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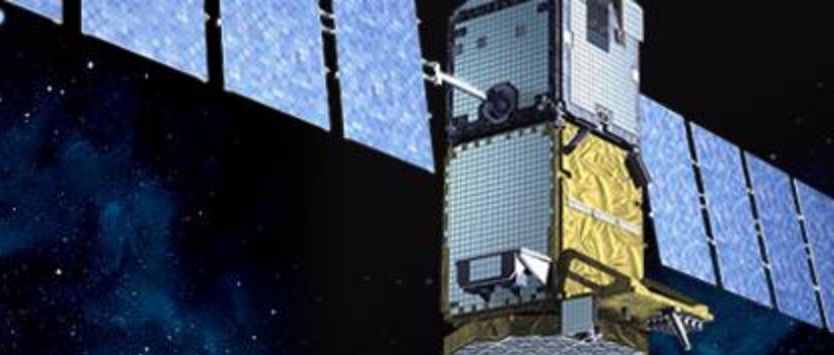

New results on spin determination of BLITS from High Repetition Rate SLR data

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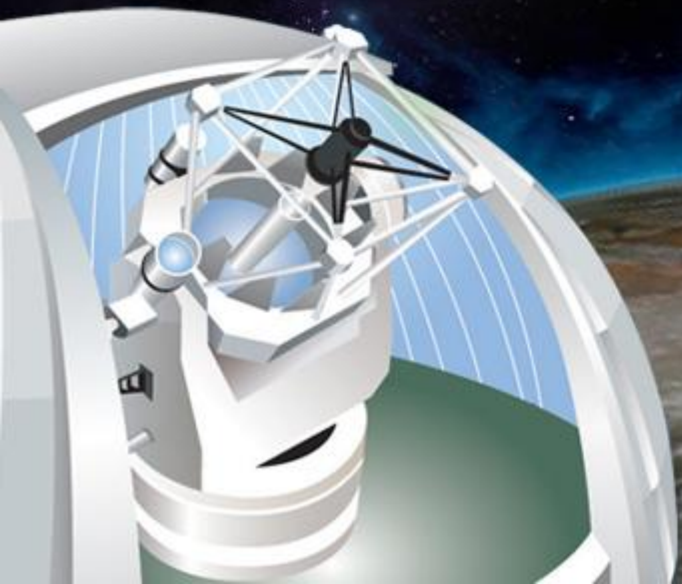

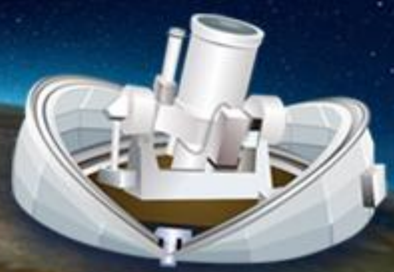

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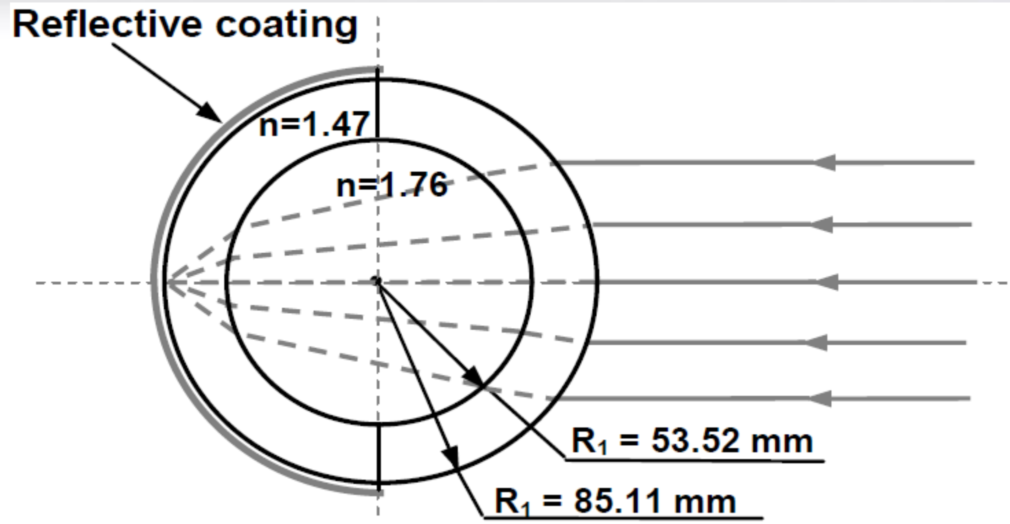
BLITS (courtesy of IPIE)
left: inner ball lens in the shell, right: assembled body



From: Spherical Glass Target Microsatellite. V.D. Shargorodsky, V.P. Vasiliev, M.S. Belov, I.S. Gashkin, N.N. Parkhomenko

BLITS is the first spherical lens type satellite.
The concept demonstrates a new technology that can be used for the future geodynamical missions.

Altitude:	832 km
Inclination:	98.77°
Orbit:	Circular orbit, sun-synchronous
Orbital Period:	101.3 min
Mass:	7.53 kg

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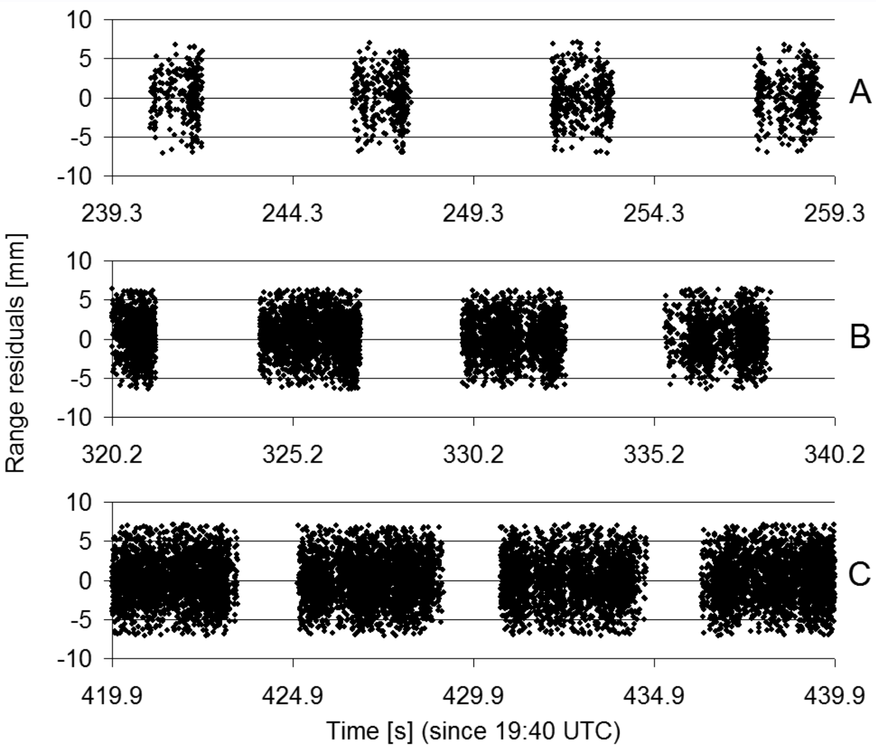

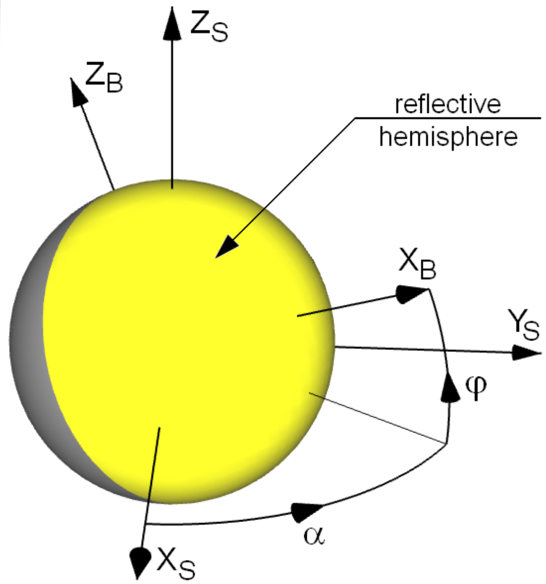

Satellite centered coordinate systems (right-handed, Cartesian): Body (B) and Spin (S). The spin phase is expressed by angle α and the latitude of the symmetry axis within the spin coordinate system by angle φ.

Range residuals of BLITS; pass measured by Graz SLR.
November 14, 2010 (423 days after launch). Three slots (20 seconds) from different parts of the pass show change of intervals duration. The 0 level is the mean value. The average RMS is 2.77 mm.

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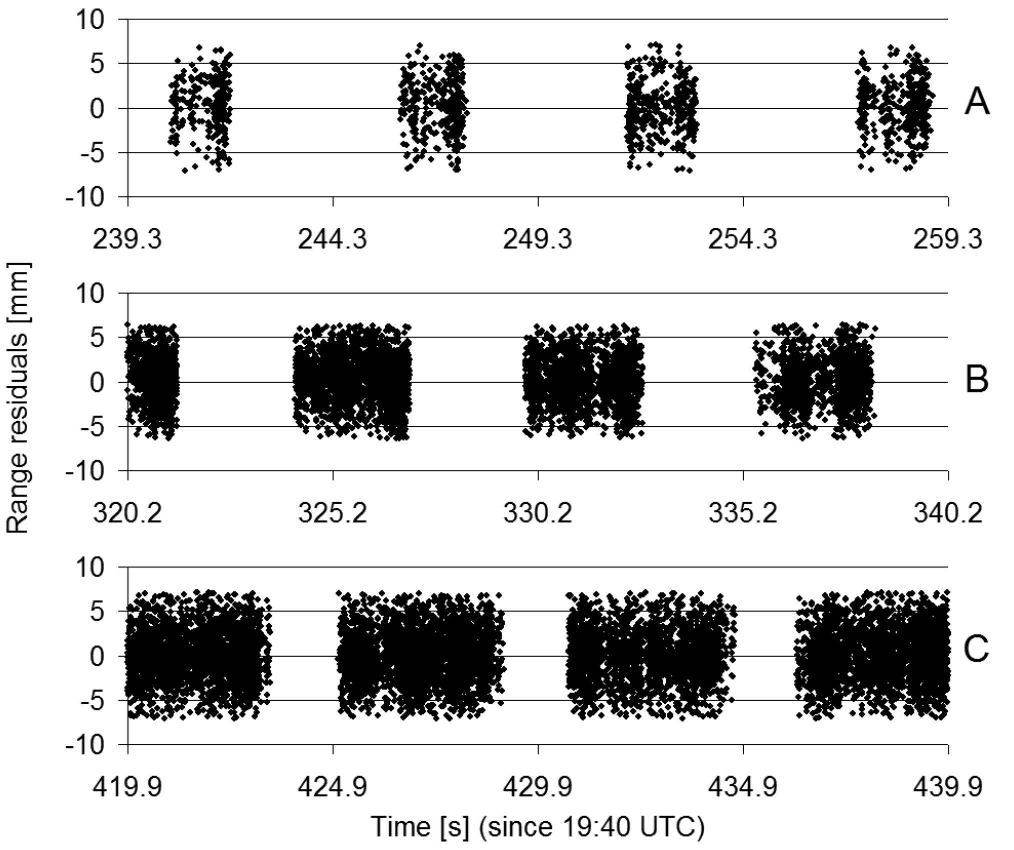

The high repetition rate of the laser allows measuring the duration of the intervals with sub-ms resolution, thus giving accurate information about the spin of the satellite.

For this investigation we used range measurements provided by all SLR stations which operate with kHz lasers (of short pulse width): Beijing, Changchun, Graz, Herstmonceux, Potsdam, Shanghai. The 962 analyzed passes have been measured between September 26, 2009 and June 18, 2012 (1005 days since launch).

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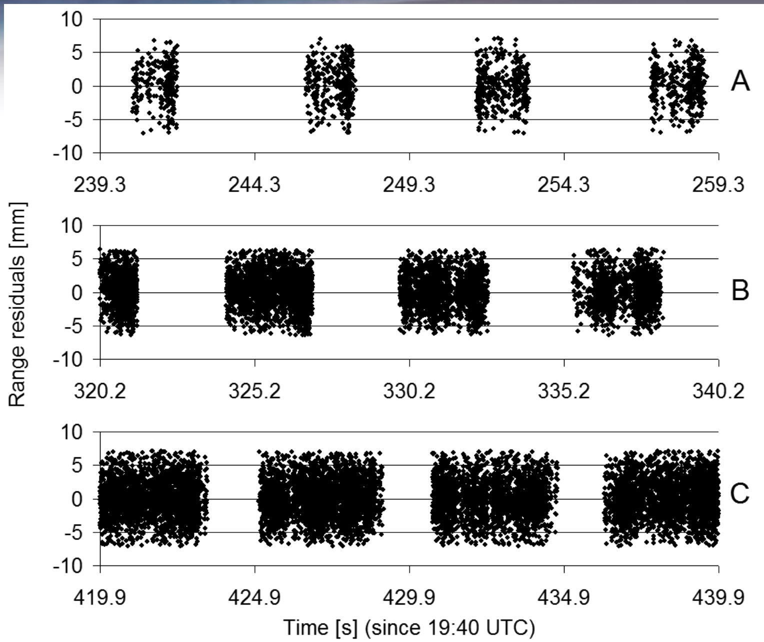

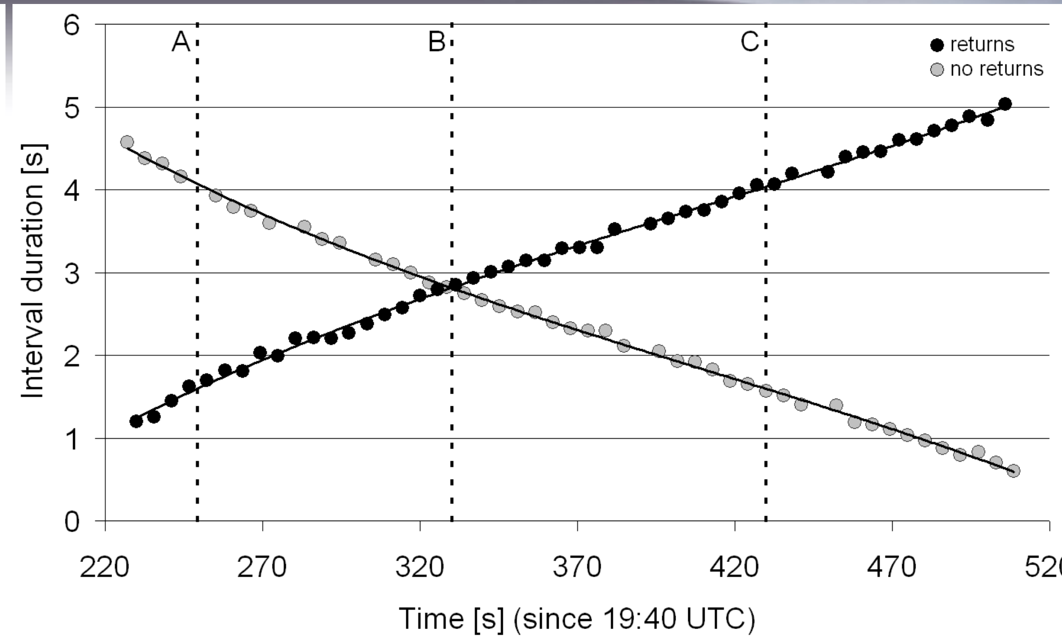

Some passes present a specific situation when the duration of the neighboring return/no return intervals is equal (case B) - this situation indicates a 90º incident angle between the laser beam and the spin axis of the satellite.

Such a condition at a given epoch allows calculating a cone of possible spin axis orientations of the satellite in the inertial reference frame. Assuming that the spin axis orientation did not change d uring a certain time (3 weeks) allows finding a large set (~10) of the cones which cross around one point indicating the spin axis solution.
The orientation of the spin axis solution can be obtained by a least squares method.

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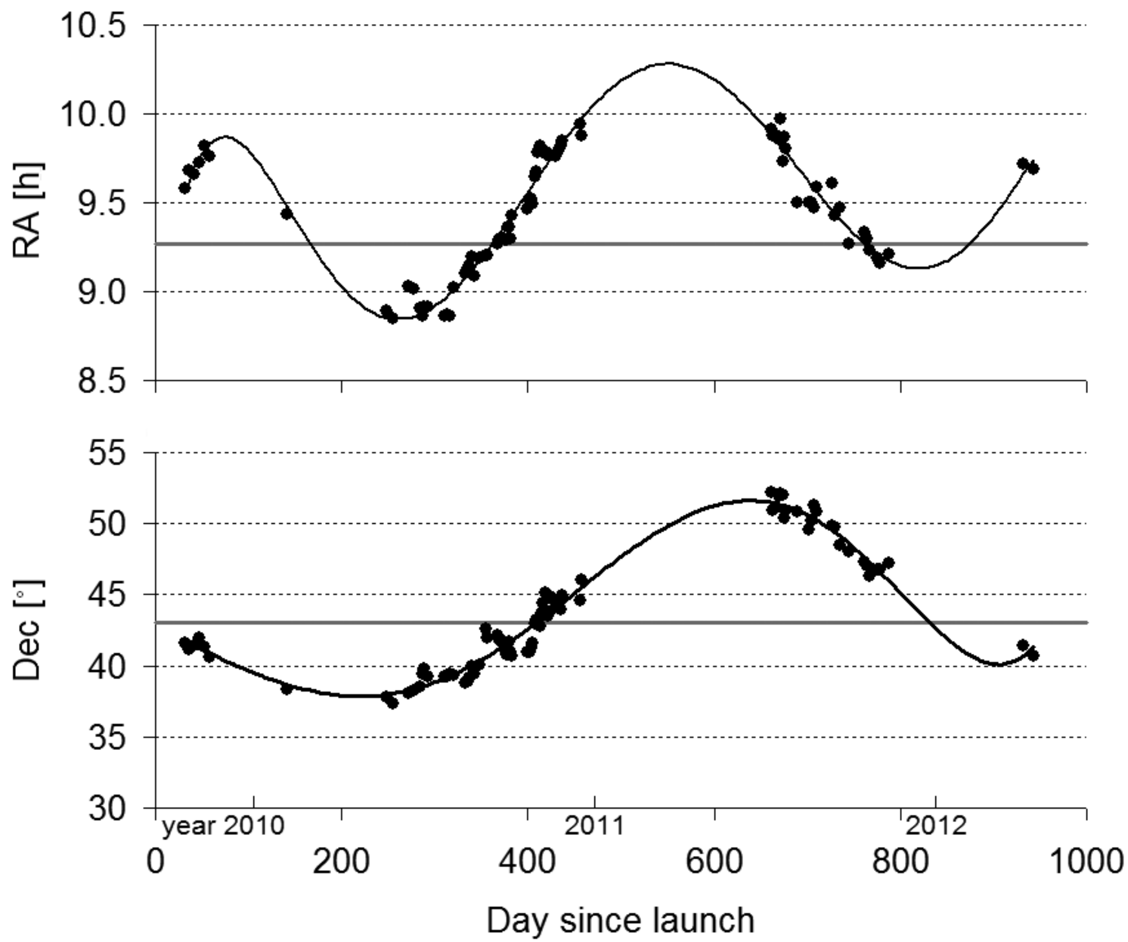

Spin axis orientation of BLITS in the J2000 inertial reference frame, approximated with polynomial functions.

The horizontal lines indicate orientation of the along track vector at the launch epoch

The spin axis oscillates around the orientation of the along track vector at the launch epoch (RA=9h16m39s, Dec=43.1º, calculated from the satellite's position predictions), which is assumed to be the initial orientation of the spacecraft. The RMS of the values around the polynomial trend functions is: RMS_{RA}=4m31s and RMS_{Dec}=0.72º.

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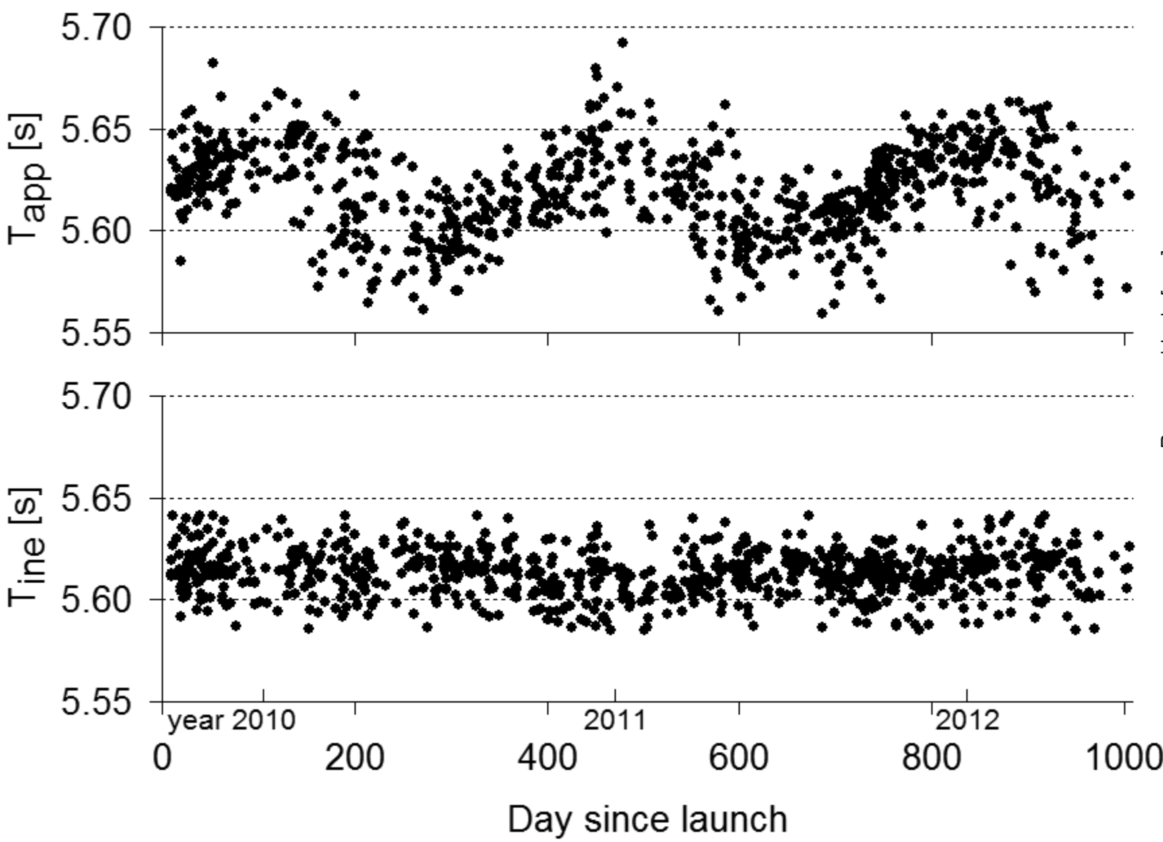

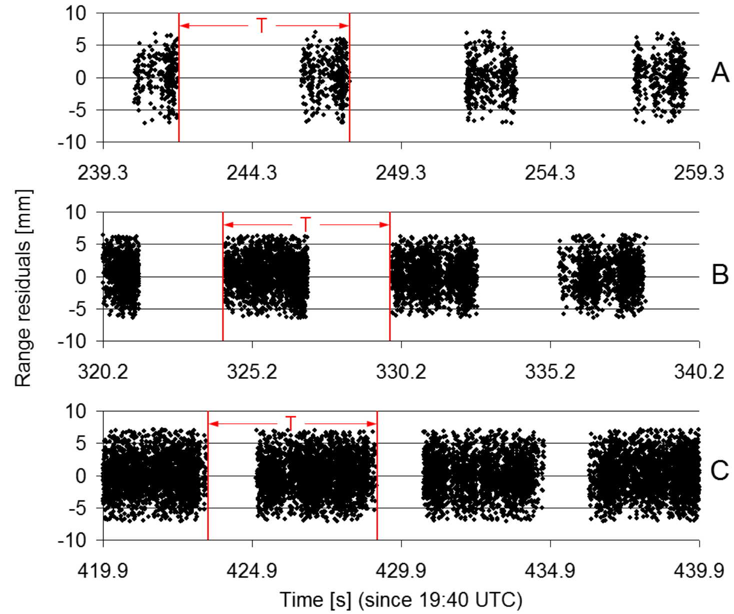

The apparent and the inertial spin period of BLITS calculated from 892 passes measured between September 26, 2009 and June 18, 2012. The inertial spin of the satellite remains stable during the investigated period, with the mean value Tmean=5.613 s, RMS=11 ms.

Due to the sun-synchronous orbit the apparent spin Tapp oscillates with a 1 year period as the orientation of the s atellite's spin coordinate system changes within the inertial, Earth's body centered reference frame.

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Conclusions

More than 1000 days of the SLR data, delivered by the 6 HRR SLR stations, were analyzed during this investigation.

The spin axis of BLITS is not completely stable, but is precessing around a position indicated by the orientation of the along track vector at the launch epoch. The change of the orientation can be caused by Earth's gravity field as it acts on the offset between the center-of-pressure (geometry) and the center-of-mass of the satellite.

The spin period of BLITS is stable – a phenomenon observed for the first time among the geodetic satellites. The non-conductive, glassy body does not allow the gravitational and magnetic field of the Earth to decrease its rotational rate.

Thank you.

This work has been published in: Kucharski, D., Kirchner, G., Lim, H. C., Koidl, F. New results on spin determination of nanosatellite BLITS from High Repetition Rate SLR data. Adv. Space Res., doi:10.1016/j.asr.2012.10.008

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