TECHNIQUES FOR USING THE RTL 2841UHIDIR Dongle with SDR # and SPECTRUM LAB for the DETECTION OF METEORS

1 Introduction

Original work in the UK using SDR dongles and the Graves Radar for the detection of meteors used the FunCube Pro[1] and Pro+ devices. Whilst these are very capable they are considerably more expensive than the RTL DVB TV[2] dongles that are also currently available. There has been interest in the 'amateur meteor radar' community in using these cheaper devices. The FunCube Pro dongles have been used with Spectrum Lab software to analyse and present the meteor echo data. It is believed that there is currently no Windows driver that enables Spectrum Lab to connect directly to the RTL2841 device. There is therefore a need to find a' work around' technique that enables Spectrum Lab to access the RTL dongle data that does not require a dedicated Windows driver. It may also be possible to use a piece of software called "VBCABLEDriver_Pack42b" [3] but this is not investigated further in this note.

A possible technique is presented that requires no additional hardware or software and can probably be implemented on Windows XP and Windows 7 using a variety of sound cards.

It will be assumed that the reader has some familiarity with the operation of SDR# [4] and Spectrum Lab [5] software and a working knowledge of setting these up for Meteor detection from Graves Radar operating at 143.050MHz [6] [7] [8] [9]

2 General Technique

In this section we will describe the basis for coupling the output stream from SDR# into Spectrum Lab. This will be followed by three specific examples of using this basic technique with the following equipment:

- Windows XP desktop with a Realtek AC97 Soundcard
- Windows 7 laptop with an IDT HD Audio Codec
- Windows 7 Desktop with a Realtek HD Soundcard

The basic technique involves the configuration of the sound card audio streaming options to enable the data from the SDR# output stream to be fed to the input of Spectrum Lab using an existing sound card driver that Spectrum Lab recognises. In some cases this may require an audio cable to be used where the sound card software cannot 'cross connect' the audio streams.

The basic process is shown in the diagram in Figure 1.

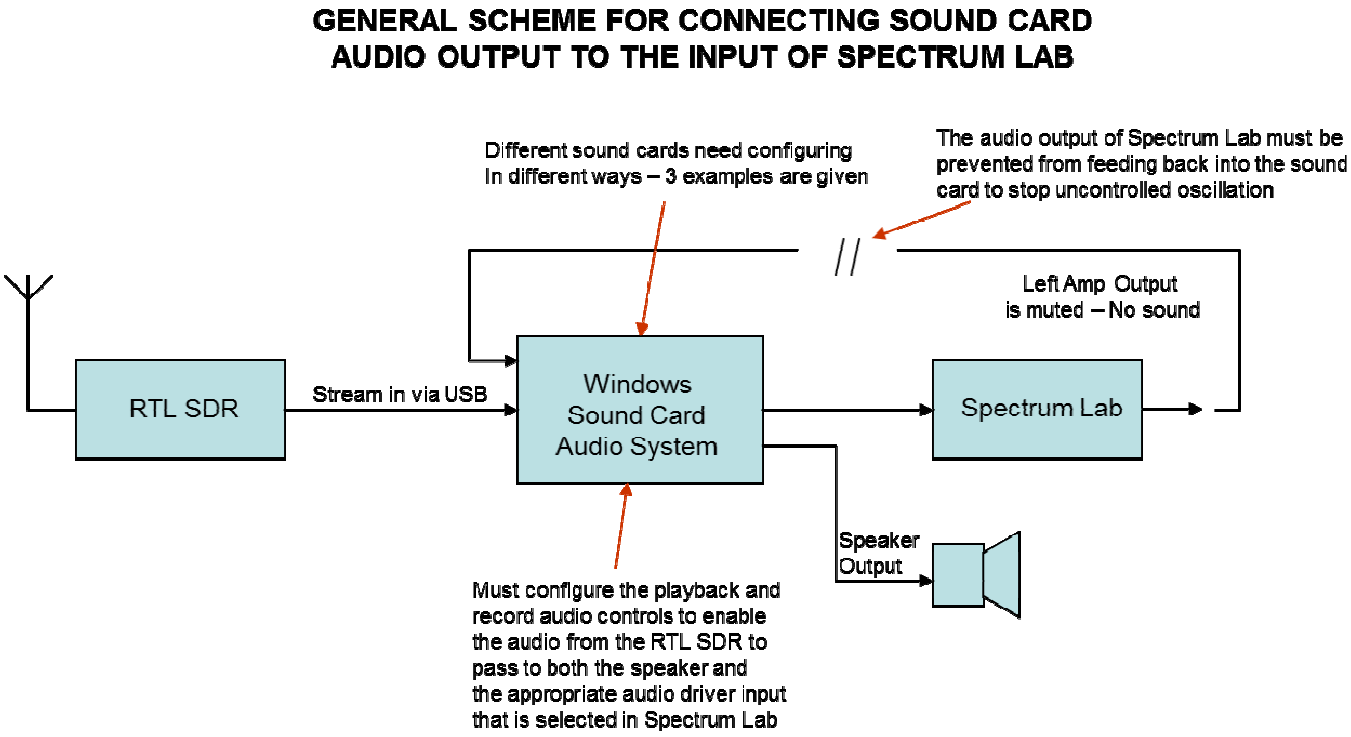

Figure 1 Basic Technique

In order for this technique to work, the audio output stream from Spectrum Lab must be disabled or this will cause significant feedback into the sound card and the whole system will become unstable and oscillate. The output can be disabled by setting the Spectrum Lab left channel audio output amplifiers to minimal gain (-100dB). See Figure 2. This assumes that Spectrum Lab is only processing a mono signal via the left channel.

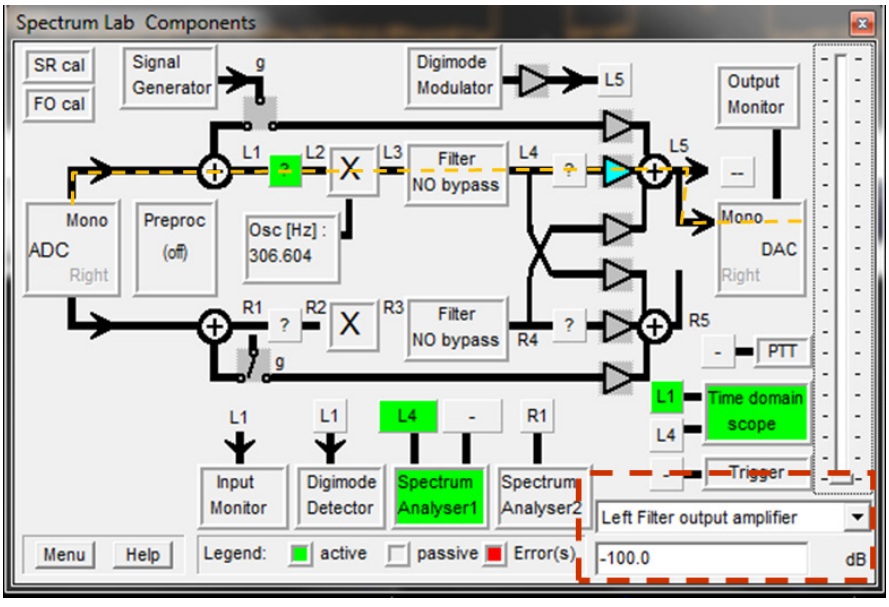

Figure 2 Spectrum Lab output is 'turned off'

Each sound card may have different software capabilities and controls - some have a feature called Mono Mix or Stereo Mix. See Figure 3.

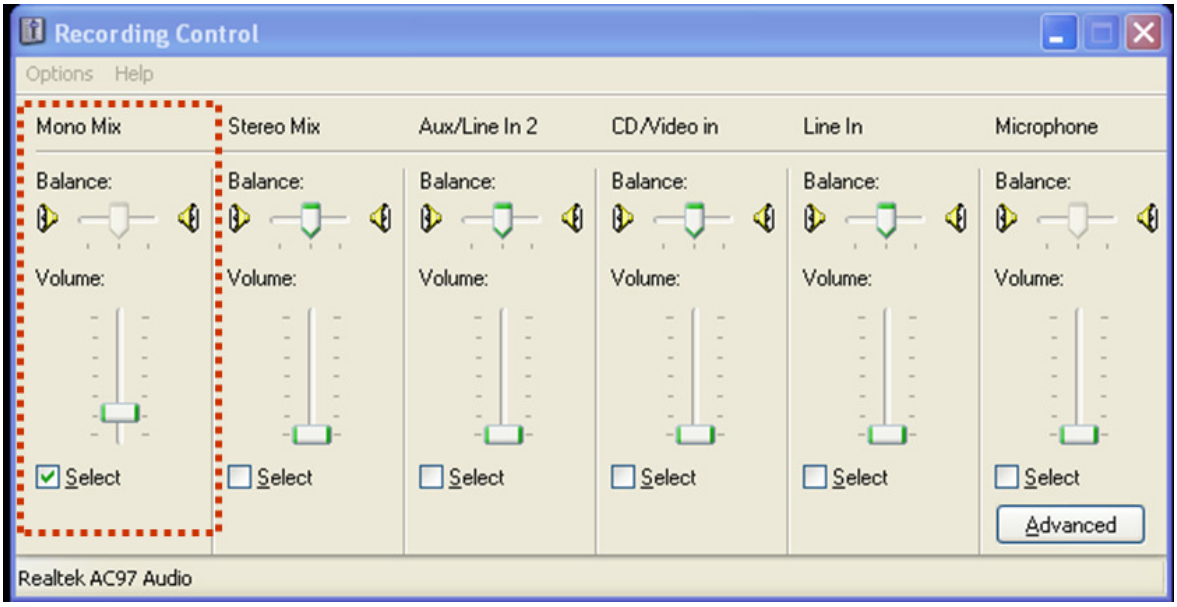

Figure 3 Typical Sound Card Mixing Controls

These can be used to cross feed the SDR# audio stream into Spectrum Lab once the appropriate input driver is selected – as shown in Figure 4.

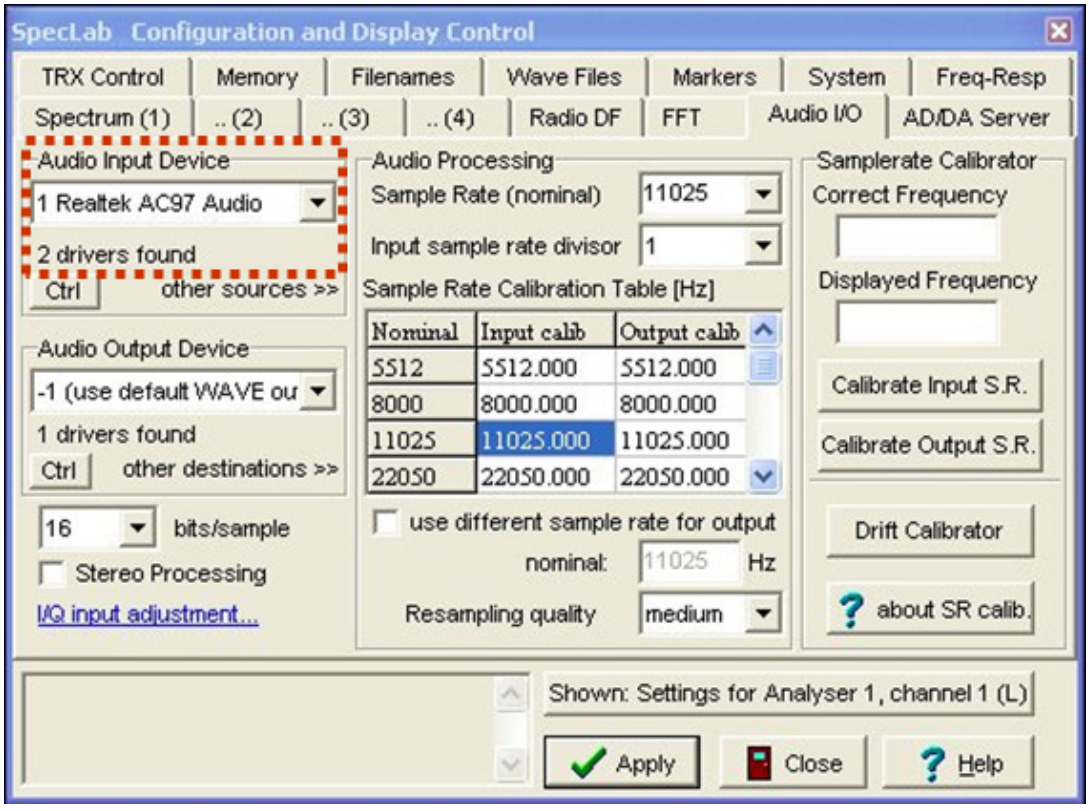

Figure 4 Selecting the appropriate input driver in Spectrum Lab

3 Example 1 Windows XP Desktop with Realtek AC97 Soundcard

This is the simplest implementation of the technique as we can use the Mono Mix function available with this sound card.
The procedure is as follows:

1 Set sound card master output to max output level
2 Select wave output level to about 50% - See Figure 5

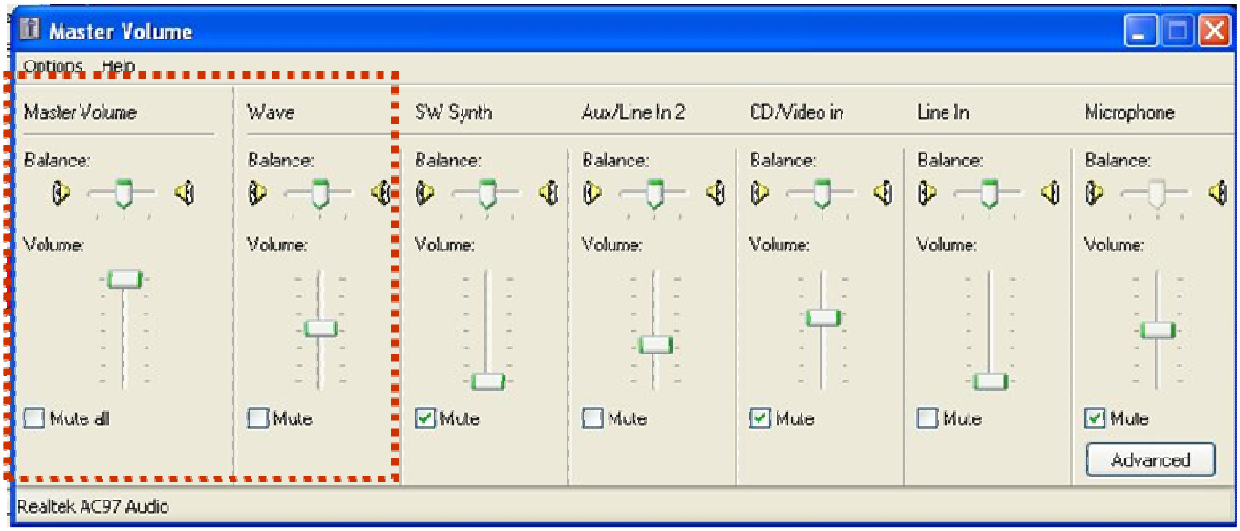

Figure 5 Realtek AC97 Output Configuration

3 Set the sound card recording levels as shown in Figure 3
4 Select the Spectrum Lab input driver as shown in Figure 4

The next steps are those you would normally do to configure and run SDR# and Spectrum Lab. (We assume some familiarity with these activities.)

The RTL dongle USB device must be connected and the Zadig [10] driver loaded before running SDR #. The frequency should be set to 143.0495MHz: this provides approximately a 1 kHz offset from the Graves transmitter such that an echo with zero Doppler shift will produce an audio tone at ~ 1kHz when upper sideband demodulation is selected. See Figure 6.

This combination of settings results in an echo with a positive Doppler shift (ie from an approaching meteor returning a frequency > 143.050MHz) to produce a Spectrum Lab frequency profile in the correct sense. Thus an approaching meteor will produce a waterfall trace with a frequency higher than 1 kHz – so frequencies higher than the 'nominal zero velocity return at 1 kHz' will be in an upward direction. See Figure 7.

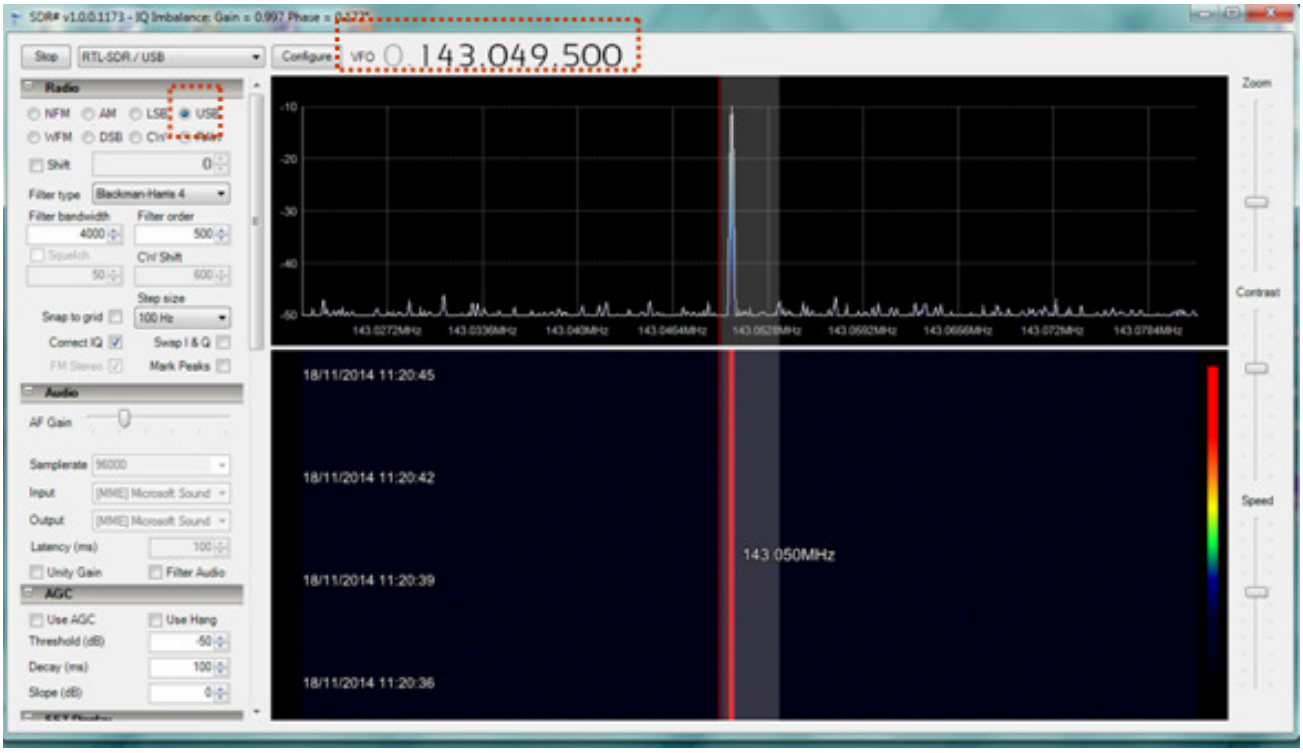

Figure 6 Frequency and Demodulation setting for SDR #

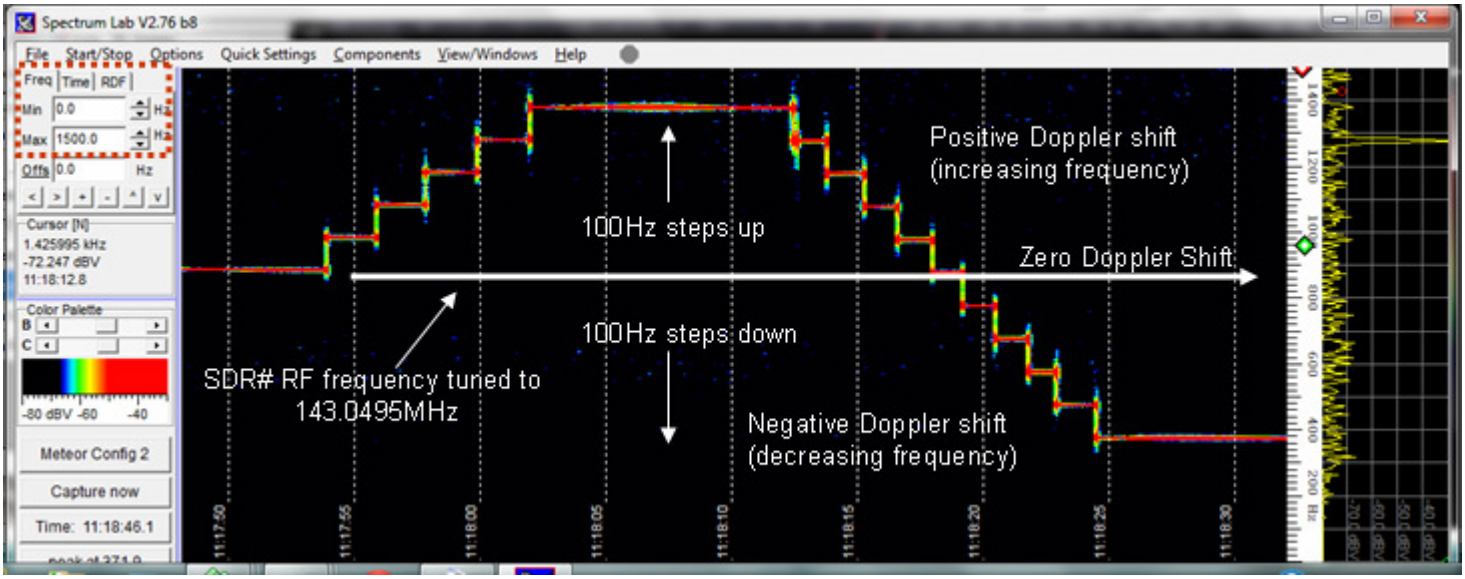

Figure 7 Spectrum Lab Waterfall Display – 'Correct' Doppler display

In this figure the displayed frequency span is 0 to 1.5kHz with the nominal zero Doppler frequency of ~1 kHz. This setting is sufficient to display most echo Doppler characteristics.

4 Example 2 Windows 7 Laptop with IDT HD 'Sound Card'

This example shows that a similar approach can be used with Windows 7. In this case an HP laptop with an IDT HD audio codec was used. The sound card controls were set up as shown in Figure 8 where the Stereo Mix function was used. It is important to remember to null the output of Spectrum Lab left output channel to avoid feedback.

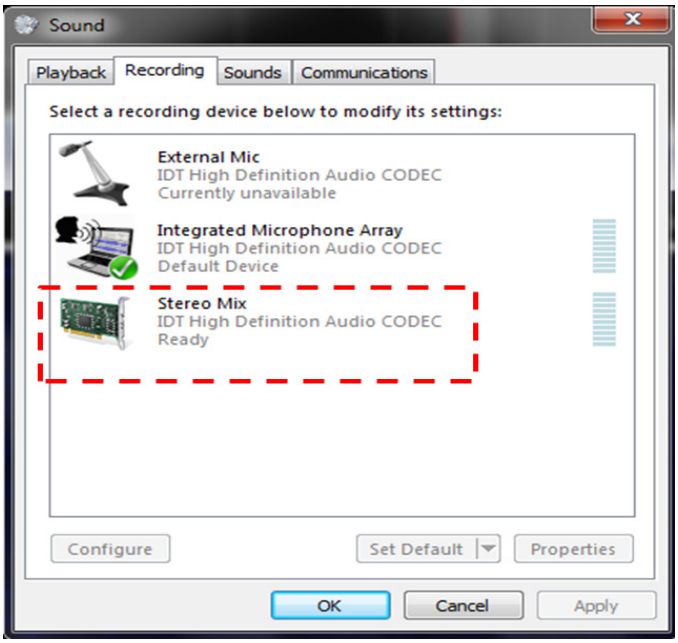

Figure 8 Windows 7 and IDT HD 'Sound card' selection of Stereo Mix function

The Stereo Mix level can be set to a value of around 80% as shown in Figure 9.

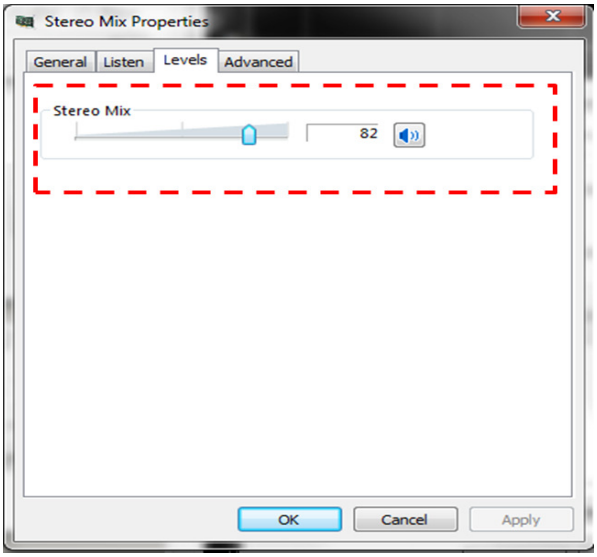

Figure 9 Stereo Mix level set to suitable value

Remember to select the appropriate input driver in Spectrum Lab!

5 Example 3 Windows 7 Desktop with Realtek HD Sound Card

This is the most difficult system to configure as it does not have a Mono or Stereo Mix function and requires the use of an audio cable to cross connect the SDR# output stream to the Spectrum Lab input. With this particular sound card the outputs and inputs are not 'available' until 3.5mm jacks are inserted into the appropriate connecter on the front or rear panel of the computer. Only when the jacks are in place does the 'system' identify the input / output channels and load the appropriate drivers.

Step 1 is therefore to locate the headphone out socket and connect this with the cable to the line input socket. See Figure 10 (This will vary depending on the specific computer and sound card and some experimentation may be required to obtain a suitable cross connection).

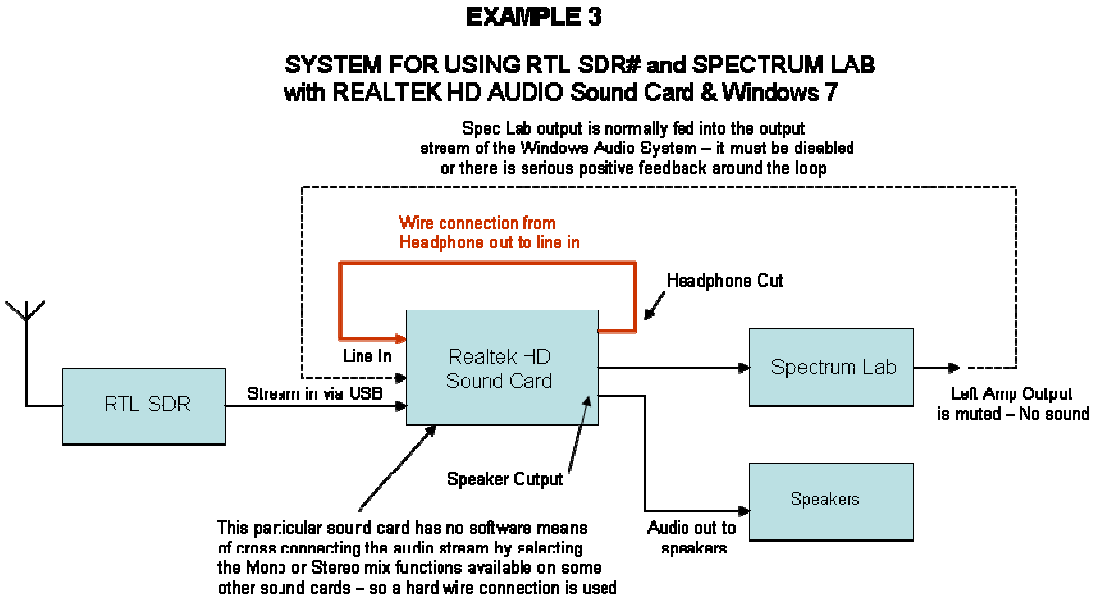

Figure 10 Hardware connection – Headphone to Line input

Figure 11 shows that the speaker and headphone outputs and one line input have been selected.

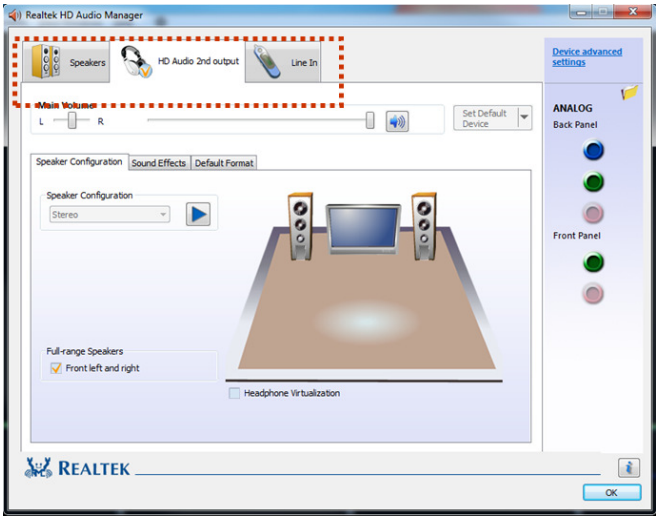

Figure 11 Identification and selection of required input and output channels

When the cable is in place and you have selected the input and outputs required in the sound card dialogue box, the levels should be set as follows:

The Line input tab should be selected and the recording and playback levels set at about 50% as shown in Figure 12.

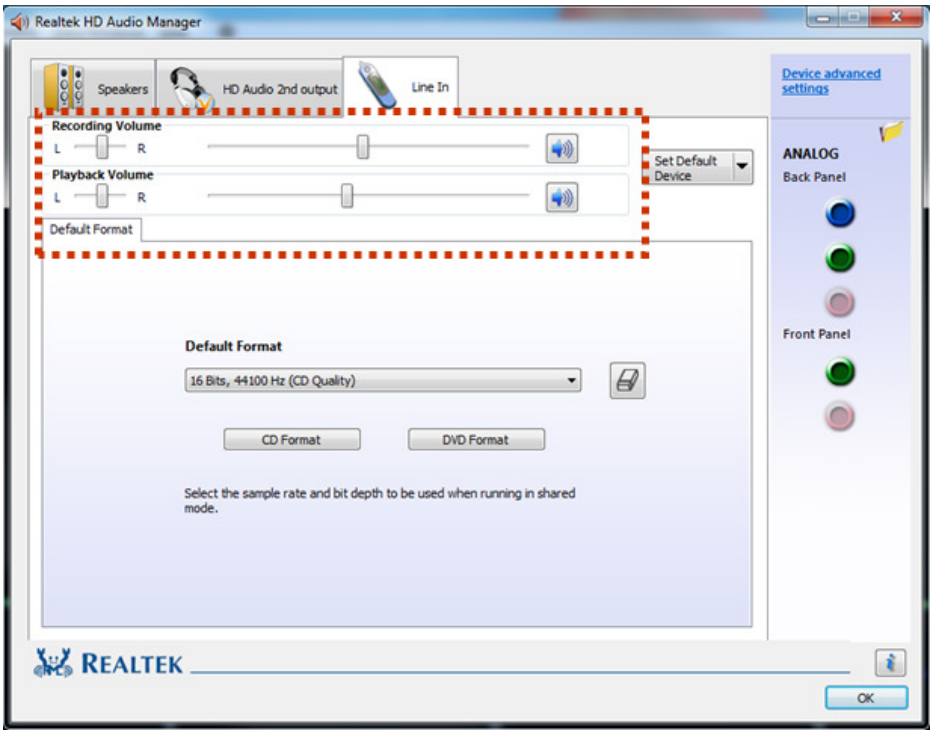

Figure 12 Line in settings

In order for this configuration to work one must access the Device advanced settings dialogue box and select the option shown in Figure 13.

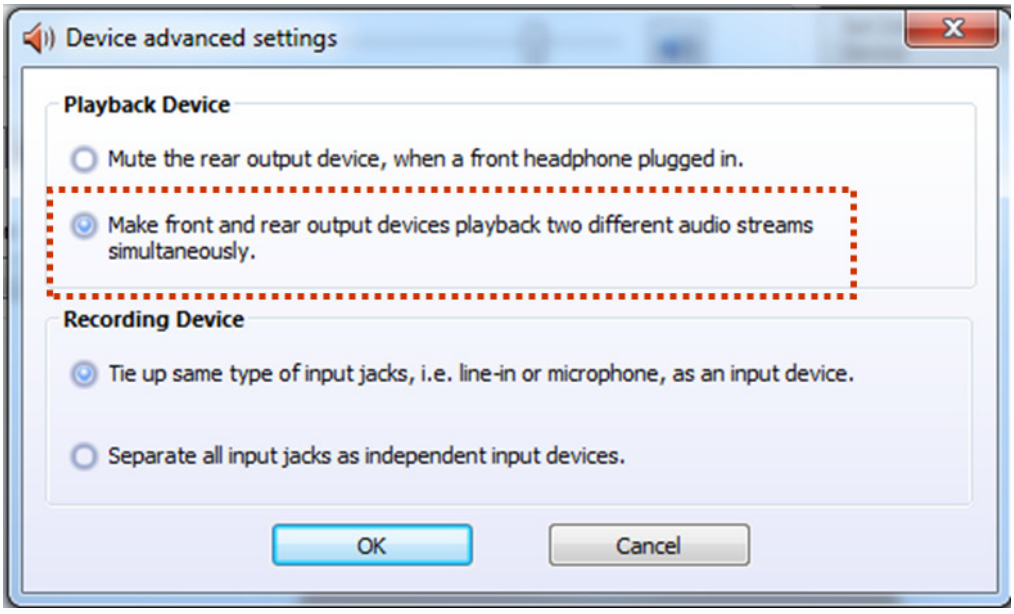

Figure 13 Setting up two simultaneous audio streams

Remember to select the correct input driver in Spectrum Lab as indicated in Figure 14.

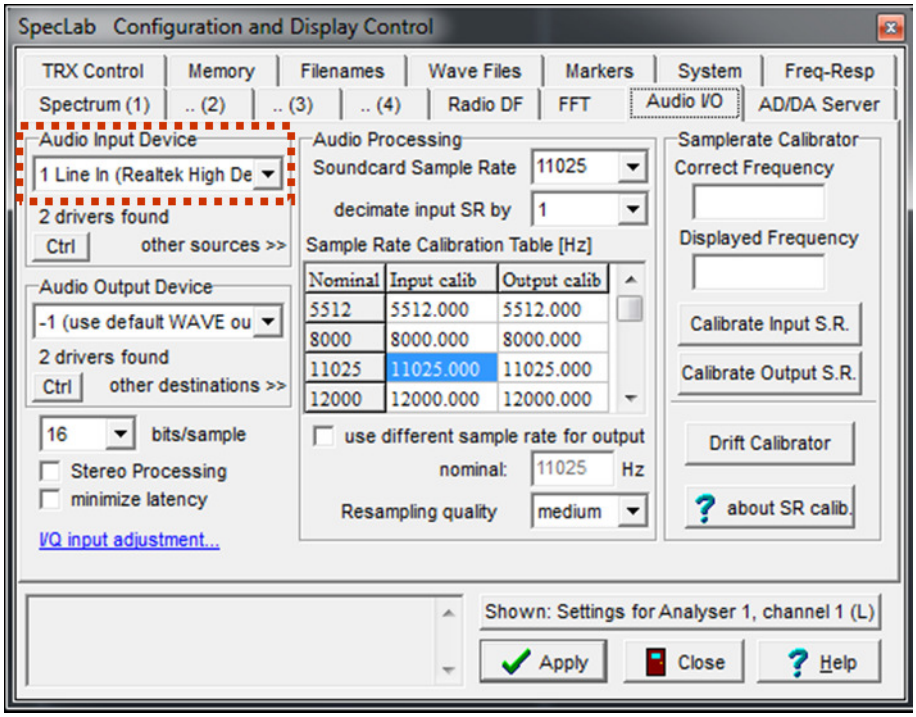

Figure 14 Select appropriate input driver in Spectrum Lab

6 Using this technique with older computers

The use of this technique requires the main processor and video processor to run both SDR# and Spectrum Lab. Both these items require a significant amount of processing power to calculate the signal Fourier Transforms and display them as waterfall plots. In some older computers this may cause the displays to judder and not provide a smooth audio output stream. It is possible to reduce the need for processing resources by slowing down the rates of the waterfall plots in both programs. The problem here is that we need a fairly high rate waterfall plot in Spectrum Lab in order to display the form of the meteor echo. This means that we need to slow down the SDR# waterfall plot as far as we can, as this is not the primary output information.

7 Additional Filtering in Spectrum Lab

The narrow section of the SDR# spectrum (2.5MHz wide) that is selectively displayed by Spectrum Lab for the presentation of Meteor echoes is from 0 to about 1.8kHz. It is possible that the spectrum of the noise floor is not flat due to the USB demodulation response. In this case the Spectrum Lab spectrum and waterfall plot can be corrected by using Spectrum Labs' internal filter function. A 'custom' filter shape can be produced that will correct for the uneven noise floor producing a corrected display of echo signal intensities.

An example of a suitable filter response is shown in Figure 15. The filter response can be set to correct for any uneven noise floor by experimenting with the filter envelope shape tool.

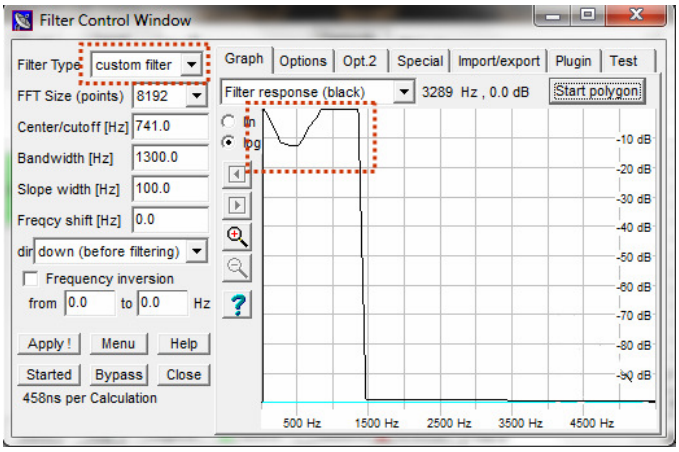

Figure 15 Spectrum Lab Custom Filter set-up

It is of course possible to select the appropriate display windows of SDR# and Spectrum Lab and present them together as shown in Figure 16.

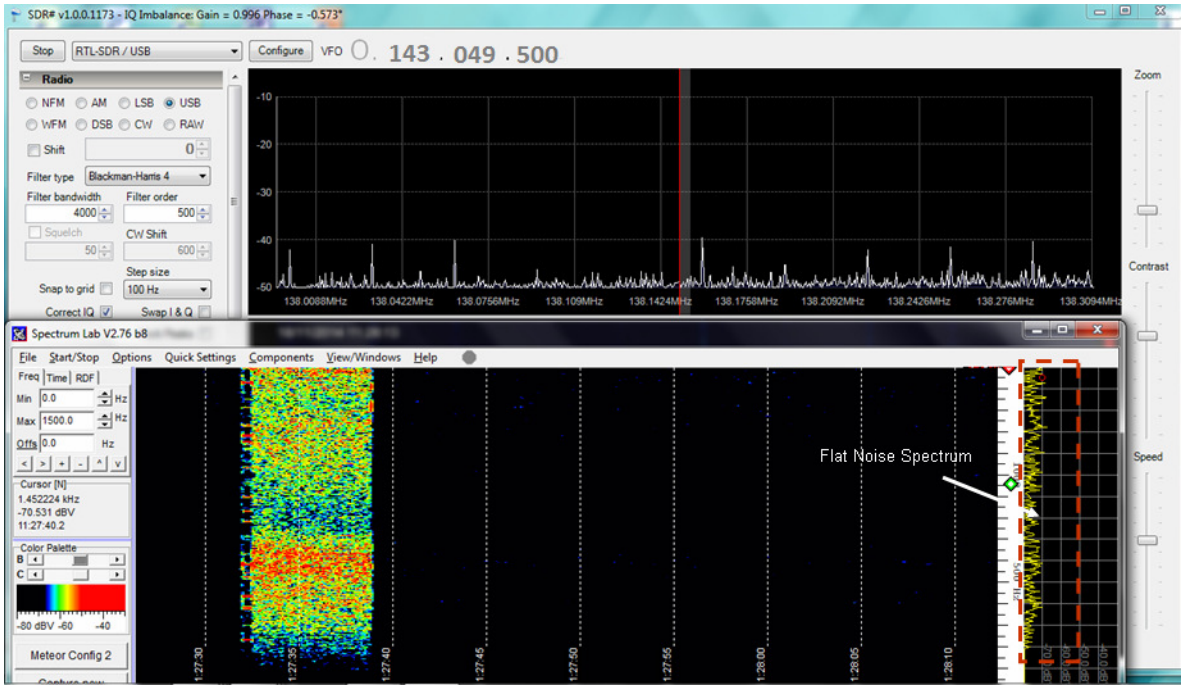

Figure 16 Combined SDR# and Spectrum Lab Display

8 Conclusions

1 It has been shown that it is possible to devise a technique that enables the RTL2841 DVB TV dongle operated through SDR# software to be 'connected' to Spectrum Lab. This enables the analysis and presentation of Meteor Radar echoes from the Graves Radar in the same way as that achieved using the FunCube Dongle with Spectrum Lab.

2 It is recognised that this technique is something of a 'work around' plan that obviates the need for a dedicated RTL driver to be written, that is compatible with Spectrum Lab.

3 The technique appears to work with a variety of sound cards being run on Windows XP and Windows 7.

4 Three worked examples are presented to show in detail how the application software and the Windows sound card options should be configured.

5 It is very important to disable the audio output stream from spectrum lab to avoid uncontrolled feedback through the system which leads to oscillation. This is done by setting the left amplifier output gain to -100dB.

6 SDR# and Spectrum Lab displays can be run in parallel if the computer being used is fast enough. If problems are experienced with older machines the SDR# waterfall plot speed can be reduced – as this is not the main display.

7 Any variation in the flatness of the Spectrum Lab spectrum display and waterfall plot can be corrected by using an appropriate custom designed digital filter. This will ensure a uniform amplitude display of meteor echoes.

References

1	FunCube Dongles	www.funcube.org.uk
2	RTL SDR	http://www.rtl-sdr.com/
3	VB Cable	http://www.d8060.agava.net/archives/file/VBCABLEDriver_Pack42b/9394544.htm
4	SDR Sharp	http://sdrsharp.com/
5	Spectrum Lab	www.qsl.net/dl4yhf/spectra1.htm
6	Meteor Detection	http://www.britastro.org/radio/projects/Detection_of_meteors_by_RADAR.pdf
7	Meteor Detection	http://www.onera.fr/en/dcps/graves
8	Sky at Night Meteor	http://www.britastro.org/radio/downloads.html
9	SDR Meteor Radar	http://www.dmradas.co.uk/new%20files%20dec%202011/RAG%20site%20pdfs/MeteorRadarSDRReceiver.pdf
10	Zadig Driver	http://zadig.akeo.ie/