VHF/UHF – An Expanding World

David Smith VK3HZ

Weak Signal

David Smith - VK3HZ

This month, I thought I'd turn the Weak Signal section over to Alan VK3XPD. Alan and I recently completed some VK record-breaking contacts on the 78 GHz band using equipment built by Alan. He has done an excellent job with both the equipment and the write-up of the contacts so, over to him:

78 GHz in VK – New Distance Records

To date, unlike Europe, the activity on our 76/78 GHz Amateur segment in Australia has been in it's infancy meaning that activity is a bit sparse. It's perhaps not surprising with the obvious technical challenges, the limited availability of hardware and of course the $costs. Aside from my homebrew equipment, I'm aware of a few VK2 Amateurs who are building gear but I'm unsure if there have been any (other) successful QSO's claimed.

My 78 GHz gear is based on the popular DB6NT hardware. I'm not currently on the usual 76032.1 MHz Call Frequency because I did not have a suitable LO to get me there. Besides, we have secondary access all the way up to 81 GHz.

The critical element, an OCXO-locked 13.03 GHz source is tripled to 39.09 GHz at circa +20 dBm and it pumps a single Diode (Mixer) on a small PCB within a purpose-built metal housing. The 78.18 GHz LO is then mixed with a 432.1 MHz IF signal of about +7 dBm or 5 milliwatts. The output from this "bare" mixer is a Double Sideband Signal (DSB) at circa -1 dBm.

This relatively standard mixer hardware format is in fact a complete 76/78 GHz transverter. Then you couple the RF via waveguide to a small splashplate-fed dish/reflector or simply mount a horn on the waveguide aperture. In average conditions, with this "bare" mixer one can expect to achieve QSO's out to 20 km or more. I'm hoping to inspire some of you enthusiasts out there to build up gear like this and get onto this band.

So then… QRZ on 76/78 GHz ?

Around the time I was collecting parts for my 2 transverters (there's no point building only one unit cos who will I work with?) I became aware that Tom Williams – WA1MBA was doing a small production run of moderate $cost 76 GHz LNA's for amateur radio operators worldwide. Subsequently, I purchased 2 units to incorporate into my transverters.

To integrate an amplifier requires additional RF componentry. Firstly, I select the LSB of 77749.90 MHz with a homebrew 3-screw waveguide filter. This filter works best at passing the LSB and attenuating the LO and USB each by circa 20 dB. The filter's insertion loss of around 10 dB is quite high but it's not a problem. The LNA has a gain of circa 28 dB and a Psat of +10 dBm. So, it can be used as a Power Amplifier too!

To achieve this requires a 4-port waveguide switch (WR-15) to reverse the LNA on Rx and turn it into PA on Tx. The transverter is coupled via this 4-port waveguide switch to a 300 mm dish with integrated Cassegrain sub-reflector. The latter makes it very easy to illuminate the dish.

The current VK 78 GHz SSB distance record of circa 32 km was set in December, 2013 down at Port Fairy with Russell VK3ZQB as the other operator. Signal Reports

were huge at 5+9 plus 20 over!! Interestingly, the current World SSB record is 252 km set over an ideal path in the northern California desert by USA amateurs.

During recent testing on the bench, I was monitoring the frequency stability of my gear on both 47 GHz and 78 GHz. I found the 47 GHz gear was always well within one KHz of where it should be. It was adequate for SSB albeit with some ongoing thermal drift up/down - depending on local ambient temperature and breezes.

However, to my surprise I found the 78 GHz gear with it's OCXO Reference had "single Hertz" drift after about an hour of warm-up. This exceptional frequency stability immediately opens the door to the wonderful Digital Modes of WSJT.

After some discussions regarding the possibilities with David – VK3HZ, we decided to try extending the current 78 GHz National Record on SSB. There was no Digital Record at the time.

As part of the planning for this activity, we firstly needed to identify suitable Line of Sight (LOS) paths. The reason - unlike the lower microwave bands (10 GHz and down) where ducting propagation allows signals to travel well beyond the visual horizon - it has been found that 78 GHz signals do NOT travel well in an "Over the Horizon" scenario due to very high path losses. This means we need high vantage points that can "see" beyond the normal visual horizon. Another factor is the Relative Humidity. Again, 78 GHz signals are degraded by high atmospheric losses due to high humidity whereas 10 GHz and down often benefit from periods of warm conditions with high humidity.

Now you may think it would be easy to find longish LOS Paths in VK. Unfortunately, we've found that is not the case. Our terrain in VK may have quite a few high mountain ranges. However, we found that many of these Ranges tend to block each other from "seeing" distant vantage points. And then there are the ever present obstructive trees that block our views and the locked gates and Walking Tracks Only ... that deny us vehicular access to many desirable summits.

After many hours of poring over the maps of VK3 looking for clear unobstructed path profiles, we finally settled on the popular tourism site at the Mt Dandenong Observatory. This site provides excellent views to successively longer LOS paths west towards Ballarat. David would operate from this site but unfortunately he would also endure the questions from many "visitors" that frequent this popular lookout - a small price to pay for such a prominent location I guess?

Another part of our planning for the longer non-visible paths (due smoke haze etc.) was to use 10 GHz as both FM Liaison and as an indicator of the bearing we needed for "pointing" the 78 GHz Dish. The 300mm Dishes used have circa 45 dBi Gain, so dish pointing and alignment accuracy is absolutely critical due to the extremely narrow beamwidth.

Figure 1 – 10GHz dish "pointing" the way for 78 GHz

Unfortunately, we failed to acknowledge our past experiences in this plan. On 10 GHz, there are usually numerous signal reflections from many different directions over circa 100 km paths. This caused us some confusion and much frustration with our pointing efforts. It was especially problematic over the longer (for 78 GHz) paths. Even though I had modified my 10 GHz transverter to deliver a mere 1 milliwatt… my signals at David's site were still crushingly strong. I still had to "off point" my dish to achieve a noisy FM signal at David's end for him to optimise on. i.e. adjust his pointing for best FM quietening ! Next time we will use 24 GHz for this function because this band is very much more LOS and not so susceptible to reflections.

And so on a fine sunny May 13th, I drove to my first spot west of Melbourne near Mt Cottrell, south of Rockbank. This 64-kilometre path has a stunning view of the Melbourne CBD with the Dandenong Ranges easily visible beyond. The 10 GHz liaison was not necessary due the visual we had but we set up regardless to test our gear.

Figure 2 – Set up at Rockbank

On 78 GHz we immediately “found” each other and after minor dish pointing tweaks, we achieved 57/58 Reports on SSB. A “bare mixer” attempt yielded weak SSB signals - not quite loud enough to complete a QSO. So we then set up for WSJT on JT65C. A “bare mixer” Digital QSO was quickly completed with reports of -14 dB both ways. There was no real point repeating this QSO with the LNA/PA combo activated. So, 2 new 78 GHz Records over this 64 km path were achieved.

I then relocated further west to a spot on the Pentland Hills Rd near Myrniong. The Dandenong Ranges were visible but hazy over this LOS path of circa 90 km. At 1315 hrs (local) we completed our SSB QSO with 53/52 Reports. We then quickly completed the Digital QSO. This time, the LNA/PA in circuit yielded very loud signals with some noticeable QSB. So, another 2 Distance Records were set/extended.

The next spot we had identified as a “possible” was near Gordon. However, on arriving I found it was not as good as hoped so I continued on towards Mt Buninyong, south of Ballarat. A geographic embarrassment meant I drove to the nearer Mt Warrenheip instead of Mt Buninyong. After a quick drive to the more southerly Mt Buninyong, I set up on the Tourist road that runs along the eastern rim of the Mount.

At circa 1515 hrs, I had a beautiful clear view to the horizon between the gaps in the large trees. The Mt Dandenong Ranges, 127 km to the east, were not visible to me so using the 10 GHz liaison hardware we quickly had our bearings sorted.

Figure 3 – View from Mt Buninyong

We had expected the SSB signals to be much weaker over this longer Path so for this QSO we decided to use the benefits of WSJT’s “weak signal” capabilities to “find” and optimise the dish pointing. To achieve this, we each in turn radiated the 1270 Hertz Sync Tone and adjusted the dishes for the strongest visible signals. We quickly completed an easily audible -8 dB WSJT QSO. Our SSB QSO was as expected fairly weak but quite readable at 51 both ways.

So, at the end of this very productive day, we had set/extended the VK 78 GHz SSB and Digital Records 3 times out to a maximum Path of some 127 km !!

But wait – there’s more !!!

Over the previous couple of weeks, I had been in discussions with various people seeking access to the Mt William summit. A day earlier, this access was finally granted and so we immediately planned for a longer shot from Mt William to a site near Colac.

On May 15th, with a warm, bright and sunny sky and high-ish Humidity… the type of conditions that are not ideal for 78 GHz propagation... we achieved our longest distance yet of 139.8 km - firstly on Digital WSJT/JT65C with -10/-12 Reports. After refining our dish pointing, we then completed on SSB with marginal 4+1 Reports both ways.

Figure 4 – Mt William

With better more appropriate weather conditions, we believe there are still possibilities for extending these distance records even further. We just need the right conditions !

The time and effort in completing these record-setting QSO's on 78 GHz was significant. But… that's what Amateur Radio is all about. Reward for effort !

We are very happy with our achievements although it came at a personal cost when a wheel bearing on my 4X4 failed on the drive back from Halls Gap - 200 km from home. I had to leave the Toyota at a Service Station in Beaufort, Victoria. Local repairs were scheduled for a few days hence and then I had to get the missus to drive two and a half hours to pick me up. But... that is another story !

Thank you, Alan – VK3XPD.

Please send any Weak Signal reports to David VK3HZ

Digital DX Modes

Rex Moncur – VK7MO

WSPR - Part 2: Critical Requirements by Leigh Rainbird VK2KRR

Frequency stability and accuracy, followed by an accurate computer time clock are probably the biggest areas of concern for being successful with WSPR on bands above HF.

Most people are pretty disappointed to find out their brand new commercially purchased top of the line rig in many cases is not sufficiently stable or accurate enough to run successfully with WSPR on 2m and above. In most cases they are OK on 50 MHz, but at 144 MHz and over their frequency trace comes up with what we tend to refer to as a 'banana', as this is what the trace ends up looking like on the

waterfall display rather than a dead straight line. The oscillator will usually drift as the radio heats up during the transmission and perhaps a cooling fan will then switch on midway through and begin to cool the radio which can make it drift back the opposite direction, which is what can cause the banana trace. Keep in mind the maximum drift the program can usually cope with is about 4 Hz over 2 minutes.

Some radios do have a high stability crystal option. In some cases this will work, and in others it won't be enough to keep the radio stable on transmit. You can only try it and see. I and a few others have found that the CR293 hi-stab crystal for the IC910H does work but usually anything above about 10 watts Tx power may still see it drift excessively.

If you find your rig is not stable enough for transmissions, in most cases it will be OK for reception reports. One option within WSPR is to set your station to receive only mode and you can upload any reports of signals that your station hears. This is also applicable to Foundation licence stations and SWL stations who are not licensed to transmit digital modes, but can provide reception reports. I will touch on this in a following issue.

While having a high stability crystal is good, what WSPR also needs is accuracy, to be within the 200 Hz bandwidth that WSPR searches for a signal. Now 200 Hz is not much of a block of frequencies to be within and many people find they will need to tune the rig away from the 144.489 dial frequency to get their rig within the 200 Hz. The best way to know if you're on the right frequency is to find a station whose rig is locked to a highly accurate reference signal, such as a GPS or Rubidium 10 MHz reference.

If you can get hold of a GPS unit that will provide a 10 MHz reference signal output then all your worries of drifty signals are possibly over. Thanks to the Australian designed and produced XRef Precision Frequency Reference circuit boards. Developed jointly by Graham VK3XDK and David VK3HZ, the XRef series of boards take a 10 MHz reference signal from a GPS reference or other high accuracy source and generates a precision reference frequency. The XRef replaces the internal reference in a range of Amateur Radio Transceivers. This eliminates the problem of your radio being off frequency and drifting as it warms up. You can find out more info about the XRef here - http://www.vk3hz.net/XRef/XRef_Home.html

Installing the XRef in your radio will give you NO frequency drift noticeable by the WSPR program, probably right up to the 10 GHz band, though I have never tested it that far up yet. This will in turn make both Tx and Rx reports much easier at each end of the path. I find it can give a better signal to noise report and faster decode rates because the program does not have to think so long when compared with trying to cope with a drifting signal.

Aside from the stability the XRef can provide, the extreme accuracy is the other bonus. You will notice if you observe two or more stations on 2m WSPR who have GPS locked rigs, that the reported frequency of each decode never changes (unless there is a decoded aircraft Doppler shifted signal), where as with most standard rigs it will move around nearly each decode. GPS locked stations are always on the correct frequency.

If your rig is not GPS locked, there are two ways you can tune up your rig via an existing GPS locked station. The first is by using the GPS locked station's transmitted signal, once you know their actual selected transmit frequency within the program. For example, Andy VK5LA uses 144.490515 MHz. Using waterfall programs such as Spectrum Lab, you can get your rig spot on the correct WSPR dial frequency by tuning your VFO so that Andy's signal appears on Spectrum Lab on the 1515 Hz marker. Your rig will then be spot on and you should decode VK5LA at 144.490515.

The other slightly more difficult way is to send a WSPR transmission to VK5LA. The tricky part is, for this to work you need to get your rig within the 200 Hz WSPR bandwidth initially. If you're in there, you may find Andy is decoding you at 144.490460. If you have chosen to TX on that particular frequency, then you have no problems, but if you find the reported signal from Andy is slightly higher or lower then you can tune your VFO to correct this and you should find you will be pretty close.

More information about GPS locked stations on WSPR can be found on the VK Logger Forums.

As for getting your timing right, don't let your computer do it itself, its never accurate enough. Remember that you really need timing accurate to within about 2 seconds of all other stations. Your best bet is to use a dedicated program that you can install on your computer, which will keep the timing in spec for you (assuming it's connected to the Internet). Probably the most widely used program is called Dimension 4. This is a free download, search for it on Google. Point it to sync with your closest local time server. You can also adjust how often the program re-syncs with the server. Mine is set to re-sync every 15 mins. This appears sufficient to keep everything running smoothly.

If you can overcome the stability, accuracy and timing hurdles, thrown up by VHF and UHF, then you shouldn't have much else to worry about and it's time to start sending out some signals and uploading reception reports and watching the propagation unfold. Next month I'll outline a little more about using the WSPR software itself.

Please send any Digital DX Modes reports to Rex VK7MO

Meteor Scatter

Dr Kevin Johnston – VK4UH

May brought not one but two major astronomical events which produced significant enhancement to VK-ZL meteor scatter activity.

The first was the much anticipated Eta Aquarid Meteor Shower, which was predicted to peak around 5-6 May. This annual event occurs as the orbit of the earth around the Sun takes us through large tracts of debris left behind from the path of Halley's Comet. Although the comet itself has long passed the debris clouds persist in the solar system and we pass through them on the same dates every year. The gravitation field of the Earth, as it approaches these clouds, accelerates the dust particles into our own atmosphere. Reaching enormous velocities the majority of these dust particles 'burn up" in the outer atmosphere at about 100 km above the earth, roughly the same altitude as the E layer. The ionised trails occurring as the comet debris is vaporised lead to the visual meteor trails, the shooting stars, and also the radio equivalent being the cause of the meteor reflections. Meteor showers are named after the star constellation where they "appear" to originate in the sky although the true source is within our own orbit of the solar system. Eta is the principle star in the Constellation of Aquarius.

Unfortunately for me, for the third consecutive year, professional commitments took me away from home and I missed the peak of the event again. The Eta Aquarids shower however is known to be a very wide and there was already enhancement of background random meteor activity apparent as early as 26th April. Recognising increased MS propagation on 144 MHz FSK441 on 2nd May a series of attempts were made between this QTH in QG62 and Arie VK3AMZ in QF22 on 70 cm FSK441. Although no contacts were completed we both received some partial decodes from a few hyper-short pings. Interestingly Peter VK5PJ (PF95) received a

full decode from me even though he was off the side of my beam.

As I was away I took the liberty of asking some of the regular MS stations for their experiences and results during the 2014 Eta Aquarid shower:

Arie VK3AMZ reported: *With much expectation the Eta Aquarids (ETA) meteor shower returned again this year. It was predicted to peak on the 6th of May. The shower returned as expected but unfortunately the intensity of the shower was disappointing as compared to last year. Many operators took advantage of the meteor shower but while conditions could be described as above average they had fallen far short of the 2013 shower. I attempted to make contact with a couple of stations (VK4JMC & VK4CZ) on 432 MHz but this resulted in only very short pings detected at each end. I did decode an extremely strong but very short duration ping from VK4CZ on the 4th of May, but even after hours of scheduling no two way contact eventuated. The highest reported ZHR (a figure of merit for the number of visual meteors) was 50 on the 6th of May, the same meteor shower last year recorded a ZHR of 135 on the same date, a considerable difference in shower activity. The next significant meteor shower due is the Southern Delta Aquarids (SDA) which is predicted to peak the 28th of July. This shower was very active last year, hopefully it can make up for a disappointing ETA shower this year?*

Adrian VK4OX reported: *I was only interested in making 2 way SSB QSO's on 144 MHz. I felt the Eta Aquarids was well below average this year. It seemed to peak on the mornings of the 6th May and 7th May, but they were working days for most operators so I made few 2 way QSO's. I do remember chatting to Arie and others on iChat and commenting that the shower was "no better than random background" for most of the time. To sum up the 2014 Eta Aquarids MS shower in one word... "Disappointing".*

John VK4JMC reported: *The Aquarids were quite active but I was unable to secure a ZL contact.*

Peter VK5PJ (PF95) sent log extracts and reported: *It's only my second year operating Meteor Scatter SSB for this shower and I had grand plans of camping in the shack for the entire week. I borrowed a friend's camp stretcher and had that ready to go. Stocked up the coffee and sugar supplied in readiness but I gave in to the comfort and warmth of my own bed.*

I had grand plans of a trip to VK8 to operate from the corner border with VK4 / VK5 / VK8 but after realising the cost to get my humble 4WD ready for such a trip, I put that one on hold. Plans have now changed to a trip to the VK5 / VK8 border at some time to point south and east. Impressions of this year - not as exciting as last year and nowhere near the same number of OP's on. As Adrian VK4OX said to me, it takes a special sort of operator to sit and wait for the right meteor to make a very rushed contact and then wait for it all over again. Stations do not need great power levels or antenna gains. Last year I ran with a bog stock IC-275H (70W I would guess). This year a CH5A PA helped me achieve 350W out on SSB. Peter successfully contacted Adrian VK4OX (QG63) and Mark VK2EMA (QF37) on 144 MHz on numerous occasions during that period.

Ross VK2DVZ (QF68) reported: *Nothing to report from my end. I was not operating during the Aquarids period. In fact I have only 2 on-air contacts logged for May, being the 9th and 16th - both were FSK441 contacts with Bob ZL3TY. My operating opportunities have been very poor of late with only 7 contacts made during the past 7 weeks. I did work Arie VK3AMZ on 29/3, 5/4 and 26/4 all on FSK.*

Gavin VK3HY (QF22) forwarded an extract from his log and reported: *My log for the period records the following Eta Aquarids shower 144MHz meteor scatter contacts: 2 May VK4KSY (FSK441), 3 May VK4JMC, VK2AMS, VK2XN (FSK441). 4 May*

VK2XN (FSK441) VK4OX (SSB). 5 May VK4JMC (FSK441) VK4OX (SSB).

Conditions were certainly down on last year but I am sure that many more contacts could have been made had there been more stations involved. It's interesting to contrast the relative ease of making M/S contacts now compared to my first Eta Aquarids contact with Adrian (then VK2FZ/4) back in 1997. It was hard work then and involved calling and listening during alternate 5-second periods for hours until a contact was completed. These days WSJT modes, liaison via the VK Logger, and reliable beacons make things so much easier. It would be nice to have more M/S activity. 50 to 100 watts, a small Yagi and a little bit of planning is all that's required to make FSK contacts at any time and SSB contacts are a cinch when there is meteor shower activity such as Eta Aquarids.

Mark VK2AMS reported: *During the Aquarid shower there was overall improvement in the speed on completions using FSK441 with Peter VK5PJ and Arie VK3AMZ particularly on the 4th May. As usual Arie VK3AMZ has a very good signal to me with most frames showing a decode and similar with Peter. Gavin VK3HY is also well represented. It was pleasing to work Kevin VK4UH and Ian VK3AXH on the 13 April for a new grid. Managed to work Bob ZL3TY on 11 May although due to my geographical position I have a large hill in the way when beaming toward ZL so it can take a hour to complete. I find the digital modes a most enjoyable facet of AR*.

So the overall consensus appears to be that the 2014 Eta Aquarid shower was disappointing compared to previous years.

The second astronomical event was a significant Meteor shower associated with the passage of Comet 209 LINEAR which peaked around 23 May. This comet was only discovered in 2004. It passed around 8 million km from Earth at its closed point and is thought to be 2 km in diameter. It has passed through our solar system twice since 2004. The comet produced spectacular meteor showers in the northern Hemisphere even being reported in the popular media. Peter VK5PJ alerted the VK-ZL community to the possibility of significant MS enhancement over the weekend of 16-17 May in a posting on the VKlogger.

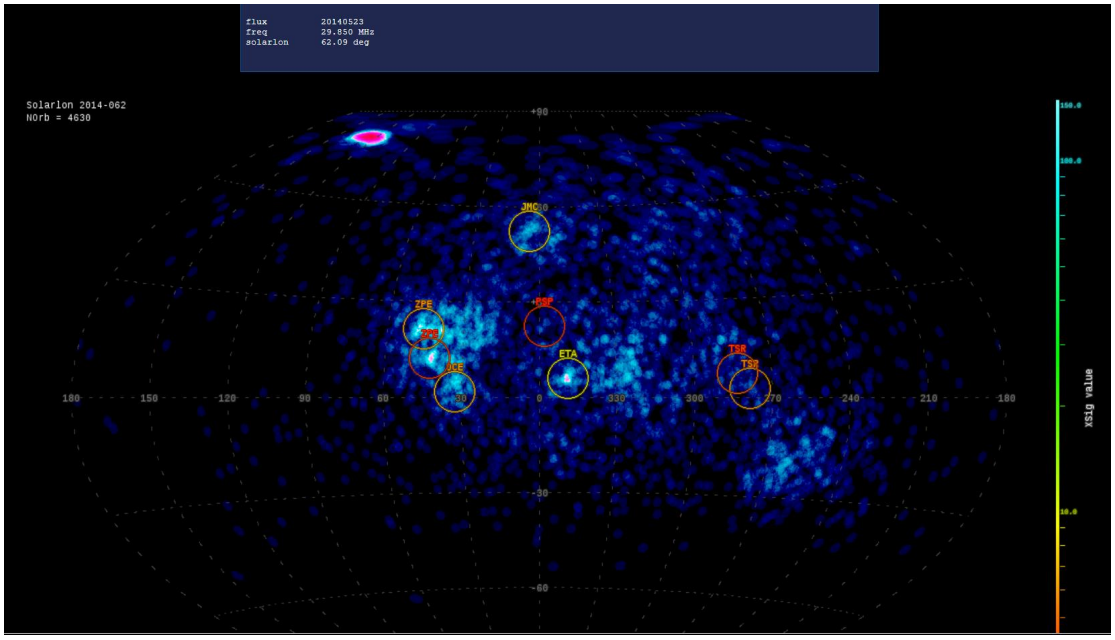

Figure 1 – Canadian Meteor Radar Plot

The bright red spot in the 11 o'clock position in Fig. 1 on this radar plot from CMOR (Canadian Meteor radar) indicates the intensity of meteor activity from the Linear

p209 shower on 24 May 2014. The remnant of the Eta Aquarid shower (ETA) can be seen in the centre of the plot for comparison. During this period FSK441 and or JTMS meteor scatter contacts on 144 MHz were completed from here with VK3AMZ, VK1WJ, VK3HY, VK5PJ, VK1KW and VK3KH - some on multiple occasions.

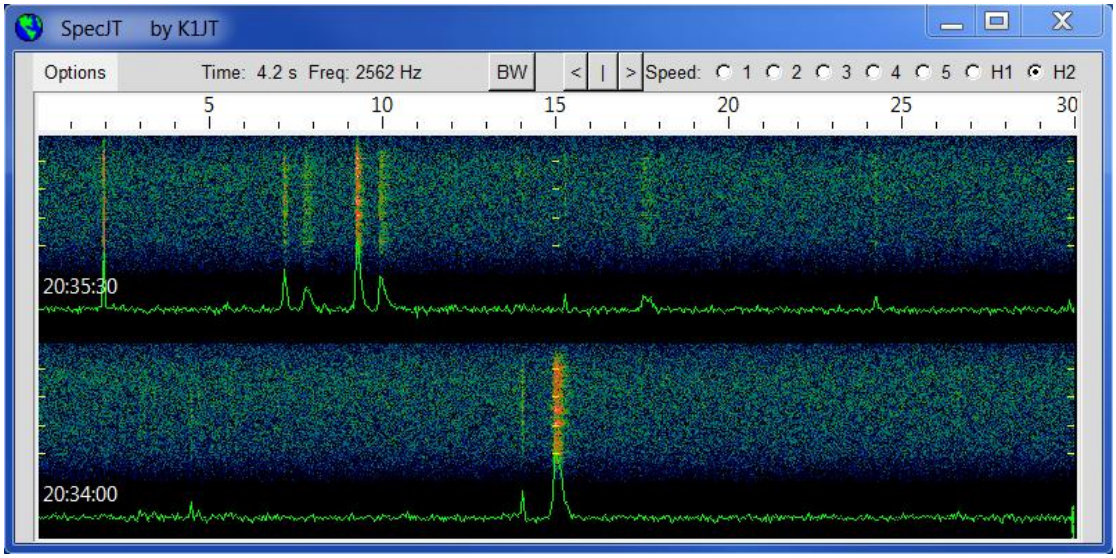

Figure 2 – WSJT SpecJT Window

Frequently 8 or more pings were visible in each thirty-second sweep period in FSK441 as in Fig. 2., captured on 24 May. The upper trace shows 10 separate pings, with the eye of faith, with clear decodes of four different stations, in the same sweep.

Next month I intend to include information regarding a number of on-line aids and applications for iphones and portable devices which may be useful for predicting and observing meteor shower activity.

Please send any reports, questions or enquiries about Meteor Scatter in general or the digital modes used to Kevin VK4UH