Yagi antennas:

Comparing Height Above Ground
Real Ground vs. Free Space
Horizontal vs. Vertical Polarization

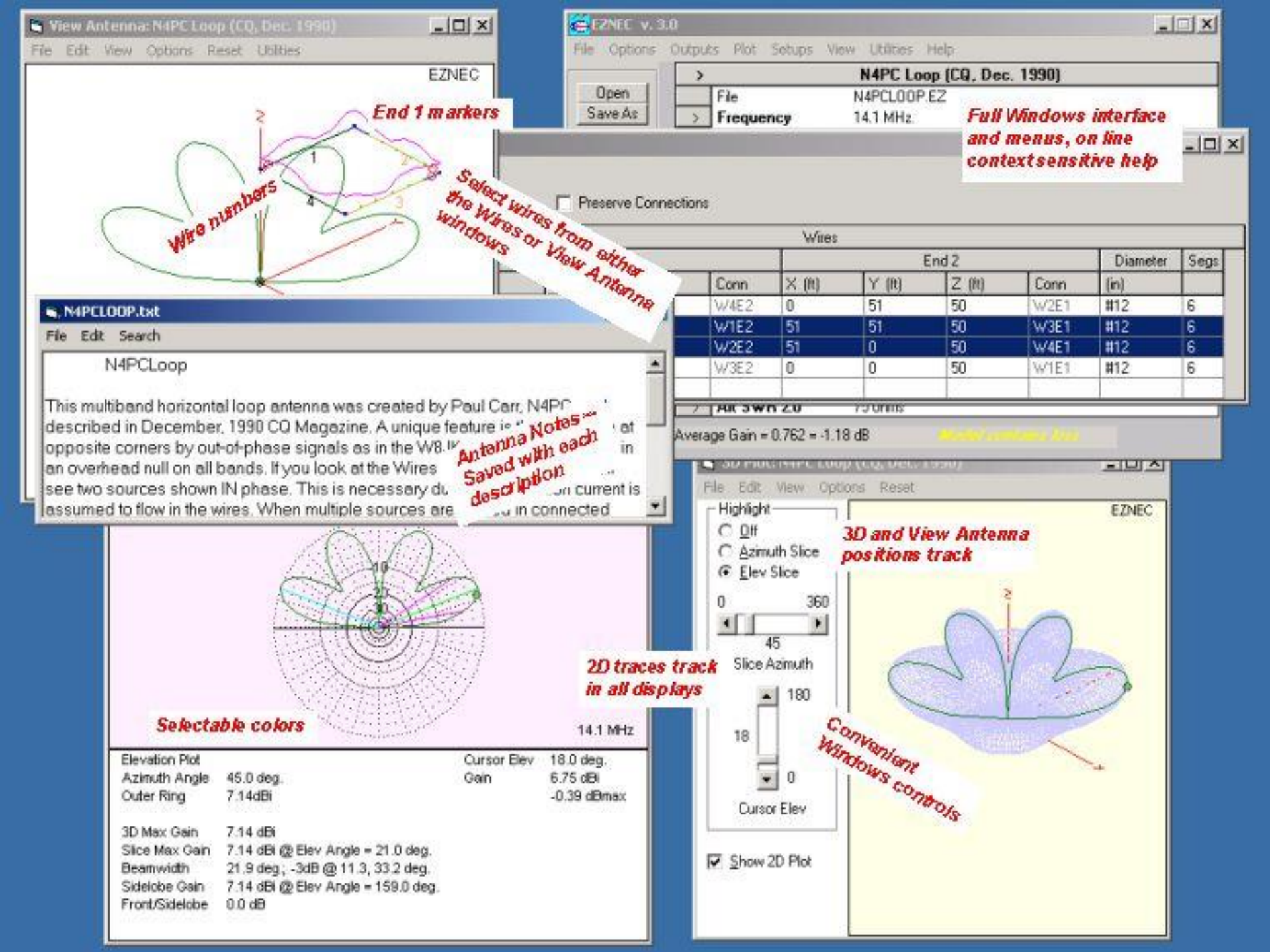
As plotted with the EZNEC Antenna Modeling Program

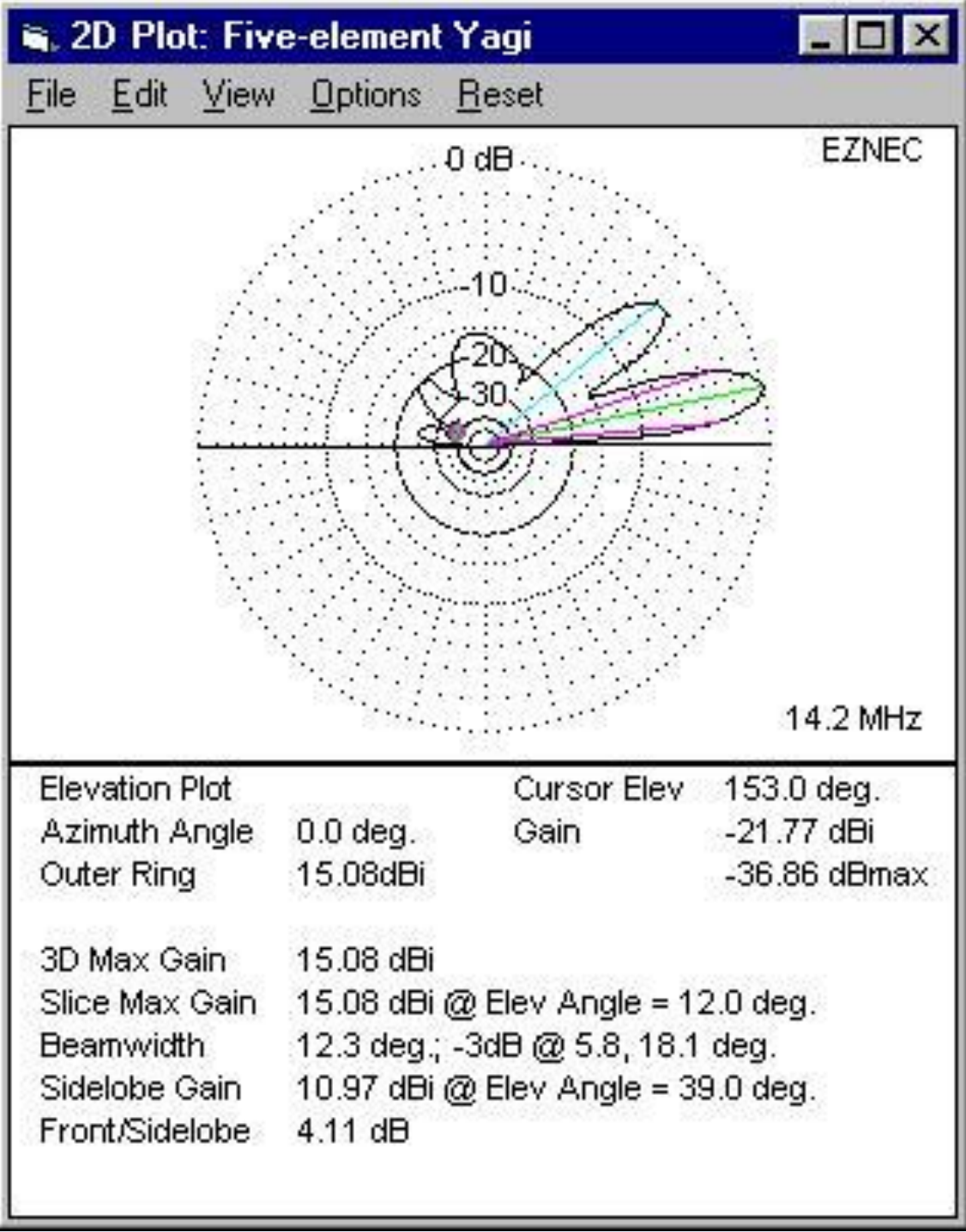
Program written by Roy Llewellen W7EL

Please note that we are going to use a 10 element 2 meter Yagi for demonstration purposes

But…

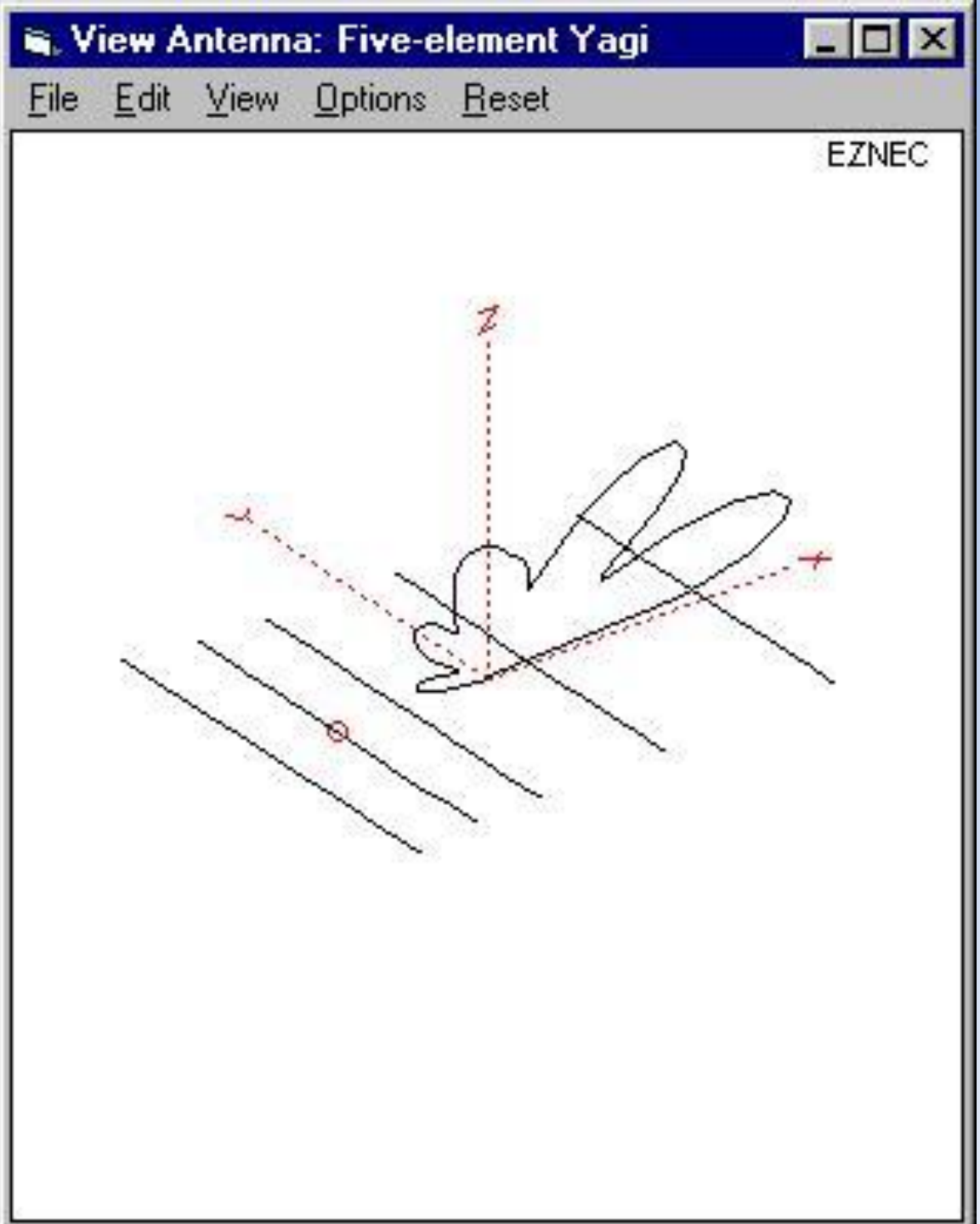
The elevation takeoff angles apply to any horizontal antenna at ‘x’ wavelengths above real ground as we will see at the end of this presentation.


View Antenna: N4PC Loop (CQ, Dec. 1990)
File Edit View Options Reset Utilities
EZNEC
End 1 markers
Wire numbers
Select wires from either the Wires or View Antenna windows
EZNEC v. 3.0
File Options Outputs Plot Setups View Utilities Help
Open
Save As
N4PC Loop (CQ, Dec. 1990)
File N4PCLOOP.EZ
Frequency 14.1 MHz
Full Windows interface and menus, on line context sensitive help
Preserve Connections
Wires
End 2
Conn X (ft) Y (ft) Z (ft) Conn
Diameter (in)
Segs
W4E2 0 51 50 W2E1 #12 6
W1E2 51 51 50 W3E1 #12 6
W2E2 51 0 50 W4E1 #12 6
W3E2 0 0 50 W1E1 #12 6
Average Gain = 0.762 = -1.18 dB
N4PCLOOP.txt
File Edit Search
N4PCLoop
This multiband horizontal loop antenna was created by Paul Carr, N4PC
described in December, 1990 CQ Magazine. A unique feature is
opposite corners by out-of-phase signals as in the W8.
an overhead null on all bands. If you look at the Wires
see two sources shown IN phase. This is necessary du
assumed to flow in the wires. When multiple sources are
Antenna Notes -- Saved with each description
Selectable colors
14.1 MHz
Elevation Plot
Azimuth Angle 45.0 deg.
Outer Ring 7.14dBi
Cursor Elev 18.0 deg.
Gain 6.75 dBi
-0.39 dBmax
3D Max Gain 7.14 dBi
Slice Max Gain 7.14 dBi @ Elev Angle = 21.0 deg.
Beamwidth 21.9 deg.; -3dB @ 11.3, 33.2 deg.
Sidelobe Gain 7.14 dBi @ Elev Angle = 159.0 deg.
Front/Sidelobe 0.0 dB
2D traces track in all displays
File Edit View Options Reset
Highlight
Off
Azimuth Slice
Elev Slice
0 360
45
Slice Azimuth
180
18
0
Cursor Elev
Show 2D Plot
3D and View Antenna positions track
EZNEC
Convenient Windows controls

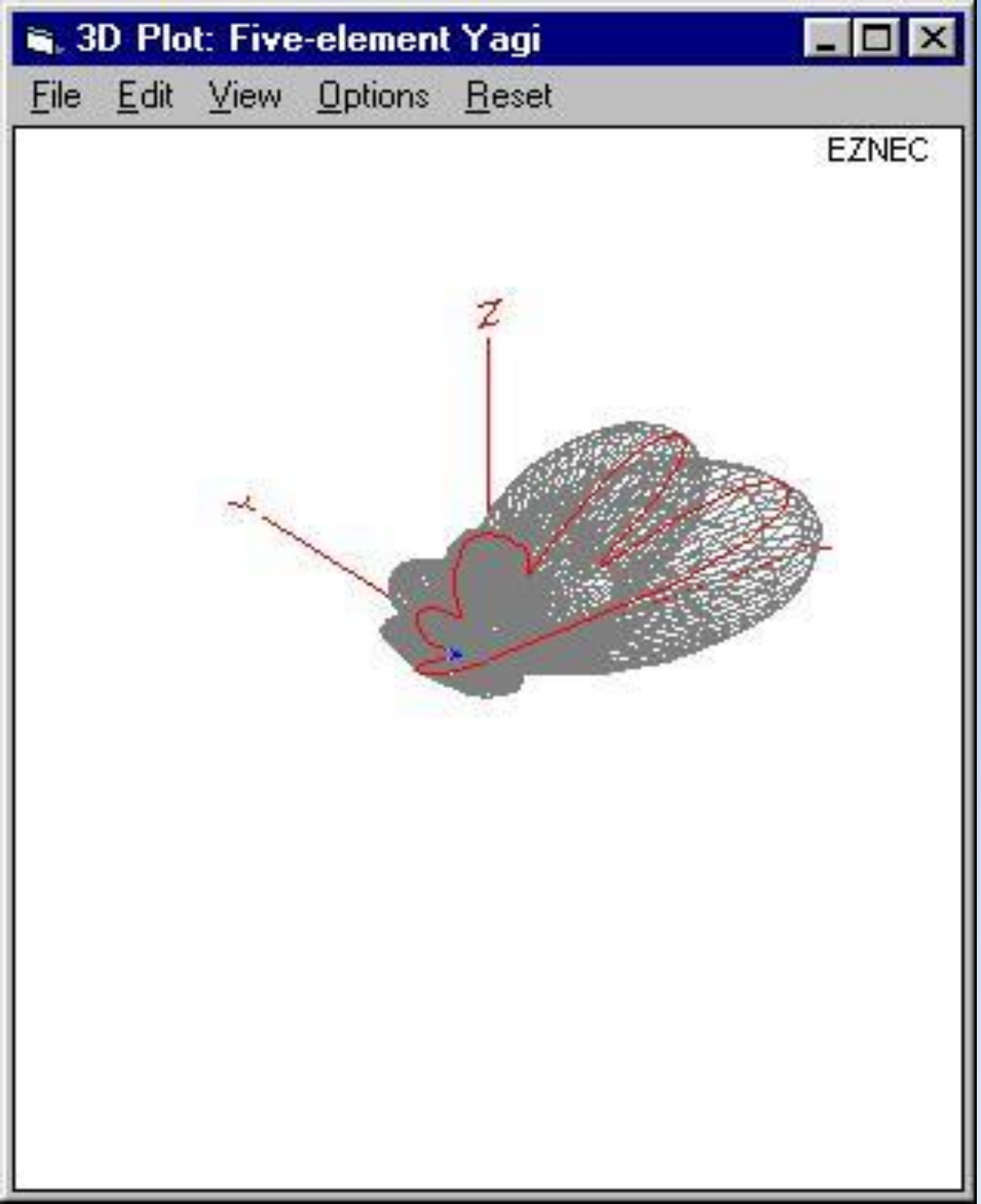


EZNEC can plot any antenna You can design and tell you Where your signal will go.

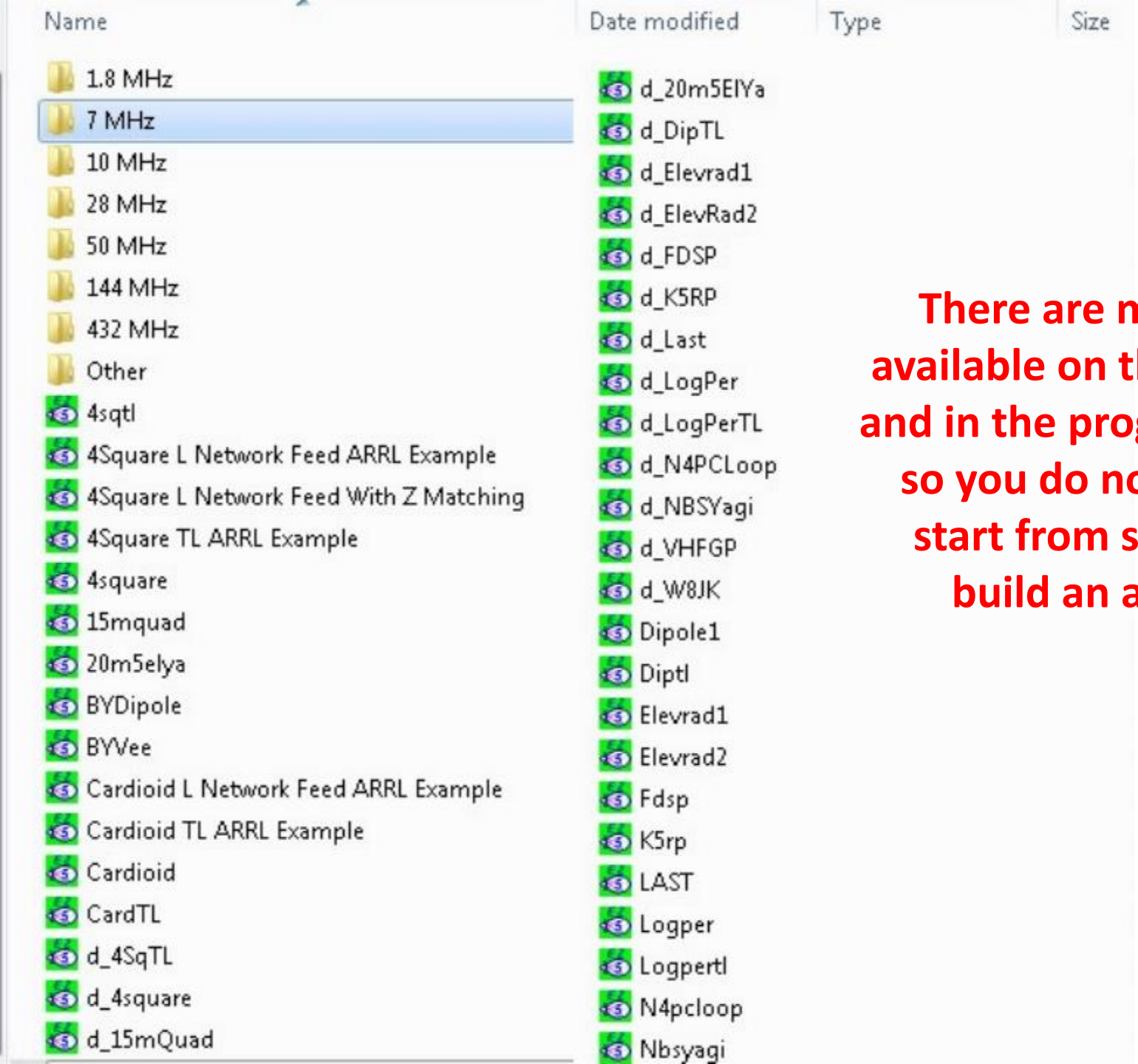
The program will tell you What you are plotting and info on gain, beam width, takeoff angles and more…



For any given height above ground it will show you the entire radiation pattern.

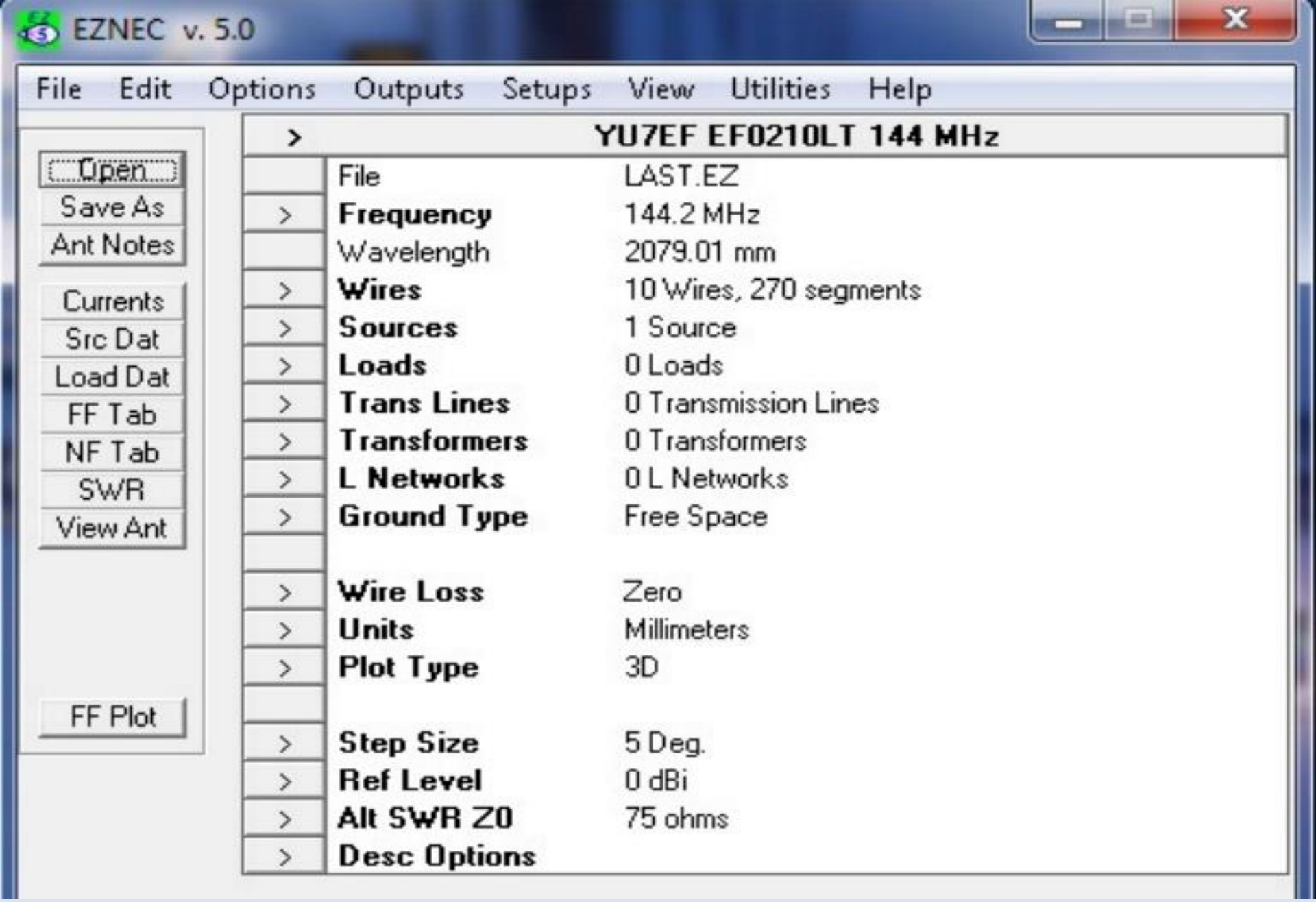


It can show you a Plot in 3-D as well.

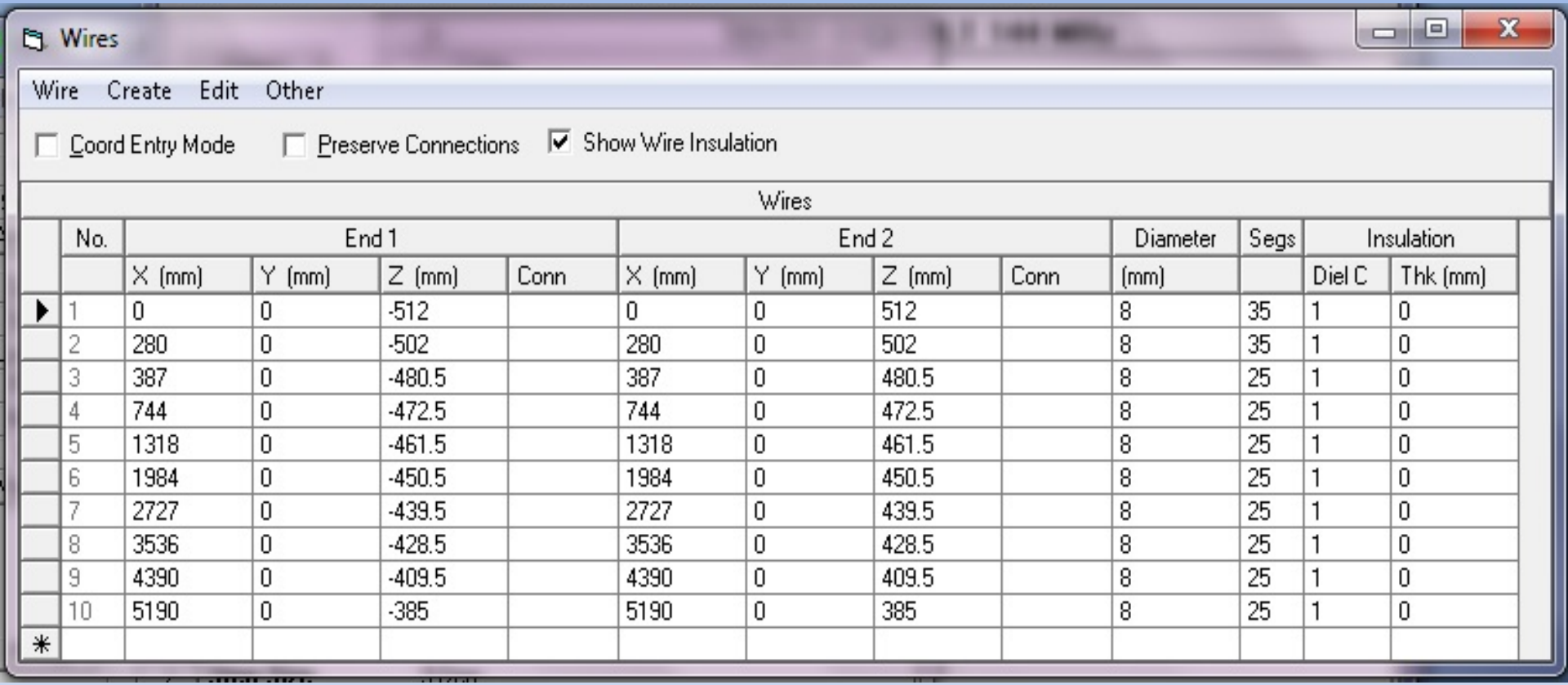


There are many files available on the internet and in the program, itself, so you do not have to start from scratch to build an antenna

Let’s start with a 10 element 2 meter Yagi



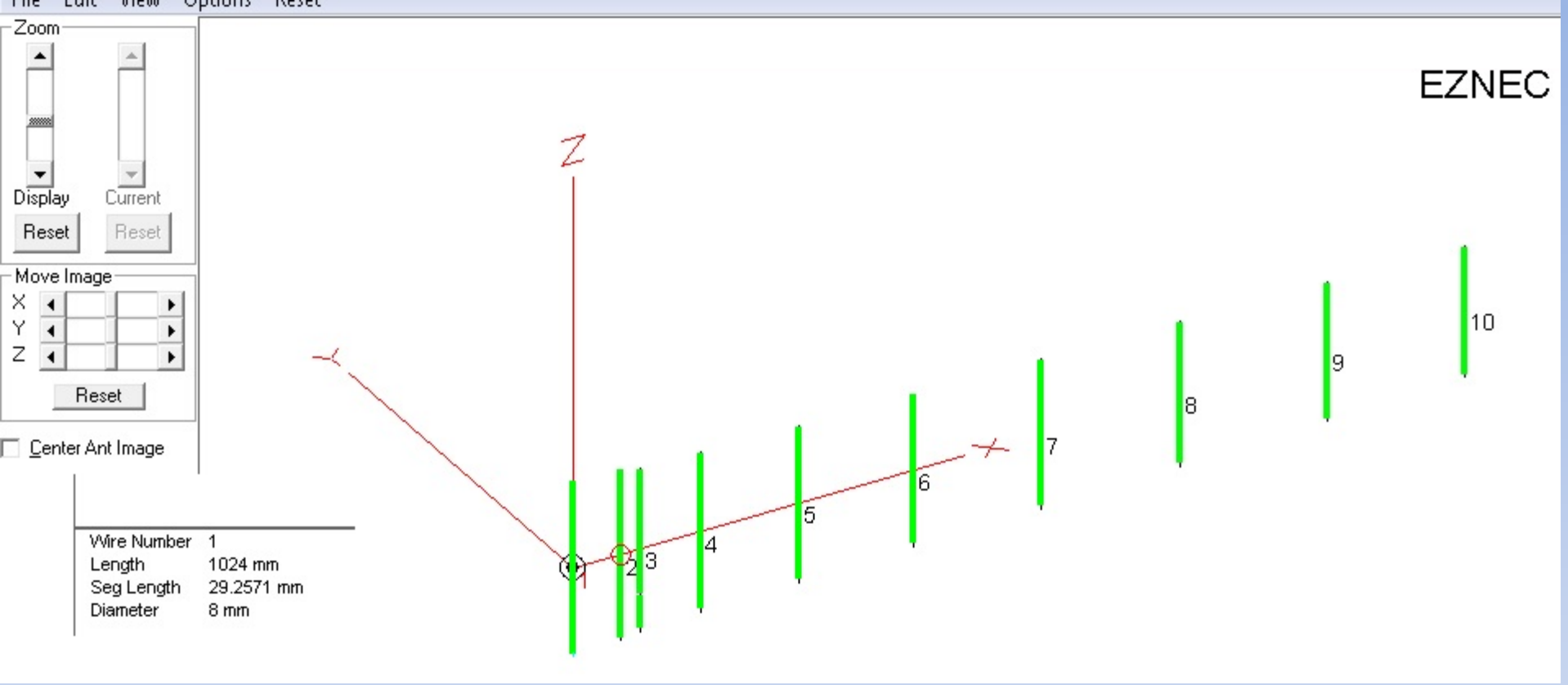
EZNEC MAIN SCREEN



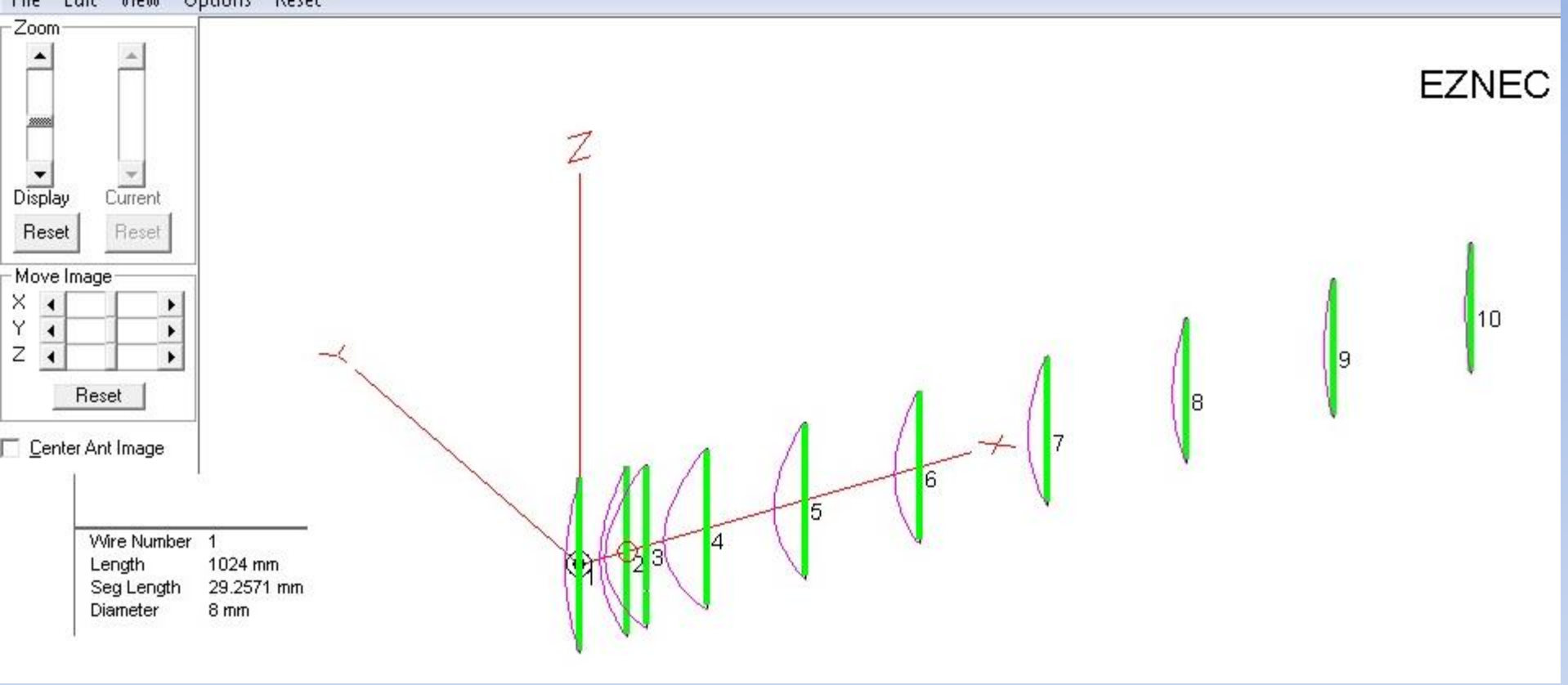
Wires

	No.	End 1				End 2				Diameter	Segs	Insulation	
		X (mm)	Y (mm)	Z (mm)	Conn	X (mm)	Y (mm)	Z (mm)	Conn	(mm)		Diel C	Thk (mm)
▶	1	0	0	-512		0	0	512		8	35	1	0
	2	280	0	-502		280	0	502		8	35	1	0
	3	387	0	-480.5		387	0	480.5		8	25	1	0
	4	744	0	-472.5		744	0	472.5		8	25	1	0
	5	1318	0	-461.5		1318	0	461.5		8	25	1	0
	6	1984	0	-450.5		1984	0	450.5		8	25	1	0
	7	2727	0	-439.5		2727	0	439.5		8	25	1	0
	8	3536	0	-428.5		3536	0	428.5		8	25	1	0
	9	4390	0	-409.5		4390	0	409.5		8	25	1	0
	10	5190	0	-385		5190	0	385		8	25	1	0
*													

The wires screen allows you to position each wire Or piece of tubing in the X-Y-Z dimensions and Designate its length, position and diameter.

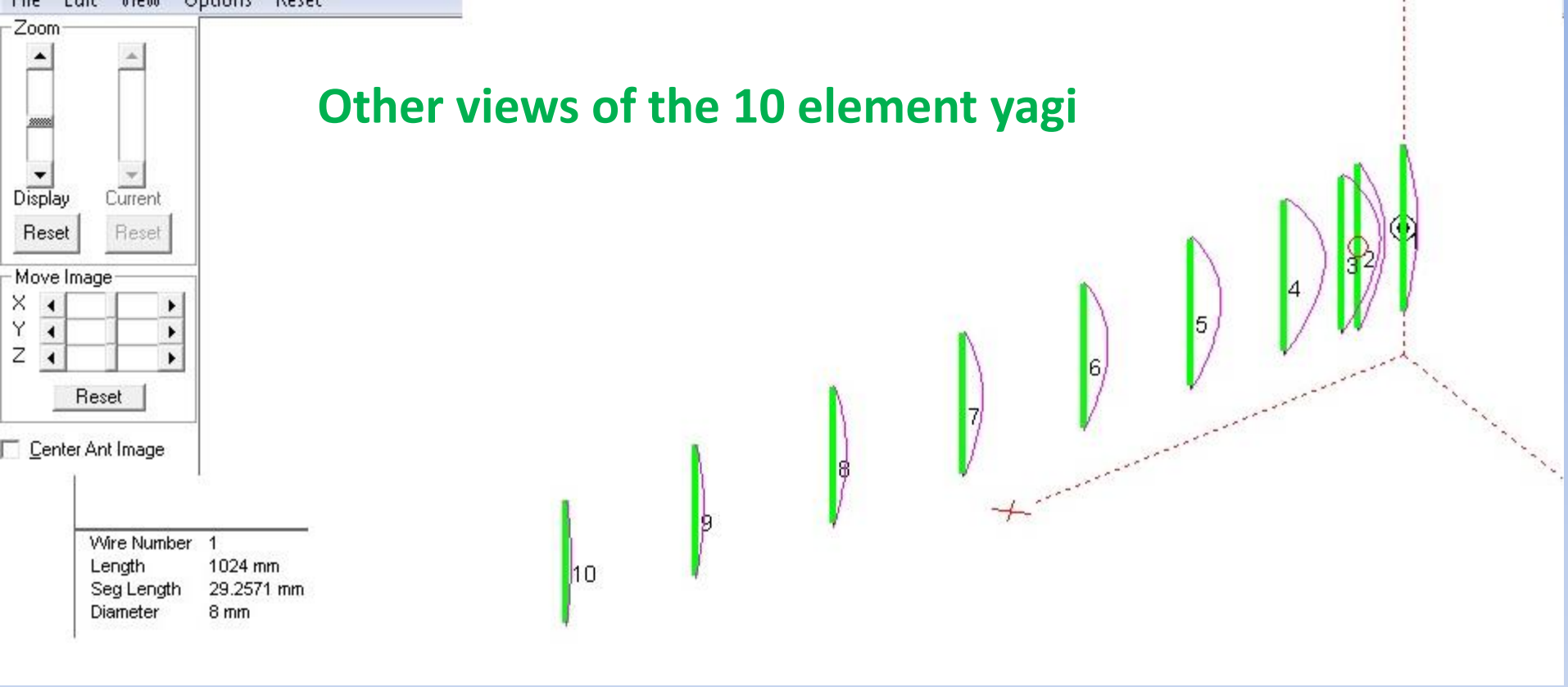


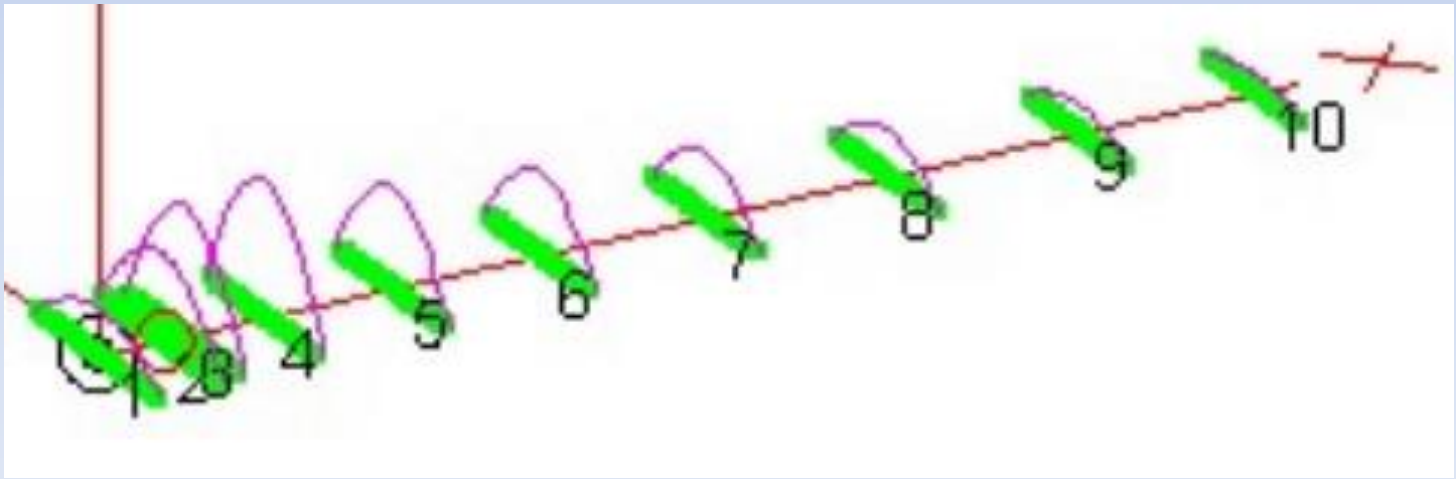
Then you can show the antenna and flip and Rotate it in all 3 planes to look at it.

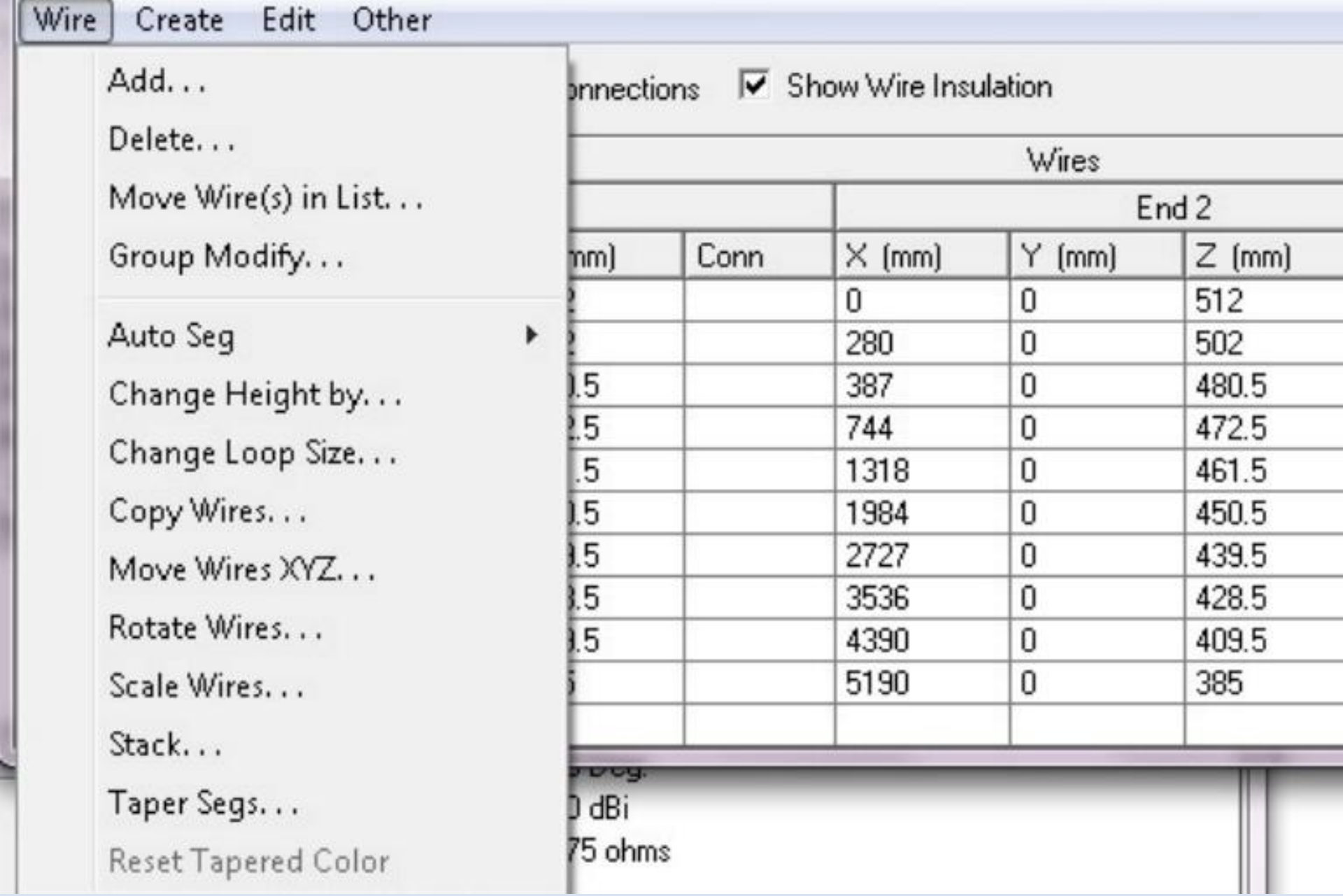


And it can display the Currents on Each element of the antenna

Other views of the 10 element yagi







You can change many parameters of the antenna

EZNEC will allow you to plot SWR curves and Smith charts for your antenna.

It can help you design matching sections, L networks and transformers.

It can examine transmission lines you may want to use with an antenna.

You can choose the type of ground your antenna is over.

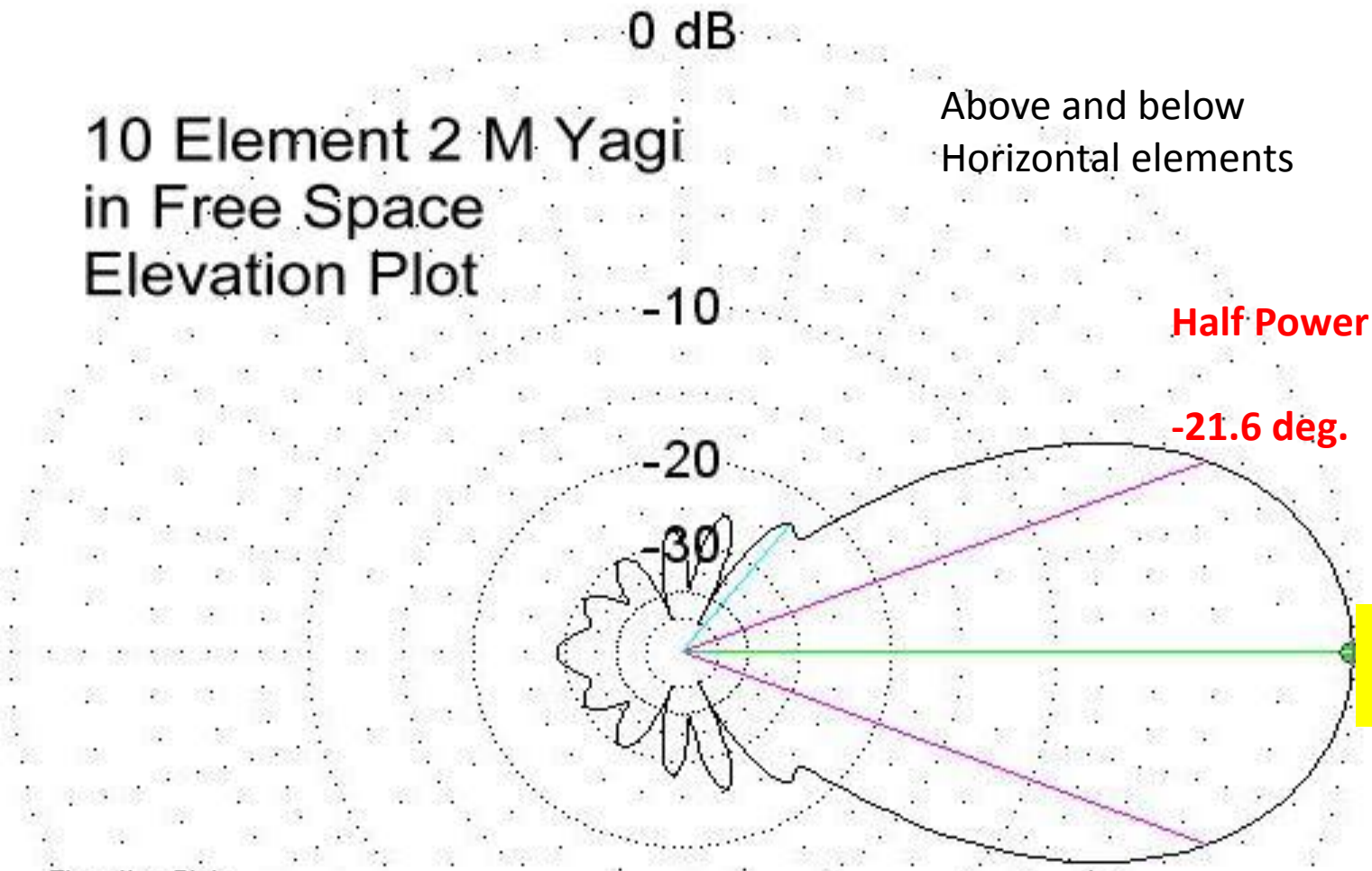
It will check that you have not made any errors in the wire symmetry that you have specified.

It allows you to write and save notes on any antenna you have designed.

Lets look at a horizontal 10 element 2M Yagi elevation and azimuth patterns in FREE SPACE.

This means the antenna Is nowhere near any ground or structures which could affect the pattern of the antenna.

(Ideally, out in Space)



10 Element 2 M Yagi in Free Space Elevation Plot

Above and below Horizontal elements

Half Power Point:

-21.6 deg.

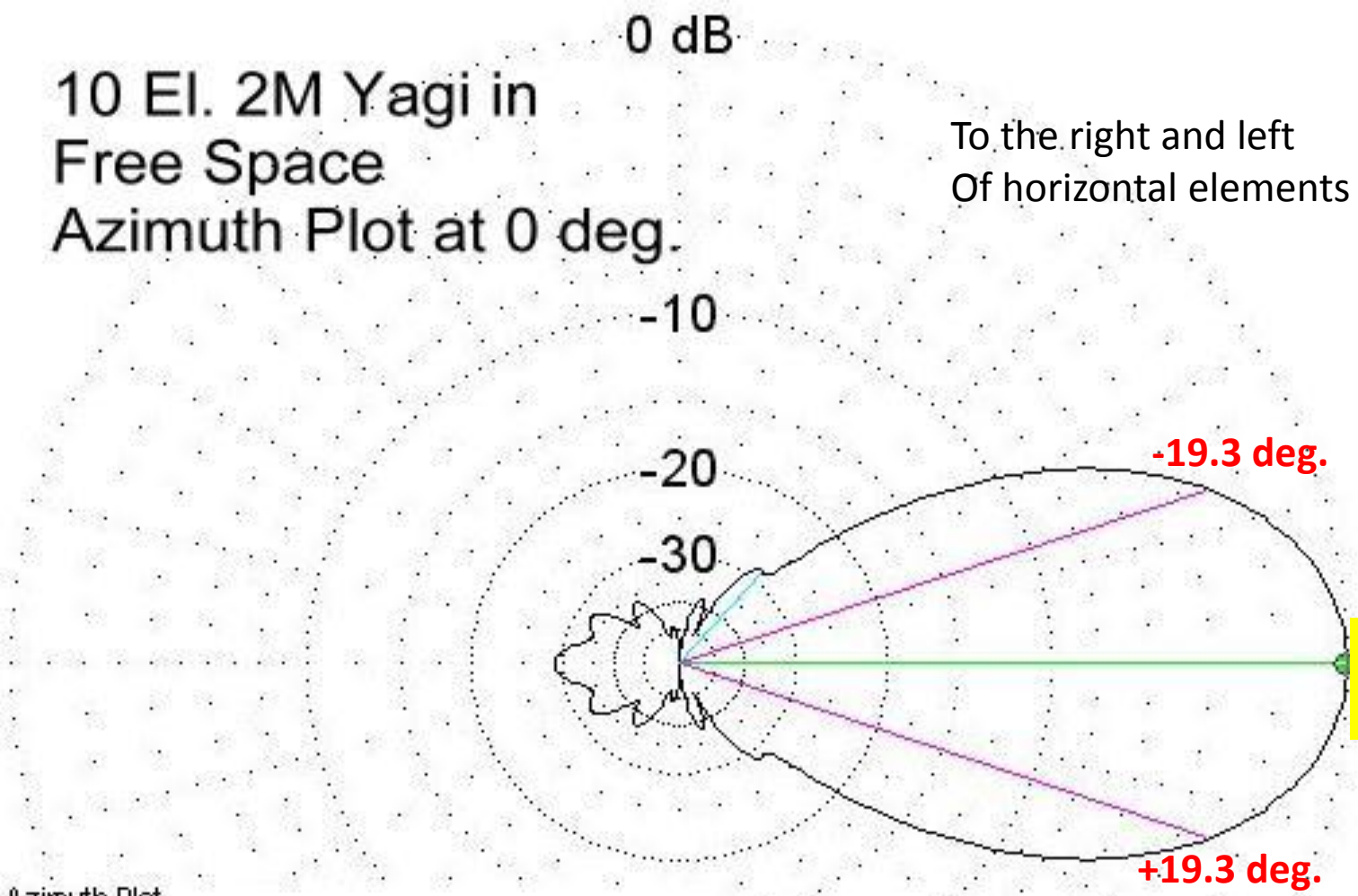
14.09 dBi Gain

+21.6 deg.

Elevation Plot	
Azimuth Angle	0.0 deg.
Outer Ring	14.09 dBi
Slice Max Gain	14.09 dBi @ Elev Angle = 0.0 deg.
Front/Back	28.83 dB
→ Beamwidth	43.2 deg.; -3dB @ 338.4, 21.6 deg.
Sidelobe Gain	-8.87 dBi @ Elev Angle = 52.0 deg.
Front/Sidelobe	22.96 dB

144.2 MHz

Cursor Elev	0.0 deg.
Gain	14.09 dBi
	0.0 dBmax



10 El. 2M Yagi in Free Space Azimuth Plot at 0 deg.

To the right and left
Of horizontal elements

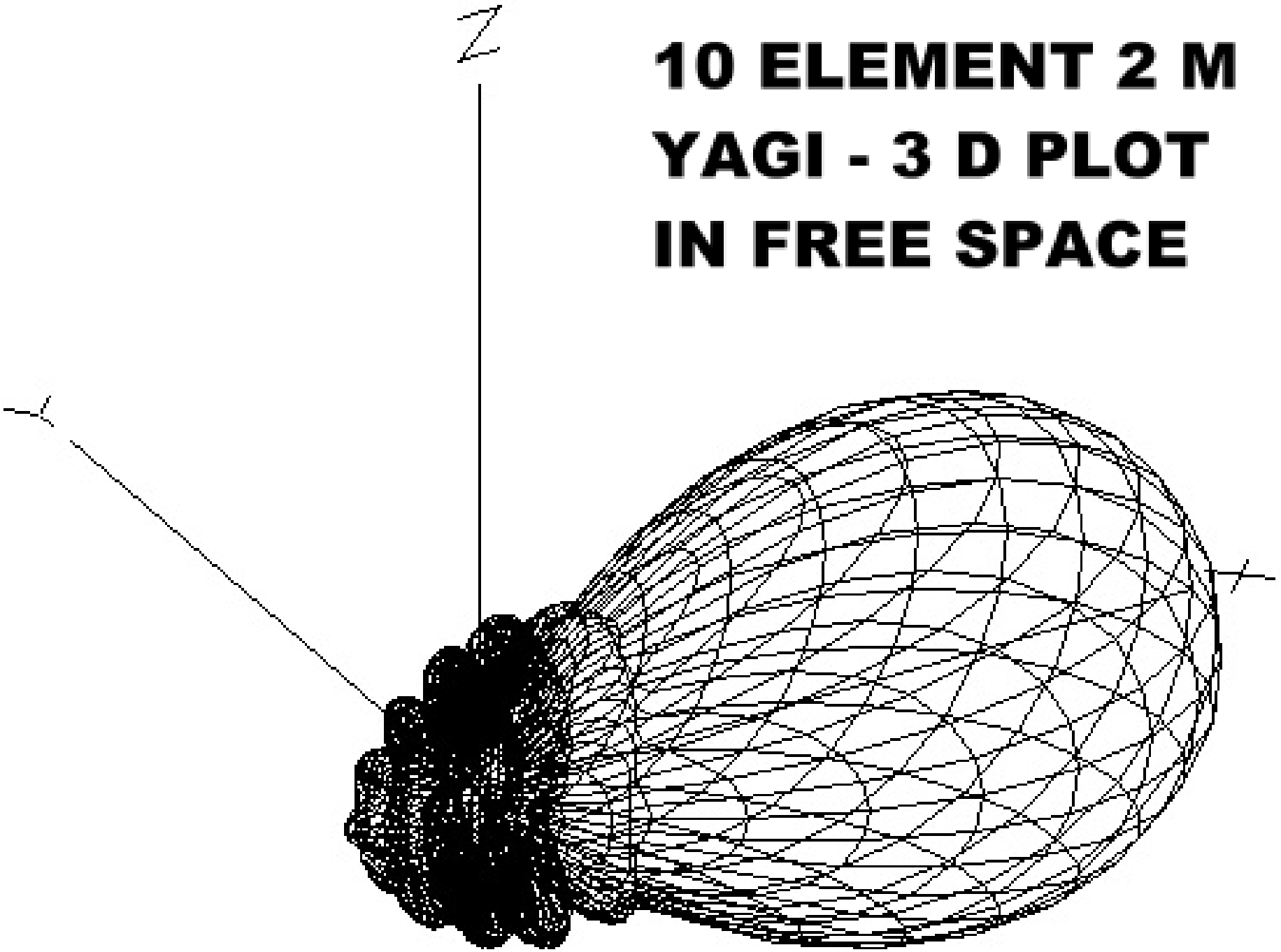
14.09 dBi Gain

Azimuth Plot	
Elevation Angle	0.0 deg.
Outer Ring	14.09 dBi
Slice Max Gain	14.09 dBi @ Az Angle = 0.0 deg.
Front/Back	28.83 dB
→ Beamwidth	38.6 deg.; -3dB @ 340.7, 19.3 deg.
Sidelobe Gain	-14.17 dBi @ Az Angle = 50.0 deg.
Front/Sidelobe	28.26 dB

144.2 MHz

Cursor Az	0.0 deg.
Gain	14.09 dBi
	0.0 dBmax

10 ELEMENT 2 M YAGI - 3 D PLOT IN FREE SPACE

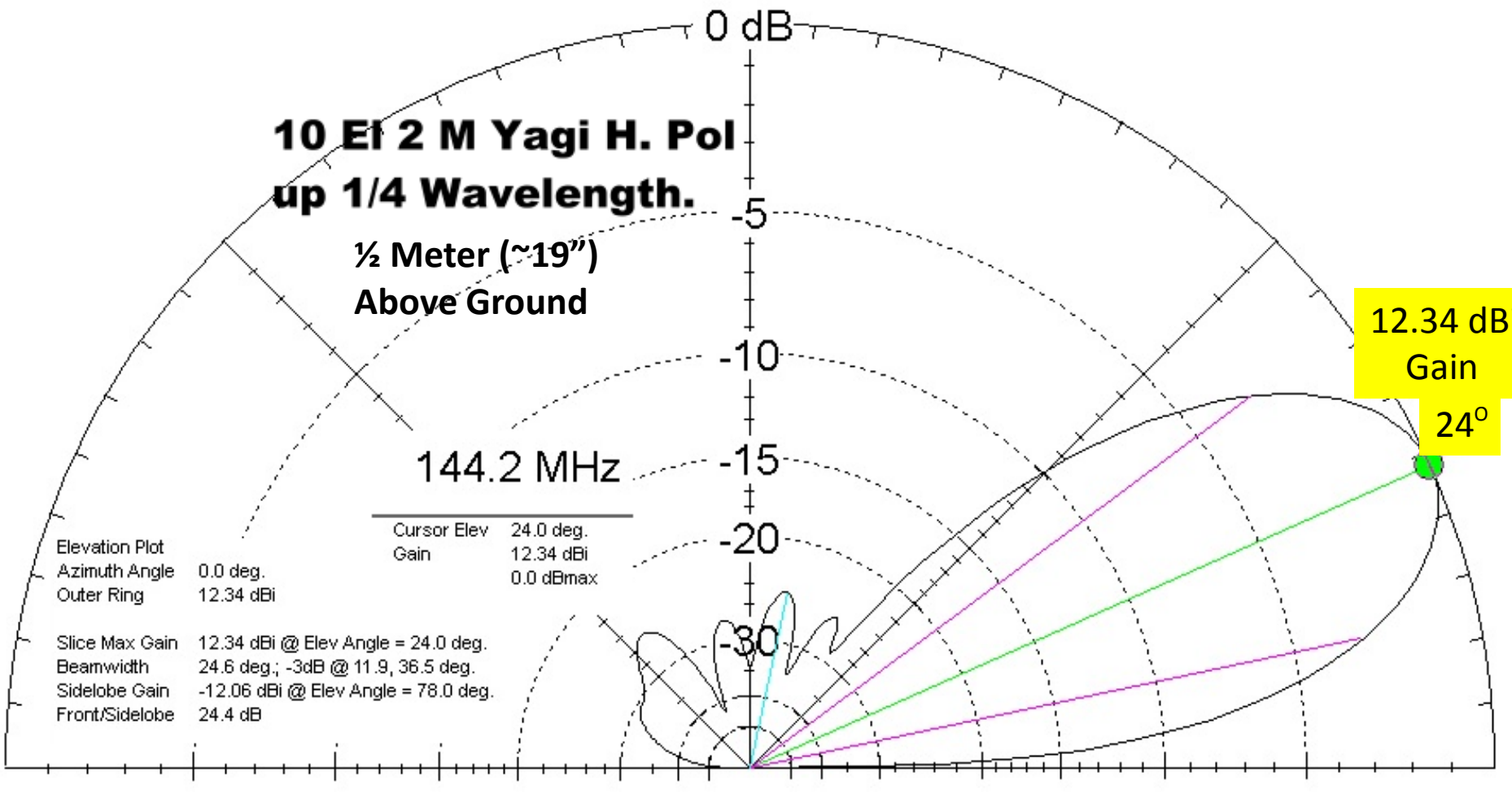


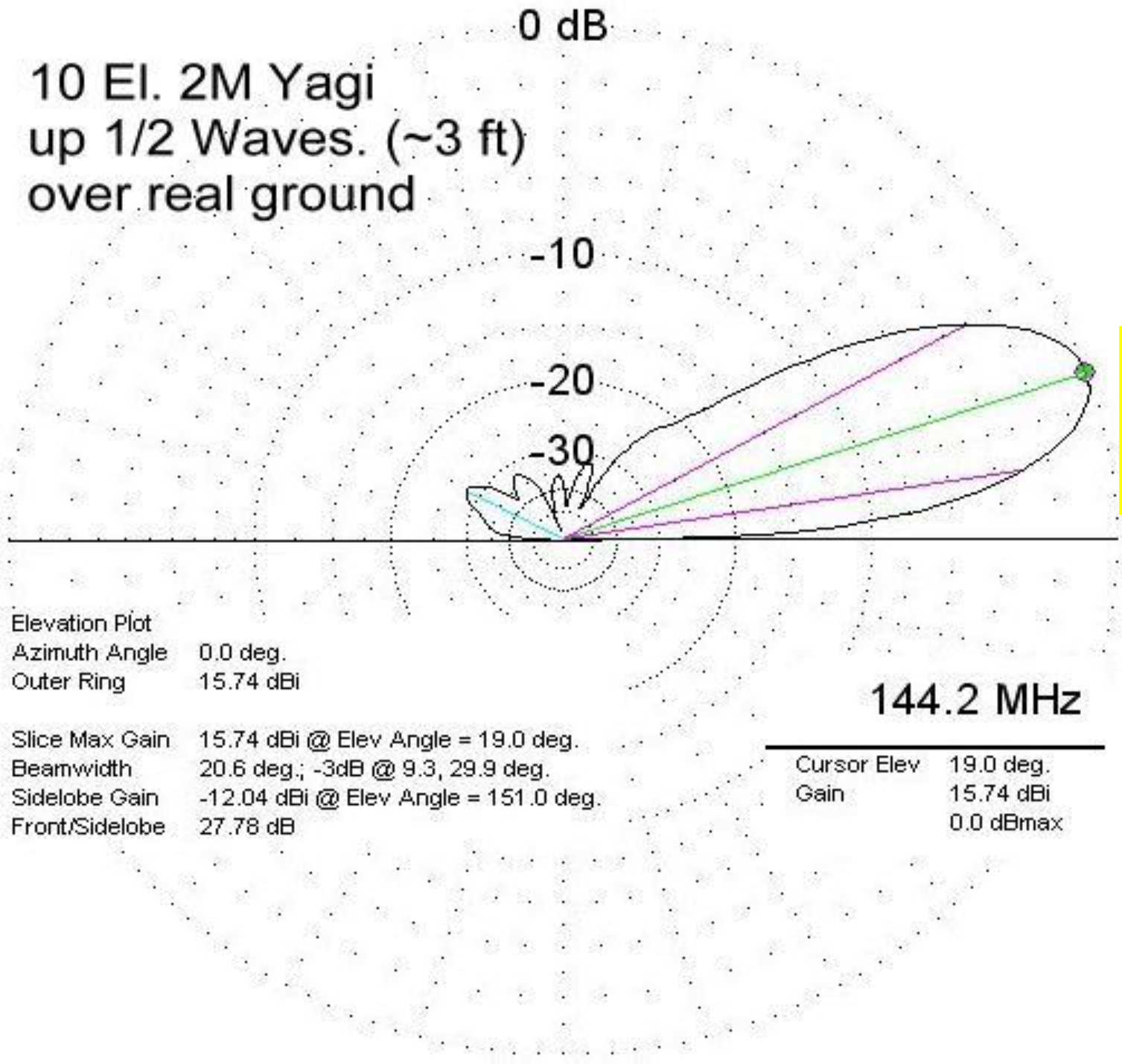
Next we put the antenna 1/4 wavelength above real ground

Note that the bottom half of the pattern is affected by the ground as is reflected in the lobes created at various takeoff angles

Also note the major lobe takeoff angle.

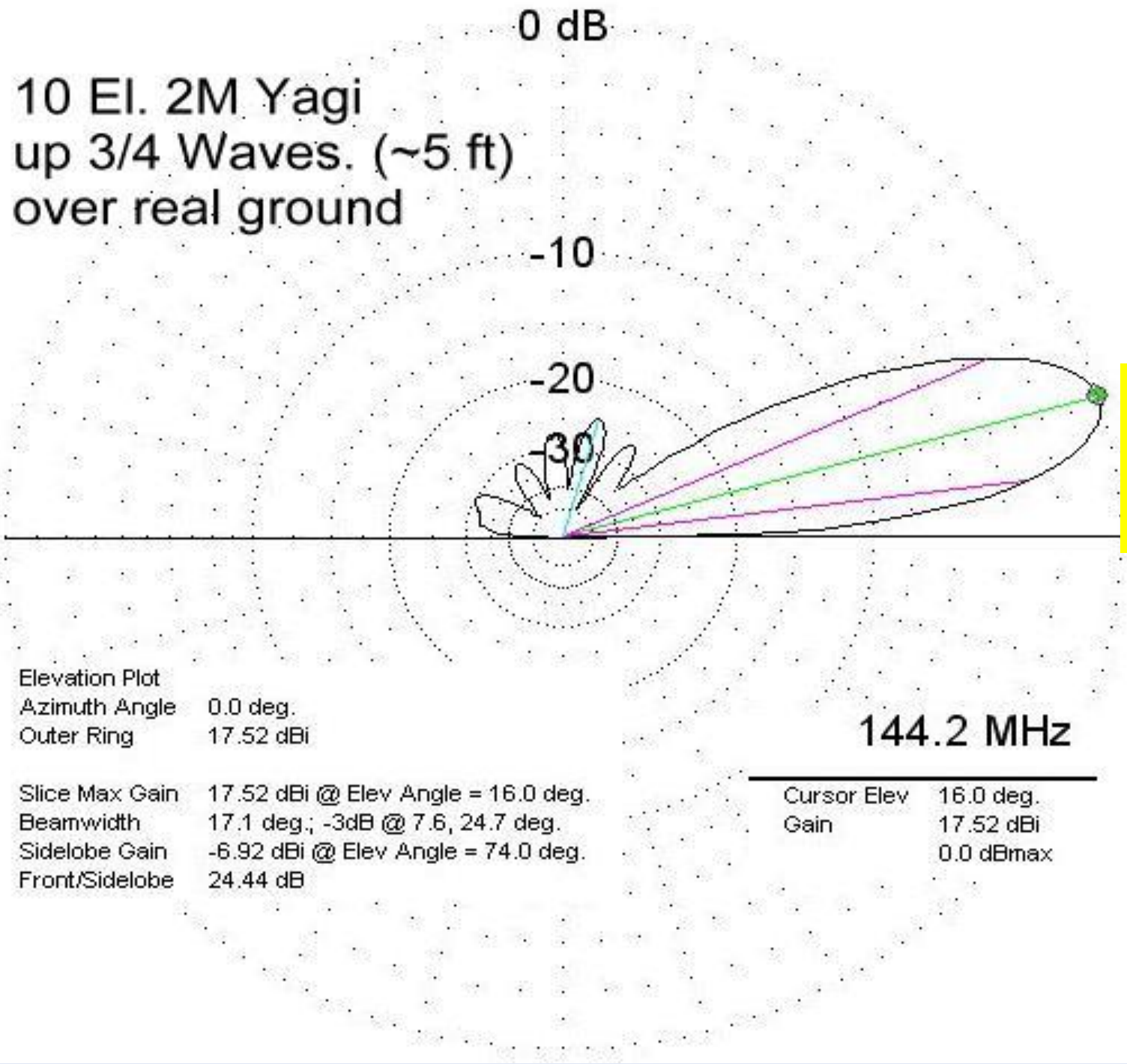
Follow the takeoff angle and number of lobes as the antenna is placed higher.

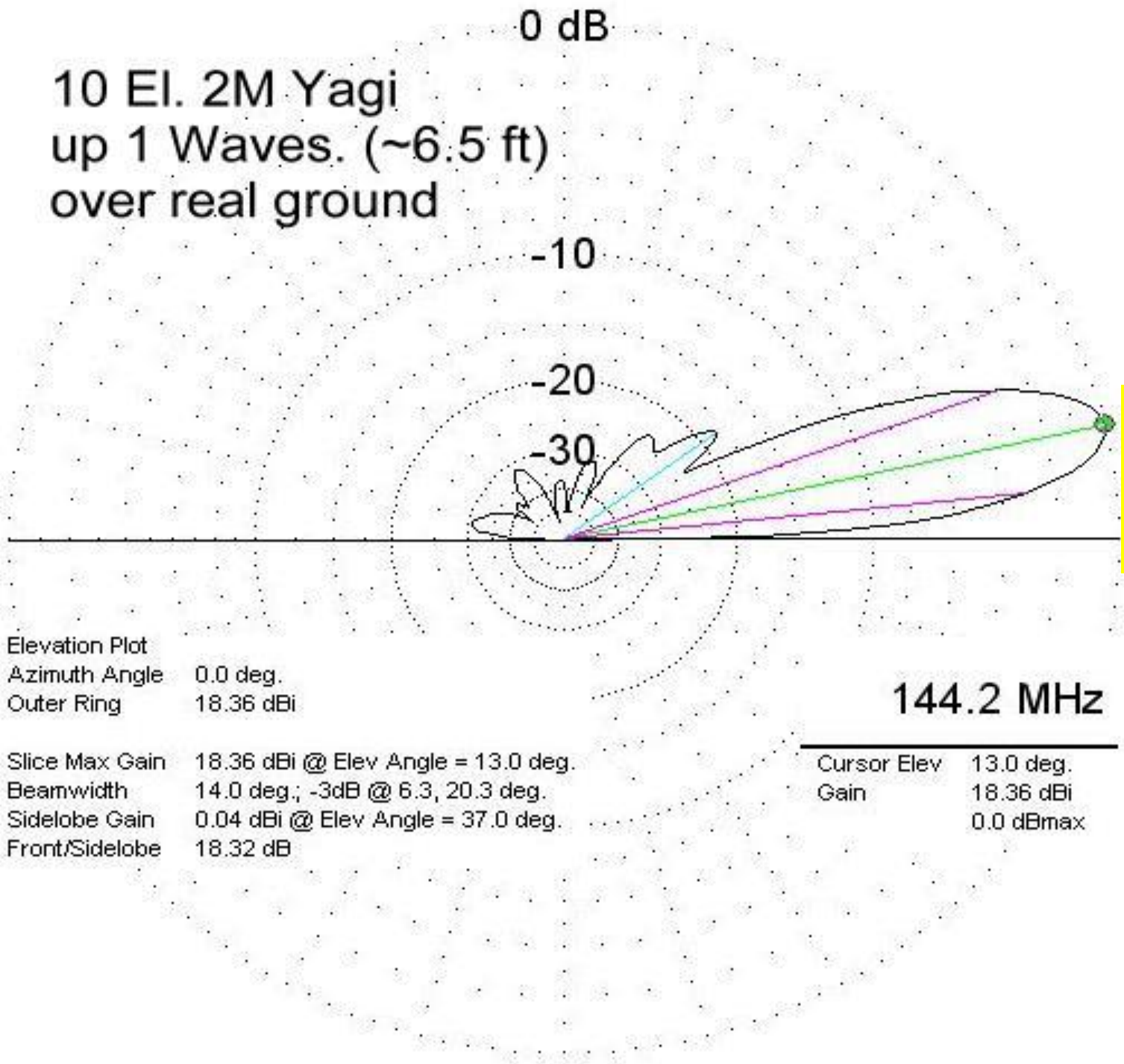

10 El 2 M Yagi H. Pol
up 1/4 Wavelength.
½ Meter (~19")
Above Ground
0 dB
-5
-10
-15
-20
-30
144.2 MHz
Cursor Elev 24.0 deg.
Gain 12.34 dBi
0.0 dBmax
Elevation Plot
Azimuth Angle 0.0 deg.
Outer Ring 12.34 dBi
Slice Max Gain 12.34 dBi @ Elev Angle = 24.0 deg.
Beamwidth 24.6 deg.; -3dB @ 11.9, 36.5 deg.
Sidelobe Gain -12.06 dBi @ Elev Angle = 78.0 deg.
Front/Sidelobe 24.4 dB
12.34 dBi
Gain
24°

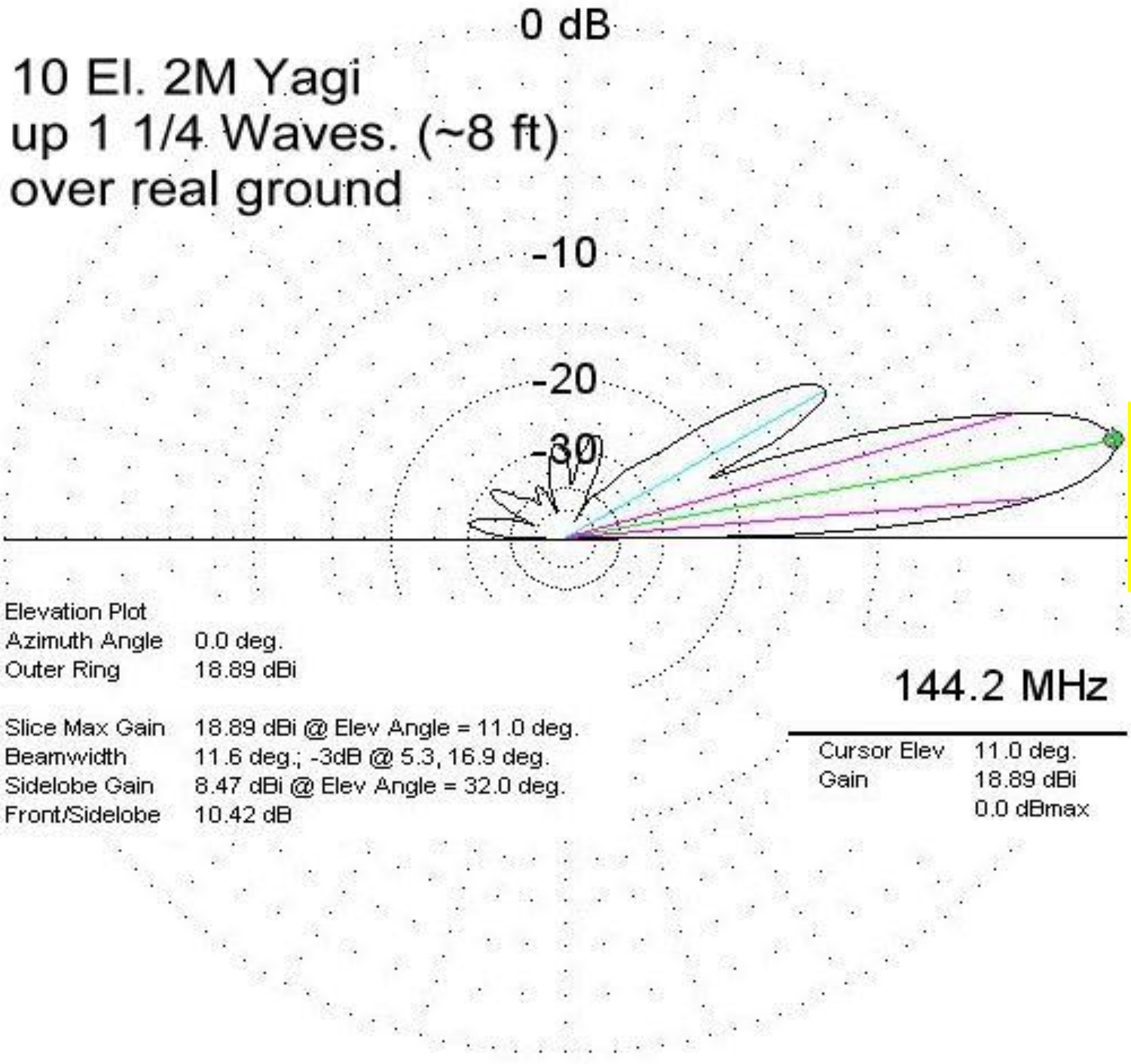


19 Deg.

15.74 dBi Gain

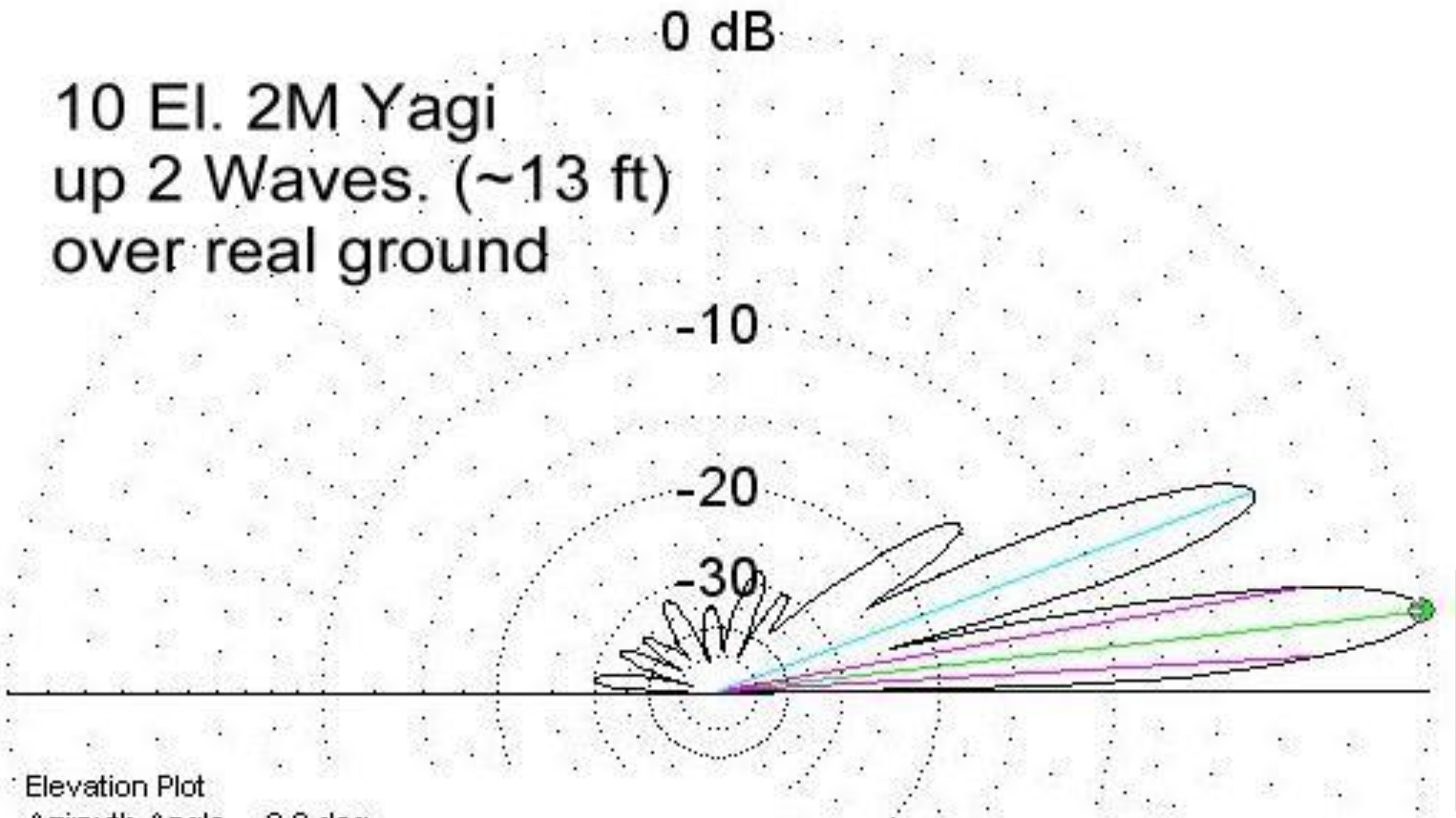

0 dB
10 El. 2M Yagi
up 3/4 Waves. (~5 ft)
over real ground
-10
-20
-30
16 Deg.
17.52 dBi Gain
Elevation Plot
Azimuth Angle 0.0 deg.
Outer Ring 17.52 dBi
144.2 MHz
Slice Max Gain 17.52 dBi @ Elev Angle = 16.0 deg.
Beamwidth 17.1 deg.; -3dB @ 7.6, 24.7 deg.
Sidelobe Gain -6.92 dBi @ Elev Angle = 74.0 deg.
Front/Sidelobe 24.44 dB
Cursor Elev 16.0 deg.
Gain 17.52 dBi
0.0 dBmax


0 dB
10 El. 2M Yagi
up 1 Waves. (~6.5 ft)
over real ground
-10
-20
-30
13 Deg.
18.36 dBi Gain
Elevation Plot
Azimuth Angle 0.0 deg.
Outer Ring 18.36 dBi
144.2 MHz
Slice Max Gain 18.36 dBi @ Elev Angle = 13.0 deg.
Beamwidth 14.0 deg.; -3dB @ 6.3, 20.3 deg.
Sidelobe Gain 0.04 dBi @ Elev Angle = 37.0 deg.
Front/Sidelobe 18.32 dB
Cursor Elev 13.0 deg.
Gain 18.36 dBi
0.0 dBmax



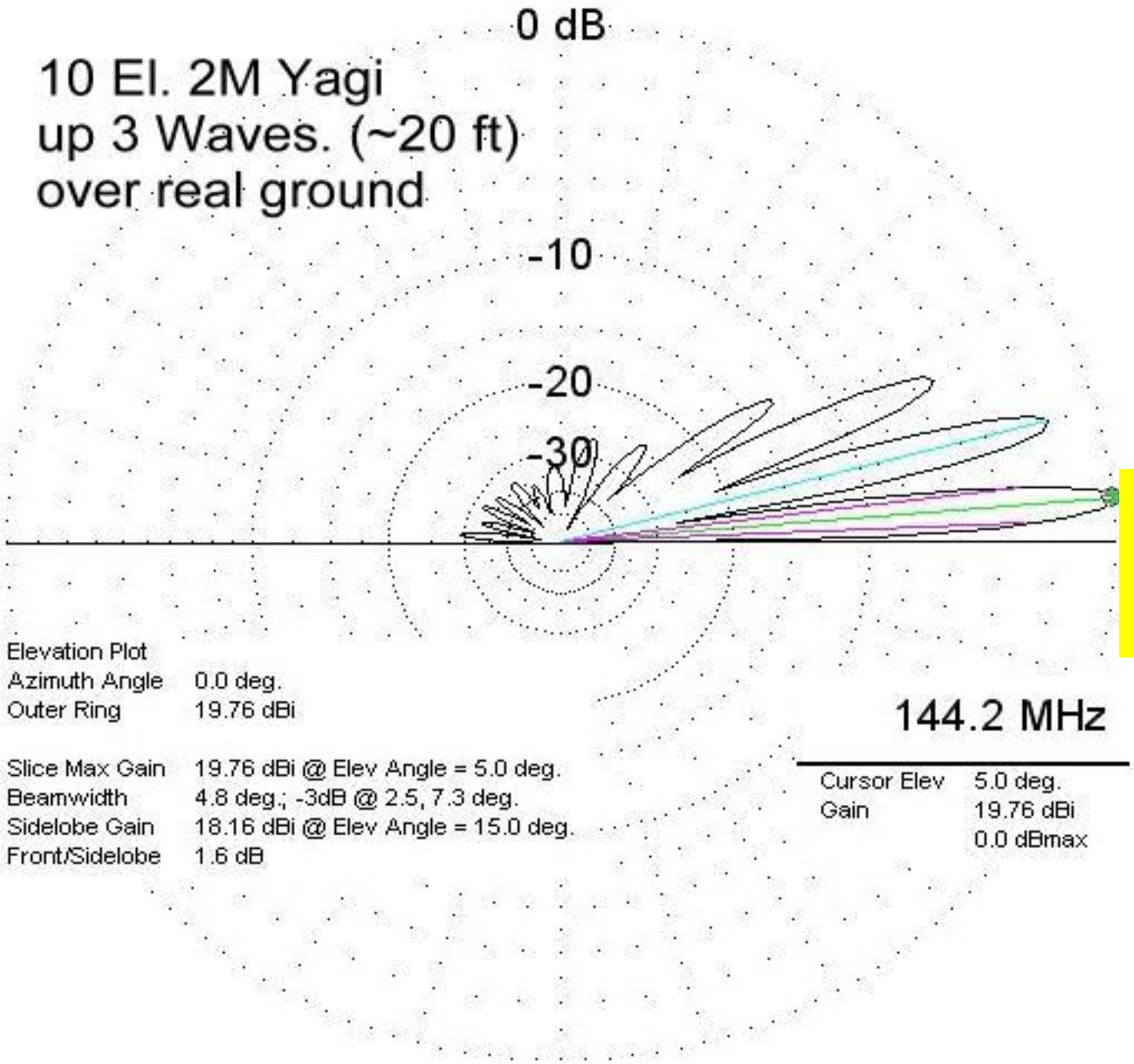
11 Deg.

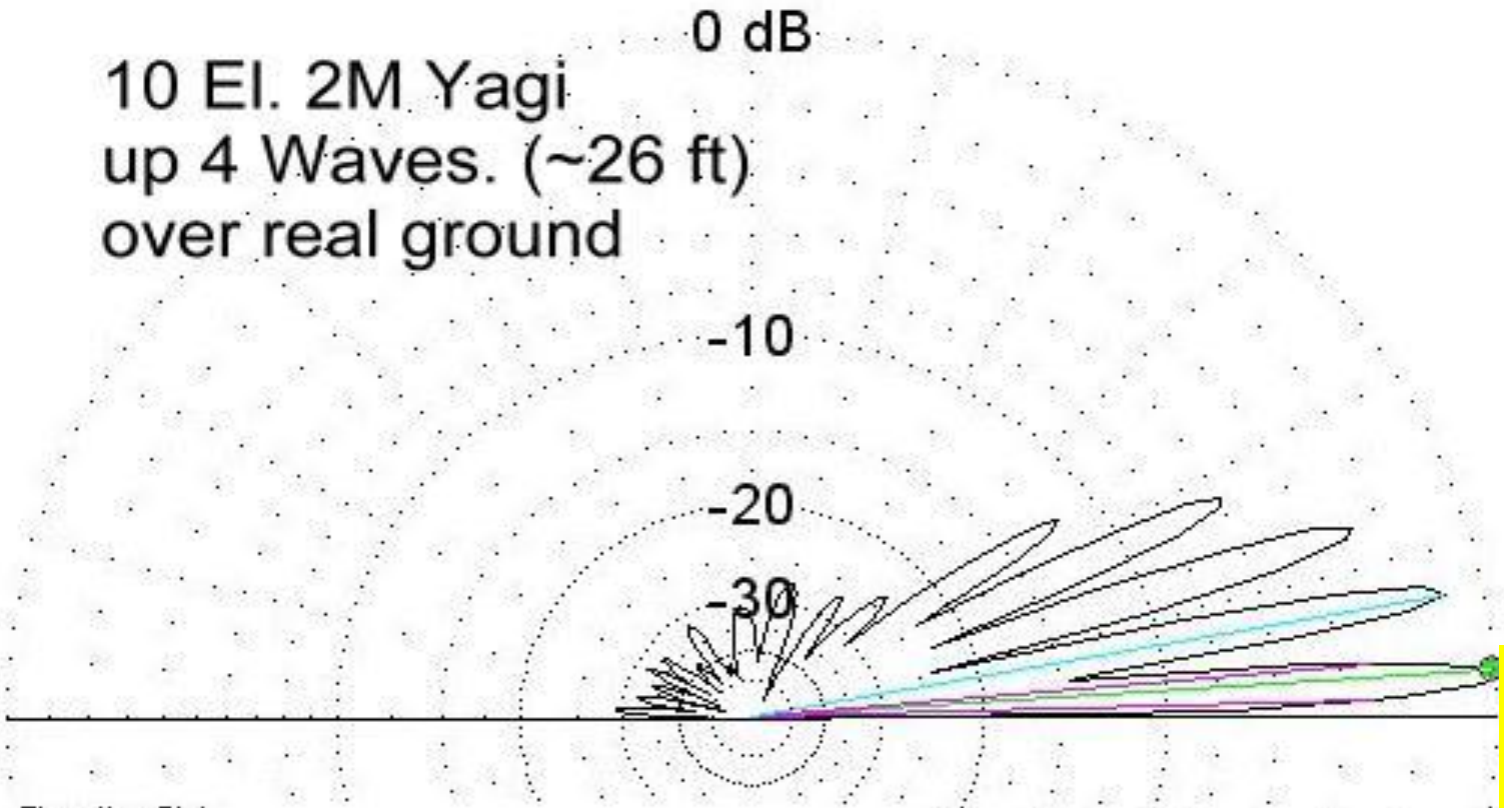
18.89 dBi Gain



7 Deg.

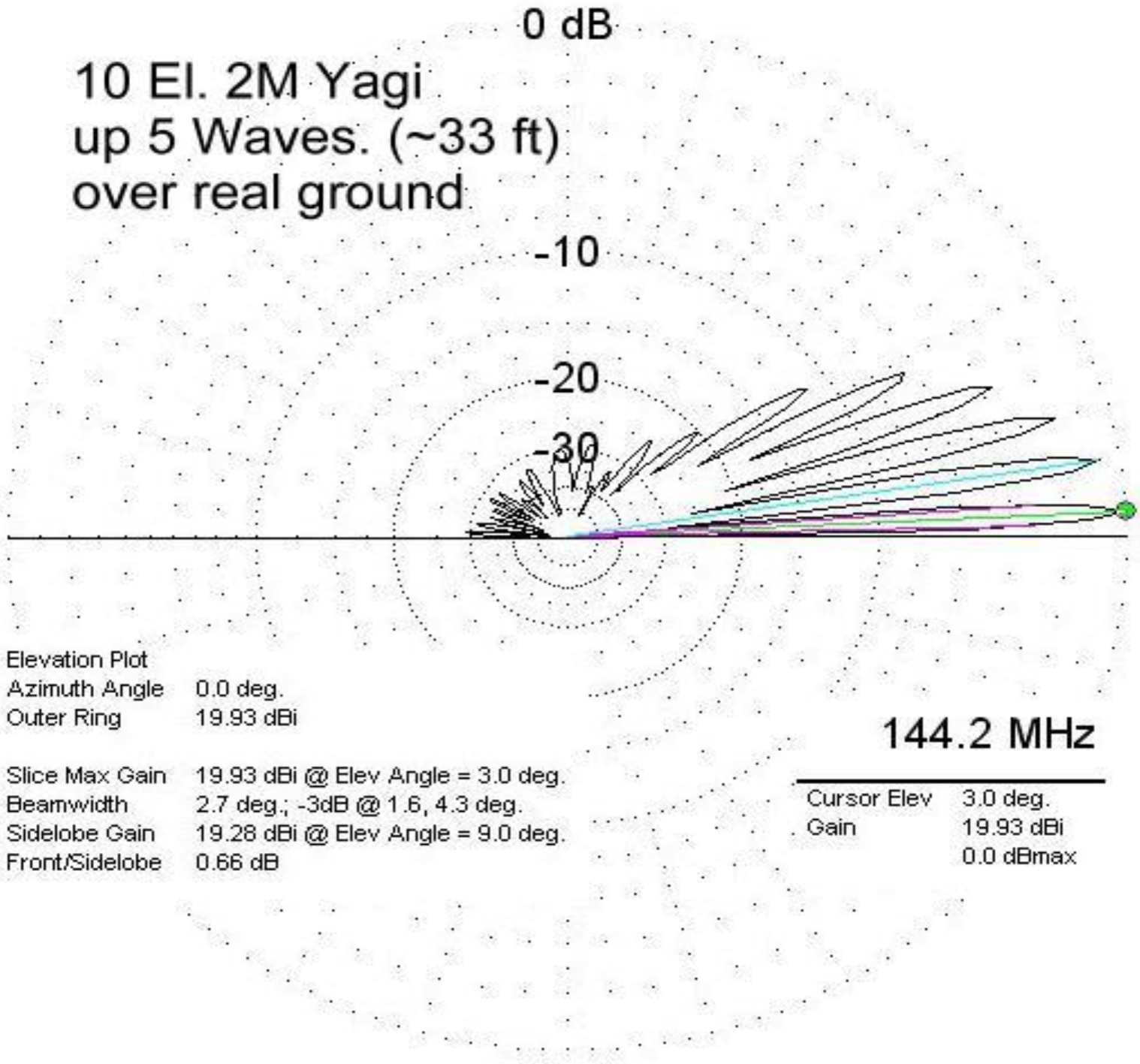
19.5 dBi Gain


0 dB
10 El. 2M Yagi
up 3 Waves. (~20 ft)
over real ground
-10
-20
-30
5 Deg.
19.76 dBi Gain
Elevation Plot
Azimuth Angle 0.0 deg.
Outer Ring 19.76 dBi
Slice Max Gain 19.76 dBi @ Elev Angle = 5.0 deg.
Beamwidth 4.8 deg.; -3dB @ 2.5, 7.3 deg.
Sidelobe Gain 18.16 dBi @ Elev Angle = 15.0 deg.
Front/Sidelobe 1.6 dB
144.2 MHz
Cursor Elev 5.0 deg.
Gain 19.76 dBi
0.0 dBmax

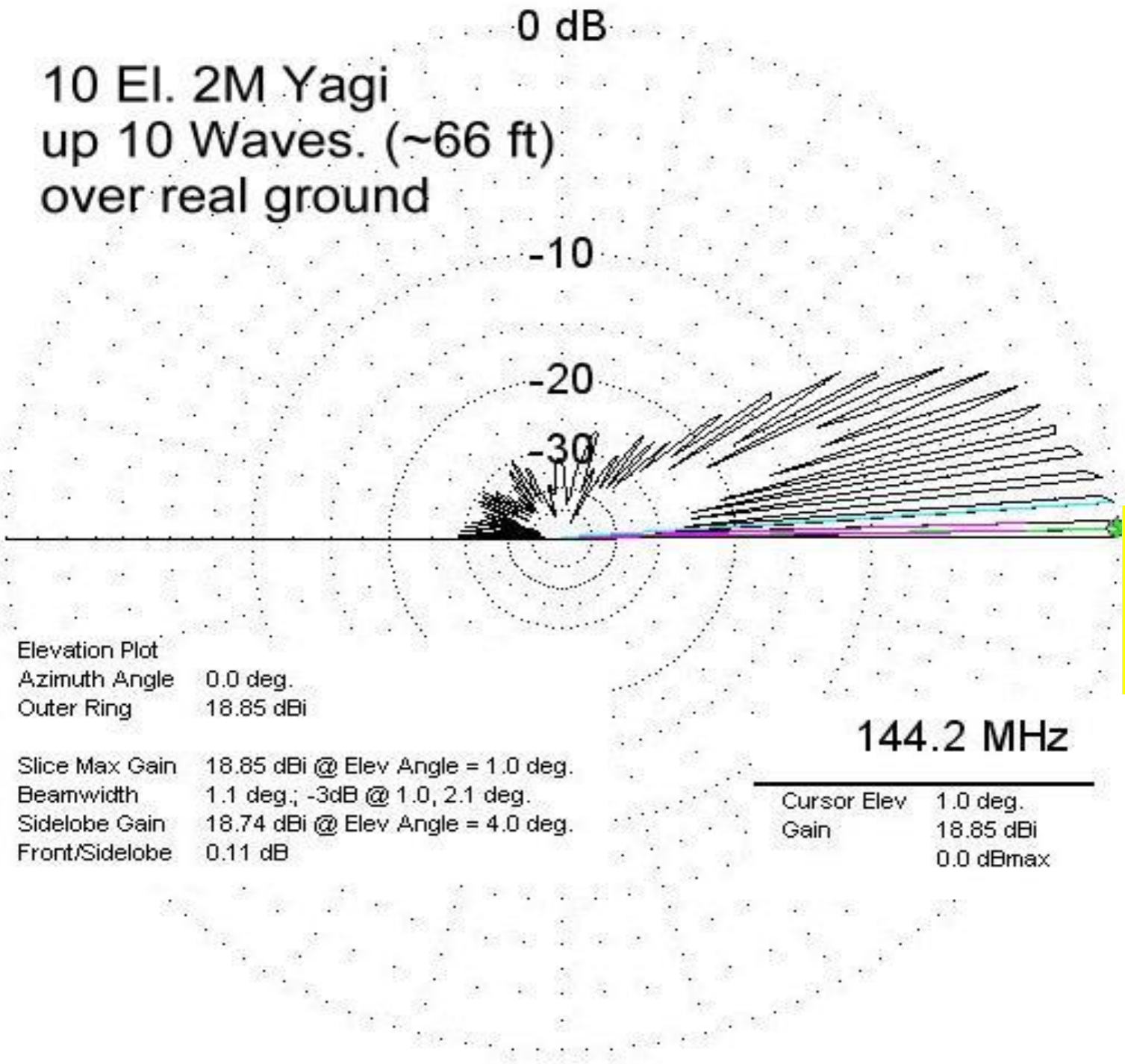


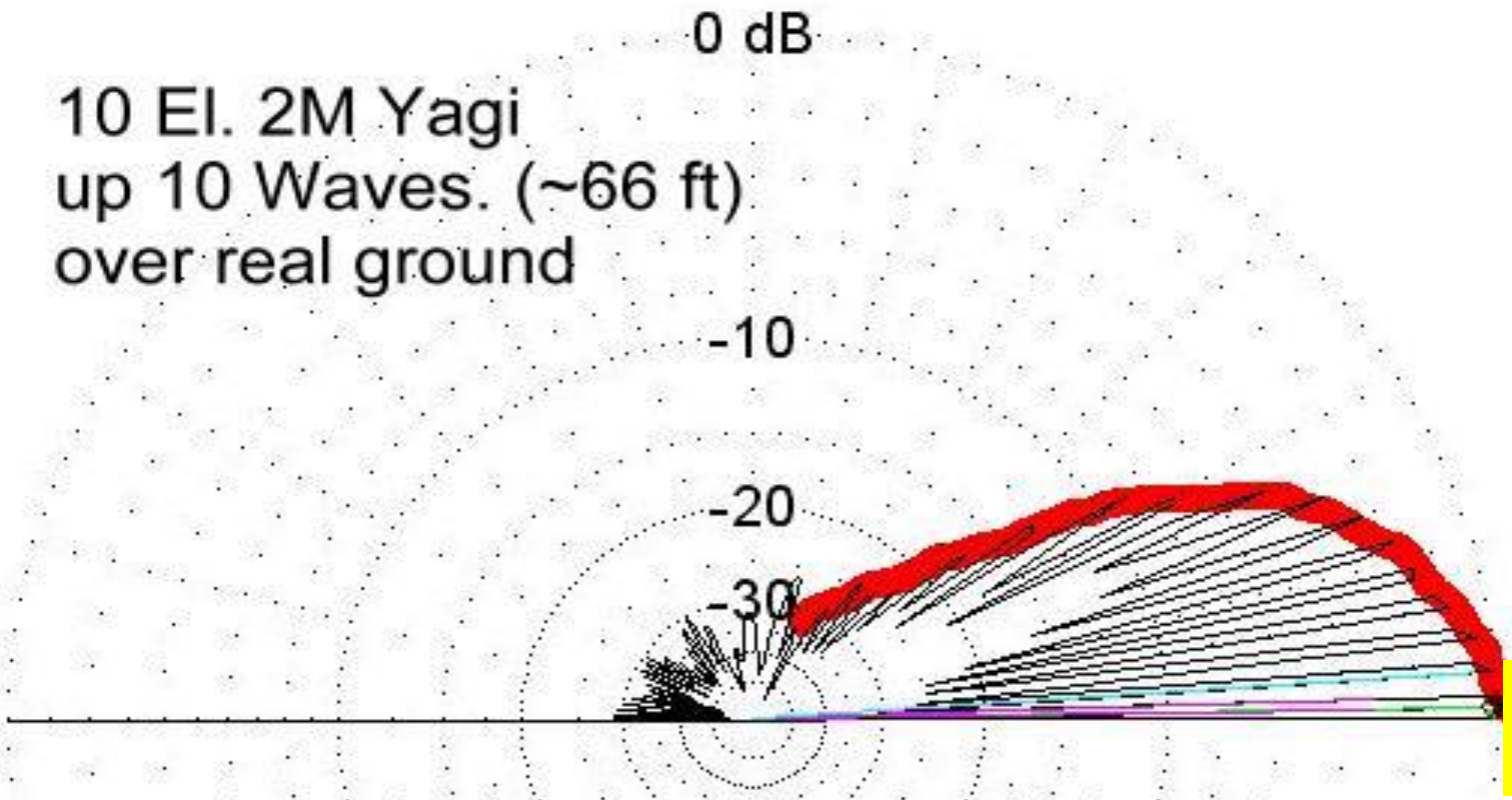
4 Deg.

19.79 dBi Gain



3 Deg. 19.93 dBi Gain


0 dB
10 El. 2M Yagi
up 10 Waves. (~66 ft)
over real ground
-10
-20
-30
1 Deg.
18.85 dBi Gain
Elevation Plot
Azimuth Angle 0.0 deg.
Outer Ring 18.85 dBi
Slice Max Gain 18.85 dBi @ Elev Angle = 1.0 deg.
Beamwidth 1.1 deg.; -3dB @ 1.0, 2.1 deg.
Sidelobe Gain 18.74 dBi @ Elev Angle = 4.0 deg.
Front/Sidelobe 0.11 dB
144.2 MHz
Cursor Elev 1.0 deg.
Gain 18.85 dBi
0.0 dBmax

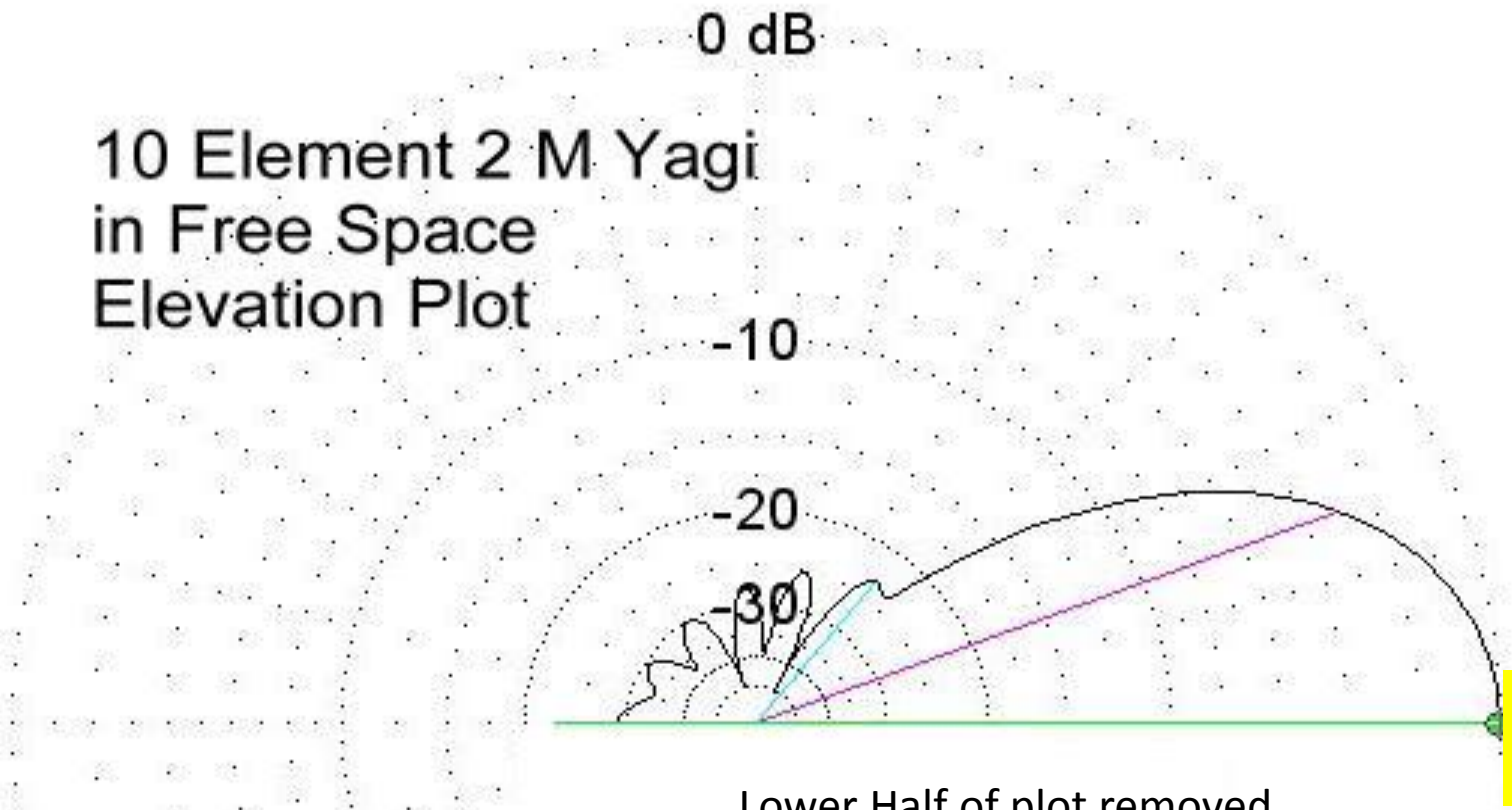


Elevation Plot
Azimuth Angle 0.0 deg.
Outer Ring 18.85 dBi

Slice Max Gain 18.85 dBi @ Elev Angle = 1.0 deg.
Beamwidth 1.1 deg.; -3dB @ 1.0, 2.1 deg.
Sidelobe Gain 18.74 dBi @ Elev Angle = 4.0 deg.
Front/Sidelobe 0.11 dB

144.2 MHz

Cursor Elev 1.0 deg.
Gain 18.85 dBi
0.0 dBmax



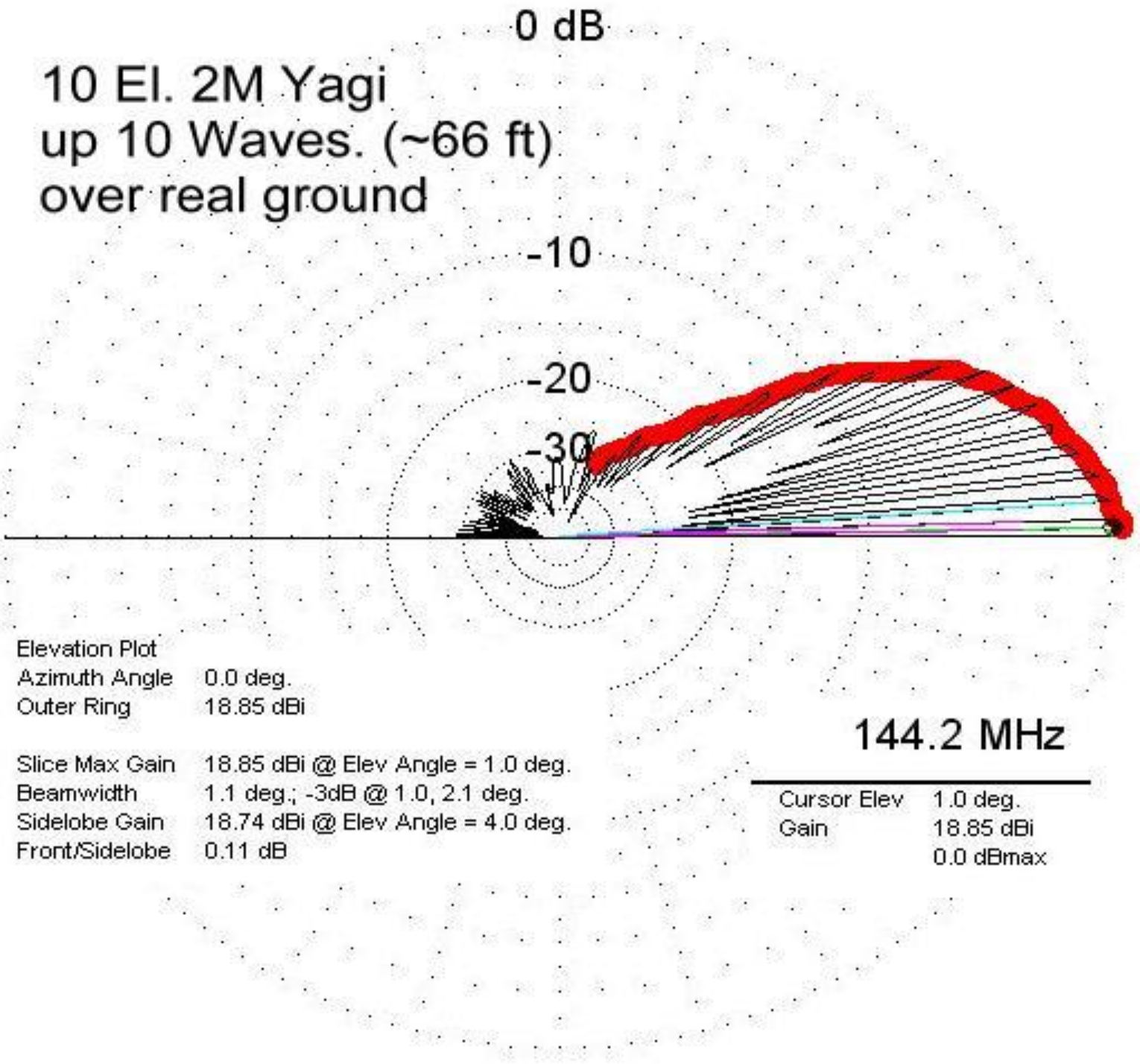
14.09 dBi Gain

Lower Half of plot removed

Elevation Plot	
Azimuth Angle	0.0 deg.
Outer Ring	14.09 dBi
Slice Max Gain	14.09 dBi @ Elev Angle = 0.0 deg.
Front/Back	28.83 dB
Beamwidth	43.2 deg.; -3dB @ 338.4, 21.6 deg.
Sidelobe Gain	-8.87 dBi @ Elev Angle = 52.0 deg.
Front/Sidelobe	22.96 dB

144.2 MHz

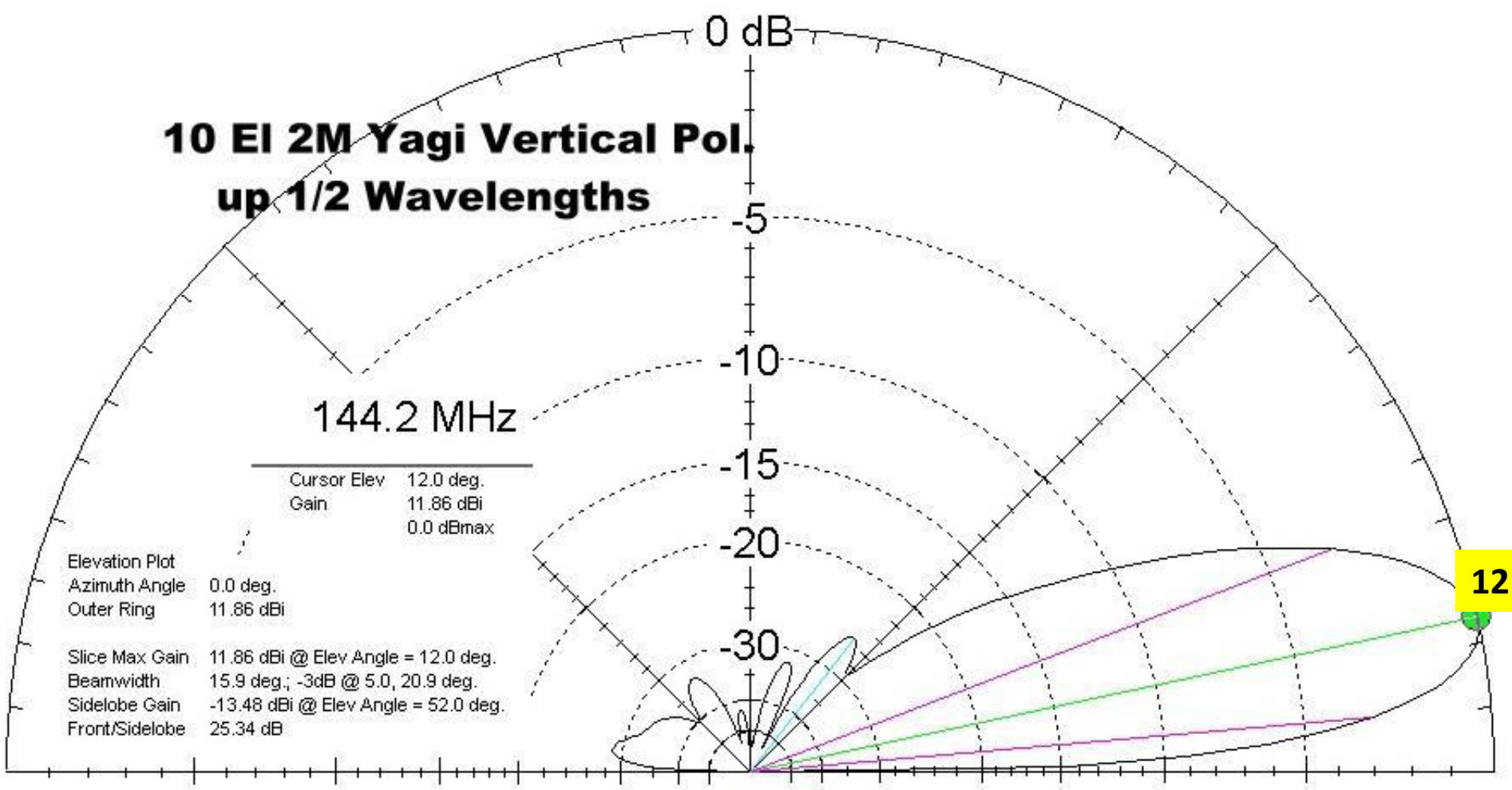
Cursor Elev	0.0 deg.
Gain	14.09 dBi
	0.0 dBmax


0 dB
10 El. 2M Yagi
up 10 Waves. (~66 ft)
over real ground
-10
-20
-30
18.85 dBi
Gain
Elevation Plot
Azimuth Angle 0.0 deg.
Outer Ring 18.85 dBi
Slice Max Gain 18.85 dBi @ Elev Angle = 1.0 deg.
Beamwidth 1.1 deg.; -3dB @ 1.0, 2.1 deg.
Sidelobe Gain 18.74 dBi @ Elev Angle = 4.0 deg.
Front/Sidelobe 0.11 dB
144.2 MHz
Cursor Elev 1.0 deg.
Gain 18.85 dBi
0.0 dBmax

What happens if we flip the antenna to vertical polarization?

Note that there is some ground gain, but not as much as with horizontal polarization.

Again diminishing returns as we go higher with the antenna.

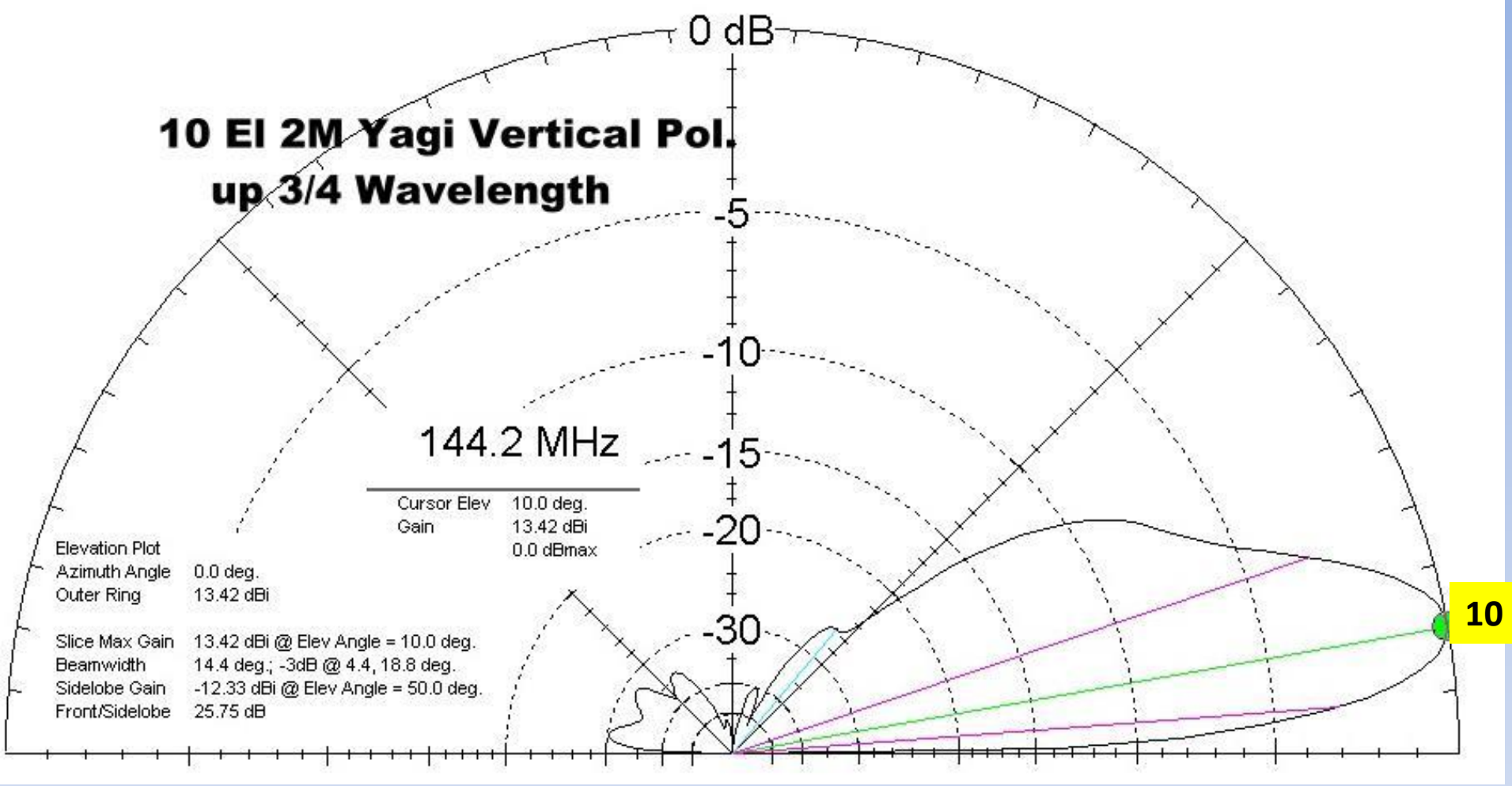


Note the lower takeoff angle for height Above ground due to vertical polarization.

11.86 dBi Gain

H. Pol (15.74 dBi)

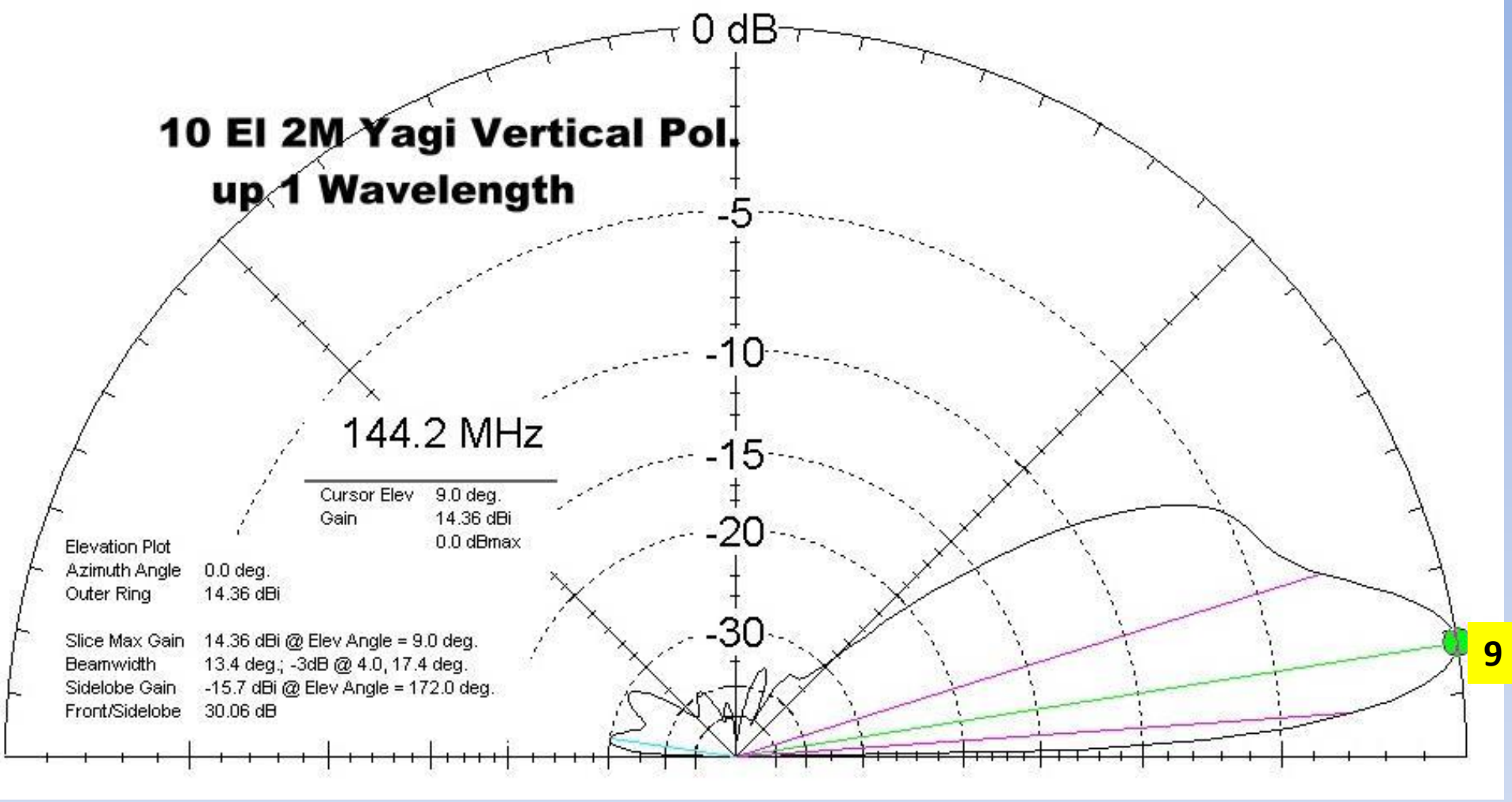
Also note lower gain vs. Horizontal Polarization



Notice that we so not see the deep nulls we see with the horizontal antennas. This is due to less interaction with the ground.

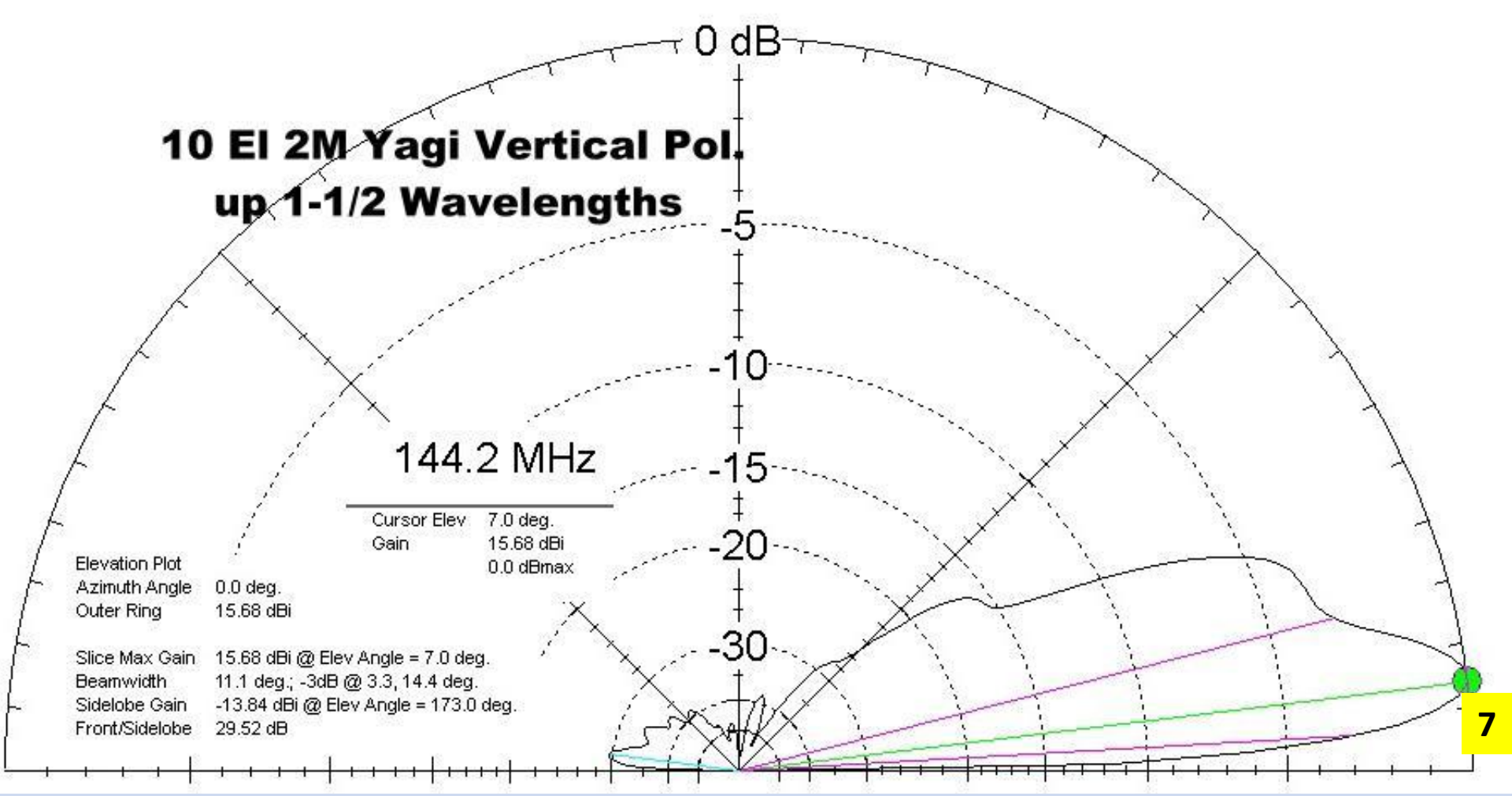
13.42 dBi Gain

H. Pol (17.52 dBi)



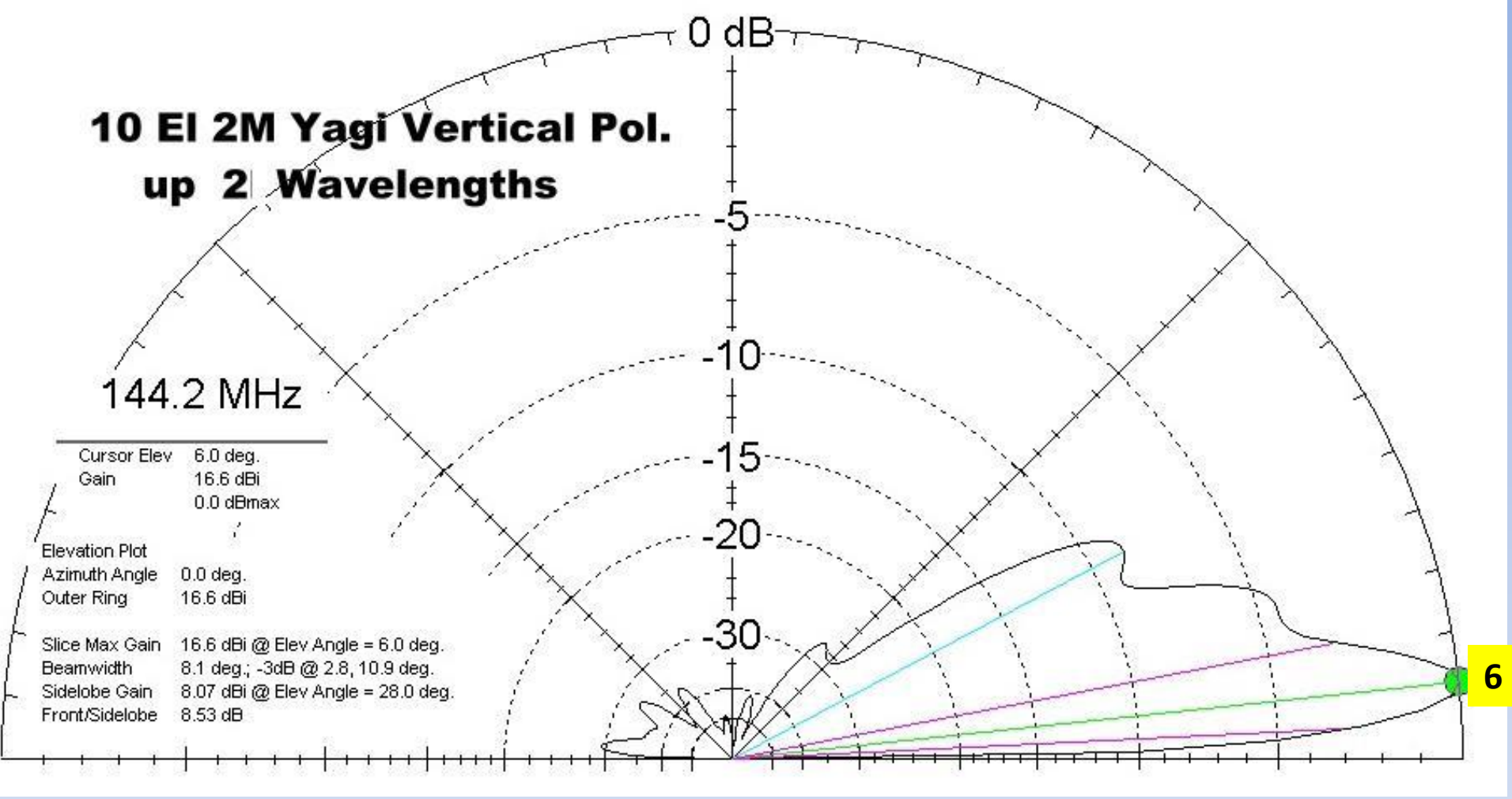
14.36 dBi Gain

H. Pol (18.36 dBi)



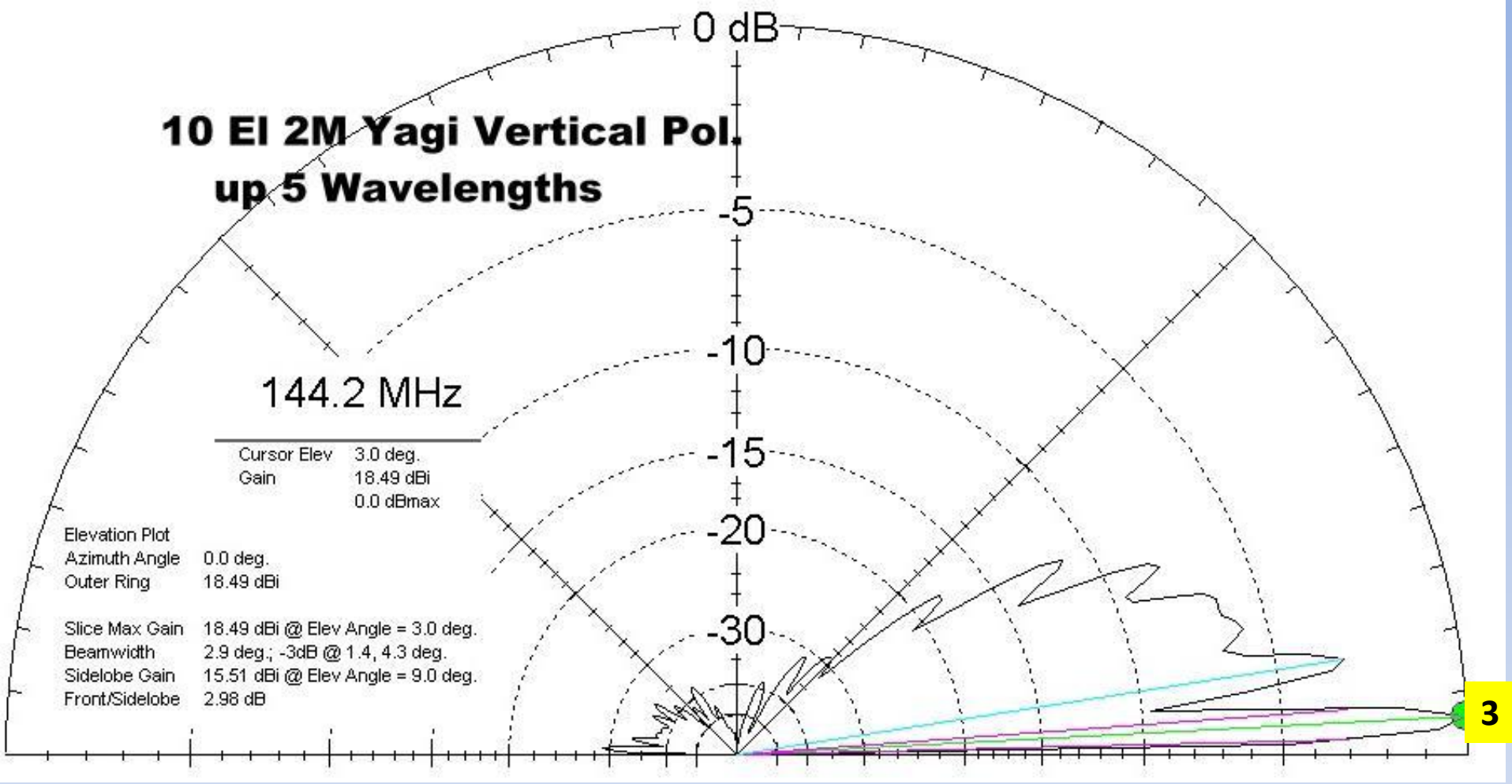
15.88 dBi Gain

H. Pol (~19 dBi)



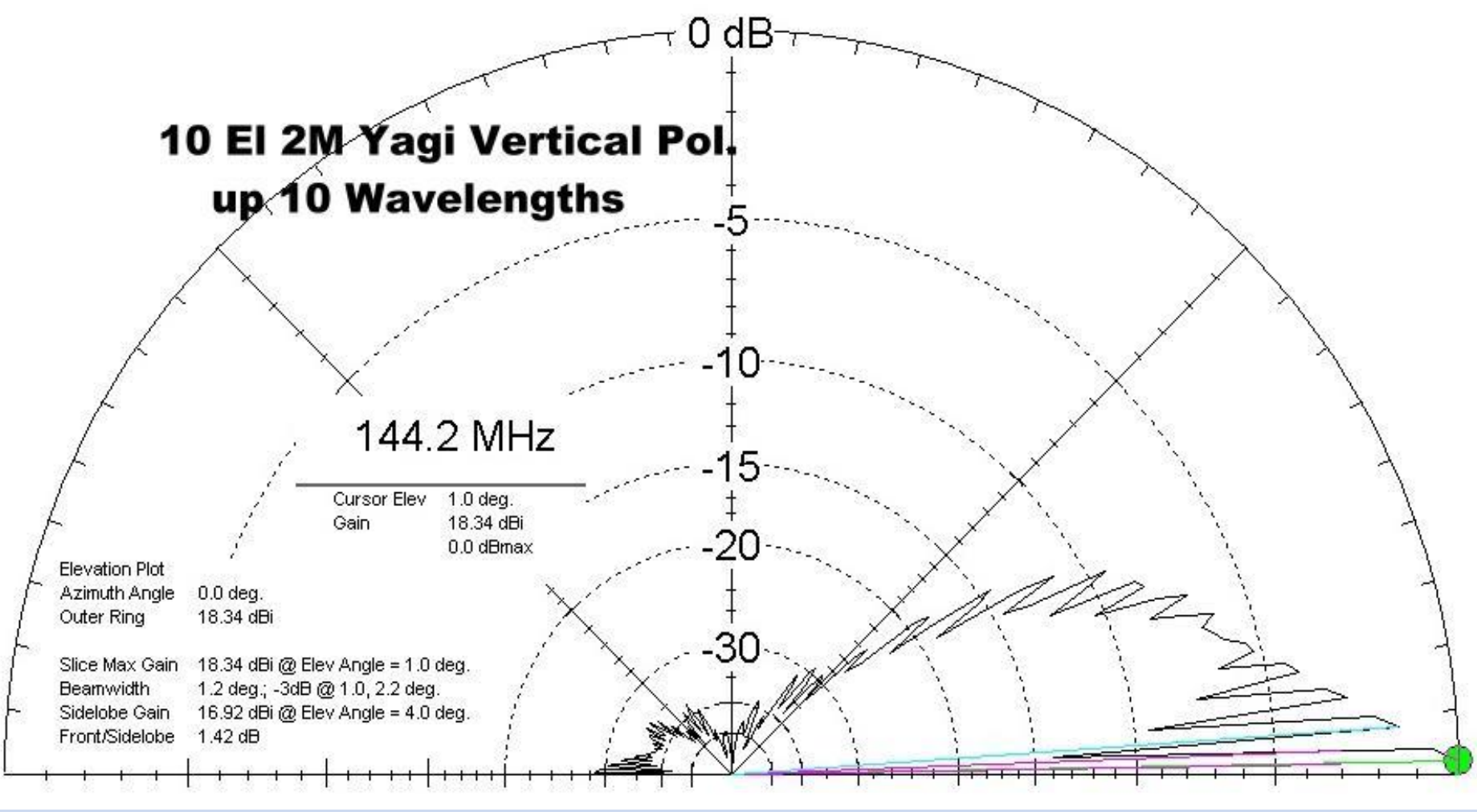
16.6 dBi Gain

H. Pol (19.5 dBi)



18.49 dBi Gain

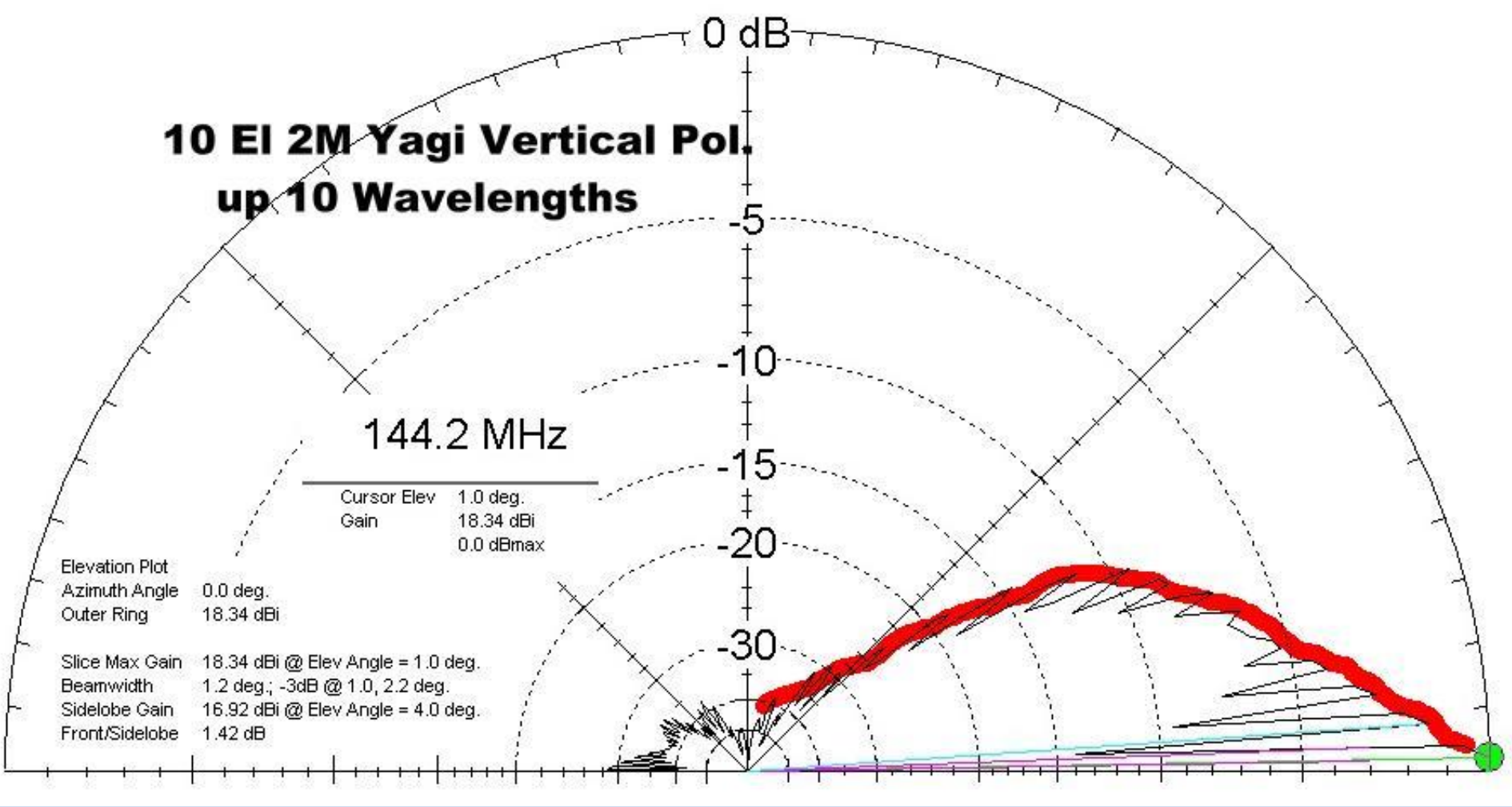
H. Pol (19.93 dBi)

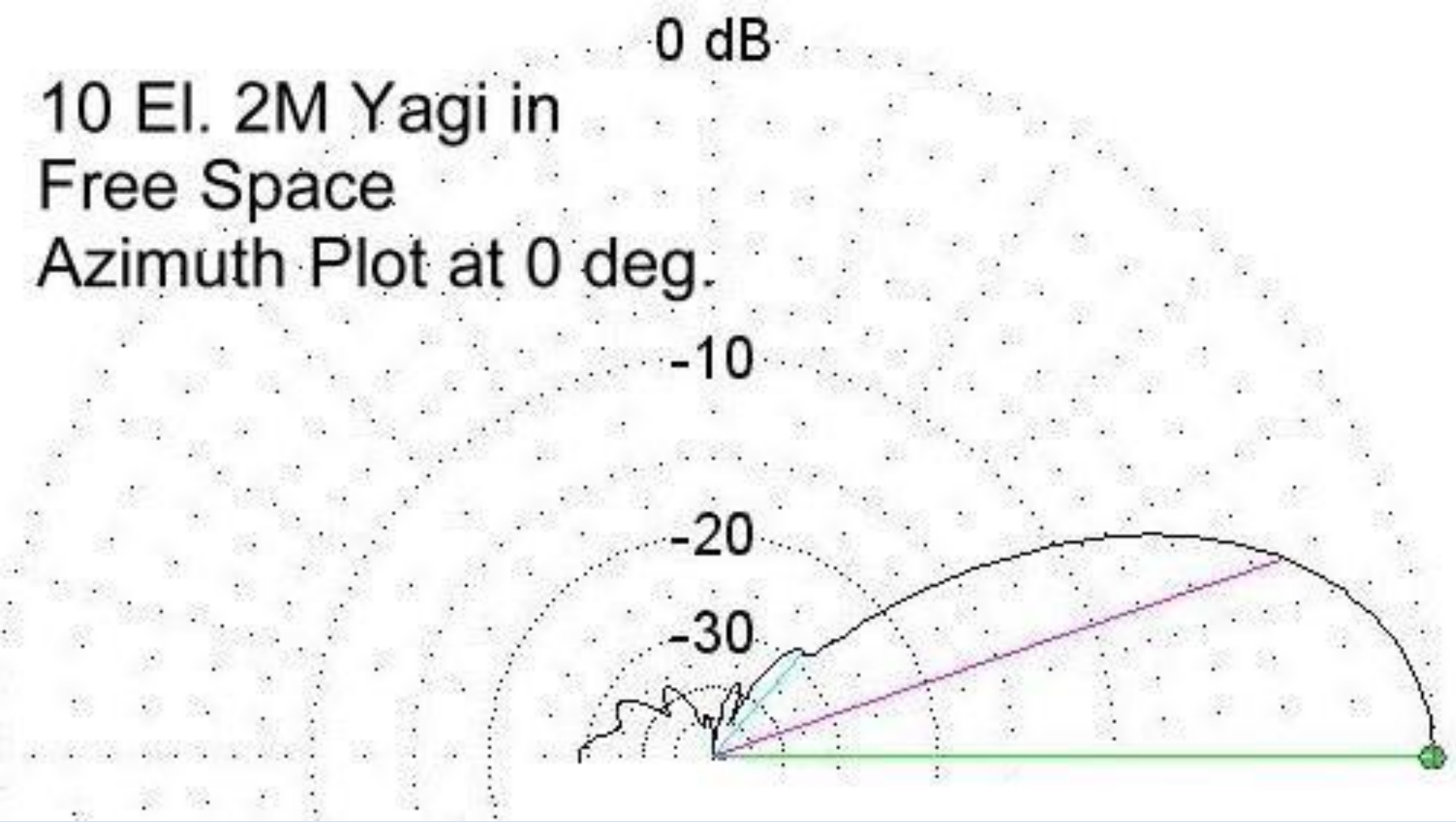


1

18.34 dBi Gain

H. Pol (18.85 dBi)


10 El 2M Yagi Vertical Pol.
up 10 Wavelengths
0 dB
-5
-10
-15
-20
-30
144.2 MHz
Cursor Elev 1.0 deg.
Gain 18.34 dBi
0.0 dBmax
Elevation Plot
Azimuth Angle 0.0 deg.
Outer Ring 18.34 dBi
Slice Max Gain 18.34 dBi @ Elev Angle = 1.0 deg.
Beamwidth 1.2 deg.; -3dB @ 1.0, 2.2 deg.
Sidelobe Gain 16.92 dBi @ Elev Angle = 4.0 deg.
Front/Sidelobe 1.42 dB


0 dB
10 El. 2M Yagi in
Free Space
Azimuth Plot at 0 deg.
-10
-20
-30

HEIGHT ABOVE GROUND	GAIN IN dBi		FIRST TAKEOFF ANGLE	LOBE
	10 EL -	10 EL		10 EL
		V POL	10 EL	V POL
Free space	14.1	14.1	0	0
1/2 WAVE	15.7	11.9	19	12
3/4 WAVE	17.5	13.4	16	10
1 WAVE	18.4	14.4	13	9
1-1/2 WAVE	19.2	15.9	9	7
2 WAVE	19.5	16.6	7	6
5 WAVE	19.9	18.5	3	3
10 WAVE	18.9	18.3	1	1

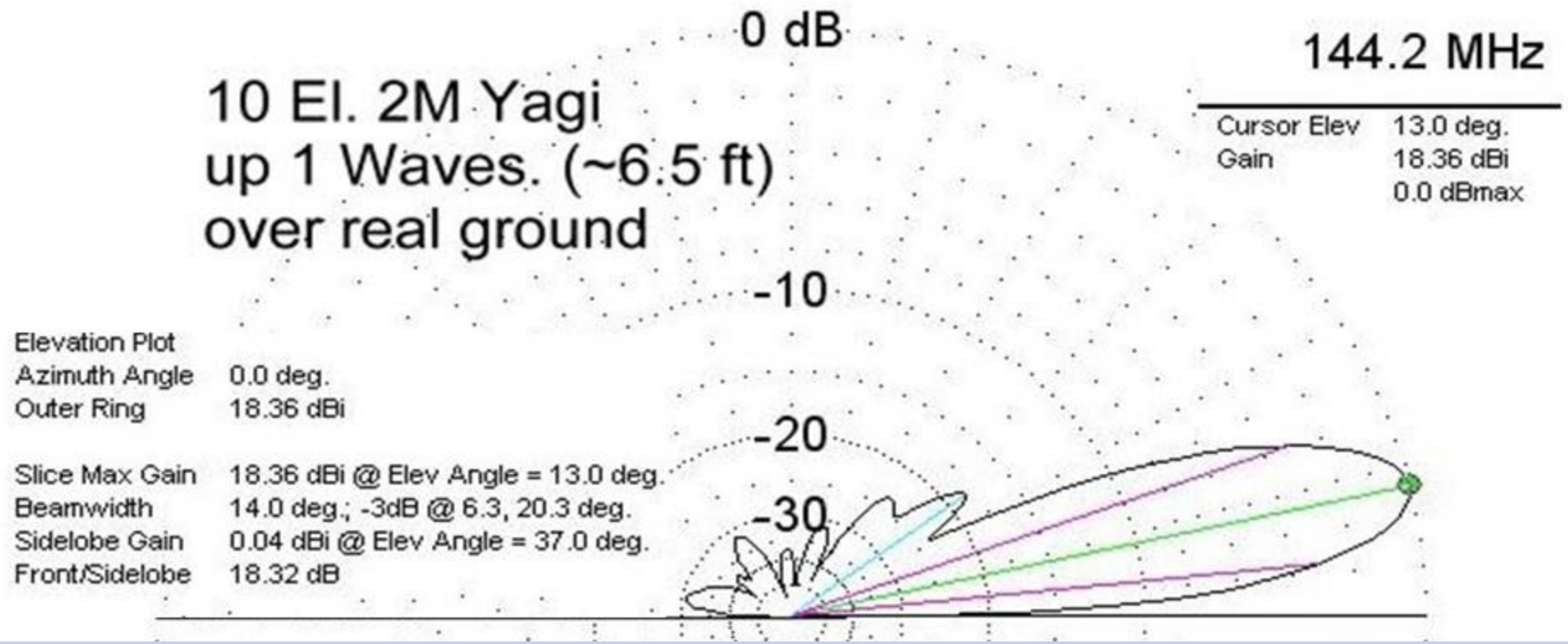
Let's see how this applies to antennas on various bands…

Will the takeoff angle be the same on every band for the same per-cent wavelength above ground?

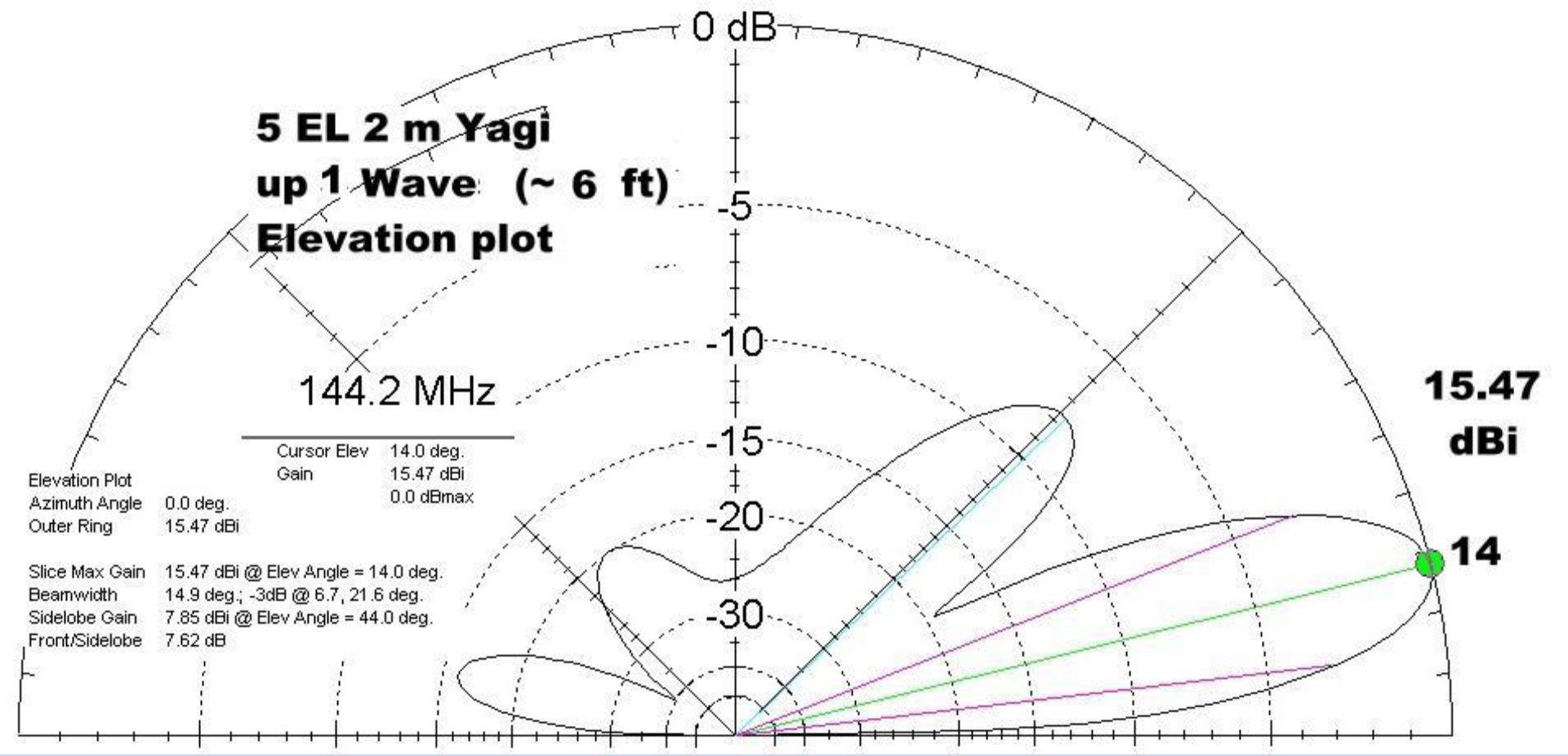
We will look at 2, 6 and 10 Meter yagis at 1, 2, and 5 wavelengths above ground.

What would you expect to see?

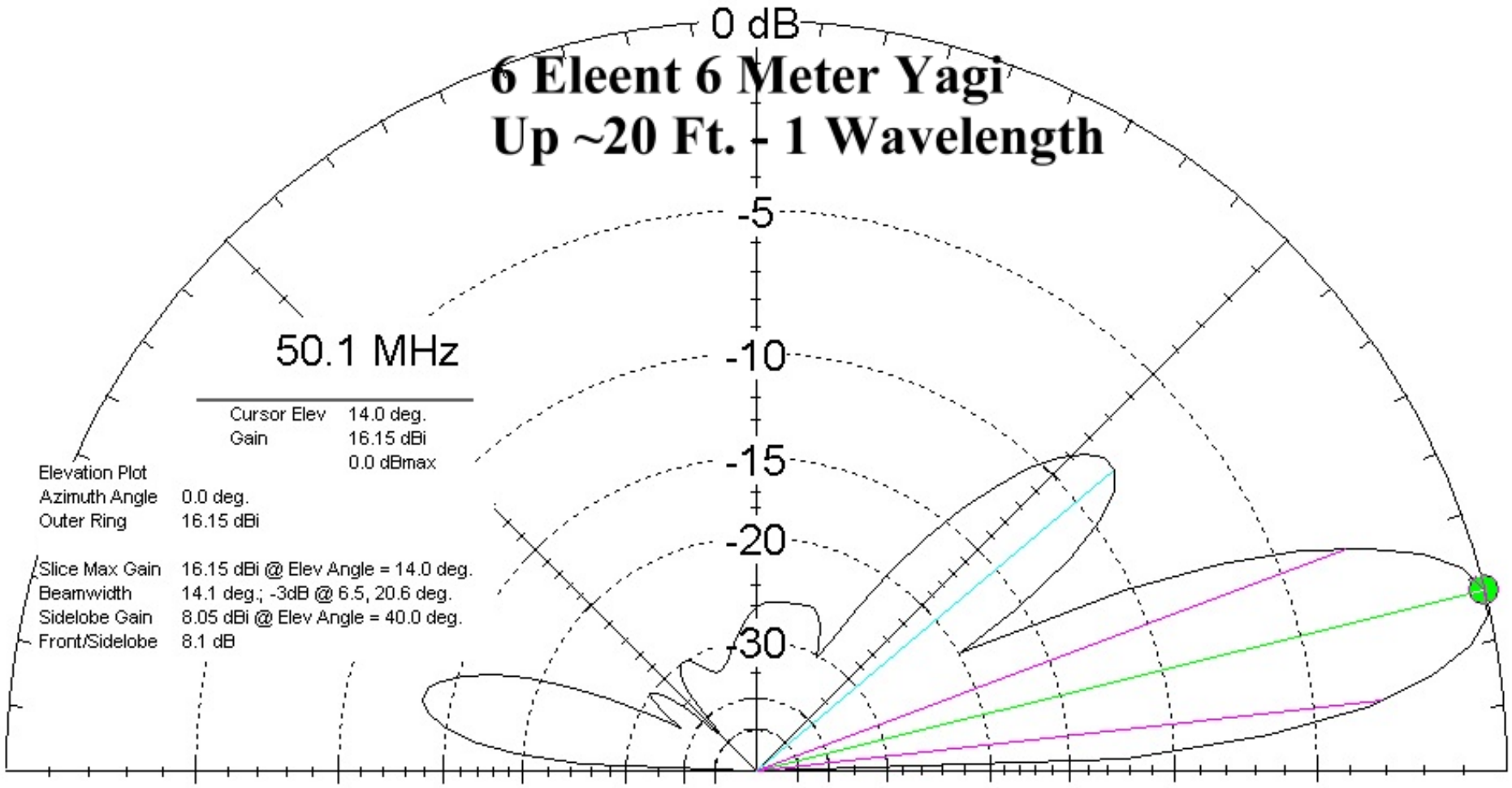
Yagis up one wavelength:



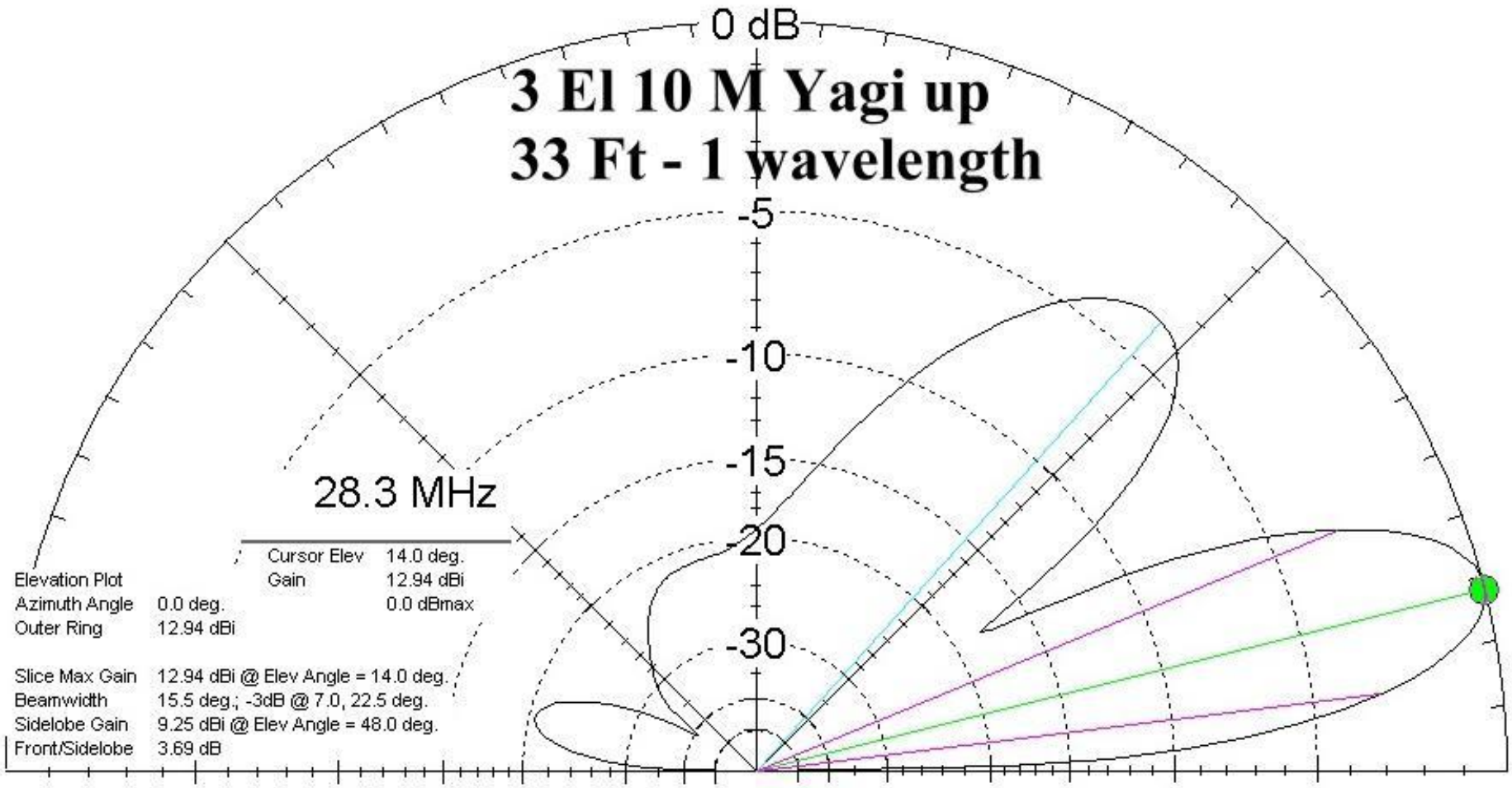
13 degrees
18.36 dBi



14 degrees
15.47 dBi



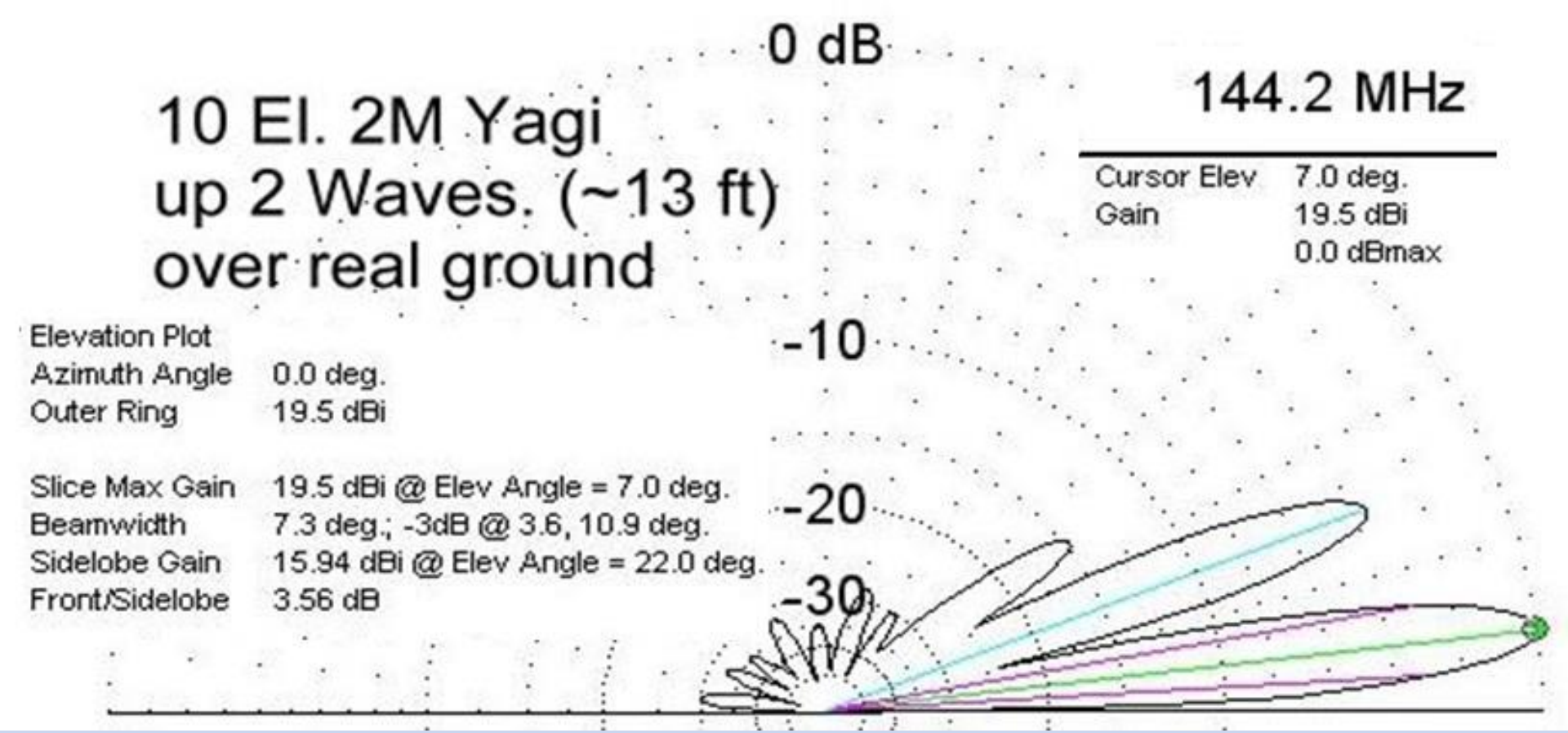
14 degrees
16.15 dBi



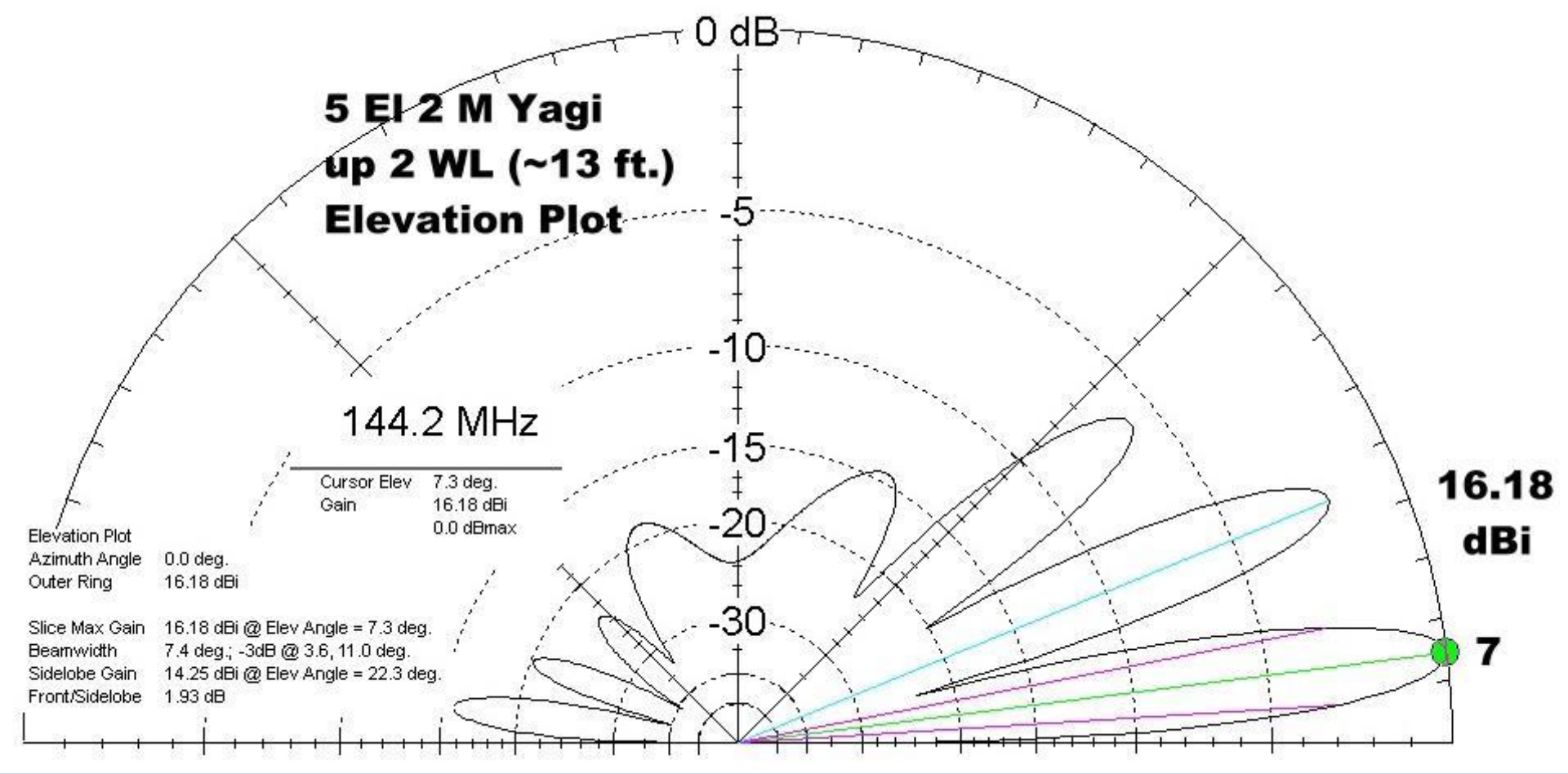
14 degrees
12.94 dBi

NOTE: a 40 M dipole up 1 wavelength
Has its major lobe at 15 degrees

Let’s go up to two wavelengths:

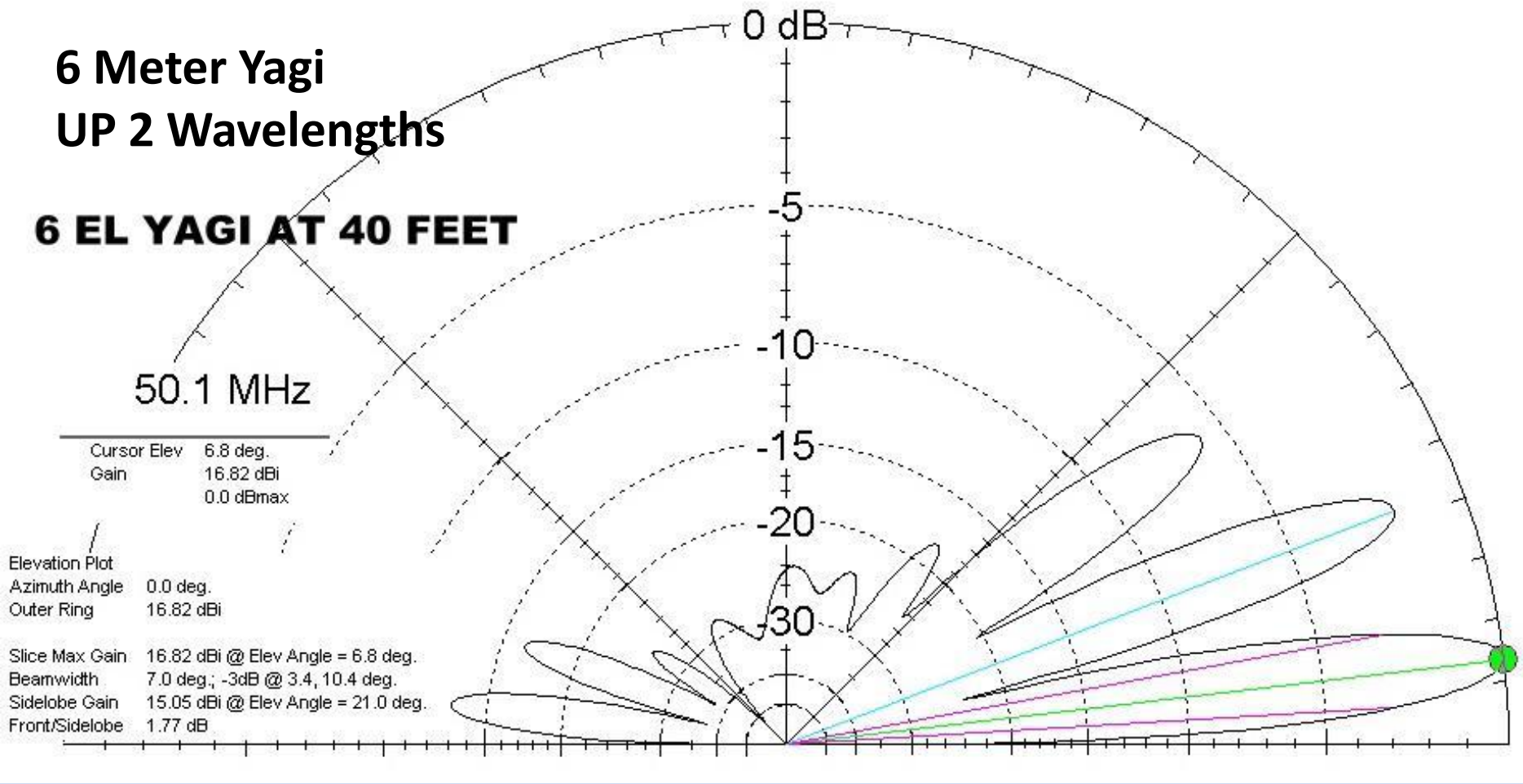

10 El. 2M Yagi
up 2 Waves. (~13 ft)
over real ground
144.2 MHz
Cursor Elev 7.0 deg.
Gain 19.5 dBi
0.0 dBmax
Elevation Plot
Azimuth Angle 0.0 deg.
Outer Ring 19.5 dBi
Slice Max Gain 19.5 dBi @ Elev Angle = 7.0 deg.
Beamwidth 7.3 deg.; -3dB @ 3.6, 10.9 deg.
Sidelobe Gain 15.94 dBi @ Elev Angle = 22.0 deg.
Front/Sidelobe 3.56 dB
0 dB
-10
-20
-30

7 Deg.
19.5 dBi

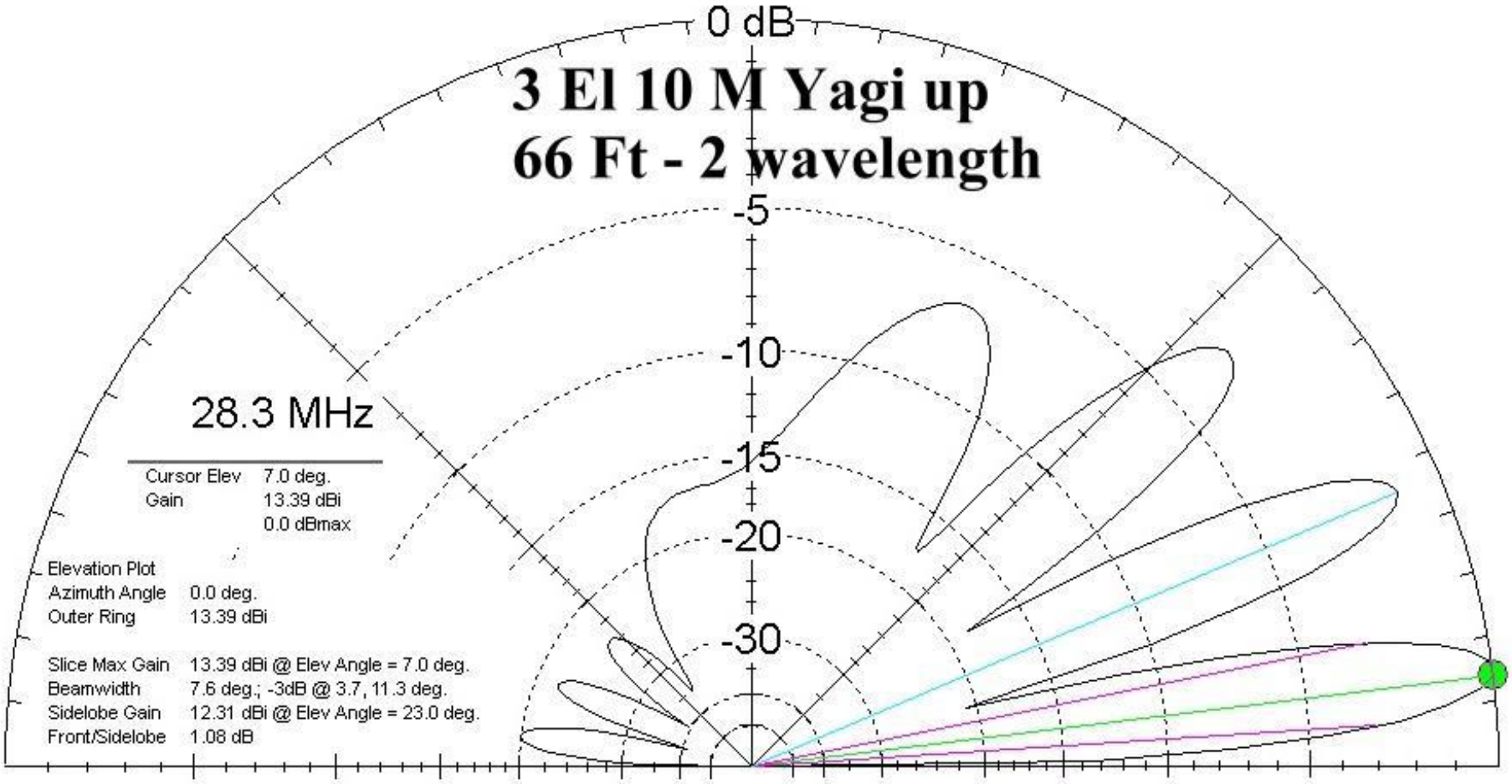


7 degrees
16.18 dBi

6 Meter Yagi
UP 2 Wavelengths



6.8 Deg.
16.8 dBi

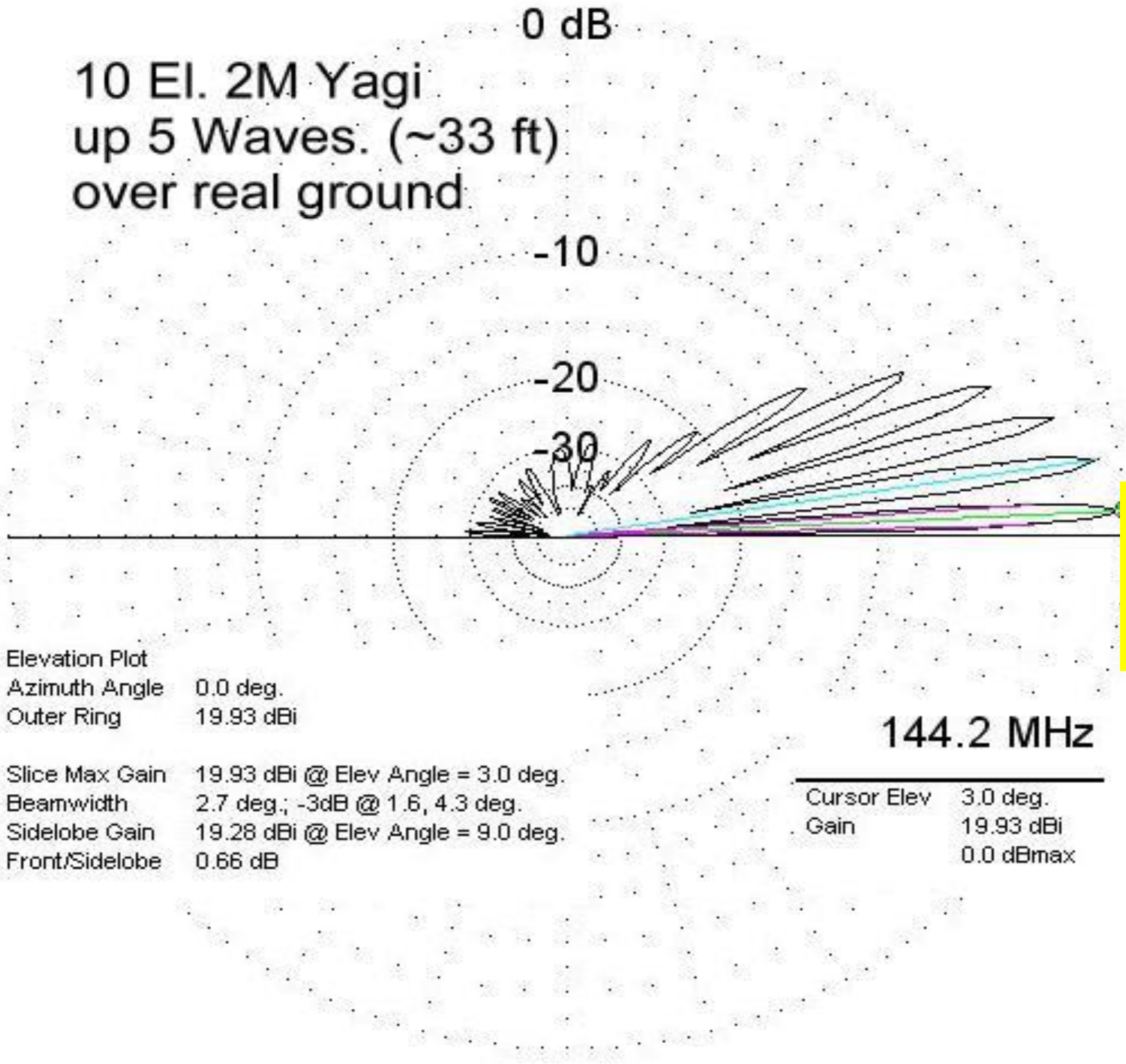


7 degrees
13.39 dBi

NOTE: a 40 Meter dipole up 2 wavelengths
Has its major lobe at 7 degrees

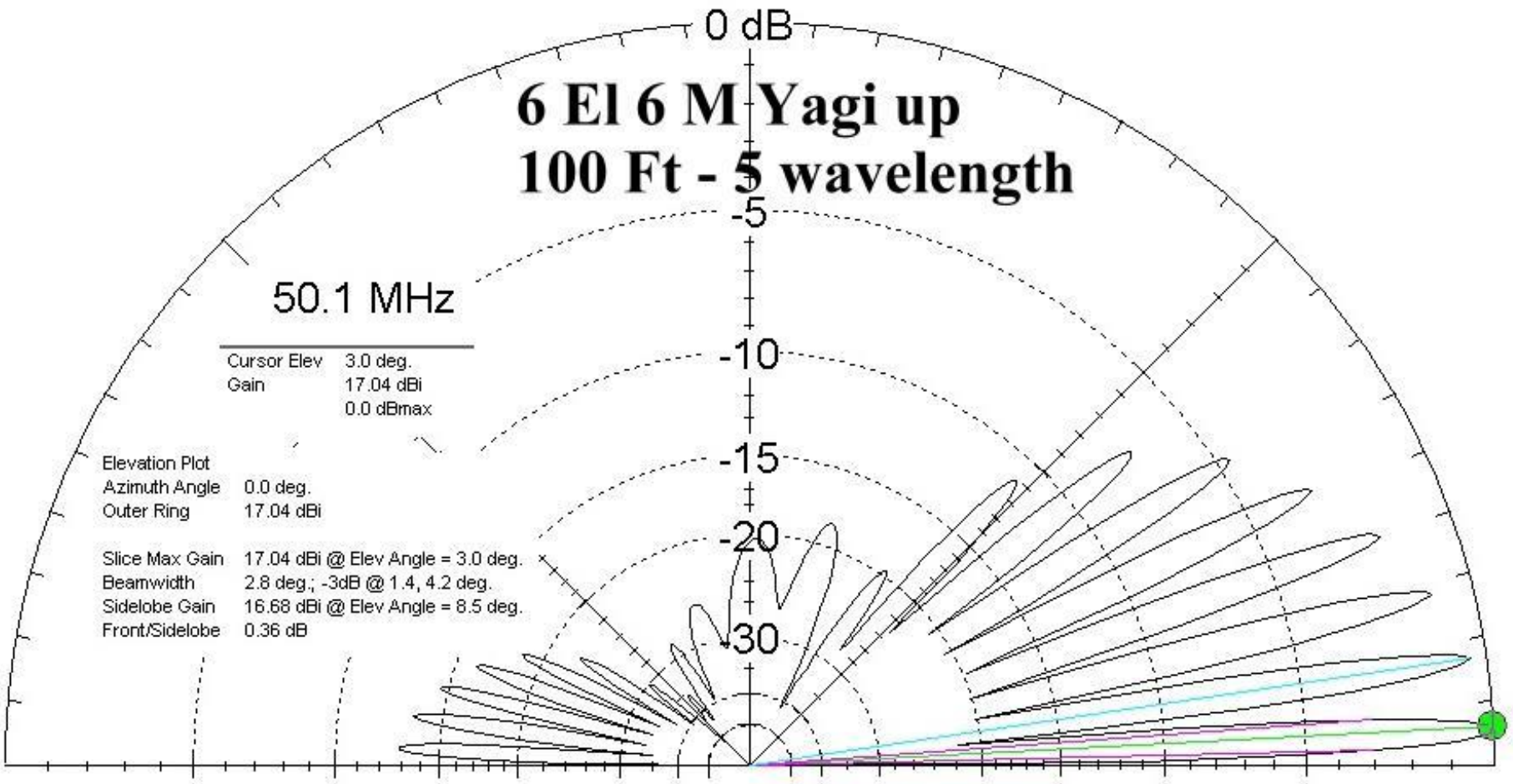
Now, what would you expect

if we go up five wavelengths?



3 Deg.

19.93 dBi Gain



3 Degrees
17 dBi

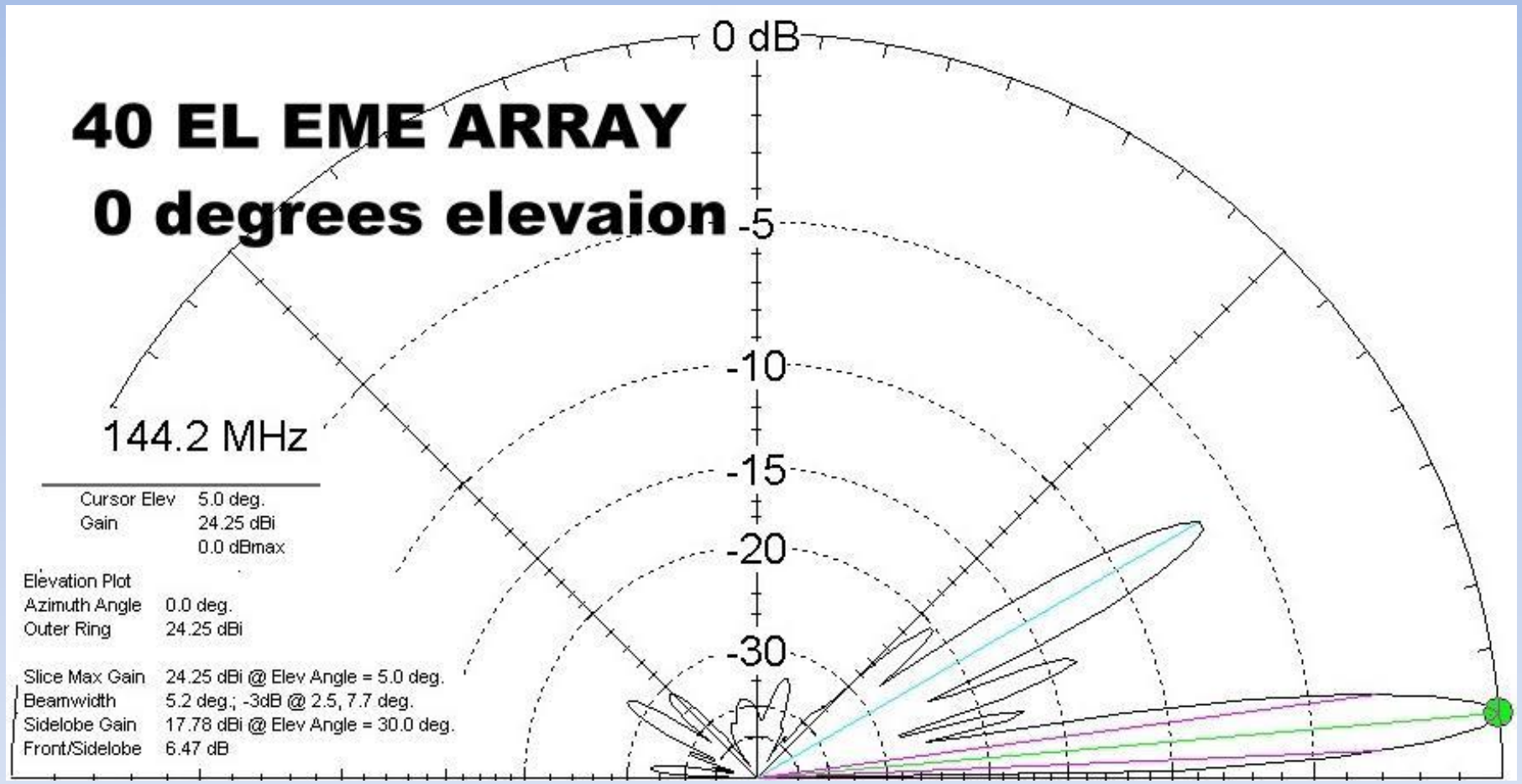
Just for fun, I have modeled my

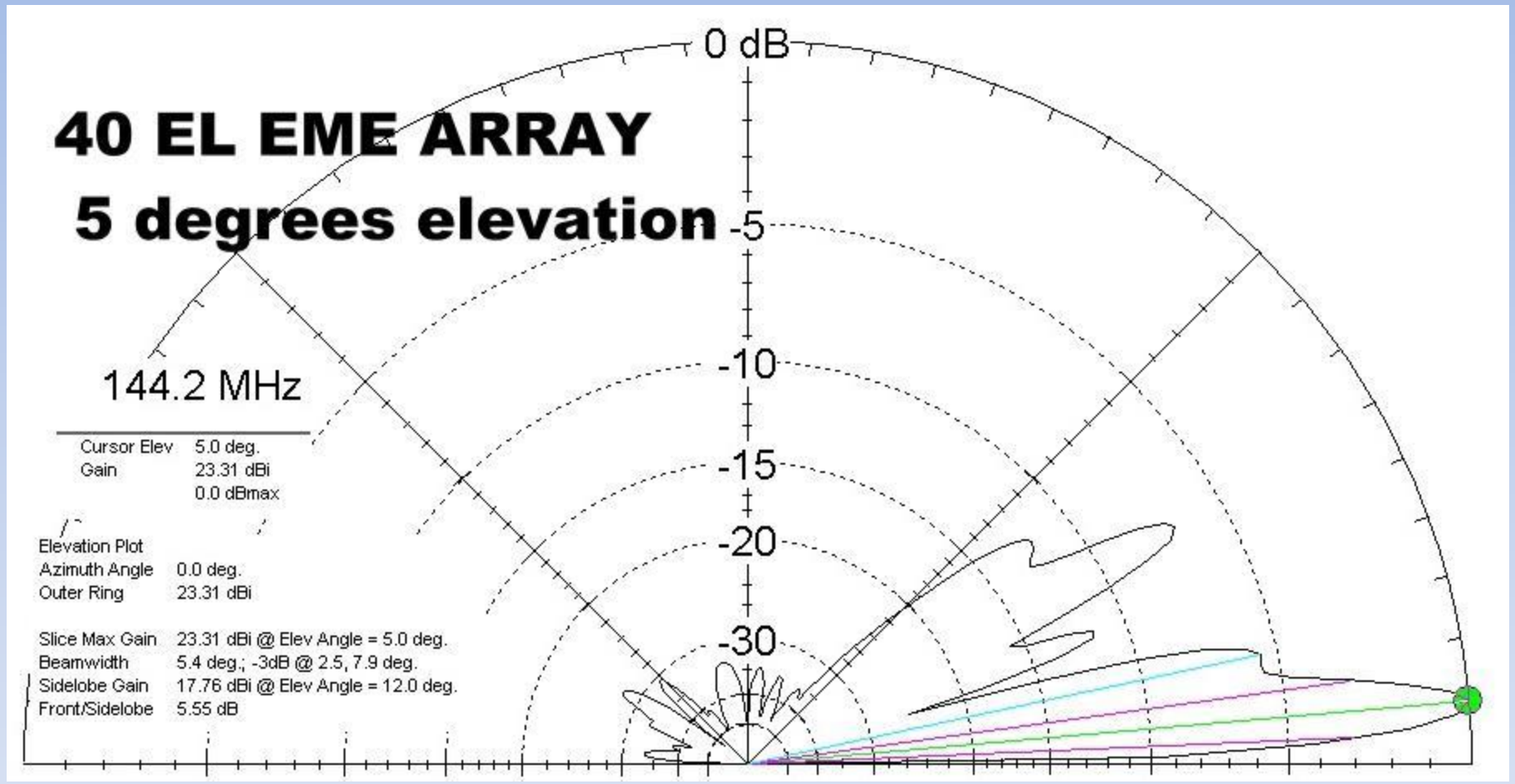
4 bay 2 meter array used for EME

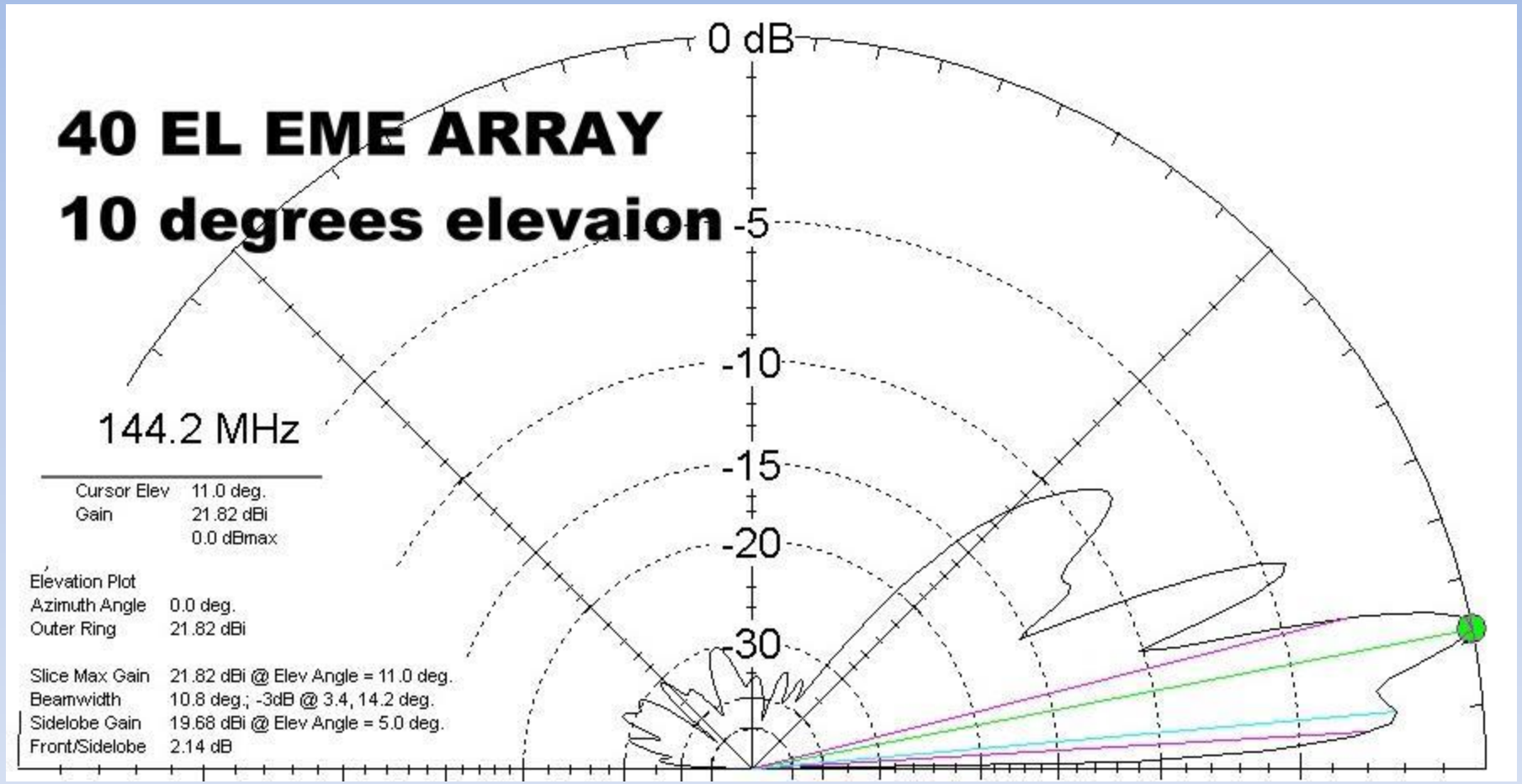
4 x 20 elements in a 12 foot square

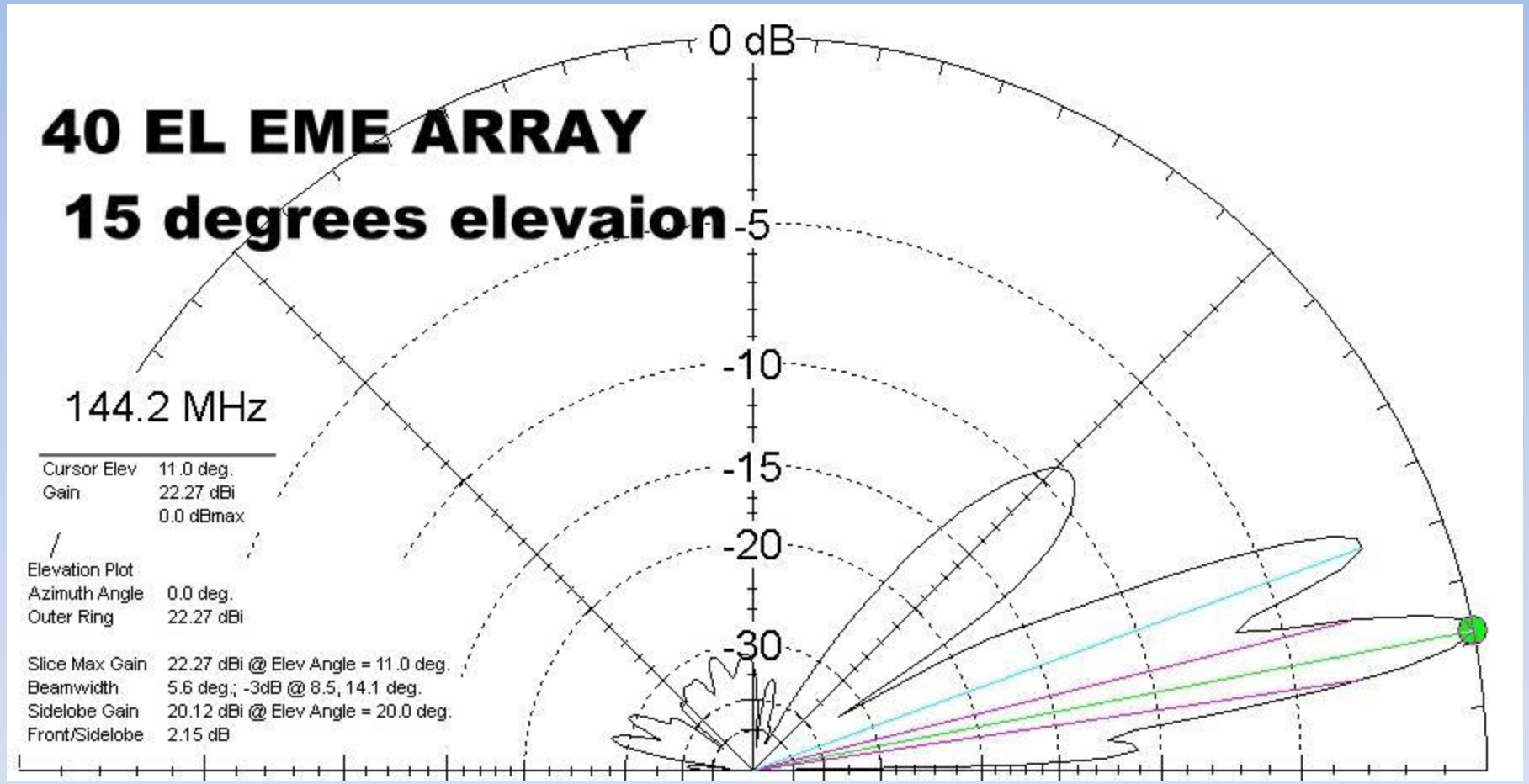
I only show the Horizontal Polarization plots…

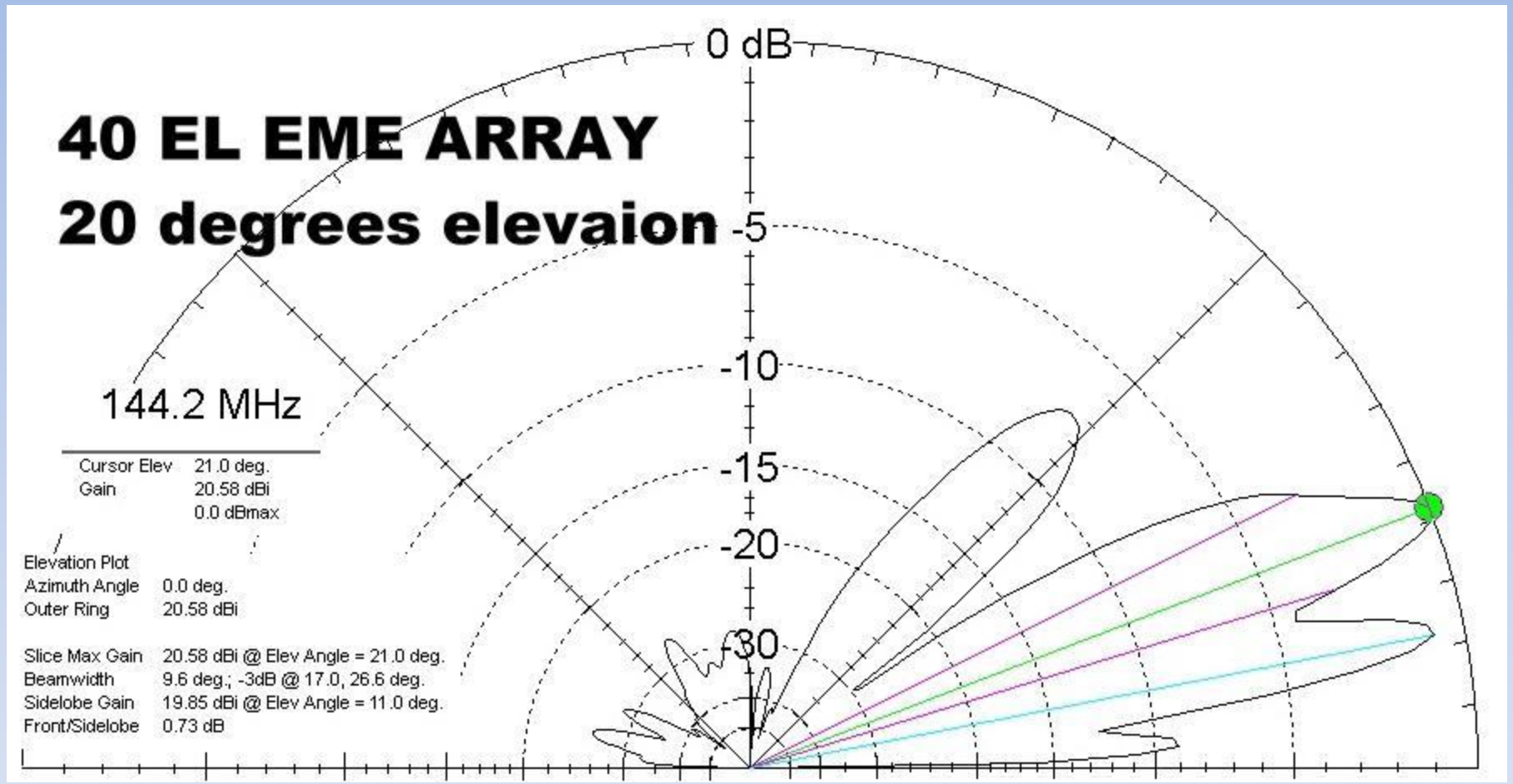
The lower 2 antennas are up 8 ft and he upper 2 are up 20 ft… The effective array height is 14 ft. or just over 2 WL high.

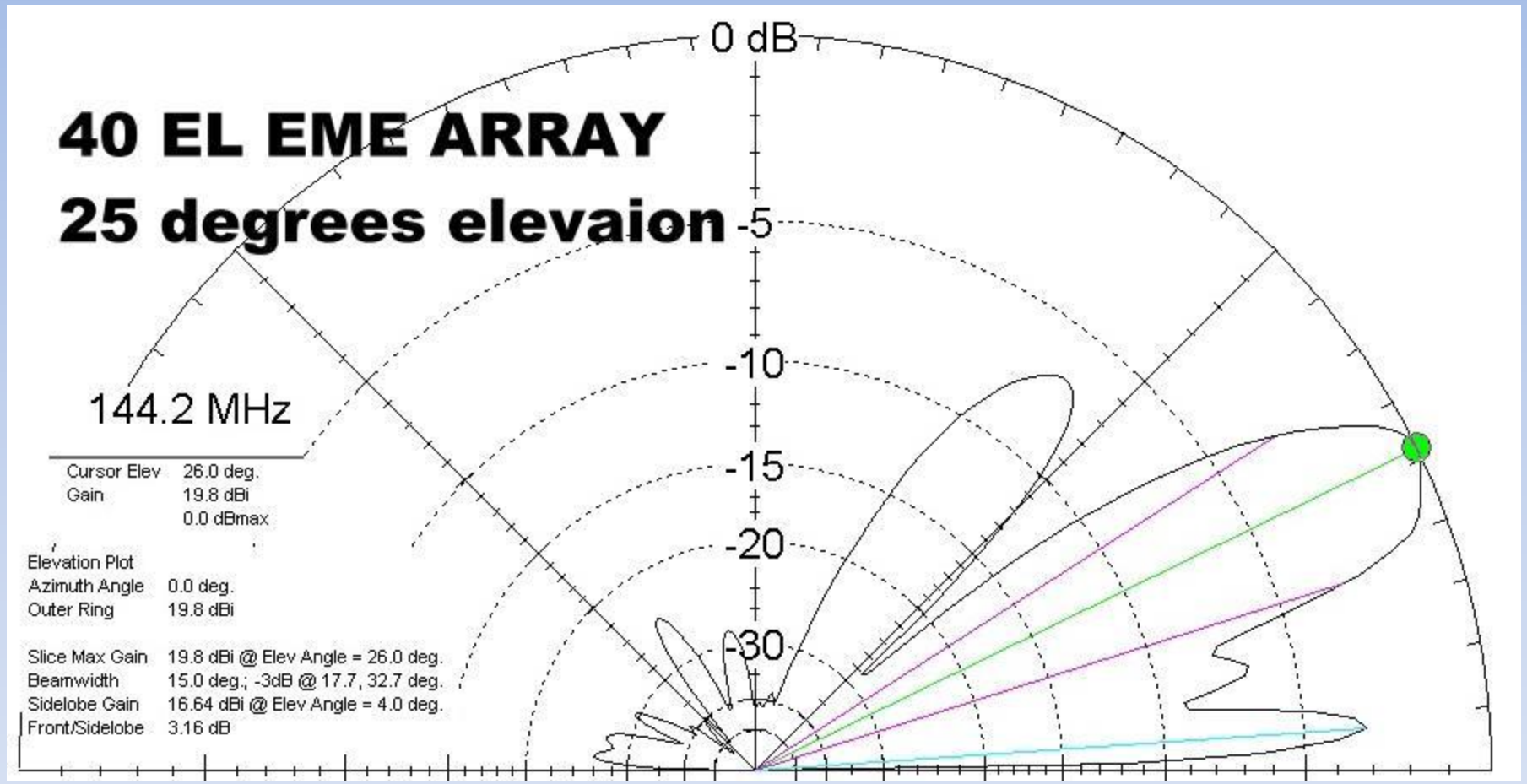

40 EL EME ARRAY
0 degrees elevaion
144.2 MHz
Cursor Elev 5.0 deg.
Gain 24.25 dBi
0.0 dBmax
Elevation Plot
Azimuth Angle 0.0 deg.
Outer Ring 24.25 dBi
Slice Max Gain 24.25 dBi @ Elev Angle = 5.0 deg.
Beamwidth 5.2 deg.; -3dB @ 2.5, 7.7 deg.
Sidelobe Gain 17.78 dBi @ Elev Angle = 30.0 deg.
Front/Sidelobe 6.47 dB
0 dB
-5
-10
-15
-20
-30

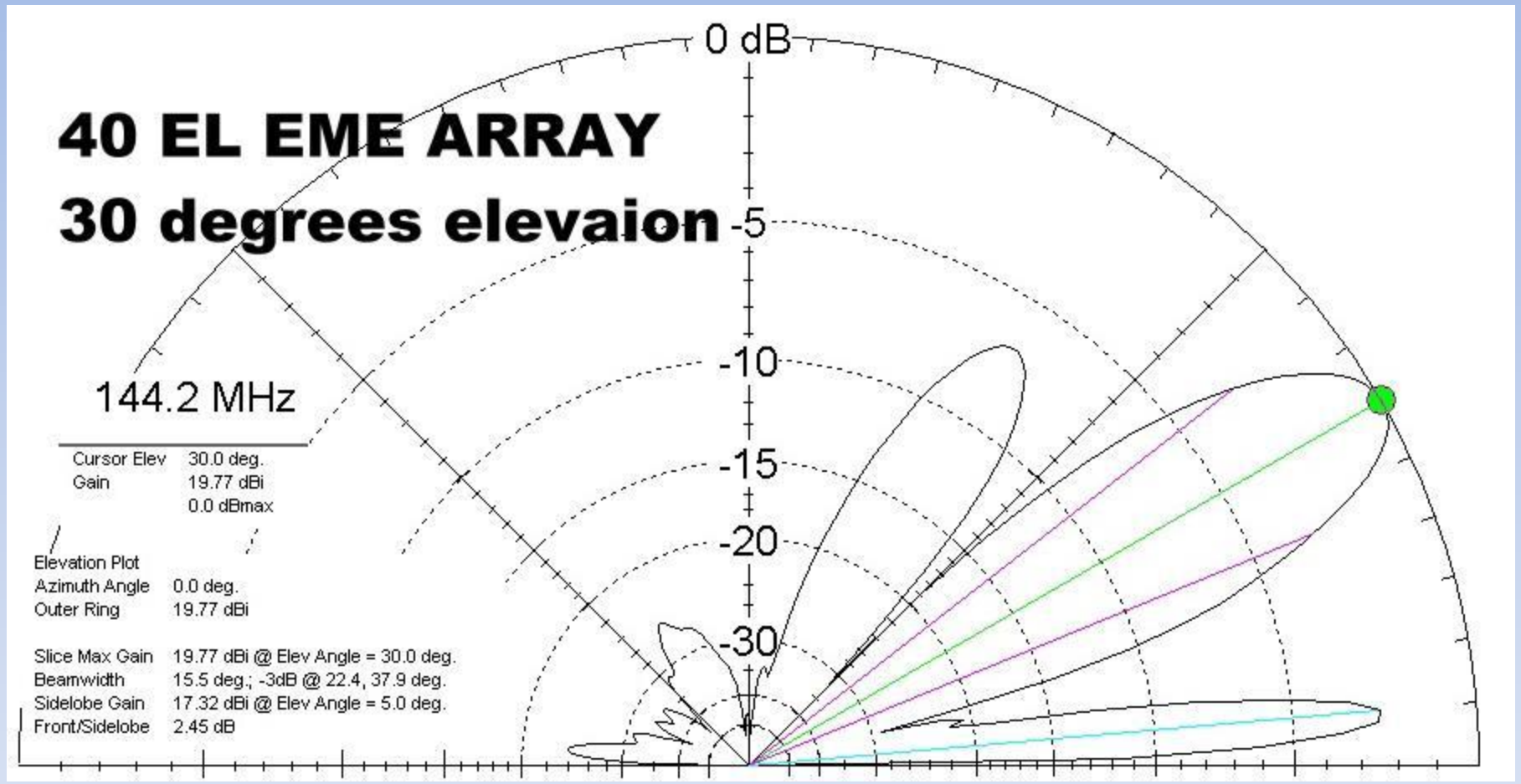

40 EL EME ARRAY
5 degrees elevation
144.2 MHz
Cursor Elev 5.0 deg.
Gain 23.31 dBi
0.0 dBmax
Elevation Plot
Azimuth Angle 0.0 deg.
Outer Ring 23.31 dBi
Slice Max Gain 23.31 dBi @ Elev Angle = 5.0 deg.
Beamwidth 5.4 deg.; -3dB @ 2.5, 7.9 deg.
Sidelobe Gain 17.76 dBi @ Elev Angle = 12.0 deg.
Front/Sidelobe 5.55 dB
0 dB
-5
-10
-15
-20
-30

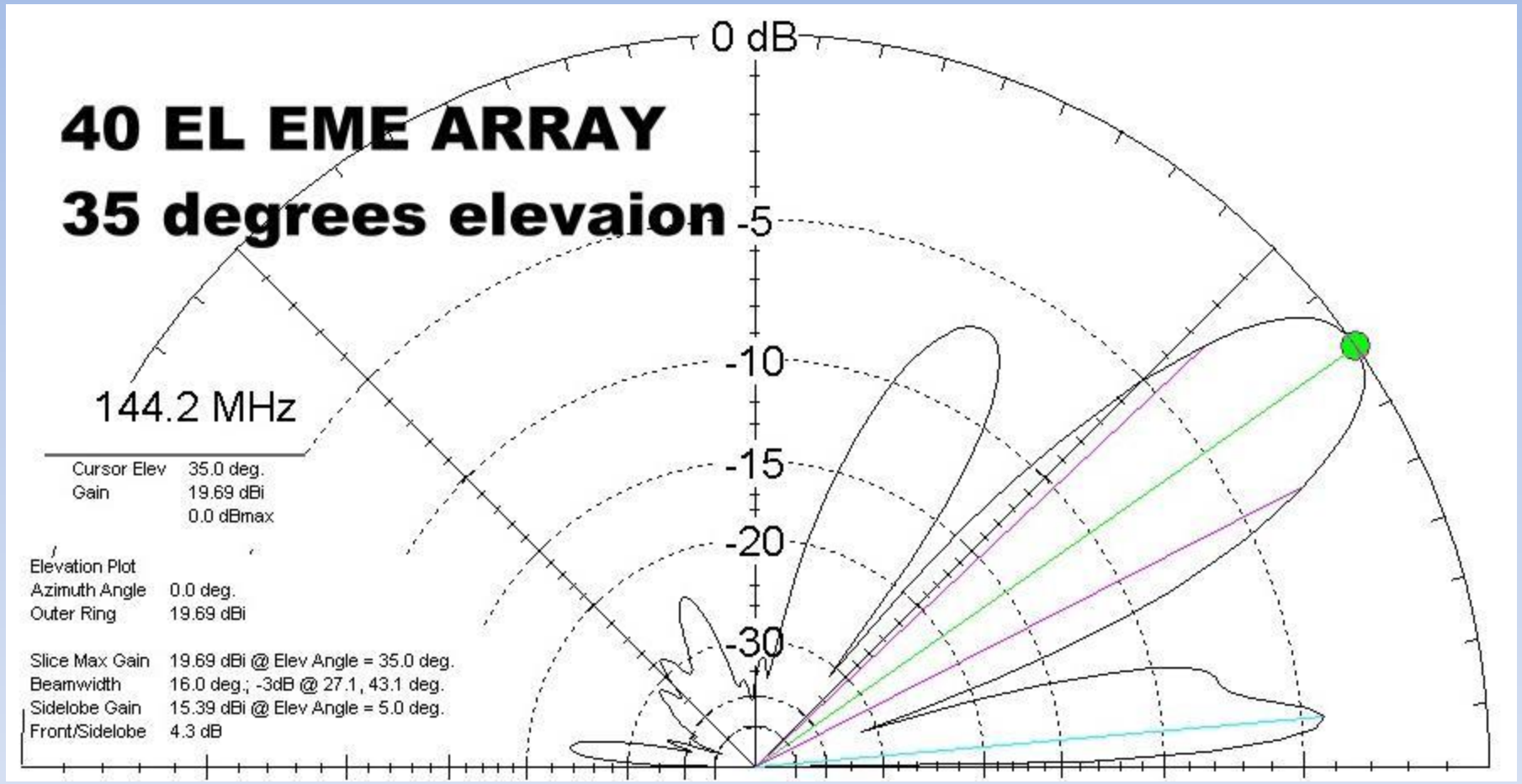

40 EL EME ARRAY
10 degrees elevaion
144.2 MHz
Cursor Elev 11.0 deg.
Gain 21.82 dBi
0.0 dBmax
Elevation Plot
Azimuth Angle 0.0 deg.
Outer Ring 21.82 dBi
Slice Max Gain 21.82 dBi @ Elev Angle = 11.0 deg.
Beamwidth 10.8 deg.; -3dB @ 3.4, 14.2 deg.
Sidelobe Gain 19.68 dBi @ Elev Angle = 5.0 deg.
Front/Sidelobe 2.14 dB
0 dB
-5
-10
-15
-20
-30

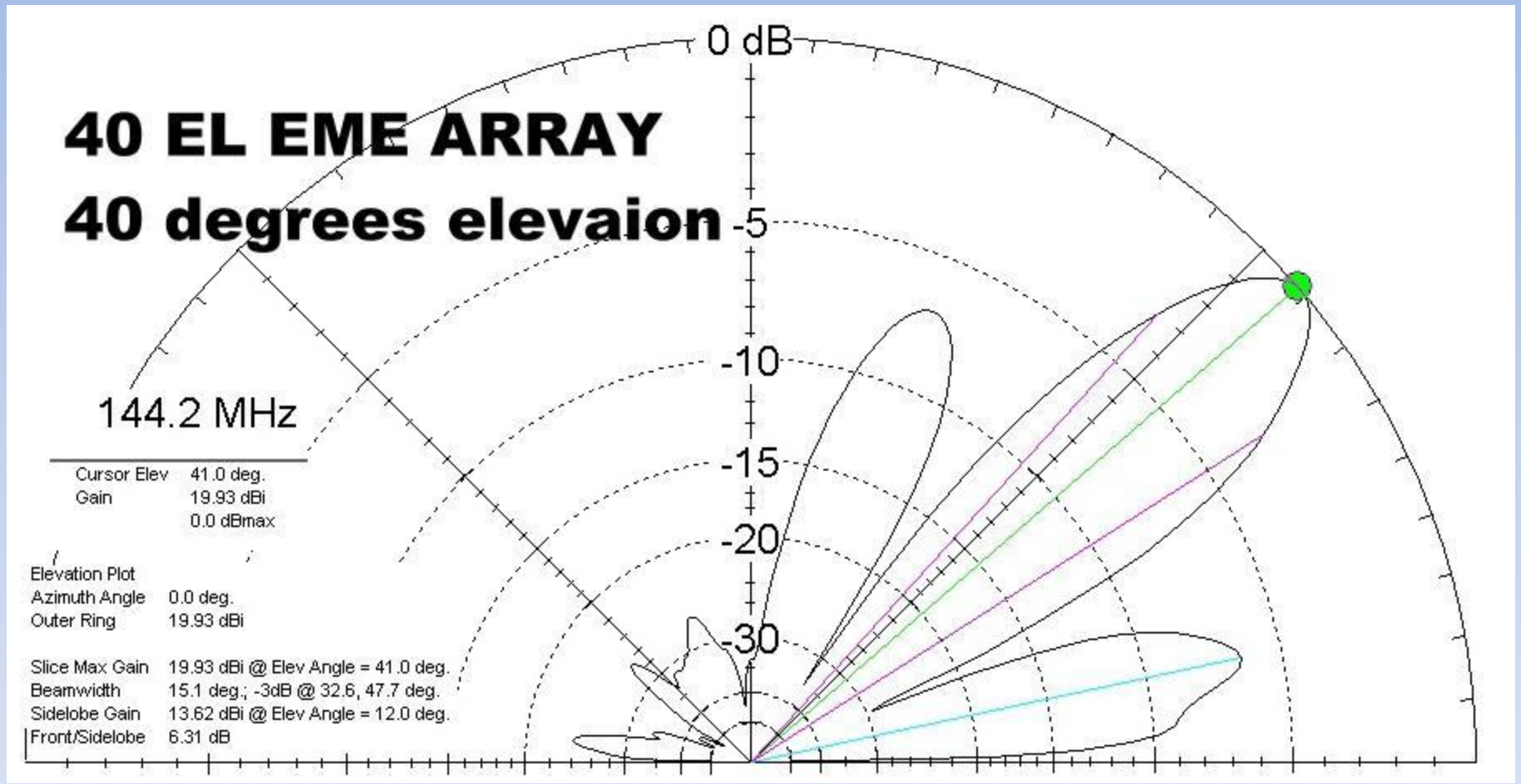

40 EL EME ARRAY
15 degrees elevaion
144.2 MHz
Cursor Elev 11.0 deg.
Gain 22.27 dBi
0.0 dBmax
Elevation Plot
Azimuth Angle 0.0 deg.
Outer Ring 22.27 dBi
Slice Max Gain 22.27 dBi @ Elev Angle = 11.0 deg.
Beamwidth 5.6 deg.; -3dB @ 8.5, 14.1 deg.
Sidelobe Gain 20.12 dBi @ Elev Angle = 20.0 deg.
Front/Sidelobe 2.15 dB
0 dB
-5
-10
-15
-20
-30

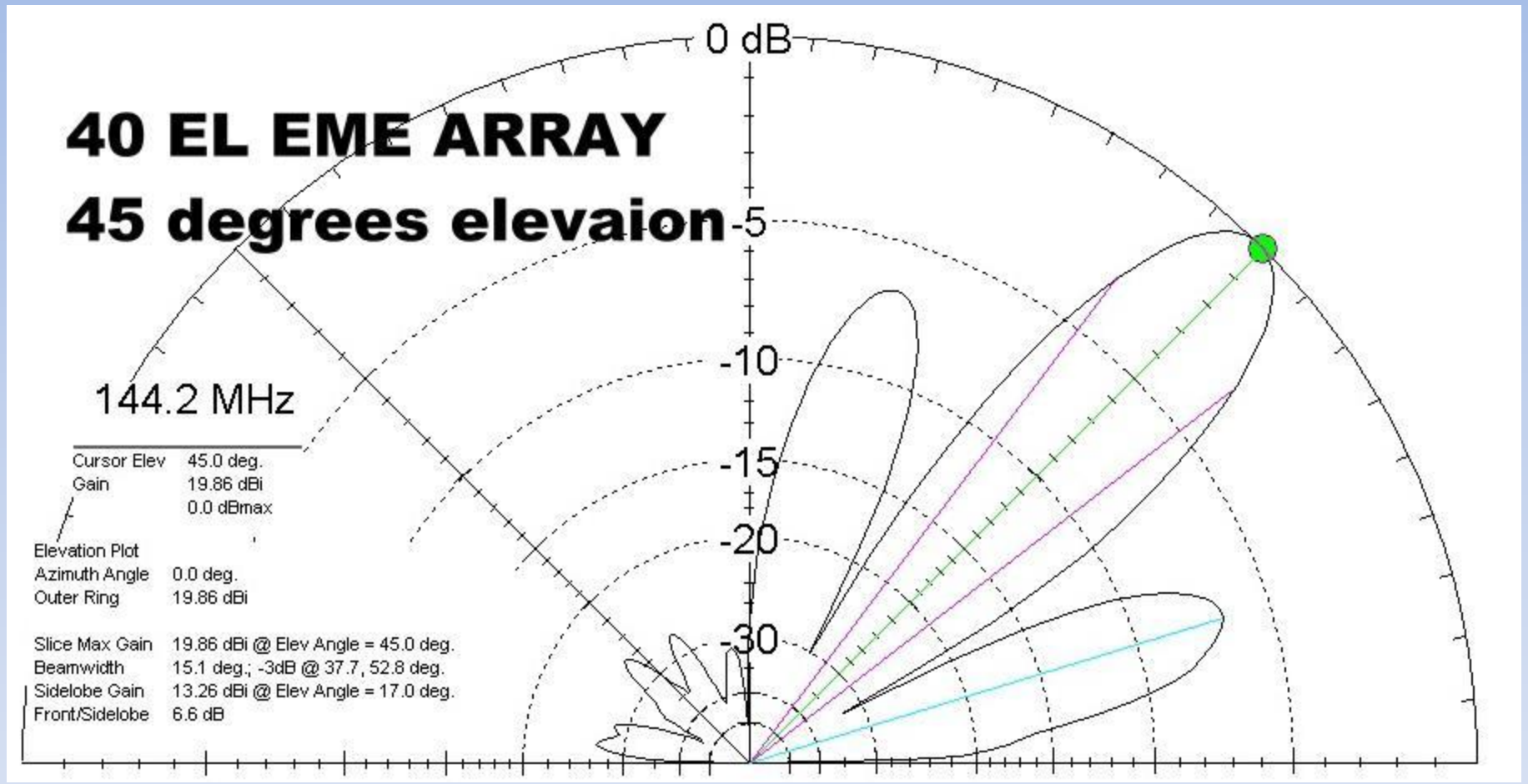

40 EL EME ARRAY
20 degrees elevaion
144.2 MHz
Cursor Elev 21.0 deg.
Gain 20.58 dBi
0.0 dBmax
Elevation Plot
Azimuth Angle 0.0 deg.
Outer Ring 20.58 dBi
Slice Max Gain 20.58 dBi @ Elev Angle = 21.0 deg.
Beamwidth 9.6 deg.; -3dB @ 17.0, 26.6 deg.
Sidelobe Gain 19.85 dBi @ Elev Angle = 11.0 deg.
Front/Sidelobe 0.73 dB
0 dB
-5
-10
-15
-20
-30

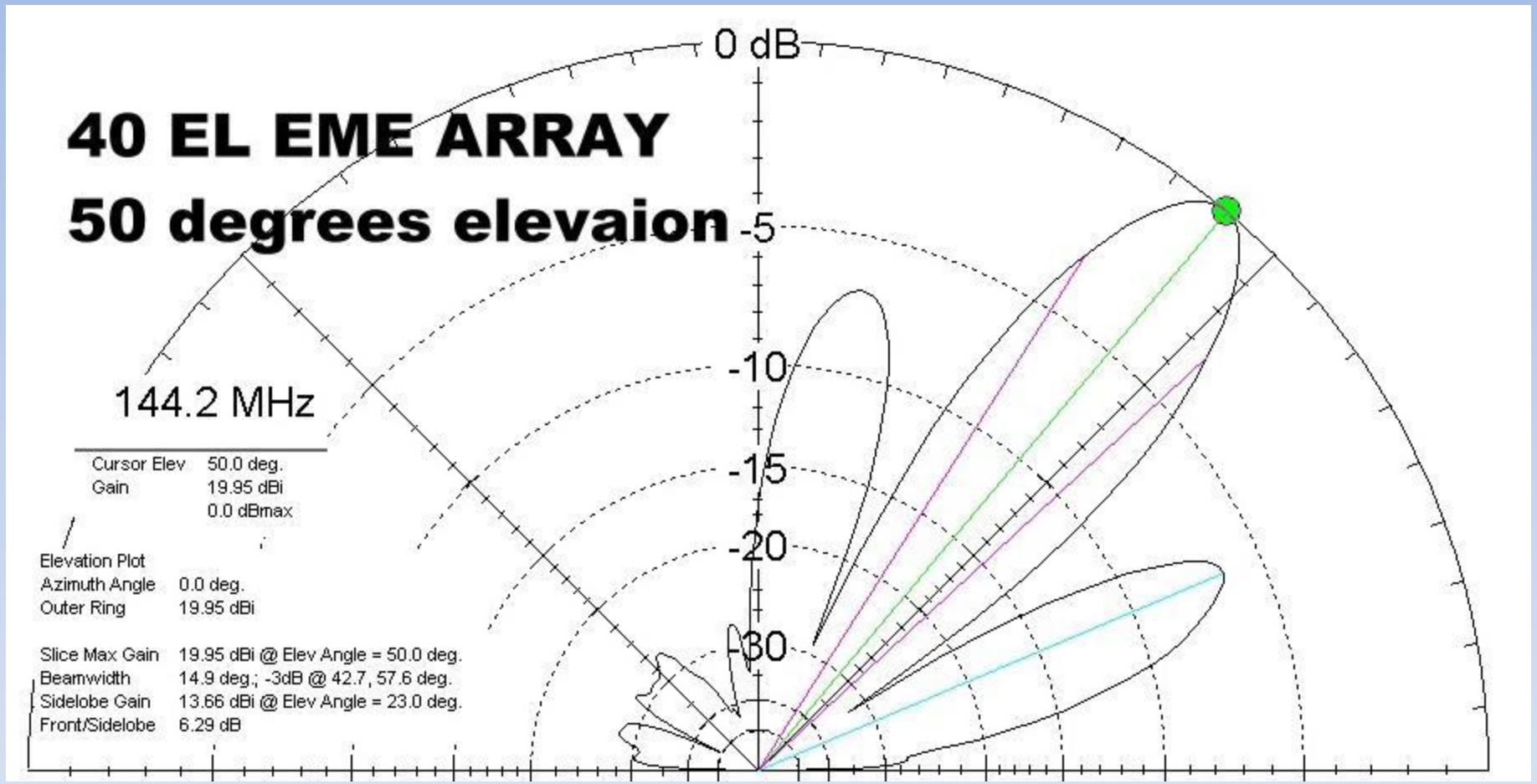

40 EL EME ARRAY
25 degrees elevaion
144.2 MHz
Cursor Elev 26.0 deg.
Gain 19.8 dBi
0.0 dBmax
Elevation Plot
Azimuth Angle 0.0 deg.
Outer Ring 19.8 dBi
Slice Max Gain 19.8 dBi @ Elev Angle = 26.0 deg.
Beamwidth 15.0 deg.; -3dB @ 17.7, 32.7 deg.
Sidelobe Gain 16.64 dBi @ Elev Angle = 4.0 deg.
Front/Sidelobe 3.16 dB
0 dB
-5
-10
-15
-20
-30

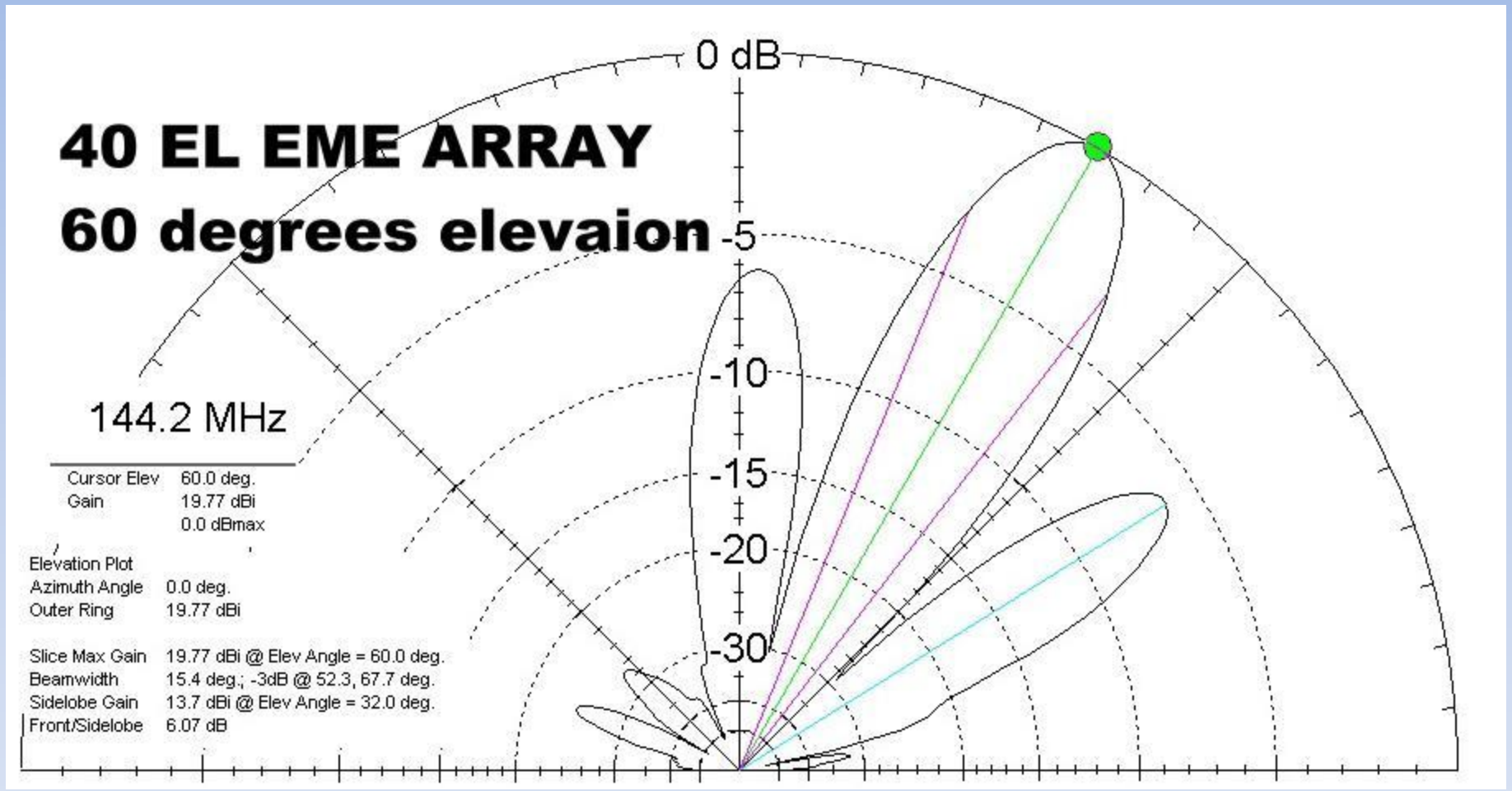

40 EL EME ARRAY
30 degrees elevaion
144.2 MHz
Cursor Elev 30.0 deg.
Gain 19.77 dBi
0.0 dBmax
Elevation Plot
Azimuth Angle 0.0 deg.
Outer Ring 19.77 dBi
Slice Max Gain 19.77 dBi @ Elev Angle = 30.0 deg.
Beamwidth 15.5 deg.; -3dB @ 22.4, 37.9 deg.
Sidelobe Gain 17.32 dBi @ Elev Angle = 5.0 deg.
Front/Sidelobe 2.45 dB
0 dB
-5
-10
-15
-20
-30

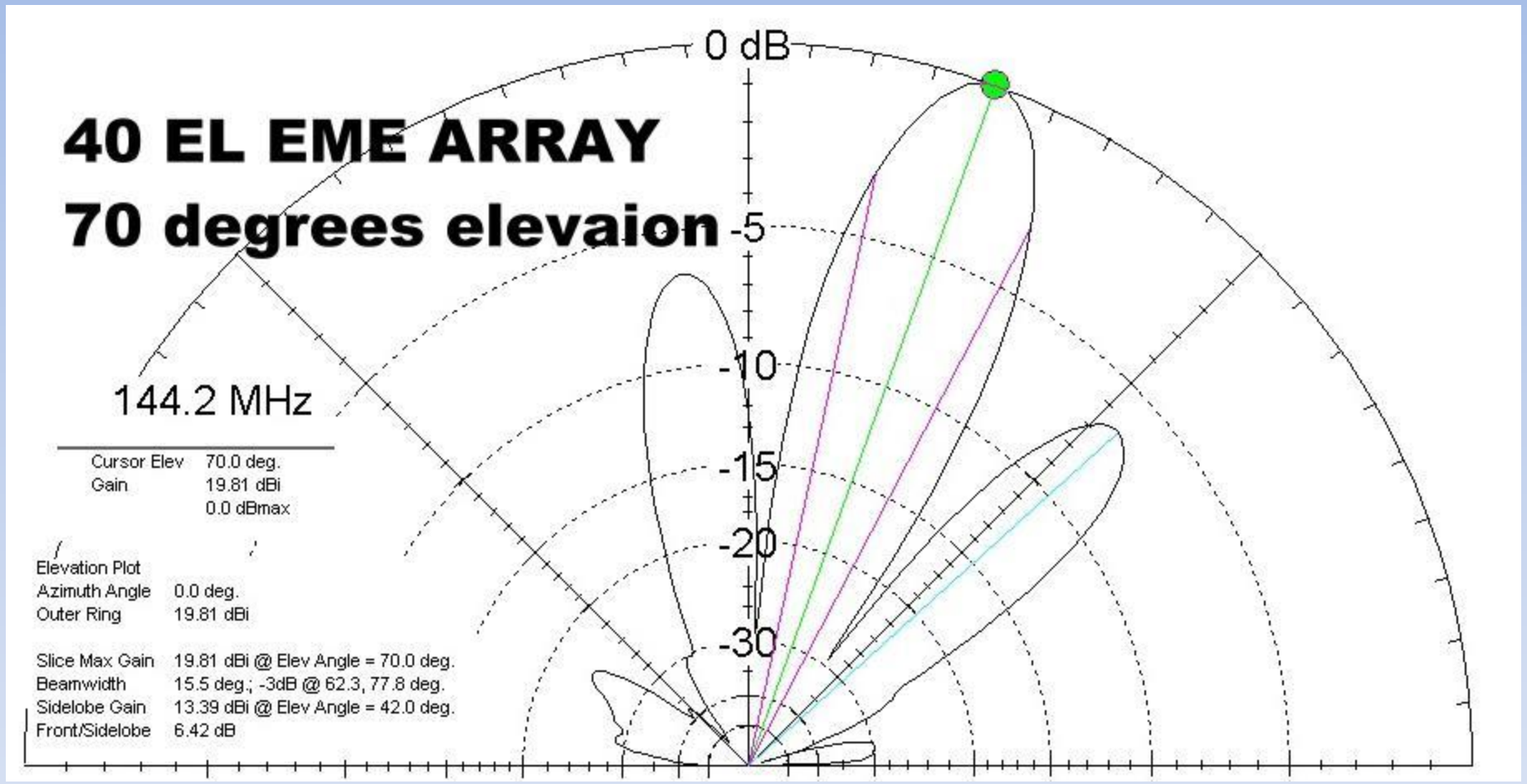

40 EL EME ARRAY
35 degrees elevaion
144.2 MHz
Cursor Elev 35.0 deg.
Gain 19.69 dBi
0.0 dBmax
Elevation Plot
Azimuth Angle 0.0 deg.
Outer Ring 19.69 dBi
Slice Max Gain 19.69 dBi @ Elev Angle = 35.0 deg.
Beamwidth 16.0 deg.; -3dB @ 27.1, 43.1 deg.
Sidelobe Gain 15.39 dBi @ Elev Angle = 5.0 deg.
Front/Sidelobe 4.3 dB
0 dB
-5
-10
-15
-20
-30

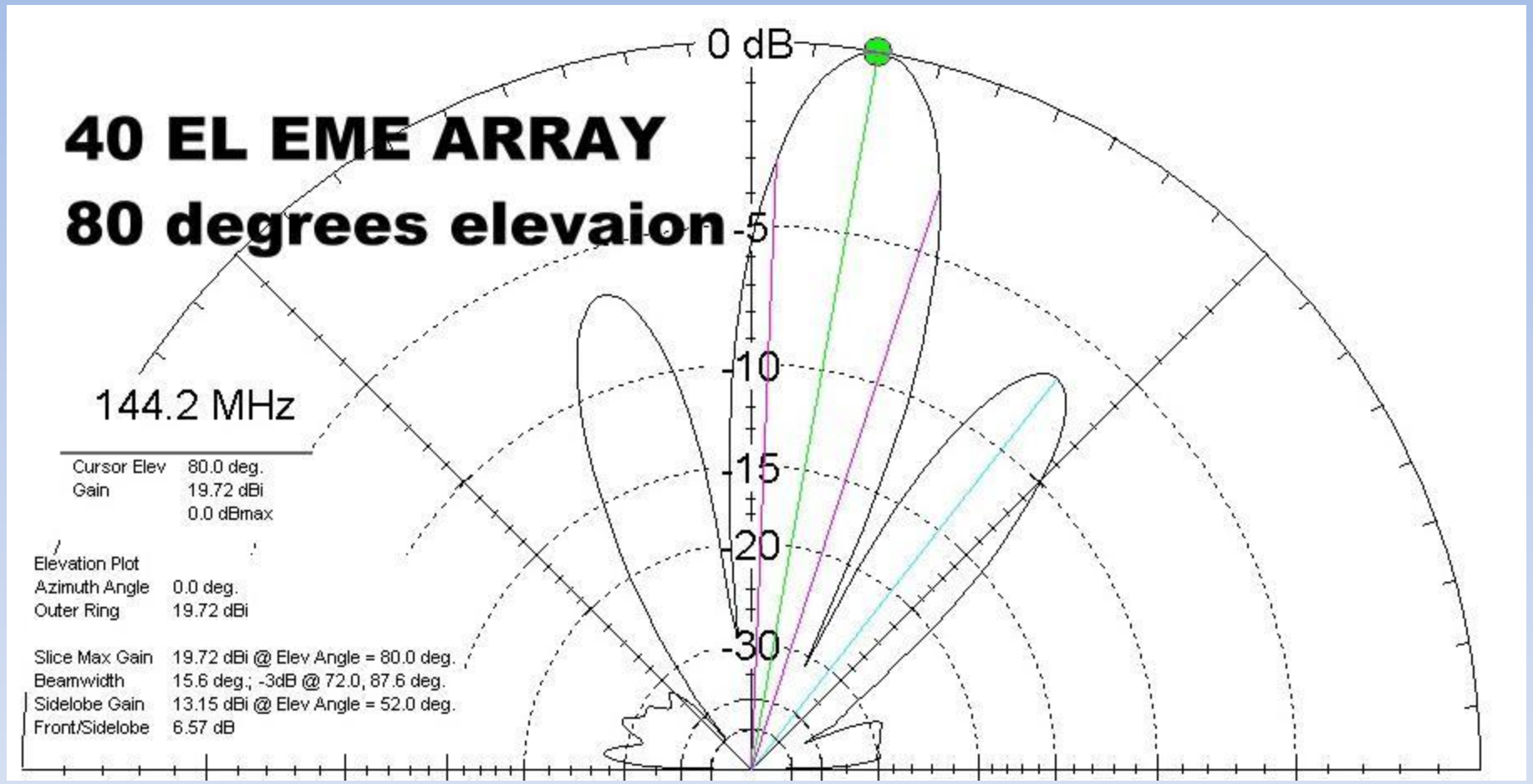

40 EL EME ARRAY
40 degrees elevaion
144.2 MHz
Cursor Elev 41.0 deg.
Gain 19.93 dBi
0.0 dBmax
Elevation Plot
Azimuth Angle 0.0 deg.
Outer Ring 19.93 dBi
Slice Max Gain 19.93 dBi @ Elev Angle = 41.0 deg.
Beamwidth 15.1 deg.; -3dB @ 32.6, 47.7 deg.
Sidelobe Gain 13.62 dBi @ Elev Angle = 12.0 deg.
Front/Sidelobe 6.31 dB
0 dB
-5
-10
-15
-20
-30


40 EL EME ARRAY
45 degrees elevaion
144.2 MHz
Cursor Elev 45.0 deg.
Gain 19.86 dBi
0.0 dBmax
Elevation Plot
Azimuth Angle 0.0 deg.
Outer Ring 19.86 dBi
Slice Max Gain 19.86 dBi @ Elev Angle = 45.0 deg.
Beamwidth 15.1 deg.; -3dB @ 37.7, 52.8 deg.
Sidelobe Gain 13.26 dBi @ Elev Angle = 17.0 deg.
Front/Sidelobe 6.6 dB
0 dB
-5
-10
-15
-20
-30


40 EL EME ARRAY
50 degrees elevaion
144.2 MHz
Cursor Elev 50.0 deg.
Gain 19.95 dBi
0.0 dBmax
Elevation Plot
Azimuth Angle 0.0 deg.
Outer Ring 19.95 dBi
Slice Max Gain 19.95 dBi @ Elev Angle = 50.0 deg.
Beamwidth 14.9 deg.; -3dB @ 42.7, 57.6 deg.
Sidelobe Gain 13.66 dBi @ Elev Angle = 23.0 deg.
Front/Sidelobe 6.29 dB
0 dB
-5
-10
-15
-20
-30


40 EL EME ARRAY
60 degrees elevaion
144.2 MHz
Cursor Elev 60.0 deg.
Gain 19.77 dBi
0.0 dBmax
Elevation Plot
Azimuth Angle 0.0 deg.
Outer Ring 19.77 dBi
Slice Max Gain 19.77 dBi @ Elev Angle = 60.0 deg.
Beamwidth 15.4 deg.; -3dB @ 52.3, 67.7 deg.
Sidelobe Gain 13.7 dBi @ Elev Angle = 32.0 deg.
Front/Sidelobe 6.07 dB
0 dB
-5
-10
-15
-20
-30


40 EL EME ARRAY
70 degrees elevaion
144.2 MHz
Cursor Elev 70.0 deg.
Gain 19.81 dBi
0.0 dBmax
Elevation Plot
Azimuth Angle 0.0 deg.
Outer Ring 19.81 dBi
Slice Max Gain 19.81 dBi @ Elev Angle = 70.0 deg.
Beamwidth 15.5 deg.; -3dB @ 62.3, 77.8 deg.
Sidelobe Gain 13.39 dBi @ Elev Angle = 42.0 deg.
Front/Sidelobe 6.42 dB
0 dB
-5
-10
-15
-20
-30


40 EL EME ARRAY
80 degrees elevaion
144.2 MHz
Cursor Elev 80.0 deg.
Gain 19.72 dBi
0.0 dBmax
Elevation Plot
Azimuth Angle 0.0 deg.
Outer Ring 19.72 dBi
Slice Max Gain 19.72 dBi @ Elev Angle = 80.0 deg.
Beamwidth 15.6 deg.; -3dB @ 72.0, 87.6 deg.
Sidelobe Gain 13.15 dBi @ Elev Angle = 52.0 deg.
Front/Sidelobe 6.57 dB
0 dB
-5
-10
-15
-20
-30

So, what have we learned from all this?

* **A Horizontally polarized Yagi close to the ground has ~4.7 dB extra gain due to the ground proximity (It can have as much as 6 dB over perfect ground)**

* **As we increase the height above ground we get an increased number of lobes but they get narrower.**

- **As we raise the antenna from ¼ WL, we also get more gain due to ground gain, to a point.**

* **As we increase the height above ground we approach the free space pattern of the antenna with lowering gain.**

- **These trends exist for ALL directional antennas over ground as we saw comparing 2, 6 and 10 meter arrays & a 40 M Dipole.**

* **Ground gain is reduced 1-3 dB for a vertically polarized antenna vs. a horizontal antenna**

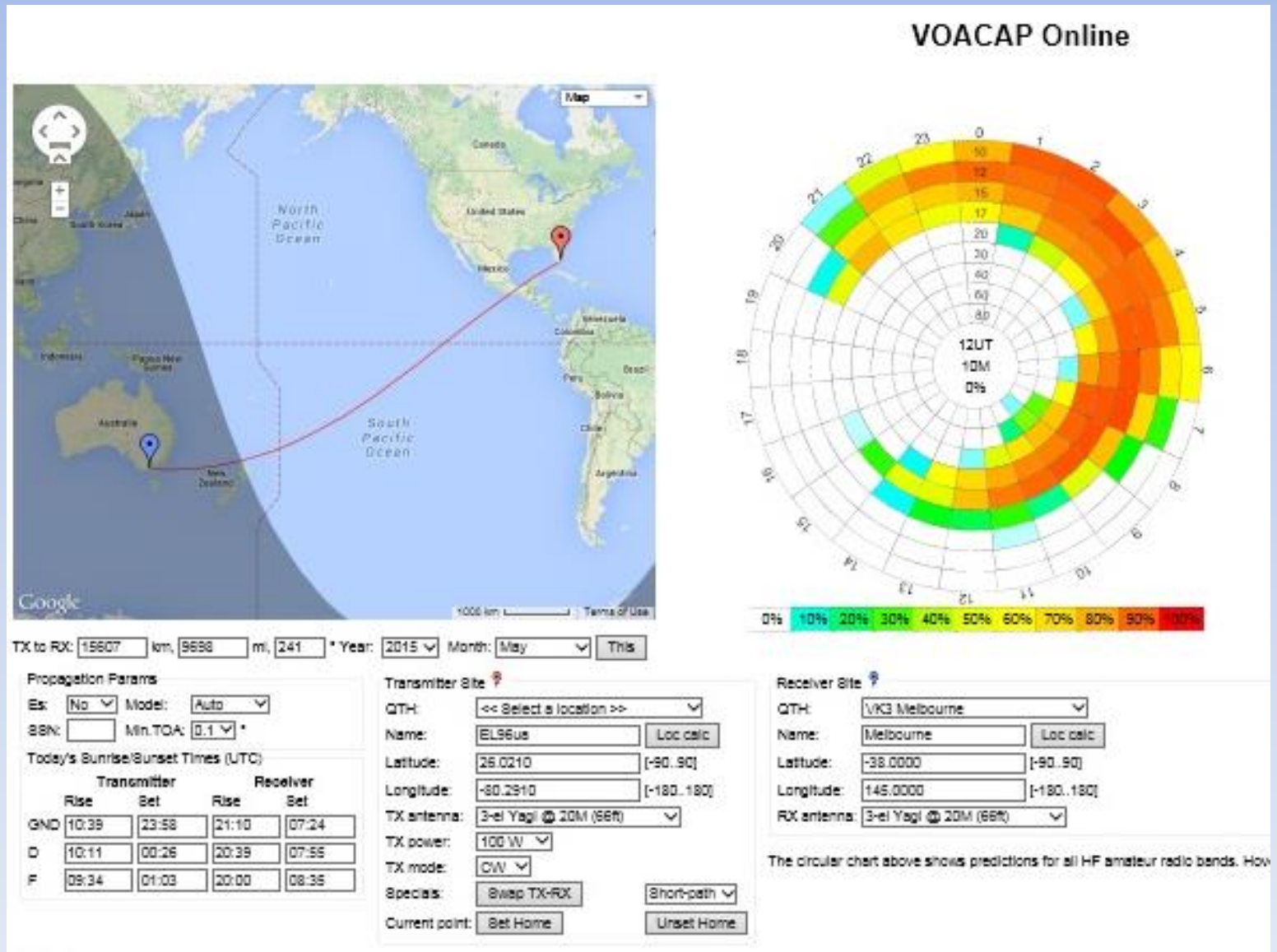
Now, How do we use this Information?

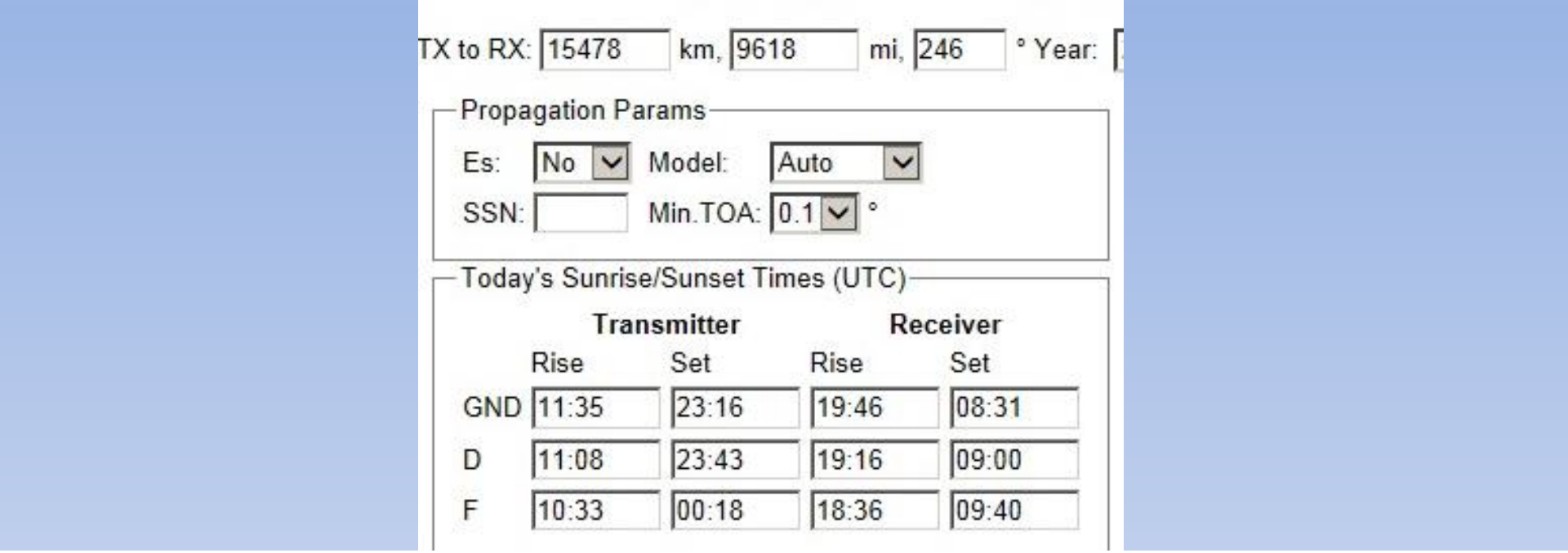
We use it to predict where our signal will go at any given time on any given band.

VOACAP knows how big and how high antennas are at both ends and it calculates the best time of day for the power you use for the path you want.

VOACAP Propagation Prediction Program
Can be Purchased or Used Online at:

http://www.voacap.com/prediction.html





: TX to RX: 15607 km, 9698 mi, 241 ° Year: 2015 Month: May This

Transmitter Site

QTH: << Select a location >>

Name: EL96ua Loc calc

Latitude: 26.0210 [-90..90]

Longitude: -80.2910 [-180..180]

TX antenna: 3-el Yagi @ 20M (66ft)

TX power: 100 W

TX mode: CW

Specials: Swap TX-RX Short-path

Current point: Set Home Unset Home

Receiver Site

QTH: VK3 Melbourne

Name: Melbourne Loc calc

Latitude: -38.0000 [-90..90]

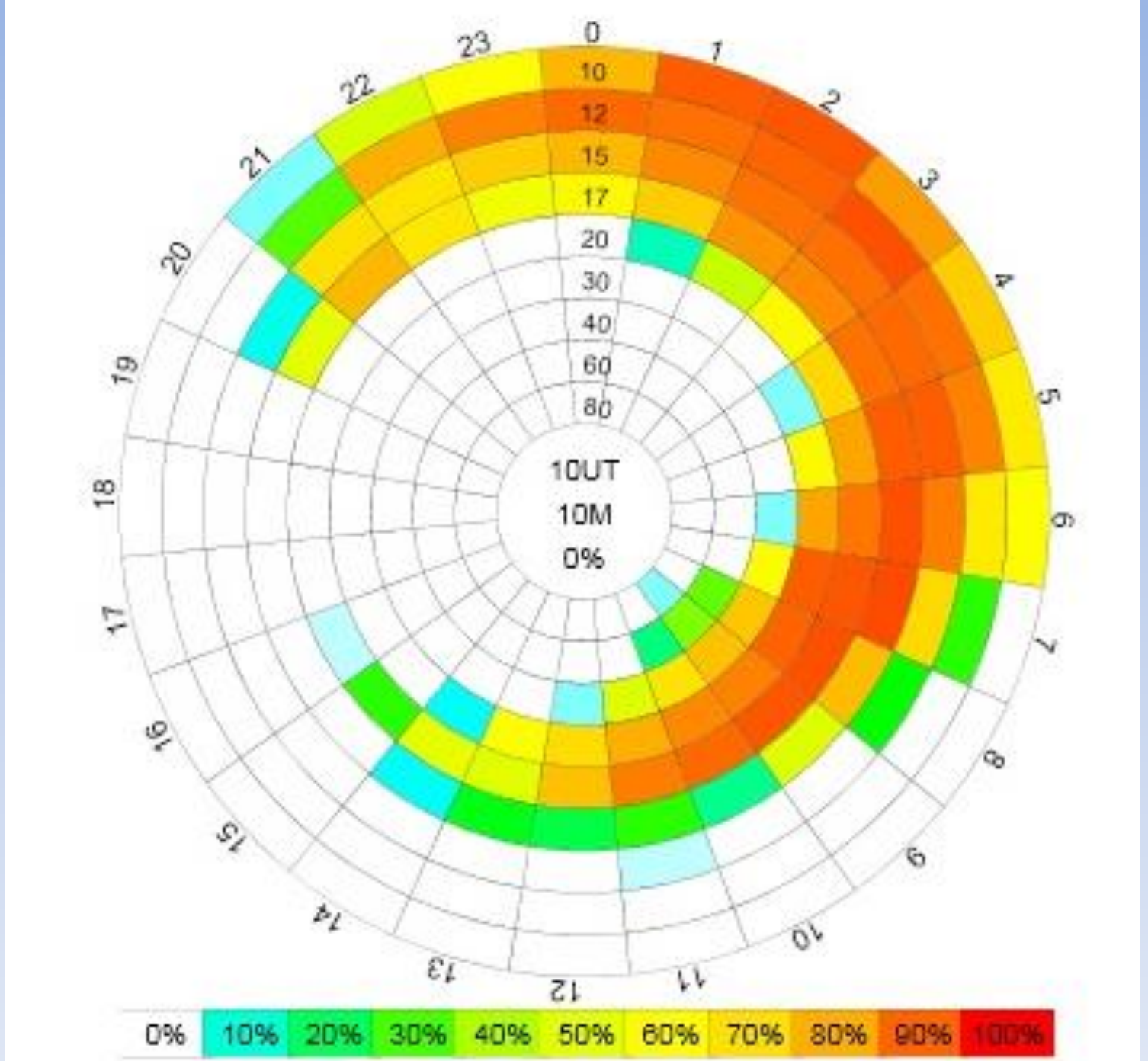
Longitude: 145.0000 [-180..180]

RX antenna: 3-el Yagi @ 20M (66ft)

The circular chart above shows predictions for all HF ama
bands. Hover the mouse over the chart for details. For pr
with more frequency coverage, click the "Run prediction!"

Run prediction!

TX to RX: 15607 km, 9698 mi, 241 ° Year: 2015 Month: May This


0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
10
12
15
17
20
30
40
60
80
10UT
10M
0%
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%

Thank you for your attention.

Any Questions?