EUPOS® **Working Group on**
Service Quality Monitoring

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Agenda

- *EUPOS* WG on Service Quality Monitoring
    - Creation background
    - Aims
    - Members

- *EUPOS* network RTK quality monitoring
    - Concept
    - Creation of monitoring + status
    - Quality a reliability testing
    - Conclusions
    - Next steps

EUPOS WG on Service Quality Monitoring
Creation background

Only physical monitoring station is accepted in EUPOS TS

- **3.1.1.6** National EUPOS reference station system consist of at least two <u>physical EUPOS monitoring stations</u> per national EUPOS reference station system;

- **3.4.2.3** EUPOS quality management measures continuous reception and check of provided EUPOS DGNSS and Network RTK by <u>monitoring stations</u> in real time and also continuously monitoring and checking of EUPOS Geodetic RINEX data;

- **2.3.1** For precise real-time position determination with an accuracy ≤ 2 cm (horizontal RMS) EUPOS provides network RTK correction.
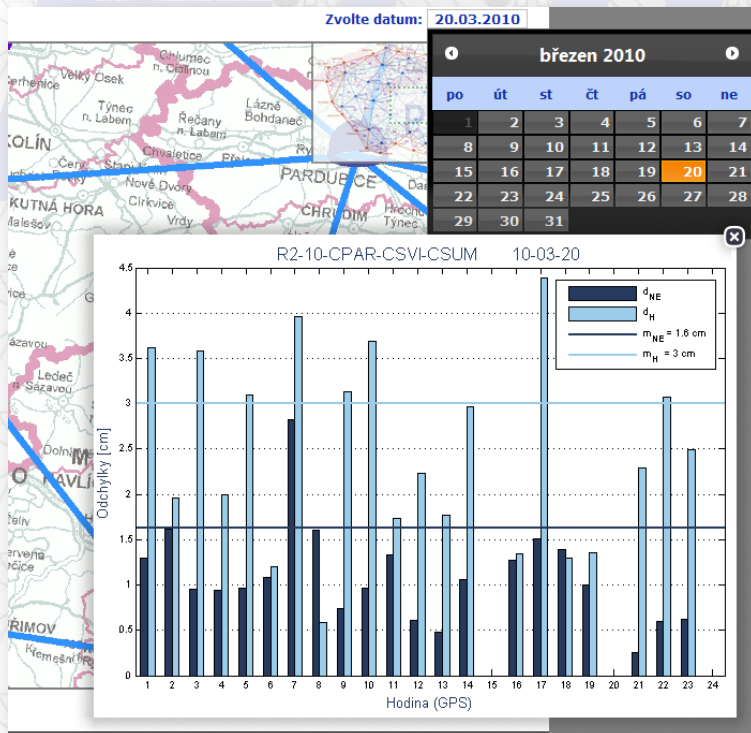
EUPOS WG on Service Quality Monitoring
Creation background

- **2009 and 2013** - network RTK quality real-time monitoring based on virtual monitoring stations was developed and set up for use in Czech republic and in Slovakia

http://czepos.cuzk.cz/_graphSearch.aspx   http://monitoringskpos.gku.sk

EUPOS WG on Service Quality Monitoring
Creation background

- **2014**
  - 25th Conference of the EUPOS Steering committee was held in Riga
  - Slovakian EUPOS member presented the SKPOS network solution quality monitoring application and offered willingness to establish the same network RTK quality monitoring application for all EUPOS members
  - EUPOS ISC accepted the willingness and founded the Working group on Service quality monitoring by the resolution 25.5 and requested Dr. Droscak to chair it

RESOLUTION 25.5 OF THE 25TH CONFERENCE OF THE EUPOS STEERING COMMITTEE OF MAY 6-7, 2014 IN RIGA, LATVIA; AGENDA ITEM NO. 14.1: SKPOS (EUPOS) NETWORK SOLUTION MONITORING APPLICATION.

The EUPOS International Steering Committee (ISC),

noting the importance of the EUPOS service quality monitoring,

appreciating the development of an early tool for the quality monitoring of the EUPOS Network RTK service that could supplement the necessity to implement physical monitoring stations into the GNSS reference stations network,

decides to create a EUPOS Working Group on Service Quality Monitoring and

requests Dr Branislav Droscak to chair this Working Group.

EUPOS WG on Service Quality Monitoring
Aims

Only network RTK quality monitoring – no single RTK

- creation of the common network RTK quality monitoring based on virtual monitoring stations for all EUPOS member countries as application under the name **EUPOS network RTK quality monitoring** similar to Slovakian solution

- verification of the accuracy and evaluation of the reliability of the results from proposed network RTK quality monitoring based on virtual monitoring stations
    - comparison outputs with results from real monitoring stations
    - comparison of Czech and Slovak solution outputs

- Set up of the server with the EUPOS network RTK quality monitoring application

- after verifying process – preparation of the text proposal for implementation network RTK quality monitoring based on virtual monitoring stations into EUPOS TS

EUPOS WG on Service Quality Monitoring **Membership**

- Chair: Branislav Droscak (Slovakia)
- Members:
  - Karol Smolík (Slovakia) – programmer
  - Artur Oruba (Poland)

- Who else?
- we will need cooperation from whole EUPOS member countries – we will need acces to RTK network corrections

EUPOS network RTK quality monitoring
Concept

- Concept copy the concept of **S**K*POS*® network solution quality monitoring application:
  - Virtual (no physical) monitoring stations
  - Baseline processing by free RTKNAVI software
  - All country monitored 24 hours a day
  - Each locality monitored once per hour
  - Results available via web (desktop/mobile)
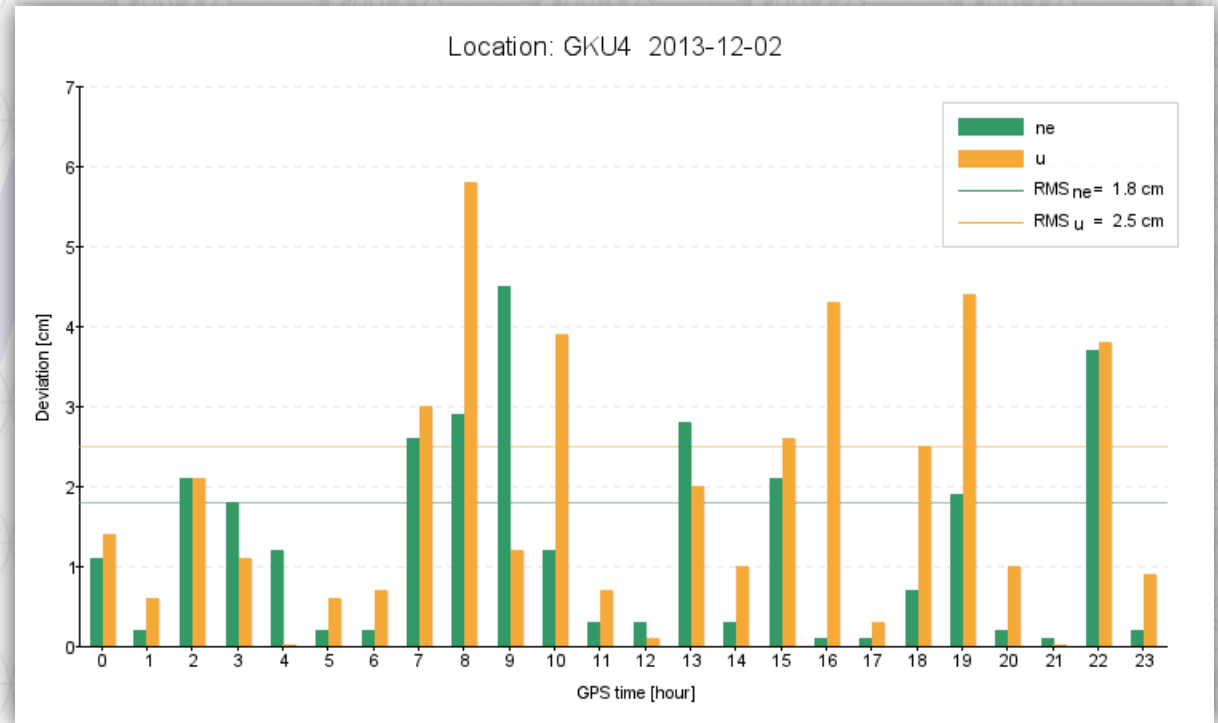 - Simple graphical output
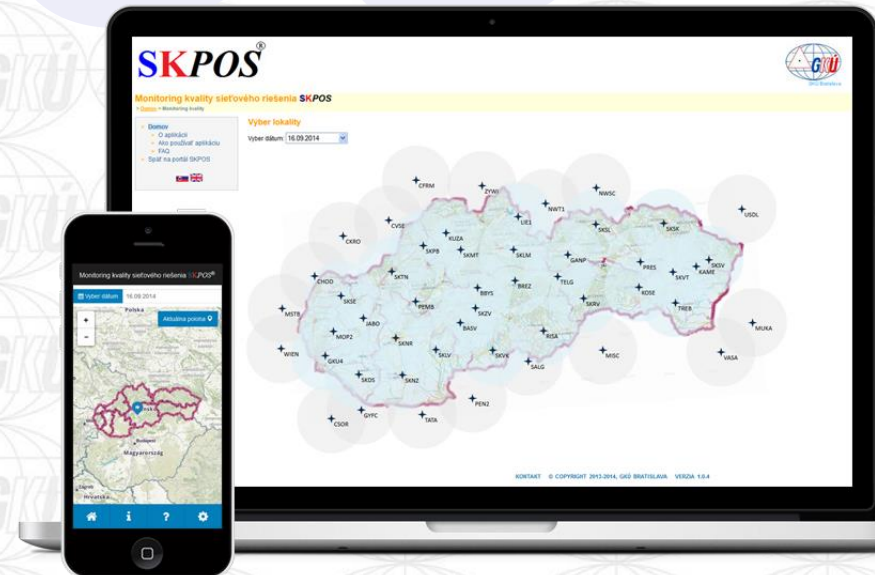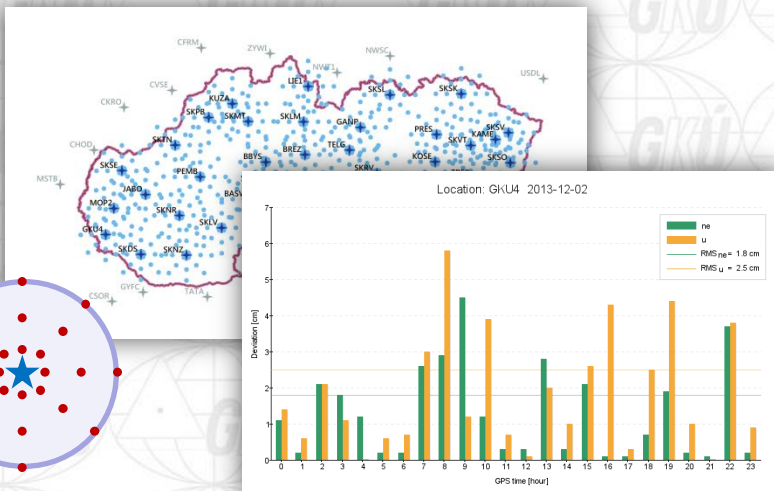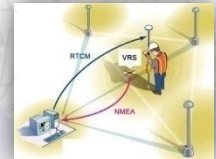
RTKNAVI
www.rtklib.com

Fix ✓
~~**Float**~~

⬇

Grubbs test
(errors elimination)

⬇

φ, λ, h → n, e, u

⬇

Deviations computation
ne (HZ plane)
u (Vertical component)

Location: GKU4 2013-12-02

ne
u
RMS $_{ne}$= 1.8 cm
RMS $_{u}$ = 2.5 cm

Deviation [cm]

GPS time [hour]
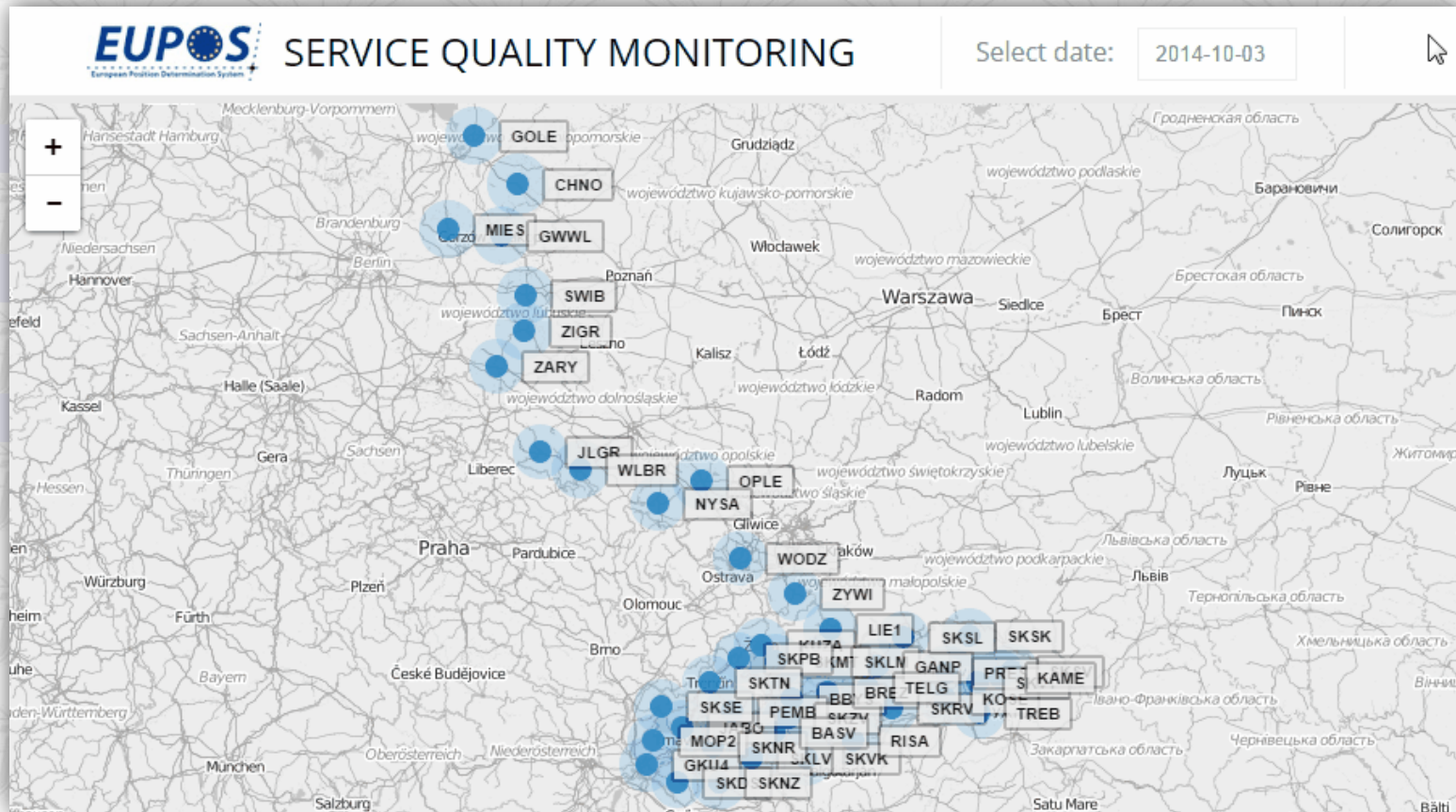
EUPOS network RTK quality monitoring
Creation of monitoring + status in October 2014

- Created on the 25th July 2014

- Monitored stations:
  - All SKPOS permanent stations
  - Few ASG-EUPOS permanent stations

- Simple responsive application written in HTML, CSS, PHP, JavaScript, MySQL, Leaflet map library

- Results available via web application: **http://monitoringEUPOS.gku.sk**
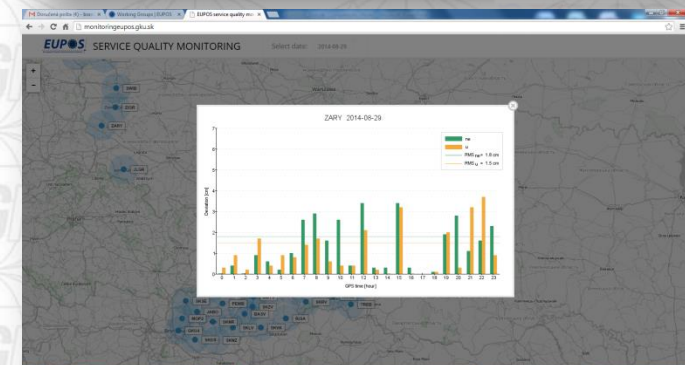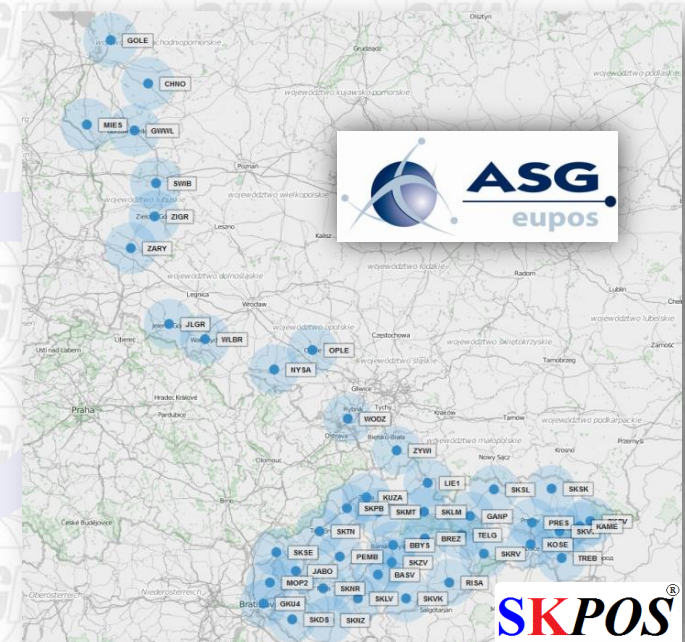
EUPOS network RTK quality monitoring
Web application – How it works

EUPOS network RTK quality monitoring
First results – ASG-EUPOS statistics

- **ASG eupos** permanent stations statistics
- Values from time period: 25/7/2014 – 6/10/2014 (73 days)
- Over 15,000 values analyzed

	Horizontal component (ne)	Vertical component (u)
Number of values	15,605	15,605
Maximal value	24.9 cm	37.1 cm
Average value	1.2 cm	1.3 cm
No fix solution	9%	

HZ RMS ≤ 2 cm (EUPOS TS) Confimed!
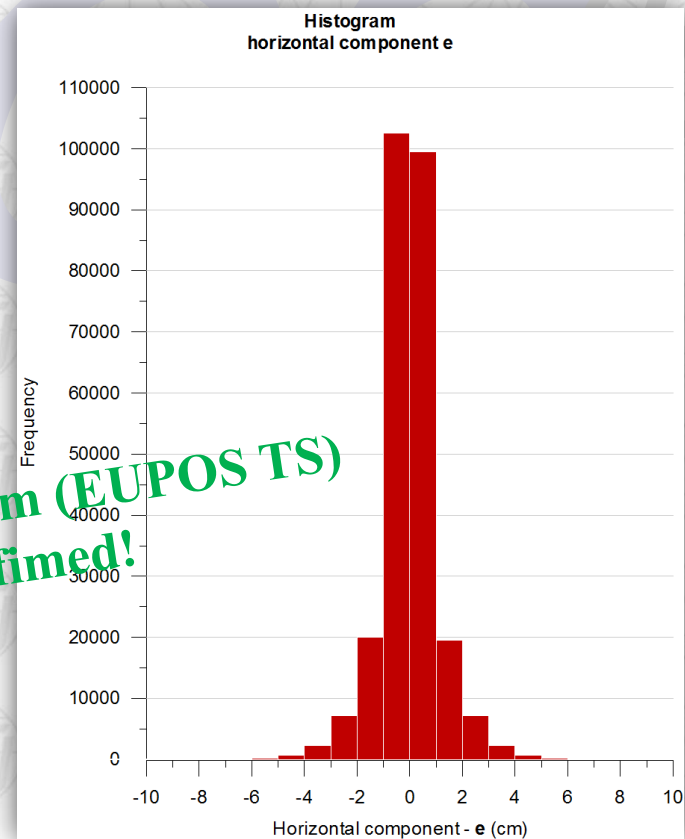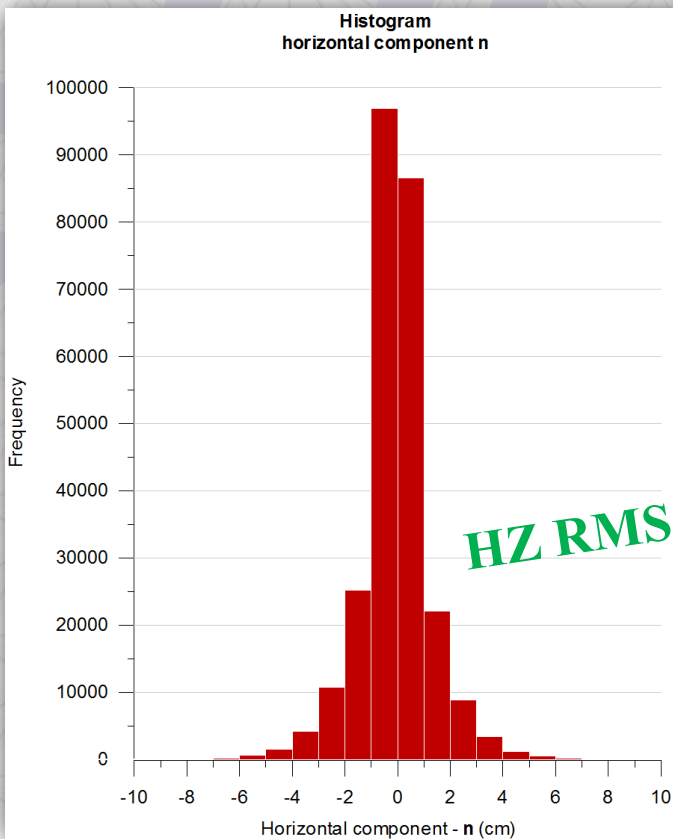
EUPOS network RTK quality monitoring
Results – **SK**POS® statistics

- **SKPOS**® permanent stations statistics
- Values from time period: 1/7/2013 – 30/9/2014 (457 days)
- Over 319,000 values analyzed

	Horizontal component (ne)	Vertical component (u)
Number of values	319,049	319,049
Maximal value	47.9 cm	49.6 cm
Average value	1.2 cm	2.4 cm
No fix solution	*HZ RMS ≤ 2 cm (EUPOS TS) Confimed!* 18%	

EUPOS network RTK quality monitoring
Results – **S****K*****POS***® **graphical statistics**

- Time period: 1/7/2013 – 30/9/2014 (457 days)
- 319,049 values
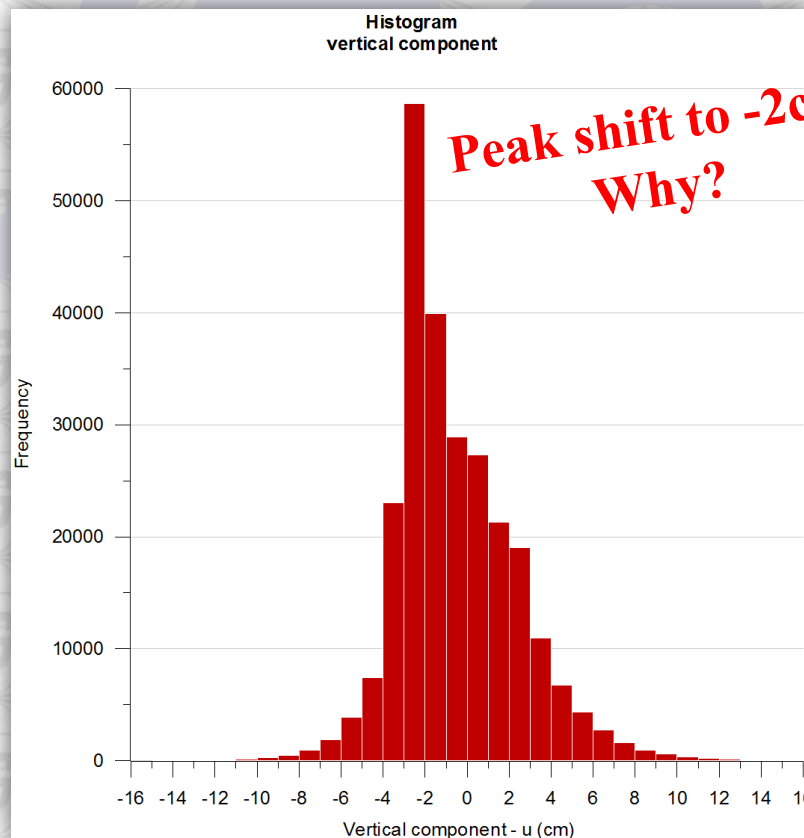- Histograms of horizontal (north, east) components

Histogram
horizontal component n

Histogram
horizontal component e

HZ RMS ≤ 2 cm (EUPOS TS) Confimed!

EUPOS network RTK quality monitoring
Results – SK*POS*® **graphical statistics**

- Time period: 1/7/2013 – 30/9/2014 (457 days)
- 319,049 values
- Histogram of vertical (up) component

EUPOS network RTK quality monitoring
Results - Statistics comparison

|	SKPOS®	ASG eupos
Values	319,049	15,605
Maximal value ne	47.9 cm	24.9 cm
u	49.6 cm	37.1 cm
Average value ne	1.2 cm	1.2 cm
u	2.4 cm	1.3 cm
No fix	18%	9%

Lower values! Why? GPSonly?

Lower value! Why? GPSonly?

Lower value! Why? GPSonly?

EUPOS network RTK quality monitoring
Virtual vs. Physical monitoring station

- New physical monitoring station **SUT1** was established in Bratislava
- SUT1 is located 4km from the GKU4 S**K***POS*® reference station
- Comparison principle on picture
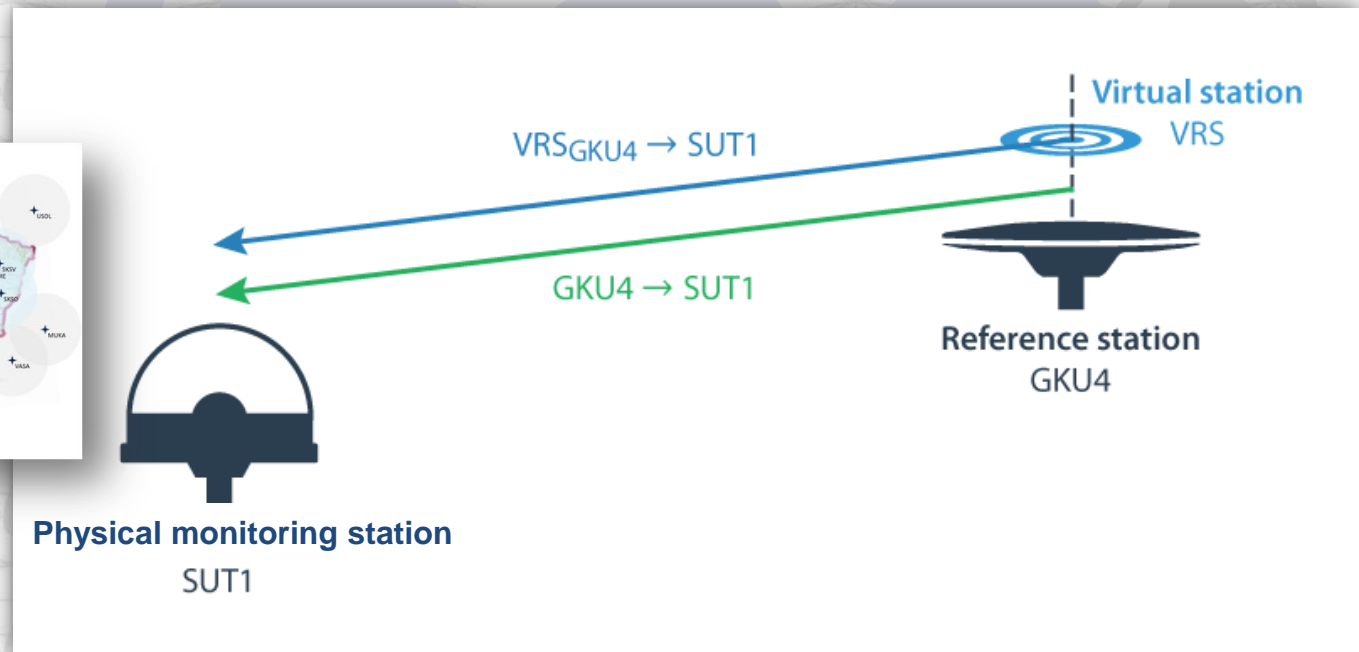
Principle:

RTKNAVI connects to S**K***POS*® and simulates the rover standing on GKU4. Once computes the baseline composed of VRS (generated for GKU4 coordinates) and SUT1 monitoring station and secondly composed of GKU4 and SUT1.

EUPOS network RTK quality monitoring
Virtual vs. Physical monitoring station

- **Results comparison**
- Time period: 19/5/2014 – 19/9/2014 (124 days)
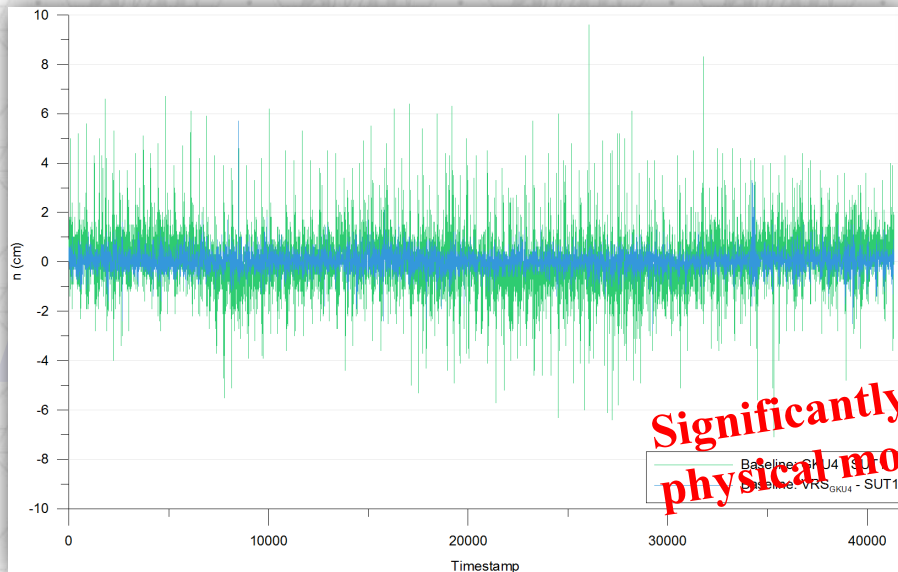- Test runs every 3 minutes
- Statistics in the table
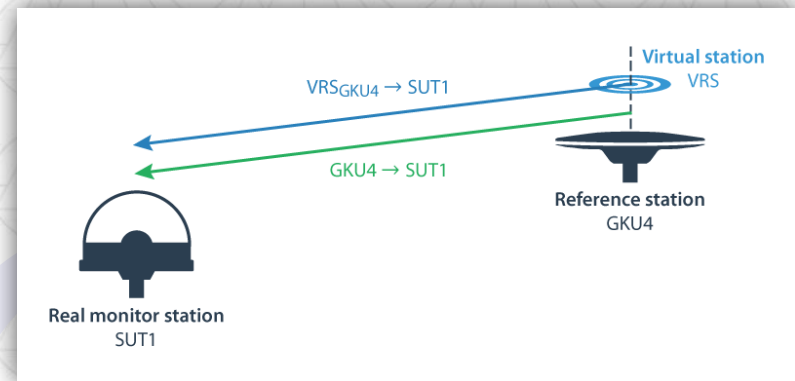
|	$n_{VRS\text{-}SUT1} - n_{GKU4\text{-}SUT1}$	$e_{VRS\text{-}SUT1} - e_{GKU4\text{-}SUT1}$	$u_{VRS\text{-}SUT1} - u_{GKU4\text{-}SUT1}$
Number of values	41,334	41,334	41,334
Maximal difference	10.0 cm	8.3 cm	13.5 cm
Average difference	0.6 cm	0.4 cm	1.0 cm

EUPOS network RTK quality monitoring
Virtual vs. Physical monitoring station

- Graphics of Horizontal components (n, e) differences

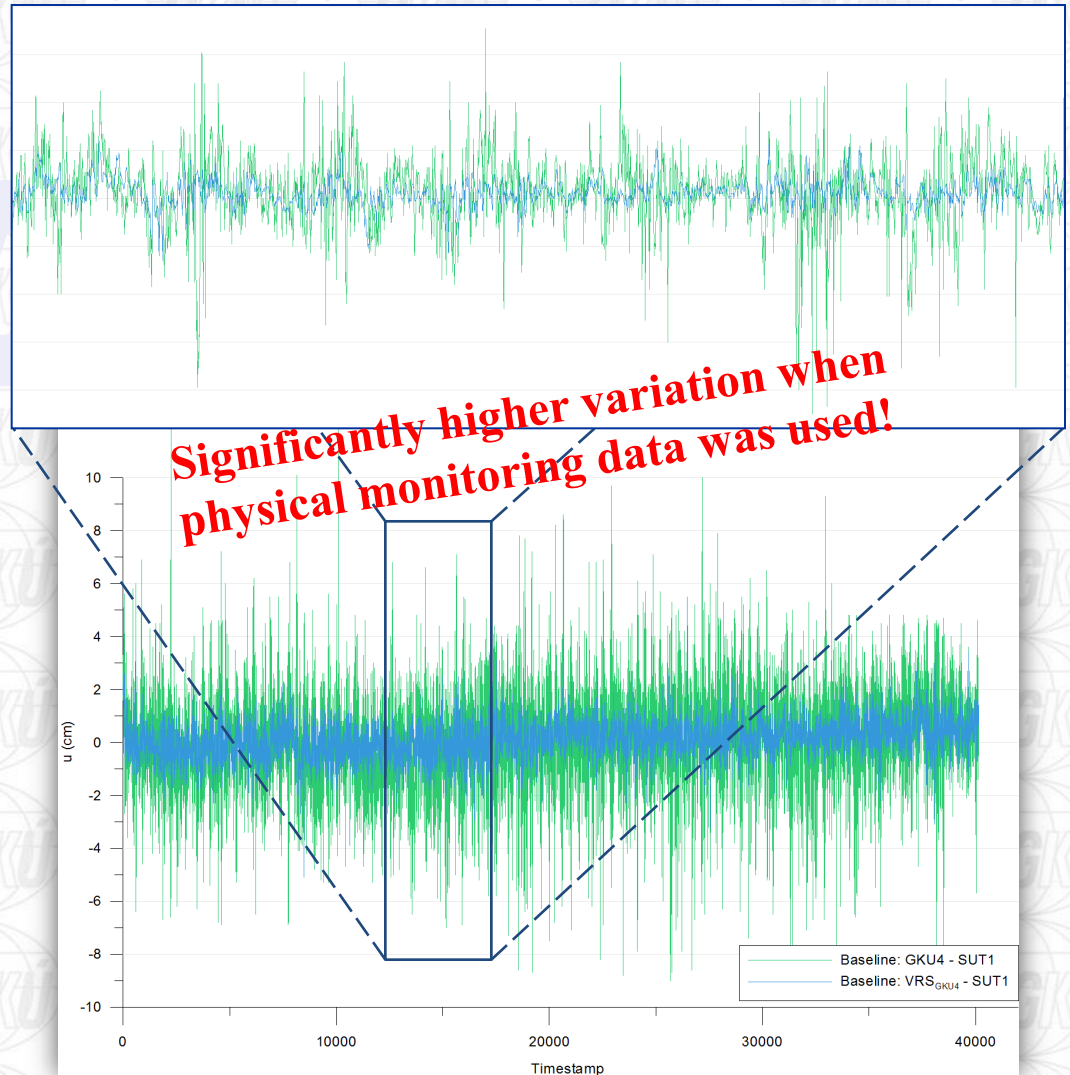*Significantly higher variation when physical monitoring data was used!*

Physical monitoring station

Virtual monitoring station

Virtual vs. Physical monitoring station

- Graphics of Vertical components (u) differences

Significantly higher variation when physical monitoring data was used!
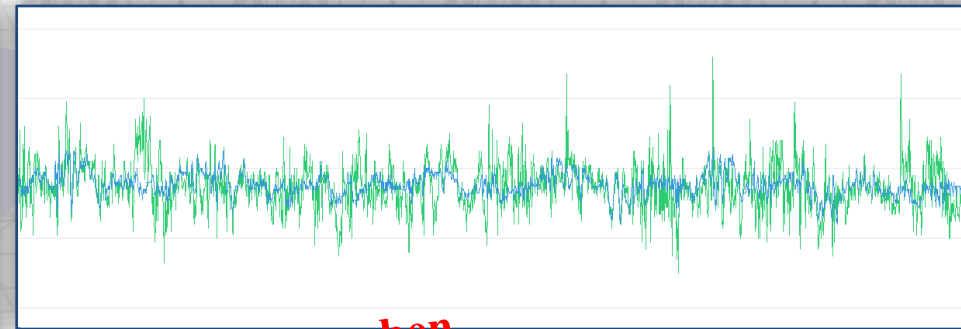
———	Physical monitoring station
———	Virtual monitoring station

EUPOS network RTK quality monitoring
Virtual vs. Physical monitoring station

- Mean value and dispersion comparison

	σ^2_n	σ^2_e	σ^2_u	E(n)	E(e)	E(u)
Baseline with physical monitoring station	0.78 cm	0.45 cm	2.87 cm	0.03 cm	-0.43 cm	0.00 cm
Baseline with virtual monitoring station	0.11 cm	0.11 cm	1.10 cm	0.02 cm	-0.41 cm	0.03 cm

Significant differences in dispersions! Is it correct?

Consistency of mean values !

Conclusions and next steps

- *EUPOS* network RTK quality monitoring is working and other EUPOS permanent stations can be added

- For that purpose we will need from National service operators:

  - access (user name and password) to the RTK network solution (VRS concept) and to all permanent stations via NTRIP Caster

  - corrections providing in RTCM 3.x format

  - information about reference stations coordinates (we can use up to date information about stations from ESDB)

  Important remark: one access can monitor 15 localities around the stations per hour. For countries with more stations - we will need more accesses (user names) to the RTK network solution and permanent stations. E.g.. In Slovakia with 32 permanent stations we use 6 usernames.

Conclusions and next steps

- *EUPOS* WG on Service Quality Monitoring will continue its work with:
  - adding other EUPOS permanent stations into *EUPOS* network RTK quality monitoring application **http://monitoringEUPOS.gku.sk**
  - comparing results from more physical monitoring stations with virtual monitoring stations
  - comparing results between different EUPOS countries
  - comparing results between Czech and Slovakia solution
  - ...
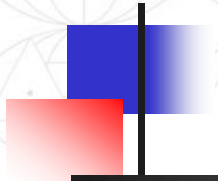
Thank you for your attention

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