



Development of multi-GNSS SSV Receiver for EPS Satellites

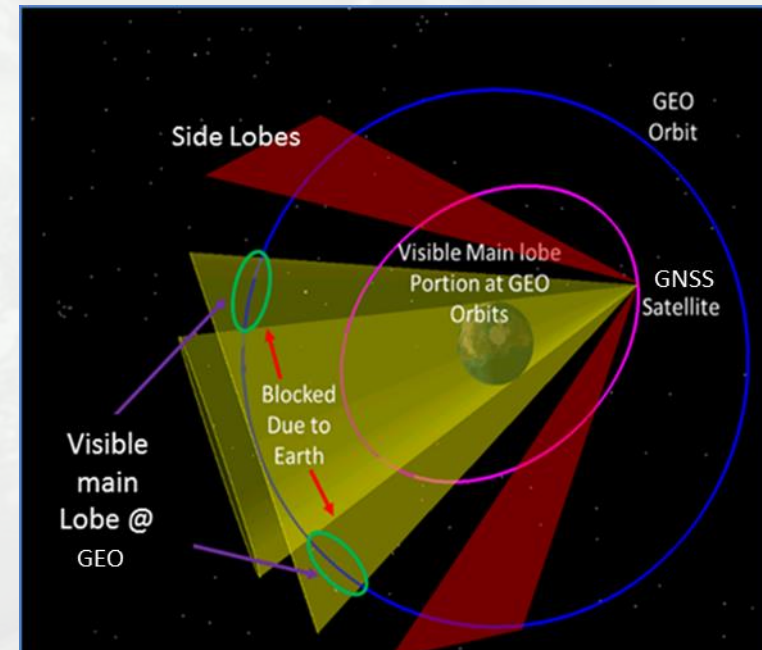
Pravin Patidar

Space Applications Centre

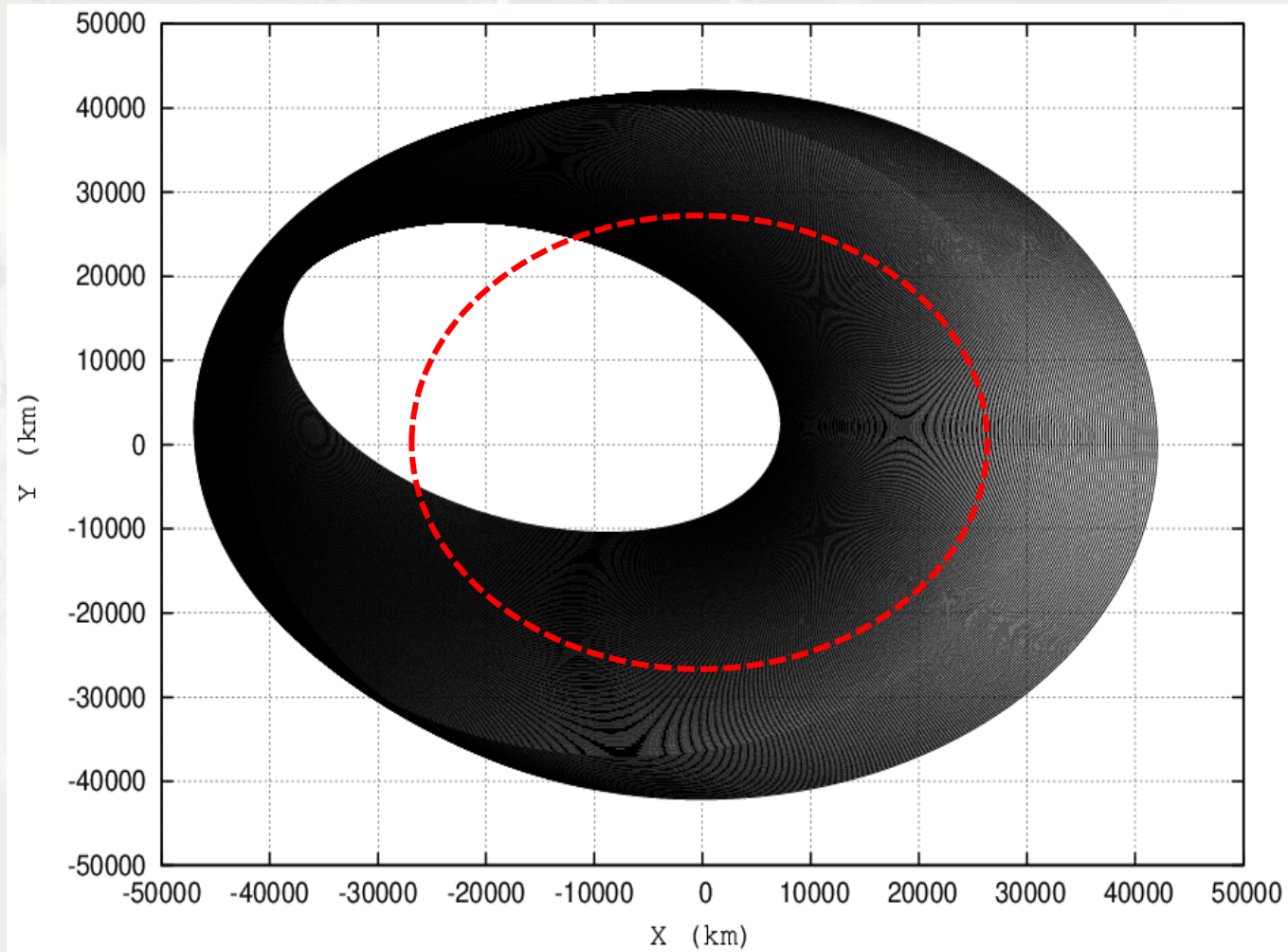
Indian Space Research Organisation

Ahmedabad, India

- Signals from GNSS satellite main lobe and side lobes are available upto GEO and beyond.
- Most of the GNSS transmit antenna main lobe is blocked by earth
 - Signal reaches to GEO orbits through residual from main lobe and side lobes only.
- GNSS SSV for Geo advantages:
 - Closer spacing of Geostationary satellites, leading to increased slot occupancy.
 - Increased availability post maneuvers.
 - Real-time autonomous onboard operations.
 - Navigation in GTO, thus reducing dependence on ground tracking network

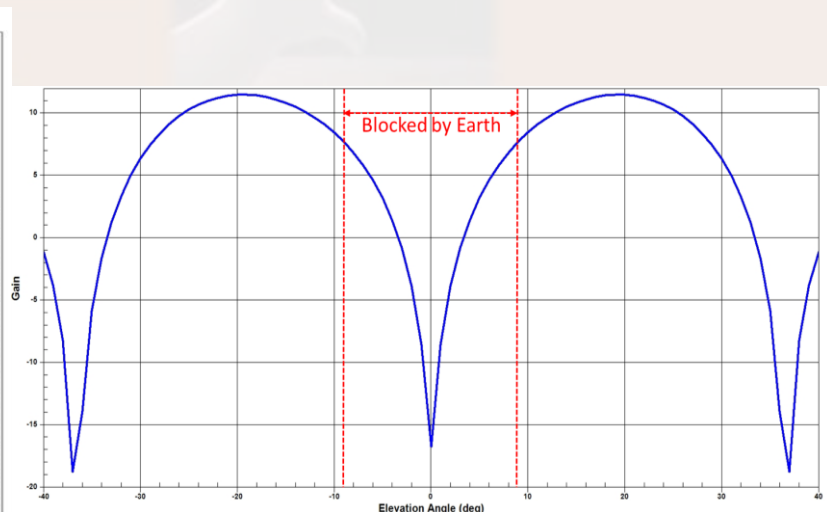
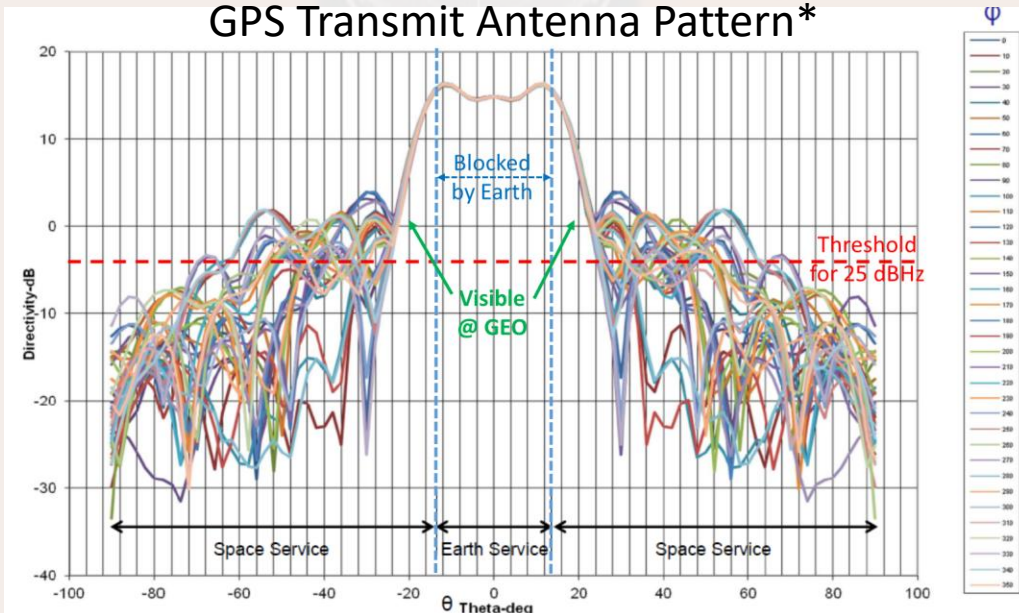


EPS Satellite Orbit raising & GNSS



Entire lower and upper SSV will be traversed by and EPS satellite

GPS Transmit Antenna Pattern*

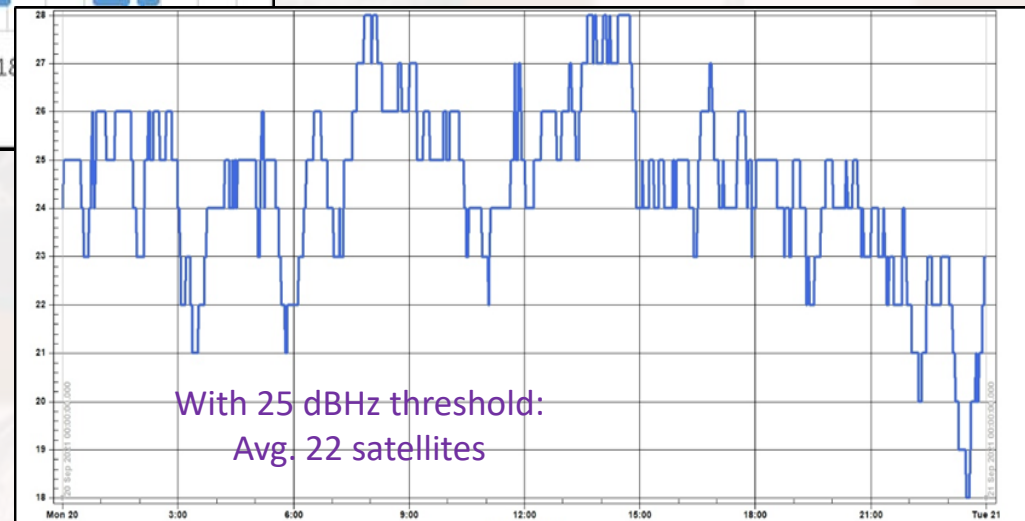
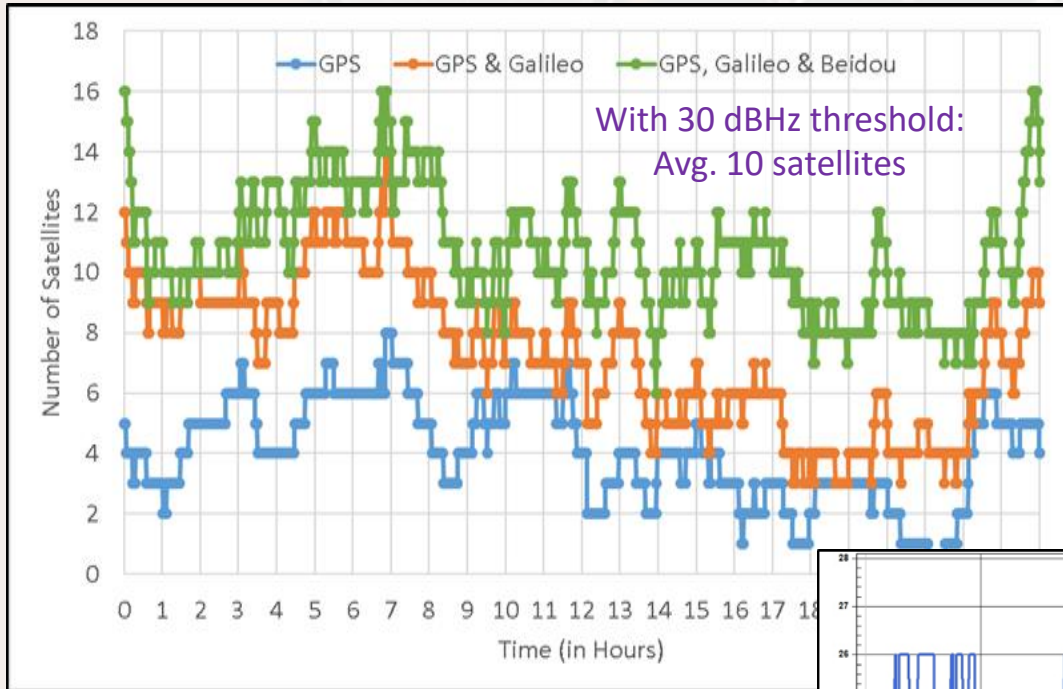


Shaped Geo Receive Antenna pattern

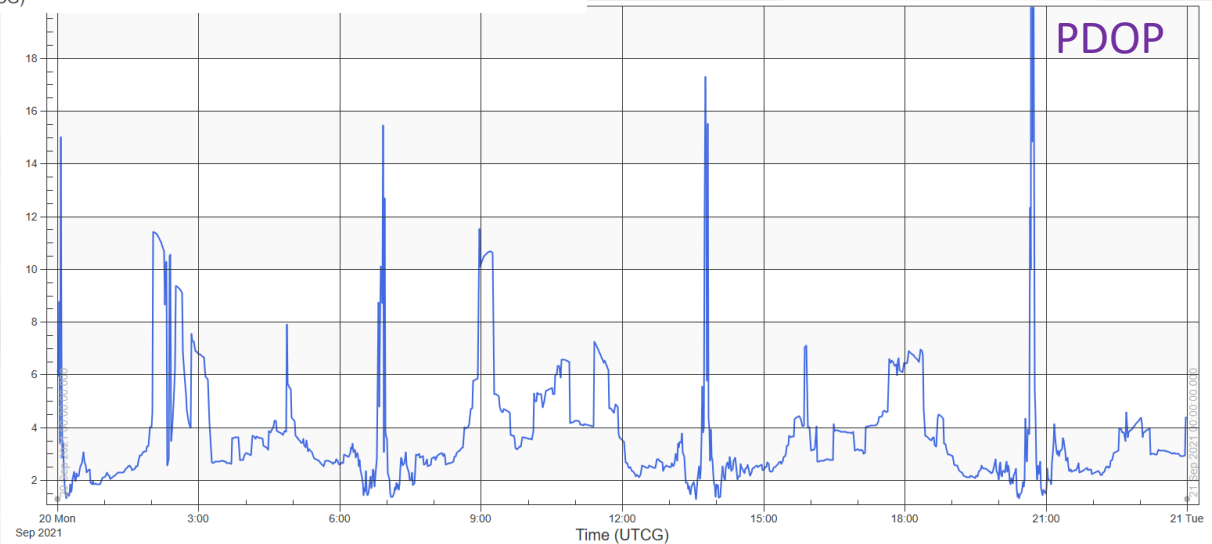
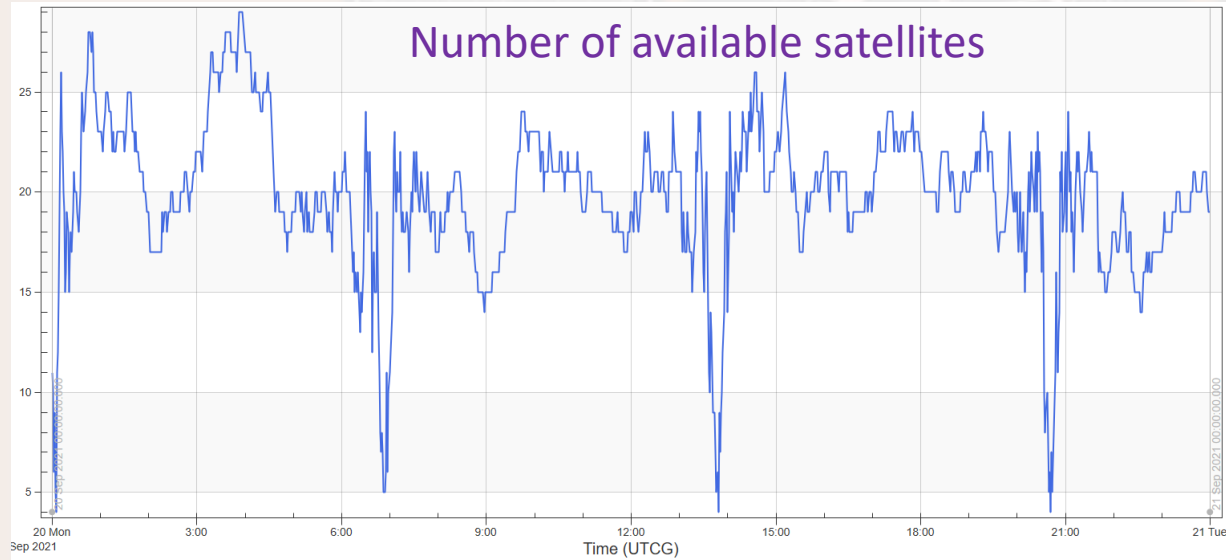
- Satellite antenna main lobe spill over and side lobes provides the signal at GEO.
- A shaped pattern receive antenna at GEO helps improve the link.
 - Null in the center reduces the noise from earth.
- With better link quality more side lobe signals are included, which are significant in improving the DOP at GEO.
- The same antenna can ensure sufficient satellite availability during GTO phase also.

* Willard Marquis, "The GPS block IIR antenna panel pattern and its use on orbit", Ion GNSS+, 2016

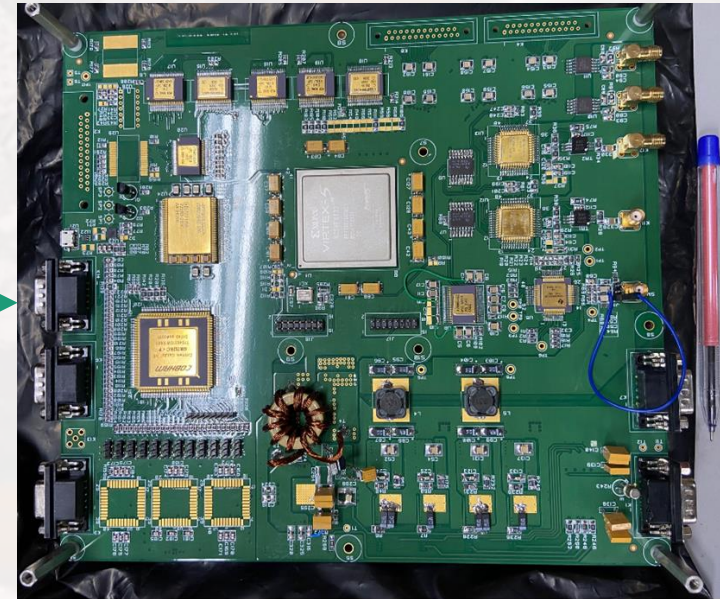
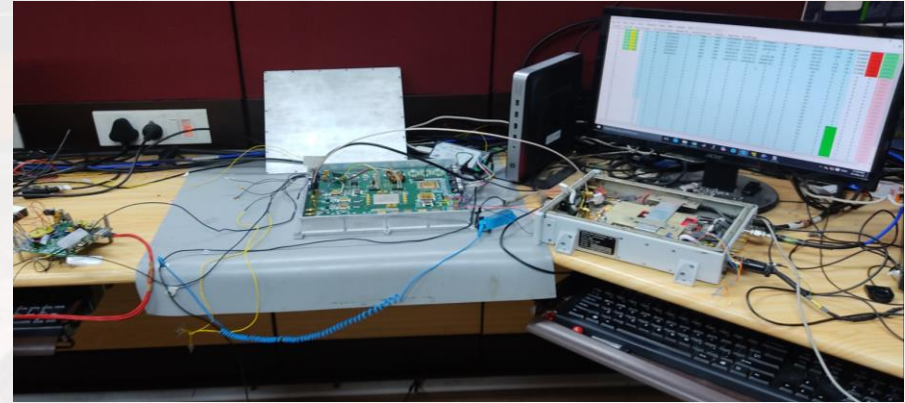
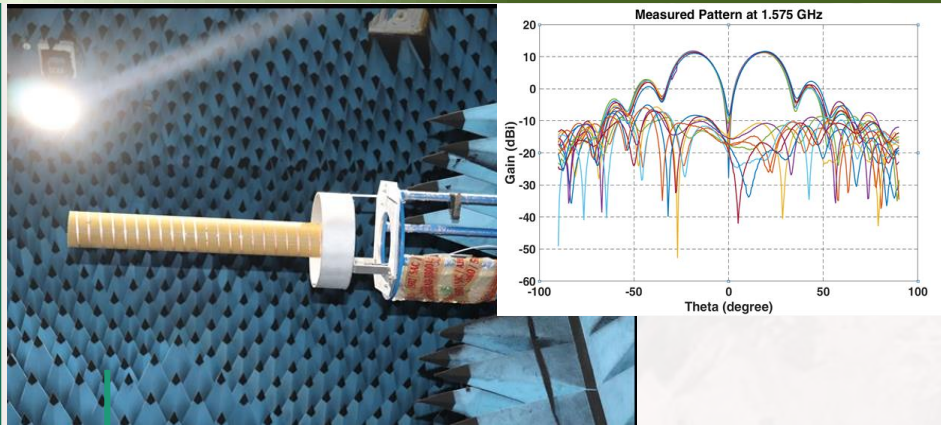
GNSS Satellite Availability at GEO



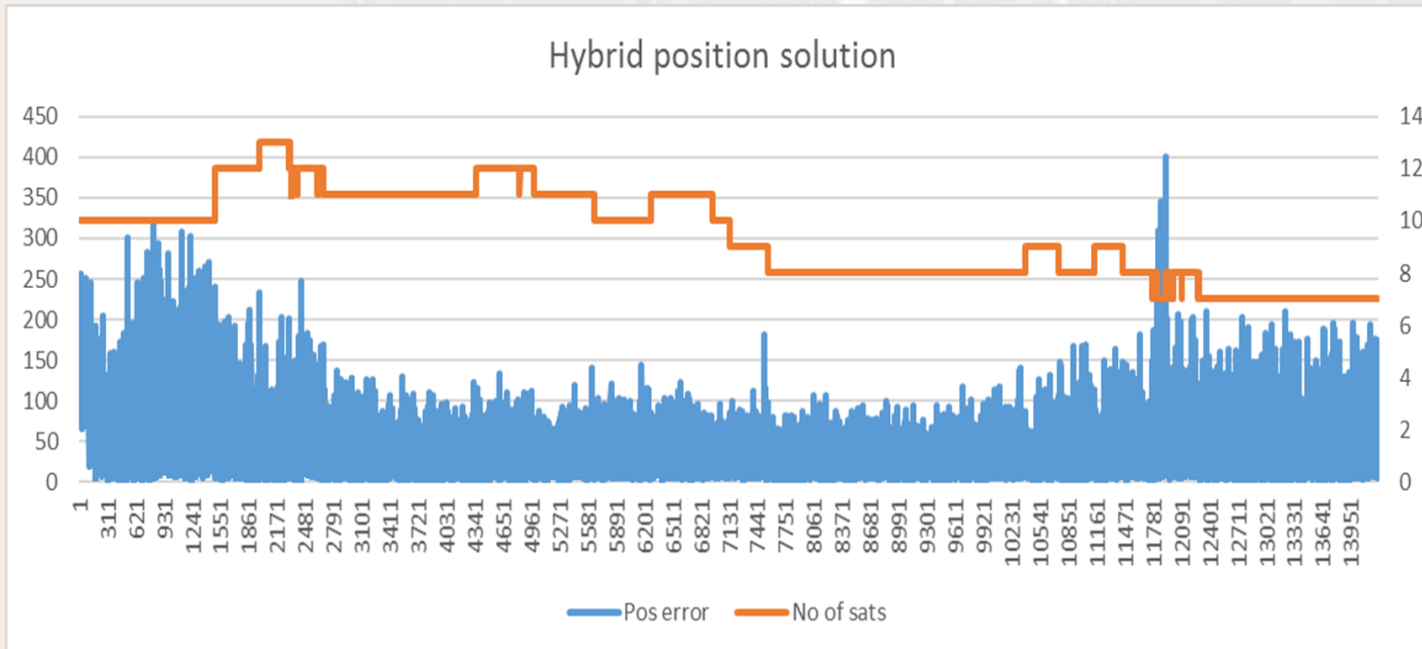
GNSS Satellite Availability in GTO



Development of multi GNSS SSV Receiver

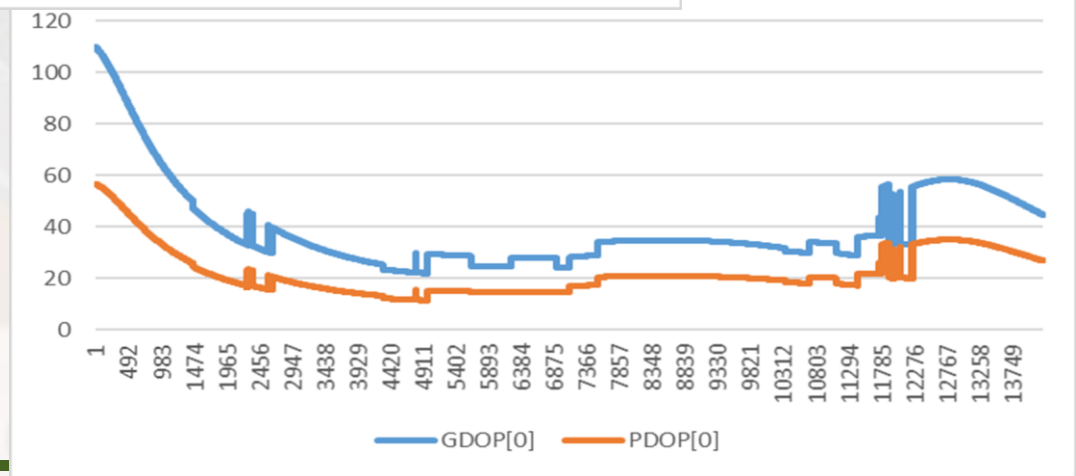


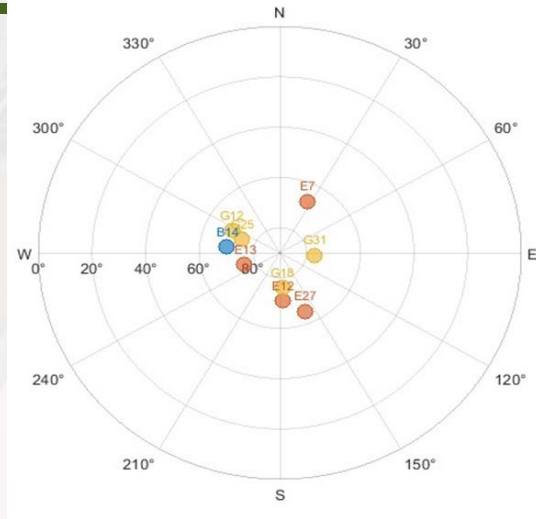
The receiver will cater to GPS L1CA/L1C, Galileo E1OS, Beidou B1C and NavIC L5-SPS.



Positioning results at geostationary slot at $111.5^{\circ}E$

3d RMS error (m)	PDOP
98 m	15 to 58

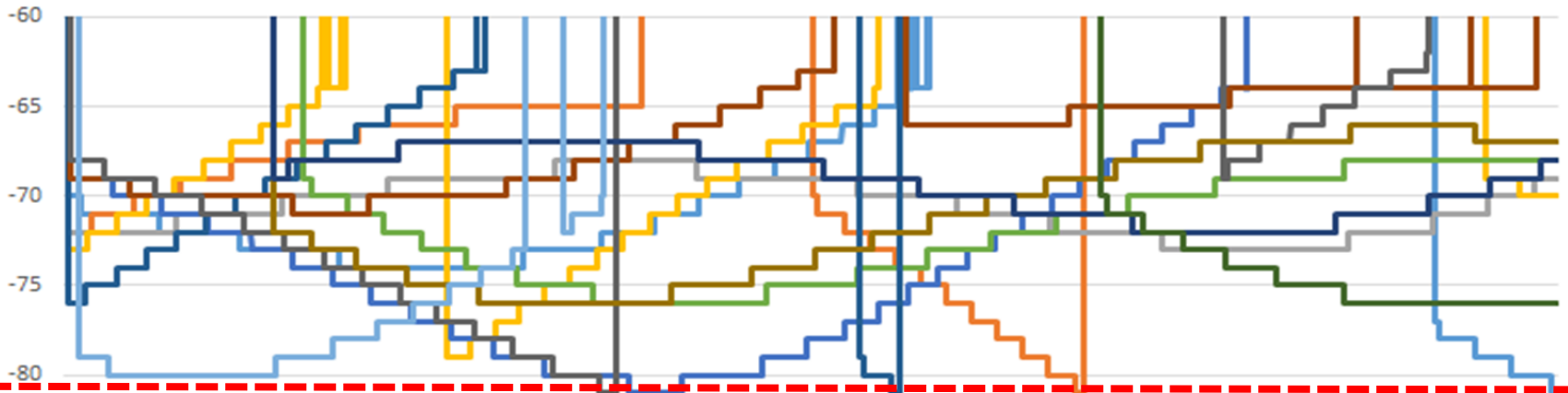




Skyplot
@ 111.5°E
Geo Altitude

ELEVATION

Beyond Earth Limb ↑



Elevation Angle of tracked satellites @ 111.5°E Geo Altitude

Summary

- Continuous standalone positioning is feasible at geostationary orbits when signals from all available constellations are utilized.
- The receiver must have high acquisition and tracking sensitivity as the signals from transmitter side lobes need to be utilized.
- The test and simulation is based on GPS satellite transmit antenna pattern. Same pattern assumed for other GNSS.
 - The accuracy of the analysis will be better if other constellation transmit antenna patterns are available.
- The proposed multi GNSS receiver will be part of ISRO's TDS-01 satellite, to be launched in 2023.

Thank You

pravinpatidar@sac.isro.gov.in