Radar Cross Section

MEASUREMENT SOLUTIONS

mVG
Microwave Vision Group
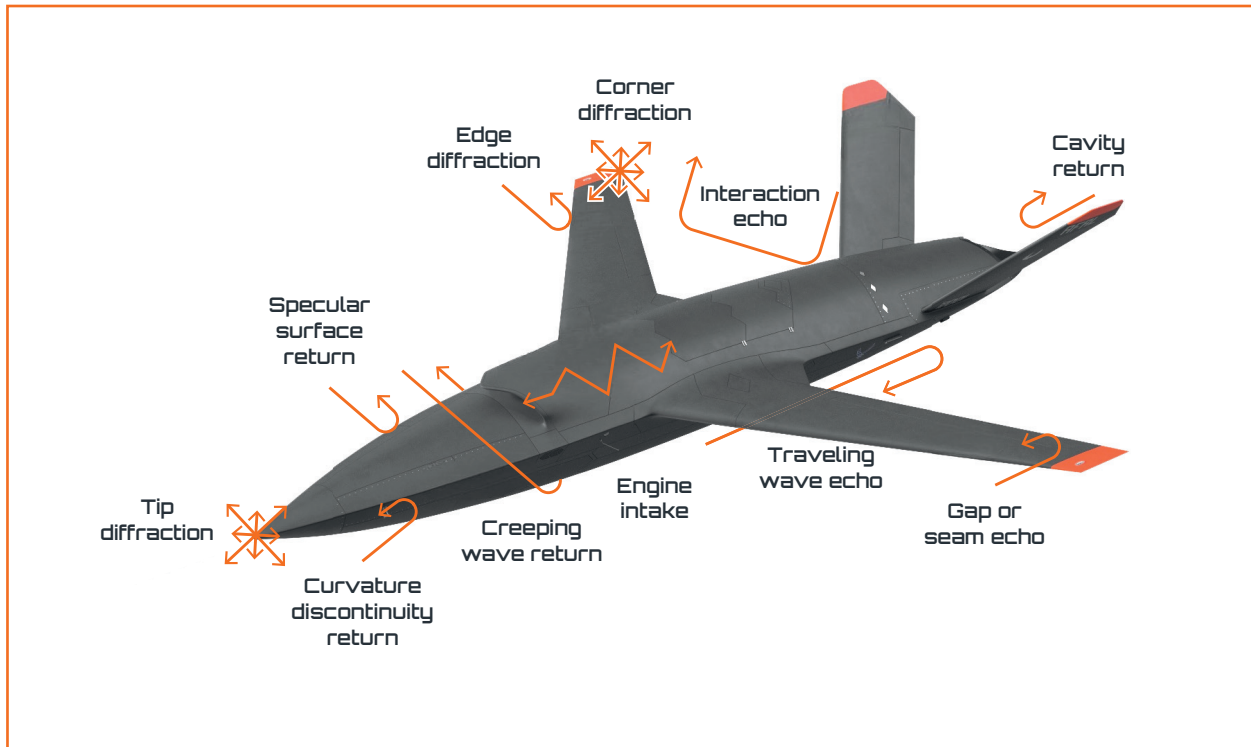
General Overview

Radar Cross Section (RCS) is a measure of how visible an object is to a radar by quantifying the energy scattered back to the radar when the object is illuminated by an electromagnetic wave.

What is the goal of RCS testing?

Characterize **reflections** from components lik **wings, fuselage, engines, and other structures**

Optimize design to reduce radar signature and enhance stealth capabilities

What are the main challenges in RCS testing?

Low signature detection:
Requires high sensitivity and minimal background (clutter) reflections

Accurate positioning:
Precise multi-angle alignment is critical for reliable measurements

Low-frequency demands:
Increase requirements on system size, performance and absorber design

Operational complexity:
Data processing, environmental control, and secure handling are key, especially in defense programs

MVG RCS Measurement Solutions

FULL PROJECT SUPPORT

MVG is vertically integrated, with full in-house design, analysis and production capabilities for a complete turn-key system - from the shielded chamber and absorbers to the RF subsystem and precision antennas.

INTERFACE-READY

Our post-processing software allows **easy integration with customer workflows and its internally designed** algorithms ensure compatibility with evolving tested objects and methodology.
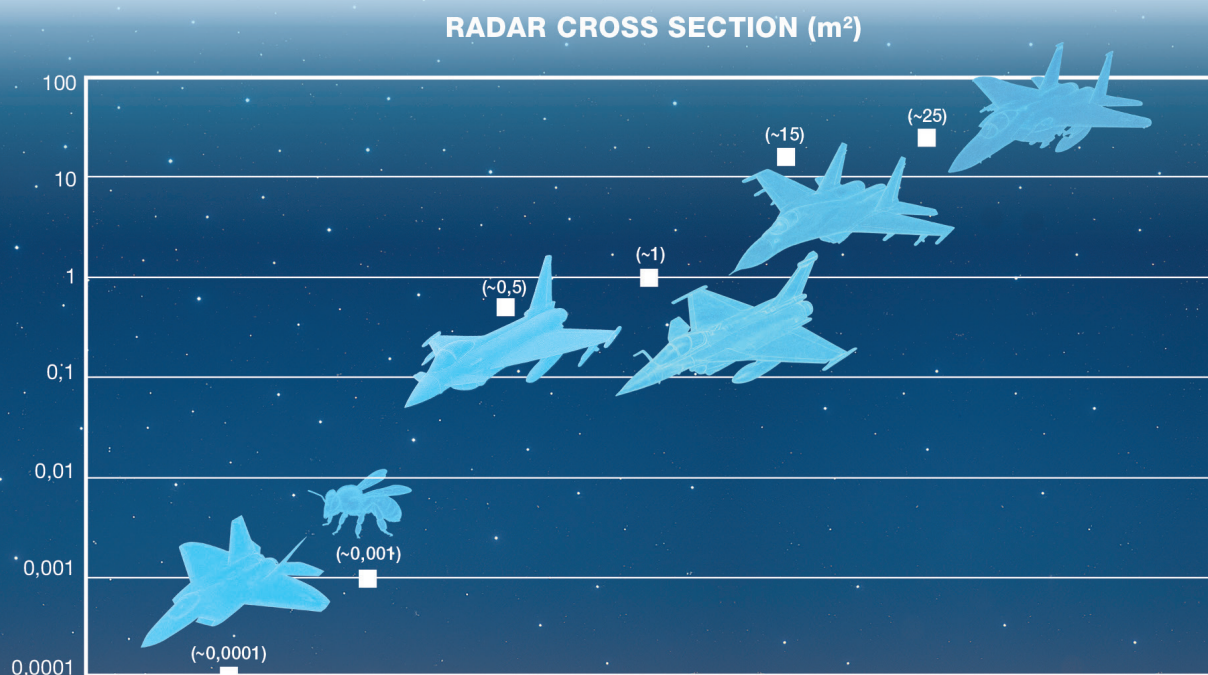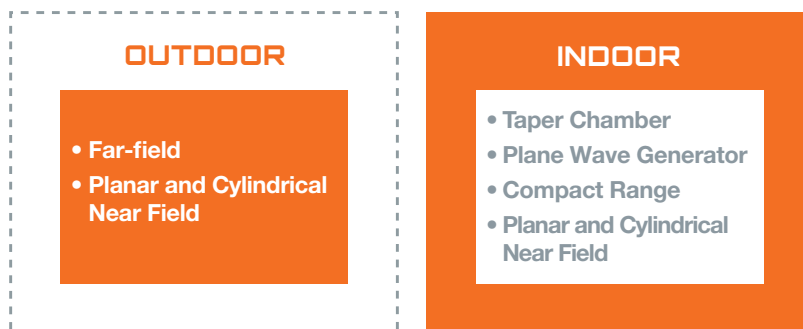
PERFORMANCE & EFFICIENCY

MVG is committed to performance at the system level, ensuring high accuracy, stability and efficient testing measurement.

USER SUPPORT & SERVICES

Our user support and services focus on maximizing system uptime and efficiency by ensuring high maintainability of complex systems. The MVG approach ensures reliable system performance and long-term operational continuity for our customers.

MVG provides **RCS Measurement Solutions**, from data acquisition to post-processing, to meet customer needs in test ranges such as:
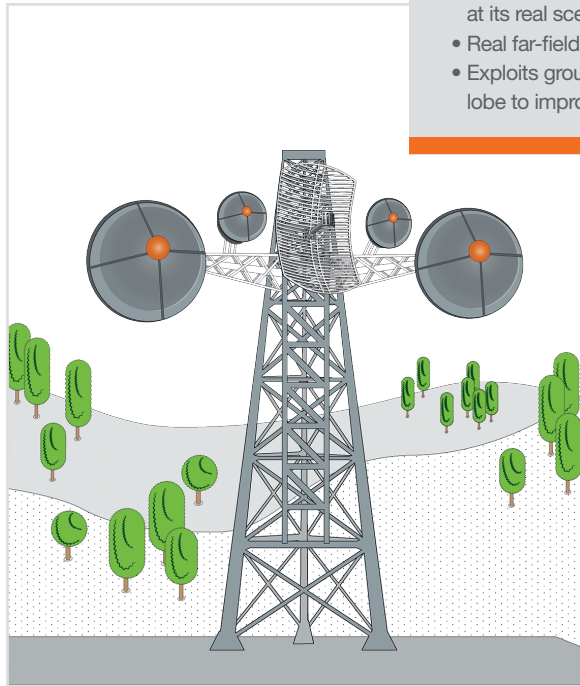
OUTDOOR

- **Far-field**
- **Planar and Cylindrical Near Field**

INDOOR

- **Taper Chamber**
- **Plane Wave Generator**
- **Compact Range**
- **Planar and Cylindrical Near Field**

RADAR CROSS SECTION (m^2)

100	
10	(~25)
	(~15)
1	(~1)
	(~0,5)
0,1	
0,01	
0,001	(~0,001)
0,0001	(~0,0001)

* Values are approximate and sourced from publicly available specifications.

Far-Field (FF)

Advantages

- Facilitates full scale target measurement at its real scenario aspect angle configuration
- Real far-field target measurements
- Exploits ground bounce first multipath lobe to improve sensitivity

KEY FEATURES

Pylon

- Changeable pylon tips for different measurement targets
- Pylon can be concealed within the concrete reaching into ground level for ease of target mounting

Adjustable Height Tx/Rx Station

- Different antenna height configurations, depending on target distance and frequency allows better ground bounce control

Clutter Control

- Different possible radar fence configurations for reduce ground bounce effect

Control Room

- Can be facilitated as fixed ground station or mobile down range vehicle

Frequency

- 0.4 - 18 GHz (typically)

Performance

* Consult your local MVG representative for information on NERCS and dynamic range performance

Planar and Cylindrical Near-Field (CNF)

Advantages

- Allows real and reliable full-scale measurements at a short distance
- Exploits ground bounce first multipath lobe to improve sensitivity (for 2D measurements)
- Interference from ground bounce and residual clutter can be filtered out by exploiting the 3D acquisition and the visualization of the 3D image

KEY FEATURES

Target

- Full-scale target measurement at short distances
- Applicable to both model and real targets – as-is / before take-off
- Fast check of platform RCS configuration
- Maintenance purposes during platform life cycle

Measurement Configuration

- SAR vertical scan (2D) in front of the target by means of Y tower scanner
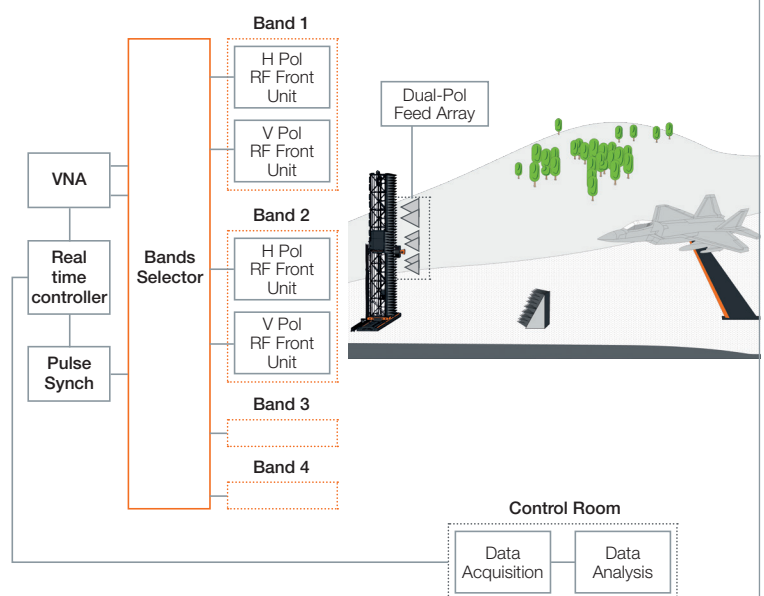- ISAR complete 3D scan by means of Y tower scanner and Pylon (AZ/EL)

Frequency

- 0.4 - 18 GHz

### Performance

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SYSTEM OVERVIEW
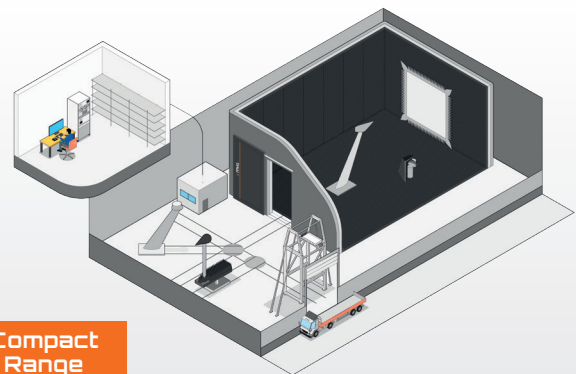
Indoor Ranges

## Why choose Indoor Anechoic Measurement Systems?

- Enables testing of Very Low Observability (VLO) capabilities

- Delivers high measurement accuracy

- Operates in an environmentally controlled setting (clutter, noise, temperature, etc.)

- Efficiency with respect to impacts from outdoor weather conditions

- Concealed facilities for R&D and testing of classified objects

- Multi purpose (material measurements, EMC, etc.)

- Suitable for large target objects (compact range / near-field)

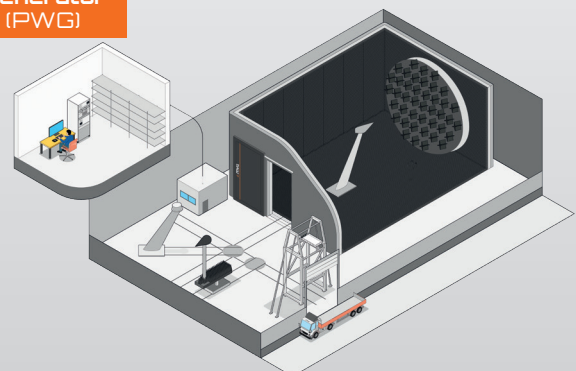- Comprehensive solutions for continuous frequency coverage from 100 MHz to 110 GHz
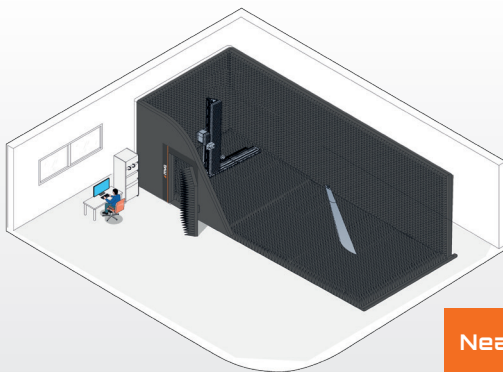
Near-Field (NF)

Compact Range (CR)
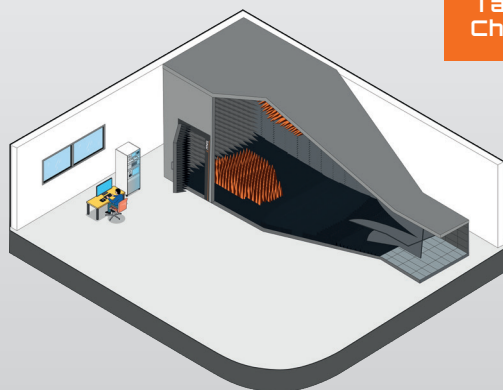
Tapered Chamber
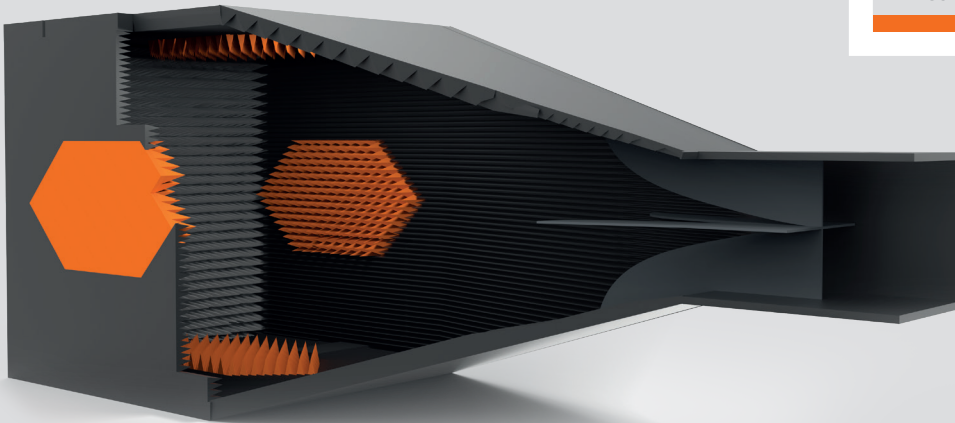
Plane Wave Generator (PWG)

Tapered Chamber

Advantages

- Frequency Coverage: Provides the possibility to perform RCS measurements at the lower frequency range
- Cost-Effectiveness: Tapered chambers are generally less expensive compared to other solutions

KEY FEATURES

Reduced reflectivity

- Tapered walls design minimize internal reflections by directing stray signals towards chamber back wall

Clutter control

Fewer multiple reflections and reduced background noise, improving signal-to-noise ratio

Integrated tapered feed

For high cross pol and planar wave front control performances
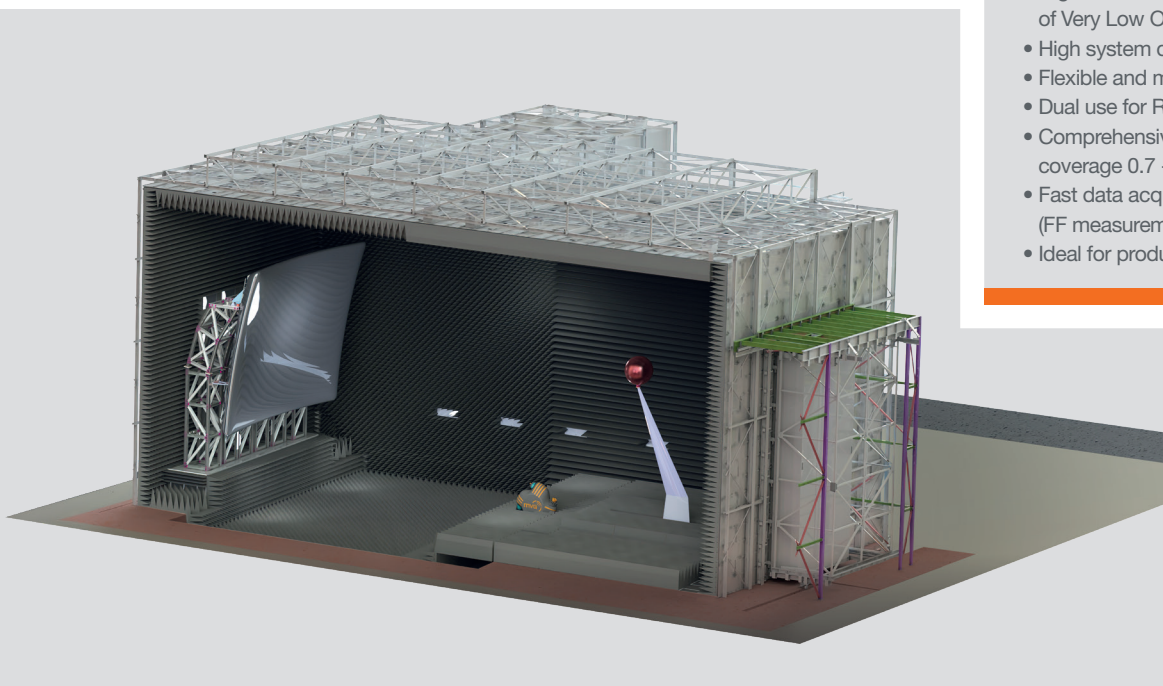
Frequency

- 0.1 - 2 GHz

Performance

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Compact Range

Advantages

- High measurement accuracy in measurement of Very Low Observability (VLO)
- High system dynamic range and sensitivity
- Flexible and modular DUT positioning
- Dual use for RCS and antenna measurement
- Comprehensive continuous frequency coverage 0.7 - 110 GHz
- Fast data acquisition and analysis (FF measurement)
- Ideal for production line test and verification

CAPABILITIES

- **Broadband coverage** across the complete frequency range (0.7 - 110 GHz)
- **Automatic feed selection** for continuous full frequency coverage
- **High system dynamic range** and high sensitivity
- **High cross polar performances**

Chamber clutter

- Well below RF system noise

Flexible and modular target positioning

- Pylon, Styrofoam, etc.

Reflector

- High surface accuracy to support mm-wave measurements
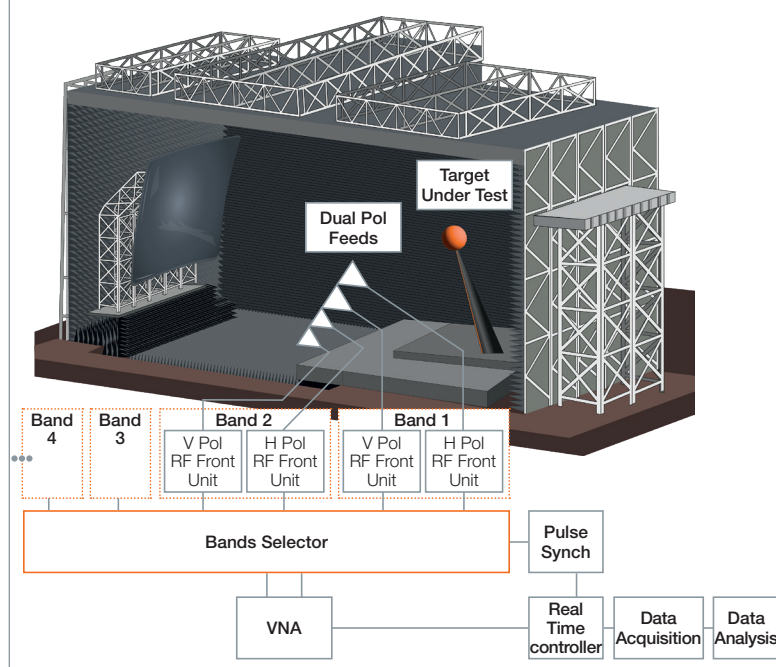
Frequency

- 0.7 - 110 GHz

Performance

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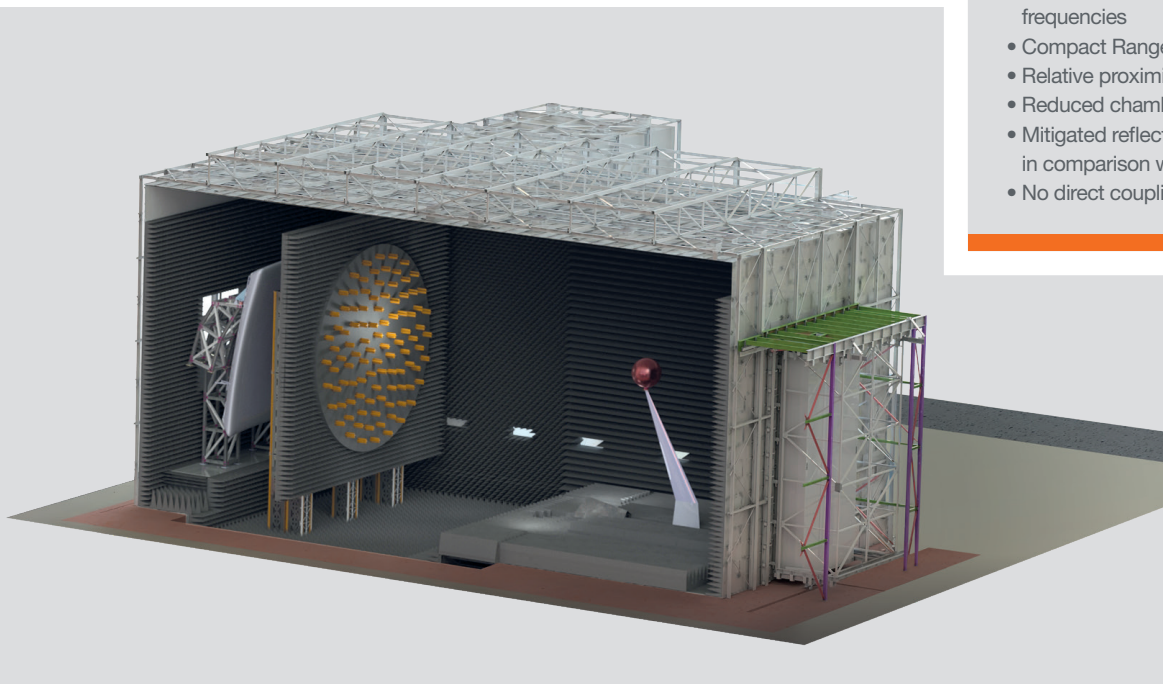
SYSTEM OVERVIEW

Plane Wave Generator (PWG)

Advantages

- Allows RCS measurements for very low frequencies
- Compact Range complementary solution
- Relative proximity to DUT
- Reduced chamber size
- Mitigated reflection from chamber in comparison with compact ranges
- No direct coupling between DUT and PWG

CAPABILITIES

- Gain
- Beamwidth
- Sidelobe levels
- Radiation pattern in any polarizations (linear or circular) and cross-polarization
- Radome measurement
- Directivity
- 2D and 3D radiation patterns
- RCS measurement
- EIRP and G/T

Frequency bands

- 0.1 - 1.0 GHz | Sub 6 GHz

Performance

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Planar / Cylindrical Near-Field

Advantages

- Allows RCS measurements of full-scale platform at short distance
- Suitable for upgrading existing EMC chambers with RCS measurement capabilities
- Cost effective solution for full scale targets measurements
- Better suitable for cluttered environment
- Allows SAR and ISAR imagining of the target
- 2D and 3D Cylindrical Images of the target are obtained
- 2D/3D SAR images are obtained with planar acquisitions, providing a better rejection of still clutter (zero doppler, etc)
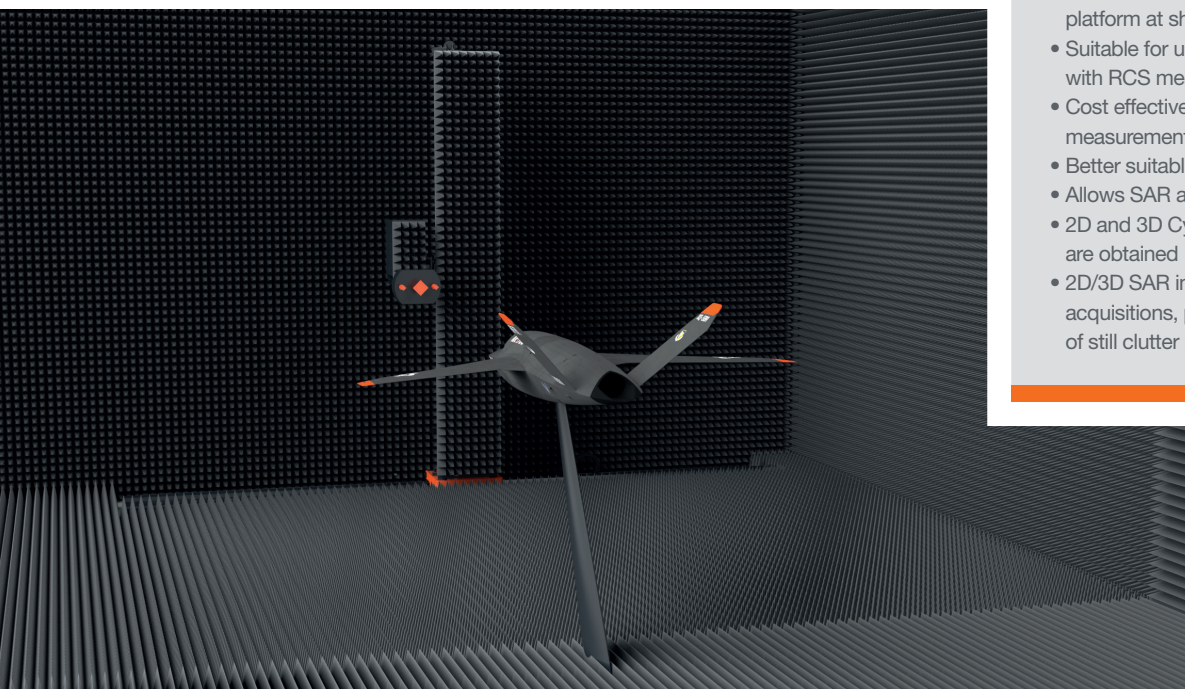
CAPABILITIES

- Near-field to far-field correction in the ISAR software tool allows focalization of the radar image
- Effectively mitigate clutter through advanced data processing techniques and high-resolution capabilities

Compact Test Environment

- NF RCS ranges require much less physical space than traditional far-field ranges, making them ideal for indoor labs, production environments, or urban locations

Cost Efficiency

- By avoiding long distances needed in far-field setups, NF RCS ranges reduce infrastructure and operational costs

Enhanced Measurement Flexibility

- The test setup allows for multi-angle and multi-polarization scanning, and can handle complex test scenarios

SAR and ISAR Imaging Capabilities

- NF RCS systems can generate SAR (Synthetic Aperture Radar) and ISAR (Inverse Synthetic Aperture Radar) images, providing high-resolution radar imagery of static or moving targets
  - SAR allows imaging by virtually moving the radar around a stationary target
  - ISAR captures images of a moving target using its motion to synthesize the aperture. These capabilities are invaluable for feature identification, scattering analysis, and target classification

Frequency

- 1.0 - 40.0 GHz

Performance

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Dual Gantry Bi-Static RCS (Material)

Advantages

- Spherical bi-static materials characterization measurements
- Highly accurate spherical positioning and pointing of both Tx and Rx arms
- Adjustable sphere heights
- Fully automated positioning and data acquisition
- Reduced environmental / multipath interference
- Wide frequency coverage and dual pol measurements
- Allows for the analysis of complex targets with intricate geometries
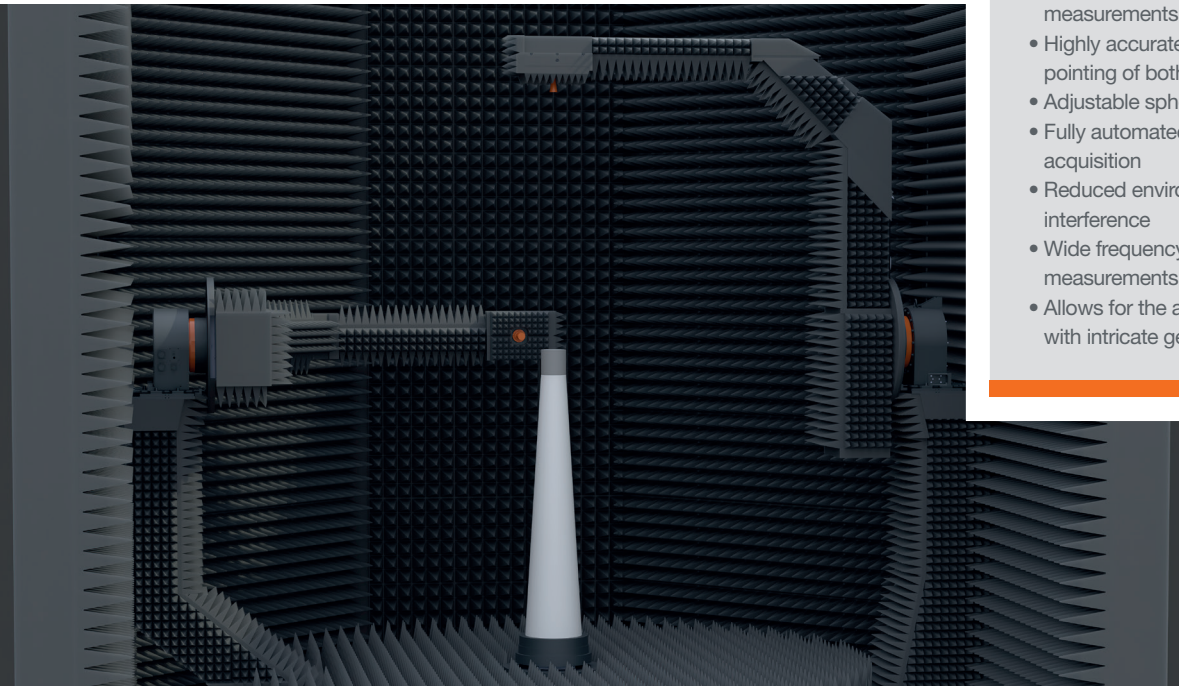
CAPABILITIES

- Equal radius gantry arms
- Incorporates an anti-collision safety features
- Antenna measurement
- Monostatic / bi-static SER and diffracted filed measurements, for material samples as a function of aspect angle and frequency, and diagnostic radar imaging for energy absorption uniformity verification
- Reflection coefficient of planar RAM/material samples as a function of incidence angle and frequency band in bi-static configuration or mono-static configuration at normal incidence
- Insertion loss (transparency) of material/FSS planar samples as a function of incidence angle and frequency, with rotation of the sample
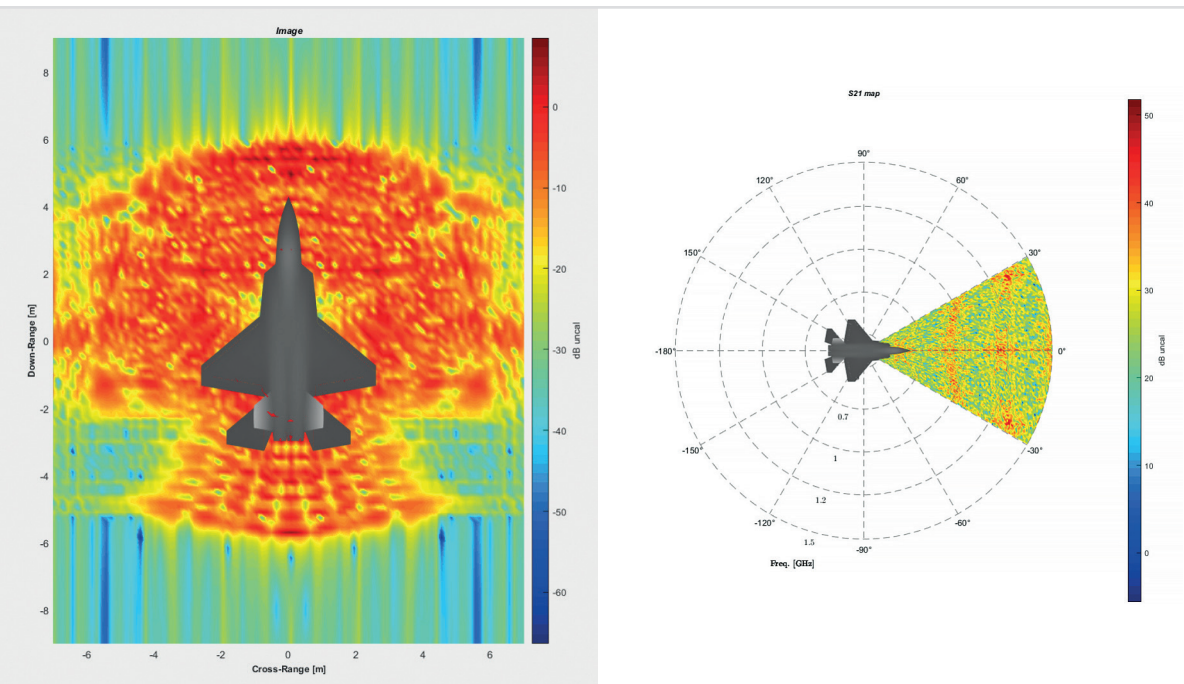
Frequency

- 1.0 - 40.0 GHz

Performance

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MV-ISAR software tool is optimized for off-line processing of RCS data collection, visualization, and analysis. Applying Inverse Synthetic Aperture Radar (ISAR) technology, it allows:

- Maximum flexibility in data processing
- Capacity to build user-customized sequences of processing steps
- Easy navigation and operation between different process buffers
- Advanced data analysis procedures for frequency response correction, RCS calibration, and highly cluttered environments
- RCS data processing in frequency and time domain
- Management of data for accurate visualization and analysis

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