Microstrip Antenna Size Reduction Using Slots

Dr. Marv Ryken
NAVAIR NAWCWD
Pt. Mugu, CA 93042
805-989-4045

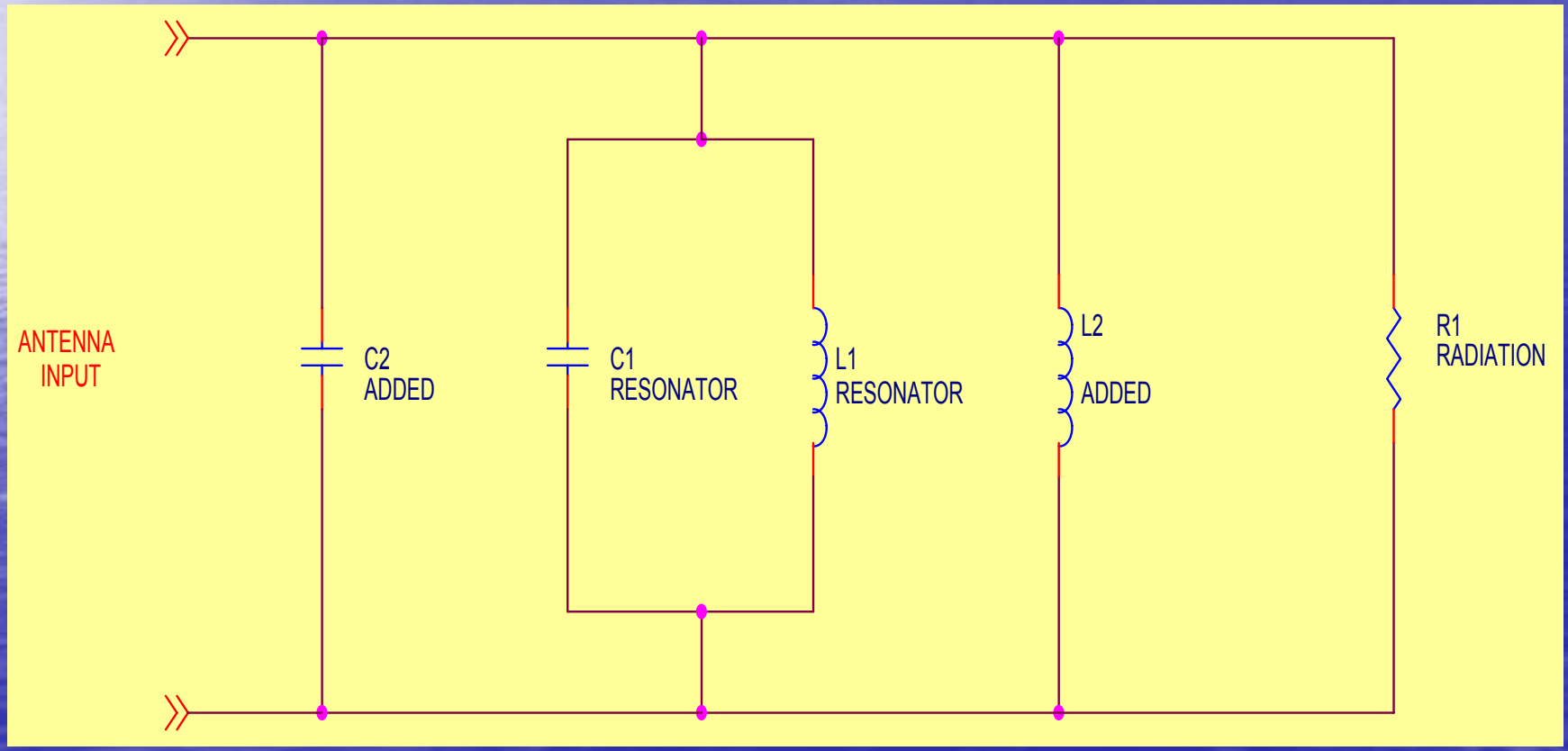
OUTLINE

- Design Conventional Microstrip Antenna
- Design Microstrip Antenna With Slot
- Compare Results & Performance

BACKGROUND

- Reduced Microstrip Antenna Size
  - Added Capacitance
  - Quarter-wave Length

OPTIONS


ANTENNA
INPUT
C2
ADDED
C1
RESONATOR
L1
RESONATOR
L2
ADDED
R1
RADIATION

SPECIFICATIONS

- Frequency – 1.575 GHz
- Circularly Polarized, RHCP
- Input – 100 ohms with quarter-wave matching section
- Duroid 6002 dielectric, 0.050 thick
- Size – Minimize square antenna dimension

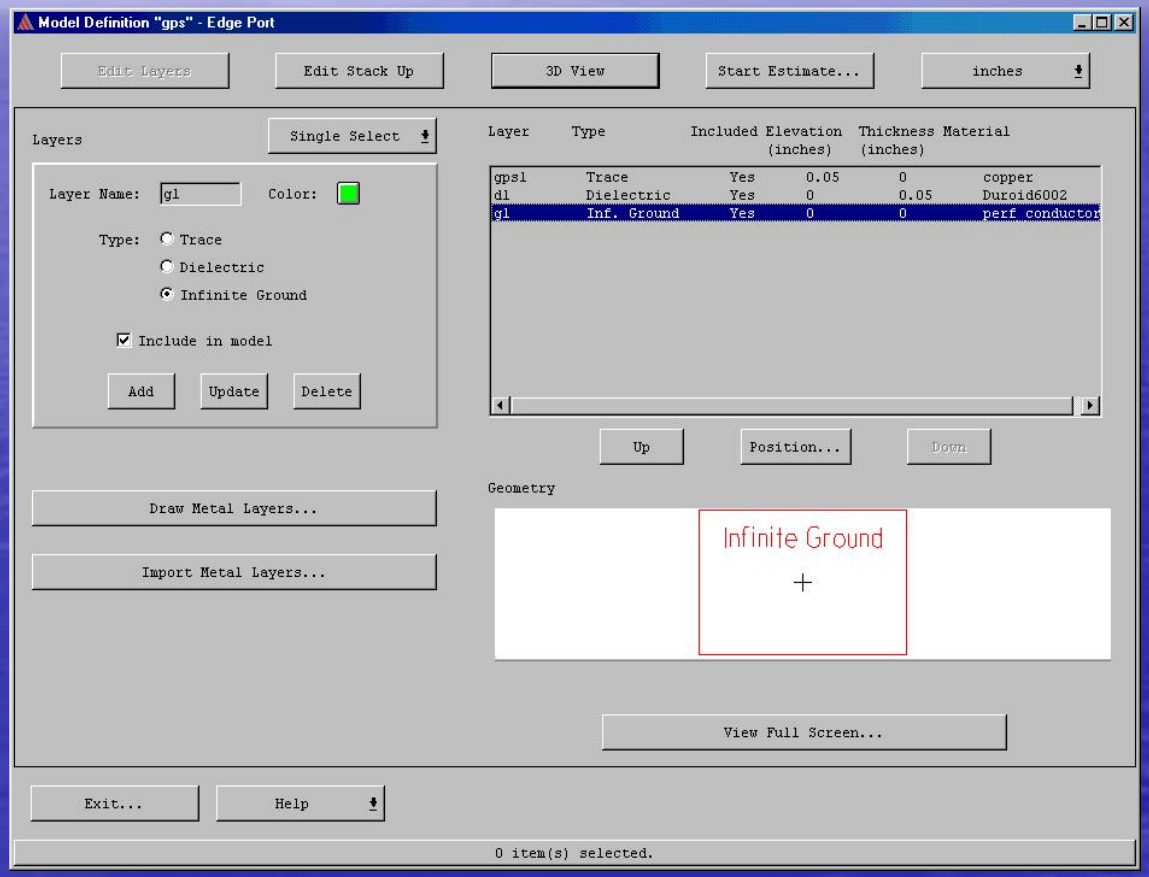
DEFINE MODEL

- Specify Units – inches
- Edit Layers – create
  - g1, Infinite Ground Plane
  - d1, Dielectric
  - gps1, Trace
- Edit Stack Up
  - Add Duroid6002 dielectric
  - Define d1: Duroid6002, 0.05 thickness
  - Define gps1: Available material - copper

EDIT LAYERS

Create:

- g1
- d1
- gps1



Edit Stack Up

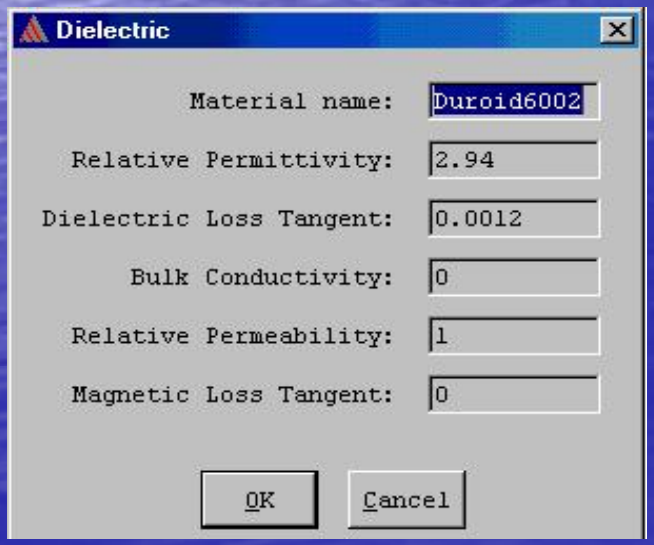
Add Duroid6002

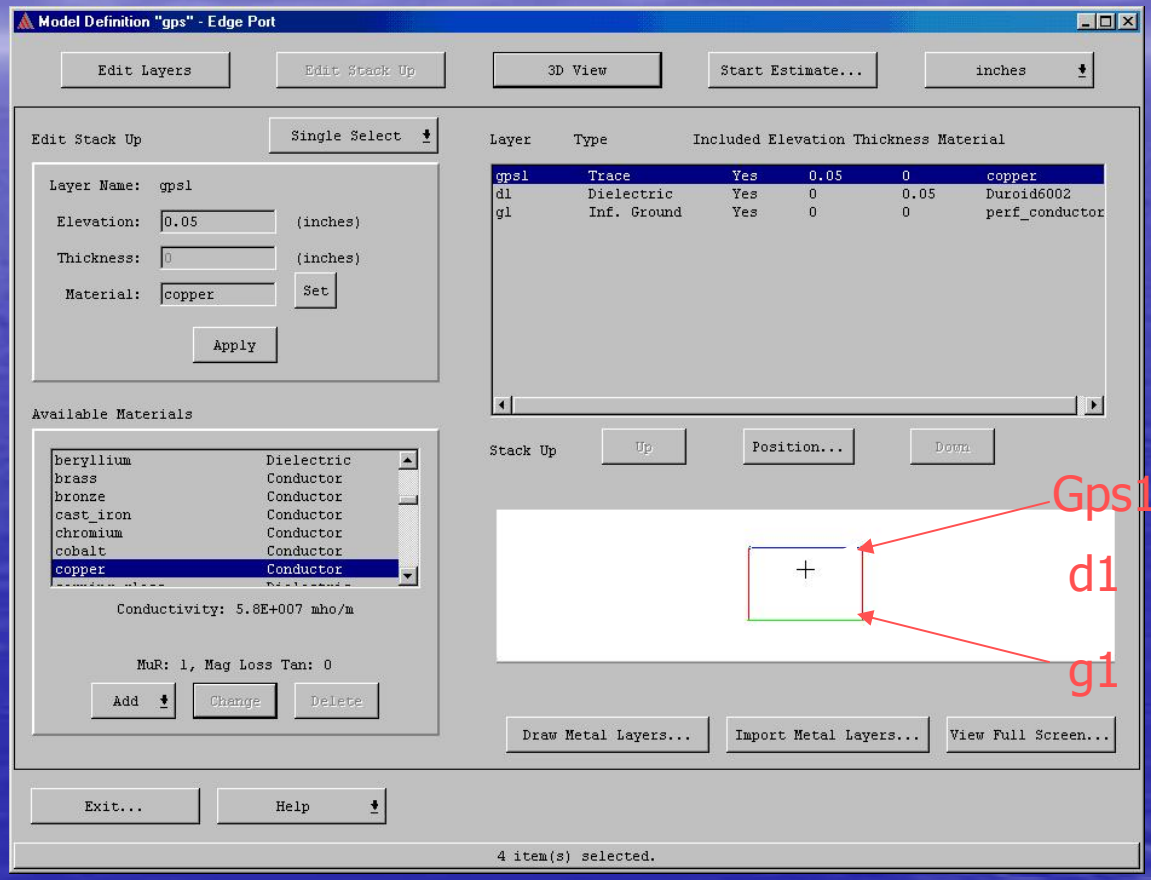
Define d1

- Duroid6002
- 0.05 thickness

Define gps1 Trace

- Avail. material – Copper



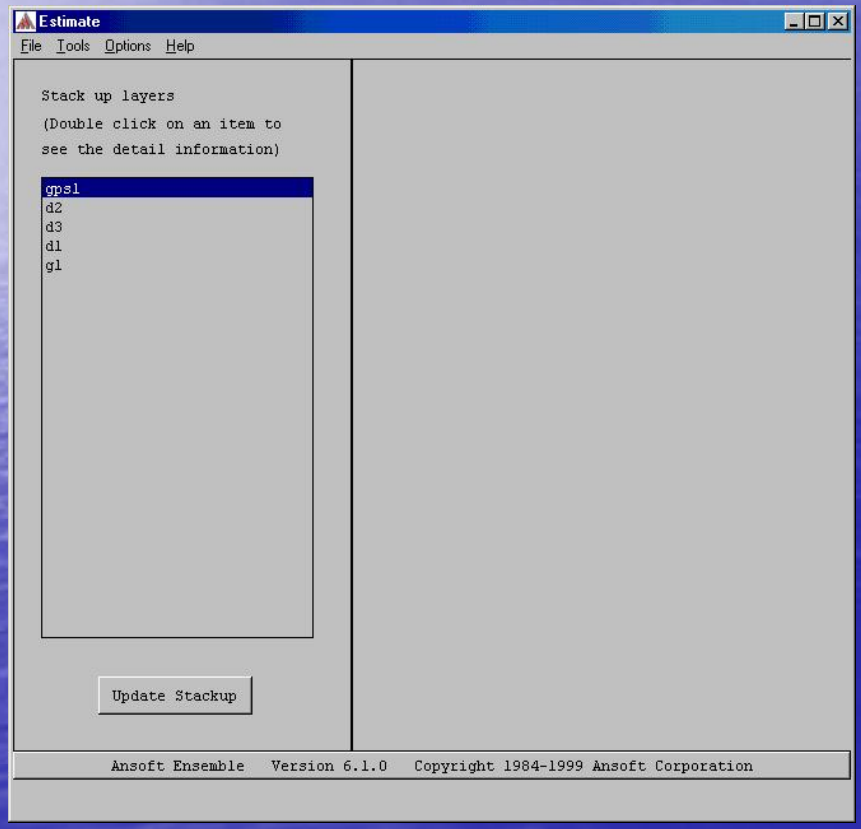


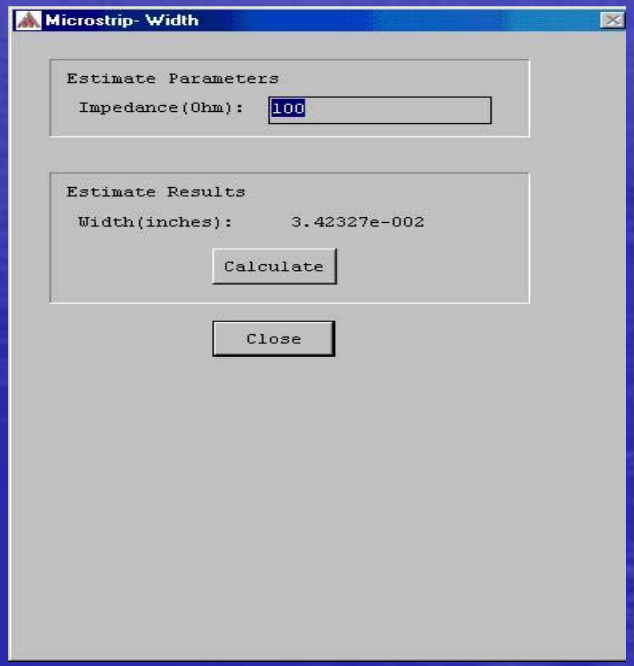
START ESTIMATE

Tools

T-line

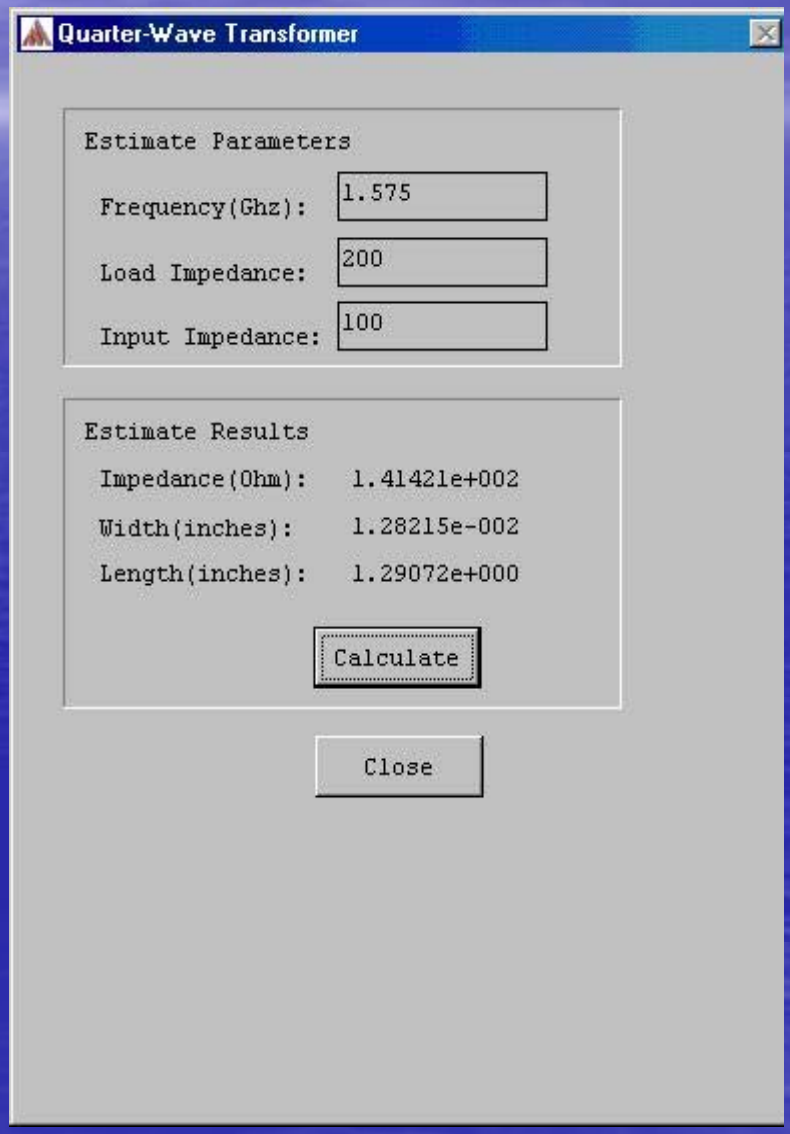
Width





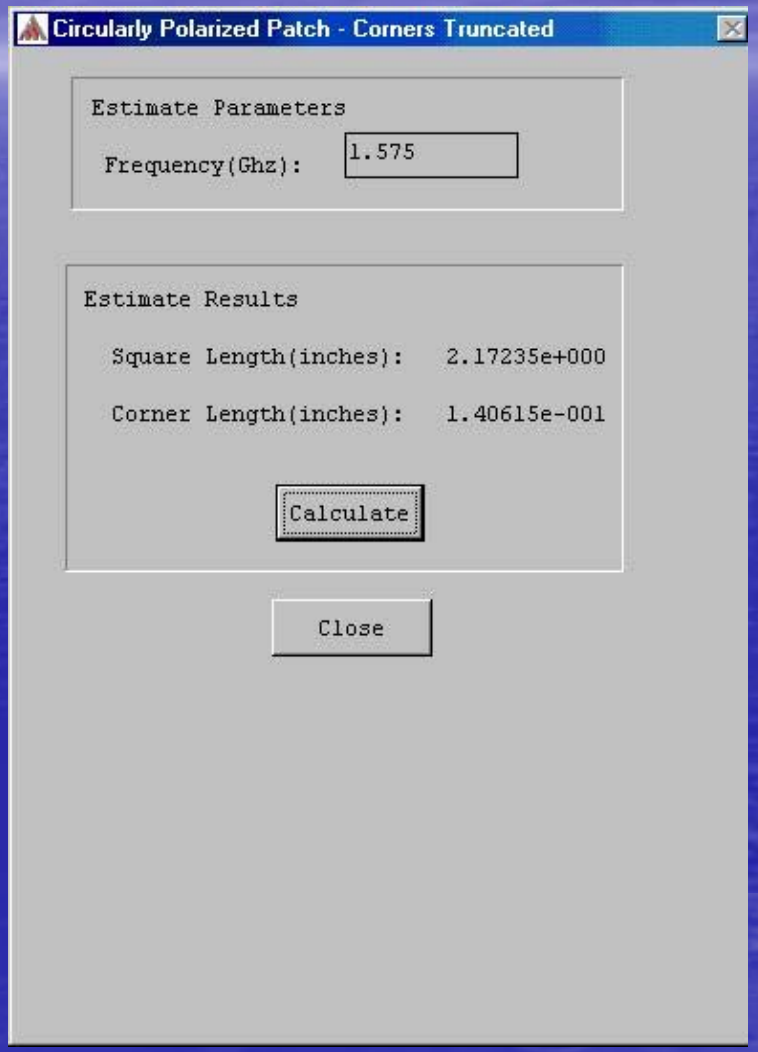
QUARTER WAVE TRANSFORMER

- Estimate
  - Tools
    - Impedance Match
      - Quarter-Wave

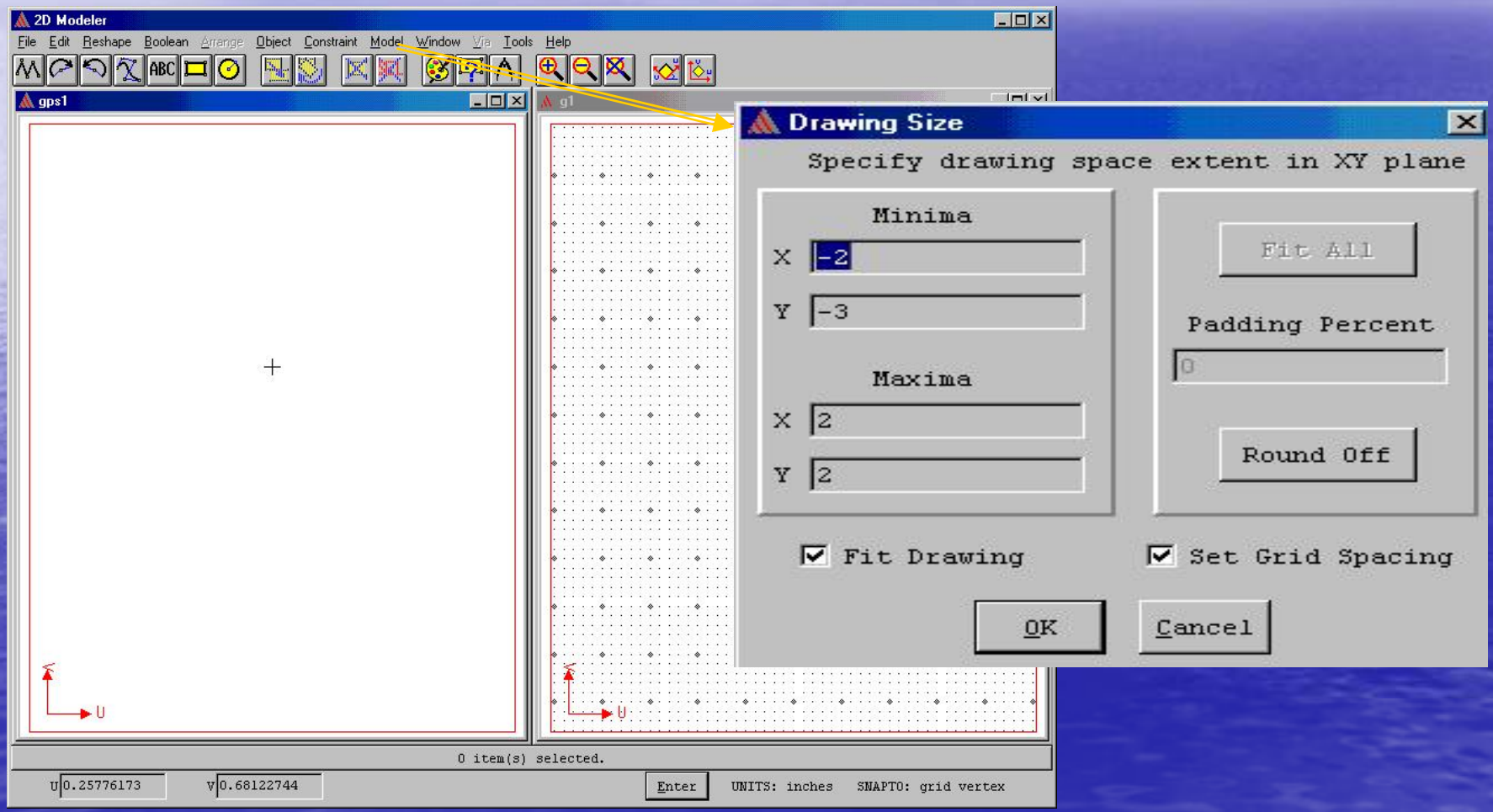


Antenna Starting Point

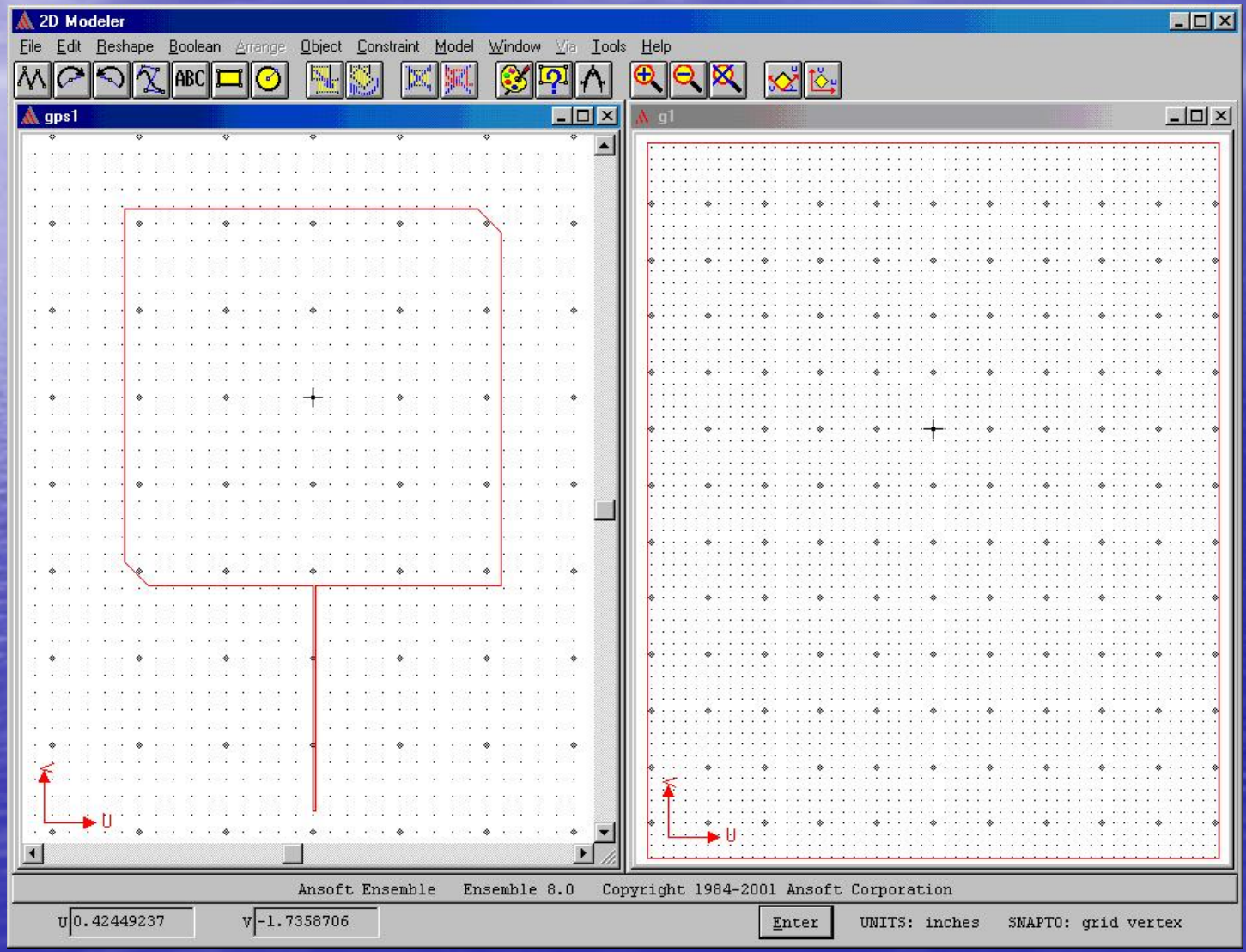
- Estimate
  - Tools
    - Printed Antennas
      - CP Corners Truncated



DRAW METAL LAYERS

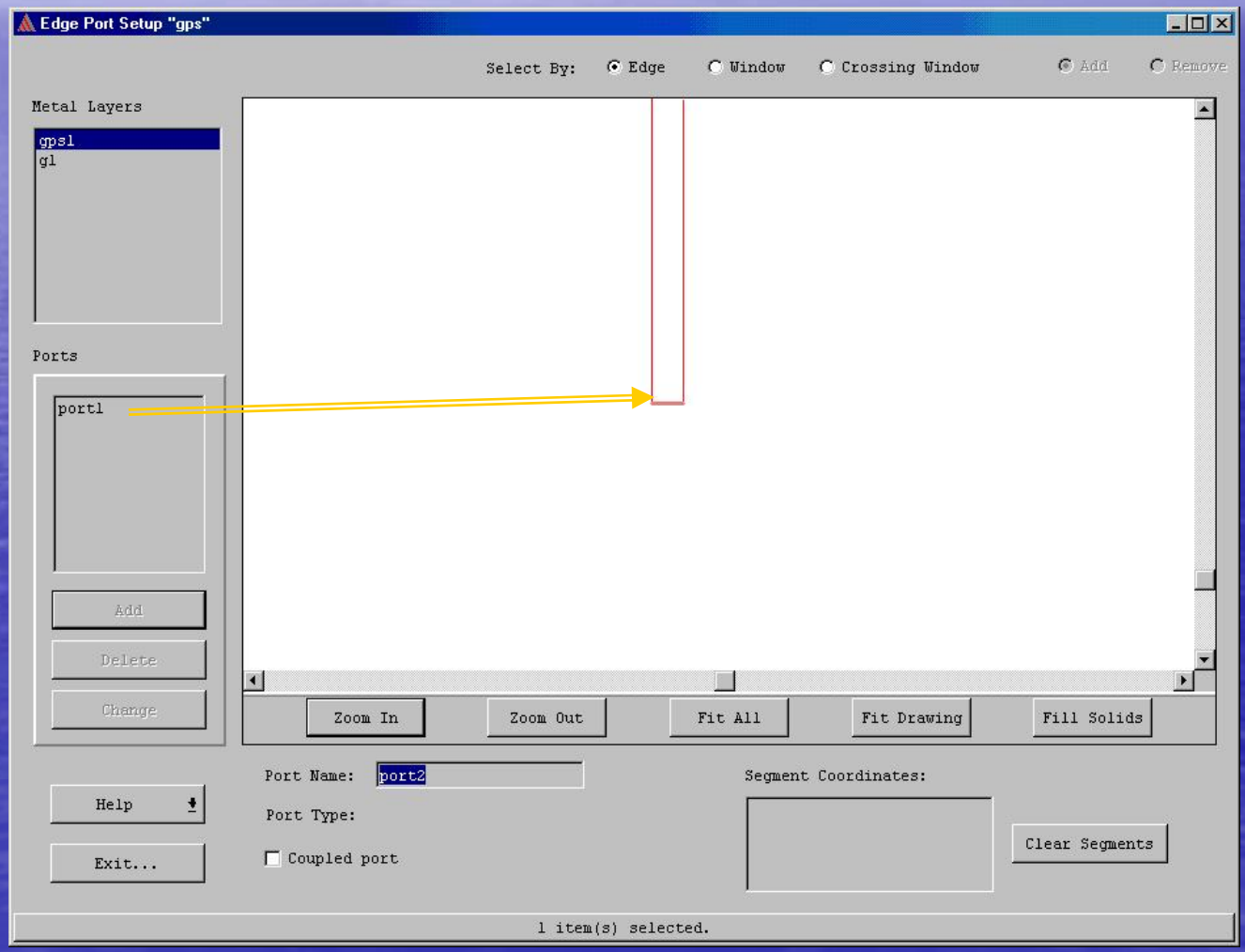


DRAW THE ANTENNA



SET-UP EXCITATION

Add Port 1



DETERMINE CORRECT SIZE

- Iterate square length – center frequency

  2.172 to 2.162

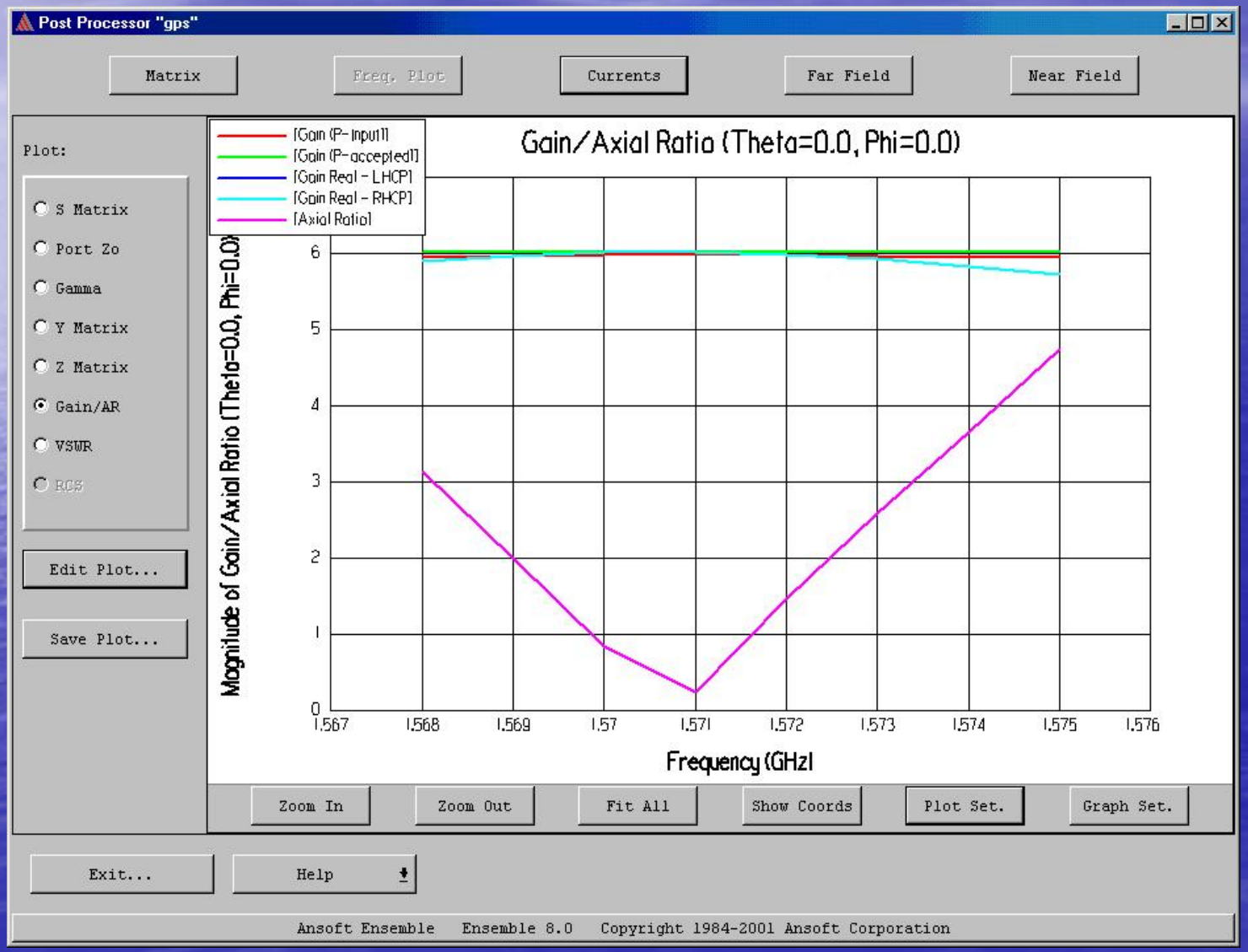
  Error = 0.5 %

- Iterate corner length – axial ratio

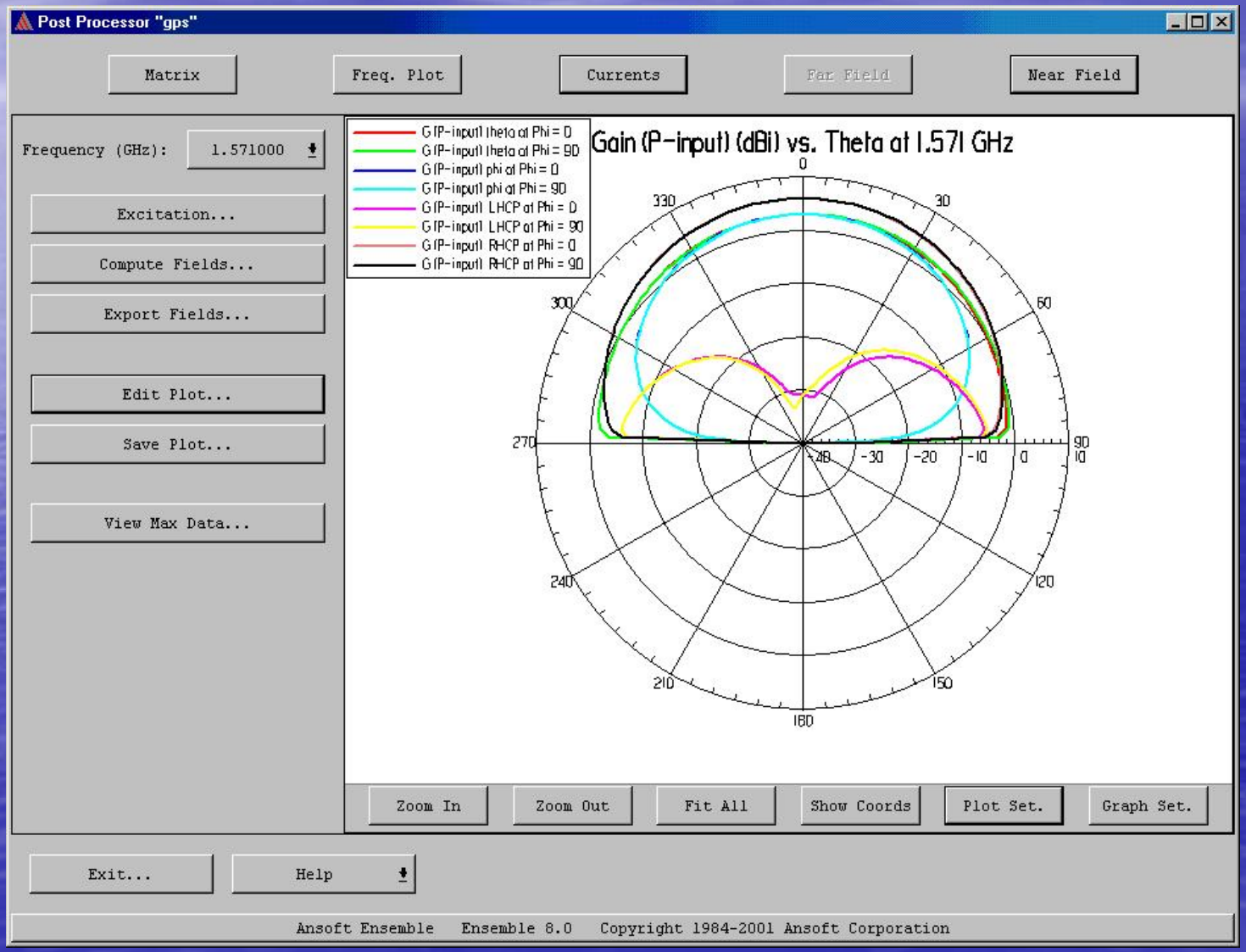
  0.141 to 0.145

  Error = 2.8 %

AXIAL RATIO


Post Processor "gps"
Matrix
Freq. Plot
Currents
Far Field
Near Field
Plot:
S Matrix
Port Zo
Gamma
Y Matrix
Z Matrix
Gain/AR
VSWR
RCS
Edit Plot...
Save Plot...
[Gain (P-input)]
[Gain (P-accepted)]
[Gain Real - LHCP]
[Gain Real - RHCP]
[Axial Ratio]
Gain/Axial Ratio (Theta=0.0, Phi=0.0)
Magnitude of Gain/Axial Ratio (Theta=0.0, Phi=0.0)
0
1
2
3
4
5
6
1.567
1.568
1.569
1.57
1.571
1.572
1.573
1.574
1.575
1.576
Frequency (GHz)
Zoom In
Zoom Out
Fit All
Show Coords
Plot Set.
Graph Set.
Exit...
Help
Ansoft Ensemble Ensemble 8.0 Copyright 1984-2001 Ansoft Corporation

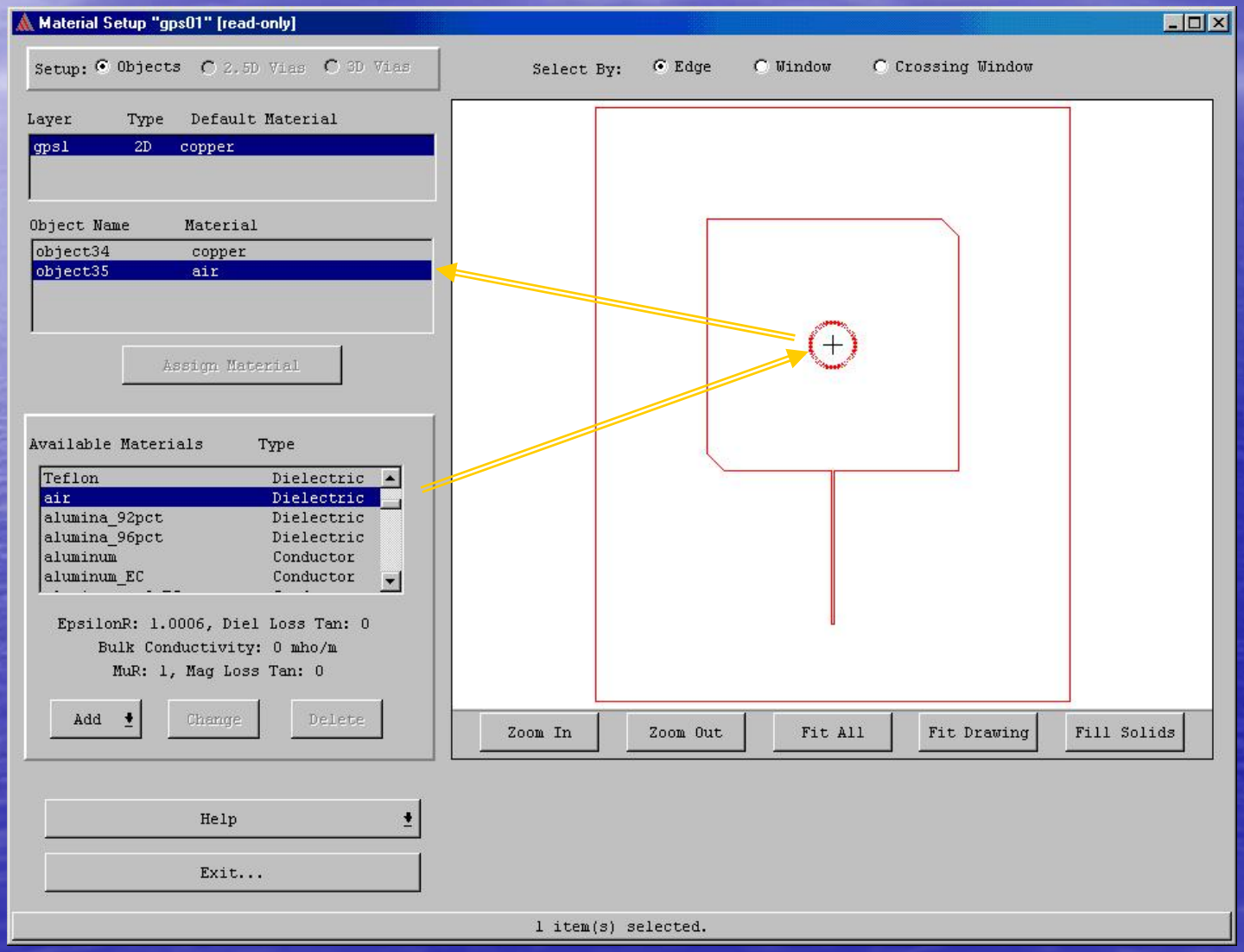
PATTERNS


Post Processor "gps"
Matrix
Freq. Plot
Currents
Far Field
Near Field
Frequency (GHz):
1.571000
Excitation...
Compute Fields...
Export Fields...
Edit Plot...
Save Plot...
View Max Data...
G(P-input) theta at Phi = 0
G(P-input) theta at Phi = 90
G(P-input) phi at Phi = 0
G(P-input) phi at Phi = 90
G(P-input) LHCP at Phi = 0
G(P-input) LHCP at Phi = 90
G(P-input) RHCP at Phi = 0
G(P-input) RHCP at Phi = 90
Gain (P-input) (dBi) vs. Theta at 1.571 GHz
0
30
60
90
120
150
180
210
240
270
300
330
dB
-30
-20
-10
0
10
Zoom In
Zoom Out
Fit All
Show Coords
Plot Set.
Graph Set.
Exit...
Help
Ansoft Ensemble Ensemble 8.0 Copyright 1984-2001 Ansoft Corporation

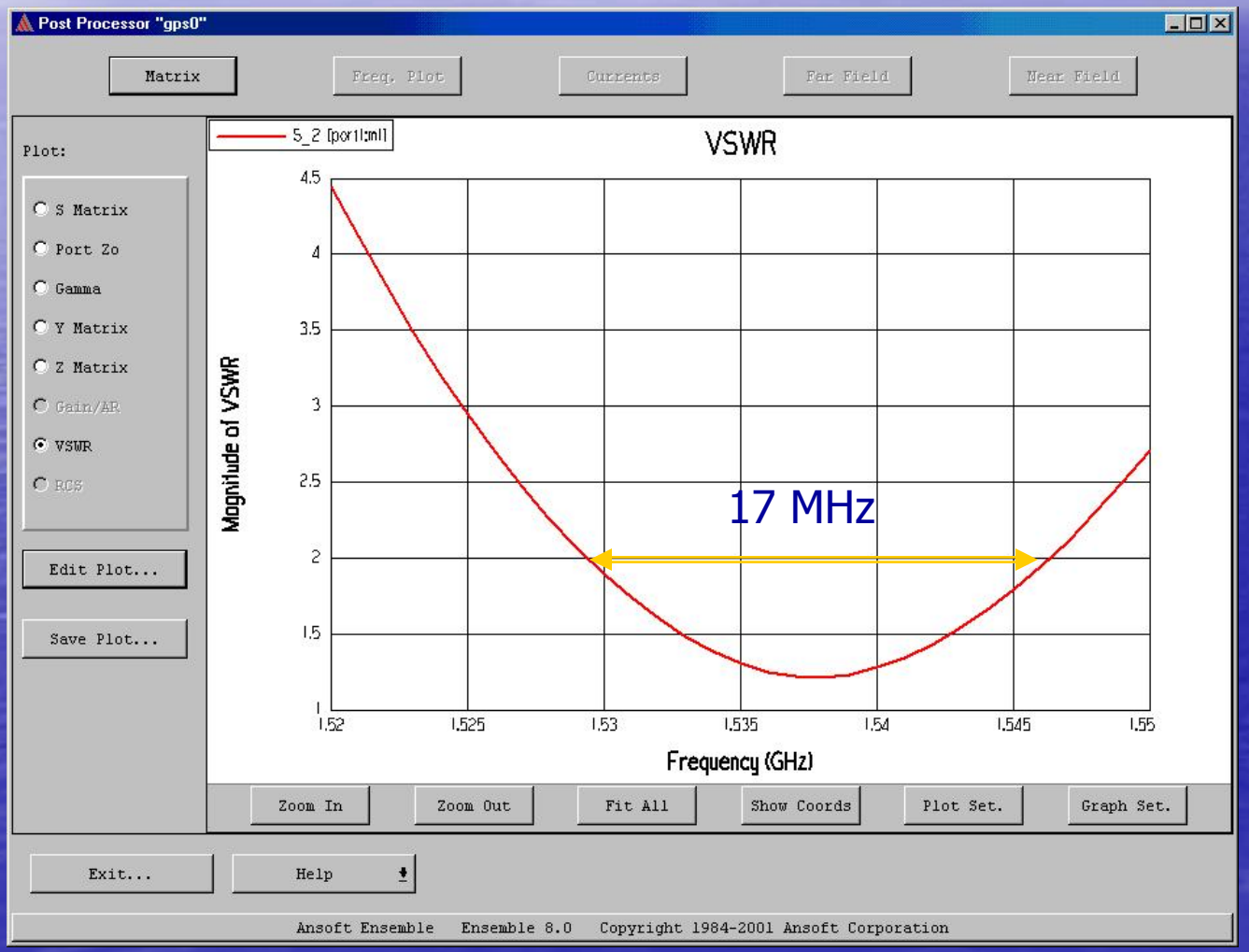
ADD ANNULAR SLOT

- 0.375 inch in center of antenna
- Center Frequency – 1.538 GHz
- New Size – 2.112 inch square
- Size Reduction – 2.162 to 2.112
  - 0.050 inch Change
  - 2.4 % Change

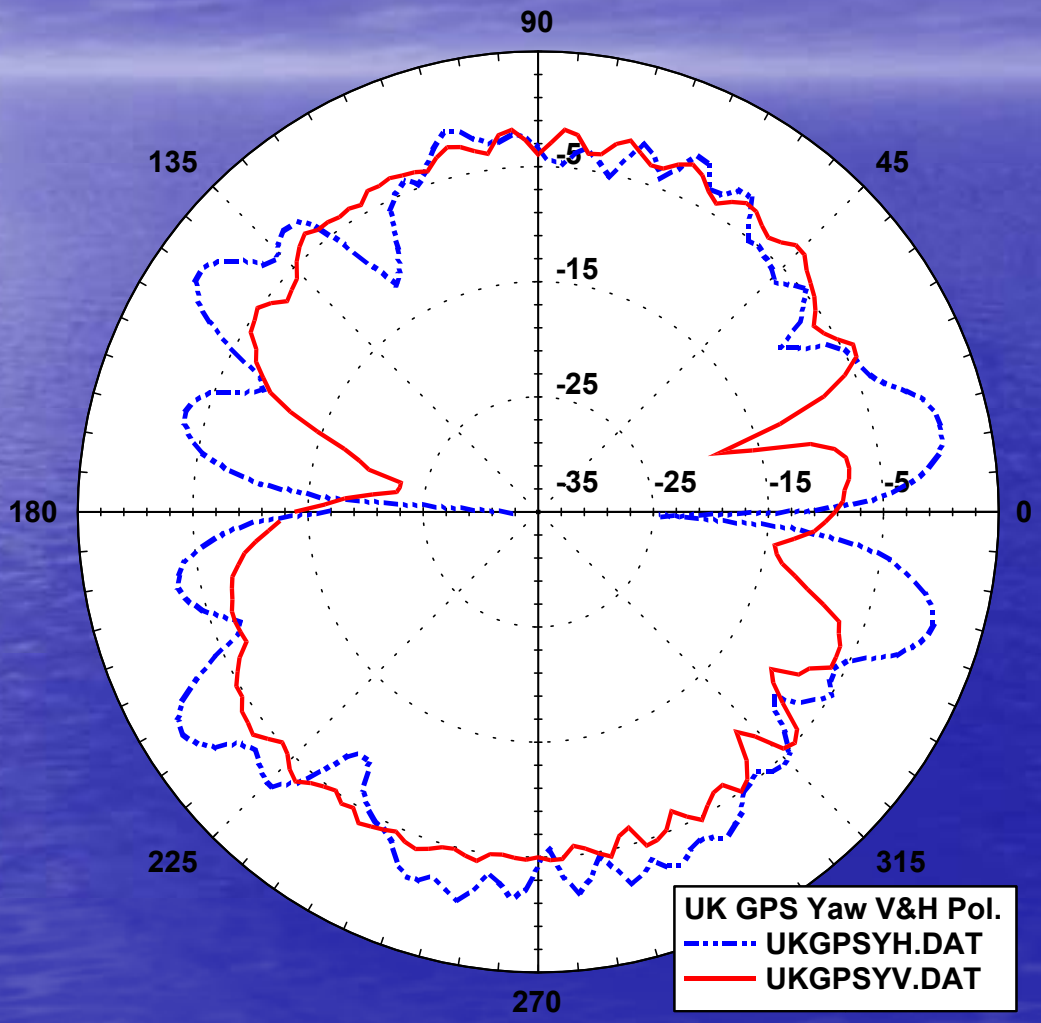
SET HOLE TO AIR



2:1 VSWR BANDWIDTH



MEASURED PERFORMANCE



CONCLUSIONS

- Design easily done in Ensemble
- Design correlates with measured data
- Annular slot does reduce size of antenna