Tx antenna at IV3PRK: the Shunt-Fed Tower

The gamma match calculations

by Pierluigi "Luis" Mansutti IV3PRK

In 1991 I substituted my old homebuilt tower with a bigger, triangular self standing one, without guys or any cable going on. It's 24 meters high, with a 5 m. mast and a four elements yagi for 15 meters as a top loading.

Since the beginning I decided to use it as a 160 m. Tx antenna and I used the following procedure for the gamma match calculations.

At that time it was not yet possible to model a complex tower structure with Eznec and so I converted the triangular structure into a simplified cylindrical model based on the following:

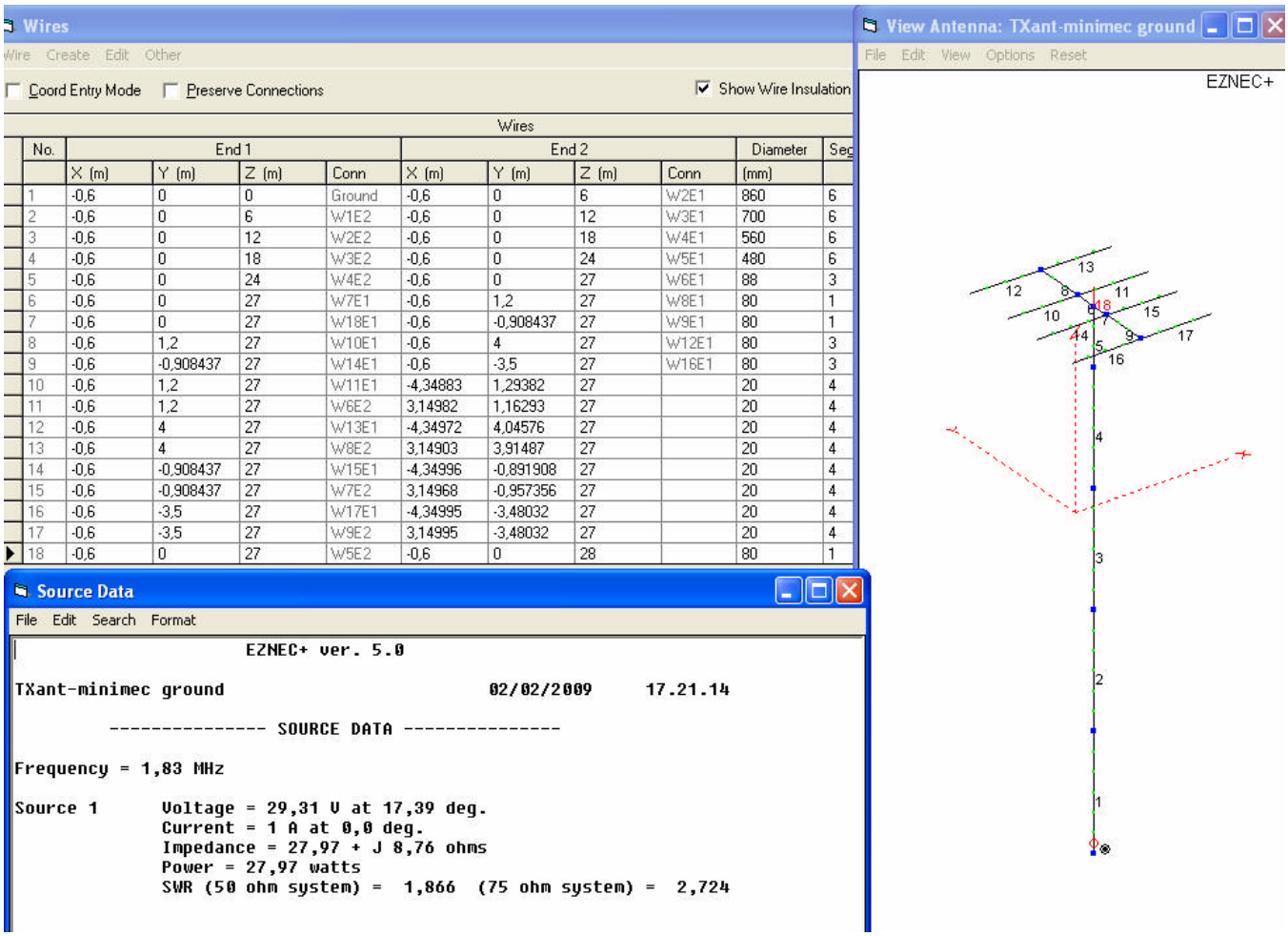
Equivalent Cylindrical Diameter = 2 * CUBEROOT [(D * F^2)/2]

where D = Tube diameter and F = Face width.

So the equivalent cylindrical diameters of the four sections of my tower are the following:

1° : 6 meters from 130 cm to 110 cm. on side - 110 mm tubes : equivalent diameter => 86 cm.
2° : 6 meters from 110 cm to 90 cm. on side - 90 mm. tubes : equivalent diameter => 70 cm.
3° : 6 meters from 90 cm to 70 cm. on side - 70 mm. tubes : equivalent diameter => 56 cm.
4° : 6 meters from 70 cm. to 70 cm. on side - 60 mm. tubes : equivalent diameter => 48 cm.

Then, with only those 4 wires, I modelled the tower in Eznec, put above it the mast and the four elements yagi, and found the impedance at the source point, on a Minimec ground.



With these impedance data let's go on the old classic "Gamma" program. At that time I was using my original one, typed in basic language from a listing published on "Ham Radio – January 1985" by WB0IKN. Now an improved version, though still in DOS, is available with all the ARRL Antenna Books free software.

The following is the printout of the results:

Gamma Match Design

Using W7ITB, WB0IKN, W6NL Equations
Version 2.0, April 2000

Frequency, MHz: 1.83
Driven element diam: 27
Gamma rod diam: 1.1
Gamma rod spacing: 36
Feed point resistance: 28
Feed point reactance: 9
Feed line impedance: 50

Gamma length (degrees): 36.9384
Gamma length (feet): 55.17212
Gamma length (inches): 662.0654
Gamma capacitor (pF): 447.1565

Do another (Y/N)?

I installed on the side of the tower an aluminium tube of 28 mm. diameter and 20 m. long, with mounting clamps adjustable for both distance and tapping positions.

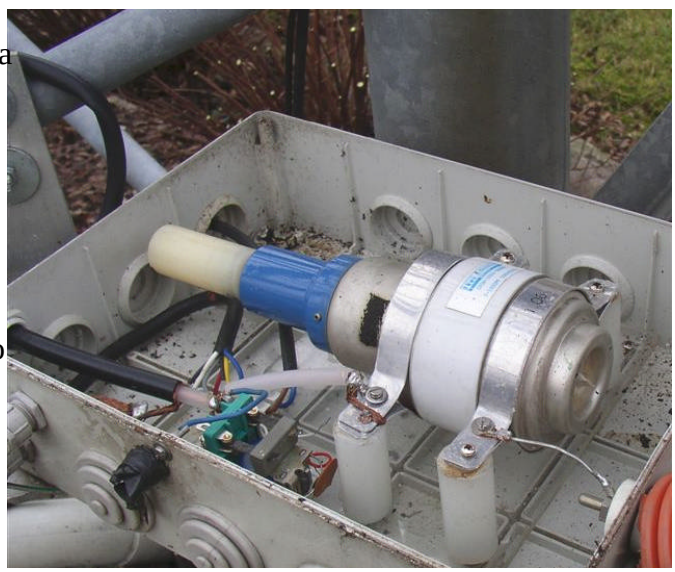
In fact the final length of the gamma rod resulted to be, for the best final match, 17.5 meters.

In the first years I was used to lay down about 60 quarter wave radials but, after a couple of seasons of rolling and unrolling them, I decided to change the ground system into a four elevated and tuned radials.

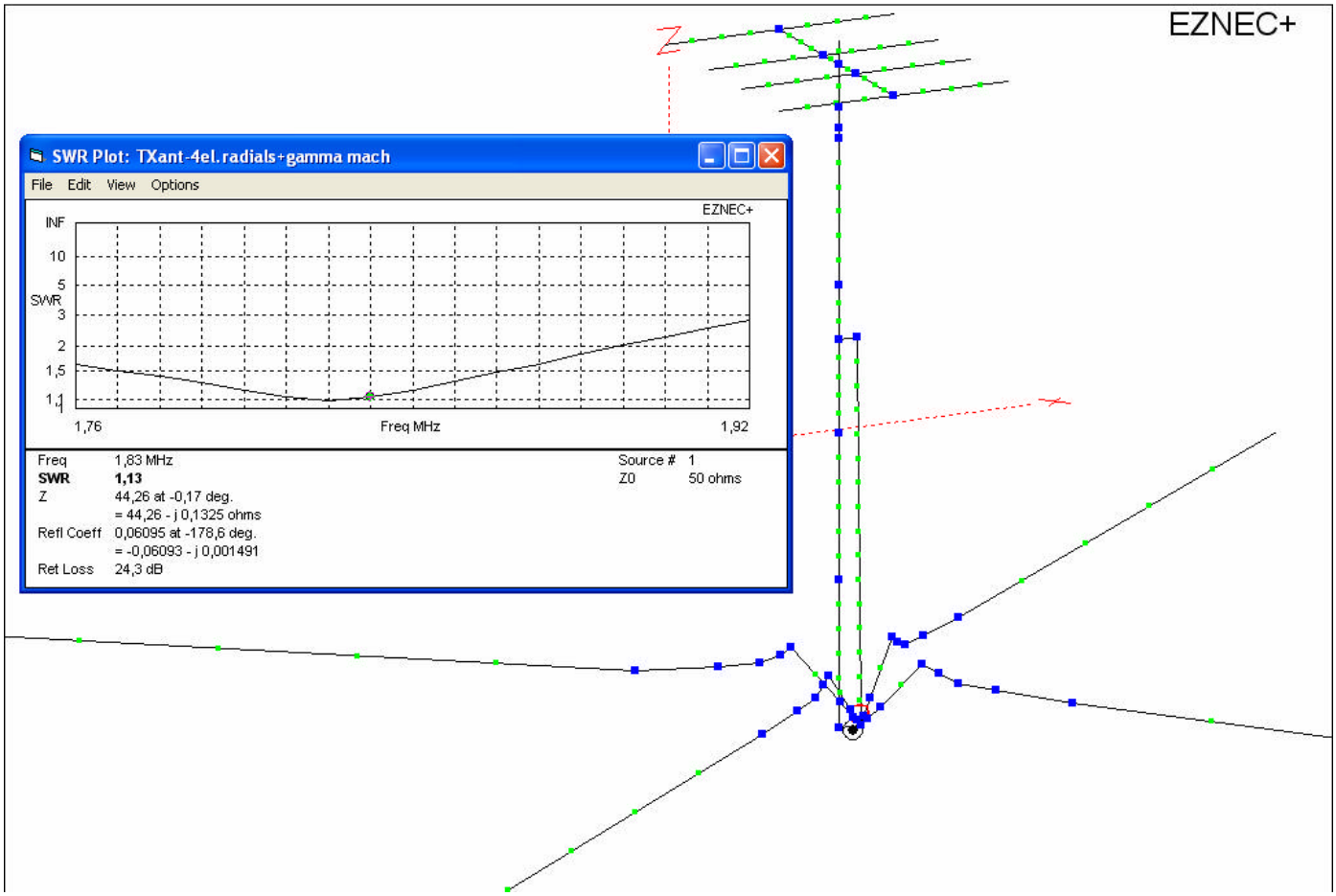
It appeared to be no decrease in the antenna efficiency and I never came back to the nuisance of the on ground radials!

There was no need to climb the tower to change the tapping position of the gamma rod, but just to find a new capacitance value for minimum SWR.

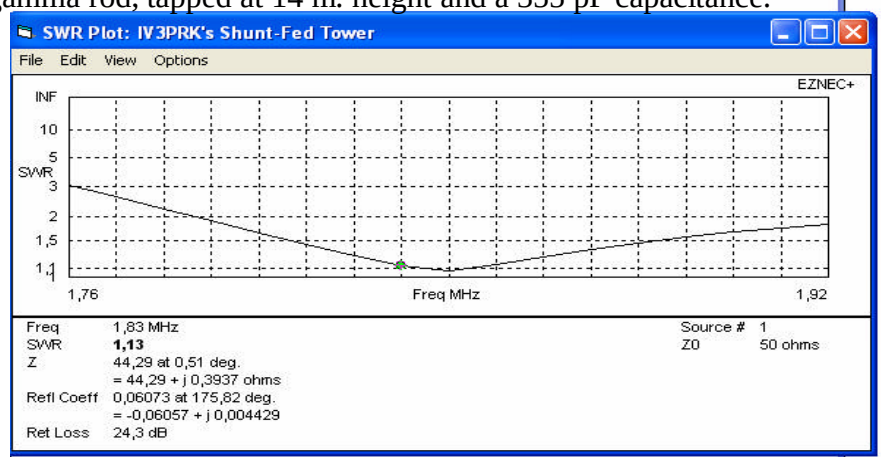
After fighting with combinations of mica and variable capacitors, I bought from "Fair Radio Sales " for 210 US$ a surplus Jennings ceramic vacuum capacitor, rated at 5KV, with a smooth regulation from 5 to 1.000 pF and never got a problem.



The following is the TX antenna model with the gamma match and the four elevated radials on real high accuracy ground. The gamma rod on this model is tapped here at 16 m. high and leads to a resistive part of the matched impedance of 44 ohms; a little bit higher should had led to 50 ohms, but it's already quite satisfying.

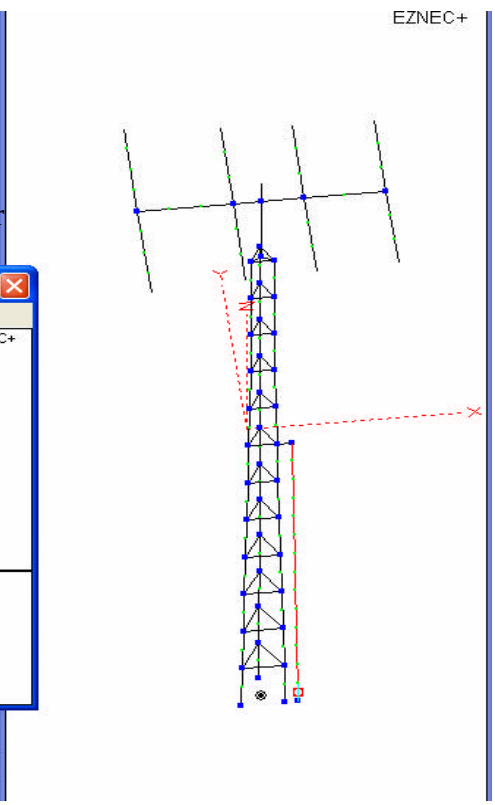


More recently our always remembered friend Earl, K6SE, the most authoritative person on shunt feeding towers, said that the equivalent cylindrical method was not working correctly for top loaded towers, and he found best accuracy by using the same diameter on all the wires. Earl offered to model accurately my own antenna and he came out with some different results: a shorter gamma rod, tapped at 14 m. height and a 355 pF capacitance.



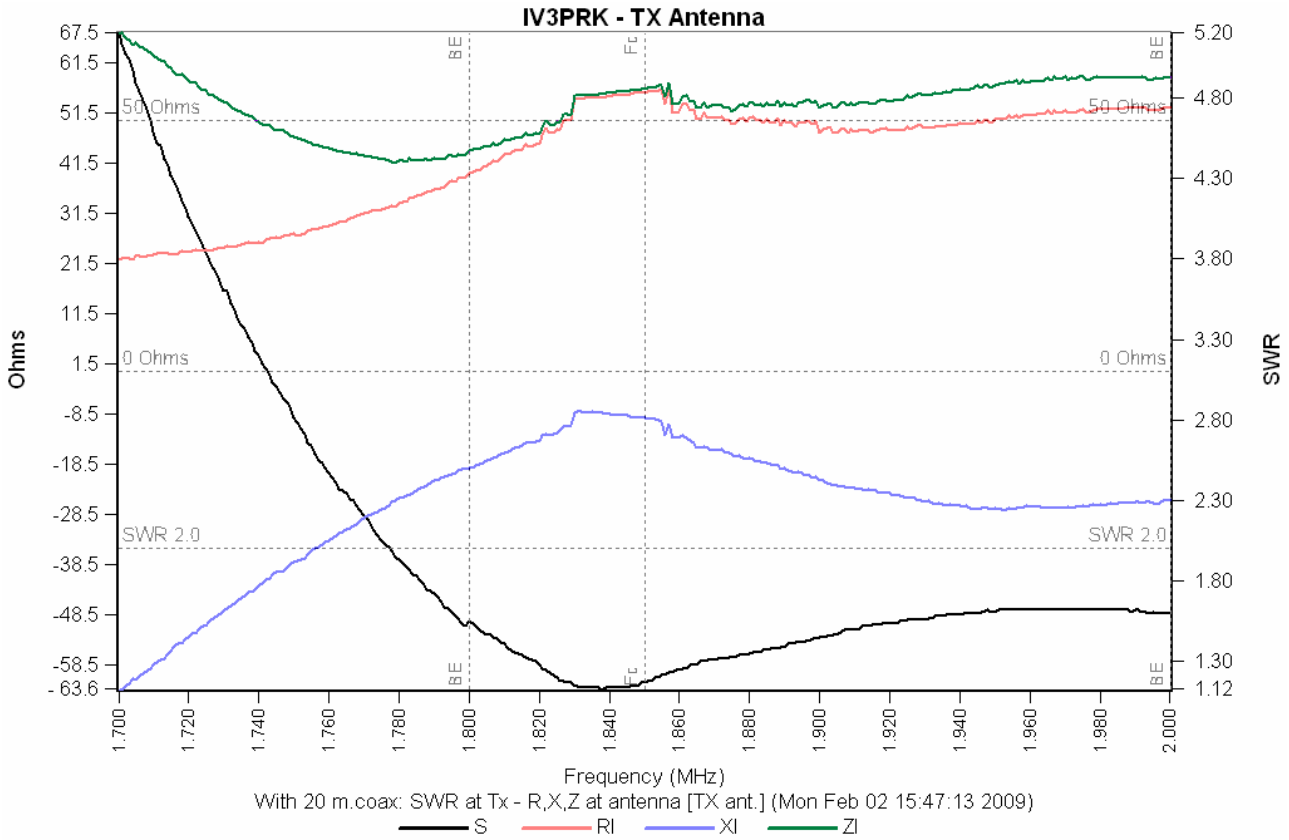
Loads

No.	Specified Pos.		Actual Pos.		R	L	C	R Freq
	Wire #	% From E1	% From E1	Seg	(ohms)	(uH)	(pF)	(MHz)
▶ 1	1	0	3,57143	1	Short	Short	354,979	0



Anyway I did not change anything. In the last 15 years I never climbed the tower to modify the gamma rod dimensions from the original 18 m. tapping point, as I never had any problem in working all the DX stations I was hearing. My problem is not on transmitting, but always on the receiving side, aimed at pulling out of the noise all the weak signals answering my CQs.

This is a check reading of the TX antenna taken today with the AEA CIA Analyzer.



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