Using EZNEC To Compare Antennas Part 2

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Topics

- How polarization affects antenna performance
- How ground type affects antenna performance

Example 1: 48' Shunt Fed Tower as 40M Vertical

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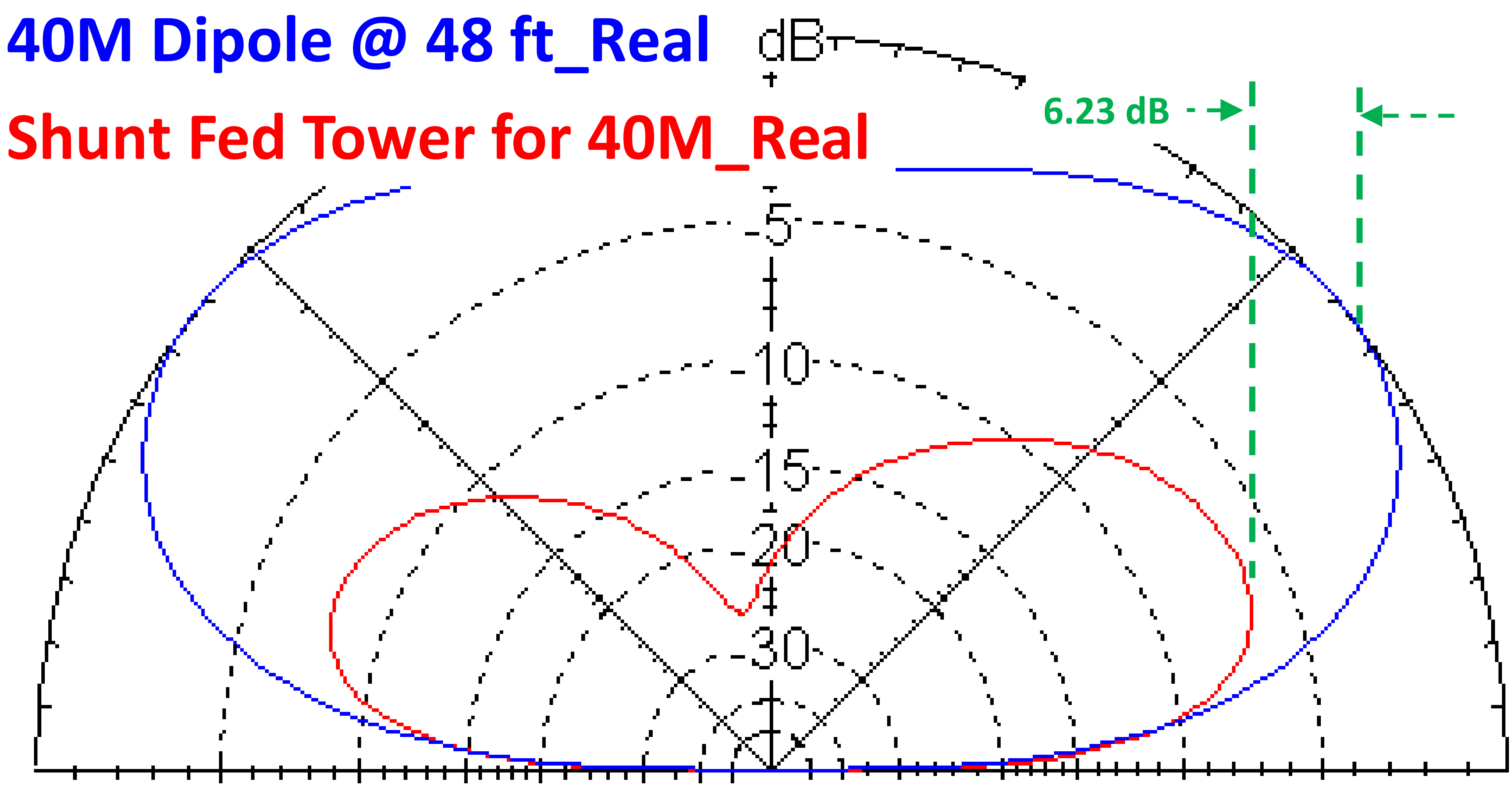
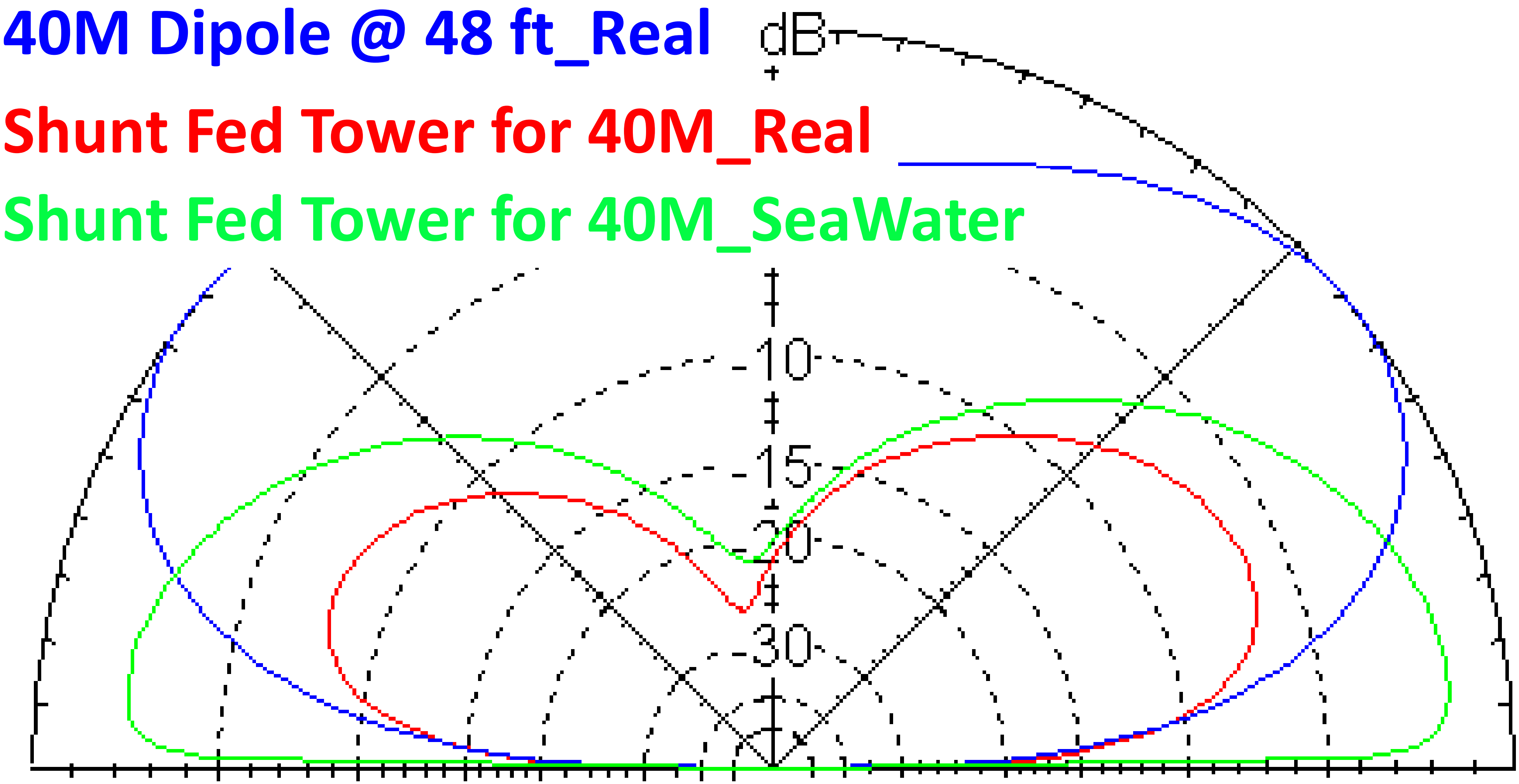
- After improving the radial system, signals from the dipole are still 6 dB to 20+ dB stronger than signals from the vertical (95% of the time)

Example 1: 48’ Shunt Fed Tower as 40M Vertical



Example 1: 48' Shunt Fed Tower as 40M Vertical



Example 1: 48’ Shunt Fed Tower as 40M Vertical

Verticals radiate equally poorly in all directions!

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Vertical Polarization

Vertically polarized antennas over lossy ground radiate equally poorly in all directions!

- **Over perfect ground, a vertcially polarized antenna can have higher peak gain than the same antenna horizontally polarized**
- **Over typical lossy (ie, not salt water) grounds:**
  - **Horizontally polarized antennas have 4.5-7 dB of *ground reflection gain* (GRG)**
  - **Vertically polarized antennas have GRG<3 dB (often <0 dB)**
- **Rule of Thumb: horizontal polarization has a ~6 dB GRG advantage over vertical polarization over lossy grounds**

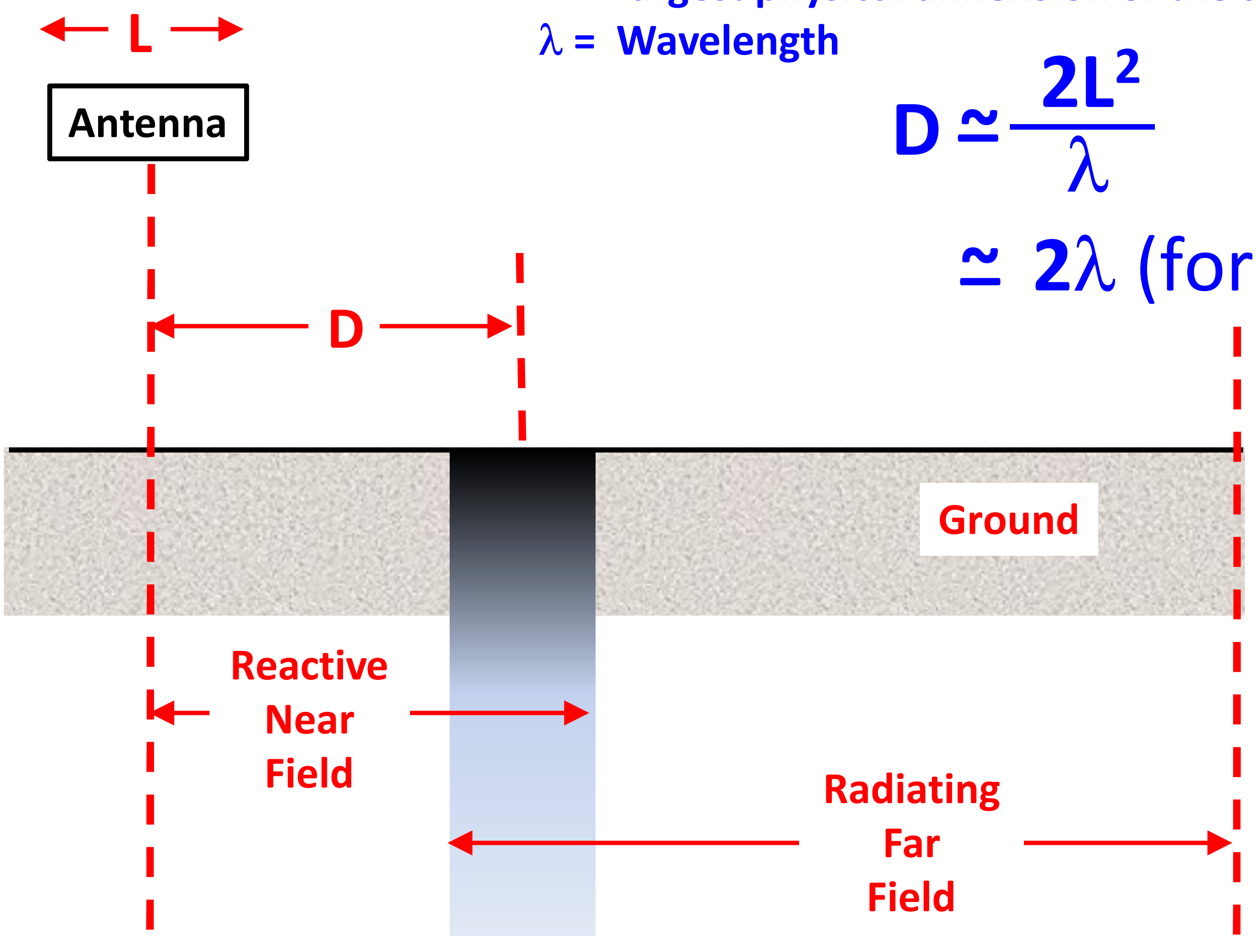
What Is "Ground"

- There are two different "RF grounds" that affect antenna performance

L = Largest physical dimension of the anternna
λ = Wavelength

$$D \simeq \frac{2L^2}{\lambda}$$

$$\simeq 2\lambda \text{ (for } L=\lambda\text{)}$$



What Is "Ground"

- **Reactive Near Field:**
  - **Magnetic field dominates over the Electric field**
  - **Energy storage, but <u>NO radiation</u> of electromagnetic energy**
  - **Affects antenna radiation *<u>impedance & efficiency</u>***
- **Radiating Far Field:**
  - **Equal energy in Electric and Magnetic fields**
  - **<u>Radiation</u> of electromagnetic energy**
  - **Affects antenna pattern (*<u>gain & shape</u>*)**
    - **Adding more 1/4λ radials won't improve gain or pattern**
  - **This is the field modelled by all NEC programs**

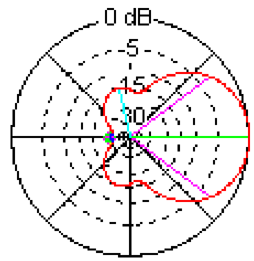
Horizontal or Vertical Polarization?

Example 2: 20M 5 Element Wide Spaced Yagi

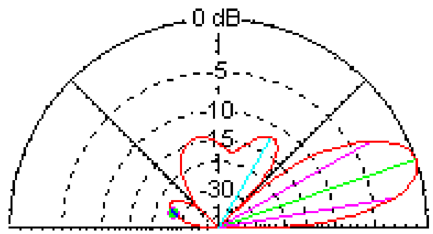
Horizontal Polarization

Height above ground = 50 feet

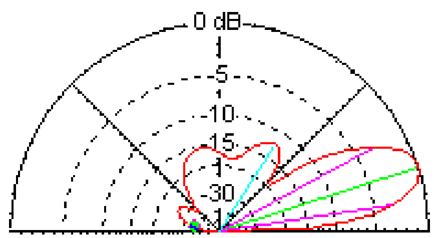
Free Space



Perfect



Real



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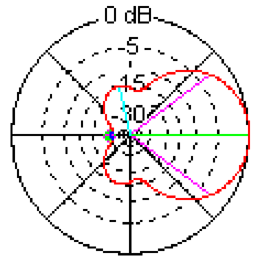
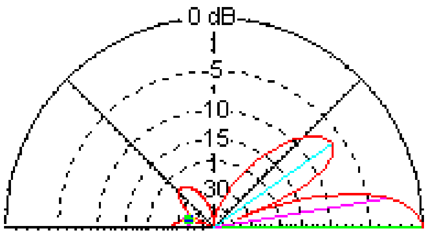
Vertical Polarization

Height above ground = 50 feet

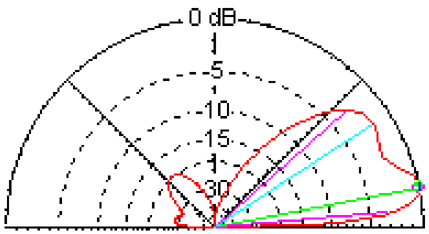
Free Space



Perfect



Real



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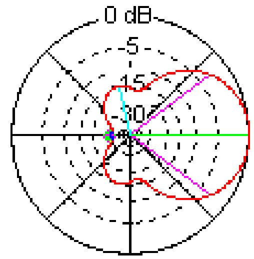
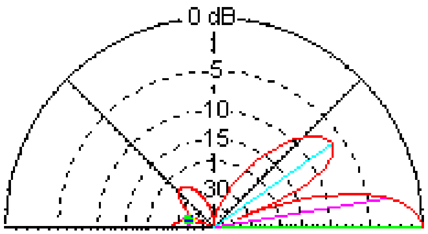
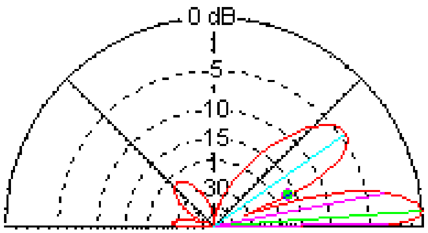


Perfect



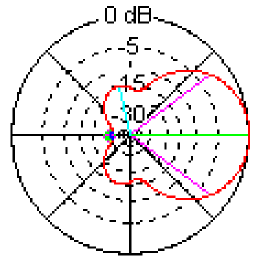
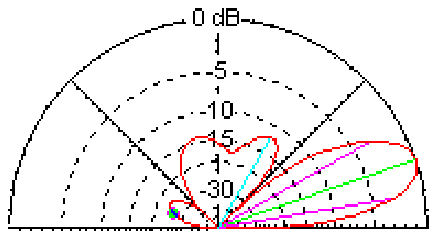
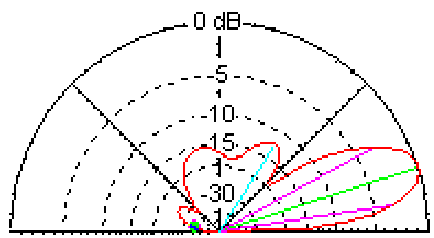
Sea Water



Example 2: 20M 5 Element Wide Spaced Yagi

Horizontal Polarization

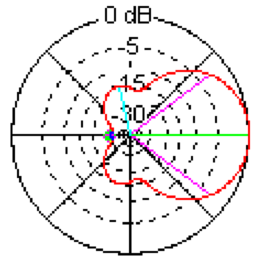
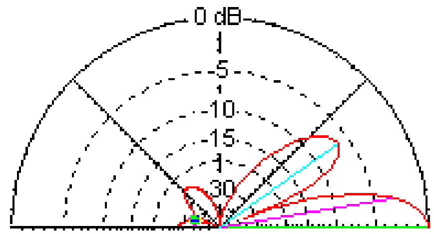
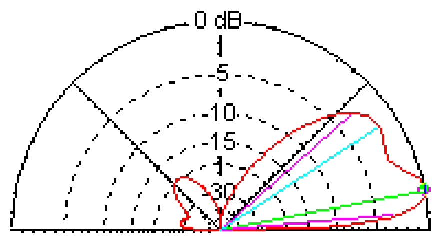
Height above ground = 50 feet

		GRG	Peak Gain
Free Space		0 dB	9.84dBi/0º
Perfect		5.28 dB	15.12dBi/19º
Real		4.61dB / -0.67 dB	14.45dBi/18º

Example 2: 20M 5 Element Wide Spaced Yagi

Vertical Polarization

Height above ground = 50 feet

	Pattern		GRG	Peak Gain
Free Space		0 dB		**9.84dBi/0º**
Perfect			6.05 dB	**15.89dBi/0º**
Real		-1.05 dB	-7.10 dB	**8.79dBi/11º**

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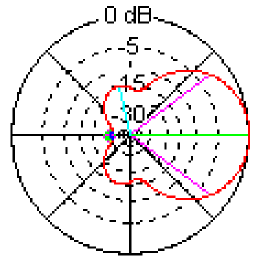
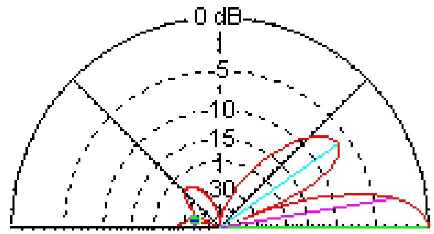
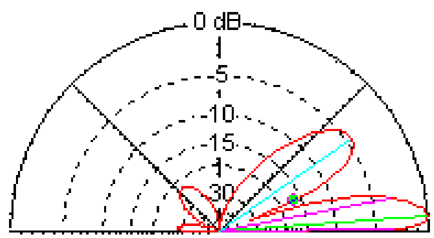
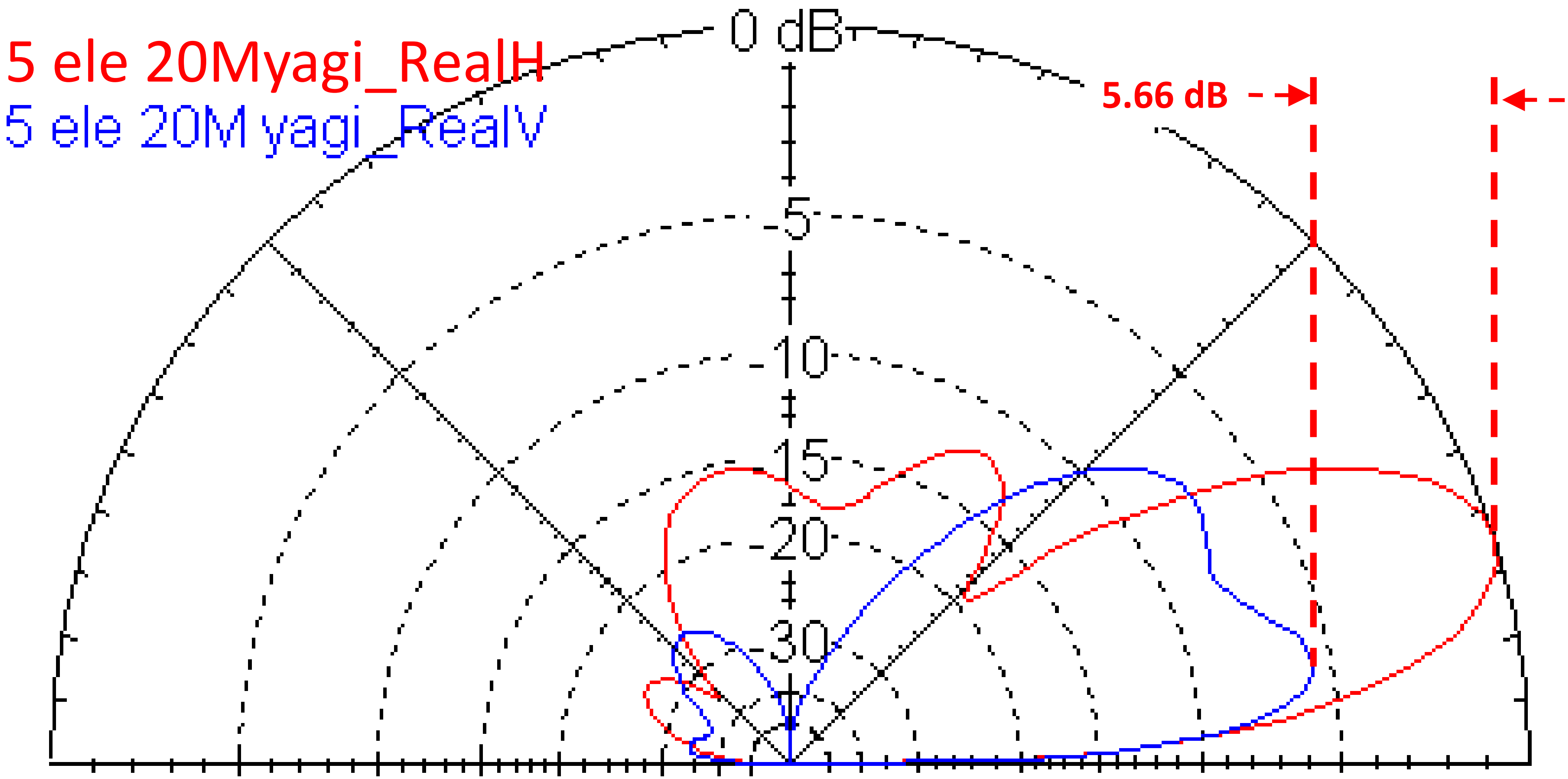
Vertical Polarization

Height above ground = 50 feet

		GRG	Peak Gain
Free Space		0 dB	9.84dBi/0º
Perfect		6.05 dB	15.89dBi/0º
Sea Water		4.08dB / -1.97 dB	13.92dBi/4º

Example 2: 20M 5 Element Wide Spaced Yagi

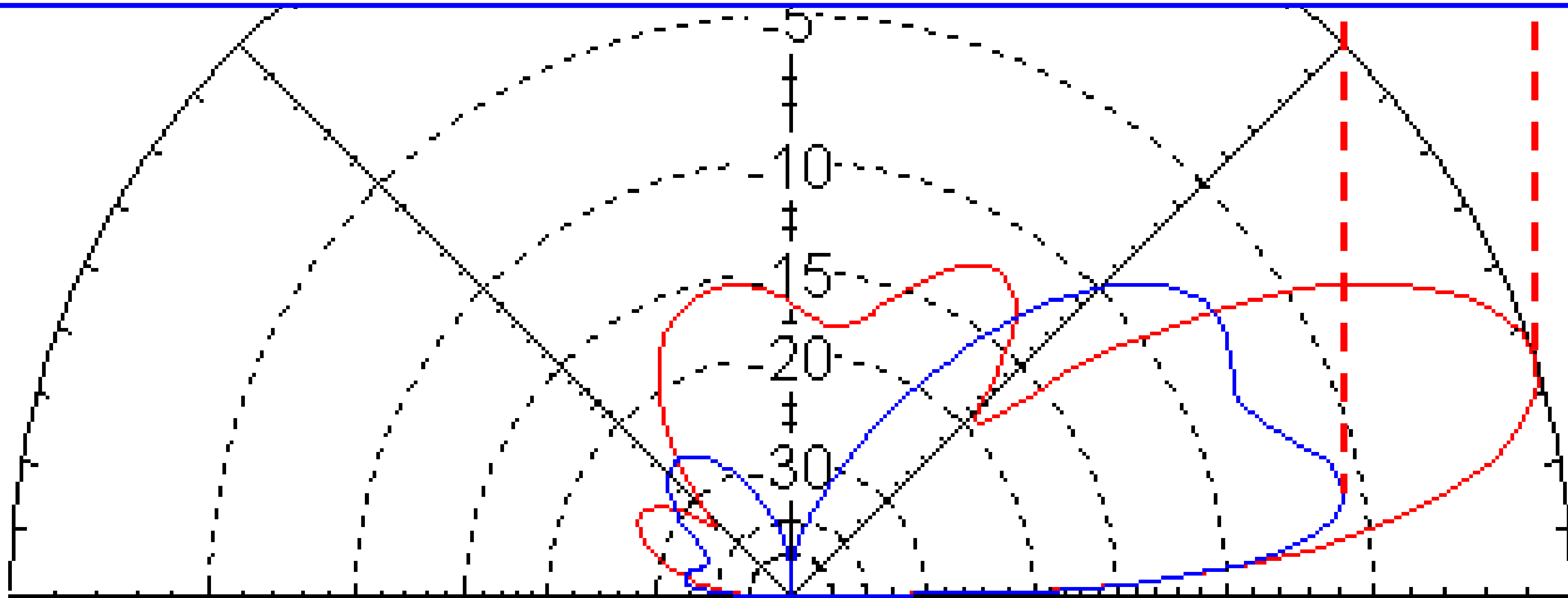
Height above real ground = 50 feet



Example 2: 20M 5 Element Wide Spaced Yagi

Compared to a Horizontal beam, the Vertical beam (over lossy ground) has:

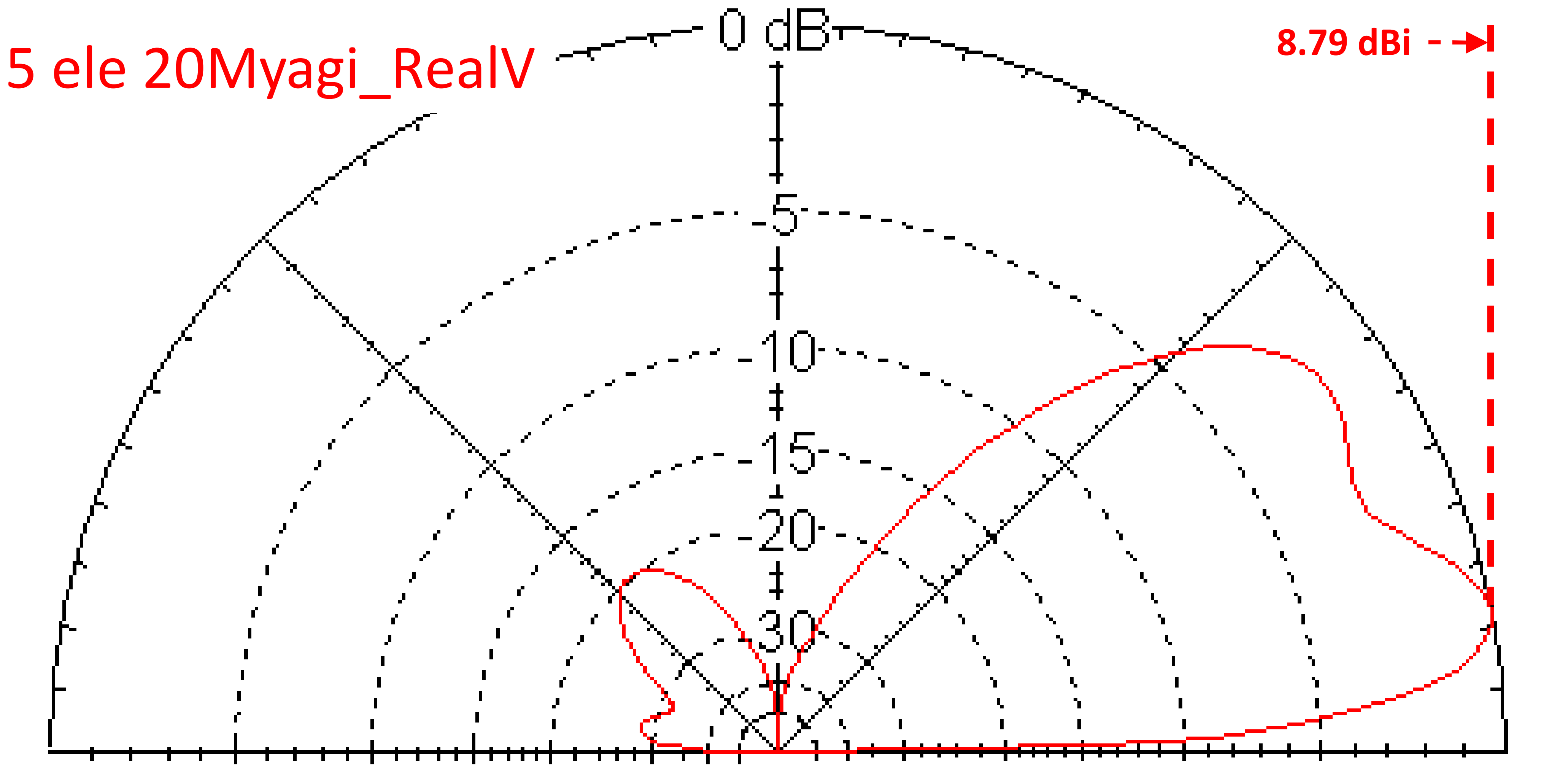
- **5.66 dB less peak gain**
- **No low angle radiation advantage**
- **Gain advantage only between 35-50°**



Type of Ground: How Important?

Example 2: 20M 5 Element Wide Spaced Yagi

Height above ground = 50 feet



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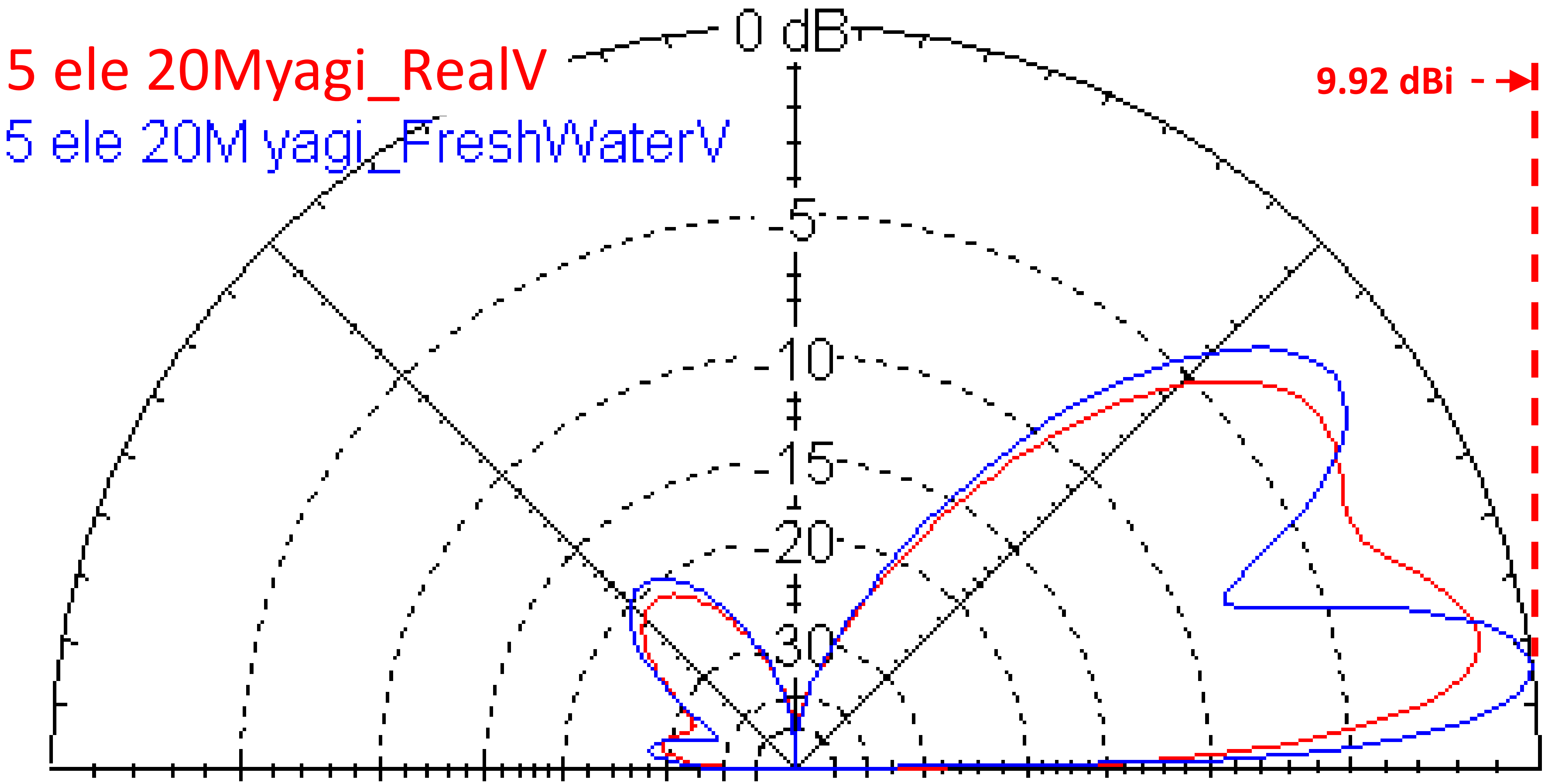
Height above ground = 50 feet



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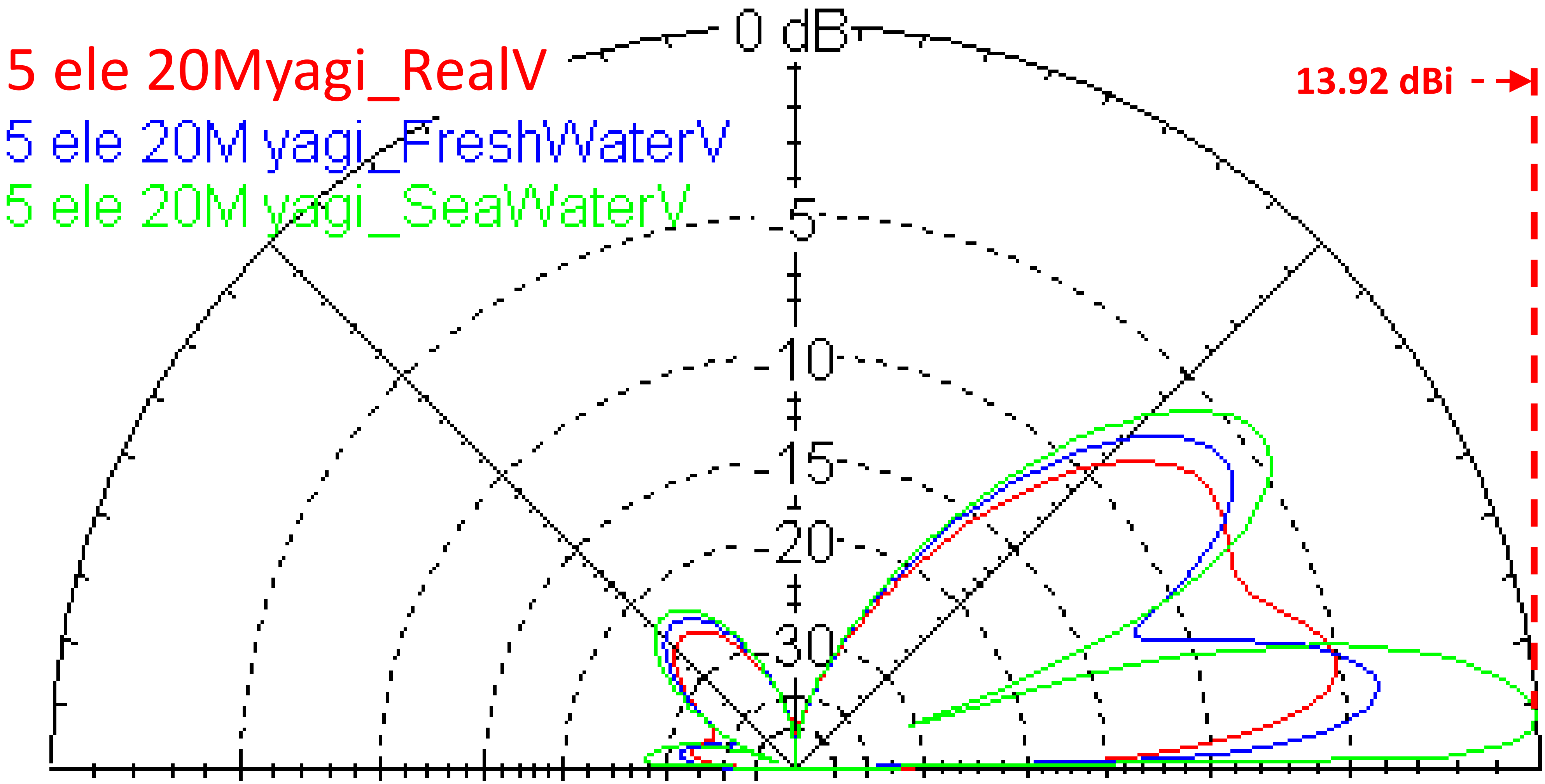

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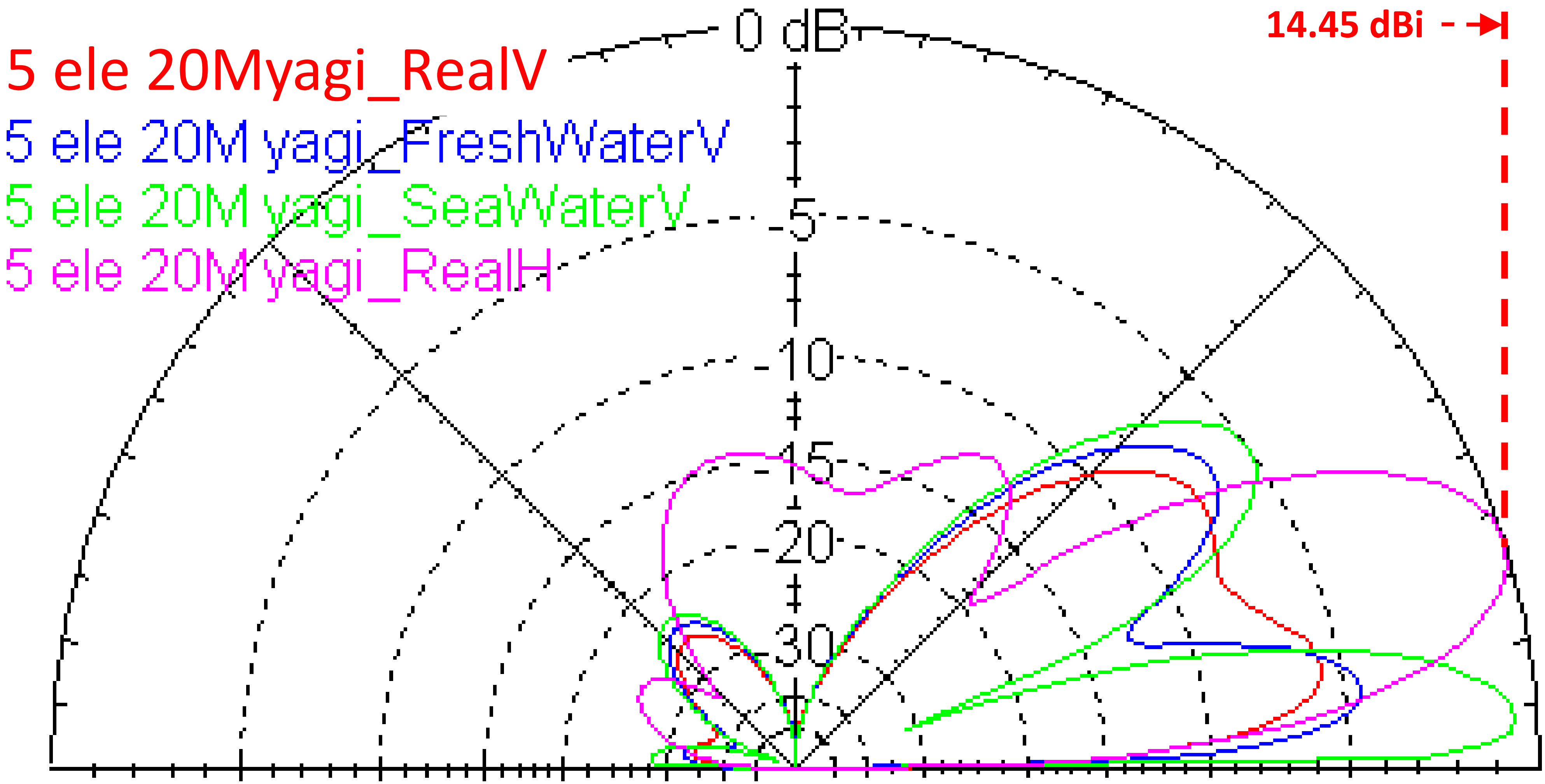

For identical conditions:

- **A Vertically polarized antenna will have gain peaks where a Horizontally polarized antenna has gain nulls, and visa versa**
- **This results from the 180^{o} phase difference of the respective ground reflections**

Vertically polarized antennas work better over salt water because of the salt (ions), not because of the water!

What Are RDF & DMF?

- **Optimum transmitting and receiving antennas have different requirements:**
  - **Transmit:** want the maximum possible ***signal strength*** in the desired direction
    - Maximum gain
    - Maximum efficiency (ie, minimum losses)
  - **Receive:** want the maximum possible ***signal-to-noise-ratio (SNR)*** in the desired direction
- **Reciprocity:** applies differently to SNR than to signal strength
- **Directivity Merit Figure (DMF):** compares forward gain at a specific direction to the average gain in the ***rear half hemisphere***
  - Use when dominant skywave noise is not uniformly distributed
- **Receiving Directivity Figure (RDF):** compares forward gain at a specific direction to the average gain in the ***entire sphere***
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The best transmit antenna may not be the best receive antenna!

- **Beverages are a popular choice for a *receive only* antenna for the low bands (80 & 160 M)**

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