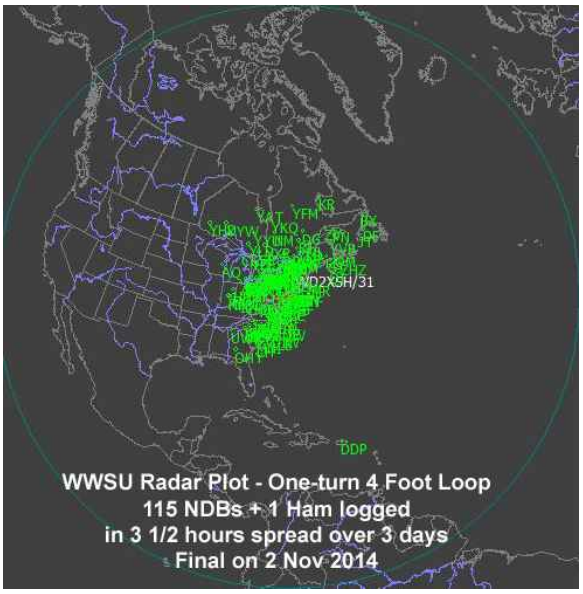
Part 2 - LZ1AQ One-turn 4 Ft Loop

Antenna	Diameter	Construction	L (uH)	R (Ohms)	Area (ft^2)
One Turn 4 ft	4 Feet	½" Al Tubing	3.6	0.0130	12.6

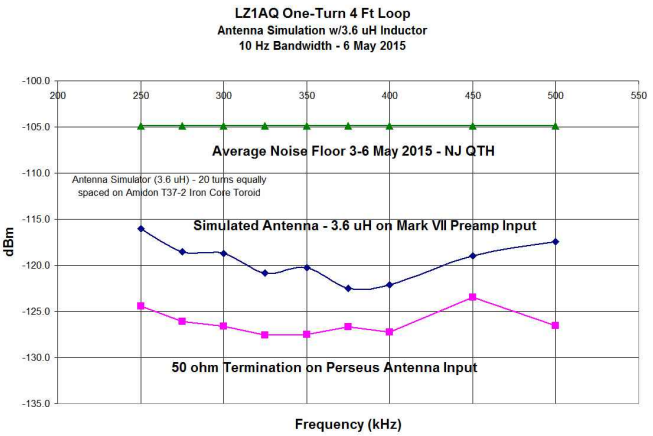
Signal & Noise - LZ1AQ One-turn 4 Ft Loop Mark VII Preamp - 4/6 May 2015 - Bandwidth 10 Hz					
		Signal (dBm)	Noise (dBm)	Signal/Noise	***Δ(S/N)***
NEL_396					
	LZ1AQ Loop	-73.2 ± 0..4	-114.9 ± 3.3	41.7 ± 3.4	***-4.4***
	ALA1530	-70.7 ± 0.3	-116.9 ± 3.3	46.1 ± 0.5	
RNB_363					
	LZ1AQ Loop	-84.8 ±0.5	-116.2 ± 3.9	31.9 ± 1.5	***-2.1***
	ALA1530	-81.4 ± 0.4	-116.8 ± 0.8	34.0 ± 4.4	
TT_369					
	LZ1AQ Loop	-79.5 ± 0.2	-113.8 ± 1.1	-30.9 ± 0.9	***-5.9***
	ALA1530	-77.1 ± 0.4	-113.9 ± 0.4	36.8 ± 0.7	
				Average =	***-4.1***
Δ(S/N) = (S/N LZ1AQ Loop) - (S/N Wellbrook ALA 1530 Loop)					



With both the antenna gain below and noise floor about the same as that of the Wellbrook, the net effect is that in a signal/noise comparison this loop is slightly inferior to the reference-serving Wellbrook ALA 1530 Loop.

But, as the above WWSU Radar Plot demonstrates, it still quite useful for DXing. In this plot note that this antenna was allotted only 3 1/2 hours of listening time ... about 1/3 the time given the other loop which were impatiently waiting in the wings for their turn at center stage. Presumably propagation conditions were good during this abbreviated period since even with this foreshortened listening time, this antenna served in logging a beacon about every two minutes.

However with only a four foot aperture, it cannot be expected to match its much larger siblings in overall performance ... and it does not do so.



LZ1AQ Two-turn 4 Ft Parallel Loop					
Antenna	Diameter	Construction	L (uH)	R (Ohms)	Area (ft^2)
Two-turn Parallel Connected Current adding connection. The loops are separated by 7 inch spacers.	4 Feet (each loop)	#8 Cu Wire	2.5	0.087	50.2
Diameter: AWG #8 Stranded Wire 0.1285 inches/3.264 mm					

Signal & Noise - LZ1AQ Two-turn 4 Ft Parallel Loop Mark VII Preamp - 1/3 May 2015 - Bandwidth 10 Hz - NJ QTH					
		Signal (dBm)	Noise (dBm)	Signal/Noise	*Δ(S/N)*
NEL_396					
	LZ1AQ Loop	--67.0 ± 0.1	-114.1 ± 2.5	47.1 ± 2.5	***+1.0***
	ALA1530	-70.5 ± 0.3	-118.6 ± 0.8	46.1 ± 0.8	
RNB_363					
	LZ1AQ Loop	-83.9 ± 0.8	-116.0 ± 1.5	32.1 ± 1.0	***-3.7***
	ALA1530	-80.4 ± 0.7	-116.1 ± 1.2	35.8 ± 1.0	
TT_369					
	LZ1AQ Loop	-79.7 ± 0.4	-113.1 ± 1.5	33.4 ± 1.3	***-3.0***
	ALA1530	-76.7 ± 0.2	-114.8 ± 0.6	37.4 ± 0.5	
				Average =	***-1.9***
Δ(S/N) = (S/N LZ1AQ Loop) - (S/N Wellbrook ALA 1530 Loop)					

Two identical versions of this loop were available for measurements - one at my NJ QTH (picture at right), the other at my secondary QTH in TN. No significant difference in performance were found. Only the NJ data are shown in the table above.

The two loops comprising this antenna were separated by 7 inch spacers. No attempt was made to vary this distance. Chavdar L. (*loc. cit.)* constructed this loop with a separation in the range of a few centimeters

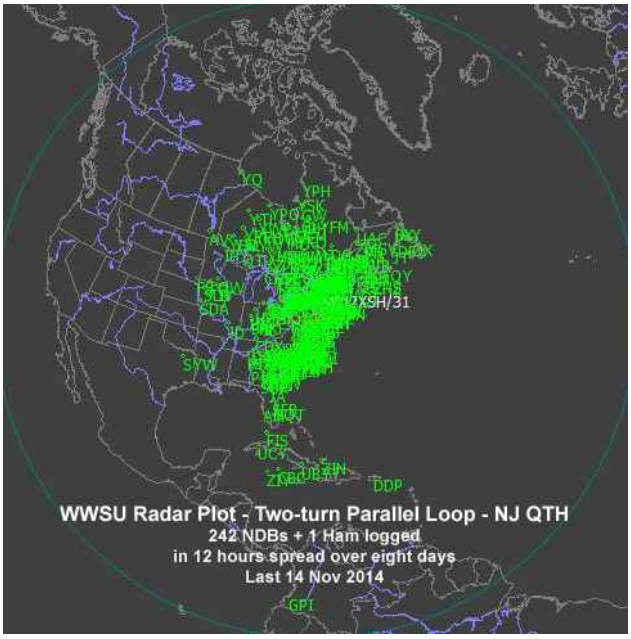
Although the daytime data in the above table indicates that this loop is has a higher noise floor and lower gain than the Wellbrook ALA 1530 Loop, it was found to be an excellent nighttime DX performer as the WWSU Radar Plots on the next page demonstrate.

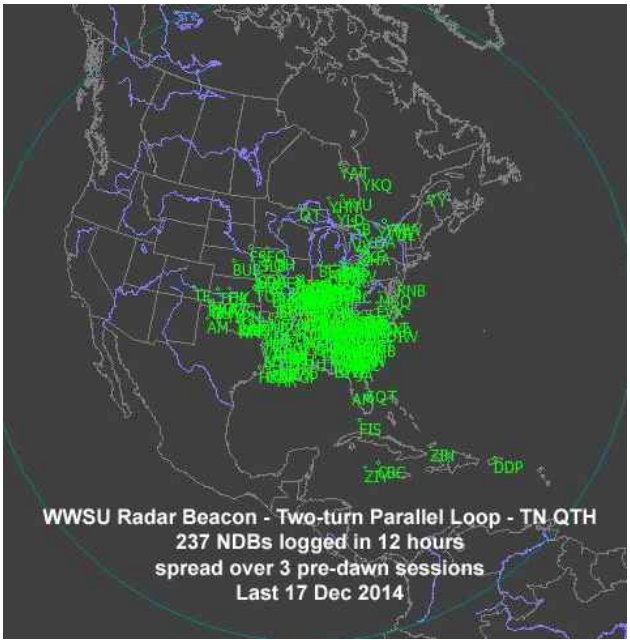
Additional: If the two loops of this antenna are identical in construction and if they are strapped so their currents oppose rather than add, then in the ideal case such a configuration would be moribund as concerns signal reception. This affords a method of checking the symmetry of the antenna's construction.

Such was done. Of the three test signals, two were down by ~23 dB from the correct strapping connection, the third (at 75 miles distance) could not be heard. Surprisingly, minor deforming the circular configuration had little effect ... less than ~1 dB.

(Pic above) Two-turn Parallel-connected loop at the NJ QTH ... distinguished by red/green loop wire. A picture of the TN version ... distinguished by black/white loop wire ... is shown on the next page.

This loop is a strong DX performer witness the WWSU beacon display for a total of 12 hours of listening in NJ (pic at left) and for a session of equal length in TN (pic at right). Consider that a total of 240 beacons logged in a 12 hour period averages to about one log entry every three minutes.





A coax switch enabled ready switching between the LZ1AQ and Wellbrook Loop which allowed comparison of the relative nighttime performance of these loops. For example, the entry for GPI_309 Guapi Apt, Columbia, South America, 2604 miles distant from the NJ QTH, was first detected by the Two-turn Parallel Loop. Next switching to the Wellbrook loop, it could not be hear ... back to the LZ1AQ Loop and the signal reappeared.

(Pic Left) Antenna on test stand (aka deck umbrella holder) awaiting transfer of the Mark VII preamp.

(Pic Right) LZ1AQ Two-turn Parallel-connected Loop at 30 feet at the Middle Tennessee secondary QTH.

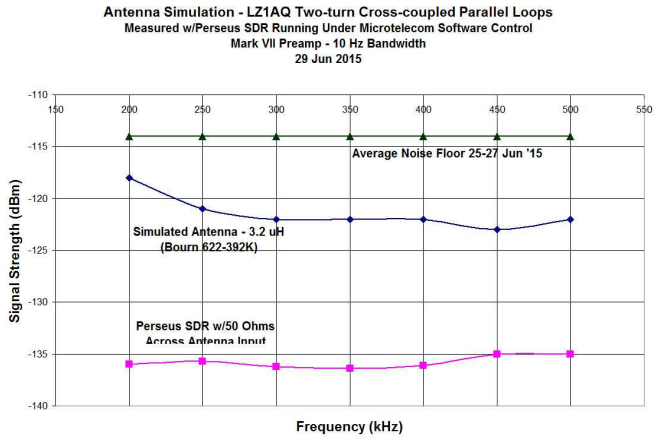
WIRE VERSION

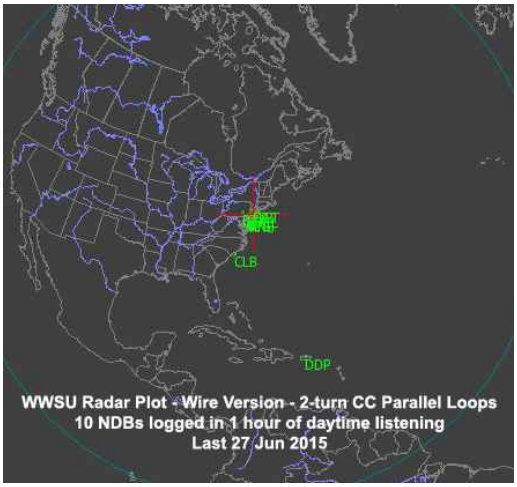
LZ1AQ Two-turn Crossed Parallel Loops - Wire Version					
	Loop Design	Const	L (uH)	R (Ohms)	Area
Wire Version	Square - 4 feet on edge	AWG #14 Stranded Wire	3.1 (5.9 & 5.7 each loop)	0.024	16 ft^2
AWG #14 Stranded Wire: Diameter = 0.0641 in / 1.628 mm, 2.525 ohms/1000 ft					

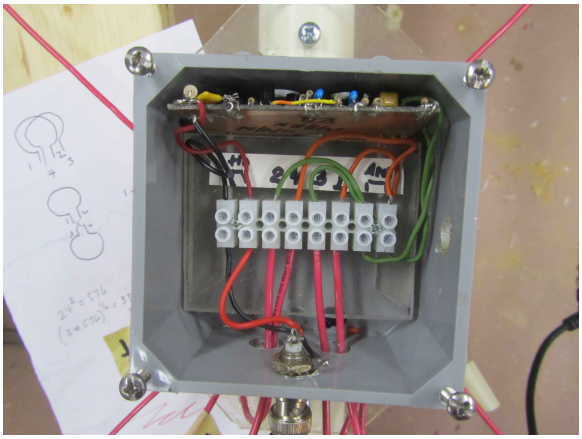
Two version of this configuration are presented - one constructed with #14 gauge wire (this page) and a second of identical dimensions but constructed with 1/2 inch tubing (next page).

Signal & Noise - LZ1AQ 2-turn CC Loop (Wire Version) Mark VII Preamp - Bandwidth 10 Hz					
		Signal (dBm)	Noise (dBm)	Signal/Noise	*Δ(S/N)*
NEL_396					
	LZ1AQ Wire	-76.7 ± 2.1	-114.5 ± 3.4	37.9 ± 4.4	***-3.9***
	ALA1530	-73.1 ± 0.9	-114.9 ± 0.8	41.8 ± 0.7	
RNB_363					
	LZ1AQ Wire	-86.7 ± 1.7	-116.8 ± 0.8	29.1 ± 1.7	***-3.5***
	ALA1530	-83.1 ± 0.3	116.8 ± 0.8	32.6 ± 1.0	
TT_369					
	LZ1AQ Wire	-83.0 ± 1.4	-115.3 ± 1.1	32.2 ± 2.2	***-3.5***
	ALA1530	-80.2 ± 0.3	-114.9 ± 1.7	35.6 ± 1.8	
				Average =	***-3.6***
Δ(S/N) = (S/N LZ1AQ Loop) - (S/N Wellbrook ALA 1530 Loop)					

As distinct from the tube version of this loop this wire version behaves as expected for NDB reception - good gain and low noise floor along with deep nulls. Also determined that could readily copy daytime signals in the MF band - WWV at 10 and 15 MHz.







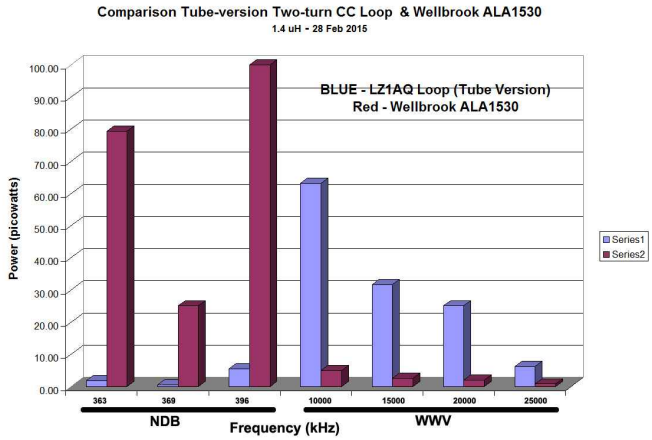
(Pic above) Radar plot for a much abbreviated daytime listening session with this antenna. Note that DDP is 1573 miles southwest of my NJ QTH … a long haul in daytime.
(Pic above right) View of interior of antenna box displaying the strap connections (orange and green wires) to the antenna's loop wire (red leads coming through the bottom of the box).

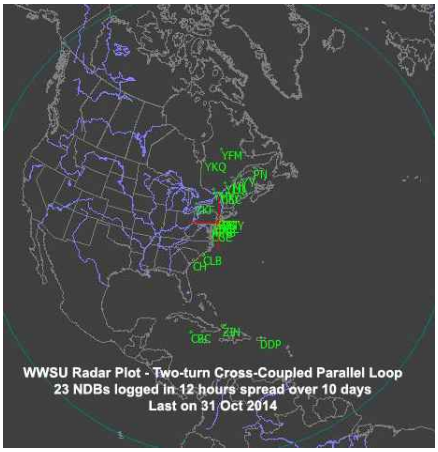
TUBE VERSION IS NOT AN EFFECTIVE ANTENNA FOR NDB DXING

LZ1AQ Two-turn Crossed Parallel Loops - Tubing Version					
	Loop Design	Const	L (uH)	R (Ohms)	Area
Al Tubing Version	Circular 4 feet diameter	1/2 " dia Al tube	1.4	0.087	25.1

This was the second of the seven LZ1AQ antennae constructed in NJ. The initial measurements gave puzzling results for its gain for NDB signals was down ~ 20 dB relative to that of the Wellbrook ALA 1380. Also it exhibited no nulls, or if they were there, the effect was too small to be detected. The antenna was behaving akin to an omnidirectional antenna. Yet it was picking up NDB at distances >1000 miles. Frustrated, the antenna was set aside to allow further thought.

After gaining experience with three other LZ1AQ configurations, it became clear that this tube version was performing as designed but that, as constructed (with tubing), it would not be effective as an NDB antenna. This conclusion was confirmed later when four daytime WWV signals in the range 10 – 25 MHz were received with good signal strength. As constructed, this version was behaving as an excellent wideband antenna for the MF and HF range, exactly as Chavdar L. had intended. (See chart below.) But Its low-frequency roll off of 6 dB/octave, beginning at ~673 dB (calculated), resulted in too low overall gain for useful NDB DXing.

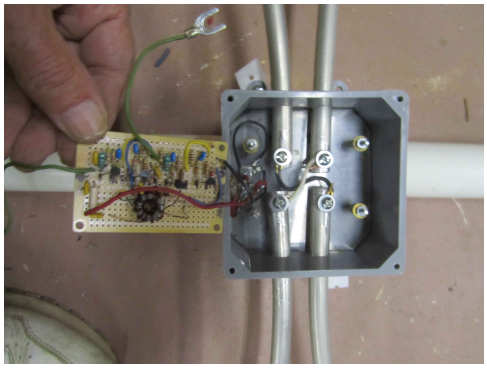




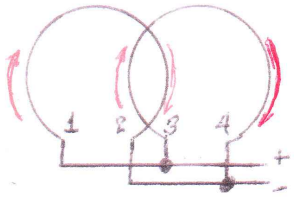
(Chart above) Comparison of LZ1AQ Two-turn CC Loop (Tube Version) performance with that of the Wellbrook ALA1530 Loop in two different frequency ranges.

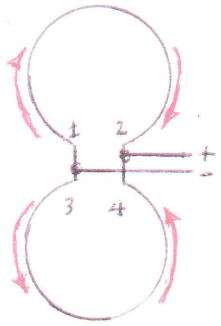
Radar Plot above right) Only 23 beacons logged but four are at distances >1000 miles ... YFM, YKQ, CBC, and DDP . It was the logging of these distant beacons that caused me to be initially confused concerning the measured low antenna gain for NDB signals.

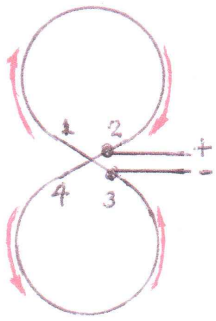
(Pic right) Mark VI Preamp awaiting preamp insertion into the antenna pole box of tube-version antenna. Note the cross-connected strapping of the antenna's loops. The green wires leading out from the preamp board remain to be connected to the loop tubing.



Evolution of the Cross-coupled Parallel Loop
After Chavdar Levkov (LZ1AQ)







For ease in presentation the Antenna Reciprocity Theorem is used in developing the following since determining the H-field due to the current in an antenna being driven by a tranmitter is a more transparent task than determining the current flow within the antenna elements induced by an external H-field.

1. The topmost figure depicts two exactly identical loops connected in parallel being driven by an rf current source. The loops are superimposed but slightly separated and lie parallel to the plane of the diagram.

The xtmr current (red lines) necessarily divides equally between the two loops and, since the current flows add, the resultant external H-field from the loops also add. This is Chavdar's Two-turn Parallel Connected Loop configuration [as opposed to the cross-coupled configuration. See (3) below.]

2. The middle figure is obtained by rotating (only) one of the loop in (1) by 180° about a horizontal axis. The individual loop connections remain the same as in (1) with the result that the xtmr currents flow in opposite directions and the resultant H-field is exactly nulled .

This configuration cannot serve as a receiving antenna but the opposing current feature does have use in NDB transmitting antenna design. (See 'Additional' below.).

3. In the bottom most figure the bottom loop (only) of (2) is rotated through 180° about a vertical axis again with the xtmr-connecting wires unchanged. This last rotation causes the xtmr currents flowing in each loop to add and hence the resultant H-fields add. This is Chavdar's Two-turn Cross-coupled Parallel configuration.

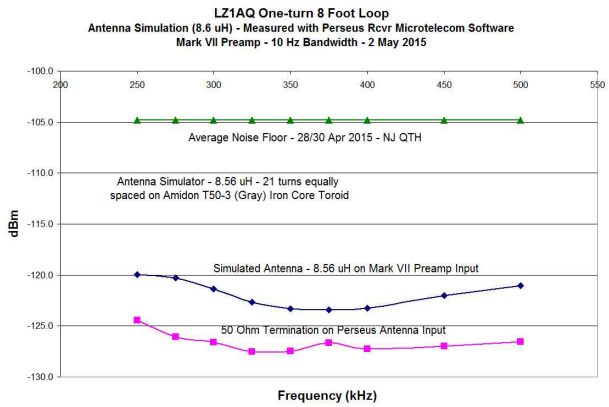
Additional: The cancellation of H-fields by current flowing in opposite directions as in (2) above is not restricted to loops. For example, in a symmetric-T NDB antenna connected at its mid-point to the overhead capacity-loading wires, the currents flow in opposite direction in/out from the midpoint.

If these two wire sections are of identical length and located on a common axis, the far-field arising from these currents exactly cancel. Hence when viewed (at far-field) the antenna radiates only in a vertical mode from its vertical member. The current charging/discharging the capacity top-loading wires must flow through the vertical member increasing its radiated power output (antenna's effective height). Such is the mechanism of increasing an antenna's power output by top-loading when viewed from the perspective of the physics involved.

Likewise, to be effective in using the same field-canceling mechanism, a spider-web top hat loading scheme must always contain an even number of spokes symmetrically arranged.

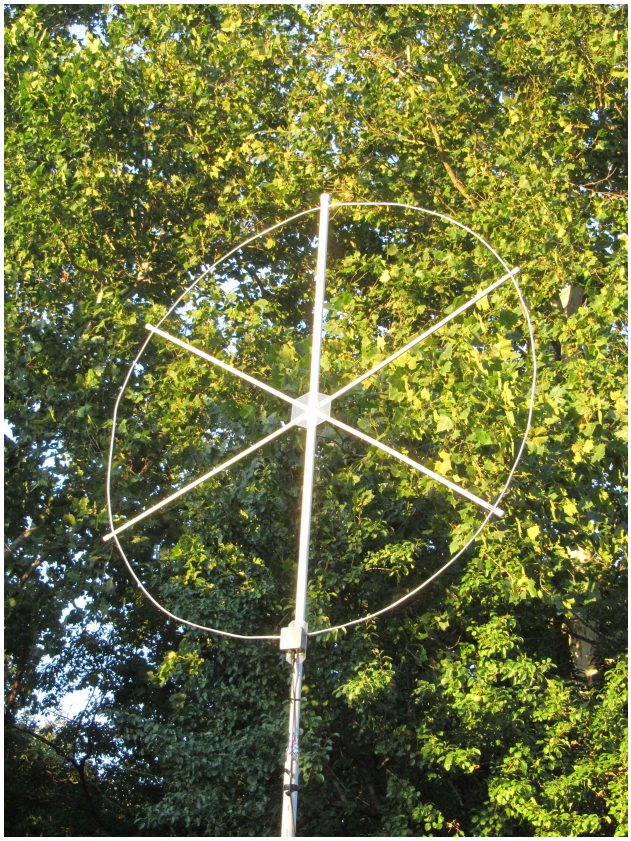
LZ1AQ One-turn 8 Ft Loop					
Antenna	Loop Diameter	Construction	L (uH)	R (Ohms)	Area (ft^2)
One Turn 8 ft	8 Feet	3/8 ” Al Tubing	8.6	< 0.1	50.3

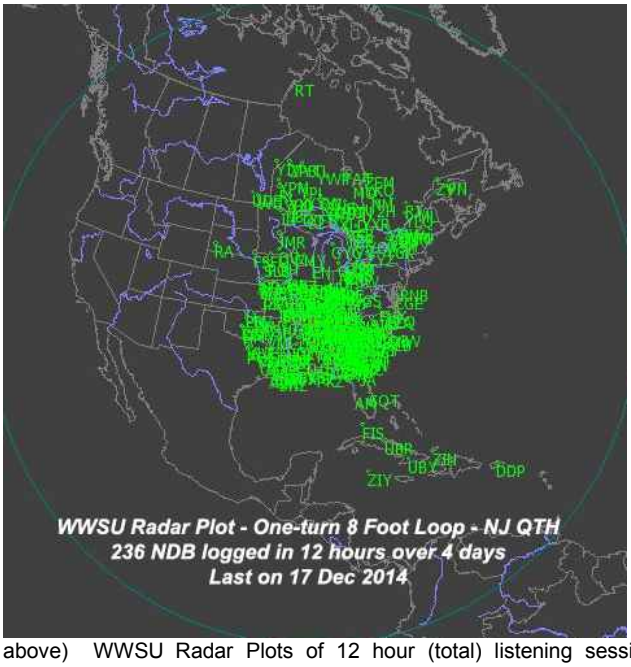
Signal & Noise - LZ1AQ One-turn 8 Ft Loop Mark VII Preamp - 28/30 Apr 2015 - Bandwidth 10 Hz					
		Signal (dBm)	Noise (dBm)	Signal/Noise	*Δ(S/N)*
NEL_396					
	LZ1AQ Loop	-67.0 ± 0.5	-115.3 ± 1.2	48.3 ± 1.3	*+2.7*
	ALA1530	-70.5 ± 0.7	-116.1 ± 2.0	45.6 ± 2.2	
RNB_363					
	LZ1AQ Loop	-77.3 ± 0.5	-113.0 ± 0.8	35.7 ± 1.0	*+2.5*
	ALA1530	-80.5 ± 0.4	-113.6 ± 1.7	33.2 ± 1.6	
TT_369					
	LZ1AQ Loop	-73.3 ± 0.1	-111.7 ± 1.5	36.4 ± 1.6	*+1.4*
	ALA1530	-76.6 ± 0.4	-113.7 ± 0.5	37.0 ± 0.6	
				Average =	*+2.2*
Δ(S/N) = (S/N LZ1AQ Loop) - (S/N Wellbrook ALA 1530 Loop)					

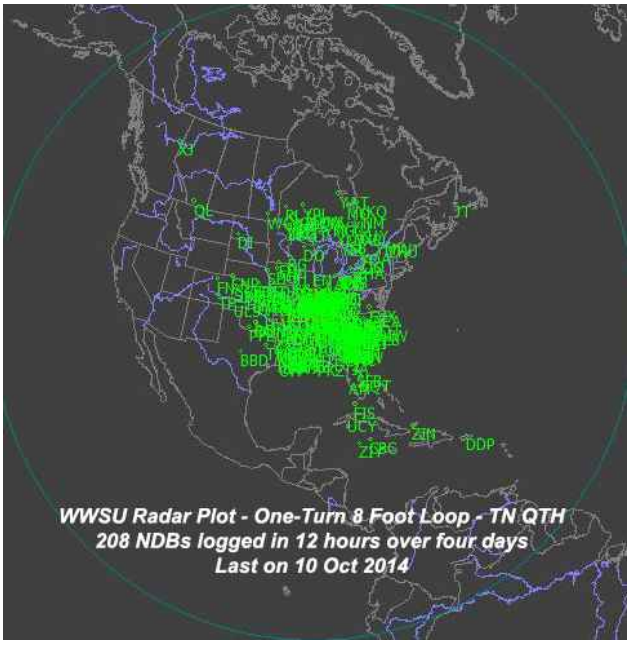


A superior performer .. lower noise floor and higher gain with respect to the reference Wellbrook Loop.

Two identical versions of this loop were constructed - one for use in New Jersey (see pic at right), the other for use in Tennessee (pic next page). Measurements on this pair gave sensibly the same results.





(Pics above) 

WWSU Radar Plots of 12 hour (total) listening sessions at primary QTH in NJ (left plot) and at secondary QTH in TN. The antennae in use were identical in construction. The same preamp (Mark VII) was used at both locations. Note that logging 200+ NDBs in a 12 hour period implies a log entry on average about every two minutes ... a strong performance since my log noted propagation conditions as being only "reasonable" during the listening periods.

(Pic above) LZ1AQ One-turn 8 Ft Loop standing majestically tall at 30 feet when installed at TN QTH during the period ending 10 Oct 2014.

(Pic at right) The antenna pictured above in Oct 2014 had withstood periods of snow, sleet, ice, and wind through coming the winter only to be humbled by ground-level straight-line winds in March 2015. These same winds brought down a few trees and fractured a 550 ft straight wire antenna (#14 wire 10 ft off ground) in two places. (The trees and wire antenna are out of view to the left in this picture.) But after falling from a height of 30 feet, its robust construction saved it from destruction. All of the PVC members were bowed by the misshaped tubing but otherwise there was no damage. When the tubing was straighten, the PVC members straightened ... the antenna was again ready for use.