KASI 한국천문연구원
Korea Astronomy & Space Science Institute

Spin of Ajisai: influence of Solar Irradiation on the spin period and precession of the spin axis measured by the Graz 2kHz SLR system

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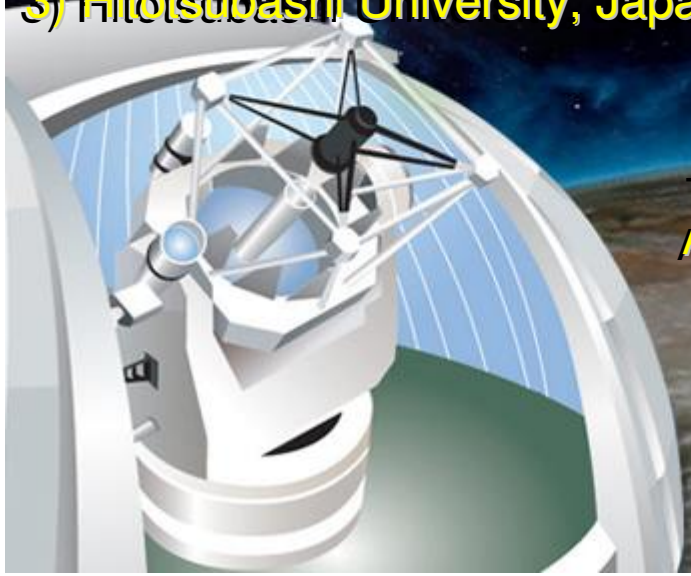
2) Space Research Institute, Austrian Academy of Sciences, Austria
3) Hitotsubashi University, Japan



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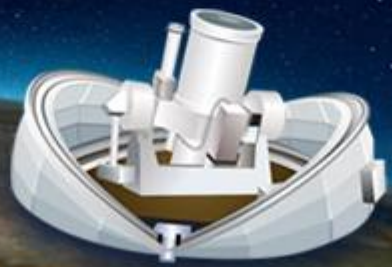
Austrian Academy of Sciences
Hitotsubashi University



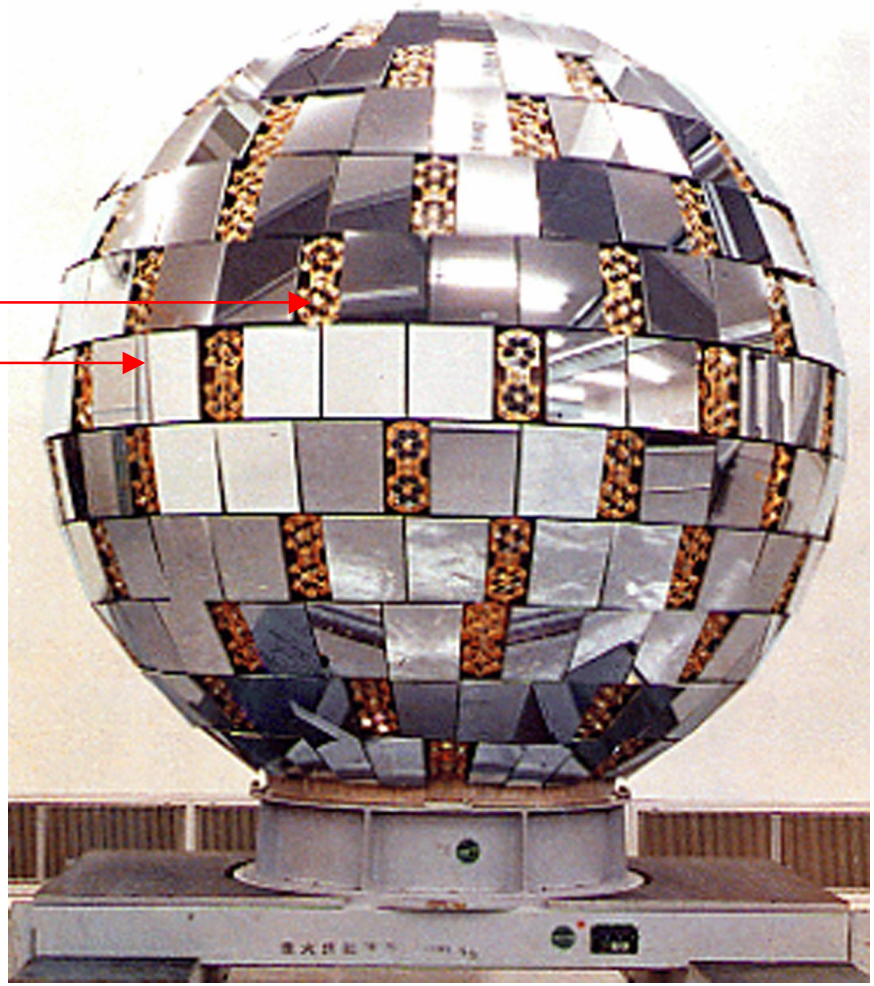
Accurate Ranging system for Geodetic Observation

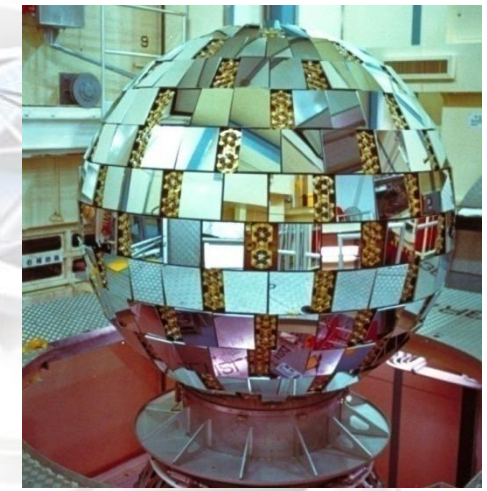
KASI KIMM KAERI SaTReC

Ajisai

Experimental Geodetic Satellite: Ajisai

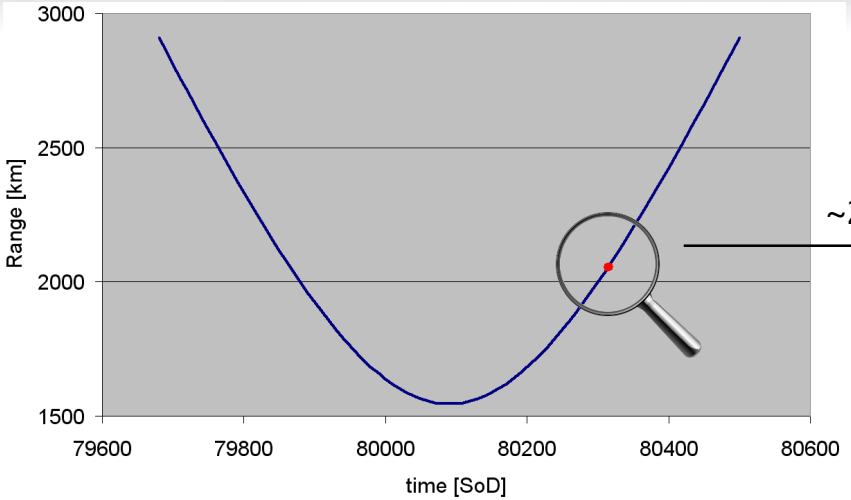
launch date: August 12, 1986, NASDA (JAXA)
quasi-circular orbit 1490 km, inclination 50º
diameter 2.15 m
120 panels of corner cube reflectors
318 mirrors
Mirrors can be used for photometric measurements of the spin parameters





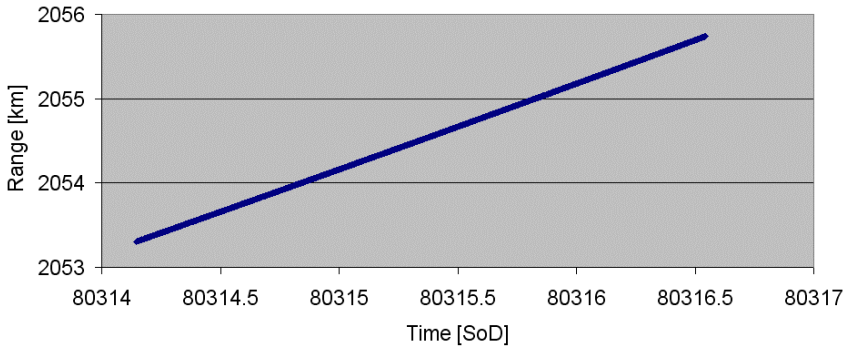
Ajisai – spin period determination

A



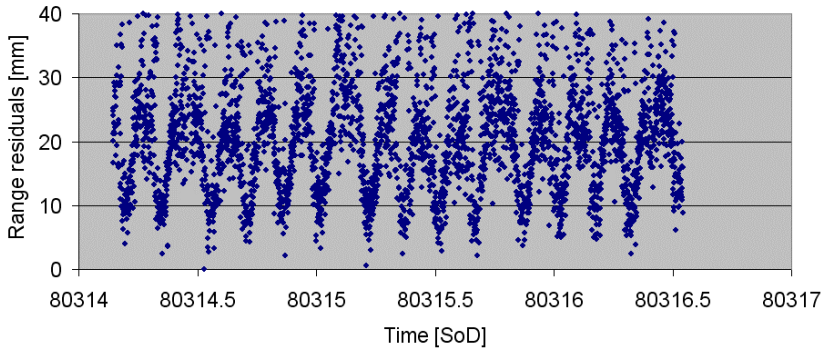
Closer look at the range measurements

B



Calculate range residuals

C

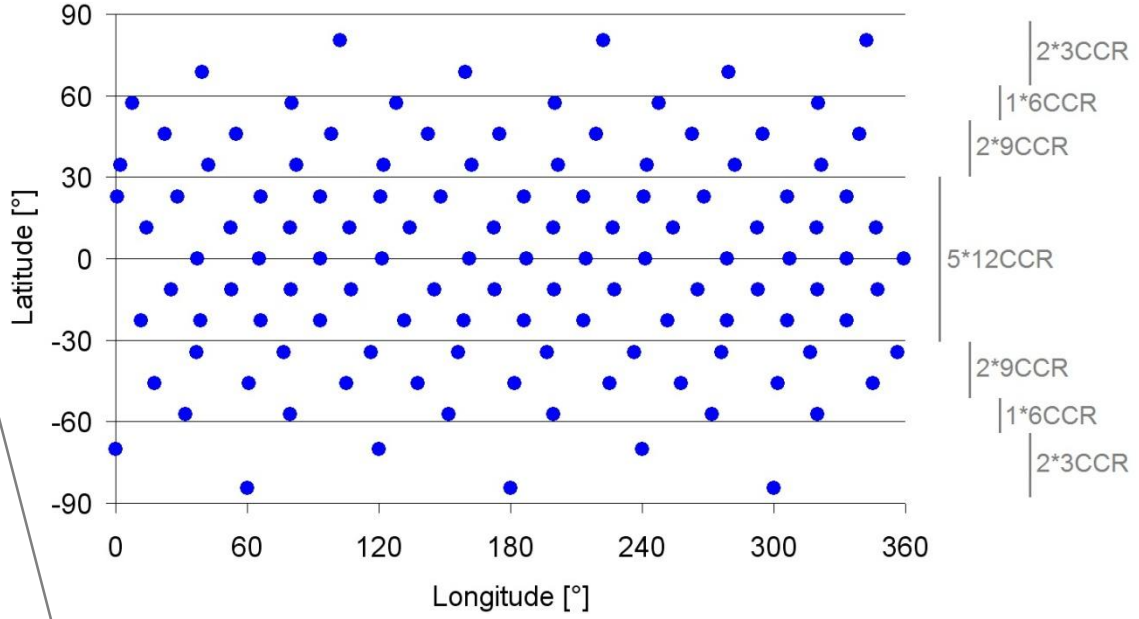


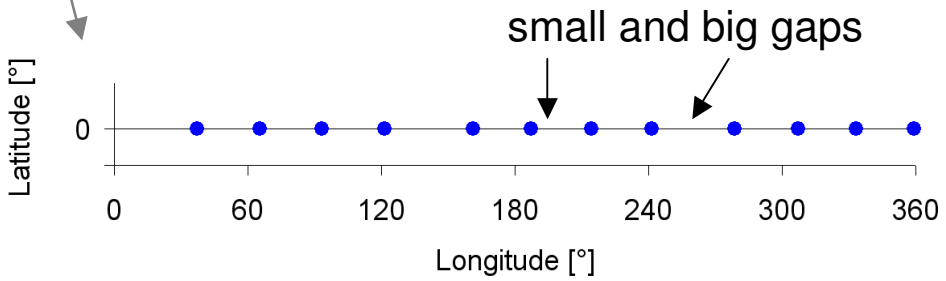
Ajisai – spin period determination

Retroreflector Array

120 CCR panels
15 rings with different number of CCRs

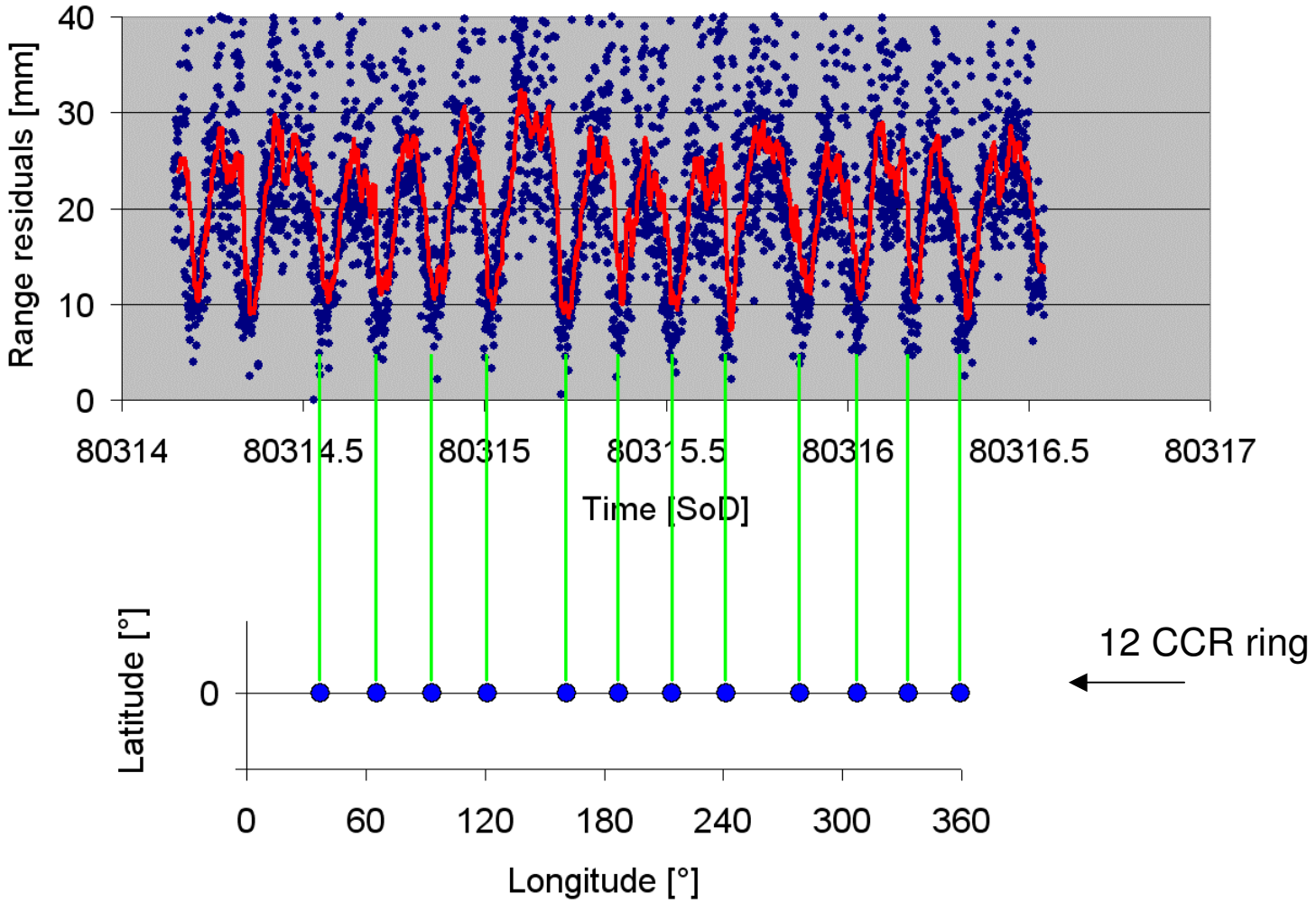
120º symmetry, 15 rings





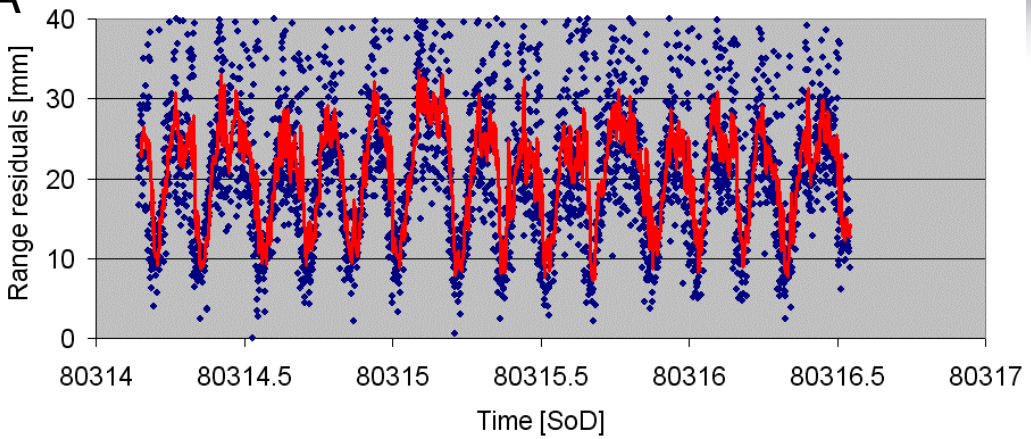
Ajisai – spin period determination

Accurate range measurements to the single CCRs



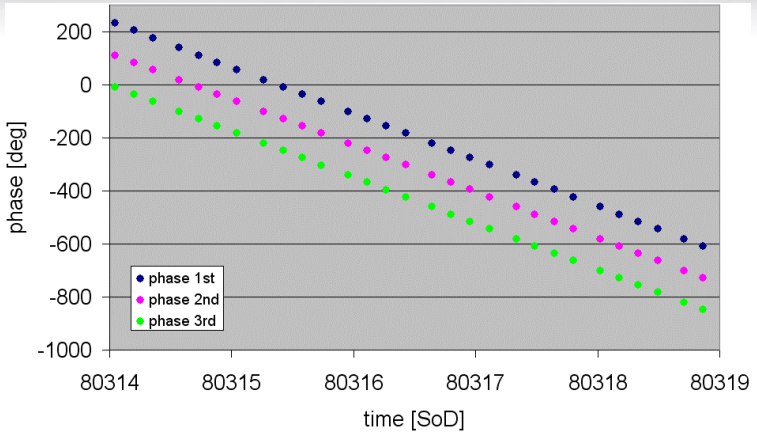
Ajisai – spin period determination

A



Calculating phase φ for epochs of the observed peaks.

B



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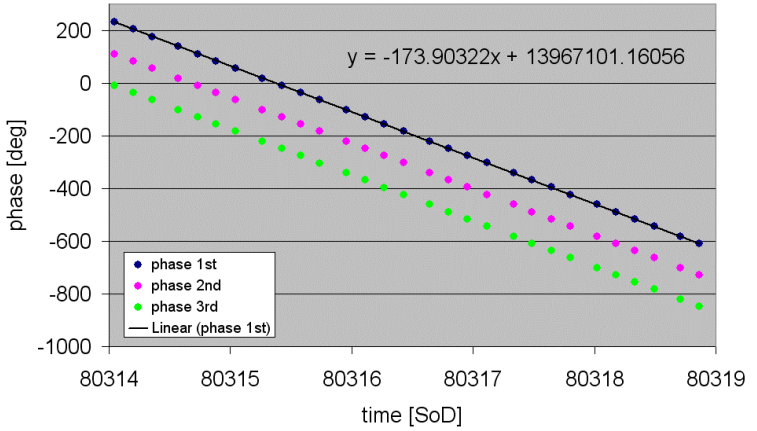
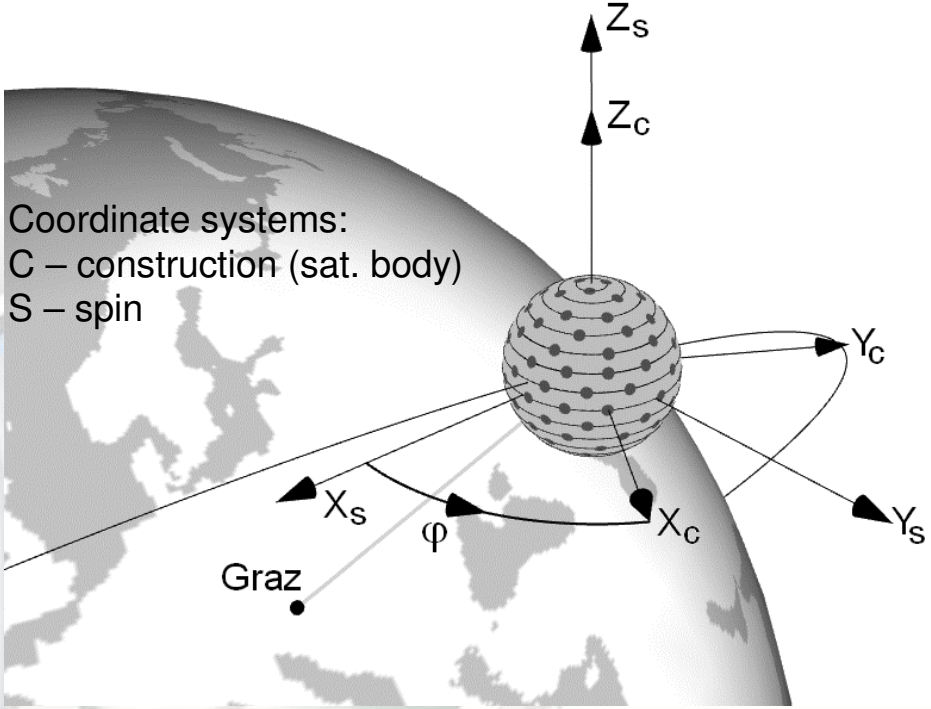




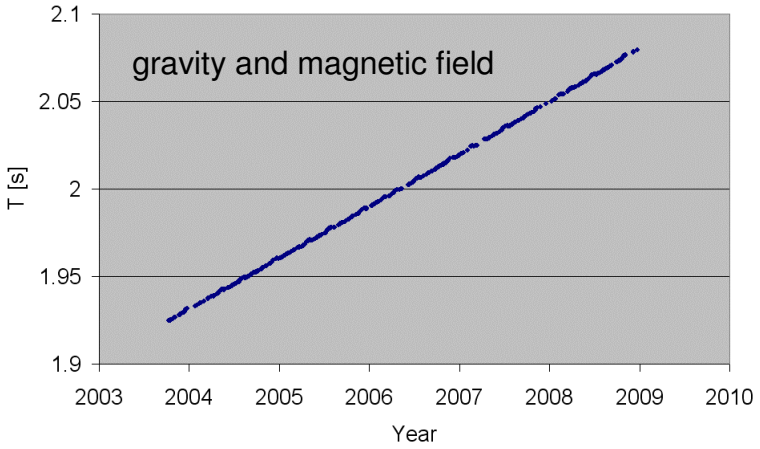
Coordinate systems:
C – construction (sat. body)
S – spin

y=ax+b
Slope of the line: a[º/s] → T [s]
RMS = 1.2 º

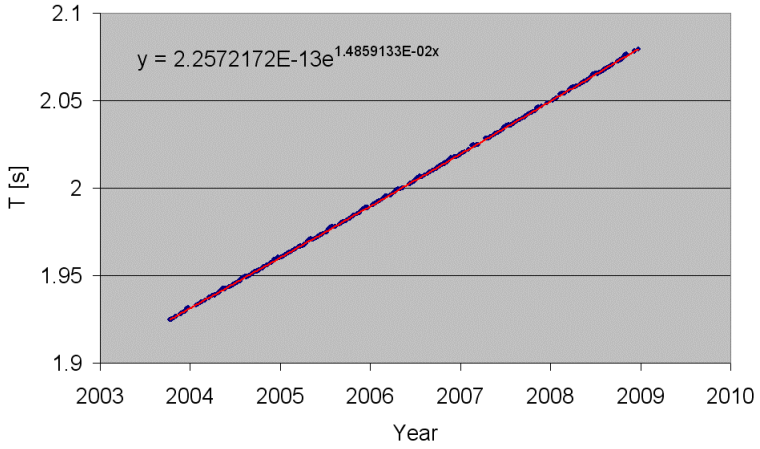
Ajisai – spin period determination

Results: 877 kHz SLR passes
more than 5 years of observation with Graz 2 kHz system

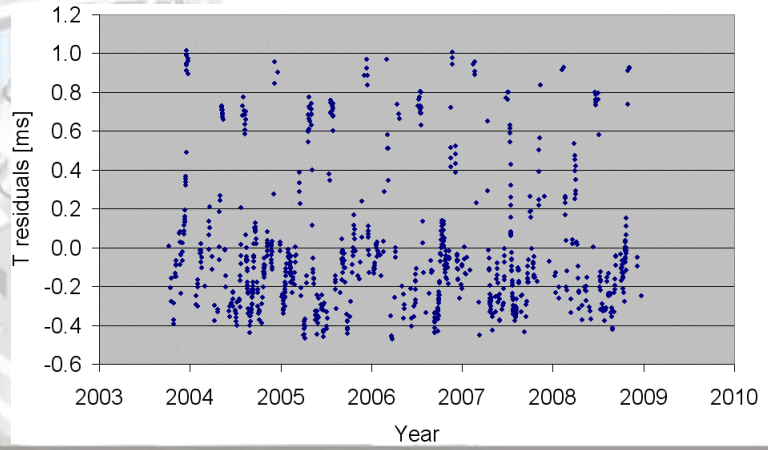
1. Spin period – increasing with time



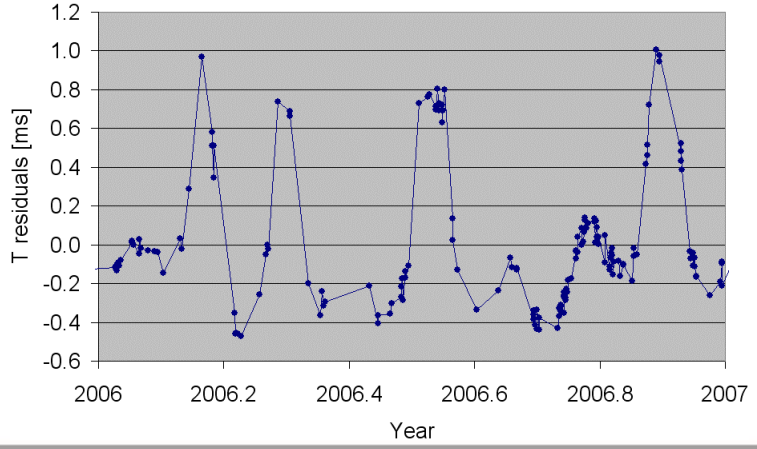
2. An exponential approximation



3. Spin period residuals – just a scatter?

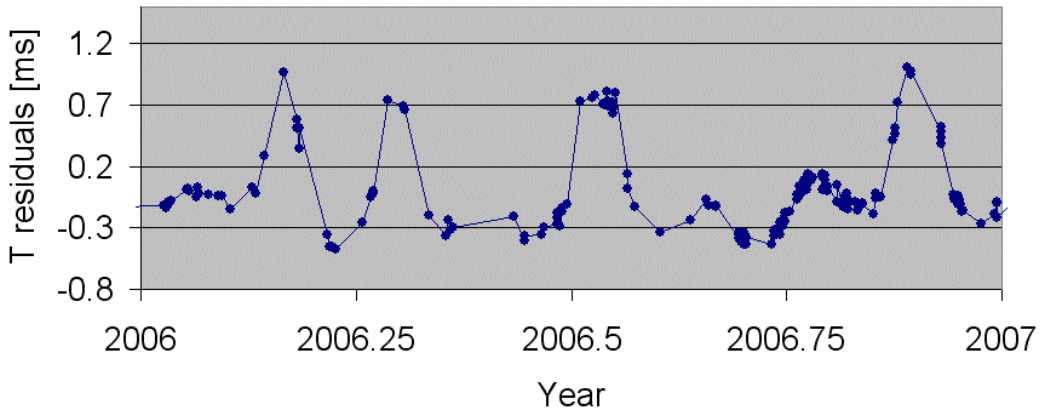


4. Spin period residuals – year 2006

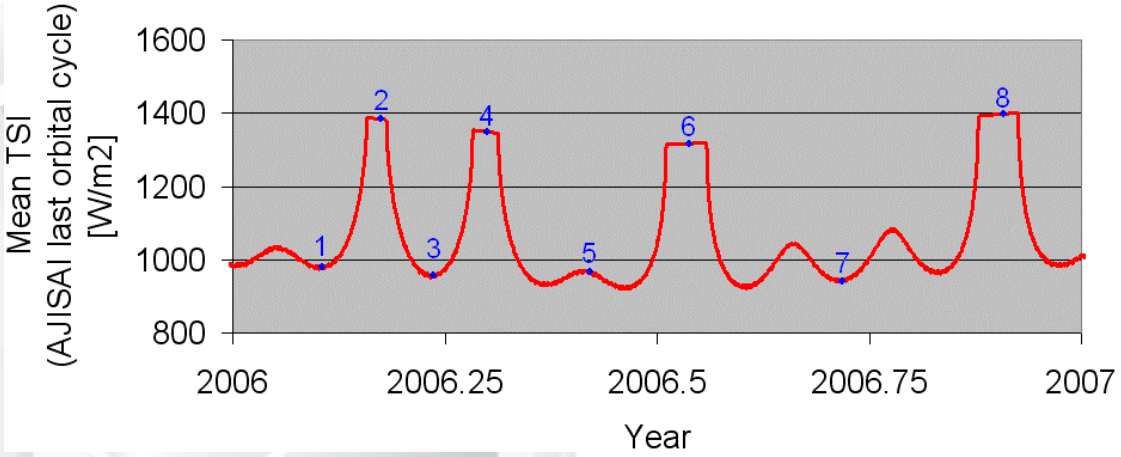


Ajisai – spin period determination

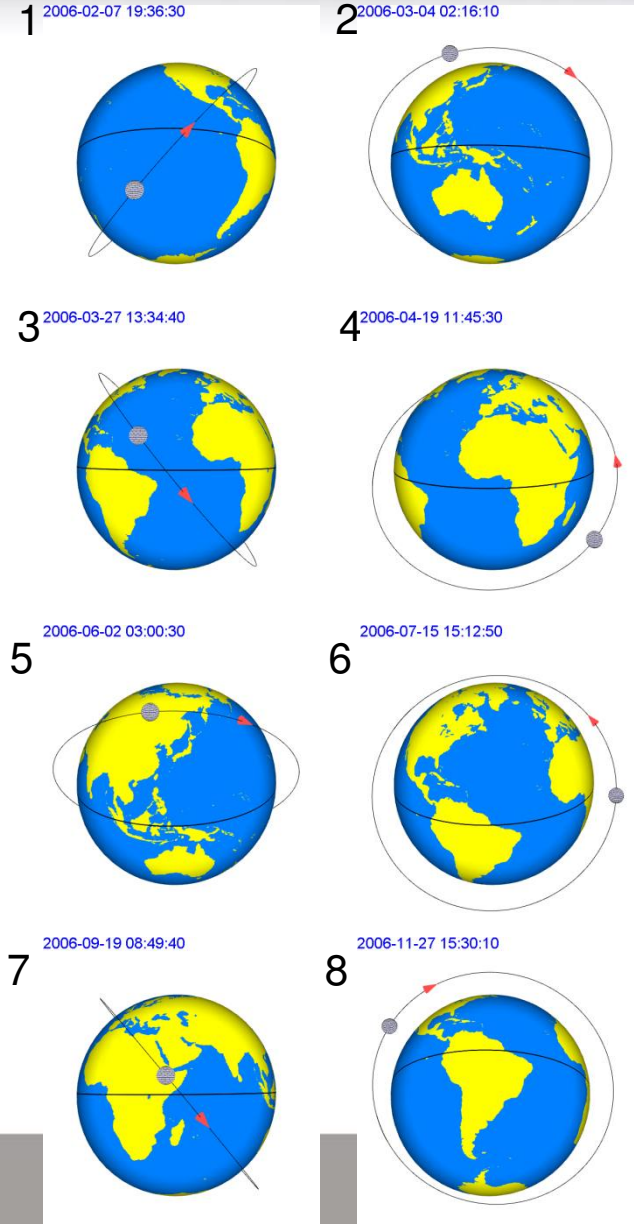
Spin period residuals – year 2006



Mean Total Solar Irradiance acting on Ajisai during last orbital cycle

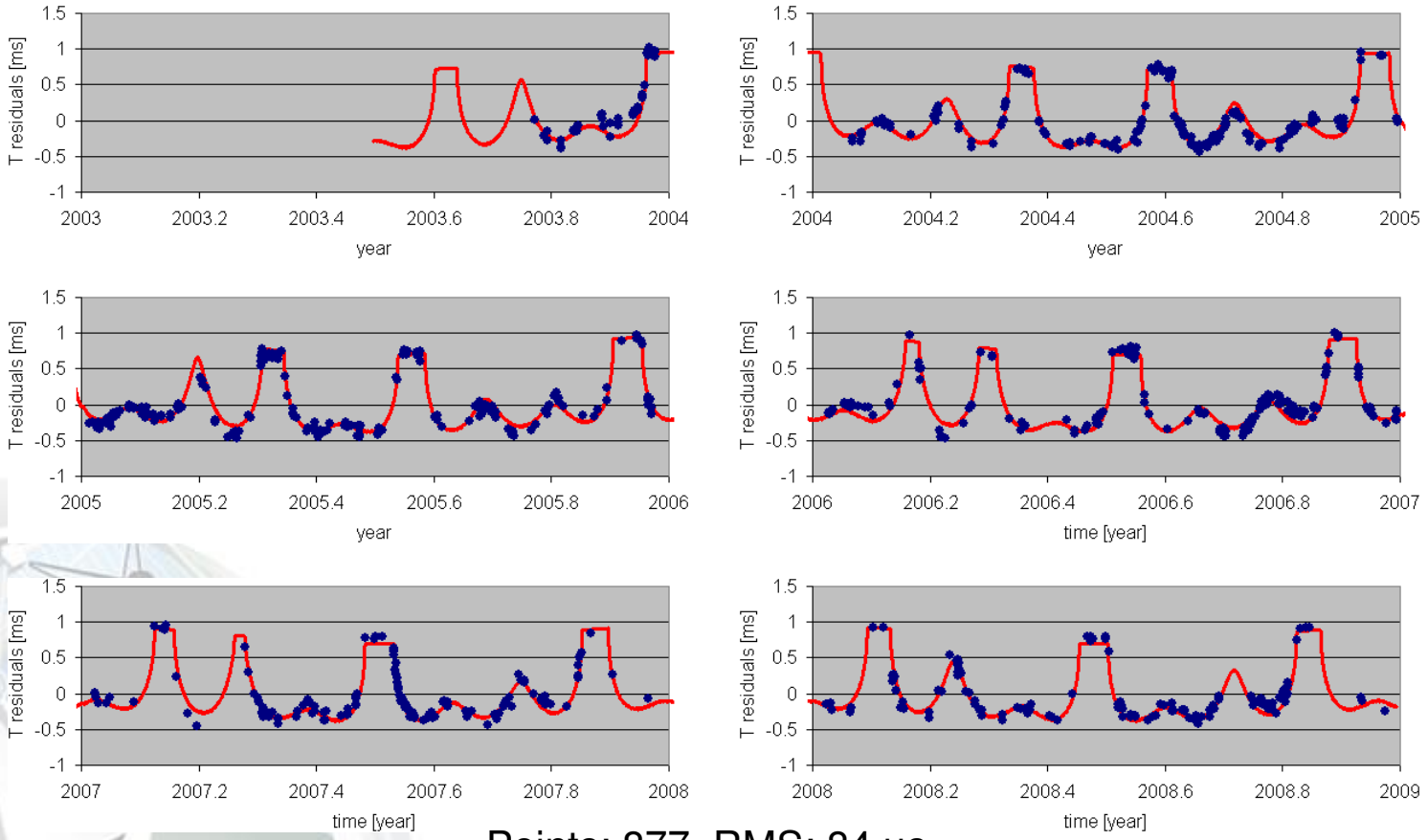


view from the Sun direction



Ajisai – spin period determination

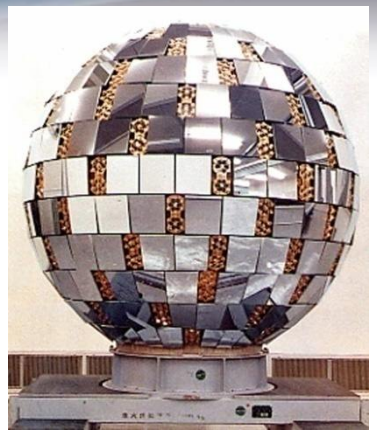
Model of the spin period residuals compared with measurements
Mean TSI acting on Ajisai during last orbital cycle agrees with trend of T residuals

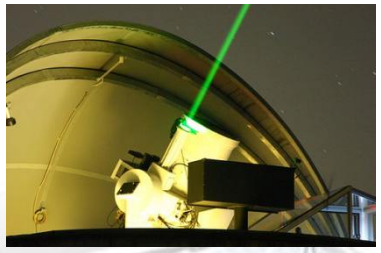


Points: 877, RMS: 84 µs

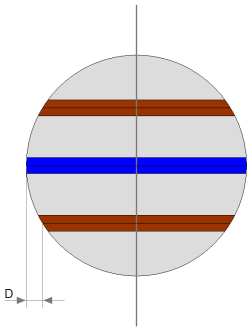
Kucharski, D., et. al. The impact of solar irradiance on Ajisai's spin period measured by the Graz 2 kHz SLR system. IEEE Trans. Geosci. Remote Sens., vol. 48, no. 3, pp. 1629-1633, doi:10.1109/TGRS.2009.2031229, March 2010.

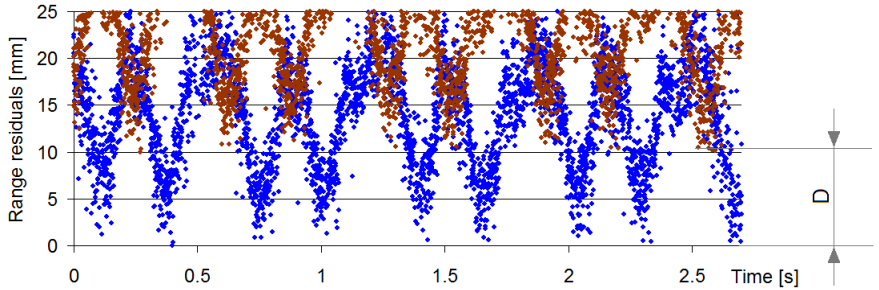
Ajisai – spin axis orientation





1





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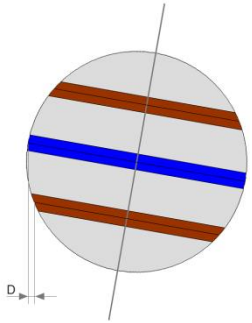

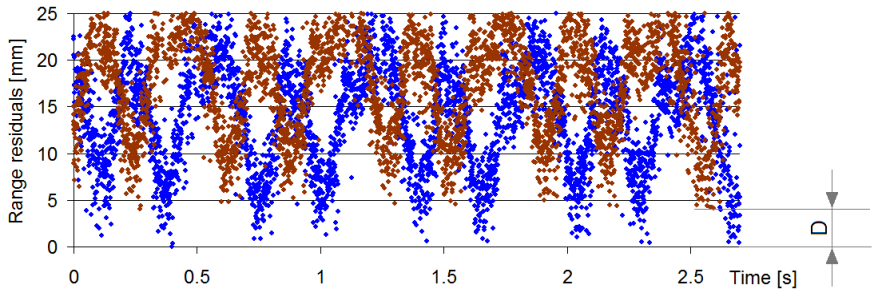

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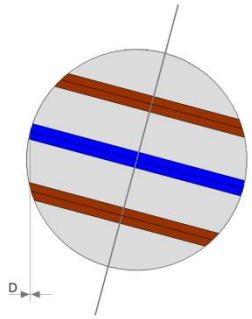
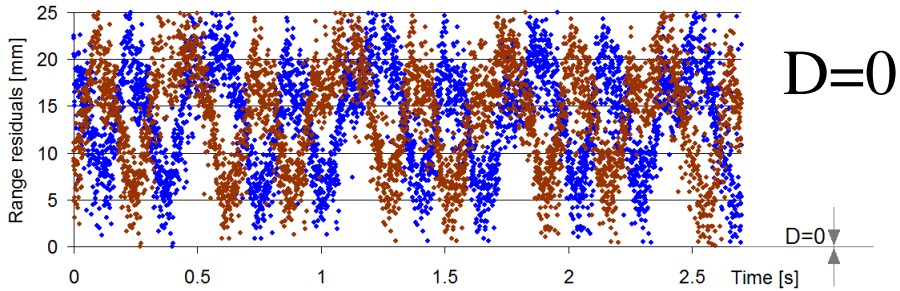
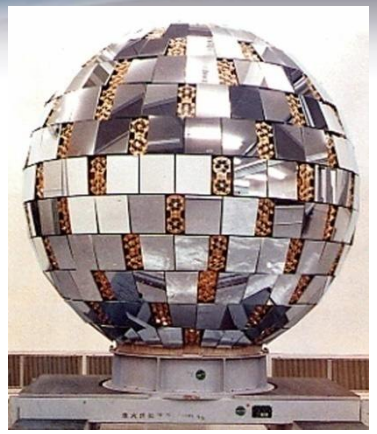
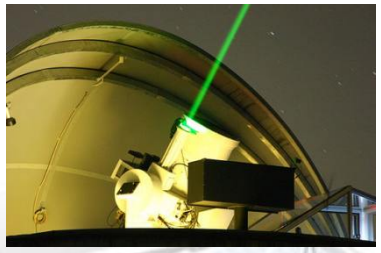




D=0

Ajisai – spin axis orientation



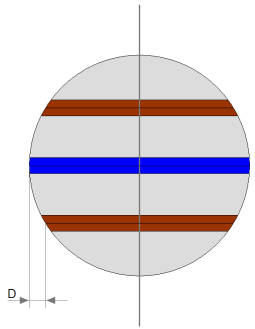


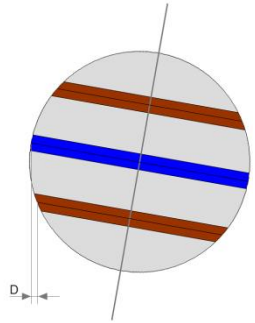
1

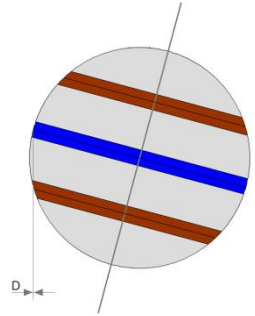
2

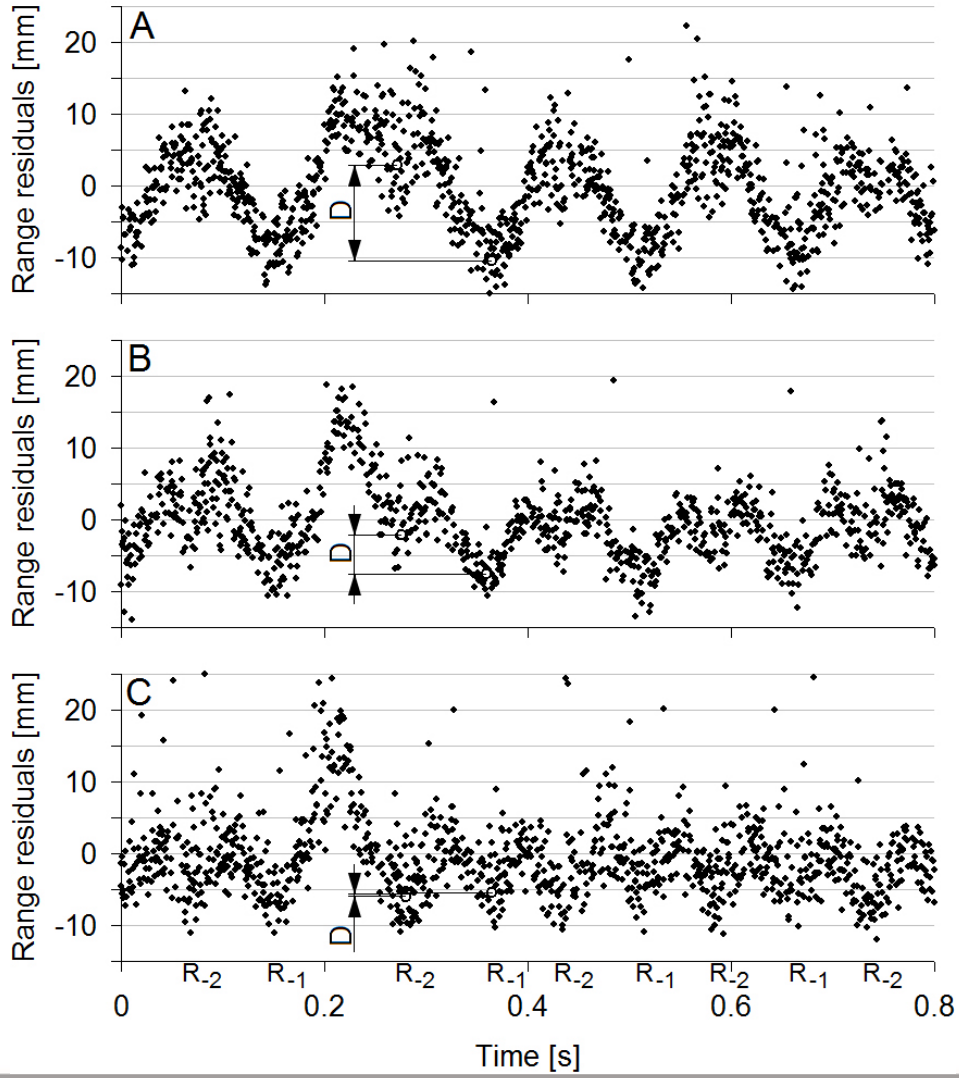
3

LASER PULSE



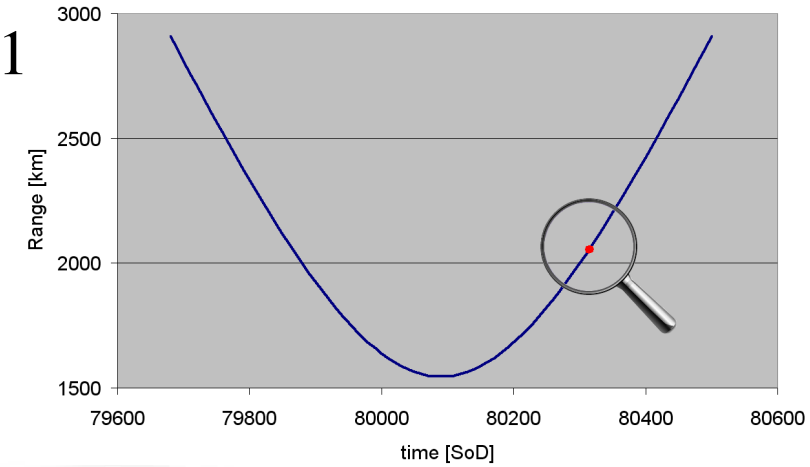




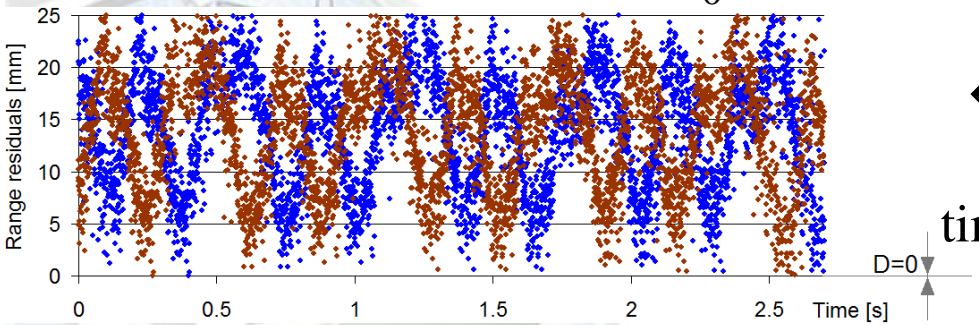


Identifying the epoch time of D_0 allows to estimate possible spin axis orientations.

1



D_0



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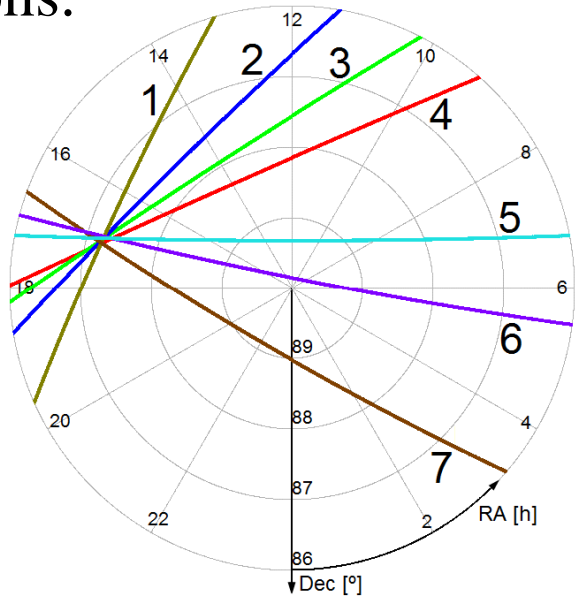
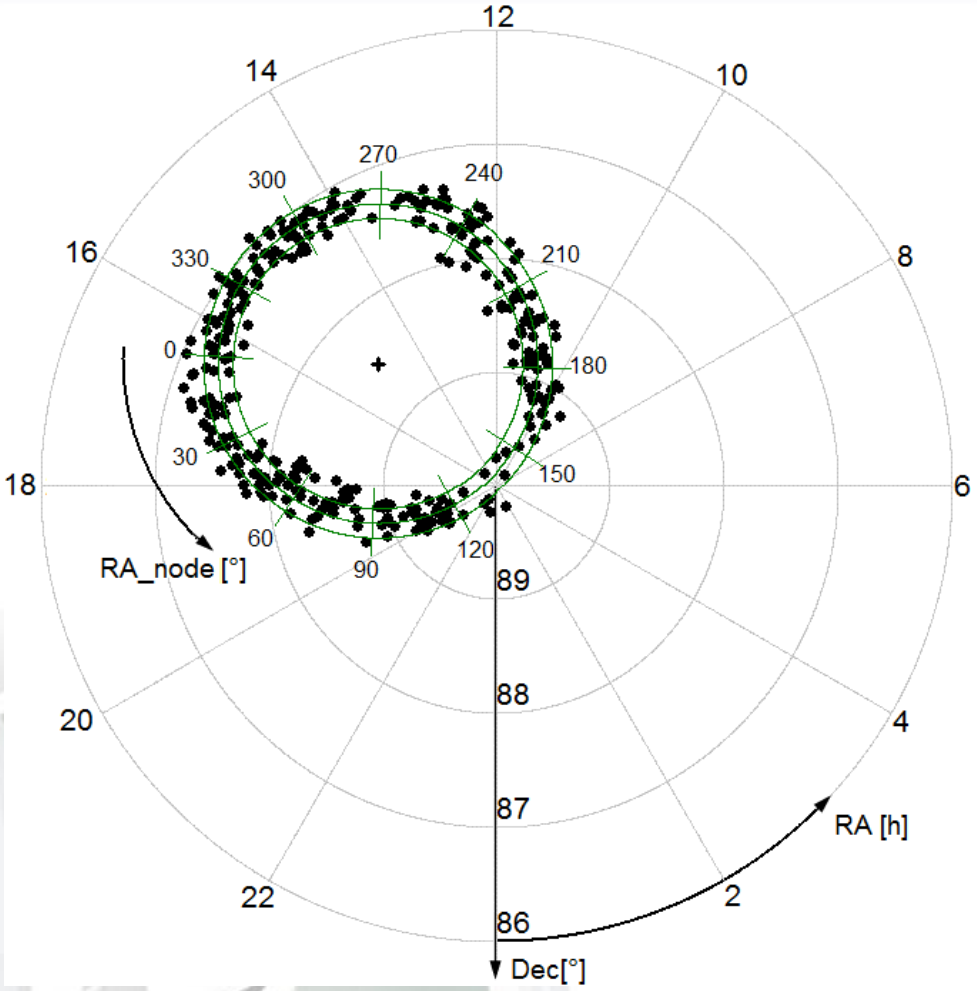


Possible spin axis orientations. Pass 21/July/2008.

← We know what is the latitude of Ajisai body we are pointing to at given epoch time. This information allows calculation of possible spin axis orientations.

Ajisai – spin axis orientation



Six years of 2 kHz SLR data
(October 2003 – October 2009)
delivered 331 orientation values

Cone center:
RA=14 h 56’ 48’’
Dec=88.51º
Cone aperture (full angle) = 2.811º
Period ~117 days
equal to the period of RA of ascending node change

Kucharski, D., et. al. Spin axis orientation of Ajisai determined from Graz 2 kHz SLR data. Adv. Space Res., vol. 46, no. 3, pp. 251-256, doi:10.1016/j.asr.2010.03.029, 3 August 2010.

Conclusions

spin of fully passive satellites gives unique information about tiny forces and torques which perturb orbital motion of the artificial satellites (possible improvement of POD)

kHz SLR is the most accurate technique able to measure spin axis orientation and spin period of fully passive satellite Ajisai during day and night.

knowledge about spin of Ajisai will allow performing next generation time transfer experiment: sending laser pulses between SLR stations via mirrors of Ajisai (TT with ps accuracy).

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Thank you!