MILLIBOX OTA TEST SALES TRAINING

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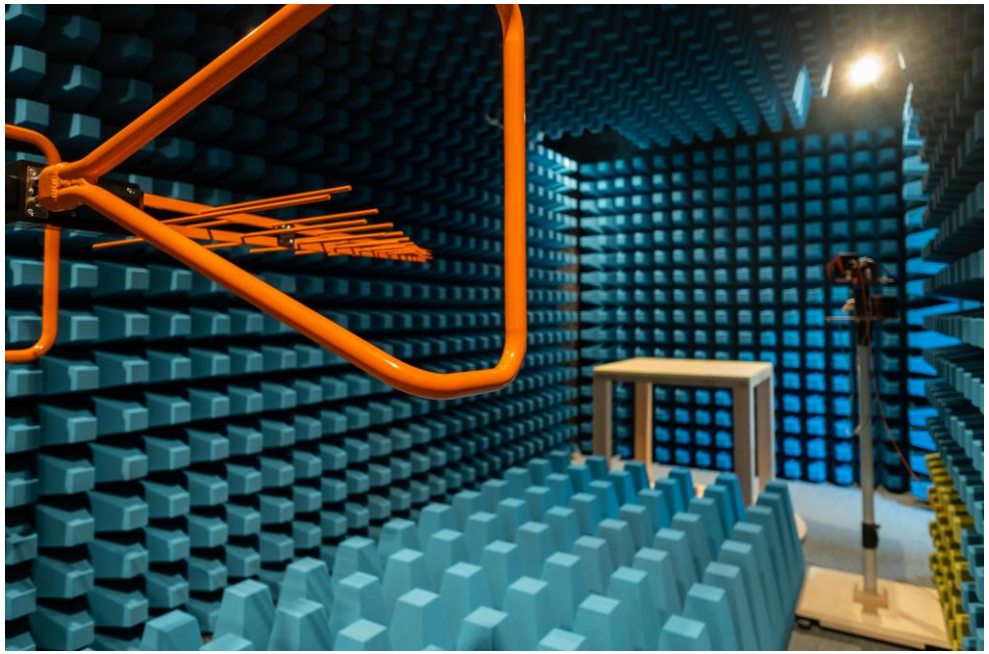
WHAT PROBLEMS ARE WE SOLVING?

- Traditional anechoic chambers for VHF, UHF, and WiFi are room sized and **VERY EXPENSIVE**
- If extensive testing is required, a chamber can be booked up for weeks at a time, delaying projects



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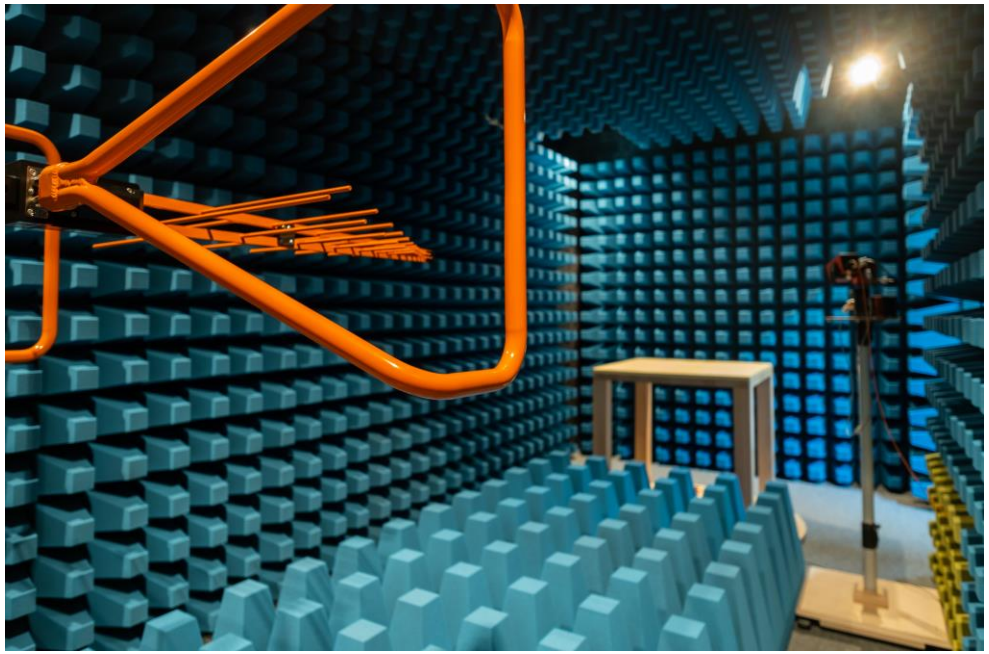
WHAT SOLUTIONS CURRENTLY EXIST?

- Anechoic chambers for VHF, UHF, and WiFi antenna test must be heavily shielded to prevent signal ingress from the outside world
- For the lower frequencies, the chamber must be physically large to allow far-field measurements to be made
- The metal shielding of the enclosure must be covered with RF absorbers to dissipate reflections
- The result is large and expensive



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WHAT IS SPECIAL ABOUT THIS SOLUTION?

- The MilliBox solution is small and relatively inexpensive compared to existing systems
- Size makes it possible to have several systems in one lab to enable simultaneous testing of multiple antennas
- This is a turn-key solution with software which drives the antenna positioners and acquires measurements from the VNA

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WHY IS THE OTA SOLUTION NECESSARY?

- Global mmWave antenna market is booming
- Rising adoption of 5G technology, increasing demand for high-speed wireless communication networks. Fixed Wireless Access delivers data to subscribers
- Growing focus on improving network capacity and coverage is propelling the market expansion
- Autonomous Vehicles and smart cities are increasing demand for mmWave antennas
- With the increasing investments in research and development, the global millimeter-wave antenna market is projected to experience substantial growth during the forecast period of 2022-2028

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WHAT IS THE OTA BUNDLED SOLUTION?

- Collaboration with MilliBox and Eravant
- Solution targeted to customers in mmWave/5G Antenna Measurements
- Already a market buzz, growth expected to continue in the coming 5+ years
- Existing solutions are large, bulky, and cost-prohibitive
- In response to existing solutions, CMT will offer smaller, more affordable OTA antenna chamber testing solution
- Two base bundled solutions available for a range of frequencies

WHAT IS THE MILLIBOX/ERAVANT OTA SOLUTION?

- MilliBox produces a compact antenna test system for use above 18 GHz
- The antennas which may be tested will come from industries like radar (not necessarily automotive), aerospace, satcom, and OTA
- The antennas must be small enough to fit within the chamber
- The system includes a VNA with extenders, the chamber, motorized gimbals to orient the antenna under test, and software for measurement control

OVER THE AIR SOLUTION PARTS

- Bundled solution will be branded cohesively
- Chamber will be blue with CMT branding
- Eravant mini-extenders will be same blue as others
- 9 GHz compatible
- Rx and Tx extender pricing

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5G OTA BUNDLE – WITH FET1854 EXTENDERS

OTA-XS-54 Includes (X= # of chambers)

- MBX0X Chamber (available in 2, 3, or 4 cubes)
- GIM04-230 Gimbal
- Cables for connecting to extender*
  - Cables to DUT sold separately
- C4209 Cobalt VNA
- FET1854 Extender Set

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CHAMBER SIZES: MBX02, MBX03, MBX04

- MBX02: 2 small cubes, 72 cm far field
- MBX03: 3 small cubes, 133 cm far field
- MBX04: 4 small cubes, 193 cm far field

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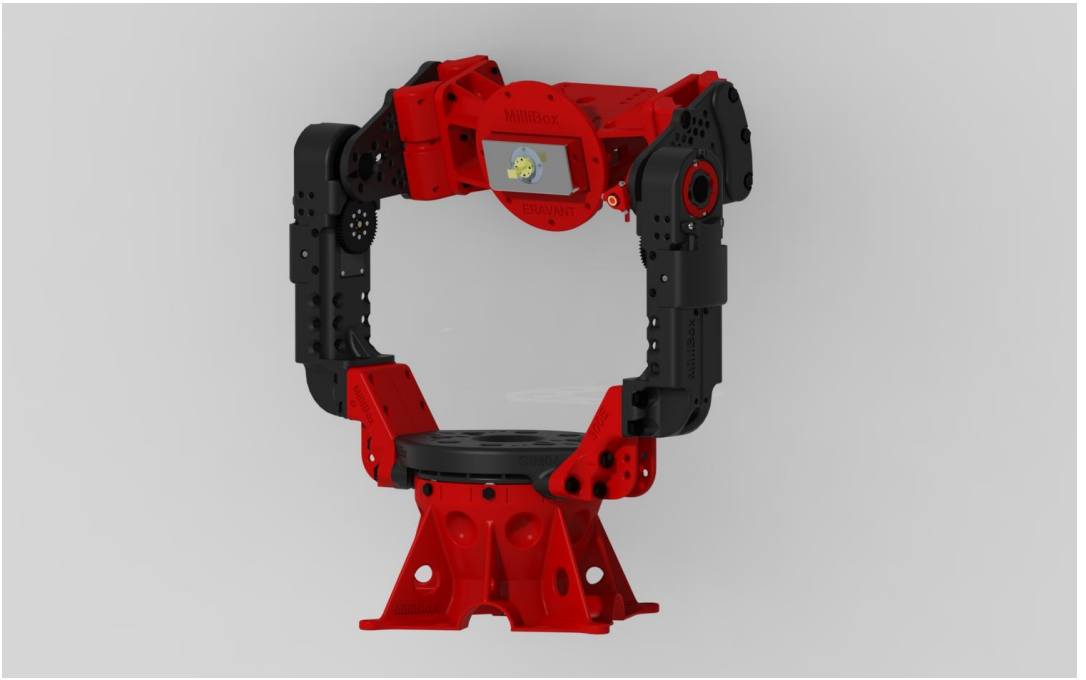
WHAT IS THE GIM4-230 GIMBAL?

- GIM4 shown at right is an H-V gimbal which rotates horizontally on its base and tilts the top piece vertically up and down.
- The 230 is meant to hold an antenna and be fed with a cable
- FET1854 extenders are located outside of the chamber



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MMWAVE OTA BUNDLE – WITH FET-WR**-M EXTENDERS

OTA-XH-XX includes (X in XH for # of chambers, XX for band)

- MBX3X Chamber (available in 2, 3, or 4 cubes)
- GIM04-300E Gimbals
- C4209 Cobalt VNA
- FET-WR**-Tx and Rx Extender Set

Solution tests from 50 GHz-220 GHz depending on extenders used

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CHAMBER SIZES: MBX32, MBX33, MBX34

- MBX32: 2 small cubes, 80 cm far field
- MBX33: 3 small cubes, 158 cm far field
- MBX34: 4 small cubes, 235 cm far field

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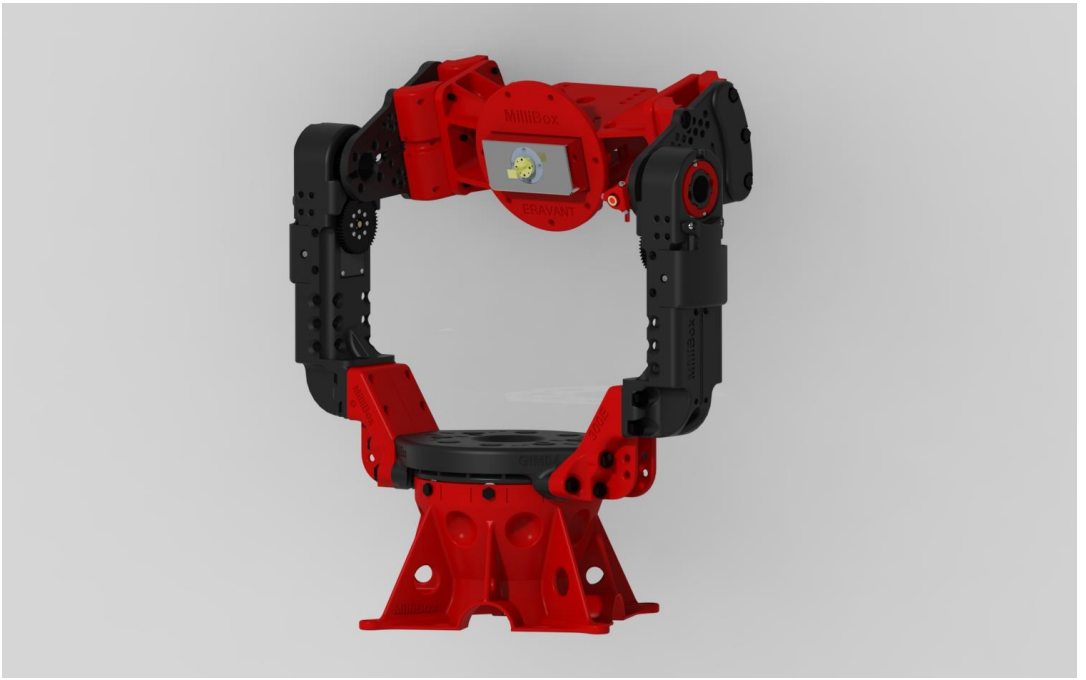
WHAT IS THE GIM4-300E GIMBAL?

- GIM4 shown at right is an H-V gimbal which rotates horizontally on its base and tilts the top piece vertically up and down.
- The 300E is meant to hold an Eravant mini extender and the antenna attaches directly to the extender module



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THE GIM5 GIMBAL

- Although it isn't part of the bundle, it's worth knowing about the GIM5 gimbal
- This gimbal rotates on its base and the top piece spins in place
- For those who want to measure in spherical coordinates

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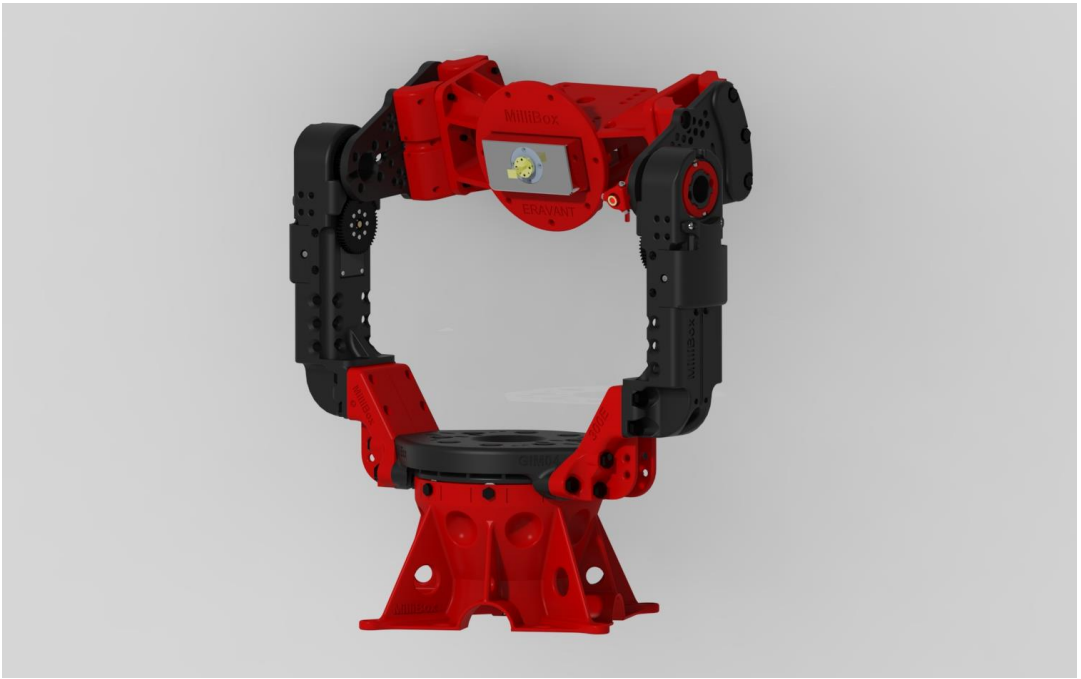
HOW DO THE GIMBALS WORK IN THE SYSTEM?

- The gimbals which orient the AUT under automation are printed PLA plastic with embedded motors
- This model turns the “U” shape horizontally and tilts the upper holder up and down vertically, an “H-V” controlled gimbal.
- The extender head is bolted into the top horizontal structure



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HOW DOES THE SMALLER CHAMBER WORK?

- The MilliBox chamber is built from standardized “cubes” made from wood panels and a PVC frame
- There is no shielding from outside interference, because none is expected at frequencies above 18 GHz
- Absorbers are still used to dissipate reflections from the walls, 50 dB 18-95 GHz

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WHAT IS SPECIAL ABOUT THIS SOLUTION?

- The controlling software is entirely written in Python code and is supplied to the customer so they may modify it
- The human interface is very straightforward and easy to use
- In the event the customer already has a test framework in place, the UI may be eliminated, and supplied APIs may be used to control the positioners directly
- The result is a low-cost, compact antenna test system

POSSIBLE PUSHBACK

- It may be that a customer has a need for this, but already owns a Keysight or Rohde VNA. ***But doesn't it make sense to purchase a dedicated USB VNA which fits beneath the system?*** CMT VNAs are integrated into the MilliBox software and perform admirably
- Some customers have SEVERAL MilliBox chambers for simultaneous testing

PRICING INFORMATION

- Total lead time is 8-12 weeks, based on longest lead time from the three companies
- Bundled products and pricing will be on Odoo to quote and on the Interactive Price List
- CMT will accept PO, place orders with MilliBox and Eravant for necessary pieces of bundled product
- MilliBox will assemble and deliver the solution to the customer
- Freight shipping will be done after PO, on customer's freight account or issued as shipping cost after confirmed by MilliBox
- For channel, discount on chamber is 10% and discount on Tx and Rx extenders from MilliBox is 12.5%

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EXTENDED PAYMENT/RENTAL/LEASING/DEMOS

- Rentals are not available at this time, will be dealt with on case-by-case basis
- Leasing is available for the system
- On-site demos will not be available, remote demonstrations by CMT only
  - MilliBox is available to support as well in more complex cases, there are some chambers at other locations globally
- 1-year standard warranty is included
- No university discount from Eravant or MilliBox, discount for universities on CMT products included in column on the price list.

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WHO WILL USE A MILLIBOX CHAMBER?

- Customers using small millimeter-wave antennas
  - 28 GHz 5G antenna panels for Fixed Wireless Access (FWA)
  - 15-17 GHz high resolution airport radar, Surface Movement Radar (SMR) and runway Foreign Object Detection (FOD).
  - 77 GHz Automotive radar
  - 60 GHz human presence detection. Commercial, Industrial, Security, safety. Good growth market, startups. Became available in 2016
  - 24 GHz industrial radar. Similar to 60 GHz, can be used for human detection

EXISTING CUSTOMERS THAT WOULD BE A FIT

USER PERSONA: **AUTOMOTIVE RADAR ENGINEER**

- Testing 77 GHz - 81 GHz
- Testing for Advanced Driver-Assistance Systems on car exterior, Infant/Hot Car Detection, Sleepy Driver Detection, etc.
- Works for a company like ST Microelectronics, Analog Devices, Infineon, NXP, Uhnder, Calterah Semiconductors

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WHAT TESTS ARE AUTO RADAR ENGINEERS DOING?

- The radiation pattern of an external radar antenna may be measured to ensure it covers the right zones in front of the vehicle
- The antenna may be measured with the bumper radome in front of it to determine dielectric loss and pattern distortion. Something like 3 dB loss is generally acceptable

WHAT DOES AN AUTO RADAR ENGINEER NEED TO KNOW?

- What sort of plots will the measurement system create? (See later slide)
  - 2D, 3D, Line plots
- Is the measurement data saved somewhere? (Yes)
  - A CSV file is created which may be opened in Excel
- What range of angles can the gimbals produce? (+/- 180 degrees)

USER PERSONA: **5G MICROWAVE ANTENNA DESIGNER**

- Testing at 28 GHz
- Designing and testing 5G antennas
- Works for a company like Ethertronics, Linx Technologies, Infinite Electronics, CommScope, MARS Antennas, Blue Danube Systems, and DVTEST

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WHAT TESTS ARE 5G ANTENNA DESIGNERS DOING?

- Panel antennas are commonly deployed for FWA. The radiation pattern can be altered by changing the phase of the signal driving the separate patches
- It is important to be able to analyze patterns to verify that energy can be directed to effectively cover chosen targets

WHAT DOES A 5G ANTENNA DESIGNER NEED TO KNOW?

- Does the MilliBox System make near-field measurements?
  - No, that would require analytical software which is not included or available from MilliBox
- Can the system measure phase as well as amplitude?
  - Yes, with proper calibration, phase measurement is possible
- Can I make 3D plots of the antenna pattern?
  - Yes, in fact you can print the result on a 3D printer!

USER PERSONA: **SATCOM ANTENNA DESIGNER**

- Testing from 18 to 40 GHz
- Designing and testing Satellite Communications antennas
- Works for a company like Cobham, L3 Harris, Qualcomm, AVL Technologies, General Dynamics, Holkirk, Norsat, Xi-an Starnet Antenna Technology

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WHAT TESTS ARE SATCOM ANTENNA ENGINEERS DOING?

- Panel antennas which steer beams to multiple targets on the earths surface must be evaluated
- The radiation pattern must be verified

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WHAT DOES A SATCOM ANTENNA DESIGNER NEED TO KNOW?

- MilliBox is capable of printing custom mounts for a gimbal
- This might be required for a large panel

USER PERSONA: **MILITARY RADAR ENGINEER**

- Frequencies are classified
- Designing and testing Radomes/Radar for Aircraft, Electronic Countermeasures
- Works for a company like Cobham, L3 Harris, EuroLab, ACR/Artex, Ball Corporation, Honeywell, CMC Electronics

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WHAT TESTS ARE MILITARY RADAR ENGINEERS DOING?

- Antenna gain
- Steered beam patterns
- Radome loss

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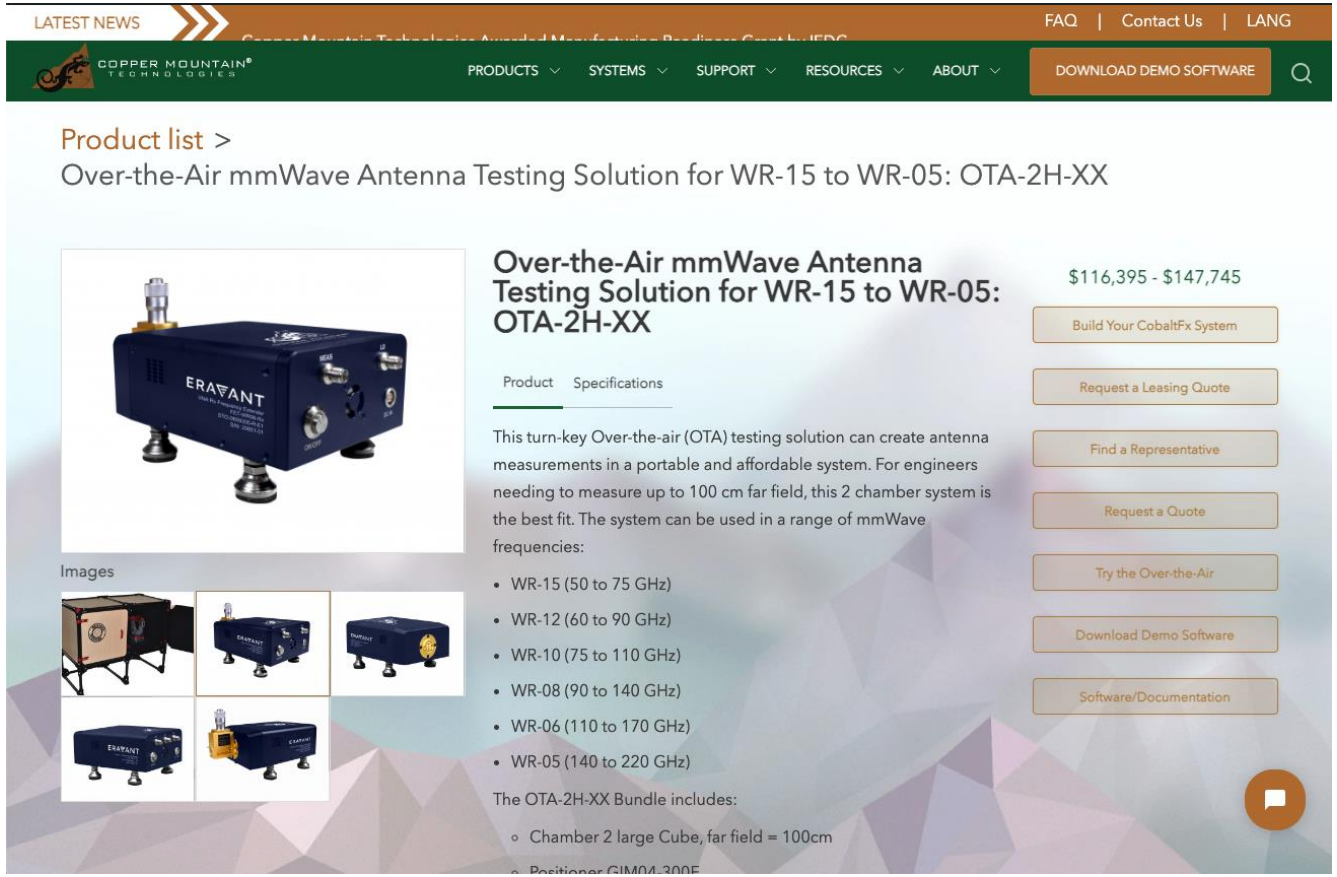
WHAT DOES A MILITARY RADAR ENGINEER NEED TO KNOW?

- Automated testing may be used to measure a series of steered beam shapes
- It is a simple matter to measure radome loss by inserting the material in front of the AUT

WHERE CAN PROSPECTS FIND THIS?

- There will be bundles for each frequency range (18-54 GHz, WR-15, WR-12, WR-10, WR-08, WR-06, WR-05) on the CMT website
- On MilliBox and Eravant websites
- Plan for webinars in February and May with MilliBox
- Co-exhibiting at IMS and EuMW
- Product catalog updates, data sheet



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WHAT DOES THE SOFTWARE LOOK LIKE?

- Software will come on flash drive with the products.
- The main menu presents choices for gimbal control, measurement and post processing which are accessed through single letter commands

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************* MAIN MENU *************************
************ USE KEYBOARD ***********************
* Press <ESC> or <q> to close ports and quit!
__________ MOVEMENT/ALIGNMENT __________
* use <arrow keys> or <ijkl> to adjust H and V angles
* use <[> or <]> to adjust polarization angle
* use <a> to reduce step size for finer alignment resolution
* use <s> to increase step size for coarser alignment resolution
* press <ZERO> key to store H0 V0 P0 position
* press <h> to go home to last saved H0 V0 P0 home position
* press <m> to open the direct move travel menu
* press <b> to start electronic beam alignment
* press <.> to print current position
_________ GIM MOTION SETTINGS __________
* press <g> to display GIM motion parameters
* press <v> to open the velocity setting menu
* press <r> to open the accel limit setting menu
* press <t> to open the angle limit setting menu
* press <e> to toggle accuracy setting
* press <w> to reset GIM motion parameters to default
_________ MEASUREMENT SETUP ___________
* press <y> to set measurement mode (VNA/SG+SA/SA/NONE) and set
equipment VISA address
* press <x> to get current power measurement
* press <n> to save current power measurement to file
* press <o> to display correction factor menu
* press <f> to force instrument re-initialization
_________ MEASUREMENT SWEEPS __________
* press <d> to start default plot H -90 90 V -90 90 Step 15deg
* press <c> to start accuracy position check menu
* press <z> to toggle zigzag movement mode for 2D sweeps
* press <1> to start a 1-D sweep
* press <2> to start a 2-D sweep
* press <3> to start a 1-D sweep in E-plane and H-plane
_________ DATA POST-PROCESSING _________
* press <p> to plot from previous measurement
* press </> to display post-processing menu
___________ SPECIAL SETTINGS ___________
* press <:> to change motor baudrate configuration
* press <+> to reset offset for home position
* press <\> to toggle test menu
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WHAT DOES THE SOFTWARE LOOK LIKE?

- After alignment, physical sweep is performed at a single frequency
- The data is saved, and the results may be plotted

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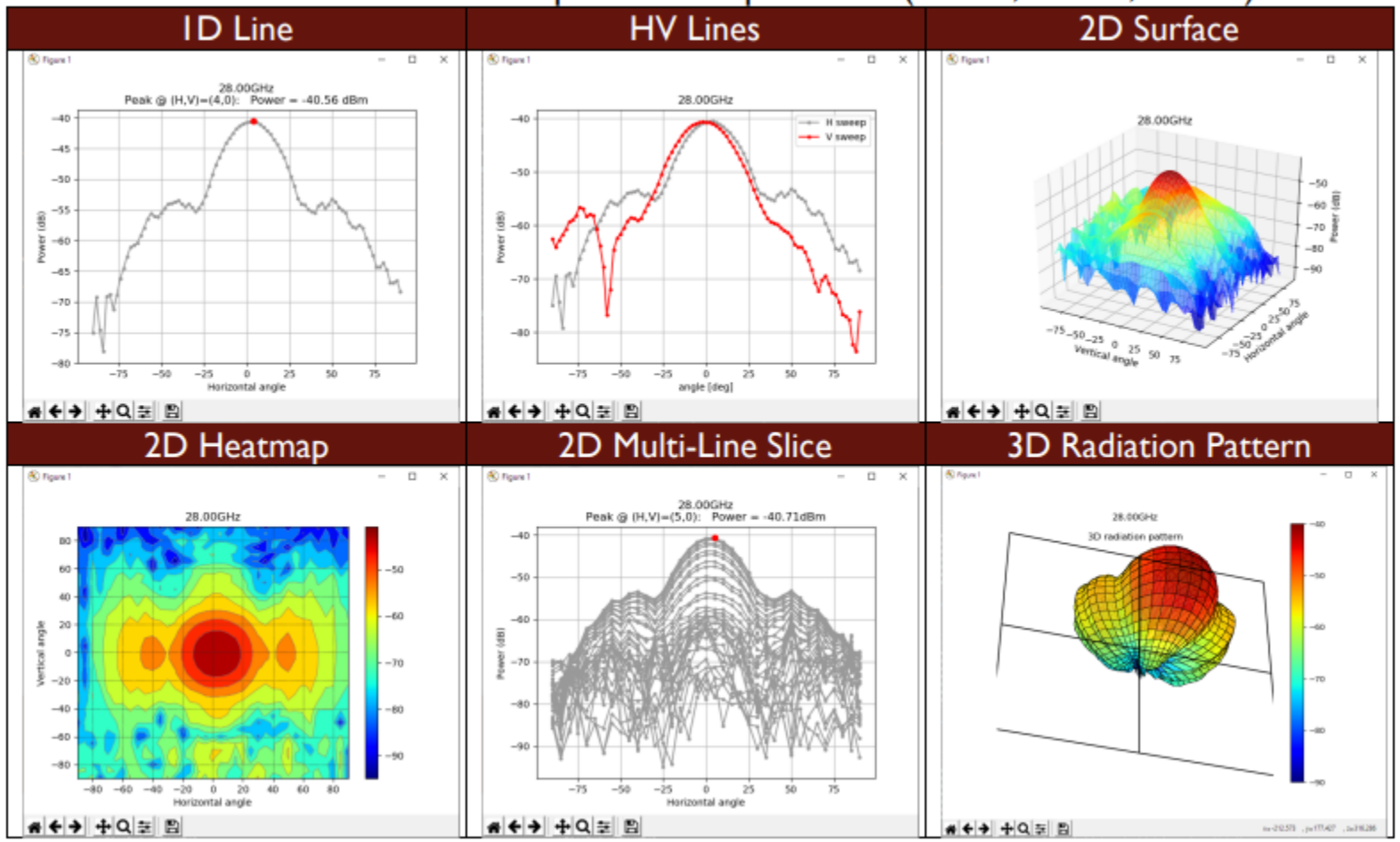
OUTPUT PLOTS

Here is an illustration of the different plots for HV positioner (GIM01, GIM03, GIM04)



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ADDITIONAL QUESTIONS

- Can I have multiple MilliBox chambers in the same room without interference?
  - Yes, the absorbers provide 50 dB of attenuation, or 100 dB total through two walls
- Can I post-process my previously measured data to make different plots?
  - Yes, the measured data is saved in a CSV file which may be read back in and plotted any number of ways

ADDITIONAL QUESTIONS

- Can I integrate the MilliBox test system into my own test framework?
  - Yes, APIs are available which can control the gimbals and the VNA directly without using the UI. Thus, testing can be integrated into existing test programming

RESOURCES FOR LAUNCH

- Link to Solution Overview for OTA Solution
- Bundle parts outline and total pricing
- Rx and Tx extender pricing
- MilliBox Operating Manual
- MilliBox Catalog

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WHY IS THE CMT SOLUTION A GOOD FIT?

- The MilliBox solution is a low-cost alternative to the room-sized anechoic chamber
- Our USB VNAs are ideal for this application due to their competitive price and small size
- It is easy to dedicate a CMT VNA to the test setup and never move it
- It's hard to beat the CMT 9 GHz VNA/Eravant/MilliBox solution