Extending the 2-Meter OWA Family
Part 2: Gain, Element Population, and Hybrid Designs

L. B. Cebik, W4RNL (SK)

We concluded the first section of this report on the extended (13-20 elements) OWA family with a list of curiosities. The curiosities related to limitations of gain performance of the extended series relative to other wide-band long-boom Yagis, where "long-boom" represents an approximate 6-wavelength boom. They are also related to the formation of sidelobes on various design types.

It is worth repeating the table that compares the gain growth of the OWA series with the gain growth of a DL6WU-type array, since the boom lengths for each new element--while not exactly the same--are quite comparable.

. . . .

Change of Gain per Added Element

Note: Free-space gain values taken at 146 MHz, which is not the peak gain for either antenna series, but a representative mid-band value. Boom lengths for each value are comparable, but not exactly the same. 20-element boom length for the OWA series is 41.83' and for the DL6WU series is 40.52'. Hence, the comparison is suggestive, but not definitive.

Antenna	OWA Series		DL6WU Series	
Elements	**Gain (dBi)**	**Delta Gain**	**Gain (dBi)**	**Delta Gain**
12	14.35	-----	14.70	-----
13	14.64	0.29	15.22	0.52
14	14.84	0.20	15.62	0.40
15	15.04	0.20	15.91	0.29
16	15.19	0.15	16.20	0.29
17	15.32	0.13	16.52	0.32
18	15.42	0.10	16.85	0.33
19	15.52	0.10	17.13	0.28
20	15.61	0.09	17.34	0.21

. . . .

As is evident, the rate of gain increase generally decreases for both beam types as the total number of elements increases. This follows from the fact, first made clear by Lawson, that the overall gain is a function of boom length more than the number of elements, so long as we have a minimum element population needed to provide performance over a desired operating bandwidth. Each new element, with roughly equal spacing between the forward-most 6 elements or so, adds a smaller percentage increment of boom length. Hence, the rate of increase per element is less as we increase the total number of elements.

More notably for our present situation is the fact that the rate of increase of gain per element in the OWA series is only about half (or less) that of the DL6WU-type series. Hence, by the 20th element or a boom length just in excess of 6 wavelengths, the OWA series shows a 1.73 dB deficit in gain relative to the DL6WU-type series. (The number is overly precise, given the conditions of comparison listed at the top of the table. However, it is certainly indicative of the deficit level.)

We initially traced the gain deficit to the lower level of relative current magnitude on the forward directors of the array--at least as that level compares to the relative current magnitude on the directors of other Yagi series in the same boom-length ballpark. As we can see in **Fig. 1**, where the maximum array current magnitudes are roughly equal in strength, the DL6WU-type and the VK3AUU-type arrays show considerably higher forward director maximum current levels.

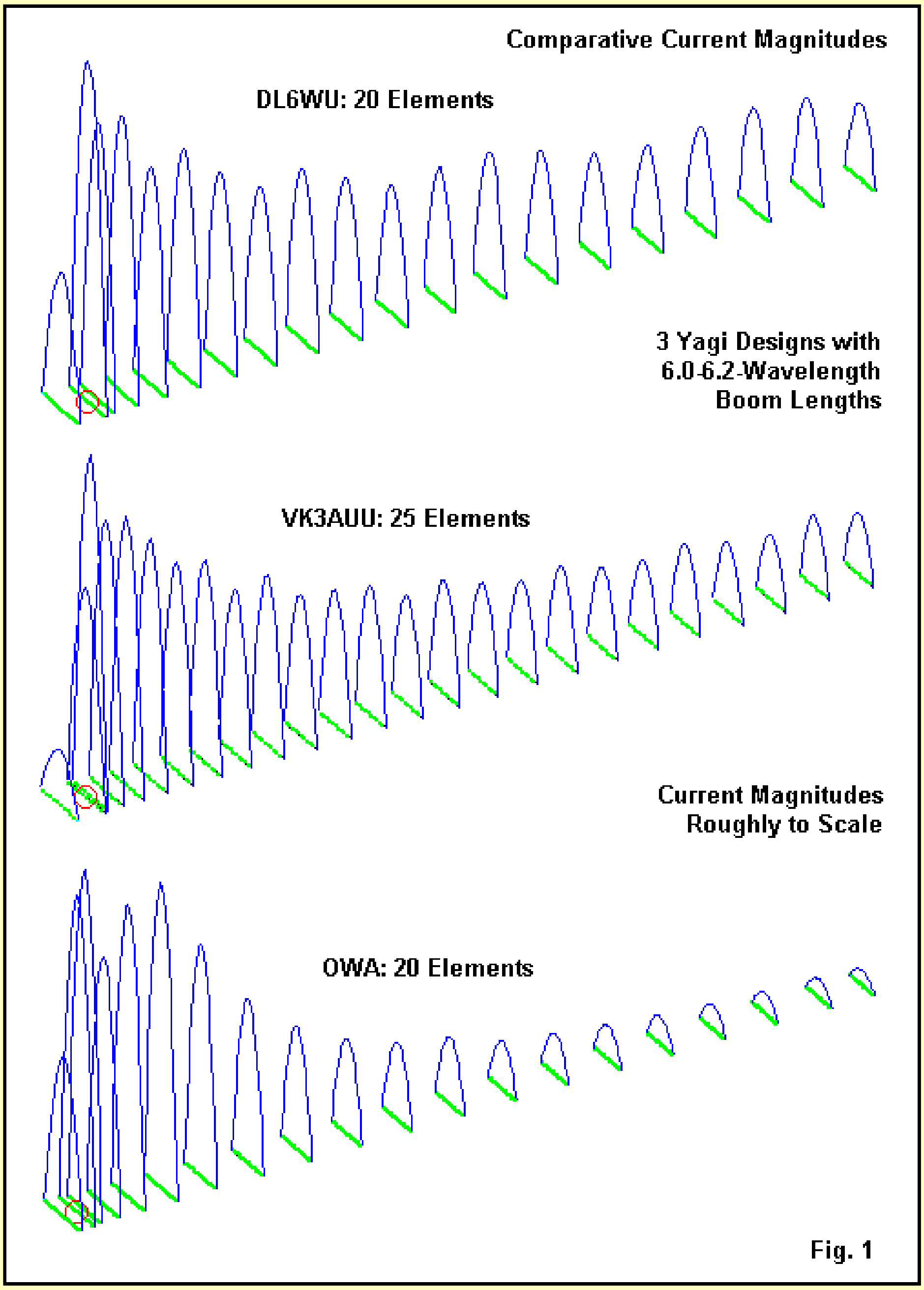

Fig. 1

Related to the gain deficit for a given boom-length is the development of sidelobes. As a general rule of thumb, the number of sidelobes on each side of the forward main lobe--and the number of rear sidelobes on each side of the main rear lobe--will be roughly equal to the boom length in wavelengths when we reduce that length to an integer value. Hence, we expect to see 6 forward and 6 rearward sidelobes on each side of the main array axis.

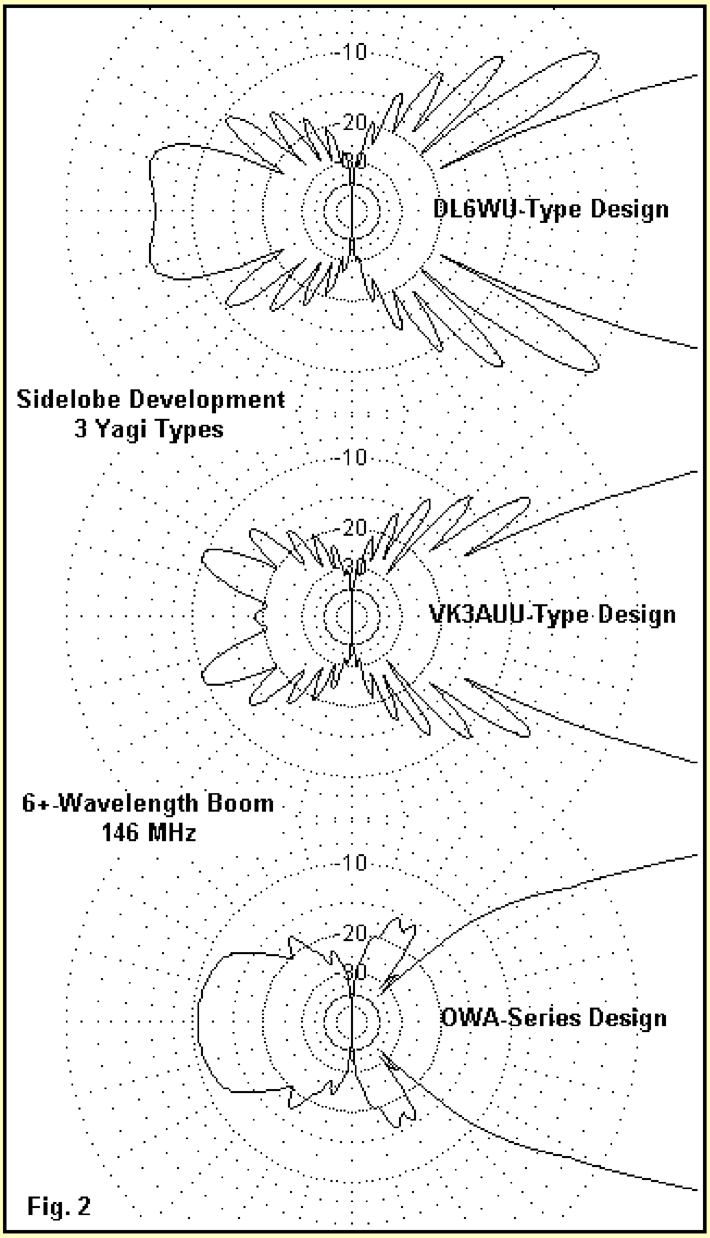

Fig. 2

Fig. 2 shows the sidelobe development of 6-wavelength boom DL6WU-type and VK3AUU-type arrays. Although the newest sidelobe close to 90-degrees off the main forward bearing is very small, even in the expanded patterns in the figure, we can count 6 clear lobes for both antennas. The rear sidelobes also add up to 6, although the main rear lobe of the DL6WU pattern is obscured by the fact that the first sidelobe on each side is so much stronger than the main or 180-degree lobe that we have the impression of a mere depression. However, if that main rear lobe were truly minuscule or missing, the rear gain 180-degrees opposite the main forward lobe would show a deep depression.

The OWA series sample, also with a 6-wavelength boom, is an exception to this general rule of thumb. At most, we might count 4 forward sidelobes and perhaps 3 rear sidelobes on each side of the pattern. As well, we may note that the first forward sidelobe is very much weaker than the second and third sidelobes. Indeed, for all three arrays, the sidelobe strengths are directly comparable. The VK3AUU-type array uses 25 elements on its 6-wavelength boom to significantly reduce sidelobe strength relative to the DL6WU-type array, even though both have roughly the same forward gain. However, the OWA series at the same boom length effects not only a suppression of sidelobe formation, but as well reduces the sidelobe strength even further. Also, it does so with 20 elements--that same number as in the DL6WU-type array.

At the simplest level, we might leave matters as they stand. The OWA series of Yagis sacrifices gain for the sake of a cleaner pattern with fewer sidelobes and weaker ones as well. We might even attribute that condition to the combined effects of the OWA core--with its critical first 5 elements (Reflector through Director 3)--and to the method of adding new elements to restore both the 50-Ohm SWR curve and the low level of sidelobe development. However, even these propositions leave us with a number of questions.

- 1. Which of the two OWA design concepts--the core or the method of adding new elements--has the dominant effect on side-lobe development?
- 2. Is there a method of obtaining more gain from the OWA series without sacrificing sidelobe suppression and attenuation?
- 3. What role does element population play in sidelobe attenuation?

None of these questions is simple, especially in light of the fact that the method of investigation will involve comparisons among available Yagi designs. We have used the DL6WU-type design as one kind of standard because it has a long and respected history. W1JR and K1FO designs have similar performance levels, especially with respect to gain and sidelobe development, although they use different algorithms for generating new elements along the boom. Hence, for 20 elements on a 6-wavelength boom, the DL6WU-type antenna will form one axis of comparison. By way of contrast, the newer VK3AUU-type design--less familiar to Yagi builders--achieves considerable sidelobe attenuation, apparently from the higher element density for a given boom length. It packs 25 elements on a 6-wavelength boom and reduces forward sidelobe to more than 20 dB down from the main forward lobe. Hence, it raises the third question in our list and requires comparison to both the OWA series and the DL6WU series.

Add to the relativity and complexity of comparisons another factor--the variety of methods by which we might achieve higher OWA series (and other series) gain levels. We may use fatter elements to increase the level of coupling between elements, but even this technique is subject to certain requirements to have any positive effect. We may also use different algorithms for new-director placement. The simplest way of approaching this technique is to create some hybrid designs. We may graft the forward directors onto the OWA core. Here, we may use the first seven OWA elements, since at the transition between elements 7 and 8 (director 5 and 6), we find the closest correlation of element lengths for both the DL6WU and the VK3AUU arrays. The hybrid may go some distance in letting us know whether the array gain is limited by the core or by the method of adding OWA directors. In addition, it may give us some insight into whether the core or the new directors are chiefly responsible for the suppression of new sidelobes and the attenuation of existing sidelobes.

The exploration will not be at all a neat progression. We shall have to backtrack and cross our own trail numerous times along the way. We shall also be dealing with numerous standard and non-standard variations on the original designs from our comparators. In a modeling jungle, we can only go where the undergrowth permits.

As a marker, the DL6WU designs are the work--before any of my modifications--of Guenter Hoch, the renown developer of long-boom Yagis for VHF and UHF work. His efforts are too well-known to require a full record. VK3AUU is David Tanner, whose work is more recent and involves different techniques of achieving wide-band performance and sidelobe attenuation than the ones used by earlier designers. I have adapted David's designs directly from models that he has personally shared with me. My DL6WU designs come from 3 sources. One is the basic program DL6WU-G, which has been the developed over the years by the efforts of KY4Z, W6NBI, G3SEK, and DL6WU himself. There is another DL6WU GW Basic program called antdl6wu.bas, developed by WA2TIF on the heels of previous developments by a large number of contributors. More recent is an EXCEL spreadsheet initially developed by VK3AUU. I have used all of these programs in generating models of DL6WU-type arrays for this study. Since many of the designs involve adaptations to the needs of this study, tracing one or another to a specific program may be difficult. But all of this is part of the undergrowth.

Let's begin by examining the antennas used for comparisons a bit more closely.

The Comparators

The DL6WU long-boom Yagi series has gone through several stages of evolution. The examples used here derive from an initially scaled 432-MHz model that resulted in 11.8-mm or 0.466" diameter elements. When I ran the 20-element model through the dl6wu-g.bas program, the returns were insignificantly different from the scaling. I then ran a 4-mm or 0.1575" diameter version of the antenna through the program to arrive at new dimensions. In all cases, the DL6WU design uses the same element spacing. Differences in element diameter answer to a set of equations for deriving the element reactance and from that figure and the new diameter, deriving new element lengths. The equations appear in the RSGB publication *The VHF/UHF DX Book*, edited by Ian White, G3SEK, and are replicated in an article at my web site on scaling VHF and UHF arrays (../vhf/scales.html). As well, George Murphy has encapsulated them in a convenient utility among his HAMCALC GW Basic suite, now available for download from the *CQ Magazine* web site.

The following table provides the dimensions of the two models whose element diameters show an almost 3:1 ratio.

. . . .

20-Element DL6WU Yagis: Element Lengths Only Re-scaled

Note: Element spacing is the same for both versions, resulting in a 6.02-wavelength boom. Both versions are derived with only minor adjustments from the program dl6wu-g.bas. All dimensions in inches.

	Cumulative	**Element Diameter**	
Element	**Spacing**	**0.1575" (4 mm)**	**0.466" (11.8 mm)**
Reflector	**----**	**39.78**	**39.68**
Driver	**16.17**	**39.16**	**38.44**
Director 1	**22.23**	**36.39**	**35.13**
Director 2	**36.78**	**36.09**	**34.85**
Director 3	**54.17**	**35.75**	**34.44**
Director 4	**74.37**	**35.41**	**34.04**
Director 5	**97.01**	**35.11**	**33.69**
Director 6	**121.26**	**34.85**	**33.36**
Director 7	**146.73**	**34.62**	**33.11**
Director 8	**173.41**	**34.42**	**32.87**
Director 9	**201.30**	**34.24**	**32.66**
Director 10	**230.43**	**34.07**	**32.48**
Director 11	**260.71**	**33.93**	**32.32**
Director 12	**292.24**	**33.80**	**32.15**
Director 13	**324.58**	**33.67**	**32.01**
Director 14	**356.92**	**33.56**	**31.90**
Director 15	**389.27**	**33.46**	**31.78**
Director 16	**421.58**	**33.35**	**31.66**
Director 17	**453.92**	**33.26**	**31.55**
Director 18	**486.26**	**33.18**	**31.45**

. . . .

Immediately apparent is the fact that the 18th director shows a much larger differential in length relative to the two element diameters than the reflector. Since the element reactance increases as it shortens, the length adjustment becomes larger. Had the reflector been longer than about a resonant half-wavelength, then the fatter version would have actually been longer than the thinner one.

By keeping a constant relative reactance in each element, the mutual coupling between elements remains close to the same as we move from one element diameter to another. We can observe this from the similarity of modeled performance reports for the two antennas.

. . . .

Modeled Performance: 20-Element DL6WU Yagis

4-mm Diameter Elements

Parameter	**144 MHz**	**146 MHz**	**148 MHz**
Gain dBi	**16.70**	**17.34**	**17.62**
180-deg F-B	**17.53**	**23.74**	**17.23**
Front-Sidelobe	**16.11**	**17.03**	**17.23**
Impedance (R+/-jX)	**55.4 - j 6.1**	**50.9 + j 6.9**	**68.1 + j 4.1**
50-Ohm SWR	**1.17**	**1.15**	**1.37**

11.8-mm Diameter Elements

Parameter	**144 MHz**	**146 MHz**	**148 MHz**
Gain dBi	**16.90**	**17.45**	**17.68**
180-deg F-B	**18.44**	**25.56**	**20.80**
Front-Sidelobe	**16.46**	**17.19**	**17.23**
Impedance (R+/-jX)	**52.2 - j 8.4**	**50.4 + j 5.0**	**68.0 + j 0.5**

50-Ohm SWR	**1.19**	**1.10**	**1.36**

. . . .

The fatter element version shows an average gain advantage of only about 0.12 dB, which is quite insignificant. Because we have used such a large change of diameter (3:1) between versions, the equations begin to lose their precision. They are best applied to element diameter ratios of about 1.5:1, especially for narrow-band designs. They are successful in wide-band designs for diameter ratios up to about 2:1. A sign that we have in the DL6WU design an operating bandwidth that is larger than normal, even for standard wide-band designs--and yet have reached or surpassed the limits of adequacy for length adjustment--appears in the 180-degree front-to-back figures. Here, the fat-element version shows a clear advantage that borders on being operationally detectable.

More recently, VK3AUU has proposed a different algorithm for calculating the required element lengths and spacing for long-boom Yagis. His arrangement uses a considerably different reflector-driver-director-1 arrangement to achieve wide-band operation in terms of the 50-Ohm SWR. As well, he employs a higher element population per unit of boom-length in order to attenuate sidelobe development. His original array that he shared with me used 41 10-mm diameter elements on a 24-meter boom. I have cut off the design at 20 elements and changed the element diameter to 3/16" (0.1875"). The resulting array underwent further adjustments to yield the model used here for comparisons. The following table shows the modeled dimensions. Of course, anything of merit in the design belongs to VK3AUU, and any deficiencies belong to my adjustments.

. . . .

25-Element VK3AUU Yagi

Note: Model derived from a 41-element original with 10-mm diameter elements. All dimensions in inches. Boom length is 6.11 wavelengths.

Element	Cumulative Spacing	Element Diameter 0.1875"
Reflector	**----**	**40.41**
Driver	**16.10**	**40.60**
Director 1	**18.88**	**37.15**
Director 2	**28.63**	**36.66**
Director 3	**41.29**	**36.23**
Director 4	**56.01**	**35.81**
Director 5	**72.34**	**35.38**
Director 6	**89.95**	**35.03**
Director 7	**108.69**	**34.68**
Director 8	**128.38**	**34.39**
Director 9	**148.93**	**34.04**
Director 10	**170.21**	**33.83**
Director 11	**192.16**	**33.54**
Director 12	**214.77**	**33.33**
Director 13	**237.94**	**33.12**
Director 14	**261.63**	**32.91**
Director 15	**285.84**	**32.70**
Director 16	**310.49**	**32.55**
Director 17	**335.58**	**32.34**
Director 18	**361.07**	**32.20**
Director 19	**386.96**	**32.06**
Director 20	**413.21**	**31.99**
Director 21	**439.83**	**31.85**
Director 22	**466.76**	**31.71**
Director 23	**494.03**	**31.63**

. . . .

Because the driver and first director make up a closely coupled element pair that constitutes the actual array driver, the driver is actually longer than the reflector. Nonetheless, the remaining elements show a regular, although not simple, increment of length decrease. The array packs 25% more elements on about the same boom length as used in the DL6WU 20-element arrays. The resulting modeled performance appears in the following table.

. . . .

Modeled Performance: 25-Element VK3AUU Yagi

0.1875" Diameter Elements

Parameter	**144 MHz**	**146 MHz**	**148 MHz**
Gain dBi	**16.91**	**17.22**	**17.27**
180-deg F-B	**25.00**	**35.65**	**23.61**
Front-Sidelobe	**20.10**	**22.28**	**24.17**
Impedance (R+/-jX)	**56.4 + j 2.7**	**59.6 + j 3.9**	**49.6 + j 6.6**
50-Ohm SWR	**1.14**	**1.21**	**1.14**

. . . .

Perhaps the most significant feature of the performance figures are the higher front-to-sidelobe ratios all across the band, relative to the figures for the DL6WU array. The difference becomes visually apparent by a review of **Fig. 2**.

We may appreciate the design goal differences between the DL6WU arrays and the VK3AUU Yagi by looking at a few overlaid curves. **Fig. 3** shows the anticipated free-space gain values derived from frequency sweeps of all three models. Although the DL6WU antennas show a higher peak value, note the rather narrow range of the Y-axis. In practical terms, both antennas fit the same operational ballpark.

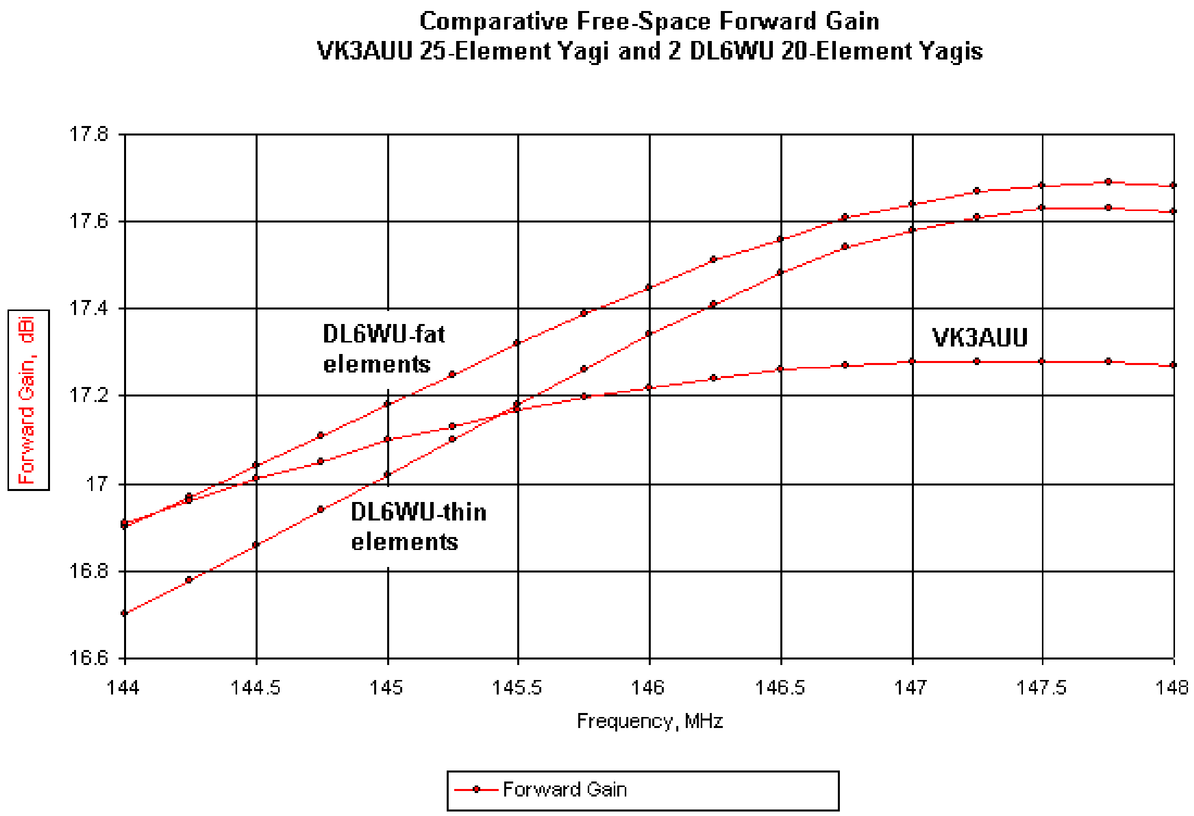

Fig. 3

As wide-band designs, the DL6WU values do not necessarily fall as we move beyond the high band edge, although we seem to see a peak just below that frequency. The DL6WU designs have multiple gain, front-to-back, and SWR peaks and valleys, and their relative positions on a frequency sweep vary with the number of elements in the design. The VK3AUU design shows a much narrower range of gain variation over the 2-meter band, with a peak that also is close to the upper passband limit.

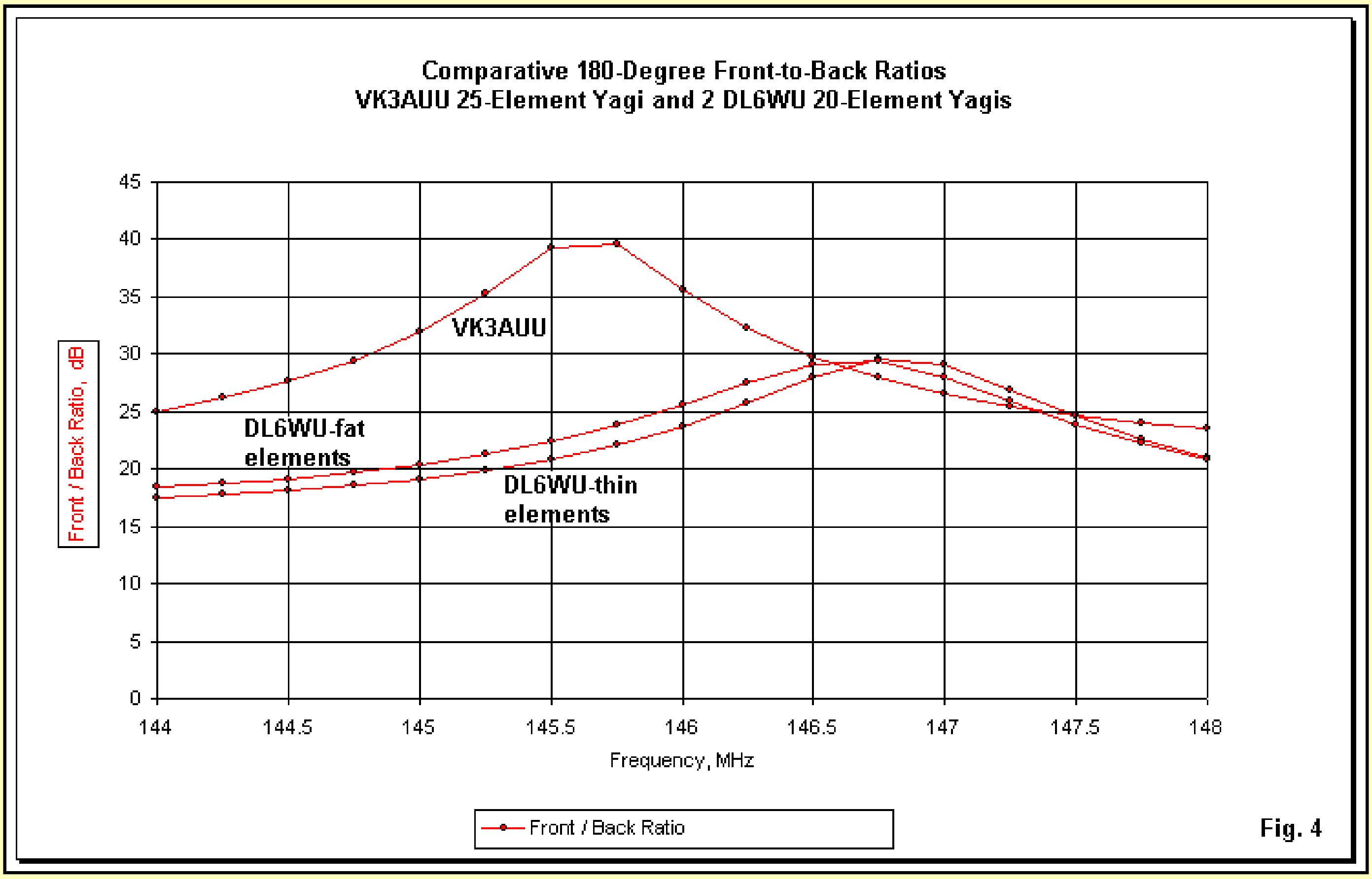

Fig. 4 shows that the VK3AUU 180-degree front-to-back peak values occur close to the design center for the array--146 MHz. The DL6WU peak values are but one of several peaks within the overall operating passband for the array, and the frequency position and peak values vary with the number of elements. 20 elements is not one of the recommended array sizes for peak front-to-back performance, although it is the size required for comparison with the largest of the OWA series developed so far.

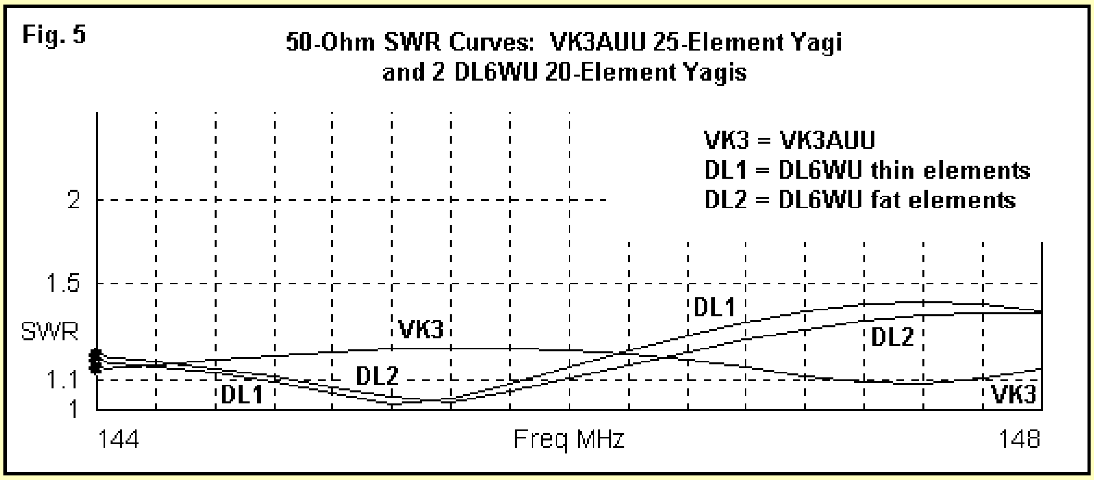

Fig. 5 overlays the 50-Ohm SWR curves for the three modeled comparators. Like the gain and front-to-back curves for the DL6WU Yagis, the SWR curves show a relatively close coincidence, with just enough departure to indicate the limits of the length adjustment equations. The VK3AUU curve shows that it is possible to obtain less than 1.25:1 SWR at 50 Ohms across the entire 2-meter band with proper spacing of the reflector, driver, and first director, without need for special treatment of the subsequent 2 directors, as is done in the OWA array.

The VK3AUU array achieves about the same gain as the DL6WU, but with better than 20 dB values for both the 180-degree front-to-back ratio and the front-to-sidelobe ratio. However, the VK3AUU array design shows all of the sidelobes typical for a 6-wavelength boom, but attenuated relative to the DL6WU (and similar designs). It does not show any sidelobe suppression, that is, a failure for the sidelobes to emerge.

This feature of the VK3AUU array permits us to answer at least one of our questions: whether the OWA core or the method of adding new elements is responsible in the main for the sidelobe suppression that we find in the 20-element, 6-wavelength boom version. To answer the question, we shall need to create some hybrids.

A Tale of Two Hybrids

The most direct--but far from the simplest--way to sort out the effects of the OWA core from the effects of the method of adding elements to the OWA series 6-wavelength boom Yagi is to create one or more hybrid designs. By judicious manipulation, it is possible to append the forward director structure of either the VK3AUU design or the DL6WU design onto the core of the OWA.

Circumstances dictated that I use the first 7 elements of the OWA design as the core. First, it was on this original design that I had begun the process of adding new directors by modifying the length and spacing of the former forward-most director and then adding the new one. Second, the length of the 8th element (Director 6) in the OWA corresponded most closely to an element in the grafted director structure. In all cases, the process required considerable juggling of the overall structure in two ways. One way led to slight frequency scaling to bring the overall hybrid antenna into a near replica of the OWA SWR curve and to center--as best possible--the operating characteristics. Further refinements required changes to the reflector, driver and first director, along with the forward-most director to complete the process well enough to achieve a usable array.

The VK3AUU director structure from about 100" of cumulative spacing forward presented the simpler of the two graftings. However, the move required some overall adjustment by frequency scaling and some touch-up of the reflector-driver portion. The following table presents the final dimensions--which might well undergo further optimizing.

. . . .

24-Element OWA-VK3AUU Hybrid Yagi

Element	Cumulative Spacing	Element Diameter 0.1875"
Reflector	----	41.04
Driver	8.91	39.61
Director 1	13.65	37.08
Director 2	25.46	36.45
Director 3	40.86	36.52
Director 4	61.59	36.30
Director 5	86.49	35.04
Director 6	108.69	34.68
Director 7	123.37	34.39
Director 8	143.91	34.04
Director 9	165.19	33.83
Director 10	187.15	33.54
Director 11	209.75	33.33
Director 12	232.93	33.12
Director 13	256.61	32.91
Director 14	280.83	32.70
Director 15	305.47	32.55
Director 16	330.56	32.34
Director 17	356.05	32.20
Director 18	381.94	32.06
Director 19	408.19	31.99
Director 20	434.81	31.85
Director 21	464.56	31.71
Director 22	487.64	31.41

. . . .

The final boom length at the 23-element mark was 6.03 wavelengths, about 0.08 wavelength shorter than the VK3AUU original and 0.19 wavelength shorter than the original 20-element OWA design. The reason for the element decrease is the smaller spacing between the early elements of the original VK3AUU design.

The performance is a fair--but not perfect--match for the performance of the original VK3AUU-derived design, as shown by the following table.

. . . .

Modeled Performance: 24-Element Hybrid OWA-VK3AUU Yagi

0.1875" Diameter Elements

Parameter	**144 MHz**	**146 MHz**	**148 MHz**
Gain dBi	**16.92**	**17.18**	**16.95**
180-deg F-B	**23.43**	**29.06**	**25.99**
Front-Sidelobe	**20.02**	**22.57**	**24.00**
Impedance (R+/-jX)	**45.0 + j 4.5**	**48.8 + j 6.0**	**34.8 - j 6.7**
50-Ohm SWR	**1.15**	**1.13**	**1.49**

. . . .

The peak gain is better centered than in the original design. Hence, we have reduced the upper passband-edge gain below the value for the original design. The SWR curve reflects OWA characteristics, with a relative fast rise in value at the upper passband limit.

The use of a single hybrid would only hint at an answer to the question that gave us a reason to create a hybrid--namely, to what extend either the OWA core or the method of adding new directors is responsible for the OWA Yagi's tendency to suppress sidelobe formation. A second hybrid, using a different forward structure predicated on a different algorithm for adding new directors might turn the hint into a strongly suggestive answer. So I tried the same technique of starting with 7 OWA elements and adding a DL6WU-type director structure.

The ensuing design challenge required the use of 0.375" diameter elements, twice as fat as the 0.1875" OWA and VK3AUU originals. This move further entailed some frequency scaling and element scaling so that the final result may not closely resemble at first site the DL6WU design from which I took the initial grafts. The array turned out to be shorter at the 20-element mark than originally planned and required the addition of 3 elements to bring the boom length above 6 wavelengths. The final 23-element length is 6.07 wavelengths.

The final dimensions for this exercise--but not necessarily for a fully adequate practical array--appear in the following table.

. . . .

23-Element OWA-DL6WU Hybrid Yagi

Element	**Cumulative Spacing**	**Element Diameter 0.375"**
Reflector	**----**	**40.60**
Driver	**9.95**	**38.60**
Director 1	**13.91**	**35.80**
Director 2	**25.67**	**35.31**
Director 3	**40.59**	**35.31**
Director 4	**60.68**	**35.11**
Director 5	**81.09**	**34.52**
Director 6	**95.40**	**34.24**
Director 7	**112.48**	**33.83**
Director 8	**132.32**	**33.44**
Director 9	**154.57**	**33.10**
Director 10	**178.39**	**32.78**
Director 11	**203.40**	**32.53**
Director 12	**229.62**	**32.30**
Director 13	**257.02**	**32.09**
Director 14	**285.61**	**31.91**
Director 15	**315.39**	**31.75**
Director 16	**346.37**	**31.60**
Director 17	**380.98**	**31.47**
Director 18	**412.85**	**31.27**
Director 19	**438.99**	**31.07**
Director 20	**465.13**	**30.88**

Director 21	**491.00**	**29.80**

. . . .

Despite the modifications, the array performs in a manner reasonably close to that of a DL6WU Yagi designed in perfect accord with the original algorithms. The modeled free-space performance appears in the following table.

. . . .

Modeled Performance: 23-Element Hybrid OWA-DL6WU Yagi

0.375" Diameter Elements

Parameter	**144 MHz**	**146 MHz**	**148 MHz**
Gain dBi	**16.94**	**17.18**	**17.13**
180-deg F-B	**36.86**	**22.30**	**20.39**
Front-Sidelobe	**22.51**	**21.92**	**20.12**
Impedance (R+/-jX)	**38.9 + j 2.2**	**52.4 + j 4.5**	**58.3 + j 4.1**
50-Ohm SWR	**1.29**	**1.10**	**1.19**

. . . .

Like many lengths of DL6WU designs, the peak gain appears near one end of the passband while the peak front-to-back ratio appears near the other.

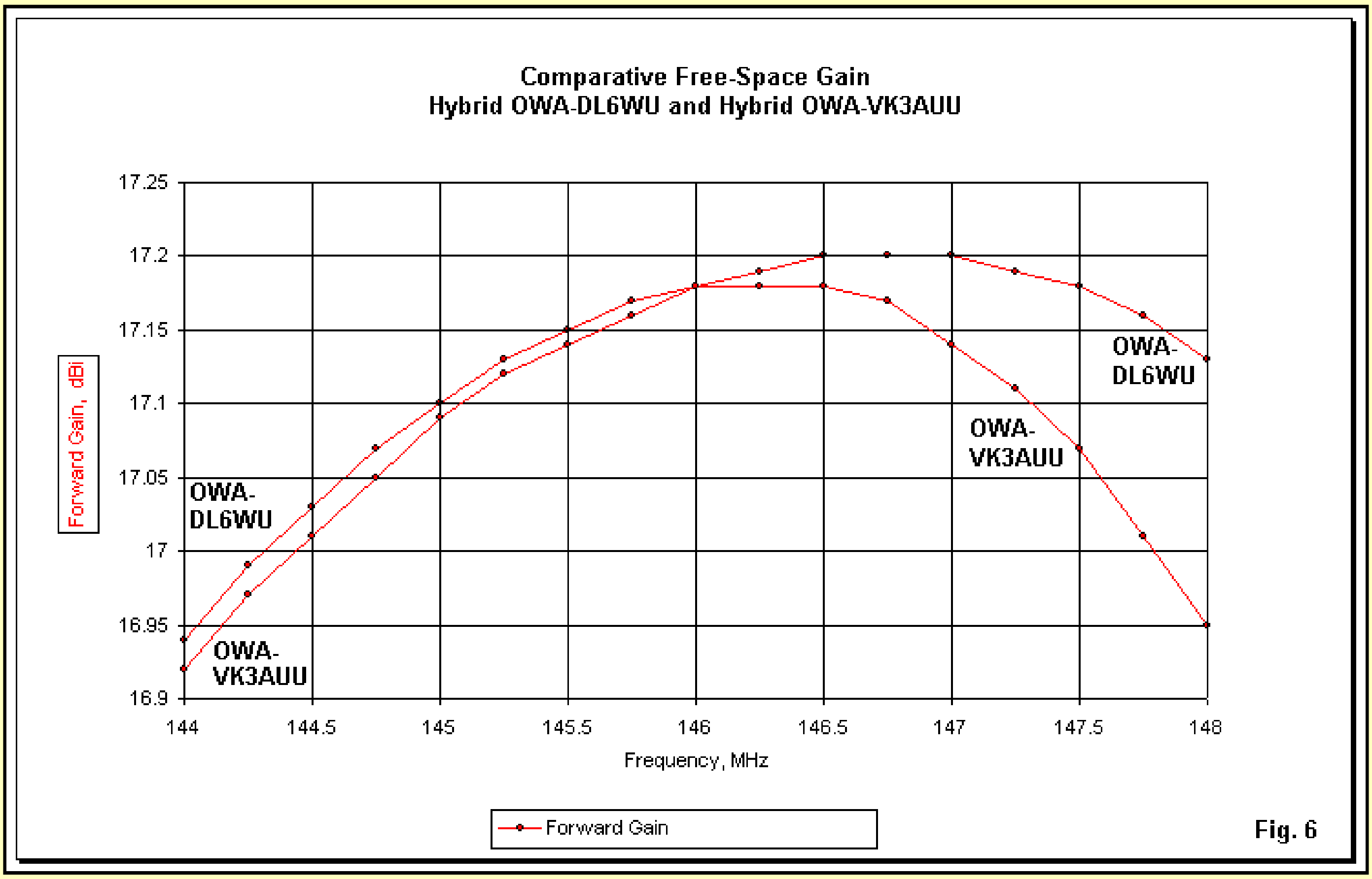

Fig. 6

We can contrast the gain curves for the two hybrid arrays by examining **Fig. 6**. The DL6WU-hybrid places its peak--at least for this portion of its total operating passband--near the passband upper limit. The VK3AUU-hybrid centers its gain curve very close to the design frequency. Given the narrow range of values on the Y-axis of the graph, the overall gain performance is comparable.

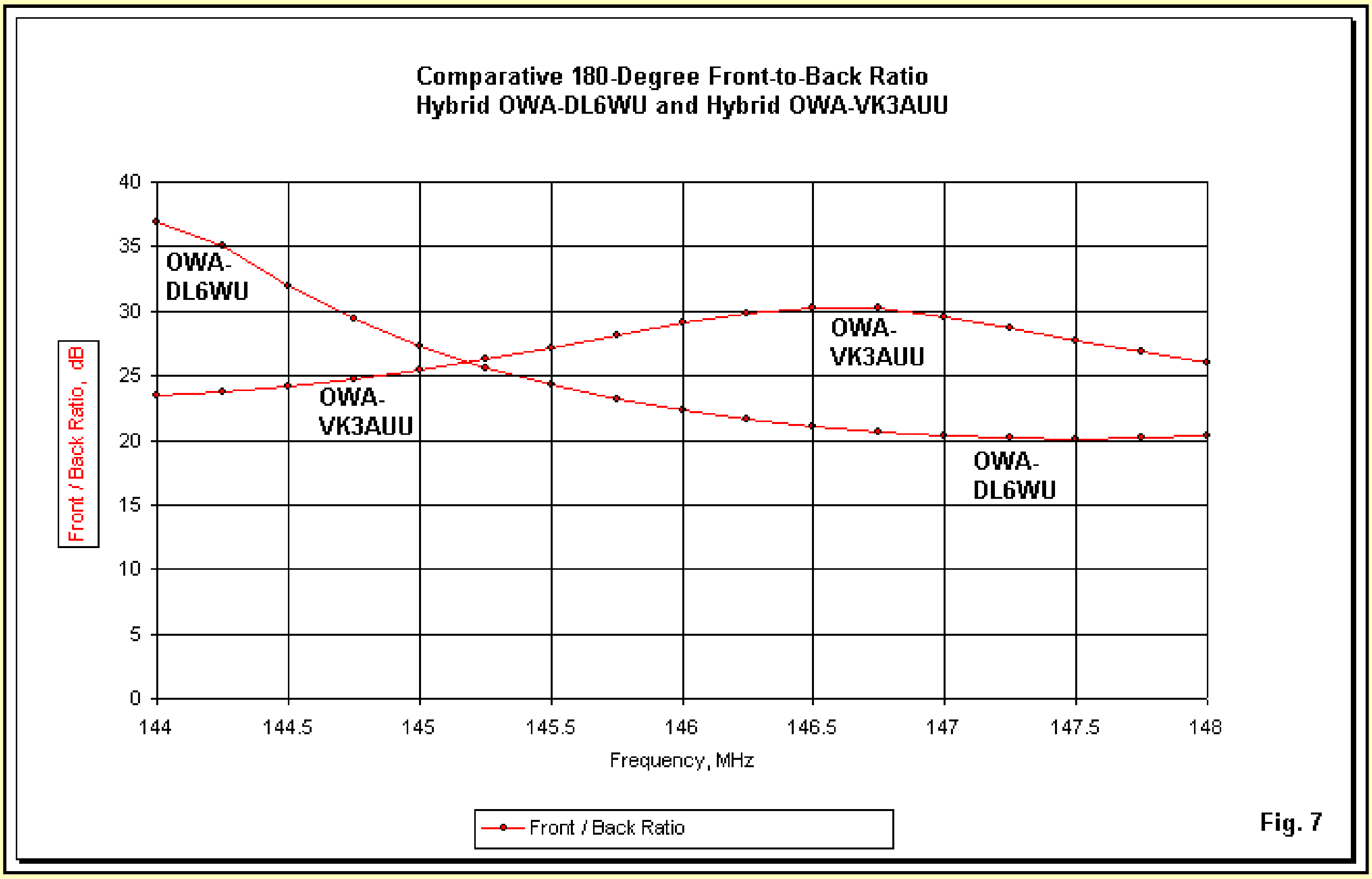

Fig. 7

Like the VK3AUU-hybrid gain curve, the array's front-to-back curve, shown in **Fig. 7**, is also quite well centered in the passband. In contrast, the DL6WU-hybrid's front-to-back curve dwindles considerably above the lower end of the passband. However, both array designs maintain a front-to-back ratio of better than 20 dB across the 2-meter band.

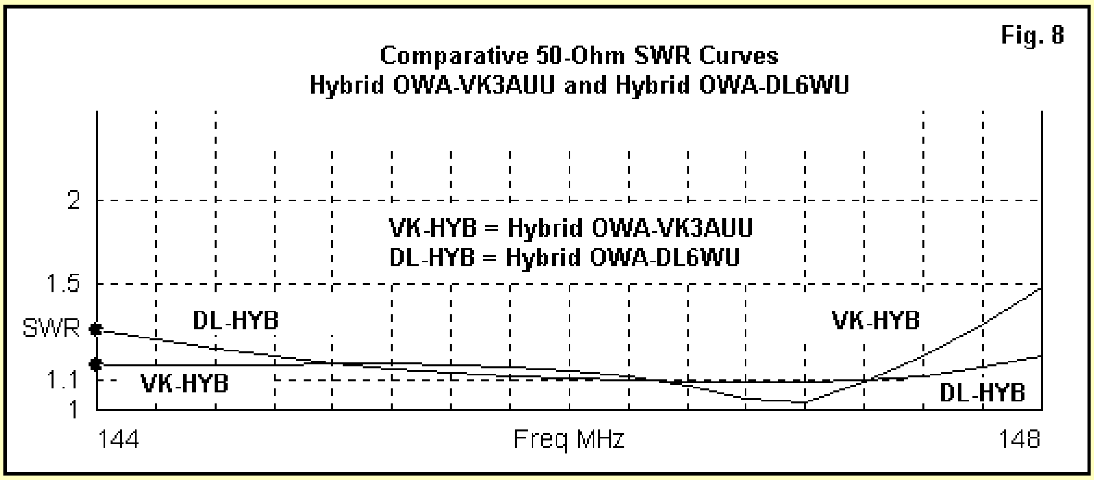

Fig. 8

Fig. 8 compares the 50-Ohm SWR curves for the two hybrids. The VK3AUU- hybrid curve has distinct OWA features. However, the DL6WU-hybrid curve is relatively featureless in terms of identifying marks. Nevertheless, without further modification of the hybrid arrays, it is slightly superior. If neither the gain nor the front-to-back ratio could be well-centered in the passband, the DL6WU-hybrid SWR curve is well-centered.

In many ways, the initial listings and comparisons are preliminary to our central question. They establish several facts to give us confidence in our answer to the question. First, hybrid designs are certainly possible and promise performance close to that of the original designs. Second, the two arrays are quite comparable in both size and performance. Hence, at a point short of being definitive but close to one of confidence, we can look at the sidelobe development of the two hybrid arrays.

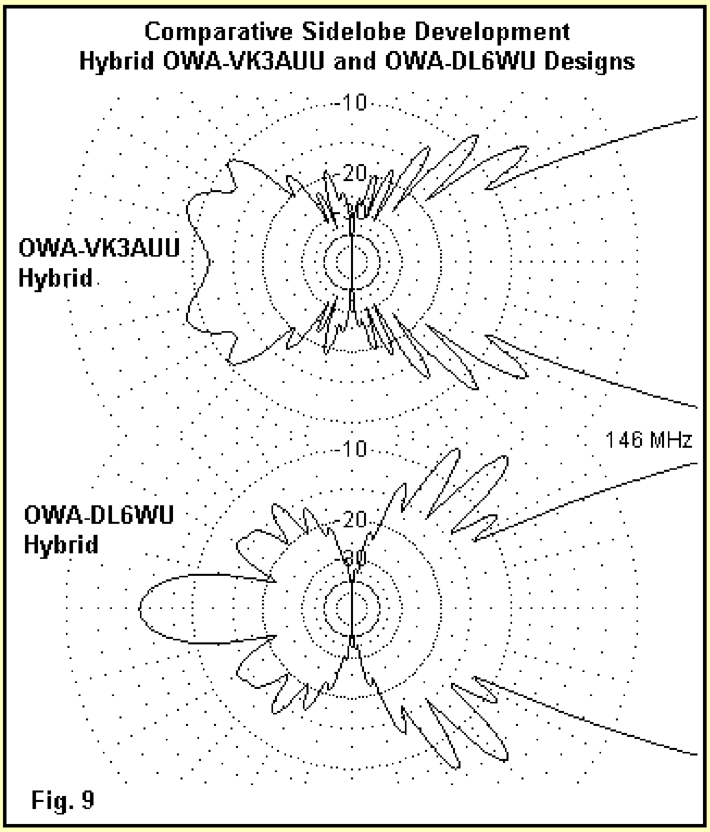

Fig. 9

Fig. 9 provides expanded views of the sidelobes of the free-space patterns for both hybrid arrays. In each of them, we can count 6 forward and 6 rearward sidelobes, although a couple of them are very diminutive. In no way is the OWA core itself able to suppress the formation of the sidelobes. The forward director structure is at least the dominant influence on their formation.

The VK3AUU-hybrid and the original derived VK3AUU 25-element array show very similar front-to-sidelobe values. However, the DL6WU-hybrid further attenuates its sidelobes by 3-5 dB relative to the original 20-element DL6WU presented at the beginning of this exploration. The most likely source of that further attenuation is the increased element (or more properly, director) population on the 6-wavelength boom for the hybrid. Although designed to different algorithms, the two director structures end up with close to the same number of directors in the same boom space. And the result appears to be an increase in the attenuation of sidelobe strength.

Conclusions

The conclusions that we may draw with reasonable confidence place responsibility for side-lobe attenuation on the density of directors. As well, sidelobe suppression appears also to be a function of the director structure, since neither the DL6WU nor the VK3AUU structures achieved any sidelobe suppression. Without claiming that these answers are more than strongly suggestive, we have cleared two of the three questions from our initial list.

However, we have one remaining question: is there a way to improve the gain performance of the original 20-element OWA Yagi? As a clue to where we might turn for an answer, I might note the unexplained increase in the diameter of the DL6WU-hybrid elements to 0.375" (3/8"). Because the route to the answer contains some necessary by-ways, I suspect that we had best devote a full third part in this series to the question.

Go to Main Index