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A New Class of 9:1 Bandwidth Ratio Phased Array Using The Frequency-scaled Ultra-wideband Spectrum Element (FUSE) Design With Aperture Tiling For Beam Shaping Reconfigurability, Part 3

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14. ABSTRACT
AFRL want to develop a detailed understanding of key trade space issues associated wideband arrays. MITRE proposed to build eight FUSE subarrays that are amenable for tiling and reconfigurability to any array shape

15. SUBJECT TERMS
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Reconfigurable FUSE Part#3

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22 March 2021

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Summary

- AFRL want to develop a detailed understanding of key trade space issues associated wideband arrays

- MITRE proposed to build eight FUSE subarrays that are amenable for tiling and reconfigurability to any array shape

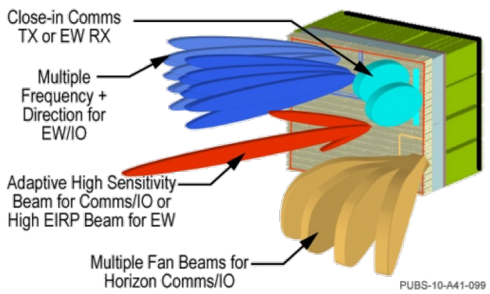

Figure 1, Multifunction concept

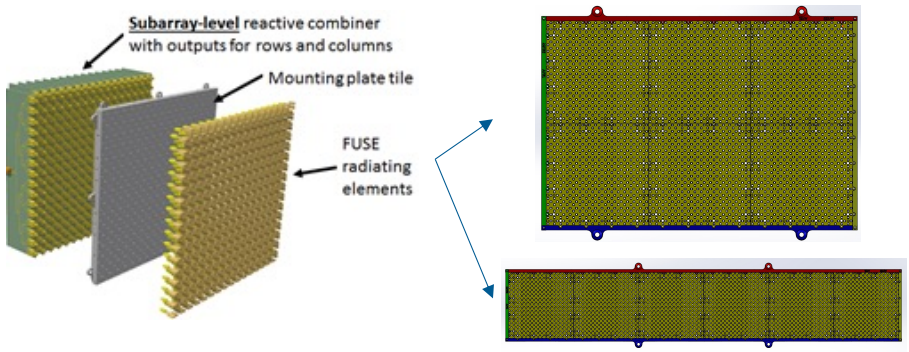

Figure 2, Tiling concept

Modular FUSE enables better understanding of trade space issues associated with practical implementation of multifunction phased arrays

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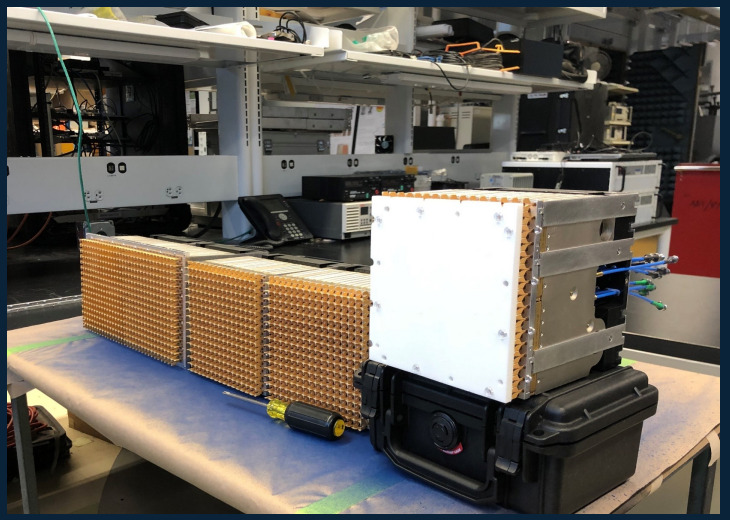
Outcome

- A 2-18 GHz FUSE subarray tile that scans +/- 60 deg. in all volume
  - A low-profile, custom-made feed cards were built to combine 16 columns, scanning +/- 60 deg. in azimuth only
  - The tile has RF-transparent Rohacell cover. A polycarbonate cover is added for extra for protection during shipping and handling
- Eight tiles were built with their associated picture frame / rails and bridges that allow the sponsor to assemble them in different configurations: 1x1, 2x2, 2x3, 1x6, and 2x4



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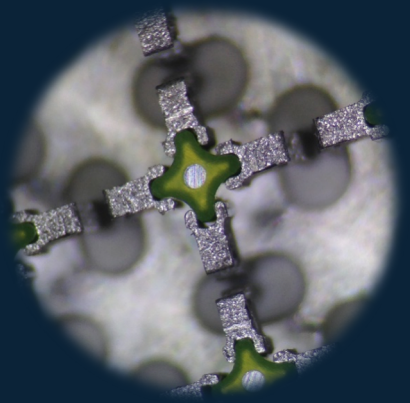
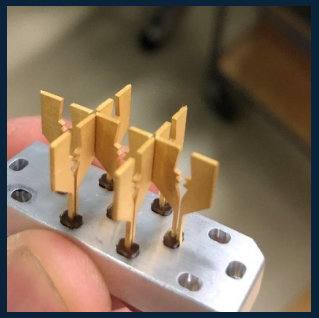
Evolution in the FUSE

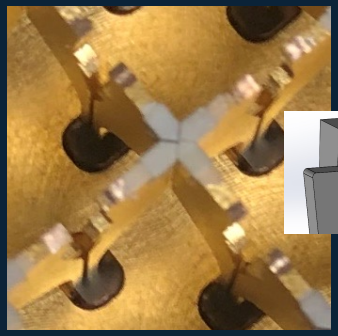
GOMAC 2016

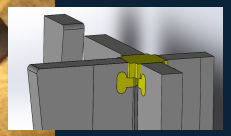


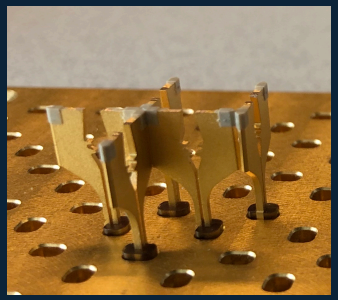
GOMAC 2018



GOMAC 2020 - Present



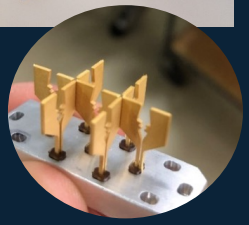




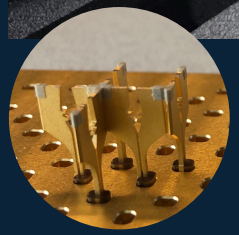
Eliminating the metallic posts reduces the FUSE baseplate weight, and eases assembly
Adding the built-in caps enables better registrations between adjoining elements

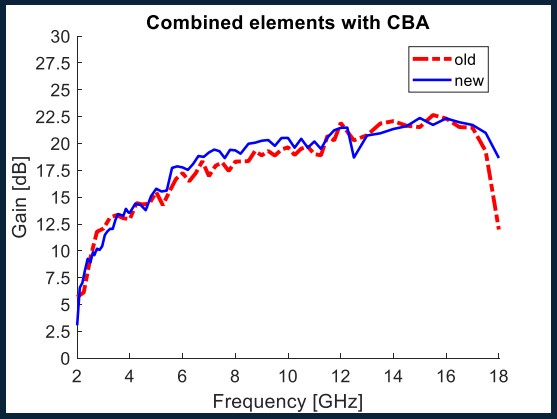
The Decade BW FUSE tile
Old vs. new performance

Old design



New design



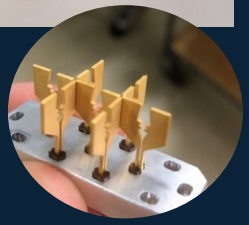


Peak gain

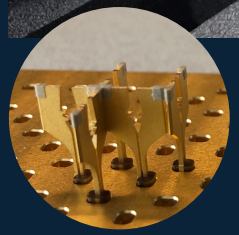
The new design has increased gain at the higher end of the band

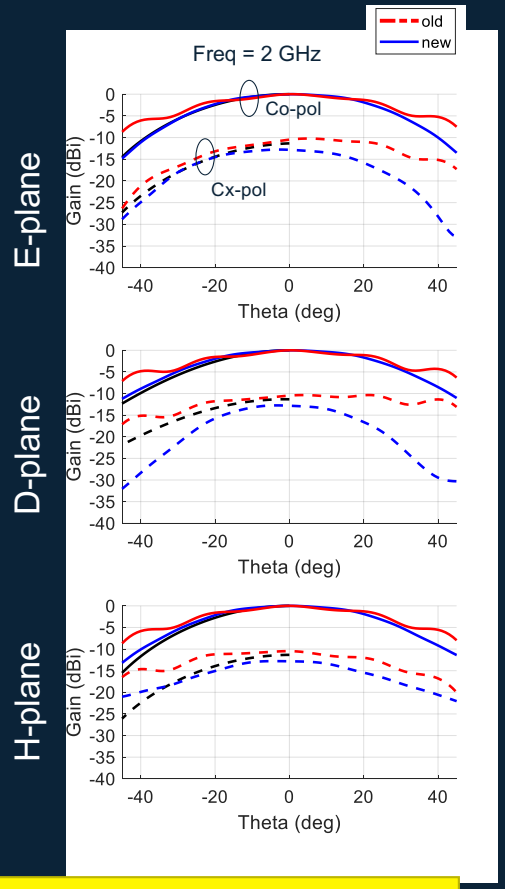
The Decade BW FUSE tile
Old vs. new performance

Old design



New design

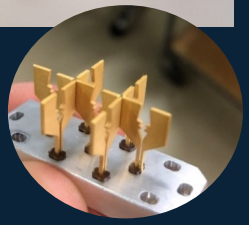




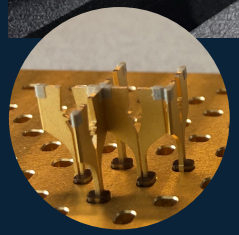
The new design has smoother patterns, and lower cross polarizations at 2 GHz

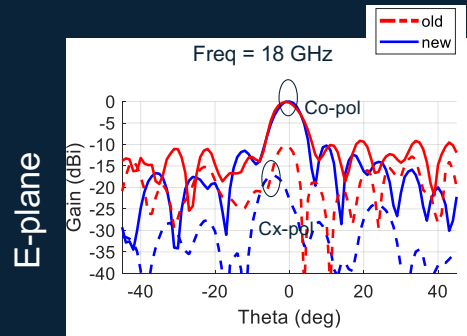
The Decade BW FUSE tile
Old vs. new performance

Old design



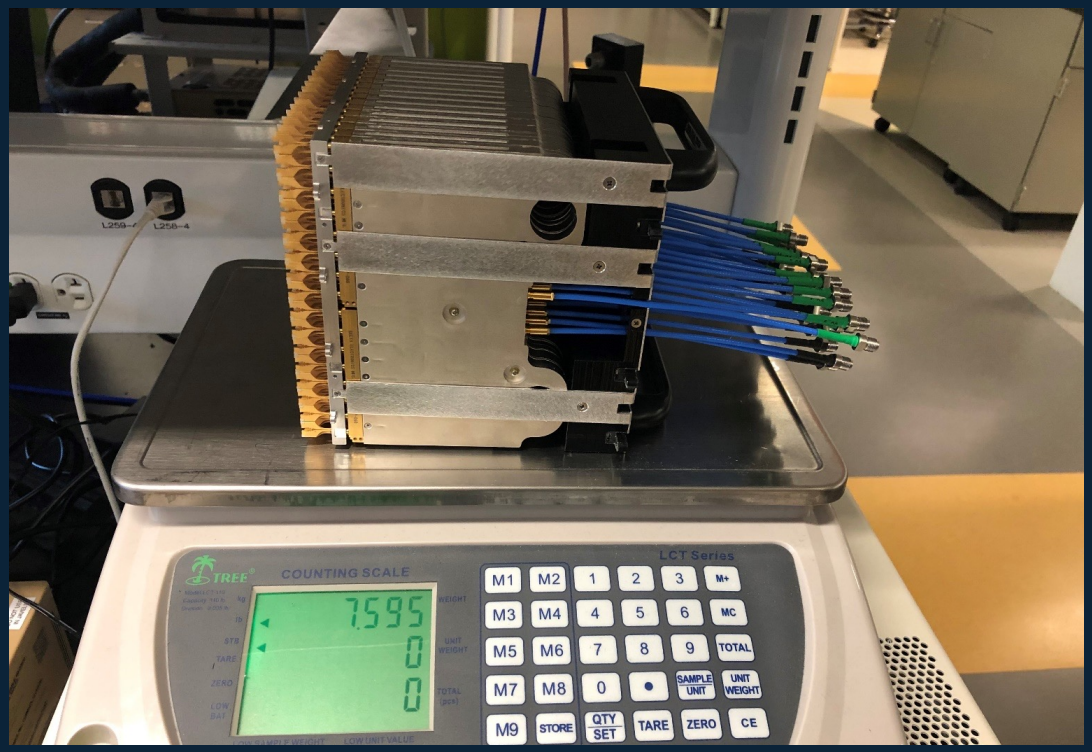
New design

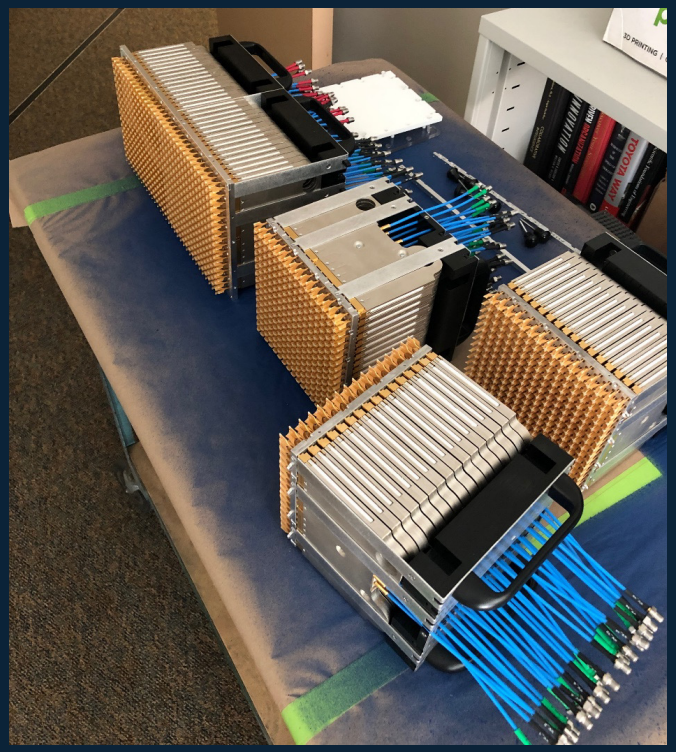




The new design has smoother patterns, and lower cross polarizations at 18 GHz

The new 16x16 Decade BW FUSE tile

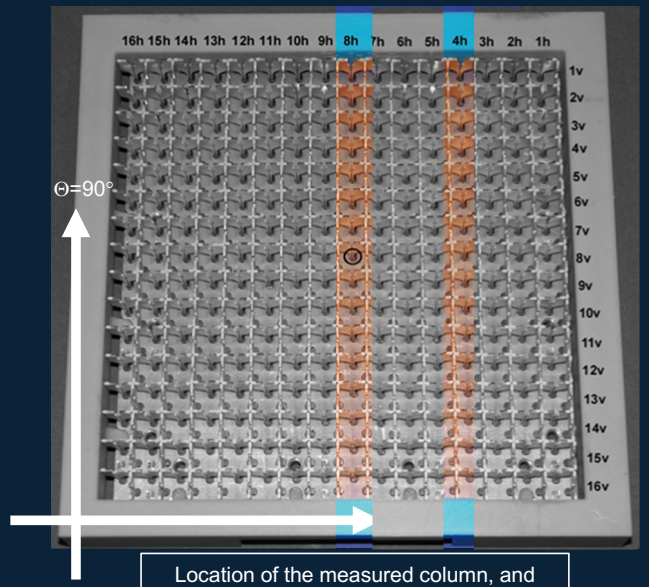




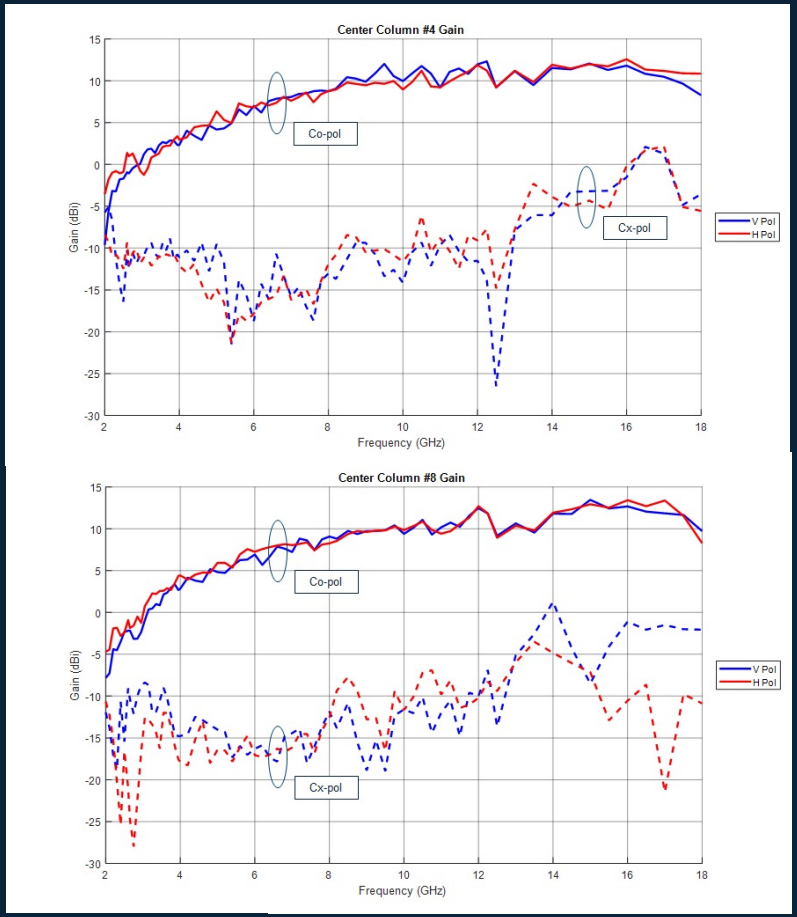
Weight of each fully assembled FUSE tile < 8 lbs

Column Data

Measurement plan:



Location of the measured column, and coordinate angles



Observations: Peak gain, cross-polarization and shape of the patterns from both polarizations in each column agree well

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Measurement setup at the MITRE antenna chamber

- **Two COTs 8-way and a 2-way power dividers are used to excite all 16-columns on the array.**
  - Their losses were removed from the subarray's measured gain data
- **The first tile was measured over the full 2 GHz – 18 GHz spectrum. Then to save time, the next five tiles were measured over 13 GHz – 18 GHz.**

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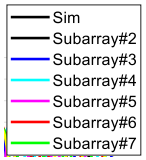
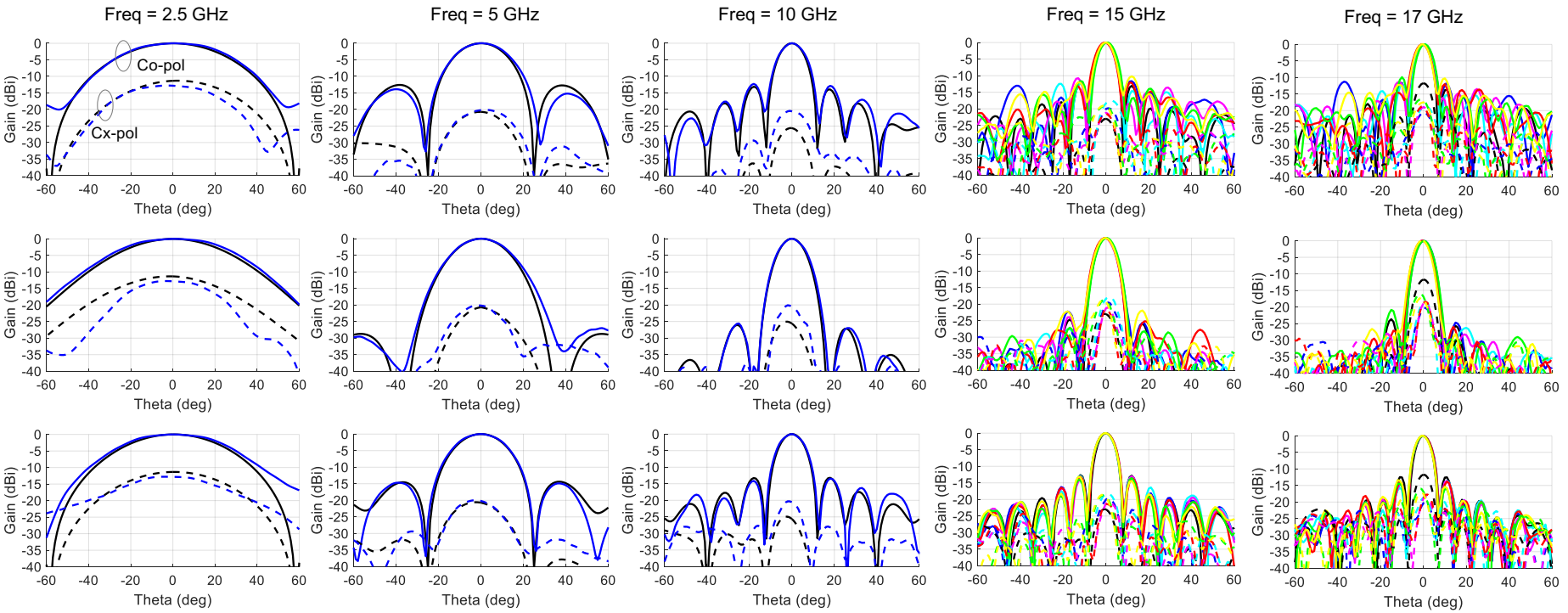
FUSE Array Performance with all CBA
Sim. vs. Meas. – Normalized H-Pol Combined Patterns



E-plane
D-plane
H-plane



Excellent agreement between simulation and measurements

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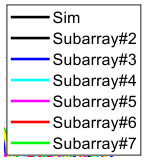
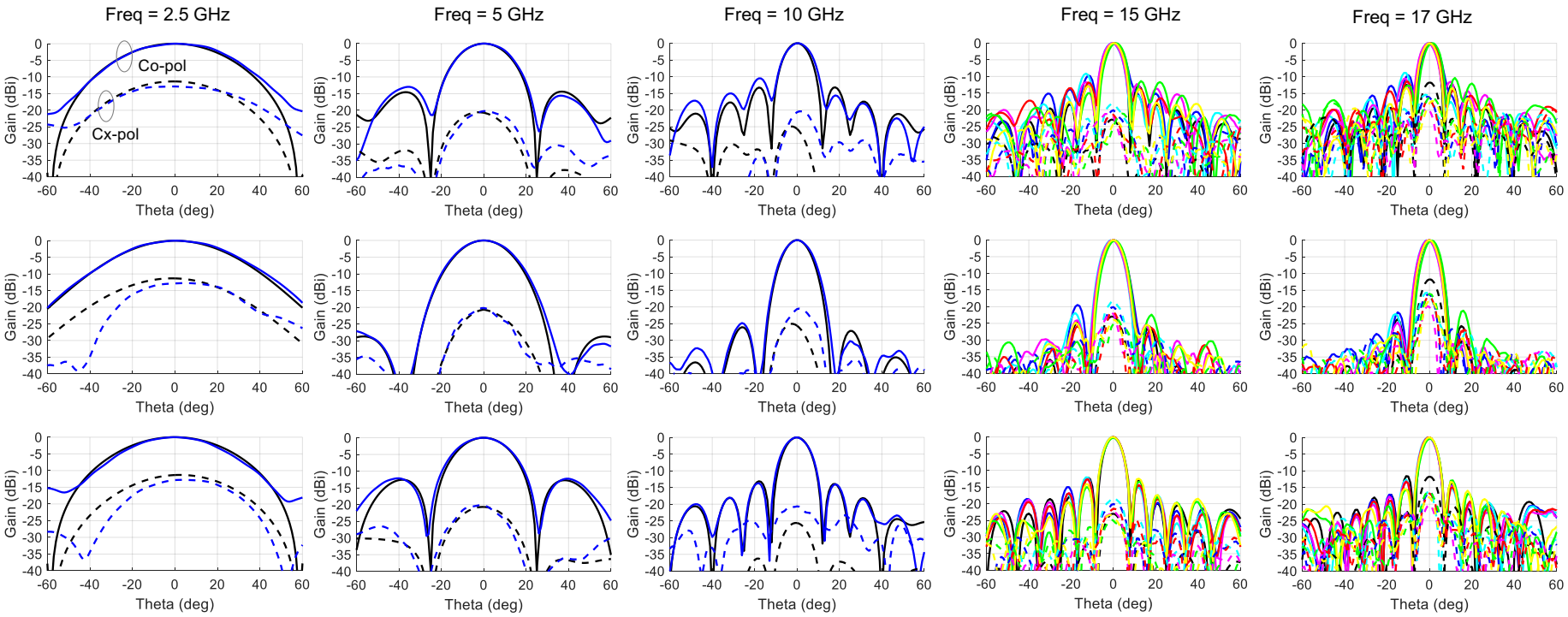
FUSE Array Performance with all CBA
Sim. vs. Meas. – Normalized V-Pol Combined Patterns



E-plane

D-plane

H-plane



Excellent agreement between simulation and measurements

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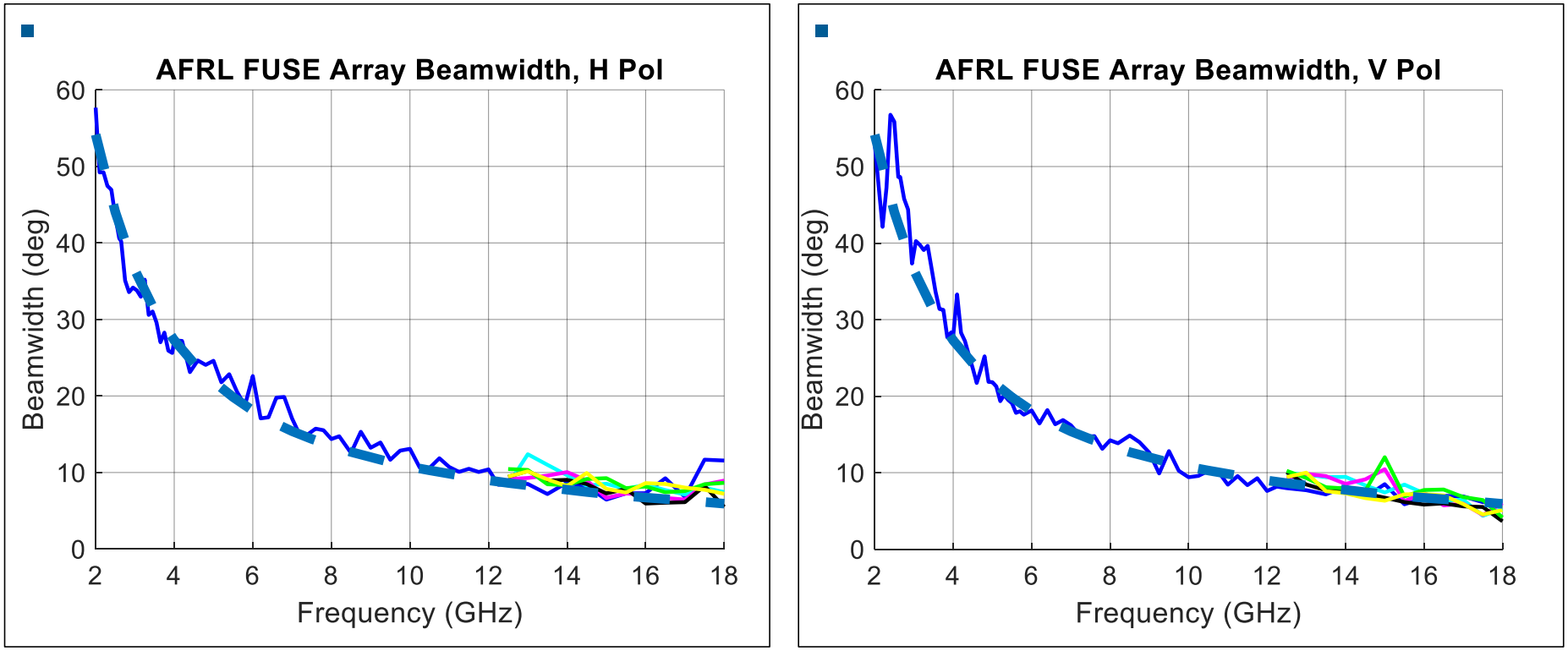
FUSE Array Performance with all CBA Beamwidths



Excellent agreement between simulation and measurements

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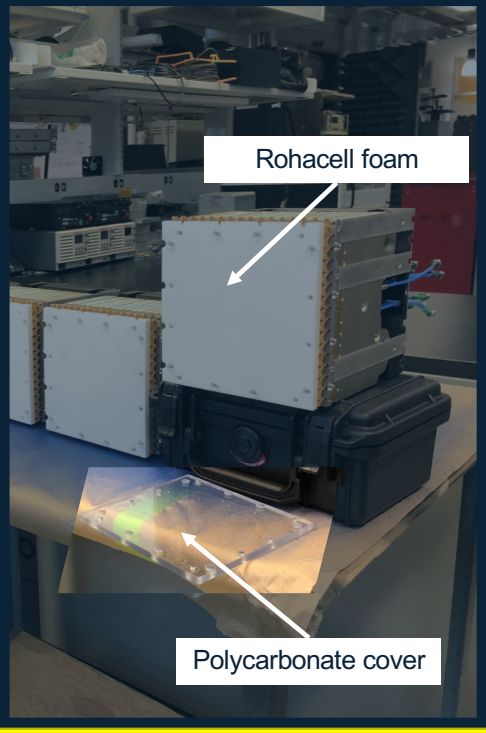
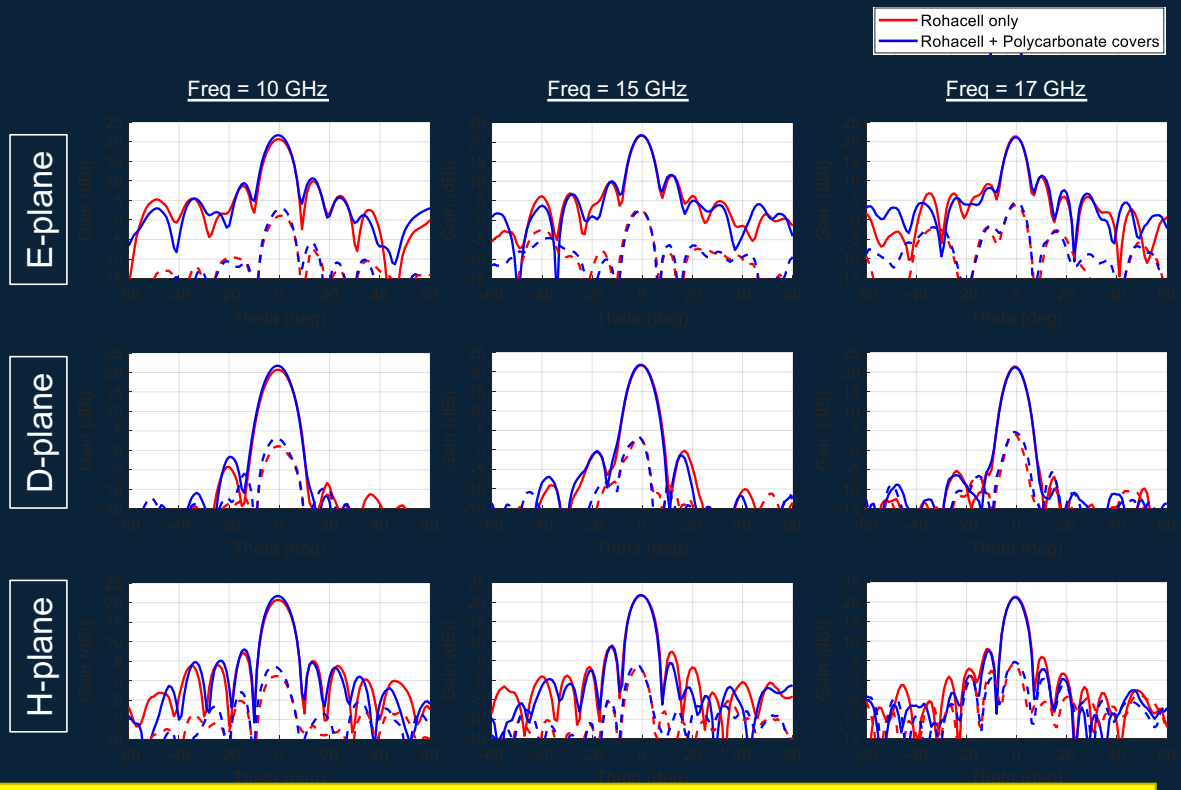
RF-transparent Rohacell and polycarbonate covers

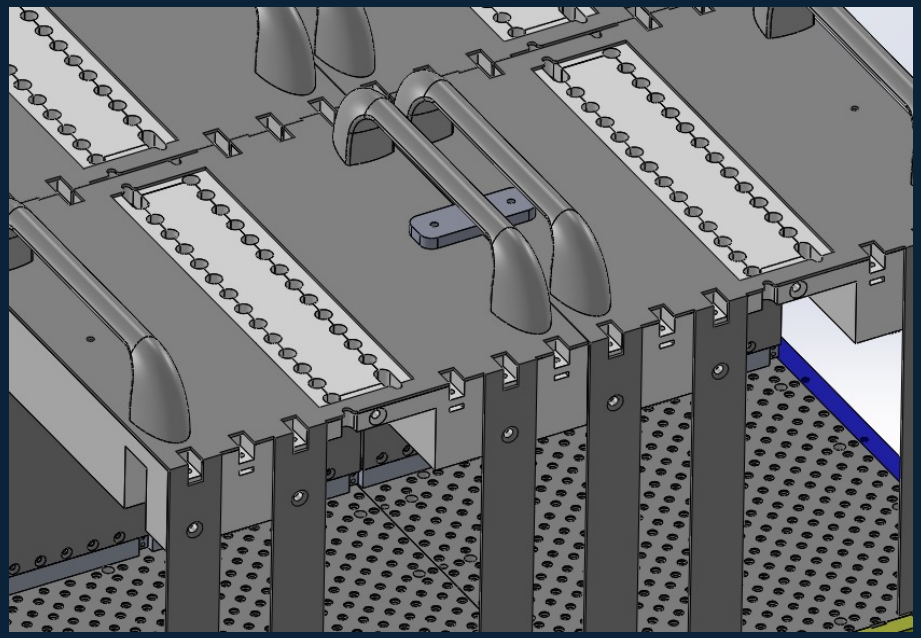


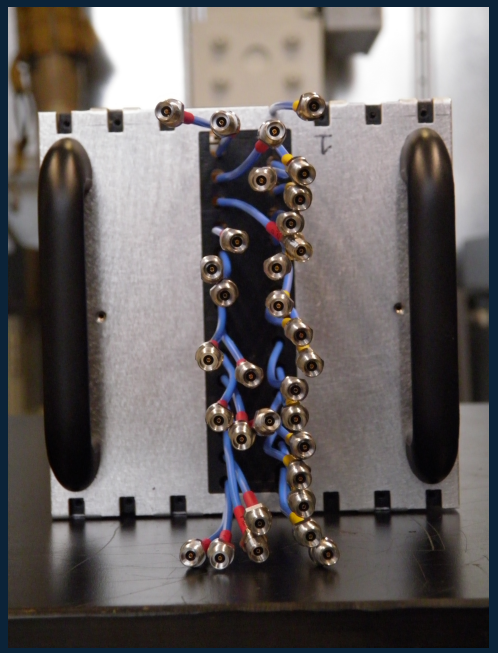


The polycarbonate covers provide additional protection during shipping and in outdoor demonstration. These covers have negligible effect on the radiation patterns at broadside

Back cover

- Designed with interlocking bridges on the backside of the tiles to prevent pivoting while carrying and handling the tiled subarrays





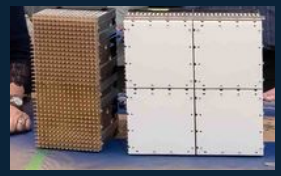
Wood mounting fixtures

- A pedestal was built to hold both tile configurations on MITRE Nearfield antenna tower
- Two swappable carriers were designed to house each configuration with all COTS combiners that will illuminate the beam from a fully excited aperture

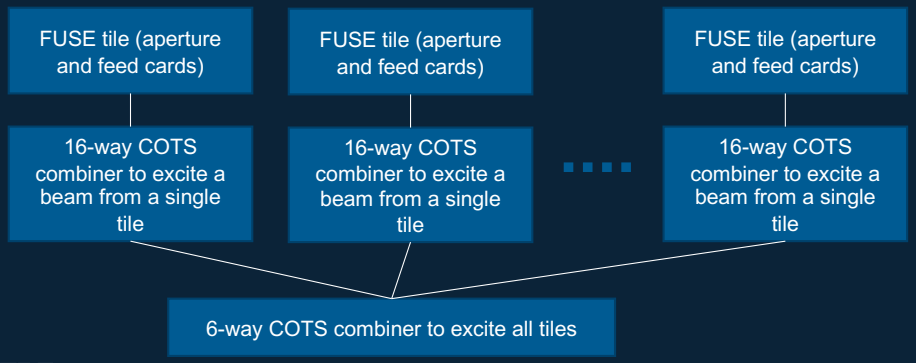
Mounting fixture for a 6x1 tile configuration

96x16 dual polarized FUSE

Mounting fixture for a 3x2 tile configuration



48x32 dual polarized FUSE



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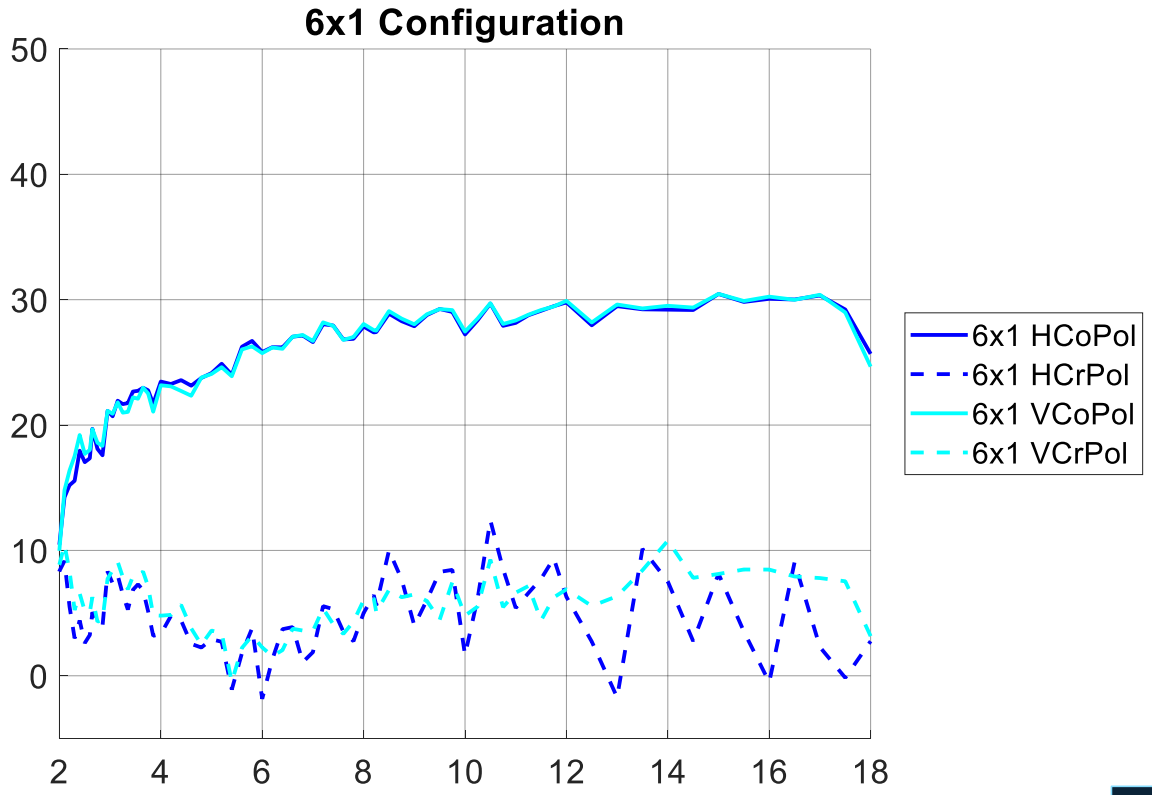
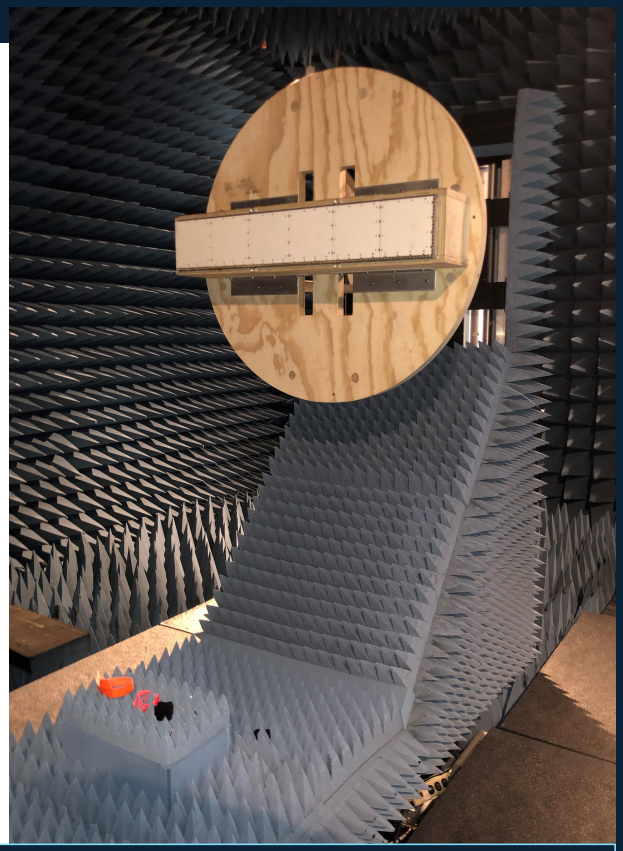
Tiled 6x1 Subarrays





Testing the FUSE at MITRE Nearfield Antenna Range

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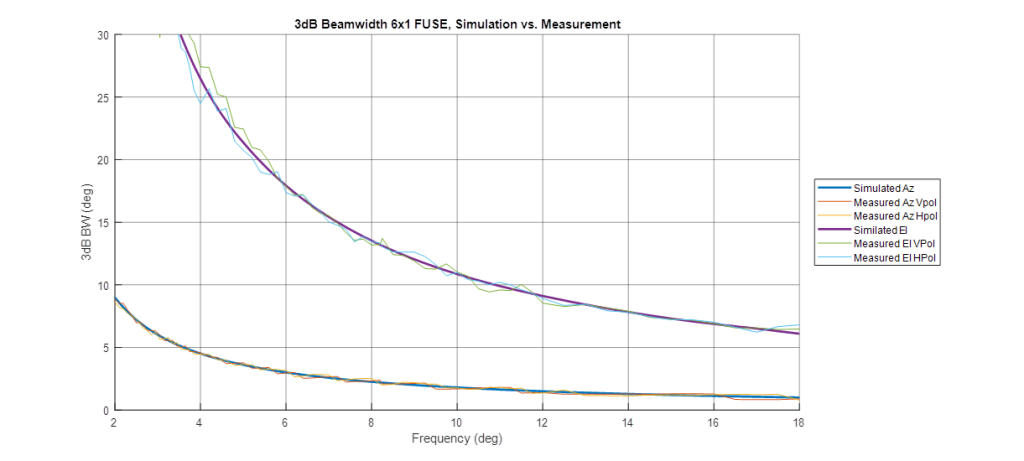
Tiled 6x1 Subarrays



Testing the FUSE at MITRE Nearfield Antenna Range

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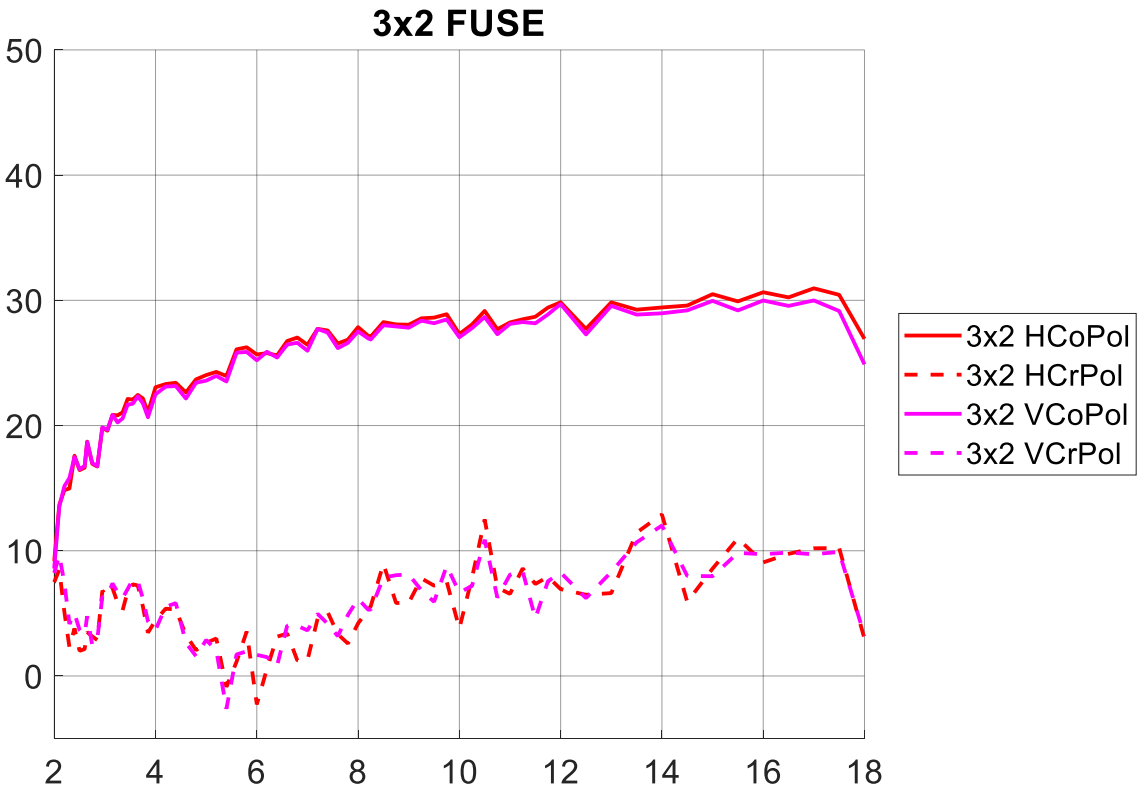
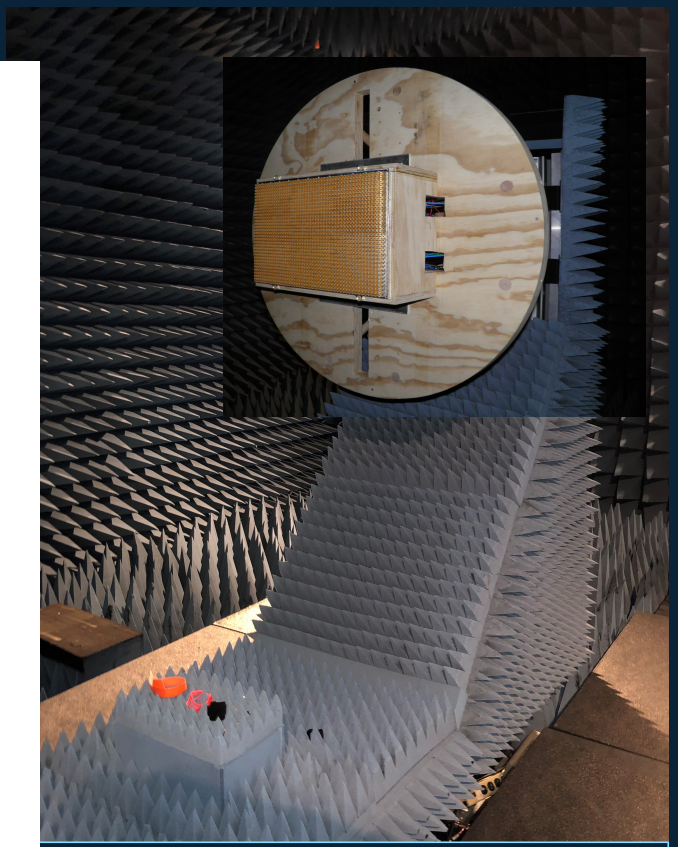
Tiled 3x2 Subarrays





Testing the FUSE at MITRE Nearfield Antenna Range

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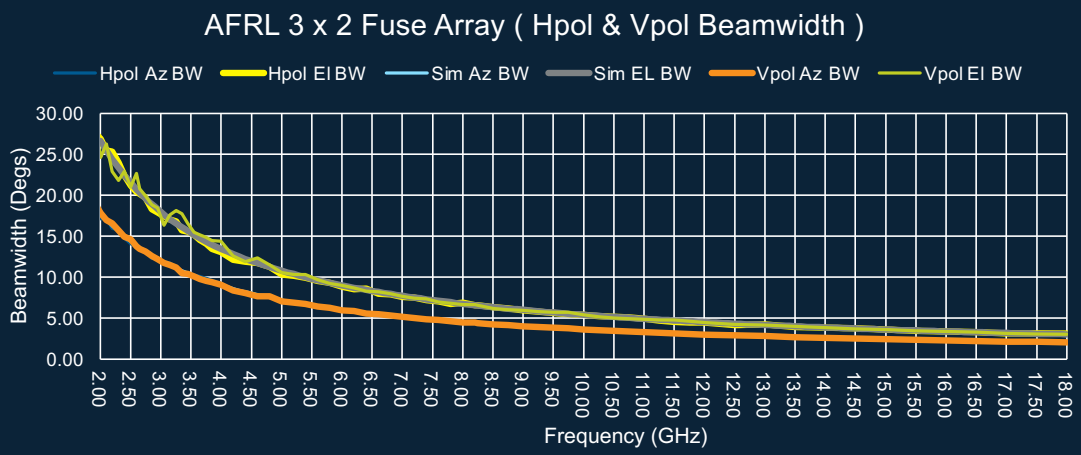
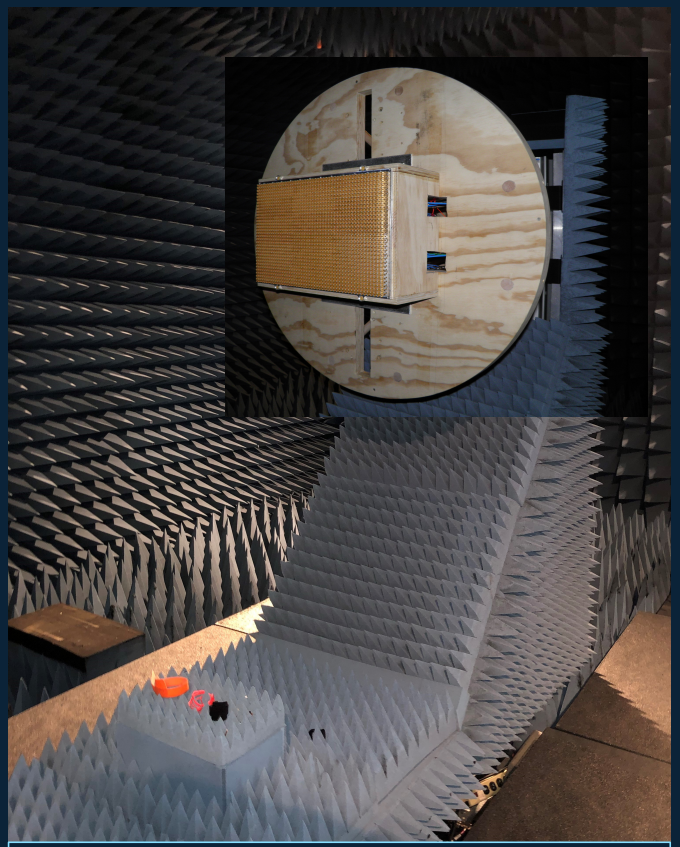
Tiled 3x2 Subarrays





Testing the FUSE at MITRE Nearfield Antenna Range

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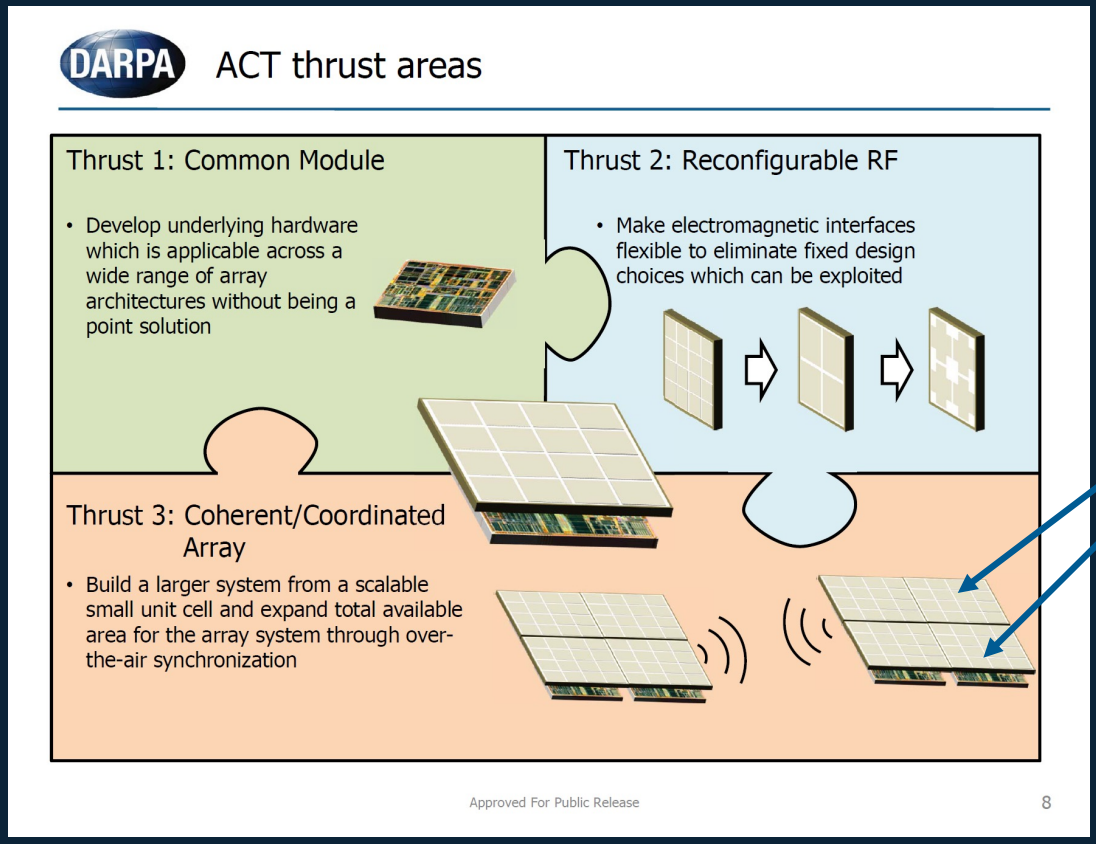
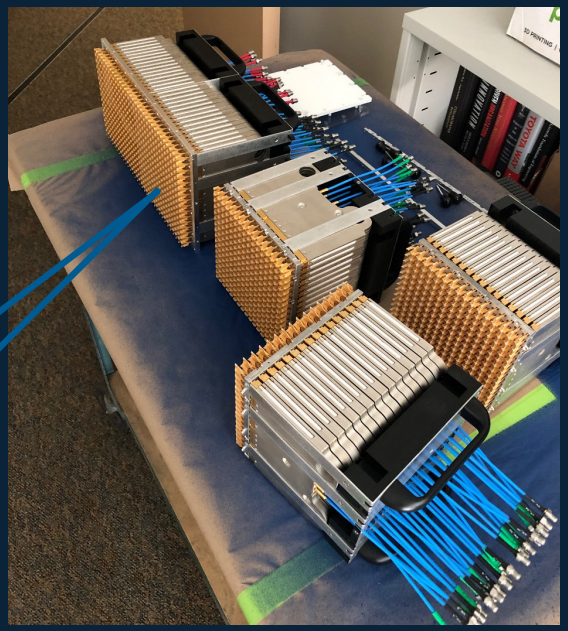
Next step: Testing FUSE wit ACT CM2





FUSE tiles to be tested with ACT CM2. The can be arranged into any shape.

Please see details are in the paper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