

# Building a Competitive Station for HF Contests and DXing

VE3VN  
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FN24br



# The beginning...VE4OY '72 to '79



# Ottawa -- 1979 to 1984

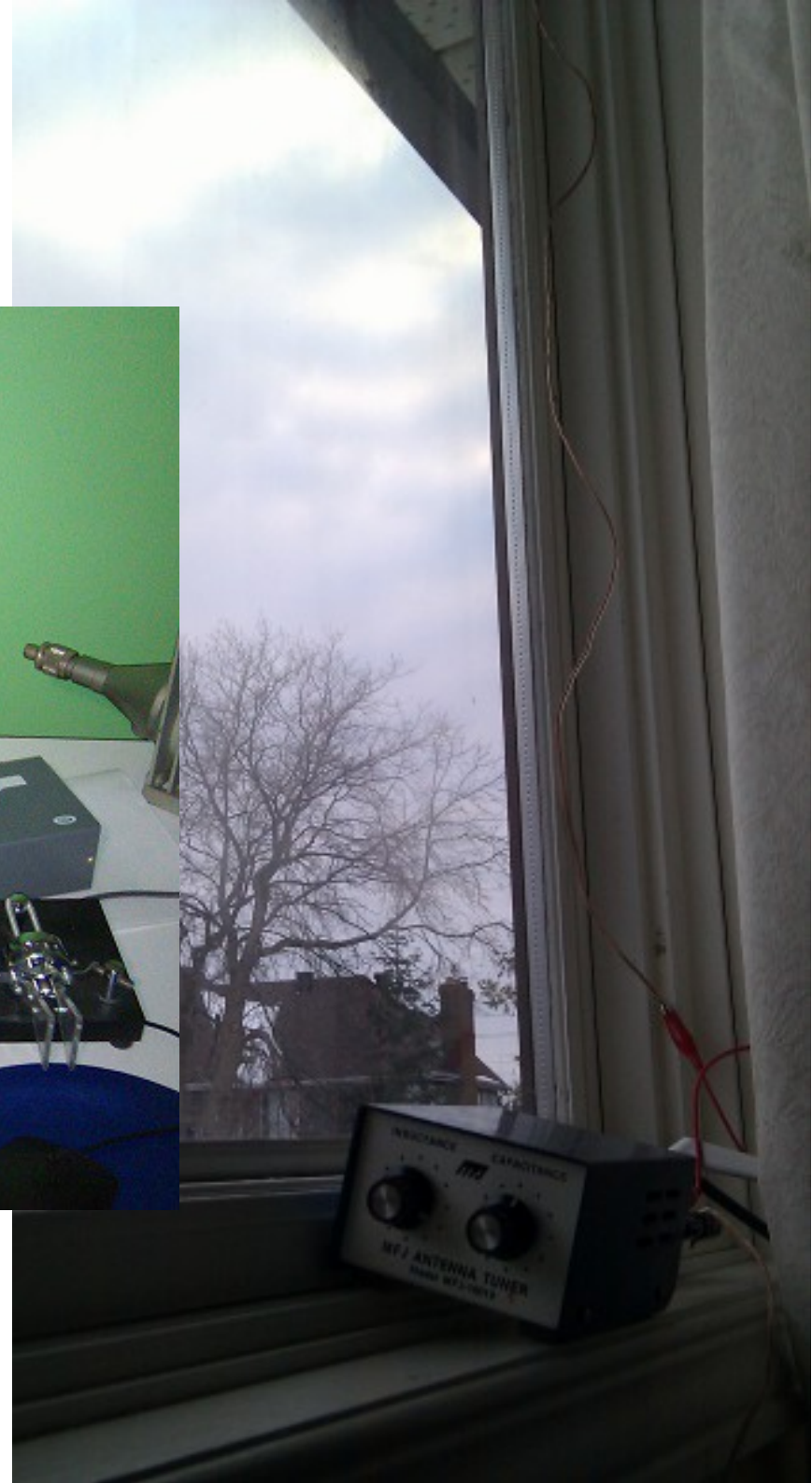
- Apartment dweller: no home station
- Active in multi-op contests and helping other build their antenna farms
  - Ottawa area: VE3PCA, VE3OCU, and many others
  - VE2, 3, 4 and 5

# VE3VN – '84 to '92



1992 to 2012

# 2013 – VE3VN returns



# Getting bigger -- '13 to '16



# Thinking bigger yet





# Time to Move



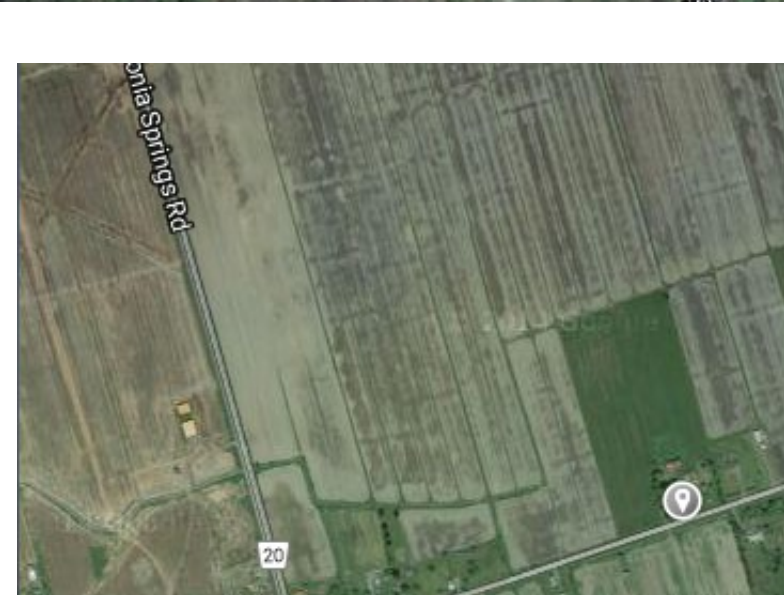
- Retirement presented an opportunity
- Freedom to do what I want
- Lots of room for towers and antennas
- Escape from noise
- Experiment with antennas
- Maybe win a contest or two
- What am I waiting for?

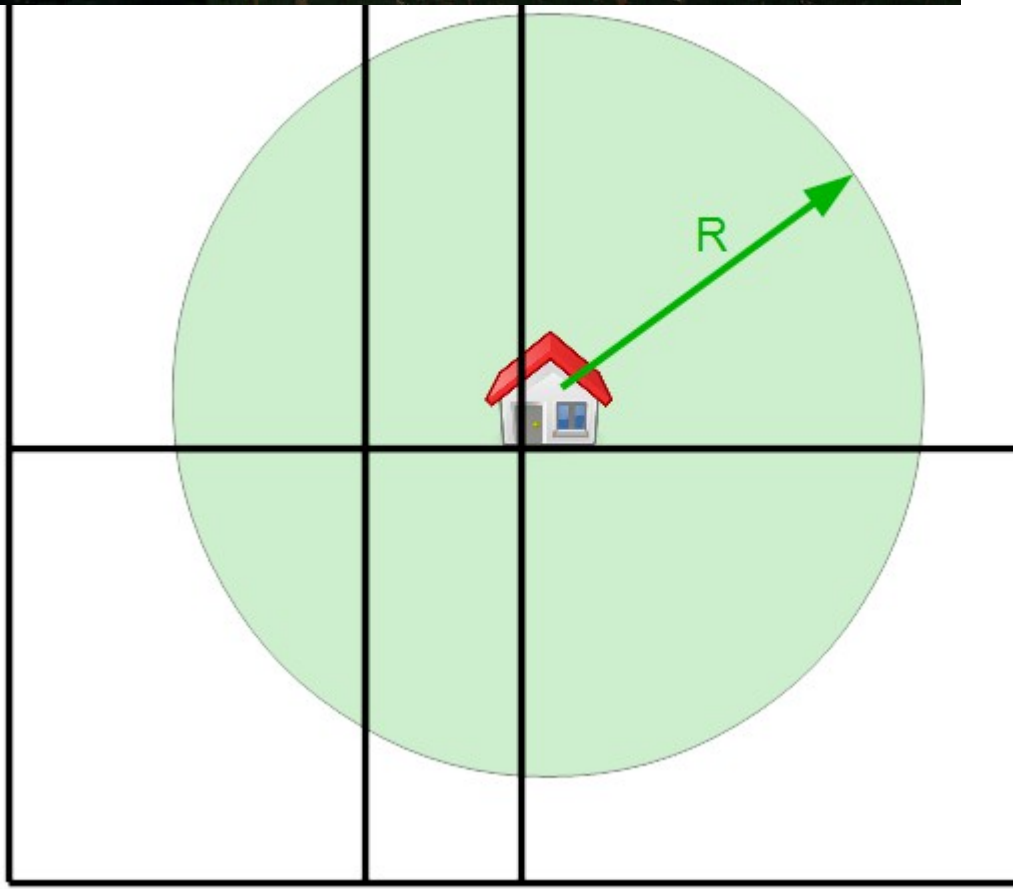
# Finding the perfect QTH

- Options for dealing with an imperfect world
  - Choose the house and adapt to the property
  - Choose the land and fix up the house
  - Choose the land and build a house
- Realtors aren't very helpful

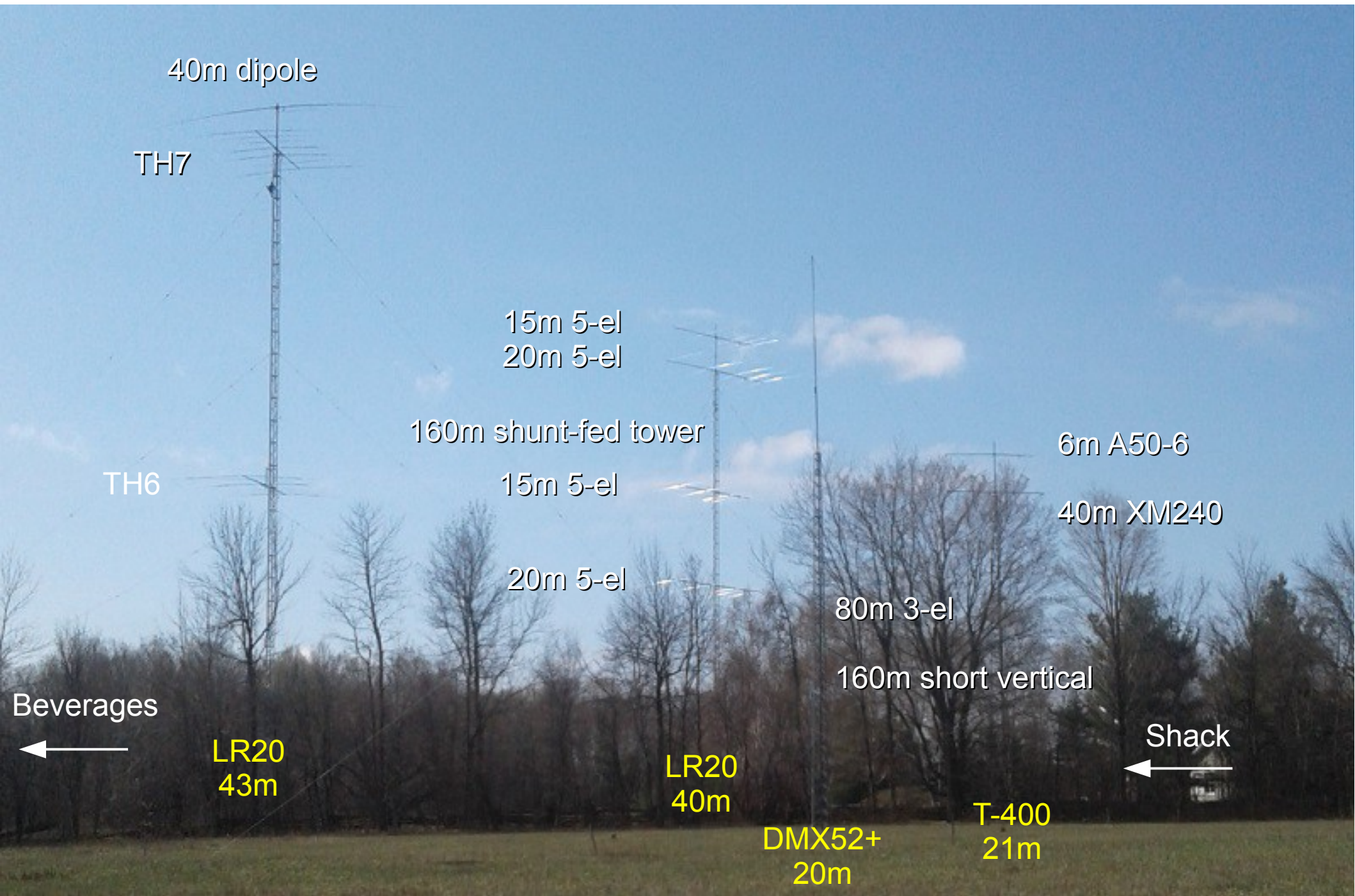


# Things To Beware

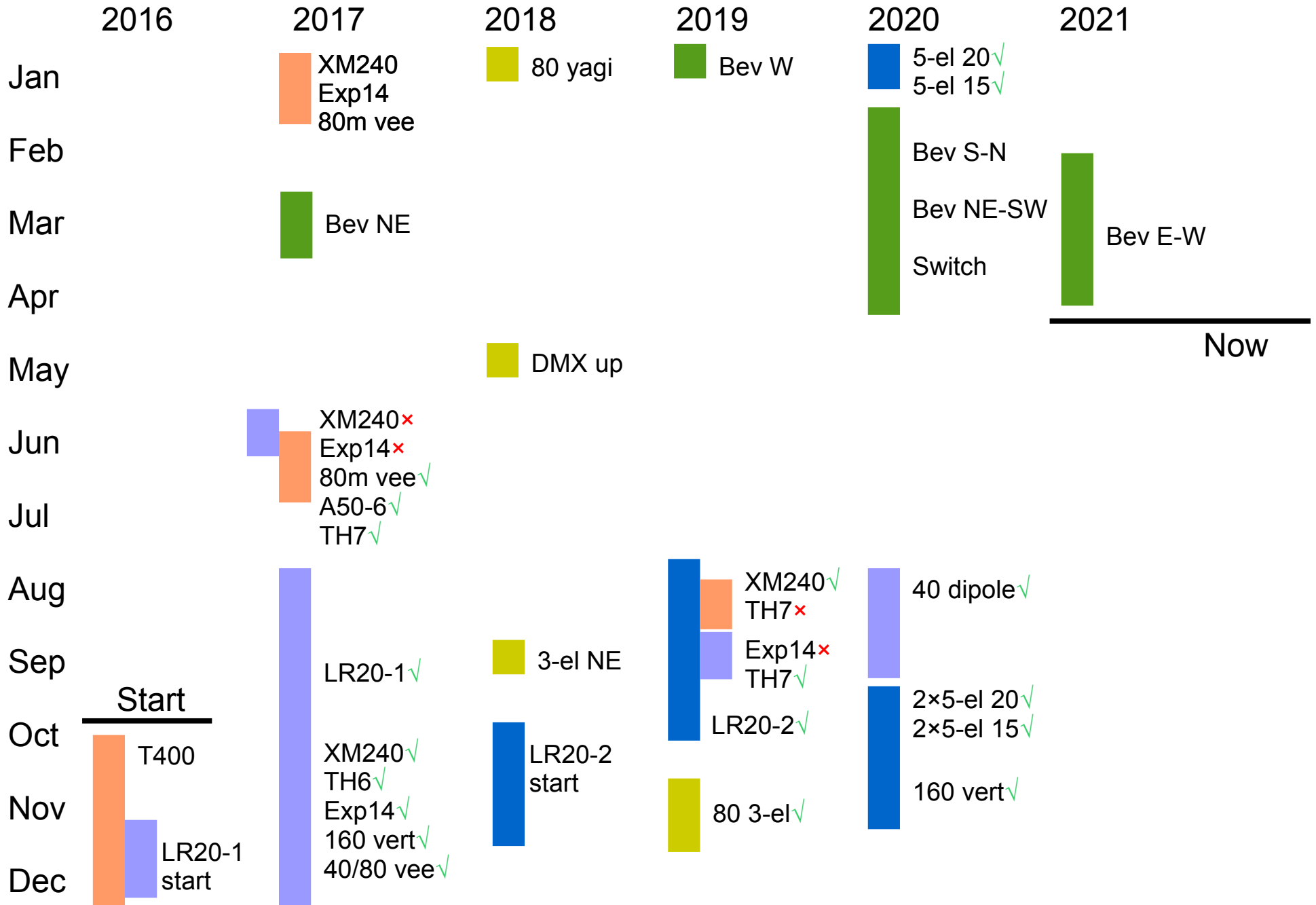




# 4-½ Years Into the Adventure



# Retirement is a Full Time Job



# Site Plan



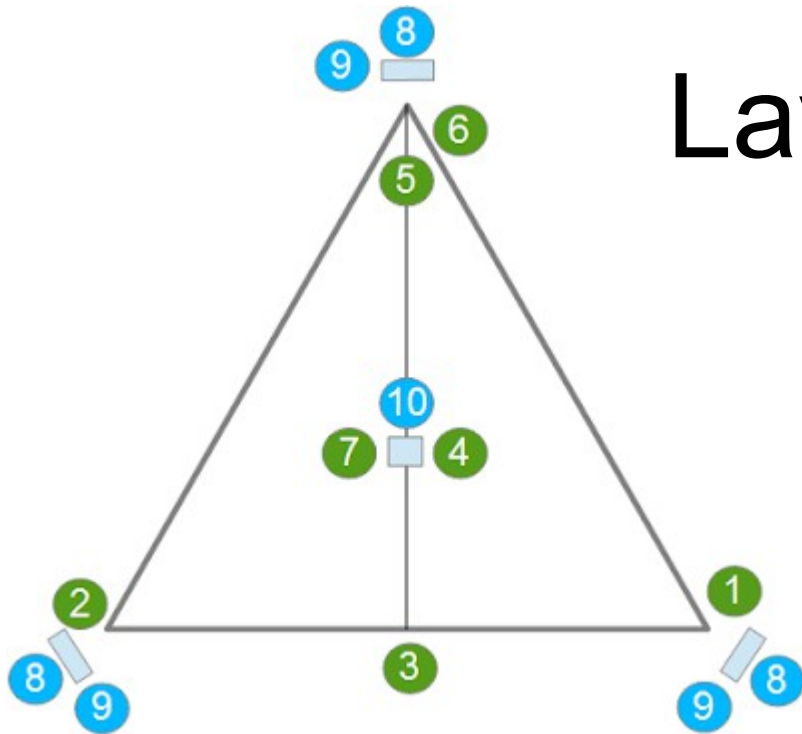
Google

# T400: Getting Started





# Layout of a Guyed Tower



- 1 acre: 200'+ baselines
- Fall zones
- Face orientation
  - Climbing & antennas



**What lies below?**



# Planting a 150' Tower Attempt #1



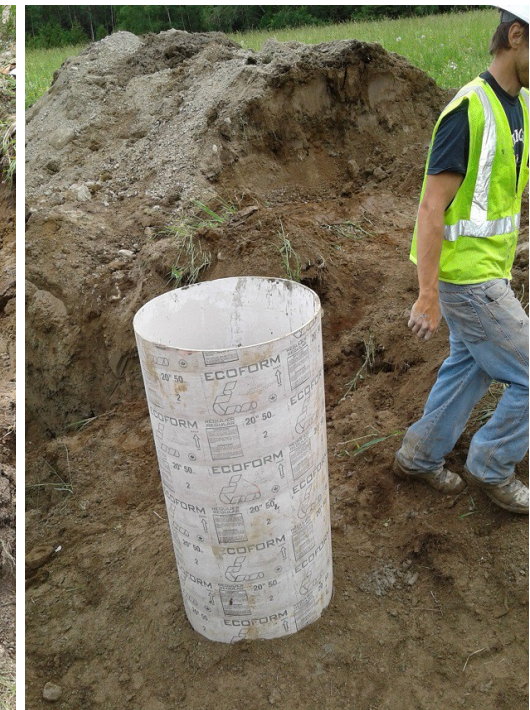
# Disaster Strikes



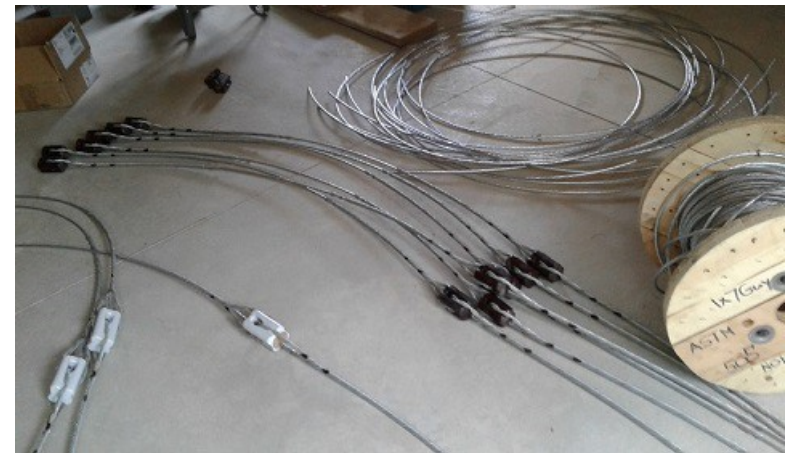
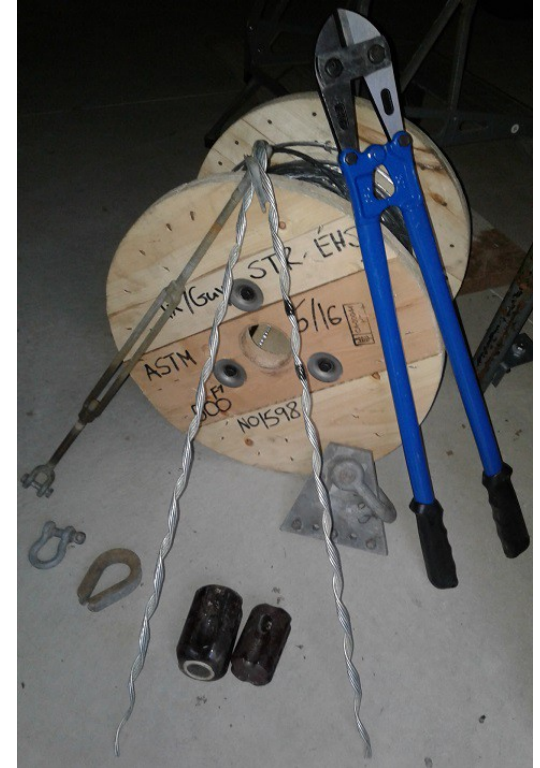
# Winter is Not an Excuse



# 150' Tower: Planted June 2017



# Preparing The Tower





# Steel Work



# Heavy Lifting

- Rigging
- Power
- Equipment
- Experience





# Raising a 150' Tower



# Mast and Rotator



# Pricing a Big Tower

10%



90%



# It All Adds Up

- Labour
- Equipment rental
- Material
- Fabrication



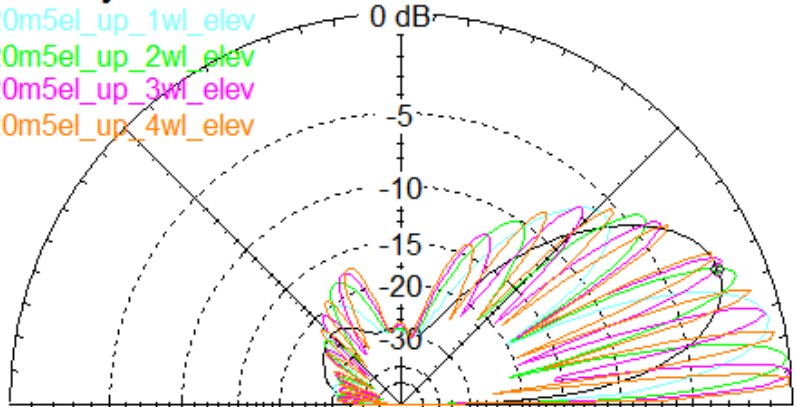
# How High is 150'?



# Why Go High?

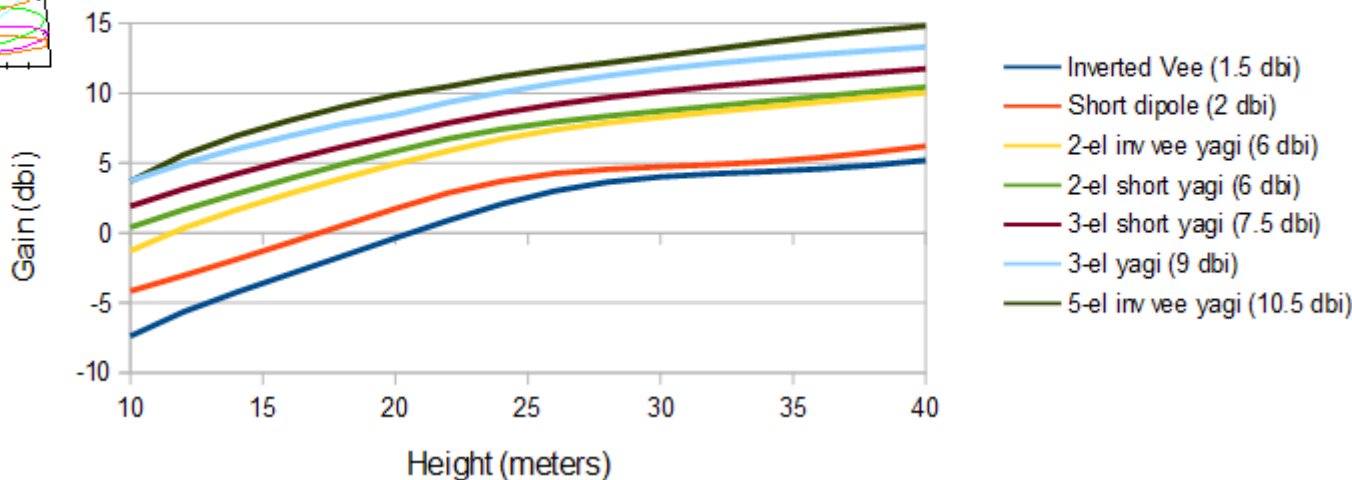
\* Primary

20m5el\_up\_1wl\_elev  
 20m5el\_up\_2wl\_elev  
 20m5el\_up\_3wl\_elev  
 20m5el\_up\_4wl\_elev



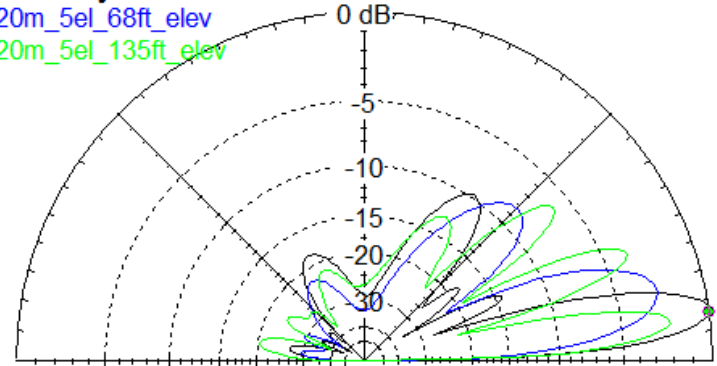
- Stacking room
- Low elevation angles
- Low band wires
- Diminishing returns

40 Meter Antenna Gain by Height  
 (Medium ground; 10° elevation; ranked by free space gain)



\* Primary

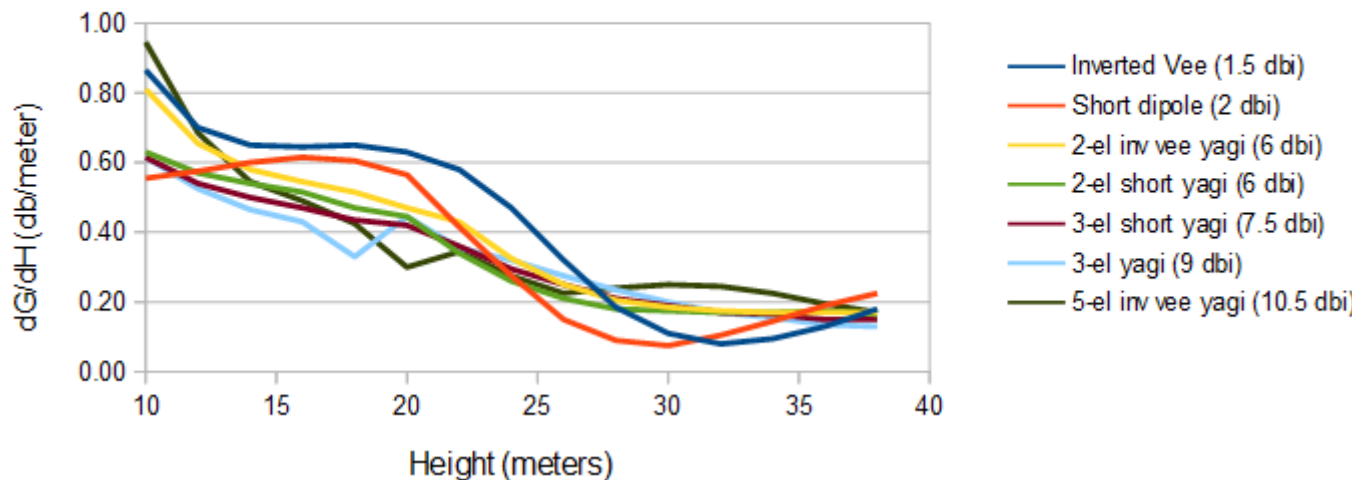
20m\_5el\_68ft\_elev  
 20m\_5el\_135ft\_elev



14.125 MHz

Elevation Plot  
 Azimuth Angle 0.0 deg.  
 Outer Ring 17.29 dBi  
 Cursor Elev 8.0 deg.  
 Gain 17.29 dBi  
 0.0 dBmax

40 Meter Antenna Rate of Gain Change by Height  
 (Medium ground; 10° elevation; gain rate for next meter height)



# Alternatives to Big Towers

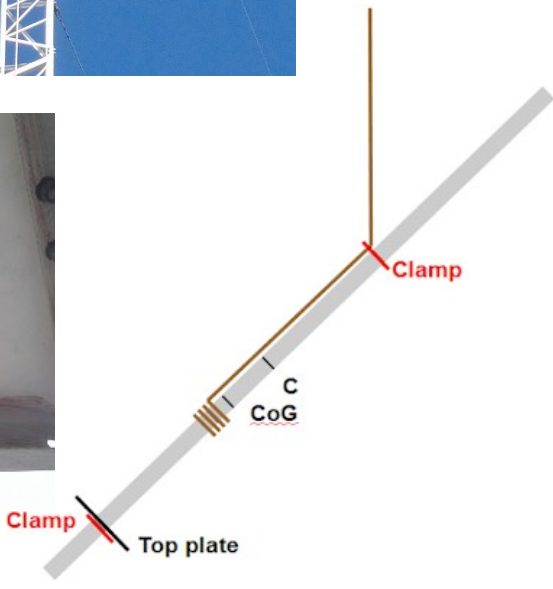
- 1 to 3 db: Mono band vs. loaded/tri-band yagi
- 1 to 4 db: Longer boom
- 2 to 4 db: Stack two yagis
- 3 to 6 db: Stack three yagis
- 0 to 3 db: Big, fat coax
- 2 to 6 db: More and longer radials (verticals)
- 10 db: Buy an amplifier!
- All of the above
- All of the above plus a big tower



# That Was Fun! Let's Do It Again

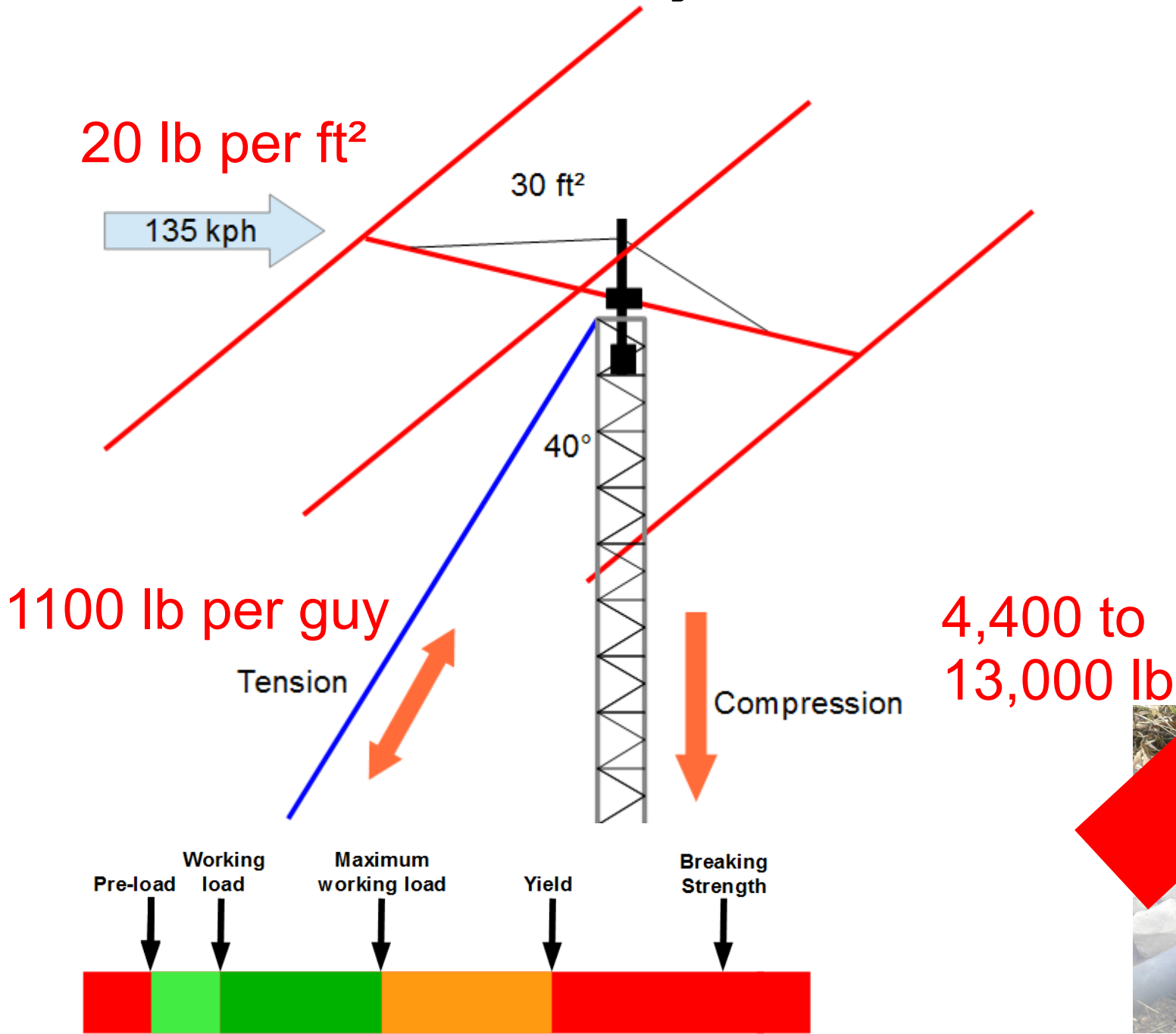


Planted Sept 2018  
Completed Sept 2019





# Forces On a Guyed Tower



# Vertical & Straight Survival

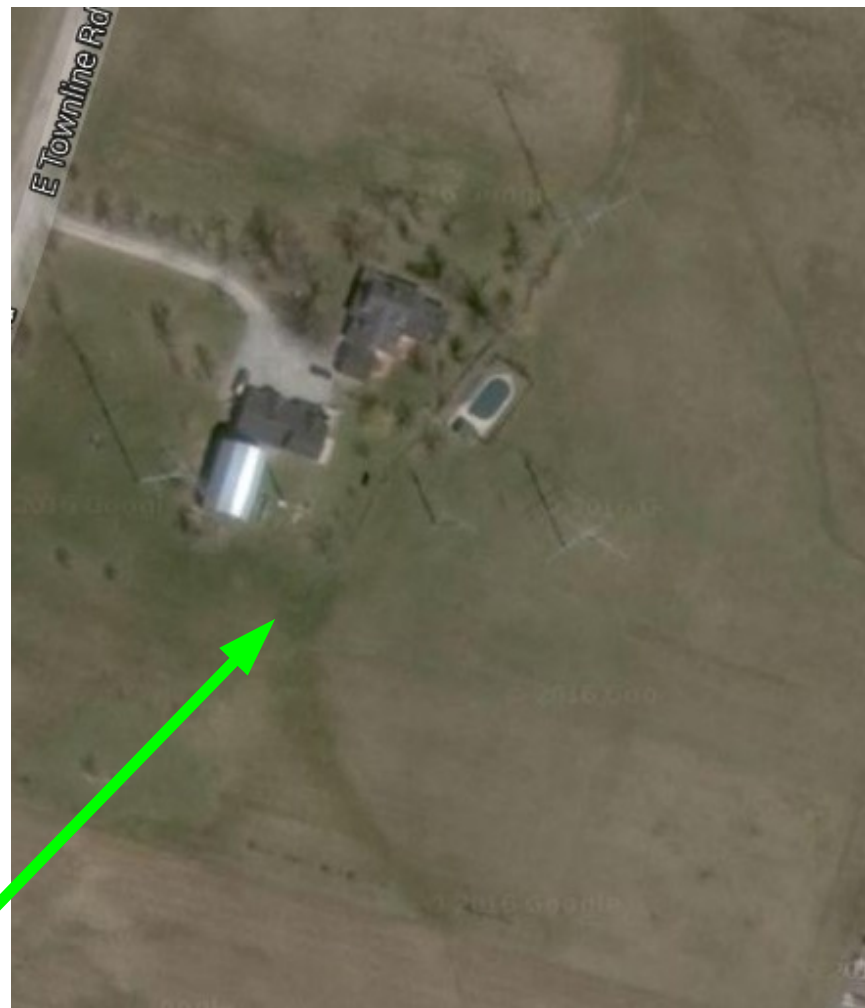


Don't let this  
happen to you!



# Antenna Objectives

- My interests and motivation
  - Contests: single and multi-op
  - Everyday DXing
  - Design, build and learn
- Gain, diversity, low SWR, directivity
- What goes into it
  - Software design
  - Learn from the very best
  - Scrounge what you need; it gets expensive!



# Computer Modelling

**EZNEC+ v.5.0**

File Edit Options Outputs Setups View Utilities Help

**80m 3-el wire vert yagi**

File: 80m\_3el\_wire\_vert\_yagi.et  
 Frequency: 3.55 MHz  
 Wavelength: 84.4486 m  
 Wires: 18 Wires, 125 segments  
 Sources: 1 Source  
 Loads: 5 Loads  
 Trans Lines: 0 Transmission Lines  
 Transformers: 0 Transformers  
 L Networks: 1 L Network  
 Ground Type: Real/MNNEC  
 Ground Descrip: 1 Medium (0.02, 13)  
 Wire Loss: Copper  
 Units: Meters  
 Plot Type: 3D  
 Step Size: 5 Deg  
 Ref Level: 0 dB  
 All SWR: 20  
 Denc Options:  
 Average Gain = 0.312 = -5.06 dB *Model contains loss*

**Wires**

Wire Create Edit Other

Good Entry Mode  Preserve Connections  Show Wire Insulation

No.	End 1			Conn	End 2			Diameter	Seg	
	X (m)	Y (m)	Z (m)		X (m)	Y (m)	Z (m)			
1	0	0	0.3	W2E2	0	0	19.9	250	30	
2	0	0	0	Ground	0	0	0.3	W1E1	250	1
3	10.5	0	0.3	W4E2	10.5	0	10.5	W11E1	2	11
4	10.5	0	0	Ground	10.5	0	0.3	W3E1	H14	1
5	-10.5	0	0.3	W5E2	-10.5	0	10.5	W13E1	H14	11
6	-10.5	0	0	Ground	-10.5	0	0.3	W1E1	H14	1
7	0	10.5	0.3	W8E2	0	10.5	10.5	W15E1	H14	11
8	0	10.5	0	Ground	0	10.5	0.3	W7E1	H14	1
9	0	-10.5	0.3	W10E2	0	-10.5	10.5	W17E1	H14	11
10	0	-10.5	0	Ground	0	-10.5	0.3	W9E1	H14	1
11	10.5	0	10.5	W12E1	6.04523	0	14.9548	H14	7	
12	10.5	0	10.5	W3E2	14.9548	0	6.04523	H14	7	
13	-10.5	0	10.5	W14E1	6.04523	0	14.9548	H14	7	
14	-10.5	0	10.5	W6E2	-14.9548	0	6.04523	H14	7	
15	0	10.5	10.5	W16E1	0	6.04523	14.9548	H14	7	

**2D Plot: 80m 3-el wire vert yagi**

File Edit View Options Reset

Highlight:  3D  Azimuth Slice  Elevation Slice

0 360  
 0  
 Slice Azimuth  
 180  
 20  
 0  
 Cursor Elev

**Total Field**

Horizontal Pol  
 Vertical Pol

0 dB  
 -5  
 -10  
 -15  
 -20

3.55 MHz

Elevation Plot: 20.0 deg  
 Azimuth Angle: 0.0 deg  
 Gain: 4.15 dB  
 Outer Ring: 4.15 dB  
 3D Max Gain: 4.15 dB  
 Slice Max Gain: 4.15 dB @ Elev Angle = 20.0 deg  
 Beamwidth: 38.0 deg @ -3dB @ 3.5, 43.5 deg  
 Sidelobe Gain: -9.11 dB @ Elev Angle = 160.0 deg  
 Front/Sidelobe: 13.26 dB

**View Antenna: 80m 3-el wire vert yagi**

File Edit View Options Reset

Zoom: [Slider]  
 Display: [Buttons]  
 Move Image: [Buttons]  
 Center Ant Image:

Wire Number: 1  
 Length: 19.8 m  
 Seg Length: 0.66 m  
 Diameter: 250 mm

**L Networks (RLC)**

L Ntwk Edit Other

No.	Specified Pos		Actual Pos		R (ohms)	L (uH)				Sw Br	
	Port 1 Wire #	Port 1 % From E1	% From E1	Seg		Series Branch	Series Branch	Series Branch	Series Branch		
1	1	0	2.5	1	Shot	0.96	Shot	0	Shot	0	Set
	V1				Shot	Shot	800	0	Set		

**SWR Plot: 80m 3-el wire vert yagi**

File Edit View Options

20  
 50 ohms  
 All (75 ohms)  
 Source R

1.18  
 1.5  
 2  
 3  
 5  
 10  
 20

3.5 Freq MHz 3.7

Freq: 3.5 MHz  
 SWR: 1.18  
 Z: 43.96 at -0.01 deg  
 = 43.71 - j4.604 ohms  
 Refl Coeff: 0.68304 at -140.97 deg  
 = -0.06451 - j0.85229  
 Ret Loss: 21.6 dB

Source # 1  
 Z0: 50 ohms

13:20  
 2008-01-27

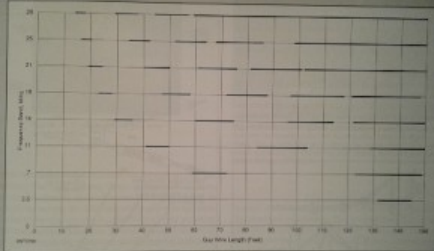
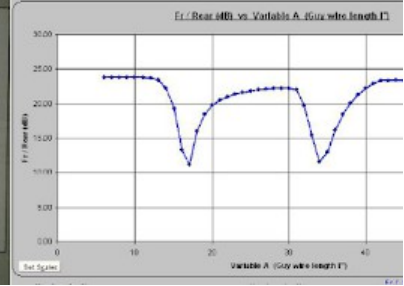
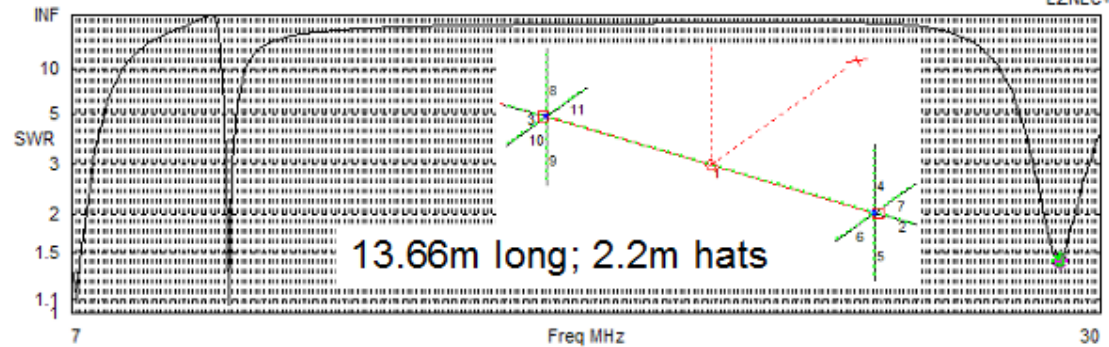
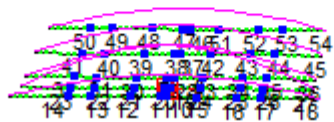
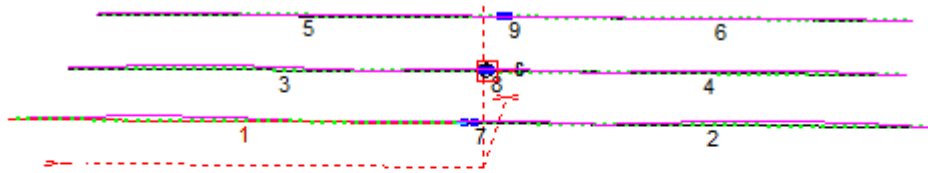
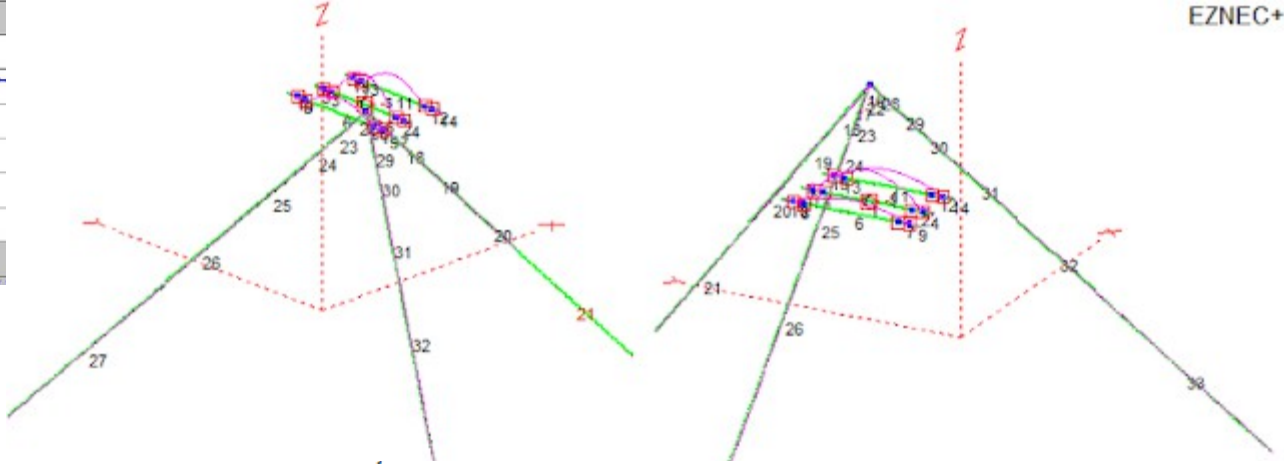


Figure 28.A — The black bars indicate ungrounded guy wire lengths to avoid for the eight HF amateur bands. This chart is based on resonance within 1% of any frequency in the band. Grounded wires will exhibit resonance at odd multiples of a quarter wavelength. (by Jerry Mark, K1ZZ)



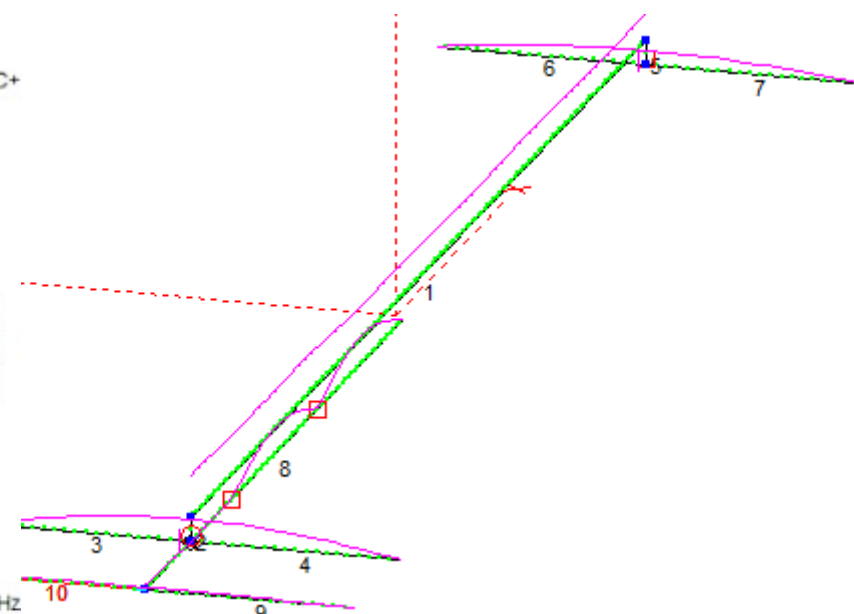
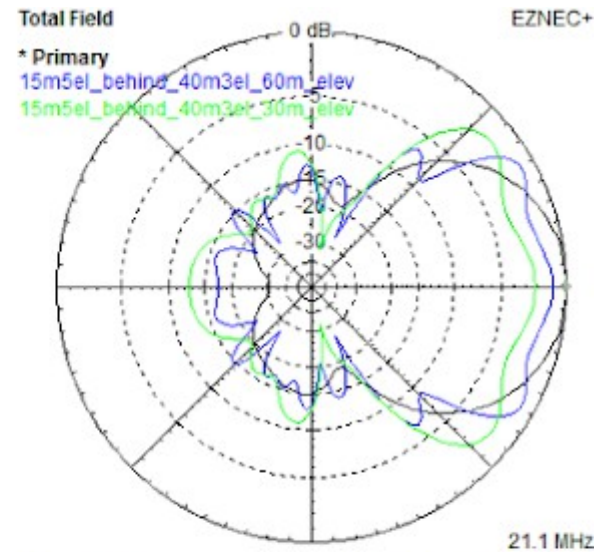
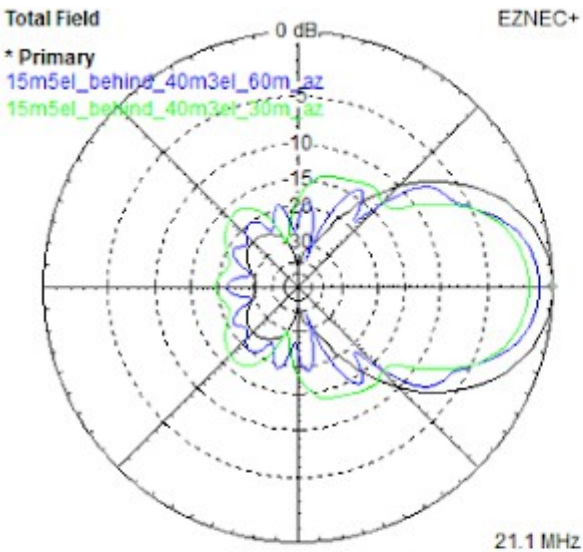
# Interactions

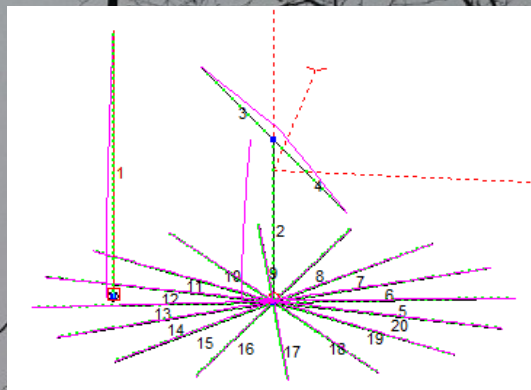
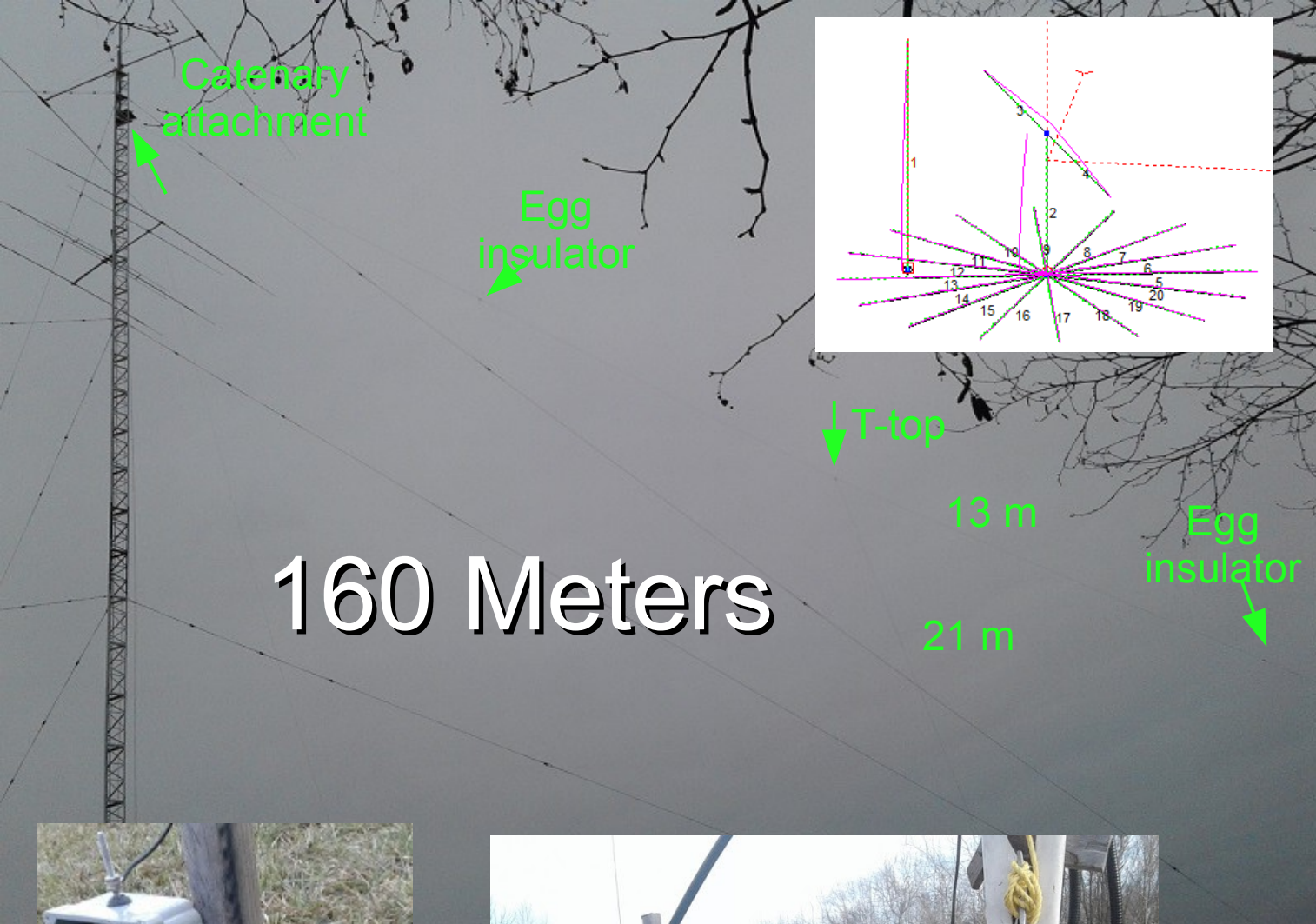
Ignorance ≠ Bliss



Freq 29.1 MHz  
 SWR 1.41  
 Z 37.06 at 9.84 deg.  
 = 36.52 + j6.336 ohms

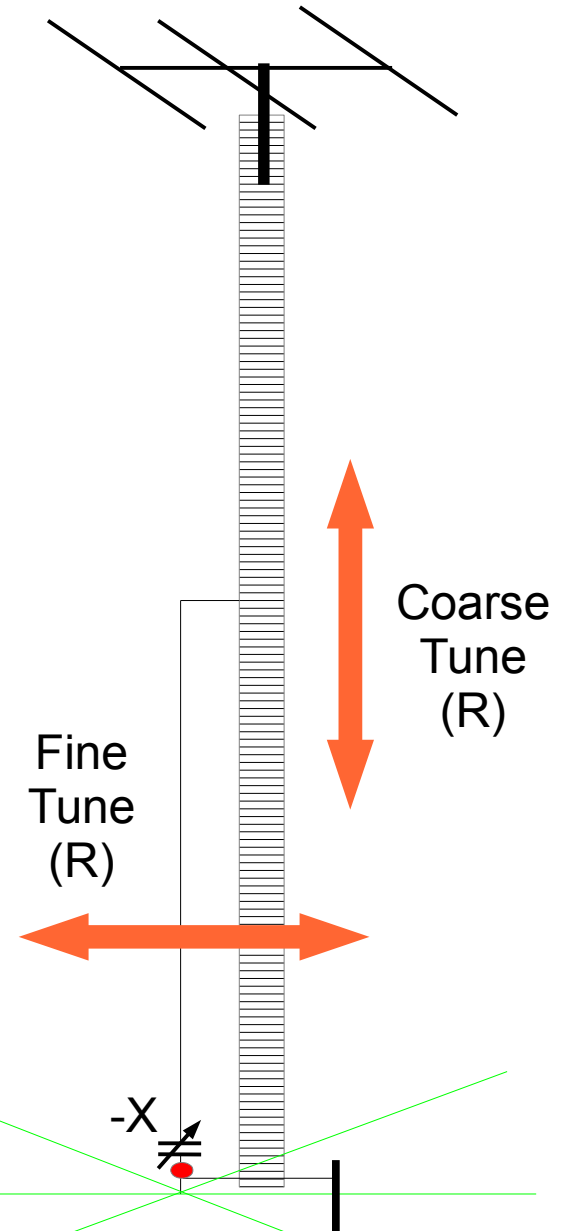
Source # 1  
 Z0 50 ohms



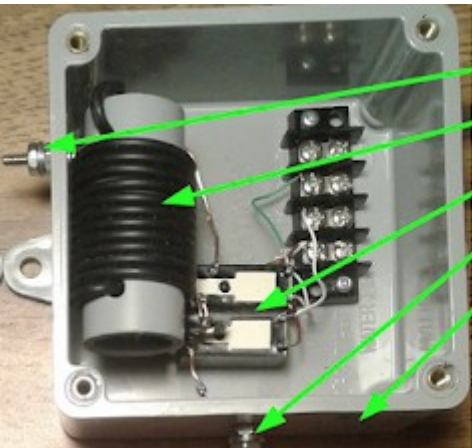


160 Meters

Electrical  $\frac{3}{8}\lambda$   
1200 kHz

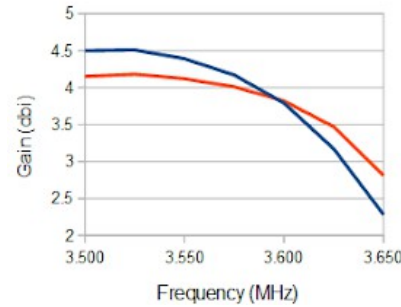


# 80 Meter 3-element Vertical Yagi

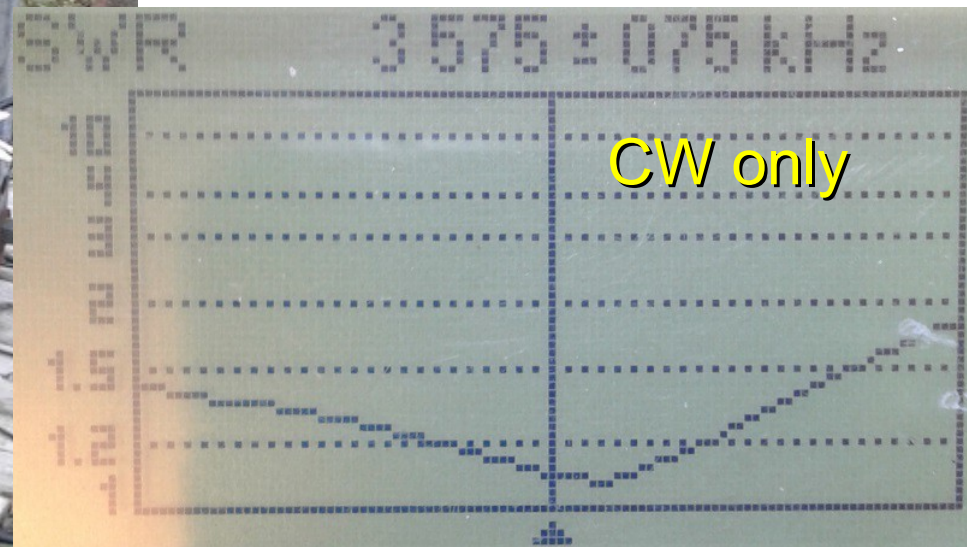
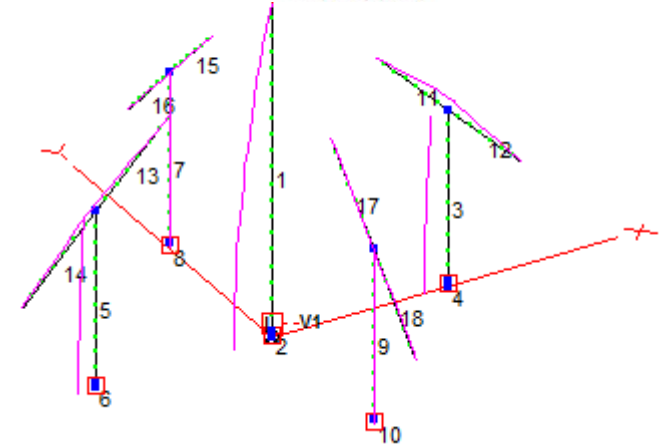
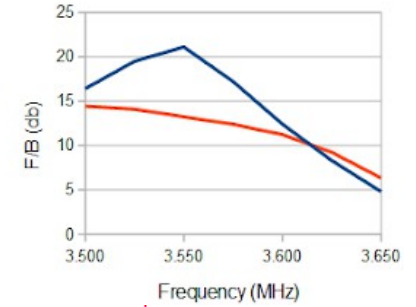


- Monopole stud
- 2.1  $\mu$ H coil
- SPST-NO relays
- Radial stud
- Cat5E entry

3-element Vertical Yagi Gain Comparison  
(good ground; 5  $\Omega$  ground ESR)



3-element Vertical Yagi F/B Comparison  
(good ground; 5  $\Omega$  ground ESR)



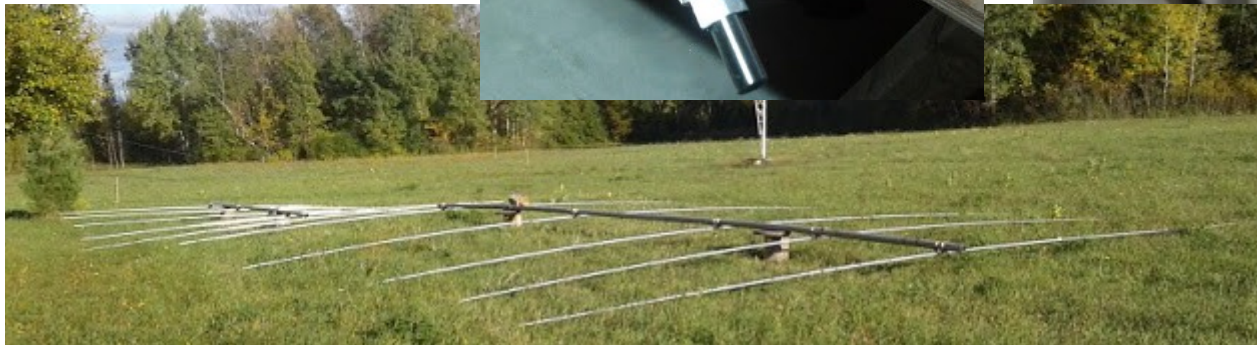


# Yagis For 40 to 10 Meters

- Tri-banders are a stopgap
  - Narrow SWR bandwidth and inefficient
- 40 meter yagis are very, very big and heavy
  - Alternatives: wire yagis, loaded yagis, Moxon
  - 3-element full size yagi planned for this year
- Big 20 meter yagis are difficult but within reach
- Big yagis for 15, 10 and VHF are not so bad
- Pick a design, tweak it, make it strong and go
  - Computer optimized designs remove the mystery and the misery of yagi design

# Building Big Yagis

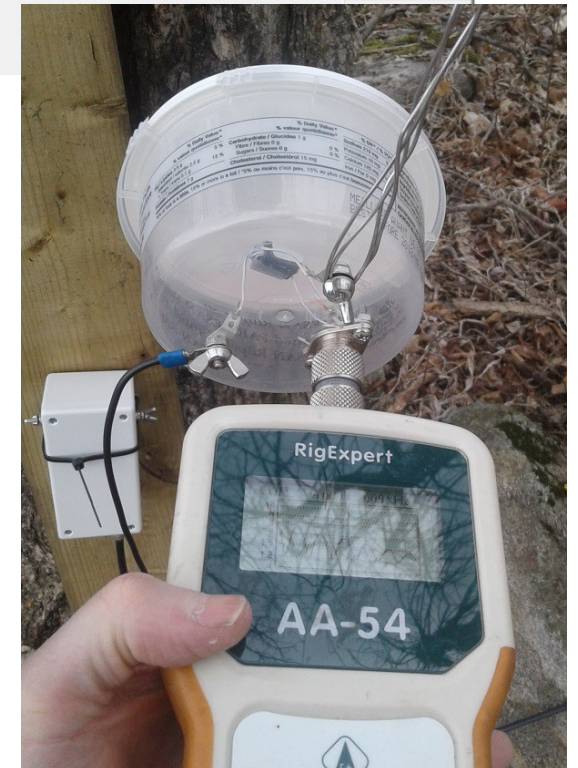
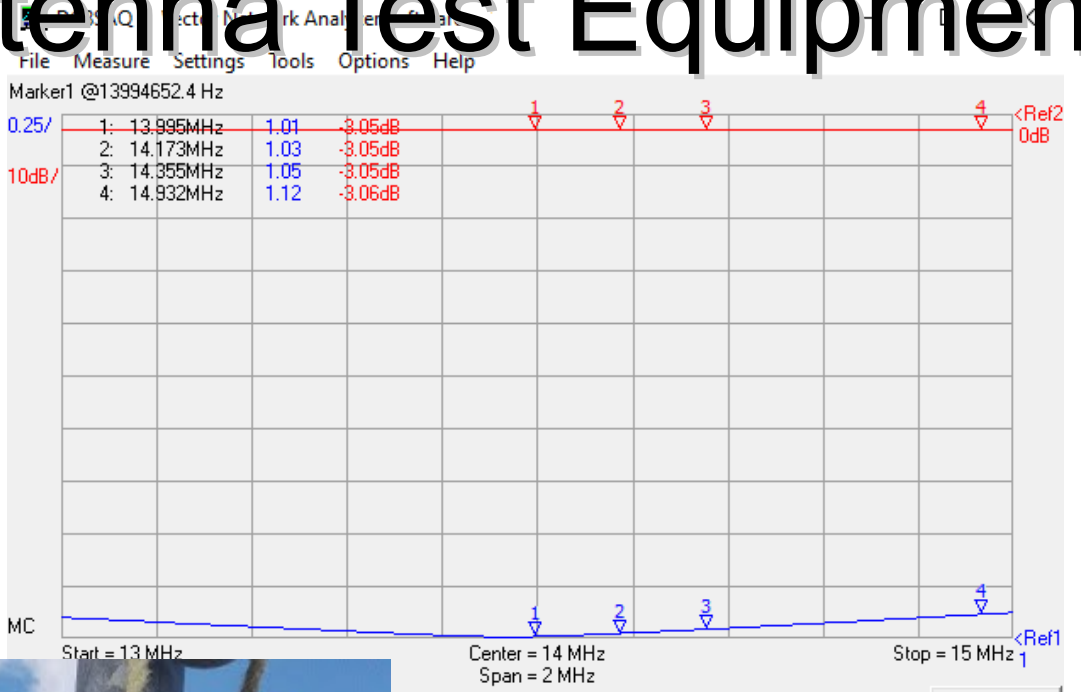
- Booms
- Taper
- Strength
- Clamps
- Matching
- Cost



# Test and Tune *Before* You Lift



# Antenna Test Equipment



# Raising Yagis



# Lifting Yagis: The Tram Line



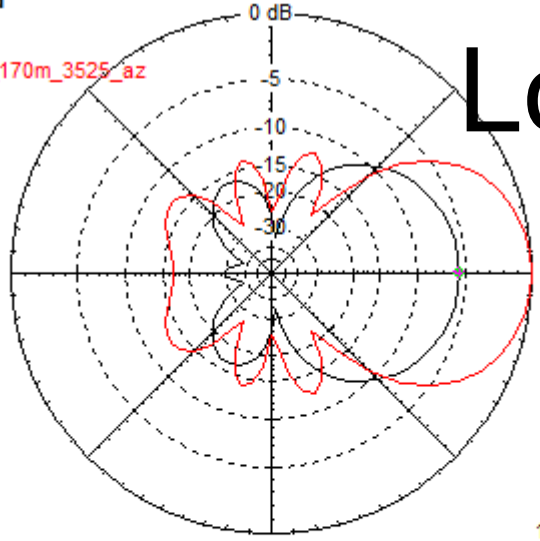
# Trams for Big Antennas



Total Field  
 \* Primary  
 beverage\_170m\_3525\_az

EZNEC+

# Low Band Receive Antennas

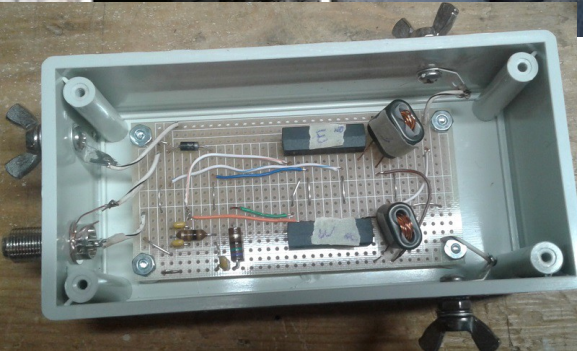
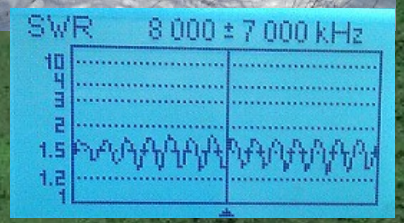
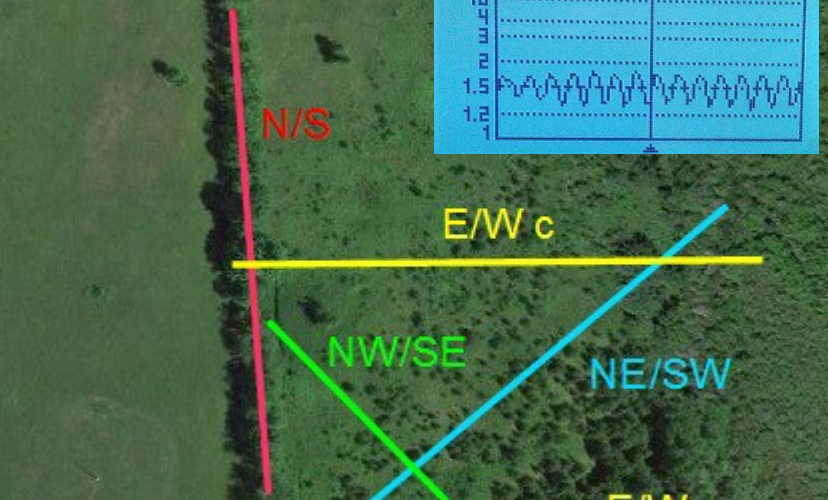


1.825 MHz

Azimuth Plot  
 Elevation Angle 35.0 deg.  
 Outer Ring -4.98 dBi

3D Max Gain -10.56 dBi  
 Slice Max Gain -10.56 dBi @ Az Angle = 0.0 deg.  
 Front/Back 24.25 dB

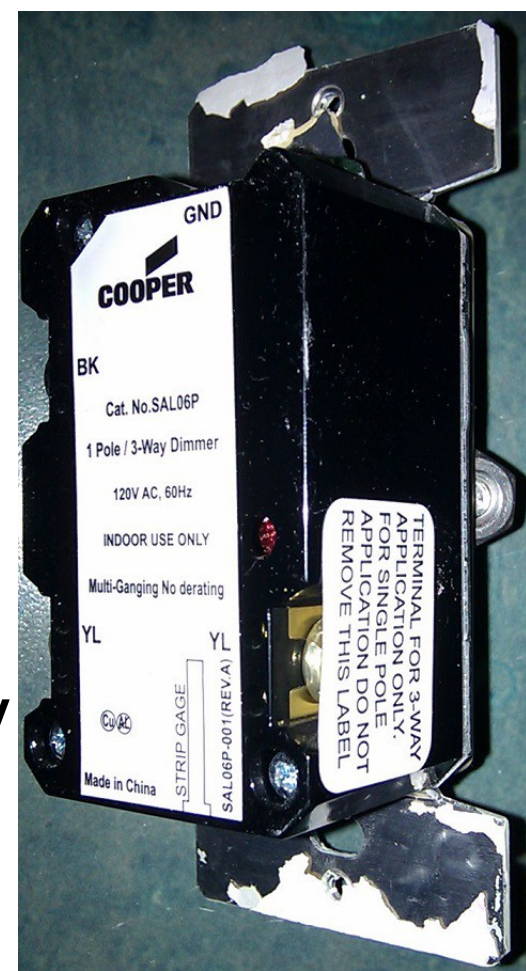
Cursor Az 0.0 deg.  
 Gain -10.56 dBi  
 0.0 dBmax  
 0.0 dBmax3D



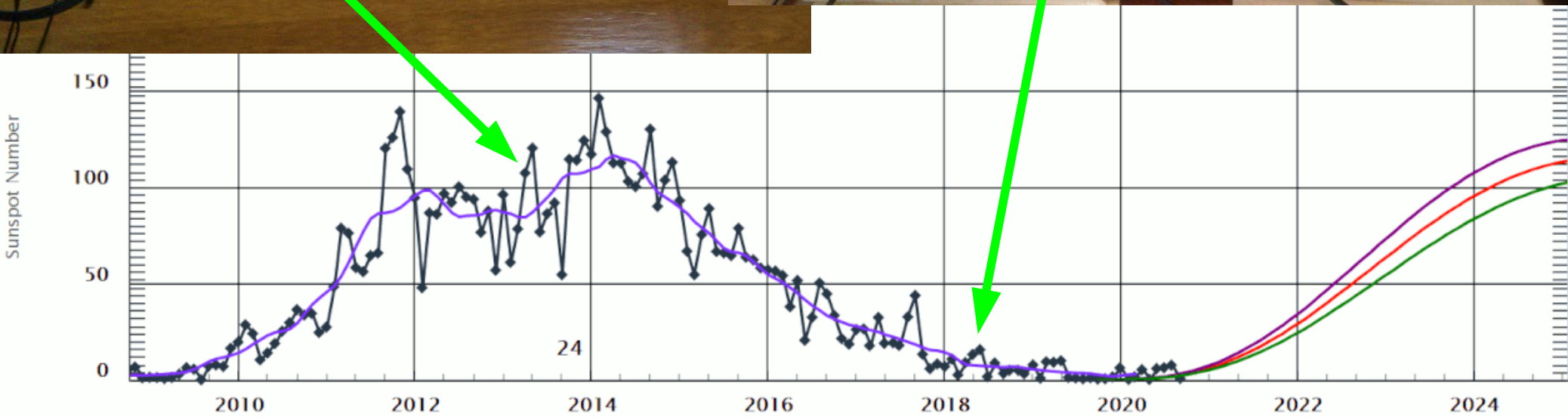
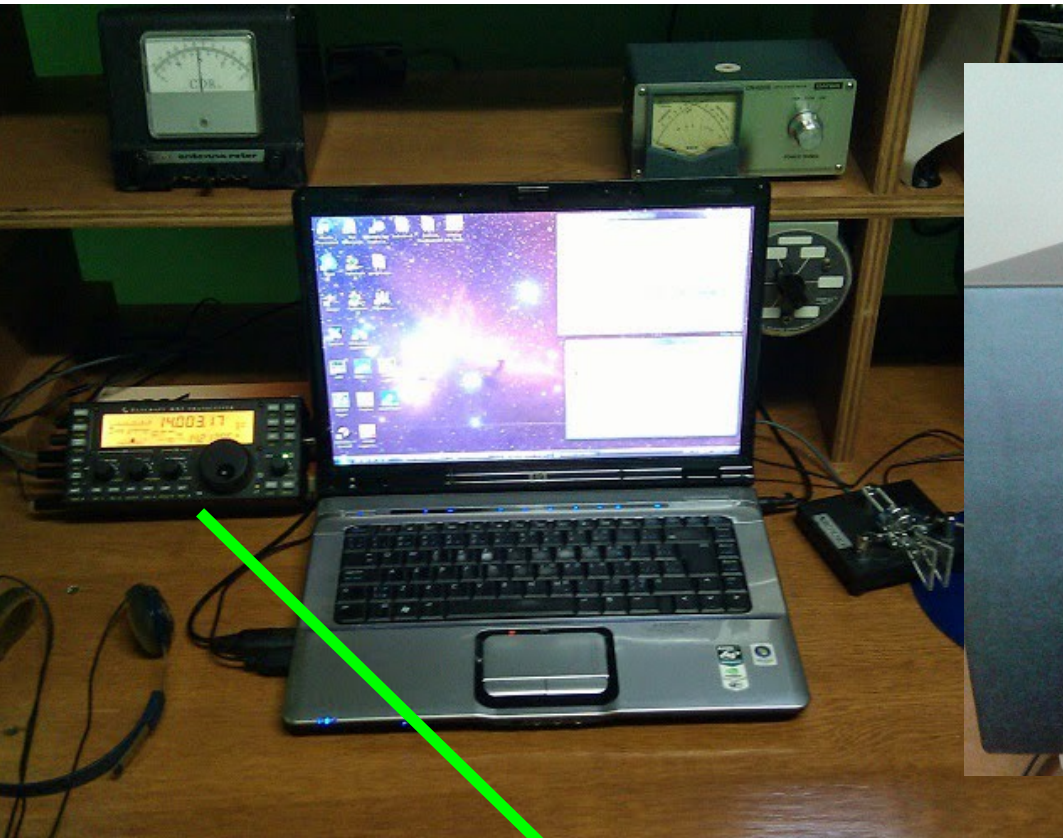


# Noise in the wilderness

- Isolation is no panacea
- Search and destroy noise in the home
  - switches; lights; appliances; data cables
- Search and destroy noise further away
  - power lines; electric fences; solar panels



# They Have to Hear You to Work 'em



# Performance, so far

- 160: Killer antennas easy with a tall support
  - Run EU; crack pile-ups; work DX with 5 watts
- 80: Gain within 1.5 db of a 4-square
  - Verticals poor for short distances: need inverted vee
- 40: High antennas extraordinary on long path
  - but, little difference to Europe for low vs. high
- 20 and 15: Stacks are band openers
  - “You're the strongest signal on the band!”
- Beverages: Awesome on 160 & 80; good on 40

# Maintenance – Build It To Last



- Every climb involves risk
- Build it right and you can avoid many climbs
- Who will you call if you don't climb?
- Stay safe, save money and enjoy what you've built





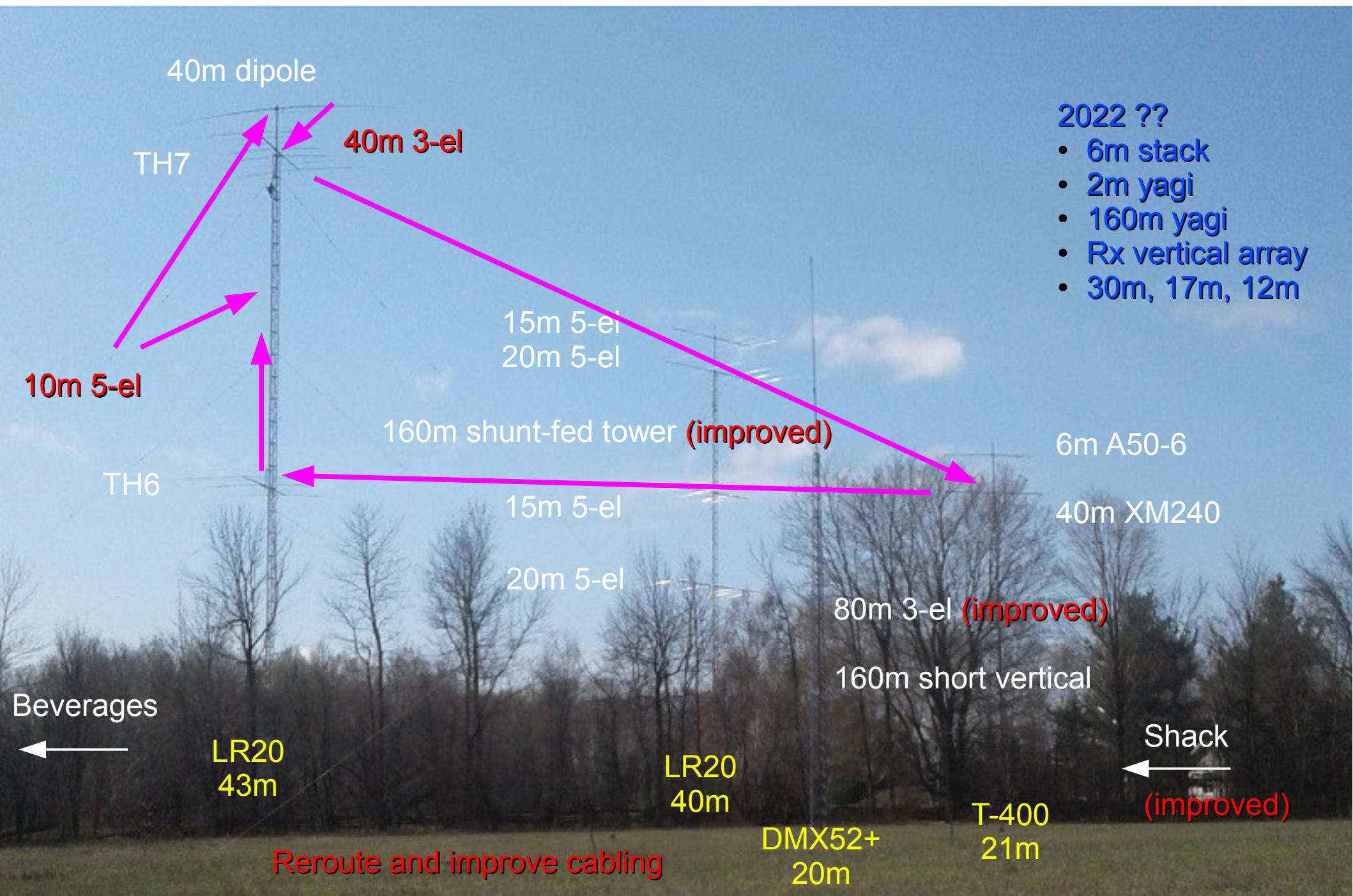
# Hard Hat Zone



It's a hobby, and  
it's fun, but...

# Plan for 2021

I am an optimist!



# Inside the Shack



15 & 20  
stacks

Antenna  
selector

Future switch

Rotators

SO2R

80m yagi

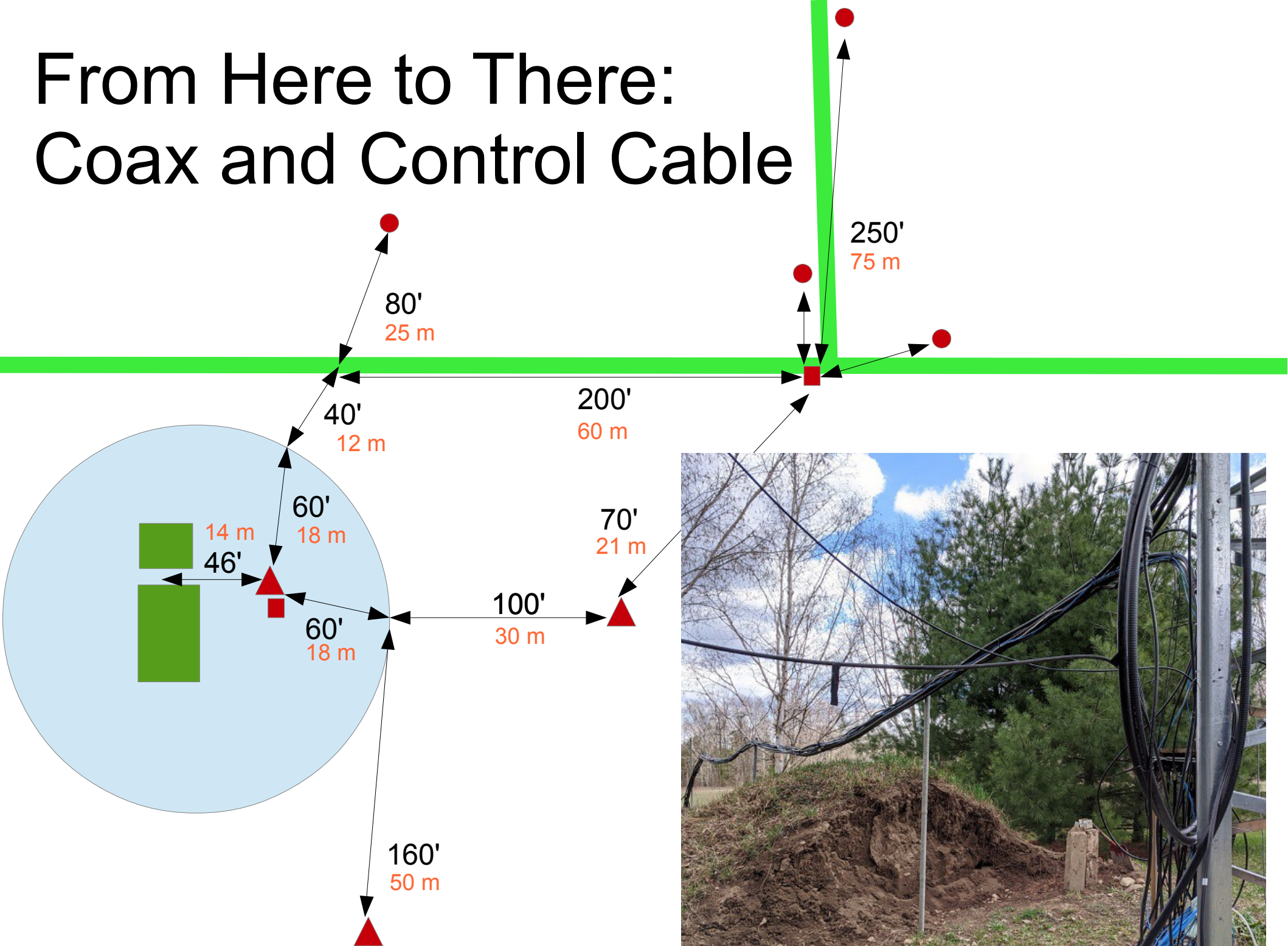
Beverages

Radio #1

Radio #2

Power supplies

# From Here to There: Coax and Control Cable

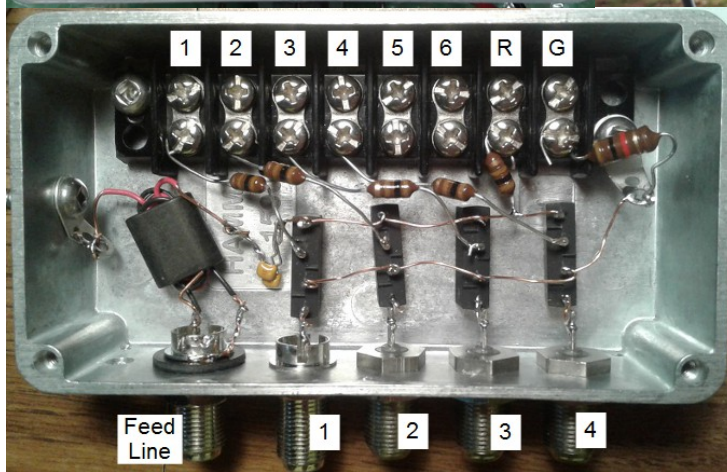
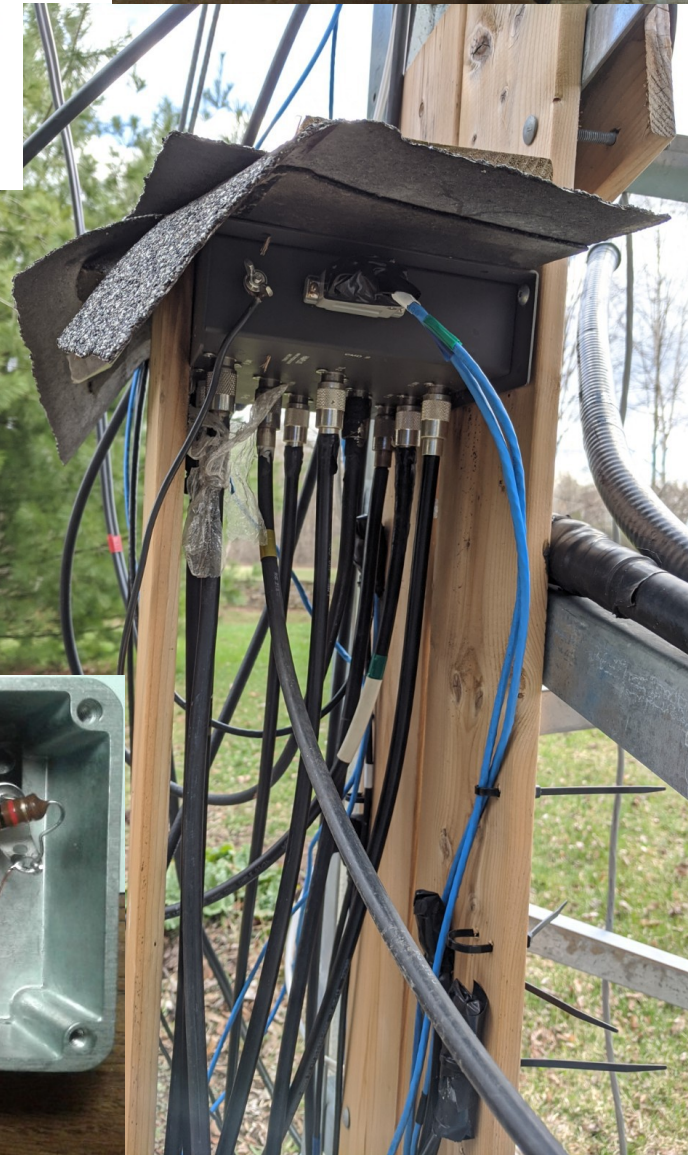
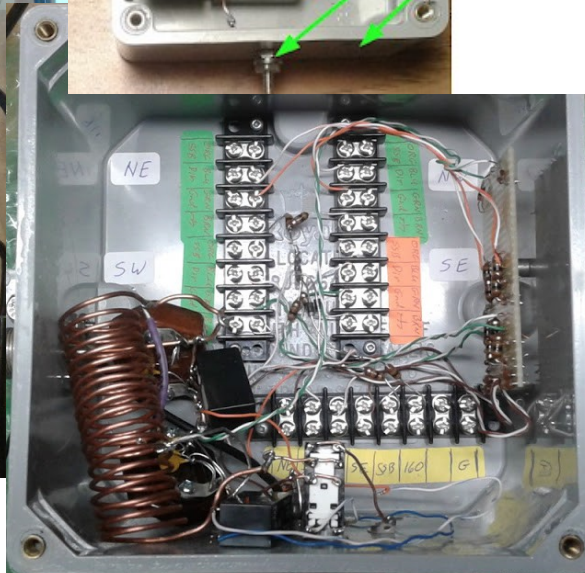
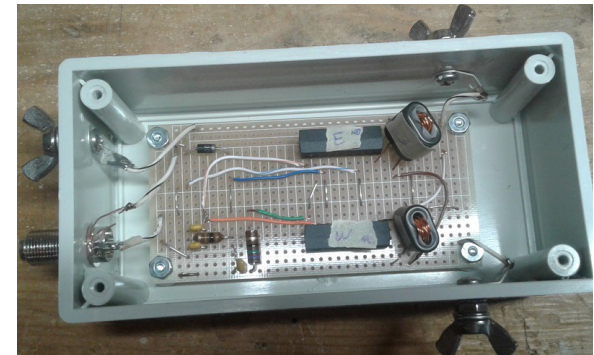
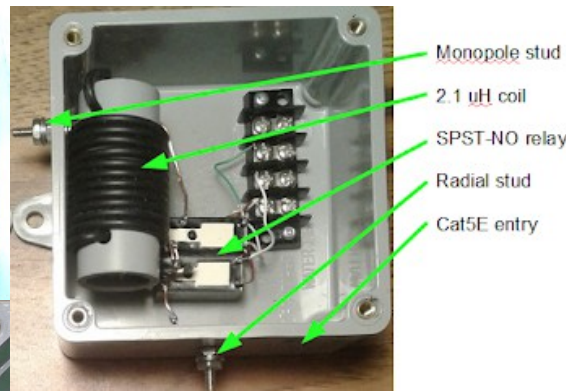
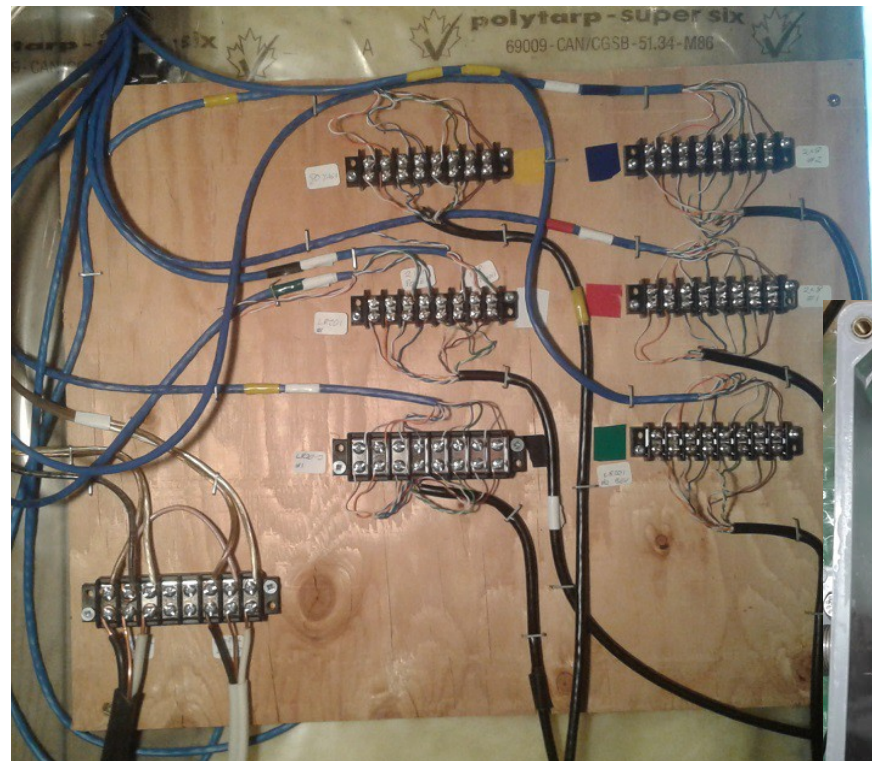




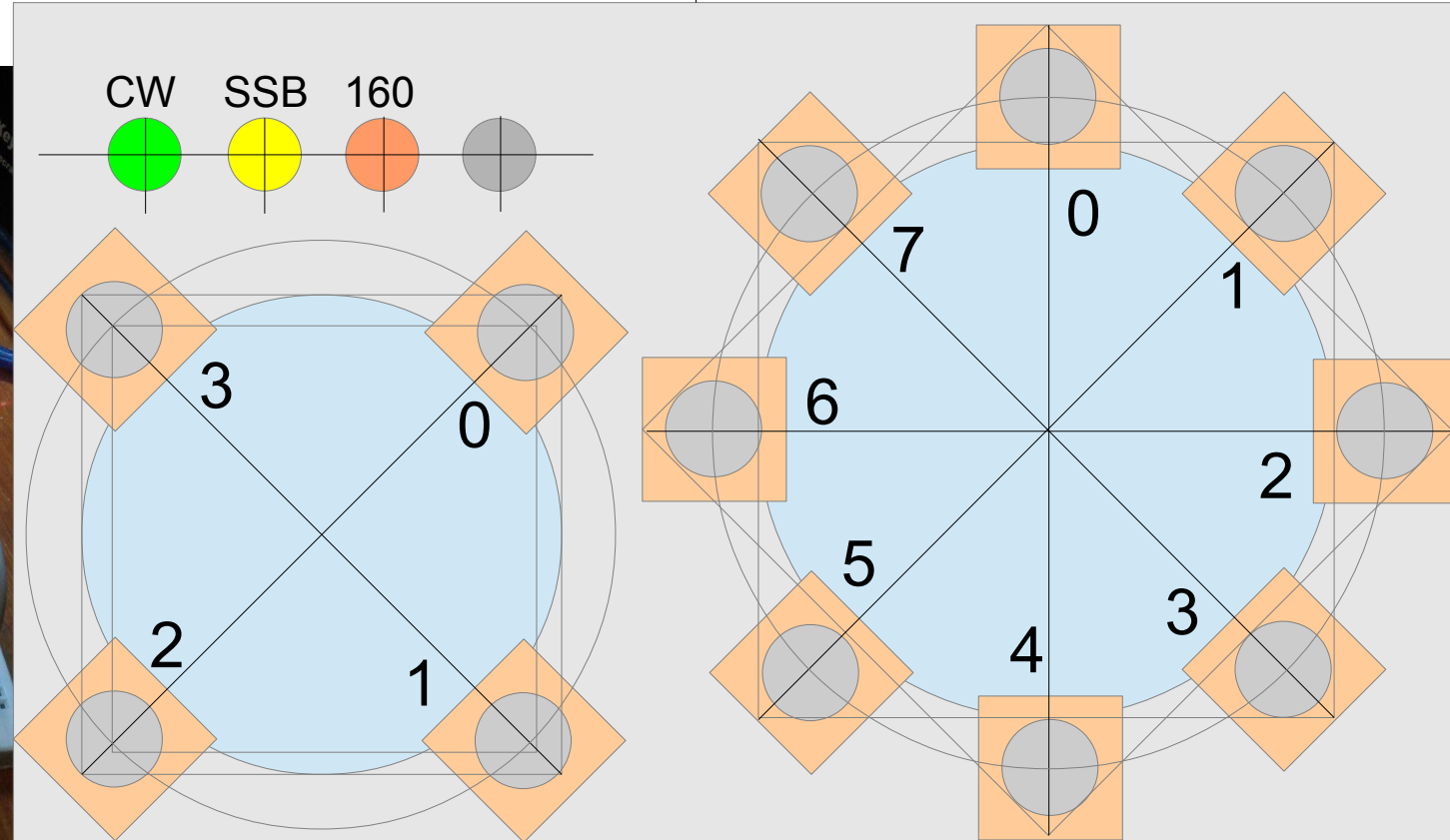
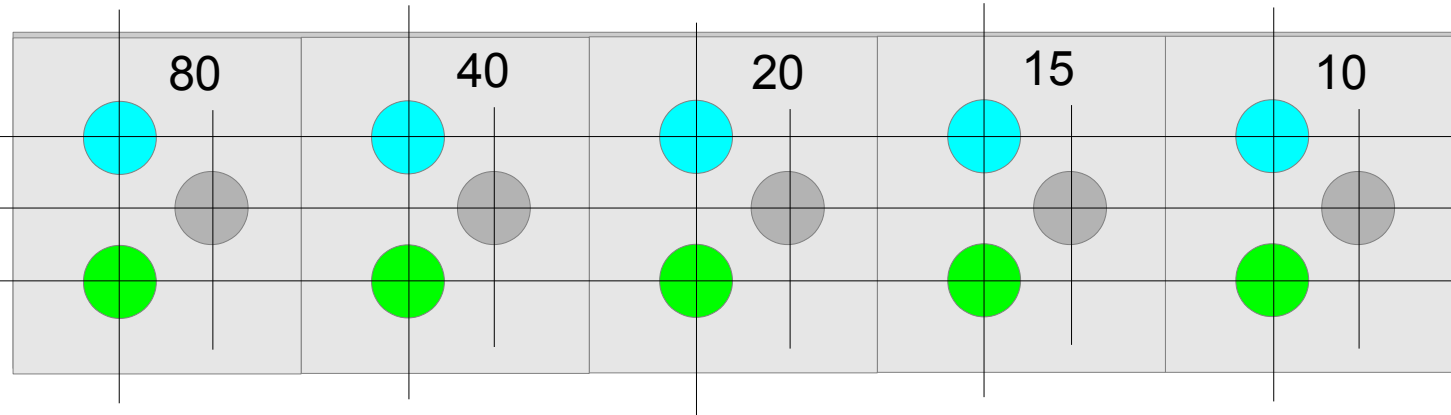
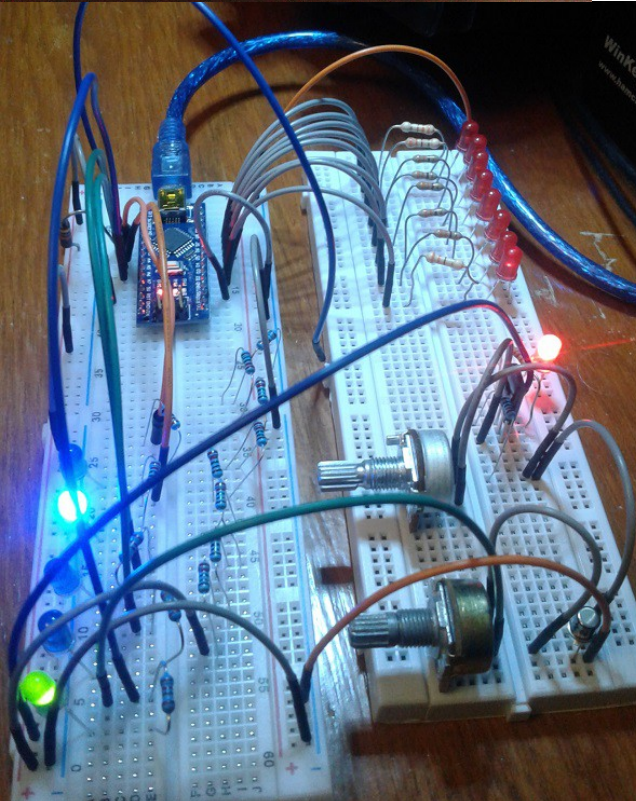
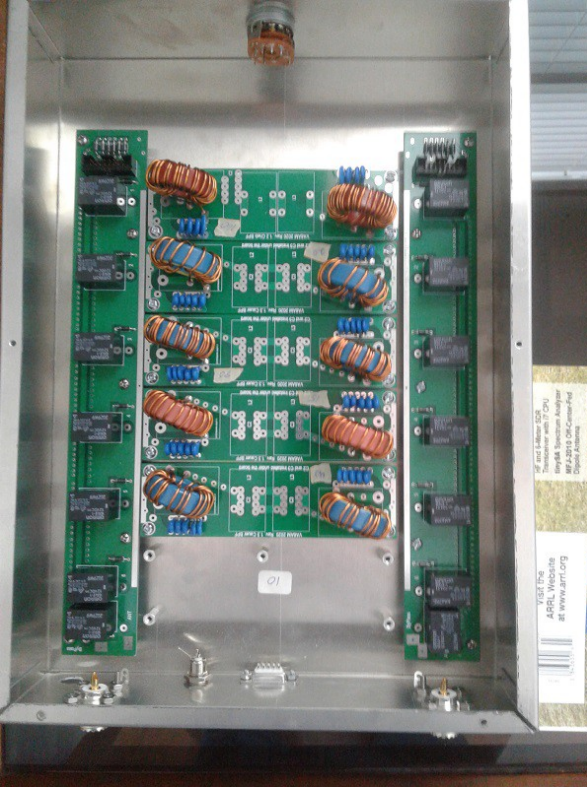
# Trench Warfare: Cable Burial



# Remote Switching



# Station Automation



# The VE3VN Advantage

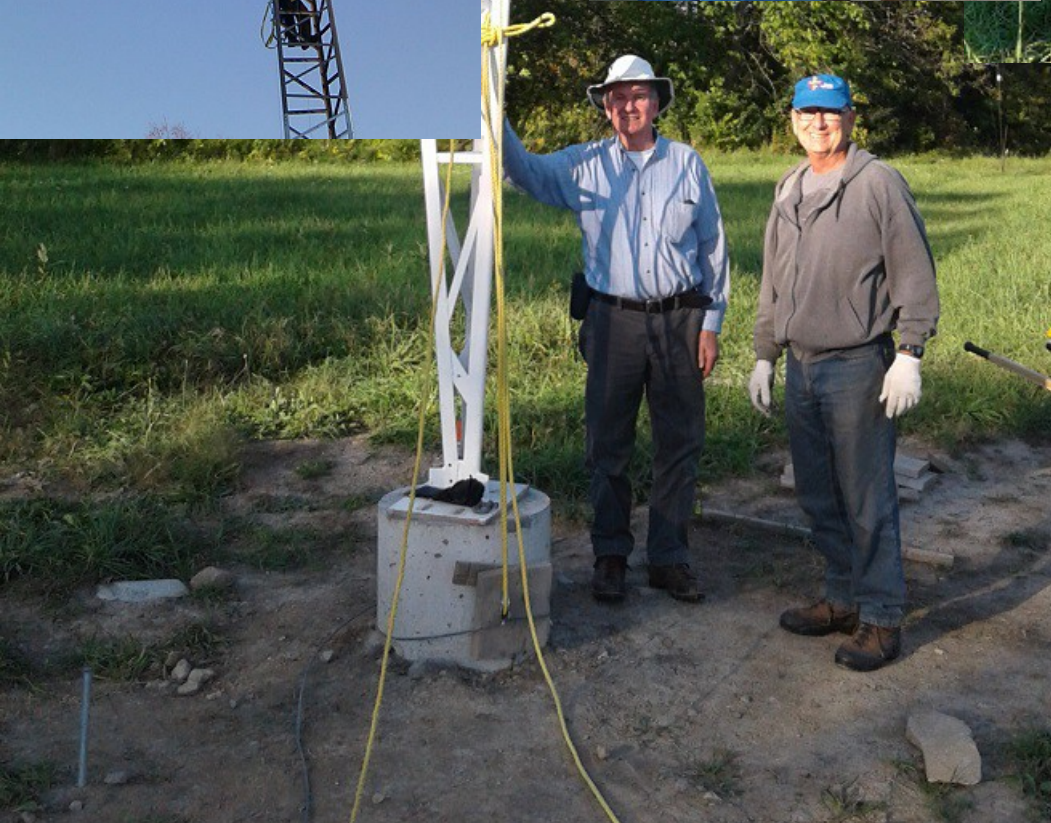


- Time (retired)
- Tower rigger
- Antenna design
- Home brewer
- Scrounger
- Motivation!

# Commitment and Investment

- What does all of this cost?
  - House and land
  - Towers
  - Antennas
  - Cable
  - Switching and control
  - Equipment on the operating desk
- Construction and maintenance isn't free!
  - Who are you going to call on or hire?
  - Do you have the knowledge, skill and tools?

# No Ham is an Island



# Building a Competitive Station for HF Contests and DXing

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FN24br



Visitors welcome!

