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Improved High-Precision RTK Positioning Through Multipath Reduction and Interference Mitigation

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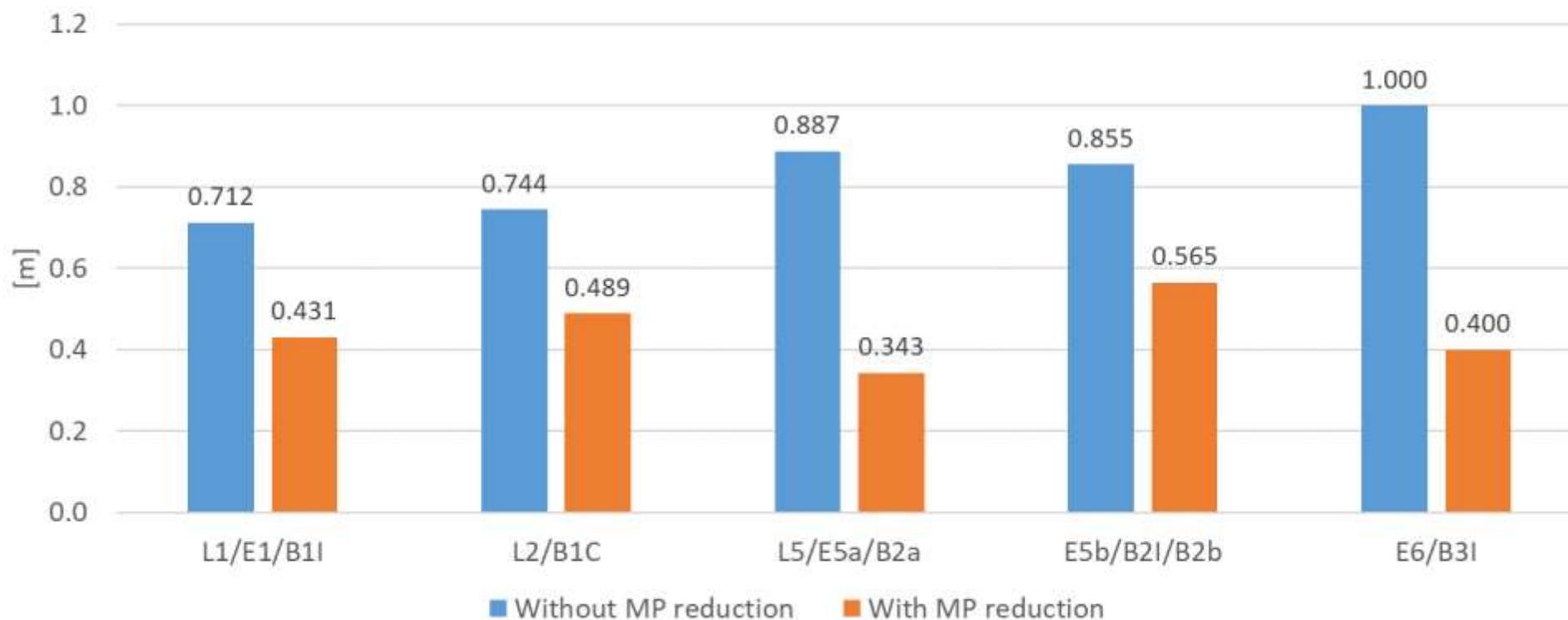
Test setup

- Multipath environment in the Heerbrugg testbed
- Base: GS18 T under open sky
- Rover: GS10 receivers connected to the same AS11 antenna via a passive antenna splitter
- GNSS: GPS + GLO + GAL + BDS (GREC)
- Cut-off angle: 10 degrees
- Single-base RTK (baseline length: 100m)
- RTK data format: RTCM v3 MSM5
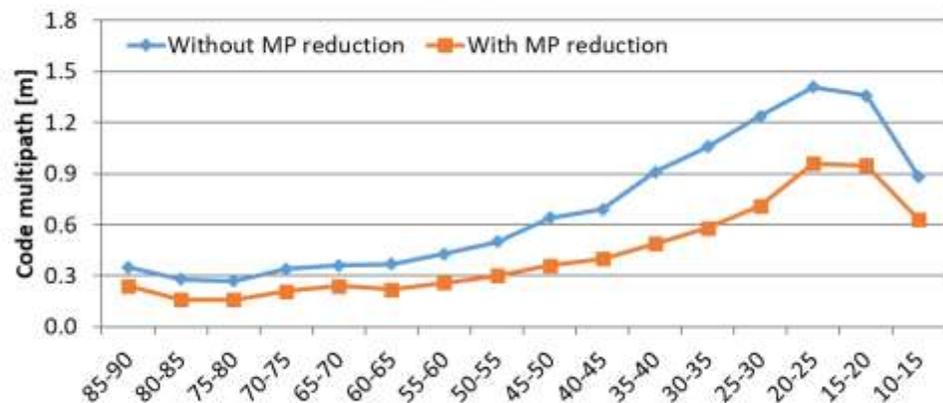- 54 hours of 1-Hz GNSS data

Average value of code multipath (cut-off: 10°)

The average code multipath error is significantly reduced by up to 60% for L5 and E6.

MP (GPS L5) Skyplot: Without MP reduction 16/04/21 11:00 - 18/04/21 17:14

MP (GPS L5) Skyplot: With MP reduction 16/04/21 11:00 - 18/04/21 17:14
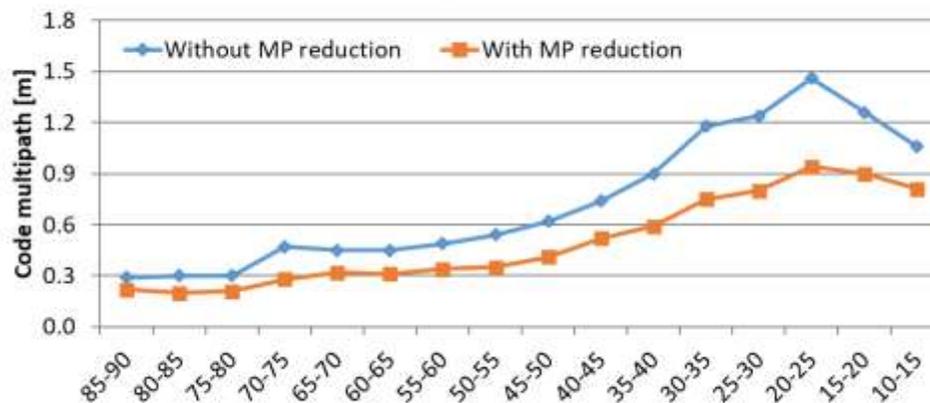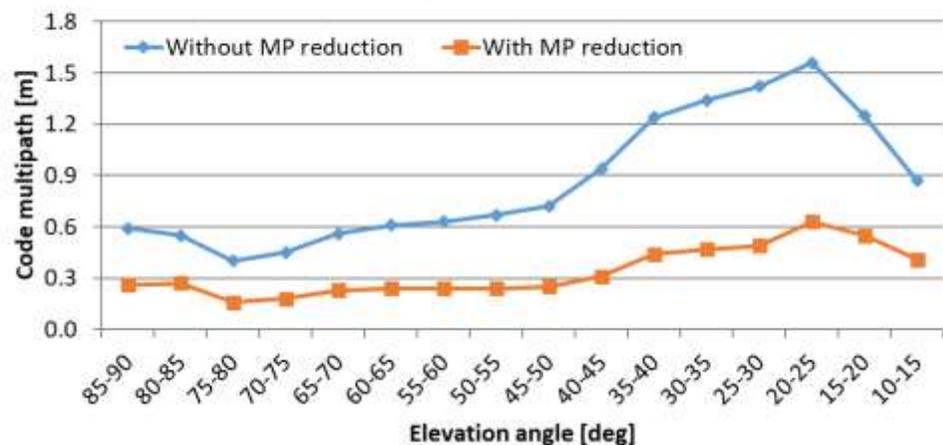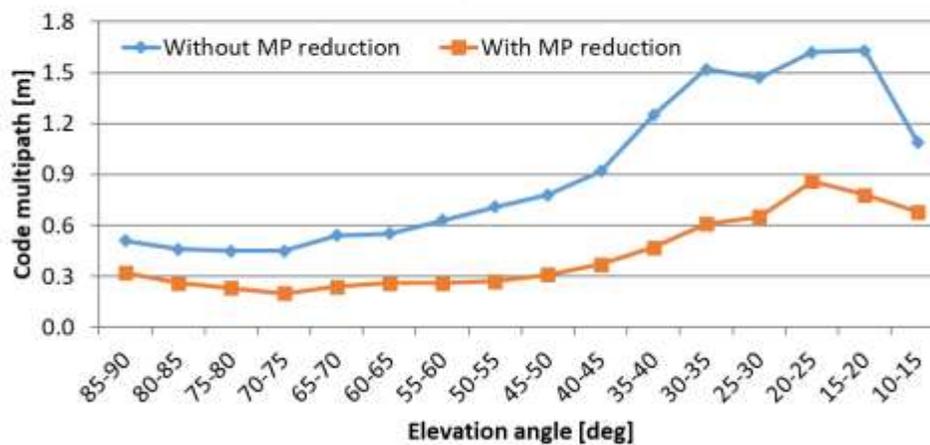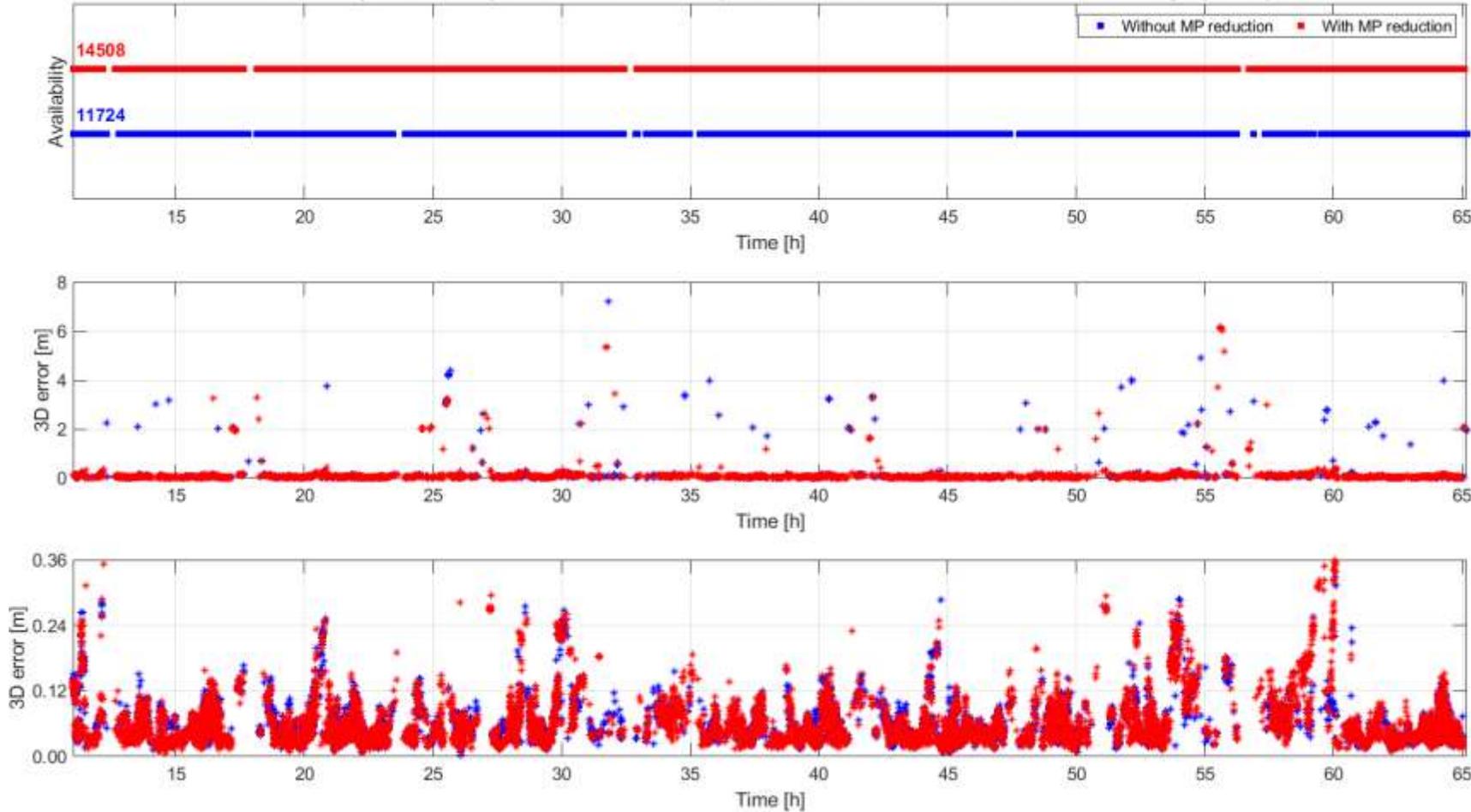
Availability and accuracy of RTK fixed solutions (multipath environment, GNSS: GREC, with ambiguity reset)

Improved availability of RTK fixed solutions by 23.7%

Reduced amounts of large position errors at the meter level

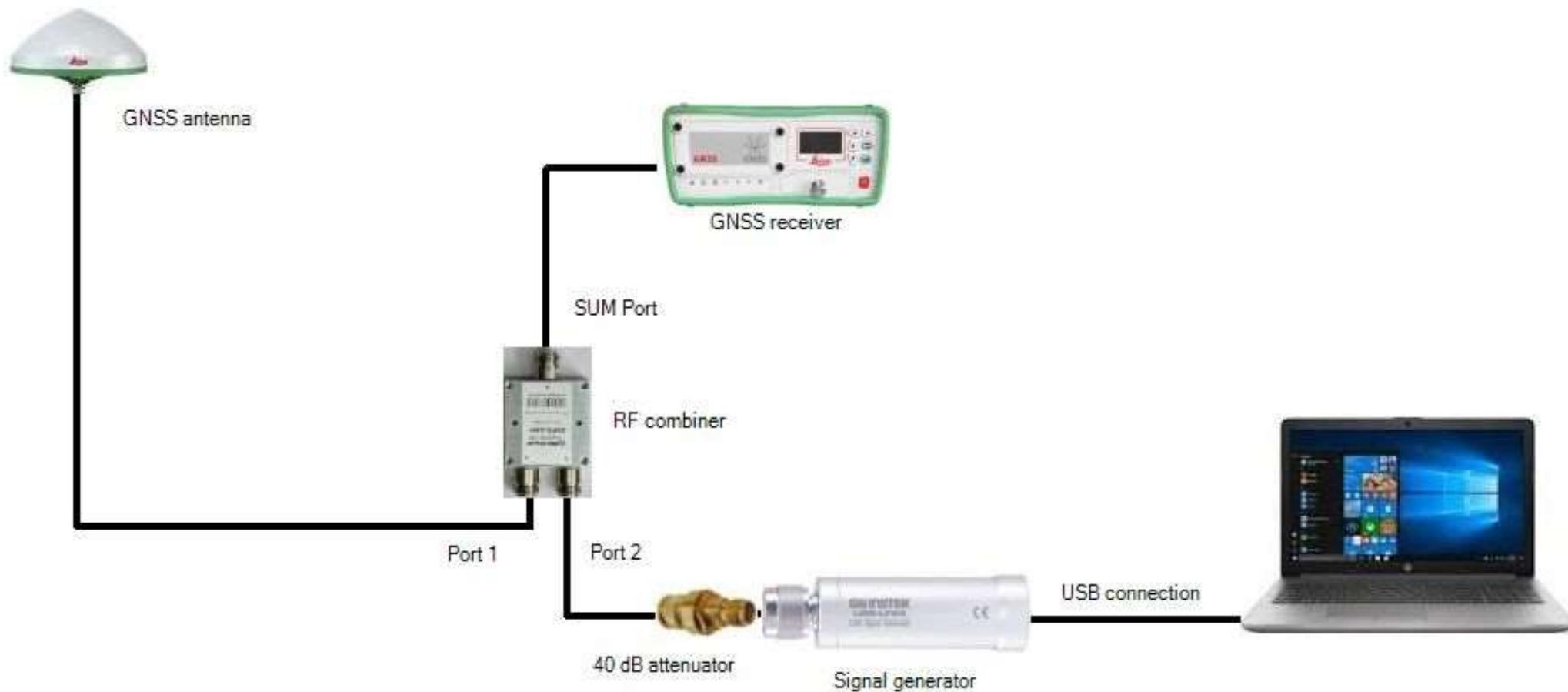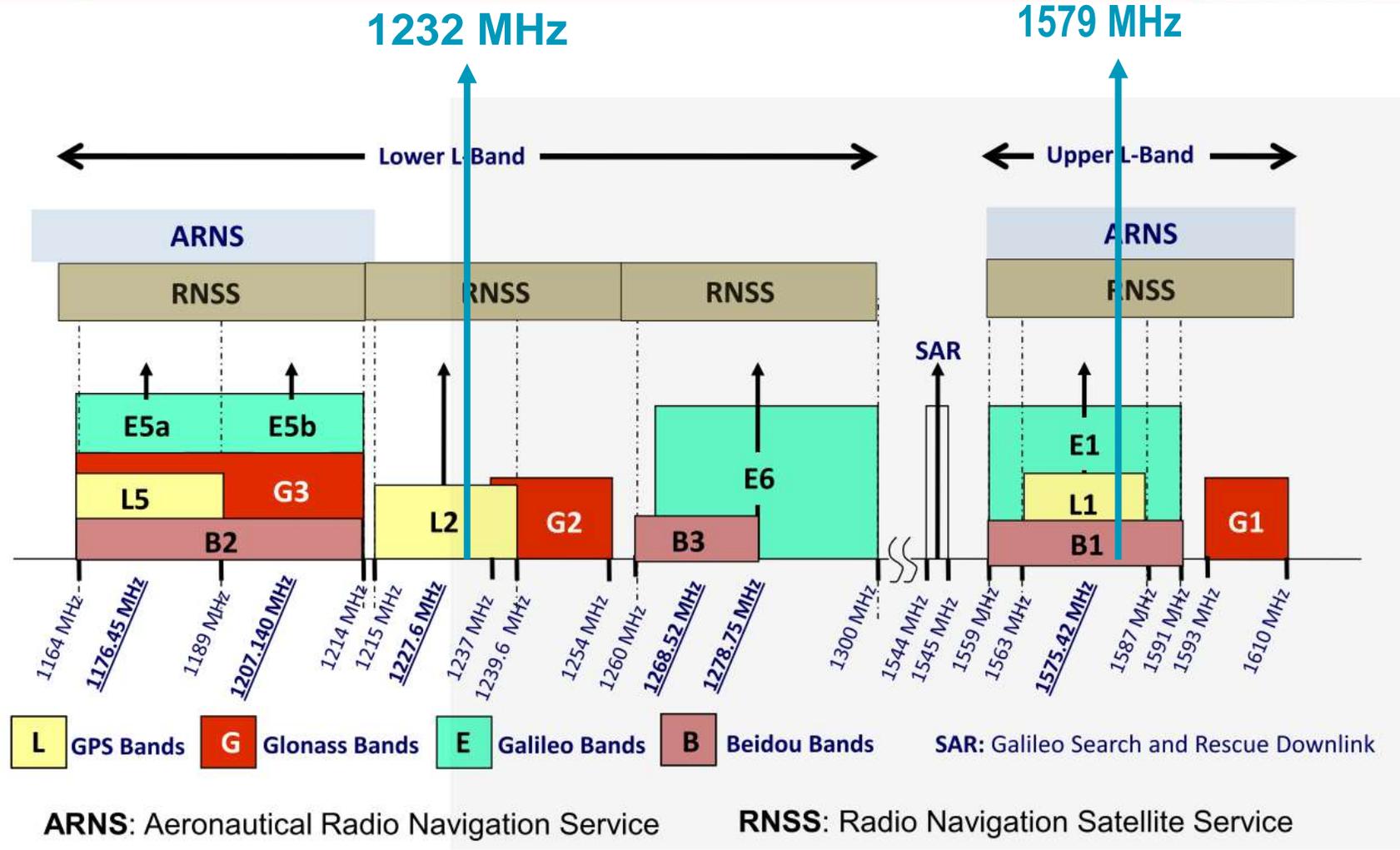No degradation in accuracy due to enhanced availability

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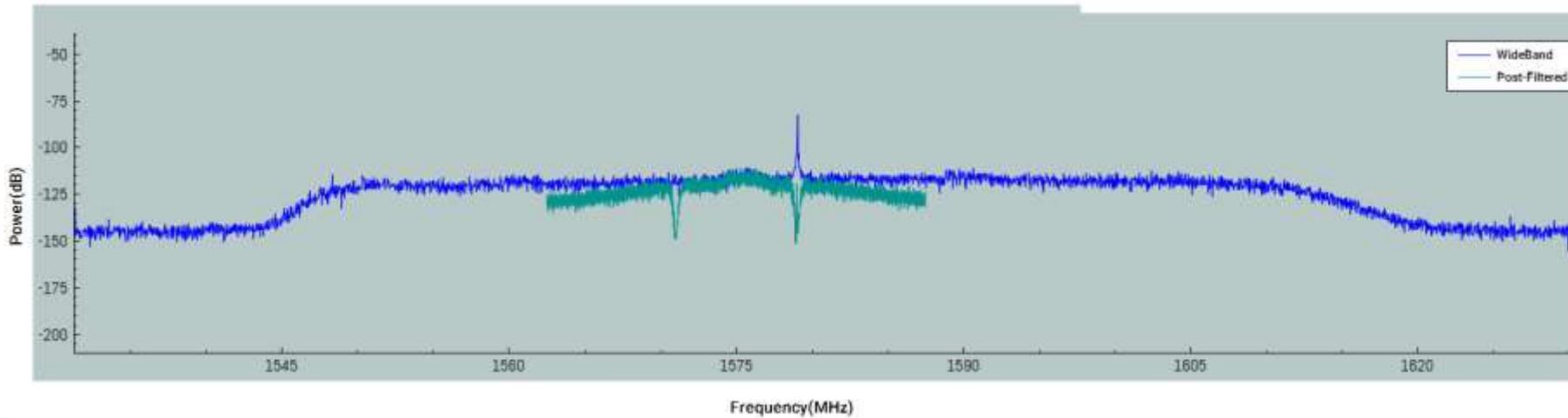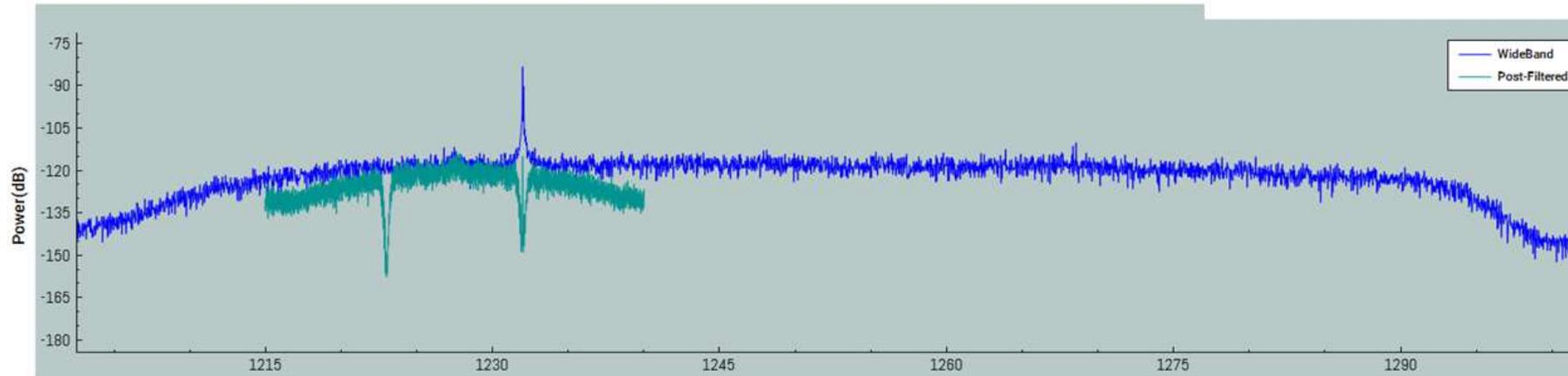Volunteering for the future –
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RR Region 1 Allocation and RR footnotes applicable to CEPT	European Common Allocation and ECA Footnotes	ECC/ERC harmonisation measure	Applications	Standard	Notes
EARTH EXPLORATION-SATELLITE (ACTIVE) RADIOLOCATION RADIONAVIGATION-SATELLITE (SPACE-TO-EARTH) (SPACE-TO-SPACE) 5.329 5.328B 5.329A SPACE RESEARCH (ACTIVE) Amateur 5.282 5.330 5.331 5.332 5.335 5.335A	EARTH EXPLORATION-SATELLITE (ACTIVE) RADIOLOCATION RADIONAVIGATION-SATELLITE (SPACE-TO-EARTH) (SPACE-TO-SPACE) 5.228B 5.329 5.329A SPACE RESEARCH (ACTIVE) Amateur Amateur-Satellite 5.282 ECA36 5.331 5.332 5.335A		Active sensors (satellite)		
			Amateur	EN 301 783	
			Amateur-satellite		Within the band 1260-1270 MHz
			GALILEO	EN 303 413	Within the band 1260-1300 MHz
			GLONASS	EN 303 413	Within the band 1237.8-1253.8 MHz
		ECC/REC/(10)02	GNSS Repeater	EN 302 645	Within the band 1164-1300 MHz
			Radiolocation (civil)		Radar and Navigation systems
			Radiolocation (military)		
			Satellite systems (military)		
			Wind profilers		Within the band 1270-1295 MHz

The European Table of Frequency Allocations and Applications in the Frequency Range
8.3 kHz to 3000 GHz (ECA Table) – ECC within CEPT

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GNSS antenna

GNSS receiver

SUM Port

RF combiner

Port 1

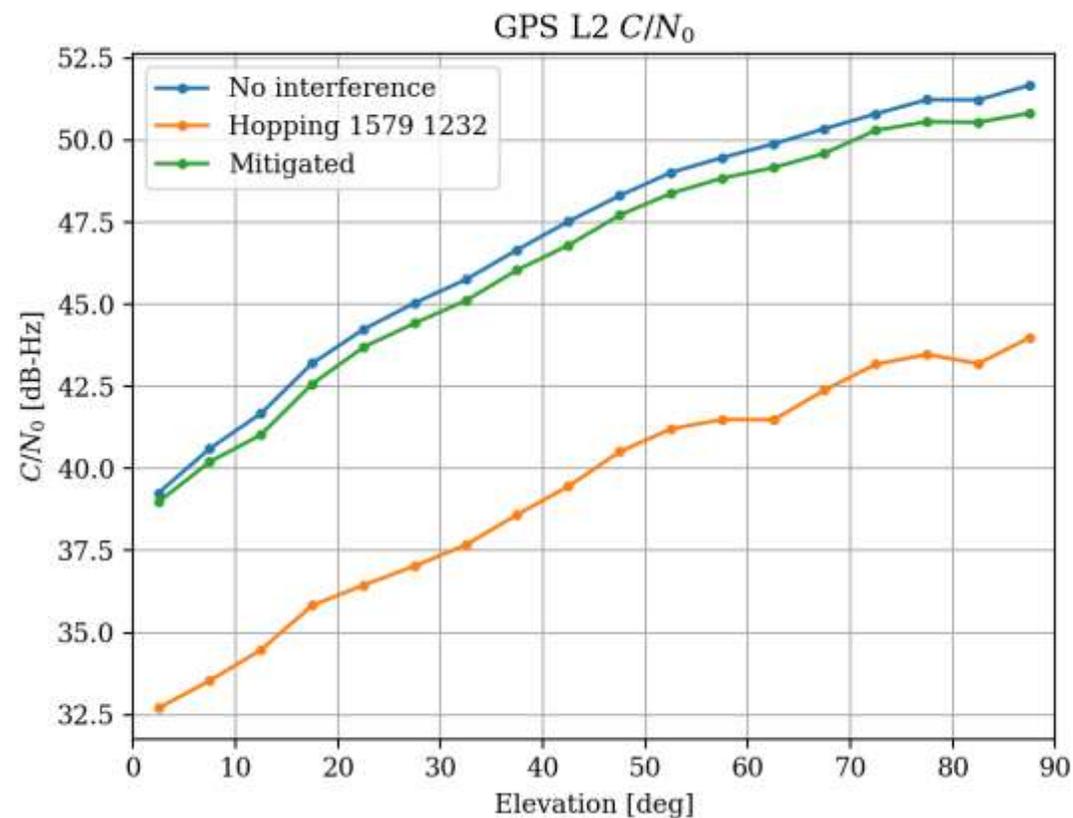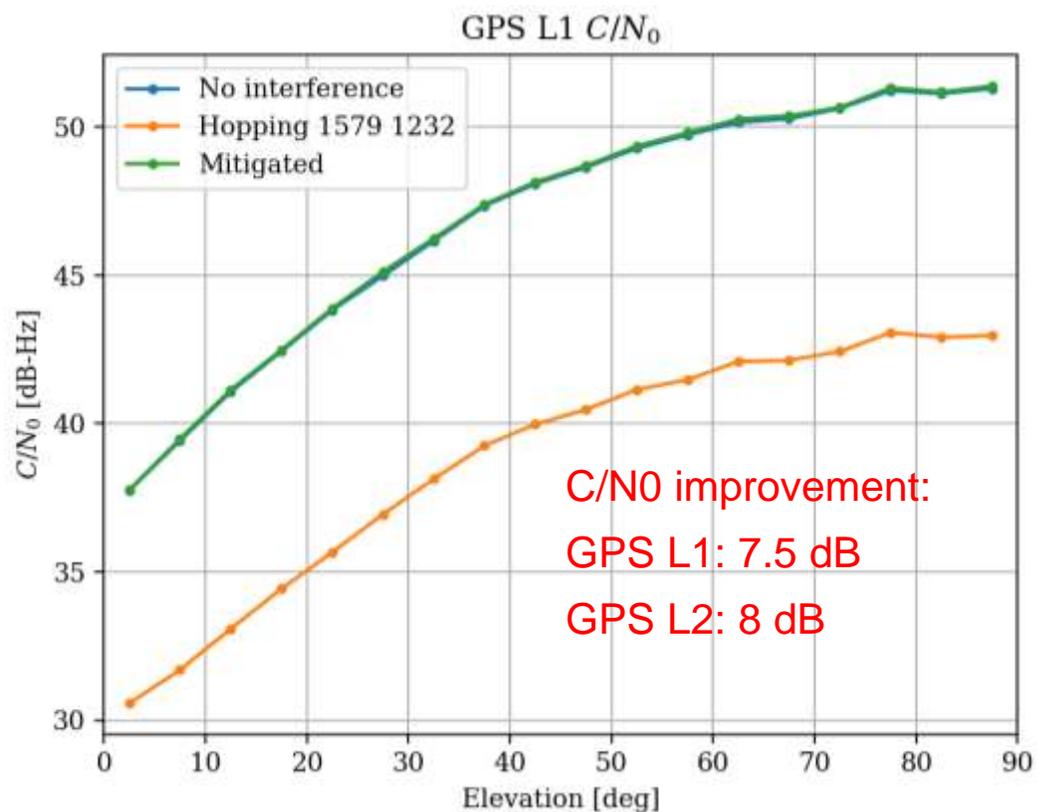Port 2

40 dB attenuator

Signal generator

USB connection

Two filters used:

Notch filter

- Frequency: **1232 MHz**
- Cut-off: 0.15 MHz

Notch filter

- Frequency: **1579 MHz**
- Cut-off: 0.15 MHz

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C/N0 improvement:
GPS L1: 7.5 dB
GPS L2: 8 dB

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	East (1σ) Error [mm]	North (1σ) Error [mm]	Height (1σ) Error [mm]
No interference	3.58	6	8.09
With interference	7.20	9.43	23.6
With interference mitigation	3.37 ↓47%	6.59 ↓30%	8.32 ↓65%

	Percentage of Fix [%]	CQ [cm]
No interference	100	1.1
With interference	92	2
With interference mitigation	100	1.2

Improvement in positioning **accuracy** and positioning **availability**
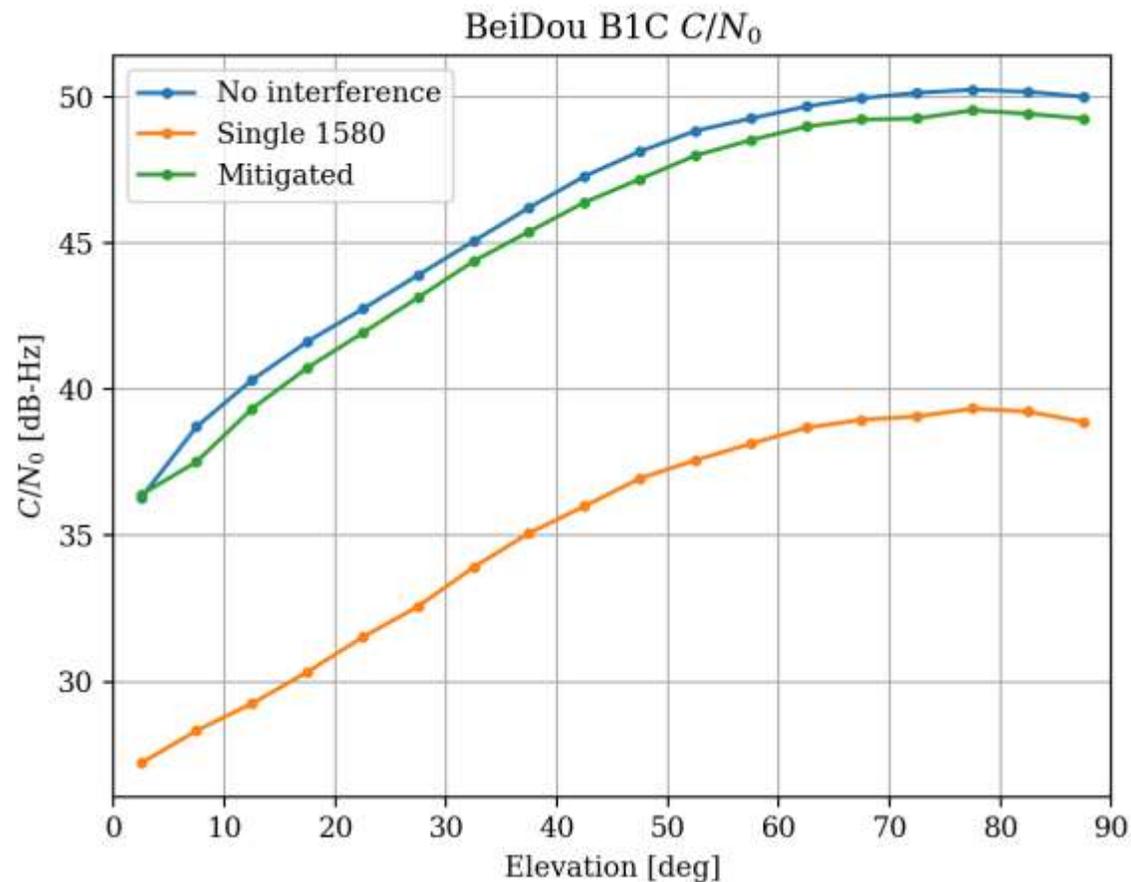
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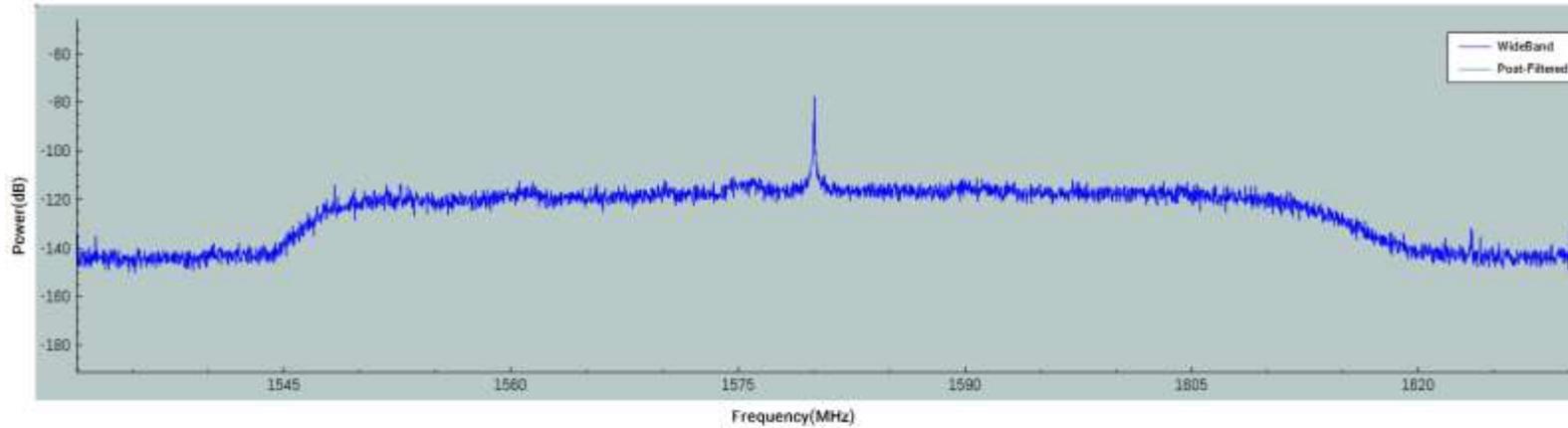
Interference:

- Frequency: **1580 MHz**
- Power: 30 dBm
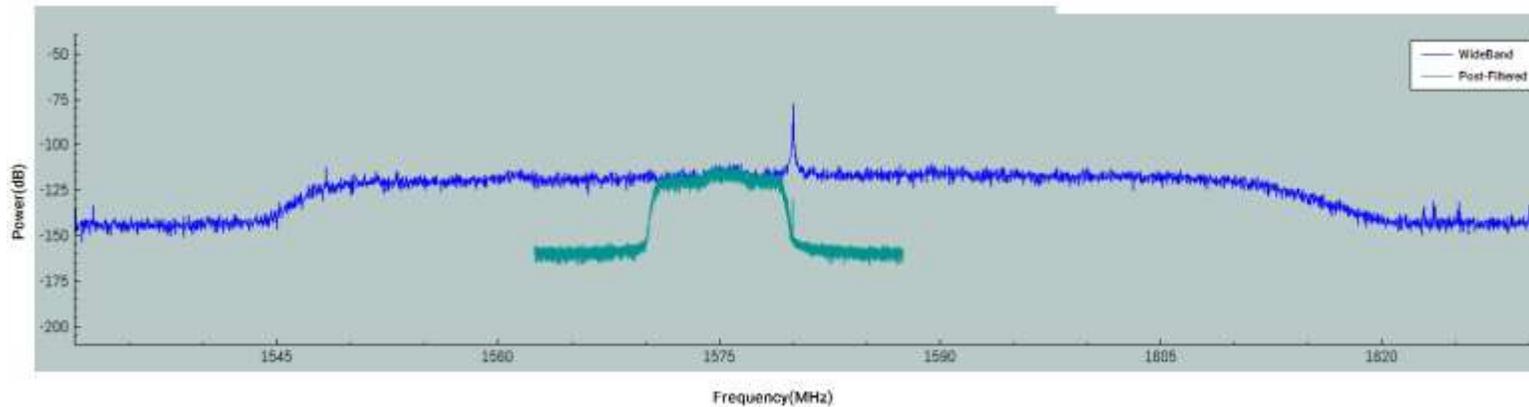
Mitigation:

Bandpass filter:

- Cut-off: 1580 MHz

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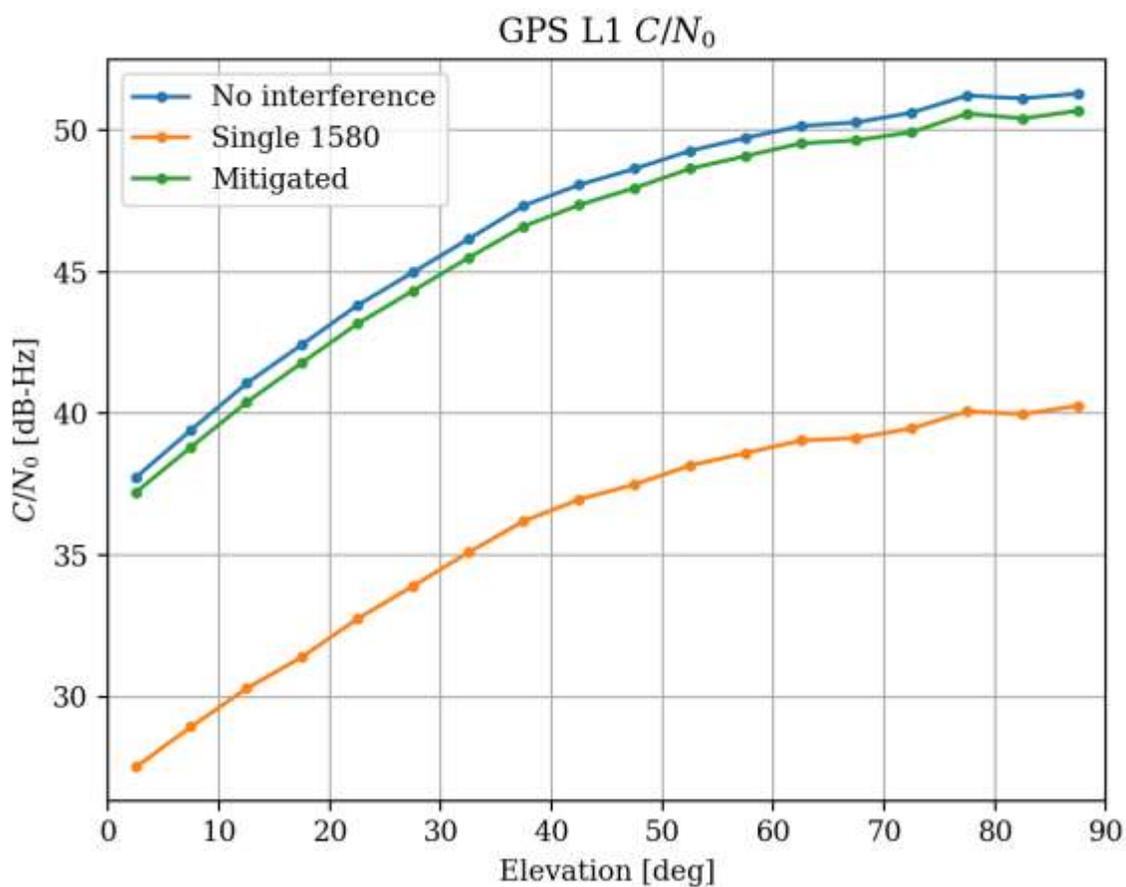
Conclusions

Multipath propagation is site-specific and cannot be modeled.

Multipath mitigation improves the availability of high-precision RTK solutions.

Multipath mitigation reduces decimeter-to-meter-level position errors caused by incorrect ambiguity fixes.

No degradation in accuracy due to enhanced availability

Interferences are increasingly common due to the increasing amount of ground wireless comm. infrastructure.

Interference mitigation can cope with interferences as close as 1.5 MHz to central frequency.

Bandpass and notch filters shall be applied for identified interferences (in- and outband).