11-12.6 Moment Method Analysis of Log Periodic Antenna

We can analyze the log periodic dipole antenna by analyzing the mutual coupling between dipoles and combining this with connecting transmissions lines as a circuit model which does not including the coupling between the dipoles and the transmission lines. This method was used by Carrel [21]. We can also generate full models which include the transmission lines in the moment method models and include the effects of coupling. This become especially important when considering and array because the coupling between the transmission lines of the multiple antennas generates narrowband frequency dropouts.

In the Carrel model the antenna is divided into an antenna section and a feeder section. The mutual impedance matrix can be found for the antenna elements alone. This mutual matrix of the dipole elements alone can be computed. The corresponding admittance matrix is the matrix inverse.

$$Y_A = \begin{bmatrix} Y_{11} & Y_{12} & Y_{13} & \cdots & Y_{1N} \\ Y_{12} & Y_{22} & Y_{23} & \cdots & \cdot \\ \cdot & & & & \cdot \\ \cdot & & & & \cdot \\ \cdot & & & & \cdot \\ Y_{1N} & & & & Y_{NN} \end{bmatrix}$$

Similarly, we compute the admittance matrix of the feed circuit.

$$Y_F = \begin{bmatrix} Y_{11} & Y_{12} & 0 & \cdots & \cdots & \cdots & 0 \\ Y_{21} & Y_{22} & Y_{23} & 0 & \cdots & \cdots & 0 \\ 0 & Y_{32} & Y_{33} & Y_{34} & 0 & \cdots & 0 \\ \cdot & & & & & & \\ \cdot & & & & & & \\ \cdot & & & & & Y_{NN-1} & Y_{NN} \end{bmatrix}$$

All terms except the diagonal and single lines off the diagonal are zero, as shown above. The two networks are connected in parallel.

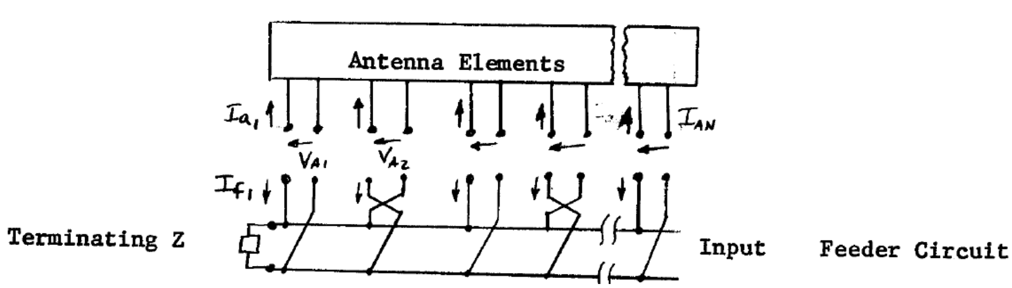

Figure 11-12.6.1 Connection impedance model of Log Periodic Antenna (Carrel's model)

Notice that the feeder circuit includes the phase reversals between elements. The current into the parallel connection of the feed circuit and the antenna is the sum two currents into each part. The voltages are the same. These define the node currents and voltages for the combination.

$$I_F = Y_F V_F \qquad I_A = Y_A V_A$$
$$I = I_F + I_A = (Y_F + Y_A) V_A$$

Multiply through the matrix equation by Z_A and we obtain the relation.

$$I = \left(U + Y_F Z_A\right) I_A \qquad U \text{ is the unit matrix}$$

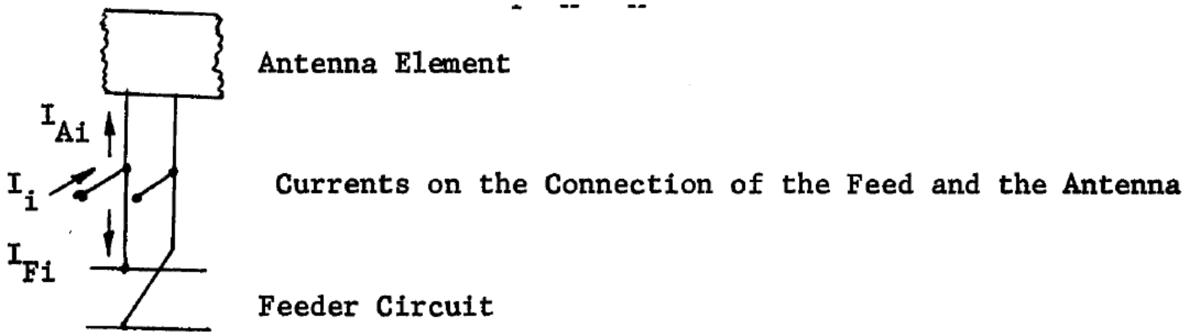

Figure 11-12.6.2 Connection between transmission line and base of dipole

The driving point current vector, *I*, has a non-zero term only at the input. The currents in the antenna element bases can be found by inverting the matrix.

$$T = U + Y_F Z_F \qquad I_A = \left[U + Y_F Z_F\right]^{-1} I$$

One we know the base currents, the antenna pattern can be calculated and the active region identified from the high base currents.

The executable LPDANW implements the Carrel method using portions of Richmond's ASAP moment code that uses sinusoidal basis functions combined with a uniform impedance transmission line to compute dipole element base currents. The program computes the antenna frequency response and generates parameters which can be extracted from a circuit model. Given the base currents as inputs to the dipoles, the pattern can be calculated. From the pattern gain, front/back (F/B), and beamwidths in the *E*- and *H*-planes are found.

Example 1 is an 18-element log-periodic dipole designed to cover the range 100- to 1000-MHz where the truncation and scaling constants have been adjusted to produce a feeder length of 82.776 inches (see input file LPDANW1.TXT). The program computes the following output.

Log Periodic Dipole Response

Number of Elements: 18
Lowest Frequency: 100.0
Scaling Constant: 0.837
Spacing Constant: 0.099
Half Apex Angle: 22.310
Psi Angle of Sides: 0.00
Truncation Constant: 0.576
Length units: in.
Open Circuited Stub Length: 0.000

Frequency Response of Log Periodic Antenna

No.	Length	Position	Diameter
1	3.306	4.028	0.058
2	3.949	4.812	0.070
3	4.718	5.749	0.083
4	5.636	6.867	0.100
5	6.732	8.204	0.119
6	8.043	9.800	0.142
7	9.608	11.707	0.170
8	11.477	13.986	0.203
9	13.711	16.707	0.242
10	16.379	19.958	0.289
11	19.566	23.842	0.346
12	23.374	28.482	0.413
13	27.922	34.025	0.493
14	33.356	40.646	0.589
15	39.847	48.555	0.704
16	47.602	58.004	0.841
17	56.865	69.292	1.005
18	67.931	82.776	1.200

Feeder Impedance: 200.00
Source Impedance: 50.00 0.00

Frequency	Gain	Source Gain	F/B	Input Impedance		VSWR	E plane	H plane
80.00	4.79	3.48	6.32	133.68	-49.26	3.087	73.89	171.49
85.00	5.46	4.49	9.27	126.56	-20.55	2.610	72.35	152.90
90.00	6.08	5.33	13.65	110.23	-23.02	2.324	70.88	139.60
95.00	6.54	6.00	19.05	100.38	8.82	2.028	69.63	130.34
100.00	6.79	5.59	19.89	141.62	25.40	2.936	68.75	124.62
105.00	6.88	5.58	17.96	147.39	-28.82	3.075	68.29	121.87
110.00	6.87	6.23	17.41	102.82	-21.68	2.174	68.21	121.44
115.00	6.82	6.23	18.26	102.50	14.32	2.102	68.41	122.68
120.00	6.76	5.57	20.31	141.49	24.62	2.927	68.78	125.00
125.00	6.71	5.37	23.05	153.01	-21.40	3.127	69.23	127.87
130.00	6.67	5.82	23.51	113.03	-30.46	2.461	69.74	130.92
135.00	6.62	6.15	20.11	96.94	-3.83	1.943	70.46	134.42
140.00	6.39	5.66	14.19	110.00	19.55	2.287	72.84	143.63
145.00	6.67	5.31	18.85	150.60	30.80	3.153	67.23	124.28
150.00	6.75	5.36	21.77	157.19	-19.20	3.196	68.71	127.57
155.00	6.74	5.75	20.62	121.43	-32.94	2.640	69.10	128.64
160.00	6.73	6.18	20.77	100.10	-13.86	2.053	69.21	128.65
165.00	6.73	6.18	21.68	101.51	11.17	2.062	69.19	128.26
170.00	6.74	5.78	22.80	123.18	27.27	2.607	69.10	127.75
175.00	6.74	5.41	23.18	153.51	15.70	3.106	69.00	127.38
180.00	6.74	5.37	22.46	155.37	-19.85	3.164	68.97	127.42
185.00	6.74	5.65	21.68	127.50	-34.63	2.769	69.09	128.07
190.00	6.72	6.03	21.96	105.00	-23.47	2.233	69.44	129.32
195.00	6.67	6.19	24.55	98.00	-3.40	1.963	70.12	131.02
200.00	6.57	5.94	35.78	105.42	15.70	2.168	71.37	133.66
205.00	6.37	5.39	26.75	125.11	25.85	2.628	73.71	138.97
210.00	6.30	5.02	22.60	149.75	17.71	3.042	75.06	144.16
215.00	6.49	5.11	26.24	158.65	-10.86	3.189	73.34	141.75

220.00	6.59	5.36	23.99	140.27	-32.77	2.979	72.21	137.48
225.00	6.61	5.69	20.58	116.49	-32.72	2.551	71.94	135.17
230.00	6.58	5.97	19.03	101.71	-19.79	2.134	72.19	134.71
235.00	6.51	6.03	18.86	97.57	-2.86	1.954	72.89	135.47
240.00	6.41	5.82	19.86	103.11	13.27	2.107	74.19	137.30
245.00	6.27	5.41	21.91	117.51	24.36	2.472	76.45	140.59
250.00	6.25	5.10	24.49	138.13	24.82	2.865	78.81	144.49
255.00	6.47	5.12	24.90	156.24	9.21	3.137	77.38	143.93
260.00	6.60	5.22	22.75	157.06	-16.03	3.178	74.46	139.39
265.00	6.61	5.37	20.64	140.70	-32.66	2.986	73.10	136.17
270.00	6.59	5.59	19.39	120.86	-34.21	2.647	72.85	135.10
275.00	6.54	5.82	19.06	106.34	-25.68	2.283	73.24	135.29
280.00	6.48	5.95	19.67	99.08	-12.72	2.025	74.15	136.19
285.00	6.40	5.91	21.03	98.67	1.24	1.974	75.45	137.70
290.00	6.31	5.69	22.36	104.61	13.95	2.140	76.85	139.93
295.00	6.25	5.41	24.30	116.57	23.13	2.443	78.41	142.77
300.00	6.35	5.27	27.89	133.49	25.33	2.781	79.13	144.26
305.00	6.54	5.25	28.90	150.83	16.42	3.057	76.90	141.71
310.00	6.62	5.24	25.88	159.57	-2.73	3.192	74.21	137.63
315.00	6.64	5.27	23.06	154.33	-22.96	3.163	72.91	135.14
320.00	6.62	5.38	21.24	139.34	-34.85	2.985	72.61	134.30
325.00	6.59	5.55	20.30	122.70	-36.41	2.708	72.85	134.42
330.00	6.54	5.73	20.15	109.42	-30.65	2.400	73.45	135.10
335.00	6.48	5.87	20.83	100.96	-21.00	2.133	74.36	136.17
340.00	6.41	5.92	22.57	97.27	-9.80	1.972	75.64	137.68
345.00	6.31	5.83	26.14	97.96	1.48	1.960	77.43	139.86
350.00	6.22	5.64	34.27	102.66	11.76	2.088	79.68	142.88
355.00	6.23	5.49	40.05	111.18	20.06	2.313	81.17	145.66
360.00	6.39	5.45	35.87	123.52	24.76	2.588	79.76	145.57
365.00	6.52	5.38	33.34	138.17	23.18	2.852	76.54	142.41
370.00	6.57	5.29	28.26	151.20	13.81	3.052	74.30	138.91
375.00	6.58	5.22	24.50	157.79	-1.65	3.156	73.35	136.73
380.00	6.57	5.21	22.11	155.26	-18.14	3.152	73.03	135.68
385.00	6.56	5.27	20.64	145.27	-30.24	3.047	73.02	135.30
390.00	6.53	5.38	19.84	132.11	-35.54	2.863	73.21	135.33
395.00	6.50	5.52	19.58	119.53	-34.70	2.630	73.57	135.61
400.00	6.47	5.67	19.77	109.48	-29.61	2.388	74.07	136.06
405.00	6.43	5.79	20.31	102.61	-22.04	2.174	74.68	136.61
410.00	6.39	5.86	21.08	98.90	-13.25	2.025	75.34	137.39
415.00	6.34	5.85	22.12	98.18	-4.11	1.968	76.33	138.87
420.00	6.28	5.76	23.46	100.26	4.75	2.011	77.94	141.20
425.00	6.28	5.67	24.68	105.05	12.80	2.141	79.52	143.48
430.00	6.40	5.65	25.01	112.67	19.35	2.335	79.57	143.83
435.00	6.54	5.61	24.16	122.95	23.12	2.562	77.88	141.66
440.00	6.60	5.51	22.76	134.87	22.74	2.786	75.87	138.67
445.00	6.61	5.38	21.47	146.54	17.24	2.977	74.46	136.60
450.00	6.60	5.27	20.56	155.39	6.75	3.114	73.68	135.58
455.00	6.59	5.21	19.98	158.95	-6.97	3.186	73.27	134.95
460.00	6.59	5.21	19.58	156.20	-20.78	3.186	73.11	134.39
465.00	6.59	5.25	19.31	148.24	-31.63	3.116	73.16	134.05
470.00	6.57	5.33	19.22	137.49	-37.91	2.988	73.44	134.09
475.00	6.54	5.42	19.37	126.30	-39.65	2.816	73.90	134.46
480.00	6.50	5.53	19.76	116.25	-37.76	2.618	74.48	135.06
485.00	6.45	5.63	20.36	108.07	-33.36	2.416	75.09	135.79
490.00	6.40	5.72	21.17	101.99	-27.38	2.228	75.80	136.77
495.00	6.33	5.77	22.32	97.98	-20.53	2.074	76.84	138.28
500.00	6.27	5.78	23.86	95.89	-13.29	1.968	78.32	140.30
505.00	6.23	5.78	25.56	95.57	-5.98	1.922	79.92	142.47
510.00	6.28	5.81	26.72	96.97	1.19	1.940	80.89	143.95
515.00	6.39	5.86	26.64	100.15	7.94	2.020	80.51	143.95
520.00	6.48	5.86	25.57	105.15	13.82	2.150	79.06	142.70
525.00	6.52	5.78	24.20	111.81	18.30	2.310	77.38	141.21
530.00	6.53	5.66	22.97	119.82	20.85	2.484	76.02	140.12
535.00	6.52	5.52	21.98	128.69	20.93	2.654	75.12	139.40
540.00	6.51	5.40	21.18	137.62	18.11	2.807	74.58	138.72
545.00	6.50	5.30	20.49	145.48	12.24	2.933	74.33	137.95
550.00	6.49	5.22	19.92	151.04	3.77	3.023	74.33	137.12
555.00	6.47	5.17	19.49	153.31	-6.22	3.072	74.49	136.34
560.00	6.45	5.14	19.20	151.94	-16.26	3.078	74.68	135.68
565.00	6.44	5.16	19.12	147.35	-24.91	3.042	74.69	135.37

570.00	6.42	5.20	19.38	140.54	-31.20	2.968	74.60	135.65
575.00	6.40	5.25	19.98	132.65	-34.79	2.863	74.77	136.35
580.00	6.37	5.31	20.80	124.68	-35.83	2.735	75.19	137.16
585.00	6.33	5.38	21.73	117.31	-34.73	2.592	75.74	138.06
590.00	6.28	5.44	22.73	110.94	-31.98	2.445	76.49	139.14
595.00	6.24	5.50	23.84	105.76	-28.06	2.303	77.56	140.52
600.00	6.20	5.56	24.98	101.81	-23.32	2.174	78.89	142.12
605.00	6.20	5.64	25.90	99.05	-18.05	2.068	80.10	143.62
610.00	6.27	5.76	26.30	97.48	-12.40	1.992	80.64	144.46
615.00	6.37	5.89	26.08	97.16	-6.54	1.955	80.10	144.32
620.00	6.46	5.98	25.38	98.12	-0.70	1.963	78.54	143.47
625.00	6.53	6.01	24.38	100.37	4.88	2.014	76.41	142.36
630.00	6.58	5.99	23.11	103.88	9.97	2.102	74.43	140.86
635.00	6.62	5.95	21.74	108.58	14.32	2.219	73.00	138.48
640.00	6.64	5.87	20.50	114.39	17.64	2.355	72.06	135.57
645.00	6.64	5.76	19.58	121.13	19.64	2.499	71.52	133.79
650.00	6.62	5.63	19.02	128.57	20.01	2.644	71.35	133.35
655.00	6.60	5.51	18.81	136.32	18.46	2.784	71.50	133.48
660.00	6.58	5.40	18.79	143.83	14.75	2.911	71.86	133.68
665.00	6.57	5.31	18.85	150.40	8.86	3.020	72.34	133.79
670.00	6.55	5.23	18.95	155.24	1.09	3.105	72.88	133.90
675.00	6.53	5.16	19.13	157.74	-7.93	3.164	73.49	134.05
680.00	6.50	5.11	19.42	157.58	-17.31	3.194	74.13	134.26
685.00	6.48	5.09	19.83	154.84	-26.14	3.195	74.78	134.49
690.00	6.45	5.08	20.35	149.98	-33.64	3.168	75.39	134.67
695.00	6.44	5.11	20.97	143.65	-39.34	3.115	75.88	134.84
700.00	6.43	5.15	21.71	136.54	-43.08	3.040	76.22	135.28
705.00	6.41	5.20	22.62	129.28	-44.94	2.945	76.53	136.26
710.00	6.37	5.24	23.68	122.31	-45.18	2.836	77.11	137.73
715.00	6.33	5.29	24.86	115.91	-44.12	2.718	78.07	139.42
720.00	6.30	5.35	26.06	110.22	-42.05	2.593	79.19	141.08
725.00	6.32	5.46	27.05	105.28	-39.18	2.467	80.10	142.40
730.00	6.37	5.61	27.50	101.12	-35.68	2.342	80.40	143.08
735.00	6.45	5.77	27.29	97.79	-31.72	2.223	79.92	143.01
740.00	6.51	5.91	26.59	95.29	-27.45	2.116	78.73	142.40
745.00	6.55	6.02	25.65	93.62	-23.03	2.026	77.19	141.61
750.00	6.58	6.10	24.64	92.71	-18.57	1.957	75.77	140.84
755.00	6.59	6.14	23.64	92.53	-14.17	1.911	74.80	140.12
760.00	6.59	6.16	22.68	93.04	-9.92	1.890	74.32	139.44
765.00	6.57	6.14	21.82	94.18	-5.87	1.894	74.20	138.82
770.00	6.54	6.09	21.13	95.94	-2.11	1.920	74.33	138.34
775.00	6.50	6.02	20.61	98.27	1.30	1.966	74.59	138.00
780.00	6.46	5.93	20.23	101.14	4.27	2.028	74.85	137.67
785.00	6.43	5.85	19.94	104.51	6.73	2.101	75.01	137.25
790.00	6.41	5.77	19.72	108.30	8.57	2.183	75.00	136.76
795.00	6.40	5.70	19.60	112.43	9.69	2.269	74.77	136.39
800.00	6.41	5.63	19.62	116.77	10.02	2.356	74.40	136.36
805.00	6.40	5.56	19.81	121.17	9.48	2.441	74.22	136.72
810.00	6.38	5.48	20.12	125.45	8.05	2.521	74.41	137.34
815.00	6.35	5.40	20.52	129.41	5.72	2.594	74.86	138.03
820.00	6.31	5.31	20.99	132.85	2.57	2.658	75.40	138.71
825.00	6.27	5.23	21.51	135.56	-1.28	2.711	75.95	139.35
830.00	6.23	5.17	22.06	137.38	-5.66	2.753	76.48	139.98
835.00	6.19	5.10	22.62	138.21	-10.32	2.782	77.02	140.61
840.00	6.15	5.05	23.23	138.02	-15.01	2.798	77.59	141.29
845.00	6.11	5.01	23.89	136.84	-19.51	2.801	78.21	142.10
850.00	6.07	4.98	24.56	134.80	-23.58	2.791	78.86	143.08
855.00	6.05	4.97	25.12	132.03	-27.07	2.769	79.58	144.25
860.00	6.04	4.99	25.47	128.73	-29.89	2.736	80.32	145.46
865.00	6.06	5.04	25.58	125.03	-31.99	2.693	80.91	146.51
870.00	6.11	5.12	25.45	121.08	-33.33	2.639	81.13	147.18
875.00	6.17	5.23	25.11	117.05	-33.90	2.576	80.81	147.35
880.00	6.24	5.35	24.60	113.09	-33.72	2.506	79.94	147.03
885.00	6.29	5.46	23.95	109.33	-32.87	2.430	78.63	146.39
890.00	6.33	5.56	23.23	105.88	-31.44	2.351	77.13	145.65
895.00	6.36	5.65	22.46	102.80	-29.52	2.272	75.80	144.92
900.00	6.37	5.72	21.69	100.13	-27.20	2.194	74.86	144.21
905.00	6.38	5.78	20.92	97.89	-24.57	2.120	74.32	143.45
910.00	6.37	5.82	20.20	96.08	-21.71	2.053	74.08	142.60
915.00	6.34	5.84	19.57	94.72	-18.65	1.994	74.06	141.72

920.00	6.31	5.84	19.07	93.79	-15.47	1.946	74.14	140.92
925.00	6.29	5.84	18.69	93.28	-12.20	1.910	74.23	140.27
930.00	6.27	5.84	18.42	93.21	-8.88	1.888	74.27	139.77
935.00	6.27	5.84	18.22	93.58	-5.54	1.881	74.25	139.32
940.00	6.28	5.85	18.08	94.38	-2.22	1.889	74.18	138.86
945.00	6.30	5.85	17.96	95.62	1.03	1.913	74.10	138.36
950.00	6.32	5.85	17.89	97.31	4.18	1.951	73.97	137.79
955.00	6.34	5.83	17.89	99.46	7.16	2.003	73.79	137.26
960.00	6.36	5.80	17.96	102.05	9.94	2.066	73.67	136.94
965.00	6.36	5.74	18.12	105.10	12.46	2.140	73.76	136.90
970.00	6.35	5.67	18.34	108.59	14.63	2.221	74.09	137.01
975.00	6.33	5.59	18.62	112.50	16.40	2.309	74.54	137.16
980.00	6.31	5.50	18.95	116.82	17.68	2.401	75.02	137.29
985.00	6.29	5.42	19.31	121.48	18.37	2.496	75.46	137.39
990.00	6.28	5.33	19.70	126.43	18.38	2.592	75.82	137.52
995.00	6.27	5.25	20.11	131.56	17.63	2.686	76.07	137.77
1000.00	6.26	5.17	20.54	136.73	16.04	2.778	76.28	138.25
1005.00	6.24	5.09	21.03	141.80	13.57	2.866	76.57	138.92
1010.00	6.22	5.01	21.57	146.59	10.22	2.948	77.01	139.73
1015.00	6.20	4.93	22.19	150.93	6.01	3.024	77.62	140.64
1020.00	6.18	4.87	22.90	154.64	1.01	3.093	78.36	141.60
1025.00	6.18	4.82	23.69	157.55	-4.65	3.154	79.13	142.57
1030.00	6.19	4.80	24.51	159.53	-10.84	3.207	79.82	143.45
1035.00	6.23	4.80	25.30	160.47	-17.37	3.251	80.29	144.11
1040.00	6.29	4.84	25.95	160.29	-24.02	3.285	80.43	144.44
1045.00	6.36	4.89	26.38	158.96	-30.54	3.309	80.15	144.42
1050.00	6.43	4.95	26.52	156.55	-36.67	3.321	79.46	144.08
1055.00	6.49	5.02	26.35	153.19	-42.18	3.321	78.48	143.54
1060.00	6.54	5.07	25.85	149.10	-46.88	3.310	77.44	142.83
1065.00	6.58	5.13	25.02	144.49	-50.70	3.288	76.50	141.80
1070.00	6.60	5.17	24.03	139.61	-53.62	3.255	75.64	140.38
1075.00	6.62	5.21	23.12	134.65	-55.68	3.214	74.79	138.93
1080.00	6.62	5.25	22.38	129.75	-56.98	3.165	74.04	137.81
1085.00	6.62	5.29	21.79	125.01	-57.59	3.109	73.49	136.99
1090.00	6.62	5.34	21.30	120.52	-57.62	3.048	73.17	136.34
1095.00	6.61	5.37	20.89	116.32	-57.14	2.982	73.05	135.84
1100.00	6.60	5.41	20.54	112.45	-56.24	2.913	73.07	135.49
Average	6.43		22.12				75.07	138.26

The results can be plotted using available external routines. However, the program will generate plots in the native HP plotter format (HPGL). A program from CERN (CERN HPGL) will generate screen plots for Windows (7, 8, and 10) using the output HPGL files.

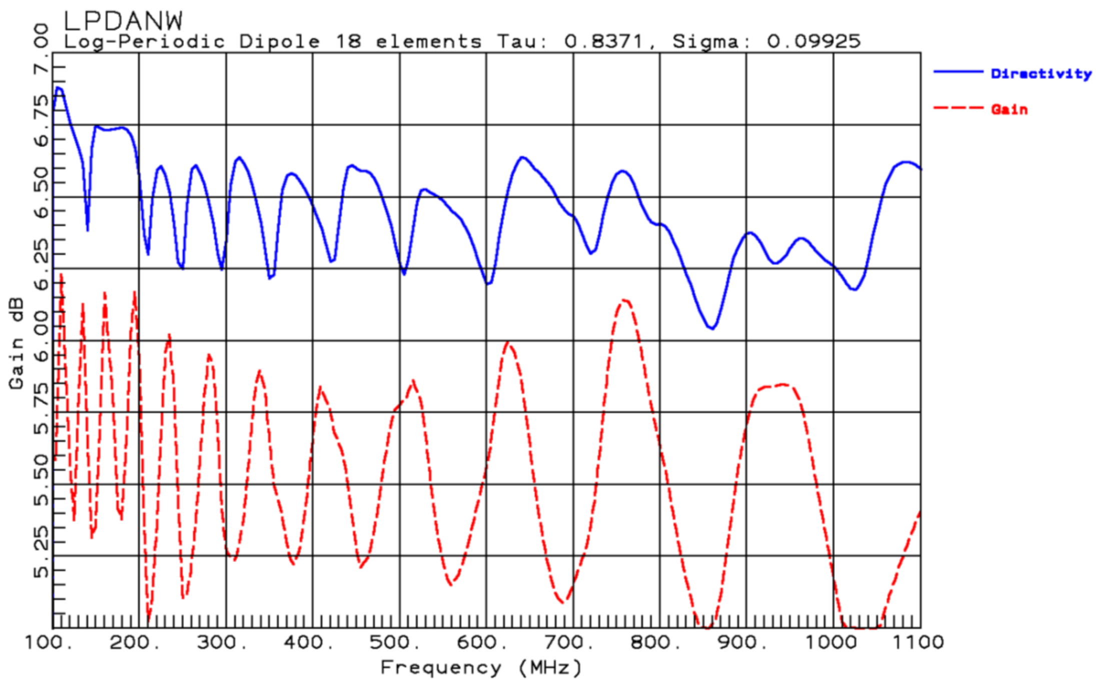

Figure 11-12.6.3 LPDANW MOM analysis Directivity and Reduction due to Impedance Mismatch

Directivity is the gain given by the program using the currents in the dipoles computed by the Carrel method while gain is the same value accounting for mismatch loss. A better estimate of directivity could be found by integration of the pattern. While MOM produces good results for patterns, the input impedance output is less reliable.

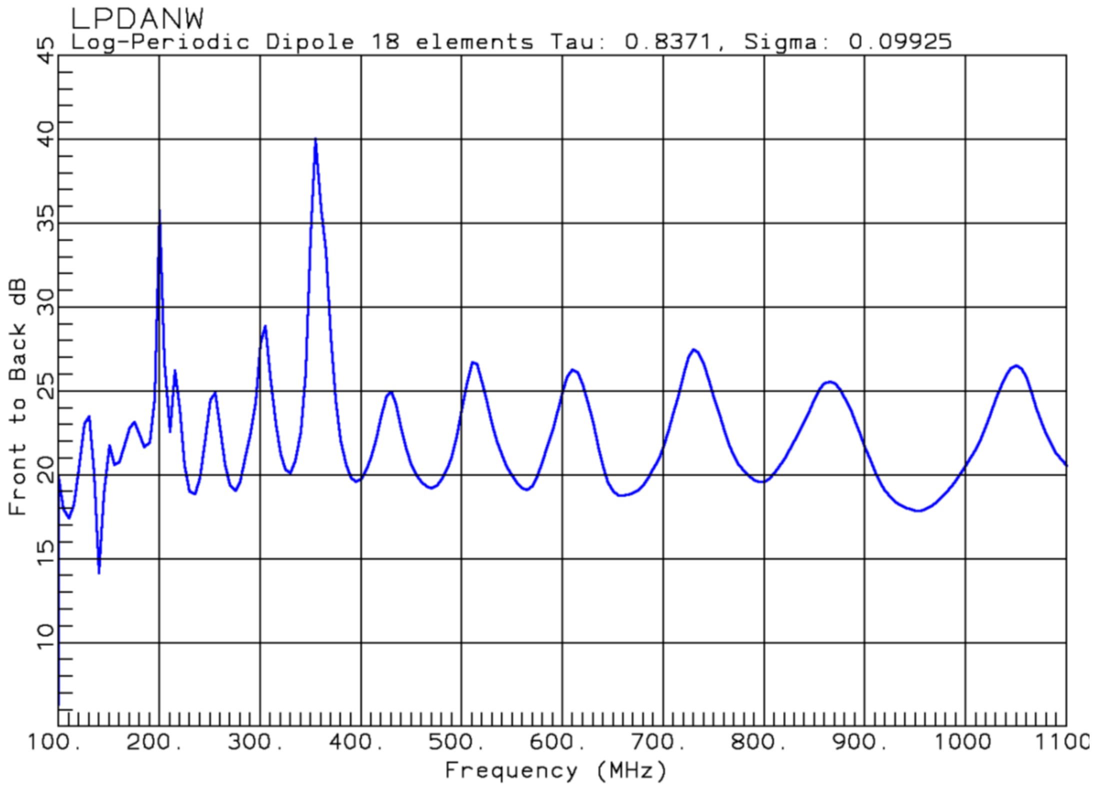

Figure 11-12.6.4 LPDANW analysis Pattern Front-to-Back

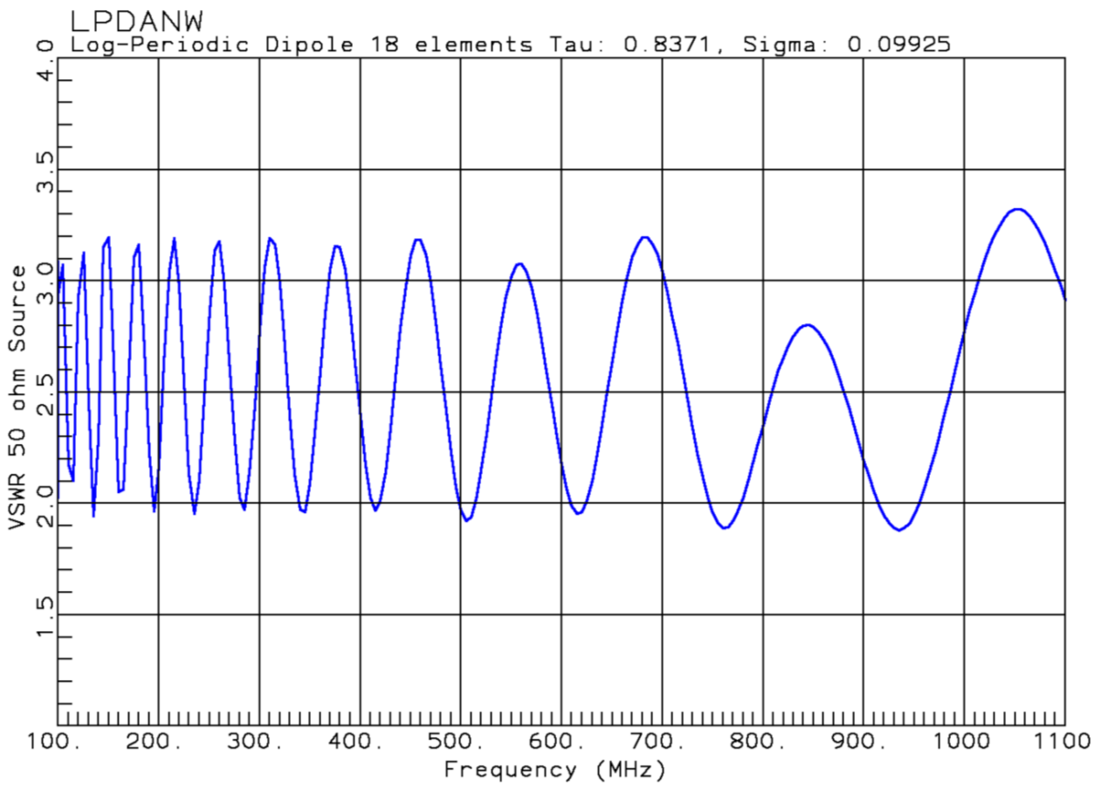

Figure 11-12.6.5 LPDANW analysis VSWR with 200 Ω Transmission Line Feeder

A lower impedance feeder would produce a lower VSWR to a 50-Ω input impedance. The listing above gives average impedance nearer to 100 Ω.

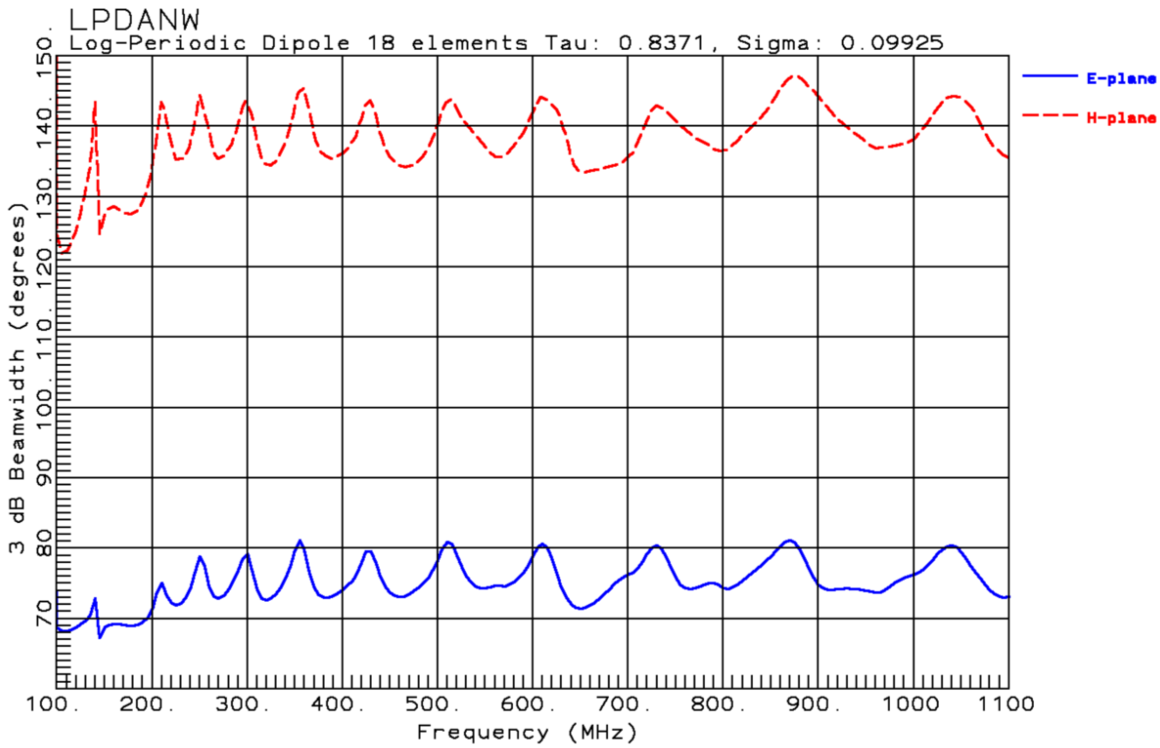

Figure 11-12.6.6 The *E*-plane beamwidth is narrowed by the dipole null at 90º.

The program will compute individual patterns at a given frequency.

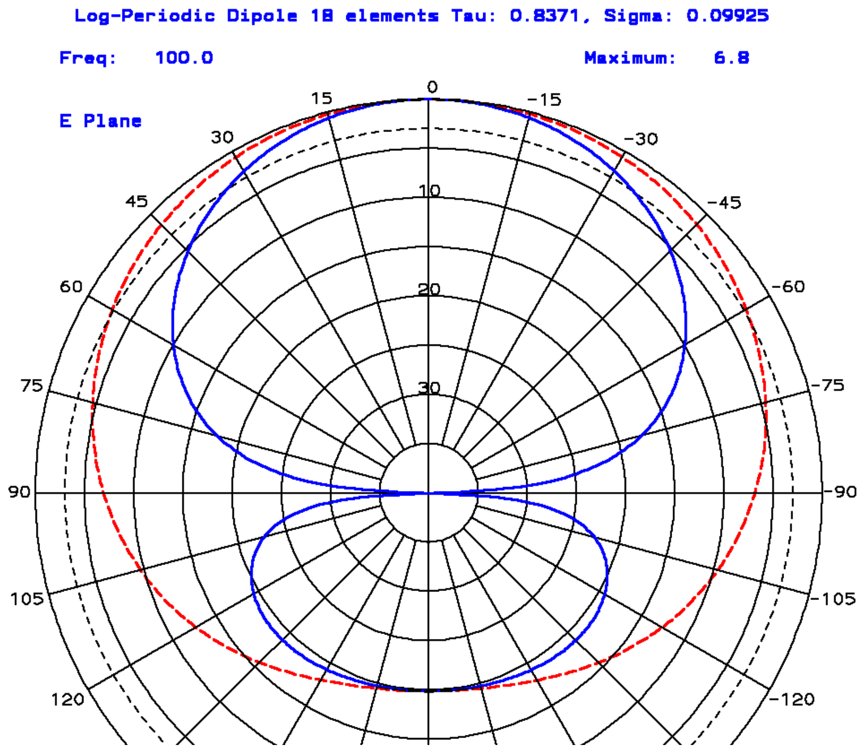

Figure 11-12.6.7 ASAP MoM 18 el LP Analysis 100 MHz

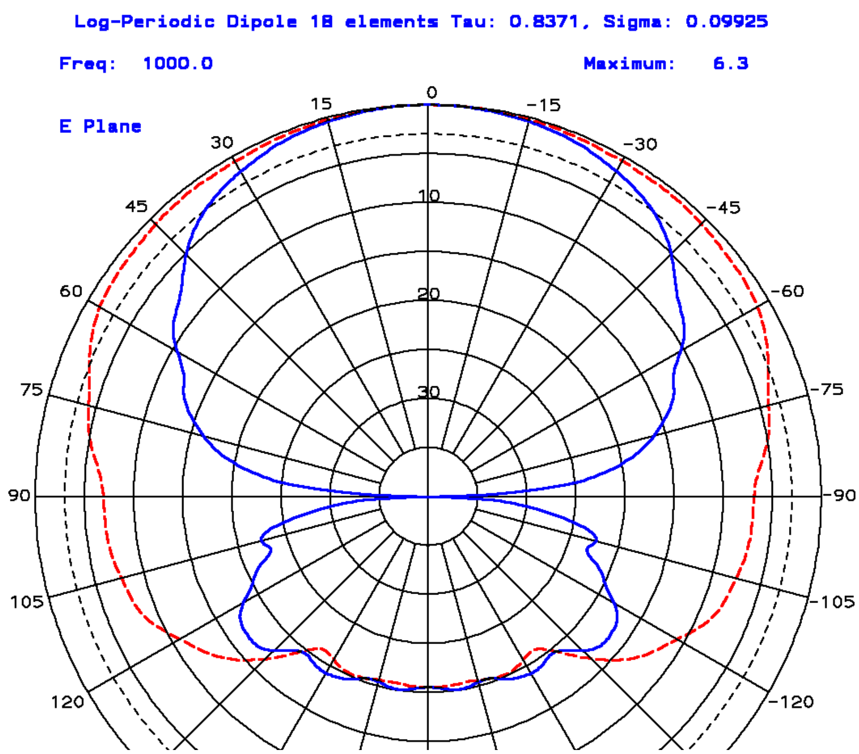

Figure 11-12.6.8 ASAP MoM 18 el LP Analysis 1000 MHz

NEC (MOM) has the built-in capability of combining dipole elements with transmission lines to analyze a dipole element log-periodic antenna. Specifying the transmission lines with negative impedances tells the program to use a criss-crossed feeder transmission lines between feed points (base of dipoles). The program LPNECW generates a NEC input file from specified log periodic dipole characteristics including the transmission feeder for a Carrel analysis. The input file LPNECW1.TXT lists the inputs to LPNECW to generate the same analysis as the example above for the MOM code ASAP.

```
LPNECW1.TXT
100,1000        lower, upper frequency MHz
1               units: inches
0.8371          scaling factor
1               enter spacing constant
0.09925                 spacing constant
n               enter truncation constants?
18              number of dipole elements
7               create NEC file
lpdnec1.nec
1               # comments
18 element LP 78.748 in. length
1               linear dipoles
0,0,0           rotation angles about axes
3,2,3           rotation axes (Z, new Y, new Z)
0,0,0           translation after rotation about feed
1.2             diameter of longest element
1               scale diameters with Tau (scaling constant)
200             impedance of feeder line
1               dielectric constant of feeder transmission line
2               wire segment length
0,0             amplitude dB, phase
0               end (no more antennas)
0               no ground plane in NEC model
0,205           linear frequency steps, steps
80,5            1st frequency, step size (MHz)
1               generate pattern
0,2,180                 Theta: start,step,#
0,10,19         Phi: start,step,#
```

LPNECW generates input to NEC-4, but there is little difference from NEC-2 input. The program generates a NEC file with the antenna pointed in the *z*-axis direction and the *E*-plane of the dipoles along the *x*-axis. The antenna maybe rotated by specifying rotation angles on individual elements to generate an array or to orientate the antenna horizontally over a ground plane. When mounted over a ground plane, the antenna needs to be translated to its position along the *z*-axis direction. The case above has only a single element. Specifying 1 for 'end' input allows for input of another LP antenna including feeding coefficients to generate an array. After all antennas are entered, ground plane, frequencies, and pattern angles are specified.

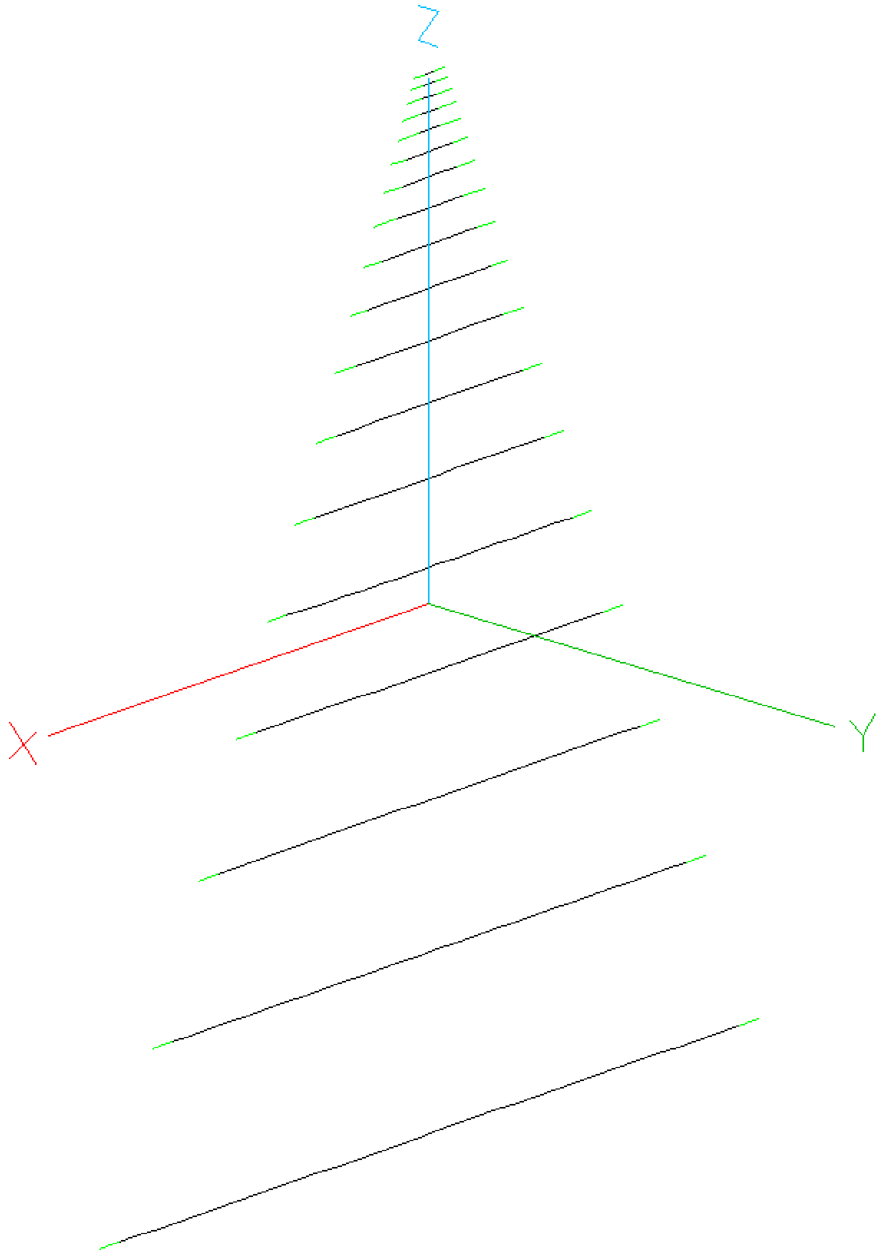

Figure 11-12.6.9 NEC Carrel Model with Transmission Lines between Dipoles, but the transmission line feeder does not show in graphics renderer.

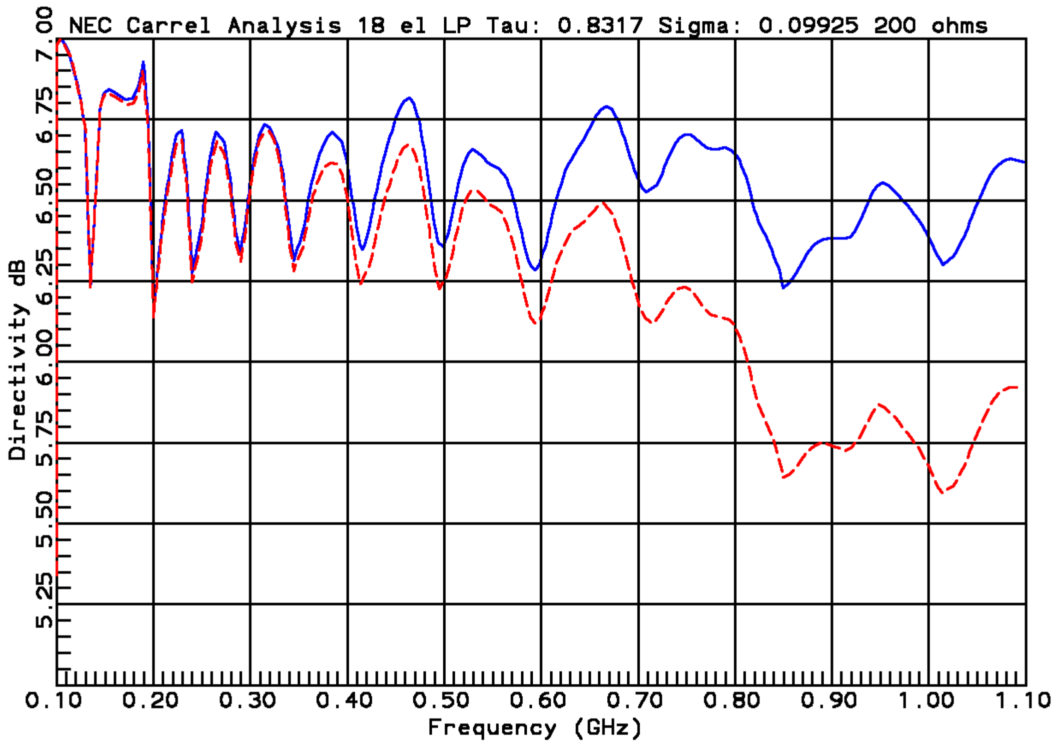

Figure 11-12.6.10 NEC analysis with 200 Ω feeder of pattern integrated directivity (blue) and maximum gain (red) from NEC Carrel analysis. The red curve is compared to the blue curve of the ASAP analysis plot given above (**Figure 11-12.6.3)**. The difference in results between the two analyses illustrates the sensitivity of an impedance analysis when included in MOM.

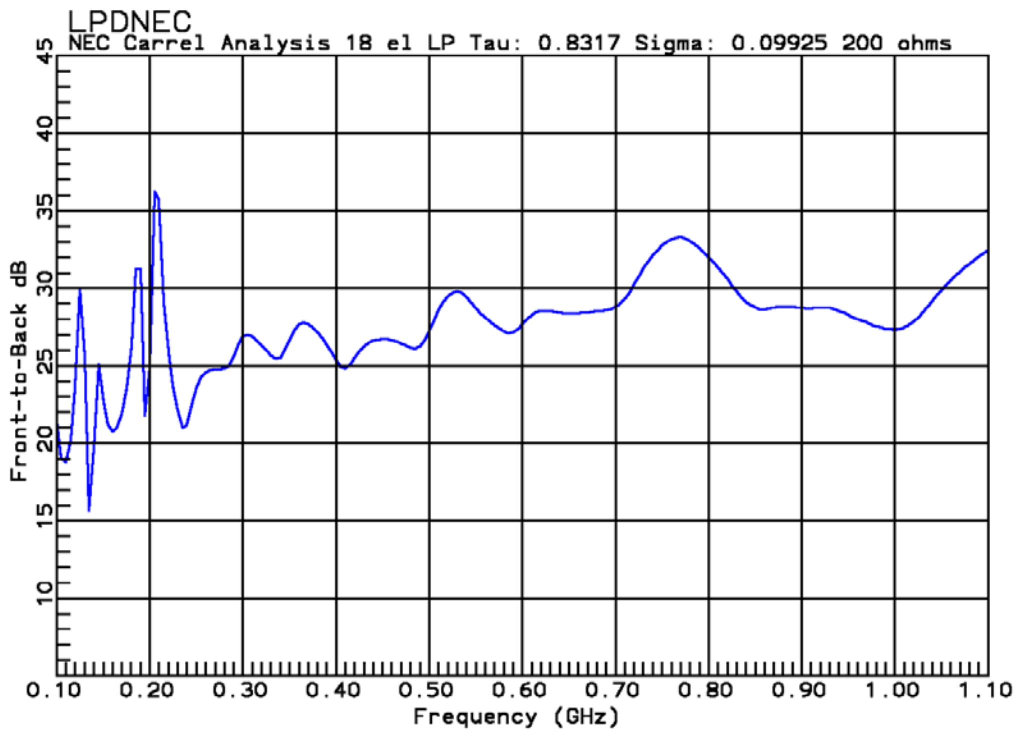

Figure 11-12.6.11 NEC analysis with 200 Ω feeder of pattern front-to-back

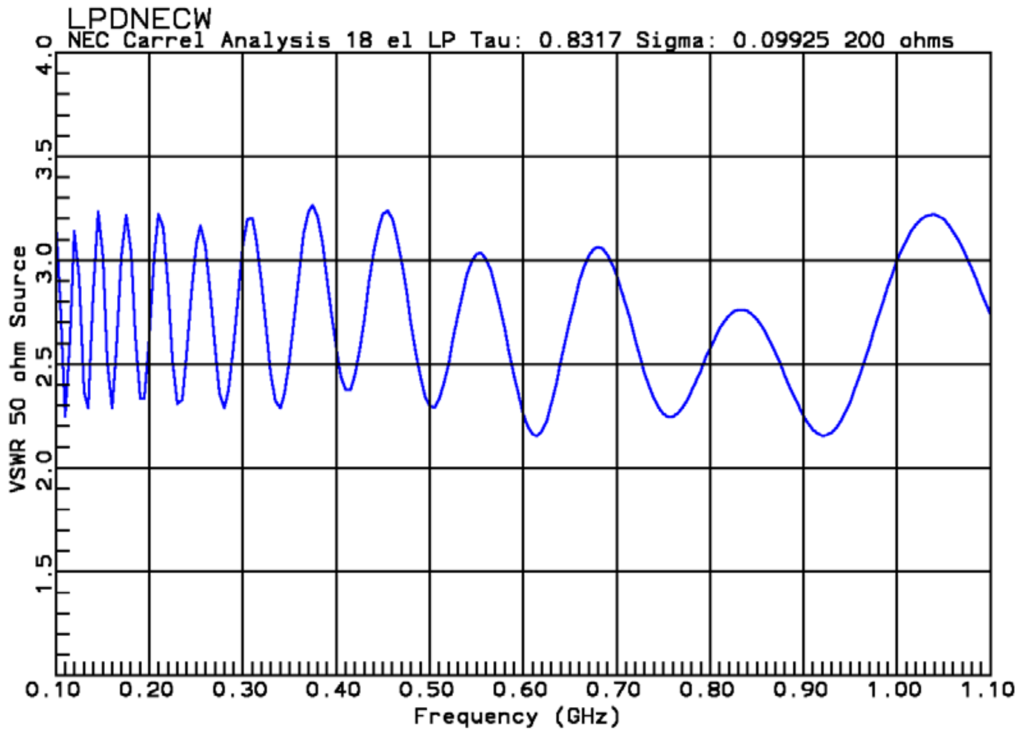

Figure 11-12.6.12 NEC analysis with 200 Ω feeder of VSWR to 50 Ω source

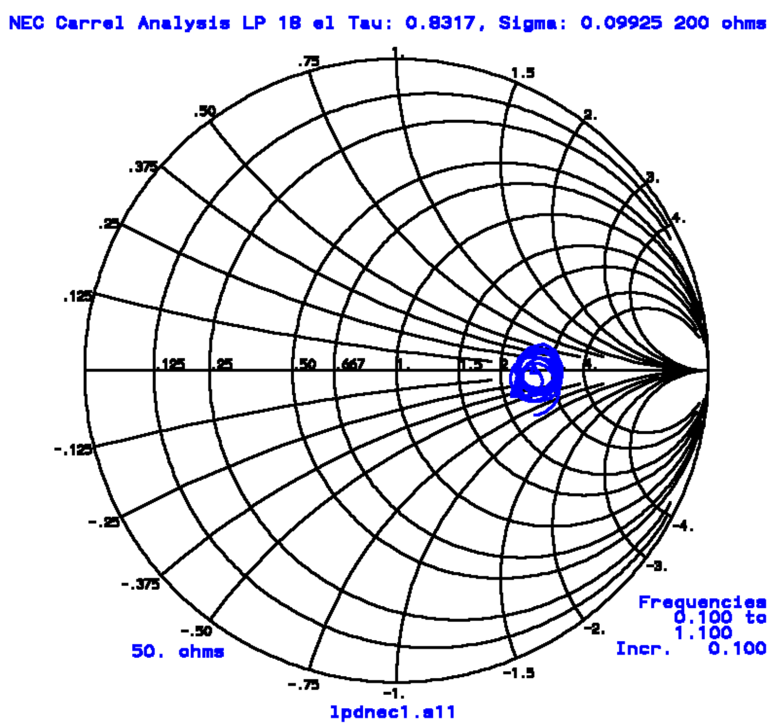

Figure 11-12.6.13 NEC analysis with 200 Ω feeder for Smith Chart Plot to 50 Ω source

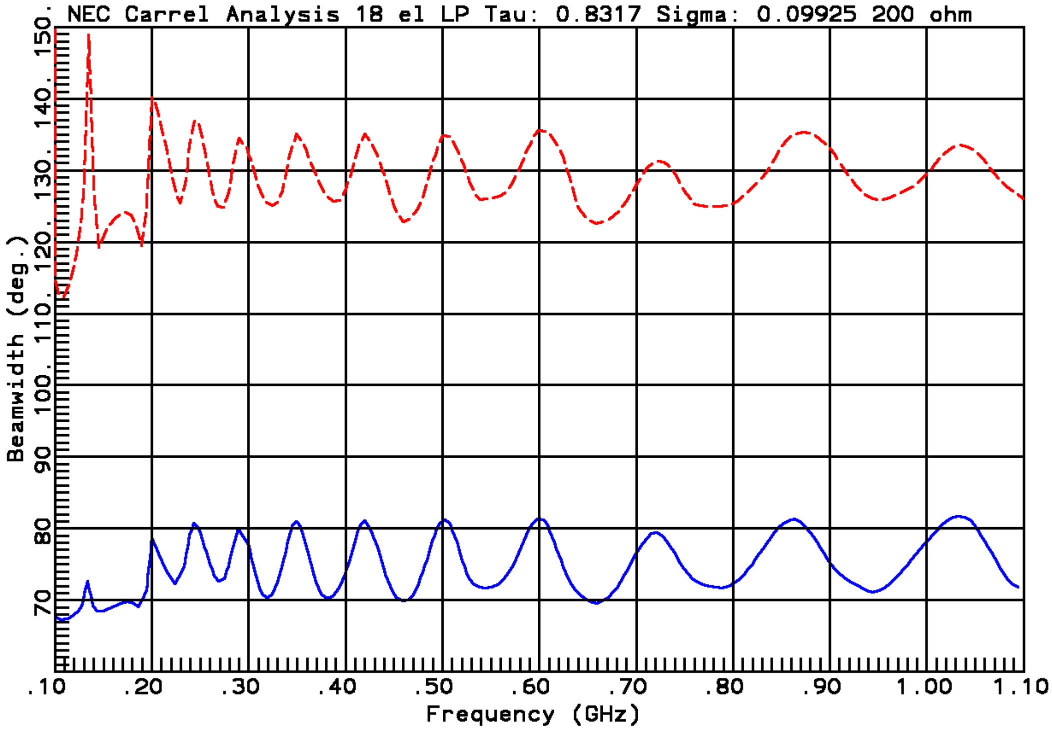

Figure 11-12.6.14 NEC analysis with 200 Ω feeder Beamwidths *E*-plane (Blue), *H*-Plane (Red)

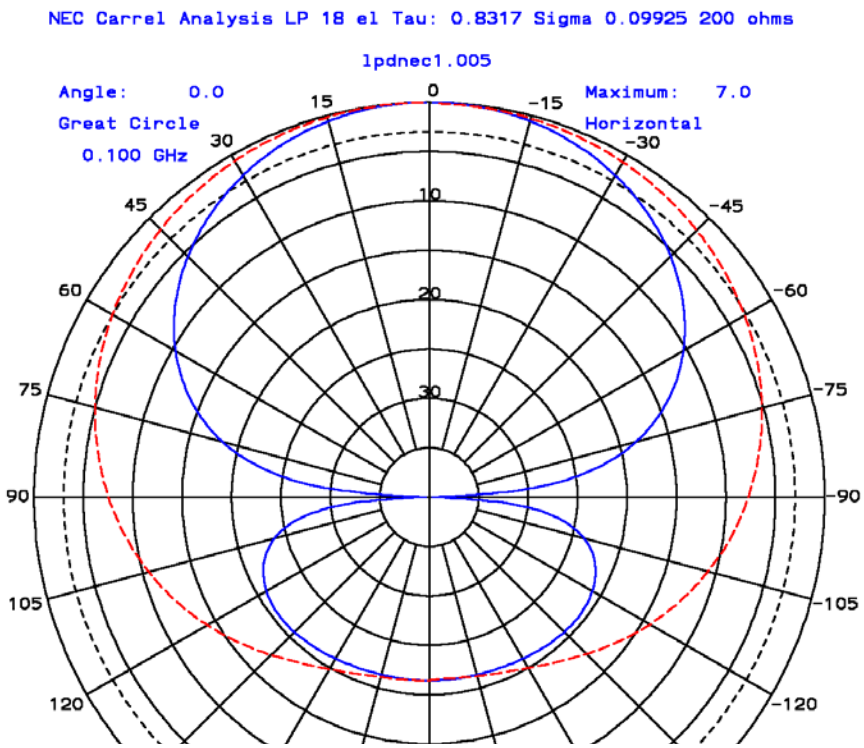

Figure 11-12.6.15 NEC analysis with 200 Ω feeder Beamwidths *E*-plane (Blue), *H*-Plane (Red) 100 MHz

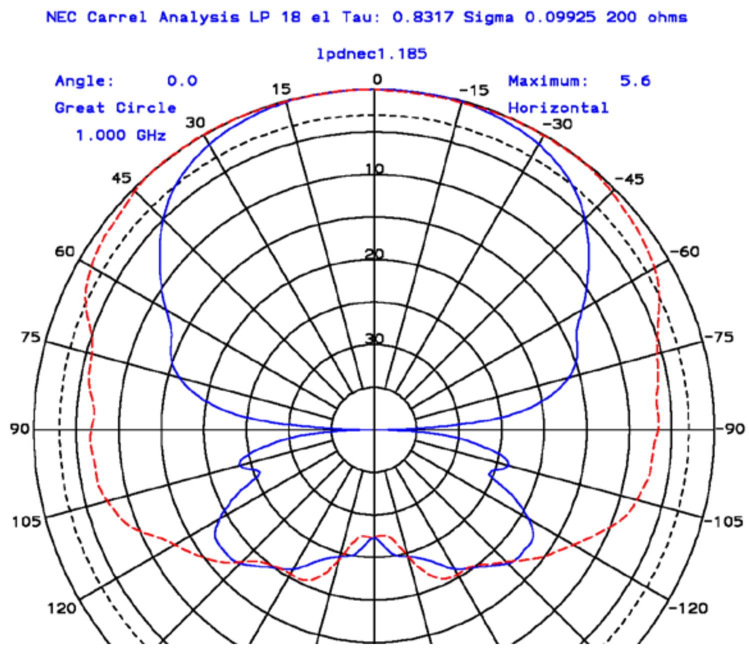

Figure 11-12.6.16 NEC analysis with 200 Ω feeder Beamwidths *E*-plane (Blue), *H*-Plane (Red) 1000 MHz

The NEC analysis was repeated with a 100 Ω feeder transmission to shift the impedance response closer to the center of the Smith chart.

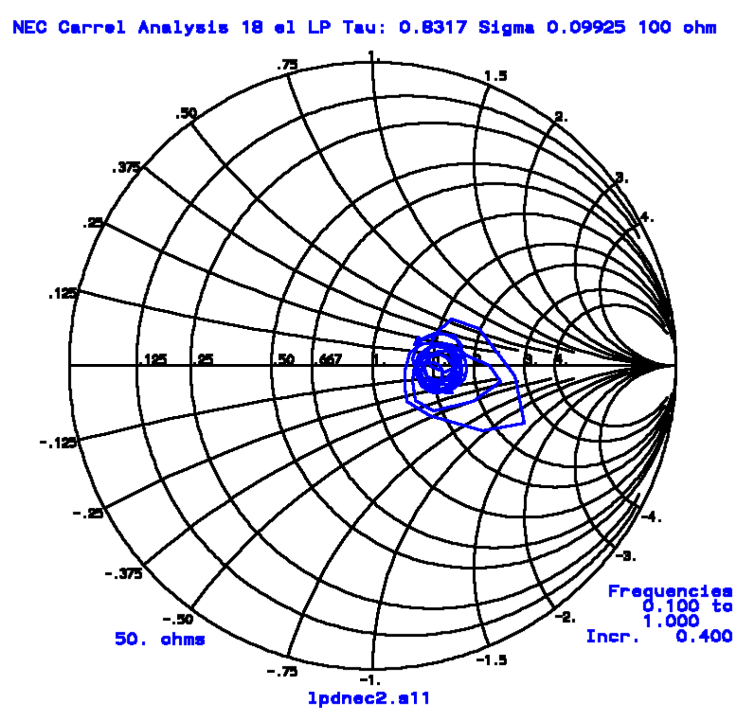

Figure 11-12.6.17 NEC analysis with 100 Ω feeder Smith Chart to 50 Ω source

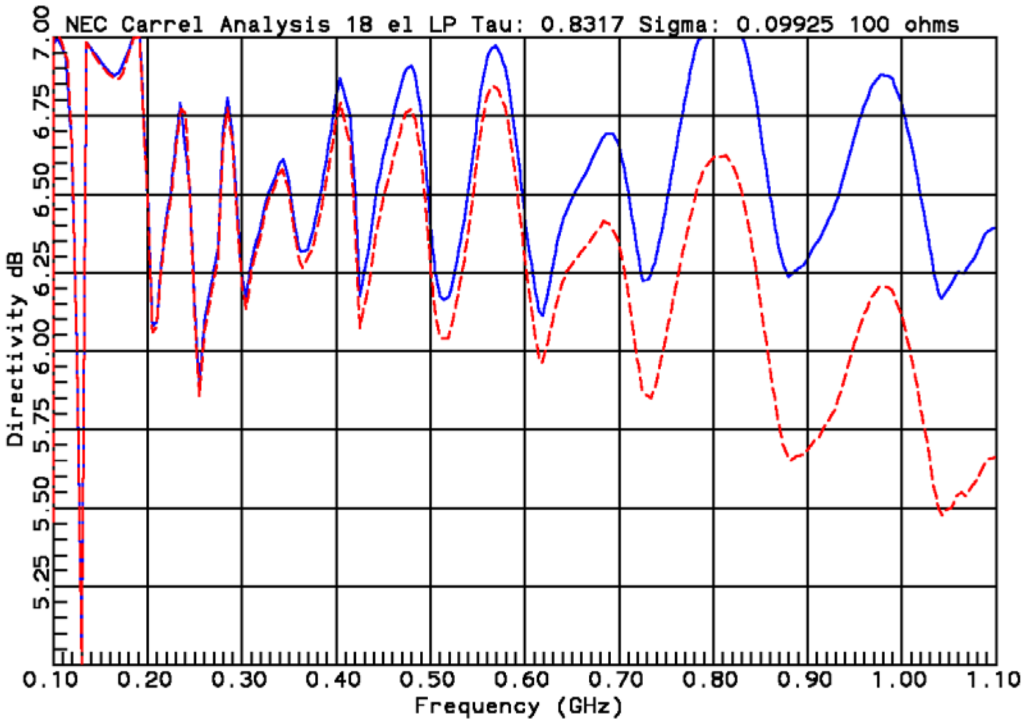

Figure 11-12.6.18 NEC analysis with 100 Ω feeder of pattern integrated directivity (blue) and maximum gain (red) from NEC Carrel analysis.

The lower impedance (100 Ω) feeder line causes greater variation of both directivity (blue) and NEC gain (red) than the 200 Ω transmission line feeder. A narrowband null occurs at about 130 MHz due to the impedance reaction between the dipoles and the feeder transmission line. Of course, the impedance analysis of a MOM analysis is less correct than the pattern analysis. With the Carrel analysis the base currents of the dipoles are determined by this impedance analysis.

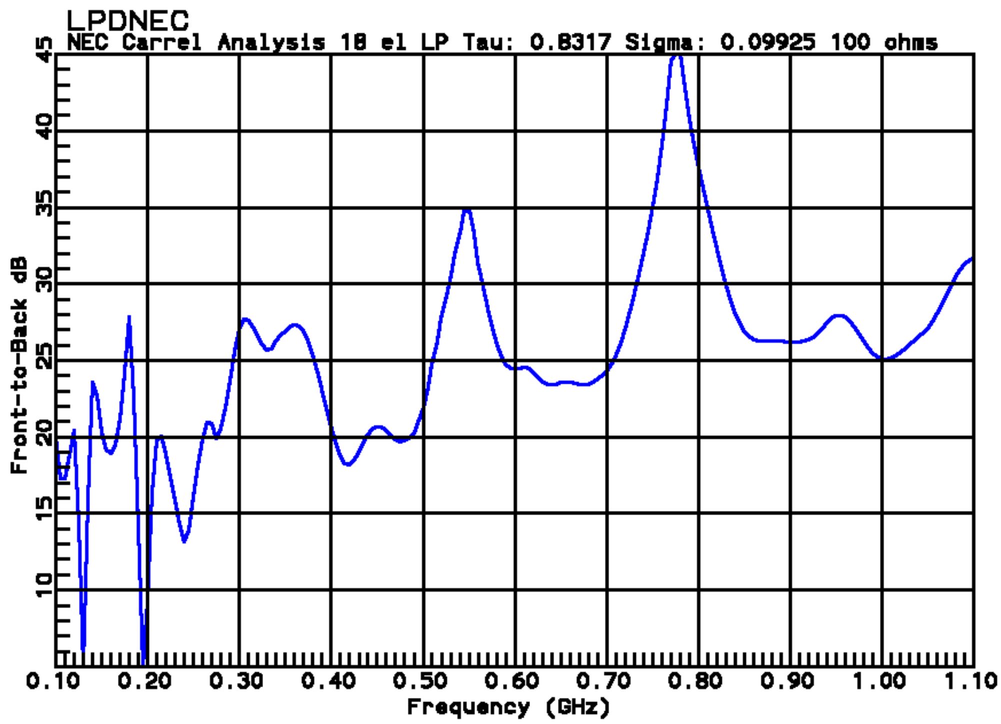

Figure 11-12.6.19 NEC analysis with 100 Ω feeder of pattern front-to-back

A comparison between **Figure 11-12.6.10** and **Figure 11-12.6.18** shows that the pattern response depends on the impedance of the feeder transmission line. The 100 Ω feeder cases shows resonant poor performance at 130- and 195-MHz while on an average basis the curves are similar.

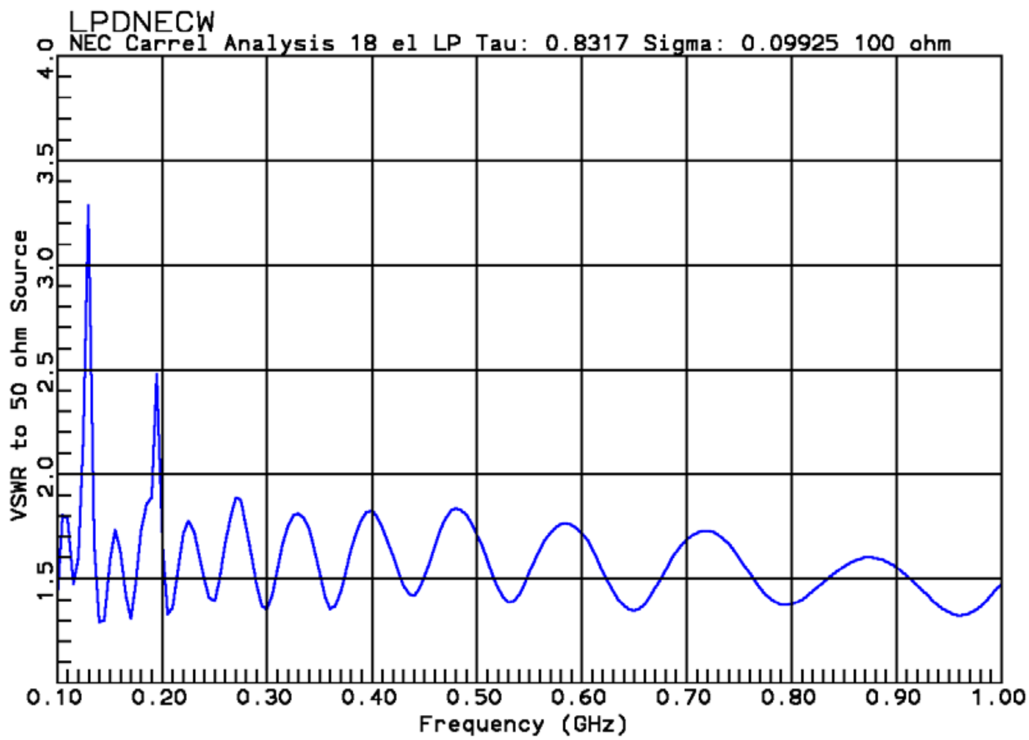

Figure 11-12.6.20 NEC analysis with 100 Ω feeder VSWR to 50 Ω source

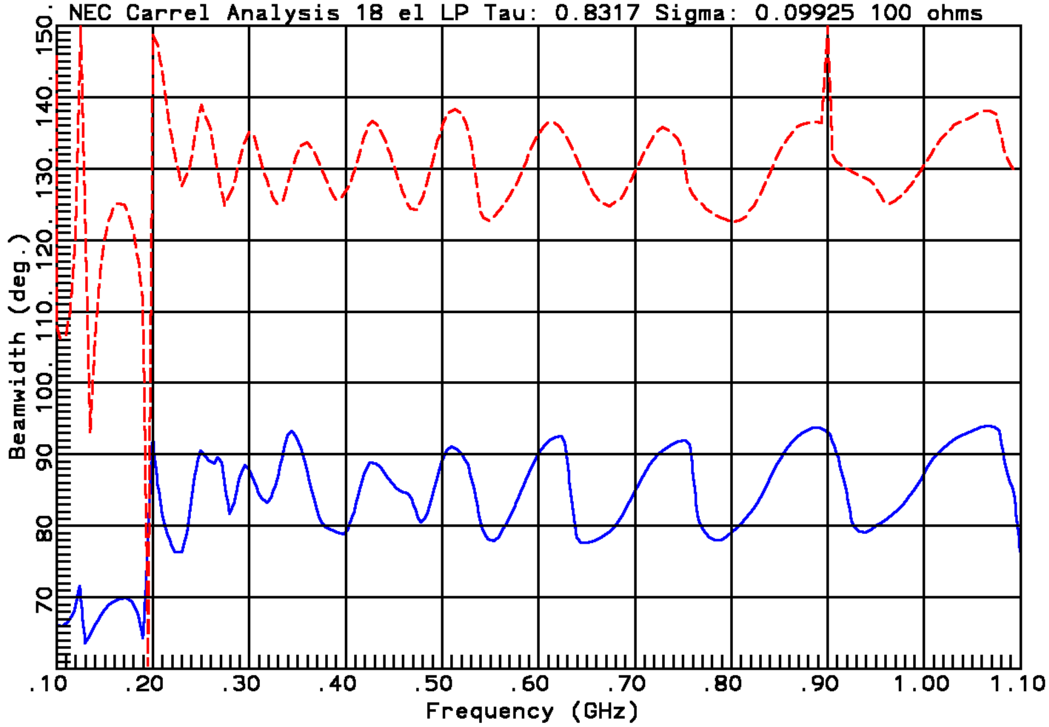

Figure 11-12.6.21 NEC analysis with 100 Ω feeder Beamwidths *E*-plane (Blue), *H*-Plane (Red)

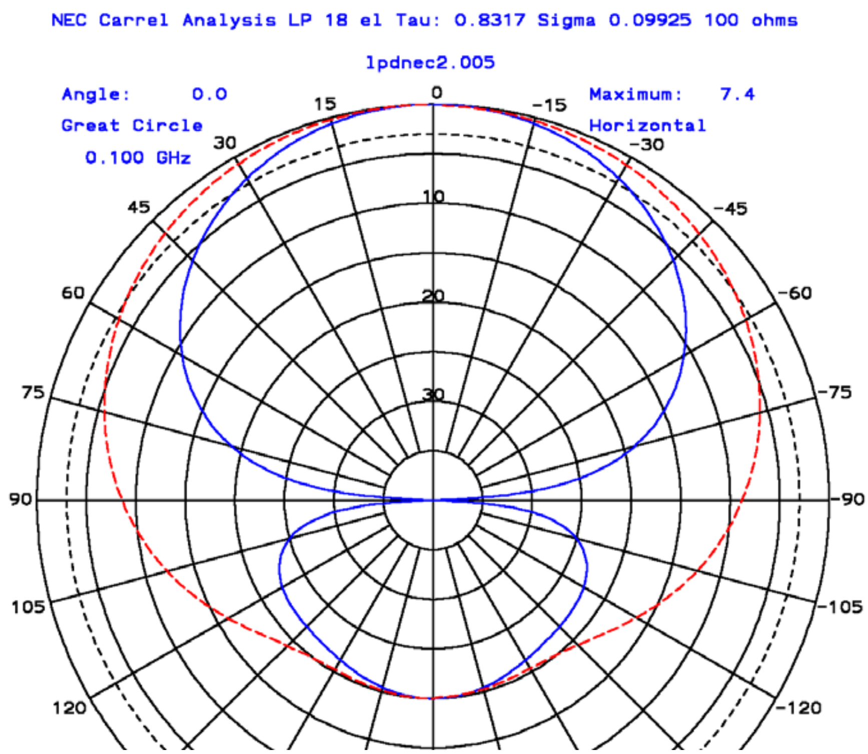

Figure 11-12.6.22 NEC analysis with 100 Ω feeder Beamwidths *E*-plane (Blue), *H*-Plane (Red) 100 MHz

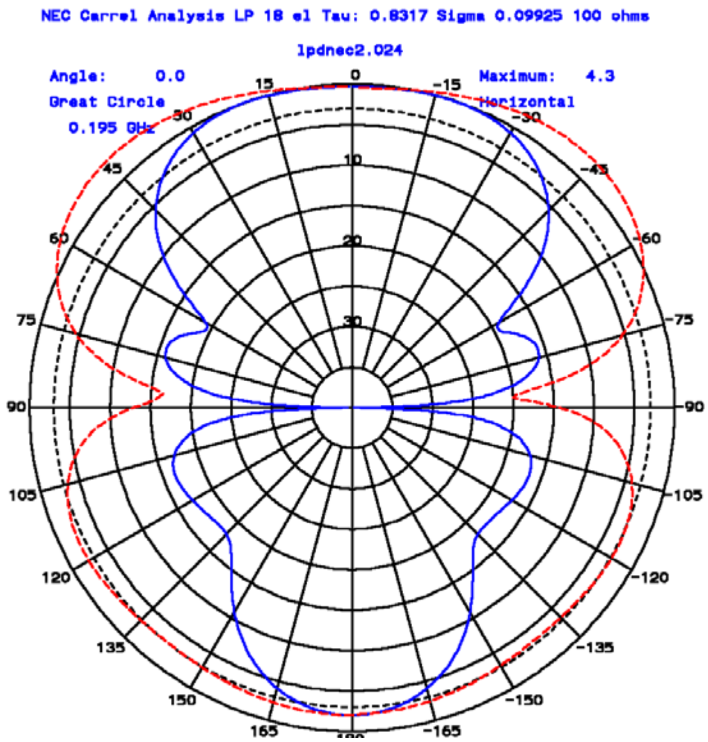

Figure 11-12.6.23 NEC analysis with 100 Ω feeder Beamwidths *E*-plane (Blue), *H*-Plane (Red) 195 MHz

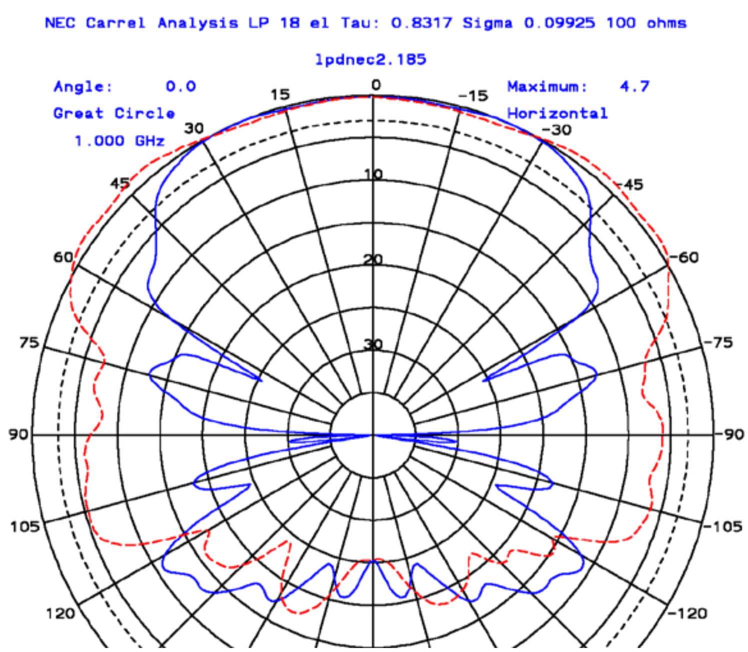

Figure 11-12.6.24 NEC analysis with 100 Ω feeder Beamwidths *E*-plane (Blue), *H*-Plane (Red) 1000 MHz

Figure 11-12.6.21 shows the resonance affect on the *H*-plane beamwidth. A comparison with **Figure 11-12.6.14** of the beamwidths of the model with a 200 Ω feeder transmission line illustrates the increased *H*-plane beamwidth. Likewise, the NEC Carrel model with a 100 Ω feeder *H*-plane beamwidth shows it is closer to the beamwidth predicted by the ASAP Carrel model (**Figure 11-12.6.6**). All three analyses have similar *E*- and *H*-plane beamwidths. The feeder transmission line impedance level can cause narrowband frequency drop-outs in the gain illustrated by the pattern **Figure 11-12.6.23.**

NEC Analysis including Two-wire Transmission Line

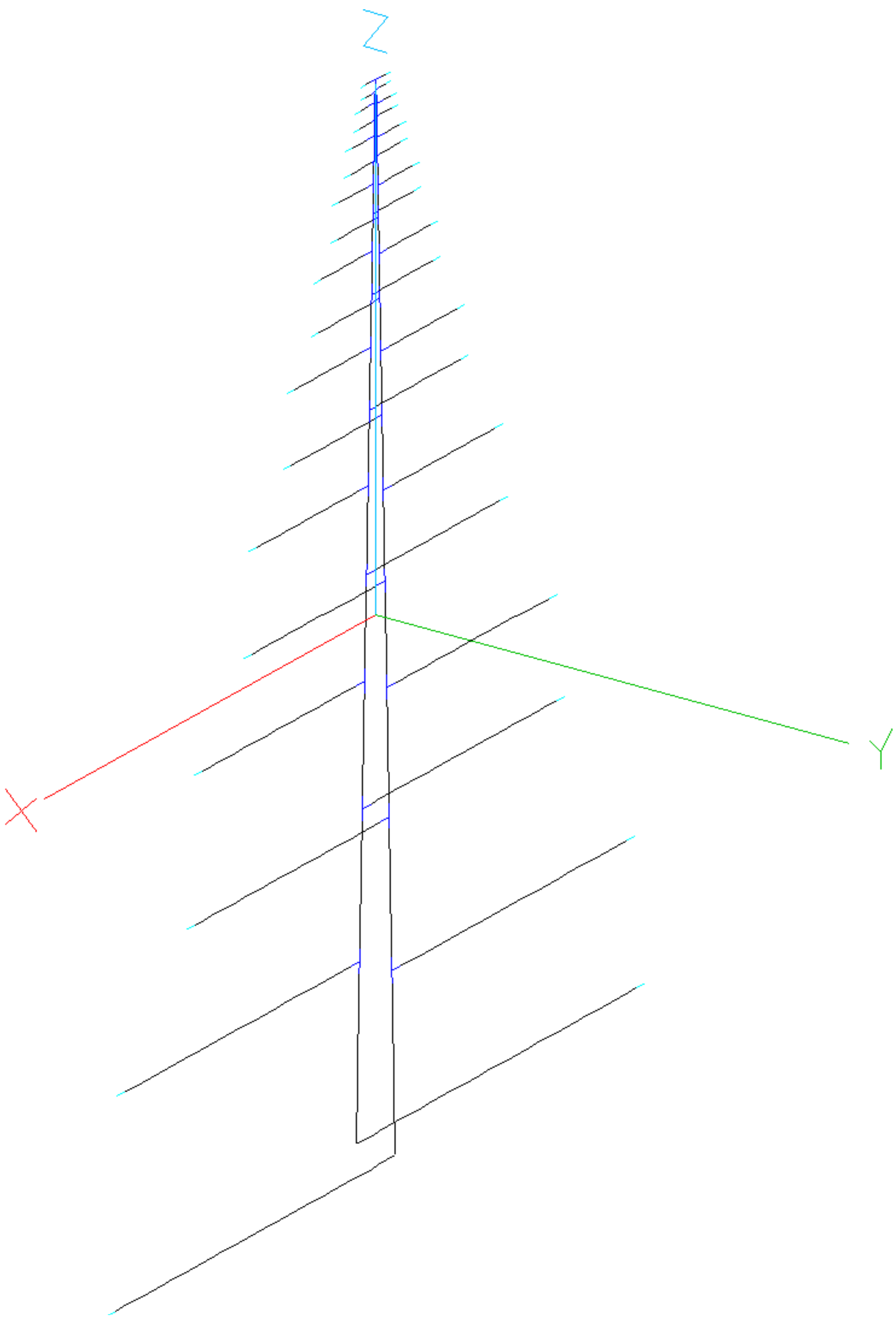

Figure 11-12.6.25 NEC Model of LP Dipole Antenna using Rods between dipoles instead of Transmission Lines of Carrel Model

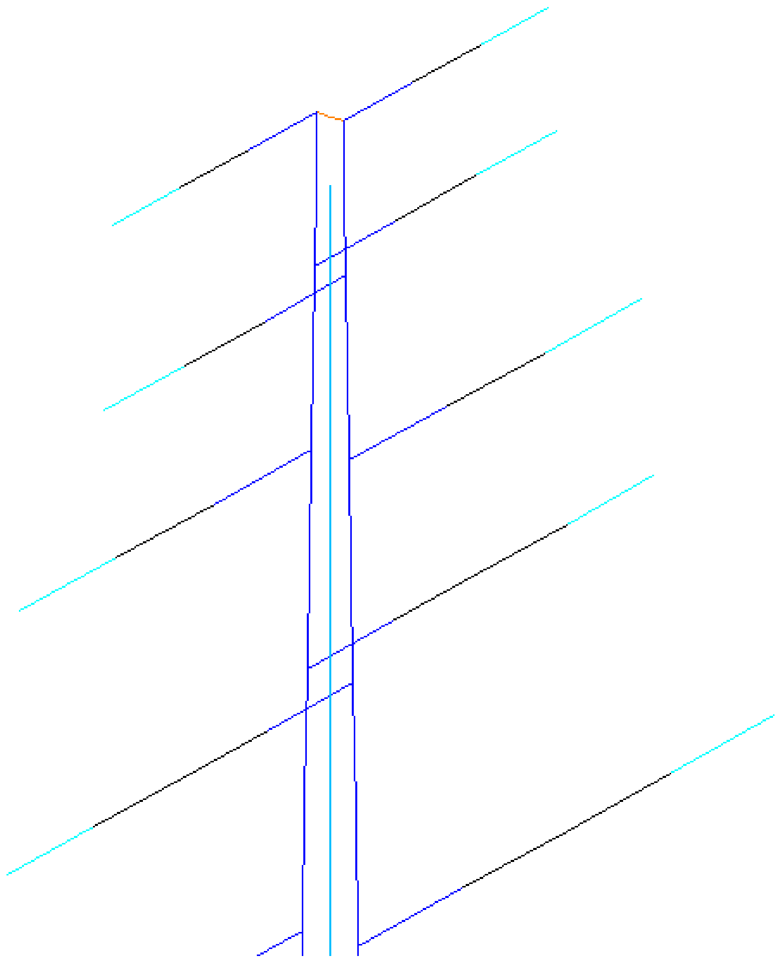

Figure 11-12.6.26 NEC Model Feed Region in Red with two Voltage Sources on Wires

This NEC model analysis adds the angle between the sides which can reduce the *H*-plane beamwidth. By including the transmission line elements in the NEC model, cross-polarization due to the feed can be computed. However, a MoM analysis of the transmission line will be poor with the closely spaced lines since MoM more accurately computes patterns than impedances.

The program RLPNECW generates a NEC-4 file for a log-periodic dipole antenna with rod feeder instead of the Carrel impedance model. The modeling includes rotating the feed line off the *z*-axis so that the antenna can be mounted over ground or so that multiple antennas can be included in the model. Each log-periodic dipole maybe independently rotated and translated and feed voltages specified.

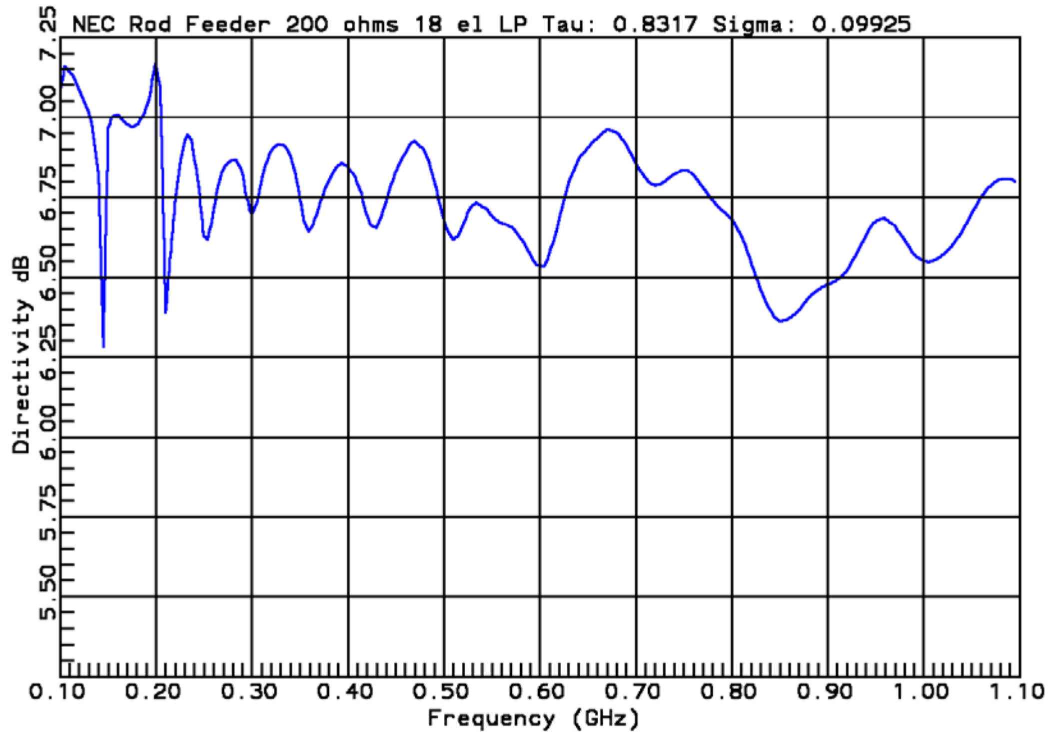

Figure 11-12.6.27 NEC Model of LP Dipole Antenna using Feeder Rods

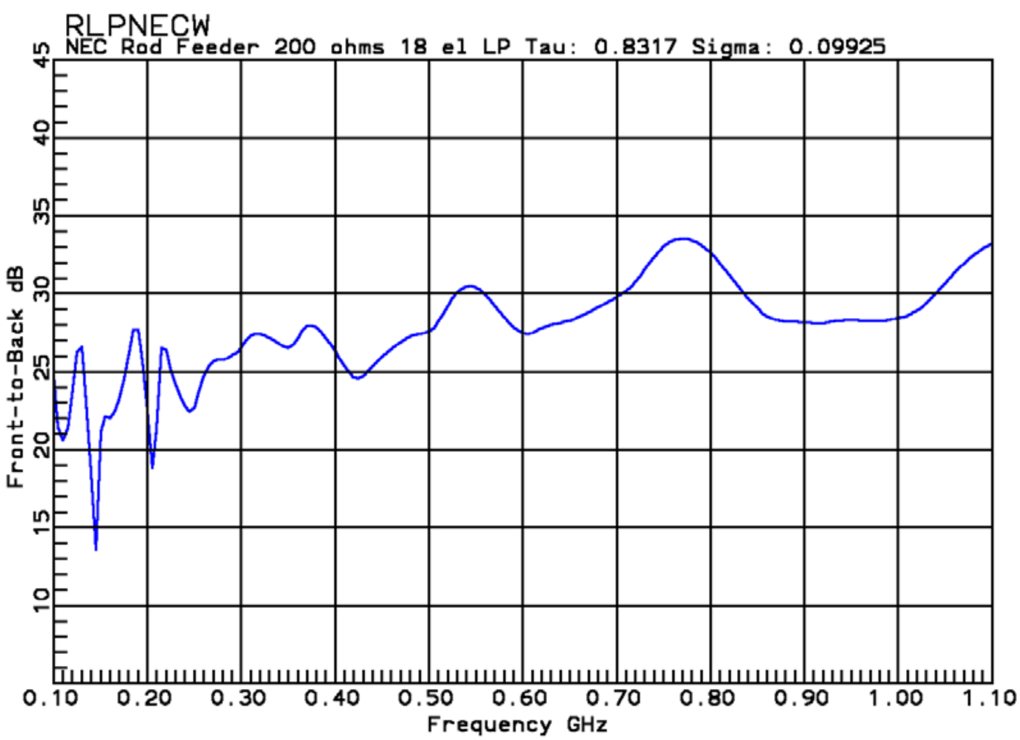

Figure 11-12.6.28 NEC Model of LP Dipole Antenna using Feeder Rods

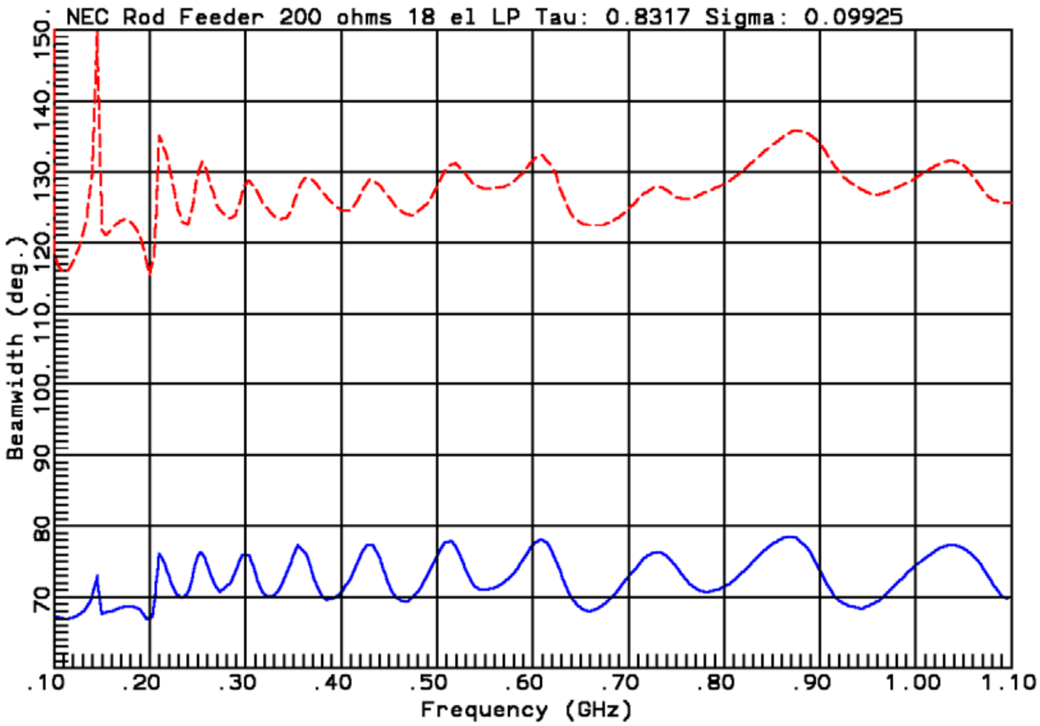

Figure 11-12.6.29 NEC Model of LP Dipole Antenna using Feeder Rods Beamwidths *E*-plane (Blue), *H*-Plane (Red)

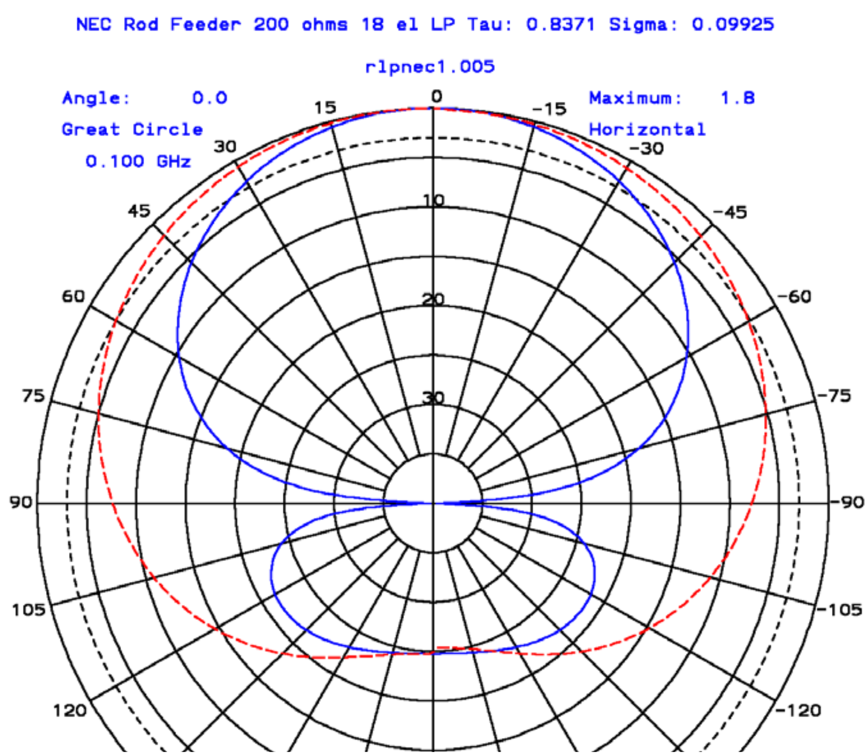

Figure 11-12.6.30 NEC Model of LP Dipole Antenna using Feeder Rods 100 MHz *E*-plane (Blue), *H*-Plane (Red)

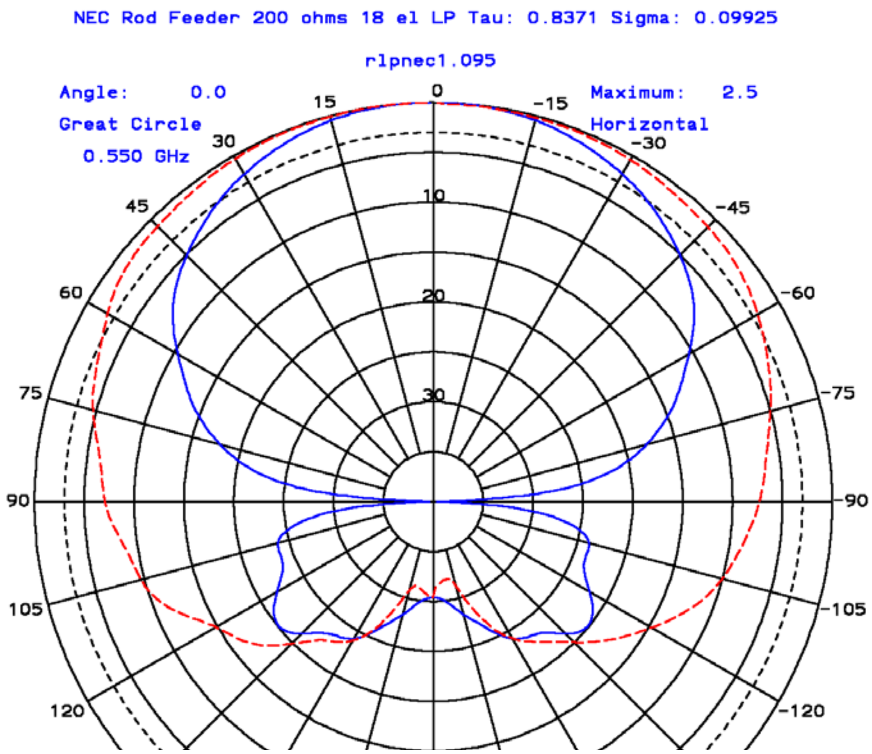

Figure 11-12.6.31 NEC Model of LP Dipole Antenna using Feeder Rods 550 MHz *E*-plane (Blue), *H*-Plane (Red)

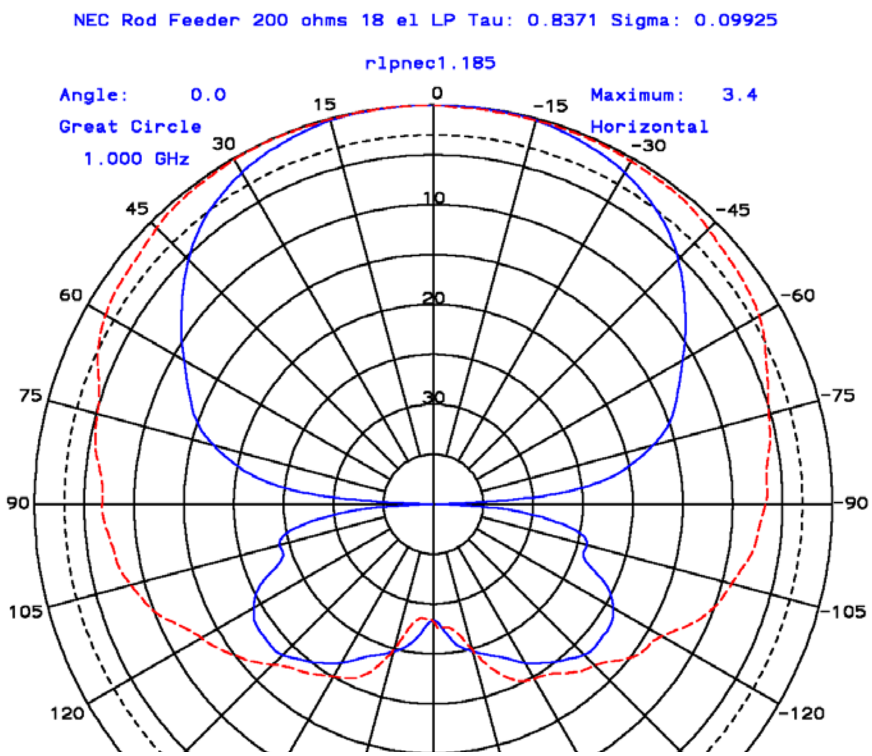

Figure 11-12.6.32 NEC Model of LP Dipole Antenna using Feeder Rods 1000 MHz *E*-plane (Blue), *H*-Plane (Red)

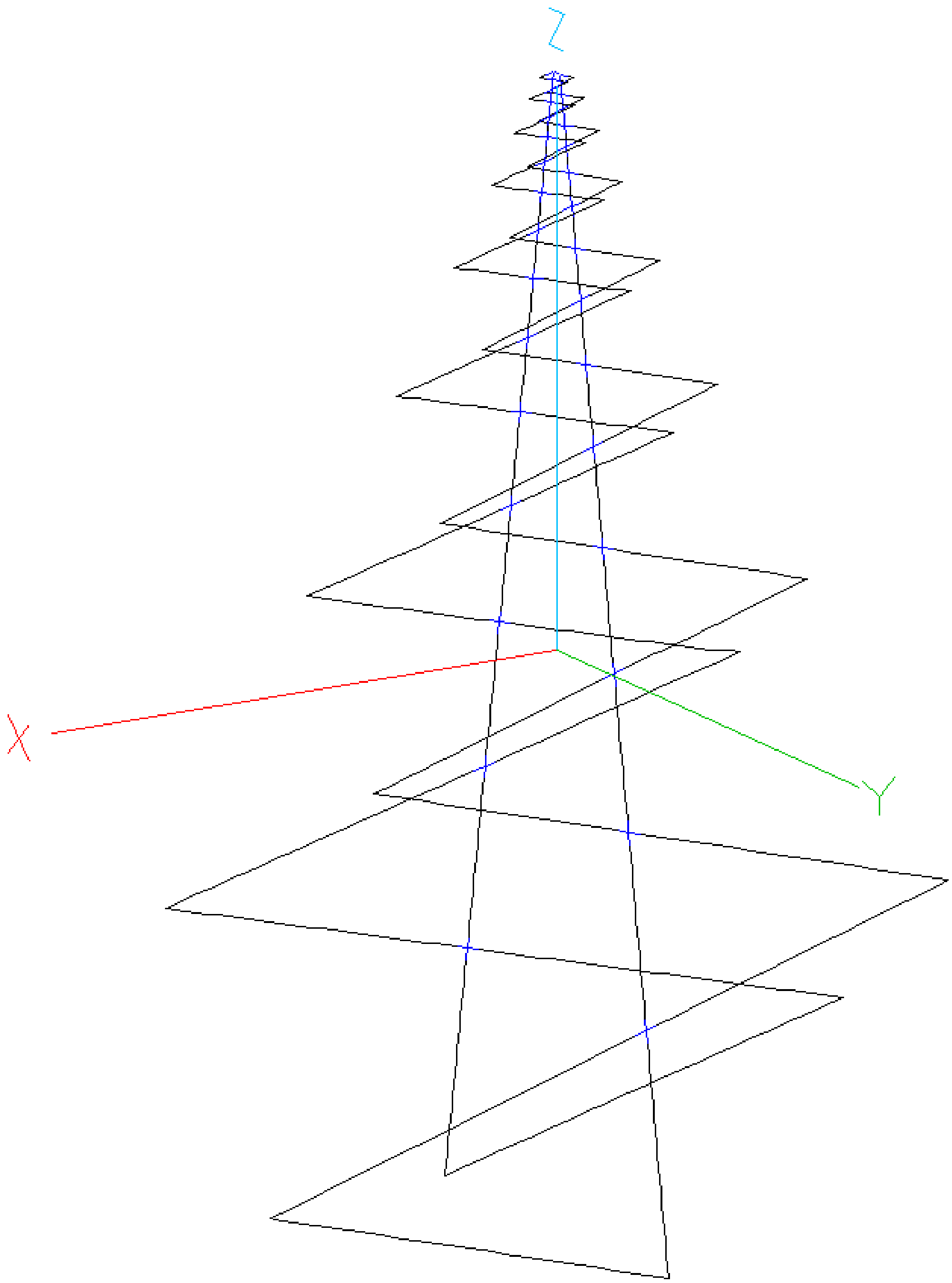

Figure 11-12.6.33 NEC Model of Triangular Tooth LP including Center Feed Rod

This model has a central feed rod which electrically connects to and supports log periodic triangular tooth elements. ZLPNEC generates the NEC geometry file for the triangular tooth LP. It can also generate the Zig-Zag log-periodic antenna that does not include the central feed-line.

The following listing gives an input file to ZLPNEC.

```
zlpnec2.nec
1                inches
0                # comments
1                another LP
0.8              Tau
.125             Sigma
16               # elements
96               longest element length
1                  include feeder wire
23.16,.82              Feeder distance bottom, top
0.,0.,-84.76           Base
0.,0.,0.         Rotation angles
3,2,3            Rotation axes
1.4,.1                 Segment length, wire radius
2                Number of elements
1.,0.            Amplitude, phase
1.,180.                Amplitude, phase
0                no more LP
0                no ground plane
0,91             linear freq step, 21 steps
100,10           frequency start, step MHz
1                pattern
0,2.,180         Theta  start, step, #
0.,22.5,16       Phi  start, step, #
```

The program can produce the NEC geometry file for an array of antennas where each antenna can be rotated and translated to locate the antenna over a ground plane. The NEC geometry file corresponding to the input file was analyzed using NEC.

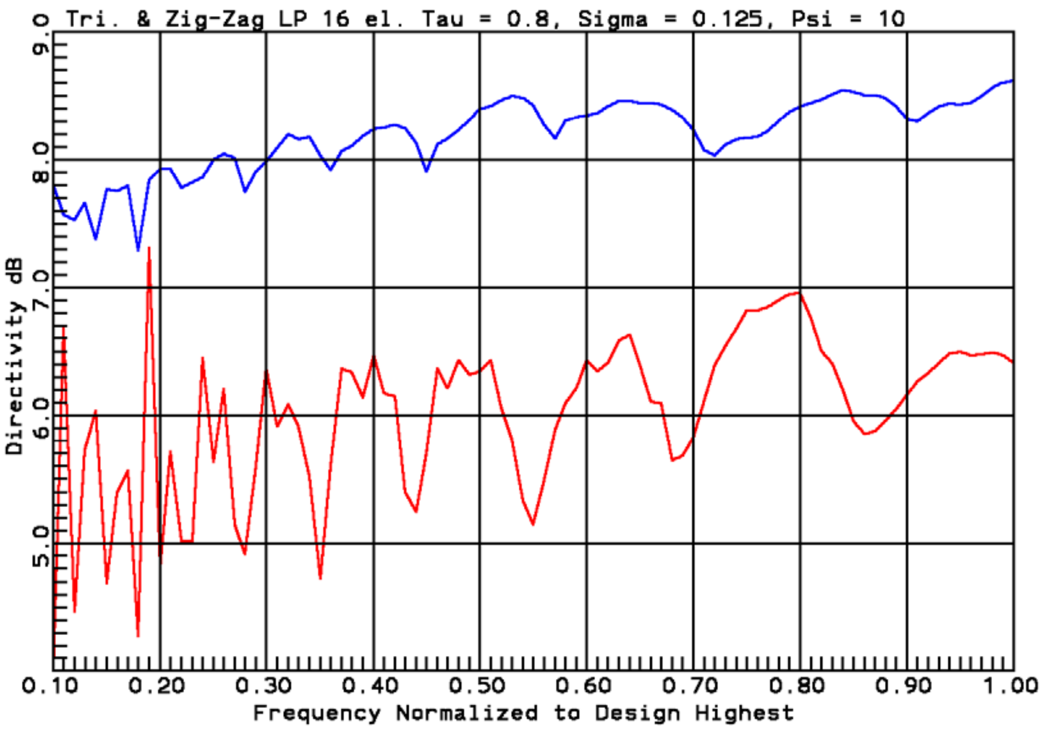

Figure 11-12.6.34 NEC Model of Triangular Tooth LP including Center Feed Rod (blue) and Zig-Zag without center feed line (red)

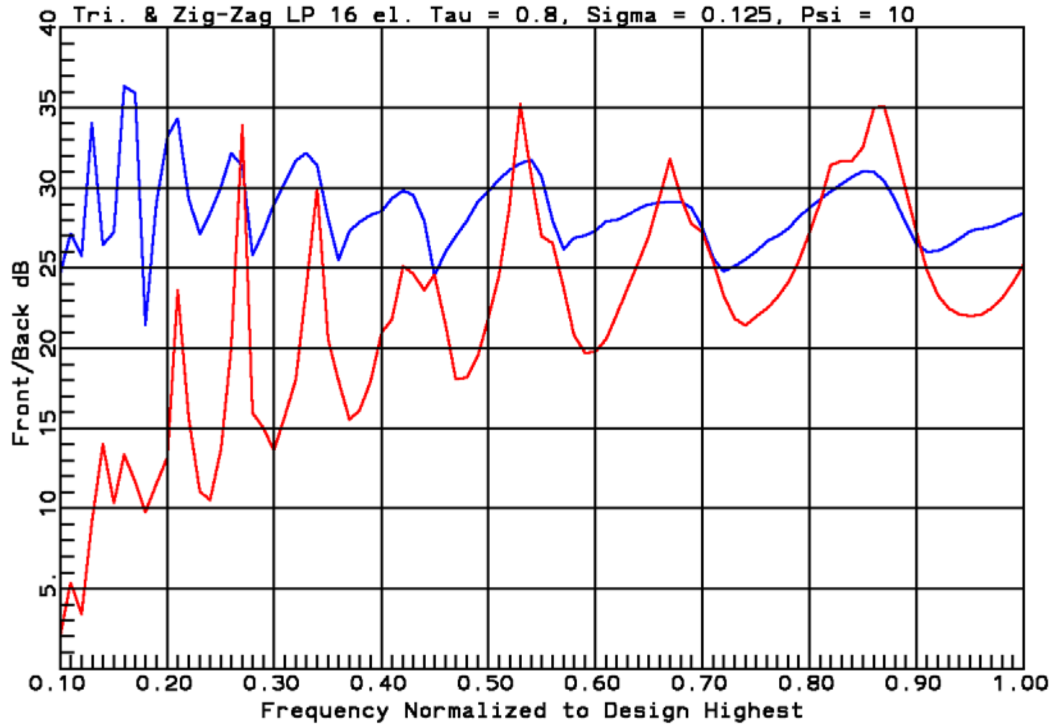

Figure 11-12.6.35 NEC Model of Triangular Tooth LP including Center Feed Rod (blue) and Zig-Zag without center feed line (red)

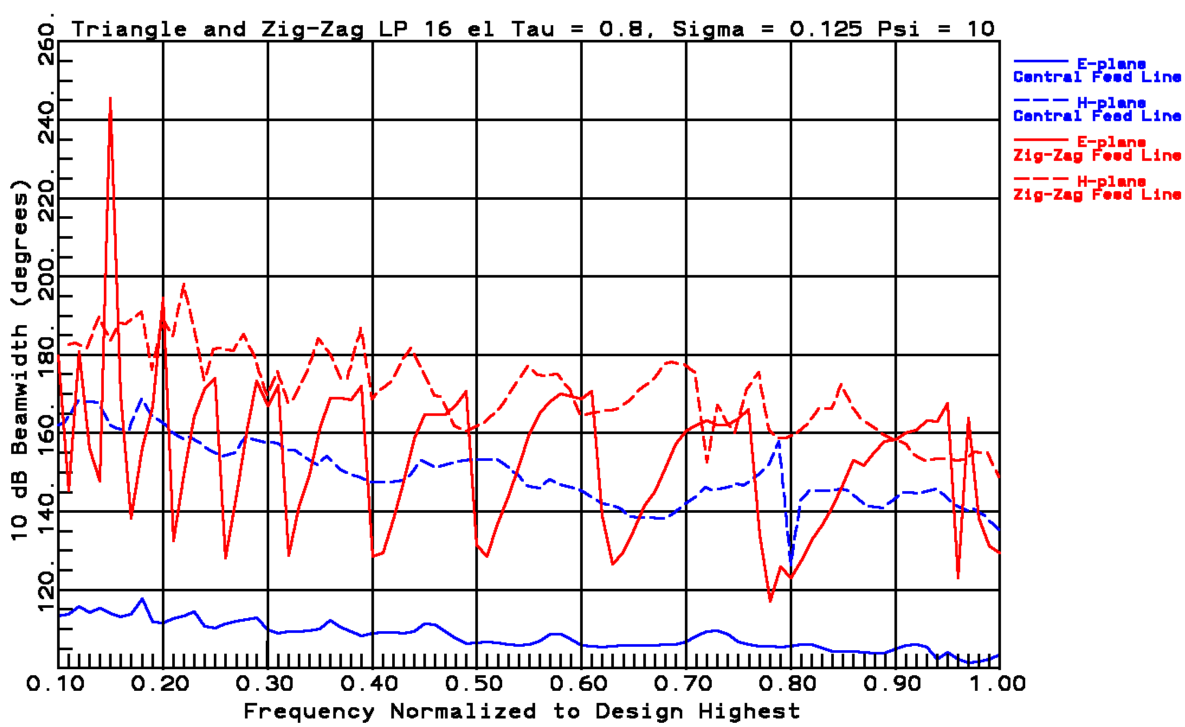

Figure 11-12.6.36 NEC Model of Triangular Tooth LP including Center Feed Rod (blue) and Zig-Zag without center feed line (red)

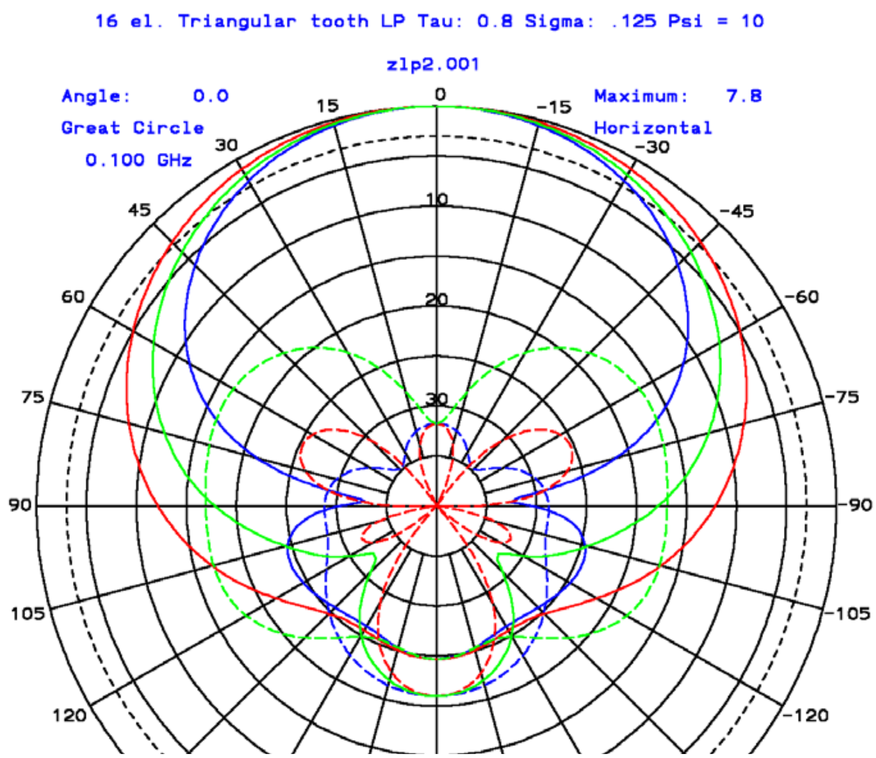

Figure 11-12.6.37 NEC Model of Triangular Tooth LP including Center Feed Rod *E*-plane (blue) *H*-plane (red) *diagonal*-plane (green) 100 MHz

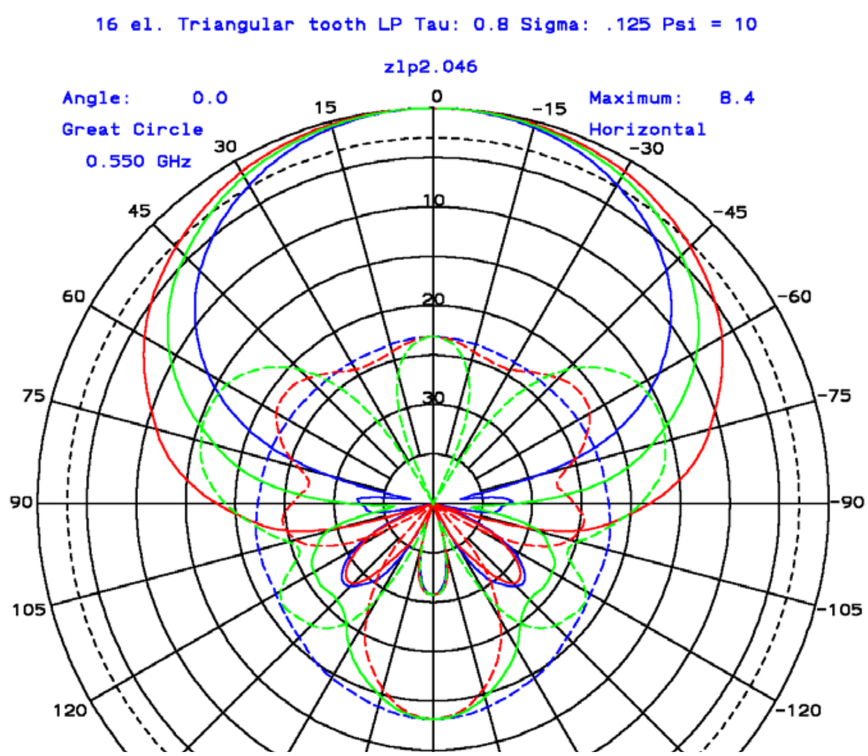

Figure 11-12.6.38 NEC Model of Triangular Tooth LP including Center Feed Rod *E*-plane (blue) *H*-plane (red) *diagonal*-plane (green) 550 MHz

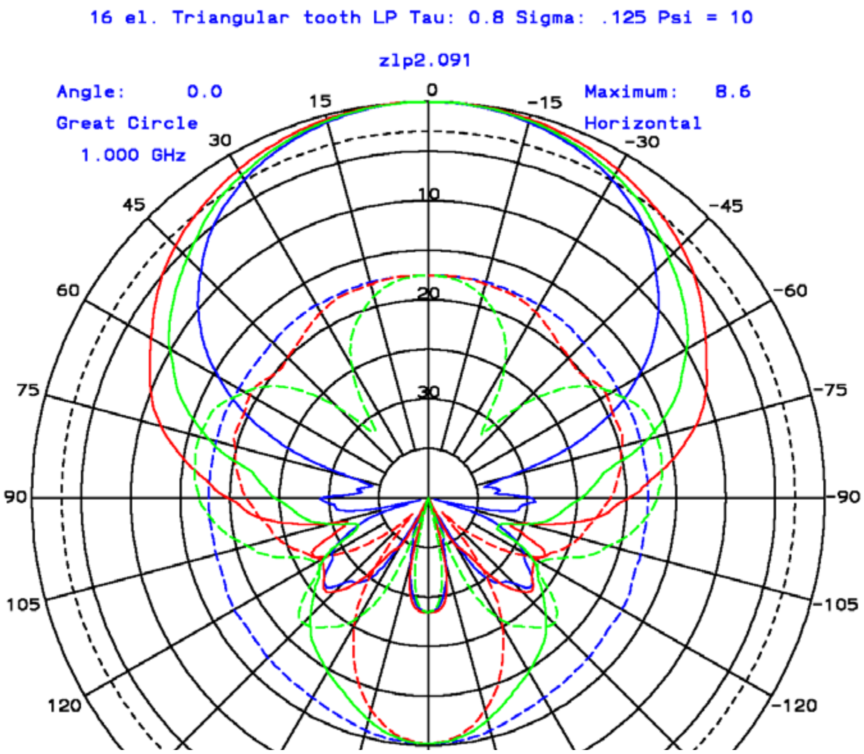

Figure 11-12.6.39 NEC Model of Triangular Tooth LP including Center Feed Rod *E*-plane (blue) *H*-plane (red) *diagonal*-plane (green) 1000 MHz

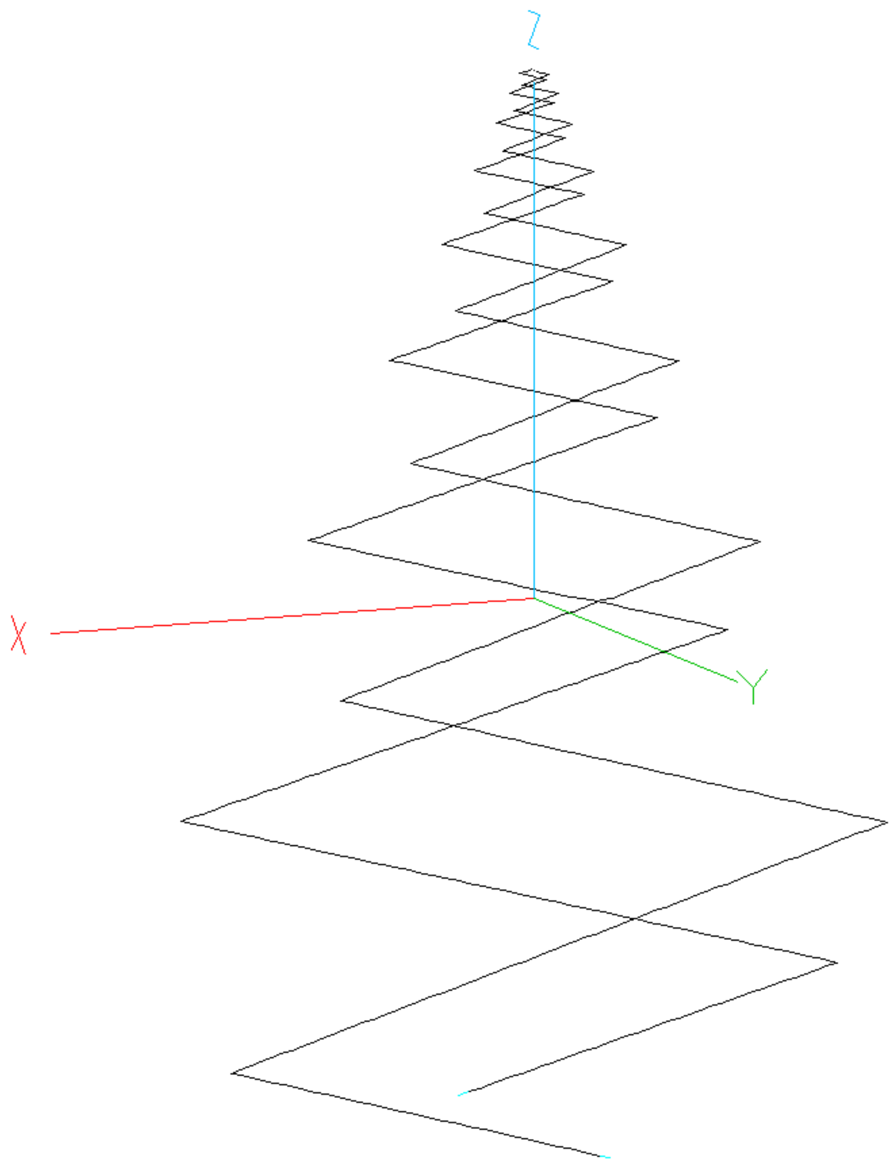

Figure 11-12.6.40 NEC Model of Triangular Tooth LP without Center Wire (zig-zag)

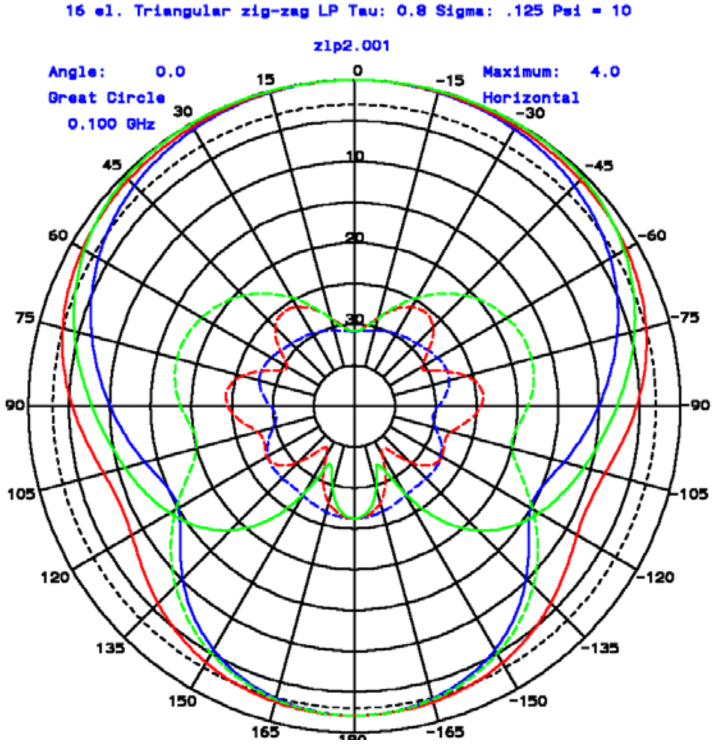

Figure 11-12.6.41 NEC Model of Zig-Zag Triangular Tooth LP without Center Feed Rod *E*-plane (blue) *H*-plane (red) *diagonal*-plane (green) 1000 MHz

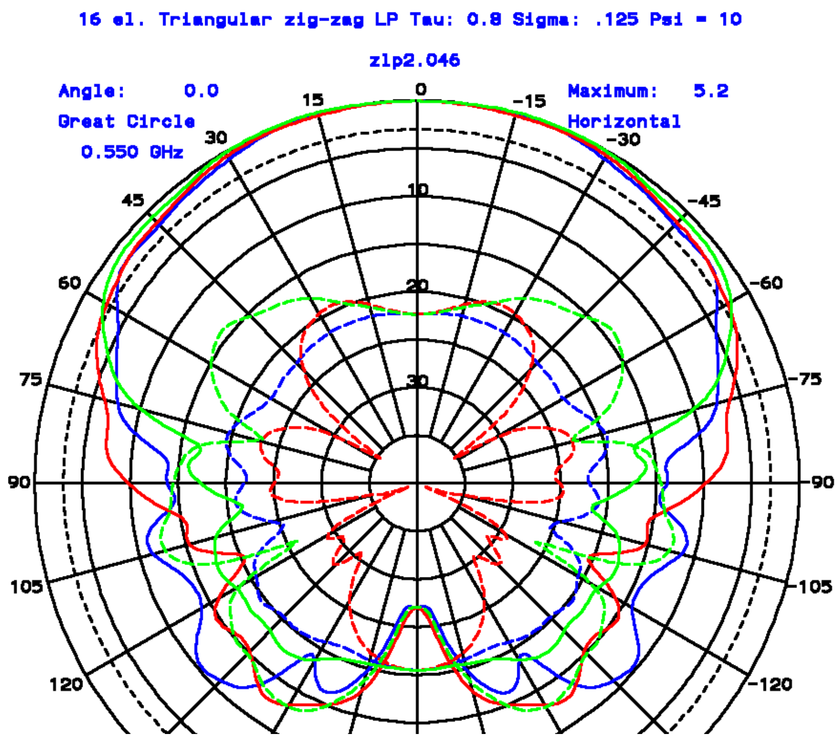

Figure 11-12.6.42 NEC Model of Zig-Zag Triangular Tooth LP without Center Feed Rod *E*-plane (blue) *H*-plane (red) *diagonal*-plane (green) 550 MHz

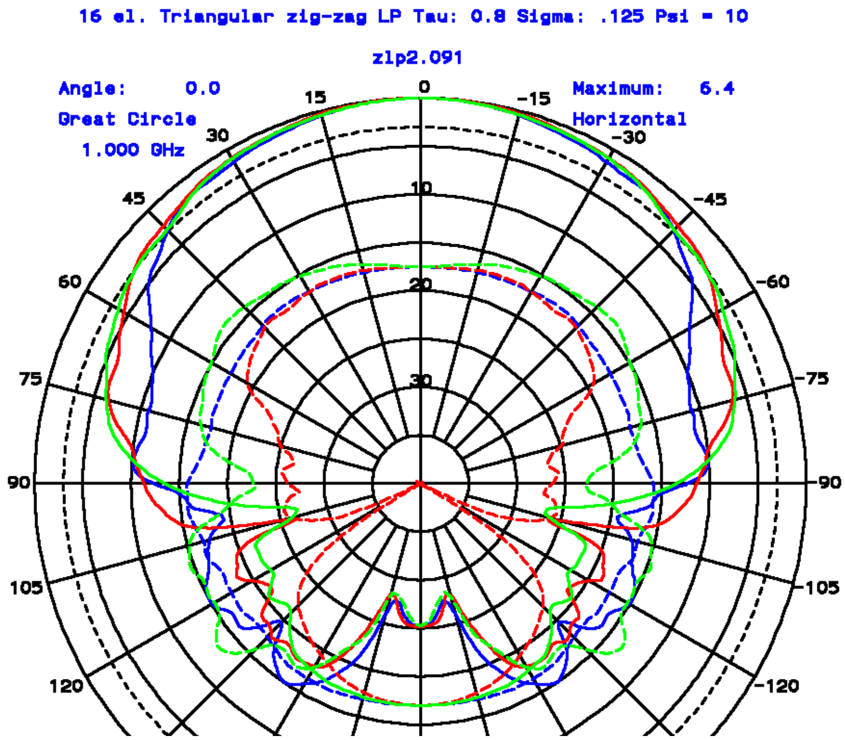

Figure 11-12.6.43 NEC Model of Zig-Zag Triangular Tooth LP without Center Feed Rod *E*-plane (blue) *H*-plane (red) *diagonal*-plane (green) 1000 MHz

The central rod of each arm significantly improves the pattern. While the Zig-Zag antenna will produce a unidirectional pattern, the transmission line formed by the central greatly improves the radiated patterns.

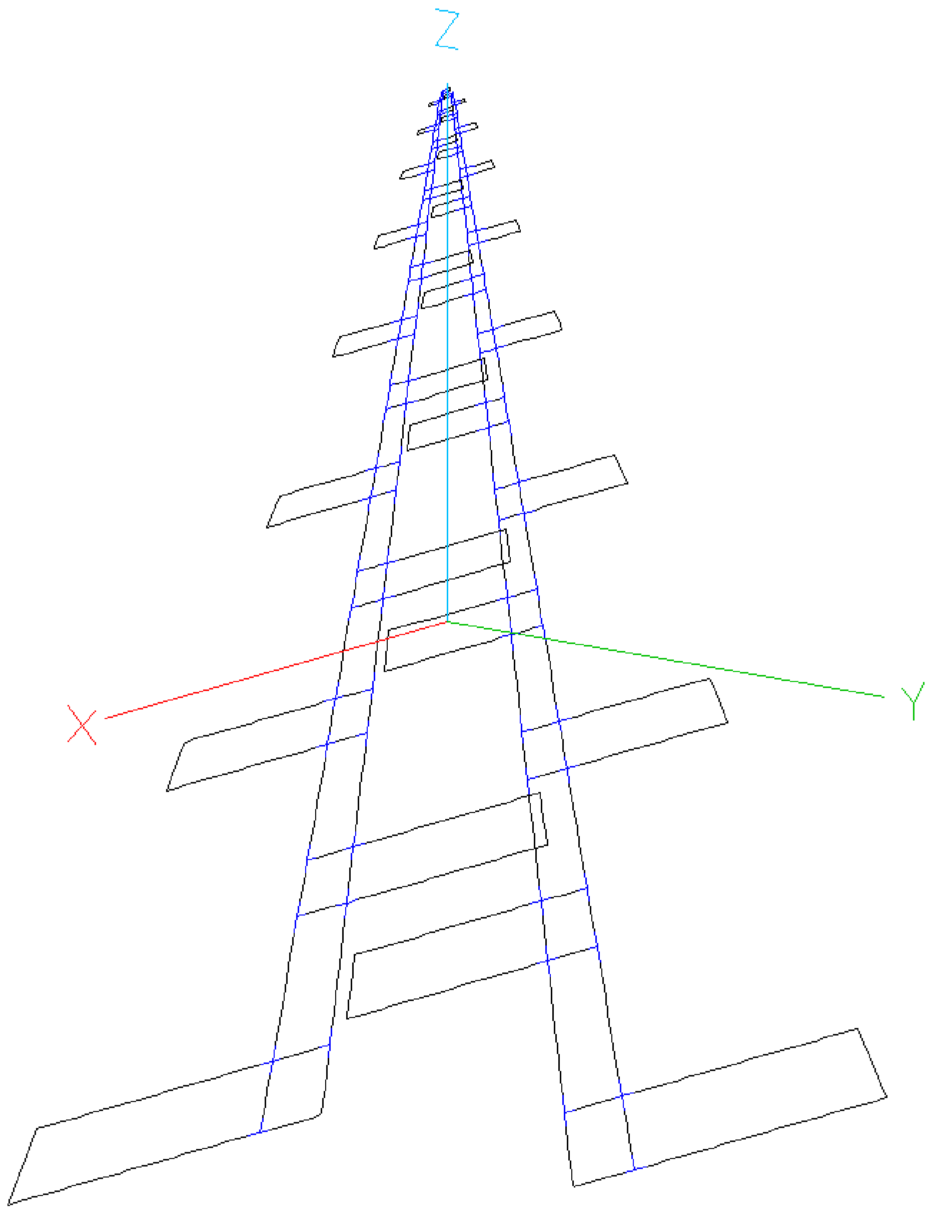

Figure 11-12.6.44 NEC Trapezoidal Tooth LP including Plate Feeder

This model uses edge wire frames for both the elements and feeder plates. The width of the feeder plane is specified by the angle *beta*. TLPNEC generates the NEC geometry file for this antenna. Following is an example of an input file.

```
tlpnec2.nec
1                inches
0                # comments
1                another LP
0.8              Tau
.125             Sigma
16               # elements
```

```
70.2                longest element length
5.8                 longest element width
7.65,.27                  Feeder width: bottom, top
15.24,.54                 Feeder distance bottom, top
0.,0.,-86.42              Base
0.,0.,0.            Rotation angles
3,2,3               Rotation axes
1.4,.1                    Segment length, wire radius
2                   Number of elements
1.,0.               Amplitude, phase
1.,180.                   Amplitude, phase
0                   no more LP
0                   no ground plane
0,91                linear freq step, 21 steps
100,10              frequency start, step MHz
1                   pattern
0,2.,180            Theta  start, step, #
0.,22.5,16          Phi  start, step, #
```

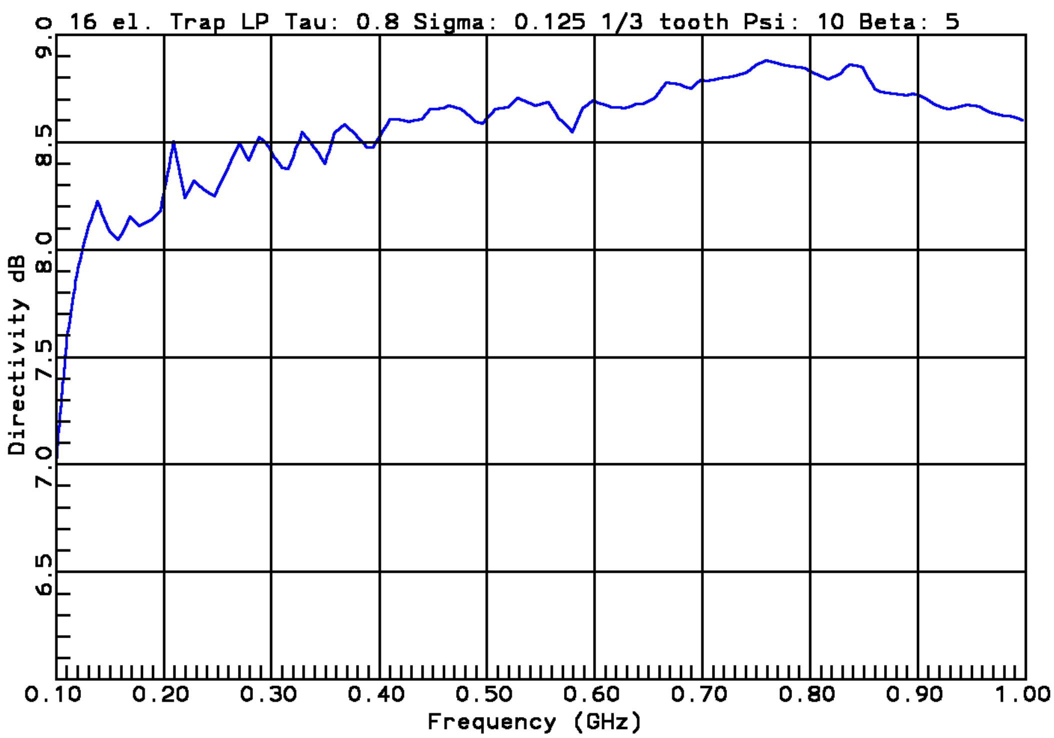

Figure 11-12.6.45 NEC Trapezoidal Tooth LP including Plate Feeder Directivity

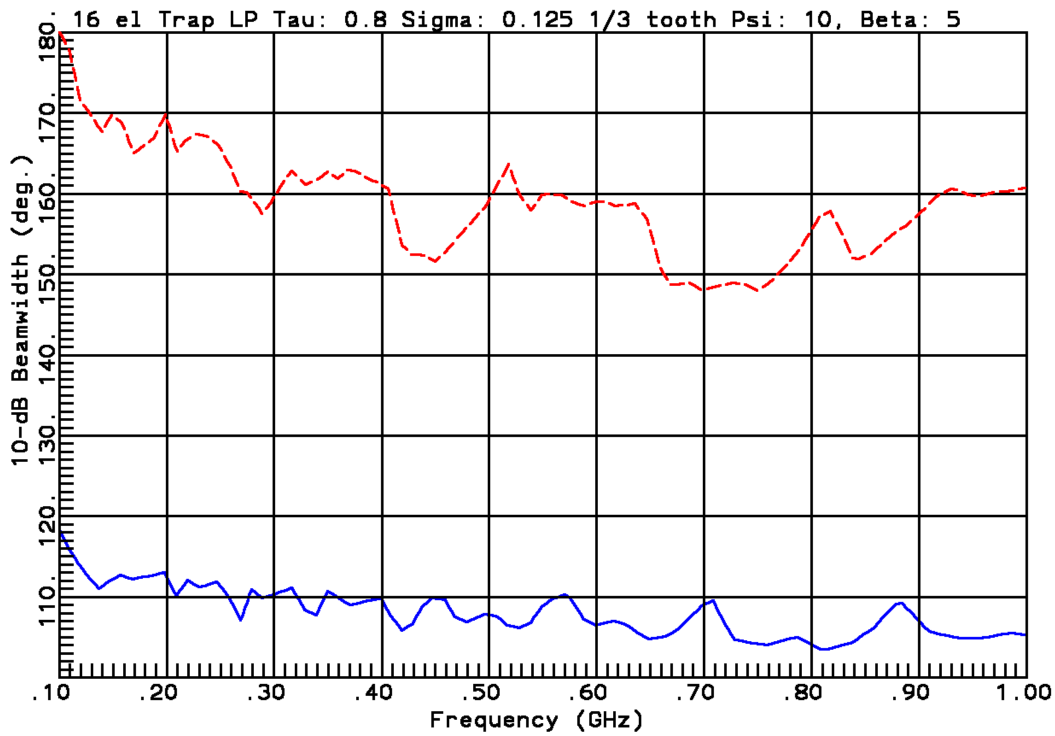

Figure 11-12.6.46 NEC Trapezoidal Tooth LP including Plate Feeder 10-dB Beamwidth *E*-plane (blue) *H*-plane (red)

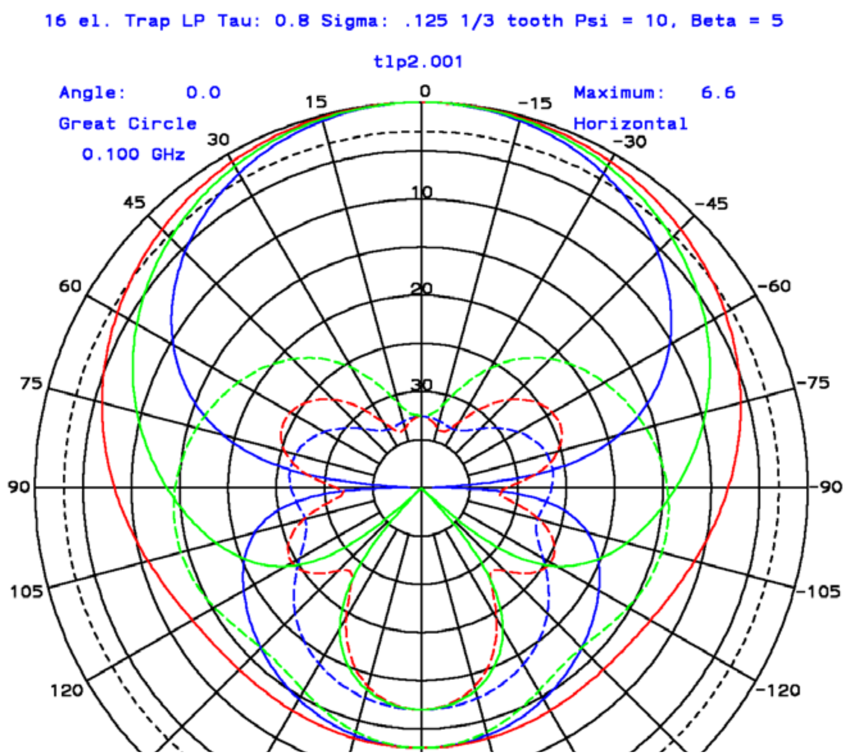

Figure 11-12.6.47 NEC Model of Trapezoidal Tooth LP with Plate Feed Rod *E*-plane (blue) *H*-plane (red) *diagonal*-plane (green) 100 MHz

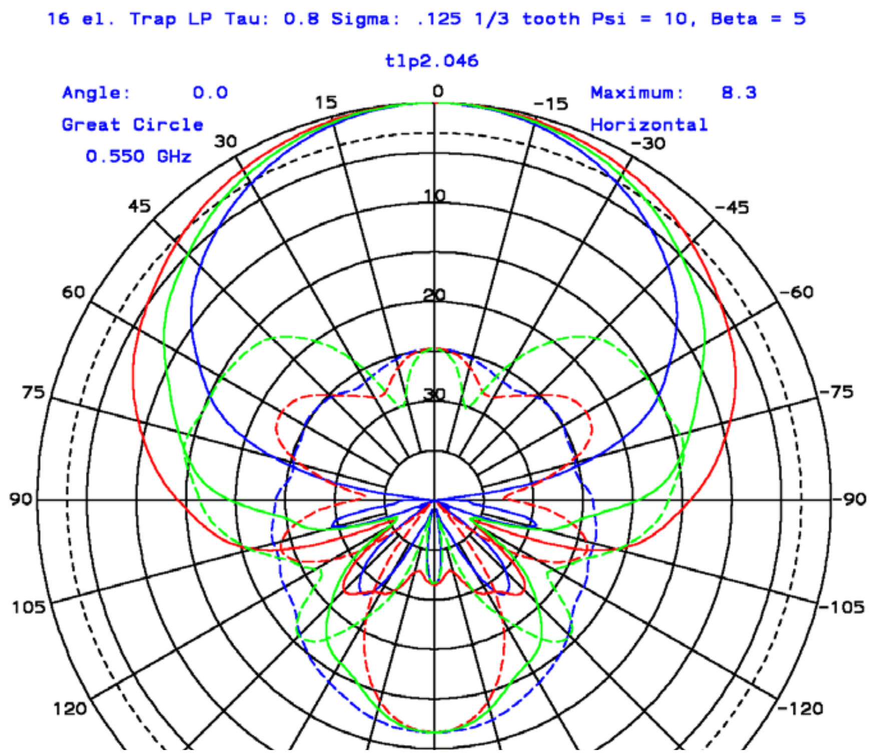

Figure 11-12.6.48 NEC Model of Trapezoidal Tooth LP with Plate Feed Rod *E*-plane (blue) *H*-plane (red) *diagonal*-plane (green) 550 MHz

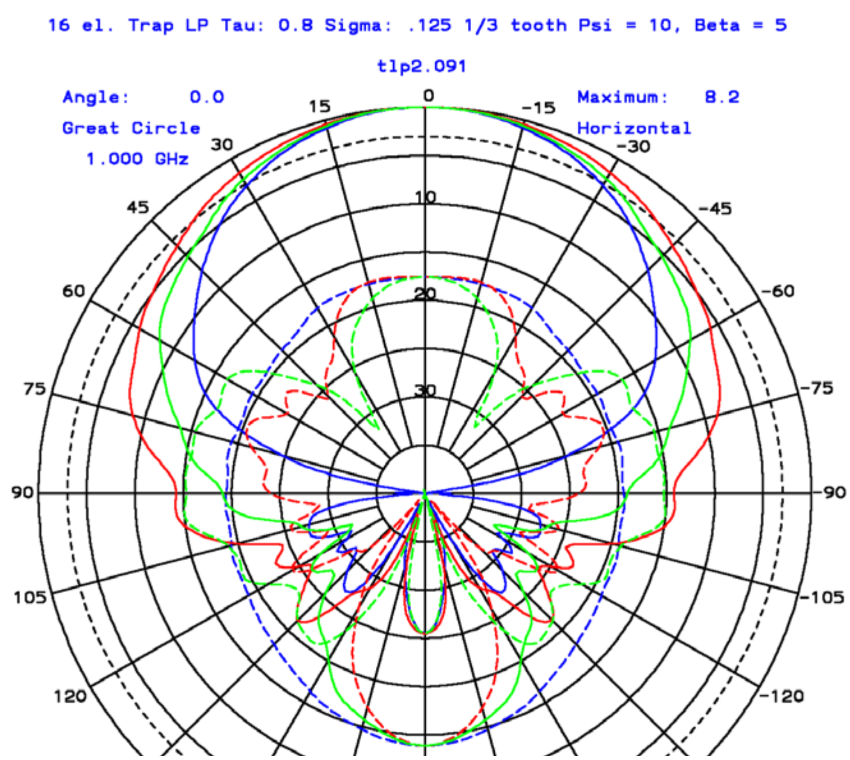

Figure 11-12.6.49 NEC Model of Trapezoidal Tooth LP with Plate Feed Rod *E*-plane (blue) *H*-plane (red) *diagonal*-plane (green) 550 MHz