



# Update on NavIC Signal Monitoring Receiver and The Advantage of NavIC L1-SPS

*Saumi S.*

*Rohan S. Urdhwareshe*

*Saurabh Bhalla*

*Rakesh Kr. Bijarniya*

*Sagar Subudhi*

*Space Applications Centre*

*Indian Space Research Organisation*

*Ahmedabad, India*

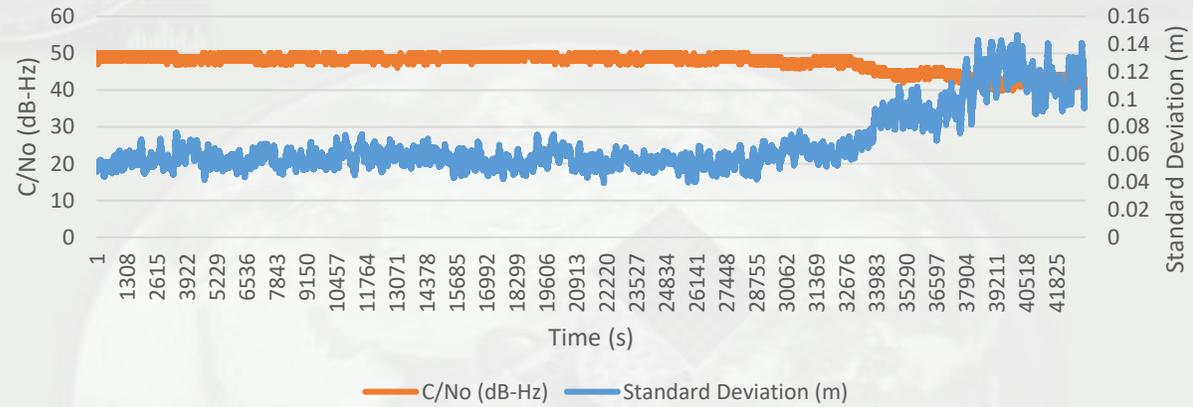
- Recently launched NavIC NVS-01 (GEO) satellites has introduced NavIC L1-SPS service along with the legacy L5 and S services.
- Payload Coherency Test Receiver used for the ground testing of NVS-01 satellite has been upgraded for the signal-in-signal monitoring of NVS-01 signals and is successfully deployed at ISRO Navigation Centre (INC).
- The receiver was used successfully for In-Orbit Testing of NVS-01 satellite and initial configuration and is in operation for continuous monitoring of the signal-in-space.
- The receiver firmware is also configurable for the processing of various other open GNSS signals with variety of modulation schemes and data formats.

# Signal Monitoring Rx Specifications

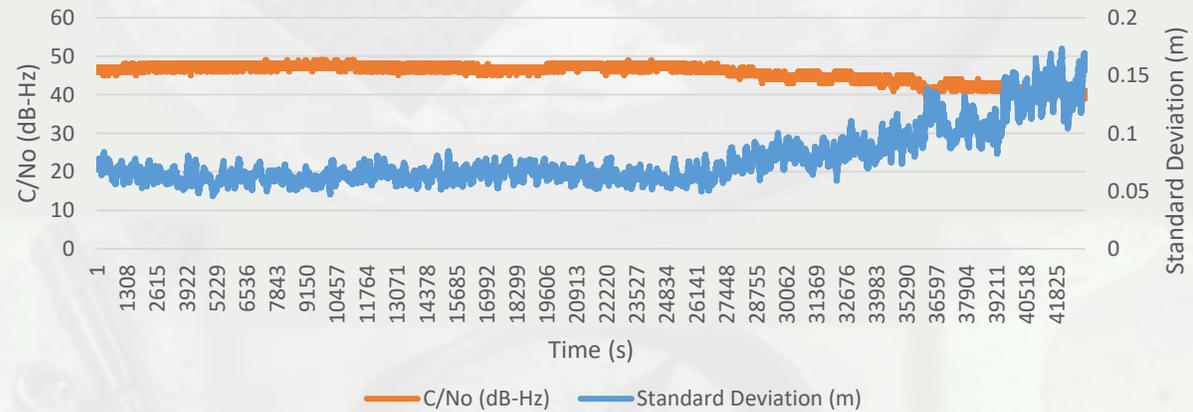
Parameter	Specifications
Number of Channels	26
Signal Support	L1 SPS signal L5/S SPS Other Open GNSS signals in L5/S/L1 Band
Sensitivity	Acquisition : 32 dB-Hz C/No Tracking : 28 dB-Hz C/No
Anti-jamming Capability	Narrowband interference mitigation and Pulse blanking and notch filtering
Individual Code Phase Accuracy	Better than 10 cm (> 44 dB-Hz C/No)
Individual Carrier Phase Accuracy	Better than 10 mm (> 44 dB-Hz C/No)
Theoretical performance	Within 10 %
Timing Mode	Time Synchronization through external 1 PPS as well as reference clock
External Interface	RF Input 1-PPS Input and Output External Reference Clock (10 MHz) Data Communication Interface (USB-UART x2)
Configuration and Commanding	User defined Channel Configuration and PRNs Signal-wise

# Performance of Signal Monitoring Receiver for NavIC SPS with SIS

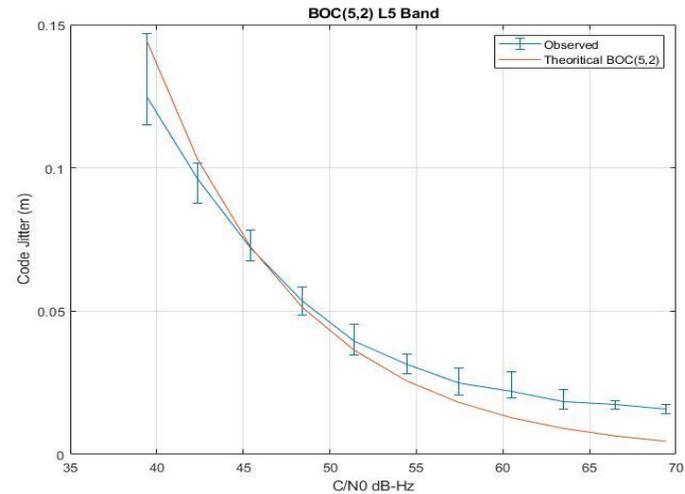
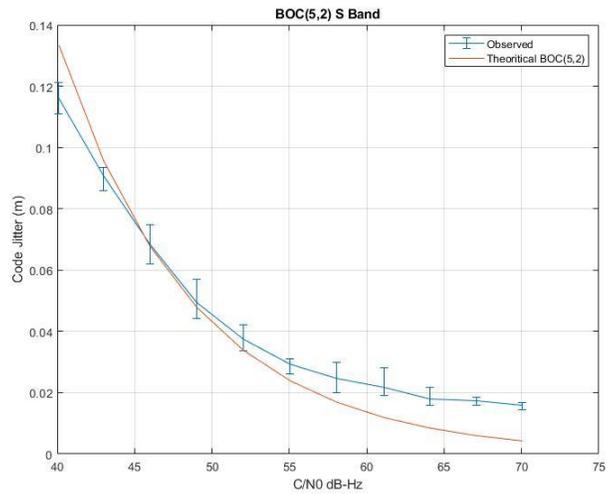
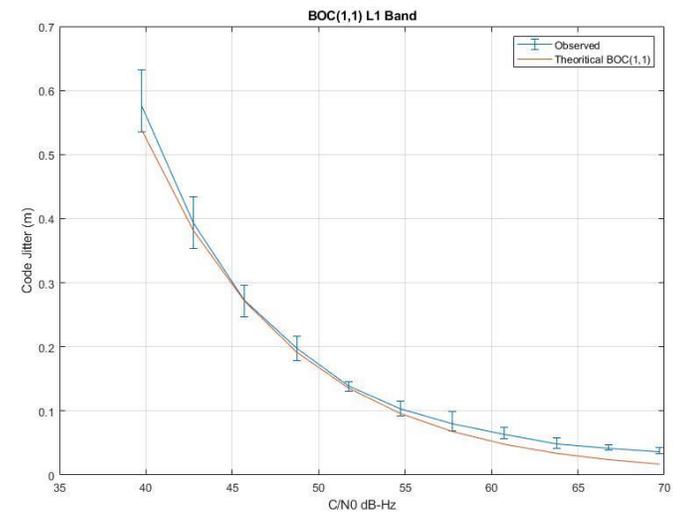
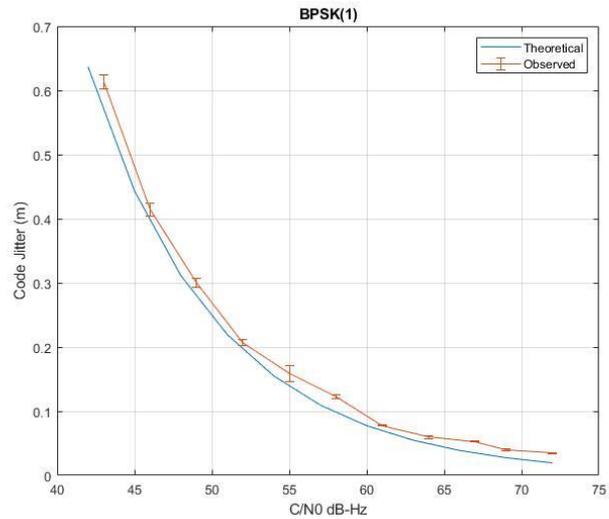
NavIC L5-SPS PRN-9 SIS Observables



NavIC S-SPS PRN-9 SIS Observables



# Theoretical Jitter Performance Comparison



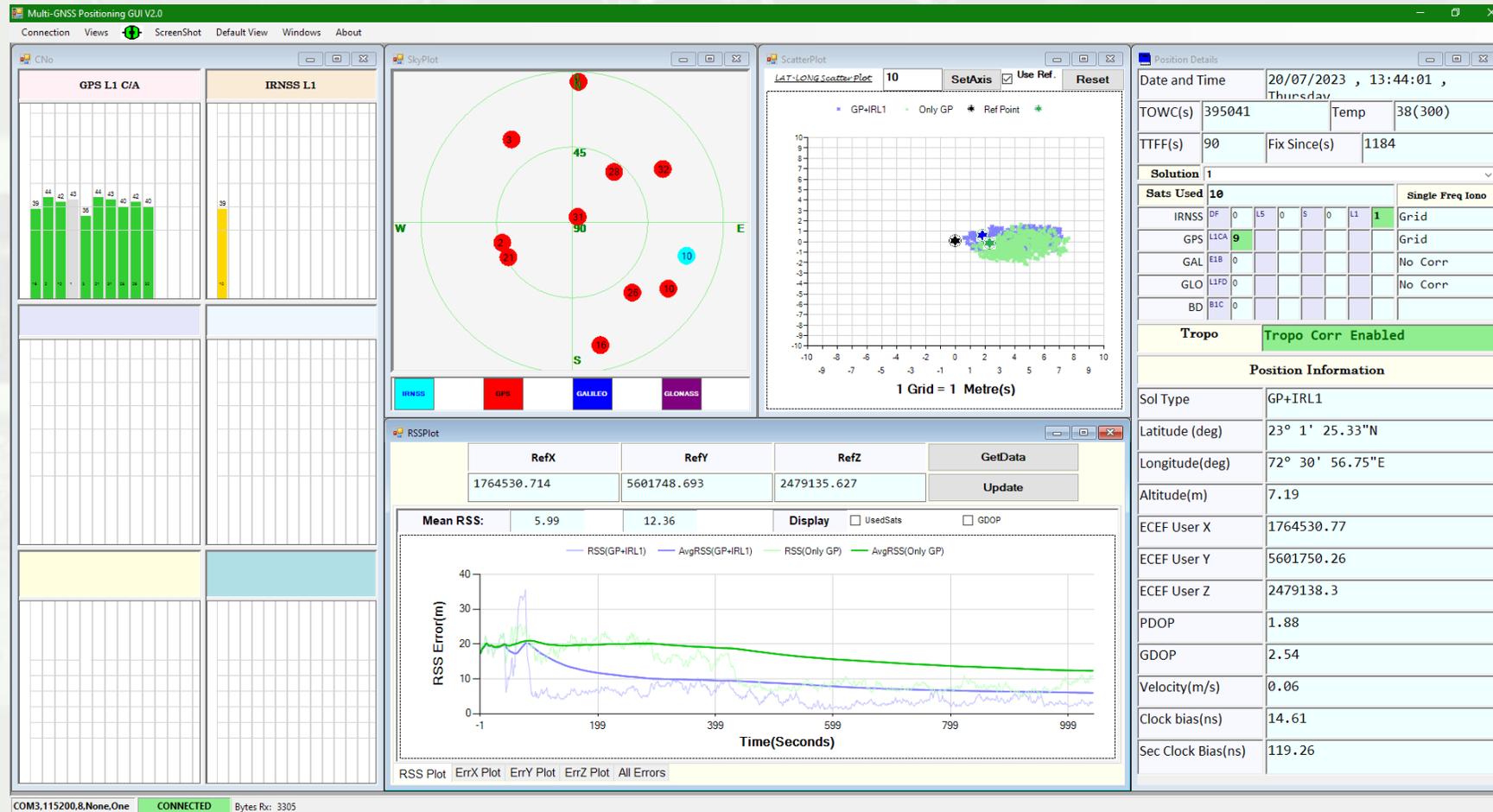
# NavIC L1 SPS Advantage

- Newly introduced NavIC L1-SPS signal has interoperability with other GNSS L1 civilian signals. The signal has novel SBOC modulation with IZ-4 PRN codes, novel LDPC as well as BCH encoding schemes offering unique advantages.
- Being regional system giving continuous availability along with improved signal performance, NavIC L1 SPS signal offers advantages.
- NavIC system provides Ionospheric grid corrections at  $5^{\circ} \times 5^{\circ}$  grids at 350 km altitude which gives very accurate Ionospheric corrections.
- In addition to this, NavIC has introduced NeQuick-N model for Ionospheric delay modeling in L1-SPS signal.
- This makes usage of NavIC L1-SPS signal immensely advantageous in multi-GNSS single frequency L1 receiver to get improved position accuracy.
- It also removes the need of having an additional SBAS channel only for Ionospheric corrections over Indian region for receiving the error correction values.

# NavIC L1 SPS Signal

S. No.	Parameter	Specifications
1	Frequency Band	1575.42 MHz +- 12 MHz
3	Bandwidth	24 MHz
4	Modulation	Synthesized Binary Offset Carrier (SBOC) Pilot(Power: 58.18%): BOC(6,1) & BOC(1,1) Data(Power: 41.82%): BOC(6,1) BOC(1,1)
5	Ranging Codes	Primary: Interleaved Z4 (IZ4) Linear Sequence Overlay: Truncated Z4-Linear Sequence
6	Symbol Rate	100 sps
7	Frame Format	18 sec Master Frame SF1: 52 sym., SF 2: 1200 sym., SF 3: 548 sym.
8	Channel Code	SF-1: BCH(52,9) SF-2/SF-3: ½ Rate LDPC
9	Navigation Parameters	Primary Bits: 576
10	Ionospheric Messages	Grid based Ionospheric corrections and Klobuchar model coefficients

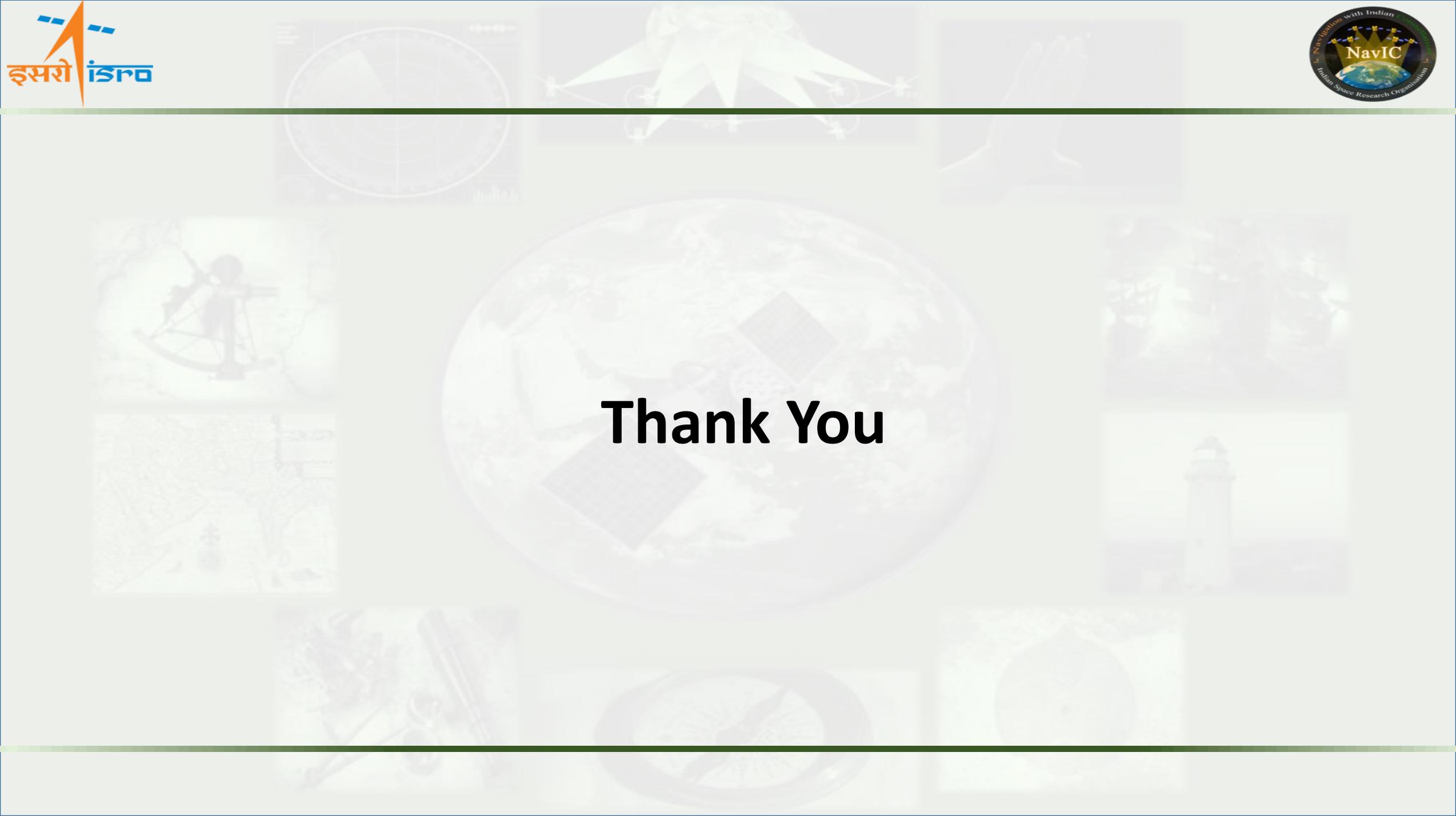
# Performance with NavIC L1 SPS



Improved position accuracy is observed with NavIC L1 SPS because of ionospheric grid corrections

# Conclusion

- The Signal Monitoring Receiver has been successfully used in In-Orbit Testing of NVS-01 satellite.
- The Receiver is deployed and under operations at NavIC Signal Monitoring Stations (INC).
- The Receiver is configurable for signals with modulations:
  - BPSK(n)
  - BOC(m,n)
  - MBOC
- Hence can be configured to cater other signal monitoring requirements.
- NavIC L1-SPS signal offers significant advantage in Multi-GNSS L1 positioning receiver because of Ionospheric grid corrections as well as advanced features introduced in signal.



**Thank You**