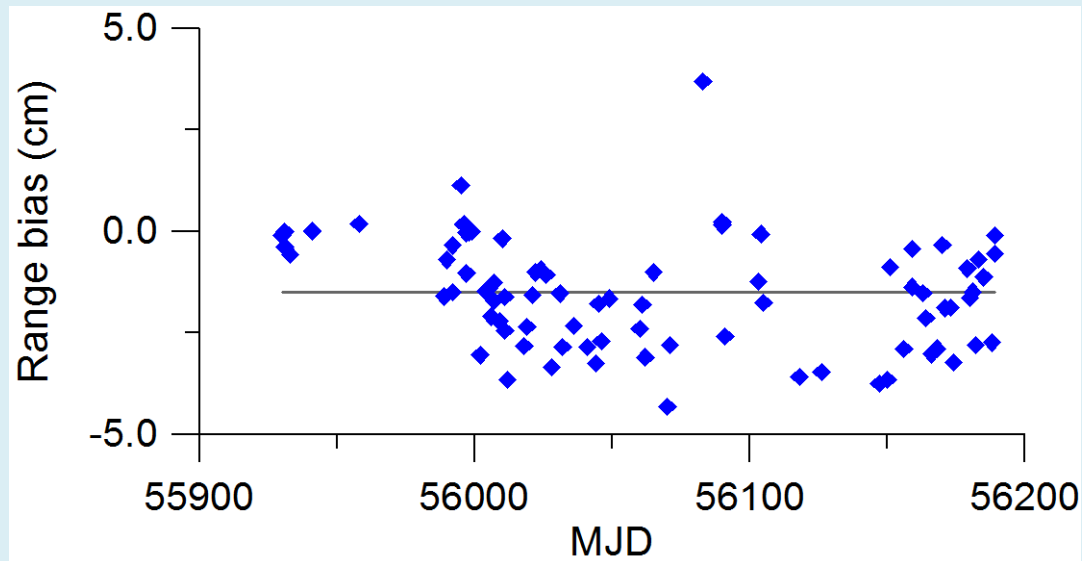
# 1889 (ZELL) L1&L2 observations



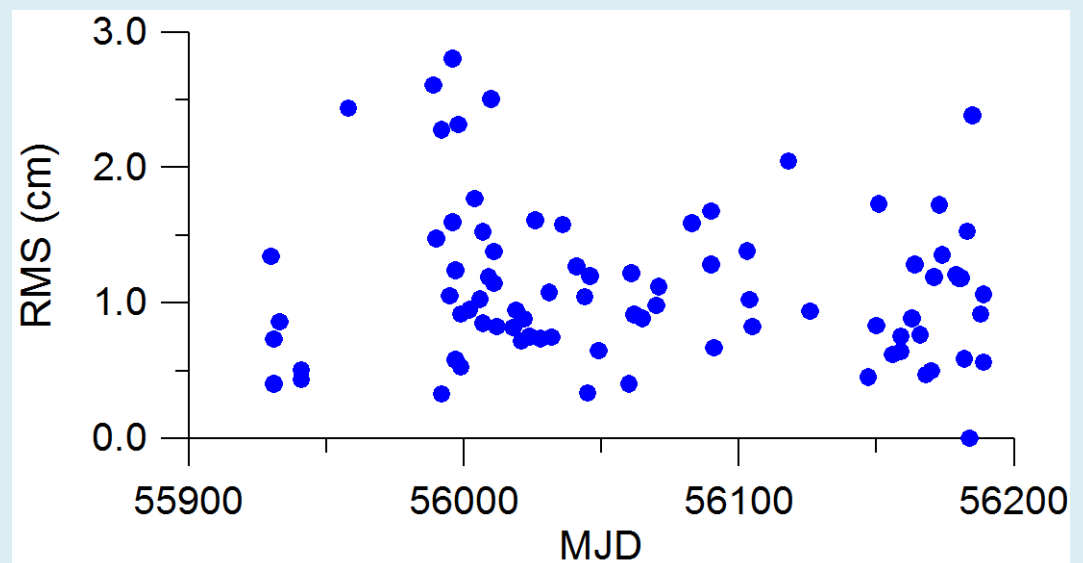
Mean RMS= 0.86 cm



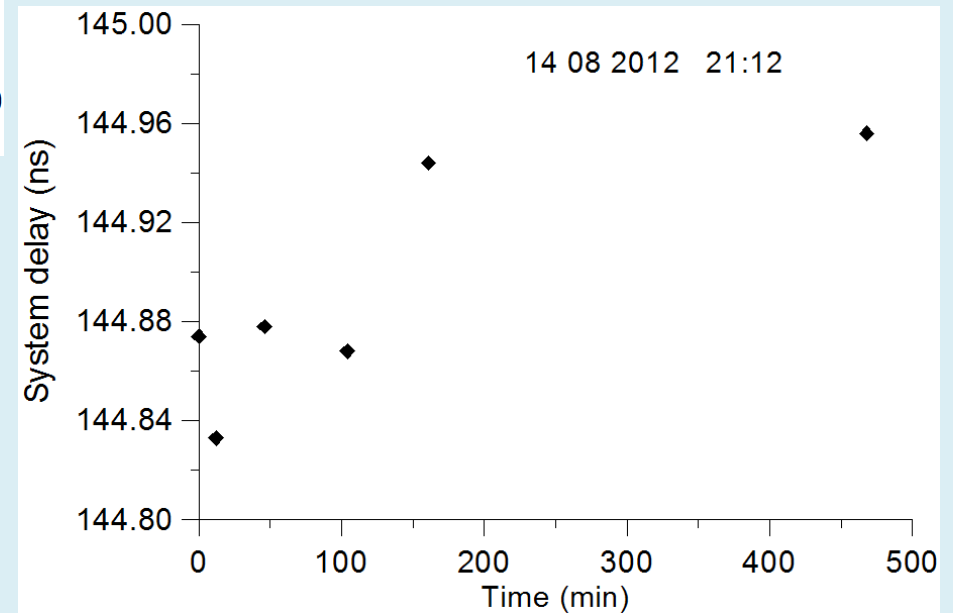
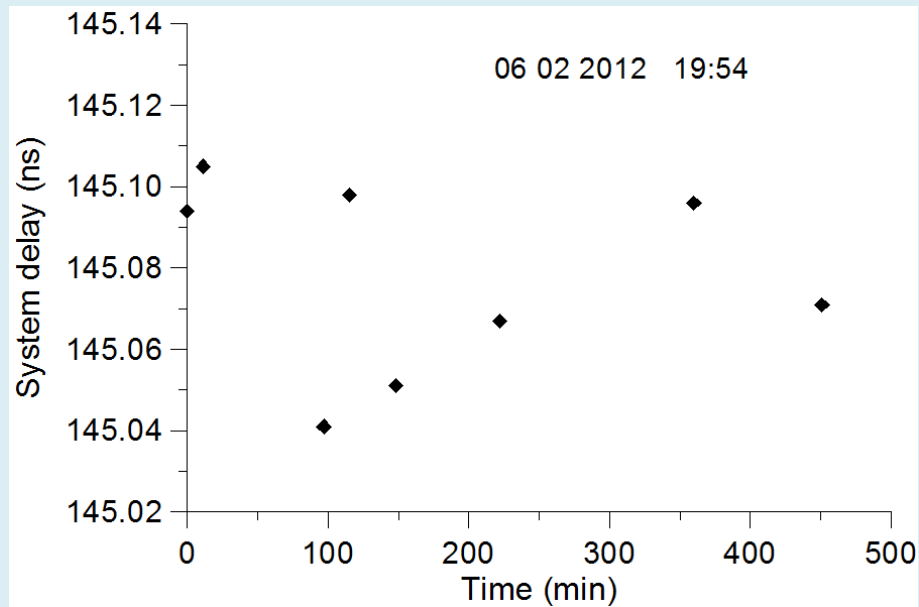
# 1890 (BADL) L1&L2 observations



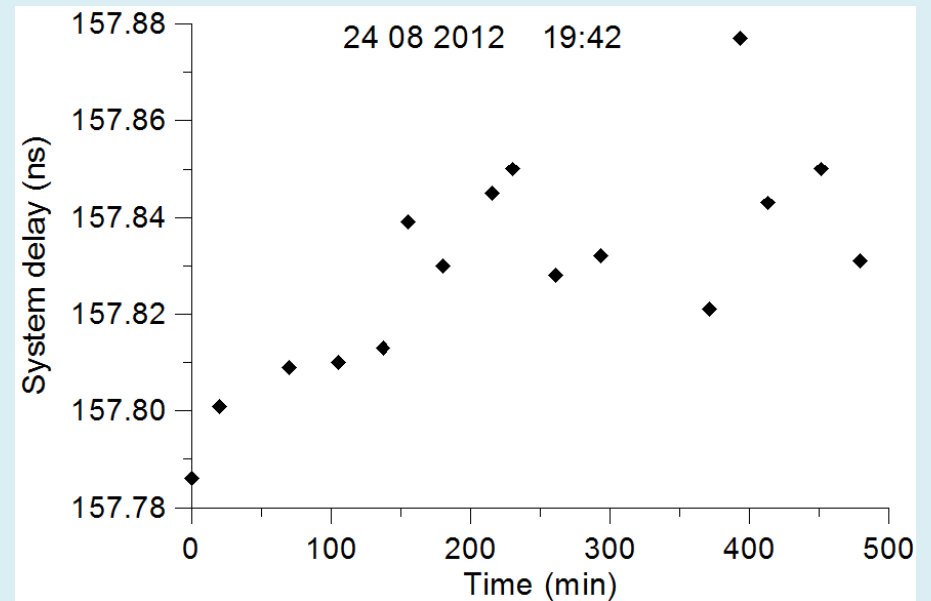
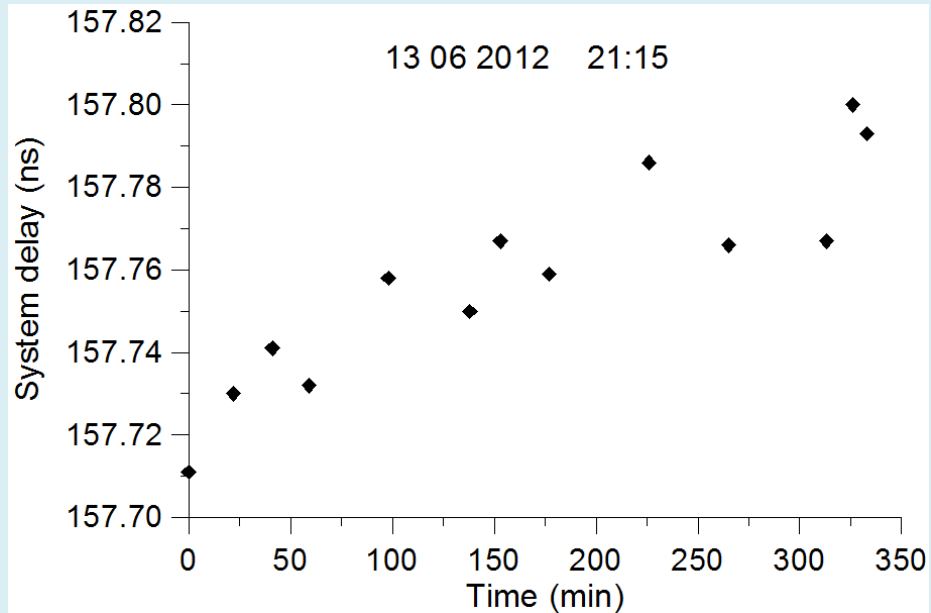
Mean RMS= 1.12 cm



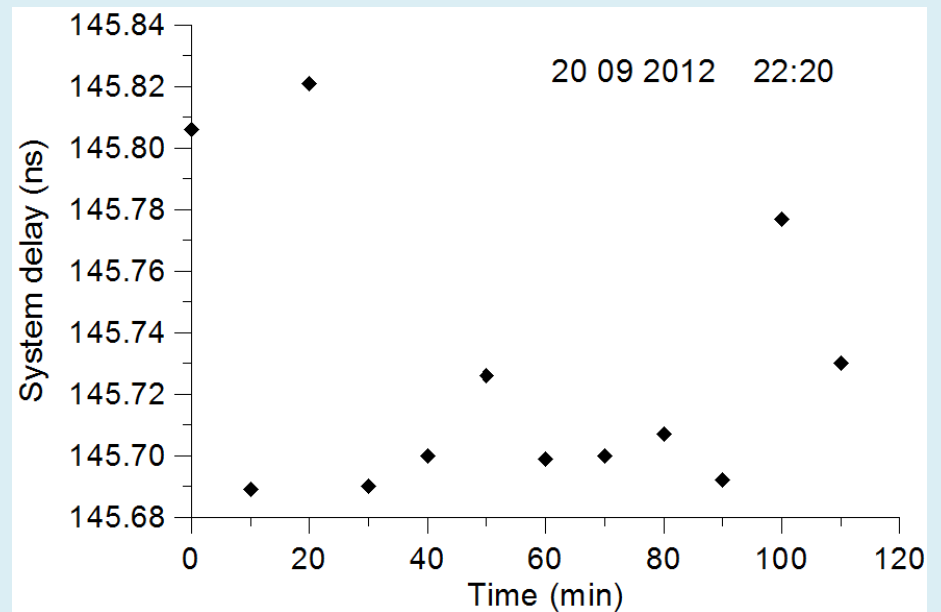
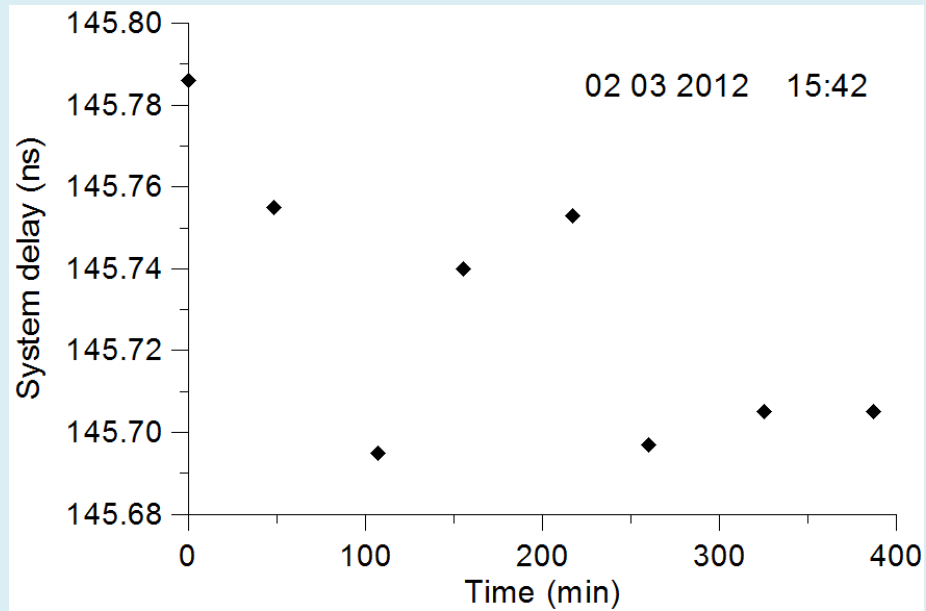
# System delay calibration data 1888 (SVEL)



# System delay calibration data 1889 (ZELL)



# System delay calibration data 1890 (BADL)



# Summary

- Normal points of L1 & L2 satellites have an accuracy about 1 cm
- Further work to be done:
  - Full use of the time keeping system (H-maser) of observatories
  - Investigation of stability of the system delay measurements
  - Improvement of station coordinates
  - Development of more sophisticated program for primary data analysis based on algorithm accounting the essentially irregular distribution of signal registration moments



*Thank you for your attention!*