2M YAGI-UDA

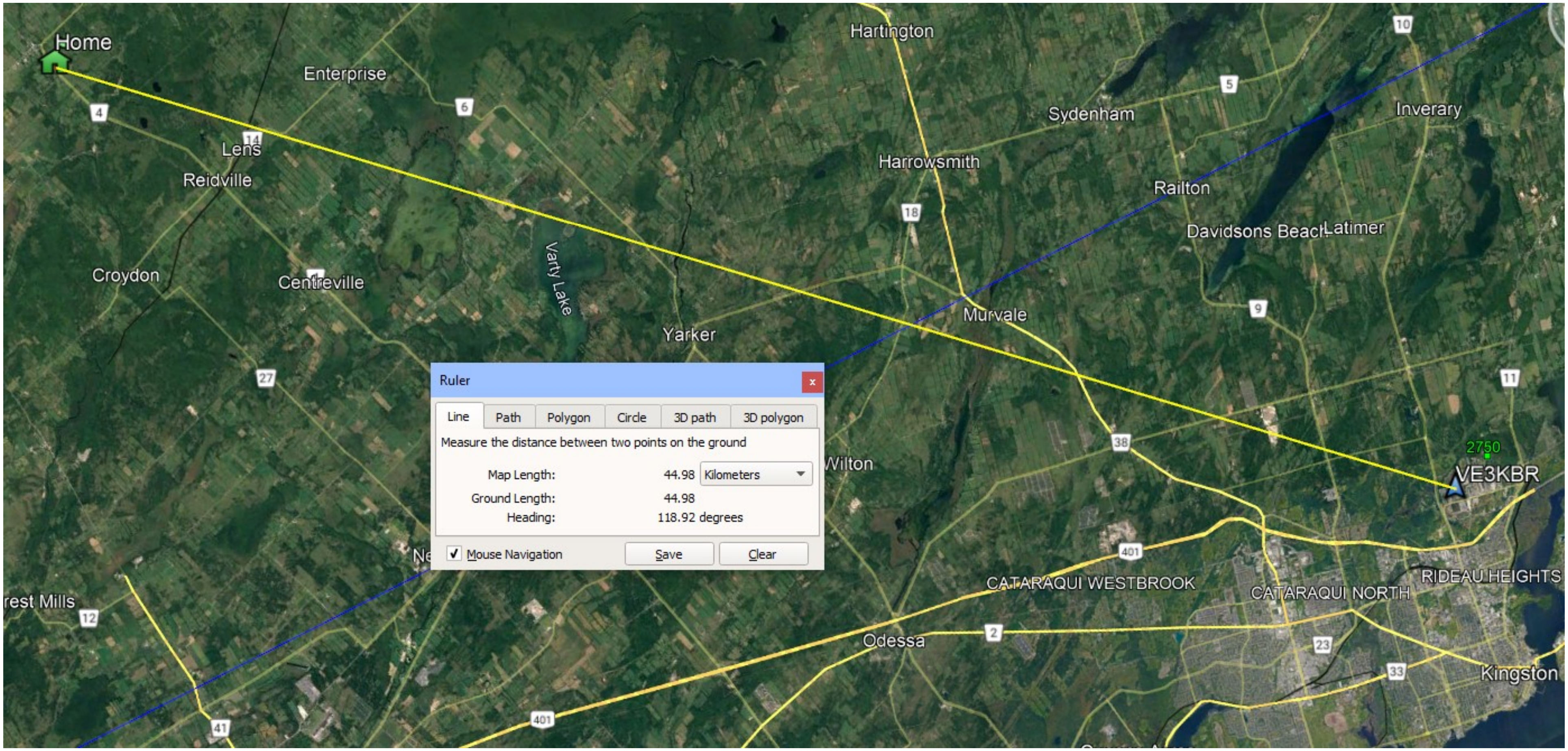
For

Fringe Area Communications

The Problem:

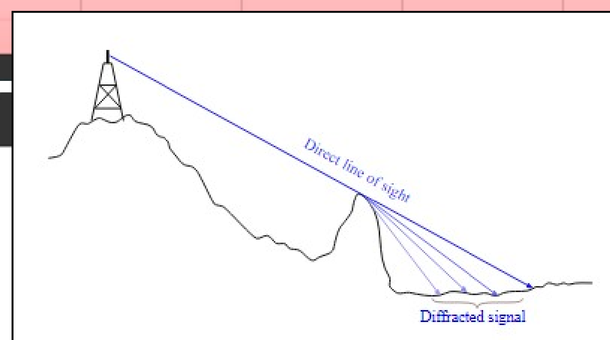
- Access the repeater that is 45 KM away
- Bearing is 120 degrees

Some signal can be heard, but extremely noisily, and even 50 Watts into a quarter wave mobile antenna will not bring up the repeater.



Further Analysis:

As you can see from this **Google Earth elevation profile** I do not have a clear path. However with diffraction effects, I should be able to communicate. Diffraction will, however, create significant additional path loss, especially on transmit.



Radio wave diffraction

The Solution

- Given we are depending on diffraction, a physically higher base antenna will provide significant help - I need to get something with gain up on the tower
- A directional antenna will help to reduce interfering noise sources in directions other than the one of interest
- I'm not sure how much gain I'll need, but since it *almost* works, an extra 6-10 dB should be sufficient

Time to try a Yagi

- A bit of number crunching, and I thought I'd start with a 6-element design
- EZNEC suggests 11.5 dBi improvement (see below)
- Design includes 1 Reflector, 4 directors, 1 driven element
- I found some 13 mm flat stock aluminum 3.5 mm thick in 8 foot lengths and some 8 foot channel stock for the boom as well on price reduction at Princess Auto (total cost $16)
- I used VK5DJ's Yagi calculator for everything but the driven element matching

The Design:

The initial design called for all metal construction with the elements and boom electrically bonded. After a bit of further research, it seems that aluminum to aluminum connections quickly degrade due to oxidation unless welded. Once the elements are no longer well connected to the boom, the frequency shifts.

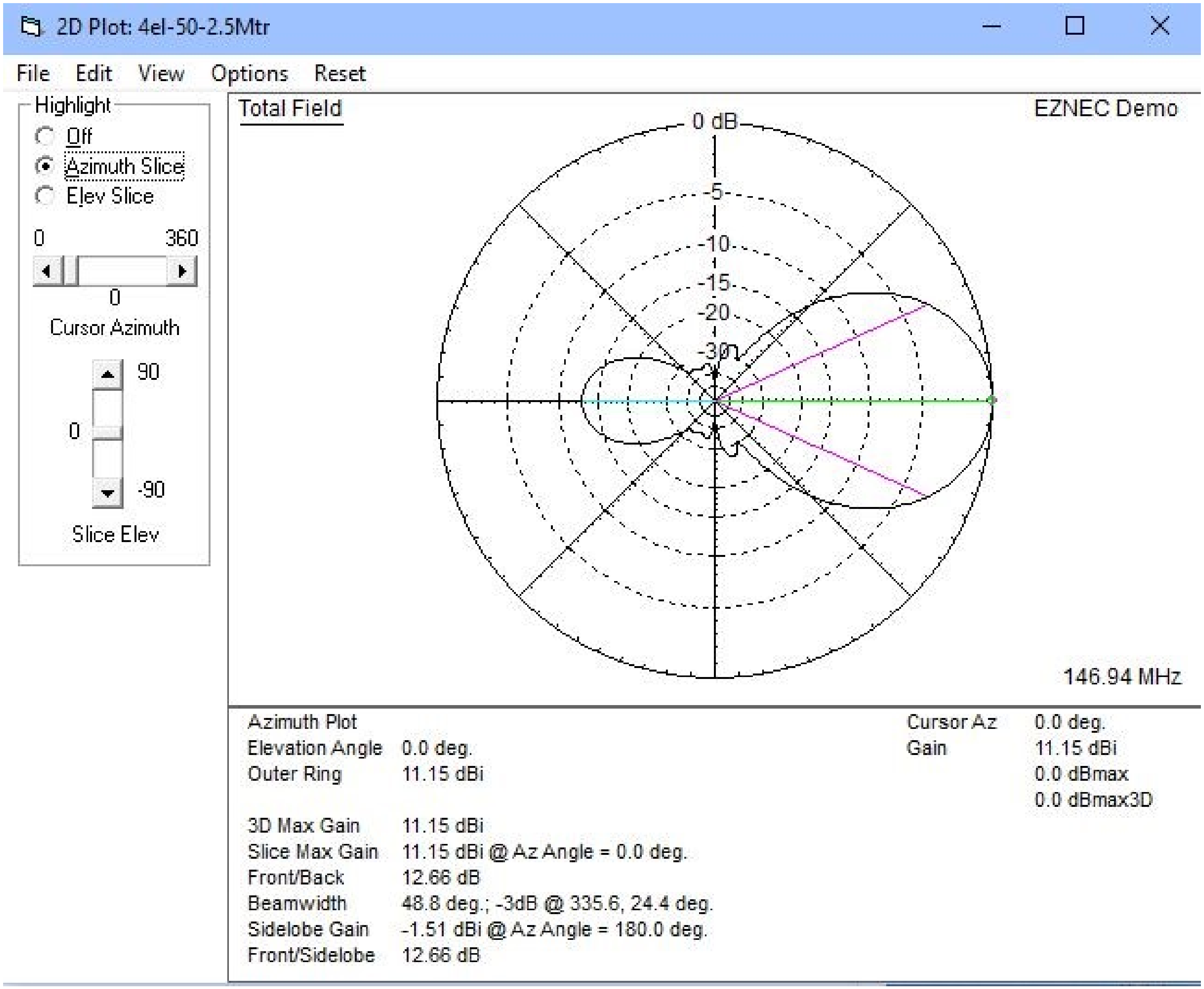
I found a package of nylon guides for sliding doors at the hardware store for $5.95 and decided I could trim them to make insulators. I recalculated the antenna for insulated connections to a metal boom, and recorded the measurements below.

Insulated from Boom						
	Length (mm)	**Length (in)**	**Spaced (mm)**	**Spaced (in)**	**Boom position (mm)**	**Boom position (in)**
Wavelength	2053.00	80.83				
Boom length	1949.10	76.74				
Reflector	1004.90	39.56		0.00	30.00	1.18
Radiator	967.80	38.10	410.70	16.17	440.70	17.35
Director-1	906.80	35.70	154.00	6.06	594.70	23.41
Director-2	897.30	35.33	369.60	14.55	964.30	37.96
Director-3	888.40	34.98	441.50	17.38	1405.80	55.35
Director-4	880.20	34.65	513.30	20.21	1919.10	75.56

Reflector and Director Mounting

Reflector and Director Mounting – other side

Simulation:


2D Plot: 4el-50-2.5Mtr
File
Edit
View
Options
Reset
Highlight
Off
Azimuth Slice
Elev Slice
0
360
0
Cursor Azimuth
90
0
-90
Slice Elev
Total Field
EZNEC Demo
0 dB
-5
-10
-15
-20
-30
146.94 MHz
Azimuth Plot
Elevation Angle 0.0 deg.
Outer Ring 11.15 dBi
3D Max Gain 11.15 dBi
Slice Max Gain 11.15 dBi @ Az Angle = 0.0 deg.
Front/Back 12.66 dB
Beamwidth 48.8 deg.; -3dB @ 335.6, 24.4 deg.
Sidelobe Gain -1.51 dBi @ Az Angle = 180.0 deg.
Front/Sidelobe 12.66 dB
Cursor Az 0.0 deg.
Gain 11.15 dBi
0.0 dBmax
0.0 dBmax3D

The matching problem:

Measuring with the NanoVNA showed feed point impedance of about 22 ohms resistive. This suggests the resonant length is right, but we will need to raise the impedance to 50 ohms.

•My first thought was a transformer. Turns ratio would be 7:5 and would also take us from unbalanced to balanced. Unfortunately my junk box did not have a suitable toroid. This might be a future modification, especially if I measure a lot of RF coming back along the coax.

•Next thought was a beta match. This U shaped wire about 5 inches long typically corrects the impedance of Yagi antennae, however my measurement showed this made things slightly worse at the frequency of interest.

•I then twisted it into a single turn coil and re-measured – impedance was lower again

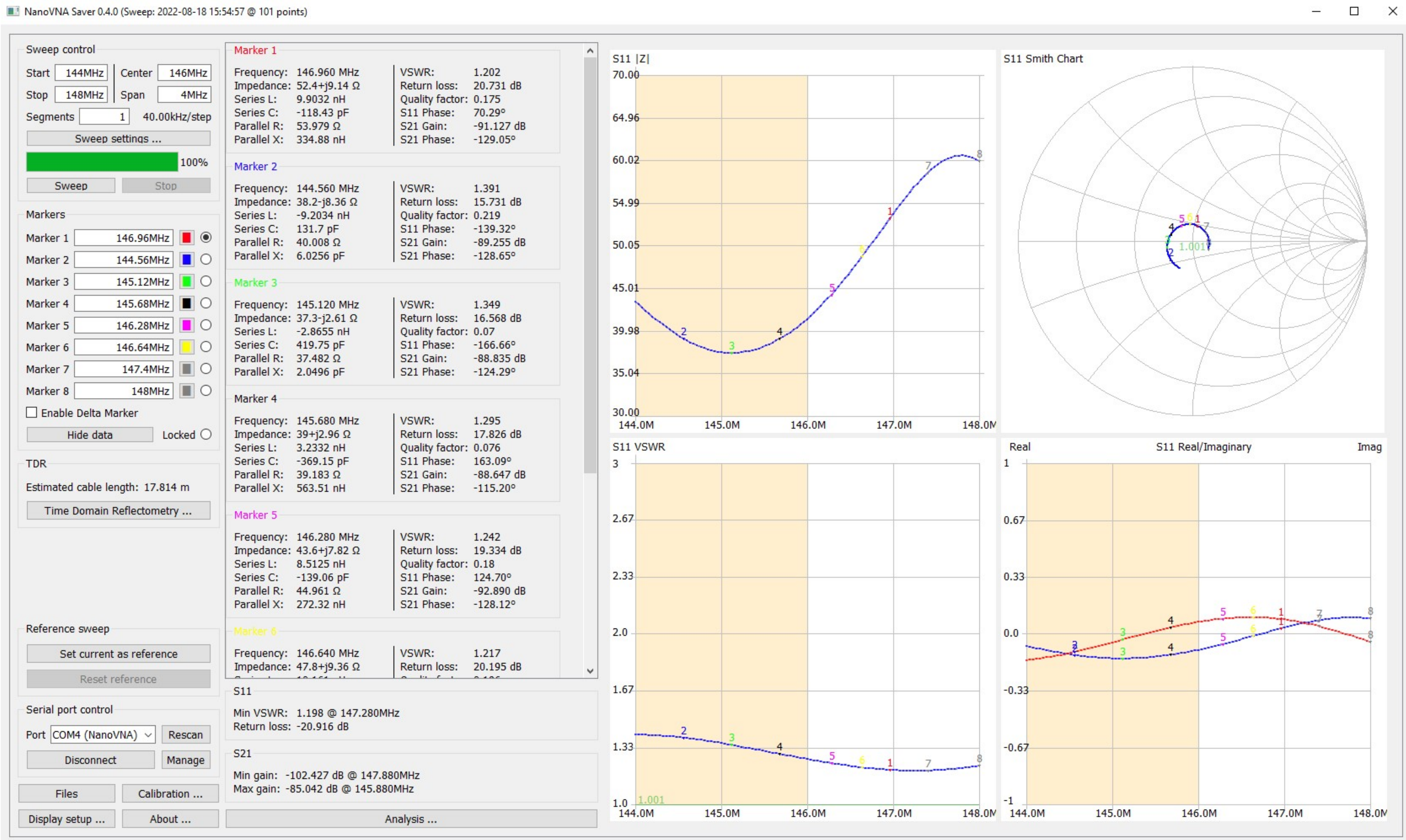
•Clearly I need a capacitive element, so I cut the wire in half and pushed the two pieces close together in parallel. This improved thing but not quite enough.

•I then bent them over parallel to the radiating element – still more improvement

•Finally I moved them as close as made sense and the match was excellent.

•**The final NanoVNA readings are attached below.**

NanoVNA Measurements



Driven Element Mounting

Driven Element Matching Network

The final product

The Result:

I was able to bring up the repeater with a Baofeng UV5R (approximately 5 watts). I logged into the repeater with Echolink, and was able to send and receive both directions. <u>This brings talking to yourself to a whole new level!</u>

Other notes:

•Because the antenna mounts vertical polarization, the support pole is ABS pipe for the first 6 feet or so to get about a wavelength away before introducing any metal into the field.

•The feed coax loops back toward the center pole at right angles to the elements, then loops far outside the elements to try to keep it not in line with the elements if possible.

•The boom was not trimmed. Initially I thought I could get another director, but it is just a bit short for that. I will trim it in future just before final mounting.

Mounted for testing in the back yard