Application of Sub-mm GPS and Terrestrial Measurements for the Precise Measurement of an EDM Calibration Baseline

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EDM calibration baseline

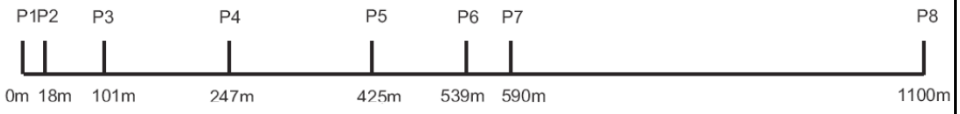
P1P2	18,7808m
P2P3	82,4572m
P3P4	146,1467m
P4P5	177,9788m
P5P6	114,2987m
P6P7	50,6254m
P7P8	509,6987m
P1P8	1099,9863m

measurement setup

4 antenna types
11 antenna (abs. labor. calibration)
2 receiver types

2 different installations

4 to 6 h observation time per session
10 sessions → 10 L1-baselines + 10 L2-basislines
10° elevation mask



result

Good GPS conditions

- **Constant near field**
- **Absolute antenna calibration**
  - **phase center offset**
  - **phase center variations**
- **Free horizon**
- **Small height differences**

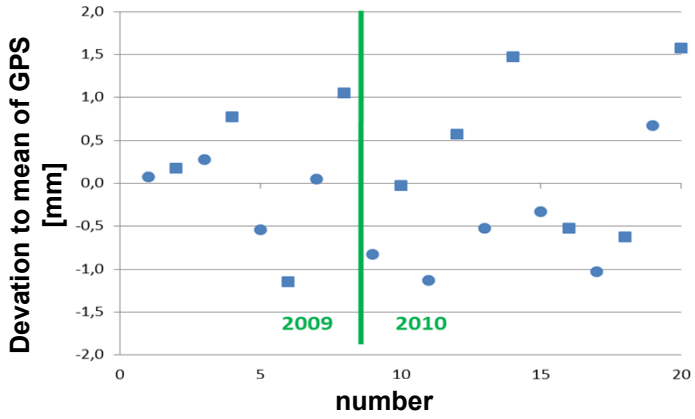
Standard deviation of single baseline 0.6 … 0.8mm

Standard deviation of mean value < 0.5mm

Is it true?

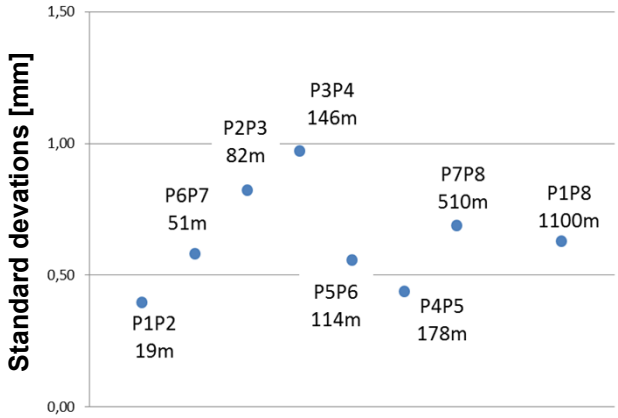
- **Inner accuracy: repetitions**
- **Comparison to precise levelling**
- **Comparison to terrestrial distance measurements**

Inner accuracy: repetition, baseline P2-P3

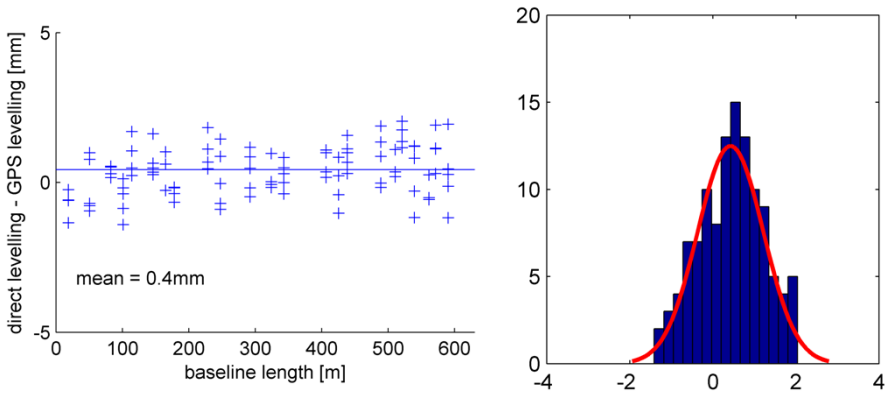


- **Empirical standard deviation s=0.8mm**

Inner accuracy: repetition, all baselines



Comparison to precise levelling



- **Reference: precise levelling of ARP, $_h$=0.5mm**
- **Empirical standard deviation s=0.8mm**

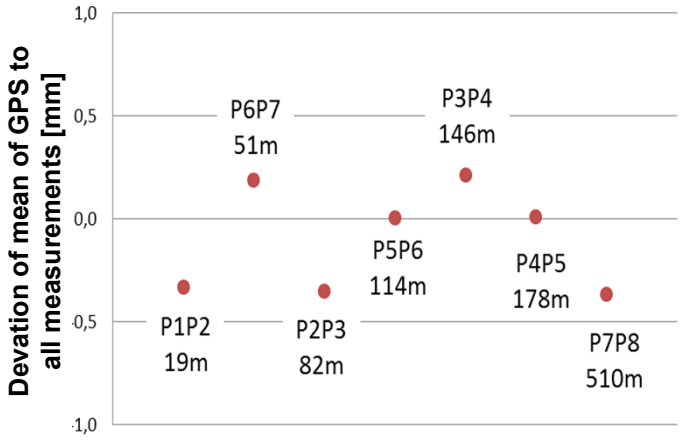
Accuracy estimation

Comparison to terrestrial distance measurements: adjustment of all observ.

institution	instrument	No of obs.	Max residual	
			From - to	[mm]
Uni Hannover	ME 5000	7	3 - 4	-0,28
TU Munich	ME 5000	7	2 - 3	-0,43
Uni Bonn	ME 5000	7	4 - 5	+0,40
UniBW Munich	ME 5000	7	7 - 8	**+0,67**
TU Karlsruhe	Leica AT 901	7	3 - 4	-0,12
TU Karlsruhe	Leica AT 401	3	2 - 3	+0,17
UniBW Munich	Leica AT 901	6	3 - 4	+0,12
Leica	4 Tacheometer	7	7 - 8	-0,33
TU Graz	Leica TCA 1800	7	5 - 6	+0,60
Uni Bonn	Leica TS30	7	4 - 5	+0,50
Uni Bonn	GPS	7	7 - 8	-0,33

Accuracy estimation

Comparison of GPS to terrestrial distance measurements



conclusions

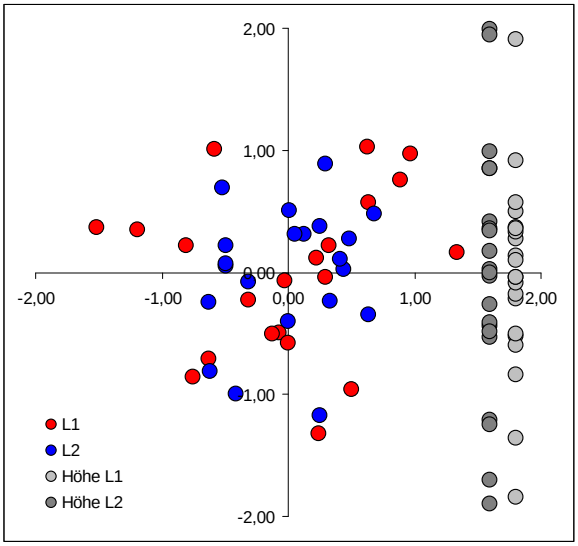
- **good GPS conditions**
  - **short baselines**
  - **small height differences**
  - **free horizon**
- **esp. calibration and near field of antenna**
- **observation time some hours**

GPS accuracy in sub-mm range

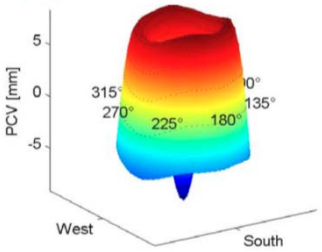
antenna calibration

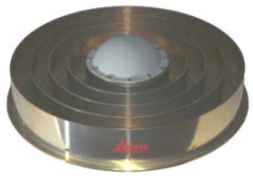
Variation of PCO:

21 Leica AR25R3 antenna

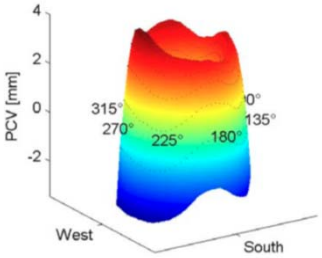


antenna calibration





Typical antenna:
- **PCV: up to 20mm**
- **elevation → strong**
- **azimuth → little**



laboratory calibration