Technology Development for a Cost-Effective SCOM on the Move System for LEO Satellite Constellations

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ABSTRACT

Low earth orbit (LEO) constellations offer lower latency, greater resilience to space phenomena, and increased affordability compared to geosynchronous earth orbit (GEO) and medium earth orbit (MEO) satellites. Consequently, LEO satellite communication (SCOM) on the move terminals is becoming attractive, particularly for enhancing 5G and upcoming 6G services in rural areas, where deploying classic terrestrial networks are both technically challenging and expensive [1]. SCOM terminals are crucial for tracking LEO satellites and range from fully mechanical to electronically scanned systems. Towards scanning speed and efficiency, choice of phased array antennas offers a compact solution with excellent scanning performance, high gain, superior radiation patterns, and multibeam capability [2]. However, these advantages come at a relatively higher cost of RF electronic components, like phase shifters, power amplifiers, low noise amplifiers, and similar. Therefore, hybrid integrated capabilities can be a balanced solution for maintaining performance and reducing RF components costs. In this study we propose an integrated and cost-effective SCOM on the move system Fig. 1, featuring electronic scanning in the elevation plane, facilitated by a flat panel leaky wave antenna (LWA) array adapted to an optimised version from folded substrate integrated waveguide (FSIW) antenna array, previously proposed in [3], with a mechanical scanning functionality in the azimuth plane. Link budget calculation [4] and block diagram of this architecture is depicted in Fig. 2. Far-field pattern measurements were conducted using an NSI™ nearfield measurement system, yielding accurate results from 10.5 GHz (Fig. 3, 4) to 12.5 GHz. These advancements will significantly improve performance, demonstrating strong potential for future satellite communication applications.

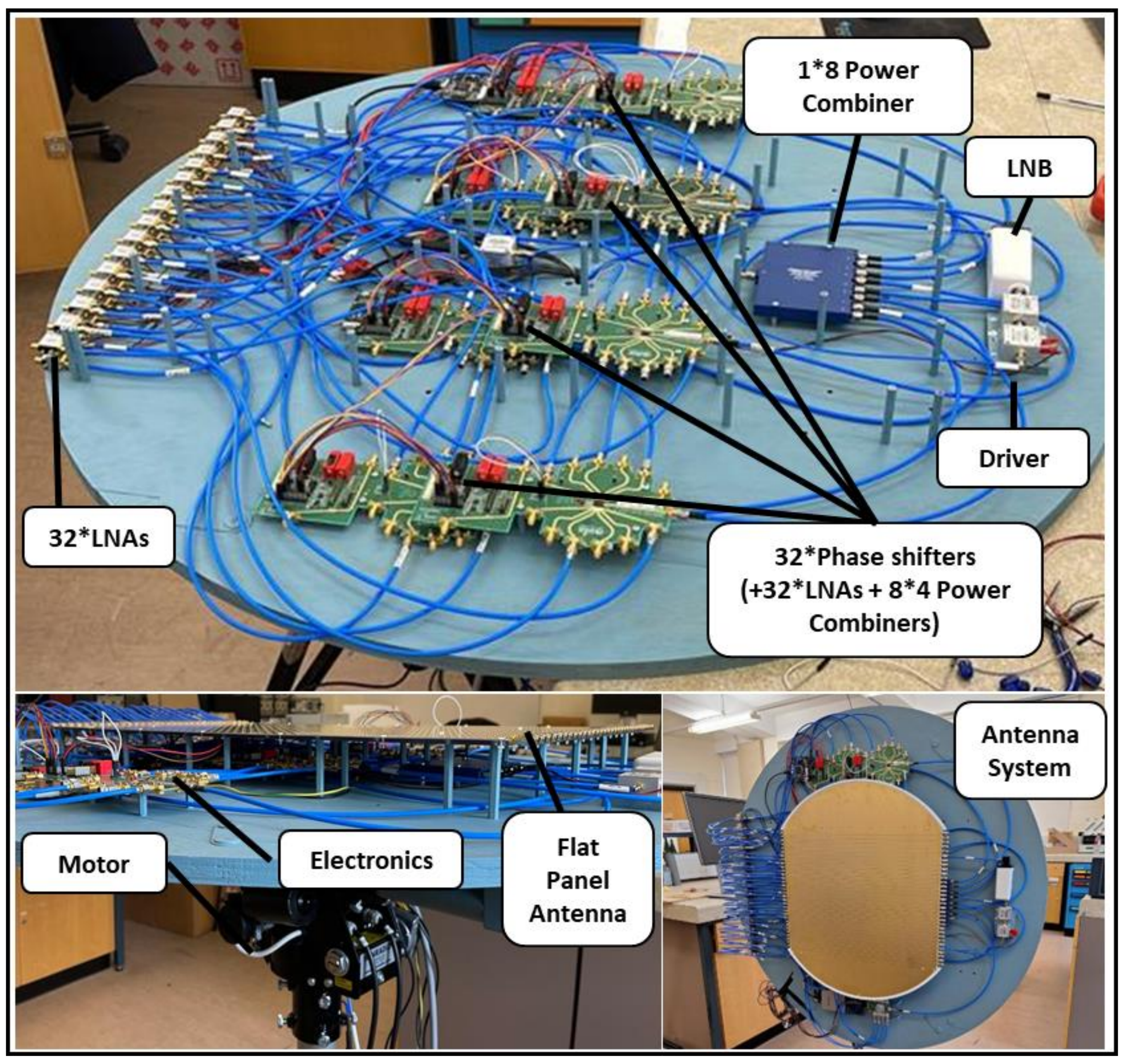

Fig. 1 Prototype with antenna system.

Methodology

A. Link Budget and System Diagram:

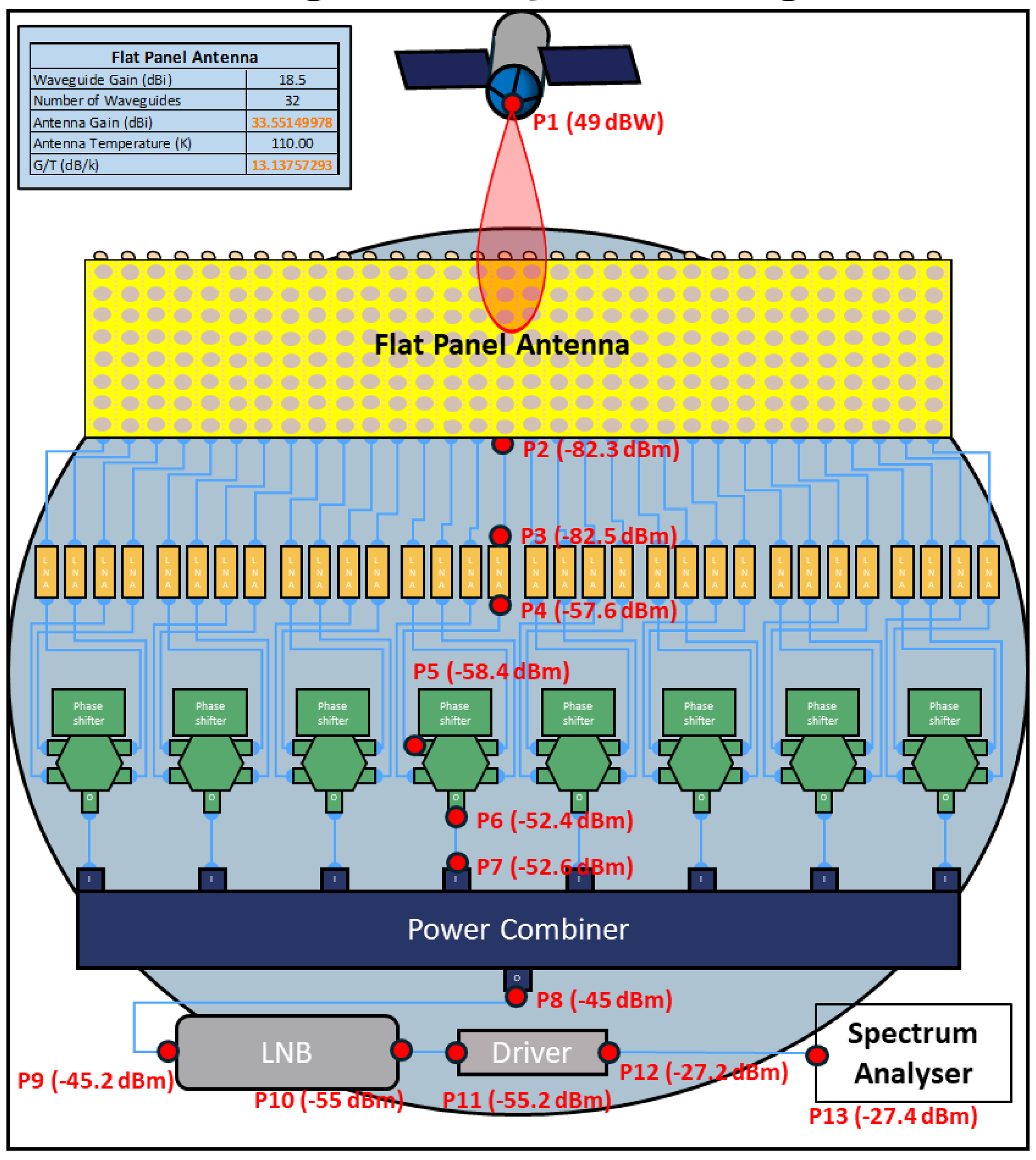

Fig. 2 System block diagram and link Budget.

- **P1**: GEO: Eutelsat 16A at 12GHz.
- **P2**: - Free Space Path Loss - Rain Loss - Atmospheric Loss - Antenna Misalignment and Polarization Loss + Flat Panel Antenna Gain.
- **P3**: - RF Cable Loss.
- **P4**: + LNA Gain.
- **P5**: - RF Cable Loss.
- **P6**: + Phase shifter inter LNA Gain + 4*Channel Combiner.
- **P7**: - RF Cable Loss.
- **P8**: + 8*Channel Combiner.
- **P9**: - RF Cable Loss.
- **P10**: - LNB Loss.
- **P11**: - RF Cable Loss.
- **P12**: + Driver Gain.
- **P13**: - RF Cable Loss. Spectrum Analyzer (SNR (signal to noise ratio) is measured).

RESULTS

A. Lab Set-up:

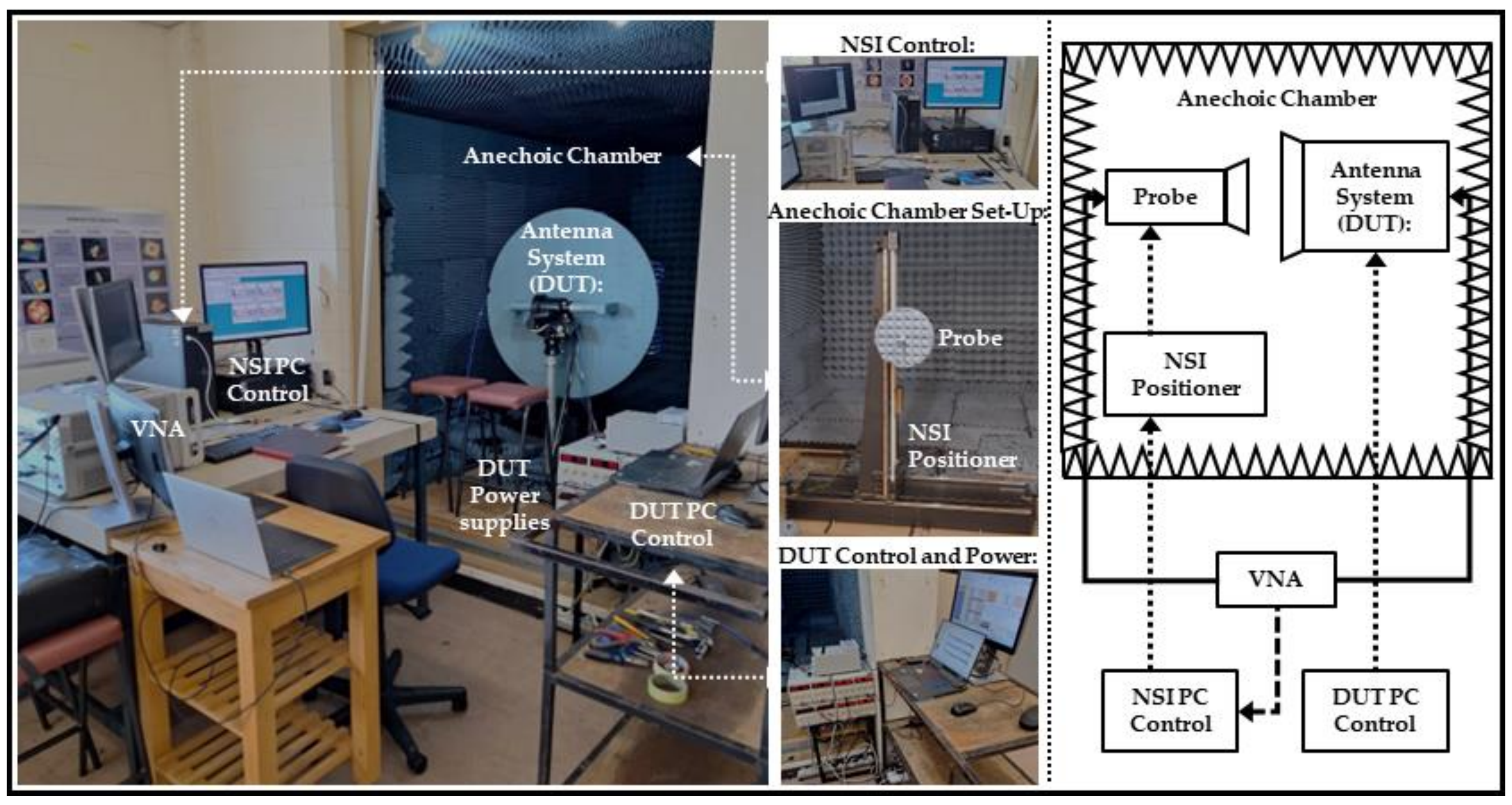

Fig. 3 Lab Set-up for NSI measurement.

B. Far-field Pattern:

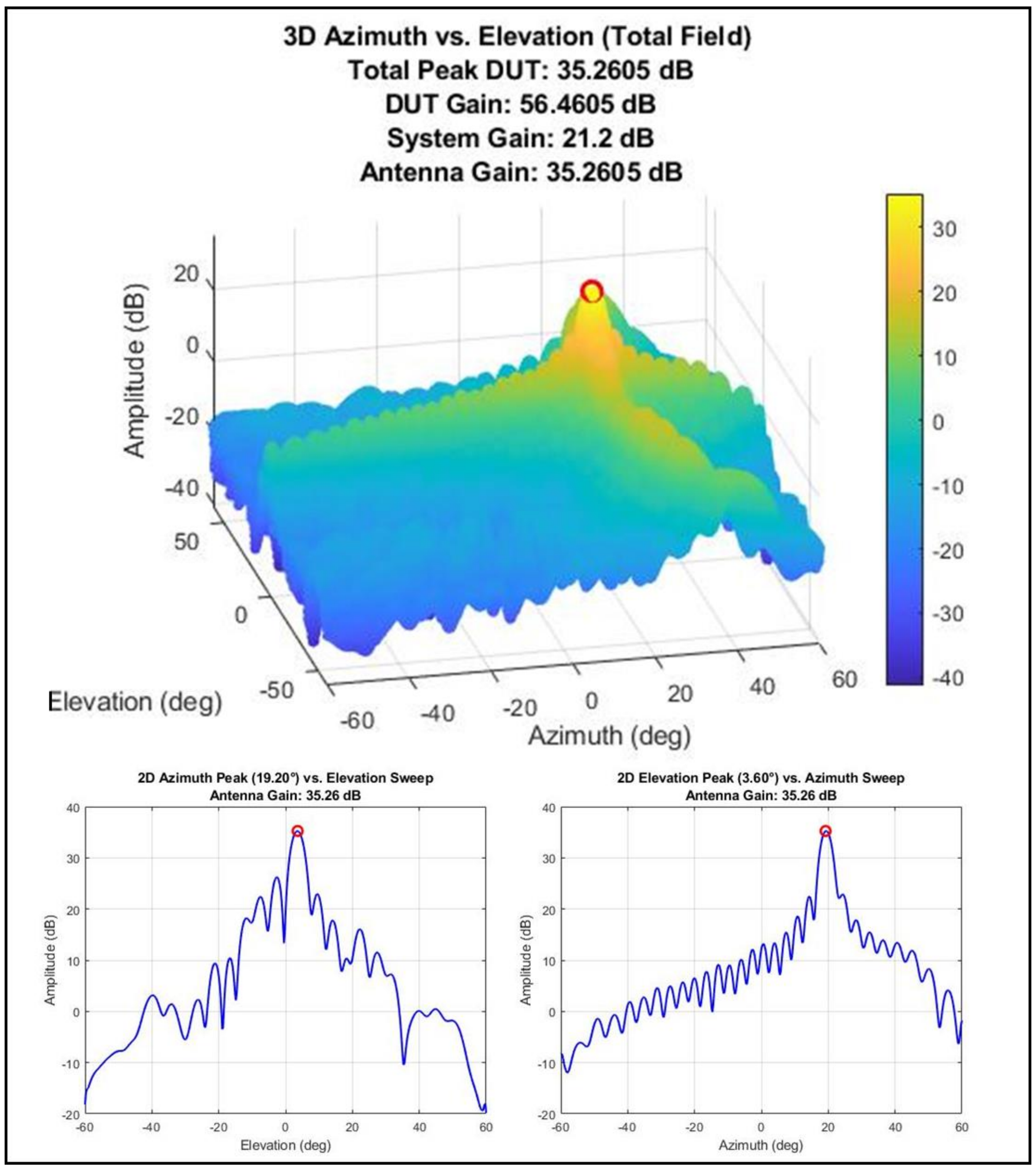

Fig. 4 RX Gain measurement at an arbitrary direction.

- **System Gain is measured; Antenna Gain is Calculated by Comparing measured data with Reference Horn Antenna.**

CONCLUSION

- ✓ **Link budget calculation and system diagram.**
- ✓ **Design of SCOM System for flat Panel antenna.**
- ✓ **Farfield pattern measurements using NSI™ nearfield measurement system at Ku Band (10.5GHz to 12.5 GHz).**
- ✓ **Future Work: Integration of subsystems at component level to further reduce insertion losses and enhance system compactness.**

REFERENCES

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