A portable Array of 2x3-Element-Yagis for 50 MHz

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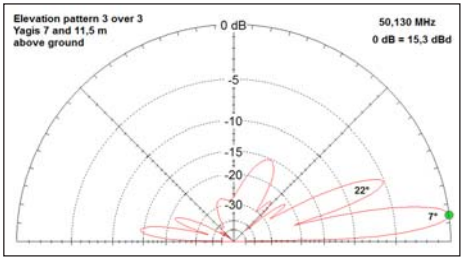
A lot of simulations with EZNEC [1] show that a stacked array of two small Yagis is much more effective than a single longer Yagi with the same gain. I gained a lot of experience with the stacked 2x2 element yagis as described in Six News #98 [2]. The first place in the UKSMG Contest 2009 as IS0/DK7ZB showed the excellent performance of the antennas. But what is better than gain? More gain! The design goal was to get 10 dBd free space gain with a very lightweight construction.

Pic. 1: The stacked array in the air.

Many comparisons of gain, weight and mechanical characteristics led to a new solution.

The new portable antenna (*see Pic 1*) consists of 2 x 3 ele 12.5 W yagis on a 2.20 m boom and has 10 dBd gain in free space. With both antennas stacked in heights of 7 and 11.5 m above ground with medium conductivity EZNEC shows 15 dBd gain (stacking losses already included!), and an elevation angle of 7° for the first lobe, excellent for DX. For short range ES we see a second lobe with 22° elevation and 10 dBd gain. These stacked antennas show a very good performance, comparable with a 1 l Yagi (6m boom) at a height of 10 m. Furthermore it is mechanically much easier to build a small stacked array compared to a single long boom yagi! An additional advantage of the 3 over 3 is the azimuth angle (E-plane) at 58,2°, compared to only 46° with the single Yagi.

The 3-Element-Yagi was designed for high gain and has a narrow bandwidth, 50-50.3 MHz which is more than enough for the use as a contest antenna. The F/B is not so good, but this should be no disadvantage. The important characteristics are listed in ***Table 1***. Naturally the antenna needs a clear surrounding area to realise these performance figures.



Pic. 2: The vertical pattern over real ground, Yagis 7 and 11.5 m high.

Here we should make a short discussion of the philosophy of 50 MHz Yagis. I know that some people prefer a 50 W direct feed and believe the 12.5 W Yagis show losses. This is

definitely not true. Paul, GW8IZR, has made some interesting measurements which are presented on the UKSMG website Forum pages. He compared the losses of a piece of a l/2 cable RG58 and two transformation cables 2 x l/4 RG58 parallel back to back. This makes a transformation 50:12.5 W and back to 50 W. The difference is absolutely negligible.

On the other hand we can design a 50 W Yagi with the same boom length. An additional matching element near to the radiator raises the impedance. We have now a 4 Element Yagi with more bandwidth and an increased weight, but with 0.3 dB reduced gain. For the comparison I have built this Yagi, and the dimensions can be found on my homepage [3].

I did run a couple of simulations with boom lengths from 1.90 with 6.5 dBd gain to 2.50 m with 7.5 dBd. It seems that a length of >2.20 m for the Yagi needs significantly more stacking space than the planned 4.50 m.

Matching the Yagi

In the past I conducted numerous trials with a gamma-match arrangement. In all cases this did not seem a good solution. I had common mode currents on the coax screen and no symmetrical pattern. The main disadvantage of the gamma-match is an insidious attribute: Because it is a series LC-circuit you can match each bad construction to a SWR of 1.0. With the "DK7ZB-match", introduced in 1995 for yagi antennas [4] you see immediately any failure in the SWR. I use a quarter wave length of 2 x 50 W cables in parallel to transform the 12.5 W to 50 W. These coax cables are wound to form a choke. With foam-PE-cable H-155 you get a lightweight construction which can handle 1 KW output. With a higher loss, RG58 (MIL-quality) is ok, however this is limited to handling up to 500 Watts. Important is the right velocity of propagation for the cable (see table 2). In the meantime many yagis built in all parts the world use this simple method.

Mechanical Solutions

For the portable application I took a 2x20x2-mm-square boom of Aluminium, for a stationary use a 25-mm-boom is better and gives more stability. With the element-holders by Pablo, EA4TX [5] an easy mounting of the parasitic elements is possible (***Pic. 3***). You can get these holders for square and round booms in metric and imperial dimensions.

Pic. 3: The EA4TX-element holders for the reflector and director mounting.

The radiator must have in insulated gap of about 15 mm in the middle part, the construction with the 25 W impedance choke can be seen in ***Pic. 4***.

Pic. 4: The radiator box with the matching choke.

The stacking method

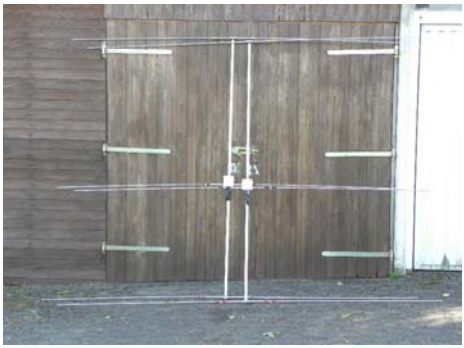
The stacking is the same as described for the 2 over 2 [2]. For minimizing the losses two 3/4-l pieces of 75 W cables RG11 with a length of 2.95 m for each cable lead to the feeding point between the two Yagis. There is a little mismatch, because in theory we would need a cable with 71 W

I have measured the stacking cable with two R&S dummy resistors of 50 W. The result was a SWR of 1:1 for the quarter wave transformer.

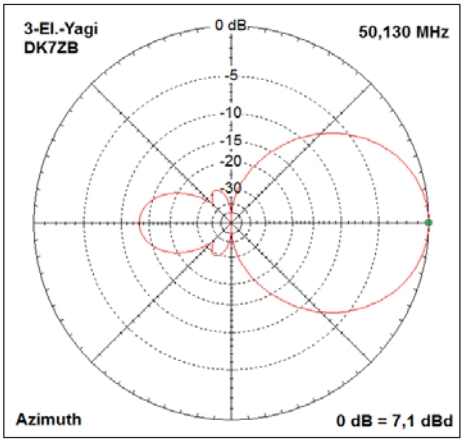
Experiences

The manageable dimensions of the antennas can be seen in ***Pic. 5***. The horizontal pattern for a single Yagi is plotted in ***Pic. 6*** *on page 37*. The measured data of the coupled group with a vector network analyzer shows a SWR < 1.5 between 50.0 and 50.3 MHz (***Pic. 7*** *and* ***8*** *on page 37*).

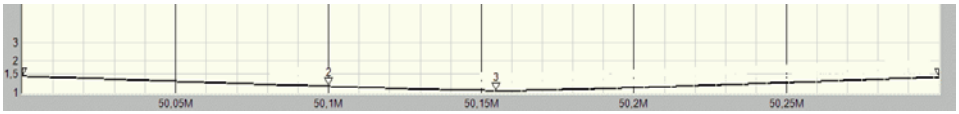
In the ES-Season 2010 I made many QSOs as ISØ/DK7ZB with the 3 over 3 stacked array



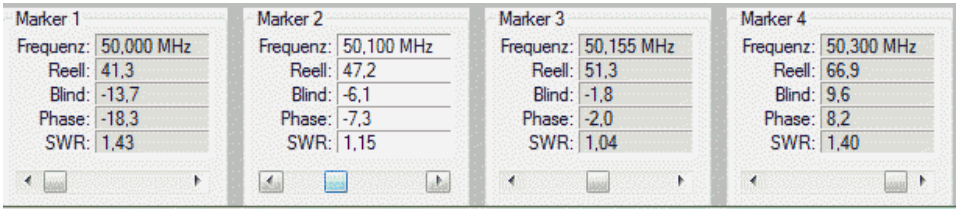
Pic. 5: The two Yagis ready for the field day.



Pic. 6: The horizontal pattern for a single Yagi.



Pic. 7: The SWR of the array, measured in CEØY with 15 m of low-loss coax.



Pic. 8: The data measured for the array 3 over 3.

	Gain	F/B	3-dB-angle E-plane	3-dB-angle H-plane
1x 3-El.-Yagi	7,1 dBd	12,5 dB	57,2°	80,2°
2x 3-El.-Yagi	10 dBd	14,5 dB	58,2°	35,6°

Table 1: The free space data of the Yagis.

Element	Element Lengths (one half)					
	Position	10 mm/8 mm	10 mm	12 mm	3/8”	1/2”
Reflector	0 mm	250 mm/1230 mm	1470 mm	1467 mm	1470 mm	1465 mm
Radiator	910 mm	250 mm/1163 mm	1399 mm	1395 mm	1400 mm	1394 mm
Director	2170 mm	250 mm/1128 mm	1360 mm	1354 mm	1362 mm	1351 mm

Table 2: The mechanical dimensions.

and I took part at the annual UKSMG Contest. Although the conditions were not so good this year, I was very satisfied with the antennas, and no detuning by rain could be seen.

We took the Yagis with us on the CEØY DXpedition in October 2010. The EME-test that we carried out with W7GJ gave an excellent receiving result with the antenna with -18 dB in JT65A, but unfortunately Lance did not copy us due to the short window. It seems that the array would be a good choice for a portable EME operation.

Sources:

[1] Lewallen, R. (W7EL): Program EZNEC +5, information on www.eznec.com

[2] Steyer, M. (DK7ZB): A 2-Element-Yagi for 50MHz, SIX NEWS Issue 96, Aug. 2008

[3] Antenna Hompage DK7ZB, www.dk7zb.org

[4] Steyer, M. (DK7ZB): Einfache Speisung von Monoband-Yagi-Antennen, FUNKAMATEUR Issue 9/1995

[5] Internet-Shop of Pablo, EA4TX: www.interlanco.com

San Severo A.R.I. Radio Club Organize the XV Gargano Contest 50 MHz

Date: The last Sunday of May 2011 (May 29th)

Time: start at 8.00 GMT and finish at 15.00 GMT

Frequencies: 50 to 51 MHz, SSB/CW operation are not allowed in the frequency range between 50.100 and 50.150. CW only is permitted to use the frequency between 50.080 and 50.100 MHz.

Mode: SSB and CW, each station can be worked only once whatever the mode.

Categories: To be specified on log

1a) Fixed

2a) Portable

Exchange: RS(T) + progressive nr. + WW Loc. complete (6 digits)

Scores: 1 point per km

Multipliers: all Italian stations with the prefix I7; IK7; IZ7; IW7 multiply x 2 the scores

Log: according to I.A.R.U. Standard (date, time, call, freq., information exchanged, loc) created formats std, or cabrillo are to be postmarked no later than last day of June and send to :

contestgargano@arisansevero.it

Prizes: Three top scoring stations of each categories

Winners will be granted prizes, sent by mail.

Any comment and photographs will be welcome.

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