Raven Advanced Phased-array Telemetry Resource

RAPTR

Antenna Development

RAVEN DEFENSE

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Program Requirements

To support evolving telemetry collection requirements at the Atlantic Test Range, requirements were developed for a new and high-performance antenna system to be hosted on the AirTec owned and operated BT-67 aircraft. In principle, the requirements were quite simple:

-It has to fit
-It has to work
-It has to survive

Use of simple, functional requirements was KEY to this development program's success.

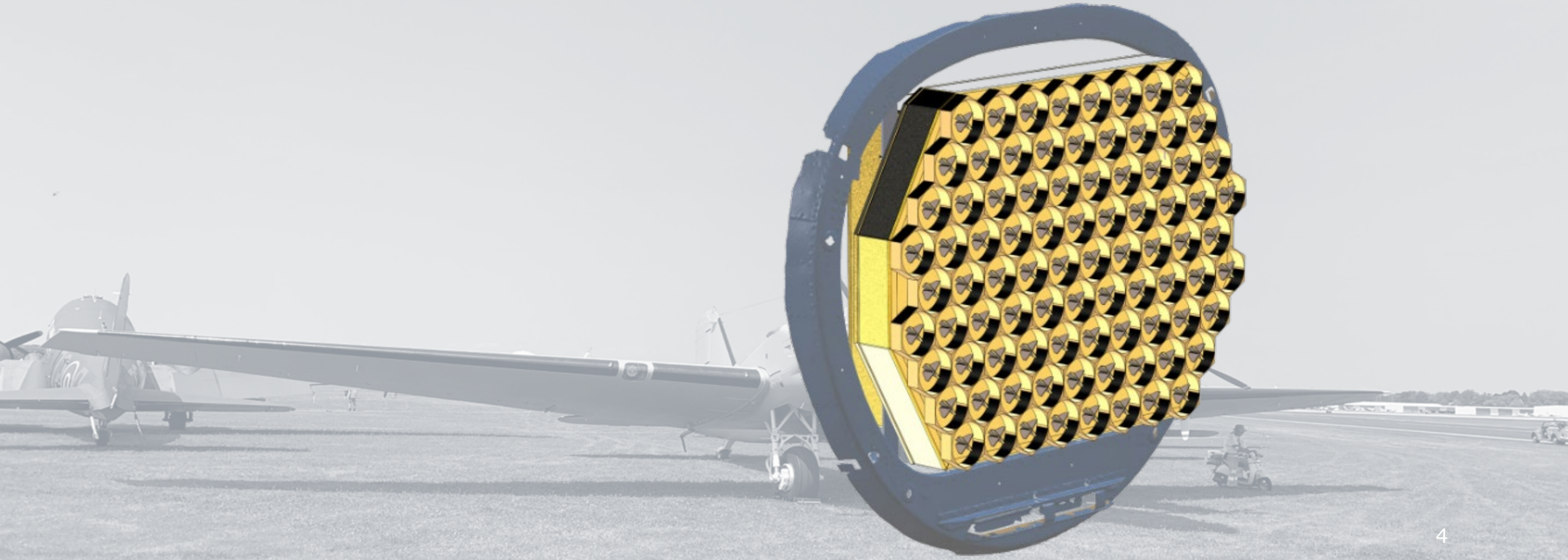
Program Requirements

-It has to FIT

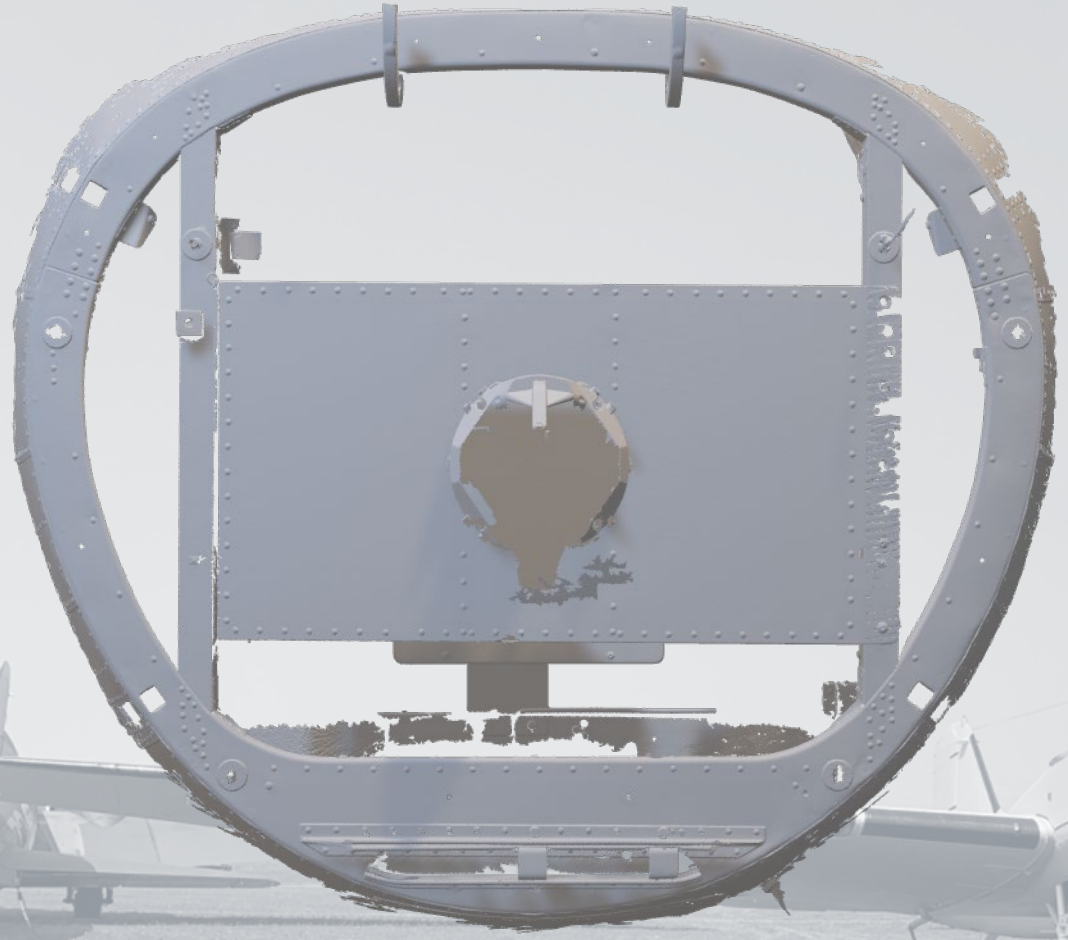
The antenna system needed to be installed within the existing volume of the nose radome of the BT-67 aircraft.

System Development

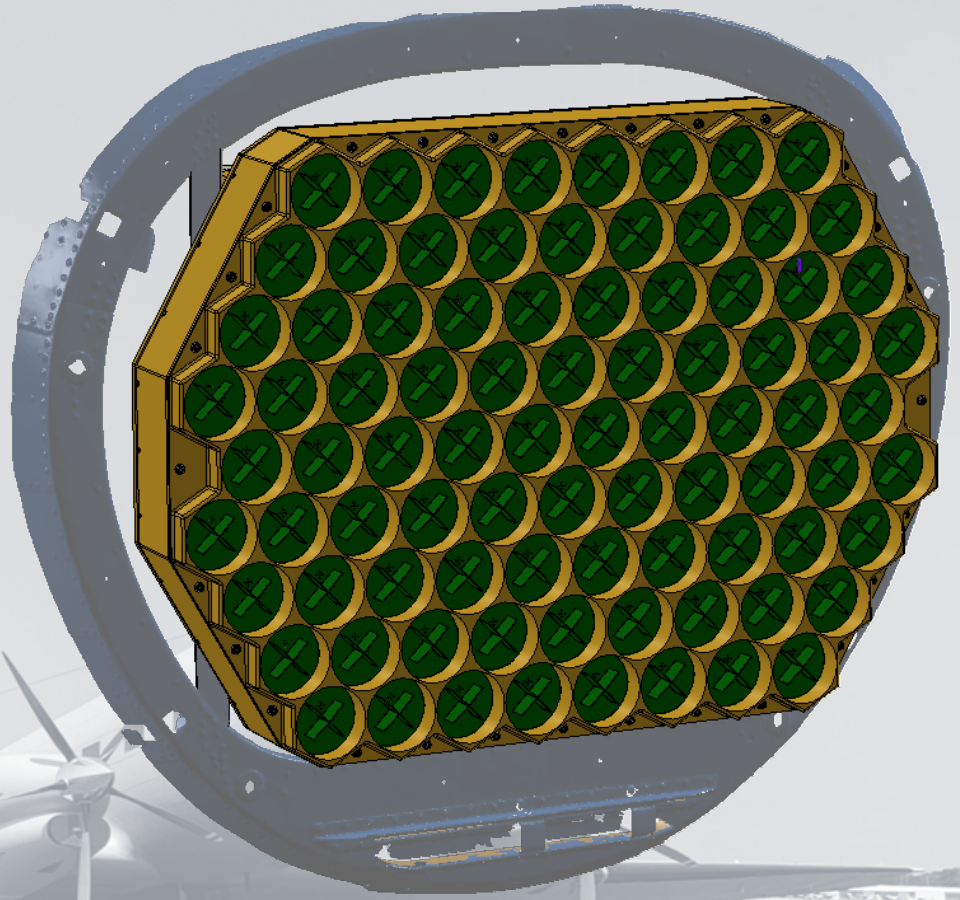
3D Scans of the nose bulkhead and radome were used from the inception of the design to ensure mechanical compatibility.



System Development



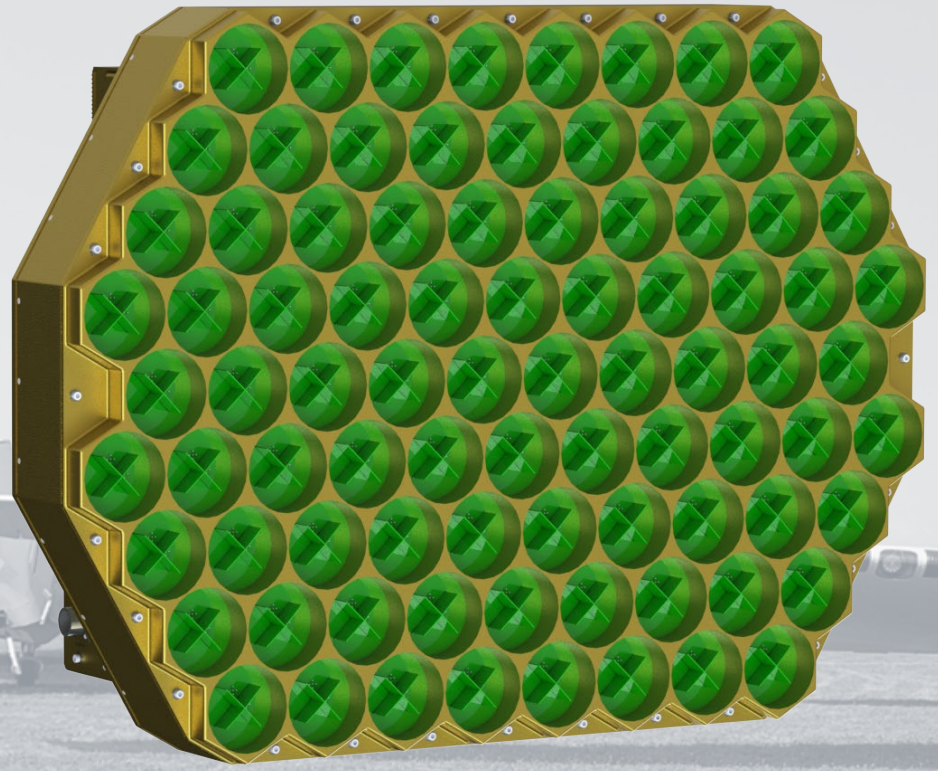
BT-67 Nose Bulkhead 3D Scan

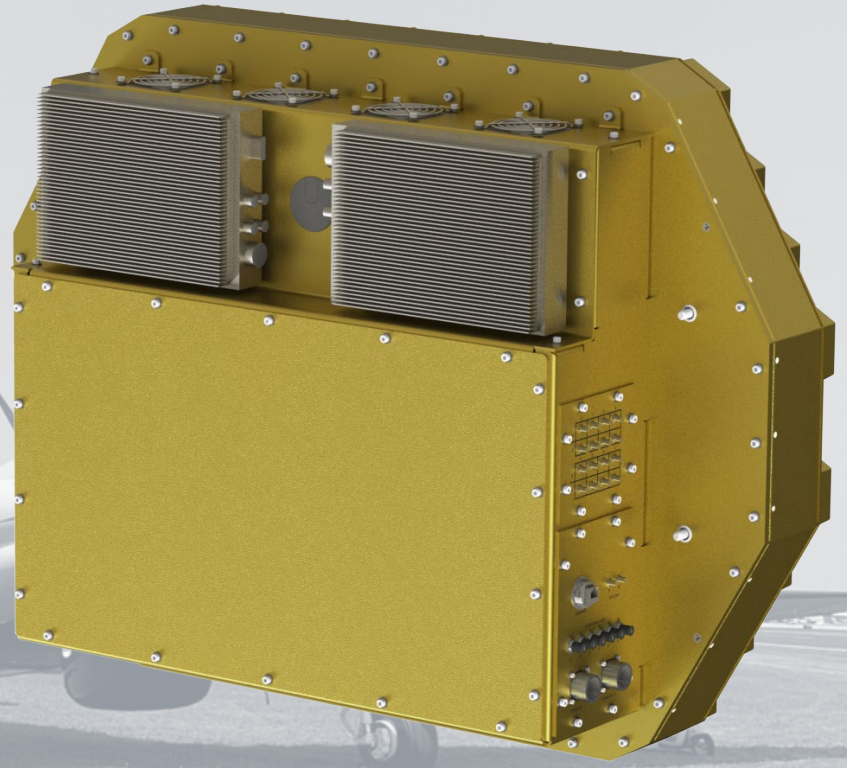


RAPTR Array Sized for BT-67

System Development

System interfaces were simplified to the maximum extent to allow for ease of installation and maintenance. External interfaces to the RAPTR antenna include only 28VDC power input, Ethernet command and status, and dual-polarized RF outputs for each beam.





Program Requirements

-It has to WORK

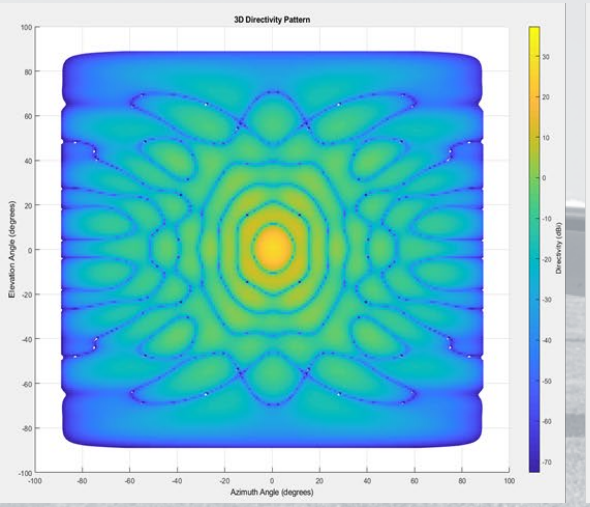
Within the volume constraints of the airframe, the antenna's performance (specifically G/T) needed to be maximized while enabling support of new mission requirements (multiple, simultaneous object tracking).

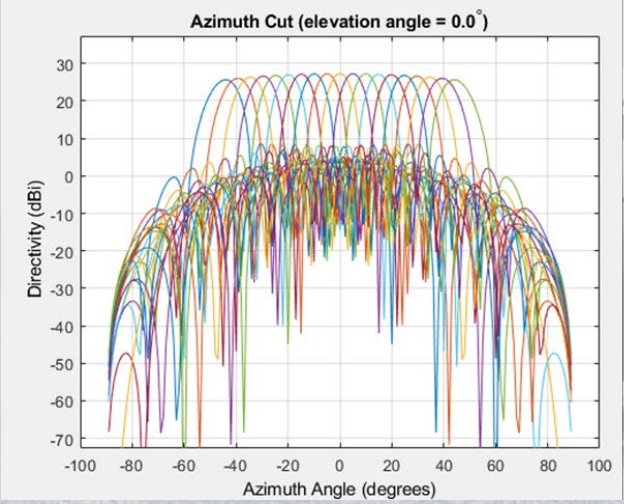
System Development

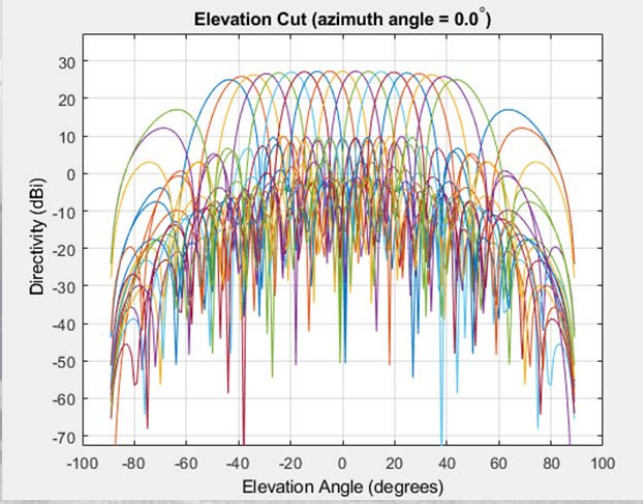
To meet the baseline requirements of multiple, simultaneous target tracking, selection of a phased array antenna system was obvious.

A hybridized beamforming architecture was used to achieve high performance within a bounded SWAP-C environment.

Significant focus was placed on fundamental antenna RF performance characteristics including return loss, mutual coupling, cross-polar isolation, axial ratio, and scan loss.







Program Requirements

-It has to SURVIVE

The antenna needed to survive the ground and flight environment of the BT-67 for vibration, temperature, altitude, and EME.

System Development

Environmental compliance relative to the BT-67 flight environment was kept at the forefront of design considerations throughout the program.

All components were spec'd and tested for temperature compliance

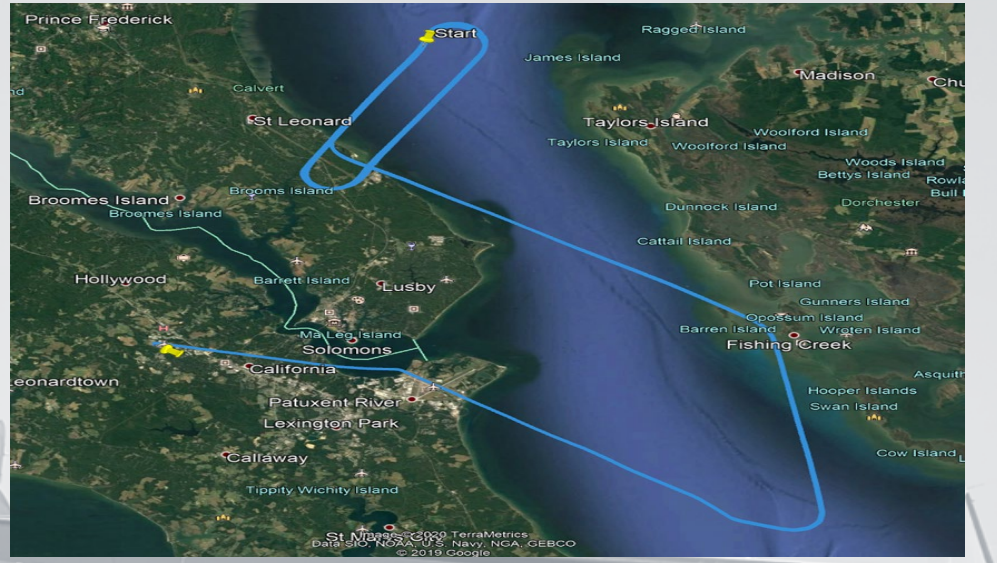
CTE compatibility was modeled at all material boundaries

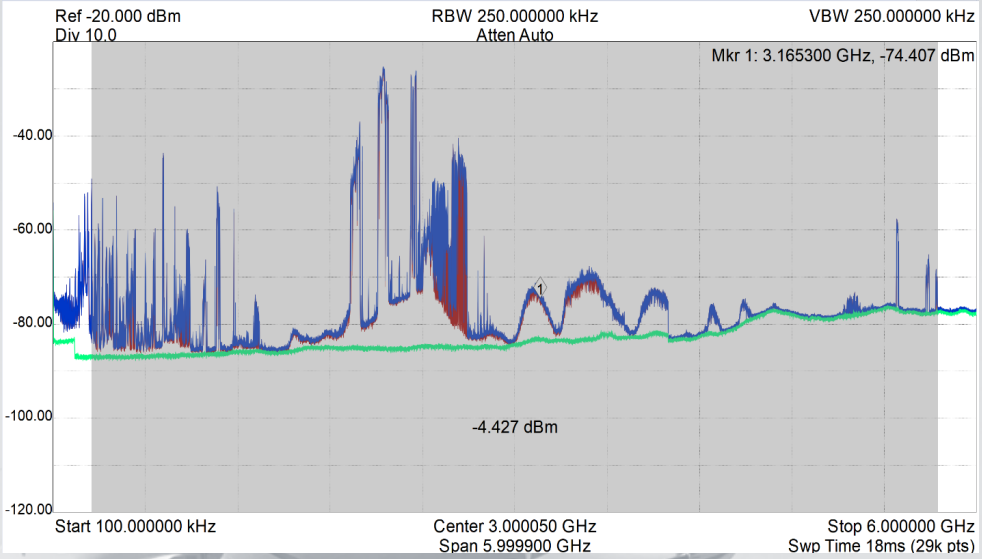
All CCAs were fully coated and tested to 100% condensing humidity

The mechanical structure and all cable harnessing was designed, analyzed, and tested for high vibration environments

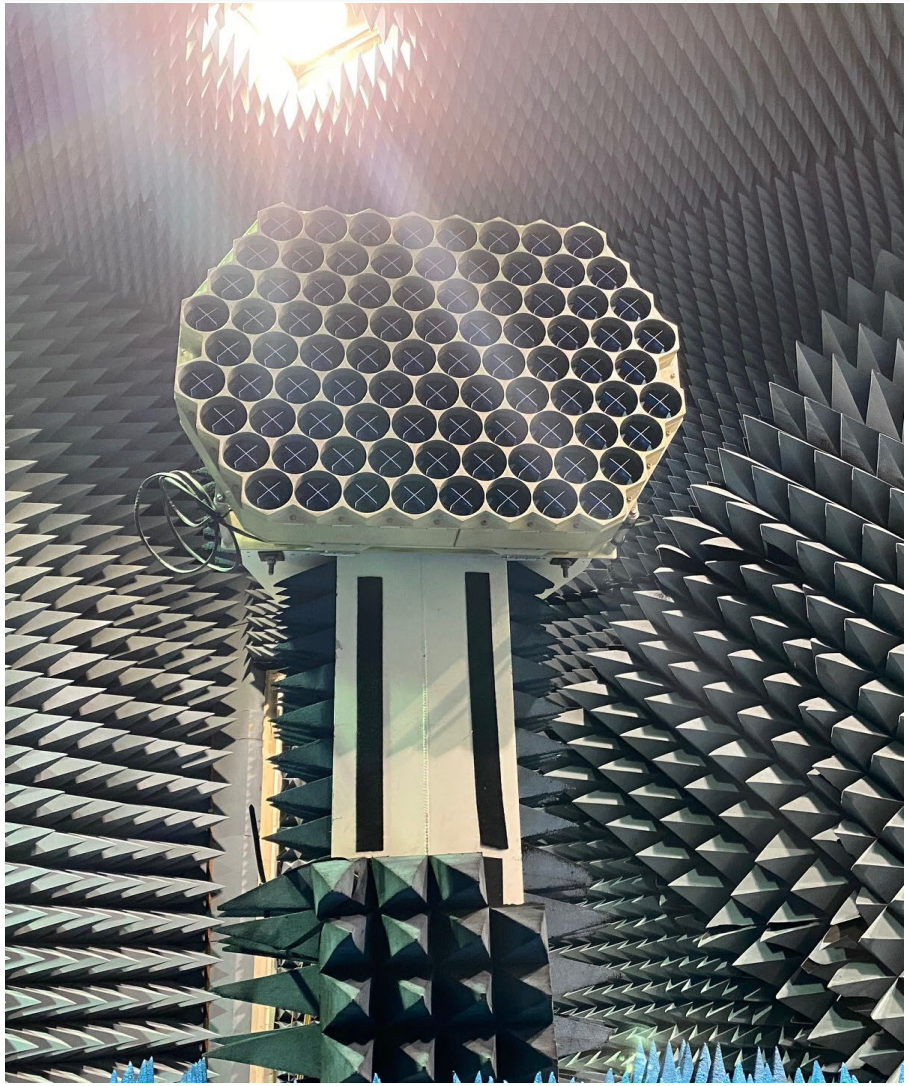
System Development

In place of chamber testing for EME compliance, an EME flight test series was used early in the program to codify the complex environment that RAPTR would be exposed to in daily operations.





Raven Advanced Phased-array Telemetry Resource

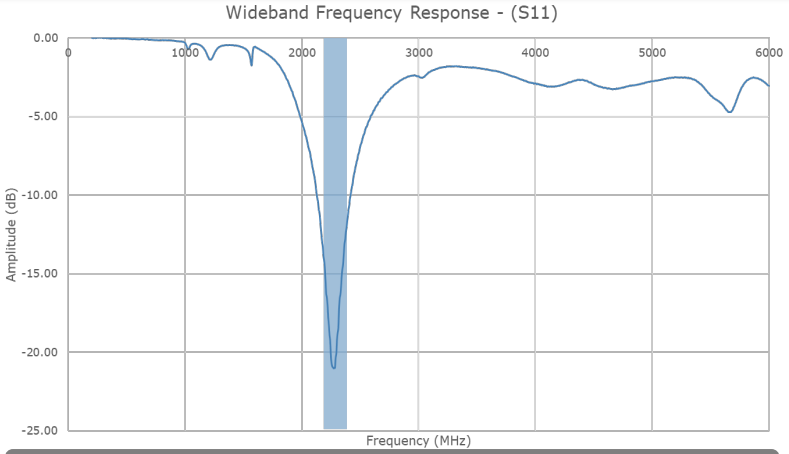


- ***Electronically steered phased array antenna for telemetry***
- ***Hybridized beamforming architecture***
- ***Operates in S-Band from 2200-2400MHz***
- ***Dual orthogonal polarized tracking and data outputs***
- ***Virtually unlimited beam steering speed***
- ***Meets MIL-STD-810H environments for:***

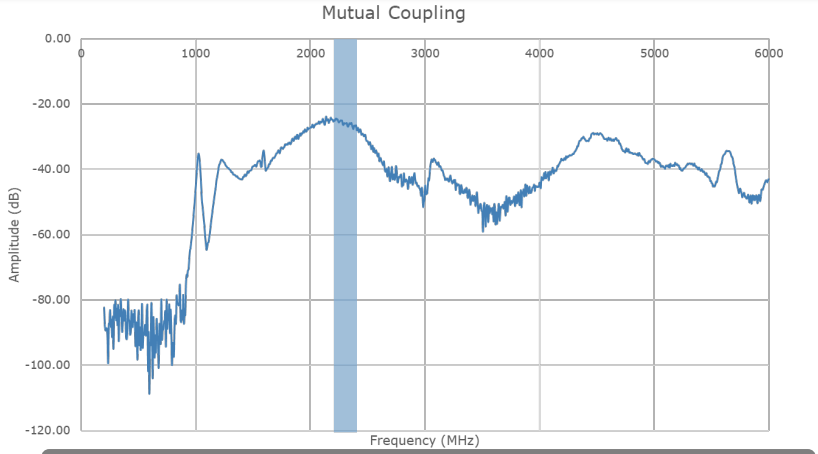
  Vibration / Temperature / Humidity / Altitude
- ***Supports Tier 0, 1, and 2 modulation types up to 40Mbps***
- ***May be configured with 4, 8, or up to 16 beams***
  - ***Each beam supports dual polarized outputs***
  - ***Supports 200MHz data reception per output***

RAPTR Integration and Test

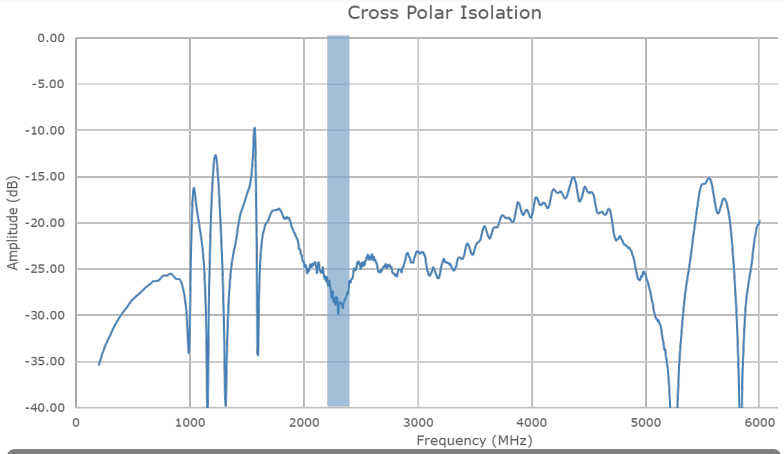
RATPR Antenna RF Performance Measurements



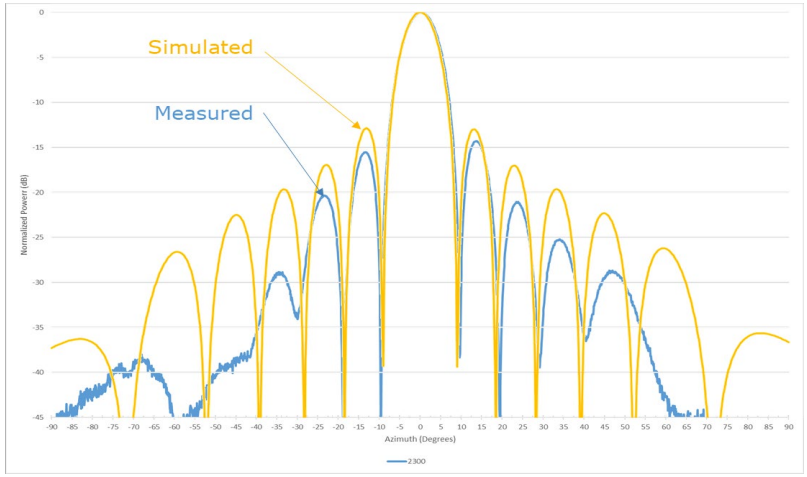
Return Loss Performance in S-Band



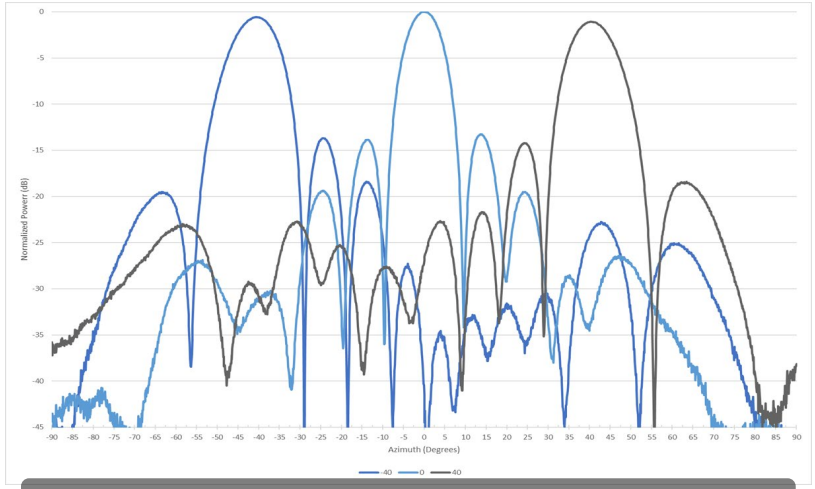
Minimized Mutual Coupling



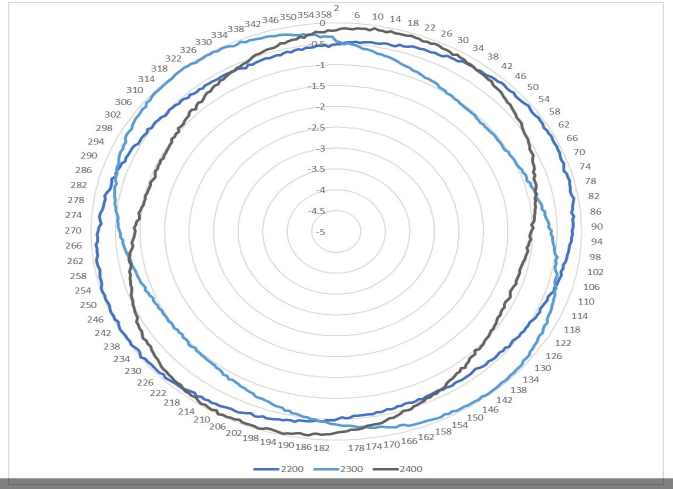
Excellent Cross-Polar Isolation



Measured Patterns Exceed Expectations



Low Scan Loss at Extreme Look Angles



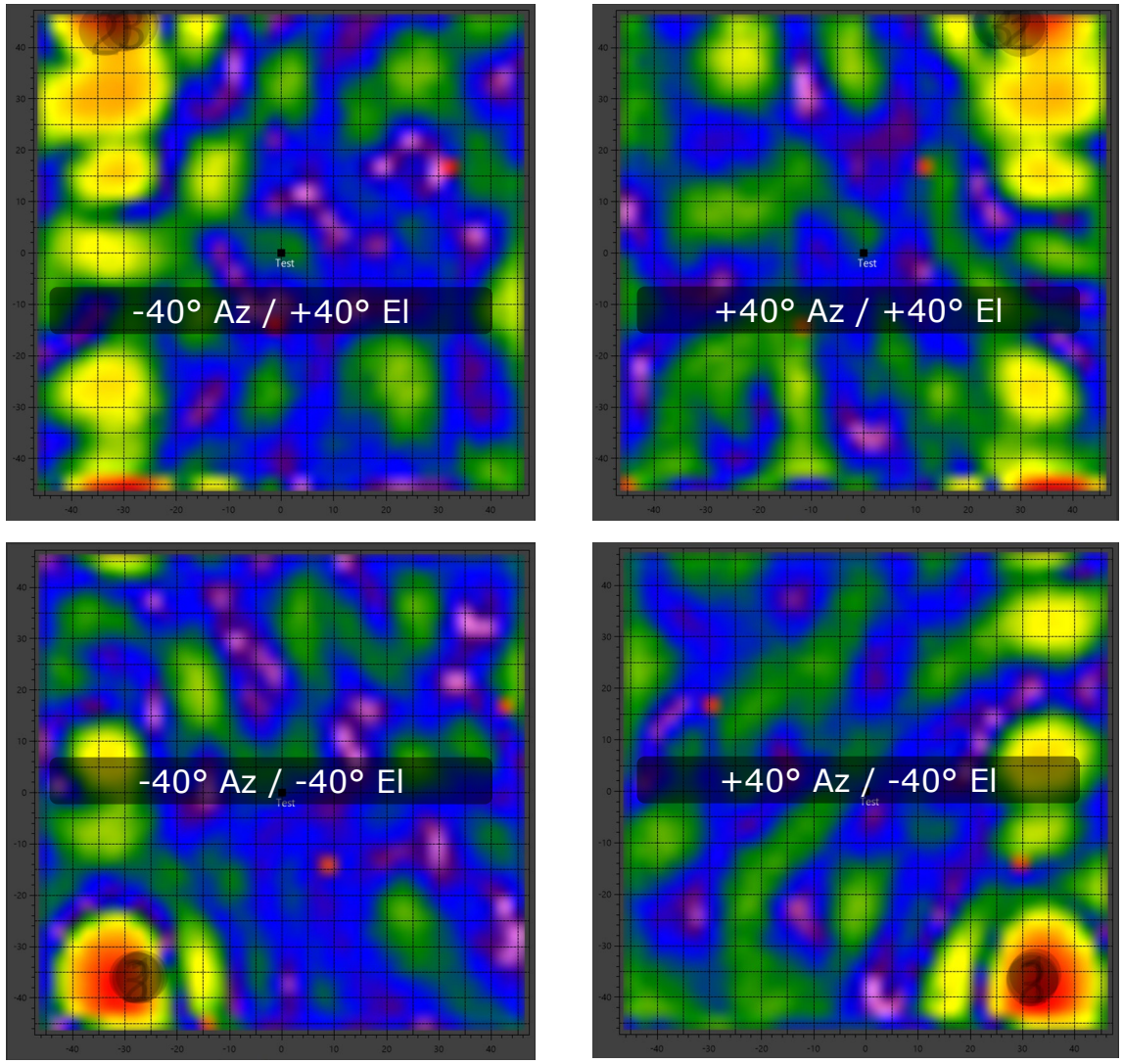
Axial Ratio Better than Expected

The RAPTR Antenna Measured Performance Data Exceeded Expectations

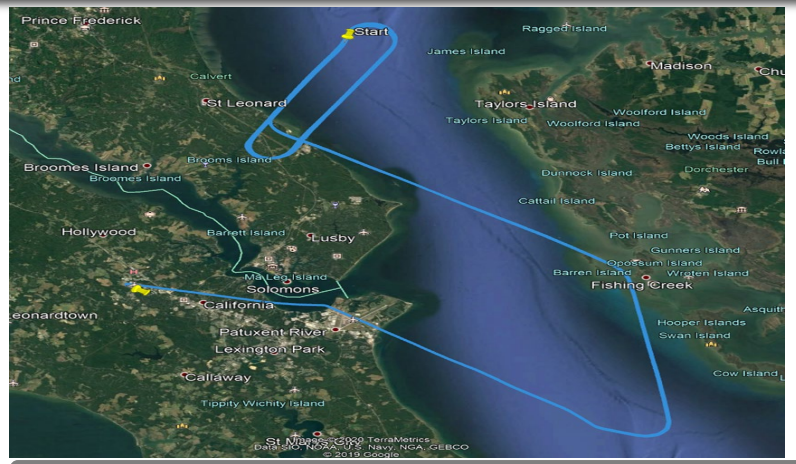
High Scan Angle Track Testing

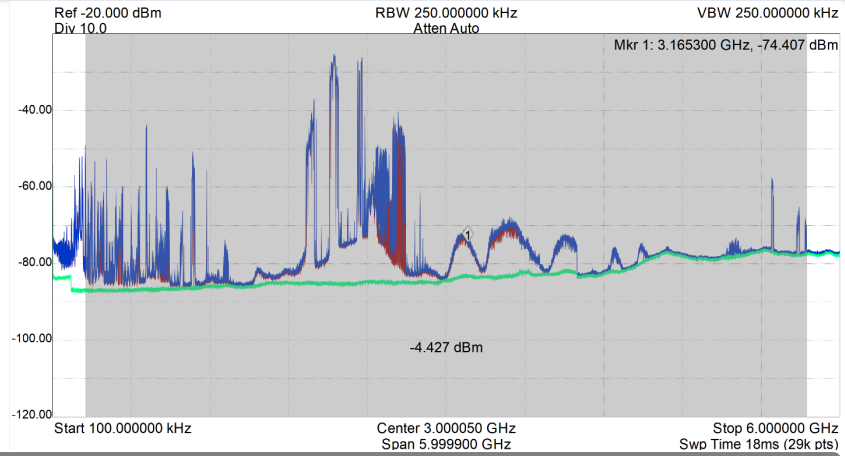
The RAPTR antenna confidently maintains tracking and data reception throughout the designed field of view for the antenna system.

Results were measured within a calibrated and accredited compact range facility and further verified through flight test activities using ground-based and airborne targets.

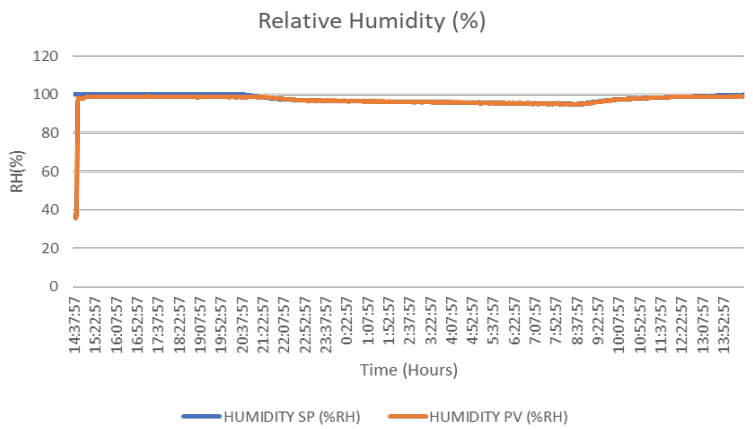


RATPR Environmental Testing

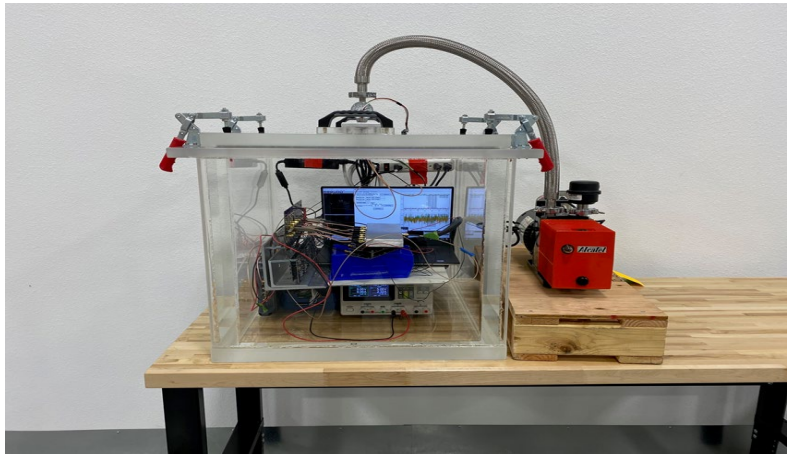




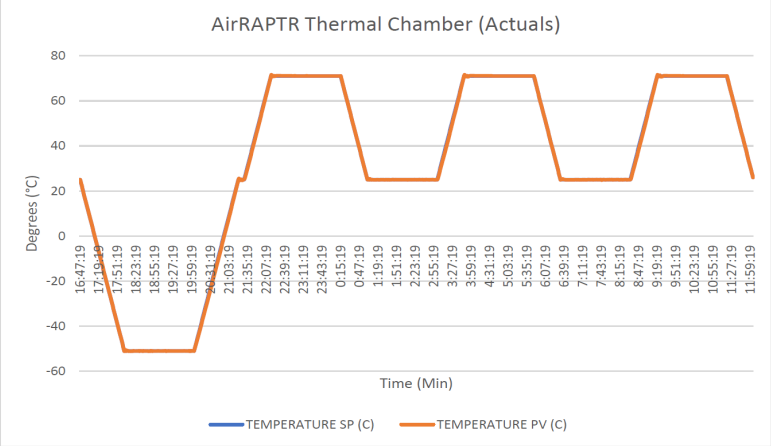
EME Tested in a Realistic Flight Environment



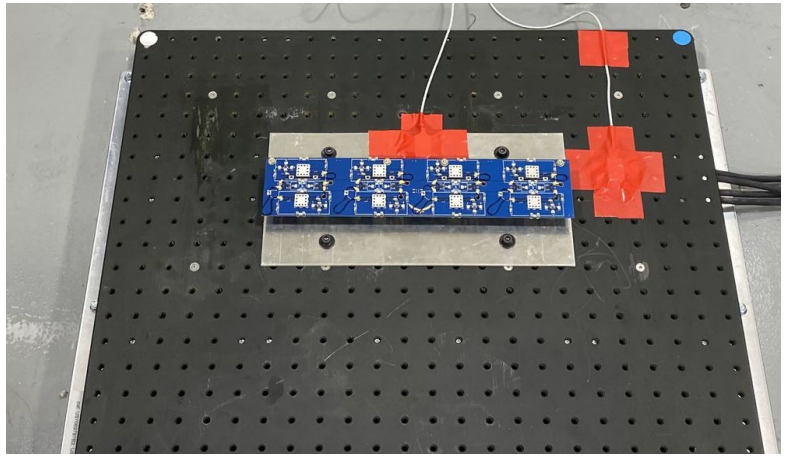
Tested to 100% Condensing Humidity



Tested to 50kft Altitude per MIL-STD-810H



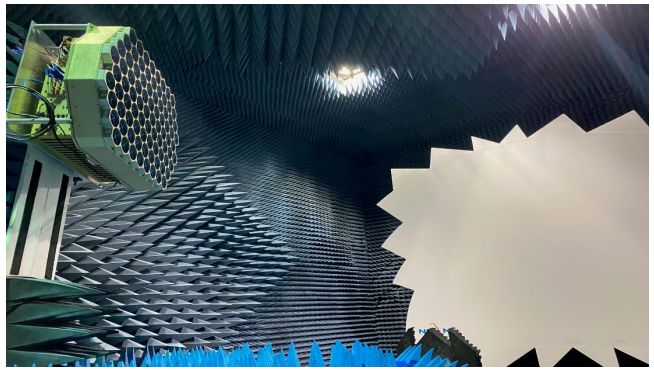
Thermal Tested to MIL-STD-810H



Components Vibration Tested to 810H

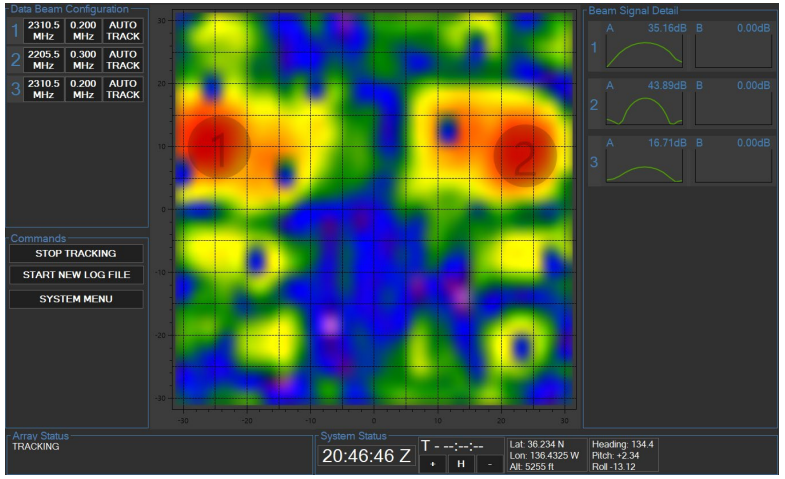
The RAPTR Environmental Test Data Shows Broad Compliance

RATPR Performance Testing

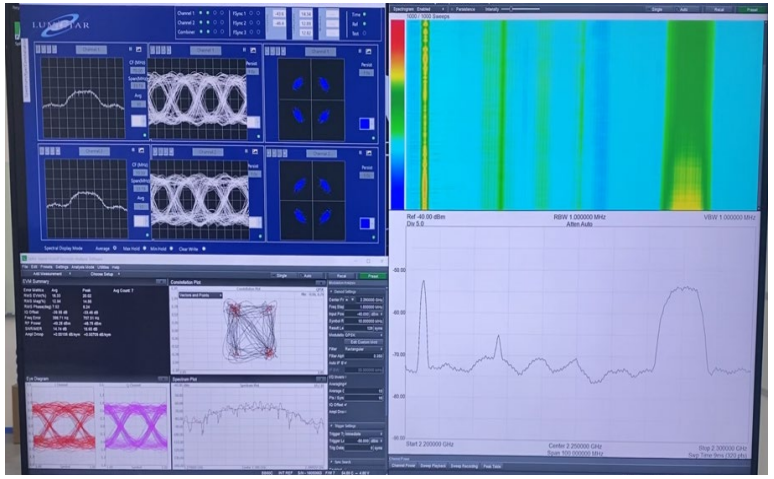


Tested on an Accredited Compact Range

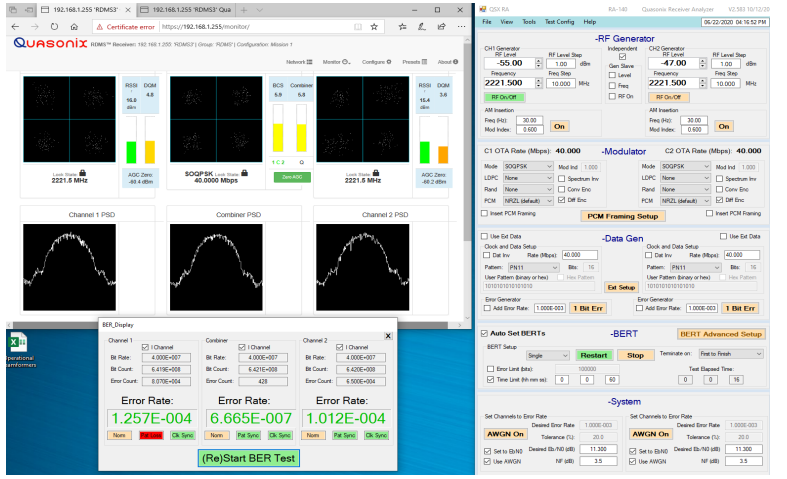
Flight Tested at Atlantic Test Range



Multiple Target Tracking Verified



Multiple Streams per Beam Verified



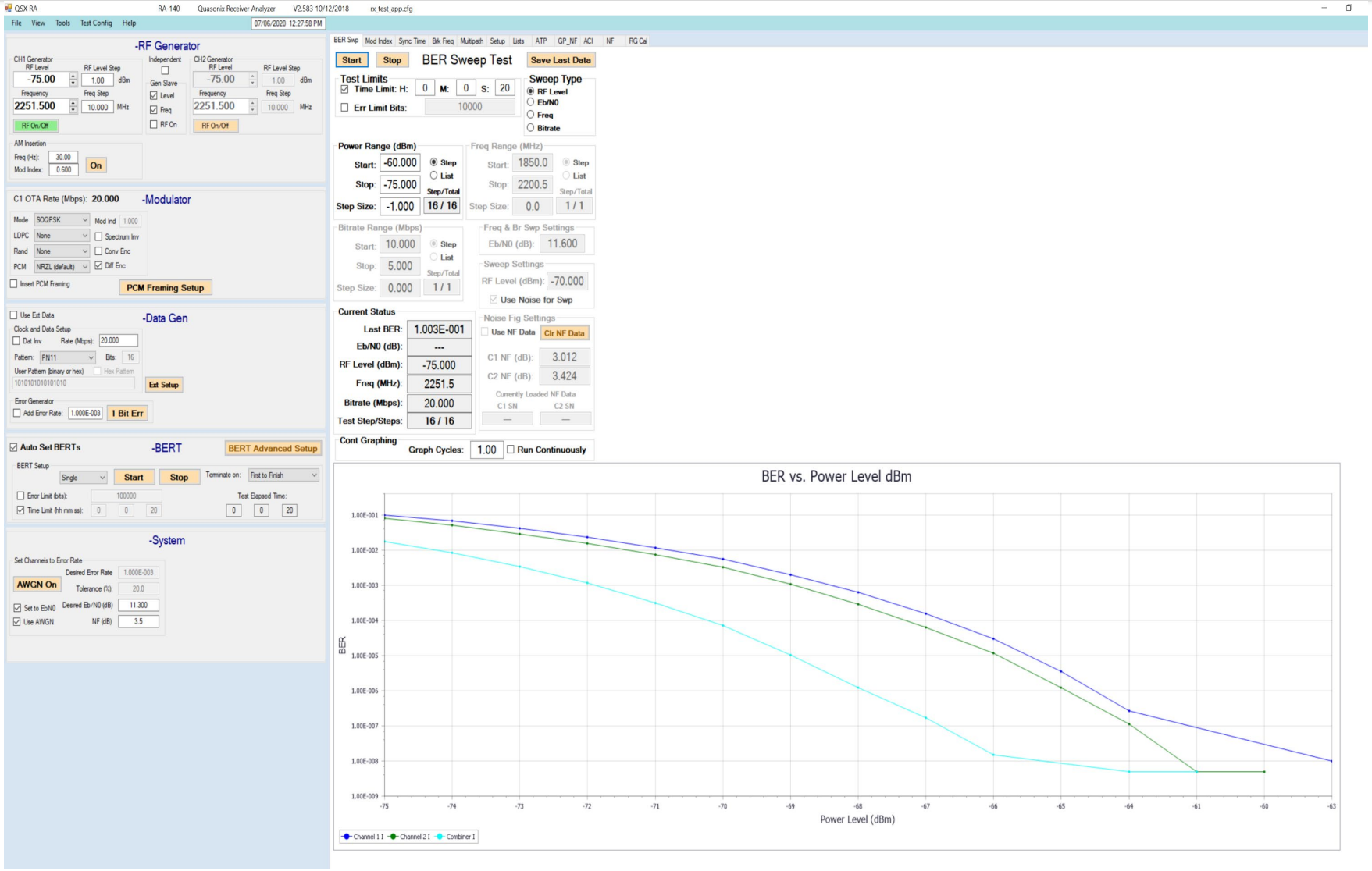
Data Reception up to 40Mbps Verified

RAPTR Chamber and Flight Test Data Showed Better than Expected Overall Performance

Array Sensitivity Testing

The RAPTR antenna sensitivity was characterized in a compact range facility by transmitting known modulated signal types at a fixed distance with varying power levels.

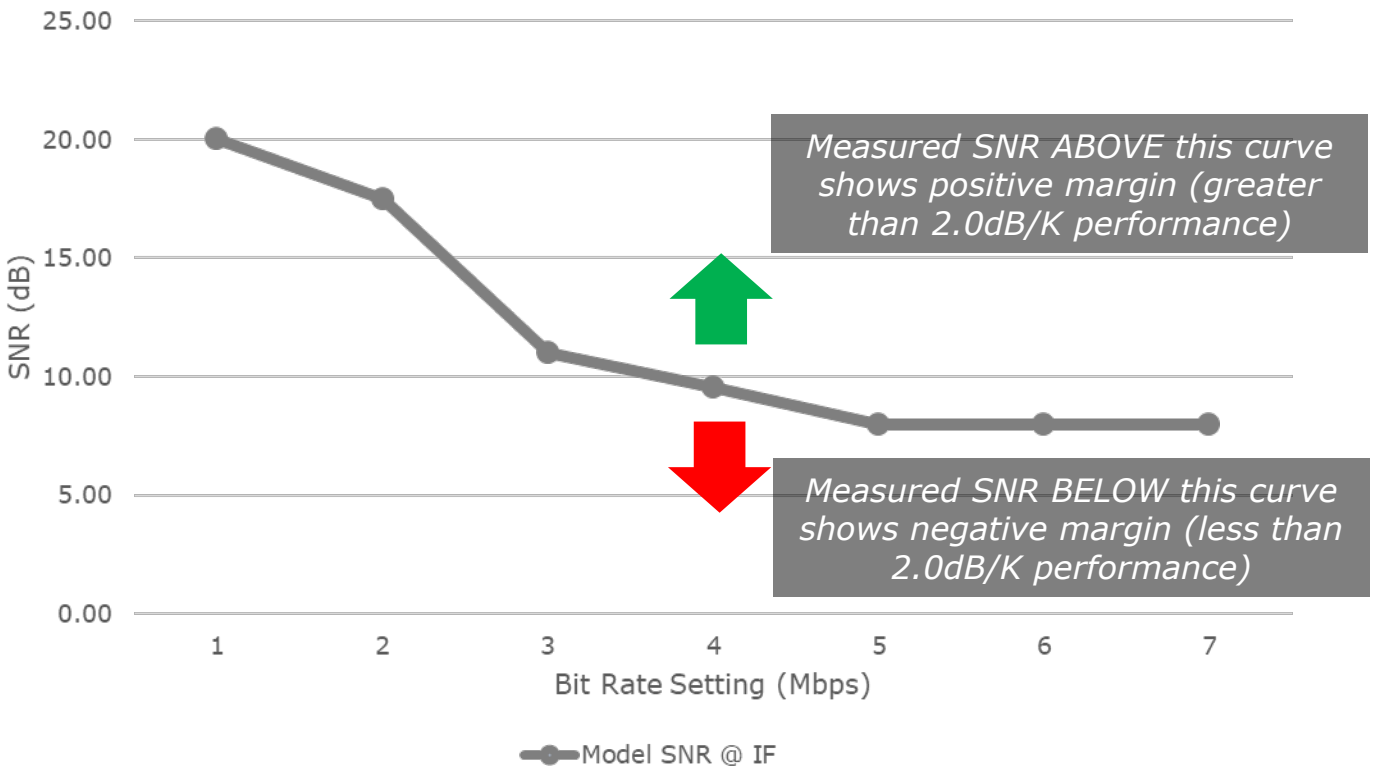
The resultant SNR and BER curves were compared to calculated link margin assessments to ascertain system G/T.



Array Sensitivity Testing

The test receiver utilized had a limited set of fixed IF filters. Using these IF filter settings at each tested bit rate in the SNR model gives an anticipated SNR curve. SNR performance data from the array above this curve indicates greater than 2.0dB/K G/T performance.

Bit Rate		IF Filter	
1	Mbps	2.5	MHz
2.5	Mbps	4.5	MHz
10	Mbps	20	MHz
20	Mbps	28	MHz
30	Mbps	40	MHz
35	Mbps	40	MHz
40	Mbps	40	MHz



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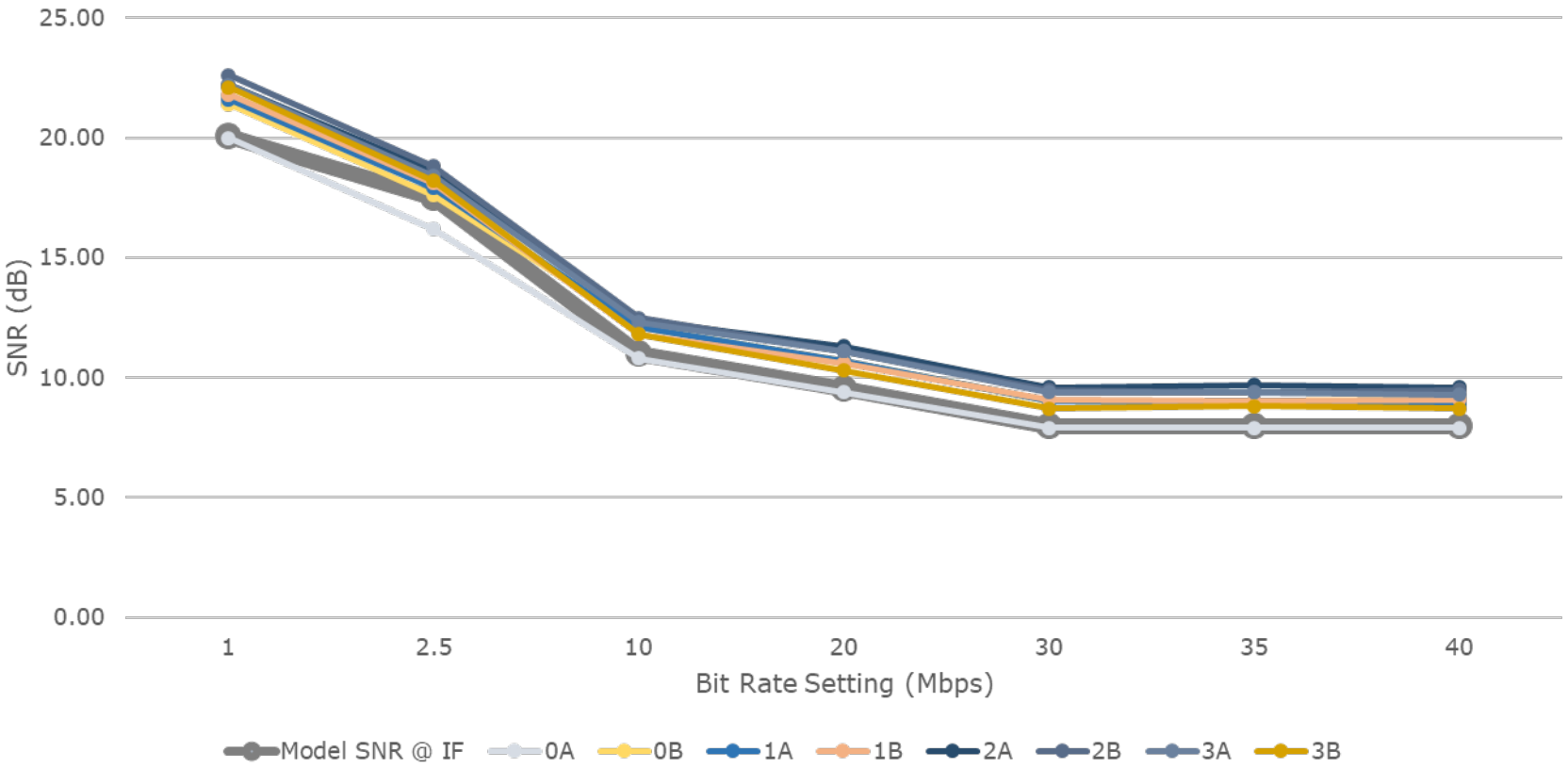
Array Sensitivity Testing



Test Data Confirms RAPTR antenna performance slightly above 2.0dB/K

RAPTR Flight Testing

A dedicated series of test flights were performed using stationary and mobile ground targets as well as an instrumented target aircraft with a telemetry test transmitter to characterize the performance of the RAPTR array.

Over this series of flight test activities, the system acquired, tracked, and received test data from signal sources ranging from 1Mbps to 40Mbps in PCM/FM and SOQPSK modulation types at varying ranges from 5nmi to in excess of 130nmi under a variety of flight conditions.

The flight test data further confirmed the verified performance data for the RAPTR antenna system gathered at the accredited Compact Antenna Test Range.