IGS 2026 WORKSHOP
SANTIAGO DE CHILE
33°26' S 70°39' O

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PGCGTG Pós-Graduação em Ciências Geodésicas e Tecnologias da Geoinformação

UFPE

Comparative Assessment of GNSS RTK Technologies for Cartographic Support

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Introduction & Motivation

Evaluating the performance of GNSS RTK on a controlled EDM calibration baseline

Context and Problem

- Real-time GNSS positioning is now widespread in engineering, geotechnologies and land management.
- The vertical component shows greater variability than the horizontal ones, especially for height control.
- Most studies rely on isolated benchmarks, rarely assessing the internal geometric consistency of the solution.
- A reference baseline with controlled geometry offers a more robust way to validate GNSS positioning.

Objective

Assess the performance of GNSS RTK on the Avenida dos Reitores calibration baseline (UFPE), focusing on the vertical component and three dimensions of quality:

Repeatability
Dispersion across 8 occupations per point in each campaign.

Geometric consistency
Agreement between the two field campaigns.

Accuracy
Discrepancies relative to the reference coordinates.

Study Area — Calibration Baseline

- Seven materialized landmarks (P1–P7) in a defined linear geometry, in an urban setting.
- Originally built to calibrate EDM instruments; validated under ISO 17123-4 and NBR 13133.
- Official SIRGAS2000 coordinates used as reference values.

Baseline layout (P1–P7). Source: Carvalho et al. (2025).

Methodology — Two Scenarios

- Receiver CHC i50 in RTK mode, base at benchmark EPS04.
- Two independent series × four repetitions = 8 occupations per point; fixed solution required throughout.

Scenario A — Fixed base
Base coordinates entered manually from the known EPS04 benchmark values.

Scenario B — PPP base
Base tracked continuously for ~1 h 20 min; coordinates estimated by IBGE PPP (SIRGAS2000) and applied as corrections.

Statistical Framework

Three analysis stages, using descriptive statistics and error metrics (σ, CV, RMSE) for the N, E and geodetic height (h) components.

1

Internal repeatability

Dispersion of the 8 occupations per point (σ and CV).

2

Between campaigns

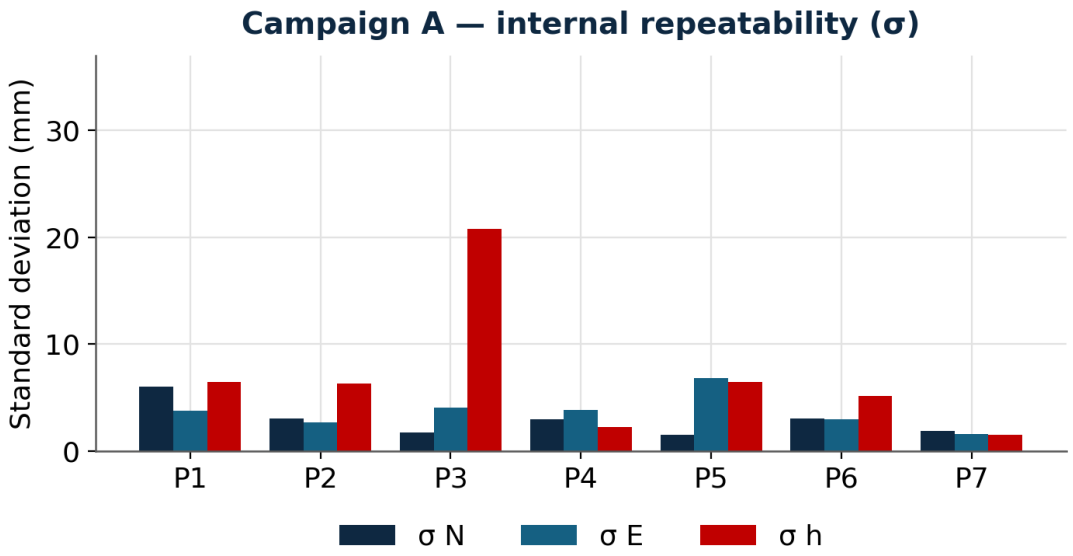
Coordinate differences (ΔN, ΔE, Δh) and RMSE between A and B.

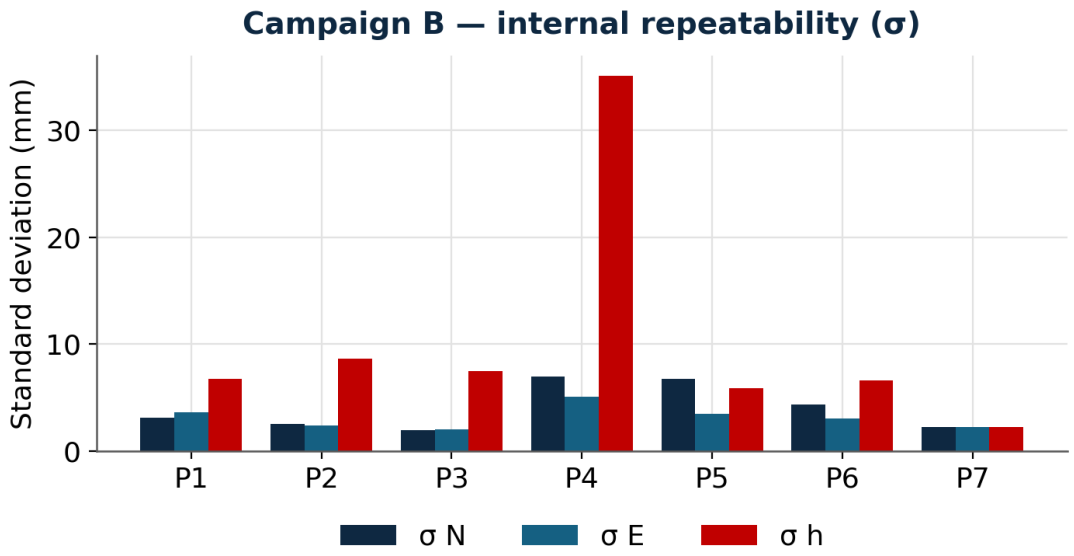
3

Height geometry

Internal Δh between consecutive points, does the height profile match?

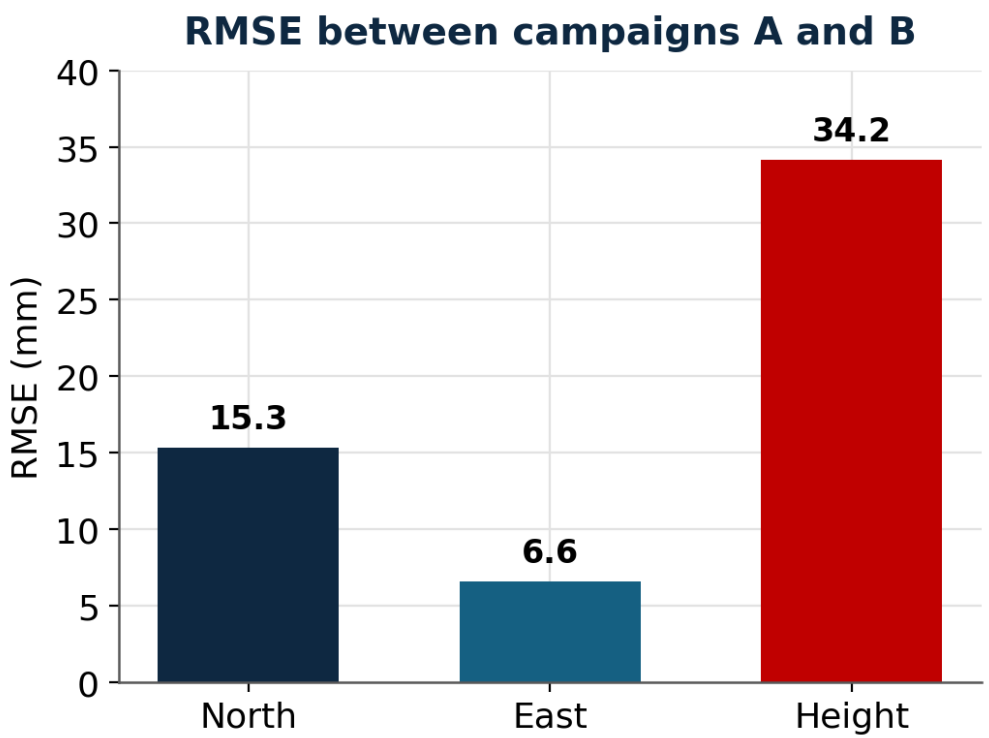
Internal Repeatability





Planimetry is highly stable (σ of a few mm); the height component dominates dispersion, with point-specific outliers (P3 in A, P4 in B).

Comparison Between Campaigns



- Planimetric differences are centimetric; ΔN is systematically positive across all marks.
- The vertical RMSE (34 mm) clearly exceeds the horizontal ones; all Δh are negative.
- Same day, points, equipment and parameters → the shift is attributable to base-coordinate strategy, not random or instrumental effects.

Inter-point Height Differences

Segment	A Δh (mm)	B Δh (mm)	B − A (mm)
P1–P2	+51.7	+51.0	−0.7
P2–P3	+113.0	+104.3	−8.7
P3–P4	+183.0	+212.3	+29.3
P4–P5	+116.2	+104.4	−11.8
P5–P6	−249.2	−260.8	−11.6
P6–P7	+45.2	+70.1	+24.9

B agrees with A within ~12 mm in four of six segments. Two segments stand out (P3–P4 and P6–P7, both ~25–30 mm). Overall, the shift between campaigns is mostly an absolute translation, not a deformation of the baseline shape.

Conclusions & Future Work

- **Repeatability:** within a group of measurements, RTK is consistent. Between groups at the same point and same base, divergences appear, especially at P3 and P4. RTK does not repeat perfectly across different moments.
- **Accuracy:** treating Campaign A as reference, Campaign B shows a systematic shift, mostly in the height. The baseline shape is preserved, a translation, not a deformation.
- **Future work:** test new technologies (e.g., Trimble RTX) and assess their positional quality; longer static survey at each point for a stronger reference; repeated campaigns on different days.

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Thank you

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