RX antennas at IV3PRK: End-Fire PENNANTS

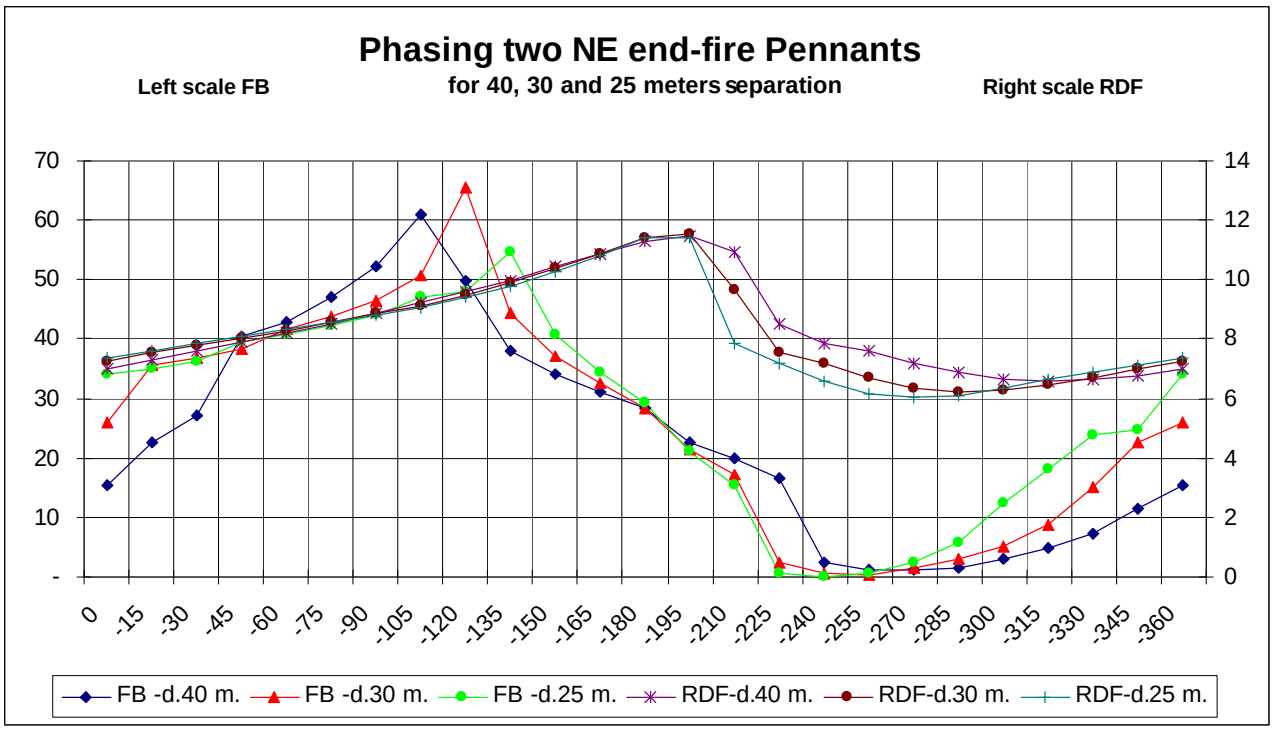
After the Waller Flag failure at the search of better results with wider spacings.

From the promising EZNEC models to the disappointing results

By Pierluigi "Luis" Mansutti IV3PRK

In my "160m. Rx ant. INTERACTIONS" study of October 2004 I had already performed many models with broadside and end-fire phasing with some of my Pennants. Some time ago I had also built all the switching stuff so I decided to try that way again.

The following graph shows that the Front to Back peaks at the phasing of about 120 degrees, but the RDF (the most important parameter) is much better around 180 degrees where the FB is still in the range of 25/30 dB. We see also that the RDF is unaffected by the distance between the two antennas.



Two further Pennants at 30 meters of distance from the existing group will fit nicely within my northern border and let me cover with end-fire feeding the NE and SW directions.

Before going on, I wanted to investigate which is the difference between Flags and Pennants at the same distance, and if could be possible to improve things by adding a Flag in place of a new Pennant.

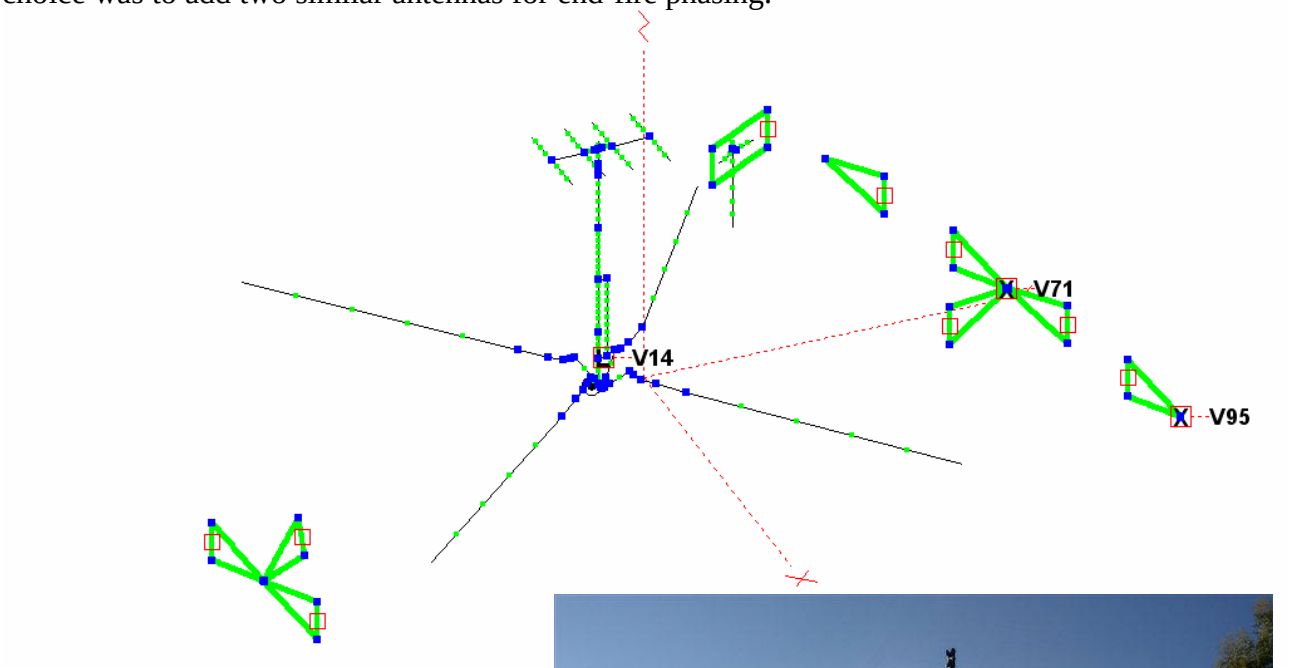
EZNEC says that the only noticeable difference between a single Flag and a Pennant is about 5 dB of more signal output from the Flag, as expected from its better geometric shape and the larger area involved.

File	Load	Gain	TO angle	BW	**FB**	Avg.gain	**RDF**
Pennant standard	858	- 35,32	30	147	**37**	- 43,11	**7,79**
Flag standard	950	- 29,97	30	149	**30**	- 37,73	**7,76**

But feeding together the two different types of antennas is not a good idea as the RDF resulted more than one dB lower. Either both Pennants or both Flags are better, with exactly the same FB and RDF, and with about 5 dB more gain with the Flags.

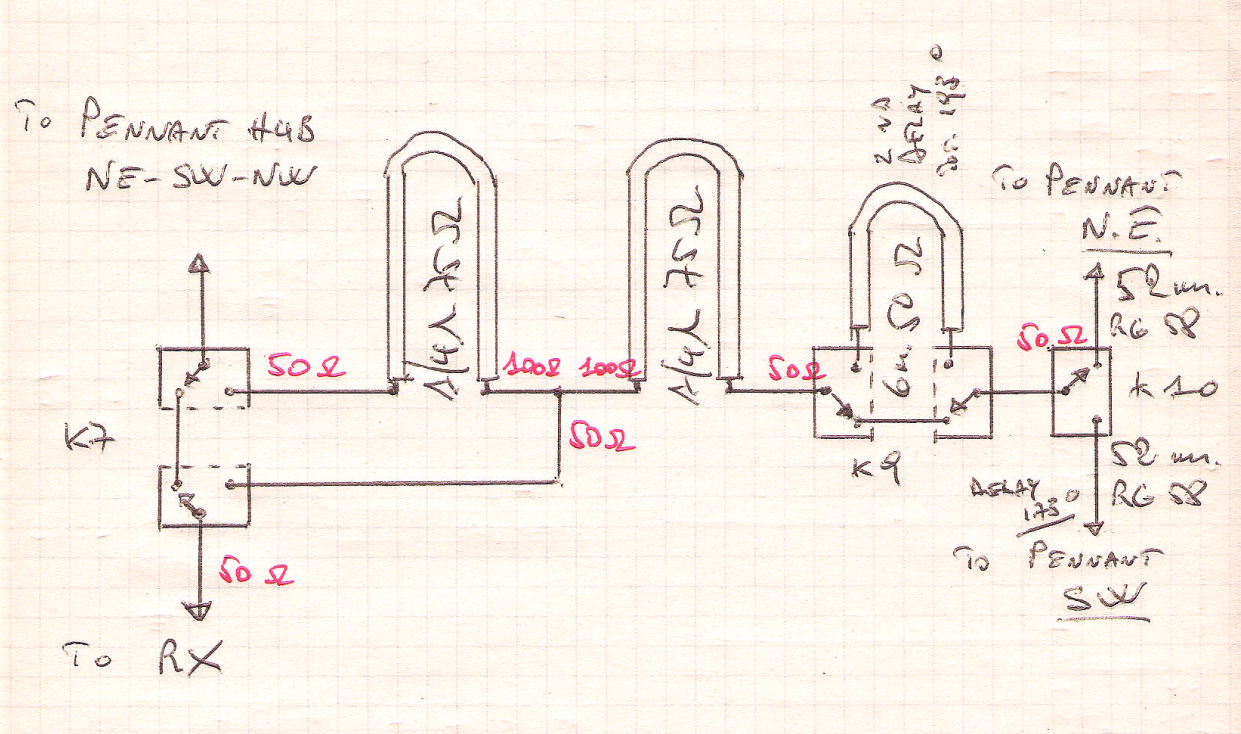
File	Phasing	Gain	TO angle	BW	FB	Avg.gain	RDF
APenn10-NE-2ef	**120**	- 33,68	25	107	**52**	- 43,23	**9,55**
Distance 30,5 m.	**135**	- 34,48	25	100	**42**	- 44,44	**9,96**
Two Pennants	**150**	- 35,47	25	94	**36**	- 45,90	**10,43**
Loads 884 + 884 ohms	**165**	- 36,69	25	87	**32**	- 47,62	**10,93**
	180	- 38,23	25	80	**28**	- 49,61	**11,38**
Pennant+ Flag	**120**	- 30,21	30	113	**43**	- 39,45	**9,24**
Load 884 + 900	**135**	- 30,79	25	106	**38**	- 40,29	**9,50**
	150	- 31,52	25	101	**36**	- 41,27	**9,75**
	165	- 32,44	25	97	**33**	- 42,37	**9,93**
	180	- 33,58	25	92	**30**	- 43,49	**9,91**
Two Flags	**120**	- 28,33	25	107	**37**	- 37,84	**9,51**
Load 900 + 900	**135**	- 29,07	25	101	**34**	- 38,97	**9,90**
	150	- 30,03	25	95	**32**	- 40,40	**10,37**
	165	- 31,31	25	87	**29**	- 42,20	**10,89**
	180	- 32,97	25	79	**27**	- 44,35	**11,38**

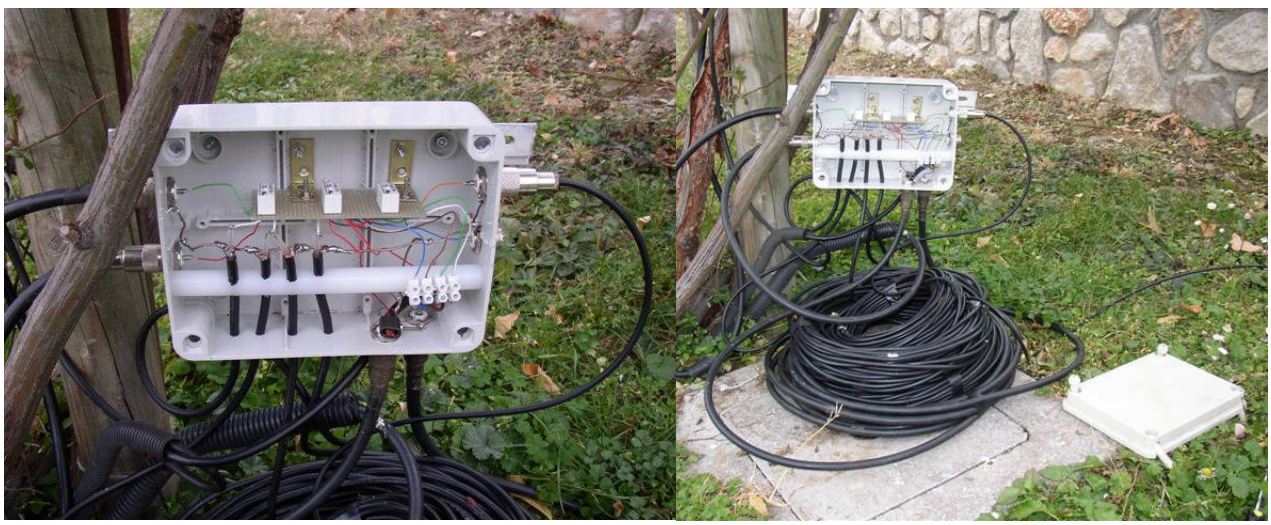
So, as it is much easier to switch two or more point fed Pennants from a single hub, my choice was to add two similar antennas for end-fire phasing.



Added new Pennant:
Dimensions: m. 2,15 + 2,15 + 9,1 + 9,10
Transformer: 2 x 8 turns on Binocular BN73-202
Load resistor: 858 ohms
RF choke: 12 turns of RG58 coax through two FT140-J (on V95)

This is the switching-phasing circuit

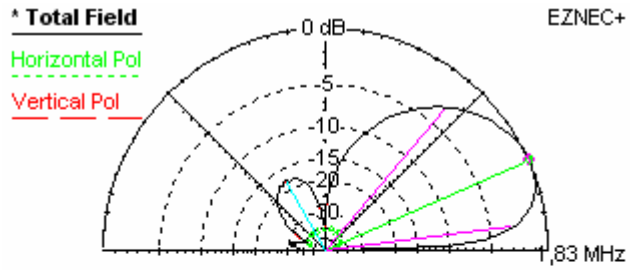




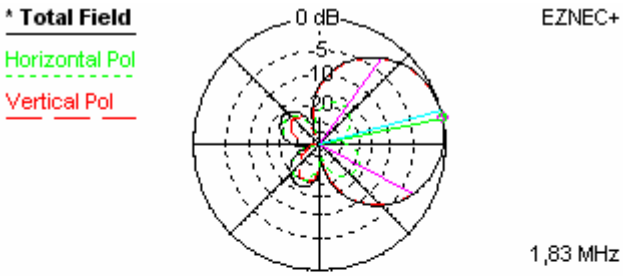
As definitive phasing lines I choose 52 meters of 50 ohm RG58 (equivalent to 173 degrees) with the possibility to add a piece of further 6 meters, thus switching from 173 to 193 degrees.

File	**Phasing**	Line length	Gain	TO angle	BW	**FB**	Avg.gain	**RDF**
Two End-fed Pennants	**153°**	46 m.	- 36,18	24	92	**36**	- 46,76	**10,58**
30 m. separation	**173°**	52 m.	- 38,00	24	82	**40**	- 49,27	**11,27**
Load 858+858 ohms	**193°**	58 m.	- 40,66	22	72	**33**	- 52,26	**11,60**
	201°	60,4 m.	- 42,03	20	67	**26**	- 53,19	**11,16**

At shorter phasing lines the RDF is too low, while at longer delays the pattern worsens with increasing secondary lobes both in the vertical and in the horizontal plane, as well shown in the next Eznec plots.

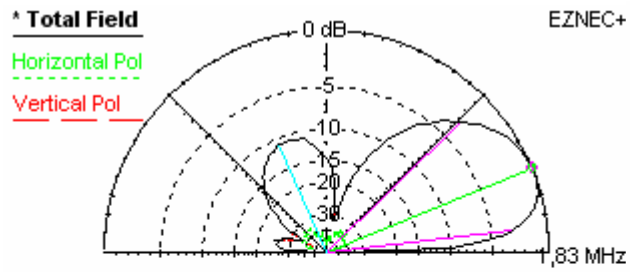


Elevation Plot		Cursor Elev	24,0 deg.
Bearing	78,0 deg.	Gain	-38,0 dBi
Outer Ring	-38,0 dBi		0,0 dBmax
			0,0 dBmax3D
3D Max Gain	-38,0 dBi		
Slice Max Gain	-38,0 dBi @ Elev Angle = 24,0 deg.		
Beamwidth	42,6 deg.; -3dB @ 7,1, 49,7 deg.		
Sidelobe Gain	-55,62 dBi @ Elev Angle = 120,0 deg.		
Front/Sidelobe	17,61 dB		

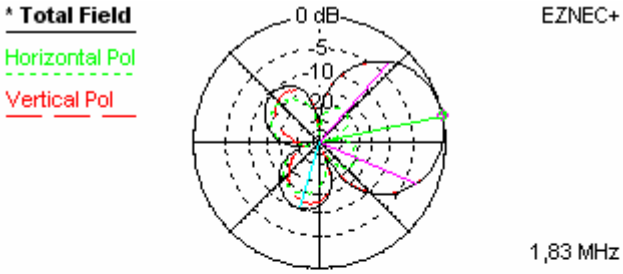


Azimuth Plot		Cursor Bear	78,0 deg.
Elevation Angle	24,0 deg.	Gain	-38,0 dBi
Outer Ring	-38,0 dBi		0,0 dBmax
			0,0 dBmax3D
3D Max Gain	-38,0 dBi		
Slice Max Gain	-38,0 dBi @ Bearing = 78,0 deg.		
Front/Back	39,81 dB		
Beamwidth	82,5 deg.; -3dB @ 35,7, 118,2 deg.		
Sidelobe Gain	-38,04 dBi @ Bearing = 74,0 deg.		
Front/Sidelobe	0,04 dB		

Distance: 30 m. - Phasing line: 173 degrees (m. 52 of RG58 coax)

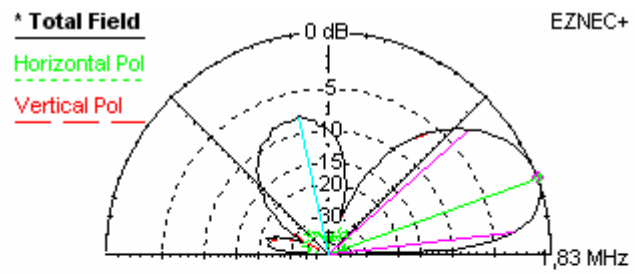


Elevation Plot		Cursor Elev	22,0 deg.
Bearing	78,0 deg.	Gain	-40,66 dBi
Outer Ring	-40,66 dBi		0,0 dBmax
			0,0 dBmax3D
3D Max Gain	-40,66 dBi		
Slice Max Gain	-40,66 dBi @ Elev Angle = 22,0 deg.		
Beamwidth	37,7 deg.; -3dB @ 6,8, 44,5 deg.		
Sidelobe Gain	-51,51 dBi @ Elev Angle = 114,0 deg.		
Front/Sidelobe	10,85 dB		

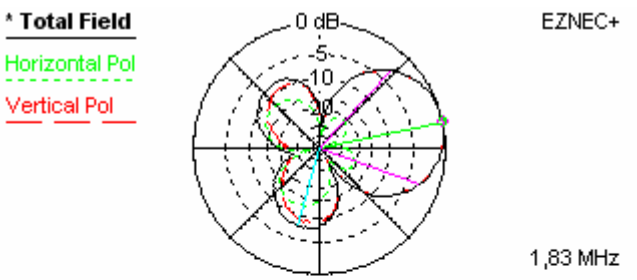


Azimuth Plot		Cursor Bear	78,0 deg.
Elevation Angle	22,0 deg.	Gain	-40,66 dBi
Outer Ring	-40,66 dBi		0,0 dBmax
			0,0 dBmax3D
3D Max Gain	-40,66 dBi		
Slice Max Gain	-40,66 dBi @ Bearing = 78,0 deg.		
Front/Back	33,15 dB		
Beamwidth	71,6 deg.; -3dB @ 41,2, 112,8 deg.		
Sidelobe Gain	-51,03 dBi @ Bearing = 196,0 deg.		
Front/Sidelobe	10,36 dB		

Distance: 30 m. - Phasing line: 193 degrees (m. 52 RG58 + m. 6.10 RG8)

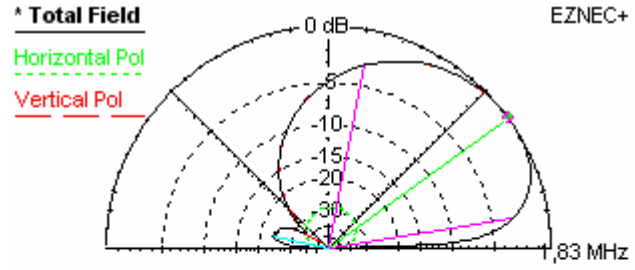


Elevation Plot		Cursor Elev	20,0 deg.
Bearing	78,0 deg.	Gain	-42,03 dBi
Outer Ring	-42,03 dBi		0,0 dBmax
			0,0 dBmax3D
3D Max Gain	-42,03 dBi		
Slice Max Gain	-42,03 dBi @ Elev Angle = 20,0 deg.		
Beamwidth	35,1 deg.; -3dB @ 6,6, 41,7 deg.		
Sidelobe Gain	-49,93 dBi @ Elev Angle = 102,0 deg.		
Front/Sidelobe	7,9 dB		

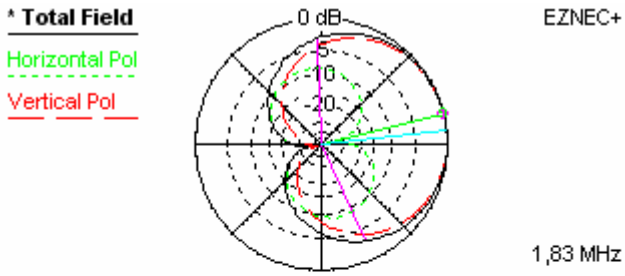


Azimuth Plot		Cursor Bear	78,0 deg.
Elevation Angle	20,0 deg.	Gain	-42,03 dBi
Outer Ring	-42,03 dBi		0,0 dBmax
			0,0 dBmax3D
3D Max Gain	-42,03 dBi		
Slice Max Gain	-42,03 dBi @ Bearing = 78,0 deg.		
Front/Back	26,33 dB		
Beamwidth	66,9 deg.; -3dB @ 43,2, 110,1 deg.		
Sidelobe Gain	-49,66 dBi @ Bearing = 196,0 deg.		
Front/Sidelobe	7,63 dB		

Distance: 30 m. - Phasing line: 201 degrees (m. 52 RG58 + m. 8.40 RG8)



Elevation Plot		Cursor Elev	36,0 deg.
Bearing	76,0 deg.	Gain	-33,04 dBi
Outer Ring	-33,04 dBi		0,0 dBmax
			0,0 dBmax3D
3D Max Gain	-33,04 dBi		
Slice Max Gain	-33,04 dBi @ Elev Angle = 36,0 deg.		
Beamwidth	69,5 deg.; -3dB @ 9,1, 78,6 deg.		
Sidelobe Gain	-56,49 dBi @ Elev Angle = 168,0 deg.		
Front/Sidelobe	23,45 dB		



Azimuth Plot		Cursor Bear	76,0 deg.
Elevation Angle	36,0 deg.	Gain	-33,04 dBi
Outer Ring	-33,04 dBi		0,0 dBmax
			0,0 dBmax3D
3D Max Gain	-33,04 dBi		
Slice Max Gain	-33,04 dBi @ Bearing = 76,0 deg.		
Front/Back	36,51 dB		
Beamwidth	157,8 deg.; -3dB @ 358,2, 156,0 deg.		
Sidelobe Gain	-33,05 dBi @ Bearing = 84,0 deg.		
Front/Sidelobe	0,01 dB		

Single Pennant

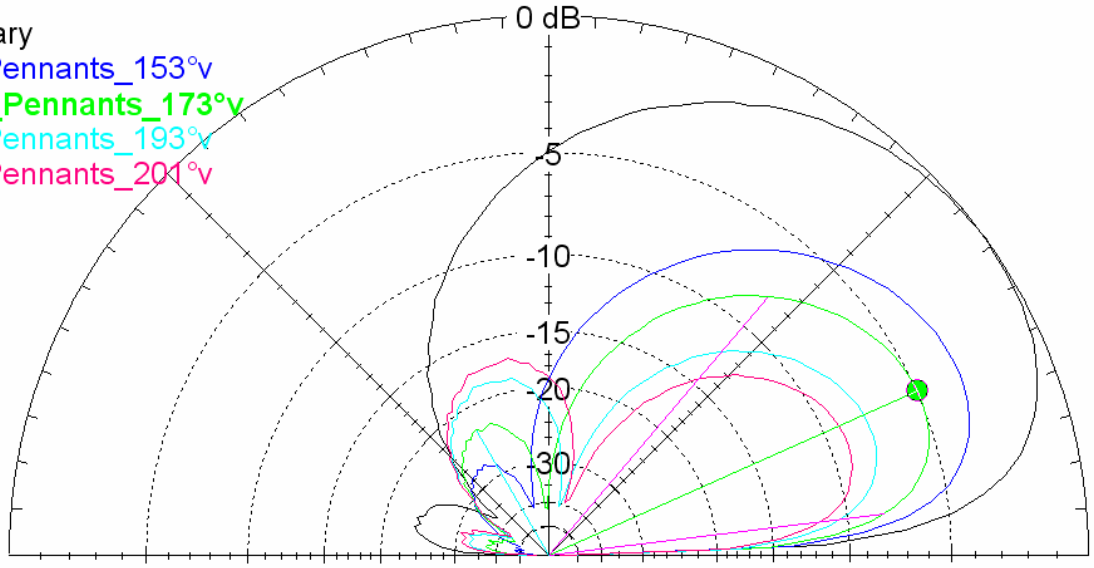
The following plots better show the difference between the wider black lobes of the single Pennant and the incorporated colored traces of the end-fed two elements.

The highlighted one is for 173 degrees phasing which shows a -5 dB gain in the forward direction, but a much more reduction at the higher angles and thus the resulting increase in the Receiving Directivity Factor.

But those are the EZNEC modelling results only!
In the reality, despite the correct impedance transformation and the perfect 1:1 SWR obtained, I never found an A-B test where the phased Pennants were better than the rotatable Flag and my final comment is: another negative experience with a lot of work was not worth ….at least <u>until I don't take down the four elevated radials and use an on ground radial system !</u>

Total Field EZNEC+

Primary
EF_Pennants_153°v
* EF_Pennants_173°v
EF_Pennants_193°v
EF_Pennants_201°v



1,83 MHz

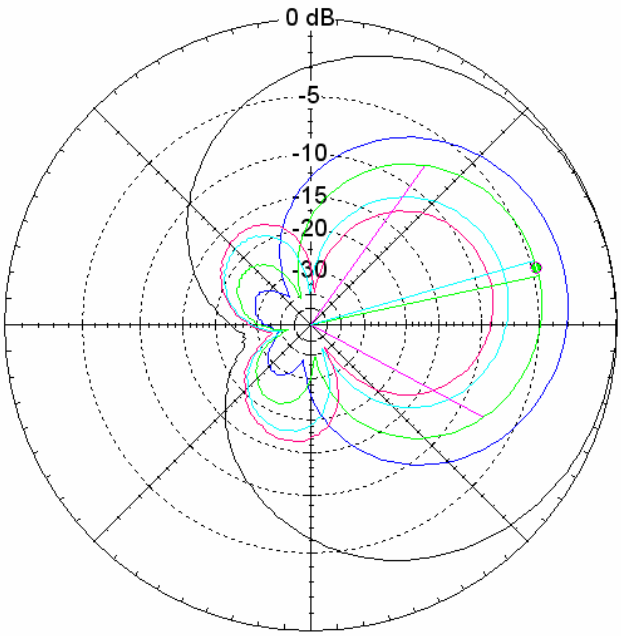
Elevation Plot
Bearing 90,0 deg.
Outer Ring -33,04 dBi

3D Max Gain -33,04 dBi
Slice Max Gain -38,0 dBi @ Elev Angle = 24,0 deg.
Beamwidth 42,6 deg.; -3dB @ 7,1, 49,7 deg.
Sidelobe Gain -55,62 dBi @ Elev Angle = 120,0 deg.
Front/Sidelobe 17,61 dB

Cursor Elev 24,0 deg.
Gain -38,0 dBi
0,0 dBmax
-4,66 dBPrTrc

Total Field EZNEC+

Primary
EF_Pennants_153°h
* EF_Pennants_173°h
EF_Pennants_193°h
EF_Pennants_201°h



1,83 MHz

Azimuth Plot
Elevation Angle 0,0 deg.
Outer Ring -33,34 dBi

3D Max Gain -33,04 dBi
Slice Max Gain -38,0 dBi @ Bearing = 78,0 deg.
Front/Back 39,81 dB
Beamwidth 82,5 deg.; -3dB @ 35,7, 118,2 deg.
Sidelobe Gain -38,04 dBi @ Bearing = 74,0 deg.
Front/Sidelobe 0,04 dB

Cursor Bear 76,0 deg.
Gain -38,04 dBi
-0,04 dBmax
-4,7 dBPrTrc