National Report of Slovenia

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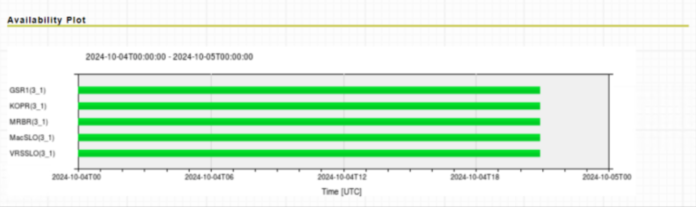
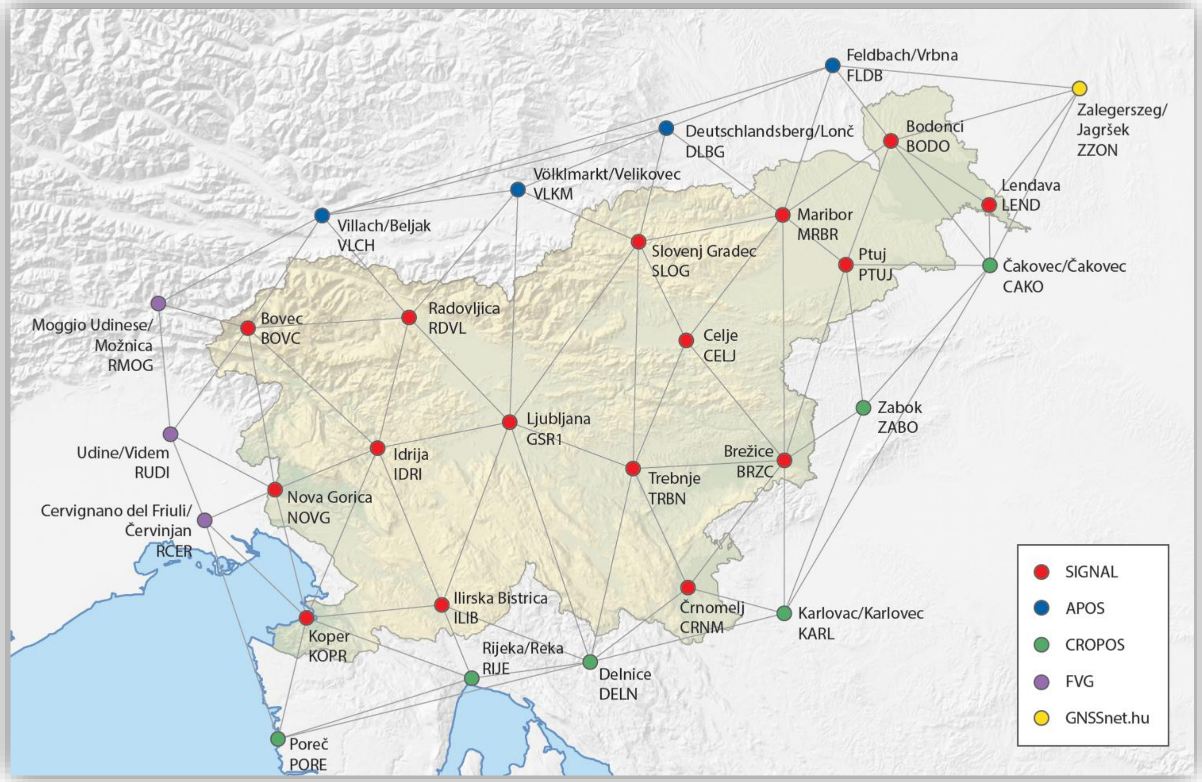
Presentation topics

- CORS Networks:
  - SIGNAL,
  - Zero-Order Network
- SLO 4D Project
- CARE4SIGNAL
- Geodetic Highlights and Inscription in National Registry of Cultural Heritage

SIGNAL Network (GBAS)

- 30 continuosly operating GNSS stations (16 in Slovenia, 14 foreign)
- 1 EPN station (GSR1, EUREF Class A)
- Trimble Pivot Platform
- Alberding Quality Control





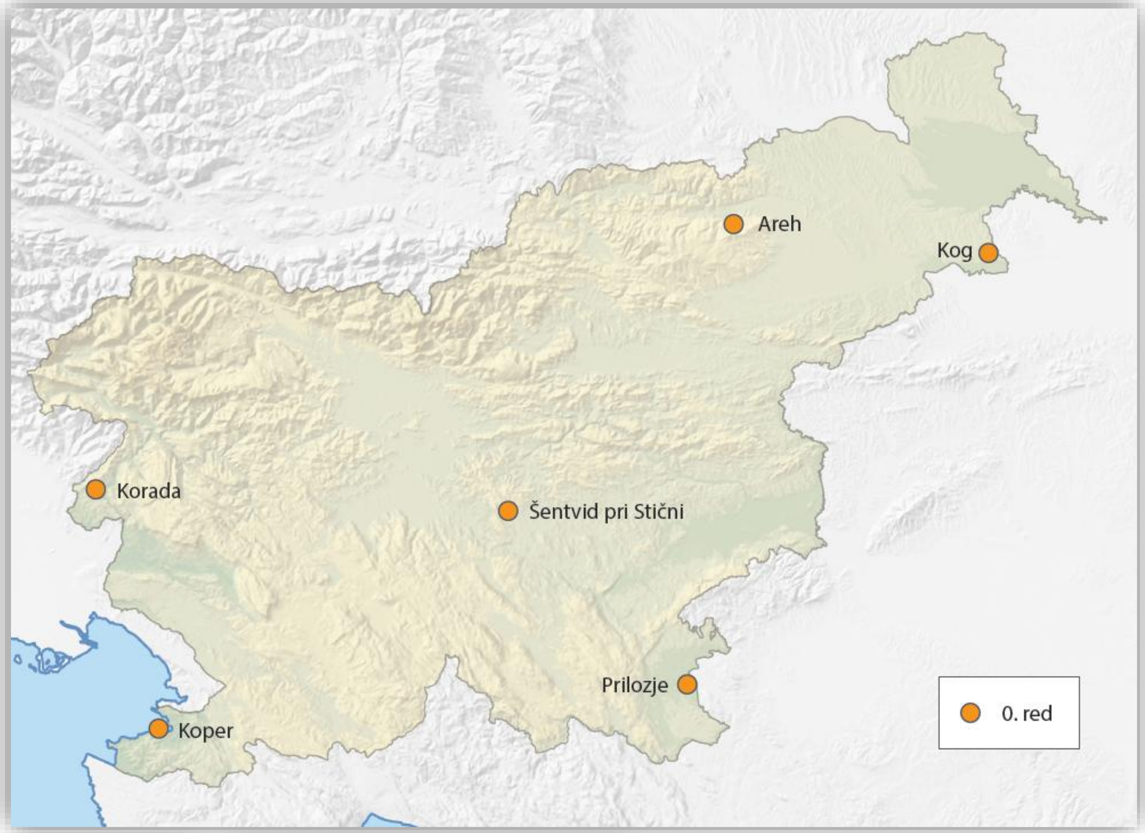
SIGNAL Network - News

- Upgraded main system to TPP v.5.1 (2024-02),
- Switched to a different hungarian station ~~ZALA~~ → ZZON (2024-06),
- New Trimble Alloy receiver on GNSS station BODO (2024-06),
- Added Beidou GNSS data to VRS mountpoints (GPS+GLN+GAL+BDS) (2024-09),
- Upgraded redundant system to TPP v.5.1.1 (2024-10),

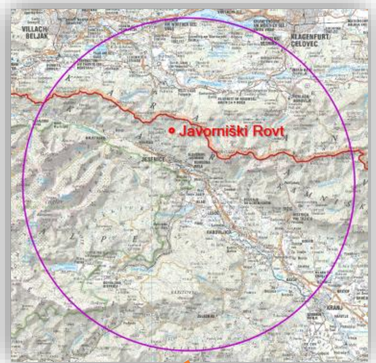
BODO	BODO	4	35	19	12	10	7	8	8	6	67.28	59.48	G19[E]
BOVC	BOVC	3	26	22	8	7	6	6	6	5	93.91	90.02	G19[E]
BRZC	BRZC	4	35	26	12	10	7	8	8	7	86.47	80.67	G19[E]
CAKO	CAKO	4	35	20	11	10	7	8	8	6	67.21	60.63	G31[E]
CELJ	CELJ	4	34	26	12	10	7	8	8	7	86.01	84.50	G19[E]
CRNM	CRNM	4	35	26	12	10	7	8	8	7	86.73	82.55	G19[E]
DELN	DELN	3	34	19	11	9	6	8	8	7	67.71	61.36	G19[E]
DLBG	DLBG	4	35	26	11	10	7	8	8	6	85.84	82.52	G31[E]
FLDB	FLDB	4	35	26	11	10	7	8	8	6	83.90	78.84	G31[E]
GSR1	GSR1	3	30	23	8	8	6	8	8	7	85.79	84.59	C25[N]
IDRI	IDRI	2	27	17	6	6	6	7	7	5	71.44	64.84	C20[N]
ILIB	ILIB	3	31	25	9	8	6	8	8	7	88.88	86.79	G19[E]
KARL	KARL	3	33	21	12	10	7	8	8	7	67.17	60.57	G19[E]
KOPR	KOPR	3	34	18	11	10	6	8	8	6	68.08	61.86	G19[E]
LEND	LEND	4	35	19	12	10	7	8	8	6	67.66	59.60	G19[E]
MRBR	MRBR	4	35	18	12	10	7	8	8	6	68.01	60.61	G19[E]

Zero Order GNSS Network

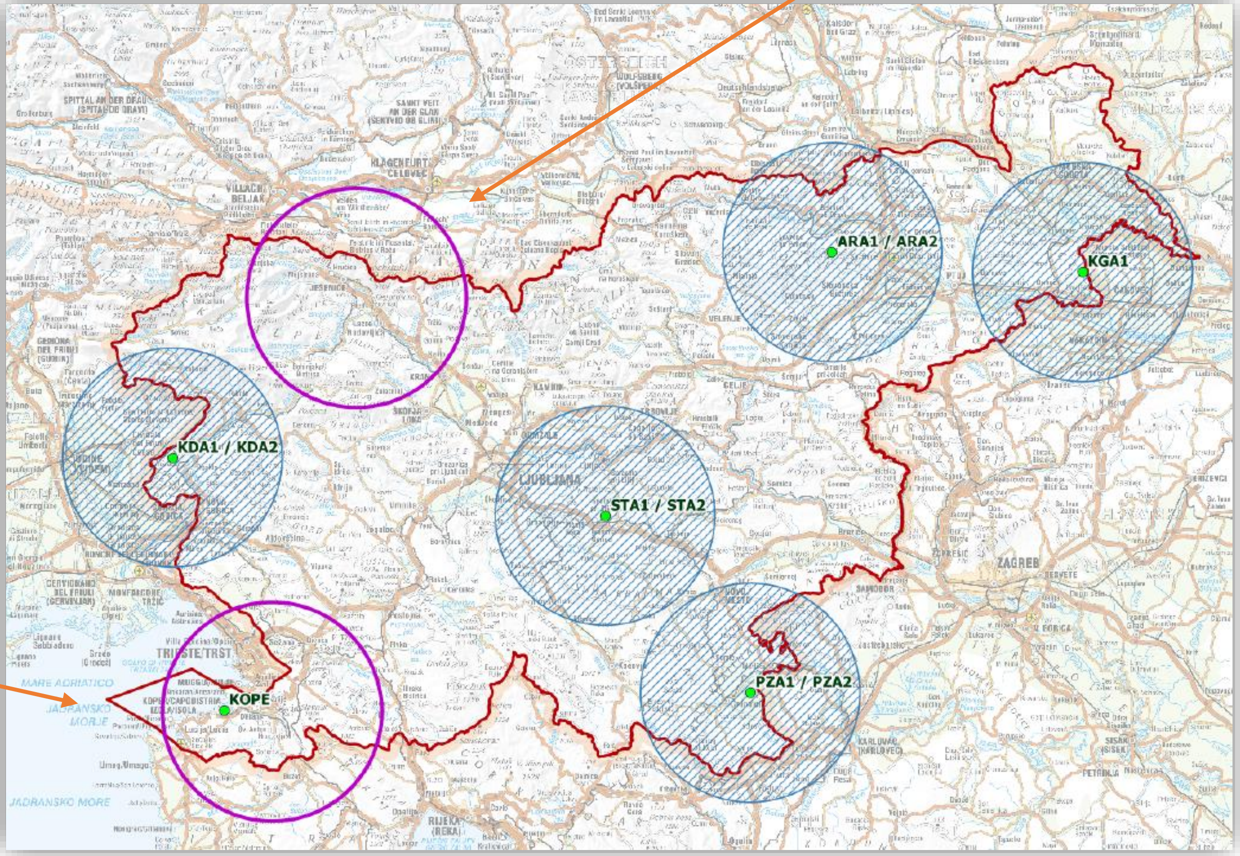
- 6 GNSS stations in Slovenia (Leica),
- Operating since 2016,
- Alberding GNSS Status Software.



Zero Order GNSS Network - News

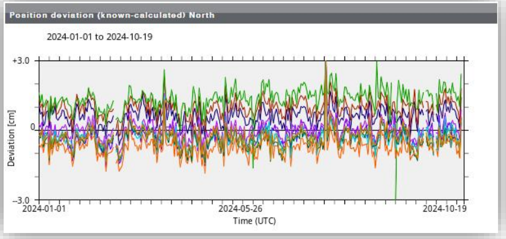


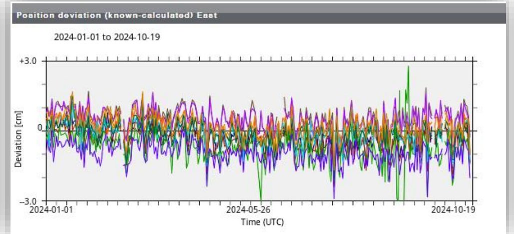
- Building two new zero-order GNSS stations:
  - Javorniški Rovt,
  - Livade,
- Reason:
  - NW of Slovenia not covered,
  - Problems with KOPE station,

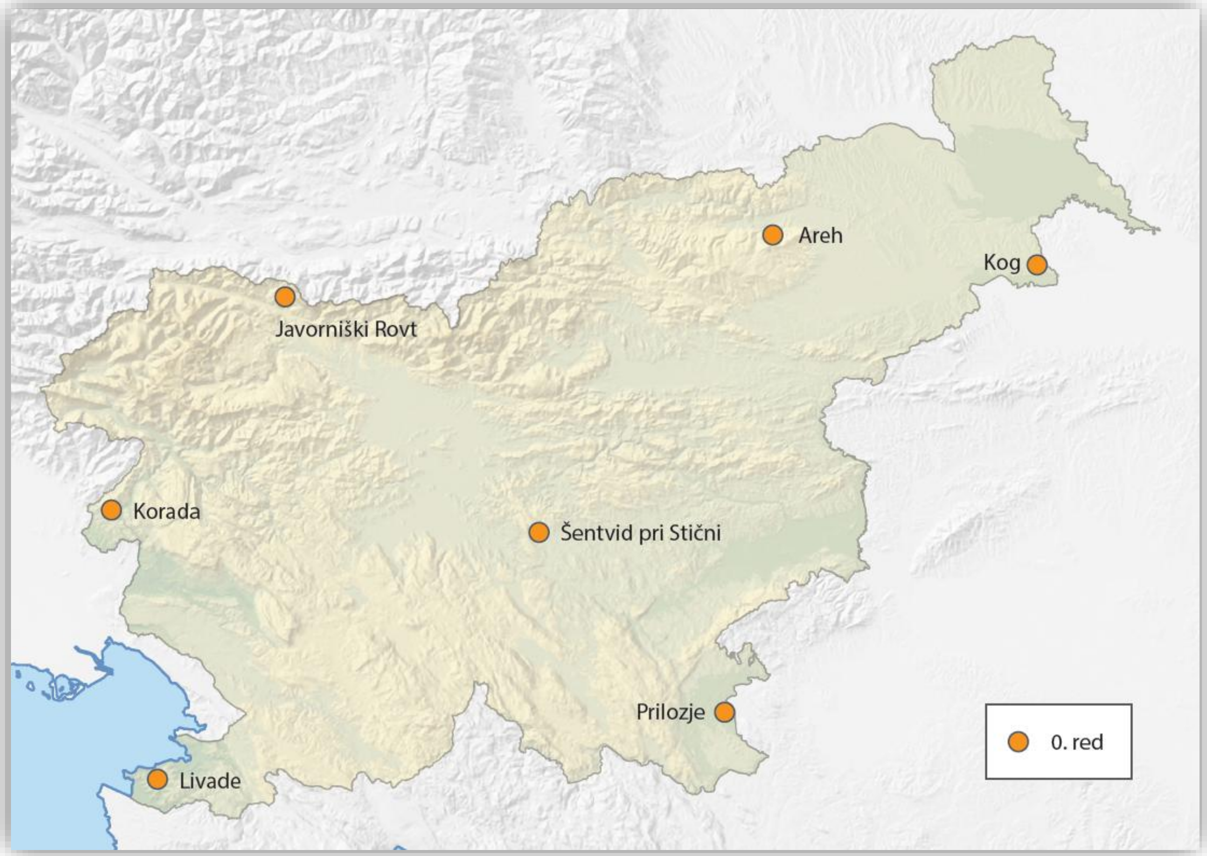


Zero Order GNSS Network - News

- Operational presumably by end of 2024.

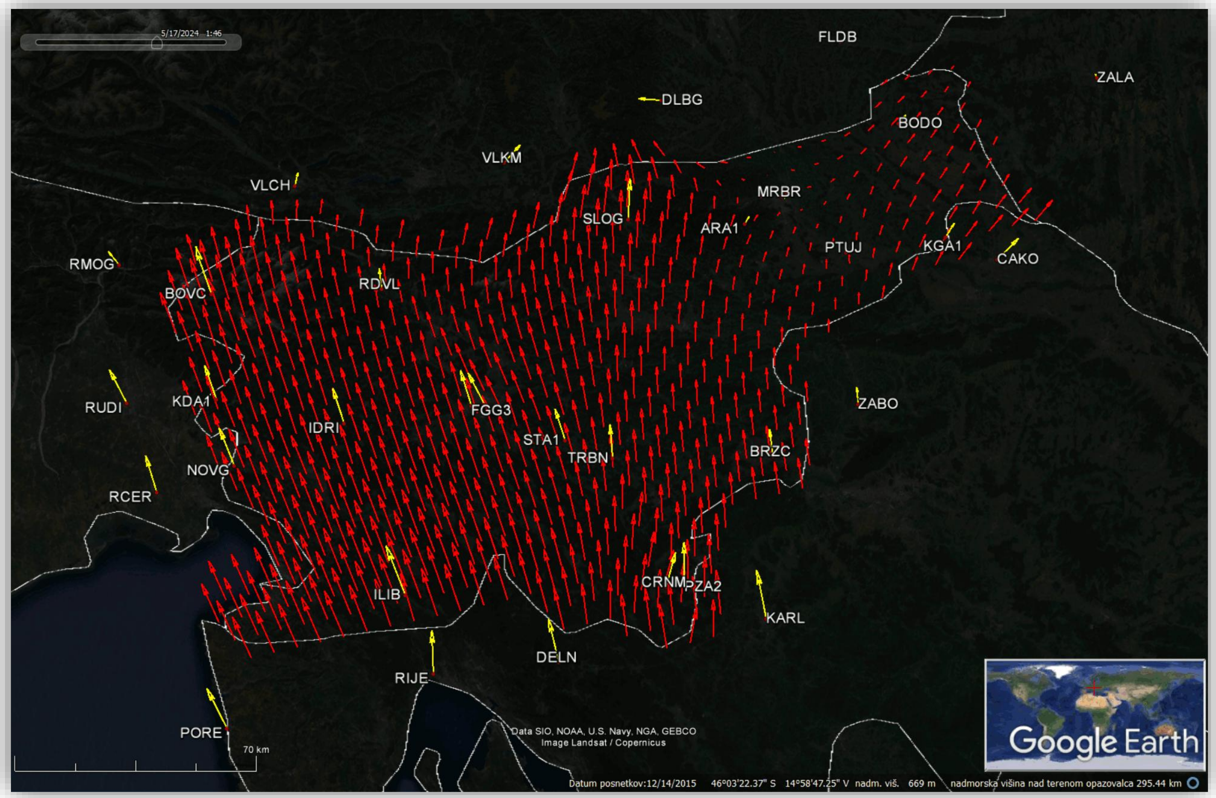






SLO4D Project

- Pilot project on introducing the 4th dimension to the national coordinate system in order to ensure its long-term sustainability
- Goal:
  - Expanding the Zero-Order Network (as mentioned),
  - Creation of a geokinematic model,
  - Investigating possible reference frame redefinition, e.g. by introducing a (semi)kinematic reference frame,
  - System for quality control of the national coordinate system.

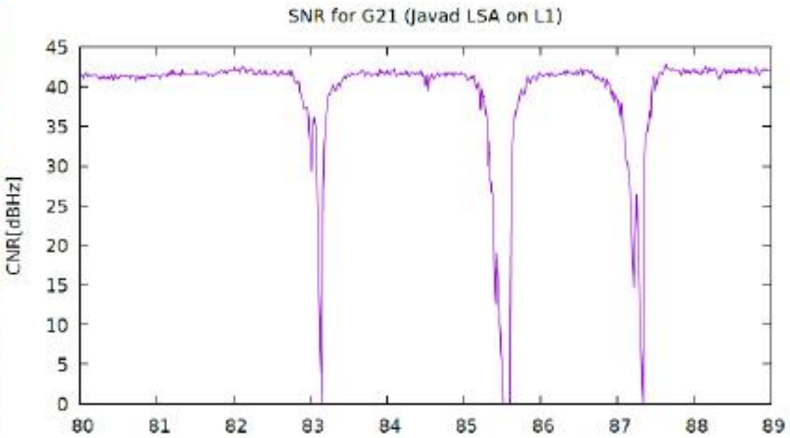


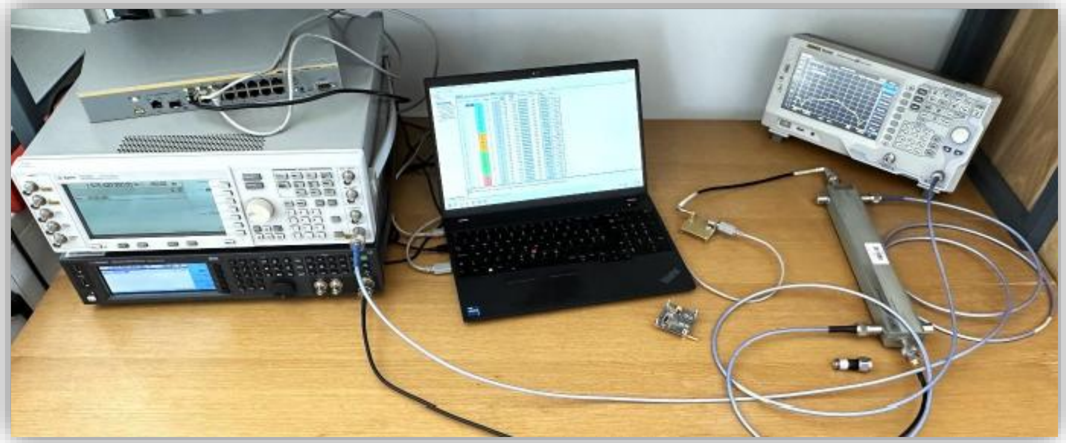
CARE4SIGNAL Research Project

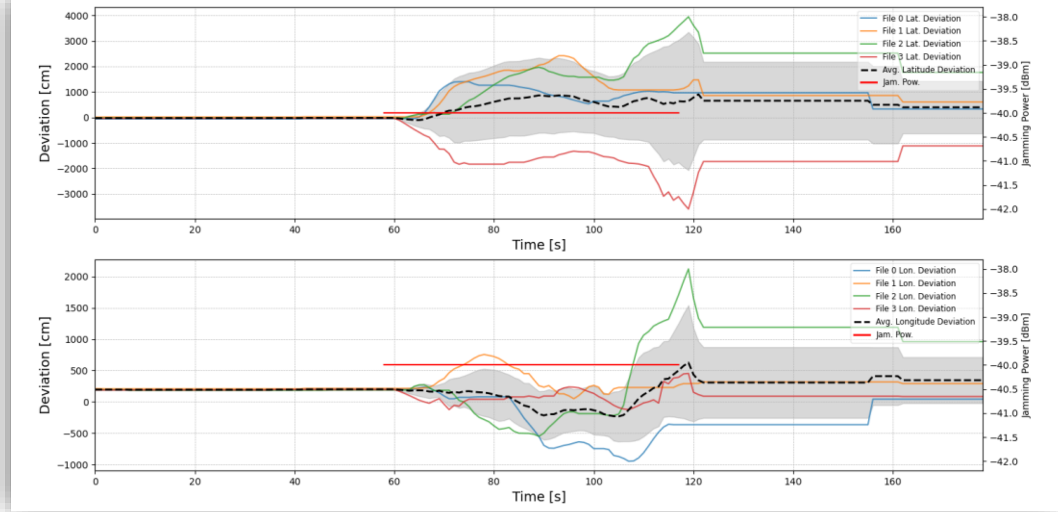
- Goal:
  - Analysis of GNSS rover vulnerability to deliberate signal interference,
  - Development and testing of methodology for signal interference detecting and the quality of GNSS observations,
  - Integration and implementation of methodology and recommendations for further research.
- Partners:
  - Faculty of Civil and Geodetic Engineering,
  - Faculty of Electrical Engineering,
  - Faculty of Maritime Studies and Transport,
  - Geodetic Institute of Slovenia.
- Project timeline: 2023 → 2025.

CARE4SIGNAL Research Project

- Field testing with jammers,
- Lab testing with a GNSS simulator,
- Recommendations:
  - low cost receivers on GNSS stations to monitor interference



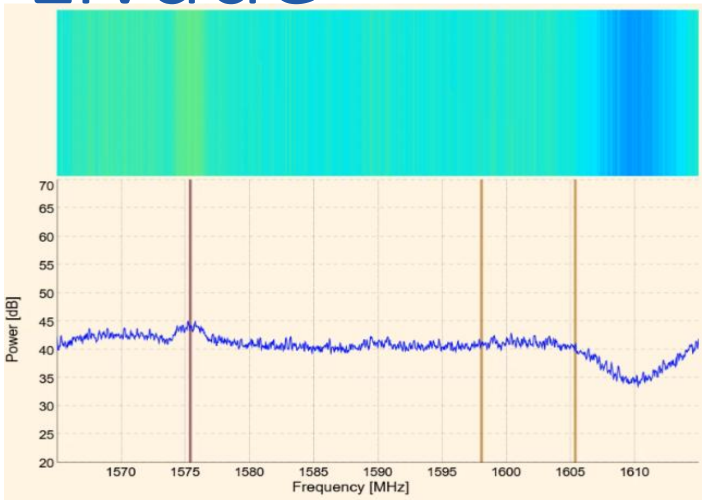




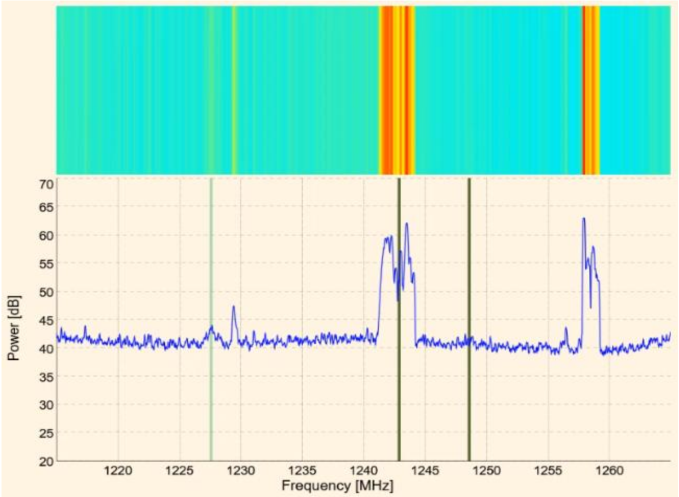
Spectrum measurement at new Zero-order GNSS station Livade

Used instrumentation:
Trimble R12i (geodetic receiver)
ublox ZED-F9P (low-cost receiver)

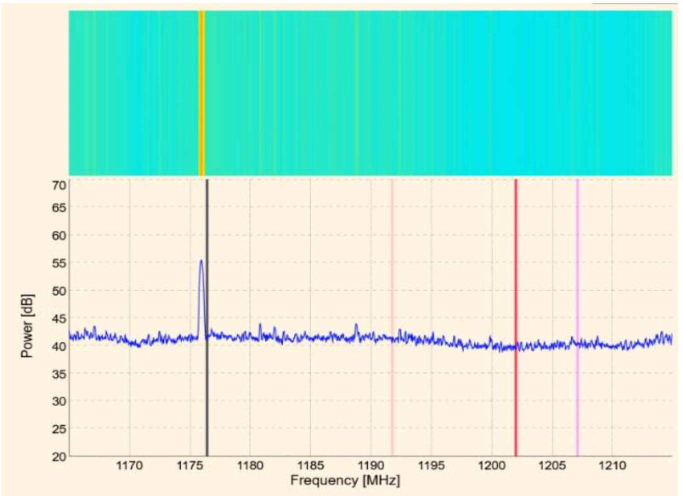
Spectrum from Trimble R12i: new GNSS station Livade



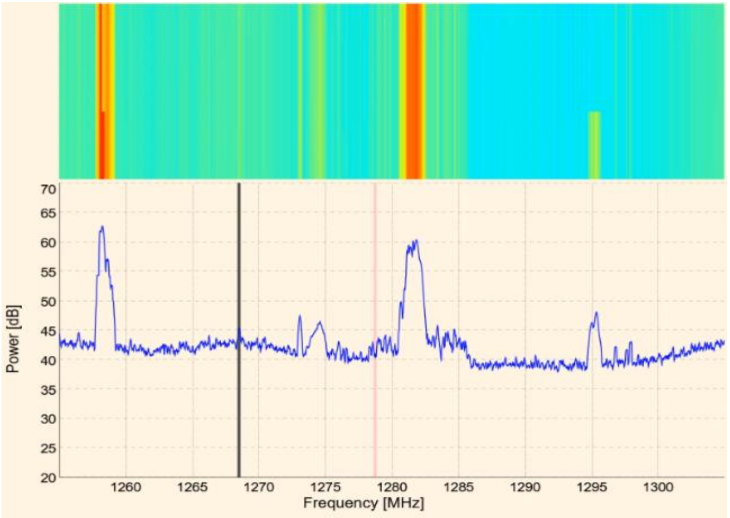
Wider L1 frequency band: L1, G1



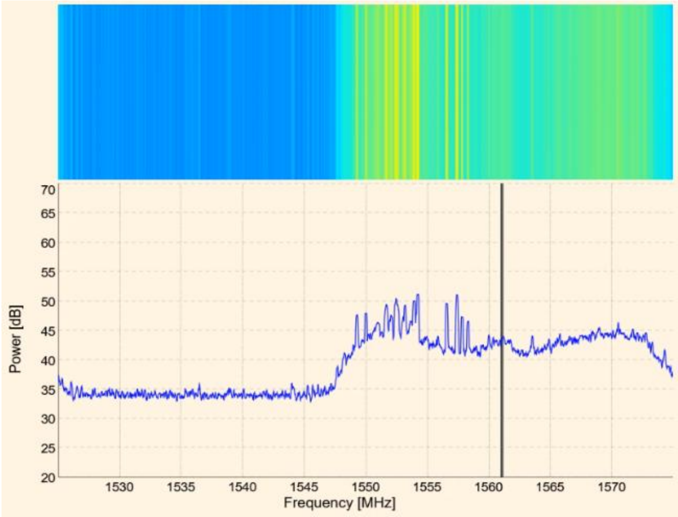
Wider L2 frequency band : L2, band for G2



Wider L5 frequency band :L5, E5a/b, G3, (E5b, E5AltBOC, B2I, B2b)

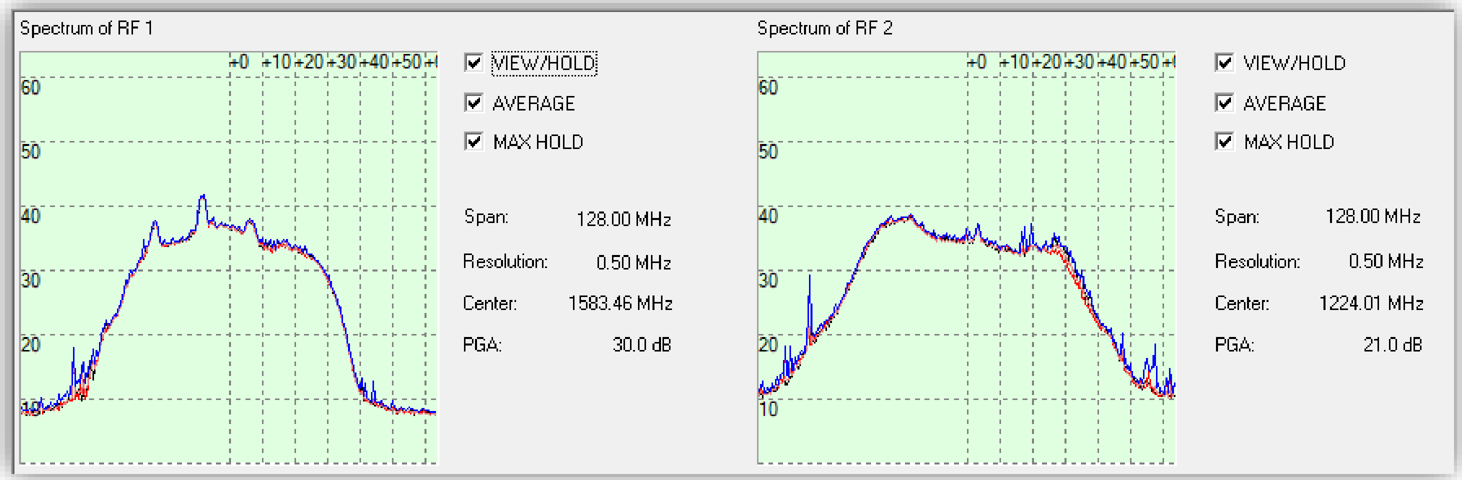


Wider E6 frequency band: B3I, E6

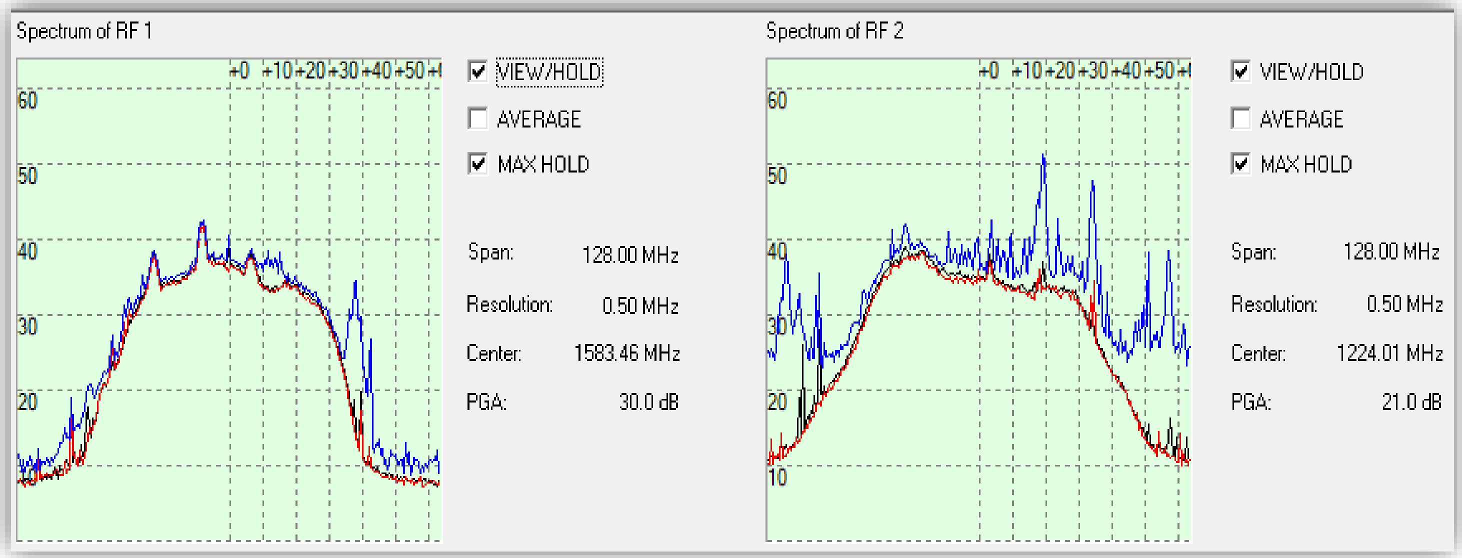


Wider B1 frequency:B1

Spectrum from ublox-ZED-F9P: new GNSS station Livade

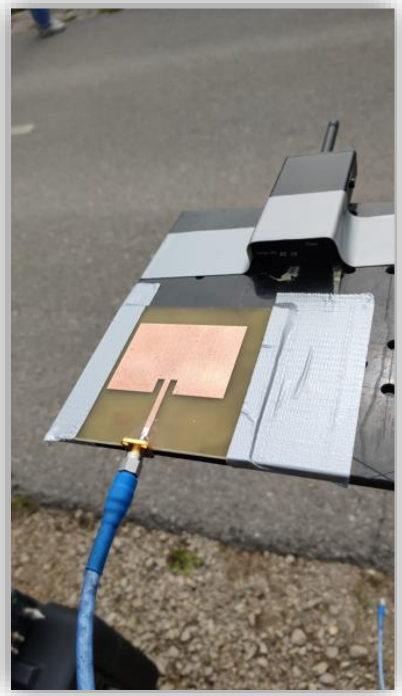


the quiet part of the spectrum (no interference)



presence of interference (unintentional)

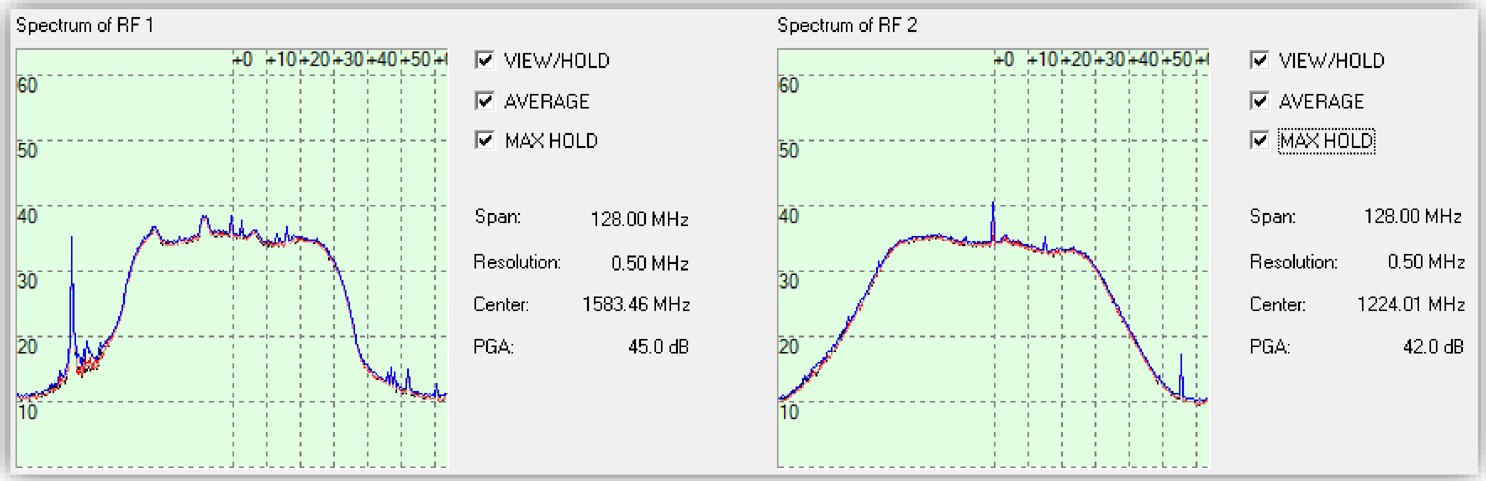
Intentional interference to GNSS signals



Geodetic receivers:
Trimble R12i
Leica GS15
Leica GS18T
ublox ZED-F9P

Source of interference:
Low-cost (L1, L5) and professional (Agilent E4438C)

Spectrum from ublox ZED-F9P: intentional interference with professional jammer (CW wave on L1)



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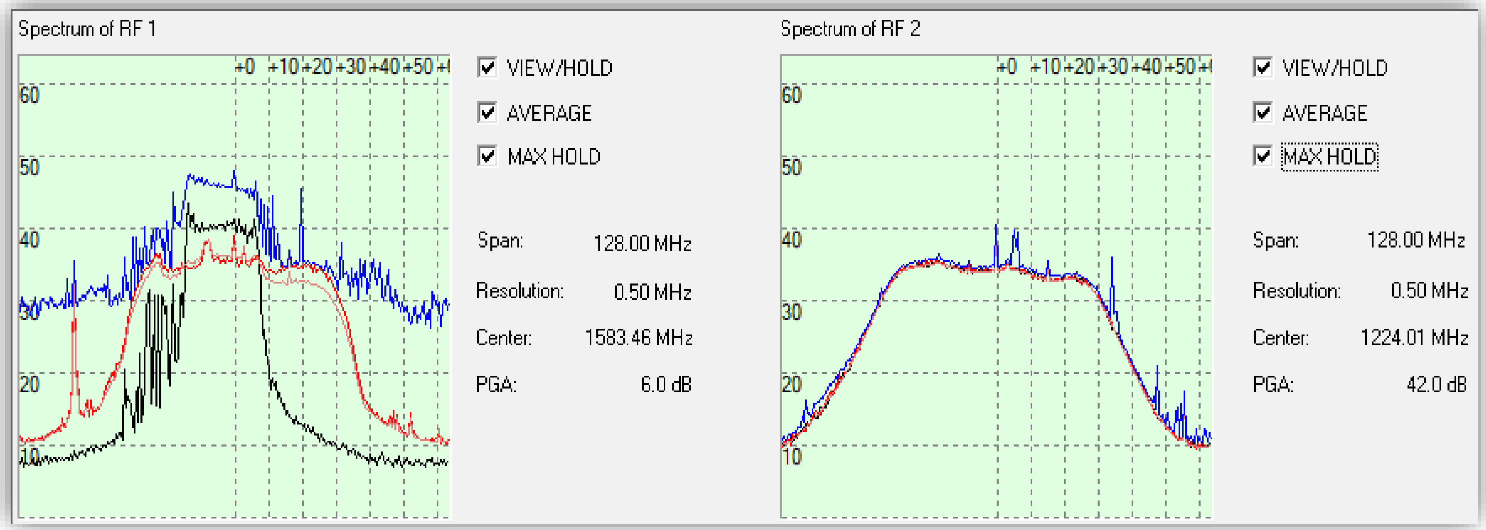
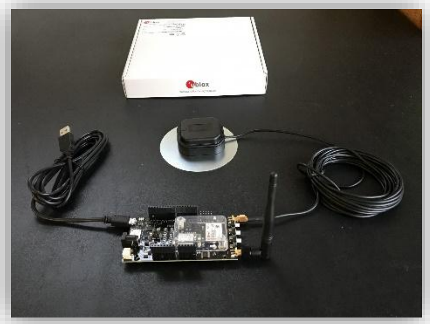


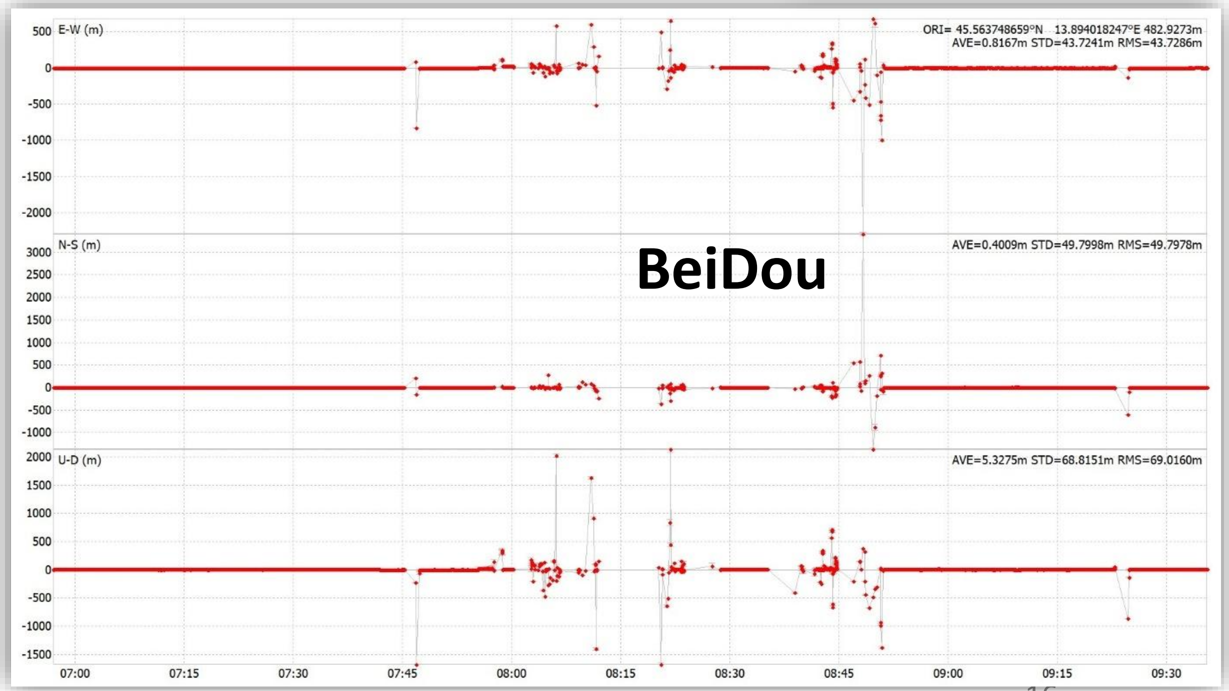
presence of interference (unintentional)

Jamming effect on low-cost receivers (ublox ZED-F9P)

Impact on single point positioning (SPP)

RMS [m]					
	GPS	GLONASS	Galileo	BeiDou	All constellations
E-W	12,279.5941	8.4027	4.8011	43.7286	10,308.8916
N-S	58,045.2810	3.0090	2.0855	49.7978	10,730.7055
U-D	87,860.6797	10.7288	13.2618	69.0160	21,041.3918

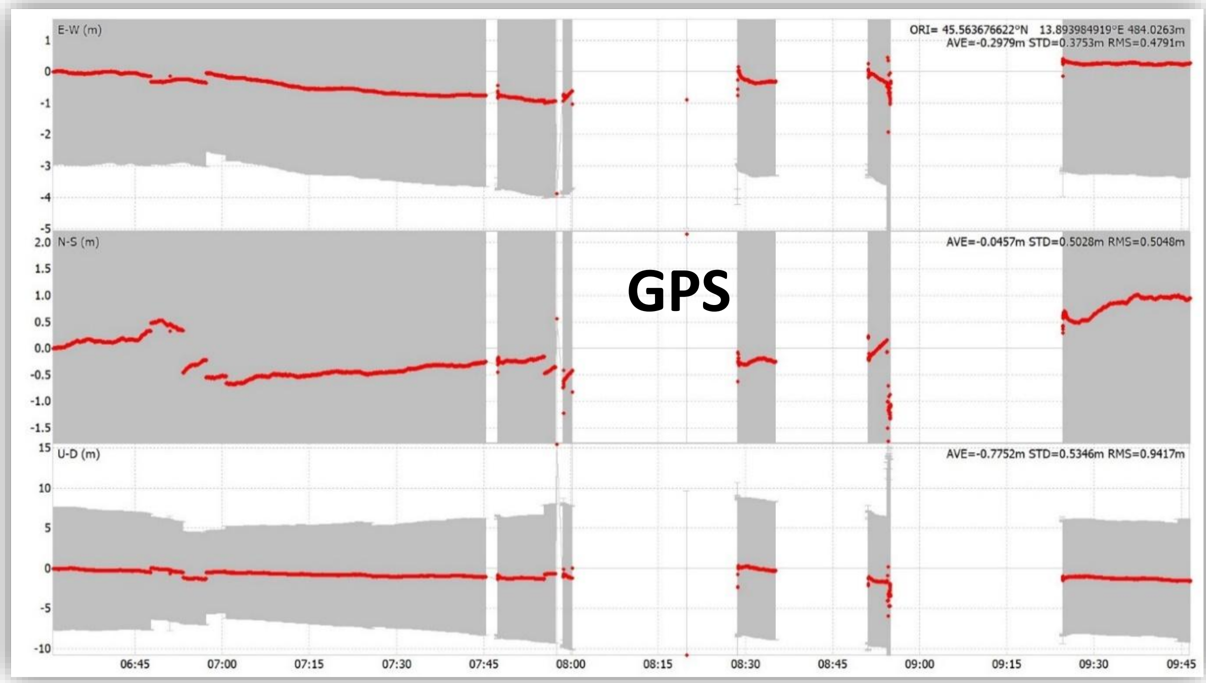


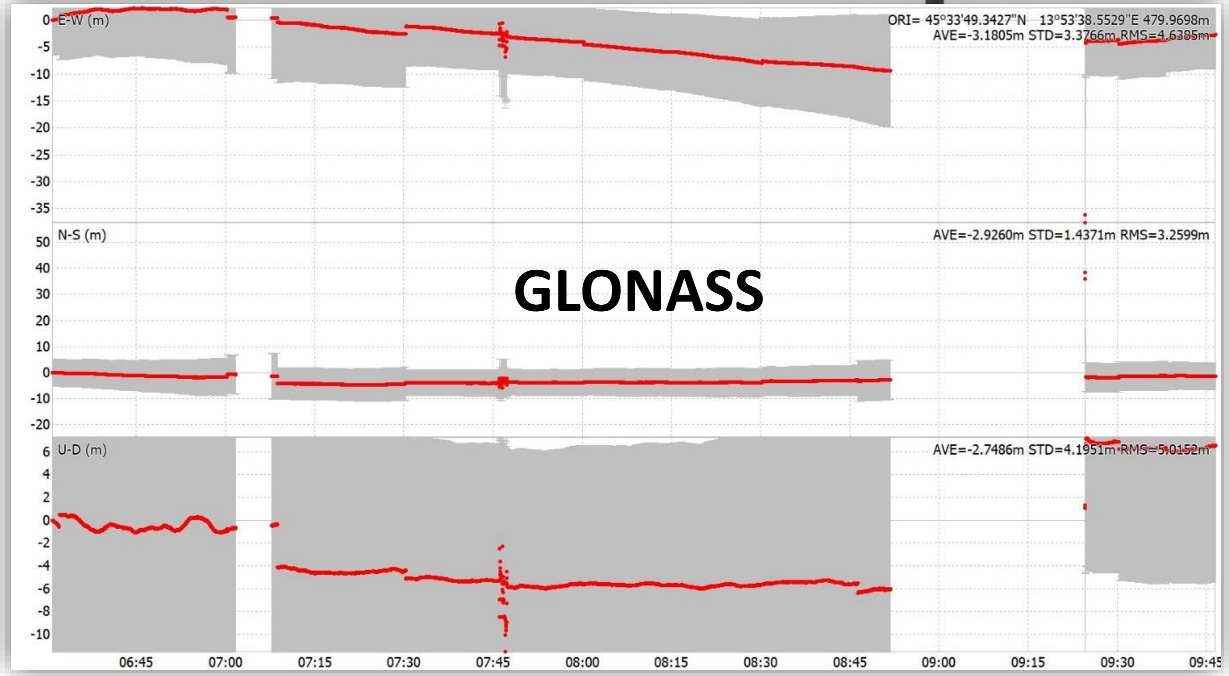


Jamming effect on professional grrade receivers (Leica GS18T)

Impact on single point positioning (SPP)

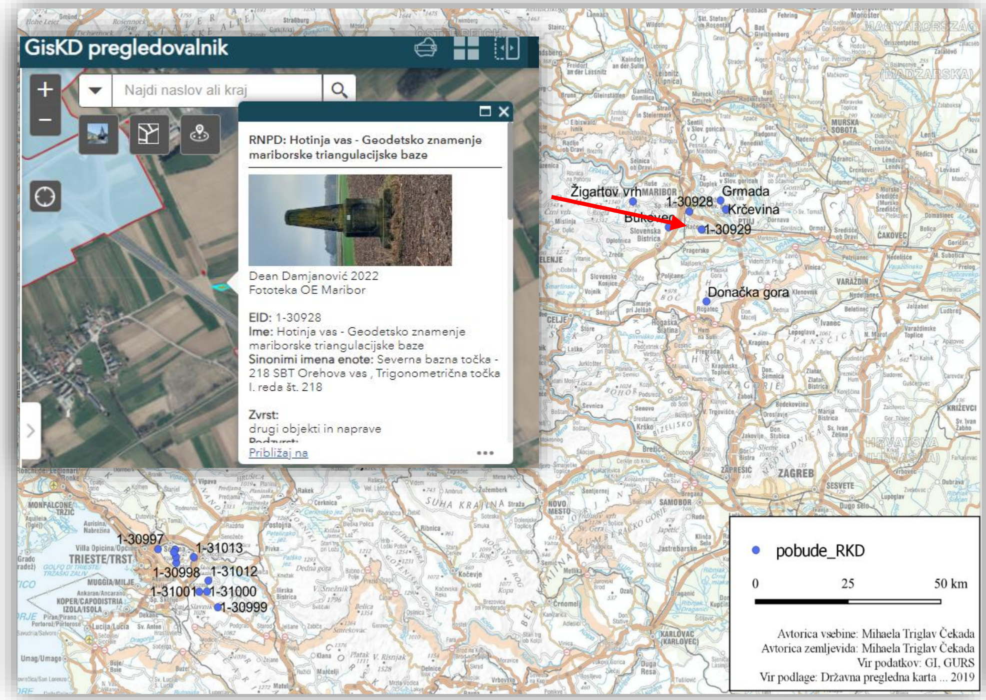
RMS [m]					
	GPS	GLONASS	Galileo	BeiDou	All constellations
E-W	0.4791	4.6385	4.6601	0.6905	0.6543
N-S	0.5048	3.2599	3.1884	0.4050	0.6997
U-D	0.9417	5.0152	5.2025	2.4971	2.7546

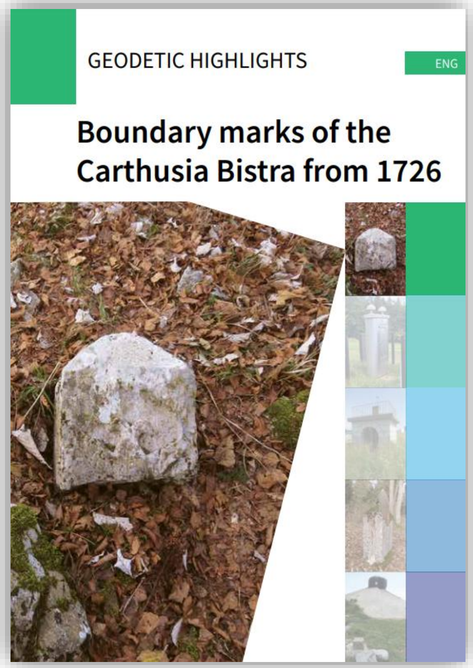


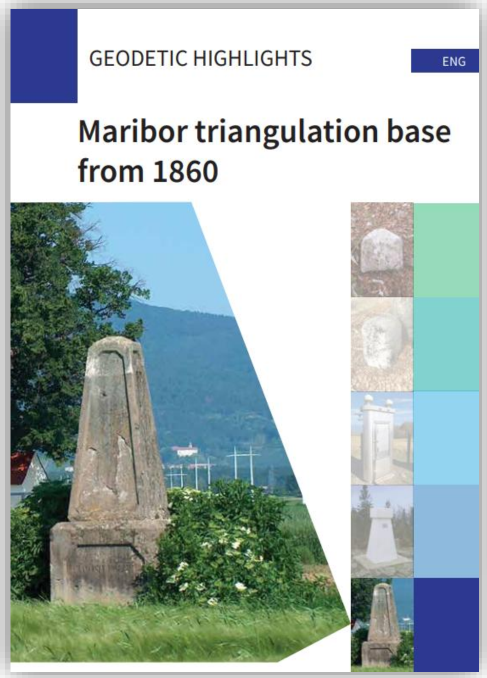


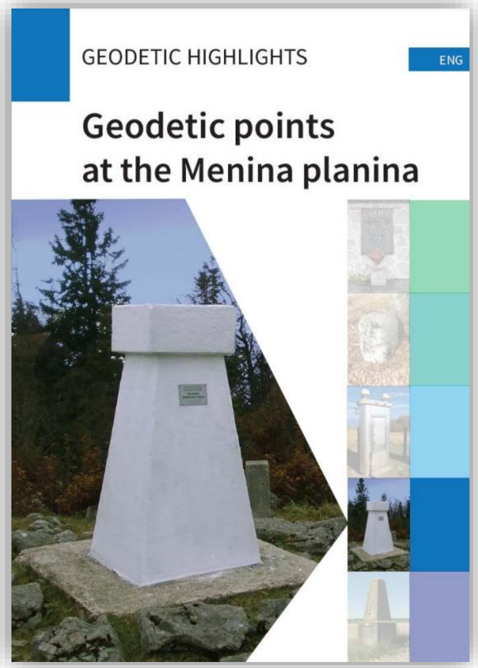
Geodetic Highlights and Inscription in National Registry of Cultural Heritage

- Aplicative Research Project L2-50090: ***Geodetic marks as material witnesses of the geodetic networks development in Slovenia,***
  - *cofinanced by Slovenian Research and Innovation Agency and Surveying and Mapping Authority of Republic of Slovenia*









GEODETSKI INŠTITUT SLOVENIJE

Thank you for your attention

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