Optimizing antennas for phased array high frequency radars

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UH-UABC monopole (2008): 11.5 MHz

- λ/4 wire coiled on λ/8 bamboo
- geometric scaling defines frequency
- base coil-loading for tuning
- fully waterproof, potted junctions, RG213 pig-tail
- 4 buried λ/4 wire radials, approximate impedance 50Ω VSWR 1.1-1.2
- wide band >f/30

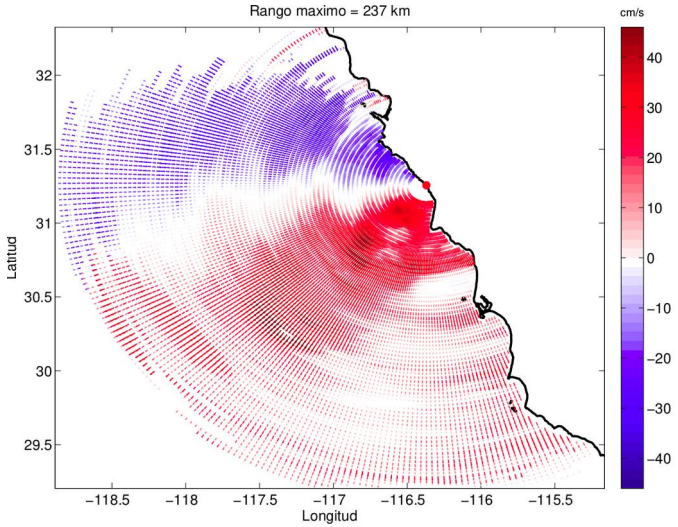
UH-UABC monopole (2008): 8 MHz

- λ/4 wire coiled on λ/8 fiberglass
- geometric scaling defines frequency
- base coil-loading for tuning
- fully waterproof, potted junctions, RG213 pig-tail
- 4 buried λ/4 wire radials, approximate impedance 50Ω VSWR 1.1-1.2
- wide band f/30

UH-UABC monopole (2008): 16 MHz

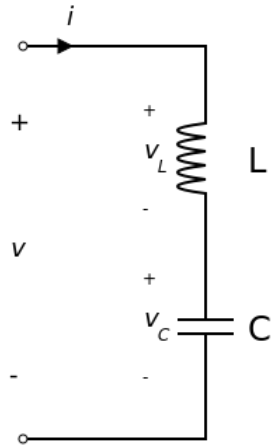
- λ/4 wire coiled on λ/8 PVC pipe
- geometric scaling defines frequency
- base coil-loading for tuning
- fully waterproof, potted junctions, RG213 pig-tail
- 4 buried λ/4 wire radials, approximate impedance 50Ω VSWR 1.1-1.2
- wide band f/30

UH-UABC monopole (2008): 8 MHz



- λ/4 wire coiled on λ/8 treated wood
- geometric scaling defines frequency
- base coil-loading for tuning
- fully waterproof, potted junctions, RG213 pig-tail
- 4 buried λ/4 wire radials, approximate impedance 50Ω VSWR 1.1-1.2
- wide band f/30

UH-UABC monopole (2008): 16 MHz



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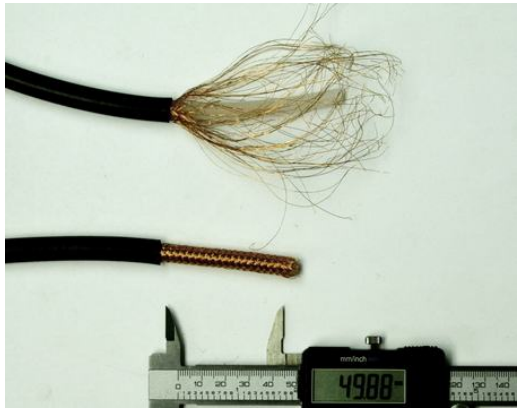
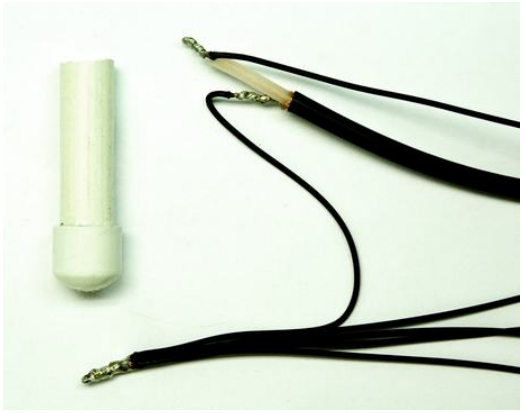
UH-UABC monopole (2008): 8 to 30 MHz, >200 built

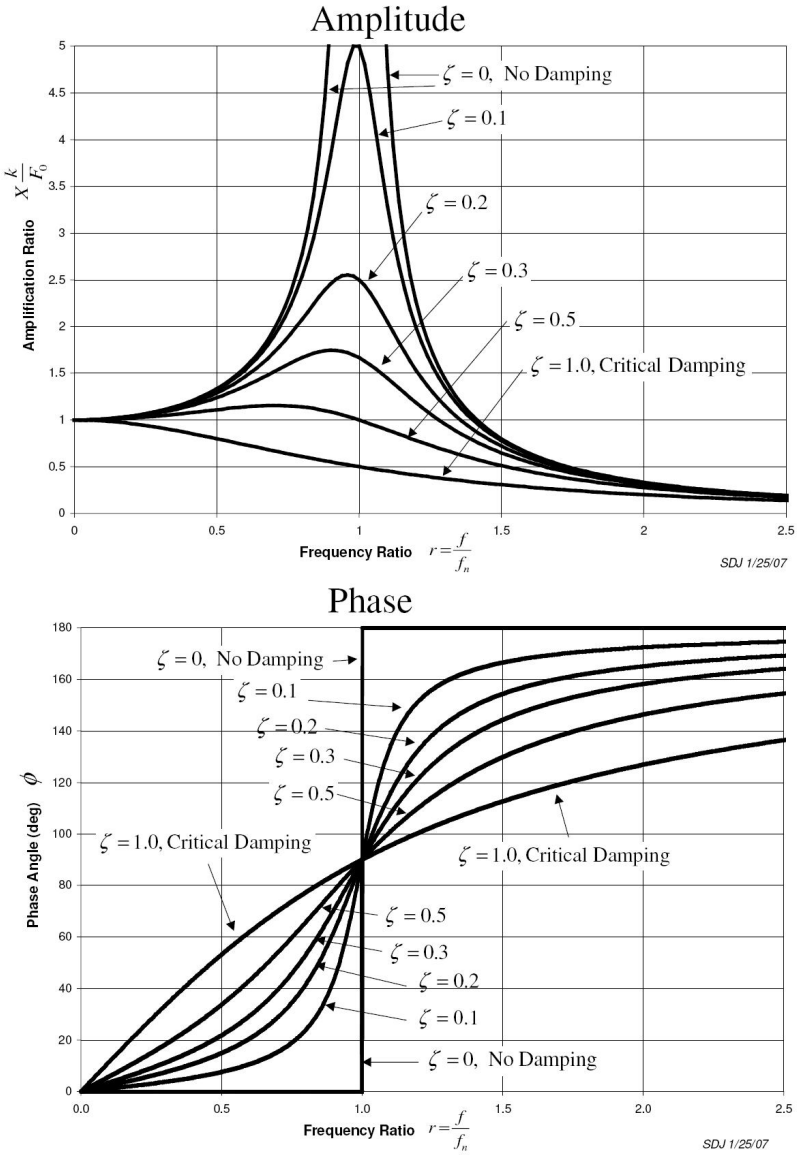
- geometric scaling defines frequency

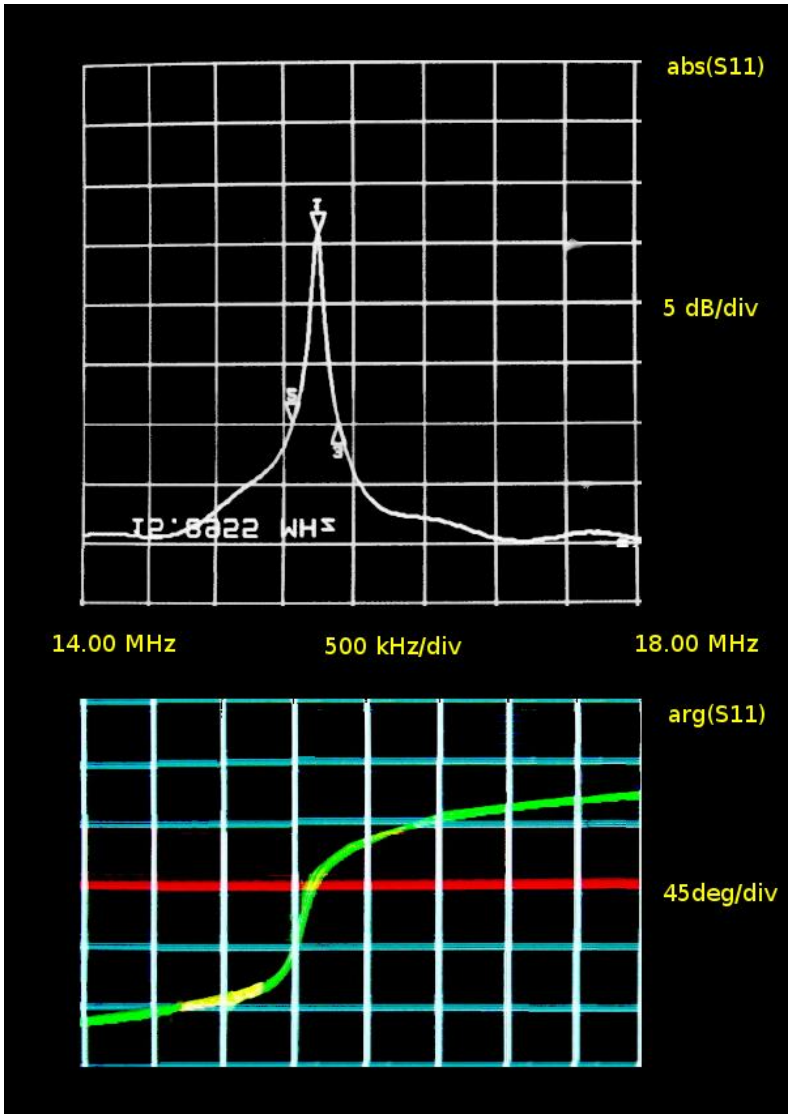
item	length general	length 4.46 MHz	length 8.25 MHz	length 13.5 MHz	length 16 MHz	length 27 MHz
wavelength	lambda	67.26 m	36.36 m	22.22 m	18.75 m	11.11 m
vertical wire	lambda/4	16.8 m	9.09 m	5.55 m	4.69 m	2.78 m
radial wires	lambda/4	16.8 m	9.09 m	5.55 m	4.69 m	2.78 m
pole height	lambda/8	8.4 m	4.55 m	2.78 m	2.35 m	1.29 m
pole diameter	lambda/300	22.4 cm	12 cm	7.5 cm	6.3 cm	3.7 cm





Passive antennas bad for phased-arry RX!

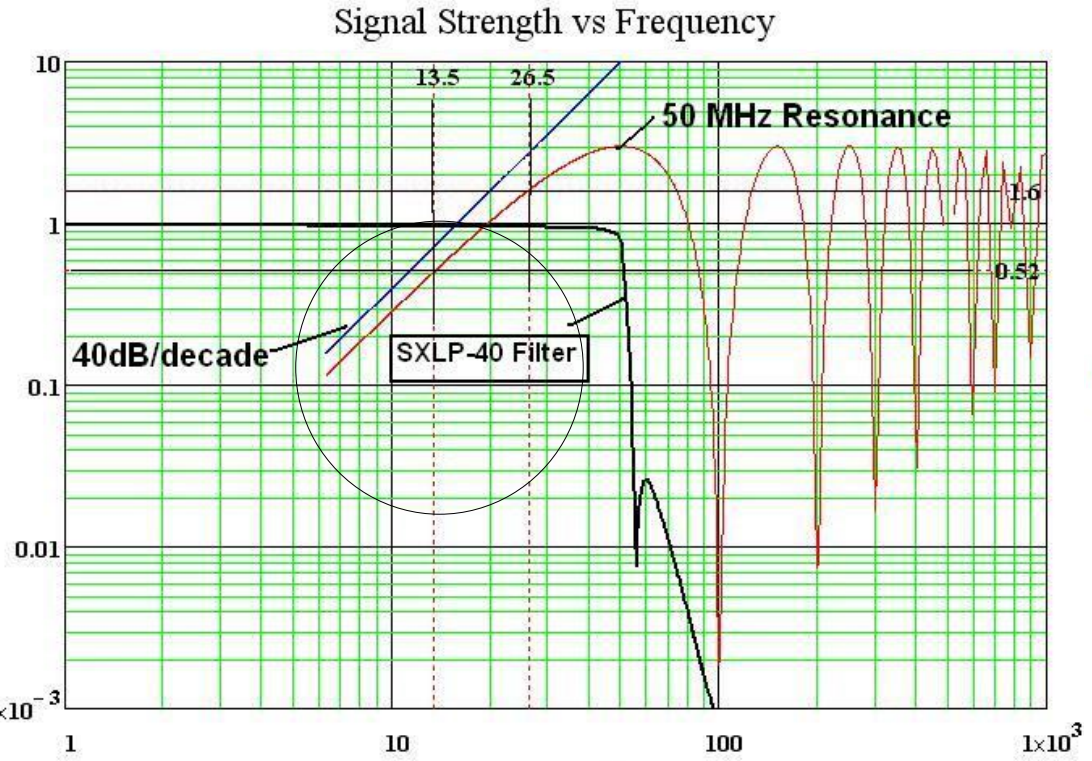


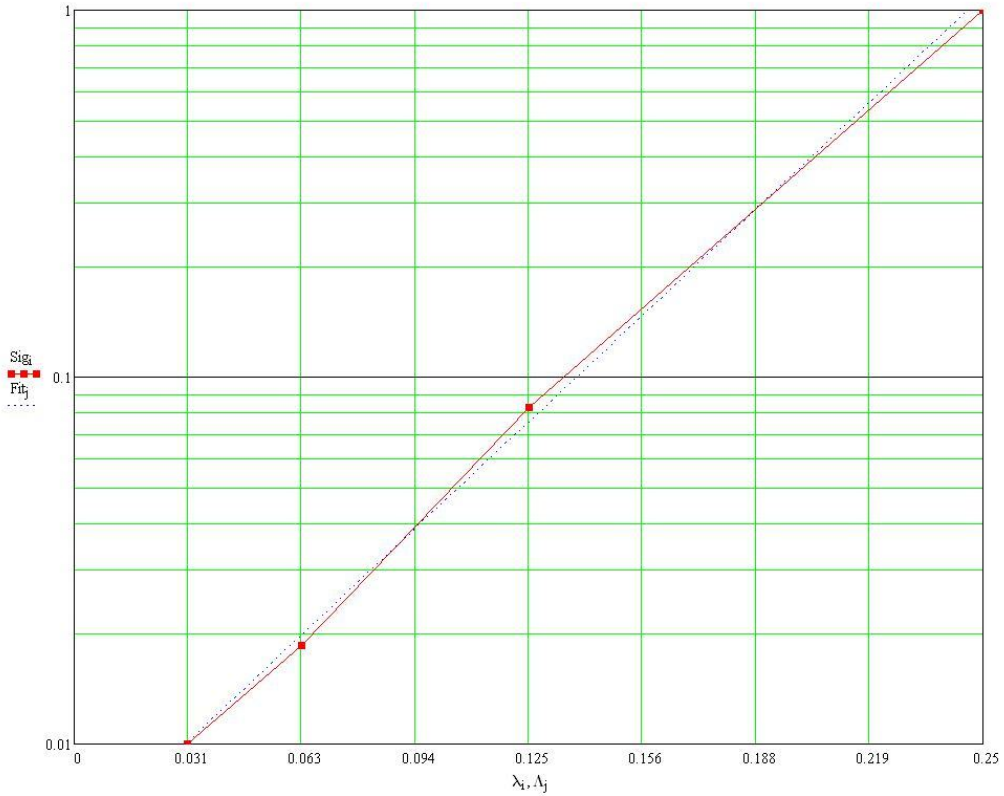


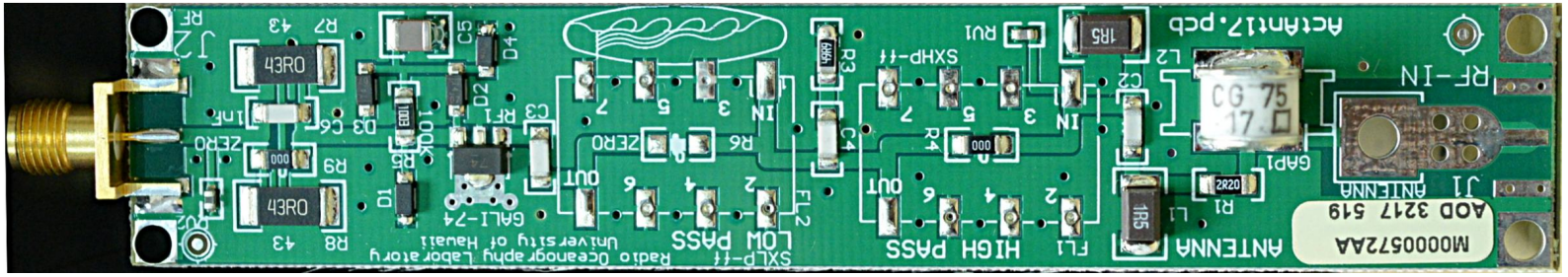
Y. Barbin, on U.H. antenna (2002)

- **stable tuning to better than 30 kHz difficult**
- **random phase array errors as chirp passes through resonance point**

UH active antenna monopoles: 3 to 50 MHz, 900 built

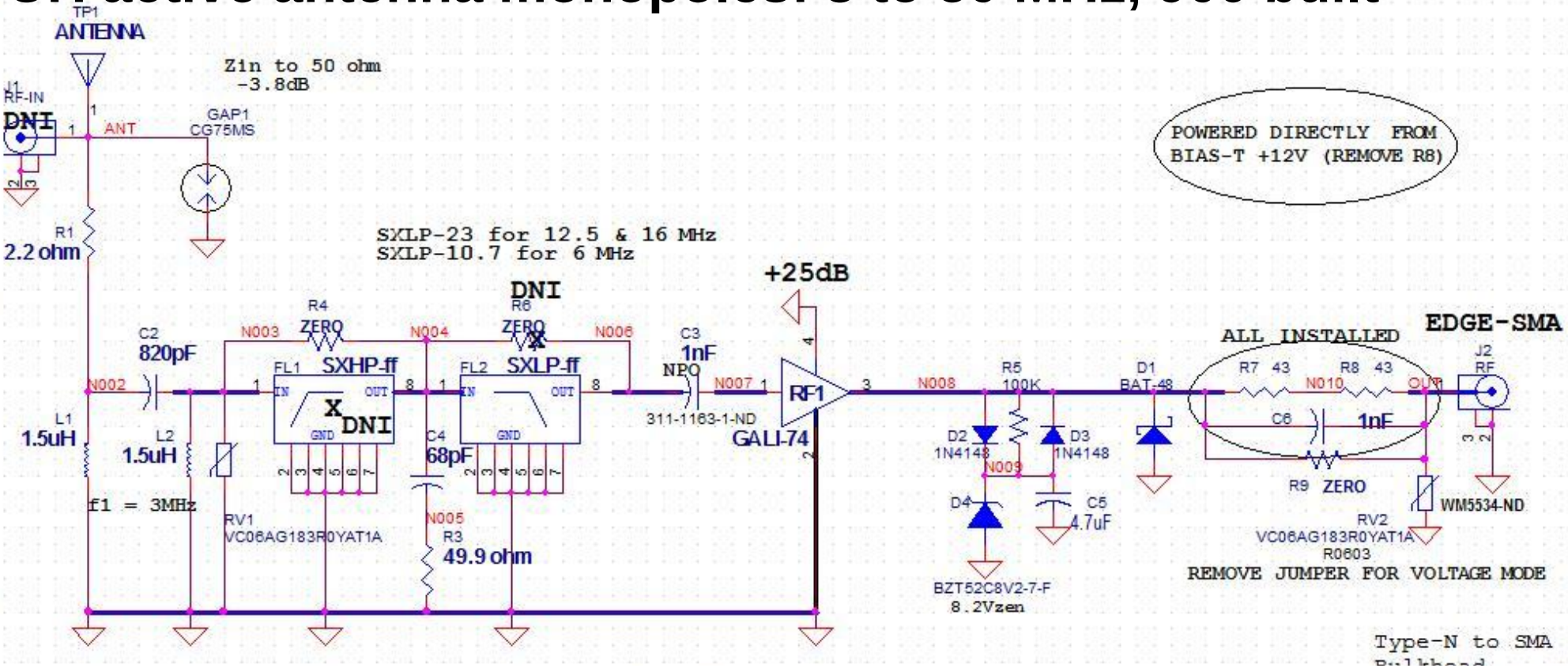


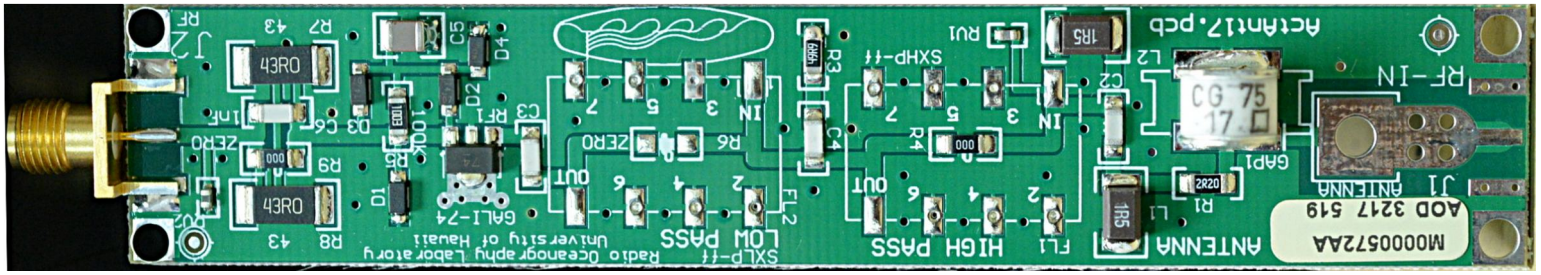




- λ/20 to λ/8 wire
- shortened monopole used below resonance point
- low-pass filter at *1.5*f* (Minicircuits SLXP-40+)
- optional high-pass filter
- 24 dB LNA with 2.7 dB noise figure
- no tuning, no radials

UH active antenna monopoles: 3 to 50 MHz, 900 built





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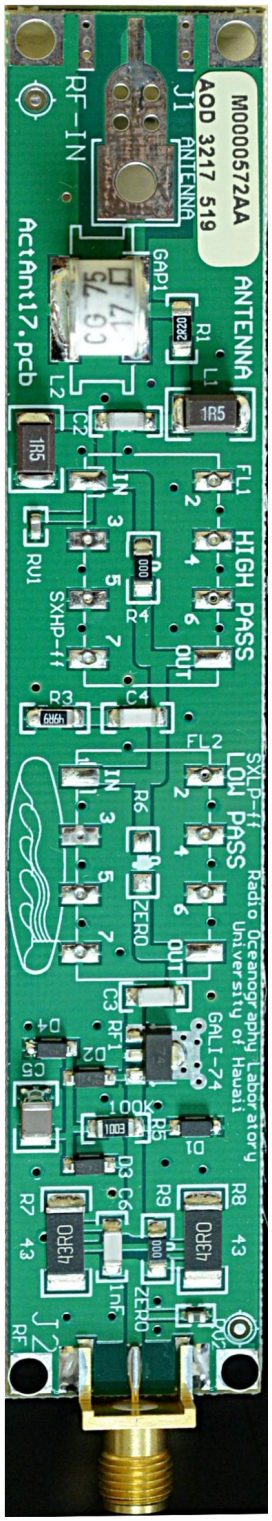
- **optional high-pass filter**
- **24 dB LNA with 2.7 dB noise figure**
- **no tuning, no radials**

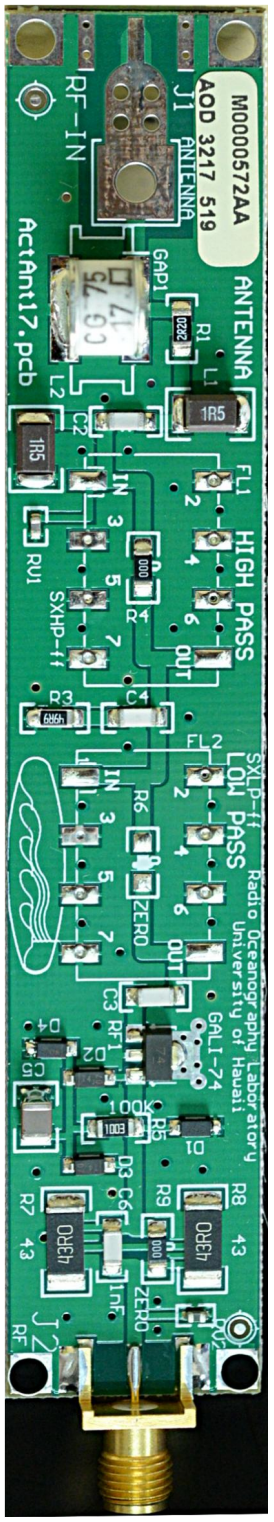
Active antenna array:
13.5 MHz range 130 km
(Chevron Kapolei)

λ = 22.2 m
λ/12 wire strait
λ/12 PVC mast



Active antenna array: 16.2 MHz range 80 km (Martha's Vineyard)

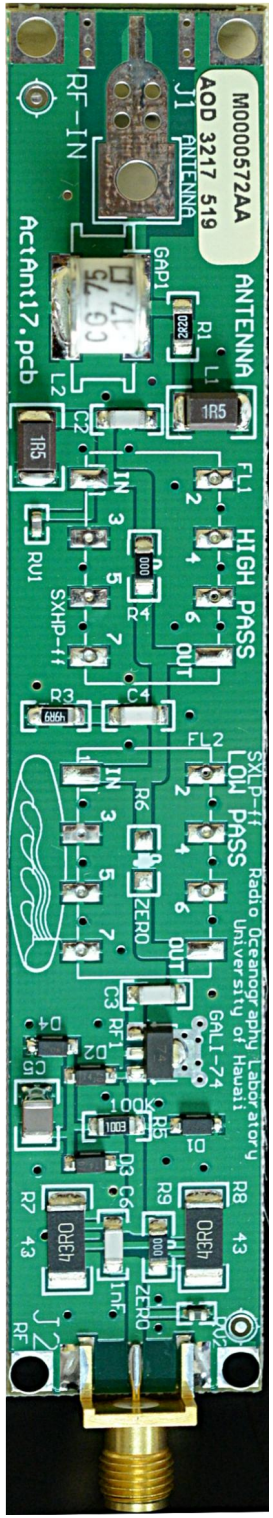
λ = 18.7 m
λ/8 wire coiled
λ/16 mast



Active antenna for field strength surveying

SOKKIA wood tripod

λ = 18.7 m
λ/8 wire coiled
λ/16 mast

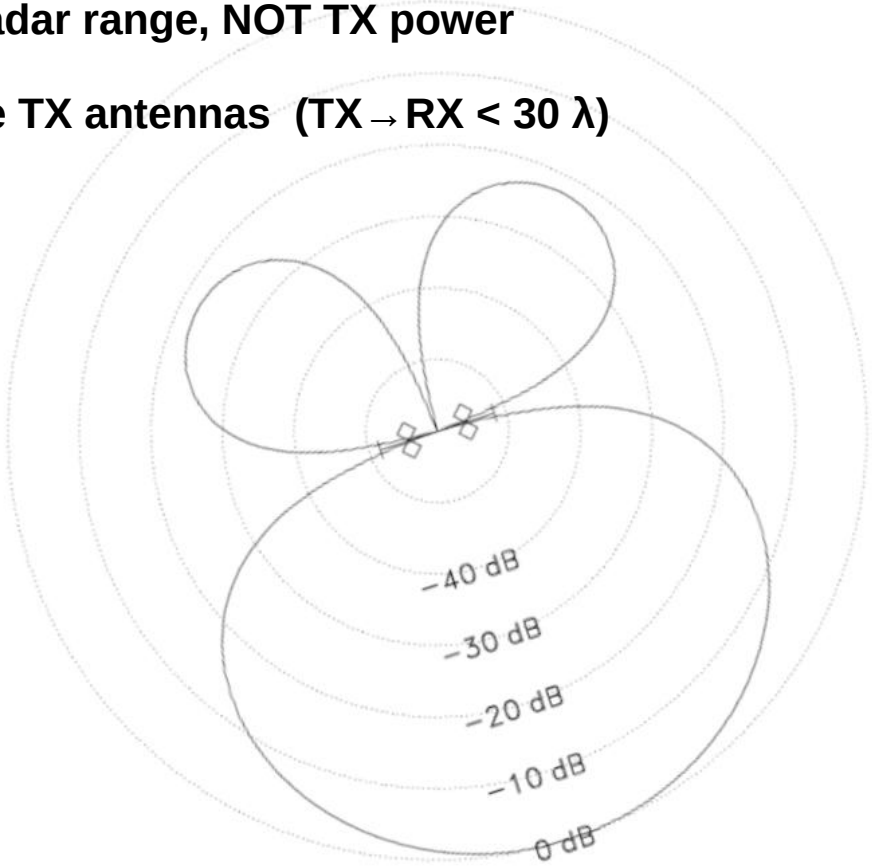


TX beamforming

Issue:

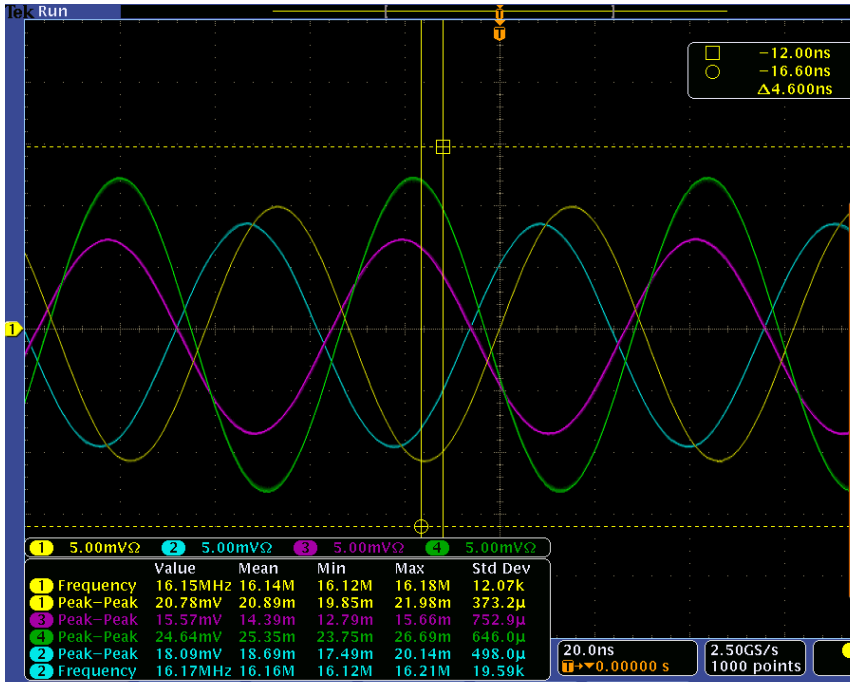
- FMCW radars require direct path rejection TX→RX
- for given RX sensitivity, direct path governs radar range, NOT TX power

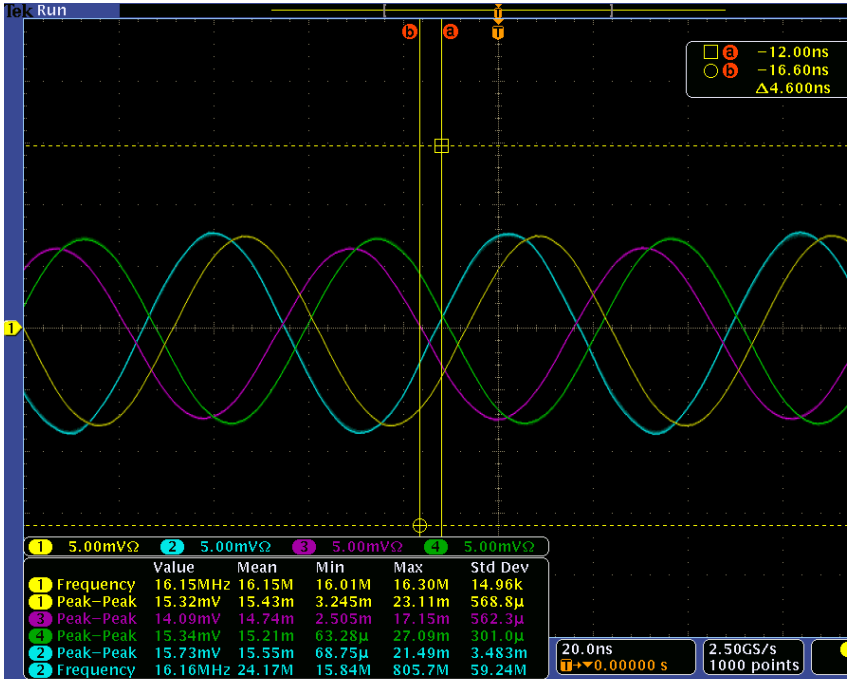
- solution 1: beam-forming on transmit, multiple TX antennas (TX→RX < 30 λ)

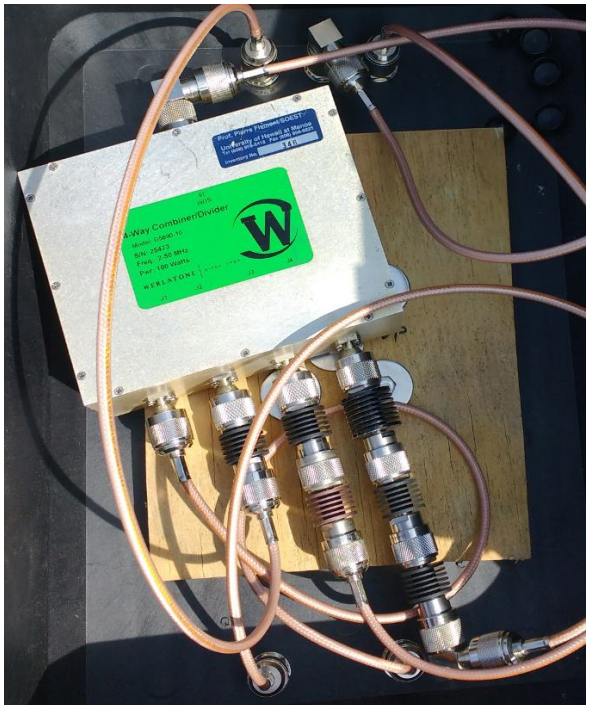


- solution 2: large distance between TX and RX (TX→RX >40 λ)
(Goro: 900 m @ 16 MHz, 1 TX antenna enough, isotropic transmission)

TX beamforming

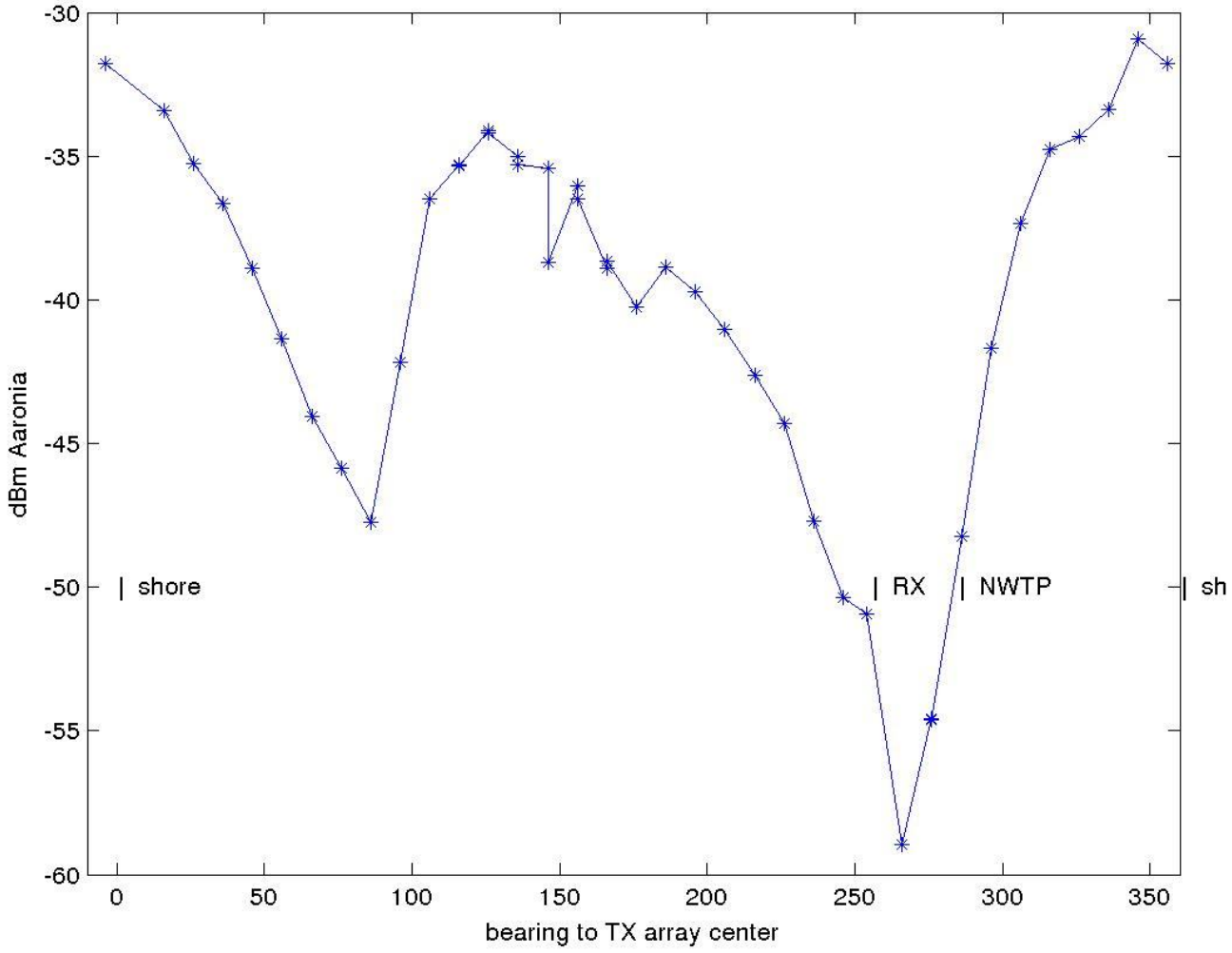






- transmit sine wave from passive RX antenna
- 4-channel scope to sample each TX antenna
- adjust amplitude with power attenuators

Mapping TX B-field



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