SLR STATION KATZIVELY-1893

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Measurement of Anomalous Angle of Deviation of Light during Satellite Laser Ranging

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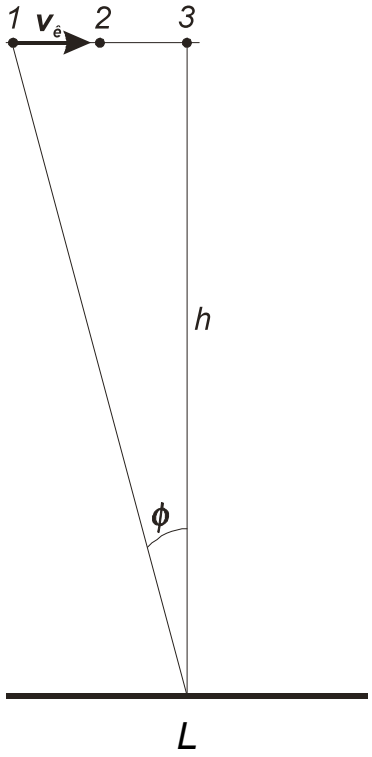
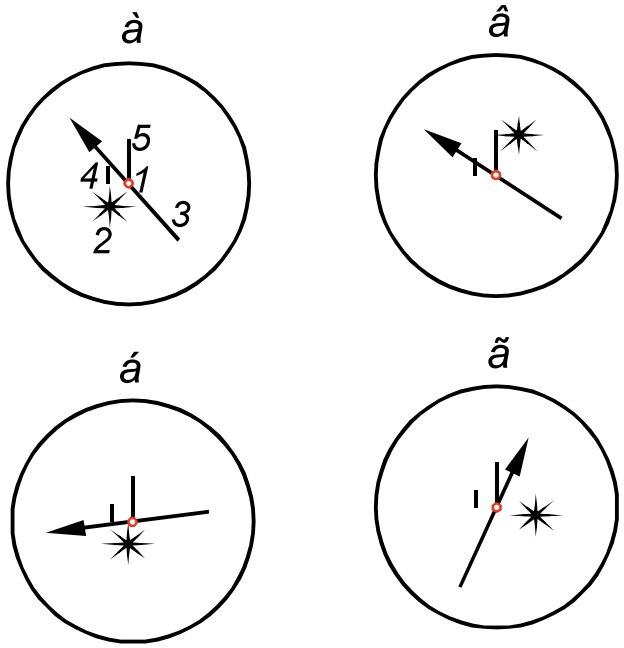
2008



1..3 – Sequence of satellite positions; L – laser ranging station; h – distance between station and satellite; ϕ – angle of velocity aberration.

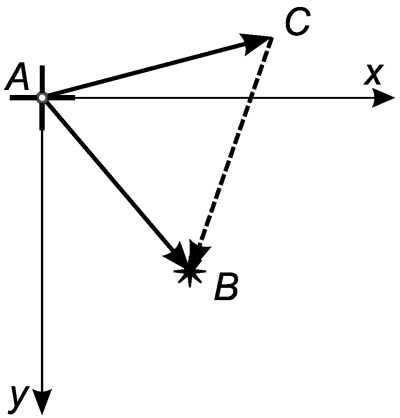
$$\frac{h\phi_v}{v_к} = \frac{2h}{c}$$

$$\phi_v = \frac{2v_к}{c}$$



Field of view of the telescope during laser ranging *[Ignatenko et al. 2004]*:
1 – telescope optical axe;
2 – satellite; 3 – direction of apparent movement of stars; 4 – scale; 5 – “crosshair”.
а) LAGEOS-1 24.06.2001 22:59:01;
б) LAGEOS-1 24.06.2001 23:03:39;
в) Ajisai 05.11.2002 15:55:02;
г) Starlette 18.04.2004 18:18:00.

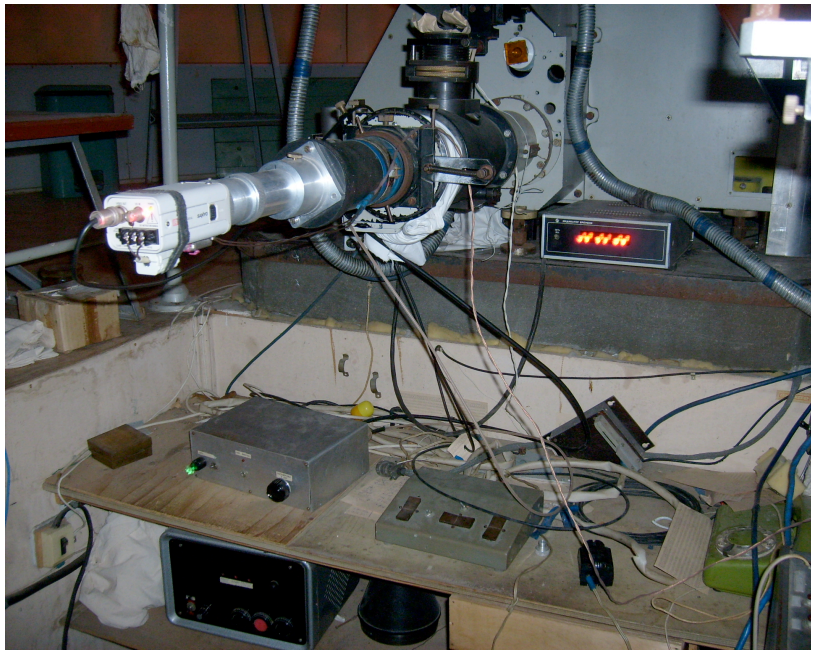
Narrow beams



A – projection of direction of the laser beam emission onto the telescope’s focal plane (telescope’s optical axe),
B – image of a satellite;
AB – apparent deviation of satellite image from telescope’s optical axe,
AC – velocity aberration;
CB – vector of anomalous deviation of light.

$$\mathbf{CB} = \mathbf{AB} + (-\mathbf{AC})$$

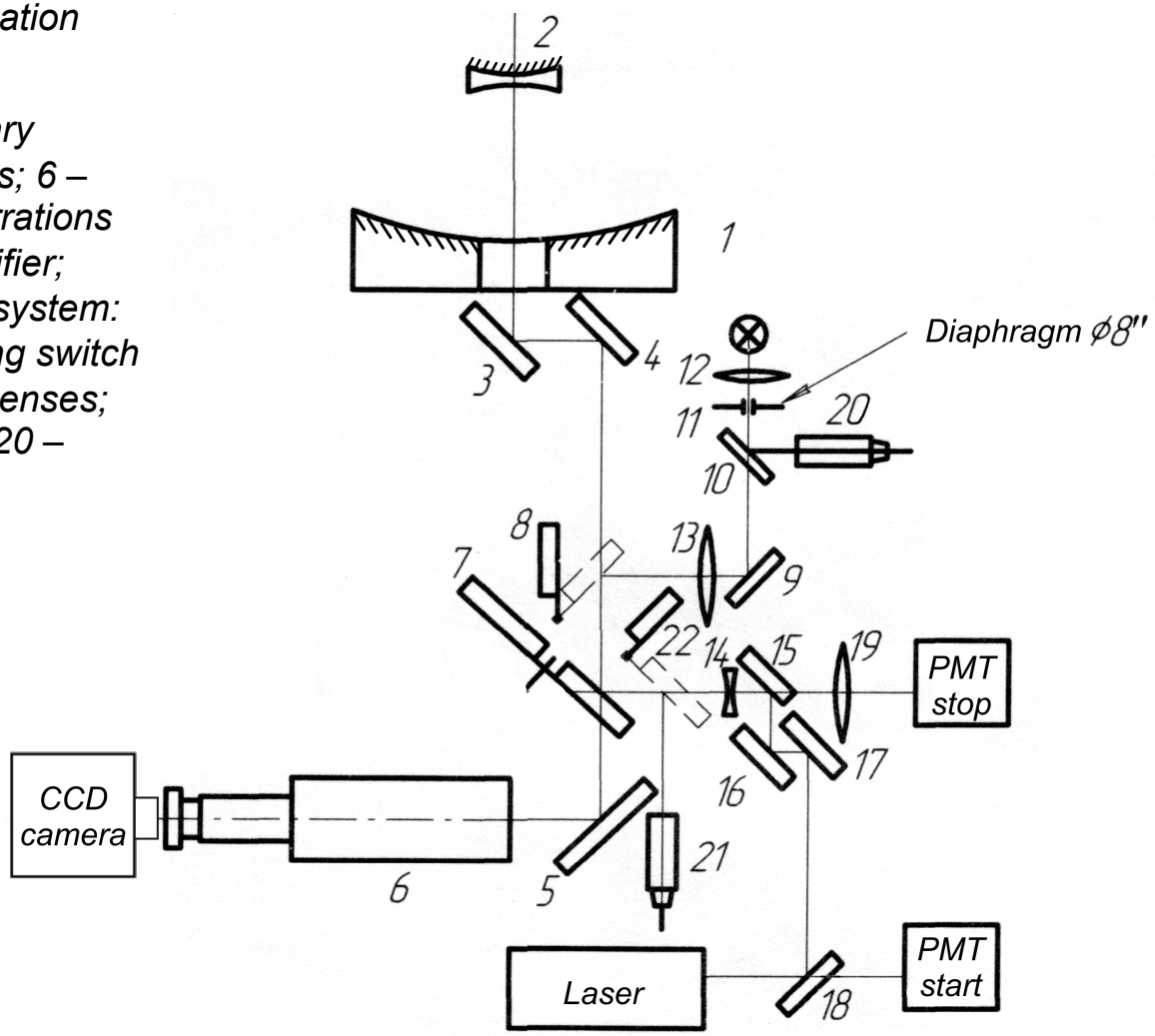
Aim of this work – experimental definition of the projection of the observed deviation of light onto the focal plane of the telescope and computation of the non-velocity-aberration term (anomalous deviation) from obtained data.

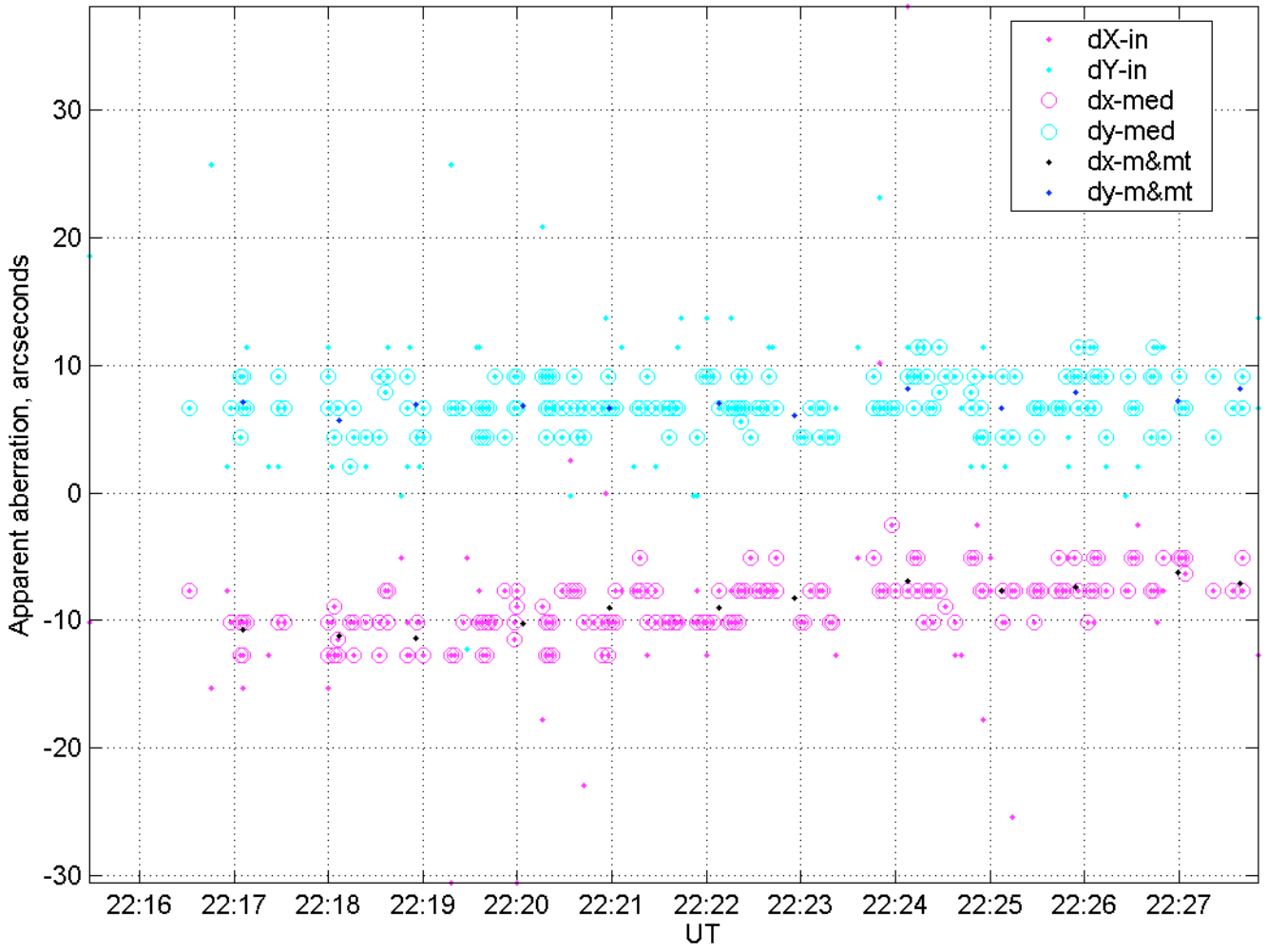


1. CCD camera was installed and calibrated;
2. Special program (C++) was written to register images at the necessary moments;
3. Also we have modified standard software in order to calculate velocity aberration in the telescope's focal plane;
4. Post-processing software for detection of the image of the satellite and computation of the anomalous deviation was written (Matlab).

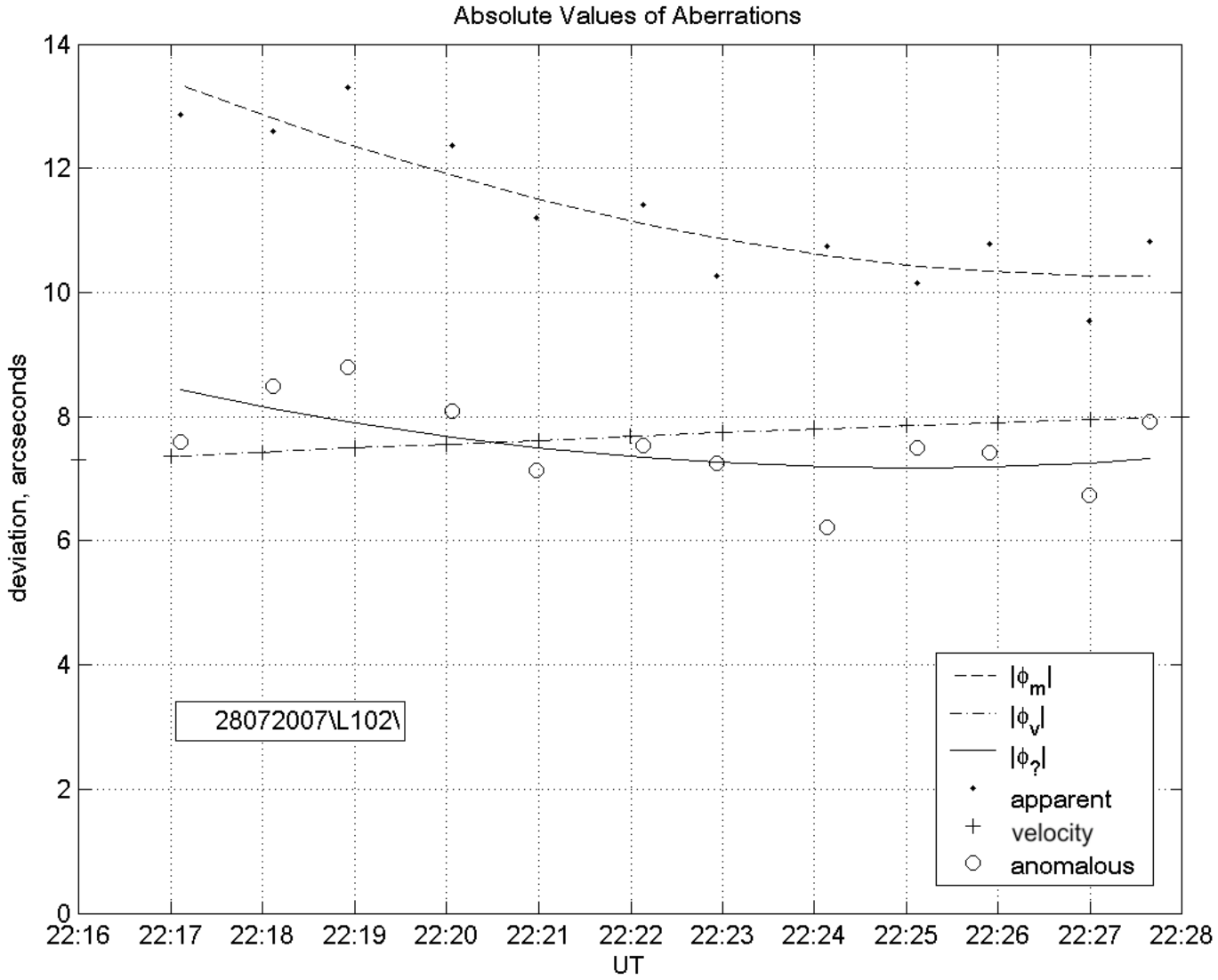
Optical scheme of the laser ranging system on Katzively SLR station

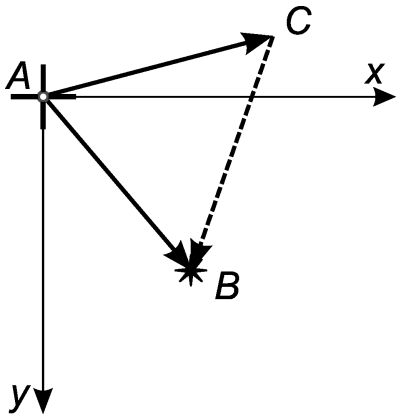
i) TPL-1 telescope:
1 – primary mirror; 2 – secondary mirror; 3, 4, 5 – diagonal mirrors; 6 – main guide with chromatic aberrations compensator and image intensifier;
ii) Laser-telescope adjustment system:
7 – rotating mirror; 8, 22 – tuning switch mirrors; 13, 14, 19 – matching lenses; 9, 15..18 – mirrors; 10, 11, 12, 20 – artificial star; 20, 21 – oculars.





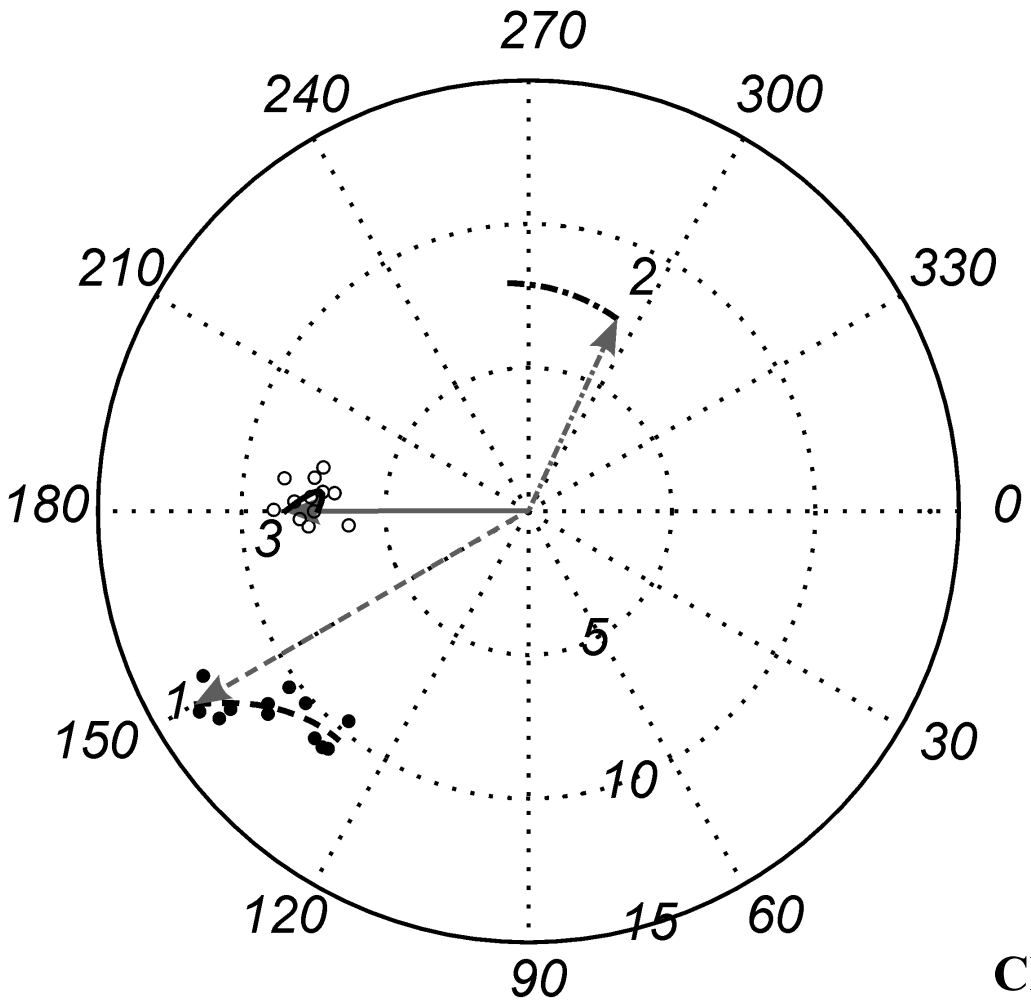
Satellite LAGEOS-1 28.07.2007. Distribution in the field of view of the telescope of measured deviations of the image of the satellite from direction of the laser beam emission (x is for abscissa, y is for ordinate): raw (dX-in, dY-in; each couple of points correspond to one frame), after median filtering (dx-med, dy-med), after use of sliding average filter to median filtered data (dx-m&mt, dy-m&mt).





Satellite LAGEOS-1 28.07.2007.

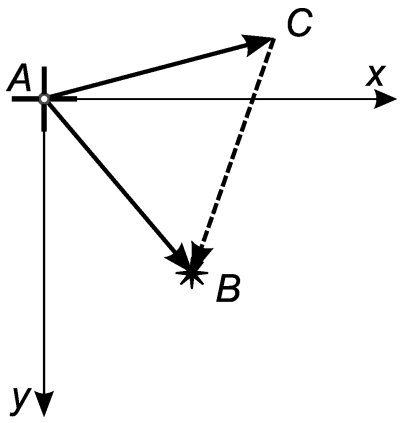
On this figure absolute values of projections of apparent deviation |**AB**|, velocity aberration |**AC**| and anomalous deviation |**CB**| in the focal plane of the telescope are shown.

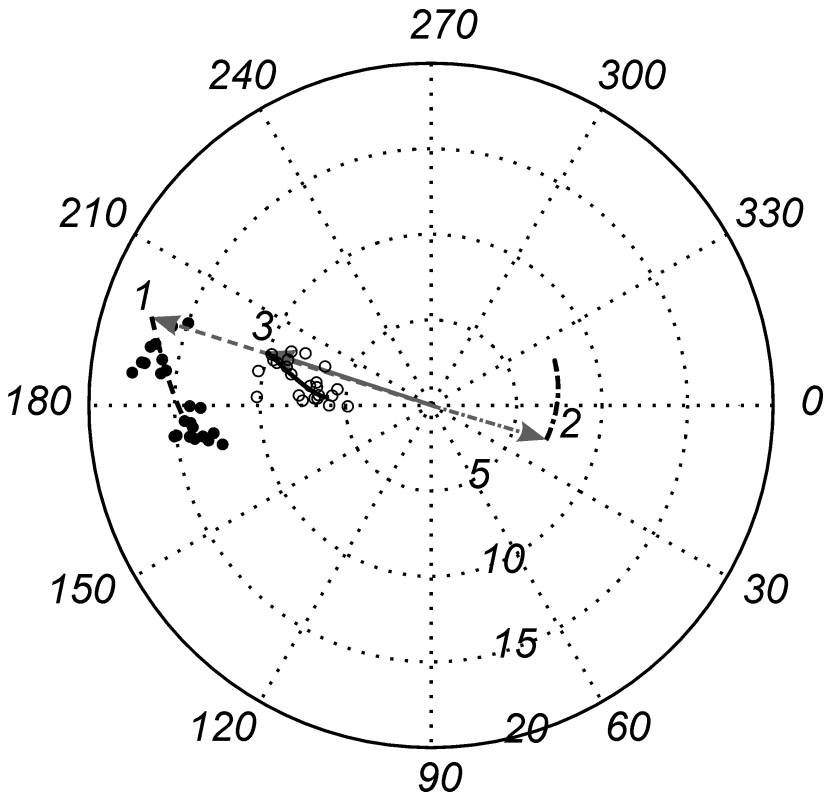


Satellite LAGEOS-1 28.07.2007
22:17-22:28 (22:22).

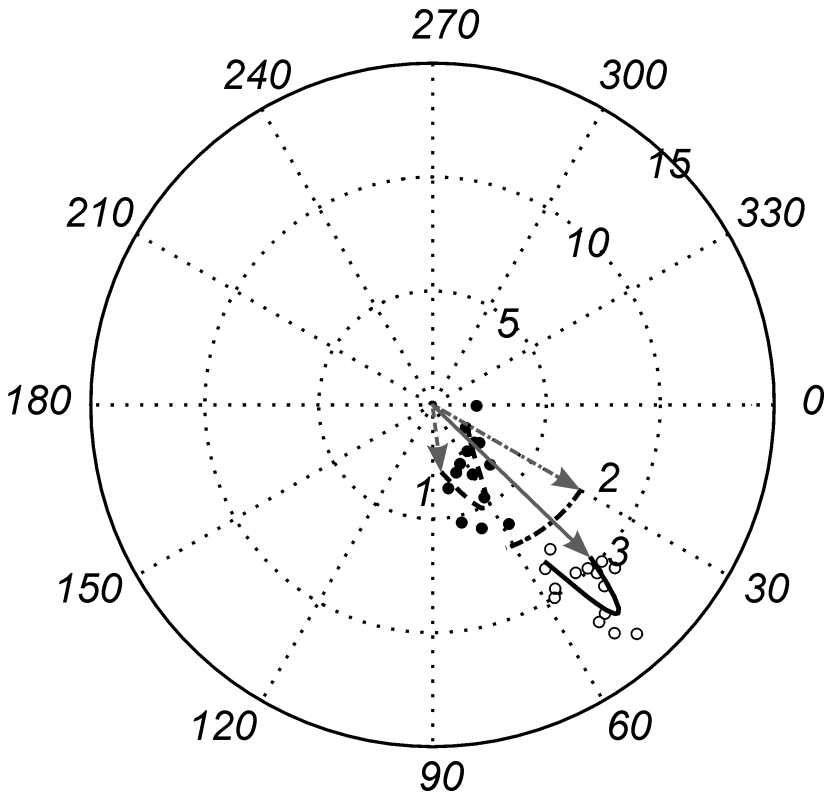
Projections onto the telescope's field of view of
1) Measured apparent deviation **AB**,
2) Vector opposite to velocity aberration **(–AC)=CA,**
3) True anomalous deviation **CB.**
Absolute values are in arcseconds, directions are in degrees relatively to the abscissa axe in the field of view. Arrows indicate the start of the pass.

$$\mathbf{CB} = \mathbf{AB} + (-\mathbf{AC})$$

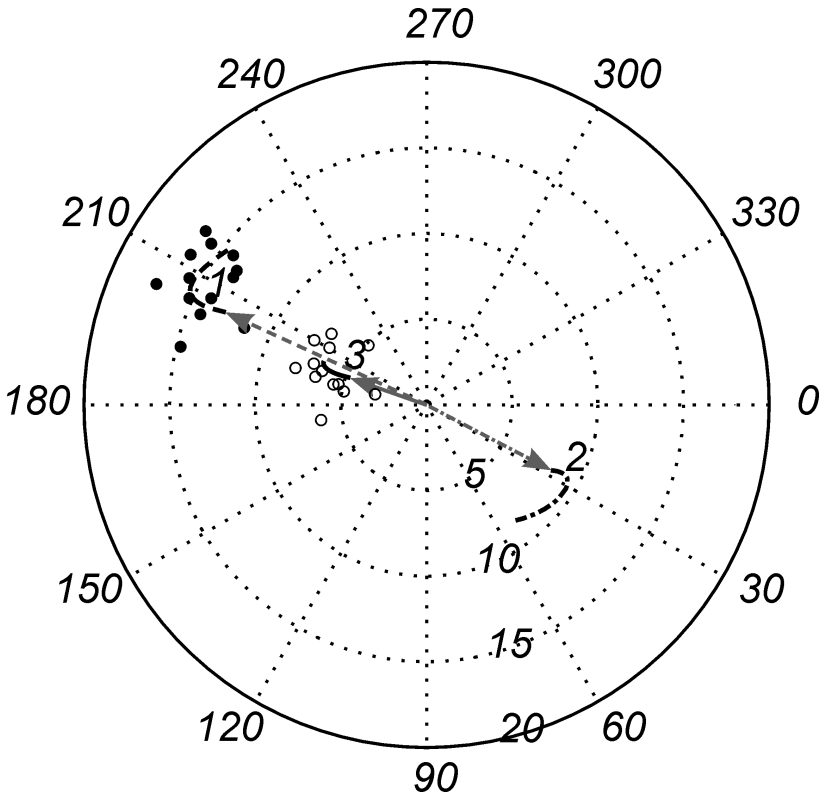




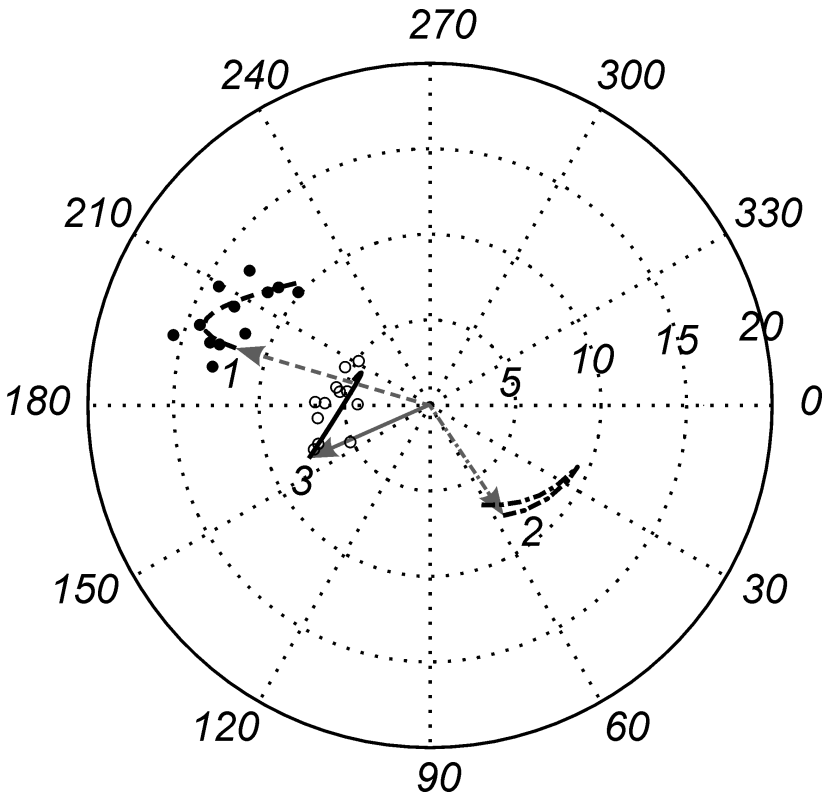
Lageos-2 28.07.2007 23:12



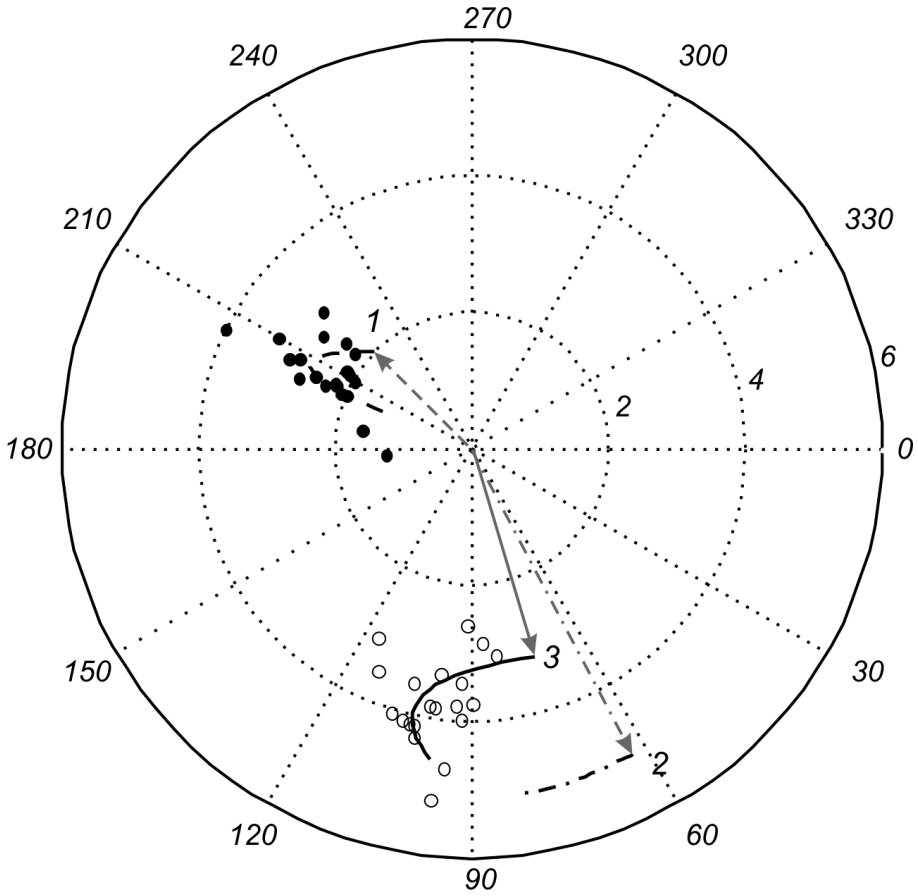
Lageos-2 12.10.2007 20:05



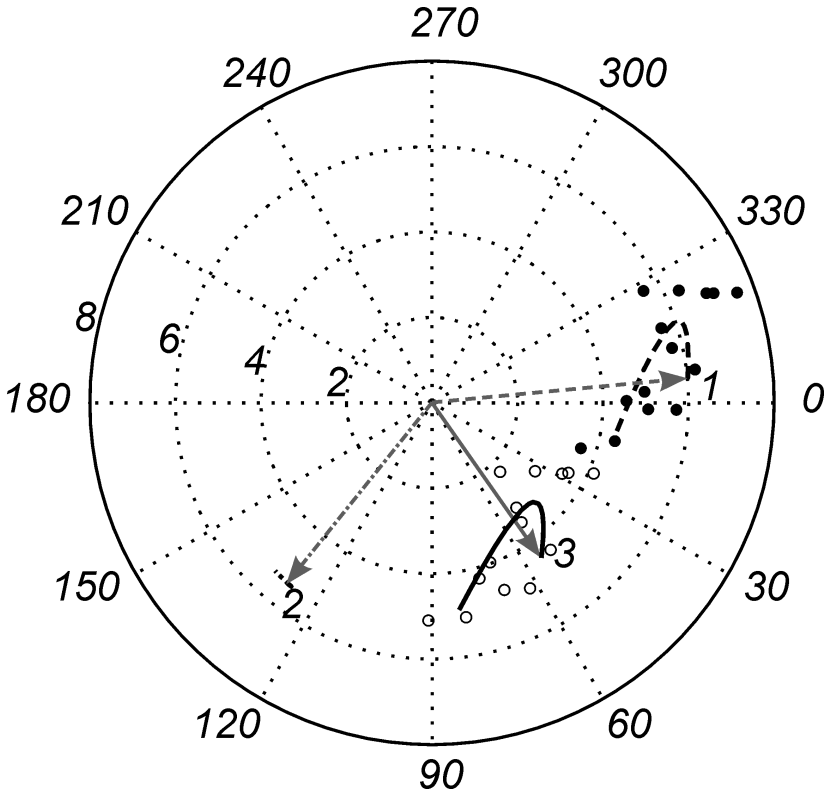
Jason-1 19.05.2007 23:30



Beacon-C 05.09.2007 17:13



Glonass-99 11.07.2008 22:40



Glonass-95 23.11.2007 02:30

Conclusion

We have developed a method of automatic registration of anomalous deviation of light during satellite laser ranging and processing of obtained data.

In this presentation first results were shown. Anomalous deviation of light is comparable with velocity aberration by absolute value but different in direction. Maximal value of anomalous deviation is about 10-12 arcseconds, its direction is seasonally dependent.

Further processing of obtained results needed. We will make an attempt to combine a 3D-vector of anomalous deviation from its different projections onto the field of view of the telescope.

THANKS!