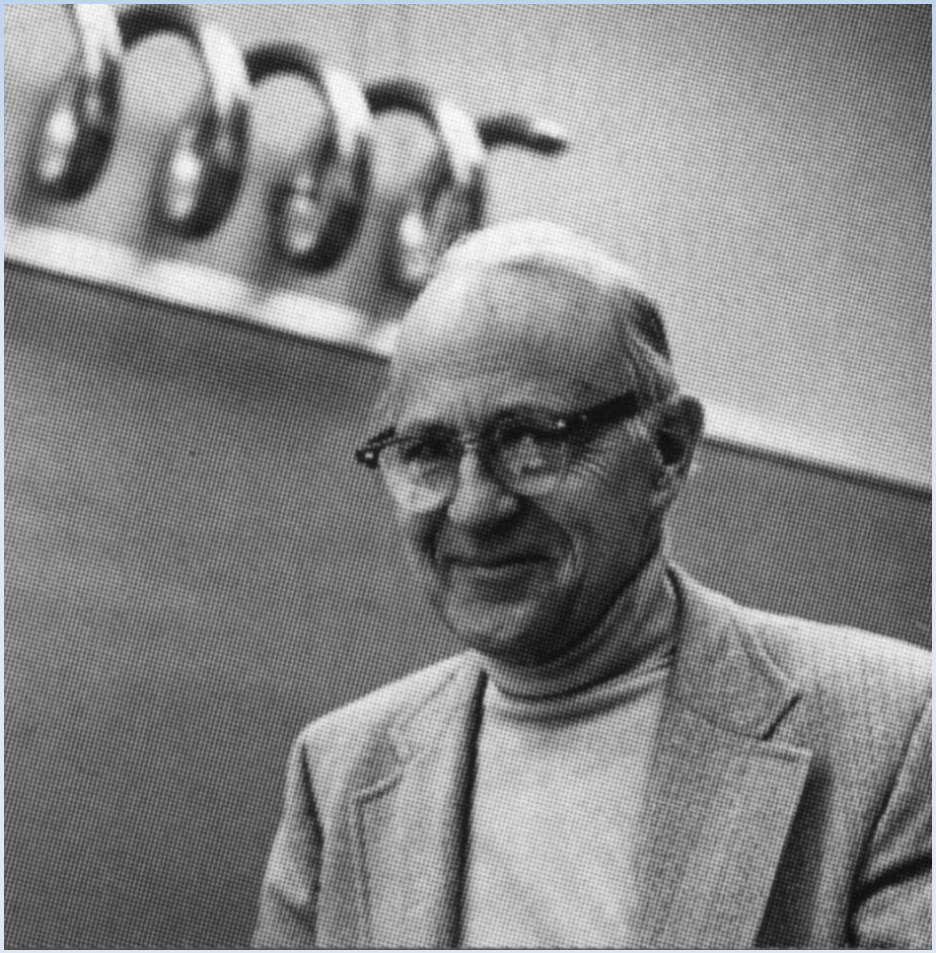
A 40+ dB Gain Antenna Made from Paper

- *Flying Antenna/QSO
- A New Antenna Theory
- *An Inexpensive SWTL
- *An All-Band Antenna
- Q&A

*Construction Article Available

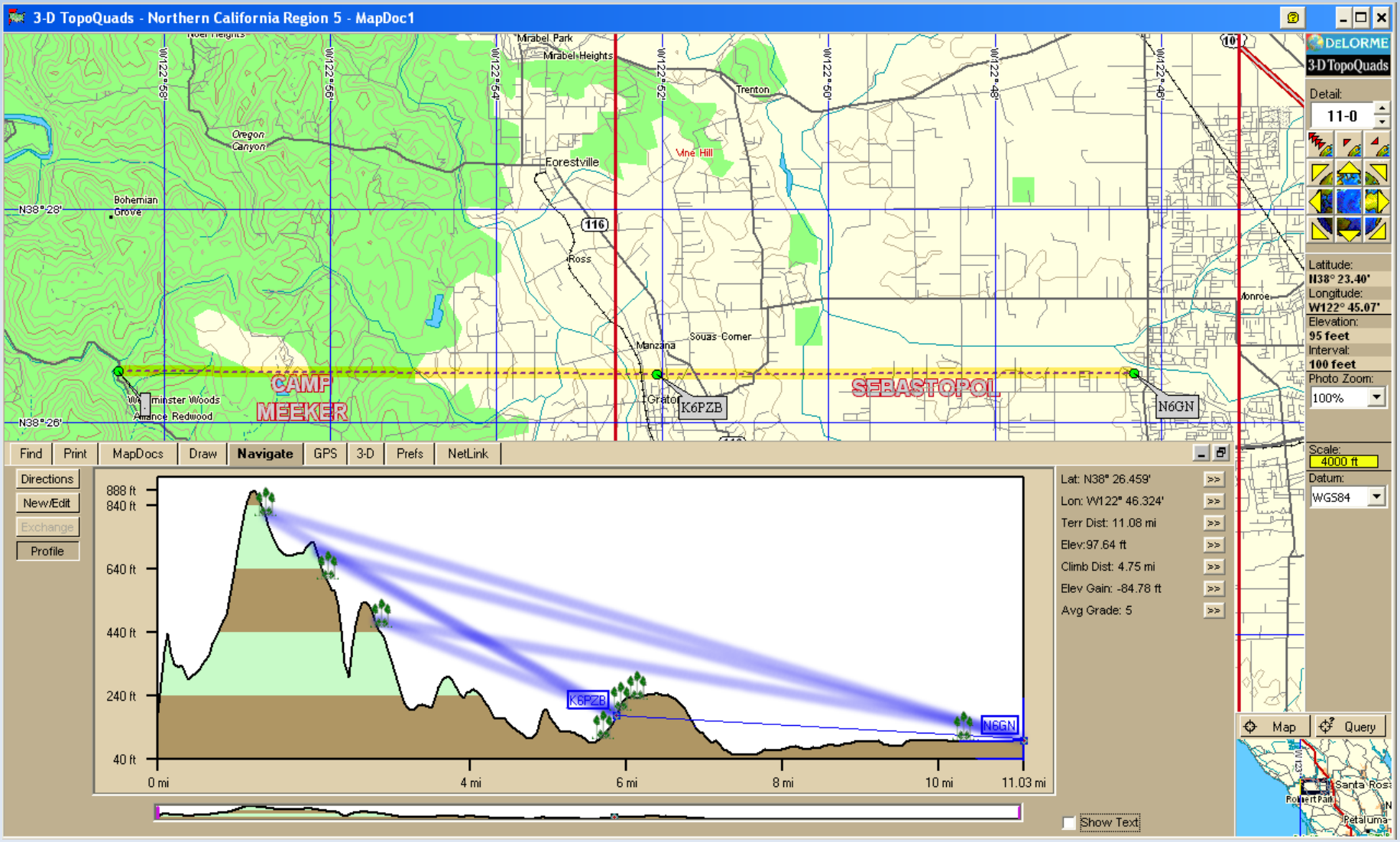
John Kraus, W8JK



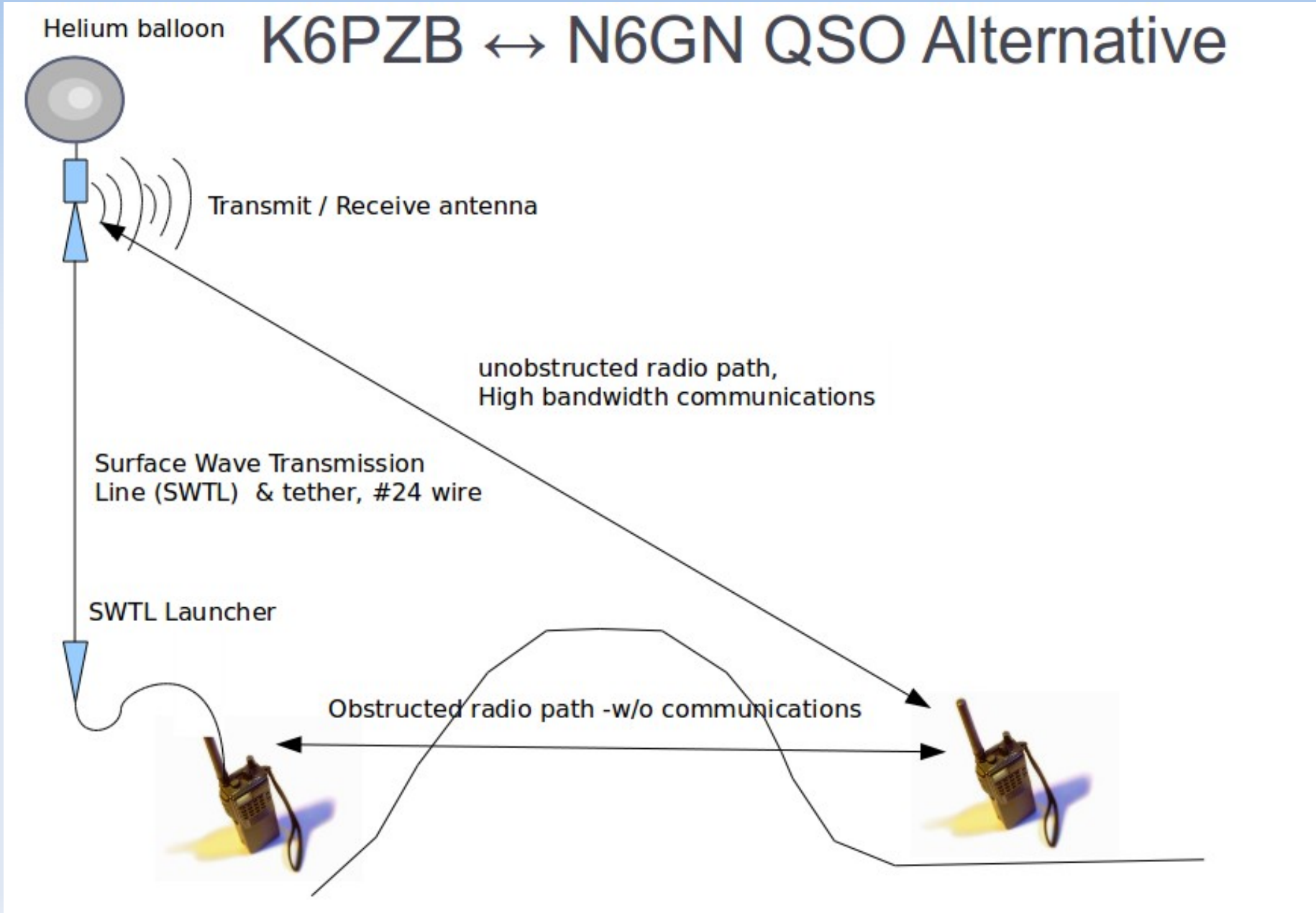
John Kraus, W8JK

Sonoma County, California

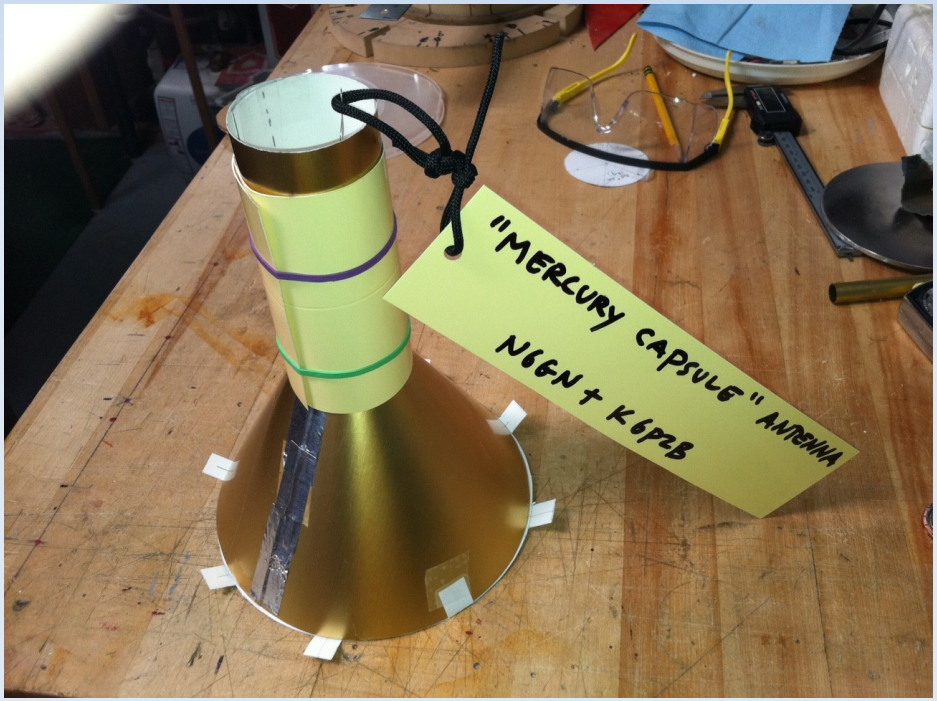
Radio Paths Beween K6PZB/N6GN

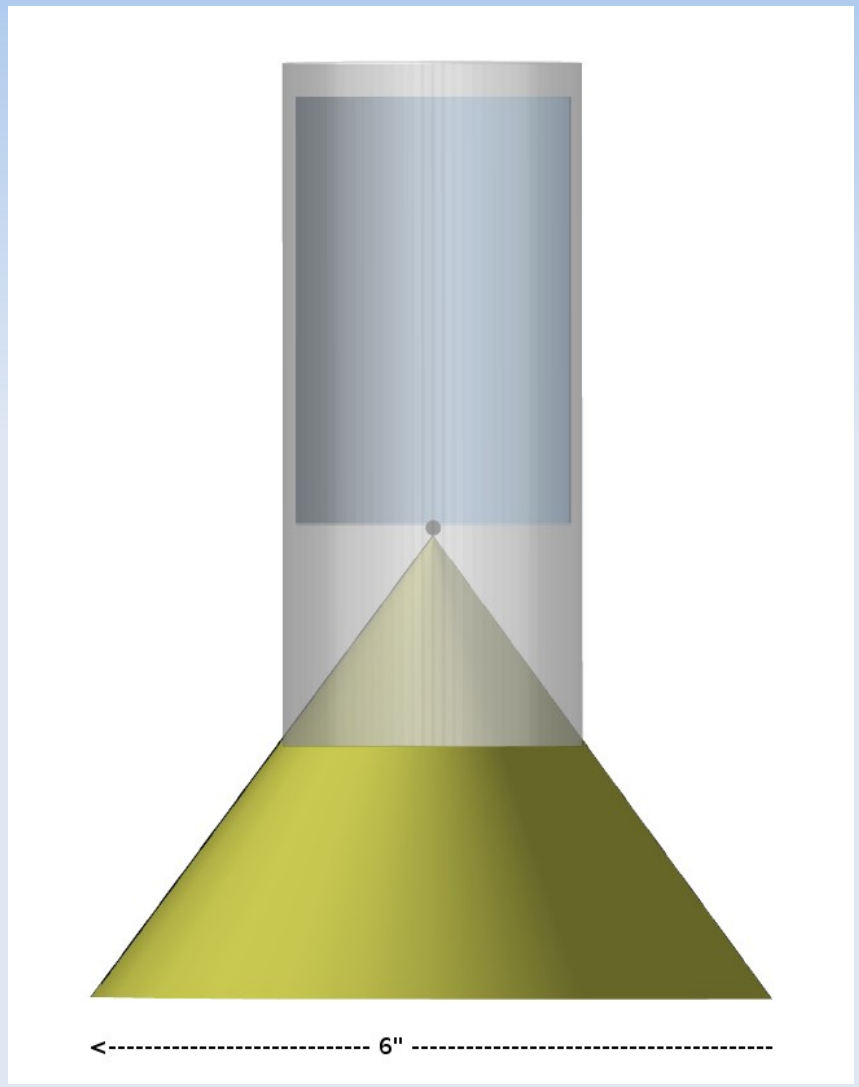


What We Did


Helium balloon
K6PZB ↔ N6GN QSO Alternative
Transmit / Receive antenna
unobstructed radio path,
High bandwidth communications
Surface Wave Transmission
Line (SWTL) & tether, #24 wire
SWTL Launcher
Obstructed radio path -w/o communications

A Flying Antenna



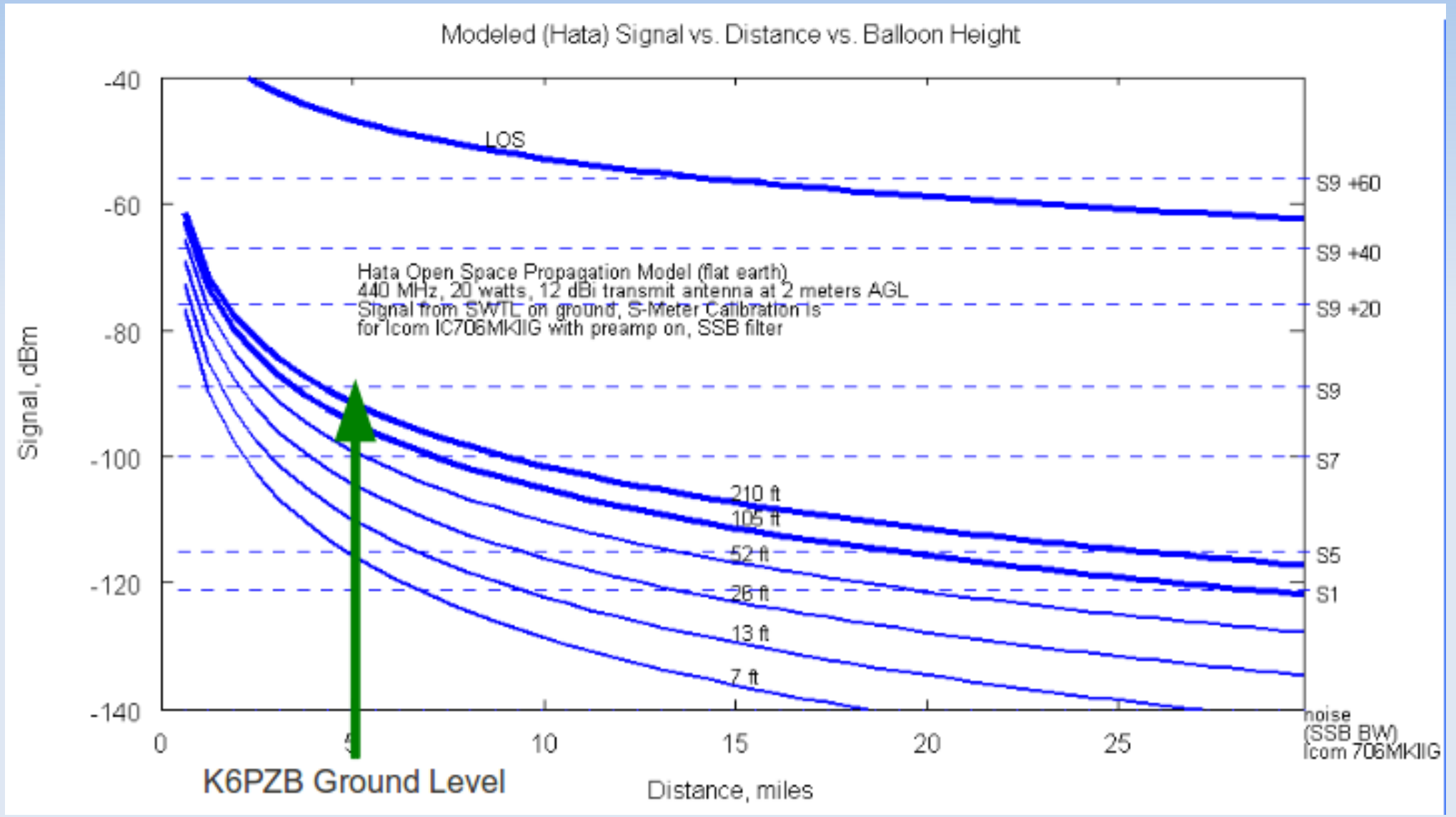


The ”Mercury Capsule” an extended Discone

Winder Photos

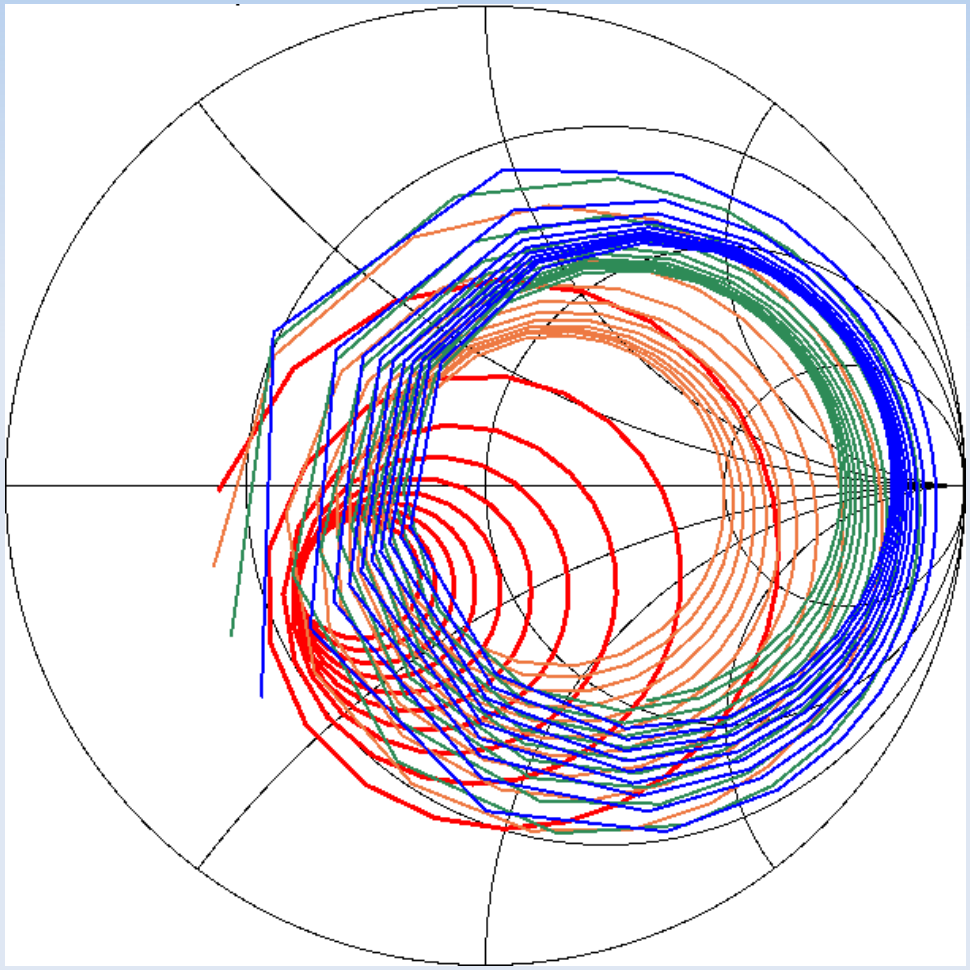
Flying Antenna Photos

Predicted Signal Vs. Height



Actual improvement > 40 dB

A New Antenna Theory



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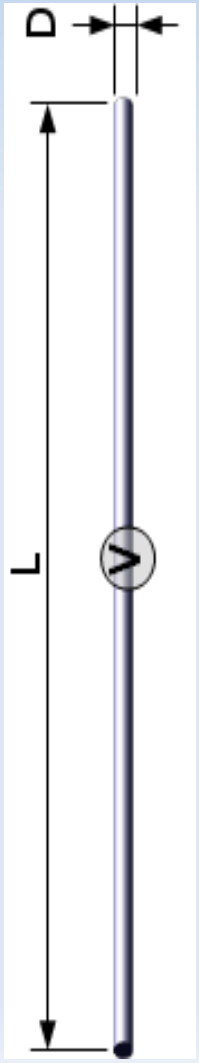
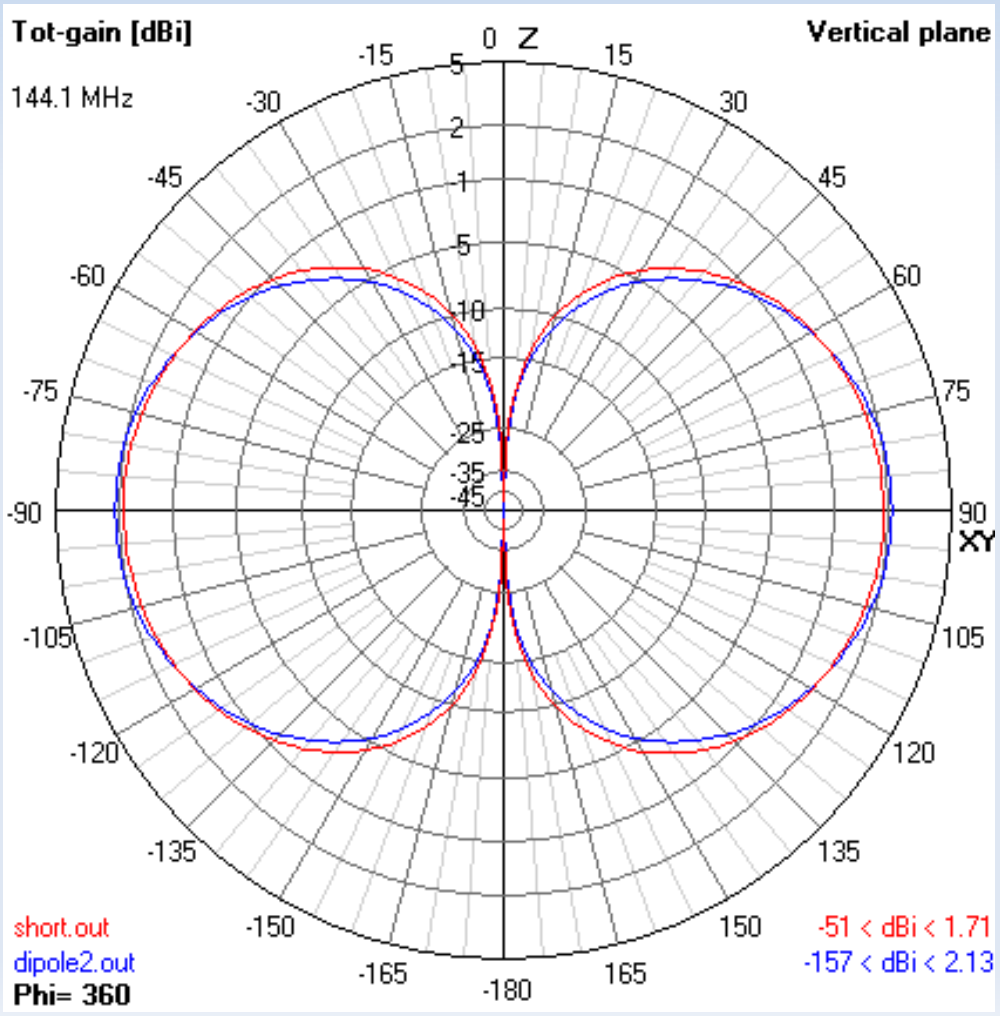
Traditional Antenna Theory

$$\vec{I} = I_0 e^{j\omega t}$$

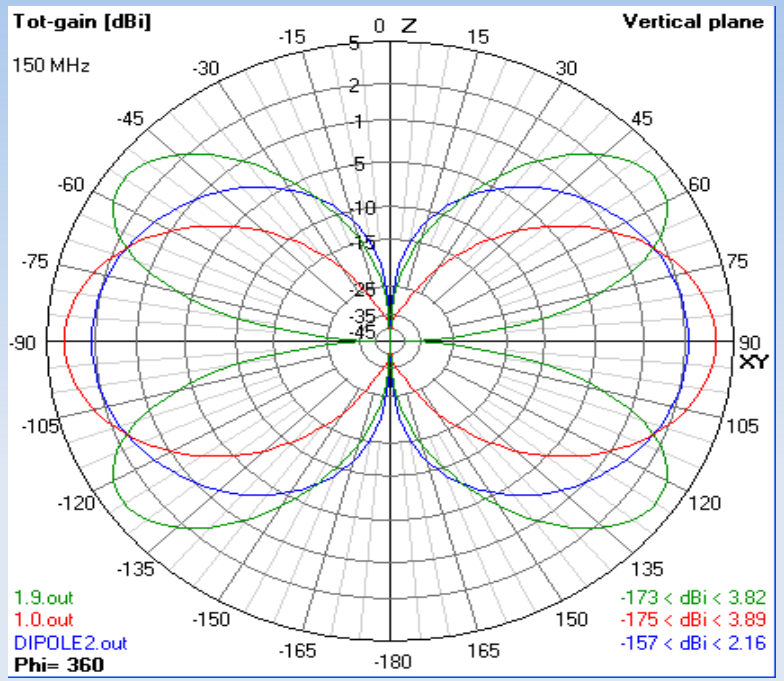
$$E_\theta = \frac{j k \mu d I_0}{4 \pi r} \sin\theta \, e^{j(k\omega t - kr)}$$

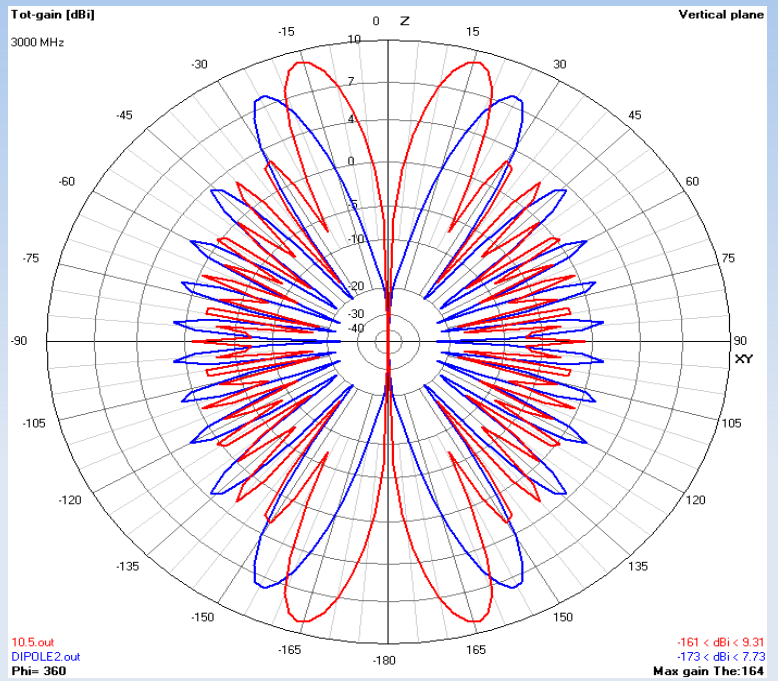




- The traditional development of dipole antenna theory is by integrating current in infinitessimal elements. This reveals both pattern and impedance.
- For most of us, there is little added understanding of ***how*** or ***why*** an antenna operates.

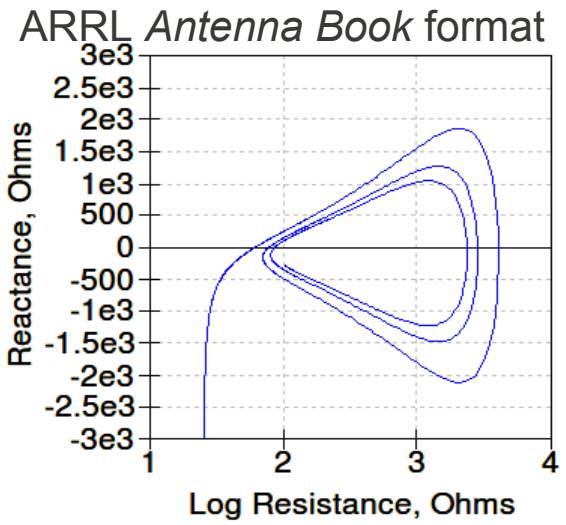
Dipole Pattern and Feed Impedance

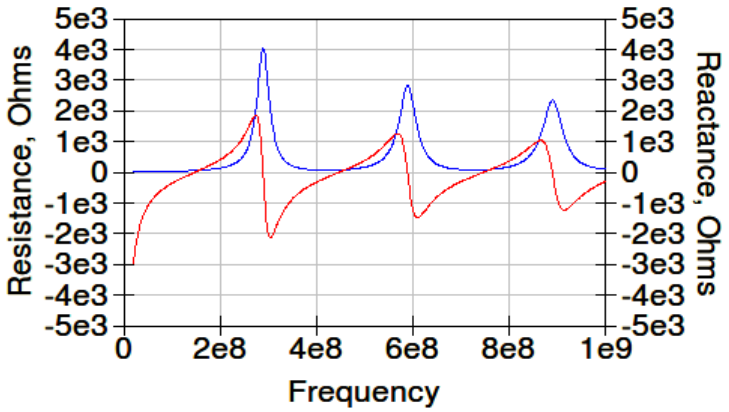


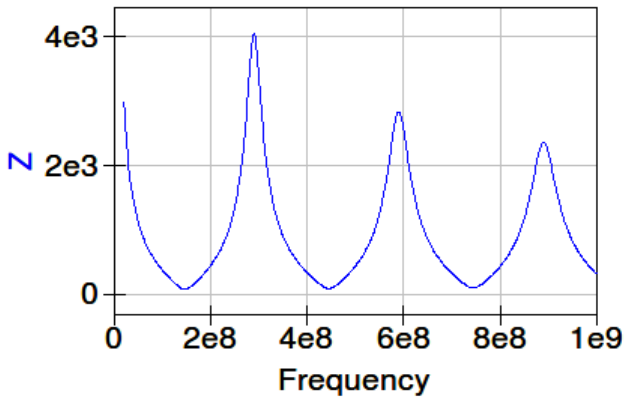


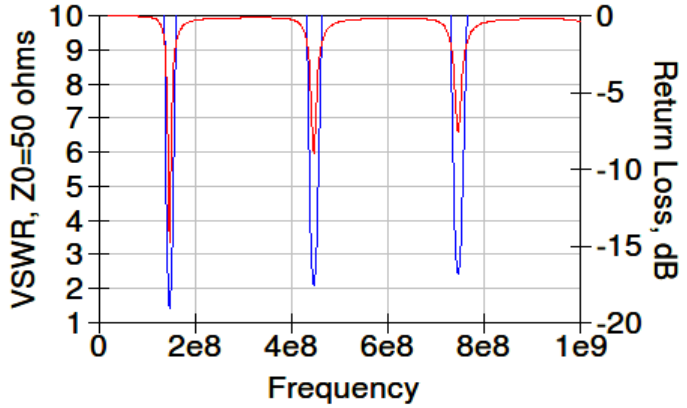
- Antenna pattern vs. dimension (wavesize)
- In these plots, the antenna is positioned vertically in free space at the center of the plot.
- Notice that for some dimensions there is zero signal broadside to the antenna.

Dipole Representations



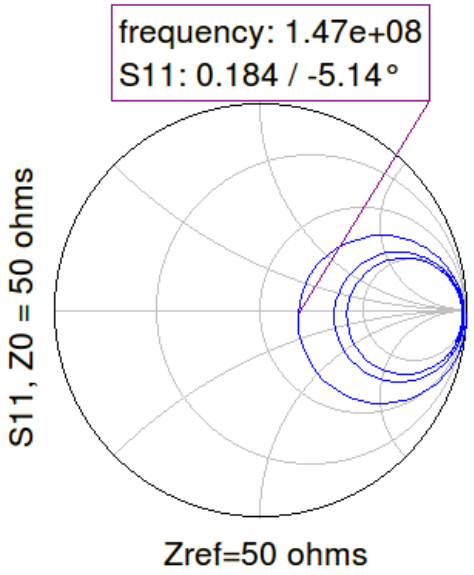


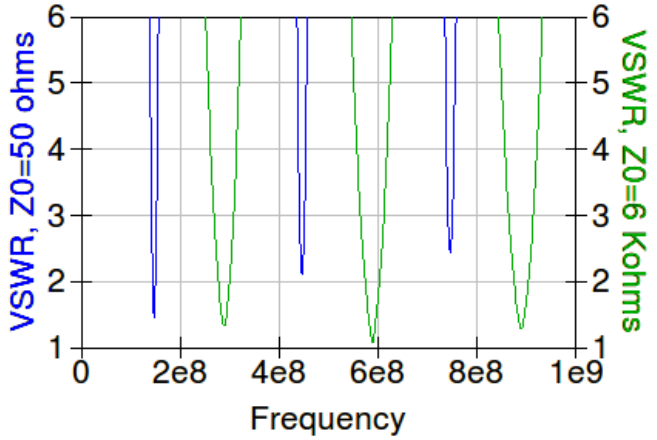


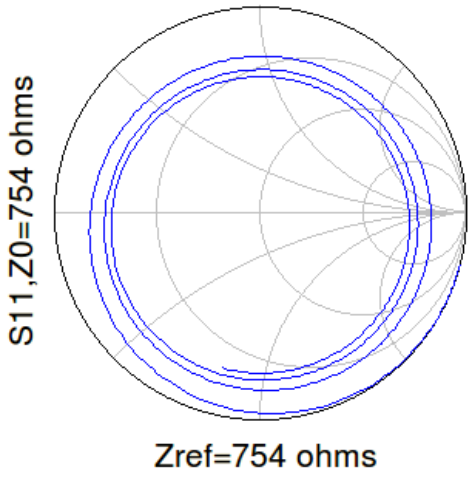


- Response vs. frequency for a one meter center fed dipole

Beyond Z_0 = 50 ohms

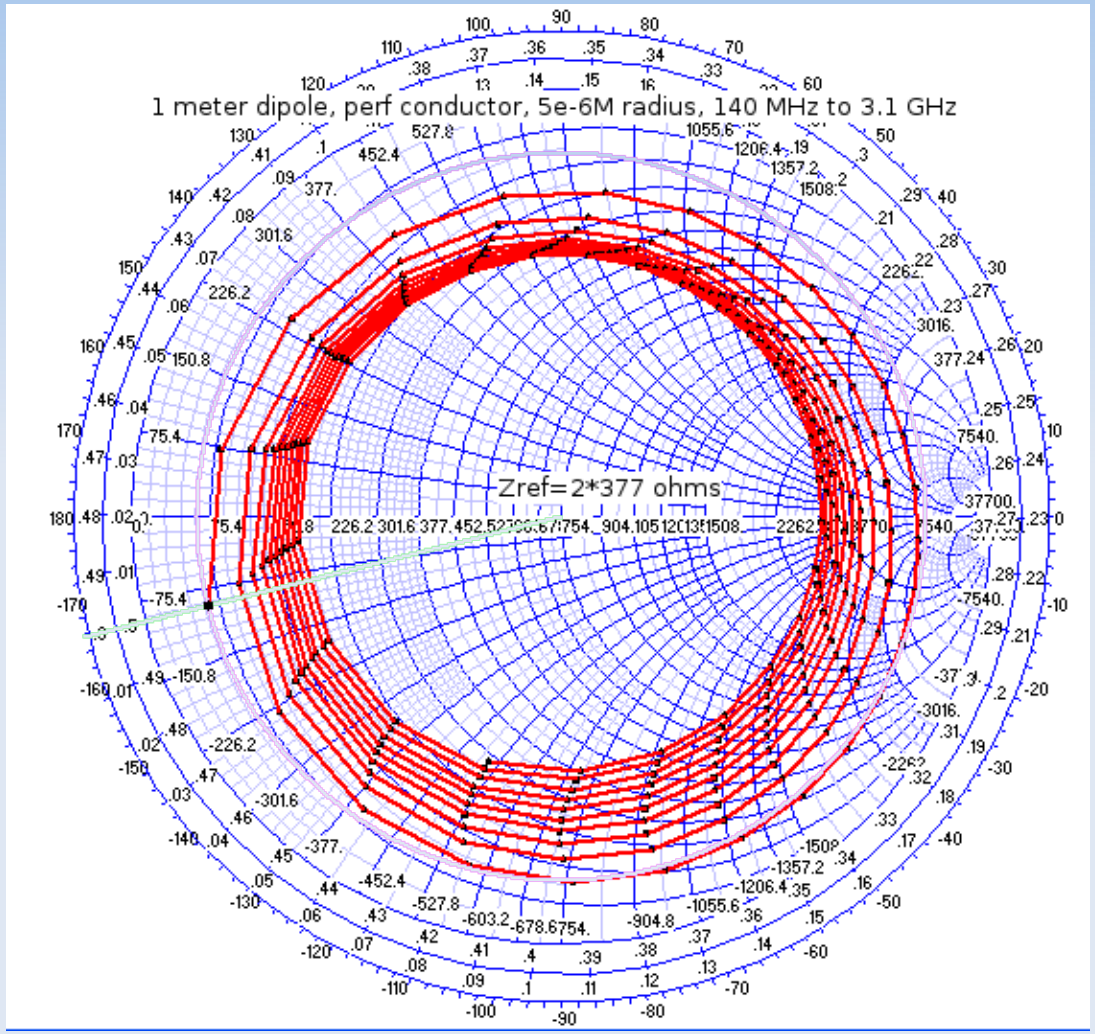






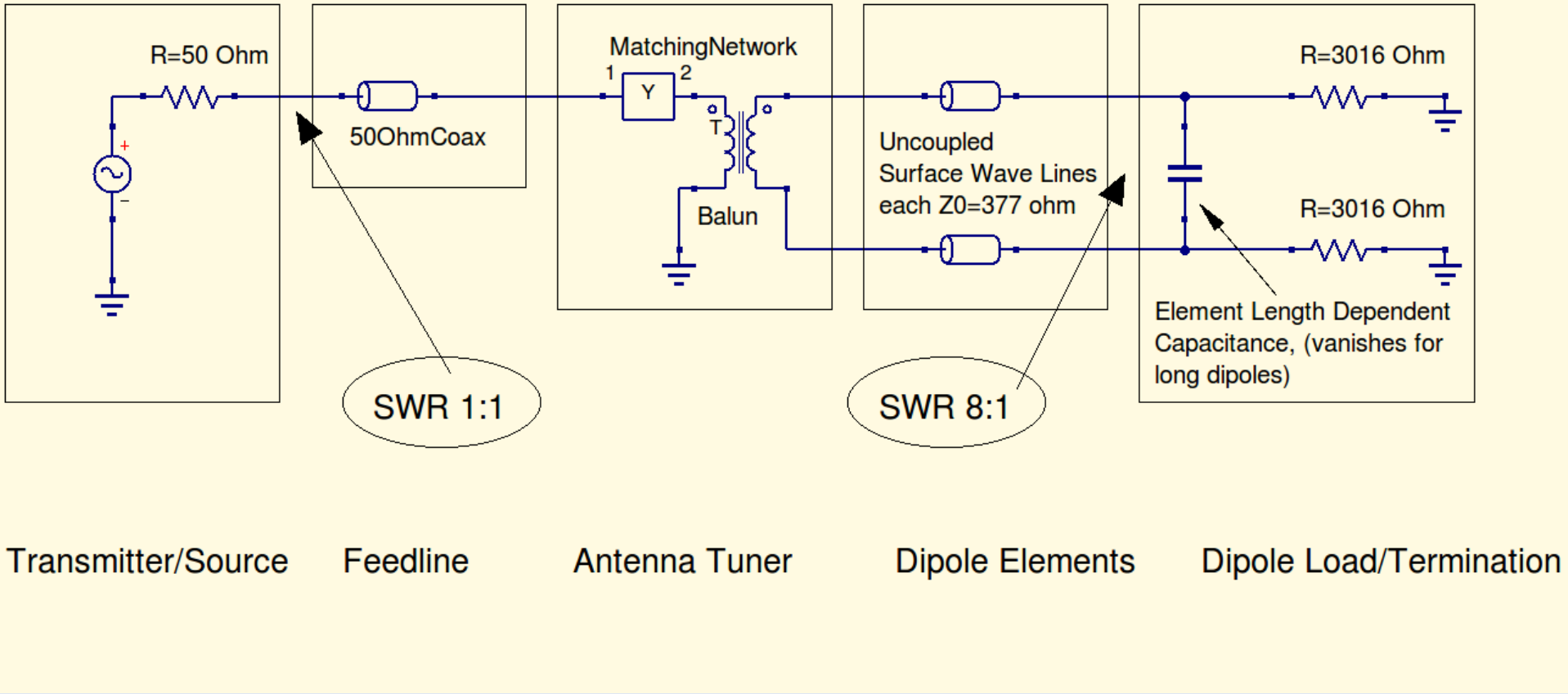
- Note broader match bandwidth at Z_0 = 6 kohms & full wave.
- A circle around Smith Chart center is characteristic of a mismatched transmission line, $Z_0 = Z_{ref} \neq Z_{load}$

The Dipole as Mismatched Lines



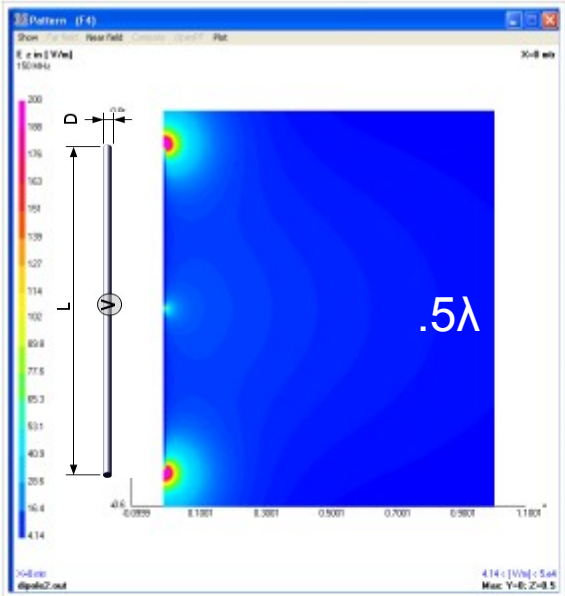
- Feedpoint impedance (4NEC2) of a thin 1 meter dipole plotted on a Smith chart with a reference impedance of 754 ohms, twice the impedance of a wave in free space.

A Circuit Designer's Dipole Model

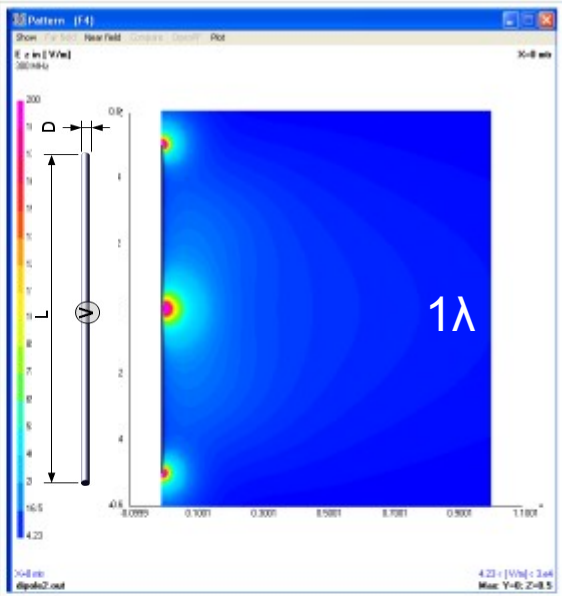


- For a radio communications system designer, the goal is usually to transfer as much of the transmitter power to the radiation resistance as possible

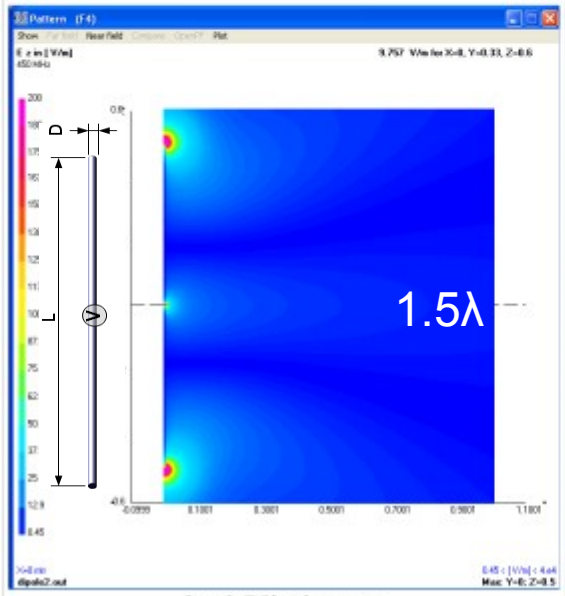
Dipole Z-Axis Near-Field



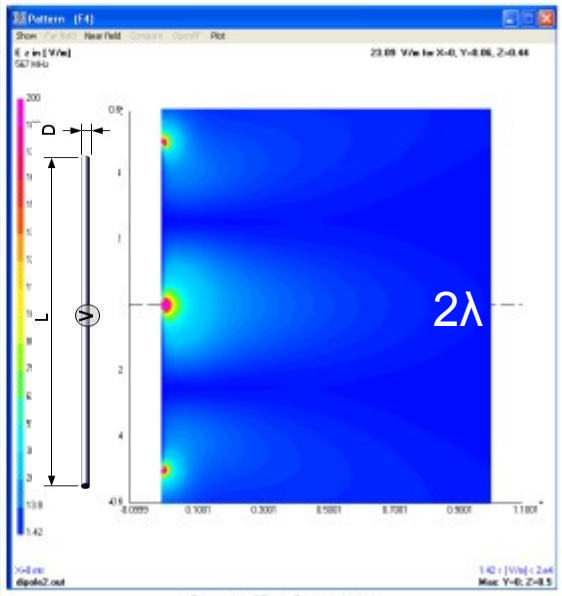
2 x 0.25λ elements



2 x 0.5λ elements



2 x 0.75λ elements

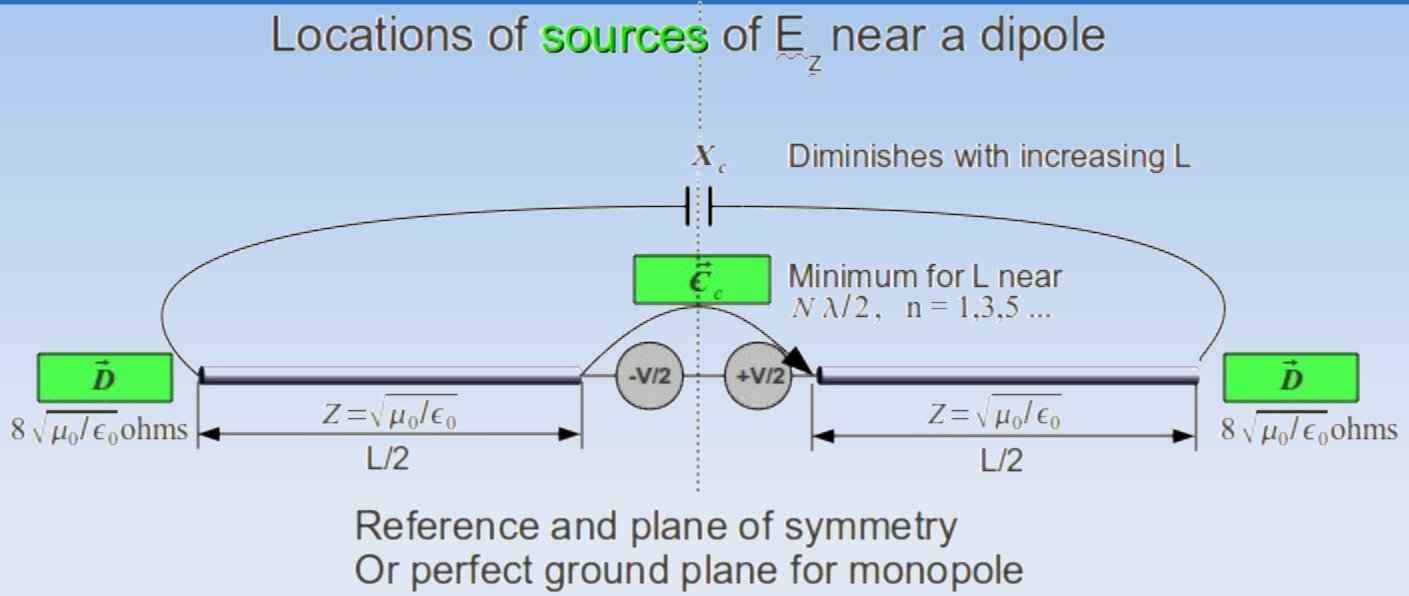


2 x 1.0λ elements

Perfectly conducting, center fed, 1 meter x 10^{-5} element diameter dipole

- Near-field electric field strength parallel to the dipole conductor for center fed dipoles of different wavelengths. (from 4NEC2).
- Due to symmetry and cancellations, E_x & E_y each become zero in the far field and may be ignored.
- Notice that significant E_z components are present only at the ends and (sometimes) at the center of the dipole.

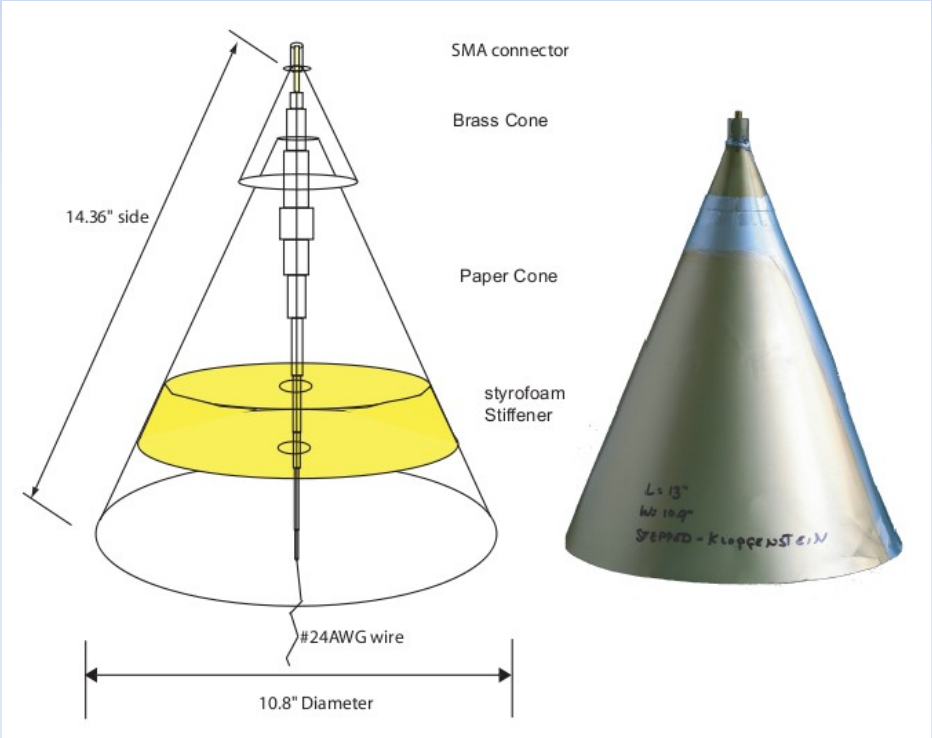
A New Interpretive Antenna Model



The radiation pattern and impedance of a dipole (or monopole) can be modeled as sources of longitudinal electric field at C and D, with sources D acting as mismatched loads to uncoupled, non-radiating 377 ohm surface wave transmission lines, along with a tip-tip capacitance which is only significant at small antenna wave size.

"Thus, a single device, in this case the dipole, exhibits simultaneously properties characteristic of an antenna, a transmission line, and a resonator."
John Kraus, W8JK, Antennas, McGraw-Hill 1950, Chapter 1

An Inexpensive SWTL



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*Construction Article Available

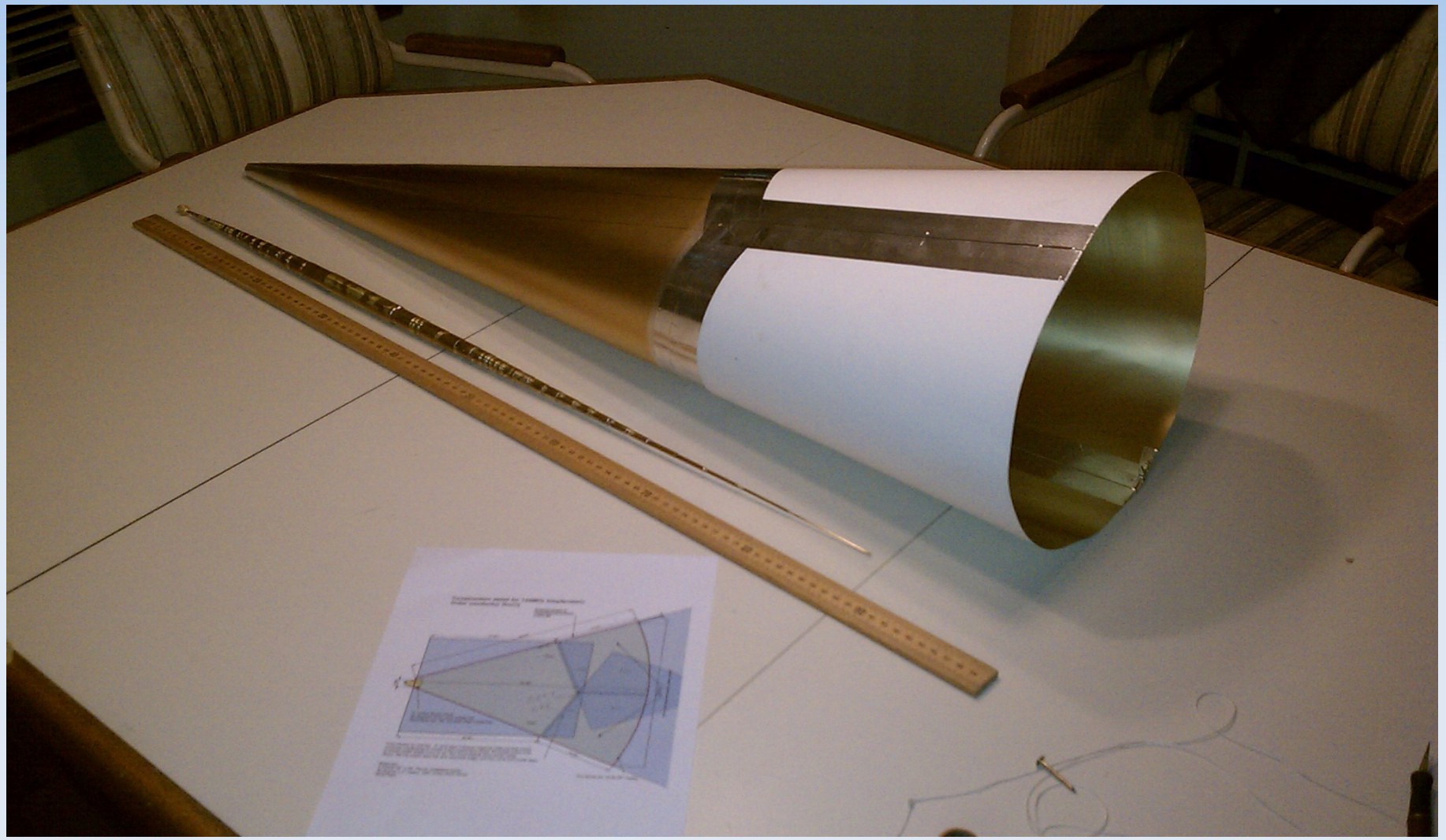
A New Type of Transmission Line

This SWTL is *not* G-line as shown in ARRL VHF Manual, QST or reference books.

- The conductor needs no insulation
- The wave is not slowed but travels right at the speed of light.
- Velocity factor is 1.0
- Not only for microwave. With suitable launchers this SWTL can operate at arbitrarily low frequency.

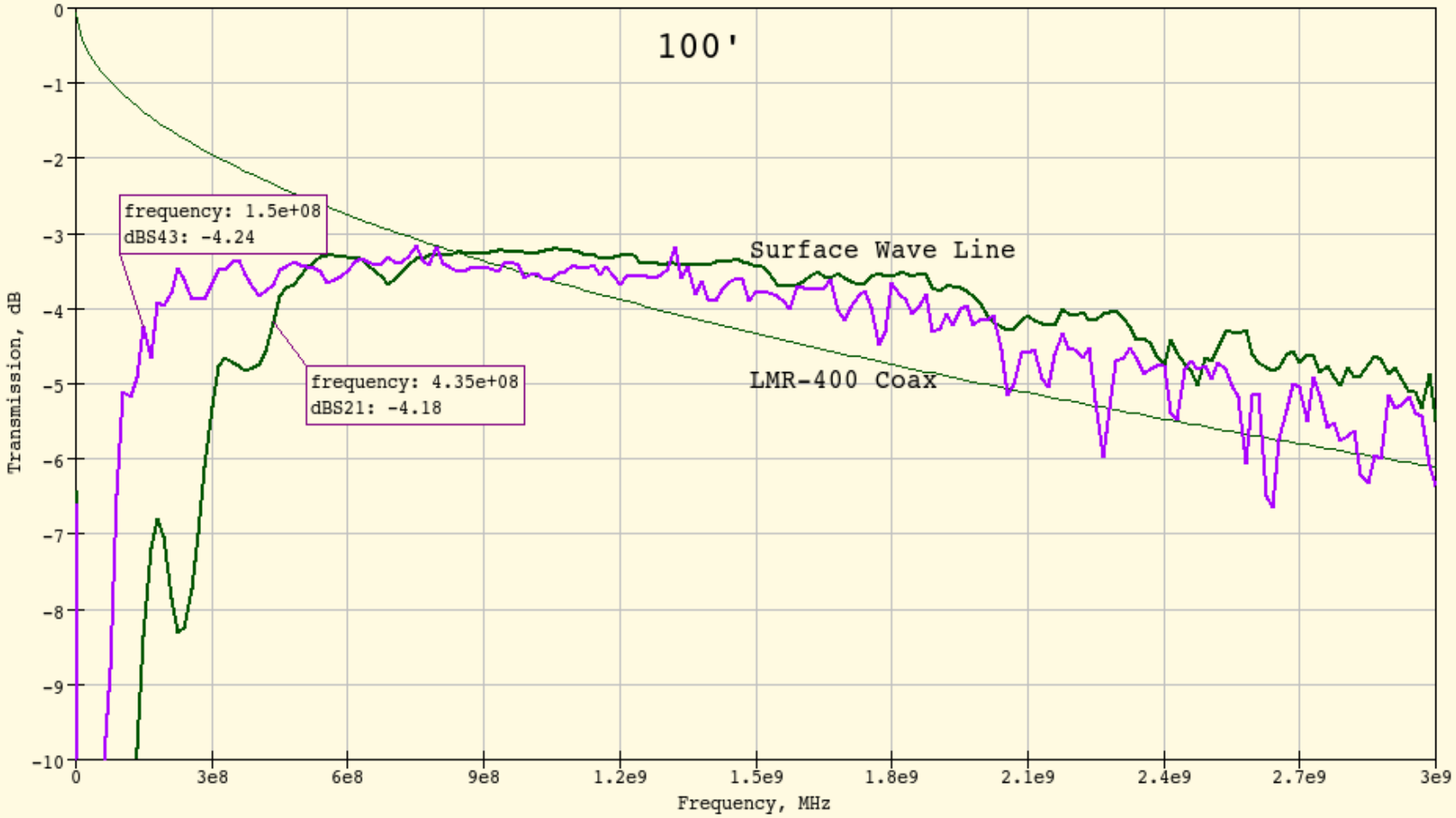
SWTL Photos

>140 Mhz Klopfenstein Taper Launcher



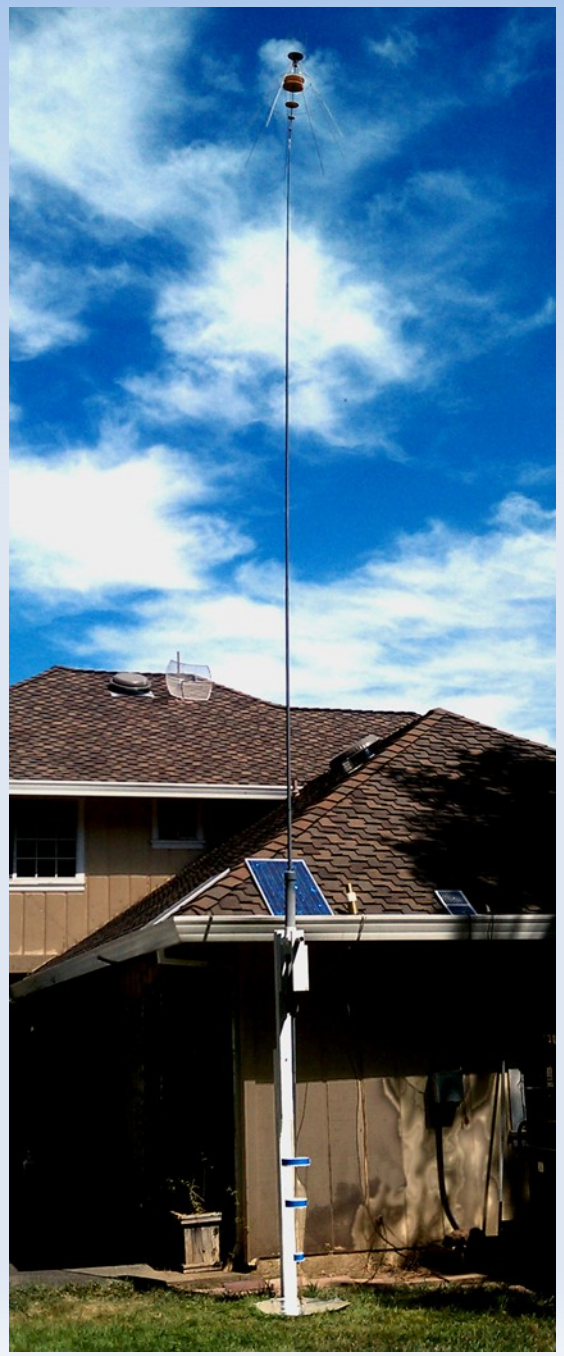
Launchers are surface waveguide adapters that convert the impedance and mode of a wave in coax to those on the single conductor waveguide

Measurements of 100' SWTL vs. Coax



144 MHz & 400 MHz Launchers/100' SWTL compared With 100' Times-Microwave LMR-400 Coaxial Cable

An All-Band Antenna



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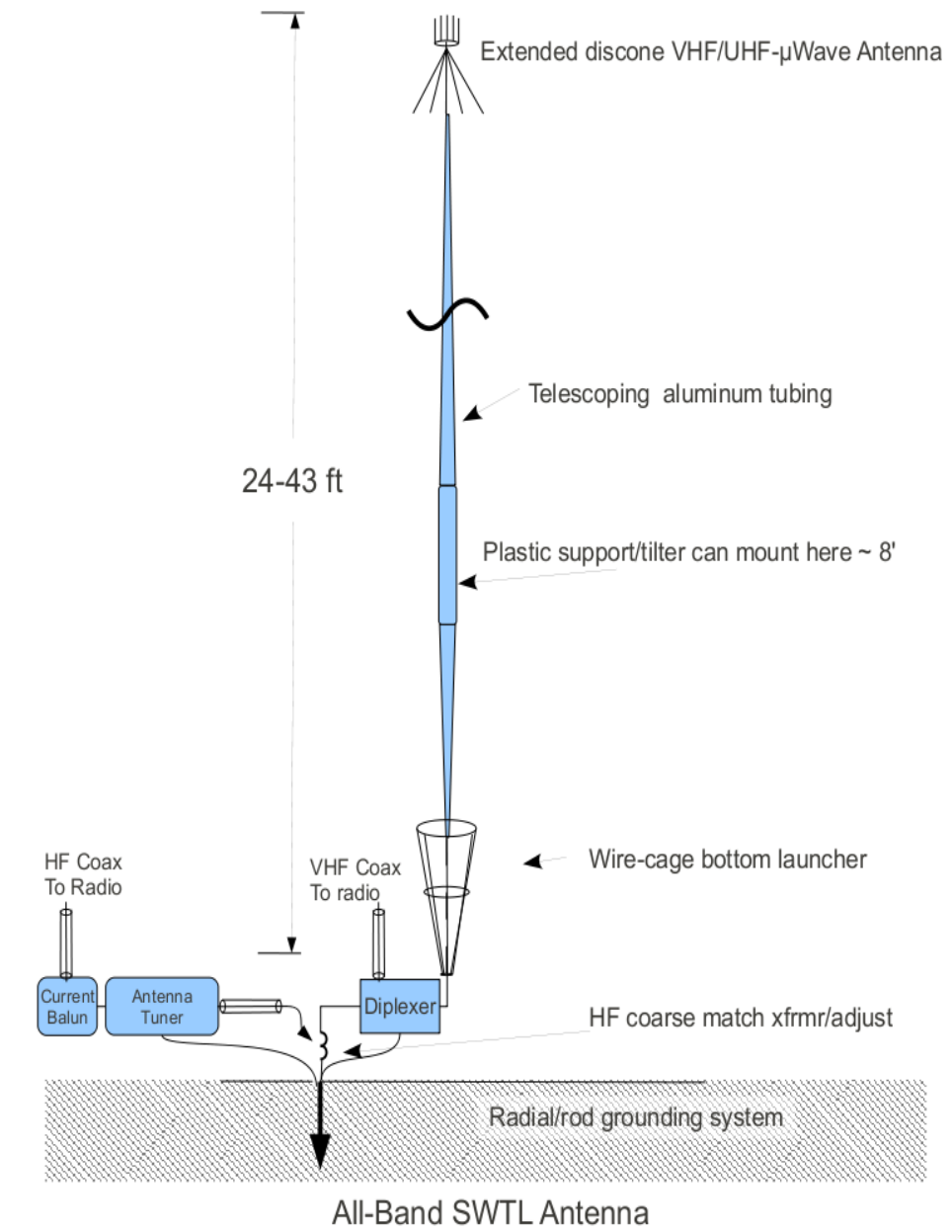
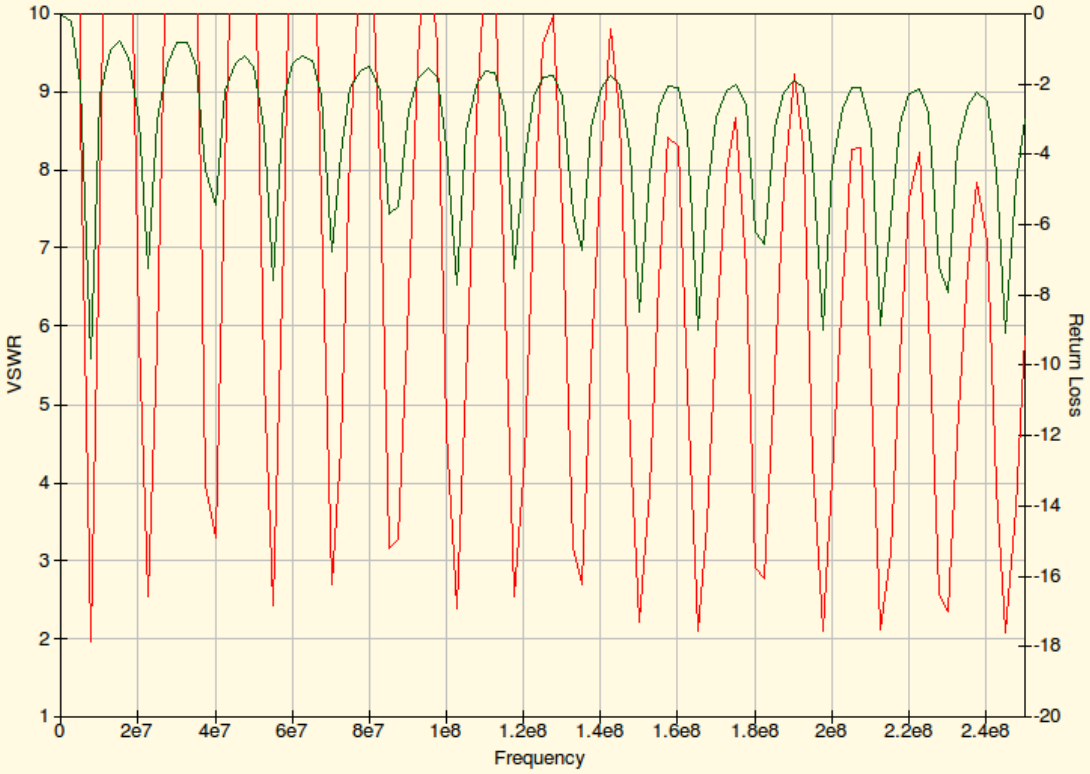
An All-Band Antenna

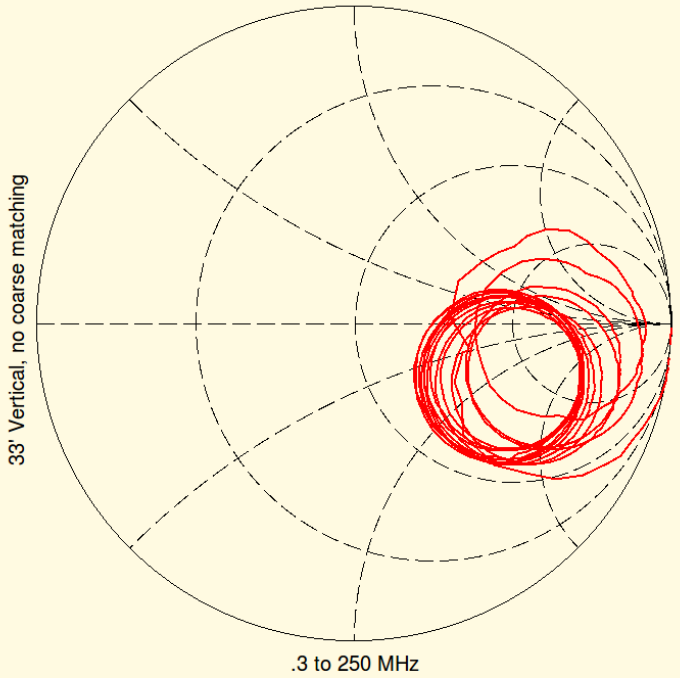


All-Band SWTL Antenna

- 160M through X band (1.8 MHz – 10,000 MHz) on a single antenna!
- Conventional end-fed vertical 160m-6m
- SWTL-fed extended discone 2m – 3cm
- Other 144+ MHz antennas possible

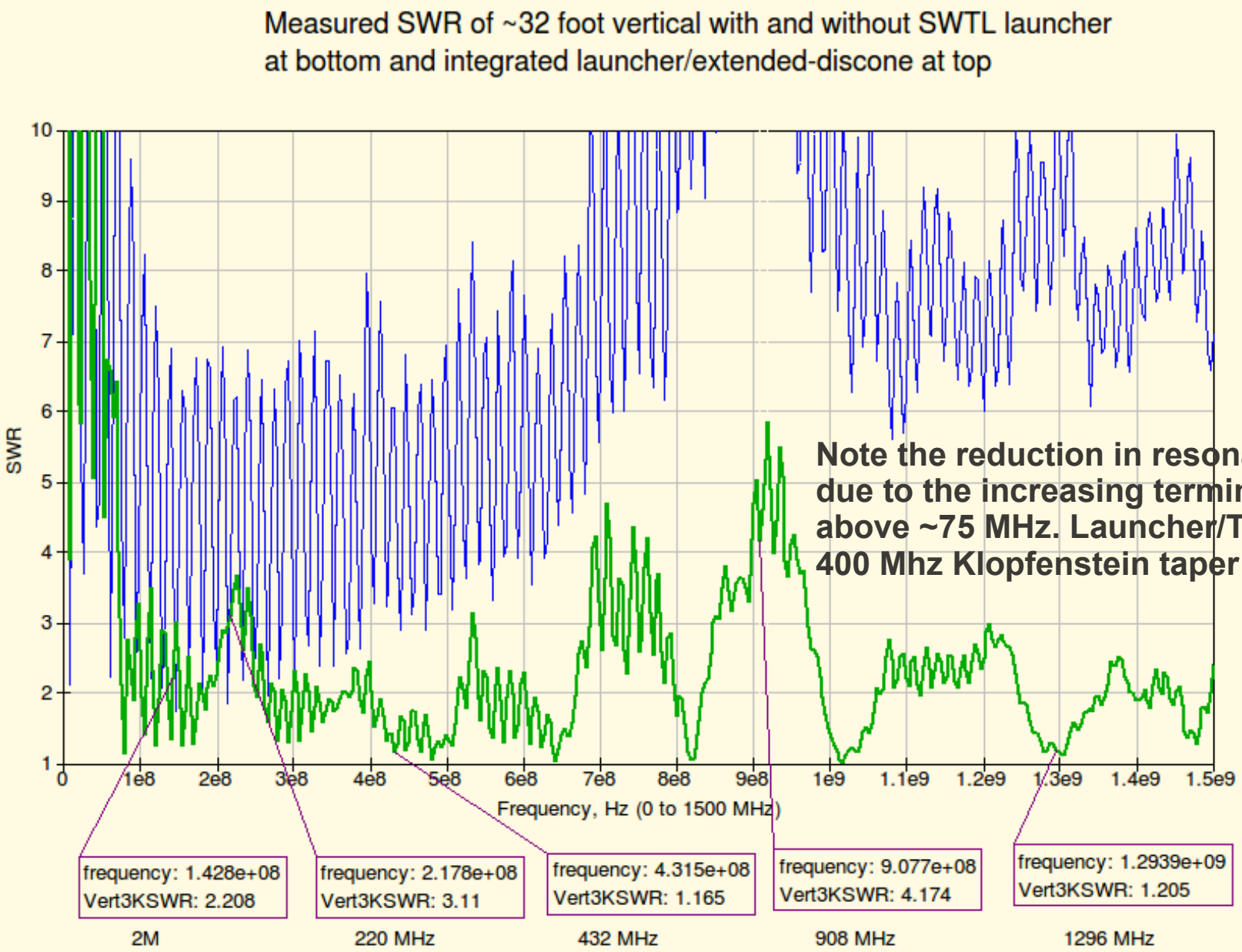
Match of 33' Vertical





Measured match of 33' vertical, .3 – 250 Mhz before SWTL launcher and VHF-microwave antenna are added

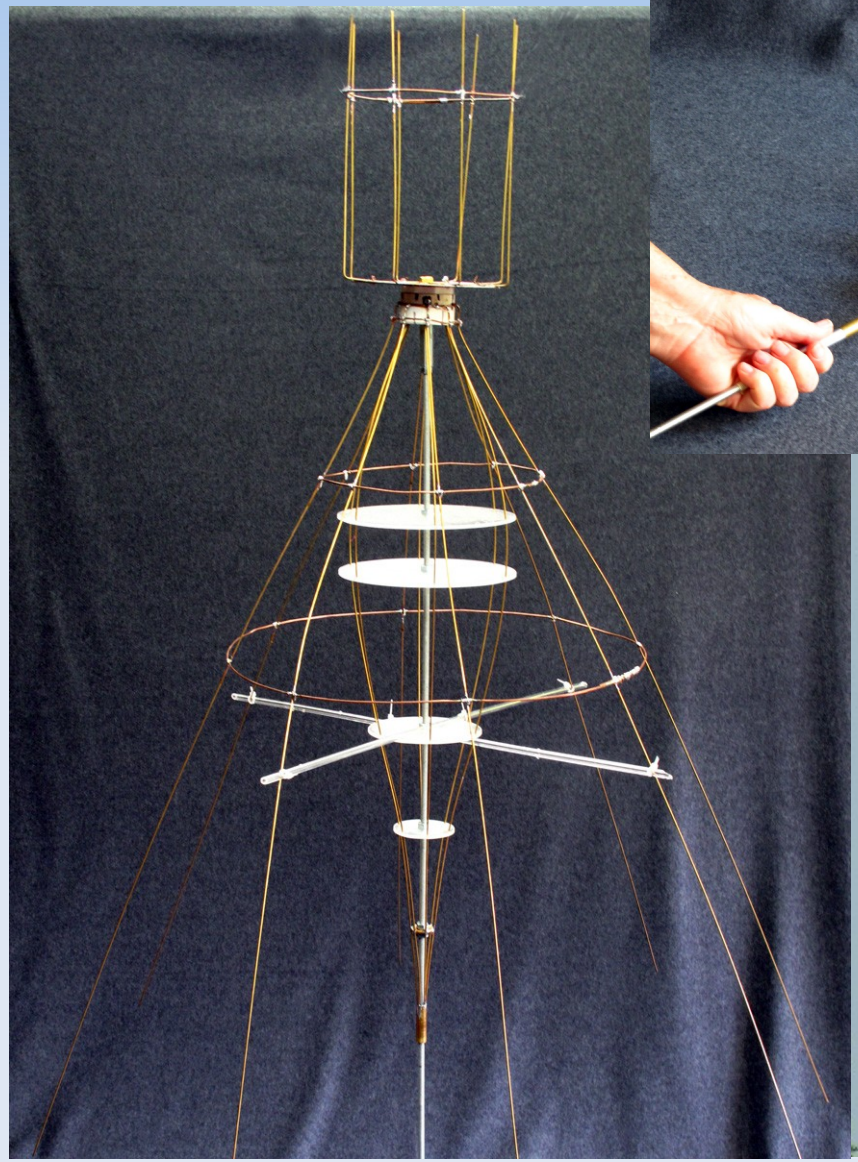
Impedance w/o & w/ SWTL

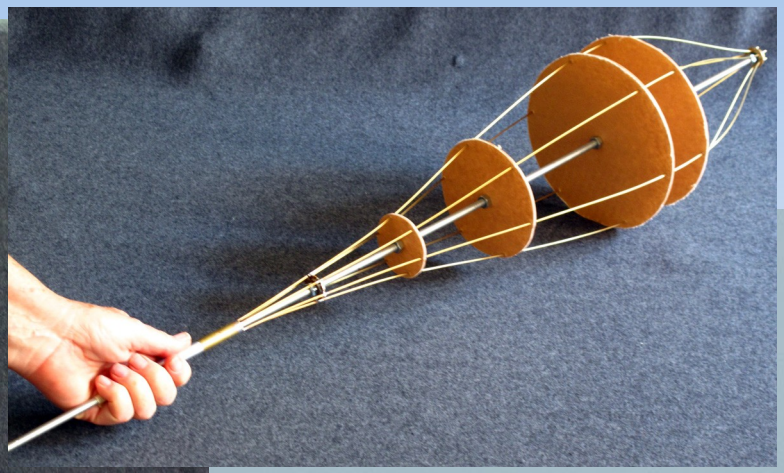


Note the reduction in resonance responses due to the increasing termination of the SWTL above ~75 MHz. Launcher/Termination was a 400 Mhz Klopfenstein taper in this example.

Bottom Launcher Photos

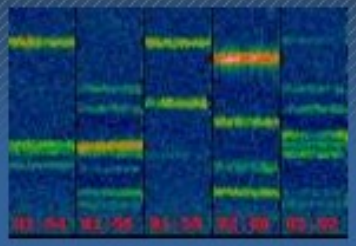
Launcher/Discone Photos





All-Band Antenna Photos

All-Band K6PZB <---> N6GN WSPR



WSPRnet

Weak Signal Propagation Reporter Network

Spot Count

70,814,715 total spots
109,961 in the last 24 hours
6,278 in the last hour

Frequencies

USB dial (MHz): 0.5024, 1.8366, 3.5926, 5.2872, 7.0386, 10.1387, 14.0956, 18.1046, 21.0946, 24.9246, 28.1246, 50.293, 70.0286, 144.489

n6gn

- My account
- Create content
- Log out

Spot Database

Specify query parameters

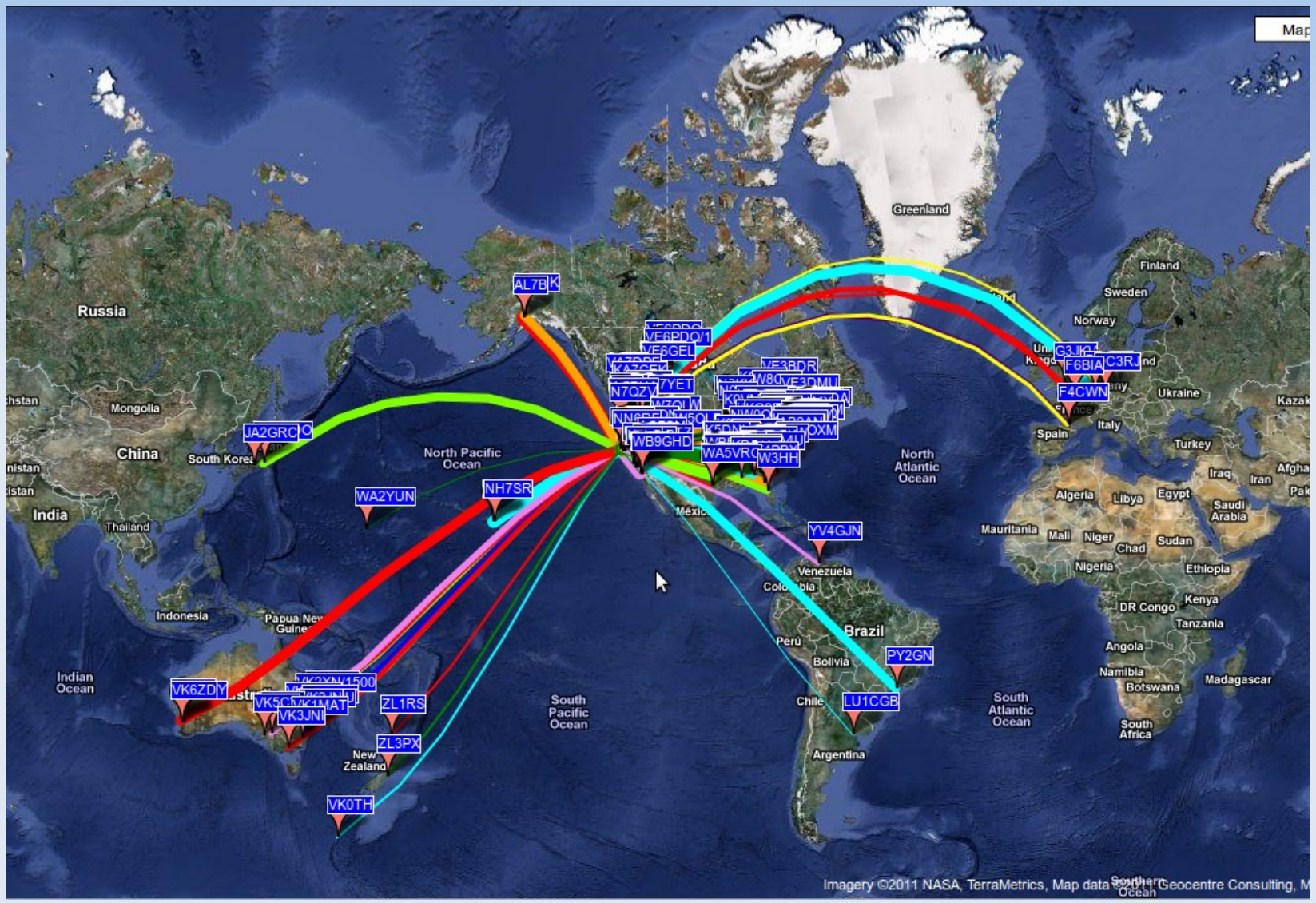
10 spots:

Timestamp	Call	MHz	SNR	Drift	Grid	Pwr	Reporter	RGrid	km	az
2011-10-05 20:40	N6GN	1.838100	-1	0	CM88ok	5	K6PZB	CM88nk	7	270
2011-10-05 20:38	N6GN	28.126098	-20	0	CM88ok	5	K6PZB	CM88nk	7	270
2011-10-05 20:36	N6GN	24.926098	-9	0	CM88ok	5	K6PZB	CM88nk	7	270
2011-10-05 20:34	N6GN	21.096099	-4	0	CM88ok	5	K6PZB	CM88nk	7	270
2011-10-05 20:32	N6GN	18.106099	-13	0	CM88ok	5	K6PZB	CM88nk	7	270
2011-10-05 20:30	N6GN	14.097099	-6	0	CM88ok	5	K6PZB	CM88nk	7	270
2011-10-05 20:28	N6GN	10.140199	-6	0	CM88ok	5	K6PZB	CM88nk	7	270
2011-10-05 20:26	N6GN	7.040099	+3	0	CM88ok	5	K6PZB	CM88nk	7	270
2011-10-05 20:22	N6GN	3.594100	+10	0	CM88ok	5	K6PZB	CM88nk	7	270
2011-10-05 20:20	N6GN	1.838100	-2	0	CM88ok	5	K6PZB	CM88nk	7	270

Query time: 0.013 sec

Link to old database interface

All-Band Antenna Performance



Typical 24 hour period for All-Band Antenna running 5 watts on WSPR & 160 through 10 meter bands

Permission to Use SWTL Technology

The surface wave transmission line technology described here is patented and requires licensing agreements to build or use. However Corridor Systems Inc, the patent holder, is permitting licensed radio amateurs worldwide to build and deploy devices and systems which use it for their personal, non-commercial use, under the terms of their amateur licenses. For other use contact Corridor Systems Inc[1]. 3800 Rolling Oaks Road, Santa Rosa, California 95404, USA.

[1] http://www.corridorsystems.com

Summary and Q&A

- ”All models are wrong but some are useful.” - George Box
- A new model of the dipole is useful and provides insights which enable new antenna and transmission line designs.
- Three inexpensive and easy-to-build designs are presented here. Complete construction articles available*.
- Permission to use the underlying SWTL technology is being granted to licensed amateurs for their personal use.

*(1) Mercury Capsule

Fly-able (fixed station) .4 to 20 Ghz extended discone made from paper (brass), needs SWTL launcher from (2)

*(2) SWTL

General amateur use, low loss, lightweight broadband surface wave transmission line for ~100 Mhz to 20 GHz

*(3) All-Band Antenna

Vertical antenna for 1.8 Mhz through 10 GHz amateur use.

Thank You!

Glenn Elmore, N6GN n6gn@sonic.net
&
John Watrous, K6PZB k6pzb@sonic.net