



Impact of Robot Antenna Calibration on Smartphone-Based High Accuracy Positioning: A Case Study Using the Huawei Mate20X

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Background and Motivation



Is **reliable** smartphone-based
RTK-level positioning possible?



*1



*1 Darugna et al. (2019)

*2 Sharma et al. (2019)

*2



- Large **code noise** and **multipath** levels
→ **phase accuracy** is essential for
ambiguity resolution

- Can Phase Center Variations (**PCV**) corrections
improve the performance?
→ **antenna calibration**

Smartphone Antenna Calibration (1/4)



Geo++ Absolute Robot-Based Antenna Field Calibration

Processing:

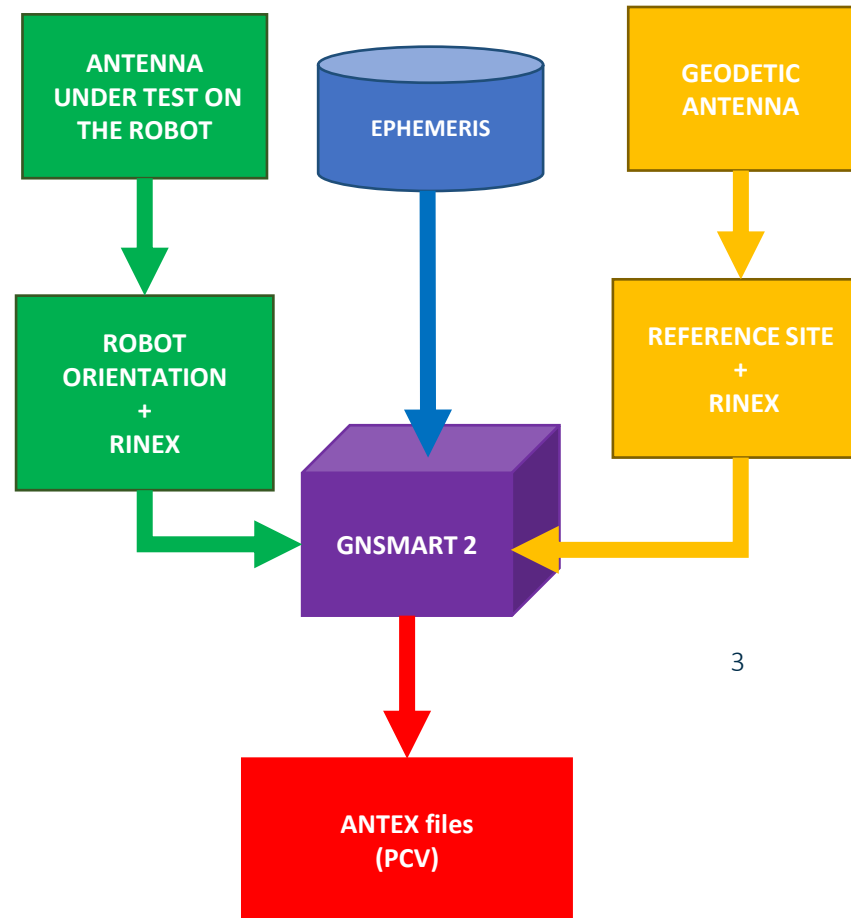
- **GPS + Galileo**
- **L1 + L5**
- **Uncombined**
observation model

Smartphone:

Huawei Mate20X

GNSS receiver:

Broadcom **BCM47755**

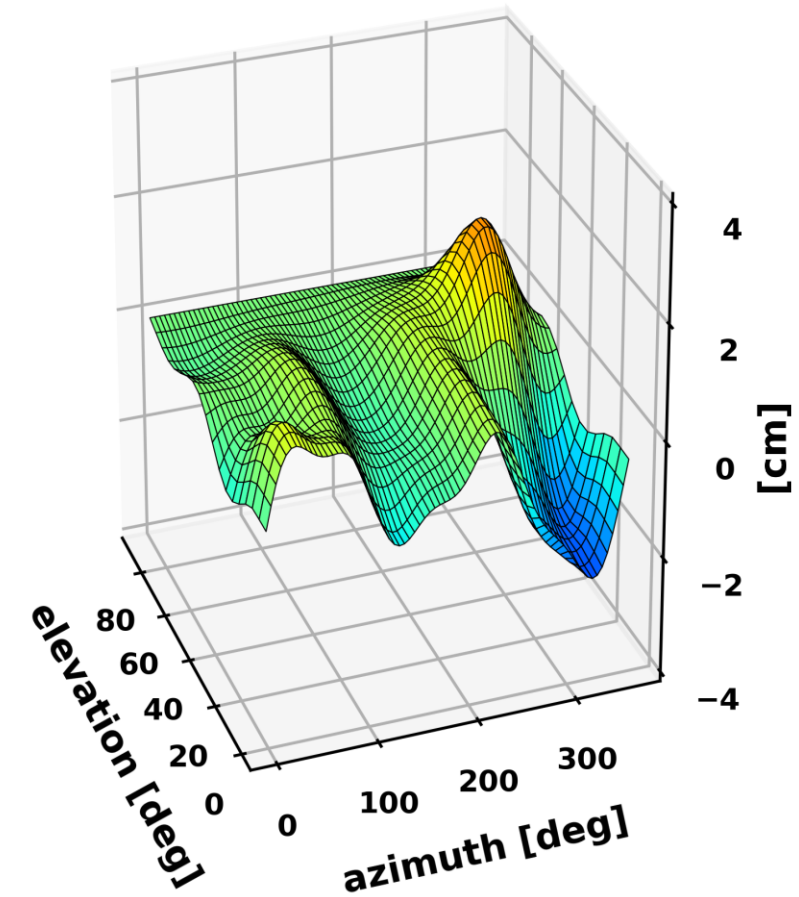
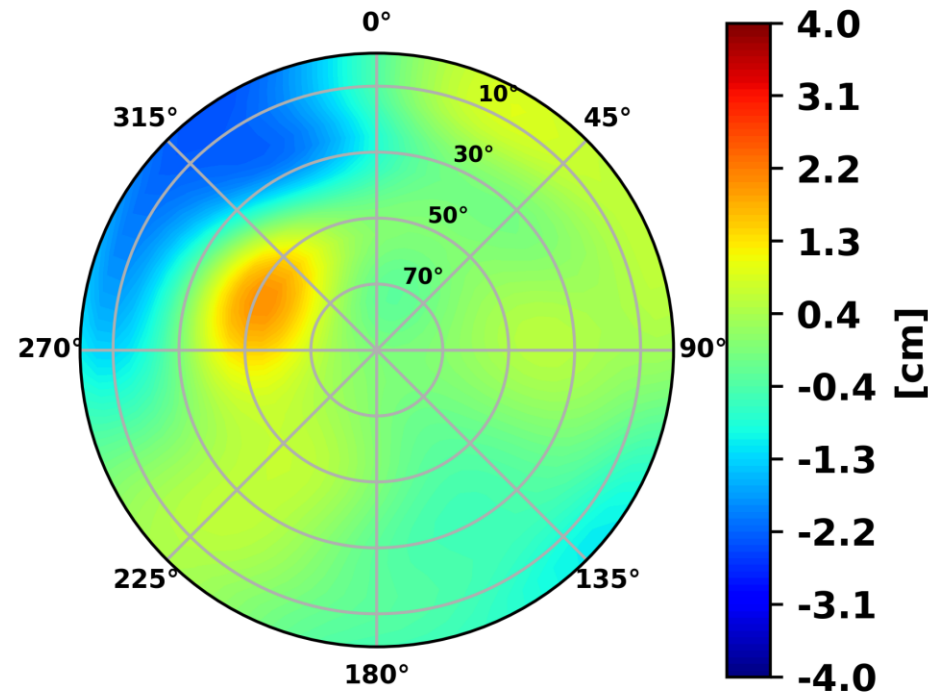


Smartphone Antenna Calibration (2/4)



L1 frequency PCV

- Max PCV magnitude:
~ 2 cm
- Empirical STD:
7 mm

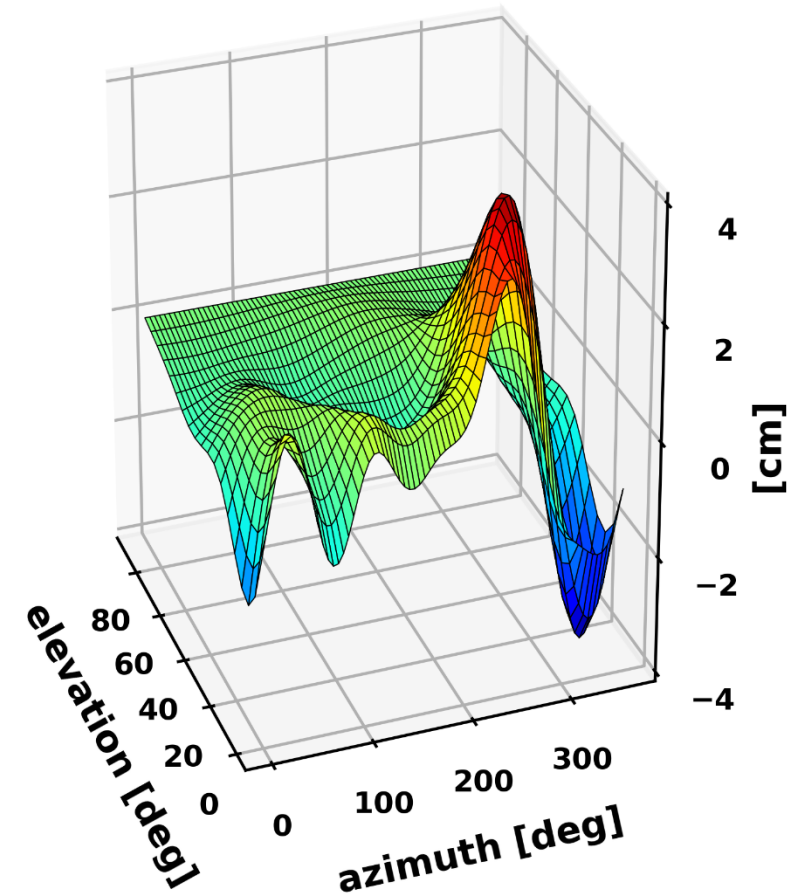
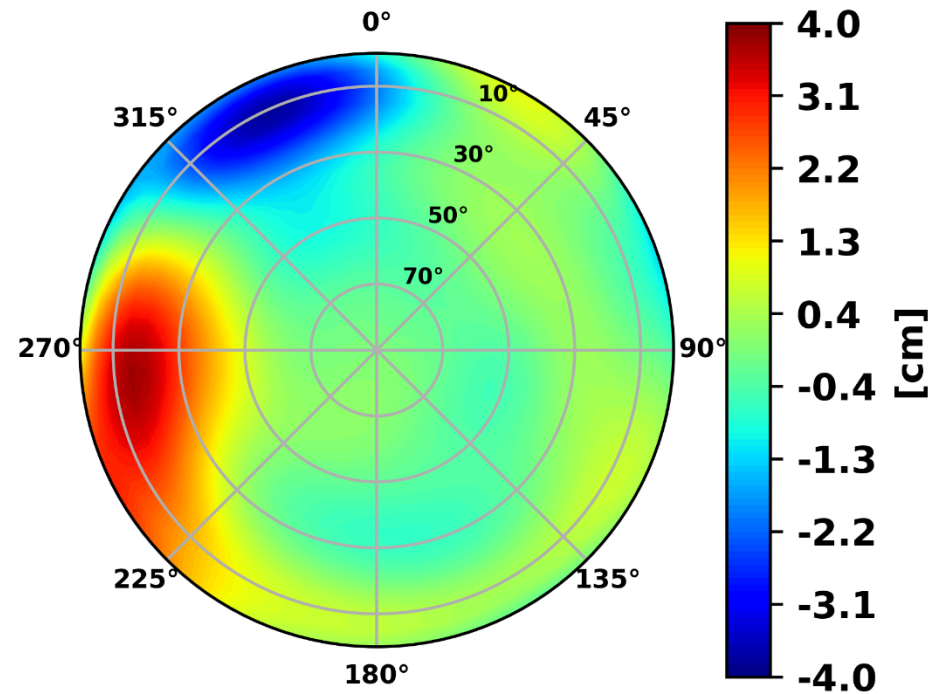


Smartphone Antenna Calibration (3/4)

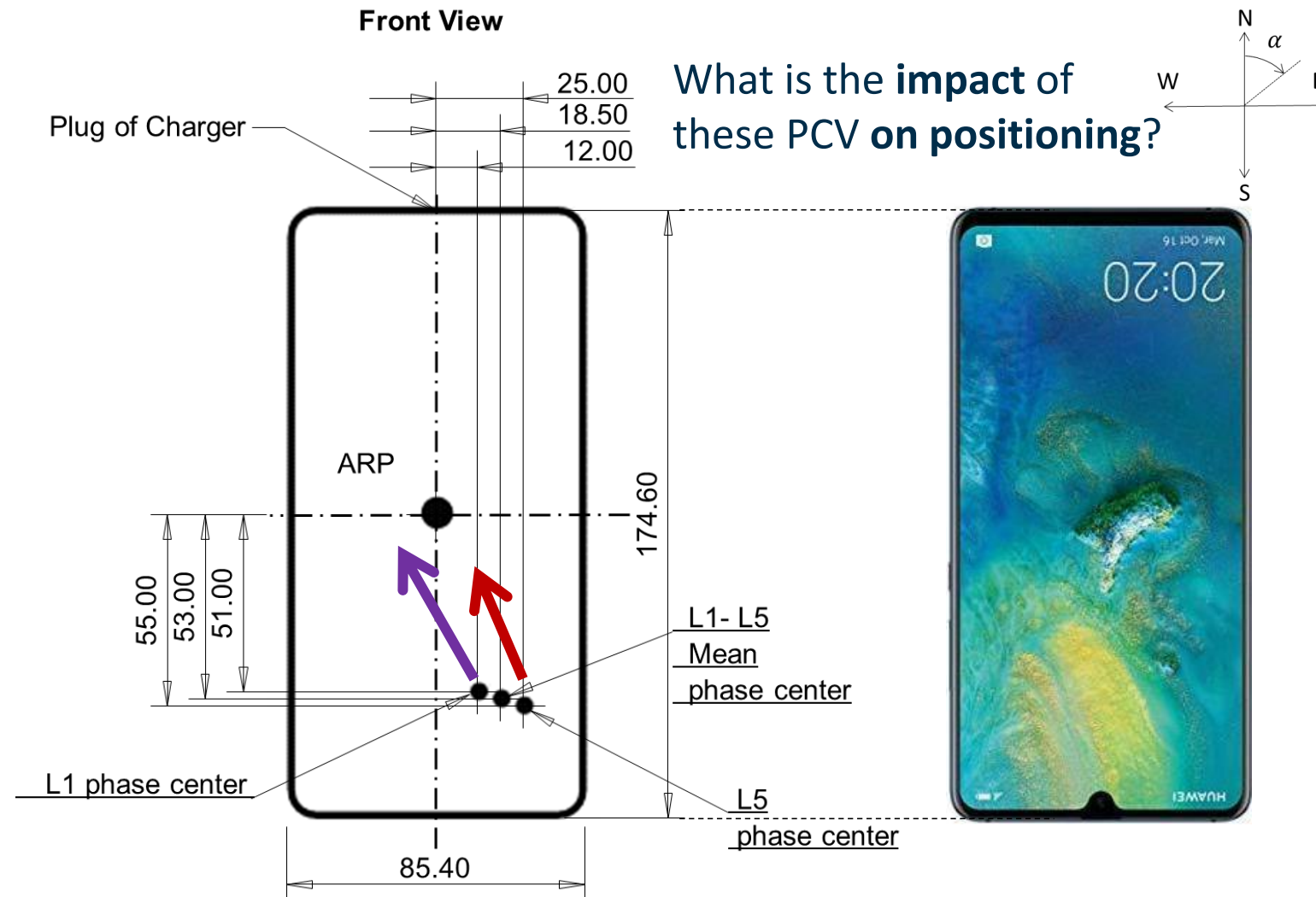


L5 frequency PCV

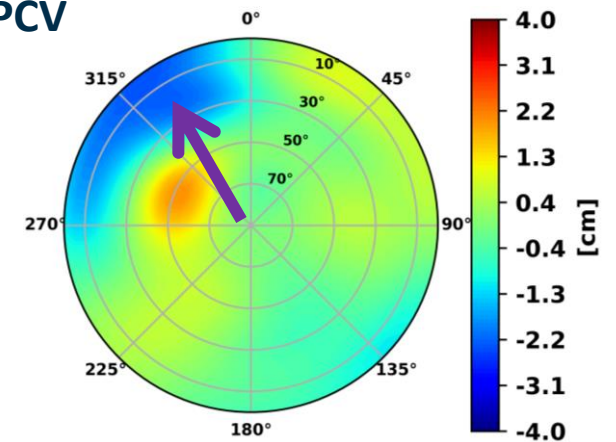
- Max PCV magnitude:
~ 4 cm
- Empirical STD:
10 mm



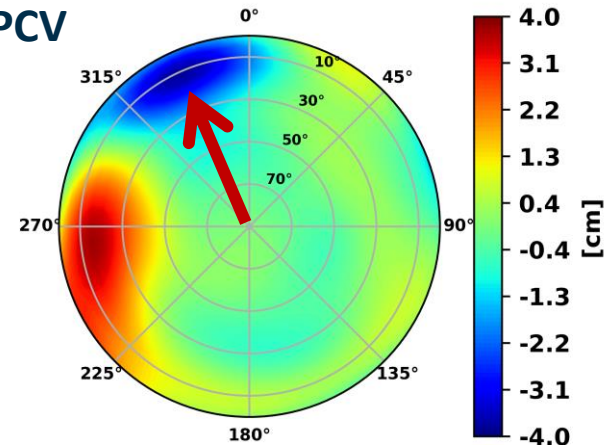
Smartphone Antenna Calibration (4/4)



L1 PCV



L5 PCV



Impact on Positioning: Setups



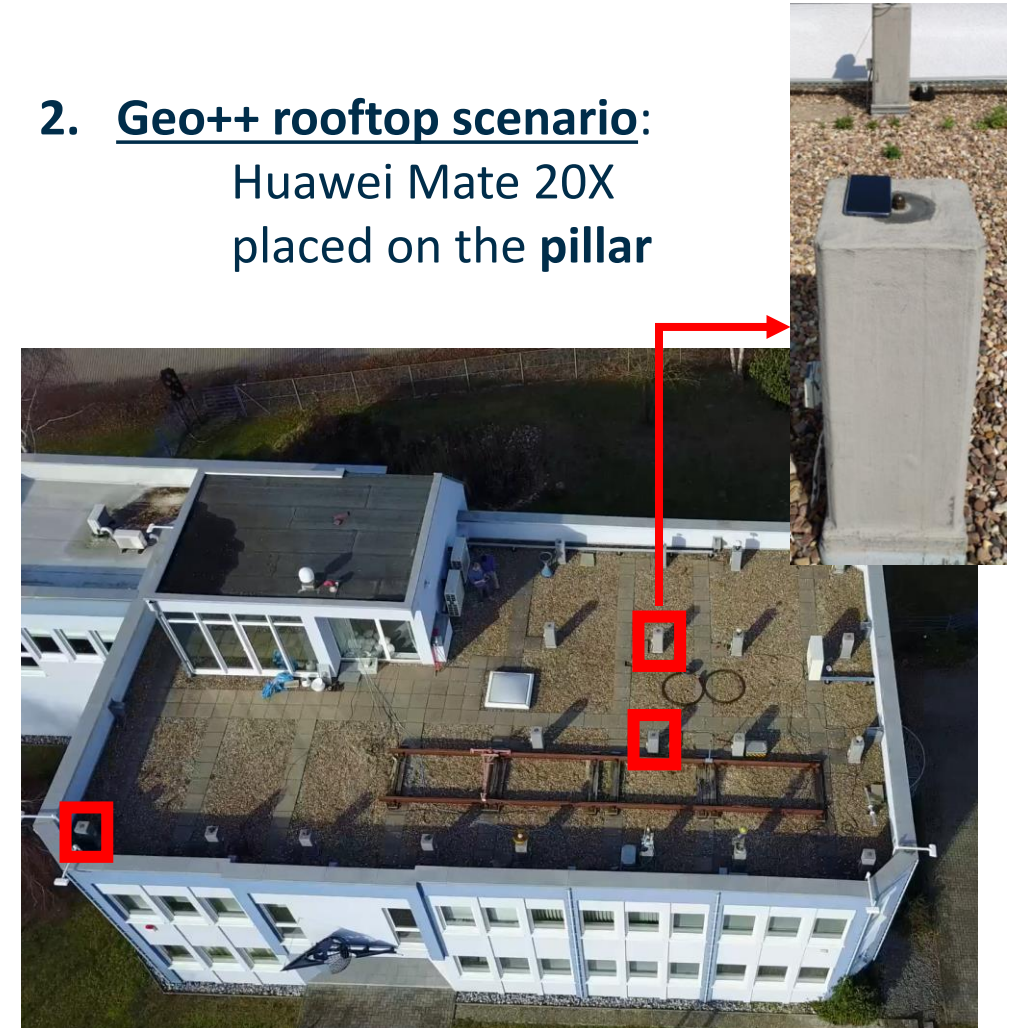
1. Soccer field scenario:

Huawei Mate 20X
placed on the **ground**



2. Geo++ rooftop scenario:

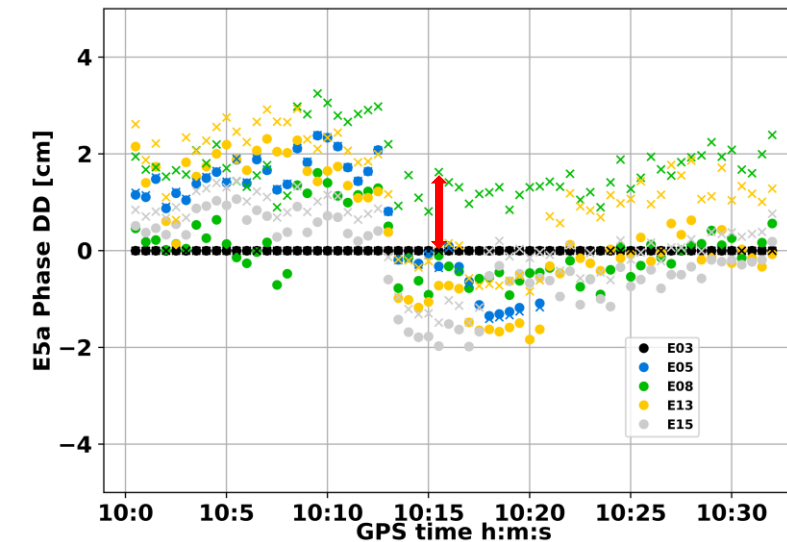
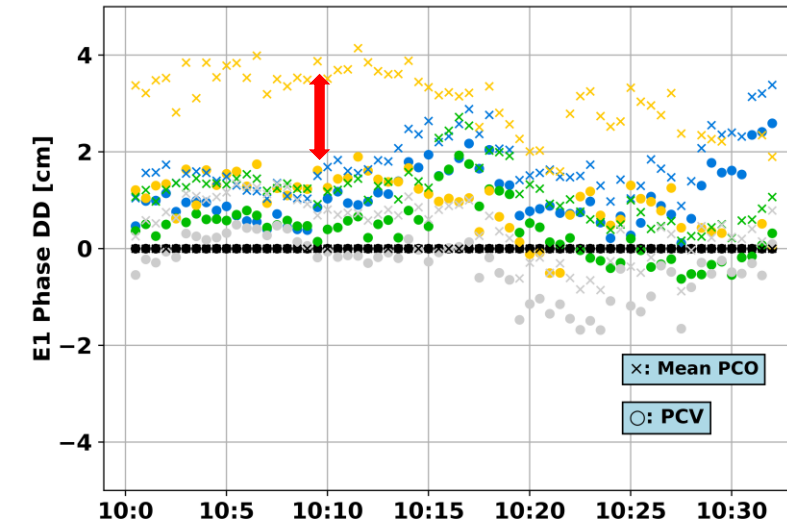
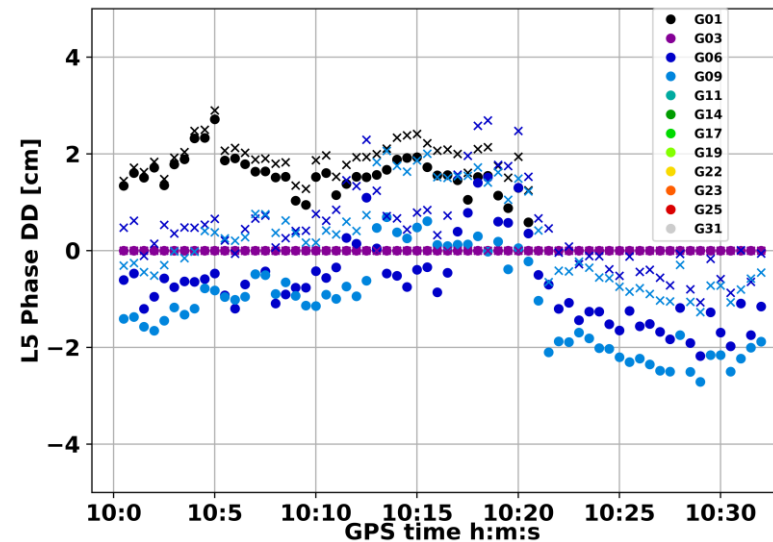
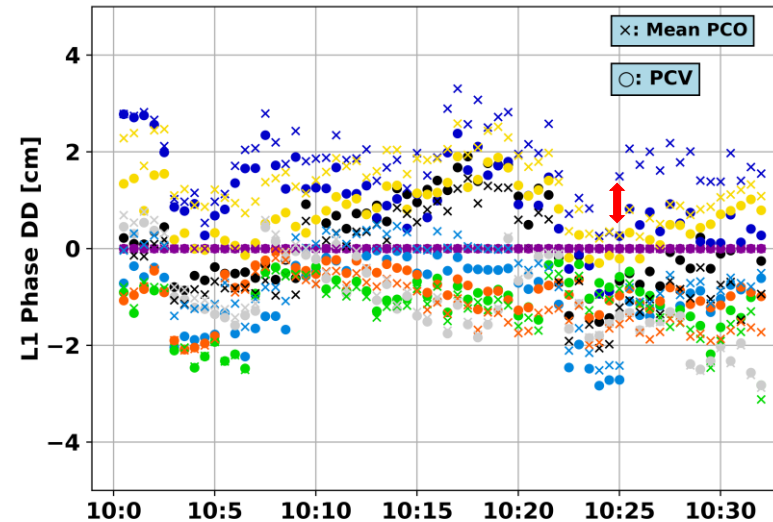
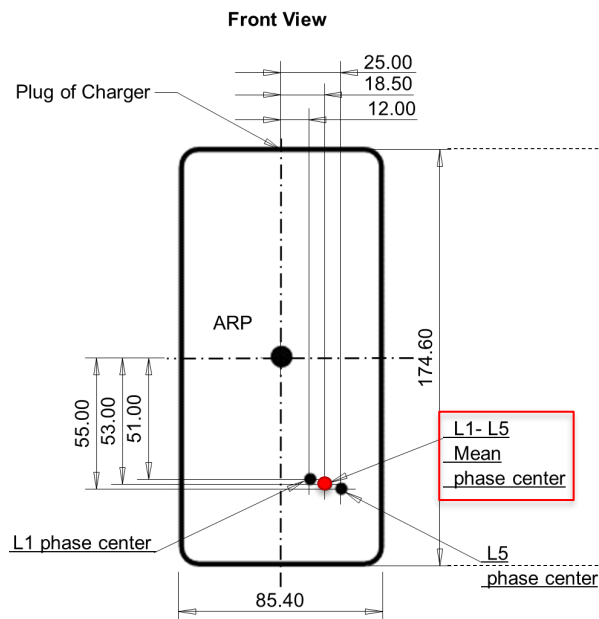
Huawei Mate 20X
placed on the **pillar**



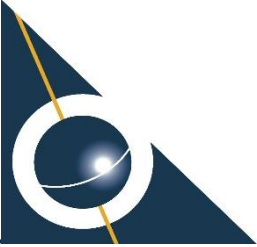
Impact on Positioning: Setups

Phase Double Difference (DD) :

- DD in **short-baseline** configuration (~50 m)
- **smoothed** data with **10 s** moving average window



Impact on Positioning: Positioning Algorithm

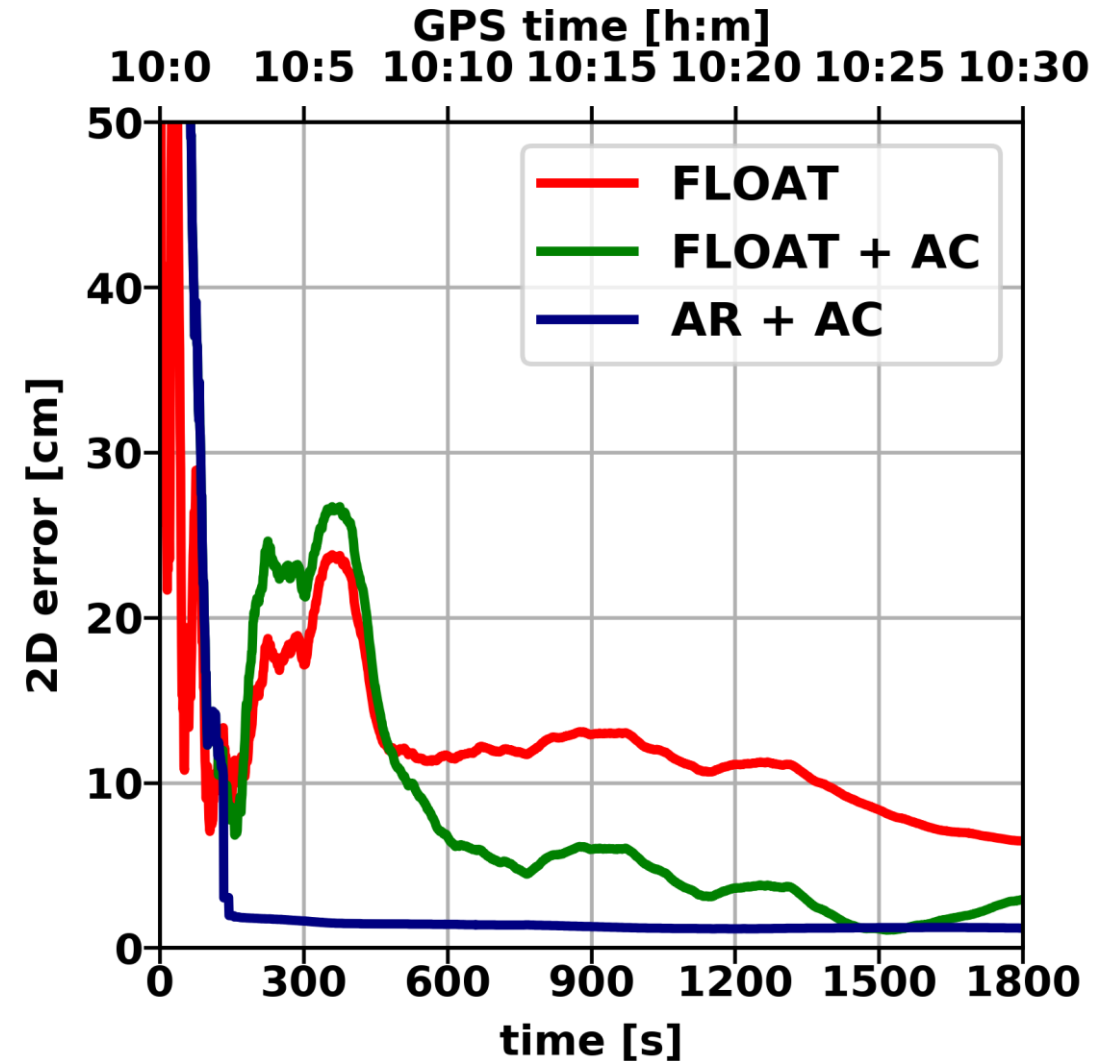


- Constellations: **GPS + Galileo**
- Frequencies: **L1 + L5**
- Observation model: **uncombined**
- Approach: **state space modeling**
- Configuration: **short-baseline** with a geodetic reference **without estimation** of **atmospheric** parameters
- Software: Geo++ **GNSMART 2**
- Mode: **static**

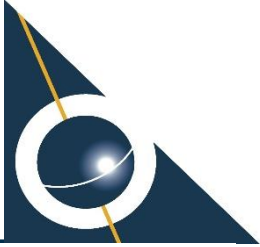
Impact on Positioning: Results of Soccer Field Test (1/2)



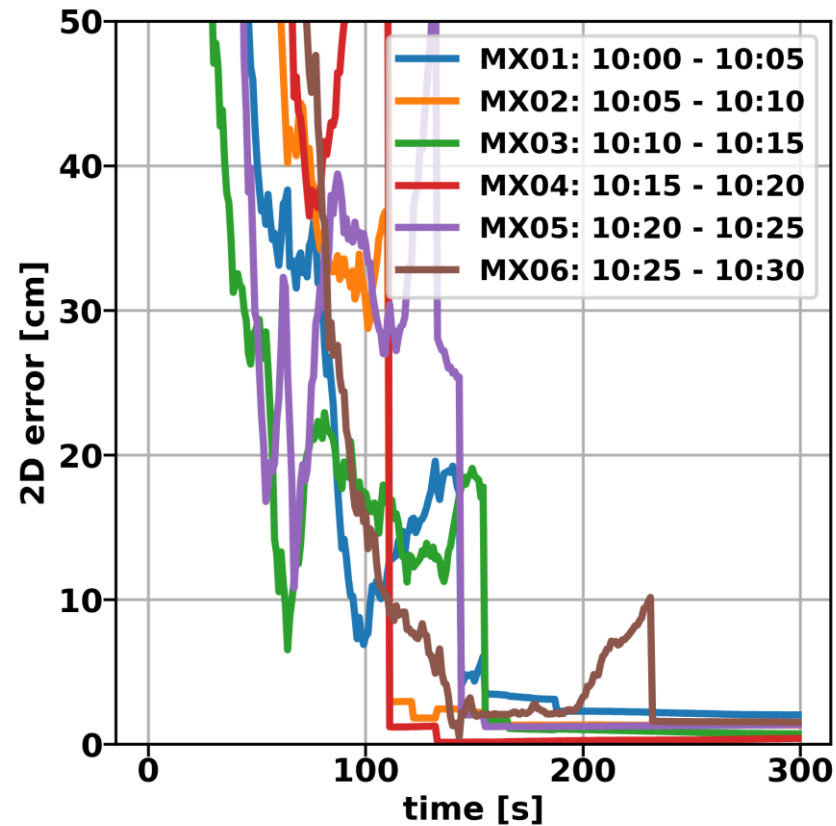
~ 50 m short-baseline
in the soccer field



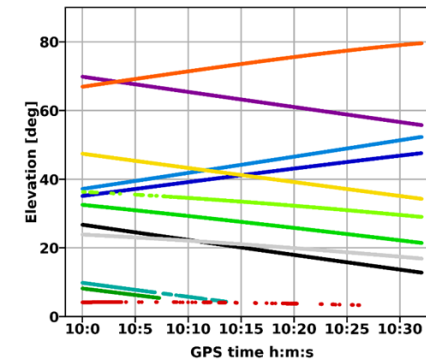
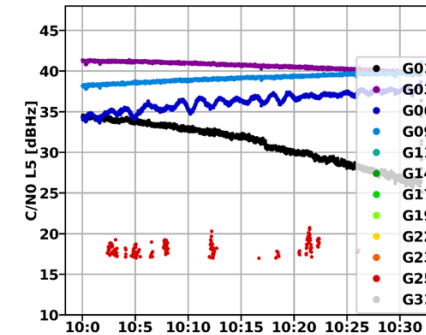
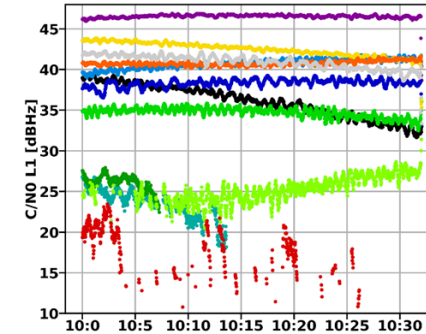
Impact on Positioning: Results of Soccer Field Test (2/2)



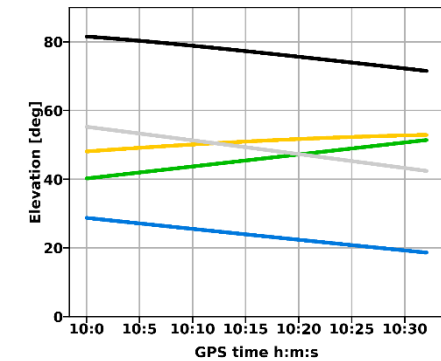
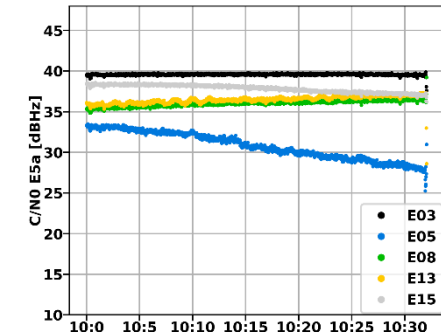
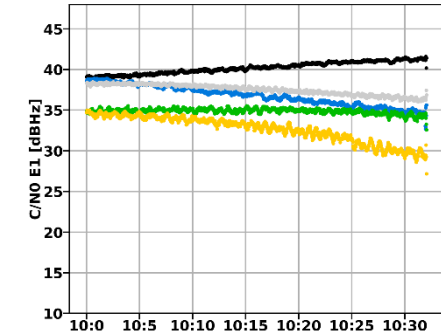
30 dBHz C/N0 mask
35 dBHz C/N0 mask for MX06



GPS



Galileo



Impact on Positioning: Setups



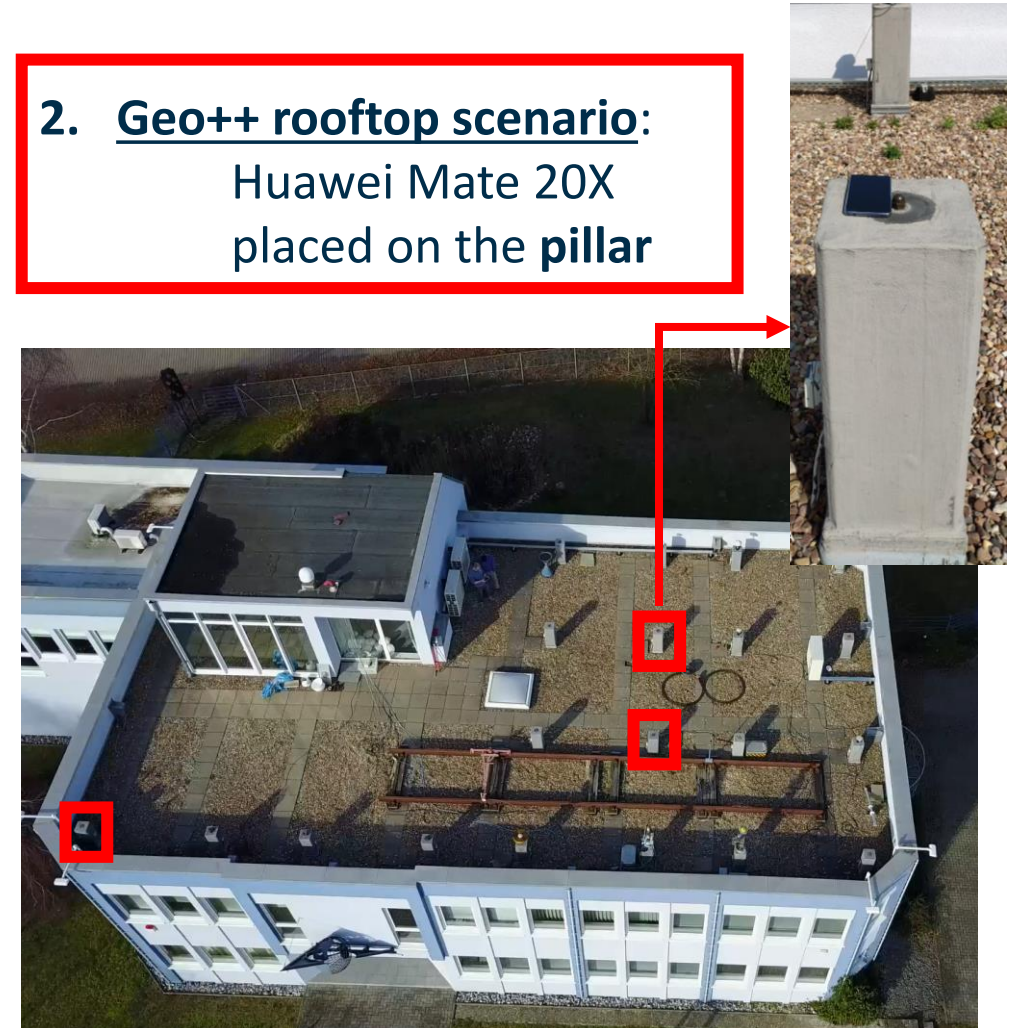
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2. Geo++ rooftop scenario:

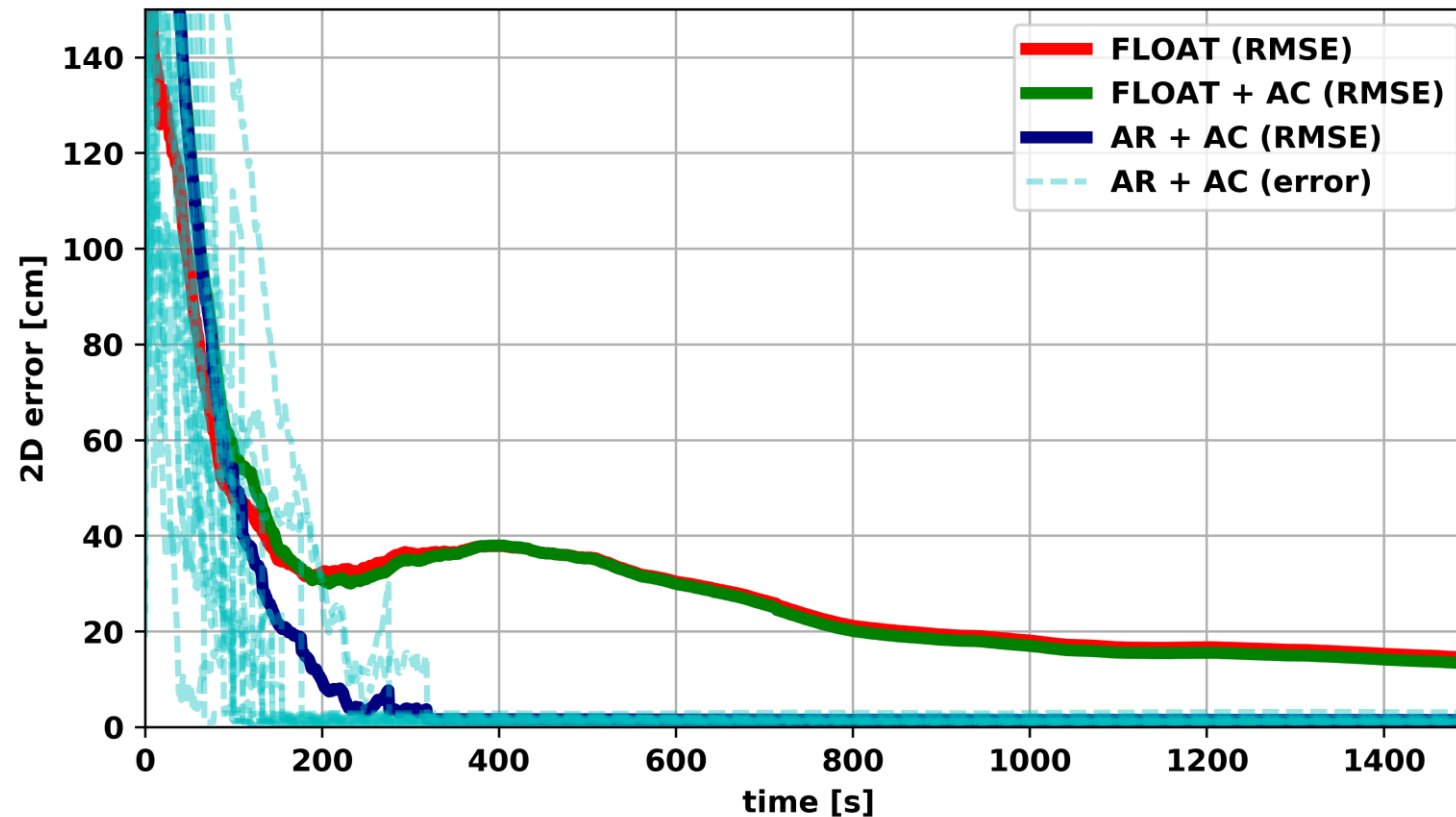
Huawei Mate 20X
placed on the **pillar**



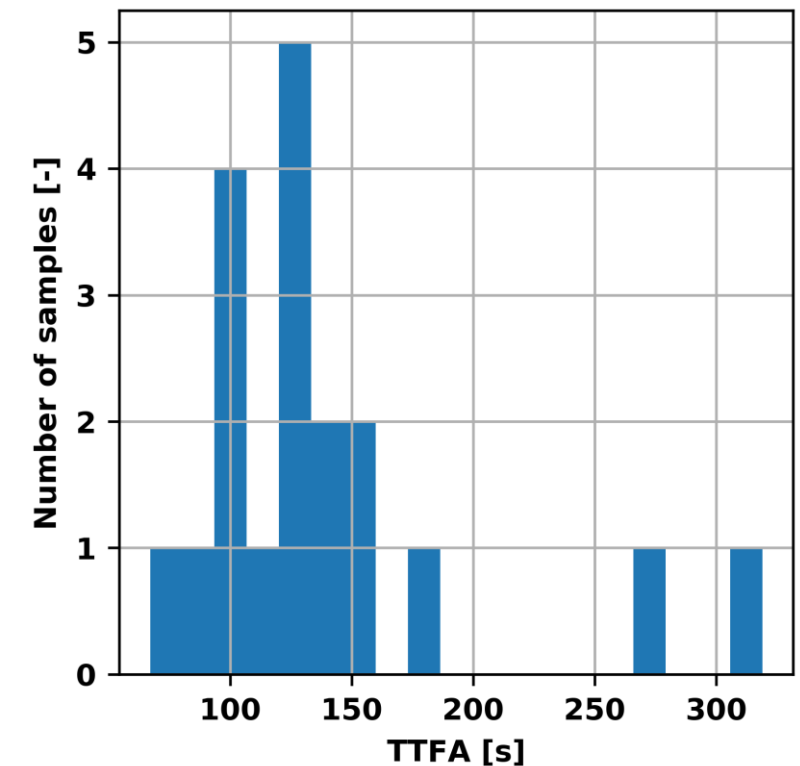
Impact on Positioning: Results of Rooftop Test



35 one-hour samples: **54 %** with **successful AR** (19 samples)



84 % in less than **3 min**



Impact on Positioning: Summary



- Time to achieve **sub-meter** solution (**TTSM**)
- Time to **fix ambiguities** (**TTFA**) with **antenna corrections** (AC)
- **2D RMSE** with AC

Setup	TTSM [s]	TTFA with AC (average) [s]	2D RMSE with AC [cm]
Soccer field ref. station distance ~ 50m	~5	151	1.5
Rooftop ref. station distance < 10m	~60	142	1.6

Conclusions



- **Huawei Mate20X** antenna has been calibrated for **L1** and **L5** frequencies in a common adjustment of **GPS** and **Galileo** observations
- PCV **magnitudes** up to **~2 cm** and **~4 cm** for L1 and L5, respectively
- PCV allows achieving **cm-level** performance in less than **3 min** using smartphone **without** any **external antenna**

Thanks for your Attention



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References



- 1. Darugna, F., Wübbena, J., Ito, A., Wübbena, T., Wübbena, G., & Schmitz, M. (2019) RTK and PPP-RTK Using Smartphones: From Short-Baseline to Long-Baseline Applications. In *Proceedings of the 32nd International Technical Meeting of the Satellite Division of The Institute of Navigation (ION GNSS+ 2019)*, Miami, Florida, September 2019, pp. 3932-3945.
<https://doi.org/10.33012/2019.17078>
- 2. Sharma H, Bochkati M, Kestel G, Pany T (2019) Researchers achieve 1–2 cm accuracy with commercial smartphone. Inside GNSS. <https://insidegnss.com/researchers-achieve-1-2-cm-accuracy-with-commercial-smartphone/>. Accessed 27 April 2020