



DAS & Small Cell Solutions

Innovative End-To-End Value

Hide in Plain Sight®

3265 Fillmore Ridge Heights, Colorado Springs, CO 80907 www.ConcealFab.com

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ConcealFab Designs and Builds Common Looking Infrastructure to Protect and Conceal RF Antennas

Core Strategic Markets

Government SATCOM



Commercial Outdoor Wireless



Commercial Oil and Gas



Other Concealment Opportunities



ConcealFab® Advantages

- Lightweight Thermoplastic Materials
- Ultra RF-Transparent for Low Loss
- Antennas that *Hide in Plain Sight™*
- Standardized Production Designs
- Fast Delivery & Lead-times
- Pre-Built in Factory to Ensure Fit and Trim
- Simplified Site Installation Assembly



ConcealFab® Capabilities



- **Antenna Shroud and Azimuth Analysis**
- **Pole Attachment Design Engineering**
- **3D Photo-Sims for Zoning Presentations**
- **RF-Transparency Testing and Analysis**
- **Rooftop and Utility Pole Engineering**
- **Prototype Design/Fabrication Services**
- **Factory Training & Site Installation**



Solves Small Cell Deployment Cycle Challenges

Deployment Hurdle

Industry Challenges

Aesthetics and Concealment

- Concealment is often an afterthought, then a scramble at the last minute
- Many mounting solutions are poorly designed, unsightly, and leave cables exposed
- Few standardized concealment products exist to facilitate high-volume deployments, mostly regionalized custom solutions

Network Optimization

- Back lobes from Macro/DAS antennas impact Small Cell antenna performance
- Some antennas may not perform optimally due to the impact certain antenna concealment solutions have on RF signal

Equipment (RRU/ BBU) Packaging

- Strict noise ordinances can hinder deployment of actively cooled RRU Cabinets
- Thermal management is a challenge for both active and passively cooled RRUs
- Current packaging solutions can be bulky and unsightly

Planning and Zoning

- Lengthy approval processes and timelines are common
- Tastes and preferences vary by regional jurisdictions
- A&E firms not always incentivized to select or aware of off-the-shelf concealment solutions, which can lead to expensive, customized deployments



ConcealFab® Universal Brackets & Mounts

CONCEALFAB® DAS & SMALL CELL SOLUTIONS

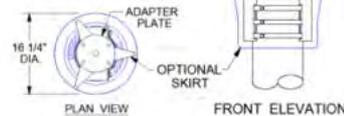
Customized for all Major Quasi-Omni Antennas



Pole-Top Mounting System

General Specifications:

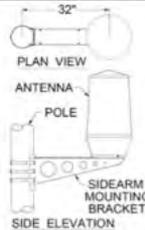
- Penetrating or clamping attachments
- Adjustable for varying pole diameters
- Color coordinated wireway systems available



Side-Arm Mounting System

General Specifications:

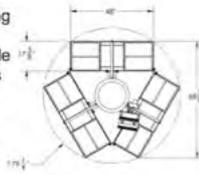
- Penetrating or clamping attachments
- Hollow core for concealing cables or diplexers
- Color-coordinated wireway systems available
- Adjustable bracing for varying pole diameters



Ballasted Rooftop Vent

General Specifications:

- One-piece construction (no on-site welding required)
- Ultra-RF transparent sheathing
- Multiple color options available
- Accommodates varied heights
- Optional RRU mounting post



Lightenna™

General Specifications:

- Penetrating or clamping Side-Arm attachments
- Site-specific adaptations available
- Hollow Side-Arm bracket for cable concealment
- 100% Thermoplastic outer shell
- Adjustable bracing for varying pole diameters



Pole-Top Extension Mount

General Specifications:

- Penetrating or clamping attachments
- Extension mast ensures proper distance from utility wires
- Structurally reinforced steel support
- Adjustable bracing for varying pole diameters

ConcealFab Corporation's DAS & Small Cell wireless solutions are ideal for fiber infrastructure build-outs, upgrades and retrofit projects. Our standardized platform integrates with any antenna and radio configuration, effortlessly blends into urban/suburban environments, and withstands harsh weather conditions.

Our vendor agnostic, DAS and Small Cell Solutions platform accommodates multiple shapes, sizes and weights, providing flexibility for future hardware needs. The product portfolio includes ultra RF-transparent, maintenance-free coverings, high-strength steel mounting brackets, and light-weight, durable carbon fiber poles. ConcealFab's product portfolio leverages three common themes: Structural Soundness, Aesthetics, and a Universal Mounting System.

☑ Structurally Sound

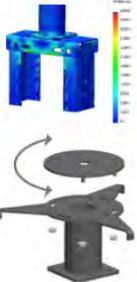
ConcealFab® DAS & Small Cell Solutions are engineered for optimal aesthetics and strength. Factory-friendly designs are structurally sound and will accommodate all Quasi-Omni and panel antennas. They are FEA rated and PE Certified for high wind loads and extreme exposure zones.

☑ Aesthetically Pleasing

ConcealFab® structural steel mounts and brackets receive a durable powder coat finish to protect against harsh environments and create a professional appearance. Optional features include maintenance free, RF-transparent antenna shrouds, cable skirting and custom-colored wireway coverings.

☑ Universal Mounting System

ConcealFab® mounting systems accommodate all major antenna brands. The system leverages common parts and hardware to reduce costs, improve quality, and minimize lead times.



Faux-Wood Pole-Top Shrouds



ConcealFab
Antenna Concealment

O-DAS & Small Cell Solutions

Integrated Monopoles, Side-Arms
and Pole-Top Attachments

Hide in Plain Sight.

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Decorative Pole Fixture Designs



Universal Side-Arm Antenna Brackets



ConcealFab® Advantages

- Lightweight Thermoplastic Materials
- Ultra RF-Transparent for signal strength
- Site Nodes that *Hide in Plain Sight*
- Standardized Interchangeable Brackets
- Fast Design and Delivery Lead-times
- Pre-Built to Guarantee Fit and Trim
- Simplified Assembly / Fast Installation



Small Cell Integrated Pole Solutions



Ultra RF-Transparent Shrouds



ConcealFab® Capabilities

- Antenna Shroud and Azimuth Analysis
- Pole Attachment Structural Engineering
- 3D Photo-Sims for Zoning Jurisdictions
- RF-Transparency Testing and Analysis
- Rooftop and Utility Pole Engineering
- Prototype Design/Fabrication Services
- In-Factory Assembly Training Sessions
- Site Installation Services Available



Wide Range of Outdoor Solutions



Unique Architectural Accents



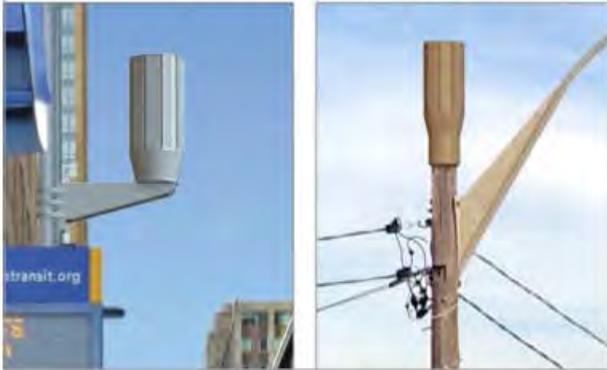
Blends into Urban Environments



Integrated RRU Thermal-Flow Designs

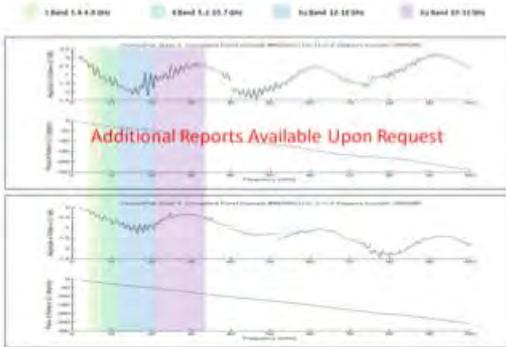


Well Suited for Common Infrastructure



RF-Performance Tested 0-100 GHz

Test Results Available for Specific Requirements



Wind-Load Reducing Tower Shrouds



Carbon Fiber "See-Thru" Design



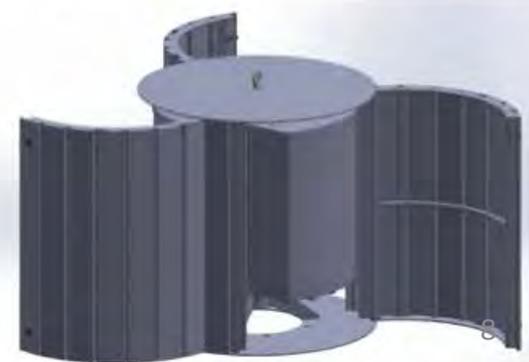
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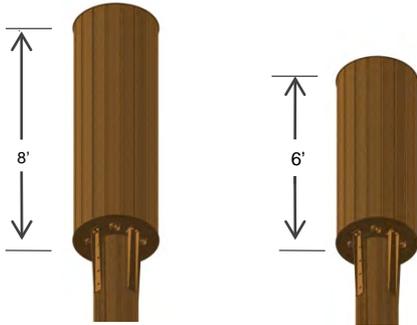


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3-Door Antenna Access Shroud



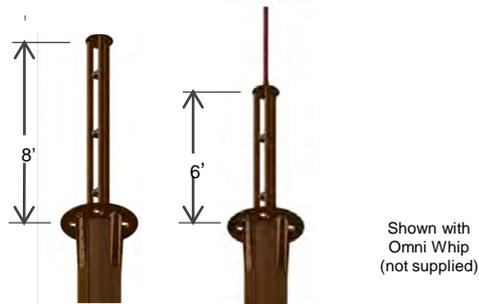
Faux Wood Utility Pole-Top Solution



Pole-Top Antenna Concealment: Full System

General Specifications:

- 30" O.D. Faux Wood RF-transparent antenna shroud
- Adjustable for a wide range of pole diameters
- Includes tri-mast for mounting multiple panel antennae
- Mounting plate for Phazar Whip (*whip not supplied*)
- Additional blank (customizable) whip antenna mounting plate supplied



Pole-Top Concealment: Tri-Mast Mount Only

General Specifications:

- Adjustable for a wide range of pole diameters
- Includes tri-mast for mounting multiple panel antennae
- Mounting point for Phazar Whip (*whip not supplied*)
- Additional blank (customizable) whip antenna mounting plate supplied



Optional External Splitter Mounting Brackets

General Specifications:

- Each pole top concealment has qty (8) attachment points for brackets
- Each bracket includes qty (6) 1/4" diameter holes to allow equipment to be mounted using cable ties

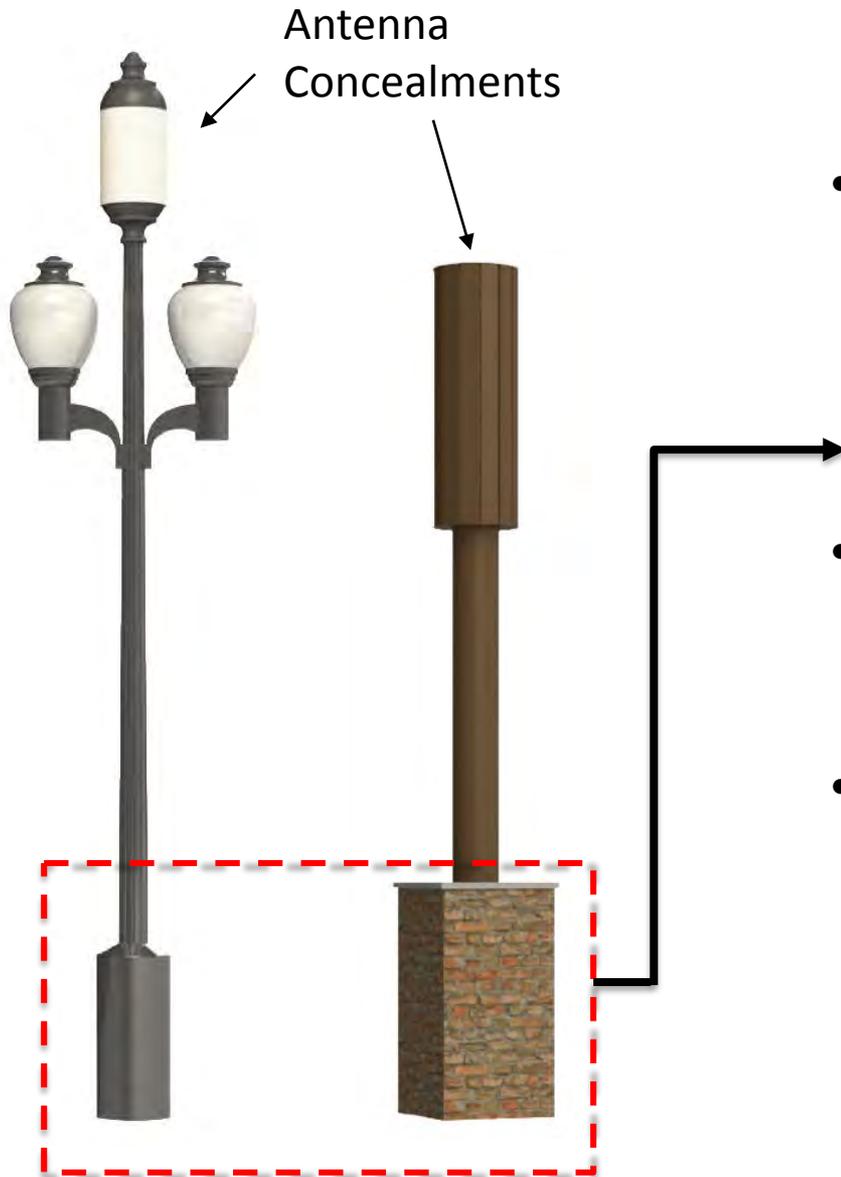


Optional Mini-Skirt Shroud

General Specifications:

- Mini-skirt option to cover mounting legs, wires and equipment
- Supplied with qty (8) external splitter mounting brackets for mini-skirt

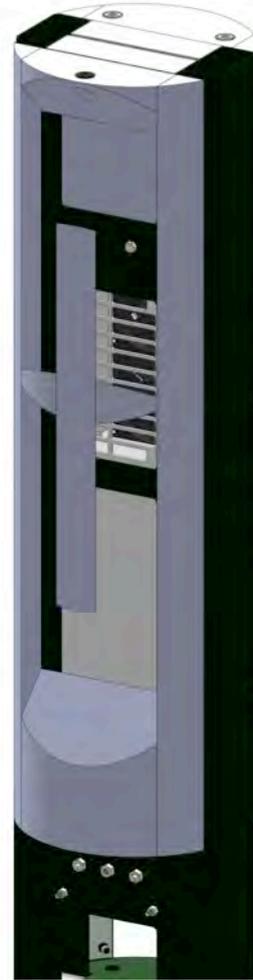
Other Decorative/Functional Pole Concepts



Ground Furniture for RRU Packaging

- Compact base cabinet to hold equipment
 - Minimizes required pole diameters
 - RRUs, BBUs, meter pans, disconnects, etc.
 - Easy-access, clamshell design with several aesthetic options
 - Thermal management and sound suppression features depending on RRU type
- Actively-cooled RRUs
 - Adequate thermal cooling with minimal envelope
 - Sound suppression technology to meet city noise ordinances
- Passively-cooled RRUs
 - Solid State, thermoelectric cooling option (under development)
 - Compact, reliable, low-DC voltage, no maintenance, long life, no noise

Integrated ION Thermal/Sound/BBU Solutions



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Dissipating Heat Concept for ALU RRH and MRO

RRH/RRH-AWS



2x MRO



MRO Shield



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MRO and RRH Form-Factors Using 12" Quasi-Omni



Site-Sim™ Mobile App Creates Instant Photo-Sims

Step 1:

Site walk participants download the Site-Sim™ mobile app onto their Apple and Android smart phone or tablet.



Step 2:

Load ConcealFab® 3D product models into your camera view, rotate, adjust, take pictures, change pole locations, take more pictures. Very Easy!



Photo Simulation

Photo Simulation

Photo Simulation

Step 3:

Instant Photo-Sims are emailed back to you, stored in your secured cloud folder, and onto your mobile phone or tablet.



ShadeHood™ available for Apple iPhones, iPad2, iPad Air, and iPad Mini to block outdoor sun glare while taking photos with SiteSim™ during site walks.



ConcealFab® Ultra RF-Transparent Shrouds



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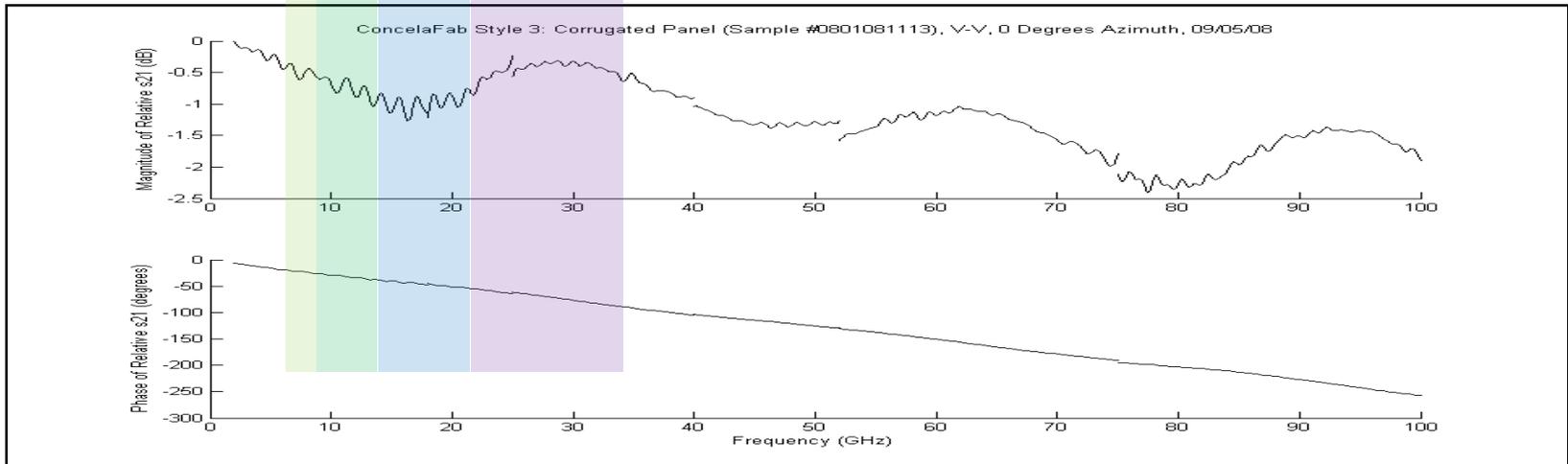
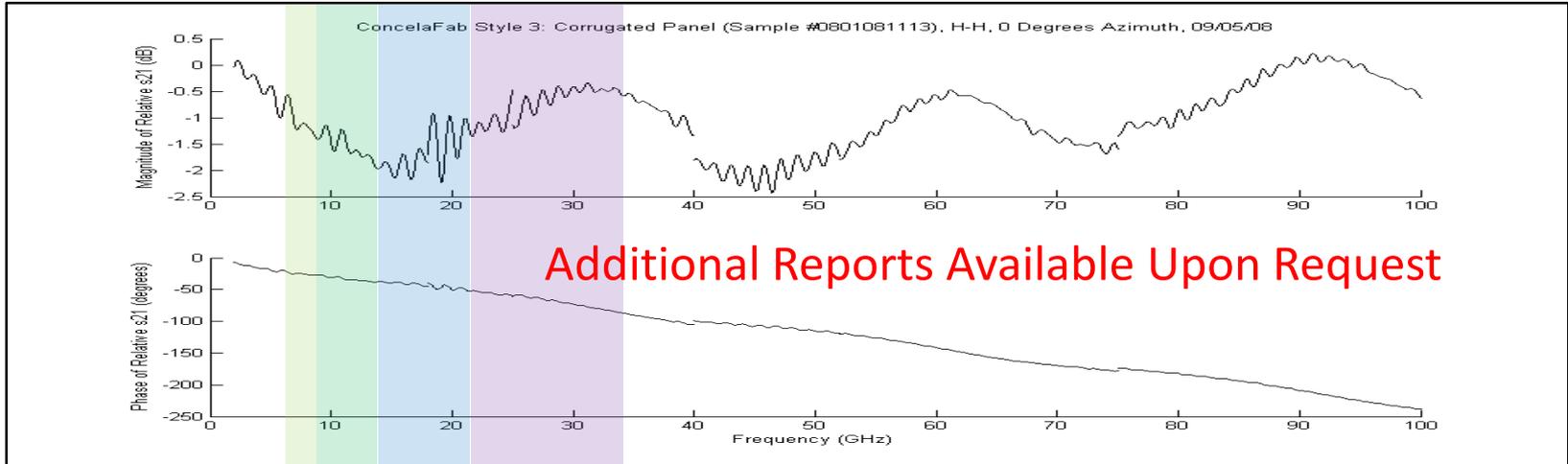
Radio Frequency Testing 0-100 GHz

C Band 3.4-4.8 GHz

X Band 5.2-10.7 GHz

Ku Band 12-18 GHz

Ka Band 19-31 GHz



Extensive Antenna Shroud RF Testing

Testing Conducted

- Three Antenna Shroud-types Tested
 - No antenna shroud
 - Standard 3/16" thermoplastic tube
 - ConcealFab Ultra-RF Transparent Thin-walled Shroud
- 4 bands evaluated
 - Low 1: 704 MHz uplink (U), 734 downlink (D)
 - Low 2: 824 MHz uplink (U), 870 downlink (D)
 - PCS: 1850 MHz uplink (U), 1930 MHz downlink (D)
 - AWS: 1710 MHz uplink (U), 2110 MHz downlink (D)

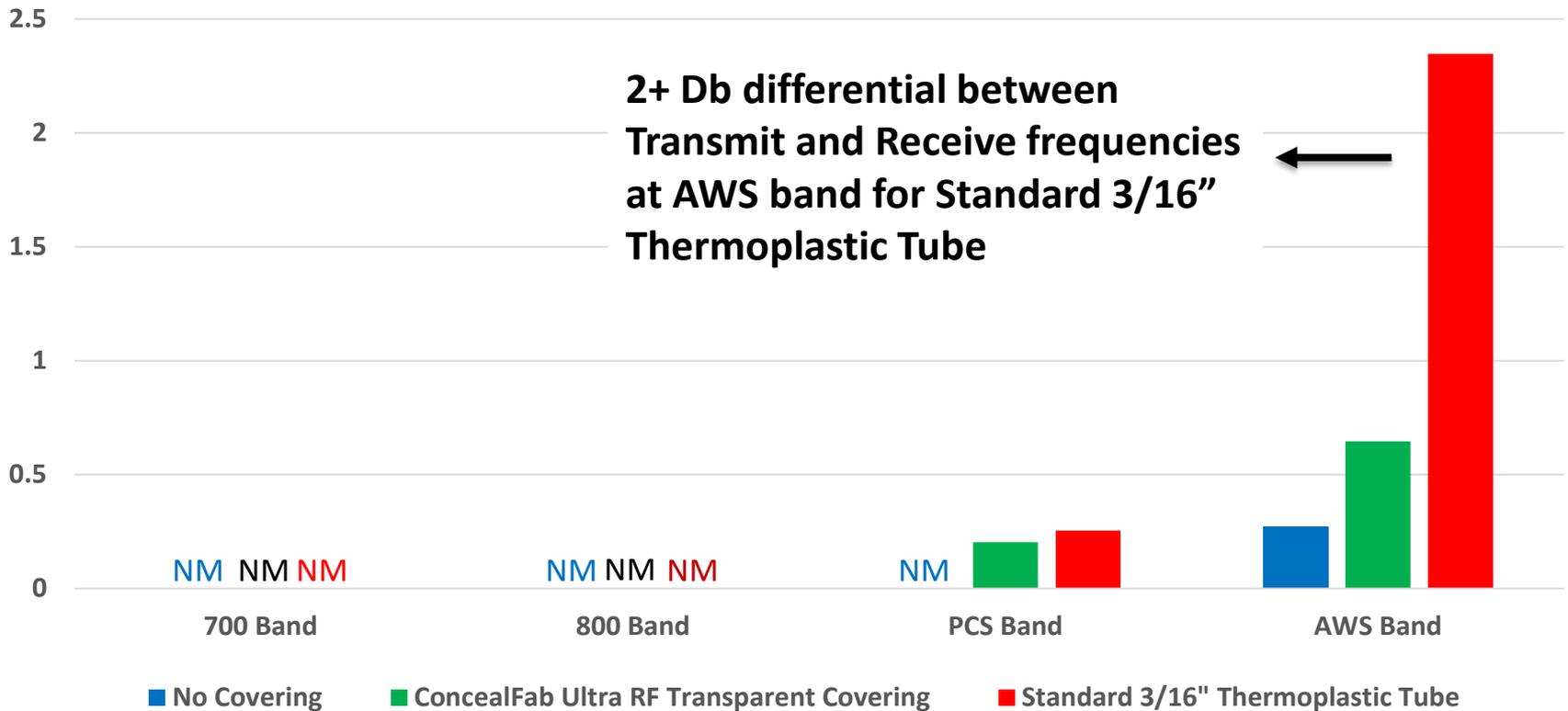
Conclusions

- At the Low bands, the antenna shrouds tested had negligible impact on the antenna patterns
- At PCS band, the impact of the standard 3/16" thermoplastic tube started to become more apparent
- At AWS band, the standard 3/16" thermoplastic tube had a very noticeable impact, 2+dB between the uplink and downlink frequencies

As carriers move toward AWS band, attention should be paid to the types of antenna shrouds used by contractors to reduce the probability of service impact

RF Test Results by Frequency Band

Db Differential (distortion) Between Transmit and Receive Frequency Patterns





Analysis of ConcealFab's Back Lobe Suppressor Generation II



RF Back Lobe Suppression Solution

Situation

- Back lobes from Macro and DAS antennas can interfere with Small Cell patterns
- Problem is most currently pronounced at stadium venues where large antennas for parking lot area interfere with patterns for small antennas inside stadium
- Back lobe phenomenon occurring at all (high and low) bands concurrently

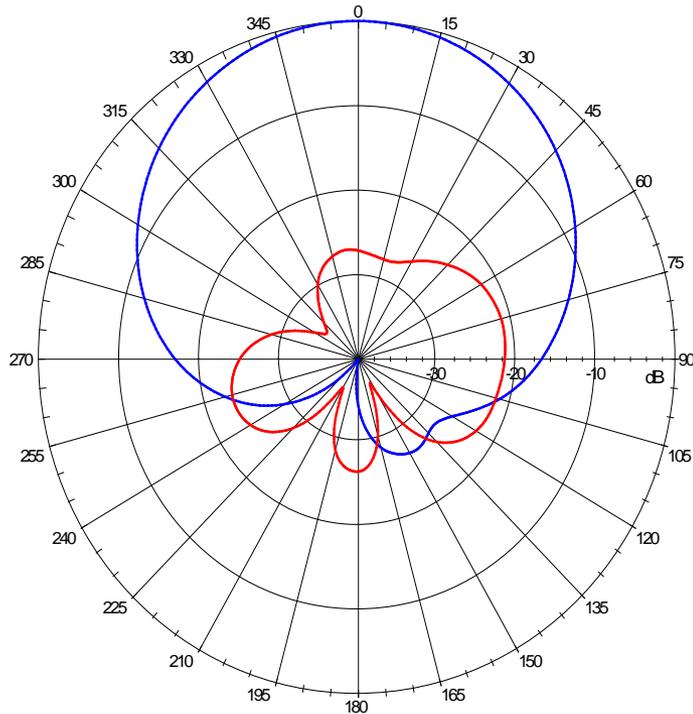
ConcealFab® Solution

- Multi-band suppression solution that wraps around the perimeter of a panel antenna, current design uses a mounting case envelope
- No impact on front lobe pattern
- Solution leverages a combination of an RF choke and specialized RF absorber to mitigate the target frequencies



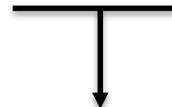
Improvement in Both Co-Pol and Cross-Pol Back Lobes

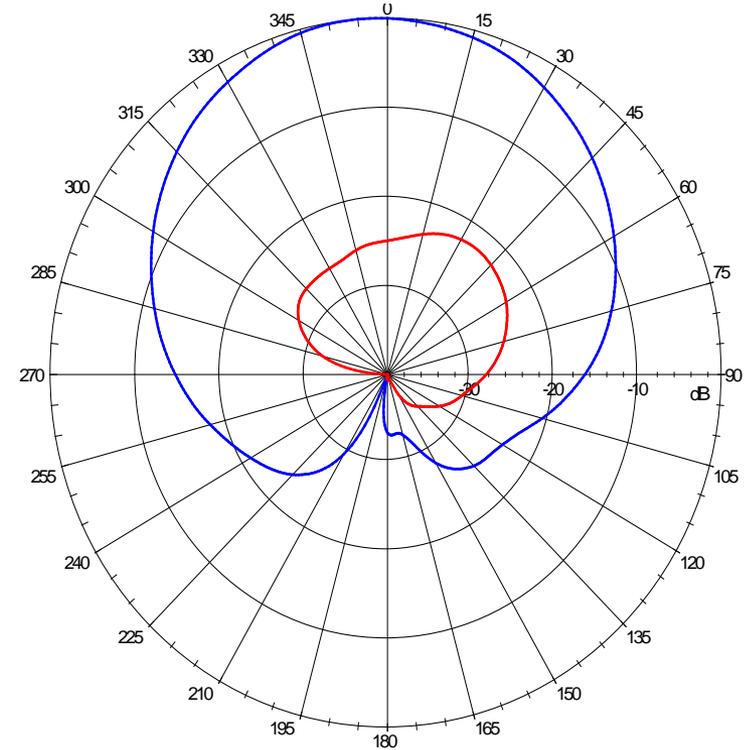
725 MHz (+45 Pol): No Suppression



725 MHz (+45 Pol): With Suppression

Co-Pol 
Cross Pol 


Backside
Energy

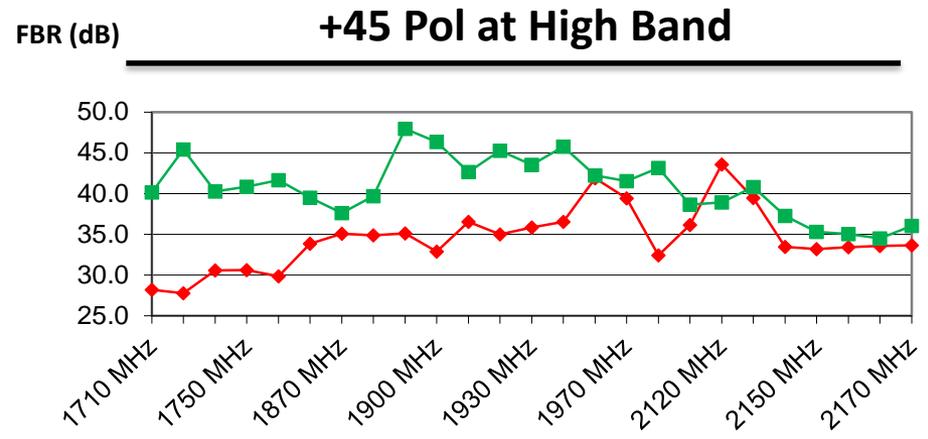
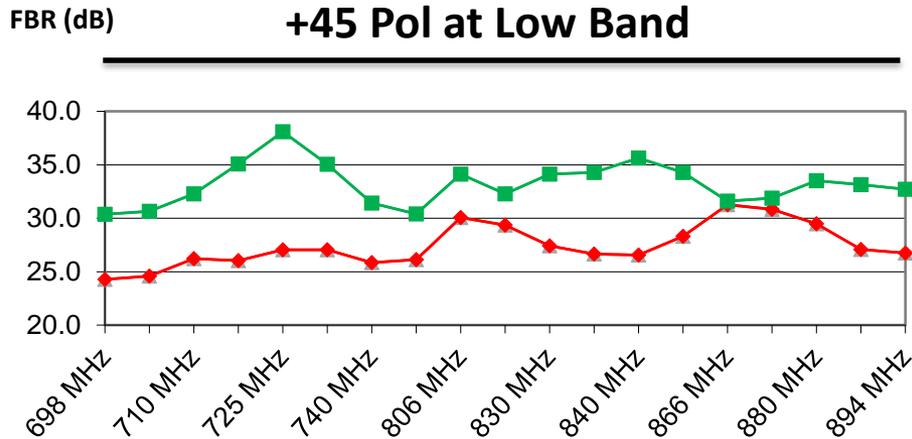


725 MHz	FBR no Suppression(Db)	FBR <u>with</u> Suppression(Db)	Improvement (Db)
Co-Pol	36.6	40.7	4.0
Cross-Pol	27.0	38.1	11.1

Study performed on a 45 degree polarized antenna. Above pattern represents the single -45 degree polarization

Front-to-Back Improvement at High and Low Bands

Full-Range Front to Back Ratio



w/ ConcealFab Suppressor ■
w/o ConcealFab Suppressor ◆



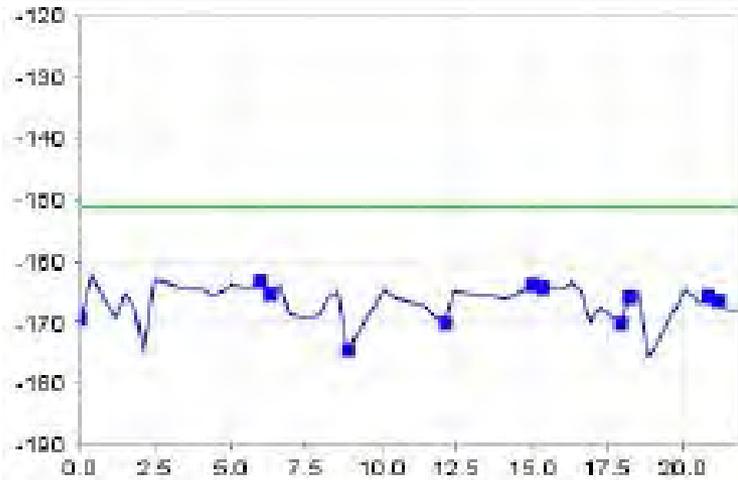
Low Band Range	Average Front to Back Ratio (Db)
Cross-Pol	27.4
w/ Suppressor	33.2
Improvement	5.8

High Band Range	Average Front to Back Ratio (Db)
Cross-Pol	34.5
w/ Suppressor	40.8
Improvement	6.3

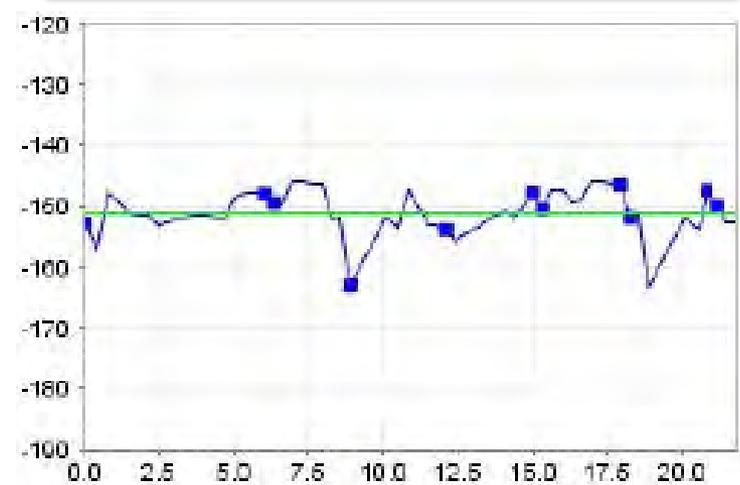
Study performed on a 45 degree polarized antenna. Above pattern represents the single +45 degree polarization

Acceptable Levels of PIM at Both High and Low Bands

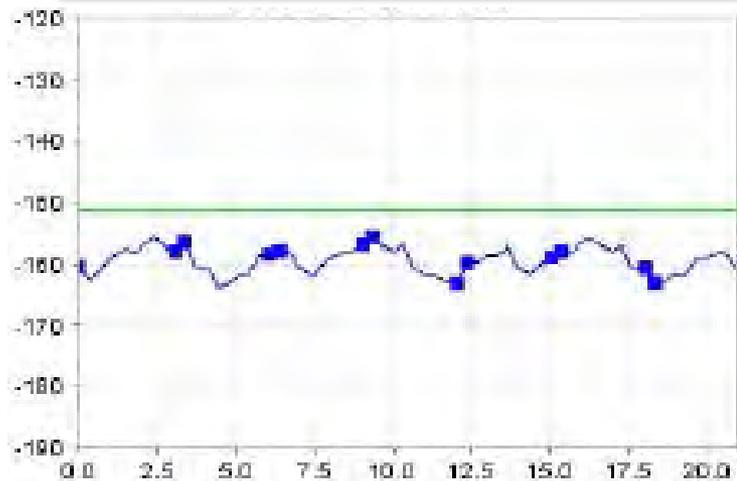
(dBc) **Low Band PIM (no suppressor)**



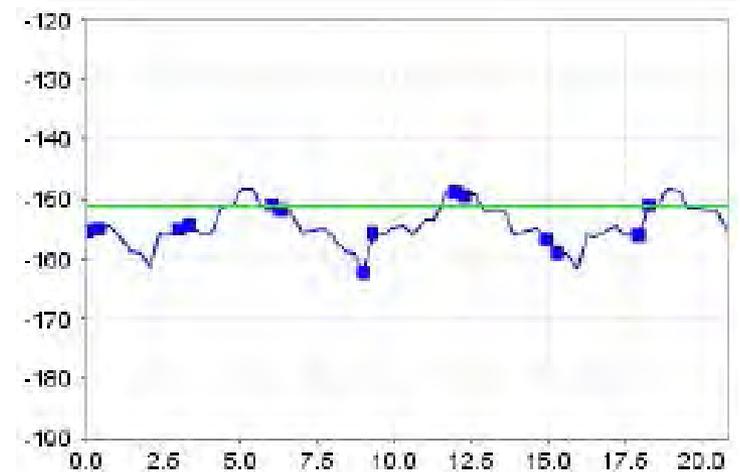
(dBc) **Low Band PIM (w/suppressor)**



(dBc) **High Band PIM (no suppressor)**



(dBc) **High Band PIM (w/suppressor)**



Study performed on a 45 degree polarized antenna. Above pattern represents the single +45 degree polarization
Low Band PIM tested at 700-732MHz; High Band PIM tested at 1,870-1,910MHz