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Slinky and Loaded Beverages

When space is limited and a Beverage antenna is too short for normal operation, increasing inductance (or capacitance) along the length of a "Beverage" will increase directivity. Inductance must be adding in series with the antenna, and doing so will increase the antenna's surge impedance.

Capacitance must be added in shunt with the antenna, and the extra capacitance reduces surge impedance. Additional shunt capacitance is very difficult to implement because each capacitor would need a ground, or you would need to surround the antenna with a slow velocity factor ***very*** thick dielectric. (Most of the air between the antenna and ground would have to be replaced with the dielectric.) There aren't any practical or easily implemented methods of slowing Vp to anything near the amount required through increased capacitance (at least none I could think of), so I will set that method aside.

There are three practical ways to slow velocity of propagation through inductance:

1. Use a spiral or zig-zag element
2. Use lumped inductor loading
3. A string of beads

How They Work

Contrary to what we might intuitively think, loaded antennas ***DO NOT*** work because we pack 800-ft of wire in a 200-ft area! They exhibit improved directivity because wave velocity is slowed, altering phase shift along the length of the antenna. Slinky (helical) and loaded Beverages show increased directivity because velocity of propagation along the antenna is ***decreased***.

As Vp is slowed, the antenna shows increased end-fire response and a gradually narrowing pattern. End-fire arrays fire in the direction of lagging phase, and the slower Vp causes more optimum phasing but only within certain limits. If phase is retarded too much, it actually starts to bring the signal back out-of-phase. With too much delay, the array tries to fire in the reverse direction.

Because of the reverse firing effect, there is a definite limit in phase delay (or Vp slowing) a system will tolerate. If the design goes beyond the optimum value, the antenna pattern tends to reverse direction, causing directivity to decrease. I've found optimum Vp for a 1/2 wl wire is generally around 0.5 times freespace velocity.

Slinky users should be particularly cautious to extend the coils an optimum amount. With 1/2 wl of distance, you would want somewhat less than 1wl of total conductor length. Too many "turns-per-foot" and the slinky, like any loaded Beverage, will try to fire backwards (towards the feedpoint).

Optimum termination impedance will always be somewhat higher than a conventional Beverage antenna. Surge impedance of the antenna is increased by the additional series inductance.

Helices vs. Lumped

For all practical purposes helices and lumped antennas are electrically identical. It doesn't matter at all if the antenna uses a string of soft-iron beads, a series of lumped inductors, zig-zags, stubs, or helices (a Slinky). The only criteria is the spacing between lumped loads must be a small fraction of a wavelength. For all practical purposes, 1/8th wl or less load spacing distance will make a lumped system perform identical to continuously loaded systems (slinkies).

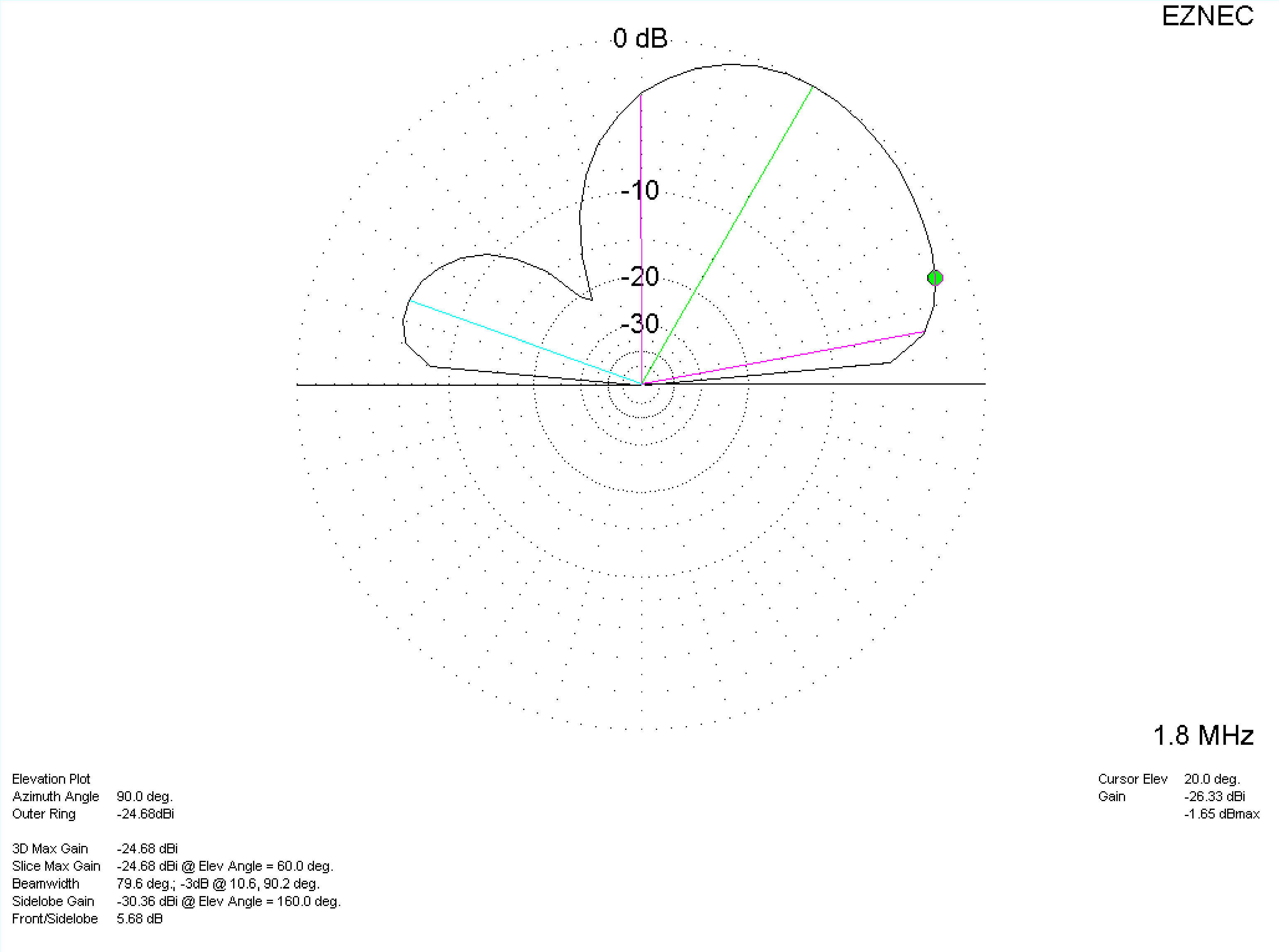
Lumped reactances, whether in the form of a bead, stub, or conventional coil should have at the minimum a somewhat modest Q. This is just another way of saying the inductances should not add excessive series resistance. ***Total*** reactance of ***ALL*** loads should be between two and fives times the surge impedance of the antenna. With nine inductors along a 1/2 wl wire, I've found optimum reactance to range between 150 and 250 ohms. Surge impedance was about 700-1100 ohms in systems I tested. A Q of 20 or more would be acceptable in each inductor.

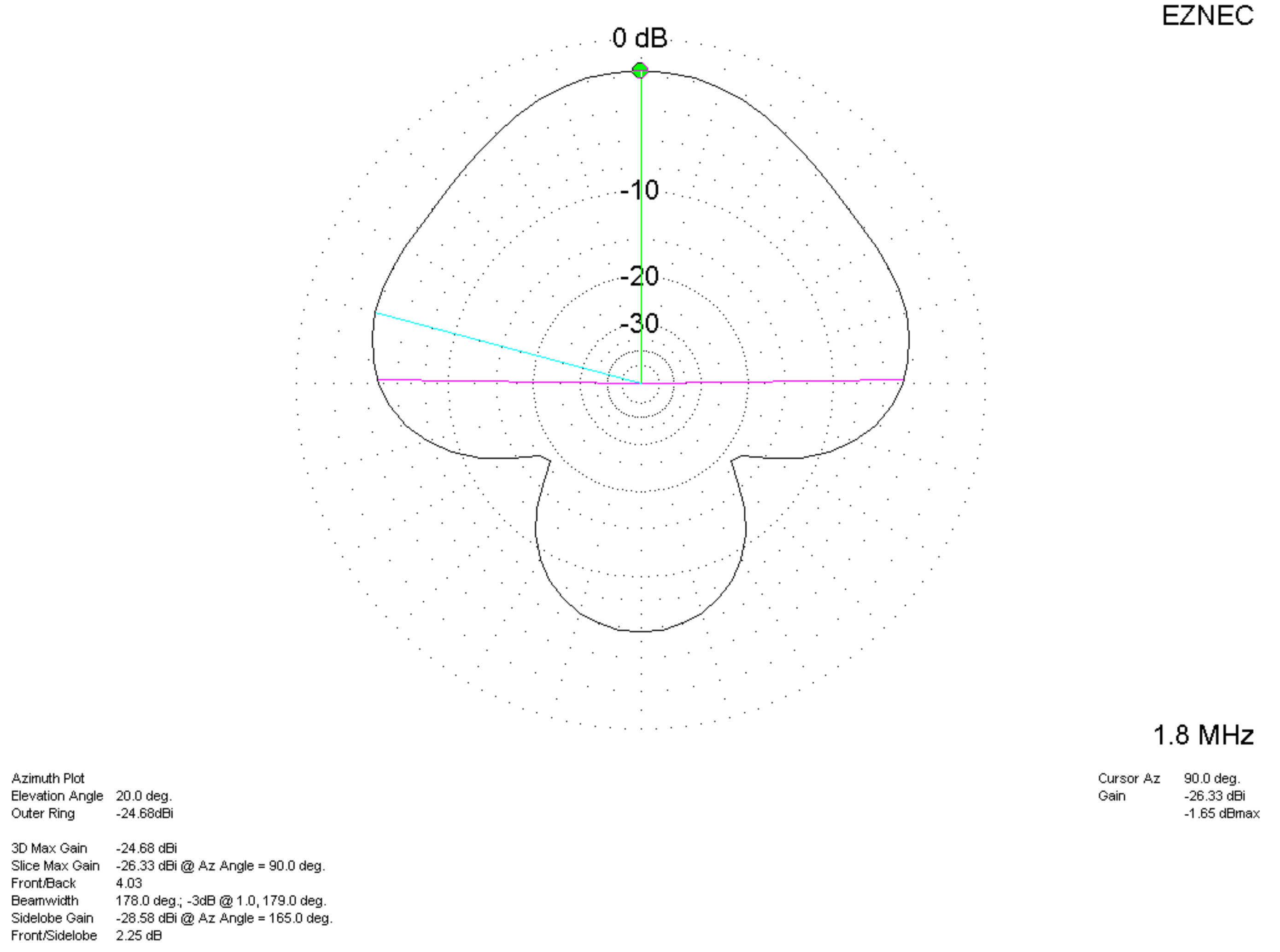
Attached Model

I've added an Eznec file of a loaded Beverage. A few things to note are I used radials to avoid a connection to high-accuracy ground at the termination. The feedpoint isn't critical, since it does not greatly affect directivity in this antenna. Unlike many antenna models, it appears a Mininec ground can be used without harming results.

Using a variety of ground-types I've found RDF remains at about 6dB. This places this antenna slightly below most elongated terminated loops, but well ahead of conventional short beverages.

loaded_bev




EZNEC
0 dB
-10
-20
-30
1.8 MHz
Azimuth Plot
Elevation Angle 20.0 deg.
Outer Ring -24.68dBi
3D Max Gain -24.68 dBi
Slice Max Gain -26.33 dBi @ Az Angle = 90.0 deg.
Front/Back 4.03
Beamwidth 178.0 deg.; -3dB @ 1.0, 179.0 deg.
Sidelobe Gain -28.58 dBi @ Az Angle = 165.0 deg.
Front/Sidelobe 2.25 dB
Cursor Az 90.0 deg.
Gain -26.33 dBi
-1.65 dBmax