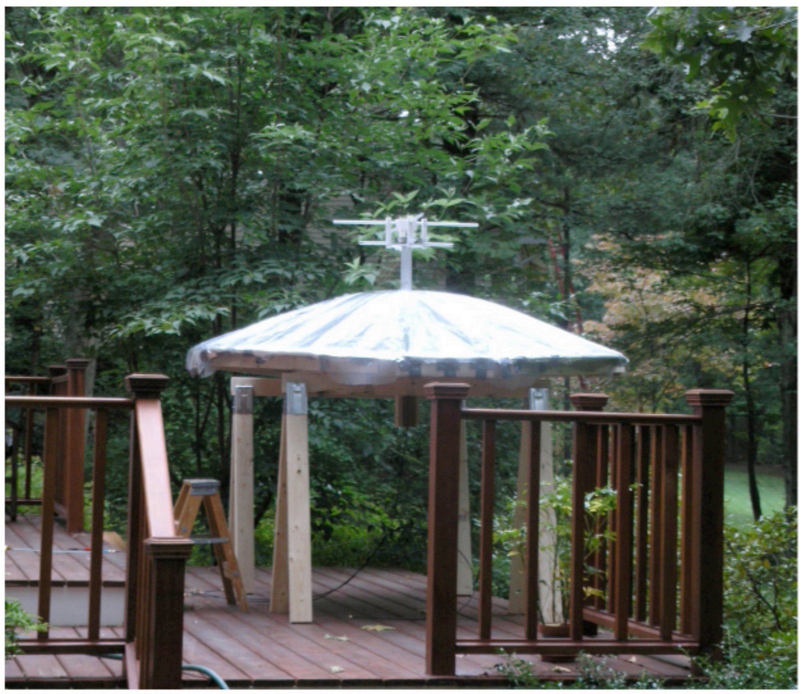
VLA VHF Feed Optimization

v. 11/01/05 LJG

The cross dipole feed and balun must be matched. The dipole impedance is determined by its length and separation from the P-band cross dipole (9 inches above the inner rim of the sub-reflector). For a fixed resonant frequency, the addition of surrounding dielectric material, i.e., the central hub and clamps, reduces the required length of the dipole. Some type of field testing has been required to establish optimal dipole length and match.

Physical Mockup

The mockup consists of a foil coated surface that approximates the inner 90-95% of a VLA subreflector to within a few inches in height (Figure 1, 2). [Empirical testing shows that 3in deviations in the surface do not appreciably effect measuured dipole impedance. Repeatability of measurements is <1 ohm.] A P-band feed assembly is used to support the 1.5m dipole assembly. Figure 3 shows impedance measurements for one of the 1.5m dipoles *alone*. The length is 13.44in + the "end length" listed in the figure annotation. This is shorter than half the 1.53m wavelength because of the effects of the dielectric that touches some parts of the dipole.



VLA VHF Feed Optimization

v. 11/01/05 LJG

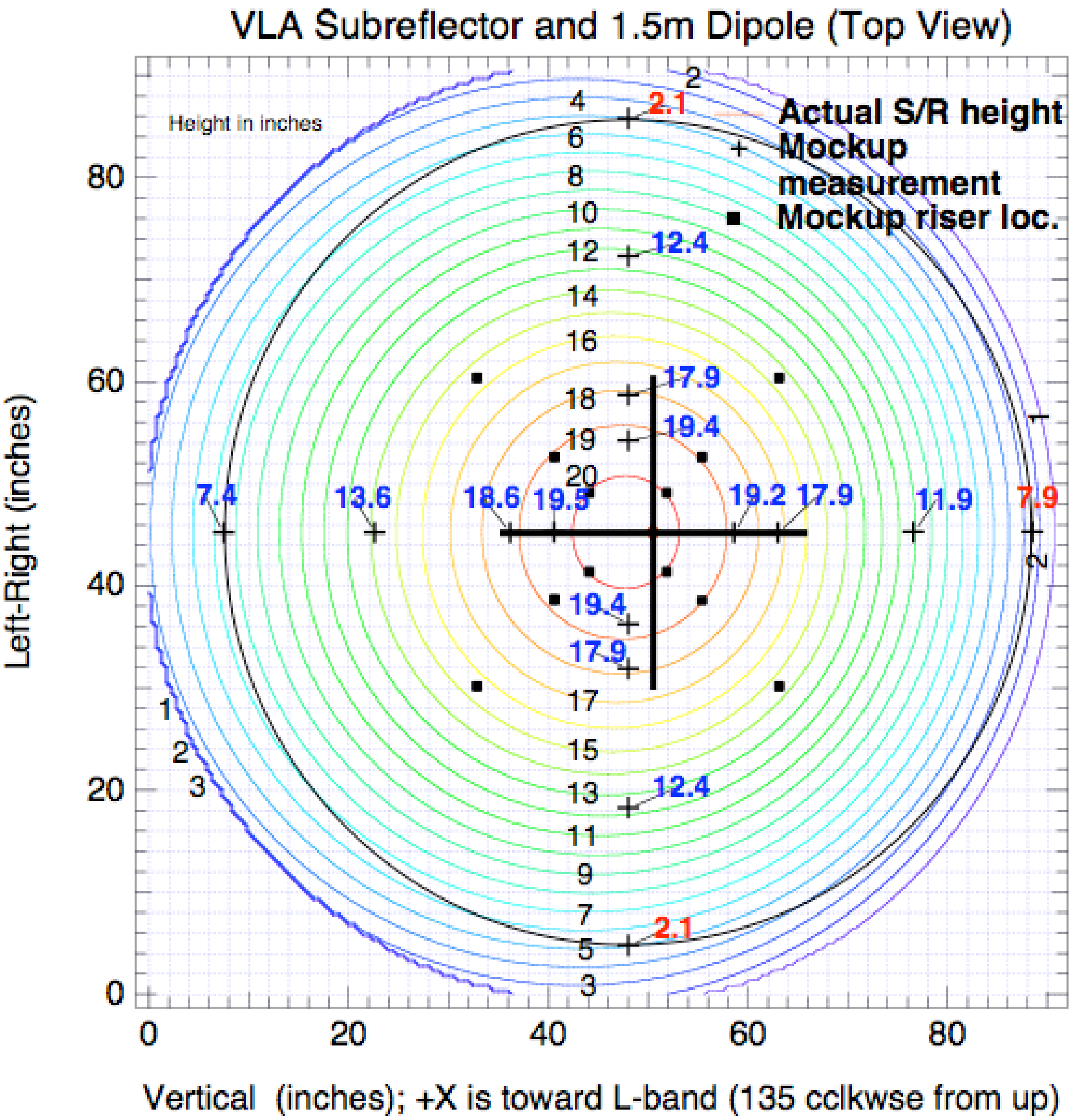


Figure: Comparison of mockup and actual sub-reflector topography

VLA VHF Feed Optimization

v. 11/01/05 LJG

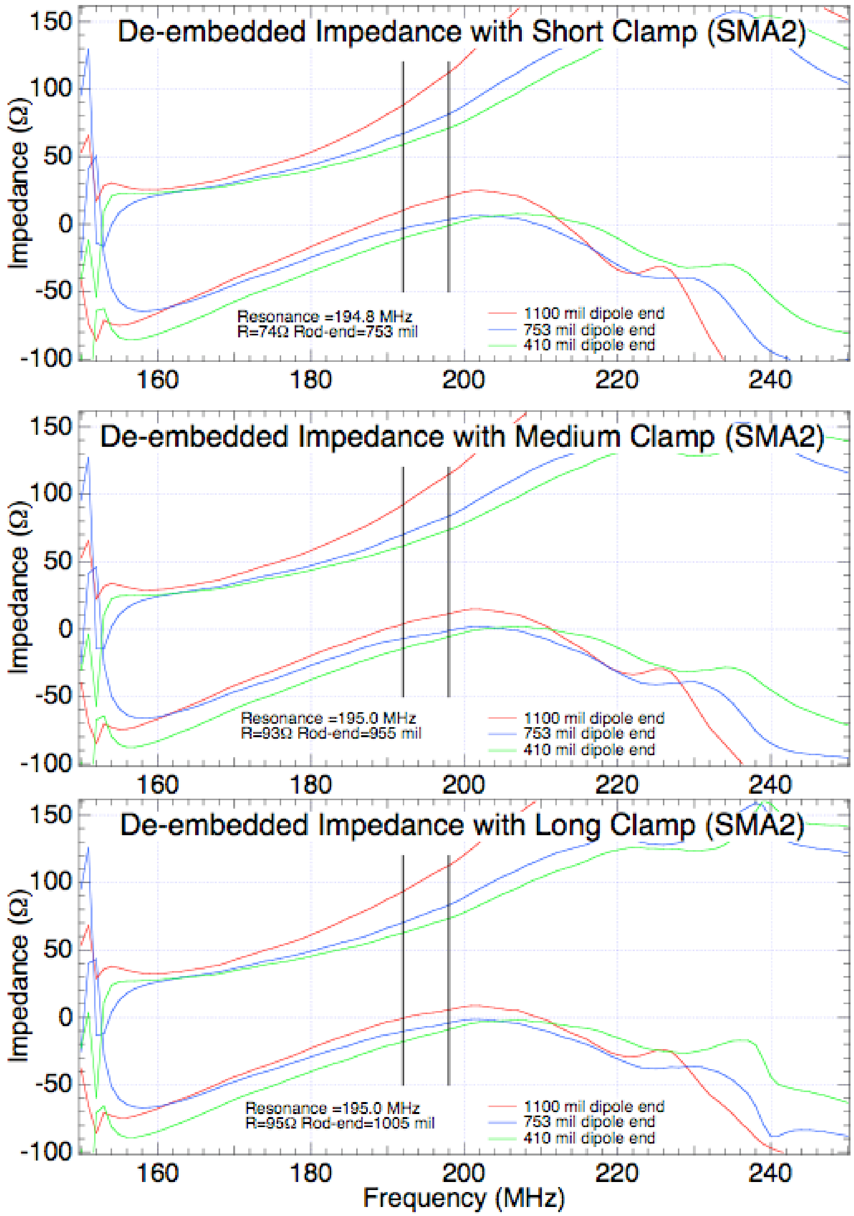


Figure: Measured dipole impedance referenced to the input of the balun.

Modeling

Model impedance results that match those obtained with the mockup for comparable conditions have been desirable because iterative adjustments can be made to the model more readily than to the mockup. Thus far, the models do not do better than ~ 20 ohms with respect to results obtained with the mockup.

MMANA

MMANA is limited to producing an infinite continuous flat ground plane. The 1.5m and loaded P-band crossed dipoles are split at the center, with a total length of $\lambda/2$.

VLA VHF Feed Optimization

v. 11/01/05 LJG

185 MHz

Distance 1.5m to P-band (cm)	Re Z (Ω)	Im Z (Ω)
15.6 (λ / 4 from S/R)	71.4	-17.2
10.0	61.0	-10.8
8.00	56.2	-9.44
5.00	47.9	-8.73

195 MHz

Distance 1.5m to P-band (cm)	Re Z (Ω)	Im Z (Ω)
15.6 (λ / 4 from S/R)	90.9	10.8
10.0	81.4	20.6
8.00	76.5	23.0
5.00	68.1	24.7

NEC4

NEC4 is more capable than MMANA vis a vis modeling complex systems. However, the curves ground plane must be approximated by a wire mesh and each dipole can only be approximated as a single continuous wire. The spacing of wires is < the wire circumference, obeying an "Equal Area Rule" with respect to a solid surface. For more simple models, NEC4 and MMANA have been shown to yield comparable results. In models that involve dipoles and wire meshes NEC4 does not give useful results. The table shows a range of models including curves meshes similar to the mockup and flat meshes intended to approximate the MMANA systems.

NEC4 Model Impedances (Ohms) for Dipole 1

Model	170 MHz	175 MHz	180 MHz	185 MHz	190 MHz	195 MHz	200 MHz	205 MHz
3.7x3.7m flat 1.5m X-dipole 0.38460m hgt	5.68055E+01 -3.33325E+01	6.45454E+01 -1.49112E+01	7.30314E+01 3.12188E+00	8.24692E+01 2.07866E+01	9.28872E+01 3.80117E+01	1.04346E+02 5.47104E+01	1.16889E+02 7.07840E+01	1.30522E+02 8.61407E+01
2.2x2.2m flat 1.5m X-dipole	5.75395E+01 -3.38953E+01	6.51538E+01 -1.56733E+01	7.35246E+01 2.17456E+00	8.27126E+01 1.96489E+01	9.27896E+01 3.67433E+01	1.03840E+02 5.34280E+01	1.15952E+02 6.96482E+01	1.29220E+02 8.53088E+01
2.2x2.2m flat 1.5m X-dipole w/ insulation 1/16x4.6 in					8.91836E+01 3.93257E+01	9.99293E+01 5.52179E+01		
2.2x2.2m flat 1.5m X-dipole w/ insulation 1/4x4.6 in					8.41743E+01 4.53242E+01	9.47348E+01 5.99249E+01		
2.2x2.2m flat 1.5m X-split dipole plane w/ insulation 1/4x4 in					Insane reactance	Insane reactance		
2.2x2.2m flat 1.5m X-dipole 0.9m X-dipole Long clamp	5.85612E+01 -3.61680E+01	6.67422E+01 -1.87625E+01	7.57711E+01 -2.00720E+00	8.56815E+01 1.40101E+01	9.64918E+01 2.91781E+01	1.08193E+02 4.33460E+01	1.20728E+02 5.63295E+01	1.33970E+02 6.79168E+01
2.2m S/R 1.5m X-dipole 0.9m X-dipole Short clamp	4.65554E+01 -4.18688E+01	5.31205E+01 -2.36980E+01	6.06705E+01 -5.77065E+00	6.93724E+01 1.18319E+01	7.94032E+01 2.89567E+01	9.09189E+01 4.53469E+01	1.04005E+02 6.06346E+01	1.18604E+02 7.43509E+01
2.2m S/R 1.5m X-dipole 0.9m X-dipole Medium clamp	5.09587E+01 -4.31755E+01	5.77082E+01 -2.53093E+01	6.53585E+01 -7.77812E+00	7.40416E+01 9.33433E+00	8.38818E+01 2.58800E+01	9.49732E+01 4.16258E+01	1.07328E+02 5.62568E+01	1.20816E+02 6.93963E+01
2.2m S/R 1.5m X-dipole 0.9m X-dipole Long clamp	5.45488E+01 -4.49790E+01	6.13675E+01 -2.74937E+01	6.90077E+01 -1.04130E+01	7.75697E+01 6.17808E+00	8.71390E+01 2.21390E+01	9.77572E+01 3.72570E+01	1.09373E+02 5.12636E+01	1.21804E+02 6.38667E+01
2.2m S/R 1.5m X-dipole 0.9m X-dipole Long clamp Dipole + 2in	6.84871E+01 -3.92607E+00	7.74801E+01 1.46650E+01	8.76113E+01 3.28098E+01	9.90230E+01 5.03652E+01	1.11826E+02 6.71011E+01	1.26058E+02 8.26940E+01	1.41631E+02 9.67381E+01	1.58249E+02 1.08818E+02
2.2m S/R 1.5m X-dipole 0.9m X-dipole Long clamp Dipole - 2in	4.32820E+01 -8.51849E+01	4.84401E+01 -6.86499E+01	5.41870E+01 -5.25230E+01	6.05973E+01 -3.68427E+01	6.77321E+01 -2.16971E+01	7.56245E+01 -7.22201E+00	8.42454E+01 6.40458E+00	9.34748E+01 1.89834E+01

- Dipoles are approximated as two continuous wires 0.7386m (1.1in rod end), one at 0.38460m height and the other at 0.36555m (0.75in offset). The voltage source is applied to the center of the wires. MMANA simulations adopt split dipoles.
- Highlighting indicates values bracketing or close to zero reactance.