Graz kHz SLR Station

Spin Parameters of GPB and AJISAI with kHz SLR data

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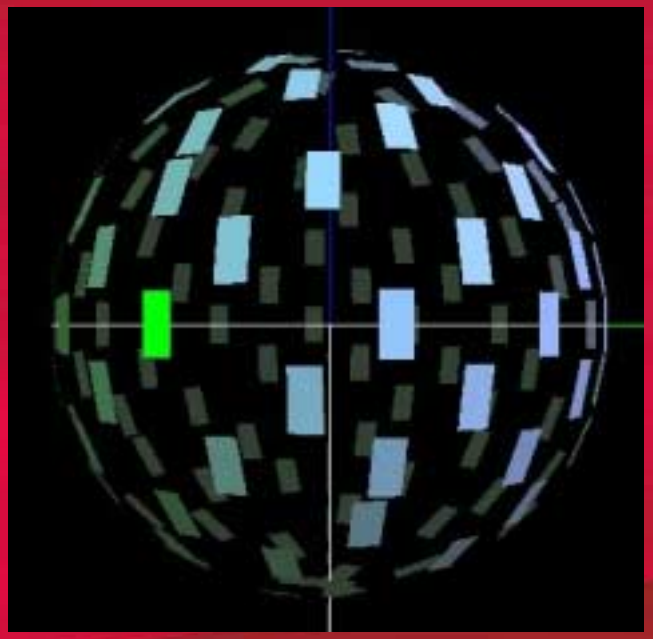
kHz SLR Operation in Graz

- Graz operates with 2 kHz since 3 years routinely;
- Laser: 400 µJ/shot, 10 ps; still running perfectly;
  - Original pump diodes: No degradation (after 10.000 h of operation)
- SS RMS: 2-3 mm (Champ, Grace …)
- Up to 100.000 points / NP (Lageos)

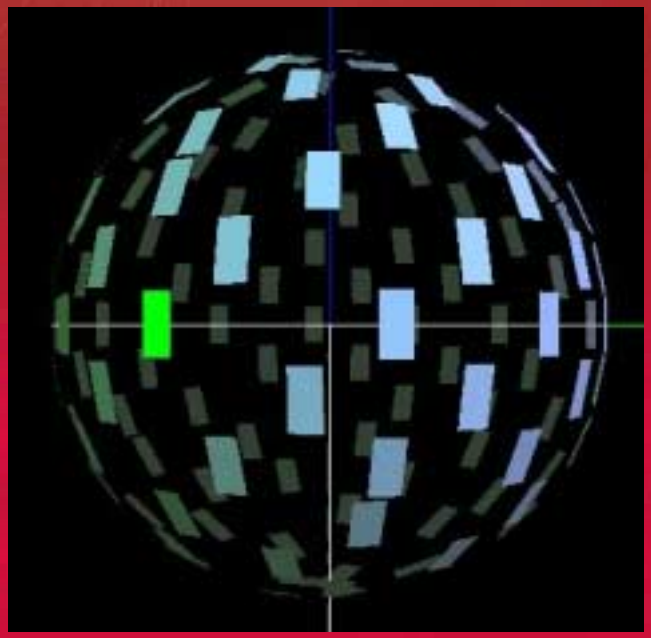
- Surprice: kHz SLR delivers additional results ☺
  - Detects Satellite Spin Parameters (AJISAI, GP-B, Lageos-1)
  - Measures Atmospheric Seeing along Laser Path
  - All FREE of CHARGE ….

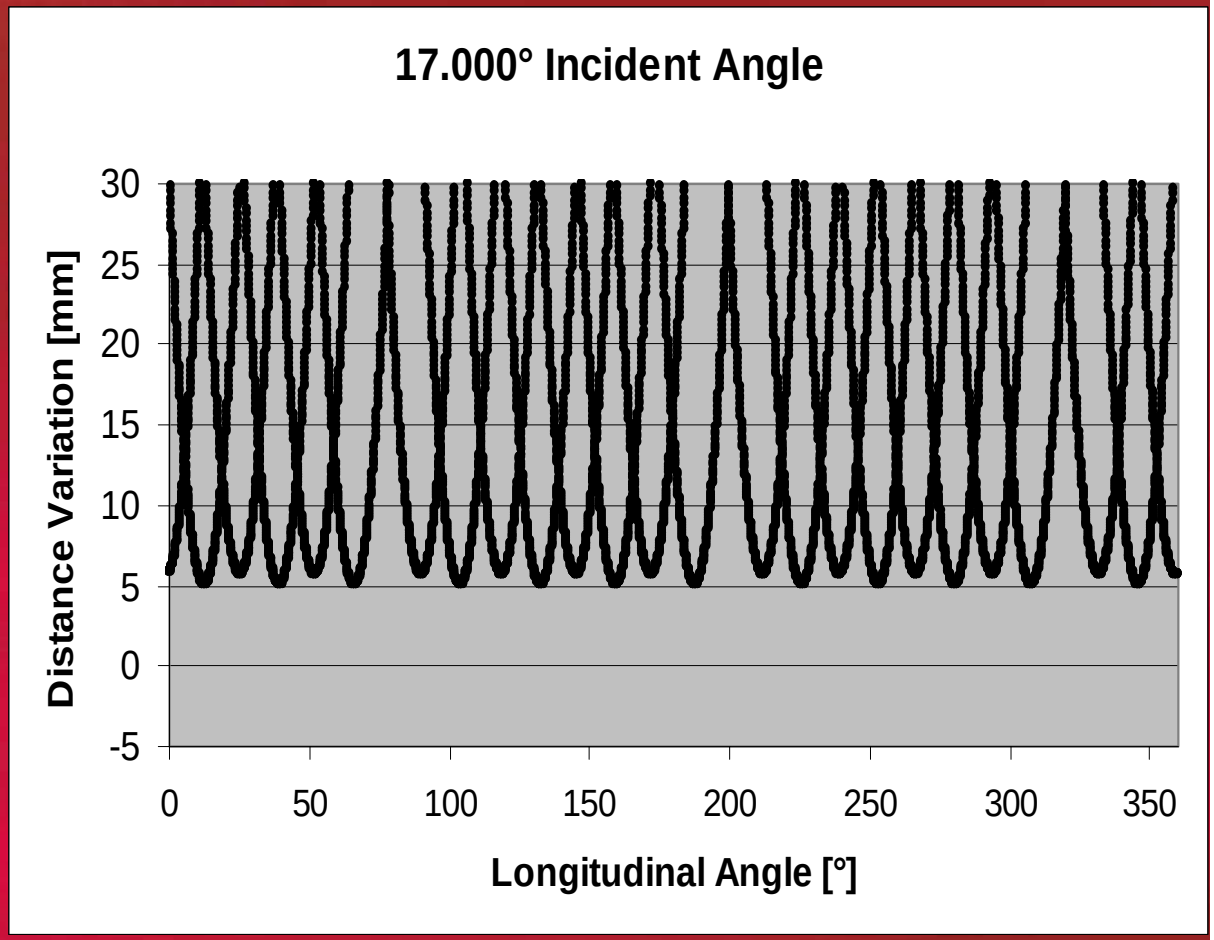
AJISAI Spin Parameters with kHz SLR

- AJISAI rotates wth 0.51 Hz
- Retro Distances are varying
- @ 10 Hz: Only larger RMS
- @ kHz: Retro Motions visible ☺

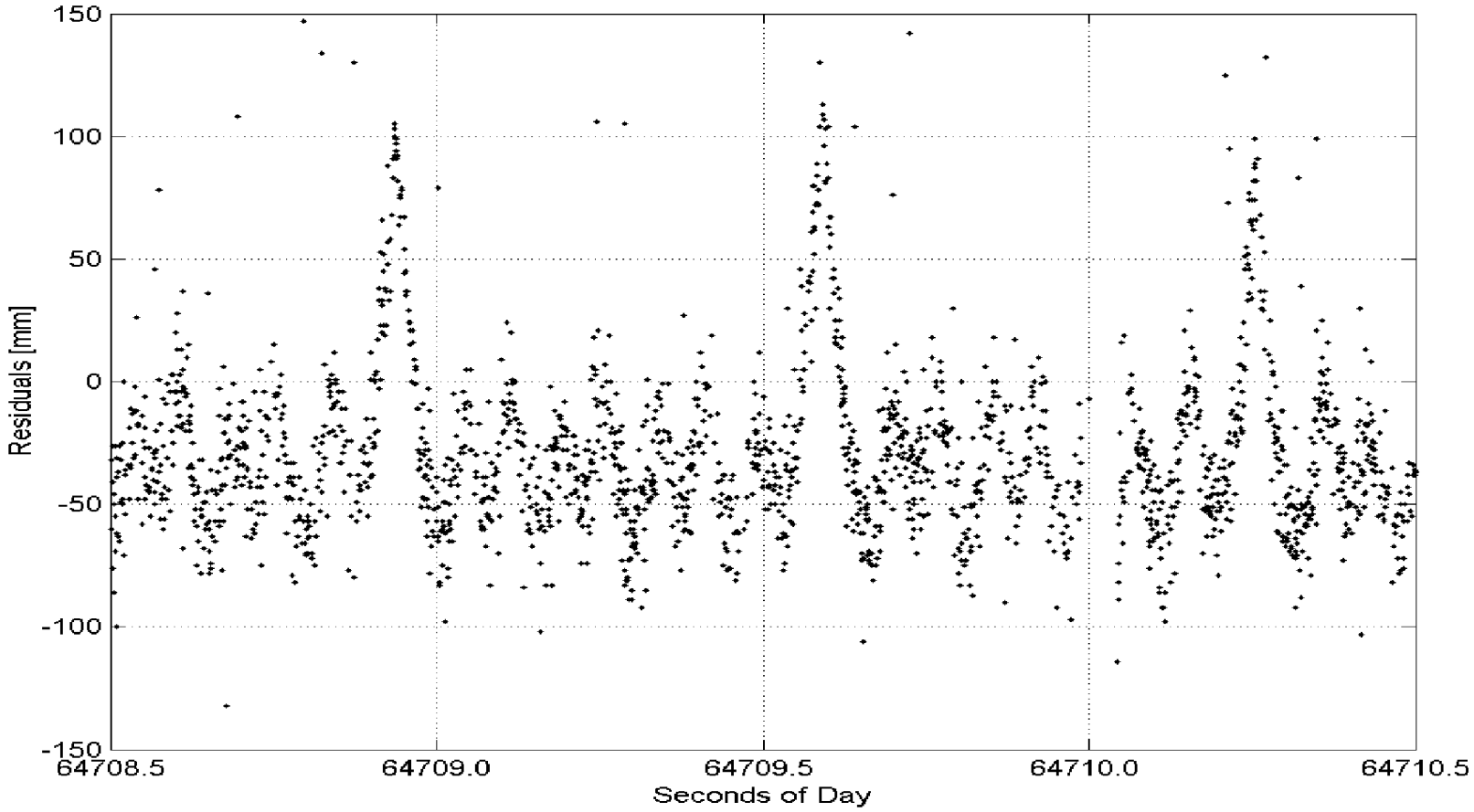


2 secs of AJISAI kHz tracking: Simulation



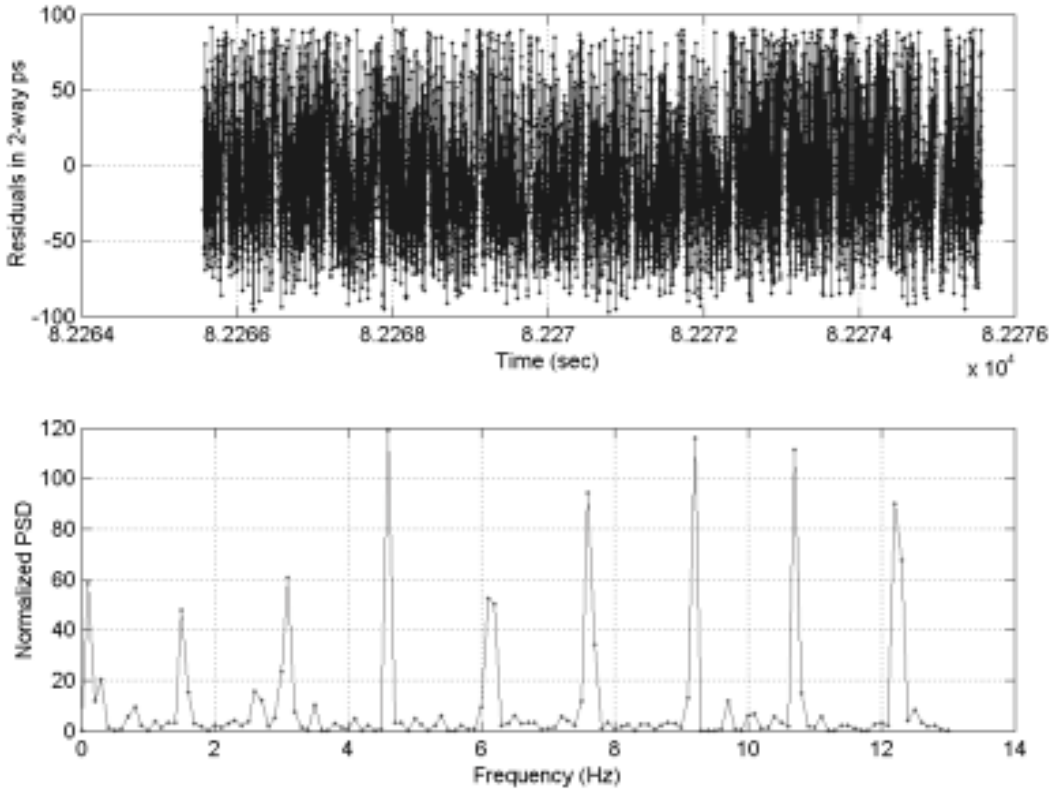


.... and real AJISAI returns (2 seconds)

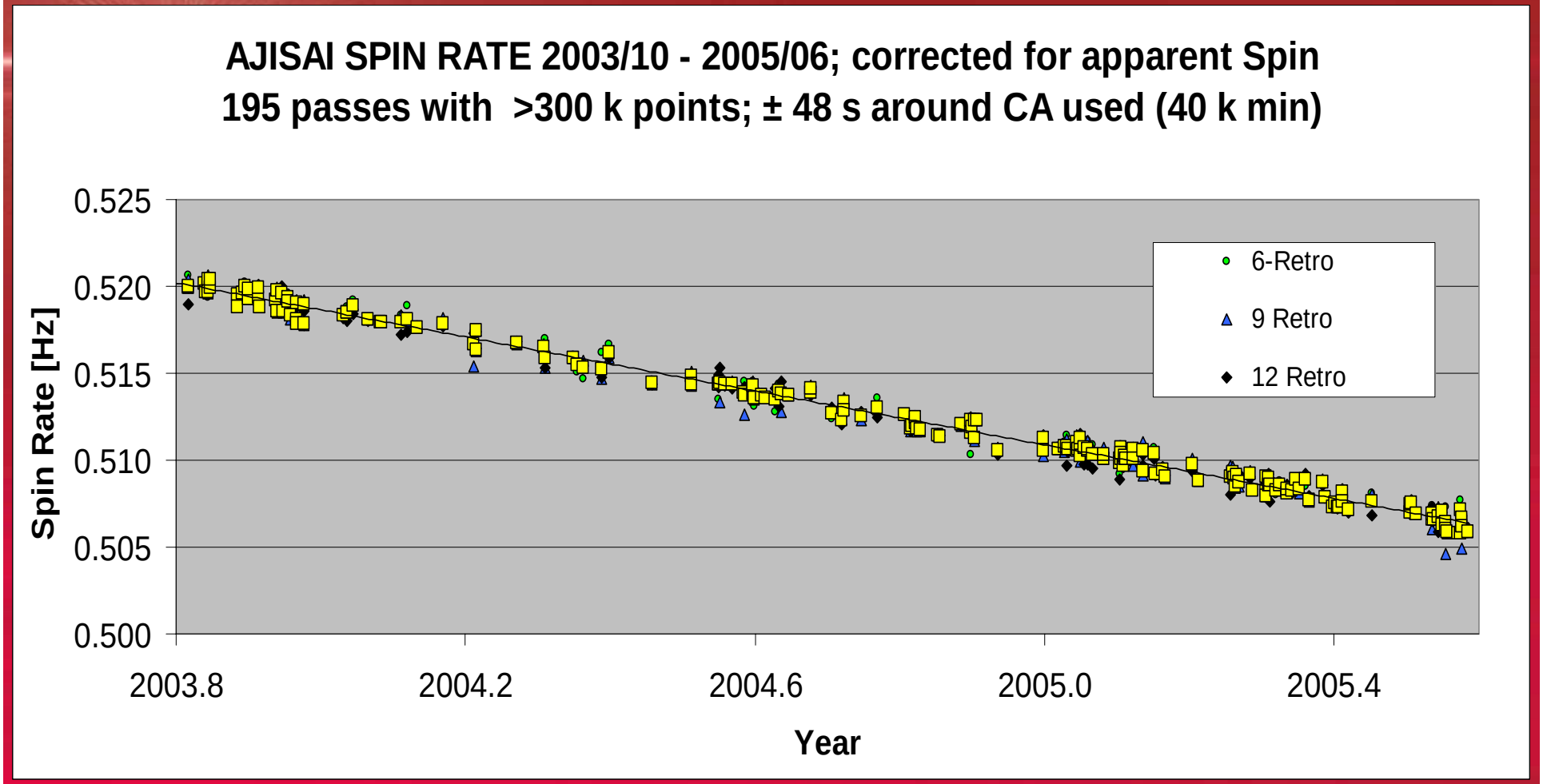


AJISAI returns: Spectral Analysis (Lomb):

- 15 retro „rings“; with 12, 9, 6 or 3 retros
- Several frequencies
- AJI: 0.51 Hz Spin (summer 2005)



AJI Spin Rate Slow Down: - 0.0077497 Hz / Year

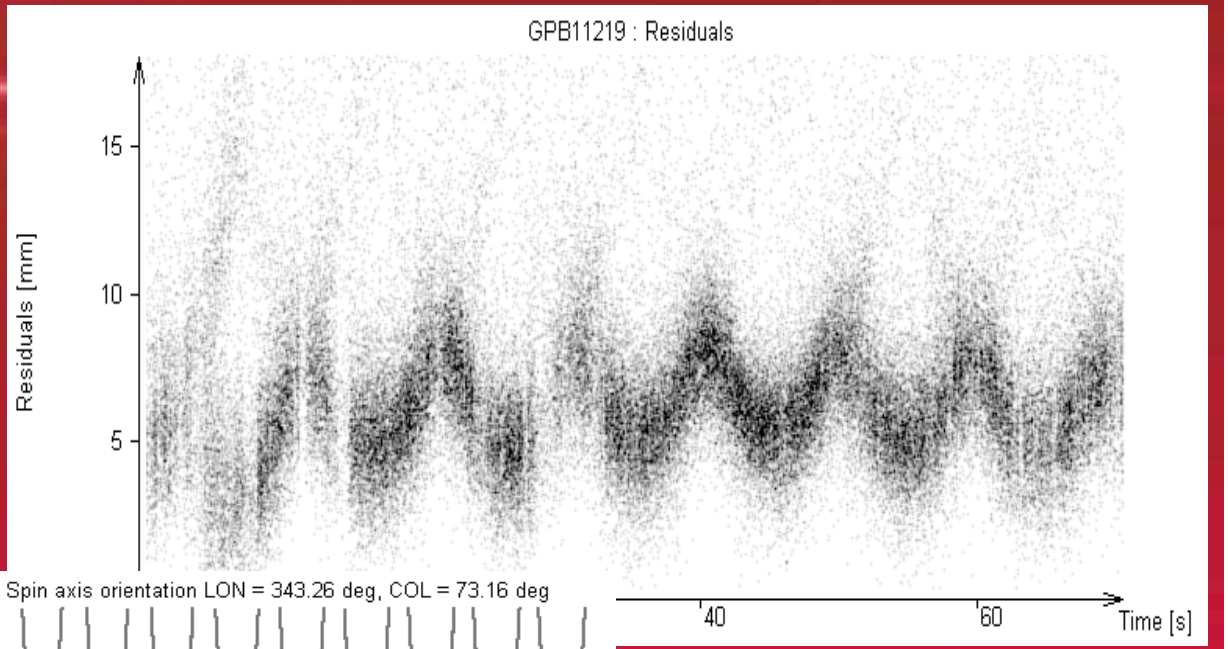


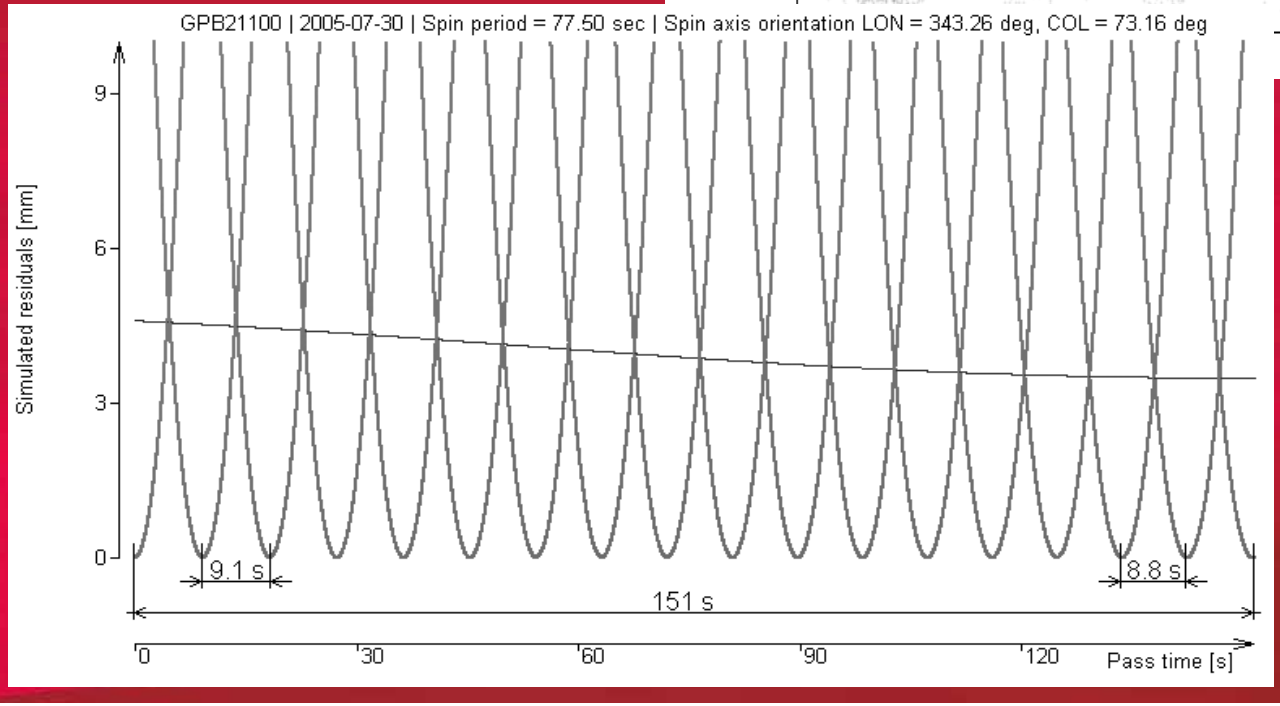
Gravity Probe-B (GP-B): 77.5 s spin period

- GP-B Retros: 1 central Retro;
- 8 Retros on ring (10 cm diam.)
- Mounted on Spin Axis

Slow GP-B Spin: Simulation & Real Returns

- Inertial Spin Period:
  ≈ 77.5 s





- Apparent Spin Period:
  Slowly changing
  during pass;
- Spectral Analysis:
  Lower Accuracy ...

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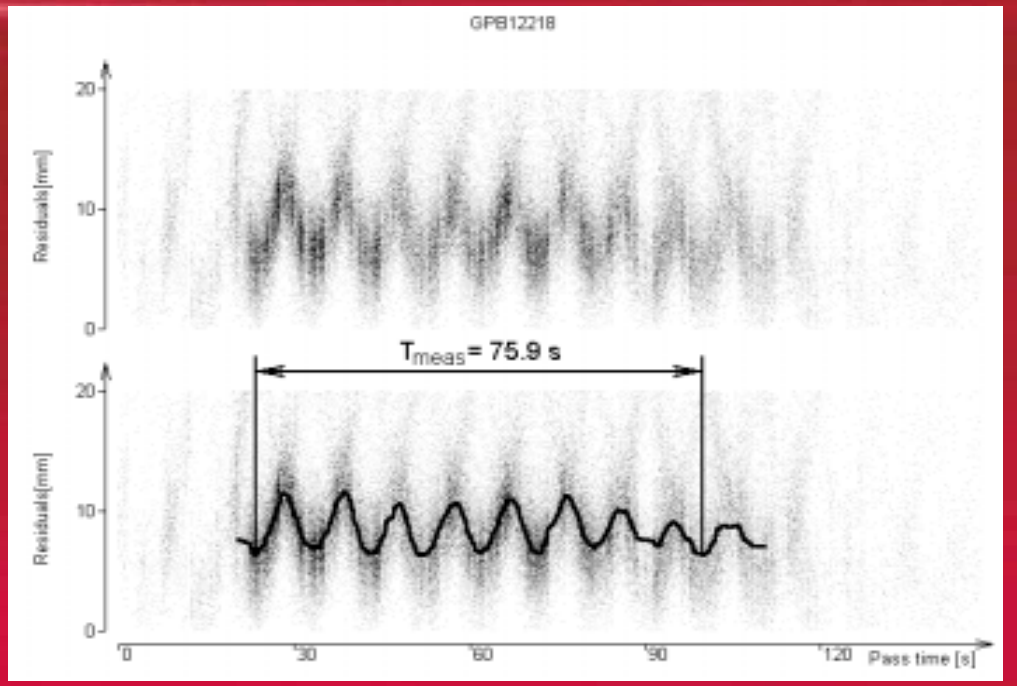
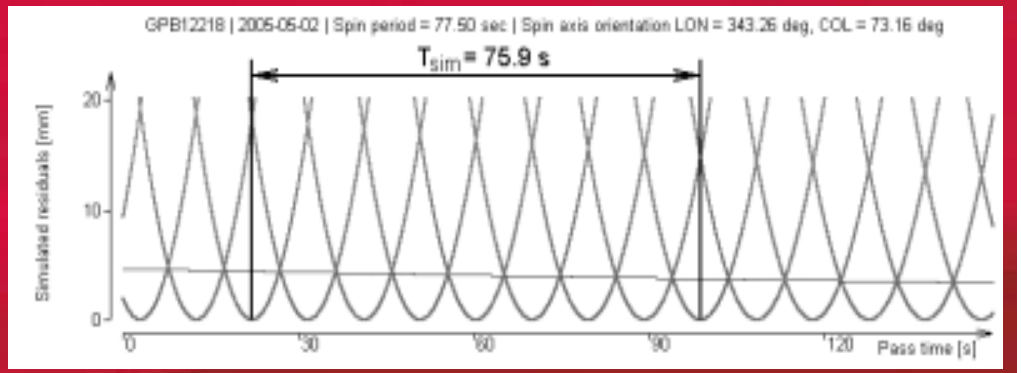
Inertial Spin Period: Compare Simulation & Returns





- From Data: Determine T_{meas} = 75.9 s (8 retro peaks => 1 full revolution)
- Simulate same pass, with inertial spin period as parameter, until $T_{sim} = T_{meas}$ at the same epoch time
- Result: Accurate Inertial Spin Period

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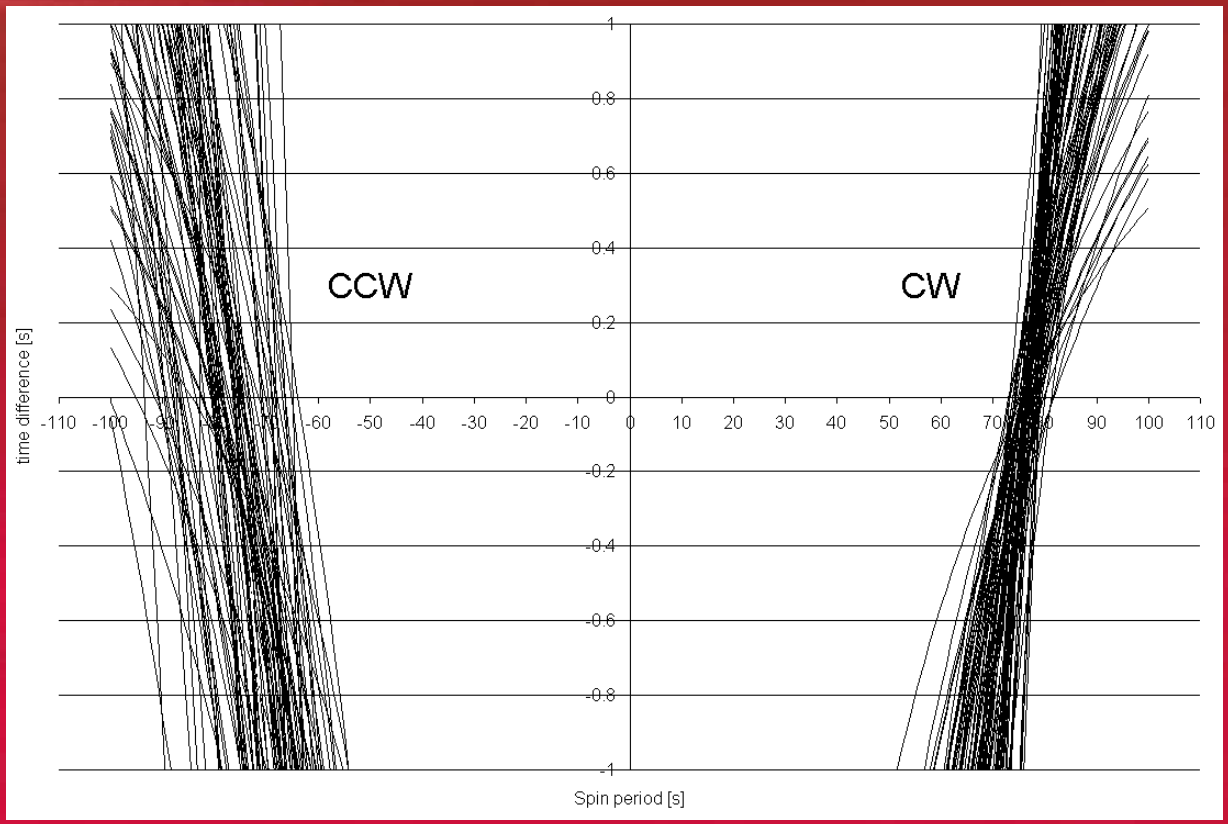
Inertial Spin Period for 100 GP-B Passes

- Simulation Results:
- Spin Period as Parameter;
- Compare Periods of Simulation and Results;
- Plot Differences;
- When ZERO: THIS is the correct Spin Period
- Left: CCW Spin simulated;
- Right: CW Spin simulated



- Inertial Spin Period for 100 GP-B Passes
- Both Spin Directions (CW + CCW) allowed

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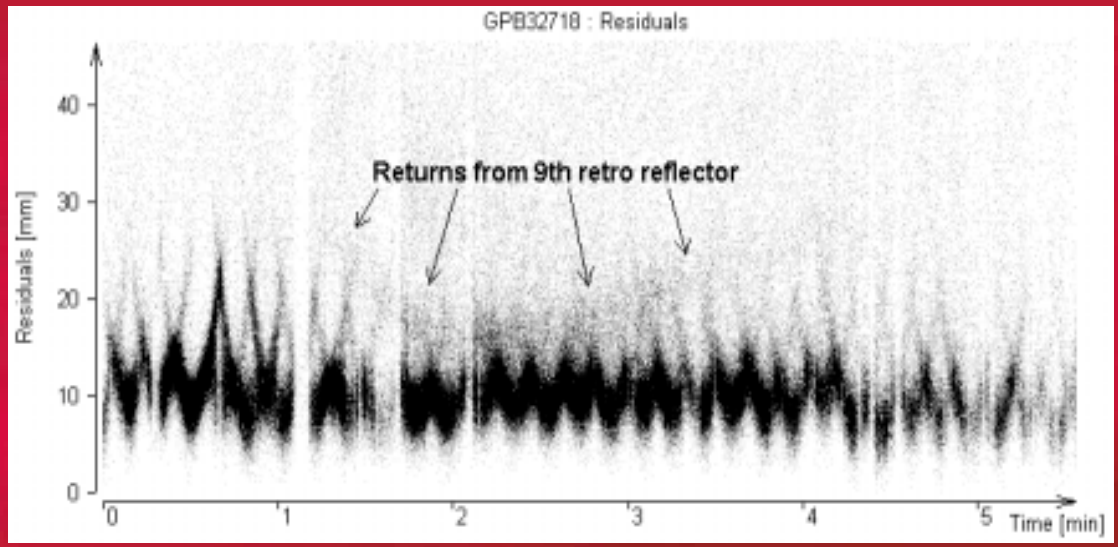
GP-B Spin Axis Orientation

- Spin axis of GP-B is known, and kept constant with high accuracy;
- GP-B always points to the star IM-Pegasus, with it‘s Spin axis;
- Allows to check our Spin Axis Orientation Results from kHz SLR Data !
- Method: Using Returns from the Central (9th) Retro



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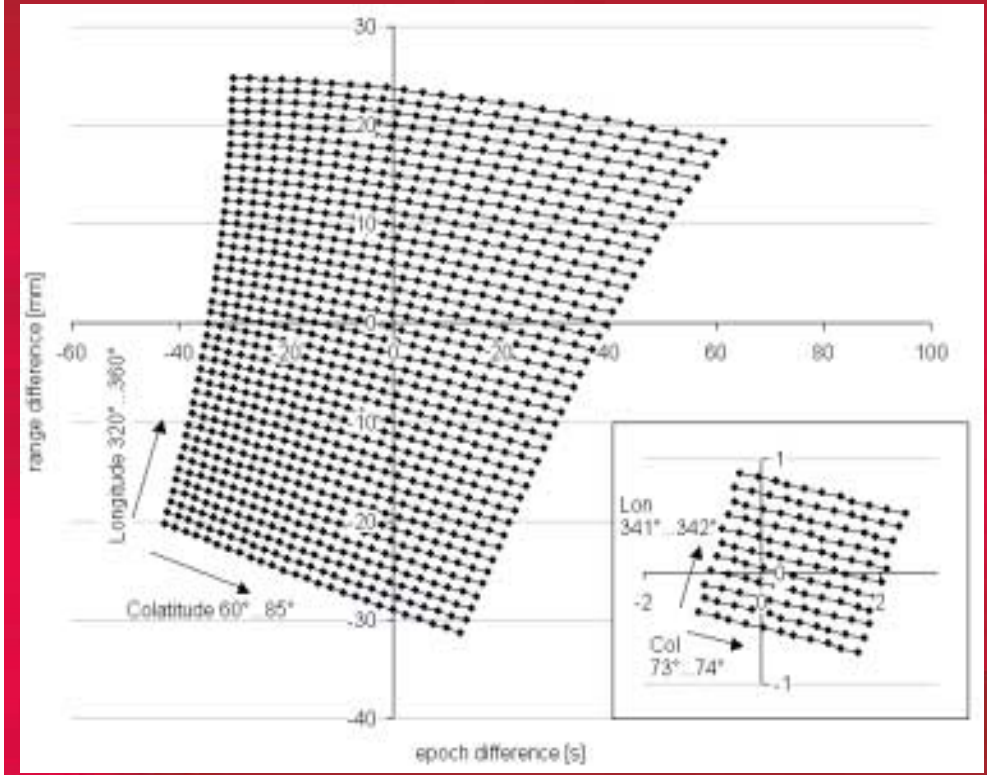
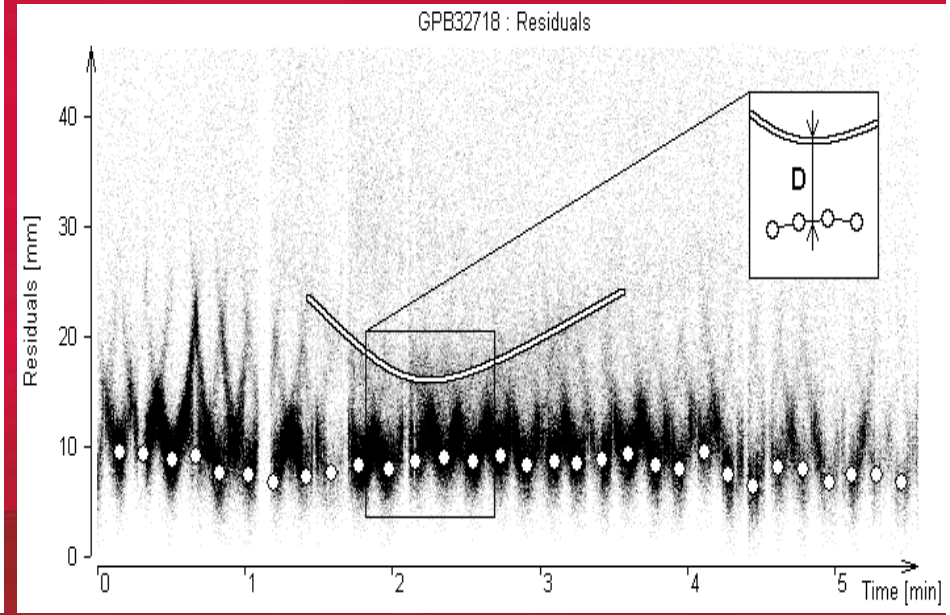
GP-B Spin Axis Orientation: Determination

- Simulate Returns also from 9th Retro; determine geometry / distance D at epoch;
- Compare it with results; iterate for varying Longitudes / Colatitudes of GP-B;
- Plot results for parameters Longitude / Colatitude / Epoch Differences;
- Find solution at Zero/Zero



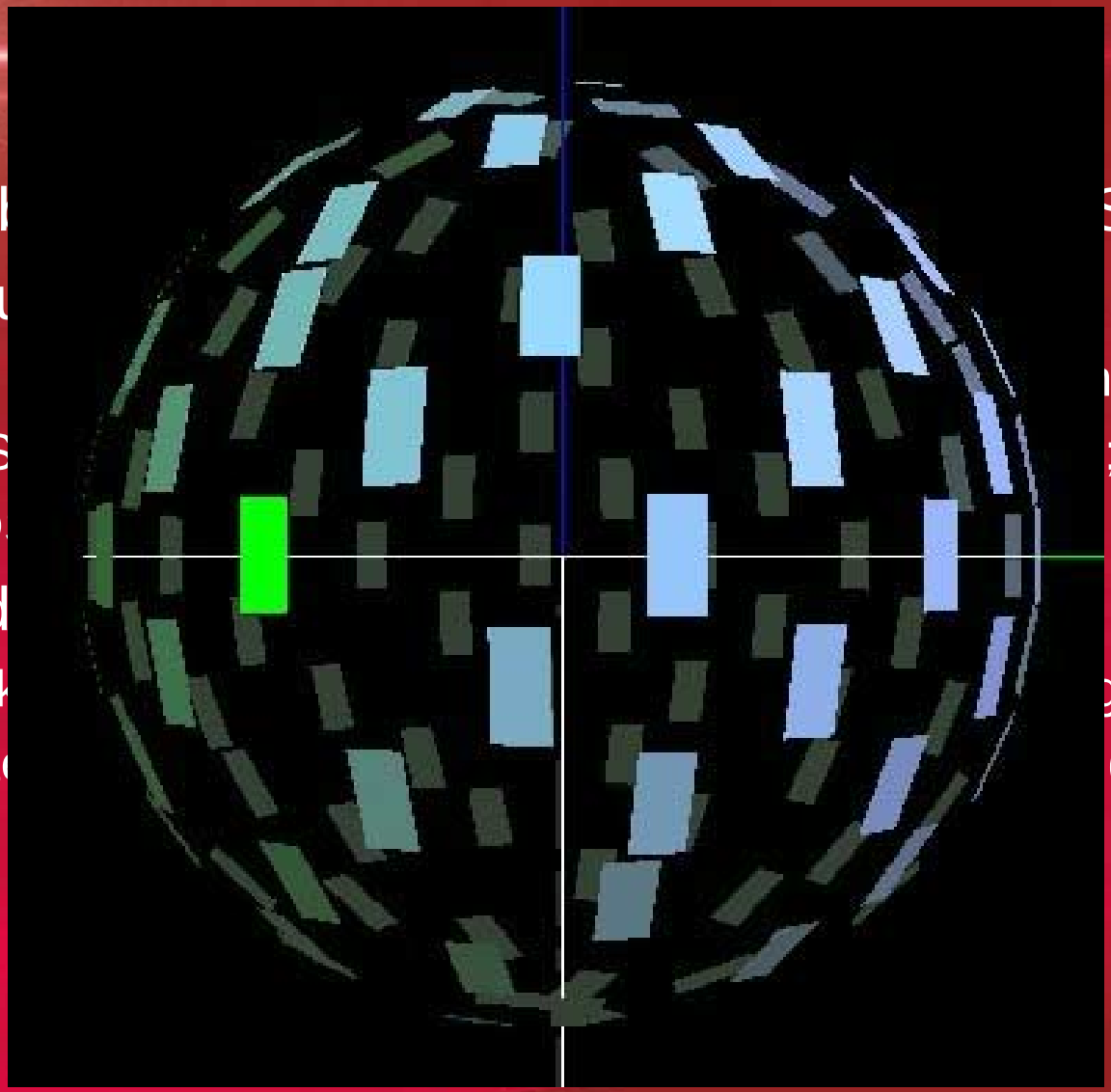


GP-B Spin Axis Orientation: Results

Diffs: kHz SLR Results minus GP-B data	Difference in Longitude (343.26°)	Difference in Colatitude (73.16°)	Difference in Spin Period (77.5 s)
GPB Pass 2004-11-22	-1.86°	-0.14°	-0.06 s
GPB Pass 2005-04-04	-3.36°	-1.46°	-1.23 s
GPB Pass 2005-07-29	-2.06°	+1.74°	-0.43 s

- 3 Passes of GP-B: Spin Axis determined;
- Longitude / Colatitude: Determined with a few degrees accuracy

Conclusions:



- It is possil SLR data;
- Good resu
  - AJISAI: ;
  - GP-B: S ;
  - LAGEO
- Increased
  - MORE k g;
  - Dedicat (e.g. geometry)