한국천문연구원
Korea Astronomy & Space Science Institute

Spin parameters of LARES spectrally determined from SLR data

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Accurate Ranging system for Geodetic Observation

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LARES (courtesy of ASI)

LARES - LAser RElativity Satellite
designed by Scuola di Ingegneria Aerospaziale at "La Sapienza" University of Rome
and manufactured by Carlo Gavazzi Space (CGS) under contract to the Italian Space Agency (ASI).

The satellite was launched by ESA on Feb.13, 2012, from the European Spaceport of Kourou (French Guyana), with the maiden flight of the new ESA small launcher VEGA.

LARES was placed in a circular orbit at a height of 1450 km, inclination 69.5°

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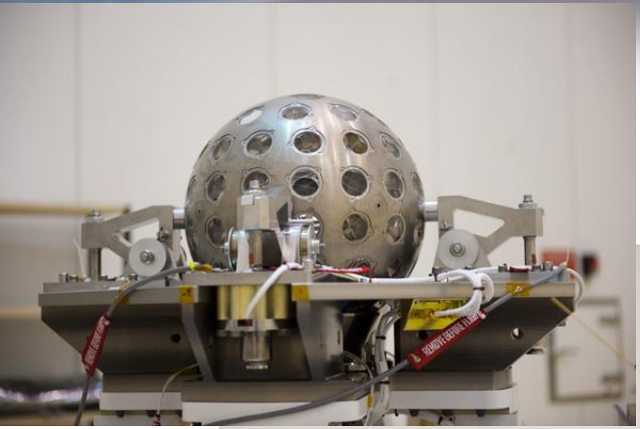

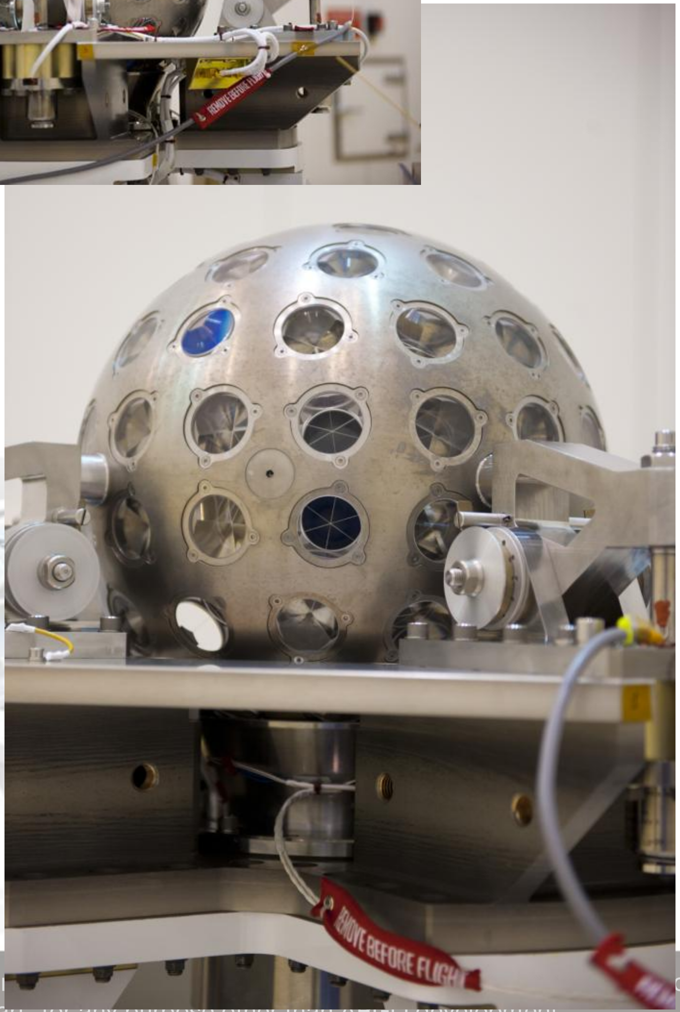

This fully passive, spherical satellite is made of a high density tungsten alloy.

It is expected that LARES will achieve important measurements in gravitational physics, space geodesy and geodynamics: in particular – together with the LAGEOS-1, LAGEOS-2 and with the GRACE models – it will improve the accuracy of the determination of Earth’s gravitomagnetic field and of the Lense-Thirring effect.

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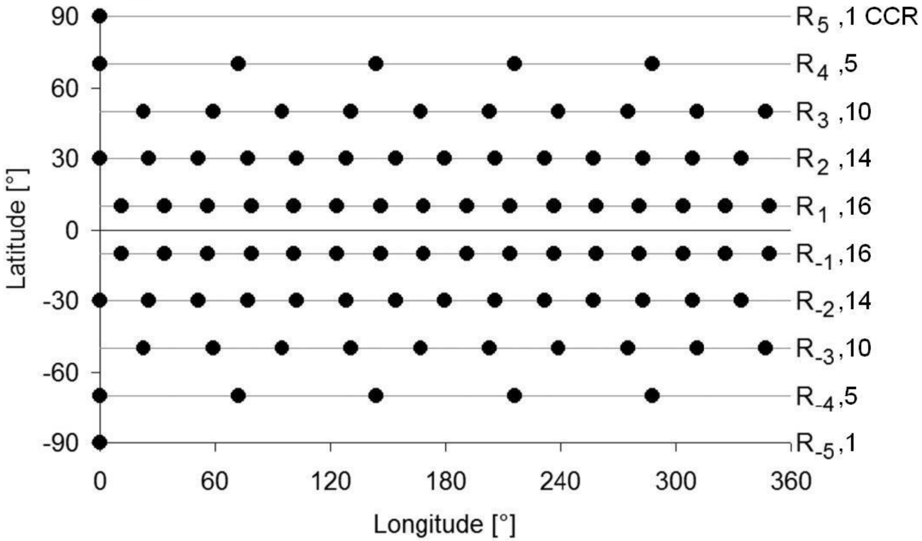
Retroreflector array

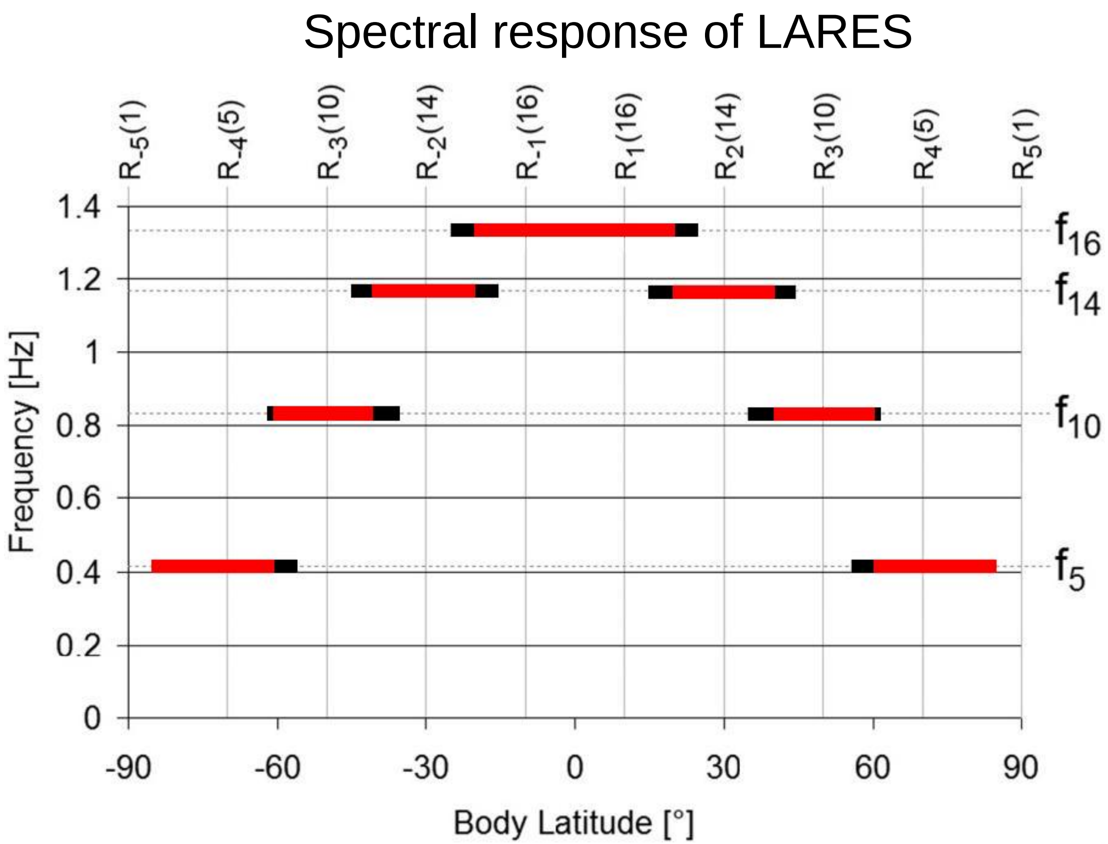


LARES is equipped with 92 corner cube reflectors (CCRs) for SLR arranged in the form of 10 rings around the polar axis of the body.

The gaps between the prisms on a single ring are constant.

All cubes are of the same type - made from Suprasil 311, not coated.

In order to determine the spectral response of LARES the range residuals are simulated for every incident angle between the laser beam and the spin axis (symmetry axis) of the satellite.



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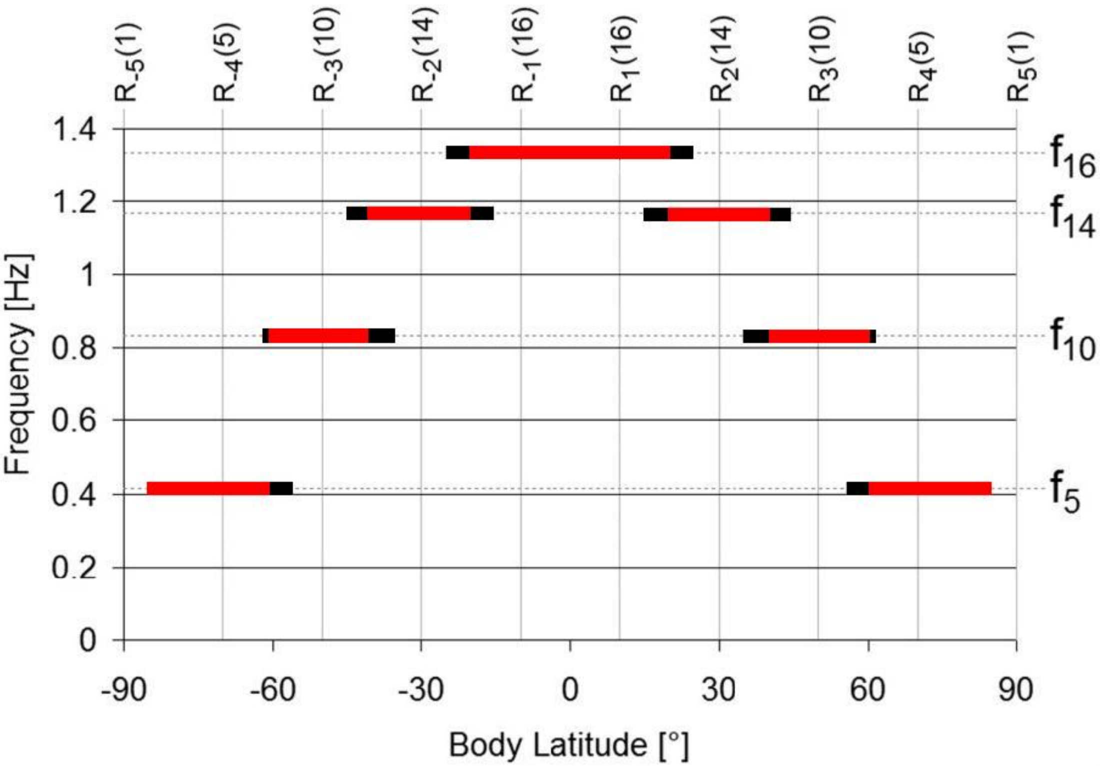
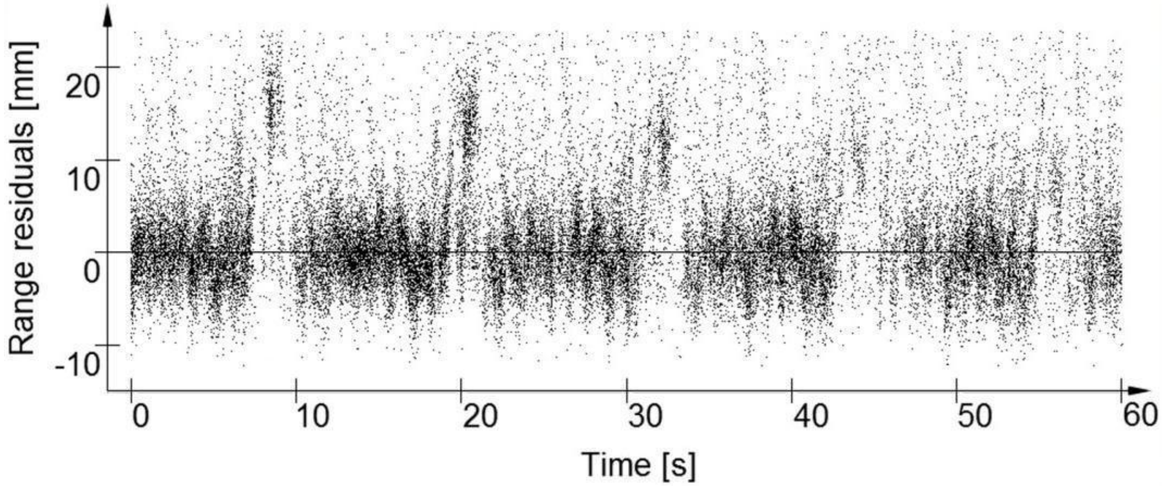
During the process the spin period of the satellite is set to 12 s (5 rpm) and kept constant. At given latitudes of the laser pointing the range residuals are simulated and spectrally analyzed.

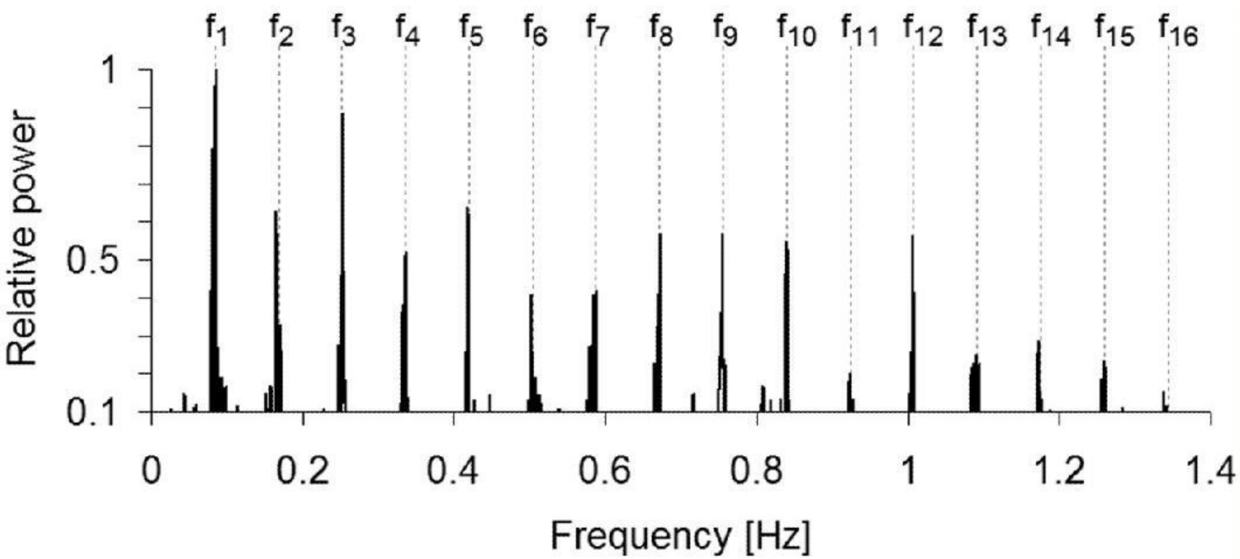
The spin frequency of the satellite is identified as f_1. The harmonics (f_5, f_{10}, f_{14}, f_{16}) visible in the spectra are generated by various geometrical distributions of the contributing CCRs. When the laser direction is perpendicular to the plane of a given ring, the detected, most powerful harmonic f_n is a product of the body's spin frequency (f_1) and the number n of the CCRs distributed around the ring: $f_n = n \cdot f_1$.

Spectral response of LARES



LARES pass measured by Graz kHz SLR station on February 22, 2012





Spectrum of the 60s part, T=11.9s

from sim: $f_{5,10,14,16}$

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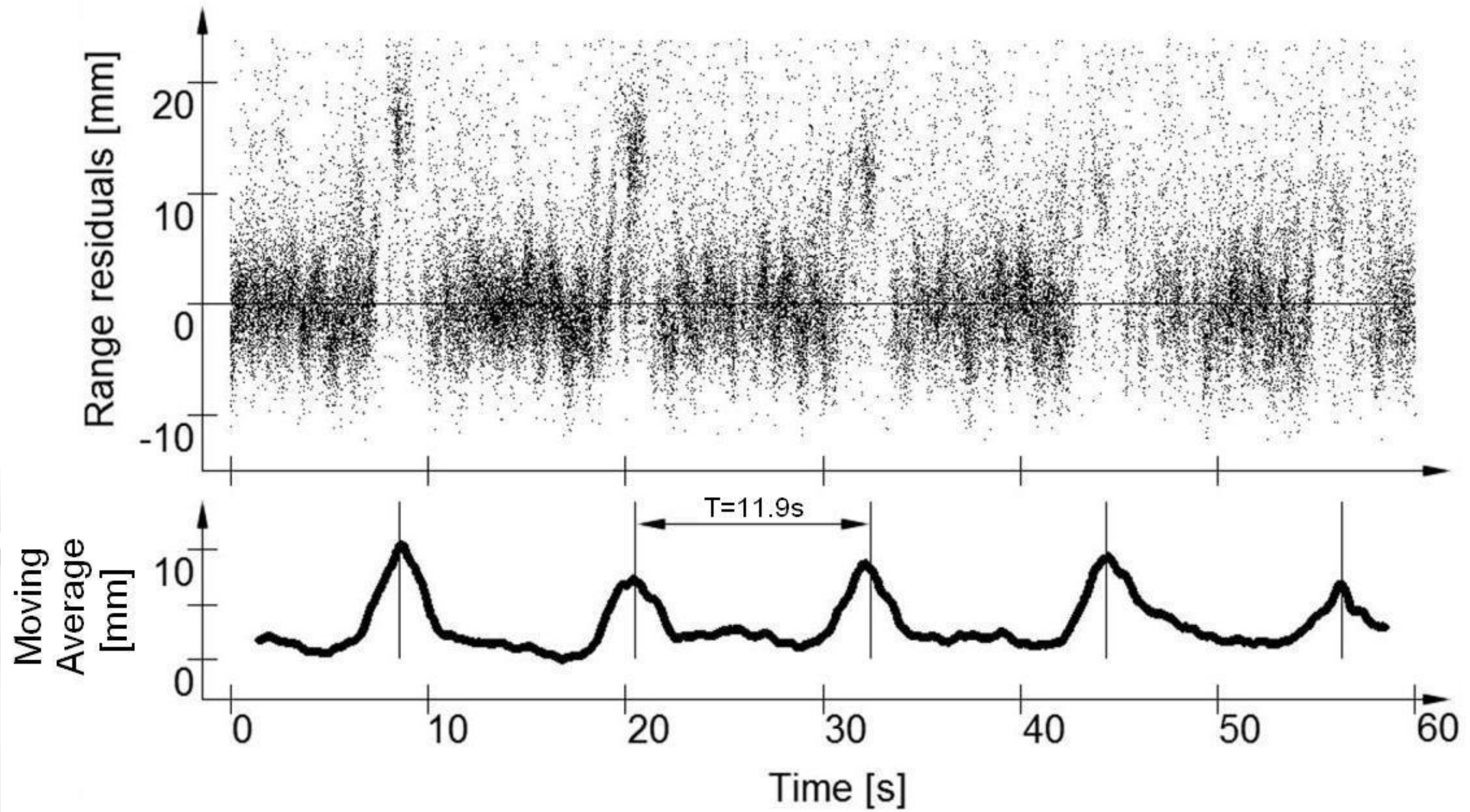
LARES pass measured by Graz kHz SLR station on February 22, 2012



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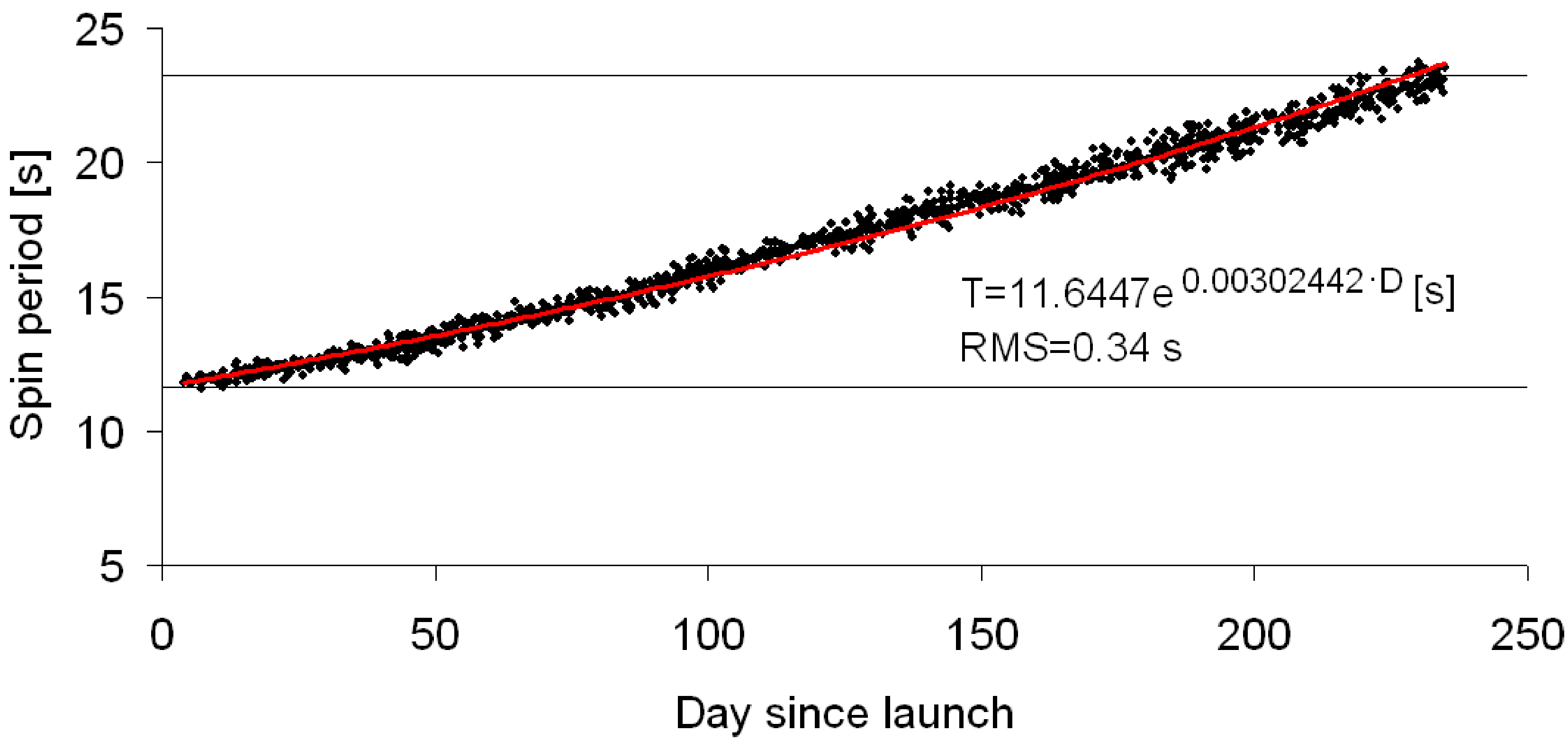
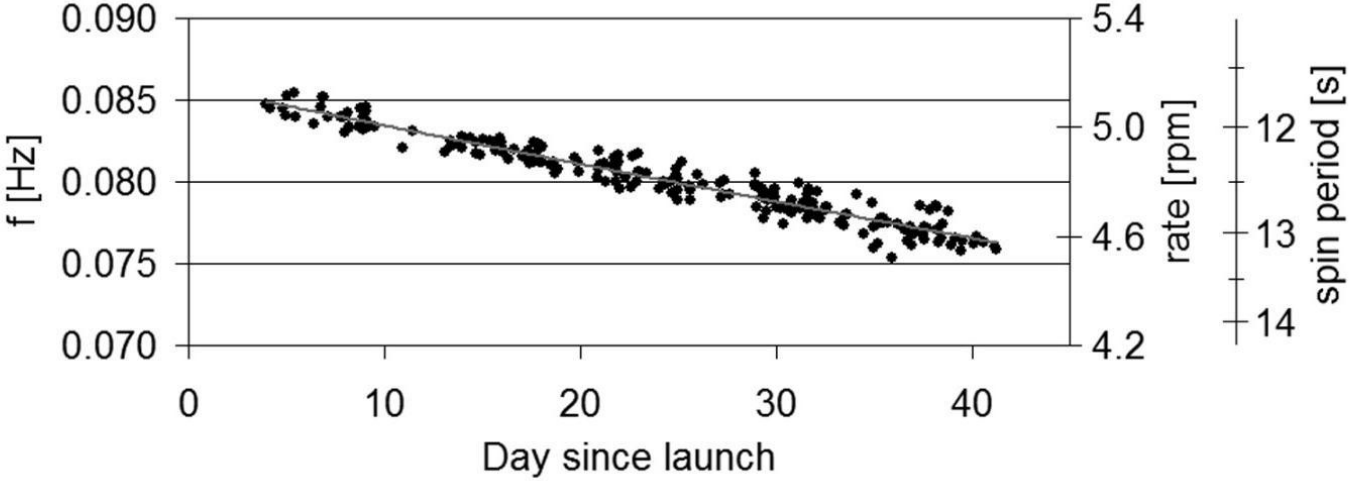
Spin period of LARES, day 4-235 (Sept.), 1550 SLR passes (10 Hz – 2 kHz) (corrected for the apparent effect)



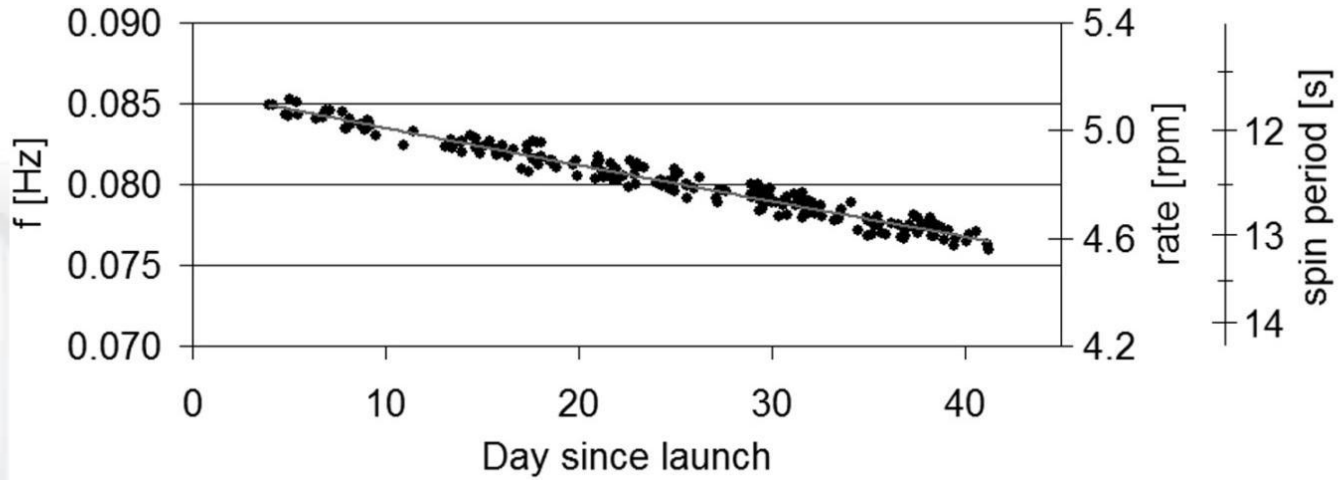
The half-life period of the satellite's spin is 229.2 days - the spin period doubles after this time.

Spin parameters of LARES spectrally determined from SLR data



$f_{apparent}$

RMS = 0.62 mHz



$f_{inertial} = f_{apparent} + AppCorr$

RMS = 0.44 mHz

Spin axis orientation:
RA=12h10m0s
Dec=-71.5°
CW direction

The apparent spin is caused by the longitudal change of the laser vector within the spin coordinate system as the satellite is passing the ground station.

Conclusions

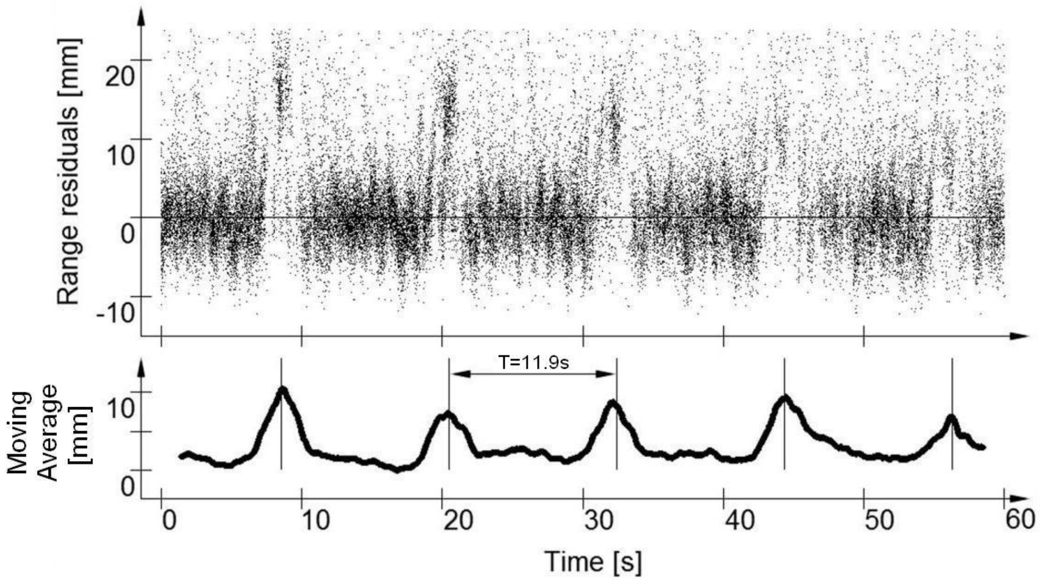
- The initial spin period of LARES was T=11.64s, RMS=0.34s

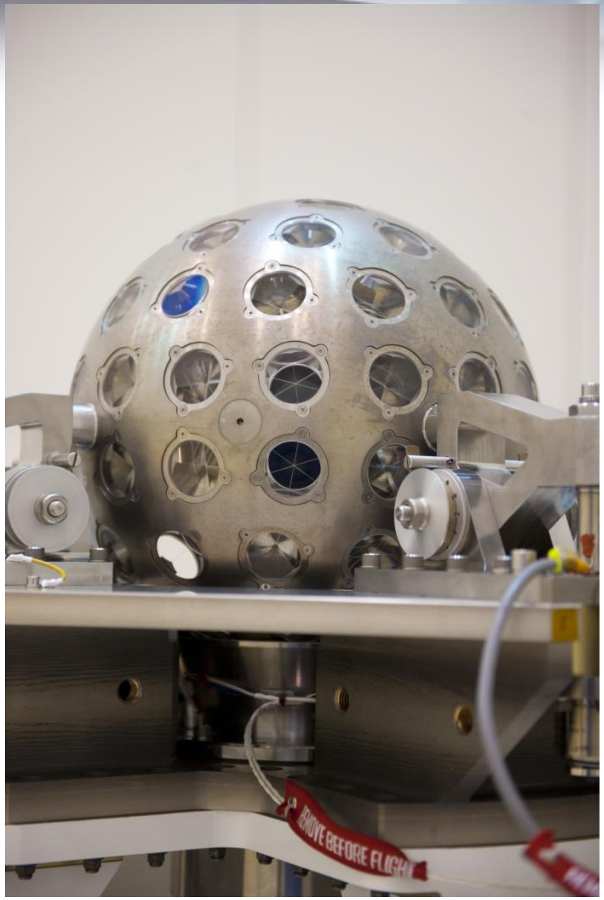
- Spin period doubles after 229.2 days (>3 minutes after 2y)

- The initial orientation of the spin axis agrees with the orientation of the launch vehicle at the injection epoch

- LARES spins CW direction

- Question: why some of the CCRs give weaker returns? Physical or mechanical reason?





Thank you.

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