## Absolute GNSS Antenna Calibration with a Robot: Repeatability of Phase Variations, Calibration of GLONASS and Determination of Carrier-to-Noise Pattern

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The absolute GNSS antenna calibration with a robot is operationally executed by Geo++ since 2000. In the last years, the conducted antenna calibrations produced an extensive database of individual antennas, different antenna types and setups. The robot calibrations can provide absolute phase center and variations (PCV) of GNSS antennas for the GPS and GLONASS observables L1 and L2 as well as antenna-receiver dependent carrier-to-noise decrease pattern.

Investigations on repeatability of individual GNSS antennas and models are possible using the Geo++ GNPCVDB database. The number of individual calibrations of one antenna type gives insight into the quality of antennas series. Also long-term analysis of individual antennas has been carried out. The analysis will focus on Dorne Margoline type antennas.

The GLONASS constellation was for a long time not sufficient to perform a GLONASS PCV calibration within a reasonable time period. However, with the current constellation several calibrations for different GNSS antenna types have been executed. The GLONASS PCV calibration differs compared to GPS, because of the different frequencies of individual GLONASSS satellites. Investigations on a frequency independent modelling of GLONASS PCV are presented.

Operationally, carrier-to-noise (CN0) pattern are estimated simultaneously with the PCV during a robot calibration. The CN0 pattern depends on antenna, wiring and receiver. Comparable antenna-receiver CN0 pattern are obtained using the decrease of CN0 instead of absolute values. CN0 pattern can be effectively used for weighting of GNSS observations. The general aspects of CN0 calibration and some examples are presented.

Investigations on GNSS antenna PCV, GLONASS PCV calibration and CN0 pattern using the absolute GNSS antenna calibration with a robot the will be discussed.