A PRELIMINARY NOTE ON DETECTION OF AIRCRAFT VOR NAVIGATION BEACONS

The French website http://www.retram.org/the-project/ recently brought to the attention of the BAA RAG discusses how to use FM radio stations and aircraft navigation beacons as possible transmitters for the detection of meteors.

What follows are my first explorations of this idea - and concentrates on the use of aircraft VOR beacons – specifically the one nearest to my location which is Brecon VOR on 117.45MHz.

Using a simple antenna this can be detected with good S/N about 40 miles away and using the techniques I have previously described for using the RTL dongle or the FCD Pro +. Good aircraft tracks have been observed. See Figure 1.

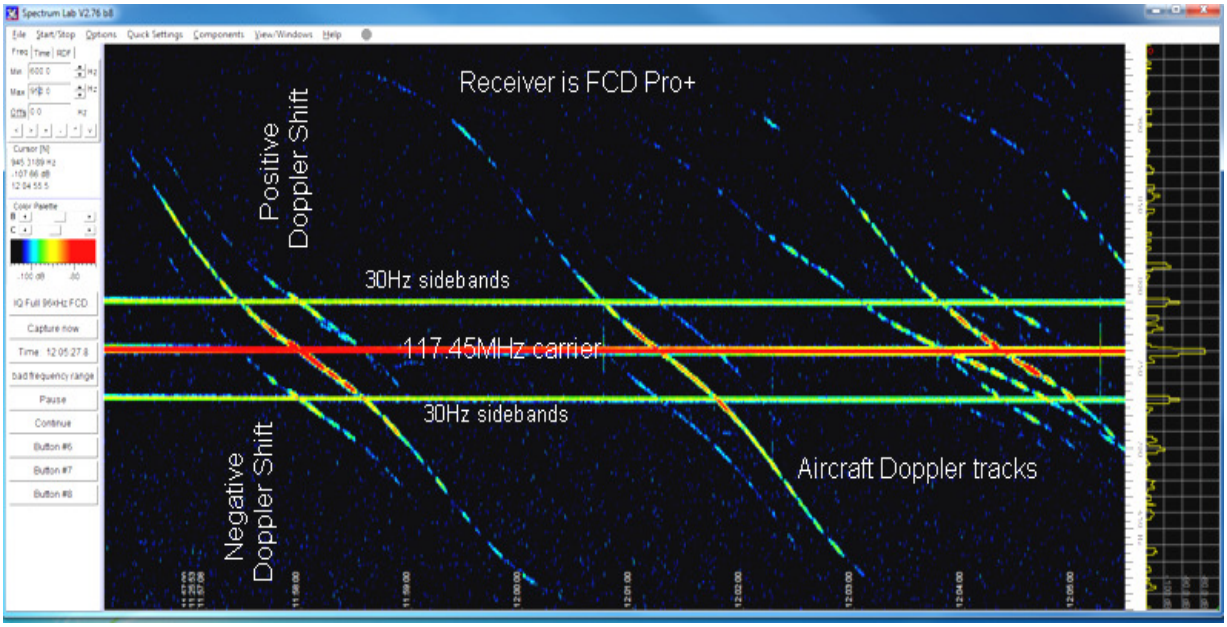

Figure 1 Aircraft Doppler Tracks from Brecon VOR

The Beacon is located as shown in Figure 2

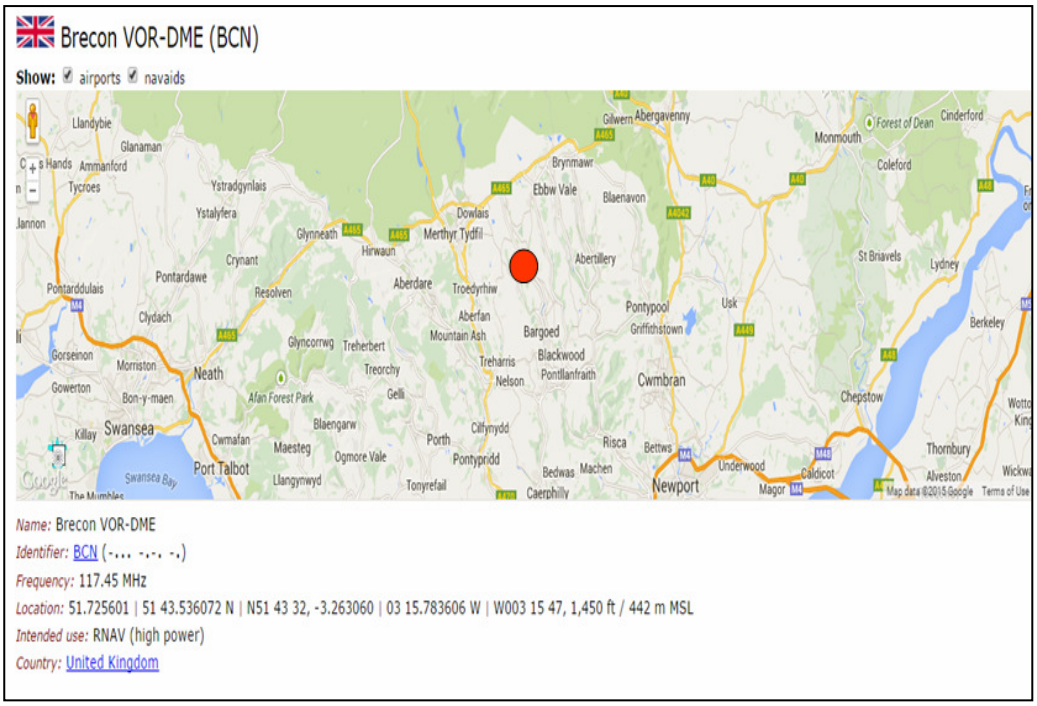

Figure 2 Location of BCN on 117.45MHz

A description of the beacon is given at http://www.trevord.com/navaids/ and is as follows :

General Principle
VORs operate in the 108 - 118Mhz VHF range (just below the aircraft air-ground voice channels). They are low power 25-100W and provide 5 degrees navigation accuracy.

The general principal of VOR technology is to have two seperate 30Hz modulations on the VHF transmissions from the VOR station. The VOR is arranged such that one of the 30Hz signals remains in the same phase at all reception positions around the VOR (Reference signal). The other 30Hz signal received (Variable signal) will differ in phase by exactly the angular displacement of the receiver around the VOR from the Zero radial. The aircraft receiver demodulates the two 30Hz signals and simply compares their phase difference.

An audio ident in morse code at 1020Hz is also transmitted to enable pilot identification of the VOR tuned and verification of its serviceability. Some VORs have speech audio channels carrying ATIS or other ident info.

Note the power is quite low, only up to 100W. For comparison the BRAMS beacon is 100W and this can produce detectable meteor echoes.

The Brecon VOR beacon is shown in Figure 3.

Figure 3 The Brecon VOR Beacon

The 30Hz sidebands produced by these beacons are bit of a nuisance if we are trying to detect meteors as the screen is very cluttered – especially if aircraft are present. The aircraft reflections also show the sidebands !

We can use the watch list plotter in spectrum lab to measure the strength of the received carrier (as described elsewhere) and the plot shows the rapid fading produced by the direct and reflected wave from the aircraft. See Figure 4.

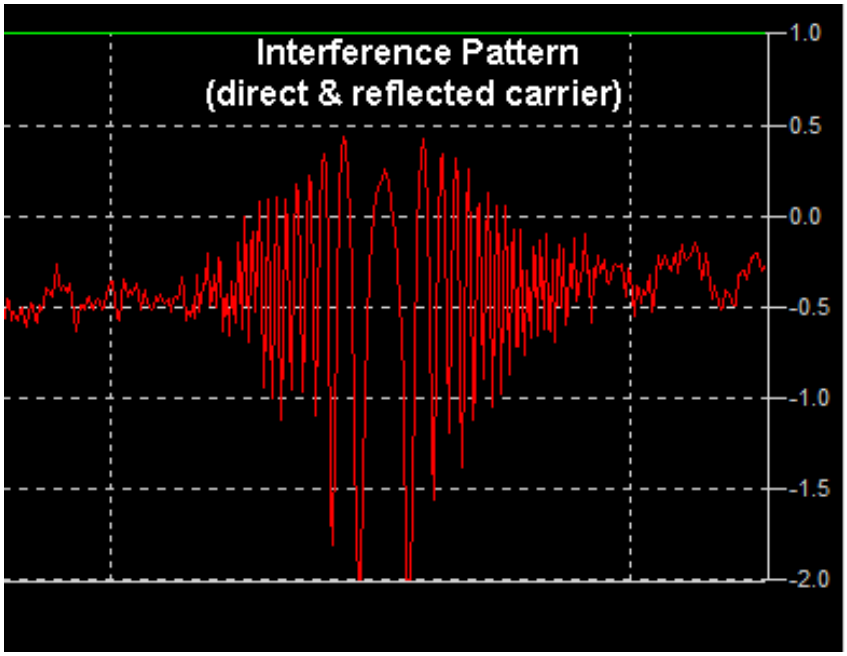

Figure 4 Interference Pattern from Aircraft

Two aircraft can be identified in Figure 5 . One is approaching and one is receding.

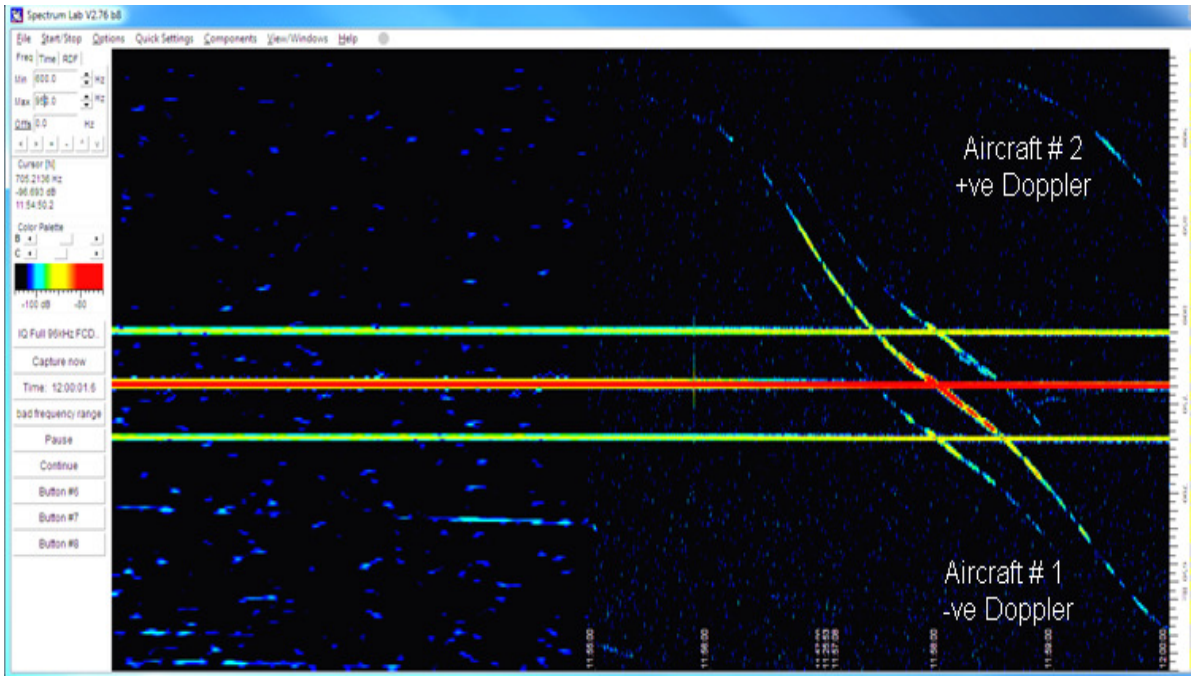

Figure 5 Doppler traces of 2 Aircraft

The aircraft are identified in Figure 6.

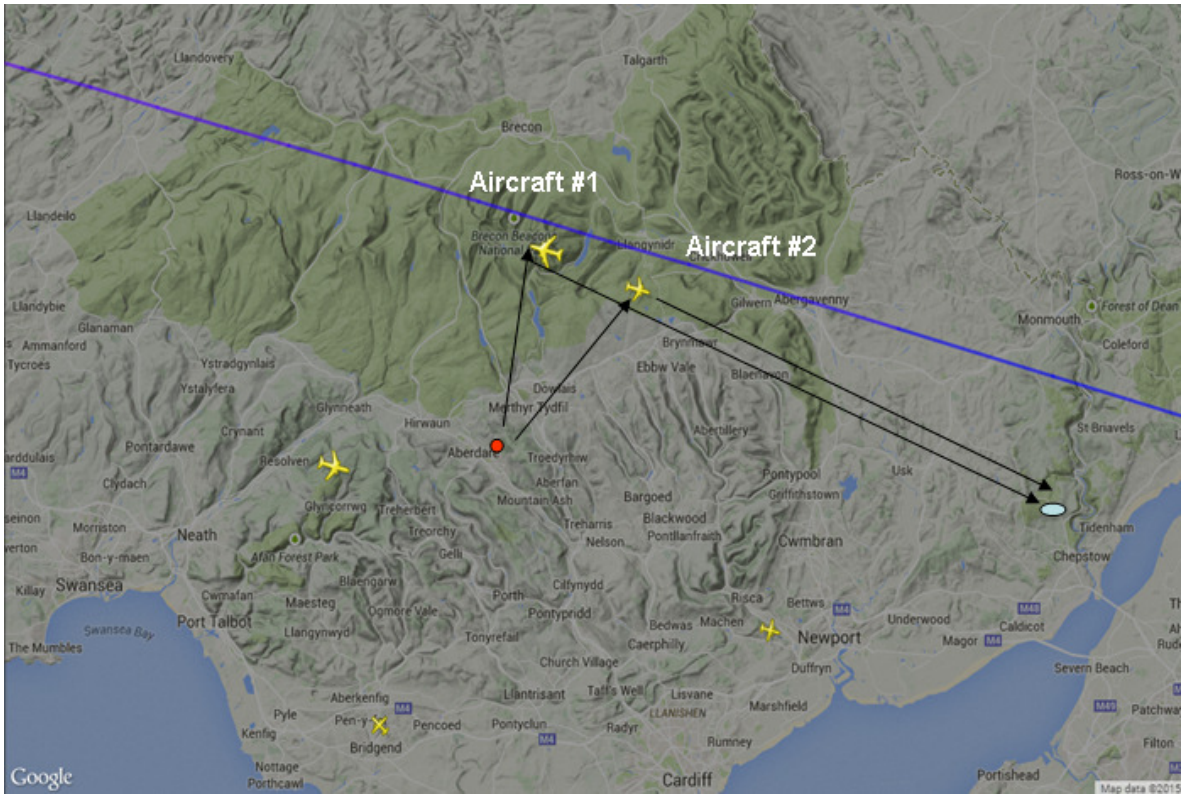

Figure 6 Just 2 Aircraft Detected

The beacon transmits an ID signal in morse code at F +1020Hz.,and can be seen in Figure 7.

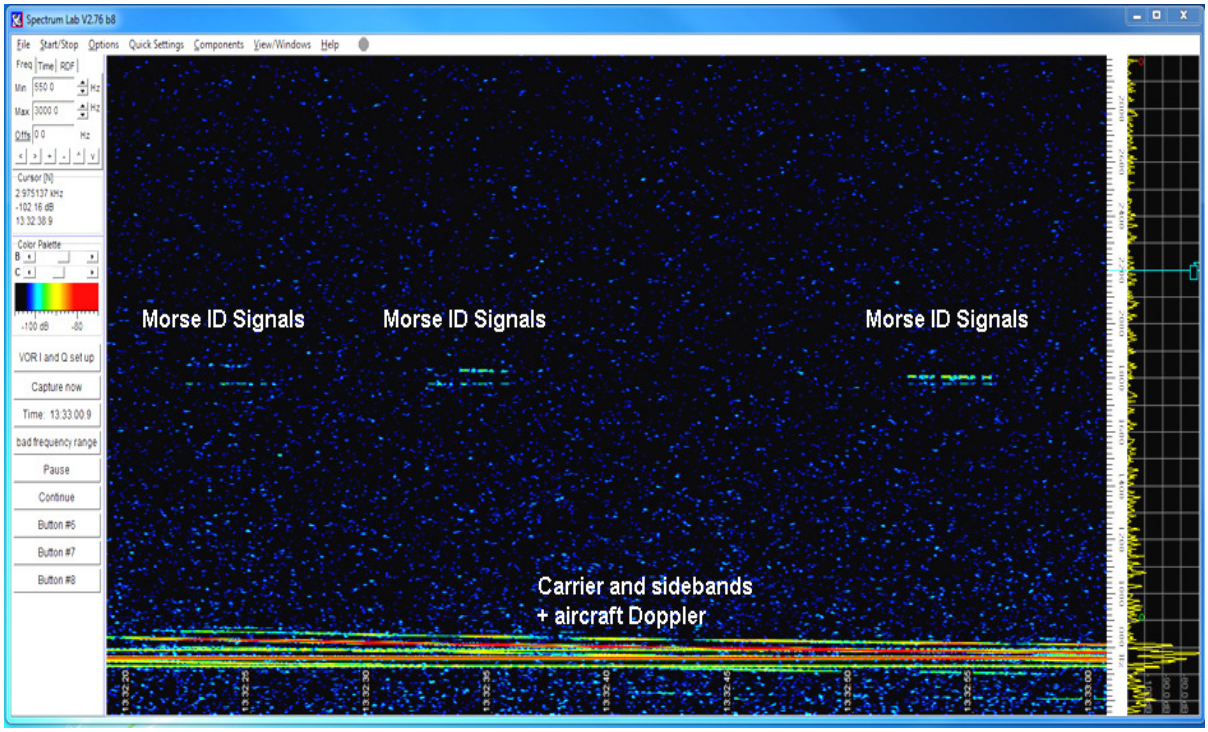

Figure 7 Morse ID Signals

It is important to establish where the Morse ID signals are in the spectrum and the waterfall plot, to avoid confusing them with possible meteor echoes.

An example of possible meteor echoes is shown in Figure 8. These occur on the carrier, not near the ID signals and have been shown to be not evenly spaced in time.

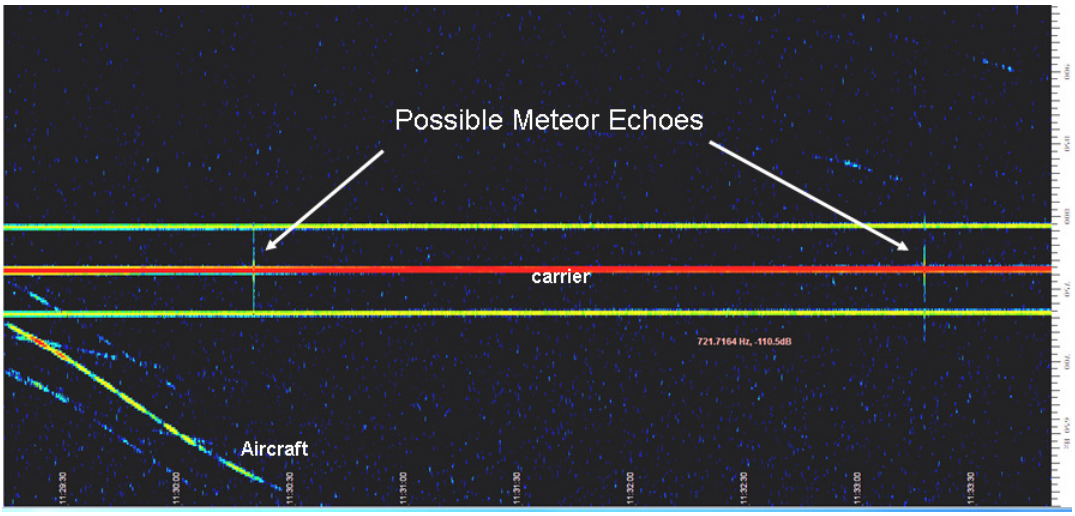

Figure 8 Possible Meteor Echoes

It is unlikely that the spikes on the carrier are interference. This would show up as covering multiple frequencies in a vertical line in the waterfall plot – and would not be associated with the carrier.

A possible meteor echo is shown in Figure 9. The time base has been speeded up in this plot.

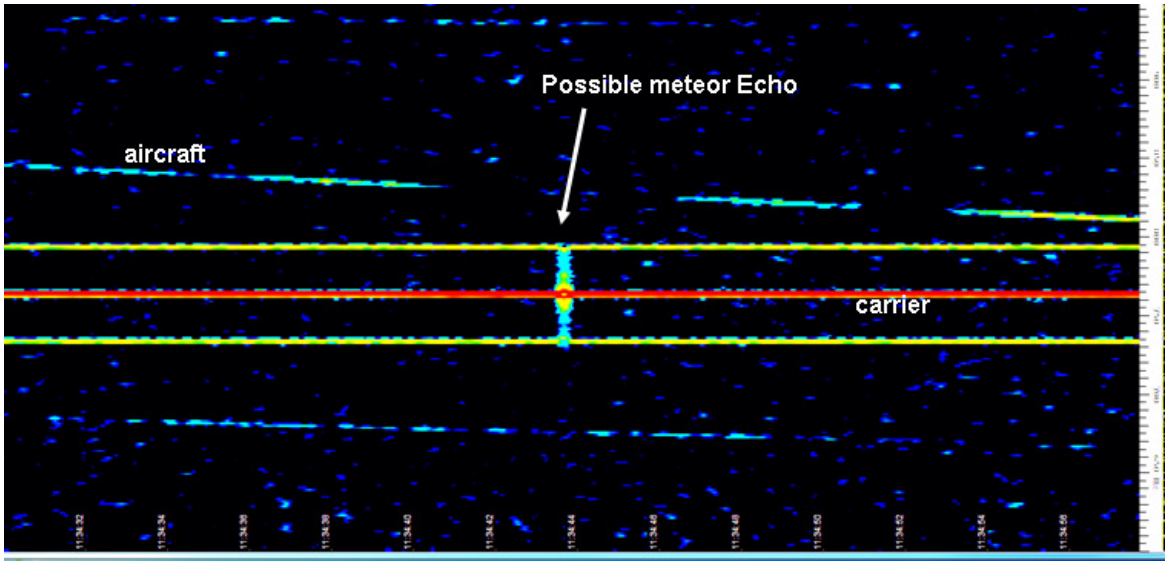

Figure 9 Possible Meteor echo from Brecon VOR Beacon on 117.45MHz

These experiments are very preliminary, I have only been looking at this for one day. I would be interested to see what other people could observe using beacons in range to them.

If nothing else, this note might encourage people to have a go at using these aircraft navigation beacons as suitable transmitters for meteor detection.

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