First experience with real-time measurements using Galileo and BeiDou satellite systems from Slovakia

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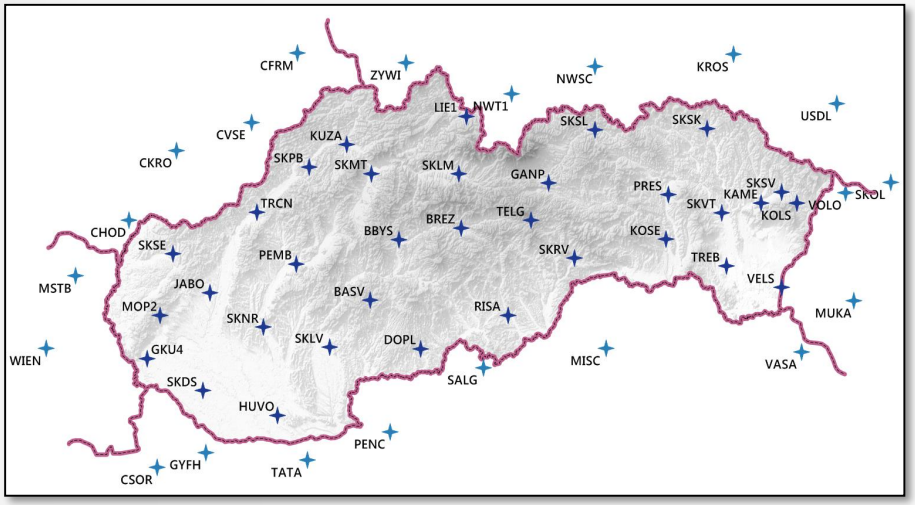
Slovak real-time positioning service

SKPOS®



NetR9

Alloy

Zephyr Geodetic 2
Zephyr Geodetic 3

Choke Ring

Trimble Pivot Platform
Ver. 3.10.5

RTXNet Processor
Since October 2018

13 years of continuous operation	+50 reference stations
+1 700 active users	GPS, GLONASS, Galileo, BeiDou

Slovak real-time positioning service

SKPOS® +Galileo and +BeiDou

from Dec 2006

- GPS+GLO

from Oct 2018

- GPS+GLO+GAL+BDS

Galileo and BeiDou usage need to be checked!

⇒ Decision to perform +Galileo +BeiDou test within SKPOS®:

- Long term RTK test (24 hours continuous RTK performance) done by GKU

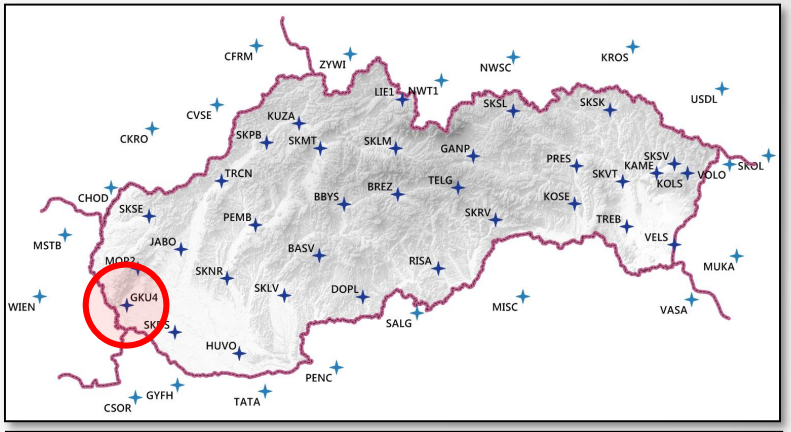
⇒ Decision to ask GNSS authorised distributors/ resellers in Slovakia for their experience

- we have asked Trimble, Leica, Topcon and others main resellers

Long term RTK test

- Two rovers Trimble R10 with identical settings
- on the GKU roof
- 1 meter distance from each other
- Only 10 meters from the nearest reference station (GKU4)

	RTKNet processor	RTXNet processor
Rover	Trimble R10	Trimble R10
Controller	Trimble TSC3	Trimble TSC3
Software	Trimble Access	Trimble Access
Format	RTCM 3.1	RTCM 3.2 MSM5
GNSS	GPS, GLO	GPS, GLO, GAL, BDS



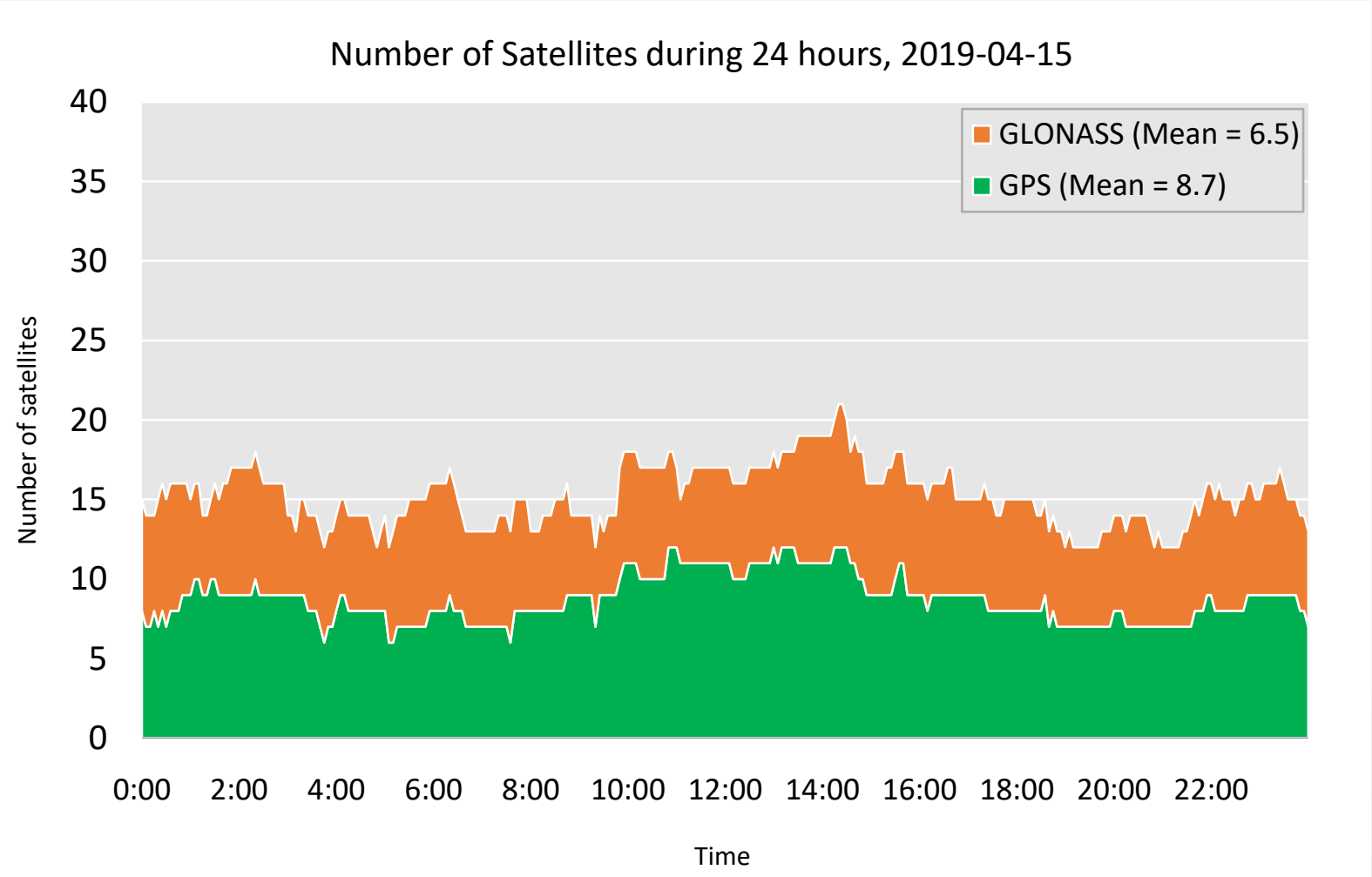
LONG TERM RTK TEST

QUANTITY CHARACTERISTICS

Number of satellites

RTKNet processor

48° 09’ 26’’
17° 10’ 18’’



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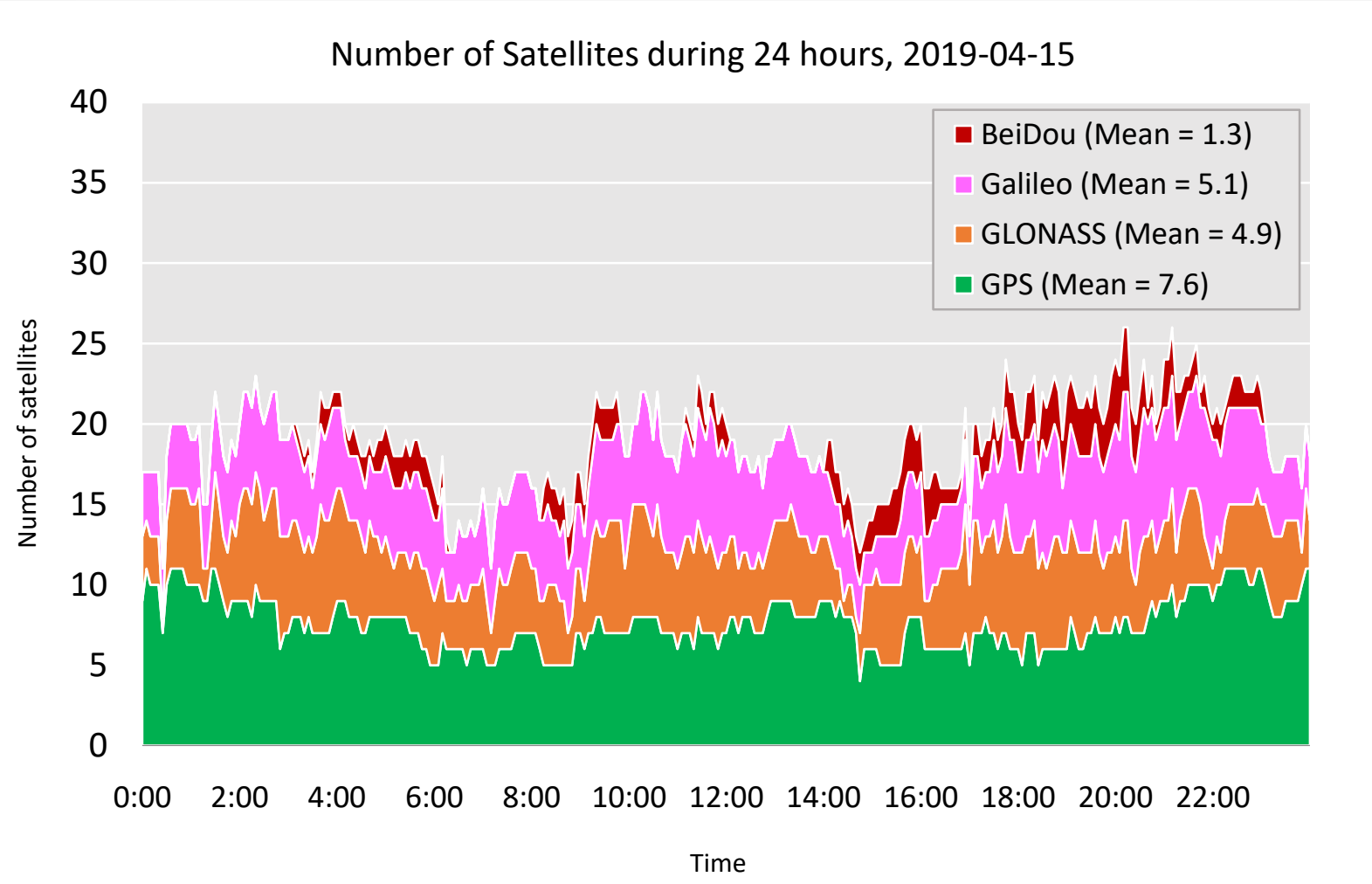
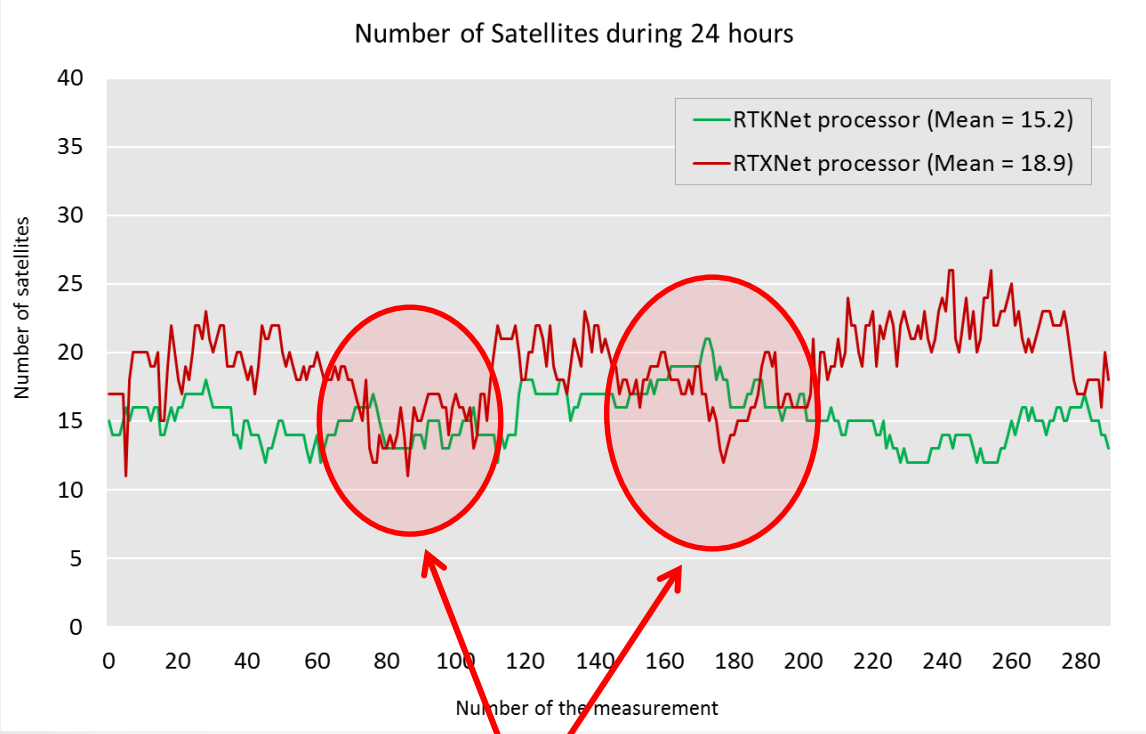


RTKNet processor vs RTXNet processor



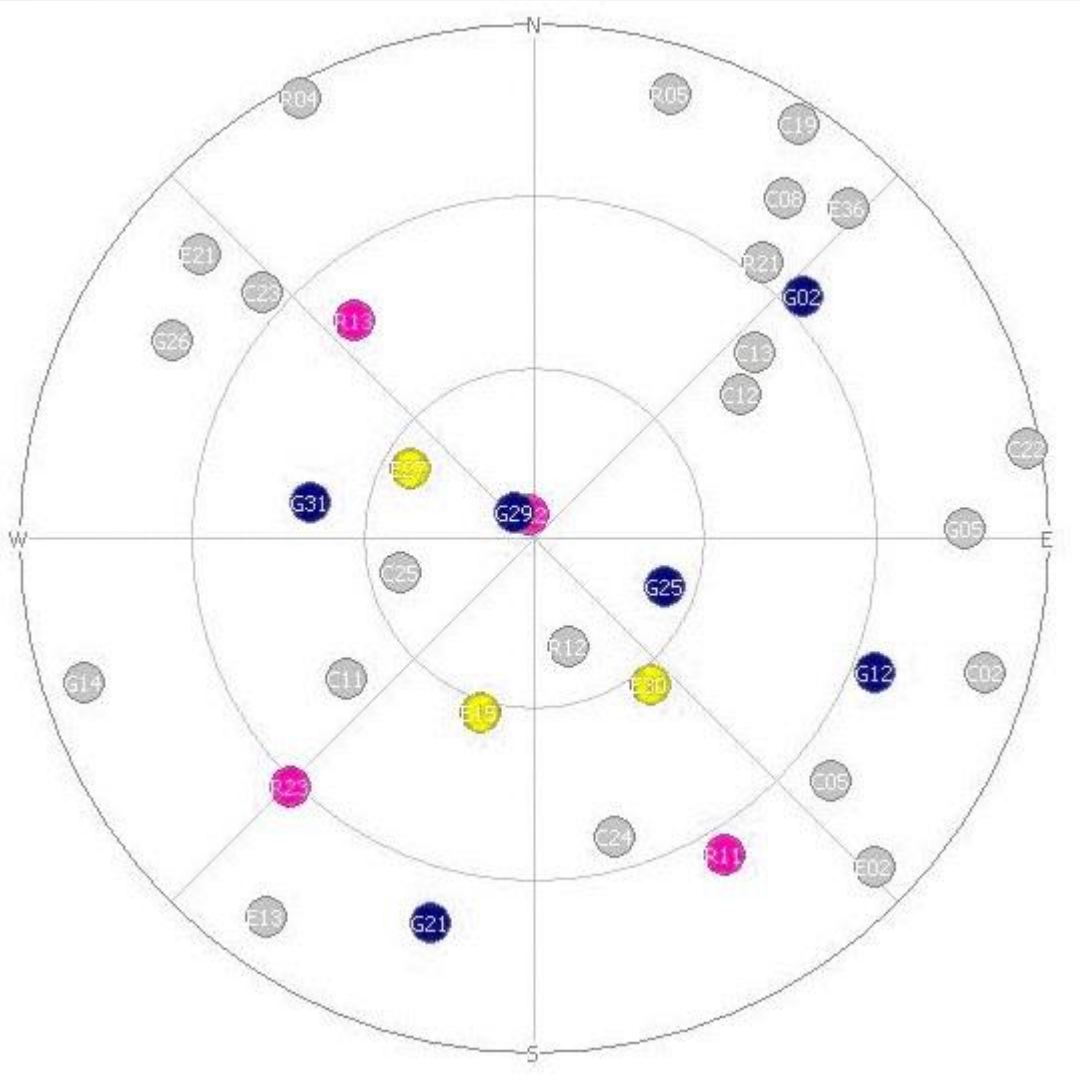
Mean values during 24 hours

GNSS	RTKNet	RTXNet
GPS	8.7	7.6
GLONASS	6.5	4.9
Galileo	-	5.1
BeiDou	-	1.3
Average	15.2	18.9

Sometimes RTXNet < RTKNet. Why?

GPS+GLO in RTXNet < RTKNet. Why?

Skyplot
12 hours animation



- GPS
- GLONASS
- Galileo
- BeiDou
- Not broadcasted in RTXNet

RTXNet processor module:

recogniced satellite selection

Why?

- unhealthy satellites
- missing navigation message
- processing power?
- politics?

Is number of GPS+GLONASS satellites in solution important?

How can lower number of GPS+GLO satellites affected users?

- In real-time (RTXNet processor)
  - majority of users still have GPS+GLO only receivers = less satellites in solution = potential problem with fix solution
- Post-processing (Reference datashop RTXNet npr files)
  - less GPS+GLO satellites in VRS post-processing files = problem for users with no GAL and BDS capability
  - no problem for them when RTKNet npr files are generated

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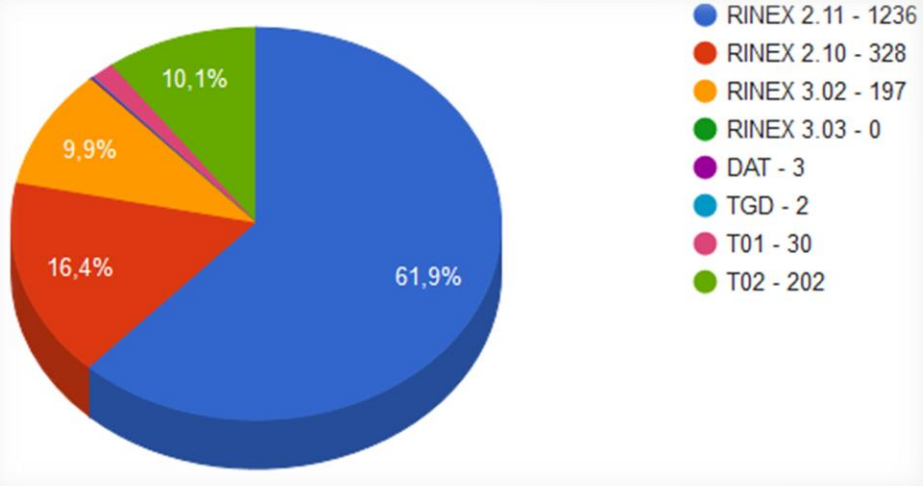
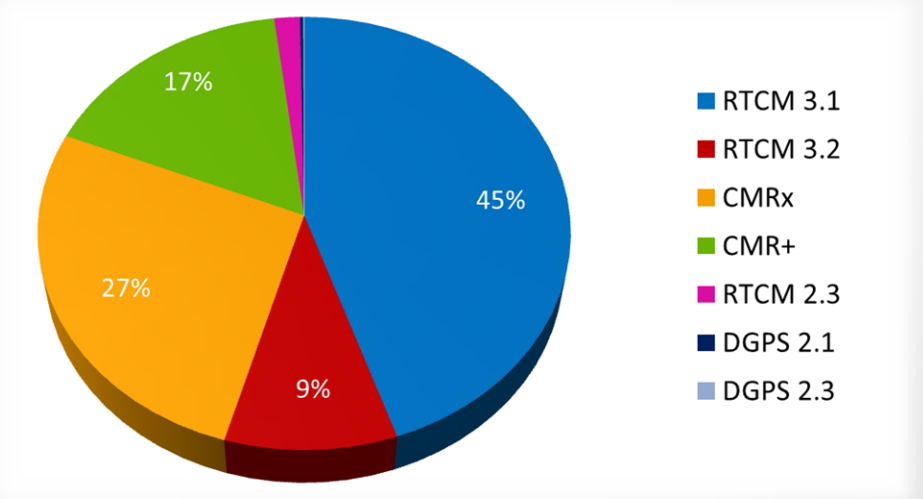
SKPOS® Data Shop and Mountpoint usage statistics

- Reference Data Shop post-processing files download statistics
  - GAL+BDS fully available only in RINEX v3 format (too in T02-4)
  - 78% of useres still use RINEX v2 files (no correct BDS)



- Mountpoint usage statistics
  - GAL+BDS provided only by SKPOS_CM_32 mountpoint (RTCM 3.2 MSM5)
  - only 9% of all SKPOS users use SKPOS_CM_32 mountpoint



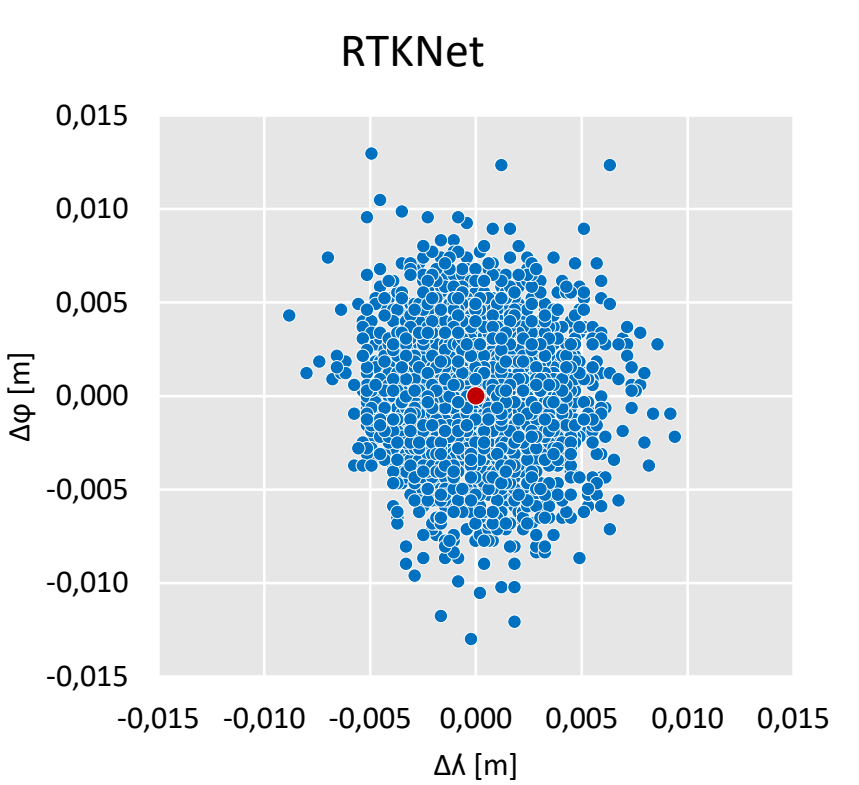
LONG TERM RTK TEST

QUALITY CHARACTERISTICS

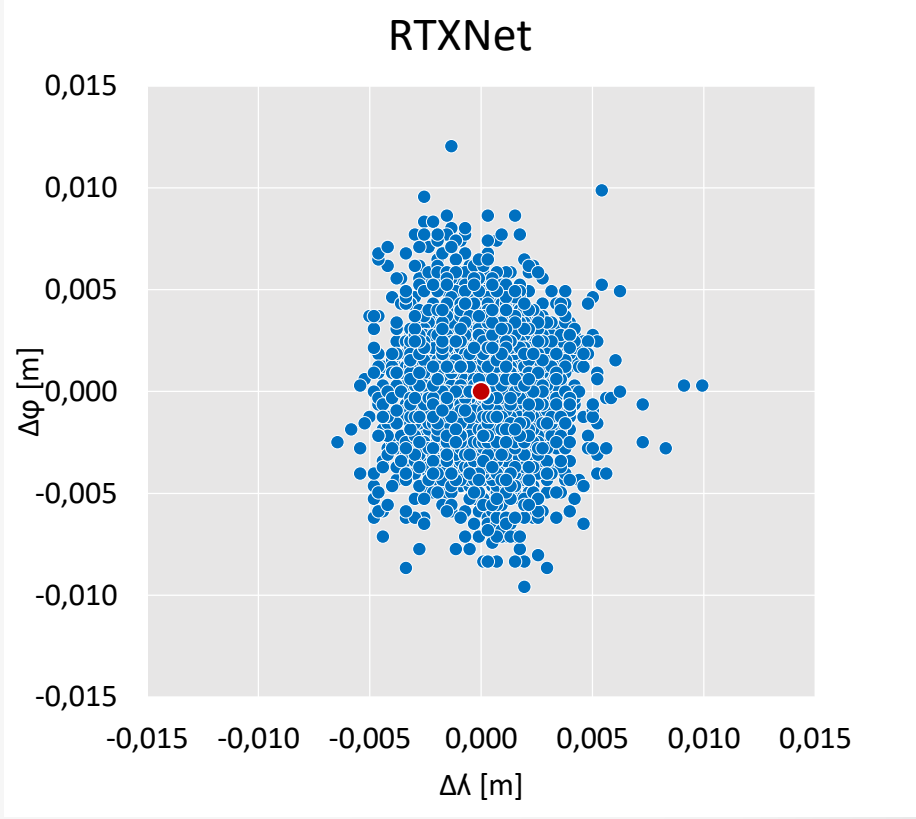
Horizontal position during 24 hours

Elevation mask 10°

STD_DEV = 2.0 mm



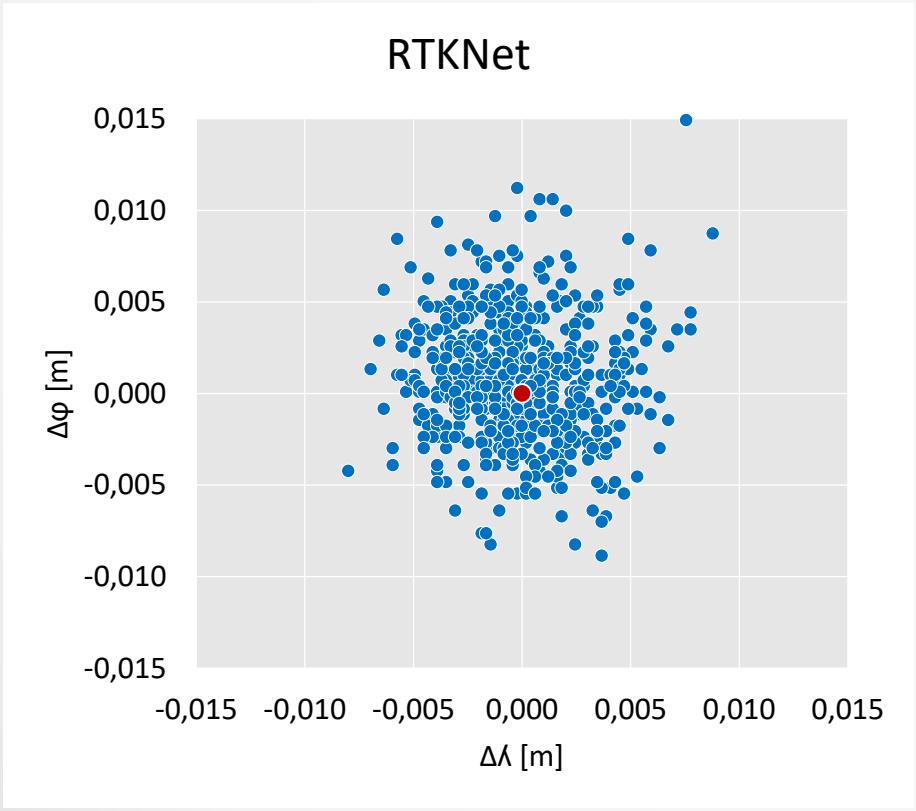
STD_DEV = 1.7 mm



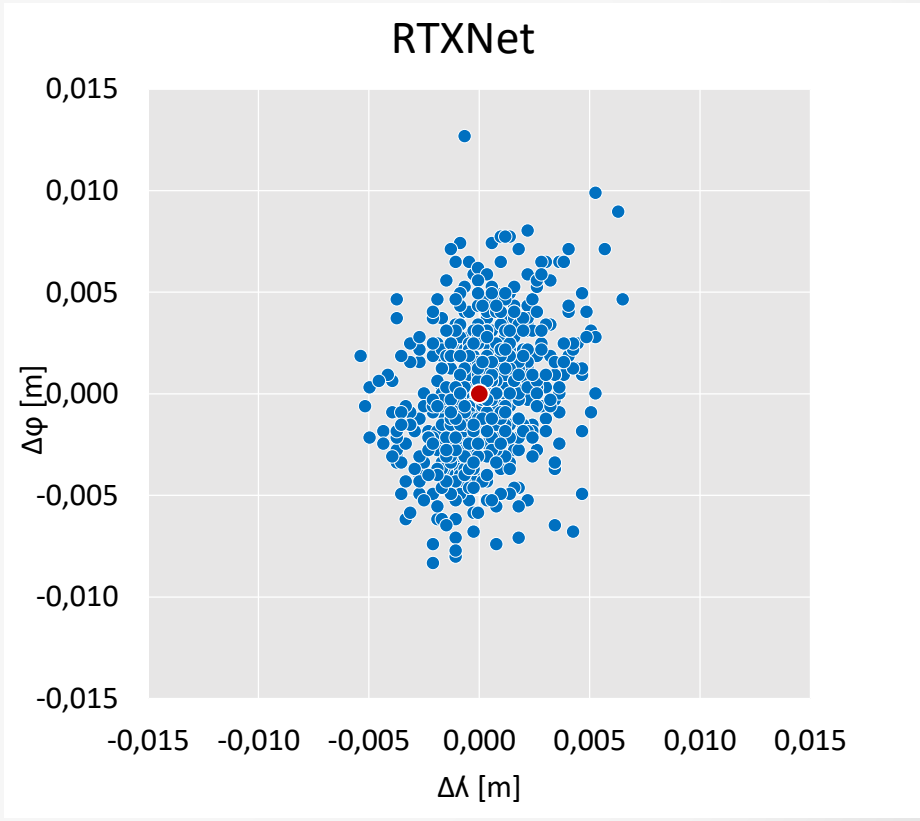
Horizontal position during 24 hours

Elevation mask 20°

STD_DEV = 2.1 mm

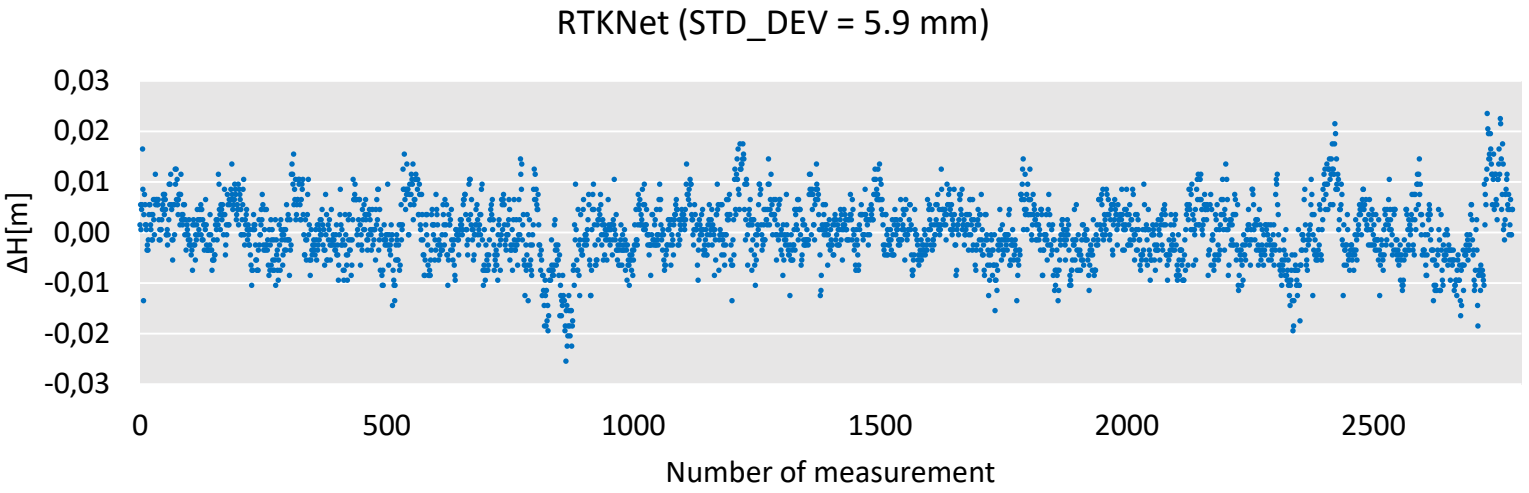


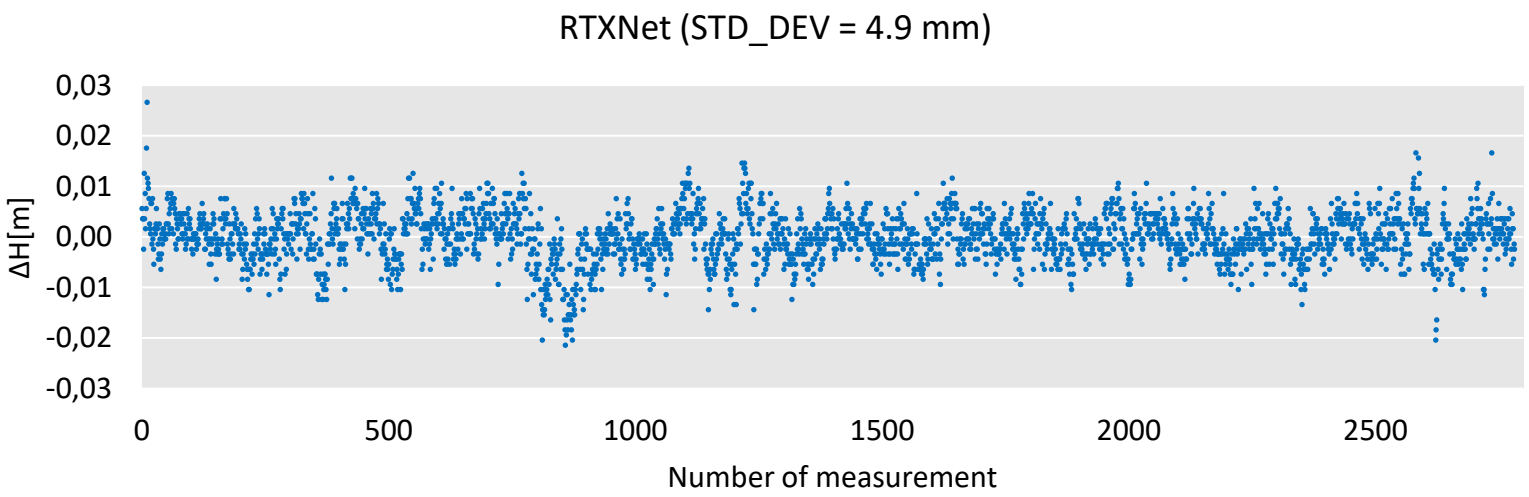
STD_DEV = 1.9 mm



Height component during 24 hours

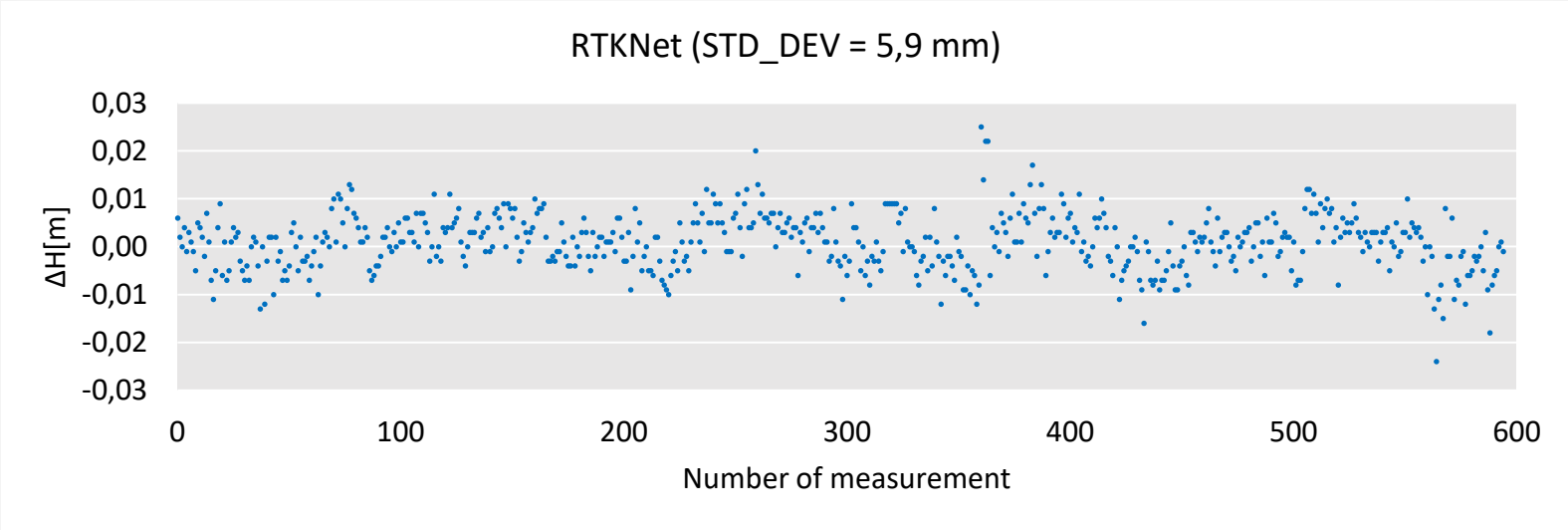
Elevation mask 10°

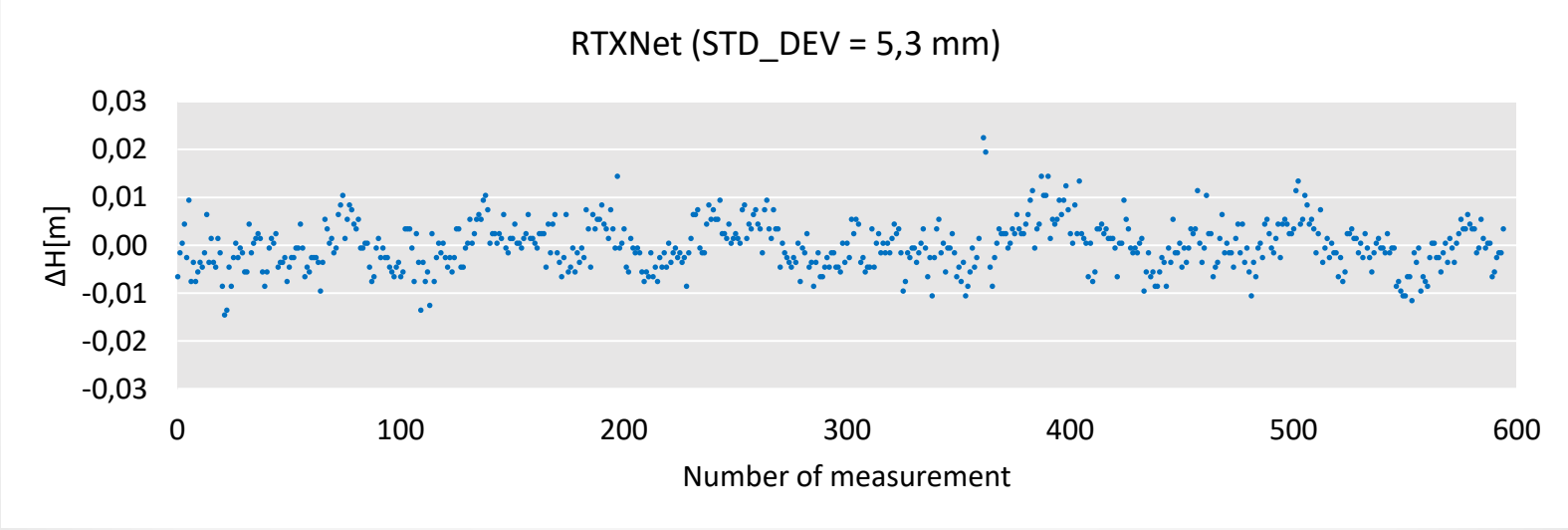




Height component during 24 hours

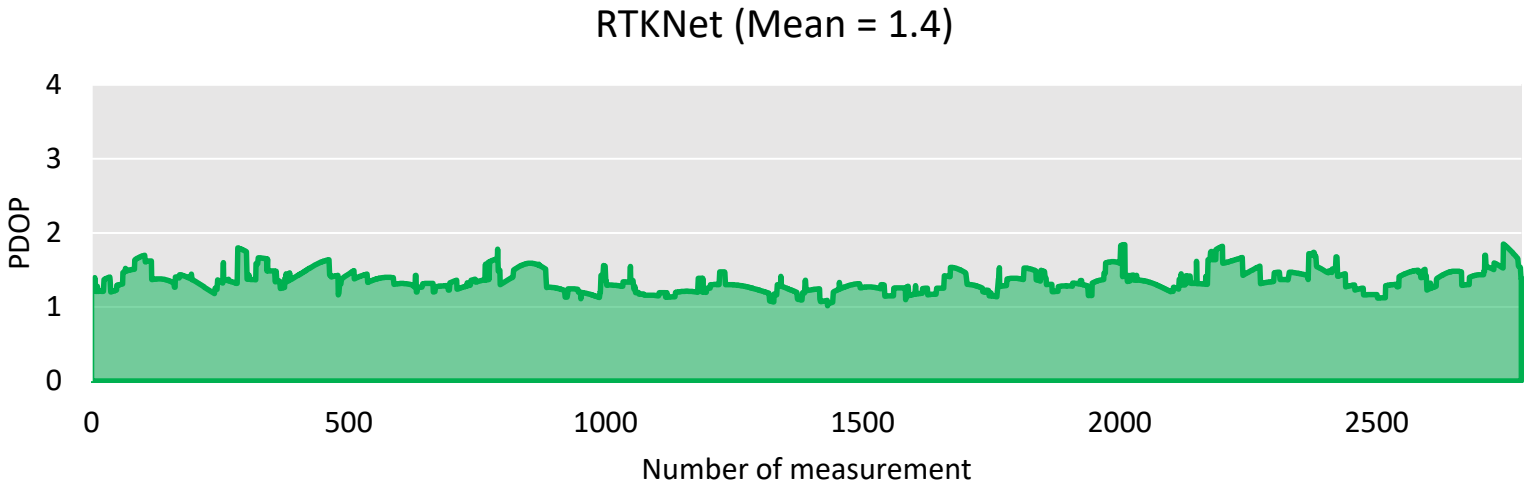
Elevation mask 20°

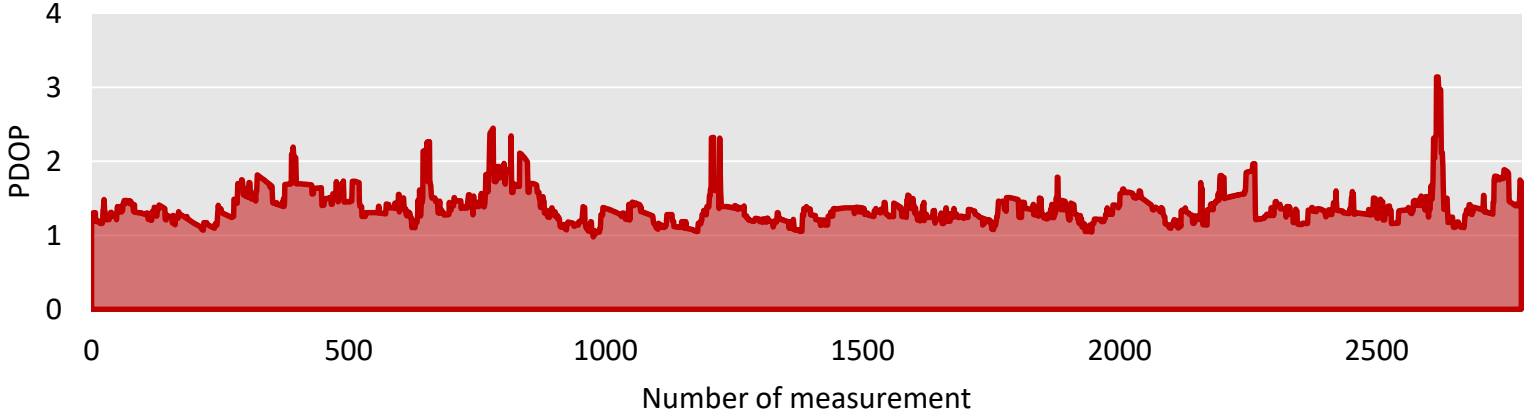




PDOP

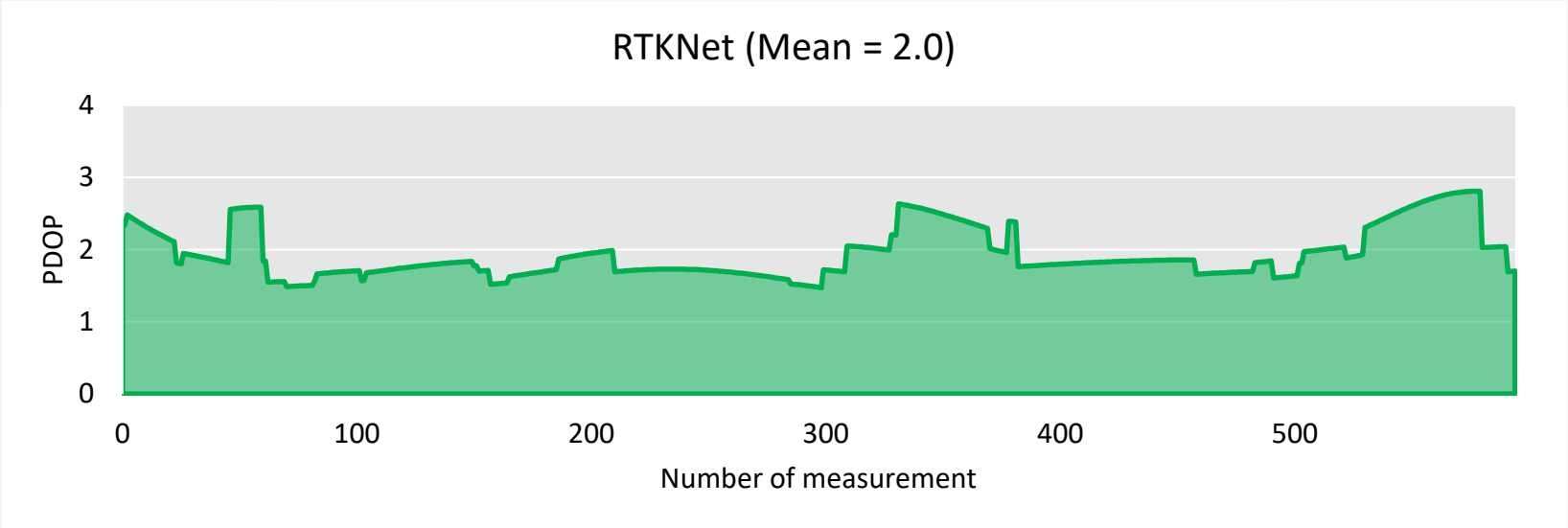
Elevation mask 10°

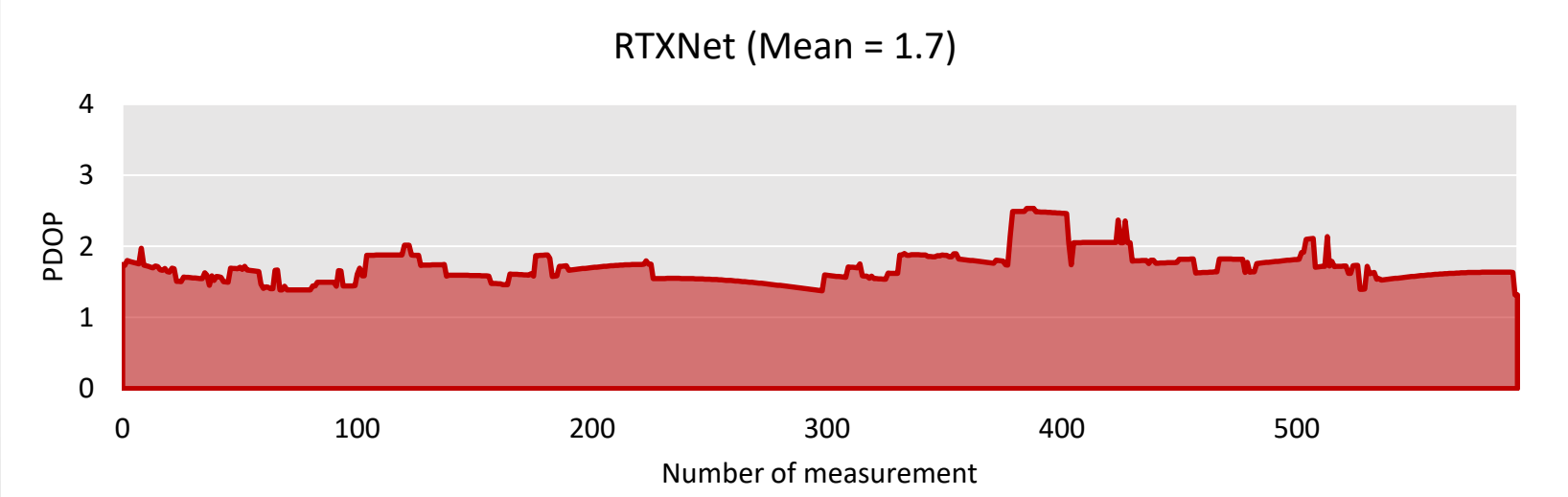




PDOP

Elevation mask 20°





Conclusions

- Performed test showed out
  - a lower STD in all coordinate components differences when Galileo and BeiDou satellite systems were used
  - altogether more satellites in +GAL +BDS solution,
  - reduction of number of GPS and GLO satellites when +GAL +BDS solution were used (in average -1 GPS and -1.6 GLO) = potential problem for GPS+GLO only users
  - sometimes less satellites in total occurred in +GAL +BDS solution = selection of satellites does not always have a positive effect
  - lower PDOP characteristics in +GAL + BDS solution

Thank you for your attention