ANTENNA TOPICS

Dave Leeson, W6NL/HC8L

"You don't get there by secrets, you get there by doing *everything* better."

W6NL Antenna Topics

- New EIA/TIA-22-G Tower Standard
- Gamma and Tee Match model correction
- 40m Moxon Yagi on Cushcraft XM240
- W6NL & HC8 foreground slope results

EIA/TIA-222-G Tower Standard

- Wind: 3-sec. gust, not “fastest mile”
- Drag factors lower in 222-G
- Exposure (terrain roughness) categories
- Wind speedup from topography
- New wind, ice maps for US counties

3 sec Gust vs. Fastest Mile

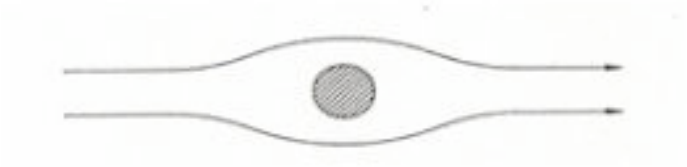
3-sec gust (mph)	Fastest-mile (mph)
60	50
70	58
80	66
85	70
90	75
95	78
100	80
105	85
110	90
115	95
120	100
125	105
130	110
135	115
140	120
145	125

From Wahba, Maloof, Brinker & Erichsen, "New Standards for Broadcast Structures, ANSI/EIA/TIA-222-G," NAB-2003presentation.pdf

Drag Factors Lower in 222-G

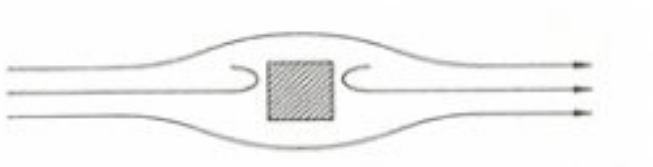
- Drag factor x projected area = effective projected area for wind force model
- Drag factor varies with shape, length, angle to wind and roughness

Round Members



Drag Factor = 0.5 Short (Discrete)
Drag Factor = 1.2 Long (Linear)

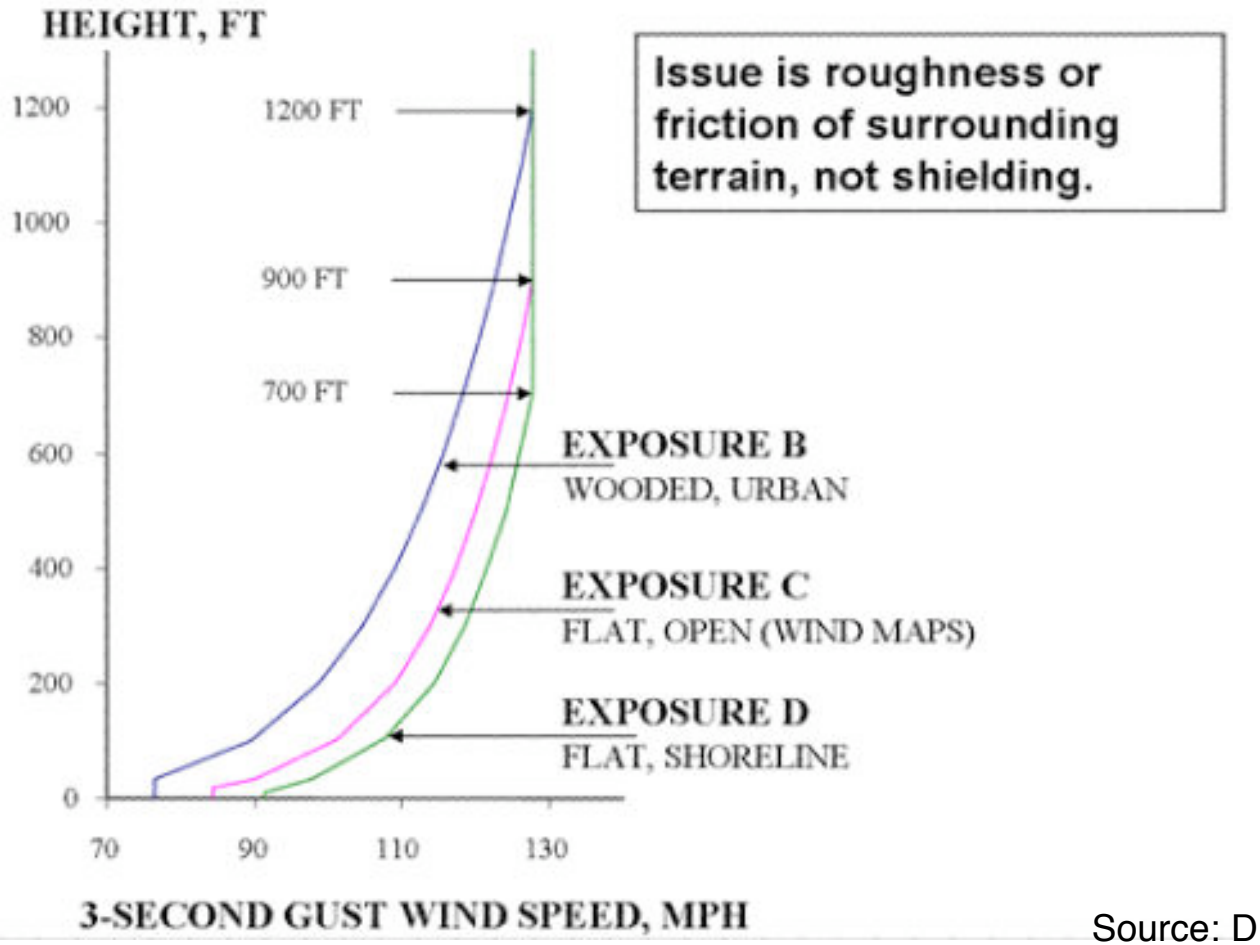
Flat Sided Members



Drag Factor = 1.2 Short (Discrete)
Drag Factor = 2.0 Long (Linear)

Source: D. Brinker

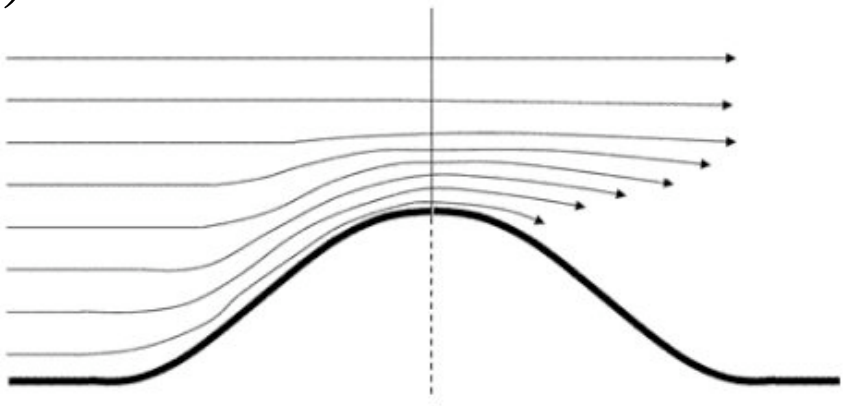
Exposure & Height Escalation



Source: D. Brinker

Topographic Wind Speedup

- Categories
  - 1: Flat land (no speedup)
  - 2: Escarpment (mild)
  - 3: Hill (medium)
  - 4: Ridge (highest)
- Up to 3x pressure

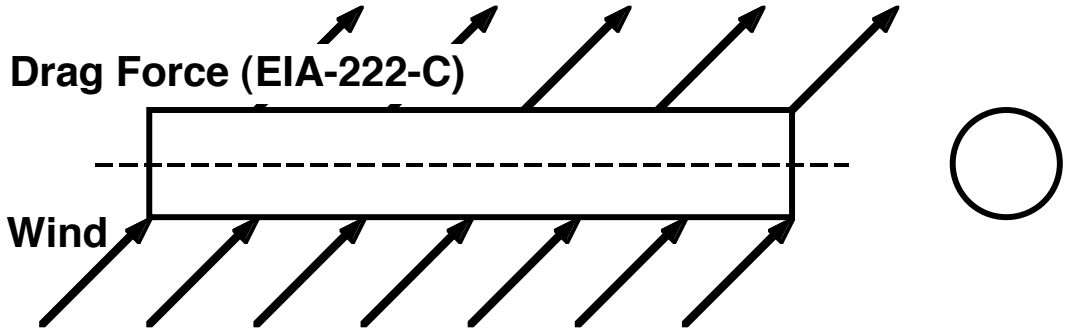


SPEED-UP VARIES WITH TYPE AND SIZE OF TOPOGRAPHIC FEATURE

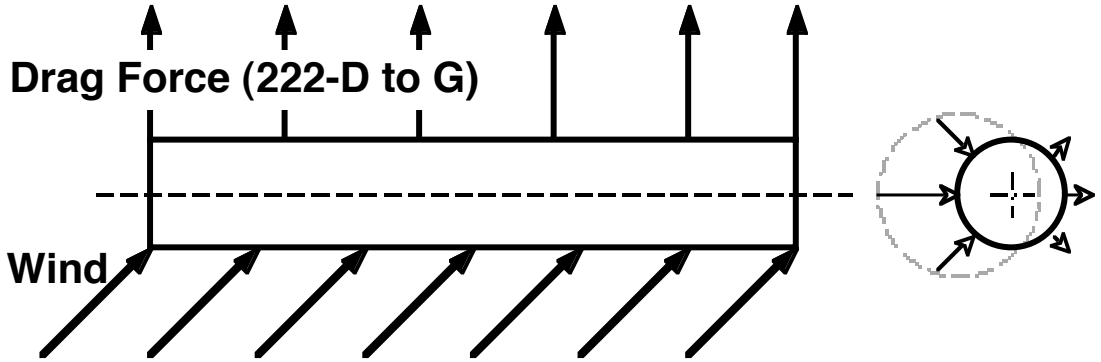
Source: D. Brinker

Wind Force on Cylinder in Yaw

- EIA-222-C: In direction of wind



- 222-D/G: Perpendicular to surface, axis



Experiment trumps theory, try it

- Doesn't weathervane
- Conclusion: 222-D to G more accurate

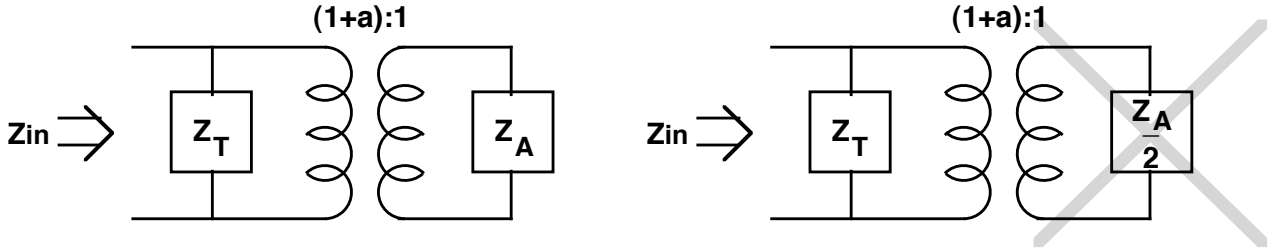
- Impact of improved model predictions:
  - Lower force on boom (but not zero if vert. gusts)
  - Element model difference nil (see K7NV web)
  - Lower effective area of Yagi, mast and tower force

EIA/TIA-222-G References

- Information and Graphics from
  - http://www.brainshark.com/tesscotechnologies/rohn
- See also
  - http://www.mei1inc.com/NAB-2003presentation.pdf
  - http://beradio.com/mag/radio_changes_tower_standards/index.html
- New standard sold by TIA, others

Gamma & Tee Match Correction

- Gamma error: don't divide dipole Z by 2



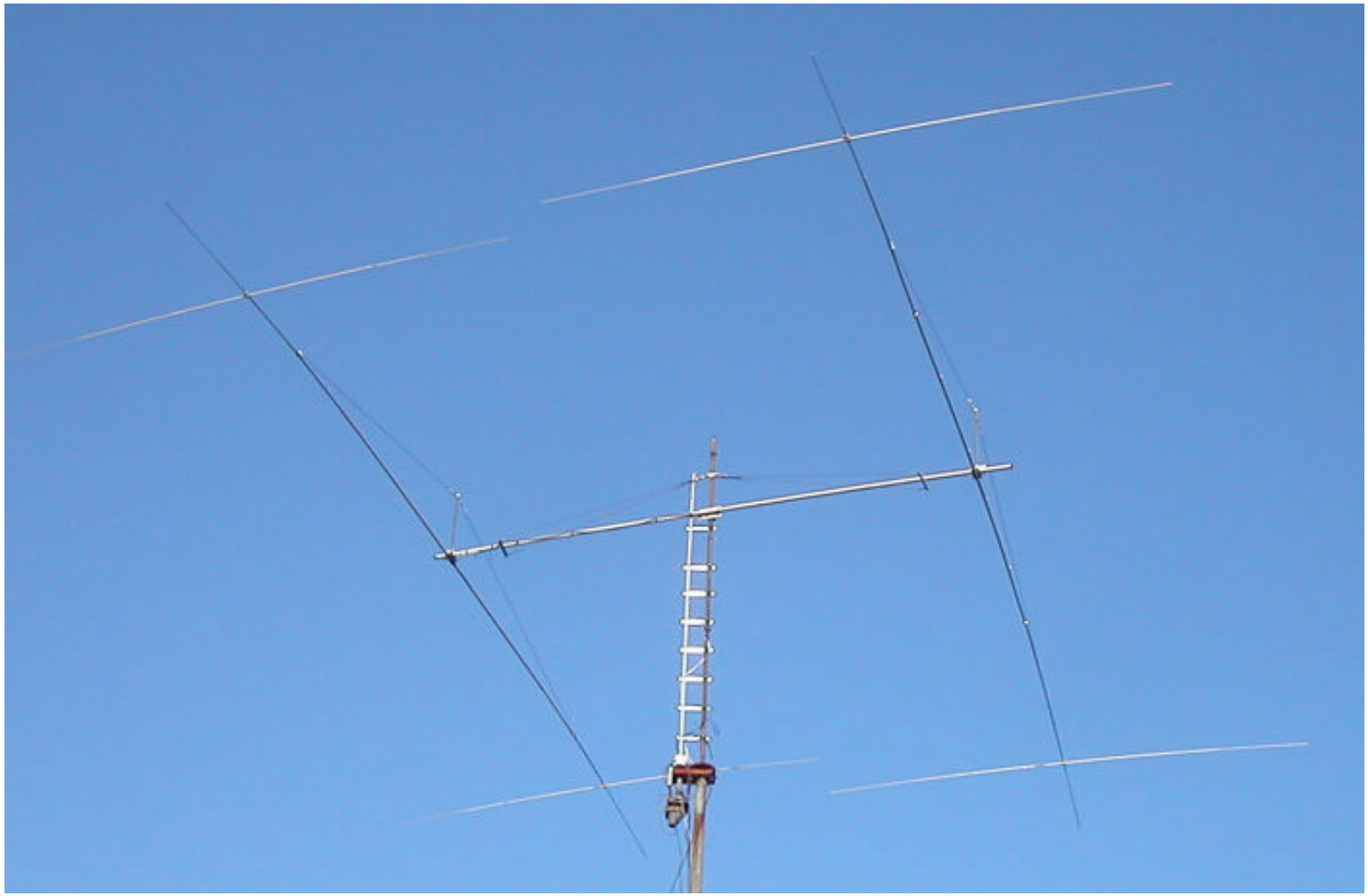
- Model effective diameter of matching section with Mushiake formula

$$D_e = e^{\ln(D_e)}, \text{ where } \ln(D_e) = \frac{D^2\ln(D) + d^2\ln(d) + 2Dd\ln(2S)}{(D+d)^2}$$

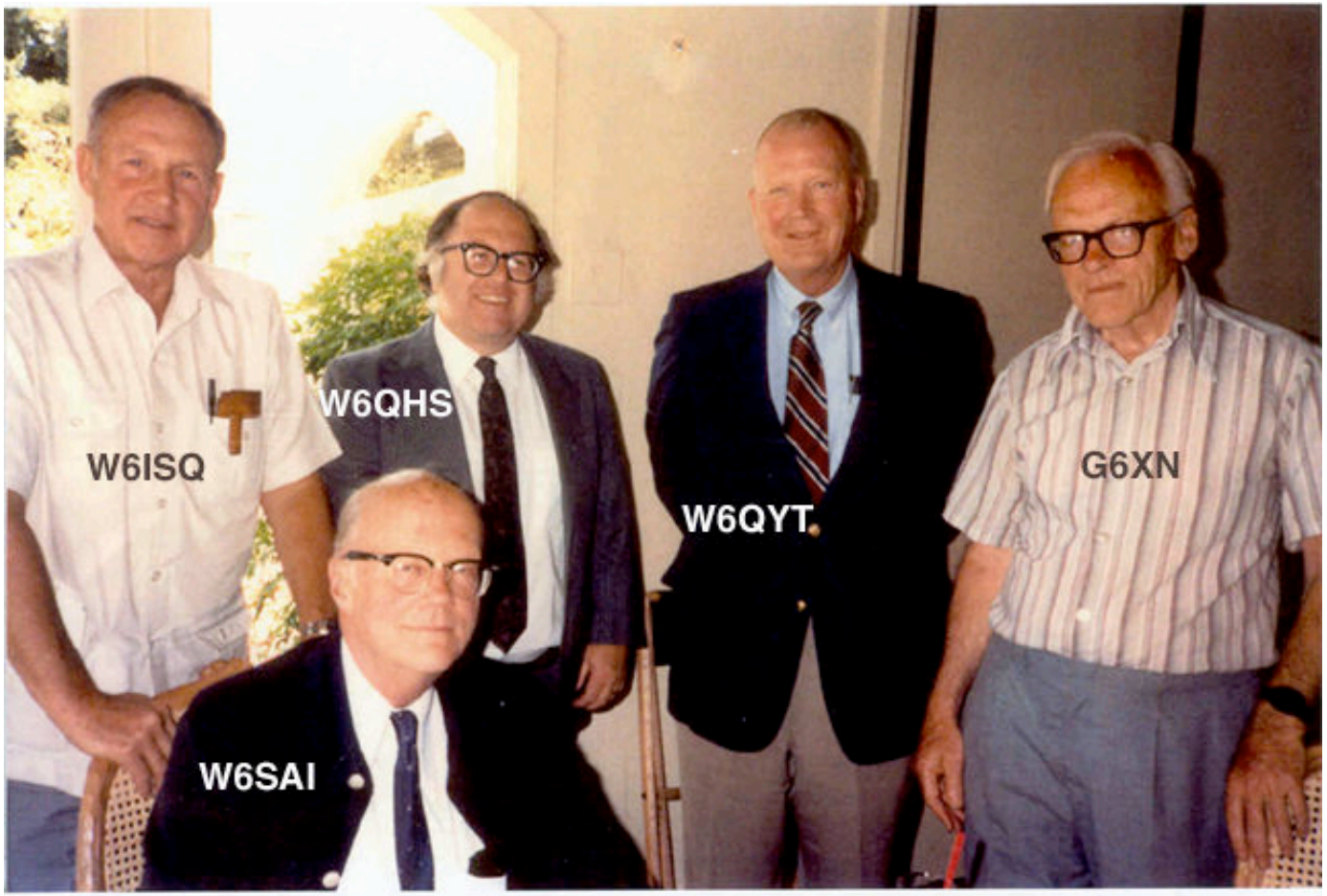
Gamma Draft Distribution 2000

- K6STI, W7EL, N6BV, W4RNL, N0AX, W3LPL, K5TR, WA3FET, K1RO, K4VX
- K6STI modeled existing Gamma antennas, found good agreement, used in YO7
- N6BV corrected Ant. Book GAMMA.BAS
- Hope to publish final paper soon

‘NL Moxon Yagi on Cushcraft 40



Antenna Inspiration (late 1980's)

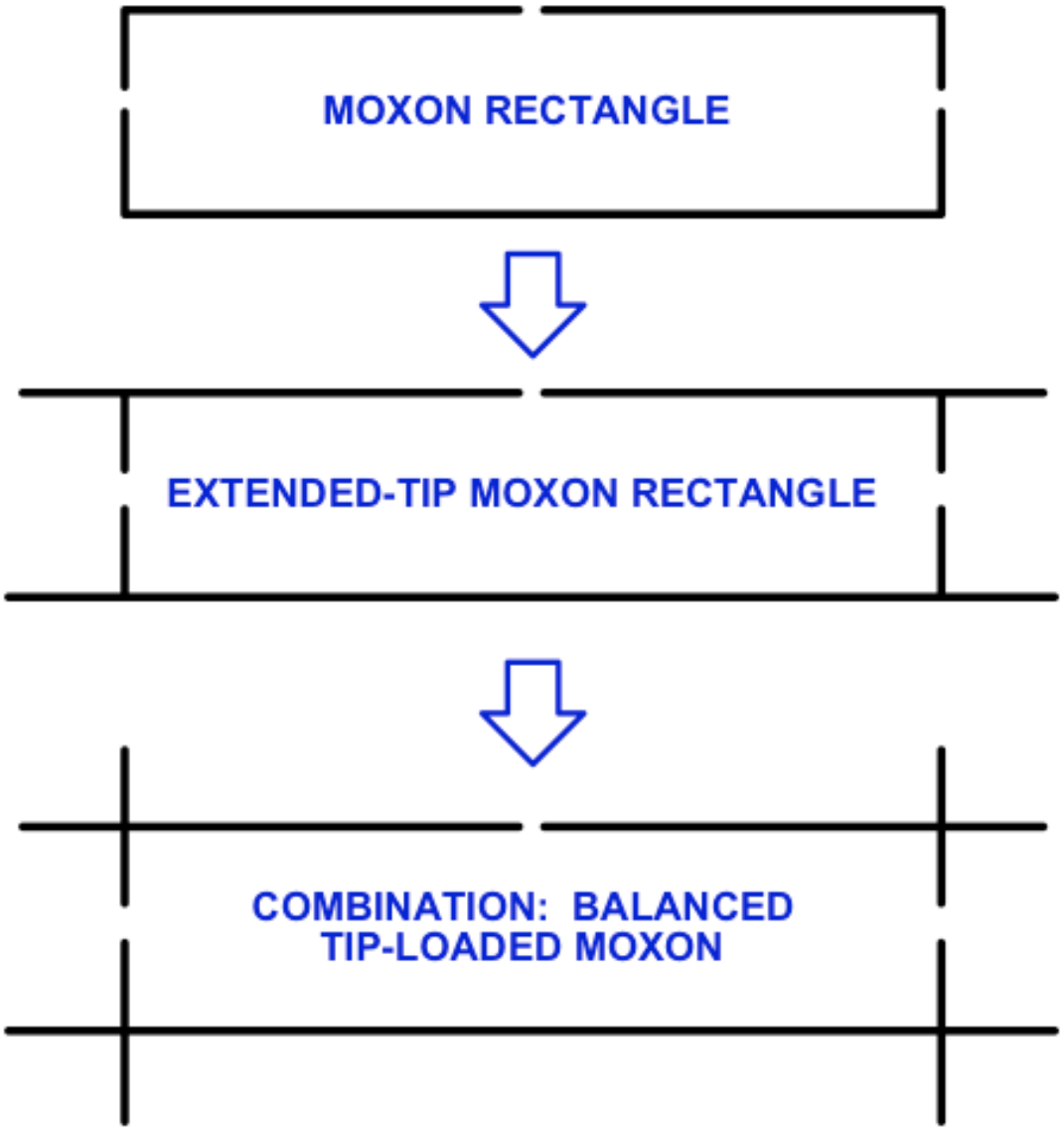


W6NL 40m Moxon Yagi

- Gain: 6 dB free space, 11 dB @ 70’
- SWR: <1.5:1 7.0-7.3 MHz
- F/B: 20 dB, reflector 2 el
- Efficiency: >99%
- Feed: 50Ω direct
- Size: 65 lb, elements 52’, boom 22’
- Wind: 110 mi/h 3 sec gust (90 mi/h f. m.)
- Modeled: AO6, K6STI

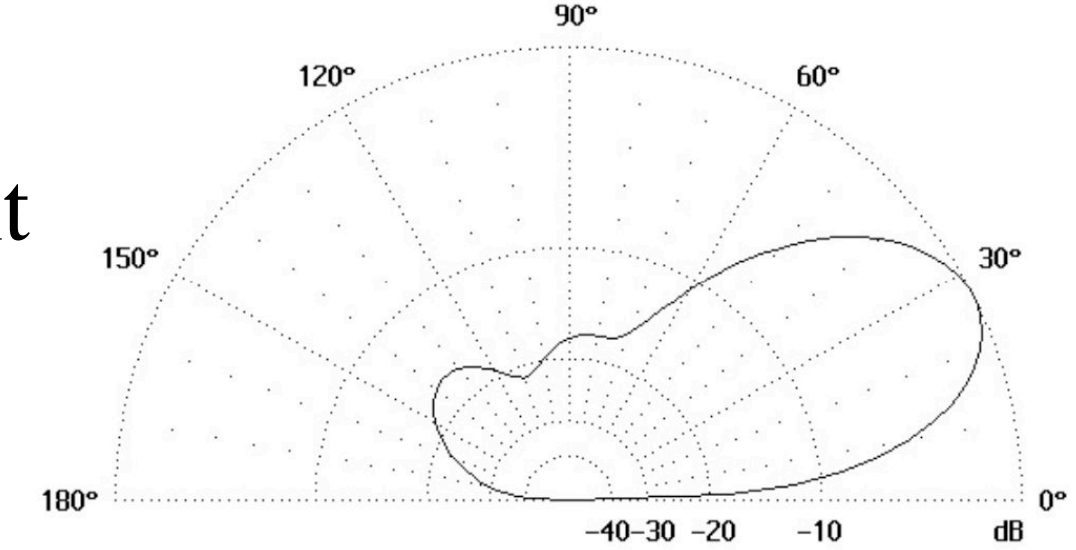
A Moxon Rectangle

- Looks like a loaded Yagi (Create, F12)
- But it's not, it's also a Moxon rectangle
  - Higher F/B, also not resonant at 15m
  - Wider bandwidth than individual elements
- Transverse tip elements have 4 functions
  - Element loading (shorter elements)
  - Efficient Moxon coupling
  - Physically balanced
  - Low wind load on main elements


MOXON RECTANGLE
EXTENDED-TIP MOXON RECTANGLE
COMBINATION: BALANCED
TIP-LOADED MOXON

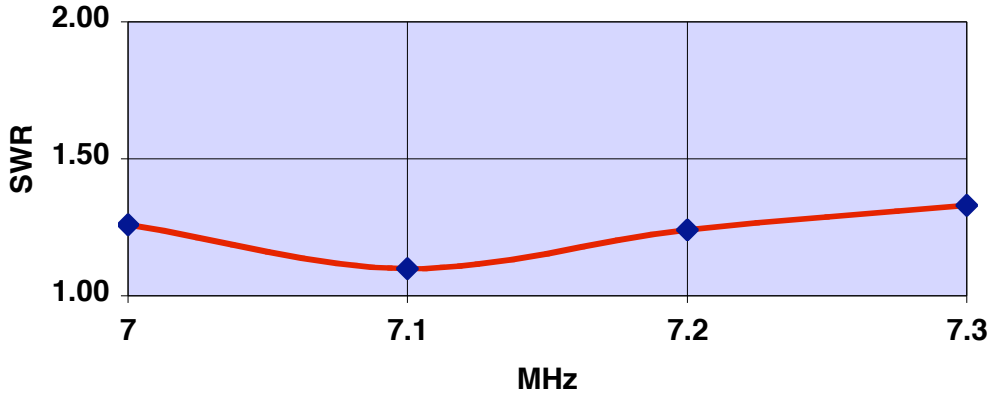
Gain Pattern & Bandwidth

- 99% efficient
- High F/B

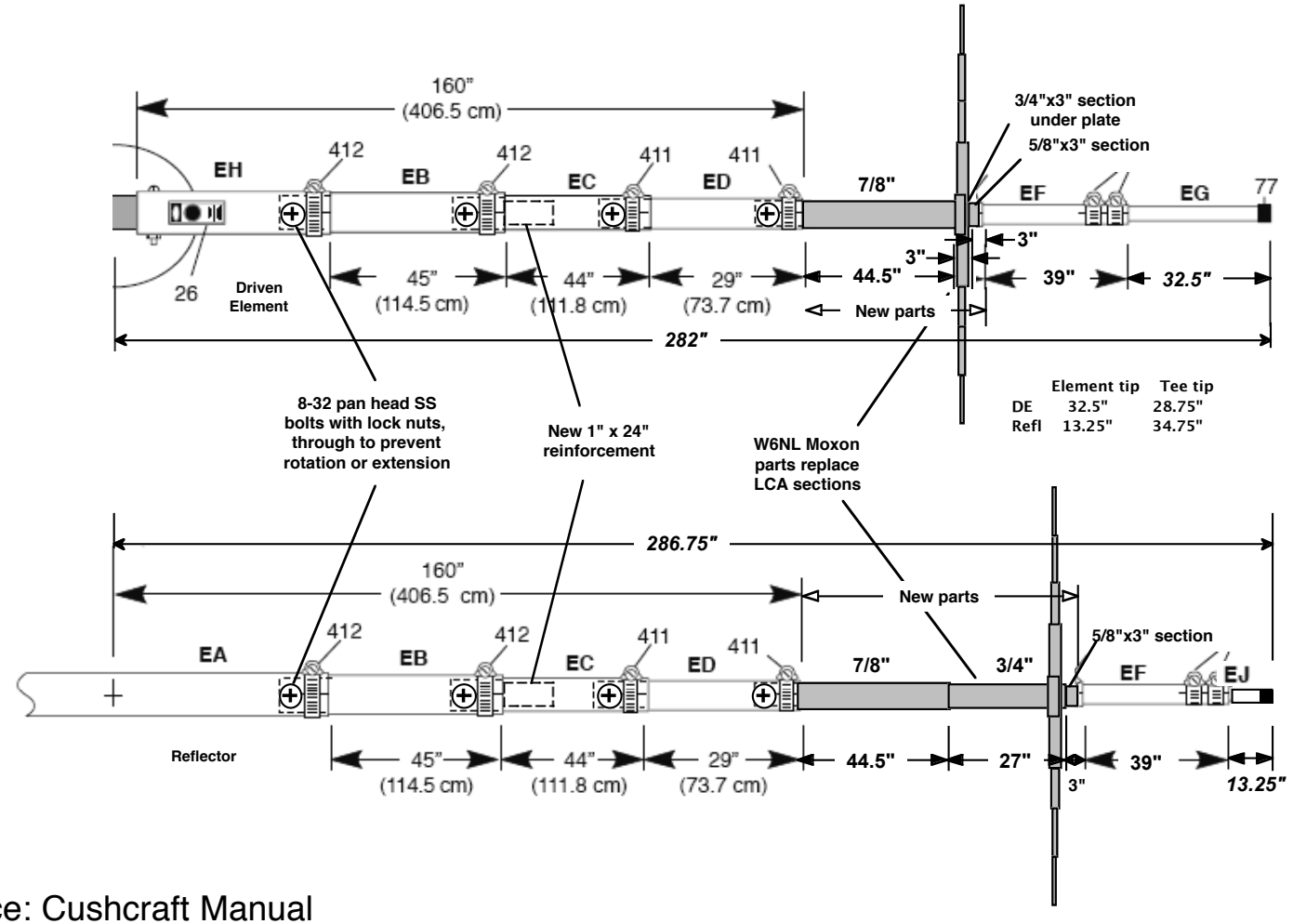


0 dB = 10.73 dBi 7.050 MHz

- 300+ kHz VSWR BW

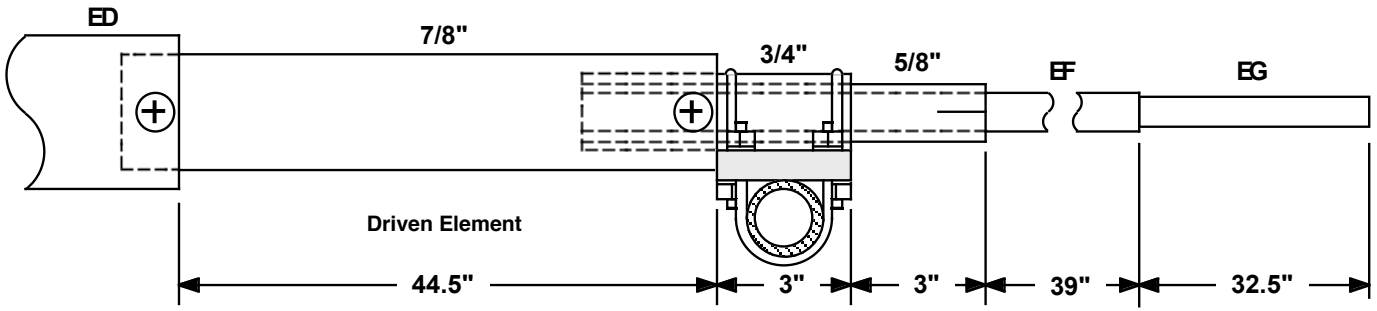


Moxon Section Replaces Coil



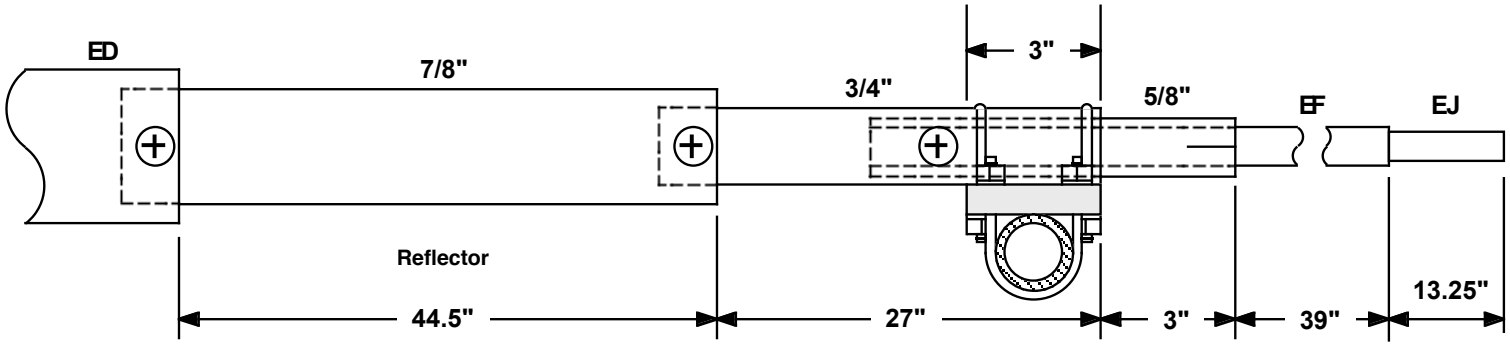
Source: Cushcraft Manual

Element Tip Details

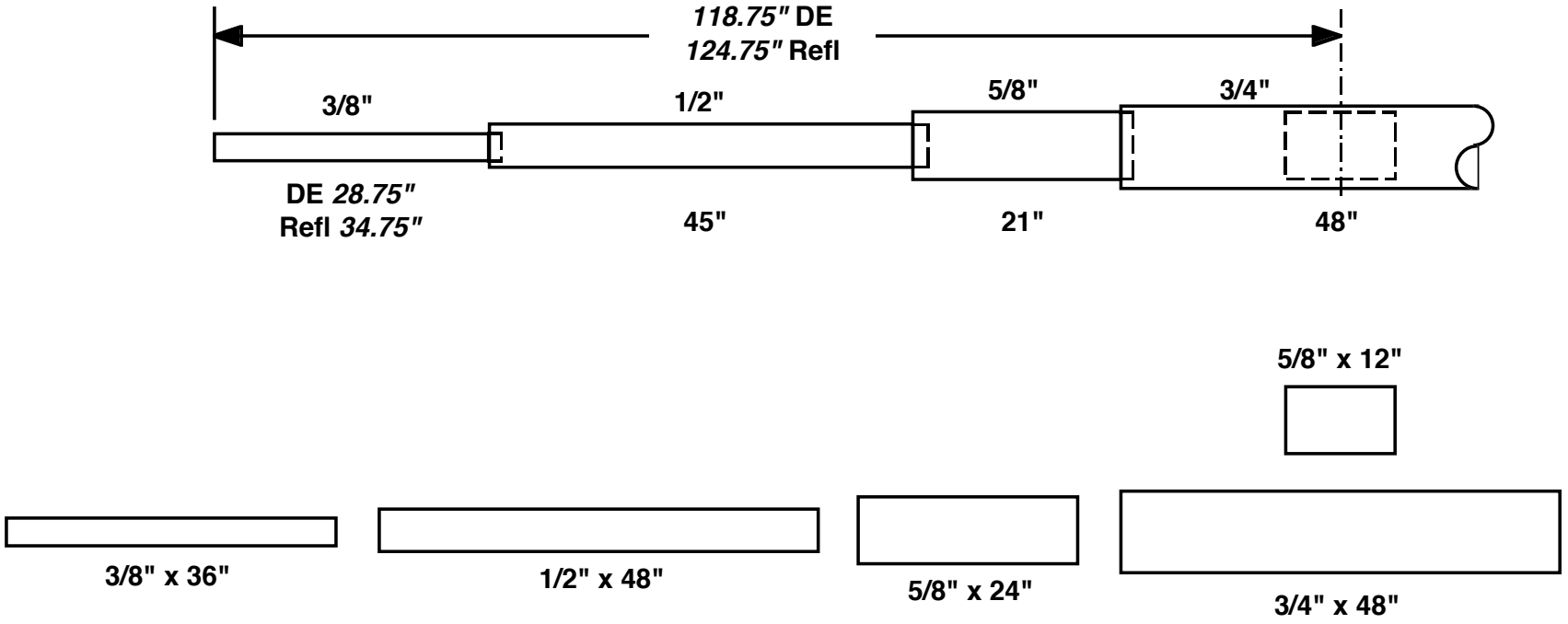


8-32 pan head SS bolts with lock nuts, through to prevent rotation or extension

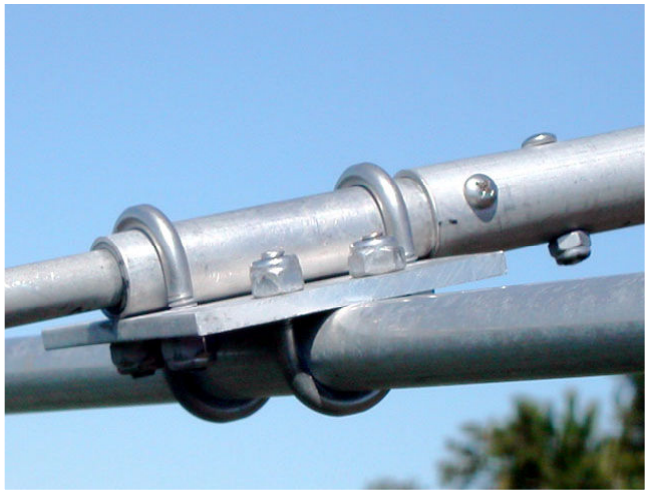
SS U-bolts
1/4"x3/4"x1-1/4"
MSC 76876028
50408-9

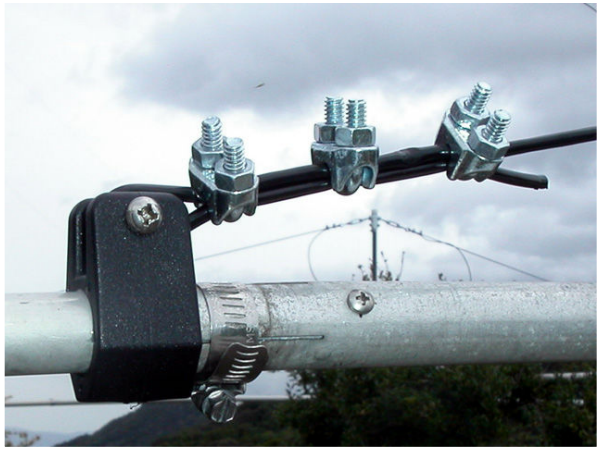


Cross Tee Elements

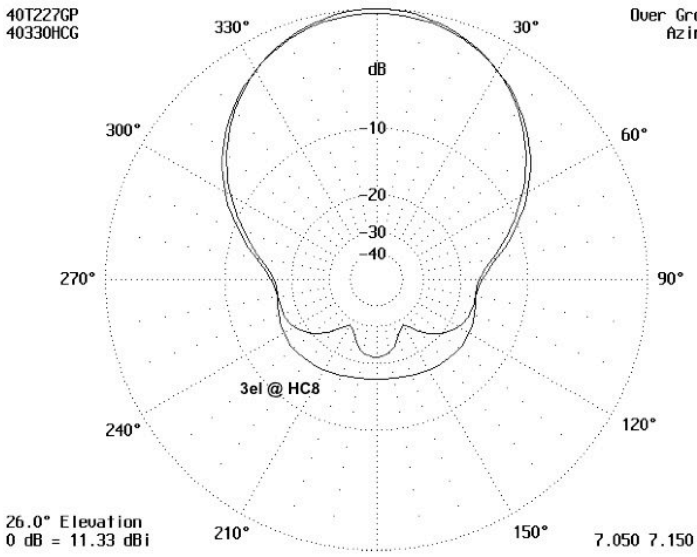


Construction Details

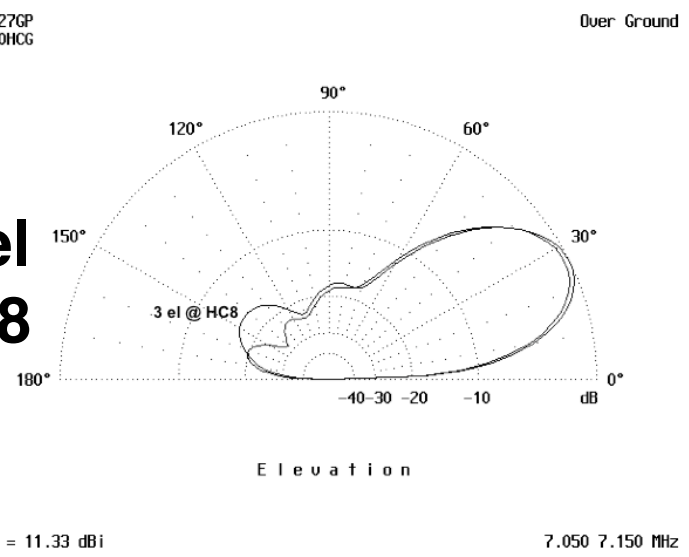


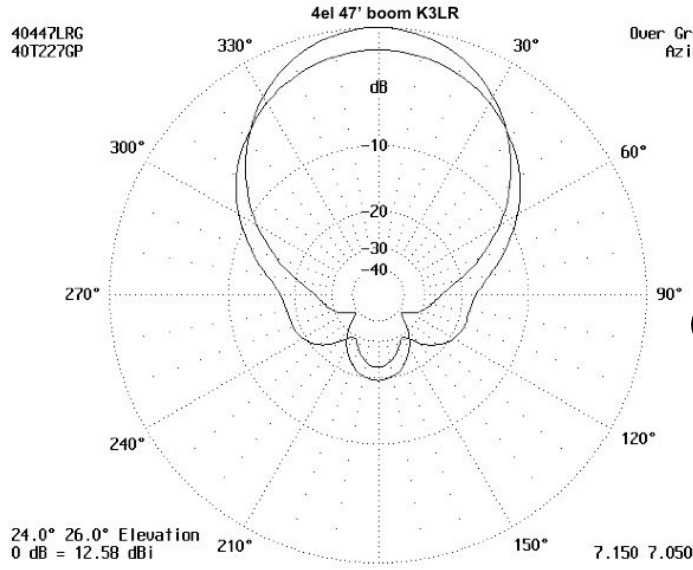


Constructed on 2” Mast Set in Pipe

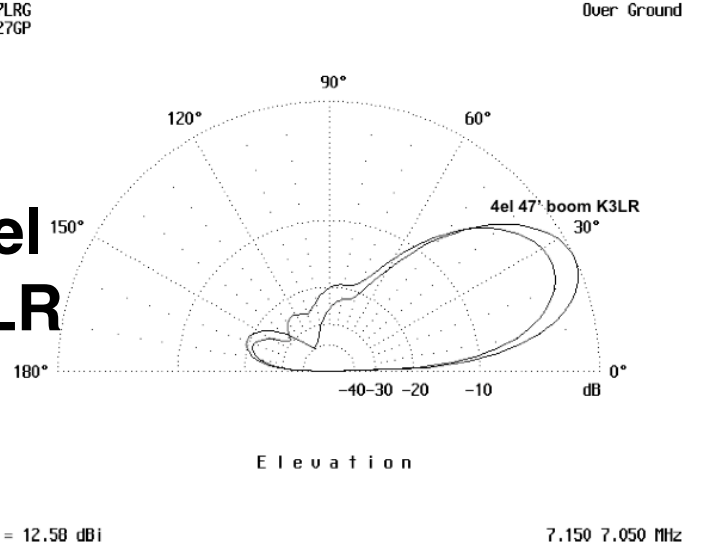


Re 3 el @ HC8





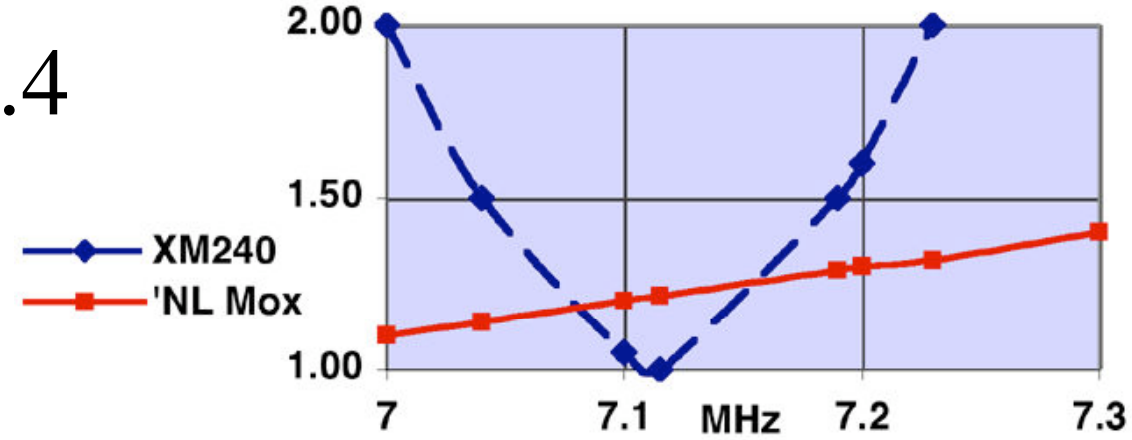
Re 4 el @ K3LR



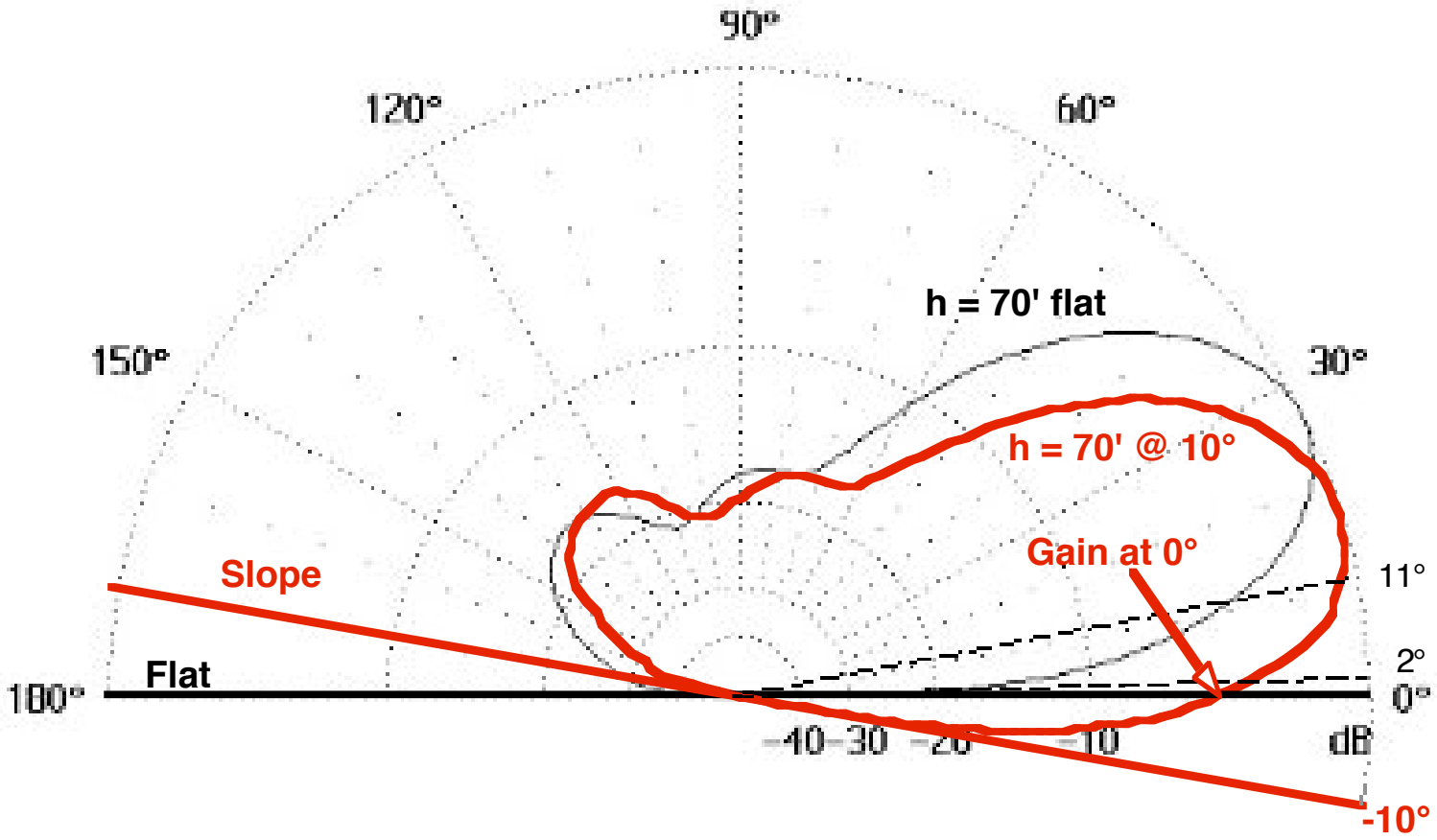
Initial On-Air Results

- Installed May 11 (thanks N6KT)
- First QSO cracked big AF pileup one call
- Measured comparisons to reference Mox:
  - Stateside: 0 to +6 dB favor of new antenna
  - DX: Equal to or better than reference standard
- VSWR >1.4

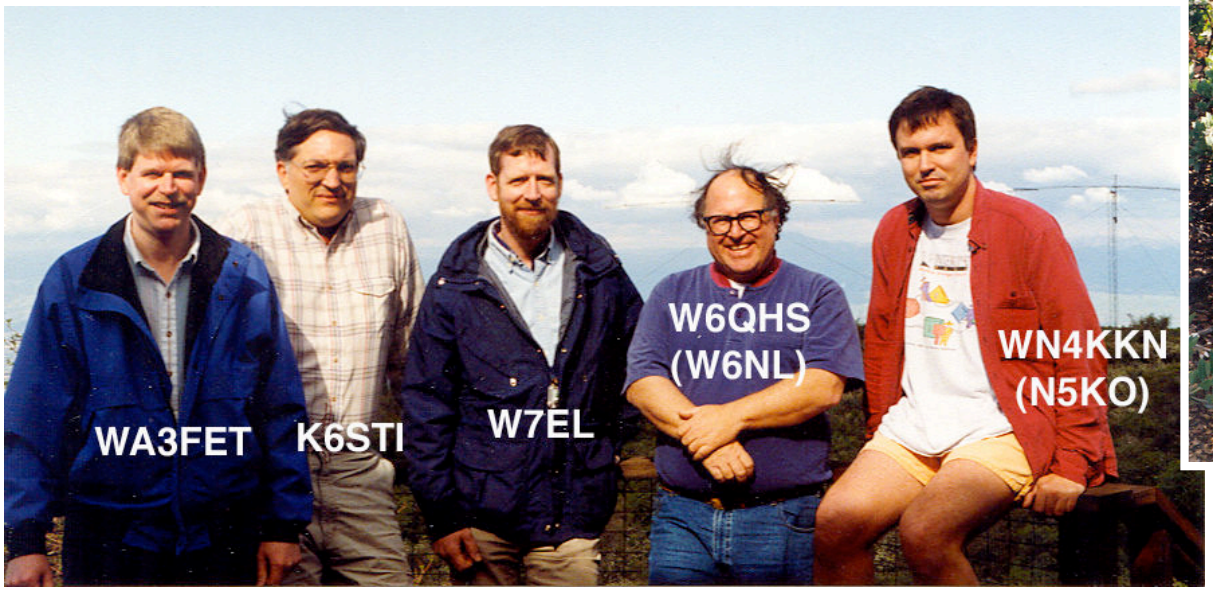
'NL Mox meas, XM240 from manual, web



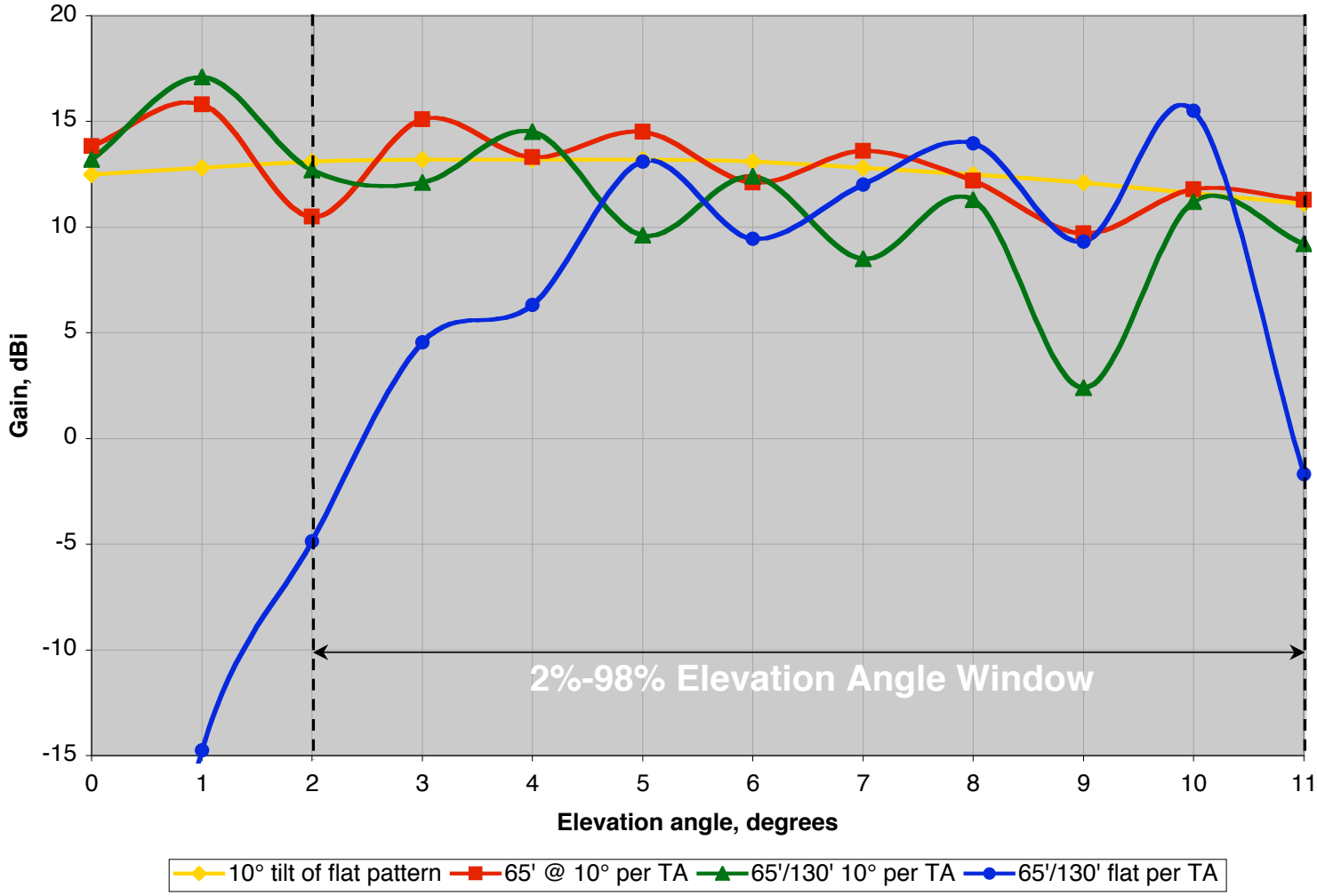
Simple Slope Model



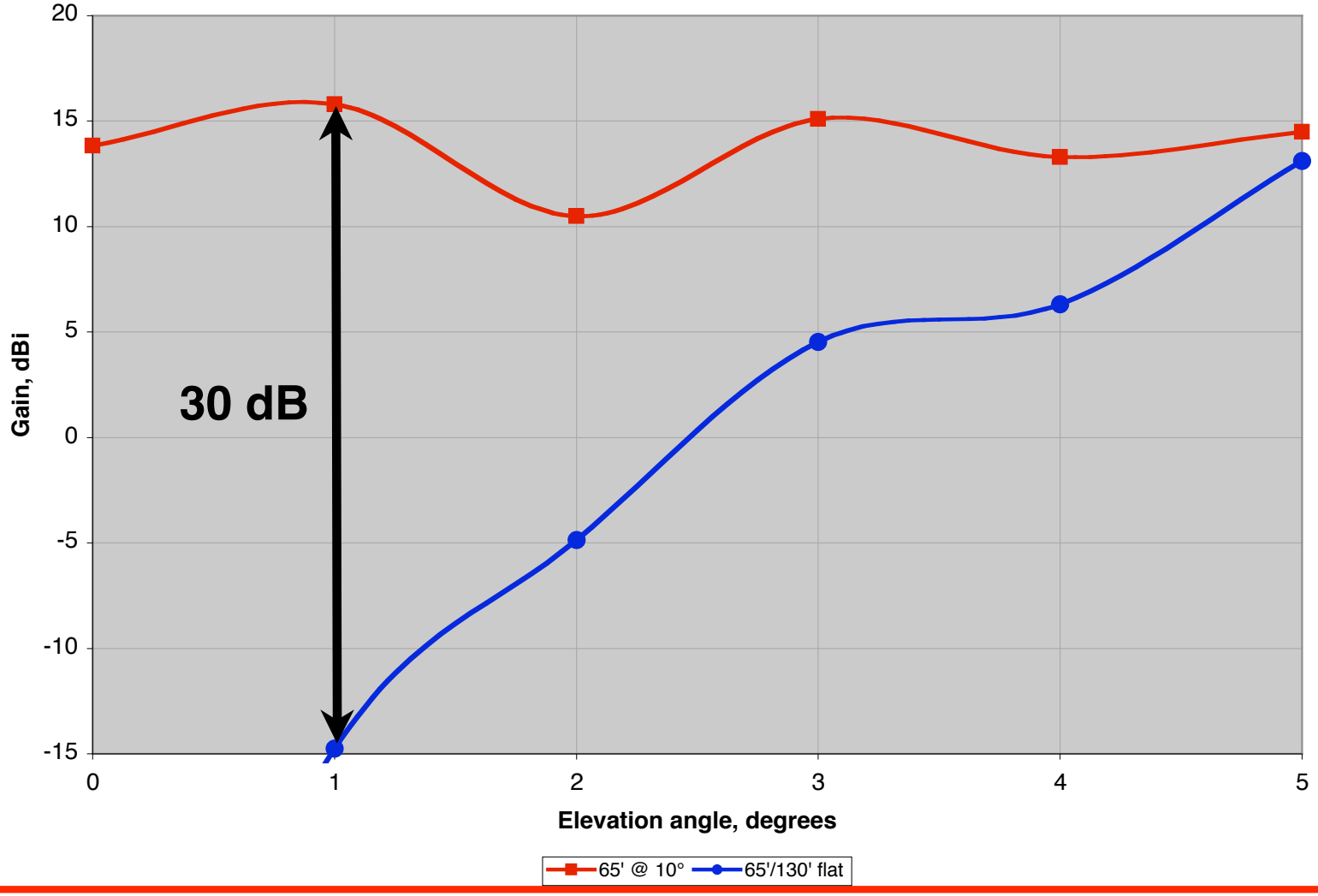
Slope Seminar Early 1990's



Gain vs. Elevation Angle



Focus on Low Angles



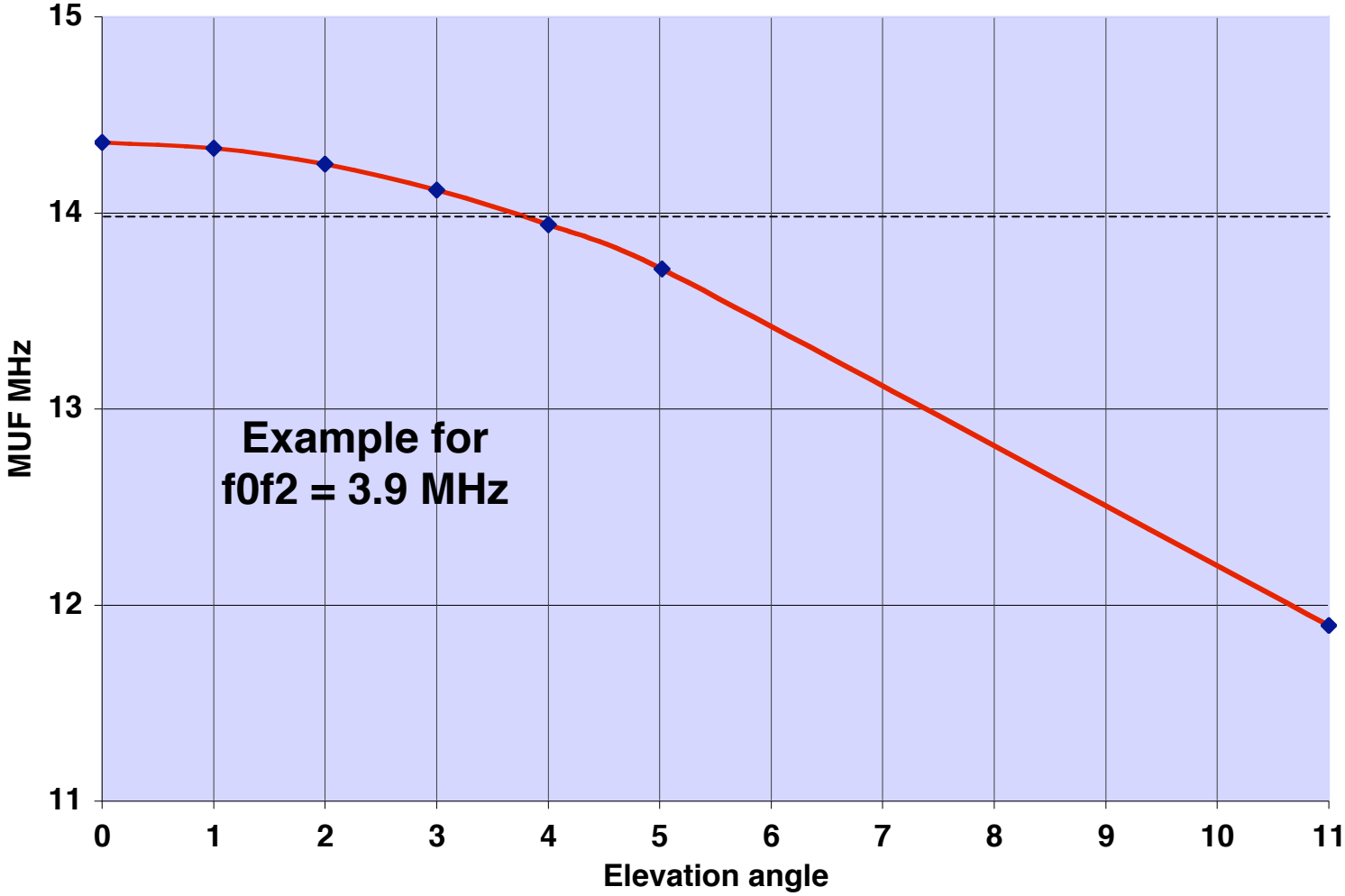
Biases of 2D Terrain Model

- Small bump becomes infinite ridge
- Power doesn't fall of as quickly as 3D
  - Overemphasizes distant artifacts (low elevation)
  - But 3D is very complex (Hagen, SRI)
- Useful, but "a model is not the real thing"

Ionospheric Propagation Basics

- F Layer reflection determined by ionization level, frequency and angle of incidence
- Vertical return below critical frequency F0
- Max oblique return frequency (MUF) higher than F0, depends on incidence angle
- Lower elevation angle yields higher MUF

MUF vs. Elevation Angle



Why Unique Propagation?

- Higher MUF at lower elevation angle
- Multihop: Grazing angle lower loss reflection (“mirage”)
- W6NL 12° downslope to JA, EU, US
  - Often “only W6 heard”
  - Contest successes NA, SS, DX
- HC8 similar topography, 35+ world 1st

W6NL Topography

HC8 Topography