# Building and Analyzing a Resonant Feedline Dipole

Bill Mitchell and Jack Burris

UC Berkeley Amateur Radio Club

April 11, 2014

# Outline

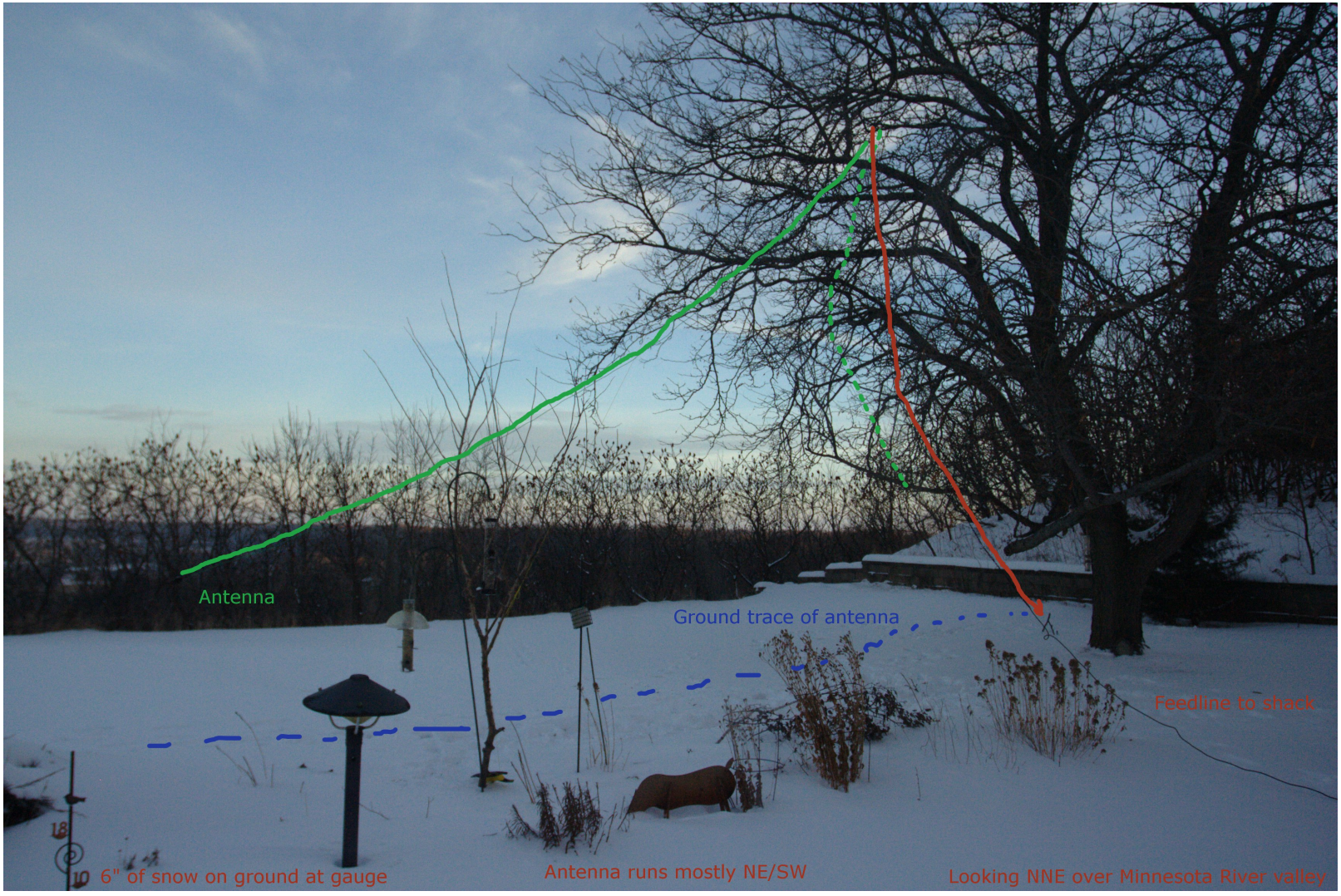
# Design Requirements

- Highly portable
  - Summits on the Air
  - Backpacking
  - Field Day
- Easy field deployment (few tie points)
- No tuner required
- Simple to build (no machining, etc.)
- Works on 40 m band (7.1 MHz)
- <$125; less is better

# Dipole

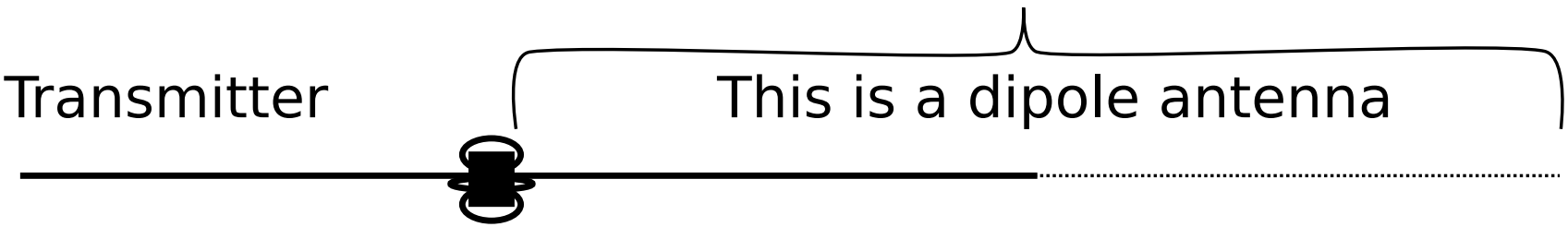
- Simple, portable antenna
- Fed in the center
- Need three tie points (a lot!)

# Dipole


Antenna
Ground trace of antenna
Feedline to shack
6" of snow on ground at gauge
Antenna runs mostly NE/SW
Looking NNE over Minnesota River valley

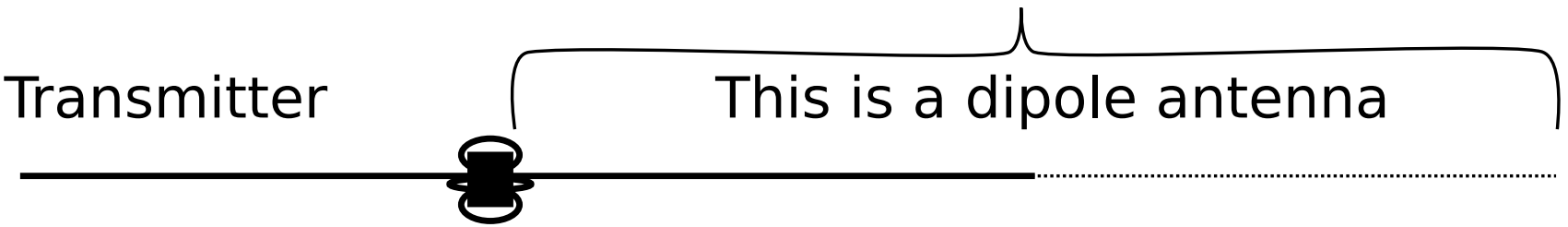
# Resonant Feedline Dipole

- James Taylor, W2OZH, Aug. 1991 QST
- Use shield of coax as radiating element
- Choke at $\lambda/4$ to block RF
- Monoband resonant: no tuner
- Easy to deploy—one or two tie points



# Resonant Feedline Dipole

- N5ESE made a few of these antennas; poor performance
  - Measurements incorrect?
  - Bad deployment?
  - Choke insufficient?
- Revisit, make some modifications on W2OZH design



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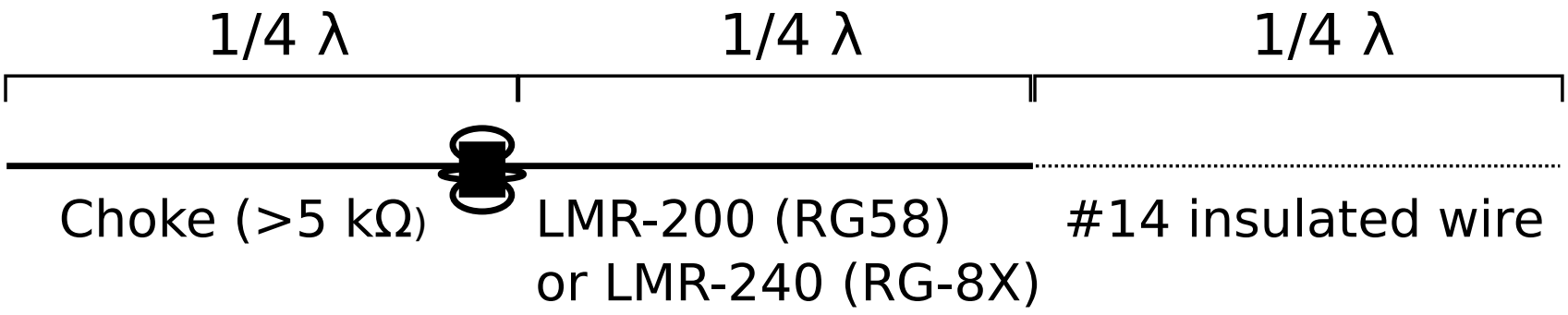


# Outline

# Materials

## Necessary Materials

- Coax: 70' LMR-240 (overkill; LMR-200 better)
- Wire: 35' #12 insulated wire (overkill; #14 better)
- BNC male connector
- #31 Big Clamp-on ferrite (part 0431177081)
- Heat-shrink tubing
- Brightly-colored tape or other marker

- Total cost as built: $105

# Materials

## Tools

- Measuring tape
- Pliers with wire cutters
- Coaxial cable stripper
- Soldering iron
- Crimp tool for BNC connector
- Hot air gun or hair dryer

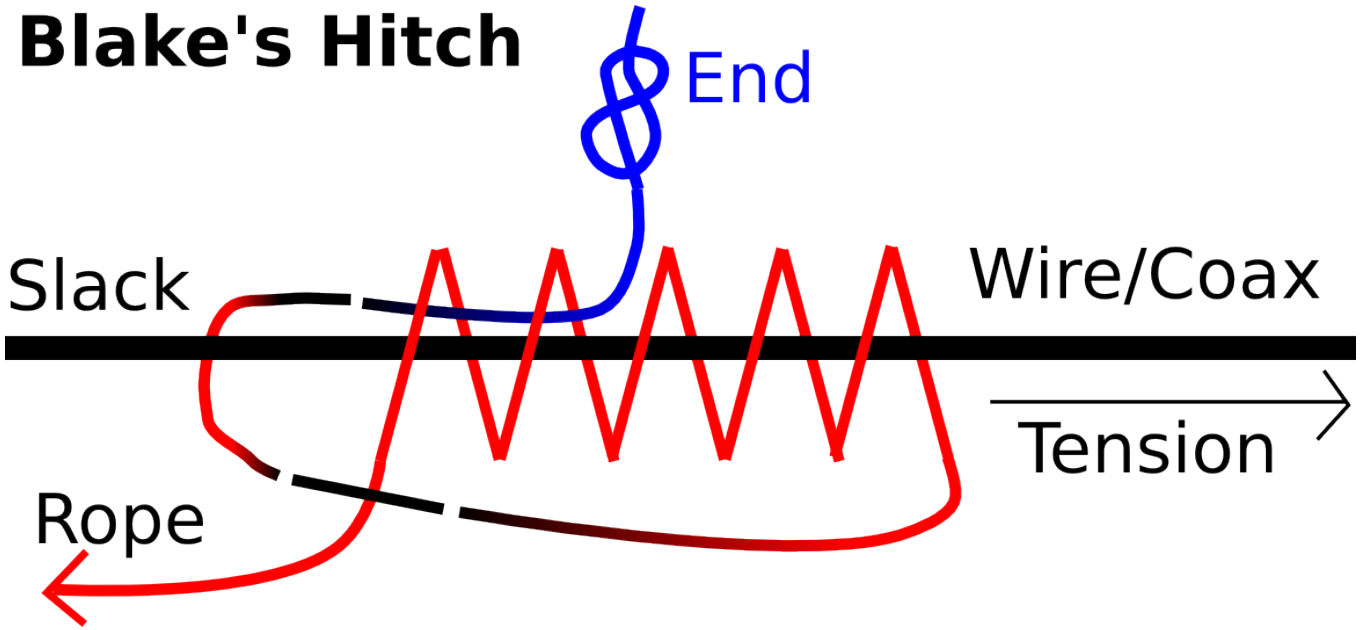
## Accessories

- Two 50'–100' ropes for hoisting
- Cord spool for storage
- Antenna-launching device (slingshot, etc.)

# Assembly

- Place heat shrink tubing onto coax
- Attach BNC connector to end
- Heat shrink connection
- Strip shield from 4" (10 cm) of other end of coax
- Remove dielectric from 3" (7.5 cm) of stripped coax
- Measure 29.45' (8.98 m) toward BNC connector from where shield begins; mark this spot with tape
- Strip 3" (7.5 cm) of wire
- Join wire to center of coax, crimp, heat shrink
- Put toroid on near side of tape mark; pass 8 turns of coax (from near side) through toroid and clamp

# Assembly

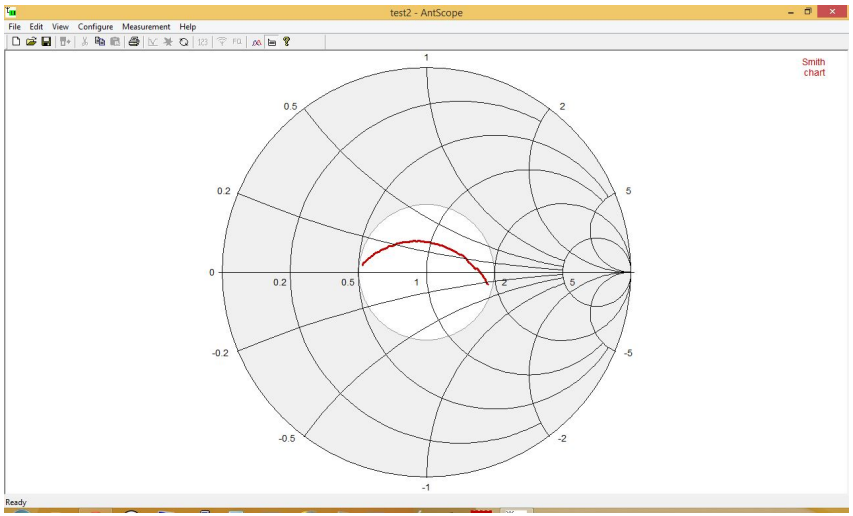


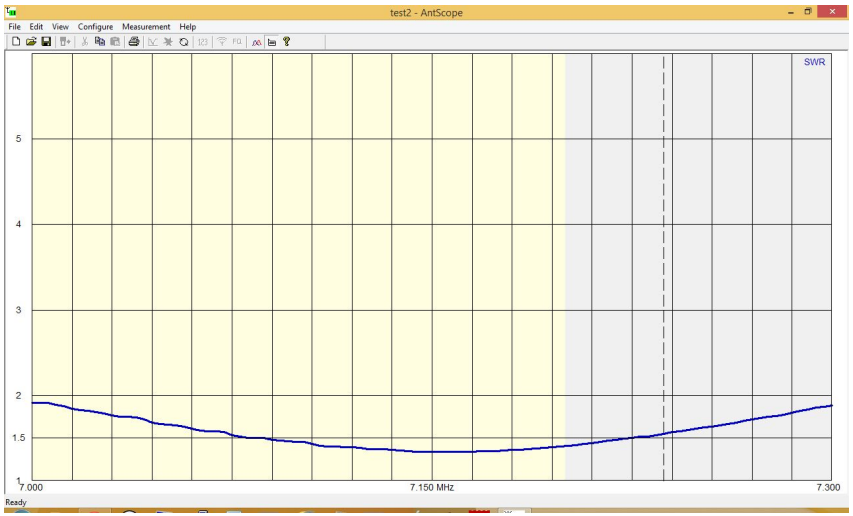

- Attach one rope to end of wire
- Attach other rope just on radiating side of toroid
- Alternate: use *Gripping Sailor's Hitch*
- As built, should handle 500 W (plenty for portable)
- With larger choke can handle 1.5 kW

# Outline

# Balcony

- As built, without adjustments
  - Vertically polarized
  - Testing only 1 m away from side of a tall concrete building
  - Closer to building increases SWR and moves minimum to higher freq.



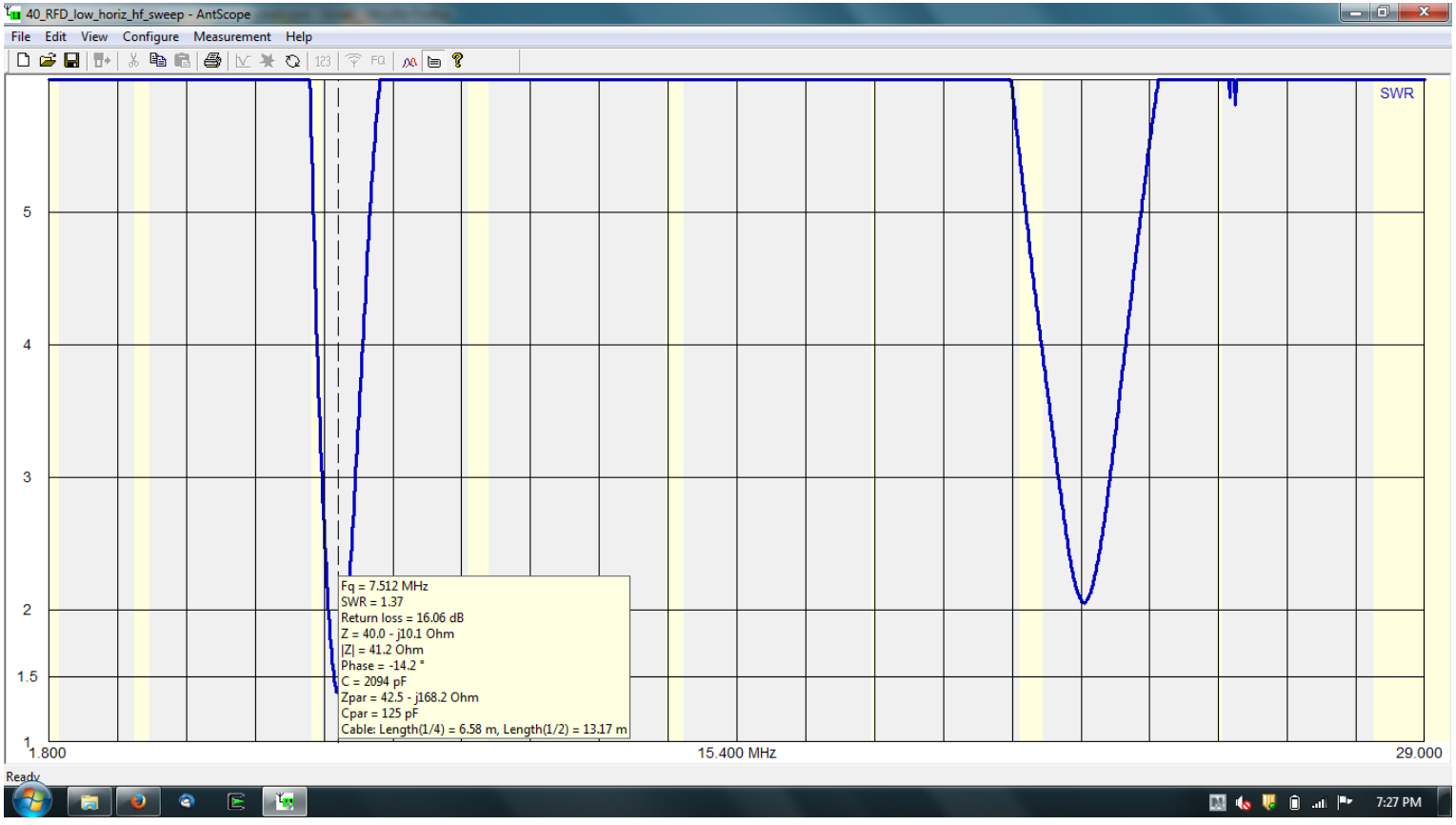



# At W6BB Station

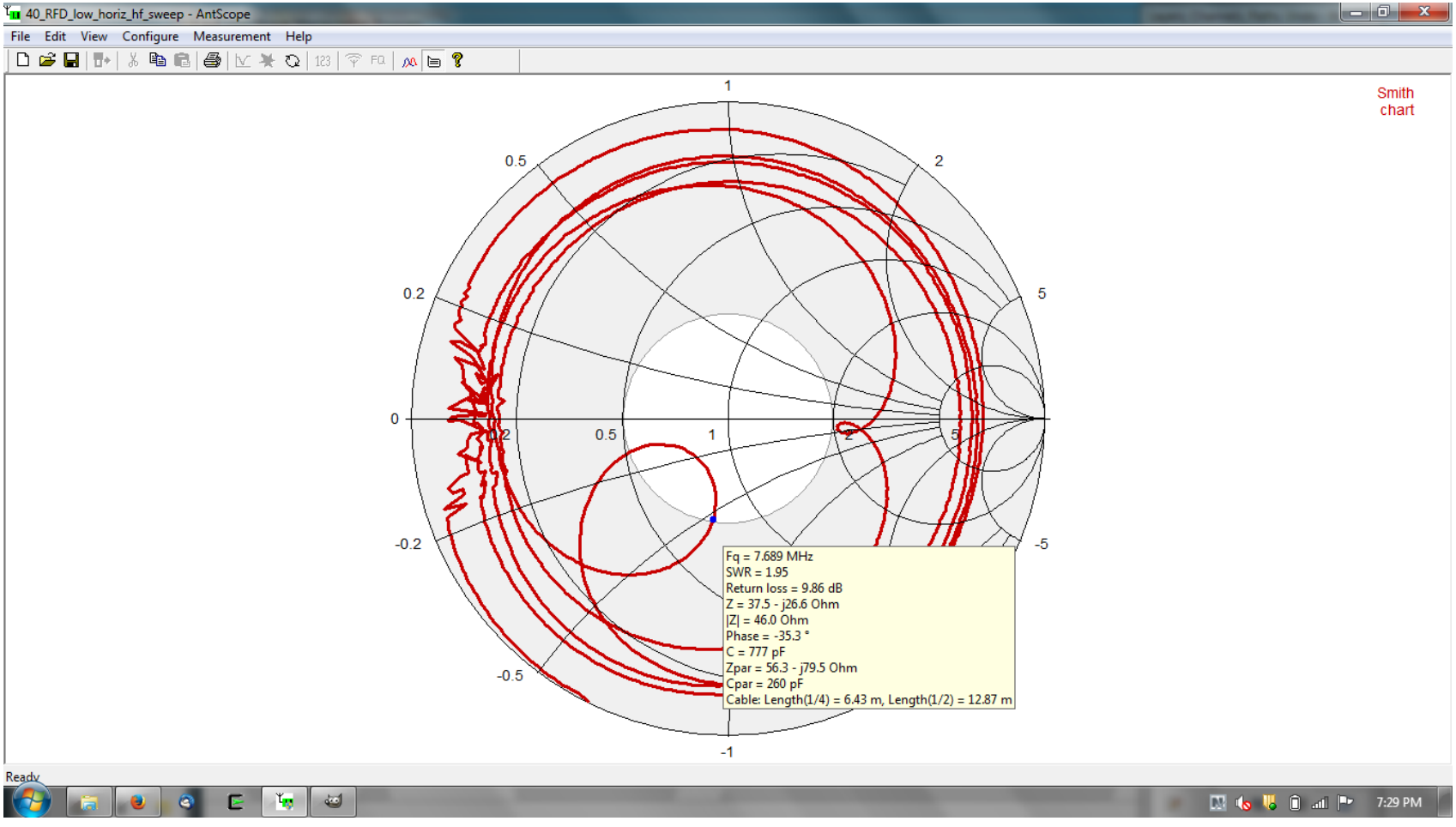
- Vertically polarized
- Choke 15' above ground
- Weird SWR: many peaks/dips within 7.000–7.300 MHz
- SWR not consistent from analysis to analysis
- Realization: 20 kW AM broadcast station just across mudflat

# At W6BB Station

- Horizontally polarized
- 10–20’ above ground

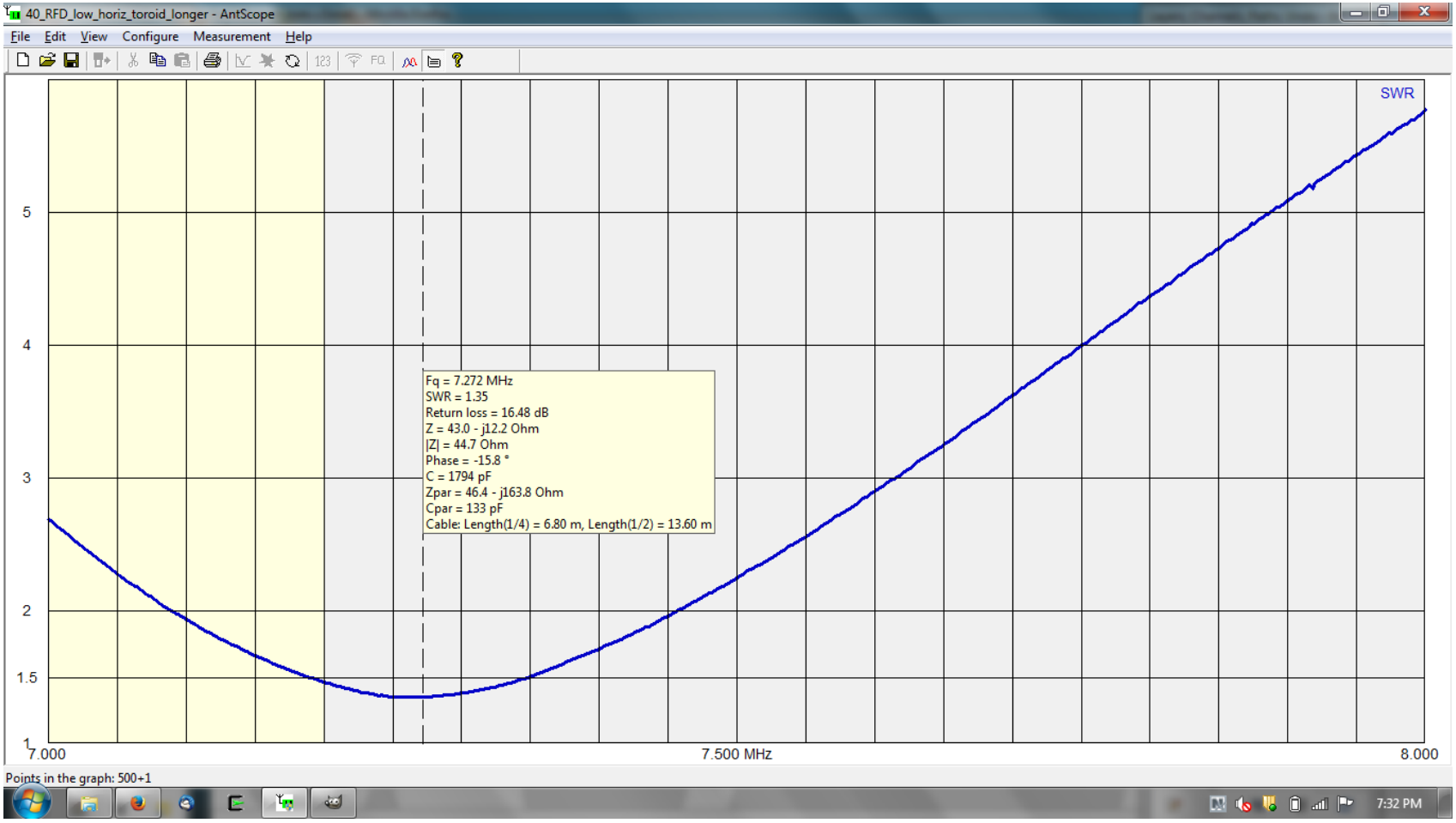


# At W6BB Station



# At W6BB Station

- Antenna too short; move toroid to lengthen



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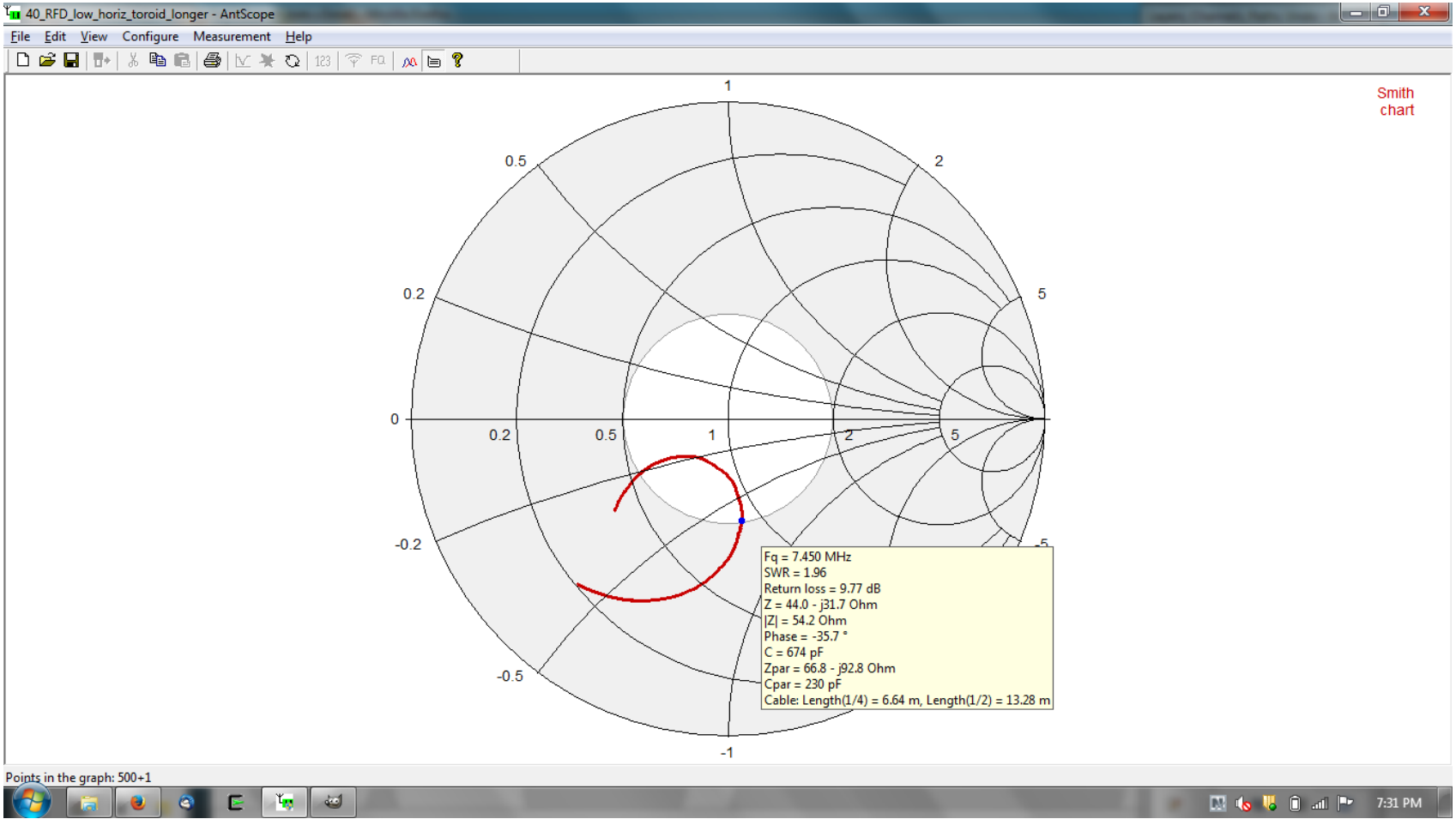


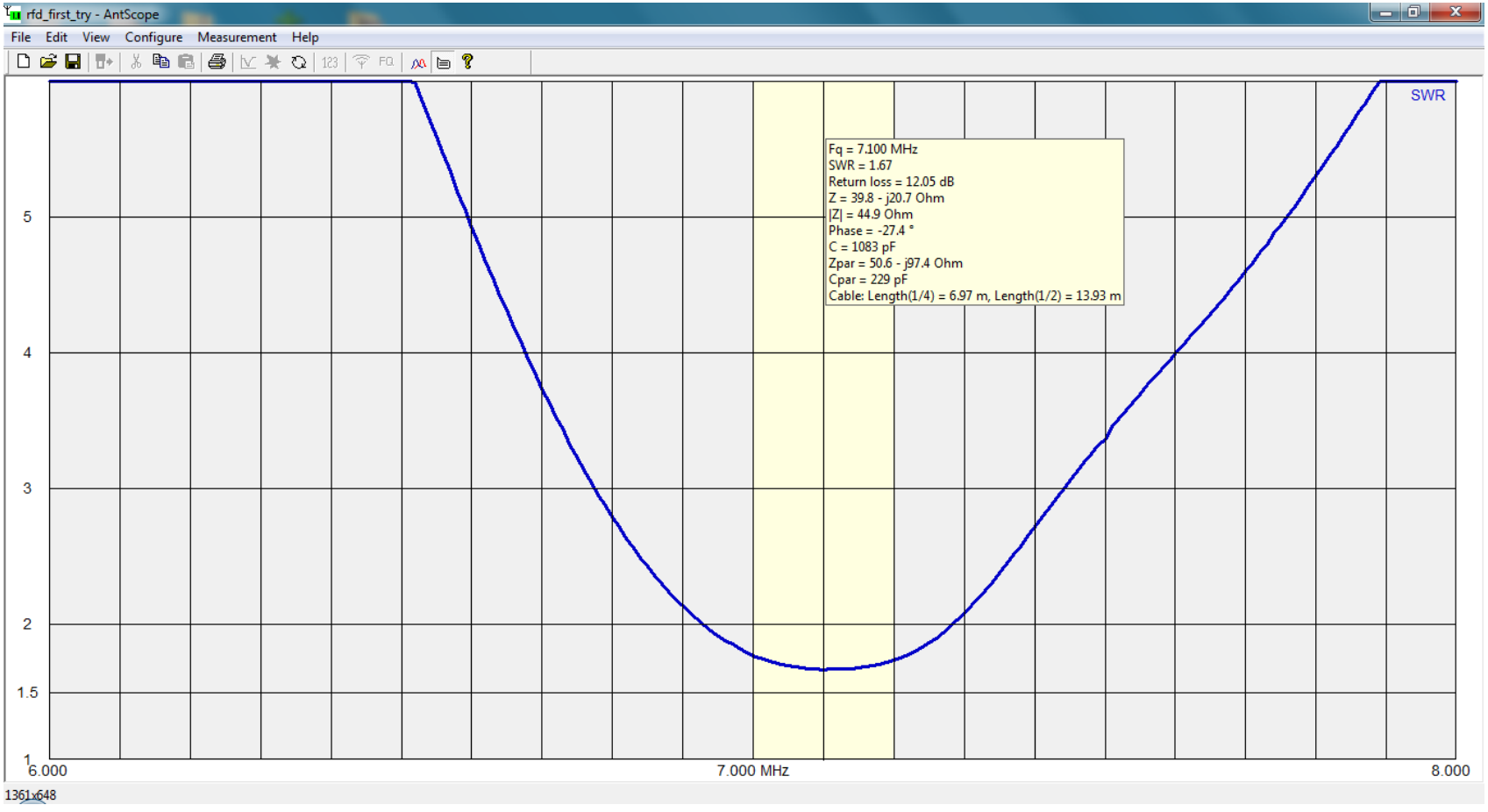
# What's Going On?

- Lots of RFI
  - KKSF 910 KHz
  - 20 kW AM station
  - 1.5 km away over mudflats
  - Vertically polarized
- Horizontal polarization helped
- RF choke near analyzer made big improvement
- No wonder the verticals at W6BB have had weird SWR!
  - Triband vertical worked horizontally
  - Tilted up, antenna went haywire

# At K6JEB Station

- Horizontally polarized
- Slung over two 20' branches (M)
- Avoiding other antennas as much as possible
- Very wet ground
- No broadcast interference
- Adjustments
  - Tension of antenna
  - Height of toroid choke
  - Location of center with respect to branches
  - Direction of nearby 3-element yagi
- Not adjusting toroid location or other antenna hardware!

# At K6JEB Station: First Try



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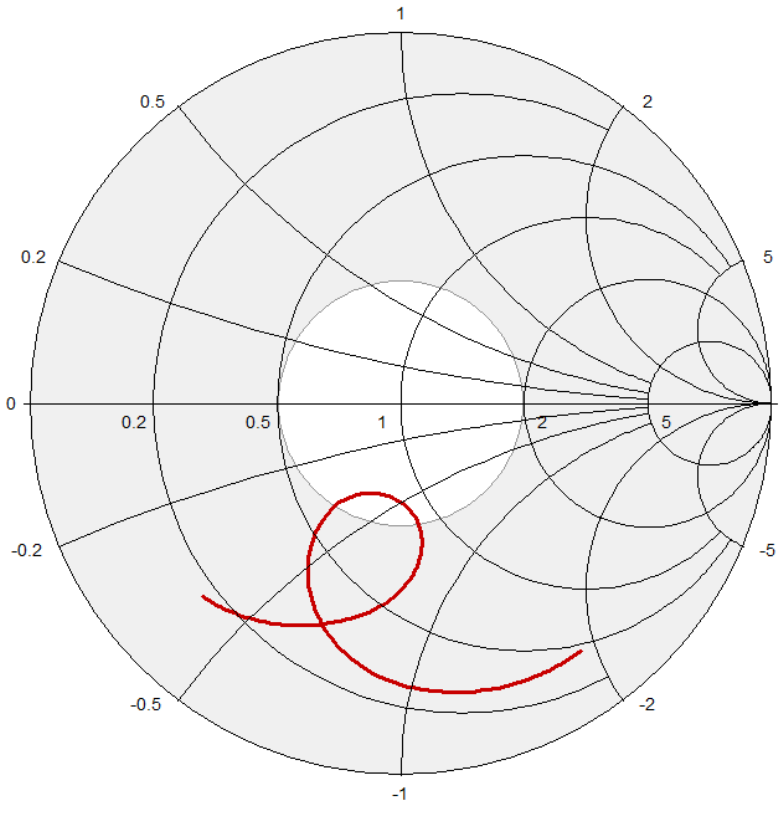
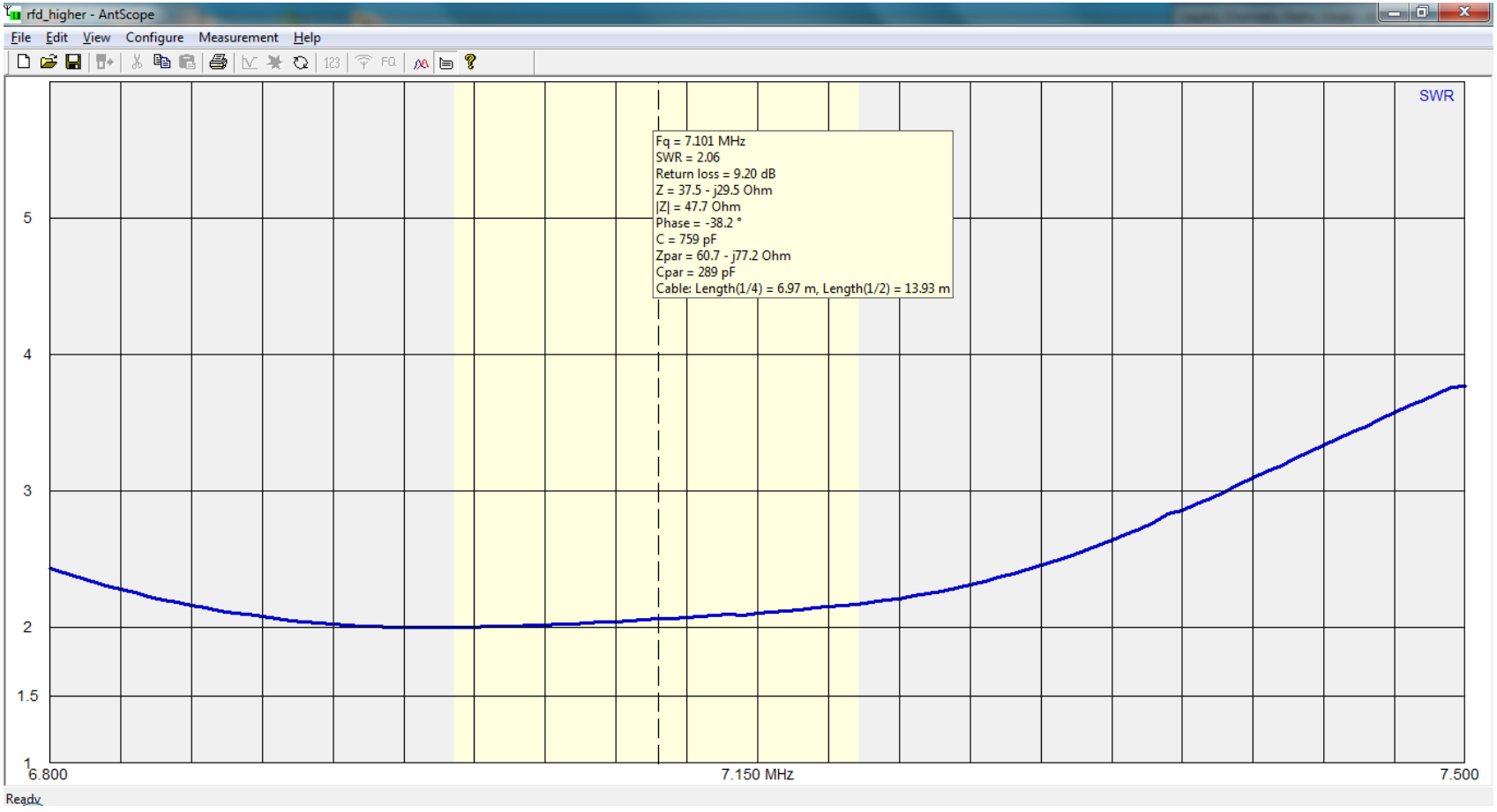
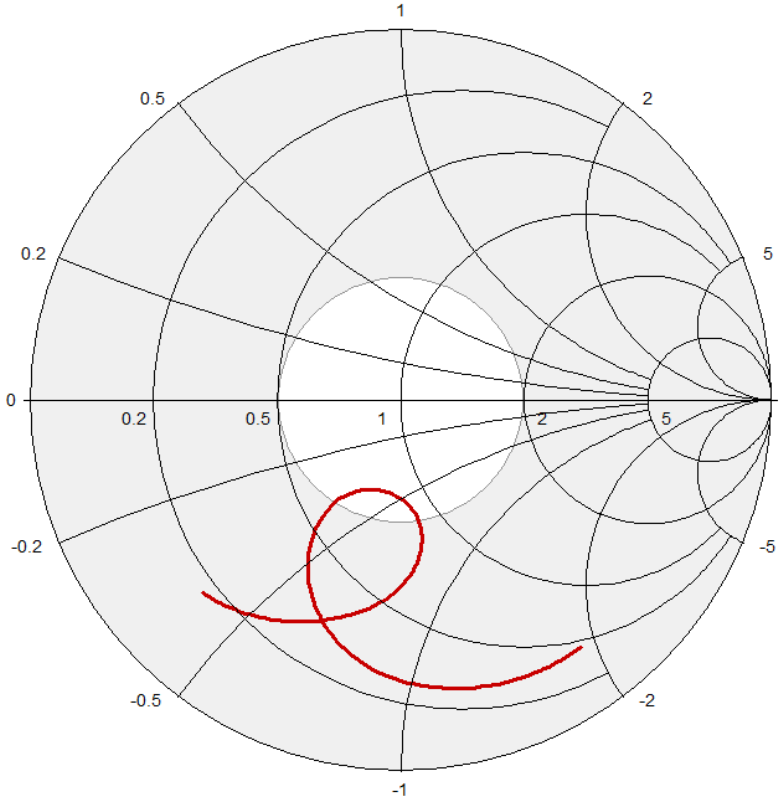


# At K6JEB Station: Higher

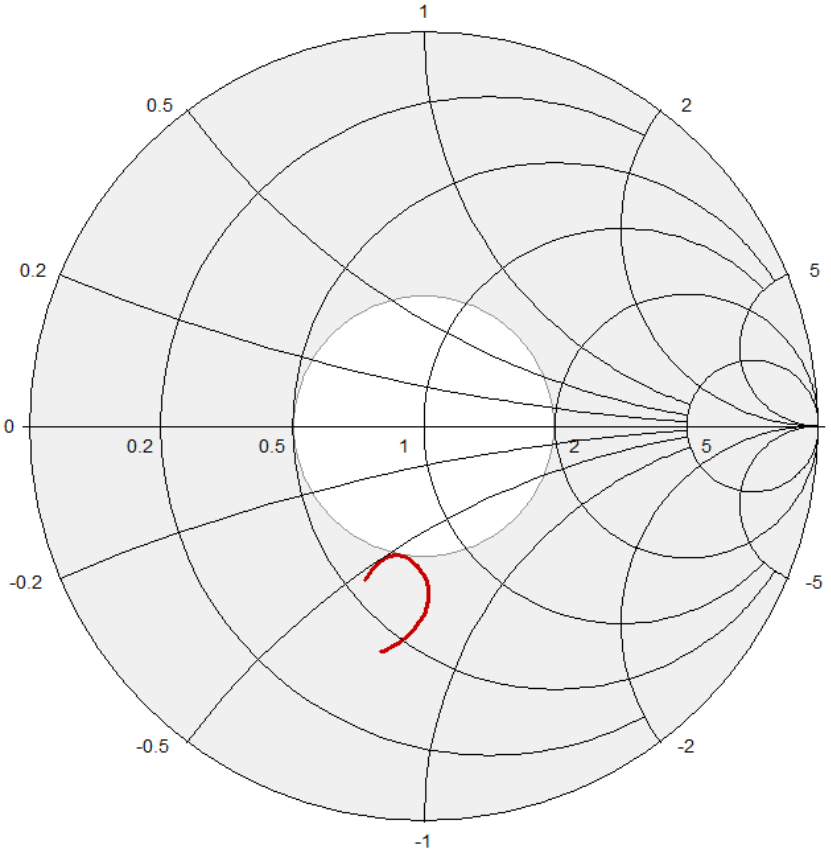


# At K6JEB Station: Higher

First try

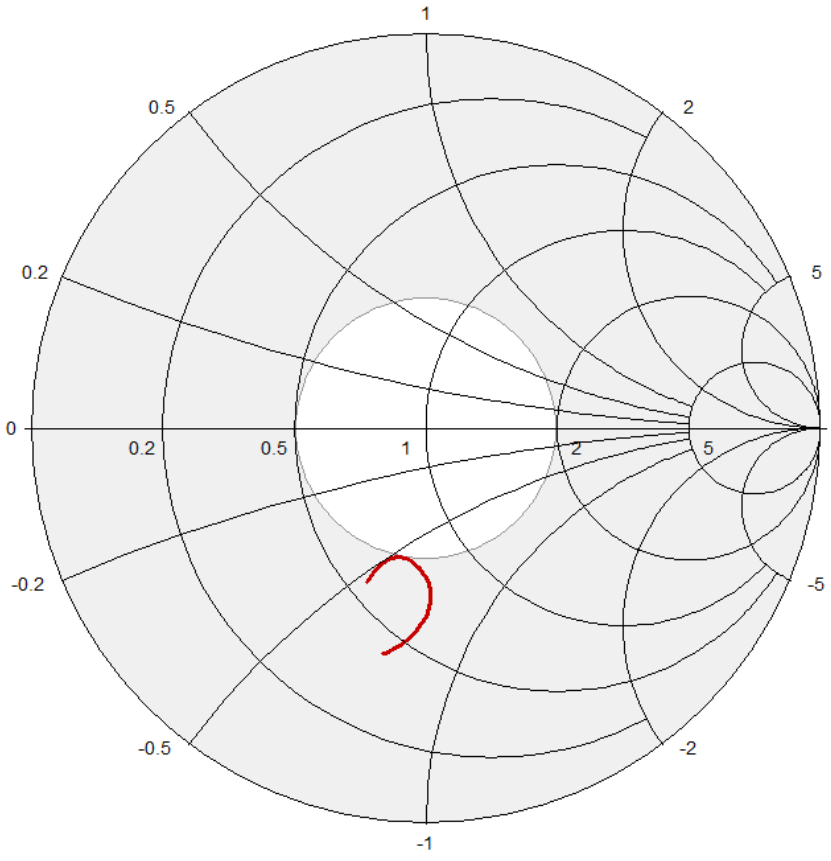



Higher

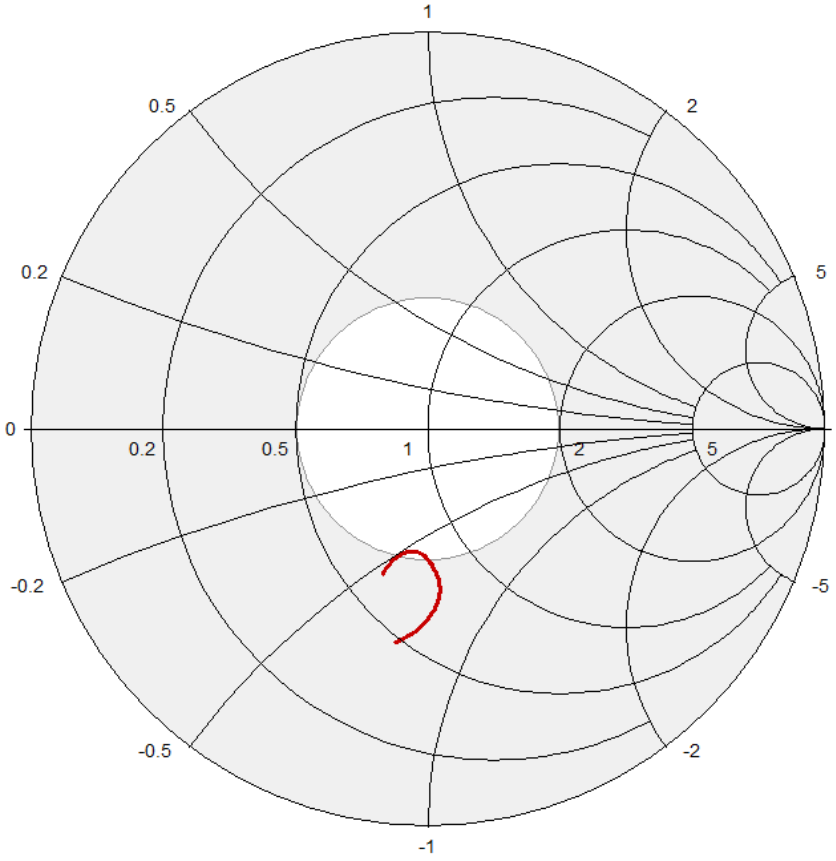


# At K6JEB Station: Turned Yagi

## Higher

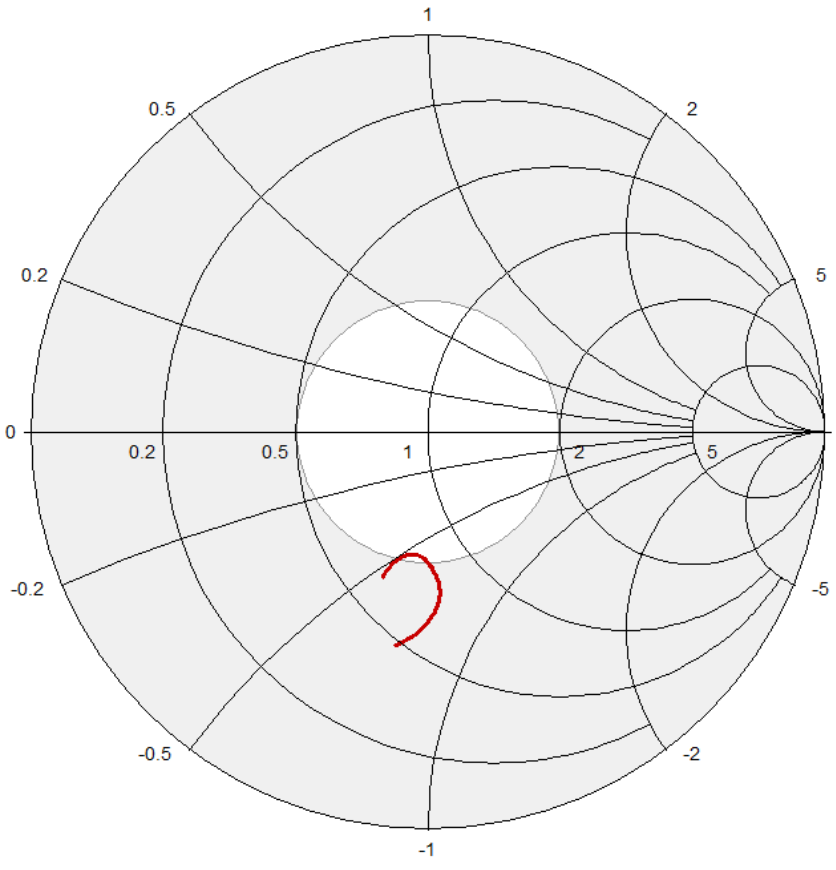



## Turned Yagi

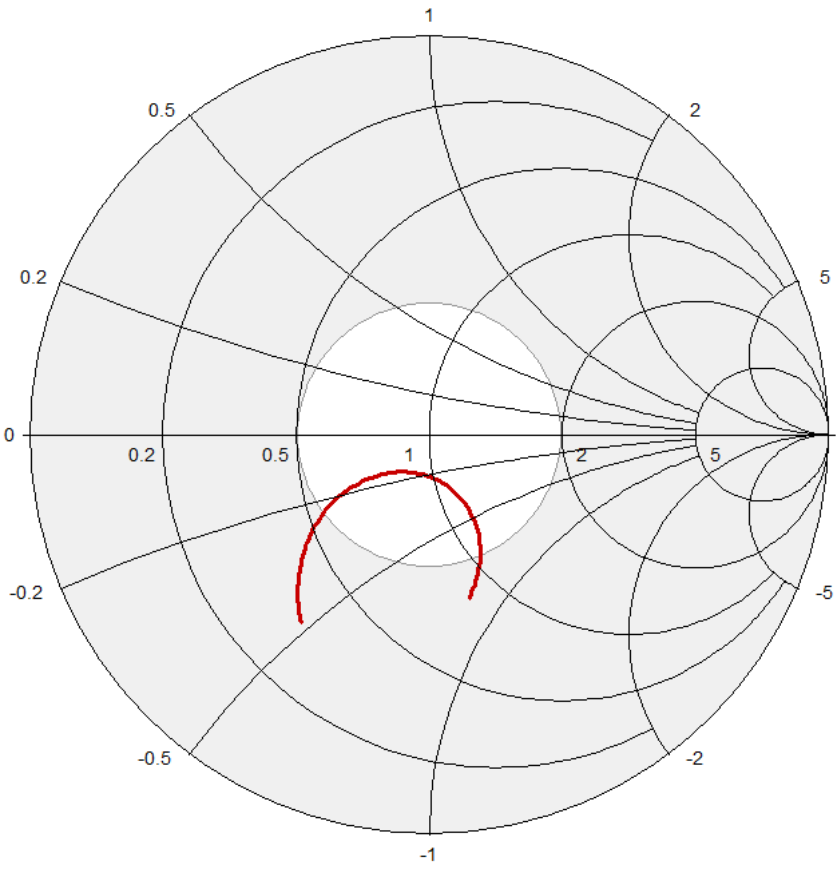


# At K6JEB Station: More Slack

## Turned Yagi

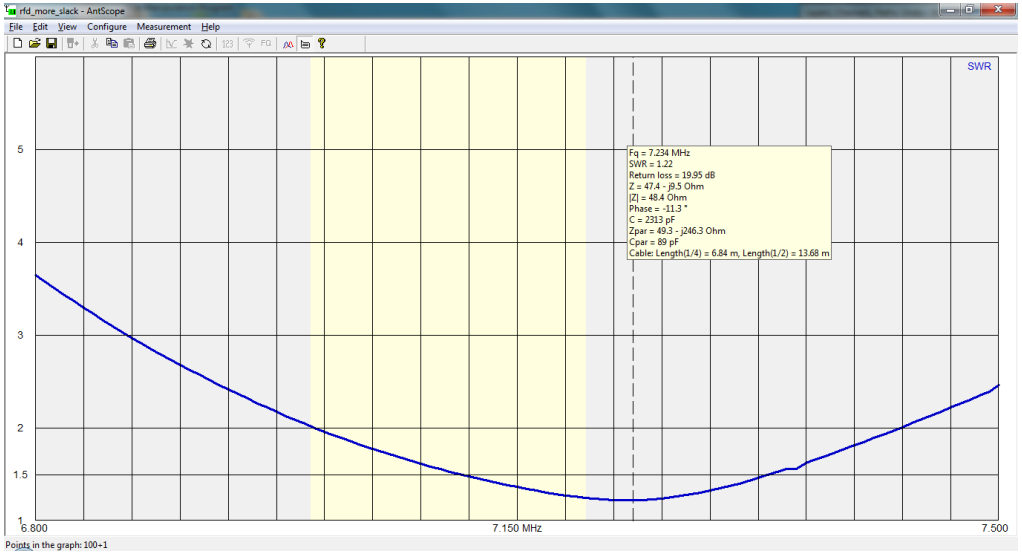



## More slack

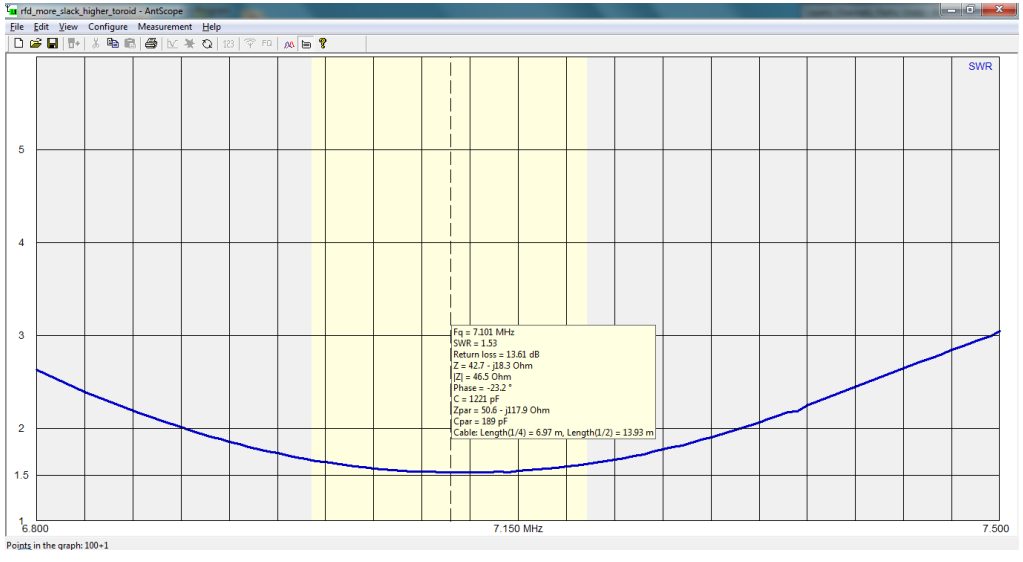


# At K6JEB Station: Raised Toroid

More slack:




Raised Toroid:



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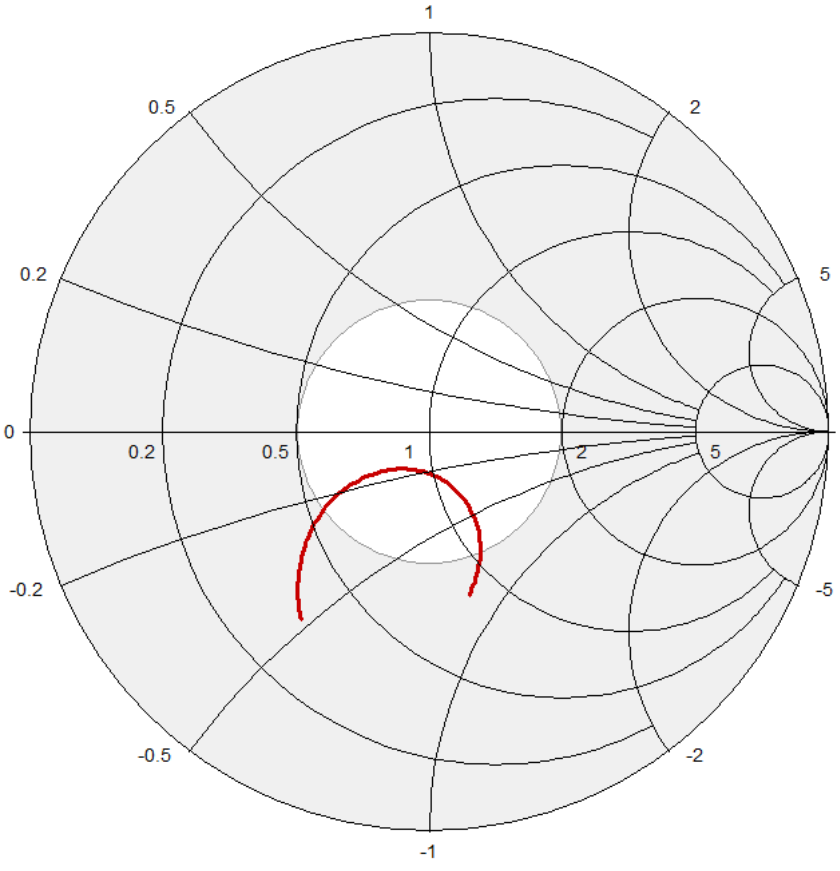


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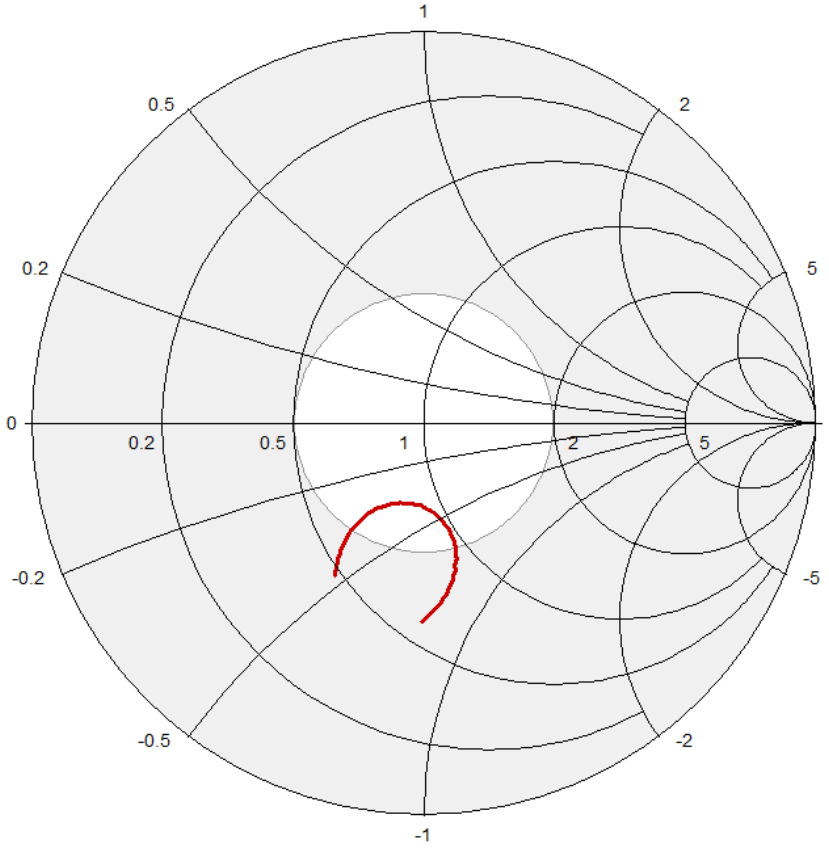
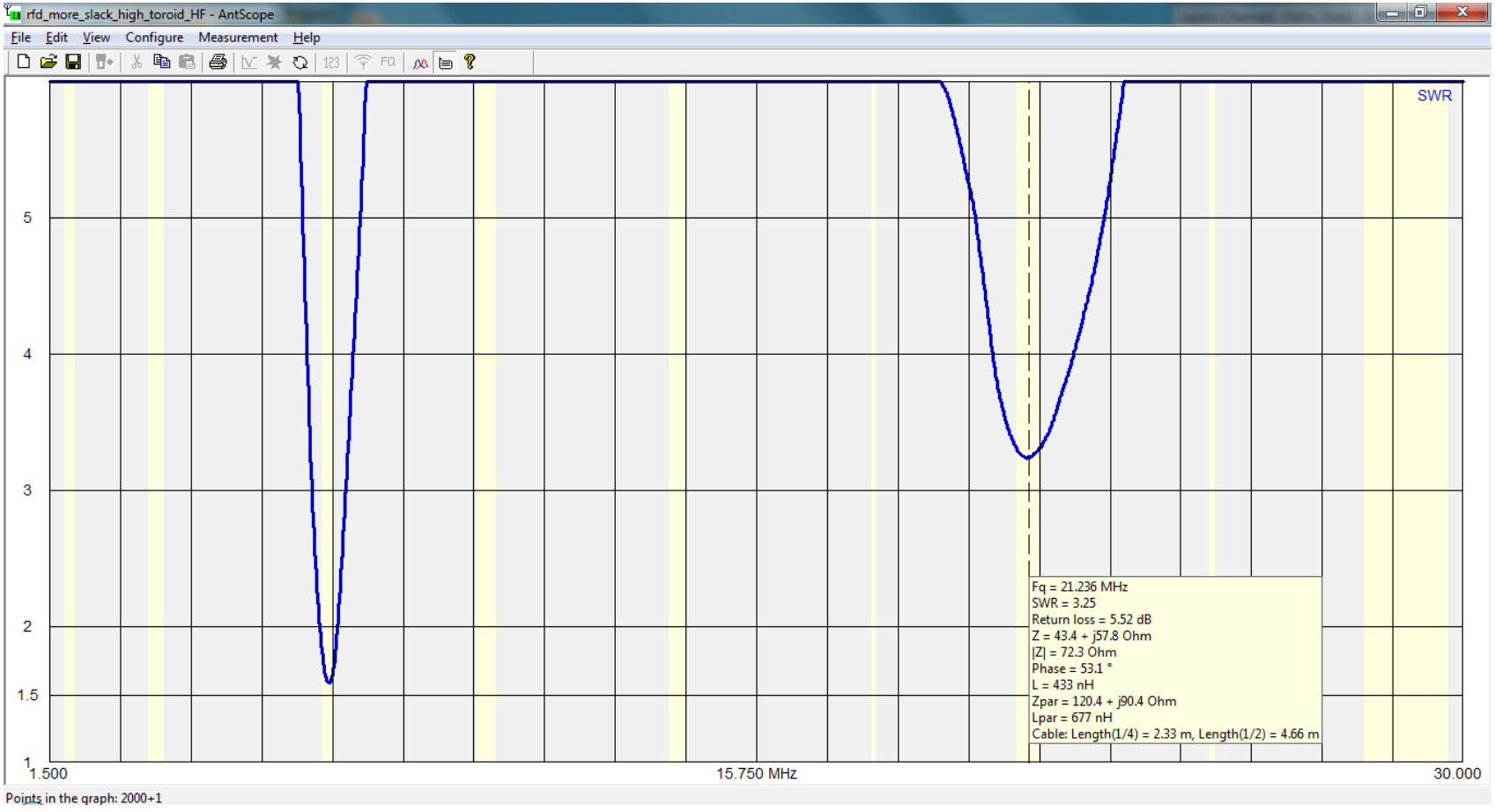
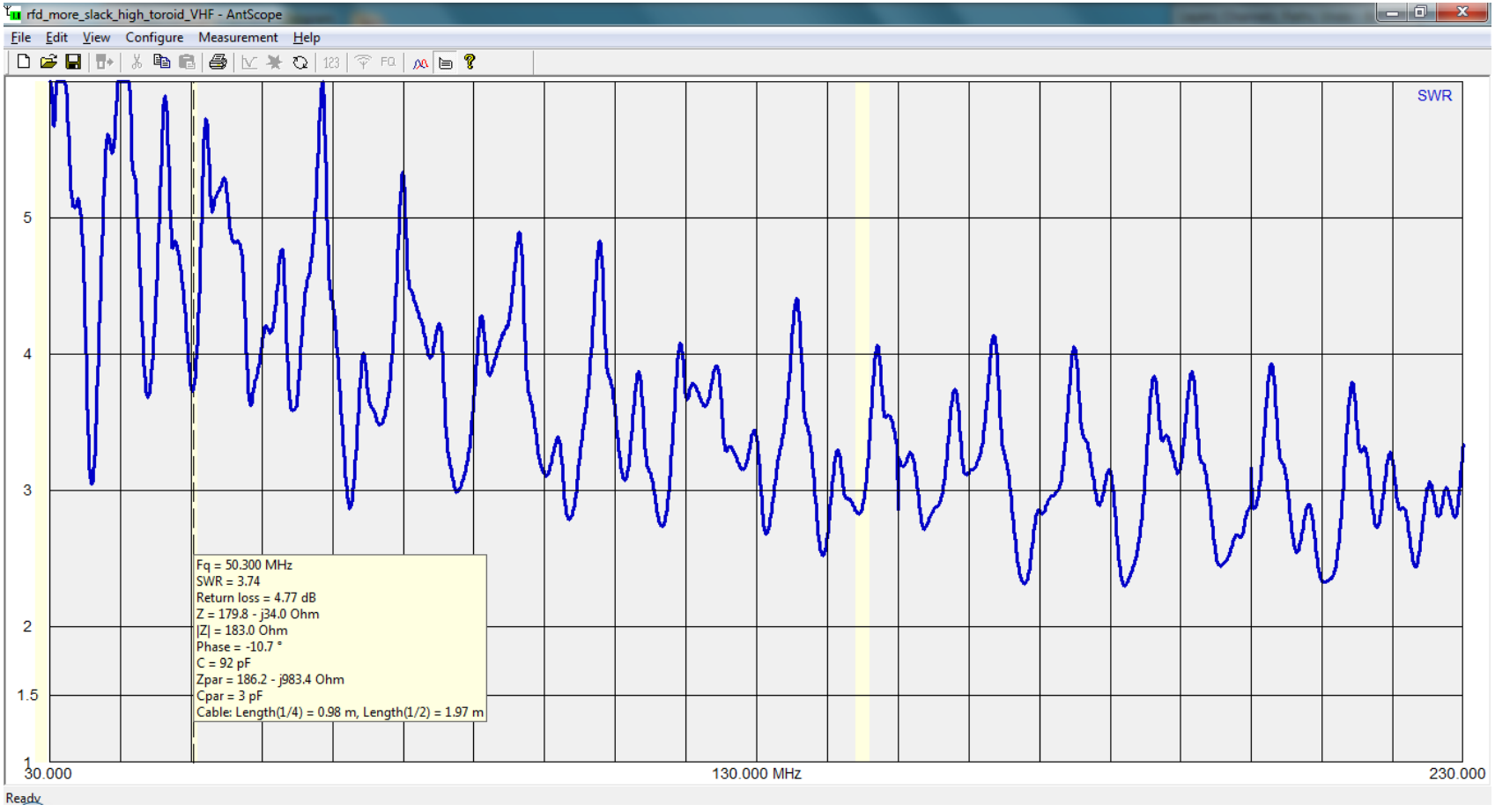


# At K6JEB Station: HF Spectrum



# At K6JEB Station: VHF Spectrum



# At K6JEB Station

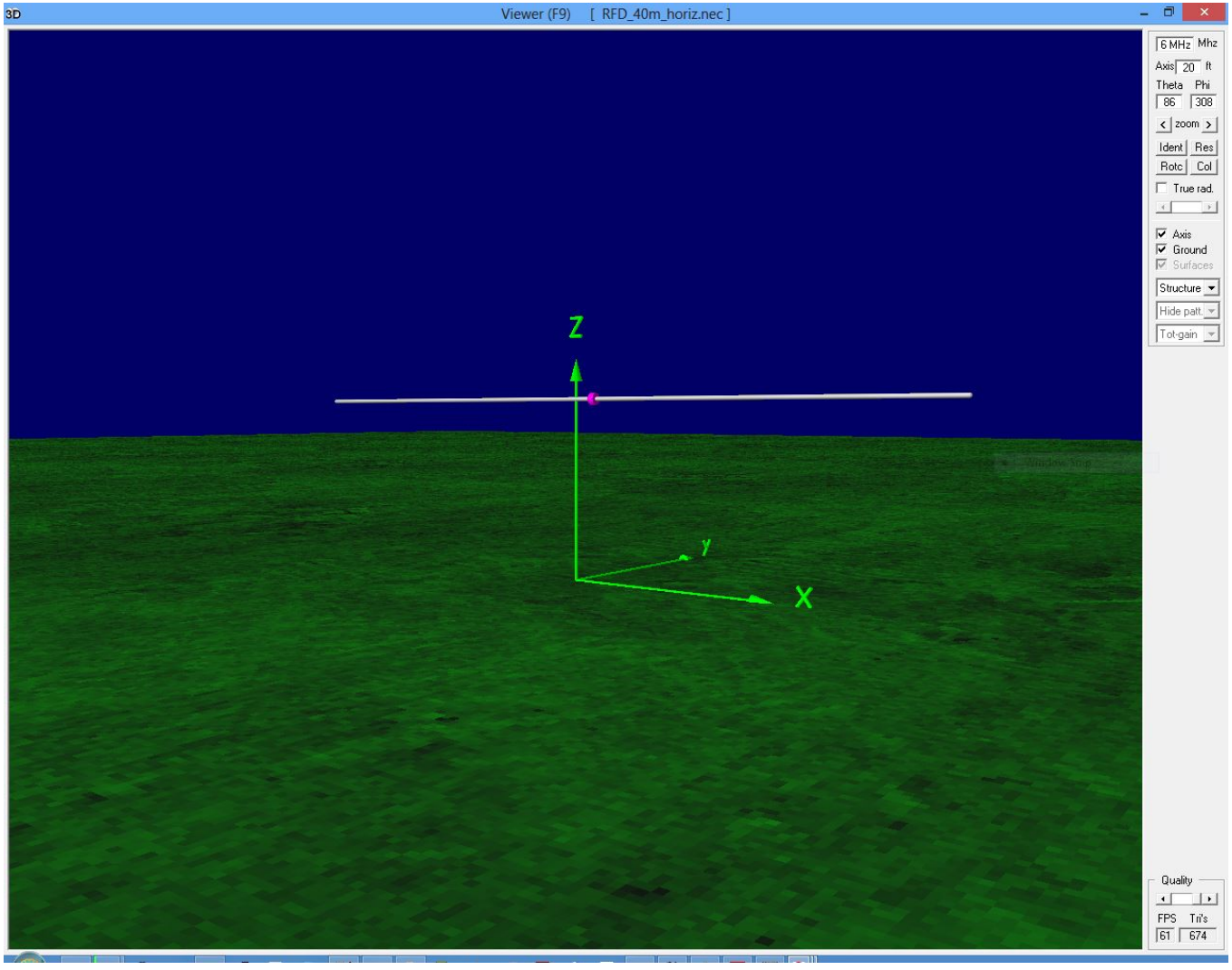
- Subjective measurements
  - Receive quality similar to vertical with 64 radials
  - 59 report on SSB to and from W1AW/7 in Oregon (100 W)
  - Worked W1AW/1 in Vermont with 400 W CW

# Outline

# Modeling

- Model for 40 m dipole
- Model higher harmonics, but move toroid
  - 20 m
  - 15 m
  - 10 m
- Model using `EZNEC` or `nec2c`

# Model: 40 m Horizontal Dipole



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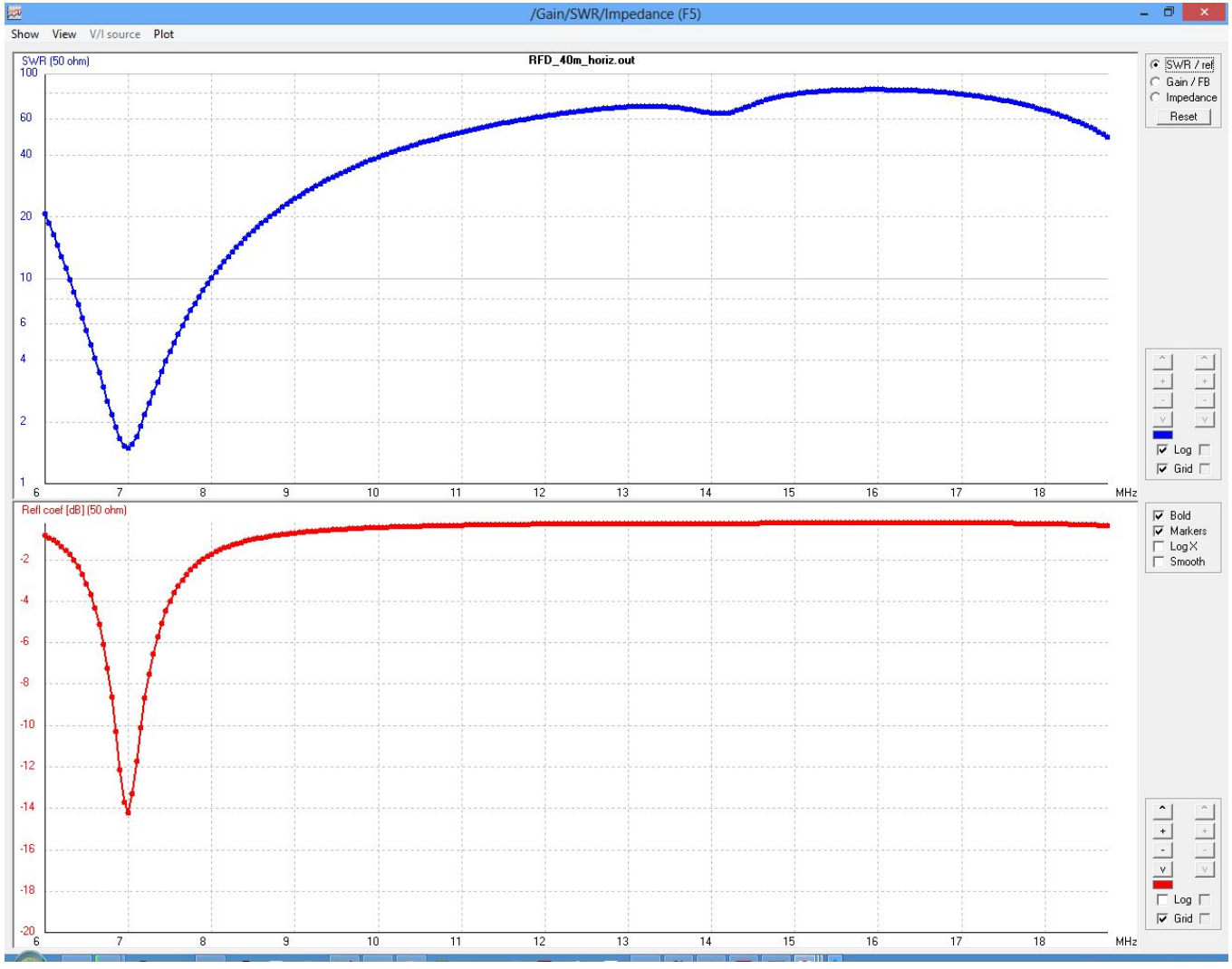
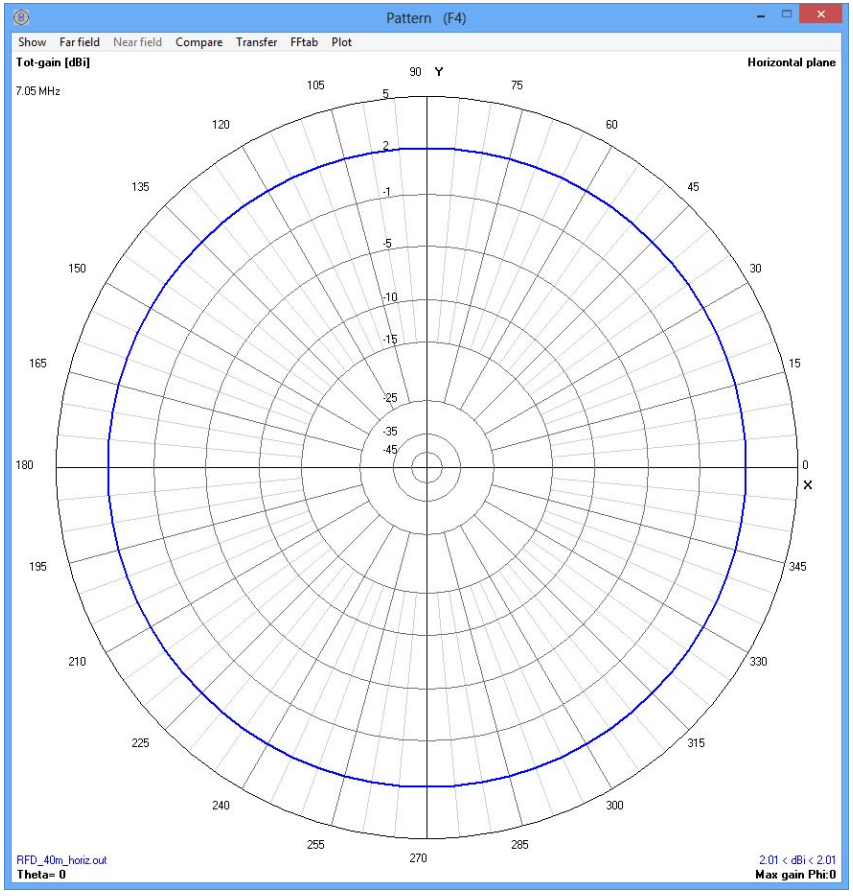
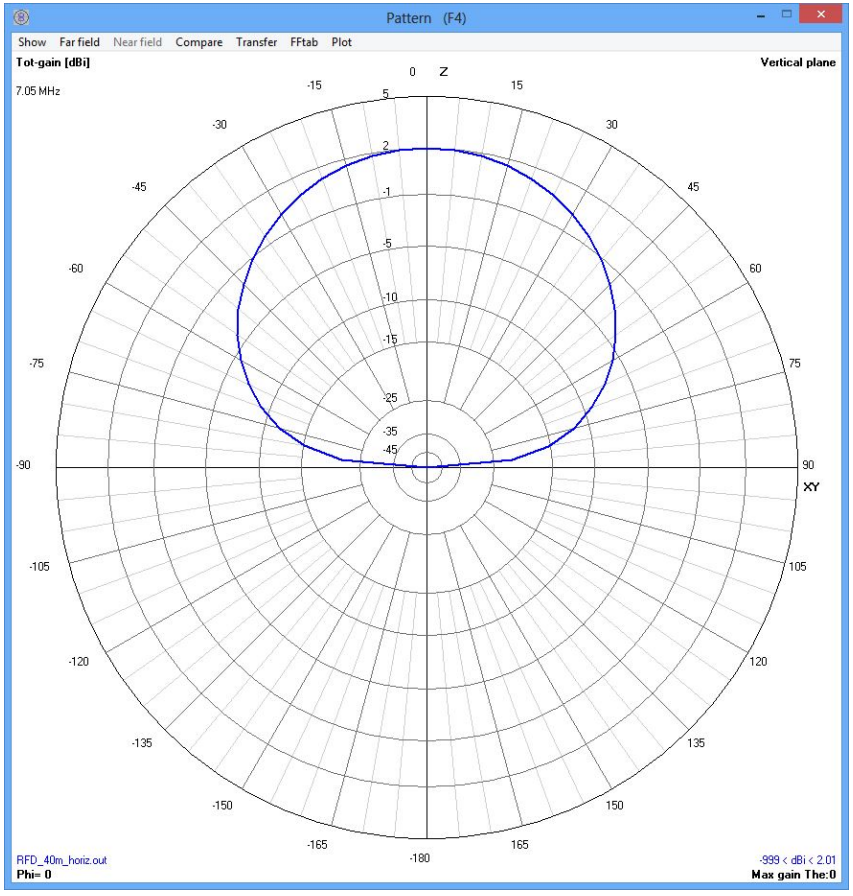


# Model: 40 m Horizontal Dipole

## Azimuth

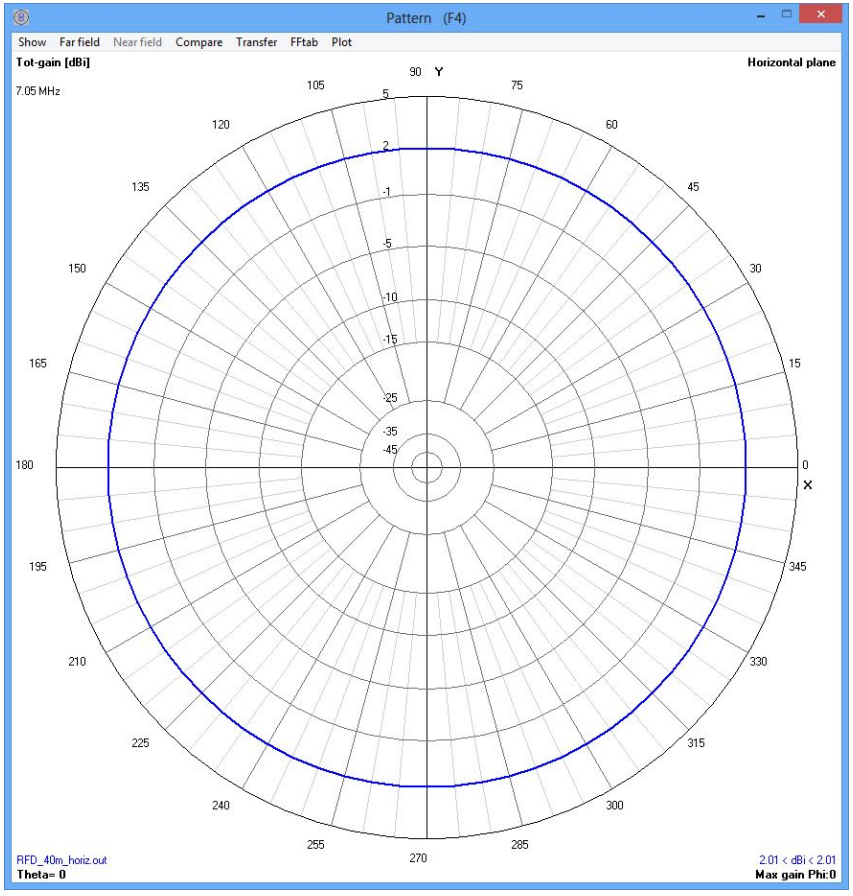



## Elevation



# Model: 40 m Vertical Dipole

## Azimuth

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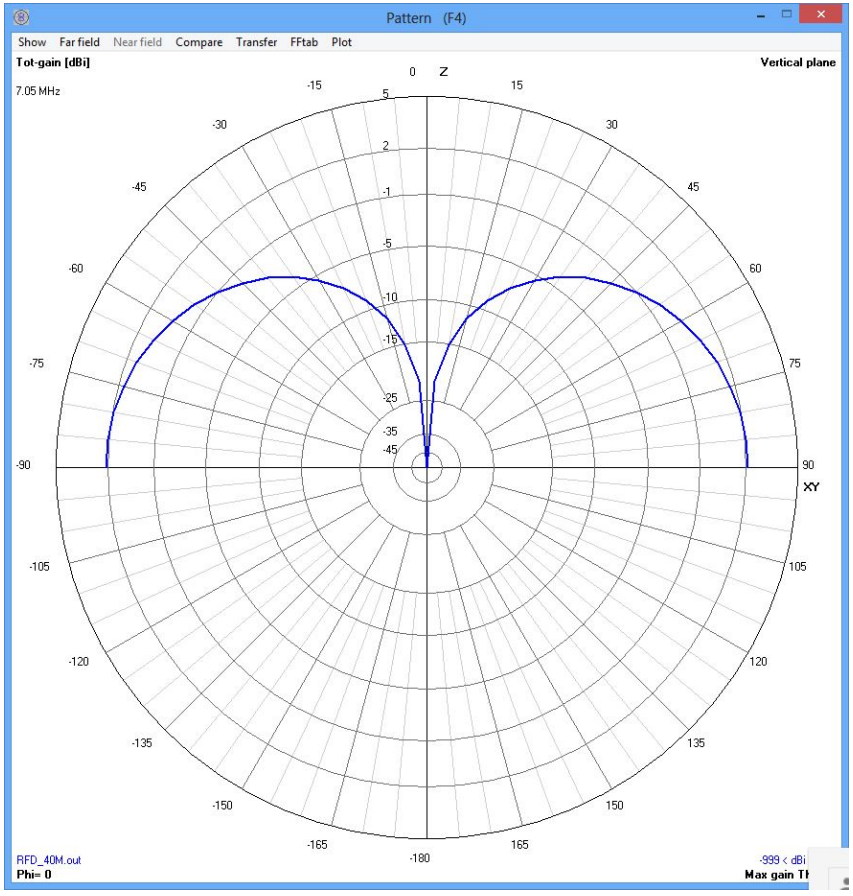
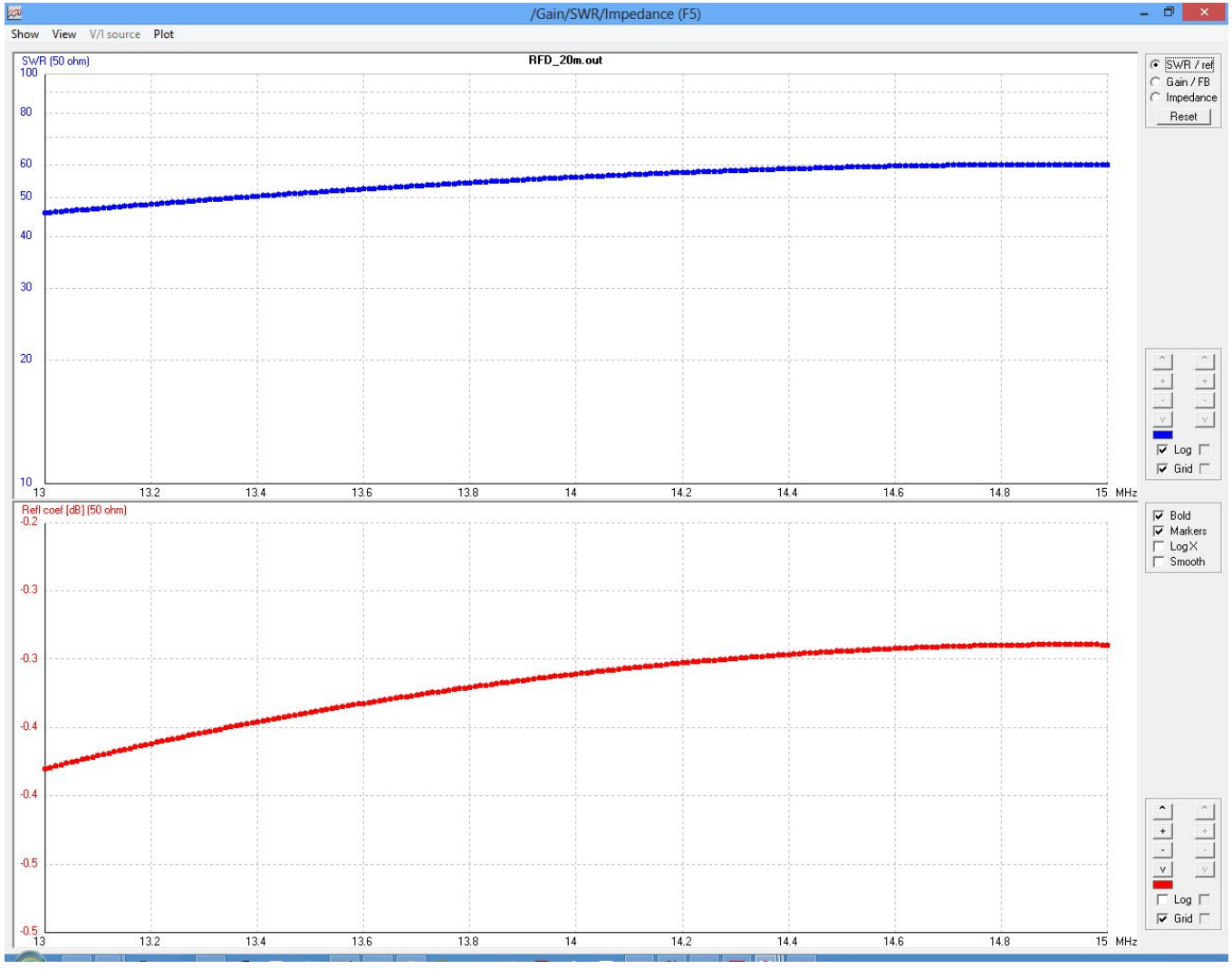
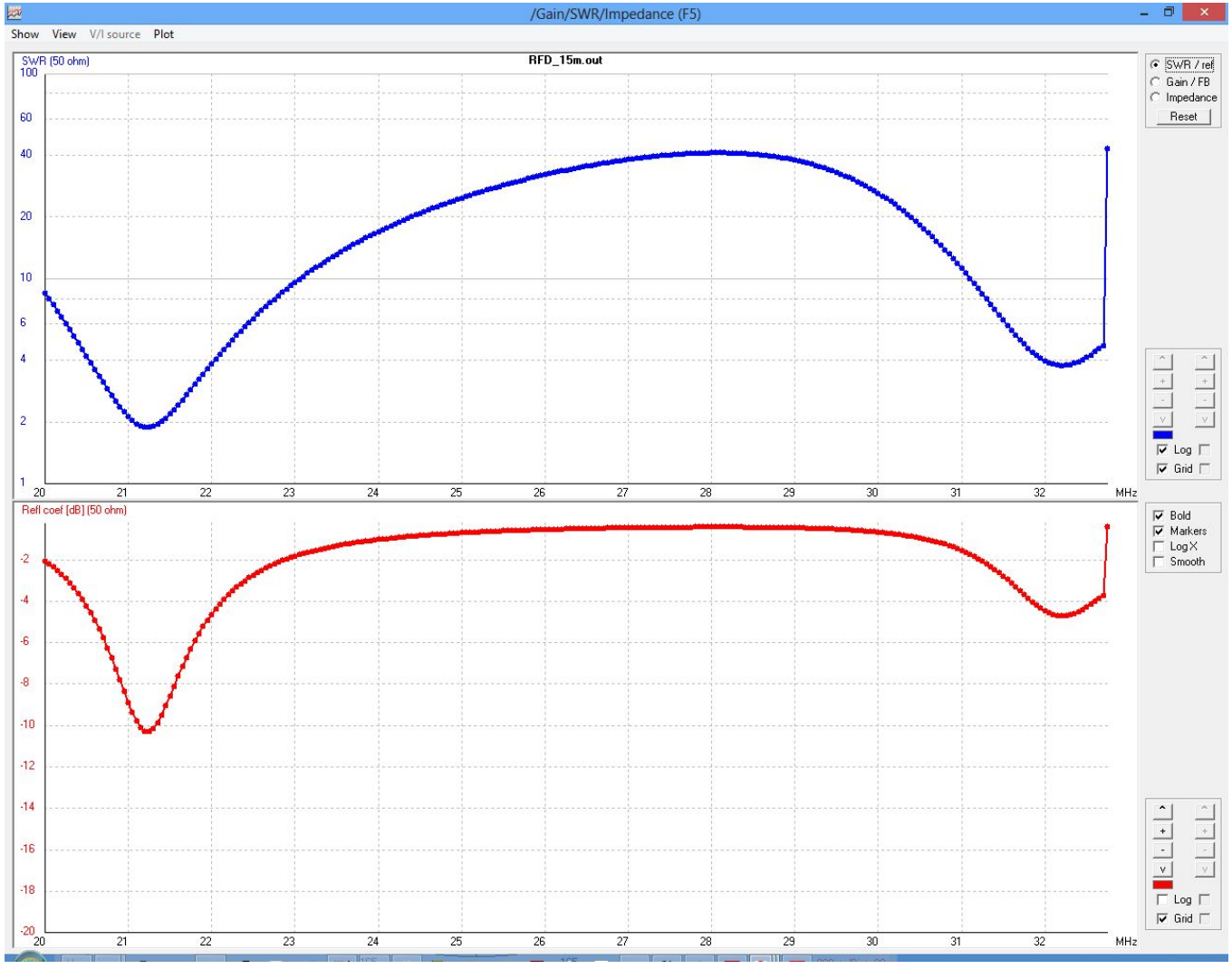


# Model: 20 m Vertical Dipole

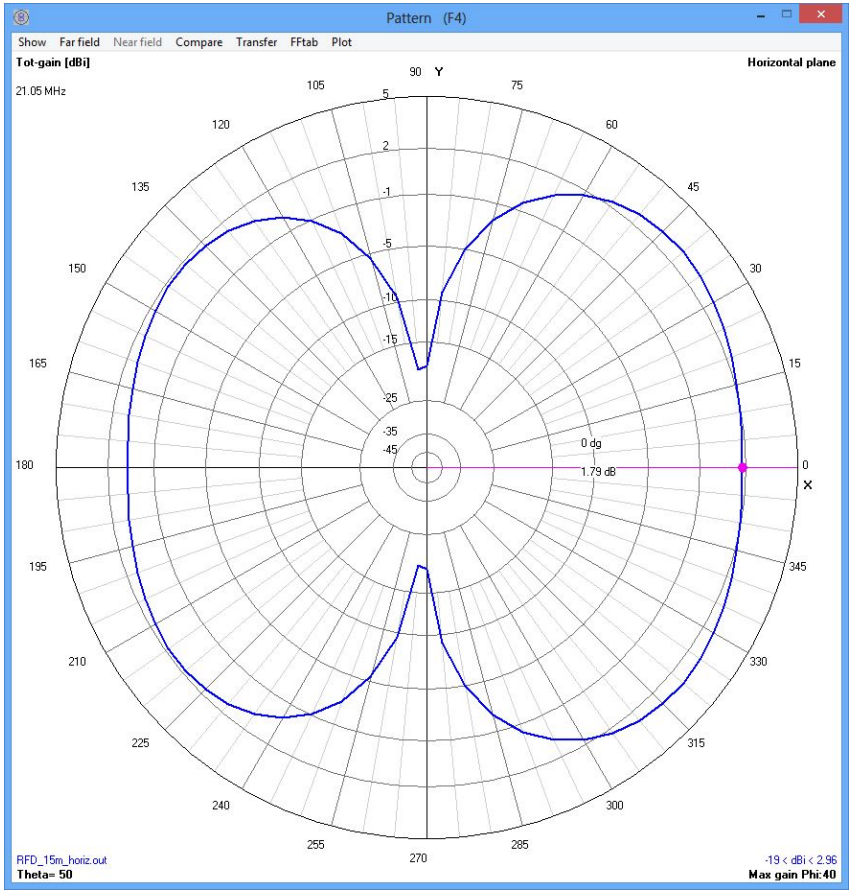


# Model: 15 m Vertical Dipole

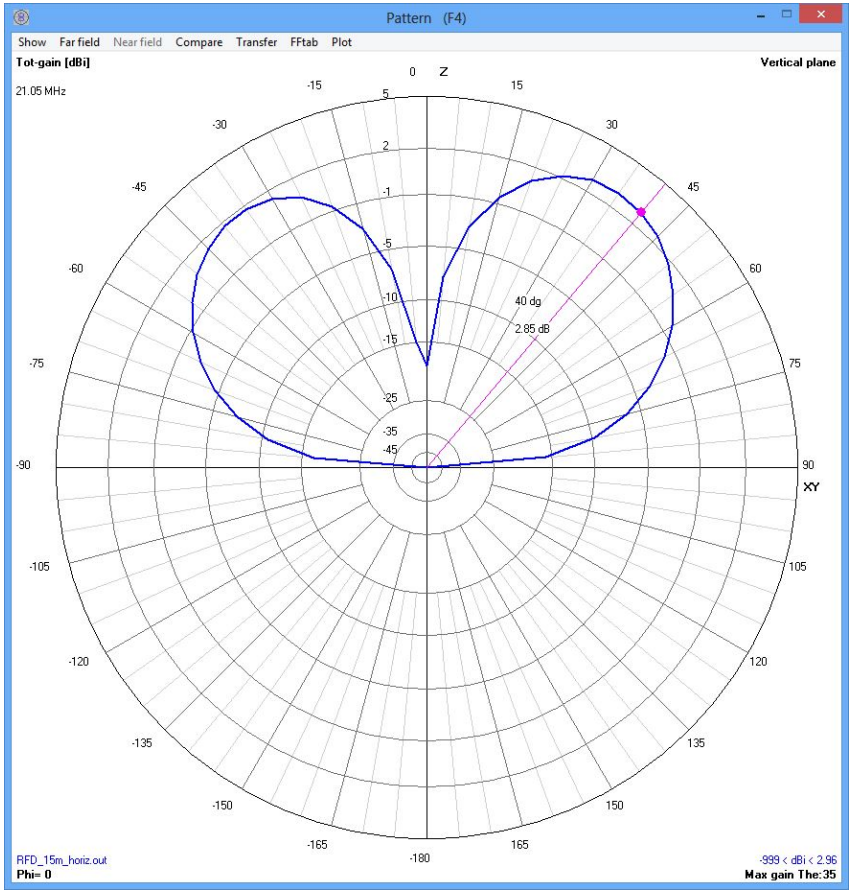


# Model: 15 m Horizontal Dipole

## Azimuth

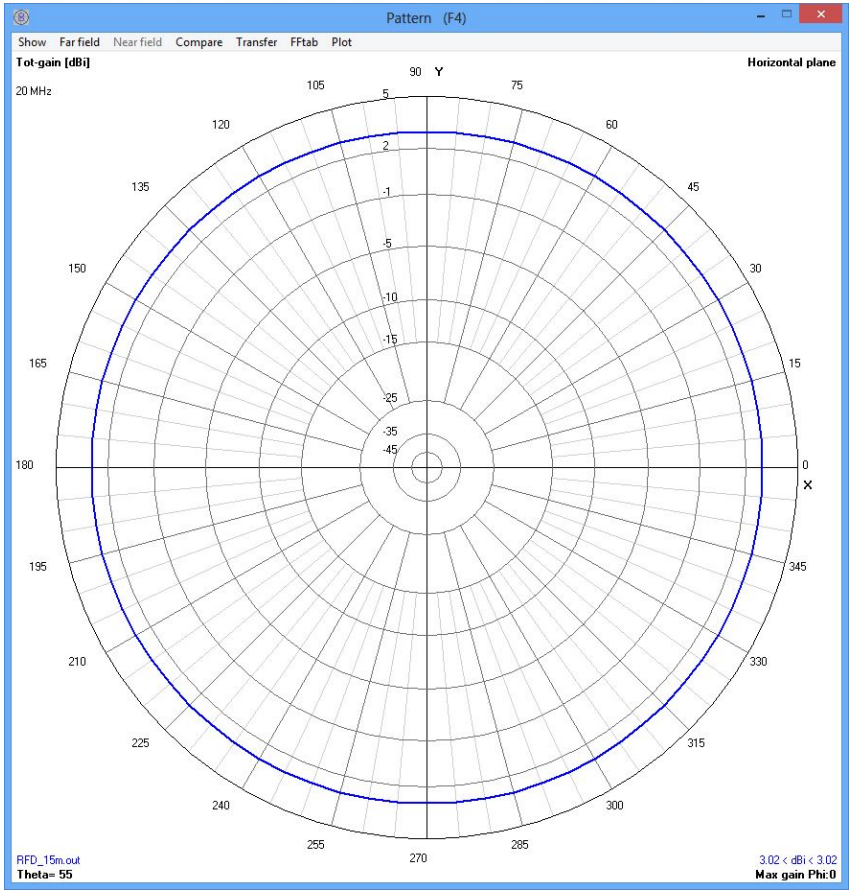



## Elevation



# Model: 15 m Vertical Dipole

## Azimuth

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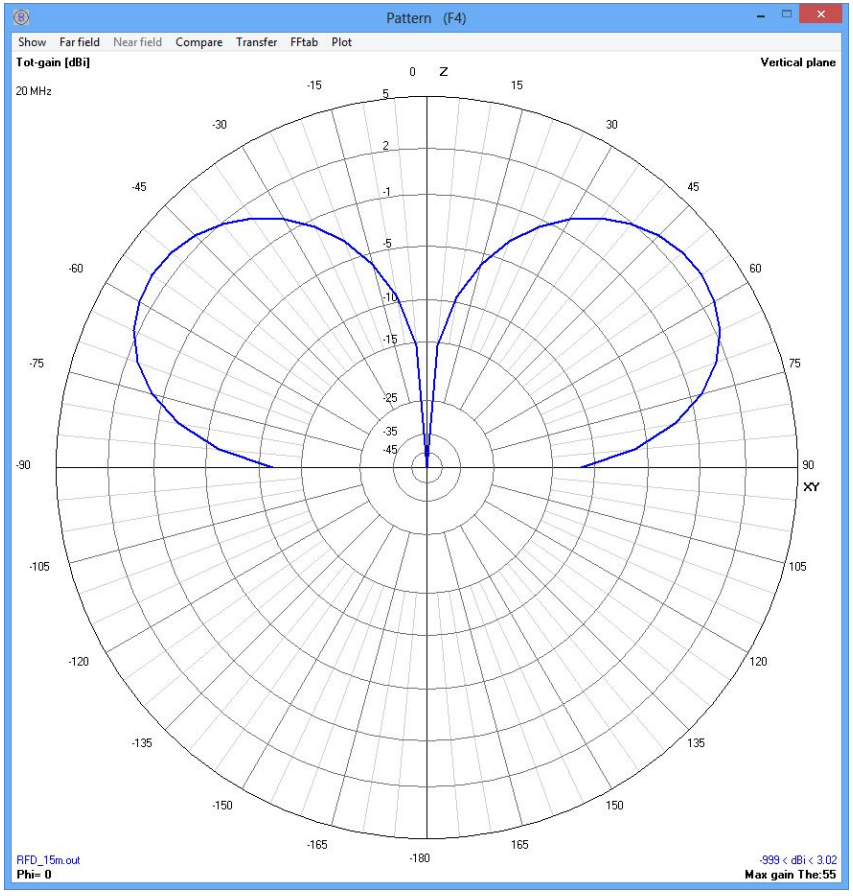


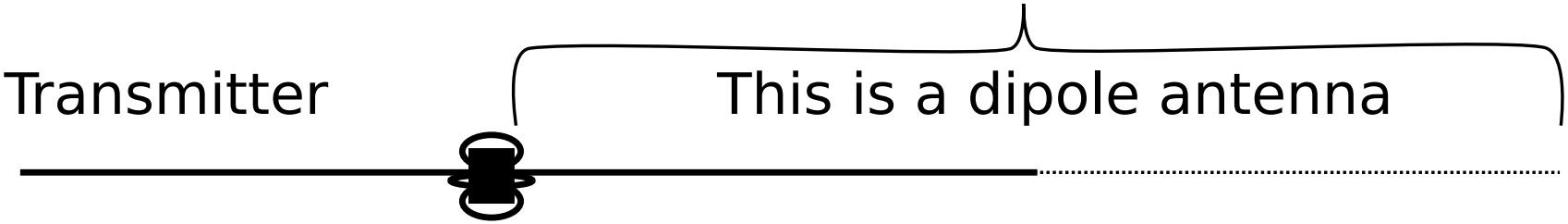
# Modeling Summary

- Works with <2:1 SWR for all of 40 m band
- Terrible for 20 m, 15 m not very good (choke wrong)
- Move toroid for 2:1 SWR on 15 m
  - Toroid goes 3.01 m (9.84') from center of dipole
  - Use 5 turns of coax in choke (c.f. K9YC's RFI handbook)
  - Radiation pattern will be weird
  - Run less power at the higher SWR

# Outline

# Conclusions

- Resonant Feedline Dipole works as designed
- Simple build
- 15 m works with 2:1 SWR if you move the toroid
- Can handle power up to 400–500 W (less on 15 m)
- Small design changes for a lighter QRP antenna
- Deployment is very important to antenna SWR
- Antenna analyzer is really useful



# Further Reading

- RFI and Toroid Handbook, Jim Brown (K9YC)
- James Taylor (W2OZH) "RFD-1 and RFD-2: Resonant Feed-Line Dipoles" *QST*, Aug. 1991, p. 24
- N5ESE's Look at the RFD, Monty Northrup (N5ESE)
- Revisiting the Resonant Feedline Dipole, Mike Boatright (KO4WX)
- *The Ashley Book of Knots*, Clifford Ashley, 1944

# Acknowledgments


- Jim Brown, K9YC
- Anita Flynn, KI6LO
- EBARC, W6CUS

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