

Simulation Study of SLR Data Compression Algorithms

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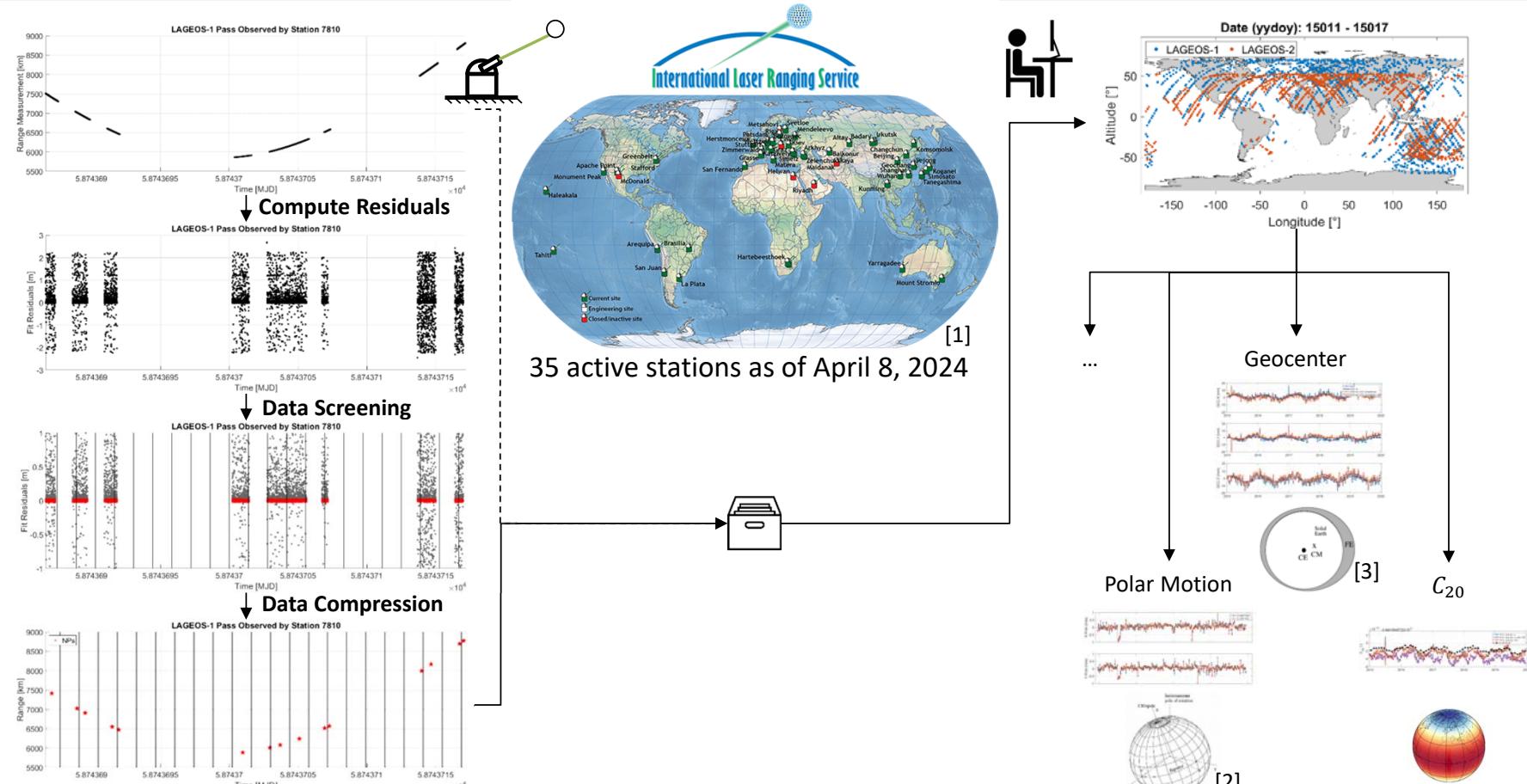
23th International Workshop on Laser Ranging, Kunming, China, 20-26 October 2024



Data Flow of SLR Observations

- Introduction
 - SLR Data Flow
 - Objective
- Simulation Study
- NPT Generation
- Conclusions & Outlook

References:
 [1]: ILRS-website
 [2]: <https://ggo.s.org/>
 [3]: Tregoning et al., 2005

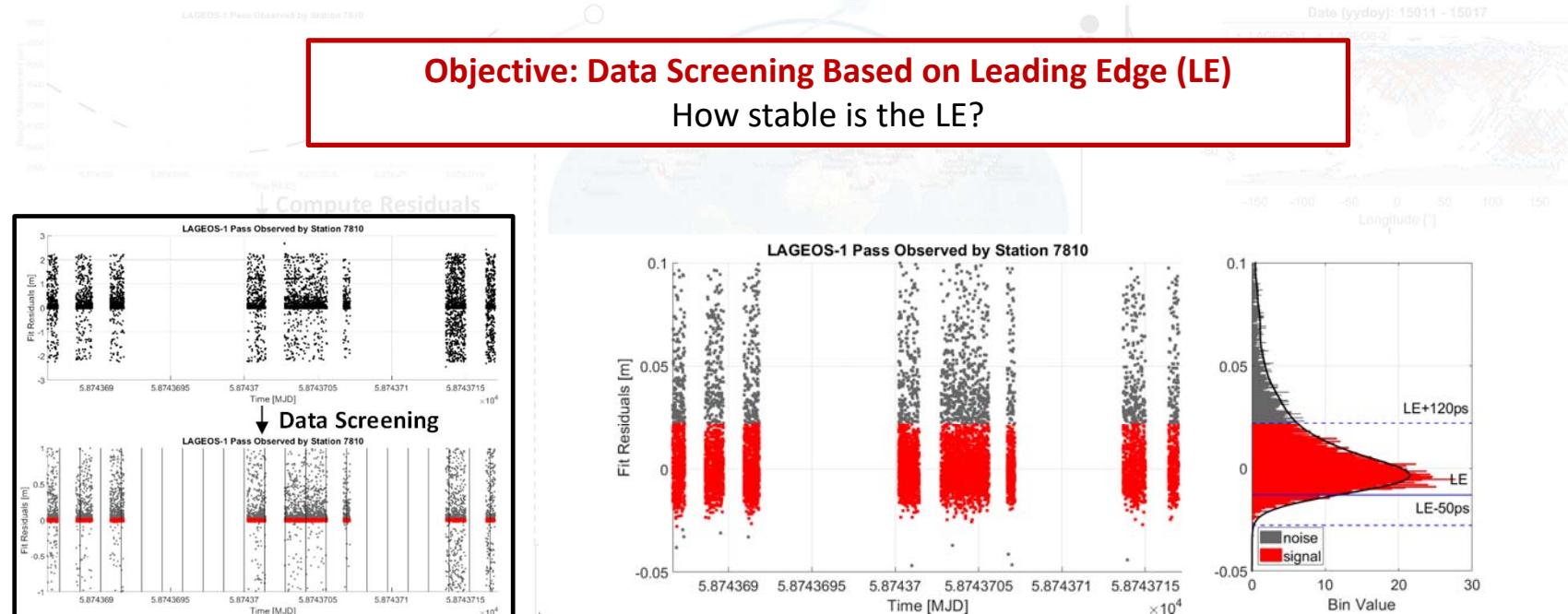


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Objectives

Objective: Data Screening Based on Leading Edge (LE)

How stable is the LE?

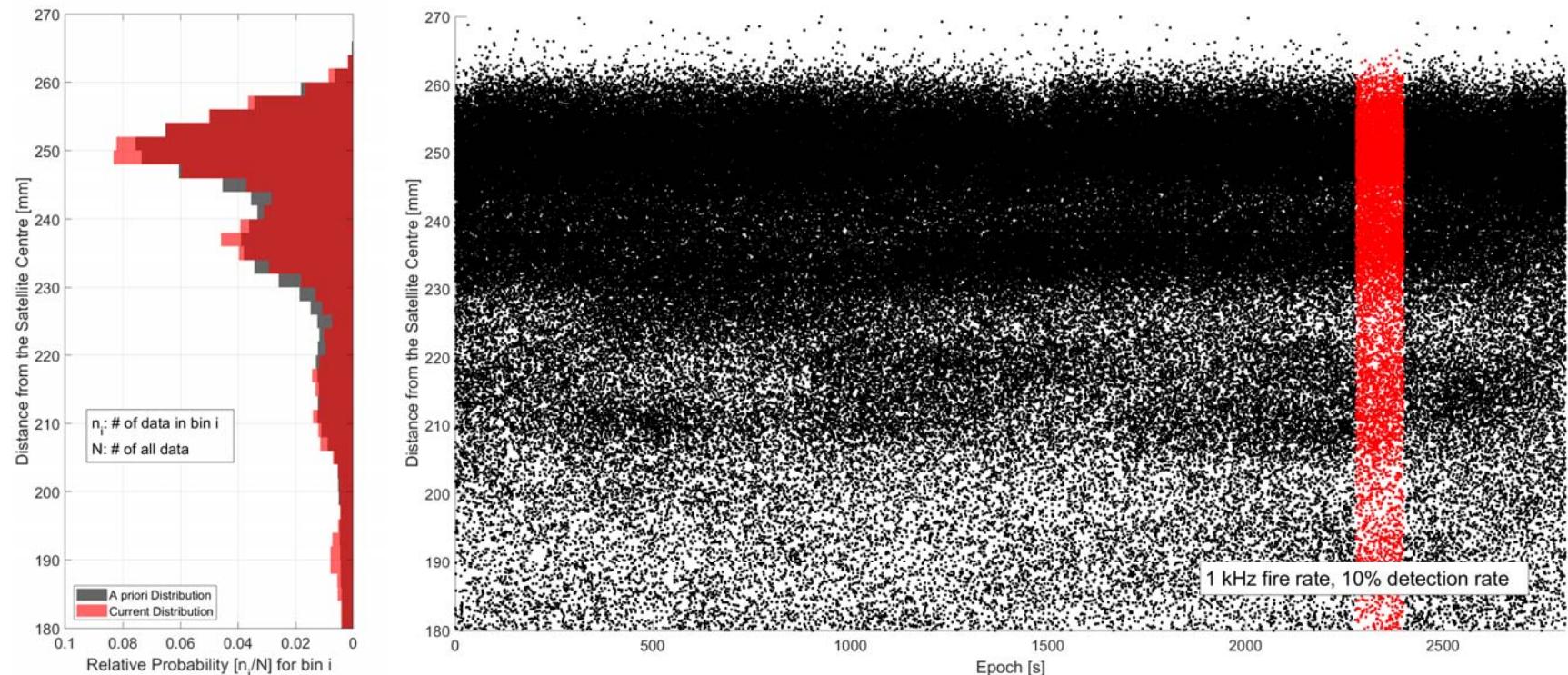


Simulation Study

1. Simulation of Fit Residuals (based on modelled distributions)
2. Find LE
3. Assess the quality of LE

- Introduction
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 - Modelled Distances from Satellite Centre
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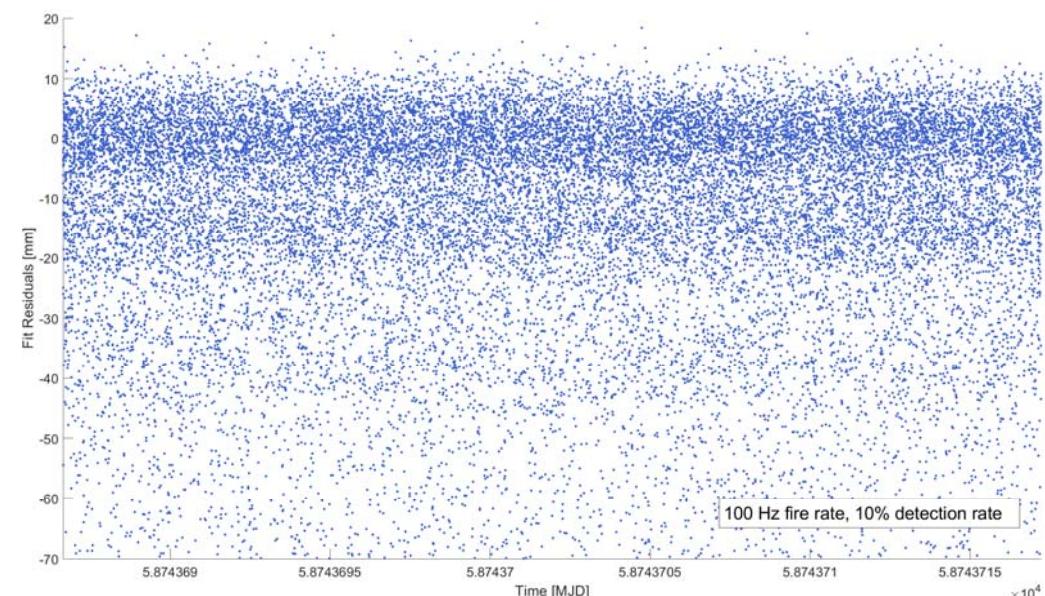
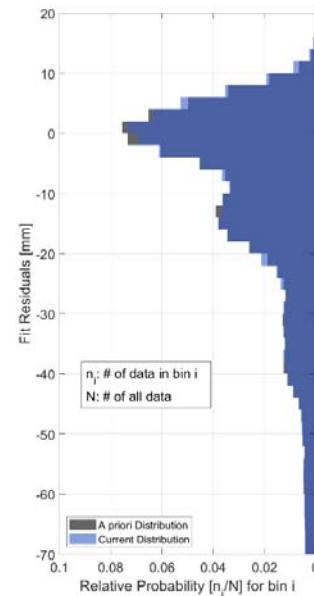
Modelled Distances from Satellite Centre: Over Pass vs Per Bin



Simulation of Fit Residuals

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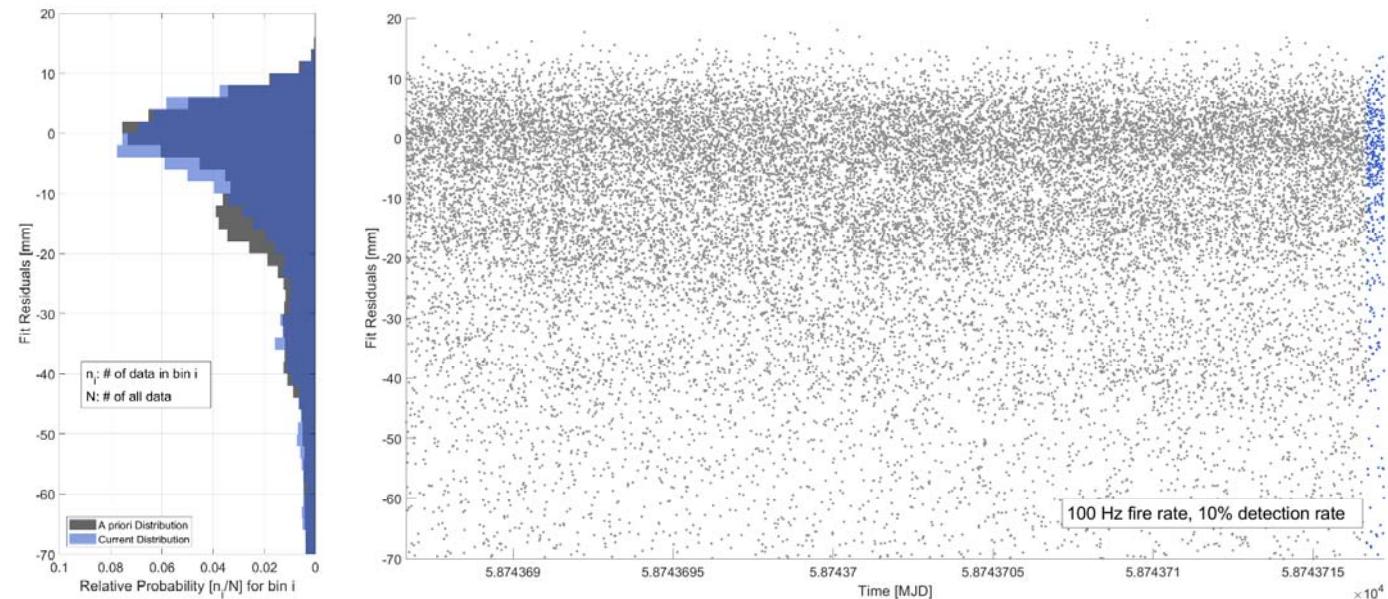
- Simulation of **fit residuals** of a LAGEOS-1 pass
 - Modelled distributions of distances: **averaged over pass**
 - Return rate: 10%
 - Length of the pass: $\sim 45\text{min}$
 - Repetition rate of the laser: 1 kHz



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- Simulation of **fit residuals** of a LAGEOS-1 pass
 - Modelled distributions of distances: averaged over pass / **per bin**
 - Return rate: 10%
 - Length of the pass: ~45min
 - Repetition rate of the laser: 1 kHz / 100Hz



Find Leading Edge

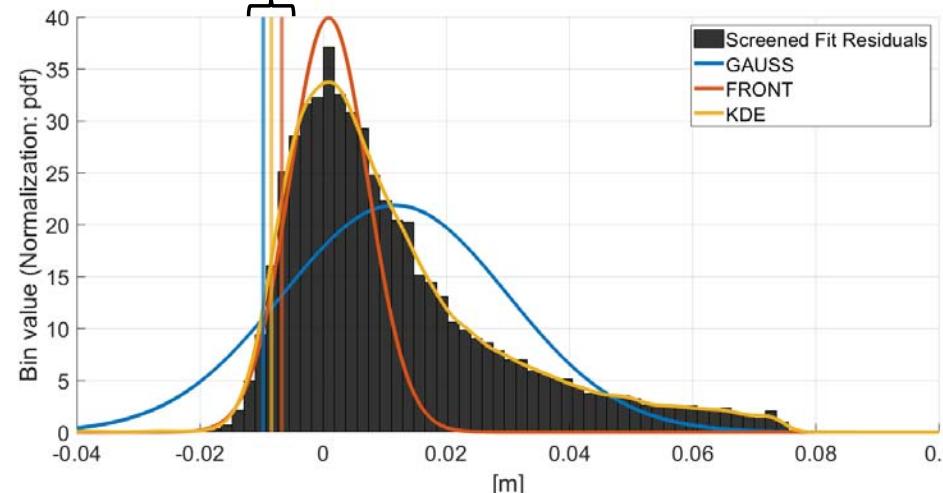
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Acronyms:

- LE: Leading Edge

- Find **Leading Edge (LE)** of the distribution of simulated fit residuals assuming
 - Gaussian distribution
 - Gaussian distribution to the front
 - Kernel distribution

LEHM = Leading Edge of Half Maximum



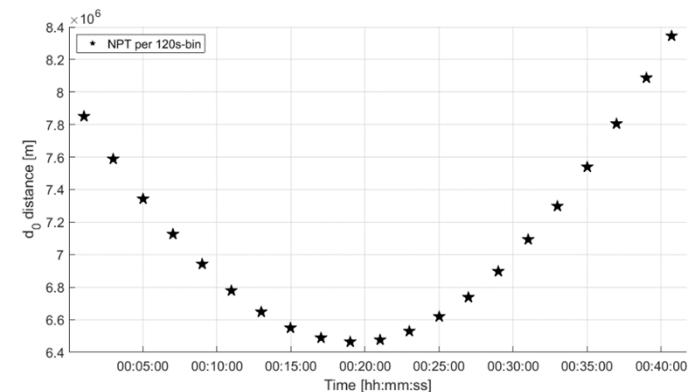
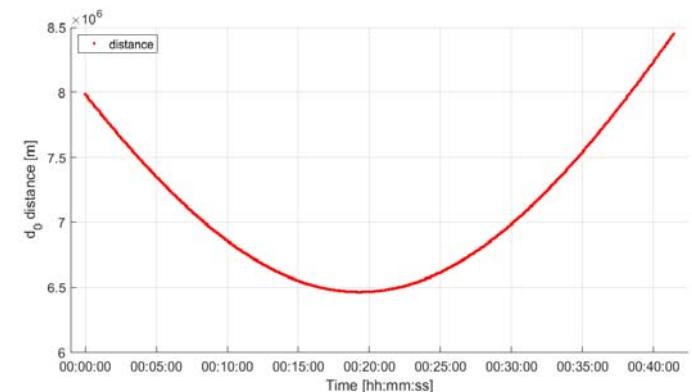
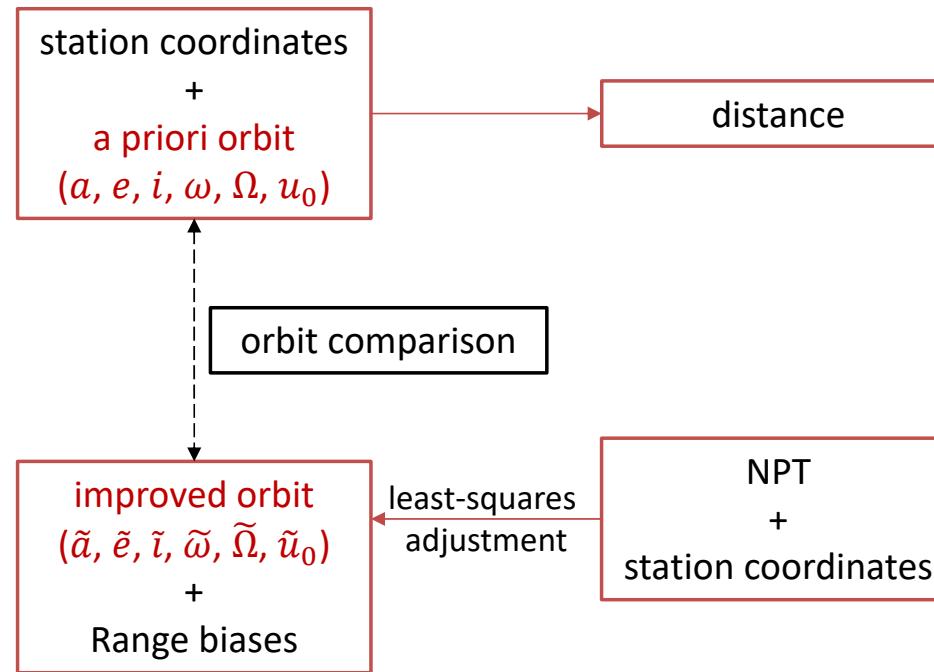
Conclusions:

- Mean LE depends on the screening method and, therefore, requires an adjusted CoM correction
- Stability of LE depends more on the repetition rate than the assumed distribution

Orbit Reconstruction

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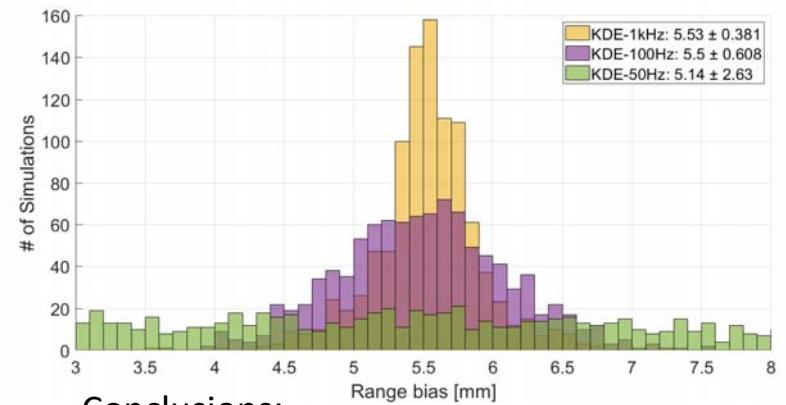
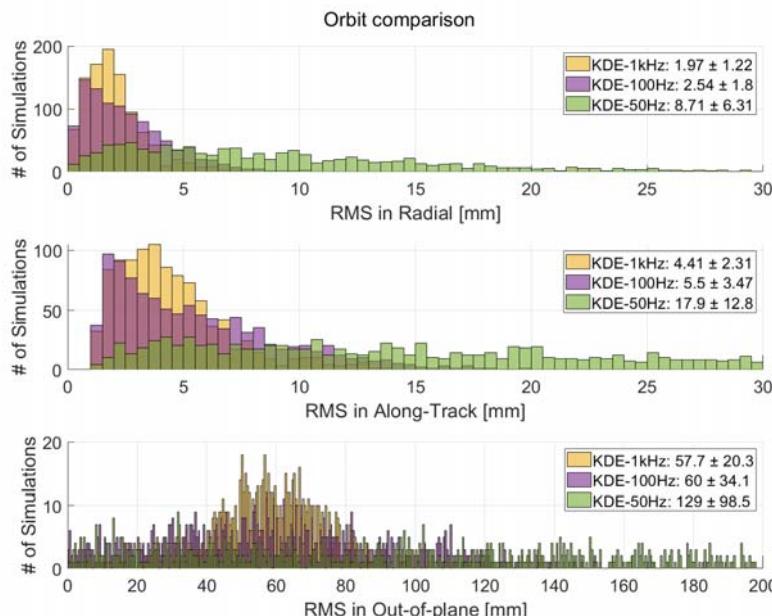
- **Orbit reconstruction** by improving the orbit elements based on the NPT in a least-squares adjustment



Orbit Reconstruction

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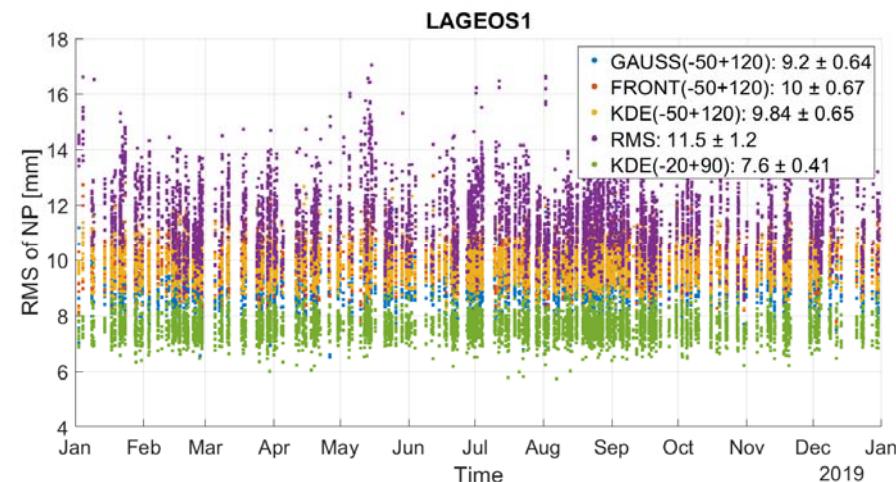
Conclusions:

- Stability of LE is reflected in the orbit reconstruction
- Orbit comparison strongly depends on the constraints of the orbit parameters

NPT Generation

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- Data set: Full-rates to LAGEOS-1/2 from Herstmonceux for year 2019
- NPT generation with different screening approaches
 - LE with assumnig **Gaussian**, **Gaussian to the front** or **KDE** distribution with clipping limits of -50ps and +120ps around LE
 - **2.5*RMS** around mean
 - LE with assuming KDE distribution with clipping limits of -20ps and +90ps around LE
- RMS level of the generated NPT



Summary & Outlook

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- **Conclusions & Outlook**

- Simulation study
 - Development of a simulation study to **assess the stability of the Leading Edge**. (Higher repetition rates increase the stability of the LE.)
 - Performance of an **orbit reconstruction** to measure the loss of information due to data compression.
 - Introduction of **more realistic observation conditions** (observation gaps, remaining trends in fit residuals,...).
 - Integration of simulations from **several stations** at different times to study the impact of the NPT formation on a global scale.
- NPT generation based on real full-rate data from HERL
 - The **level of the RMS** depends on the NPT formation approach.
 - **NPT generation for other SLR stations.**



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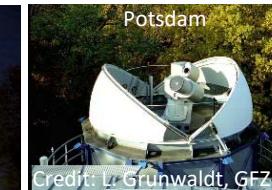
- Generation of NPTs for more and other SLR stations



Credit: ILRS webpage



Credit: Christian Kettnerbach



Credit: L. Grunwaldt, GFZ



Credits: Tyson Hartley

...

Wish for the SLR stations:

Could you please provide the full-rate data including all returns within a limit of, e.g., $\pm 5\sigma$.

Thank you for your attention!

Contact: linda.geisser@unibe.ch

