16 years of LAGEOS-2 Spin Data from launch to present

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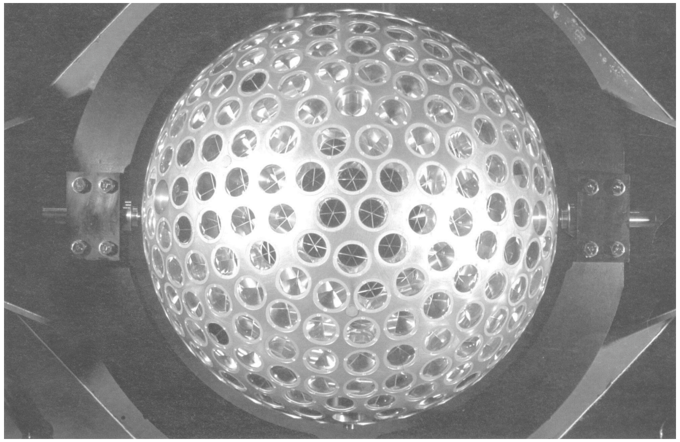
16th International Workshop on Laser Ranging, Poznań, Poland

LAGEOS missions

LAGEOS-1 and LAGEOS-2

mission parameters

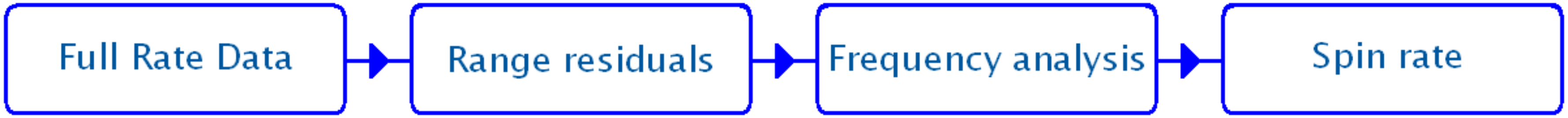


	LAGEOS-1	LAGEOS-2
Sponsor	United States	United States and Italy
COSPAR ID	7603901	9207002
Launch Date	May 4, 1976	October 22, 1992
Orbit	circular	circular
Inclination	109.84 degrees	52.64 degrees
Eccentricity	0.0045	0.0135
Perigee	5,860 km	5,620 km
Weight	406.965 kg	405.38 kg

LAGEOS spin

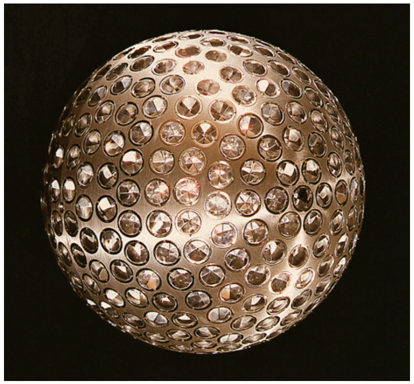
- Two measurement techniques
  - Photometry (L1:29 and L2:463 – LOSSAM)
  - SLR

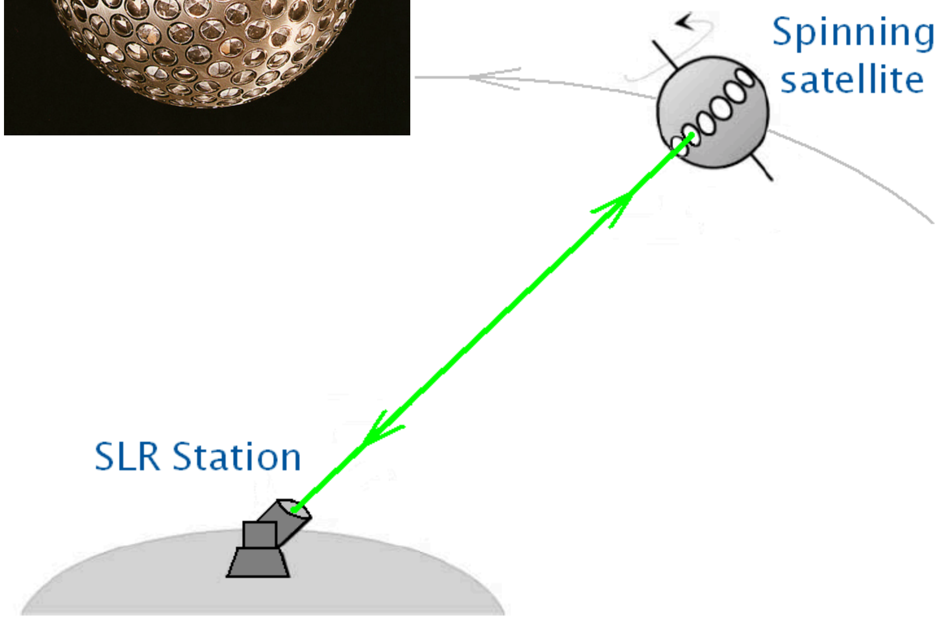
- Full Rate Data of SLR measurements (Global Data Centers)

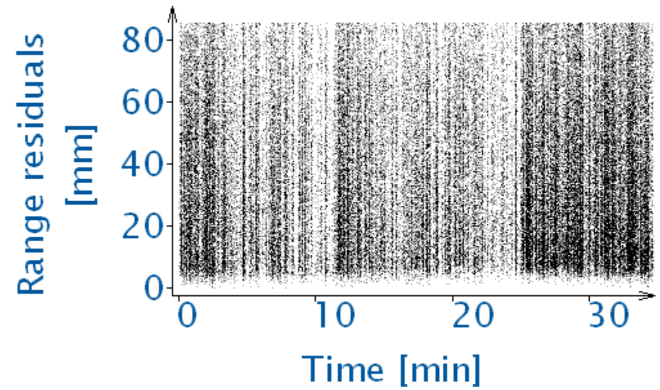


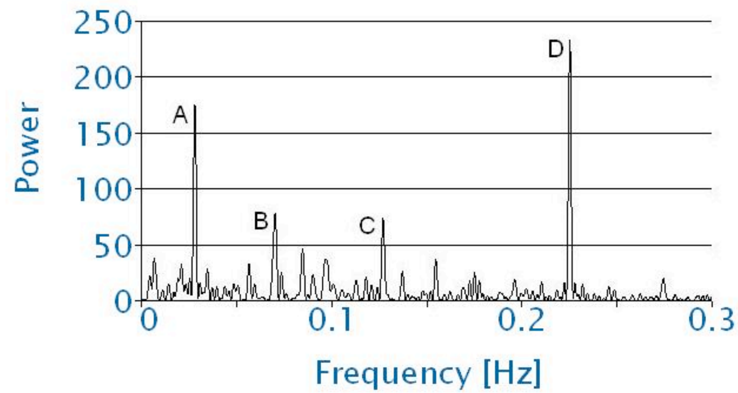
LAGEOS spin

- Frequency analysis of SLR FR Data Spinning satellite





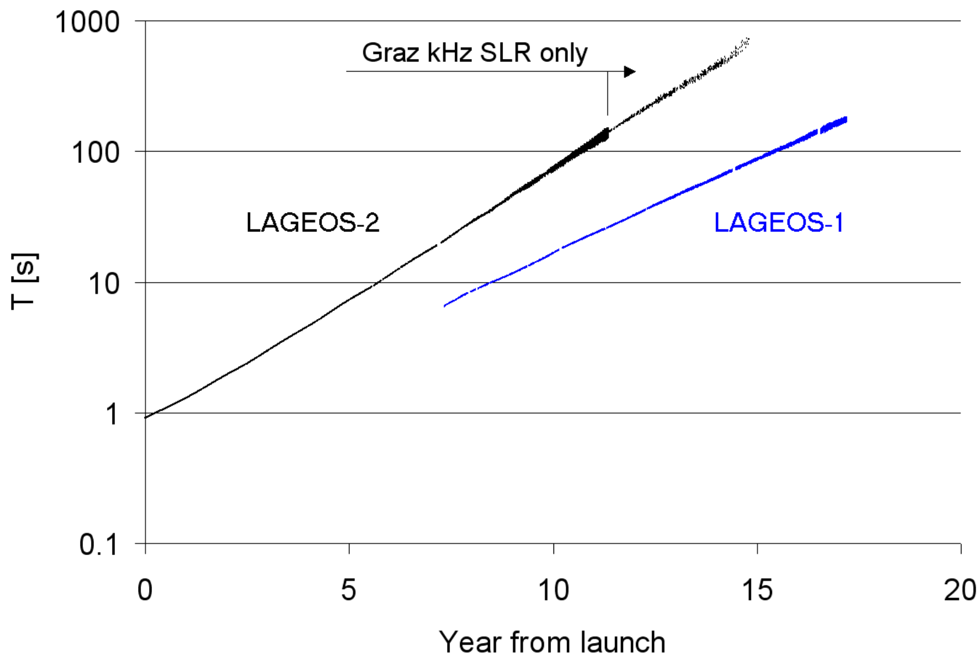




L2 pass from Graz kHz SLR station – 15th of March 2004

LAGEOS spin – SLR results

- Frequency analysis has been applied to all FR Data sets (LAGEOS-1 and LAGEOS-2) of all SLR stations and to Graz kHz SLR data sets of LAGEOS-2.



LAGEOS-1

6th Sep 1983 – 25th July 1993

>10k spin period values

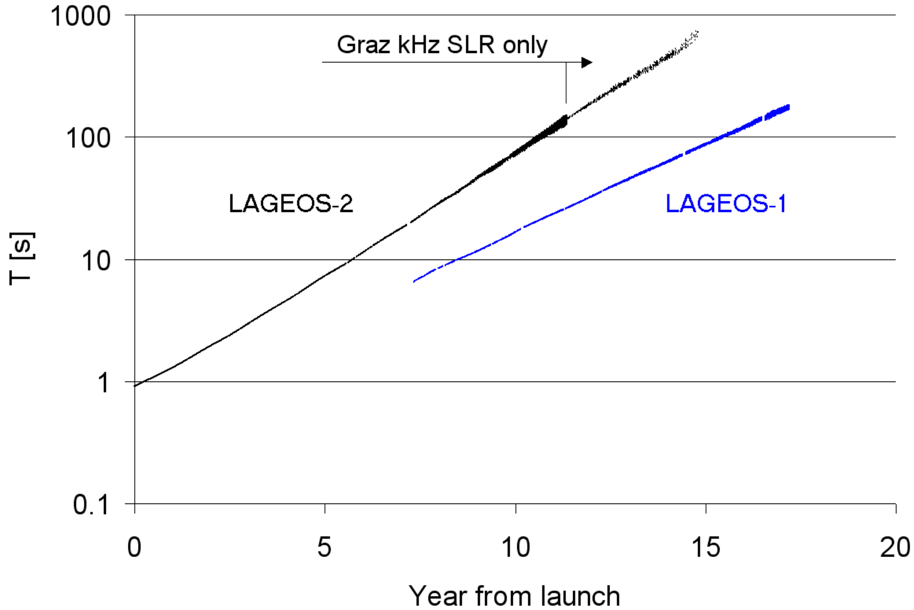
LAGEOS-2

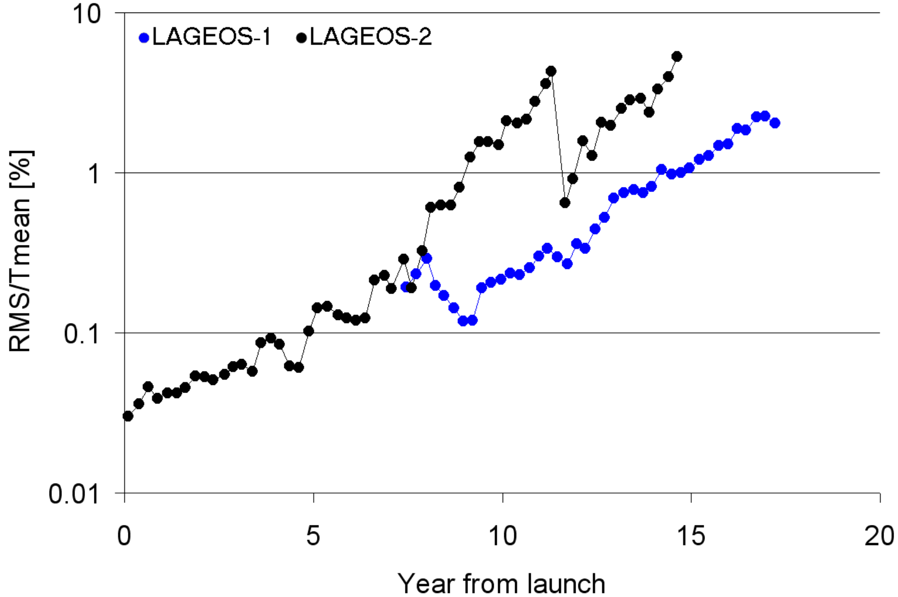
23rd Oct 1992 – 15th Aug 2007

>15k spin period values

LAGEOS spin

- Accuracy

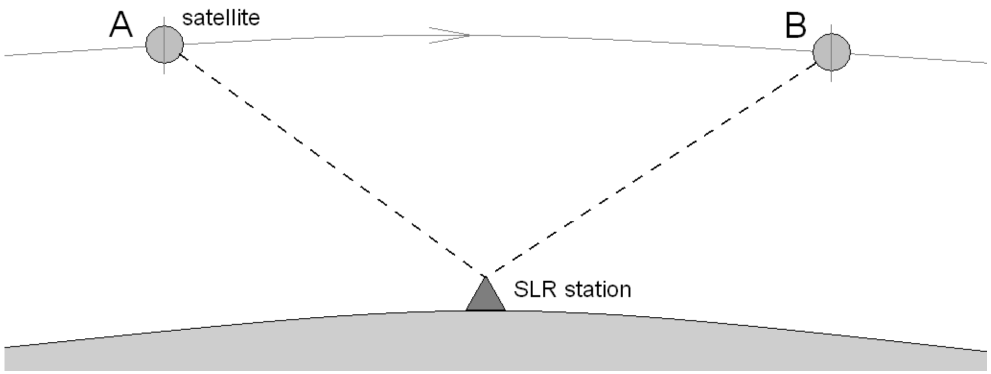




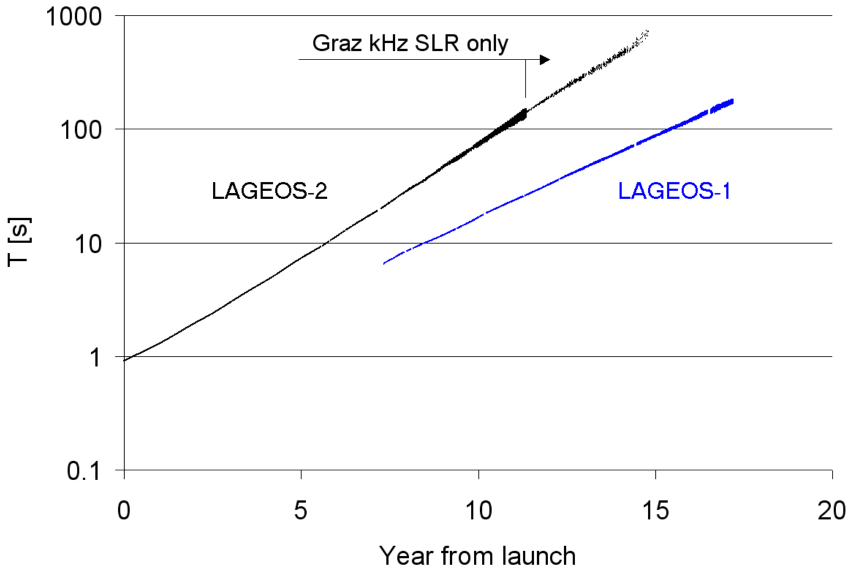
- Decreasing of accuracy is caused mainly by increasing of spin period
- Longer spin period = less revolutions per pass = weeker frequency signal

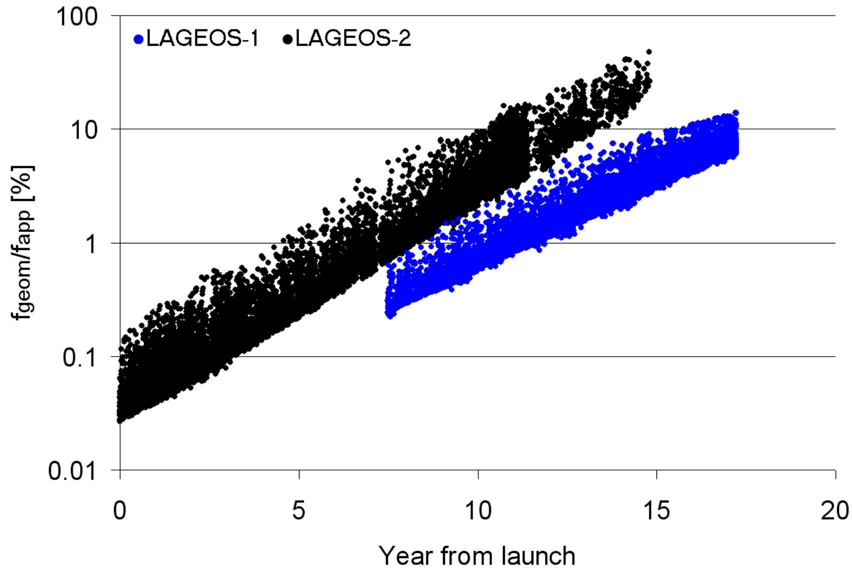
LAGEOS spin

- Apparent spin



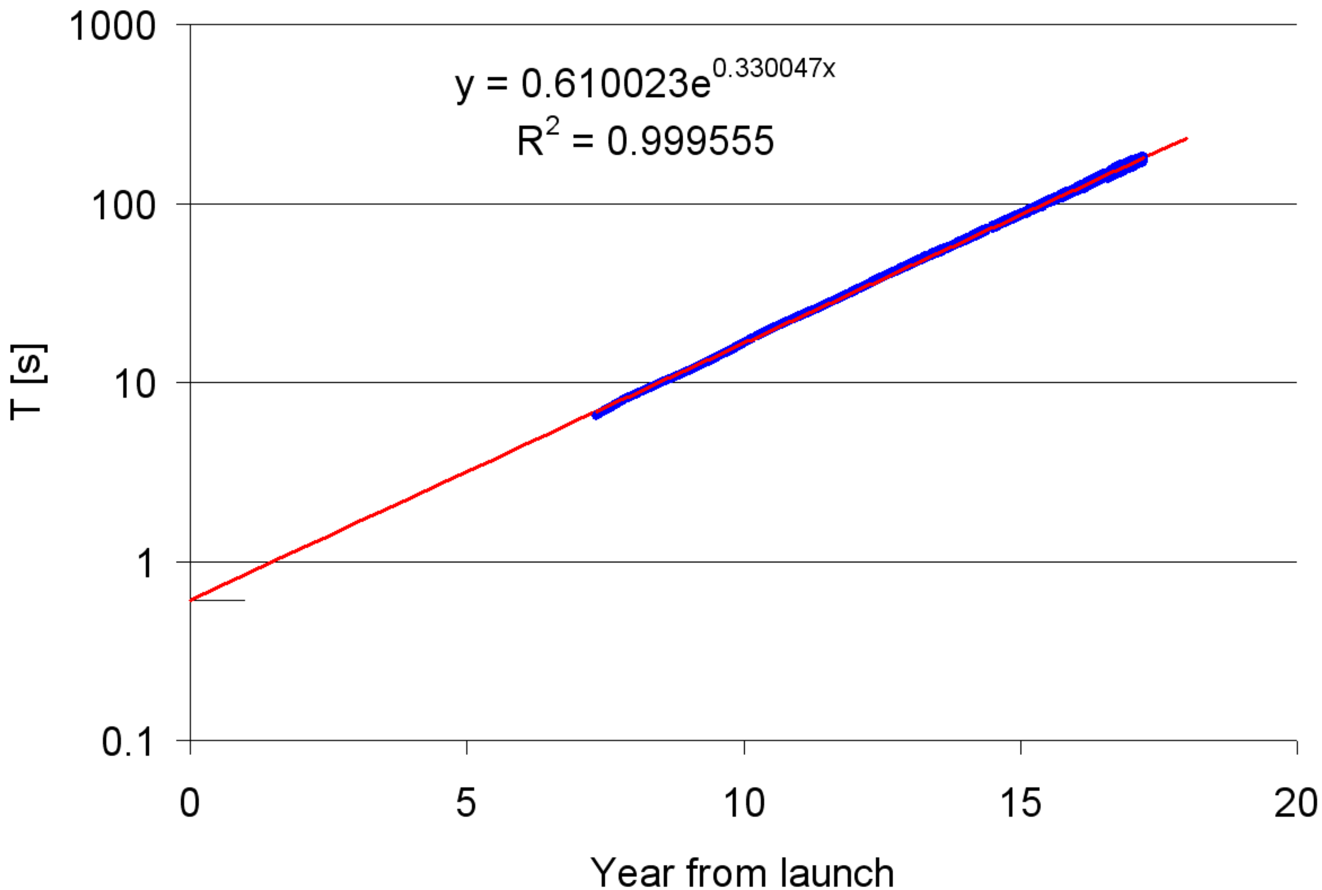
$$f_{app} = f_{inertial} + f_{geom}$$





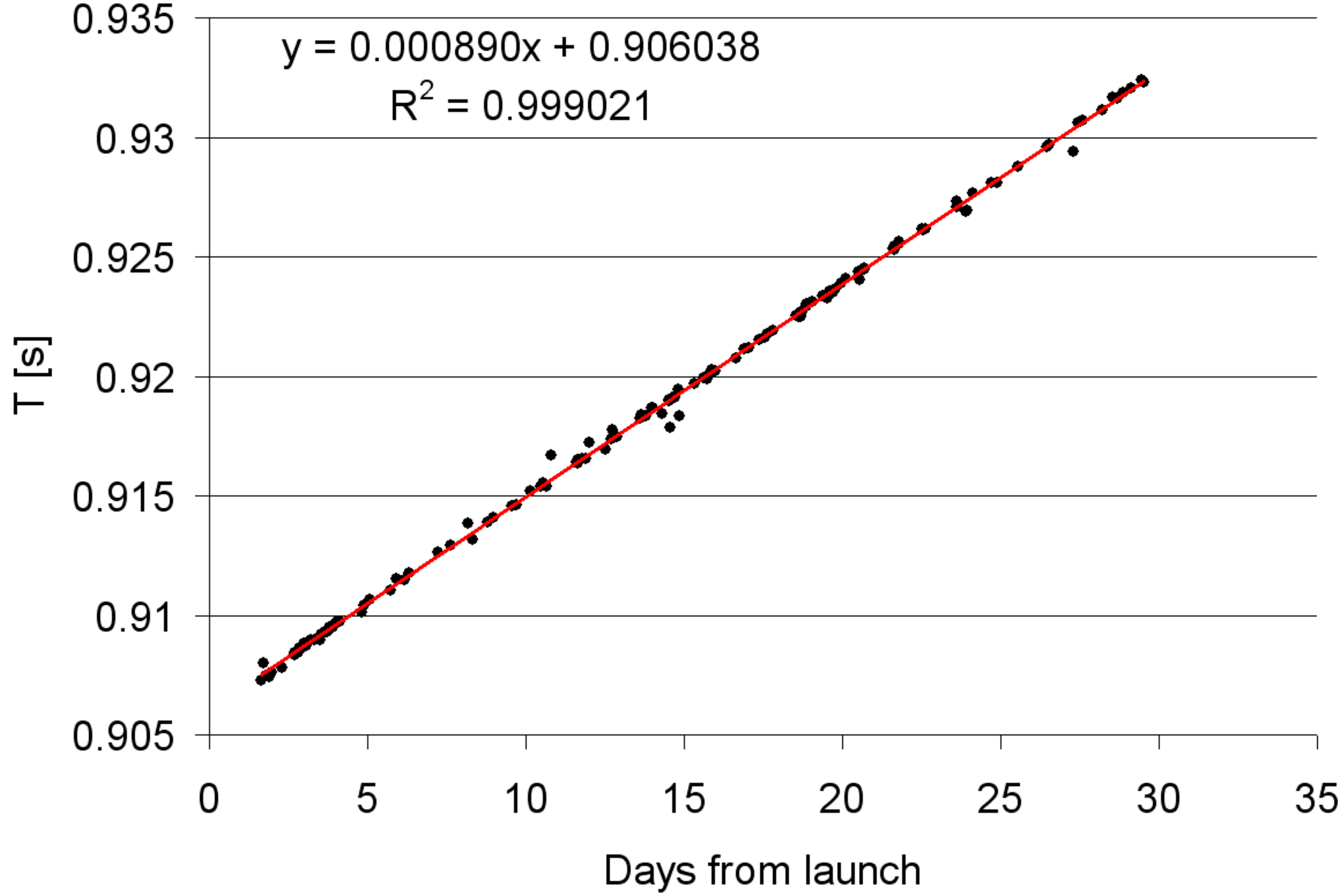
LAGEOS spin – data processing

- Initial spin period determination
- LAGEOS-1, exponential trend function, $T_{0L1}=0.61$ s



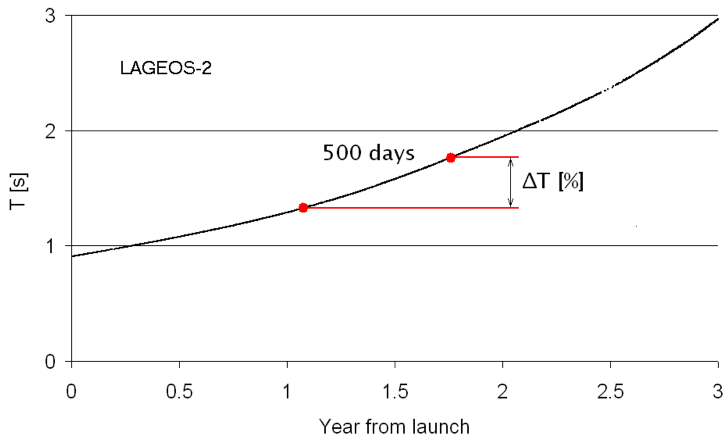
LAGEOS spin – data processing

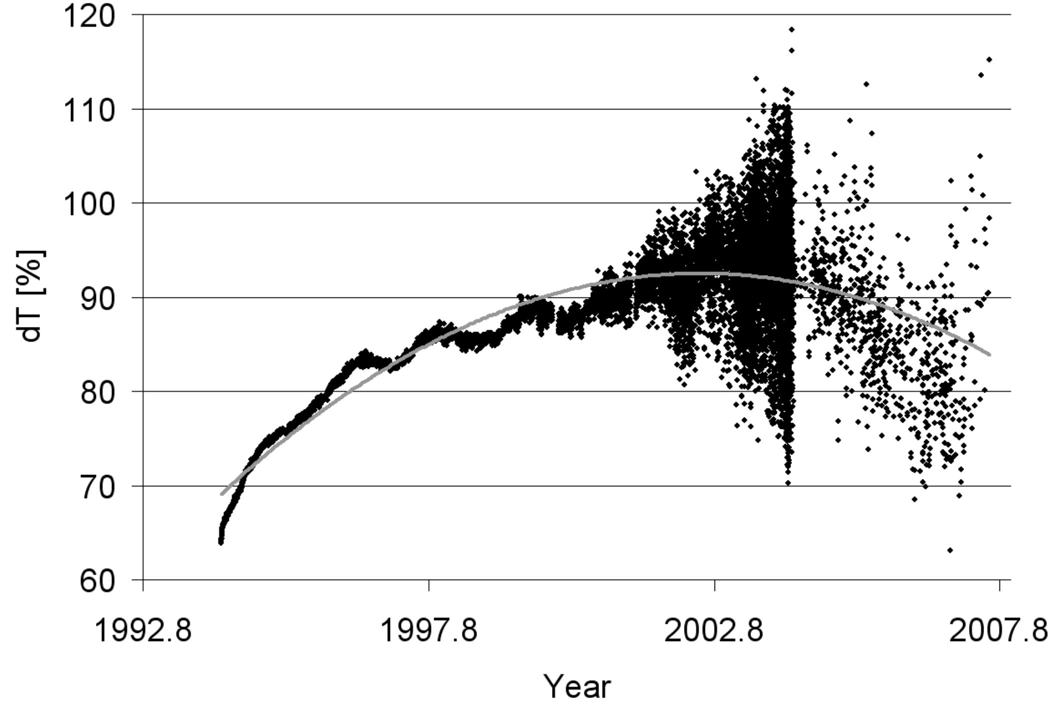
- Initial spin period determination
- LAGEOS-2, 137 spin points approximated by linear function (RMS=0.228 ms), T_{0L2}=0.906 s



LAGEOS spin – data processing

- Is the spin period increasing with a constant rate?

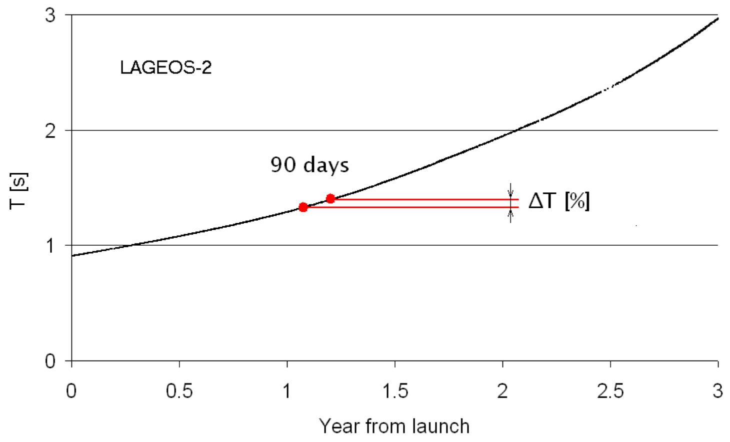


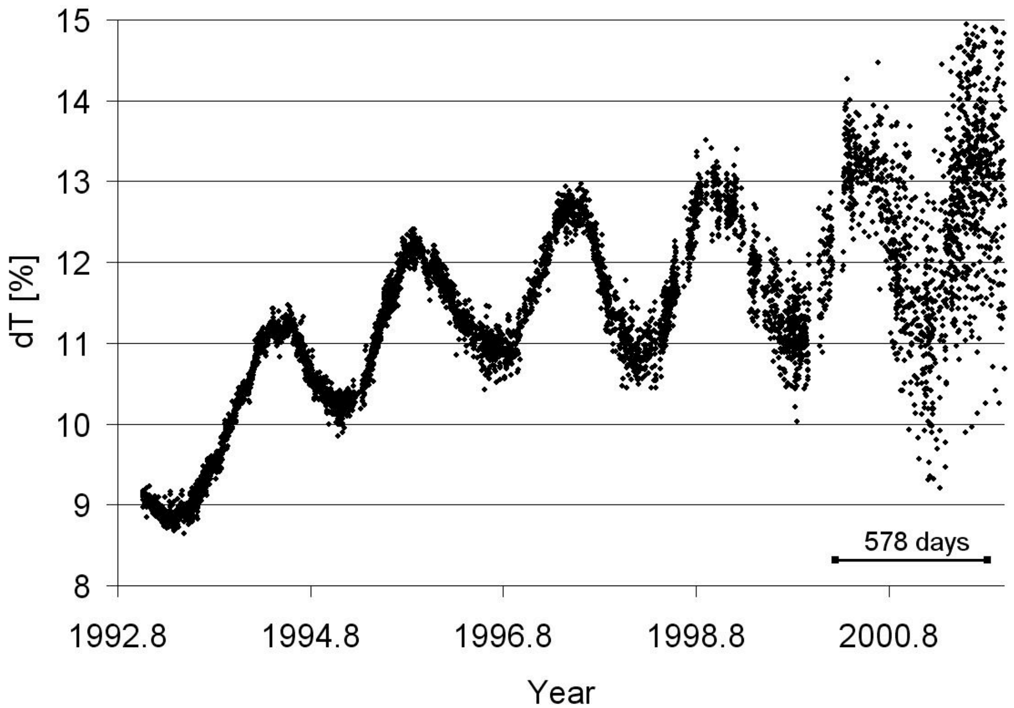


- L2 spin period changes: percent of change between points separated by 500 days

LAGEOS spin – data processing

- Long term oscillation of the rate of spin period change

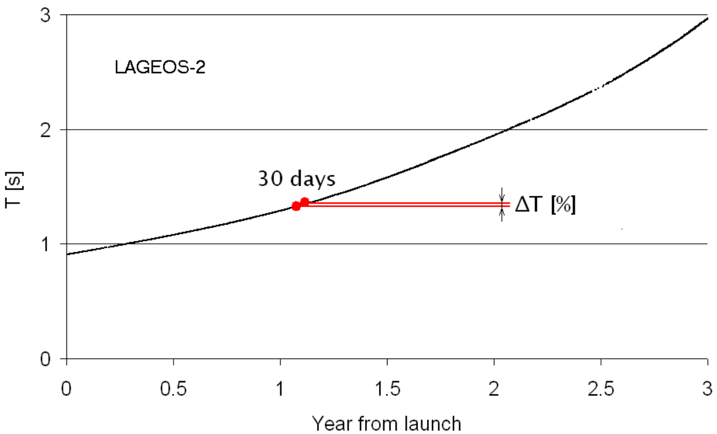


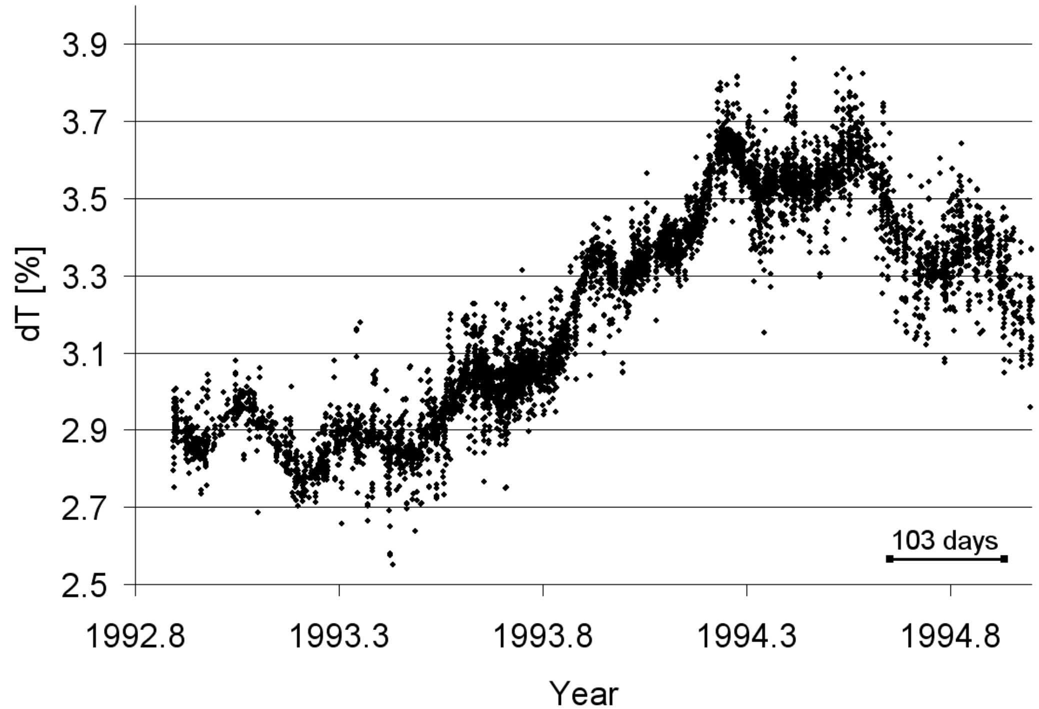


- L2 spin period changes: percent of change between points separated by 90 days
- long term oscillation period: $T_{L2-Long}$=578 days

LAGEOS spin – data processing

- Short term oscillation of the rate of spin period change

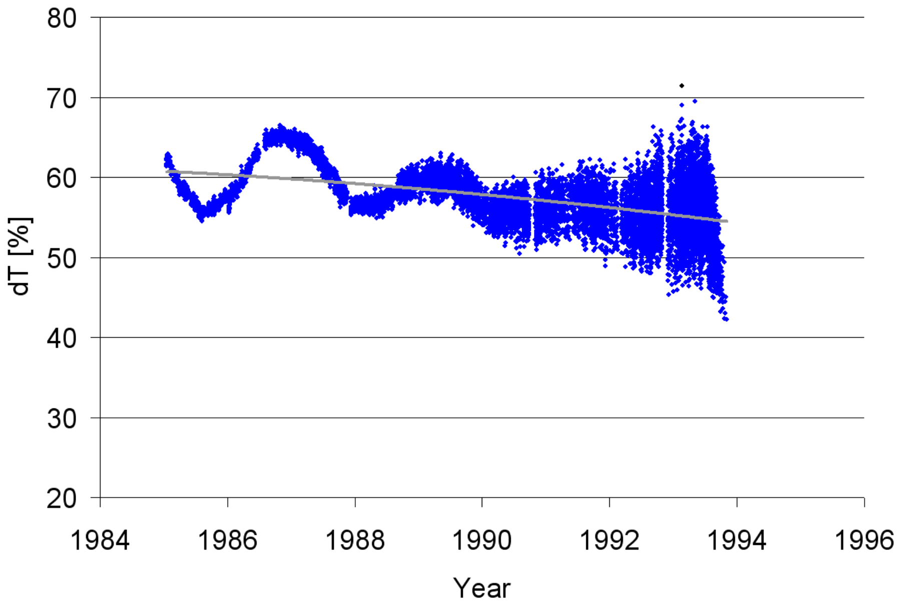


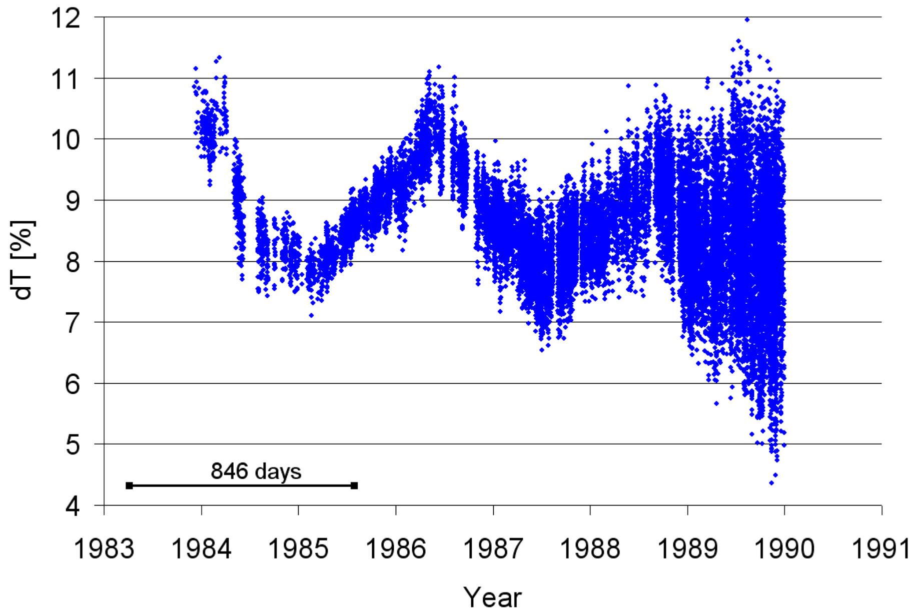


- L2 spin period changes: percent of change between points separated by 30 days
- short term oscillation period: $T_{L2\text{-}Short}$=103 days

LAGEOS spin – data processing

- Long term oscillation of the rate of spin period change

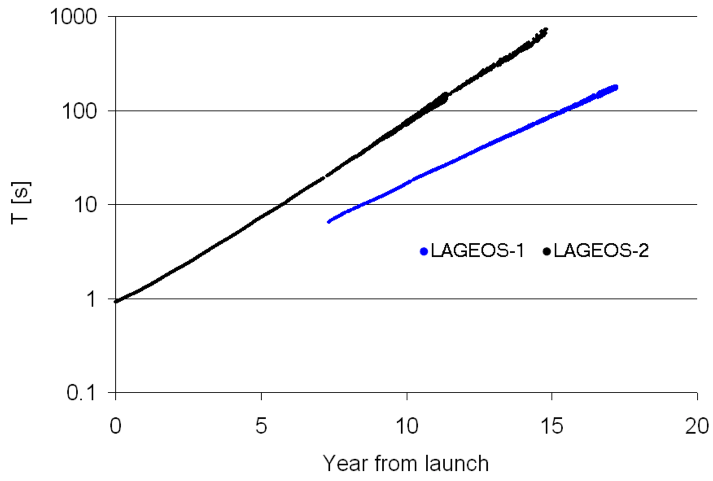


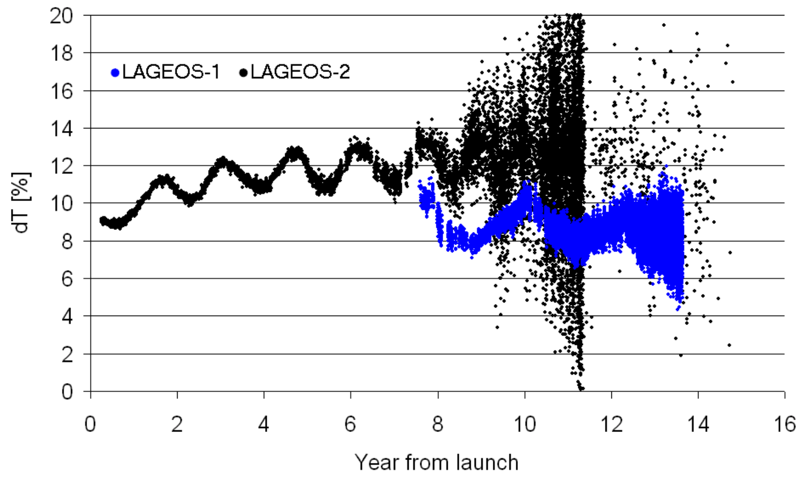


- L1 spin period changes: percent of change between points separated by 500 days (left) and 90 days (right)
- long term oscillation period: $T_{L1-Long}$=846 days

LAGEOS spin – data processing

- Comparison between L1 and L2





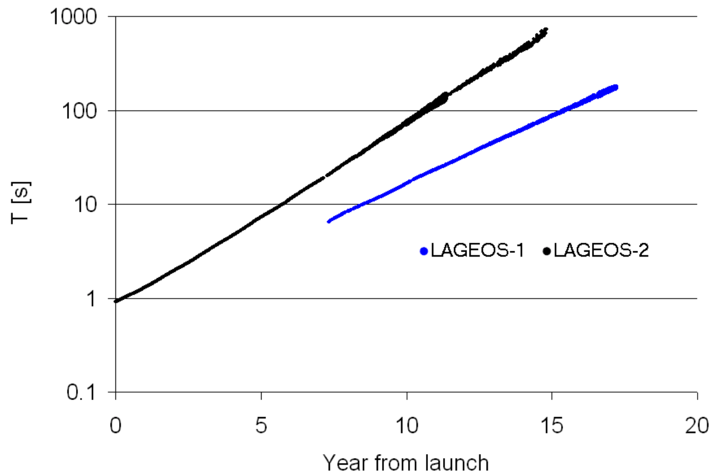
$T_{0L1}=0.61\text{s}$ $T_{0L2}=0.906\text{s}$ $T_{L1-Long}=846$ days $T_{L2-Long}=578$ days

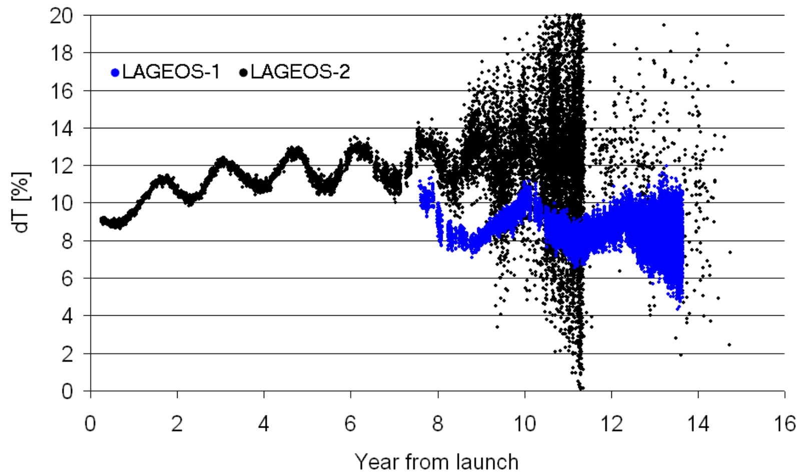
$T_{0L2}/T_{0L1}=1.485$ $T_{L1-Long}/T_{L2-Long}=1.464$

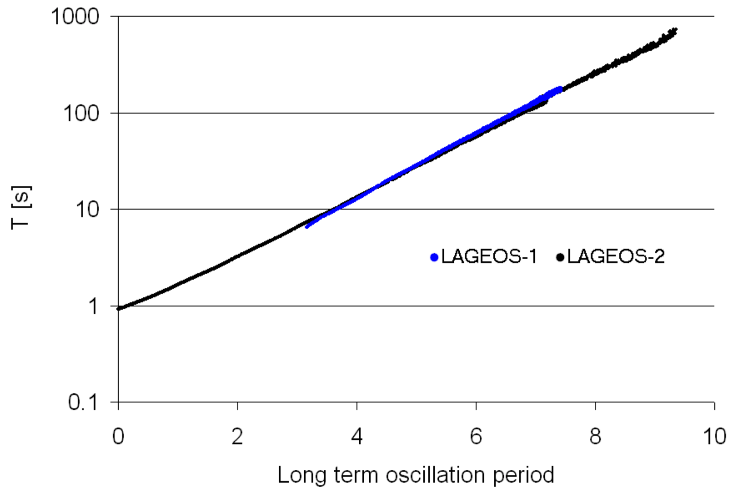
$$T_{0L1}\,T_{L1-Long}=T_{0L2}\,T_{L2-Long}$$

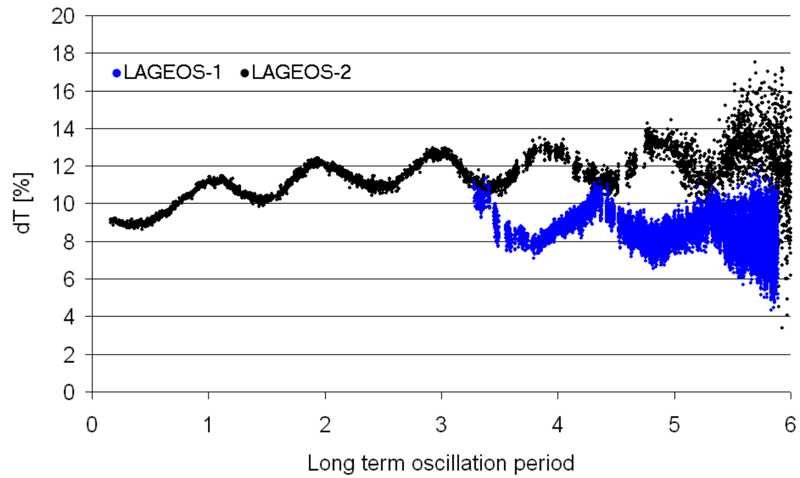
LAGEOS spin – data processing

- Comparison between L1 and L2







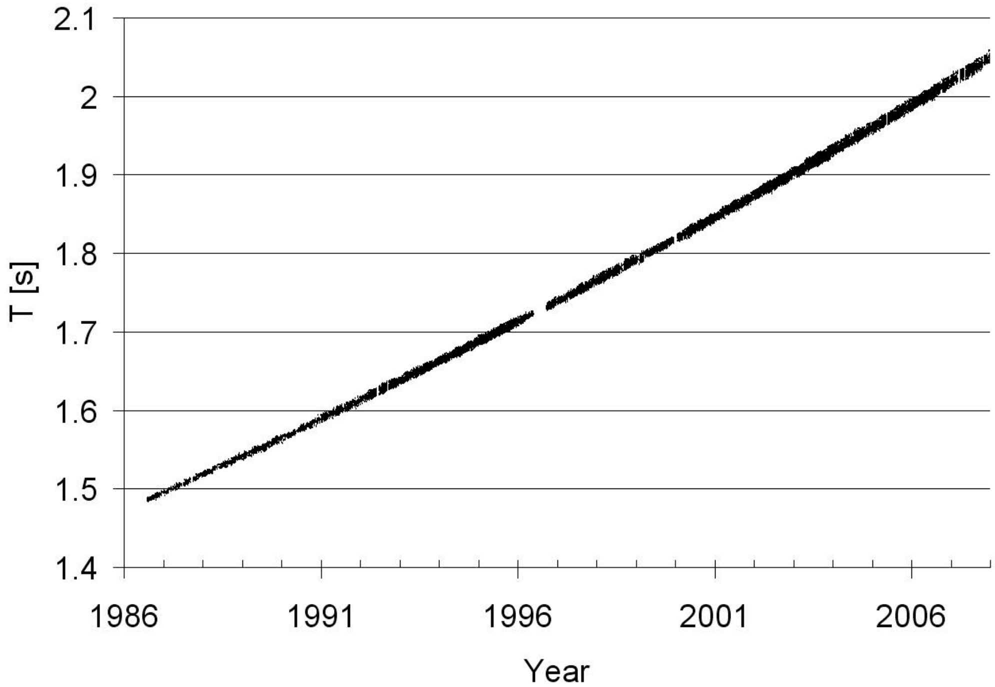


LAGEOS spin – Conclusions

- SLR is a perfect (very efficient) tool for sat-spin determination
- HRR systems allow to calculate T with an order of magnitude better accuracy than 10Hz systems,
  AND allow to extend max investigated T from 150s to 700s
- All the results presented here are in very good agreement with LOSSAM
- T of L1 and L2 is not increasing with a constant rate, but is oscillating with a period depending on initial spin rate of the body.
- The oscillations are caused by Earth's gravitational field which is changing spin axis orientation of the satellites. This affects the rate of spin period changes of the spacecrafts.
- The evolution of T contains information about forces which are causing perturbation of the orbits. Now for the first time accurate determination of long series of spin period values can be used to upgrade models of all those forces.

The next target

AJISAI – 22 years of data! – from launch till now



Thank you