



# **CENTISPACE LEO Augmentation Navigation System Status**

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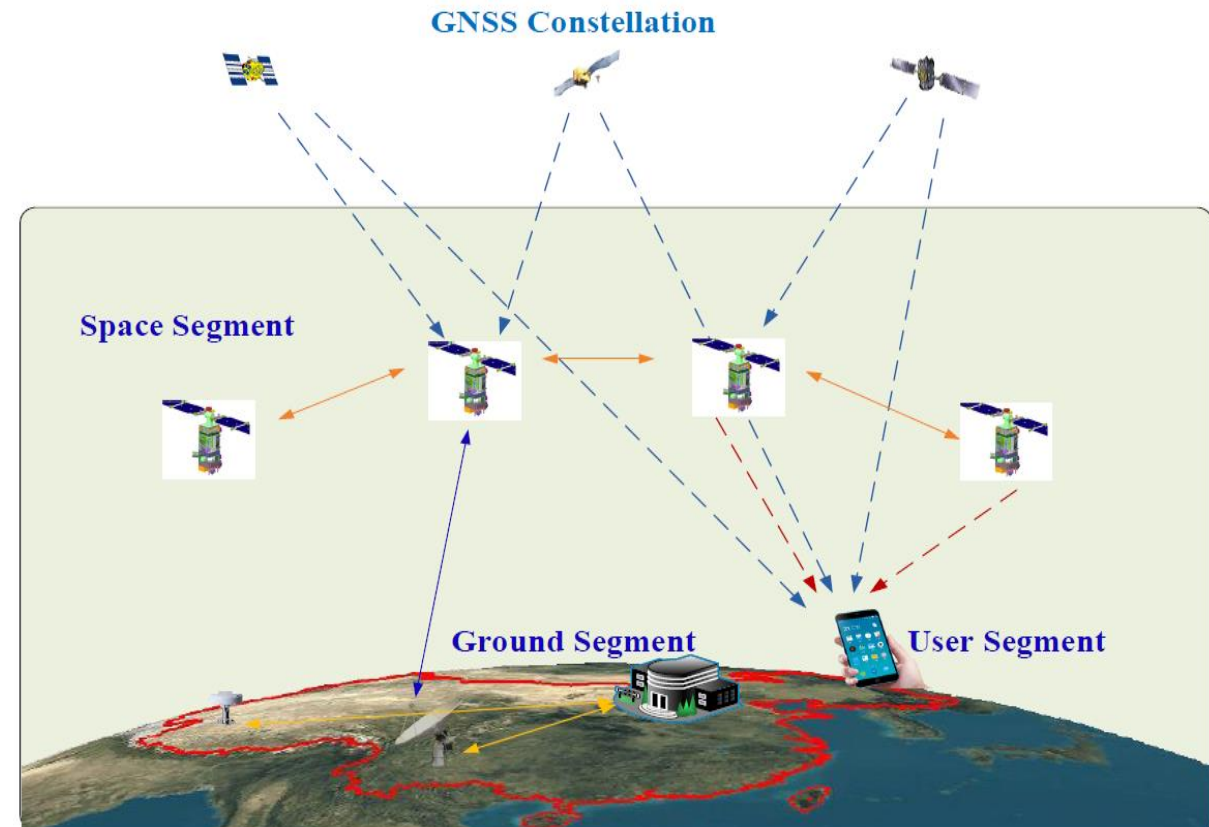
## Outline

1. CENTISPACE program overview
2. CENTISPACE project status
3. Next steps

# 1. CENTISPACE program overview

## ◆ System Description

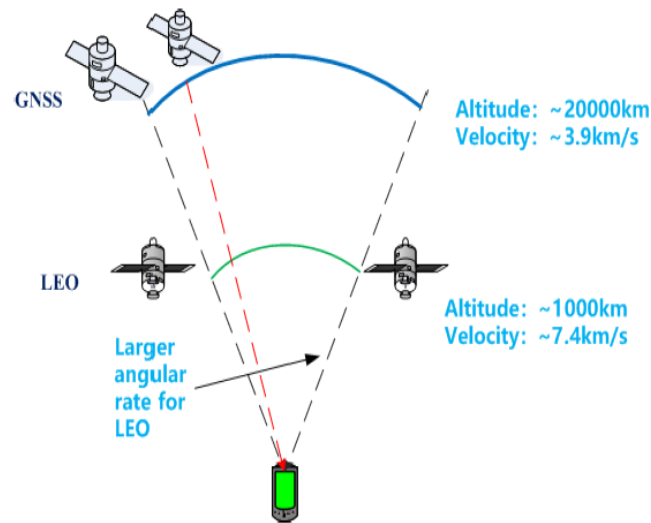
- Commercial LEO augmentation navigation system
- High Accuracy Service, Integrity augmentation Service, and GNSS monitoring Service
- Global System
- Space Segment, Ground Segment and User Segment



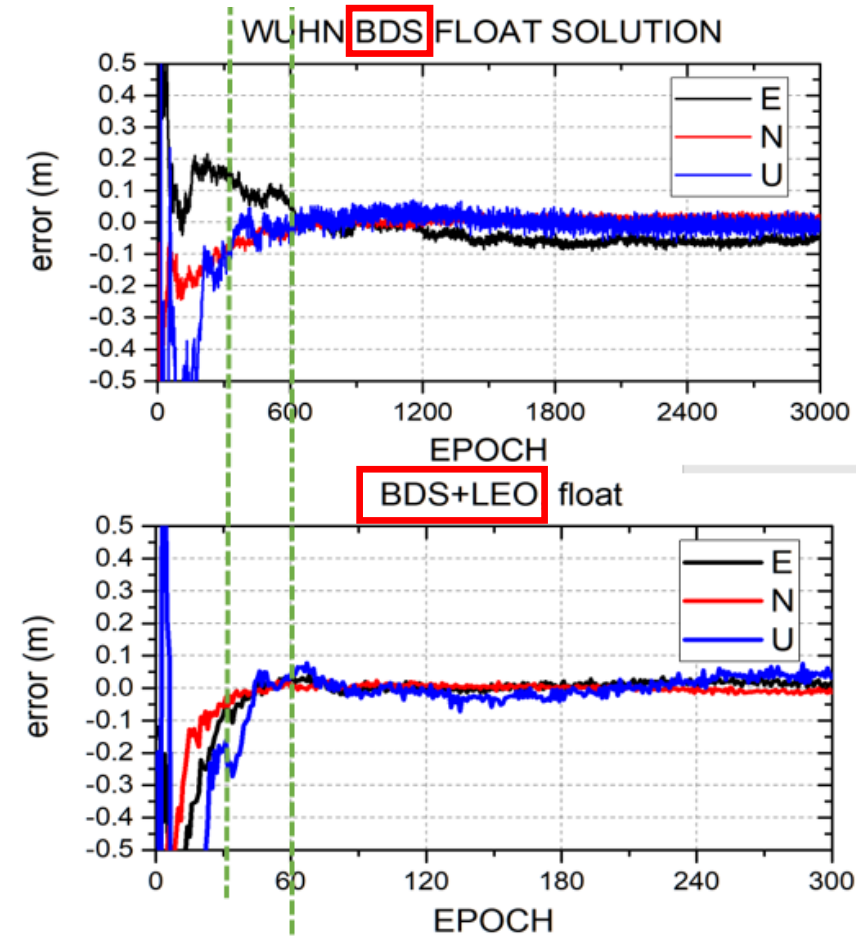
# 1. CENTISPACE program overview

## ◆ Technical Principles

- LEO satellites broadcast precise ephemeris and precise satellite clock correction
- The convergence time of accuracy augmentation based on LEO+MEO satellites is better than 1 minutes



OrbitType	Ambiguity convergence time
LEO (1000km)	1 min
MEO (20000km)	20 min
BDS IGS0 (36000km)	2 hour
BDS GEO (36000km)	$+\infty$

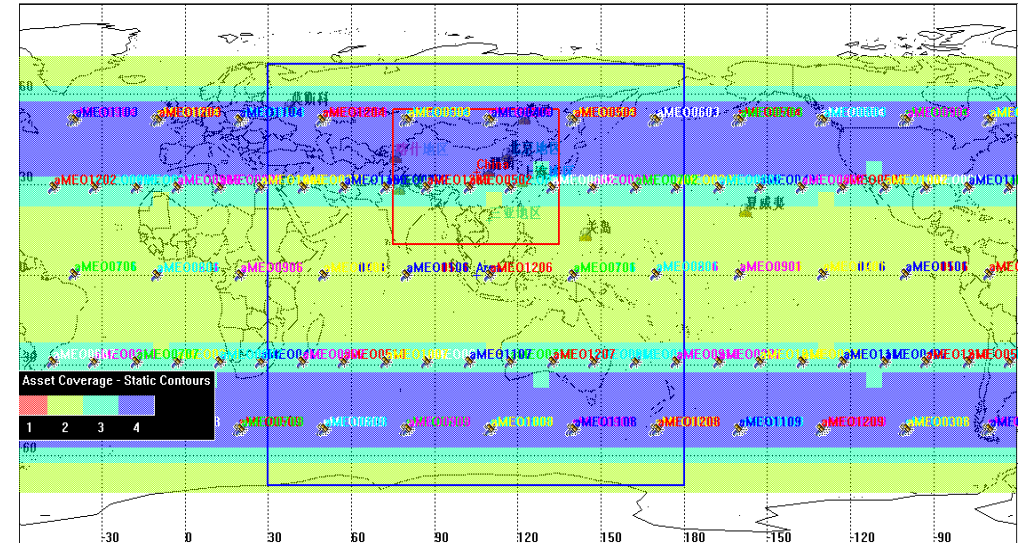
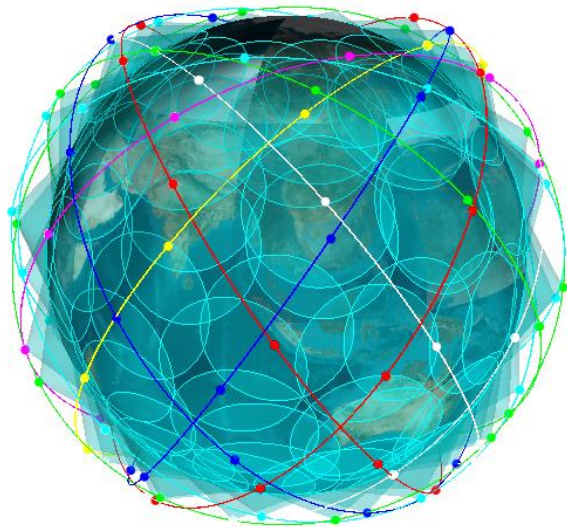




# 1. CENTISPACE program overview

## ◆ Sub-constellation I

- ★ Constellation: WALKER120/12/1
- ★ Orbit altitude: 975km
- ★ Inclination: 55°



Lat, Lon	Visible Sats	Lat, Lon	Visible Sats
(0°, 0°)	2-6	(40°, 0°)	5-7
(5°, 0°)	2-5	(45°, 0°)	5-7
(10°, 0°)	3-4	(50°, 0°)	5-7
(15°, 0°)	3-5	(55°, 0°)	4-7
(20°, 0°)	3-4	(60°, 0°)	4-6
(25°, 0°)	3-5	(65°, 0°)	2-5
(30°, 0°)	4-5	(70°, 0°)	2-3
(35°, 0°)	5-6		

More than 2 coverages are between 70°N and 70°S

# 1. CENTISPACE program overview

## ◆ Sub-constellation II

- ★ Constellation: WALKER 30/3/1
- ★ Orbit altitude: 1100km
- ★ Inclination: 87.4°
- ★ Expand coverage in polar regions

## ◆ Sub-constellation III

- ★ Constellation: WALKER 40/4/1
- ★ Orbit altitude: 1100km
- ★ Inclination: 30.0°
- ★ Expand coverage in low latitude regions

# 1. CENTISPACE program overview

## ◆ Ground Segment

- **Master Station:** manage and control of the entire system equipment; process monitoring data observed by satellite or ground GNSS receiver; calculate and generate precise ephemeris and satellite clock correction data
- **TT&C Station:** track and control CENTISPACE satellites
- **Monitor Station:** generate GNSS observation data

# 1. CENTISPACE program overview

## ◆ User Segment

- Chips
- OEM, Modules
- Receivers
- Product Solutions
- .....





# 1. CENTISPACE program overview

## ◆ Our ITU Filings

ID number (SNS)	adm	ORG or Geo.area	Satellite name	Earth station	long_nom	Date of receipt	ssn_ref	ssn_no	WIC/IFIC (ifc.mdb)	WIC/IFIC date
<u>up down</u>	<u>up down</u>	<u>up down</u>	<u>up down</u>	<u>up down</u>	<u>up down</u>	<u>up down</u>	<u>up down</u>	<u>up down</u>	<u>up down</u>	
<a href="#">118520162</a>	CHN		<a href="#">CENTISPACE-1</a>		N-GSO	06.07.2018	API/C	488	<a href="#">2878</a>	04.09.2018
<a href="#">118520162</a>	CHN		CENTISPACE-1		N-GSO	06.07.2018	CR/C	4801	<a href="#">2882</a>	30.10.2018
<a href="#">118520283</a>	CHN		<a href="#">CENTISPACE-2</a>		N-GSO	11.09.2018	API/C	539	<a href="#">2881</a>	16.10.2018
<a href="#">118520283</a>	CHN		CENTISPACE-2		N-GSO	11.09.2018	CR/C	4847	<a href="#">2886</a>	08.01.2019
<a href="#">120545323</a>	CHN		CENTISPACE-3		N-GSO	29.12.2020	API/A	12741	<a href="#">2942</a>	23.03.2021
<a href="#">120520264</a>	CHN		CENTISPACE-3		N-GSO	29.12.2020	CR/C	5516	<a href="#">2953</a>	24.08.2021
<a href="#">122545286</a>	CHN		CENTISPACE-4		N-GSO	24.11.2022	API/A	13236	<a href="#">2991</a>	07.03.2023

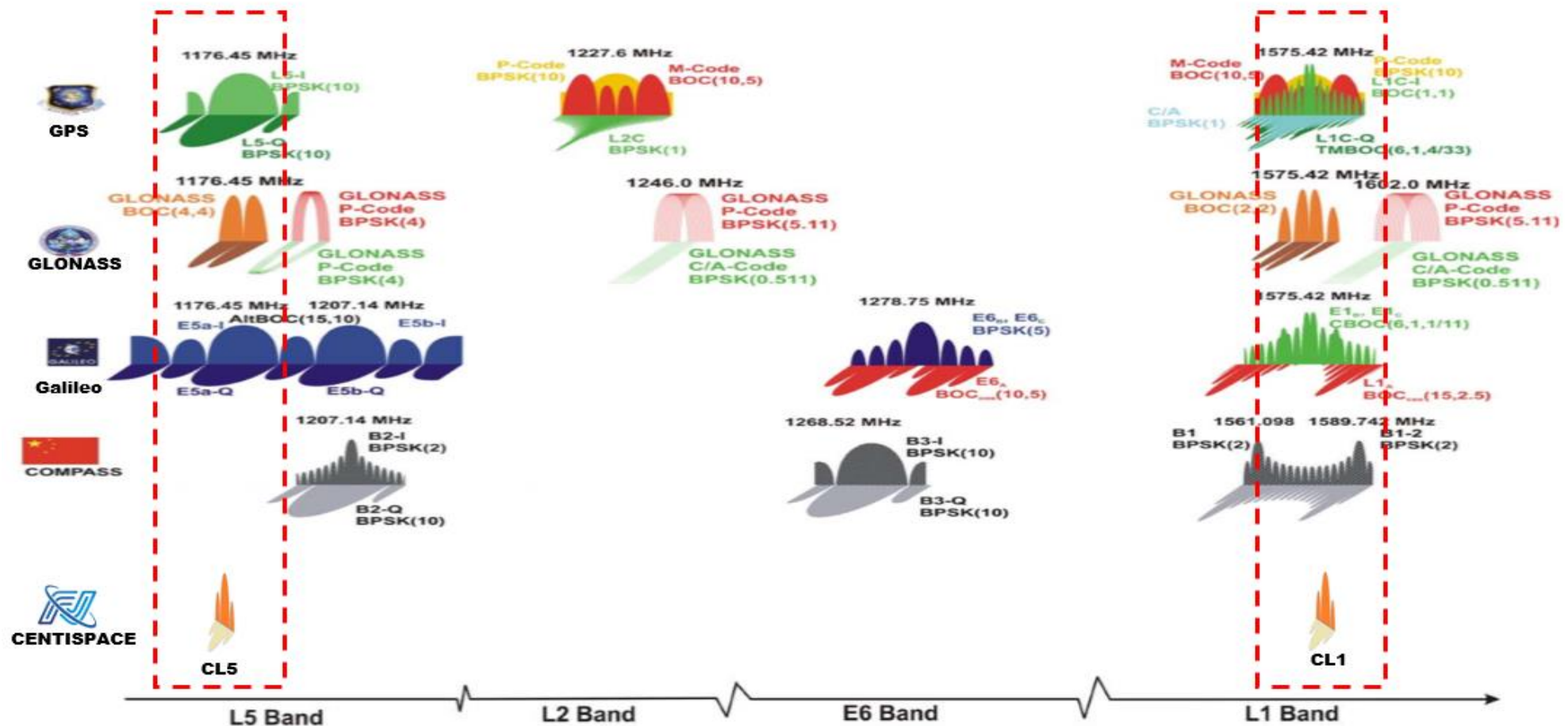
# 1. CENTISPACE program overview

## ◆ RF Characteristics

Parameters	GENTISPACE	
	CL1	CL5
Modulation Type	BPSK	BPSK
Frequency Band (MHz)	1569 - 1581	1170 - 1182
Data rate(bps)	1000	1000
Chip Rate(Mcps)	2.046	2.046
User Received Power (Typical, dBW)	-157.0	-157.0

# 1. CENTISPACE program overview

## ◆ Frequency Plan



# 1. CENTISPACE program overview

## ◆ OS Performance Characteristics

High Accuracy Service	Integrity augmentation service	GNSS monitoring service
<ul style="list-style-type: none"><li>● Dm level service: &lt;50cm, (cold start, 5s)</li><li>● Cm level service: &lt;10cm, (cold start, 1min)</li><li>● Number of users: unlimited</li><li>● Features: high accuracy, fast convergence, low cost, low power consumption</li></ul>	<ul style="list-style-type: none"><li>● Availability: 99.99%, 50cm</li><li>● Alarm time: &lt;3s</li><li>● Features: serving both professional and public users</li></ul>	<ul style="list-style-type: none"><li>● GNSS: BDS, other GNSS</li><li>● Coverage: Global Regions</li><li>● Features: satellite-based monitoring stations, real time observation data transferring with inter-satellite links</li></ul>



## Outline

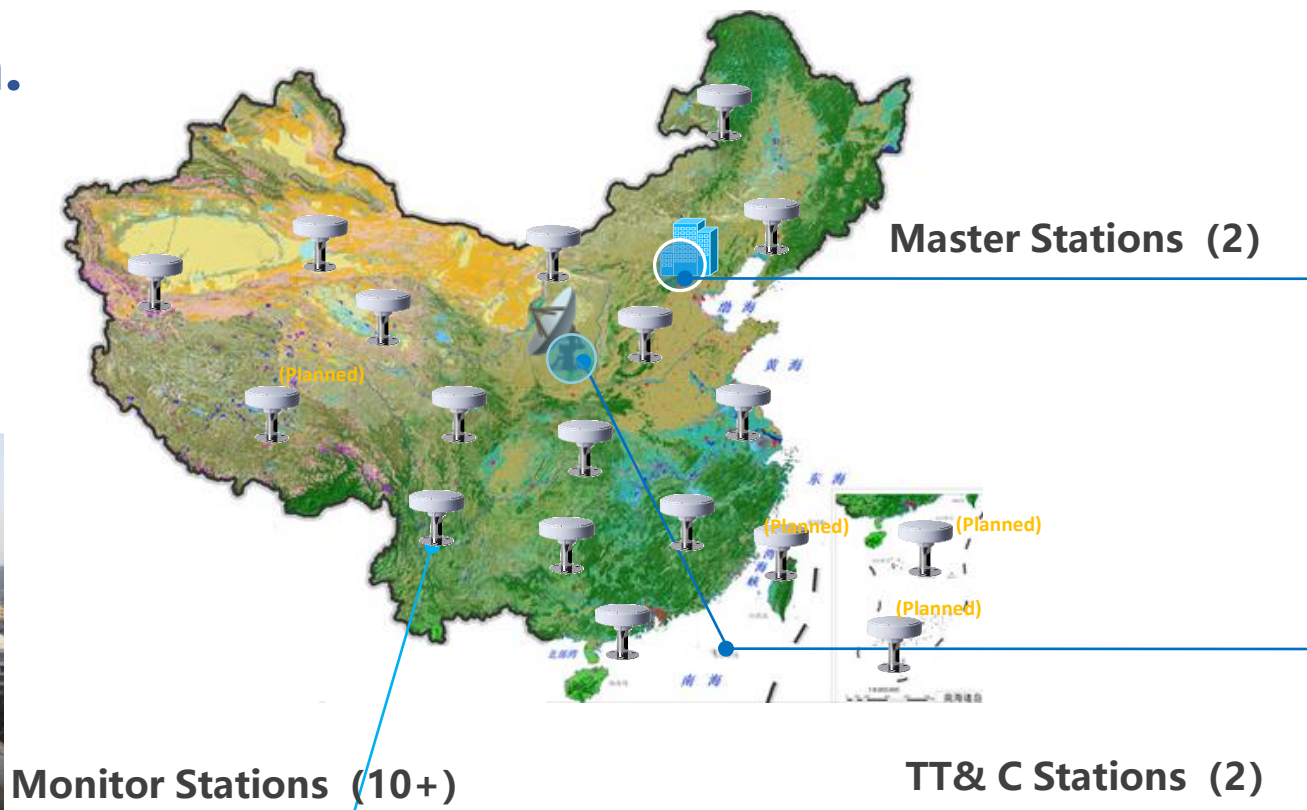
1. CENTISPACE program overview
2. CENTISPACE project status
3. Next steps



## 2. CENTISPACE project status

### ◆ Ground Segment

- Master、TT&C and Monitor stations are in operation.



## 2. CENTISPACE project status

### ◆ Space Segment

- 5 experimental satellites in orbit.
- Conducted some effective experiments on satellite platforms and payloads.
- The test work is still ongoing.



**CENTISPACE-S1**  
(Launch Date: 29 Sep 2018)



**CENTISPACE-S3 / S4**  
(6 Sep 2022)



**CENTISPACE-S5 / S6**  
(7 Oct 2022)

## 2. CENTISPACE project status

### ◆ Signal Receive Test



**Static Test**



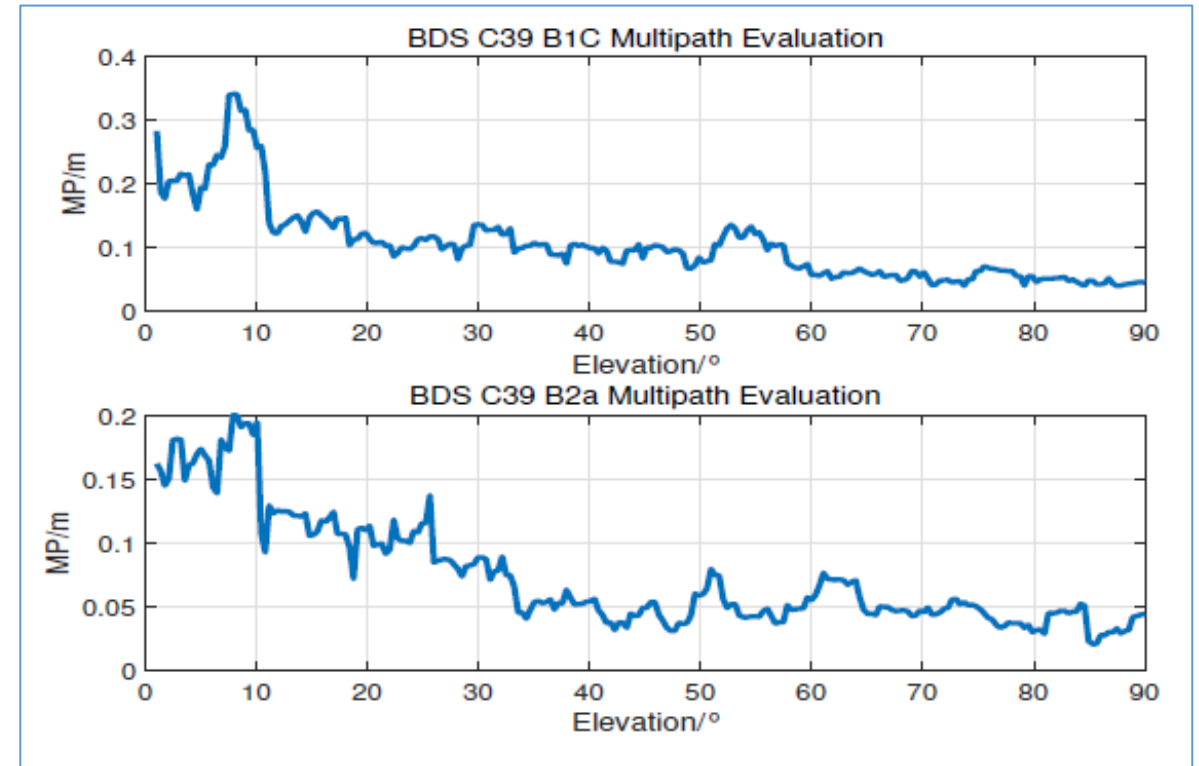
**Kinematic Test**



## 2. CENTISPACE project status

### ◆ GNSS Observation Quality

- The multipath statistical results of all the BDS satellites are 0.027-0.482m for B1C signal and 0.019-0.332m for B2a signal respectively, which are less than 0.5m and match the results from iGMAS tracking stations.

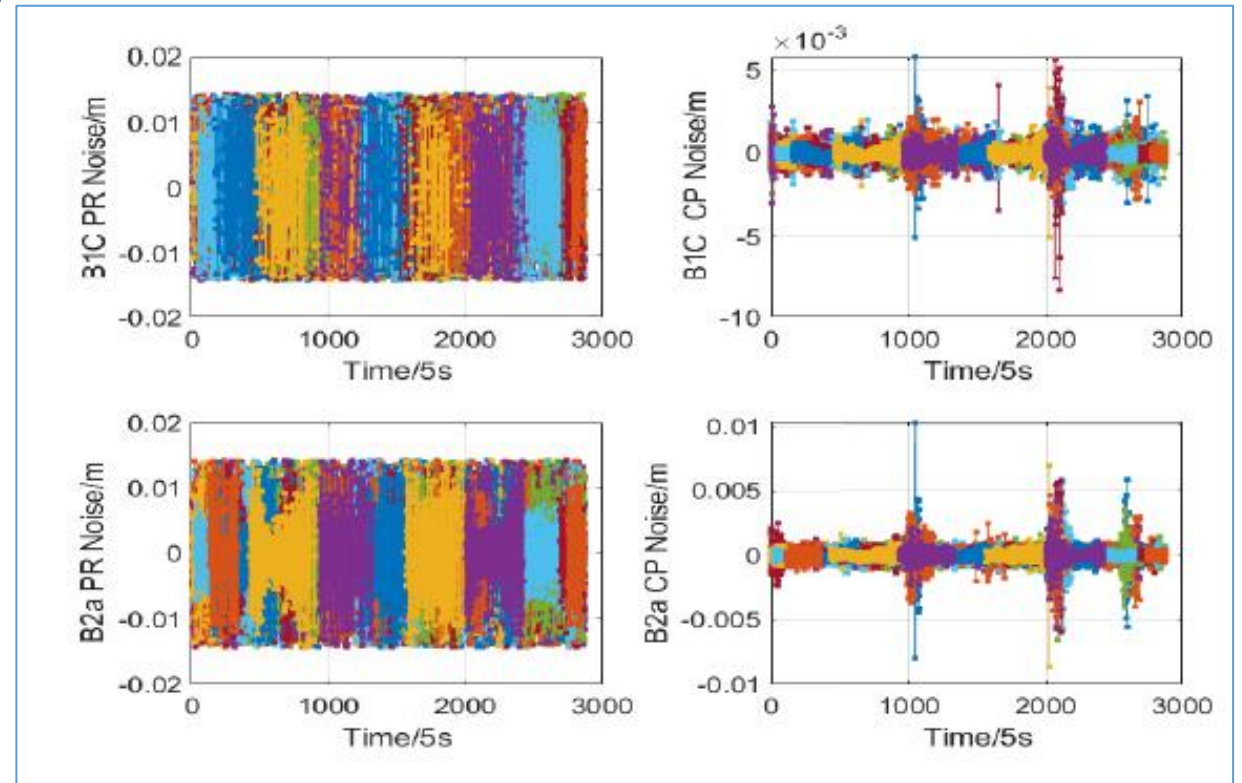


Multipath Evaluation for BDS C39

## 2. CENTISPACE project status

### ◆ GNSS Observation Quality

- The measurement value of pseudo range noise for BDS signals: **<8cm**.
- The measurement value of carrier phase noise for BDS signals: **<2mm**.



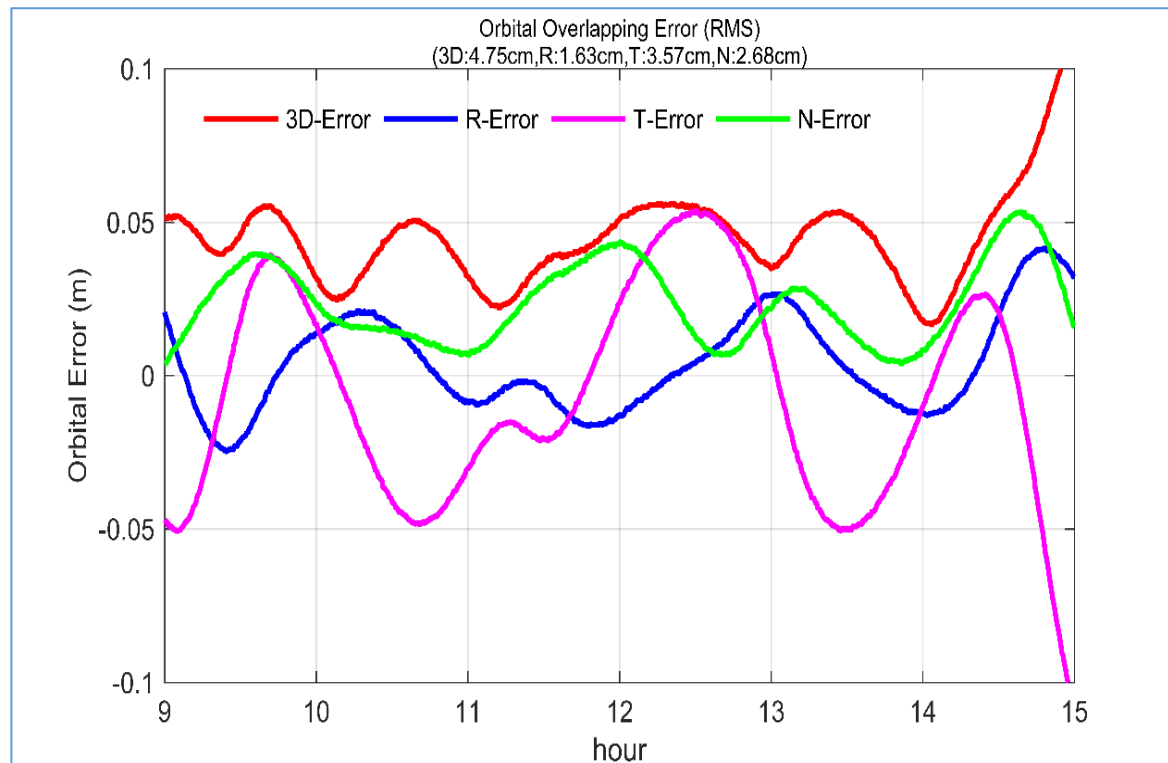
**BDS Measurement Noise  
Observed by Space-borne GNSS Receiver**



## 2. CENTISPACE project status

### ◆ Precise Orbit Determination

- BDS satellites' orbit determination error: **<5cm.**

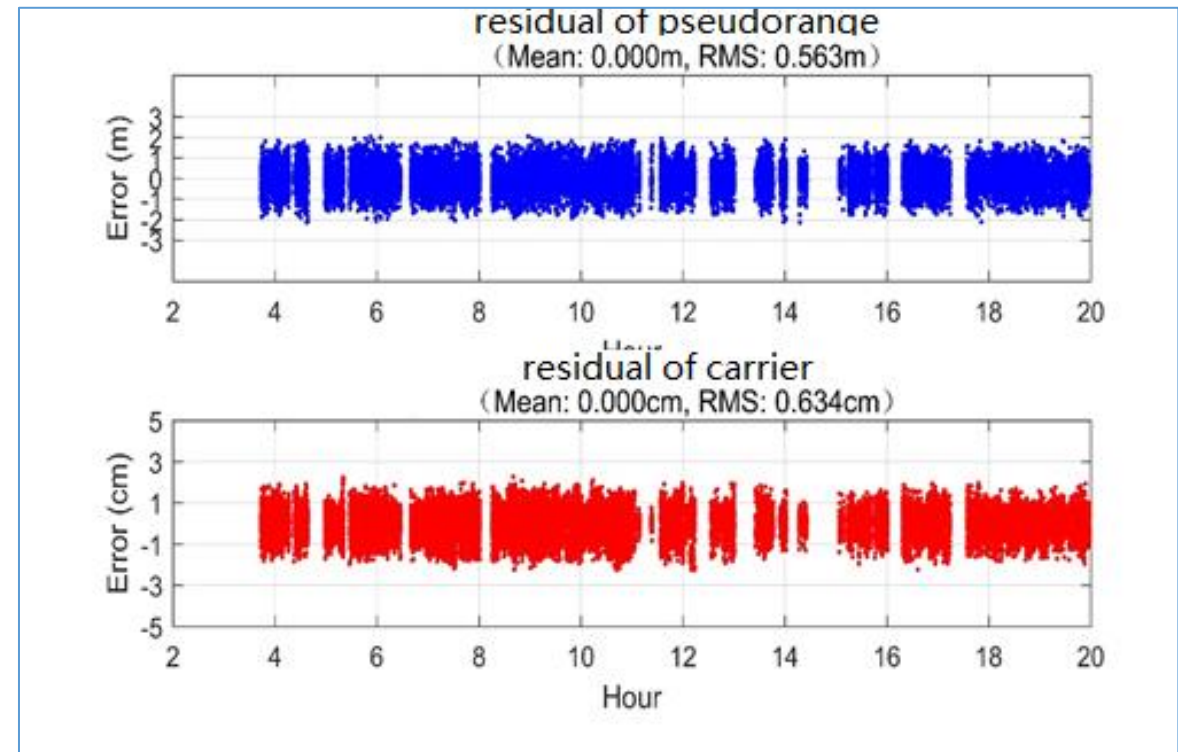


Precision orbit determination results based on BDS observation

## 2. CENTISPACE project status

### ◆ Precise Orbit Determination

- LEO satellites orbit determination residual of pseudo range: **0.563m (RMS)** .
- LEO satellites orbit determination residual of carrier phase: **0.634cm (RMS)** .



LEO precision orbit determination ranging residual  
(Based on BDS observation data)

## 2. CENTISPACE project status

### Augmentation Signal Quality

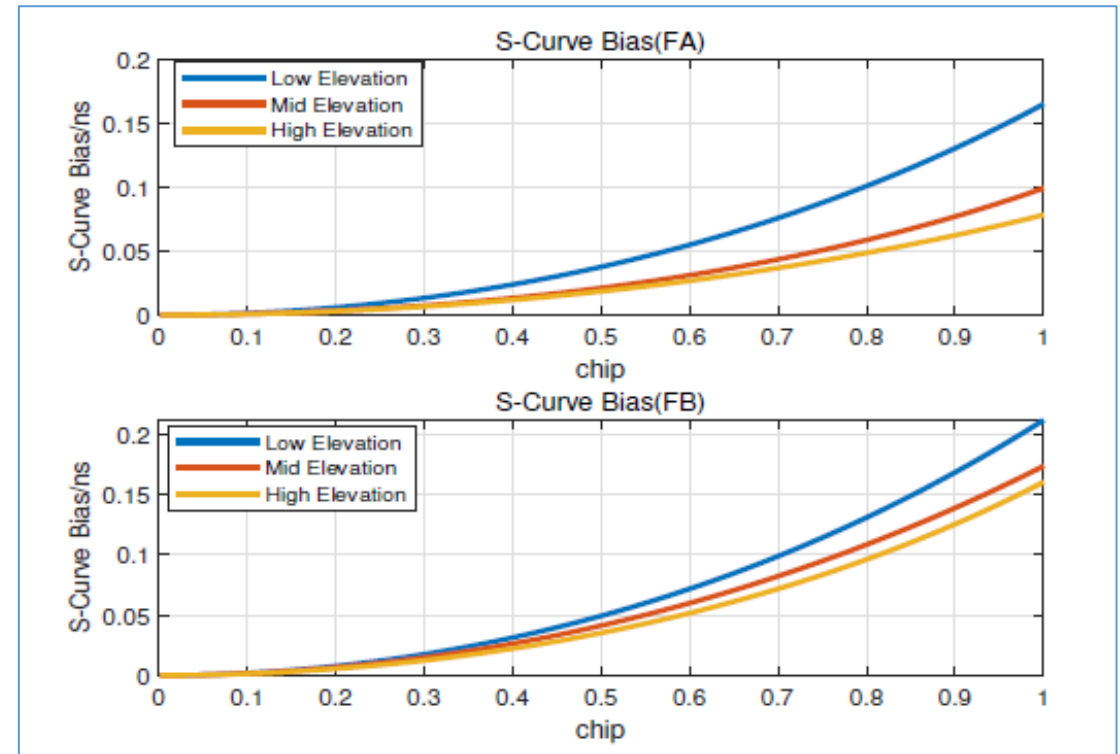
#### Phase Difference Between Two Signal Components

Signal	High Elevation	Mid Elevation	Low Elevation
CL1	0.38°	0.37°	1.69°
CL5	0.32°	0.35°	1.45°

#### Correlation Loss

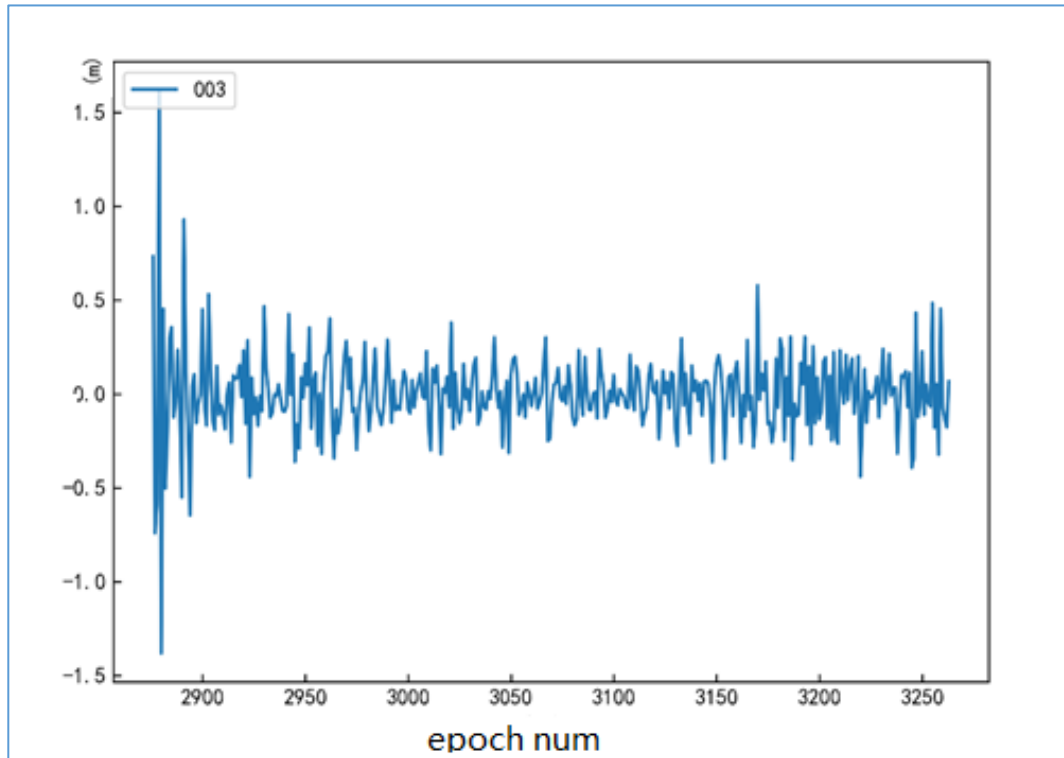
Signal	High Elevation	Mid Elevation	Low Elevation
CL1	I	0.25dB	0.34dB
	Q	0.23dB	0.31dB
CL5	I	0.17dB	0.29dB
	Q	0.20dB	0.25dB

#### S-Curve Bias

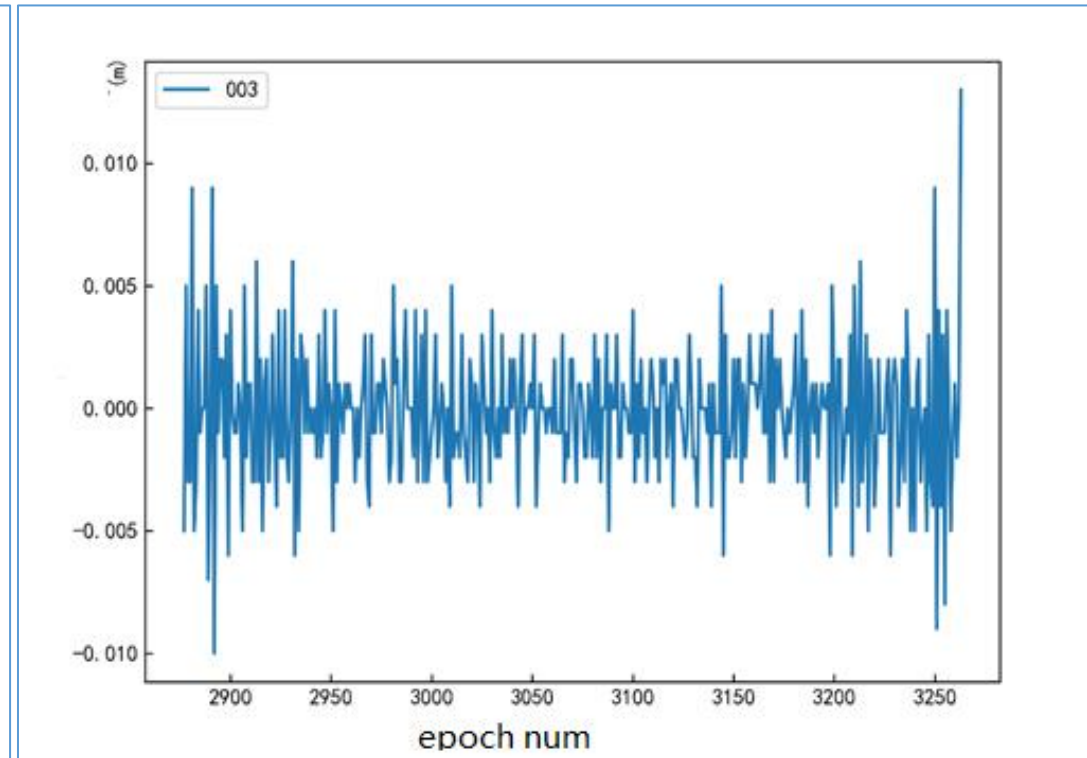


## 2. CENTISPACE project status

### ◆ Augmentation Signal Quality



**DD of Pseudo range GF Combination  
(RMS: 3.2cm)**



**DD of Phase GF Combination  
(RMS: 0.4mm)**



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## 3. Next steps

### ◆ By the end of 2023

- Around September: 1 rocket 10 satellites
- Around December: 1 rocket 10 satellites
- Establish preliminary service

## 3. Next steps

### ◆ Next Steps

- **Complete the construction of whole constellation consisting of 190 satellites**
- **Provide worldwide and commercial augmentation navigation services**



THANK YOU FOR YOUR ATTENTION !



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