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Systematic range residuals 2021-2022

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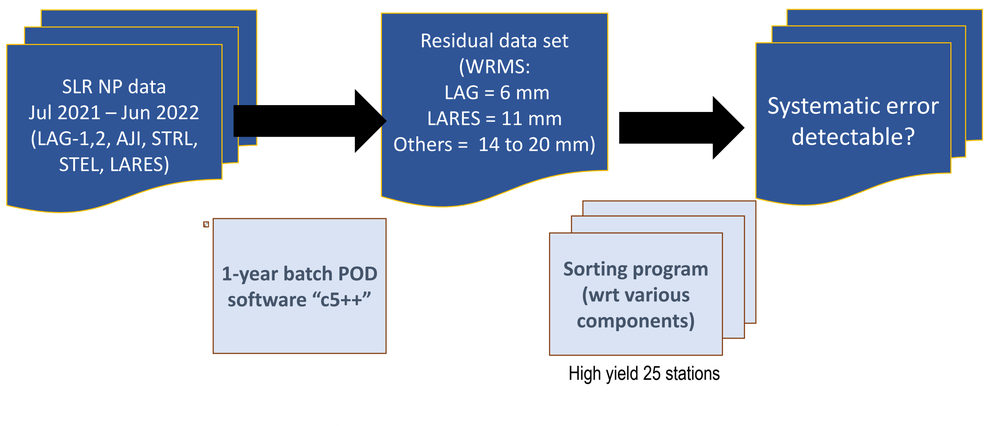
Following the methods presented at the previous workshops (e.g. Otsubo, 2017 ILRS Technical Workshop; Otsubo, 21st International Workshop on Laser Ranging, 2018), we precisely look into the latest SLR data. First, global SLR data to the six satellites, LAGEOS-1, 2, AJISAI, STARLETTE, STELLA and LARES, of one year span, July 2021 to June 2022, are reduced in one batch by our software c5++. Then, the post-fit residuals are related to other parameters, such as number of normal point returns, bin rms, applied system delay, hour of day and range rate. Systematic trends have been detected in various "satellite x station" combinations. Station representatives are advised to look at the charts linked from the NESC Forum.

"Slow & Precise QC" procedure



Single-batch POD: Setup

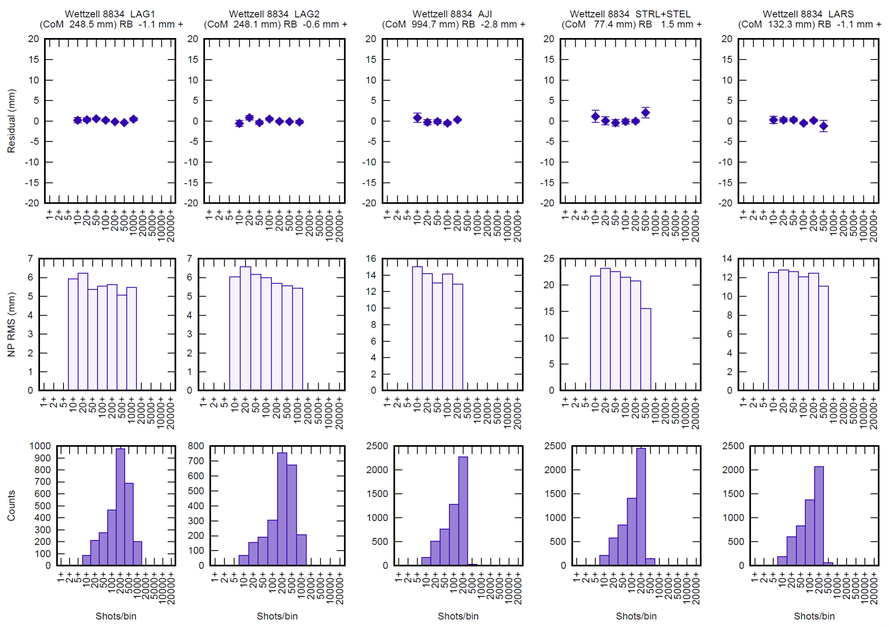
Software "c5++"

- 5 satellites combined (LAGEOS 1+2, AJISAI, STRLETTE, STELLA & LARES).
- One-year single batch. 2021-07-03 0:00 UTC to 2022-06-30 0:00 UTC.
- Orbit: 5-day arc for LAGEOS-1 and -2. 3-day arc for LEOs.
- Station-dependent CoM correction from J Rodriguez (version: Oct 2022).
- Acceleration parameters:
  - Gravity field: GOCO6S up to 60x60, estimating 5x5 coefficients.
  - 5 empirical params twice per arc.
- EOP fixed to EOPC04.
- Station coordinates
  - Position: All solved for with loose constraints. Velocity: Fixed to ITRF2020.
  - ITRF2020 PSD applied. Atmospheric loading (u-strasbg ATMIB) applied.
- Range bias: estimated per station per satellite types ("LAG1" "LAG2", "AJI", "STRL+STEL", "LARS").
- Other models compatible with IERS Conventions 2010.

Author's Pick Best Cases

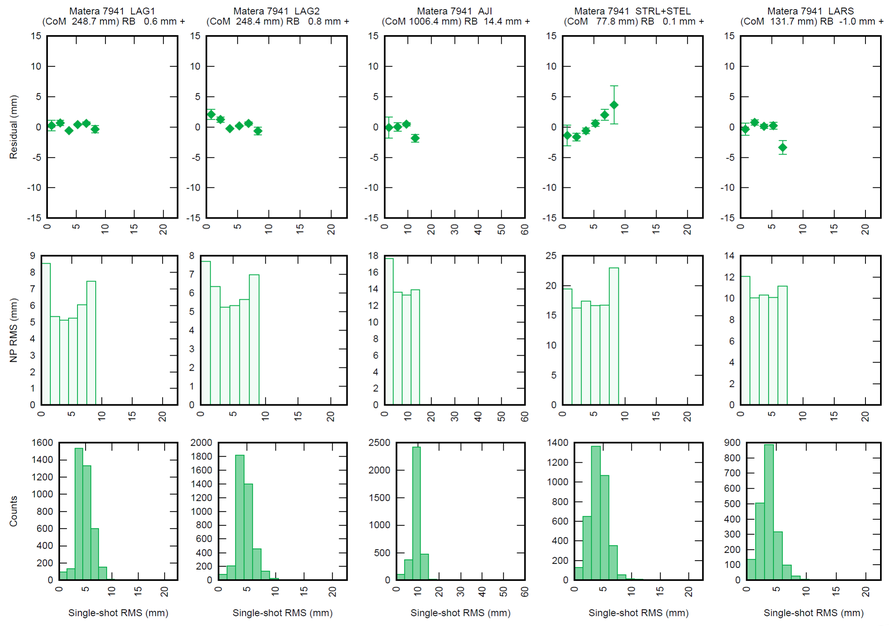
#1: Single-shot returns per NP bin

Intensity dependence. Typical: strong signal → short range.



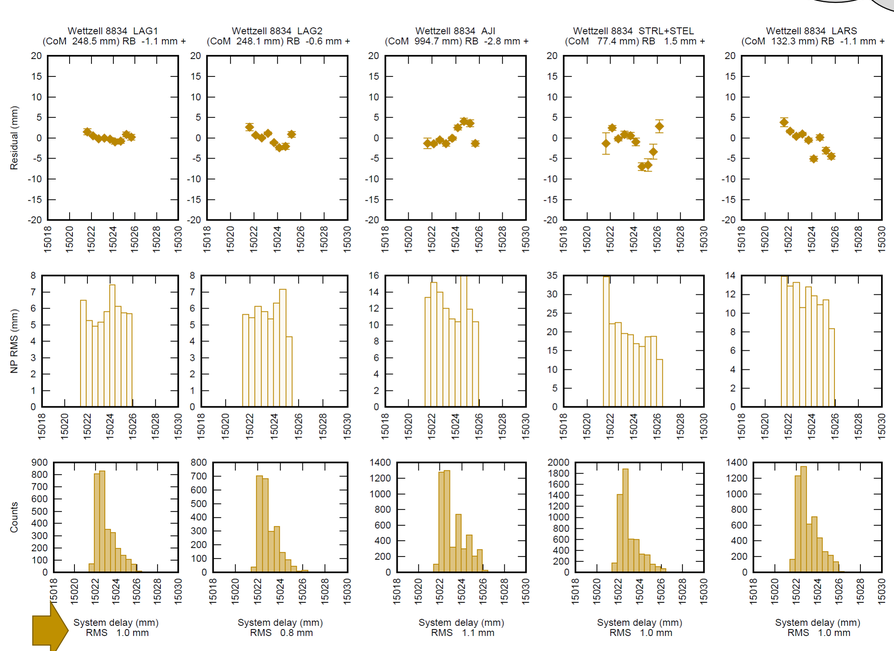
#2: Single-shot RMS of a NP bin

Controversial: harmful for geodesy or not. Typical: large rms → long range.



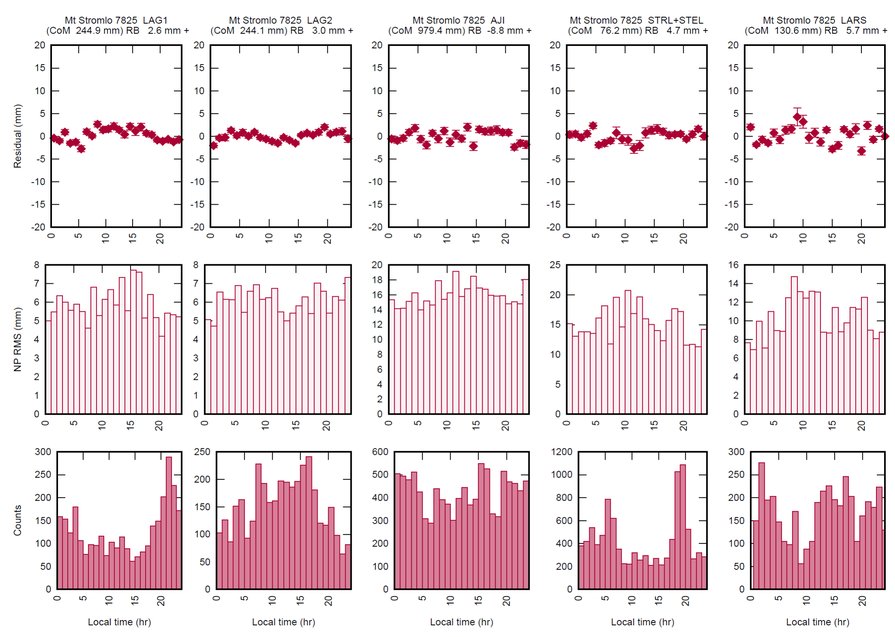
#3: Applied system delay

Properly calibrated? Amazingly stable calibration in Wettzell.



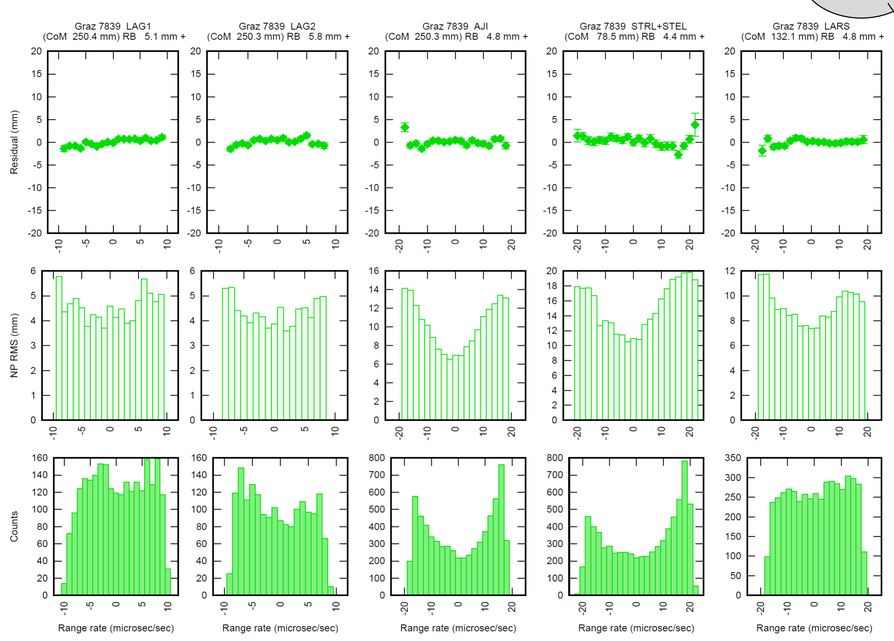
#4: Local time of day

Day/night difference? Operated 24 hr?



#5: Range rate

Slope = time bias. Asymmetric histogram of "Counts" → Not a good sky coverage.



Visit this post on ILRS NESC Forum to find your station's case.
http://sgf.rgo.ac.uk/forumNESC/index.php?topic=68.0

International Laser Ranging Service forum
Networks and Engineering Standing Committee

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Systematic Residual Charts 2021-2022 (Guadalajara Workshop spoiler)
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Dear SLR Station colleagues,

After a few years' break, a number of "station x satellite" systematic residual charts are created using one year data from July 2021 to June 2022. See you at my poster in Guadalajara or online (https://congreso-yebes.ign.es/web/portal/home).

What's new in 2022: ITRF2020 velocity and PSD. Rodriguez's CoM corrections. GOCO6S gravity model. LAGEOS-1 and -2 handled separately.

- **POD residuals vs Intensity (returns per NP bin)**
  http://geo.science.hit-u.ac.jp/slr/bias/2022sp/SortIntensity22b.pdf
  (Negative trend indicates a typical "stronger=shorter" dependence. Probably underestimated for LAGEOS because it also depends on elevation. Some stations moved to single photon mode and eliminated the trend.)
- **POD residuals vs Single shot RMS**
  http://geo.science.hit-u.ac.jp/slr/bias/2022sp/SortRms22b.pdf
  (Positive trend indicates the mean being affected by the tail clipping. I know it's a bit controversial - I am not sure whether it is harmful to geodetic products or not.)
- **POD residuals vs Applied system delay**
  http://geo.science.hit-u.ac.jp/slr/bias/2022sp/SortDelay22b.pdf
  (Negative 1:1 trend indicates untrue variation in calibration. Some stations show very stable calibration: only 1 mm RMS thoughout the year in Wettzell 8834!)
- **POD residuals vs Local time**
  http://geo.science.hit-u.ac.jp/slr/bias/2022sp/SortHour22b.pdf
  (Day-night observability and stability.)
- **POD residuals vs Range rate**
  http://geo.science.hit-u.ac.jp/slr/bias/2022sp/SortRR22b.pdf
  (Negative = pass start, Zero = closest point, Positive = pass end. A slope indicates time bias although such a case is not clearly observed this time. Do not worry much with a small wobble if seen only in one satellite - possibly due to insufficient POD models. Asymmetric "Counts" histograms show that some stations do not try to cover the whole pass.)