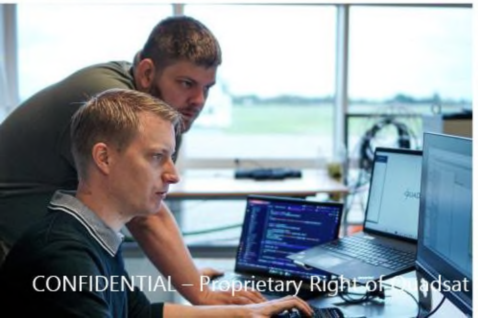
Quadsat – Technical overview and applications

QUADSAT

About Quadsat

Verifying and Optimizing RF Performance anytime and anywhere

- Develops UAV-based RF measurement equipment based on state-of-the-art RF, robotics and drone technology
- Offers fully flexible methods to verify and test antenna and network performance
- Operates within satellite and defense industries



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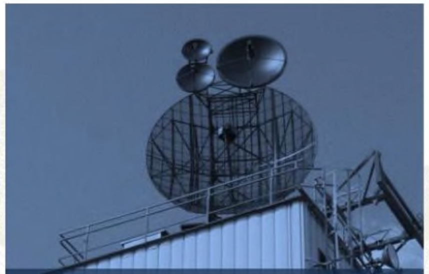
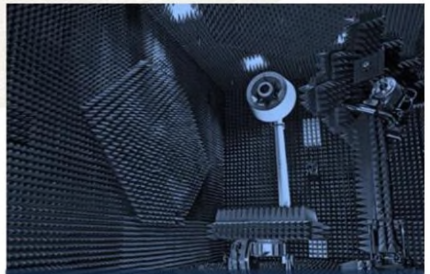
NEXTGEN OUTDOOR MEASUREMENT RANGE

Making Antenna Testing possible, any time and anywhere

Quadsat's UAV-based measurement system is changing the status quo of RF testing by offering an accurate testing method with proven accuracy enabling antenna testing and satellite emulation anytime anywhere


Boresight / In Orbit Testing


Outdoor Far field


Indoor Near-field

UAV BASED TEST AND MEASUREMENT EQUIPMENT

QUADSAT SW SUITE

Planning, execution, analysis in one single package with a diverse feature list and patented test methodologies

QUADSAT SWAP PAYLOADS

Sate-of-the-art robotic payload mounted on any drone platform and transportable to any location in the world

QUADSAT CLOUD PLATFORM

Storing and sharing of test data amongst satellite operators, antenna manufacturers, service organisations, and regulators. Enables data analytics.

Test RF Equipment Throughout It's Lifecycle

Quadsat's testing method can verify and test RF and tracking performance at all stages of the tested equipment's lifecycle.

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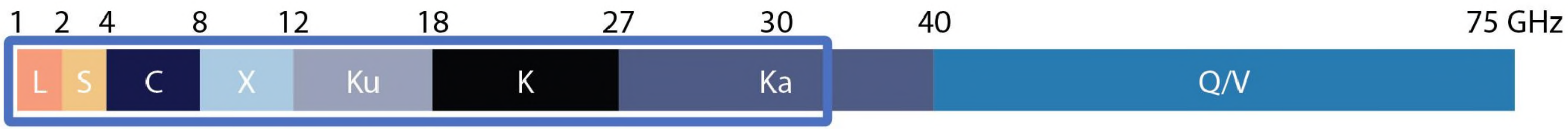
The Quadsat System

UAV antenna measurement



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PAYLOAD COMPARISON	CW DL PAYLOADS			SDR DL/UL PAYLOADS		
	QS 1-18 DL	**QS 6-24 DL**	**QS 17-31 DL**	**QS 2-12 DL/UL**	**QS 6-24 DL/UL**	**QS 17-31 DL/UL**
FREQUENCY RANGE	1-18 GHz (S-KU band)	6-24 GHz (X-Ka low band)	17-31 (Ka band)	2-12 GHz (S-KU band)	6-24 GHz (X-Ka low band)	17-31 GHz (Ka band)
FEED SYSTEM	Single circular polarized horn	Linear dual-polarized quadridged horn	Circular dual-polarized horn	Dual circular polarized horn	Linear dual-polarized quadridged horn	Circular dual-polarized horn
POLARIZATION	LHCP or RHCP	Full 360 degree feed rotation. VP, HP	LHCP, RHCP	LHCP, RHCP	Full 360 degree feed rotation. VP, HP	LHCP, RHCP
CROSS POLAR DISCRIMINATION	25-30 dB (2-18 GHz)	25-30 dB typical	25-35 dB	20-25 dB	25-30 dB	25- 35 dB
TRANSMIT POWER	EIRP -35 dBm to +15 dBm. Adjustable in 0,1 dB step.	EIRP -30 dBm to +20 dBm. Adjustable in 0,1 dB step.	EIRP -40 dBm to +10 dBm. Adjustable in 0,1 dB step.	EIRP -80 dBm to +5 dBm. Adjustable in 0,1 dB step.	EIRP -75 dBm to +10 dBm. Adjustable in 0,1 dB step.	EIRP -75 dBm to +10 dBm. Adjustable in 0,1 dB step.
RECEIVING POWER				EIRP +5 dBm to -105 dBm. Adjustable in 0,1 dB step.	EIRP +10 dBm to -100 dBm. Adjustable in 0,1 dB step.	EIRP +10 dBm to -100 dBm. Adjustable in 0,1 dB step.
DOWNLINK	✓	✓	✓	✓	✓	✓
UPLINK				✓	✓	✓
CONTINUOUS WAVE SIGNAL GENERATION	✓	✓	✓	✓	✓	✓
MODULATED SIGNAL GENERATION				✓	✓	✓

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Radiation Performance Tests

Patterns

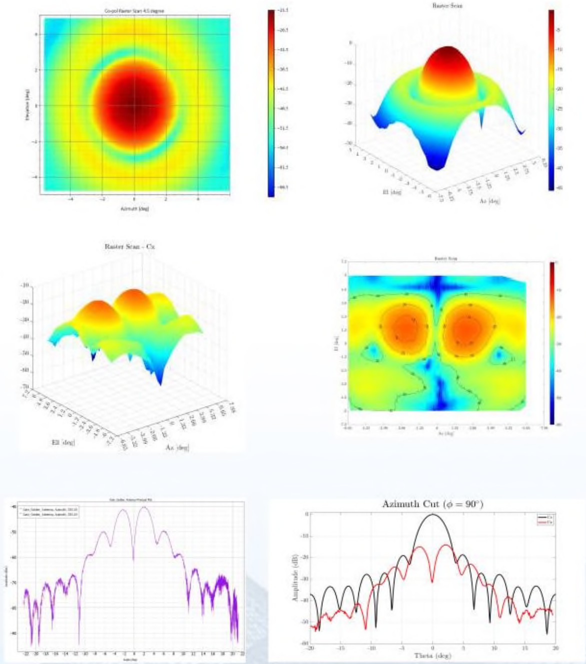
2D raster & 1D cuts, RX/TX alignment, and multiple beam states.

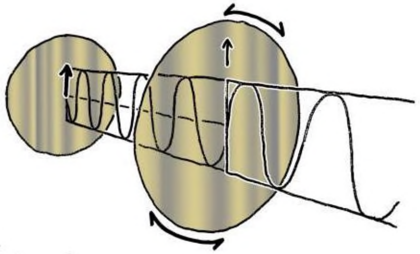
Polarization

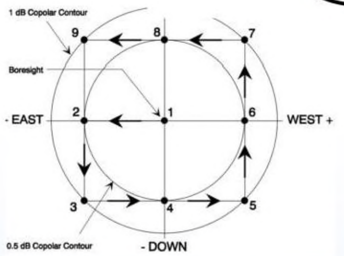
On-axis and Off-axis, cross polar discrimination, and axial ratio.

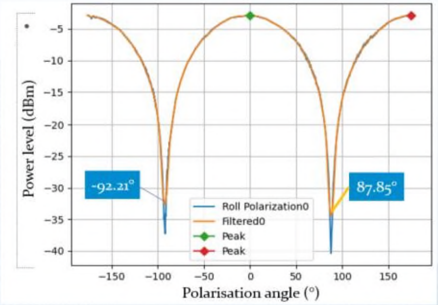
Gain

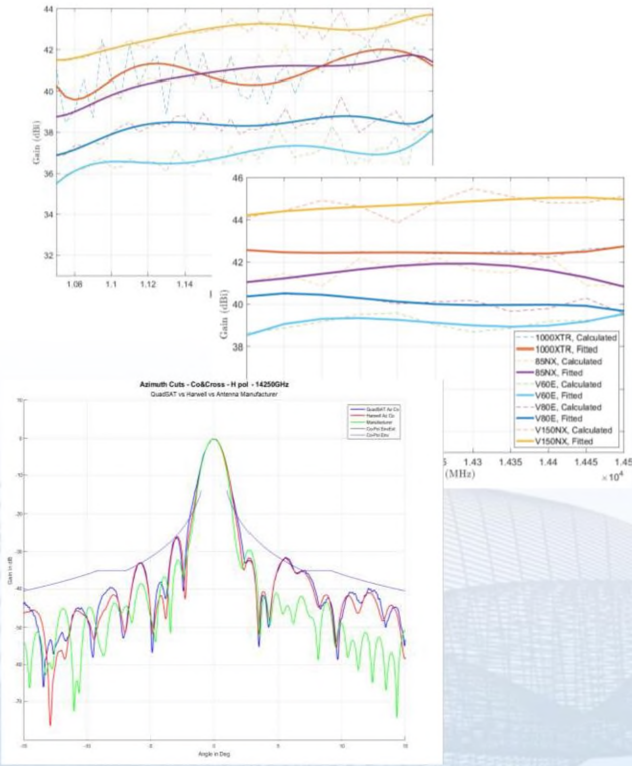
EIRP and G/T.











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Tracking & pointing verification

Pointing verification

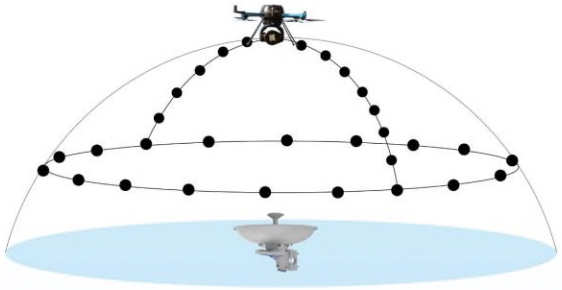
Pointing accuracy

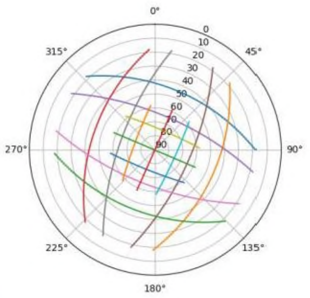
Tracking verification

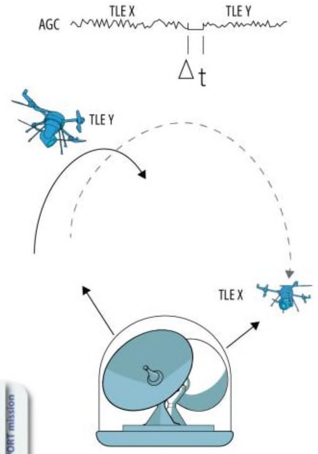
Emulation of LEO/MEO trajectories with a satellite payload in the loop

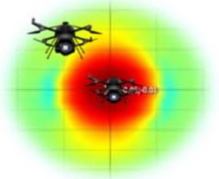
On-the-Move performance

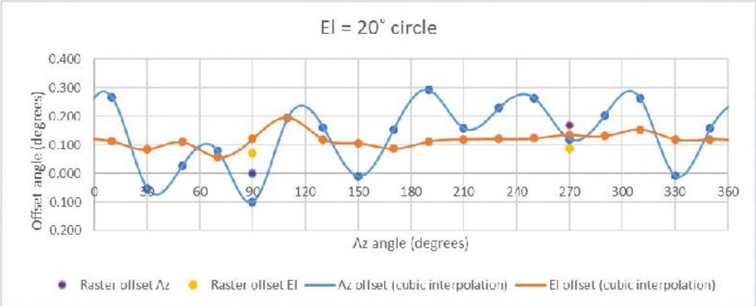
Depointing performance during on the move scenarios

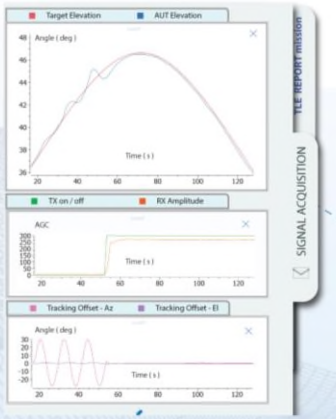












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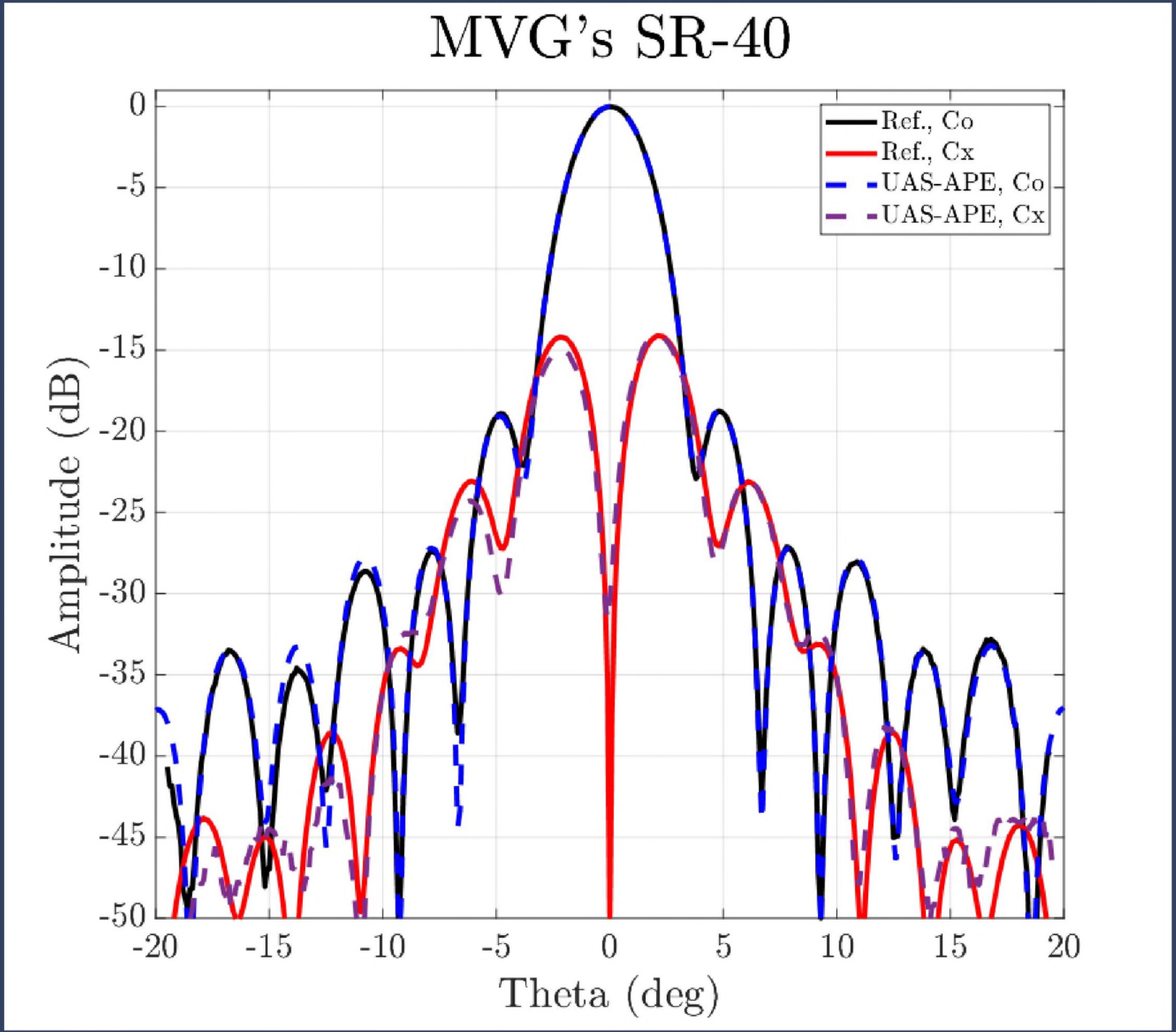

COMPARATIVE RESULTS WITH ESA-ESTEC'S TEST RANGE

- Comparison of Az cut measurement performed by Quadsat and ESA-ESTEC test facilities in The Netherlands
- For co-pol, Quadsat's measurement is shown in blue and ESA-ESTEC's in black
- For cross-pol, Quadsat's measurement is shown in purple and ESA-ESTEC's in red¨.
- EES (Equivalent Error Signal):

Cut	Co	Cx
Azimuth	-56 dB	-47.5 dB
Elevation	-48 dB	-58 dB

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CASE STUDIES

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EUTELSAT - *France, Paris – Rambouillet Teleport*
Batwing 3.7 Ka – band
Comparing Quadsat with ESVA

MARLINK – *Norway, Eik Teleport*
Uts from 60cm to 1m – Ku band.
Comparing gain between similar products.

TELESPAZIO – *Italy, Fucino Teleport*
17m earth station – Ka band
Validation after frequency upgrade.

Oxford Space Systems – *UK, Harwell Campus*
3m and 5 m deployable – X band.
Prototype validation and alignment of struts.

OneWeb – *Svalbard and Nuuk teleports*
3.7 m XY – Ku band.
Subreflector alignment and calibration.

ESA ESOC – *Sweden, Kiruna*
15m earth station – X band.
Tracking verification and SUM/DELTA measurements

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SUM/DELTA COMPONENTS MEASUREMENTS

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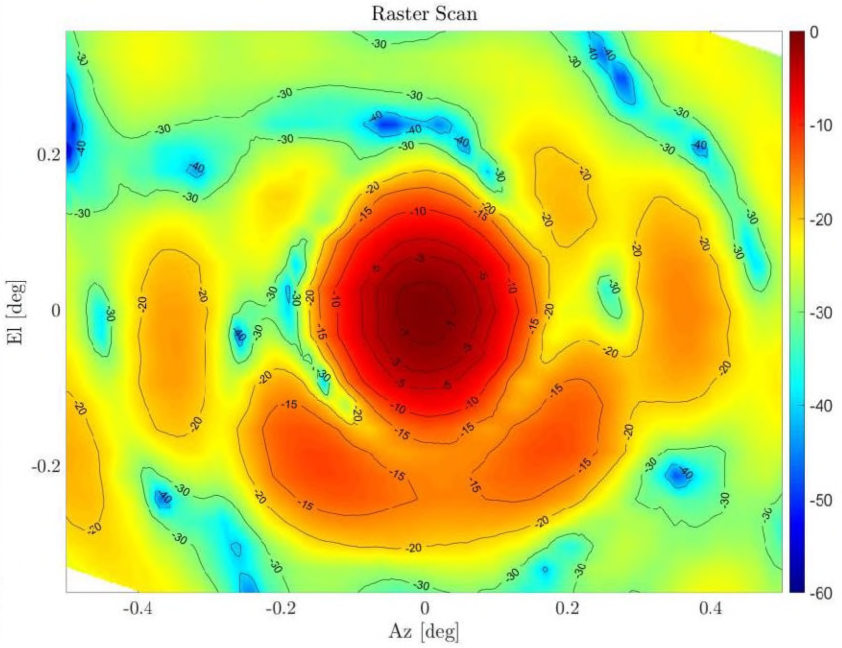
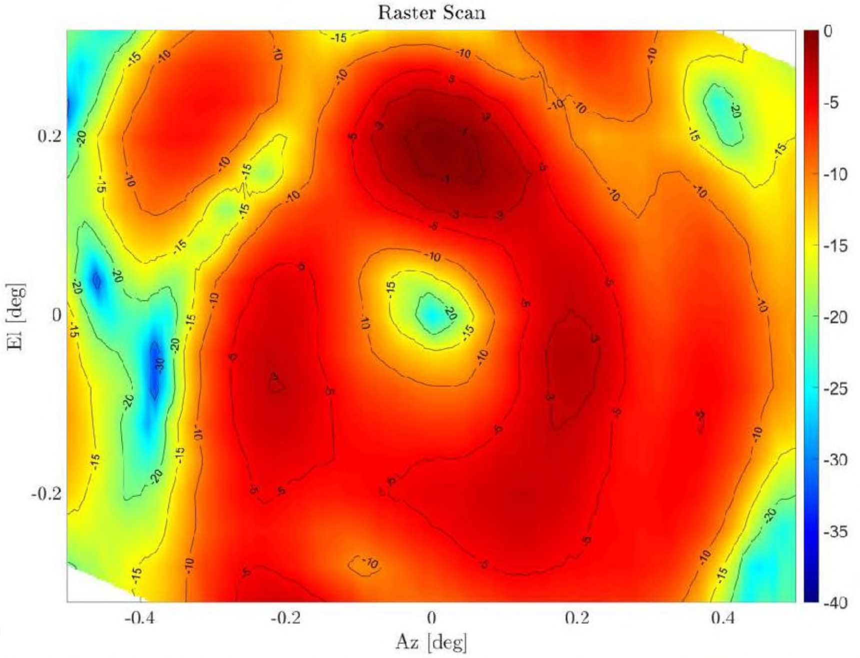
Measurement of SUM and DELTA components for monopulse tracking systems.

SUM



DELTA



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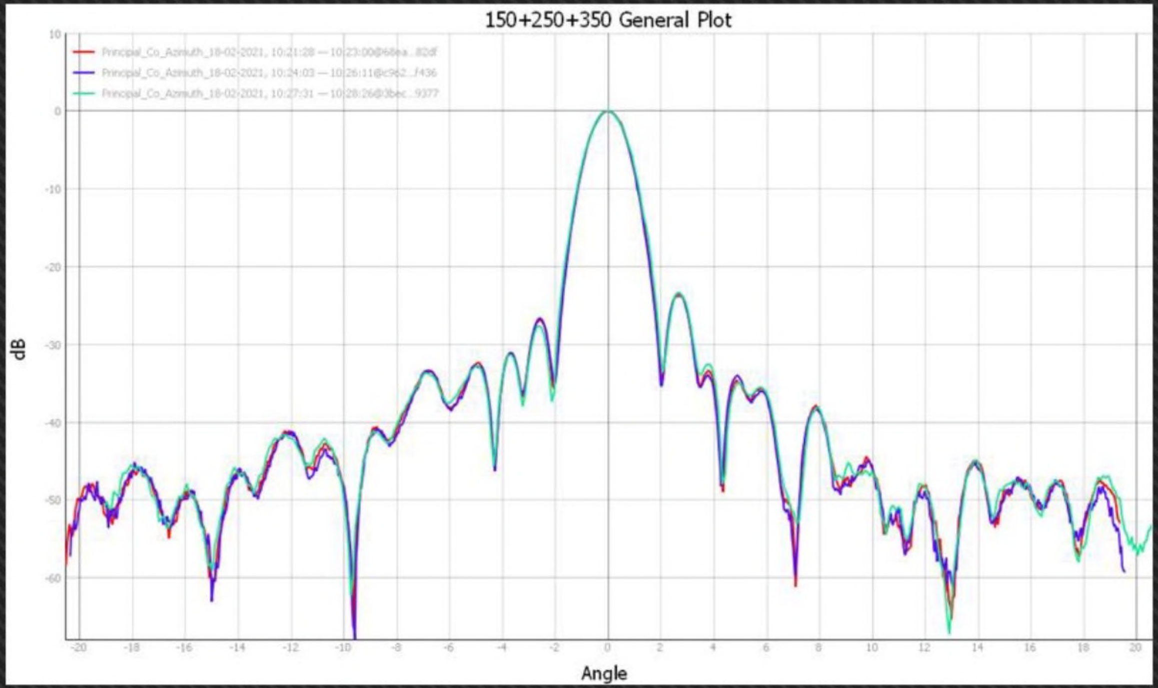
ADJUSTABLE DISTANCE BETWEEN DRONE AND AUT

- Overlayed Azimuth cuts to verify that measurements are not affected by ground reflections
- Diagram on the right show's measurements done at 150, 250, and 350 meters from the antenna under test



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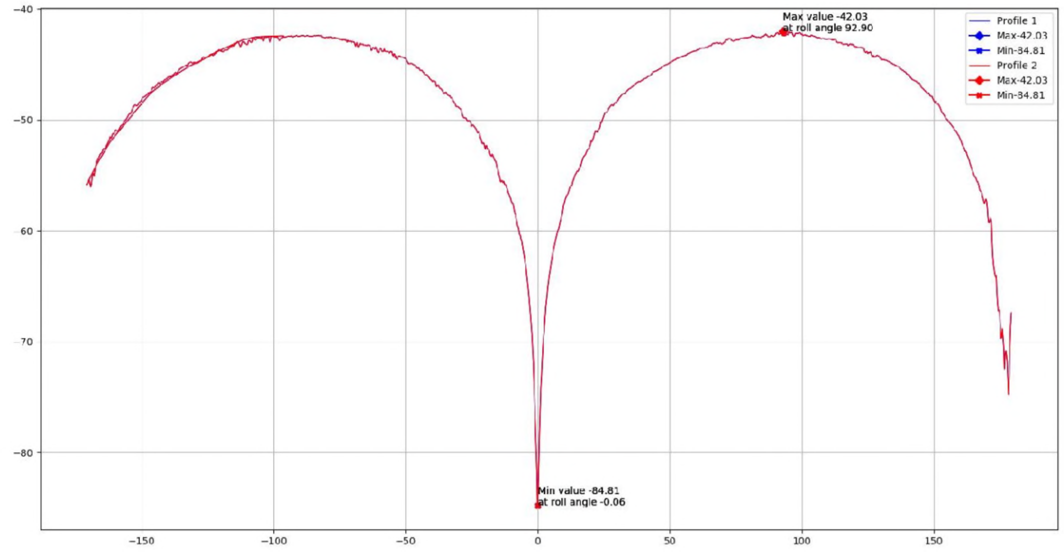
POLARISATION MEASUREMENTS

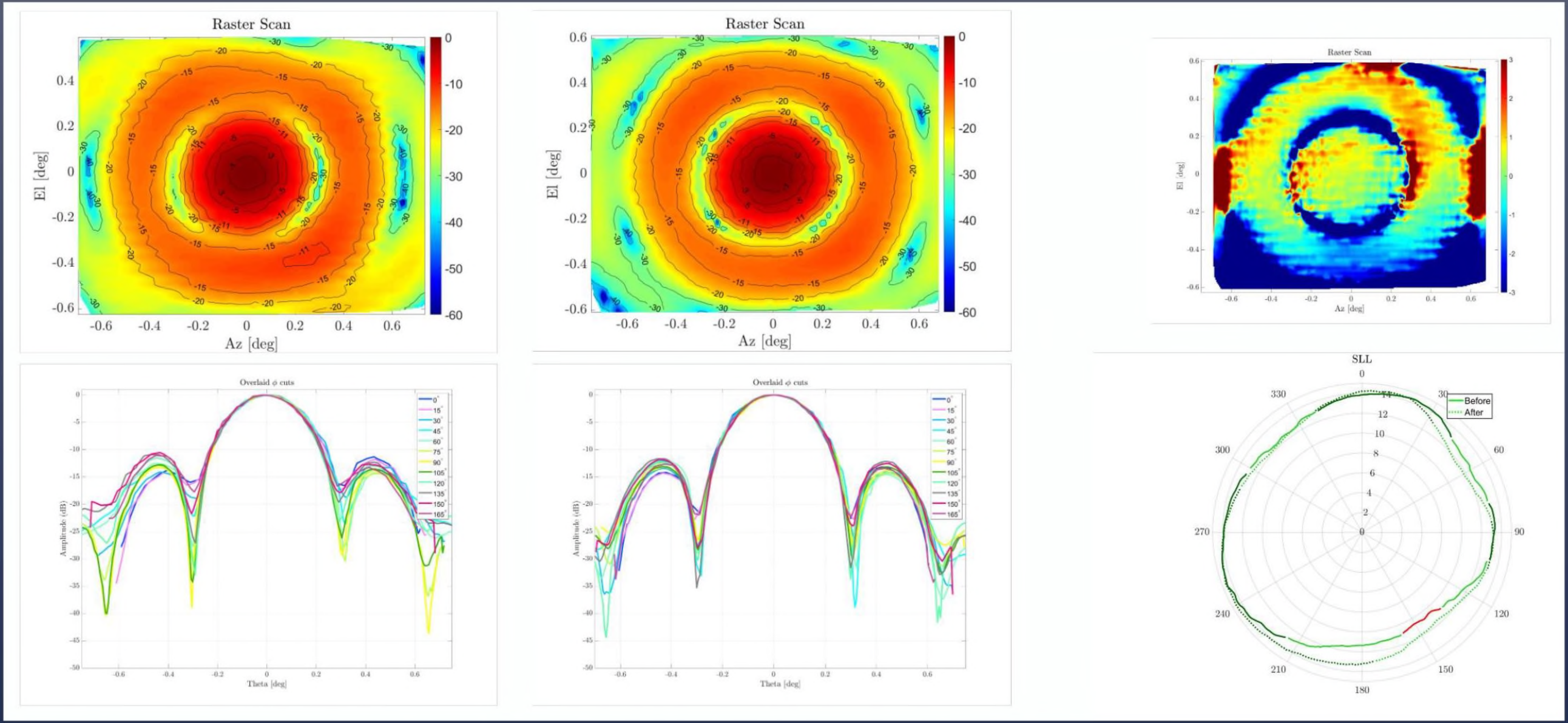
- Quad-ridged horn with dual linear polarisation
- CP generated by merging the two ports together

- On-axis polarisation measurement
- Or any other method, e.g. Eutelsat 9 points



QuadSAT

SUBREFLECTOR OPTIMIZATION - BEFORE AND AFTER ANALYSIS



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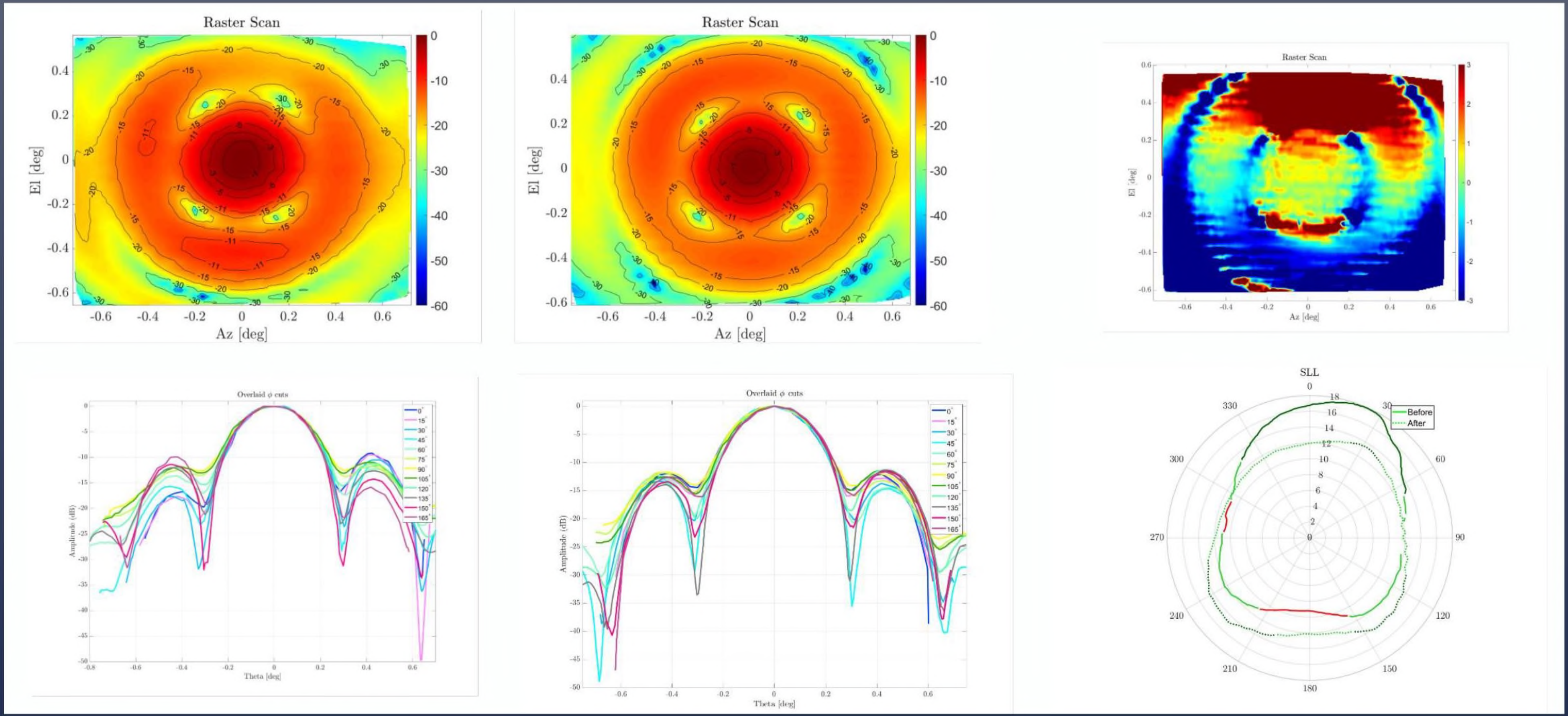
BEFORE AND AFTER ANALYSIS



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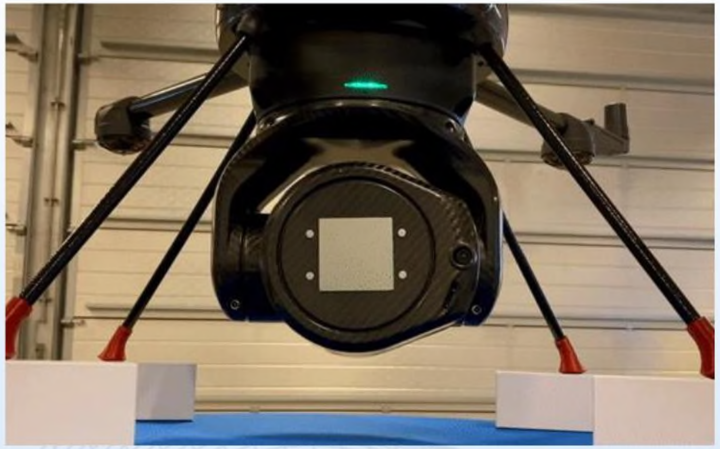
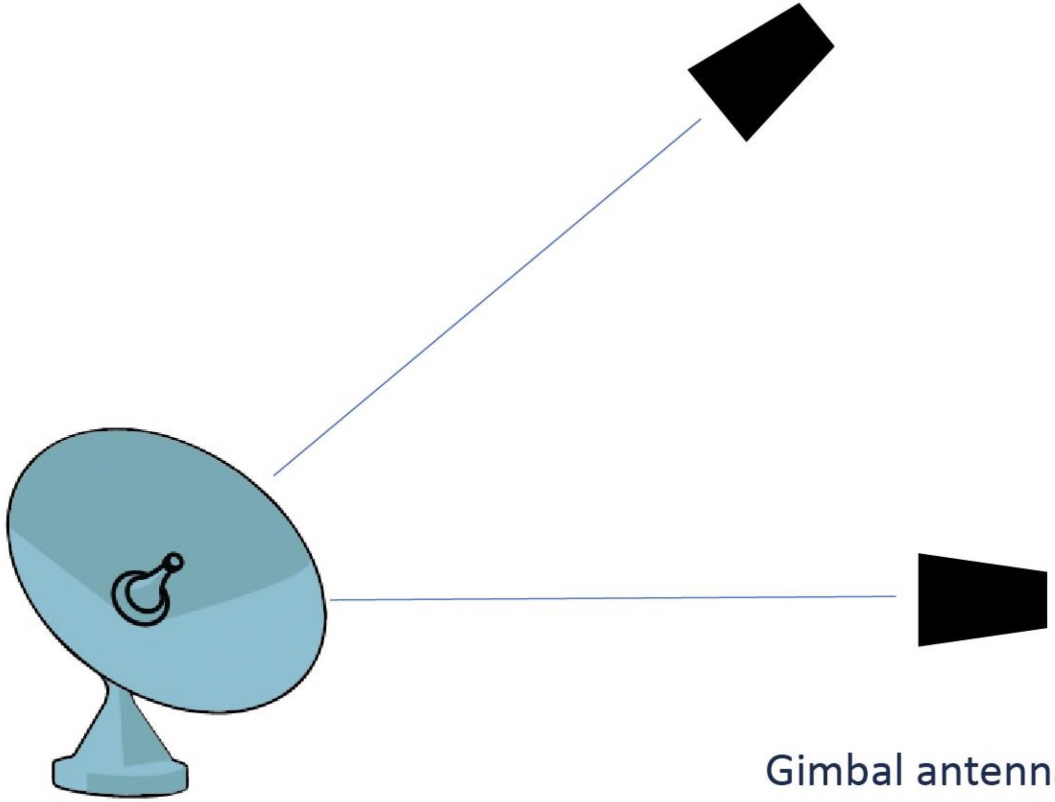
GIMBAL STABILIZATION DURING TEST

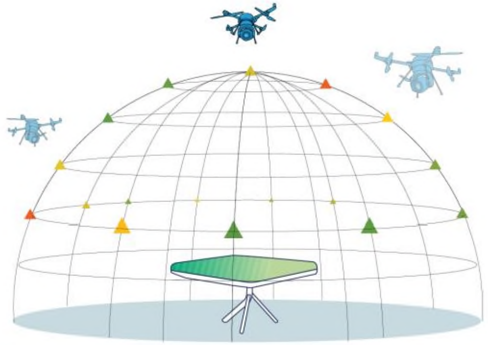


GIMBAL POINTING DURING MEASUREMENT

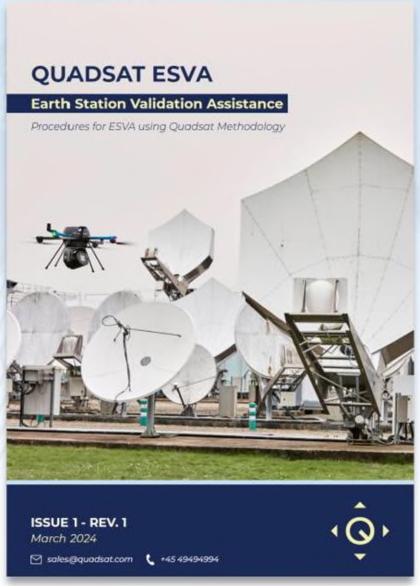


Gimbal antenna always points towards the AUT

The distance to the AUT is kept constant



Quadsat's Recognition in SATCOM



Accepted by SOMAP

Quadsat's testing method has been accepted by the SOMAP (Satellite Operator Minimum Antenna Performance) group's framework of minimum antenna testing requirements.

The SOMAP group consists of Intelsat, Eutelsat, SES, Inmarsat, and AsiaSat.

SOPs for Satellite Operators

Quadsat works closely with satellite operators on defining standard operating procedures for using Quadsat's testing in uplink approval programs. This includes approval programs such as Eutelsat's testing procedures for Earth Station Validation (ESVA).

Winner of WTA's 'Teleport Technology of The Year' Award

Quadsat received in 2024 the World Teleport Association's 'Teleport Technology of The Year' award for its solution allowing teleports to quickly validate antennas in-situ, allowing optimized performance and obtaining uplink approval with satellite operators.

QUADSAT

Thank You!

Contact us for more information

sales@quadsat.com

/Quadsat

www.quadsat.com

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QS SkyRange

Your Mobile, Configurable Test Range for Efficient Antenna Characterization

QS SkyRange provides a flexible UAV-based solution for efficient in situ antenna characterization and optimization.

Unlike traditional fixed test ranges and facilities, QS SkyRange provides laboratory-grade measurements where and when they are needed. Its onsite testing mitigates installation and calibration challenges by considering real-world operational conditions, ensuring optimal antenna performance. The solution is fully configurable to match specific antenna types and test objectives, leveraging Quadsat's RF payload range and intuitive software planning tools.

QS SkyRange helps organizations gather comprehensive data on radiation performance to reduce deployment risks, optimize installations, and maintain high-performance connectivity where and when it matters most.

Key Features

- ✓ Efficient in situ characterization of satellite and radar antenna
- ✓ Compact, mobile solution for testing anywhere in the world
- ✓ Matches different AUT sizes and frequencies
- ✓ Customized measurement plans and automated execution
- ✓ Full compliance testing & reporting.

Why QS SkyRange?

Application examples and benefits

Test and verify antennas across their lifecycle
Track performance over time - from R&D to periodic checks after deployment.

Calibrate and diagnose misalignments
Optimize sub-reflector and feed alignment in installed antennas for maximum gain.

Compare antenna models & technologies
Make data-driven performance decisions.

Conduct comprehensive SAT
Ensure a comprehensive Site Acceptance Test - avoid performance disputes down the line.

Verify radome impact
Assess signal attenuation, pattern distortion, and performance degradation caused by the radome.

Test uplink performance
Validate transmission quality to ensure signal integrity and optimal link performance.

Ensure Compliance
Facilitate regulatory approval and antenna registration efficiently.

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QS SkyRange - Technical Specifications

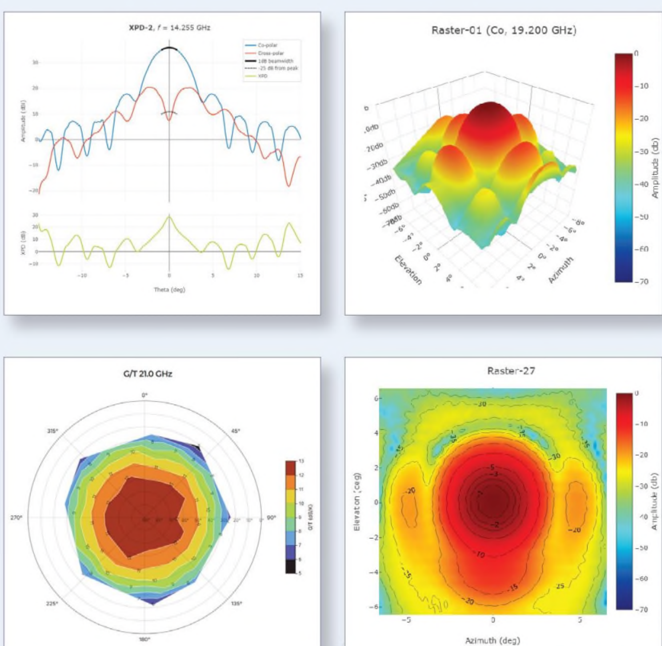
Antenna Measurements	
Radiation pattern cuts	Principal cuts and diagonal cuts
Radiation pattern Rasters	3D measurement by performing rasters and star patterns, with heat-map visualization
Cross-polar discrimination	Measure the antenna XPD and/or axial ratio
Antenna Gain	Obtain antenna gain through substitution method using reference gain antenna
G/T	Measure the antenna G/T at customizable elevation angles
EIRP	Measure the system EIRP and linearity
Beam peak location	Determines antenna pointing accuracy
Radial measurements	Evaluation of environmental reflections

Measurements for Electrically Steerable Antennas	
Beam states	Measure multiple beam states
G/T & EIRP	Measure as a function of the antenna pointing angle
RX/TX alignment	Confirm simultaneous alignment of TX and RX beams

Compliance Testing Procedures
GovSat VES - Validation of Earth Stations
Viasat MTR - Mandatory Test Requirements
Eutelsat ESVA - Earth Station Validation Assistance
WGS - Wideband Global SATCOM
SOMAP - Satellite Operator's Minimum Antenna Testing Requirements

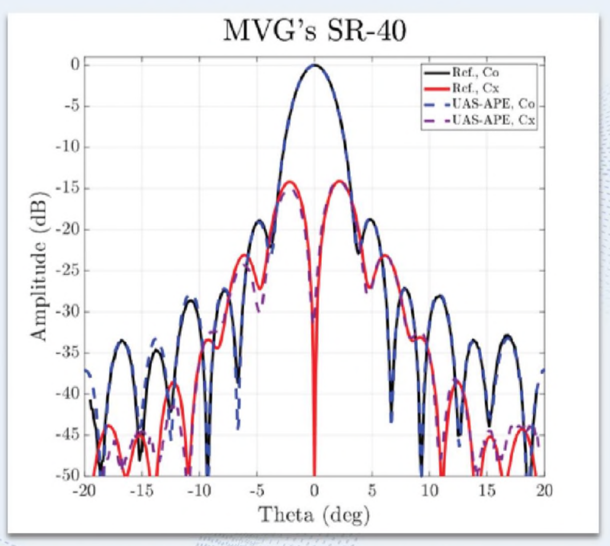
Technical Features	
Antenna types	Parabolic gateways, user terminals, phased array and radar antennas
Frequencies and bands	2-31 GHz S, C, X, Ku, K and Ka band
Payload configurations	QS 2-12 GHz (CP) - DL or DL & UL QS 6-24 GHz (LP) - DL or DL & UL QS 17-31 GHz (CP) - DL or DL & UL
Measurement Planning	Stationary Points, Cuts, Raster Patterns and star patterns
Measurement axis setup	Alignment with the beam pointing and polarization axis
Measurement execution	Automated execution, pause, repeat, monitor
Measurement data analysis	Contours, masks, gain calculation, sidelobe level extraction, pointing error
Measurement output	Raw data files, plots, QS Cloud
Frequency settings	Fixed and sweep
User interface operating system	Windows / Linux
Antenna interface	OpenAMIP, Rest API

Accuracy	
Probe position uncertainty	2 cm RMS
Probe position keeping error	Within ±5 cm @ 5m/s wind, ±10 cm@ 15m/s wind
Probe pointing error	0.3°
Pattern measurement equivalent error signal (EES)	50 dB
Absolute accuracy after calibration	0.5 dB



High-Precision Antenna Measurements

Quadsat vs. ESA ESTEC



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QS SatSim

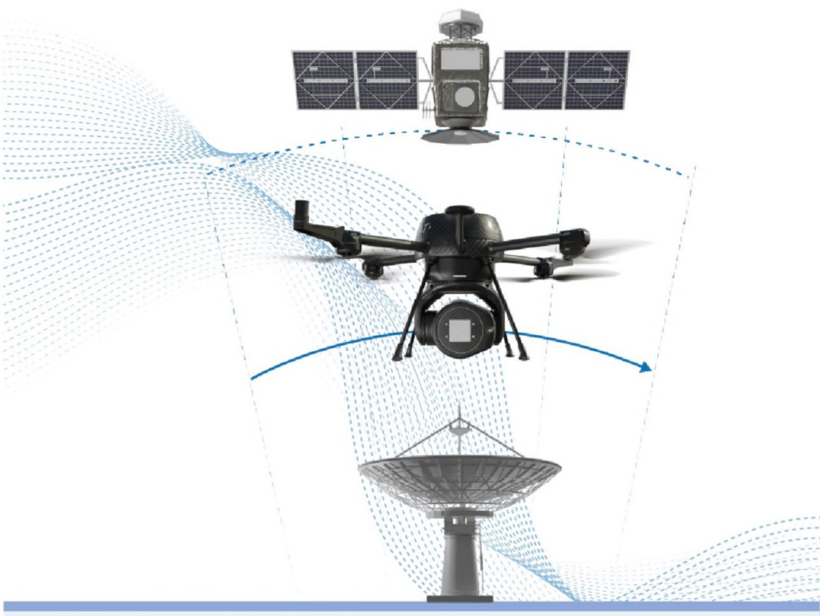
Over-the-Air Satellite Emulation for Optimal Antenna Tracking Performance

QS SatSim enables over-the-air testing of an antenna's dynamic satellite link capabilities - without requiring access to a live satellite.

As SATCOM networks expands with growing LEO constellations and increasing global demand, ensuring seamless tracking and connectivity is more critical than ever. QS SatSim enables tracking performance validation, waveform acquisition testing, and simulation of complex satellite handovers. All within a configurable RF environment.

Unlike traditional over-the-cable tests, QS SatSim enables full-system validation, ensuring ground infrastructure can acquire, track, and maintain links under realistic conditions. This approach reduces deployment risks, supports constellation planning, and optimizes network performance.

By providing a controlled and repeatable test environment, QS SatSim helps SATCOM actors stress-test hardware, fine-tune tracking algorithms, and ensure mission readiness - before launch and beyond.



Key Features

- ✓ On-Demand Over-the-Air Satellite Emulation
- ✓ Multi-Orbit Emulation (LEO, MEO, GEO, HEO)
- ✓ Efficient Tracking Algorithm Calibration
- ✓ High-Confidence Pass Emulation
- ✓ Custom TLE Generation Tool
- ✓ Satellite Payload Emulation

Why QS SatSim?

Use cases and application examples

Test Without a Live Satellite
Validate antenna tracking, link acquisition, and handover performance without satellite access.

Simulate Passes for Calibration & Troubleshooting
Perform repeatable test scenarios to fine-tune tracking, optimize pointing, and replicate error cases.

Ensure Ground Segment Readiness & Signal Lock
Verify waveform acquisition, signal locking, and infrastructure performance before satellite deployment.

Validate Multi-Orbit & Constellation Operations
Test tracking, acquisition, and handovers across LEO, MEO, HEO, and GEO for optimized constellation planning.

Emulate Challenging Tracking Scenarios
Simulate satellite anomalies, high-confidence passes, and demanding link conditions for resilient tracking.

Demonstrate Antenna & System Performance
Showcase real-world antenna and subsystem capabilities in controlled, repeatable conditions.

Extend Emulation to Other Moving Targets
Simulate passes for rockets, missiles, UAVs, and other dynamic test scenarios beyond satellites.

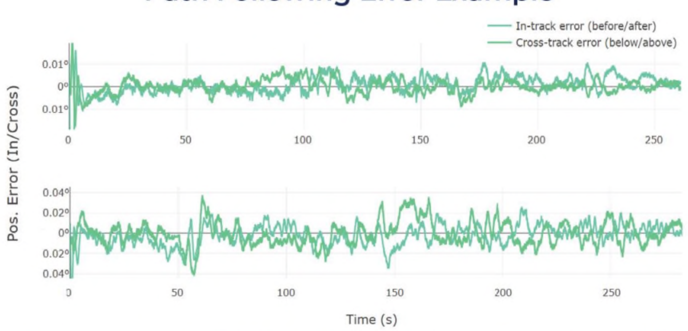
QS SatSim - Product Specifications

Technical Features	
NGSO satellite tracking emulation	Emulate the trajectory of LEO, MEO, and HEO satellite, including LEOP
GEO satellite emulation	Position UAV system at any angular position to simulate worldwide antenna functionality
TLE generation tool	Generate any trajectory on demand, and output the TLE
IQ replay function	Upload I/Q file with waveform and acquisition sequence, and replay during pass
IQ record and store function	Record what the AUT is emitting and store it for further post processing
Bent pipe function (upcoming feature)	Receive, change frequency, delay, retransmit for full emulation of a satellite connectivity experience
Signal modification function	Doppler, signal delay, rain fade, and path loss
Trajectory modification function	TLE trajectory error and path delay
Multi beam & multi orbit	Link systems for emulating multiple satellite targets and multi orbit scenarios (LEO-MEO-GEO)
Handover / Make before break	Use two systems to verify handover time and transition quality

Technical Specifications	
Antenna types	Parabolic gateways, user terminals, electronically steerable antennas
Frequencies and bands	2-31 GHz S, C, X, Ku, K and Ka band
Payload configurations	QS 2-12 GHz (CP) - DL or DL & UL QS 6-24 GHz (LP) - DL or DL & UL QS 17-31 GHz (CP) - DL or DL & UL
Emulated trajectories	LEO, MEO, GEO, and HEO TLEs, or any other pre-programmed space-time trajectory (ECEF, XYZ format)
Modulation types	CW, DVB-S2, OFDM, or any premodulated I/Q files
IQ replay limits	Up to 10 Msps for large files, up to 50 Msps for files up to 1.5 GB
IQ store limits	10 Msps for large files, up to 50 Msps for files up to 1.5 GB
Channels	1 TX, 2 RX (dual polarised)
RF channel bandwidth	200 kHz - 56 MHz IBW
System-on-chip (SOC)	AMD® Zynq® Ultrascale+ XCZU3EG
ADC/DAC sample width	12-bits
Clock	GPS disciplined oscillator
EIRP range	-80 to +5 dBm
Receive sensitivity	-100 to +5 dBm
Antenna interface	OpenAMIP, cloud Rest API interface

Accuracy	
Probe position uncertainty	2 cm RMS
Trajectory following error	Within ±5 cm @ 5m/s wind, ±10 cm @ 15m/s wind
Angular path error @120m (time & space)	0.02° @ 5 m/s wind, 0.05° @ 15 m/s wind
Angular path error @300m (time & space)	0.01° @ 5 m/s wind, 0.02° @ 15 m/s wind

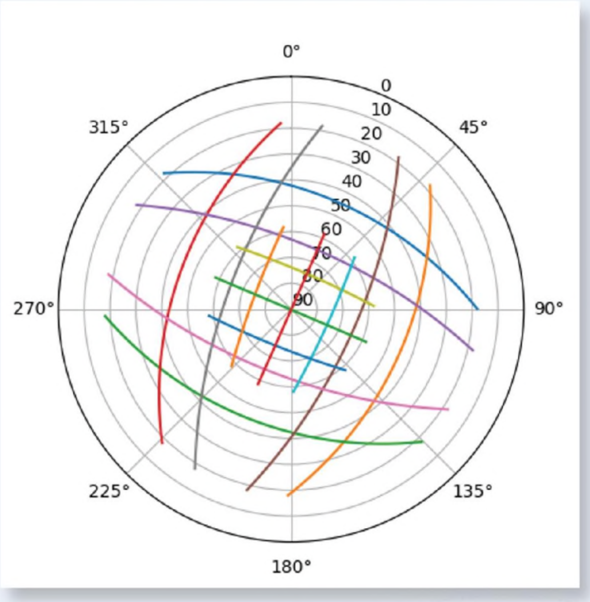
Path Following Error Example



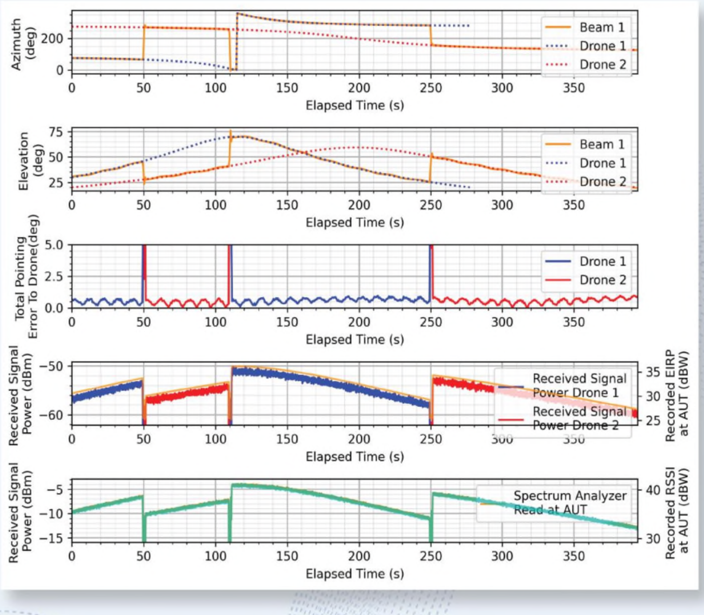
Top: Distance from AUT: 300 m, Max elevation: 45°, wind speed: 6 m/s

Bottom: Distance from AUT: 120 m, Max elevation: 65°, wind speed: 9 m/s

Passes Auto-Generated by the TLE Tool



Example Result for Handover Testing



QS EW
A Strategic Edge in Spectrum Surveillance

Enhancing Operational Dominance with Airborne Electronic Warfare

Strategic Advantage for Modern Defense

QS-EW is a next-generation EW system that extends beyond traditional RF surveillance to deliver strategic battlefield insight and decisive actionability. By fusing direction finding, geolocation, and intuitive interface design, it empowers defense forces to close the decision loop from detection to engagement.

For Ministries of Defense and defense technology integrators, this represents a future-proof capability for achieving spectrum dominance and battlefield overmatch. Whether securing the homeland or deploying in active conflict zones, this EW platform is engineered to deliver mission-critical intelligence with unmatched agility and precision.

The Future of Spectrum Dominance

Modern military operations are increasingly shaped by the ability to understand, navigate, and survey the electromagnetic spectrum. From national infrastructure security to high-intensity conflicts, Electronic Warfare (EW) systems are critical enablers for situational awareness, tactical superiority, and mission execution. The QS-EW system represents a leap forward in field-ready capabilities, offering airborne spectrum monitoring, direction finding, and geolocation functionalities that deliver actionable intelligence at both operational and strategic levels.

Building on airborne Spectrum Surveillance technologies originally developed for the space segment, the QS-EW system can be integrated with UAVs under 30 kg. This enables compact, mobile units to perform high-value EW operations - once reserved for much larger platforms – using only a team of 4-6 operators. The result is a tactically deployed system with strategic-level impact, ideal for rapidly evolving mission environments.

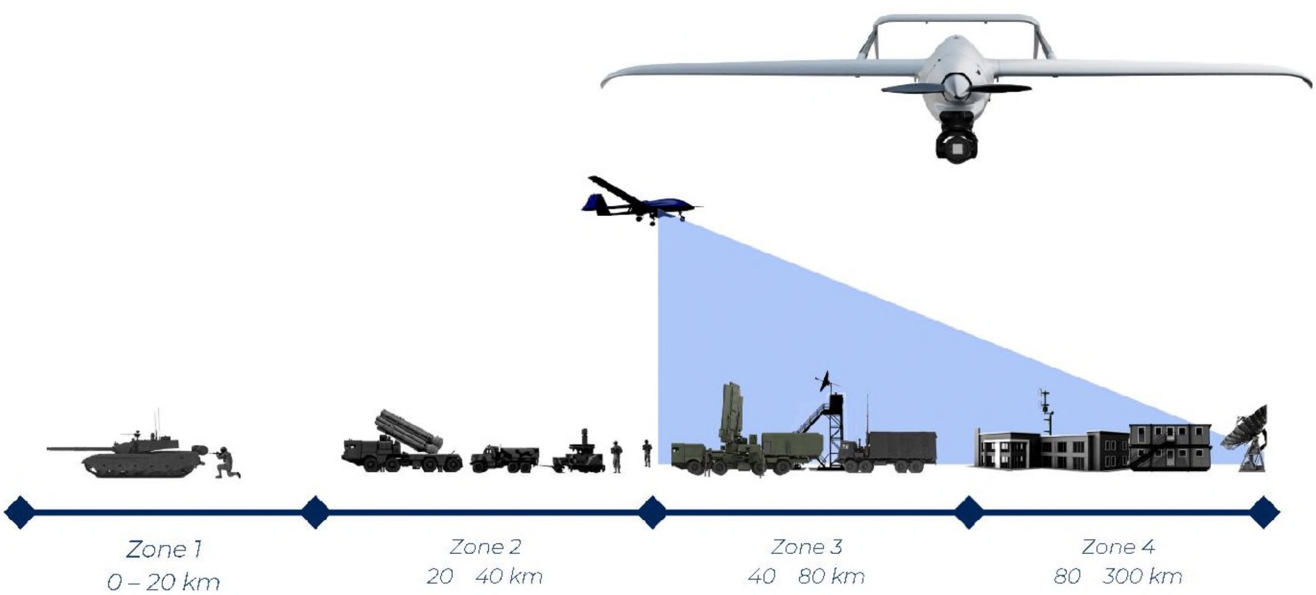
At its core, the system empowers military forces to conduct comprehensive surveillance and detection missions with speed and precision. It is uniquely designed to scan the RF spectrum in 2–18 GHz, (S-, C-, X-, Ku Band), identify potential signals of interest (SOIs), determine the direction of emissions, and accurately geolocate hostile or unauthorized RF sources. Typical high value targets are listed in the table below.

This capability proves vital in scenarios ranging from peacetime spectrum monitoring around critical national infrastructure to real-time detection of radar, missile guidance systems, and enemy communications on the battlefield. By integrating spectrum, time, and spatial data into a unified interface, the system allows operators to make rapid, informed decisions under pressure.

The capability is delivered in an RF payload designed for seamless integration onto a wide range of UAVs. The technology is platform-agnostic, enabling flexible deployment without being tied to a specific drone model. This modularity ensures rapid mission readiness and operational effectiveness in diverse environments.

RF Emitters by Operational Depth

Understanding the electromagnetic landscape requires categorizing RF emitters not just by type, but by their position and function within the battlespace. From tactical comms near the frontline to strategic surveillance systems deep behind enemy lines, each emitter contributes to the broader operational picture. The figure below illustrates representative RF systems by operational depth—and highlights the strategic advantage of deploying an airborne RF system. When mounted on a UAV, the system can cover high-value strategic targets from standoff distances of 40 km and beyond, enabling safe, wide-area spectrum dominance without exposing ground teams to frontline threats.



Typical high value targets in S-, C-, X-, Ku Bands

Frequency Range	Application
2700 MHz to 2900 MHz	Radar and Navigation Systems
2900 MHz to 3100 MHz	Radar and Navigation Systems
3100 MHz to 3300 MHz	Spaceborne Radars
3100 MHz to 3410 MHz	Airborne Surveillance Radars
4200 MHz to 4400 MHz	Airborne Radio Altimeters
5250 MHz to 5725 MHz	Tactical, VTS, Weapon Control, Weather Radars
5725 MHz to 5850 MHz	Weather Radars
8500 MHz to 10000 MHz	Precision Approach Radars, Air Defense Radars
8850 MHz to 9000 MHz	Maritime Navigation Radars, Shore-based Radars
9200 MHz to 9300 MHz	Maritime Navigation Radars, Shore-based Radars
9300 MHz to 9500 MHz	Airborne Weather and Military multifunction Radars
9500 MHz to 9800 MHz	Spaceborne Radars
10.0 GHz to 10.5 GHz	Civil and Military Radars
13.25 GHz to 14.0 GHz	Military Radars, Ship Berthing Radars
15.4 GHz to 15.7 GHz	Ground Movement Radars
15.7 GHz to 17.20 GHz	Military Radar Applications
17.2 GHz to 17.7 GHz	Missile Control Radars

Operational Impact

Electronic Warfare systems generate value not just through technical sophistication, but through the real-world effects they enable in dynamic and contested environments. The QS-EW system delivers measurable operational advantages by enhancing situational awareness, accelerating decision-making, and supporting precision targeting. From early threat detection to the geolocation of high-value emitters deep behind enemy lines, the system empowers forces to act faster, safer, and with greater strategic insight across a range of mission profiles.

Spectrum Monitoring & Surveillance

The system continuously monitors the electromagnetic environment, establishing a baseline of normal activity and highlighting anomalies or unauthorized transmissions that may indicate emerging threats.

SOI Detection & Classification

Through automated clustering, the system flags potential Signals of Interest (SOIs), providing operators with an intuitive interface to investigate and prioritize relevant signals in real time.

Direction Finding (DF)

With a proprietary gimbal-mounted directional antenna, the system accurately determines the direction of incoming signals, even during dynamic airborne operations. Its mechanical steering in both pitch and yaw enables agile and precise bearing estimation in real time. At operational altitudes, the system is capable of performing direction finding on RF emitters at ranges of up to 130 km, depending on signal strength, antenna gain, and environmental conditions.

Geo-localization

Using Angle of Arrival (AoA) methods, the system provides accurate emitter geolocation based on multiple line-of-bearing observations. When operating at altitudes above 1500 meters, it can detect RF emissions at distances of up to 130 km. For emitter targets located between 25-80 km from the QS-EW system, the platform typically achieves geolocation uncertainty within ~350m-2000m, depending on signal strength, tracking duration, and observation geometry.

Strategic Deployment

The QS-EW system is delivered with a dedicated software suite and is flight-proven in operational deployments in both Denmark and Ukraine. It is also integration-ready with existing command-and-control (C2) architectures, through a partnership with Palantir for real-time operational data sharing.

Technical Superiority that Drives Tactical Effectiveness

The airborne QS-EW system combines a suite of cutting-edge technologies to provide robust and versatile capabilities in contested environments.

Key Technical Specifications

- Frequency Coverage: 2–18 GHz
- Instantaneous Bandwidth: 50 MHz
- Dynamic Range: 60 dB
- Minimum Discernible Signal (MDS): ~120 dBm (narrowband)

Direction Finding & Geolocation

- DF Technique: Actively controlled gimbal-mounted directional horn antenna, capable of precise pitch and yaw adjustments
- Geolocation Method: AoA (Angle of Arrival) based, allowing triangulation and emitter mapping at strategic ranges

Deployment & Integration

- Platform Agnostic: While platform-agnostic, the system is optimized for airborne deployment to maximize range, speed and flexibility while reducing geolocation uncertainty
- Interoperability: Designed for networked operations; planned integration with Palantir for real-time data exchange with command-and-control systems

Signal Analysis

- SOI Identification: Automated clustering algorithms highlight potential SOIs. Human-in-the-loop decision-making ensures secure and verified classification
- Interface Design: Unified application presenting spectrum, temporal, and spatial data for real-time assessment and response

Technical Specification Overview – QS EW

Category	Specification
Frequency Coverage	2 - 18 GHz
Instantaneous Bandwidth	50 MHz
Dynamic Range	60 dB
Minimum Discernible Signal (MDS)	≈120 dBm (narrowband, good-case conditions)
Sweep speed	6 GHz scanned in approximately 5 seconds (full-band sweep)
Antenna Type	Directional horn antenna (gimbal-controlled)
Antenna gain	7.5 dBi @ 2GHz 11 dBi @ 4 GHz 13 dBi @ 8-18 GHz
Agular Scan Coverage	± 165° azimuth 10°/-70° elevation
Polarization Support	LP and CP
Direction Finding Technique	Active mechanical scan using directional antenna on proprietary gimbal
Geolocation Method	AoA (Angle of Arrival).
Geolocation Range	Up to 25 km (typical), with ≤ 350m x 350m uncertainty (See detailed information below)
Line-of-Bearing Range	Up to 130 km (from altitude of 1500 m or higher)
Geolocation Latency	1-25 secs depending on communication link
Signal Classification	Automated clustering; operator validation required
Interface Environment	Cross platform
Platform Compatibility	Airborne-focused, but Platform agnostic
Power Consumption	≤ 60 watts
Size & Weight (SWaP)	174 x 160 x 214 [mm] 2.4 kg
Interoperability	Planned Integration with Palantir for C2 data exchange
Data Encryption	Encrypted data storage on both
Remote Operation Capability	Remote operation available through online data analysis post flight.
Deployment History	Flight-proven in Denmark and Ukraine; simulated kill-chain mission ongoing
Software interface	Integrated software suite supporting real-time control, spectrum visualization.
Communication	Primary data link established via the UAV's communication channel to the Ground Control Station (GCS), enabling real-time telemetry and payload data transfer
Positioning	The QS-EW payload receives position, heading, and timestamp data directly from the UAV's onboard navigation system to ensure accurate geolocation and time-tagging of signal events.

Key Factors Influencing SOI Detection and Geolocation Performance

Target Bandwidth: A wide transmission bandwidth spreads the emitter's power across a broader range, reducing power spectral density. This can make detection more difficult – especially for low-SNR environments – and weakens the precision of line-of-bearing estimates. Note: baseline link budget calculations assume a narrowband signal (e.g., continuous wave, bandwidth ≈ 0 Hz).

Target Frequency: At lower operating frequencies, the payload's horn antenna exhibits a wider 3 dB beamwidth. This results in increased angular uncertainty in the line-of-bearing, reducing geolocation accuracy. Higher frequencies offer better directional precision but may be more susceptible to atmospheric and propagation losses.

Platform Elevation: Elevation is key for maintaining an unobstructed line of sight to ground emitters, especially in cluttered environments (urban, forested, mountainous). However, altitude itself does not directly enhance geolocation accuracy. What matters more is maintaining a clear signal track and achieving favorable observation geometry over time.

Target Range: Reducing the distance between the sensor and the emitter improves both SNR and angular resolution. A closer range enhances line-of-bearing precision and leads to faster convergence in the geolocation algorithm.

Signal Tracking Duration: Longer tracking durations provide more measurement points (bearings from different positions), which feed into the geolocation algorithm. The accumulation of data over time reduces the uncertainty of the estimated emitter position (assuming consistent signal availability).

Observation Geometry (Range Traversal): Geolocation performance improves when the platform samples line-of-bearings from positions that are geometrically diverse (i.e., not all aligned along the same bearing line). Lateral movement or curved flight paths introduce linearly independent observations, enhancing triangulation confidence.

Target EIRP (Effective Isotropic Radiated Power): A higher emitter EIRP increases received signal strength, improving SNR and leading to more accurate bearing estimates. Stronger emitters are easier to track and localize consistently, particularly at longer distances or in low-gain antenna regions.

QUADSAT

Optimizing The World's Radio Spectrum

An Introduction to Quadsat

What We Do

- Provides radio frequency (RF) measurement systems for the SATCOM and defense.
- Validates and troubleshoots antennas and other RF equipment globally.
- Assists its customers in ensuring optimal, resilient network performance and ROI
- Covers frequencies from L to KA-band
- Sells measurement systems directly for in-house testing and Testing as a Service
- Increases the accessibility of antenna testing through global service partner network.

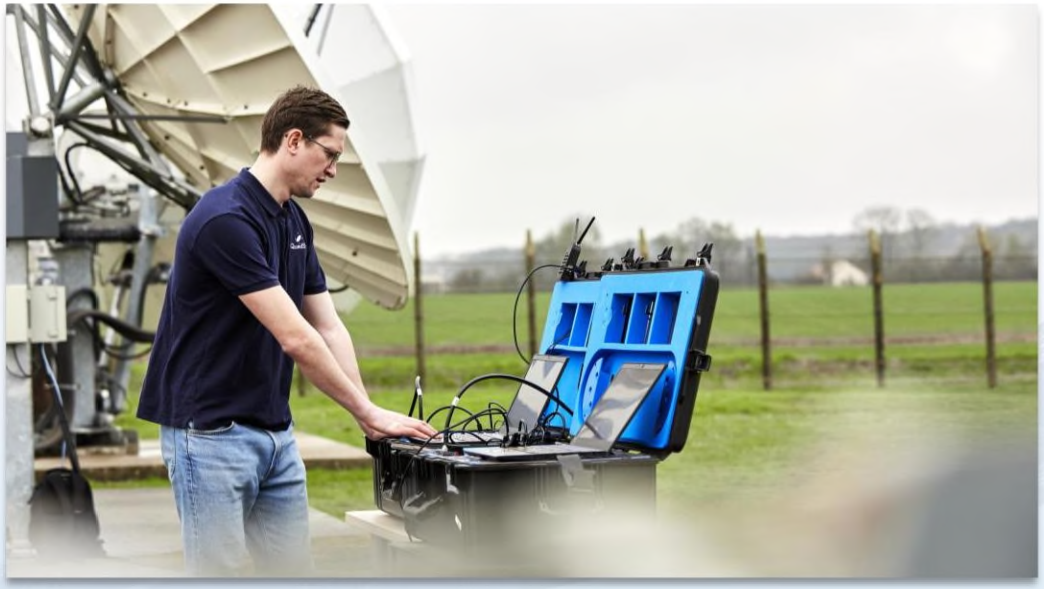
Who We Are

- Founded in 2017 by two engineers specialized in RF and SATCOM
- Headquartered in HCA Airport in Odense, Denmark, with local offices in the UK and USA
- 80 % of staff are engineers focusing on innovation, RF and customer technology requirements.

Enhancing SATCOM by Democratizing Antenna Testing

Quadsat empowers the SATCOM industry in testing and validating antenna performance to ensure efficient ground infrastructures, quality of service, and maximized efficiency.

We do so by making antenna testing accessible to the entire industry, with mobile measurement systems for rapid onsite testing.



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Our Antenna Testing Is UAV-Based.

Quadsat manufactures UAV-based RF measurement systems that can be deployed rapidly for efficient onsite testing of antennas and RF equipment.

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A Congested Spectrum Increases the Need for Testing

A vast number of satellites and networks are being deployed to cope with increasing demand for satellite communication, increasingly congesting the RF spectrum.

Hence, the importance of antenna testing is increasing to ensure an efficient ground infrastructure and spectrum, as it is key for maximizing spectrum utilization, minimizing interference, and hence ensuring the reliability and quality of satellite communication.

Our Customer Base

Satellite Network Operators

Teleports

Antenna Manufacturers

Government & Defense

Radar Manufacturers

SATCOM End-users

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Serving The SATCOM Industry With a Collaborative Approach

We work closely with **Satellite Operators** on implementing testing procedures for antenna validation to facilitate compliance and optimal performance in the ground infrastructure.

We enable **Network Operators** such as teleports, integrators and SATCOM service providers to perform measurements throughout the antenna's lifecycle to ensure and optimize quality of service.

We support **Antenna Manufacturers** in testing and evaluating antenna designs during development and obtaining type approvals to deliver according to specifications.

The Quadsat Series

Mobile RF measurement systems consisting of advanced RF payload mounted on a drone, ground control and RTK system.

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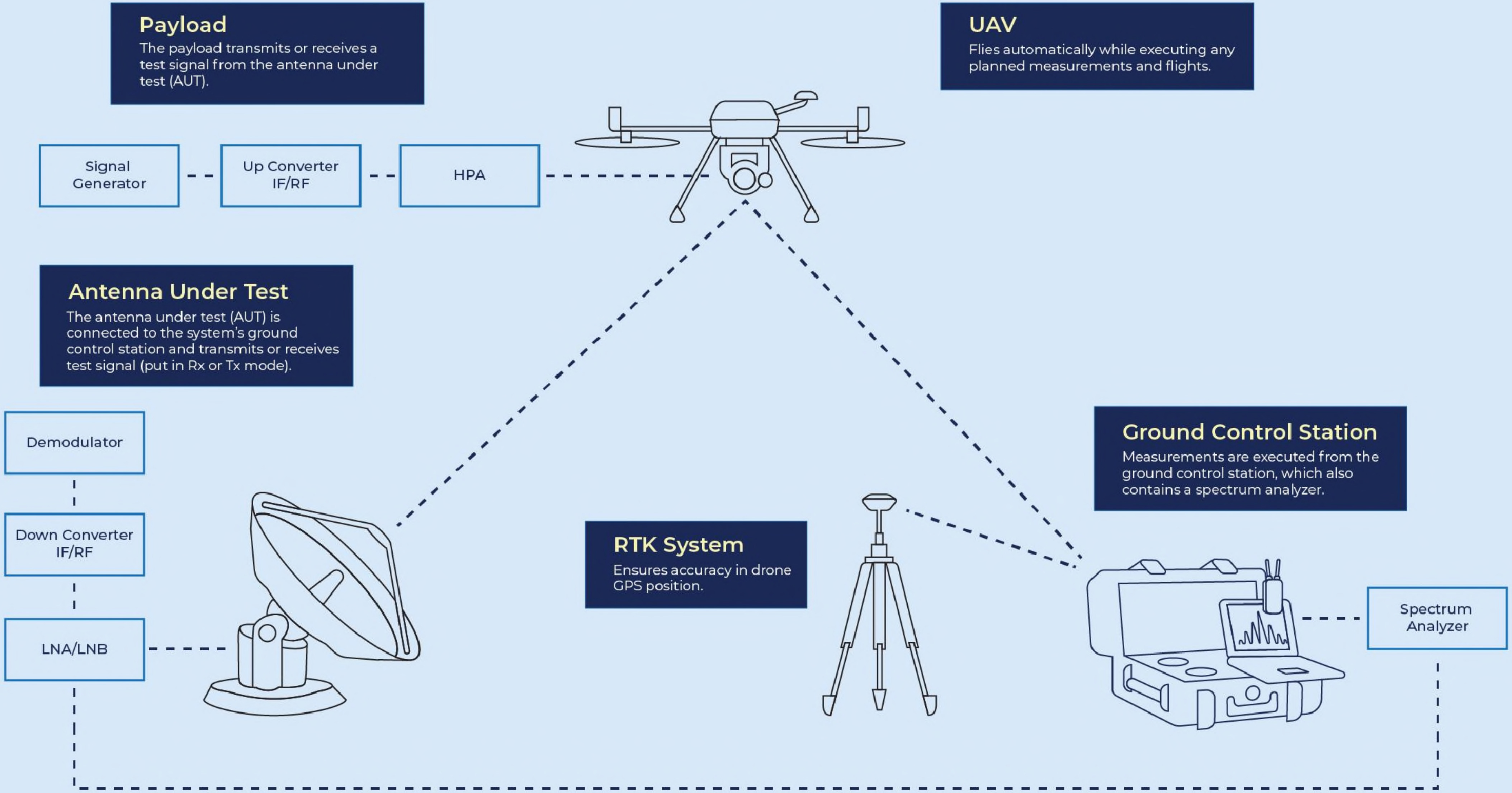
How It Works.


Payload
The payload transmits or receives a test signal from the antenna under test (AUT).
UAV
Flies automatically while executing any planned measurements and flights.
Signal Generator
Up Converter IF/RF
HPA
Antenna Under Test
The antenna under test (AUT) is connected to the system's ground control station and transmits or receives test signal (put in Rx or Tx mode).
Demodulator
Down Converter IF/RF
LNA/LNB
Ground Control Station
Measurements are executed from the ground control station, which also contains a spectrum analyzer.
RTK System
Ensures accuracy in drone GPS position.
Spectrum Analyzer

RF Measurements and Testing Capabilities

- Radiation Pattern Measurements
- Pointing and Tracking Tests
- Geo Location & Spectrum Monitoring
- Electronic Support Measures Validation

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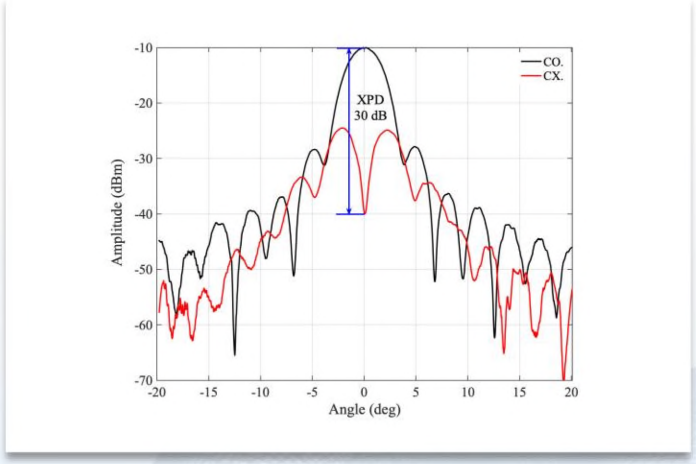

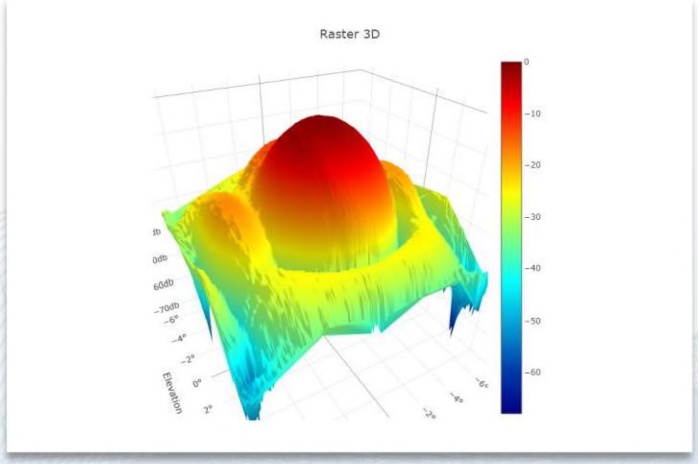

Radiation Pattern Measurements

Quadsat measures and assesses antennas' radiation patterns. With principal cuts in elevation and azimuth, 2D and 3D heat maps, polarization discrimination and gain measurements.

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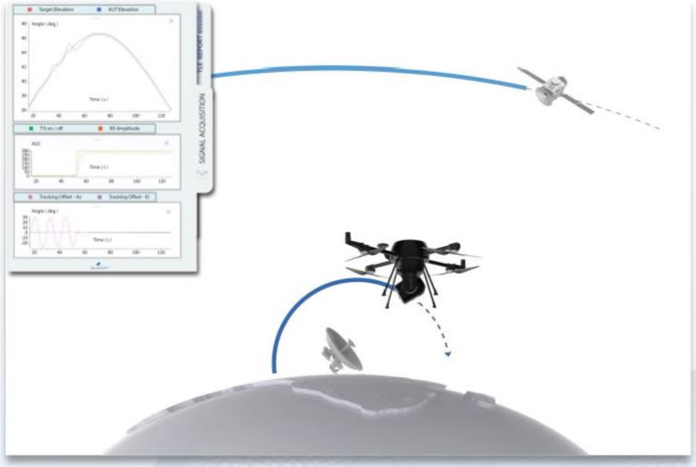

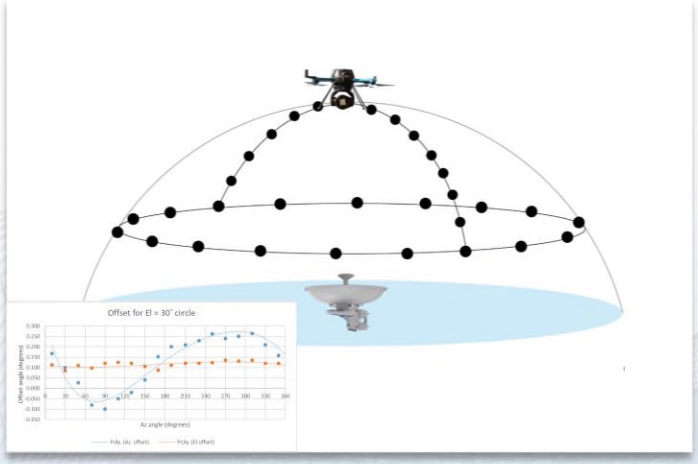

Satellite Emulation
- Pointing and Tracking Tests

Satellite emulation for antenna tracking and pointing tests, providing on-demand LEO and MEO satellite passes. Covers pointing offset over the entire angular range as well as on-the-move testing.

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Optimization of OneWeb's Ground Infrastructure

OneWeb

OneWeb is a global communications network powered by a constellation of 648 low Earth orbit (LEO) satellites, enabling high-speed, low latency connectivity for governments, businesses, and communities everywhere around the world.

Objectives

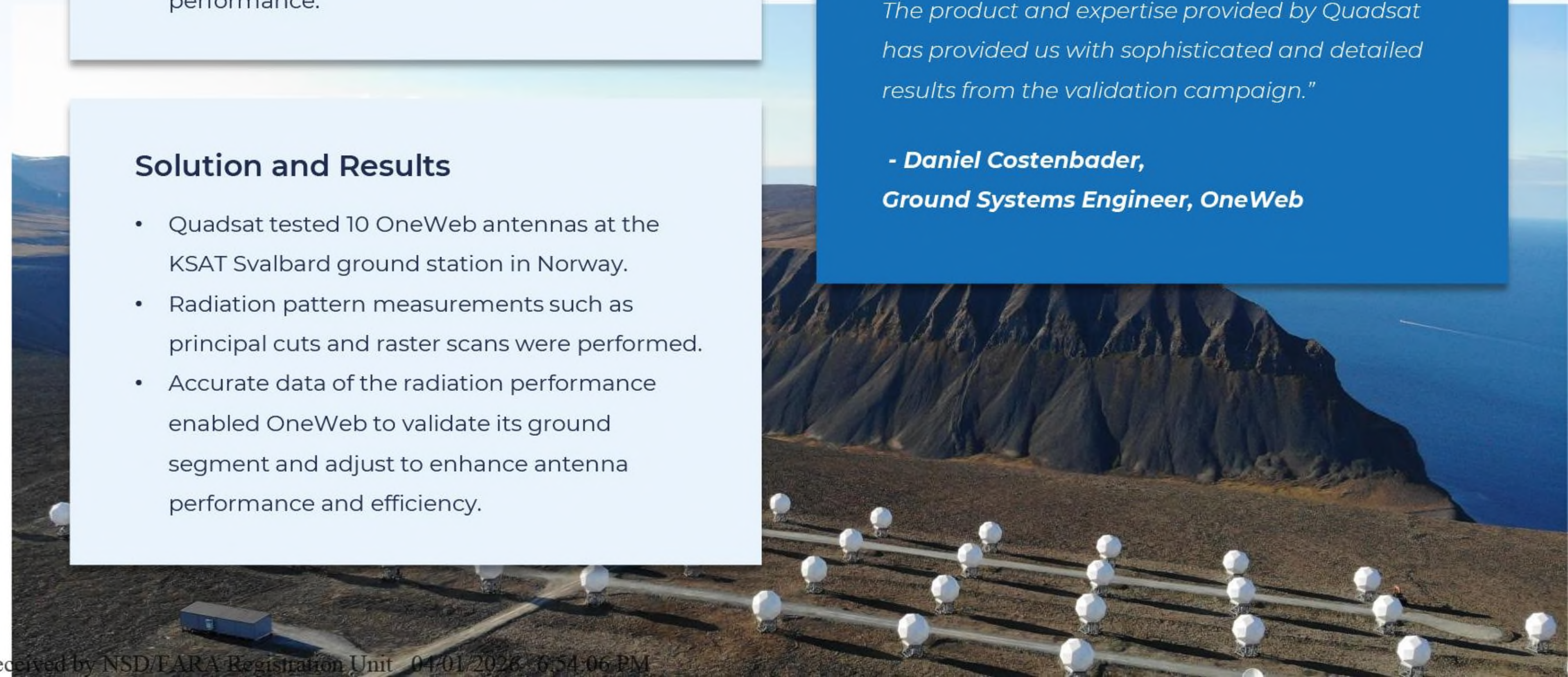
- Optimize antenna performance to enhance ground segment performance.
- Implement a cost-effective testing regime.
- Review environmental influences on antenna performance.

Solution and Results

- Quadsat tested 10 OneWeb antennas at the KSAT Svalbard ground station in Norway.
- Radiation pattern measurements such as principal cuts and raster scans were performed.
- Accurate data of the radiation performance enabled OneWeb to validate its ground segment and adjust to enhance antenna performance and efficiency.

"As the rollout of our ground segment progresses, we are utilising innovative methods to ensure that our networks are robust and accurate. By validating our antennas insitu, we can review and verify the technology in its own environment. The product and expertise provided by Quadsat has provided us with sophisticated and detailed results from the validation campaign."

- Daniel Costenbader,
Ground Systems Engineer, OneWeb



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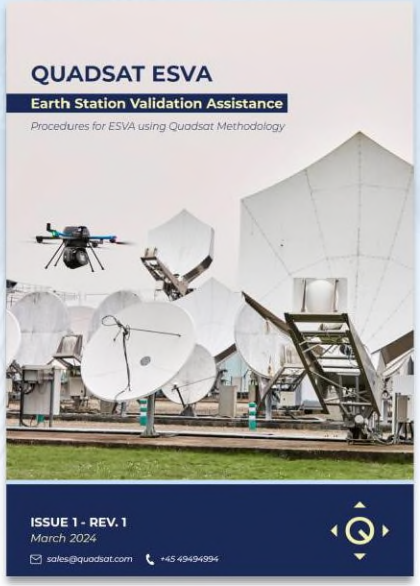
Quadsat’s Recognition in SATCOM



Accepted by SOMAP

Quadsat’s testing method has been accepted by the SOMAP (Satellite Operator Minimum Antenna Performance) group’s framework of minimum antenna testing requirements.

The SOMAP group consists of Intelsat, Eutelsat, SES, Inmarsat, and AsiaSat.

SOPs for Satellite Operators

Quadsat works closely with satellite operators on defining standard operating procedures for using Quadsat’s testing in uplink approval programs. This includes approval programs such as Eutelsat’s testing procedures for Earth Station Validation (ESVA).

Winner of WTA’s ‘Teleport Technology of The Year’ Award

Quadsat received in 2024 the World Teleport Association’s ‘Teleport Technology of The Year’ award for its solution allowing teleports to quickly validate antennas in-situ, allowing optimized performance and obtaining uplink approval with satellite operators.

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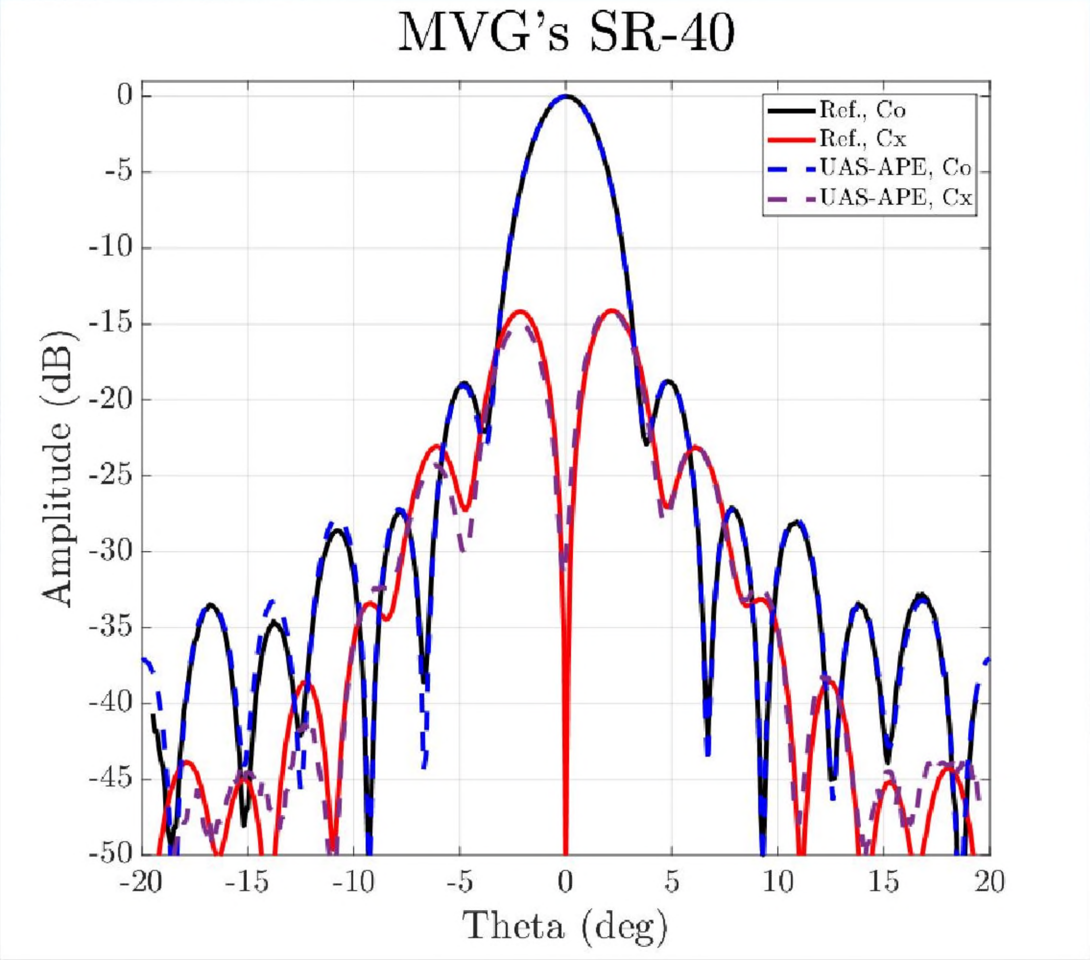
Comparative Test at ESA-ESTEC's Facilities

Comparison of Azimuth cut measurements performed by Quadsat and ESA-ESTEC's test facilities in The Netherlands.

For co-pol, Quadsat's measurement is shown in blue and ESA-ESTEC's in black.

For cross-pol, Quadsat's measurement is shown in purple and ESA-ESTEC's in red.



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