209 km with New Narrow Beamwidth Transmitter

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A new 60 LED Transmitter has been constructed using small Fresnel secondary lenses to increase the gain by about 16 dBo in optical terms giving an expected 32 dBe improvement in electrical terms. In a test with this new transmitter on 24 November 2008, JT65a signals peaked at -6 dB on the WSJT scale over a 209 km cloudbounce path. The actual improvement in signal to noise ratio was measured at 26 dBe.

NEW TRANSMITTER

The new transmitter is based on the previous 60 Luxeon III approach using small plastic torch type lenses L2 Optics type L2OP005 which have a so called 5 degree divergence. One would therefore expect a 10 degree beamwidth. In practice this specification applies to the Luxeon I and the Luxeon III with its larger chip produces around 15 degrees beamwidth. The new Transmitter achieves its improved performance by narrowing the beamwidth from 15 degrees to around 2.2 degrees with secondary Fresnel lenses. The penalty is much greater difficulty with alignment but this can be accepted where long distances are involved and one only needs to make adjustments in azimuth as the elevation angle will always be very close to the horizon.

With the new transmitter the torch type lenses are used to focus the energy on a secondary Fresnel lenses of 330 mm focal length that have been cut down to a 12 cm square. It would require around twice the size of Fresnel lens to capture the majority of energy from the primary torch type lens and this would make the array impractical for transport so some loss estimated at around 3 dB optical has had to be accepted. The construction of the new TX is based on each LED with torch Lens being mounted on separate heat sinks that can be adjusted using oversized mounting holes to line each up in the same direction using a test board as shown in Figure 1.

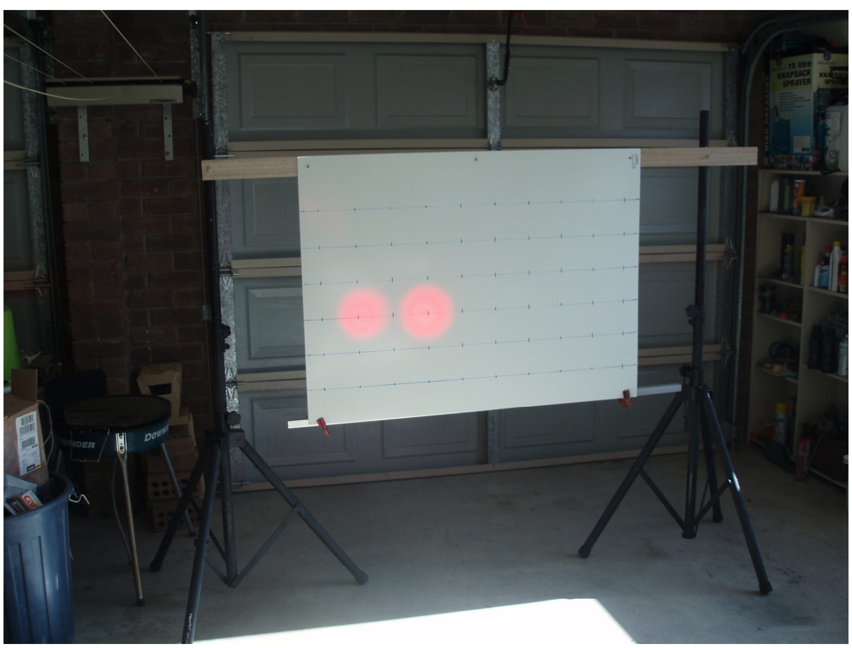

Fig1: Aligning individual units on a test board

Fig 2: The front view with VK7JG – photo courtesy of Alvin VK7NDQ

Fig 3: Rear View of new TX showing 60 Luxeon Heat sink mounts and Azimuth and Elevation arrangement, also VK7JG – Photo courtesy of Alvin VK7NDQ

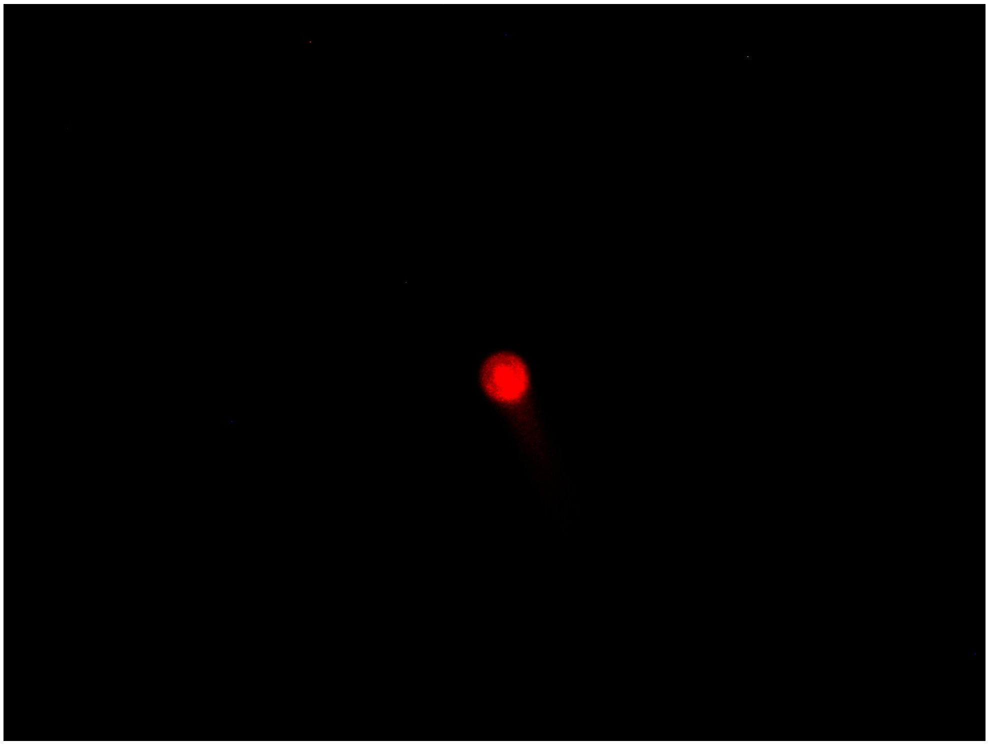

Fig 4: Photo of the narrow beam on the clouds – note central bright spot

Tests with the new TX gave an output of 275 microwatts per sq cm at 65 metres. Australian aviation safety requirements set various limits on light emissions depending on the distance from an airport. The intensity of this new TX is such that it is necessary to limit operations to beyond 10 NM of an airport and turn it off in the unlikely event that an aircraft approaches to within 120 metres. In practice we monitor it continuously and turn if off if an aircraft is visible.

Our tests showed that the new TX produced peak improvement in gain of 16.3 dBo and an average improvement of around l6 dBo over the 1.6 degree beamwidth of the RX. Thus if the narrower beamwidth TX could be perfectly aligned we could expect up to 32 dBe improvement in electrical terms.

RECEIVER

The receiver is the 10x10 mm large area APD unit described previously in the report of 8 September 2008.

PATH

The path as shown below is from a hill 70 metre above sea level near Circular Head, Stanley Tasmania to Mt Horror which is 687 meters above sea level.

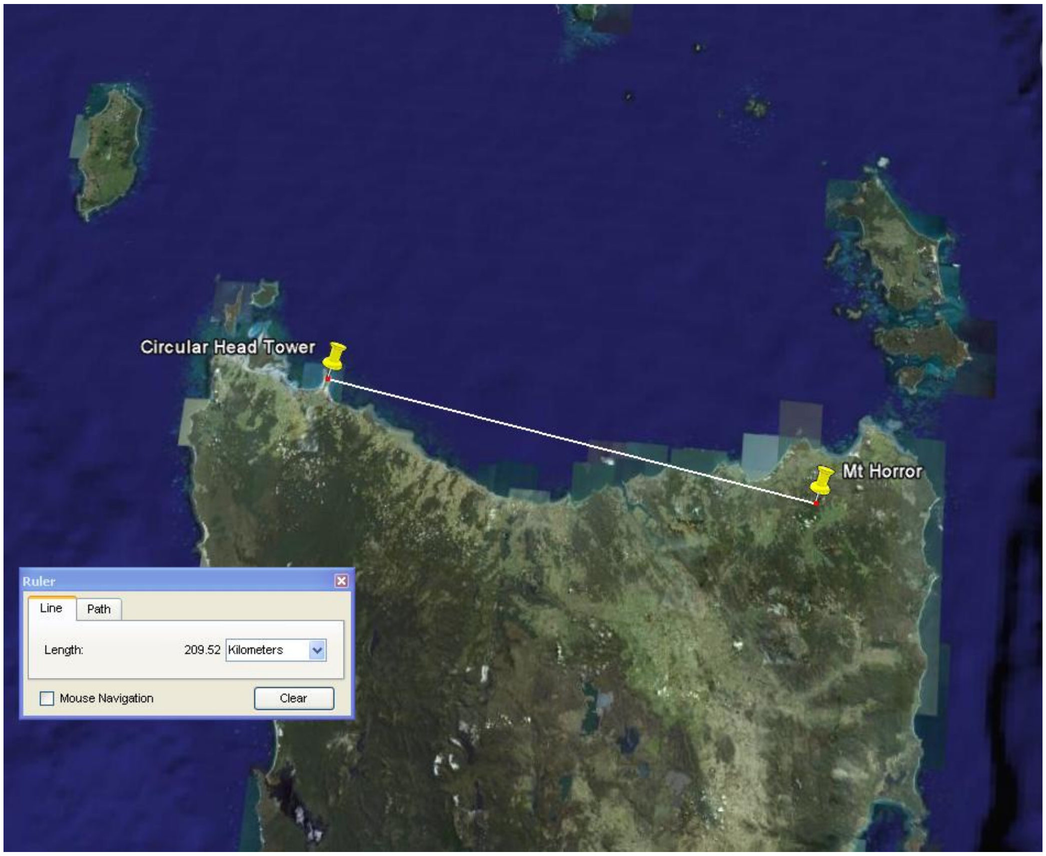

Fig 5 Path with VK7MO at Circular Head and VK7JG at Mt Horror

WEATHER CONDITIONS AND CLOUD COVER

On the morning of the test the Bureau of Meteorology Forecaster advised of expected cloud cover at one to two thousand feet with lower cloud later in the evening. This forecast was suitable and proved accurate with low cloud (fog) coming in at Mt Horror just after completion of the test.

Prior to the tests there was variable stratus cloud up to one to two thousand meters that sometimes extended to the horizon and could possibly block the path completely.

RESULTS

Spectrum Lab was used with 20 mHz bandwidth to measure the signal to noise ratio of a 824 Hz tone as shown in Figure 6 below. It is seen that early in the evening the signal was rising from a low value. This is partly because it was not dark and the sky noise was high but possibly also due to low clouds restricting the energy available to the receiver. A check around 10:PM showed the signal to noise ratio had stabilized at around 44 dB. At around 10:15 the transmitter was changed to the original transmitter and signals dropped around 26 dB compared to the expected 32 dB. The difference is possibly due to the difficulty of achieving good alignment of the narrow beamwidth TX but there could also be a change of conditions as it took some 10 minutes to change over. The gap in the data between about 9:00 PM and 10 PM is the period when WSJT tests were conducted.

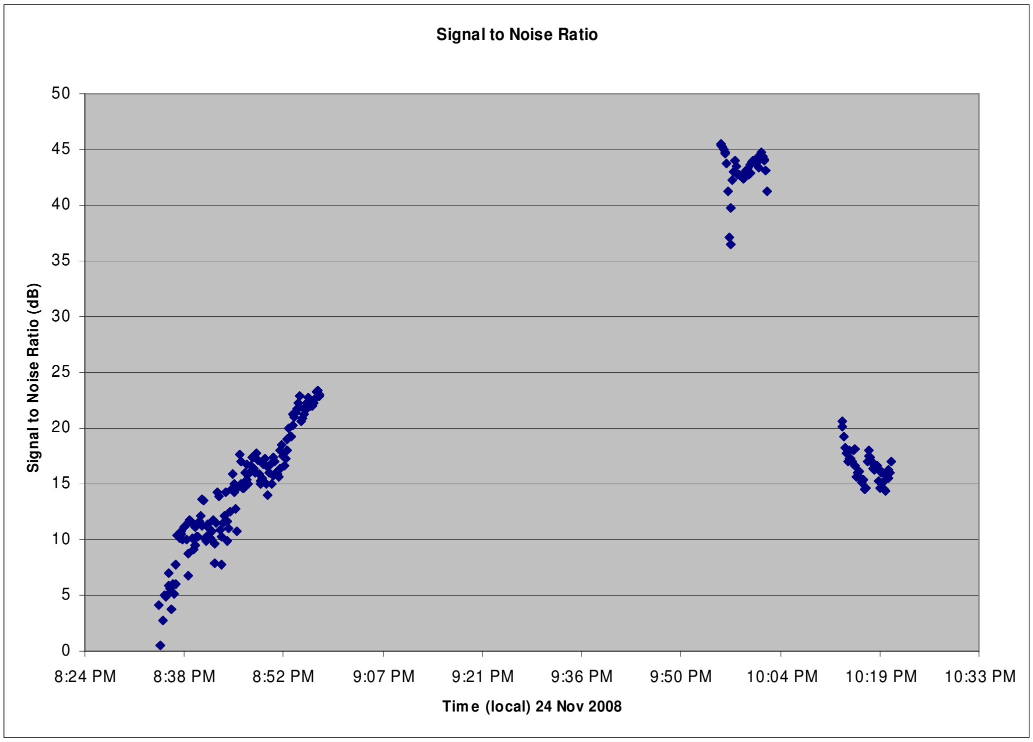

Fig 6 Signal to Noise ratio in 20 mHz BW for new TX up to 10:15, then for original TX.

The data transferred in the WSJT tests is below. Note the -22 dB signal report at 1047 is the result of a partial transmission when the generator supplying AC power to the TX ran out of petrol. The lack of a message at 1051 is because it was deleted as the operator used language which was entirely suitable to the excitement and success of the situation yet in-appropriate for general publication.

101900	16	-13	-0.2	0	3	*	VK7MO VK7JG QE38		1	10
102100	14	-12	0	0	3	*	VK7MO VK7JG QE38		1	10
102300	12	-11	-0.2	0	3	*	VK7MO VK7JG QE38		1	10
102500	17	-12	-0.2	0	3	*	VK7MO VK7JG QE38		1	10
102700	12	-15	-0.2	0	3	*	VK7MO VK7JG QE38		1	10
102900	11	-12	0	0	3	*	VK7MO VK7JG QE38		1	10
103100	15	-12	0	0	3	*	VK7MO VK7JG QE38		1	10
103300	16	-11	0	0	3	*	VK7MO VK7JG QE38		1	10
103500	17	-10	0	0	3	*	VK7MO VK7JG QE38		1	10
103700	2	-11	-0.2	0	3	*	VK7MO VK7JG QE38		1	10
103900	16	-7	0.2	0	3	#	VK7MO VK7JG QE38	OOO	1	10
104100	16	-7	0	0	3	#	VK7MO VK7JG QE38	OOO	1	10
104300	16	-7	0	0	3	#	VK7MO VK7JG QE38	OOO	1	10
104500	17	-7	0	0	3	*	CONGRATS REX		1	0
104700	0	-22	-1.8	0	0	#				
104900	14	-7	0.1	0	3	*	CONGRATS REX		1	0
105100	20	-7	0.1	0	3	*			1	0
105300	11	-6	0	0	3	*	CONGRATS REX		1	0

Fig 7 Data received using WSJT's JT65a

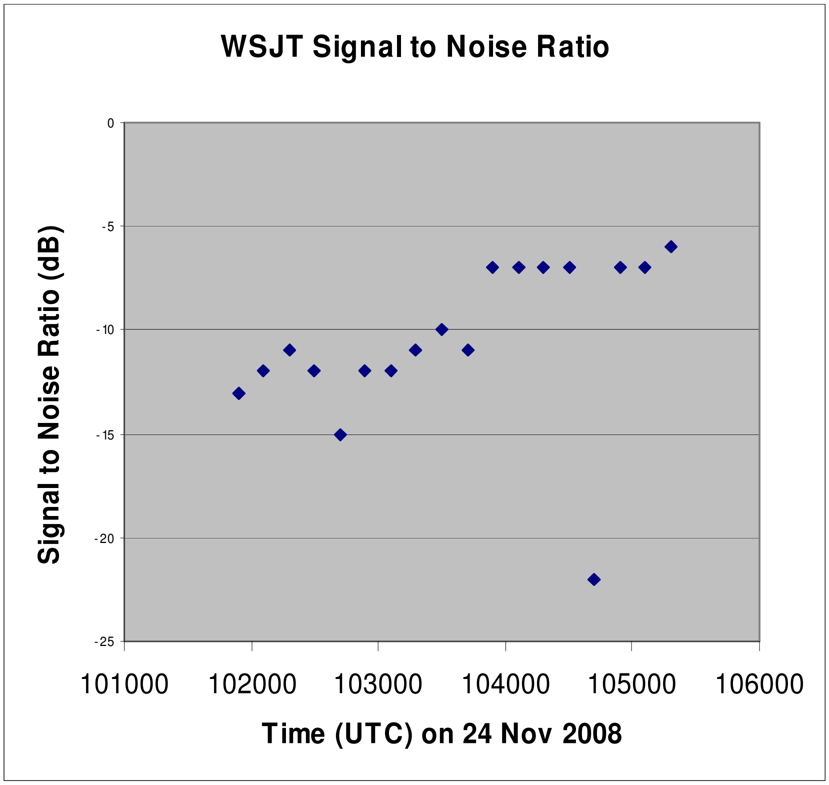

Fig 8 WSJT signal levels over Test

It is seen that the signal level continued to rise on WSJT from around -13 dB and then stabilised at around -7 dB with a peak at the end of -6 dB. While at the start this can be explained by it getting darker and thus reduced sky noise, it seems there must have also been an improvement in cloud conditions.

CONCLUSION

The new transmitter has demonstrated an improvement of 26 dB and has achieved signal levels under good conditions around -7 dB on the WSJT scale. As JT65a works to around -28 dB there is around 20 dB to spare over a 209 km path. The penalty with the new transmitter is much greater difficulty in alignment and the need to set the azimuth to within half a degree.