The New and Improved Carolina Windom Antenna and ½ Wave End Fed 20 Meter Vertical and Sloping Wire Antennas

EZNEC analysis

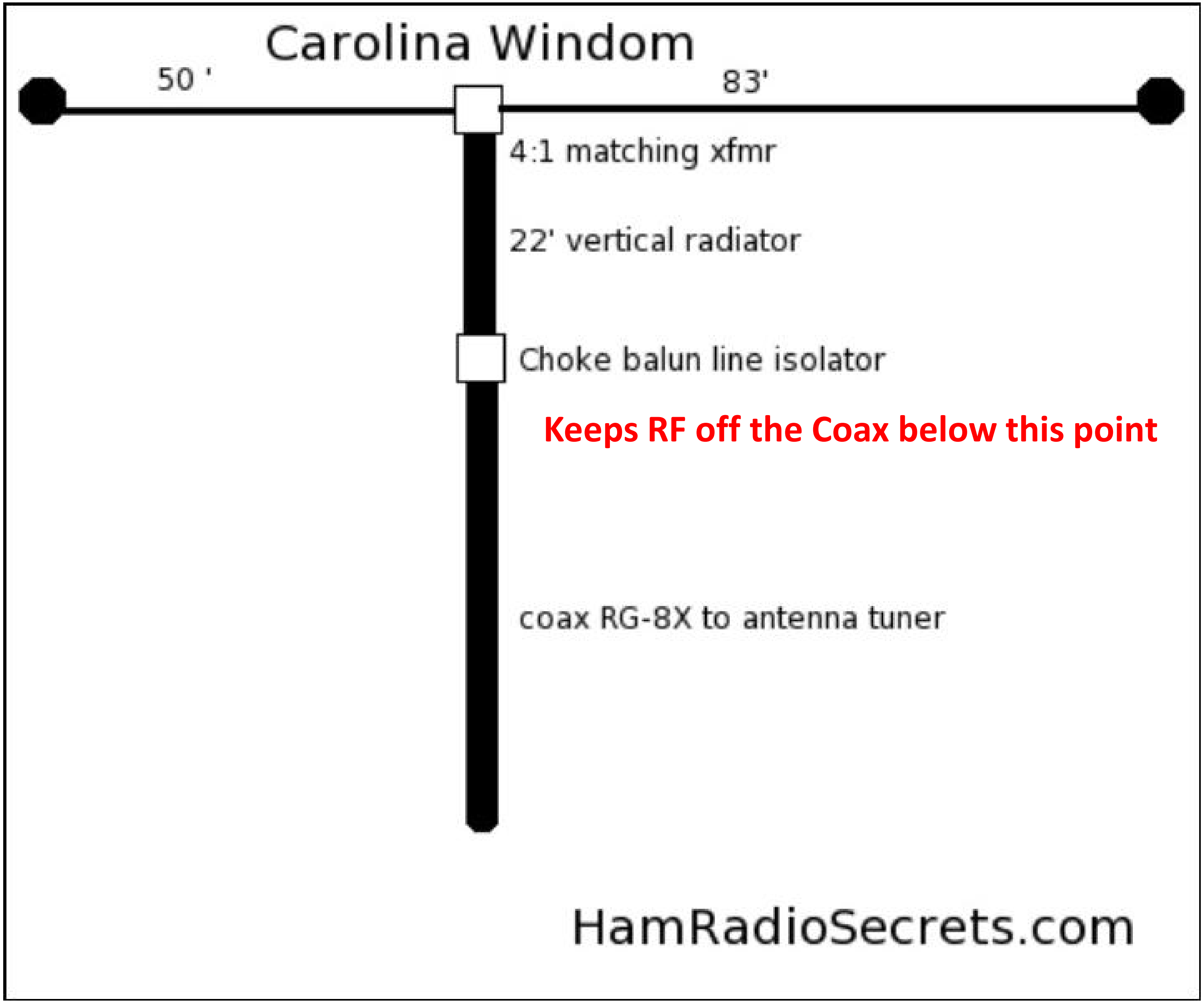
by Pete Rimmel, N8PR

Windom Antenna
The Carolina Version

Think of the *"Carolina" windom* antenna (the modern version of the windom) as an "upside down vertical antenna", hanging down from its counterpoise strung (more or less horizontally) some 10 meters (or more) above ground.

In other words, the 22 feet vertical component of the *"Carolina"* - between the 4:1 matching voltage transformer and the current choke balun - is a vertical antenna, fed at the tip. **`(top?)`**

This vertical does not require a ground or a system of radials!



The Original Windom Antenna of The 1930's

The original windom was a Zepp-type antenna fed 14% off-center with a single wire.

The single-wire feeder radiated RF all the way into the operating position.

A very undesirable side-effect ... that the *"Carolina"* version not only eliminated but transformed into an extra asset by...

1. choking off the RF, present on the coax, before it enters the shack,
2. thus forcing the choked off RF to travel instead toward DX stations.

How The Carolina Windom Works

Because the antenna is not fed at its center, the RF currents in each horizontal radiating section are very much *unequal*. This makes the vertical coaxial feedline radiate RF energy.

Normally, in the case of normal (balanced) dipoles, we try to *avoid* this from happening.

But, in this case we **want** the feedline to radiate!

(part of)/

Extra Radiation

By letting it do so, the outer shield of the 22 feet long *vertical* coax (RG-8X) radiates to fill in the gaps in the signal pattern radiated by the top portion of the antenna.

The 22 feet portion of the feedline effectively becomes an *upside down* vertical, located high above ground and free of ground losses normally associated with verticals based on the ground!

That may all be true if the antenna is strung out horizontally. If it is held up in the middle and is in an "inverted vee" configuration" is this still true? … I suspect that the vertical polarization from the sloping wires creates interesting interference with the 22 ft section. The EZNEC plots will show how the antenna actually radiates, and where…

The *"Carolina" windom* thus becomes a near-omnidirectional antenna. This is a very desirable characteristic on the lower bands 40 meters, 80 meters and 160 meters.

I have not included 160 M, but you will see that the pattern on the 80 and 40 meter bands is pretty much straight up… a cloud warmer.

Yes, it omni-directional, but only at high take-off angles.

The choke balun at the bottom of the 22 feet radiating vertical effectively isolates it from the coaxial feedline going down to the transceiver. This prevents RF from being fed back into the radio operation position. Another very desirable feature.

Oustanding Performance

The users of this special version of a windom antenna have reported that the near-omnidirectional characteristic is most pronounced near and over salt water.

?????

The *"Carolina" windom* is...

- Very efficient because no RF energy is lost in a "lossy" ground system.
- Very effective because a large portion of the RF energy is radiated, much of it at low angles, omnidirectionally.

These same characteristics also make the *"Carolina" windom* an excellent receiving antenna.

Really? Let's take a look !

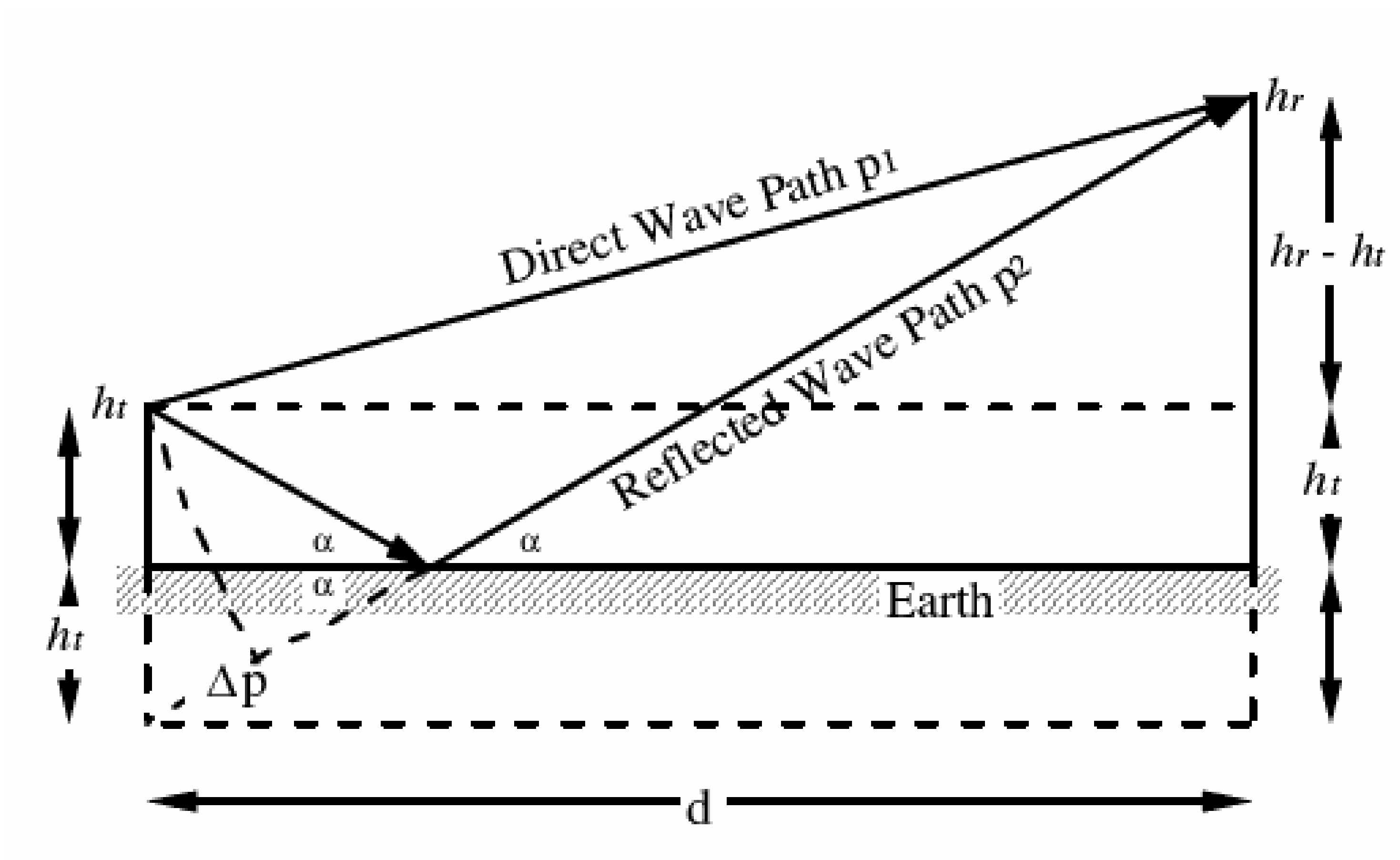
NOTE: Every antenna is affected by the ground system under it. That is why we get different take-off angles dependent on height above ground. Otherwise, the Antennas would all radiate as if they were in free space !

We will look at the elevation plots of the antenna at 33 feet then at 66 feet For the bands 80 – 40 – 20 – 15 – 10 Meters. (I have ignored the WARC bands for simplicity)

BUT, FIRST, some basic antenna theory:

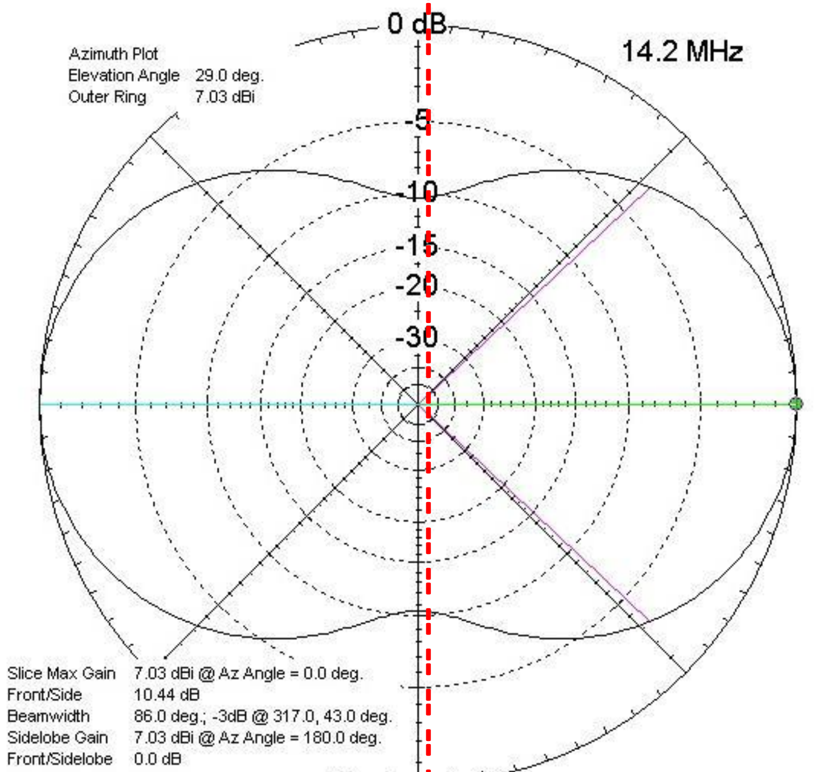
Every antenna above real ground has a pattern That is affected by its height above ground By its length, and by its orientation.

In the ELEVATION plots we will be looking at, the plots show where the RF goes, in various takeoff angles, due to the interaction of the signal in the far field with the reflected RF signal where the ground acts like a mirror.



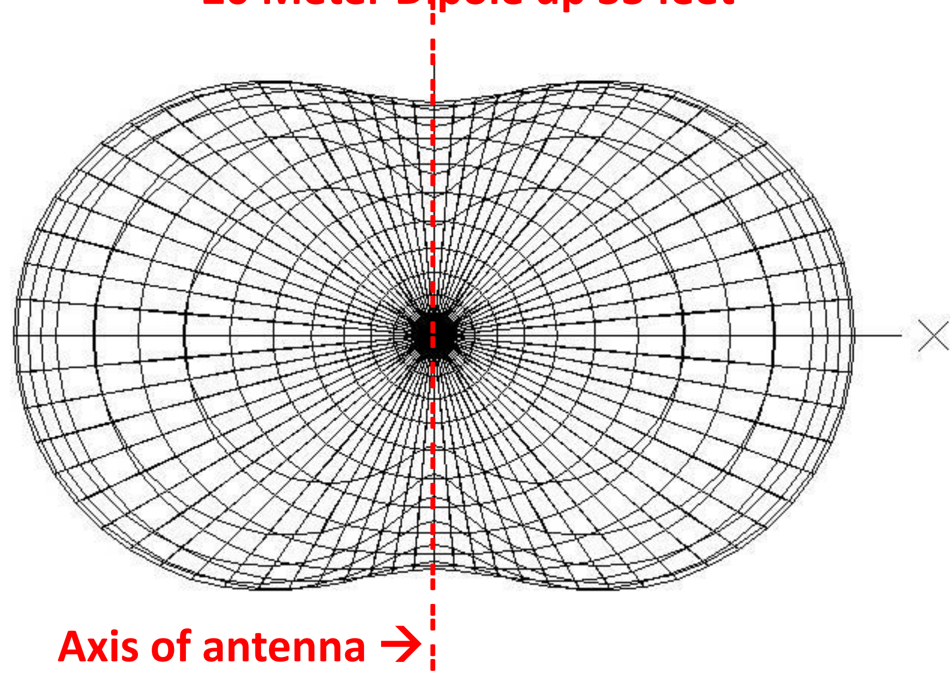
AND
Because I was asked to, I have plotted the ½ wave 20 meter end fed antennas and a 20 Meter Dipole up 33 feet.

We will look at those first, to see what "good" plots Might look like !



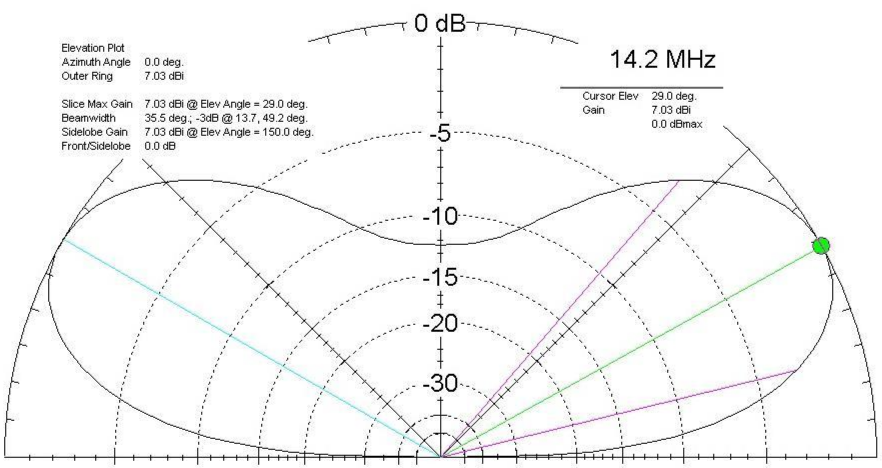
Azimuth plot (above)

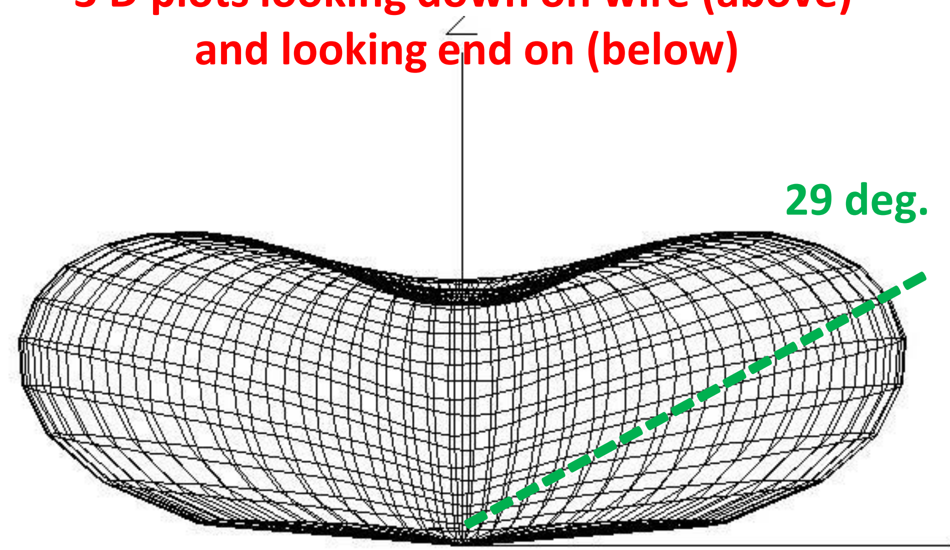
20 Meter Dipole up 33 feet



3 D plots looking down on wire (above) and looking end on (below)

29 degree elevation plot (max . takeoff angle)

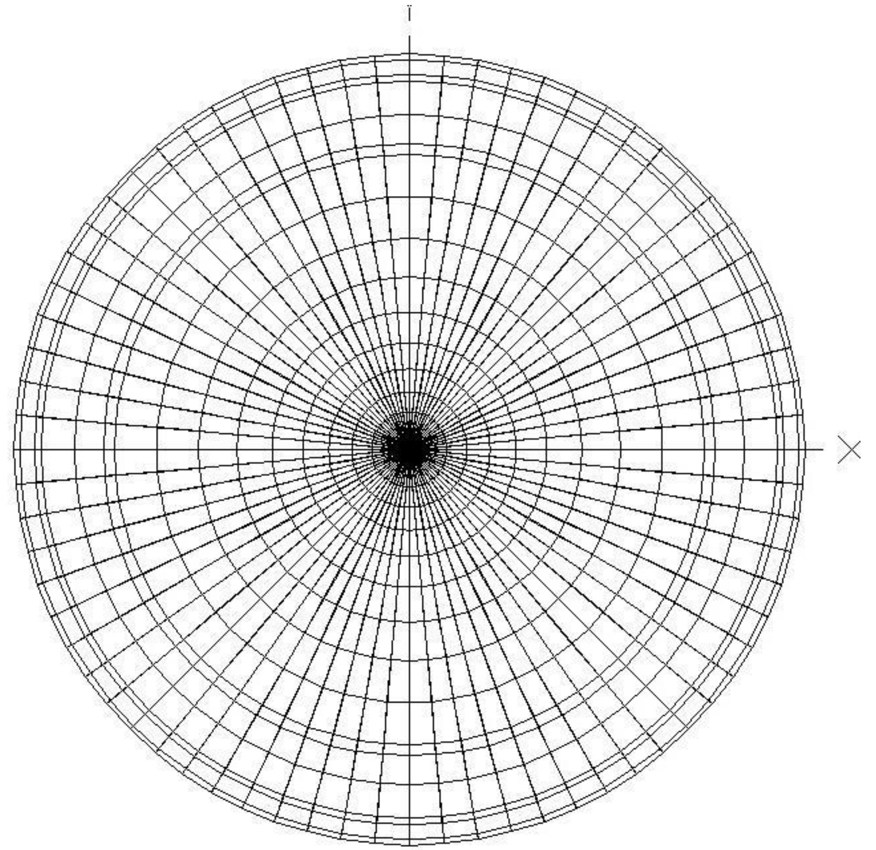


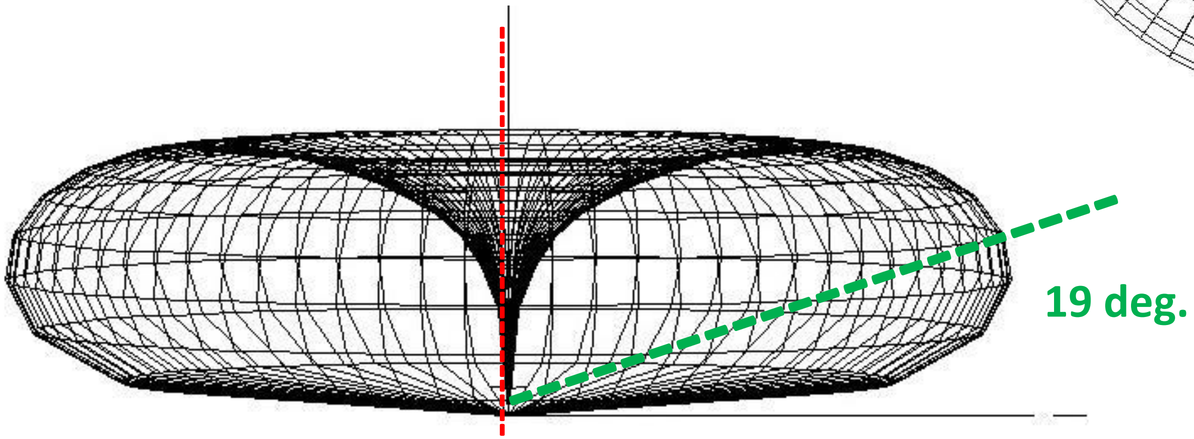


This is a ½ wave 20 Meter vertical end fed wire

Notice the symmetrical pattern.

Each line around the circle is 5 degrees.



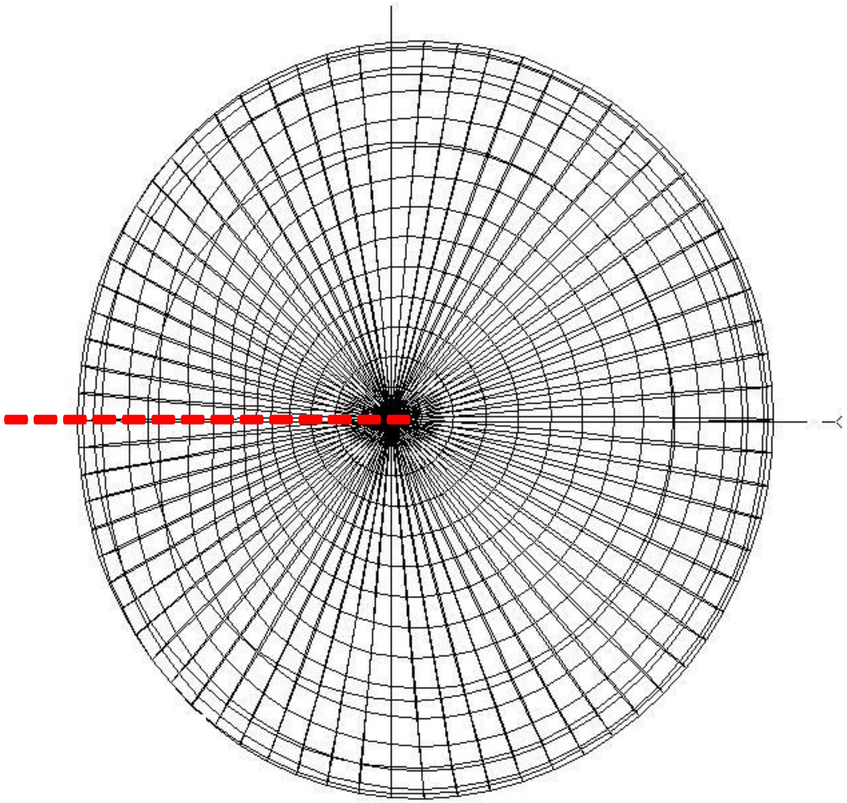


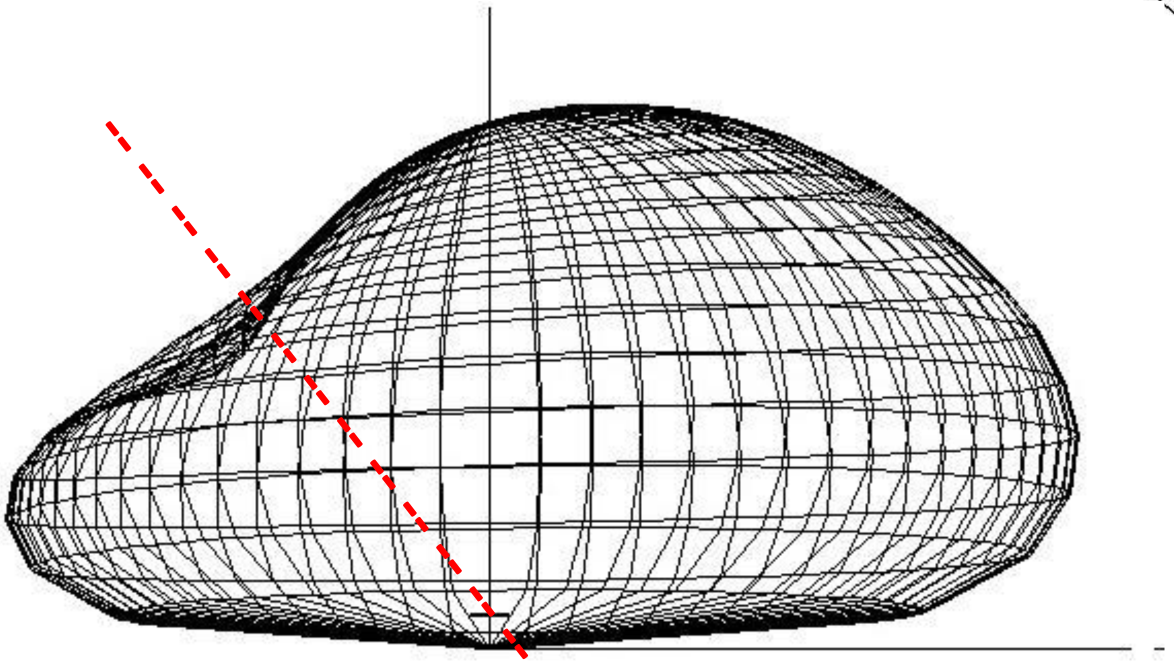
3 D azimuth plot of antenna
Looking down from the top

Side view of antenna – 3D elevation plot

This is the ½ wave 20 meter sloping wire with the wire 30 degrees from vertical.

Note the null off the end and the pattern better broadside than in line with the antenna.

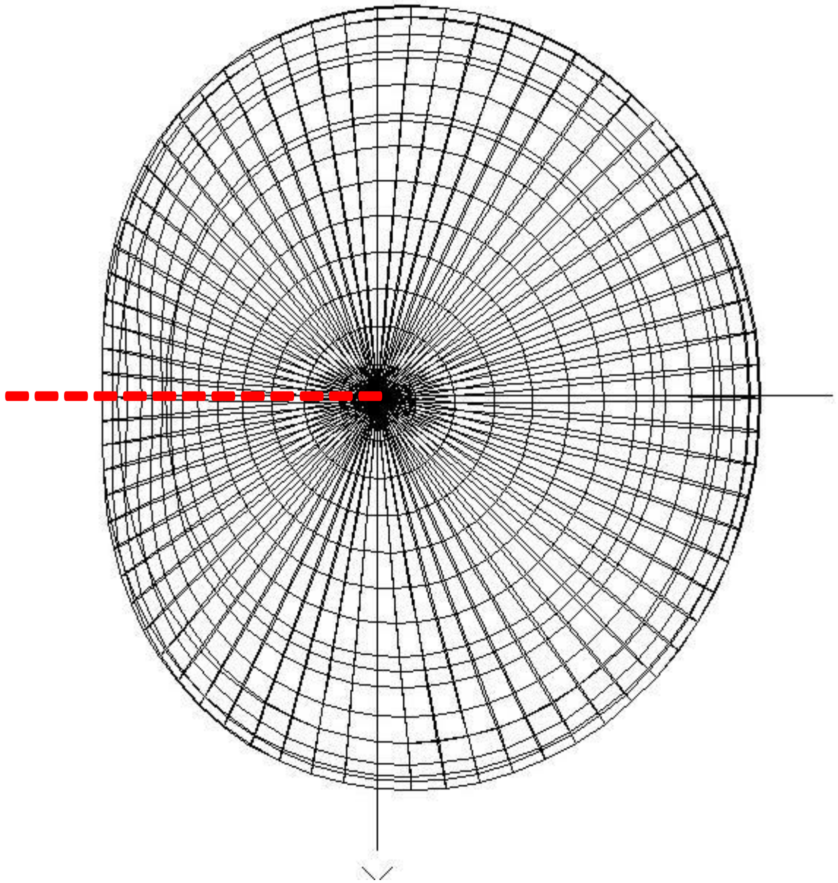


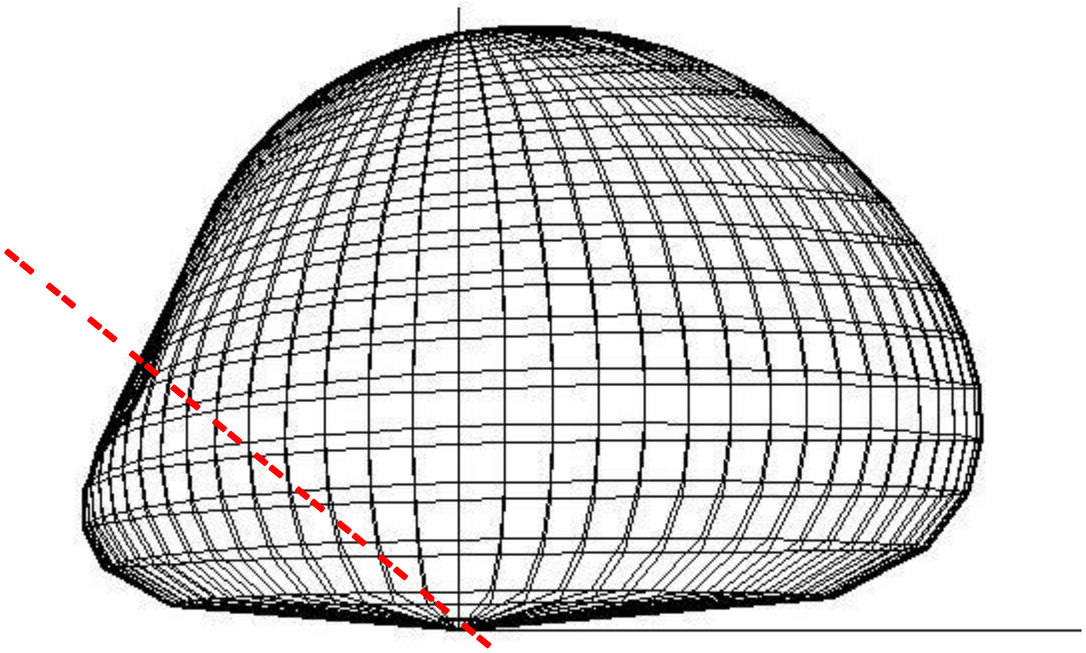


This is the ½ wave end fed sloping wire with the wire 45 degrees to the ground.

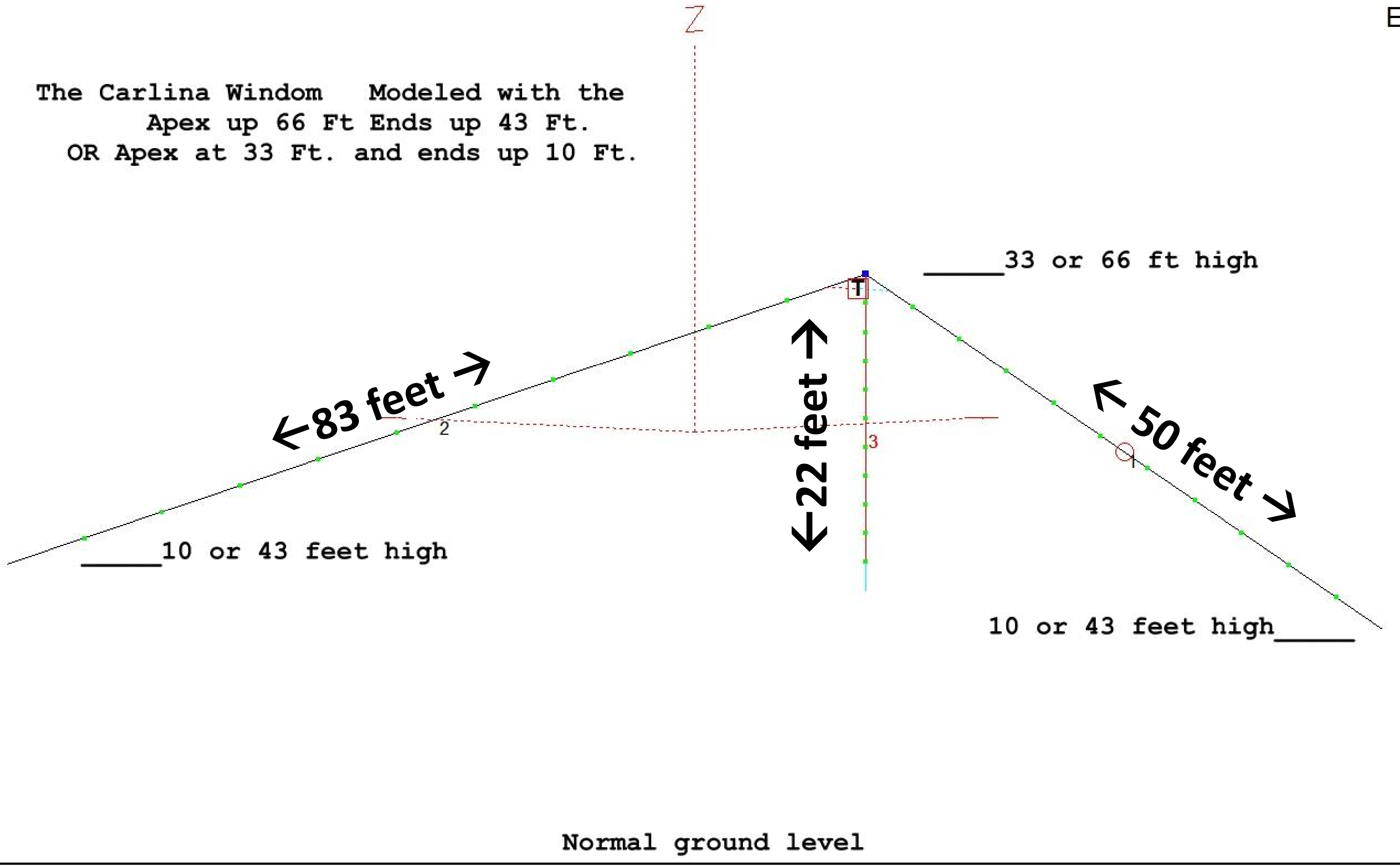
Notice that the pattern is better off the sides than in the direction of the slope, or away from the slope.

If there were a metal support holding the wire up, there might be some directivity to the right.

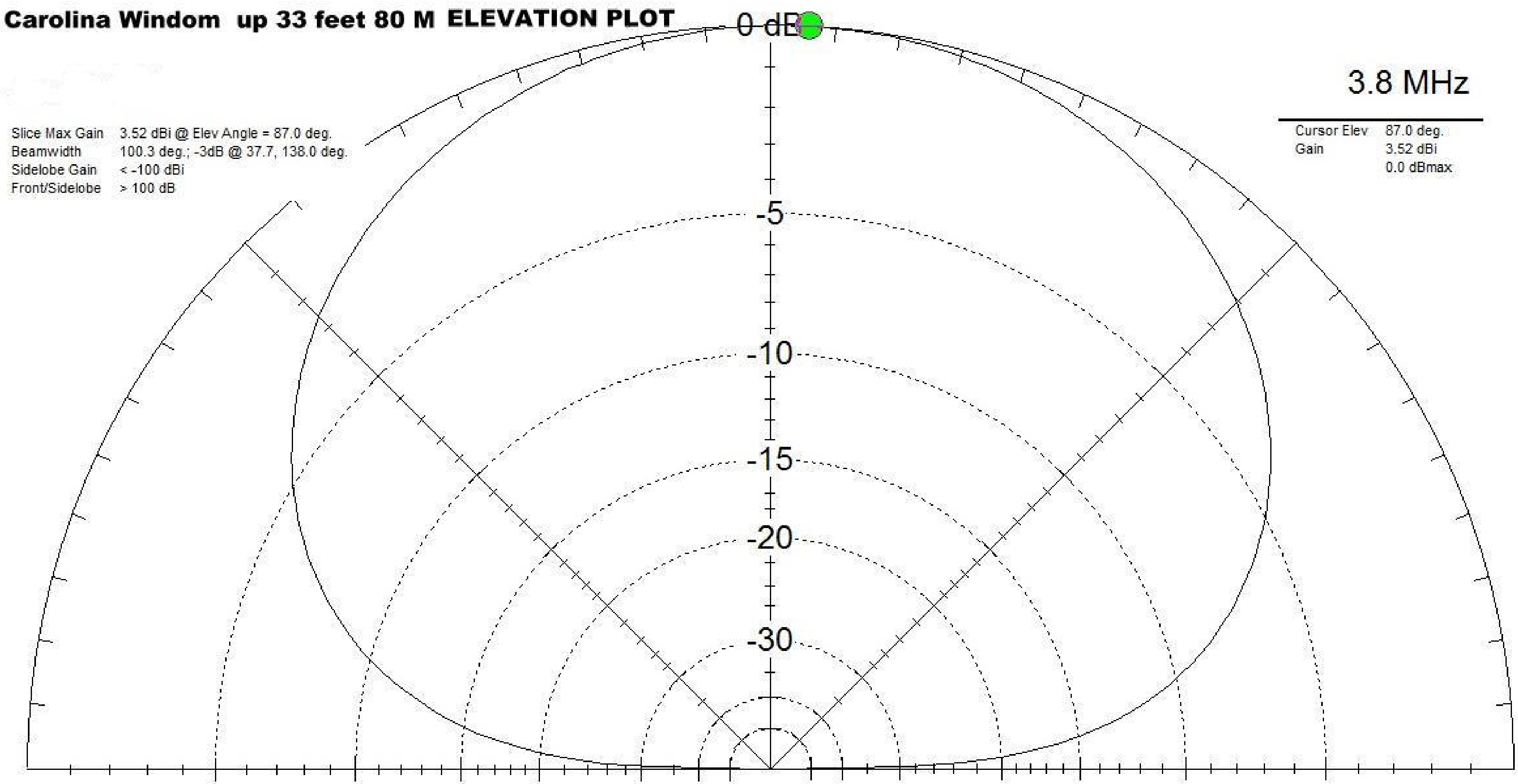




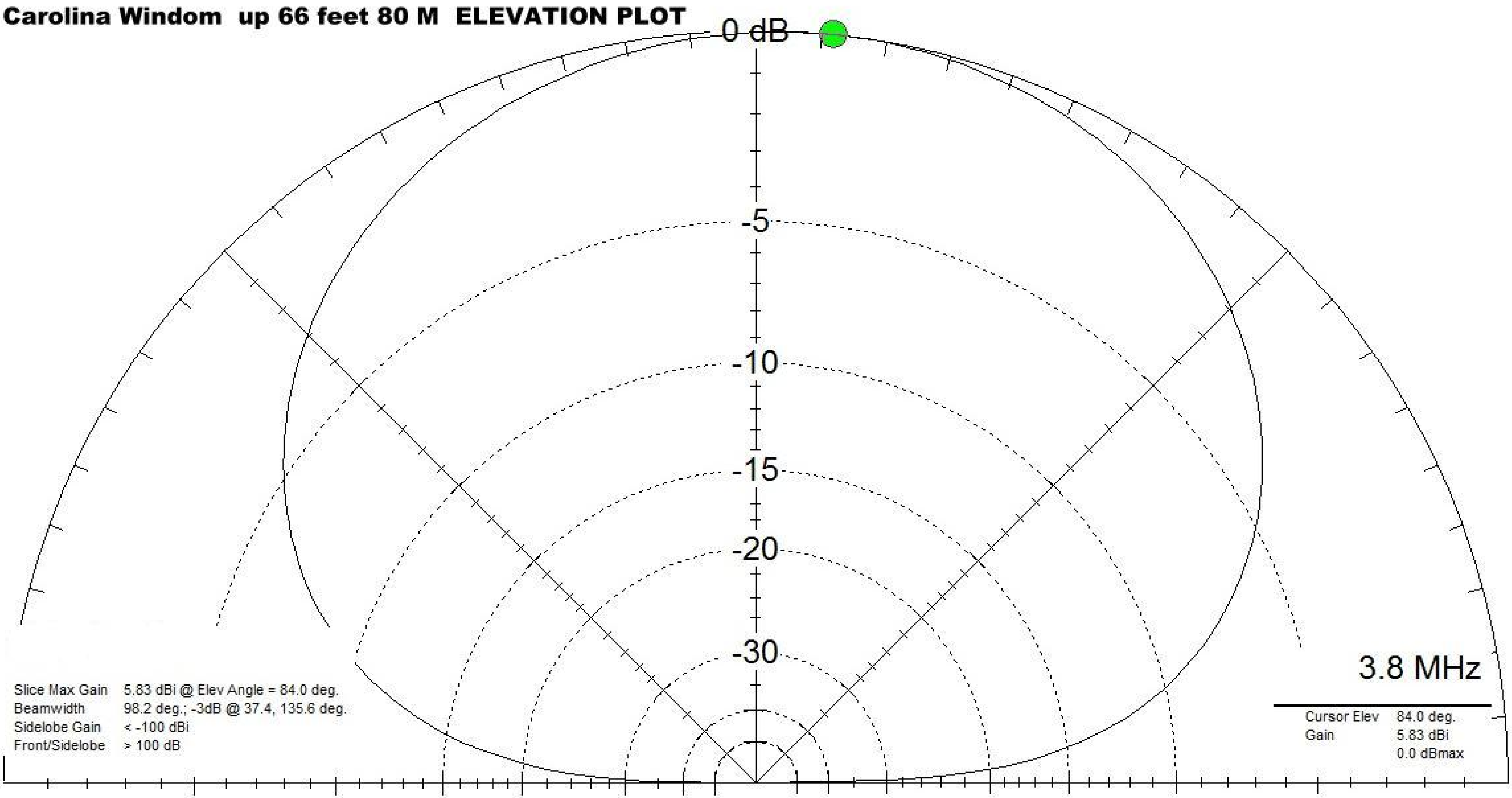
Now for Sandy's antenna
Here is the actual Carolina Windom antenna that I modeled:



We know that at 33 ft this is a real cloud warmer… too low for DX on 80 Meters



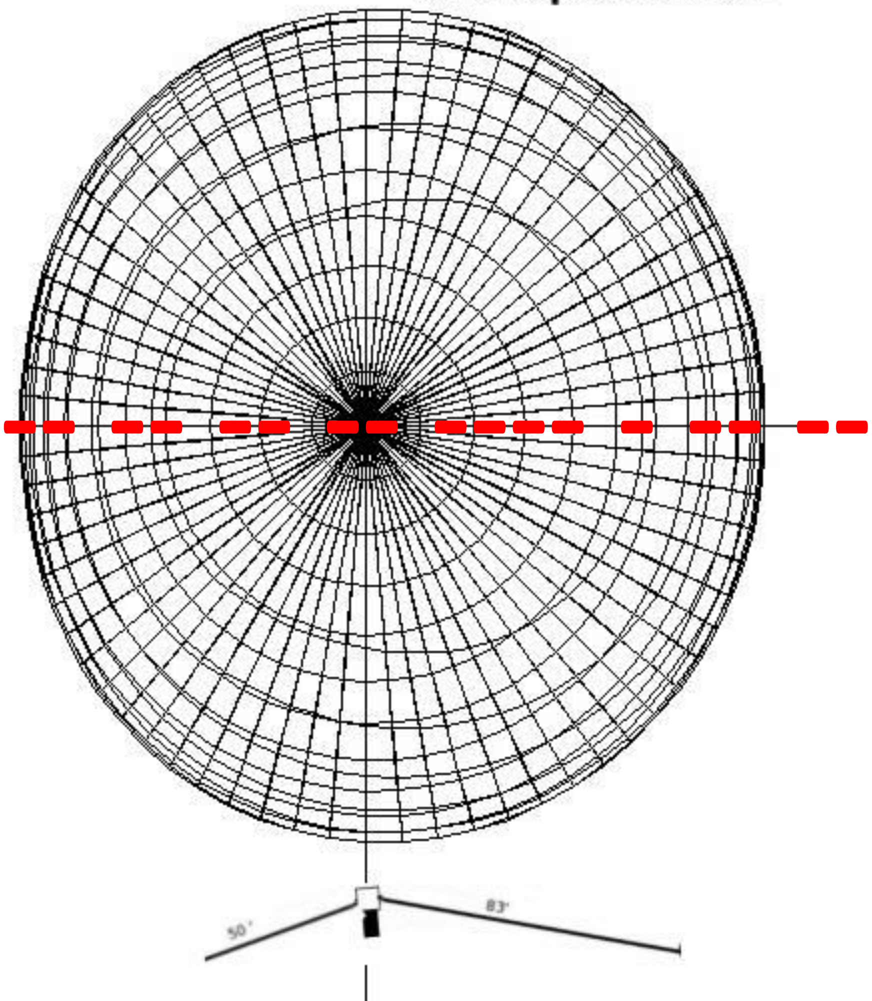
Even at 66 ft this antenna would be considered a cloud warmer. Most of the RF is going up more than 45 degrees, and not being refracted back to earth at any distance. However, some low angle RF does get to DX stations.



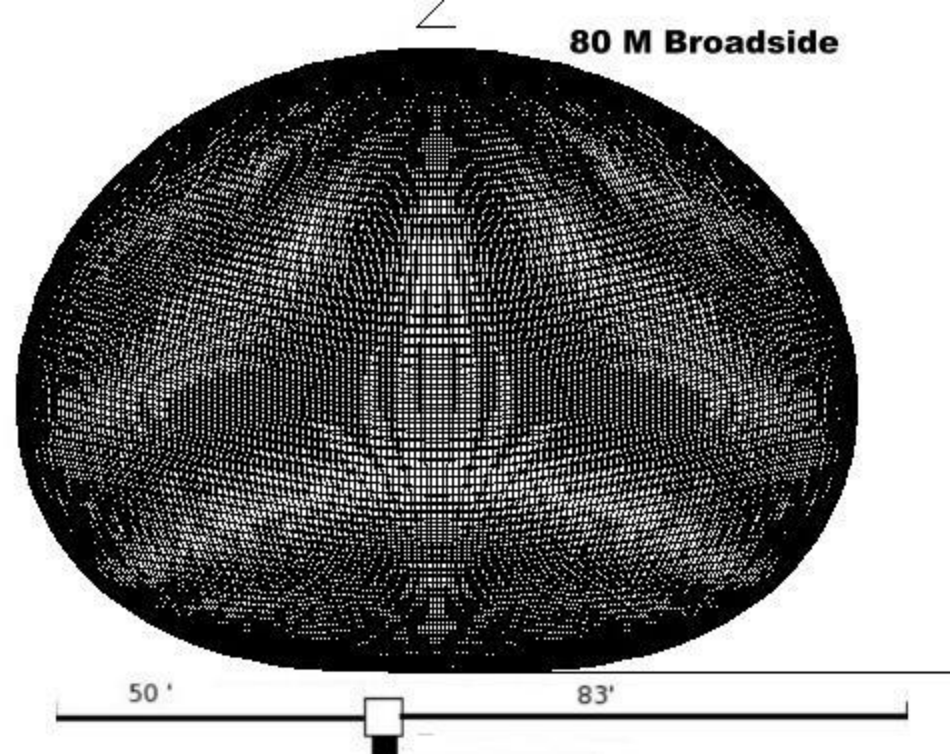
80 meter paterns (up 33 ft)

Pretty much what you would expect.

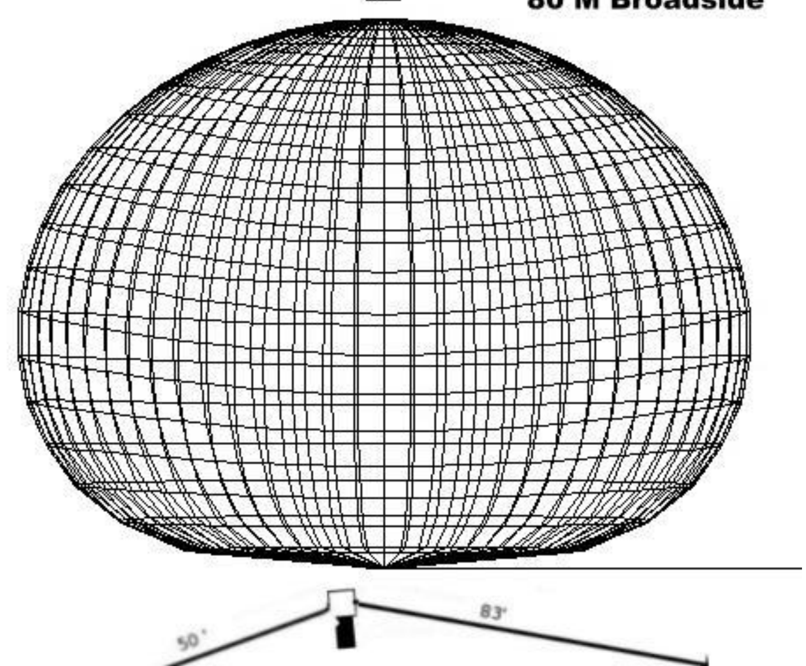
80 M top down view



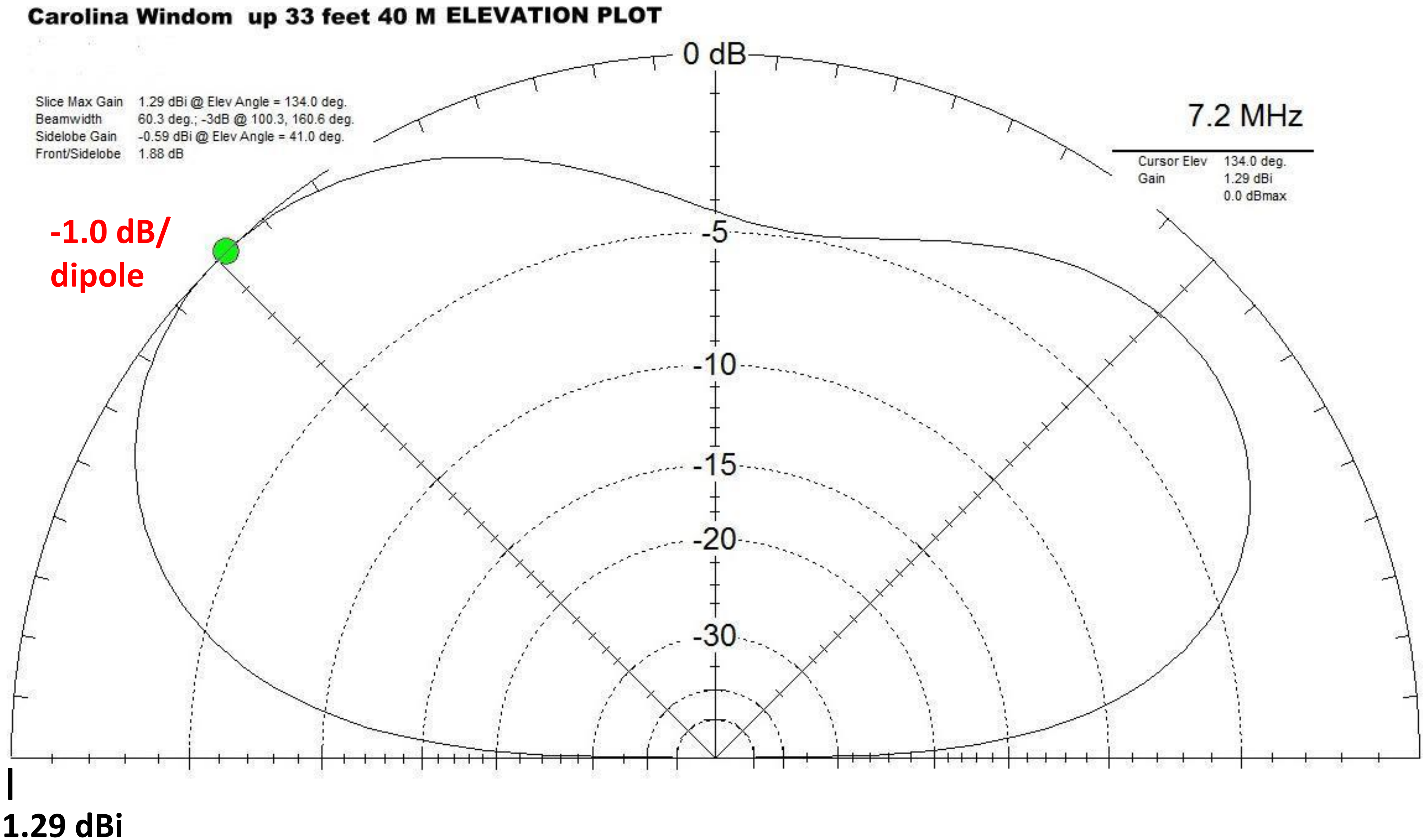
80 M Broadside



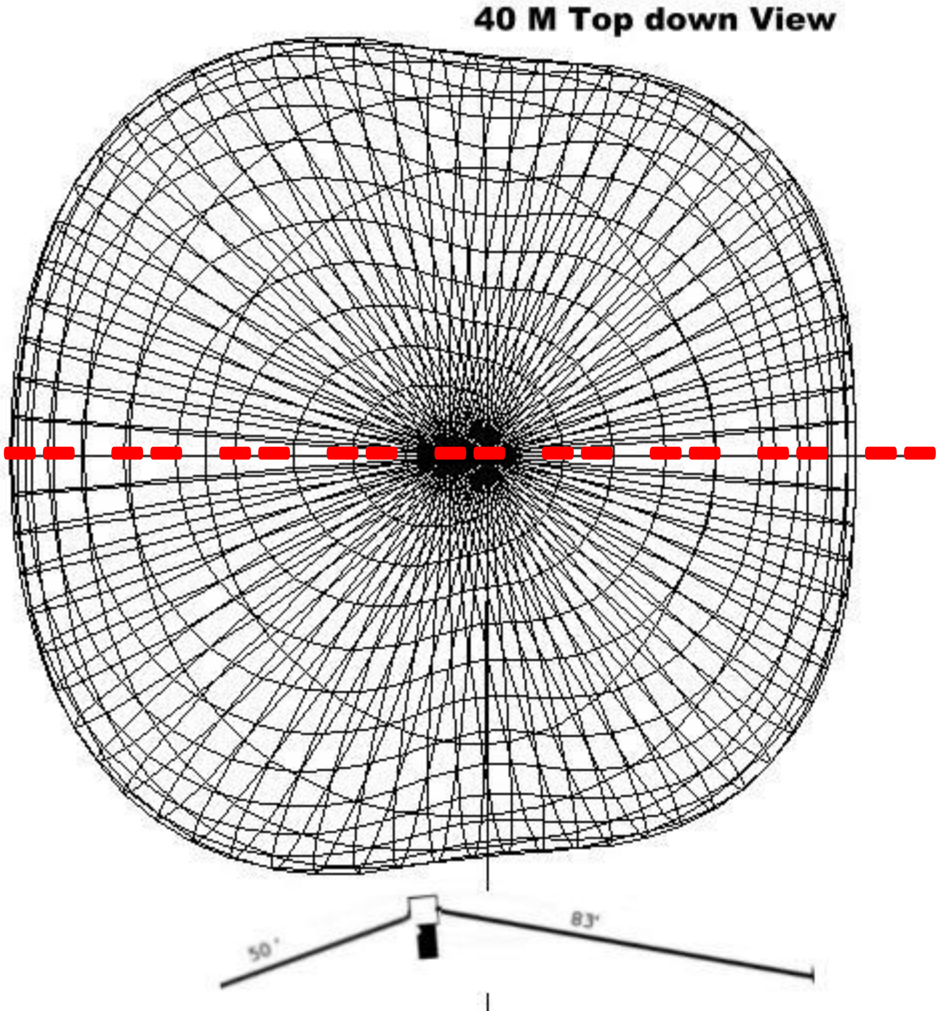
80 M Broadside

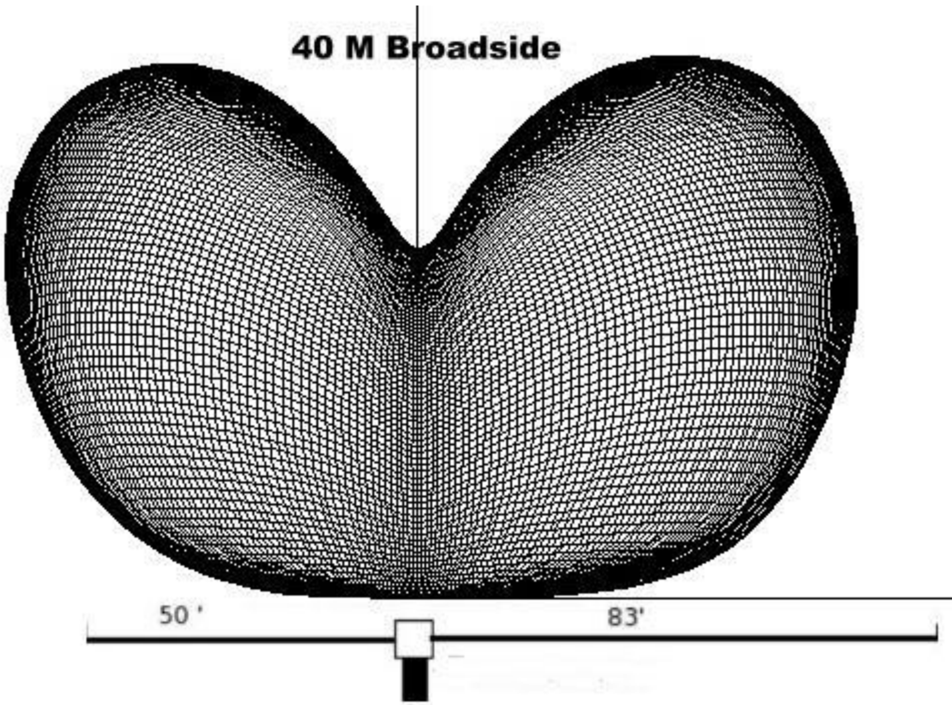


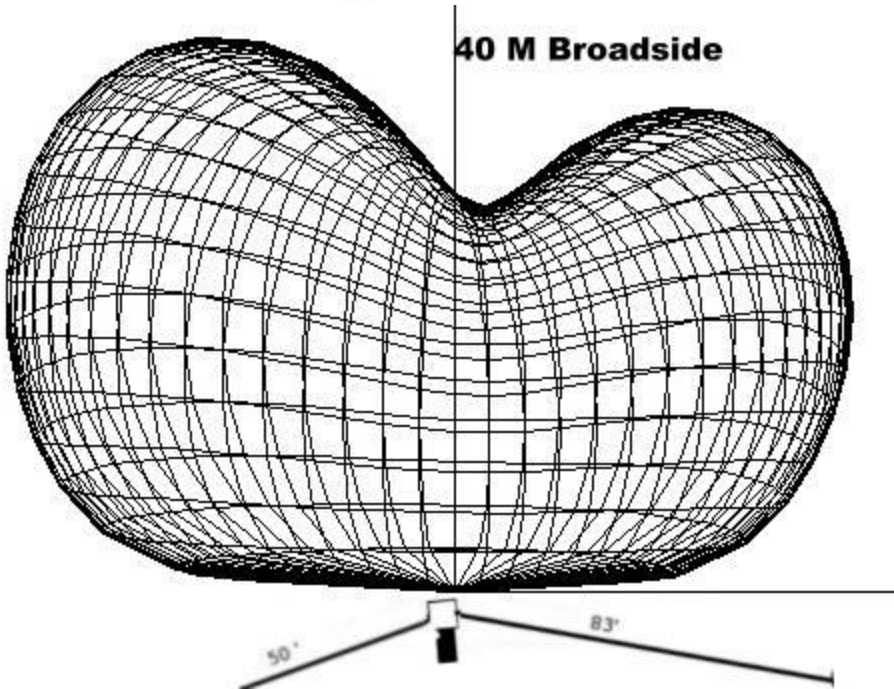
At 33 ft, on 40 M the antenna is only 1/4 wavelength high, and although some RF has low angle takeoff most is still higher than 45 degrees. Notice the effect that the longer end has on the somewhat asymmetrical pattern.



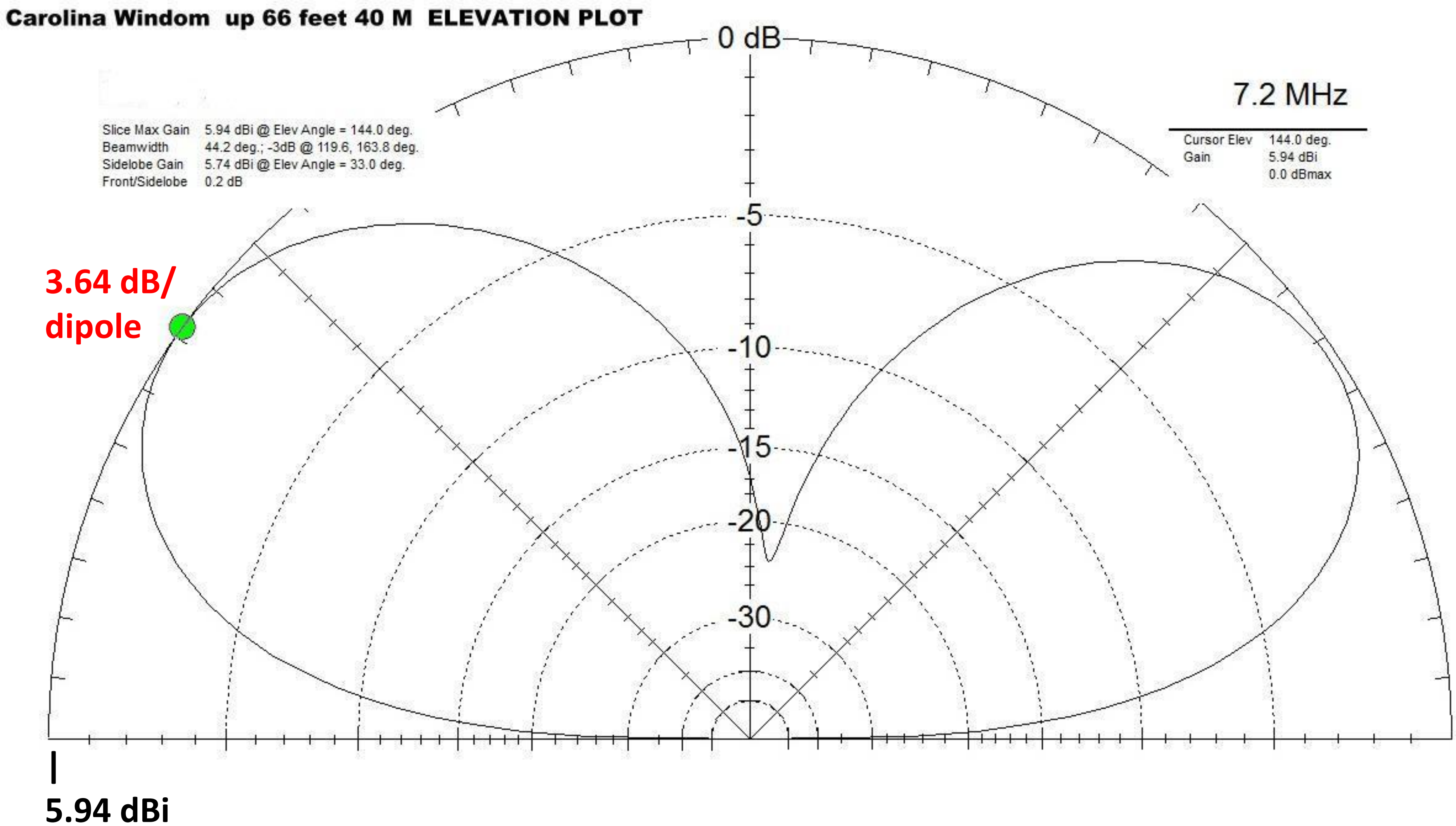
40 Meter Antennas up 33 ft.



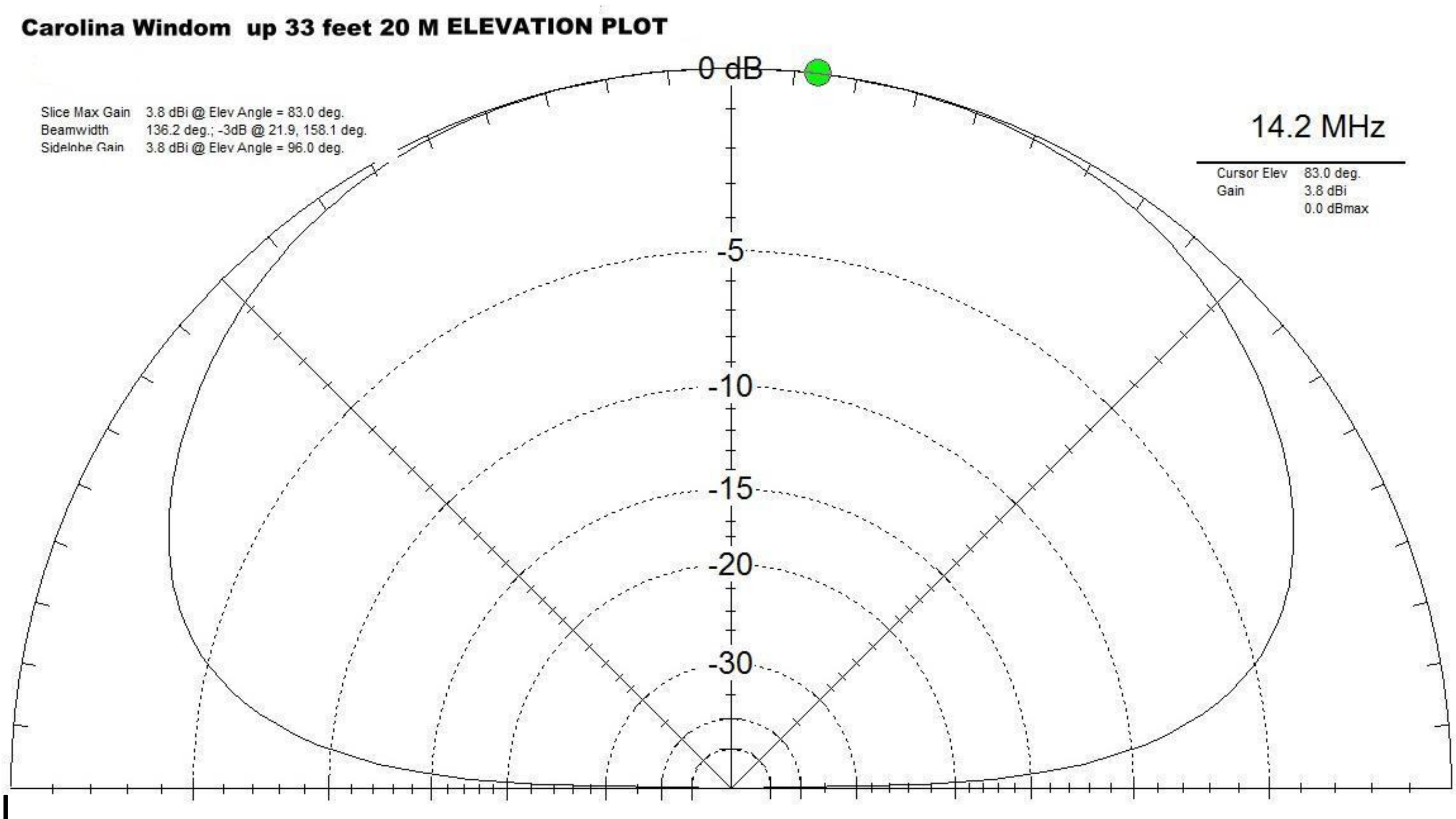




At 66 feet – 1/2 wavelength high, the antenna has a good pattern on 40 Meters, and some gain over a dipole in the direction of its major lobe. BUT, remember, a dipole has a similar pattern, with peaks and nulls.



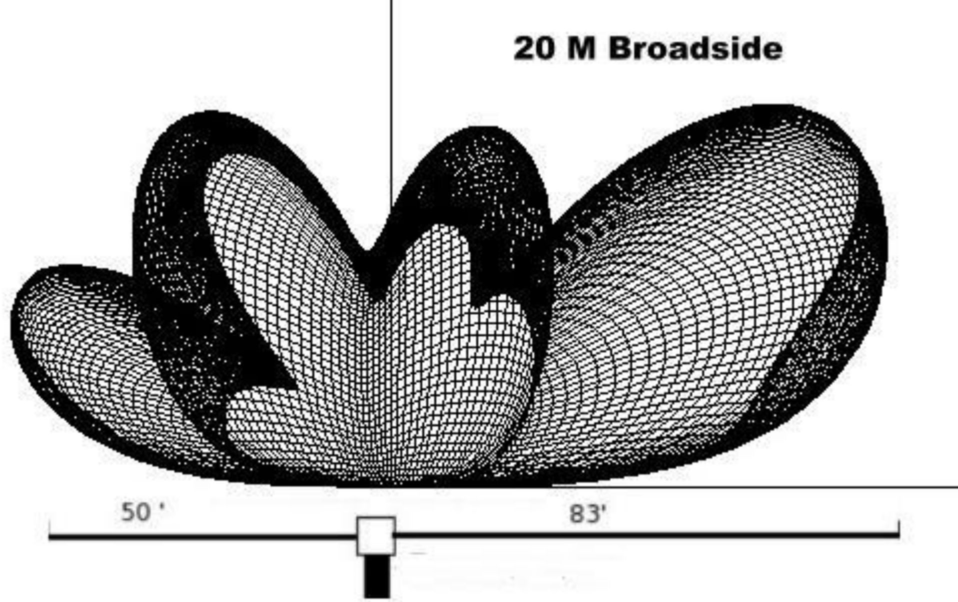
Even up 1/2 wavelength, the antenna on 20 Meters does not haveA low takeoff angle… is the antenna too long? Remember those pretty dipole patterns? Check these out…

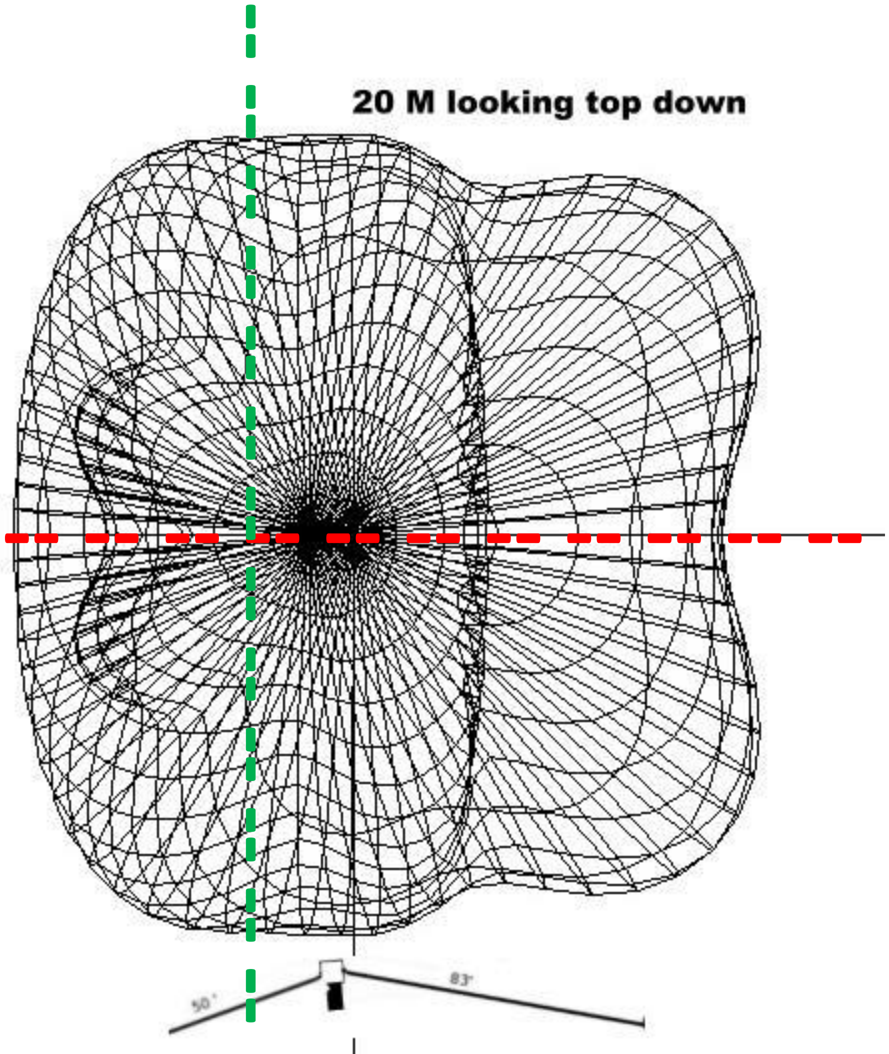


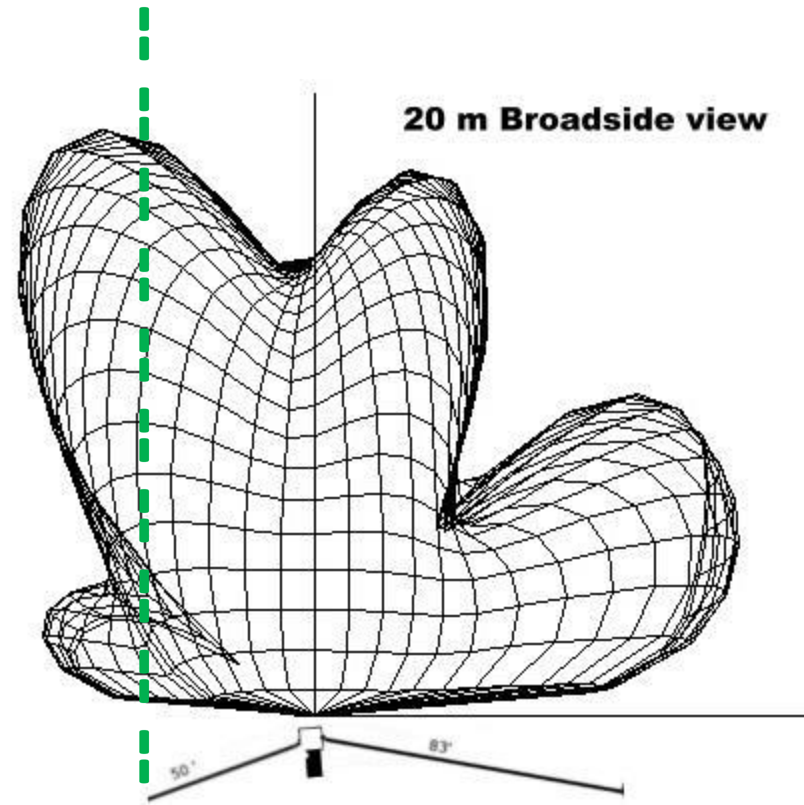
3.8 dBi

20 Meter patterns - Antennas up 33 feet

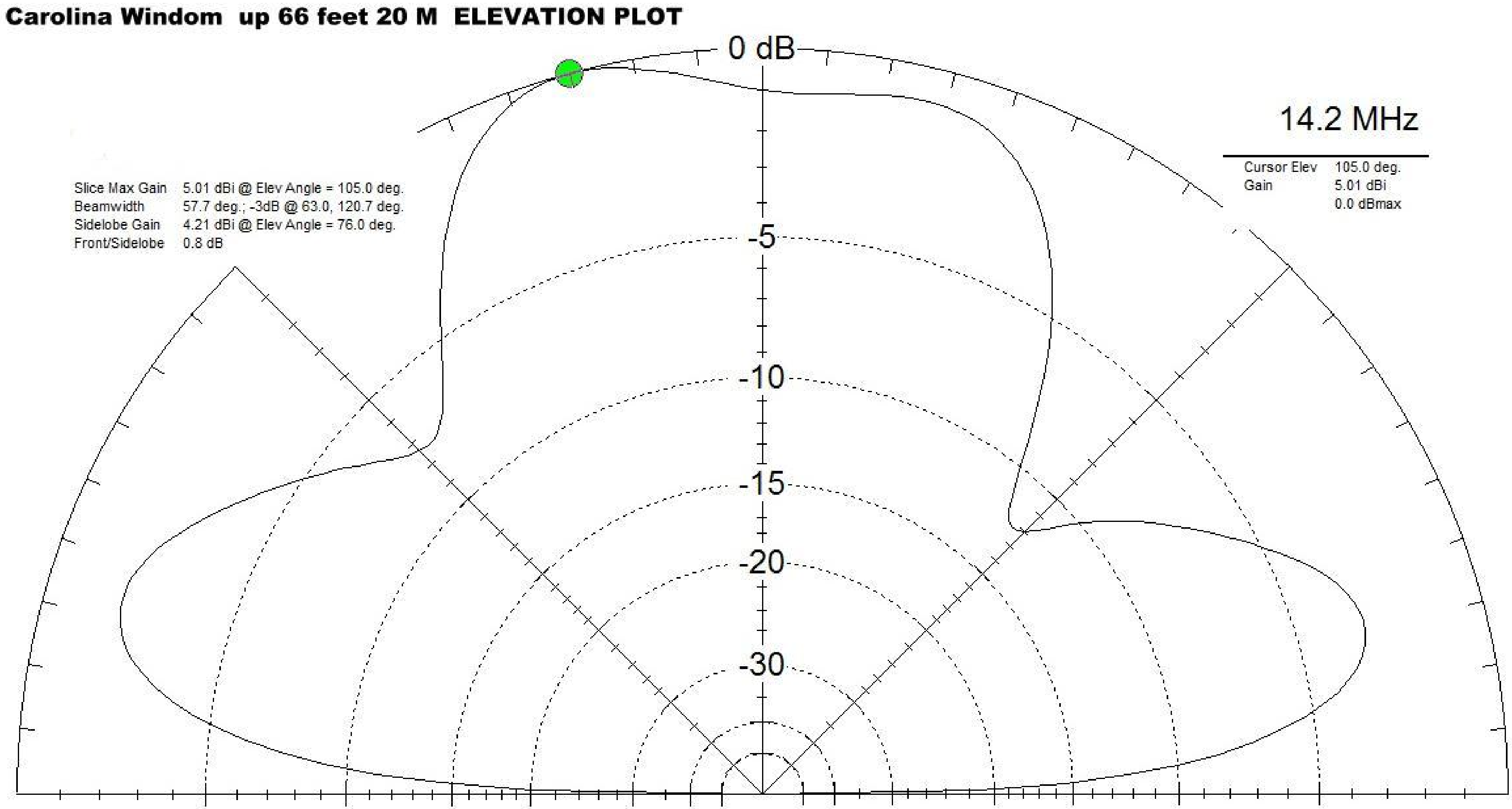
Previous page "pretty" pattern is the green vertical cut in the radiation pattern.







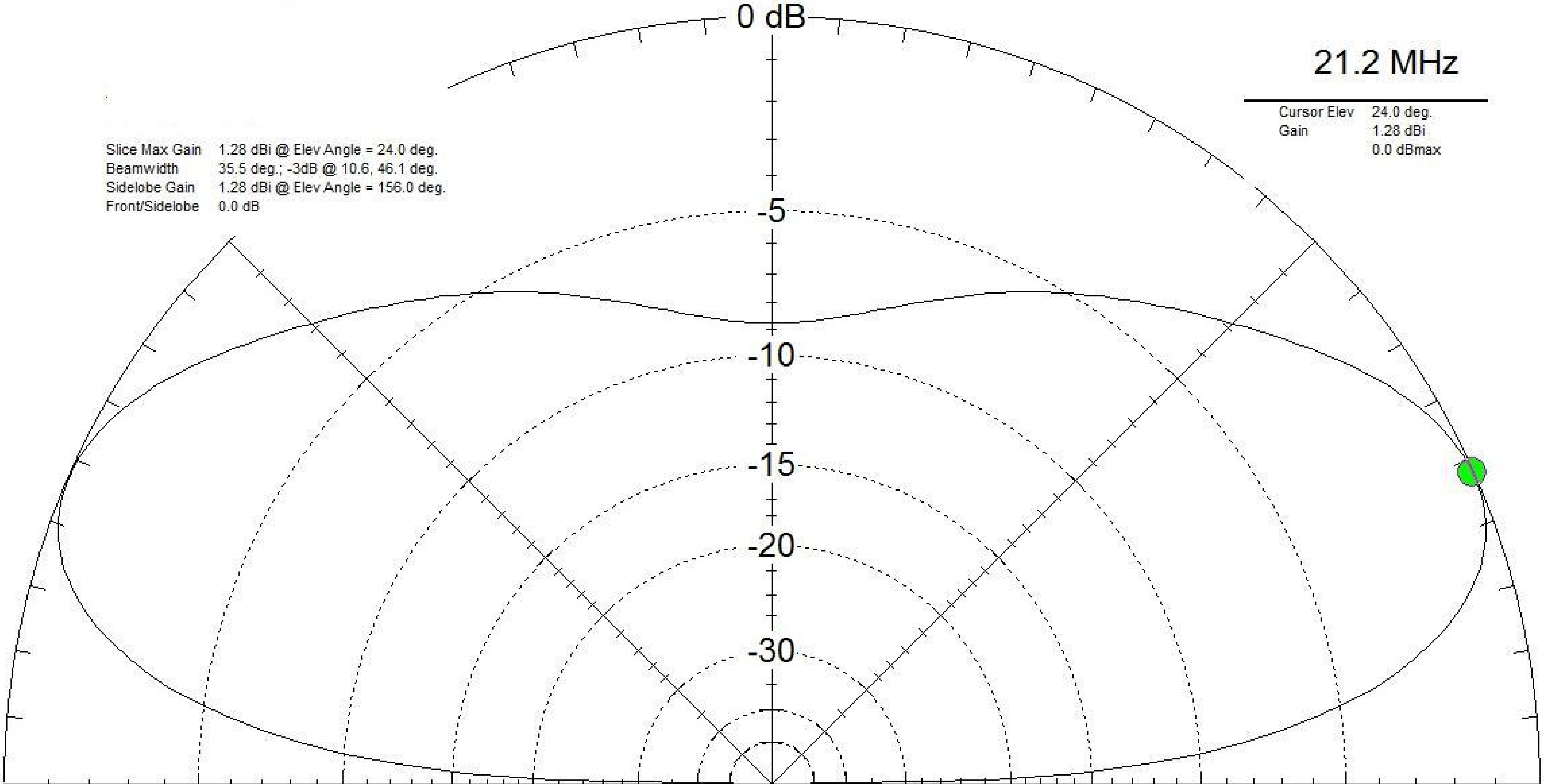
Notice that even up 1 wavelength, much of the RF is going UP



|

5.1 dBi

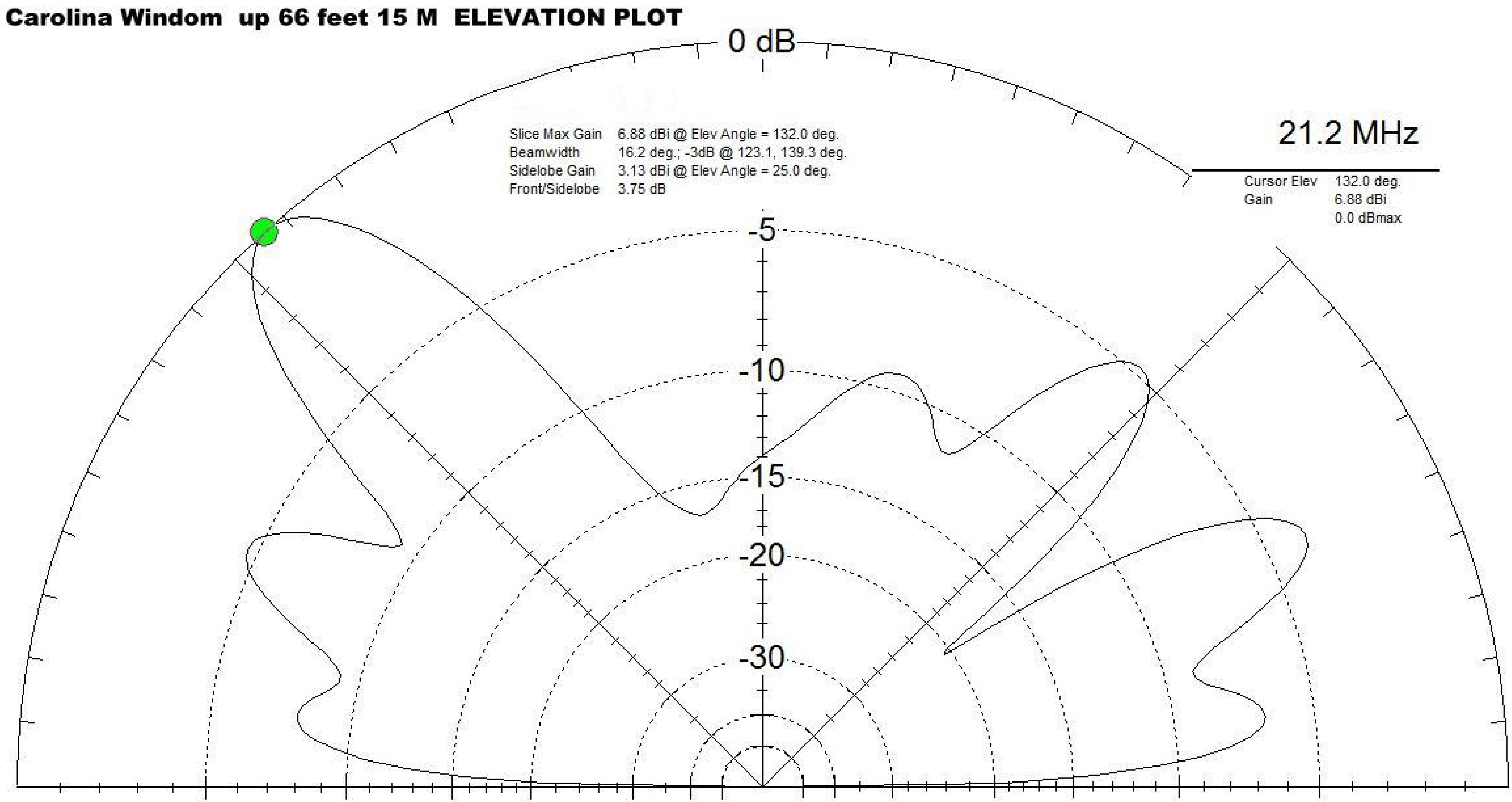
Carolina Windom up 33 feet 15 M ELEVATION PLOT



|

1.26 dBi

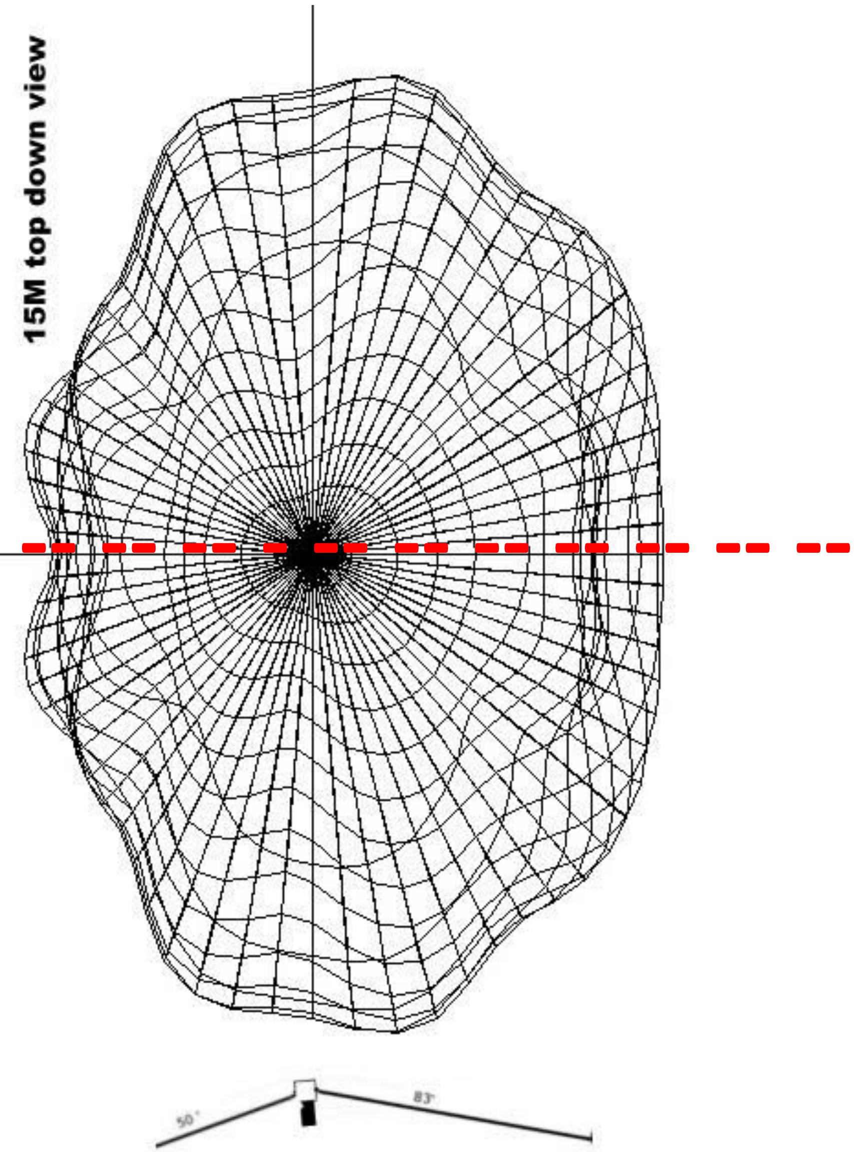
Note that at 66 feet the 22 ft vertical section interacts with the longer horizontal Leg to give a whopping 4.58 dB (over a dipole) at 50 degrees takeoff.

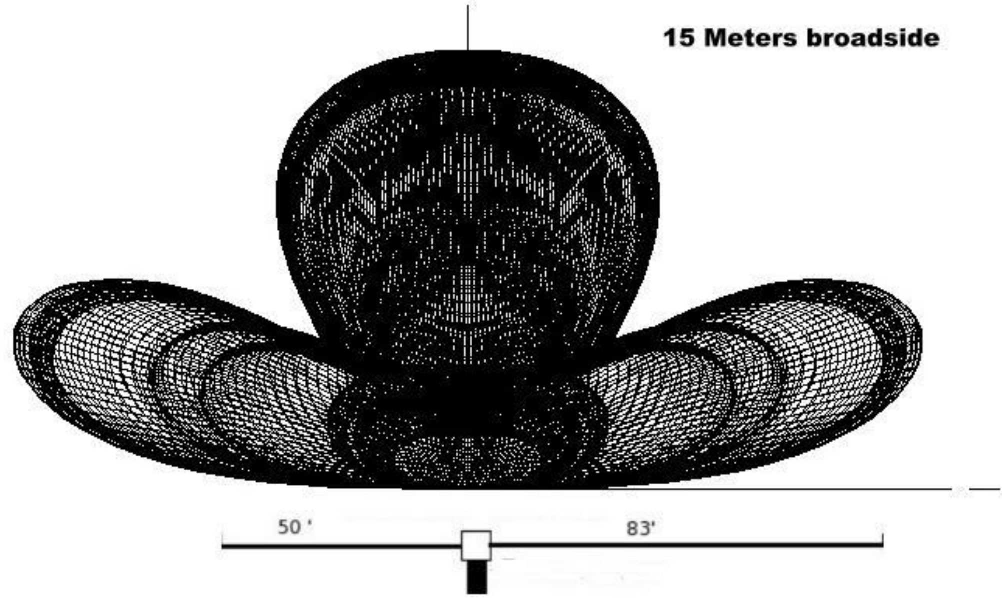


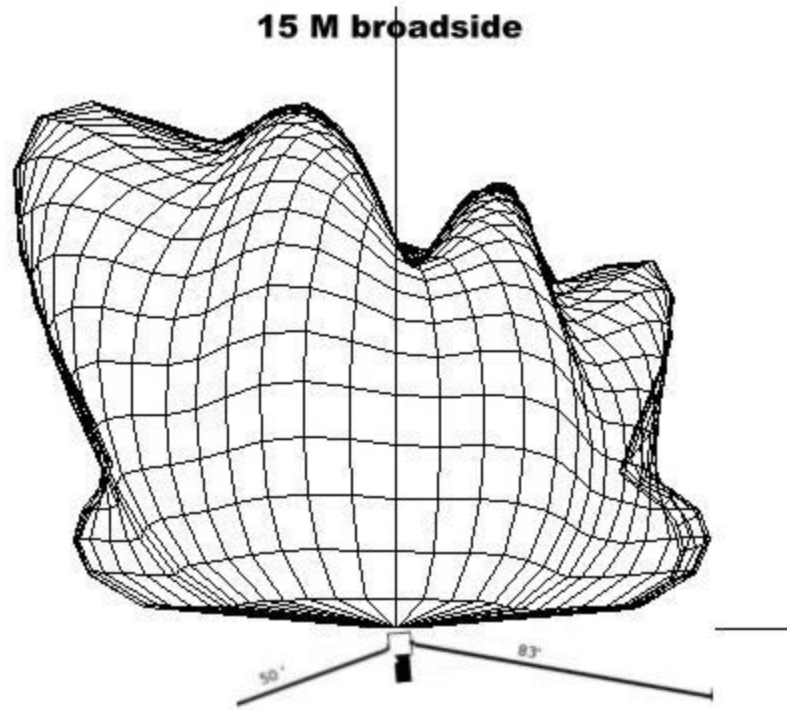
|

6.88 dBi

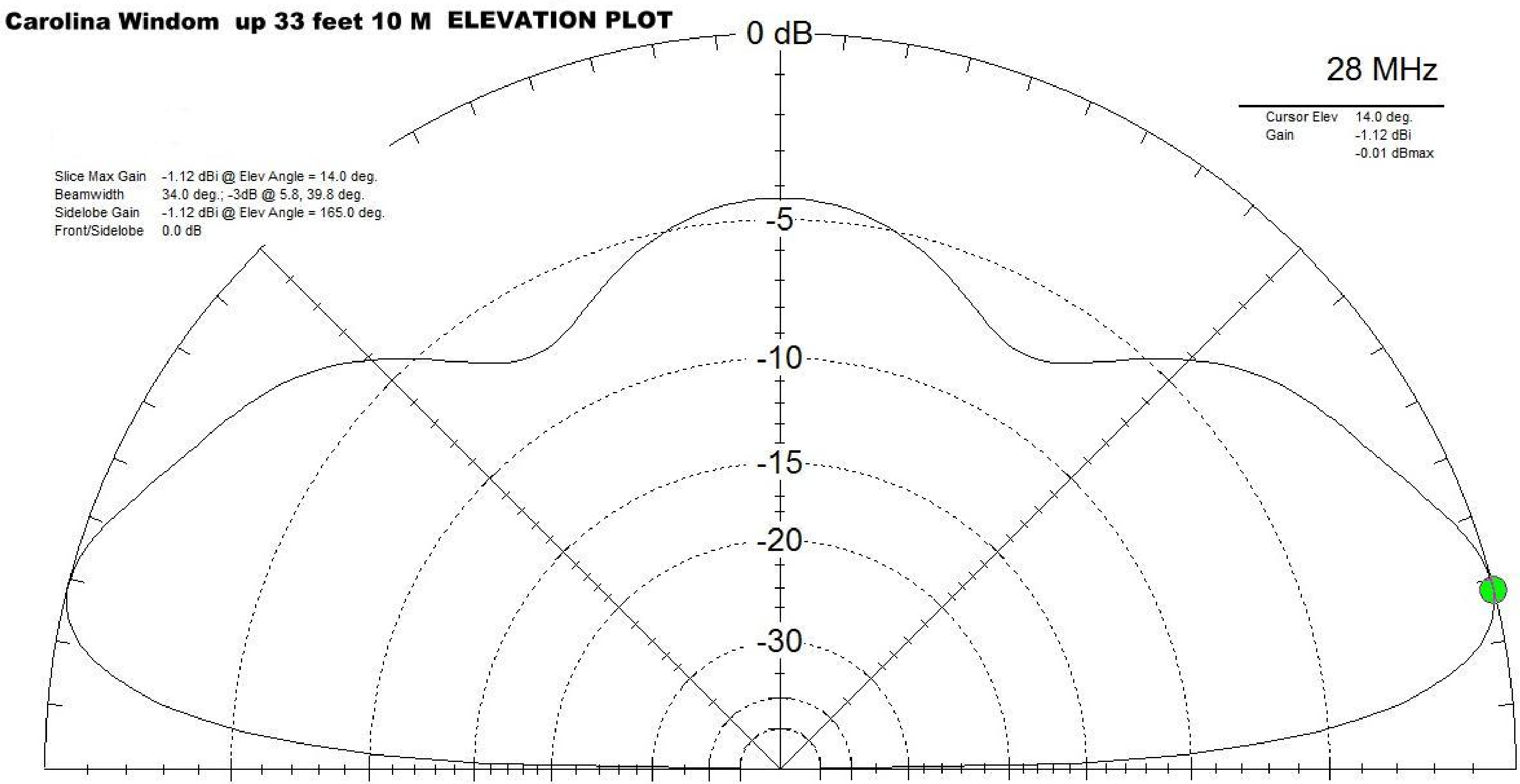
15 Meter patterns up 33 ft







At 1 wavelength on 10 M we get a nice low takeoff angle, but ~1.1 dB less than a dipole

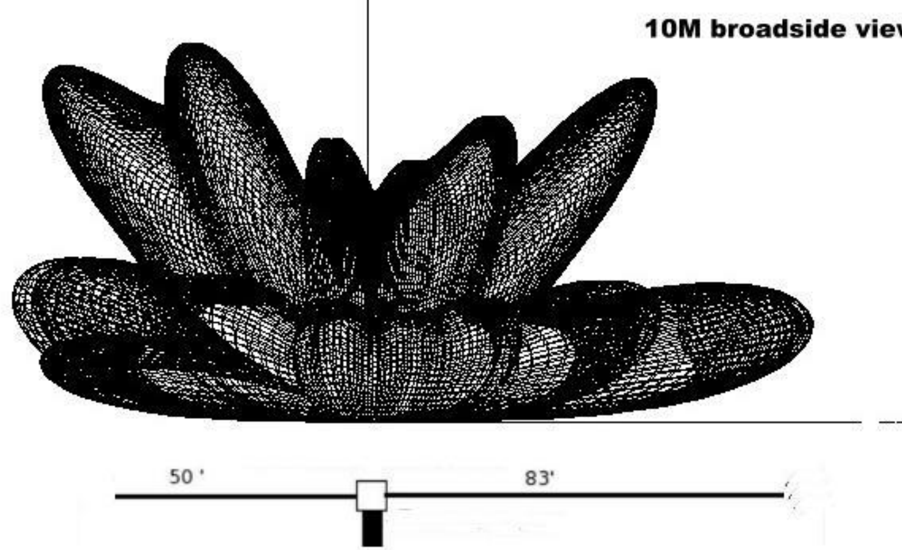


|
- 1.2 dBi

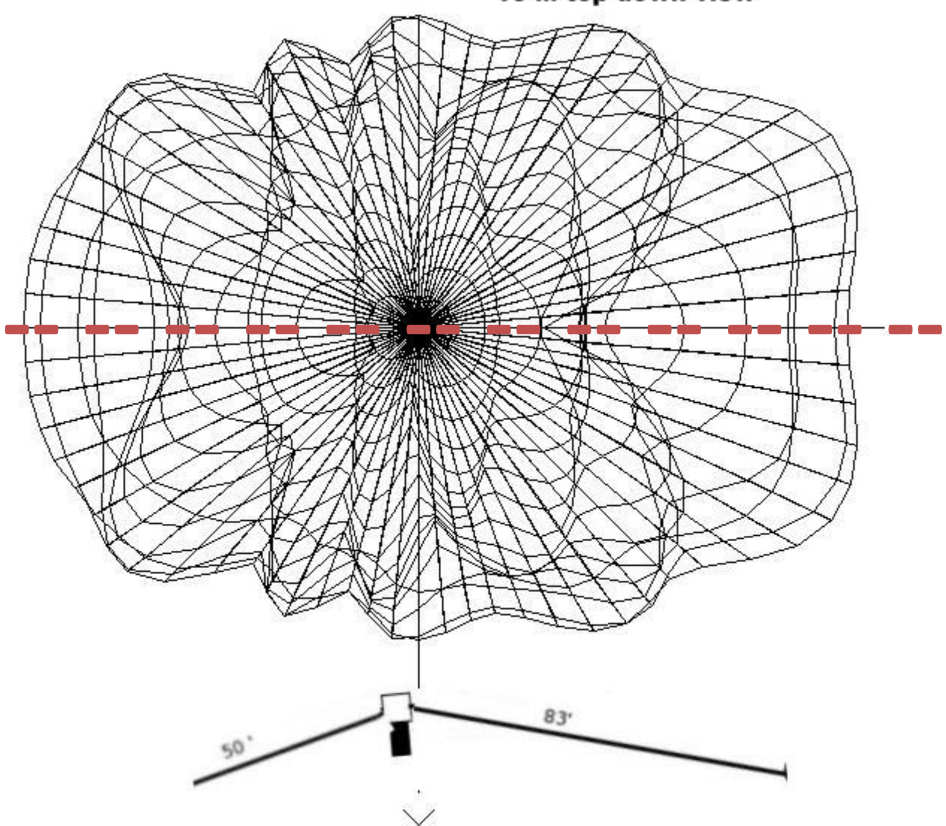
10 Meter patterns up 33 ft

Notice how the pattern is pulled toward the ends of the wires and is better than the broadside pattern

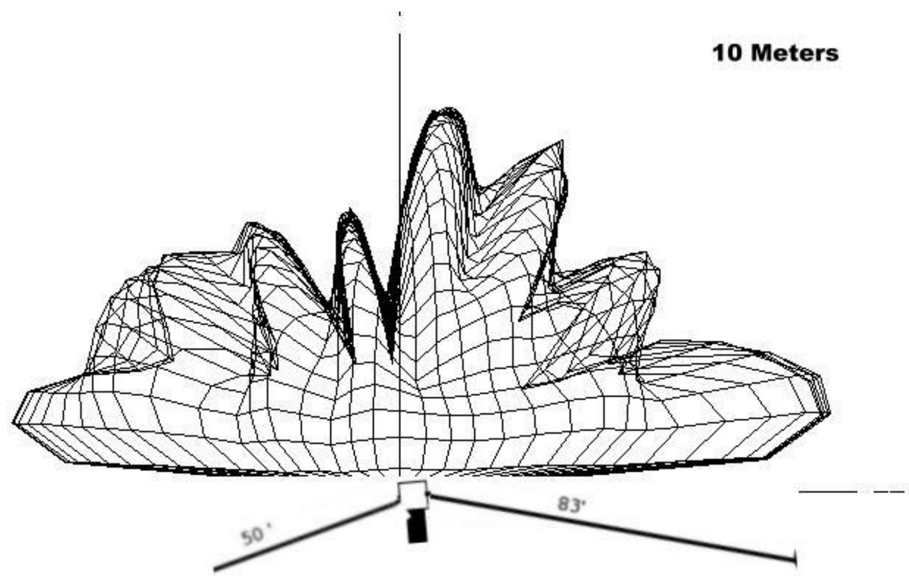
10M broadside view



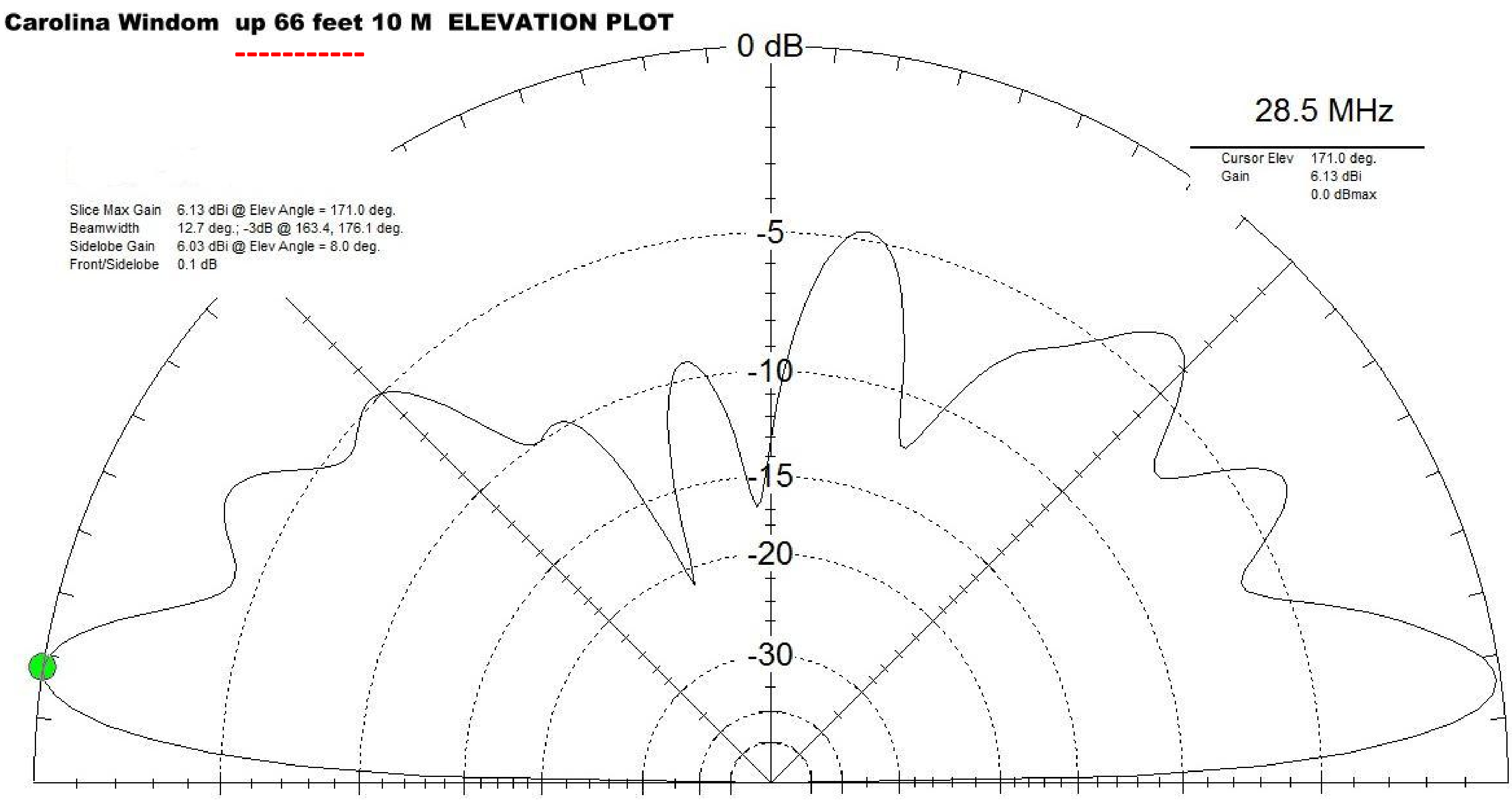
10 M top down view



10 Meters



At 2 WL high, this seems to be a good low angle antenna, with high components, too.



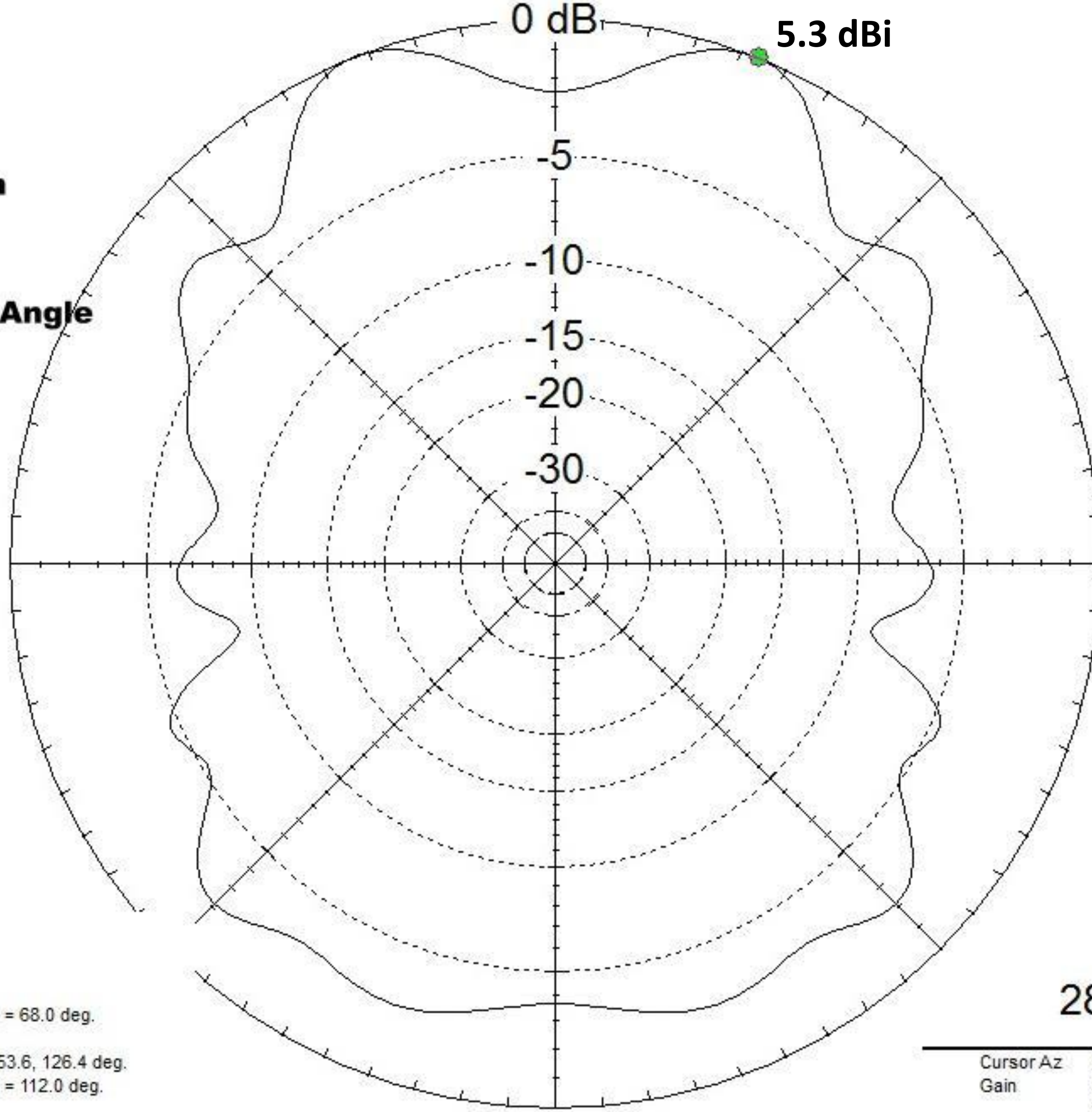
|
6.13 dBi

Now let's take a look at the azimuth pattern for each band
33 feet up first and then 66 feet up after that…

I have chosen the best takeoff angle for each band
as shown on the elevation plots

10 Meters

Carolina Windom
up 33 feet
AZIMUTH PLOT
14 degree Takeoff Angle



Azimuth Plot
Elevation Angle 14.0 deg.
Outer Ring 5.3 dBi

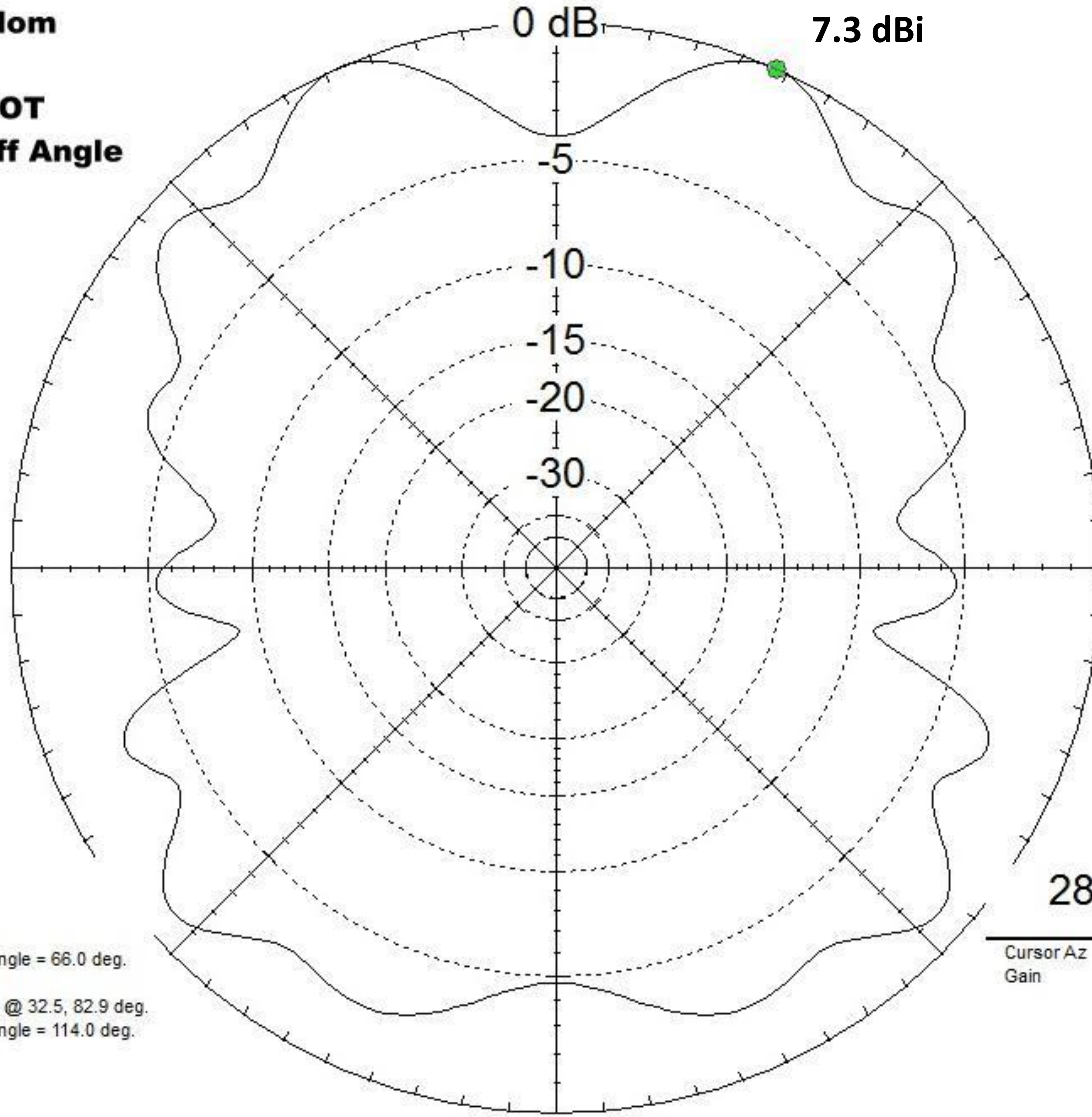
Slice Max Gain 5.3 dBi @ Az Angle = 68.0 deg.
Front/Back 2.57 dB
Beamwidth 72.8 deg.; -3dB @ 53.6, 126.4 deg.
Sidelobe Gain 5.3 dBi @ Az Angle = 112.0 deg.
Front/Sidelobe 0.0 dB

28 MHz

Cursor Az 68.0 deg.
Gain 5.3 dBi
0.0 dBmax

Carolina Windom
up 66 feet
AZIMUTH PLOT
9 degree Takeoff Angle

10 Meters

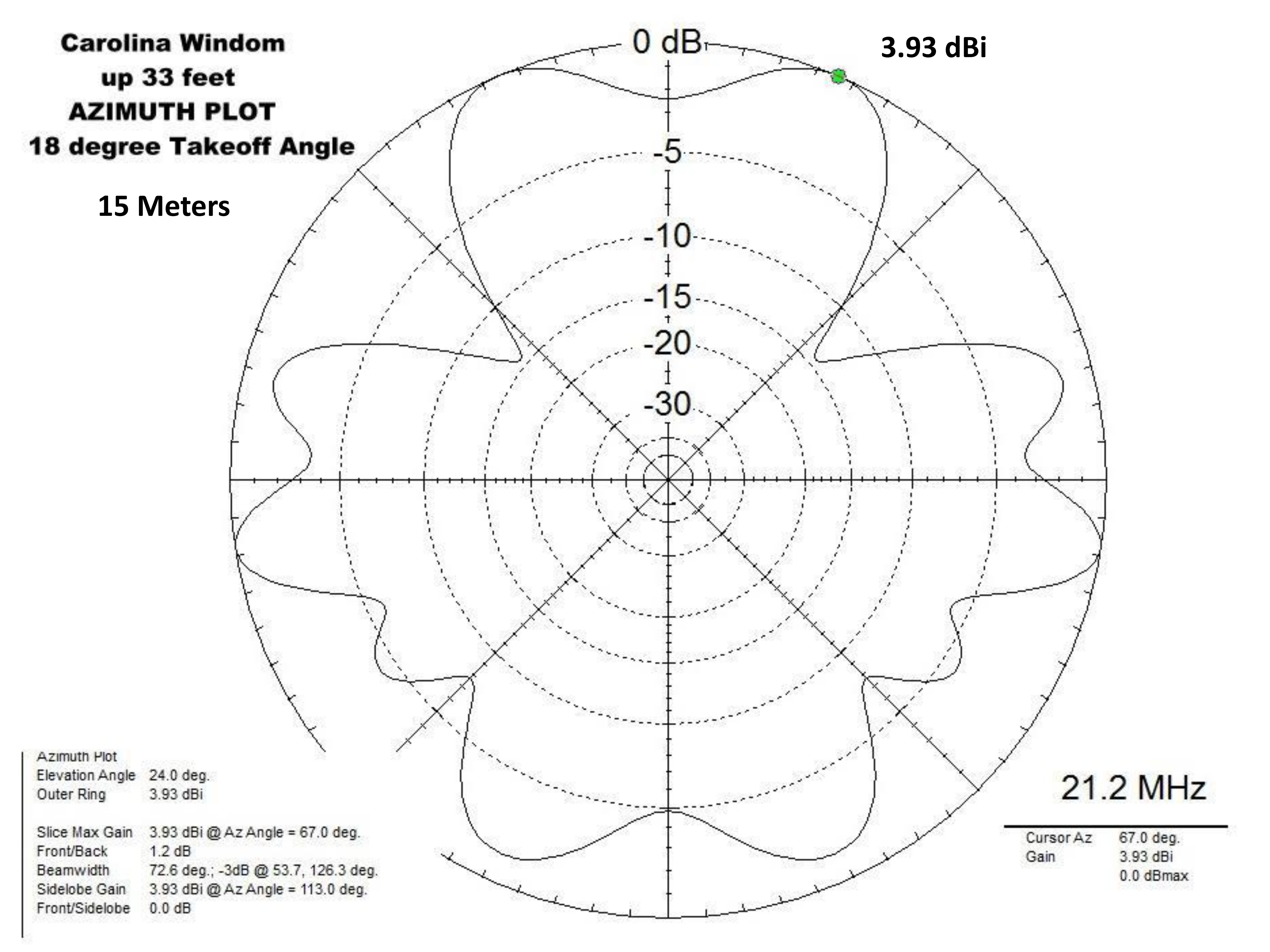


28.5 MHz

Cursor Az	66.0 deg.
Gain	7.3 dBi
	0.0 dBmax

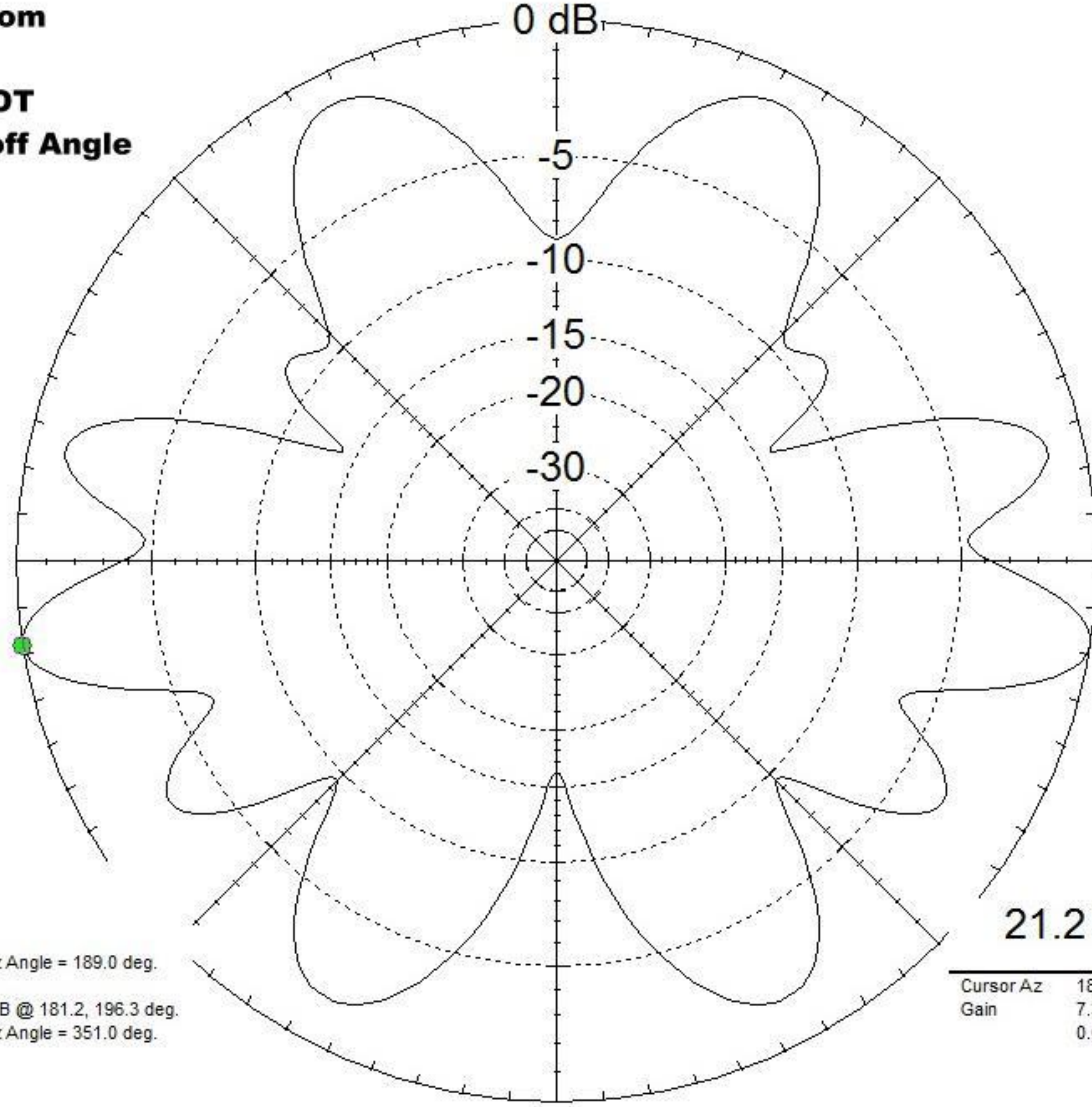
Azimuth Plot

Elevation Angle	9.0 deg.
Outer Ring	7.3 dBi
Slice Max Gain	7.3 dBi @ Az Angle = 66.0 deg.
Front/Back	2.22 dB
Beamwidth	50.4 deg.; -3dB @ 32.5, 82.9 deg.
Sidelobe Gain	7.3 dBi @ Az Angle = 114.0 deg.
Front/Sidelobe	0.0 dB


Carolina Windom
up 33 feet
AZIMUTH PLOT
18 degree Takeoff Angle
15 Meters
0 dB
3.93 dBi
-5
-10
-15
-20
-30
21.2 MHz
Azimuth Plot
Elevation Angle 24.0 deg.
Outer Ring 3.93 dBi
Slice Max Gain 3.93 dBi @ Az Angle = 67.0 deg.
Front/Back 1.2 dB
Beamwidth 72.6 deg.; -3dB @ 53.7, 126.3 deg.
Sidelobe Gain 3.93 dBi @ Az Angle = 113.0 deg.
Front/Sidelobe 0.0 dB
Cursor Az 67.0 deg.
Gain 3.93 dBi
0.0 dBmax

Carolina Windom
up 66 feet
AZIMUTH PLOT
13 degree Takeoff Angle

15 Meters



7.37 dBi

Azimuth Plot
Elevation Angle 13.0 deg.
Outer Ring 7.37 dBi

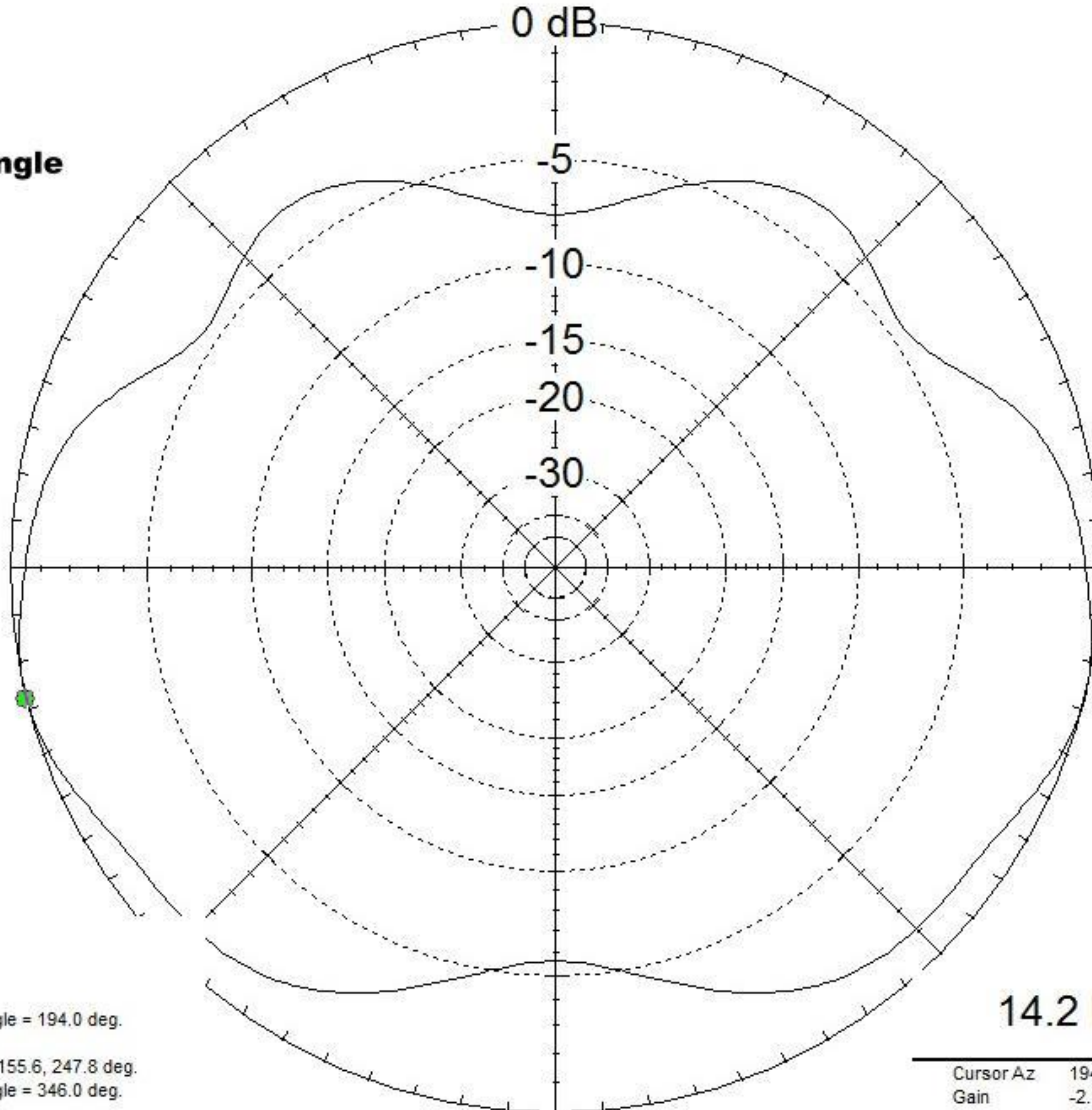
Slice Max Gain 7.37 dBi @ Az Angle = 189.0 deg.
Front/Back 2.0 dB
Beamwidth 15.1 deg.; -3dB @ 181.2, 196.3 deg.
Sidelobe Gain 7.37 dBi @ Az Angle = 351.0 deg.
Front/Sidelobe 0.0 dB

21.2 MHz

Cursor Az	189.0 deg.
Gain	7.37 dBi
	0.0 dBmax

Carolina Windom
up 33 feet
AZIMUTH PLOT
10 degree Takeoff Angle

20 Meters

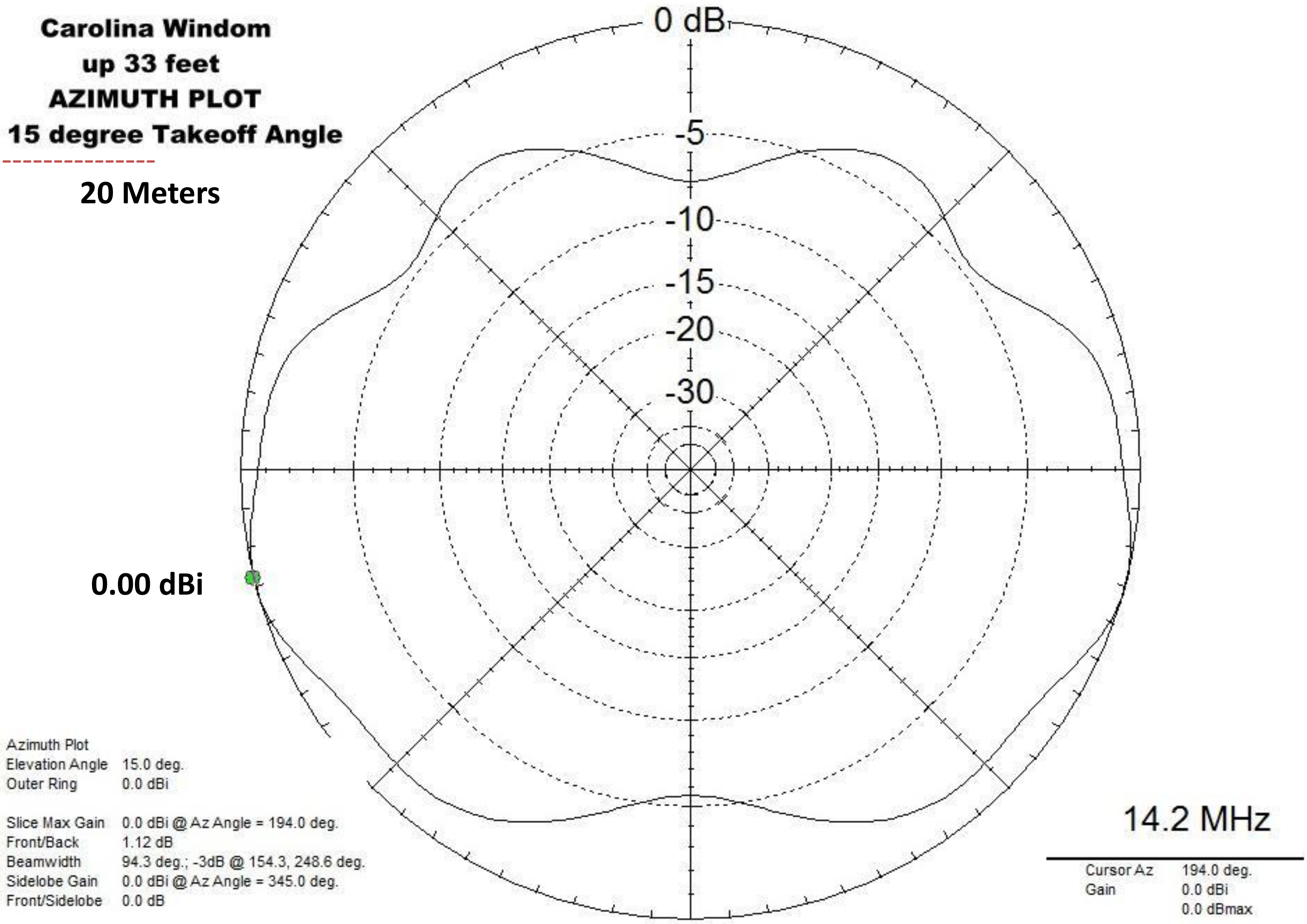


Azimuth Plot	
Elevation Angle	10.0 deg.
Outer Ring	-2.18 dBi
Slice Max Gain	-2.18 dBi @ Az Angle = 194.0 deg.
Front/Back	1.26 dB
Beamwidth	92.2 deg.; -3dB @ 155.6, 247.8 deg.
Sidelobe Gain	-2.18 dBi @ Az Angle = 346.0 deg.
Front/Sidelobe	0.0 dB

Cursor Az	194.0 deg.
Gain	-2.18 dBi
	0.0 dBmax

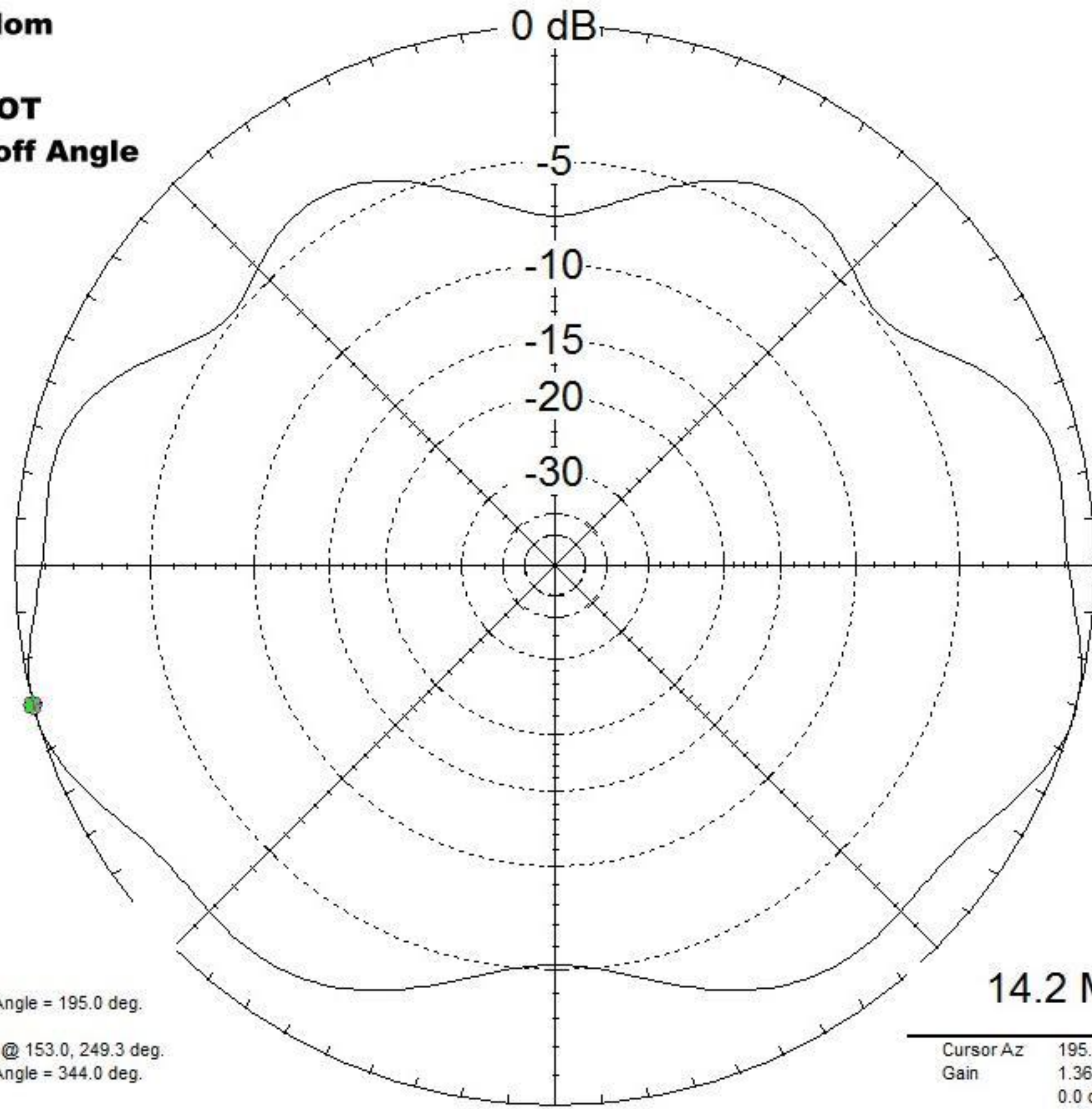
Carolina Windom
up 33 feet
AZIMUTH PLOT
15 degree Takeoff Angle

20 Meters



Carolina Windom
up 33 feet
AZIMUTH PLOT
20 degree Takeoff Angle

20 Meters



1.36 dBi

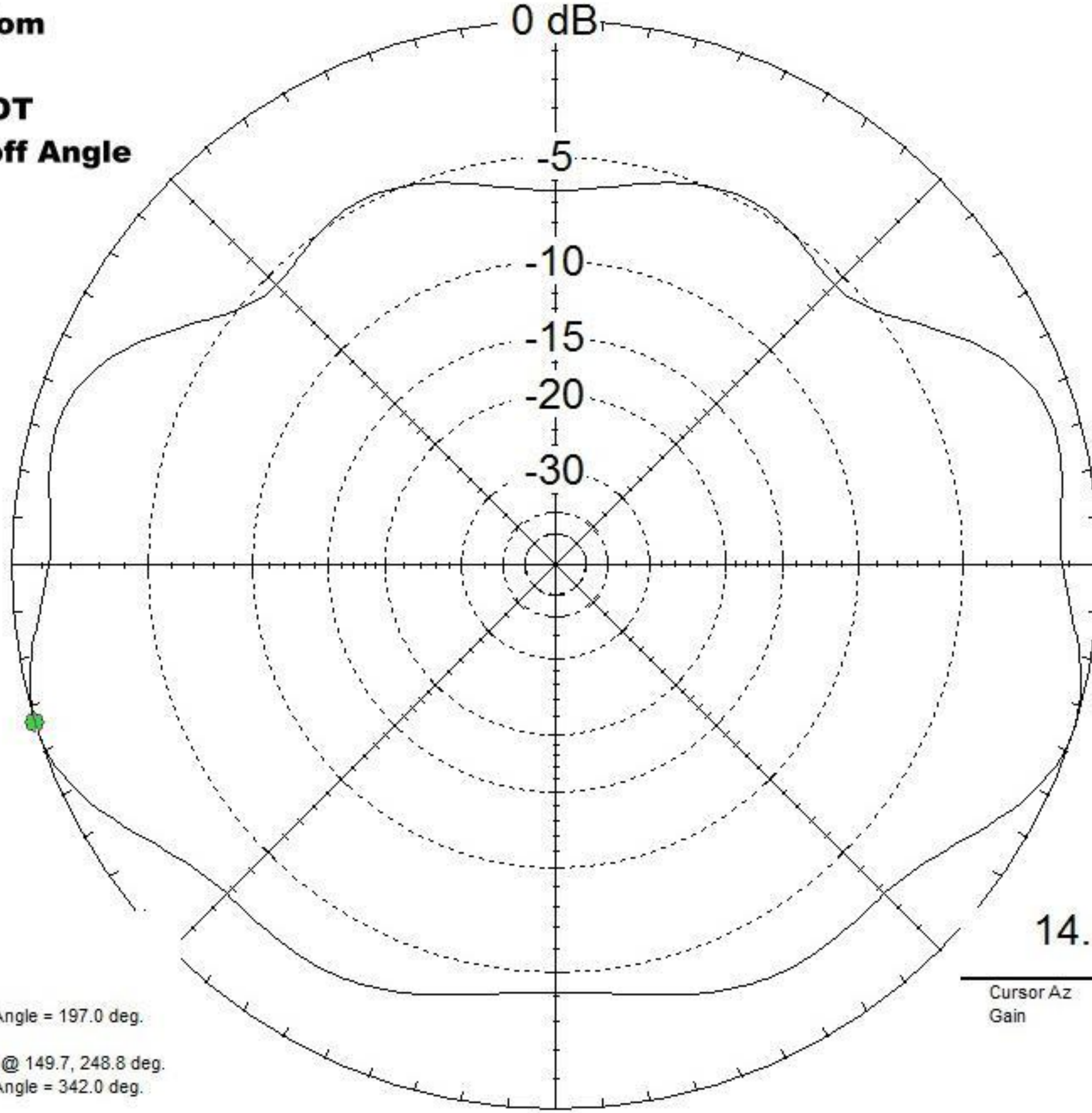
14.2 MHz

Azimuth Plot	
Elevation Angle	20.0 deg.
Outer Ring	1.36 dBi
Slice Max Gain	1.36 dBi @ Az Angle = 195.0 deg.
Front/Back	1.06 dB
Beamwidth	96.3 deg.; -3dB @ 153.0, 249.3 deg.
Sidelobe Gain	1.36 dBi @ Az Angle = 344.0 deg.
Front/Sidelobe	0.0 dB

Cursor Az	195.0 deg.
Gain	1.36 dBi
	0.0 dBmax

Carolina Windom
up 33 feet
AZIMUTH PLOT
30 degree Takeoff Angle

20 Meters



3.04 dBi

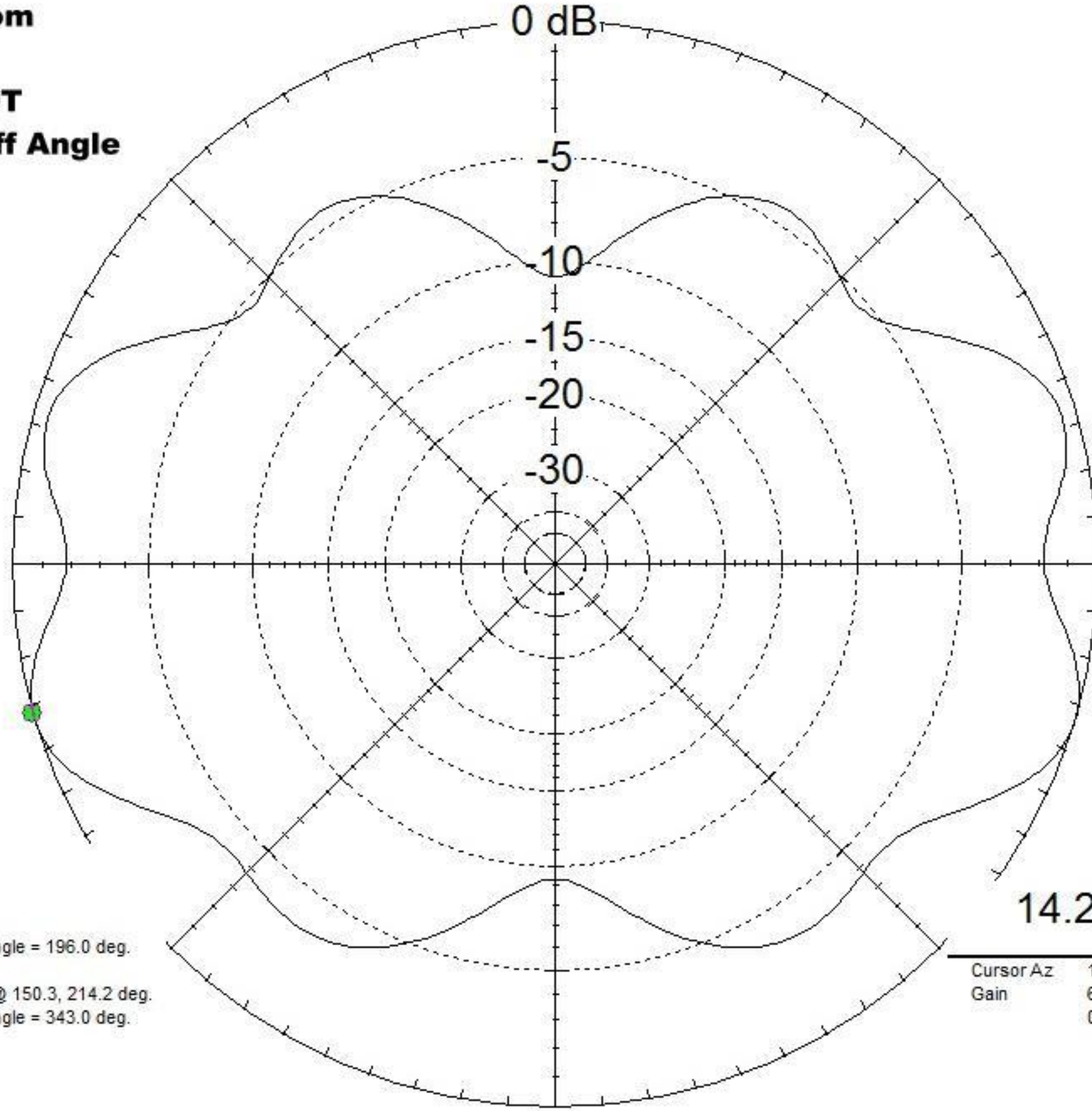
14.2 MHz

Azimuth Plot	
Elevation Angle	30.0 deg.
Outer Ring	3.04 dBi
Slice Max Gain	3.04 dBi @ Az Angle = 197.0 deg.
Front/Back	0.9 dB
Beamwidth	99.1 deg.; -3dB @ 149.7, 248.8 deg.
Sidelobe Gain	3.04 dBi @ Az Angle = 342.0 deg.
Front/Sidelobe	0.0 dB

Cursor Az	197.0 deg.
Gain	3.04 dBi
	0.0 dBmax

Carolina Windom
up 66 feet
AZIMUTH PLOT
20 degree Takeoff Angle

20 Meters



6.75 dBi

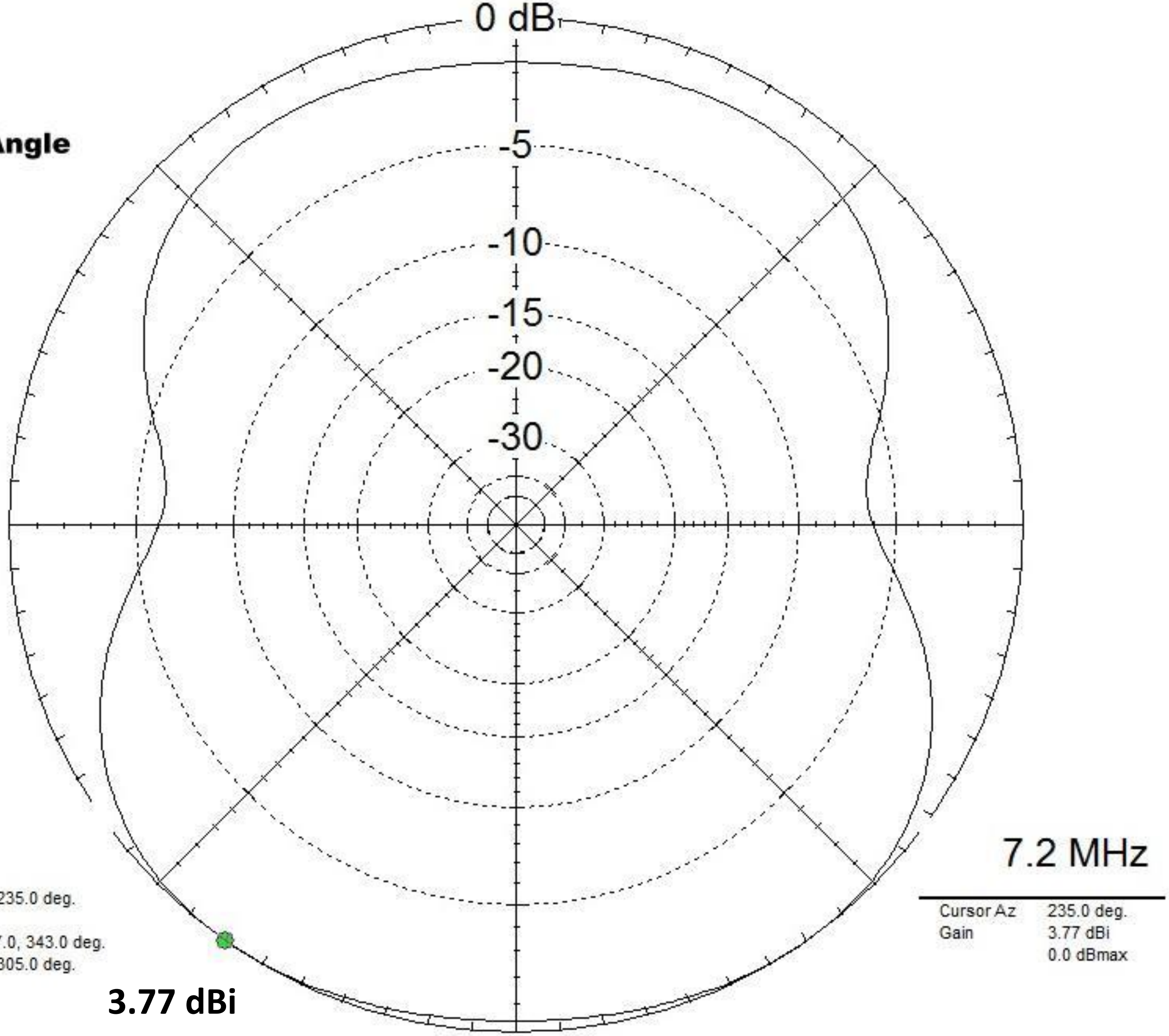
Azimuth Plot	
Elevation Angle	20.0 deg.
Outer Ring	6.75 dBi
Slice Max Gain	6.75 dBi @ Az Angle = 196.0 deg.
Front/Back	0.48 dB
Beamwidth	63.9 deg.; -3dB @ 150.3, 214.2 deg.
Sidelobe Gain	6.75 dBi @ Az Angle = 343.0 deg.
Front/Sidelobe	0.0 dB

14.2 MHz

Cursor Az	196.0 deg.
Gain	6.75 dBi
	0.0 dBmax

Carolina Windom
up 33 feet
AZIMUTH PLOT
45 degree Takeoff Angle

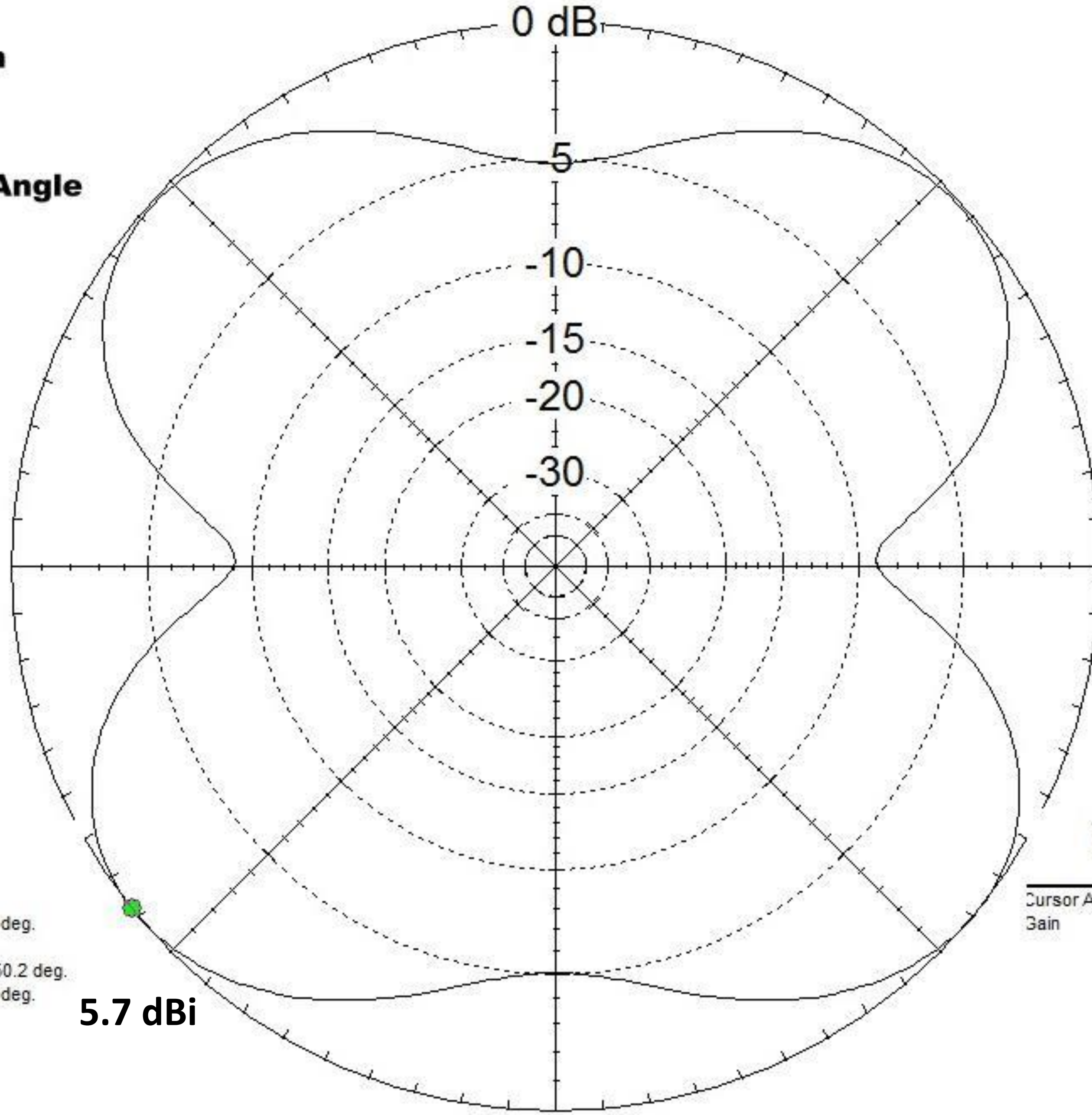
40 Meters



Azimuth Plot	
Elevation Angle	45.0 deg.
Outer Ring	3.77 dBi
Slice Max Gain	3.77 dBi @ Az Angle = 235.0 deg.
Front/Back	1.33 dB
Beamwidth	146.0 deg.; -3dB @ 197.0, 343.0 deg.
Sidelobe Gain	3.77 dBi @ Az Angle = 305.0 deg.
Front/Sidelobe	0.0 dB

Carolina Windom
up 66 feet
AZIMUTH PLOT
28degree Takeoff Angle

40 Meters



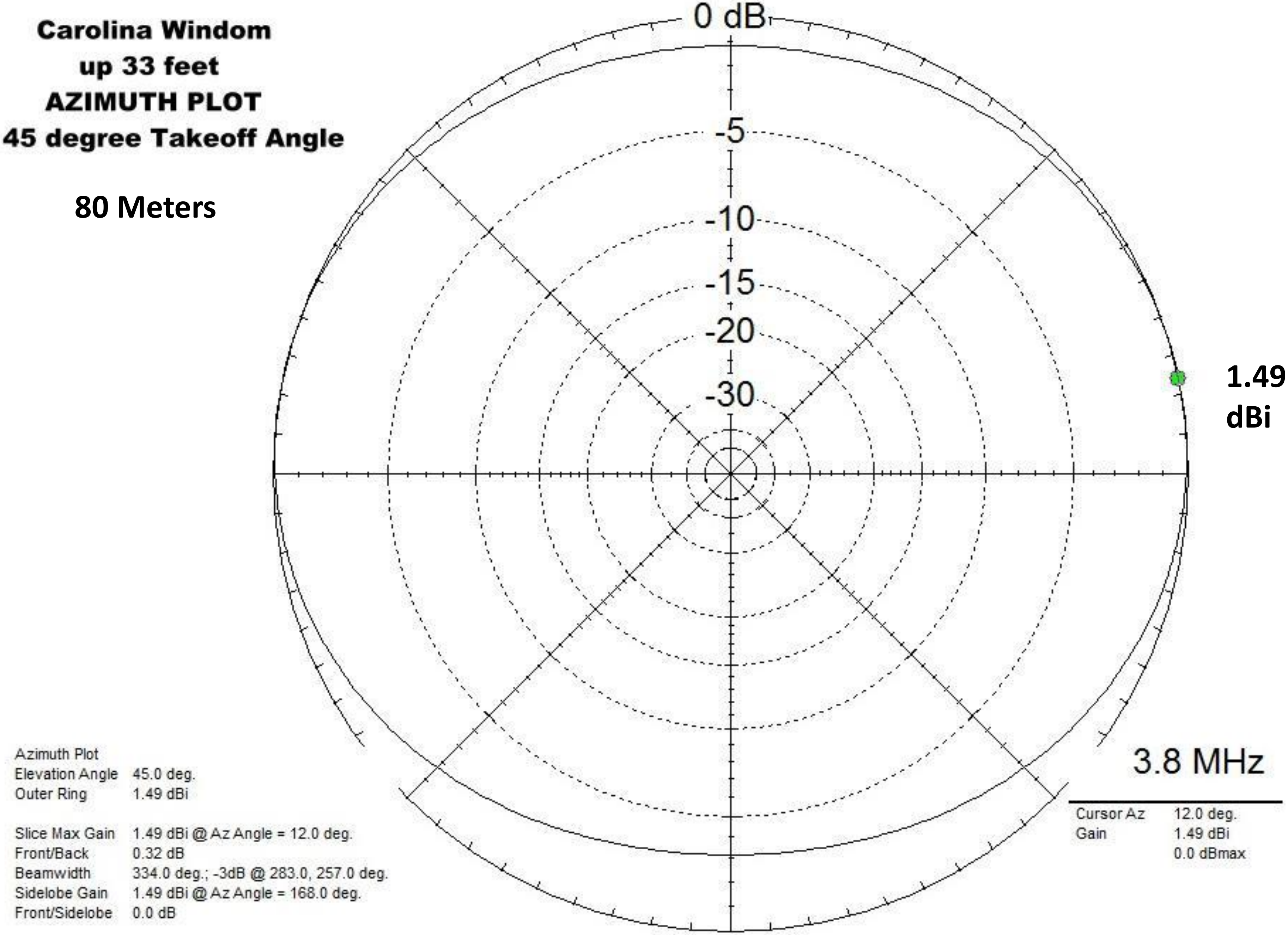
Azimuth Plot	
Elevation Angle	28.0 deg.
Outer Ring	5.7 dBi
Slice Max Gain	5.7 dBi @ Az Angle = 219.0 deg.
Front/Back	0.14 dB
Beamwidth	53.8 deg.; -3dB @ 196.4, 250.2 deg.
Sidelobe Gain	5.7 dBi @ Az Angle = 321.0 deg.
Front/Sidelobe	0.0 dB

7.2 MHz

Cursor Az	219.0 deg.
Gain	5.7 dBi
	0.0 dBmax

Carolina Windom
up 33 feet
AZIMUTH PLOT
45 degree Takeoff Angle

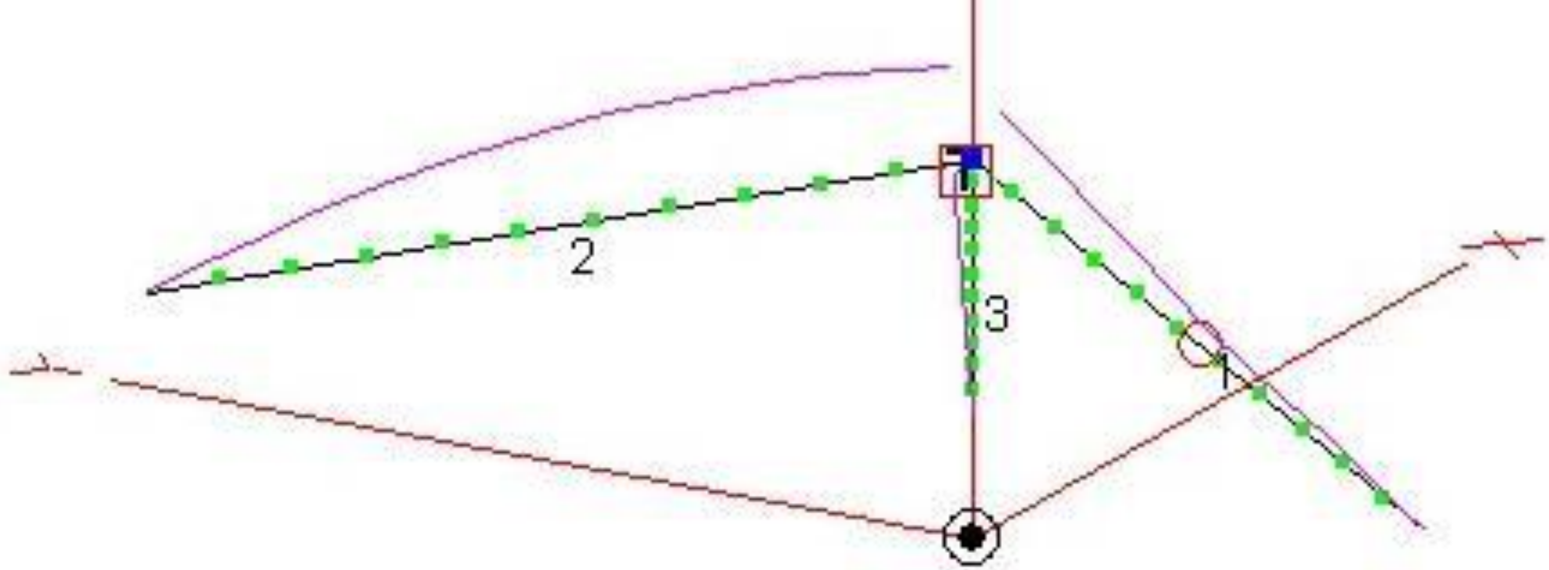
80 Meters



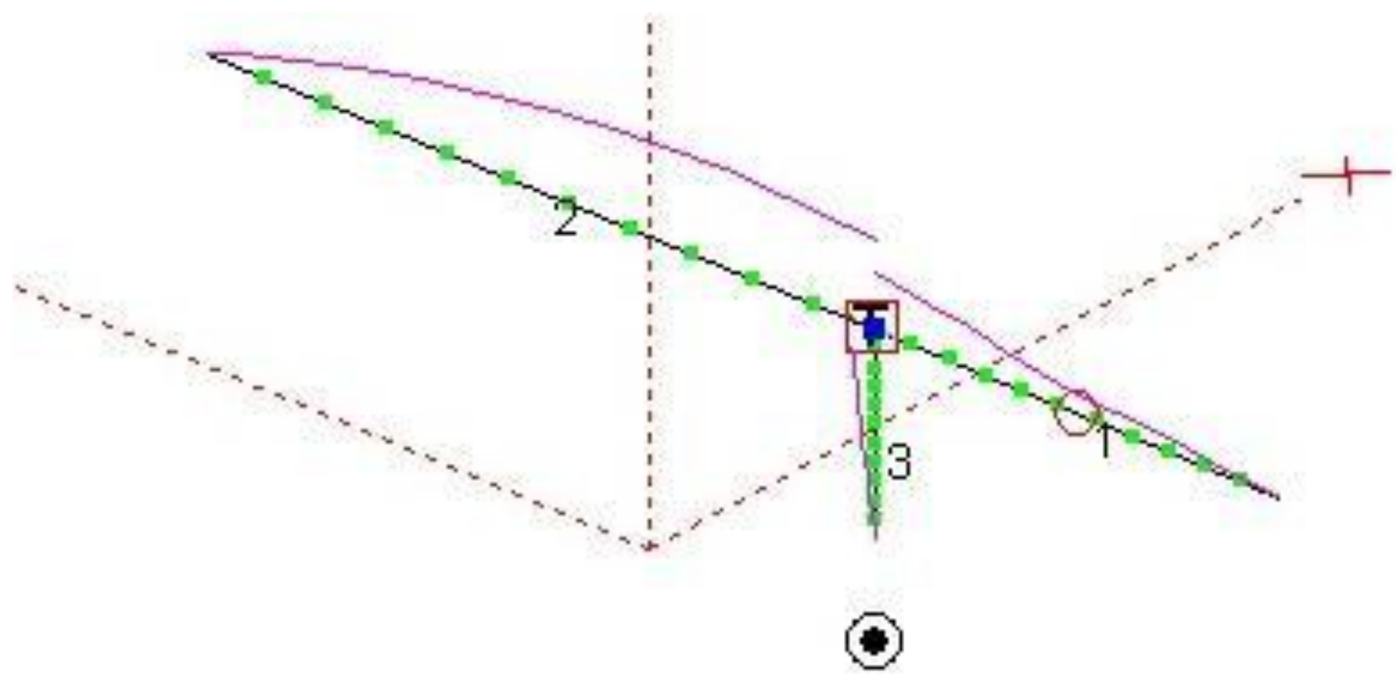
OK, So what is causing all this confusion in the patterns?

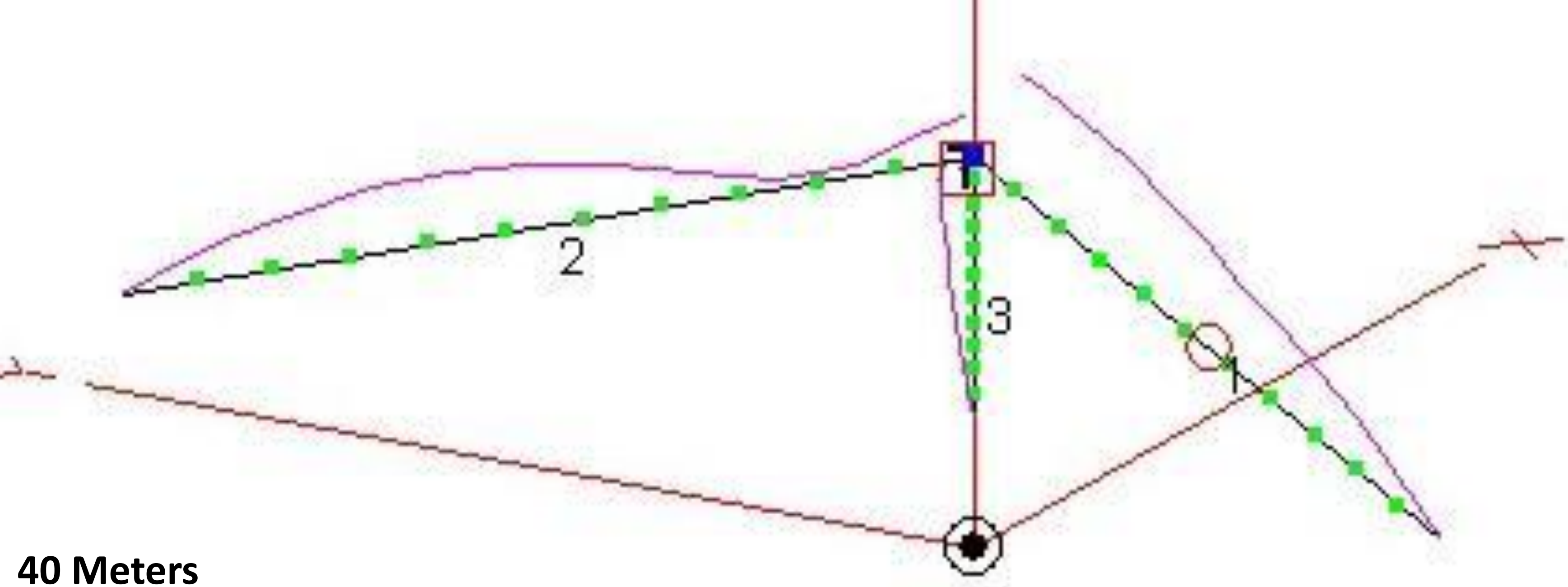
Why are they not like the patterns we are used to seeing from a dipole or yagi?

Let's look at the wires, themselves, and where the most currents are flowing:



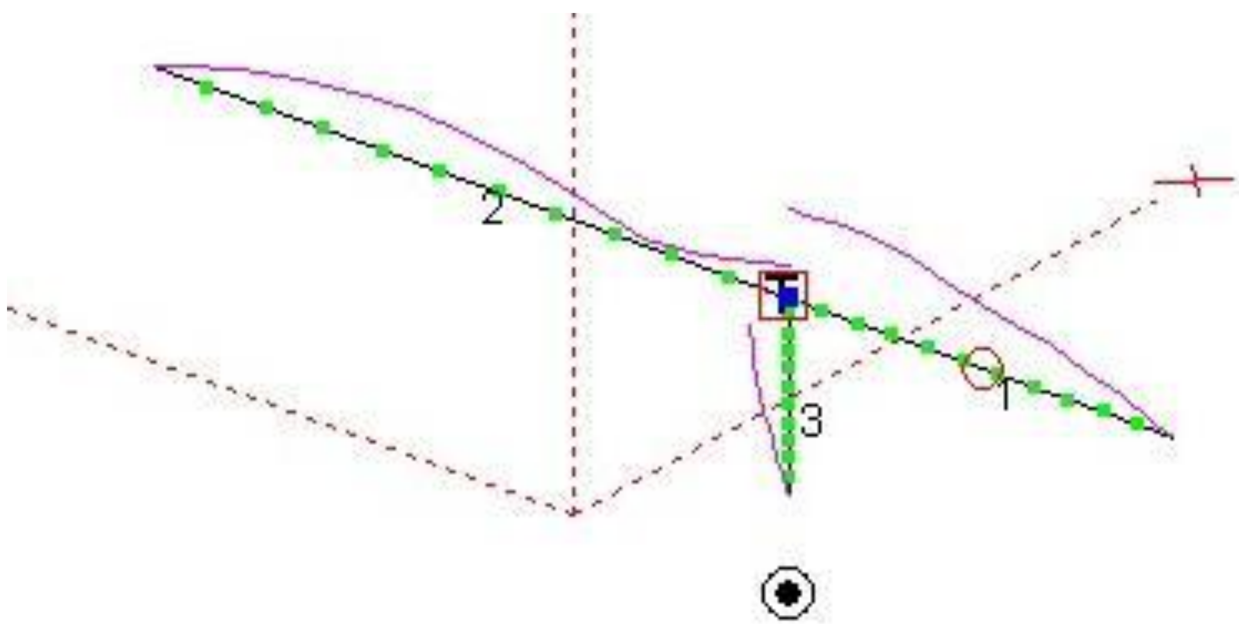
80 Meters **Since the top 2 wires total length is 133 ft, it acts like a half wave dipole, as expected.**



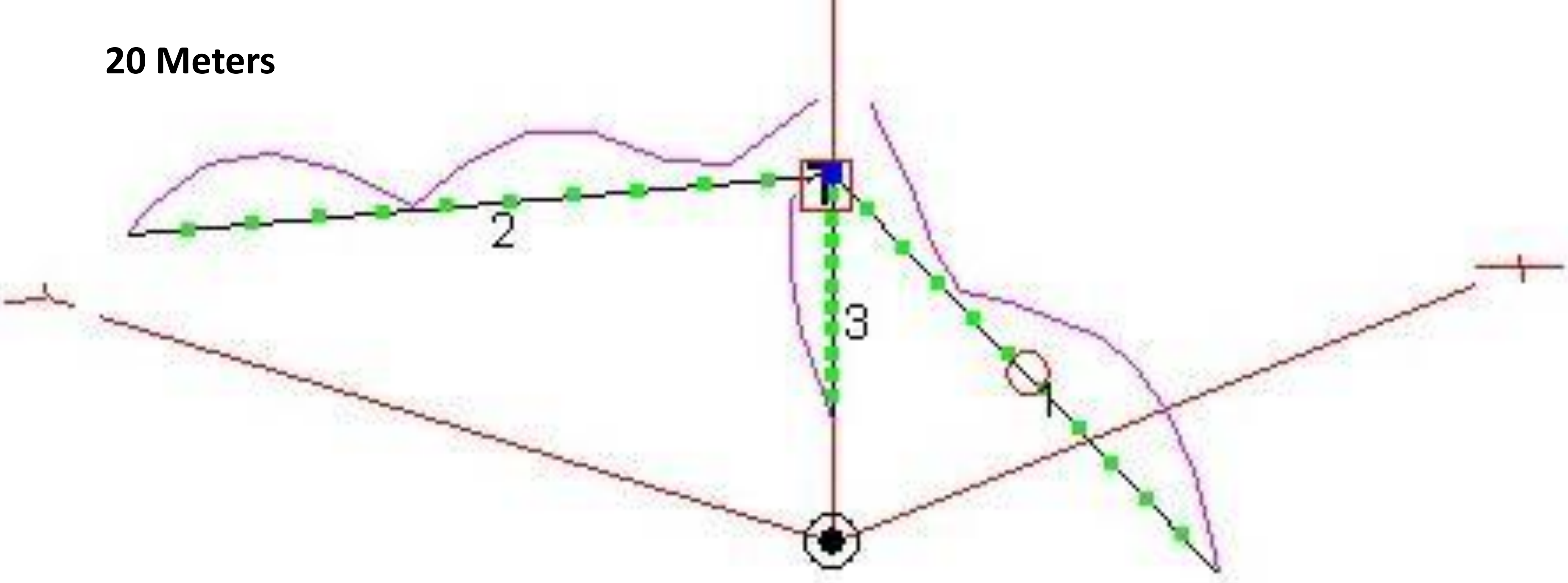


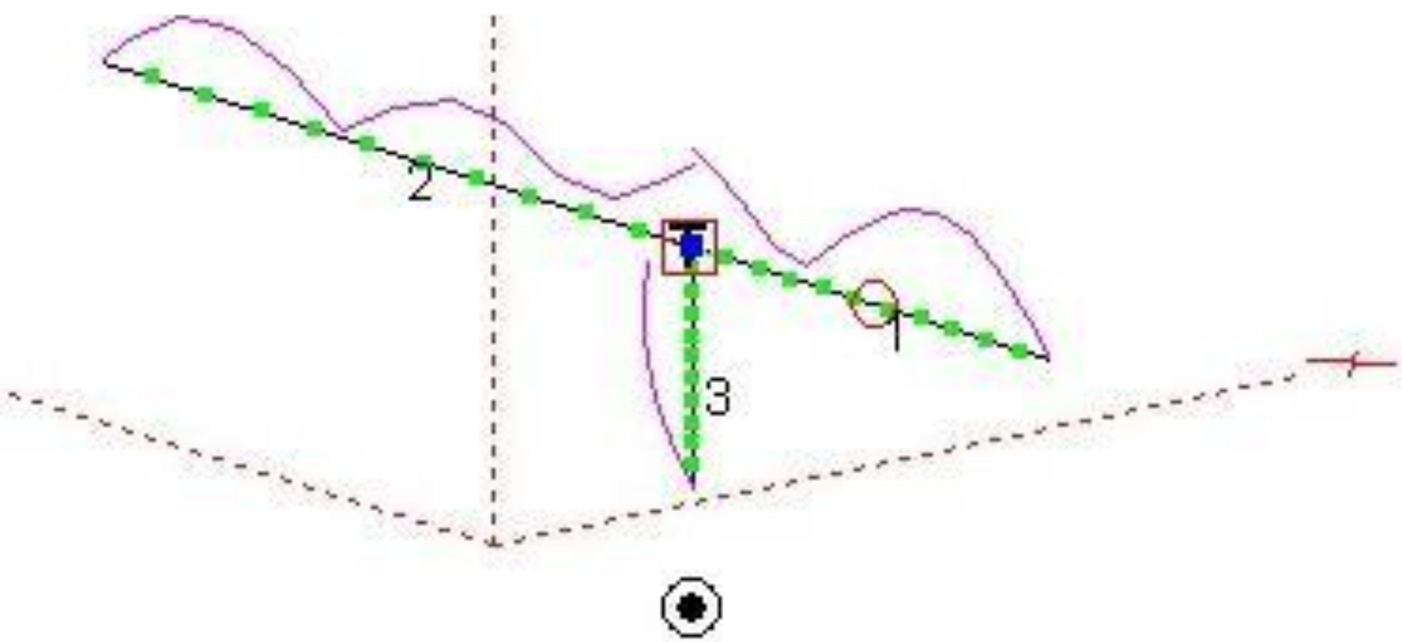
40 Meters

Currents pretty much like a full wave antenna

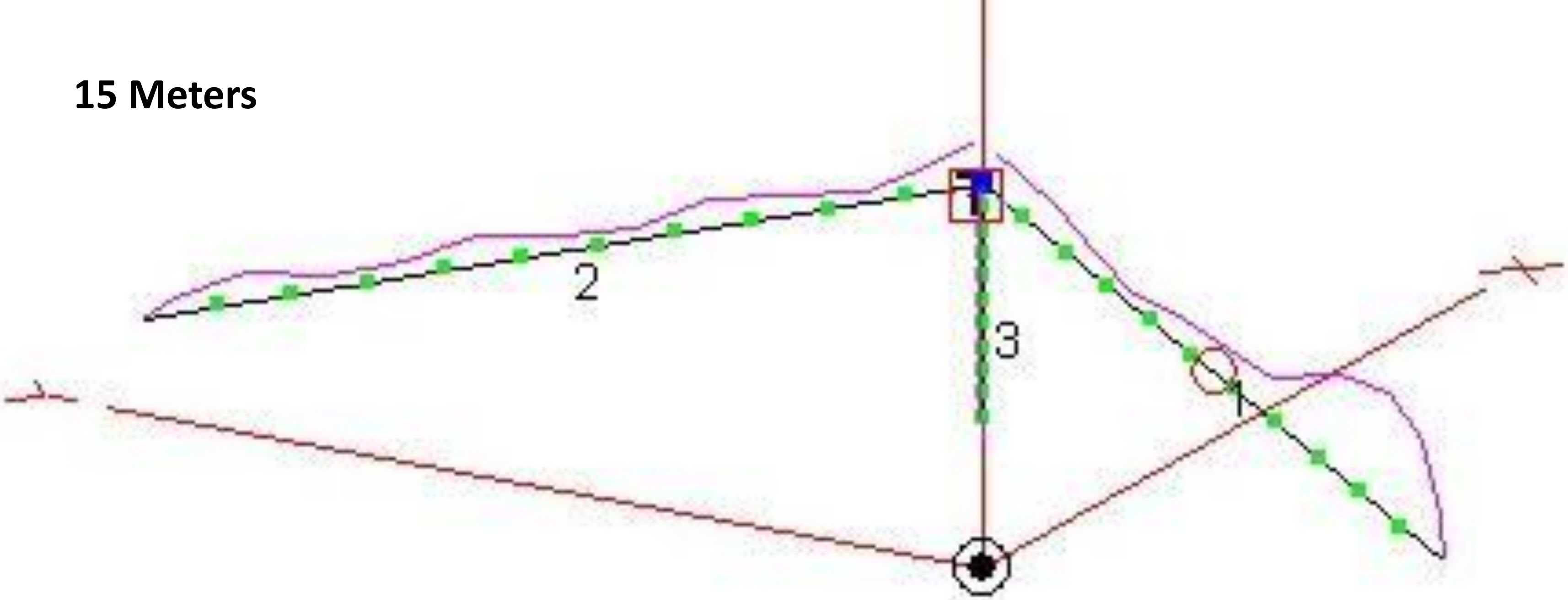


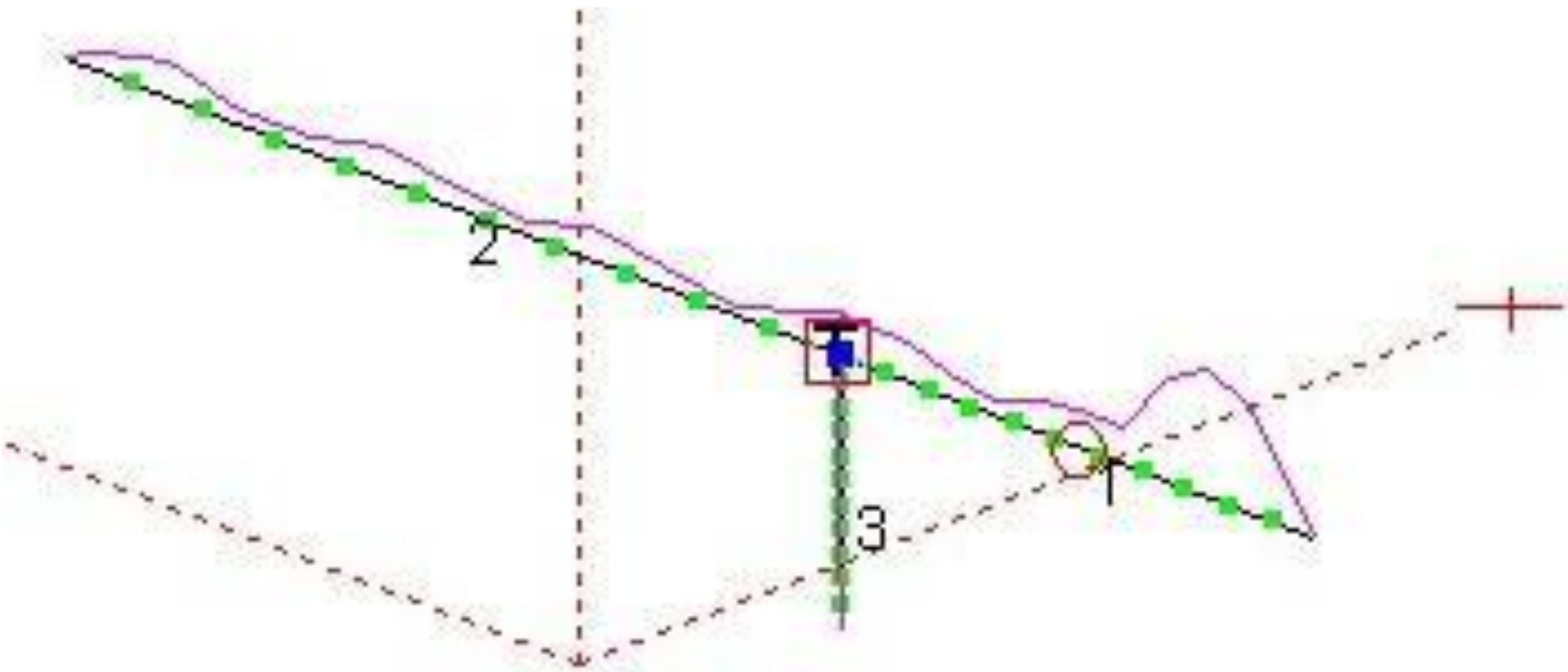
20 Meters



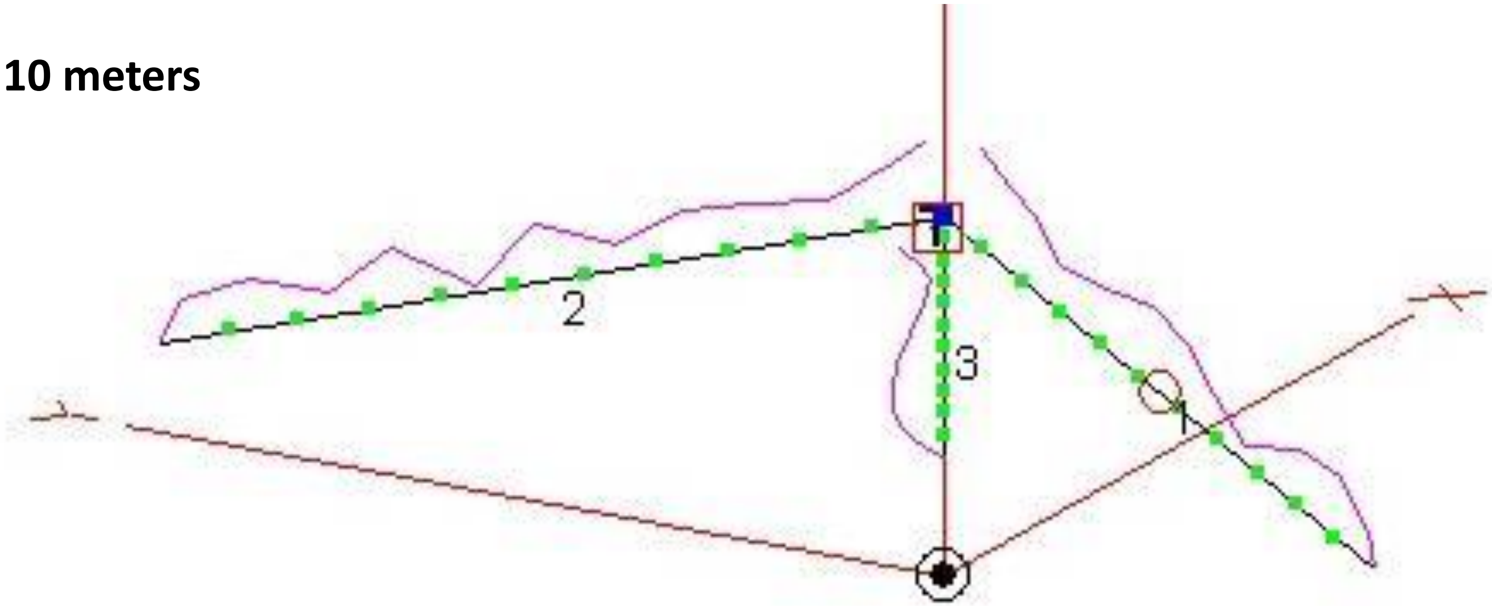


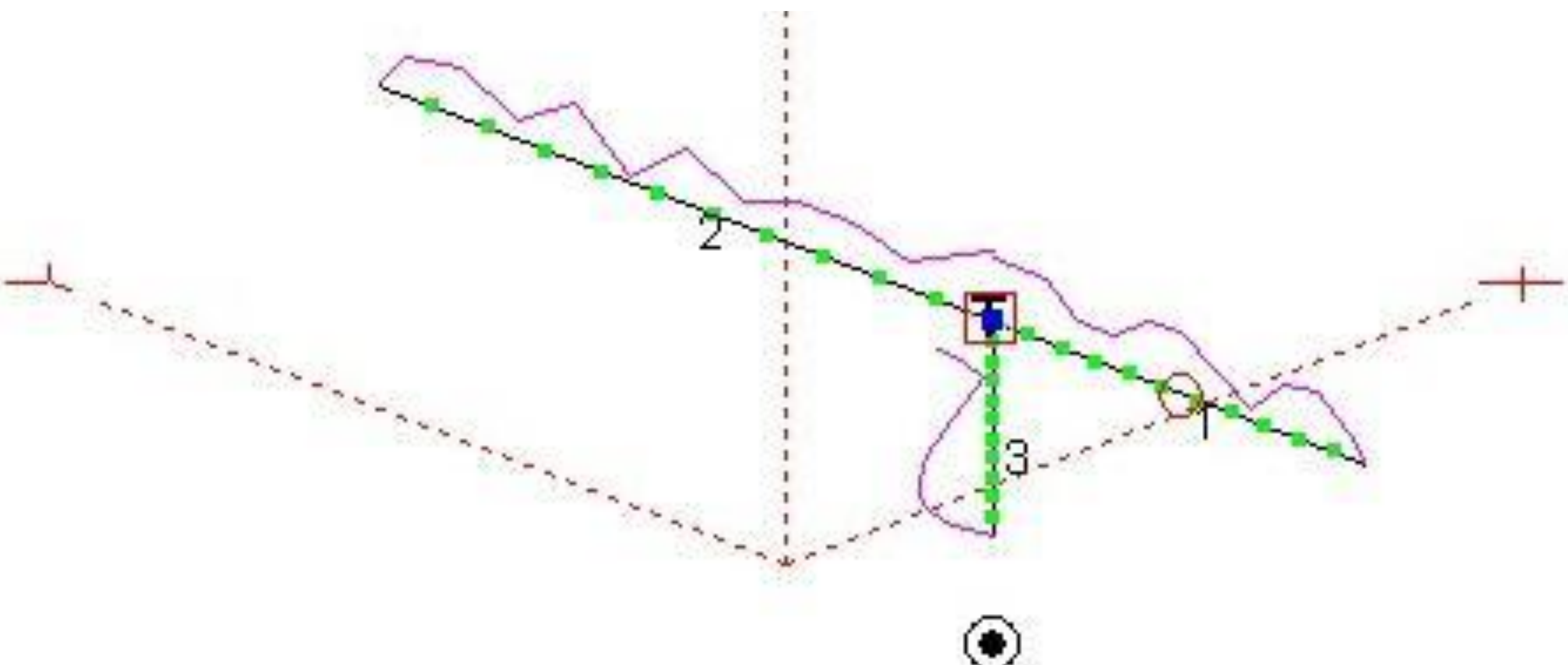
15 Meters





10 meters





SO… What have we learned?

The currents and patterns certainly are confusing…

Signals do not go “cleanly” broadside or in a omni-directional pattern.

Yes, the RF radiates both in line and perpendicular to the axis of the wires.

Yes, there are both low and high takeoff angle patterns.

Is it better than a dipole, Extended Double Zepp or G5RV?

That is up to you… All the antennas radiate the RF put into them,

I guess it just matters if there is someone out there where the RF goes, to call you !

73, de — •   — — — • •   • — — •   • — •