

# Improving accuracy GNSS service and time to fix with new signals

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9 Meeting of the International Committee on Global Navigation Satellite  
Systems (ICG)  
November 2014, Prague

# Positioning with multi-system GNSS receivers

- - GIS;
- DGPS, RTK
- - Geodesy;
- RTK
- - Machine control application;
- RTK
- - Automatic Agricultural systems  
StandAlone, DGPS, RTK



# Evolutions of positioning methods with GNSS signals

PPP, PPP-AR(PPP-RTK)

Network RTK, VRS

DGPS and RTK

Standalone

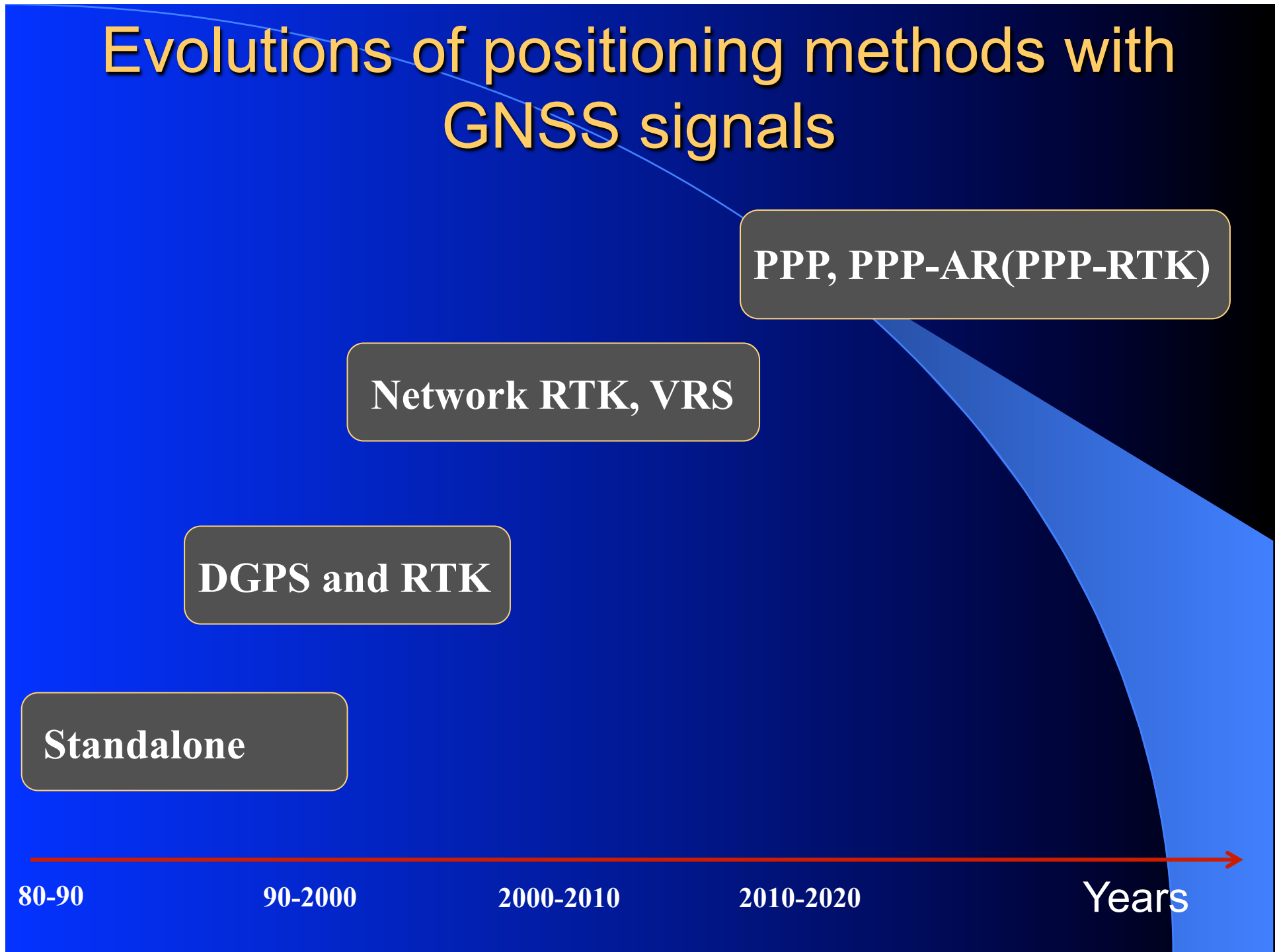
80-90

90-2000

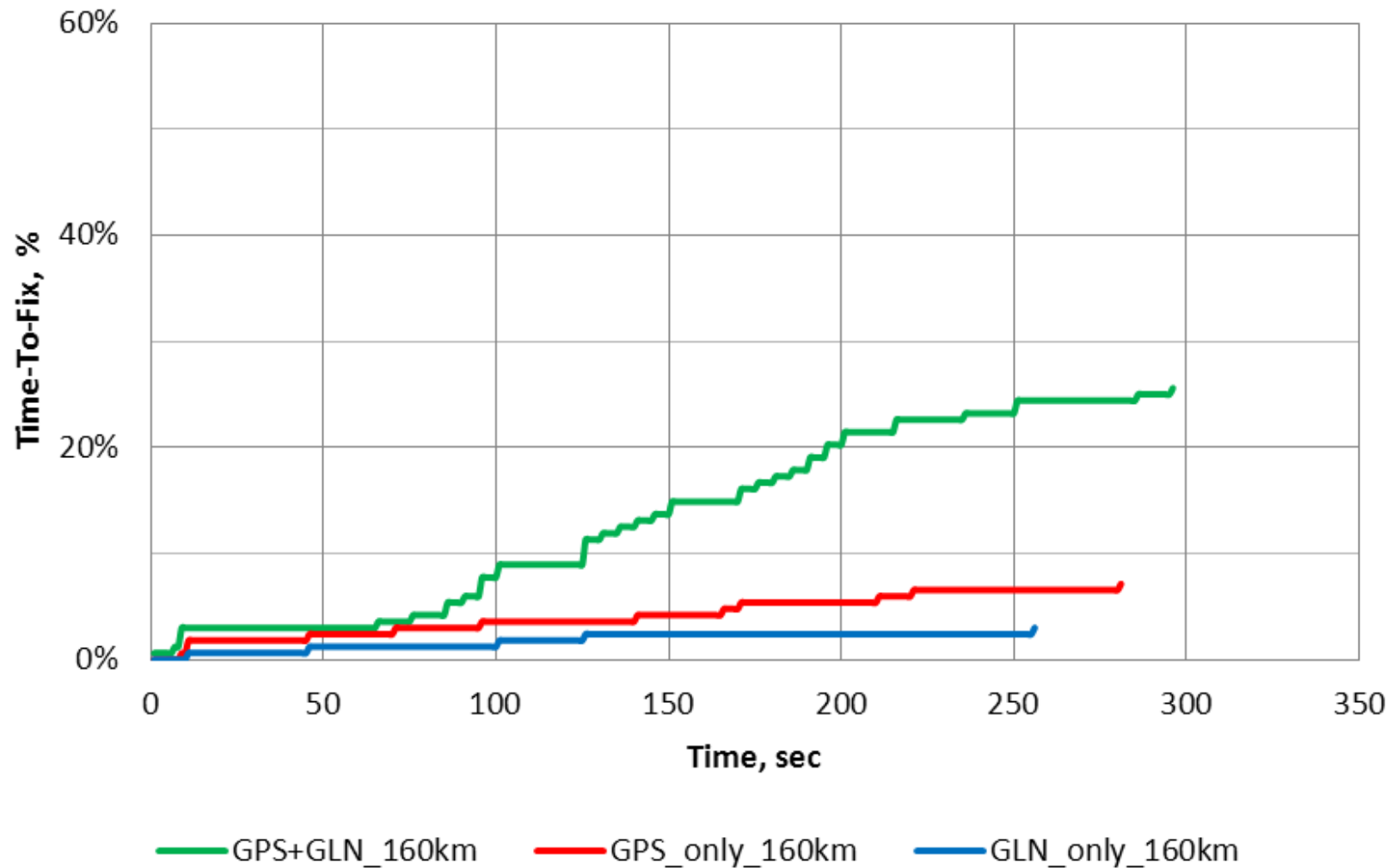
2000-2010

2010-2020

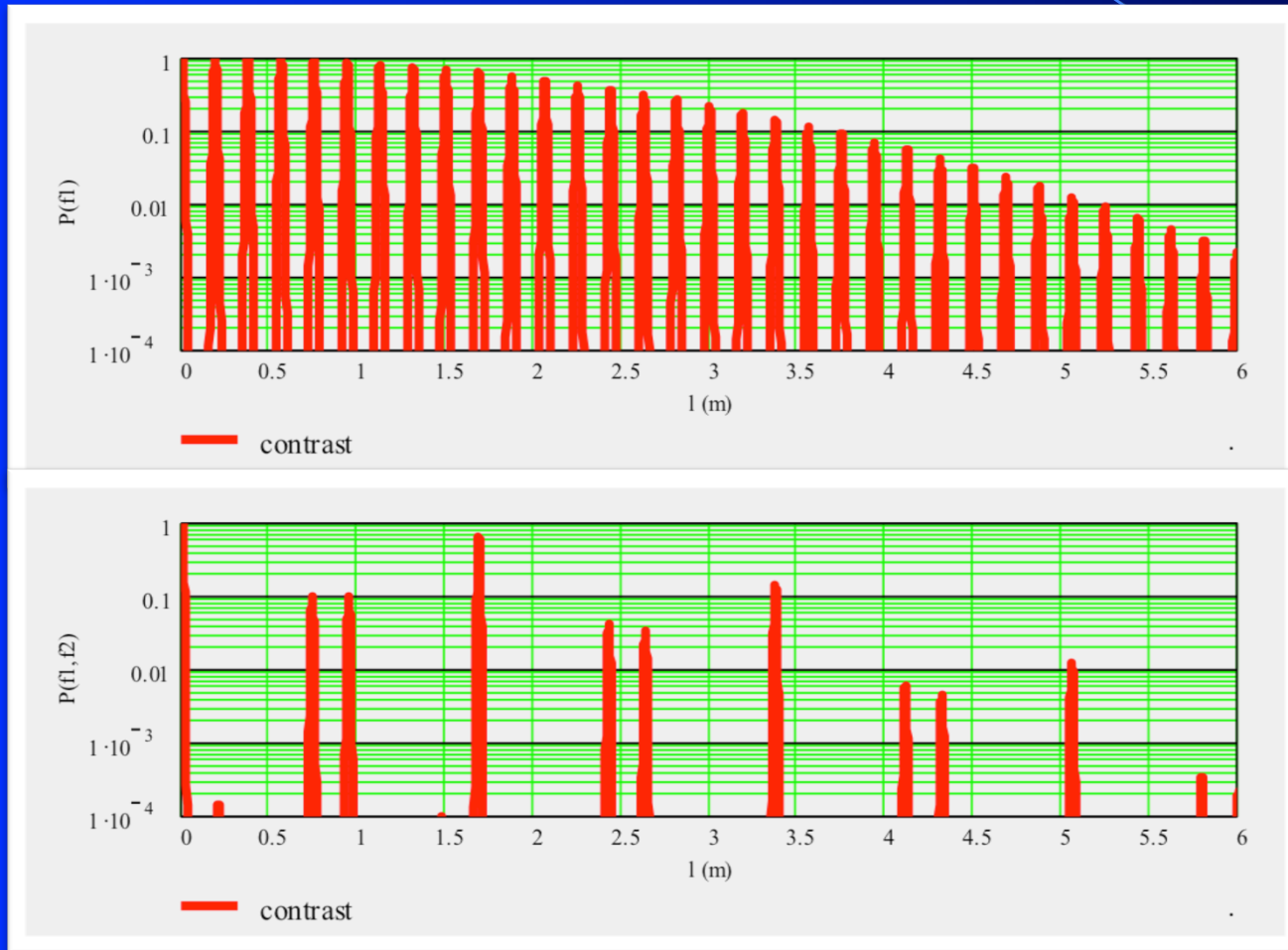
Years



# Time to fix for Ambiguities resolution RTK for long range base line



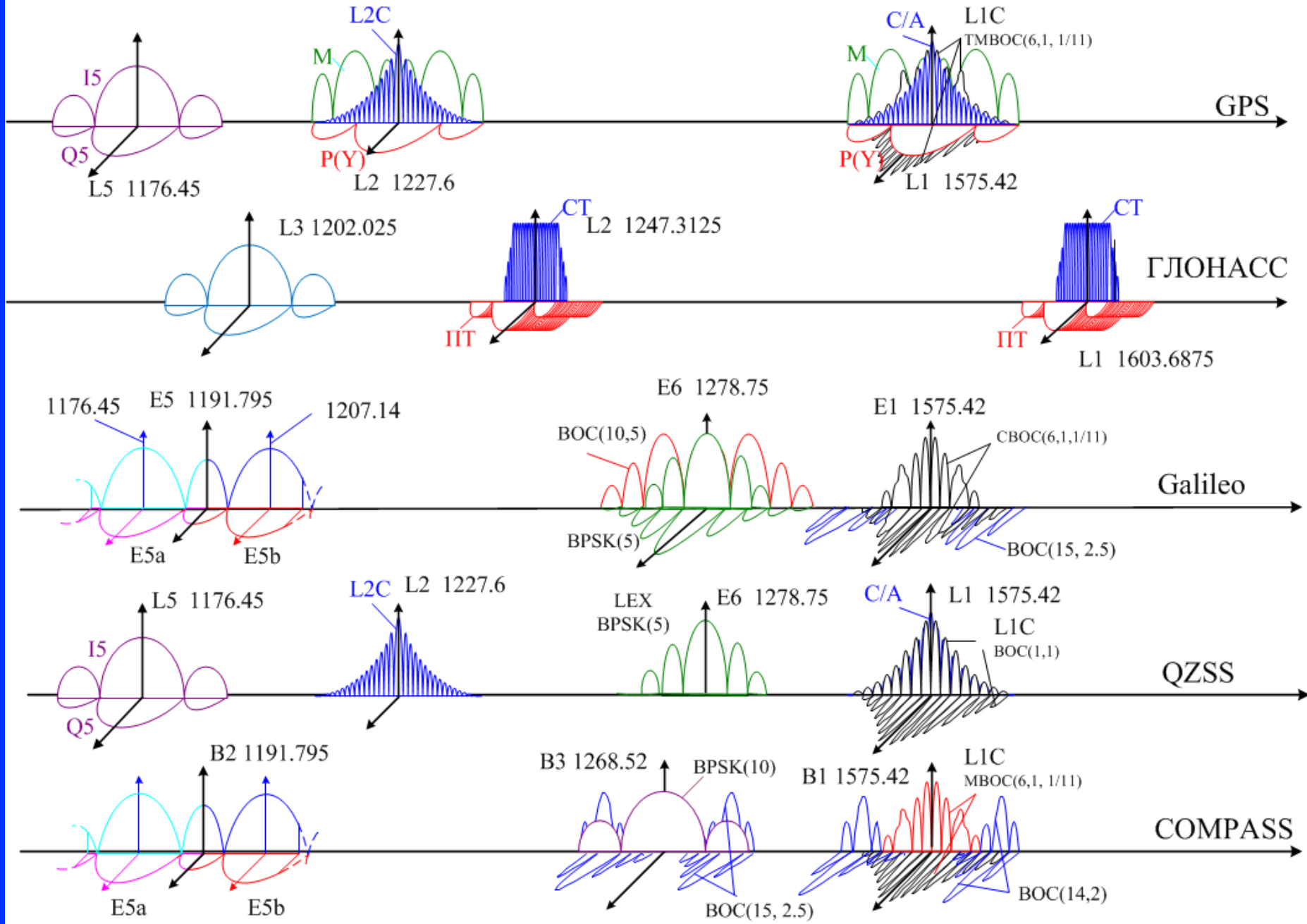
# Two frequency ambiguities resolution for RTK



One  
frequency  $L1$

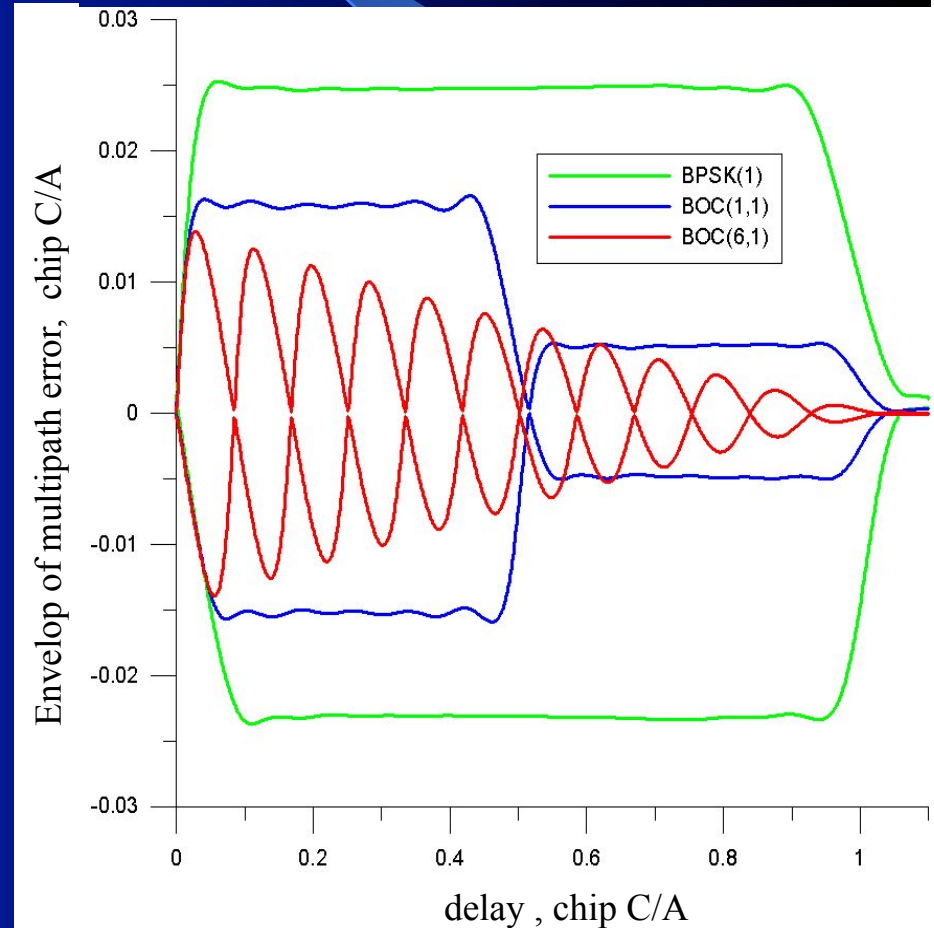
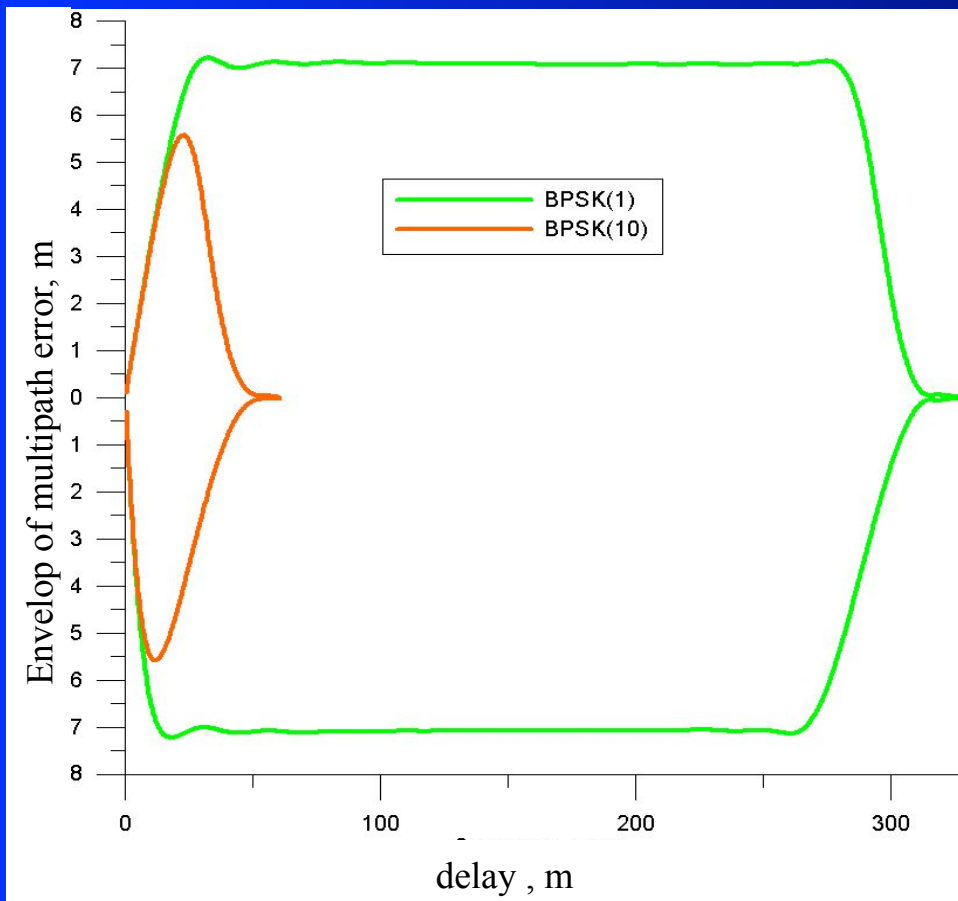
Two  
frequency  
 $L1, L2$

# GNSS signals

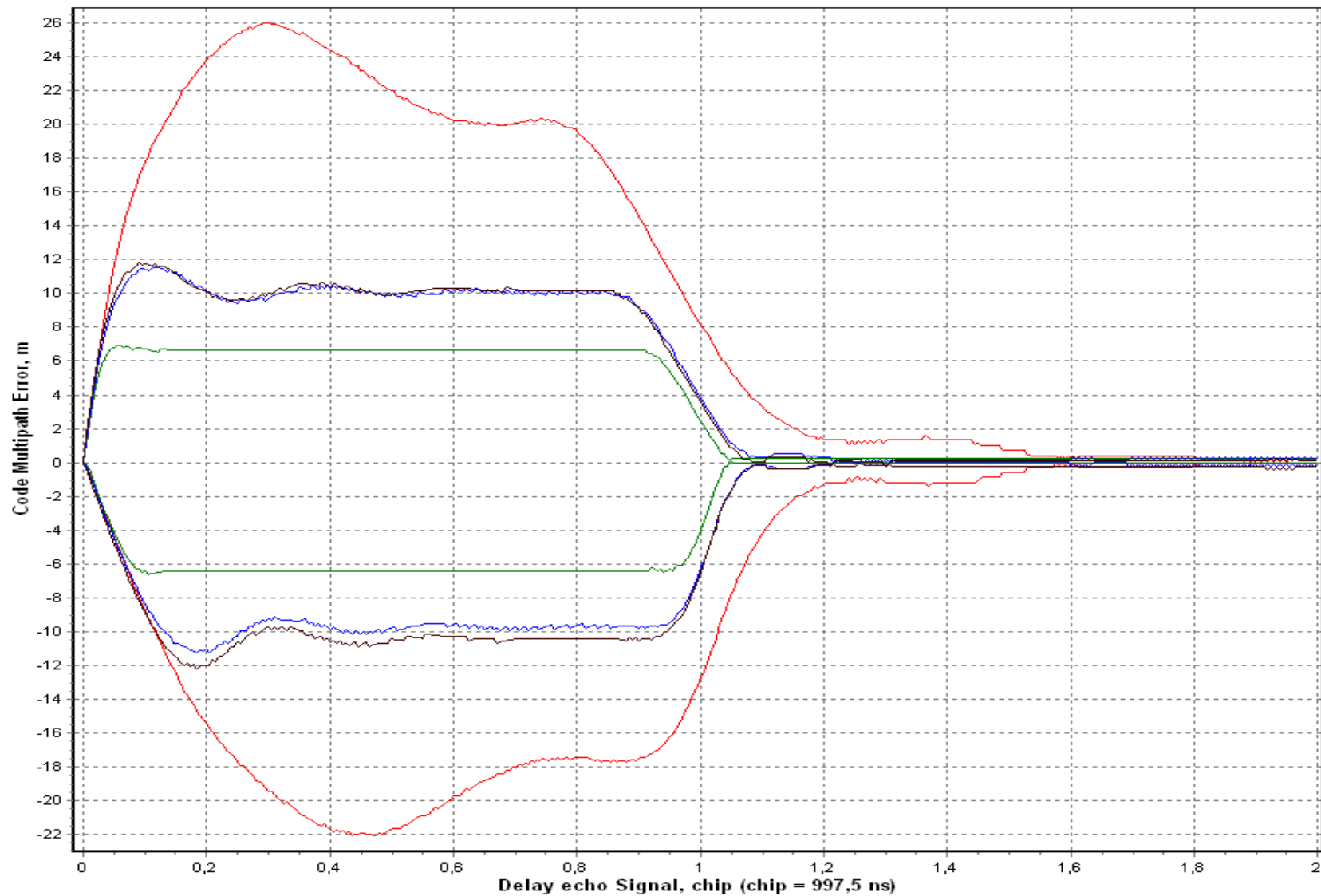


# Multipath error for different GNSS signals

Multipath envelopes for reflection signal with amplitude of 0.5

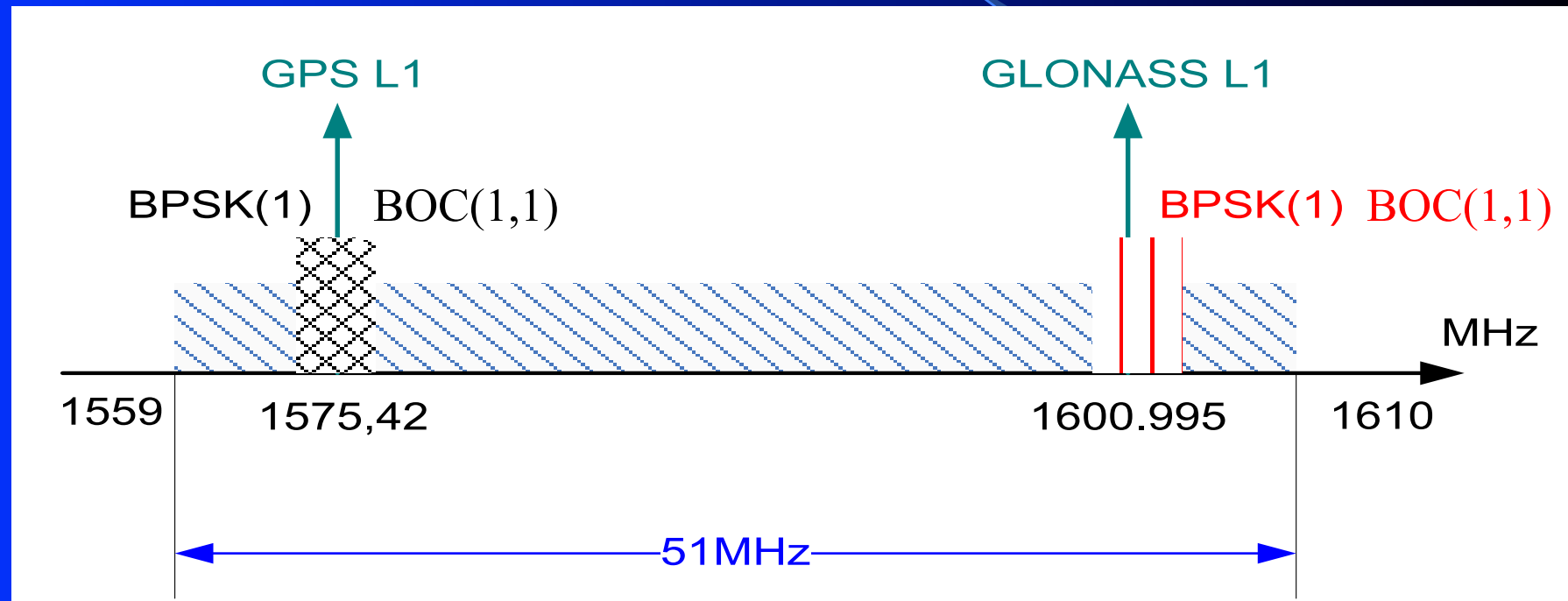


# Multipath error for different navigation receivers technology

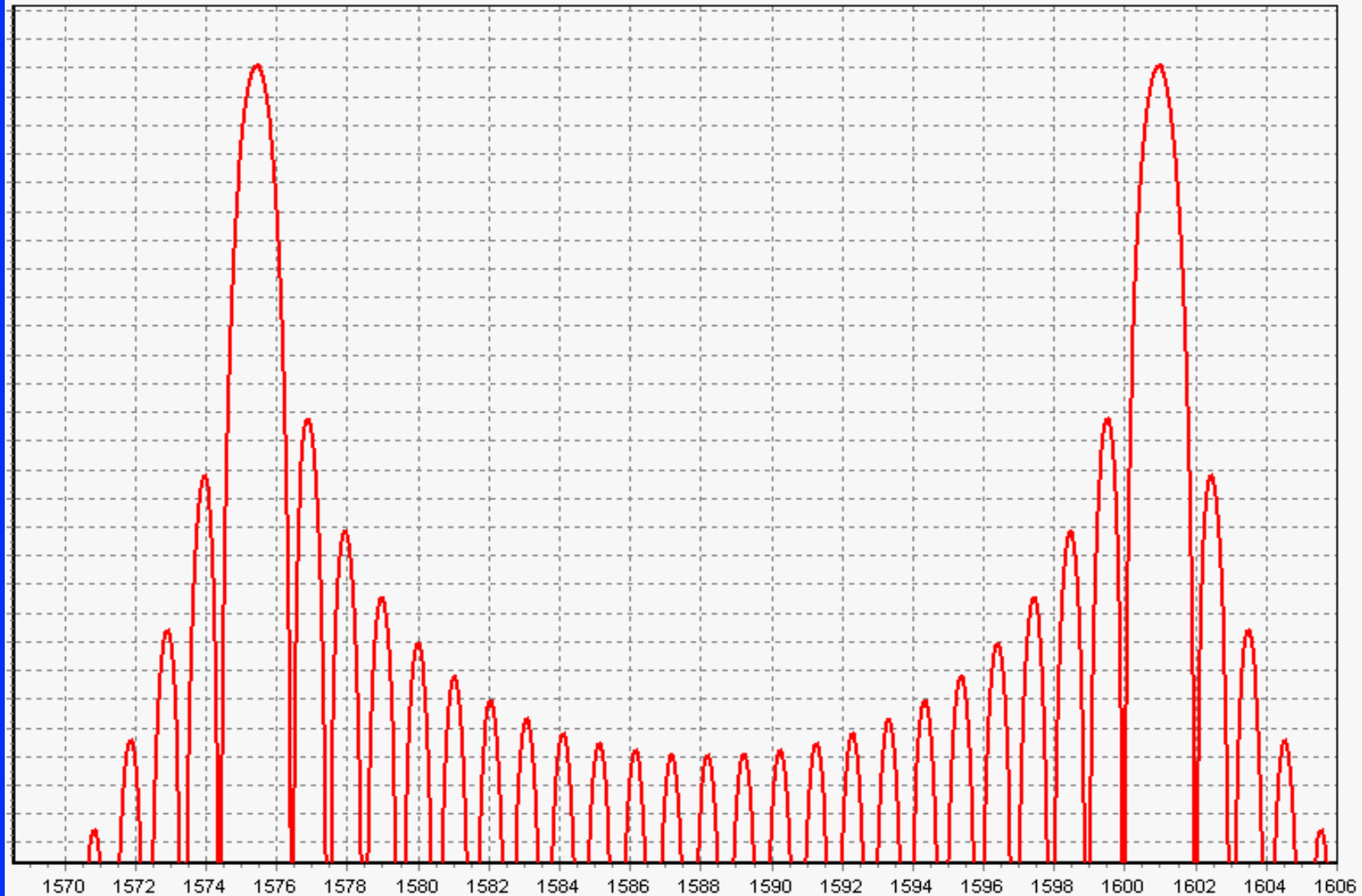




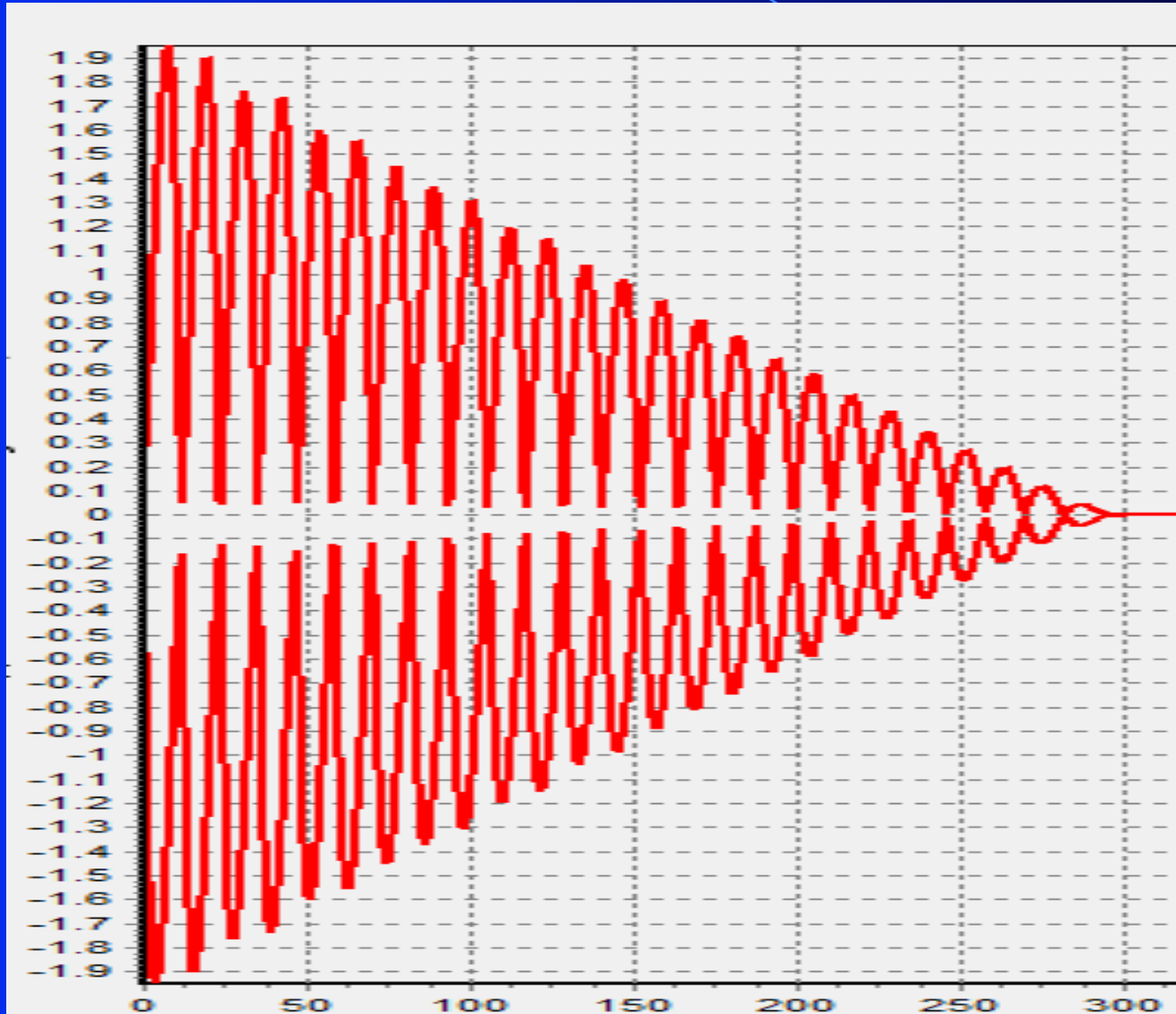
# GNSS signals for L1 frequency band



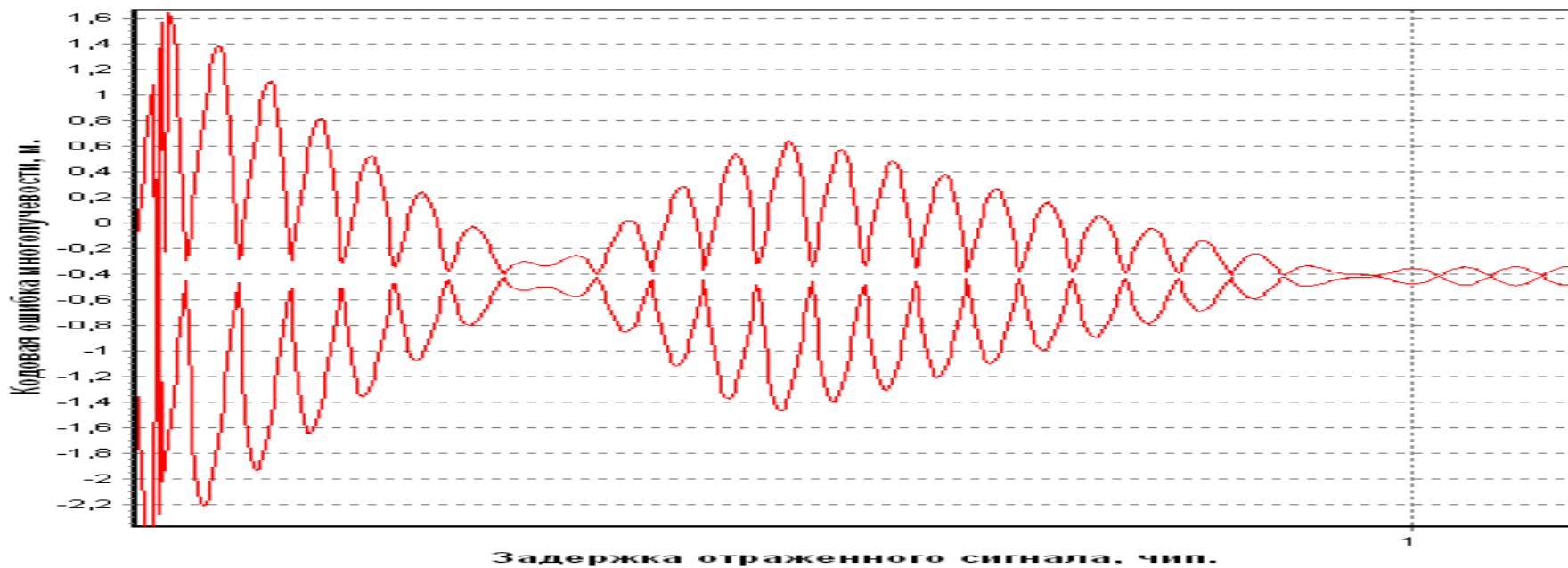
# Spectrum in L1 frequency band (GPS/ GALILEO L1 and GLONASS L1)



# Multipath error for wideband signal in L1 frequency band

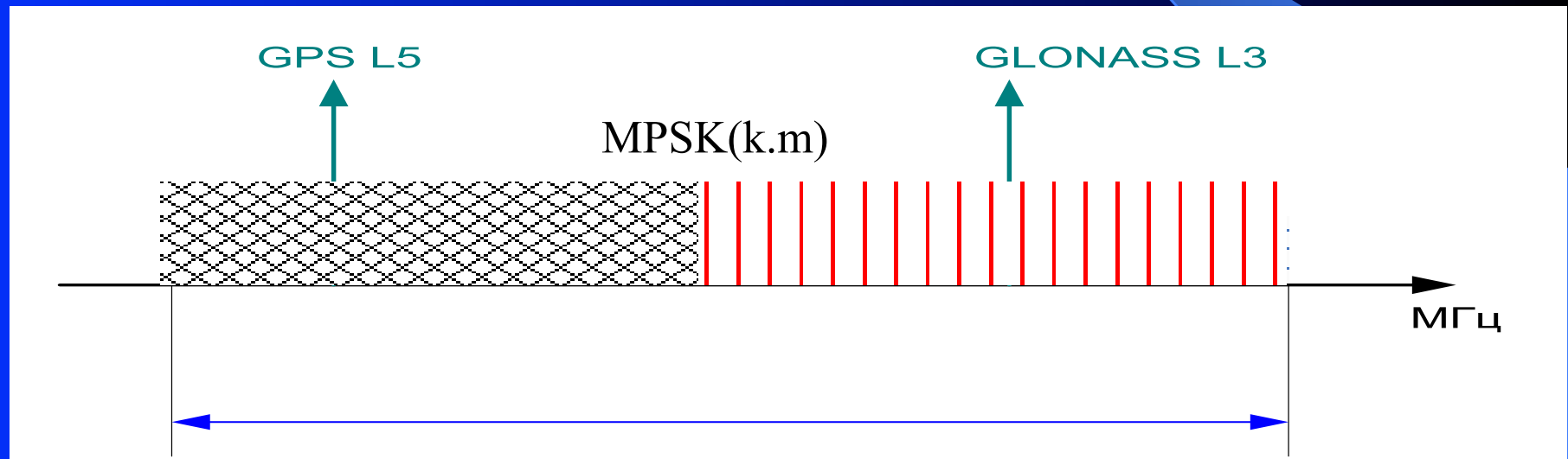


# Multipath error for DBOC signal



Signal	Maximum code multipath error, m.	
C/A BPSK(1)	7,284	
BOC(1,1)	3,86	
BOC(10, 5)	2,8	
DBOC	<b>2,341</b>	

# GNSS signals in frequency band of GPS L5, GALILEO E5, GLONASS L3



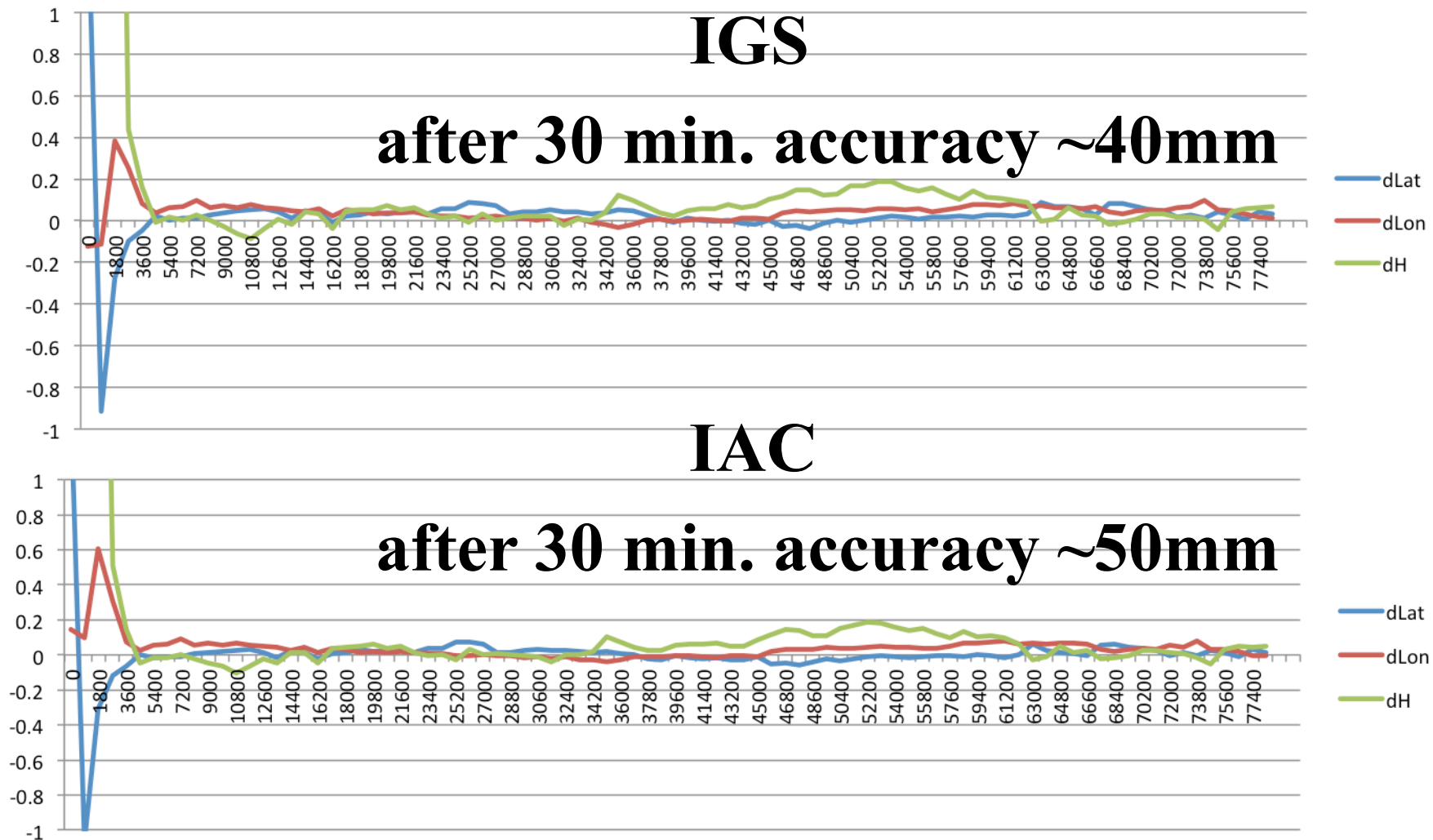
# Multipath error wideband signal in E5 (L5/L3) frequency band



# Precise Point Position

- Current PPP service
  - StarFire
  - OmniSTAR
  - TerraStar
  - IGS-RT
- Calculation precise orbit and clocks
  - Base stations network
  - Calculation satellite parameters
  - Real-time corrections
- User Positioning
  - Accuracy
  - Convergence time

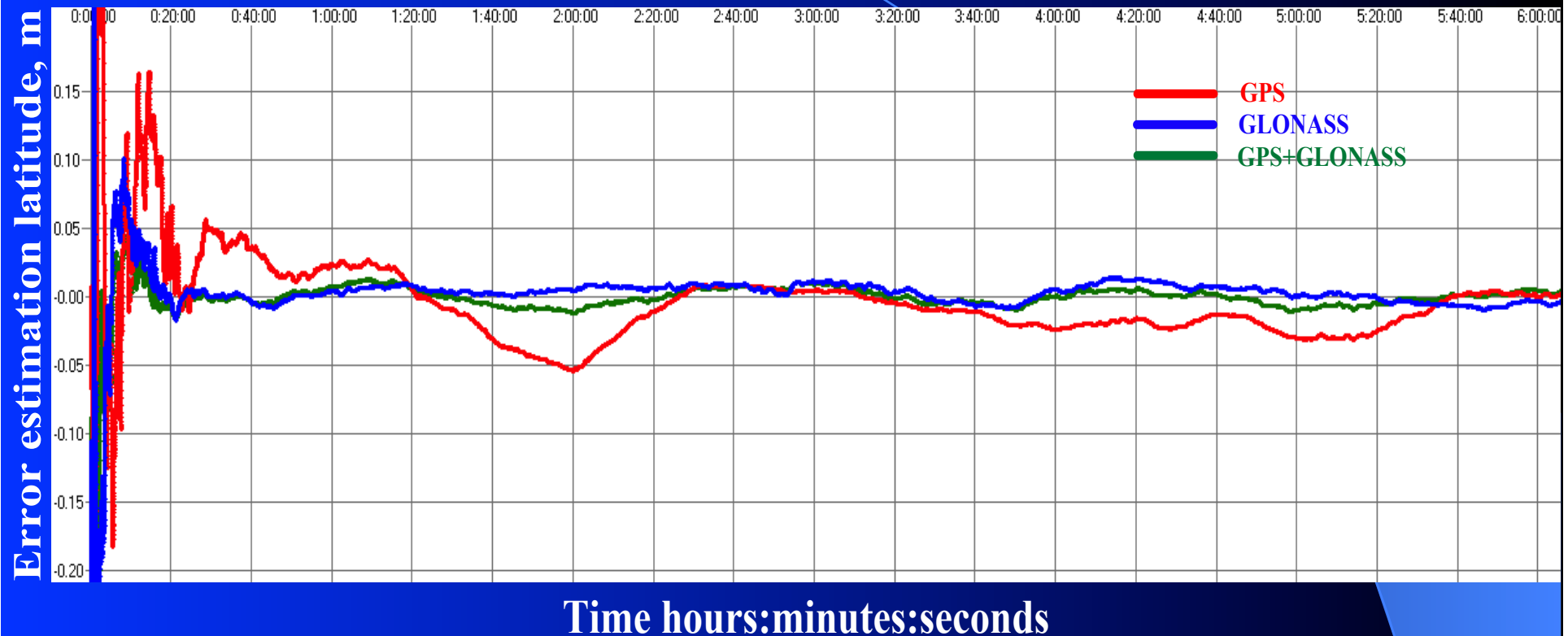
# Precise point position with precise orbit and clocks from different IGC analytic centres





# PPP with GPS, GLONASS and GPS+GLONASS

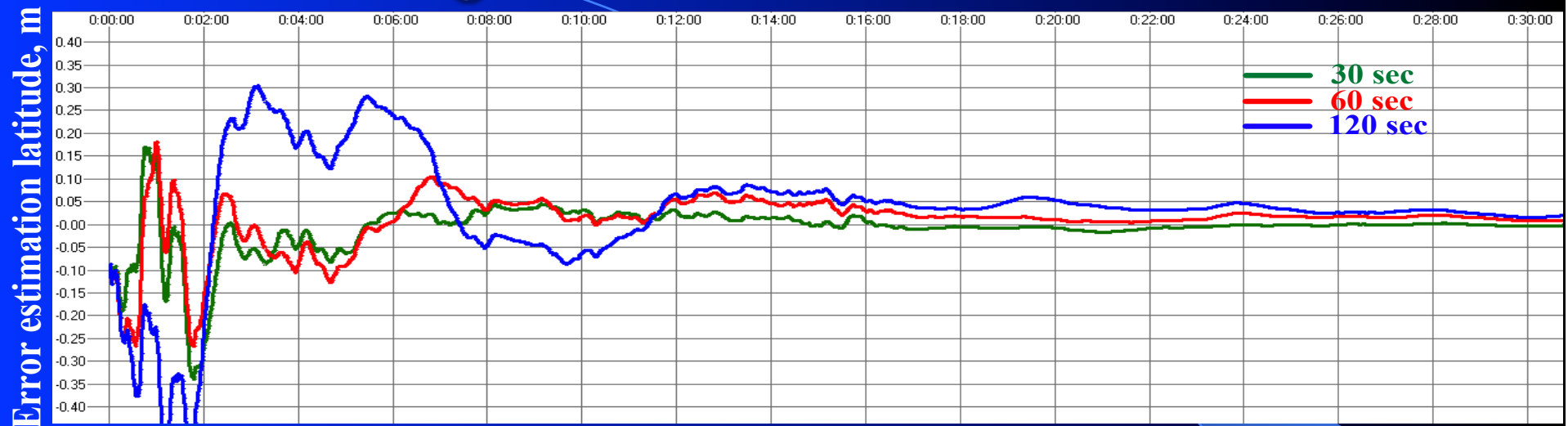
Used Final Precise Orbits and clocks from Analytic center IGS.  
Period of correction – **30 seconds**;



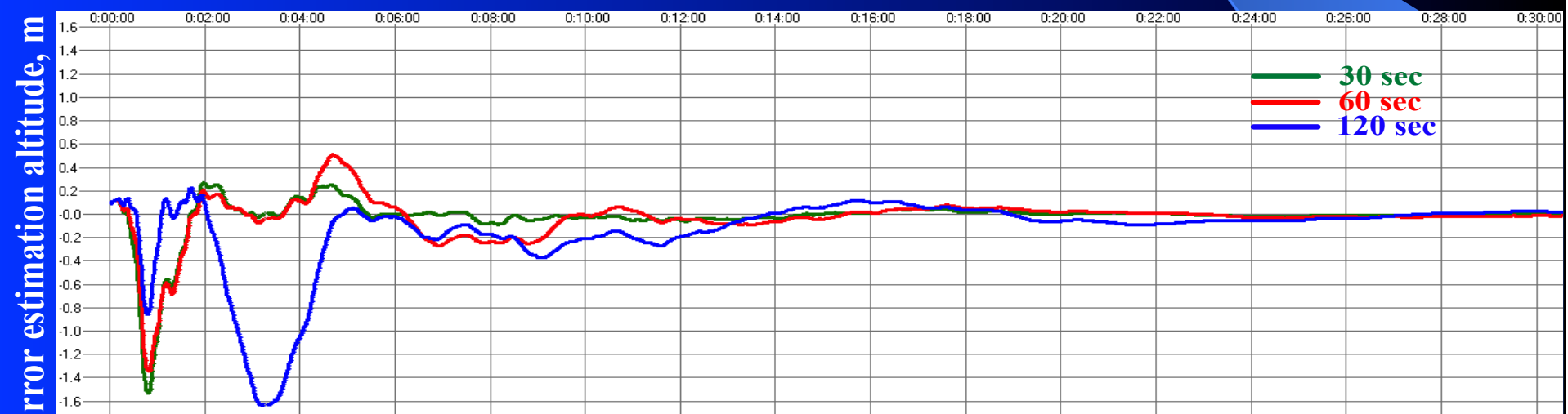
	RMS, m			
	Latitude	Longitude	Vertical	2DRMS
<b>GPS +GLONASS</b>	0.005	0.018	0.019	0.019

Estimated solution RMS after **20 minutes** - period of convergence.

# PPP convergence time from correction rate



Time hours:minutes:seconds



Time hours:minutes:seconds

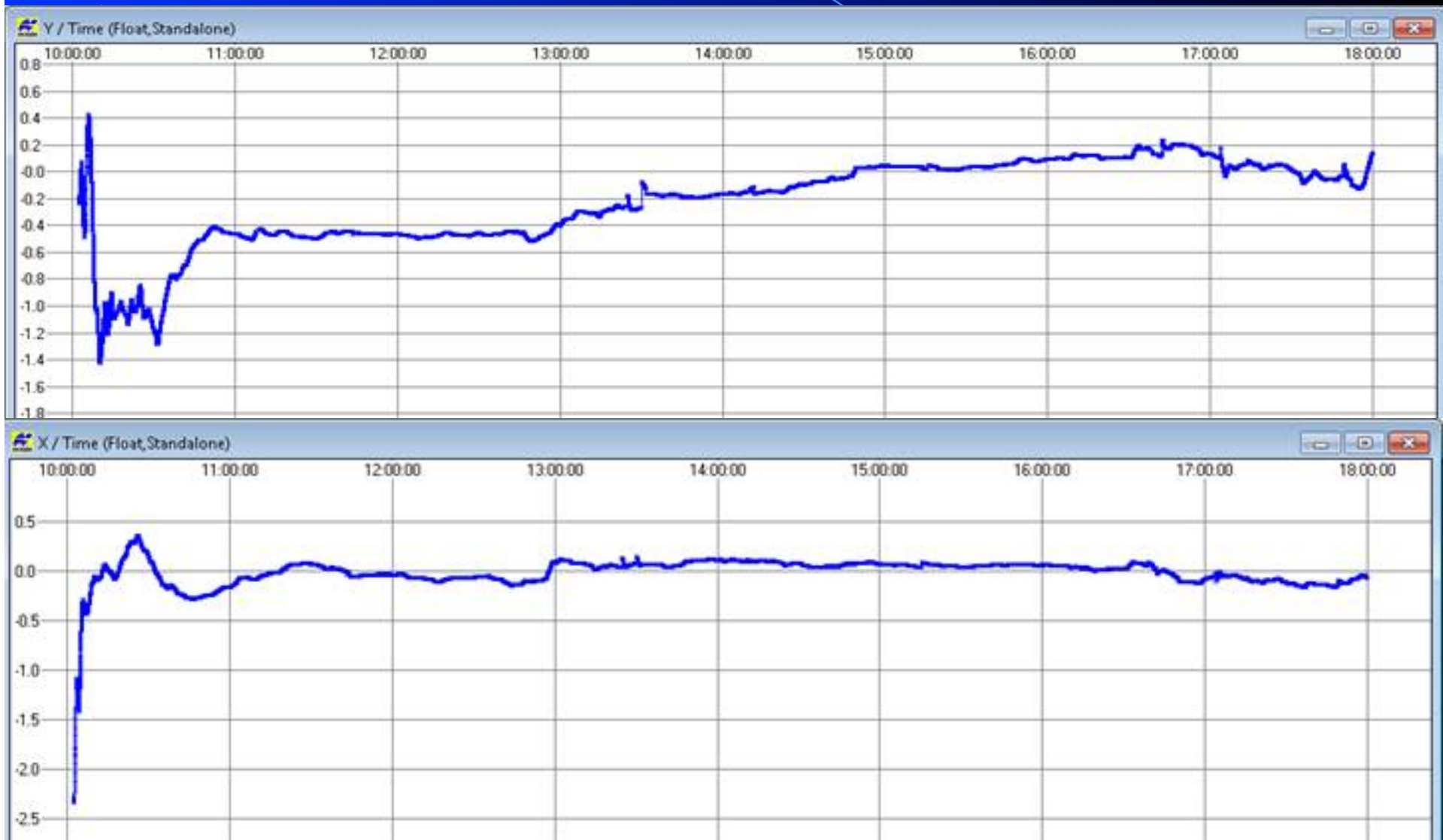
Investigations influence of various periods of transmitting Precise clocks corrections on convergence period of PPP solution.

# Regional PPP service: QZSS LEX signal

- Time multiplexing Long and Short Codes
- Chip rate 5.115 MHz
- The 4ms Short Code modulated by navigation information by using code shift keying
- 256 code shift position is used
- 2000 Bits/s data stream Reed-Solomon encoded
- The Long Code with length 410ms modulated by square wave with period 820 ms

# MADOCA-LEX Precise Point Positioning

- RTCM correction from QZSS MADOCA-LEX signal
- Small period of time availability, low elevation and SNR in Moscow



# GNSS Signals with precise orbit and clock correction

Information about precise orbit and clocks recommended the fast update rate and can be useful for global region

The QZSS transmitted precise orbit and clocks in MADOCA-LEX signal. GALILEO planning to use the E6 for commercial service.

In the future PPP correction from all GNSS provides, free user access and interoperability this service?

# Summary

1. Possibility to global transmitting of precise orbit and clock corrections with high rate will be improve of accuracy positioning with PPP methods in receivers.
2. Common wide band signal for all GNSS in E5 band (E5a/L5 + E5b/L3 band) and L1 band will be minimize multipath error and improve time-to-fix for high precision application and will be compatible with low-cost receiver when used the signal in half wide band.



Thank you for attention!