



AFRL-RQ-WP-TM-2016-0150

**SLOTTED WAVEGUIDE ANTENNA STIFFENED
STRUCTURES (SWASS) DEVELOPMENT FOR
COMMERCIAL OFF-THE-SHELF (COTS) RADAR
(BRIEFING CHARTS)**

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BerrieHill Research Corporation

OCTOBER 2016

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14. ABSTRACT This slide show describes SWASS development.					
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Integrity ★ Service ★ Excellence

RQVS SWASS Development for COTS Radar

7 March 2016

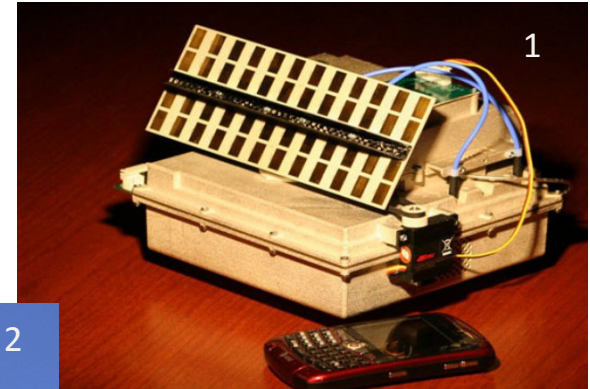
**David Zeppettella
Electronics Engineer
AFRL/RQVS**



SWASS for ImSAR



- NanoSAR : 3 lb., 30 W
- Applications: SAR, FOPEN, MTI
- Frequencies: UHF, L, X, Ku
- Pod mount options: 7-19 lbs



1

ImSAR Pods ₃



2



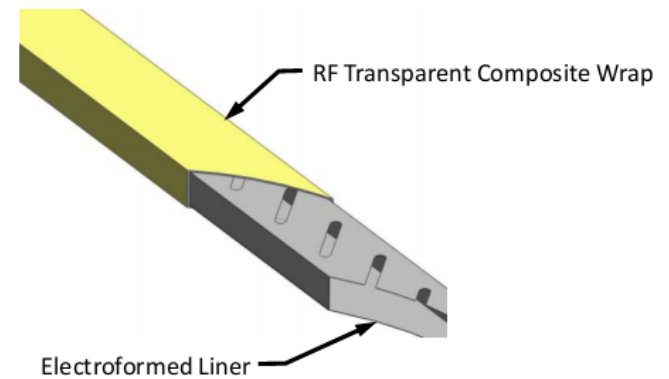
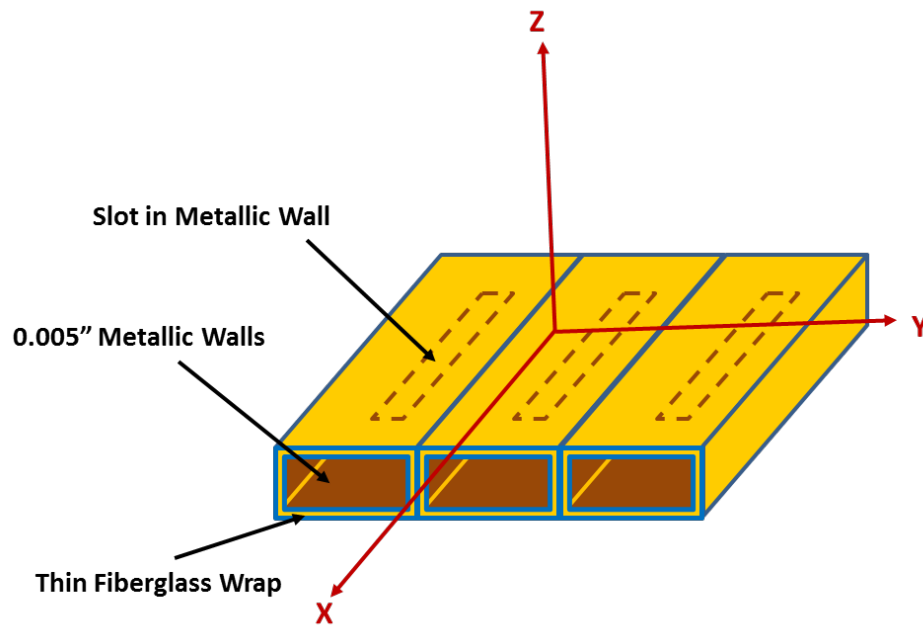
4

NanoSAR on Scan Eagle

- We have focused on X band SAR and MTI

1. <http://www.uasvision.com/2012/06/15/imsar-gets-24m-nano-sar-contract-for-uas-from-us-army/>
2. http://www.barnardmicrosystems.com/UAV/features/synthetic_aperture_radar.html
3. <http://www.imsar.com/pages/products.php?name=nanosar>
4. <http://www.defenseindustrydaily.com/Us-Army-Wants-a-Small-Radar-for-Small-UAVs-07408/>

Fundamental CLAS/SWASS Concept

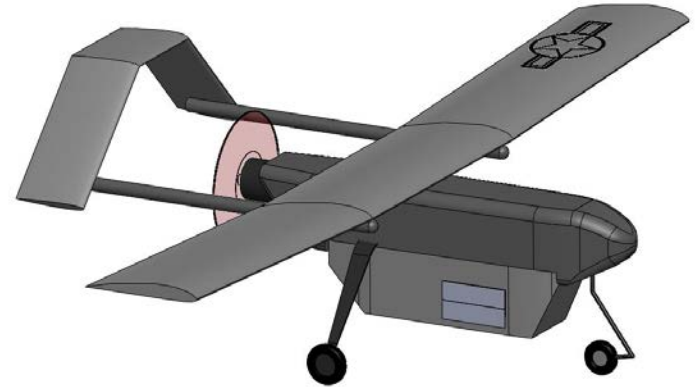
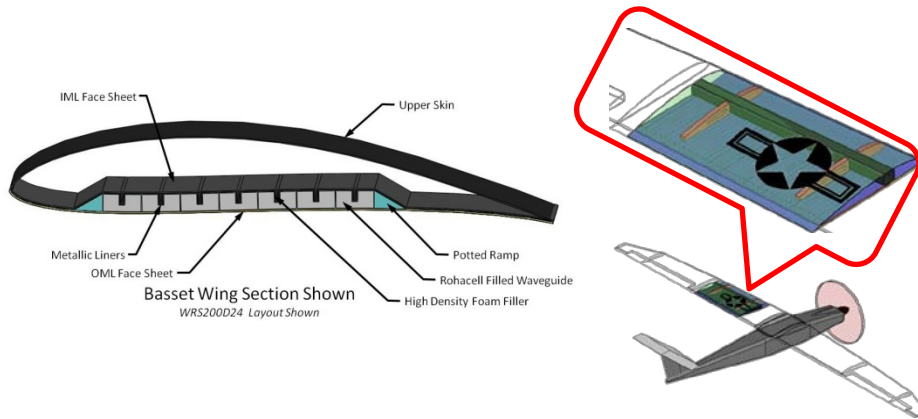


Electroformed Composite Wrapped Waveguide

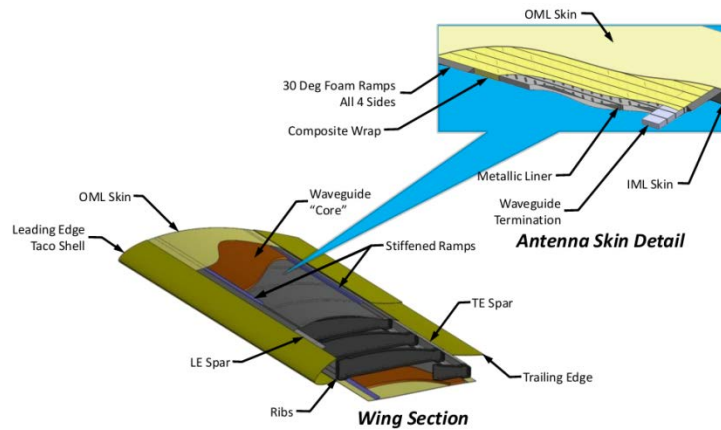
Note: This is applicable for Astroquartz and Glass Fibers

- **Slotted Waveguide Antenna**
- **Lightweight**
- **Structural / Load Bearing**
- **Conformal with airframe body**

Potential CLAS/SWASS Airborne Implementations

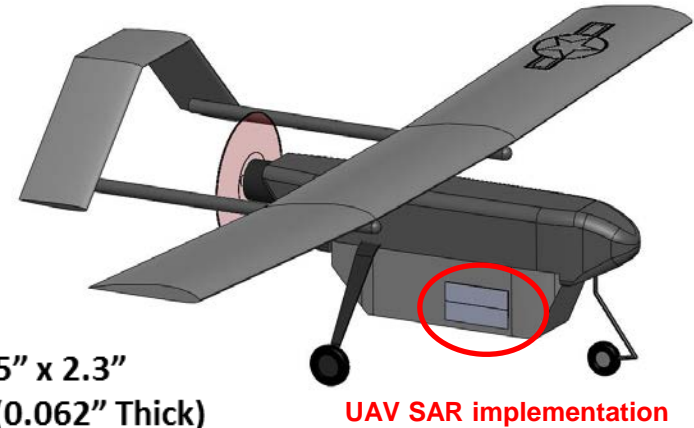
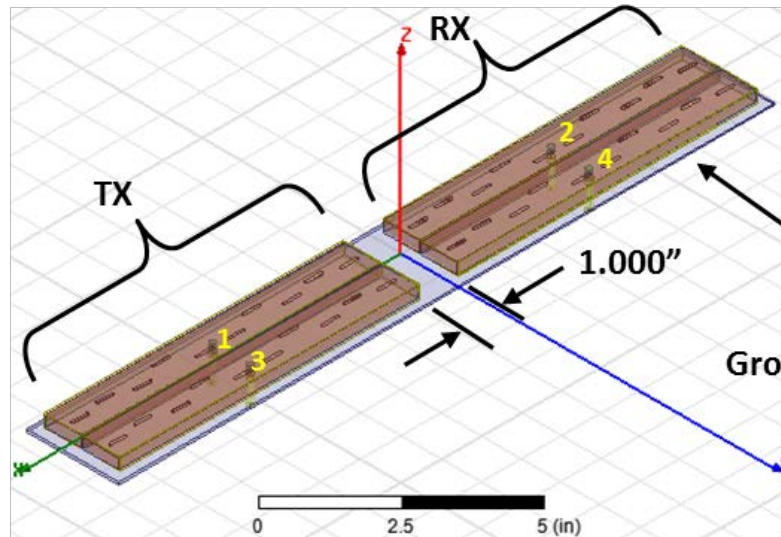


Body / Fuselage Implementation



Wing Implementation

Coax Center-Fed Slotted Waveguide Antenna



Potential Airborne Applications

- Radar (GMTI, SAR, MTI, FOPEN)

Advantages

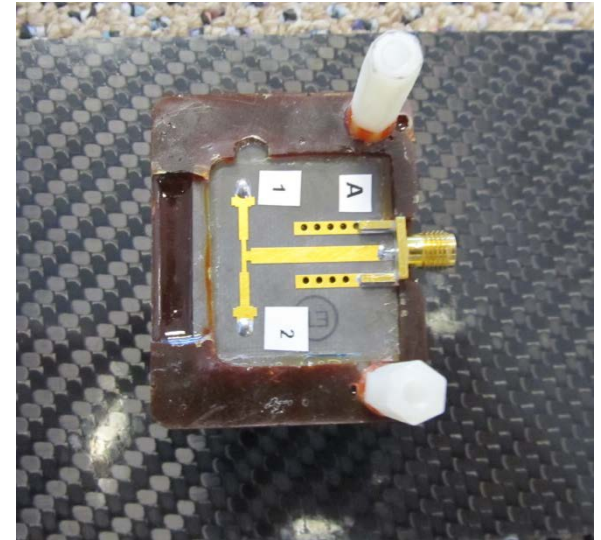
- Low to moderate loss
- Little touch labor
- Decent control of side lobes
- Very low X-Pol
- Can be adapted for 1-D scanning
- Moderate to high power capability
- Ability to scale to large apertures

Disadvantages

- Narrow banded (5% to 10%)
- Lack of 2-D scanning capability
- Lossy combiner network (unless manufactured with waveguide technology)

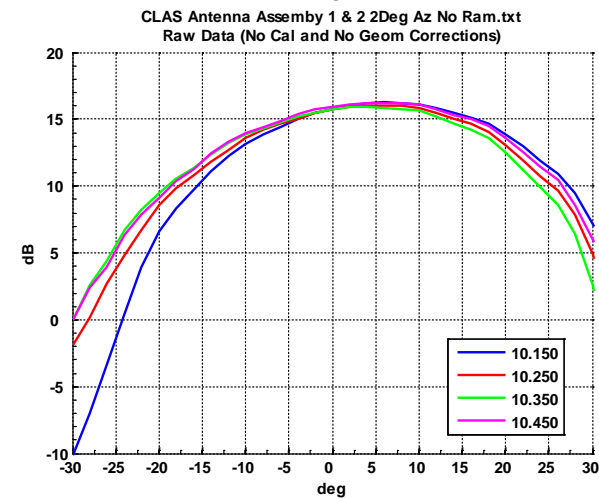
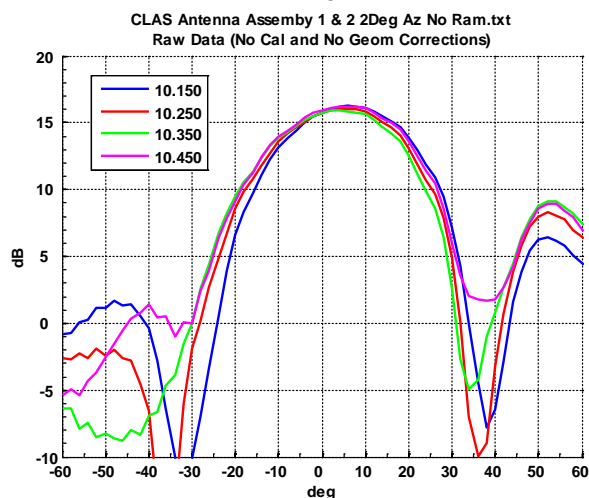
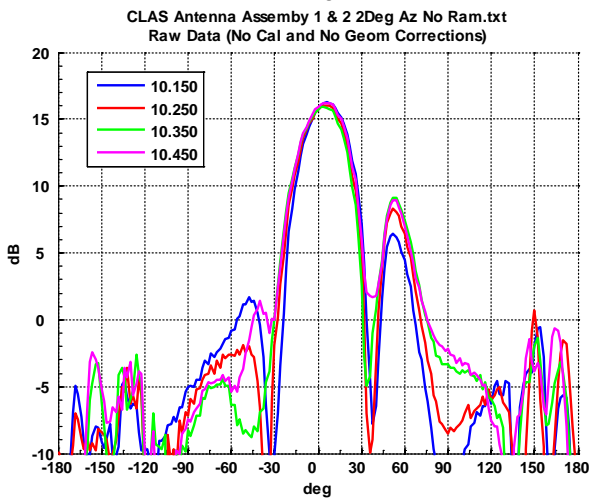
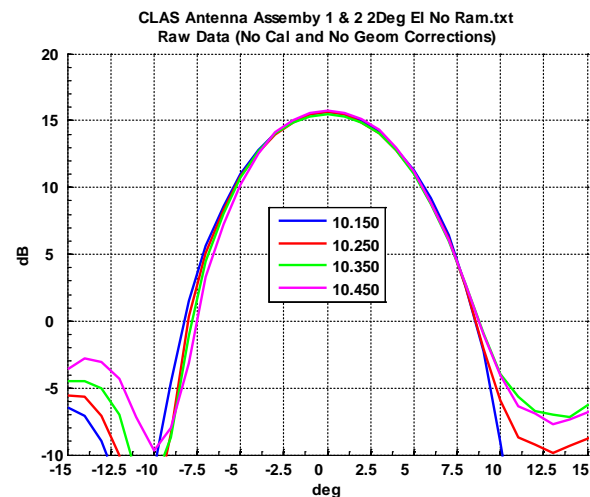
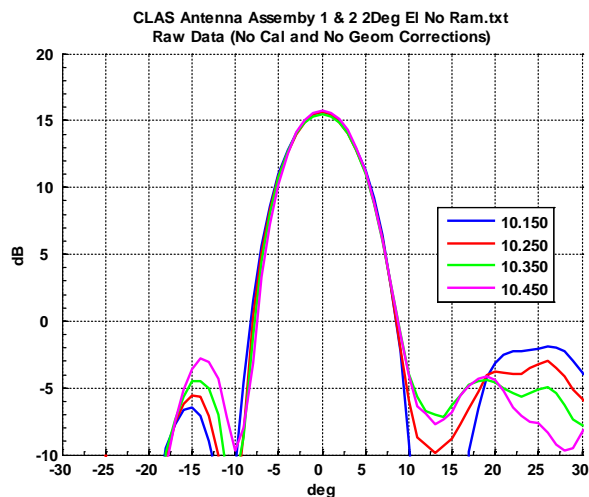
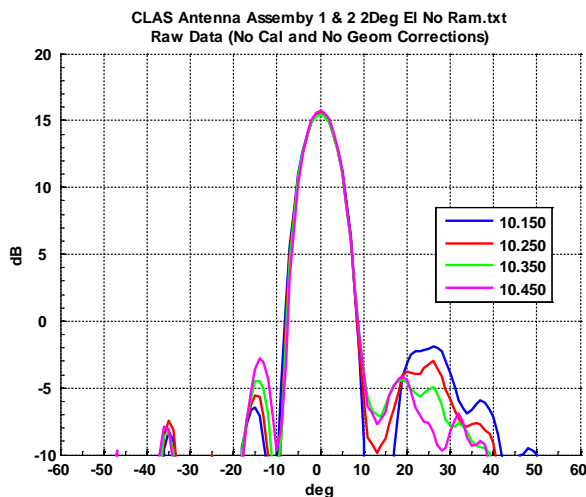
BRC NanoSAR Demo

2 Sock, Epoxy Loaded Slots (190 probes, additional cleaning, internal sanding)



BRC NanoSAR Demo

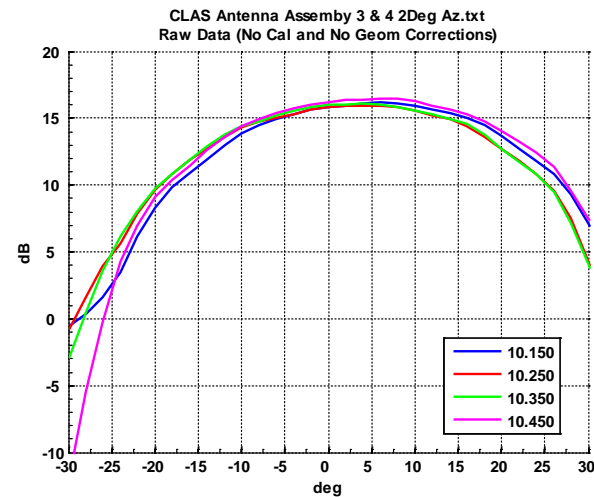
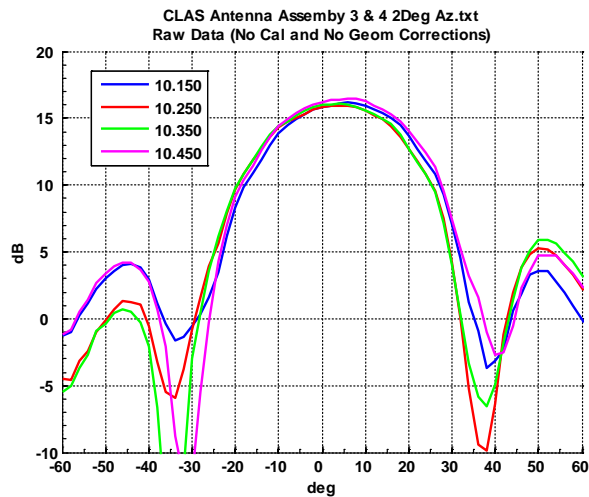
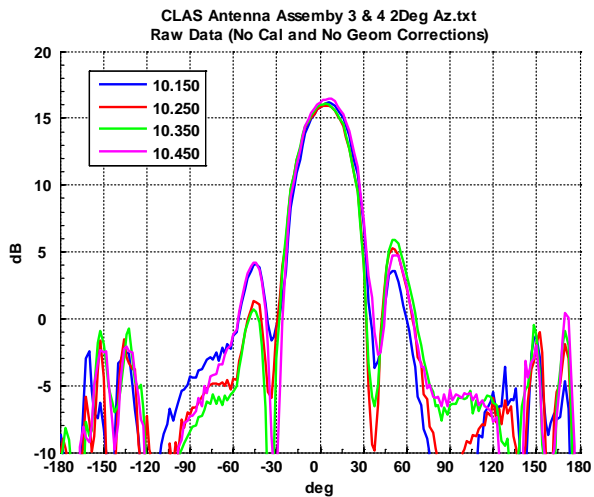
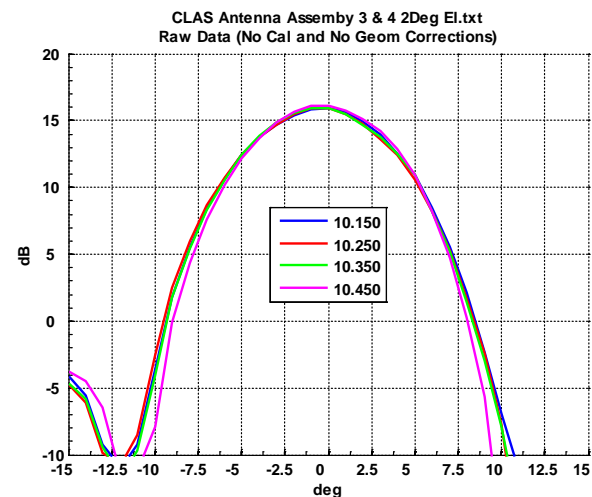
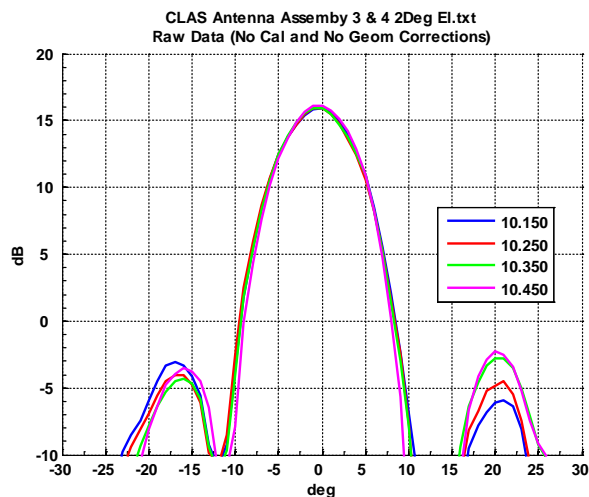
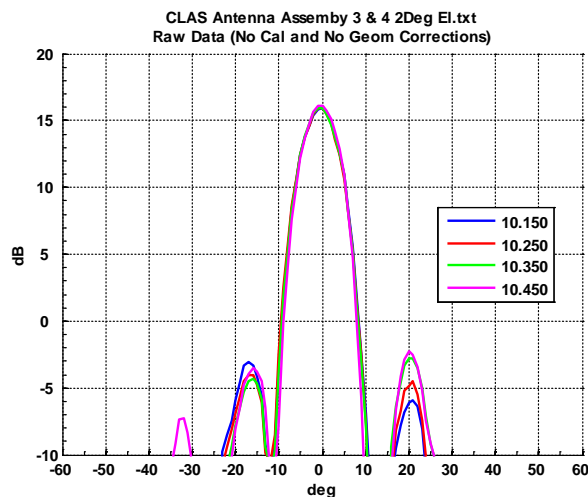
2 Sock, Epoxy Loaded Slots (190 probes, additional cleaning, internal sanding)



4-Stick, *No RAM* (Sticks 1+2)

BRC NanoSAR Demo

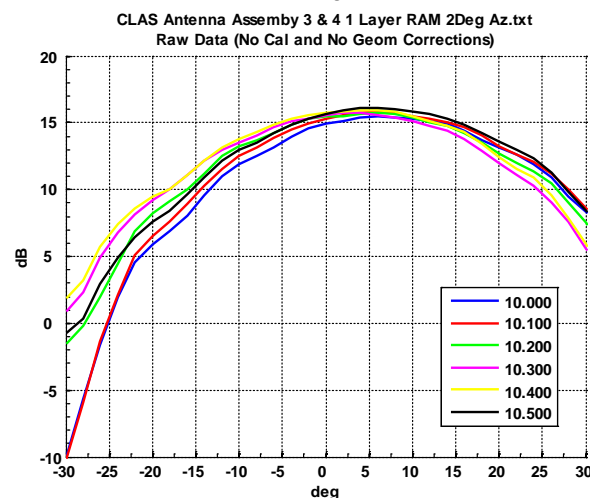
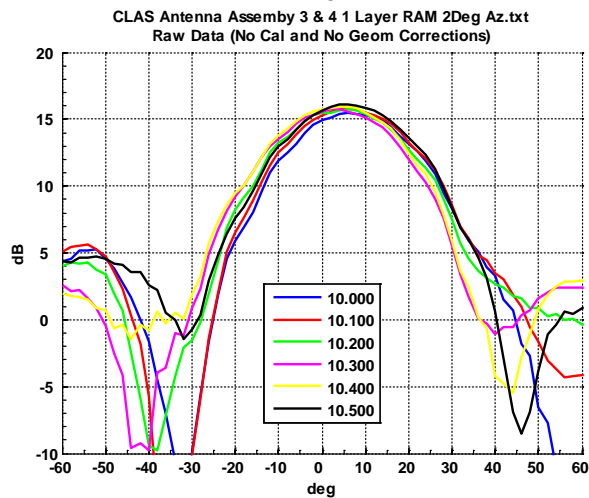
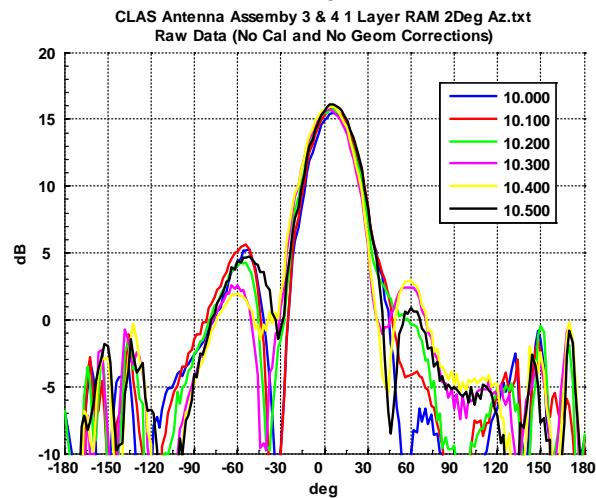
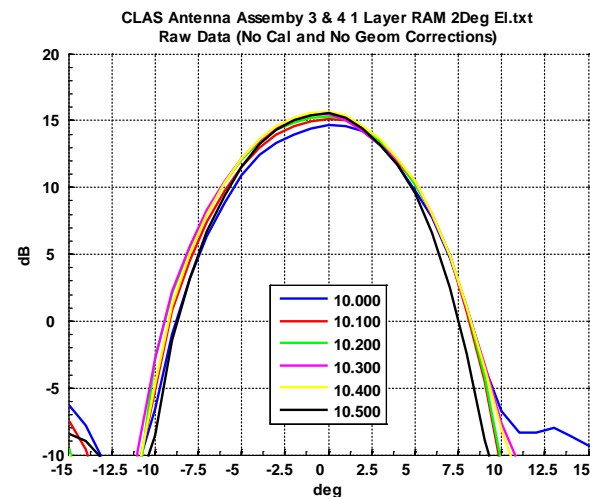
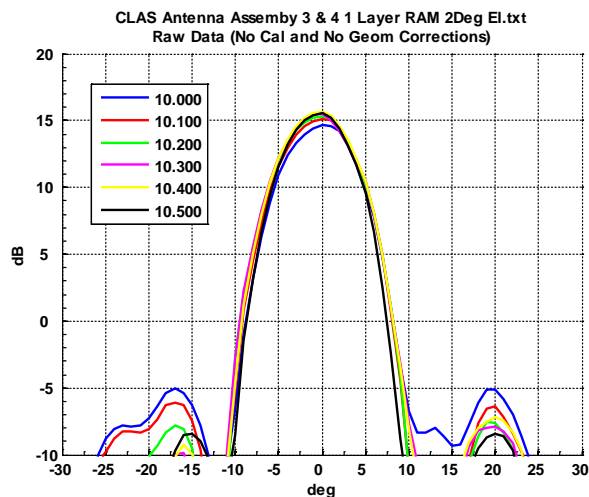
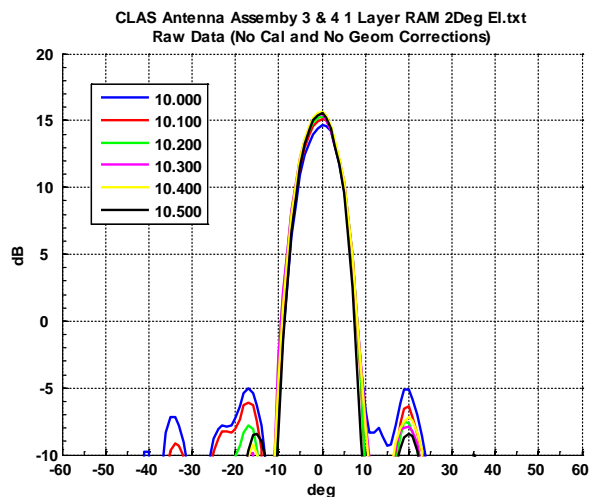
2 Sock, Epoxy Loaded Slots (190 probes, additional cleaning, internal sanding)



4-Stick, *No RAM* (Sticks 3+4)

BRC NanoSAR Demo

2 Sock, Epoxy Loaded Slots (190 probes, additional cleaning, internal sanding)

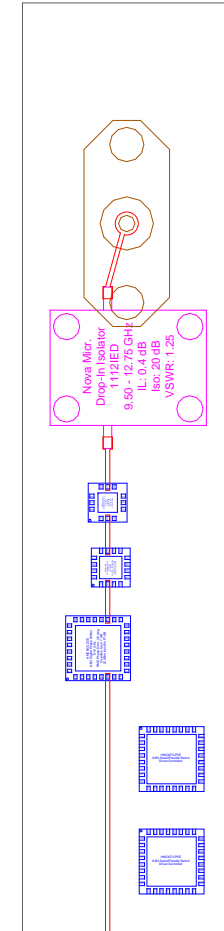
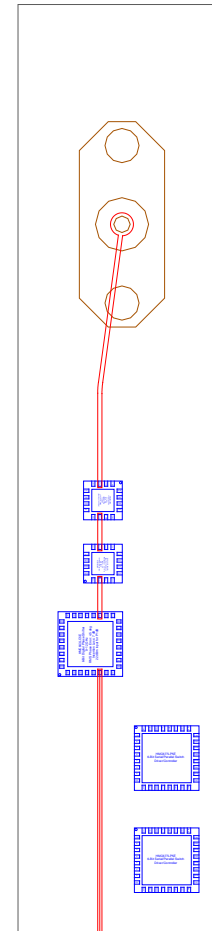
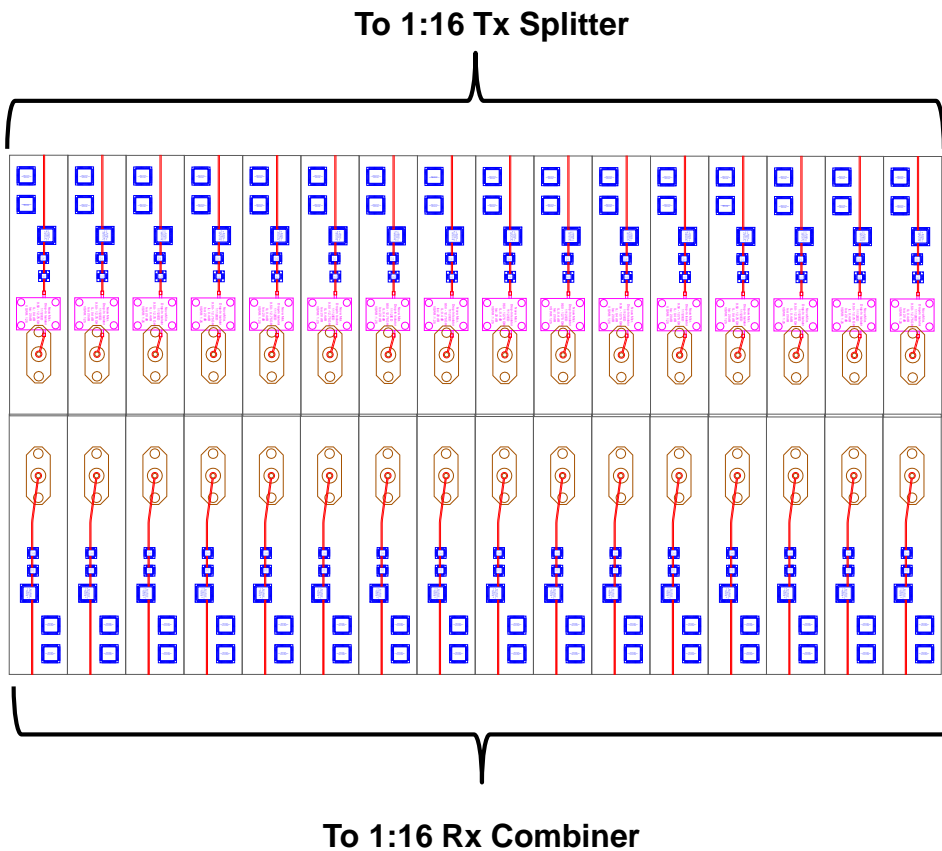


4-Stick, (Sticks 3+4 & 1 RAM Layer)

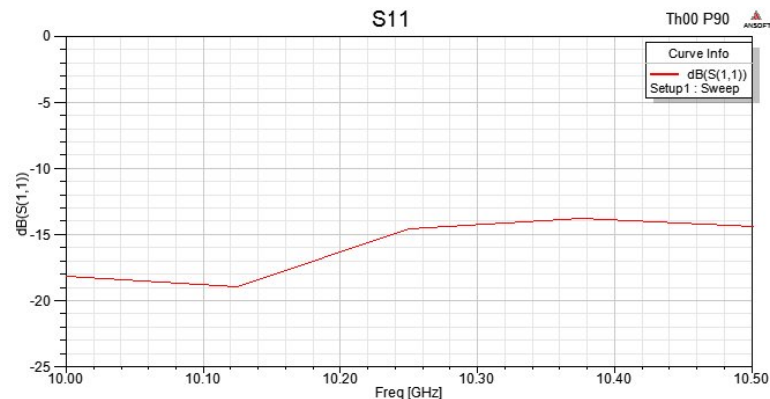
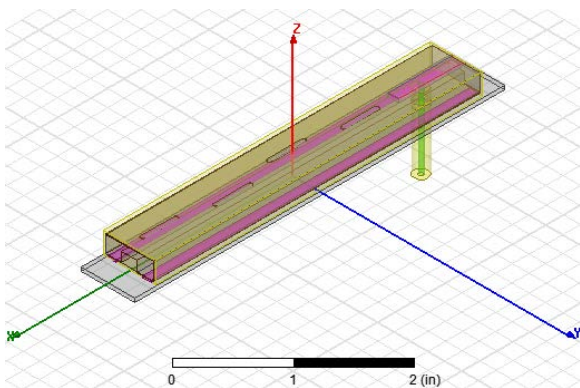
Sample Dual Slot Stick Configuration (Suitable for ImSAR Radar)

Substrate

- 10mil Thickness
- 13 mil Trace ($Z_0=51\Omega$)
- $Dk=6.15$ (e.g. Arlon TC600)
- ~ 0.38 dB Loss per inch



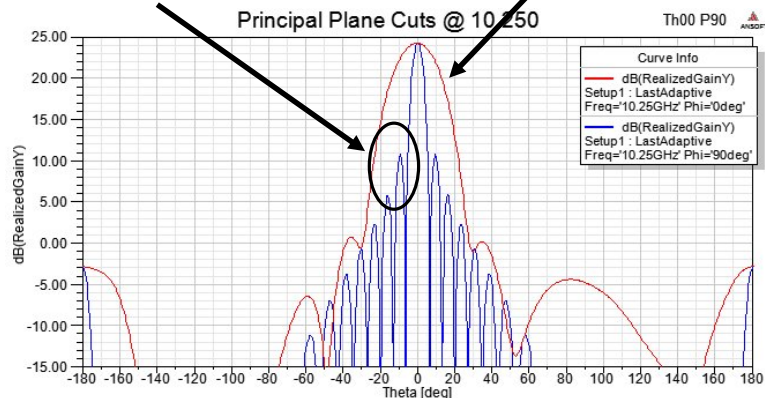
Quad Slot Sticks (16 Sticks) - 0° Azimuth Scan



Active Impedance (0° Azimuth Scan)

Azimuth Side Lobes can be reduced via controlling the stick-to-stick power levels.

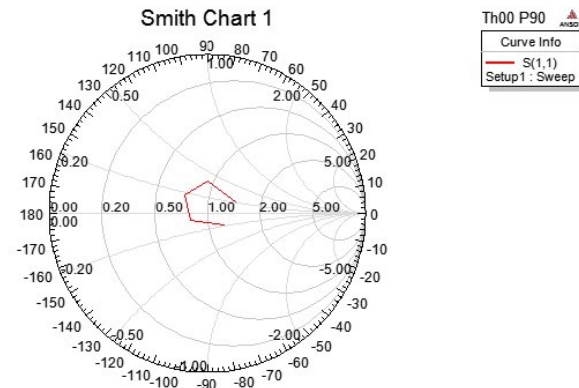
Elevation Pattern is likely too narrow for the ImSAR Radar



Principal Plane Patterns @ 10.250 GHz (0° AZ Scan)

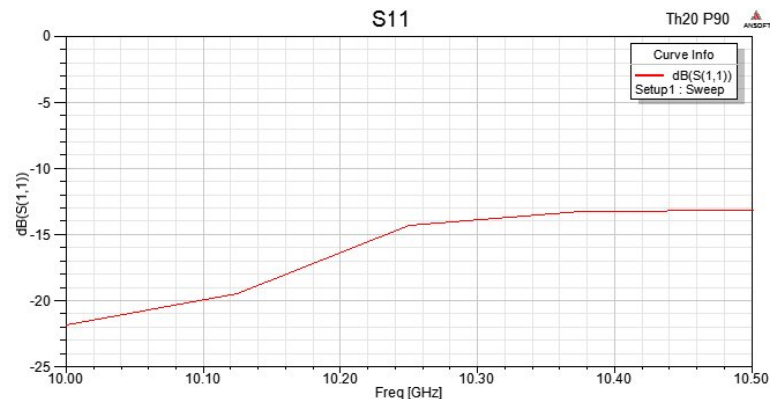
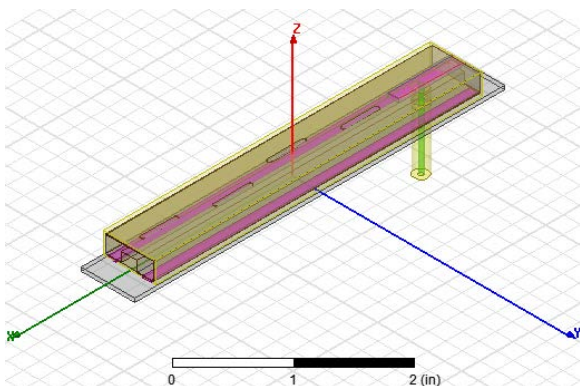
Red: EL (X-Z Plane) Blue: AZ (Y-Z)

Pattern assumes 16 Sticks

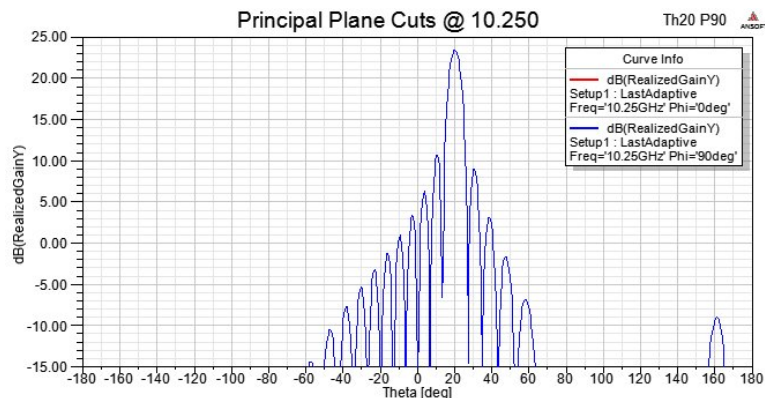


Active Impedance (0° Azimuth Scan)

Quad Slot Sticks (16 Sticks) - 20° Azimuth Scan



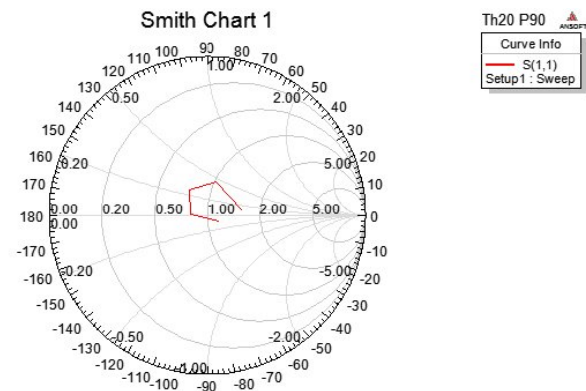
Active Impedance (20° Azimuth Scan)



Principal Plane Patterns @ 10.250 GHz (20° AZ Scan)

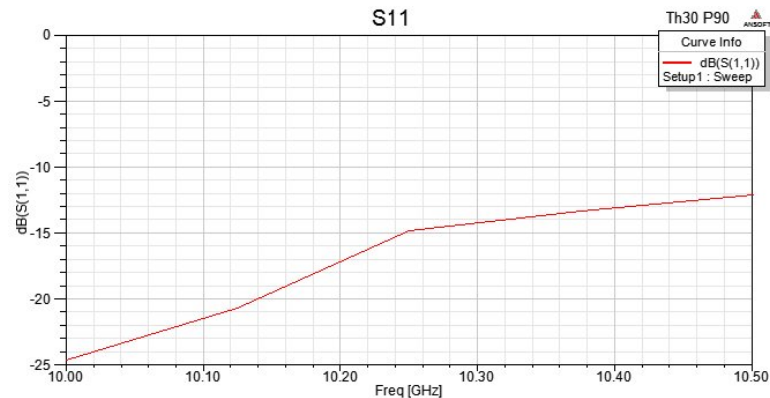
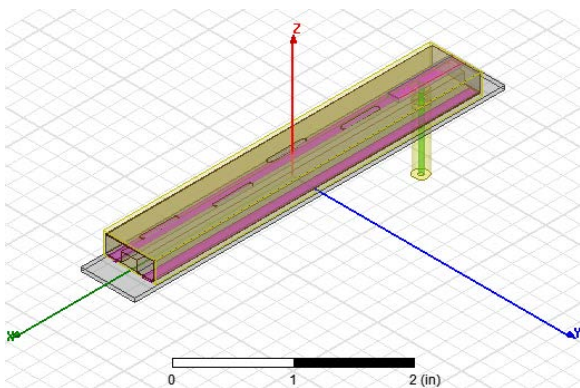
Red: EL (X-Z Plane) Blue: AZ (Y-Z)

Pattern assumes 16 Sticks

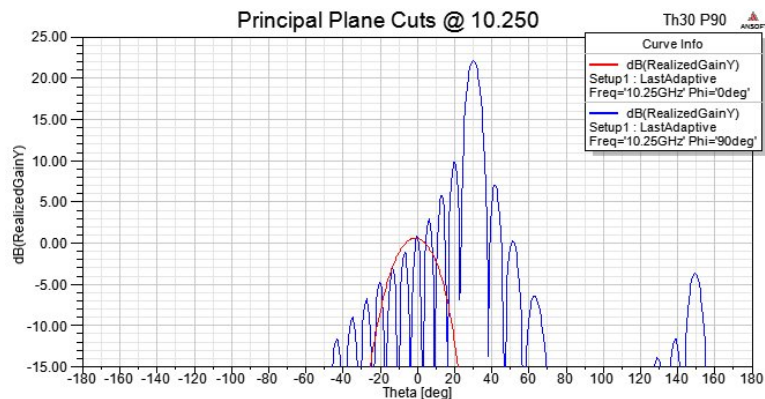


Active Impedance (20° Azimuth Scan)

Quad Slot Sticks (16 Sticks) - 30° Azimuth Scan



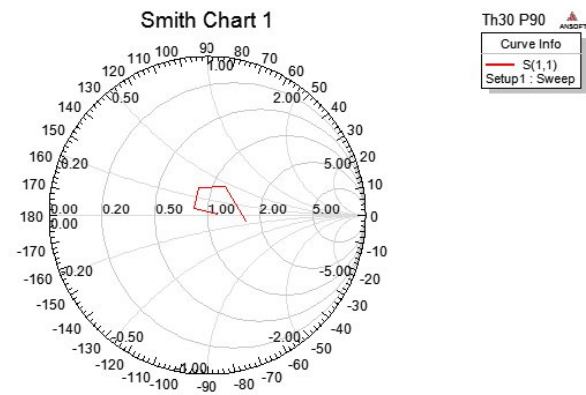
Active Impedance (30° Azimuth Scan)



Principal Plane Patterns @ 10.250 GHz (30° AZ Scan)

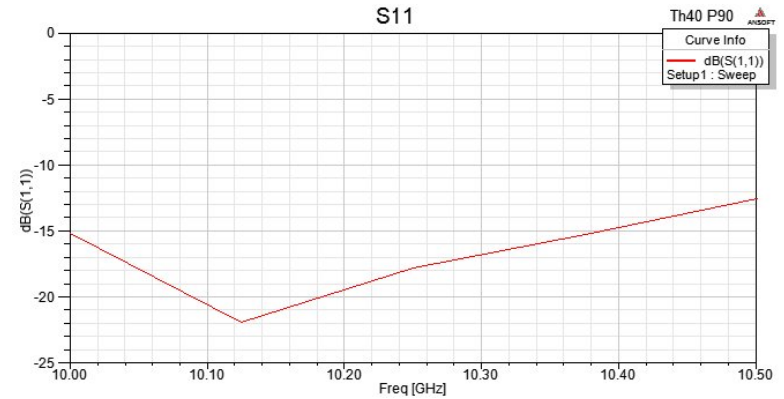
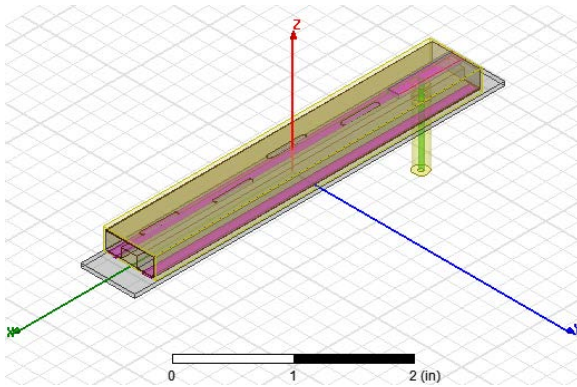
Red: EL (X-Z Plane) Blue: AZ (Y-Z)

Pattern assumes 16 Sticks

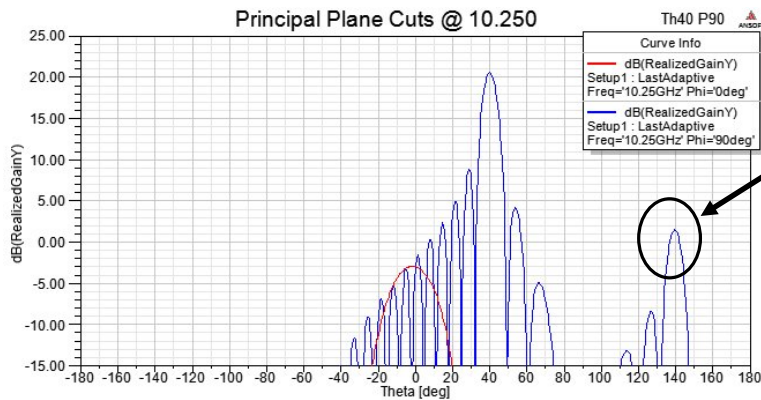


Active Impedance (30° Azimuth Scan)

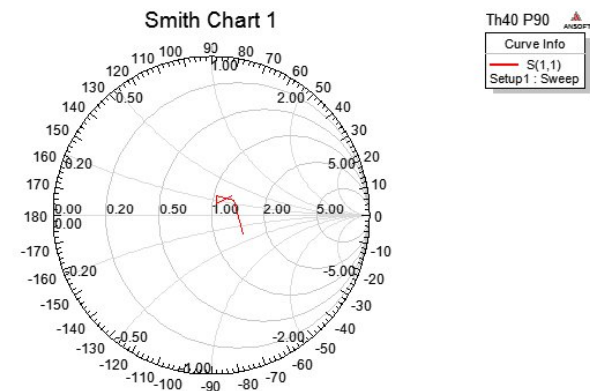
Quad Slot Sticks (16 Sticks) - 40° Azimuth Scan



Active Impedance (40° Azimuth Scan)

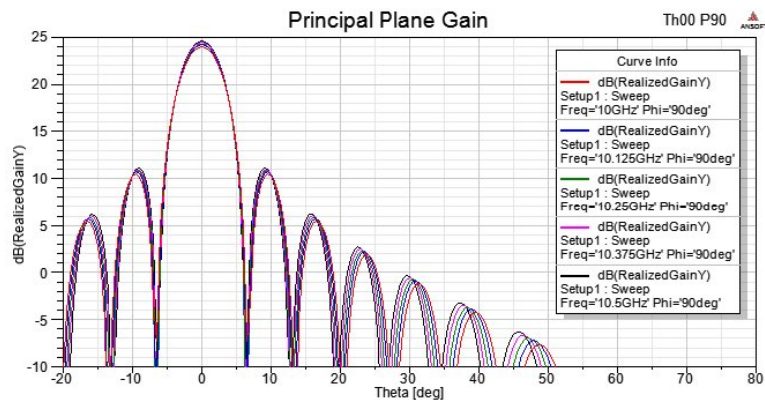


Principal Plane Patterns @ 10.250 GHz (40° AZ Scan)
 Red: EL (X-Z Plane) Blue: AZ (Y-Z)
 Pattern assumes 16 Sticks

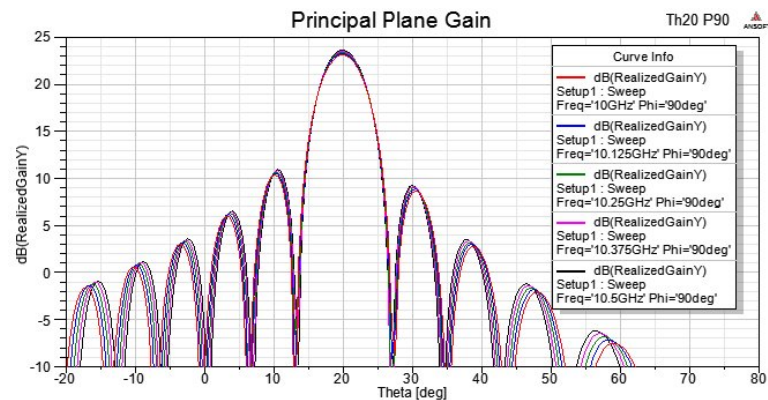


Active Impedance (40° Azimuth Scan)

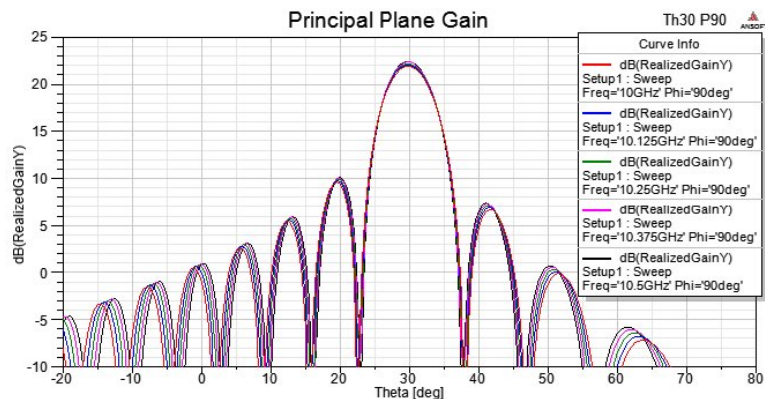
Quad Slot Sticks (16 Sticks)



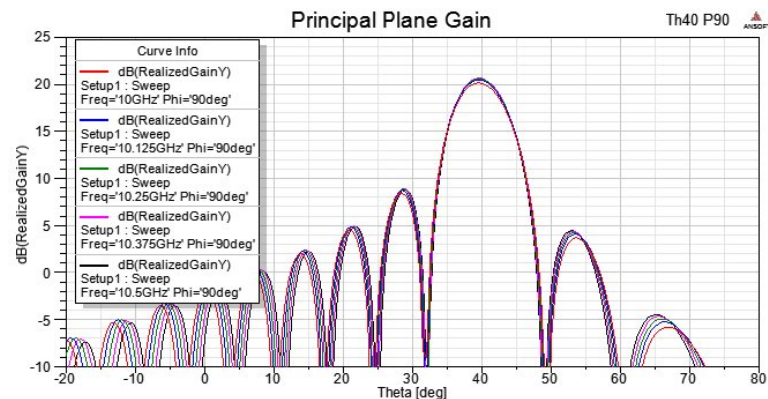
Azimuth Cuts at @ 0° AZ Scan
Pattern assumes 16 Sticks



Azimuth Cuts at @ 20° AZ Scan
Pattern assumes 16 Sticks



Azimuth Cuts at @ 30° AZ Scan
Pattern assumes 16 Sticks



Azimuth Cuts at @ 40° AZ Scan
Pattern assumes 16 Sticks