On The Calibration of TanDEM-X Precise Baselines via SLR

Rolf König, Yongjin Moon, Ludwig Grunwaldt

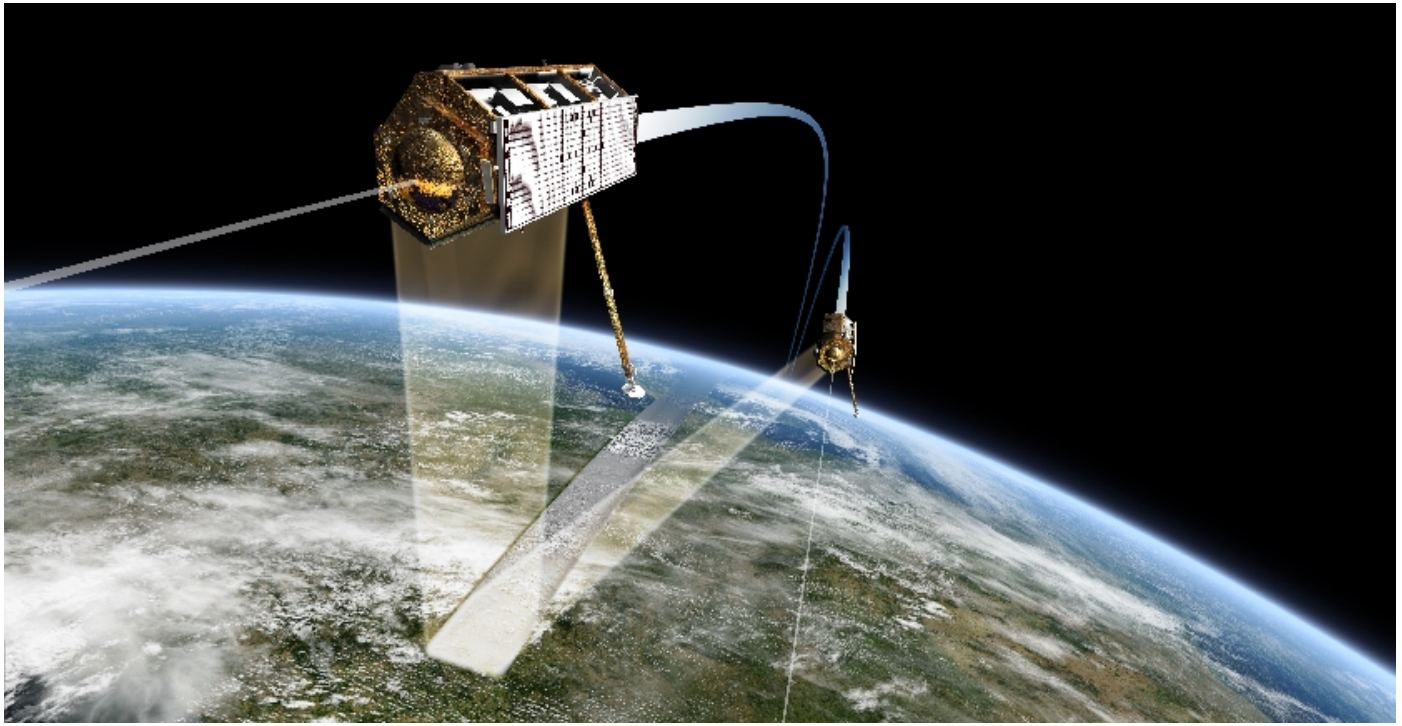
GFZ German Research Centre for Geosciences

Content

- TanDEM-X mission
- Baseline generation and accuracy
- The idea to validate baselines via SLR
- Results

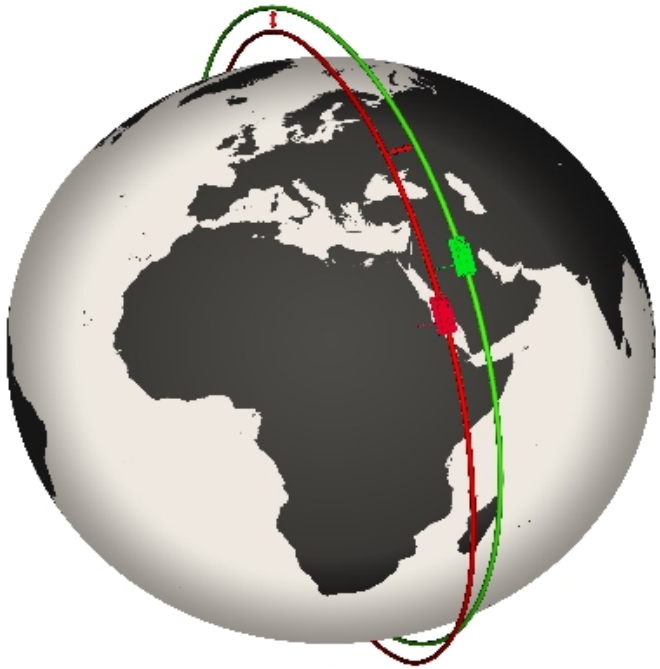
TanDEM-X Mission

- Twins TerraSAR-X (*070615) and TanDEM-X (*100621)
- Objective: Global DEM with 2 meter height accuracy



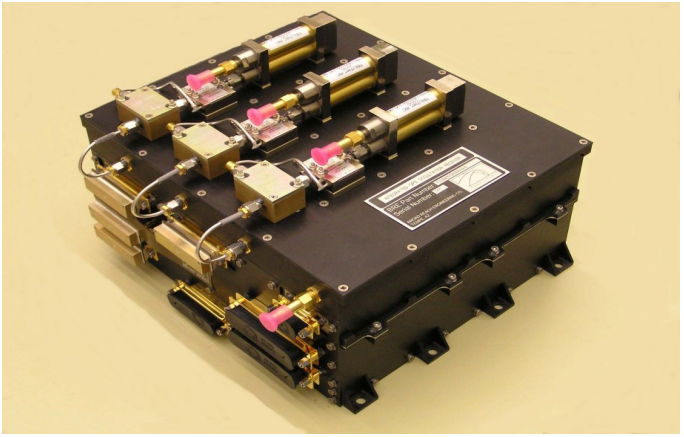
TanDEM-X Mission, II

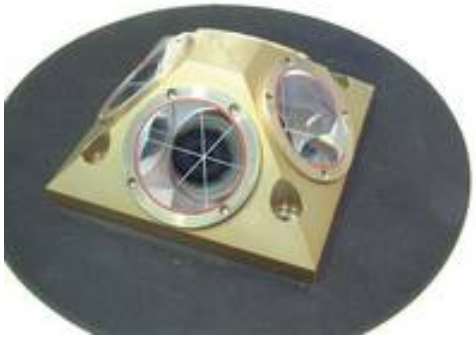
- Satellite size 5 x 2.4 x 2.4 m^3
- Close formation: “Helix”
  - Cross-track distance at equator: 360 m
  - Radial distance at pole: 400 m
  - Mean along-track distance: 0 m
- Circular dusk-dawn orbit
  - Altitude 514 km
  - Inclination 97.4 deg
  - 11 day repeat

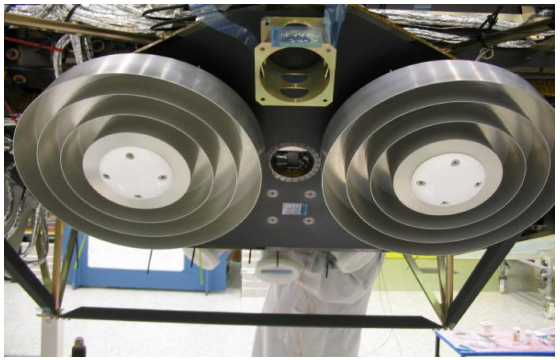


TOR Instrument

- Integrated GPS Occultation Receiver (IGOR)
  - JPL Blackjack -> Broadreach Inc., USA
  - Geodetic grade, two-frequency receiver
  - Choke rings manufactured at GFZ
- Laser Retro-Reflector (LRR)
  - Housing manufactured at GFZ
  - Prisms from small company in Germany

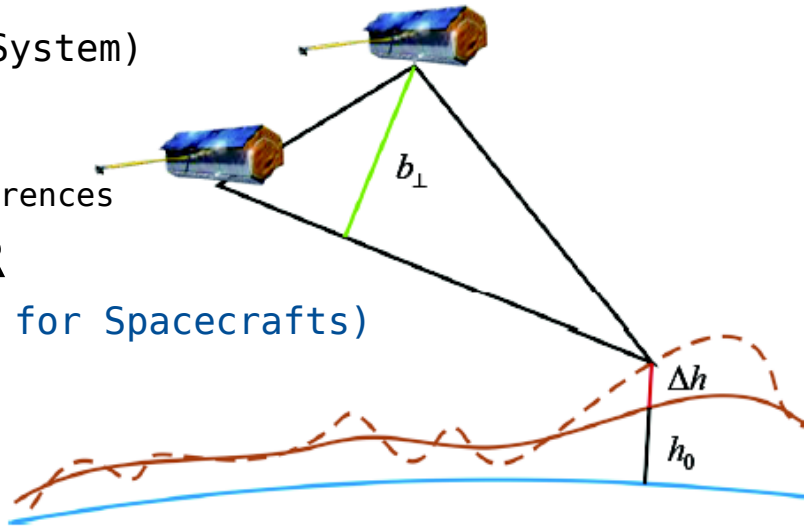






Baseline Generation

- Baseline = prerequisite for DEM processing
- Baseline determination
  - Operationally within TDX ground segment (G/S)
  - Purely from space-borne GPS measurements
- TDX ground segment baseline provider GFZ
  - Two chains:
    - EPOS (Earth Parameter and Orbit System)
      - Dynamic POD, zero differences
    - BERNESE
      - Reduced-dynamic POD, single differences
- Additional baseline from DLR
  - FRNS (Filter for Relative Navigation for Spacecrafts)

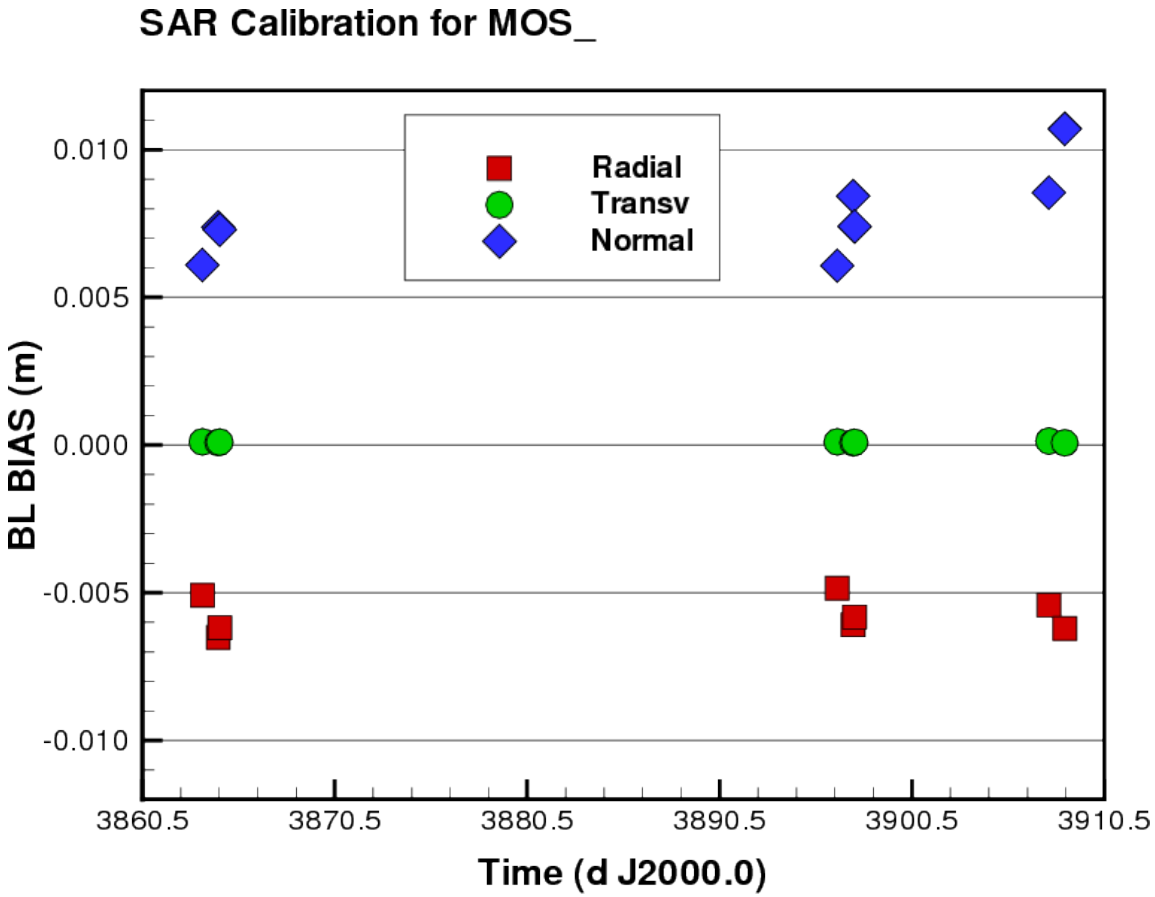


Pre-Flight Validation via GRACE

- Comparison of all software solutions with K-band range data (quasi truth in along-track due to µm accuracy)
  - Standard deviations at 0.8 mm
- Comparison between independent solutions
  - Systematic biases in the few mm
    - The G/S installed a bias calibration chain via SAR data takes over test areas
- Merging of solutions
  - Improves accuracy by ca. 20%

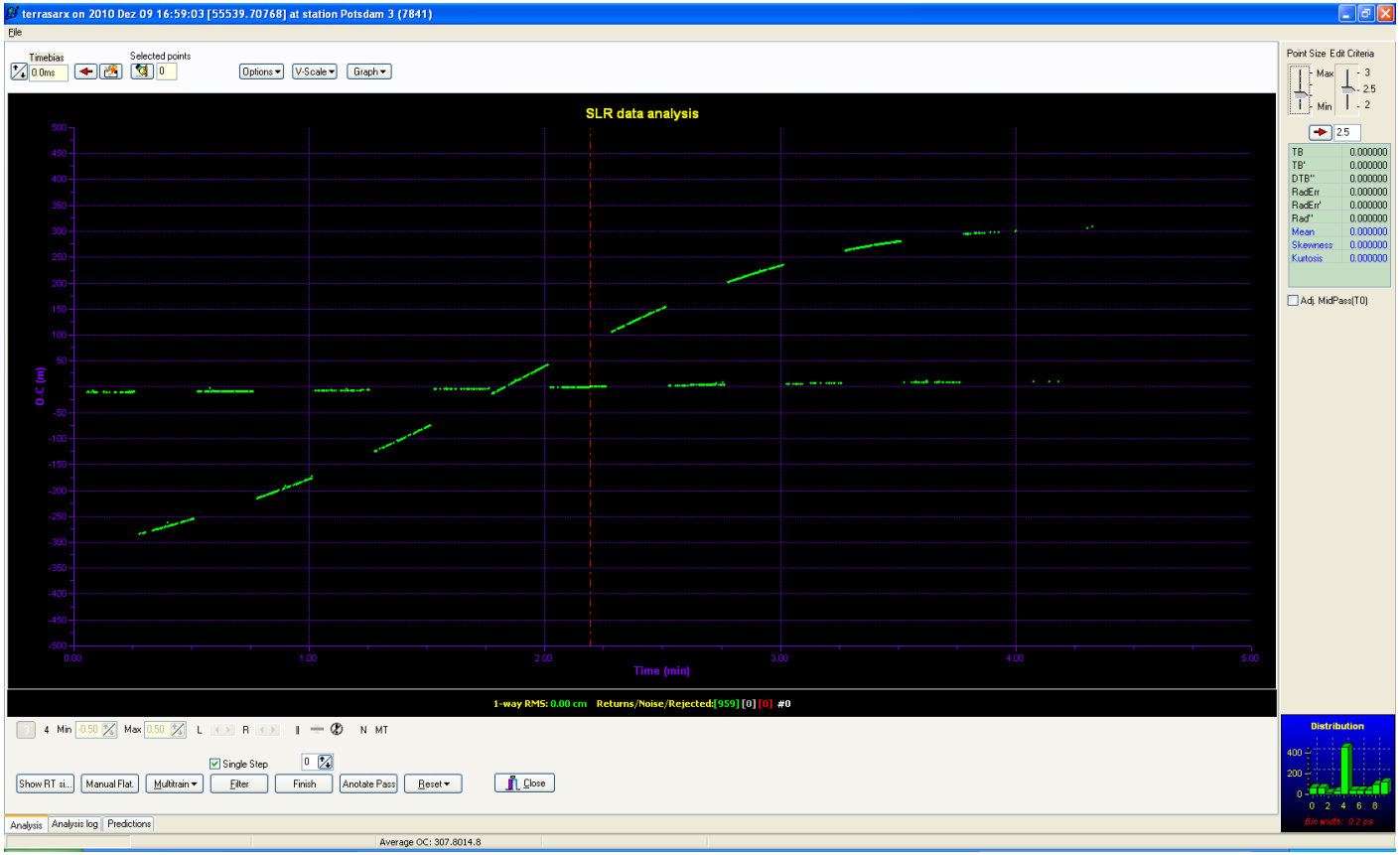
In-Flight Validation

- Repeat comparison of all software solutions and correlate with GRACE results
  - Standard deviations at the 1 mm and better
  - Biases at a few mm
- SAR calibration chain
  - Delivers biases in radial and normal direction



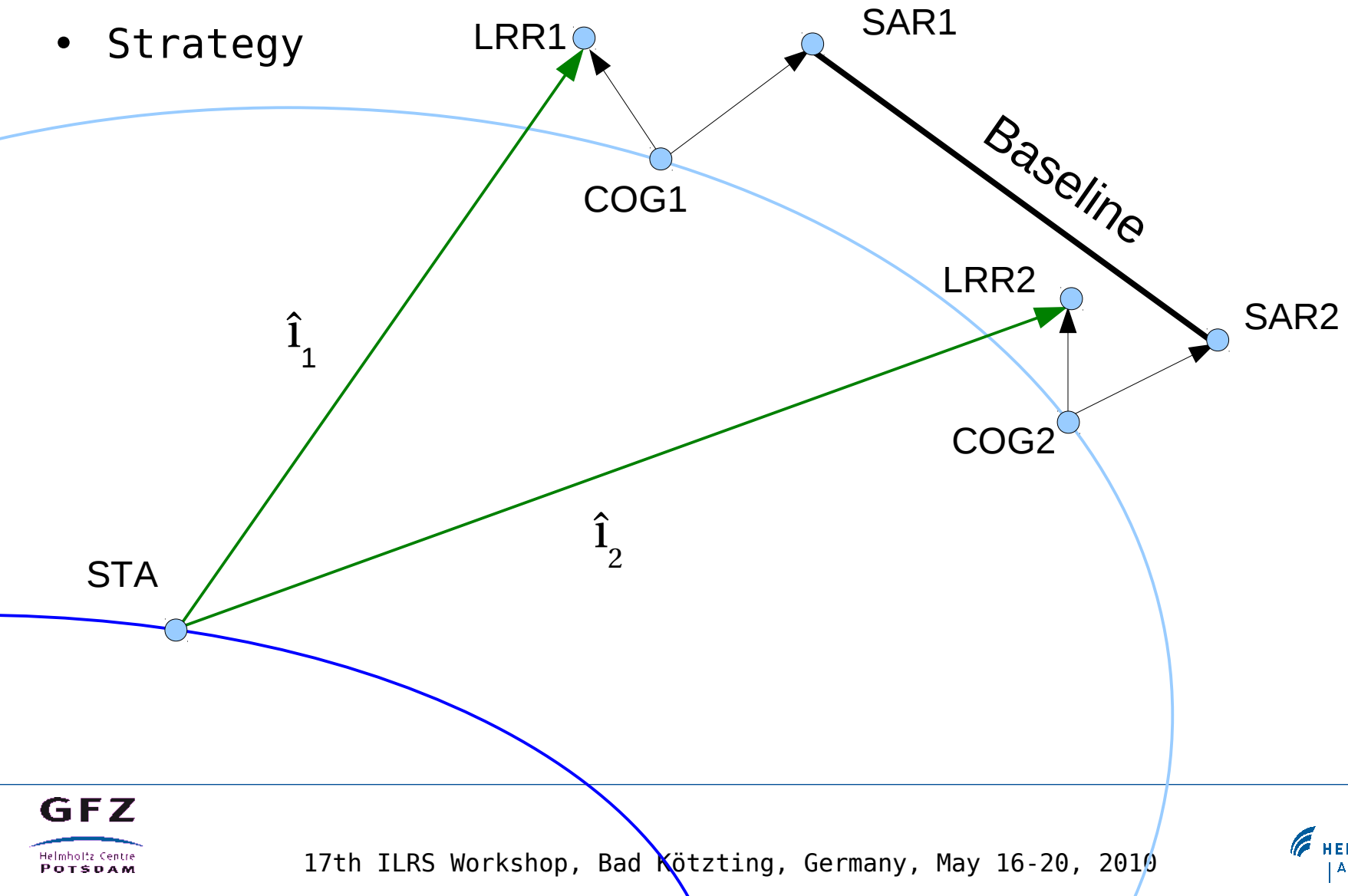
Validation via SLR

- Use interleaving tracking by Herstmonceux and Potsdam



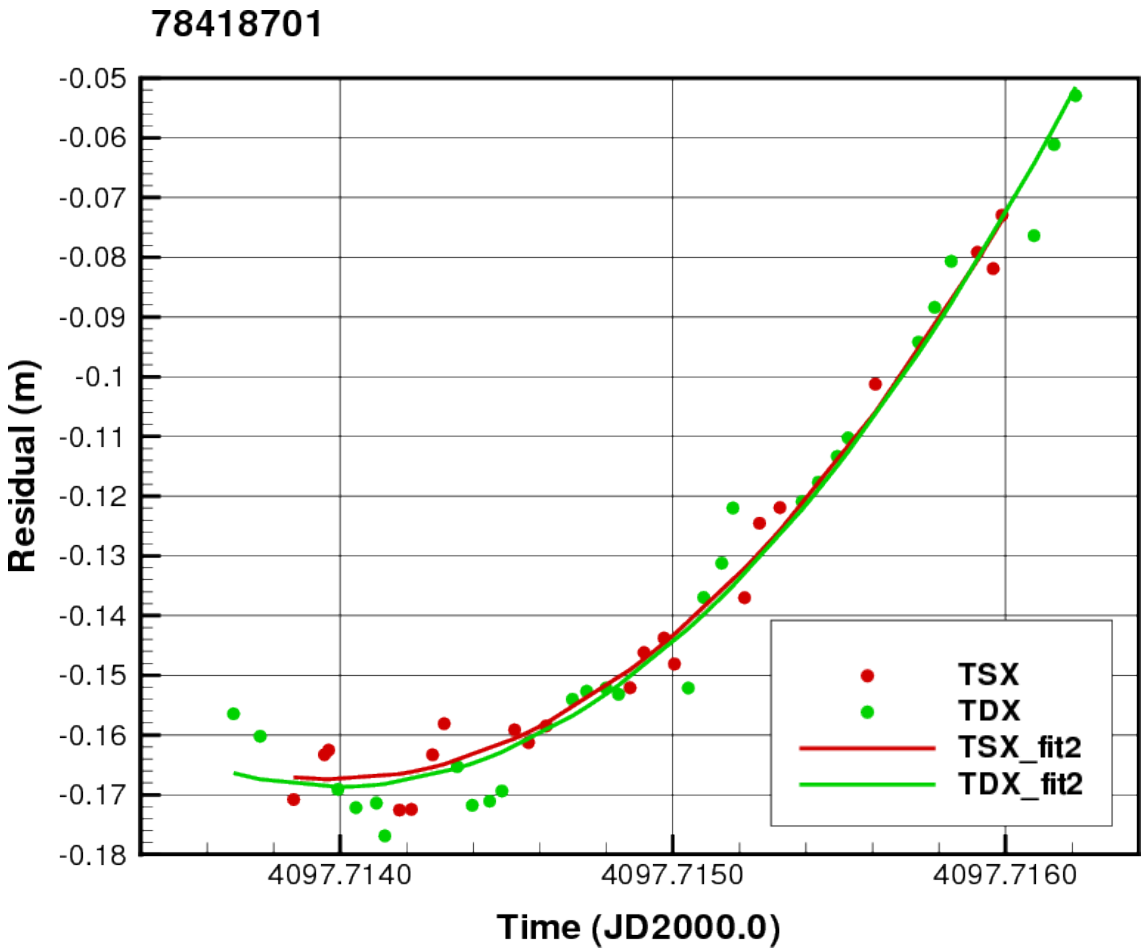
Validation via SLR, II

- Strategy



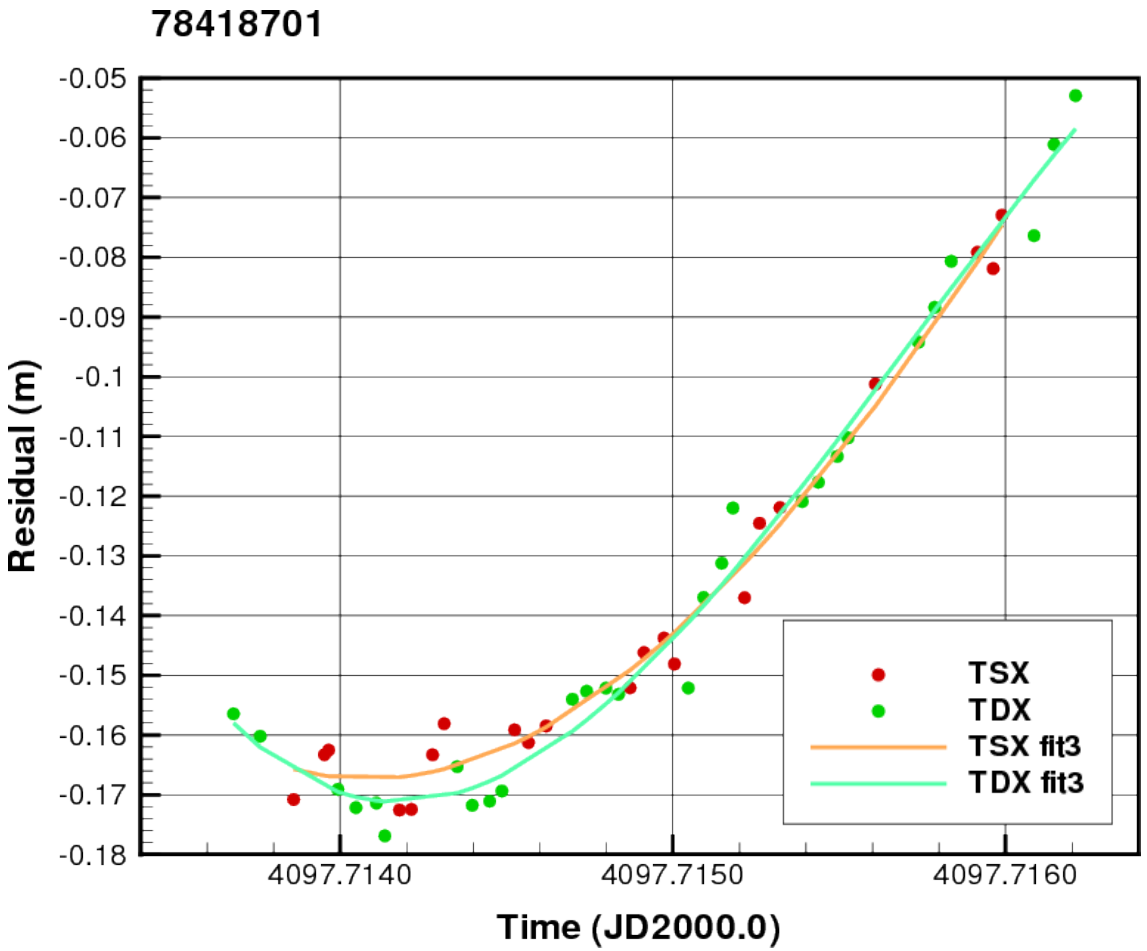
Results

- Character of POD residuals for Potsdam
- Polynomial fit of degree 2
- Fit:
  - TSX: 4.4 mm
  - TDX: 6.2 mm



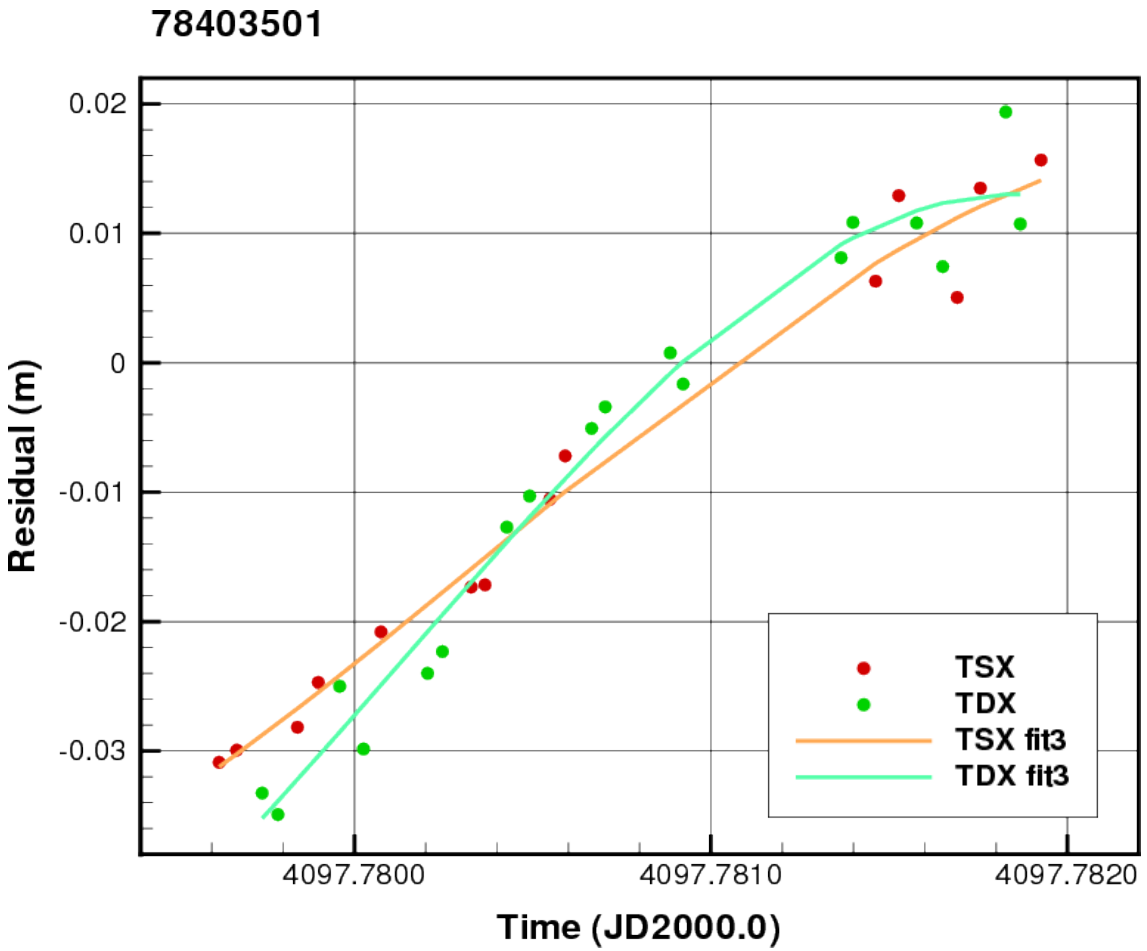
Results

- Character of POD residuals for Potsdam
- Polynomial fit of degree 3
- Fit:
  - TSX: 4.4 mm
  - TDX: 4.9 mm



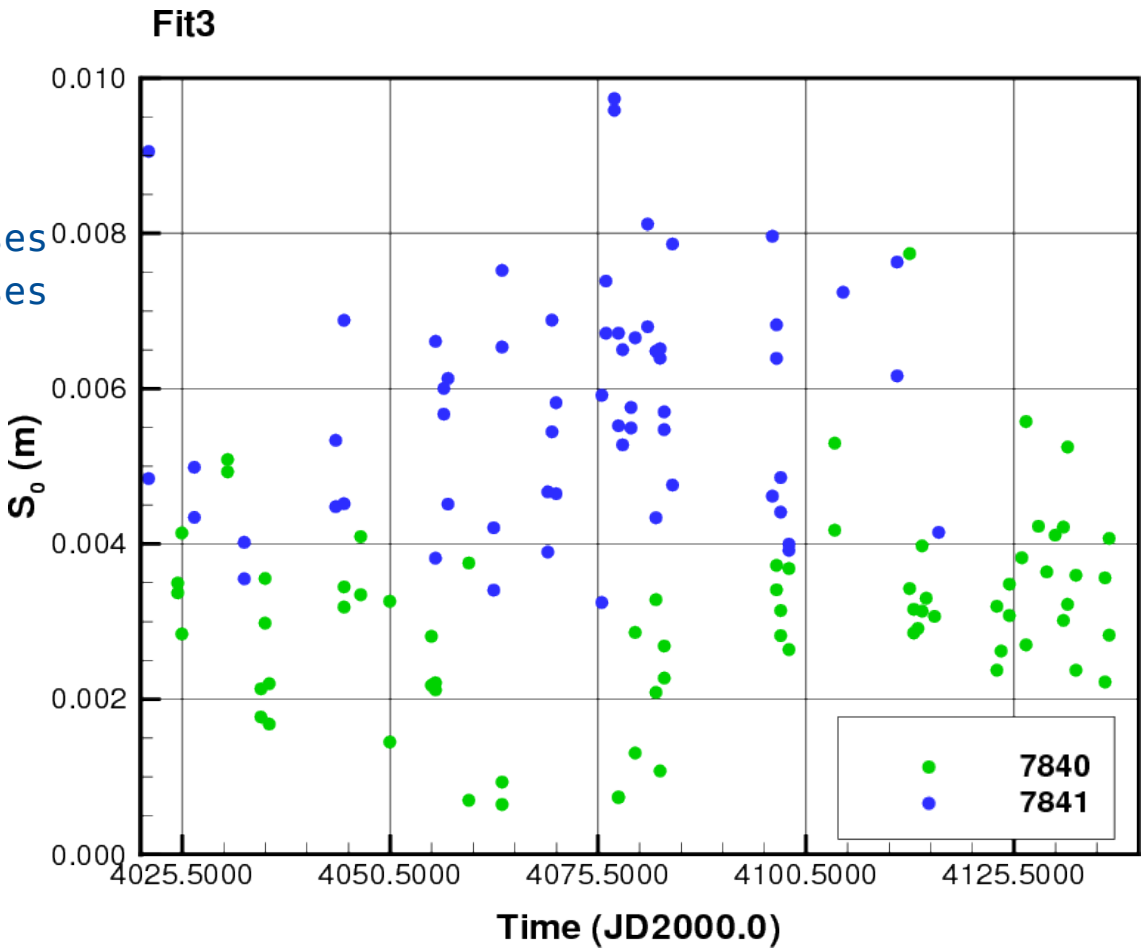
Results

- Character of POD residuals for Herstmonceux
- Polynomial fit of degree 3
- Fit:
  - TSX: 2.8 mm
  - TDX: 3.1 mm



Results

- Polynomial fit of degree 3
- Fit:
  - 7840: 3.3 mm / 81 passes
  - 7841: 5.6 mm / 66 passes



Summary

- Within the TanDEM-X ground segment precise baselines are generated with mm accuracy
- Validation is done via comparison of independent solutions and via SAR over test areas
- Interleaving SLR tracking of both satellites offers difference ranges
- Accuracies of the NPs are at the order of some mm
  -> probably too large
- Open:
  - Test full rate data
  - Impact of geometry