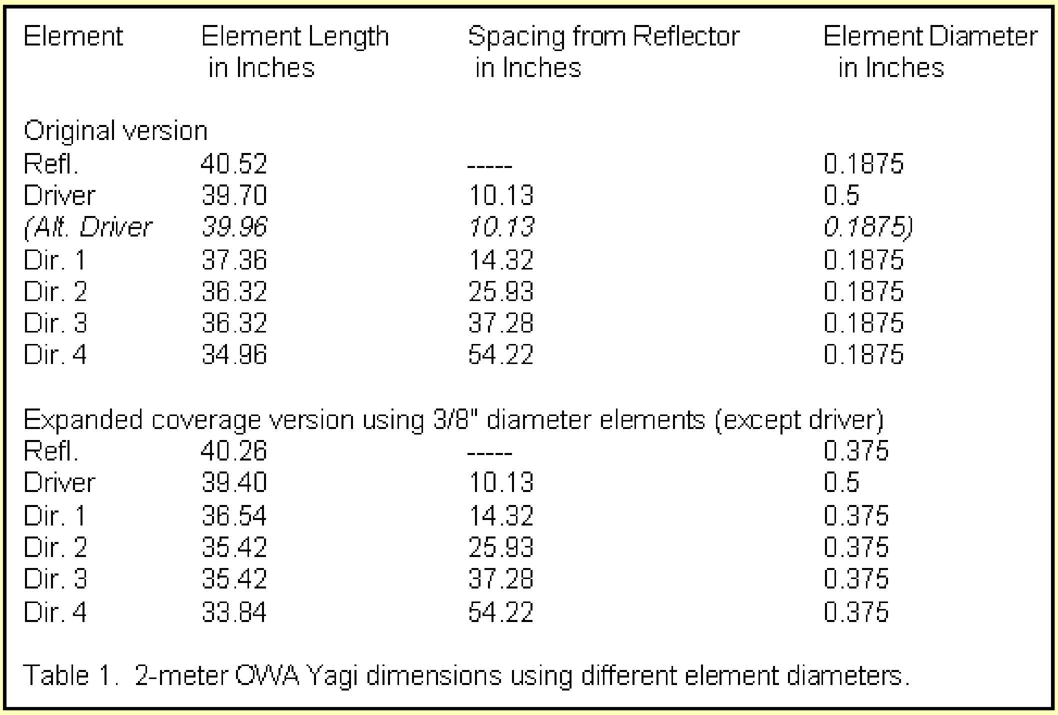
Expanded Coverage for the 6-Element 2-Meter OWA Yagi
142-150 MHz

L. B. Cebik, W4RNL (SK)

In December, 2004, *QST* published my adaptation of OWA to VHF Yagis ("Building a Medium-Gain, Wide-Band 2 Meter Yagi," pp. 33-37). I had designed the antenna to cover the entire 2-meter band (144-148 MHz) with relatively even gain and at least 20 dB 180-degree front-to-back ratio all across the span. Those design features allowed the beam to be used either horizontally or vertically without having to build specialized antennas for different services. The free-space gain ranged from 10.1 to 10.3 dBi, a variation of only 0.2 dB. The 50-Ohm SWR curve was extremely flat and never exceeded 1.25:1 across the band. I used 3/16" aluminum rods for elements, except for the driver. To allow for through-boom construction (using a PVC boom), I used 1/2" aluminum tubing for the driver, with a 3/8" section of fiberglass rod aligning the two halves of the directly fed driver. The design required no matching network or assembly, because the inherent feedpoint impedance of the antenna is close to 50 Ohms.

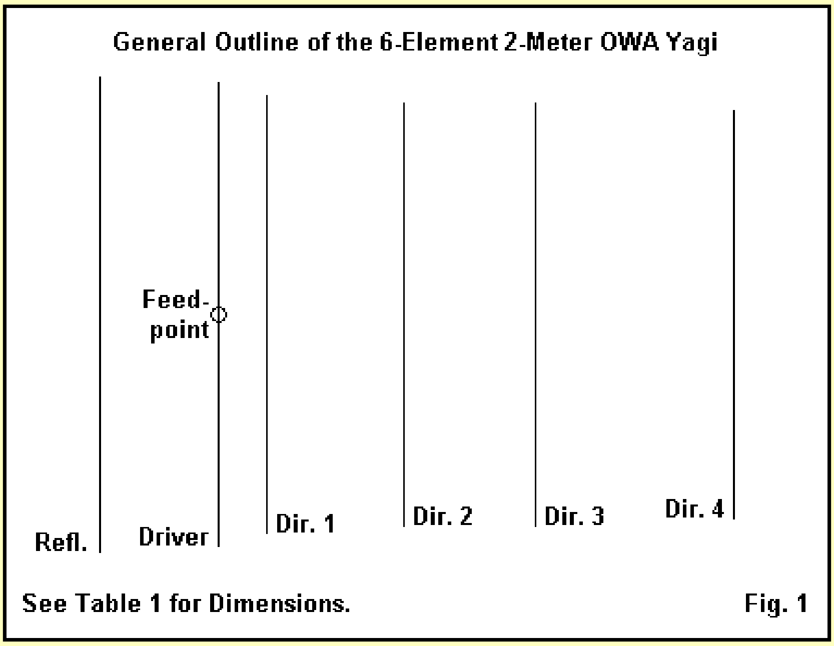
Since the appearance of the article, I have received two kinds of questions. The first group wonders if the beam is adaptable to operation outside the 2-meter band, where we find special services, such as MARS. The other group has wondered about adapting the design to 3/8" tubing, which may be easier to obtain than the aluminum rod material. I have combined both inquiries into a re-design of the array so that it covers 142 to 150 MHz. The SWR above 149.5 MHz climbs steeply, and the front-to-back ratio below 142.5 MHz begins to fall somewhat. However, the resulting design with 3/8" diameter aluminum elements (except for the driver) retains the relatively smooth gain performance and usable front-to-back and SWR values across the specified passband.



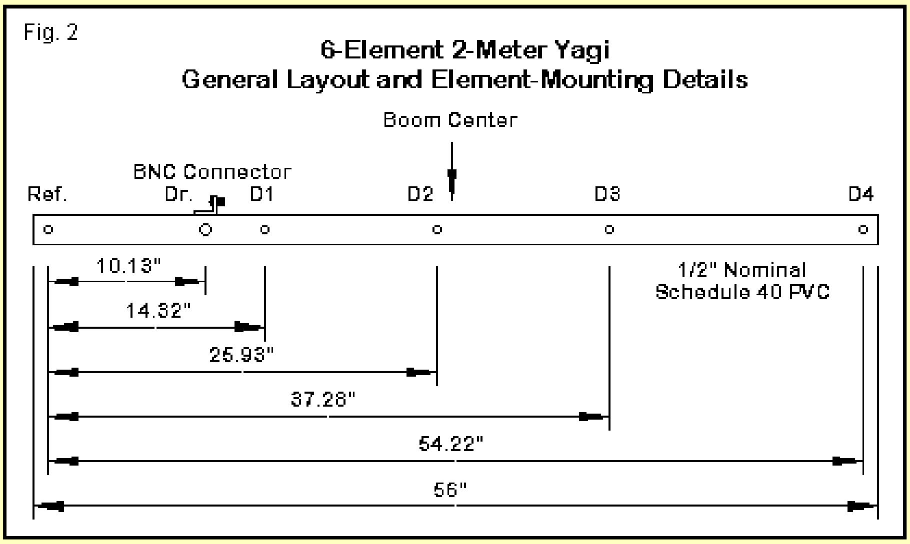
Element	Element Length in Inches	Spacing from Reflector in Inches	Element Diameter in Inches
Original version			
Refl.	40.52	-----	0.1875
Driver	39.70	10.13	0.5
(Alt. Driver	*39.96*	*10.13*	*0.1875)*
Dir. 1	37.36	14.32	0.1875
Dir. 2	36.32	25.93	0.1875
Dir. 3	36.32	37.28	0.1875
Dir. 4	34.96	54.22	0.1875
Expanded coverage version using 3/8" diameter elements (except driver)			
Refl.	40.26	-----	0.375
Driver	39.40	10.13	0.5
Dir. 1	36.54	14.32	0.375
Dir. 2	35.42	25.93	0.375
Dir. 3	35.42	37.28	0.375
Dir. 4	33.84	54.22	0.375

Table 1. 2-meter OWA Yagi dimensions using different element diameters.

Table 1 shows the original dimensions of the array along with the dimensions of the version using 3/8" elements. Although the element lengths have changed, I have retained the element spacing. **Fig. 1** shows the general outline of the beam to give a sense of its proportions. As with all OWA designs, the first director actually serves as a secondary driver and tends to control the upper half of the passband. As well, OWA designs use the second and third directors (with equal or close to equal lengths) to control the shape of the forward lobe. For longer OWA Yagis, the control directors tend to suppress and not merely attenuate emerging forward sidelobes. Since this design uses a boom that is less than 1 wavelength, there are no sidelobes to control. However, many similar size designs tend to show a small emerging forward sidelobe at the upper end of the passband.



As we move to **Fig. 2**, we find my preferred construction method for VHF: passing elements through the boom and securing them on either side with hitchpin clips (also called hairpin cotter pins). You may select your own favorite assembly method or refer to the original article for construction details. You may even wish to increase the diameter of the PVC tube used in the original by one tubing size to accommodate the increased diameter of all parasitic elements in the array. My goal in these notes is to review the performance potentials of the re-design.



One detail that bears repeating is the arrangement of the 1/2" fed driver element. As shown in **Fig. 3**, I used a BNC connector with a small bent plate crafted from some 1" by 1" by 1/6" L-stock that I had on hand. The BNC center pin uses a standard soldered jumper to one side of the driver. The shell and the mounting plate form a curve to fit the PVC boom and make a direct connection to the other side of the element. Since the mounting hardware for the element has a minimum size (perhaps #6), the fiberglass rod that separates and aligns the driver halves has to be about 3/8" in diameter so as to maintain its strength once drilled for the hardware. That makes the 1/2" driver element tube very sensible.

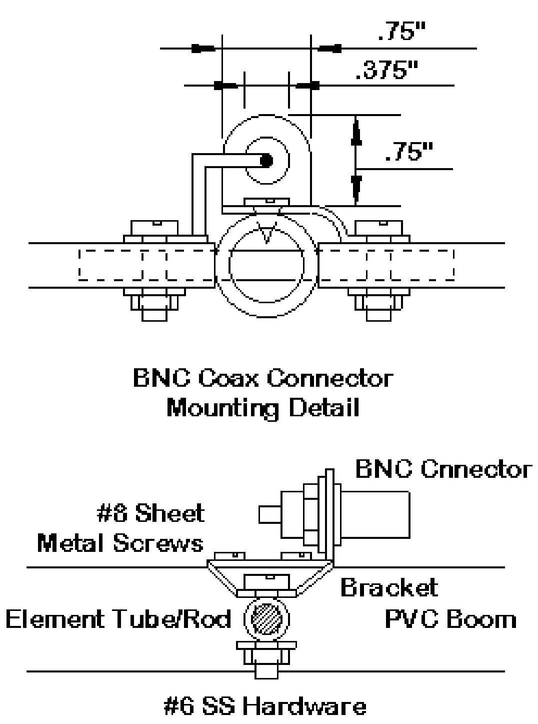


Fig. 3

How well does the array actually perform? I have promised expanded coverage, but does the beam deliver adequate performance outside the amateur 2-meter allotment? To answer these questions, we may look at some sample data and frequency sweep curves. The first graph (**Fig. 4**) shows the free-space gain and the 180-degree front-to-back ratio across the widened passband.

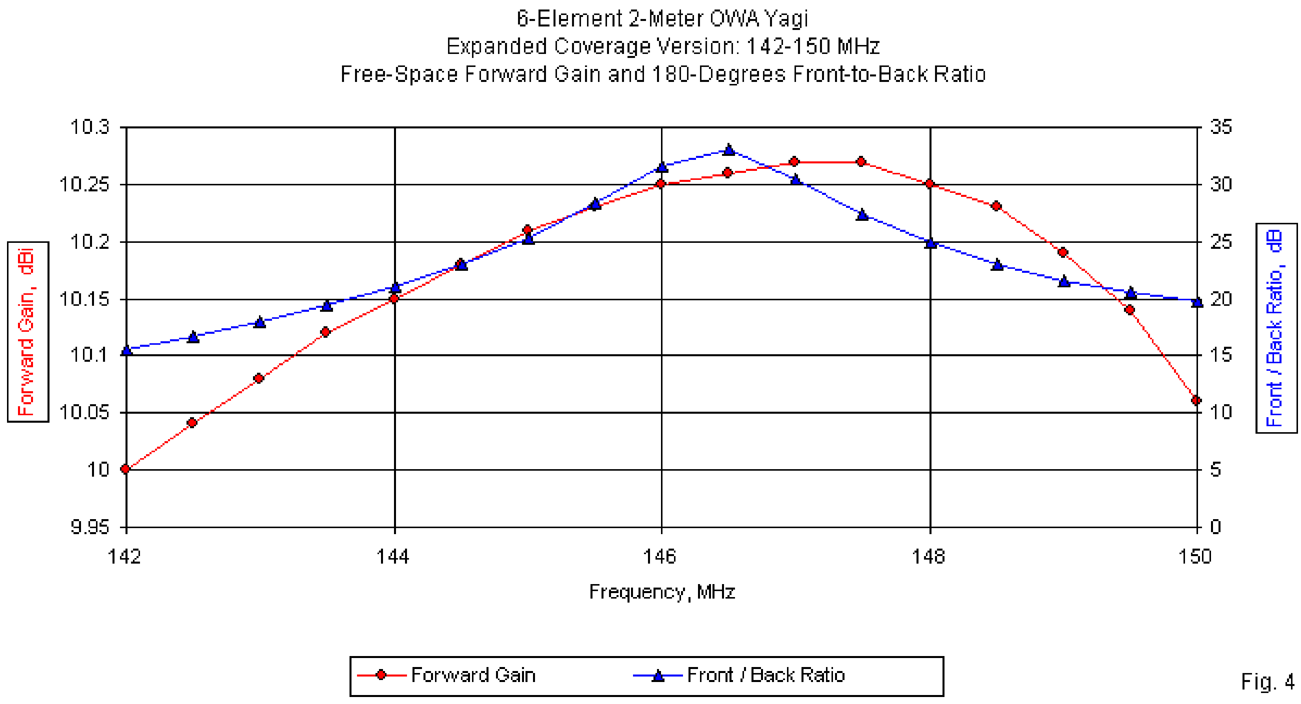


Fig. 4

The gain varies from a low value of 10.0 dBi to a maximum value of 10.27 dBi, or about a quarter-dB variation across the entire operating spectrum. The OWA design allows one to place the peak gain inside the passband, which tends to reduce the level of variation within the band. Standard designs tend to show a rising gain curves across the band. Hence, while such designs may show a peak gain the exceeds to OWA gain (but not by much), the gain at the low end of the spectrum may be much lower.

One limitation of a very wide-band Yagi design is that it is not usually possible with shorter booms (compared to very large boom Yagis used for serious point-to-point DXing) to sustain a front-to-back ratio at the 20-dB level everywhere in the band. Hence, the front-to-back performance falls off at the lower end of the new wider band, but is still in excess of 15.5 dB. For most general purposes, this value provides satisfactory performance.

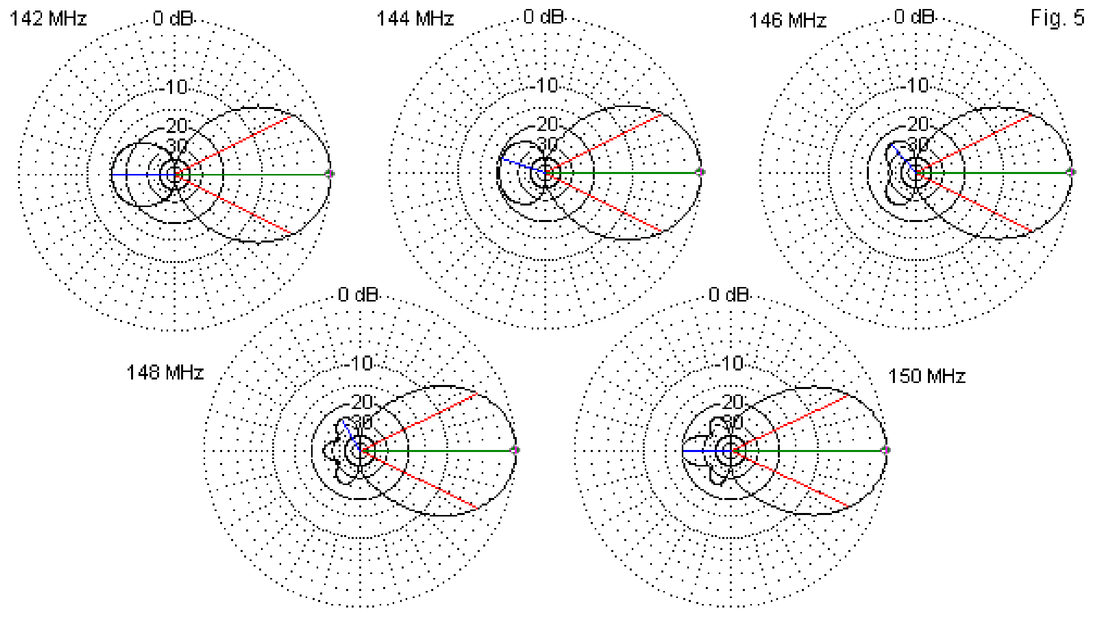
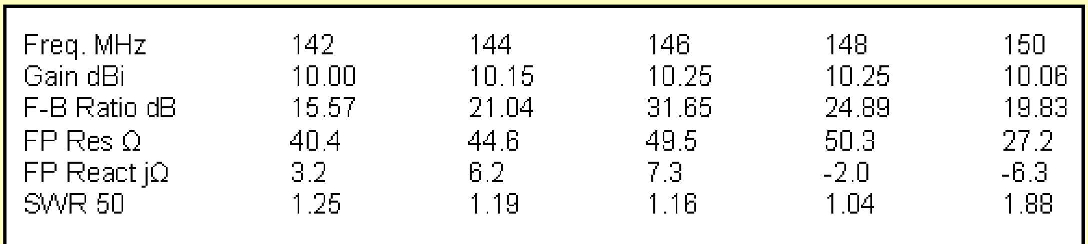


Fig. 5

Selected Free-Space E-Plane (Azimuth) Patterns
6-Element 2-Meter OWA Yagi with Expanded Coverage: 142-150 MHz

To give us a different view of the graphed data, we can examine the selected free-space E-plane (azimuth) patterns in **Fig. 5**. The patterns reveal that the array is very well behaved across the entire passband with no unexpected lumps or aberrations. The free-space E-plane patterns generally reflect very precisely the sorts of patterns we will obtain with the antenna horizontally oriented above ground. Of course, if we set the antenna to a vertical orientation, the beamwidth will be significantly wider, since a Yagi always exhibits a narrower beamwidth in the plane of the elements.



Freq. MHz	142	144	146	148	150
Gain dBi	10.00	10.15	10.25	10.25	10.06
F-B Ratio dB	15.57	21.04	31.65	24.89	19.83
FP Res Ω	40.4	44.6	49.5	50.3	27.2
FP React jΩ	3.2	6.2	7.3	-2.0	-6.3
SWR 50	1.25	1.19	1.16	1.04	1.88

Table 2. Selected free-space performance data from NEC-4.

Table 2 provides the modeled data reports to go along with the graphs and the E-plane patterns. You can correlate the tabular entries with both the individual plots and the proper positions on the graph in **Fig. 4**. The data table holds no surprises, except perhaps for the impedance and SWR values at 150 MHz. They seem high and represent the other limitation of wide-band design. The OWA impedance curve shows a rather rapid decline in resistance above the final SWR minimum. The passband then is a joint function of limiting values of SWR at the high end of the band and limiting values of the front-to-back ratio at the low end of the band. **Fig. 6** shows how the resistance and the SWR change across the operating passband.

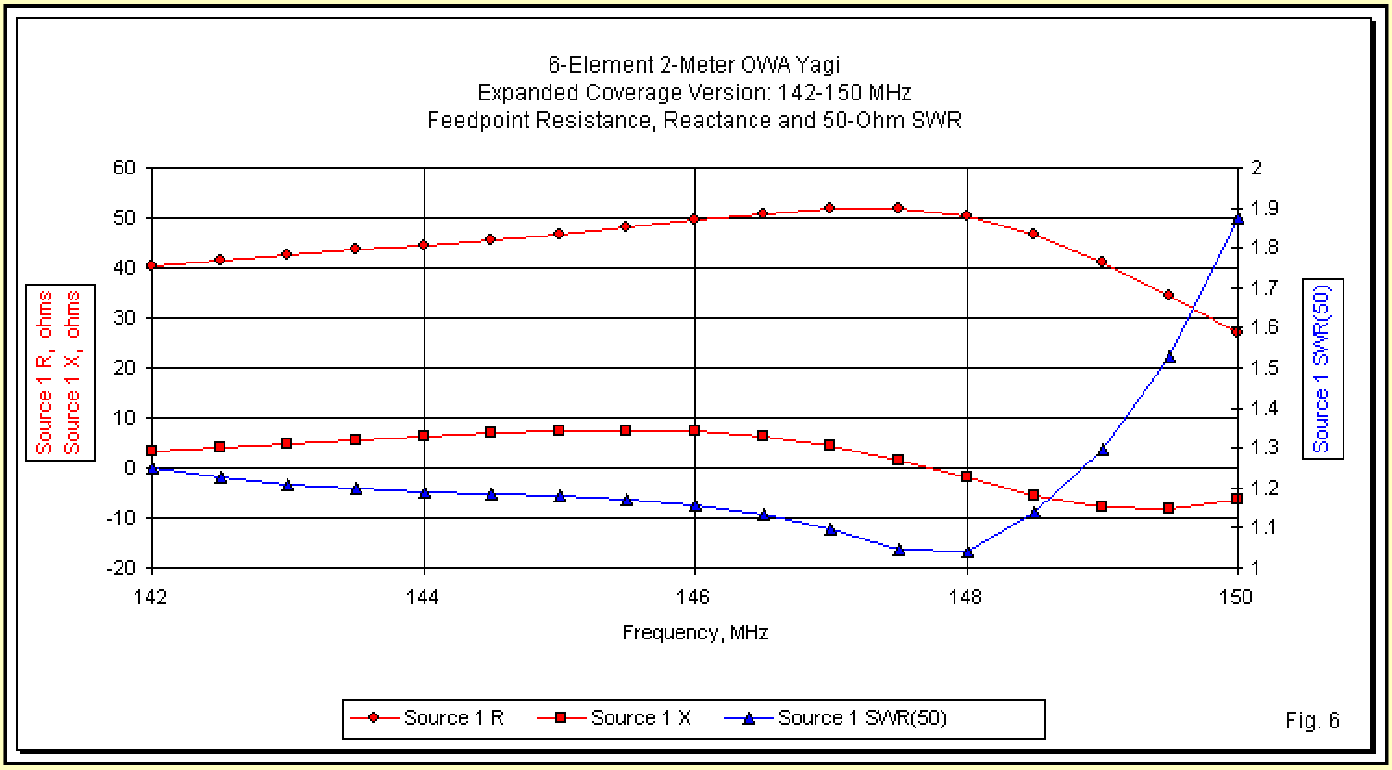


Fig. 6

Across the entire 8 MHz spread for the expanded beam, the feedpoint reactance varies by no more than about 16 Ohms. For almost all of the passband, the resistance hovers within a 12-Ohm range. However, as we pass 148 MHz, the resistance begins a rapid decline, with a commensurate rise in the 50-Ohm SWR. However, at 149.5 MHz, the SWR is only about 1.5:1. If the primary operation is the 2-meter amateur band and above, then one might reduce the lengths of both the fed driver and the first director/secondary driver to raise the resistance and lower the SWR at the upper end of the band, while sacrificing some performance below the amateur band.

My goal, however, was to see if I could redesign the 2-meter 6-element OWA to use 3/8" tubing and--at the same time--expand coverage on both sides of the amateur band. The design shown here achieves both goals in an acceptable manner. If you need the coverage and wish to use only one beam for all purposes in the 2-meter range, then this design just might work for you.

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