Portable Vertical Antenna for 75m & 40m

BOXBORO

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Objectives

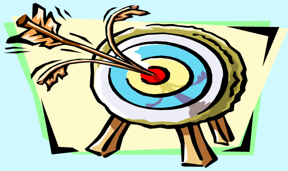
1- Portable Antenna for 75m et 40m

2- Low radiation angle for DX

3- Efficient

4- Easy to install. Max height: 30 ft.

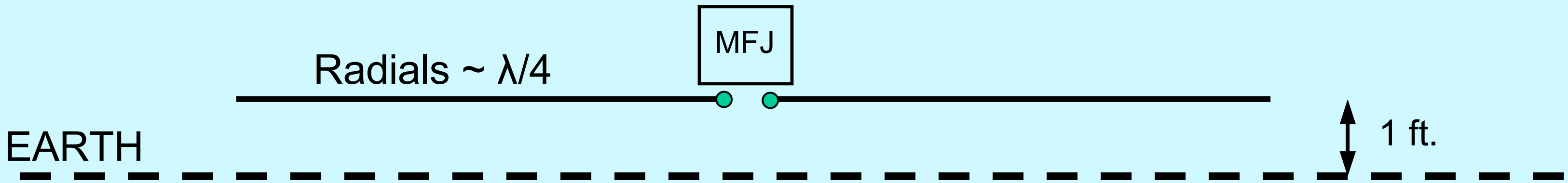
5- Easy match to 50 ohms



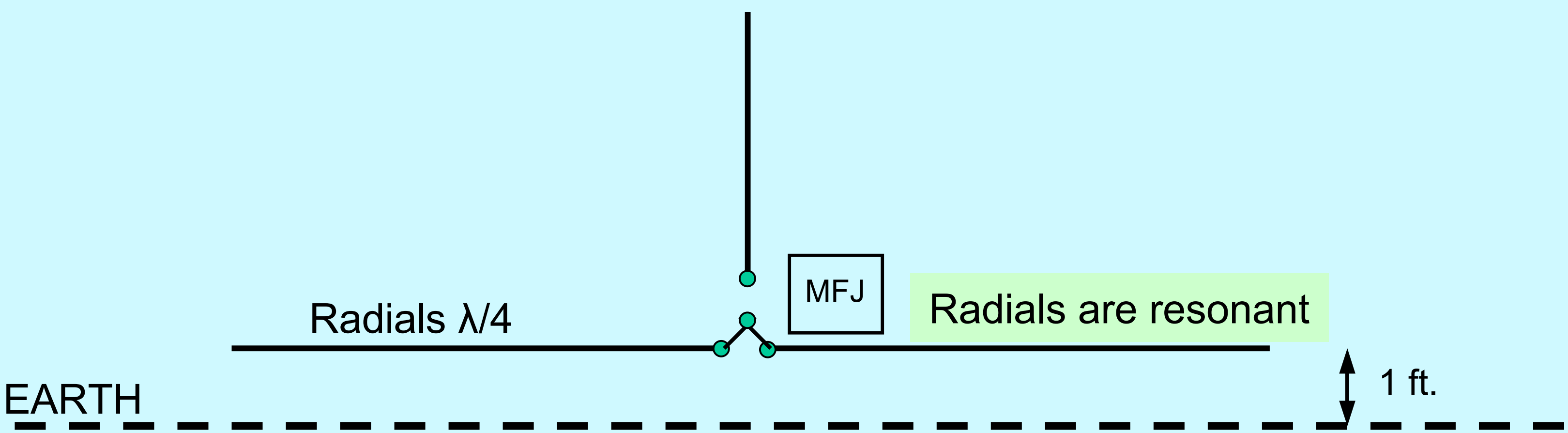
Designing the Antenna

Vertical on the Beach ?
(reference 1)

1- Radial length is adjusted to resonate at the desired frequency, using an SWR analyzer



2- The vertical element is adjusted to resonate at the desired frequency



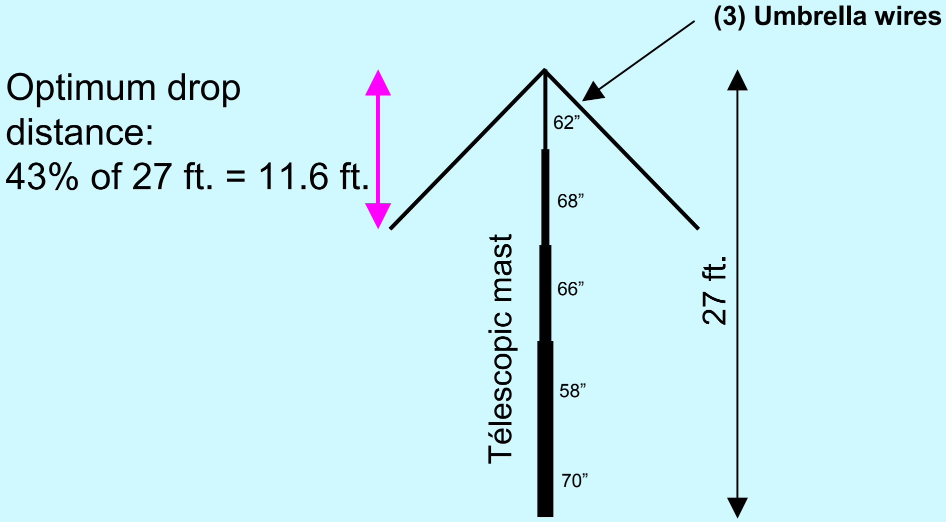
Designing the Antenna for 3.8 MHz

- With a regular vertical: 62 ft. mast is required - Too long

- Radial length ~ 60 ft. - Too long

- Use a Telescopic mast, 27 ft. and a 3 wire “ umbrella ” on top

- Radial length ~27 ft.   Same as vertical radiator height



Basic Design

- Chosen length: 27 ft. - (22 ft. telescopic + 5 ft. pipe)

- Similar to the antenna used for DXpedition (reference 1)
 "Antennas Here are Some Verticals on the Beach"…   R. Dean Straw N6BV
   The ARRL Antenna Compendium Vol. 6, page 216

- Radials above earth for best efficiency

Raising Radials above Earth Increases the Gain !

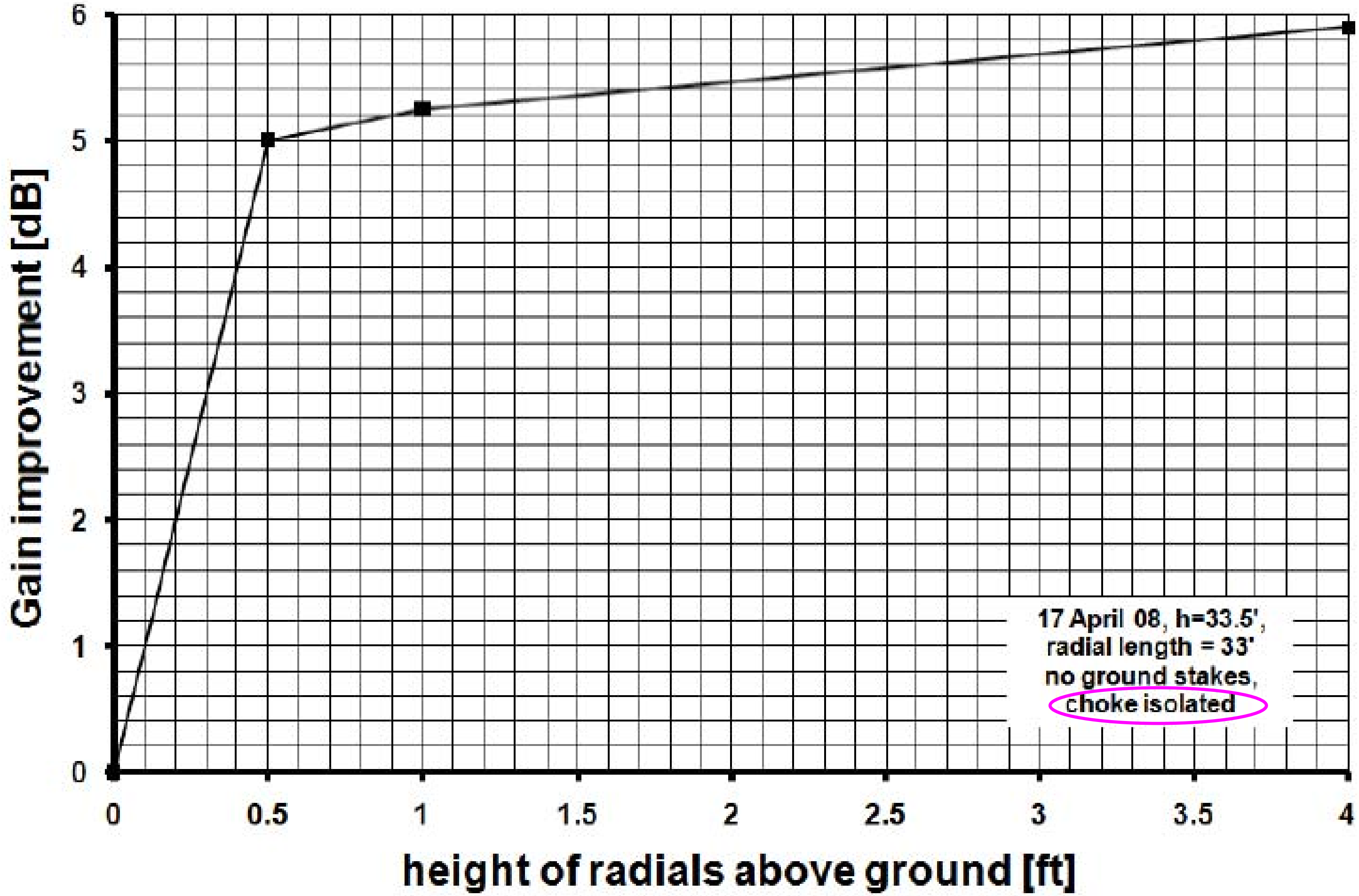


Figure 17 - Measured change in gain as four radials are elevated above ground.

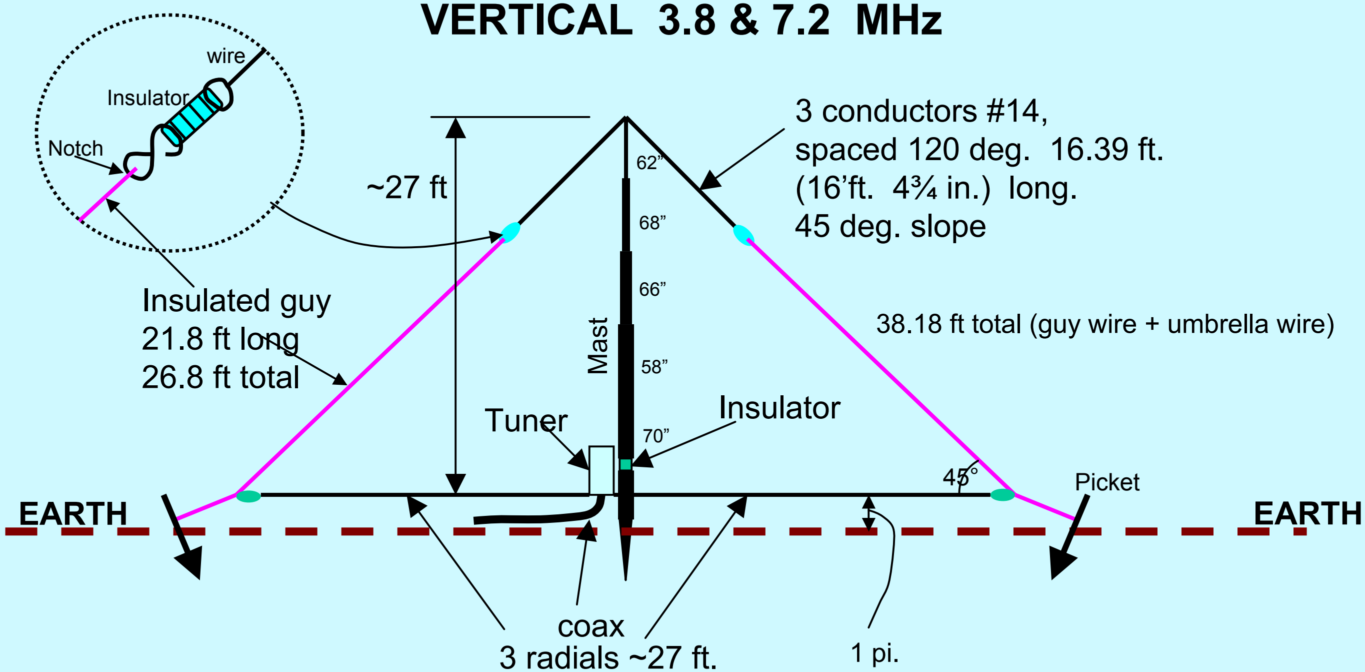
(On 40 m band)

From: Rudy Severns N6LF Ref. 7

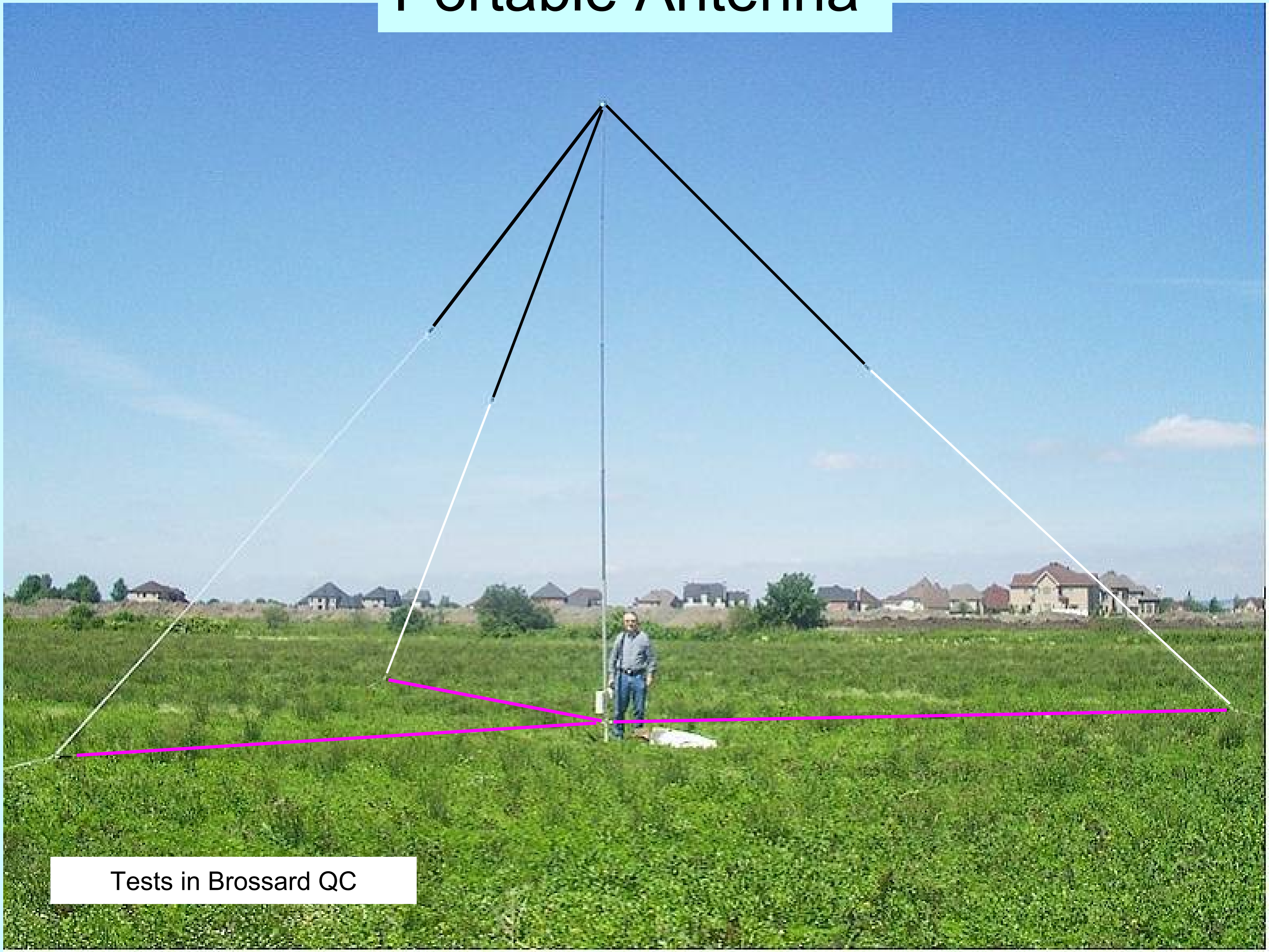
Portable Antenna

- Will use 3 radials (27 ft.) one feet above earth and 3 umbrella wires
- The resonant frequency ~ 5.5 MHz, is in-between 40m and 75 m bands
- The antenna is capacitive on 3.8 MHz and inductive on 7.2 MHz
- The reactance should not be too high on both bands, to improve matching efficiency
- A remote tuner will easily match this antenna from 3.5 to 7.5 MHz

VERTICAL 3.8 & 7.2 MHz



Portable Antenna



BRING RESONANCE ON BOTH BANDS

Using a Parallel L-C Trap (as part of Custom Tuner)

Procedure:

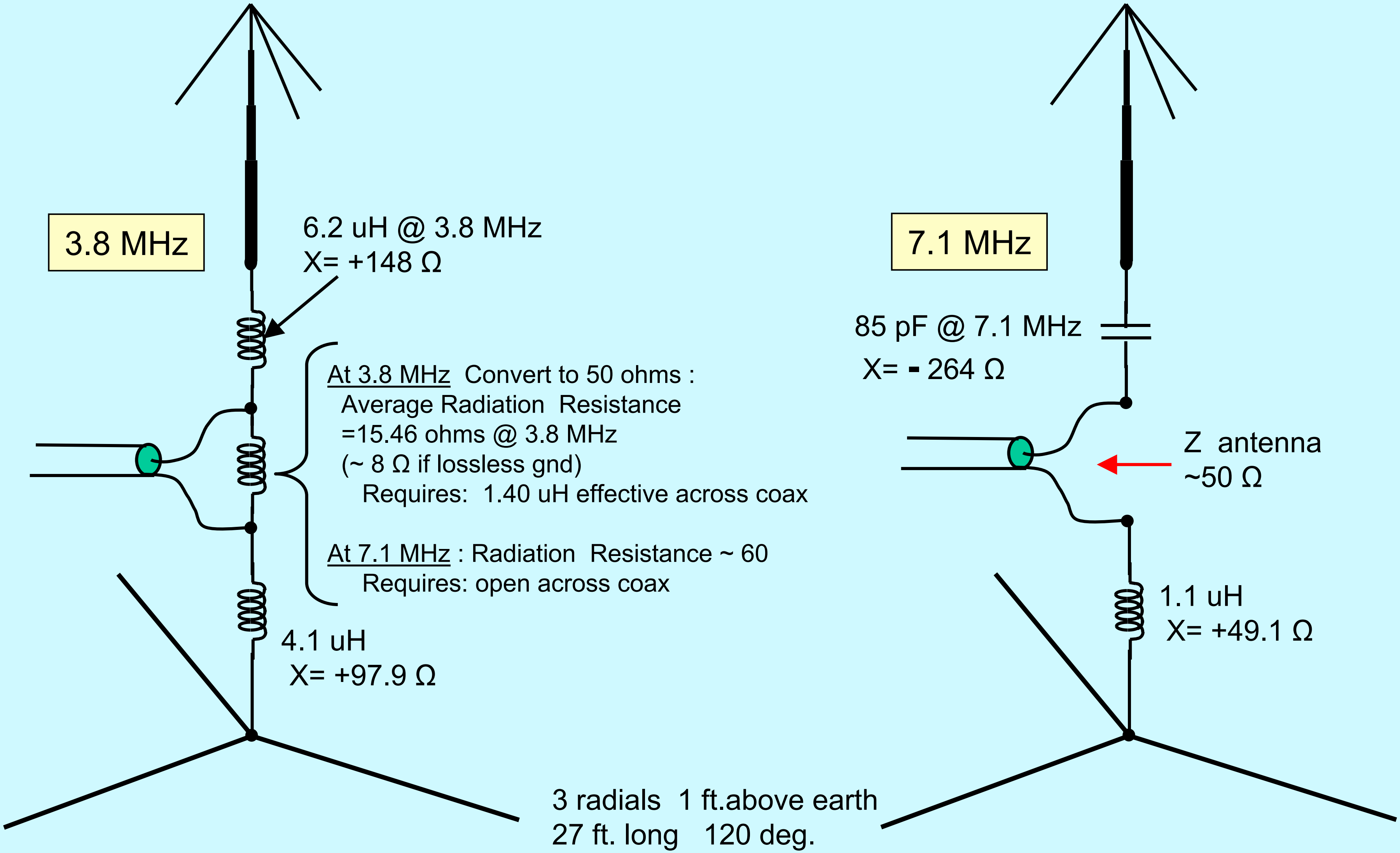
- Find the resonant frequency without matching.
  It should be between 4.6 MHz and 5.6 MHz
  Ideally around 5.1 MHz, the geometric mean frequency.
  This insures that the reactance will not be too high on the 75m and 40m bands, and the matching losses will be minimal.

- Find the inductance (L) required at 3.8 MHz to resonate it.
  That is the point of zero reactance. (Here L= 10.3 uH)

- Find the capacitance (C) required at 7.1 MHz to resonate it.
  (Here C= 104.6 pF)

- Compute the Lp-Cp parallel values that will give the required L-C values.
  I provide an Excel sheet on my web site: L-C_Par_Calculator.xls

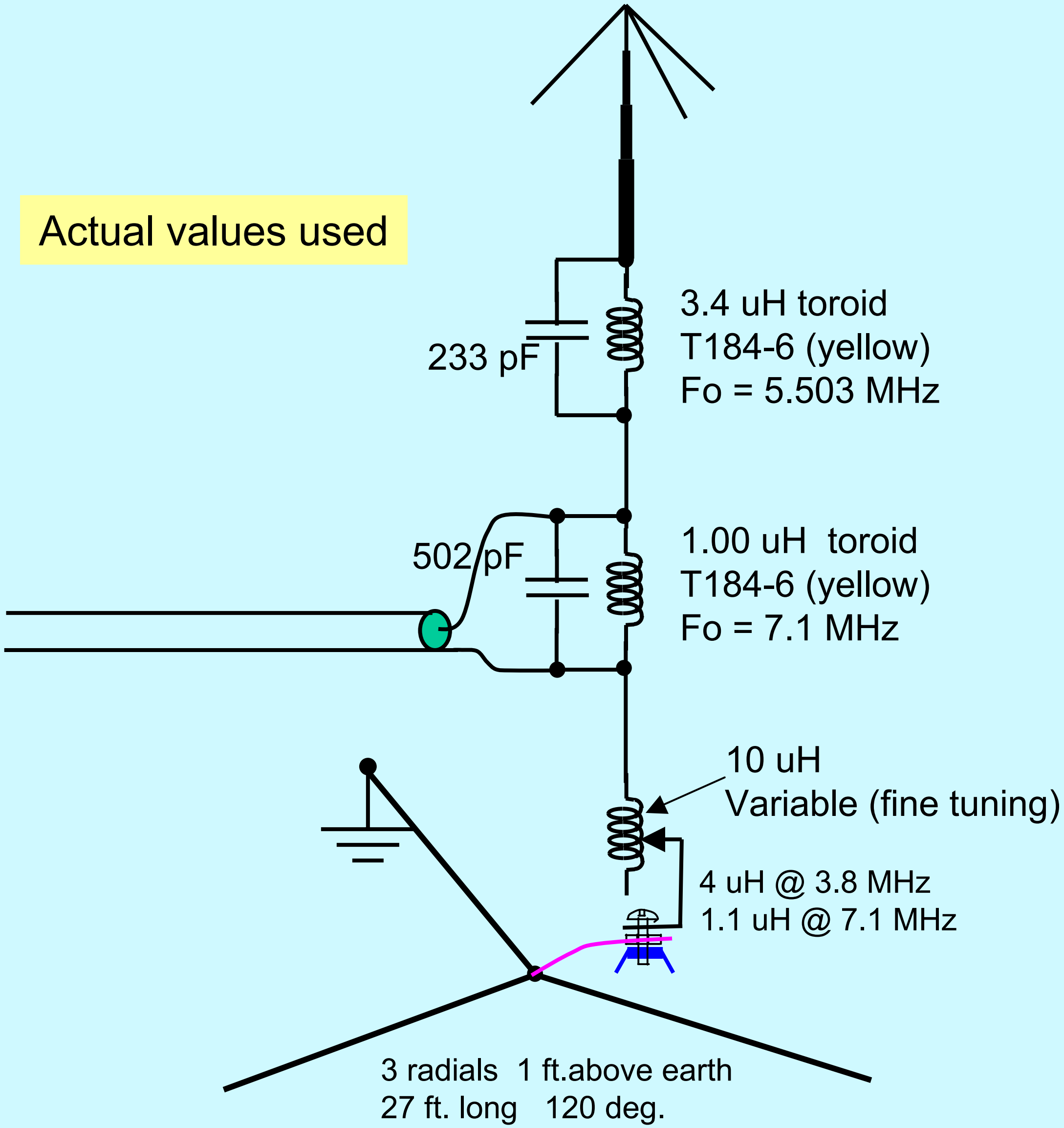
Matching with a Custom Tuner



Ref: Z-LC-Par.mcd and RadialTest.xls

Matching with a Custom Tuner

Actual values used



NOTE: Toroids are High Q Iron Powder type.

DO NOT use ferrite cores for the resonant circuits.

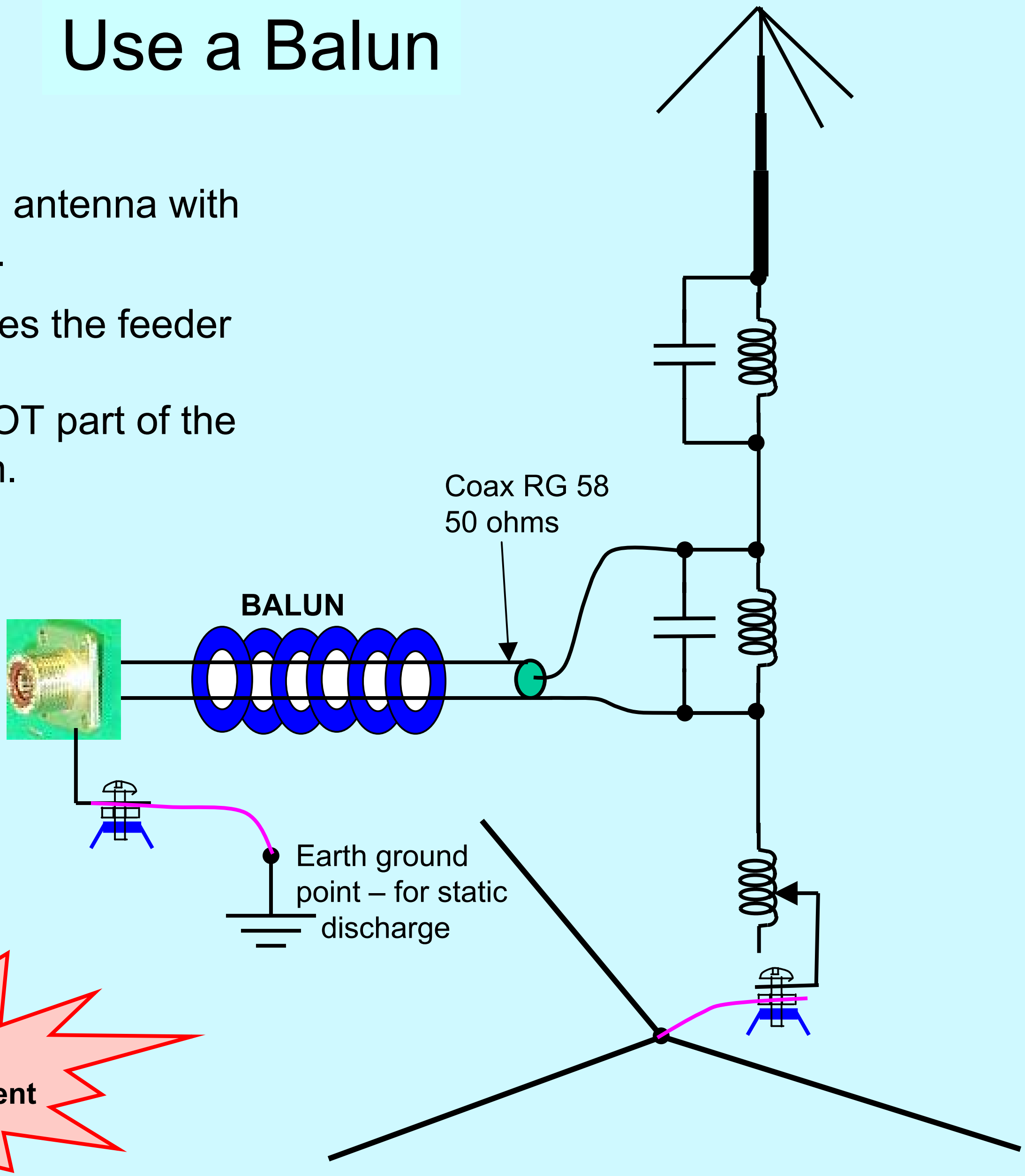
They are too lossy and the inductance value is NOT stable

What's missing ?

Use a Balun

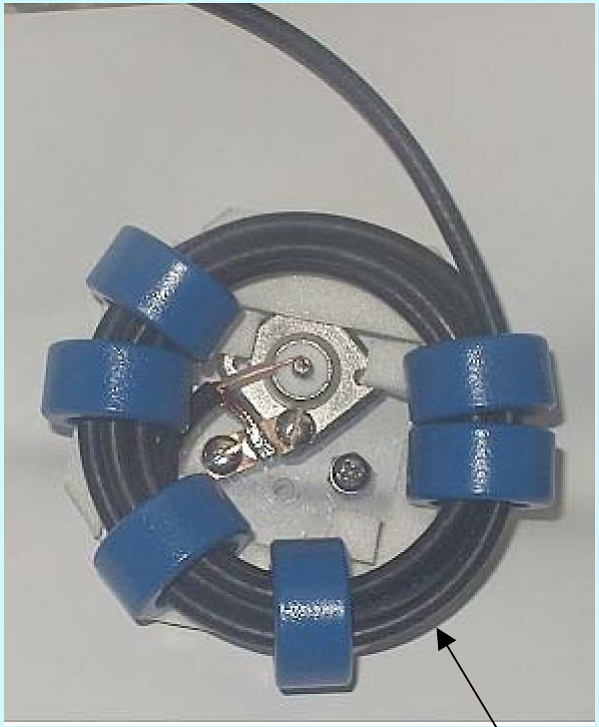
This is a vertical antenna with elevated radials.

The balun isolates the feeder from the radials.
The feeder is NOT part of the radiating system.



Balun Used

Isolates the feeder from the elevated radials.



6 toroids similar to FT114A
type 77 material

Measured impdeance
2200 Ω at 3.8 MHz
1300 Ω at 7.1 MHz

Overall diameter: 4 in.

6 turns RG-58A

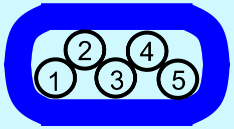
A Better Balun

Ref: http://www.ifwtech.co.uk/g3sek/in-prac/

3 oval toroids
type 77, 31 or 43 material
5 turns

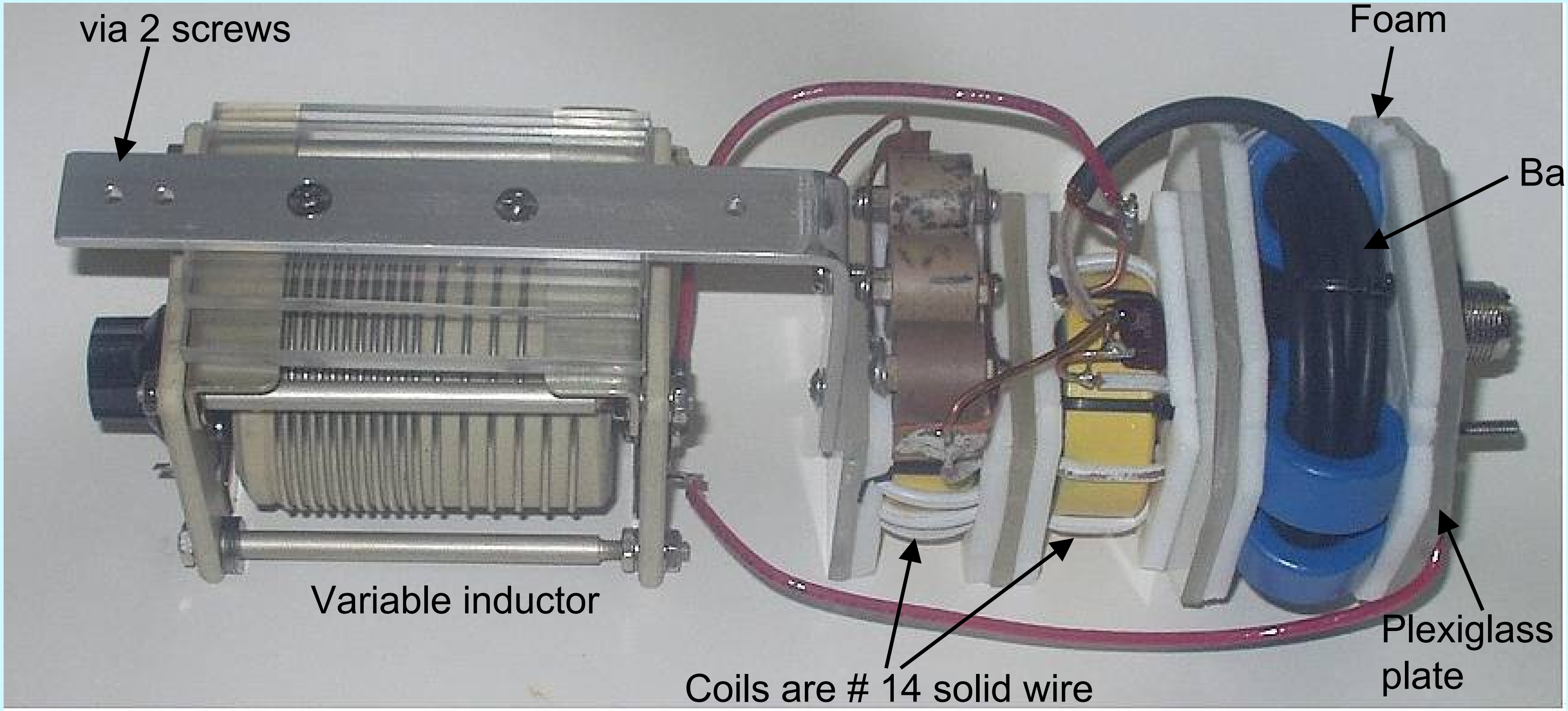
Measured impedance
3000 Ω at 3.8 MHz
6000 Ω at 7.1 MHz

Notice the flat winding.
Wires don't cross.

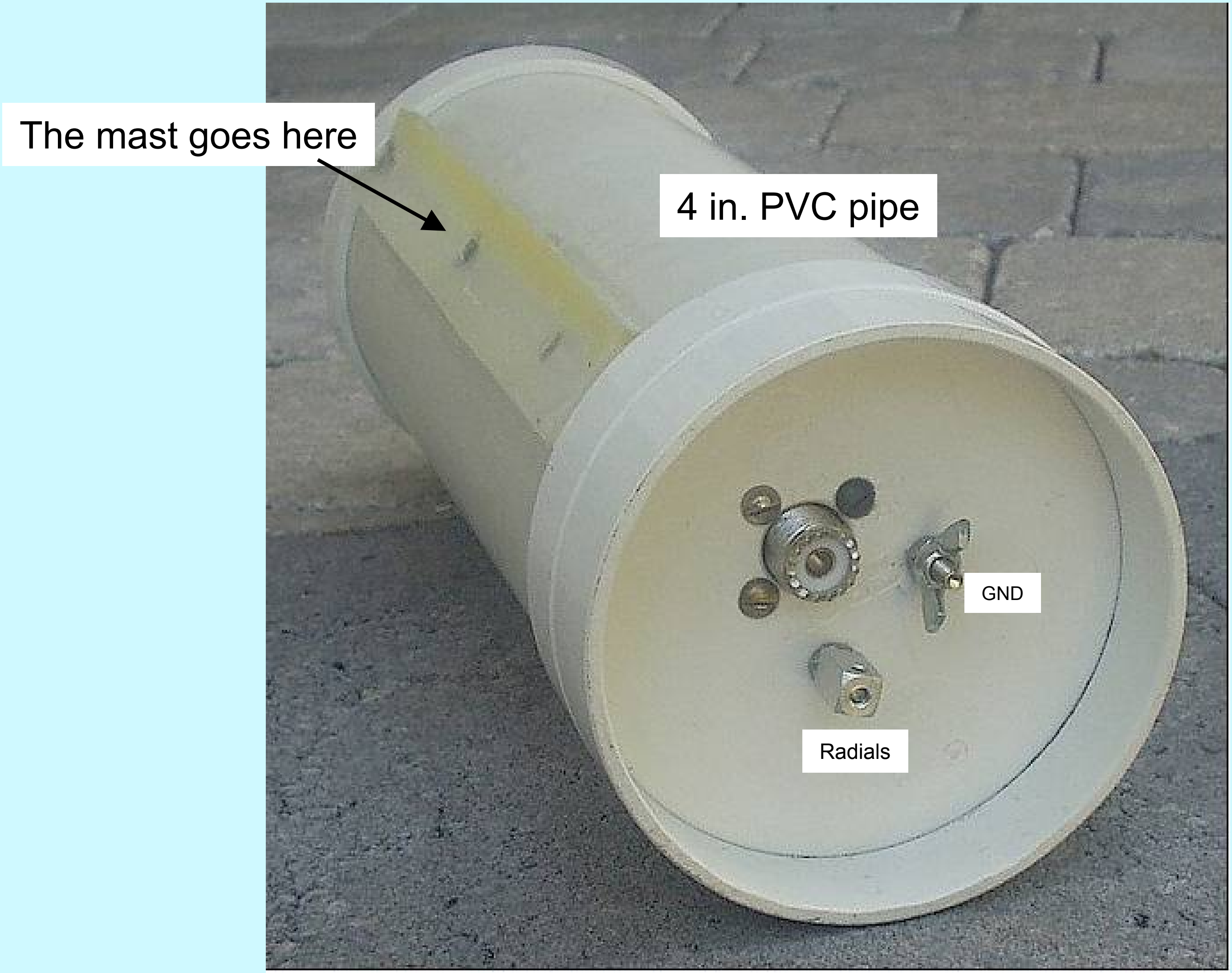


Winding method for
larger coax

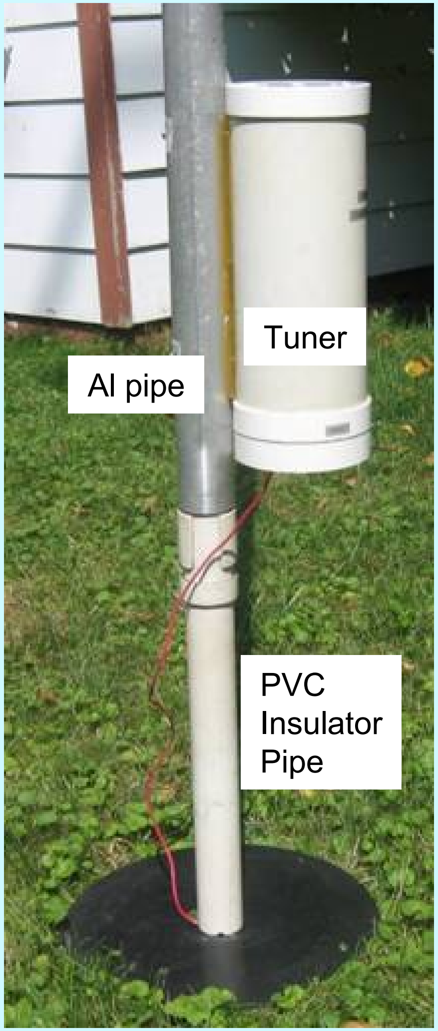
CUSTOM TUNER Inside View

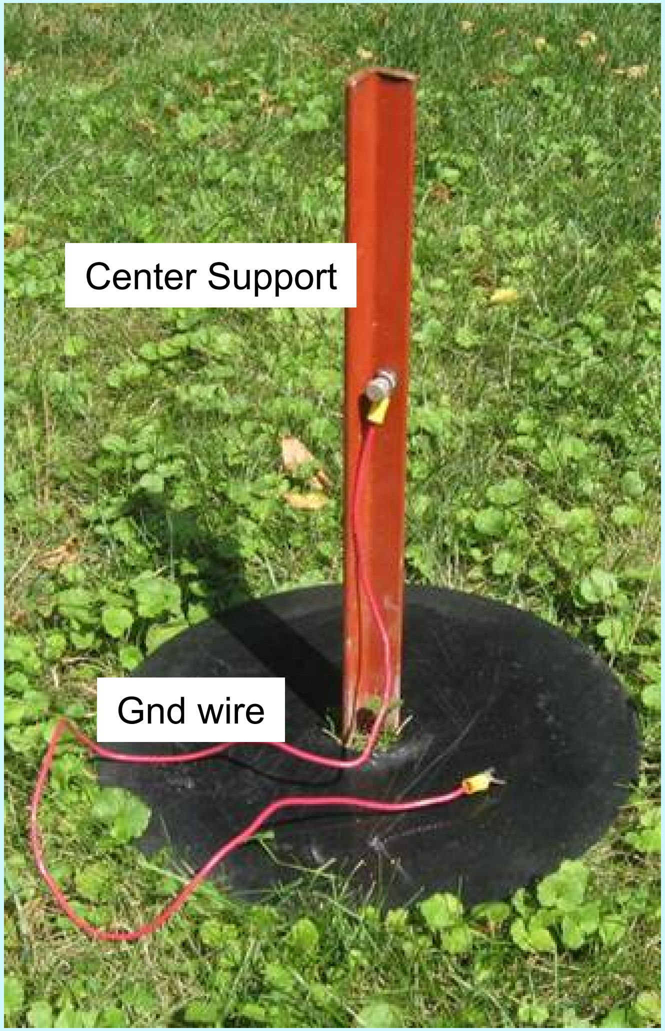


CUSTOM TUNER

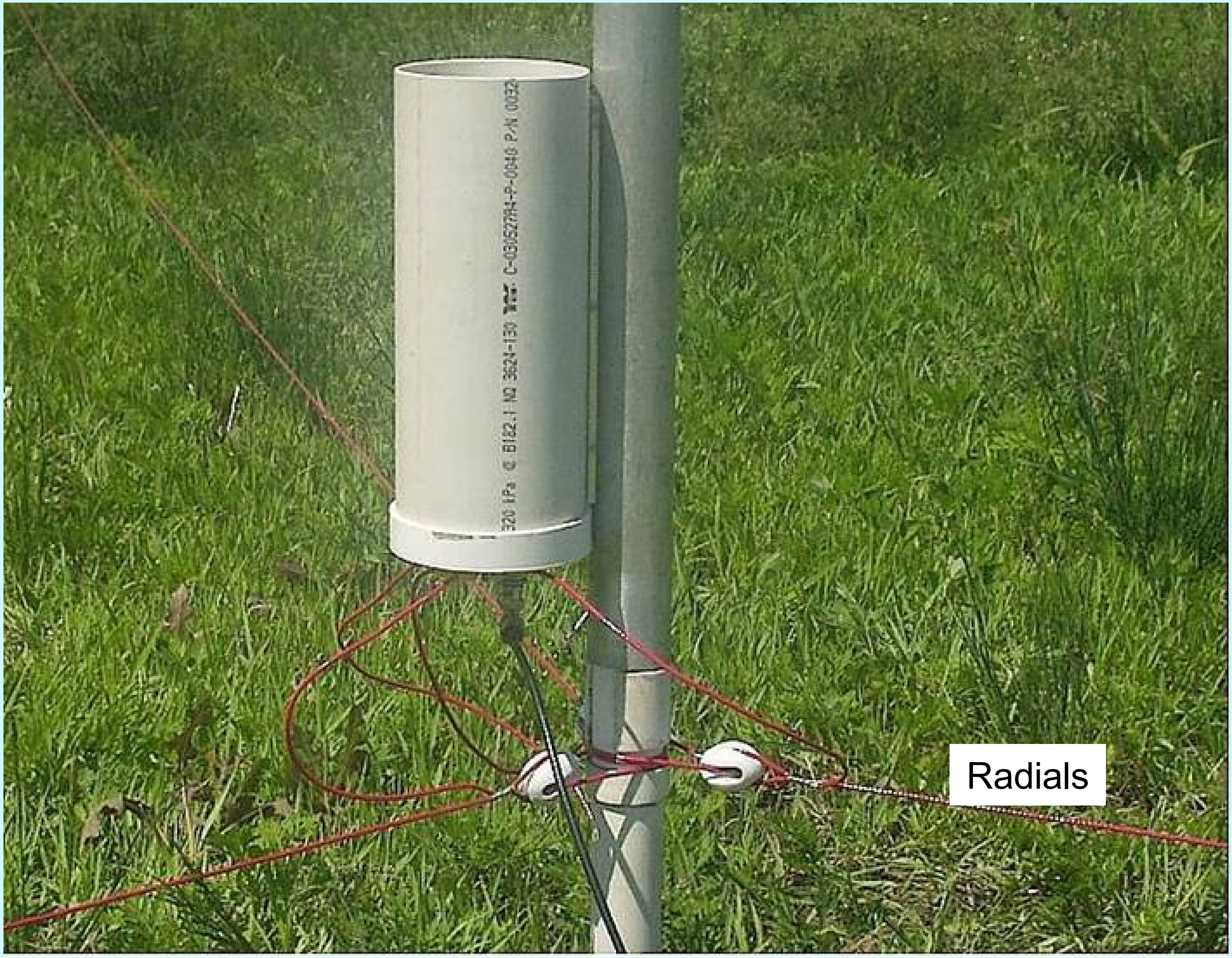


Portable Antenna

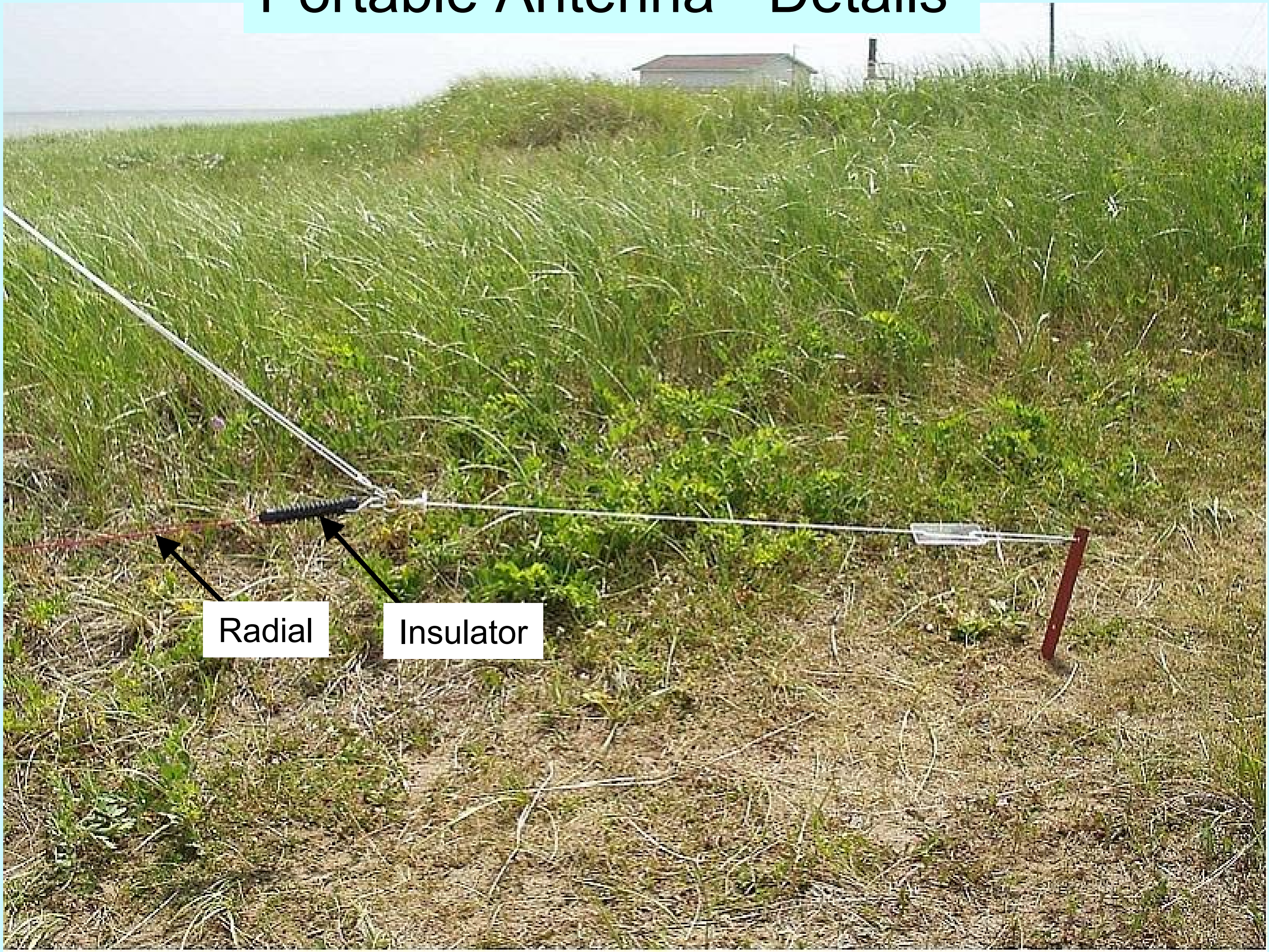




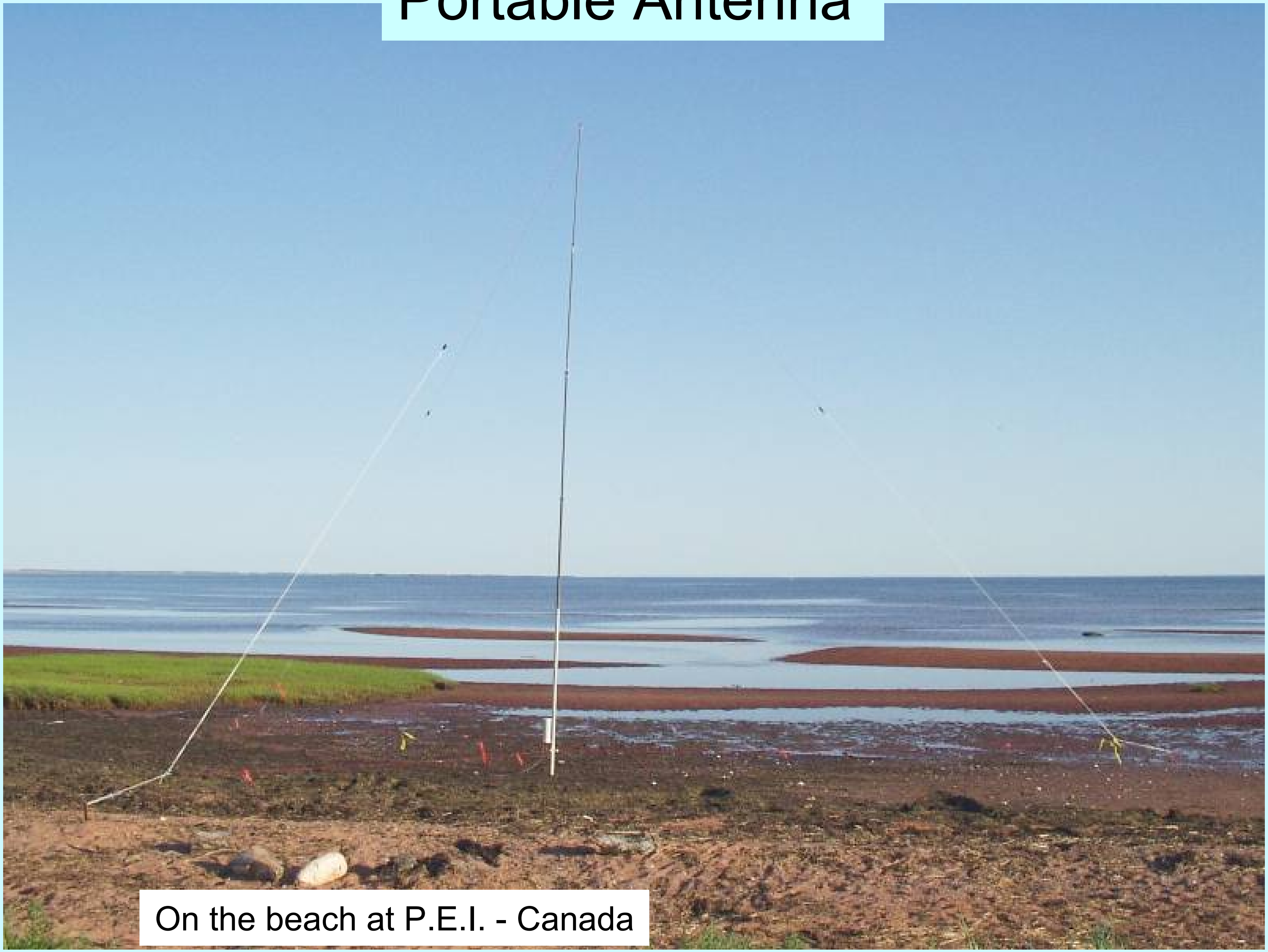
TUNER Connected to the Radials



Portable Antenna - Details



Portable Antenna

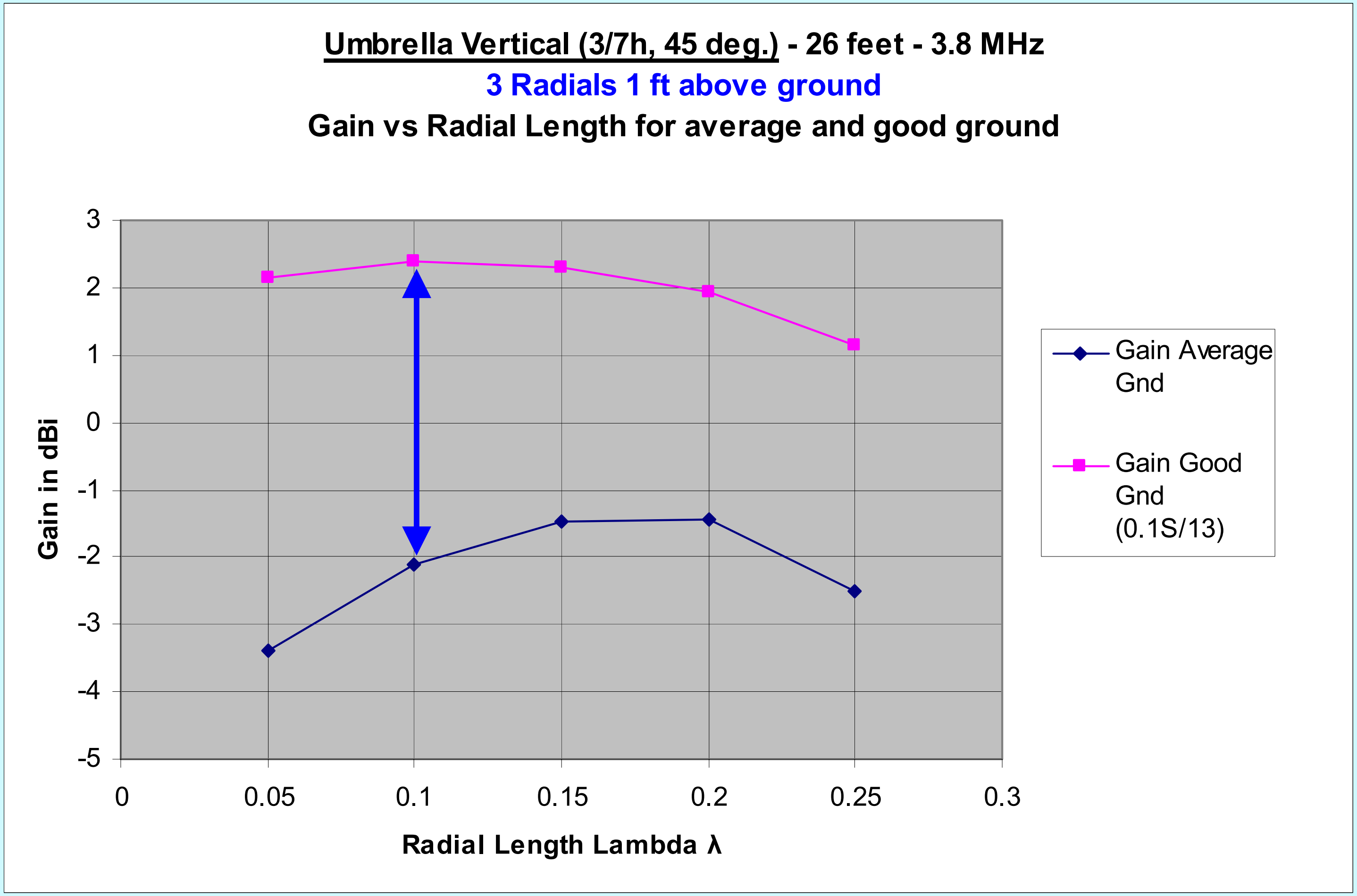


On the beach at P.E.I. - Canada

SIMULATIONS with NEC Win plus

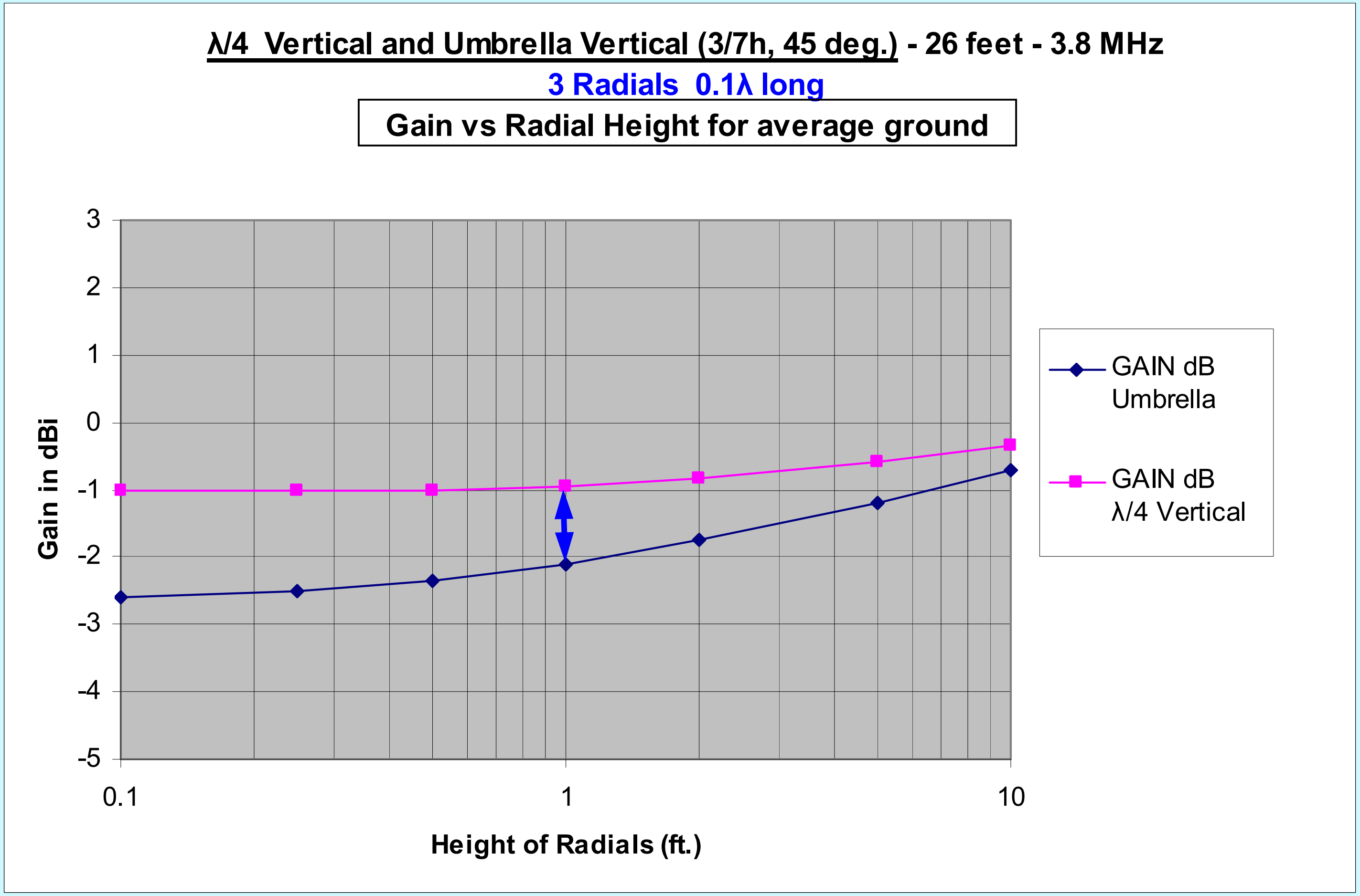
Gain vs Radial Length

Efficiency is most critical at 3.8 MHz
Radial and vertical element length ~ 0.1 wavelength at 3.8 MHz
The ground quality makes a big difference



SIMULATIONS

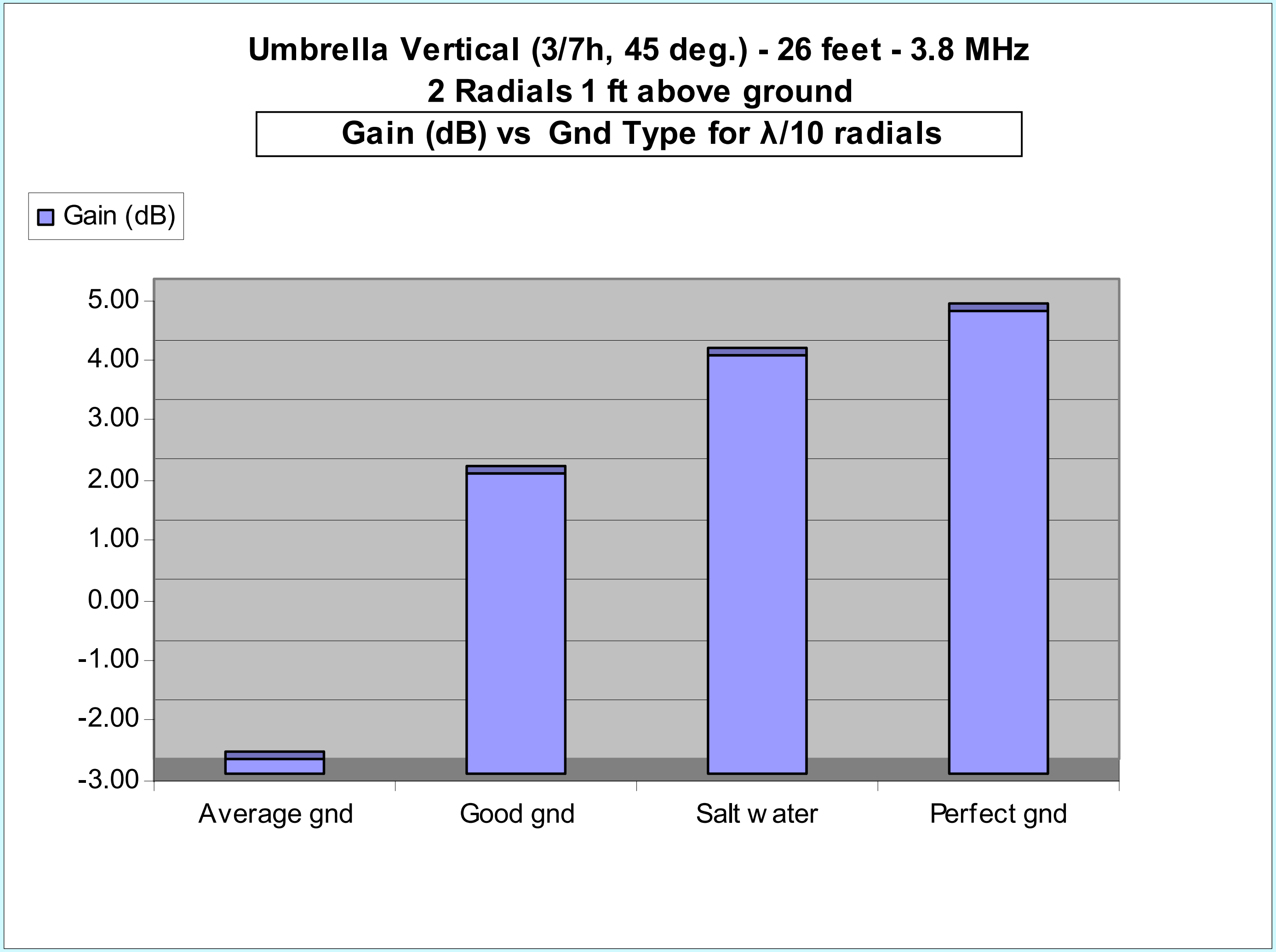
Gain vs Radial Height for Average Ground



Note that the umbrella antenna has lower gain, since it has lower impedance

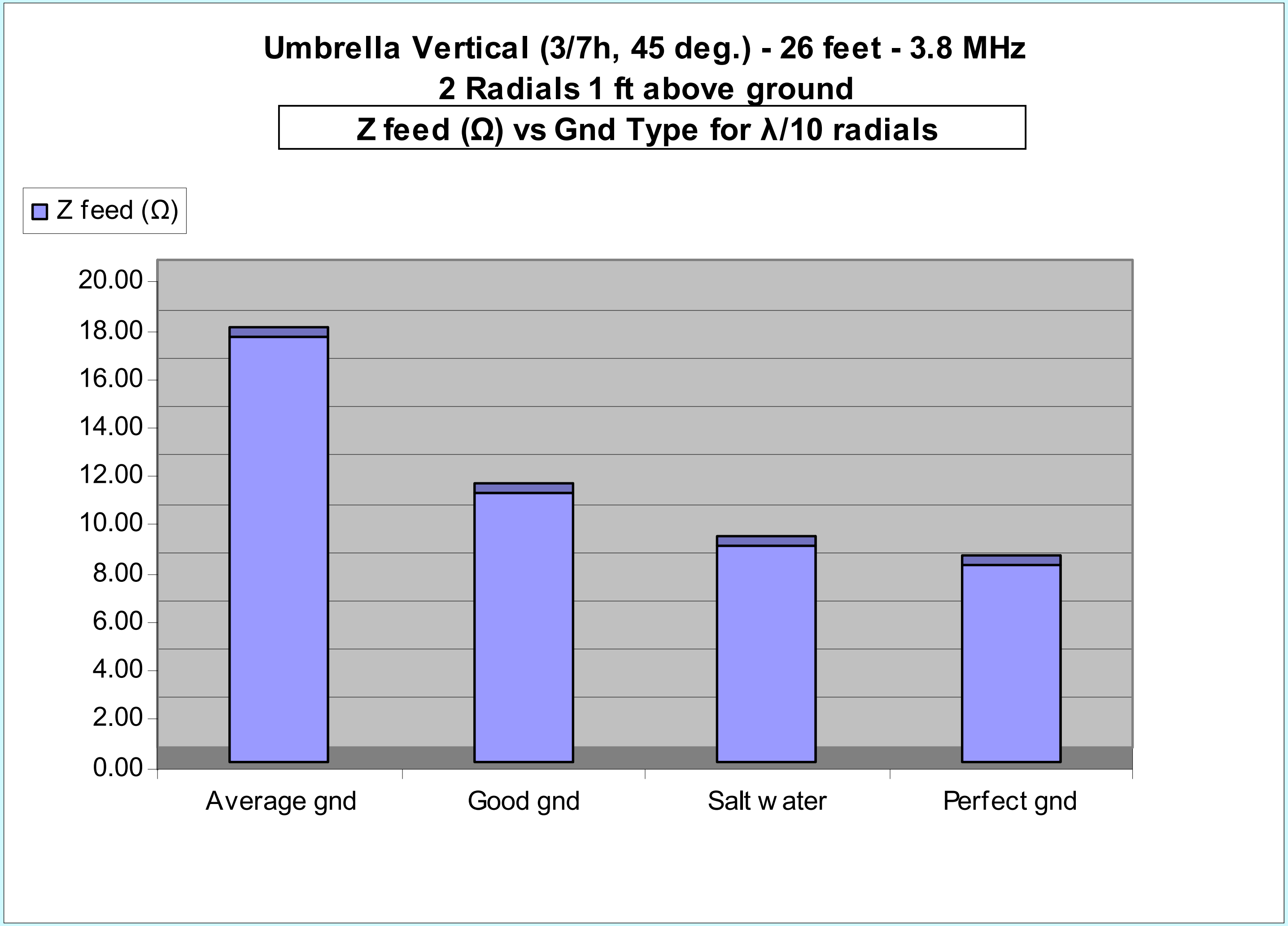
SIMULATIONS

Gain vs Ground Type



SIMULATIONS

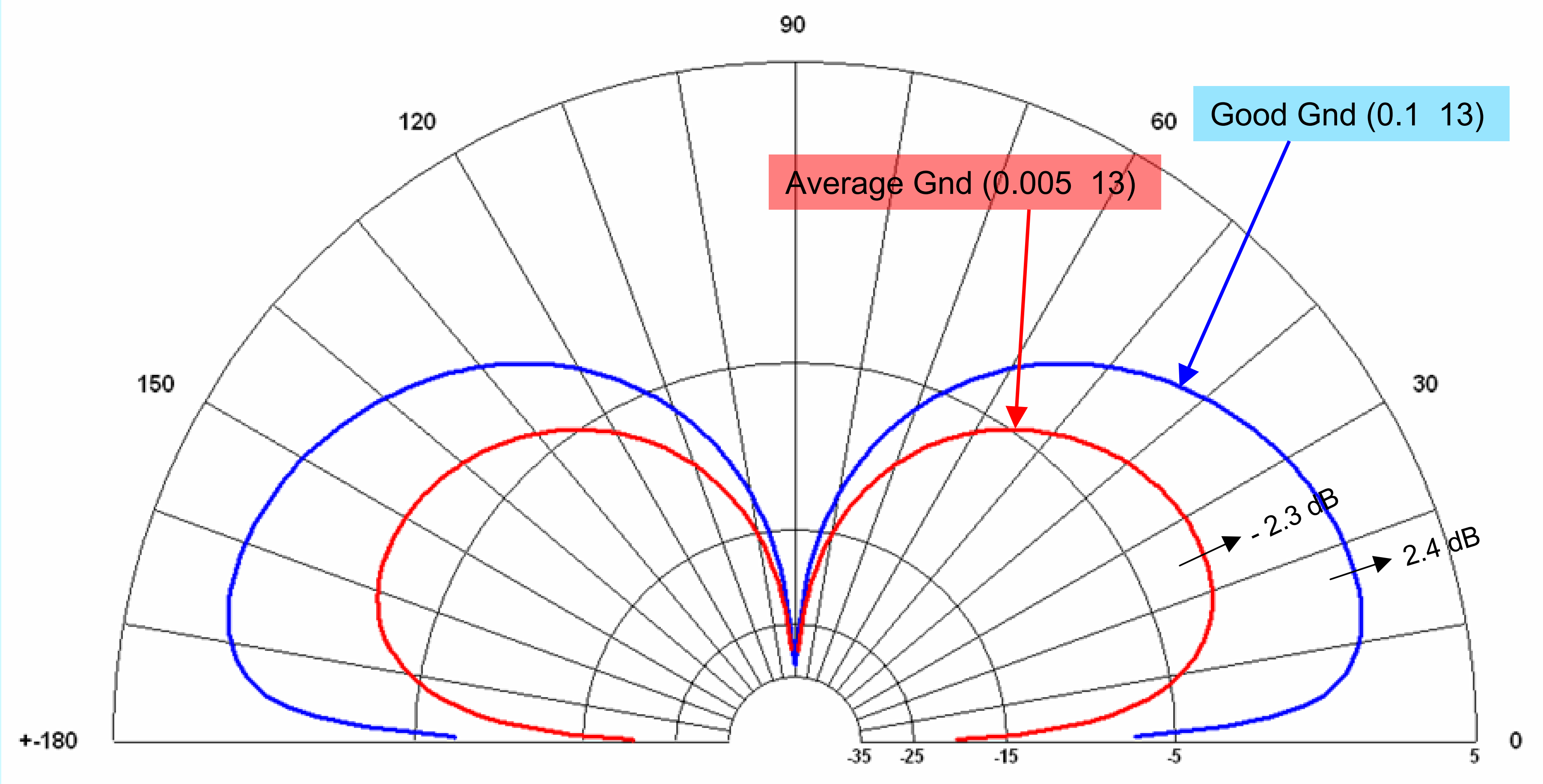
Antenna Impedance vs Ground Type



For average ground, the impedance is about doubled w/r to perfect ground. Thus ~ 50 % of the power is lost in the earth, with an average ground.

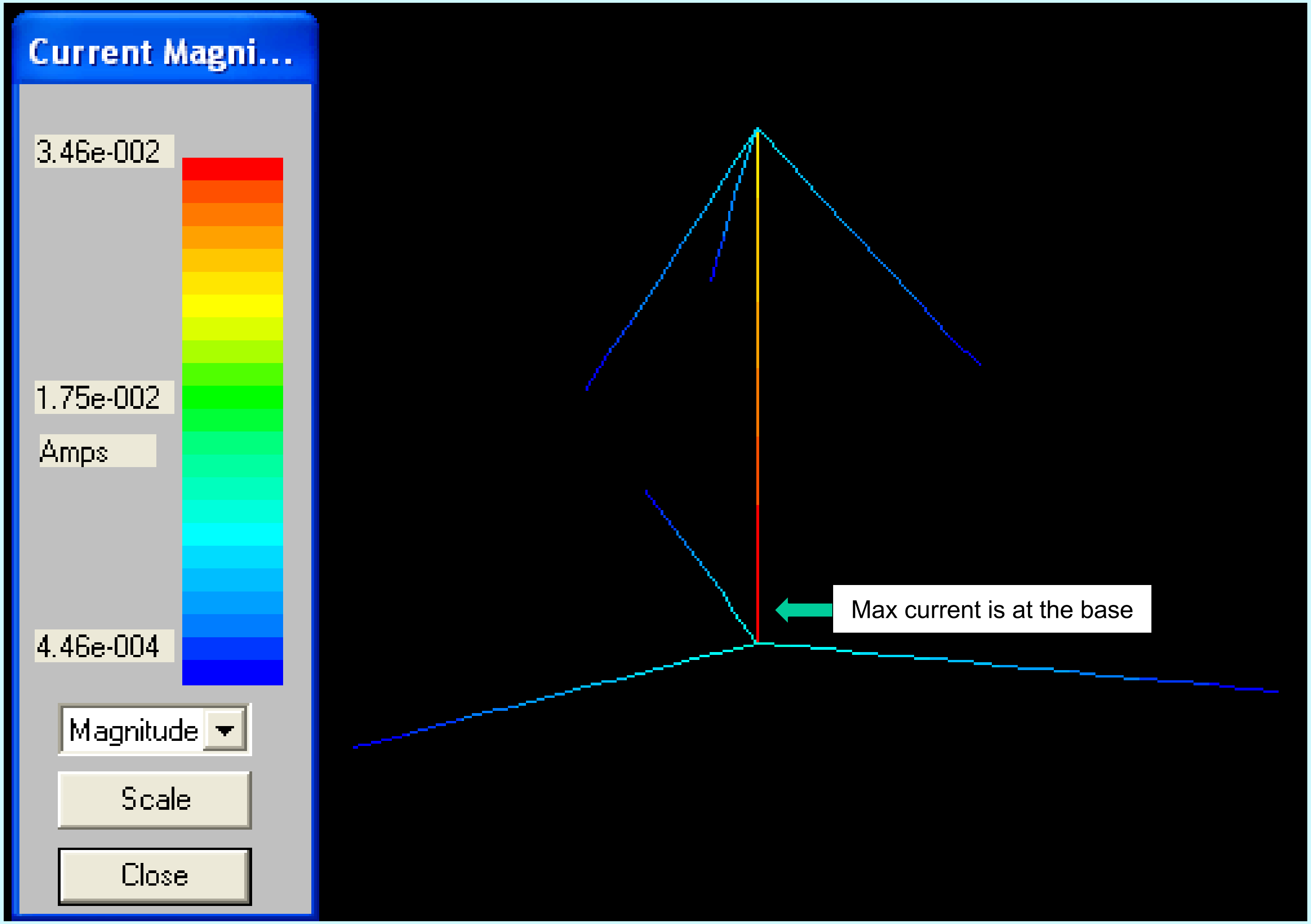
SIMULATIONS

Elevation plots at **3.8 MHz**



SIMULATIONS

Antenna Currents at **3.8 MHz**

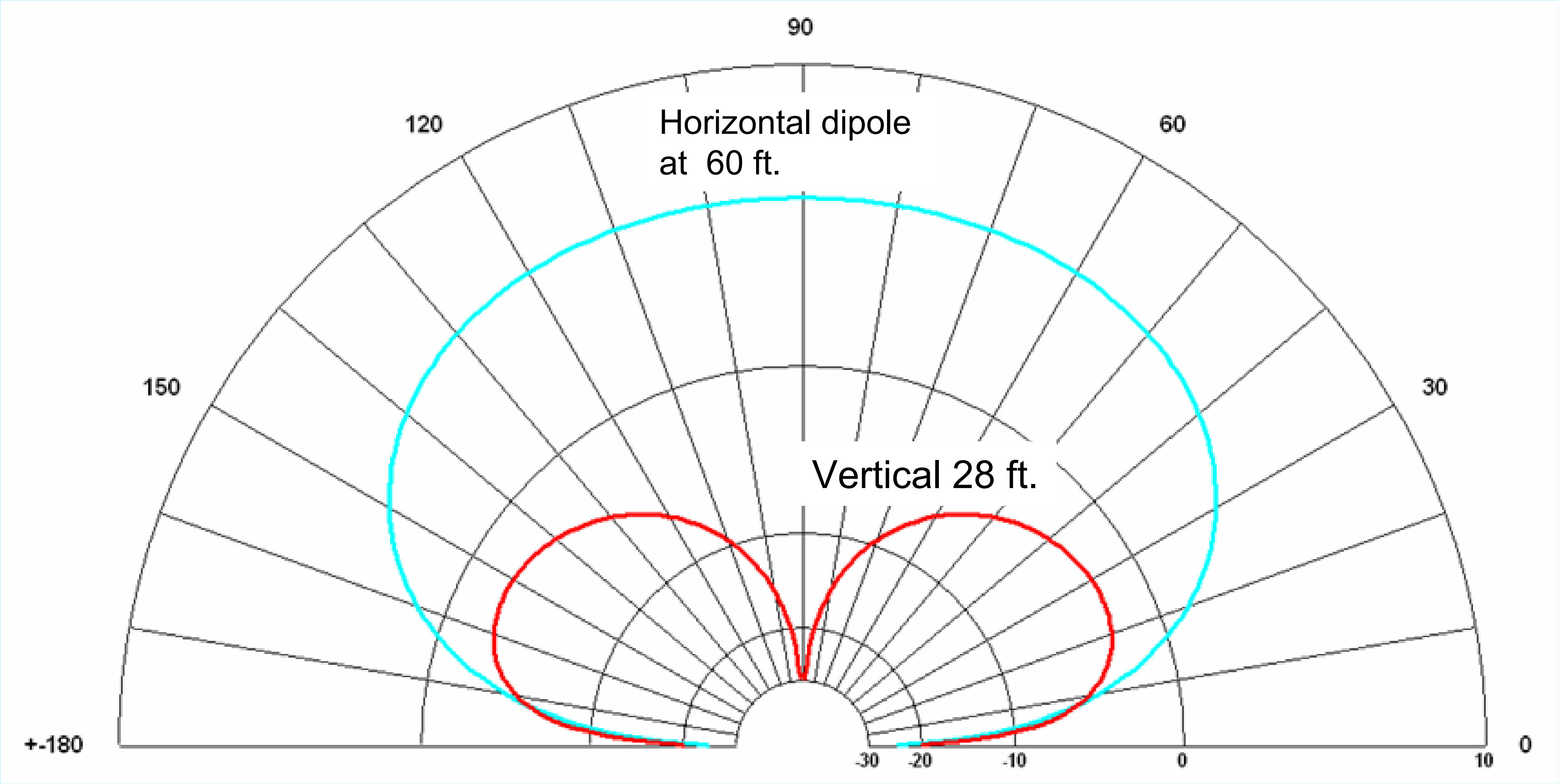


SIMULATIONS

Comparing: dipole vs vertical at **3.8 MHz**

Average ground: 0.005 13

The vertical is equal or better than a dipole
at angles below 10 deg.



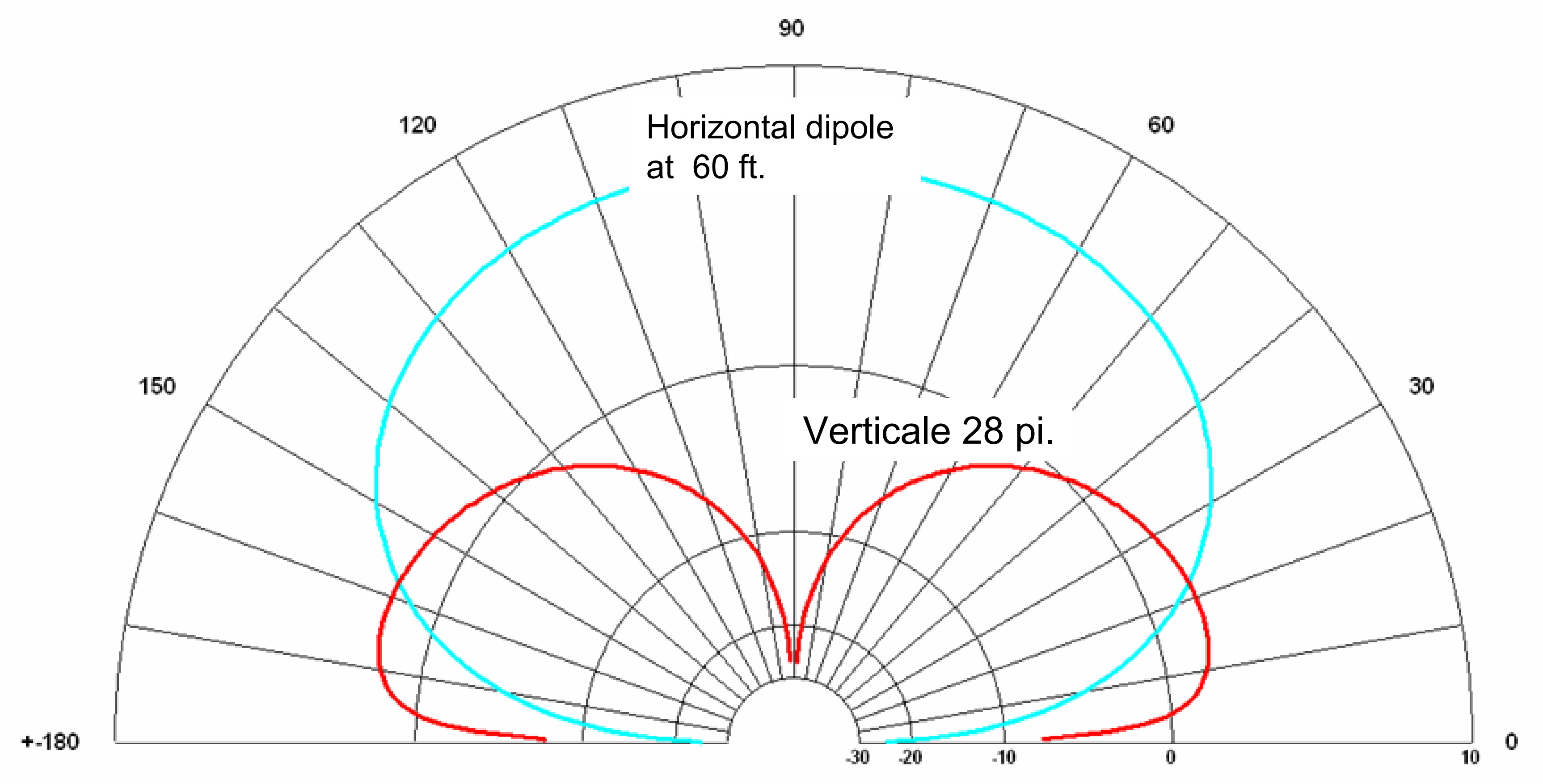
testdipole3A.nwp
vert270L-10C

SIMULATIONS

Comparing: dipole vs vertical at **3.8 MHz**

Good ground: 0.1 13

The vertical is equal or better than a dipole
at angles below 23 deg.

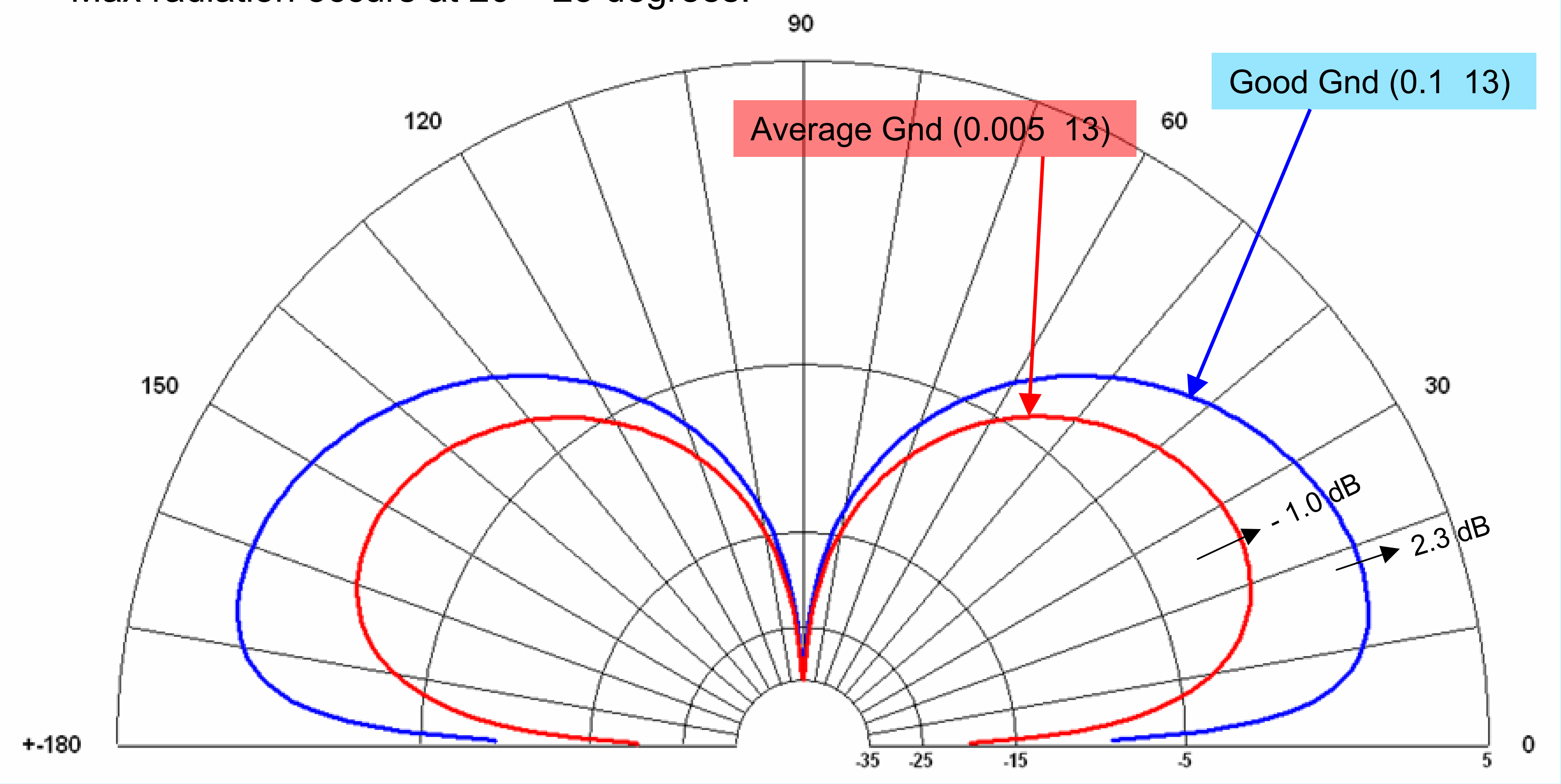


testdipole3.nwp
vert260L-10C

SIMULATIONS

Elevation plots at 7.1 MHz

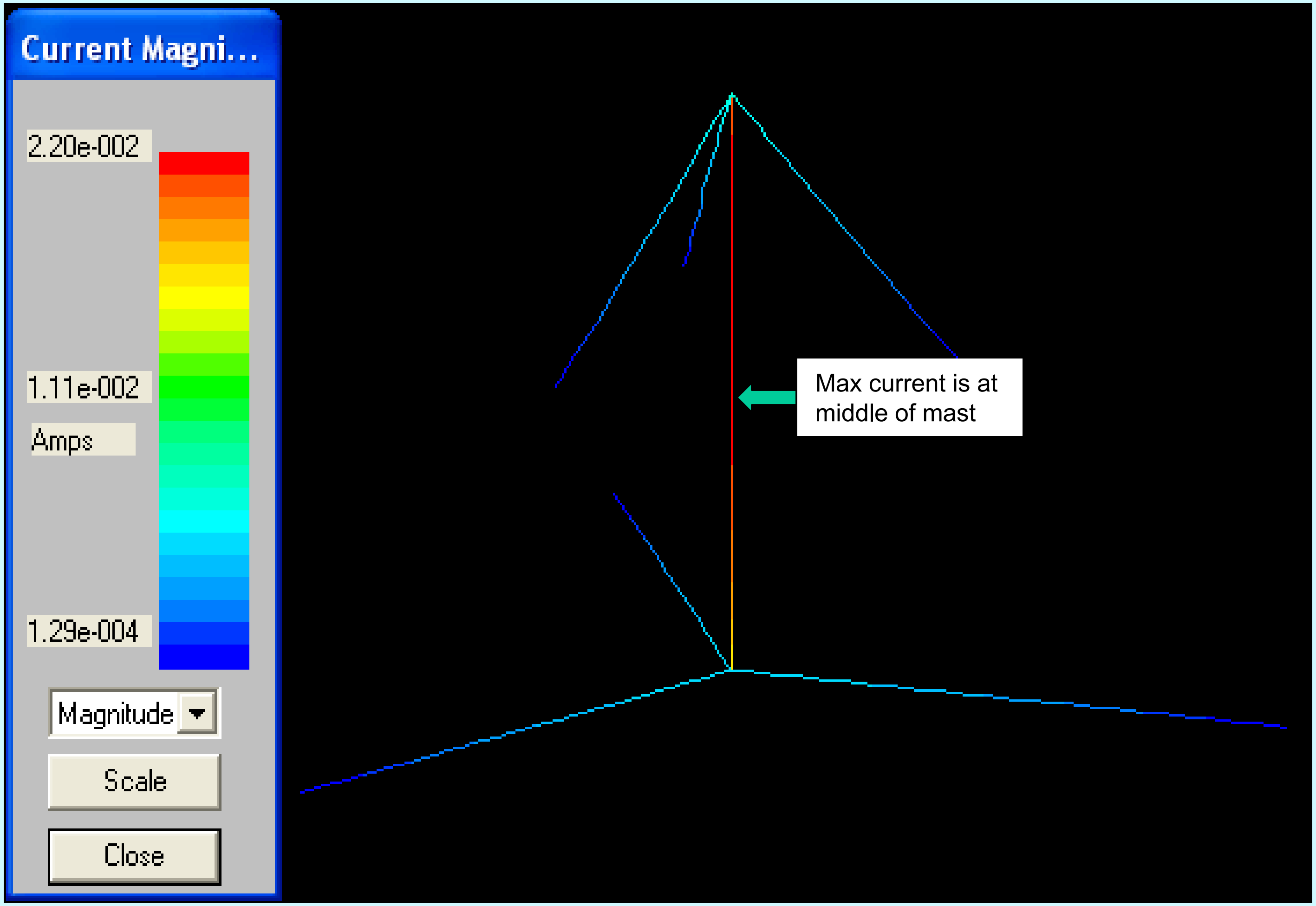
- Gain difference is less on 40m
- For both bands the radiation pattern is similar.
- Max radiation occurs at 20 – 25 degrees.



vert270L-10C-7m.nwp
vert260L-10C-7m.nwp

SIMULATIONS

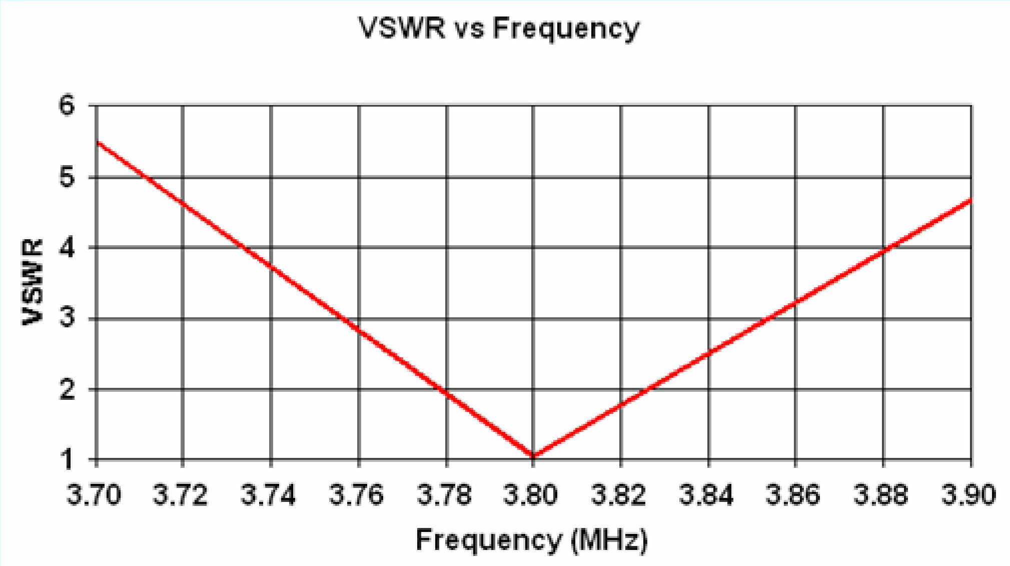
Antenna currents at **7.1 MHz**



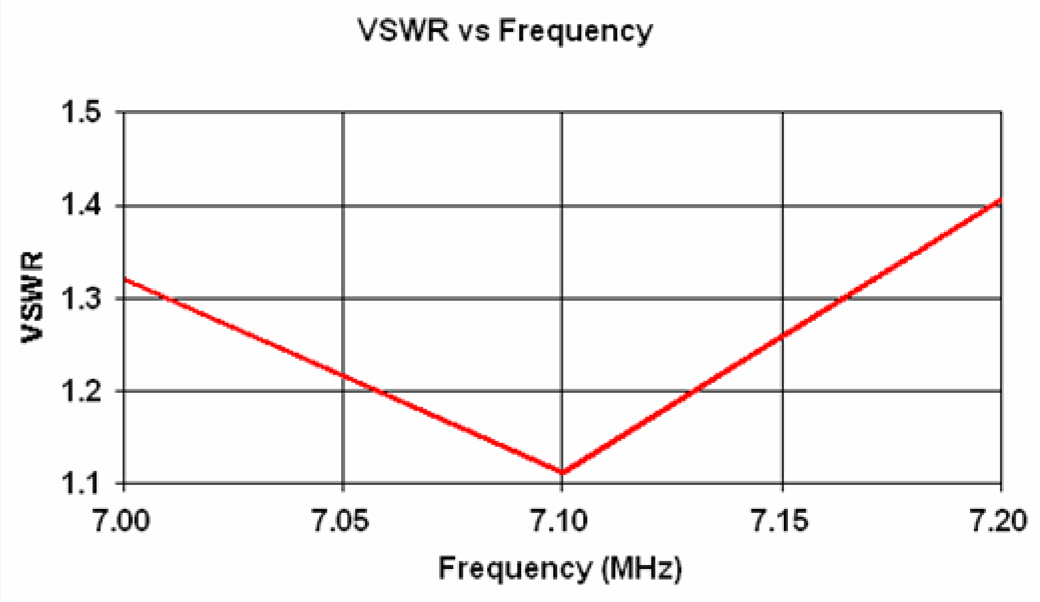
SIMULATIONS

SWR on 75 m

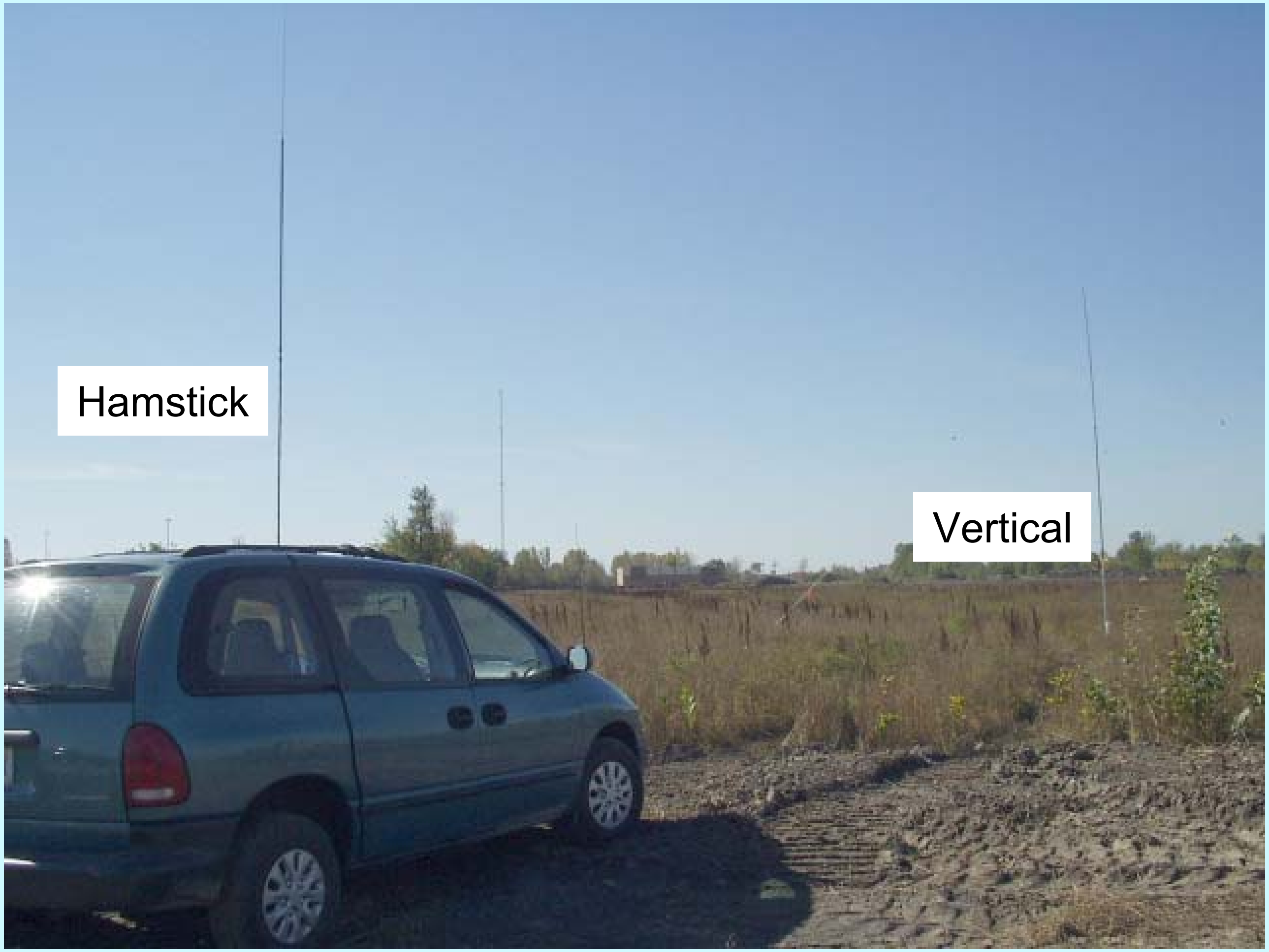
SWR changes faster



SWR on 40 m



On the Air Tests



Comparison with the Hamstick Mobile Antenna - 40m

<u>The signal from the vertical antenna were always strongest !</u>

Signal reports:

Stations located far away: 2 S-units difference (~ 10 dB)

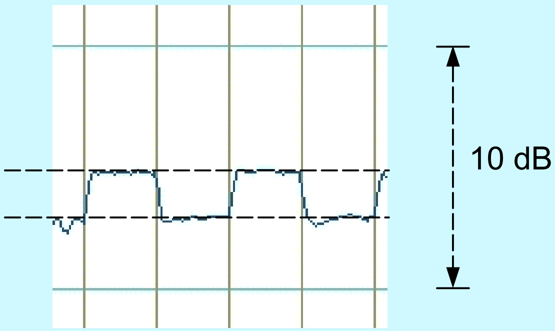
Stations close: 1 S-unit difference.

Signal Level Comparisons on RX, 40m band, Measured Data

Using CIAOradio software

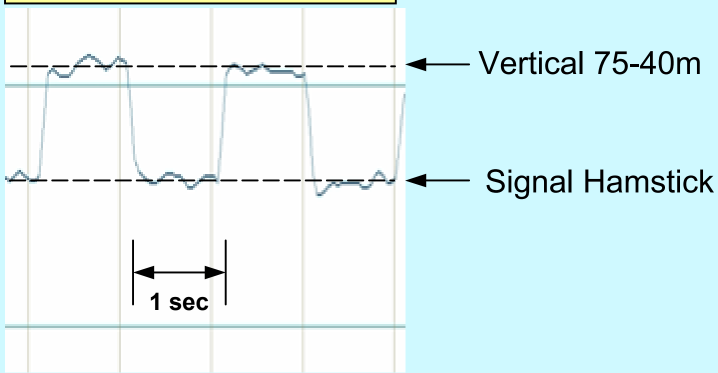
Local signal 2Km

Note:
NO fading



Δ = 2.1 + 1 = 3.1 dB

Local signal ~ 30Km

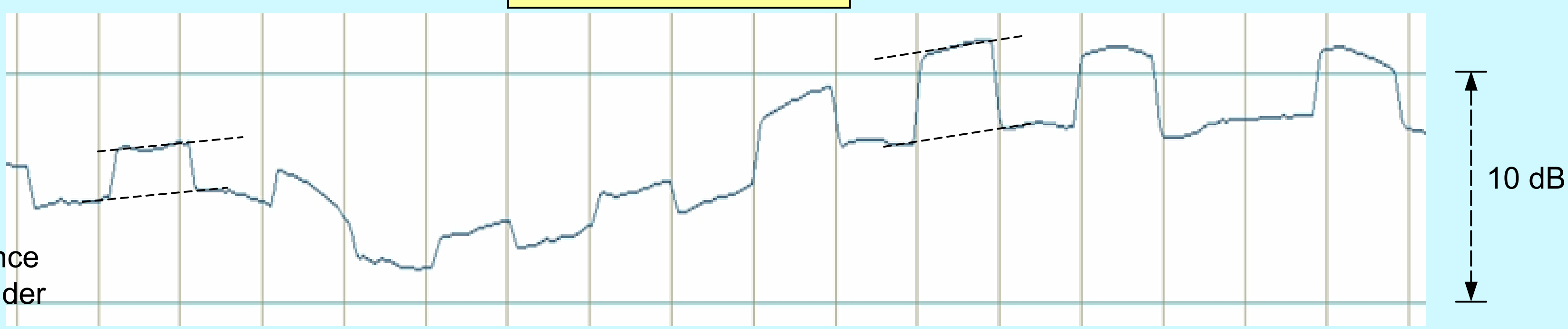


Δ = 4.7 + 1 = 5.7 dB

Note: 1 dB added to take into account coax losses (100 fti. RG-8X)
When feeding the 28 ft. vertical

Far Signal 950 Km

Note:
The difference changes under Fading.



Δ = 2.1 + 1 = 3.1 dB

Δ = 3.9 + 1 = 4.9 dB

Improving the Efficiciency of the Vertical Antenna on 75m

- Using a regular antenna tuner yields simpler system.
  The range of impedances required is easily covered by the tuner.

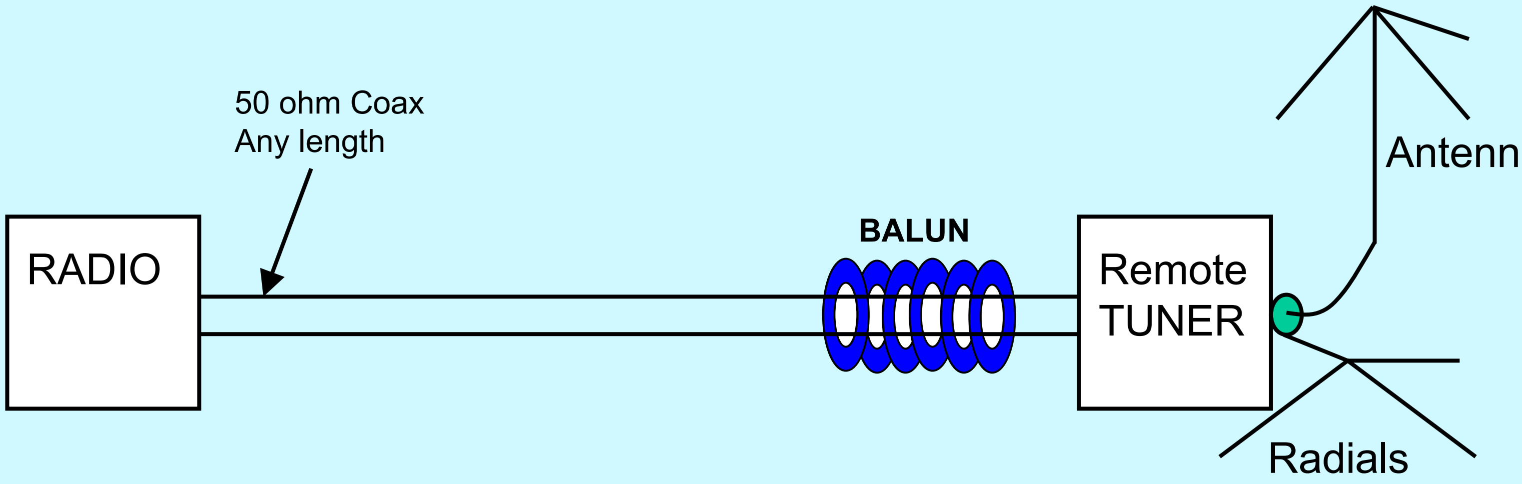
~ 50% efficiency on average ground with elevated radials

- Use Top Loading. This will increase the antenna radiation resistance and lower losses.
  However simulations predict <u>no increase in gain over average ground at 3.8 MHz.</u>
  <u>The ground quality makes all the difference.</u>

- Don’t forget the Balun !

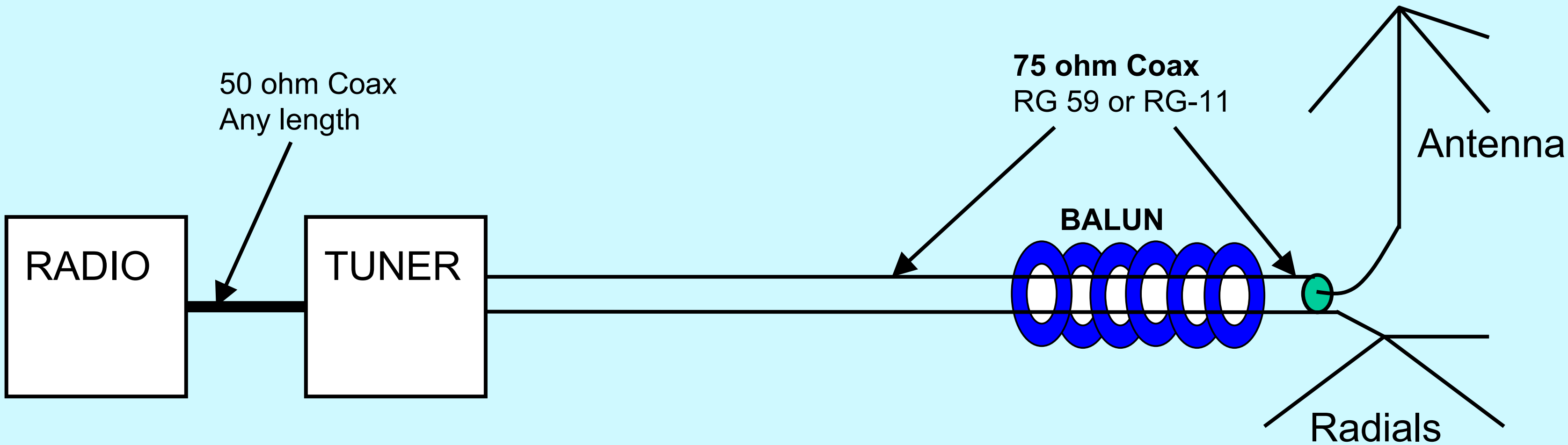
Using a Remote Tuner at the Antenna

- The remote tuner is connected right at the antenna



Using a Tuner at the Radio end of the Coax Feedline

- Use a 75 ohm cable of the recommended length. (Improves tuner efficiency)
- The recommended length in feet: 93 * Vf (Where Vf is the velocity factor)
- The length includes the balun. It is measured from the tuner to the antenna



SINGLE BAND VERSIONS

- No traps. Vertical element length = radial length.
  (My simulations assume that # 12 wire is used on all conductors).

- For 75 m. Use ~ 36.5 ft. radials and vertical elements.
  Gain improves 1 dB (over average gnd).
  Zantenna = 28 ohms.
  Compare this to a regular λ/4 vertical at 62 ft. high.

- For 40 m. Use ~ 19.8 ft. radials and vertical elements.
  Gain decreases 0.6 dB (over average gnd).
  Zantenna = 28 ohms.
  A standard λ/4 vertical is 32 ft. high.

SUMMARY

- Portable Vertical Antenna for 75m and 40m makes up a compact 28 feet high antenna.

- Assembled in 20 minutes by two persons.

- Uses elevated radials for higher gain. 5 to 6 dB improvement as measured on 40m by Rudy Severns N6LF.

- A standard / remote tuner at the feedpoint will ease construction and allow operation from 3.5 to 7.5 MHz. The self resonant frequency should be between 4.6 MHz and 5.6 MHz to improve matching efficiency.

- Simulations did not show gain improvements using top loading.

- Current distribution in the radials - Currents should be equal for omni performance. Ground / soil condition may affect current symetry. Rudy Severns recommends 10 – 12 radials to minimize asymetry.

- Use a balun to feed this antenna, since it behaves as a vertical dipole. Connect the remote tuner between the balun and the antenna.

References

1- Antennas Here are Some Verticals on the Beach… R. Dean Straw N6BV
The ARRL Antenna Compendium Vol. 6, page 216 The author uses 2 elevated radials, resonated separately as a dipole at the desired frequency. Operation near salt water.

2- Short Radials for Ground-Plane Antennas Rudy Stevens N6LF
The ARRL Antenna Compendium Vol. 6, page 212 Lots of data on using 4 elevated radials on 160 m

3- An Electrically Small Umbrella Antenna for 160 Meters
John S. Belrose VE2CV The ARRL Antenna Compendium Vol. 7 Uses a short elevated tuned radial

4- Elevated radial systems for vertically polarized ground-plane type antennas
John S. Belrose VE2CV Communications Quarterly winter 1998 Basic data at 3.75 MHz where the number of radials is varied from 4 to 64 and radial height varies from 0.00006 lambda (5mm) to 0.1 lambda.

5- Short Vertical Antennas and Ground Systems Ralph Holland VK1BRH
http://www.arising.com.au/people/Holland/Ralph/Antsim.htm
Covers elevated radials.

6- Folded Umbrella Top Loaded vertical Antenna John S. Belrose VE2CV
Ham Radio September 1982. Basic construction data. Radials at the ground level.

7- A Closer Look at Vertical Antennas With Elevated Ground Systems Rudy Severns N6LF
AntenneX March 2012 or QEX March / April 2012.

8- Vertical Antenna for 40 and 75meters Paul A Scholz W6PYK Ham Radio September 1979
Available from the author of this presentation.

Commercially Built Verticals Using Umbrellas

Commercially Built Verticals Using Umbrellas

Marconi Museum - Glace Bay / Cap Breton Island – Nova Scotia - Canada

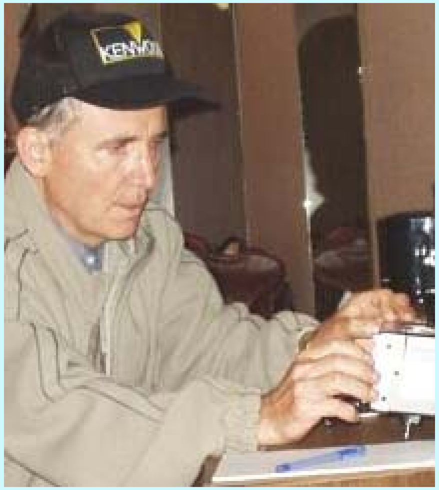
Marconi Vertical Antenna System

Building one of the four Towers

What Remains Today of Marconi's Antenna

Looking East, Facing the Atlantic
Where Marconi had his Antenna

Looking South



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