



Electromagnetic Simulation Software

# 60 GHz Phased Array Antenna Design Using XFDTD for WiGig Application

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Application Engineer



# Overview

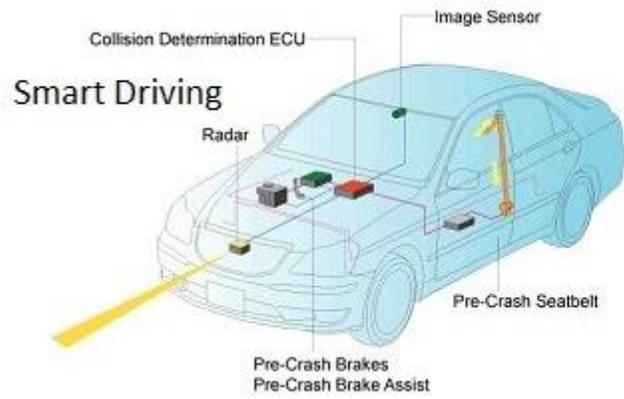
- Antenna Element
- Superposition simulation results
- Array optimization results
- Max hold and CDF of EIRP



Source: Qualcomm



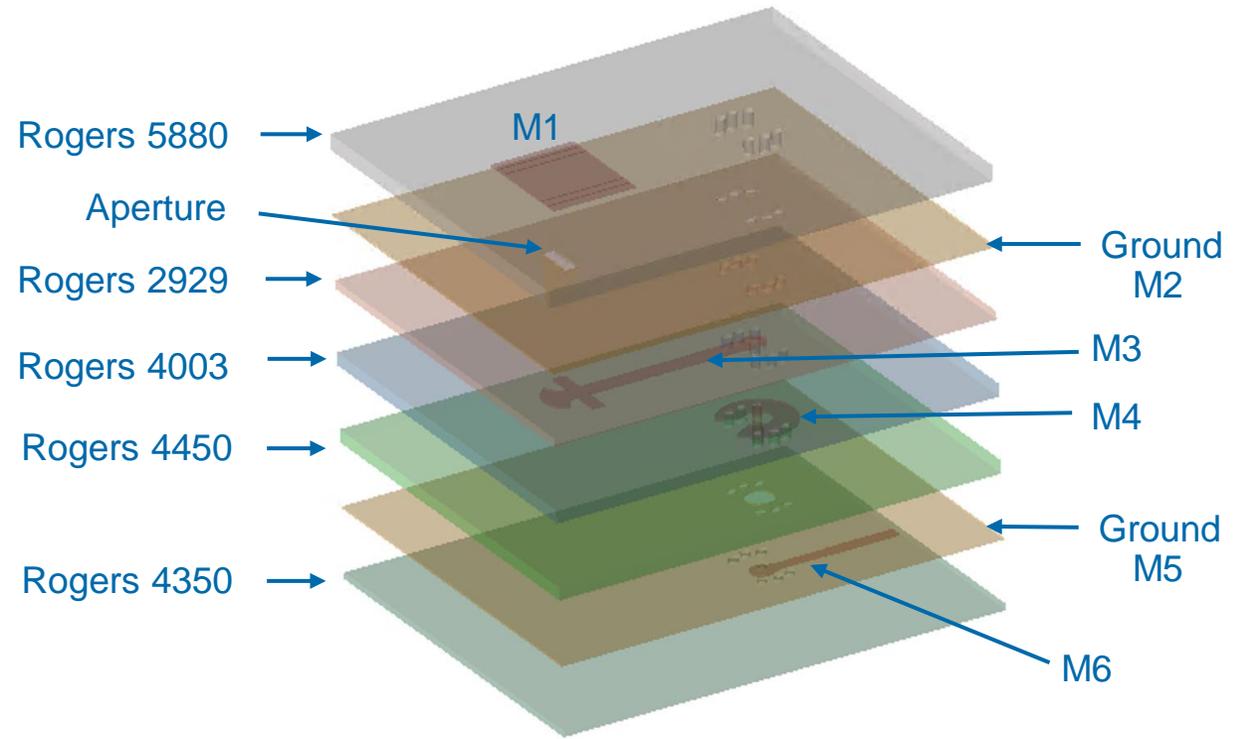
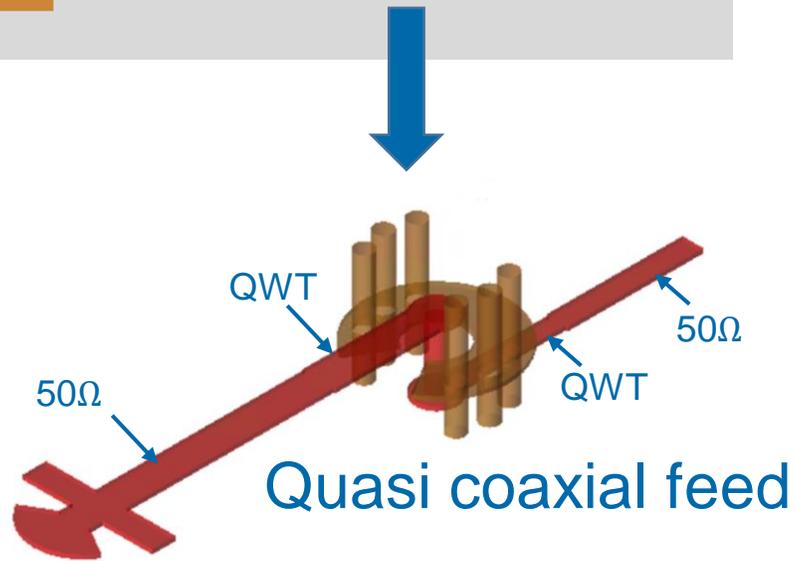
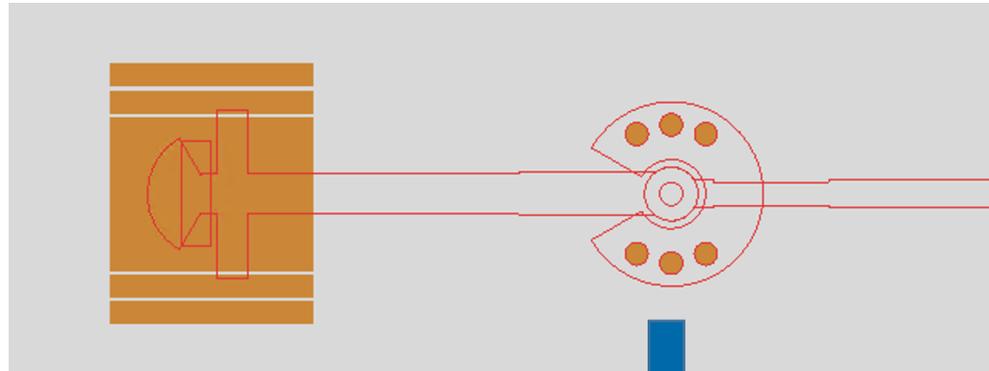
Source: Fast Company



Source: RF page



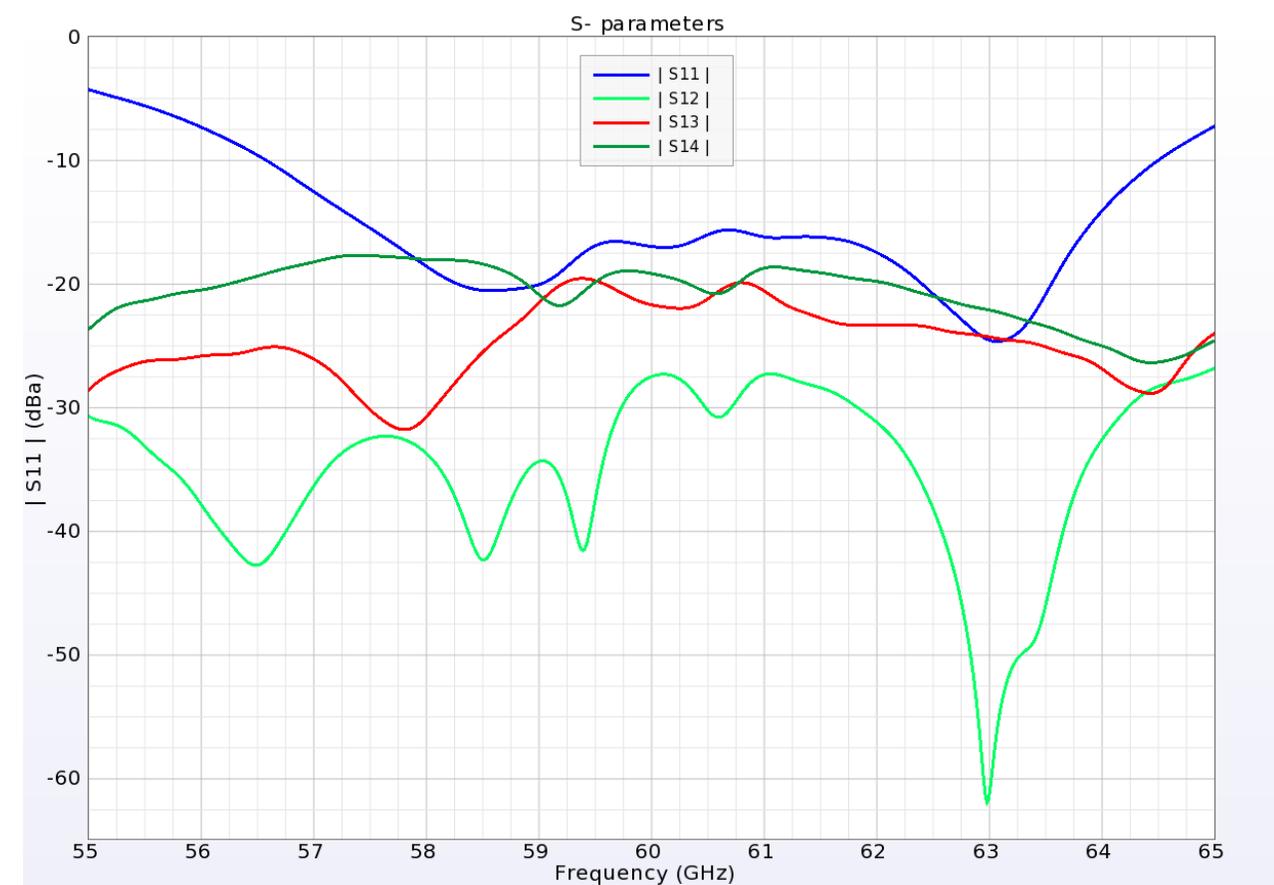
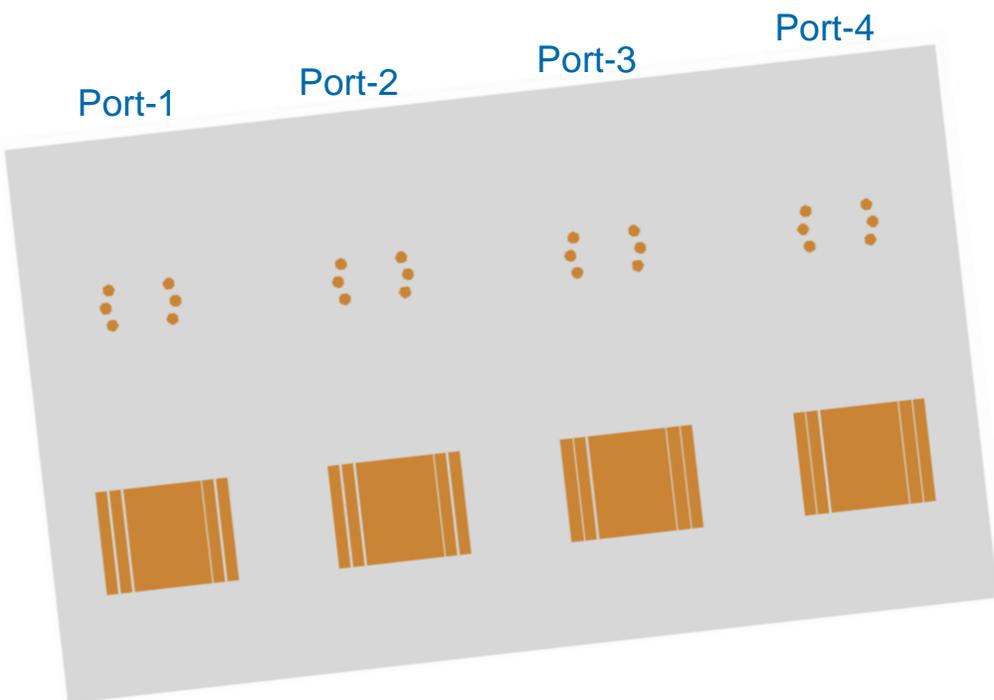
# Antenna Element



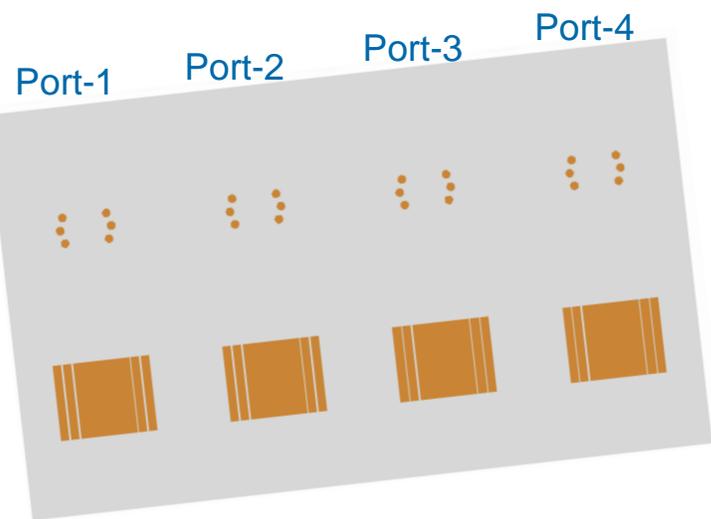
Antenna stack up

T. Zhang, L. Li, M. Xie, H. Xia, X. Ma and T. J. Cui, "Low-Cost Aperture-Coupled 60-GHz-Phased Array Antenna Package With Compact Matching Network," in IEEE Transactions on Antennas and Propagation, vol. 65, no. 12, pp. 6355-6362, Dec. 2017, doi: 10.1109/TAP.2017.2722867.

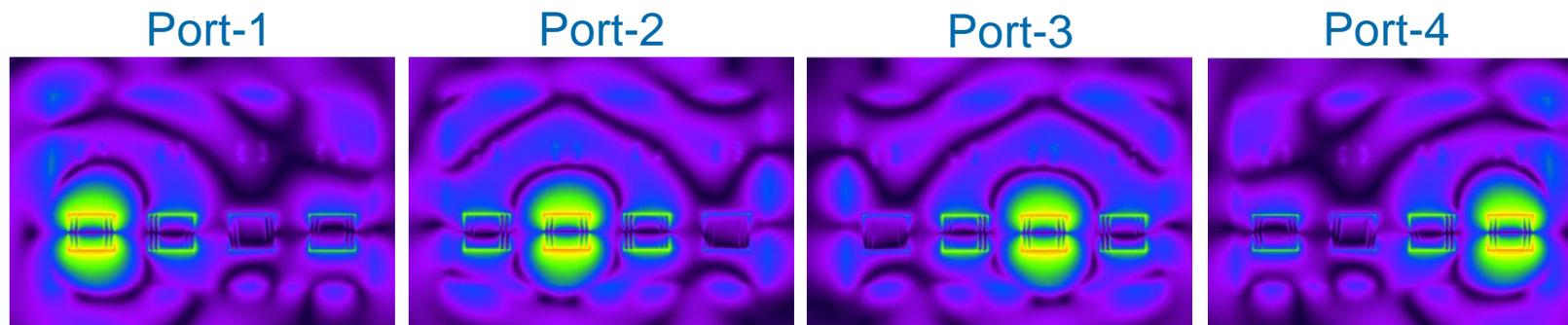
# FDTD Simulation



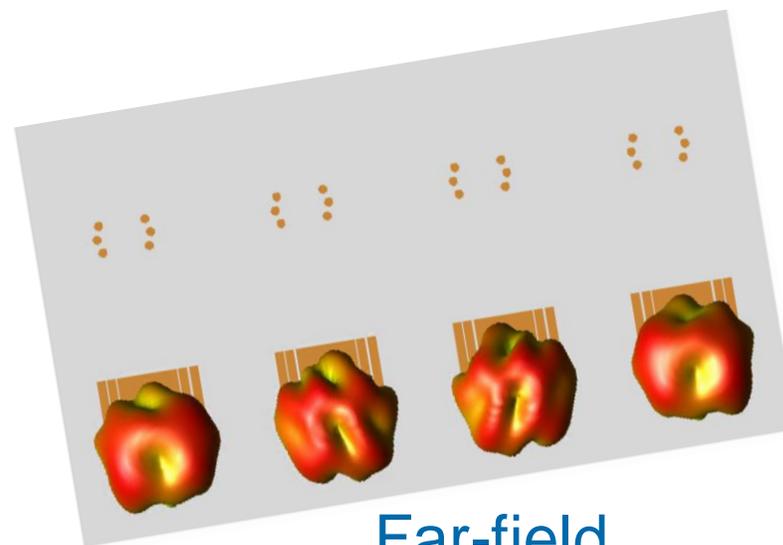
# FDTD Results



FDTD simulation  
(minutes, hours)

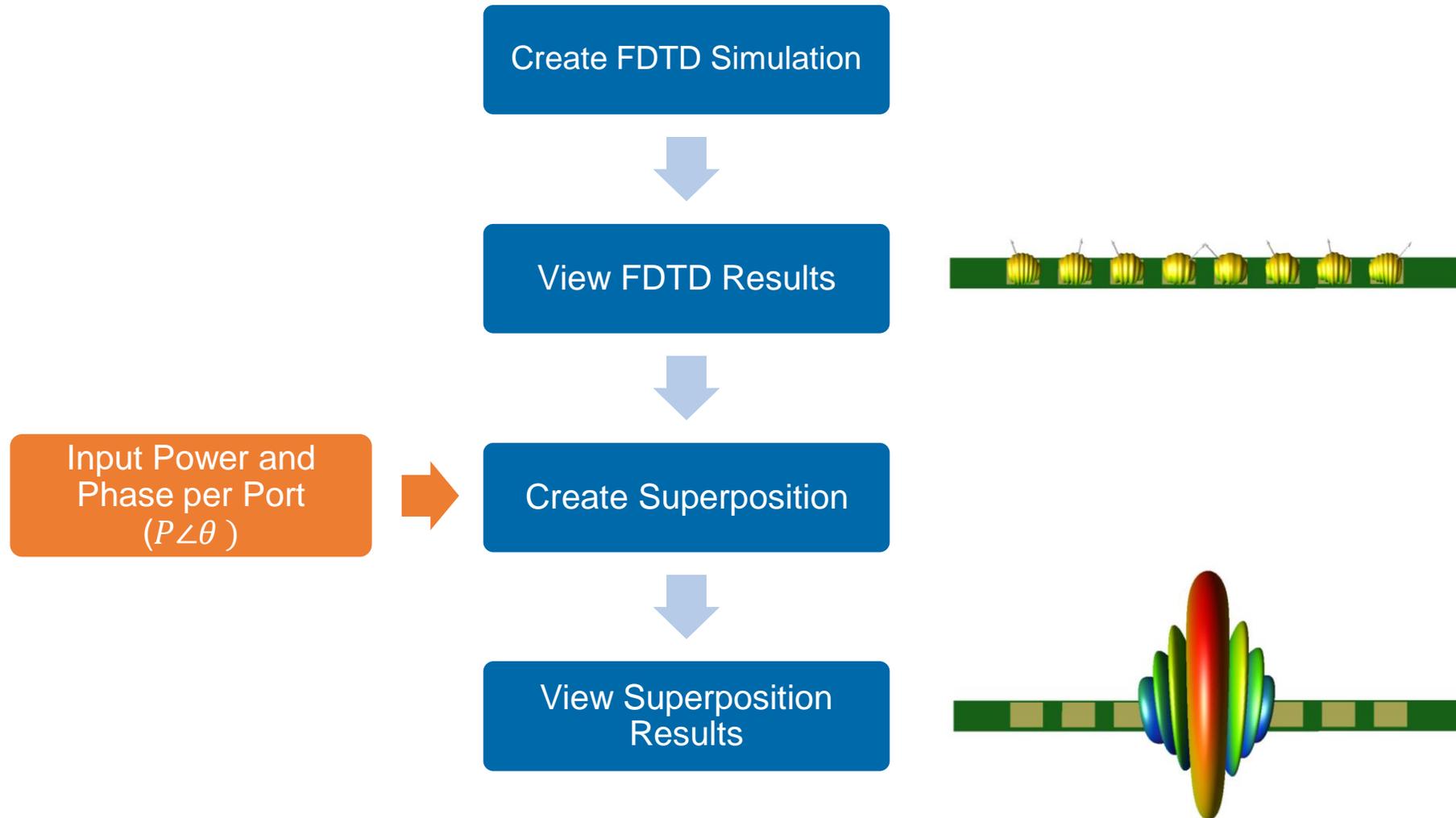


Near-field



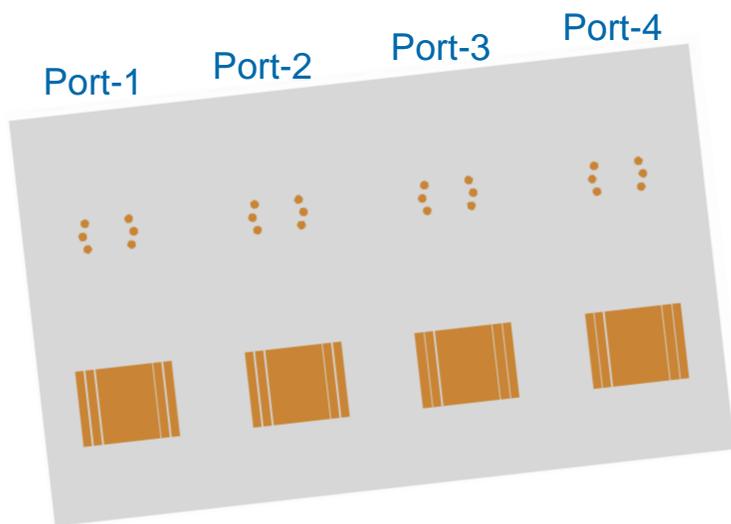
Far-field

# Superposition Simulation

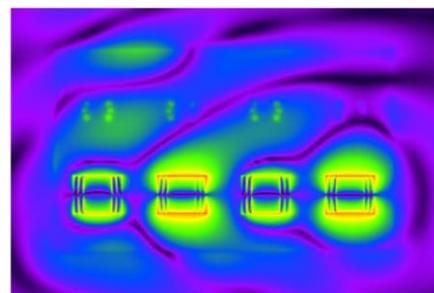


# Superposition Simulation

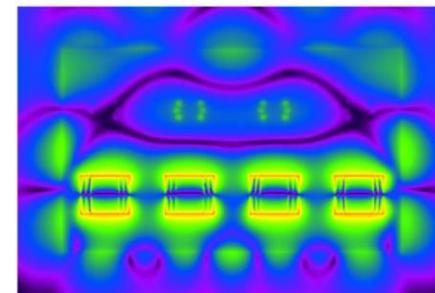
Post-processing feature allows users to combine steady-state results from an FDTD simulation.



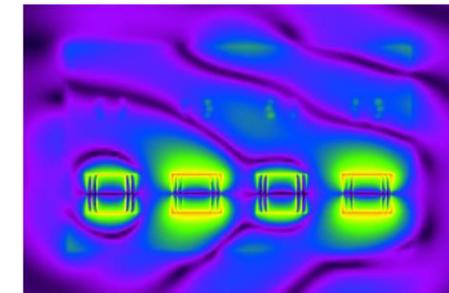
Superposition  
( $<$  seconds)



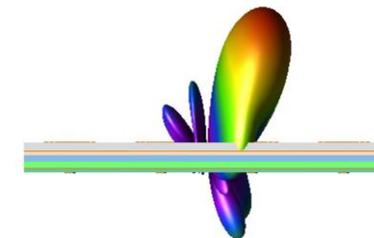
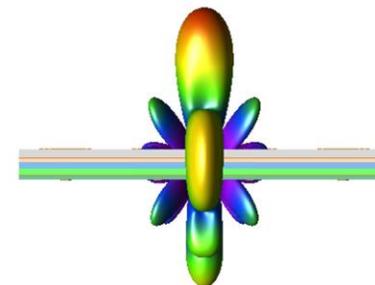
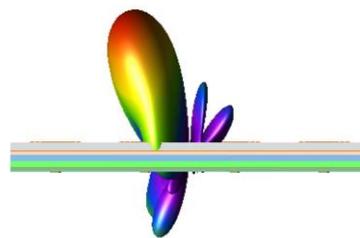
$-90^\circ$



$0^\circ$



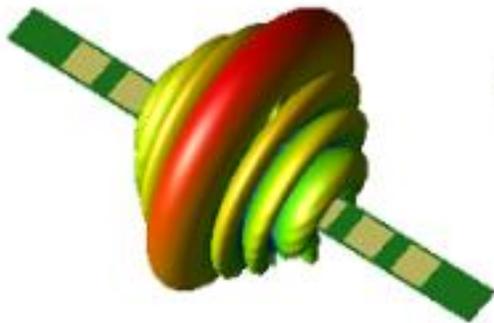
$90^\circ$



# Array Optimization

Array optimization determines the set of port phases that maximize an array's EIRP in specified direction.

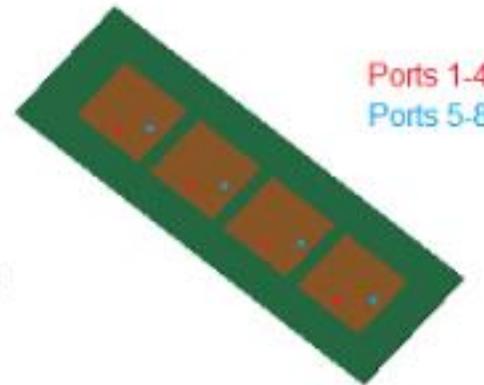
Supported use cases:



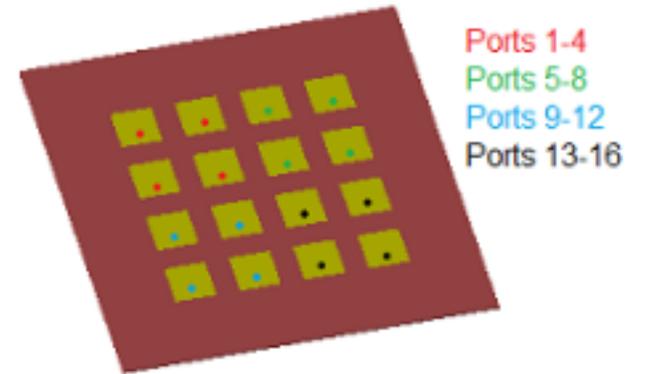
Phased Array



Multiple Arrays

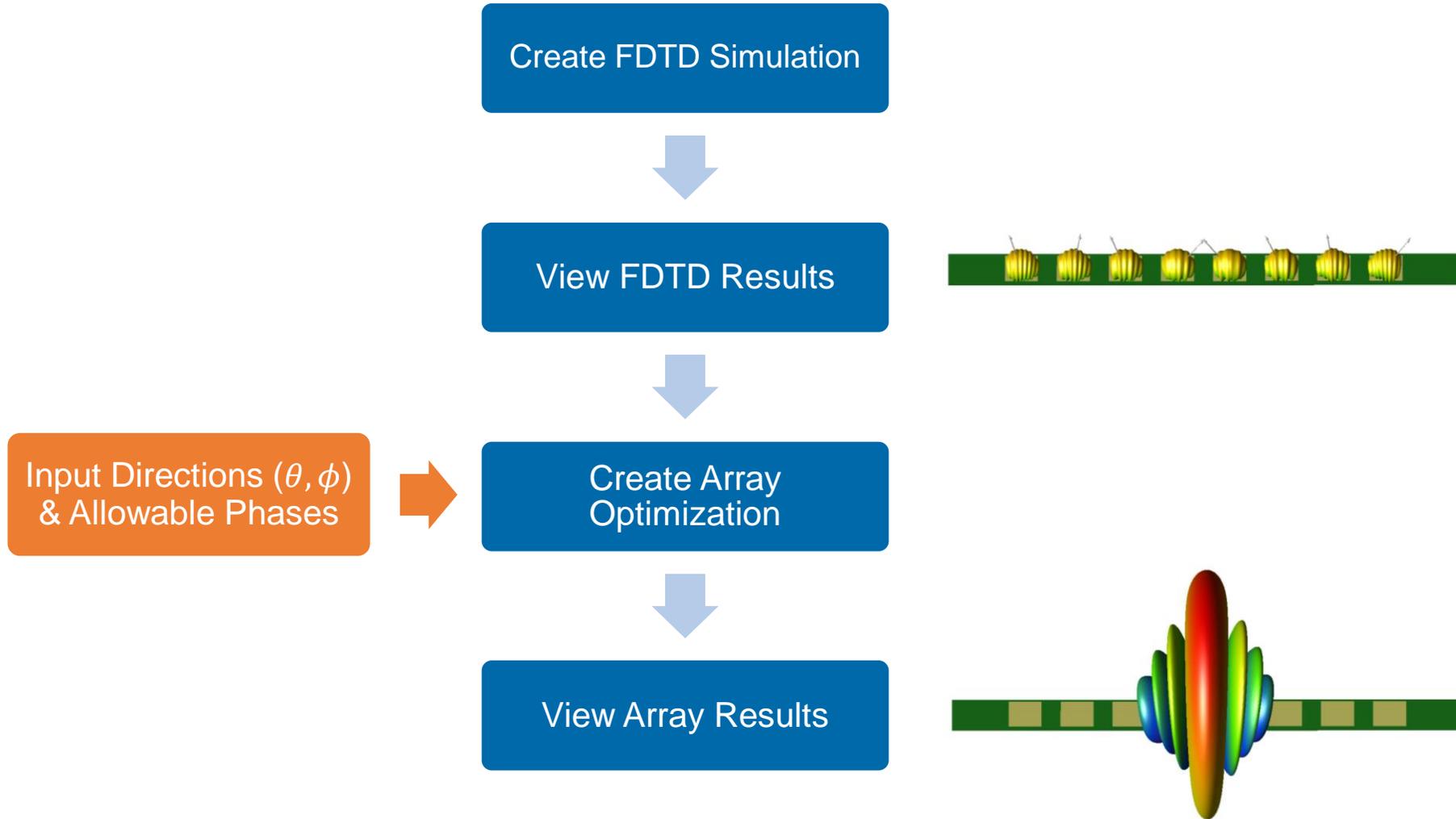


Dual Polarized

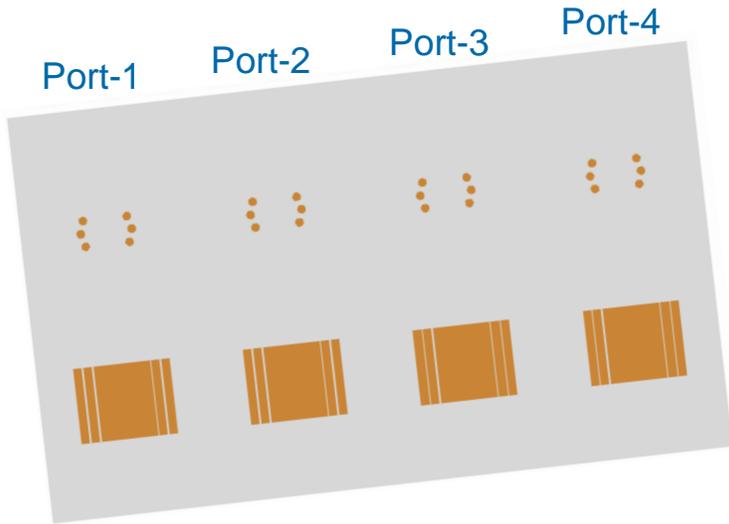


Subarrays

# Array Optimization Workflow

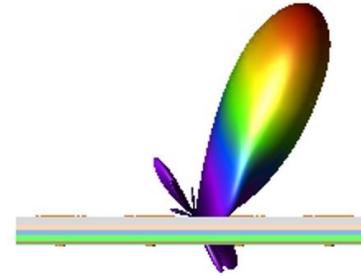


# Array Results



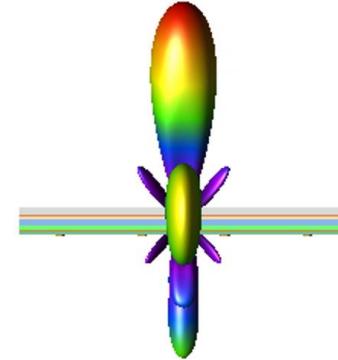
Array optimization  
( $<$  seconds)

$[30^\circ, 90^\circ]$



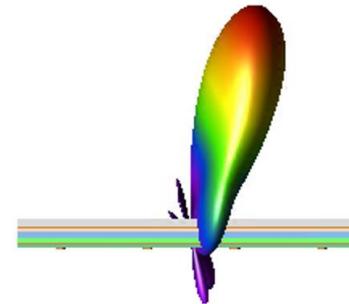
$[10^\circ, 245^\circ, 140^\circ, 35^\circ]$

$[0^\circ, 0^\circ]$



$[130^\circ, 125^\circ, 125^\circ, 130^\circ]$

$[15^\circ, 90^\circ]$



$[65^\circ, 0^\circ, 300^\circ, 235^\circ]$

# Workflow Comparison

## Superposition

Power and phase are known

Create FDTD Simulation



View FDTD Results



Input Power and Phase per Port ( $P \angle \theta$ )



Create Superposition



View Superposition Results

Create FDTD Simulation



View FDTD Results



Create Array Optimization



View Array Results

## Array Optimization

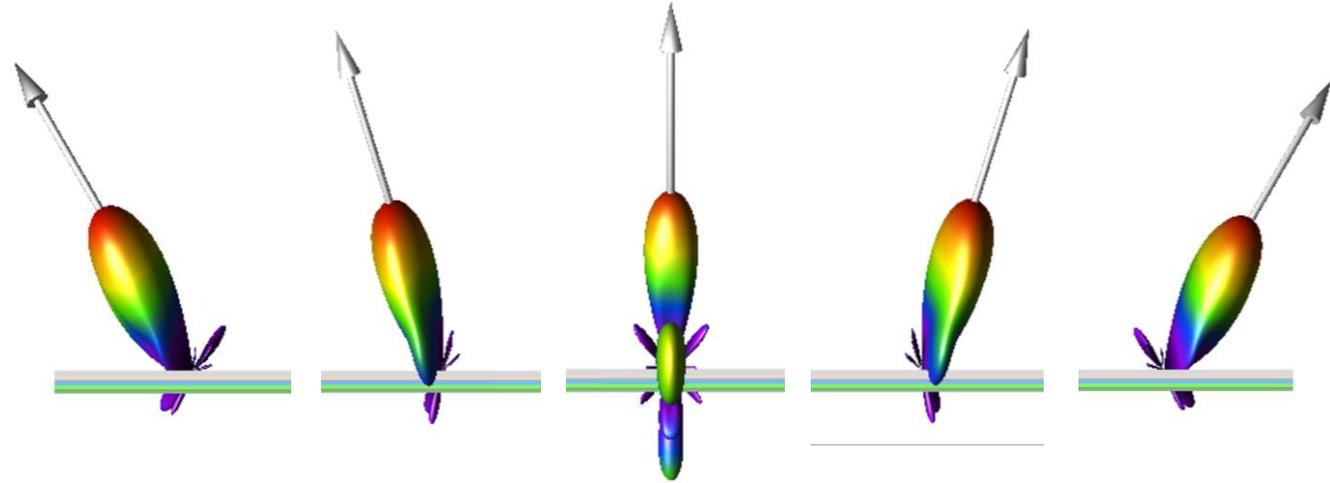
Power and phase are **not** known

Input Directions ( $\theta, \phi$ ) & Allowable Phases

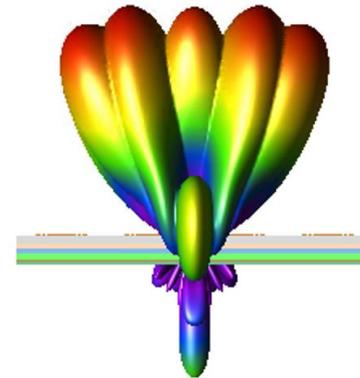


# Max Hold

4 element array supports five beams ranging  $-30^\circ$  to  $+30^\circ$

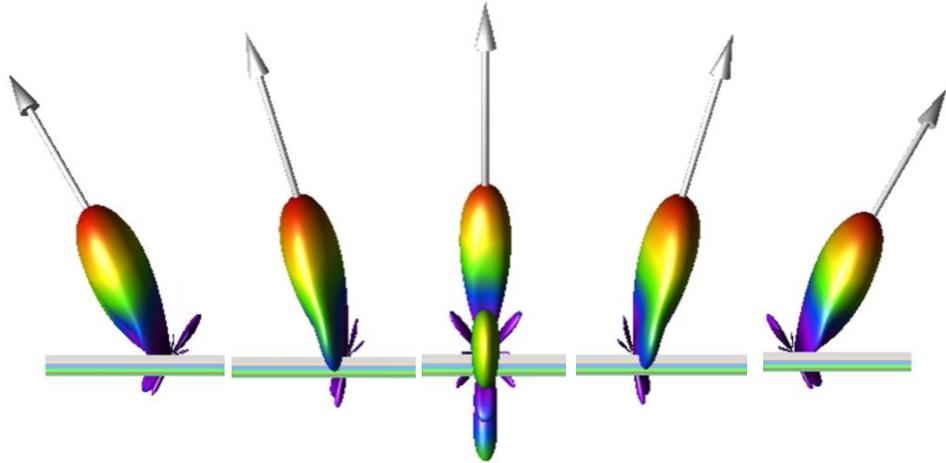


Max hold pattern is the envelope of the five beams

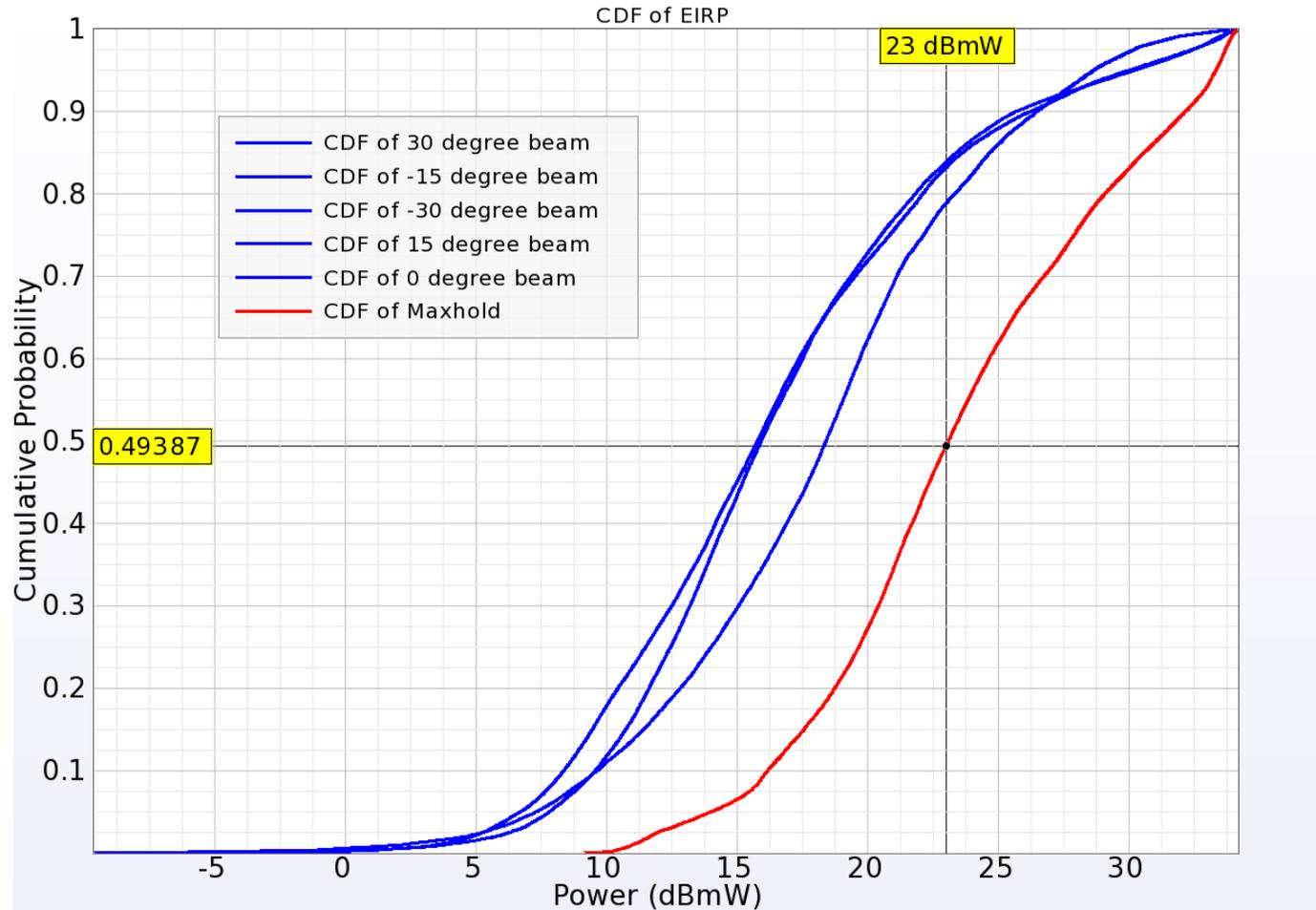
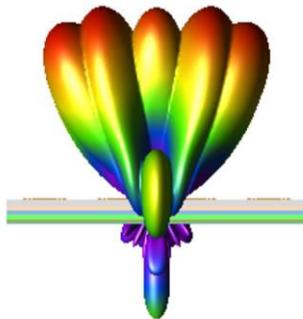


# CDF of Max Hold (Single Array)

Five Beams



Max Hold Pattern





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