A Folding 11-Element Yagi for 432 MHz

Steve Kavanagh, VE3SMA, October 2015

1. *Introduction*

For portable VHF/UHF operation I have found it convenient at times to have some antennas which fold up quickly to take less space in the car. This antenna was designed and built in something of a hurry when VE3RZ and I decided to operate together in the Limited Rover class of the 2015 ARRL September VHF Contest and the space I had formerly used to store my 432 MHz Yagi was now to be occupied by Tony! It seemed to behave as expected during the contest, but has not been subjected to any gain measurements.

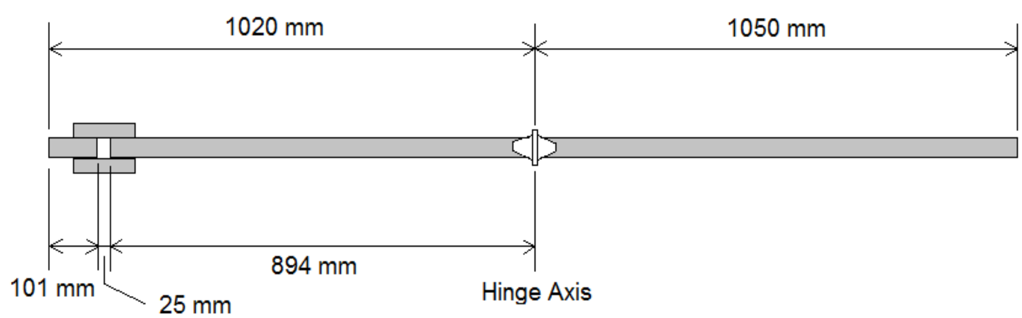
2. *Dimensions*

Element diameter: 1/8 inch (solid aluminum parasitic elements, brass tubing for driven element)
Boom: ¾" thick pine (made from 1X2), total length 81.5 inches, folds to 41.5 inches
Boom depth (top-to-bottom): Mostly about 0.8 inch, tapering up to 1.5 inch at mounting clamp and hinge
Tolerances: I tried to stay within +/-1 mm on element positions, perhaps +/-0.5 mm for element lengths
Length Corrections: No boom correction factor is applied to the element lengths and it should not be necessary with a wood boom of this thickness. The parasitic element lengths were adjusted according to a simple formula [1] for solid elements, while the tubular driven element was not corrected.

Element	**Distance from rear end of boom (mm)**	**Distance from forward end of boom (mm)**	**Element length in NEC model (mm)**	**End correction (mm)** [1]	**Actual element length (mm)**
Reflector	10.0	2060.0	336.0	-1.6	334.4
Driven Element (at centre)	113.5	1956.5	(see details below)	(none)	(see details below)
Director 1	190.2	1879.8	312.8	-1.6	311.2
Director 2	344.5	1725.5	304.0	-1.6	302.4
Director 3	566.6	1503.4	296.6	-1.6	295.0
Director 4	812.2	1257.8	290.6	-1.6	289.0
Director 5	1070.0	1000.0	290.0	-1.6	288.4
Director 6	1310.4	759.6	292.6	-1.6	291.0
Director 7	1564.9	505.1	289.0	-1.6	287.4
Director 8	1810.0	260.0	282.6	-1.6	281.0
Director 9	2060.0	10.0	273.8	-1.6	272.2

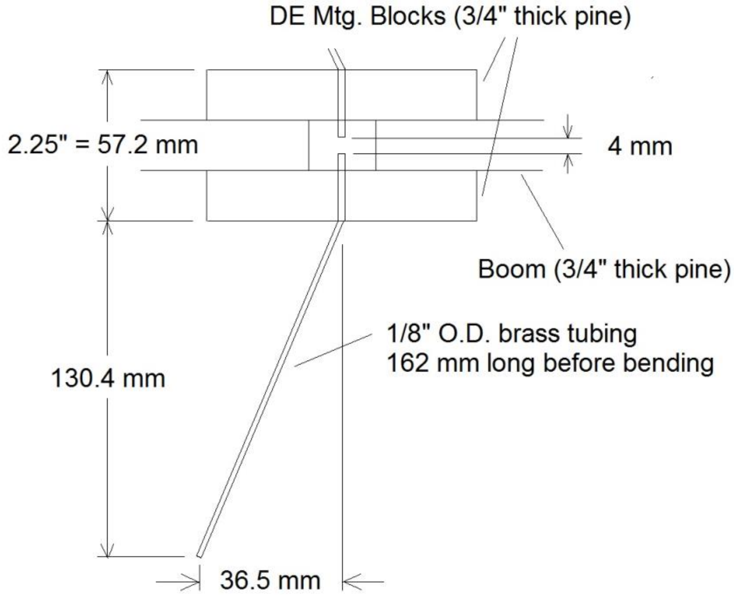
3. *Boom Details*

Refer to the sketch below. The boom is made from 1x2 pine (actually ¾" x 1-1/2"). The front part is 1050 mm long (from the hinge point to the tip). The rear part is made up from 4 pieces. The main part is 894 mm long, from the hinge point to the gap for the driven element. There are two driven element mounting blocks and a reflector support piece (101 mm long) also made from ¾" thick pine, arranged to provide a 25 mm gap around the driven element and a total rear part length of 1020 mm (from the hinge point to the rear end of the boom). The lengths of the driven element mounting blocks is not critical, but they need to be long enough that their joints with the main and reflector mounting parts of the boom are strong enough , but short enough to keep clear of the reflector and first director. In general the boom cross-section is 0.75 x 0.80 inch, but near the hinge point the depth of each part is tapered from 0.8 inch up to the full 1.5 inch dimension of the 1X2 in order to provide a place to attach a mounting clamp and to ensure that the boom is straight when opened out. The rear part pieces are joined together with wood glue and dowels to avoid bringing any additional "horizontally polarized" metal close to the driven element. I used ¼ inch diameter dowels through all three pieces, with two dowels on each side of the driven element. The hinge is a "2 inch strap hinge" fastened to the tops of the boom sections with wood screws (drill pilot holes first to avoid splitting the wood). I found it necessary to tighten the hinge before mounting it to the boom (by squeezing it carefully with vice-grips) to avoid too much wobble. The boom is drilled (1/8" diameter bit) for each of the elements at the positions given in the table). The elements are epoxied into place with a small fillet of epoxy where they exit the wood. The boom is then painted or varnished. Don't paint the elements unless you know very well the RF properties of the paint!



4. *Driven Element Details*

See the following figure. A bent dipole driven element is used for matching and control of coupling to the nearby elements, as introduced by K6STI and developed and described in more detail by DG7YBN [2]. The element halves are inserted in 1/8" holes in the mounting blocks such that there is a 4mm gap between their inner ends, then bent to the right shape. Dimensions of the bent part are to the centre line of the tubing. The driven element should be soldered to the coaxial cable, and then epoxied in place, after bending. I found it useful to make a paper template and place it under the antenna when bending the driven element.



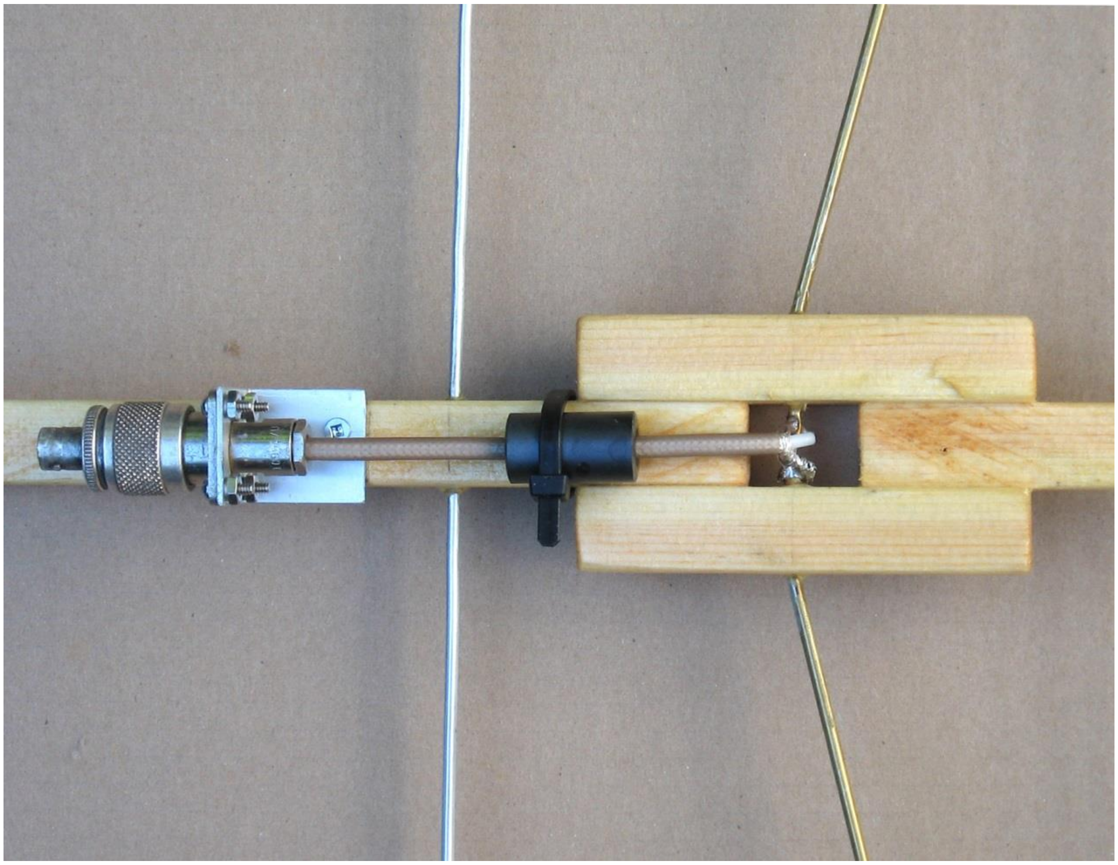
5. *Balun*

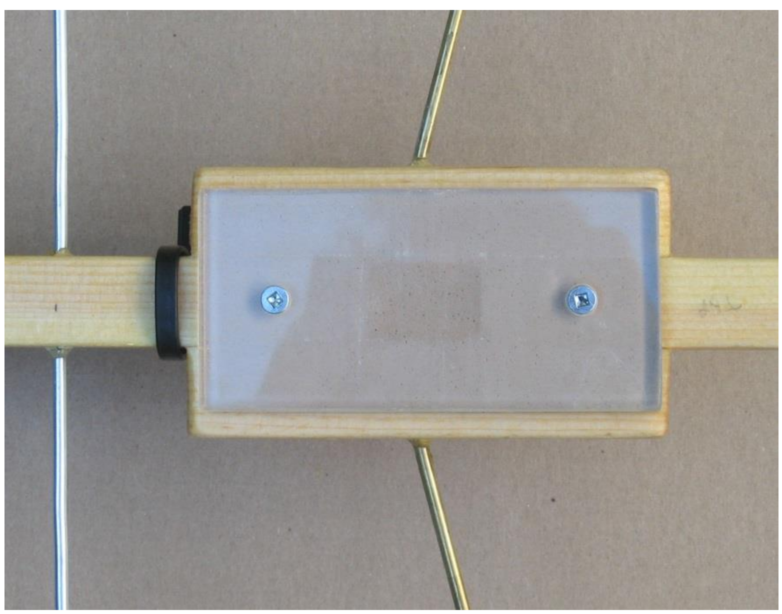
I put a single 1.125 inch long by 0.562" O.D. by 0.250" I.D. Type 43 ferrite bead on the coax near the driven element to reduce current flowing on the outside of the coaxial cable. The impedance of this as a choke may be a bit marginal and possibly two beads would be better (and could certainly handle more transmitter power). I have used this antenna only at about 10 watts. You can just see the ferrite in the second photo, under the boom between the connector and the driven element. That photo was taken before varnishing the boom. After the varnish was dry I fastened the ferrite bead to the boom with a cable tie, as seen in the third photo.

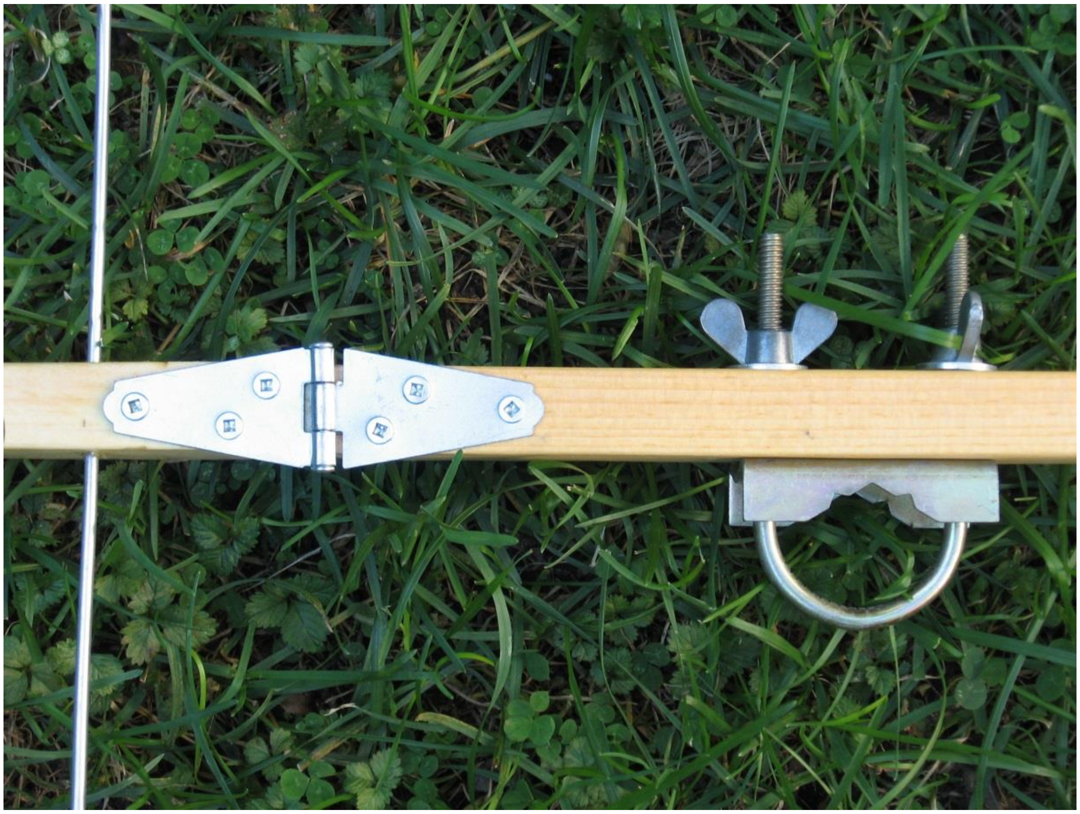
6. *Feed Cover*

The boom gap at the feed point is protected from rain by a small piece of Plexiglas (any rigid plastic or thin wood would probably do) which is held in place with two screws into the boom. I put a thin piece of foam (from Michael's) between the cover and the wood as a gasket. Alternatively it could be sealed with silicone sealant.

7. Photographs



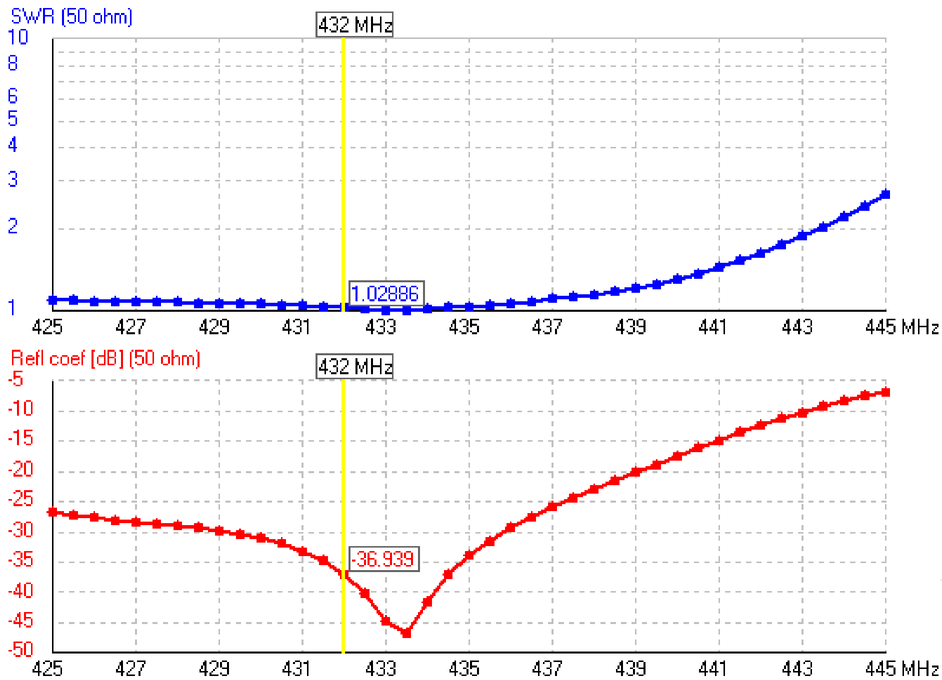


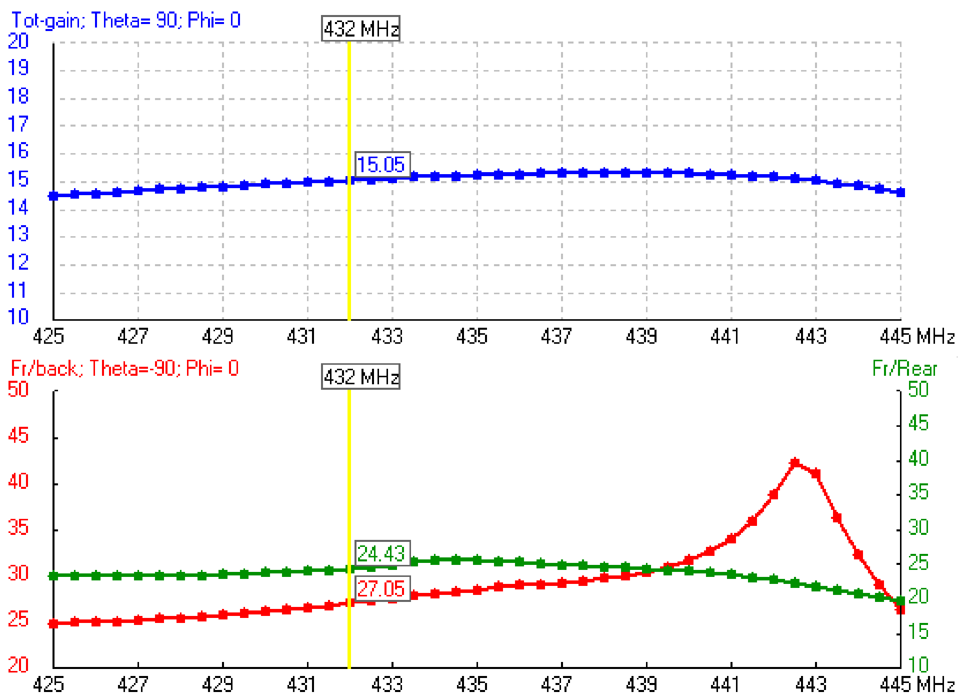


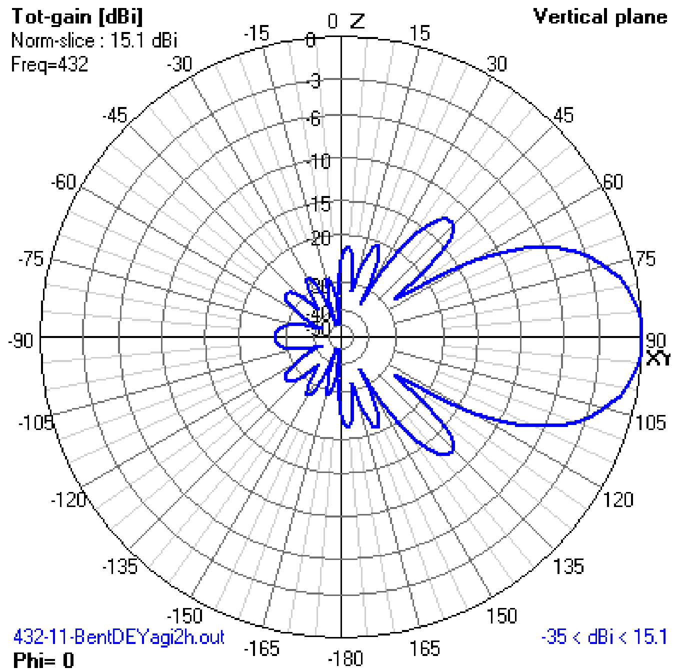
8. __Predicted Performance__

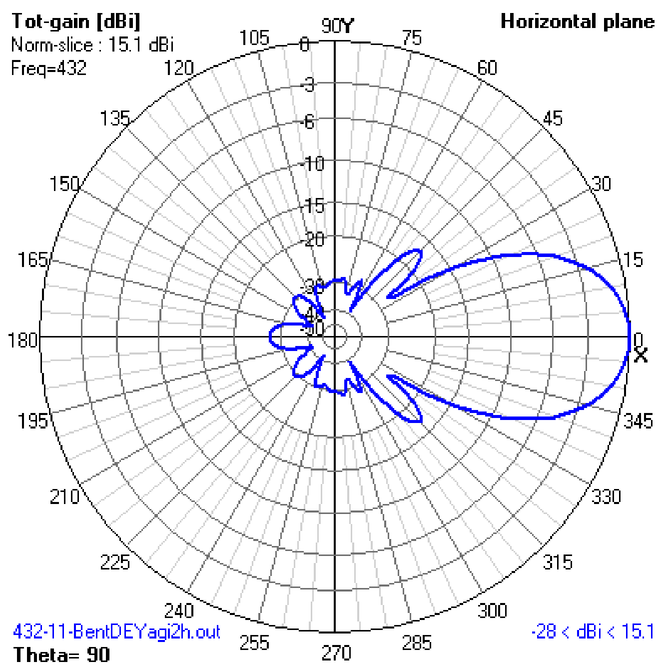
Software: 4NEC2

Assumptions: No conductor loss, no balun loss.









9. *References*

[1] http://www.qsl.net/ve3sma/Length_Correction_for_Solid_Yagi_Elements.pdf

[2] http://dg7ybn.de/Milestones_Bent_DE_Yagi_Design.htm