Absolute Robot-Based GNSS Antenna Calibration at the Senate Department for Urban Development and the Environment in Berlin Germany

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Absolute Robot-Based GNSS Antenna Calibration

Motivation

For precise geodetic measurements a detailed knowledge of receive characteristics of the used GNSS antennas is necessary.

The consideration of antenna calibration data has become common praxis for all GNSS measurements and analysis with a high level of accuracy.

Especially for the exact definition of heights the calibration data are indispensable.

Absolute Robot-Based GNSS Antenna Calibration

Main task

the determination of absolute antenna phase center offsets and variations (PCV) without influence on any reference antenna.

Application

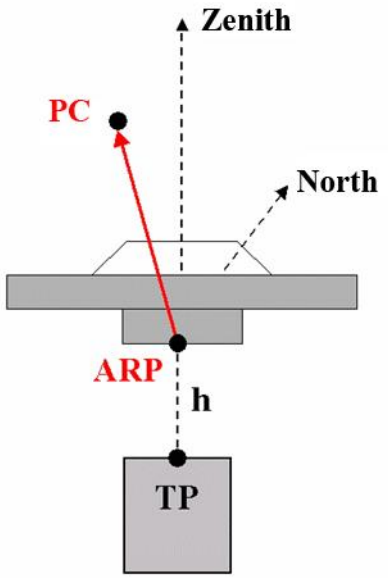
- for any mixed antenna type GNSS
- RTK networks
- precise GNSS engineering tasks
- for global and scientific GNSS applications

Antenna Phase Center Offset and Variations (PCV)

- ARP – Mechanical reference point of the antenna
- PC – electro-magnetical phase center from the received satellite signals

- PC depends on the satellite positions and the orientation of the receiver antenna
  ➔ ARP and PC are not coincident

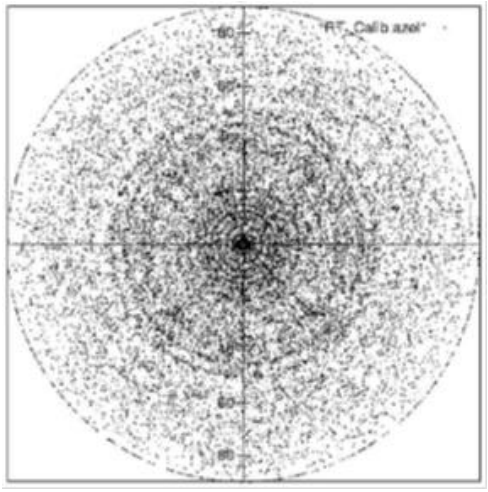
- PCV depends also on the frequency of the phase signals



Absolute Robot-Based GNSS Antenna Calibration

Basic information

- tilting and turning GNSS antennas
- uses actual GNSS signals
- atmospheric and orbit errors can be eliminated by using a near reference station
- the result is a homogeneous coverage of the hemisphere

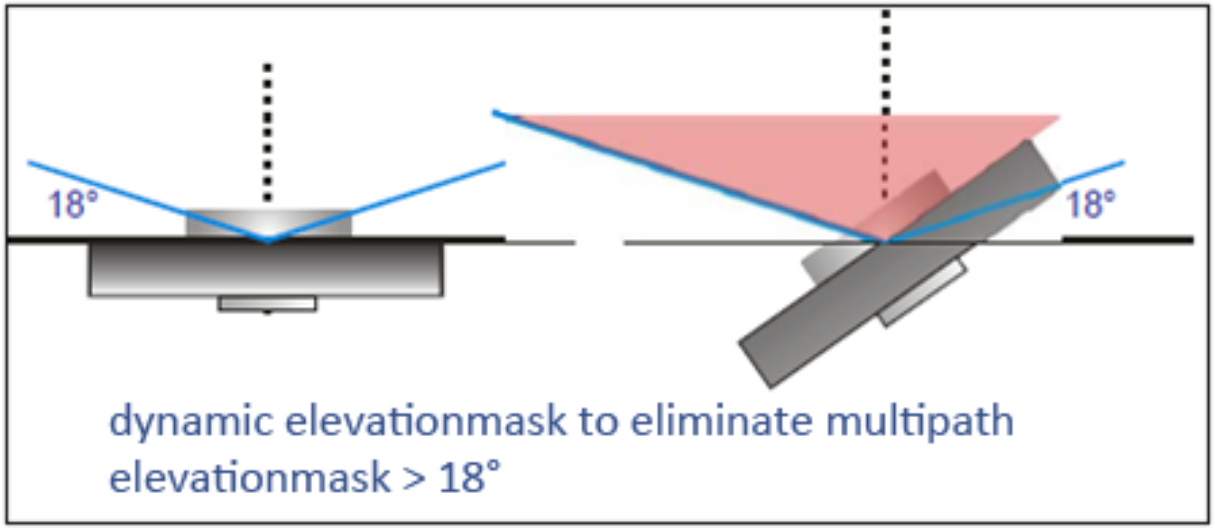


typical antenna coverage from robot-based calibration

Absolute Robot-Based GNSS Antenna Calibration

Basic information

- far-field multipath
  - locked out with a high elevation mask larger than 18°, dynamically adjusted to tilted orientations
  - eliminated by modeling and using high correlation between consecutive epochs (1-2s)
- also for observations at negative elevations

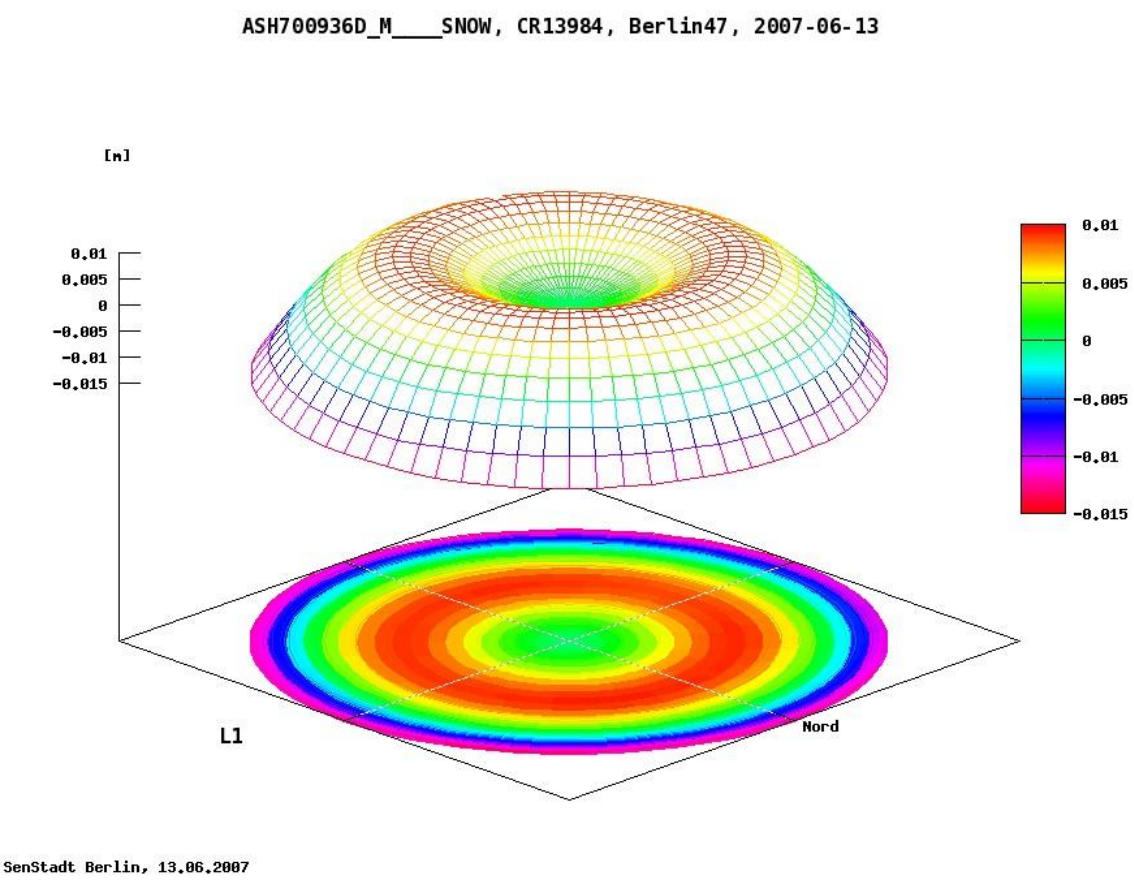


Features of Robot-Based GNSS Antenna Calibration

- absolute 3D offset (magnitude mm to cm)
- absolute phase center variations (magnitude mm to cm)
- PCV from (<) 0° to 90° elevation (5° steps)
- PCV from 0° to 360° azimuth (5° steps)
- simultaneous L1, L2 GPS and GLONASS PCV
- standard deviation of 0.2 ... 0.3 mm for the complete PCV (offsets plus variations)
- without influence on multipath
- site and locations independent
- verification of accuracy through repeatability

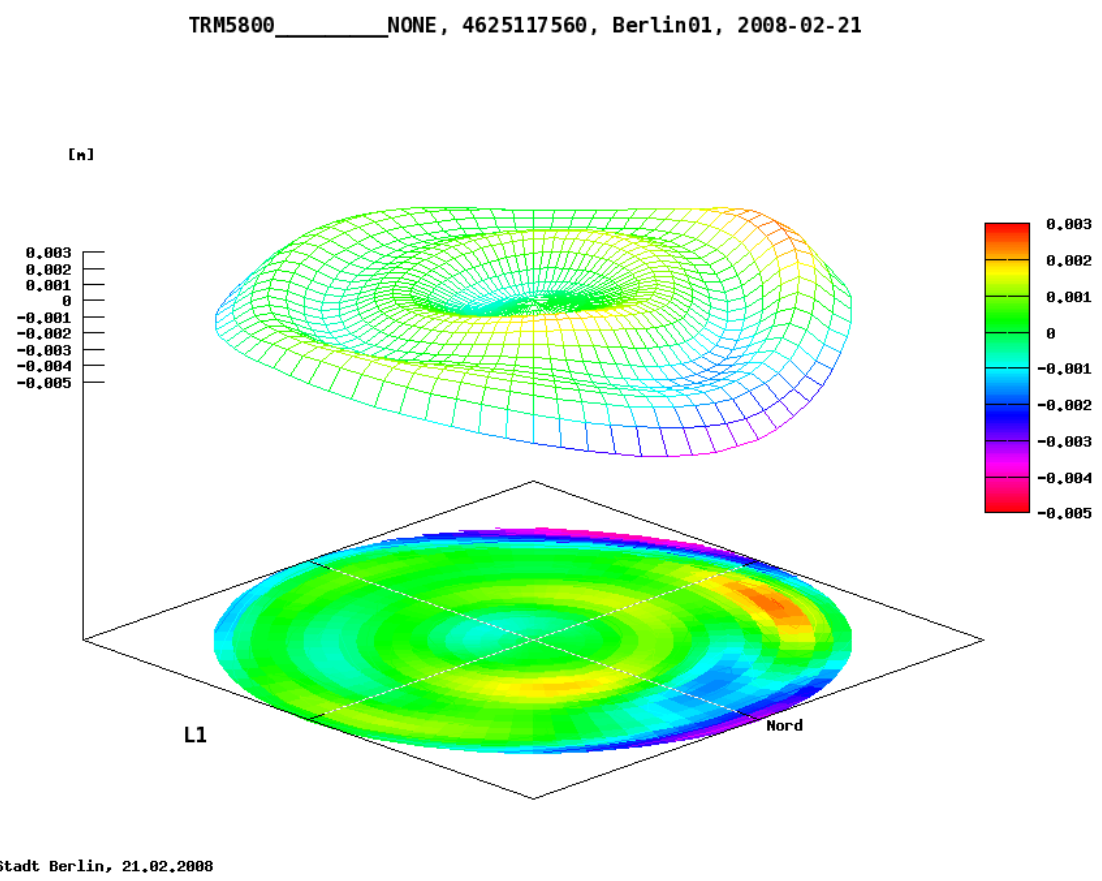
Findings

GPS PCV Pattern Ashtech GNSS Choke-Ring-Antenna L1



Findings

GPS PCV Pattern Trimble R8 GNSS Rover-Antenna L1



Antenna calibration in Berlin

robot-based GNSS antenna calibration developed and operated since 2000

2006 running of the complete system of robot-based absolute real-time calibration of GNSS antennas at the Senate Department for Urban Development and the Environment in Berlin

2013 complete renewal of the entire system

features and functionalities are always up to date

➔ that ensures the high precision of this calibration system

Antenna calibration in Berlin

- the process is constantly being developed and optimized
- it guarantees the latest state of the art
- results from different robots at different locations show no significant differences
- maximum deviation of 1mm is assumed in the PCV value
- price per antenna is currently 650 € (GPS and GLONASS)

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Thank you for your attention

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