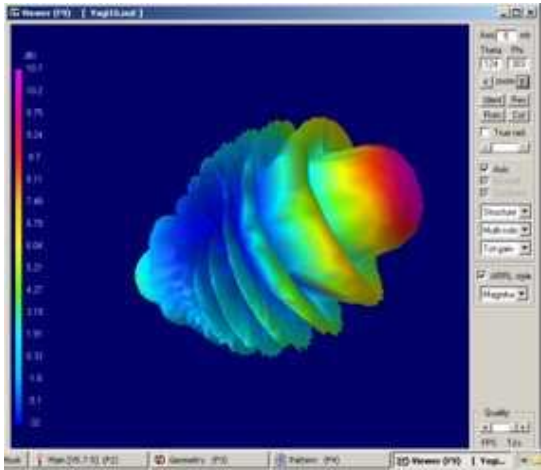
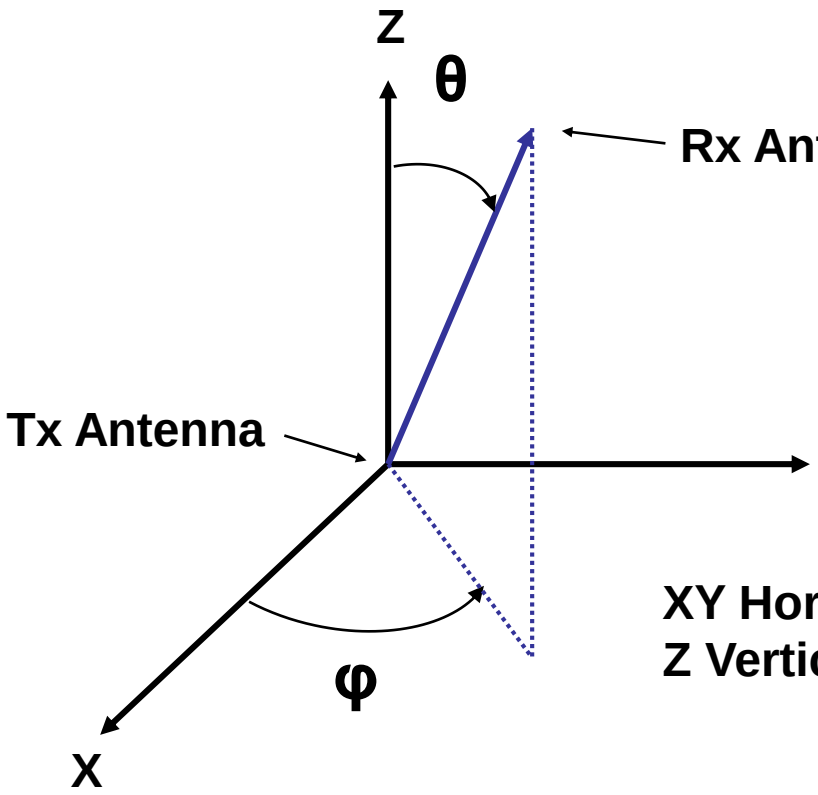
VE3KL Presentation
4NEC2
Antenna Simulator by Arie Voors

- Based on the NEC2/4 Fortran Kernel
- Uses the classic Method of Moments
- Models radiating wires, loads, ground, sources…….more
- Four Editors with extensive Math capabilities
- Smith Charts
- Optimizer
- ***Extremely powerful graphics capabilities***
- Free, users forum, updated frequently



Spherical Coordinate System



Elevation angle = 90 - θ

XY Horizontal Plane
Z Vertical axis

φ is the horizontal azimuth angle
Θ is the angle measured from vertical

Method of Moments

- A discrete numerical method
- Divide wires into many segments…25 per wavelength
- Apply Coulomb's Law and match boundary conditions
- Solve large matricies
- EE Students usually solve the 3D Capacitor Problem

3D Capacitor Example

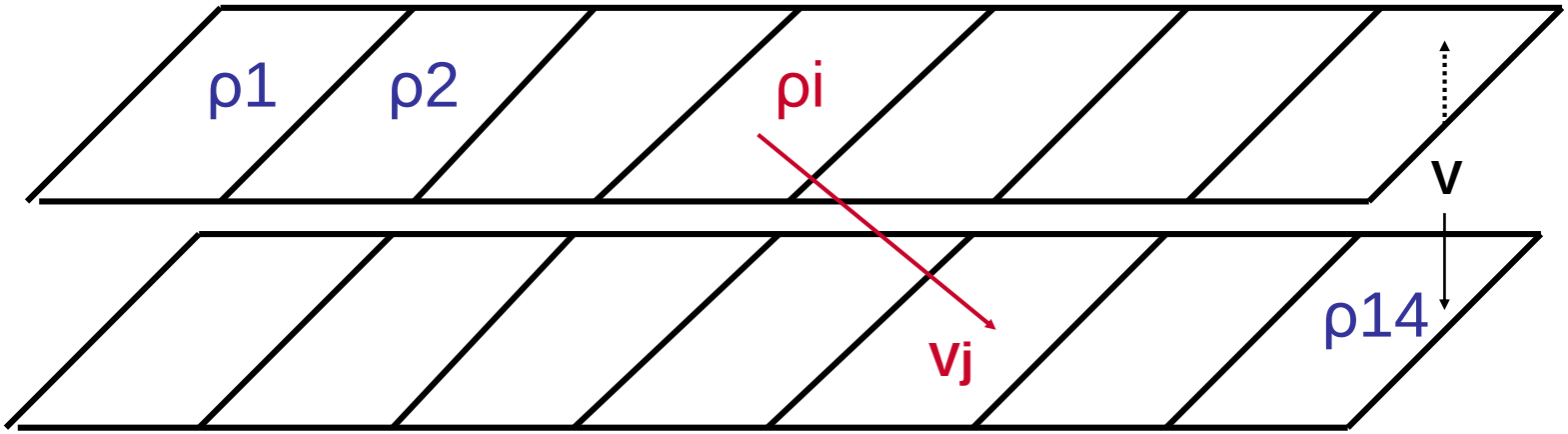
Divide plates into 14 segments

Assume each plate has a point charge, ρi…not equal

Apply a voltage V across the plates

Write Coulombs Law for each charge > 14 by 14 Matrix

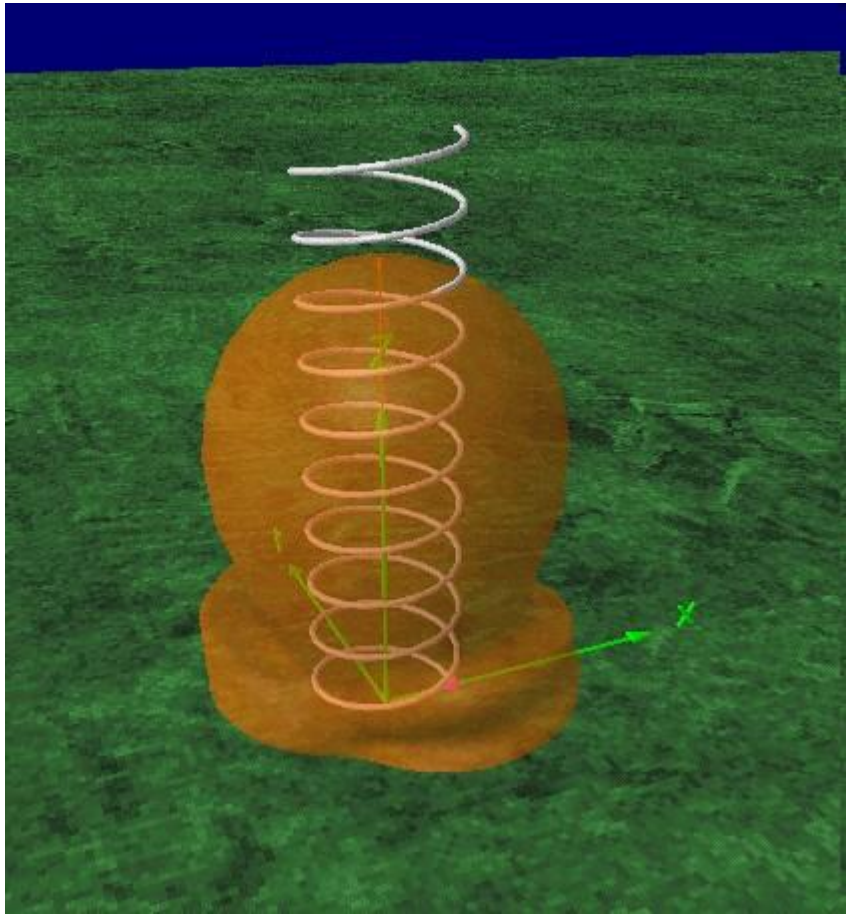
Solve for charge by matrix inversion



ρ1>ρ2 .. Charge piles up at edges

4NEC2
Super Graphics

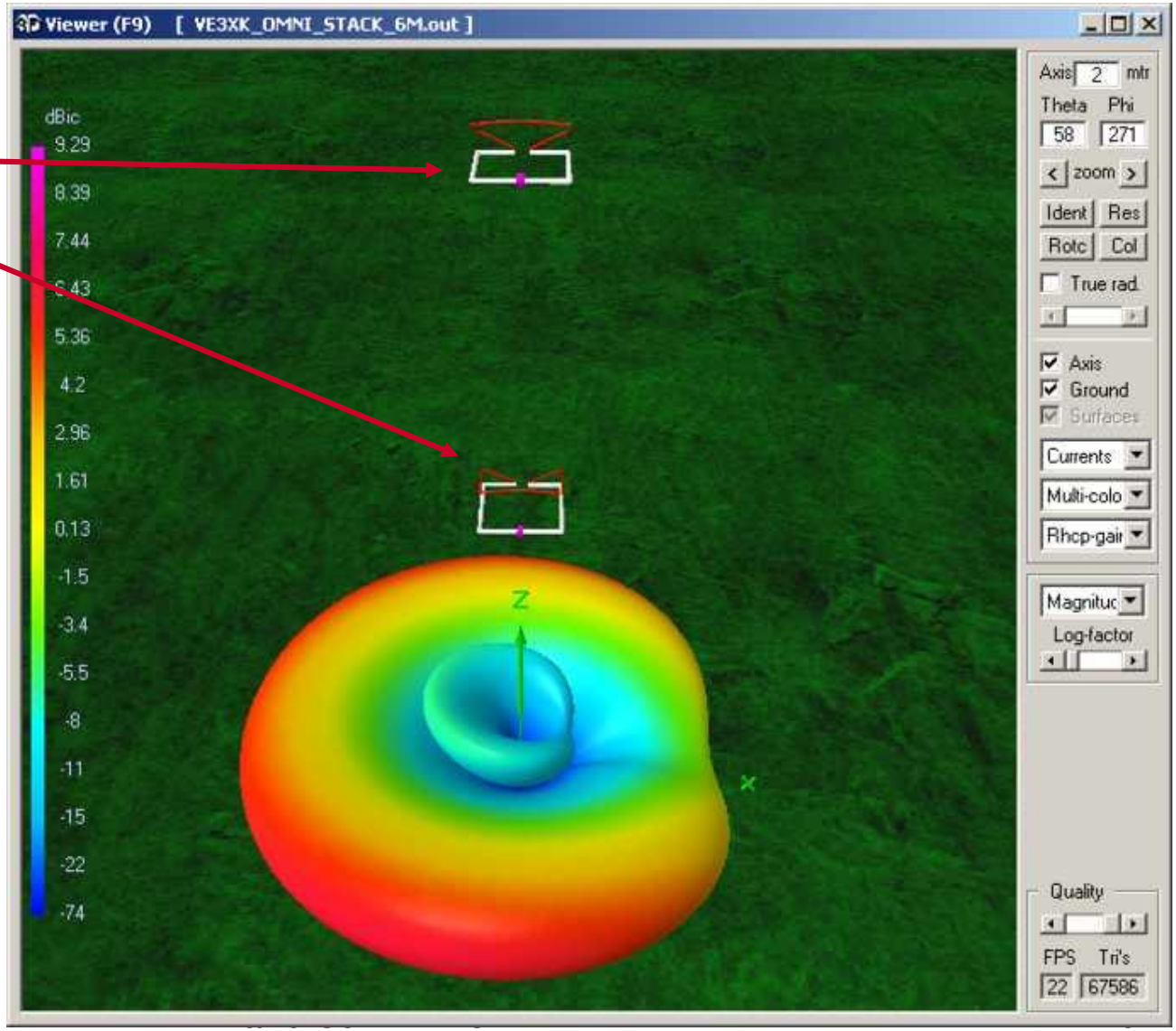
Helix Antenna
Vertically Oriented



3D VE3XK 50 MHz Stack

50 MHz OMNI Source Side Along X Axis

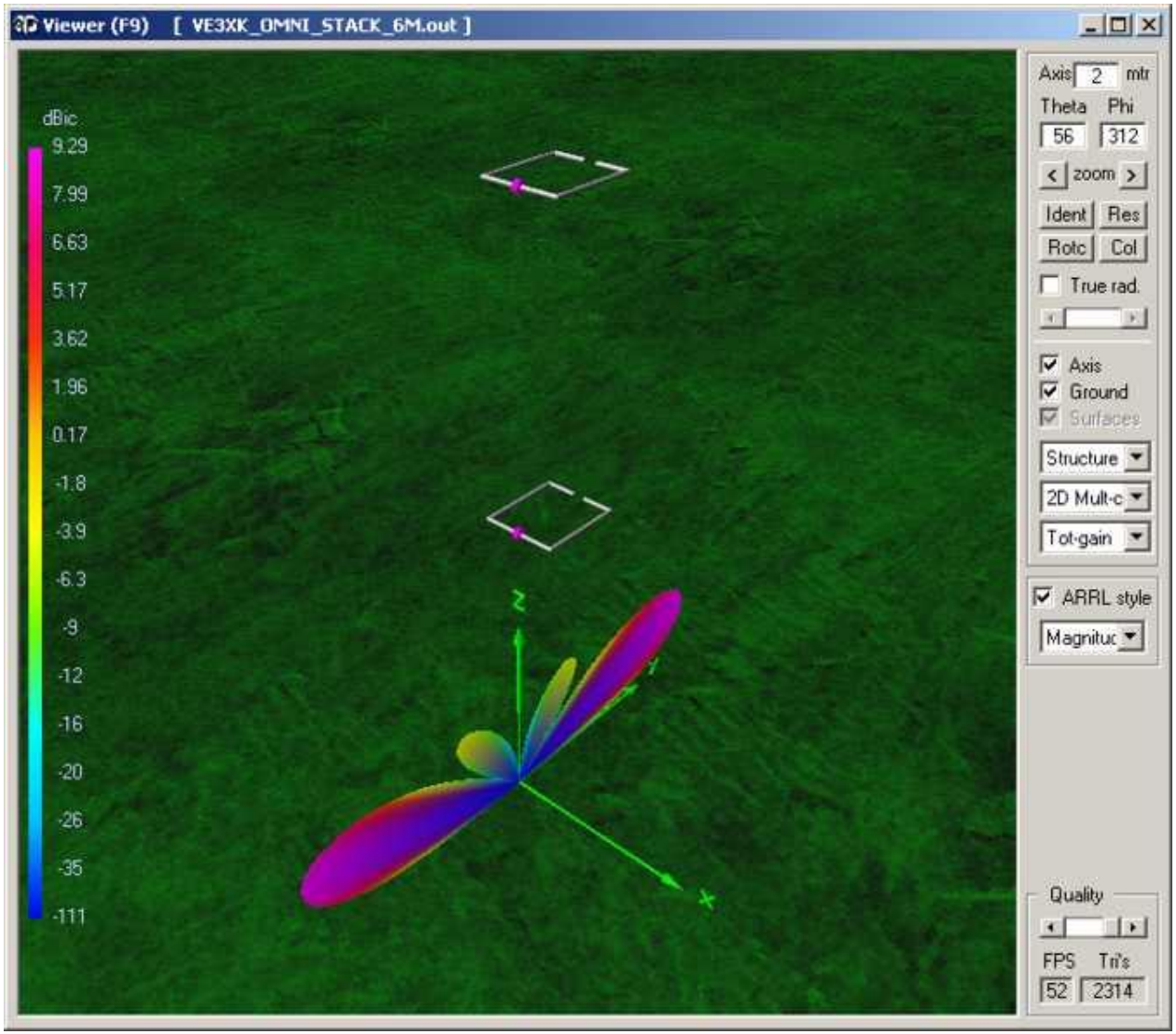
Right Hand Circular Polarization Shown



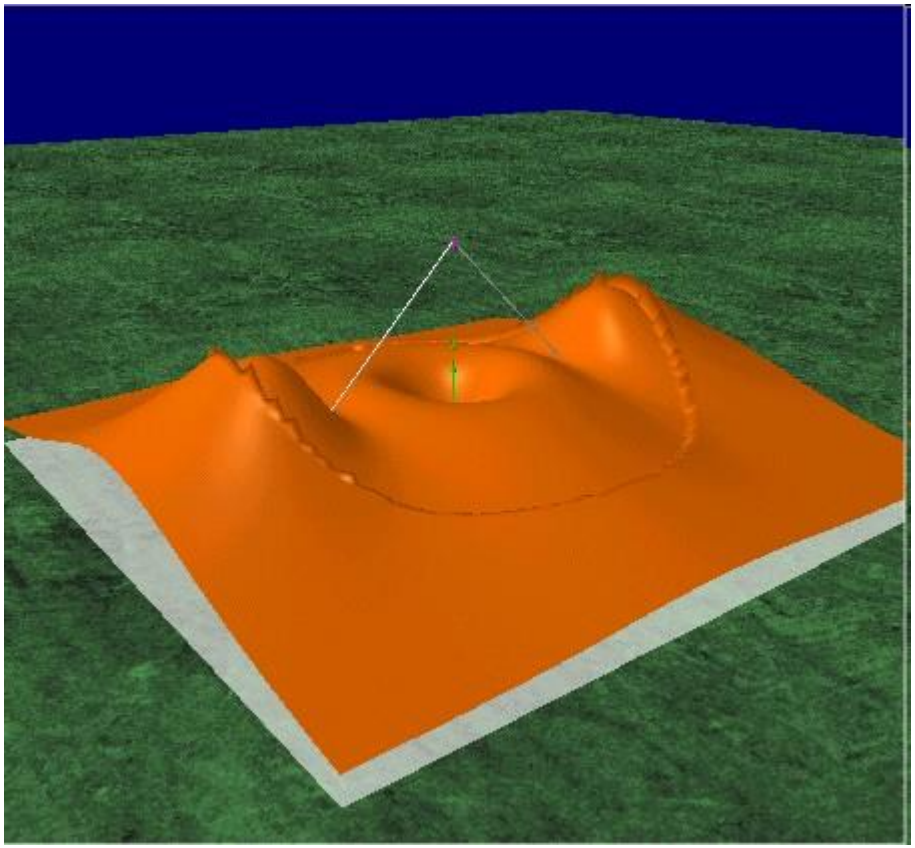
2D VE3XK 50 MHz Stack

50 MHz OMNI Source Side Along X Axis

Total Gain Shown

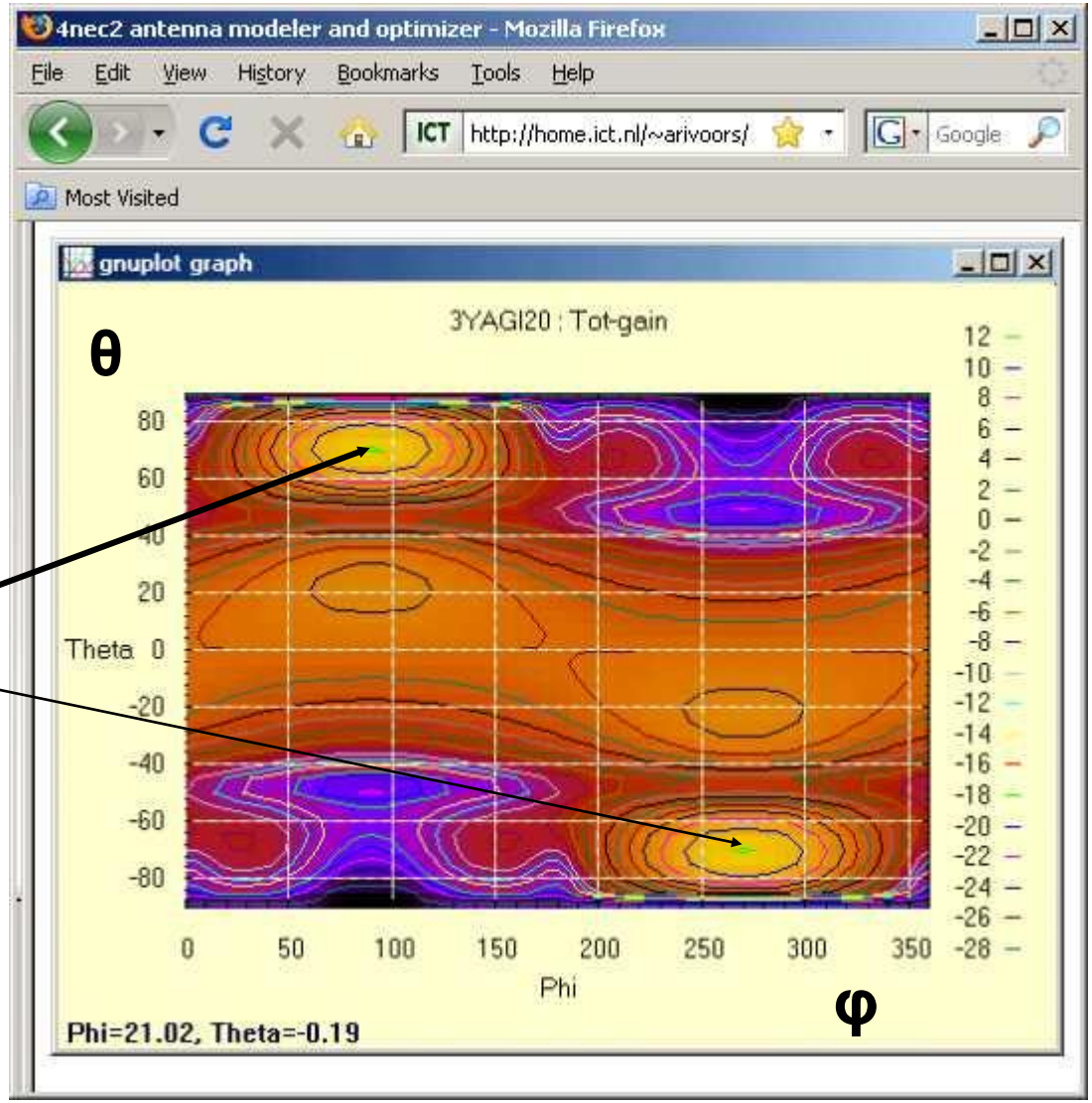


4NEC2
3D Near Field



4NEC2
Advanced Far Field Map

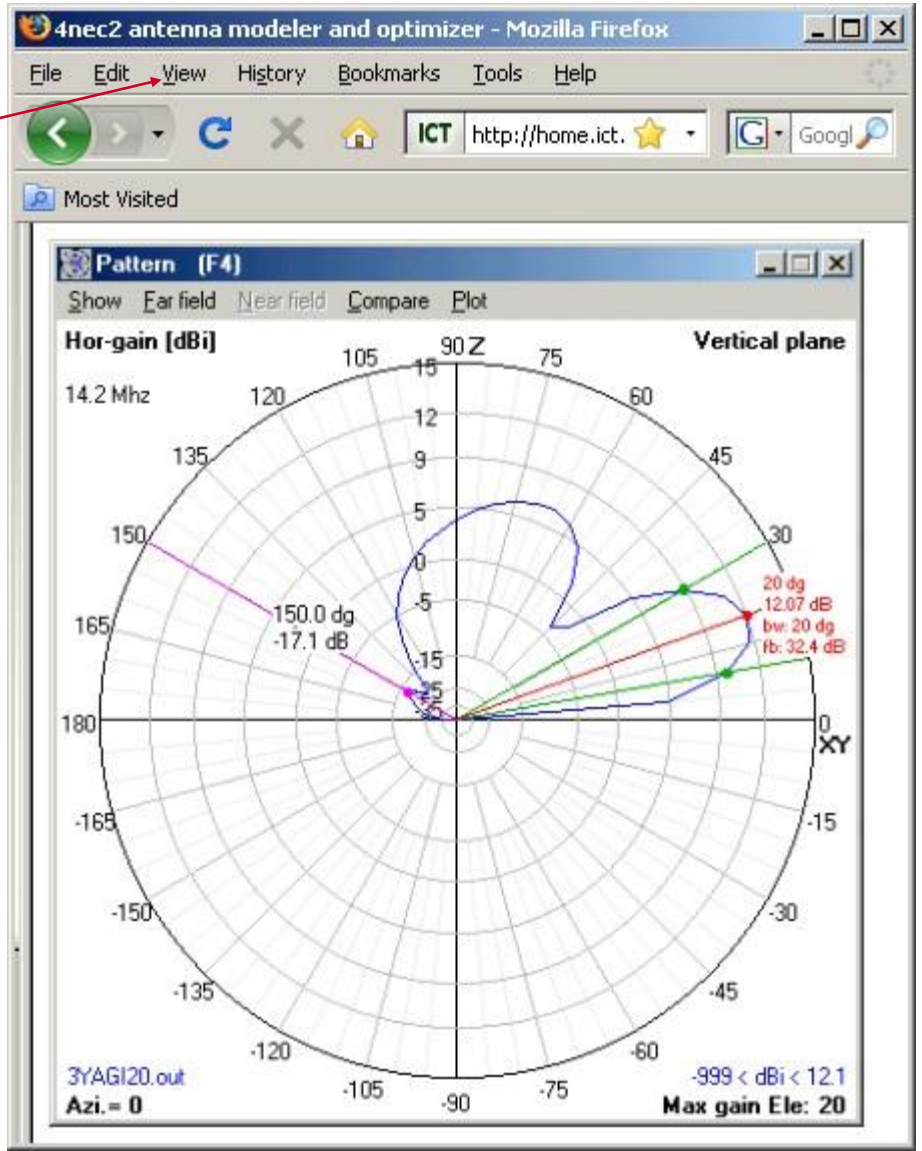
High Gain



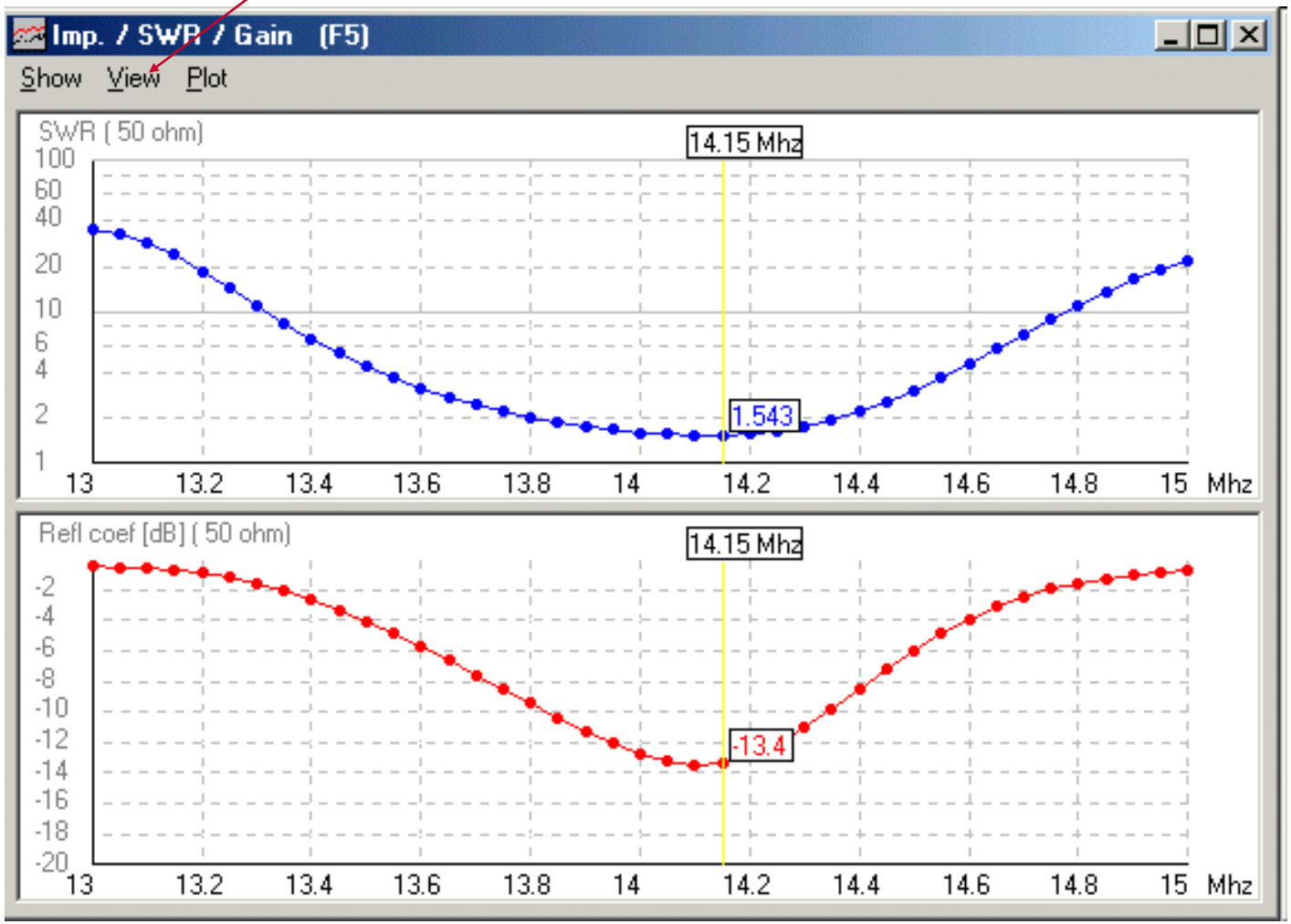
4NEC2
Far Field Traditional Plot

Several Views

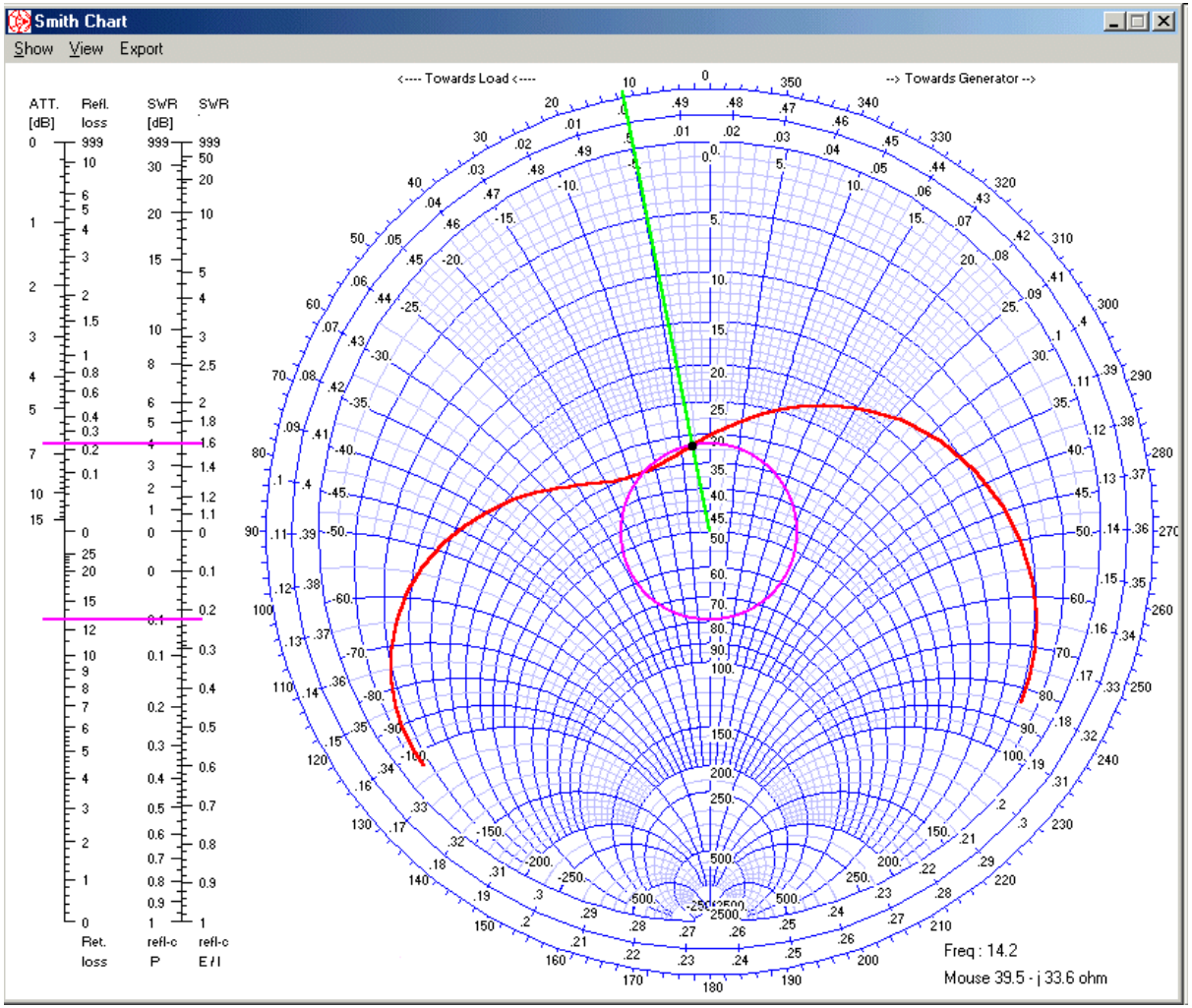
- **Vertical, Horizontal, Total**
- **Circular Polarization**
  RHC, LHC, Total



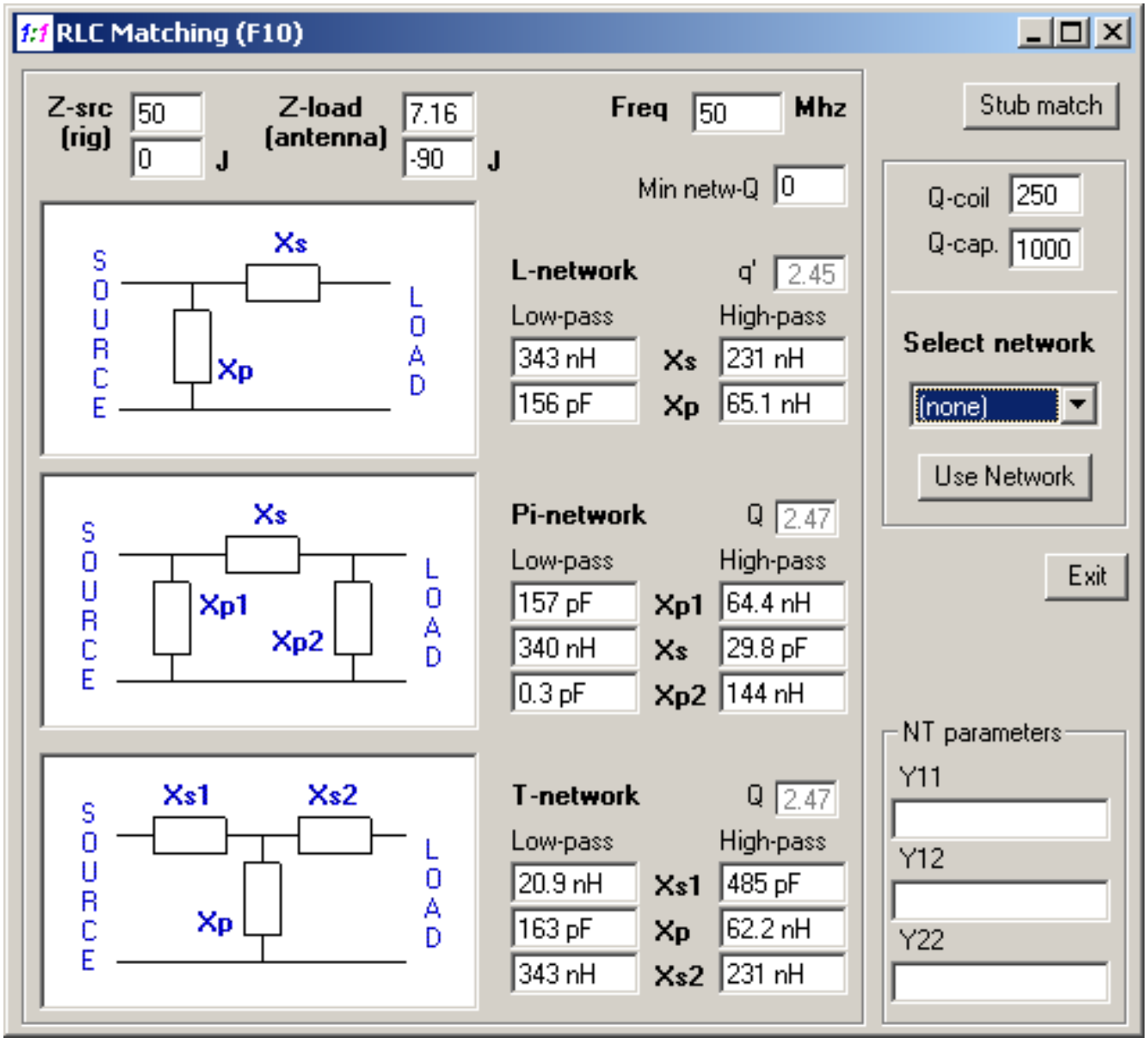
4NEC2
Several Views of Frequency Response



4NEC2
Smith Chart

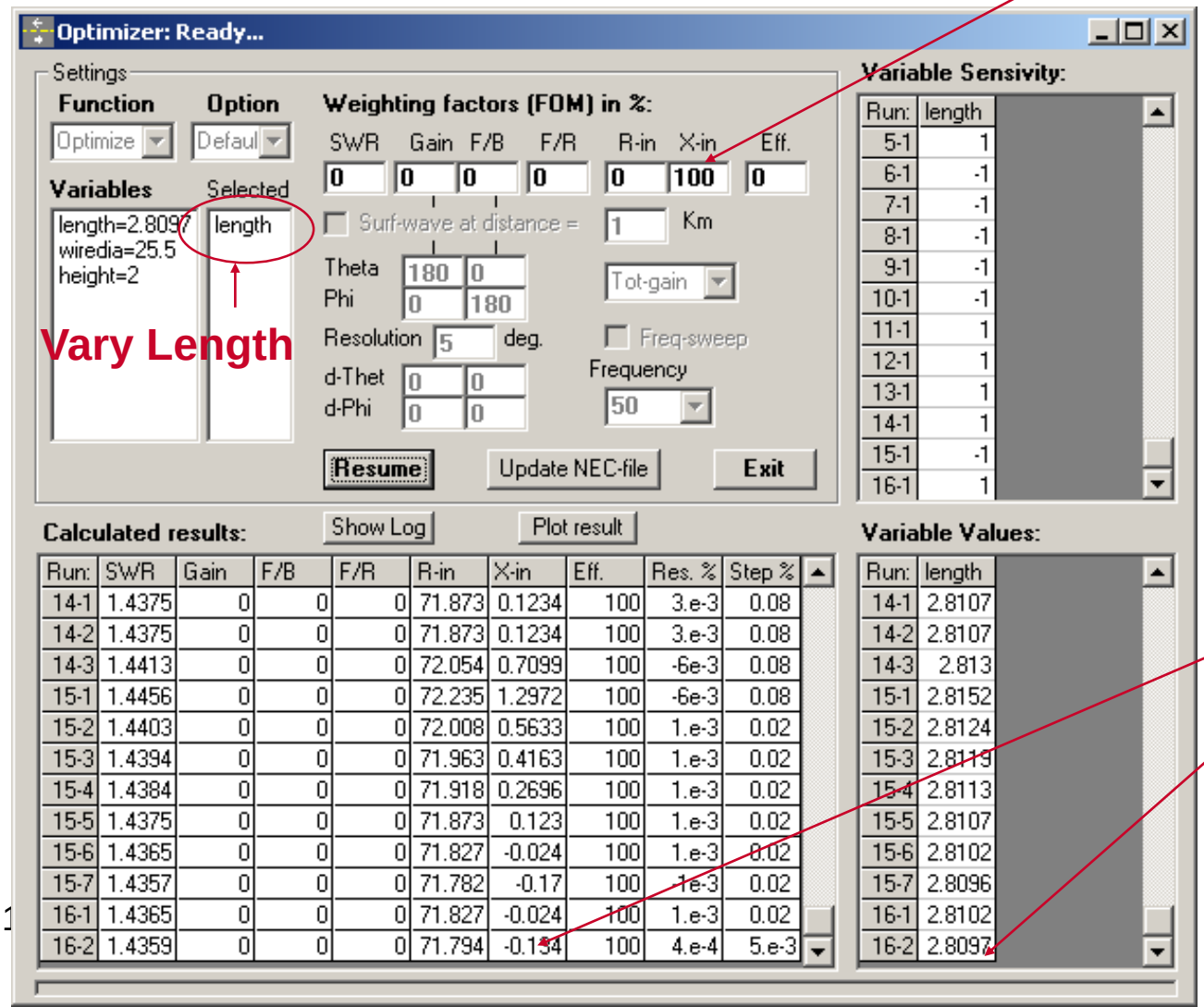


Matching


RLC Matching (F10)
Z-src (rig)
50
0
J
Z-load (antenna)
7.16
-90
J
Freq
50
Mhz
Stub match
Min netw-Q
0
Q-coil
250
Q-cap.
1000
Select network
(none)
Use Network
Exit
Xs
Xp
SOURCE
LOAD
L-network
q'
2.45
Low-pass
High-pass
343 nH
Xs
231 nH
156 pF
Xp
65.1 nH
Xs
Xp1
Xp2
Pi-network
Q
2.47
Low-pass
High-pass
157 pF
Xp1
64.4 nH
340 nH
Xs
29.8 pF
0.3 pF
Xp2
144 nH
Xs1
Xs2
Xp
T-network
Q
2.47
Low-pass
High-pass
20.9 nH
Xs1
485 pF
163 pF
Xp
62.2 nH
343 nH
Xs2
231 nH
NT parameters
Y11
Y12
Y22

4NEC2..The Big Gun (Optimization)
Optimize (Tune) a 2 metre dipole to 6 metres

Adjust reactance to zero



Results

L= 2.8 metres

Xin = -0.13 Ohms

Optimization Issues

- An extremely complex and active field of study
- Local minimum vs. global minimum .. Optimizer gets trapped
- Poorly defined problem by the user .. Optimizer loops forever
- Type of Objective function

minimum ..	for science and math people
good enough ..	for engineers
constrained values ..	for engineers

- Can be difficult for beginners

- Example: An optimizer might set the antenna length to infinity!

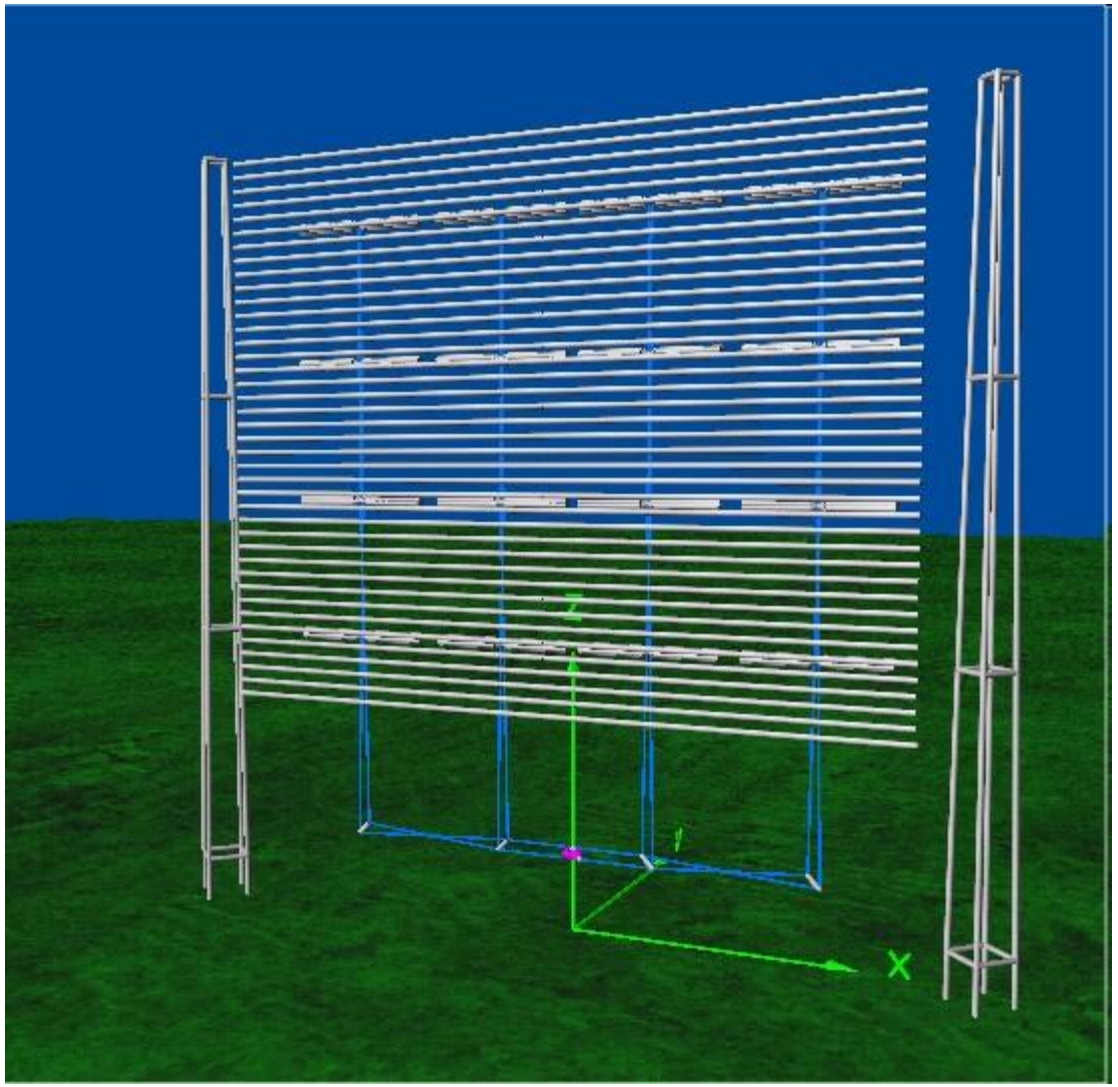
Using the Editors

Define the wires and axis

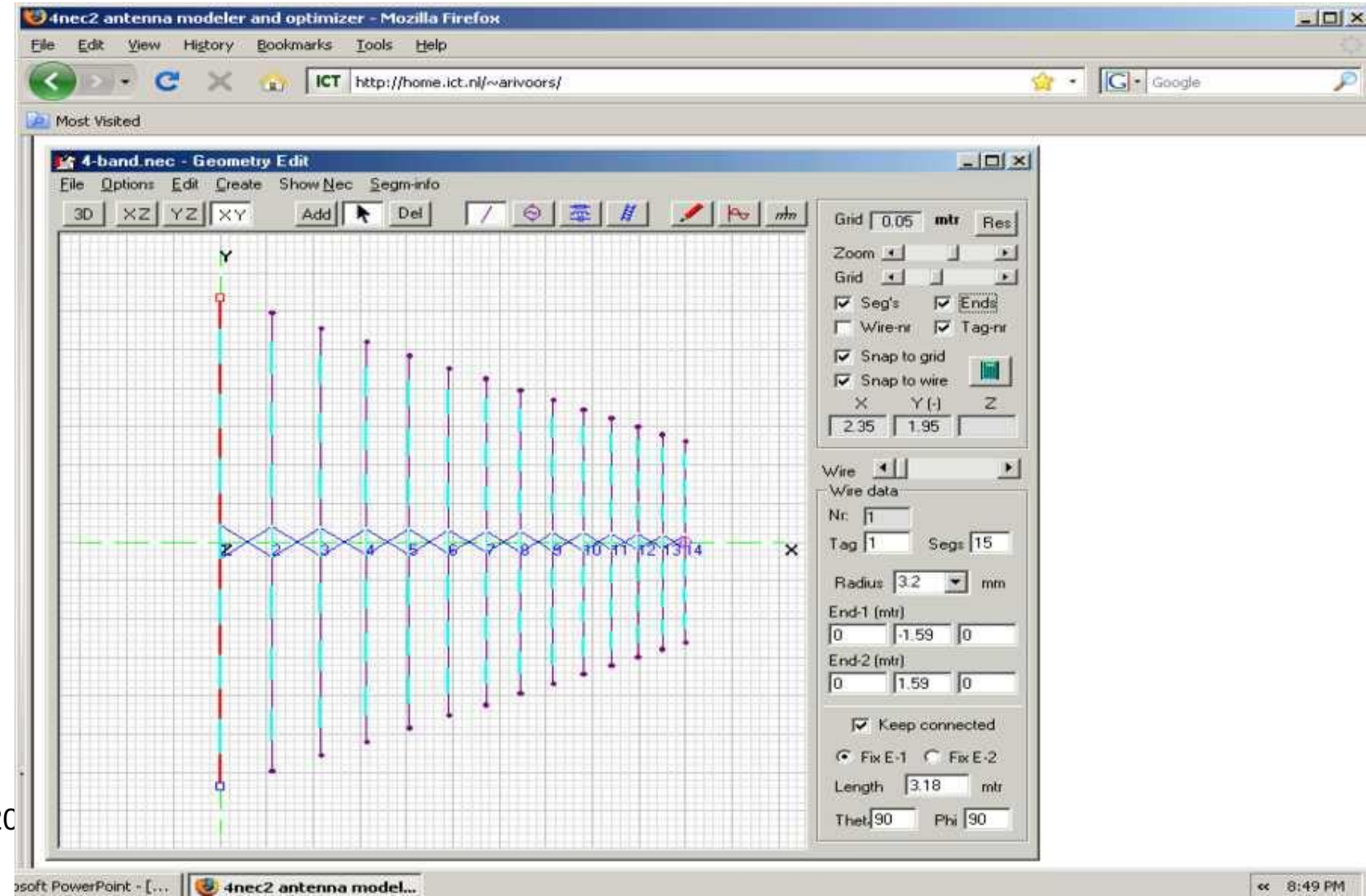
Define the Voltage Sources

Define the Ground Type if any

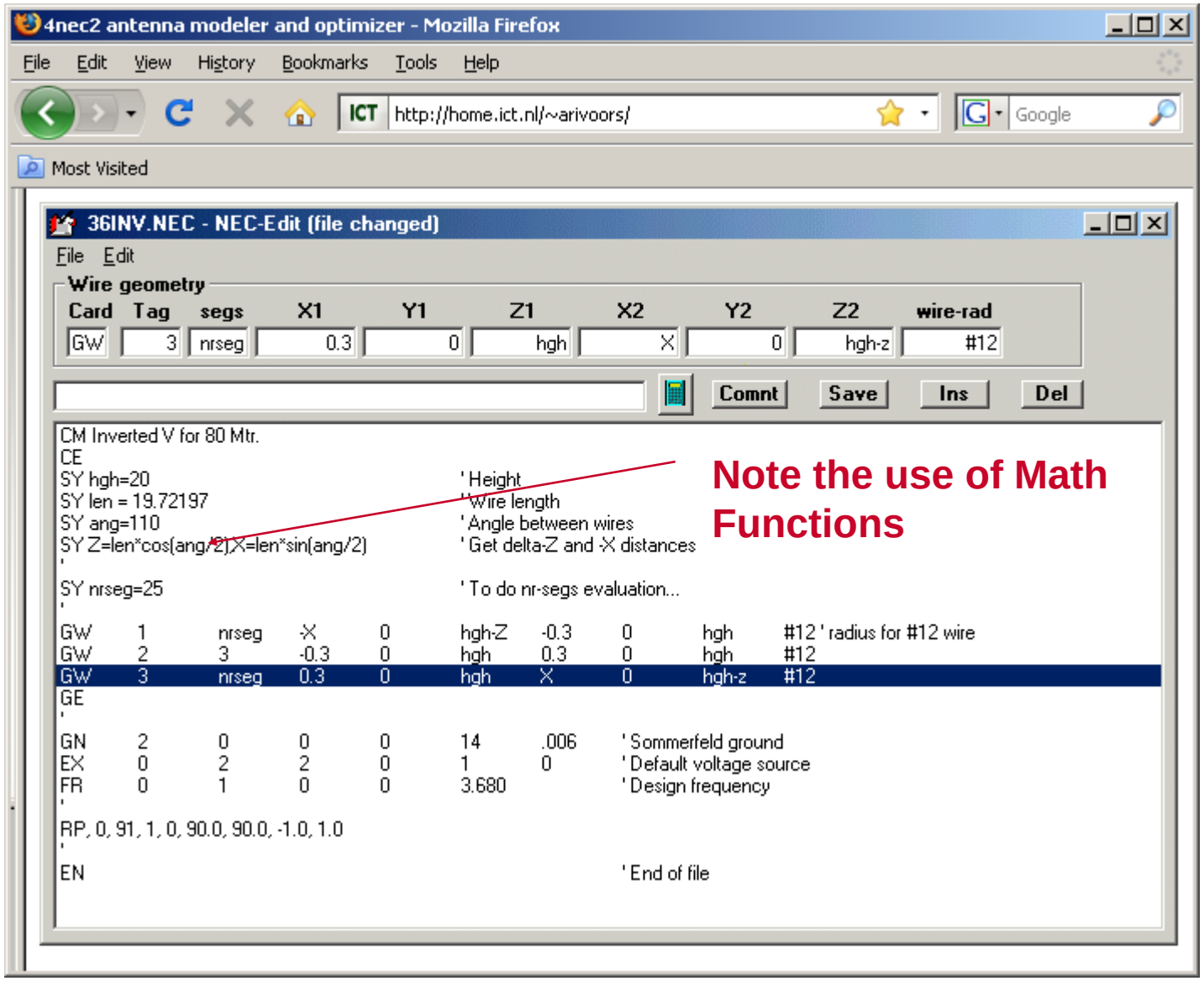
Define R,L,C, Transmission Line components



4NEC2
Graphical Editor for Beginners



4NEC2 NEC Editor to Describe the Antenna



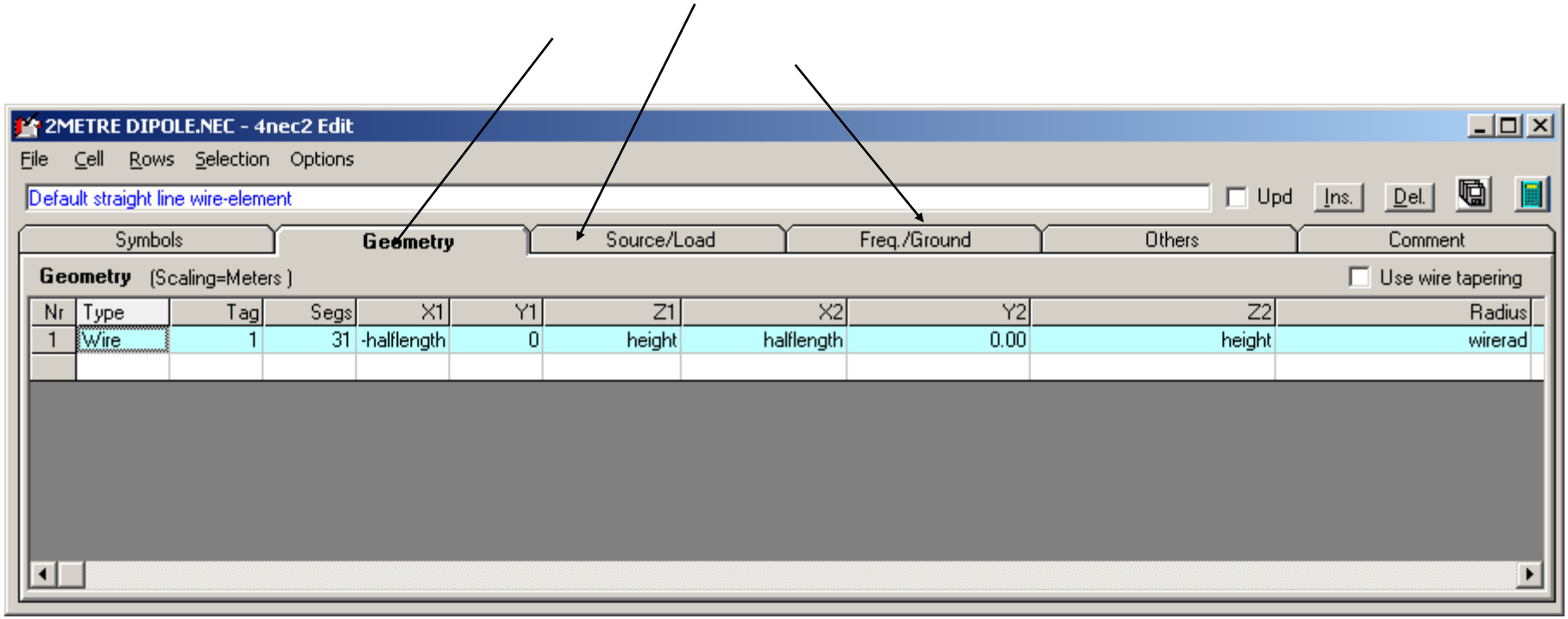
Simple Text Editor

Best for Computer Defined Antennas

```
'VE3XK OMNI 6 metres..stack
SY height=3       'height in metres
SY Freq=50.0      'freq in MHz
SY B=0.3556       'metres
SY C=0.8128       'metres
SY D=0.29845      'metres
SY rad=3.17e-3    'metres
SY spacingWave=0.5      'spacing in
wavelengths
SY spacing=spacingWave*300/freq
          'spacing in metres
GW        1         21        -B        0
          height    B         0.00      heigh
          height+spacing      rad
GW        8         21        B         C
          height+spacing      B-D       C
```

A New Windows Menu Type Editor

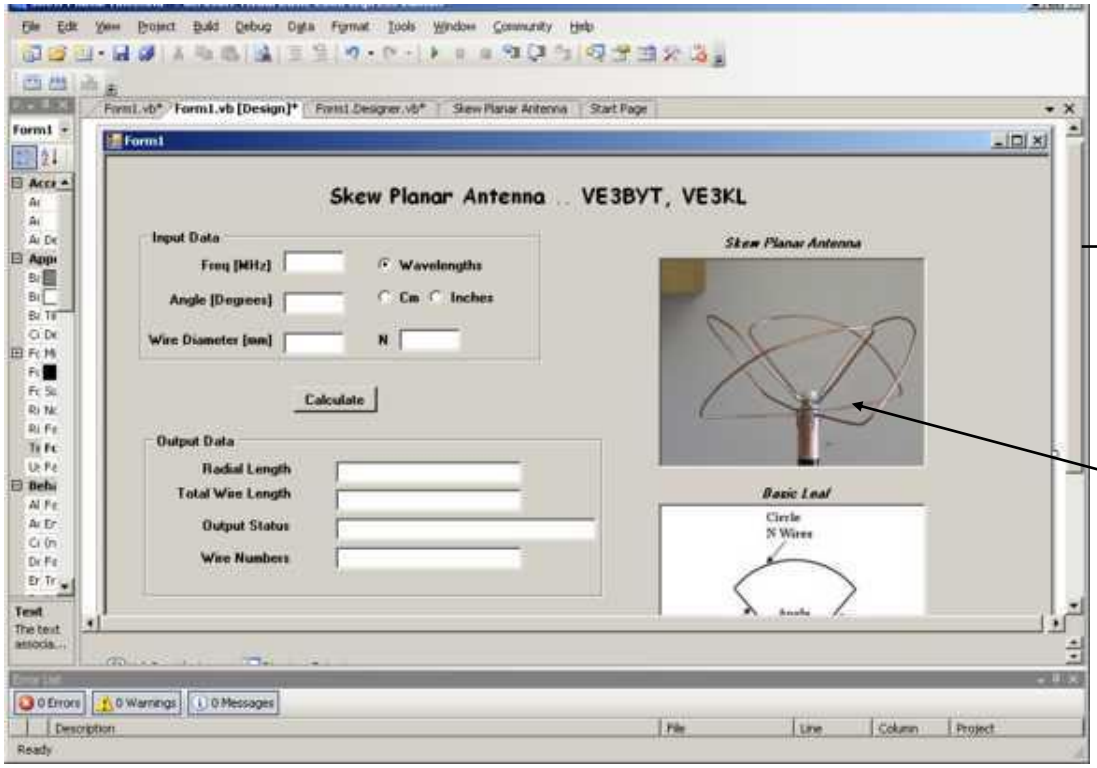
Menu Bar on top allows user to define files rapidly



Geometry Menu Open in this example

Editing Big Antennas..500 Segments Complex Geometry

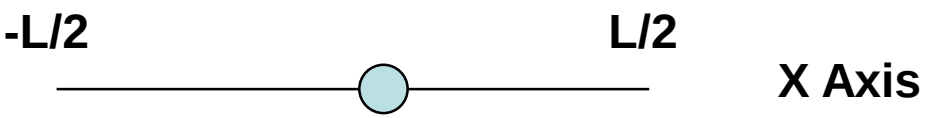
- **Use VB.Net or C#.net to drive the editors.**



4NEC2 Text Editor

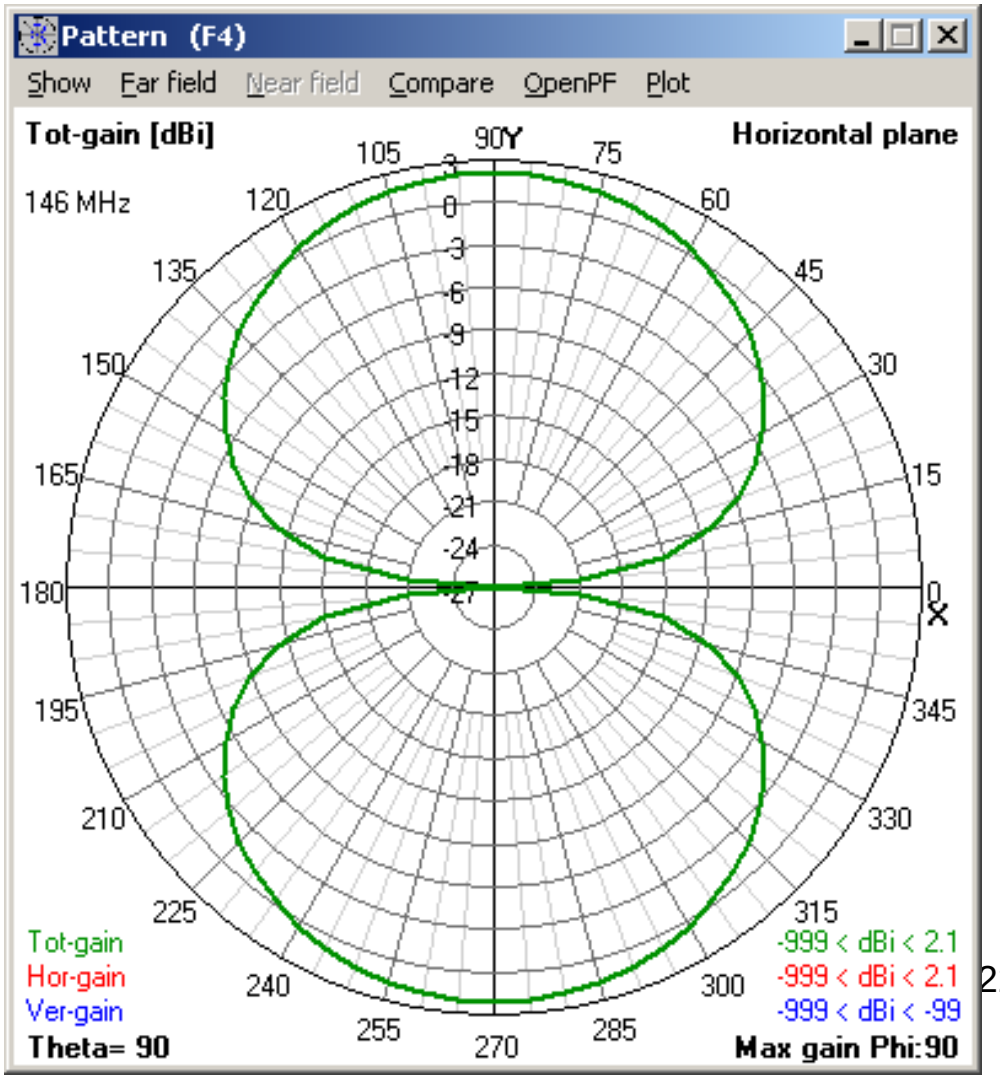
VB.net Program Skew Planar Antenna

Examples "Simple" 2m Dipole Free Space

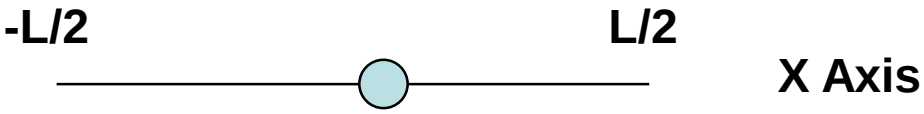


Horizontal Plane
Theta = 90 degrees
Horizontally Polarized
No Vertical Component

(No surprises Here!)

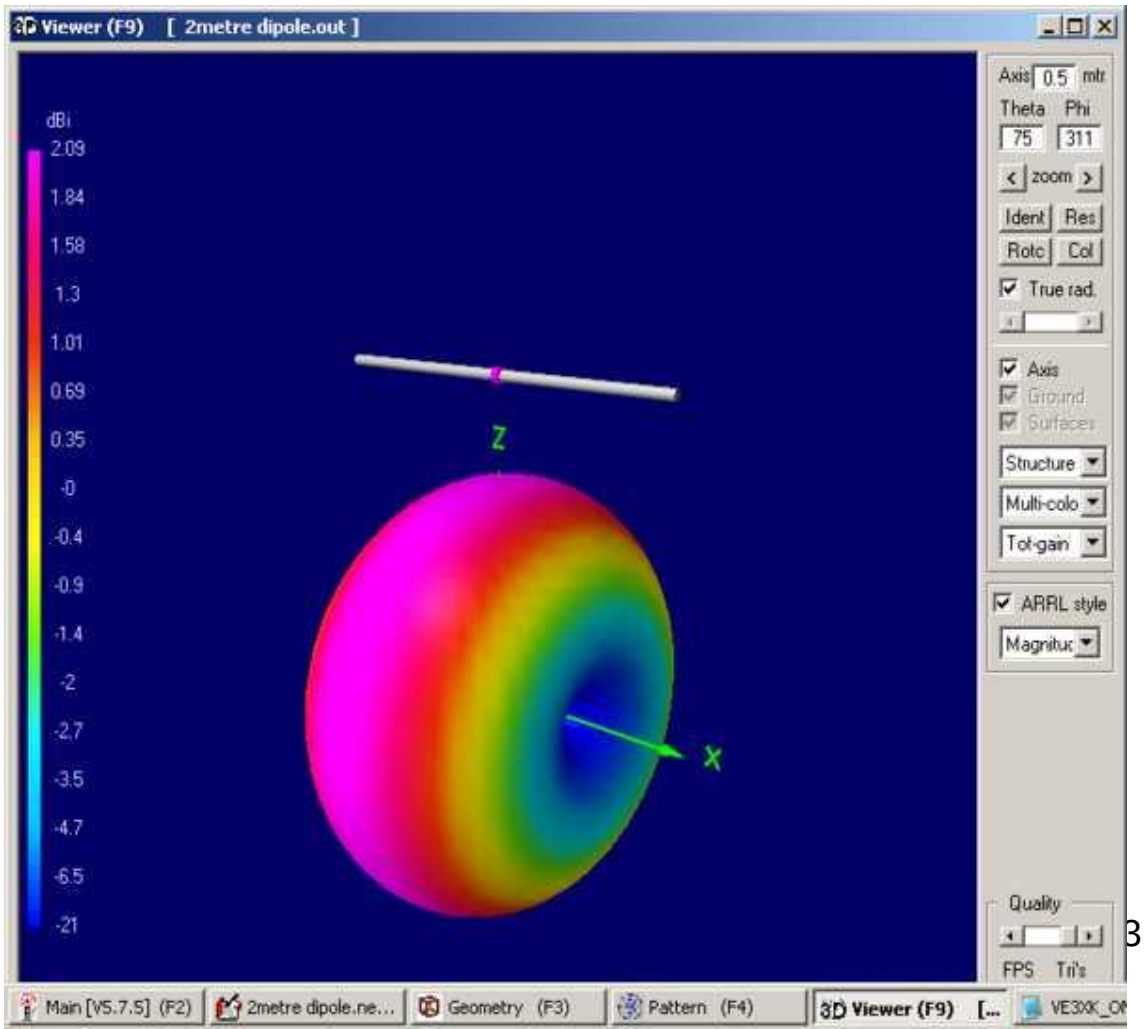


Examples "Simple" 2m Dipole Free Space

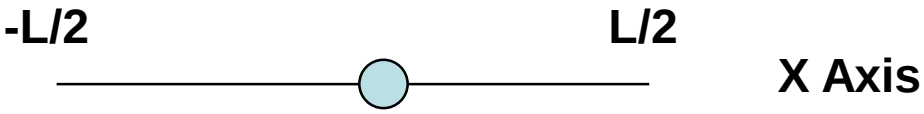


Horizontal Plane
Theta = 90 degrees
Horizontally Polarized
No Vertical Component

(No surprises Here!)



Examples..Simple 2m Dipole

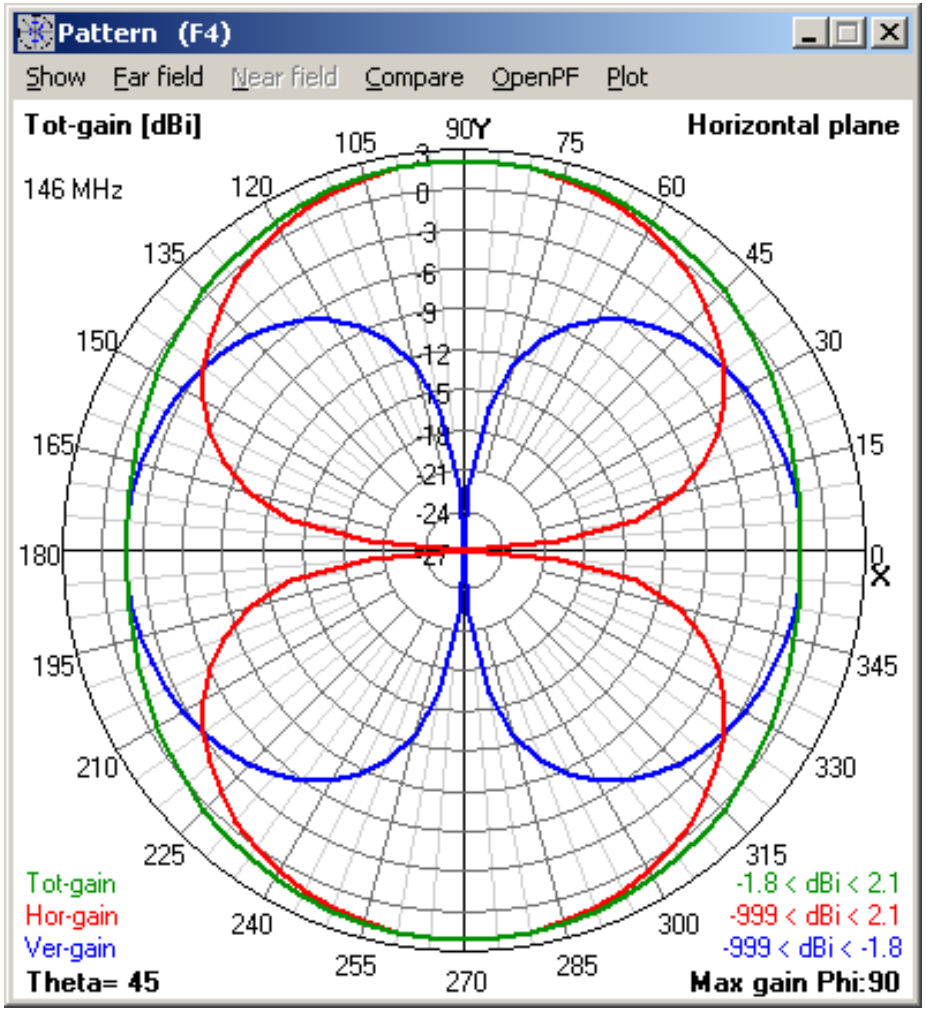


Horizontal Plane

BLUE :Vertical E Field
RED: Horizontal E Field
Green: Total Field

Theta = 45 degrees

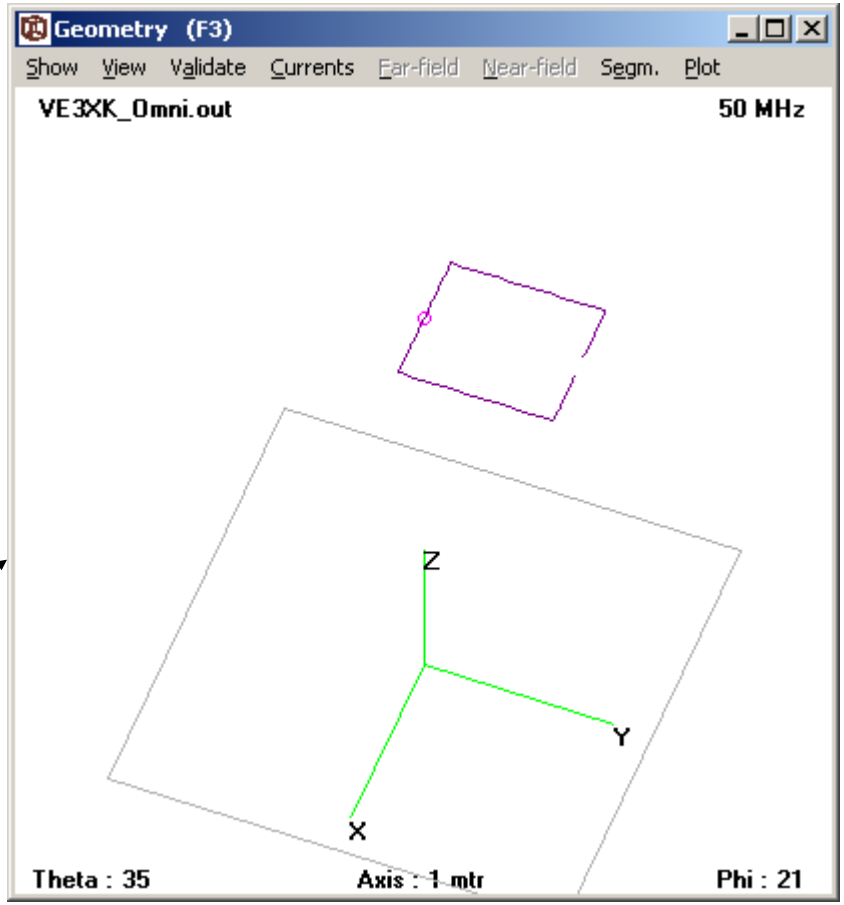
(Is it OK to say that a dipole is Horizontally Polarized?)



50 MHz Horizontal OMNI

Geometry
Source side on X axis
Horizontally Mounted

Geometry Window



50 MHz Horizontal OMNI Pattern

Horizontal Plane
Showing Circular Polarization
Blue RHCP
RED LHCP
Green Total

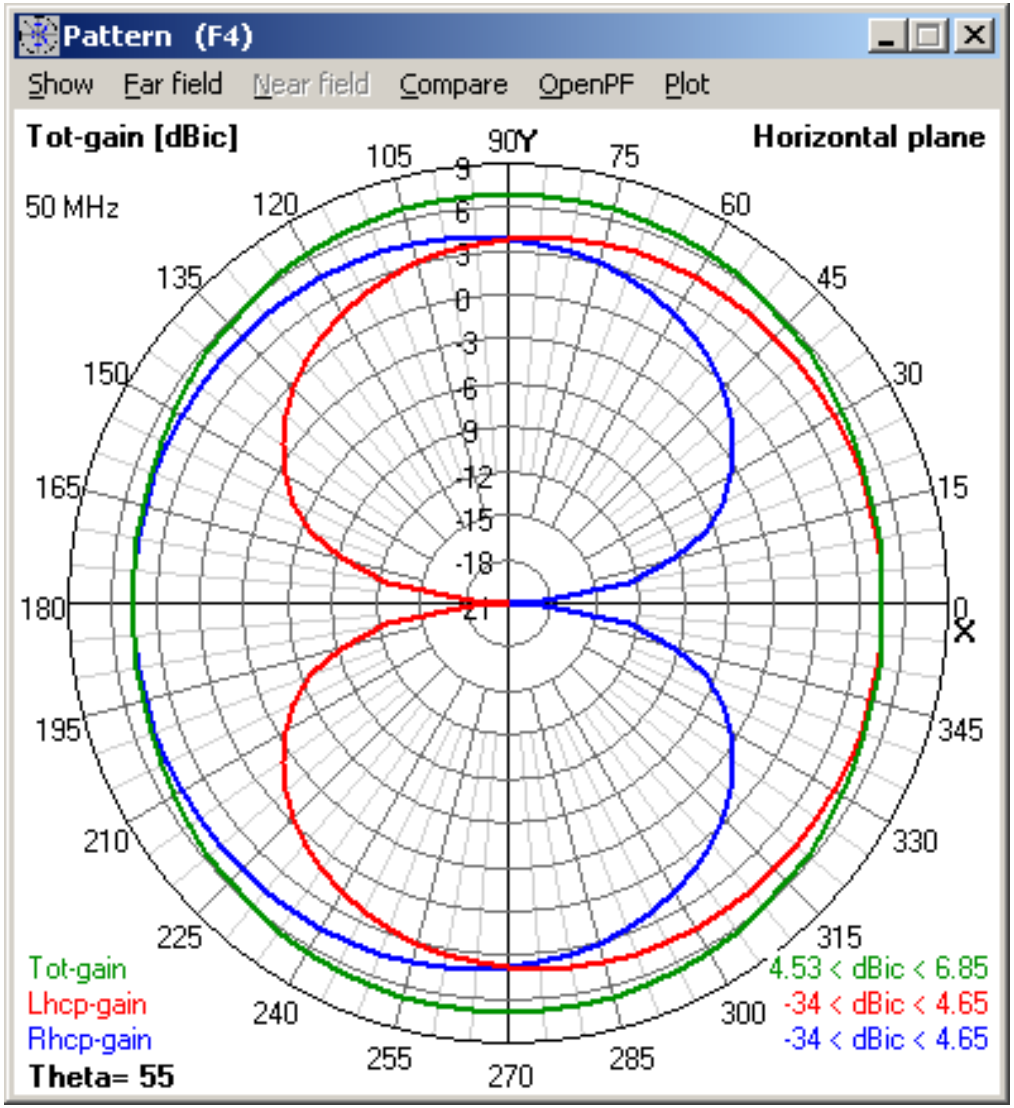
Nearly Omni Directional

Circular Polarization on X axis

Linear Polarization on Y axis

Note the Red/Blue Cardioids

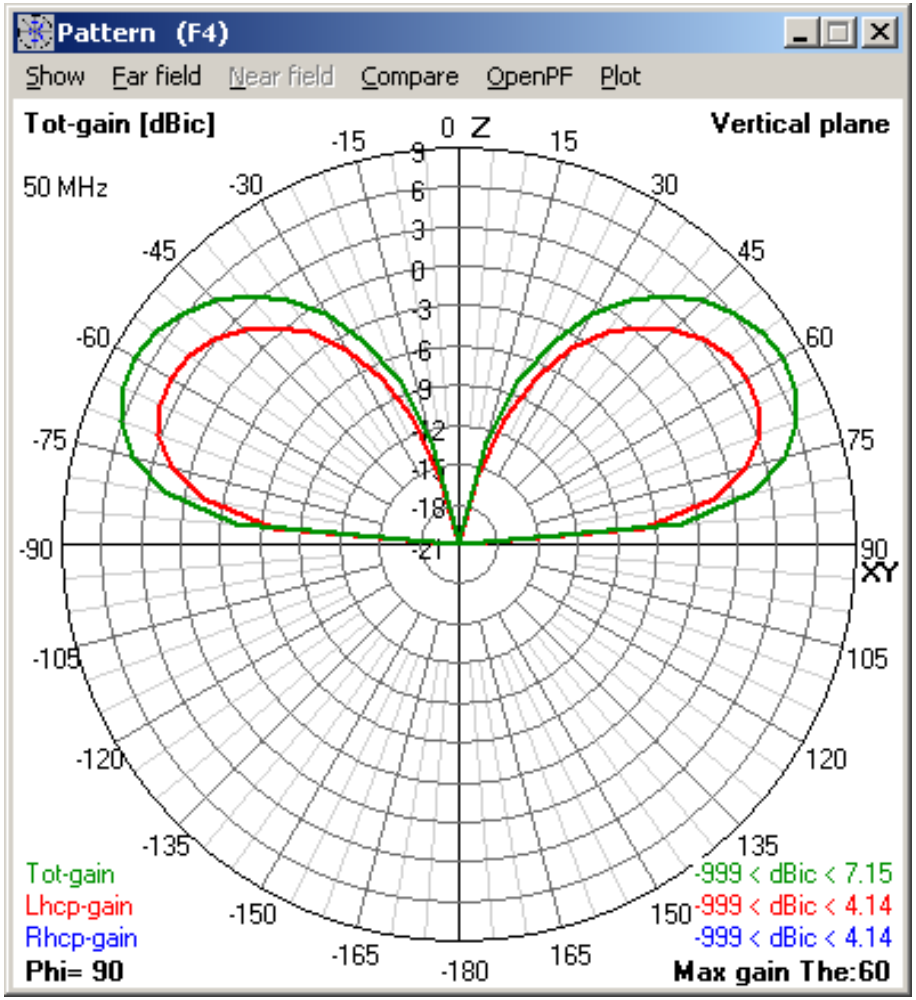
θ = 55 Degrees



50 MHz Vertical OMNI Pattern
Height = 3 metres

Vertical Plane
Linearly Polarized
Takeoff angle 30 deg
Max Gain = 7.15 dBi

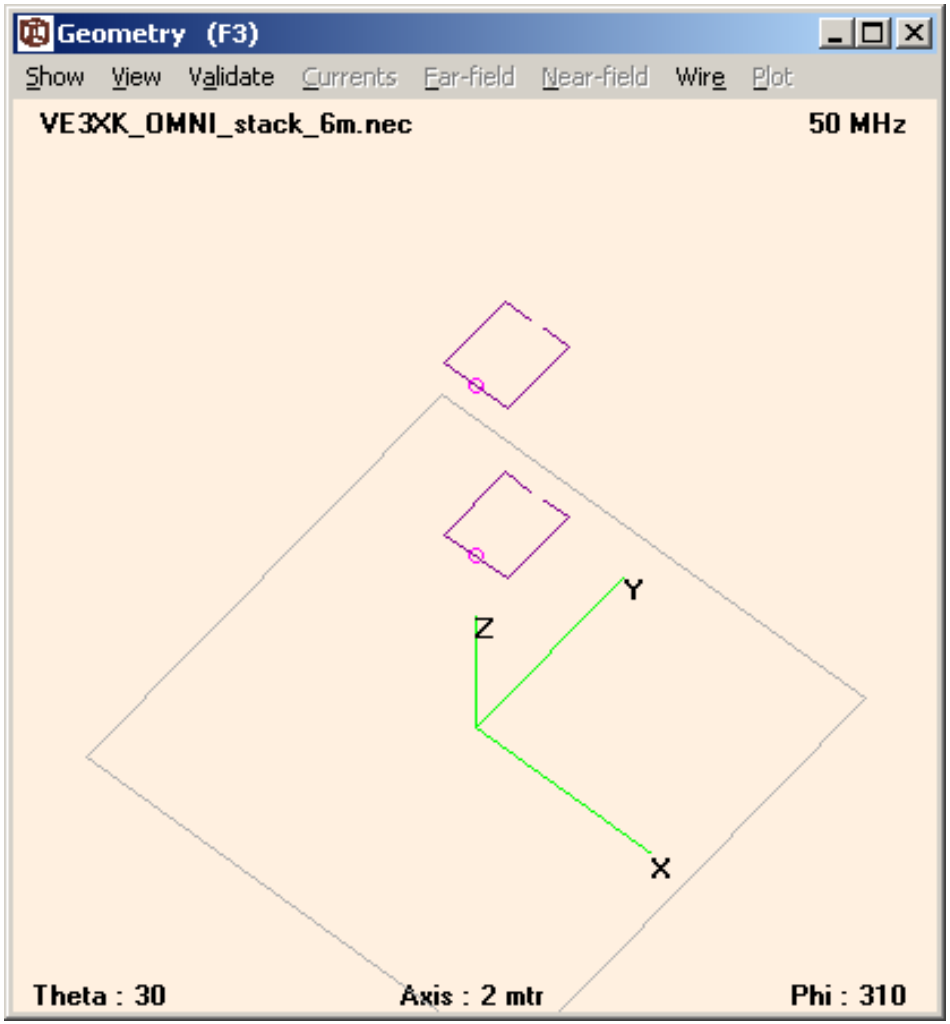
θ = 90 Degrees



50 MHz OMNI Stack

Same Orientation as Single Element

Height = 3 metres
Spacing = 0.5 wavelengths



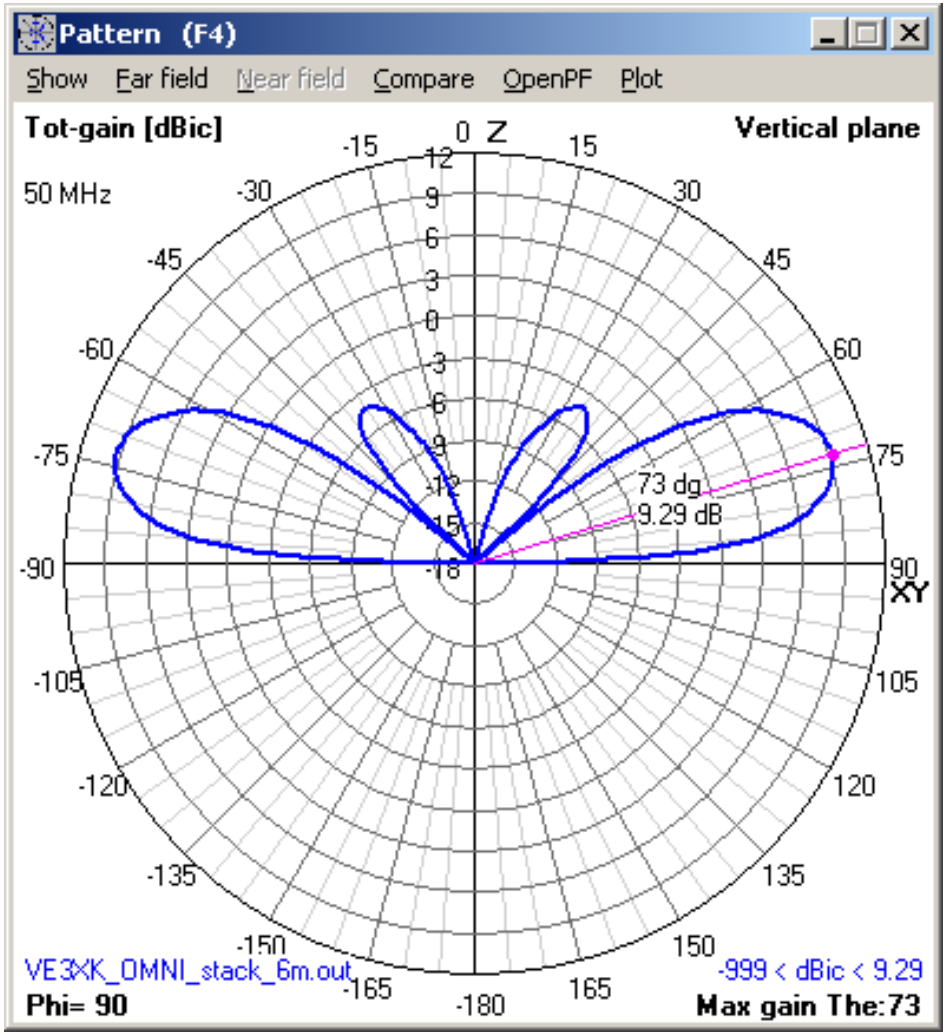
50 MHz OMNI Stack Vertical Plane

Same Orientation as Single Element

Height = 3 metres
Spacing = 0.5 wavelengths

Gain Increased to 9.29 dBi
Take off angle now 15 degrees

Some high angle side lobes.



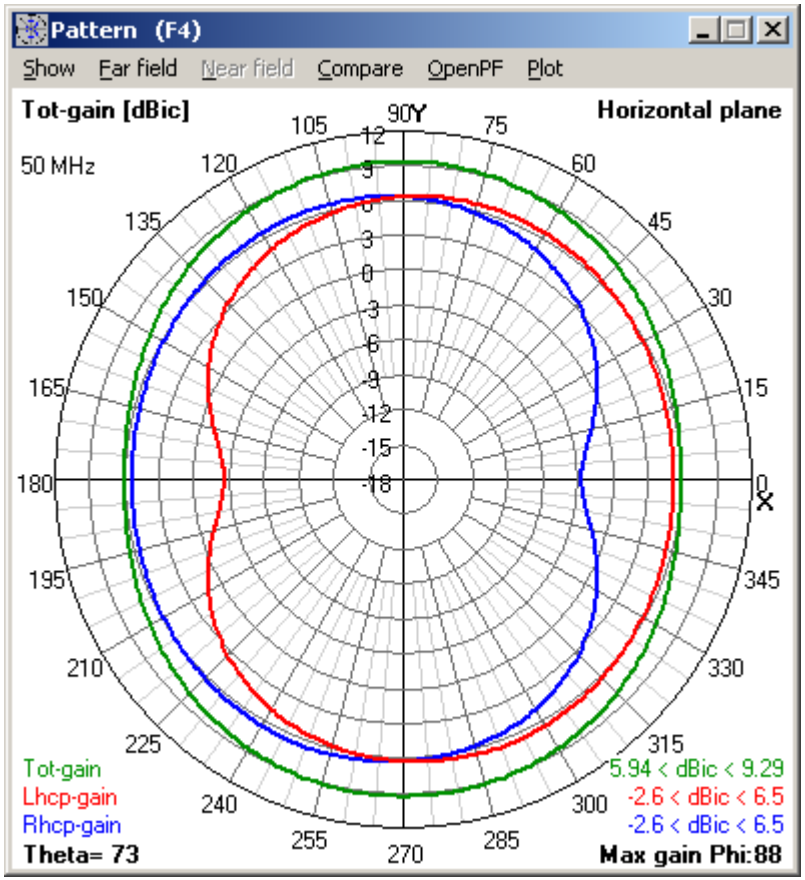
50 MHz OMNI Stack Horizontal Plane

Same Orientation as Single Element

Height = 3 metres
Spacing = 0.5 wavelengths

Circularly Polarized along the X axis

Θ = 73 degrees



Summary

- **Uses NEC2 or NEC4 Engine**
- **Contains an Optimizer**
- **Outstanding Graphics capability**
- **Uses four different editors**
- **Many features not covered in this talk**

Fundamental Wave Reflection Talk Available

73 Dave VE3KL