Keynote talk:

Modeling and Bias

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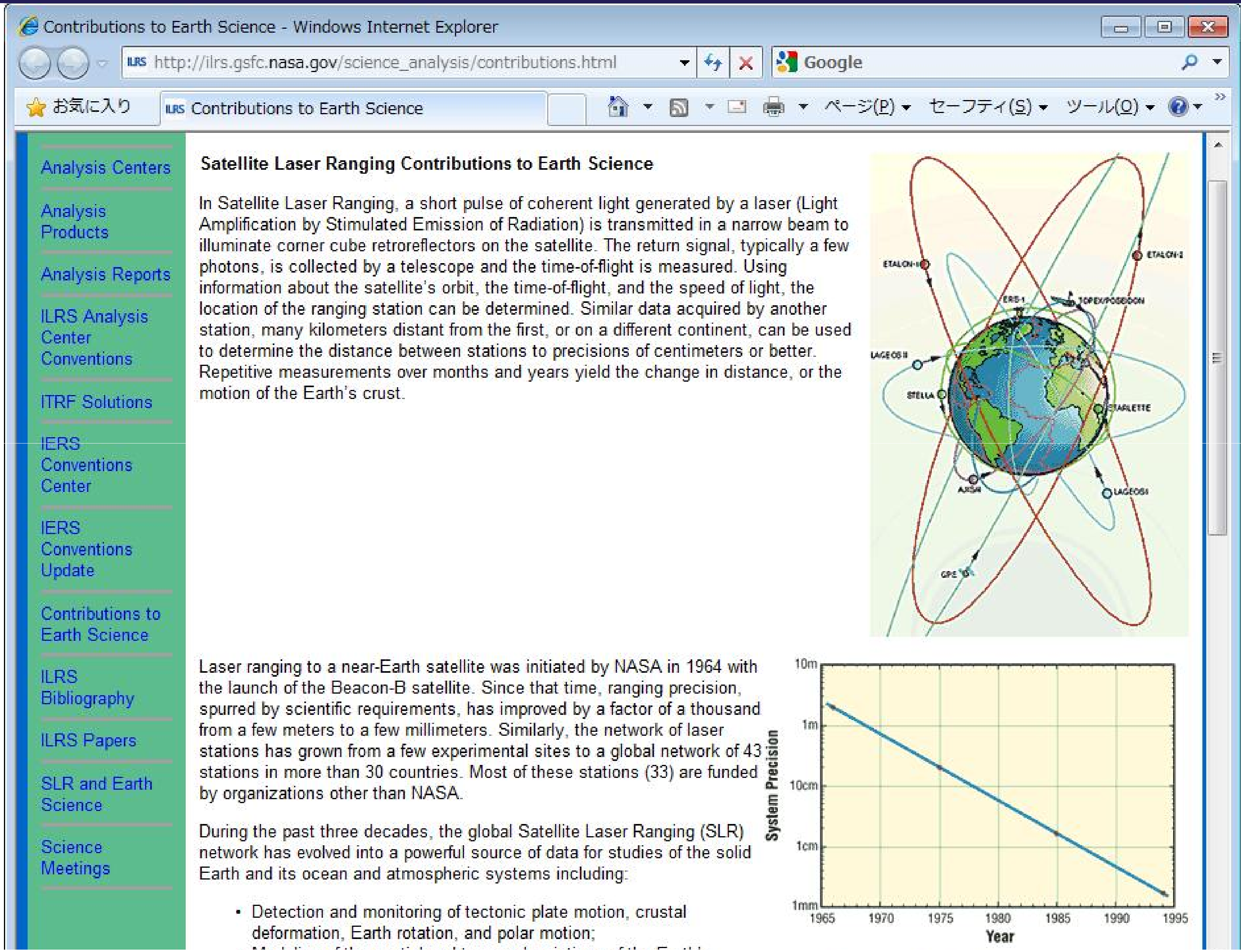
17th International Workshop on Laser Ranging, 17 May, 2011.

Have you seen this ILRS webpage?


Contributions to Earth Science - Windows Internet Explorer

http://ilrs.gsfc.nasa.gov/science_analysis/contributions.html

Google

お気に入り | Contributions to Earth Science | ページ(P) | セーフティ(S) | ツール(O)

- Analysis Centers
- Analysis Products
- Analysis Reports
- ILRS Analysis Center Conventions
- ITRF Solutions
- IERS Conventions Center
- IERS Conventions Update
- Contributions to Earth Science
- ILRS Bibliography
- ILRS Papers
- SLR and Earth Science
- Science Meetings

Satellite Laser Ranging Contributions to Earth Science

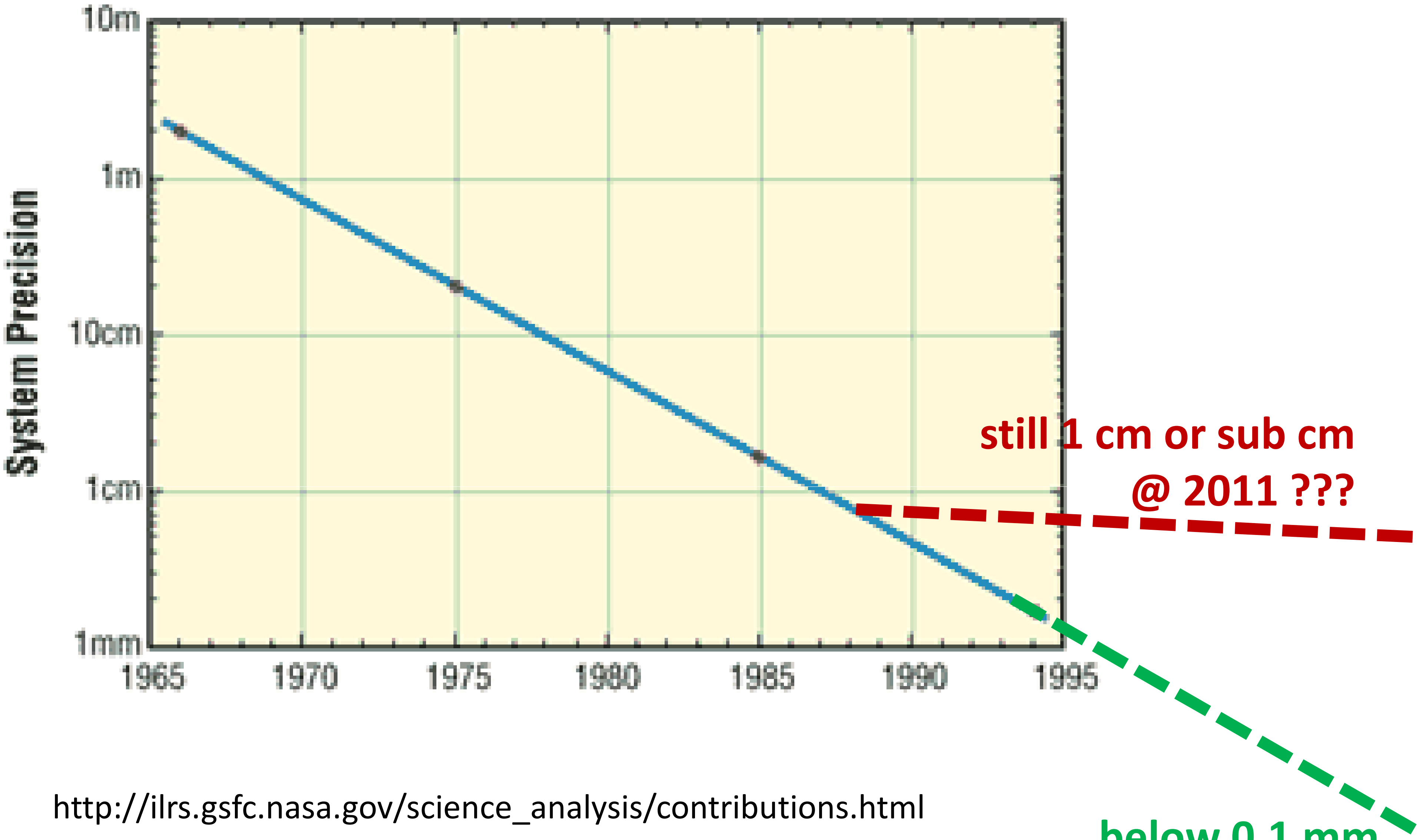
In Satellite Laser Ranging, a short pulse of coherent light generated by a laser (Light Amplification by Stimulated Emission of Radiation) is transmitted in a narrow beam to illuminate corner cube retroreflectors on the satellite. The return signal, typically a few photons, is collected by a telescope and the time-of-flight is measured. Using information about the satellite's orbit, the time-of-flight, and the speed of light, the location of the ranging station can be determined. Similar data acquired by another station, many kilometers distant from the first, or on a different continent, can be used to determine the distance between stations to precisions of centimeters or better. Repetitive measurements over months and years yield the change in distance, or the motion of the Earth's crust.

Laser ranging to a near-Earth satellite was initiated by NASA in 1964 with the launch of the Beacon-B satellite. Since that time, ranging precision, spurred by scientific requirements, has improved by a factor of a thousand from a few meters to a few millimeters. Similarly, the network of laser stations has grown from a few experimental sites to a global network of 43 stations in more than 30 countries. Most of these stations (33) are funded by organizations other than NASA.

During the past three decades, the global Satellite Laser Ranging (SLR) network has evolved into a powerful source of data for studies of the solid Earth and its ocean and atmospheric systems including:

- Detection and monitoring of tectonic plate motion, crustal deformation, Earth rotation, and polar motion;

http://ilrs.gsfc.nasa.gov/science_analysis/contributions.html



http://ilrs.gsfc.nasa.gov/science_analysis/contributions.html

1 mm, sub-mm achievable?

Random error (precision)

kHz ranging has reduced the NP precision

Single-shot 5 mm RMS / Sqrt[10000 (shots/NP)] = 0.05 mm (NP)!!

Systematic/offset error (accuracy)

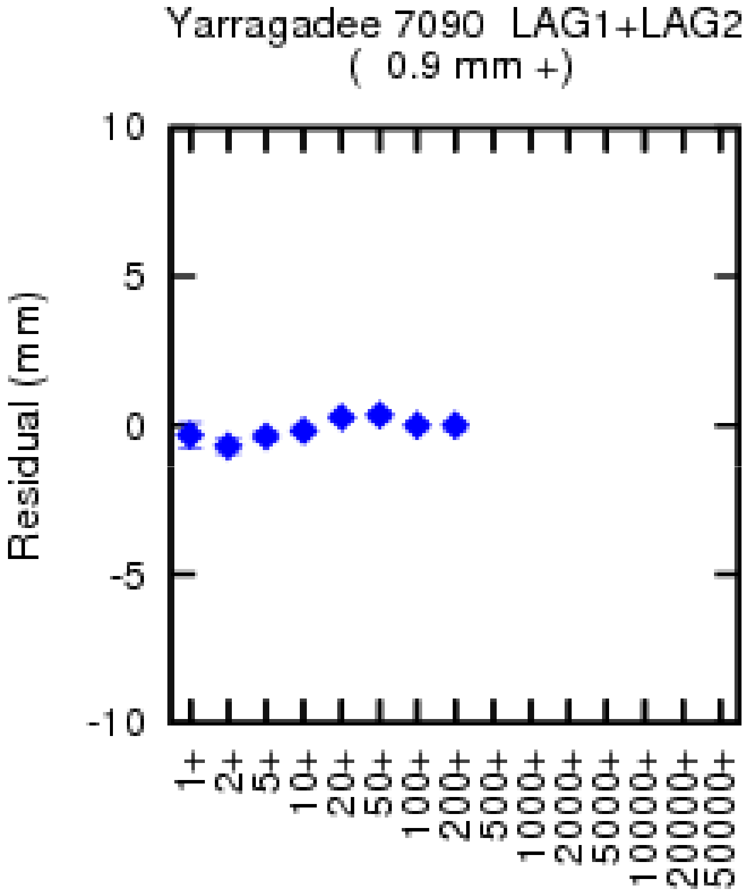
timer, laser, calibration, local survey, etc.

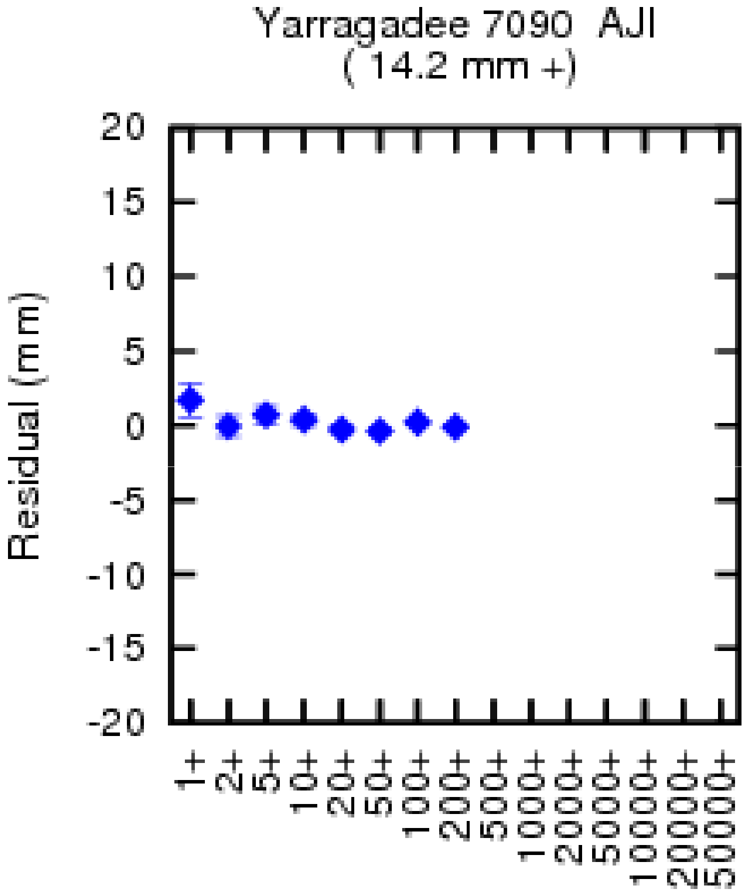
atmospheric delay

- intensity dependence
- microwave vs laser
- centre-of-mass correction
- modeling in orbit analysis

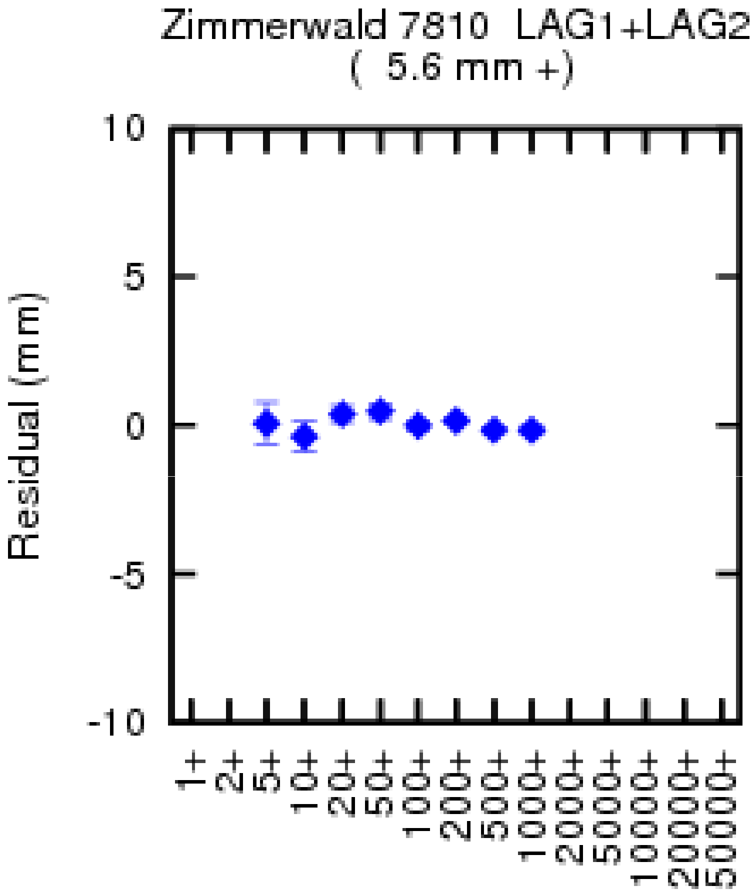
→ **all affecting the quality of analysis products**

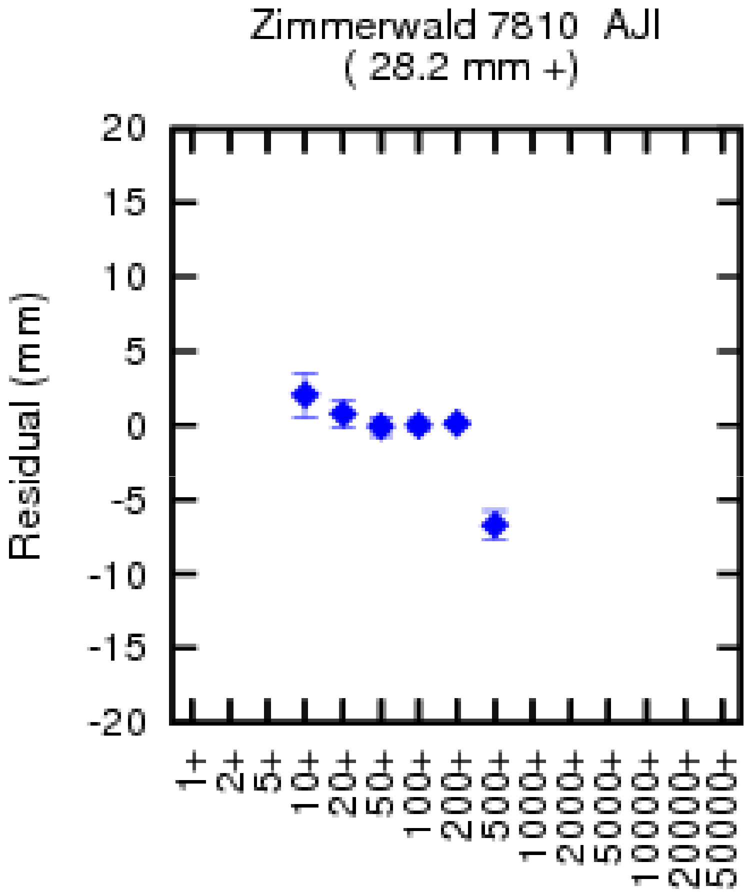
Bias vs Intensity 2010



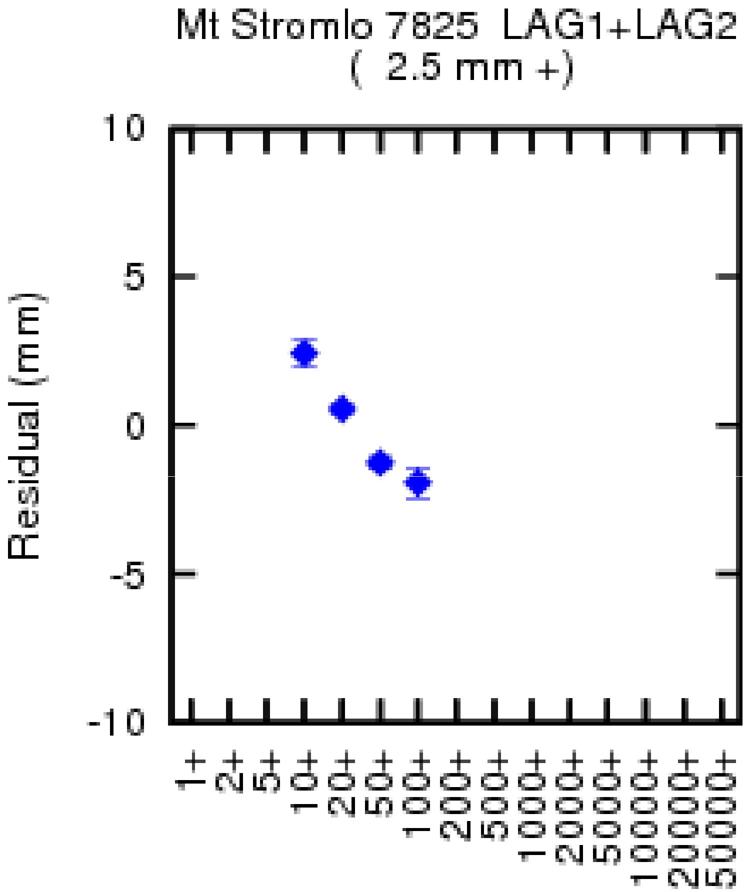


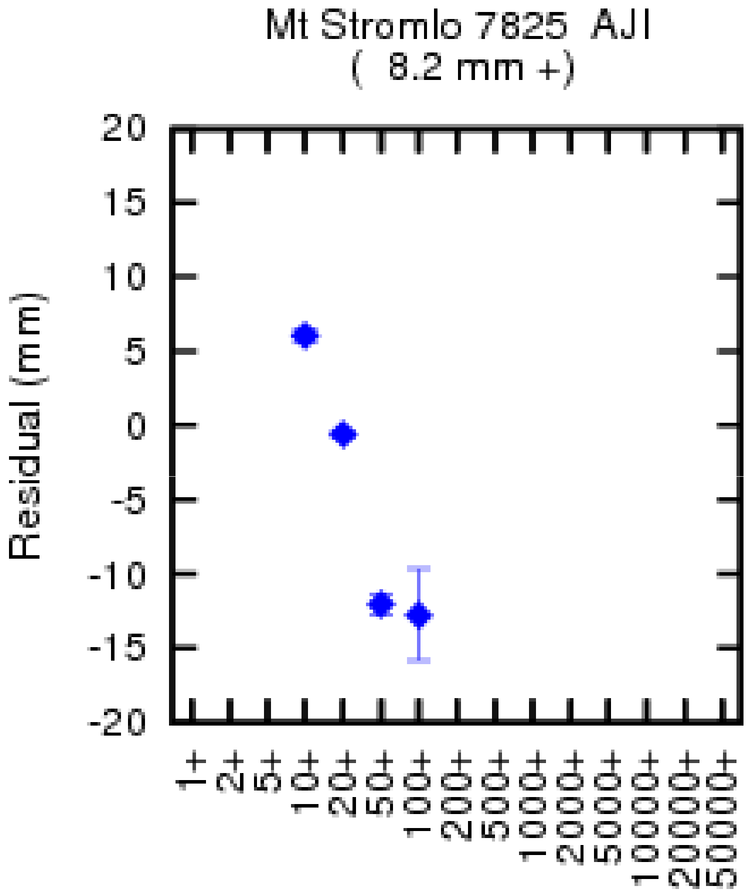
Bias vs Intensity 2010



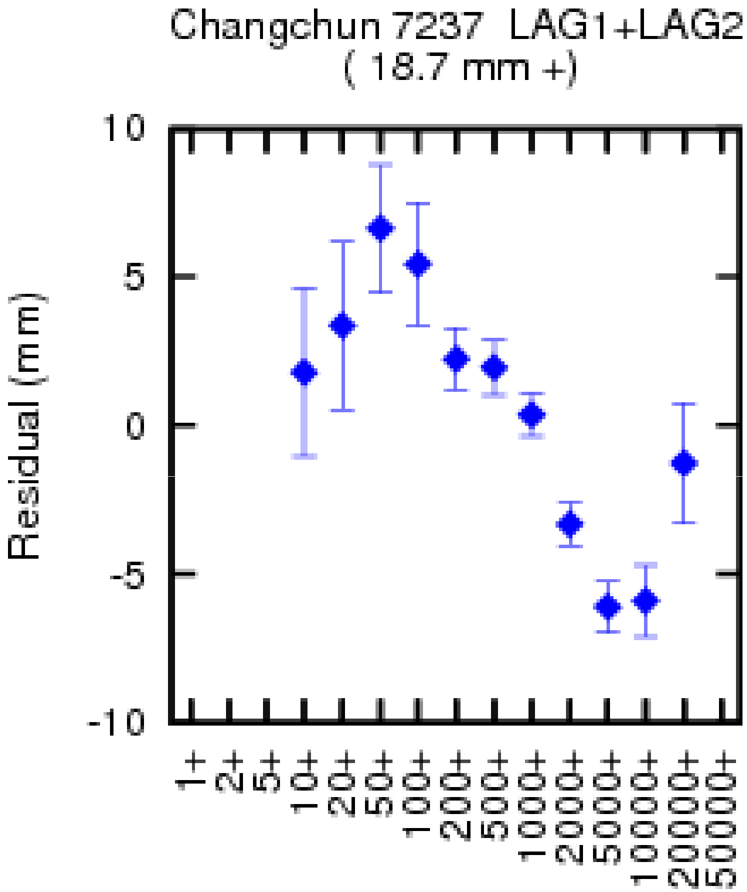


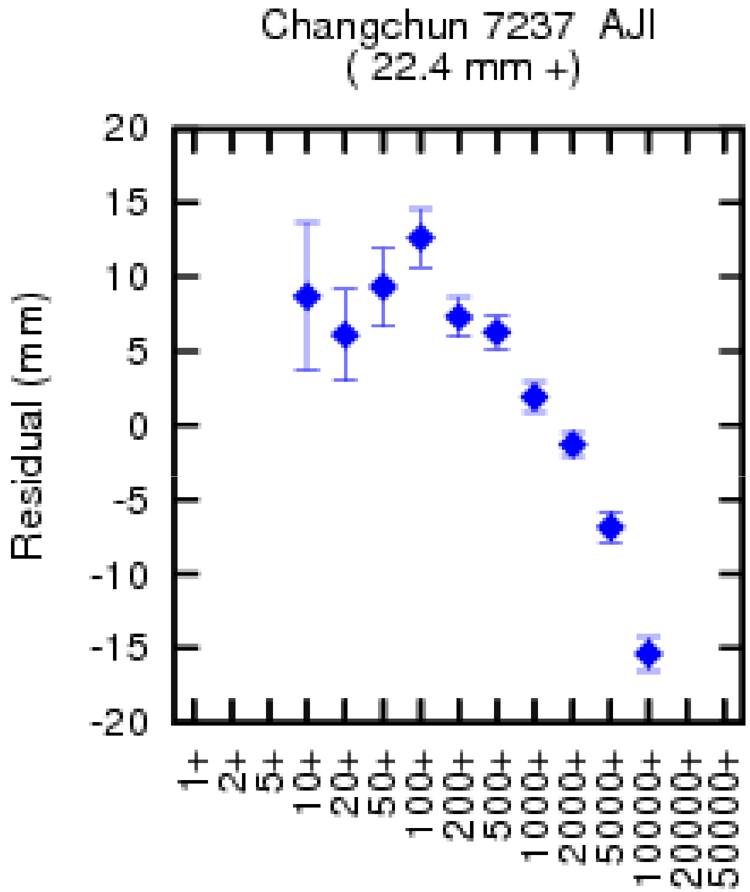
Bias vs Intensity 2010





Bias vs Intensity 2010





Contact me this week, or visit
http://geo.science.hit-u.ac.jp/
next week, for more stations
(up to most productive 20).

Werner Gurtner says:

[1] The laser tracking stations are continuously spending huge amount of budget (compared to the analysis institutes, and also to the GNSS stations).

[2] The tracking stations can not guarantee mm-level accuracy.

[First half of this session]

How can the ACs handle the bias-hidden data?

How can the ACs make the best use of the current tracking data for their best products?

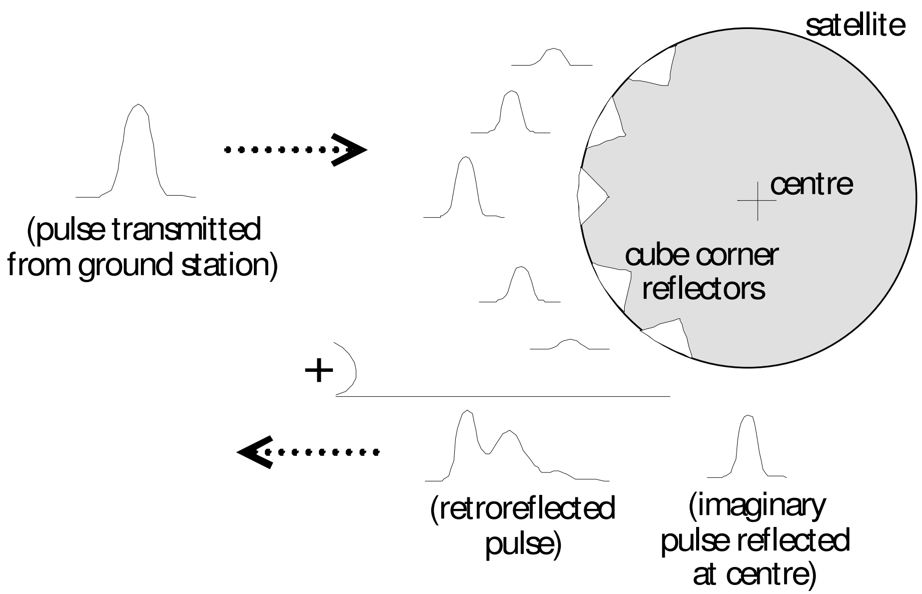
Spin: “Spin-off” of SLR

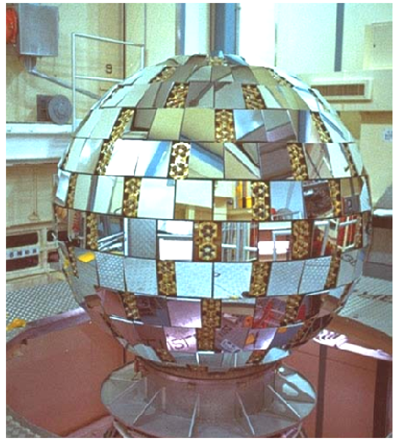
SLR can measure the satellite spins as well as the orbits.

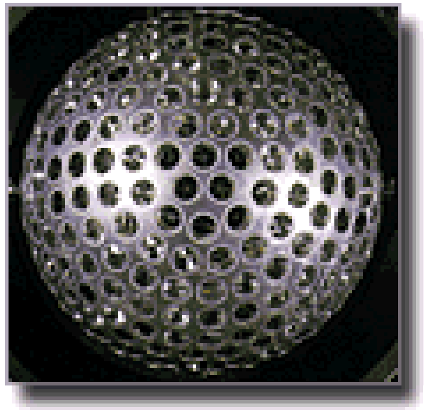
Ajisai: Otsubo, IEEE TGARS, 2000.

Lageos-2: Bianco, JGR, 2001.

Various: Kirchner/Kucharski, 200x-201x.



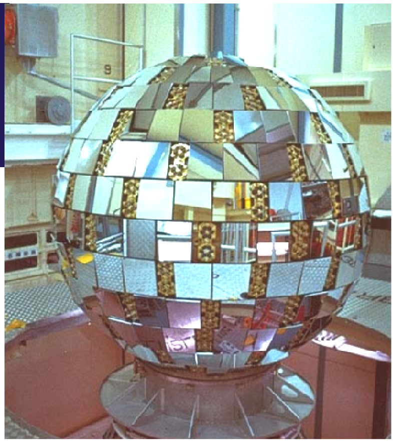


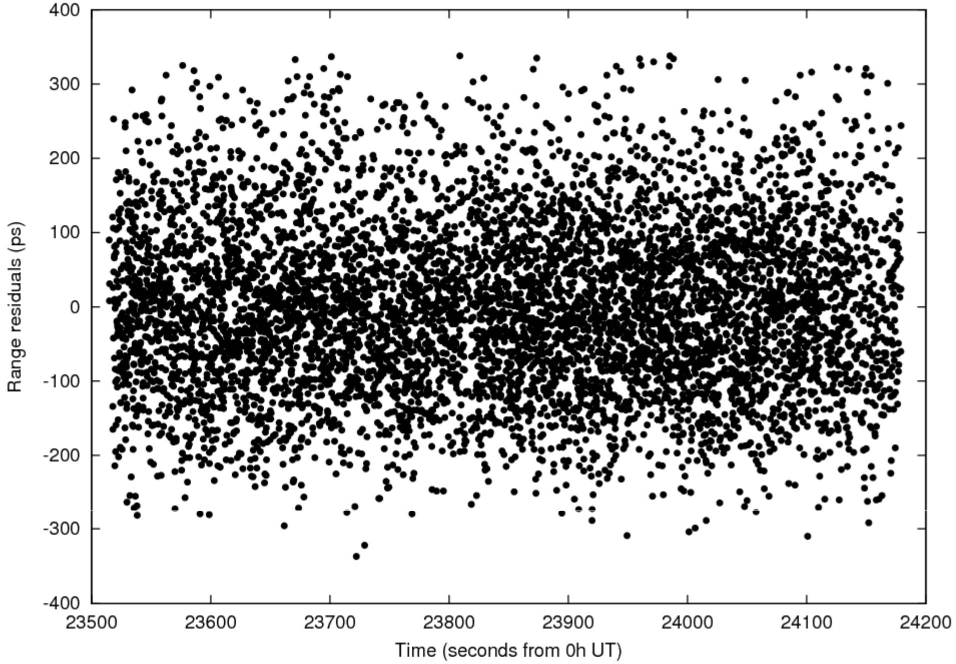


Less affected by SLR systematic error, utilising its high “precision”.

Precise spin parameters can improve the orbit determination.

(Old) Example of Ajisai spin

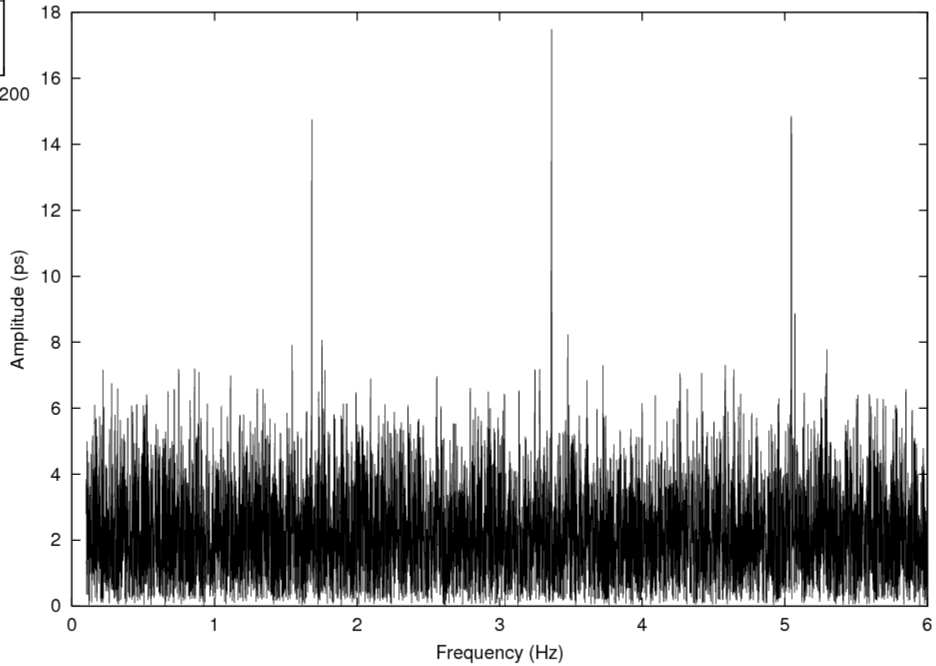




→ **Spin rate/period**

3rd harmonics
6th harmonics
9th harmonics

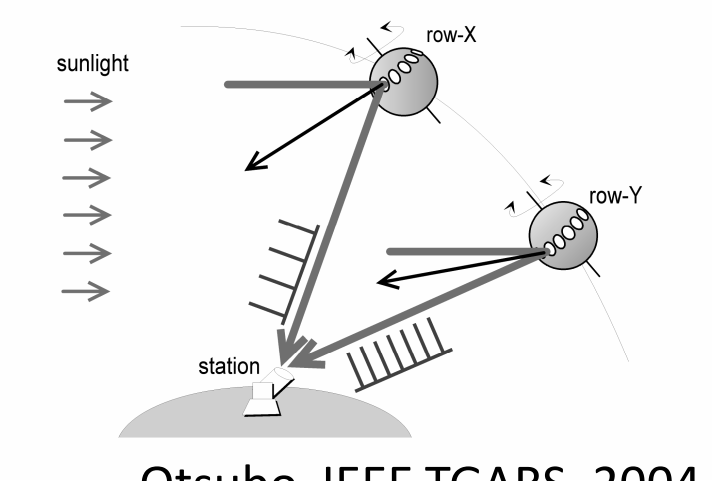
Spectral Analysis



Otsubo, IEEE TGARS, 2000.

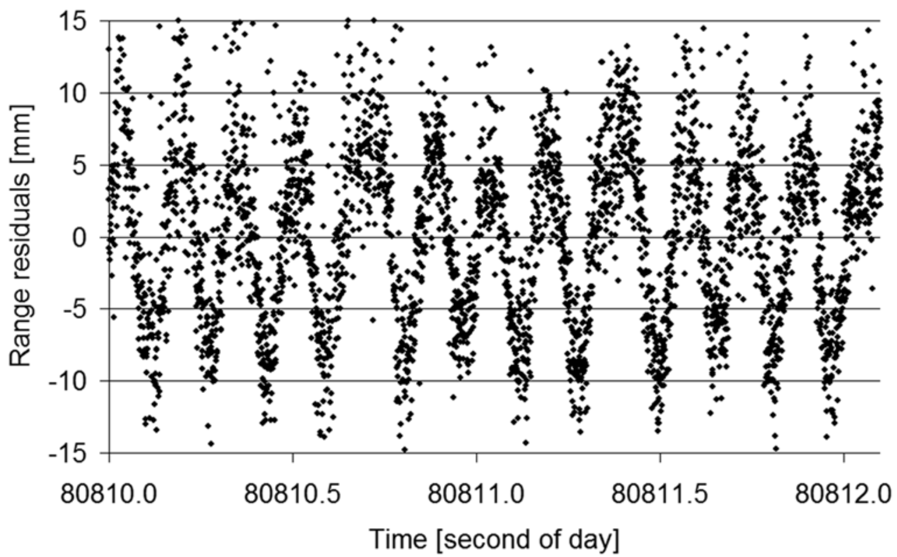
Methods to obtain the satellite spin/orientaion

[Second half of this session]



Otsubo, IEEE TGARS, 2004.

[1] Photometry



Kucharski, JPGU, 2009.

[2] SLR residuals

[3] POD-based, More?