Antenna Modeling

Based on ARRL Antenna Book SW

Part I: EZNEC

Part II: TLW, YW, HFTA

Larry Banks, W1DYJ

First licensed: 1962 (KN1VFX)

W1DYJ since 1966 – Amateur Extra

33 Blueberry Hill Road Woburn MA

Much cheaper (and faster) than (re)building them!

"All models are wrong. Some are useful"

British Statistician *George Box*, 1976

https://www.qsl.net/w1dyj/

W1DYJ ~ Larry Banks

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Abstract: Antenna Modeling: TLW, YW, HFTA

This presentation will start with some history detailing why Larry has always been interested in understanding antennas. It will then introduce three applications: TLW, YW, and HFTA, from the ARRL Antenna Book. It will hopefully help you get a start at modeling your own antenna systems.

Larry was licensed in 1962 as novice KN1VFX and became W1DYJ in 1966. He was an engineer and manager for Hewlett-Packard Medical from 1969 to 1993. Moving to HP Education in 1993, he was responsible for technical and project management training. When Agilent split out of HP in 1999 he became Agilent Technology's global program manager for their Learning Management System. He "retired" in 2005 and then consulted for Avago Technologies (now Broadcom) on eLearning technologies through 2012.

Larry holds three degrees in EE from MIT. He holds 9BDXCC and 8BWAS, spending his time chasing DX and contesting in Woburn MA, traveling with his wife Maren, and attending as many jazz and classical concerts as they can. He is also the net manager and newsletter editor for the Minuteman Repeater Association, publications editor for HamXposition, and a member of the Yankee Clipper Contest Club.

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Antenna Modeling ~ Agenda

- Why I became interested in antennas
- LW
- YW
- HFTA
- Appendix

The Goal:

You will learn some theory and gain some understanding about antennas.

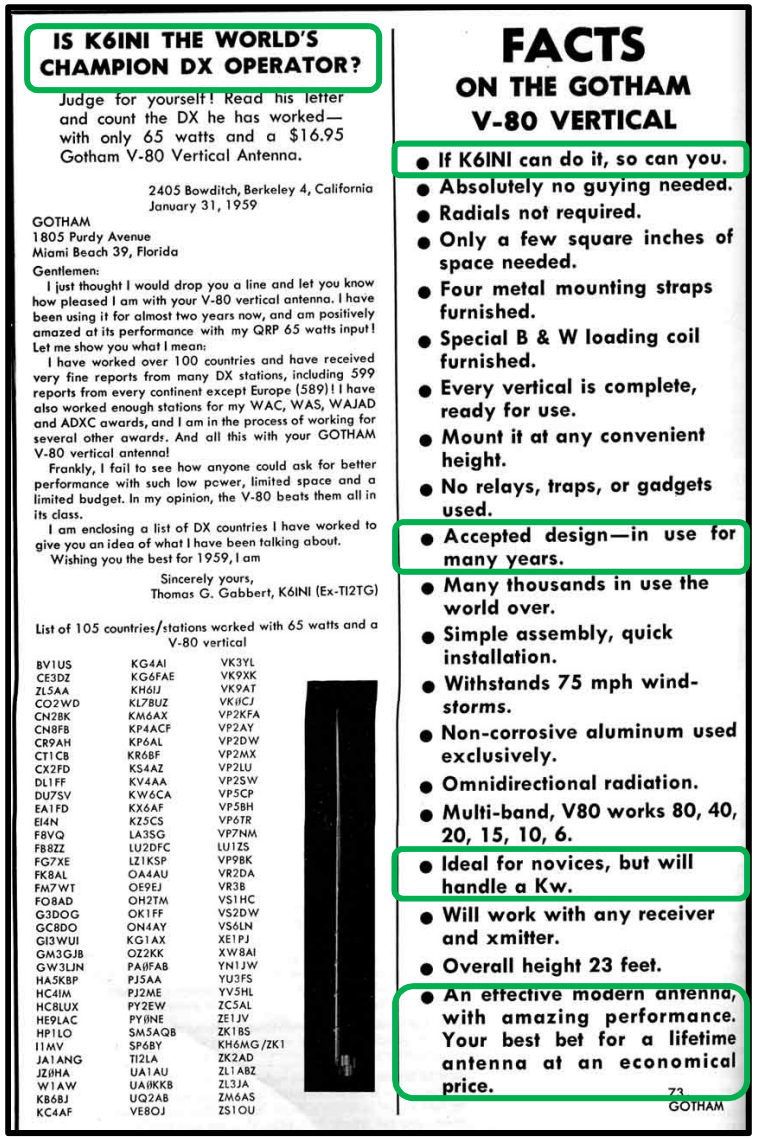
An antenna story ~ the Gotham V80 (1962)

- New novice KN1VFX
- *I knew nothing about antennas*
- I built a HB 80m 807 CW [XTL] transmitter
- I fed my end-fed random wire out of my 2nd floor bedroom window [SWL]
- It didn't work

A 1962 QST Advertisement

- My first "real" antenna for 80M
- $16.95 was "big bucks" for a sophomore in HS in 1962 [~$130 today]

A beautiful example of *MARKETING!*



IS K6INI THE WORLD'S CHAMPION DX OPERATOR?

Judge for yourself! Read his letter and count the DX he has worked—with only 65 watts and a $16.95 Gotham V-80 Vertical Antenna.

2405 Bowditch, Berkeley 4, California
January 31, 1959

GOTHAM
1805 Purdy Avenue
Miami Beach 39, Florida

Gentlemen:

I just thought I would drop you a line and let you know how pleased I am with your V-80 vertical antenna. I have been using it for almost two years now, and am positively amazed at its performance with my QRP 65 watts input! Let me show you what I mean:

I have worked over 100 countries and have received very fine reports from many DX stations, including 599 reports from every continent except Europe (589)! I have also worked enough stations for my WAC, WAS, WAJAD and ADXC awards, and I am in the process of working for several other awards. And all this with your GOTHAM V-80 vertical antenna!

Frankly, I fail to see how anyone could ask for better performance with such low power, limited space and a limited budget. In my opinion, the V-80 beats them all in its class.

I am enclosing a list of DX countries I have worked to give you an idea of what I have been talking about.

Wishing you the best for 1959, I am

Sincerely yours,
Thomas G. Gabbert, K6INI (Ex-TI2TG)

List of 105 countries/stations worked with 65 watts and a V-80 vertical

BV1US	KG4AI	VK3YL
CE3DZ	KG6FAE	VK9XK
ZL5AA	KH6IJ	VK9AT
CO2WD	KL7BUZ	VK6CJ
CN2BK	KM6AX	VP2KFA
CN8FB	KP4ACF	VP2AY
CR9AH	KP6AL	VP2DW
CT1CB	KR6BF	VP2MX
CX2FD	KS4AZ	VP2LU
DL1FF	KV4AA	VP2SW
DU7SV	KW6CA	VP5CP
EA1FD	KX6AF	VP5BH
EI4N	KZ5CS	VP6TR
F8VQ	LA3SG	VP7NM
FB8ZZ	LU2DFC	LU1ZS
FG7XE	LZ1KSP	VP9BK
FK8AL	OA4AU	VR2DA
FM7WT	OE9EJ	VR3B
FO8AD	OH2TM	VS1HC
G3DOG	OK1FF	VS2DW
GC8DO	ON4AY	VS6LN
GI3WUI	KG1AX	XE1PJ
GM3GJB	OZ2KK	XW8AI
GW3LJN	PA6FAB	YN1JW
HA5KBP	PJ5AA	YU3FS
HC4IM	PJ2ME	YV5HL
HC8LUX	PY2EW	ZC5AL
HE9LAC	PY6NE	ZE1JV
HP1LO	SM5AQB	ZK1BS
I1MV	SP6BY	KH6MG/ZK1
JA1ANG	TI2LA	ZK2AD
JZ0HA	UA1AU	ZL1ABZ
W1AW	UA0KKB	ZL3JA
KB6BJ	UQ2AB	ZM6AS
KC4AF	VE8OJ	ZS1OU

FACTS ON THE GOTHAM V-80 VERTICAL

- If K6INI can do it, so can you.
- Absolutely no guying needed.
- Radials not required.
- Only a few square inches of space needed.
- Four metal mounting straps furnished.
- Special B & W loading coil furnished.
- Every vertical is complete, ready for use.
- Mount it at any convenient height.
- No relays, traps, or gadgets used.
- Accepted design—in use for many years.
- Many thousands in use the world over.
- Simple assembly, quick installation.
- Withstands 75 mph wind-storms.
- Non-corrosive aluminum used exclusively.
- Omnidirectional radiation.
- Multi-band, V80 works 80, 40, 20, 15, 10, 6.
- Ideal for novices, but will handle a Kw.
- Will work with any receiver and xmitter.
- Overall height 23 feet.
- An effective modern antenna, with amazing performance. Your best bet for a lifetime antenna at an economical price.

73
GOTHAM

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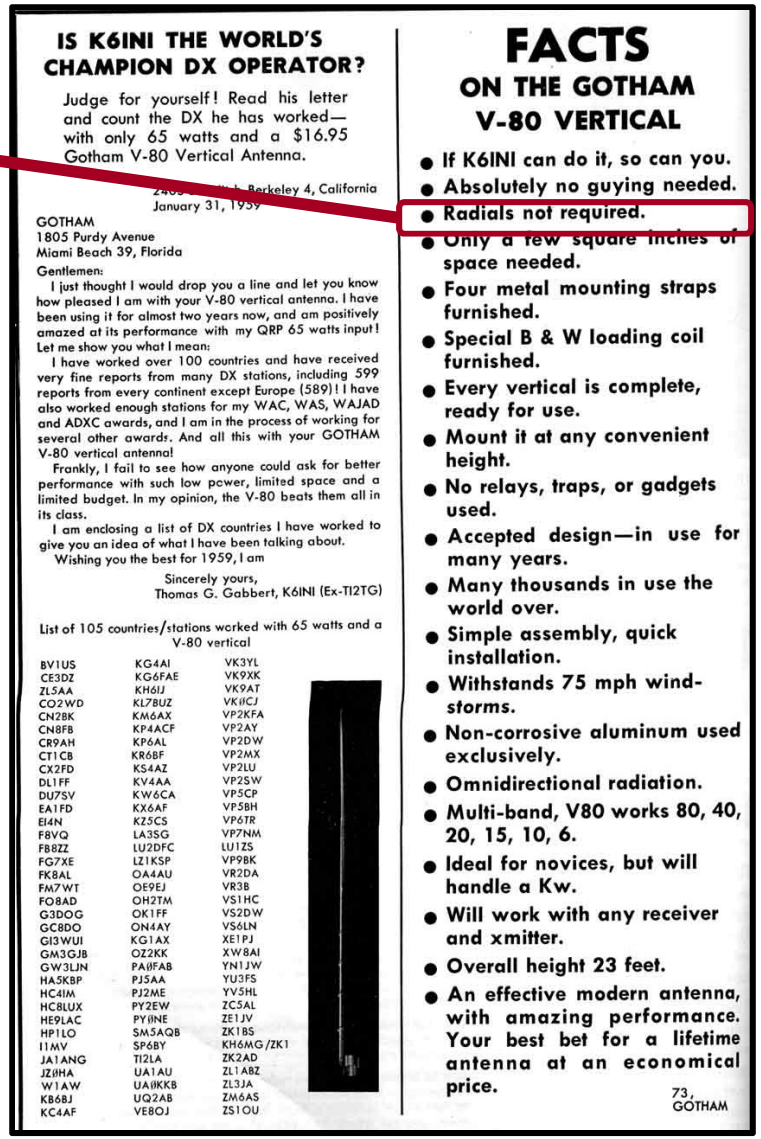
An antenna story ~ the Gotham V80

Radials not required

- I never worked anyone – Best DX was a 40M OO report: "Out of Band"
- As a result, I never really learned CW
- I have not believed advertisements since!
- I also learned that *you need to understand the physics* of antennas

→→→ Modeling (1993)



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CT1CB	KR6BF	VP2MX
CX2FD	KS4AZ	VP2LU
DL1FF	KV4AA	VP2SW
DU7SV	KW6CA	VP5CP
EA1FD	KX6AF	VP5BH
EI4N	KZ5CS	VP6TR
F8VQ	LA3SG	VP7NM
FB8ZZ	LU2DFC	LU1ZS
FG7XE	LZ1KSP	VP9BK
FK8AL	OA4AU	VR2DA
FM7WT	OE9EJ	VR3B
FO8AD	OH2TM	VS1HC
G3DOG	OK1FF	VS2DW
GC8DO	ON4AY	VS6LN
GI3WUI	KG1AX	XE1PJ
GM3GJB	OZ2KK	XW8AI
GW3LJN	PA0FAB	YN1JW
HA5KBP	PJ5AA	YU3FS
HC4IM	PJ2ME	YV5HL
HC8LUX	PY2EW	ZC5AL
HE9LAC	PY0NE	ZE1JV
HP1LO	SM5AQB	ZK1BS
I1MV	SP6BY	KH6MG/ZK1
JA1ANG	TI2LA	ZK2AD
JZ0HA	UA1AU	ZL1ABZ
W1AW	UA0KKB	ZL3JA
KB6BJ	UQ2AB	ZM6AS
KC4AF	VE8OJ	ZS1OU

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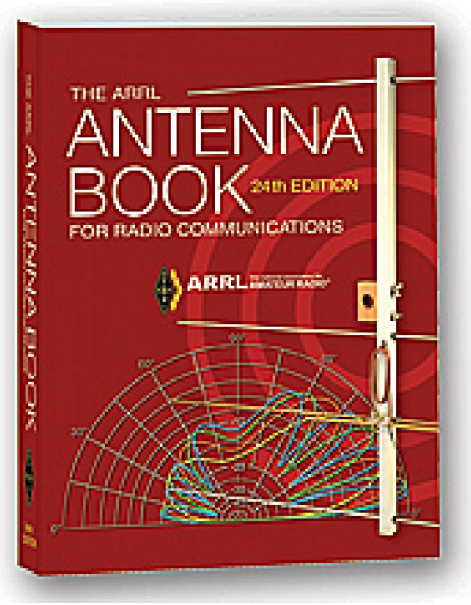
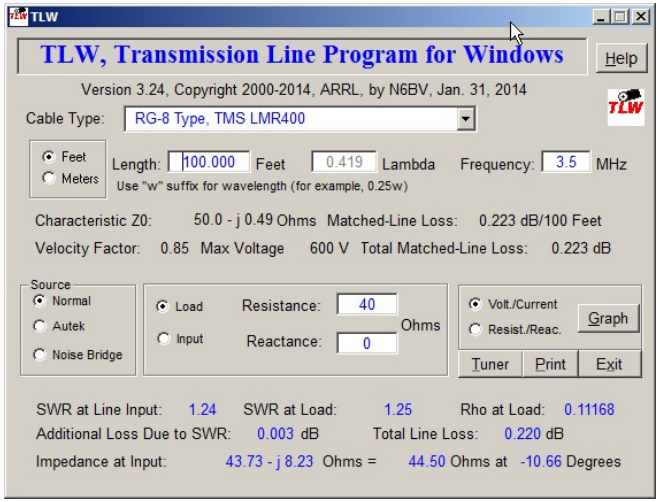
Antenna Modeling ~ Agenda

- **TLW**
- YW
- HFTA



TLW – Transmission Line Program for Windows

R. Dean Straw ~ N6BV

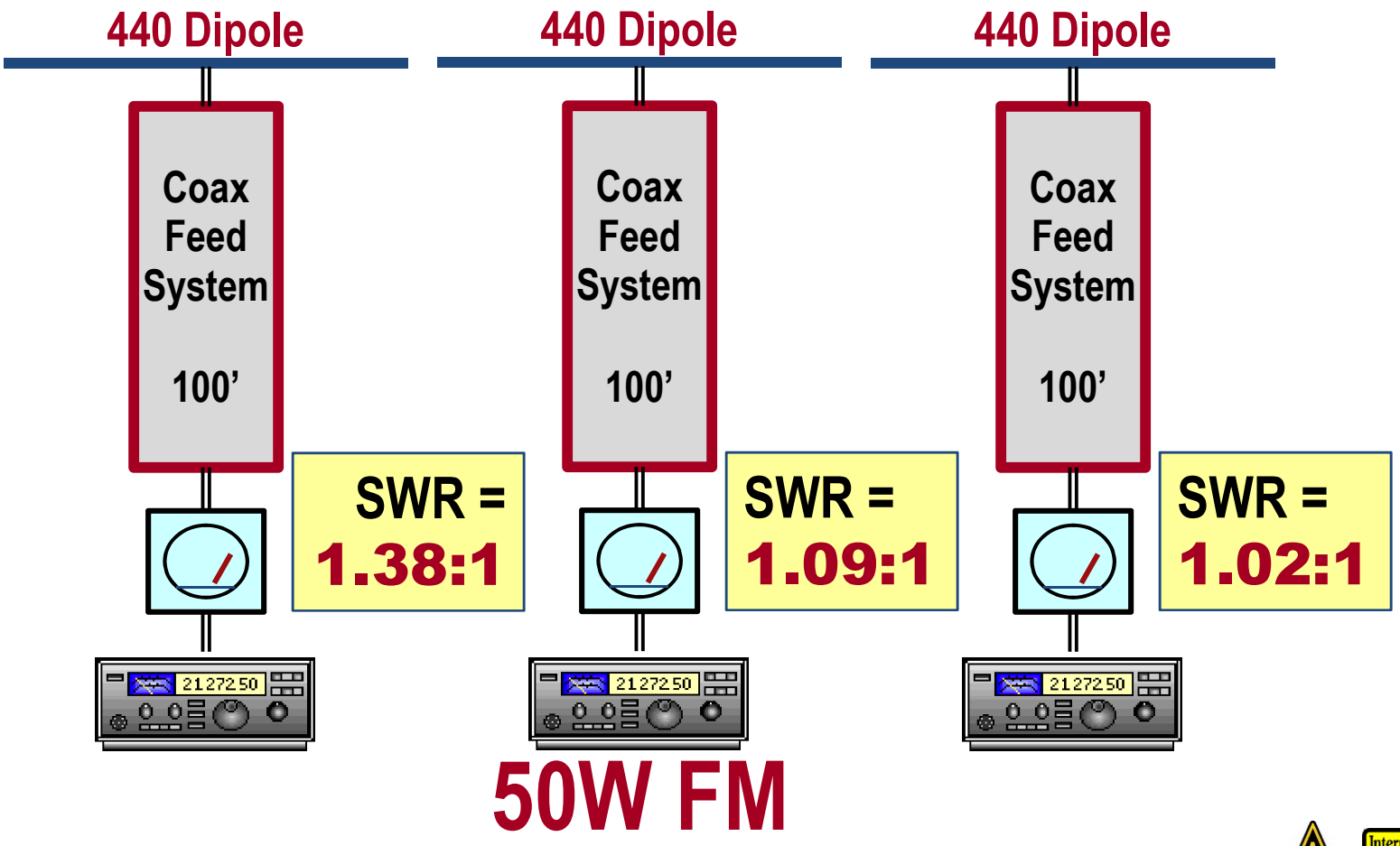


Basic Purpose:

- Input = cable type, frequency, dimensions, and load impedance
- Output = SWR at input, load, and feedline loss

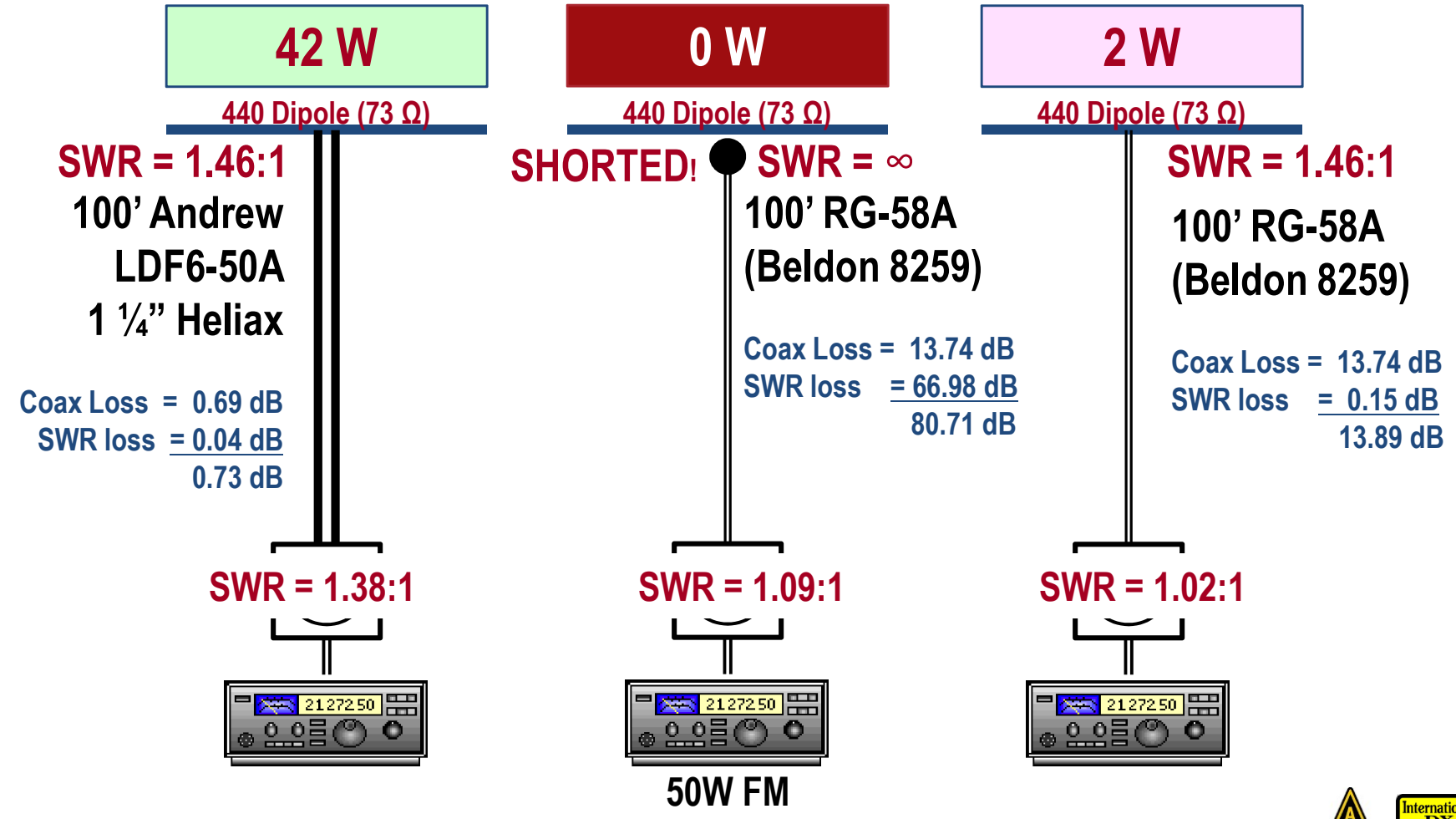
A Spot Quiz!

Question: Which is the better situation?



A Spot Quiz!

Answer: ***Beware the Myth of Low SWR!***



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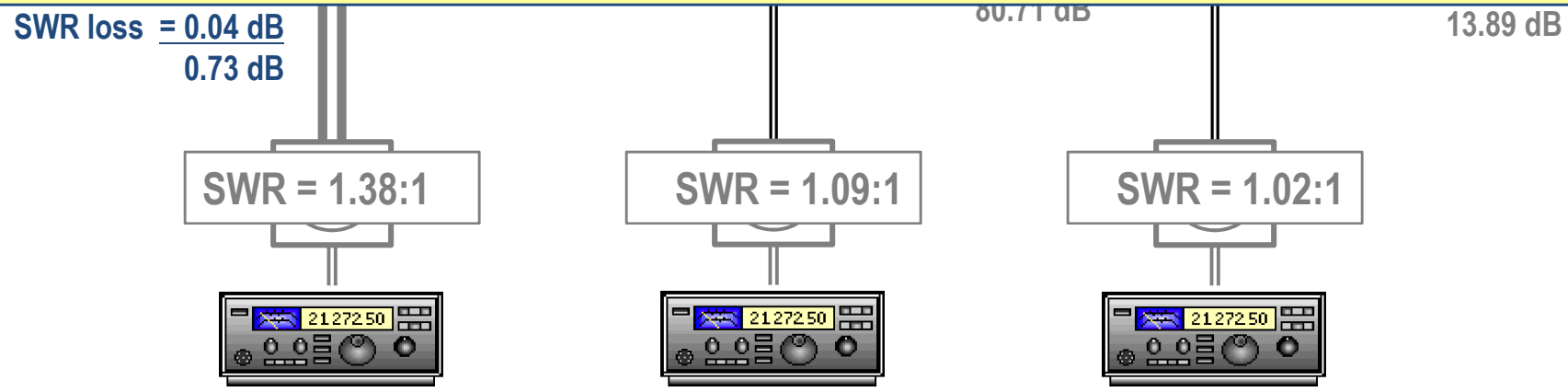
A Spot Quiz!

It's really too bad that SWR is so easy to measure in the shack – it can be very misleading.

Remember: the "ideal" SWR is generated with a broadband, matched dummy load!



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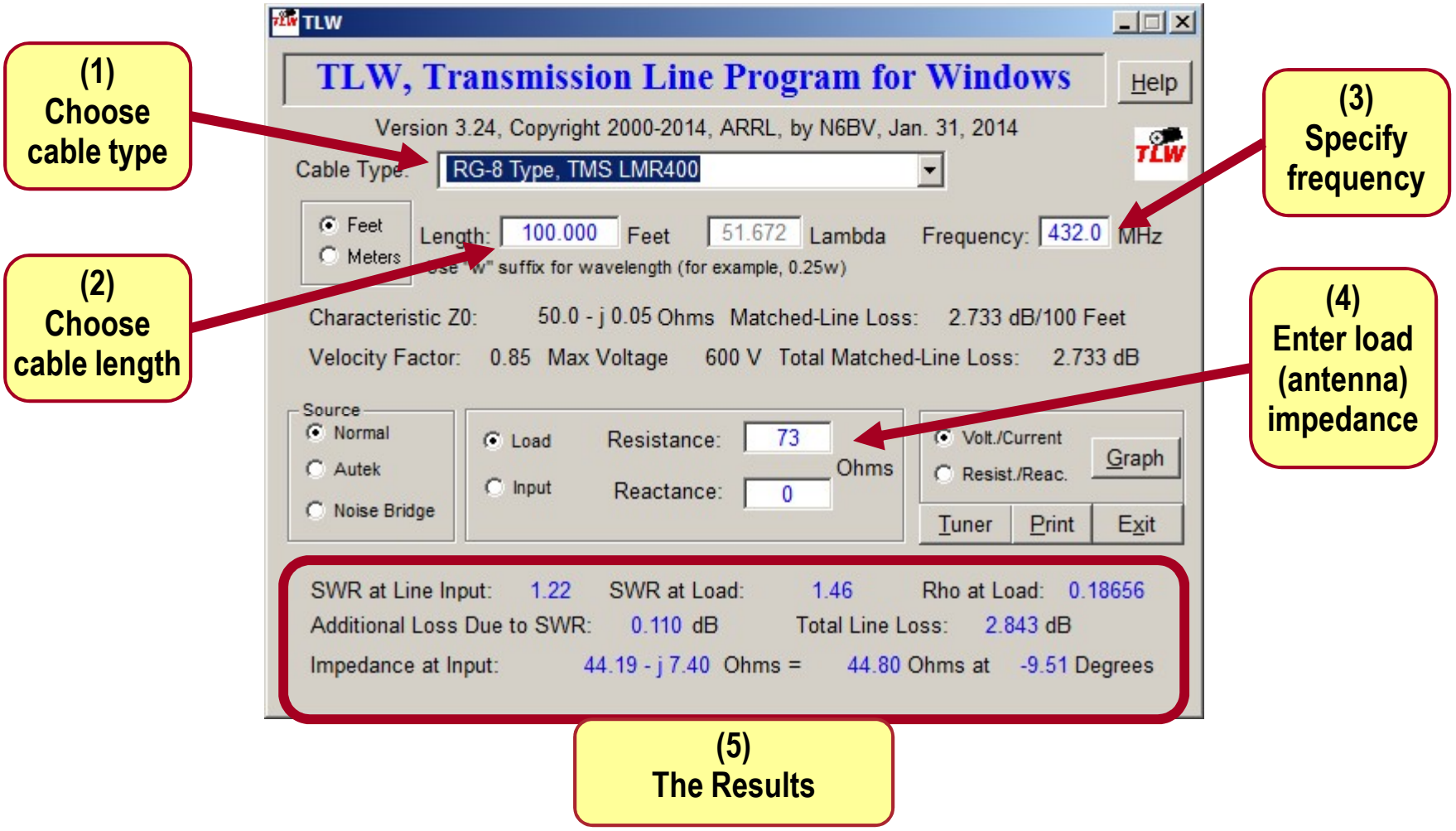
TLW – Transmission Line Program for Windows



TLW – Transmission Line Program for Windows

Coax	SWR @70cm	Total Loss @70cm	Delivered Power 70cm
1 ¼" Heliax	1.38:1	0.73 dB	42 W
½ " Heliax	1.31:1	1.54 dB	35 W
LMR 400 "RG8"	1.22:1	2.83 dB	26 W
8267 RG213	1.12:1	5.28 dB	15 W
LMR 240"RG8X"	1.12:1	5.37 dB	14 W
LMR 200 "RG58"	1.08:1	7.14 dB	10 W
9258 "RG8X"	1.05:1	9.08 dB	5 W
8259 "RG58A"	1.02:1	13.89 dB	2 W

50 W @ Transmitter / 100' Coax / 73 Ω Antenna

$dB = 10 \log_{10} (W_i/W_o) \rightarrow \quad W_o = W_i / 10^{dB/10}$

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TLW – Transmission Line Program for Windows

Coax	SWR @70cm	Total Loss @70cm	Delivered Power			
			70cm	2M	10M	80M
1 ¼" Heliax	1.38:1	0.73 dB	42 W	46	48	49
½ " Heliax	1.31:1	1.54 dB	35 W	41	46	49
LMR 400 "RG8"	1.22:1	2.83 dB	26 W	34	43	47
8267 RG213	1.12:1	5.28 dB	15 W	26	38	46
LMR 240"RG8X"	1.12:1	5.37 dB	14 W	25	37	45
LMR 200 "RG58"	1.08:1	7.14 dB	10 W	19	33	43
9258 "RG8X"	1.05:1	9.08 dB	5 W	16	32	43
8259 "RG58A"	1.02:1	13.89 dB	2 W	9	25	40

50 W @ Transmitter / 100' Coax / 73 Ω Antenna

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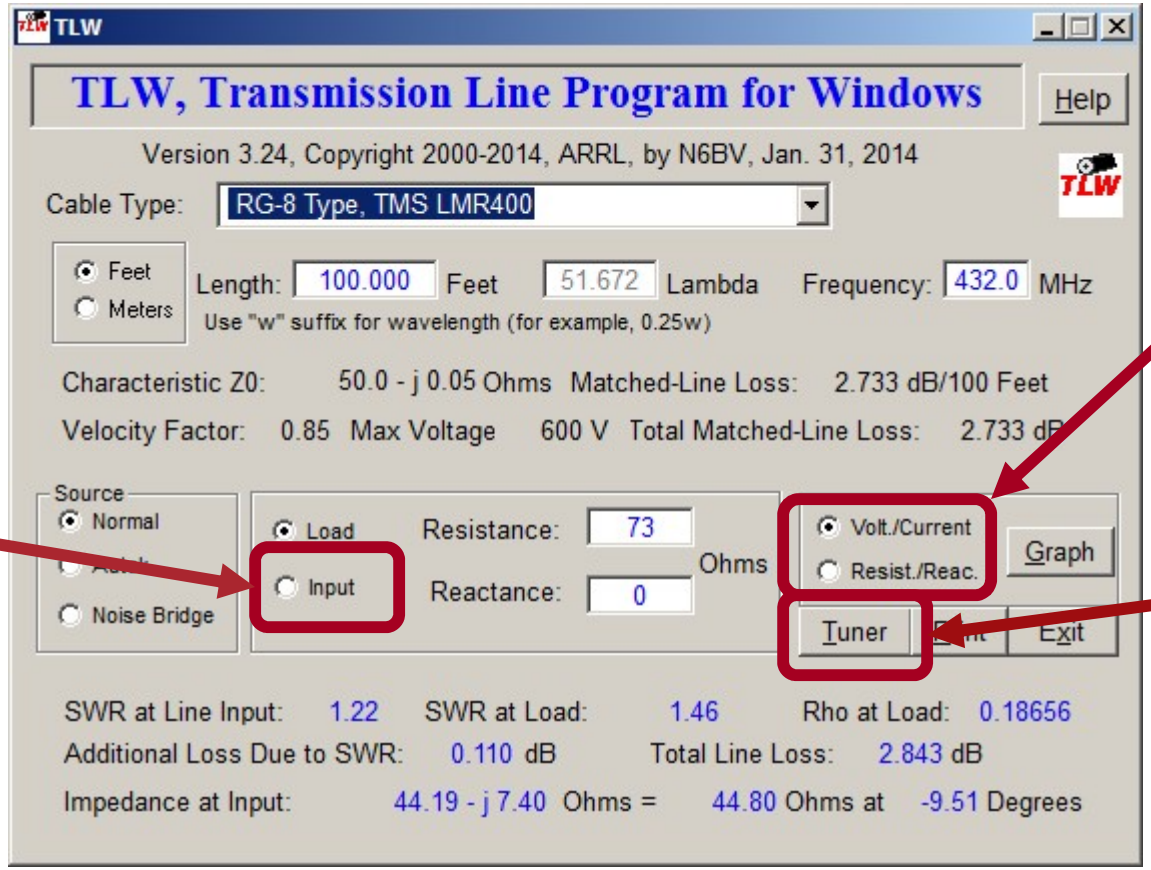
TLW – Transmission Line Program for Windows

Left to you for Homework…



If you know the impedance in your shack, you can estimate the load impedance

You can look at the Voltage, Current, Resistance, and Reactance on the transmission line

You can use TLW to help you design a TransMatch.

NOTE:
Antenna Tuners **DO NOT** tune anything!

TLW – Transmission Line Program for Windows

Summary:

- **It's really too bad that SWR is so easy to measure in the shack**
- **It is only one parameter in the understanding of your *Antenna System***
- **However, do measure it, document it, and use it as one measure of your *Antenna System's* health – it will tell you if something has changed**

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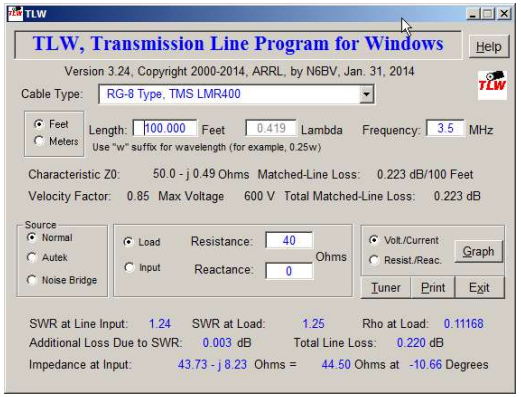
TLW – Transmission Line Program for Windows

Helps you understand and design your Antenna System



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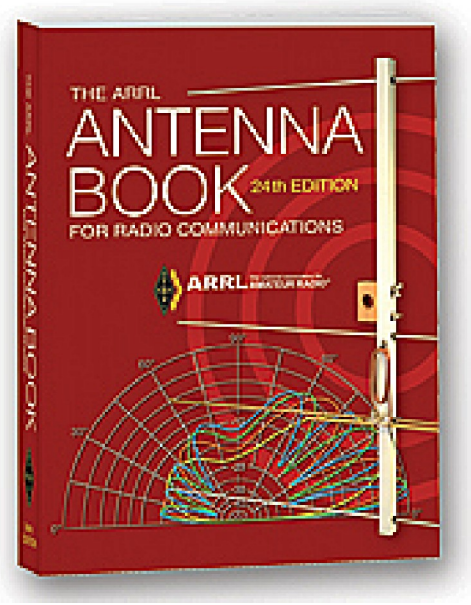
Antenna Modeling ~ Agenda

- TLW
- **YW**
- HFTA



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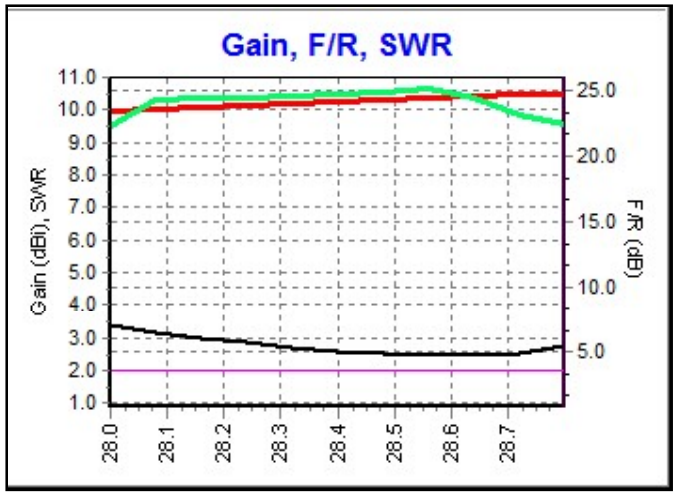
YW – Yagi for Windows

R. Dean Straw ~ N6BV ©ARRL



Purpose:

- **Input = dimensions of a traditional monoband Yagi, its height and its matching**
- **Output = graphs/patterns of Gain, F/R, SWR**

YW – Yagi for Windows

Description

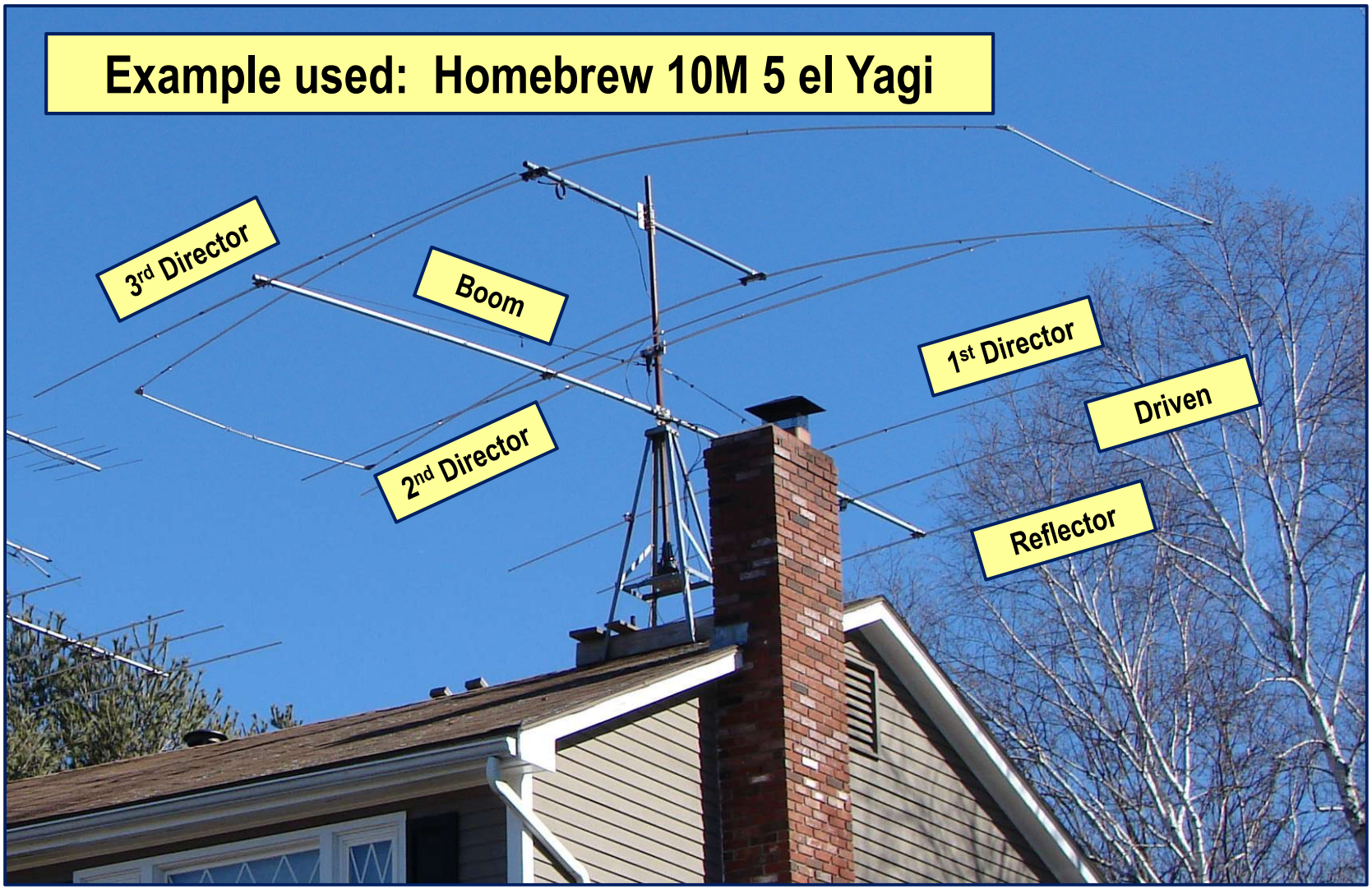
- Similar to earlier DOS based program: YO from Brian Beezley
- Computes Gain, worse-case F/R, SWR, E- & H-plane patterns
- Generates on-screen graphs
- Results compare closely with YO, EZNEC, NEC-4
- Runs much faster
- Includes design files for 80+ Yagi designs included in ARRL Antenna Book

YW – Yagi for Windows

Limitations

- Works only for "traditional" monoband Yagis
- Evaluations done over flat "perfect" ground
- Not accurate below height of λ/8
- Not accurate in stacks, near other antennas, etc.
- Does not generate output data files
- No optimization routine – like YO

33 Blueberry Hill Rd – Woburn Antennas



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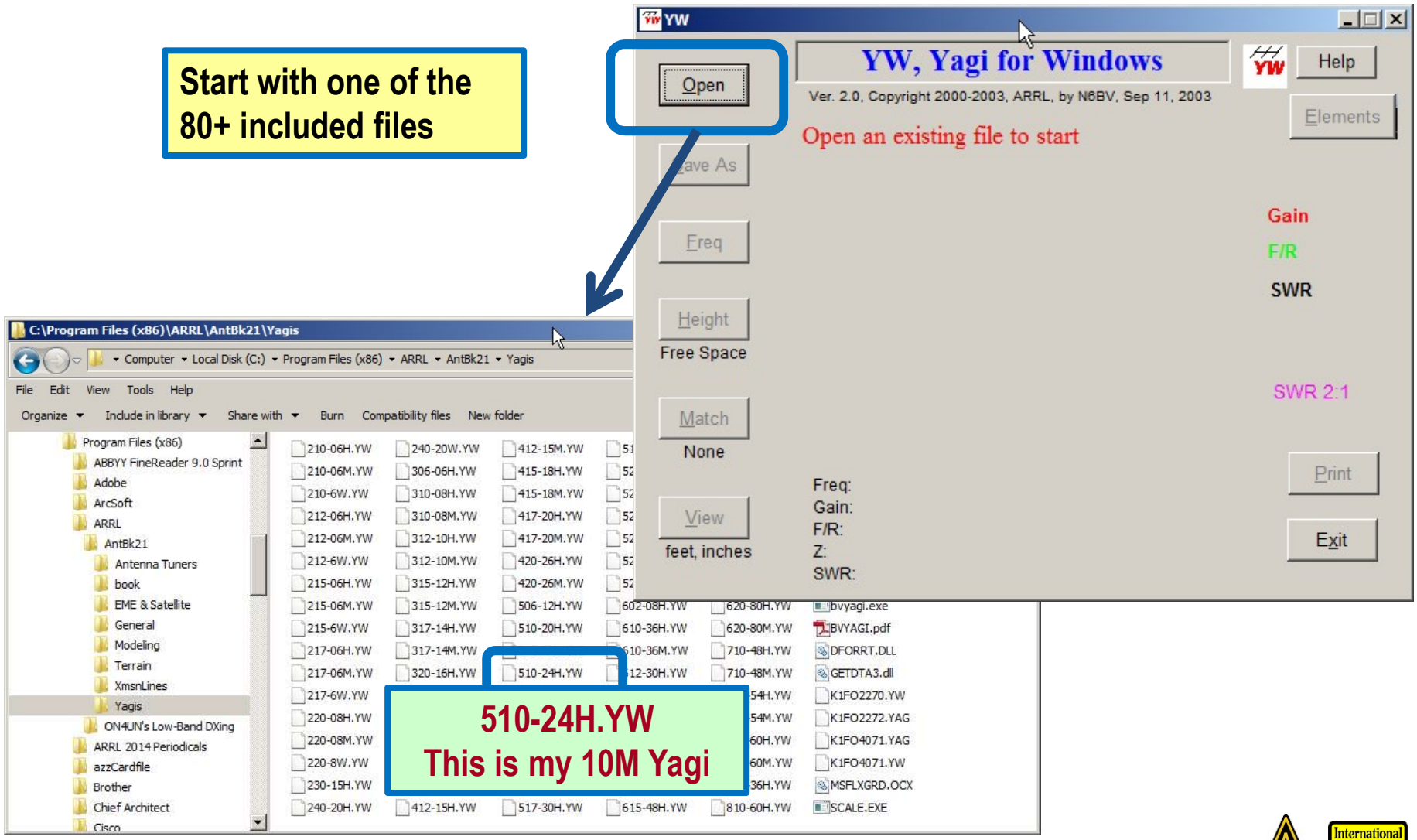
YW Example: 5el 10M yagi

Initial Screen

Click *OPEN*

YW Example: 5el 10M yagi

Start with one of the 80+ included files



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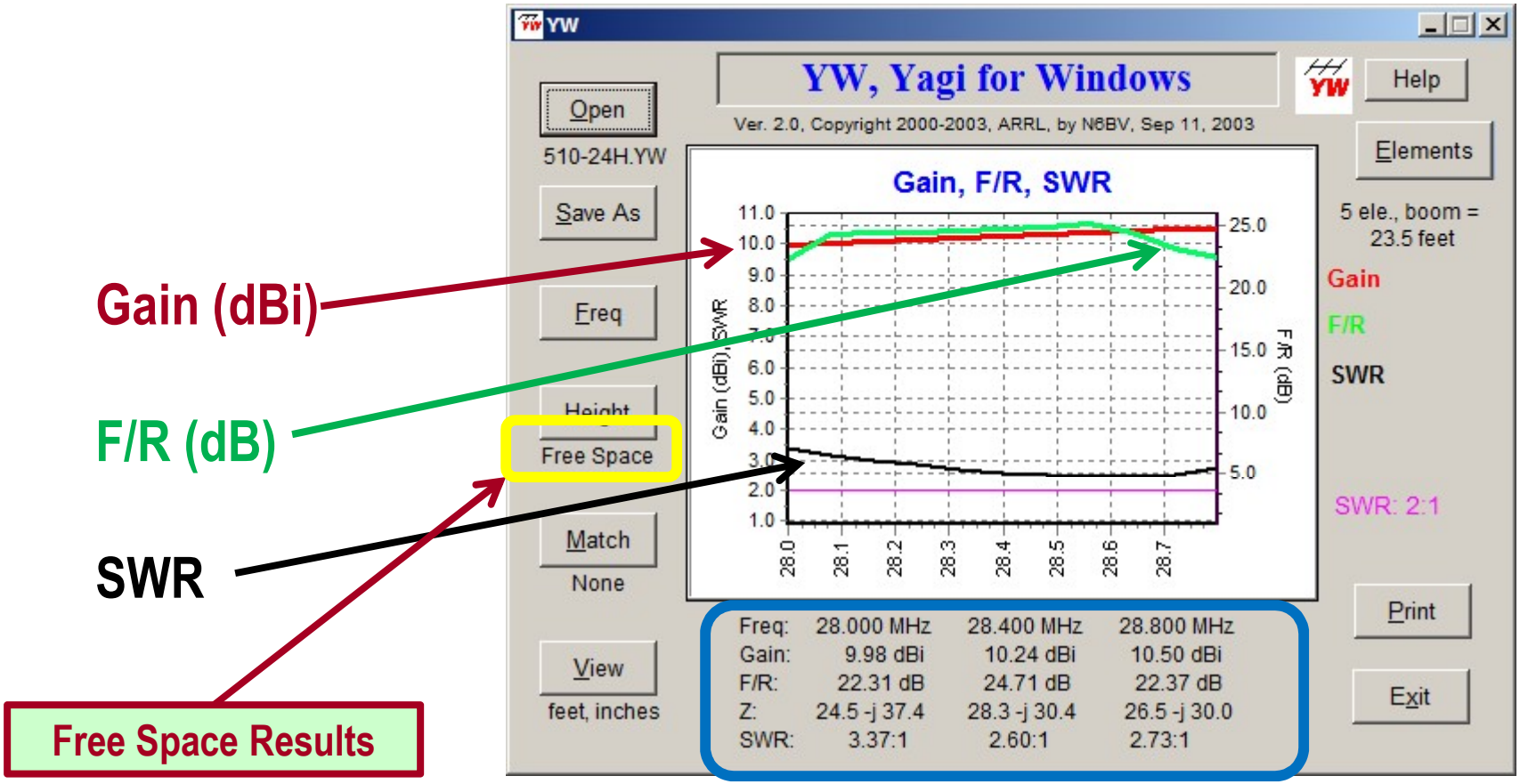
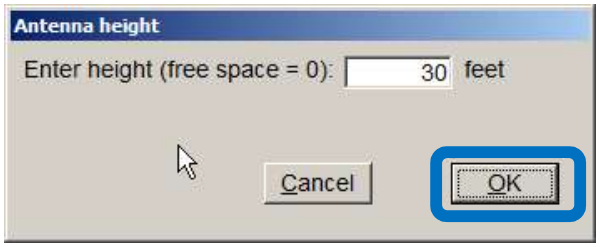
YW Example: 5el 10M yagi

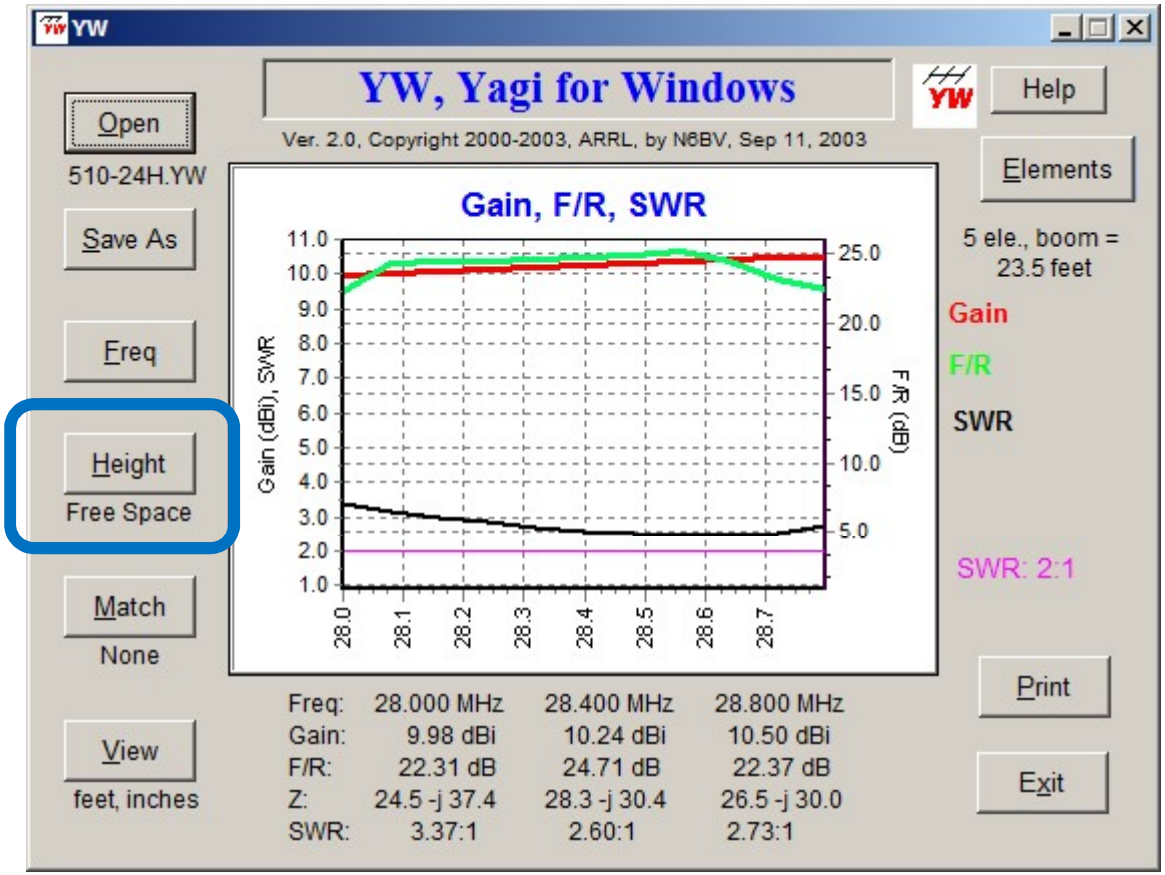


Free Space, unmatched

YW Example: 5el 10M yagi

Enter Yagi height

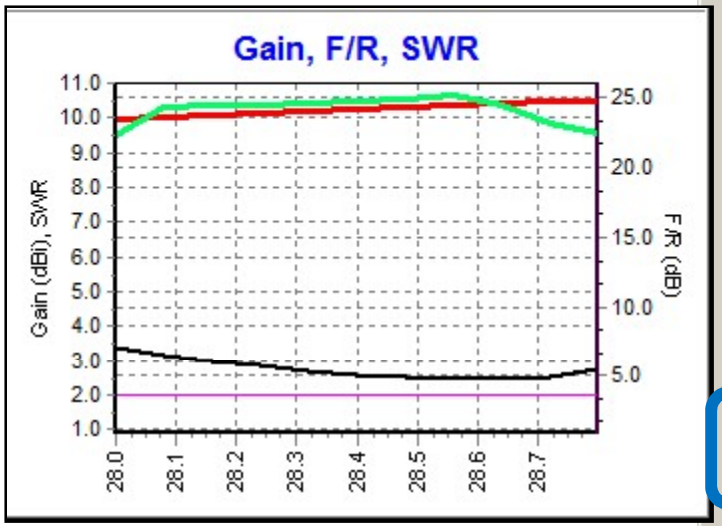




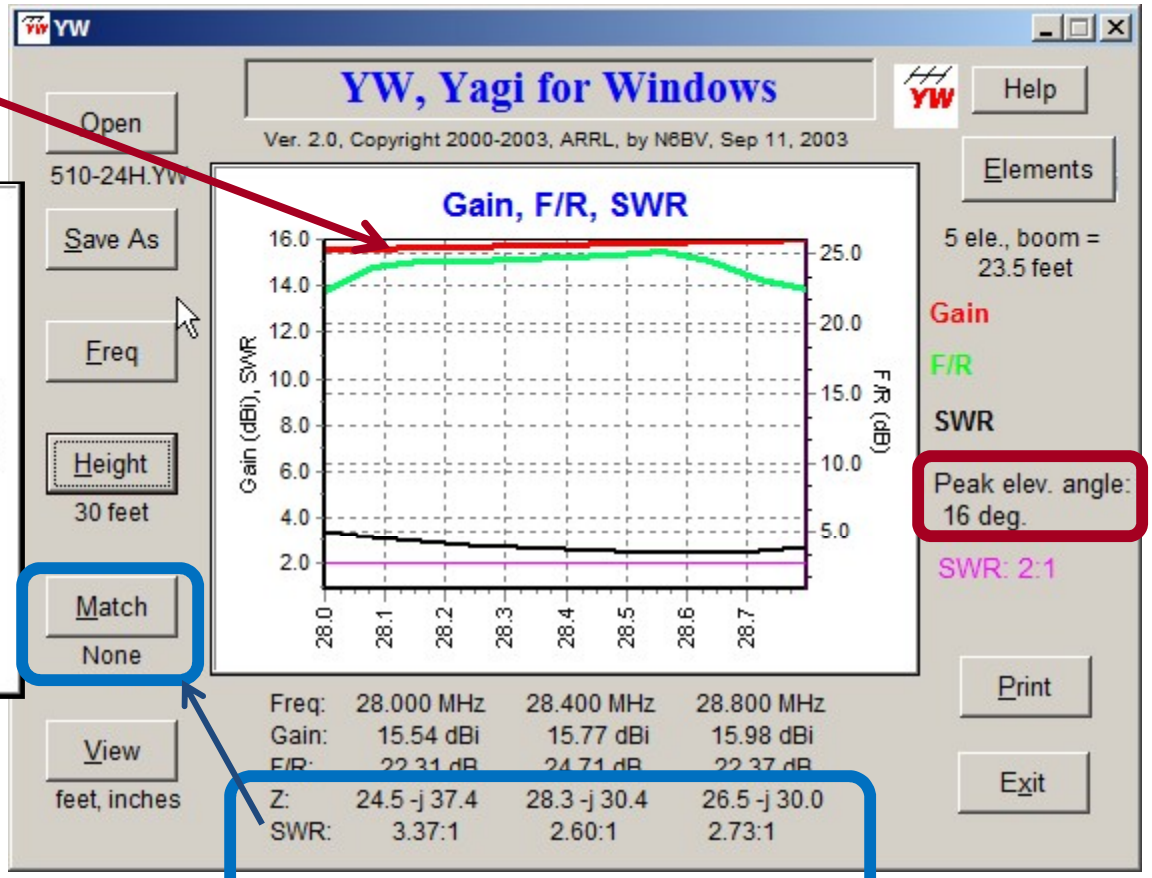
YW Example: 5el 10M yagi

30' High, unmatched

Note that Gain has increased, @ 16° elevation angle.



Free Space



SWR unchanged - Now we need to match it

Choose a Gamma Match

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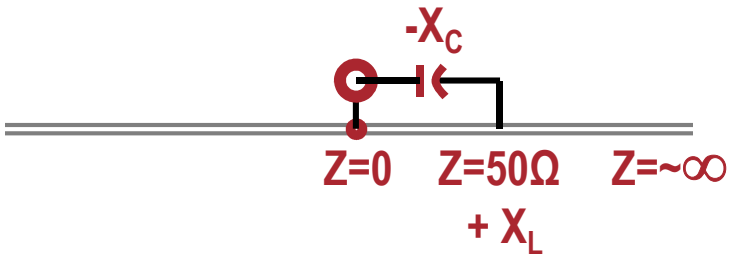
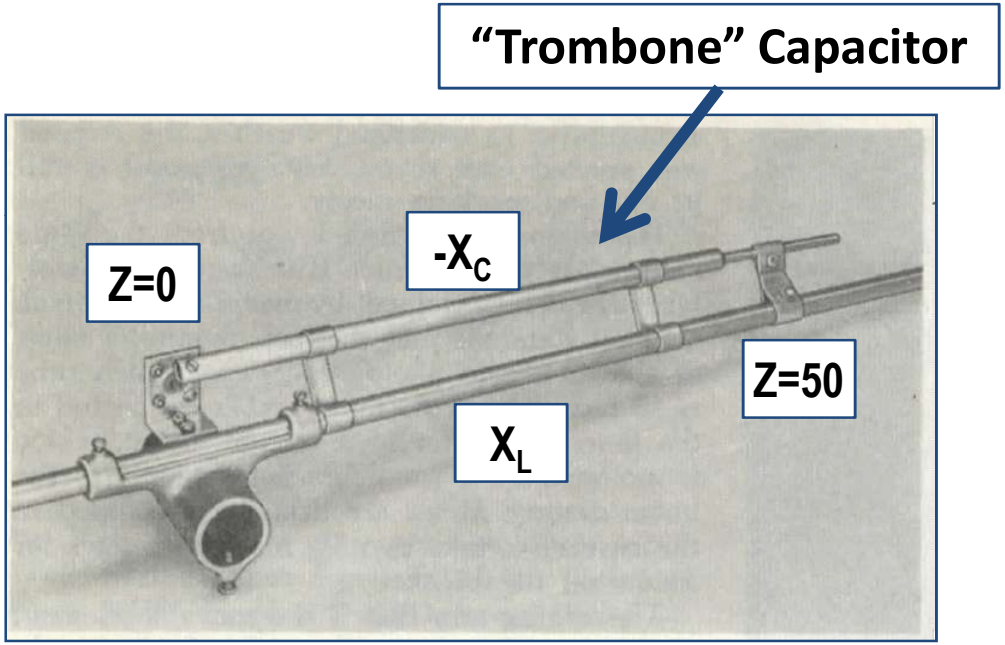
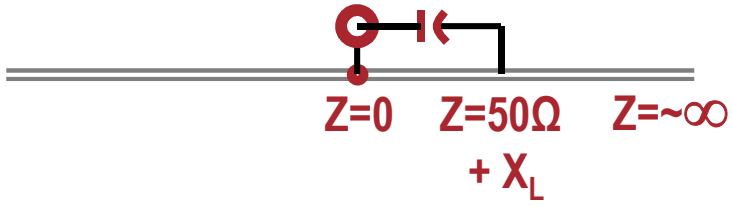
YW Example: What is a GAMMA Match?



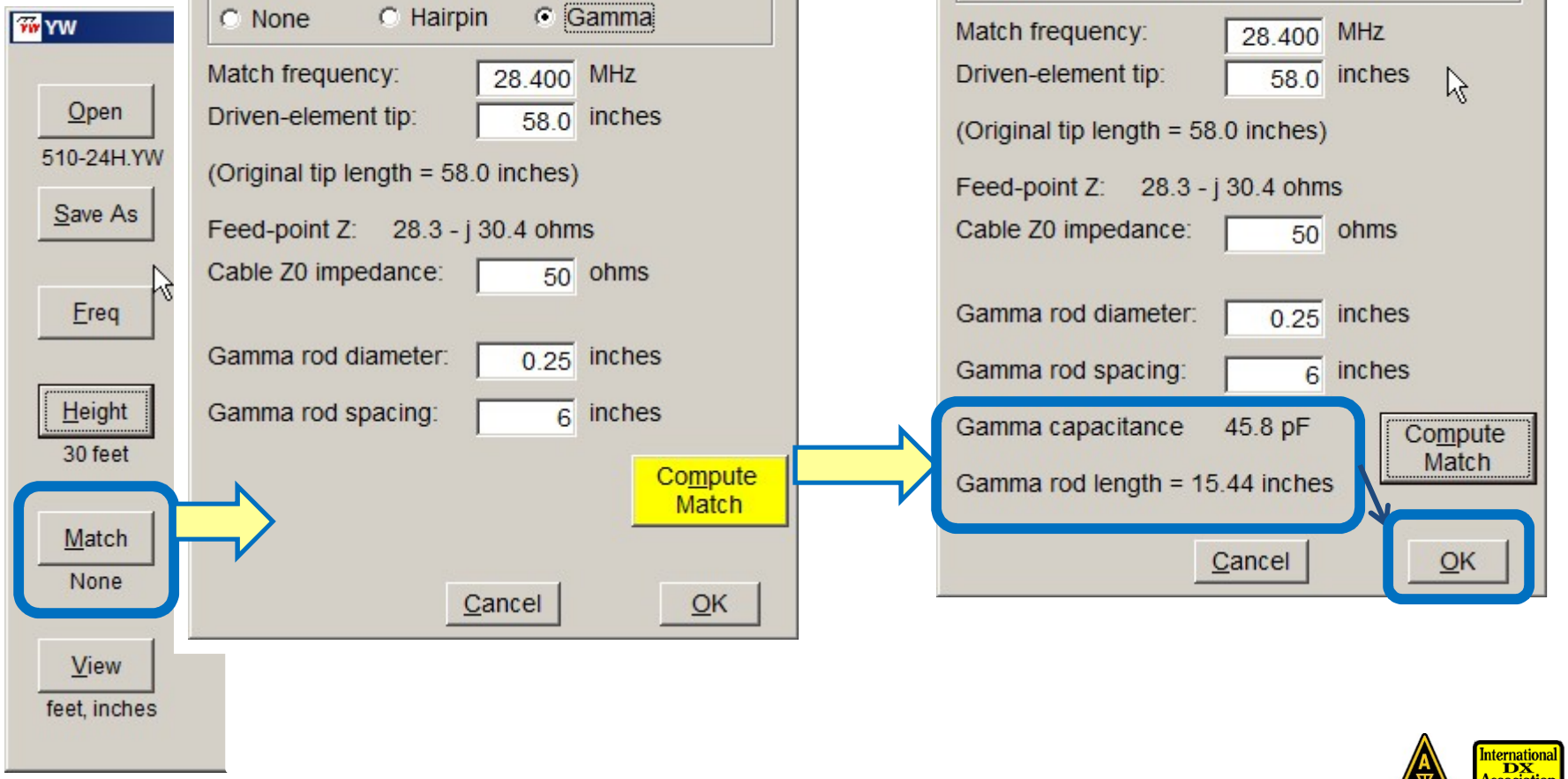


ARRL V.H.F. Manual © 1965

YW Example: 5el 10M yagi



Match it (Gamma Match)



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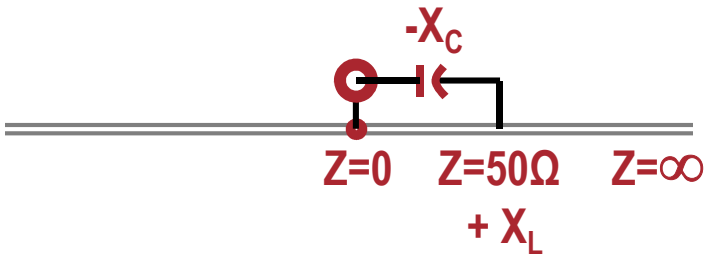
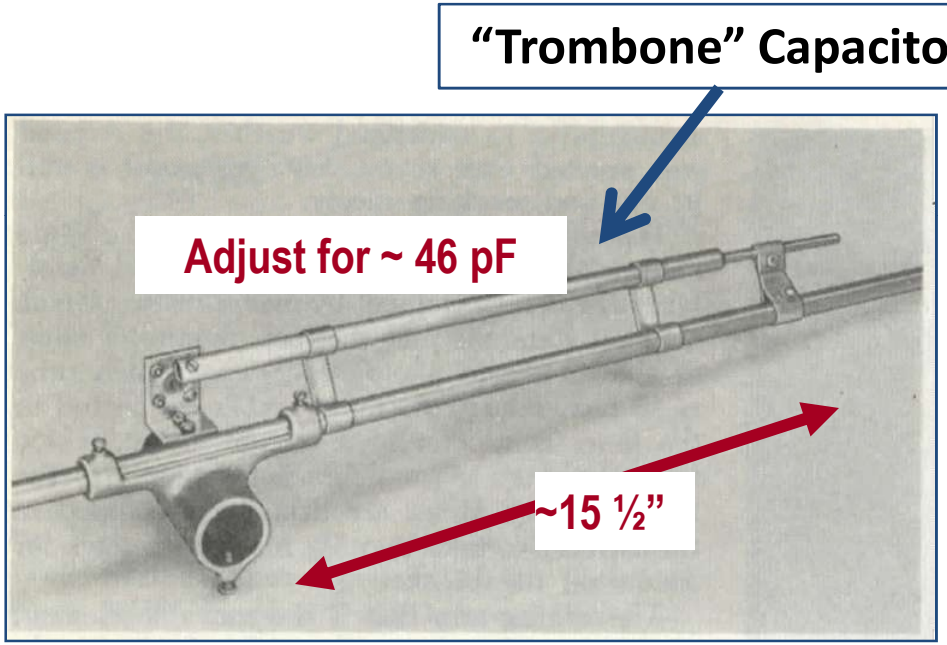
YW Example: What is a GAMMA Match?





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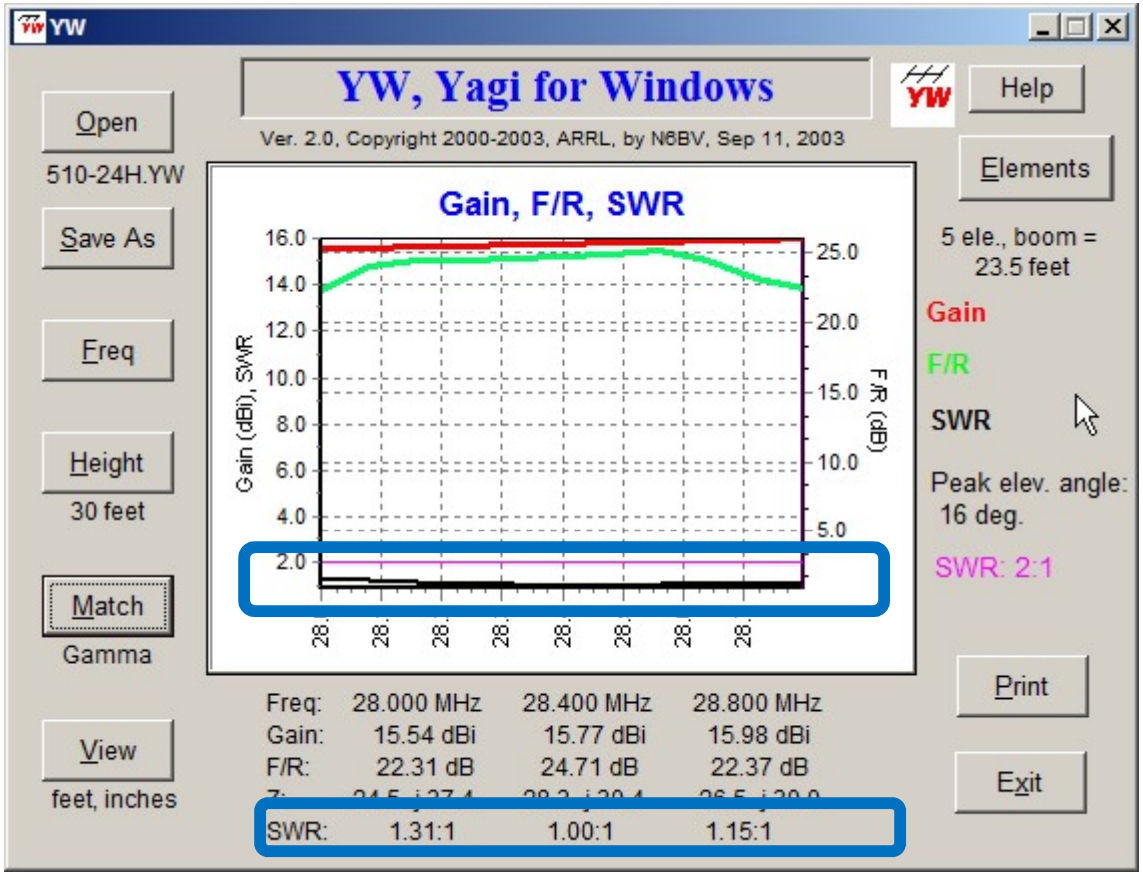
YW Example: 5el 10M yagi

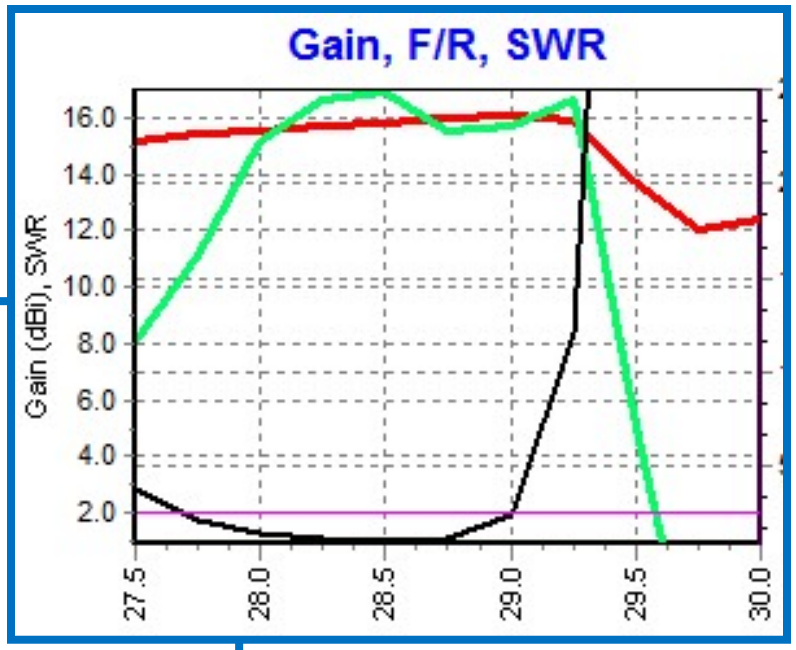
30' high, matched

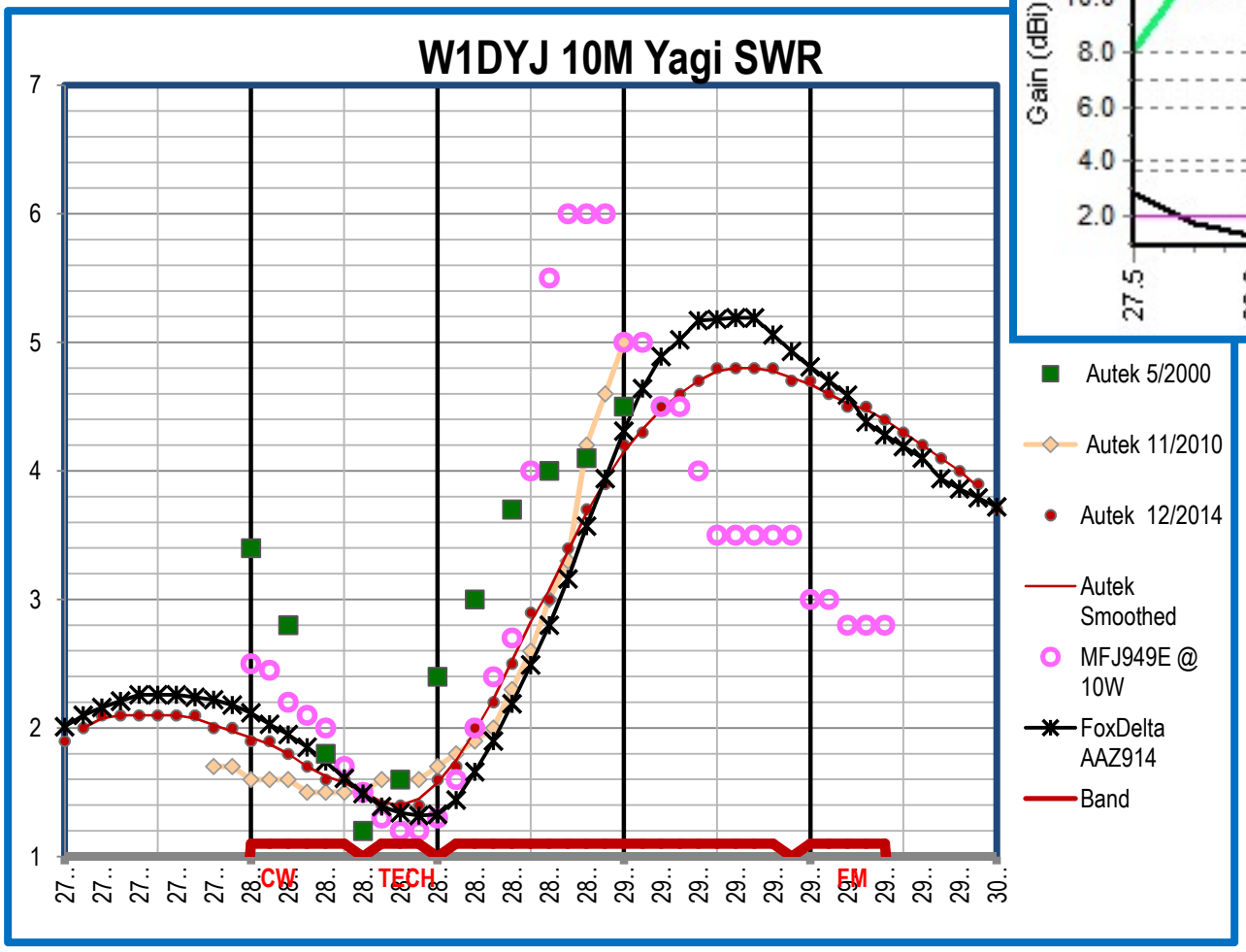


SWR is "tamed".

YW Example: 5el 10M yagi

Compare to Actuals





27.5 MHz. → 30MHz.

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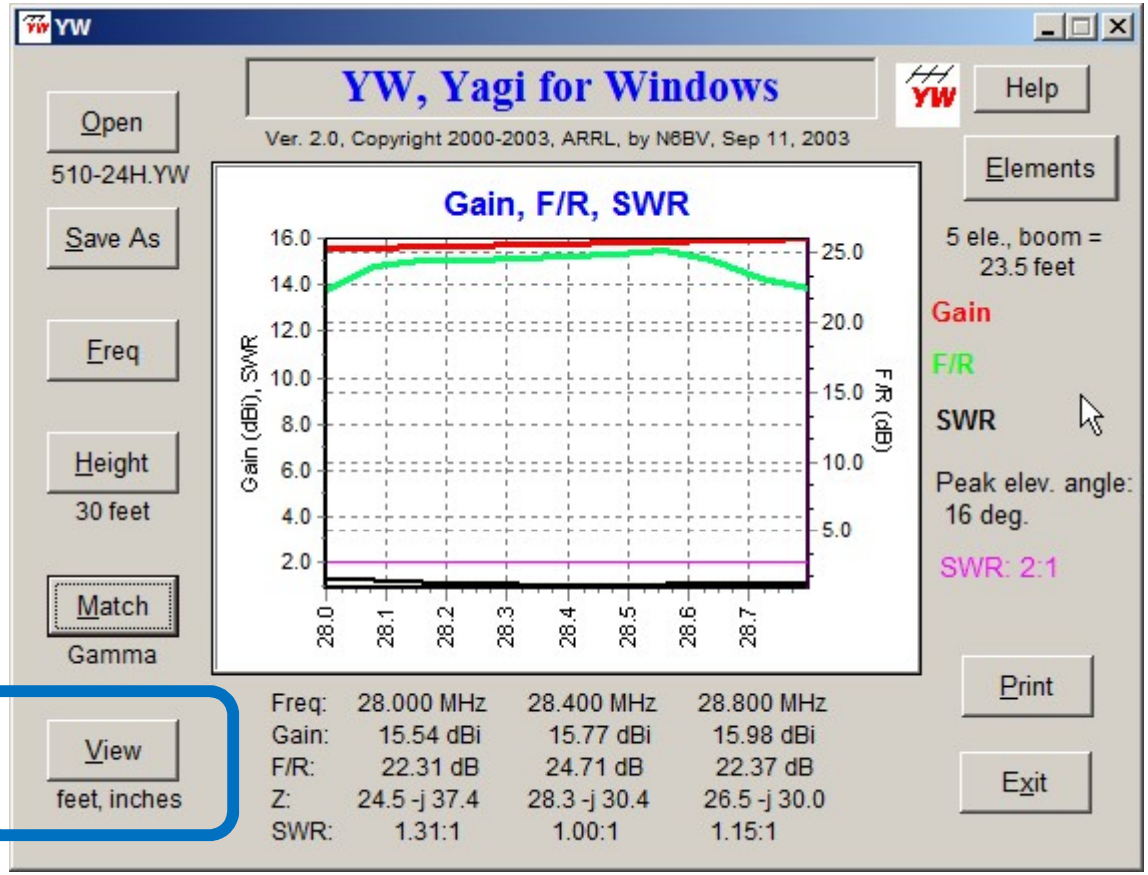
YW Example: 5el 10M yagi

SWR is NOT the only criteria!

Antennas are PASSIVE: they generate "gain" by redirecting the RF.

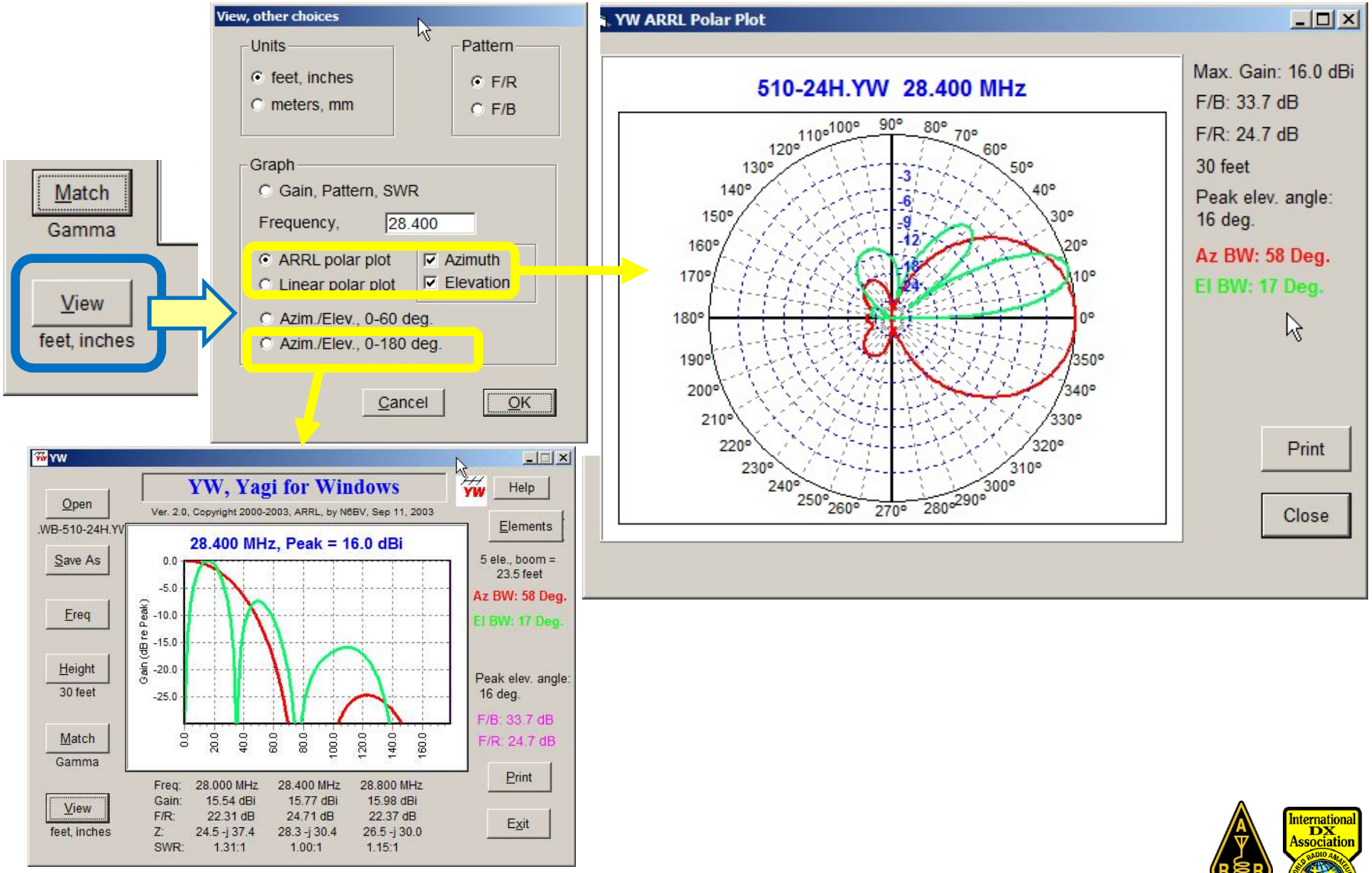
WHERE is the RF going?!



Plot the patterns

YW Example: 5el 10M yagi

30' high, matched



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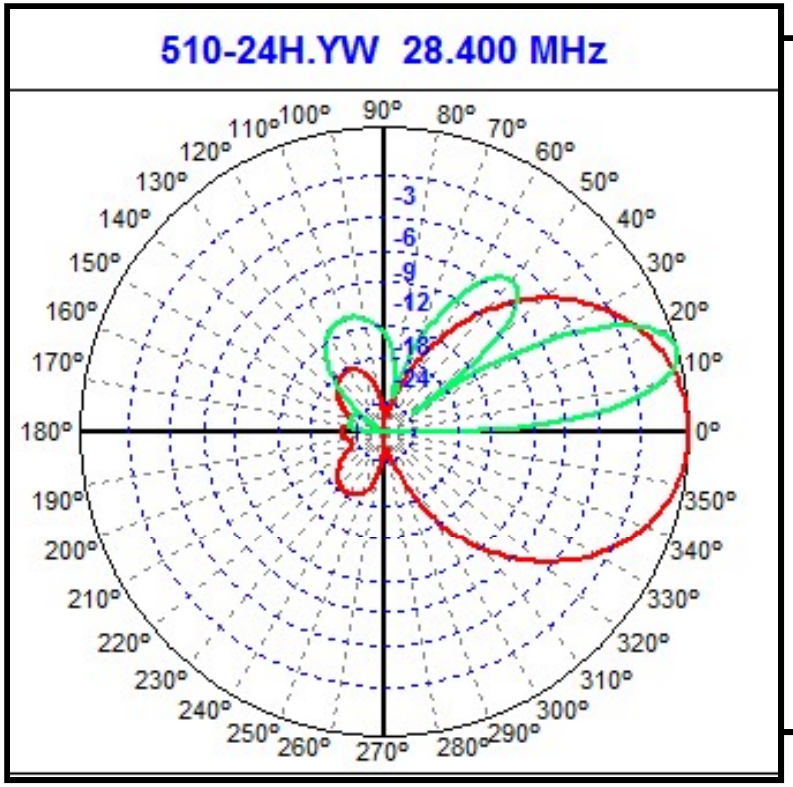
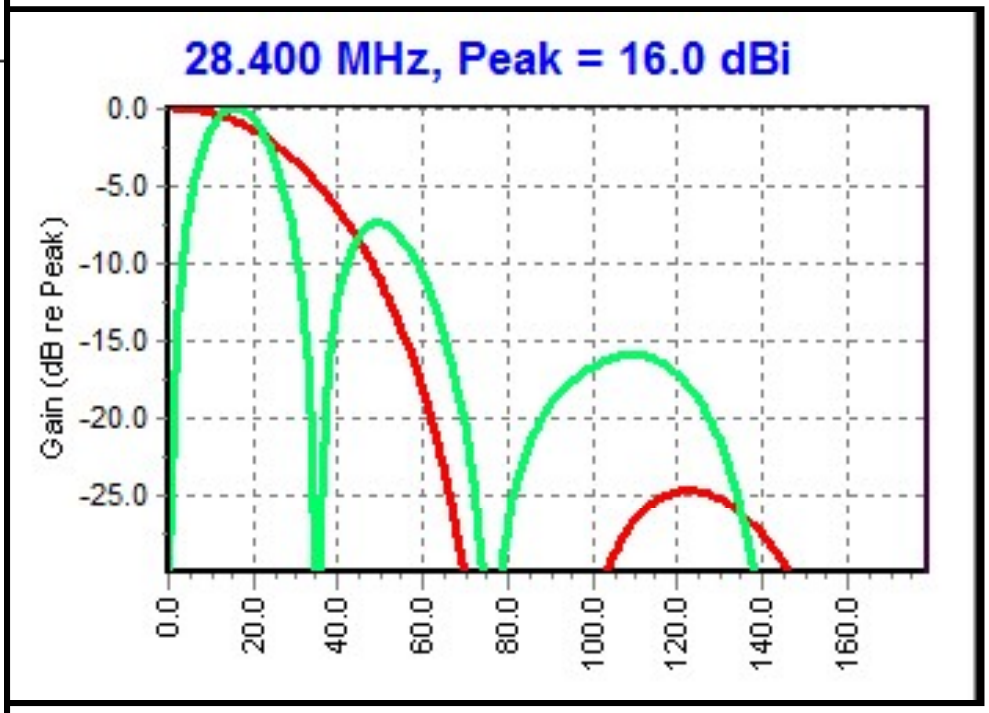
YW Example: 5el 10M yagi

30' high, matched





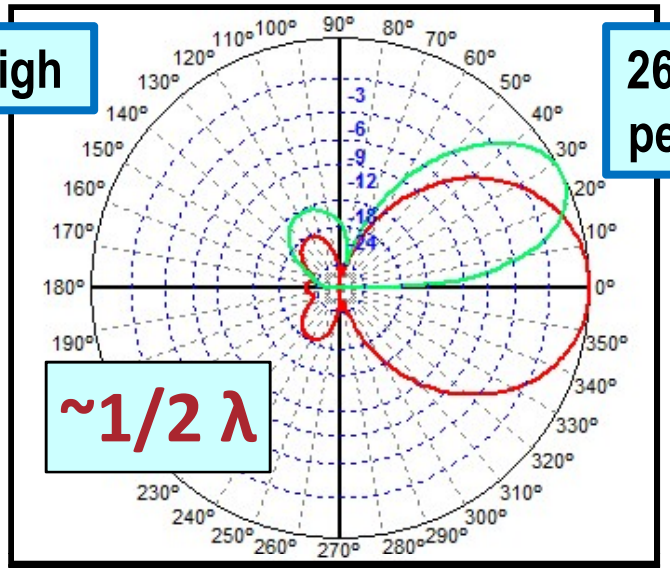
POLAR Plot **Same Data** **CARTESIAN Plot**

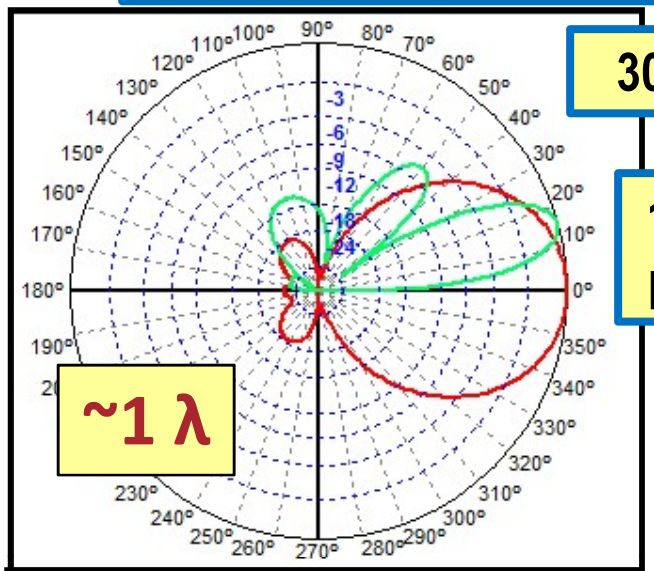
Elevation

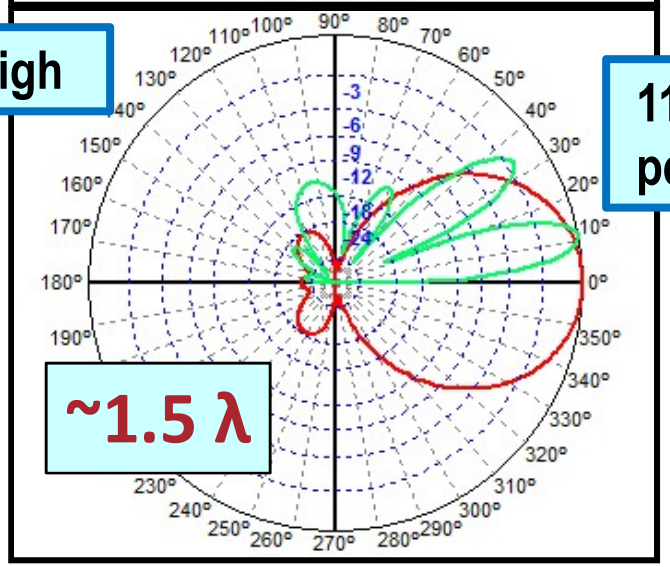
Azimuth

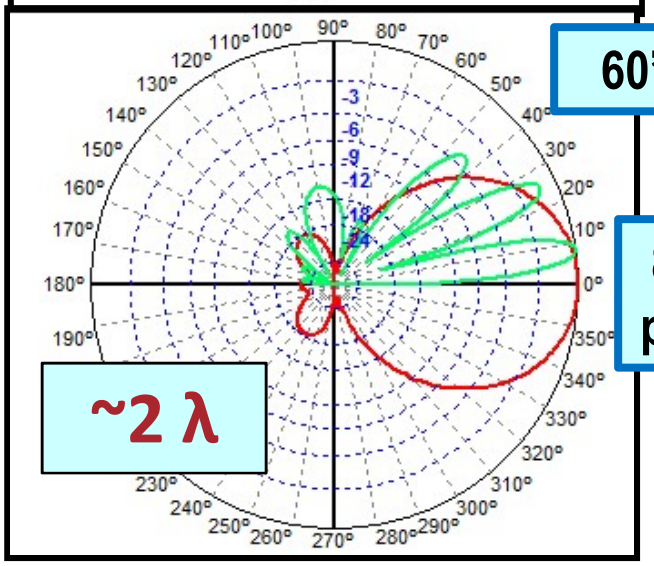
YW Example: 5el 10M yagi

Idealized pattern at different heights









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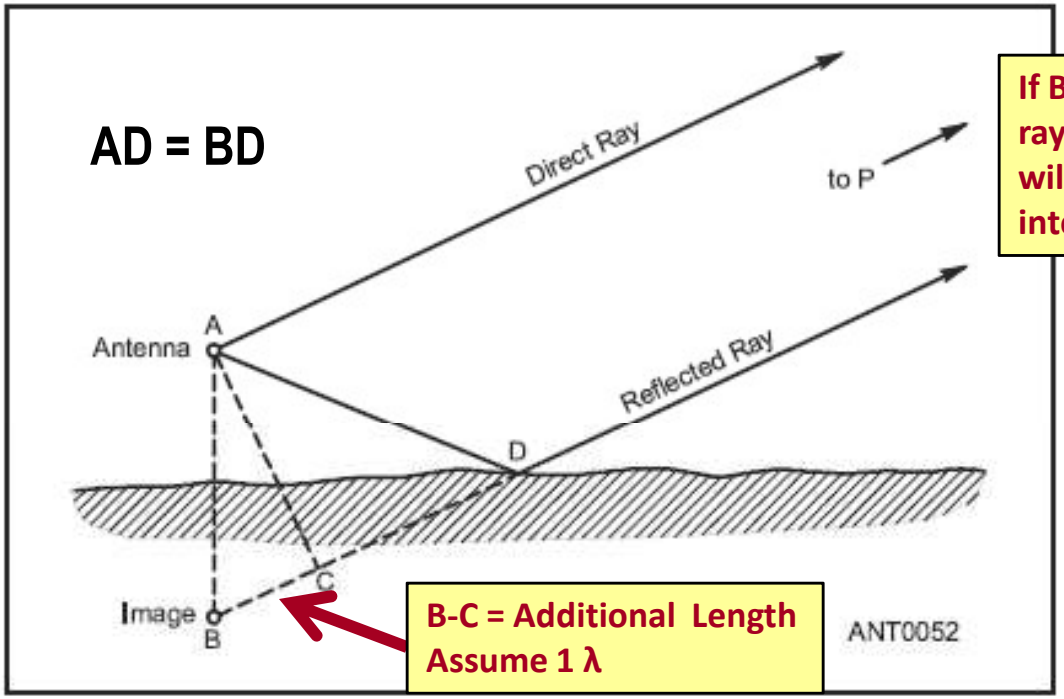
YW Example:
What's really going on with different heights?



If B-C = 1 λ, then the two rays are in phase, there will be constructive interference >> a peak

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Antenna Book

Figure 3.38 — At any distant point, P, the field strength will be the vector sum of the direct ray and the reflected ray. The reflected ray travels farther than the direct ray by the distance BC, where the reflected ray is considered to originate at the image antenna.

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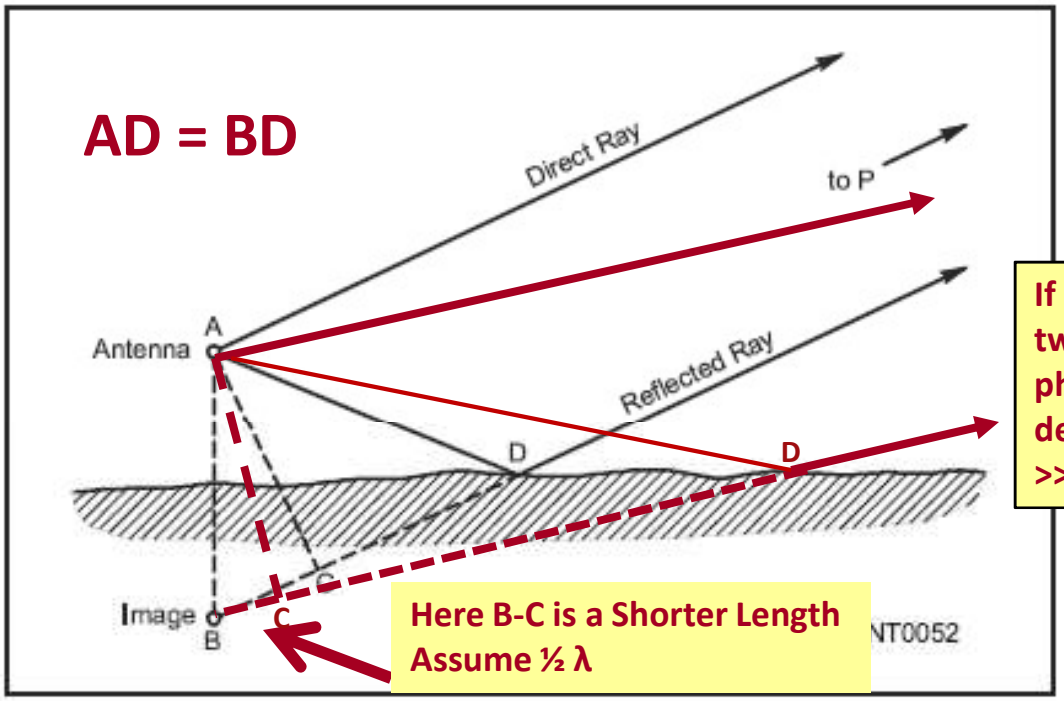
YW Example:
What's really going on with different heights?



If B-C = 1/2 λ, then the two rays are out of phase, there will be destructive interference >> a null

Here B-C is a Shorter Length
Assume ½ λ

Figure 3.38 — At any distant point, P, the field strength will be the vector sum of the direct ray and the reflected ray. The reflected ray travels farther than the direct ray by the distance BC, where the reflected ray is considered to originate at the image antenna.

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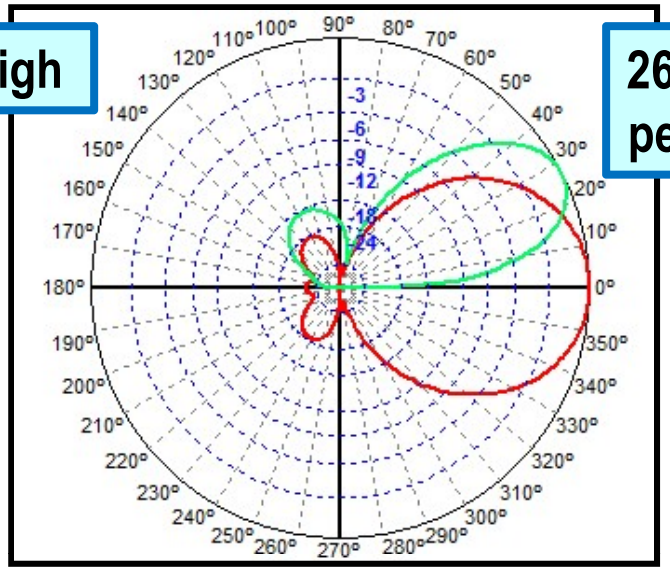
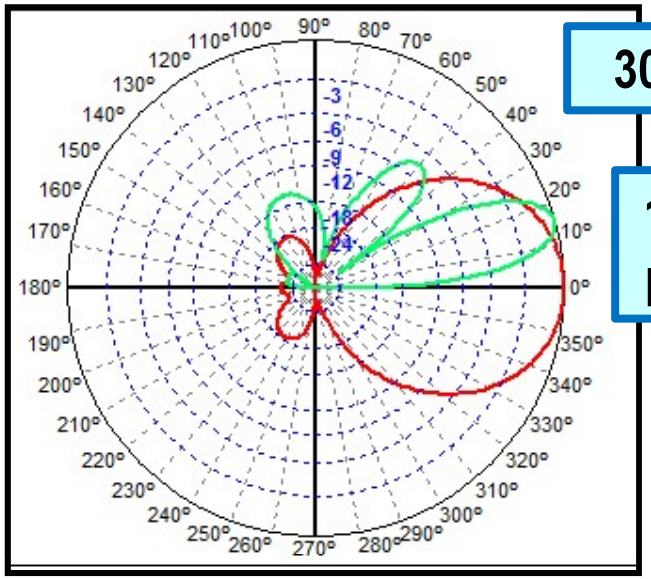
YW Example: 5el 10M yagi

15' high

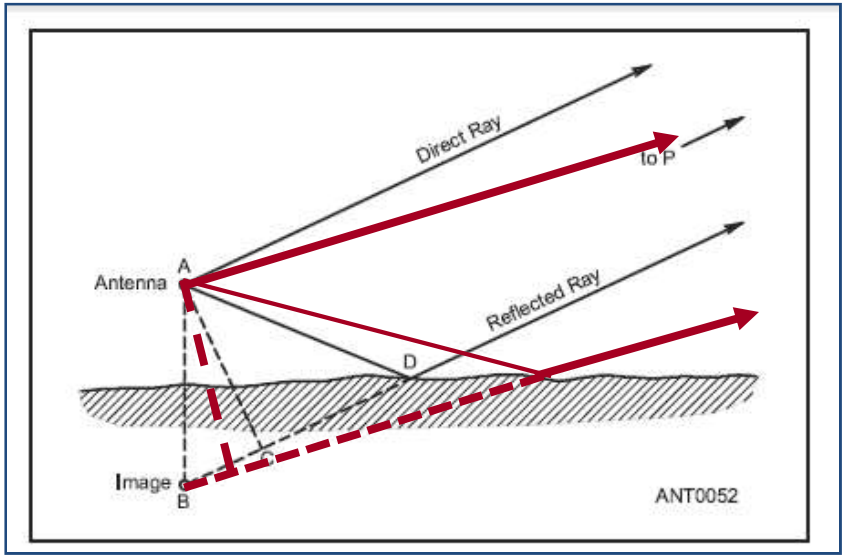


26° peak



30' high

16° peak



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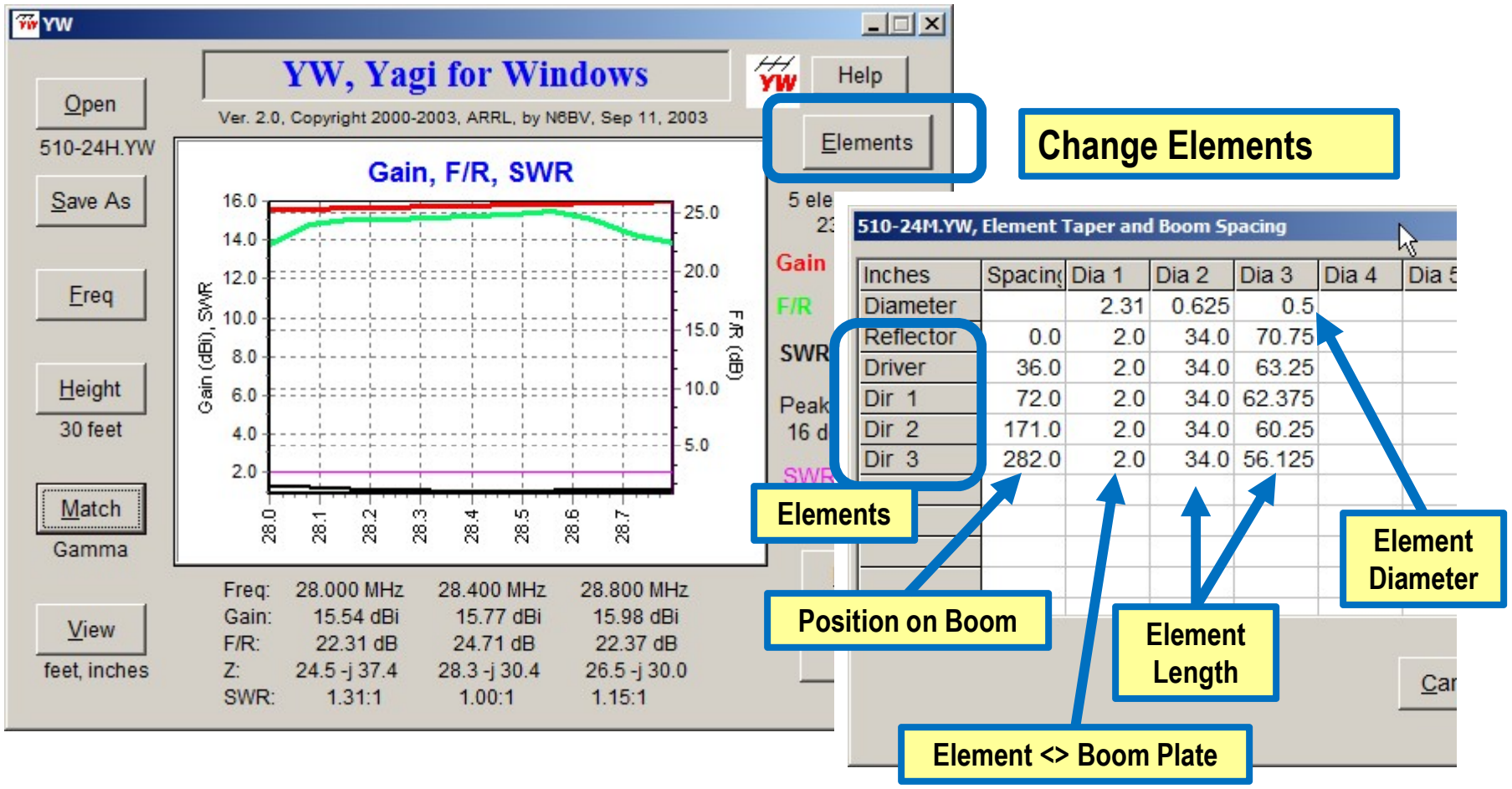
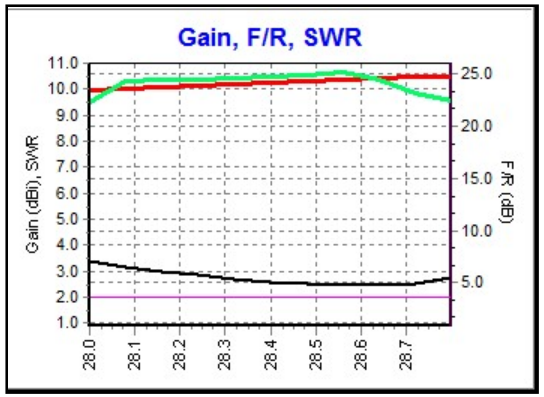
YW Example: 5el 10M yagi → Redesign



YW does not have the "automatic" optimization routine that YO had.

YW – Yagi for Windows

Helps you understand/design your monoband Yagis,
but – assumes flat, perfect ground



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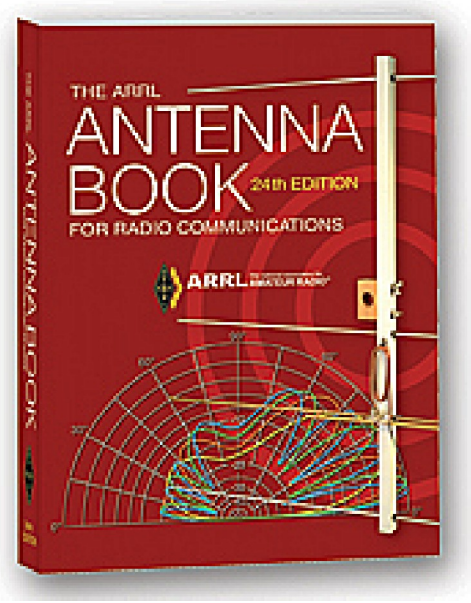
Antenna Modeling ~ Agenda

- TLW
- YW
- **HFTA**



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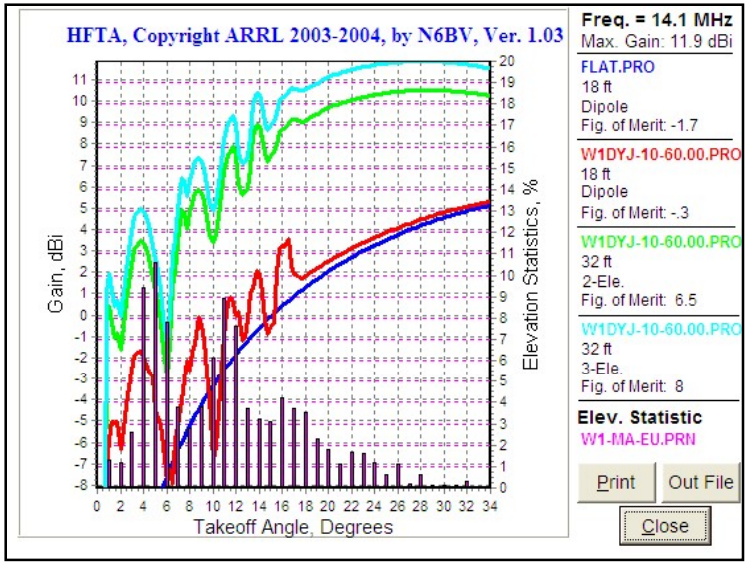
HFTA – High Frequency Terrain Assessment

R. Dean Straw ~ N6BV ©ARRL



Purpose:

Assesses the effect of uneven local terrain on the transmission and reception of HF signals.

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HFTA – High Frequency Terrain Assessment

Agenda

- Overview of HFTA
- What are Elevation Statistics?
- What are Terrain Files?
- Using HFTA

HFTA – High Frequency Terrain Assessment

What problem does HFTA attempt to solve?

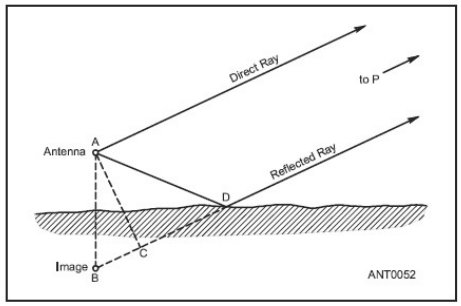

Figure 3.38 — At any distant point, P, the field strength will be the vector sum of the direct ray and the reflected ray. The reflected ray travels farther than the direct ray by the distance BC, where the reflected ray is considered to originate at the image antenna.

YW assumes flat ground

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HFTA – High Frequency Terrain Assessment

What problem does HFTA attempt to solve?

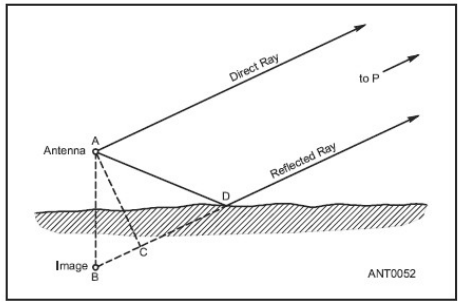

Figure 3.38 — At any distant point, P, the field strength will be the vector sum of the direct ray and the reflected ray. The reflected ray travels farther than the direct ray by the distance BC, where the reflected ray is considered to originate at the image antenna.

YW assumes flat ground

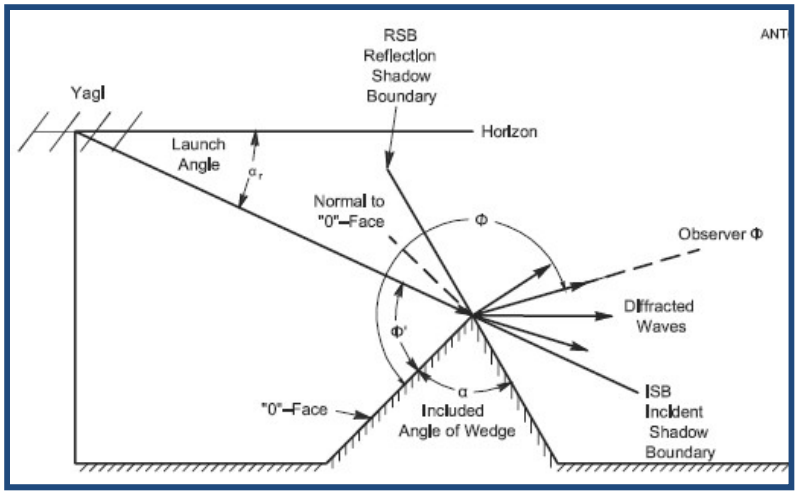

Fig 14.29
©ARRL Antenna Book

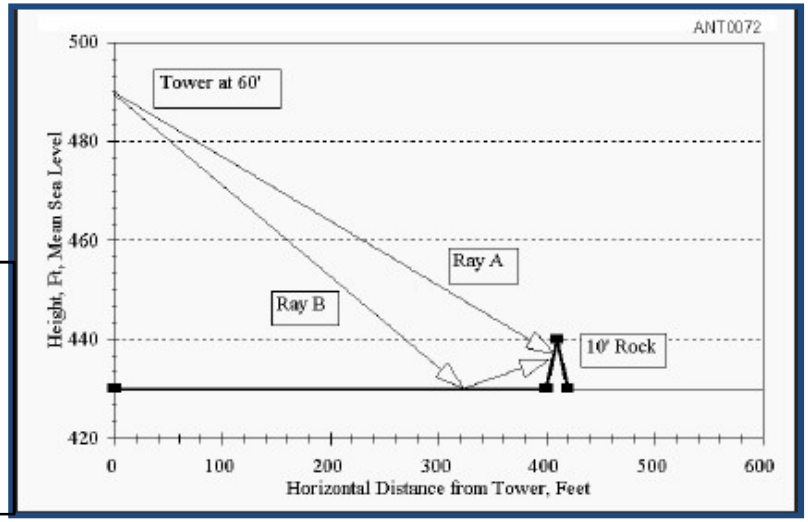

Fig 14.30
©ARRL Antenna Book

HFTA takes into account diffraction and local terrain

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HFTA – High Frequency Terrain Assessment

Attributes

- HFTA is a ray-tracing program designed to evaluate the effect of foreground terrain on the elevation pattern of up to four multi-element HF monoband Yagis in a stack.
- Models horizontally polarized Yagis, and "works" with simple horizontal dipoles
- Takes into account the effects of Fresnel horizontal ground-reflection
- Takes into account diffraction
- Includes *Elevation Statistics Files* ~ the angle the RF comes from
- Latest version of earlier "YT" program

HFTA – High Frequency Terrain Assessment

Limitations

- Does not work with vertical polarization
- Free-space gain assumed for default Yagis;
  example: model is 8.5 dBi
- Does not take into account mutual impedance ground effects

Additional Requirement

- Requires a *Terrain Data File*

HFTA – High Frequency Terrain Assessment

Agenda

- Overview of HFTA
- What are **Elevation Statistics?**
- What are Terrain Files?
- Using HFTA

Elevation Statistics

Fundamentally → Where is the DX?

At what angle (from the horizon) does the RF arrive?

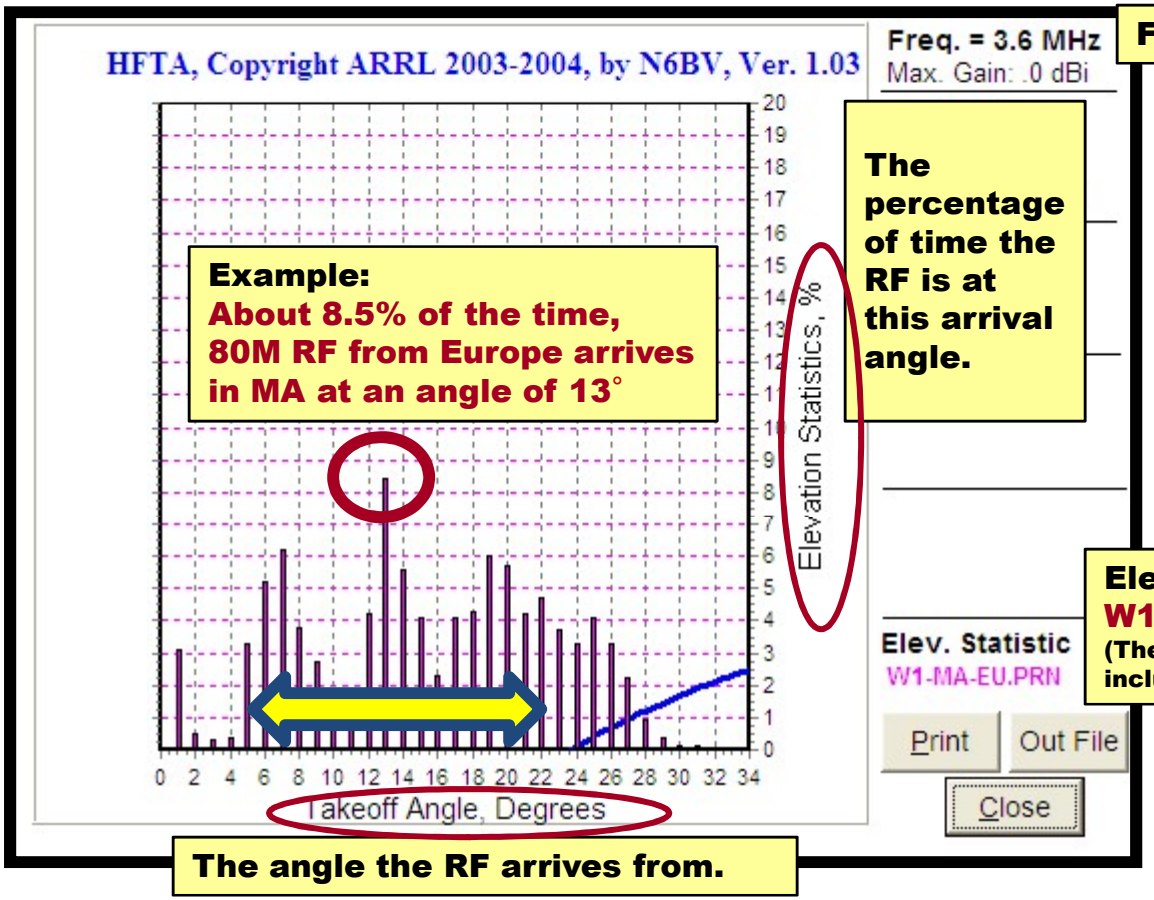
We must always remember this simple truth:

The ionosphere controls the elevation angle of the received RF at your location, not your antenna!

HFTA ~ Elevation Statistics Example: 80M: MA →EU

Note:
This data is an overall average of all time; i.e. for any time, any day, any season, any part of the 11-year sunspot cycle.

Specific propagation "today" will be very limited in angle.



Conclusion, from this one graph:
About 80% of the time, European 80M RF arrives at arrival angles between 5 → 22°

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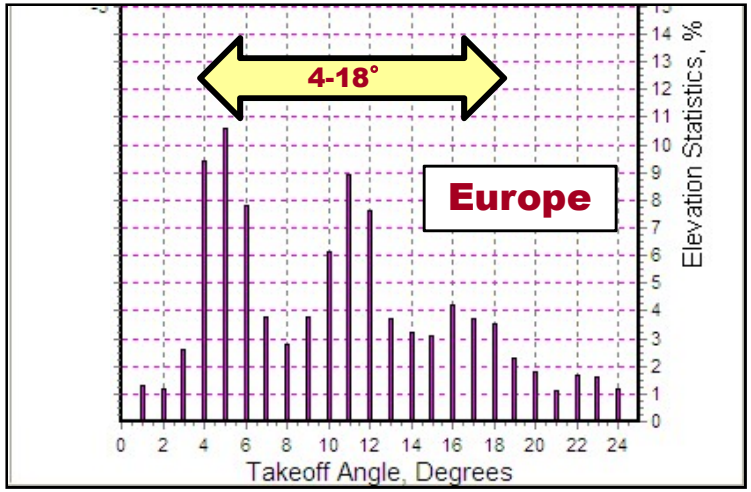
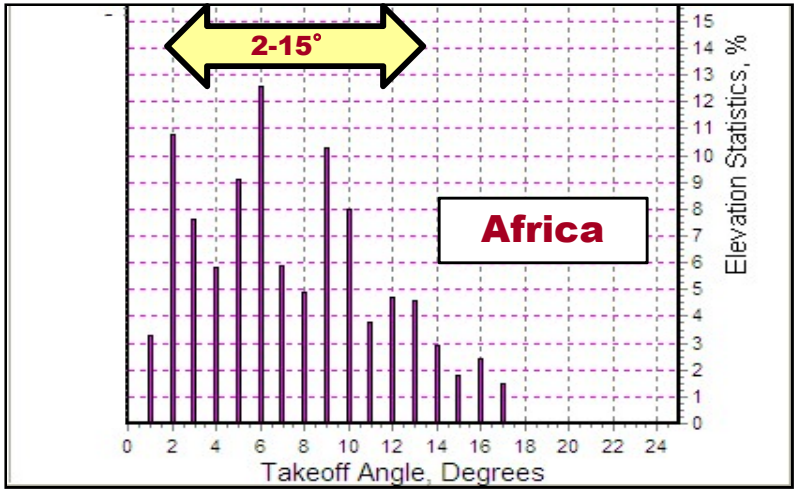
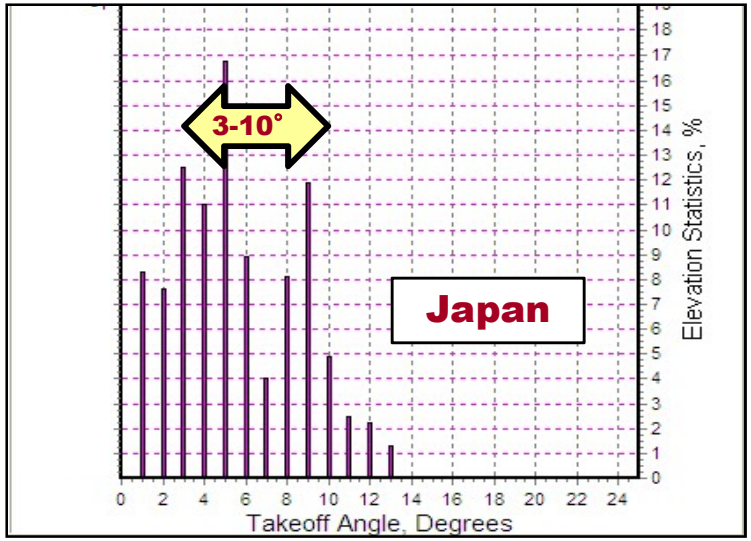
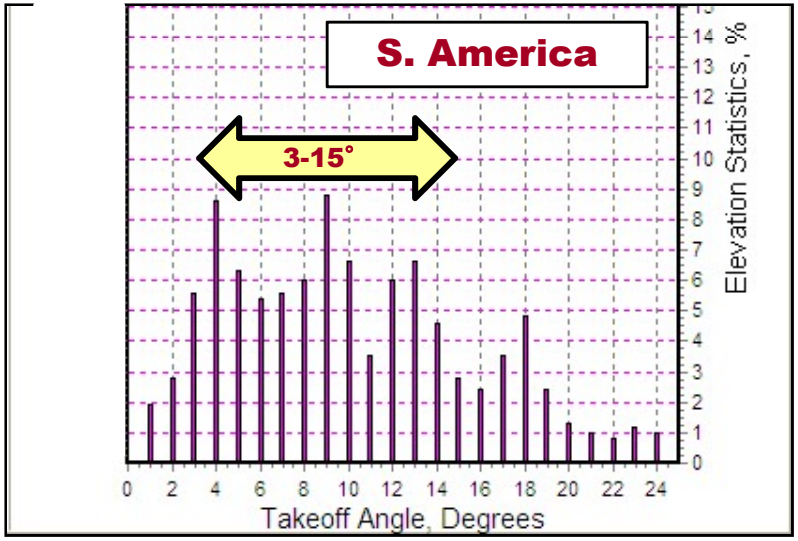
HFTA ~ Elevation Statistics Example: 20M in MA









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HFTA – High Frequency Terrain Assessment

Agenda

- Overview of HFTA
- What are Elevation Statistics?
- What are Terrain Files?
- Using HFTA

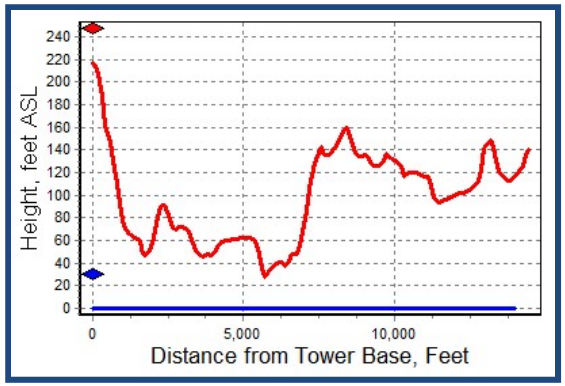
Terrain File → Unique to your location

ASCII files that describe the terrain in all 360 degree directions from your antenna site.

AZI-0.00.PRO - Notepad

File Edit Format View Help

```
meters
          0      66.2
         30      63.1
         60      60.1
         90      58.5
        120      57.4
        150      54.8
        180      50.9
        210      45.5
        240      43.3
        270      43.3
        300      44.0
        330      46.4
        360      48.8
        390      50.1
        420      49.5
        450      49.4
        480      50.1
        510      49.9
        540      49.6
        570      49.1
        600      48.9
        630      48.8
        660      48.0
        690      47.1
        720      48.2
        750      48.2
        780      46.5
        810      43.8
        840      44.9
        870      48.2
        900      50.2
        930      51.6
```



It used to be difficult to obtain:

- *Measure from a topo map*
- *Pull from xxx.gov web site*
- *Use MicoDEM to generate*

Now it's easy:

- *https://paas.k6tu.net*
- *Create a free account*
- *>> HF Terrain Analysis*
  - *At bottom under "Documentation"*
- *Read directions & request a Profile*
- *Download*

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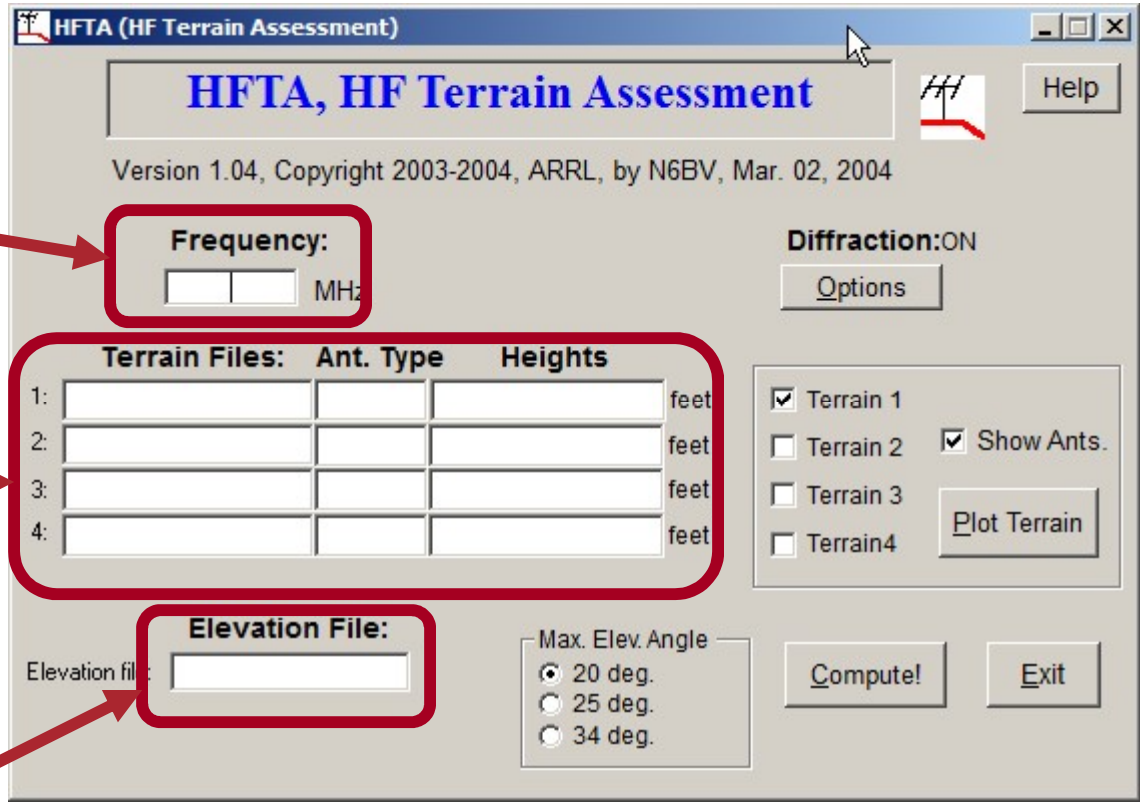
HFTA – High Frequency Terrain Assessment

Agenda

- Overview of HFTA
- What are **Elevation Statistics**?
- What are **Terrain Files**?
- **Using HFTA**

Using HFTA

Initial Screen



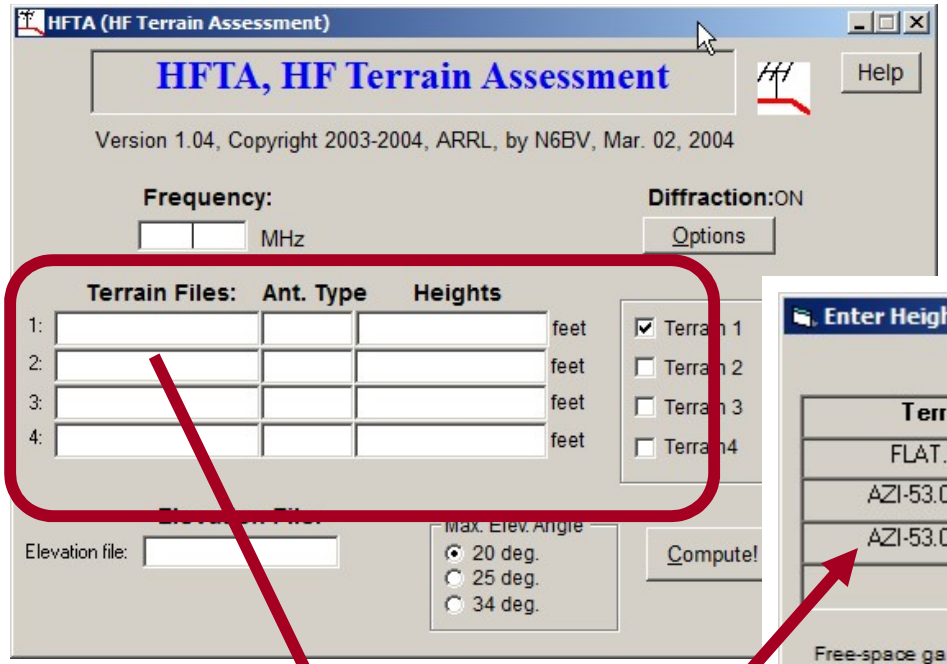
Enter the frequency of interest

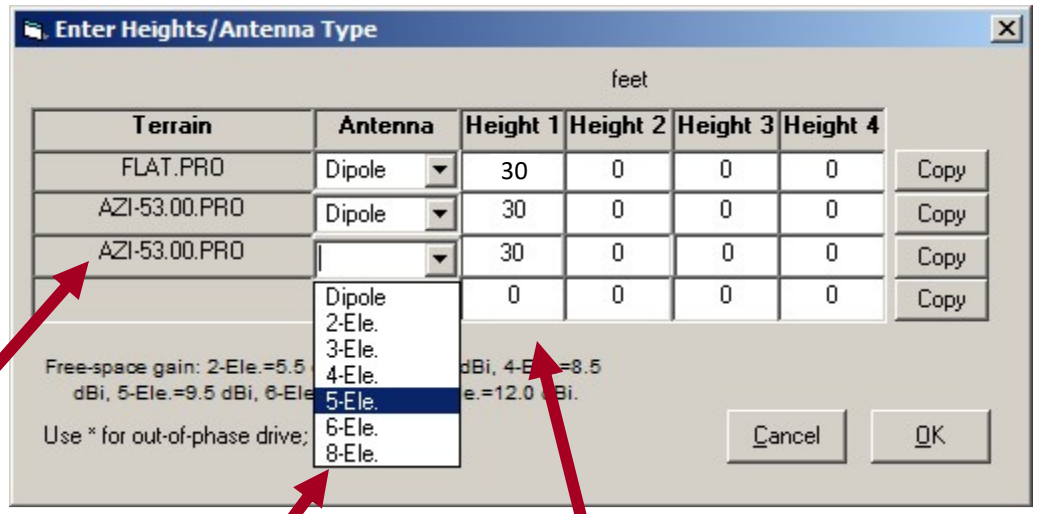
Select your terrain file, antennas, & heights

Choose one of HFTA's elevation statistic files

Using HFTA

Select Antenna Types & Heights





Clicking here opens up the folder with your terrain files

Then select the antenna type…

…and enter the height

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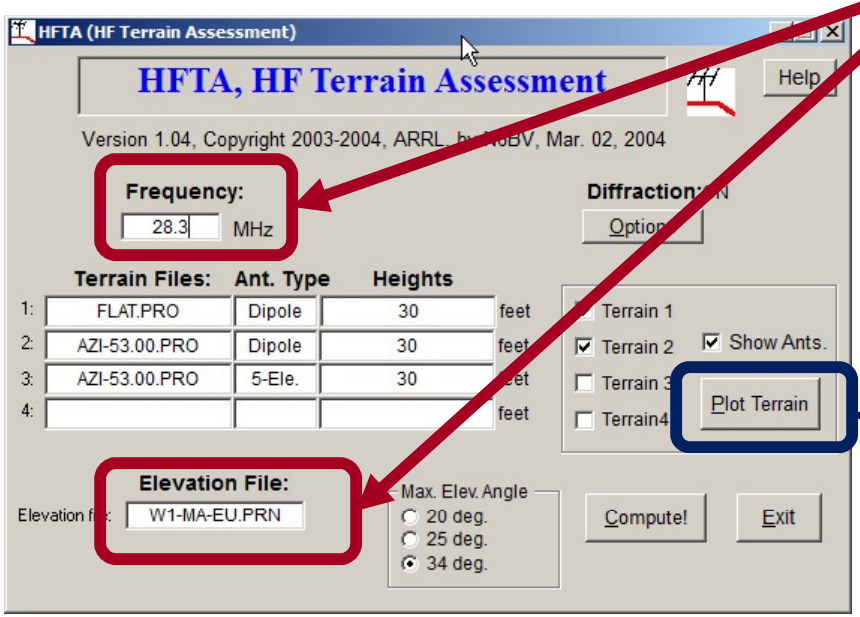
Using HFTA

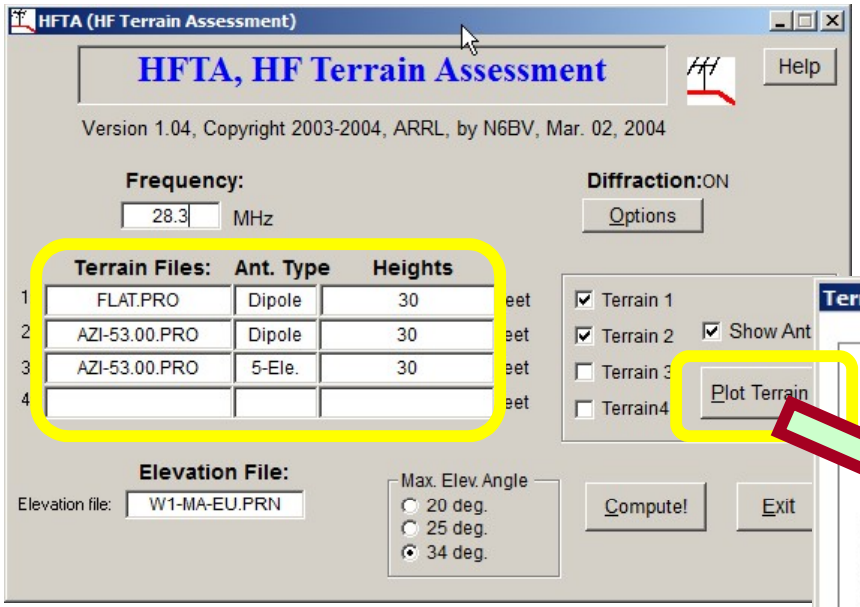


Enter Freq / Select Elevation File

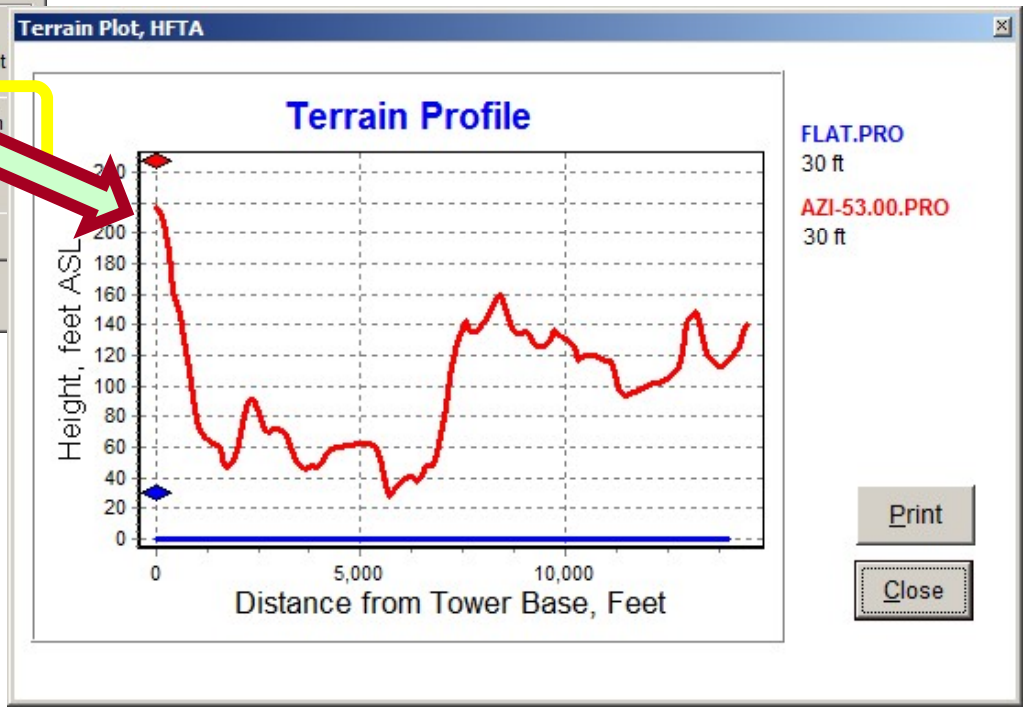
As a check, first click on *Plot Terrain*

Elevation File:
W1-MA <=> Europe

Using HFTA



Terrain from
W1DYJ @ 53° → England



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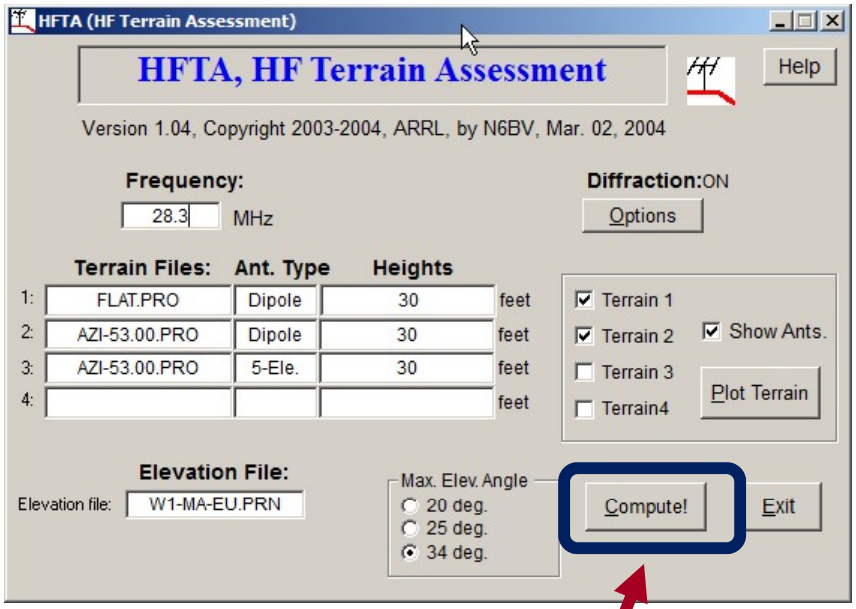
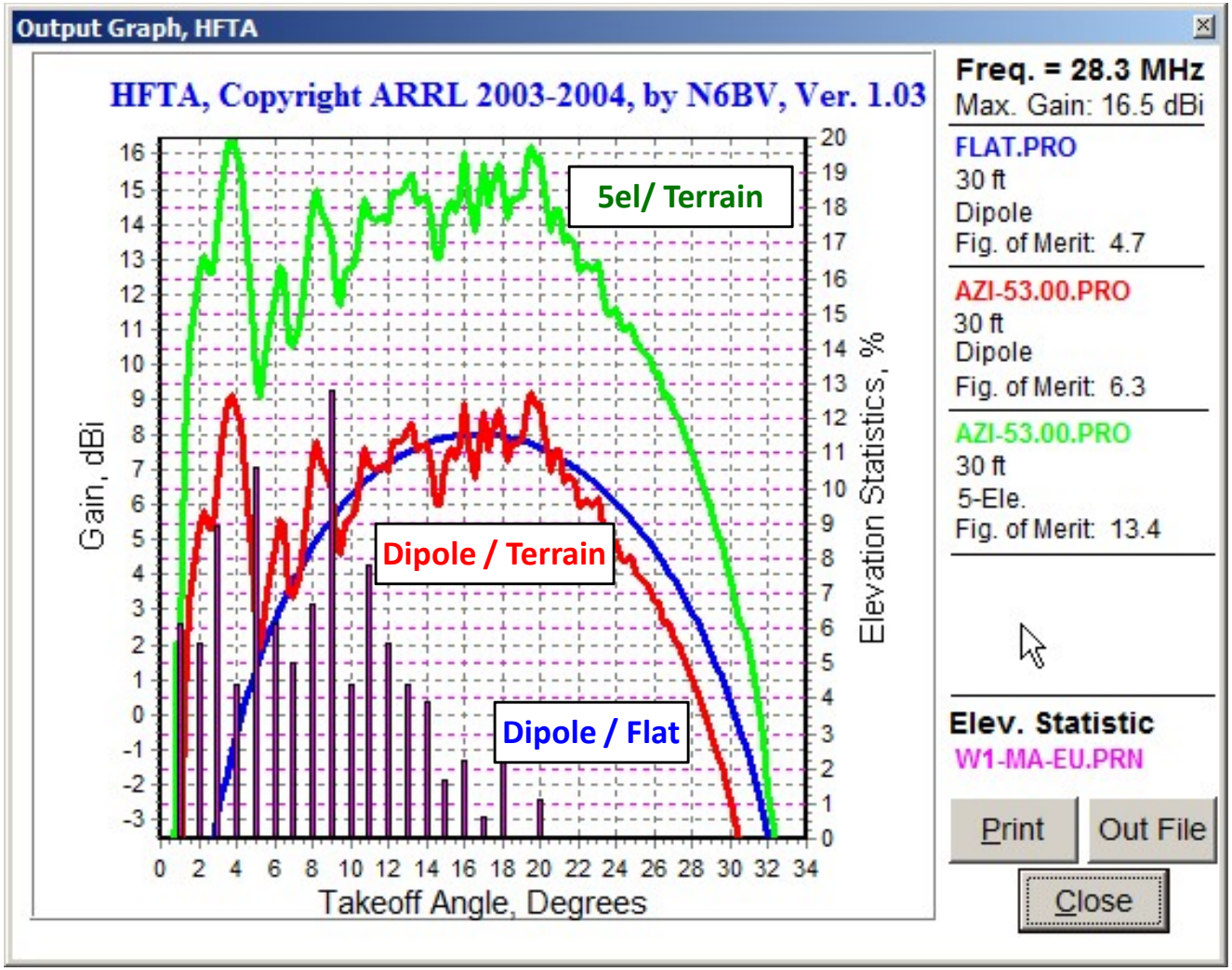
Using HFTA

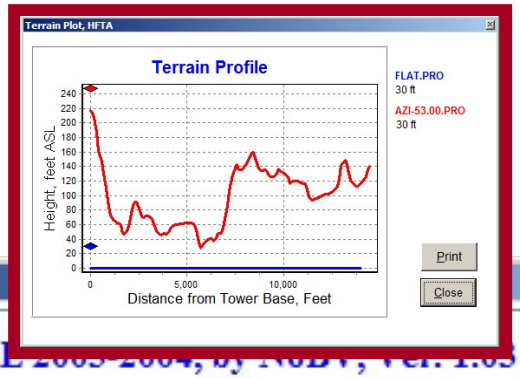


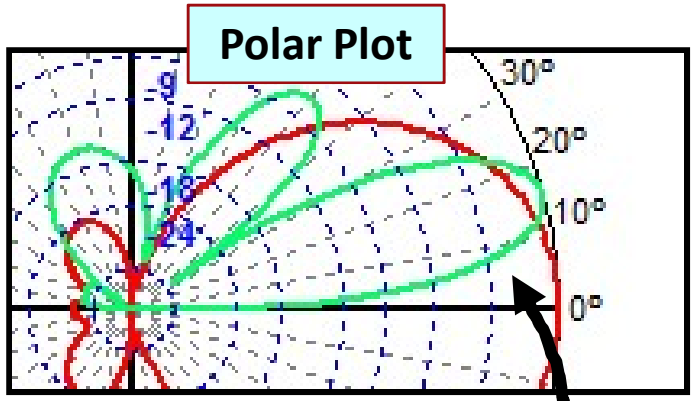
Then : Compute

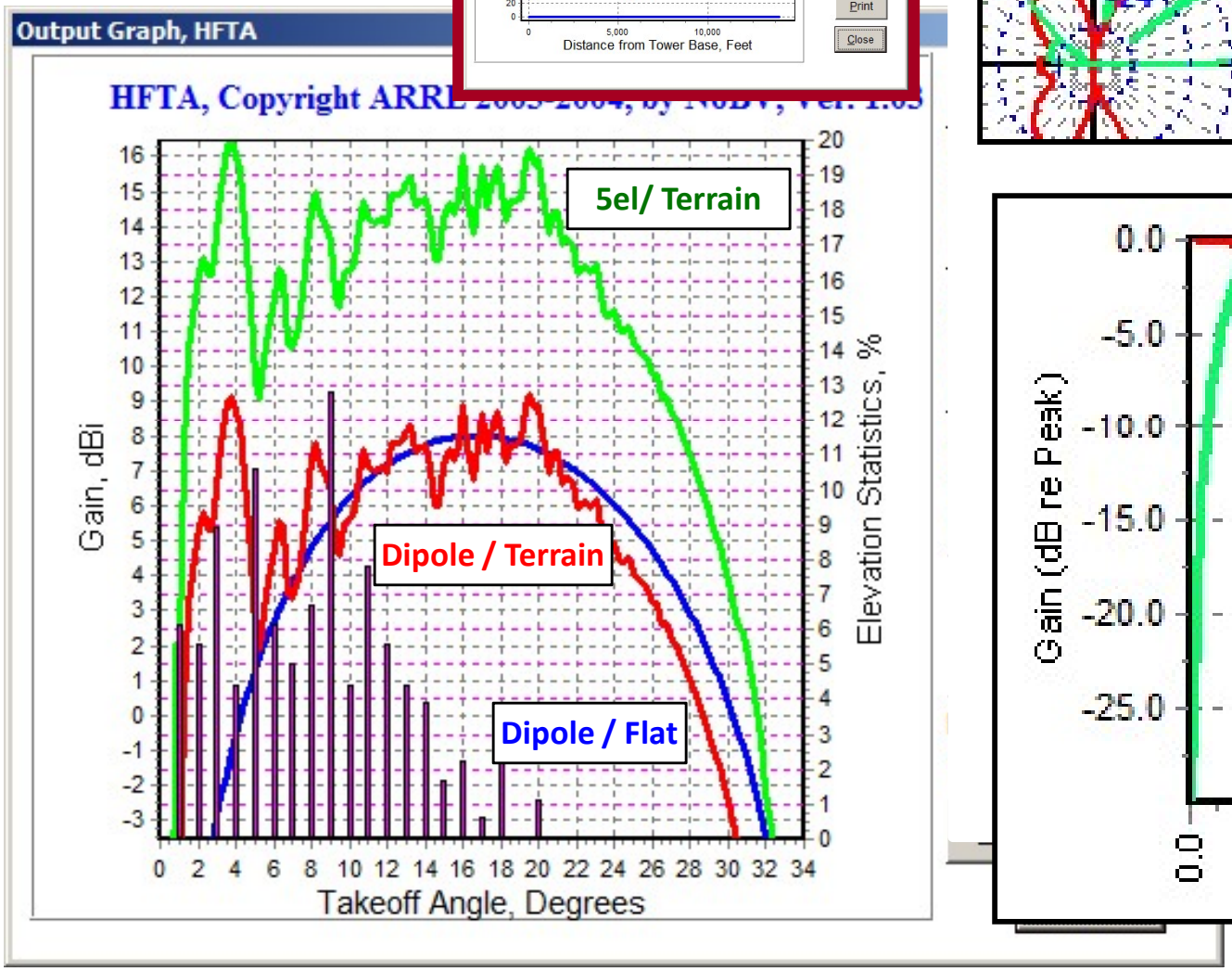
Using HFTA


Output Graph, HFTA
HFTA, Copyright ARRL 2003-2004, by N6BV, Ver. 1.03
5el/ Terrain
Dipole / Terrain
Dipole / Flat
Gain, dBi
Elevation Statistics, %
Takeoff Angle, Degrees
Freq. = 28.3 MHz
Max. Gain: 16.5 dBi
FLAT.PRO
30 ft
Dipole
Fig. of Merit: 4.7
AZI-53.00.PRO
30 ft
Dipole
Fig. of Merit: 6.3
AZI-53.00.PRO
30 ft
5-Ele.
Fig. of Merit: 13.4
Elev. Statistic
W1-MA-EU.PRN
Print
Out File
Close

Using HFTA







Same Curve

Cartesian Plot

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Using HFTA

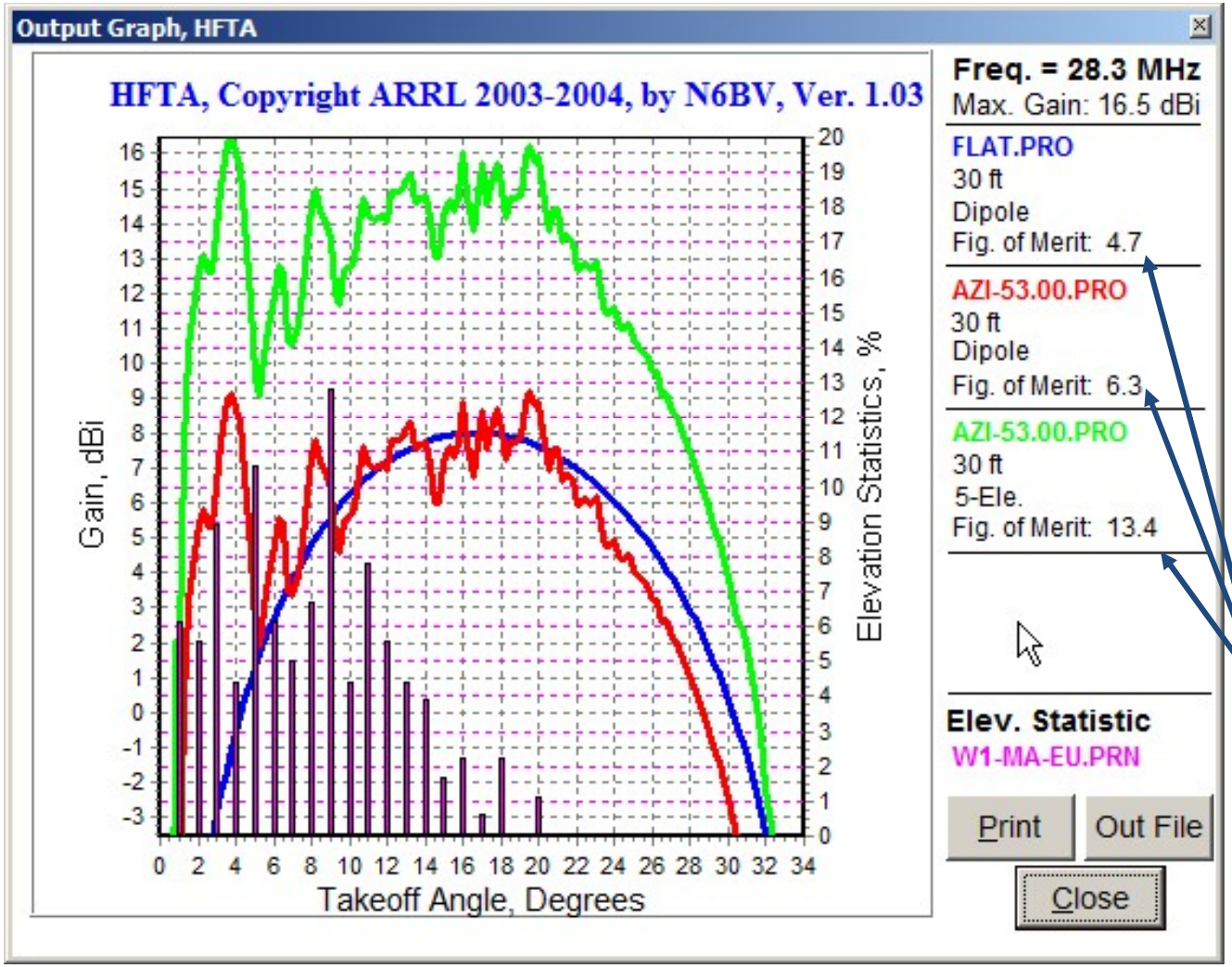
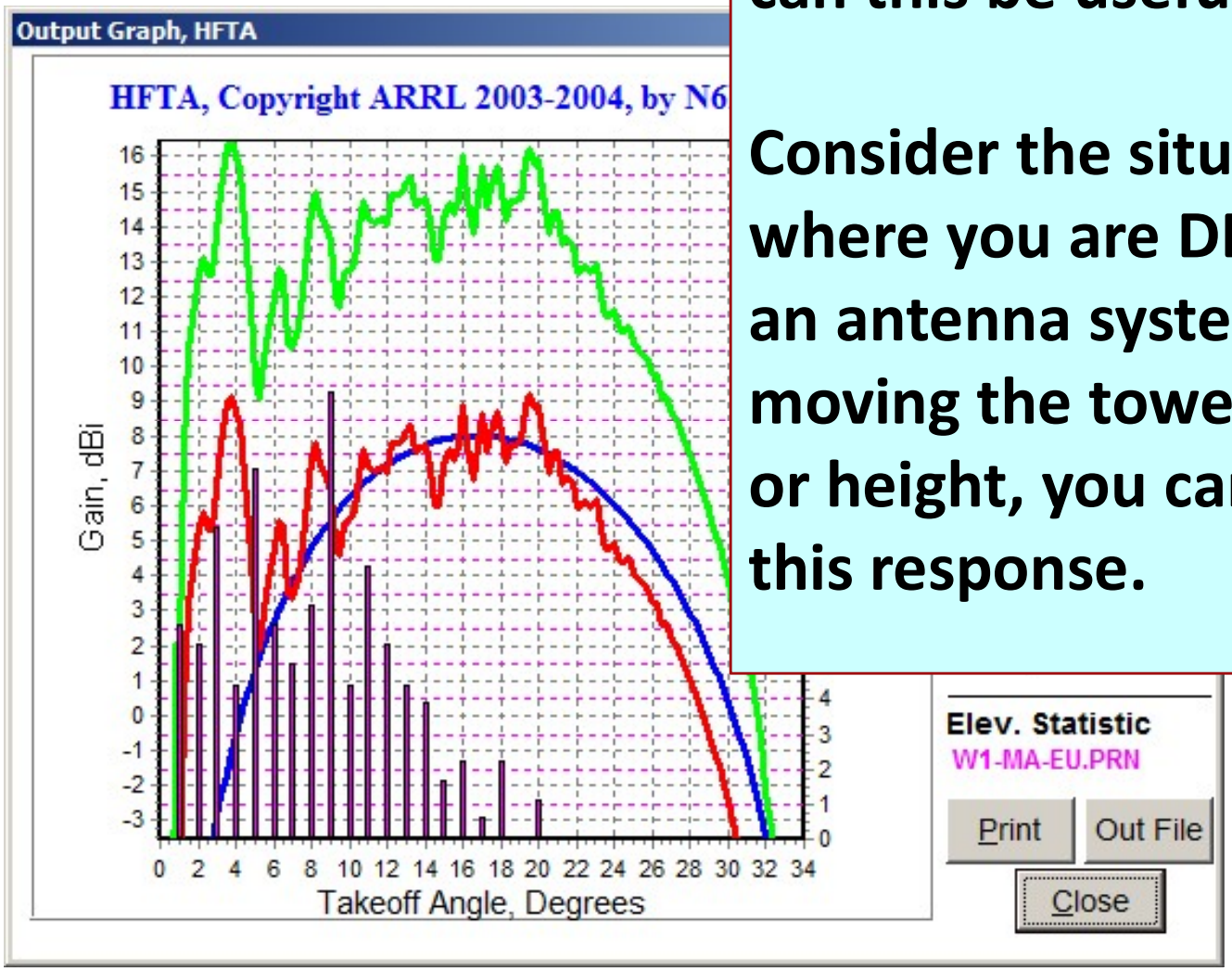


Figure of Merit (dB):
Weighted statistical average of gain times % open.

Using HFTA

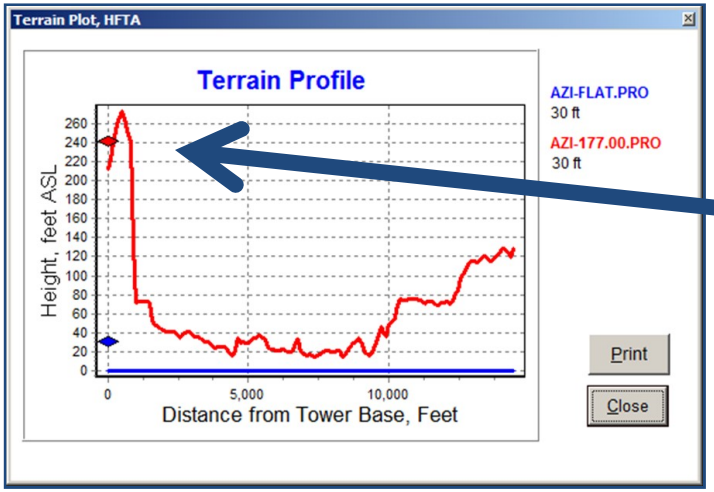


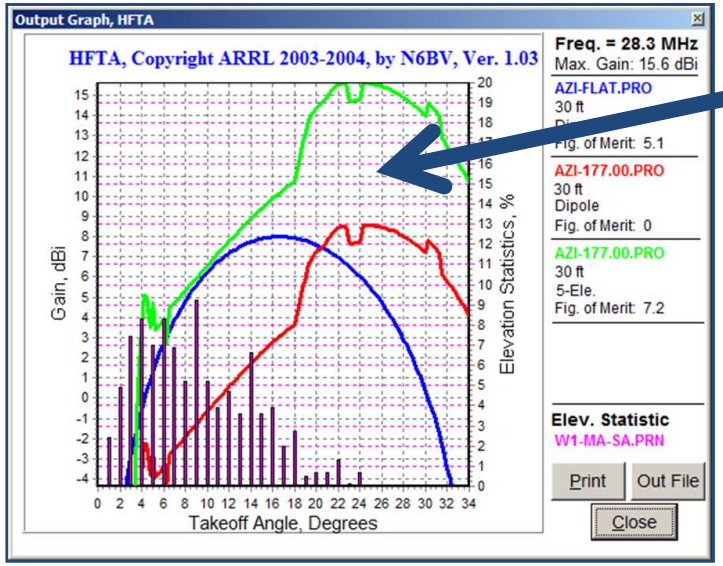
This is an analysis. How can this be useful?

Consider the situation where you are DESIGNING an antenna system. By moving the tower location or height, you can optimize this response.

HFTA– HB 5 el 10M Yagi @ 33 BBHR

Example: How to improve my 10M yagi to South America



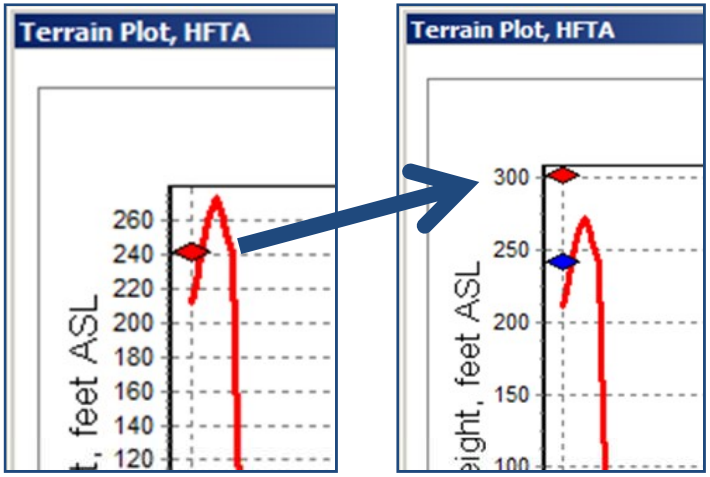


Note that my yagi is BEHIND the hill to my south…

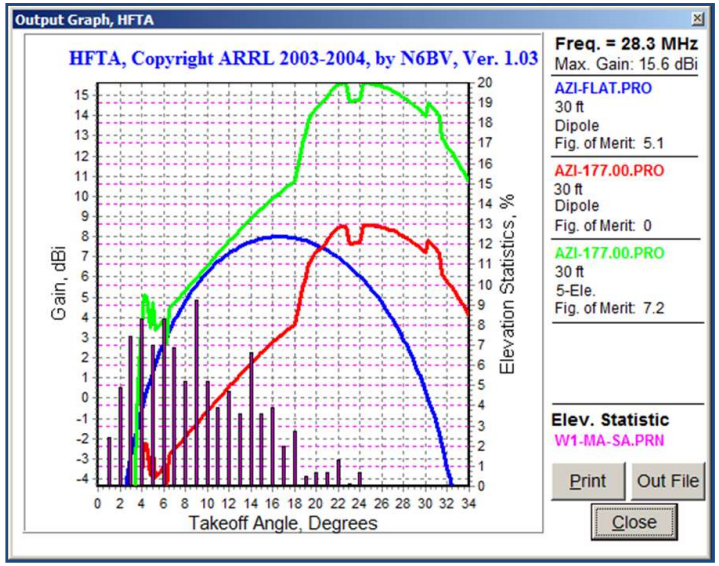
…and as a result, the yagi's response is where there are no signals being receive from South America

HFTA– HB 5 el 10M Yagi @ 33 BBHR

Example: How to improve my 10M yagi to South America



Increase antenna height: 30' → 90'



HFTA– HB 5 el 10M Yagi @ 33 BBHR

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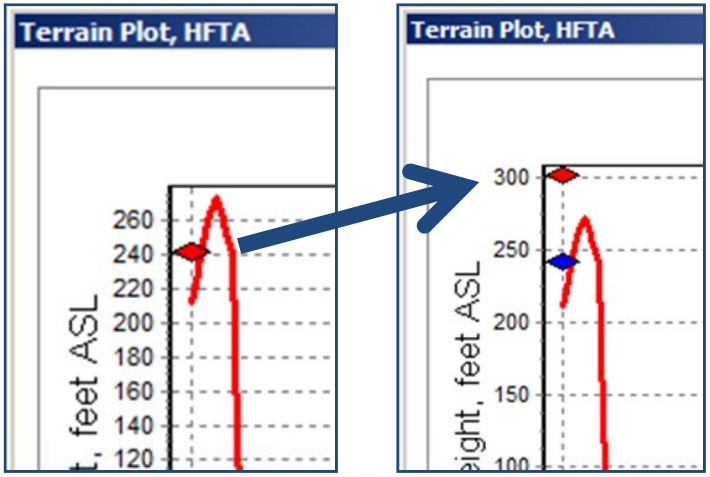
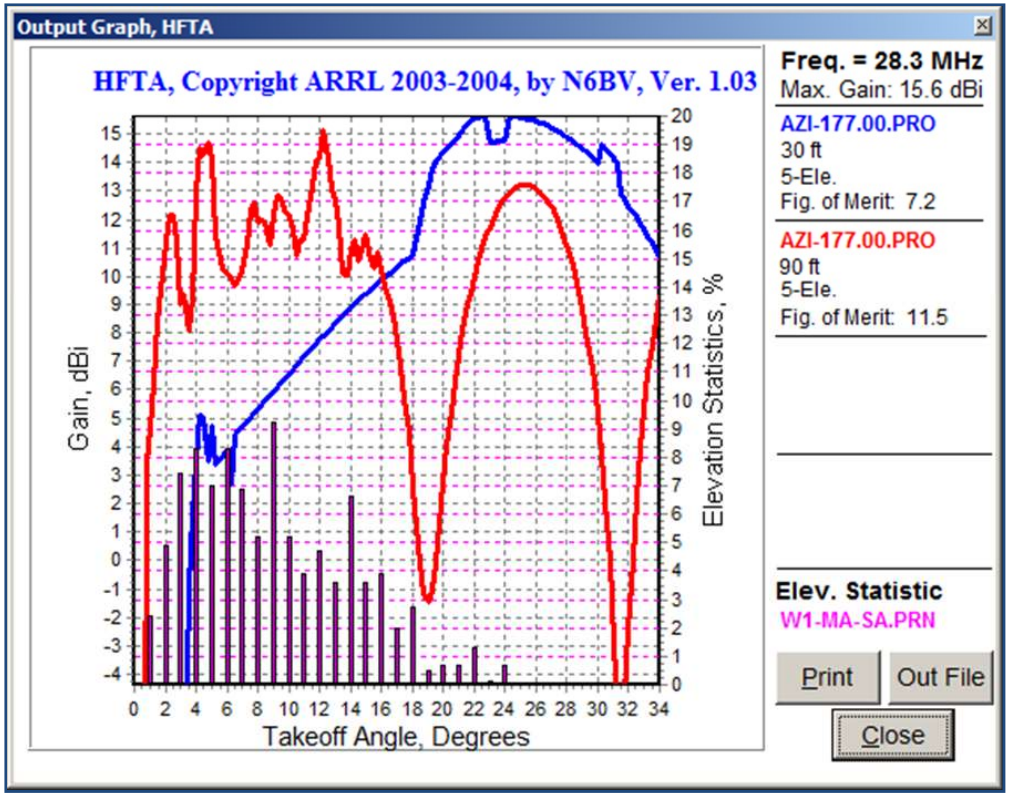
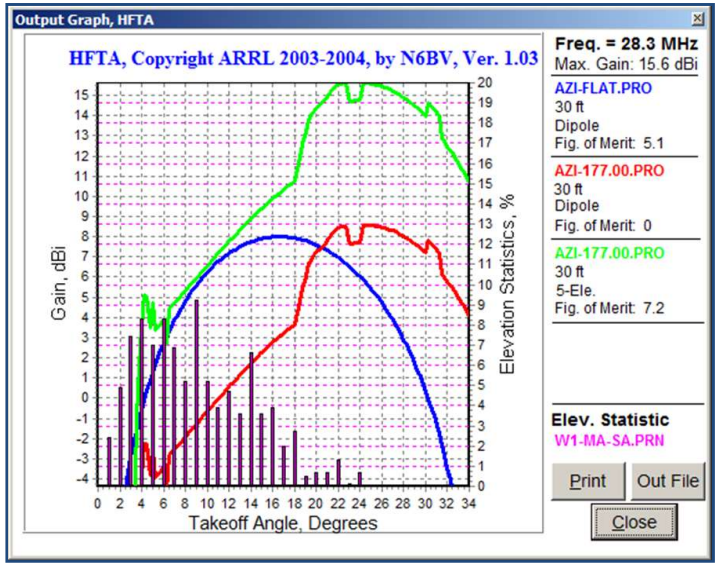


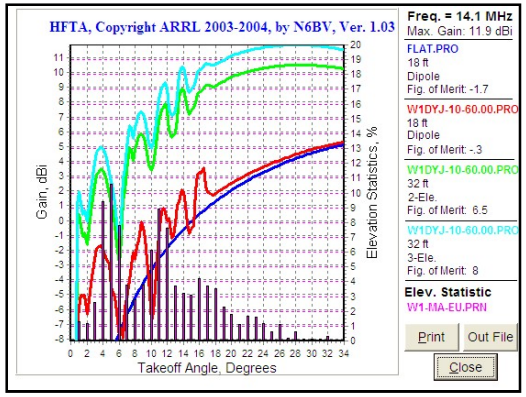
Increase antenna height: 30' → 90'





HFTA – High Frequency Terrain Assessment

Lots of steps. Uses standard Yagis. Helps you understand your local terrain's effects to plan/assess your antenna system.



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Conclusions

- **You Can't Beat Physics**

➢ Understanding antennas
→understanding ANTENNA SYSTEMS
→all three of these programs will help

  - HOW YOU WANT TO USE YOUR ANTENNA
  - EFFECTS OF TRANSMISSION LINES
  - LOCAL TERRAIN
  - GROUND CHARACTERISTICS

- All antennas are COMPROMISES
- All models are SIMPLE EXAMPLES of reality
- Your real antenna WILL NOT MATCH your model

Summary

We've looked at:

- TLW – Transmission Lines
- YW – Simple Yagis
- HFTA – Effects of Terrain

We've seen how these software programs can be used to plan your antenna systems

Questions???

"All models are wrong. Some are useful"

British Statistician *George Box*, 1976

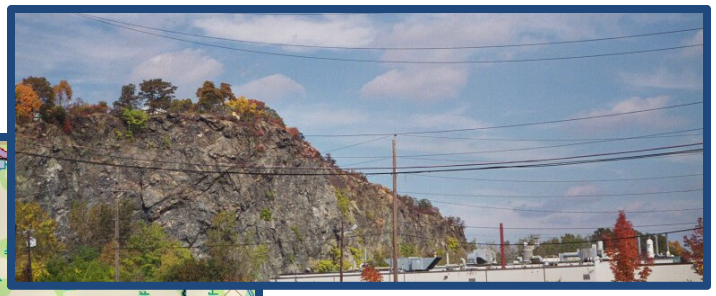
Appendix

- W1DYJ Antennas in Woburn MA
- W1DYJ Antennas in Harpswell ME
- ARRL Handbook SW
- ON4UN's Low Band Dxing SW
- Additional ARRL Antenna Book SW
- Abstract / Bio

https://www.qsl.net/w1dyj/

33 Blueberry Hill Rd – Woburn Antennas

DX Azimuths @ 33 BBHR



Delorme Topo USA 7.0

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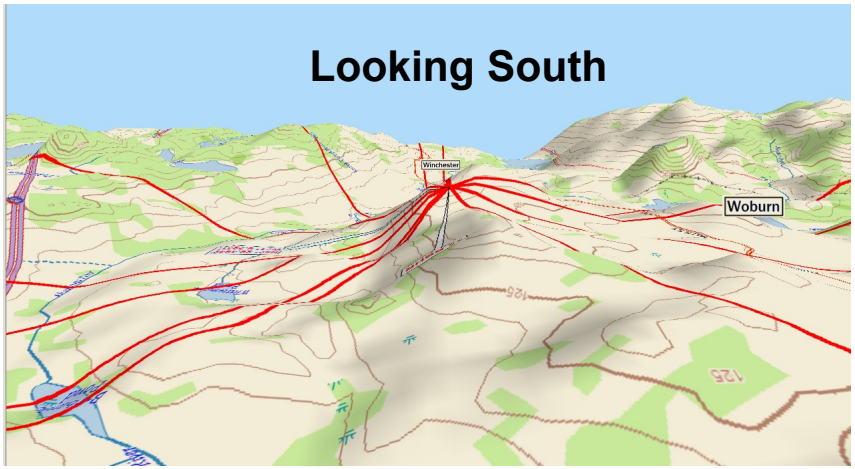
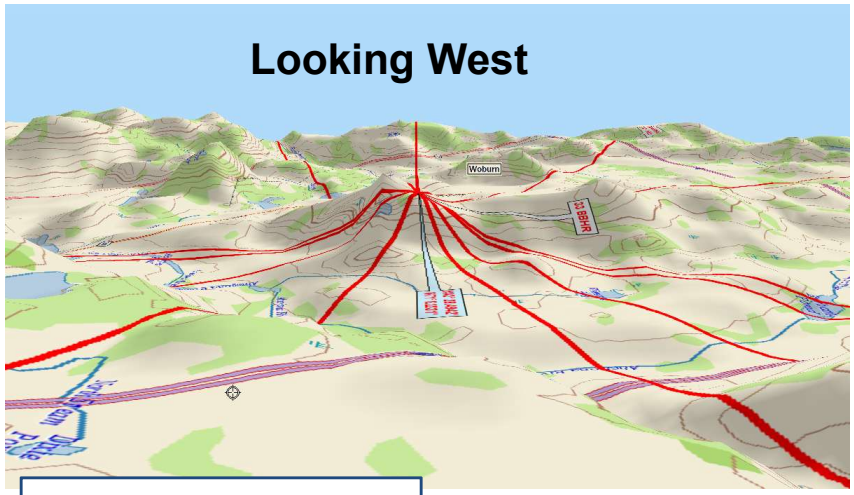
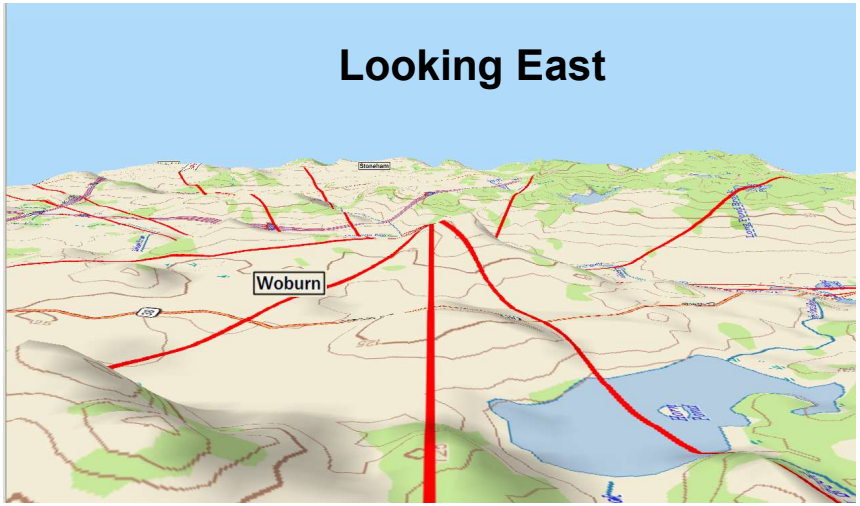
33 BBHR 3D Maps







Delorme Topo USA

Note: Vertical dimensions are enhanced by a factor of 8

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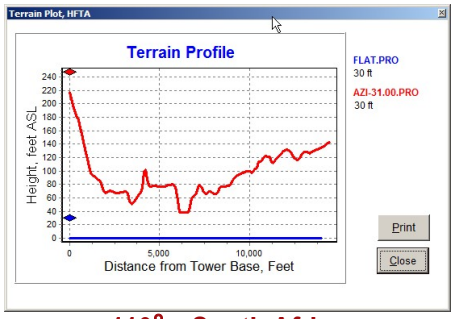
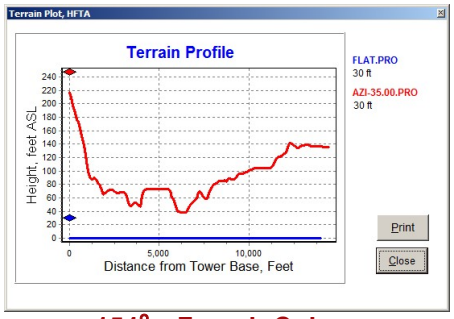
HFTA – Local Terrain @ 33 BBHR

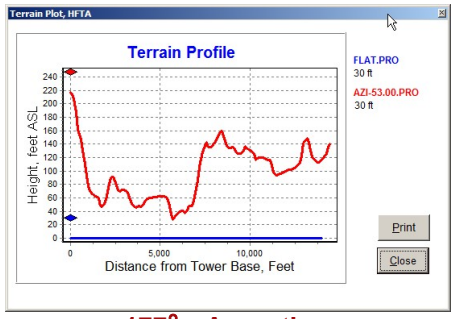
31° India



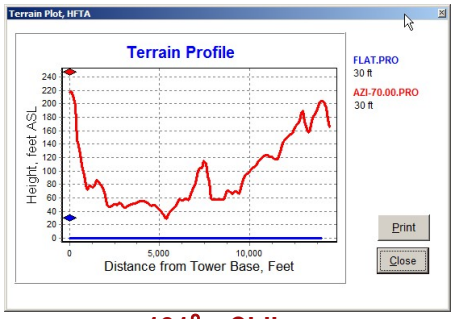
35° Iceland / EurRussia



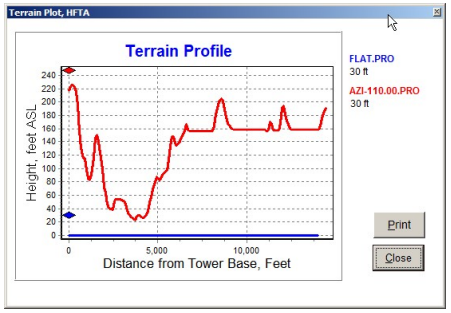
53° England



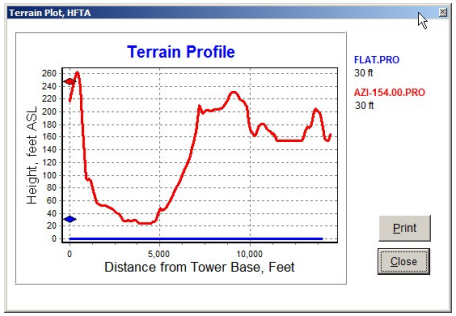
70° Spain



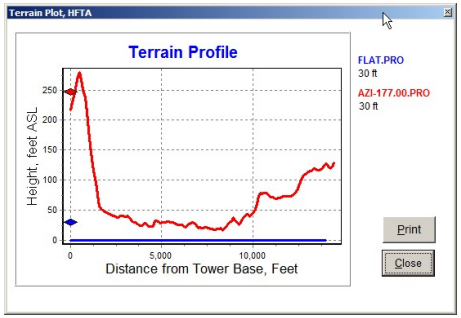
110° South Africa



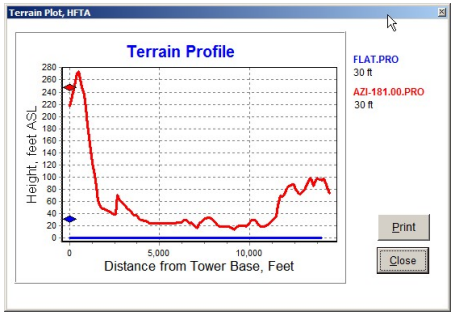
154° French Guiana



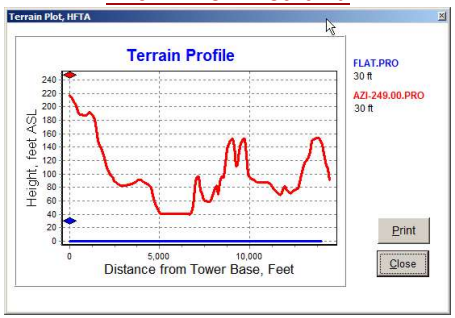
177° Argentina



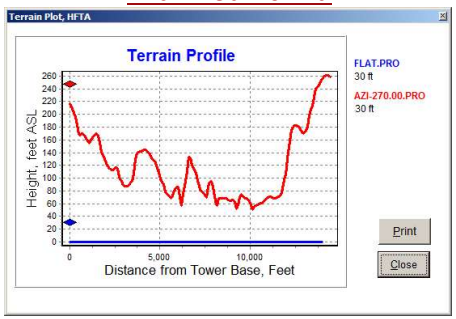
181° Chile



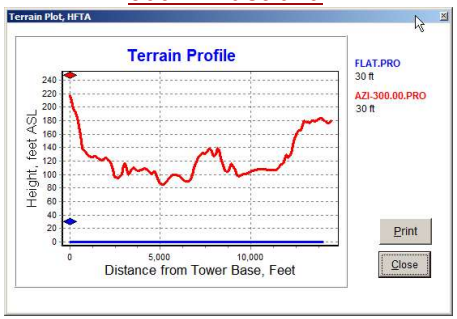
249° New Zealand



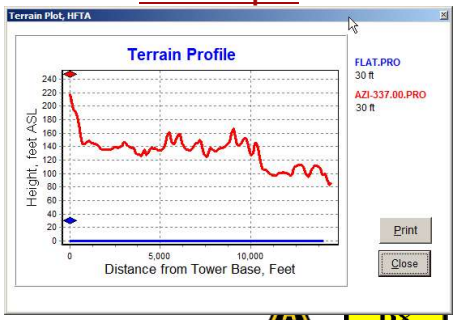
270° California



300° Australia



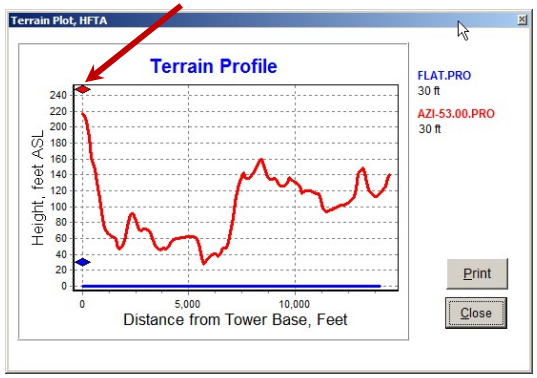
337° Japan

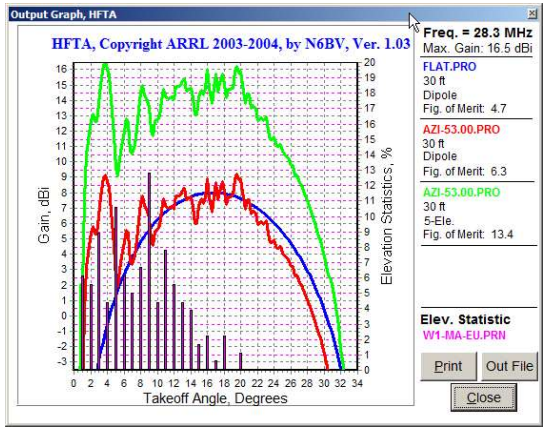


HFTA– HB 5 el 10M Yagi @ 33 BBHR

53° England

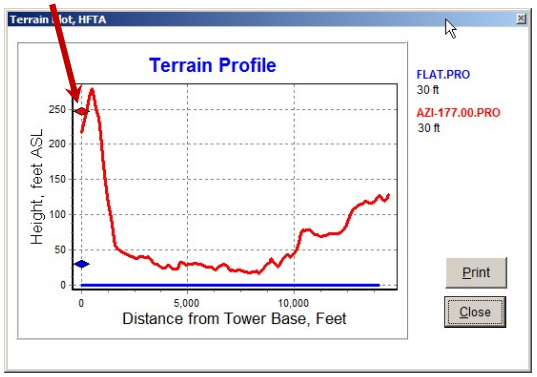
Note: Antennas are IN FRONT of Hill

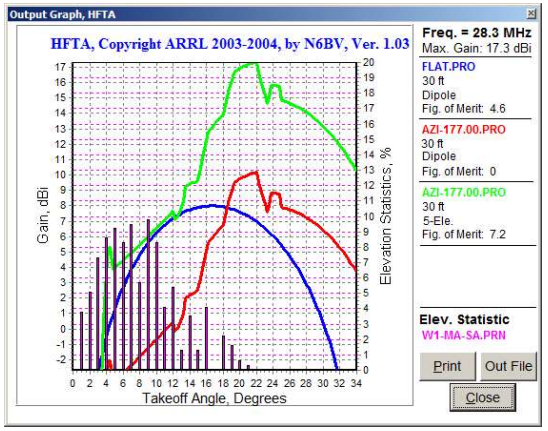




177° Argentina

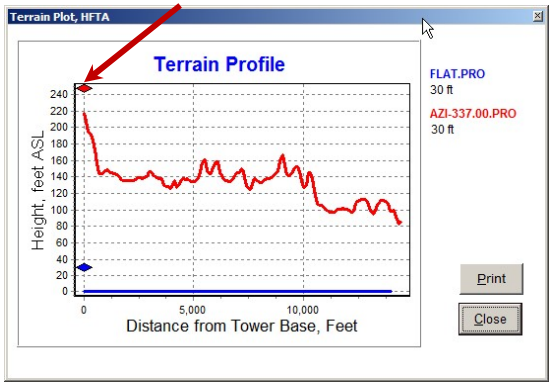
Note: Antennas are BEHIND Hill

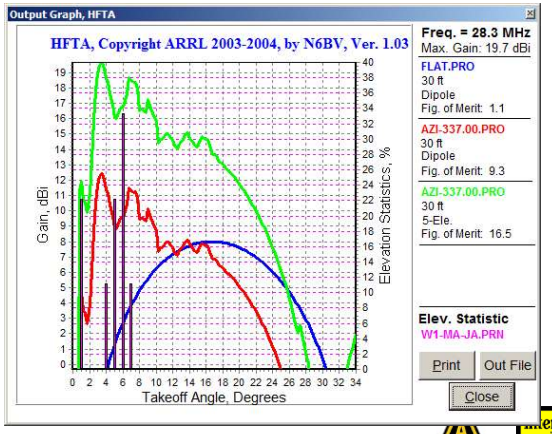




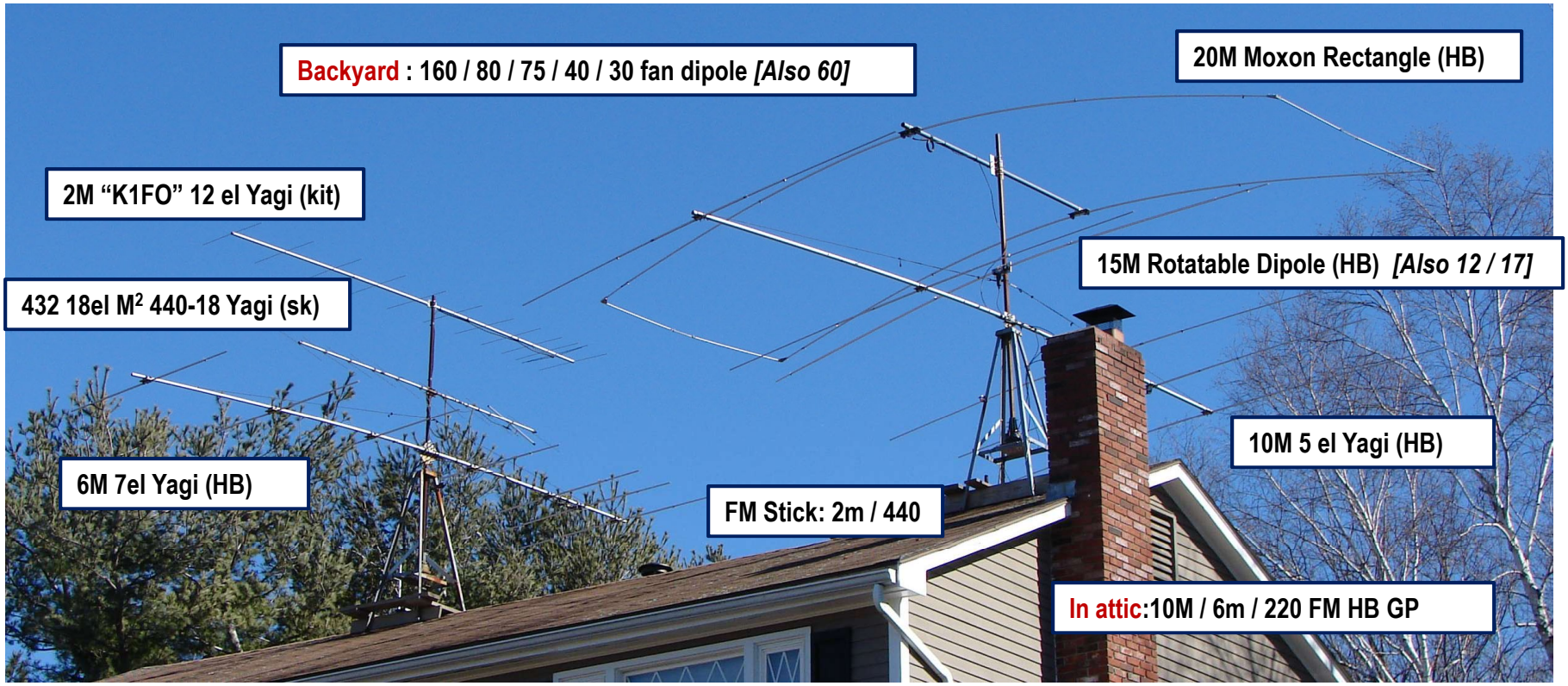
337° Japan

Note: Antennas are IN FRONT of Hill

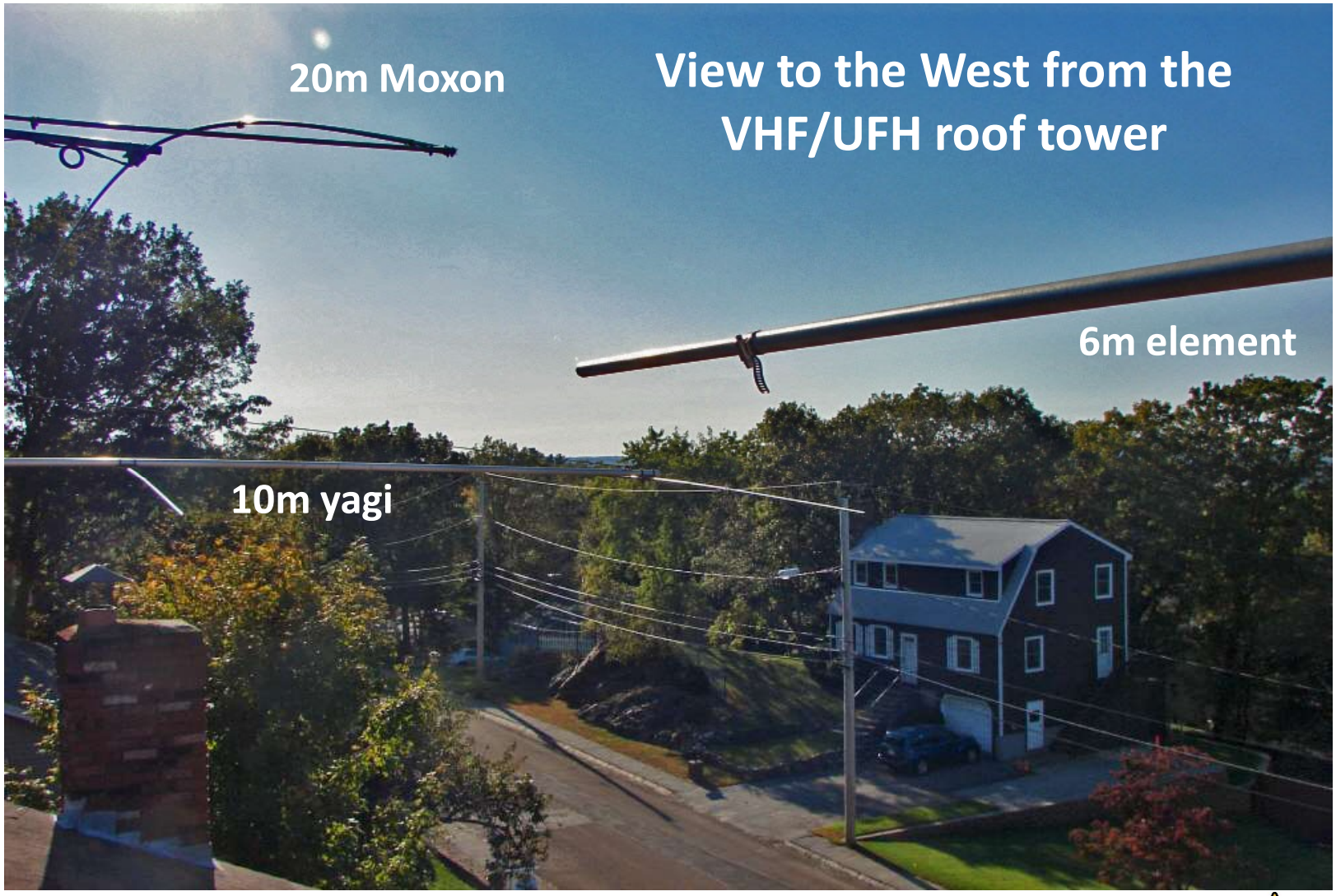




33 Blueberry Hill Rd – Woburn Antennas

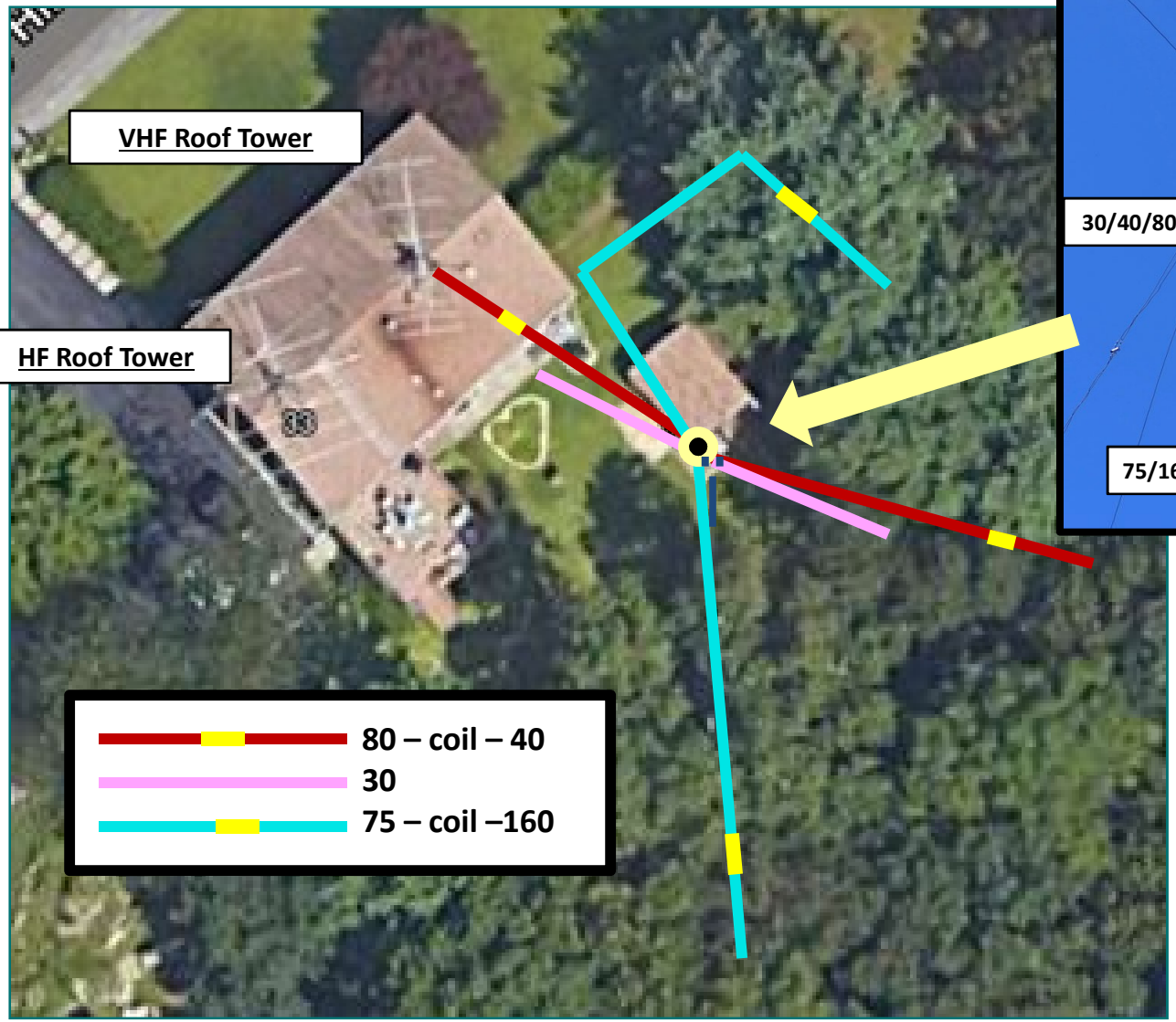


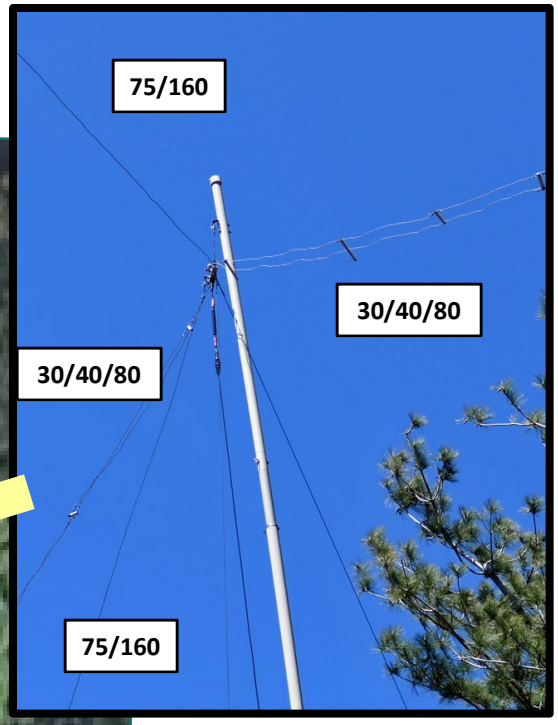
33 Blueberry Hill Rd -- Woburn



W1DYJ Antennas in Woburn MA

W1DYJ Antennas in Woburn MA





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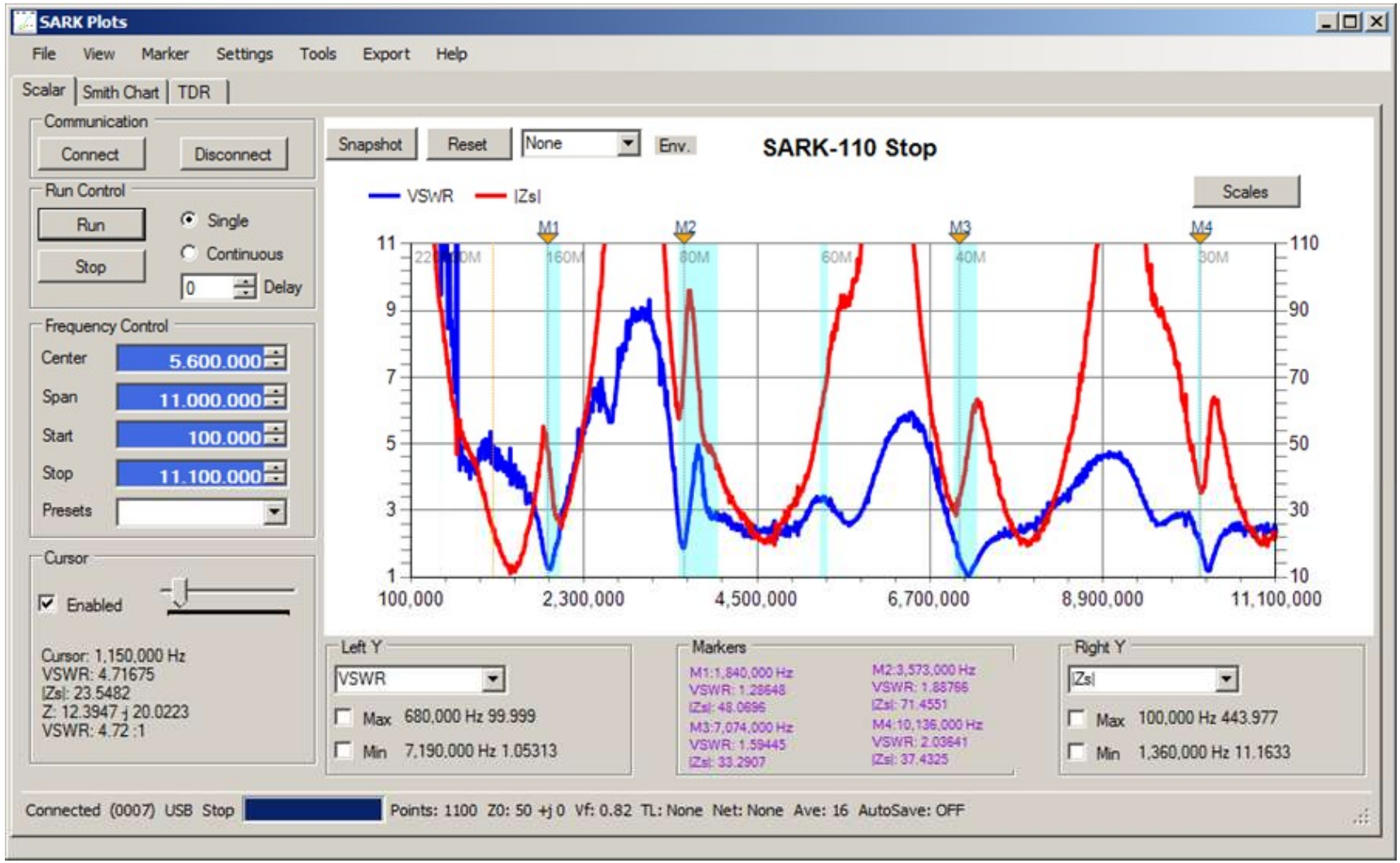
Woburn MA ~ Low HF SWR/|Zs| sweep



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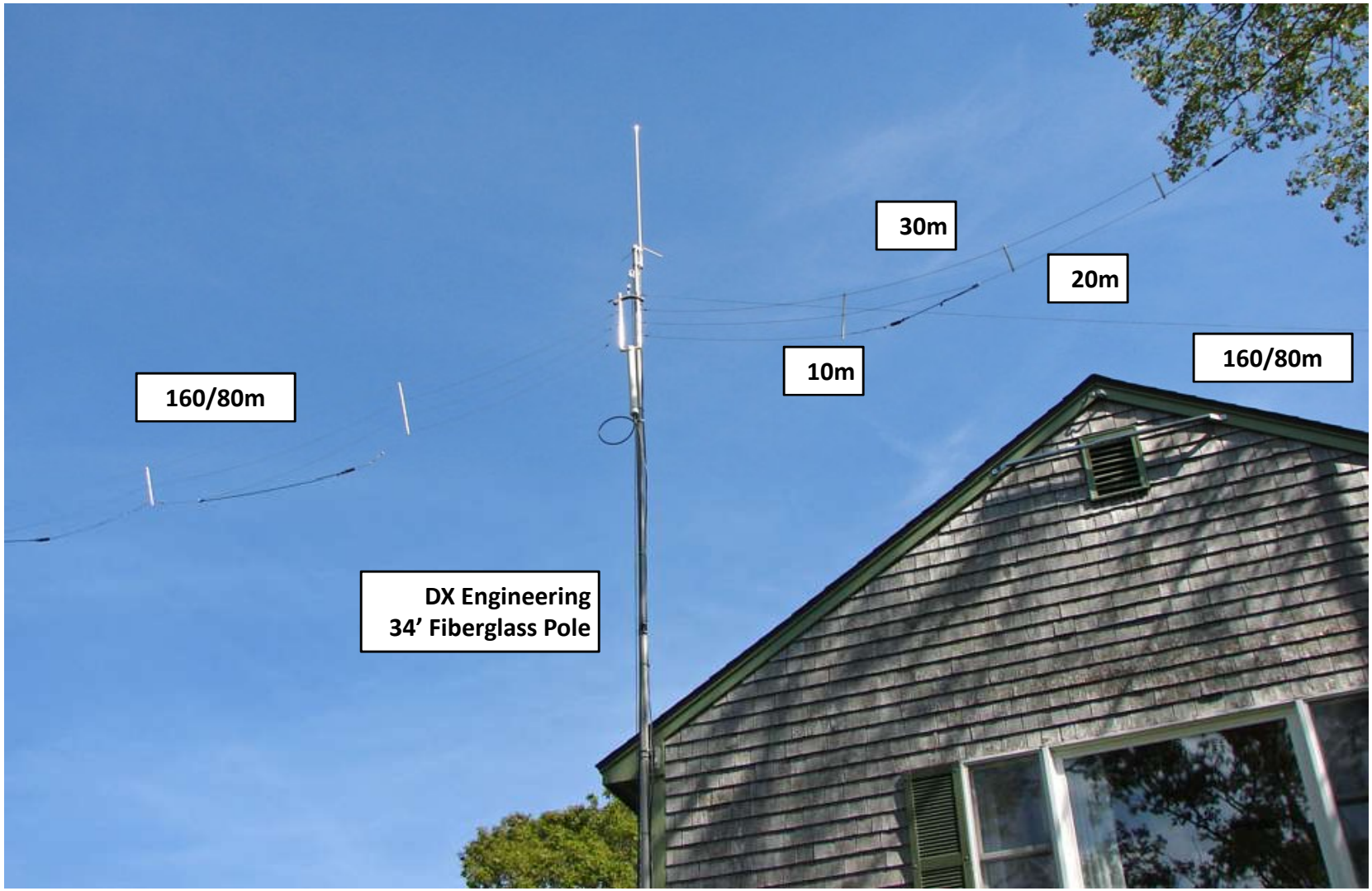
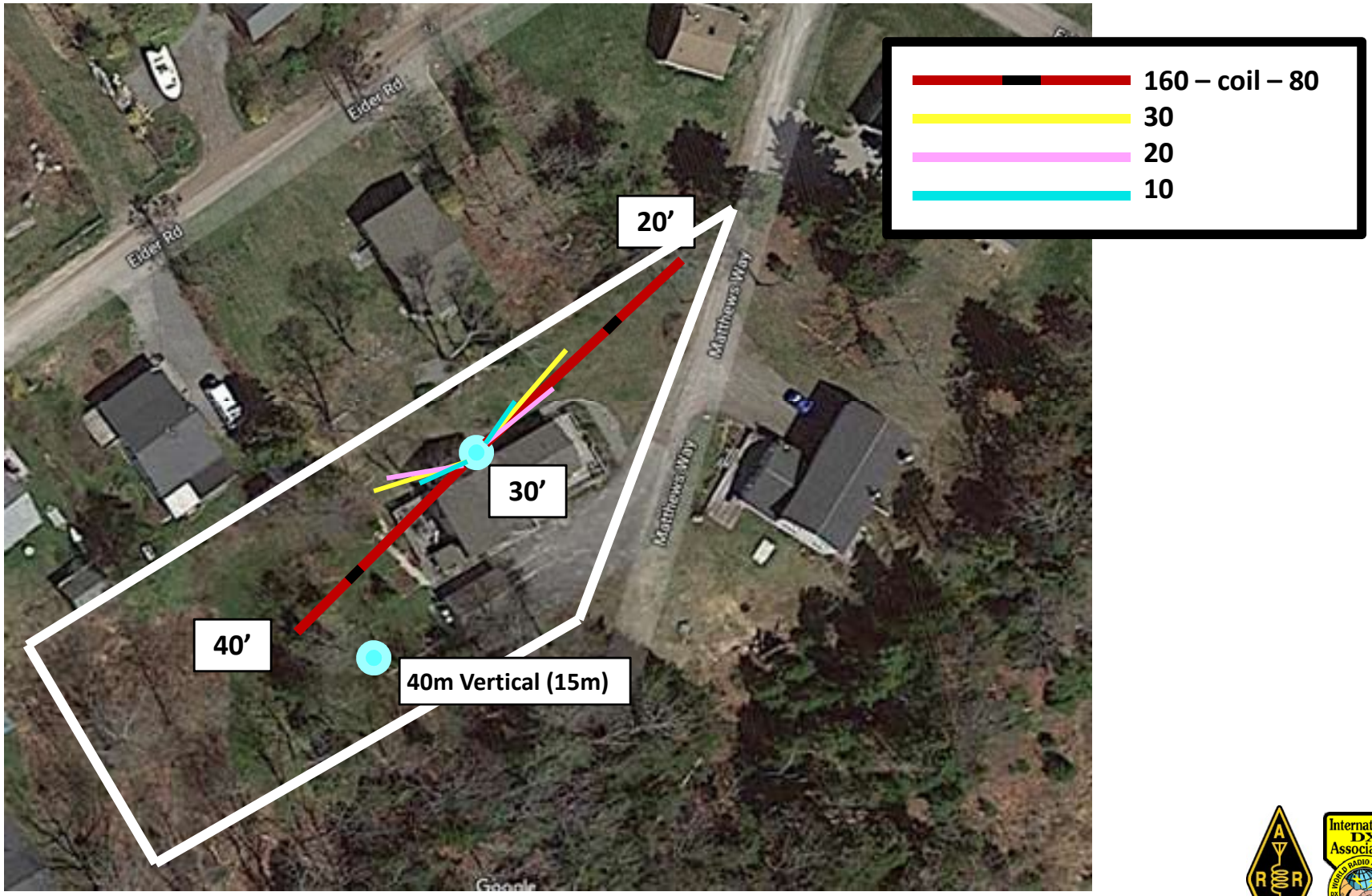
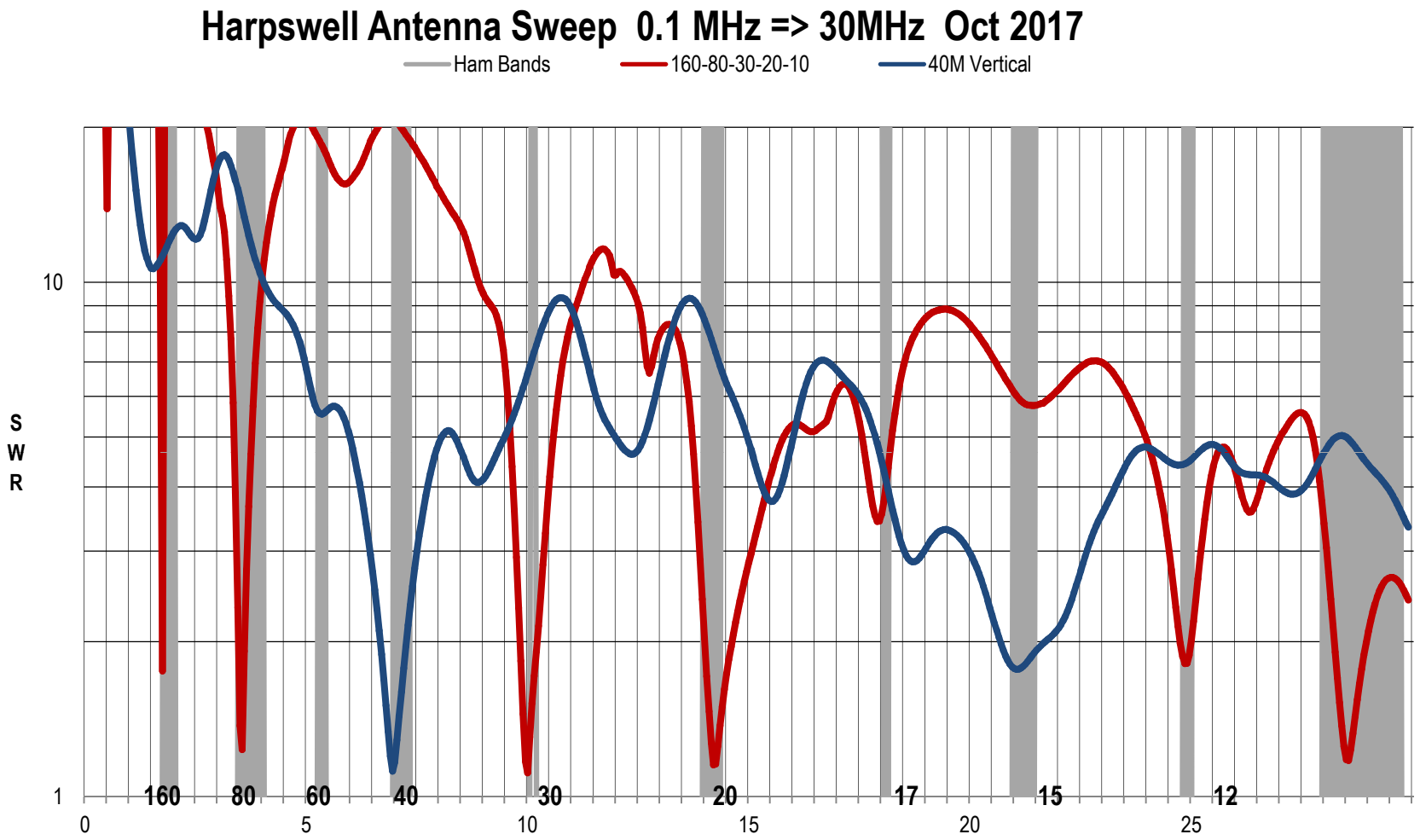
W1DYJ Antennas in Harpswell ME *[no longer there]*



W1DYJ Antennas in Harpswell ME *[no longer there]*



Harpswell ME ~ SWR sweep *[no longer there]*



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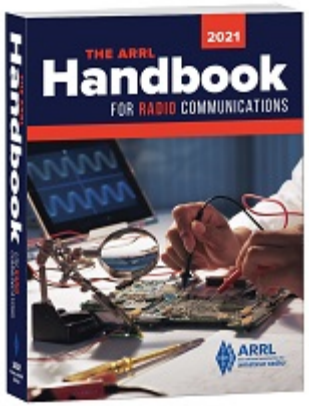
SW: ARRL Handbook



- **TubeCalculator** Design tube-type High Power linears
- **ClassE** Designs single-ended Class E RF amplifier
- **Diplexer** Designs both high-pass/low-pass and band-pass/band-stop types of diplexers
- **Helical** Designs and analyzes helical-resonator bandpass filters usually used in VHF and UHF
- **Elsie** A lumped-element filter design and analysis program (the student edition)
- **MeterBasic** Designs and prints professional-quality analog meter scales
- **OptLowpass** Designs and analyzes transmitter output low-pass filters
- **PIEL** Designs and analyzes pi-L networks for transmitter output
- **QuadNet** Designs and analyzes active quadrature networks
- **SVCFilter** Standard-value component routine to design low-pass and high-pass filters
- **Supplemental Files** Additional discussion, additional projects, full-size PC board etching patterns, program examples and other useful information

W1DYJ's

1962
1968
1970
1996
2012
2023

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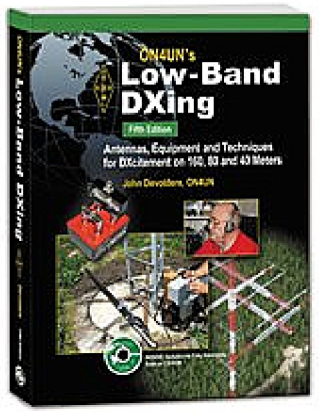
SW: ARRL OH4UN's Low Band DXing



W1DYJ's
4th Edition
2005

- **Conversion Calculator** Excel spreadsheet that converts signal levels typically encountered at receiver inputs between µV, mV, dBµV, µW, etc
- **Receiver Levels** Excel spreadsheet tool shows you levels involved with radio signals from transmit power to received signal
- **RX noise figure and MDS calculation** Excel spreadsheet tool shows you the relation between receiver bandwidth, temperature and receiver MDS
- **ON4UN Low-Band DXing Software (DOS)**
  Propagation Software; Mutual Impedance and Driving Impedance; Coax Transformer/Smith Chart; Impedance, Current and Voltage Along Feed Lines; Two- and Four-Element Vertical Arrays; The L Network; Series/Shunt Input L-Network Iteration; Shunt/Series Impedance Network; Line Stretcher (Pi and T) Stub Matching; Parallel Impedances (T Junction); SWR Value and SWR Iteration; Radiation Angle for Horizontal Antennas; Coil Calculation; Gamma-Omega and Hairpin Matching; Element Taper
- **ON4UN-Yagi-Design (DOS)**
  The Analyze Module; Generic Dimensions; Element Strength; Element Taper; Mechanical Yagi Balance; Yagi Wind Area; Matching; Optimize Gamma/Omega; Feed-Line Analysis; Rotating Mast Calculation

OH4UN John Devoldere (SK)

Out of Print

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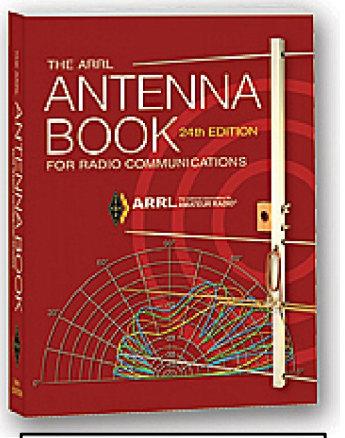
SW: ARRL Antenna Book



- **TLW** Computes parameters for transmission lines and antenna-tuners
- **YW** Computes parameters for Yagi-Uda antennas
- **HFTA** Evaluates the effect of local terrain on the launch of HF signals

→24th Edition: Software is available online

W1DYJ's
17th Ed. – 1994
23rd Ed. – 2015
24th Ed. – 2019

- Many of the apps from previous editions are available at: www.arrl.org/antenna-book

AAT	Automatically evaluates antenna tuner networks
Arrayfeed1	Computes parameters necessary for feeding 2-element and 4-element phased-arrays.
GAMMA	Computes the parameters for a gamma match
LPCAD30	For computing LPDA designs
MOBILE	Evaluating and designing mobile whip antennas and coils
Range-Bearing	Computes the range/bearing from one lat/lon point to another
SCALE	Scales Yagi designs to other frequencies

EZNEC 7 *Roy Lewallen W7EL (retired)*

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