UHF Broadband Pylon Antenna Technology

PRESENTED BY Nicole Starrett

Pylon Antennas

- Term coined by RCA
- Top mounted slotted coaxial antenna
- Long, thin, round structures
- Smaller in size and less wind load than other broadcast antennas
- Fewer parts/connections
    - Simplicity = Reliability!

Pylon Antennas

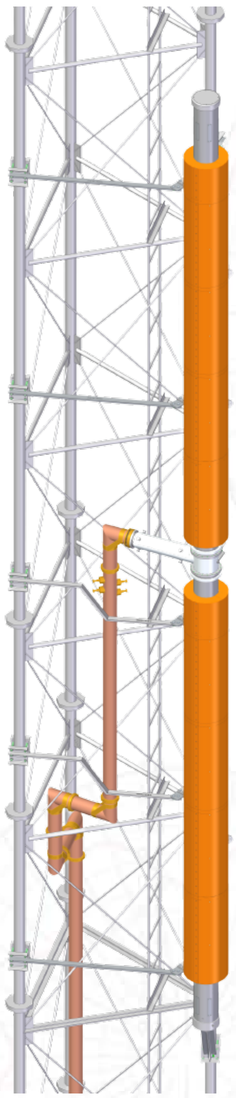
- One disadvantage: inherently narrow bandwidth

$$\%bw = \frac{f_h - f_l}{f_0} x100$$

- Natural bandwidth: 1-2% at UHF
- For most applications usage is only considered for single channel operation

For Today's Presentation:

- Method to increase the bandwidth of a slotted coaxial antenna – requiring external feedlines
- Method to reduce the impact of external feedlines on the azimuth pattern

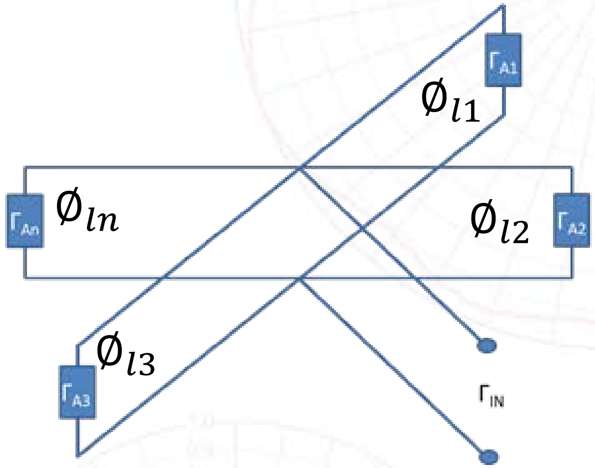


Corporate Feed Networks – Phase Cancellation

- The total reflection coefficient of multiple loads fed in parallel is the summation of the individual loads each with a phase offset

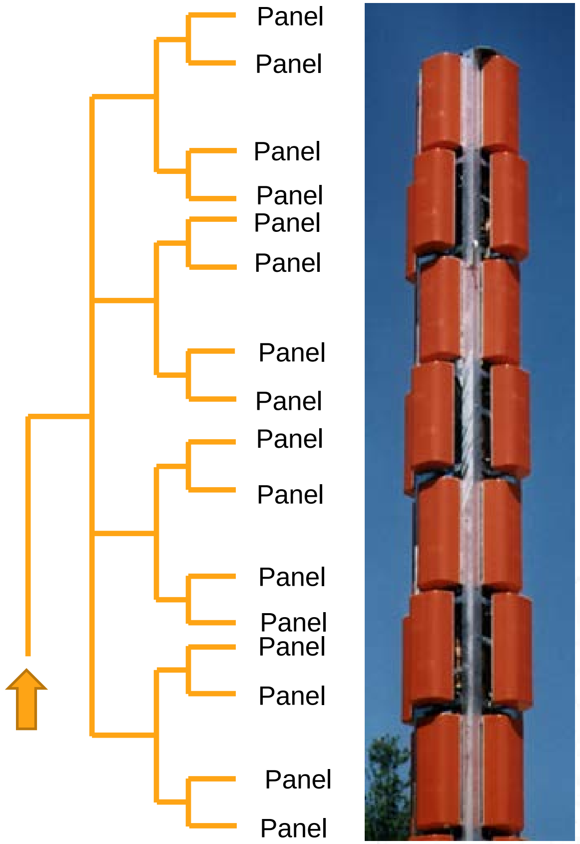
$$\Gamma_{IN} = \frac{\sum_{p=1}^{n} \Gamma_{A_n} e^{-j2\pi\emptyset_{l_n}}}{n}$$

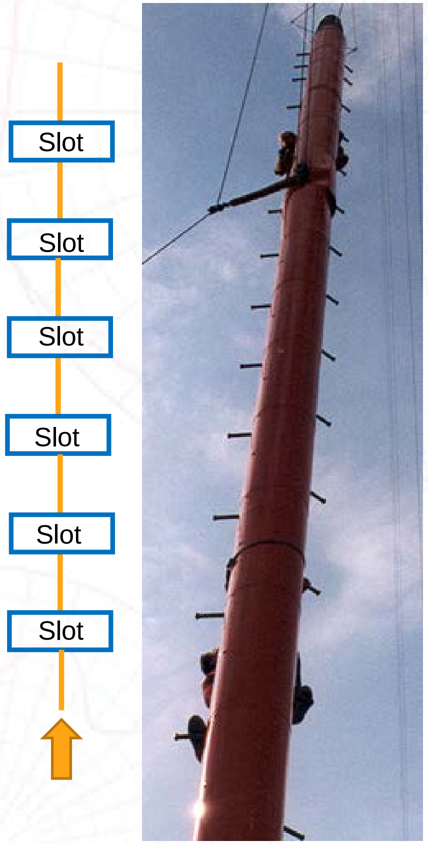
- Changing the phase between loads can provide impedance cancellation



Corporate Feed Networks – Phase Cancellation

- Phase cancellation is done through a corporate feed network
- Common practice in broadband panel antenna
  - Many loads fed in parallel
  - Many power dividers and feedlines
- How can this be applied to slotted coaxial antennas?
  - All loads fed in series

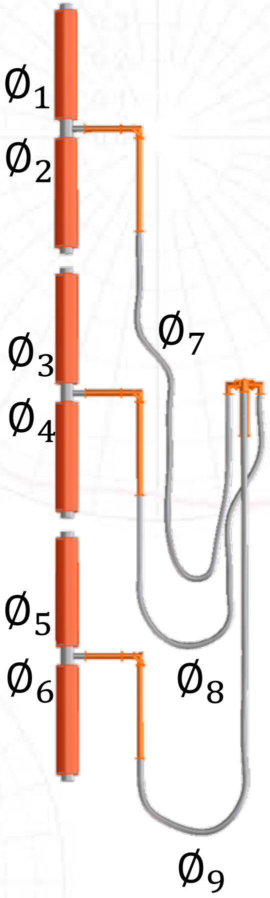




Multi-Sectional Slotted Coaxial Antennas

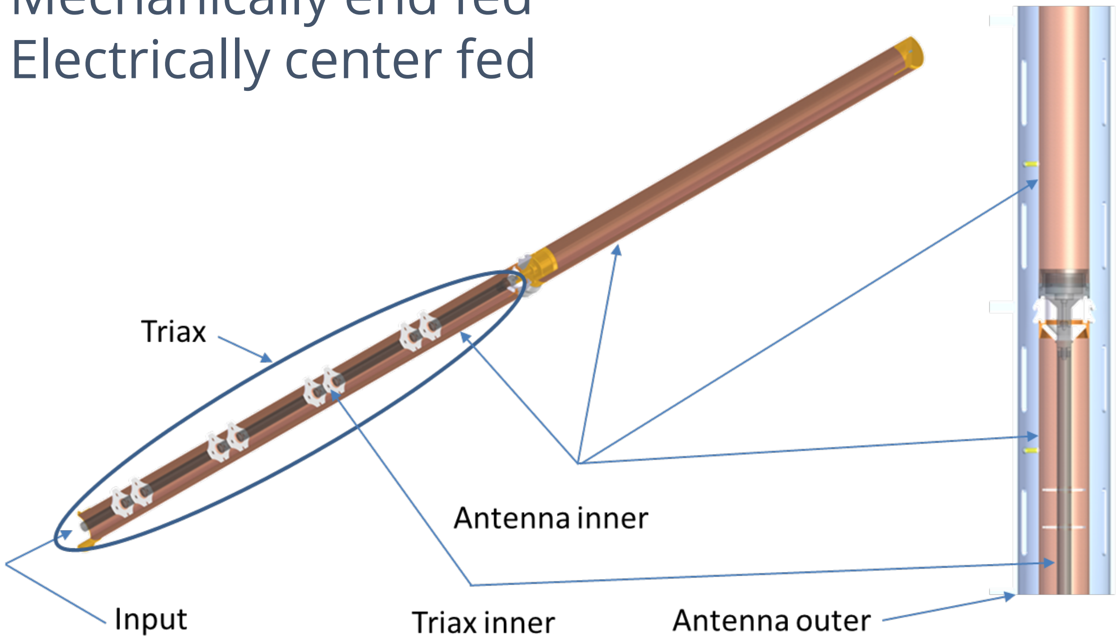
- How can we fix the bandwidth limitation of pylon antennas?
- Apply phase cancelation similar to panel antennas
- Split antenna into multiple sections
- Feed each section with separate feedline from common power divider – single input

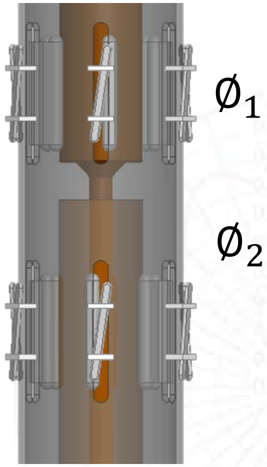
- Example:
  - 24-layer antenna split into 3 center fed sections
  - Each section is center fed with an external feedline
  - 9 locations to apply phase offset
  - **Limited to side mounted antennas** :1



Multi-Channel Top Mounted Antennas - Stacks

- Historically top mounted multi-channel pylons are single channel antennas structurally stacked
- Each are center fed by a harness
  - Mechanically end fed
  - Electrically center fed

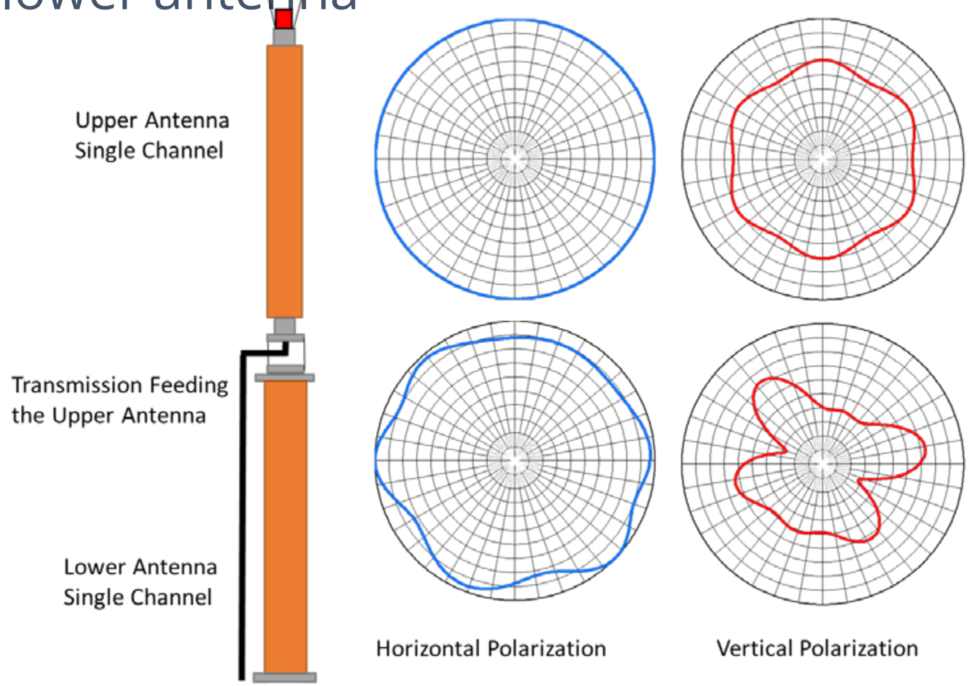


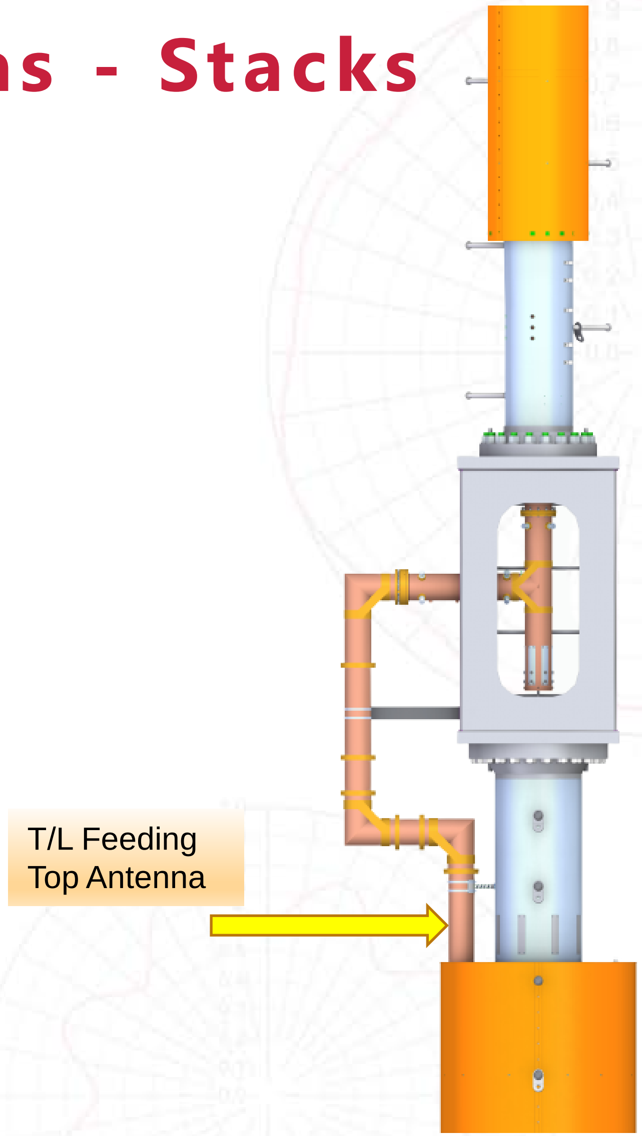


Phase offset between top and bottom half by shifting the harness feed

Multi-Channel Top Mounted Antennas - Stacks

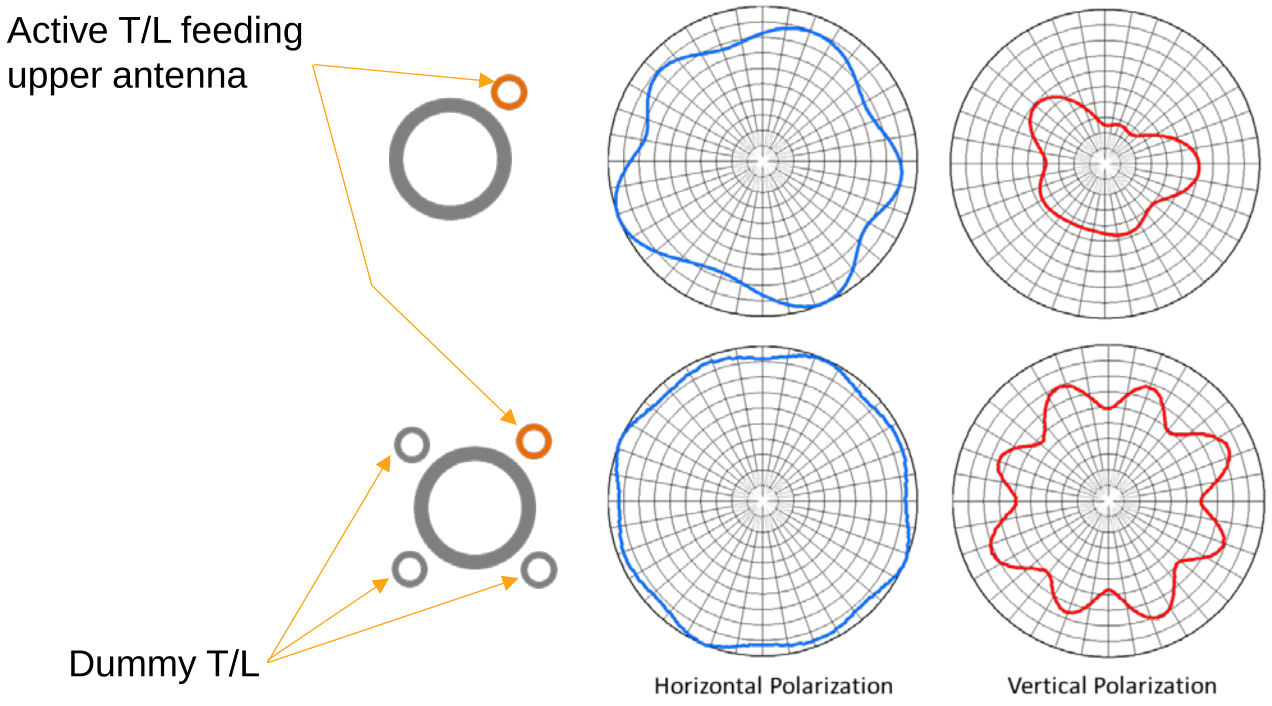
- Disadvantages:
  - Twice the height of single antenna
  - TL feeding top antenna affects the pattern of the lower antenna

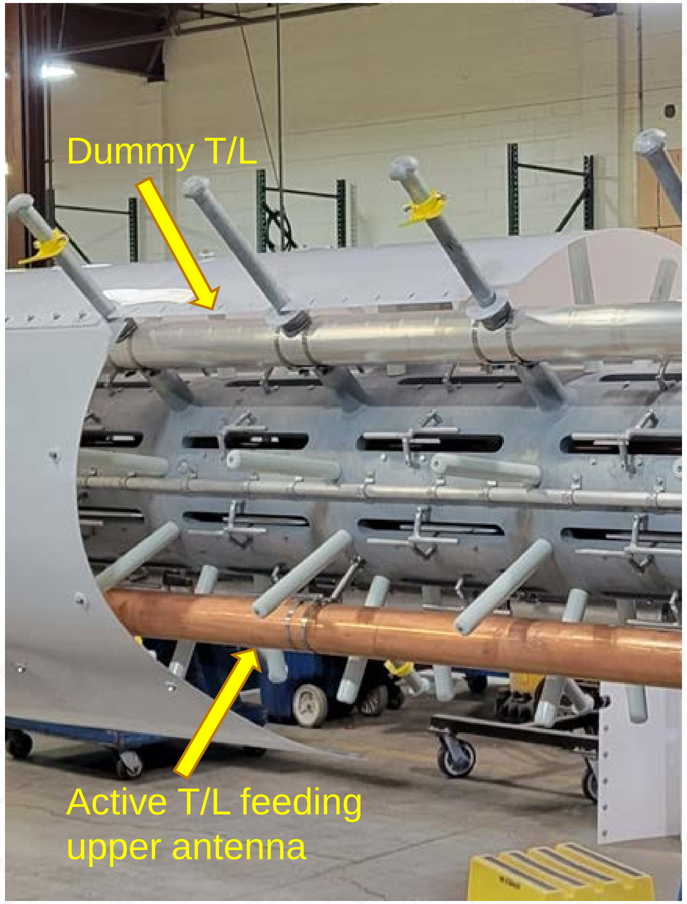




Circularity Improvement

- Accomplished by adding dummy cylindrical lines around the antenna instead of a single line

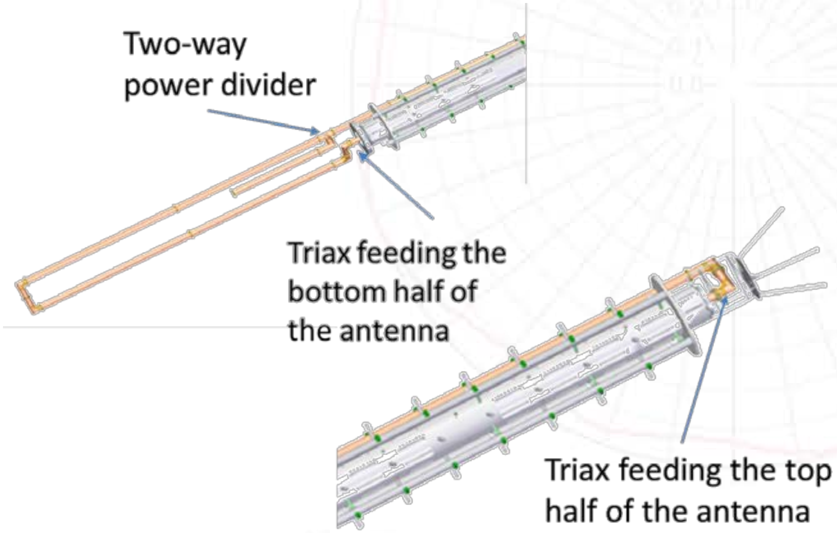


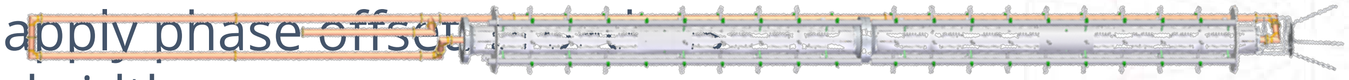


Sectionalizing a Top Mount Pylon Antenna

- Create a dual harness design to take advantage of phase cancelation
- Add dummy TL to improve circularity

- Example:
  - 32-layer split into two center fed 16-layer sections
  - Harnesses fed by power divider below tower top
  - One harness feeds bottom antenna section from bottom
  - Other harness feeds top antenna section from top
  - Top and bottom antenna sections structurally attached by a flange
  - 6 locations to apply phase offset
    operating bandwidth

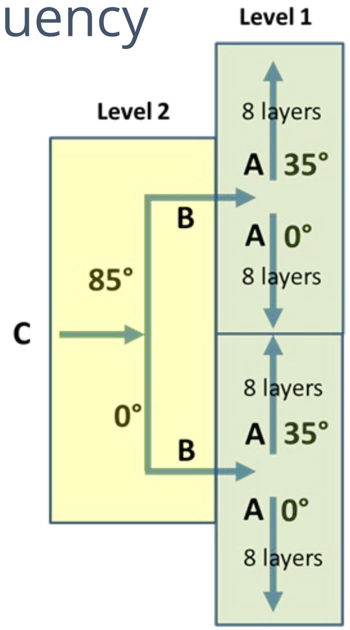


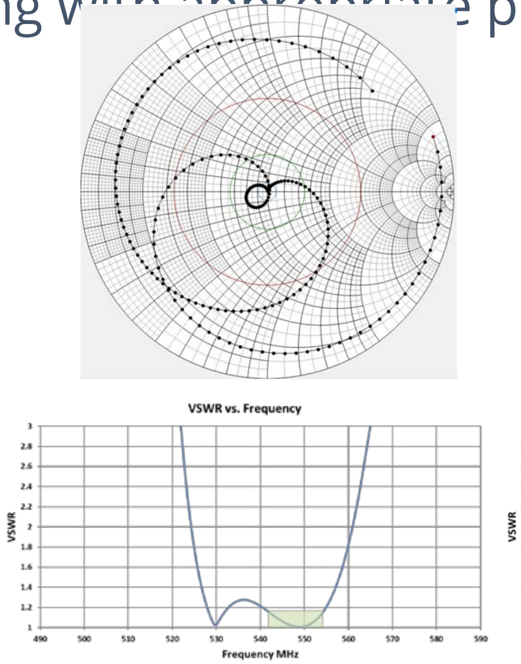


BB Pylon – Determining Theoretical Bandwidth

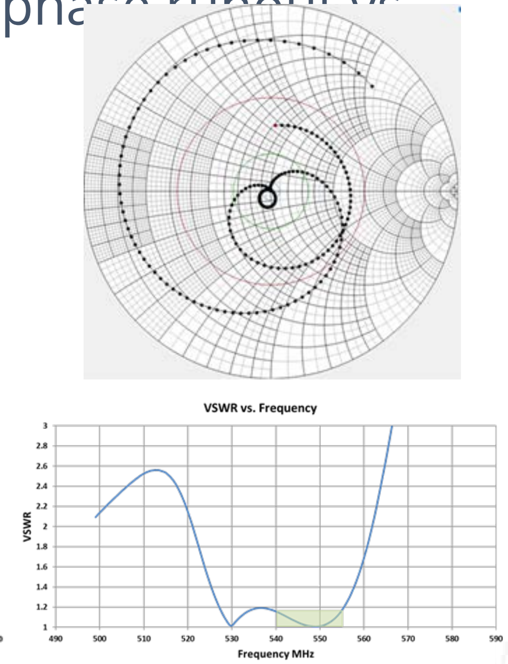
- Dual harness 32-layer example, 2-level/6-point phase offset
- Using equation along with appropriate phase runout vs frequency

$$\Gamma_{IN} = \frac{\sum_{p=1}^{n} \Gamma_{A_n} e^{-j2\pi\emptyset_{l_n}}}{n}$$

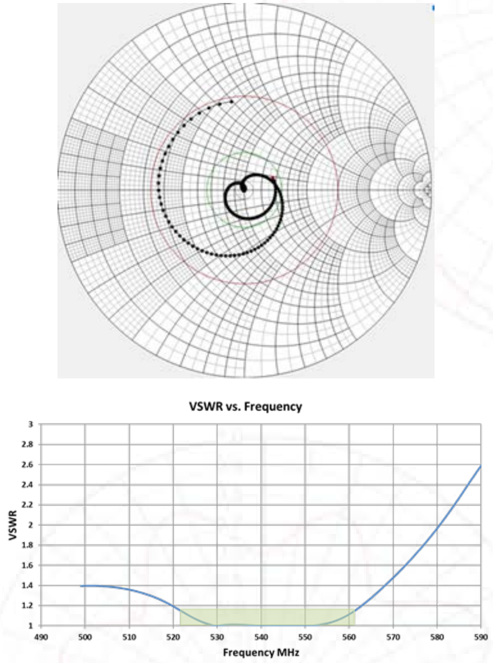




Point A
Typical series fed response
2% bw at max 1.15 VSWR



Point B
Typical series fed response
2.6% bw at max 1.15 VSWR



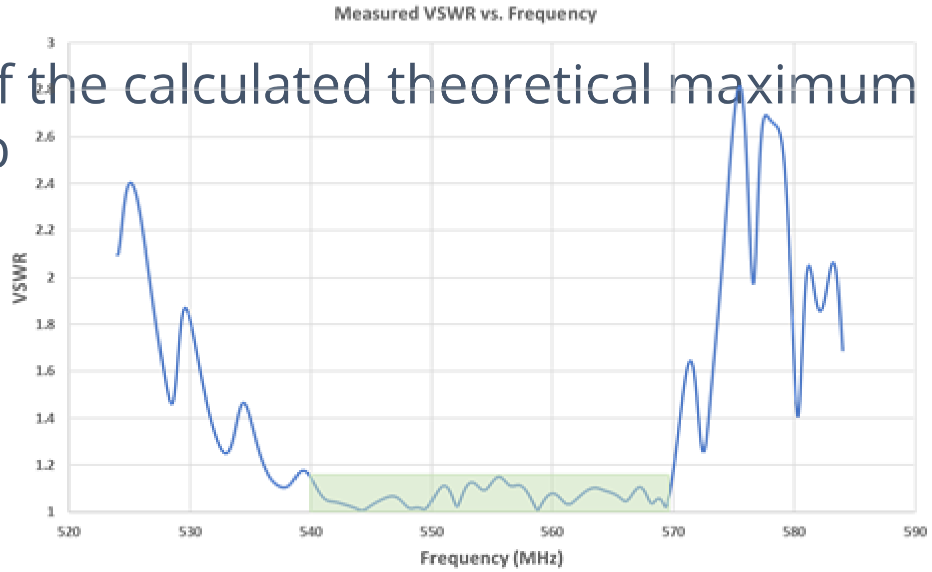
Point C
Typical series fed response
7.2% bw at max 1.15 VSWR

BB Pylon – Theoretical Bandwidth

- This example provides a theoretical maximum bandwidth for the design
- Assumptions:
  - All impedances at point A are identical
  - All materials are perfect, doesn't account for material/manufacturing tolerances
    - Typical steel pipe – 12% tolerance on wall thickness
    - Compounding 1.05 to 1.2:1 VSWR offset at each layer
  - No impedance contribution at power splitting points
- Actual product bandwidth will be reduced from theoretical ma

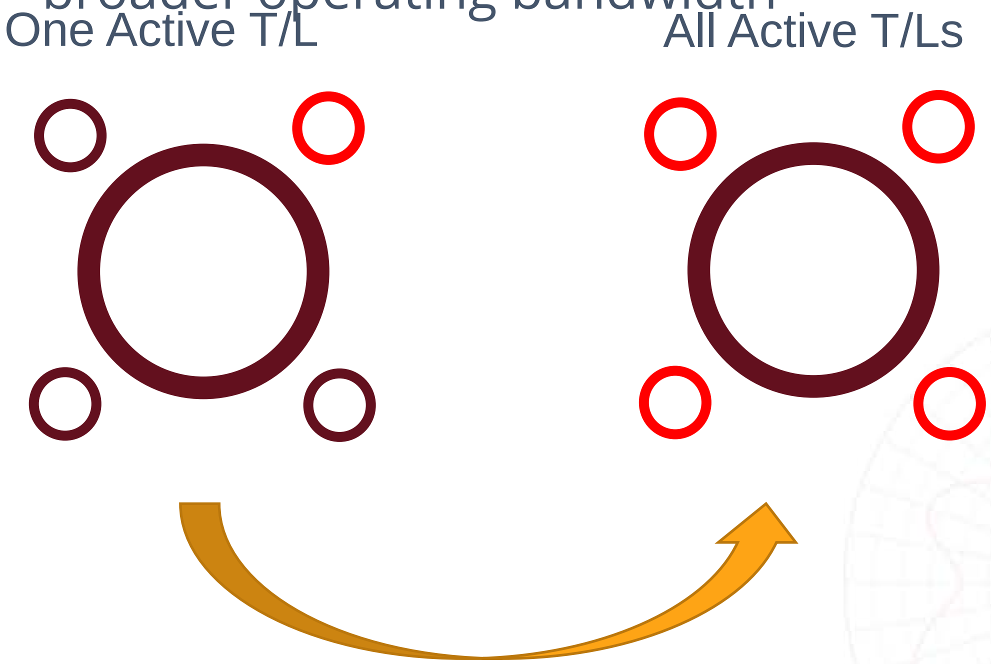
BB Pylon – Dual Harness Practical Application

- Theoretical design implementation
  - First BB pylon designed and manufactured for channels 26 – 29
  - Service Omaha Nebraska
  - 32-layer, dual harness design
  - Measured usable bandwidth of 5.4% for max VSWR of 1.15:1
  - 75% of the calculated theoretical maximum – rule of thumb



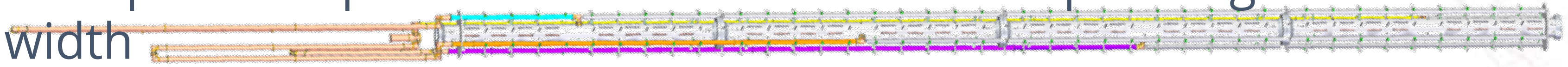
Expanding Application for Broader Bandwidth

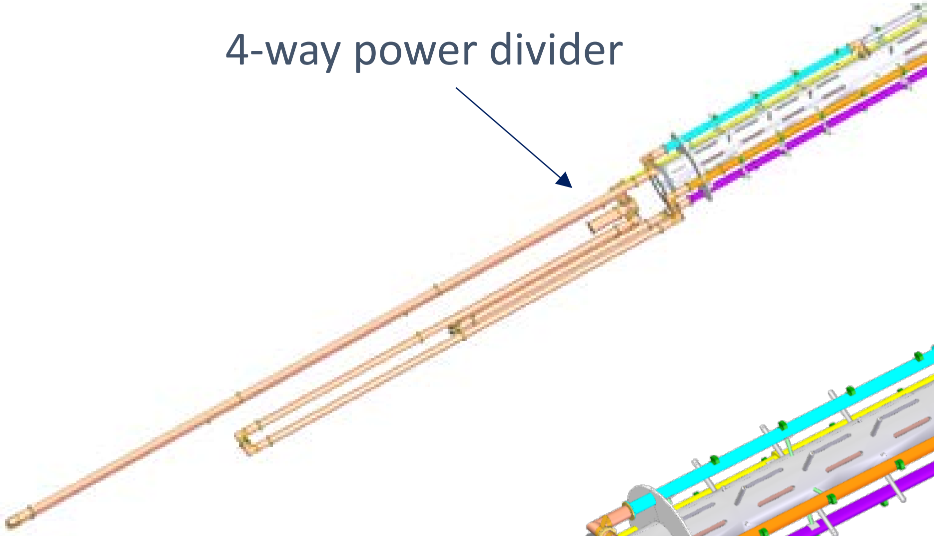
- Previous dual harness design utilized 1 of the 4 external T/Ls
- Using the other 3 allows for more feed points
- More feed points = more opportunities for phase cancellation
- More phase cancellation – broader operating bandwidth

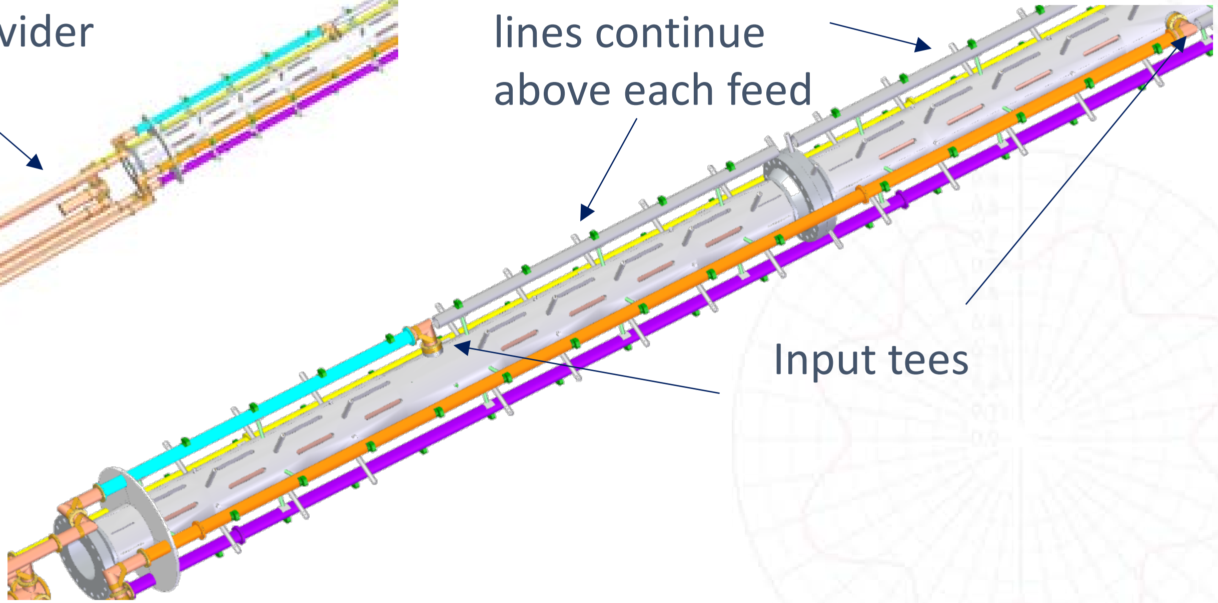


BB Pylon – Quad Tee Theoretical Application

- Quad tee design
  - 32-layers split into 4 center fed sections – each fed with an input tee
  - Sections are structurally attached by flanges
  - 2-level/12-points of phase offset used to broaden operating bandwidth







Quad BB – Determining the Theoretical Bandwidth

- Quad tee design/example
  - 2-level/12 points of phase cancellation – theoretical analysis
  - Using equation along with appropriate phase run out vs frequency

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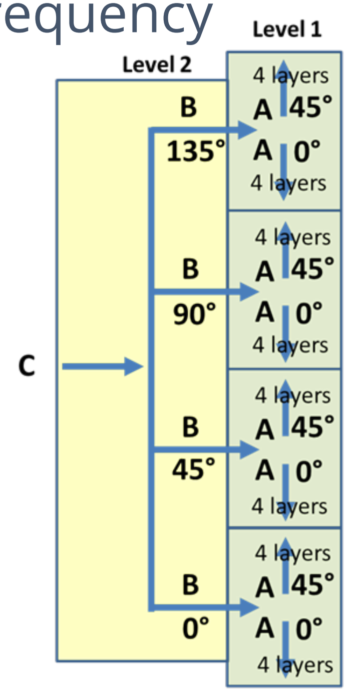
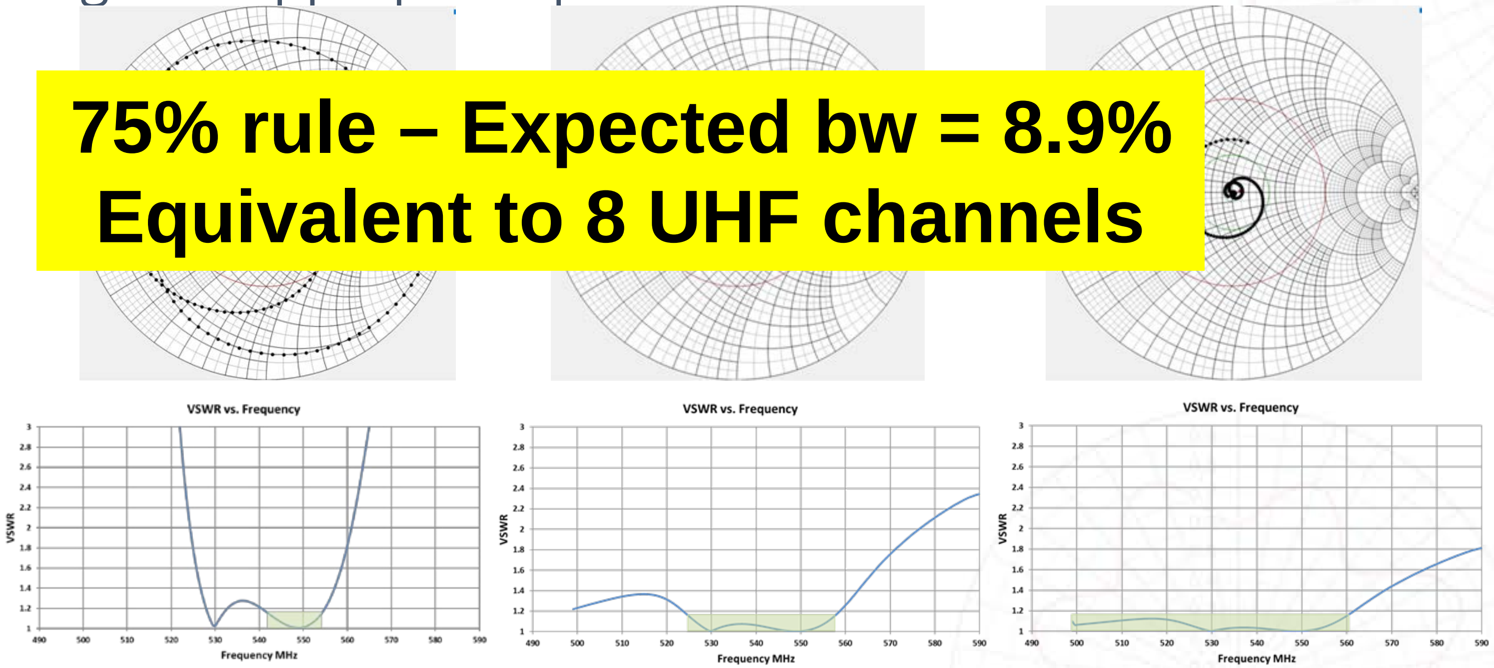


75% rule – Expected bw = 8.9%
Equivalent to 8 UHF channels



Point A
Typical series fed response
2% bw at max 1.15 VSWR

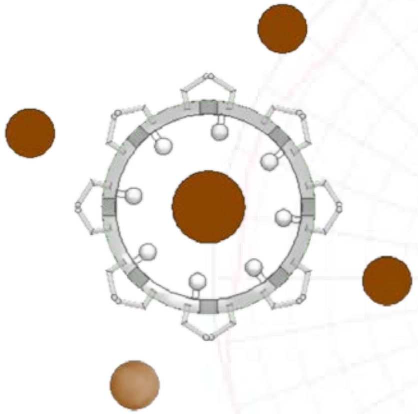
Point B
Typical series fed response
5.8% bw at max 1.15 VSWR

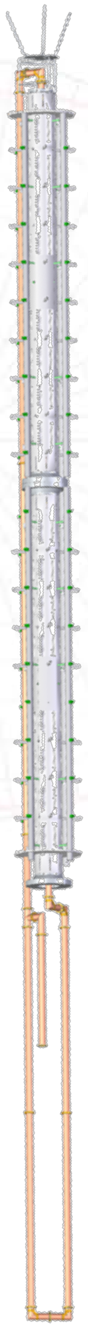
Point C
Typical series fed response
11.8% bw at max 1.15 VSWR

Conclusion

- High power top mounted pylon broadcast antennas can be used for broadband multi-channel applications
- Accomplished by applying multi-point phase cancellation
- External transmission lines used to improve the azimuth pattern circularity are also used to feed each section of the antenna
- New technology provides a:
    - Simple
    - Reliable
    - Low wind load
    - Cost effective

alternative to broadband panel solutions





Dual Harness design: proven, 2 systems shipped so far

Quad Tee design: in process, more to come!

Patent Pending

THANKS FOR YOUR TIME!

ANY QUESTIONS?

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