Stacking Antennas

A Helpful Reference for Novice and Expert Alike

With references to work done by W1JR, VK2ZAB, DL6WU and others

Questions to be Answered

- What are the reasons for stacking antennas?
- Would building a bigger antenna be better than stacking?
- If we stack, what order of gain increase can we expect?
- Is it better to stack vertically or horizontally?
- How far apart do we stack the antennas?
- How do we manage the phasing requirements?
- How do we manage the matching requirements?

Why Stack Antennas?

- Single-band advantages
  - Greater Gain (compared to boom length increases)
  - Directivity / Noise cancellation
- Multiple bands on one mast or tower

Considerations For Multiple Bands On One Mast

- Interaction
  - Aperture fitting / Stacking distance
  - Supporting framework
  - Coax routing
- Survivability
- Available Space

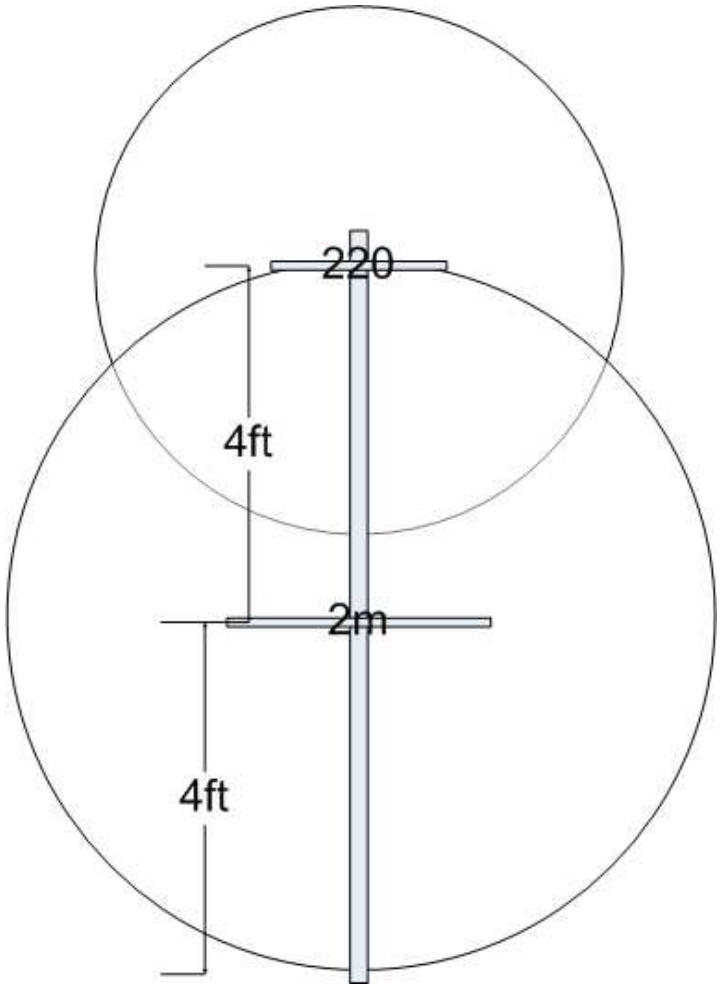
What Is Aperture?

- The area surrounding an antenna that is within that antenna's capture area
  - E and H plane patterns
- The minimum stacking distance is the distance where the apertures of stacked antennas just barely touch one another

How Close Can You Stack These?

- 144 MHz antenna
  - recommended stacking distance is 8 Feet
- 222 MHz antenna
  - recommended stacking distance is 6 feet

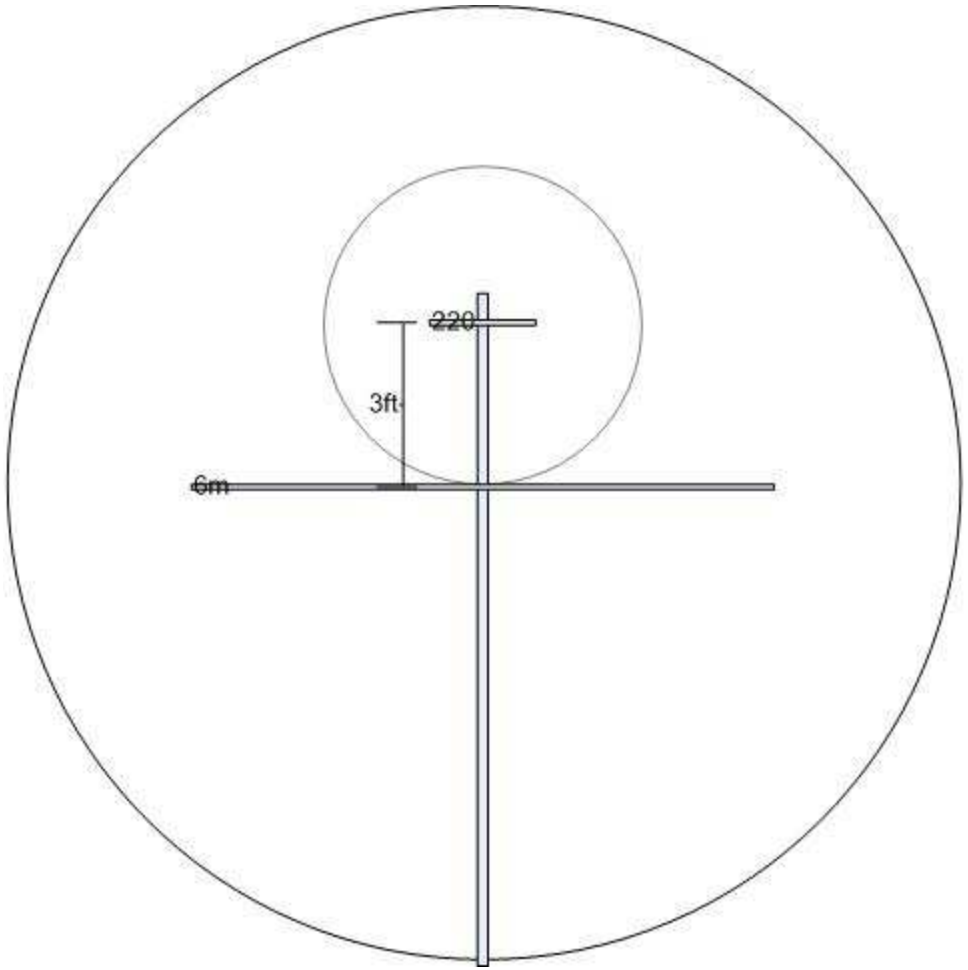
Solution? (144 and 220 MHz)



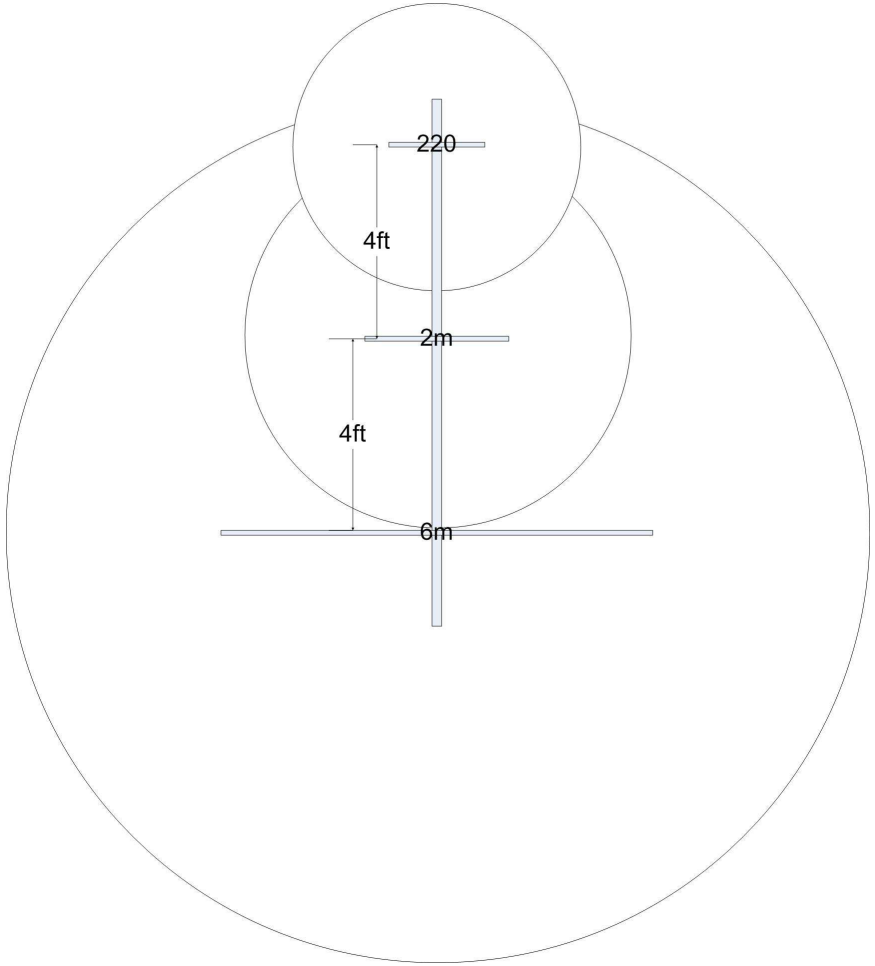
How Close Can You Stack These?

- 50 MHz antenna
  - recommended stacking distance is 18 Feet
- 222 MHz antenna
  - recommended stacking distance is 6 feet

Solution? 6 and 1.25M

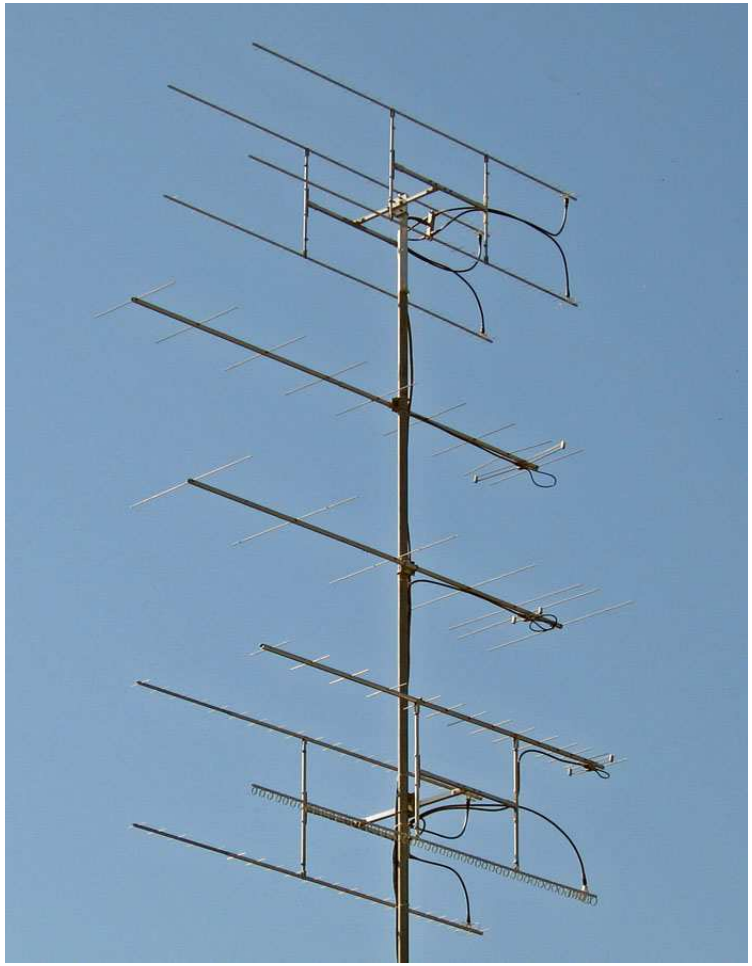


Solution? (6-2-1.25M)



Multiple Bands – One Mast

- 7-band example



Gordon McDonald VK2ZAB

- We stack Yagis in order to increase the gain over that obtainable from one Yagi and/or to decrease the beamwidth. The increase in gain is due to the reduction in beamwidth and it should be noted that the beamwidth is reduced in the plane of stacking only. If we stack vertically the beamwidth is decreased in the vertical or “H” plane of a horizontally polarised Yagi. Stacking horizontally results in a narrower beamwidth in the horizontal or “E “plane of a horizontally polarised Yagi. In some applications, such as interference from or to points off to one side or below the main lobe, the reduction in beam width is a more important consideration than the gain increase. However most people stack to get more gain.

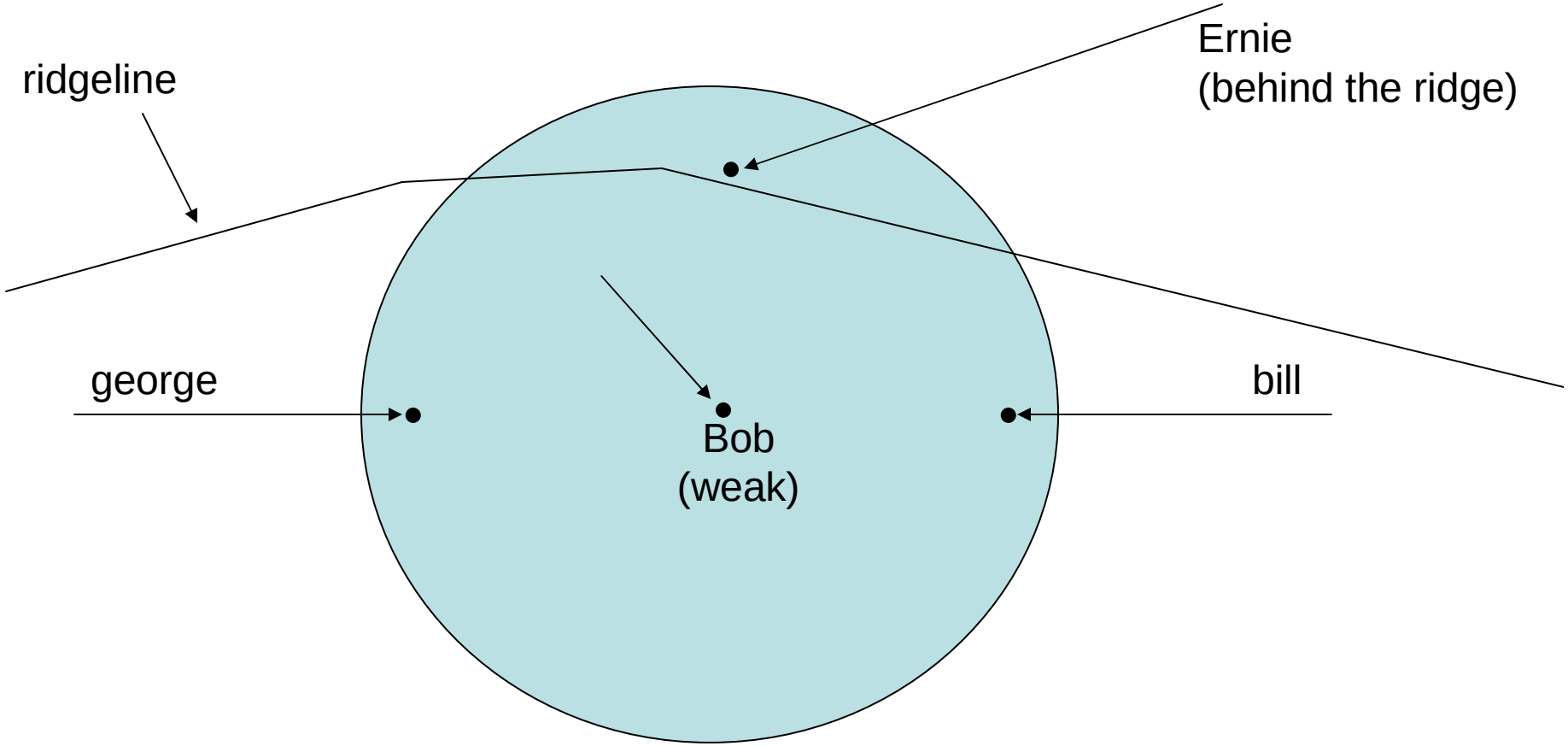
Considerations For a Single-Band Increase in Gain

- Do I use a longer antenna or stack shorter ones?
  - 2.35db gain for 2x boom length increase
    - Advantage or disadvantage?
  - 2.7 to 2.9 db gain for stacking 2 antennas
- Space available
- Main lobe beamwidth
- Stacking distance optimization

Stacking Choices

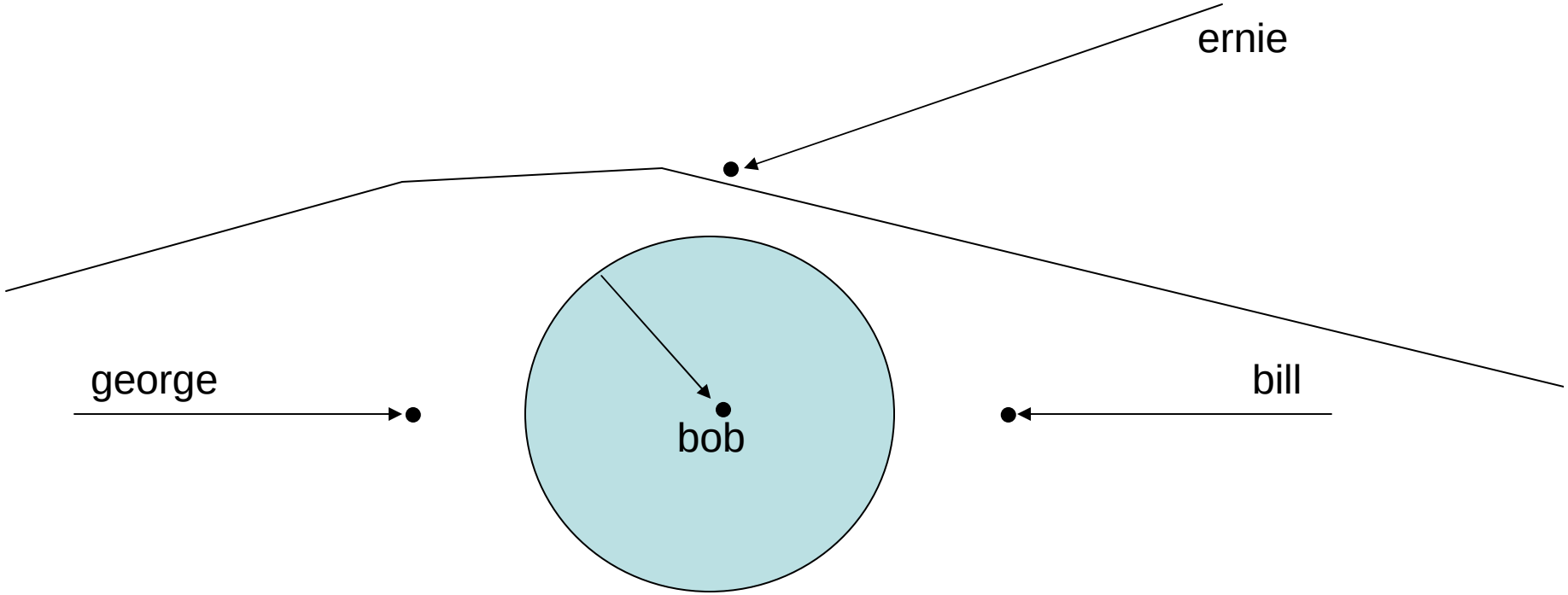
- Vertical or Horizontal?
  - Can I put up with a narrow azimuth?
  - What is my surrounding terrain?
- Both E and H plane Stacking
- Mechanical considerations

Antenna Coverage



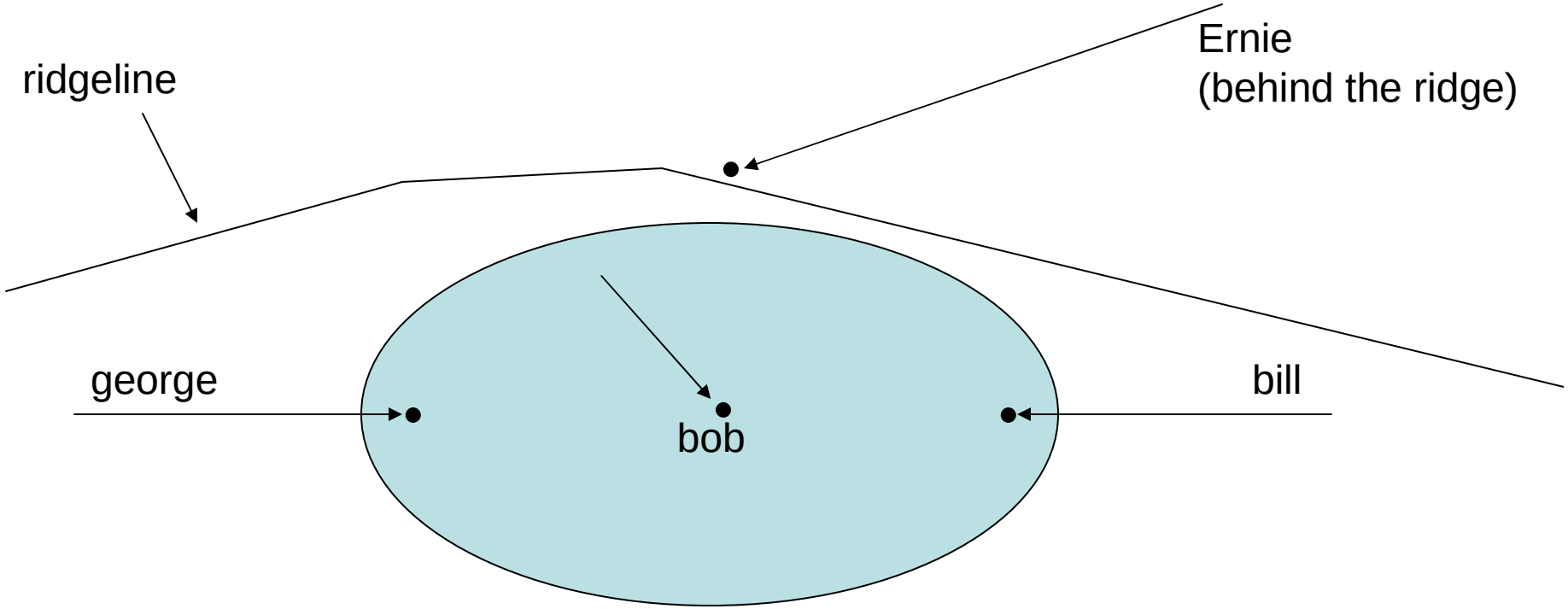
Antenna Coverage

(horizontal and vertical stacking)



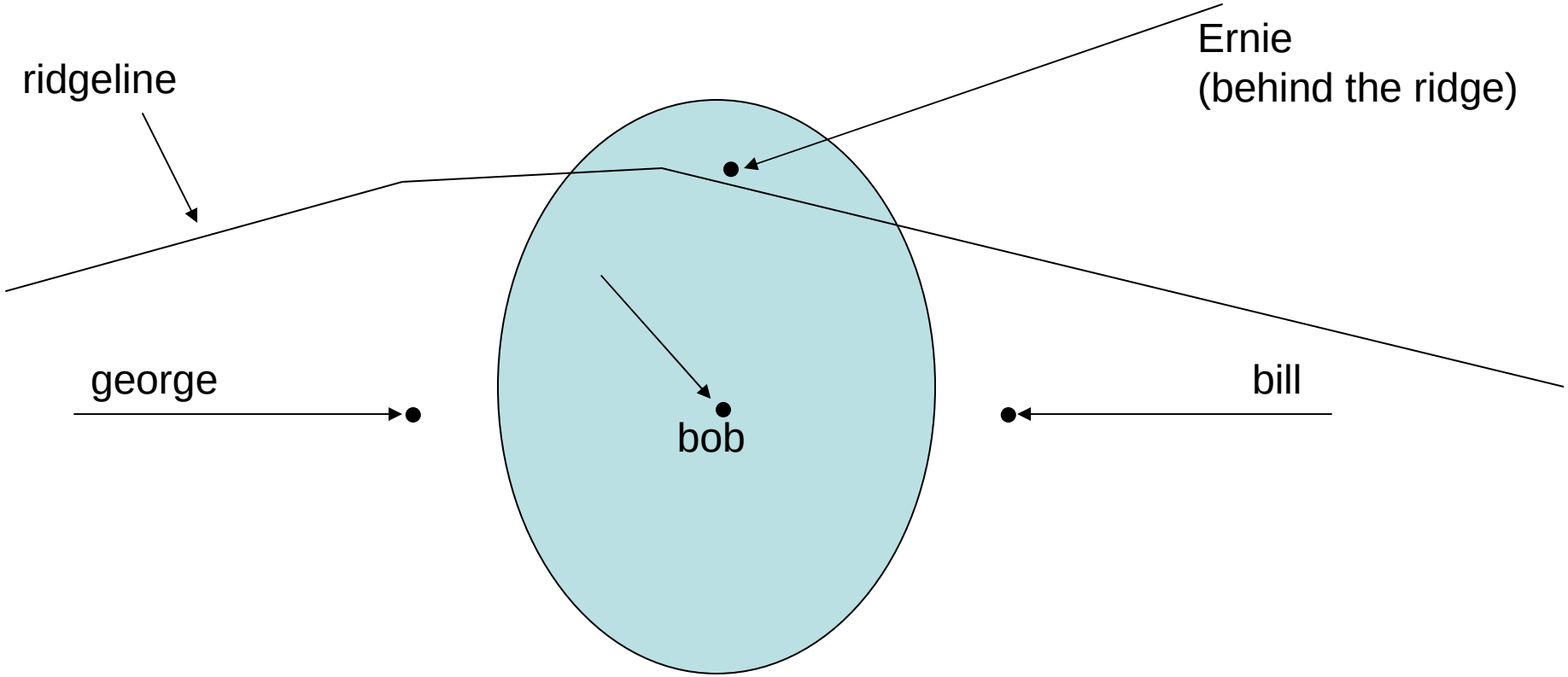
Antenna Coverage

(vertical stacking)



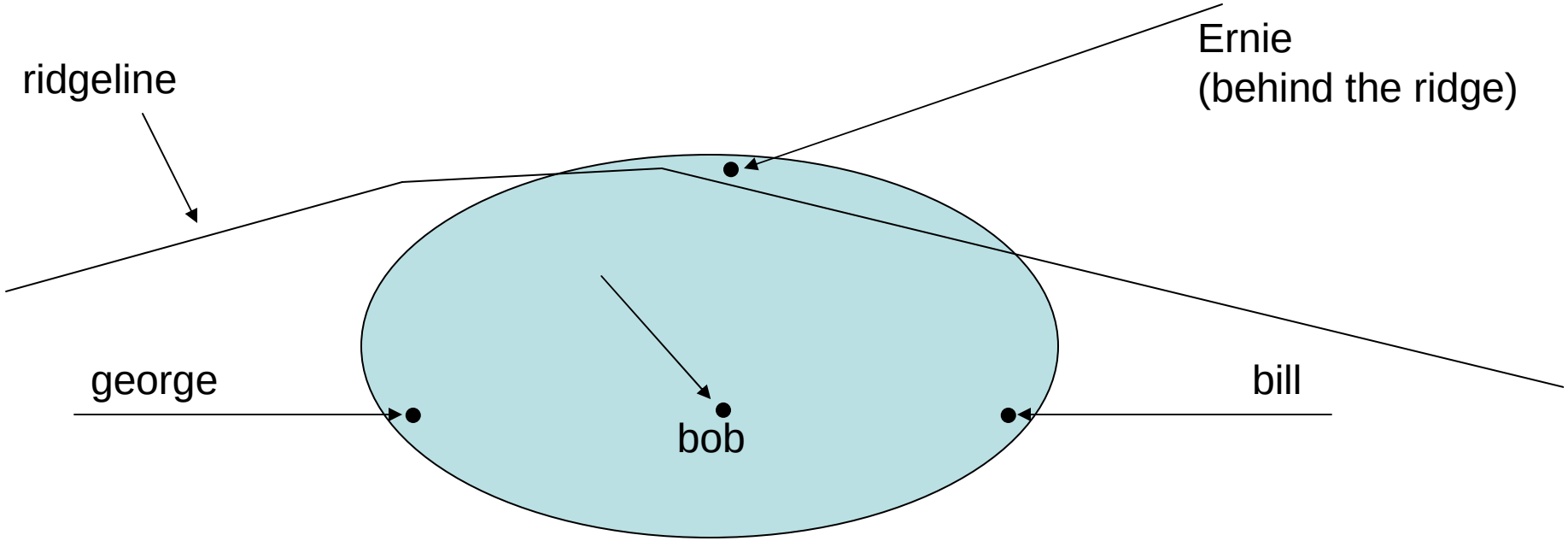
Antenna Coverage

(horizontal stacking)



Antenna Coverage

(vertical stacking with tilt)



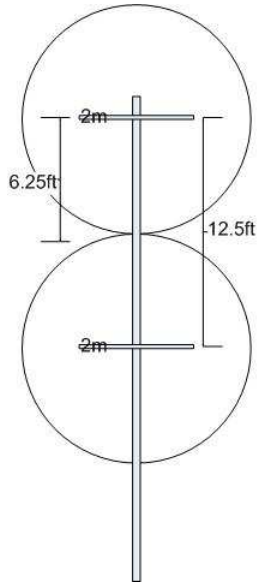
How Close Do We Stack For Gain?

- Optimum stacking distance (Dopt)
  - How do we calculate this?
    - Reduced to a simple formula, Dopt (in wavelengths) is the number 57 divided by the 3db beam-width of a single antenna (in degrees)
  - What is Dopt for a 2m antenna with a 3db beam-width of 30 degrees?

2m Antenna Dopt = 12.5 feet

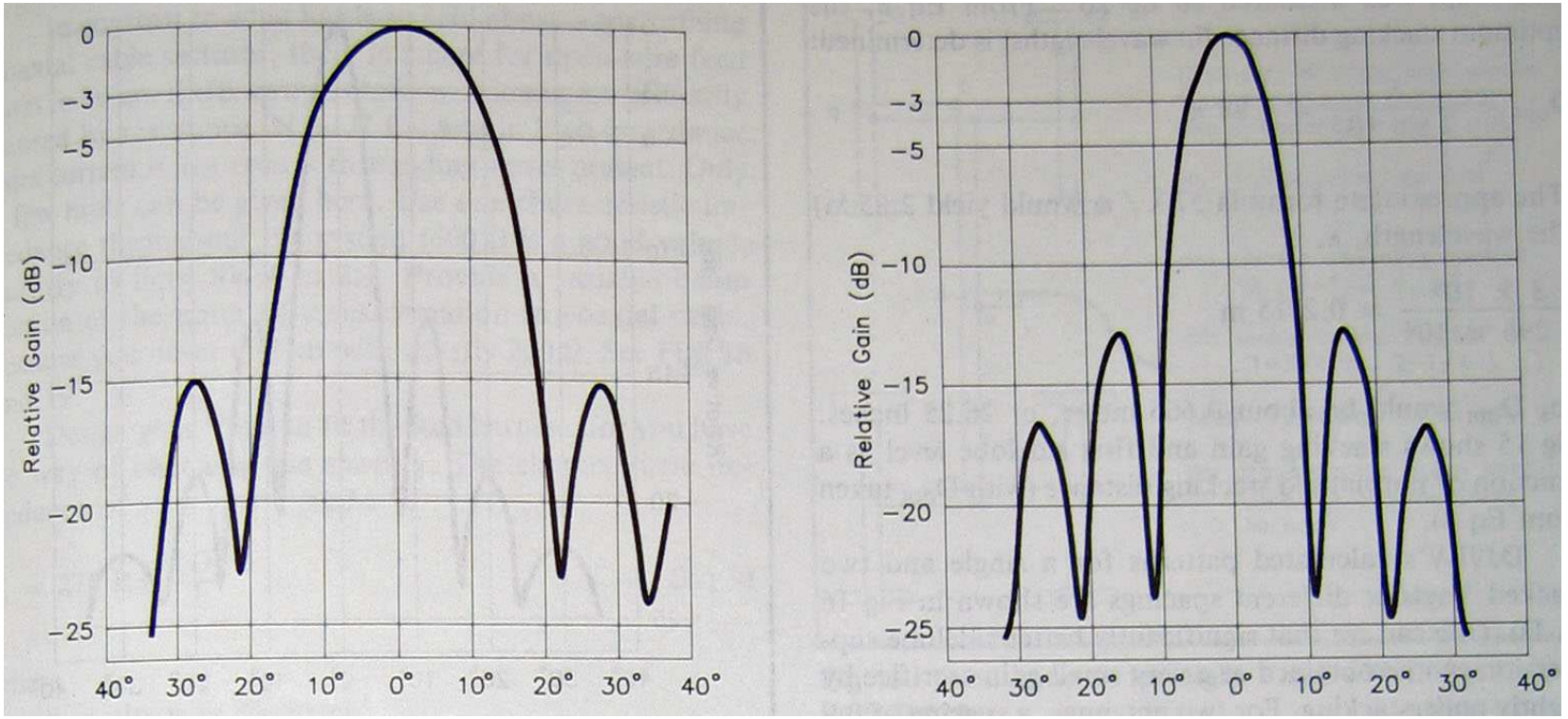
- 57 divided by 30 = 1.9 wavelengths
- 1.9 times 2 meters = 3.8 meters
- 3.8 meters is 149 inches, or 12.47 feet

This is good, but there may be one more adjustment to make



Understanding Stacking Patterns

Courtesy of the ARRL UHF/Microwave Experimenters Manual



A single antenna

Two antennas stacked at Dopt

How stacking distance will affect gain and sidelobe levels

(courtesy of the ARRL UHF/Microwave Experimenters Manual)

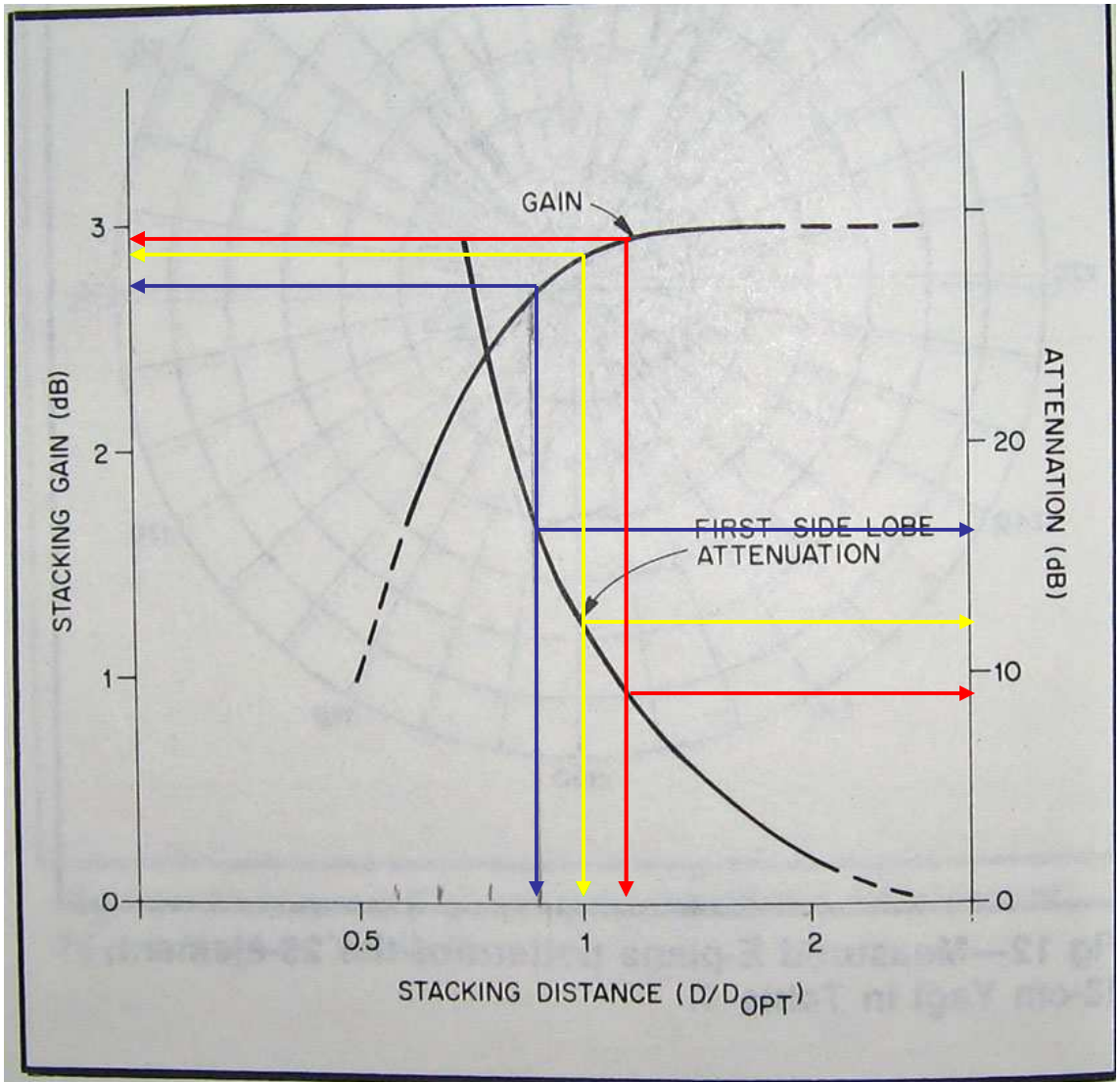
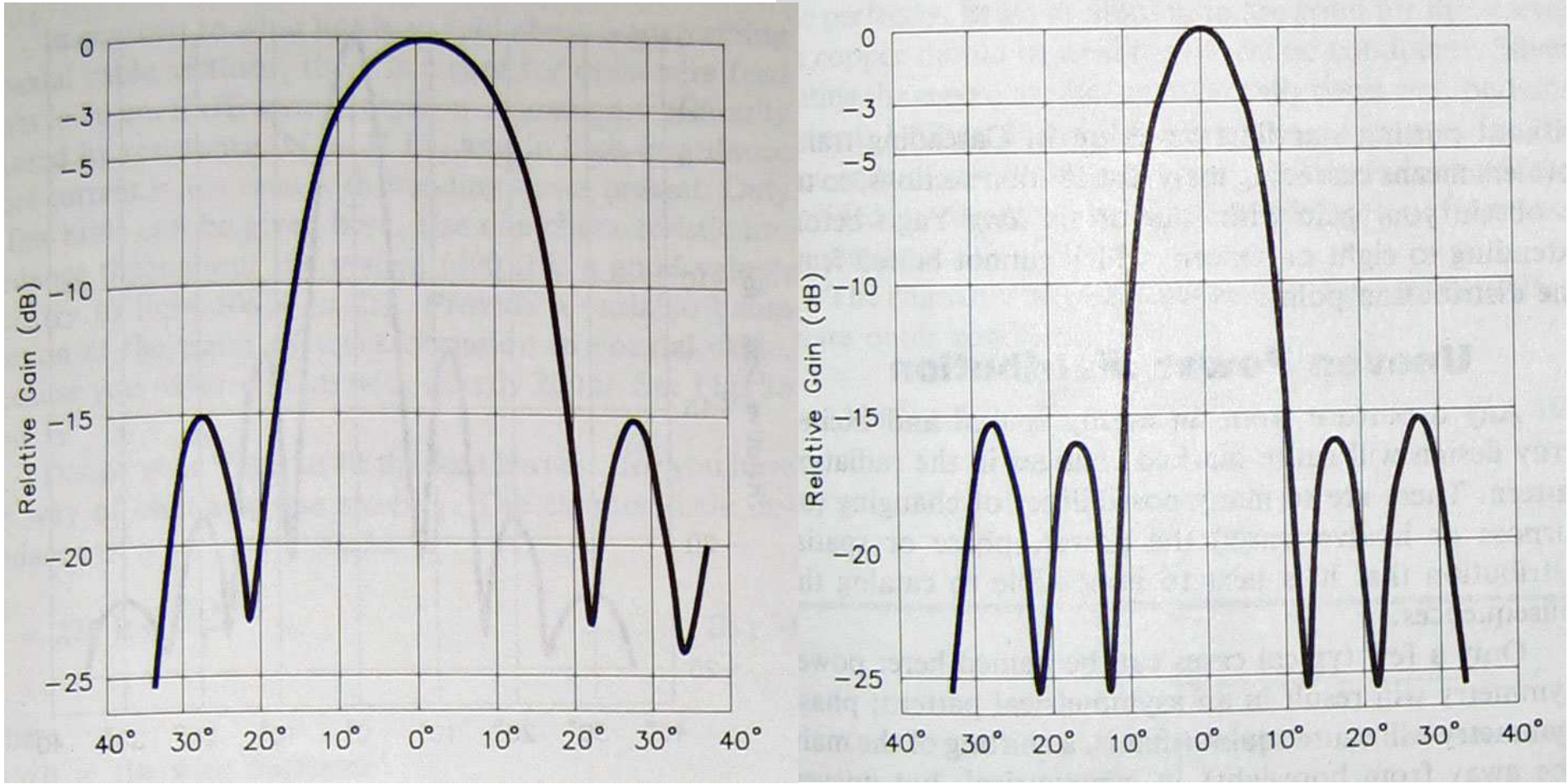
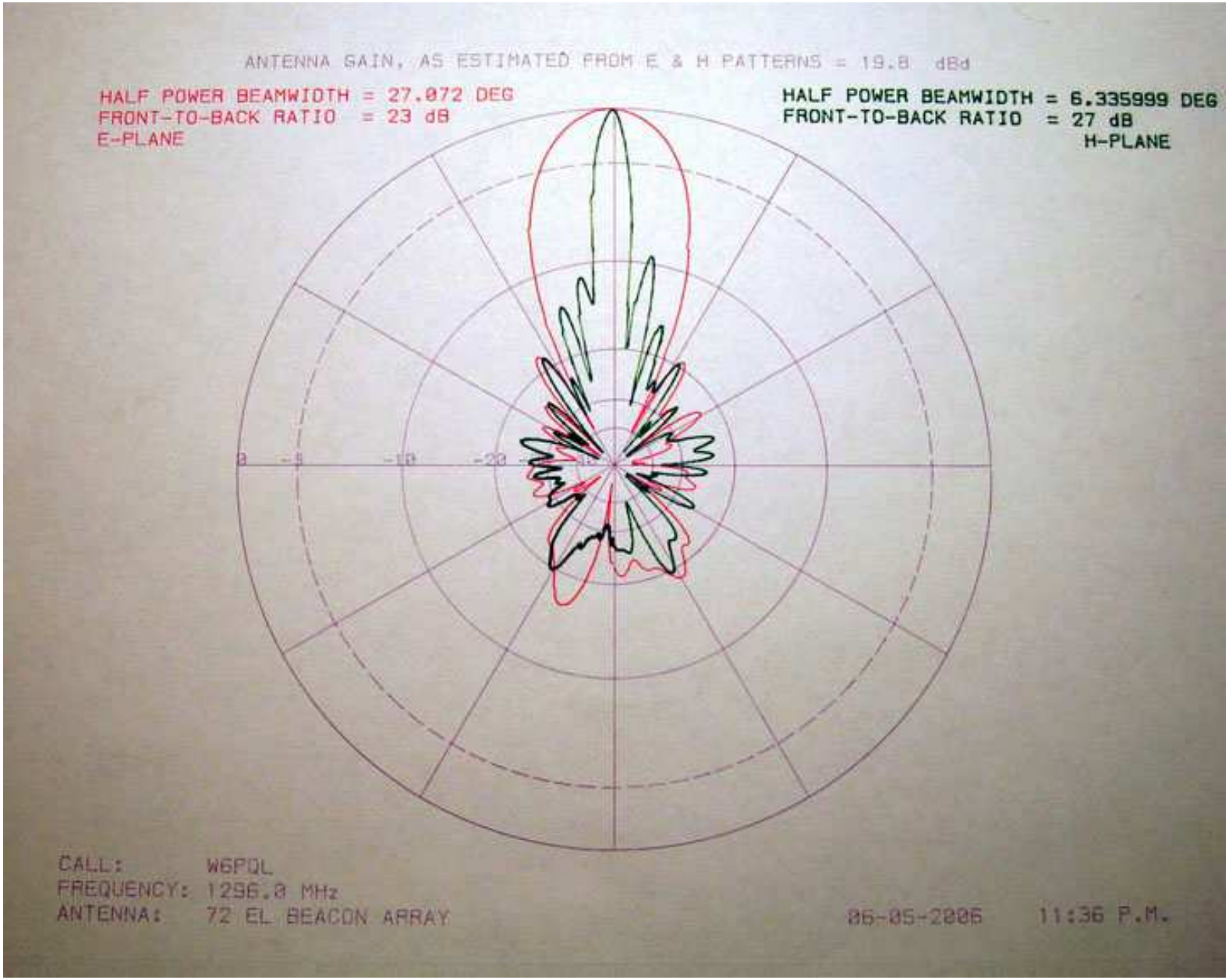


Fig 15—Stacking gain and sidelobe level versus normalized stacking distance (two antennas).

At .9 Dopt, The Pattern Is Very Clean




ANTENNA GAIN, AS ESTIMATED FROM E & H PATTERNS = 19.8 dBd
HALF POWER BEAMWIDTH = 27.072 DEG
FRONT-TO-BACK RATIO = 23 dB
E-PLANE
HALF POWER BEAMWIDTH = 6.335999 DEG
FRONT-TO-BACK RATIO = 27 dB
H-PLANE
0 -5 -10 -20
CALL: W6PQL
FREQUENCY: 1296.0 MHz
ANTENNA: 72 EL BEACON ARRAY
06-05-2006 11:36 P.M.

Did we Cover All These?

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- Would building a bigger antenna be better than stacking?
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